

NORDIC REGULATION ASPECTS ON CONTROL OF INTERNAL EXPOSURE

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GENERAL

The five Nordic countries Denmark, Finland, Iceland, Norway and Sweden have a past interlinking history and a similar cultural background. The countries as also the radiation protection institutes have close contacts at many different levels. The radiation protection legislation has been rather similar following the recommendations of ICRP. The implementation of the EU directive No 96/29/Euratom indicates a further harmonisation in the three countries, Denmark, Finland and Sweden, that have joined the European Union.

The first Radiation Act in Finland came into force in 1957 and that in Sweden in 1958. In Finland the current Radiation Act of March 1991 and the decree have been supplemented with many amendments especially after Finland joined the European Union at the beginning of 1995. Further regulations are given by the Radiation and Nuclear Safety Authority- STUK as Guides in the ST and YVL series. In Finland as well as in Sweden demands are also stipulated in license conditions to individual license holders.

In Denmark, Iceland and Norway the general aspect on control of internal radiation doses is similar to that in Finland and Sweden. The need for control of internal doses is however more limited since the number of radiation workers in those countries without nuclear power plants is much smaller.

FINLAND

The first section of the Radiation Act says, "The purpose of this Act is to prevent and limit health hazards and other detrimental effects of radiation. The Act covers the use of radiation and practices that involve or may involve exposure to radiation hazardous to human health." The following section says that to be acceptable the use of radiation and practices that involve exposure to radiation shall meet the principles of justification, optimisation and limitation.

The Finnish authorities are defined in the Act. The Ministry of Social Affairs and Health is the supreme authority on supervision of compliance with the Act in matters that concern general evaluation of the health hazards caused by radiation, evaluation of the need for measures to limit exposure to radiation, and laying down requirements concerning such measures, requirements that concern monitoring of the radiation exposure of workers.

According to the Guide ST 1.6 "Monitoring of Radiation Exposure and Registration of Doses" the responsible party shall organise monitoring of the radiation exposure and related working conditions at the place of work to whatever extent is required by the nature and scope of the practice. The Guide defines the concepts relevant to the monitoring of radiation exposure and provides guidelines for determining the necessity of monitoring and subsequently organising it.

Monitoring means both the measurements of doses caused by external radiation and the determination of radioactive materials that have entered the body. Monitoring is divided into monitoring of radiation exposure and monitoring of working conditions. Radiation exposure monitoring means individual monitoring and registration of doses. Monitoring of radiation exposure usually requires the use of a personal dosimeter or the determination of radioactive materials that have entered the body. Monitoring of working conditions is done to ascertain the need for individual monitoring.

The Radiation Act demands that the national authority STUK maintains a dose register. The personal data of workers engaged in radiation work and the doses they have been exposed to shall be reported to STUK for inclusion in the Dose Register. Data on radiation workers whose dose is below the registration threshold shall also be reported to the Dose register.

Maximum values for and limitations on radiation exposure

According to the Radiation Decree monitoring of radiation exposure required by the nature of the operations shall be performed in such a way that the exposure of each person engaged in radiation work can be determined.

Monitoring of radiation exposure from internal irradiation is necessary for work in a laboratory of type A, work in a laboratory where I-125 or I-131 labelling are done or when monitoring is required by the terms of a safety license or other document. To ascertain the need for monitoring of exposure to internal irradiation it is recommended that the amount of radioactive materials in inhaled air be monitored through sampling or calculation. Exposure to internal irradiation does not need to be monitored in laboratories where there are no radioactive materials in gaseous or easily volatile form.

Guidance is also given on the organisation of monitoring. It says that in the handling of unshielded sources, radioactive materials can enter the body through lungs, mouth, skin and wounds. Adequate ventilation, proper use of protective devices and proper choice of working methods shall therefor be attended to. If, in addition, contamination in the workplace is regularly measured, it is not necessary, except in some special cases, to determine radioactive materials in the body.

Radioactive materials such as H-3, C-14 and S-35, which emit beta radiation with low maximum energy ($E < 300$ keV), effectively cause exposures only when they enter the body. Monitoring shall take the form, say, of urine analyses. If unshielded sources are used, attention shall also be paid to skin contamination and the dose resulting from this.

The activity of gamma emitters in the body can be determined with appropriate equipment such as thyroid monitor, gamma camera or whole body counter. The activity can also be estimated from the activity concentration in inhaled air.

Except for routinely reported data the date of contamination shall be reported in the case of an internal dose. For internal doses the registered dose is the committed effective dose $E(50)$, determined by measurement or other means. Laboratories carrying out labelling with I-125 or I-131 shall keep a register of the measurements of thyroid activity. If the thyroid activity exceeds 10 kBq, the measured value shall be reported to the STUK Dose Register.

The guide also gives advice on measures required in situations liable to lead to exceptional exposure. When it is noticed or suspected that a worker has been exposed to an exceptionally large dose of radiation or a workplace or environment has been severely contaminated with radioactive materials, the radiation exposure shall immediately be reduced to a minimum. The Radiation Hygiene Laboratory at STUK shall be contacted in order to have the internal dose determined by whole-body counting or some other method.

NUCLEAR POWER PLANTS

Only Finland and Sweden produce energy with nuclear power. This created a bigger demand of regulations specified for the use of nuclear energy. The use of nuclear energy is in Finland prescribed by the Nuclear Energy Act and the Decree.

Finland

The Finnish Guide YVL 7.10 "Monitoring of occupational exposure at nuclear power plants gives extra guidance for a special activity". The guide starts by pointing out the three radiation protection principles justification, optimisation and limitation. The arrangement of monitoring of radiation exposure has to be approved by the Radiation and Nuclear Safety Authority STUK.

A continuous monitoring of individual dose is not generally relevant. However, the nuclear power plant shall have sufficient arrangements for detecting any intake of radioactive substances.

Data required for the determination of dose based on internal activity shall be recorded, e.g. the data in a work permit, work-specific data on increased surface contamination and radionuclide concentration of air, and also data on any individual contamination requiring radical decontamination measures.

For the determination of internal dose, the nuclear power plant shall be provided with equipment for monitoring internal activity, which is capable of detecting from the upper body area any activity of Co-60 which is a

hundredth part of the annual limit for intake. Those working in the controlled area during an annual maintenance outage shall, as a rule, be checked with this equipment when their work is accomplished. The measurement requirement also applies to other outages or repairs, which may involve the intake of radioactive substances by humans.

Internal radiation shall also be measured whenever measurements to detect contamination of the skin or protective clothing of those leaving the controlled area, or some other observation, indicate internal contamination deviating from what is normal may have occurred.

If, on the basis of the measurements, exceptional individual internal exposure is detected, also other workers on the same assignment shall be measured for internal radiation, as deemed necessary.

The following groups shall be monitored: a pre-selected group of the nuclear power plant's permanent staff assessed to run the greatest risk of internal contamination and during annual maintenance and refuelling a group selected so that it represents each class of work having the greatest risk of internal contamination and represents all the single work performances exposing workers to contamination.

Nuclide specific gamma activity measurement equipment shall be used for the monitoring, sufficient number of workers shall be chosen to obtain representative data on internal doses and contamination. Excretion or other biological samples shall be used, if necessary, for assessment of internal dose. The time of the measurements shall be so chosen that potential contamination be best detected. Doses from the intake of radioactive substances shall be assessed using a calculation method approved by STUK.

The results of whole-body counting measurements at the Finnish NPP:s during the period 1994 to 1998 show that annually some 20 to 30 committed effective doses reported exceeded 0.1 mSv and only one or two 0.25 mSv.

The Finnish and Swedish authorities have agreed on a procedure whereby doses received in nuclear power plants in either country are transmitted to the Dose Register of the worker's home country every month. Upon request STUK gives a Finnish worker a radiation exposure monitoring document in accordance with EU Directive 90/641/Euratom.

Sweden

In Sweden the regulatory view on management of internal dose monitoring has been to focus on measurements of persons working in areas with a considerable high risk for internal contamination.

In Sweden all demands on monitoring of internal doses are stipulated either in license conditions to individual license holder or in general radiation protection regulations depending on the type of activity.

Nuclear power plants

In the case of the field of nuclear power, SSI have a general regulation covering all activities in the area of radiation protection. Concerning internal dose measurements the conditions covers whole body monitoring using whole body counters.

The ambition has been not to monitor all workers but to optimise the number of measurements and to choose those persons with the highest risk for internal contamination.

The regulation stipulate monitoring in the following cases:

When an intake has occurred or when one can suspect that an intake has occurred.

In work places with high risk for air bound radioactivity. Since the worker always should use protection equipment there is no demand to monitor all persons but instead to make a proper selection of worker to measure. If measurements should result in verified intakes then monitoring should be performed on everybody in the same work team.

Recurrent monitoring on a reference group which consists of workers with the workplace in controlled area. The selection for this reference group should be made by radiation protection staff on the plant. The idea with this reference group is to have proper control of work environment, methods and working conditions in general.

Results from whole body monitoring at NPP:s

The level of estimated committed effective dose which should be reported to the authority is 0,25 mSv. During the past 10 years the number of exposed person >0,25 mSv from internal exposure at the NPP:s have been very few.

The highest dose from the above monitoring was estimated between 2 and 3 mSv. However the majority of the cases had estimated doses below 1 mSv. The number of doses higher than 0,25 mSv registered were 3, 11, 11, 7, 8 10, 0, 7, 6 and 5 from 1989 to 1998 respectively.

Fuel fabrication plants

In Sweden there is one fuel fabrication plant. The main radiation protection concern in that plant is the risk of inhalation of uranium isotopes. SSI have laid down specific conditions for monitoring of internal dose to the work force at the plant. Monitoring of activity in lungs should be carried out twice a year on every person working with non-encapsulated uranium isotopes. Among those persons there are also a reference group who are monitored four times every year.

Work with non encapsulated sources at laboratories

In the case of other types of laboratory work where there is a risk for internal contamination the regulatory condition only states that the personnel concerned shall be monitored. Monitoring methods, intervals and action or investigation levels are not pointed out in the regulations but should be part of local instructions.

Work with radioactive iodine

There is a specific regulation in Sweden that lay down protection criteria for laboratory work with large amounts of radioactive iodine. In this regulation there are conditions for measurements of the thyroid of the work staff. On staff with continuously ongoing work, monitoring should be carried through at least once a month. In the case of work in limited time monitoring of the thyroid should be done in close connection to the completion of work.

Methods and instrumentation

So far neither methods for dose calculation nor equipment's for monitoring of internal doses at work places have been formally approved by the national authority in Sweden. One explanation to this fact is that in relation to external doses the amount of persons exposed to internal radiation are very few and the estimated internal doses are low.

However in the light of the new EG directive 96/29/Euratom, The Swedish authority (SSI) will in the near future lay down new regulations in different radiation protection areas, including the monitoring of internal doses.

In the new Swedish regulations for workers in nuclear power plants there will be a new demand on using whole body counters according to a documented procedure and also to document equipment and computer programs used for estimation of doses. These procedures and equipment should also be approved by SSI.

THE NORDIC COUNTRIES

Nordic intercomparison measurements using different kinds of phantoms have been done beginning in 1984. All Nordic laboratories have taken part. This is important since we exchange dose assessment data and have

agreements on assistance in emergency situations. The number of laboratories is small enough to handle. Some of the laboratories have also taken part in European and international intercomparison runs. In Finland an accreditation procedure including whole-body counting has been started.

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