

# **Regulatory views on Internal Exposure Management at Swedish Nuclear Power Plants**

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## **Abstract**

The main principle of internal exposure control at nuclear facilities in Sweden has been to as far as possible avoid the intake of radioactive nuclides into the human body. The main argument for this principle is the difficulty in practice to achieve a low intake and in the same time eliminate the risk for a large intake. The strategy has been to keep a good record of the working environment concerning contamination levels and to always use necessary protective equipment to live up to this principle. So far it has been a successful approach as the numbers of person exposed to internal radiation from intake at nuclear plants are very few and the doses in the few cases appeared are very low. Along with the principle of avoiding internal contamination there is also a program of whole body measurements. Conditions of such measurements are stipulated in Swedish radiation protection regulations. The main purpose of the whole body counting program is to verify that nobody is exposed to internal radiation from intake but it is also used to estimate the internal dose in case an intake should happen.

## **Introduction**

The base of the radiation protection legislation in Sweden consists of the Act (ref 1), the ordinance (ref 2). The next level of the legislation consists of radiation protection regulations issued by the Swedish Radiation Protection Institute (SSI), which is the radiation protection regulatory body in Sweden. These regulations contain a large part of the conditions for the licensees. Finally there is also a possibility for the authority to stipulate license conditions to individual license holder.

Conditions on internal exposure control occur in general terms in the regulations on dose limits (ref 3) where it is stated that internal doses should be included in the total effective dose when compared with dose limits. Further, in regulations on dose monitoring (ref 4), it is stated that in workplaces where there is a risk of intake of radioactive substances in the human body, monitoring shall be done in a way that is well adjusted to the radioactive nuclides and kind of practice. The dose from internal exposure shall be determined by estimating the intake of activity. The committed effective dose shall be determined with the aid of the dose coefficients in the EG directive 96/29/Euratom (ref 5).

In addition to the general regulations mentioned above, SSI has also issued regulations on radiation protection of workers in nuclear plants (ref 6), which gives some more detailed guidance on performing internal dose control. One should however bear in mind that Swedish regulatory conditions in general are not very detailed but leaves to the licensees to implement the conditions in a proper way and to prepare internal company instructions to fulfil authority conditions.

## **Internal Dose Control**

In the Swedish nuclear power industry the main protection philosophy in the case of internal exposure has always been to as far as possible avoid internal contamination, that is to use the appropriate protective clothing, to give the workers enough information and to have a good control of the working area. SSI has also supported this approach and the main argument for this principle has been the difficulty in practice to achieve a low intake and in the same time eliminate the risk for a large intake.

The control of intake of radioactive nuclides in the human body in Swedish nuclear power plants could be divided into different levels.

The first level is to classify all work places and rooms in a controlled area with respect to the risk of radioactive contamination in air and at surfaces. This means that such areas should be regularly monitored in order to set the appropriate level of access restriction and of protective measures (for example extra step-over, extra clothing).

In the case when there is a risk for air contamination there should be air monitors with alarm function. To have a good control of the working environment is an important factor to avoid intake of radionuclides.

The next level of control occurs when persons are leaving a controlled area. All persons are passing an exit monitor to check for external contamination. This procedure also gives a first rough indication on the possibility of a significant intake. This is due to the fact that cobalt-60, with the relative high gamma energy, is the dominant nuclide in the Swedish power reactors.

#### *Whole body measurements*

The next level in the control of intake of radioactive nuclides is whole body measurements using equipments with germanium detectors.

In the regulation on radiation protection of workers (ref 6), SSI has stipulated conditions concerning the use of whole body measurements. 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 main purpose of the whole body counting program is to verify that nobody is exposed to internal radiation from intake but it is also used to estimate the internal dose in case an intake should occur.

The regulation stipulate monitoring in the following cases:

- If there are reasons to expect that individuals have been internally contaminated, or if internal contaminations are confirmed, all those individuals shall undergo whole body counting.

This category includes persons involved in incidents or accidents and also persons who are stopped at exit monitors and where external contamination can be excluded.

- Next, whole body counting shall be performed on a sample of individuals working in environments where a particular risk of intake of radioactive substances is considered to exist. At least one individual from each team shall be measured at the end of the working period. If there is long-term work such measurement shall be performed at least once a month. If an intake that is calculated to imply a committed dose exceeding 0.25 mSv or more is found, the whole team shall be measured.

In this case radiation protection staff shall make a selection of persons to monitor. Examples of work that belongs to this category is work on primary-side of steam-generators, work with control rod drives, work with open primary systems and cleaning work of reactor vessel or fuel handling pools.

- Finally, whole body counting shall be performed on a reference group, in the first place consisting of individuals mainly working within a controlled area. The samples shall be representative for the practices and the individuals in the group shall be measured at least four times a year.

Radiation protection staff on the plant shall make the selection for this reference group. The idea with the reference group is to have proper control of work environment, methods and working conditions in general.

#### **Whole body measurement results**

During the last ten years whole body measurements have been performed according to the program described above. This means that approximately a total of 1500 whole body measurements have been performed every year at the nuclear plants (including the research facility in Studsvik). The results from these measurements during the past ten years show that very few persons are monitored with internal contamination corresponding to a committed effective dose exceeding the reporting level of 0.25 mSv, see table 1. The highest estimated dose from these measurement results was between 2 and 3 mSv. However the majority of the cases had estimated doses below 1 mSv.

This shows that internal doses are not a significant problem at the Swedish nuclear plants, and compared to external doses it gives in fact a negligible contribution to the total dose. SSI believes that this circumstance is a result of good internal exposure management at the plants including good working condition, the use of right protective equipment and personal clothing and a good behaviour of the performing work staff in general.

Table1. Number of persons at Swedish nuclear plants with measured internal doses exceeding 0.25 mSv

Year	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998
Number of Persons >0,25 mSv	5	6	7	0	10	8	7	11	11	3

### Methods and instrumentation of internal dosimetry

As described above, Swedish radiation protection regulations consists to a high degree of general conditions and do not specify in detail how the licensee should act in all matters.

One example of this is that 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. Another 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 (ref 5), SSI will in the near future lay down new regulations in different radiation protection areas, including the monitoring of internal doses. In the revised Swedish regulations for workers in nuclear power plants there will be a new demand on using whole body counters according to a documented procedure that is approved by the Swedish Radiation Protection Institute. Such documentation shall include

- the measurement equipment and routines for its use,
- the competence of the persons performing the measurements,
- methods used for calculating the intake and the committed effective doses,
- routines for evaluating the obtained results and
- routines for calibrations and checks of the equipment.

### Reporting and documentation

In the Swedish regulations there is a demand that stipulate that doses should be reported to a national dose database. In the case of nuclear plants the nuclear companies in Sweden manage the dose database. SSI has approved the database and has full access to it. The main use of the database is of course to save results of measurements of individual external doses. However the database also consists of results from measurements of internal contamination. All final results from whole body measurements are documented in the base, also such measurements showing that no intake has occurred. Such information is very important.

### Conclusions

The management of internal dose control in Swedish nuclear facilities has so far resulted in very few cases of internal doses. The most important factor to this result is that both industry and authority have had a common view to always try to avoid internal intakes. This common ground is supplemented with a system of internal dose control at different levels to assure that the high level of protection against intake is retained.

### References

1. The Swedish Radiation Protection Act (SFS 1988:220)
2. The Swedish Radiation Protection Ordinance (SFS 1988:293)
3. The regulations of the Swedish Radiation Protection Institute concerning dose limits at work with ionising radiation (SSI FS 1998:4)
4. The Swedish Radiation Protection Institute's Regulations on Monitoring and Reporting of Individual Radiation Doses (SSI FS 1998:5)
5. Council Directive 96/29/Euratom of May 13, 1996, laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation
6. The Swedish Radiation Protection Institute's Regulations on Radiation Protection of People Exposed to Ionising Radiation at Nuclear Plants (SSI FS 1994:2)