LIFE TIME EXTENSION OF NUCLEAR POWER PLANTS –

TECHNICAL BACKGROUND FOR THE APPLICABILITY OF THE ESPOO CONVENTION

Steam Generator replacement French 900 MWe PWR (AREVA+EDF)

ONLINE WORKSHOP

ENVIRONMENT AGENCY AUSTRIA

MARTIN GIERSCH, 21 APRIL 2022

ENVIRONMENT AGENCY AUSTRIA umweltbundesamt

OVERVIEW

- Ageing of NPP
- Obsolescence
- Technical terms: PLiM, PLEx, LTO and LTE etc.
- "Situations" of the Espoo Guidance LTE of NPP
- Key Points

AGEING OF NPP

Physical Ageing of Structures, Systems and Components (SSC)

- Structures: Civil Engineering - building, concrete + steal enforcements, confinement, containment, cooling towers
- Systems: Technical installation to fulfill (also safety) functions: Heat transfer, cooling, instrumentation and control, power conversion, material transport and storage, chemical treatment and separation, ventilation, power grids, fire protection, data acquisition and documentation etc.
- Components: Depending on the context equipment may be part of more than one category (a component as part of a system etc.) e.g. valves, motors, piping, cabels.

Ageing: Physical ageing by material degradation, erosion, embrittlement, stress-corrosion, loosing material properties required by design to fulfill safety functions.

Physical Ageing at Pressurizer electrical heaters of Kmelnizki NPP

OBSOLESCENCE

…is the “ageing” of (safety) concept:

Even if equipment is physically "as good as new", the concept might be obsolete (see e.g. old-timer cars).

1. Knowledge base on loss of safety function is increasing by operation experience
2. Increasing safety requirements (e.g. enhanced margins for design parameters)

Euratom Nuclear Safety Directive 2014/87/Euratom (Article 8e Peer reviews) requires

(Euratom) *Member States shall, at least once every 10 years, arrange for periodic self-assessments ... invite an international peer review ... with the aim of continuously improving nuclear safety.*

IAEA Convention on Nuclear Safety (CNS) Vienna Declaration on Nuclear Safety (VDNS):

1. *New nuclear power plants are to be designed, sited, and constructed, consistent with the objective of preventing accidents … and, should an accident occur, mitigating possible releases of radionuclides ....*
2. *Comprehensive and systematic safety assessments are to be carried out periodically … throughout their lifetime in order to identify safety improvements that are oriented to meet the above objective. Reasonably practicable or achievable safety improvements are to be implemented in a timely manner.*


State of the art Control Room


Control Room from the 80th

LIFE TIME EXTENSION - AGEING & OBSOLESCENCE MANAGEMENT

…LTE has to address both: physical ageing and conceptual obsolescence

Main Safety objectives to ensure ALWAYS:

1. Criticality control (control of fission power)
2. Heat removal (from fission an radioactive decay)
3. Containment integrity (against radioactivity release)

Safety systems has to be ALWAYS in the condition to fulfill the safety functions.

Steam Generator Replacement (380 t) in French 900 Mwe PWR, BOUYGUES CONSTRUCTION SERVICES NUCLEAIRES + EDF, 2002

TECHNICAL TERMS

Following IAEA Nuclear Safety Glossary, Safety Standards, WENRA Safety Reference Levels (for existing reactors) etc.

Definitions are used in a setting and cannot be replaced without technical justification!

LTE - Life Time Extension

Operation beyond an established design life time - used in Espoo Guidance

LTO - Long term operation

Preferred by some nuclear operators "just to continue without declared extension"

PLiM - Plant Life Management

Assessment of equipment against technical requirements, its maintenance, repair and replacement

PLEx - Plant Life Extension (see LTE)

Design Lifetime

Established period for which equipment is certified and authorized (to fulfill safety functions)

Structures, systems and components should be certified (question of liability) and authorized (by the regulator) to fulfill safety functions. License is applied according to compliance with limits and conditions.

SITUATIONS

5 Situations are used in the Espoo Guidance

A specific case may be classified under more than one situation at the same time!

Situations 1

“The end date of a time-limited licence has been reached, but the plant is intended to continue operation”

Rare case!

Example: Rovno 1+2 case (operation license was limited to 30 years).

For LTE Espoo procedure is required – decision by Espoo MoP

Only in few countries time-limited license are applied!

SITUATIONS

Situations 2

“The nuclear power plant has a time-unlimited licence, but the design life of irreplaceable safety-critical structures, systems and components has been reached”

A common case!

Challenge is to identify design life of irreplaceable safety-critical structures, systems and components.

Most of (safety critical) plant equipment can be maintained, repaired or replaced.

Examples of irreplaceable SSCs are the reactor pressure vessel (RPV) or the containment structure.

The project proponent has to demonstrate the fulfillment of current safety requirements for new reactors as part of nuclear safety assessment. The authorization may trigger application of an Espoo procedure.

SITUATIONS

Situations 3

“A periodic safety review is carried out in support of the decision-making process for a lifetime extension”

A common case!

Usually a periodic safety review (PSR) is applied every 10 years to re-assess plant status against limits and conditions. Evaluation criteria should reflect state of the art/current safety requirements.

Authorization of LTE based on PSR (and not PSR alone) may trigger application of an Espoo procedure. This is valid for requalification of safety critical Structures, Systems and Components:

a) …beyond originally established design life time and
b) …against new safety requirements

PSR may trigger requalification of safety critical SSC even if their design life is out of scope! This may induce an Espoo procedure.

SITUATIONS

Situations 4

“Modification of a nuclear power plant not covered by the existing authorization to operate and therefore requiring a licence modification”

Cases under this situation are usually connected to major physical works or activities such as:

- power increase
- safety upgrades or backfitting of safety systems
- Large scale investments to improve plant operation (e.g. efficiency, load-follow-capability...)

Also this situation may be combined with other situations!

SITUATIONS

Situations 5

“The nuclear power plant has a time-unlimited licence but the time of operation is limited by law”

Change of time-limits or other restrictions by law may also trigger an Espoo procedure, even if the technical operation authorization is untouched.

Also this situation may be combined with other situations!

KEY POINTS

- All Structures, Systems and Components are designed to fulfill technical limits and conditions during design lifetime.
- For safety analysis "loads" from normal operation and expected events are defined using an established design lifetime. Therefore technical arguments support the concept of life time extension.
- With in-depth plant inspection lifetime extension may be possible with SSC maintenance, physical repairs or replacement. Requalification to meet license conditions is necessary.
- If a safety relevant SSC cannot fulfill limits and conditions and cannot be replaced, the plant reaches end of lifetime, (even before design lifetime).
- Requalification of equipment is independent from but may imply physical work, it is based on certification and agreements for warranties and liability.
- With requalification the actual safety requirements (as for new NPP) has to be applied for authorization!
- Authorization of plant operation is based on legal decisions and may trigger an Espoo procedure.