# RADIATION PROTECTION RELATED TO THE ENVIRONMENT OF THE FINNISH NUCLEAR POWER PLANTS

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## ABSTRACT

The aim of radiation protection is to keep doses as low as reasonably achievable. In Finland there has been, since 1976, a regulatory limit of 0.1 mSv/a for the maximum individual effective dose commitment in the environment of nuclear power plants. The control of operation at and releases from the Finnish nuclear power plants as well as the monitoring of the environment of the plants have indicated that this goal is clearly achieved. New regulations for the safety of nuclear power plants were issued in 1991 as the decision of the Council of State aiming at further decreasing the risks of postulated and severe accidents.

## INTRODUCTION

There are at present four nuclear power reactors operating in Finland. Two of them are 440 MWe PWR-units (in Loviisa, on the south coast of Finland) and the other two are 710 MWe BWR-units (in Olkiluoto, on the west coast of Finland). There are interim spent fuel storages at both power plant sites and a final repository for operational radioactive wastes on-site of the Olkiluoto plant.

The Finnish Centre for Radiation and Nuclear Safety (STUK) is the regulatory body responsible for both radiation protection and nuclear safety. Its regulation of the operation of the nuclear power plants covers all aspects that affect plant safety and the releases of radioactive materials into the environment.

Limitation of radiation exposure in the environment of a nuclear power plant has since the commissioning of the nuclear power plants been based on three main goals:

- ALARA
- a limit for the maximum individual effective dose commitment of 0.1 mSv/a
- prevention of incidents and accidents as well as limitation of their potential consequences.

STUK has also given guidelines for the environmental monitoring programmes of the Finnish nuclear power plants. The aim of environmental monitoring is to extensively cover the ecosystem in order to give a picture of the spreading of radioactive materials released into the environment of a nuclear power plant.

The present Finnish Nuclear Energy Act and Decree came into force in 1988 /1/. A decision of the Council of State on the safety of nuclear power plants was issued in 1991 /2/. This includes regulations concerning the monitoring of releases of radioactive material and the limitation of radiation exposure in the environment of nuclear power plants.

ENVIRONMENTAL SURVEILLANCE

The monitoring of radioactivity in the environment of the nuclear power plants in Finland has been carried out since 1976. The environmental monitoring programme at every Finnish nuclear power plant site is extensive and includes about 500 samples taken annually from both the terrestrial and aquatic environments. Most of the sampling and laboratory analyses are performed by the environmental laboratory of STUK /3/.

The important food stuffs, such as milk, drinking water, grain, meat and garden products are collected. In addition, the monitoring programme includes samples of air, deposition, soil and hair moss in the terrestrial environment, as well as sea water, sinking matter, bottom sediments and indicator organisms in the aquatic environment. The samples are collected either continuously or 1 - 4 times a year depending on the sampling object. The bulk of samples is taken within a radius of 10 km from the power plant. In general the samples are analyzed gammaspectrometrically, but partly also for tritium, radioactive strontium and transuranic elements.

The results of environmental control so far have indicated that very small amounts of radioactivity originating in the Finnish nuclear power plants is regularly detected in certain samples. Most detections have been in the aquatic environment. In sea water samples $^{3}H$ is typically detected, sometimes also activated nuclides ($^{54}Mn$, $^{60}Co$, $^{110m}Ag$) and fission products ($^{134}Cs$, $^{137}Cs$). These are frequently found in samples of sinking matter and aquatic indicator organisms. However, $^{134}Cs$ and $^{137}Cs$ dominantly originate from the Chernobyl nuclear power plant disaster.

The results of the environmental measurements are consistent with the releases measured from the nuclear power plants. Because the actual detections in the environment are very low amounts of radioactivity, the effective dose equivalent commitment cannot be calculated based on them.

Calculated maximum individual effective dose commitments for the annual releases have been so far in the order of a few µSv (Figure 1). The main contribution has been due to $^{60}Co$ in aquatic discharges, respectively $^{14}C$ and $^{60}Co$ in airborne discharges.

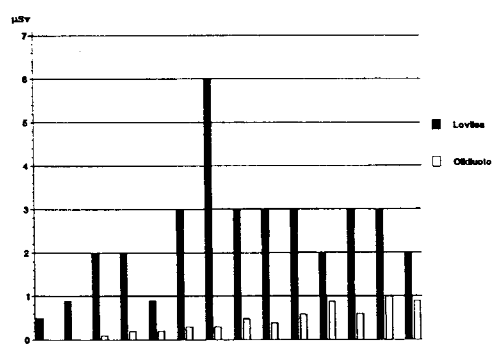


Figure 1. Average doses of critical groups in the environs of Loviisa and Olkiluoto NPPs. (STUK/Blomqvist, Pusa 1991)

## EVOLUTION IN REGULATION

During the 1980's STUK issued new guides dealing thoroughly with the safety of nuclear power plants /4 - 6/. These guides were aimed especially at the possible design of new nuclear power plants, but constituted at the same time the basis for the regulatory work dealing with operating plants. These were taken into account when the utilities planned and made further construction changes in their plants.

Based on the new Nuclear Energy Act and Decree this guidance was then followed by the decision of the Council of State on the general regulations for the safety of nuclear power plants /2/.

It is worth to refer to the present limit for a postulated accident: "The limit for the dose of an individual of the population, arising, as the result of a postulated accident, from external radiation in the period of one year and the simultaneous radioactive materials intake, is 5 mSv."
and for a severe accident: "The limit for the release of radioactive materials arising from a severe accident is a release which causes neither acute harmful health effects to the population in the vicinity of the nuclear power plant nor any long-term restrictions on the use of extensive areas of land and water. For satisfying the requirement applied to long-term effects, the limit for an atmospheric release of $^{137}Cs$ is 100 TBq. The combined fall-out consisting of nuclides other than cesium-isotopes shall not cause, in the long term, starting three months from the accident, a hazard greater than would arise from a cesium release corresponding to the above-mentioned limit".

The possibility that, as the result of a severe accident, the above mentioned requirement is not met, shall be extremely small. This means that the probability of a severe accident shall be less than $10^{-6}$/a.

## IMPROVEMENTS AT THE OPERATING NUCLEAR POWER PLANTS

Since the commissioning of the operating Finnish nuclear power plants, the utilities have made several technical changes at the plant units in order to improve their safety. Some of these improvements are more directly connected to decreasing the radiation risk of the population. Such are e.g. changes aiming at the limitation of the release of radioactive materials caused by a severe accident. Here the emphasis has been on ensuring the engineering safety functions and, especially, on keeping the reactor containment intact during severe accident conditions. In Olkiluoto (BWR) there is a filtered containment venting system and in Loviisa (PWR) an external containment spray system at each plant unit.

The utilities have made changes at the operating plants which would allow reasonable accident management. These include e.g. the sampling and measurement of radioactive material from the containment water and air during severe accident conditions.

The utilities are installing additional automatic radiation monitoring networks in the vicinity of the nuclear power plants. These comprise of four to six measuring stations located at a distance of 1 - 2 kilometers and about ten measuring stations at a distance of 5 kilometers from the plant. All measuring stations send their results to a central unit on-site and are further connected to a national real time measuring network operated by authorities.

## CONCLUSIONS

The safety targets shall be set so that they are clear and can be communicated to and understood by the public. Furthermore, operational experience shall prove that the set targets are clearly achieved.

We feel that the environmental limit of 0.1 mSv/a set in 1976 in Finland for nuclear power plant operation fulfils the requirements above. Besides this the goal has been to prevent accidents and to limit their potential consequences. This has led to more stringent requirements in recent regulation. The adaption of the requirements as well as the advancement of science and technology have produced further improvement at the operating nuclear power plants.

The experience of a single regulatory body responsible for both radiation protection and nuclear safety has been encouraging. A very important thing is the commitment of the operating organisation of a nuclear power plant to safety thinking and doing.

## REFERENCES

1. Nuclear Energy Act and Decree, Unofficial translation by the authorities, Helsinki (1988)

2. STUK-B-YTO 87 Decision of the Council of State on the general regulations for the safety of nuclear power plants (395/91) and of a disposal facility for reactor waste (398/91), Unofficial translation, Helsinki (June 1991)

3. STUK-A92 Monitoring of radionuclides in the environs of the Finnish nuclear power stations in 1988, Helsinki (March 1991)

4. STUK, YVL-guide 1.0 Safety criteria for design of nuclear power plants, Helsinki (December 1982)

5. STUK, YVL-guide 7.1 Limitation of public exposure from nuclear installations, Helsinki (October 1987)

6. STUK, YVL-guide 2.2 Transient and accident analyses for justification of technical solutions at nuclear power plants, Helsinki (October 1987)