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Title	General Instructions for Radiation Protection at the Paul Scherrer Institute
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Summary:

The essential aspects of safety, security, health protection and environmental protection (SSHE "*Sicherheit, Gesundheitsschutz und Umwelt*" known as "SGU") are based on the Paul Scherrer Institute's Organisational Regulations, and are governed by "SGU directive" AW-01-07-02 [1].

In addition, these General Instructions issued by the Department of Radiation Safety and Security (*Abteilung Strahlenschutz und Sicherheit, ASI*) set out the regulations relating to radiation protection at PSI, together with the responsibilities according to Article 132 of the Swiss Radiation Protection Ordinance (*Strahlenschutzverordnung, StSV*) and Appendix 3 of the Swiss Nuclear Energy Ordinance (*Kernenergieverordnung, KEV*). They also include the fundamental modes of conduct for the protection of staff and the environment from the risks caused by radioactive materials and ionising radiation.

The structure of the process used by ASI to implement the instructions is documented in the ASI quality management system.

In line with practice adopted in the statutory texts, this document often uses only the masculine personal form. All descriptions always apply equally to women.

These instructions were approved at the Directorate meeting on 19 November 2008 and entered into force on 1 January 2009. Review 6 was approved by the Director on 15 March 2016.

Dist.	Dept.	Recipients	Copies	Dept.	Recipients	Copies		Copies
	PSI	All non-German speakers who work in a controlled zone		PSI	All spokesmen and main proposers of experimental groups		Library	2
	BAG	Via the PSI Safety Delegate	1		Experimental barracks	1	Reserve	1
	ENSI	Via the PSI Safety Delegate	1	9600	All Radiation Protection Officers	each	Total	50
		Publication on the Intranet and reference in PSI-Aktuell			Dosimetry unit PSI-West		Pages	37
					Dosimetry unit PSI-East		Encls.	-
				1300	Human resources management		Checked:	
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1 Introduction

1.1 Purpose

- 1 These instructions govern the way in which radioactive materials and ionising radiation are handled at PSI.
- 2 The main purpose of radiation protection is to protect staff and the environment.
- 3 We aim to make radiation protection at PSI clear and comprehensible by presenting the instructions, responsibilities and processes in a transparent manner.

1.2 Statutory foundations

- 1 The Swiss Federal Nuclear Safety Inspectorate (*Eidgenössisches Nuklearsicherheitsinspektorat, ENSI*) is the regulatory authority for nuclear safety and radiation protection for PSI's nuclear facilities. The Swiss Federal Office of Public Health (*Bundesamt für Gesundheit, BAG*) is responsible for activities relating to the non-nuclear facilities, including the application of ionising radiation and radioactive materials to the human body and animals.
- 2 The Radiological Protection Act (*Strahlenschutzgesetz, StSG*) and the Radiation Protection Ordinance (*Strahlenschutzverordnung, StSV*) lay down the legal principles for dealing with radioactive materials and ionising radiation.
- 3 In addition, the Swiss Nuclear Energy Act (*Kernenergiegesetz, KEG*) and the Nuclear Energy Ordinance (*Kernenergieverordnung, KEV*) also apply to the nuclear facilities.
- 4 The further legal framework is provided by e.g. the ENSI Guidelines ENSI-B03 ("Guidelines for Swiss Nuclear Installations"), ENSI-B04 ("Measuring Safe Levels of Materials and Areas"), ENSI-G09 ("Operational Documentation") and HSK-R-07 ("Guideline for Monitored Zones in Nuclear Installations and the Paul Scherrer Institute") as well as the ADR ("European Agreement concerning the International Carriage of Dangerous Goods by Road") and the SDR ("Swiss Federal Ordinance on the Transport of Hazardous Goods by Road"). The ENSI Guidelines can be accessed using the following link:
<http://www.ensi.ch/de/document/document-category/richtlinien-schweizer-kernanlagen/title/ascending/?per-page=all>.
- 5 ENSI, BFE and BAG issue the appropriate authorisations and approvals to operate those facilities at PSI where radioactive materials or ionising radiation occur.
- 6 The above documents form the basis for a closely woven set of regulations, directives and instruction leaflets. The Department of Radiation Safety and Security (ASI) keeps a list of the relevant documents applicable to radiation protection at PSI. All PSI employees can access this list via the ASI Intranet site, while all other persons according to Section 1.4 Point 1 can get access via the contact persons set out in Section 3.1 Points 6 and 8.

1.3 Structure of PSI documents with respect to radiation protection and safety

- ¹ Together with AW-01-07-02 (Safety, Security, Health Protection and Environmental Protection (SSHE) instructions) [1], these instructions constitute the radiation protection regulations that are mandatory for the use of nuclear facilities, other controlled zones and work areas of PSI, and therefore form part of the operational regulations of the nuclear facilities.
- ² The other applicable documents can be accessed by all PSI employees via the ASI Intranet site, while all other persons pursuant to Section 1.4 Point 1 can get access via the contact persons set out in Section 3.1 Points 6 and 8.

1.4 Scope

- ¹ These instructions are binding for all persons at PSI who deal with radioactive materials or facilities used to generate ionising radiation, or who spend time in controlled zones (see Section 6.1) for any other reason.
- ² These instructions apply throughout the entire PSI sites in Würenlingen and Villigen, i.e. both inside and outside the fenced-off supervised areas of the operational sites, and on the works road that connects them. The precise fenced-off, supervised areas of the operational sites and the declared controlled zones are updated by the Operational Radiation Protection Section (*Betriebsstrahlenschutz, BSS*) every year, and notified to the regulatory authorities.

1.5 Quality assurance

- ¹ The ASI activities are set out in a quality management system (QMS), which is evaluated on a periodic basis.
- ² The ASI-QMS encompasses the following activities and facilities:
 - Inspection body (Type A) SIS 034 responsible for ensuring the protection of individuals and the environment from threats caused by ionising radiation: checking the radiation protection measuring equipment, radiation monitoring system and professional transportation of radioactive and nuclear materials.
 - Calibration laboratory SIS 075 for radiation protection measuring equipment.
 - Testing laboratory STS 173 responsible for analysing radio isotopes as part of the immission, emission and incorporation monitoring processes (*in vitro*).
 - Testing laboratory STS 491 for personal dosimetry, *in vivo* radioactivity measurement and environmental dosimetry.

2 Basic principles and stipulated aims of radiation protection

2.1 Justification

- ¹ Since any exposure to radiation entails a potential health risk, any task that involves people being exposed to ionising radiation may only be undertaken if the benefits associated with it outweigh the disadvantages caused by the radiation. Any **unnecessary exposure** of individuals to radiation must be **avoided**.

2.2 Optimisation

- ¹ In the case of activities where exposure to radiation is justified, radiation protection must be optimised to limit exposure to radiation based on experience, the latest scientific findings and technology to limit radiation exposure. Optimisation measures must be taken to achieve a further reduction in dose. The principle of “As Low as Reasonably Achievable” (**ALARA**) applies.
- ² When designing and operating facilities that are used to generate ionising radiation, care must be taken to ensure that as little radioactive waste as possible is produced.
- ³ This duty of optimisation still applies even if it is unlikely that a dose limit value or guideline value will be exceeded.

2.3 Limits

- ¹ Any individual who handles or is responsible for radiation sources must take all the necessary steps to comply with the dose limit values prescribed by StSV.
- ² The release of radioactive materials into the environment (emissions) and direct irradiation from PSI facilities must be maintained at the lowest possible level, and the conditions specified in the relevant approvals must be met.
- ³ The dose limit values in Table 1 in Appendix 1 apply.
- ⁴ The limit values for emission of radioactive materials in Table 2 in Appendix 1 apply.
- ⁵ The limit values for immission of radioactive materials in Table 3 in Appendix 1 apply.
- ⁶ The categories for the transport of radioactive materials and nuclear materials in Table 4 in Appendix 1 apply, alongside the dose output limits and activity.
- ⁷ The limit values for release of inactive materials in Table 5 in Appendix 1 apply.

3 Organisation of radiation protection

3.1 Structure of responsibilities

- ¹ The PSI Director bears overall responsibility for the safety of the facilities. He has delegated the associated duties and tasks relating to radiation protection to the delegated radiation protection expert (*Beauftragter Strahlenschutz-Sachverständiger*) and equipped him with the necessary powers.
- ² The delegated radiation protection expert ensures that the statutory and official instructions relating to radiation protection are implemented correctly in-house in line with operational needs, and he monitors compliance. He is supported by recognised, full-time ASI radiation protection experts that carry out the tasks assigned by him. He uses inspections and audits to monitor the work of the full-time and part-time (See Section 3.1 Point 3) radiation protection staff, and reports to the Director.
- ³ Part-time specialist personnel known as radiation protection officers (*Strahlenschutzbeauftragte*) may also undertake radiation protection duties relating to third parties within certain clearly defined areas of activity that have a well-known potential for radiological hazard, particularly in laboratories [2]. Organisationally, these individuals do not report to ASI but to the relevant facility or laboratory manager. They must provide evidence of having one of the radiation protection qualifications recognised by the authorities. The scope of their powers must be set out in writing, by agreement with the BSS group leader responsible. The contact information for all part-time radiation protection officers is listed on the ASI Intranet site for all PSI employees. All other persons pursuant to Section 1.4 Point 1 can obtain this information from the contact persons set out in Section 3 Points 6 and 8.
- ⁴ Part-time specialists may also be appointed to assume responsibility for other tasks related to radiology (officers responsible for sources [3], transportation [4], hazardous goods (pursuant to SR 741.622, Swiss Ordinance on Officers responsible for the Transportation of Hazardous Goods by Road, Rail and Water (*Verordnung über Gefahrgutbeauftragte für die Beförderung gefährlicher Güter auf Strasse, Schiene und Gewässern*)) and transport coordinators [5] etc.). They are required to hold an adequate, documented qualification in line with the relevant subject, and their tasks and powers must be set out in writing.
- ⁵ PSI line managers bear responsibility in line with their level of seniority for ensuring that all regulations are followed within their area of responsibility, and that their staff and the external personnel that report to them receive adequate radiation protection training in their respective tasks and responsibilities [1].
- ⁶ If PSI facilities are handed over for use to experimental groups in which experiments are carried out by external personnel, the leaders of the user groups (spokesmen or main proposers) must nominate the corresponding contacts. These individuals are responsible for compliance with PSI's internal radiation protection regulations. The primary responsibility for radiation protection remains with the PSI contact.
- ⁷ Anyone who employs an individual to work in a controlled zone must ensure that these individuals are made known to the BSS group leader responsible at an early stage so that they can be categorised as a person "occupationally exposed to radiation" or "not occupationally exposed to radiation", and the necessary dosimetric monitoring can be

arranged [6]. In experimental groups, this is the responsibility of the leaders of the user groups (spokesmen or main proposers) or their PSI contacts.

⁸ Anyone who intends to employ external companies in controlled zones must inform the BSS group leader responsible in advance so that the authorisation situation and the scope of dosimetric monitoring can be clarified [7]. A responsible contact who is familiar with the PSI regulations must also be nominated to supervise any short-term access by external staff to a PSI controlled zone.

⁹ New projects and activities that may entail the emission of ionising radiation as well as intended changes to existing facilities of relevance for radiation protection must be notified to the BSS section leader in good time so that an evaluation of the radiation risk can be undertaken. In the case of larger projects, the ASI Department Head appoints an ASI project consultant, who inputs ASI concerns in an ongoing manner into the project.

¹⁰ Anyone who intends to bring a radioactive source onto the PSI site must declare this intention in accordance with Section 8, Point 5.

¹¹ ASI's full-time radiation protection staff, in particular the BSS section, must ensure safe operation by comprehensively monitoring the radiological condition of the facilities. This monitoring should be continuous at important locations. The radiation monitoring (*Strahlenüberwachung, SU*) group leader of the BSS Section, together with the SU technicians and specialists (SU staff) allocated to the group leaders, advise and support the facility and project managers in the practical implementation of the in-house instructions regarding radiation protection, including working methods and protective measures. From a statutory viewpoint, they are entitled to prohibit work where this prohibition is necessary for radiation protection reasons. They can ban individuals from handling ionising radiation on a temporary basis. They can also exclude individuals from controlled zones if they violate the radiation protection regulations, thus exposing themselves or others to the risk of unauthorised radiation.

¹² The regulatory authorities are entitled to inspect documents, and to demand access to operations in so far as this is necessary for the fulfilment of their regulatory duty.

¹³ The ASI organisational structure is given in Figure 1 in Appendix 2.

¹⁴ Table 6 to Table 14 in Appendix 3: Overview of the responsibilities for all matters relating to radiation protection at PSI provides an overview of the organisational responsibilities for all matters relating to radiation protection at PSI.

¹⁵ The contact information for the individual radiation protection office-holders is listed on the ASI Intranet site for all PSI employees. All other persons pursuant to Section 1.4 Point 1 can obtain this information from the contact persons set out in Section 3 Points 6 and 8.

3.2 Authorisations of the radiation protection office-holders

¹ The authorisations of the BSS and the specialists appointed by it (for their area) are summarised in Appendix 4: Authorisations.

4 Basic and advanced training in radiation protection

- 1 Any individuals who handle ionising radiation must be trained in radiation protection to a level that is appropriate to their position and their responsibilities. They must undergo regular training in order to maintain their basic knowledge. In particular, they must be informed of the possible health risks, and learn how these can be minimised by the use of appropriate working methods. The head of the department, laboratory or facility defines the type and scope of the training, in agreement with the BSS group leader responsible.
- 2 The training courses are normally staged at PSI's Radiation Protection School. Equivalent training courses at other institutions are recognised.
- 3 Basic radiation protection training is mandatory for all new employees at PSI. Staff will be notified of the time and location of this training when they join the institution.
- 4 In addition to their basic training, new employees working in PSI controlled zones must also undergo induction by their superior or a person instructed by him in the appropriate working methods, the relevant radiation protection regulations that are specific to each location and activity, and the risks caused by incorrect behaviour at the workplace.
- 5 People carrying out experiments at the PSI-West accelerator facilities must successfully complete a PC-driven interactive introduction to radiation protection, designed specifically for the relevant facility, before they start working at PSI for the first time and at two-yearly intervals. Only then they will be issued with their personal dosimeter and the associated approval to work in the controlled zones.
- 6 Any employees of external companies working for longer than two weeks in controlled PSI zones must have completed basic radiation protection training, and received instructions on how to behave if any incidents should occur. In the event that such employees work for shorter periods in controlled zones, they must be instructed and supervised by their PSI contact.
- 7 Radiation protection officers must have a radiation protection qualification recognised by the regulatory authority, and have an internal PSI appointment by BSS in order to exercise their function.
- 8 The radiation protection specialists, technicians and full-time experts must have a radiation protection qualification recognised by the regulatory authorities in order to exercise their function.
- 9 The Radiation Protection School runs revision courses as part of its advanced training programme. Superiors send their staff on these courses as required, or at the request of the BSS group leader responsible.
- 10 The training courses must be documented in writing, and the relevant documents must be passed on for storing in the personal file to Human Resources. This documentation must be kept in a safe place for ten years from the time at which the relevant individual leaves the position, stops carrying out the function, or completes the task.

5 People-related instructions and principles

5.1 Classification of workers

¹ In general StSV distinguishes between people who are “occupationally exposed to radiation” and “not occupationally exposed to radiation”. The regulation applicable at PSI derived from that distinction can be found in the document “Personal dosimetry at PSI” [8]. The explanations in Sections 5.1.1 and 5.1.2 apply in particular.

5.1.1 People who are “occupationally exposed to radiation”

¹ People who are “occupationally exposed to radiation” are defined as all those people who could accumulate an effective dose of more than 1 mSv per year from a controllable source of radiation, or be at risk of incorporating radioactive substances as a result of their professional or training activities. This group of people also includes all those individuals (including the employees of external companies) who expect to spend time in the PSI controlled zones for a total of more than two months in the course of a year. This category is independent of the possible accumulated personal dose.

² Within their own areas of responsibility, BSS group leaders decide whether individuals should be classified as “occupationally exposed to radiation” or “not occupationally exposed to radiation”, based on their specific functions. The decision about classification is made on the basis of the information provided by the line manager (“Questionnaire on personal dosimetry at PSI” [9]). Any persons who have previously been classified as “occupationally exposed to radiation” must hand their personal dose document over to the dosimetry service.

³ The personal dose must be established by the PSI dosimetry service on an individual basis for all those people who are “occupationally exposed to radiation” [8]. The BSS group leader decides on the type of dosimeter to be worn.

⁴ PSI employees who are “occupationally exposed to radiation” regularly undergo precautionary examinations to establish their fitness for working with ionising radiation (see Section 5.5).

⁵ Young people under the age of 16 may not be employed as persons who are “occupationally exposed to radiation”.

⁶ Breast-feeding mothers may not carry out any work involving radioactive materials where there is a risk of incorporation or radioactive contamination.

5.1.2 Other persons

¹ “Other persons” as defined by these instructions are individuals who can be in controlled zones at PSI but who are not occupationally exposed to radiation in accordance with StSV. This relates in particular to: (i) Individuals who only work sporadically (for a total of less than two months per year) in controlled zones, and who accumulate less than 0.5 mSv per year, (ii) Individuals who sporadically enter (approximately 1 day/week) controlled zones but accumulate < 1 mSv/year or (iii) course graduates [8]. Their personal dose must also be determined individually by the PSI dosimetry service.

- 2 For those people who only stay in controlled zones for a short time (e.g. visitors), there is no need to determine the personal dose individually (e.g. group dosimeters could be used). The competent contact is responsible for ensuring that the required dosimetry is carried out correctly.

5.2 External dosimetry

- 1 Various types of dosimeter are used to monitor external exposure to radiation at PSI, depending on the activity and the place of work. The main distinction is made between neutron and photon dosimeters and between whole body and partial body dosimeters (e.g. finger ring dosimeters).
- 2 The BSS group leaders decide which type of dosimeter must be worn to determine the external personal dose. The PSI dosimetry service supplies personal dosimeters. It organises changes of dosimeter and evaluates the dosimeter on a three-monthly basis.
- 3 Dosimeters (labelled, personal dosimeters) are explicitly assigned to individual people to determine individual personal doses. The SU staff responsible can require that additional electronic dosimeters with a direct readout be worn for activities involving increased exposure to external radiation.
- 4 Each person has a duty to wear their personal dosimeter visibly on their torso, chest or abdomen when they enter a controlled zone. If they are wearing a lead apron, their dosimeter should be worn under the apron.
- 5 If PSI employees are working in a controlled zone in a different establishment (national or international), they will be under the control of the dosimetry service at that location. Any accumulated dose that may occur must be notified to the dosimetry service at PSI. The PSI personal dosimeter may only be worn at PSI.
- 6 In the event of absence from PSI, the personal dosimeter must be deposited in the boxes provided for this purpose at the relevant entrance to the site.

5.3 Internal dosimetry

- 1 The BSS group leaders decide within their own particular area of responsibility whether and how an individual must be subject to incorporation monitoring. This decision depends on the risk of incorporation and the information provided by the superior.
- 2 Incorporation monitoring is implemented by means of formal incorporation measurements or through simplified tests on site (triage testing).
- 3 In the case of certain activities, triage testing must be used for incorporation monitoring [10], [11]. This triage testing is organised by BSS. An incorporation measurement must be undertaken if the triage limit is exceeded.
- 4 Incorporation measurements include whole-body, thyroid and/or urine measurements. PSI's own dosimetry service is responsible for organising these measurements.
- 5 Additional incorporation measurements can also be carried out for special reasons. These are arranged by BSS via the dosimetry service,

5.4 Dose registration

- 1 All the doses recorded individually (external and internal doses) are registered by the PSI dosimetry service. In addition, all doses for people who are “occupationally exposed to radiation” are also reported regularly to the regulatory authorities and the central dose registry. All the doses not recorded on an individual basis (involving short periods spent in controlled zones) are only documented by the office issuing the dosimeter.
- 2 The dosimetry service maintains a database that records personal details and dose values, as well as administrative and organisational information for the work to be carried out. Each registered individual is authorised to view all the information relating to him at the dosimetry service. When their work contract ends, each person “occupationally exposed to radiation” is given a personal dose record containing details of the doses they have accumulated while at PSI.
- 3 The line managers responsible and BSS receive regular database extracts from the dosimetry service, giving the current dose levels for the people reporting to them. Line managers advise their staff on the dosimetry results on an individual basis. This information is personal data in accordance with the Data Protection Act.
- 4 If any tasks are performed outside PSI, the dosimetry service will, upon application, prepare a personal temporary dose document for the facility to be visited.

5.5 Medical monitoring

- 1 All PSI employees classified as “occupationally exposed to radiation” are explicitly required to register with the Swiss Accident Insurance Organisation (*Schweizerische Unfallversicherungsanstalt, Suva*). The preventive medical examination required by Suva must be undertaken within 30 days. Suva’s occupational medicine department assesses the results of the examination and decides whether an individual is suitable for work involving ionising radiation. In justifiable cases, they can demand restrictions on further work in controlled zones. In this case the superior and Human Resources are informed who then decide together the further procedure and take any necessary measures.
- 2 The dosimetry service registers these persons at Suva, organises the medical examinations (initial examination and annual monitoring check-ups) and informs the individuals concerned. All persons “occupationally exposed to radiation” at PSI must undergo the prescribed medical examination.
- 3 Persons aged up to 50 who are expected to carry out tasks in protective suits will also be tested for their suitability for wearing them. The need for this precaution is formulated by these individuals’ line managers. This type of work cannot be assigned to employees who are over 50 years of age.
- 4 External companies who employ persons “occupationally exposed to radiation” and therefore have a BAG approval must ensure the medical aptitude (Suva decision) of the staff to be employed before they begin work.

6 In-house radiation protection

6.1 Controlled zones

- ¹ In order to limit and monitor exposure to radiation, the individual areas or spaces within the fenced supervised PSI operational site and in the training building are defined as “controlled zones” because of their potential radiological risk. According to StSV, controlled zones must, in particular, be established where
- work is carried out with unsealed radioactive sources
 - the possibility of radioactive contamination of the air or surfaces cannot be excluded
 - individuals could accumulate an effective dose of more than 1 mSv per year from external exposure to radiation
 - a zone of this kind is designated by the authorities.
- ² Zones are distinguished in terms of their contamination risk as follows (Values CA and CS in accordance with StSV Appendix 3):
- **Type 0 zone** (yellow zone): surface contamination < 1 CS in Appendix 3, StSV, air contamination < 0.05 CA
 - Zones with an increased risk of contamination in accessible state (yellow zones):
 - Zone type I:** surface contamination < 1 CS, air contamination < 0.1 CA
 - Zone type II:** surface contamination < 10 CS, air contamination < 0.1 CA
 - Zones in which the dose limit for people “occupationally exposed to radiation” can be exceeded as a result of contamination of the surfaces and/or the air in the room (red zones).
 - Zone type III:** surface contamination < 100 CS, air contamination < 10 CA
 - Zone type IV:** surface contamination > 100 CS, air contamination > 10 CA
- ³ Zone types I to IV are all inside buildings, and thus enclosed on all sides. They are subject to graded negative pressure with lower pressure in higher categories. The entrances to the zones are based on the specifications in HSK-R-07 and normally comprise a closet with a barrier and protective clothing in accordance with the clothing provisions, a possibility for measuring contamination and a decontamination facility. The access rules in Section 6.1.2 must be observed.
- ⁴ Within the zones, there is a further sub-division of areas in accordance with directive HSK-R-07 depending on the prevalent ambient dose rate.
- **Area Type V**, where the increase in the ambient dose rate is slight, $\dot{D} < 0.01$ mSv/h (no restriction on length of stay),
 - **Area Types W and X**, where the increase in the ambient dose rate is hazardous, 0.01 mSv/h < $\dot{D} < 0.1$ mSv/h and 0.1 mSv/h < $\dot{D} < 1$ mSv/h (restriction on length of stay),
 - **Area Type Y**, where the increase in the ambient dose rate is very hazardous, 1 mSv/h < $\dot{D} < 10$ mSv/h (severe restriction on length of stay). Access only in line with the Institute’s regulations under the supervision of BSS),

- **Area Type Z**, where the increase in the ambient dose rate is extreme, $\dot{D} > 10$ mSv/h (very severe restriction on length of stay). Access only in line with the Institute's regulations under the supervision of BSS),

5 Areas with higher ambient dose rates are marked and if necessary closed off by the SU staff responsible.

6 Laboratories are divided into the working areas of the following types, depending on the scale of the activities being carried out (authorisation thresholds LA in accordance with StSV, Appendix 3):

- **Laboratory Type C**, with activities involving 1 up to 100 authorisation thresholds per process or per day
- **Laboratory Type B**, with activities involving 1 up to 10,000 authorisation thresholds per process or per day
- **Laboratory Type A**, with activities up to an upper limit defined in the authorisation procedure.

6.1.1 Identification

1 The boundaries of controlled zones are clearly indicated by radiation warning signs. These include the danger sign (the trefoil radiation symbol) at the very least. Depending on the particular radiation sources being used, controlled zones and areas of work have to be indicated in addition in accordance with Appendix 6 StSV and ENSI Directive HSK-R-07.

6.1.2 Access

1 Only those people who have a personal PSI dosimeter are allowed access to controlled zones. Exceptions must be approved by the BSS section leader.

2 Young people aged between 14 and 16 may only enter controlled zones in exceptional cases and for good reason, with the express agreement of the SU staff responsible, and accompanied by a PSI employee with basic knowledge of radiation protection [12].

3 Young people under the age of 14 may only enter controlled zones during special events such as open days, when the zones have been released in advance by the BSS section leader [12].

4 The rules regarding protective clothing, displayed at the entrances to controlled zones must be strictly observed.

6.1.3 Working in controlled zones

1 Young people under the age of 18 may only work in controlled zones for training purposes.

2 Eating, drinking, smoking and applying make-up are all forbidden in controlled zones of Types \geq I, and within all working areas of Types C, B and A.

3 Special clothing for particular zones must be worn in areas of work and other controlled zones with a risk of contamination [12]. The relevant instructions are displayed at the

entrance to the zone. Work clothes that are colour-coded in red or yellow are for exclusive use in the appropriate areas, and must not be worn outside these areas.

4 The contamination monitors positioned at the exits from the zones must be used to check for any possible contamination each time an individual leaves the zone.

5 If contamination is discovered on any individual, the contaminated locations must be decontaminated as locally as possible, in accordance with the instruction leaflet "Immediate measures following contamination of personnel" (*Sofortmassnahmen nach einer Personenkontamination*) available on site, and the radiation protection staff responsible must be informed. If there is any residual contamination, the SU (radiation monitoring) staff responsible must be called in. They will initiate the additional measures designed to prevent the spread of contamination, to obtain samples and (if necessary) to arrange for transfer to the personnel decontamination areas set up specifically for this purpose by ASI. Even after decontamination has been successfully completed, those affected persons must ensure that they can still be contacted to ensure that necessary additional measurements and samples can be obtained.

6 Anyone who wishes to remove material from a controlled zone must call in the SU staff responsible in every case, in order to check and release the material. This applies in particular to all solid waste. Hence, only the material that is directly and absolutely necessary for work should be brought into controlled zones. For example, as much packing material as possible must be removed outside the controlled zone.

7 Barriers and protective equipment around areas that have an increased ambient dose rate (see Section 6.1 Point 4) must not be removed or modified without the permission of the SU staff.

8 As part of the duty of optimisation, a detailed radiation protection plan that meets the requirements of the ASI quality management system must be drawn up for any proposed projects during which collective doses of more than 10 person-mSv could be generated as a result of exposure to external radiation, or where incorporation cannot be excluded [13]. The competent BSS group leader decides to what extent the plan should be implemented, in agreement with the head of the facility and/or the radiation protection officer responsible. Work involving an increased radiation risk may only be started if a positive response has been received from the radiation protection staff responsible.

9 Work that could lead to a collective dose of more than 50 person-mSv has to be approved by the relevant regulatory authority. Working documents that have been optimised with regard to radiation protection must be handed to the head of the BSS section for examination and forwarding in good time before work begins.

6.2 Working with radioactive materials and ionising radiation

6.2.1 Working with sealed radioactive sources

1 The term "sealed radiation sources" only covers those radiation sources that are surrounded on all sides by inactive material, and whose method of construction completely prevents the escape of radioactive materials (and the resulting possibility of contamination) under the anticipated stresses. Test and calibration sources whose activity level exceeds one hundred times the authorisation limit (LA in accordance with

StSV, Appendix 3) must undergo a type test in accordance with the ISO standards and be classified accordingly [3].

2 Sealed radiation sources must be marked in such a way that they can be identified at any time. The radioactive sources service maintains an inventory of all calibration and test sources available at PSI, in accordance with the ASI-QM system, and stores those sources that are not currently required in a room kept especially for this purpose.

3 Radioactive calibration and test sources must be tested every year for leaks. The owner or a person who has been instructed by the owner is responsible for ensuring that these checks are carried out (in accordance with the instructions of the radioactive sources service). Any suspicion of damage to or leakage from a radiation source must be reported immediately to BSS. The head of the BSS section then decides on the further use of this source.

4 If it is not possible to fit suitable shielding in particular cases, the radiation protection staff will decide on any other necessary radiation protection measures.

5 When dealing with radiation sources, care must be taken to ensure that a minimum distance (appropriate to the activity of the source) is maintained between individuals and the radiation source. Suitable tools may be used if necessary.

6 Part-time staff commissioned to work with the sources may undertake and supervise work involving radioactive sources. The details are set out in a separate set of instructions [3].

7 If handling the radiation sources leads to unavoidable exposure, the radiation protection staff can call for a radiation protection plan to be prepared. This covers all aspects of radiation protection relevant for handling this source, including an assessment of the radiation risks and the definition of protection and monitoring measures. The radiation protection plan must be presented to the appointed radiation protection expert for approval.

8 Radioactive sources may only be removed from PSI's operational supervision area after the necessary QM formalities have been concluded, and only with the permission of the radiation protection staff responsible. The radiation protection staff, in collaboration with the transport co-ordinators, provide the client with support in the preparation of the necessary transportation documents.

6.2.2 Working with unsealed radioactive sources

1 The term "unsealed radioactive sources" covers all those radioactive materials that disperse outwards and could cause contamination. Work involving this type of radiation source must be carried out in laboratories or working areas that have been equipped and identified specifically for this purpose. This applies in particular already to the opening of containers holding unsealed radiation sources.

2 If it is impossible to exclude the risk that radioactive aerosols, gases, vapours or radioactive dust might be created during the work, this activity must be carried out in a glove box or in a negative-pressure flow-cupboard. If this proves impossible, a written radiation protection plan must be prepared, taking account of the protective measures specified by the radiation protection staff responsible.

3 Unsealed radiation sources must never be touched by unprotected hands.

4 Any manipulation or storage of radioactive liquids should normally be undertaken in retention vessels. They must be large enough to contain all the available liquid. If this is

not possible, care must be taken to ensure that the potential contamination is restricted to the workroom in the event of accident or mishandling.

- 5 If handling the radiation sources leads to unavoidable exposure, the radiation protection staff can call for a radiation protection plan to be prepared. This covers all aspects of radiation protection relevant for handling this source, including an assessment of the radiation risks and the definition of protection and monitoring measures. The radiation protection plan must be viewed by the radiation monitoring group leader responsible. In the case of collective doses > 20 person-mSv, it must be presented to the head of the Operational Radiation Protection Section or the ASI Department Head for approval.
- 6 After the completion of work, the operator of the laboratory must check all the equipment and articles used (e.g. laboratory journal) and the workplace itself for contamination, and must decontaminate them as necessary. Any surfaces not fully decontaminated must be identified and the radiation protection staff responsible informed.
- 7 Radioactive materials must be handled in such a way that the minimum possible amount of radioactive waste is created.

6.2.3 Storage of radioactive sources

- 1 Radioactive sources whose activity is greater than the authorisation limit (LA) according to StSV, Appendix 3, Column 10 must be stored in such a way that they are only accessible to those persons who are authorised to use them. The storage locations should be designed and shielded in accordance with the requirements specified by the radiation protection staff responsible. They may not be used for any other purpose.
- 2 Storage containers for radiation sources must be designed in such a way that the dose rate does not exceed 10 $\mu\text{Sv/h}$ at a distance of 1 m from their surface, or exceed a value of 200 $\mu\text{Sv/h}$ on their surface. The containers must be clearly marked with the radiation hazard symbol. The radiation protection staff can specify other radiation protection measures for the storage of activated components in the controlled store (WAKA) and in the holding stores (WALA, WASA).
- 3 Unsealed radiation sources must be packed in such a way that the possibility of contamination can be excluded.
- 4 Radiation sources must be labelled in such a way that it is always possible to identify them fully.

6.3 Activities in accelerator installations

- 1 The applications for new experiments must contain detailed information about the radiological and conventional risks [14], [15], [16]. This information is evaluated by the BSS section leader and/or the safety section leader, who define any additional protective measures that may be necessary.
- 2 Anyone who intends to make changes to approved test installations in a way that could be relevant to radiation protection must obtain the agreement of the head of the BSS group responsible.
- 3 Test installations must be arranged and safeguarded in such a way that no individual is subjected to any unnecessary irradiation at any time.

- 4 Once an experiment has been set up for the first time, the person responsible for the experiment briefs the radiation protection staff with responsibility for that particular area of the site, who checks the adequacy of the shielding and the physical barriers at the beginning of the experiment.
- 5 Experiments involving dose rates that fluctuate strongly in accessible locations must be permanently monitored, and the radiological measurement data must be recorded. This applies in particular to the commissioning phase of any experiments that are being carried out for the first time. In such cases, a timetable must be agreed with the radiation protection staff at an early stage or a preliminary assessment should be undertaken by BSS.
- 6 Any tools and other items that are not absolutely necessary for the conduct of the experiment must be removed from the affected area of the site, or they must be stored in such a way that they cannot be activated or contaminated.
- 7 At the end of an experiment, all the apparatus and items that may have become activated or contaminated must be checked by the SU staff responsible, and either released for further use or temporarily stored as radioactive material. The head of the User Group (the spokesman or main proposer) appoints contact persons who are responsible for ensuring that no material leaves the PSI controlled zones without being checked (Section 3.1, Point 6).
- 8 The radiological status of the workplace must be assessed before any work is carried out in a test installation. Before carrying out any service or repair tasks, the person responsible informs the radiation protection staff responsible directly. They then carry out the measurements and define the necessary protective measures. Outside normal working hours, or if the intended work may be outside the dose competence delegated to individuals nominated by BSS, the on-call radiation protection staff must be informed. At their discretion, they can also agree by telephone to a particular action.
- 9 At the end of service work, all the tools and equipment that were brought in to do the work and are now to be removed from the facility must be checked for contamination by the SU staff responsible and decontaminated as necessary.
- 10 Exchanged components must be checked with regard to activation and contamination by the radiation protection staff responsible. The radiation protection staff determine protective measures for the continued use, adaptation or storage of these components on the basis of the radiological conditions.
- 11 In beam vaults inspection rounds must furthermore ensure that no-one is still in the bunkers when the radiation operation begins. The vault managers are responsible for ensuring that the accelerator or beam bunkers in their area of responsibility comply with the radiation protection requirements.
- 12 In order to protect the staff, all the primary vaults and the experimental vaults and site areas/zones/huts must be locked by means of a personnel safety system specified by ASI and tested once a year by the ASI staff member responsible to make sure that it is working properly.
- 13 Any maintenance or repair work, that is expected to last more than one week, which could either lead to a collective dose of more than 10 person-mSv or to more than one cubic metre of radioactive waste, requires a written programme of work optimised with regard to radiation protection and agreed with the radiation protection group responsible (radiation protection plan). It must meet the requirements of the ASI quality management system, including the disposal path for any radioactive waste that may occur.

6.4 Monitoring ambient doses

- 1 Ambient doses must be measured inside the fenced-off supervised area of the operational site. The dose values must be notified to the regulatory authorities every 3 months.
- 2 BSS establishes the dosimetry networks to be used for the site and for the facilities (measuring locations, type of dosimeter and benchmark values), and updates them as necessary. It also changes the dosimeter on a regular basis.
- 3 The dosimetry network for the site must be sub-divided as follows for the measurement of ambient doses:
 - Outside the controlled zone - outside the buildings
 - Inside the controlled zone - inside the buildings
- 4 The dosimetry network for the facilities must be sub-divided as follows for the measurement of ambient doses:
 - Inside the controlled zone - permanent places of work
 - Inside the controlled zone - temporary places of work
 - Inside the controlled zone - cordoned-off locations
- 5 The dosimetry service analyses the dosimeter and reports the doses to the regulatory authorities and the operators.

7 Emission and immission monitoring

- 1 Emission and immission monitoring at PSI is based on the “Regulations for the Release of Radioactive Materials and the Monitoring of Radioactivity and Direct Radiation in the Area around PSI” issued by the regulatory authorities (BAG 5.07.01-4, HSK 2/370).

7.1 Emission monitoring

- 1 The monitoring of PSI radiological emissions must meet at least the following criteria:
 - Preliminary auditing of the water in a radioactive waste water system before discharge into the environment,
 - Periodical auditing of all radioactive discharges through the exhaust air systems.

In addition, the ambient doses from direct radiation and sky shine must also be measured.

7.1.1 Radioactive waste water

- 1 BSS, in collaboration with the operator, determines which waste water should be sent to the radioactive waste water system.
- 2 Before emptying a tank or retention vessel, the operator must hand waste water samples over to the radioanalytics staff so that it can be analysed and audited.

- 3 All the discharge through the radioactive waste water system must be analysed and audited in advance. No potentially radioactive waste water may be released into the receiving water course without the prior permission of the radioanalytics or SU staff.
- 4 If all the measurement results are below the limits established by the protection targets, the radioanalytics staff or BSS will hand over the permit for discharge of a radioactive waste water system to the operator.
- 5 The radioanalytics staff audits all the radioactive waste water released from PSI and notifies the regulatory authorities and the operator of the activities delivered and the resulting doses.

7.1.2 Radioactive exhaust air

- 1 In collaboration with the operator, BSS determines which rooms, cubicles, boxes, machine components or other installations are to be connected to a radioactive exhaust air system.
- 2 In collaboration with the ventilation experts, BSS specifies the quality of the exhaust air filters to be fitted.
- 3 The ventilation experts change the exhaust air filters in agreement with BSS.
- 4 The radioanalytics staff determines the measuring method to be used to audit the radioactive aerosols and exhaust gases released through the monitored exhaust air system into the environment. It carries out all the measurements for the auditing system, changes the filters [19], [20] and notifies the results to the regulatory authorities and the operator every three months.
- 5 In collaboration with the calibration laboratory, the radioanalytics staff and the operator, BSS determines the method to be used for monitoring the radioactive exhaust air released from PSI.
- 6 The operators must determine the permeability of the exhaust air filters in the facilities under their care periodically in line with ASI-QM and report the results to BSS. Once it has carried out the inspection, it passes on the results to the regulatory authority.

7.2 Dispersal of radioactive materials in the environment

- 1 ASI maintains the ESS-41 computer program for calculating the dispersal of radioactive materials, which has been tested and approved by the regulatory authority. It also stipulates the procedure for calculating the activity intervention thresholds and the resulting dose from the discharge caused by the activities of PSI during normal operation and during any incidents.

7.3 Immission monitoring

- 1 The PSI system for monitoring radioactive immissions must fulfil at least the following criteria:
 - Periodic measurement of radioactive materials in the area around PSI,
 - Measurements of the ambient doses outside the fenced-off supervised areas of the operational site.

- 2 The radioanalytics staff specifies the methods to be used to monitor the level of radioactivity in the waters, on the ground and in the air within the area around PSI.
- 3 The radioanalytics staff collects and evaluates the environmental samples
It reports its results to the regulatory authorities.

7.3.1 Ambient doses outside the PSI site

- 1 The ambient doses outside the fenced-off supervised area of the operational site must be measured. These dose values must be reported to the regulatory authorities every three months.
- 2 The dosimetry service establishes the dosimetry network for the surrounding area (measurement locations and type of dosimeter) in accordance with the “Regulations for the Release of Radioactive Materials and the Monitoring of Radioactivity and Direct Radiation in the Area Around PSI”, and updates this network as necessary. It changes the dosimeter periodically and reports the doses to the regulatory authorities.

8 Import, export, transportation, transfer and relocation of radioactive materials

- 1 The import, export and transportation of radioactive materials outside the operational area all require authorisation. In addition, the national and international directives relating to method of dispatch, packaging, labelling and paperwork for carriage must also be complied with. These directives apply to the sender, the carrier and the recipient.
- 2 PSI has a duty to transport radioactive materials and nuclear materials in accordance with a quality management programme. The head of the transportation of dangerous goods group has a duty to keep this programme up to date and to pay attention to all the requirements of the ADR/SDR (Swiss Federal Ordinance on the Transport of Hazardous Goods by Road). The members of this group are known as the “Transport Co-ordinators” and have a duty to check the work of those responsible for transportation, and (where appropriate) of SUT (SU staff when Transporting radioactive materials), and to collect all the information relevant to the regulatory authorities. They are also responsible for the necessary notifications to the regulatory authority.
- 3 To ensure that all consignments to and from PSI can be processed correctly and in accordance with national and international directives in every respect, any consignments and deliveries must be notified to those responsible for transportation as soon as possible (FORT01 [21], FORT11 [22]). They then help the senders to comply with the directives and the recipients to carry out entry checks. They ensure that the quality assurance programme is implemented.
- 4 Obligations towards offices external to PSI in connection with the carriage of radioactive materials (contracts with haulage companies, agreements to transports to PSI, etc.) may only be entered into after the material has been checked and released for transportation by a transport co-ordinator. They must then be processed under a PSI transport number.

- 5 Incoming deliveries of radioactive materials and of empty transportation containers for radioactive materials must be notified to the transportation staff responsible for the purpose of entry controls so that the consignment can be cleared in accordance with the quality assurance system. This notification must be made by
- the carrier,
 - the PSI-East security control room (SIZ) or the security guard at the entrance to PSI-West,
 - the incoming goods section, or at the latest by
 - the recipient.
- 6 Radioactive materials must usually be transported, transferred or relocated by the shortest available route if possible without any stoppages. They must always be kept under direct observation, or secured in such a way that anyone who is not involved does not accumulate any avoidable radiation doses, and does not gain uncontrolled access.
- 7 PSI holds an exemption from the cantonal road traffic office for the transfer of radioactive materials via the internal traffic system (between the PSI-East and PSI-West areas), [23]). It includes two relaxations with regard to the SDR directives, as long as radiological security is guaranteed. These relaxations relate to the packaging of the goods to be despatched and the instruction regarding the marking of the vehicles. All other SDR directives must be followed, especially those relating to the permit for and equipment of the vehicles, and the training given to the driver of the vehicle. The transportation papers must be completed in full and carried on board with the consignment.
- 8 One SU technician or specialist on each side of the area checks the transfer at the location of the sender and the recipient, and signs the quality management checklist provided for this purpose.
- 9 Anyone who wishes to move radioactive substances or materials outside controlled zones, but still within one of the two fenced-off supervised areas of PSI must inform the SU staff member responsible before the consignment takes place [24]. This staff member determines the conditions of work and checks that the requirements relating to packaging for transportation are met. If the necessary conditions cannot be fully met in individual cases, the SU staff can grant exceptions, as long as compensatory measures are adopted and the material is relocated under their direct supervision.
- 10 The approval of the employee responsible for PSI safeguards or possibly the safety delegate is also required for the transportation, transfer or relocation of nuclear materials.

9 Radioactive waste

9.1 Solid radioactive waste

- 1 Because of the high costs involved in the conditioning, interim storage and final storage of radioactive waste, the work must be designed in such a way that it generates as little waste as possible.
- 2 Unprocessed radioactive waste must be conditioned for interim and final storage, in accordance with specific processes approved by the regulatory authorities. To allow the Dismantling and Waste Management section to handle unprocessed radioactive waste safely and routinely, it must be collected separately according to the types and classes described in the Appendix to the Ordinance on the Mandatory Duty of Delivery of Radioactive Materials (*Verordnung über die ablieferungspflichtigen radioaktiven Stoffe*) as soon as it is created. The procedure described in the directive on the "Handing over of Radioactive Waste to the Dismantling and Waste Management Section" (*Abgabe von radioaktivem Abfall an die Sektion Rückbau und Entsorgung*) must be followed [25]. The dismantling and waste management section is responsible for information gathering (preparing an inventory) in relation to the radioactive waste delivered to the section for the purpose of conditioning and interim storage.
- 3 The relevant operator, in collaboration with his radiation protection officer or vault manager, is responsible for the recording, correct specification and necessary declaration at the place of origin for the unprocessed radioactive waste. The radiation protection staff helps with measuring the waste and filling out the prescribed accompanying ticket.
- 4 Waste containing only radionuclides with a half-life of ≤ 60 days must be stored in the operational areas where they occur, until their activity decays below the exemption limit set by StSV (StSV, Article 85).
- 5 Radioactive materials may not be mixed with inactive materials for the sole purpose of removing them from the scope of the Radiation Protection Ordinance.
- 6 Contaminated items with sharp edges, in particular syringes, should be sealed (e.g. in cardboard boxes) in such a way that the container's contamination barrier cannot be damaged on the way to the conditioning process.

9.2 Radioactive waste in liquid, gaseous and aerosol form

- 1 With the exception of low-level radioactive washing water (specific activity < 100 LE), liquid radioactive waste must not be poured down the drains in laboratories or other areas of work. They must continue to be treated as concentrates.
- 2 Gaseous, aerosol or liquid radioactive waste with a low level of activity may be released into the environment after it has been checked by BSS and audited for by the radioanalytics staff.

10 Radiological incidents and duty of notification

¹ Within the intendment of this directive, radiological incidents are unforeseen events that give rise to an exceptional risk of radiation to people or the environment, or that result in the limit values prescribed by the authorities being exceeded. This applies in particular to:

- inadmissible exposure of individuals to radiation,
- incorporation of radioactive materials caused by disregarding operational instructions,
- contamination that is above a guideline value (CS), but is outside the controlled zones and cannot be eliminated immediately,
- contamination that led to uncontrolled proliferation,
- violations of the limits for activities, activity inventories and dose rates approved by the authorities for buildings, items and discharge into the environment,
- damage to storage containers and waste containers that compromises their function,
- loss of a radiation source.

A detailed list of reportable radiological incidents is included in the ENSI-B03 guideline. The general procedure at PSI is described in [26]. The following applies in particular:

² Each radiological incident, or even a suspicion that one may have occurred, must be reported to both BSS and the person responsible for the facility. Outside normal working hours, the on-call radiation protection staff for the affected area must be mobilised (directly via the security control room (SIZ) for PSI-East or via the WBGB control room with a report to SIZ for the PSI-West site). The mobilised SU staff, together with the person responsible present on site, immediately initiate the necessary urgent measures to protect all those who are present and to prevent any possible spread of the incident. They then inform the head of BSS, the person responsible for the facility, the radiation protection expert responsible, the ASI head of department and the safety delegate.

³ In all of these situations, the regulatory authority responsible (BAG or ENSI) must be informed of the importance of the incident by the PSI safety delegate within a time period that depends on its severity and significance. In the absence of the safety delegate, his deputy will contact the regulatory authority responsible, including a recognised radiation protection expert in the process whenever possible. In the event that the emergency organisation is called into service, the emergency staff will notify BAG and/or the on-call ENSI engineer via SIZ. If the general public could be affected by the escape of radioactive materials, the National Alarm Centre (*Nationale Alarmzentrale*, NAZ) must also be informed.

⁴ In the event of personal contamination, the procedure outlined in the leaflet "Immediate measures in the event of personal contamination" (*Sofortmassnahmen bei Personenkontaminationen*) must be followed. The SU staff must display this instruction leaflet in every controlled zone where unsealed radioactive sources are being used. Even after successful decontamination measures have been concluded, those affected must still be reachable so that further measures may be undertaken as necessary, and samples obtained.

- 5 The loss or discovery of a radioactive source must be reported to the SU staff of the relevant area of work as soon as this has been discovered. They will initiate any further action that needs to be taken.
- 6 Anyone who observes a radiological incident within the PSI site, or on the works road where it is clear that a large contingent of specialist staff will probably be needed to deal with the situation or where a warning needs to be issued to all those present on the PSI site, must mobilise the emergency organisation via the emergency number 3333.
- 7 PSI has an emergency organisation (NFO) comprising specialists whose task it is to minimise the effects of sudden and generally unforeseen events with usually serious consequences for an organisational unit or an area [25].
- 8 If the emergency (NFO) sirens are sounded, the rules of conduct that are on display must be followed.
- 9 If human life is at risk, the operational dose limit values and radiation protection directives may be exceeded. The officer-in-charge must then make sure that nobody is subjected to unnecessary radiation, and that individual doses of more than 250 mSv are not accumulated under any circumstances (StSV, Art. 96).
- 10 Individuals affected by a radiological incident must remove themselves as quickly as possible from the direct area of danger and go to a safe place of assembly, which will be determined on site, depending on the situation. While there, they will be checked for contamination by the SU staff.
- 11 After every radiological incident, the safety delegate launches an investigation into the causes, and the established and possible effects with the involvement of the Head of ASI. All relevant information must be provided directly to the radiation protection expert appointed by ASI for the incident. The result of the investigation as well as a description of the follow-up measures must be recorded in an ASI report and viewed by the radiation protection expert appointed. The result of the investigation must be sent to the regulatory authority responsible.

11 Reporting

- 1 Each operator of a facility in a controlled zone or a working area has a duty to keep records and to prepare the reports required by the regulatory authorities.
- 2 ASI has a duty to prepare the periodic reports relevant to radiation protection required by the regulatory authorities.

12 Other applicable documents (accessible on the Intranet)

- [1] AW-01-07-02, «Safety, Security, Health Protection and Environmental Protection at PSI (SSHE instructions)».
- [2] AW-96-04-01, «Preconditions for the appointment of radiation protection officers, their responsibilities and obligations».
- [3] AW-96-99-05, «Regulations for handling sealed radioactive radiation sources at PSI».
- [4] AW-96-06-03, «Deployment of transport officers, responsibilities, obligations and powers».
- [5] CLRT21, «Planning of dispatch of radioactive materials (for transport co-ordinators)».
- [6] VADM01, «Personal dosimetry».
- [7] AW-23-98-19, «Procedure when using staff from external companies at PSI with regard to radiation protection».
- [8] AW-96-99-08, «Personal dosimetry at PSI».
- [9] FODM02, «Questionnaire on personal dosimetry at PSI».
- [10] AW-96-03-02, «Incorporation monitoring by triage and incorporation measurements at PSI».
- [11] AW-96-99-06, «Triage measurement in work with α -emitters».
- [12] AW-96-00-10, «Access conditions and clothing provisions for working in PSI controlled zones».
- [13] VASU10, «Radiation protection planning».
- [14] AW-96-08-09, «Handling chemicals at PSI».
- [15] AW-96-08-20, «Handling laser at PSI».
- [16] AW-96-99-10, «Regulations for the safe handling of electromagnetic fields and non-coherent optical rays (NIS) at PSI».
- [17] AW-23-93-01, «Schedule for the monitoring of the exhaust filters at PSI».
- [18] AW-96-12-03-Rev.2, «Schedule for the monitoring of the exhaust filters at PSI (ENSI)».

- [19] AARA53, «Collection and analysis of the tests for auditing exhaust air emission monitoring».
- [20] AARA54, «Test collection for auditing exhaust air emission monitoring».
- [21] FORT01, «Registration of dispatch of radioactive materials».
- [22] FORT11, «Registration of receipt of radioactive materials».
- [23] VASU14, «In-house handling of radioactive materials and nuclear materials at PSI».
- [24] AW-96-12-05, «Relocation of radioactive materials within the PSI-West or PSI-East sites».
- [25] AW-92-05-04, «Release of radioactive waste to the Dismantling and Waste Management section».
- [26] AW-11-16-02, «Incidents at PSI: Notification procedures and reporting».
- [27] AW-NFO-98-01, «Emergency organisation (NFO) of PSI Statutory foundations, purpose and structure, organisation, alarm and conduct measures».

13 Appendix

13.1 Appendix 1: Limits and guideline values

Table 1: Dose limit values

Subject	Limited parameter	Limit value	Reference
Individuals "occupationally exposed to radiation"	Effective dose, E Skin dose, $H_p(0.07)$	20 mSv/year 500 mSv/year	StSV: Section 4, Points 1 and 2
Extremities	Skin dose, $H_p(0.07)$	500 mSv/year	
Lens of the eye	$H_p(0.07)$	150 mSv/year	
Personal doses, 16-18 year olds	Effective dose, E	5 mSv/year	
Pregnant women	Effective dose, E $H_p(10)$ on the abdomen	1 mSv 2 mSv	
Individuals not "occupationally exposed to radiation"	Effective dose, E	1 mSv/year	
Personal doses outside PSI premises caused by direct radiation	Effective dose, E	0.1 mSv/year	HSK 2/370 Regulations , BAG 5.07.01-4

Table 2: Emission of radioactive materials: limit values

Subject	Limited parameter	Limit value	Reference
Exhaust air and waste water	Source-related dose guideline value, Effective dose E , for the most affected population	Discharge/year: 0.15 mSv	HSK 2/370 Regulations , BAG 5.07.01-4
		Short-term discharges: 0.2 mSv per incident	

Table 3: Immission of radioactive materials: limit values

Subject	Limited parameter	Limit value	Reference
Air	Activity concentration	$CA^a / 300$	StSV, Art. 102
Drainage water	Activity concentration	$LE^b / 50$	StSV, Art. 102

a Guideline value in Bq/m^3 for permanent activity in the air for individuals occupationally exposed to radiation (StSV, Appendix 3)

b Exemption limit for specific activity in Bq/kg and for absolute activity in Bq (StSV, Appendix 3)

Table 4: Transport of radioactive materials and nuclear materials in accordance with ADR/SDR (Swiss Federal Ordinance on the Transport of Dangerous Goods by Road): Categories of transported goods and packaging, together with dose output limits

Conditions		
Transport Index (TI)	Highest dose output at every point on the external surface (DL_{max})	Category
0	DL _{max} < 0.005 mSv/h	I-WHITE
0 < TI ≤ 1	0.005 mSv/h < DL _{max} ≤ 0.5 mSv/h	II-YELLOW
1 < TI ≤ 10	0.5 mSv/h < DL _{max} ≤ 2 mSv/h	III-GELB
TI > 10	2 mSv/h < DL _{max} ≤ 10 mSv/h	III-YELLOW ^c
Limit values for loose contamination	4 Bq/cm ² for sources of beta/gamma radiation 0.4 Bq/cm ² for alpha radiation	

c Must also be transported under exclusive use.

Table 5: Release of inactive materials

Subject	Limited parameter	Guideline values	Reference
Daily use items	Surface contamination	1 CS ^d	StSV, Appendix 2
	Dose output	0.1 μSv/h in 10 cm	
	Specific activity	0.01 LE	
	Absolute activity	1 LE	
Solid materials and items	Surface contamination		ENSI-B04
	Dose output	0.1 μSv/h in 10 cm	
	Specific or absolute activity	1 LE	

d Guideline value in Bq/cm² for surface contamination outside the controlled zone, averaged over 100 cm²

13.2 Appendix 2: Organisation Chart of ASI

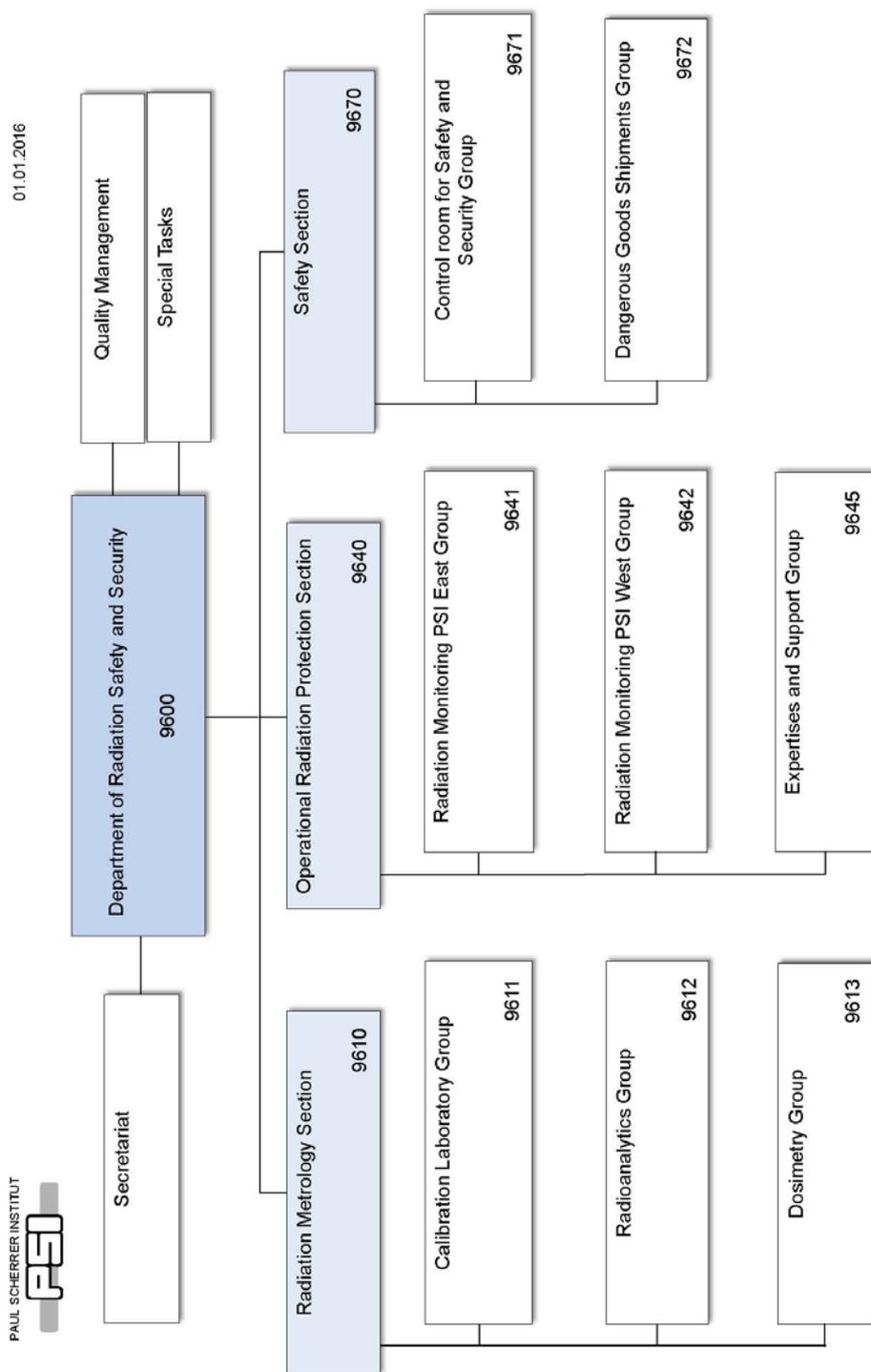


Figure 1: Organisation Chart of ASI.

13.3 Appendix 3: Overview of the responsibilities for all matters relating to radiation protection at PSI

Abbreviations:

- ASI	Department of Radiation Safety and Security (<i>Abteilung Strahlenschutz und Sicherheit</i>)
- BSS	Operational Radiation Protection Section (<i>Betriebsstrahlenschutz</i>)
- SU	Radiation Monitoring Groups (<i>Strahlenüberwachung</i>)
- SU staff	SU technician/specialist employee
- MW	Radiation Metrology Section (<i>Sektion Messwesen</i>)
- DM	Dosimetry Group (<i>Dosimetrie</i>)
- ES	Calibration Group (<i>Eichstelle</i>)
- RA	Radioanalytics Group (<i>Radioanalytik</i>)
- SI	Safety Section (<i>Sicherheit</i>)
- GGT	Transport of Dangerous Goods Group (<i>Gefahrguttransporte</i>)
- SIZ	Security Control Room (<i>Sicherheitszentrale</i>)
- BAG	Swiss Federal Office of Public Health (<i>Bundesamt für Gesundheit</i>)
- ENSI	Swiss Federal Nuclear Safety Inspectorate (<i>Eidgenössisches Nuklearsicherheitsinspektorat</i>)
- NAZ	National Alarm Centre (<i>Nationale Alarmzentrale</i>)
- StSG	Radiological Protection Act (<i>Strahlenschutzgesetz</i>)
- StSV	Radiation Protection Ordinance (<i>Strahlenschutzverordnung</i>)
- KEG	Nuclear Energy Act (<i>Kernenergiegesetz</i>)
- KEV	Nuclear Energy Ordinance (<i>Kernenergieverordnung</i>)

Table 6: Responsibility for radiation protection.

Elements	Key words	Responsibility	See Section
Zone concept	ENSI regulatory areas (nuclear facilities)	BSS, in collaboration with the relevant operator	6.1
	BAG regulatory areas		
Radiation protection planning	General	BSS, in collaboration with the relevant operator	6.1.3 Point 8
	Must be registered		6.3 Point 13
	Must be released		6.1.3 Point 9
	Must be authorised		3.1 Point 8, 9
Workplace monitoring (on-site radiation protection)	ENSI regulatory areas (nuclear facilities)	SU PSI-East site	3.1 Point 12
	BAG regulatory areas	SU PSI-East and West sites	
	Radiation protection measuring equipment	BSS	3.1 Point 11
	Physical monitoring of individuals (personal dosimetry)	SU PSI-East and West sites	5.1
	Job dosimetry		
	Local dosimetry		6.4
Zone entry and exit requirements for individuals	Suitability, clothing	Operator; Checked by SU PSI-East and West sites	6.1.2
	Check of BAG approval for external companies	Client, in collaboration with the SU	3.1 Point 8
Documentation	Radiation protection matters	ASI	11
	Operational matters	Operator	

Table 7: Radiation protection training.

Elements	Key words		Responsibility	See Section		
Training	General	Concept		Head of ASI, BSS	4	
		Course implementation		PSI School for Radiation Protection; other recognised radiation protection training providers		
		Documentation		Personal file		
	ASI staff	Selection and call to course	Rad. protection officers	BSS management	4 Point 8	
			BSS staff	BSS management		
			Transport co-ordinators	Head of SI Section		
	Course accounts		ASI QM	4 Point 10		
	PSI staff, people carrying out experiments	Selection and call to course	BSS officers		Operator, with agreement of BSS management	4 Point 7
			Transport officers		Operator, with agreement of Head of GGT	
			Other PSI staff and people carrying out experiments		Operator in collaboration with the SU group managers	4 Point 5
		Course accounts		PSI School for Radiation Protection	4 Point 10	
	External staff, people carrying out experiments	Selection and call to course	External personnel carrying out experiments		Operator in collaboration with the SU group managers	4 Point 5
			External staff			4 Point 6
Course accounts		PSI School for Radiation Protection; ASI secretariat	4 Point 10			
New entries		All called to course		Personnel Dept.	4 Point 3, 4	
	Course accounts		ASI secretariat	4 Point 10		
Basic and advanced training	ASI staff	Selection and call to course	BSS staff	BSS management	4 Point 9	
	PSI staff, people carrying out experiments		SU officers			Operator, with agreement of BSS management
			Other PSI staff and people carrying out experiments			Operator in collaboration with the SU group managers
	Course accounts		PSI School for Radiation Protection; ASI secretariat	4 Point 10		

Table 8: Physical and medical monitoring of individuals.

Elements	Key words	Responsibility	See Section
Medical monitoring	Report to Suva	DM for PSI staff	5.5
	Call for medical exam. Suva certificate	Suva	
Physical monitoring (external dosimetry)	Order	SU PSI-East and West sites, via DM	5.2
	Collection of personal dosimeter and analysis of all dosimeters	Dosimetry service	
	Collection of finger dosimeters	SU PSI-East and West sites	
	Notification of radiation doses	DM	5.4
Incorporation monitoring (internal dosimetry)	Triage measurements	SU PSI-East and West sites	5.3
	Incorporation measurements (whole body and thyroid monitor)	DM	
	Incorporation measurements (excretion analyses)		
	Notification of follow-on doses	DM	5.4

Table 9: Monitoring and auditing of the radioactive discharges to the environment.

Elements	Key words	Responsibility	See Section
Immission monitoring	Environmental dosimetry	DM	7.3.1
	Collection and analysis of the environmental samples	RA	7.3
Monitoring and auditing of radioactive emissions in the form of gases and aerosols	Monitoring	Operator	7.1.2 and 9.2 Point 2
	Collection and measurement of samples and accounting	RA	
	Maintaining the facilities	Operator	
	Functional check on facilities	BSS	
Monitoring and accounting for radioactive waste water	Monitoring	Operator; SU PSI-East and West sites	7.1.1 and 9.2 Point 1
	Collection and measurement of waste water samples	Operator; RA for DIORIT retention basin	
	Auditing	RA	
	Maintaining the facilities	Operator	
	Functional check on monitoring facilities	BSS	
Checking the permeability of the exhaust air filter	Hot lab.	Technical services, hot lab.	7.1.2 Point4, 6
	Rest of PSI	"Heating, Ventilation and Air Conditioning" group	
	Validation/Report	BSS	
Checking the solid radioactive waste	Measurement	BSS	9.1
	Delivery	Operator; Checked by SU PSI-East and West sites	
Checking the materials and premises	Separation of active/inactive	SU PSI-East and West sites	6.1.3 Point 6; 6.3 Point 7
	Proliferation monitors	SIZ	--

Table 10: Radiation protection measuring equipment, Radiation protection measuring facilities, Personal safety systems.

Elements	Key words	Responsibility	See Section
Radiation protection measuring equipment (Portable SU measuring equipment)	Selection, purchase	Collaboration: Operator, BSS, ES	3.1 Point 11
	Calibration	ES	
	Functional check	SU PSI-East and West sites	
	Service, repair	ES	
Radiation protection measuring facilities (Permanently-installed SU measuring facilities)	Selection, purchase	Collaboration: Operator, BSS, ES	
	Calibration	ES	
	Functional check	SU PSI-East and West sites	
	Service, repair	Operator, ES	
Personal safety systems (PSYS = PSA + LAC + LBC)	Basic concept	Head of ASI	6.3 Point 12
	Installation	Operator, AIE	
	Functional tests	BSS with support from operator	
	Maintenance	Operator	

Table 11: Other PSI radiation protection tasks.

Elements	Key words	Responsibility	See Section
Sending and receiving radioactive materials	Transportation of nuclear material	Transport co-ordinator with person responsible for Safeguards	8 Point 10
	Transportation of other radioactive materials	Transport co-ordinator	8 Points 1 to 6
	Managing the BSS containers	SU PSI-East site	
	Managing the operational containers	Operator	
Transfer of radioactive materials (PSI-East ↔ PSI-West)	Transfer/relocation of other radioactive materials	SU PSI-East and West sites with person responsible for Safeguards	8 Point 10
Relocation of radioactive waste (PSI-East, PSI-West)	Transfer/relocation of other radioactive materials	SU PSI-East and West sites	8 Points 7 to 9
	Managing the operational containers	Operator	
Managing the radioactive test sources	RA source service	Pool sources	SU PSI-West site
		Owned sources	Owner, validation by SU PSI-East and West sites
		Checking seals	Owner, validation by SU PSI-East and West sites
	Inventory	SU PSI-West site	--
RA source rooms	RA source room PSI-West site	SU PSI-West site	--
	RA source room PSI-East site	SU PSI-East site	
Managing the radiation protection materials	SU magazine	SU PSI-East and West sites	--
	Emergency (NFO) SU material	SU PSI-East site	
	NAZ measurement case PSI	SU PSI-East site	
X-ray facilities	Inspections	ENSI	--
		BAG	
	Inventory/approvals	BSS	--

Table 12: Radiation protection in an emergency.

Elements	Key words	Responsibility	See Section
Radiation protection team	Emergency Organisation (NFO) SU support groups	Head of Emergency Organisation (NFO) SU team;	10 Point 2, 7
	DEKO group		
	Other SU Emergency Organisation (NFO) groups	Head of Emergency Organisation (NFO) SU groups	
	Internal deployments	Following silent alarm or emergency alarm	
	SU material	SU	
Radiation protection – on- call service	SU on-call service – external to PSI	BSS	10 Point 2
	SU on-call service – internal to PSI	SU PSI-East and West sites	
	SU material deployment vehicle	SU	--
SU deployments external to PSI	Quotations/orders/organisation Reporting/invoicing	BSS	--
Emergency exercises	Must be registered	Head of Emergency Organisation (NFO)	--

Table 13: Duty of notification and reporting

Elements	Key words	Responsibility	See Section
New projects	Must be registered	Operator, checked by BSS	3.1 Point 9
	Design, construction and operation releases or approvals		
	Must have outline approval	Operator	
Operational changes	Must be registered	Operator, checked by BSS; BSS within the framework of ENSI-B04	
	Must be released		
	Must be approved		
Import, export and transportation of radioactive materials	Must be approved	GGT group with the sender/recipient	3.1 Point 10, 8 Point 1, 7
Radiological incidents	Conduct in the event of deviations and violation of limits or guideline values	Operator in collaboration with BSS and ASI management and PSI safety delegate	10
	Conduct in the event of incidents or accidents in controlled zones	Operator in collaboration with SI, ASI management, BSS and PSI safety delegate	
	Messages to authorities	Operator via ASI and PSI safety delegate	10 Point 3
Periodical notifications	Duty to keep records and prepare reports	Operator via PSI safety delegate	11 Point 1
	(Quarterly) reports on radiation protection	DM, RA, BSS via PSI safety delegate	11 Point 2

Table 14: Quality assurance.

Elements	Key words	Responsibility	See Section
Inspection body	SIS 034	Person responsible for QM in collaboration with BSS and ES	1.5
Calibration laboratory	SCS 075	Person responsible for QM in collaboration with ES	
Testing laboratory	STS 173	Person responsible for QM in collaboration with RA	
	STS 491	Person responsible for QM in collaboration with DM	

13.4 Appendix 4: BSS authorisations

Table 15: Summary of the authorisations of BSS¹ and the specialists appointed by it for their area.

Authorisations	See also
BSS determines the scope of competencies of the specialists used for radiologically relevant tasks	Section 3.1 Point 3 Section 3.1 Point 4
BSS assesses projects for their radiation risks and calls for measures if necessary and/or programmes of work optimised with regard to radiation protection	Section 3.1 Point 9 Section 6.3 Point 13
BSS and the specialists appointed by it can refuse all activities (also the operation of the facilities concerned) if the necessary radiation protection of the persons or the area or of the neighbouring population can no longer be guaranteed	Section 3.1 Point 11 Section 6.3 Point 8
BSS and the specialists appointed by it can demand further training on radiation protection topics if required	Section 4 Point 9
BSS determines the hazard level of activities and thus the classification of individuals occupationally exposed to radiation and individuals not occupationally exposed to radiation	Section 5.1.1 Point 2
BSS determines the type of dosimeter to be worn	Section 5.1.1 Point 3
BSS can instruct that an additional dosimeter must be worn	Section 5.2 Point 3
BSS decides whether incorporation monitoring is necessary and instructs incorporation monitoring to be carried out if necessary	Section 5.3 Point 1 Section 5.3 Point 5
BSS sets out further measures to prevent the spread of contamination if necessary	Section 6.1.3 Point 5
BSS determines the scope of any radiation protection plan necessary	Section 6.1.3 Point 8
BSS determines the further use of sealed radioactive sources if their tightness can no longer be guaranteed	Section 6.2.1 Point 3
BSS makes general decisions on the need for and type of radiation protection measures	Section 6.2.1 Point 3 Section 6.2.3 Point 2 Section 6.3 Point 1 Section 6.3 Point 2 Section 6.3 Point 4 Section 6.3 Point 5
BSS grants approval or instructs for storage of potentially contaminated or activated items	Section 6.3 Point 9 Section 6.3 Point 10
BSS or the Radiation Metrology Section determines the networks of facility, site or environmental dosimetry	Section 6.4 Point 2 Section 7.3.1 Point 2
BSS determines which waste water should be sent to the radioactive waste water system	Section 7.1.1 Point 1
BSS or the Radiation Metrology Section can refuse the release of potentially radioactive waste water into the receiving water course	Section 7.1.1 Point 3 Section 7.1.1 Point 4
BSS determines which installations must be equipped with a system for radioactive exhaust air	Section 7.1.2 Point 1
BSS determines the quality of the exhaust air filters to be used	Section 7.1.2 Point 2
BSS or the Radiation Metrology Section determines the measurement methods for the monitoring and auditing of the exhaust air, waters and ground	Section 7.1.2 Point 4 Section 7.1.2 Point 5 Section 7.3 Point 2
BSS and the specialists appointed by it can refuse the transportation of radioactive substances within the site or from PSI	Section 8 Point 4 Section 8 Point 8 Section 8 Point 9

¹ Including employees from the Radiation Metrology Section among others