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This is a translation of the recommendation entitled “ESK-Leitlinien zur Durchführung von periodischen Sicherheitsüberprüfungen und zum technischen Alterungsmanagement für Zwischenlager für bestrahlte Brennelemente und Wärme entwickelnde radioaktive Abfälle”. In case of discrepancies between the English translation and the German original, the original shall prevail.



**ESK guidelines for the performance of periodic safety reviews and on technical ageing management for storage facilities for spent fuel and heat-generating radioactive waste**  
**RECOMMENDATION**

**Contents**

<b>1</b>	<b>Introduction .....</b>	<b>2</b>
<b>2</b>	<b>Scope of application.....</b>	<b>3</b>
<b>3</b>	<b>Objectives of the PSÜ-ZL .....</b>	<b>3</b>
<b>4</b>	<b>PSÜ-ZL: responsibilities and periods .....</b>	<b>3</b>
4.1	Responsibilities .....	3
4.2	Periods .....	4
<b>5</b>	<b>Scope of the PSÜ-ZL .....</b>	<b>4</b>
5.1	Up-to-date description of the facility .....	4
5.2	Survey of the safety-relevant changes performed or occurred during the period under review .....	4
5.3	Evaluation of operating experience .....	5
5.4	Accident analysis .....	5
5.5	Review with regard to technical ageing.....	6
5.6	Safety management.....	6
5.7	Long-term documentation and electronic data processing systems.....	7
<b>6</b>	<b>Results of the PSÜ-ZL .....</b>	<b>7</b>
<b>7</b>	<b>Technical ageing management .....</b>	<b>8</b>
7.1	Defining the monitoring concept .....	8
7.2	Performance of inspection/testing and monitoring measures, evaluation of inspection/test results and dealing with findings.....	9
7.3	Reporting and documentation .....	10
<b>8</b>	<b>References.....</b>	<b>11</b>

## 1 Introduction

Storage facilities for spent fuel and heat-generating radioactive waste are operated in Germany on the basis of a storage licence issued pursuant to § 6 of the Atomic Energy Act (Atomgesetz – AtG) [1], which is currently generally limited to 40 years. They are subject to governmental supervision during construction, operation and decommissioning and in case of modifications of the storage facility and its operation mode as far as safety-relevant areas are concerned. Any potential interactions due to a combined or mixed storage with non-heat-generating radioactive waste in connection with licences pursuant to § 12(1)3 of the Radiation Protection Act (Strahlenschutzgesetz – StrlSchG) [2] are to be taken into account.

The central safety element of dry storage of spent fuel and heat-generating radioactive waste are accident-resistant transport and storage casks licensed under traffic law at the time of emplacement and whose transportability must also be ensured for later removal. With the granting of the licence, safe enclosure of the radioactive inventory, adequate shielding of ionising radiation, maintenance of subcriticality and the safe removal of decay heat are assessed and verified as fundamental protection goals.

Compliance with the requirements for the safe operation of the storage facility, made mandatory with the storage licence, is to be ensured by the safety management of the operator. For subsequent storage, significant operational boundary conditions arise from cask manufacturing, loading and handling. Both the operators and the authorities with their authorised experts should use adequate instruments for the exchange of experience across the facilities.

As part of regulatory supervision, the condition of the storage facility and its operation is continuously monitored for compliance with the provisions of the licensing decisions. In this context, the necessity of implementation of new safety-related knowledge resulting from operating experience is also examined by the operator and the authorities.

The periodic safety review of the storage facility (Periodische Sicherheitsüberprüfung des Zwischenlagers – PSÜ-ZL) includes deterministic considerations on the current safety status of the storage facility. Probabilistic considerations are usually not required since there are mainly passive safety functions in place. Active measures exclusively serve to monitor the condition (e.g. the lid sealing system) and the boundary conditions (e.g. ventilation, environmental influences). The regulations on the PSÜ-ZL are set out in Chapters 3 to 6 of these guidelines.

Ageing management comprises continuous measures during operation with the aim to manage ageing effects and to ensure the required quality of systems and components. The requirements related to the management of technical ageing are compiled in Chapter 7 of these guidelines. Measures for non-accessible areas of containers and inventories are not covered by these guidelines. Reporting on experiences/implementations of ageing management has to take place within the framework of the periodic safety review.

## **2 Scope of application**

These guidelines are to be applied to facilities for dry cask storage of spent fuel and heat-generating radioactive waste according to [3]. A review on physical protection, which is also of importance for the overall assessment of the safety status of a facility, is carried out separately and is not the subject of these guidelines.

## **3 Objectives of the PSÜ-ZL**

These guidelines specify the verification and evaluation of the safety status of the storage facilities to be performed every ten according to § 19a (3) of the Atomic Energy Act (AtG) [1].

The PSÜ-ZL is an element of the safety management of the operator. Its review is an additional instrument besides the ongoing supervisory activities of the authorities. The PSÜ-ZL serves to verify the safety status of the storage facility, also taking into account changes occurring during operation. The PSÜ-ZL pursues the following objectives:

- Summarised documentation and evaluation of all events and findings within the review period with regard to the safety level and operating reliability of the storage facility, as well as the radiation exposure.
- Up-to-date safety assessment of the actual condition of the storage facility on the basis of the licences issued and the necessary precautions to be taken according to the state of the art in science and technology to prevent damage resulting from the storage of nuclear fuel with regard to
  - the safe and reliable continued operation of the storage facility,
  - an effective and reliable accident management,
  - the impacts of ageing mechanisms on the condition of the storage facility and its installations, and on the transport and storage casks, and
  - the safe handling and later removal of the transport and storage casks.
- Derivation of findings and measures for further operation.

The results of the PSÜ-ZL should demonstrate the compliance with the protection goals and the requirements derived thereof according to [3] for the remaining licensed operating life. These proofs required and any necessary measures may differ from the state of the art in science and technology if it can be demonstrated that the necessary precautions against damage are in place.

## **4 PSÜ-ZL: responsibilities and periods**

### **4.1 Responsibilities**

The operator of the storage facility is responsible for carrying out the PSÜ-ZL. The PSÜ-ZL and its results and the measures derived are to be documented transparently by the operator and submitted to the supervisory authority.

The nuclear supervisory authority is responsible for the assessment of the PSÜ-ZL carried out by the operator. The supervisory authority uses the periodic safety review to complement its ongoing supervisory activities and presents the results of its review in a summary report, which is made available to the nuclear licensing authority. Where required, the supervisory authority defines necessary measures for the continued operation of the storage facility reviewed and monitors, as part of its supervisory activities, their timely and proper implementation.

The nuclear licensing authority takes note of the results of the periodic safety reviews of the storage facilities as well as of their assessment by the supervisory authority and – if necessary – may derive updated or additional requirements for ongoing or future licensing procedures.

## **4.2 Periods**

The periodic safety review is to be conducted for each storage facility after the start of operation, i. e. after emplacement of the first loaded container, for the first time after ten years, and then at intervals of ten years.

About six months after completion of the periodic safety review and submission of the final report by the operator, the supervisory authority should submit the summary report of its review results.

## **5 Scope of the PSÜ-ZL**

### **5.1 Up-to-date description of the facility**

The deterministic safety status analysis has to be preceded by a description of the storage facility. It serves the purpose of giving an up-to-date survey of the safety concept, the design features of the storage facility and of all safety-relevant measures. The description of the facility is structured in accordance with the safety report on the basis of which the storage facility has been licensed. The description has to include the current status of the facility, including information on the emplaced inventory and storage facility occupancy, to the extent not contrary to the requirements of physical protection.

### **5.2 Survey of the safety-relevant changes performed or occurred during the period under review**

For the survey of the safety-relevant changes performed or occurred during the period under review, the following aspects have to be taken into account:

- changes in the licensing status: modification licences issued; subsequently imposed licence conditions,
- changed regulatory requirements,
- organisational changes,
- modifications of the storage facility: refitting; repairs and retrofitting, amendment of the regulations on operation, maintenance and inspection/testing,

- changes in the operating condition of the storage facility: changes with regard to the emplaced inventory and storage facility occupancy,
- changes/new findings regarding the site conditions, and
- interactions with neighbouring facilities and installations.

The compilation of the safety-relevant changes performed or occurred during the period under review serves to supplement the up-to-date description of the facility and provides the basis for the overall assessment of the safety status of the storage facility (as described in Chapter 6).

### **5.3 Evaluation of operating experience**

The evaluation of the safety-relevant operating experience should include the following areas of the facility's own and external experience:

- operating experience in the storage facility,
  - operational management,
  - facility operation,
  - evaluation of the results of in-service inspections and other inspection/test results,
  - findings from routine and individual inspections,
  - maintenance (including reliability of components),
  - radiation protection (including radiation exposure),
  - experience feedback,
  - reportable events,
  - emergency preparedness, and
  - ageing management
- experiences from information notices,
- operating experience in comparable storage facilities (evaluation of operating reports, information from expert committees, other findings).

The evaluation of operating experience serves the review of operational efficiency of the safety-related design of the facility, the reliability of safety-relevant systems and compliance with the protection goals.

### **5.4 Accident analysis**

Based on the accident spectrum considered in the licence, the following issues are to be examined:

- existence of other relevant event sequences from experience gained with comparable storage facilities or from updating of rules and regulations,

- up-to-dateness of safety analysis methods applied,
- consideration of current boundary conditions and changes in site conditions, as well as
- measures planned for beyond design basis events.

The basic principle is the protection-goal-oriented approach. New analyses are necessary only if there is reasonable doubt as to the reliability or conservatism of safety demonstrations performed.

### **5.5 Review with regard to technical ageing**

As part of the PSÜ-ZL, an overall assessment of the ageing management measures (see Chapter 7) performed within the period is to be made and of the knowledge gained from it.

### **5.6 Safety management**

As part of the PSÜ-ZL, the management system, which is focused on the achievement, continuous maintenance and enhancement of safety, is to be subjected to an internal review. Here, the results of periodic and event-related reviews of the management system carried out in the period under review are to be taken into account.

For the internal review, the following aspects are to be considered in particular, paying special attention to the longer-term developments of storage facility operation:

- operational organisation and assignment of powers and responsibilities with regard to the safety-relevant functions of the storage facility,
- definition and documentation of the safety-relevant processes and the performance indicators, audits, etc. applied for monitoring of the quality of processes,
- up-to-dateness of the operating instructions and measures for beyond design basis events,
- measures for maintaining the requisite technical qualification of the operating personnel responsible for storage,
- measures for ensuring the provision of the necessary resources and competences for normal operation and design basis events, as well as a forward-looking human resources strategy with regard to personnel recruitment, qualification and training,
- measures for the evaluation of operating experience (as described in Chapter 5.3) and for ensuring regular exchange of knowledge and experience between the facility operators, and
- up-to-dateness and completeness of the management system.

In addition, the management system itself has to be assessed to determine whether with respect to longer-term developments of operation and organisation, restructuring at an early stage or precautionary adjustments would be advantageous.

### **5.7 Long-term documentation and electronic data processing systems**

The documentation on licensing and on the operation of the storage facility is to be checked to verify that it will be available, readable and usable over the entire period of operation<sup>1</sup>. For the documents, which are mostly available in electronic form, but also for paper documents, the standard requirements in the nuclear sector and additionally, where appropriate, relevant technical standards are to be applied. It is to be checked

- whether and how complete and true to the original the stored documents are actually still available,
- whether the format, the form of storage and the kind of contents provision may have to be adapted to more recent standards,
- what measures are to be initiated for the recovery or rescue of already “lost” data, and
- what measures are to be initiated for preventive protection against data loss.

Regardless of this, hardware and software of electronic data processing systems are to be checked for availability and compatibility on a regular basis anyway.

## **6 Results of the PSÜ-ZL**

For finalisation of a PSÜ-ZL, the safety status of the storage facility is to be assessed by the licensee. For this purpose, the results of the respective analyses have to be summarised for an informative overall picture. The assessment criterion is the fulfilment of the protection goals and requirements derived from it. Where necessary, safety improvements are to be presented and included in an action plan.

The individual analyses and results are to be summarised in a report in a comprehensible and verifiable manner and submitted to the competent supervisory authority as documentation for the PSÜ-ZL.

For the assessment of the safety significance of these results by the nuclear supervisory authority, the following general questions should be addressed:

- Does the evaluation of operating experience show sufficient reliability of the respective components and installations?

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<sup>1</sup> See also § 38 of the Site Selection Act (Standortauswahlgesetz – StandAG) [4]

- Do the existing safety installations limit the consequences of the coverage-providing design basis accidents to be considered with the required effectiveness and reliability in accordance with the protection goal oriented requirements?
- Have weaknesses been identified in the safety concept?
- Is the action plan proposed for the case of safety-relevant non-compliances suitable for improving the safety status of the storage facility?

Any necessary improvement measures are to be determined by the operator in agreement with the competent authority.

## **7 Technical ageing management**

For ageing management, the technical equipment, including any necessary auxiliary materials and operating supplies, are to be considered according to their safety significance in line with a graded safety concept (“graded approach”).

Ageing management serves to ensure the monitoring of safety-relevant damage mechanisms that have been identified and assessed within the licensing procedure. Further safety-relevant damage mechanisms identified are to be included in the monitoring programme. Causes and impacts of these damage mechanisms are to be controlled for the safe operation of the storage facility and later removal of the casks by appropriate measures.

### **7.1 Defining the monitoring concept**

To define the inspection scope for technical ageing management, a survey of the technical equipment is to be prepared under consideration of the protection goal relevance together with the safety-relevant damage mechanisms.

For systems and their components that are directly relevant for compliance with the protection goals (e.g. the transport and storage cask, including its protection goal relevant components), the quality required to comply with the design requirements is to be ensured throughout the entire storage period.

For systems and their components that are directly relevant for compliance with the protection goals, a potential systematic failure due to ageing processes must be detected in time and any corrective measures required be taken.

Technical equipment not directly or indirectly relevant for compliance with the protection goals are not covered by these guidelines.



The required inspection/testing and monitoring measures of ageing management are defined in a monitoring concept, taking into account the reviews performed and data provided in the framework of the periodic in-service inspection (ISI), maintenance and in-service monitoring. The measures are to be described in an inspection/testing manual and presented in the form of inspection/test instructions.

In the monitoring concept, special attention should be paid to components and systems that are designed for the entire useful life and that are generally not interchangeable. Also for interchangeable components and systems, the measures required for reasons of radiation protection should be targeted, as far as possible, to functional integrity for the entire service life.

For each safety-relevant damage mechanism of a component or a system, the monitoring concept has to include at least the following specifications:

- Type of measure to detect damage mechanisms (e.g. visual inspection, functional testing, additional safety analyses, generic studies).
- Frequency and sample size of the inspection/testing and monitoring measures (e.g. “precautionary replacement every ten years”, “full check every year”, “full check every ten years”, “exemplary check every ten years”, “exemplary special examination on individual systems or components). The frequency is to be determined for each system and component, taking into account the ageing and damage mechanisms and the safety relevance. In addition to tests on all relevant components, tests on representative samples are also permissible. It must be ensured that all inspection/testing and monitoring measures will be performed at least once every ten years.
- Place of implementation of the measures, drawing a distinction between the following variants:
  - system-specific checks that take place in all storage facilities,
  - system- or component-specific cross-facility checks (e.g. in consultation with the operators of other storage facilities in one or more facilities), and
  - generic checks (e.g. on material behaviour) carried out centrally (e.g. by the manufacturer on the basis of agreements).

## **7.2 Performance of inspection/testing and monitoring measures, evaluation of inspection/test results and dealing with findings**

The implementation of the inspection/testing and monitoring measures comprises the performance of the inspections/tests at the time intervals specified and the documentation of the results (facility-internally or, where appropriate, cross-facility-wise).

The results of the measures performed are to be assessed as regards the following aspects:

- protection goal relevance (direct, indirect, negligible), taking into account changes in quality of components and systems previously occurred,

- future changes in quality of components and systems to be expected, taking into account future load conditions to be expected (trend analyses, extrapolation).

If the inspection/test results indicate signs of ageing, these are to be assessed with regard to necessity and urgency of measures. Necessary measures are to be planned and implemented in a timely manner on the basis of a cause analysis, using criteria defined in a transparent manner.

Possible measures to deal with ageing-related findings are:

- adaptation of the monitoring measures, the monitoring scope and monitoring periods,
- adaptation of maintenance measures,
- protection/repair measures of the system or component affected, and
- replacement of the system or component.

The measures for the management of ageing-related findings are to be integrated into the monitoring concept.

Furthermore, ageing-related findings are to be assessed with regard to their applicability to other systems and components.

The effectiveness of the measures taken to identify and control damage mechanisms is to be assessed on the occasion of certain events and at appropriate intervals. Where necessary, the measures defined in the monitoring concept are to be adapted to specific requirements. This may be required, for example, if ageing-related findings occurred at components that have not or inadequately been covered by monitoring so far or if new knowledge on the behaviour of components is available from the analysis of the state of the art in science and technology.

### **7.3 Reporting and documentation**

Reporting on the ageing management measures performed and on findings has to take place annually within the regular reporting. In addition, safety-relevant findings from ageing management are to be reported on an ad-hoc basis.

## 8 References

- [1] Gesetz über die friedliche Verwendung der Kernenergie und den Schutz gegen ihre Gefahren (Atomgesetz - AtG) vom 23. Dezember 1959, Atomgesetz in der Fassung der Bekanntmachung vom 15. Juli 1985 (BGBl. I S.1565), das zuletzt durch die Bekanntmachung vom 3. Januar 2022 (BGBl. I S. 14) geändert worden ist
  
- [2] Gesetz zum Schutz vor der schädlichen Wirkung ionisierender Strahlung Strahlenschutzgesetz vom 27. Juni 2017 (BGBl. I S. 1966), das zuletzt durch die Bekanntmachung vom 3. Januar 2022 (BGBl. I S. 15) geändert worden ist
  
- [3] EMPFEHLUNG der Entsorgungskommission Leitlinien für die trockene Zwischenlagerung bestrahlter Brennelemente und Wärme entwickelnder radioaktiver Abfälle in Behältern, revidierte Fassung vom 10.06.2013
  
- [4] Gesetz zur Suche und Auswahl eines Standortes für ein Endlager für hochradioaktive Abfälle (Standortauswahlgesetz - StandAG) Standortauswahlgesetz vom 5. Mai 2017 (BGBl. I S. 1074), das zuletzt durch Artikel 1 des Gesetzes vom 7. Dezember 2020 (BGBl. I S. 2760) geändert worden ist