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ANALYSIS OF WORKERS' DOSES IN THE KRŠKO NPP

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INTRODUCTION

The Krško NPP is a Westinghouse pressurised water reactor (PWR) with electrical output of 700 MW. In the year 2000 it performed a comprehensive maintenance after nearly 20 years of operation. The modernisation also included the replacement of two steam generators. The implementation of radiation protection standards given in [1] is very important especially during a comprehensive maintenance of the NPP. As shown in the ISOE database [2], the general downward trend of the average collective effective dose of workers at PWRs in the recent years is mainly due to the implementation of work management principle and the reduction in outage duration. The analyses of the workers' exposures in the Krško NPP are presented and the comparison with the worldwide trends is done.

ANALYSIS OF DOSE TRENDS IN THE KRŠKO NPP

The *Central Dose Register for Workers in Nuclear Installations* has been established at the Slovenian Nuclear Safety Administration in the last years. The register enables the analysis of the main performance indicators in order to estimate the influence of the specific practice on occupational exposure. Usually the individual annual effective dose averaged over a group of all workers is used. In addition, also the values of maximum annual dose or median annual dose can describe the distribution of number of workers as a function of occupational doses. In some cases subsidiary dosimetric quantities should be used (collective equivalent dose, collective effective dose, dose commitment...).

The ISOE programme covered 461 reactors from 29 countries at the end of the year 2001. The annual average collective effective dose per reactor included in this programme clearly demonstrates downward trend. It reached 0.91 man Sv in 2001 for PWRs [2]. The trend of the annual collective effective dose at the Krško NPP is compared to the ISOE data in the Figure 1. The annual collective effective dose in 2001 in the Krško NPP

was 1.13 man Sv with 887 monitored workers. In that year the normalised collective effective dose (collective effective dose/produced electrical energy) reached minimum in the time interval from 1998 to 2001, its value was 1.88 manSv/GWyear.

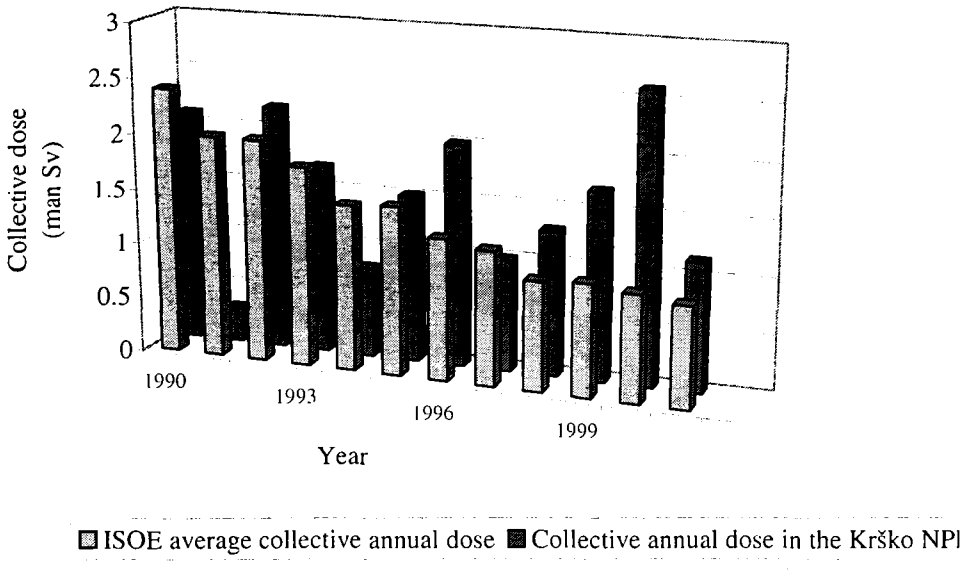

Figure 1. The trend of the annual collective effective dose at the Krško NPP is compared to the ISOE average.

The analyses of dose trend in PWRs show that a substantial part of the dose is due to the outage tasks when maintenance works as well as the fuel handling take place. In the Krško NPP the average outage duration was 44 days from the year 1997 to the year 2001. The longer outage was in the year 2000 when the steam generators replacement took place, the outage period was 62 days. The shortest outage was in the year 1997, it lasted only 31.6 days. The Table 1 shows the annual collective effective dose during the outage as well as the total annual collective dose in that period. The data are taken from [3-7].

The effect of the modernisation of the NPP in the year 2000 is shown as a maximum of the outage collective effective dose and also a maximum of the total collective effective dose.

Table 1. Annual collective effective dose during outage and the total annual collective dose.

Year	**Annual outage collective effective dose** (man mSv)	**Total annual collective effective dose** (man mSv)
1997	*	990
1998	*	1250
1999	1460	1650
2000	2420	2600
2001	1003	1130

* not reported separately in [3], [4]

During the outage period the majority of outside workers as defined in [8] is employed. In the Krško NPP around 60% of all radiation workers were outside workers [7] in the year 2001. Their annual average dose was 1.71 mSv while the average dose of the permanent personnel was 0.61 mSv in that year. As reported in [7] none of the workers received the annual dose above 20 mSv in the year 2001 and 65.3% of workers received an annual dose bellow 1.1 mSv [9].

In the Figure 2 the distribution of collective effective dose in the year 2001 is presented as a function of specific jobs performed in that year. As shown in [9] the exposures related to the waste management do not present a substantial dose to the total collective effective dose if no specific tasks are performed at the site of the NPP related to the radioactive waste management. Usually the percentage of the collective effective dose related to the radioactive waste processing is just around 1% of the total collective effective dose.

CONCLUSIONS

The standards established in [1] and [2] together with the lifetime cycle of the nuclear installation require development of the suitable performance indicators, which can be used as a evaluation tool in the radiation protection. Some of those indicators are already internationally used [2]. The detail analysis of the trends of workers' doses requires also a comprehensive analysis of the jobs performed at the site of the nuclear installations. The analysis of the doses at the Krško NPP shows the expected decrease after the modernisation of the NPP in the year 2000.

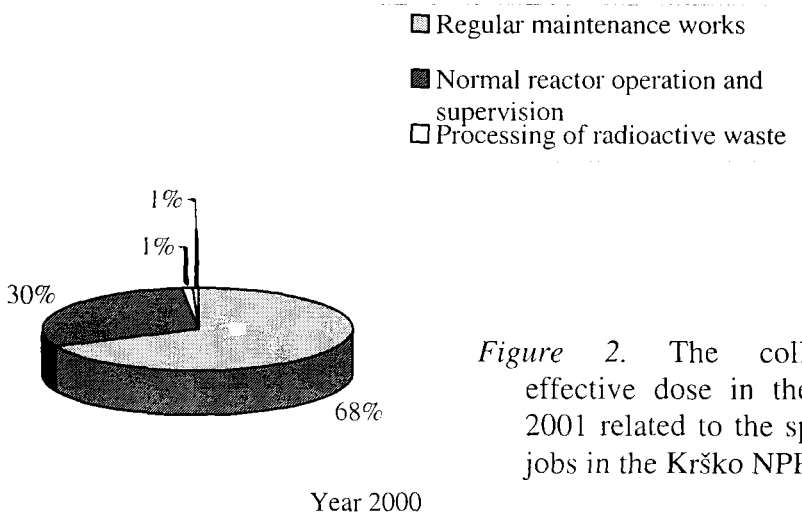

Figure 2. The collective effective dose in the year 2001 related to the specific jobs in the Krško NPP.

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