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Swiss Federal Nuclear Safety Inspectorate ENSI



## Decommissioning of Nuclear Installations

Guideline for Swiss Nuclear Installations

ENSI-G17

April 2014 Edition



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# 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 stipulates the requirements for the decommissioning of nuclear installations. It also specifies the detailed requirements for the application documents regarding decommissioning.

Measures to ensure the financing of decommissioning are regulated by the ordinance of 7 December 2007 concerning the decommissioning fund and the disposal fund for nuclear installations (Decommissioning and Disposal Fund Ordinance, 732.17) and are not covered by this guideline.

The requirements for conventional safety at work and for the management of non-radioactive waste are regulated by the legislation at Federal or cantonal level, and are likewise not subject of this guideline.

## 3 Legal basis

This guideline is based on:

- a. Articles 26 to 29 of the Nuclear Energy Act dated 21 March 2003 (732.1)
- b. Articles 41, 42 and 45 to 49 of the Nuclear Energy Ordinance dated 10 December 2004 (732.11)

## 4 Requirements for decommissioning

### 4.1 Phase concept

- a. The post-shutdown period and the decommissioning work should be divided into several phases (see Annex 2). The phases are consecutive.

- b. The post-shutdown period (phase 0) starts when the installation is finally shut down.
- c. Decommissioning from phase 1 onwards shall be planned in the decommissioning project. This period starts when the decommissioning order becomes legally binding. From phase 1 onwards, each phase requires a permit by ENSI unless otherwise stated in the decommissioning order.
- d. Activities which require permits as per Article 47 of the Nuclear Energy Ordinance shall also be included in the planning of the phases. If these activities cannot be planned in detail within the initial phase concept, ENSI may issue permits later within the affected phase.

## **4.2 Final shutdown**

- a. The owner of a nuclear installation shall notify ENSI in writing upon the decision of the final shutdown. This notification shall include the tentative date when the installation will be finally shut down.
- b. The owner shall submit the decommissioning project no later than two years after the final shutdown. ENSI may set a different time limit in particular cases.

## **4.3 Post-shutdown period**

- a. The owner shall submit the documents as specified in section 5.3 concerning the changed requirements for the post-shutdown period to ENSI.
- b. The planned changes to the installation during the post-shutdown period shall not deviate significantly from the operating licence and shall not prejudice the decommissioning order.

## **4.4 Demonstration of safety and security**

- a. The compliance with the fundamental protection objectives as per Article 2 of the Ordinance of the Federal Department of the Environment, Transport, Energy and Communications dated 17 June 2009 on Hazard Assumptions and the Assessment of Protection against Accidents in Nuclear Installations (732.112.2) shall be demonstrated in each decommissioning phase. The demonstration shall take account of the remaining hazard potential and of the nature and scope of the planned activities.
- b. To demonstrate compliance with the security requirements, the following aspects shall be taken into consideration in each phase:

1. The hazard assumptions according to the security guideline, classified as SECRET
  2. The hazard potential relating to nuclear materials and to the radiological inventory
  3. The structural condition as it is modified during the decommissioning work, on a case-by-case basis.
- c. If there are several nuclear installations with independent operating licences on the same security perimeter and if they cease to be subject to nuclear energy legislation gradually over time, the security concept for the overall installation shall be based on the highest hazard potential, or independent security concepts shall be assigned to the nuclear installations.

## **4.5 Radiological characterisation of the entire installation**

Before or at the latest upon final shutdown, a comprehensive radiological characterisation of the entire installation shall be carried out on the basis of assessments, taking account of current nuclide-specific analyses, contamination and dose rate measurements, as well as the operating history including relevant events. The results of this characterisation shall be documented and updated for each phase.

## **4.6 External storage of nuclear materials**

After the installation is finally shut down, the nuclear materials shall be transported to another suitable nuclear installation. In particular, the fuel elements (or other forms of nuclear fuel in the case of research facilities) shall be transported to such a location as soon as reasonably possible.

## **4.7 Conditioning and temporary storage**

The requirements of the Guidelines ENSI-B05 and ENSI-G04 for the conditioning and temporary storage of radioactive waste also apply to decommissioning.

## **4.8 Human and organisational factors**

### **4.8.1 Organisation and staff**

- a. The requirements for the organisation of a nuclear installation as per Guideline ENSI-G07 shall continue to apply for the post-shutdown period and accordingly as of the legally binding decommissioning order.

- b. The requirements for the radiation protection personnel as per the legislation on radiation protection and Guideline ENSI-B13 shall apply.
- c. The party obliged to carry out decommissioning shall designate an individual to be responsible for the decommissioning. This individual's competencies and the requirements applicable to his position shall correspond to those of the position for technical operation of the installation. He/she shall manage the project by means of planning, control and monitoring, and shall coordinate the project procedure in such a way as to ensure safety at all times.
- d. The personnel required for decommissioning shall basically satisfy the requirements set out in the Guideline ENSI-B10.

#### **4.8.2 Management system**

The requirements for the management system of a nuclear installation as per Guideline ENSI-G07 shall continue to apply for the post-shutdown period, and accordingly as of the legally binding decommissioning order.

#### **4.9 Radiation protection**

- a. The concepts for monitoring and protection against incorporation, and the related measures, shall be adapted to the requirements and changed overall conditions due to decommissioning. Particular consideration shall be given to the following aspects:
  - 1. Extended exposure of staff to areas with contamination, compared with power operation
  - 2. Possibility of chemical or mechanical decontamination of installation components prior to dismantling
  - 3. Remote monitoring of work undertaken under difficult conditions.
- b. The logistics for the waste shall ensure that radioactive and non-radioactive materials are separated as per the regulations, and that any remixing of the two types is excluded.
- c. The Guidelines ENSI-G15 and ENSI-B04 also apply to the decommissioning.
- d. The requirements for radiation protection measuring equipment are stated in the Ordinance of the Federal Department of Justice and Police dated 7 December 2012 on Measuring Equipment for Ionising Radiation (941.210.5) and in the Guideline ENSI-G13.

## **4.10 Emergency preparedness**

- a. The emergency response organisation must be adapted in relation to the hazard potential that is still present, and to the nature and scope of the activities planned for each phase of decommissioning. Consideration must also be given to events arising from a combination of non-nuclear and nuclear hazards, and to the changed composition of staff. The provisions of the Guidelines ENSI-B11 and ENSI-B12 apply accordingly to decommissioning.
- b. When updating the emergency preparedness regulations and the emergency instructions (hereinafter “emergency documents”), experience gained from emergency exercises and incidents in the licensee's own dismantling project and in other such projects must be taken into account.

## **4.11 Reporting and duty of notification**

- a. As of the legally binding decommissioning order annual reports on the decommissioning shall be compiled as per section 6 of the Guideline ENSI-B02.
- b. In addition, quarterly reports shall be compiled for each nuclear installation. As long as nuclear materials are present in nuclear power plants, the matters addressed in section 8 of guideline ENSI-B02 must be taken into account. For the following phases and for other nuclear facilities, the requirements as per section 7 of the Guideline ENSI-B02 are applicable.
- c. The Guideline ENSI-B03 applies to the duty of notification accordingly.

## **4.12 Archiving of documents**

By analogy with the provisions of Article 41 of the Nuclear Energy Ordinance, the relevant documents compiled in connection with decommissioning must be safe kept in addition to the organisational and technical documents as per Annex 3 of the Nuclear Energy Ordinance. The retrieval and readability of the documents in protected storage must be ensured.

## **4.13 Deferred dismantling**

- a. The requirements set out in sections 4.4 to 4.12 shall apply to the deferred dismantling accordingly.
- b. The nuclear materials shall be transported to another nuclear installation prior to commencement of the deferred dismantling.

- c. The choice of deferred dismantling and the planned duration of this phase must be motivated in the decommissioning plan and in the decommissioning project, and must be subject to a complete safety assessment within the decommissioning project. In this regard, the following requirements apply:
  - 1. Consideration must be given to changes in the nuclide vectors for nuclear installation contamination.
  - 2. The ageing and where applicable degradation or breakdown of existing barriers must be taken into account.
  - 3. It shall be demonstrated how the absence of contamination may be measurably proven with reasonable effort after the end of the deferred dismantling.
  - 4. All information relevant to the subsequent dismantling of the nuclear installation from the operational and post-shutdown periods must be documented. This documentation must be compiled so that the necessary key safety information is still available even if the party obliged to carry out decommissioning should change during the continuation of the subsequent decommissioning work.
- d. To create the deferred dismantling, technical and structural measures shall be implemented which safely contain the radioactive inventory of the nuclear installation for the planned period of deferred dismantling, even if staffing and monitoring expenditures are reduced.
- e. In order to guarantee the protection objectives, only components and systems should be used if they function independently of external supplies (e.g. of power and water).
- f. Measures taken during the course of the deferred dismantling shall not impede the subsequent dismantling work significantly.
- g. Maintenance of the operational and design documentation must be guaranteed during the deferred dismantling.
- h. A periodic safety review (PSR) must be carried out every ten years during the deferred dismantling.

## **5 Requirements for the application documents**

### **5.1 Decommissioning concept**

- a. In the decommissioning concept, the applicant must describe the expected final status and the timescale up to the point when this status is attained.

The documentation must show which decommissioning variants have been considered by the applicant. The decommissioning concept must also indicate the measures provided in the design of the nuclear installation to facilitate the performance of the subsequent decommissioning work.

- b. If there are several nuclear installations on the same site, this must be taken into account in the decommissioning concept.

## **5.2 Decommissioning plan**

- a. The decommissioning plan must include an overview of the nature, scope and timescale for all the work after the installation is finally shut down, and must take account of the following points:
  - 1. Choice and motivation of decommissioning variant
  - 2. Measures during operation and in case of changes to the installation in order to facilitate subsequent dismantling
  - 3. Description of the existing safety-related systems and installation components that will still be needed or adapted in the relevant phase
  - 4. General description of additional equipment and systems required for dismantling and waste management
  - 5. General safety assessment
  - 6. Description of security measures
  - 7. Description of the requisite human, technical and financial resources
  - 8. Concept to take account of human and organisational factors
  - 9. Description in terms of quantity and schedule of the expected radioactive waste and cleared materials, including a waste management concept
  - 10. Concept for the procurement of suitable transport and storage casks for the removal of the fuel elements or nuclear fuel after the installation is finally shut down
  - 11. Description of any dependencies, interfaces and interactions of systems and organisation with other nuclear installations on the same site
  - 12. Report on the evaluation of experience gained from current decommissioning projects of comparable nuclear installations in Switzerland and abroad.

- b. The decommissioning plan must be updated at least once every ten years and submitted to ENSI for assessment.

### **5.3 Post-shutdown period**

- a. The following documents regarding the changed requirements for the post-shutdown period must be compiled and submitted to ENSI for review:
  - 1. Description of the nature and scope of the work in the post-shutdown period, with time schedule
  - 2. Updated safety analysis report as per Annex 3
  - 3. Concept for the removal and interim storage of the nuclear fuel, including procurement of suitable transport and storage casks
  - 4. Programme to take account of human and organisational factors, including an organisational analysis with an action plan
  - 5. Description of the expected radioactive waste and cleared materials during the post-shutdown period.
- b. Prior to the completion of this review by ENSI, the provisions of the operating licence shall continue without change.

### **5.4 Decommissioning project**

- a. In addition to compliance with the basic protection objectives and security requirements, the ALARA (“As Low As Reasonably Achievable”) principle must be taken into account for all activities in each phase of the decommissioning project.
- b. In relation to the decommissioning project pursuant to Article 27 of the Nuclear Energy Act, the below mentioned documents must be submitted.

#### **5.4.1 Phases and timetable for decommissioning work, decommissioning variants (Article 45, letter a, Nuclear Energy Ordinance)**

- a. The licensee obliged to carry out decommissioning must motivate the choice of the decommissioning variant, with reference to the decommissioning plan. Immediate dismantling is the decommissioning variant to be given preference. Specific motivation shall be provided by the licensee obliged to carry out decommissioning for any other variant. The time-schedule must be specified and in particular, a final deadline for completion of the decommissioning objective must be stated. The expected final status shall be clearly defined, and it must be possible to furnish proof thereof.

- b. The individual phases must be planned in the decommissioning project. It shall be demonstrated that the planned sequence can be implemented safely. Operational experience from other decommissioning projects (including international ones) must be taken into account.
- c. In cases of a planned deferred dismantling the decommissioning project must not only describe the measures and significant safety relevant equipment which will conduct the preparation and transfer of the installation for deferred dismantling, but also all the necessary measures during the deferred dismantling period. In addition, it shall be showed how further dismantling of the installation can be carried out safely upon the end of the deferred dismantling period.

#### **5.4.2 Individual steps of decommissioning work (Article 45, letter b, of the Nuclear Energy Ordinance)**

The main tasks and associated required resources, as well as any new buildings, parts of buildings and installations needing to be constructed, must be described for all the planned phases of decommissioning. Moreover, the planned infrastructure and logistics for the decontamination and conditioning of systems and equipment must be presented, together with the choice of demolition techniques and methods.

#### **5.4.3 Procedure for separating radioactive and non-radioactive waste and management of radioactive waste (Article 45, letter c, Nuclear Energy Ordinance)**

- a. Storage rooms or areas must be designated for the various material flows both inside and outside of the controlled zone. The use of existing transport routes and the construction of additional transport routes, respectively, must be shown.
- b. The choice of decontamination methods must be assessed in terms of radiation protection, utilisation (recycling) of materials, reduction of the volume of radioactive substances and the production of secondary waste. The planned methods for clearance measurement must be presented in detail.
- c. The material inventory destined for decay storage shall be described. It is also necessary to state where decay storage should take place, and that suitable storage capacities are provided for.
- d. The volumes of generated waste shall be estimated, for both types of radioactive and non-radioactive waste. In the case of inactive and cleared materials, conventional waste must be distinguished from hazardous waste.
- e. The following points must be demonstrated regarding the remaining radioactive waste:

1. Whether or not it presents a non-nuclear collateral hazard (e.g. asbestos)
  2. Which quantities are to be conditioned, where, specifying the conditioning method
  3. Where the conditioned waste is to be stored until it is transferred to the deep geological repository.
- f. The waste container types (WCT) planned for the identified unconditioned waste must be stated.

#### **5.4.4 Measures for radiological protection (Article 45, letter d, Nuclear Energy Ordinance)**

The concepts and measures for monitoring and incorporation protection must be presented. The estimated radioactive discharges associated with exhaust air and wastewater must be quantified, as well as the expected direct radiation outside of the monitored area. Where appropriate, motivated proposals for new release limits must be submitted.

#### **5.4.5 Security measures (Article 45, letter e, Nuclear Energy Ordinance)**

- a. An adapted security concept must be submitted for the planned phases and the resultant structural changes to the nuclear installation. This concept must meet the security requirements of Article 9 of the Nuclear Energy Ordinance.
- b. The documentation should describe the security measures derived from the hazard assumptions and should prove that the security-related protection objectives as per Article 2, paragraph 1, of the Ordinance of the Federal Department of the Environment, Transport, Energy and Communications dated 16 April 2008 on Hazard Assumptions and the Assessment of Protection against Accidents in Nuclear Installations and Nuclear Materials (732.112.1) are guaranteed.
- c. Information which could be used to deduct potential for sabotage that are relevant to nuclear safety must be classified (Article 5, paragraph 3, of the Nuclear Energy Act).

#### **5.4.6 Accident analyses and emergency preparedness measures (Article 45, letter f, Nuclear Energy Ordinance)**

- a. The documentation for the accident analyses must cover all the phases. The investigations for the systematic determination of potential accidents and procedures, and the results thereof, must be documented comprehensively.

- b. The accident analyses consist in deterministic accident analyses according to the relevant requirements in the Guidelines ENSI-A01, ENSI-A08 and ENSI-G14. A representative range of initiating events originating inside and outside of the installation should be taken as the basis, with specific consideration of decommissioning operations. The potential accidents must be determined systematically. Experience from comparable facilities and projects must be taken into account for this purpose. The accidents must be allocated to accident categories as per guideline ENSI-A01. Compliance with technical and radiological criteria as per the Ordinance of the Federal Department of the Environment, Transport, Energy and Communications dated 17 June 2009 on Hazard Assumptions and the Assessment of Protection against Accidents in Nuclear Installations (732.112.2) must be proven.
- c. As long as nuclear materials are present in the installation, the existing Probabilistic Safety Analysis (PSA), levels 1 and 2, must be adapted as per guideline ENSI-A05. In particular, risk variables FDF and SLERF must be stated. Guideline ENSI-A06 applies accordingly to the use of the PSA. In addition, technical decision-making aids for accident management (Severe Accident Management Guidance, SAMG) as per guideline ENSI-B12 must be procured for this period.
- d. The requirements for the effectiveness and reliability of systems derived from the accident analyses must be documented. It must be proven that these requirements are met through suitable measures.
- e. The requirements for the emergency response organisation derived from the accident analyses must be documented. It must be shown that adequate and effective defence against hazards can be ensured. The events considered for this purpose, arising from a combination of non-nuclear and nuclear hazards, must be documented.

#### **5.4.7 Human and organisational factors (Article 45, letter g, Nuclear Energy Ordinance)**

- a. In particular, human resources required in the dismantling of and for the necessary operation of the installation must be determined in the decommissioning project. These must be shown on a function-specific basis with the help of the planned decommissioning sequence. A concept for dealing with any delay in the time schedule must be provided.
- b. The organisational structure and the planned procedures must be described. The programme to take account of human and organisational factors must be presented, including methods for the design of working equipment, the work environment and processes.

#### **5.4.8 Management system (Article 45, letter h, Nuclear Energy Ordinance)**

- a. The quality management programme required as per Article 45, letter h, Nuclear Energy Ordinance as an integral part of the management system must comprise all the definitions and activities required to attain the project objectives in quality assurance by means of quality planning, control and review.
- b. The decommissioning project must show how the requirements for the management system as per section 4.8.2 are taken into account. In particular, the relevant processes to guarantee safety shall be described in detail.

#### **5.4.9 Environmental impact report (Article 45, letter i, Nuclear Energy Ordinance)**

The environmental impact report shall be adhered to the Federal legislation on environmental protection.

#### **5.4.10 Total costs and securing of the financing (Article 45, letter j, Nuclear Energy Ordinance)**

The costs of decommissioning and waste management as per Article 2 and Article 3 SEFV, respectively, must be determined in the decommissioning project under consideration of internationally recognised methods.

### **5.5 Phase 1 and subsequent phases**

The following documents in particular must be submitted for the permit for a decommissioning phase as per section 4.1:

- a. Planned decommissioning work, including flow chart
- b. Updated safety analysis report as per Annex 3
- c. Operational plan to maintain the necessary infrastructure
- d. Procedure for work permits and monitoring of tasks
- e. Procedure for clearance measurement of accrued materials
- f. Management of the generated radioactive waste
- g. Detailed radiation protection planning
- h. Updated programme to consider human and organisational factors
- i. Presentation of the design of workplaces, work resources and procedures.

## 5.6 Final report

- a. Upon reaching the final status defined in the decommissioning order, the party obliged to carry out decommissioning must provide a final report and submit it to ENSI.
- b. The final report shall set out the following points in particular:
  1. Summarised description of the dismantling of the nuclear installation
  2. Proof of attainment of the anticipated final status
  3. Description of the current radiological condition
  4. Proof of compliance with the waste management obligation for radioactive and non-radioactive waste
  5. Accounting for radioactive waste and cleared materials.

This guideline was approved by ENSI on 17 March 2014.

The Director General of ENSI:        signed H. Wanner



# **Annex 1: Terms and definitions (as per the ENSI glossary)**

## **Licensed operational limits and conditions**

The licensed operational limits and conditions (OLC) are specified in the operating licence, the technical specifications and the power plant regulations. Licensed operational limits and conditions comprise operational limits, trigger values for safety systems and limiting conditions for operation (LCO).

## **Final shutdown**

Final shutdown is the definitive discontinuation of the operation of a nuclear installation for its intended purpose. When an installation is finally shut down, its owner is legally bound to decommission it.

## **Post-shutdown period**

The post-shutdown period (phase 0) starts with final shutdown and ends when the decommissioning order becomes legally binding.

## **Dismantling**

Dismantling comprises disassembly, deconstruction, decontamination and demolition.

Dismantling commences when the decommissioning order becomes legally effective and ends when the nuclear installation is no longer subject to nuclear energy legislation.

## **Deferred dismantling**

The term deferred dismantling (sometimes called safe storage, safe store or safe enclosure) designates an interim condition of a nuclear installation created by technical and structural measures after final shutdown and after removal of the nuclear materials. The installation remains in this condition for an extended period of time, and the remaining radioactive inventory is safely enclosed. As a result, final dismantling is deferred and the nuclear installation continues to be subject to nuclear energy legislation.

## **Decommissioning work**

Decommissioning work comprises all the activities required in order to attain the decommissioning objective.

## **Decommissioning objective**

The decommissioning objective is a condition in which the installation is no longer subject to nuclear energy legislation.



## Annex 2: Phase concept

Operating licence		Decommissioning order			
Operation for the intended purpose	Post-shutdown period and installation changes as per section 4.3	Disassembly and dismantling or deferred dismantling as per the decommissioning order			
	Phase 0	Phase 1	Phase 2	...	

Decommissioning work activities may proceed in parallel and may extend over multiple phases.



## **Annex 3: Content of the safety analysis report**

The safety analysis report for a phase (phase 0 and subsequent phases) takes account of the following points in particular:

- a. Description of the site, description of the nuclear installation (including the radiological characterisation)
- b. Analysis of interactions between decommissioning measures and adjacent installations
- c. General safety assessment for the relevant phase, including a description of how compliance with the fundamental protection objectives is to be guaranteed as per Article 2 of the Ordinance of the Federal Department of the Environment, Transport, Energy and Communications of 16 April 2008 on Hazard Assumptions and the Assessment of Protection against Accidents in Nuclear Installations and Nuclear Materials (732.112.1)
- d. Description of safety-related systems and installation components which are still required or are adapted for the current and subsequent decommissioning phases
- e. Description of additional auxiliary systems and equipment
- f. Technical basis for the licensed operational limits and conditions (OLCs)
- g. Fire protection and escape route concept including technical documentation
- h. Description of relevant aspects of the organisation and the management system, including function-specific human resources, training and qualification of staff
- i. Radiation protection concept and measures as per section 5.4.4
- j. Accident analyses as per section 5.4.6; counter-measures and emergency preparedness measures to deal with accidents.





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