STUK

GUIDE **YVL C.2** / 20 MAY 2014

RADIATION PROTECTION AND EXPOSURE MONITORING OF NUCLEAR FACILITY WORKERS

continues

With regard to new nuclear facilities, this Guide shall apply as of 1 June 2014 until further notice. With regard to operating nuclear facilities and those under construction, this Guide shall be enforced through a separate decision to be taken by STUK. This Guide replaces Guide YVL C.2, 15 November 2013.

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Authorisation

According to Section 7 r of the Nuclear Energy Act (990/1987), *the Radiation and Nuclear Safety Authority (STUK) shall specify detailed safety requirements for the implementation of the safety level in accordance with the Nuclear Energy Act.*

Rules for application

The publication of a YVL Guide shall not, as such, alter any previous decisions made by STUK. After having heard the parties concerned STUK will issue a separate decision as to how a new or revised YVL Guide is to be applied to operating nuclear facilities or those under construction, and to licensees' operational activities. The Guide shall apply as it stands to new nuclear facilities.

When considering how the new safety requirements presented in the YVL Guides shall be applied to the operating nuclear facilities, or to those under construction, STUK will take due account of the principles laid down in Section 7 a of the Nuclear Energy Act (990/1987): *The safety of nuclear energy use shall be maintained at as high a level as practically possible. For the further development of safety, measures shall be implemented that can be considered justified considering operating experience, safety research and advances in science and technology.*

According to Section 7 r(3) of the Nuclear Energy Act, *the safety requirements of the Radiation and Nuclear Safety Authority (STUK) are binding on the licensee, while preserving the licensee's right to propose an alternative procedure or solution to that provided for in the regulations. If the licensee can convincingly demonstrate that the proposed procedure or solution will implement safety standards in accordance with this Act, the Radiation and Nuclear Safety Authority (STUK) may approve a procedure or solution by which the safety level set forth is achieved.*

Translation. Original text in Finnish.

1 Introduction

101. The use of nuclear energy is prescribed in the Nuclear Energy Act (990/1987) and in the Nuclear Energy Decree (161/1988) issued by virtue of the Act, and Government Decrees (716/2013, 717/2013 and 736/2008). Some requirements of the Radiation Act (592/1991) and the Radiation Decree (1512/1991) are also applied to the use of nuclear energy with the aim of protecting individuals against the harmful effects of radiation.

102. The ICRP's recommendations and the IAEA's regulations have affected the Finnish radiation protection legislation. The national legislation of Finland has taken into account also the Council of Europe's decisions.

103. Under Section 2 of the Radiation Act, *to be considered acceptable, the use of radiation and practices involving exposure to radiation shall meet the following criteria:*

1. *The benefits derived from the practice shall exceed the detriment it causes (principle of justification);*
2. *The practice shall be arranged so that the resulting exposure to radiation hazardous to health is kept as low as is reasonably achievable (principle of optimization);*
3. *No person shall be exposed to radiation exceeding the maximum values prescribed by Decree (principle of limitation).*

In radiation protection, the optimisation principle is called the ALARA principle (As Low As Reasonably Achievable).

104. Section 9 of the Radiation Act presents the requirements for radiation work and the dose limits to be complied with in the monitoring of radiation exposure.

105. Radiation protection at nuclear facilities is based on good planning of activities; appropriate working methods; up-to-date radiation protection methods, instruments and protective equipment; utilisation of previous experience; as well as co-operation between the nuclear facility's different organisation units. Commitment to the implementation of radiation protection objectives concerns the nuclear facility's entire personnel.

106. The radiation safety of the nuclear facility's workers is looked after for the facility's entire lifetime. A detailed assessment of radiation protection is conducted in a scope deemed necessary when construction and operating licences are applied for, in connection with plant modifications, periodically during the facility's lifetime and finally during decommissioning.

2 Scope of application

201. This Guide applies to the radiation protection and radiation exposure monitoring of nuclear facility workers. The ST Guides published by the Radiation and Nuclear Safety Authority (STUK) supplement the YVL Guides. The following functions, for example, which are subject to the Radiation Act and require a safety licence, are addressed in the ST Guides: use of open radiation sources, use of sealed radiation sources, use of X-ray machines, radiography as well as the import and export of radioactive substances.

202. A nuclear facility's structural radiation safety is addressed in Guide YVL C.1. Radiation monitoring systems and equipment in nuclear facilities are addressed in Guide YVL C.6. A nuclear power plant's emergency arrangements and radiation protection procedures during emergency situations are addressed in Guide YVL C.5. A nuclear facility's decommissioning, its treatment and transports of waste are addressed in Guides D.3–D.5.

203. Guide YVL A.4 deals with a nuclear facility's organisation and personnel. Guide YVL A.3 describes the management systems of nuclear facilities. Reporting on a nuclear facility's operation is dealt with in Guide YVL A.9. A nuclear facility's operating experience feedback is addressed in Guide YVL A.10.

204. Medical surveillance of occupationally exposed workers is described in detail in Guide ST 7.5. The measurands and definitions used in radiation exposure monitoring are described in Guide ST 7.2. Occupational exposure to radon

and the relevant radiation measurements are addressed in Guide ST 12.1. Calculation of the committed effective dose caused by internal radiation and the conversion factors for calculation are set out in Guide ST 7.3. The reporting of data to STUK's Dose Registry is described in Guide ST 7.4. Approval of dosimetry services for radiation activities other than nuclear power plants is described in Guide ST 1.9. Warning signs for radiation sources and their use is described in Guide ST 1.3.

3 Occupational radiation protection

301. Chapter 9 of the Radiation Act obliges the responsible party engaged in radiation practices to protect occupationally exposed workers. Monitoring of radiation exposure and medical surveillance are enacted in more detail in Chapter 3 of the Radiation Decree.

302. Under Section 32 of the Radiation Act, *the responsible party shall plan and implement protection of workers according to the following principles:*

1. *the radiation exposure to which workers are subjected and the factors affecting this exposure shall be investigated in advance, also having regard to exceptional working conditions;*
2. *working areas shall, where necessary, be classified as controlled areas and supervised areas, and*
3. *workers who must be individually monitored for radiation exposure shall be classified in a separate group (category A).*

303. Occupational dose limits in radiation work are enacted in Section 3 of the Radiation Decree as follows:

The effective dose caused to a worker by radiation work shall not exceed an average of 20 millisieverts (mSv) per year reckoned over a period of five years, nor 50 mSv in any one year. The annual equivalent dose in the lens of the eye shall not exceed 150 mSv, nor shall the annual equivalent dose at any point on the hands, feet or skin exceed 500 mSv.

304. Annual dose is the sum of the effective dose arising from external radiation during a calendar year and of the committed effective dose incurred from the intake of radioactive substances within the same period of time.

305. Section 4 of the Radiation Decree enacts dose limits for young trainees. Dose limits for members of the public are addressed in Section 6 of the Radiation Decree and the protection of the foetus in Section 5. The Decree states i.a. the following:

The use of radiation shall be planned and organised so that the annual effective dose of a person not engaged in radiation work does not exceed 1 mSv. The equivalent dose in the lens of the eye shall not exceed 15 mSv per year, nor shall the equivalent dose at any point on the skin exceed 50 mSv per year.

The foetus shall be protected in the same way as any member of the public. When a woman has announced her pregnancy, her work shall be arranged so that the equivalent dose of the foetus is as low as reasonably achievable; it shall not exceed 1 mSv for at least the remainder of the pregnancy.

306. The nuclear facility's organisational structure and operations shall be planned to continuously implement radiation protection in accordance with regulations, facility-approved instructions and the ALARA principle. Special attention shall be paid to work during which radiation protection and the correct use, or supervision of use, of protective equipment is demanding due to working conditions, the scope or exceptional nature of work, or other reasons.

307. The nuclear facility's management system shall describe procedures enabling the efficient correcting of any shortcomings detected in radiation protection. Systematic records shall be kept of observations, events, shortcomings, arrangements and measurement results significant to radiation protection.

308. In addition to individual occupational doses, collective doses (the total of radiation doses) shall be monitored by task and worker group. The nuclear facility shall undertake measures if collective doses indicate a need to improve the radiation protection measures.

309. The nuclear facility shall have a written programme (the ALARA action programme) to keep doses low. The programme shall include both short-term and long-term plans and measures to limit the doses of occupationally exposed workers. The action programme shall take into account from the overall viewpoint of radiation protection e.g. the facility's operation, water chemistry, plant modifications, materials, decontamination, waste management, testing and inspections etc. The programme shall include target limits for the highest individual annual dose and collective dose (manSv/GW) that shall not be exceeded based on the principle of continuous development. The ALARA action programme shall be kept up-to-date and submitted to STUK for information.

310. If the collective occupational dose at one nuclear power plant unit exceeds the licensee-set collective dose limit per one GW net electric power as an average of two consecutive years, a report of the causes and the measures to improve radiation safety shall be drawn up and submitted to STUK for information.

311. In order to limit individual radiation exposure in accordance with the ALARA principle, the nuclear facility shall enforce dose constraints lower than the dose limits set in the Radiation Decree.

312. If a worker's individual dose at a nuclear facility exceeds 20 mSv during one calendar year, when taking into account doses incurred in radiation work elsewhere, a report shall be drawn up of the reasons leading to this dose. The report shall be submitted to STUK for information.

313. If the annual equivalent dose to the lens of the eye of a worker at a nuclear facility exceeds 20 mSv in a year, a report shall be submitted to STUK for information.

314. Before the nuclear power plant's refuelling, repair and maintenance outage, a report shall be drawn up and submitted to STUK, stating i.a. the following

- the number of personnel taking part in radiation protection monitoring and control, their shift arrangements and responsibilities
- planning of radiation protection training
- arrangements for radiation protection, housekeeping and waste management during an outage
- arrangements for monitoring of doses and contamination
- estimated number of outage workers, highest individual doses and task-specific doses
- collective dose estimate.

315. If the dose resulting from a task or a combination of certain tasks at the nuclear facility is anticipated to exceed 0.05 manSv, or if a significant risk relating to contamination management or to a high individual dose is associated with a task or a combination of certain tasks, a detailed work plan and a document describing radiation protection measures shall be submitted to STUK for information well before work is started.

316. A summary report describing the realisation of radiation protection of realised refuelling outages as well as of extensive maintenance and repair outages shall be drawn up in accordance with Guide YVL A.9.

4 Operation of the radiation protection organisation

4.1 Personnel

401. The nuclear facility's responsible manager is responsible for the nuclear facility's safe and reliable operation. The responsible manager manages activities relating to the nuclear facility's operation and maintenance as well as technical support at the facility. The responsible manager shall ensure sufficient resources and authority for the personnel implementing radiation protection. These resources shall be adequate already before the plant's commissioning.

402. An operational unit responsible for implementing radiation protection in practice and for co-ordinating related functions shall be established within the nuclear facility's operating organisation or such a unit shall be made available to it. The radiation protection manager of the plant acts as the unit's head. Tasks and responsibilities relating to the implementation of radiation protection shall be described in the facility's management system.

403. Unforeseen conditions burdening the radiation protection function, e.g. unplanned maintenance outages, shall be taken into account in the operations and resources management of a radiation protection unit. The unit shall be capable of operation at all times of the day, where necessary.

404. The radiation protection manager shall manage and develop the implementation of radiation protection at the facility. He or she shall ensure that radiation protection functions take into account research results from the field, national and international development and operating experience feedback.

405. The radiation protection unit shall know the structure of the facility, its operating principles and the radiation sources at the facility. The unit shall monitor radiation conditions at the facility by making measurements and oversee from the viewpoint of radiation protection work and measures carried out in the controlled area.

406. The radiation protection unit shall ensure the availability of an adequate number of radiation monitoring instruments and protective equipment at the facility. The unit shall also ensure that these instruments and equipment are operable and used in accordance with the instructions given.

407. The radiation protection unit shall participate in the planning of work done in the controlled area that is anticipated to cause occupational radiation exposure. Radiation protection shall be taken into account in the different implementation phases of work. Radiation protection personnel shall have adequate authority to stop work on radiation-protection grounds and implement measures that aim to restrict doses.

408. During the nuclear power plant's refuelling outages as well as extensive maintenance and repair outages, those responsible for radiation protection shall implement internal quality control in radiation protection. To be recorded are i.a. events and issues relating to items of radiation protection monitoring, essential radiation protection measures and decisions as well as deviations in radiation protection and the relevant corrective actions. Corresponding monitoring of the scope necessary shall be carried out during the facility's operation.

409. If, in addition to the facility's radiation protection personnel, temporary radiation protection workers are employed at the nuclear facility, they shall act in accordance with the facility's radiation protection instructions, trained by the nuclear facility and under its control.

410. The nuclear power plant shall have a team of experts co-operating in radiation protection and in other plant operations (e.g. operation, maintenance, safety) or some other procedure to ensure that radiation protection is taken into account extensively enough within the various domains of technology at the facility.

4.2 Radiation protection training

411. Under Section 36 of the Radiation Act, *workers shall be provided with training and instructions for their duties appropriate to the kind of work and to conditions at the workplace. Particular attention shall be paid to information on the health hazards of radiation and on safety-enhancing work procedures in order to prevent unnecessary exposure to radiation and events leading to exceptional exposure thereto.*

412. STUK shall be informed about the contents of and plans for radiation protection training arranged at the nuclear facility.

413. Radiation protection training shall be given to those working in the controlled area in good time before the commissioning of the facility.

4.3 Introductory radiation protection training

414. Introductory radiation protection training (hereinafter 'introductory training') aims at providing workers with knowledge about radiation legislation and the regulations issued under it as well as at providing them with the preconditions for correct working in the controlled and supervised areas as well as at furthering the accomplishment of radiation protection goals. The training shall provide preconditions for consistent actions in accordance with safety aspects if unexpected situations occur at the workplace. In training and giving instructions, the worker's responsibility for taking care of their own radiation safety, and that of others, shall be highlighted.

415. Training shall be given to all permanent and temporary workers of the nuclear facility working in the controlled area. All workers shall be given this training irrespective of their nationality. Knowledge of languages shall be taken into account so that workers understand markings essential for radiation protection at the facility.

416. Workers shall demonstrate the adequacy of their radiation safety knowledge in a written or computer-based exam. A record shall be prepared of the exam indicating the individual who made the evaluation and the worker taking the test.

417. In addition to introductory training, refresher training shall be given at regular intervals. Training equal in scope to introductory training shall be arranged at least every three years.

418. Introductory training may be considered to apply at all Finnish nuclear facilities if plant-specific administrative and structural characteristics and differences have been taken into account in the training. This can be ensured for example by handing out written material to the workers. Introductory training given in Sweden may apply at Finnish nuclear facilities on the same grounds.

4.4 Other radiation protection-related training

419. The functioning of the nuclear facility's organisation shall be continuously developed to obtain the objectives set for radiation protection. Training programmes shall be prepared to develop and maintain the expertise of those holding positions vital to radiation protection. Permanently employed radiation protection personnel shall undergo an exam to demonstrate their understanding of the radiation protection regulations and measures presupposed by their duties and their knowledge of the use of information systems, tools and instruments required in radiation protection work.

420. Specific radiation protection training shall be given to those whose work (e.g. work planning) significantly affects the results of radiation protection. This applies to the facility's own and contractor personnel.

421. In co-operation with radiation protection experts, personnel contributing to work planning shall ensure that work phases are reviewed or practised before their implementation at work sites that are challenging in terms of radiation protection.

4.5 Radiation protection instructions

422. The nuclear facility shall have instructions to implement radiation protection. They shall include at least the following

- radiation protection principles and the organisation responsible for implementing them
- organising radiation protection training
- regulations for procedures in the controlled and supervised areas
- radiation work categories of workers
- medical surveillance of radiation workers
- radiation measurements in the controlled and supervised areas
- monitoring of individual radiation exposure
- real-time dose monitoring
- decontamination of workers
- radiation work permit procedure
- work planning process for maintenance and modifications important to radiation protection
- radiation protection procedures for unexpected and urgent repairs or maintenance during power operation
- use requirements for personal protective equipment
- procedures to ensure the implementation of the ALARA principle

- procedures for radiation protection quality control.

The radiation protection instructions shall be submitted to STUK for information.

423. The radiation protection instructions shall be kept comprehensive, up-to-date and they shall be regularly evaluated as defined in the nuclear facility's management system. Activities in accordance with in the radiation protection instructions shall be evaluated as part of the facility's quality management.

424. The nuclear facility shall have the necessary detailed instructions listing practices in radiation protection and radiation measurement as well as information on instruments for measuring or analysing radiation. These instructions shall be incorporated in the facility's management system.

5 Radiation conditions-based area and zone classification of a nuclear facility

5.1 General principles of zone classification

501. In the nuclear facility area, dose rates shall be measured as well as the airborne radionuclide concentration and surface contamination (surface activity) systematically determined. Based on the results of the measurements, work sites are divided into controlled and supervised areas.

502. The area outside the controlled and supervised areas is uncategorised in terms of radiation protection.

503. The zone classification at nuclear facilities does not apply to radon. Radon in workplaces is addressed in Guide ST 12.1.

504. In industrial radiography, the zone classification in the nuclear power plant's uncategorised area complies with Guide ST 5.6. In the controlled area, industrial radiography induced radiation beams shall be taken into account by using unambiguous warning signs and access restrictions.

5.2 Supervised area

505. If the effective dose in an area can exceed 1 mSv, or the equivalent dose to the eye (15 mSv) or the equivalent dose to hands, feet or skin (50 mSv) per year, the area shall be classified as a supervised area at minimum.

506. Working conditions in the supervised area and, where necessary, individual radiation exposure shall be monitored according to the nature and extent of radiation exposure. Radiation sources in the area and the associated radiological danger shall be appropriately marked. The markings in the area shall indicate that the area is a supervised area.

507. Workers shall be provided with instructions on working in the supervised area, the use of radiation sources and the radiological danger associated with the sources. The outlines of the supervised area, radiological conditions and the adequacy of protective measures shall be regularly checked.

5.3 Controlled area

508. At least those rooms in the facility where the external dose rate can exceed 3 µSv/h or where a 40-hour weekly stay can cause an internal dose in excess of 1 mSv per year due to radionuclides originating from a nuclear facility shall be defined as a controlled area.

509. In the controlled area, special rules and procedures shall be followed, which aim to protect workers from ionising radiation and prevent the spreading of radioactive substances.

510. The attached appendix (Table A01) lists the limit values for surface contamination in the lowest zone of the controlled area as well as limits for when exiting the controlled area.

5.4 Zones of the controlled area

511. The rooms in the controlled area shall be divided into zones based on external dose rate, surface contamination and airborne radionuclide

concentration. There shall be at least three zones. The minimum zone classification of the facility is given in the attached Appendix (Table A02).

512. External dose rate, surface contamination or airborne radionuclide concentration may locally exceed the classification limit provided that access to the area in question is restricted by access barriers and visibly marked with signs indicating the radiation situation, potential stay limitations and the protective equipment required. Exceptional radiation sources shall be visibly marked.

513. The classification of an area into zones shall be clearly indicated by signs at the entrance. If the radiation situation changes, the signs indicating an area's classification shall be changed correspondingly.

514. An up-to-date record shall be kept of the zone classification of and radiation conditions in the nuclear facility's rooms. The record shall cover conditions during normal operation and the annual maintenance outage.

5.5 Access to the controlled area

515. Access to the controlled area shall be controlled. If the dose rate in a room can exceed 25 µSv/h, the room shall be locked or entrance controlled.

516. The spreading of contamination in the controlled area shall be restricted where necessary by keeping rooms locked and limiting access to them.

517. The use of dose monitoring devices shall be easy to verify. Those accessing the controlled area shall have a personal badge visible for identification.

518. At least protective overalls and shoe covers shall be used as protective clothing together with additional protective gear (protective gloves and shoes, respirators) required in a specific task. Shoe covers may be replaced by shoes (plant shoes) that are only used in the controlled area. Protective overalls may be replaced by protective coats in case of justified exceptions if the contamination risk of clothes is low. If any of these principles are deviated from, approval for substitutive procedures shall be obtained from STUK.

519. Eating, drinking and smoking are prohibited in the controlled area. Separately allocated cafeterias and break areas can constitute an exception to this rule. The use of water dispensers can constitute an exception as well. However, these premises and dispensers may only be used when it can be ensured by radiation measurements that their use will not cause any internal radiation exposure to workers.

520. Those leaving the controlled area shall be checked with a measuring instrument for surface contamination. The instrument's measuring geometry shall be such that it duly covers the body, limbs and head of those being measured. The area may be normally exited if a worker's contamination limits are not exceeded (see the appendix, table A01). If any of these principles are deviated from, approval for substitutive procedures shall be obtained from STUK.

521. Measurement results exceeding the surface contamination limit shall be registered. Procedures shall be in place for the changing of contaminated protective clothing. Appropriately equipped personnel decontamination rooms shall be available at the nuclear facility for the elimination of surface contamination in workers.

522. Materials removed from the controlled area shall be measured for surface contamination. Materials may be removed if the limits in table A01 are not exceeded. Clearance of nuclear waste is described in Guide YVL D.4.

5.6 Radiation work permit

523. A radiation work permit or instruction is required for work done in the controlled area if justifiable on radiation safety grounds. A permanent permit may be issued for routine and repetitive tasks. The methods and responsibilities for issuing the radiation work permit shall be defined in the facility's radiation protection instructions. If necessary, a radiation work permit for multi-phased work may be divided into different phases.

524. The radiation work permit or related documents shall include at least the following:

- issuer (also who approves it, if not the same individual)
- date of issue
- foreman (or the names and number of workers)
- work site and its radiation conditions
- description of work
- requirements for measurement of dose rate, surface contamination and airborne nuclide concentration
- radiation protection measures or instructions and required protective equipment.

525. The radiation work permit shall be kept visible at the work site. If not possible due to a lack of space etc., the radiation work permit shall be made available so that the workers and radiation protection personnel can, where necessary, easily check the work site requirements indicated in the radiation work permit.

6 Radiation work categories and medical surveillance of radiation workers

6.1 Radiation work categories

601. Radiation workers shall be categorised into radiation work categories A or B under the Radiation Decree. Under Section 10 of the Radiation Decree, *category A shall include those workers whose effective dose caused by their work exceeds, or may exceed, 6 mSv per year, allowing for the possibility of a work-related incident resulting in abnormal radiation exposure, or whose equivalent dose is or may be greater than three tenths of the dose limits stipulated for the lens of the eye, the skin, hands or feet.*

602. *Radiation work category B worker is a worker who performs radiation work and does not belong to radiation work category A.*

603. *Those working in the controlled area of nuclear facilities usually belong to category A. However, if category B workers are allowed to carry out work in the controlled area of the nuclear facility, this shall be justified. If a category B worker's radiation exposure at the nuclear facility exceeds 6 mSv in a year, this event and its causes shall be immediately reported to STUK.*

604. According to Section 37 of the Radiation Act, *a person performing radiation work shall have attained the age of 18 years. Persons younger than this, but not less than 16 years of age, may participate in the use of radiation sources insofar as this is necessary for their vocational training. They are not categorised as radiation workers, however.*

6.2 Medical surveillance

605. The Occupational Health Care Act (1383/2001) and regulations given under it enact in general terms the arranging of occupational health care for workers.

606. The nuclear facility shall ensure that radiation workers are covered by medical surveillance for those engaging in radiation work. The medical surveillance of radiation work category A workers shall be arranged in accordance with Chapter 9 of the Radiation Act and Chapter 3 of the Radiation Decree. The details of implementing medical surveillance are given in Guide ST 7.5.

607. The medical surveillance of radiation workers aims, among other things, to

- ensure their suitability for radiation work and that their health does not prevent it
- ensure that they are capable of using the protective equipment required in radiation work
- monitor their health during radiation work to detect in particular such potential changes that would prevent them to continue radiation work
- determine the health significance of exposure whenever it is established or suspected that exposure exceeds the dose limit or is otherwise exceptional.

608. The organisation operating the nuclear facility shall give to external workers, either directly or via their employer, all necessary information and explanations on work site circumstances and

on any changes in operation. The information shall be forwarded to the medical practitioner responsible for medical surveillance. In addition, the licensee shall obligate external employers to forward the dose information of their workers to the medical practitioner responsible for medical surveillance.

609. The nuclear facility shall keep a record of the medical examinations of category A workers.

610. The medical surveillance of workers participating in emergency situations is addressed in Guide YVL C.5.

7 Monitoring of radiation exposure

7.1 General principles in radiation exposure monitoring

701. Section 11 of the Radiation Decree states the following about dose monitoring:

Individual monitoring shall be arranged for category A workers in order to monitor radiation doses due to their work. The monitoring shall be based on personal dose measurements or on some other appropriate method for determining individual doses.

702. All workers in the nuclear facility's controlled area shall be provided with personal dosimeters.

703. When not in use, personal dosimeters shall be kept by the entrance of the controlled area or in some other way approved by STUK so that

- their use can be monitored
- their exposure to background radiation, ultraviolet radiation and strong light is low
- ambient humidity and temperature of the dosimeter racks does not compromise their functioning
- reading of dose and checking for surface contamination are easily done.

704. Dosimeters and their racks shall be provided with identification data. Dosimeters in permanent use shall be provided at least with the identification number and the user's name.

705. A personal dosimeter is used for determining the average radiation dose of the whole body. The dosimeter shall be placed in a position enabling a representative measurement. Other dosimeters shall be used where necessary to determine, e.g. in cases of uneven radiation exposure, the dose to the different parts of the body.

706. The radiation exposure of personnel working in the supervised area shall also be evaluated.

707. Under Section 12 of the Radiation Decree, the scope of individual dose monitoring of workers other than those in radiation work category A shall ensure that

1. *the monitoring is adequate to verify that workers have been classified appropriately into categories A and B;*
2. *the radiation exposure of workers can be determined, and*
3. *unforeseen abnormalities in factors affecting the radiation exposure of workers can be detected without delay.*

708. If transfers of material are made in the nuclear facility's supervised area or uncategorised areas that could entail an occupational dose deviating from regular background radiation in the area, workers shall be subject to personal dose monitoring considering the possibility of a work-related event leading to abnormal radiation exposure.

709. In order to ensure that dose limits are not exceeded, occupational doses earlier in the year and during the previous four years shall be established prior to engaging in radiation work at a nuclear facility. Those responsible for dose monitoring at the nuclear facility shall, where necessary, obtain user rights to the national Dose Registry to access such dose data. In other cases, the worker's dose pass or, where necessary, other official document shall be used to establish their dose data.

710. Emergency situations shall be taken into account in determining radiation exposure and the availability of dosimeters. Emergency situations are addressed in Guide YVL C.5.

7.2 Determination of external radiation exposure

711. Under Section 12 of the Radiation Act, *the expression approved dosimetric service shall refer to an operational unit or service provider that is responsible for measuring and determining the personal radiation doses of workers as part of radiation exposure monitoring, and which has been approved by the Radiation and Nuclear Safety Authority – STUK in the manner prescribed in Section 32 of this Act.*

712. Section 32 a of the Radiation Act states the following about the approval of dosimetric services:

[– –] The prior approval of the Radiation and Nuclear Safety Authority shall be sought for the dosimetric service before operations begin.

When assessing the acceptability of a dosimetric service particular attention shall be paid to the suitability of measuring procedures, to the competence of measuring personnel and to the quality system employed in operational control. Dosimetric services shall be approved for a specified period not exceeding five years at a time.

713. The measurand in dose monitoring shall be personal dose equivalent $H_p(10)$ (penetrating) for high-energy photon radiation and $H_p(0.07)$ (superficial) for low-energy photon radiation and beta radiation. The measurand for a dose to the lens of the eye is $H_p(3)$.

714. Valid standards, guidelines and recommendations shall be taken into account in the planning, approval and use of the system. The essential documents at the time of publishing this Guide are presented in references [21, 22, 23, 24].

715. The prerequisites for approval and operation are that

- the measuring system has been tested, inspected and suits the task in question
- training for the users of the measuring system and the operating organisation is sufficient for the performance of the task
- a quality control programme is used to ensure the reliability of measurements
- the measuring system's calibration can been traced to a national or international metrology laboratory.

716. The operation of an approved dosimetry service requires the presence of trained experts at the plant capable of quickly determining the radiation dose of a worker, where necessary.

717. A personal dosimeter is to

- distinguish between a deep dose and skin dose
- reliably measure a deep dose arising from gamma radiation within the range of 0.1 mSv…1 Sv when photon energy is between 80 keV...3 MeV
- detect neutron doses, if necessary
- detect dose to the lens of the eye, if necessary.

718. The dosimeter's response to photon radiation shall be known also outside the energy range mentioned above. The energy response shall be taken into account in the determination of both a deep dose and skin dose.

719. Dose measurement may be hampered by the simultaneous presence of different radiation types and energies. This shall be taken into account in tests surveying the properties of dosimeters.

720. The nuclear facility shall have procedures and instructions in place to ensure continuous high-quality dose monitoring.

721. The monitoring of radiation exposure shall also function under such exceptional conditions where it is not possible to use the equipment normally employed for dose reading. Examples of such conditions include a long-term loss of power supply to equipment used for the determination of radiation exposure or contamination of rooms and equipment used for the determination of radiation exposure. The facility shall have action plans and predetermined procedures for exceptional conditions of this kind.

722. The measurement data yielded by dose monitoring, the dose data calculated based on it and

the calculation method shall be recorded. In addition, records shall be kept of the quality control, maintenance, repair and testing of the equipment used for dose monitoring. The storing time of such information shall be defined in the dose monitoring instructions.

723. The results of the periodic inspections of the individual dose monitoring system shall be submitted to STUK for information.

7.3 Determination of an internal radiation dose

724. The nuclear facility shall have monitoring equipment for the detection of internal radioactivity in those working in the controlled area. The equipment shall be sensitive enough to detect with adequate accuracy from the upper body area such radioactive substances originating from nuclear facilities and emitting gamma radiation, which may, based on the level of radioactivity at the moment of measurement, cause an effective dose exceeding the recording level.

725. In addition, technical equipment and a calculation method shall be available at the nuclear facility for determining the internal dose caused by radionuclides originating from nuclear facilities. In this context, an internal dose means an accumulated effective dose during a period of 50 years arising from the intake of radioactive substances.

726. A nuclide-specific measurement shall be conducted on workers assessed to be at risk from internal contamination due to the nature of their work. Workers from the nuclear facility's permanent staff and from contractors' staff shall be chosen for the measurement. The number of workers chosen shall be adequate to ensure representativeness of monitoring.

727. The data required to determine the internal radiation dose shall be recorded. Information of this kind includes the place and time of exposure, amounts of work-site surface contamination and airborne radionuclide concentration, and also data on previous individual contaminations that required decontamination.

728. Exposure caused by internal radiation shall also be determined whenever measurements to detect contamination of the skin and protective clothing of those leaving the controlled area, or some other observation, indicate that exceptional internal contamination is possible.

729. If an internal occupational exposure originating in a nuclear facility, which exceeds the recording level, is detected based on measurement results, the internal radiation exposure of the other participants in the same work shall be determined.

730. Measurement results shall be recorded. The records shall show the personal data of those measured, the time of measurement and the total activity of measured radionuclides. Measurements not exceeding the detection level shall also be recorded.

731. Excretion or other biological samples, if necessary, may be used to assess an internal dose. The measurement dates shall be chosen to best detect a potential exposure.

732. Internal dose shall be determined by a procedure approved by STUK and described in the licensee's documentation. If the procedure undergoes changes that can impact the determination of an internal dose, STUK's approval for the changes is required. Such changes include changed measuring principles or dose calculation models.

7.4 Determination of a radiation dose in special cases

733. The radiation doses of visitors to the controlled area shall be measured. Group dosimeters may be used if they yield a radiation dose representative of every individual.

734. A calculation method to determine the equivalent dose to the skin or the lens of the eye caused by surface contamination or a radioactive particle, which is approved by STUK, shall be used at the nuclear facility.

735. If only a part of the body (such as head, eyes, hands) is mainly exposed to radiation, the licensee shall have a procedure for the determination of partial body doses approved by STUK.

736. In the monitoring of radiation exposure caused by neutron radiation, dosimeters applicable to the purpose shall be used. An individual monitoring of neutron doses shall be arranged if the deep dose arising from neutron radiation can, under exceptional circumstances, exceed 0.2 mSv per month. Situations of this kind can occur during spent fuel transfers or handling, for example.

7.5 Real-time monitoring of radiation exposure

737. In addition to a system that monitors individual occupational radiation exposure, the nuclear facility shall have a measurement system for the real-time monitoring of the accumulation of occupational radiation dose in the controlled area caused by external radiation. In real-time radiation exposure monitoring, teledosimetry shall be used, where necessary.

738. The information yielded by the real-time dose measuring system shall be used to verify the reliable operation of the measuring instruments used for individual dose monitoring.

739. If the official dose measuring fails due to the dosimeter having been lost or due to some other exceptional event, the dose measurement data recorded by the real-time dose monitoring system may be utilised in radiation exposure assessment. The dose for such a monitoring period shall be reported to the Dose Registry as an estimated dose.

740. Real-time dosimeters shall have a dose display and an adjustable dose alarm as well as a dose rate alarm if necessary.

741. The real-time monitoring of radiation exposure shall gather information for work planning and ensuring that the radiation protection measures are adequate.

8 Reporting radiation doses to the Dose Registry

8.1 General principles

801. Section 34 of the Radiation Act states the following about the keeping of the Dose Registry:

STUK shall keep a file on the radiation exposure of workers engaged in radiation work (Dose Register). The individual particulars of each worker and information on the type of radiation work, the methods used to monitor radiation exposure, factors affecting the exposure and the results of exposure monitoring shall be recorded in the Dose Register.

The responsible party shall ensure that the data to be registered and the results of exposure monitoring are submitted to STUK, itemised in the manner specified by the latter so that the radiation exposure of each worker can be determined.

802. The Personal Data Act (523/1999) shall be complied with in recording doses at nuclear facilities.

803. Radiation dose reporting procedures shall be described in the nuclear facility's instructions. The instructions shall include procedures for normal operational states and exceptional events.

804. If dosimeters other than those of the nuclear facility are used in the controlled area of the facility, it shall be ensured that individual doses are not recorded twice in the Dose Registry.

8.2 Regular reporting

805. Nuclear facilities shall report at least once a month the individual radiation doses of radiation workers to STUK's Dose Registry. To be reported at the same time are the personal data of workers who have started and accomplished work subject to individual dose monitoring as well as the type of work and the starting and finishing dates of work. Under Section 11 of the Radiation Decree, *the responsible party shall ensure that the results of individual monitoring are reported to the worker concerned and to the responsible practitioner.*

806. The personal information to be reported to the Dose Registry includes the name and social security number of a worker and, for a foreign worker name, birth date, sex and nationality. In addition, the radiation work category (A or B) of radiation workers shall be indicated in the report.

807. The name, line of business, contact information and contact person of the employer of a radiation worker shall also be reported to the dose records for inclusion in the Dose Registry.

808. The following limits apply to reporting:

- The recording threshold for a deep dose is 0.1 mSv per month. Individual doses below this level shall be reported to the Dose Registry as zero doses.
- The neutron doses measured shall be reported to the Dose Registry separately. The recording threshold for deep doses resulting from neutrons is 0.2 mSv per month.
- Surface doses and finger doses shall be reported to the Dose Registry separately. Their recording threshold is 1 mSv per month.
- The recording threshold for a dose to the eye is 1 mSv per month.
- The recording threshold for a dose to the thyroid is 2 mSv per month.

809. If an accurate measurement result is below the recording threshold, the radiation dose shall be reported to the Dose Registry as 0 mSv. Doses above the recording threshold are reported to the accuracy of 0.01 mSv.

810. Doses caused by internal radiation shall be reported to the Dose Registry if the dose commitment arising from the intake of radioactive substances originating from work carried out at a nuclear facility exceeds 0.1 mSv. Internal radiation doses shall be separately reported to the Dose Registry within a month from the day of their detection.

811. A nuclear facility shall ensure that the employer of an external worker receives information on the doses incurred by the worker at least once a month. This applies also to doses received by non-Finnish workers. The licensee shall inform the employer about the obligation to provide subcontractors with the radiation dose data if such are employed by the contractor.

812. Nuclear power plants and facilities intended for the storing, handling and final disposal of spent nuclear fuel shall ensure that doses received by Swedish workers are reported also to the central dose records of the Swedish nuclear power plants in a manner agreed upon by the Radiation and Nuclear Safety Authority and Strålsäkerhetsmyndighet [25].

813. Dose incurred in work shall be marked in the workers' radiation passes in an approved manner.

8.3 Reporting exceptional situations

814. Section 13 a of the Radiation Decree states the following about reporting during exceptional situations:

The responsible party shall report the following observations without delay to the workers concerned, the medical practitioner responsible for their medical surveillance and to STUK:

1. *a dose limit has been, or is suspected to have been exceeded,*
2. *a dose constraint referred to in Section 7 has been, or is suspected to have been exceeded, and*
3. *a result of individual monitoring or an observation made in the course of monitoring working conditions differs from what is typical for the practice or working area in question in a manner significant from the point of view of safety. The responsible party shall ensure that abnormal radiation exposures and the reasons for them are investigated and reported, and that the necessary remedial measures are implemented.*

815. If, during an emergency, radiation exposure arises from immediate measures necessary to mitigate a radiation hazard and to bring a radiation source under control it shall be reported to the Dose Registry kept by STUK separate from exposure resulting from other radiation work. If no measurement results are available of the exposure, an exposure estimate with assessment

justification is given. The assessment justification shall be sent to the Dose Registry by letter, for example.

816. Besides the identification data of each worker, the following information is recorded in the Dose Registry: type of radiation work, methods of monitoring for radiation exposure, factors affecting radiation exposure and the results of radiation exposure monitoring.

817. Radiation doses determined using a non-regular method of determination shall be recorded and reported as estimated doses to the Dose Registry kept by STUK. This could be the case if the reading of a personal dosimeter fails or the dosimeter is contaminated, lost or broken. Those having the right to perform these radiation dose determinations shall be nominated in the facility's internal instructions.

818. All events involving an occupational exposure in excess of dose limits or unclear radiation exposures shall be immediately reported to STUK in accordance with Guide YVL A.10.

9 Regulatory oversight by the Radiation and Nuclear Safety Authority

901. STUK oversees the implementation of radiation protection at a nuclear facility over the nuclear facility's entire lifetime. STUK has separate inspection programmes for the construction, commissioning, operation and decommissioning of a nuclear facility.

902. STUK reviews the descriptions of radiation protection procedures and the available measuring equipment and procedures as part of the review of the facility's Preliminary and Final Safety Analysis Reports and the facility's sets of instructions.

903. STUK oversees the nuclear facility's design, construction, operation and decommissioning as described in Guide YVL A.1. Guide YVL A.6 describes STUK's monitoring of the annual maintenance outage and Guide YVL A.8 monitoring of modifications, repairs and maintenance work.

904. STUK reviews the operational reports discussed in this Guide and approves the dosimetry services used by nuclear power plants. Documentation required in the procurement and use of instruments used for the measurement of radiation exposure is discussed in more detail in Guide YVL C.6.

905. The Nuclear and Radiation Safety Authority inspects items significant for radiation protection and the implementation of modifications as well as conducts other inspections during outages. As a part of the periodic inspection programme, STUK oversees the implementation of radiation protection and the monitoring of radiation exposure at the plant site. STUK conducts at its discretion other inspections of operations essential for radiation protection.

906. An approval shall be applied in accordance with Guide YVL A.1 for significant modifications at nuclear facilities. STUK conducts at its discretion a separate commissioning inspection of significant modifications to the controlled area.

907. STUK conducts at its discretion blind tests of the dose measurement system to ensure its functionality and accuracy.

908. In radiation protection and the determination of radiation exposure, STUK contributes to research, international operating experience feedback work, follows the advancement of science and technology nationally and internationally as well as reports the implementation of radiation safety in its reports (i.a. quarterly and annual reports).

Definitions

Dose limit

Dose limit shall refer to a maximum value that a radiation dose must not exceed within a specified time period.

Dose constraint

Dose constraint shall refer to a limit value lower than the dose limit that is used to implement the optimisation principle and to account for exposure arising from different radiation sources.

Dose Registry

Dose Registry shall refer to a file into which the dose information and identification information of the employees engaged in radiation work is saved.

Decontamination

Decontamination shall refer to cleaning radioactive substances from components, structures or rooms.

Effective dose

Effective dose shall refer to the weighted sum of the equivalent doses in tissues and organs exposed to radiation, where equivalent dose denotes the product of the mean energy imparted by radiation to tissue or to an organ, per unit mass, and a weighting factor specified for the radiation.

Derived Air Concentration (DAC)

Derived air concentration shall refer to a radionuclide-specific maximum value for the average airborne activity concentration, under which 2,000 hours of work may be carried out annually without exceeding the dose limits.

Contamination

Contamination refers to undesirable radioactive substances on surfaces (surface activity), or within solids, liquids or gases (also in the human body).

Radiation exposure

Radiation exposure shall refer to being exposed to radiation.

Supervised area

Supervised area shall refer to an area where working conditions are supervised in order to protect employees against radiation. However, area is not designed as controlled area and normally no special radiation protection measures are needed.

Controlled area

Controlled area shall refer to a working area in which specific radiation protection procedures shall be followed and to where access is controlled.

Annual dose

Annual dose shall refer to the sum of the effective dose arising from external radiation within the period of one year, and of the committed effective dose from the intake of radioactive substances within the same period of time. (Government Decree 717/2013)

Annual Limit on Intake (ALI)

Annual limit on intake (ALI) shall refer to a radionuclide specific maximum value for activity that may enter the body without the annual limit of the effective dose being exceeded. When more than one radionuclides enter the body, the annual limit of the effective dose is not exceeded when the sum of the activities entering the body from all radionuclides divided by the annual limits on intake of the said nuclides does not exceed one.

Zone classification

Zone classification shall refer to the division of the premises of the controlled area into zones based on the external dose rate, surface contamination and airborne radionuclide concentration.

References

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2. Nuclear Energy Decree (161/1988).
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6. Radiation Act (592/1991).
7. Radiation Decree (1512/1991).
8. Occupational Health Care Act (1383/2001).
9. Personal Data Act (523/1999).
10. The 2007 Recommendations of the International Commission on Radiological Protection, ICRP Publication 103, Annals of the ICRP, Volume 37, Nos 2-4 2007, ISBN 978-0-7020-3048-2.
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13. IAEA, Radiation Protection and Safety of Radiation Sources: International Basic Safety Standards, No. GSR Part 3 (Interim), Vienna 2011
14. Guide ST 7.5, Medical Surveillance of Occupationally Exposed Workers, Radiation and Nuclear Safety Authority.
15. Guide ST 7.2, Application of Maximum Values for Radiation Exposure and Principles for the Calculation of Radiation Dose, Radiation and Nuclear Safety Authority.
16. Guide ST 1.3, Warning Signs for Radiation Sources, Radiation and Nuclear Safety Authority.
17. Guide ST 12.1, Radiation Safety in Practices Causing Exposure to Natural Radiation, Radiation and Nuclear Safety Authority.
18. Guide ST 7.3, Calculation of the Dose Caused by Internal Radiation, Radiation and Nuclear Safety Authority.
19. Guide ST 7.4, The Dose Register and Data Reporting, Radiation and Nuclear Safety Authority.
20. Guide ST 1.9, Radiation Practices and Radiation Measurements, Radiation and Nuclear Safety Authority.
21. IEC 61066:2006 Thermoluminescent dosimetry system for personal and environmental monitoring.
22. ISO/IEC-EN 17025:2005 General requirements for the competence of testing and calibration laboratories.
23. RP 160:2009, Technical Recommendations for Monitoring Individuals Occupationally Exposed to External Radiation, EC.
24. IEC 62387-1:2007 Radiation protection instrumentation – Passive integrating dosimetry systems for environmental and personal monitoring – Part 1: General characteristics and performance requirements.
25. Agreement between STUK-SSM concerning the routines in delivering dose information of NPP workers between Sweden and Finland, 16 June 2006 (in Swedish only).

Appendix A Tables

Table A01. Limit values for surface contamination at a nuclear facility.

Radioactive substance	Work sites and tools and materials used in work	Workers	
	Lowest zone in the controlled area Bq/cm²	Clothes Bq/cm²	Skin Bq/cm²
Alpha emitters (radiotoxity class 1)	0.4	0.4	0.2
Other nuclides	4	4	2

Table A02. Zone classification of a nuclear facility.

	External dose rate	Surface contamination (surface activity)	Derived Air Concentration (DAC)
Zone 1	≤ 25 µSv/h	Beta emitters ≤ 4 Bq/cm² Alpha emitters ≤ 0,4 Bq/cm²	≤ 0.3 DAC
Zone 2	25 µSv/h…1 mSv/h	Beta emitters 4 Bq/cm²…40 Bq/cm² Alpha emitters 0.4 Bq/cm²…4 Bq/cm²	0.3 DAC…30 DAC
Zone 3	≥ 1 mSv/h	Beta emitters ≥ 40 Bq/cm² Alpha emitters ≥4 Bq/cm²	≥ 30 DAC