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ANALYSIS OF ACTION TO TURN THE TREND OF INCREASING COLLECTIVE DOSES IN SWEDISH LWR'S

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ABSTRACT

Since the first nuclear power reactor in Sweden, Oskarshamn 1 was started in 197 1 and further on with a total reactor program of 12 reactors (4 NPP sites) the occupational collective dose have been less than the ambition level of 2 manSv per GW installed capacity up to the year 1991. This rather favourable picture was changed for the BWR's in 1992. The trend and some of the forecast discussion shows an dose increase for the BWR's, while the PWR's after 1989 have shown a decreasing dose trend. Increasing safety requirements resulting in extending inspection programs, ageing reactors are factors also contributing to this. The changed situation has called for the establishment of more extended ALARA programs for the LWR's. In April 1993 SSI started a development program in dose reduction. The purpose was to identify the various reasons for the increasing dose levels, study the expected dose- and dose rate- trends for coming years and to advice on concrete actions to reduce occupational doses in the long time perspective. In an other action the SSI has alert the plant management on the situation by direct ALARA inspections where the different components in the radiation protection programme at the various plants has been focused at. In the paper, results from these analysis are presented and expected actions to be taken are discussed.

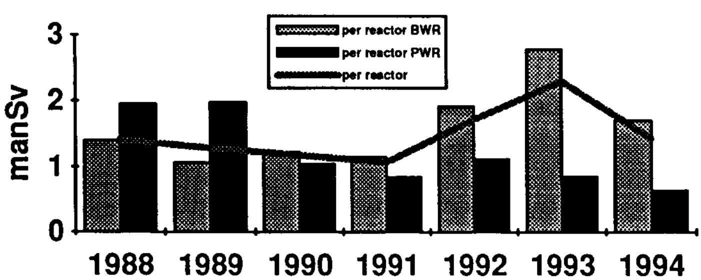
INTRODUCTION

Occupational dose reduction is important not only for the health and safety of the workforce but also because the associated requirement for a good management system enhances safety, quality and reliability of the installation and thus the economy of the plant. Indeed, during the eighties and beginning of the nineties progress has been made and occupational doses have decreased in most countries but unfortunately this is not the situation in Sweden. We have learned that there is no time for complacency because as plants become older there is a general tendency of increased maintenance and repair requirements. Moreover, the ICRP Publication 60, which recommends more stringent dose limits, further draws the attention to the exposure of workers and consequently to ways of reducing such exposure.

TRENDS IN OCCUPATIONAL DOSES

Traditionally occupational radiation doses in the Swedish nuclear industry have been low seen in the international perspective. The decrease in doses we saw in the end of the eightees and in the beginning of the ninetees (figure 1), didn't give any motivation for implementing new ideas with regard to lower the doses.

Figure 1



Unfortunately the situation changed radically 1992. From the positive trend up to 1991, we found the collective dose for 1992 to be "all time high", 20,5 manSv and it become even worse in 1993. In 1993 the total collective dose reached the level of about 28 manSv, i.e. 2.8 manSv per installed GWe, which in fact exceeds the planning level of 2 manSv per GWe which SSI has required as an average for 5 consecutive years.

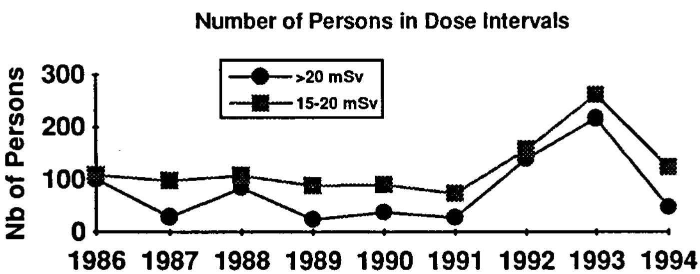
In July 1992, a safety valve in the automatic depressurization system at Barsebäck 2 opened inadvertently at 30 bar and blew steam to upper drywell causing a simultaneous clogging of both trains of the emergency core cooling system. Five of the Swedish reactors, those with external recirculation pumps and small strainer areas, were later that year taken out of operation due to this incident.

At four of the five reactors a decision was taken to replace most of the fibre insulation with metallic insulation. At the fifth reactor fibre-glass insulation was chosen. All of them increased their strainer areas.

From a radiation protection point of view, we have had some unsatisfactory experience from the use of metallic insulation, it requires some time-consuming and troublesome handling.
We have also seen a considerable increase in the individual doses to insulator personnel. Therefore, we had some doubts in the whole operation.
However, the replacement took place and it was not a success neither from a radiation protection nor a technical point of view.
Lack of planning, wrong drawing support combined with an extremely tight time schedule gave a collective dose of approximately 7 manSv in total for the four reactors installing metallic insulation.

Also, the annual individual doses have increased during the same years but are still well below the dose limits (50 mSv for any single year and 100 mSv as a total for five consecutive years). Moreover, the annual average dose for all the work force are below the ambition level of the SSI of 5 mSv per year. However, for some groups the average individual doses have exceeded that level. The number of persons with annual doses of more than 20 mSv was in 1993 about 200 but the number decreased to less than 50 for 1994 (see Figure 2).

Figure 2



REASONS FOR INCREASING DOSES

Collective doses at nuclear power plants are caused by the works that are needed to be carried out i areas where the dose rates are elevated. The dose rates are in general higher the closer to the reactor and its primary systems you are. The five oldest BWR-reactors are here of particular interest in that their recirculation loops require significant inspection and test activities causing important doses to the personnel. In PWR similar problems exist as regard their steam generators.

Works

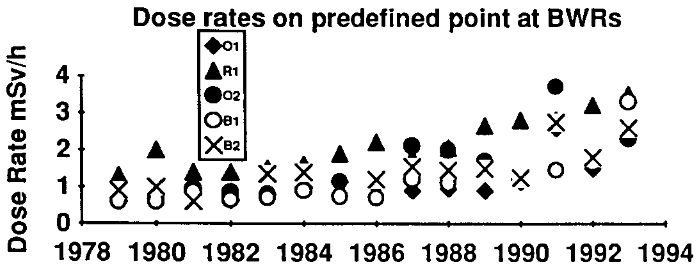
Due to significant amounts of work, the doses have increased considerably during 1992 and 1993. The increasing doses can partly be explained by the fact that some of the reactors are ageing thus requiring significant maintenance and repair works. Increasing safety requirements resulting in extending inspection programs are also contributing to this. In particular, a significant safety related event happened in 1992, when some insulation material was fed into the inlets of the safety injection systems causing risk of clogging . This event led to repair and modification works at all the BWRs of similar design leading to collective doses of about 7 manSv for the five reactors concerned.

Dose rates

Erosion and corrosion of base material in the reactor systems mean that large amounts of corrosion products are fed into the reactor. An important part of them are deposited onto the fuel, activated and thereafter spread in the reactor systems.

Activated corrosion products and in particular Cobalt-60 are the main source of the radiation fields in the nuclear power plants and thus to the resulting radiation doses. Cobalt is one element in stainless steel. The most important contribution comes from stellite which amounts up to 60 percent cobalt in the hard facing alloy, common in valves. Also, fuel failures are causing an increased spread of cobalt-60 from the fuel to the reactor systems. This phenomenon is presently studied in more detail, but it is already now evident that increased attention to fuel failures are needed also from the occupational exposure point of view.
To get a measure of the evolution of the dose rates in the reactor systems, the nuclear industry is measuring regularly the dose rates at a number of places in the reactors. One such series of measurements is shown in figure 3, from which it is evident that the radiation levels at some places in the primary reactor systems are increasing with time. The curve shows the dose rates at all the reactors with external recirculation loops.

Figure 3



At the Radiation Protection Institute (SSI), we cannot accept a prolonged negative dose trend, and therefore, we have worked hard to find countermeasures to turn the trend.

Using our research funds, we started a significant development program in the field of dose reduction. The Swedish "reactor maker" ABB-Atom was on one behalf studying the reasons for the increasing dose levels, estimating the expected dose situation during the years to come as well as giving advice on concrete actions to reduce occupational doses (project DORIS, DOse Reduction In Swedish BWRs).

In the new regulations (SSI FS 1994:2) on occupational exposure, new requirements were included. First of all we decided to introduce a new individual dose limit, 100 mSv in 5 consecutive year in addition to the annual individual dose limit which is 50 mSv.

We have also required an extended education and training program in radiation protection, addressed especially to foreman and team-leaders, working for the utilities as well as for contractors. We believe that this program will increase the understanding and motivation of the personnel to more heavily engagement in dose reduction.

Additionally, we believe in an ALARA, or work management approach, i e where the utilities systematically review their strategy towards radiation protection and develop goals in the area of occupational doses.

In the regulation mentioned above, we also require that each utility have to prepare an ALARA program. These programs shall contain objectives and dose targets for the short and longer terms, discussions on the basic considerations behind the choice of such objectives and targets, dose reduction plans (source and exposure time reductions to be considered) and ways to monitor, follow up and analysing experience. Finally, the plans shall contain programs for education and training of the workforce as well as the organisational aspects related to all the above.