Hungarian Atomic Energy Authority

Guideline 4.14

Activities to be implemented by the operator to support the license application for operation beyond design lifetime

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PREAMBLE

The uppermost level legal regulations for safety of the peaceful use of atomic energy are established in Act CXVI of 1996 on atomic energy.

The stipulations on the nuclear safety requirements for nuclear facilities and the associated regulatory activities are established in Govt. decree 118/2011.(VII. 11.) Korm. and its annexes the so called Nuclear Safety Codes.

All those shall comply with the nuclear safety requirements and stipulations, who are under continuous regulatory supervision according to Subsection (2) of Section 9 of the Atomic Act, conduct an activity bound to regulatory license by this decree, contribute to such an activity or submit an application for licensing such an activity. In addition to the nuclear safety requirements and stipulations, individual regulatory prescriptions, provisions and obligations, which can be established in its resolution by the nuclear safety authority for the safety of the nuclear facility, are also obligatory.

The authority can develop recommendations on the compliance with the regulations of the Nuclear Safety Codes, which are issued in the form of guidelines. The guidelines are published in the website of the Hungarian Atomic Energy Authority.

Pursuant to Subsection (3) of Section 3 of Govt. decree 118/2011.(VII. 11.) Korm., if a regulation is complied with in accordance with a guideline, then the nuclear safety authority considers the selected method as applicable to demonstrate the compliance with the nuclear safety requirements, and it does not assess the adequacy of the applied method.

If methods differing from those described in the guidelines are applied, then the authority assesses the adequacy, applicability and comprehensiveness of the applied method in details, which may require longer administrative procedure, involvement of external experts and additional costs.

The guidelines are orderly reviewed with a frequency established by the nuclear safety authority or out of order based on the proposal of the licensees.

The listed regulations are supplemented by the internal regulating documents of the licensees and other organizations participating in the use of nuclear energy (designers, manufacturers, etc.), which are prepared and maintained in accordance with their own management systems.

Before applying a given guideline, always make sure whether the newest, effective version is considered. The effective guidelines can be downloaded from the HAEA's website: http://www.haea.gov.hu.

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1. INTRODUCTION

1.1. Scope and objectives

This guideline provides recommendations on activities to be implemented by the operator to support the license application for operation beyond design service lifetime.

The objectives of the Guideline are to make the regulatory expectations unambiguous by the recommendations included, and to facilitate the supervision of compliance with the nuclear safety criteria during legally required procedures.

1.2. Corresponding laws and regulations

The legal background of the nuclear safety requirements are provided by the Act CXVI of 1996 on Atomic Energy and the Govt. Decree 118/2011 (VII.11.) Korm.

2. DEFINITIONS AND ABBREVIATIONS

2.1. Definitions

The current chapter does not include the definitions established in Annex 10 of Govt. decree 118/2011. (VII. 11.) Korm.

Degradation process:

Degradation caused by the impacts appearing during the operation, maintenance and tests of systems, structures and components and of environmental conditions, as a result of which the inherent safety margin of systems, structures and components may decrease, their performance parameters and operational reliability may degrade, the probability of the failure may increase.

2.2. Abbreviations

ABOS	Safety classification of nuclear power plant systems, structures and components
EOP	Symptom-based emergency operating procedures
CUF	Cumulative Usage Factor
FBOS	Seismic safety classification
MCP	Main circulating pump
TLAA	Time-limited ageing analysis
NSC	Nuclear Safety Code
PTS	Pressurized Thermal Shock
OLC	Operational Limits and Conditions
SLE	Service life extension

3. DETERMINATION OF THE SCOPE OF THE LICENSE APPLICATIONS

In accordance with Section 20 of Govt. decree 118/2011. (VII.11.) on the nuclear safety requirements for nuclear facilities and the associated regulatory activities and Sub-Chapter 1.2.6 of Volume 1 of the Nuclear Safety Codes, the licensee should submit a programme and a license application for the operation of the nuclear power plant unit beyond its design lifetime.

“In the case of nuclear power plant units, the following items belong to the scope of licensing of operation beyond the designed service life:

a) systems, structures and components with safety function,

b) those non safety class components, the failure of which can prevent a system or component in fulfilling its safety functions, and

c) systems, structures and components taken into the scope with ad hoc authority decision.” (1.2.6.0300 of NSC Volume 1)

Figure 1 shows how the licensee should identify those systems, structures and components, which belong to the scope of the extension of the operating license.

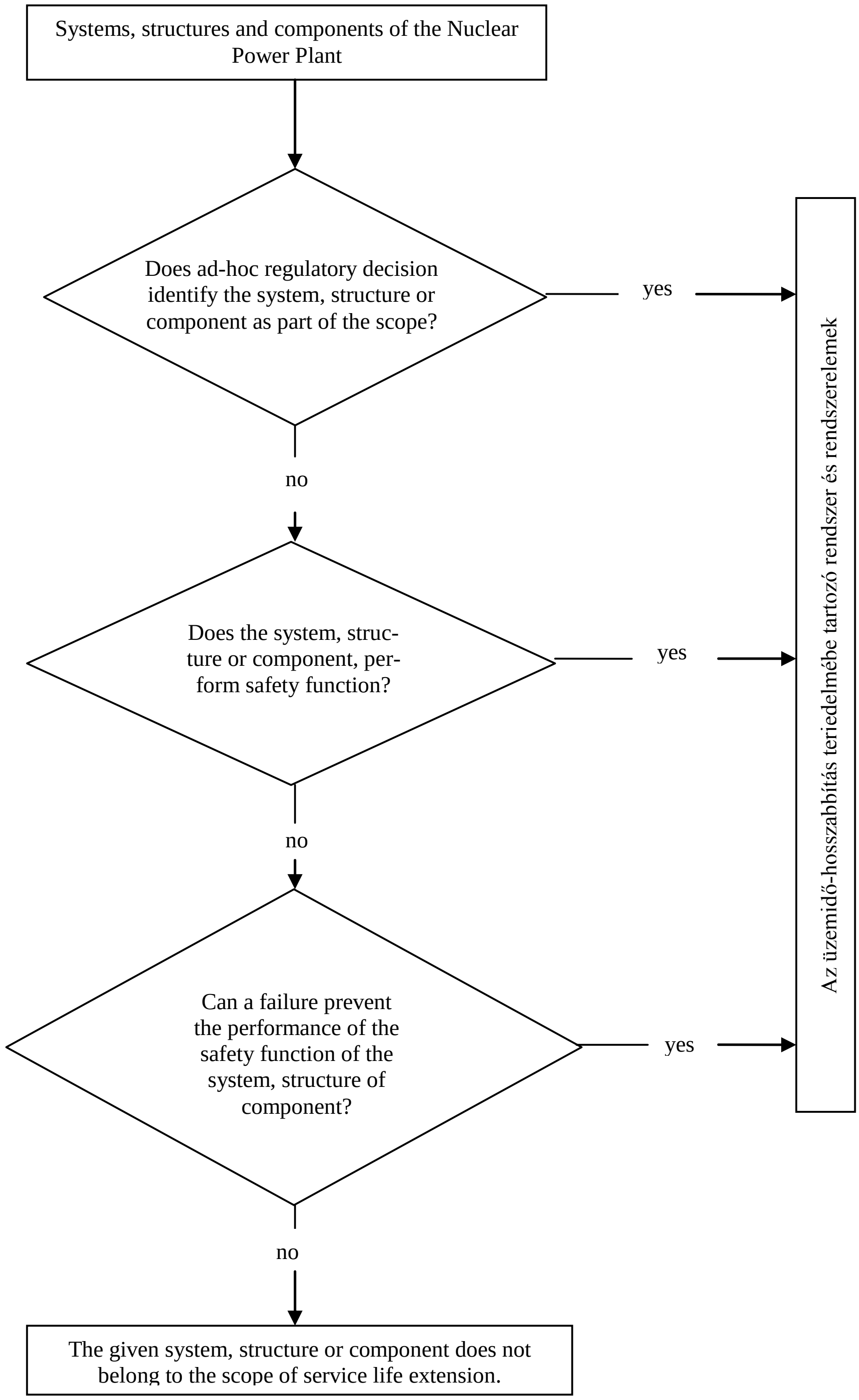

Figure 1 – Identification of systems, structures and components belonging to the scope of SLE

An ad-hoc regulatory decision identifies a system component or analysis as part of the scope of service life extension, if a regulatory resolution determined the validity of the operating license of a system, structure or component or a safety analysis within the design service lifetime of the nuclear facility.

As a minimum, the following systems, structures and components should be identified as such that perform a safety function:

a) safety systems and their primary system components classified into ABOS 1-3;

b) such individual system components and structures (e.g. building structures, civil structures), which perform individual safety function;

c) system components categorized to Class 1-3 regarding their resistance against hazards having natural origin, including those classified FBOS 1-3.

The safety function of a safety system, structure or component may be jeopardized by a failure of a non safety classified system, structure or component. For example the loss of medium through a break of a non safety important pipeline may cause damage to a system component performing safety function (e.g. the electric board of a motor operated valve). Thus these systems, structures and components should also be included into the scope of service life extension.

"The scope definition of operation beyond the design lifetime shall be consistent with the actual licensing base of the nuclear facility." (4.15.0.400 of NSC Volume 4)

"Those relevant safety functions of systems, structures and components shall be identified which were the cause for including the specific system, structure or component into the scope of licensing for operation beyond the design lifetime." (4.15.0.400 of NSC Volume 4)

The scoping should be documented as specified by Guideline 1.28.

4. JUSTIFICATION OF APPLICABILITY OF SYSTEM COMPONENTS BELONGING TO SERVICE LIFE EXTENSION SCOPE

4.1. Within design lifetime

Within the design service lifetime the licensee should continuously justify the capability of performing the required safety functions according to the regulatory conditions of the current licensing basis, including the required performance parameters.

The guidelines containing recommendations in relation to these requirements are as follows: 4.2, 4.21, 4.7, 4.8, 4.10, 4.12 and 4.13.

The justification may take place by the application of one or the harmonized combination of more of the methods listed below (4.6.0.0100 of NSC Volume 4):

a) safety analyses,

b) environmental qualification and its preservation,

c) operation of ageing management programmes,

d) monitoring maintenance effectiveness.

The licensee should decide on the selection of the method to be applied, with the following restrictions:

a) environmental qualification should be implemented for electric, instrumentation and control components operating in harsh environment,

b) ageing management should be implemented for the components of the primary cooling system and their support structures, at the ageing locations identified there (4.6.0.0200 of NSC Volume 4).

4.2. Beyond design lifetime

In order to operate the given nuclear power plant unit beyond its design lifetime the licensee should justify the adequacy of each system component belonging to the scope of service life extension. In addition to the activities determined in Subchapter 4.1 (i.e. the licensee should continuously justify the capability of performing the required safety functions), this should cover:

a) the justification of acceptability of TLAAs,

b) the justification of the adequacy of the ageing management of passive and long-lived system components (Paragraph c) and d) of 1.2.6.0500 of NSC Volume 1).

The actions to be performed for the justification of the performance of the required safety functions beyond the design lifetime are described below.

4.2.1. Justification of the adequacy of time limited ageing analyses (TLAAs)

“The licensee shall identify those time limited ageing analyses of that substantiate the suitability of system components that belong to the licensing scope of operation beyond the design lifetime for the nuclear unit, furthermore it shall demonstrate that the analyses remain valid throughout the extended service life of the nuclear unit.” (4.15.0.0800 of Volume 4 of the NSC)

4.2.1.1. Identification of existing and missing TLAAs

Those analyses should be identified as TLAA, which are:

a) the fulfilment of the mentioned requirements can only be demonstrated by assuming a given time-period related to systems, structures and components, and by considering the stresses occurring during the normal operation and anticipated incidents as well as the conditions occurring during design basis accidents belonging to the current licensing basis,

b) The assumption for the time period may refer to an operational or calendar time-period, stress cycle frequency or to the occurrence of a certain condition.

c) The identification of the TLAA is determined by the existence of the above mentioned conditions. If the identified TLAA appears in the Final Safety Analysis Report of the facility or in other documentation approved by the authority, then the TLAA is regarded as existing one, otherwise it is a missing one.

As minimum the following lifetime limiting analyses are identified as TLAA:

1) low cycle fatigue analysis of ABOS 1-2 mechanical components;

2) lifetime limit environmental qualification of ABOS 2-3 electric, instrumentation and control components;

3) lifetime limit PTS analysis of reactor pressure vessels;
4) determination of pressure/temperature limit curves of reactor pressure vessels for normal operation, pressure test or symptom based emergency operating procedures;
5) lifetime limit crack propagation analysis of detected flaws;
6) thermal stratification phenomena induced lifetime limit fatigue analysis of ABOS 1-2 pipelines;
7) extension of the scope of safety analyses corresponding to high energy line brake assigned to specific CUF limit;
8) high cycle fatigue lifetime limit analysis due to flow induced vibration of reactor pressure vessel internals;
9) high cycle fatigue lifetime limit analysis due to flow induced vibration of steam generator heat exchanger tubes;
10) crack tolerance lifetime limit analysis considering reduction of fracture toughness of reactor pressure vessel internals;
11) fatigue lifetime limit analysis of hermetic penetrations;
12) fatigue lifetime limit analysis of components belonging to hermetic claddings (welds, transient welds);
13) crack tolerance lifetime limit analysis of 22K casting steel weld components caused by thermal embrittlement;
14) fatigue lifetime limit analysis of cranes performing safety functions;
15) fatigue lifetime limit analysis of spent fuel pool cladding;
16) lifetime limit analysis of material property changing of steam generator heat exchanger tubes;
17) lifetime limit analysis of material property change of heavy concrete structures;
18) allowability lifetime limit analysis of increased pressure integrated leakage tests;
19) lifetime limit analysis of corrosion wall thickness allowance;
20) fatigue lifetime limit analysis of main circulating pump fly-wheel;
21) analysis of building sinking and its consequences;
22) evaluation of B10 loss of spent fuel pool grids;
23) analysis of the impacts of cracks embedded due to the weakening of the grain boundary heat affected zone of the cladding of reactor pressure vessel;
24) analysis of the change of material properties of the ceramic thermal insulation of the upper block.

Those analyses, which are able to guarantee sustaining the required safety level for unlimited period of time should not be identified as a TLAA.

4.2.1.2. Management of TLAAs

Possible manners of TLAA management are as follows:

a) Demonstration that the conditions of safety are met based on the analysis performed for the design lifetime of the facility even if the analysis is performed for the beyond design service lifetime period of the facility.

b) The conservative assumptions made in the original TLAA are replaced by less conservative assumptions in a justified degree. In such a case the programme of the required actions, the justification of their effectiveness and the possible degree of the change of analysis data should be presented. It should be taken into account that the safety margins required for the analyses should not be decreased by the end of the extended service life.

c) If the validity period of the TLAA cannot be extended beyond the design lifetime of the facility, then it should be justified that such ageing management programmes will be introduced during the extended service lifetime, which allow managing the assumed consequences of the non-compliance by the end of the extended service lifetime. In such a case it should be justified during the modification of the ageing management programmes that the planned modifications will be really introduced and their effectiveness will be applicable to manage the potential effects of TLAA non-compliance.

The validity of the TLAA should be extended by the end of extended service lifetime, including a margin of 10 years.

"If the results of a time limited ageing analysis it can be demonstrated that a system component can be safely operated beyond the designed lifetime but not as long as the extended lifetime then a new deadline may be initiated to be determined to allow for the update of the analysis and the execution of necessary measures which complies with the analysis results but still ensures the required safety margins." (4.15.0.1100 of NSC Volume 4)

If the above described manners of TLAA managements cannot be implemented, then the licensee should, before the expiry of validity of the TLAA, replace the concerned system components, for which the acceptability for the extended service life can be justified.

The TLAA analysis should be documented in such a way that they could fully be audited by an external expert.

If, based on the results of the TLAA performed during the preparation of license application for operation beyond the design service lifetime, the conditions of safe operation could not be ensured even by the end of the design lifetime of the installation, then the identified safety problem should be resolved in the frame of the current operating license (1.2.6.0500 a of NSC Volume 1).

Except for the cases mentioned in the preceding paragraph, according to Guideline 1.28, the documentation of extension of the TLAA analysis should be submitted to the authority as part of the license application for operation beyond design lifetime.

4.2.2. Comprehensive review of ageing management programmes

A comprehensive ageing management review should be performed on the passive and long-lived systems, structures and components for those belonging to the scope of licensing of operation beyond the design lifetime as defined by Paragraph 1.2.6.0300 of NSC Volume 1, in order to justify that the degradation processes requiring ageing management have been identified and adequately managed during the extended service life, in a way that the ageing effects cannot jeopardize their functionality.

"Based on the results of the comprehensive review the licensee shall identify whether new ageing management programmes shall be developed and implemented, or if any of the available programmes shall be modified." (4.15.0.0700 of NSC Volume 4)

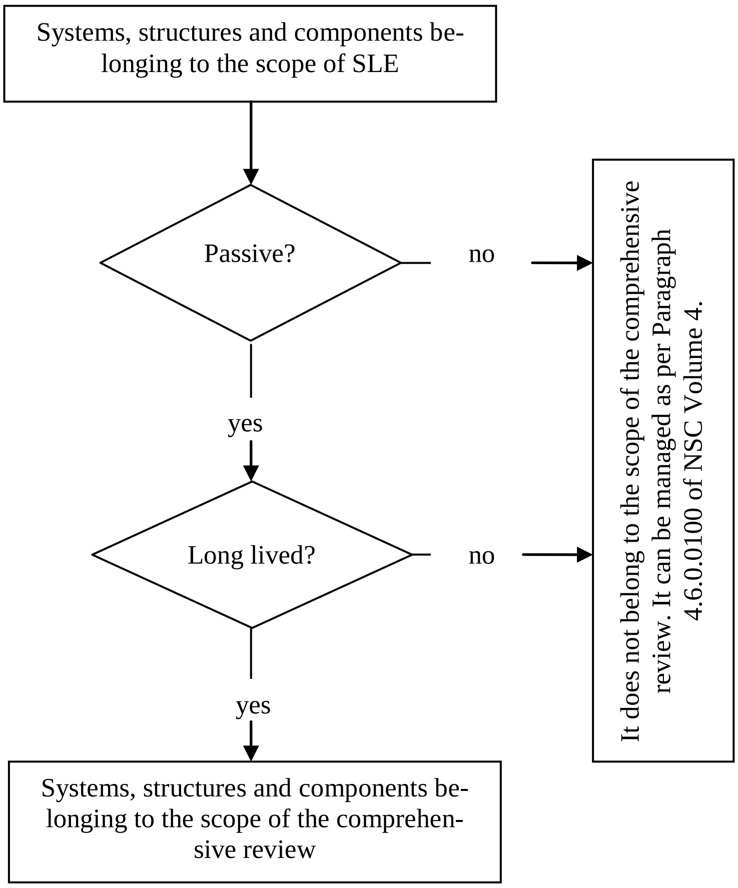

Figure 2 – Identification of systems, structures and components belonging to the scope of the comprehensive review

The passive system components should be identified according to Definition 135 of Volume 10 of the NSC. Typical but not exclusive examples for passive components are: reactor pressure vessel, pressure boundary of primary circuit, steam generators, pipelines, pump and valve housings, core support structures, other supporting structures, heat exchangers, pressure boundaries, containment and its penetrations, electric connections, cables, cable trays etc. The annex of this guideline contains typical examples of methods fulfilling typical passive safety function in the different crafts.

Examples of non long-lived components are interim rods or parts quickly wearing out.

The objective of the comprehensive review is to determine the ageing processes that could occur in case of the given component, if they are duly addressed by the current programmes and what supplementary programmes are still necessary.

The deficiencies revealed may be managed by the modification of the existing ageing management program, however, if it is impossible or not effective enough, new ageing management programmes should be elaborated.

If such deficiencies are revealed during the review, which violate the safe conditions of operation stipulated in the legal documents and regulatory requirements, then irrespectively of the intention to operate beyond the design lifetime it should be handled within the current licensing basis (1.2.6.0500 a of NSC Volume 1).

In case of modification of the programmes or elaboration of new programmes the licensee should justify that the modified program or the old and new programmes together ensure that the component would be capable to fulfil its intended safety function in accordance with the conditions of the current operating license during the extended service life.

The ageing management programmes are compiled and introduced such a way that its due effectiveness would be justified not later than at the expiry of the design lifetime.

Examination and documentation of systems, structures and components belonging to the scope of comprehensive review should take place in accordance with the system of viewpoints described in paragraph 4.3.1 of Guideline 4.12.

Out of the components belonging to the scope of the comprehensive review the review should be performed individually for the major components, in case of the others evaluation by groups formulated by similar features (base material, operating medium, operating parameters) is allowed.

5. IDENTIFICATION OF DOCUMENTS TO BE MODIFIED

The licensee should observe that besides those specified by the comprehensive ageing management review, which documents should be modified for the operation beyond design lifetime. At least the need for modification of the following documents should be assessed:

a) Final Safety Analysis Report;

b) OLC;

c) the document summarizing how to sustain the adequate conditions of systems, structures and components according to Chapter 4.6 of Annex 4 of Govt. decree 118/2011. (VII. 11.) Korm.;

d) symptom based emergency operating procedures regulating the response to design basis accidents;

e) accident management guidelines;

f) emergency preparedness and response plan of the facility.

6. ANNEX
TYPICAL EXAMPLES OF METHODS PERFORMING PASSIVE SAFETY FUNCTIONS

Typical examples of methods how mechanical and I&C components perform passive safety function
Ensuring the pressure boundary for delivering prescribed flow rate at appropriate pressure
Ensuring filtering
Ensuring flow restriction (choking)
Ensuring structural support/clamping/fixing for safety components
Ensuring electric connection for prescribed sections of electric circuits to maintain system voltage and system current
Ensuring heat exchange
Typical examples of methods how building and other civil structures perform passive safety function
Ensuring prescribed fire barrier to restrict a possible fire or to prevent its propagation to neighbouring areas
Ensuring shielding/protection for safety related components
Ensuring structural support/clamping/fixing for safety equipment
Ensuring water barrier (for internal and external flooding)
Ensuring pressure boundary or leak-tight barrier to maintain the safety of and avoid harmful impacts on the health of the public in case of occurrence of any design basis accident
Ensuring spray protection or sump to direct the coolant (e.g. safe drainage to the containment sump)
Ensuring shielding against radiation
Ensuring protection against flying object (internal or external)
Ensuring protection against high energy line brake
Ensuring structural support/clamping/fixing for such not safety related components, the failure of which may endanger the fulfilment of safety related functions
Ensuring protection against pipe whipping
Ensuring route of gases leaving with or without filtration
Ensuring coolant supply source for shutting down of the plant
Ensuring heat sink during accidents