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Swiss Federal Nuclear Safety Inspectorate ENSI

Basic Training, Recurrent Training and Continuing Education of Personnel in Nuclear Installations

Guideline for Swiss Nuclear Installations

ENSI-B10

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Inhalt

1 Introduction

The Swiss Federal Nuclear Safety Inspectorate (ENSI) is the regulatory authority for nuclear safety and security of the nuclear installations in Switzerland. ENSI issues guidelines either in its capacity as regulatory authority or based on a mandate in an ordinance. Guidelines are support documents that formalise the implementation of legal requirements and facilitate uniformity of implementation practices. They further concretise the state-of-the-art in science and technology. ENSI may allow deviations from the guidelines in individual cases, provided that the suggested solution ensures at least an equivalent level of nuclear safety or security.

2 Subject and scope

This guideline regulates the general requirements for the basic training, recurrent training and continuing education of the personnel in Swiss nuclear installations that is relevant to nuclear safety. Pursuant to the Ordinance on the Qualifications of Personnel in Nuclear Installations (732.143.1), it regulates the further requirements on training, licensing exams, repeat training, further education and requalification of the licensed personnel in nuclear installations. In nuclear power plants, it additionally regulates the special requirements on the maintenance personnel, the remaining technical-scientific personnel and sub-contractors.

Subjects not covered in this guideline are:

a. the requirements on the personnel that are specified within the procedure to qualify test procedures pursuant to guideline ENSI-B07;

b. the requirements on the radiation protection personnel pursuant to the Radiation Protection Ordinance, which are regulated in guideline ENSI-B13;

c. the requirements on the documentation and its safekeeping pursuant to Article 37 of the Ordinance on the Qualifications of Personnel in Nuclear Installations, which are regulated in guideline ENSI-G09;

d. the requirements concerning the training organisation, which are regulated in guideline ENSI-G07;

e. the reporting obligation pursuant to Article 38 of the Ordinance on the Qualifications of Personnel in Nuclear Installations, which is regulated in guideline ENSI-B03.

The requirements on the security officers pursuant to Article 5 of the Ordinance on the Qualifications of Personnel in Nuclear Installations have to be understood as supplementing the Ordinance on the Security Guards of Nuclear Installations (732.143.2) and are not the subject of this guideline.

3 Legal basis

This guideline essentially implements the Ordinance on the Qualifications of Personnel in Nuclear Installations (SR 732.143.1) of 9 June 2006.

4 General basic training, recurrent training and continuing education of personnel in nuclear installations

Chapter 4 regulates the general requirements on the personnel in nuclear installations that are relevant to nuclear safety. The more detailed requirements specific to each group of persons will follow from Chapter 5 of this guideline. Within the scope of this graded procedure, the following groups of persons relevant for nuclear safety are defined:

a. Licensed personnel

b. Personnel whose appointment has to be reported

c. Other personnel whose activities may influence nuclear safety.

4.1 Basic Training

Every person in a nuclear installation relevant to nuclear safety acquires the requisite knowledge and skills through training. This has to be proven by means of appropriate documents. Especially the skills for safety-oriented consideration, decision-making and conduct have to be part of these competences. This entails that the potential safety-related impacts of the person's own activity are dealt with, as part of the training.

4.1.1 Training Methods

A prerequisite for employment in a nuclear installation is, besides personal aptitude, adequate qualification and training and extensive expert knowledge to fulfil the tasks. To this end, a systematic training method has to be applied which uses the following factors to take account of the significance of the activity for nuclear safety:

a. The relevance and complexity of the product manufactured or the activity

b. The potential danger for and the range of a potential impact on safety, health, the environment, security and the quality of the manufactured products or activities carried out

c. The potential consequences of the product failing or the activity being carried out incorrectly.

To ensure adequate training and extensive expert knowledge for fulfilling the tasks, a systematic training method must in particular take into account the following aspects:

a. Preparation of training methods adapted to the person or the group of persons concerned, taking into account each person's qualification: to impart the requisite knowledge and skills, appropriate learning objectives have to be derived and a training programme with the necessary training contents has to be prepared. Participation in the training measures has to be documented

b. Use of suitable training methods and adequate training material, depending on the learning objective to be achieved and the respective learning contents

c. A procedure that ensures that the course and training material used is up-to-date

d. Regular review of the training programmes with regard to it being up-to-date and effective: In this context, the participants' feedback must be taken into account as well. The results have to be considered within the scope of the continuous improvement of the training programmes.

Pursuant to Article 36 of the Ordinance on the Qualifications of Personnel in Nuclear Installations, it is necessary to check that each person has achieved the learning objectives required for nuclear safety. This has to be documented in a comprehensible manner.

The employed full-time instructors must have sufficient technical competence and prove that they have sufficient knowledge in the field of further education and teaching methodology for adults. In co-operation with the training officer, internal assistant advisors have to be taught, the basics in methodology and didactics. The full-time instructors benefit from further education on a regular basis.

4.1.2 General training contents

In addition to their own expert knowledge, the personnel in all fields of expertise must also be knowledgeable about the connections between their own activity and the activities of co-workers. The training programme has to function and specifically ensure that the following topics in particular are taught:

a. Fundamentals of nuclear technology, overview of safety goals and potential risks as well as safety principles

b. Structure and design of the nuclear installation

c. Organisation and administrative processes

d. Specific work instructions and the basis thereof as well as the expected work results

e. Principles of the operation and maintenance of systems and components

f. Code of conduct regarding nuclear safety, in particular within one's own field of activity

g. Code of conduct regarding industrial safety, fire protection, radiation protection, environmental protection and accident management

h. Relevant laws, ordinances and guidelines issued by the authorities as well as standards to be applied both nationally and internationally

i. Content of the safety analysis report, technical specification and the component and system specifications licensed by the authorities; essential, relevant internal and external events with a high risk potential or considerable impacts.

4.2 Promotion of social (soft skills) and communication skills

The operator has to provide measures in the basic training programme, in the recurrent training programme and in the continuing education programme which particularly promote the ability of the worker in individual, methodical and social competencies (soft skills). In addition, special attention has to be paid to effective information and communication. For leadership positions, appropriate leadership training has to be provided.

The personnel has to be continuously made aware of the significance of their tasks and activities, learning from experience as well as of the consequences that errors may have on safety. To this end, the following topics in particular must be included in the training programmes in a group-specific and function-related manner:

a. Promotion of safety consciousness and safety-oriented behaviour

b. Overall communication skills and communication in critical situations

c. Safety-oriented decision-making and safe coping with critical situations

d. Handling of low-level events, near misses and critical assessment of one's own work environment.

The review of the personal aptitude required pursuant to Article 23 of the Ordinance on the Qualifications of Personnel in Nuclear Installations must be analysed systematically, and the results have to be taken into account when developing training contents in the field of methodical competence and social (soft) skills.

4.3 Recurrent training

4.3.1 Procedural requirements

The operator has to ensure through appropriate procedures that the technical and social competences the personnel needs for fulfilling their tasks safely are sufficiently available and at all times. In case of any deficiencies that indicate a lack of competence, appropriate additional training measures have to be provided. If systematic deficiencies are detected, the procedure has to be reviewed. The requisite competence also has to be examined when the person holding the position has been absent for an extended period. For the periodic recurrent training, a programme taking into account the requirements listed under 4.1 and 4.2 has to be prepared.

4.3.2 Content requirements

In the recurrent training programme, the following aspects have to be especially considered with particular attention to the employee's function:

a. Preserving and deepening the basic knowledge obtained during basic training, special measures in the fields in which deficiencies were identified

b. Preserving and deepening knowledge and skills for trouble-shooting and emergency tasks as well as raising awareness to risks during routine activities

c. Regular training of activities that are never performed or only rarely and which may, however, be relevant in case of an emergency

d. Preserving and promoting the consciousness of responsibility for the safe operation of the installation and of the consequences of disregarding work instructions or other safety requirements

e. Knowledge gained from findings and events in ones' own installation and the feedback of experience from other installations

f. Modifications in the installation, in provisions and internal documentation

g. Preserving and updating knowledge of the laws, ordinances and guidelines issued by the authorities to be applied as well as of the national and international standards and norms or additional requirements.

4.4 Continuing education

The operator has to facilitate continuing education that is tailored to each respective group of person and the function of each person. To this end, he also has to prepare and implement the training programmes required. Thereby, the worldwide industrial and operating experiences of installations with high risk potential and new findings from nuclear safety research have to be considered. The continuing education programme in particular has to take the following objectives into account:

a. Enhancing knowledge of the technologies used in the installation

b. Increasing the understanding of selected topics of the basic (initial) training

c. Further education to acquire knowledge of the current state-of-the-art in science and technology

d. Adapting or enhancing the ability to assume new tasks or activities

e. Relaying findings from the internal and external exchange of experience and knowledge.

5 Training of licensed personnel in nuclear power plants

5.1 Nuclear basic training

Article 6, paragraph 2, letter b, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

Nuclear basic training consists in participating in training courses that are carried out at external training centres, in the plant, or as a combination of internal and external training measures. The nuclear basic training has to impart to the prospective reactor operators the theoretical basis for their future task.

At least a week before the training begins, the documents listed under 5.1.4 a to c have to be submitted to ENSI. The training material mentioned under 5.1.4 d must be available to ENSI upon request.

5.1.1 Requirements for the content of the training courses

The subject area to be dealt with in the required training courses are specified in advance and contain in particular the topics mentioned in Annex 1. The training programme and contents have to be updated on a regular basis.

For each type of training, a catalogue of learning objectives specifying the extent and depth of knowledge and skills to be acquired has to be kept. The catalogues of learning objectives must be prepared in co-operation with the officers responsible for training in the nuclear power plants and take fundamental technological advances in nuclear power plants into account.

An adequate part of the training period has to be reserved for traineeships and practical exercises. If all parts of the training take place at the nuclear installation, on-the-job training courses may be credited as traineeships.

5.1.2 Requirements for the trainers

The trainers and teachers are adequately qualified (university or applied sciences university degree or a technical qualification acquired at the plant) in their fields of expertise. They improve continuously their qualification to keep up to date in their particular areas of expertise.

The trainers and teachers either have a didactical and methodological qualification in adult education or have comparable knowledge due to experience gained in adult education for several years. When hiring a new trainer or teacher who has no qualification in didactics, adequate training has to be provided for, within the first year of employment.

5.1.3 Proof of the knowledge the training participants have acquired

The state of knowledge acquired has to be established by passing a final oral and written examination. In the final written examination, all subject areas pursuant to Annex 1 have to be covered by relevant questions. In the individual training courses, achievement of learning objectives has to be checked. The results have to be included in the overall assessment of the final written examinations. If not all subject areas pursuant to Annex 1 can be covered by the responsible training centre, the contents of the missing subjects have to be addressed with the same requirements as mentioned under 5.3.1.

5.1.4 Documentation of the basic nuclear training

To demonstrate the knowledge and skills imparted, the respective responsible training centre has to compile the following documentation:

a. Catalogue of learning objectives

b. Schedule indicating the subjects covered

c. Examination rules and regulations

d. Complete set of the current training material

e. Examination papers with the examination questions of the written part of the final examination and the evaluation thereof for each examinee

f. Minutes of the oral examination with assessment for each examinee.

5.2 Plant-specific training

The plant-specific training has to be carried out for the plant for which the authorisation (license) is valid. It is conducted by trainers or instructors who have detailed knowledge and experience in the operation and by personnel from the technical departments. The training encompasses the imparting of theoretical knowledge about systems and components of the plant (technology course) as well as about the behaviour of the plant during normal operation and in case of deviations of normal operation incidents and accidents. In the development of the learning objectives, the safety analysis report, the results of the probabilistic safety analysis (PSA), system descriptions as well as the essential operating experience in the trainee's own and in foreign installations have to be taken into account. In the case of nuclear power plants, the practical knowledge for the monitoring and operation of the plant are acquired by activities on site and exercises on a plant-specific simulator and with trainers or instructors who are either authorised shift supervisors with sufficient experience or on-call engineers. Persons without such an authorisation have to prove that they have a similar qualification.

Before the plant-specific training begins, a training programme has to be submitted to ENSI. The programme has to show the depth and extent of the training, taking into account proven previous qualification and experience of the respective candidate.

In the case of nuclear installations that are in construction, it may not always be possible to perform the required prior practical work. After consultation with ENSI, then latter may be substituted by increased training measures, intensive preparation, in the case of nuclear power plants with a plant-specific simulator by a considerably more extensive simulator training, and the participation in the establishment and commissioning of the plant (Article 6 paragraph 2 letter e; Article 7, paragraph 2, letter d; and Article 8, paragraph 2, letter e, of the Ordinance on the Qualifications of Personnel in Nuclear Installations). For this, the operator has to prepare and submit a training programme to ENSI in due time.

5.2.1 Reactor operators

Article 6, paragraph 2, letters c and d of the Ordinance on the Qualifications of Personnel in Nuclear Installations

Prospective reactor operators have to complete a training course on a plant-specific simulator which takes several weeks. In this training course, the knowledge for monitoring and operating the plant are imparted to such an extent that the person acquires sufficient operating safety, becomes sufficiently confident as well as receptive to criticism both towards himself or herself and others. In particular, the theoretical and practical knowledge mentioned in Annex 2 has to be imparted. The subject areas mentioned under 4.2 have to be considered with specific regard to the training phase. The achievement of the learning objectives of the specified training phases has to be evaluated with an appropriate, comprehensible system.

5.2.2 Shift supervisors

Article 7, paragraph 2, letters c to c of the Ordinance on the Qualifications of Personnel in Nuclear Installations

Based on the person's previous experience as a reactor operator, the plant-specific training has to impart the contents required for fulfilling the function. To this end, the shift supervisors have to deepen their theoretical and practical knowledge of abnormal operation, design basis and beyond-design-basis accidents and practise the handling thereof on the plant-specific simulator in the function as shift supervisor. In particular, the theoretical and practical knowledge in Annex 2 has to be imparted. The technical training has to be supplemented by a leadership training that meets the demands for leading a group of shift personnel as well as for leadership in stressful situations in the nuclear power plant. The subject areas mentioned under 4.2 have to be considered with specific regard to the training phase. The achievement of the learning objectives of the specified training phases has to be evaluated with an appropriate, comprehensible system.

5.2.3 On-call engineers

Article 8, paragraph 2, letters b to d of the Ordinance on the Qualifications of Personnel in Nuclear Installations

Based on the person's knowledge and skills as shift supervisor, the plant-specific training has to impart the knowledge and skills required for fulfilling the function as an on-call engineer. The training includes detailed knowledge and understanding of beyond-design-basis accidents as well as of the potential consequences and impacts thereof, leadership skills in emergency situations as well as activities relating to security issues. This aspect has to be trained with a shift or training group as an on-call engineer on the simulator. In particular, the theoretical and practical knowledge mentioned in Annex 2 has to be imparted. The subject areas mentioned under 4.2 have to be considered with specific regard to the training phase. The achievement of the learning objectives of the respective specified training phases has to be evaluated with an appropriate, comprehensible system.

5.3 Authorisation of the operating personnel

In all examinations for the purpose of authorisation, the examinees must not be aware of the selected questions or simulator or emergency scenarios in advance. Furthermore these shall be representative of the entire subject matters dealt with in the training.

5.3.1 Examination of the basic knowledge of nuclear engineering

Article 27 of the Ordinance on the Qualifications of Personnel in Nuclear Installations

5.3.1.1 Preparation of the examination

The examination procedure has to be described by the training centre in the examination rules and regulations. The document has to include in particular information on the implementation of the examination, evaluation criteria, repeat examinations, exclusion from the examination, and certification of the examination. It has to be made known to the participants.

The operator and the training centre have to co-ordinate the dates for the final oral examination with ENSI at an early stage.

The operator has to submit the following documents on the examinee to ENSI at least one week prior to the final oral examination:

a. Personal data (name, first name, date of birth)

b. Certification of the successful written examination.

At the beginning of the oral examination, all documents from the final written examination are available to the examination board for inspection.

5.3.1.2 Examination procedure

The final examination consists in a written and an oral part. Both parts are organised by the operator or, by order of the operator, by the training centre. The final examination includes:

a. Final written exam

   This exam is carried out by the executing training centre upon instruction of the operator. The examination questions have to be especially selected from the topics mentioned in Annex 1. The examination is graded by expert trainers and evaluated according to a coherent system. If not all subject areas can be covered by an executing training centre, the missing subject areas have to be submitted later with the same requirements.

b. Final oral exam

   In the presence of the examination board, the examinee is examined by the course instructor, training officer or expert trainer in the respective subject areas. The examination questions are in particular a selection from the topics mentioned in Annex 1. The topics nuclear physics and reactor physics are a given; the other topics are selected at random. The examination must take at least 45 minutes for each examinee. The members of the examination board may ask additional questions.

If the topics of subject area 1 “Basic systems engineering” of Annex 2 are also covered in the basic nuclear engineering training and examined in the final examination, subject area 1 “Basic systems engineering” is considered as fulfilled for the examination for authorisation for nuclear power plants pursuant to number 5.3 2 of this guideline.

In cases where examinees of nuclear power plants can demonstrate that due to their training and education (e.g. a degree in nuclear physics), they have the theoretical knowledge pursuant to the set of topics in Annex 1, particular conditions apply. They then only have to pass a final oral exam in the field of basic knowledge of nuclear engineering (Article 27, paragraph 1, of the Ordinance on the Qualifications of Personnel in Nuclear Installations), as described above. For each examinee, the procedure has to be applied for in advance to the supervisory authority, presenting the required proofs.

5.3.1.3 Examination board, evaluation and decision on the result of the examination

It is the task of the examination board to decide whether the final examination was passed or not (Article 27, paragraph 3, of the Ordinance on the Qualifications of Personnel in Nuclear Installations). The examination board achieves the quorum if at least the representatives mentioned in Article 27, paragraph 4, of the Ordinance on the Qualifications of Personnel in Nuclear Installations are present. With the examinee's consent, non-participant observers may attend the examination. For each examinee, the course of the oral exam has to be documented in writing. The minutes are taken by an authorised person or the training centre commissioned by the operator.

Immediately after the oral exam, the course of the examination is recapitulated. Subsequent to the oral exam, the examination board decides on the result. After consultation, the chair of the examination board makes a suggestion for the result of the assessment of the examination. The members of the examination board vote on this proposition. For a positive outcome of the examination, the examination board has to come out in favour unanimously. A negative decision has to be justified, in writing if desired by the examinee.

If the examinee has not passed the final examination, he or she may take a repeat examination. The examination board decides on the admissibility and the requisite scope of the repeat examination. The date has to be co-ordinated with ENSI. A second repeat examination has to be applied for to ENSI, substantiating the application in writing.

5.3.2 Examination procedure of examinations for authorisation in nuclear power plants

Articles 28 and 30 of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The procedure applies to reactor operators, shift supervisors, on-call engineers.

5.3.2.1 Preparation of the examination

The operator and the training centre have to co-ordinate the dates of the examination for authorisation (dates for oral and written examination) with ENSI at an early stage.

The operator has to submit the following documents on the examinee to ENSI at least one week prior to the oral examination:

a. Personal data (name, first name, date of birth)

b. Professional career

c. Proof of basic nuclear engineering training (for prospective reactor operators)

d. Proof of basic training and continuing education at the nuclear power plant

e. Certification of the successful written examination(s)

f. Specification of potential scenarios for the practical examination on the simulator.

Regarding the presentation of the examinee's professional career, the requisite proofs pursuant to Article 6, paragraph 2, letter a, of the Ordinance on the Qualifications of Personnel in Nuclear Installations have to be submitted.

In order to be admitted to the oral and practical examination, the successful participation in the written examination(s) is required. All documents of the written examination for authorisation are available to the examination board for inspection at the beginning of the oral examination for authorisation.

The proof of the examinee's personal aptitude is available to the examination board for inspection at the beginning of the oral examination for authorisation.

5.3.2.2 Examination procedure

The examination for authorisation consists in a theoretical (written and oral) and a practical part. Both parts are organised by the operator.

a. Theoretical examination

   The theoretical examination consists in a written and an oral part.

   1. Written part

      The examination is performed internally by the operator. The examination has to be carried out as an individual examination at the end of the training or as coherent verification that the learning objective has been achieved, with the achievement being checked with regard to the specified respective training phases. The examination questions have to be especially selected from the topics of Annex 2. The questions pertaining to the field of operational disturbance and design basis accidents have to be balanced with the remaining examination questions. If subject area 1 from Annex 2 has already been covered within the scope of the basic nuclear engineering training, it can be dispensed with in the examination. The examination is graded by the training officer and evaluated according to a coherent system. In the written exam, the examinee has to demonstrate his plant-specific knowledge to the degree required for the respective function.

   2. Oral part

      In the oral examination, the examinee has to demonstrate that he or she is familiar with the various components and systems of the installation and of the plant behaviour; the examinee also has to demonstrate that he or she can identify and handle operational disturbances. The examination subjects are in particular a selection taken from Annex 2 and have to be randomly determined by the examination board immediately before starting the examination. If subject area 1 from Annex 2 has already been covered within the scope of the basic nuclear engineering training, it can be dispensed with in the examination. The examination is carried out in the form of an oral examination by a representative of the operator and in the presence of the examination board. Examination questions have to be formulated as broadly as possible so that the examinees can themselves develop and explain their thoughts. The members of the examination board may ask supplementary, more detailed questions from the subject areas according to Annex 2 at any time. The operator takes the minutes of the examination. The oral examination has to take a minimum of 60 minutes for reactor operators and shift supervisors and a minimum of 90 minutes for on-call engineers.

b. Practical examination

The practical examination is carried out on the simulator. It demonstrates that the examinee has sufficient understanding of the installation and processes, high operating safety, adequate leadership skills (shift supervisors and on-call engineers) and appropriate communication skills. The scenarios have to be chosen such that the examinee has to cope with challenging tasks which clearly demonstrate the above-mentioned abilities. They have to be derived from the examination subjects in Annex 2 in particular. The examination scenarios are selected randomly in the presence of the examination board or by the examination board prior to the beginning of the practical examination. After the simulator scenarios have been completed, the examination board may ask the examinee questions.

For reactor operators, the demonstration on the simulator may be performed individually, with a shift supervisor or the entire shift team. The demonstration on the simulator has to take at least 30 minutes. For shift supervisors, the demonstration is carried out with the involvement of a shift team. The demonstration has to take at least 30 minutes. After the exercise has been completed, the examination board may ask the examinee questions.

Within the scope of the examination, only the examinees may be assessed. If several examinees are assessed at the same time, distinct scenarios have to be used. The total time is at least 90 minutes.

For on-call engineers, the practical part of the examination consists of an assignment as on-call engineer in an emergency exercise. This exercise can be a regular emergency exercise pursuant to guideline ENSI-B11 or an exercise specifically developed for the examination which allows the assessment of the examinee. The scenario has to be derived from the examination subjects mentioned in Annex 2. The exercise has to take at least 45 minutes. The examination ends with the on-call engineer's report to the emergency team.

5.3.2.3 Examination board, assessment and decision on the result of the examination

It is the task of the examination board to decide whether the final examination for authorisation was passed or not (Article 30, paragraph 2, of the Ordinance on the Qualifications of Personnel in Nuclear Installations). The examination board reaches a quorum if at least the representatives mentioned in Article 30, paragraph 3, of the Ordinance on the Qualifications of Personnel in Nuclear Installations are present. With the examinee's consent, non-participant observers may attend the examination. For each examinee, the course of the oral exam has to be documented in writing. The minutes are taken by a person authorised by the operator.

Immediately after the oral and practical exam, respectively, the course of the examination is recapitulated. If requested by one participating party, the representatives of operator and ENSI will withdraw for separate deliberation about the evaluation. Each representative of the operator and ENSI announces the assessment in the examination board, also justifying the decision. The members of the examination board have to substantiate their assessment of the examination and the resulting examination decision on the basis of an appropriate and safety-oriented assessment of the examinee. For a positive examination decision, the examination board has to rule unanimously in favour. A negative decision has to be justified, in writing if requested by the examinee.

The representative of the operator advises the examination board's decision to the examinee. If the examinee has passed the examination, all members of the examination board sign the certificate of authorisation. One copy will be filed by the operator and one by ENSI.

If the examinee has not passed the examination for authorisation, he or she can take a repeat examination no sooner than upon the expiry of a period of 6 weeks. The examination board decides on the admissibility and the requisite scope of the repeat examination. The date has to be set in co-ordination with ENSI. A second repeat examination has to be applied for to ENSI, substantiating the application in writing.

5.4 Recurrent training and continuing education of licensed personnel in nuclear power plants

Article 35, paragraph 2, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

For the design and performance of the annual recurrent training and continuing education programme, the general requirements under 4.3, 4.4 and 5.2 apply and the following chapters of this section have to be considered with respect to the different functional levels.

For the licensed personnel, training measures have to be established that guarantee the required career-long professional learning competence.

The annual programme for recurrent training and continuing education has to be submitted to ENSI for their information one week prior to the beginning of the validity period of the respective annual programme.

5.4.1 Periodic recurrent training on important basic and plant-specific knowledge

Article 35, paragraph 2, letters a, b and d of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The basic knowledge of the subjects mentioned in Annexes 1 and 2 has to be periodically refreshed in recurrent training courses. The subject areas under 4.2 have to be considered in the recurrent training to an adequate degree. For the different subjects, the repetition periods, duration of training and the learning objectives to be achieved have to be specified depending on their relevance for safety. Subjects pertaining to nuclear operating practice and thermodynamics/thermal-hydraulics must be repeated at regular intervals. The annual further education programme additionally has to take the following information sources into account:

a. The requalification examinations

b. The observations made by supervisors and instructors during operation and during simulator exercises

c. Operating experience in the person’s specific plant and in foreign installations

d. Modifications to the installation

e. Training-relevant results from appraisal interviews

f. The demands of the personnel.

5.4.2 Periodic recurrent training on the simulator

Article 35, paragraph 2, letter c, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The operator prepares an annual programme for periodic simulator training.

In a plan covering several years, the periods for the recurrent training of the scenarios to be covered have to be specified. This multi-annual plan has to ensure that all scenarios to be covered are periodically repeated. The scope and complexity of the scenarios for the annual simulator exercises have to be designed in such a way that their successful handling demonstrates compliance with Article 35, paragraph 2, letter c, of the Ordinance on the Qualifications of Personnel in Nuclear Installations. This requires that the achievement of the learning objectives be adequately verified and that the aspects listed under item 6. “Teamwork, leadership and communication” of Annex 2 be observed when developing the scenarios. Within the scope of the scenario debriefing, the basic knowledge of nuclear engineering relevant for the respective scenario also has to be discussed.

Within the scope of the simulator training, the leadership skills of shift supervisors and on-call engineers as well as the team and communication skills and behaviour of the shift team have to be trained and assessed. In doing so, the non-technical aspects mentioned in subject area 6 of Annex 2 should also be taken into account in the simulator scenarios.

5.4.3 Extraordinary training measures

Article 35 of the Ordinance on the Qualifications of Personnel in Nuclear Installations

Should analyses of events in the specific plant or in foreign installations or other findings indicate that special training is required, extraordinary training measures must be carried out and documented.

If any gaps in a person’s knowledge regarding certain events are identified, measures to remedy them have to be taken immediately. The measures have to be documented.

If modifications to the plant have a substantial influence on the operation of the plant and communications during either normal operation or in the event of operational disturbances, design basis accidents or beyond-design-basis accidents, then prior retrofitting of the simulator and simulator training have to be considered. If this is not possible, appropriate training measures conveying the required knowledge have to be conducted.

5.5 Requalification of licensed personnel in nuclear power plants

Article 34, paragraph 4, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

5.5.1 Requirements for the practical examination of technical competence, team work and communication on the simulator

Article 34, paragraph 4, letter a, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The operator has to specify a procedure for the requalification of the licensed personnel requiring authorisation within the scope of simulator training. The procedure has to account for the respective function requiring authorisation of the candidate to be requalified. For this purpose, a set of criteria has to be specified with the aid of which the skills and behaviour of the person to be requalified can be evaluated. The criteria must reflect the aspects for simulator scenarios mentioned in Annex 2. The person is assessed by trainers experienced in simulator training or similarly qualified personnel who observe and subsequently evaluate the person. In particular, the function-specific theoretical and practical knowledge pursuant to Annex 2 has to be observed.

The scenarios have to be designed with regard to scope and complexity in such a way that they are suitable for verifying the required knowledge and skills of the respective function of a person or the shift team, respectively. Information on the characteristics of the scenarios is included in Annex 2. The requalification scenarios must not be known in advance to the participants.

If there is only one requalification candidate, the assessment of requalification has to be made by one, if there are two or more requalification candidates to be evaluated at the same time, by at least two competent examiners. ENSI has to be informed in advance about exceptions, also stating the reasons.

To give ENSI the opportunity of attending, it has to be informed about the requalification dates at an early stage (Article 34, paragraph 2, of the Ordinance on the Qualifications of Personnel in Nuclear Installations). The scenarios provided for the requalification have to be submitted to ENSI upon request.

5.5.2 Theoretical examination of the understanding of the scenarios practised on the simulator

Article 34, paragraph 4, letter b, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The scenario debriefing should assess whether the participants have understood the behaviour of the plant and the relating fundamentals of the scenario practised. Whether the function-specific tasks for coping with the disturbance were understood and fulfilled, is also a matter to be checked. The results have to be taken into account in the assessment.

5.5.3 Examination of the knowledge of modifications to the plant and power-plant-internal provisions

Article 34, paragraph 4, letter b, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

It is also necessary that the licensed personnel demonstrate knowledge of relevant modifications to the plant prior to commissioning, in a manner commensurate with the function and the function-related provisions relevant for nuclear safety, and this before the changes come into force. Before restarting the plant, the shift personnel must have been informed about any modifications to the plant that are relevant to their function.

5.5.4 Simplified examination of the personal aptitude

Article 34, paragraph 4, letter c, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

For the evaluation of the personal aptitude of authorised persons, observation of activities and behaviour during daily work, observations during simulator exercises, within the scope of requalification on the simulator and relevant findings gained from appraisal interviews are of relevance. The overall assessment has to be documented.

5.5.5 Decision on the requalification examination

Article 34, paragraph 9, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The requalifications carried out periodically are evaluated as a whole, with the Division Head Operation deciding together with the training officer, on the result of the requalification. The decision on the requalification has to be documented for each person.

5.6 Withdrawal of authorisation

Article 33 of the Ordinance on the Qualifications of Personnel in Nuclear Installations

If one of the conditions pursuant to Article 33, paragraph 1 or 3, or Article 34, paragraph 8, of the Ordinance on the Qualifications of Personnel in Nuclear Installations applies, the operator has to withdraw the authorisation concerned. These procedures and the associated information on which the decisions are based have to be documented and presented to ENSI upon request.

5.6.1 Assignment at the corresponding functional level

Article 33, paragraph 1, letter d, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

In addition to the successful participation in recurrent training courses as well as a successful requalification, it is necessary for maintaining authorisation that the person is assigned to a position of responsibility at the corresponding functional level.

If the person has not been assigned to the corresponding functional level by the next 6 months following the requalification, a minimum training period of one day is required prior to his or her next assignment. If the person has not been assigned to the corresponding functional level by a period of 9 months, a minimum training period of two days is required prior to his or her next assignment.

This also applies to the maintaining of authorisation of the licensed personnel that predominantly work the day shifts. For these persons, the number of days he or she has worked at the corresponding functional level in the calendar year have to be documented in a comprehensible manner.

In cases where licensed personnel that predominantly does shift work is subsequently delegated to leave shift work in order to collaborate in practical projects, this collaboration may in justified cases be accepted to maintain authorisation , as fulfilment of the required assignments. An application has to be made to ENSI prior to the beginning of the project, indicating the project (type, scope and expected duration) as well as the reasons how this activity contributes to maintaining authorisation.

6 Training of the non-licensed personnel in nuclear instillations

For non-licensed personnel two groups of persons are distinguished:

a. Personnel relevant to nuclear safety whose appointment has to be reported

b. Other personnel whose activities may influence nuclear safety.

For personnel pursuant to Articles 2, 3, 4, 5, 10, 11, 12, 14, 19, 20, 21 and 22 of the Ordinance on the Qualifications of Personnel in Nuclear Installations as well as personnel not covered by the aforementioned articles of the Ordinance on the Qualifications of Personnel in Nuclear Installations whose appointment is, however, reportable pursuant to Article 38 of the Ordinance on the Qualifications of Personnel in Nuclear Installations, a procedure has to be specified and implemented which has to be based on the correspondingly graded relevance of the activity for nuclear safety and at least taking into account the procedure described under 4.1. The requirements for the recurrent training, continuing education and promotion of the social and communication skills for this group of persons are specified under 6.5.

For the other personnel not listed under 6.1 to 6.4 whose activity may, however, influence nuclear safety, a training procedure has to be specified and implemented which ensures that the knowledge required for the safe performance of the activity is imparted and examined.

6.1 Plant operators

Article 10, paragraph 2, letter b, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The training programme must also take the general requirements mentioned under 4.1 into account, specific to each function. The training of the plant operators comprises:

a. General knowledge of the plant

b. Detailed knowledge of the locations in respect of the individual components and control equipment

c. Basic knowledge of the structure, function and operation of relevant components

d. Process engineering knowledge relating to systems, in particular such systems that are essentially operated on-site

e. Knowledge of the risks of handling hazardous materials at the plant (H_2, N_2, oils, acids, bases, etc.), risks due to water or highly pressurised gases, steam and other media used in the plant; risks and behaviour in the controlled zone

f. Knowledge of relevant shift instructions, instructions for function checks and forms for industrial safety and physical protection (securing or isolation)

g. Plant-specific knowledge of the subjects (basic systems engineering, systems and components) of Annex 2 adequate to the functional level.

Prior to taking over the function as plant operator, the person must be shown to have sufficient plant- and function-specific knowledge. The examination has to include in particular the reliable operating and handling of safety on-site. The training measures have to be documented in the training documentation.

6.2 Maintenance personnel

Article 11 of the Ordinance on the Qualifications of Personnel in Nuclear Installations

Depending on their functions, the personnel carrying out maintenance activities have an entry qualification as an engineer or physicist with a university or university of applied sciences degree, as a technician, or a qualification based on an apprenticeship or vocational training time. The required professional experience pursuant to Article 11, paragraph 2, of the Ordinance on the Qualifications of Personnel in Nuclear Installations applies irrespective of the entry qualification.

Taking the general requirements under 4.1 and 4.2 into account, the training programme for maintenance personnel has to include the following additional aspects:

a. Understanding the operating and maintenance principles for specific equipment and components

b. Knowledge of the basic principles and procedures for securing /normalisation and isolating/de-isolating of systems and components

c. Knowledge of the risks involved when handling hazardous materials at the plant (H2, N2, oils, acids, bases, etc.), risks due to water or highly pressurised gases, steam and other media used in the plant

d. Practical skills for the monitoring and inspection of and specific maintenance activities on mechanical, electro-technical and instrumentation and control systems

e. Training at the manufacturer's, training on component models (mock-up) and working under the supervision of experienced personnel

f. Knowledge of the potential consequences that faults during maintenance activities may have on safety (derived from appropriate occurrences in the own plant, in other nuclear installations or from other industries)

g. Early and purposeful training for special, rare and complex activities

h. New findings concerning the field of work or the work environment have to be imparted to the employees concerned.

If special instruments, tools or equipment are required for carrying out an activity, their correct use has to be ensured by means of adequate training.

For complex tasks or activities performed under time constraints that involve high requirements in practice, and which cannot be practised on operating systems and represent a considerable safety risk, the operator has to provide adequate training models (mock-up), demonstration models, or comparably effective training means.

Maintenance personnel that carries out, manages or supervises specific work in high-radiation or high-contamination areas has to be instructed in additional, practical training courses on radiation protection practices.

Maintenance personnel in the field of electro-technical or instrumentation and control (I&C) maintenance has to receive instructions on specific, technical features of the electrical engineering of the system.

The training measures have to be recorded in the training documentation.

6.3 Other technical and scientific personnel

Article 12 of the Ordinance on the Qualifications of Personnel in Nuclear Installations

Other technical and scientific personnel are assigned to the following tasks in particular:

a. Monitoring of the plant

b. Planning, co-ordination and implementation of comprehensive modifications to the plant

c. Support of maintenance in case of any technical issues

d. Analysis of the system and component behaviour

e. Preparation of technical studies and analyses

f. Treatment, transport and disposal of radioactive waste

g. Emergency management.

The training programme for the following functions also has to function-specifically take the general requirements mentioned under 4.1 and 4.2 into account. The training measures required for fulfilling the functions have to be documented.

6.3.1 Functions requiring appointment

The operator does not assign the tasks for the subsequently specified functions on his own authority until the respective holder of the position has demonstrated that he or she has the knowledge and skills required for this function. These are examined prior to taking over the respective function and confirmed through a formal appointment of the person by the operator.

To take over the function independently and on one's own authority, sufficient experience in the person's own plant is required.

6.3.1.1 Core design

Persons responsible for the core design have to have a degree from a university or a university of applied sciences in a technical and scientific discipline and sufficient knowledge of nuclear physics as well as of the core design of the reactor of the own plant. The function-specific training preferably has to take place at the reactor and/or fuel element supplier.

6.3.1.2 Core monitoring

Persons responsible for core monitoring have to have a degree from a university or a university of applied sciences in a technical and scientific discipline. The persons have to have sufficient knowledge in the field of nuclear physics, reactor physics, thermal-hydraulics, reactor safety as well as a function-specific training for the monitoring of the reactor core. Furthermore, the person requires sufficient knowledge about the reactor core behaviour during normal operation and in case of operational disturbances, design basis accidents and beyond-design-basis accidents.

6.3.1.3 Water chemistry

Persons responsible for the water chemistry have to have a degree from a university or a university of applied sciences in chemistry. The persons also need plant- and function-specific training in water chemistry and/or radiochemistry which corresponds to their task.

6.3.1.4 Ageing monitoring

Persons responsible for ageing monitoring have to have a degree from a university or a university of applied sciences in a technical and scientific discipline or a comparable qualification and additional knowledge about ageing monitoring methods as well as sufficient experience in the respective field of expertise (electrical, structural, mechanical engineering).

6.3.1.5 Safety analyses (deterministic, probabilistic)

Persons responsible for the performance of safety analyses have to have a degree from a university or a university of applied sciences in a technical and scientific discipline. In addition, they require basic training and education in systems engineering, nuclear physics, reactor physics, thermal-hydraulics and reactor safety as well as training and education concerning the design principles of nuclear installations and function-specific training in verification and analysis methods which has to be conducted by an appropriate facility (training facility of a university, reactor or fuel element supplier, manufacturer of the plant, research institute, etc.). Also, knowledge of the design, operation and behaviour of the plant in case of operational disturbances as well as in case of design basis accidents and beyond-design-basis accidents is required.

6.3.2 Tasks requiring minimum knowledge

The persons mentioned in the following perform tasks in sequences or processes for the performance of which advanced knowledge or corresponding experience is required.

6.3.2.1 Modifications to the plant

Persons who plan modifications to the plant, make a safety-related assessment of the modifications and implement them require – depending on the complexity of the modification – detailed knowledge of the design, operation and behaviour of the plant during normal operation, in case of operational disturbances, design basis accidents and beyond-design-basis accidents. Depending on the type of modification, technical competences in structural, electrical, instrumentation and control, mechanical system and nuclear engineering and in ergonomics are required. In addition to the technical knowledge, sufficient expert knowledge for considering human and organisational factors is necessary. Furthermore, competences in the field of industrial safety, fire protection, radiation protection, environmental protection, physical protection and accident management are needed. Project managers need an additional qualification regarding the methods of project management or appropriate experience.

Persons responsible for the design of displays, user interfaces, visualisation systems and work flows for the monitoring and operation of the plant require both a technical qualification and sufficient expert knowledge in the field of ergonomics and workplace design. Sufficient knowledge about the plant and proven practical experience in the use of relevant methods and techniques for taking into account the human, technical and organisational aspects of rules and regulations according to the current state of the art in science and technology is required.

6.3.2.2 Evaluation of operating experience

Persons who collaborate in the evaluation of operating experience require, depending on the task assigned, detailed knowledge of the plant and its behaviour, specific knowledge of event analysis methods and experience in their application, knowledge in the field of organisation and human behaviour as well as knowledge and experience with interview techniques.

6.3.2.3 Emergency team

Persons who are member of the emergency team must have the knowledge and skills required for fulfilling their task pursuant to emergency preparedness regulations, emergency provisions, Severe Accident Management Guidance (SAMG), etc. The requisite knowledge and skills specified in the regulations and provisions have to be trained and practised in a training programme on a regular basis. In doing so, training courses and the regular participation in internal emergency exercises have to be considered as part of the staff work. The programme has to be reviewed and adapted periodically. If the annual emergency exercises show need for improvement, targeted training and further education measures have to be initiated.

6.3.2.4 Designing work processes

Persons who are responsible for designing work processes and thus for review of the management system, its implementation, effectiveness and continuous improvement need a higher technical qualification and a recognised additional qualification in the field of quality management as well as sufficient knowledge of the plant and the organisation.

6.4 External contract personnel

Article 13 of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The operator is responsible for the correct performance of all activities in his plant. He has to train and instruct the external contract personnel according to the specified tasks so that all safety requirements are met. In doing so, the contractors’ existing qualification has to be classified as follows:

a. Personnel with detailed knowledge of processes and components (from suppliers of large plant areas like reactor, fuel, turbine/generator)

b. Personnel with detailed knowledge of components (from manufacturers of auxiliary equipment, pumps, motors etc.) but only limited knowledge of the power plant process

c. Specifically qualified personnel (e.g. radiation protection, instrumentation and control) with experience gained in the plant over several years

d. Temporary staff that has no experience with nuclear power plants, hired from companies for simpler tasks such as cleaning duties, unless the task is directly supervised by the operator's personnel.

The external contract personnel have to be instructed according to their assignment. In doing so, especially the following topics have to be imparted to the extent necessary for the assignment:

a. General industrial safety and plant-related safety
b. Procedures regarding work permit
c. Radiation protection
d. Risks in the installation
e. Emergency prevention
f. Conduct in case of an emergency, alarm plan
g. Methods and rules of work in the plant, culture, work standards, provisions to be applied, access criteria
h. Rules for tools and supplementary means
i. Material transfer out of and into the nuclear installation
j. Local conditions (plant structure, arrangement of the building)
k. Cleanliness requirements
l. Communication paths
m. Specialized technical knowledge for particular tasks
n. Appropriate topics from Chapters 6.2 and 6.3 as well as the general requirements from Chapters 4.1 and 4.2.

It has to be considered that in case of activities carried out independently in the plant, the external contract personnel has to meet the same qualification requirements for the activities to be performed as if the task were performed by the plant personnel. If it is found that the external contract personnel do not have sufficient previous knowledge, the operator has to take the necessary actions and document them. The participation in the plant-specific training or instructions has to be documented.

6.5 Recurrent training, continuing education and promotion of social (soft skills) and communication skills

Article 35 of the Ordinance on the Qualifications of Personnel in Nuclear Installations

For the personnel mentioned under 6.1 to 6.3 (Article 35, paragraphs 4 and 5, of the Ordinance on the Qualifications of Personnel in Nuclear Installations), the requirements for recurrent training, continuing education and promotion of social (soft skills) and communication skills mentioned under 4.2 to 4.4 apply. The measures have to be documented.

6.5.1 Management personnel

Article 35, paragraph 6, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

With regard to the requirements for recurrent training, continuing education and promotion of social and communication skills, the requirements mentioned under 4.3 apply.

For actively remaining up-to-date with the state of the art in science and technology and the rules and regulations pursuant to Article 35, paragraph 6, letter a, of the Ordinance on the Qualifications of Personnel in Nuclear Installations, the following requirements apply:

Active monitoring of the state of the art in science and technology and the rules and regulations includes, besides private studies, collaboration

a. in innovations of laws, ordinances and guidelines issued by the authorities to be applied and in appropriate national and international standards and norms or other provisions (e.g. suppliers, manufacturers);

b. in national and international legislative committees and other expert commissions (e.g. Verein Grosskraftwerksbetreiber VGB, World Association of Nuclear Operators WANO);

c. in international nuclear committees such as the International Atomic Energy Agency IAEA and OECD Nuclear Energy Agency NEA, authorities and expert discussions;

d. in national and international nuclear research projects in the respective field of expertise.

The participation and/or collaboration has to be documented. In doing so, the private study time must not exceed the time spent on participation and/or collaboration.

7 Training of the licensed personnel in research reactors

7.1 Nuclear basic training

Article 15, paragraph 2, letter b, and Article 16, paragraph 2, letter b, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The nuclear basic training provides the prospective reactor operators and reactor technicians with the theoretical basis for their future task. The same requirements as mentioned under 5.1 apply.

7.2 Plant-specific training

The plant-specific training has to be carried out for the research reactor for which the authorisation is valid. It is conducted by trainers and instructors who have detailed knowledge and experience in operating a research reactor. The training encompasses the imparting of theoretical knowledge of systems and components as well as of the design of the research reactor, the behaviour of the installation during normal operation, in case of operational disturbances, design basis accidents and beyond-design-basis accidents. In the development of the learning objectives, system descriptions as well as the essential operating experience in one's own and in foreign installations have to be taken into account. The practical knowledge for monitoring and operating the installation is acquired at the own reactor under supervision by an experienced instructor.

Prior to the plant-specific training, a training programme showing depth and scope of the training, taking into account the demonstrated previous qualification and experience of the candidate, has to be submitted to ENSI.

7.2.1 Reactor operators

Article 15, paragraph 2, letters c and d, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The practical training for monitoring and operating the installation has to be imparted to such an extent that the person acquires sufficient operating safety. Furthermore, the person has to develop enough self-confidence, but also become sufficiently receptive to criticism, both towards him- or herself and others to. Especially the topics mentioned in Annex 2 have to be dealt with in appropriate depth, graded according to research reactors. The subject areas mentioned under 4.2 have to be considered with specific regard to the training phase.

7.2.2 Reactor technicians

Article 16, paragraph 2, letters c and d, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The practical training of reactor technicians has to meet the necessary, technical requirements that are requisite for fulfilling this function. For this purpose, detailed knowledge of the design of the research reactor as well as theoretical and practical knowledge regarding operational disturbances, design basis accidents and beyond-design-basis accidents has to be deepened. In particular, the theoretical and practical knowledge mentioned in Annex 2 has to be imparted, graded according to research reactors. The subject areas mentioned under 4.2 have to be considered with specific regard to the training phase.

7.2.3 Reactor physicists

Article 17, paragraph 2, letters c to d, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The practical training of reactor physicists has to impart the knowledge and skills required for fulfilling the specified function. This includes in particular comprehensive knowledge of the plant, detailed knowledge of the design of the reactor core and experiments to be carried out as well as the understanding of potential, severe accidents and their potential consequences and impacts. In particular the theoretical and practical knowledge mentioned in Annex 2 has to be imparted, graded according to research reactors. The subject areas mentioned under 4.2 have to be considered with specific regard to the training phase.

7.3 Authorisation of the operating personnel

For all examinations for authorisation, the selected questions or scenarios must not be known in advance to the examinees; also, they must be representative samples of the entire subject matter dealt with in the training.

7.3.1 Examination of the basic knowledge of nuclear engineering

Article 27 of the Ordinance on the Qualifications of Personnel in Nuclear Installations

Pursuant to the set of topics in Annex 1, examinees of research reactors who can demonstrate, that due to their training and education (e.g. a degree in reactor physics), they have the theoretical knowledge in the field of basic nuclear engineering, may be exempted from the final examination in the field of basic knowledge of nuclear engineering (Article 27, paragraph 5, of the Ordinance on the Qualifications of Personnel in Nuclear Installations). For each examinee, the exemption has to be applied for to ENSI, and the required proofs must be presented.

Apart from the exemption from the final examination, the same examination procedure as described under 5.3.1 applies.

7.3.2 Examination procedure for examinations for authorisation of research reactors

Articles 29 and 30 of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The procedure applies to reactor operators, reactor technicians, reactor physicists.

The procedure as described under 5.3.2 has to be applied and adapted to research reactors. Depending on the function, the content of the practical part of the examination as specified under 5.3.2.2 b has to be demonstrated by operating the installation and/or being deployed as emergency manager.

The required proofs substantiating the professional career, pursuant to Article 15, paragraph 2, letter a, of the Ordinance on the Qualifications of Personnel in Nuclear Installations have to be submitted.

The examination subjects and questions have to be based on Annex 2, adapted to research reactors and the respective function.

7.4 Recurrent training and continuing education of licensed personal in research reactors

Article 35, paragraph 3, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The requirements as described under 5.4 apply, adapted to the conditions, necessary scope and depth required for research reactors.

7.5 Requalification of the licensed personnel in research reactors

Article 34, paragraph 5, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

The operator has to specify a procedure for the requalification of the licensed personnel in the respective plant and prepare a corresponding programme for each functional level. The requirements pursuant to 5.5 apply, adapted to the conditions, scope and depth required for research reactors. The assessment of the requalification has to include in particular the practical knowledge mentioned in Annex 2, in a manner that is function-specific and adapted to research reactors.

7.6 Withdrawal of authorisation

Article 33 of the Ordinance on the Qualifications of Personnel in Nuclear Installations

If one of the conditions pursuant to Article 33, paragraph 1 or 3, or Article 34, paragraph 8, of the Ordinance on the Qualifications of Personnel in Nuclear Installations applies, the operator has to withdraw the authorisation concerned. These procedures and the associated information on which the decisions are based have to be documented and presented to ENSI upon request.

7.6.1 Assignment at the corresponding functional level

Article 33, paragraph 1, letter d, of the Ordinance on the Qualifications of Personnel in Nuclear Installations

In addition to a successful participation in recurrent training courses as well as a successful requalification, it is necessary for maintaining authorisation that the person performs shift work in a position of responsibility at the corresponding functional level.

If the person has not been assigned to the corresponding functional level longer than 6 months after examination, a minimum training period of half a day is required prior to the next assignment. If the person has not been assigned to the corresponding functional before 9 months, a minimum training period of one day is required prior to the next assignment. For these persons, the number of days he or she has worked at the corresponding functional level in the calendar year have to be documented in a comprehensible manner.

In justified cases, collaboration in practical projects may be accepted as fulfilment of the required assignments. for a corresponding application has to be presented to ENSI prior to the beginning of the project, indicating the project (type, scope and expected duration) as well as the reasons how this activity contributes to maintaining authorisation.

This guideline was approved by ENSI on 1 Oktober 2010 and is applicable from 1 January 2011.

The Director General of ENSI: signed H. Wanner

Annex 1: Examination subjects and contents of the training courses for the basic nuclear training of licensed personnel in nuclear installations

For the examination of basic knowledge of nuclear engineering, especially questions from the following subject areas have to be selected:

Nuclear physics, reactor physics, thermodynamics and thermal hydraulics; reactor engineering and reactor safety, chemistry; radiation/radiation protection and legal basis. For these subject areas, the following contents have to be imparted in particular:

1. Nuclear physics

Structure and modules of an atom, atomic number, mass number

Terms: isotope, nuclide, isobar, isomer, neutron, proton, electron, γ-quantum

Types of ionising and non-ionising nuclear radiation: α-, β-, γ-, n-radiation

Nuclear transformation for radionuclides with neutron excess: β^--decay, βn-decay

Nuclear transformation for radionuclides with neutron deficit: β^+-decay, electron capture ε

Nuclear decay for heavy nuclei: α-decay, spontaneous fission

Representation of the types of decay by means of the table of nuclides, decay series and explanation of the information in the table of nuclides.

Terms: Activity and half-life period. Properties of α-, β-, γ-radiation. Thermal and fast neutrons. Nuclear fission: process, binding energy, energy balance record during fission; reaction cross-sections and their dependence on the neutron energy; fission and activation products, mass defect, neutron flux density; particle fluence, breeding and conversion processes; recapitulation of the most important fissionable nuclides and nuclides that can be used for breeding; material embrittlement with neutrons; shielding measures against neutrons.

2. Reactor physics

Chain reaction, energy distribution of the fission neutrons; prompt and delayed neutrons as well as their relevance for the controllability of the reactor; development of the delayed neutrons; classification, mean life of the prompt and the delayed neutrons; moderation, reaction cross-sections: scattering cross-section, absorption cross-section in dependence on the type of nuclide and on the neutron energy.

Terms: critical mass, critical assembly. Link between neutron flux density and reactor power. Multiplication factor, reactivity, subcritical, critical, supercritical, promptly critical and promptly supercritical reactor. Operating behaviour and time history of the neutron multiplication for the supercritical and promp-critical reactor, reactor period.

Connection between reactor period and reactivity (InHour curve); neutron multiplication for the subcritical reactor; multiplication factor and four-factor formula, individual factors: neutron efficiency, fast fission factor, thermal utilisation factor, resonance escape probability. Under- and over-moderation of a reactor, Doppler effect, reactivity coefficients: coolant temperature coefficient, fuel temperature coefficient, void coefficient, power coefficient.

Neutron flux and reactor power: change of the density of the moderator and its influence on the neutron flux density. Neutron flux detectors during start-up and power operation. Qualitative information on the distribution of the neutron flux density across the core, close to a fuel element and close to a control element.

Structure, purpose and effect of neutron sources.

Control of the reactor power with control rods and change of the coolant flow rate (void contents) or with control rods and change of the boron concentration; operating behaviour below and above critical condition and in different power ranges. Experiments in case of a critical reactor that have or may have an influence on the reactivity and operating limits of the reactor.

Fission product poisoning: Samarium-149, xenon poisoning, in particular xenon-135 (denomination, constitution process, dependence on neutron flux density and type of power change, time response, influence on reactivity). Change of the axial power distribution through xenon, xenon oscillations. Burn-up, stretch-out operation, reduction of the thermal neutron flux density through plutonium and influence of this reduction on the ρ-bonding by xenon; reactivity changes through control rods, boric acid, influence of gadolinium on the reactivity. Differential and integral effectiveness of the control rods, core burn-up, reactivity balance/trip-safety. Influence of mixed-oxide fuel elements on the nuclear physical operating behaviour.

3. Thermodynamics and thermohydraulics

Basic terms and system parameters: Pressure, volume or specific volume, density; temperature, level, mass, time; flow velocity, vapour content, enthalpy and specific enthalpy; entropy and specific entropy; internal energy and specific internal energy.

Properties of water, impacts of density and temperature on the process fluid; wet steam, saturated steam and superheated steam; change in volume of the water during heating, evaporation of the water – vapour pressure curve, isotherms of the water vapour; evaporation of the water in the h-T diagram. Change of the water/water vapour condition in the T-s diagram, change of the water/water vapour condition in the h-s diagram; cyclic process in the thermal power station (Rankine cycle), cyclic process in the T-s diagram, cyclic process in the h-s diagram; the terms expansion and throttling; changes of the condition of boiling water in case of compression or decompression in the h-s diagram.

Fundamentals of fluid mechanics: Continuity equation, laminar and turbulent flow, law of conservation of energy; total pressure, static pressure, dynamic pressure (Bernoulli equation).

Flow measurements with standardised orifice devices, flow resistances in pipes and valves, resistance characteristic of a fuel element. Operating conditions of centrifugal and piston pumps, pump curves; operating limits, cavitation, net positive suction head (NPSH).

Drain from containers or systems under pressure: water (cold, hot), steam, critical pressure ratio, critical velocity, laval nozzle. Influence of leakages on the tank pressure and water level.

Physical behaviour of air/water-vapour mixtures, humid air.

Terms: power density, heat flux density, linear power. Mechanisms of heat transfer. Thermal conduction, convection, radiation.

Heat transfer in heat exchangers, heat transfer from metal to water, heat transfer from metal to steam. Nukiyama curve, terms: nucleate boiling, film boiling, departure of nucleate boiling (DNB), critical heating surface load, DNB-ratio. Protection against film boiling, heat conduction in the fuel; temperature distribution in the fuel rod, in the coolant, inner and outer cladding tube. Protection against film boiling of the cooling channel for PWR: DNBR, protection against dry-out of the cooling channel for BWR: MCPR.

Critical point of boiling heat transfer, critical boiling heat transfer; LHGR, CPR, prevention of fuel melt BWR/DWR, terms: MFLPD (BWR), hot-channel factors, hot spot factor. Mechanisms and qualitative classification of the energy release (heat generation) in the fuel, moderator, coolant, in the core internals, in the shielding.

Natural circulation (single phase, two-phase), limits of natural circulation, two-phase energy transport.

Structure of hydrogen concentrations in water-vapour/air mixtures, ignition limits, methods to prevent ignition limits and reduction of hydrogen.

4. Reactor engineering and reactor safety

Power and research reactors: structure, mode of operation and characteristic features of BWR and PWR, comparison with zero-power reactor.

Risks in the use of nuclear energy (fission product inventory, control of subcriticality, residual-heat removal and activity retention); decay heat, risk, operating limits and conditions, terms: specified normal operation, operational disturbances, design basis accidents, accident, beyond-design-basis accidents, safety levels (defence in depth). Principle, structure and functionality of the barriers against leakage of radioactive substances into the installation and the environment.

Safety principles (safety concepts), terms: inherent safety, fail-safe principle, single-failure criterion; redundancy, diversity, self-monitoring, work and rest principle; barrier concept, physical separation, bunkering, segregation; quality assurance, periodic testing. Fundamentals of ageing management.

Faults and failure types: single failure, systematic failure, subsequent errors, active and passive failures, common mode failures (CMF), common cause failures (CCF). Term: single-failure criterion, operator handling errors, accidental fault, ageing failure, initiating event.

Overview of tasks and typical modes of operation of important active and passive safety systems: reactor protection system, safety system, passive safety devices, active safety devices.

Physical principles for temperature, pressure, flow and level measurement and the measured value indication in case of faults, measuring inaccuracies.

Basic aspects according to which reactor protection or safeguard actions become necessary; typical event sequences to be assumed that may cause a hazard to the personnel, the installation (also including damage to the reactor core) and the environment. Protection goal control, partial load diagram PWR, reactor operation characteristic chart BWR.

Residual-heat removal during specified normal operation (PWR and BWR); residual-heat removal after failure of the main heat sink (PWR and BWR). Residual-heat removal in case of a loss of coolant. Residual-heat removal in case of beyond-design-basis accidents.

Internal and external initiating events, potential impacts and protective measures. Administrative controls and process concepts.

5. Chemistry

Structure of the periodic table of elements, classification of the elements, chemical types of bonding and compounds; aqueous solutions, properties of acids and bases, reaction equations. Hazardous chemical substances in nuclear power plants (hydrogen, acids...).

Solubility of substances in water and their dependence, types of corrosion, corrosion for iron and their influencing potential, corrosion-resistant materials; composition, development and decay of pure water, radiolysis, natural substances of water; types, origin and impact of contaminations; methods to remove foreign substances, mode of operation of deionisers, principles of coolant treatment for the reactor coolant, secondary and cooling tower system; methods for measuring conductivity, pH value, O_2, H_2 and boric acid concentration.

6. Radiation/radiation protection

General: hazards to health due to ionising radiation, radiation protection tasks; justification, limitation, optimisation, ALARA principle.

Terms: activity, half-life period, dose, equivalent dose, committed effective dose; half-value thickness, specific activity, activation; contamination, incorporation, inhalation, ingestion; immersion, submersion, external exposure, radiotoxicity.

Interaction between radiation and matter (embrittlement, ageing, ...).

Important activation and fission products, open and enclosed radioactive substances; loose and solid contamination, other radiation sources (e.g. x-ray tube); dose-effect relationship for tumours and acute early damage, natural radiation exposure, man-induced radiation exposure of the population, comparison to other risks.

Radiation protection measures: Zone and barrier concept, shielding, distance, duration of stay, protective clothing, respiratory protection; measures against uncontrolled spread of contamination, dictates and prohibitions; filtration, decay systems, decontamination.

Qualitative information on the shielding against radiation (attenuation, shielding, scattering).

Radiation protection goals: Dose limits for persons occupationally and non-occupationally exposed to radiation during specified normal operation; dose limits for accident precautions, dose limits for the protection of the population and especially for the rescue of human lives; derived reference levels for local dose rates depending on the type of area; contamination reference values for the skin; surface and air contamination reference values depending on the zone type; exemption limit for activity.

Radiation protection monitoring: Functional principle, handling and scope of application of radiation measurement devices and equipment for measuring the dose in the □- and n-radiation field: ionisation chamber, scintillation detector, neutron detector, TLD/DIS, digital dosimeters. Response capacity depending on type, energy, flow and geometry of radiation.

Theory and practice of handling measuring devices for radiation protection as well as the scope of application of radiation measuring devices to measure surface and air contamination in case of α- and β-/γ-radiation. Principle of determining the activity with semi-conductor detectors or γ-spectrometry.

Measures and facilities for monitoring the personal doses, time intervals for the controls of the personal doses as well as radiation protection-related medical examinations of occupationally exposed persons.

7. Legal basis

Overview and knowledge of important chapters of the Nuclear Energy Act and Nuclear Energy Ordinance, Radiological Protection Act and Radiological Protection Ordinance as well as the contents of other relevant ordinances and guidelines.

Pyramid of rules and regulations (law, ordinance, guideline...), responsibilities (authority/operator), general design features and safety philosophy (defence in depth).

Annex 2: Examination subjects and contents of the training courses for the requisite plant- and subject-specific knowledge of the licensed personnel in nuclear installations

For the examination of the plant- and subject-specific knowledge, the following levels of knowledge in the respective fields of expertise are – depending on the functional level – a prerequisite in particular:

1 Fundamentals of systems engineering:

Subject	R-Op	SC	PI
Mechanical engineering	1	(1)	(1)
Electrical engineering	1	(1)	(1)
Instrumentation and control engineering in nuclear installations	1	(1)	(1)

2 Systems and components

Subject	R-Op	SC	PI
Nuclear steam generation system	2	1	(2)
Containment and containment systems	2	1	(2)
Reactor shutdown and activation of the safety systems	2	1	(2)
Reactor control/regulation	2	1	(2)
Primary- and secondary-side residual-heat removal systems	2	1	(2)
Emergency core cooling	2	1	(2)
Auxiliary reactor systems	2	1	(2)
Water-steam circuit	2	1	(2)
Cooling water systems	2	1	(2)
Control stations and instrumentation & control	2	1	(2)
Electrical systems	2	1	(2)
Fuel handling	2	1	(2)
Other nuclear systems and important operating systems	2	1	(2)
Systems for beyond-design-basis accidents	(2)	1	(2)
Physical protection	(3)	(2)	2
Fire protection	2	1	(2)
Radiation protection	(2)	1	(2)
Administrative provisions and regulations	2	1	1

3 Normal operation and operational disturbances

Subject	R-Op	SC	PI
Start-up	2	1	(2)
Shutdown	2	1	(2)
Power changes	2	1	(2)
Refuelling	2	1	(2)
Operational disturbances	2	1	1

4 Design basis accidents

Subject	R-Op	SC	PI
Reactivity accidents	2	1	1
Core cooling/coolant inventory accidents	2	1	1
Confinement of activity	2	1	1
Other accidents during plant operation	2	1	1
Accidents due to external impacts	(2)	1	1

5 Beyond-design-basis accidents

Subject	R-Op	SC	PI
ATWS (BWR / PWR)	(3)/(3)	2/(2)	1/1
Combined events, jointly forming beyond-design-basis conditions	(3)	(2)	1
Emergency preparedness	(3)	(3)	1
Events with core damage	-	(3)	(2)

6 Team work, leadership and communication

Subject	R-Op	SC	PI
Communication	1	1	1
Working method	2	2	2
Decision-making	2	1	1
Teamwork	2	2	2
Leadership skills	3	1	1
Safety consciousness	1	1	1

7 Examination subjects on practical skills for licensed personnel in research reactors

Subject	
Practical knowledge of the reactor operators	1
Practical knowledge of the reactor technicians	1
Practical knowledge of the reactor physicists	1

Legend for all tables above

R Op = reactor operator

SC = shift supervisor

PI = on-call engineer

The required level of knowledge is defined for each subject area as follows:

1 = Overall knowledge of the field of knowledge

2 = Overviews of the field of knowledge

3 = Insight into the field of knowledge

A number in brackets means: knowledge of this field is a prerequisite but is not target of the examination.

Note: As the nuclear installations are designed differently, individual systems or components may not exist, be named differently in the respective nuclear installation, or belong to another group of systems. Therefore, the application has to be based on analogy.

1 Fundamentals of systems engineering

To achieve a basic understanding of the installation, the following knowledge has to be imparted in particular:

1.1 Mechanical engineering

Pumps: piston pump, centrifugal pump, operating conditions, pump characteristics, duty point and regulation of centrifugal pumps. Cavitation, net positive suction head (NPSH), operating limits. Mode of operation and operating behaviour of steam turbines, mode of operation and operating behaviour of heat exchangers, special heat exchangers, humid air, cooling tower.

1.2 Electrical engineering

Basic electro-technical parameters (current, voltage, Ohm's law, alternating current, direct current, etc.); electro-magnetic field, electric power transfer, alternating current consumers, alternating current circuit; measurement on electrical circuits, electrical machines; synchronous generator in isolated operation and when connected to the network; generator operation, three-phase current asynchronous motor, electrical systems, emergency power systems.

1.3 Instrumentation and control engineering in nuclear installations

Tasks and types of instrumentation and control in nuclear installations, hierarchy of the control levels, block diagram of the regulation system. Structure of measuring circuits, measuring errors and reading inaccuracies for measuring-point displays, process information and operating systems. Allocation of instrumentation and control functions to schematic representations. Binary signal transmission chains, evaluation logics such as AND, OR, NOT Mode of operation of control loops as well as P, PD, PI and PID behaviour; disturbance variable impact, temporal behaviour of control loops, allocation of control engineering functions to schematic representations; basic mode of operation of overriding control loops, basic mode of operation of the reactor safety system, structure and mode of operation of the core instrumentation.

2 Systems and components

Within the scope of the training in the field of systems and components, the following aspects have to be considered in particular:

Task, mode of operation, arrangement and structure of the most important components; plant identification system (AKZ, KKS,…), design and operating data relevant for incidents, accidents and emergencies; extent and structure of the instrumentation, potential modes of system operation, interpretation of the measured values, use of system diagrams; component names, logic diagrams and control system schematic diagrams. Influence of operating modes on connecting systems or influence by other systems, checking function stand-by, identification of disturbances; knowledge of the different alarms (optical and acoustic) and their meaning; initiation of corrective measures in case of disturbances; operating limits, function tests, function and structure of the control and shutdown devices; fundamentals of reactor control and monitoring in the start-up and power range. Reactor protection system and instrumentation & control system. Objective of the reactor protection system, its function, inspection and activation. Tasks and function of the operating instrumentation and control systems, manual and automatic reactor trip (scram). Basic knowledge of the content of the technical specification. Structure, content and principles of the system operating provisions.

The imparted theoretical knowledge of systems and components has to be deepened by practical work like e.g. plant walk-downs, operational monitoring within the scope of a participation in shift work, securing/normalisation and isolating/de-isolating and training on the simulator. During simulator training, the deviation of the behaviour or the depth of the simulation from the real installation has to be pointed out. When imparting system-specific knowledge on the simulator, normal courses of action that have a noteworthy impact on the installation have to be taken into account.

To acquire the requisite basic knowledge of the structure of individual systems and components as well as their modes of operation, the following knowledge has to be imparted in particular:

2.1 Nuclear steam generation system

Reactor pressure vessel including internals, reactor core with fuel elements and control rods, control rod drive system; cover seal, circulation system (BWR), isolation (BWR); reactor coolant pumps (PWR), pressuriser with relief and safety valves (PWR), steam generators (PWR); main steam blow-down and safety valves (PWR), main stop valves, main steam and feed-water system.

2.2 Containment and containment systems

Primary containment, secondary containment, isolation systems; vacuum break systems, emergency exhaust air system, hydrogen depletion system; annulus, cooling, spray system, inertisation (BWR); recirculation pump system, leakage monitoring, leakage suction system, emergency exhaust (PWR). Arrangement of the components and systems.

2.3 Reactor shutdown and activation of the safety systems

Reactor trip system, reactor protection system (including activation of the safety systems), activation of the safety systems from the remote shutdown station; pressure vessel instrumentation, neutron flux instrumentation, poison injection system (BWR), leakage monitoring systems.

2.4 Reactor control/regulation

Reactor circulation control (BWR), reactor water level control, reactor pressure control; coolant temperature control loop (PWR), control rod control and information system, power control, reactor power calculation.

2.5 Primary and secondary-side residual-heat removal systems

Residual-heat removal system, pressure relief system (BWR), bleed and feed operation (PWR); auxiliary feedwater (PWR), emergency feedwater (PWR), emergency water supply (PWR); main steam and feedwater isolation, energy sources and sinks; energy transport during power operation, in case of shutdown reactor with forced circulation or in natural circulation.

2.6 Emergency core cooling

High-pressure and low-pressure injection systems, automatic depressuration system (BWR), remote shutdown station; high-pressure safety injection (PWR), accumulator (PWR), low-pressure injection (PWR); core cooling via containment sump (PWR).

2.7 Auxiliary reactor systems

Reactor water clean-up system and reactor water conditioning system, spend fuel pool cooling and clean up system.

2.8 Water-steam circuit

Feedwater and condensate system, turbine systems with turbine bypass; condenser, bypass control, shaft seal, auxiliary steam system.

2.9 Cooling water systems

Service water system, nuclear intermediate cooling system, emergency cooling system, intermediate component cooling system, main cooling water system, emergency core cooling system.

2.10 Control stations and instrumentation & control

Main control room, remote shutdown and control stations, alarm annunciation system; emergency instrumentation, means of communication; process information and process visualisation systems, safety parameter display system.

2.11 Electric systems

Structure of the power and second-level emergency power supply system and its behaviour in case of station blackout and operational malfunctions. General structure of the switchgear station. Auxiliary station supply, emergency diesel generator, external power supply, direct-current supply, secured alternating current supply, uninterruptable power supply, graded circuit protection.

2.12 Fuel handling

Facilities for handling fuel, fuel element transportation locks, fuel loading machine. Research reactors: Loading of the reactor and storage of the fuel outside the reactor; characteristics of the different moderators, their influence on reactor operation and their conditioning, procedure in the approach to criticality.

2.13 Other nuclear systems and important operating systems

Ventilation systems, control air, drainage; sampling, exhaust system, waste water systems; seismic instrumentation, building equipment, locks.

2.14 Systems for beyond-design-basis accidents

Containment feed-and-bleed system, filtered venting, special emergency systems.

2.15 Security

Access control, physical protection, alarm systems; buildings and arrangement of the buildings, access regulations, escape and intervention routes.

2.16 Fire protection

Fire protection monitoring, fire alarm systems, escape routes and doors; gathering places in case of emergencies, fire compartments, fire doors; location and application range of the extinguishing devices, smoke extraction possibilities; control of the turbine, the generator or the reactor in the event of a fire; behaviour of the ventilation system and other appliances in case of a fire.

2.17 Radiation protection

Responsibilities pursuant to the Radiological Protection Ordinance and radiation protection regulation, competences and duties of the shift and radiation protection personnel; ALARA principle and radiation protection planning; zone concept, exclusion areas and access regulations; radiological monitoring of circuits, rooms and suction systems; work place monitoring with regard to dose rate, air contamination and surface contamination; personal monitoring in respect of external radiation, contamination and incorporation; systems for monitoring the radioactive emissions and immissions, radiation protection metrology, radiological impacts of incidents in the installation; identification and procedure when limits are exceeded, storage of operationally requisite radiation protection measuring devices and the use thereof; radiation protection means and existing shielding; radiation protection limits and obligations; separation, decontamination, packing and storage of activated/contaminated materials; criteria for the clearance of materials as inactive.

Source-related reference dose, reference value for radiation exposure due to radioactive substances discharged with the air and water; derived limit values for the maximum permissible activity discharge with water and air.

Initial protective measures in case of radiological incidents and radiation accidents until the radiation protection personnel arrive. Procedure for the decontamination of persons including measuring methods, measures to be taken in case of incorporation, measuring method in case of incorporation, measures for the preservation of evidence.

2.18 Administrative provisions and regulations

Relevant administrative provisions such as power plant and emergency preparedness regulations, obligations and directions imposed by the authorities, operating regime and shift instructions.

Organisational structure, tasks, responsibilities and presence of the different officers in charge; knowledge of important chapters of the safety analysis report and the operating provisions; isolation procedures, documentation of switching operations and reactor data; knowledge of the structure and tasks of the emergency organisation as well as conduct in case of an emergency.

3 Normal operation and operational malfunctions

Within the scope of the training and to prevent and control operational malfunctions, the following aspects have to be considered in particular:

Checking functional stand-by of the system, monitoring of the operating limits; knowledge of the operating and safety limits as well as of the technical and administrative measures to ensure that they are adhered to. Identification of the plant condition and deviations from normal operation by interpreting plant and system parameters; initiation of actions to be taken in case of operational malfunctions; performance of function tests, knowledge of the content and structure of the technical specification; monitoring of fuel element handling; monitoring of the dose rates during walk-downs in the installation (electronic personal dosimeter (EPD), stationary and mobile measuring devices).

Within the scope of the training, the relevant operating experience in the own and in foreign installations and the resulting relevant modifications to the installation have to be imparted.

Within the scope of the simulator training, the requisite switching operations to be carried out have to be imparted and the safe use of the operational documents (operating provisions, function and system diagrams) has to be consolidated for normal operation. In doing so, attention has to be paid to the use of targeted, structured communication and team behaviour.

Within the scope of the simulator training, the necessary strategy for controlling the respective disturbance situation has to be imparted and the skills of handling the systems to be used have to be consolidated for operational malfunctions. The use of the technical specification has to be included in appropriate scenarios. In doing so, communication, team behaviour and leadership skills have to be used with respect to the respective situation.

For on-call engineers, knowledge relating to the use and assessment of the plant condition with regard to regulatory reporting criteria has to be imparted.

To acquire the requisite knowledge and to prevent and control operational malfunctions, the following contents have to be imparted in particular:

3.1 Start-up of the power plant

Heating the reactor up and rendering it critical; heating rate, ensuring the main heat sink, power increase; critical heating surface loading, film boiling, partial load diagram (PWR), operating characteristics diagram (BWR).

3.2 Shutdown of the power plant

Power reduction, monitoring of subcriticality, residual-heat removal with or without main heat sink; residual-heat removal system, shutdown gradient, different plant conditions in shutdown operation.

3.3 Power changes

Power reductions, power increase, influence and impact of secondary-side operation modifications to the reactor coolant system; impact of disturbances in the high-voltage system, programmes to not stress the plant, and plant limits.

3.4 Refuelling

Loading and unloading of the reactor core, shuffling; system monitoring and system requirements during shutdown operation and outage of the plant; disturbances during fuel element handling.

3.5 Operational malfunctions

Disturbances: in the feedwater system, in the condensate system, during circulation of the reactor coolant system, during primary (secondary) pressure regulation; in reactivity (control rods, boric acid, output control), at the turbine, at the generator; in the auxiliary station supply, the high-voltage system, the exhaust system; at the ventilation in the controlled areas (pressure gradation), at the supply and auxiliary systems, at process information systems.

Leakages: in the reactor coolant system, in the steam generator (SG tube), in the condenser; in the volume control system, in the primary clean-up water system, in coolers.

4 Design basis accidents

Within the scope of the training for the control of design basis accidents, the following aspects have to be taken into account in particular:

Identification and impacts of design basis accidents and the actions to be taken. Safe application of the operating documents. Structure and principles of the event- and symptom-oriented provisions, identification of the plant condition from alarms and plant parameters; interpretation of the information of the Safety Parameter Display System (SPDS); knowledge of the impacts on relevant plant parameters (reactor power, reactor/ pressuriser/steam generator filling level, reactor pressure and steam generator pressure). Control of the activation of protective and limiting functions as well as initiation of the safety systems by means of the feedback and the plant condition. Monitoring the safety goals and checking the function of the challenged operating or safety systems; control of the initial measures after reactor trip (scram); control of the effectiveness of measures; identification of system malfunctions.

Within the scope of the simulator training for design basis accidents, the necessary strategy for controlling the respective incident situation has to be imparted and the skills for monitoring the automatically activated safety functions and ensuring compliance with the protection goals have to be consolidated. In doing to, the correct communication models, the appropriate understanding of one's role within the team and necessary leadership of the team have to be practised. The scenarios have to include design basis accidents during power operation, start-up and shutdown operation as well as outage of the installation and combinations of design basis accidents and disturbances.

For shift supervisors, the use of the technical specification, knowledge of the radiation protection provisions, first assessment of the contaminations and discharge limits, knowledge of the RABE criteria and assessment of the measured values of the RABE detectors have to be imparted.

For on-call engineers, knowledge of the classification of the incident according to internal and external reporting criteria, tasks relating to emergency management and assessment of the radiological situation have to be imparted. Furthermore, knowledge of confidential regulations regarding physical protection (organisation, agreements, powers, communication devices and procedure in case of security-relevant events) has to be imparted.

To acquire the requisite knowledge to control design basis accidents, the following contents have to be imparted in particular:

4.1 Reactivity disturbances

Incorrect positioning of the control rod (BWR), inadvertent insertion of a control element (PWR), inadvertent movement of control rods or control rod banks; faulty boron dilution, inadvertent ejection of a control element (PWR); inadvertent drop of a control element (BWR), controller malfunctions, faulty addition of a reactor coolant pump (PWR); incorrect operation of reactor circulation pumps, pressure disturbances, supercooling transient; failure of reactor circulation pumps, nuclear-thermal-hydraulic oscillations, poison injection system (BWR); cold water feed into the reactor coolant system, trip-safety during shutdown.

4.2 Core cooling disturbances / coolant inventory

Heat removal malfunctions: Reactor level malfunctions, overpressure protection of the reactor coolant system, spurious opening or closure of safety/blow-off valves; incorrect pressuriser spraying (PWR), incorrect activation of safety functions, disturbances in the main steam system; disturbances in the residual-heat removal system, faulty closure of the main steam isolation valves; failure of the feed-water supply; loss of the main heat sink, loss of offsite power.

Malfunctions with loss of coolant: small, medium, large leak in the reactor coolant system, pipe rupture in the main steam or feedwater system; leakages in the high-pressure or low-pressure feed system, reactor water purification; instrument lines of the reactor coolant system, piping in the turbine building (BWR), steam generator tube rupture (PWR).

4.3 Activity retention

Loss of the pressure differences, containment leakages, incidents during the transportation and handling of fuel elements, cladding tube damage.

4.4 Other disturbances in the operation of the power plant

Malfunctions in the auxiliary or supply systems (alternating/direct-current supply, auxiliary and closed cooling water, instrument air system, ventilation system); leakages or ruptures in the exhaust system or on other activity-retaining systems; internal flooding, fire.

4.5 Accidents due to external impacts

Earthquakes, aircraft crash, explosion blast wave, fumes, flooding, extreme weather conditions, sabotage.

5 Beyond-design-basis accidents

Within the scope of the training for reducing the hazard due to beyond-design-basis accidents, the following aspects have to be considered in particular:

Identification and impacts of beyond-design-basis accidents and the actions to be taken. Assessment of the safety goals and safety functions as well as initiation of countermeasures according to the emergency provisions and emergency preparedness regulations of the installation.

To acquire the knowledge required for reducing the risks due to beyond-design-basis accidents, the following contents have to be imparted, in particular:

Loss-of-coolant accidents in the turbine building with containment isolation failure (BWR). Multiple failures of emergency cooling components, failure of the primary pressure relief, ATWS incidents; low-pressure path (PWR), large leak with failure of several accumulators (PWR); disturbed heat removal in sump operation, containment leakages up to containment failure; considerable degradation of the heat transfer conditions in the steam generator up to a total breakdown of the heat transfer function; failure of main steam isolation, spurious opening of the main steam safety valve and/or the valve remaining open with the steam generator tube rupture in the steam generator affected; unusual ambient conditions.

To acquire the requisite accident management knowledge for reducing the impacts of beyond-design-basis accidents, the following contents have to be imparted, in particular:

Discharge paths (exhaust air, waste water), direct radiation in case of beyond-design-basis accidents, assessment of the activity released, assessment and rules of thumb for determining the ambient dose. Alerting, reporting and communication with the authorities in charge, report pursuant to guideline ENSI-B03 and INES categorisation; division of the environment into zones and meaning of the zones 1 and 2; activation criteria RABE (warning, alarms and false alarms), activation criteria “fast accident”, knowledge regarding the information of the general public and measures for its protection (dose-measure-concept).

Within the scope of beyond-design-basis accidents, the strategy for controlling the respective accident situation has to be imparted with the aid of simulators as far as possible. The scenarios to be developed have to be such that they require the application of both symptom- and event-oriented emergency provisions and the use of the emergency preparedness regulations and the emergency manual or SAMG. In doing so, communication, team behaviour and leadership skills have to be practised with respect to the respective situation.

6 Team work, leadership and communication

Within the scope of the training, team work, leadership skills and communication within the shift team, with the other plant personnel and with external bodies as well as work techniques and safety consciousness have to be promoted.

The following aspects have to be considered during the simulator training and assessed in the requalification in particular:

a. Effective communication and understanding of one’s role within the team;

b. Behaviour in respect of relaying information, decision-making, co-operation and leadership

c. Systematic and target-oriented performance of tasks

d. Correctly assigning priorities in carrying out work

e. Precise and target-oriented briefing of the team members

f. Including the knowledge of the entire team

g. Adhering to clear and precise instructions in the team.

7 Examination subjects on practical skills for licensed personnel in research reactors

7.1 Practical knowledge of the reactor operators

Operation of the reactor according to the instructions of the reactor technicians or reactor physicists and description of selected plant conditions; monitoring of the installation during reactor operation: instrumentation, alarms and other displays as well as their diagnosis; using provisions and reference materials; operation and use of the control room instrumentation; communication and co-operation with other team members; tasks when performing service and maintenance activities.

7.2 Practical knowledge of the reactor technicians

Operation of the reactor as well as description of selected plant conditions; monitoring of the plant: instrumentation, alarms and other displays as well as their detailed and complete diagnosis; using provisions and reference materials, operation and use of the control room instrumentation; communication and co-operation with other team members; tasks when performing and checking service and maintenance activities.

7.3 Practical knowledge of the reactor physicists

Interpretation and diagnosis of events or plant conditions based on alarms, plant records, instrumentation or other displays; assessment of the plant condition by means of the protection goals or critical safety functions (including the identification of beyond-design-basis accidents); initiation of the activation of alarms for external organisations and of the emergency team contingent; classification of the event according to INES and guideline ENSI-B03; further tasks within the scope of accident management.

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