

Amendments up to SSI FS 2003:2 are inserted.

The Swedish Radiation Protection Authority's Regulations on Monitoring and Reporting of Individual Radiation Doses;

issued on October 29th 1998.

On the basis of 7 and 9 §§ in the Radiation Protection Ordinance (1988:293) the Swedish Radiation Protection Authority has issued regulations as follow.¹

1 § These regulations apply to measurements of individual radiation doses to workers of category A² engaged at work with ionising radiation and reporting of such doses to the National Dose Data Base.

Definitions

2 § In these regulations the following concepts are used with the meanings specified here

<i>Effective dose:</i>	the sum of all equivalent doses to organs and tissues, weighted for their different sensitivity for radiation, (see also annex 1),
<i>equivalent dose:</i>	an absorbed dose to an organ or tissue, weighted by factors taking into account the biological efficiency of the kind of radiation, (see also annex 1),
<i>external exposure:</i>	exposure to a source situated outside the human body,
<i>skin contamination:</i>	radioactive substances in or on the skin,
<i>committed effective dose:</i>	the total effective dose after an intake of radioactive substances determined over 50 years (see also annex 1),
<i>internal exposure:</i>	exposure to radioactive materials after intake into the body orally, by inhalation or through the skin,
<i>National Dose Data Base:</i>	data base at the Swedish Radiation Protection Authority recording the measured individual doses,
<i>individual dose:</i>	a generic term meaning effective dose, equivalent dose, committed effective dose or committed equivalent dose,
<i>personal dose equivalent:</i>	the equivalent dose to soft tissue at a suitable depth d (mm) under a given point on the body, ³

¹ Council Directive 96/29/Euratom, OJ L159, 29.6.1996.

² Regulations on category A are given in the Swedish Radiation Protection Authority's Regulations on Categorisation of Workers and Workplaces at Work with Ionising Radiation (SSI FS 1998:3).

³ In dose reports concerning external exposures the recorded personal dose equivalents are used: For the whole body Hp(10), for the lens of the eye Hp(3) and for hands, fore-arms and skin Hp(0.07). These are considered to reflect the effective dose and the equivalent dose respectively if no special event has caused doses close to or exceeding the annual dose limits.

personal dose meter: an instrument containing one or more detectors in order to measure the individual personal dose equivalent, designed to be worn by the user and having at least one function the reading of which can not be manipulated by the user,

laboratory for individual dose monitoring: company or institution that provides personal dose meters, evaluates them and reports the doses.

Monitoring of individual doses

3 § Anyone who conducts a practice with ionising radiation shall ensure that monitoring of individual doses are performed for all persons of category A.

4 § If an unexpected change of dose to any worker occurs, the reason shall be investigated by the one who conducts the practice.

5 § If a measurement shows that a worker in one month has received a personal dose equivalent corresponding to

1. an effective dose larger than 6 mSv or
2. an equivalent dose to the eye larger than 45 mSv or
3. an equivalent dose to hands, fore-arms or the skin larger than 150 mSv

the one who conducts the practice shall report the dose to the Radiation Protection Authority and tell the reason.

6 § Immediately after an event that can be suspected to give abnormally large individual doses, the one who conducts the practice shall report the event to the Radiation Protection Authority. The dosimeters of the persons involved shall immediately be evaluated.

7 § If the Radiation Protection Authority for particular practices has issued regulations on periods of monitoring, levels of reporting or other circumstances concerning individual dosimetry which differ from these regulations, those special regulations shall apply in stead of the corresponding sections in these regulations.

External exposure

8 § Measurements of individual doses shall be performed with dose meters from a laboratory for individual dose monitoring which is approved by the Radiation Protection Authority. The monitoring period shall be one month or four weeks.

The personal dose meter shall be well adjusted to the practice and the present kinds of radiation. The readings must not, at normal use, be affected by other agents than ionising radiation.

9 § If the work is of such a kind that large doses can be expected to the lens of the eye, the hands and fore-arms or to the skin, measurements of these parts shall be performed. If continuous dose monitoring obstructs the work in an essential way, the dose monitoring may be done as spot tests in such an extent that allows estimation of the annual individual doses.

Internal exposure and skin contamination

10 § In workplaces where there is a risk of intake of radioactive substances in the human body or there is a risk of skin contamination, monitoring shall be done in a way that is well adjusted to the radionuclides 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 mentioned in annex 1.

Reporting and recording

11 § Anyone who conducts a practice shall ensure that the recorded equivalent doses are reported to the National Dose Data Base within 6 weeks after the end of each monitoring period. The reporting may be handled over directly to the laboratory for individual dose monitoring.

Dose recordings that cause time consuming investigations may be reported at a later date after contact with the Radiation Protection Authority.

Anyone who conducts a practice shall within 6 weeks after the turn of the calendar year report the yearly estimates in accordance with § 9, concerning the previous year .

12 § Information about committed effective dose shall be sent to the National Dose Data Base if the intake of radioactive substances imply a committed effective dose exceeding 1 mSv.

Information about committed equivalent dose to the hands, fore-arms or to the skin by skin contamination shall be sent to the National Dose Data Base if the committed equivalent dose exceeds 20 mSv.

13 § All reports to the National Dose Data Base shall be given electronically, if not otherwise is permitted, in a format as decided by the Radiation Protection Authority.

Individual doses received by specially planned irradiation, by accidents or in emergency situations shall be reported separately.

14 § Anyone who conducts a practice with ionising radiation shall keep records on doses until the persons involved are or would have been 75 years old. However the records must be kept at least for 30 years after the work in category A ceased.

Individual doses received according to the second sub clause of section 13 shall be noted separately.

If the practice closes down before the end of the keeping period, the Radiation Protection Authority shall be informed.

Approval of laboratories for individual dose monitoring

15 § Application for approval is done at the Radiation Protection Authority. The application shall include a description according to section 16 and information on what kind of radiation, energy intervals and type and design of the detectors that the approval is intended to cover.

If the laboratory for individual dose monitoring has chosen to be accredited according to the Law (1992:1119) on technical check, an approval is granted after an announcement to the Radiation Protection Authority. Such an announcement shall include information on the type of detector, kind of radiation and energy intervals as well as a certificate on accreditation. The corresponding is valid for a laboratory for individual dose monitoring which is accredited towards the standard EN ISO/IEC 17025 by an accreditation body in another country within EES that fulfils and applies to the requirements in the standard ISO/IEC Guide 58.

16 § An approved laboratory for individual dose monitoring shall possess a written quality control program that corresponds to the principles laid down in the ISO 9000 family. In particular the quality control program shall include

1. the organisation,
2. the internal responsibilities and competence and,
3. the routines for the work.

In stead of what is stated in the first paragraph an accredited laboratory for individual dose monitoring shall meet the requirements that are established by the accreditation body. The laboratory shall possess suitable technical equipment and resources for calibration.

17 § A laboratory that applies for approval shall send un-exposed dose meters, the number of which is told by the testing laboratory respectively to the Radiation Protection Authority or some other testing laboratory that is accredited for the intended quantity towards the standard ISO/IEC 17025 by an accreditation body within EES that fulfils and applies to the requirements in the standard ISO/IEC Guide 58.

The dose meters are returned for evaluation after exposure to doses that are known by the testing laboratory. If the dose meter shows a reading directly, the evaluation shall be done at the testing laboratory.

At application for an approval documentation that shows that the dose meters fulfil the requirements according to Annex 2 shall be enclosed.

18 § The type or types of personal dose meters involved in the measuring procedures at an approved laboratory must not be changed in any respect without consent of the Radiation Protection Authority.

19 § An approval is valid for two years. A new approval may be granted after test evaluations according to section 17.

20 § The Radiation Protection Authority may cancel an approval if the conditions have been changed in a way that affects the quality negatively or if these regulations and other conditions that may have been given are not fulfilled.

21 § The Radiation Protection Authority may in particular cases make exceptions from these regulations.

These regulations enter into force as of July 1st 1999. The first sub clause of the section 8 do not apply until January 1st 2000.

On behalf of the Board of the Radiation Protection Authority

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SSI FS 2003:2 enters into force on August 1, 2003.

Some dose concepts**Equivalent dose (H_T)**

The equivalent dose H_T to an organ or tissue T is the sum of the mean absorbed dose $D_{T,R}$ in T, multiplied by the weighting factor w_R for each type of radiation R.

$$H_T = \sum_R w_R D_{T,R}$$

Effective dose (E)

The effective dose is the sum of all weighted equivalent doses in all organs and tissues of the body according to the Table 2, from external and internal exposure. E is calculated by

$$E = \sum_T w_T \sum_R w_R D_{T,R}$$

w_T is the weighting factor for the organ or tissue T.

Table 1 Weighting factors (w_R) for various types of radiation and energies

Type of radiation and energy range	w_R
Photons, all energies	1
Electrons and muons, all energies	1
Neutrons of energy E (MeV)	$5 + 17 \exp \frac{-(\ln(2E))^2}{6}$
Protons, other than recoil protons, energy > 2 MeV	5
Alpha particles, fission fragments, heavy nuclei	20

Table 2 Weighting factors (w_T) for organs or tissues

Organ or tissue	w_T	Organ or tissue	w_T
Gonads	0.20	Liver	0.05
Bone marrow (red)	0.12	Oesophagus	0.05
Colon	0.12	Thyroid	0.05
Lung	0.12	Skin	0.01
Stomach	0.12	Bone surface	0.01
Bladder	0.05	Remainder	0.05
Breast	0.05		

Committed effective dose (E_T)

The committed effective dose (E_T) after an intake of radioactive substances is the sum of the committed equivalent doses to organs or tissues, each of which multiplied by the appropriate weighting factor.

The committed equivalent dose (H_T) to the organ or tissue T is defined as the integral over the time 50 years (for children 70 years) of the equivalent dose rate [$H'_T(t)$] to the organ or tissue T at the time t after the intake such that

$$H_T = \int_0^{50 \text{ y}} H'_T(t) dt.$$

Summing up all committed equivalent doses to the organs and tissues multiplied by the weighting factors w_T respectively gives the committed effective dose E_T :

$$E_T = \sum_T w_T H_T$$

The calculations are simplified by the use of the dose coefficients. If the estimated intake (Bq) is multiplied by the dose coefficient (Sv/Bq) the committed effective dose is obtained for each nuclide. The dose coefficients include such parameters as kind of radiation, where in the body the nuclide is absorbed and the biological half-life. The integrating time 50 years (for children 70 years) is also taken into account.

The dose coefficients to be used are given in annex III in the Council Directive 96/29/Euratom laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (OJ no L159, June 29th 1996). The coefficients concerning workers are also published in a report from the Radiation Protection Authority. The Authority can give information about coefficients that are omitted in the report.

If there is an intake of different nuclides at the same time or via different ways (ingestion or inhalation) the total committed effective dose (E_{INTERN}) is calculated by:

$$E_{\text{INTERN}} = \sum_i H_{i,\text{or}} J_{i,\text{or}} + \sum_i H_{i,\text{in}} J_{i,\text{in}}$$

where $H_{i,\text{or}}$ = the dose coefficient for intake of nuclide i by ingestion,
 $J_{i,\text{or}}$ = the intake of activity by ingestion of nuclide i,
 $H_{i,\text{in}}$ = the dose coefficient for intake of nuclide i by inhalation,
 $J_{i,\text{in}}$ = the intake of activity by inhalation of nuclide i.

Performance requirements on dose meters⁴

A) Lowest dose required to be measured

The lowest dose required to be measured (H_o) is 1/10 of the dose given by the dose limit for five consecutive years uniformly spread over the monitoring periods during the five years.

Example: If the 5 years limit is 100 mSv and the monitoring period is one month then $H_o = 0.1 \cdot 100 / (5 \cdot 12) = 0.17$ mSv.

B) Highest dose required to be measured

A personal dose meter shall be able to measure at least 100 mSv.

C) Accuracy

The evaluated values (H_m) are acceptable if they are within the interval

$$L_{r,l} = H_m / H_t = L_{r,u}$$

where the true personal dose equivalent is H_t . $L_{r,l}$ (the lower relative limit) and $L_{r,u}$ (the upper relative limit) are given by

$$\begin{aligned} L_{r,l} &= 0 && \text{if } H_t < H_o, \\ L_{r,l} &= (1/1,5) \cdot [1 - 2H_o / (H_o + H_t)] && \text{if } H_t \geq H_o. \end{aligned}$$

$$L_{r,u} = 1,5 \cdot [1 + H_o / (2H_o + H_t)]$$

However $L_{r,u}$ must not exceed 2.

D) Requirements on angular response

The personal dose equivalent depends on the angle of incidence. The reading of a personal dose meter therefore shall also vary with the angle. The magnitude of the variance is also dependent on the energy.

When testing at personal dose meter system regarding the angular response the dose meters are exposed from four different directions for one or more energies within the appropriate interval.

For each energy (E) the response i.e. the ratios (R_{E0} , R_{E20} , R_{E40} and R_{E60}) between the measured and true values at exposure from the angles 0° , 20° , 40° and 60° versus perpendicular incidence are determined. Perpendicular incidence has the angle of incidence 0° . The mean ($\Sigma R_{E,i} / 4$) is denoted R_E . The dose meters are acceptable if

$$|R_E - 1| \leq 0,4$$

⁴ A more comprehensive technical description and recommendations is given by the European Commission in the report Radiation Protection 73: Technical recommendations for monitoring individuals occupationally exposed to external radiation; EUR 14852 EN, 1994.

An example on tolerances on acceptable ratio (H_m/H_t) where H_m is the evaluated value and H_t is the true value is shown in figure 1 for $H_t = H_p(10)$. The example is based upon the requirements that yields for 100 mSv/5 years. Of 10 exposures with known doses, one reading at the most may lie outside the borders.

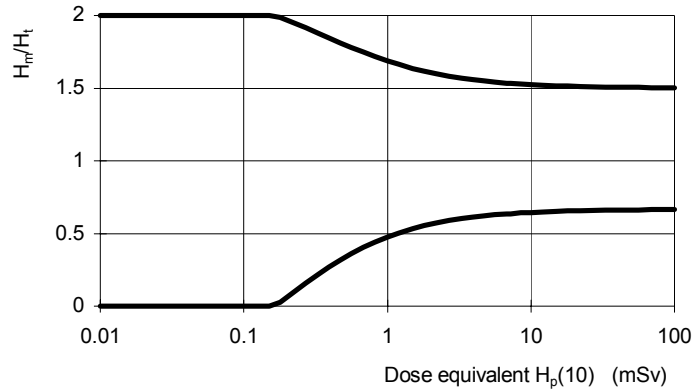


Figure 1 Tolerances on upper and lower readings of the personal dose equivalent at the dose limit 100 mSv/5 years. The monitoring period is 4 weeks.