ASSESSMENT OF THE INTERNAL CONTAMINATION OF NUCLEAR POWER PLANT WORKERS IN FINLAND

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INTRODUCTION

Two nuclear power plant (NPP) sites with two reactors each are located in Finland. At Loviisa the reactors are of the PWR (VVER) type and at Olkiluoto of the BWR (ABB Atom) type. Finnish NPP surveillance regulations require that doserate, air and surface contamination be monitored and that partial-body monitors (also thyroid monitors) be available at the plant site for direct measurements of internal contamination. The risk of NPP workers becoming internally contaminated is highest during the annual refuelling and maintenance outage. During the outage period, a group representing workers with the highest risk of internal contamination must be measured with a system giving nuclide specific results. For this purpose, whole-body counter measurements are performed by the Finnish Centre for Radiation and Nuclear Safety (1).

MATERIAL AND METHODS

The body monitors detection limits of some thousands of becquerels at the NPP:s are used especially for internal contamination control of outage workers. For whole-body counter measurements a mobile unit with chair geometry and one HPGe detector or a stationary scanning type counter equipped with NaI(Tl) and HPGe detectors in Helsinki are used (detection limits ~ 50 Bq for ^{137}Cs)(2). With the mobile whole-body counter at STUK a small group of workers varying from 30 - 130 persons, representing different types of job involving risks of internal contamination is routinely measured once during the annual outage and once during normal operation each year and always if internal contamination is suspected. Each worker showers and changes into clean clothes before the measurement. The measured body content of radionuclides is considered to be internal although part of it might be skin contamination. In the mobile system the measurement time is usually 1000 s and in the stationary system about 1800 s.

After incidents involving risks of internal contamination workers are monitored and further investigations are performed if decontamination procedures are not effective enough. In such cases the stationary scanning counter in Helsinki is used for whole-body counting.

RESULTS

Varying but small amounts of activation and corrosion products have been detected (e.g. ^{51}Cr, ^{54}Mn, ^{58}Co, ^{59}Fe, ^{60}Co, ^{95}Zr, ^{95}Nb, ^{110m}Ag, ^{124}Sb and small amounts of ^{131}I), mainly during outage periods. Figure 1 illustrates two contamination cases at the NPP:s in Loviisa and Olkiluoto. In the present paper all detectable body burdens ($\geq$ 100 Bq) are classified as contamination (Fig.2). The mean body burdens have usually been < 1 kBq (3).

The body burdens of persons working together have been found to vary much thus showing the importance of radiation protection instructions and of good individual working habits. Some profile scan measurements have been done in order to gain more information on the distribution of radionuclides in the body and the retention pattern.

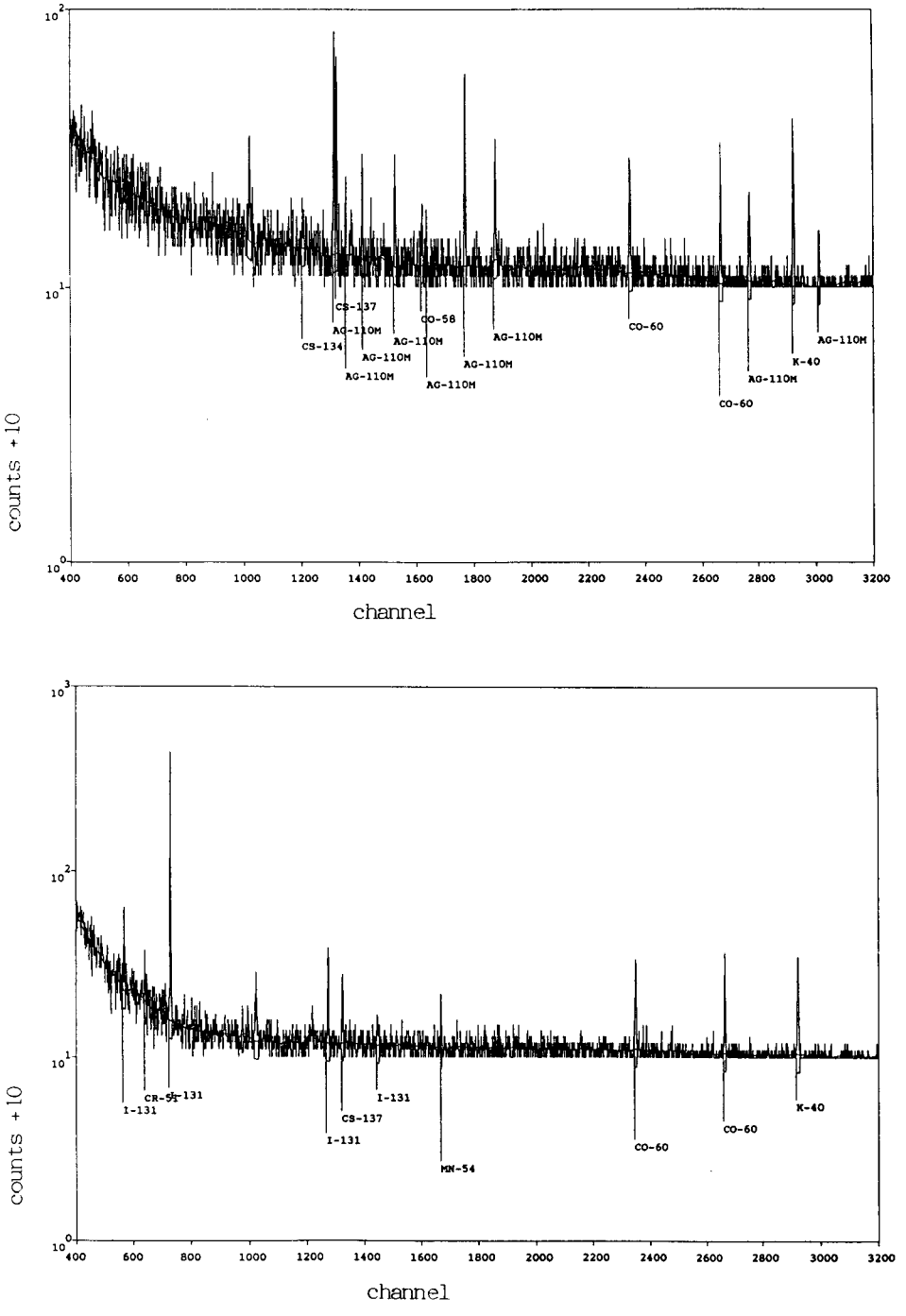

Figure 1. The upper spectrum was measured at the PWR NPP (100 Bq ^{58}Co, 400 Bq ^{60}Co, 1000 Bq ^{110m}Ag) and the lower spectrum at the BWR NPP (1200 Bq ^{51}Cr, 100 Bq ^{54}Mn, 500 Bq ^{60}Co, 2400 Bq ^{131}I) during the annual outages in 1994. The radiocesium originates in the Chernobyl accident.

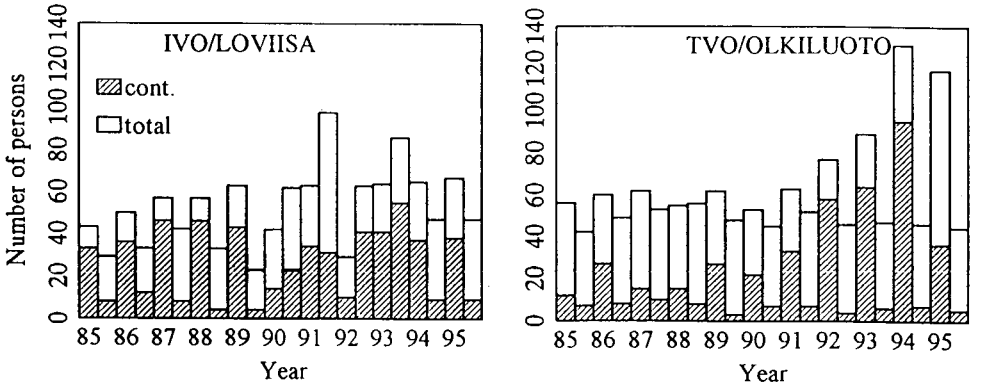

Figure 2. The number of persons measured at both NPP:s from 1985 forwards. The bar to the left represents the outage period each year. All detectable body burdens are classified as contamination (≥ 100 Bq).

DISCUSSION

A typical occurrence for VVER reactors is the appearance of ^{110m}Ag in workers, as also reported by Ormai et al. from Hungary (4). No ^{110m}Ag was detected in workers from the BWR NPP in Finland, although it was detected in the primary coolant. In terms of radiation protection ^{60}Co is the most important radionuclide.

Contamination levels depend greatly on the type of repair and maintenance work done during the outages. Experience has shown that, if the internal effective dose approaches 1 mSv, an incident has occurred. In an outage, usually no more than 20 % of the whole-body counted workers receive a dose of > 0.1 mSv, which is the minimum recording level in Finland. If the body burden of a worker is considerably higher than the mean body burdens during an outage, this person will be remeasured and the radiation history established so that the radiation dose can be estimated more accurately. If possible, such persons are measured repeatedly during a longer period of time to enable even more accurate estimation of the half-lives of the radionuclides in question.

In addition to dose control, whole-body counting aims to monitor radiation hygienic conditions in work areas and especially to motivate workers to pay close attention to their own working habits. The whole-body counter measurements help to keep the doses as low as possible. They are also important for reassuring workers that working conditions are satisfactory.

REFERENCES

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