RESULTS FROM THE DECONTAMINATION OF AND THE SHIELDING ARRANGEMENTS IN THE REACTOR PRESSURE VESSEL IN OSKARSHAMN 1 – 1994

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ABSTRACT

In September 1992 Oskarshamn 1 was shut down in order to carry out measures to correct discovered deficiencies in the emergency cooling systems. Due to the results of a comprehensive non destructive test programme it was decided to perform a major replacement of pipes in the primary systems including a full system decontamination using the Siemens'CORD process. The paper briefly presents the satisfying result of the decontamination performed in May-June 1993. When in late June 1993 cracks also were detected in the feed-water pipes situated inside the reactor pressure vessel (RPV) the plans were reconsidered and a large project was formed with the aim, in a first phase, to verify the integrity of the RPV. In order to make it possible to perform work manually inside the RPV special radiation protection measures had to be carried out. In January 1994 the lower region of the RPV was decontaminated, again using the CORD-process, followed by the installation of a special shielding construction in the RPV. The surprisingly good results of these efforts are also briefly described in the paper.

INTRODUCTION

Oskarshamn 1 is an ABB Atom BWR, 462 MW, in commercial operation since 1972. In September 1992 Oskarshamn 1, together with four other Swedish BWR's of the same design, was shut down in order to carry out measures to correct discovered deficiencies in the emergency cooling systems. One of the measures was to replace most of the insulation in the containment with reflective metallic insulation. Taking the opportunity of having a great number of pipes free from insulation a comprehensive programme of non destructive testing was executed. As a result of these tests, cracks were detected in cold-bended pipes in the shut-down cooling systems. After an inventory of cold-bended pipes in the primary systems and further tests, additionally cracks were found. In April 1993 it was consequently decided to perform a major pipe replacement. In order to save dose to the personnel involved, a decontamination of the affected systems was performed during 4 days in May-June 1993. Siemens' CORD-process, a Chemical Oxidation Reduction Decontamination using permanganic acid and oxalic acid, was used in 3 cycles with an excellent result. A total of 7 kg of metals (70 % Fe) with a total activity of 350 GBq (73 % Co60) were removed and an averaged decontamination factor of 17 was achieved. The collective dose saved has been estimated to 3.1 manSv. However, when in late June 1993, cracks also were found in four of the six feed-water pipes situated inside the reactor pressure vessel (RPV) the situation called for a reconsideration. A large project with the aim of verifying and upgrading Oskarshamn 1 was initiated. In Phase 1 of this project the main task was to test and verify the integrity of the RPV. Most of the tests in the RPV could be performed on distance under water. But the tests and the repair work in the lower parts had to be performed on dry surfaces. As it obviously, to some extent, was a need for manual work in the lower region of the RPV, special radiation protection measures had to be considered. A plan including decontamination- and shielding procedures was presented. Calculations showed that it might be possible to perform at least certain jobs on the spot.

DECONTAMINATION OF THE RPV

After studies and investigations it was decided - with approval from the authorities - to perform a decontamination using - again - the CORD-process. Though the very short time available for the preparing of the decontamination it was carried out on the scheduled time in January 1994. The fuel and all the RPV-internals were removed from the RPV. To be able to store the RPV-internals under water in the reactor pool an extension was connected to the RPV.

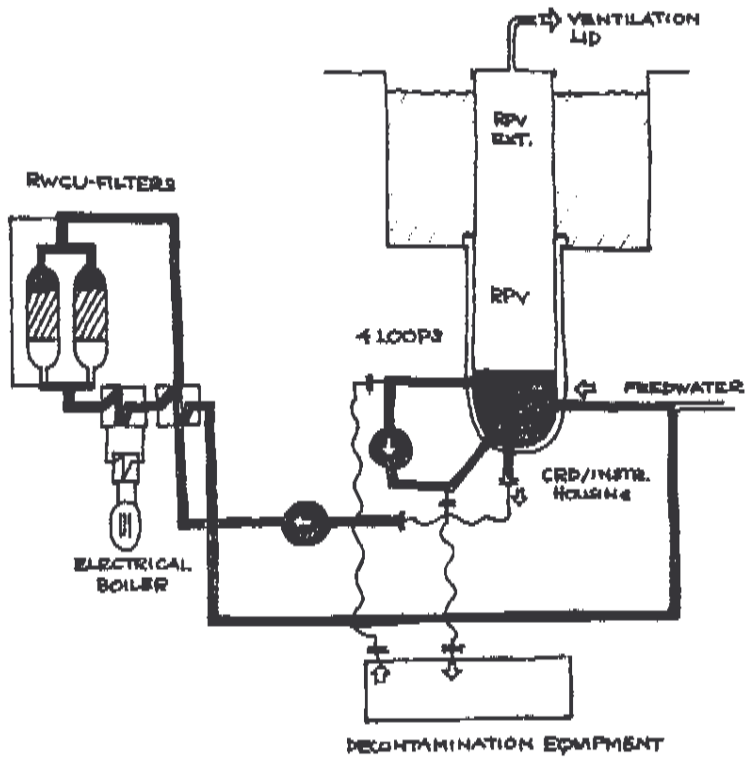

Fig 1. Schematic view of the decontaminated systems (in black)

The RPV was filled with decontamination liquid up to a level 1 m up in the core region. The RPV was covered by a ventilated lid. The main recirculation pumps were used to circulate the decontamination liquids in the RPV and they were heated by means of an existing 5 MW electrical boiler. The ion exchange columns in the reactor water clean-up system were used for taking care of the dissolved cations and activity. A total area of 1 350 m^2 was treated of which approximately 900 m^2 already had been decontaminated in June 1993. The total volume of the affected systems was 156 m^3. The decontamination was performed in four cycles, approximately 30 hours each. In all the operation took 8 days. The result of the decontamination was excellent: 27 kg metals (62 % Fe) and 2,3 TBq (93 % Co60) were removed. According to calculations it corresponded to a removal of 99,88 % of the activity. The waste volume produced was 3,7 m^3 ion exchange resins. After the chemical decontamination the RPV was finally flushed with water at high pressure (< 500 bar).

THE SHIELDING ARRANGEMENTS IN THE RPV

The shielding equipment was then installed. This equipment consists of 5-10 cm thick circular iron walls shielding the inside of the RPV from the top to 2,5 m above the RPV-bottom and a 5 cm thick iron floor placed just above the control rod housing.

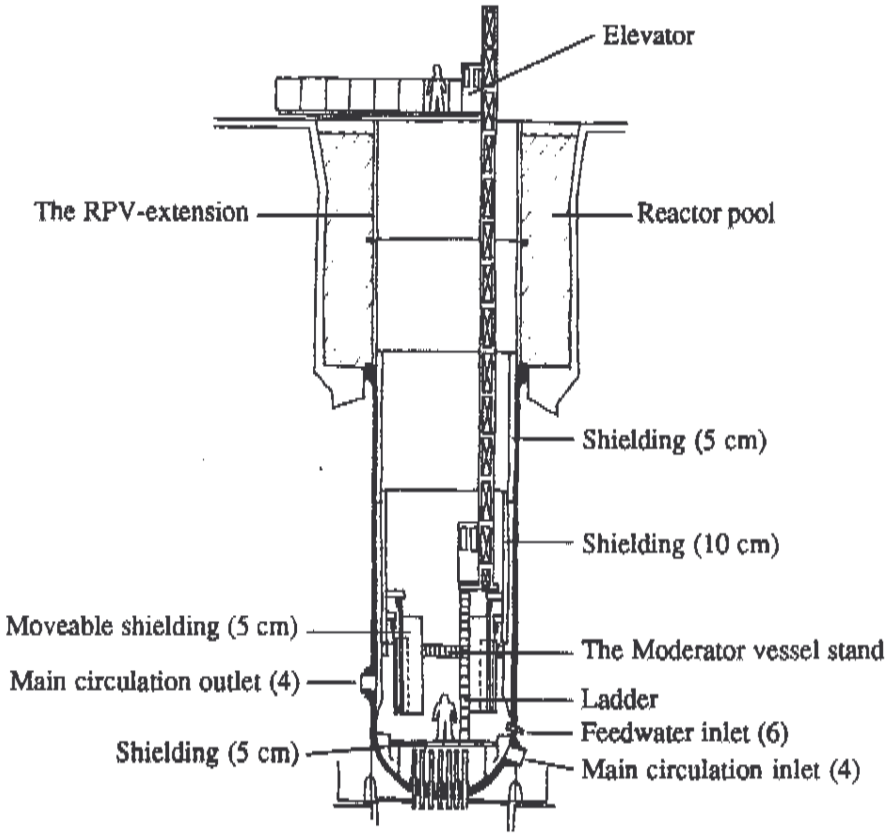

Fig 2. RPV-shielding arrangements

The surface doserate in the core region without shielding was 120 mSv/h and with the shielding 5 mSv/h. The doserate measured on the surface of the RPV underneath the shielding floor was 15-20 μSv/h which indicates a decontamination factor of approximately 200. The lower part of the shielding walls consists of moveable parts for the purpose of not having to remove more shielding than needed for different jobs. The average doserate at the centre of the working area with a 60 ° gap in the moveable shielding walls was measured to be 0,3 mSv/h and at a distance of 0,5 m in front of the gap 0,6 mSv/h. The moderator vessel stand is the main source of radiation in the working area and was therefore specially shielded. The surface doserate on that shielding was 3,5 mSv/h. But we think we are able to take additional measures in order to reduce the doserate further in certain areas if needed.

CONCLUSION

In conclusion we are quite satisfied with the results of our efforts to make it possible to perform the intended work in the RPV. We have also gained valuable experiences for the future. In order to, as far as possible, maintain the low doserates in the primary systems during the future operation we are considering possible methods to minimize recontamination. The verdict upon the RPV will be given in April-May 1994 and hopefully Oskarshamn 1 is back in operation late 1994.

Author Biography

Bengt Löwendahl is a Senior Radiation Protection Officer, acting as a corporate radiological advisor and controller at OKG AB, owner and operator of Oskarshamn NPP in Sweden. OKG AB operates three BWR´s and the Swedish Central Interim Storage Facility for Spent Nuclear Fuel (CLAB). During his time with OKG AB he has held positions as Head of Radiation Protection Section and Head of a Health and Safety Department (Radiation Protection, Emergency Planning, Industrial Safety, Fire Protection and Security). Before joining the OKG AB he worked for the Swedish State Power Board as Head of a Chemistry Section at the Ågesta Nuclear Central Heating and Power Station, a PHWR (now decommissioned) situated in the vicinity of Stockholm.

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DISCUSSION

Wood: What do you do with the radioactive waste from the decontamination?

Löwendahl: As we used the normal clean-up system, we handled the resin as normal plant resin is handled.

Wood: You put it with your regular resins?

Löwendahl: Yes.

Wood: Did you use the ultraviolet process for destroying the decontamination chemicals?

Löwendahl: Yes, the ultraviolet-light process was used for the decomposition of the remaining oxalic acid together with a stoichiometric amount of hydrogen perioxide.