Effective approach to Long Term Operation justification: a case for 60 to 80 years lifetime extension

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Outline

- Dutch Nuclear Industry
- NRG Pallas in LTO
- Importance of regulatory framework
- Approach to (subsequent) LTO
- Safety Demonstration & Periodic Safety Review
- Case for subsequent LTO
- Closing remarks

Lorenzo Stefanini

Specialisation

- Ageing Management & Long-Term Operation (LTO) policies & licensing
- Management

Experience

- *NRG PALLAS, Petten (May 2016 to Present)*
  - Team leader AM|LTO (2024-present)
    - Contract owner, PM, PSR(LTO-2) & SD policies for KCB LTO-2 (2024-present)
  - Maintenance Manager at High Flux Reactor (2021-2024)
  - Project Manager Asset Integrity Team (2018-2021)
    - HFR Ageing Management development – PM
  - Engineer Asset Integrity Team (2016-2018)
    - Specialist in Probabilistic Fracture Mechanics
- *SCK CEN, Belgium (2015-2016)*
  - Structural Materials Engineer

- IAEA Specialist/Expert/Reviewer since 2021

Education

- Master of Science in Nuclear Engineering – Structural Engineering Specialization (2013-2015).
- Bachelor of Science in Nuclear Engineering & Industrial Safety (2009-2013).

The Dutch Nuclear Industry

NRG PALLAS
Petten
High Flux Reactor
Pallas Newbuild

URENCO
Uranium
enrichment

Thorizon SMR
development

TU-Delft research
reactor

NRG | PALLAS
Arnhem

Allseas SMR
development

NPP New Build
locations for large
LWRs

Dodewaard NPP
60MWe BWR
Decommissioned

COVRA Waste
storage facility

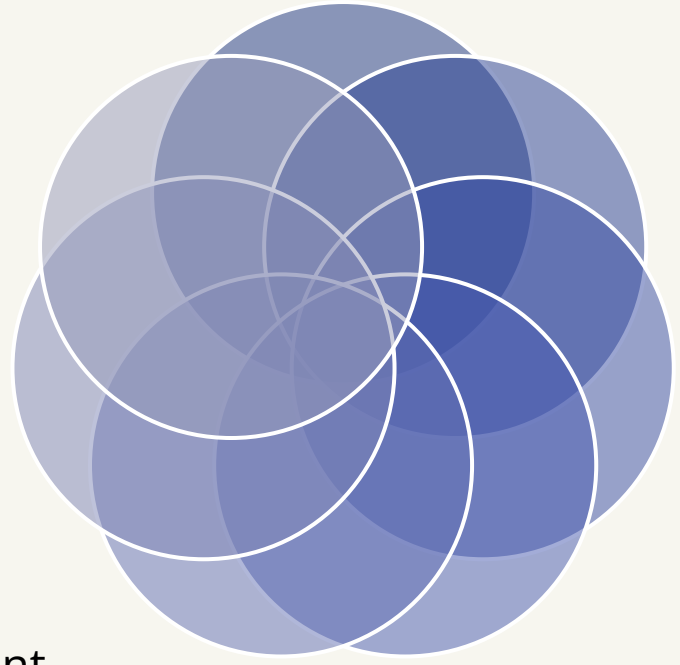
Borssele NPP
500 MW PWR (KWU)
In LTO

Ageing Management & Long Term Operation support at NRG Pallas

Ageing management and LTO project management/ overall support

PSR preparation and conduct

Policies and Methodologies development for LTO



Identification and revalidation of TLAAs

Equipment Qualification and Technological Obsolescence

TULIP LTO

In accordance with IAEA Safety Standards

Development, implementation and improvement of AMPs

Scope Setting & Ageing Management Review

TULIP LTO

NRG PALLAS
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NPPs Supported over the world

Sweden

- Oskarshamn & Ringhals

Finland

- Olkiluoto

Netherlands

- Borssele

Belgium

- Doel-4

Belgium

- Tihange-3

Japan

- Mihama 3

Argentina

- Atucha-1

South Africa

- Koeberg-1&2

Basis for successful LTO justification project

One of the most important factors for a successful LTO justification project is a strong and agreed regulatory framework and shared and achievable regulatory expectations.

Some countries foresee the justification of LTO (or license renewal) in their regulatory framework and govern them accordingly.

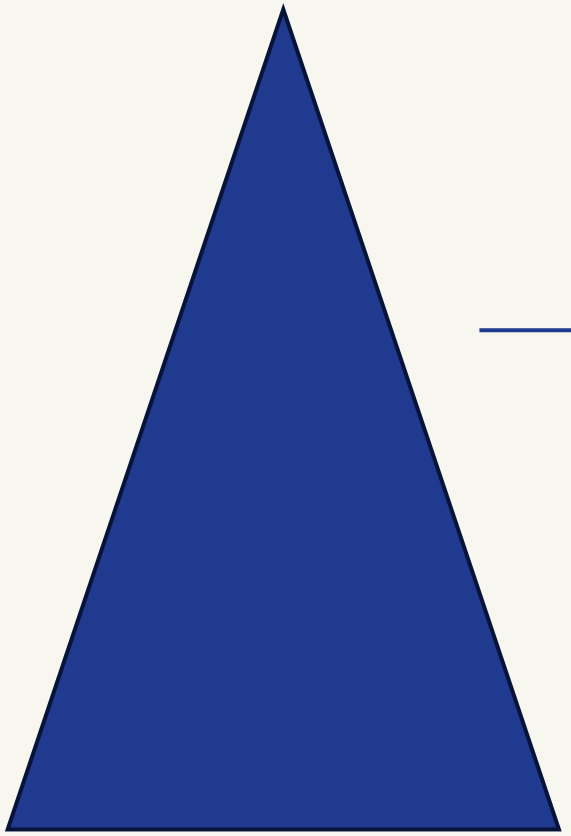
Some countries don’t.

In this cases an adequate framework needs to be agreed with the regulatory body.

A solution is to base this framework on the international requirements, codes and standards. Such as the IAEA Safety Standards.

The TULIP-LTO approach is based on the satisfaction of IAEA Safety Standards.

NL – Regulatory framework for subsequent LTO



Kernenergiewet (KeW)

→ Artikel 15a/b

Decree for nuclear installations, fuels and ores

→ Artikel 18

Use of Intern. Codes and Standards

New operating licenses will be based (also) on requirements from IAEA SSR 2/2 (Rev.1)

→ Requirement 16 from SSR 2/2 (rev. 1)

→ Basis for technical justification subsequent LTO

Requirement 16 SSR 2/2 Rev.1

Requirement 16: Programme for long term operation
Where applicable, the operating organization shall establish and implement a comprehensive programme for ensuring the long term safe operation of the plant beyond a time-frame established in the licence conditions, design limits, safety standards and/or regulations.

4.53. The justification for long term operation shall be prepared on the basis of the results of a safety assessment, with due consideration of the ageing of structures, systems and components. The justification for long term operation shall utilize the results of periodic safety review and shall be submitted to the regulatory body, as required, for approval on the basis of an analysis of the ageing management programme, to ensure the safety of the plant throughout its extended operating lifetime.

4.54. The comprehensive programme for long term operation shall address:
(a) Preconditions (including the current licensing basis, safety upgrading and verification, and operational programmes);
(b) Setting the scope for all structures, systems and components important to safety;
(c) Categorization of structures, systems and components with regard to degradation and ageing processes;
(d) Revalidation of safety analyses made on the basis of time limited assumptions;
(e) Review of ageing management programmes in accordance with national regulations;
(f) The implementation programme for long term operation.

Structure of successful approach to LTO justification - technical feasibility

(Dutch) Law

IAEA SSRs/GSRs

Regulatory body

Regulatory Framework

Req. 16 SSR 2/2 (rev.1)

Safety Assessment

Objective:
Maintain currently licensed (high) level of safety by comprehensive management of physical and non-physical ageing

Safety Demonstration

SSG-48

SALTO scope

SSG-25

SRS-121

PSR(LTO)

Objective:
Identify Safety Improvements for the subsequent Long Term Operation period (e.g. in light of anticipated changes)

Process SD according Chapter 7

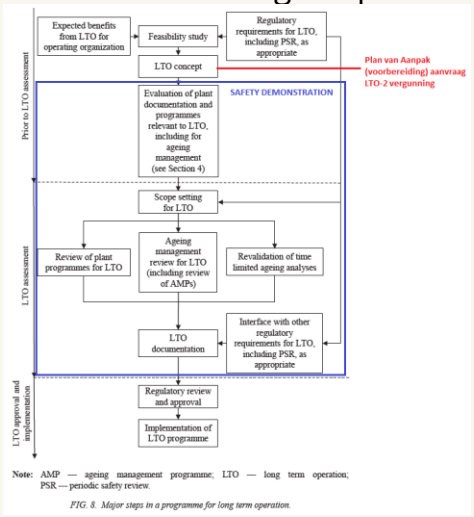


FIG. 8. Major steps in a programme for long term operation.

Scope Setting for LTO

AMRs & AMPs LTO

PPs Optim. LTO

Technol. Obso. LTO

SF1

SF7

SF2

SF3

SF4

SF5

SF6

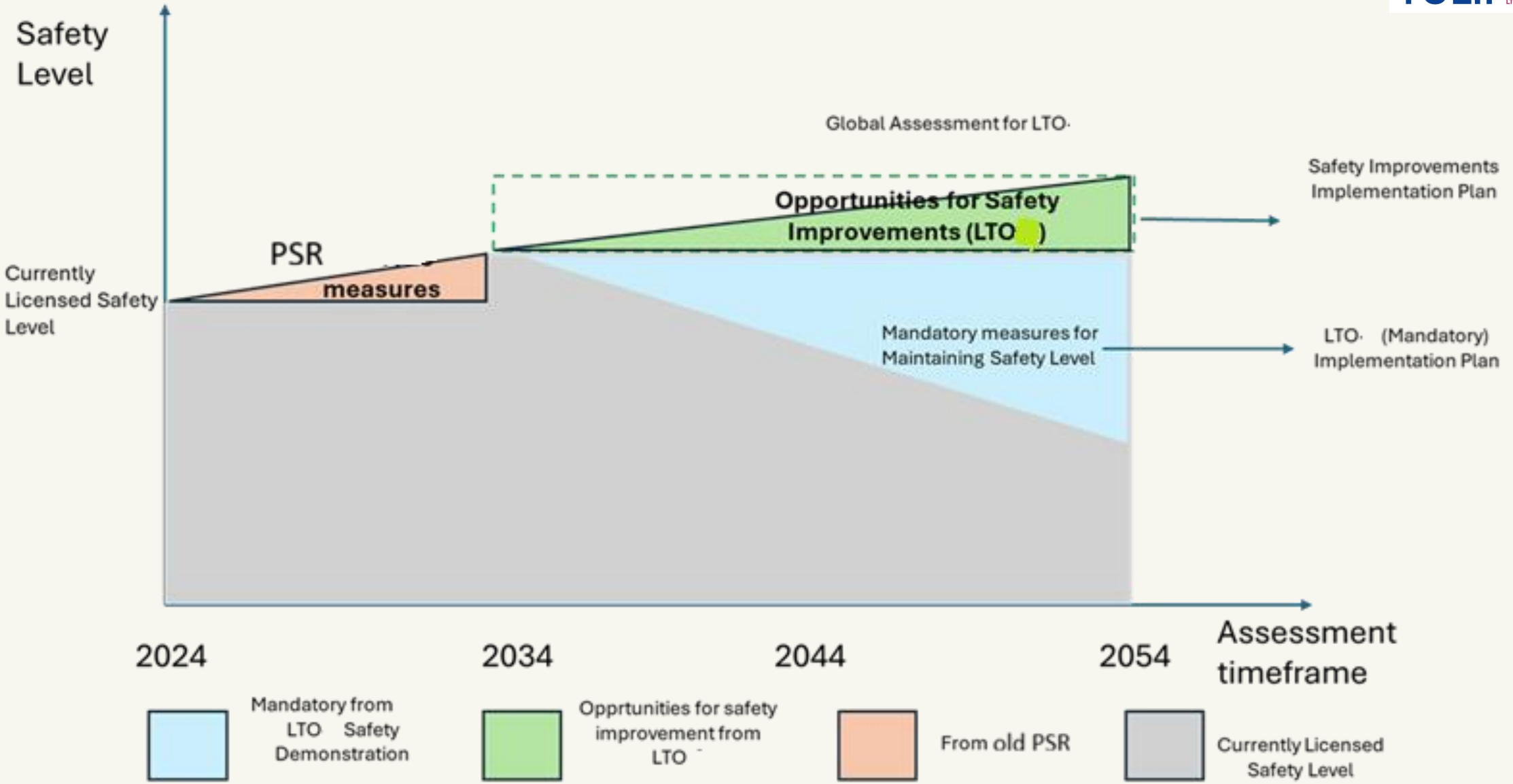
SF9

Other SFs

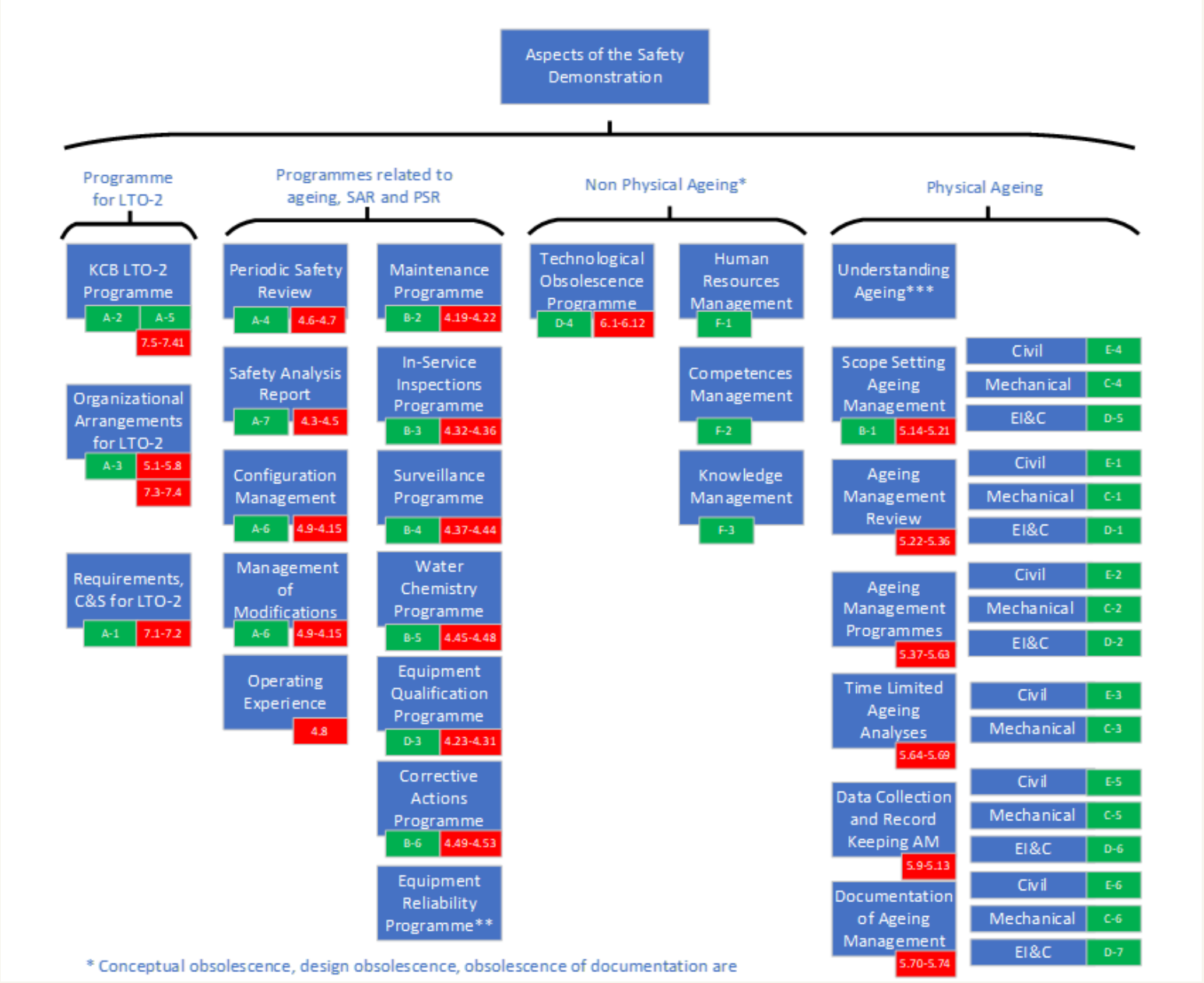
Implementation Plan for LTO programme

Update SAR & LTO License Request → Modified license

Simplified understanding of the SD+PSR approach



Safety Demonstration – Maintaining high level of safety

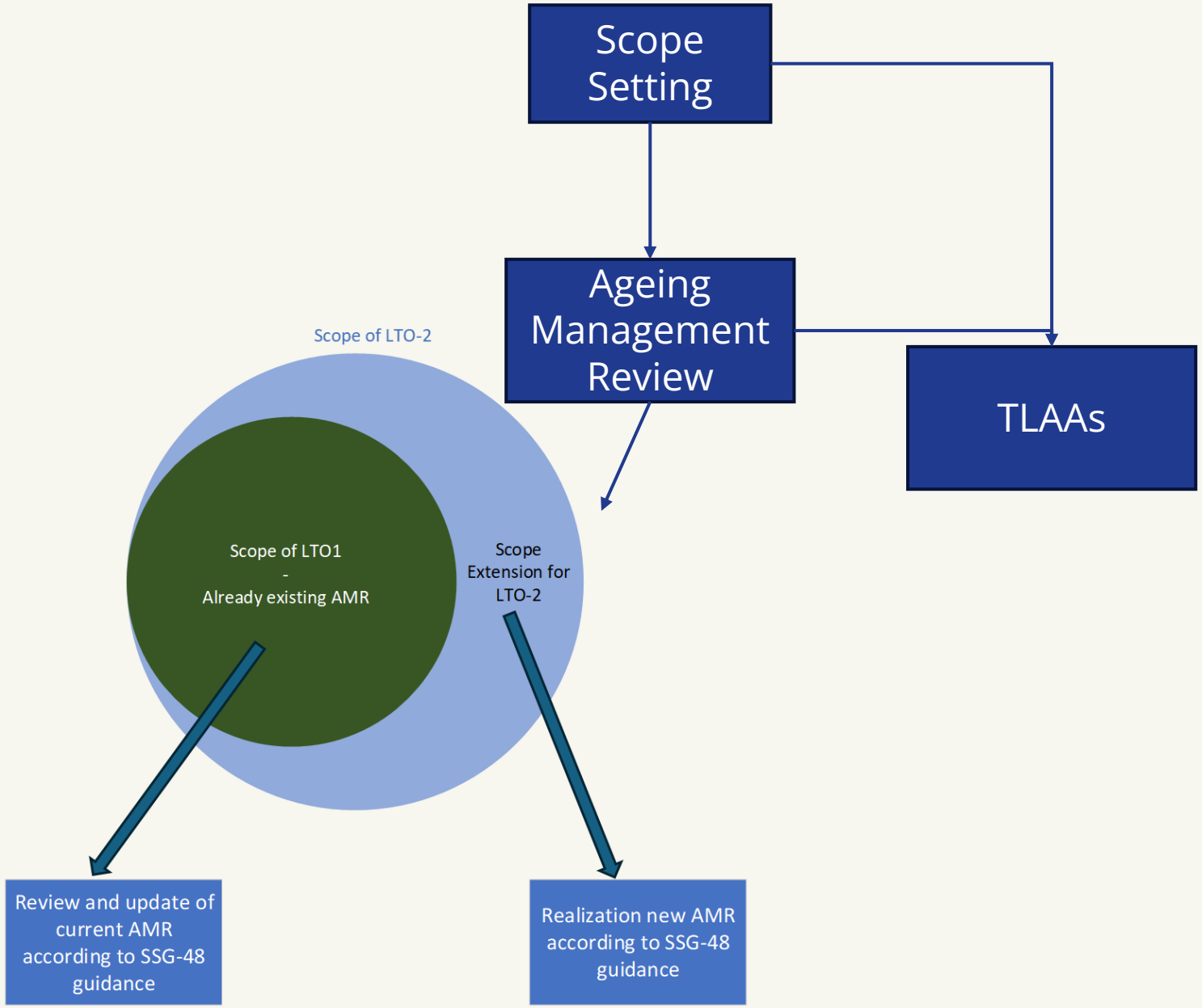


1st Step: Conformance Review based on SALTO scope + Plant specific areas

~self assessment of plant status at start (subsequent) LTO project.

Basis = SSG-48

Safety Demonstration – Assessment phase

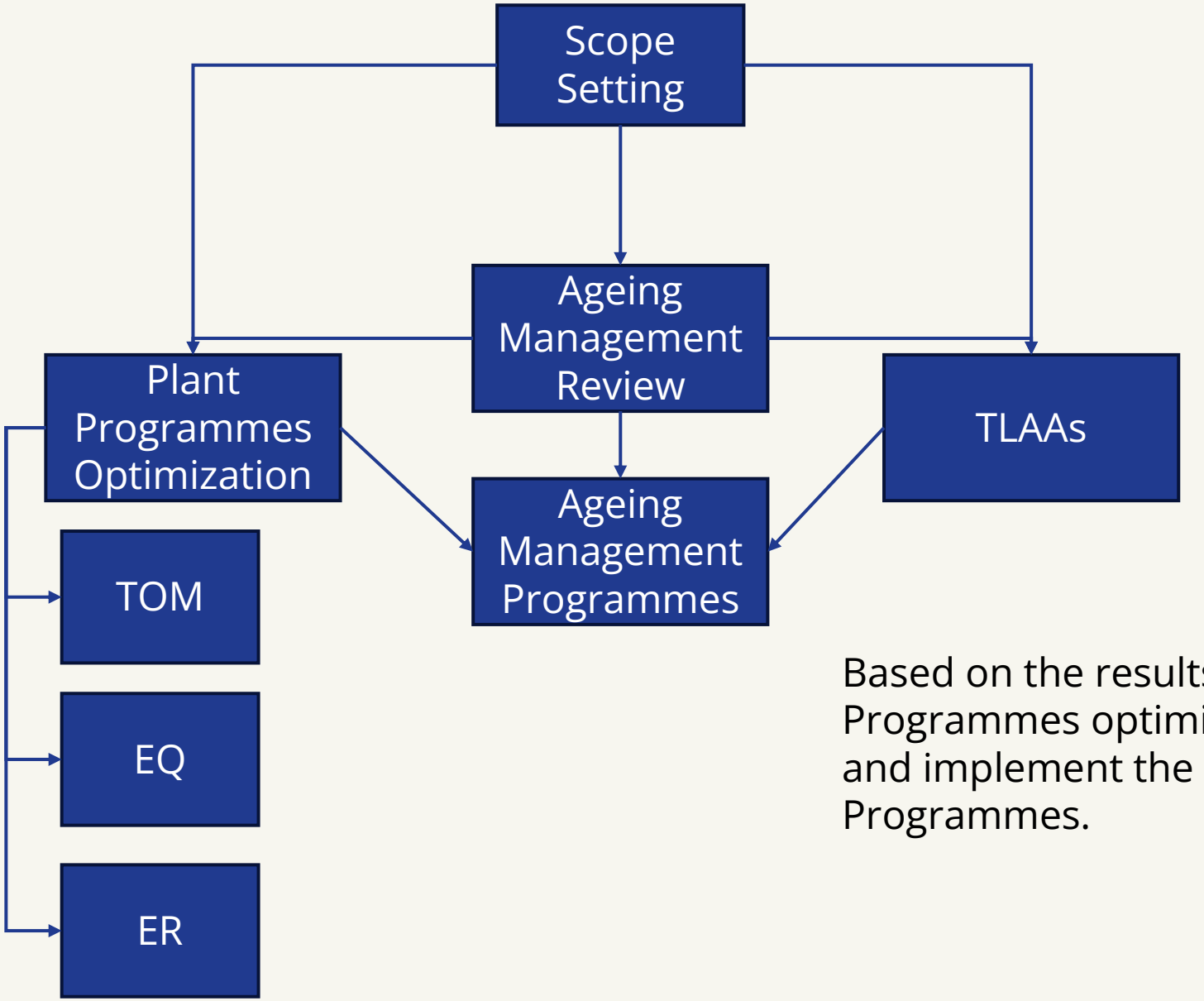


Scope Setting is the first step and is to be done according SSG-48. This is first encounter with differences in subsequent LTOs and carries on also in later steps. Scope according to SSG-48 tends to be broader.

Based on the (new) scope it is possible to make an initial screening of relevant TLAAs and it is possible to proceed to the Ageing Management Review.

Note: a first TLAA selection can be based on IGALL/GALL. The plant should have a TLAA identification methodology and review the TLAAs scope at the end of the AMR phase.

Safety Demonstration – Assessment phase

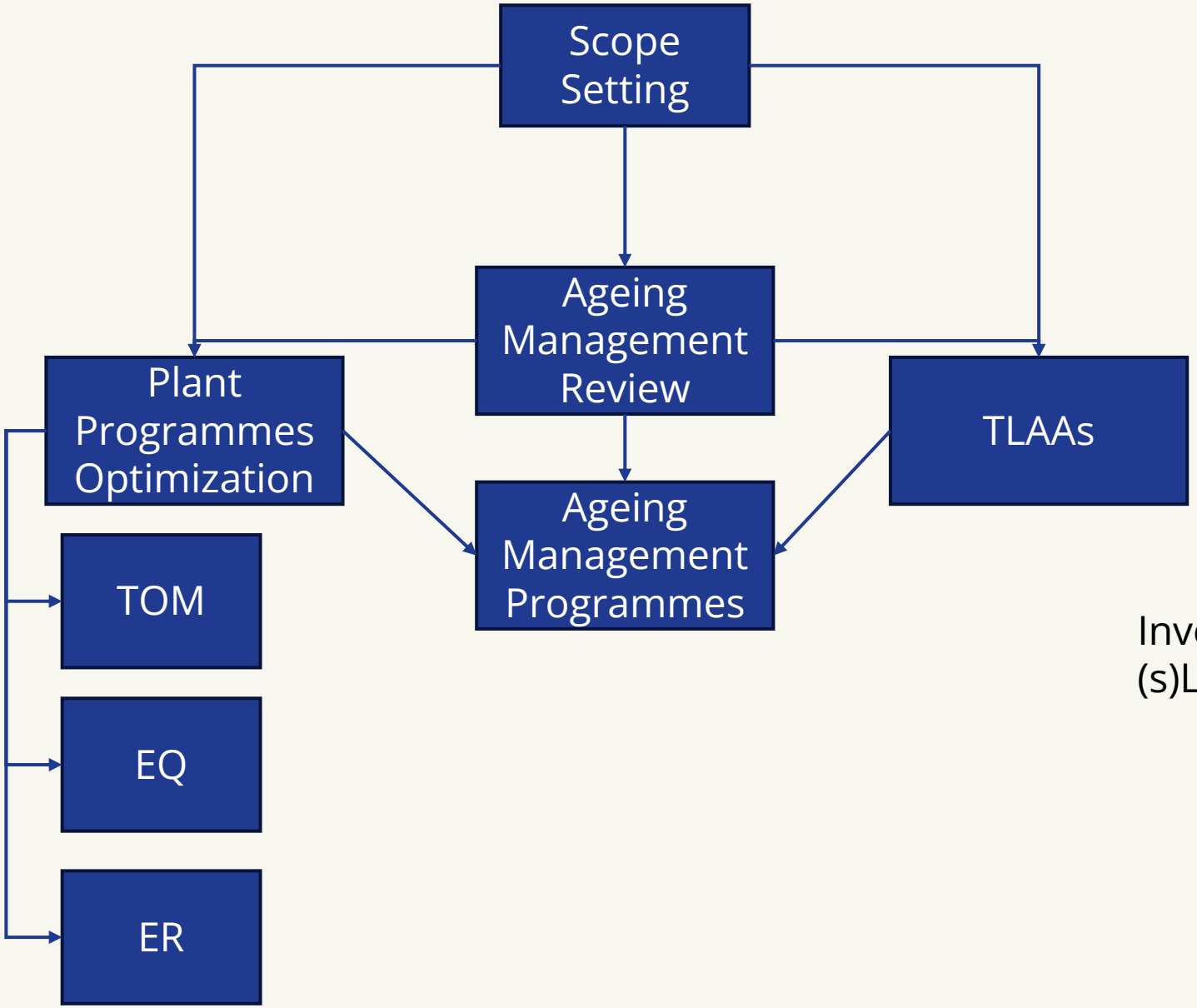


Base on the (new) scope for LTO, a parallel optimization (if necessary) can be started to bring Plant Programmes to the state-of-the-art. Particularly important for subsequent long term operations are the Technological Obsolescence Management, the Equipment Qualification and, if present, the Equipment Reliability (~active components) Programmes

Note: final update to the PPs is more effective upon completion of the AMR.

Based on the results of TLAAs revalidation, AMR and Plant Programmes optimization it is possible to define, develop and implement the relevant Ageing Management Programmes.

Safety Demonstration – What comes out of it?



Replacements, refurbishment, modernizations.

One time inspections.

New programmes and procedures.

Investment Plan for (s)LTO

Safer and more reliable plant

(Periodic) Safety Review – Focus on Safety Improvements

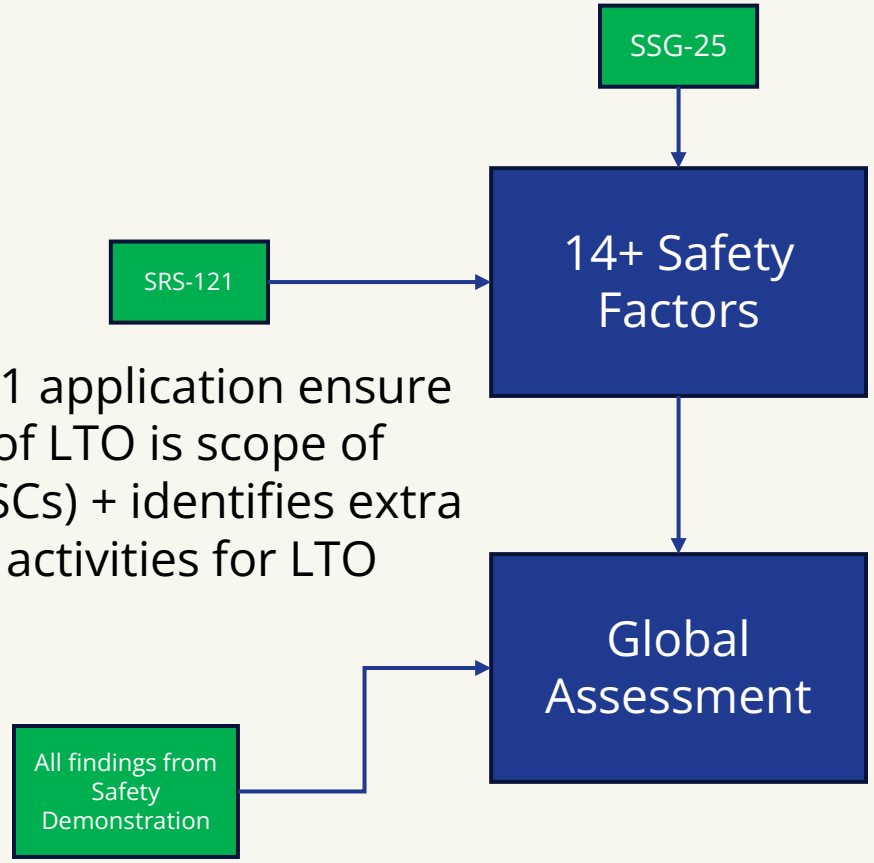
Note: some countries foresee LTO justification by PSR with in detail review of ageing related SFs. This comes down to a partial cover of the Safety Demonstration. Implementation of identified measures is postponed to after completion PSR (generally this is still well in advance of the LTO period).

In this approach the PSR for LTO focuses on the identification of Safety Improvements to cope with the challenges posed by a Long Term Operation. Particularly for plants aiming to 80 years (or more) this can be important as they were designed according to older standards.

PSR for LTO are carried out to cover the whole period for Long Term Operation (usually 20 years extra then the typical PSR).

(Periodic) Safety Review – Focus on Safety Improvements

SSG-25 ensures methodology of PSR for LTO is sound



SRS-121 application ensure scope of LTO is scope of PSR (SSCs) + identifies extra review activities for LTO

Focus on (s)LTO –among others-:

- Impact of climate change;
- Impact of long term changes in site characteristics and usage;
- Obsolescence of knowledge/competences;
- Obsolescence of codes and standards;
- Processes supporting LTO (e.g. procurement);
- International lessons learned from LTO programmes;
- Supply chain criticalities (including due to geopolitical shifts).

Current Case for subsequent LTO (KCB)

2013 → KCB enters first LTO-1 period (up to 60 years) with support of NRG Pallas

2020 – Government asks EPZ to investigate LTO-2

2021-2023 – 10EVA23 → no LTO (KeW 15a)

2024: NRG PALLAS initiates support on structure Safety Demonstration

2025: Lot-1: preliminary work in preparation of justification phase

Lot-2 phase I (justification)

Planning: Medio 2027: LTO-2 license request submitted

Lot-2 phase II (follow up, close open points)

Planning: Begin 2029: LTO-2 license obtained

In case of positive decision shareholders:

1/1/2034: LTO-2 (up to 80 years).

How does NRG Pallas support KCB LTO-2 justification:

- Ageing Management Review
- Ageing Management Programmes
- Technological Obsolescence
- Equipment Qualification (programmatic and engineering)
- Civil maintenance (ageing)
- Periodic Safety Review
- Licensing documentation management
- Time Limited Ageing Analyses
- Project Management

Closing Remarks

Focus on subsequent LTO

Subsequent LTO is in principle not different from first LTO (as confirmed by NRC and NRG Pallas-initiated LTO Beyond 60 years study from OECD/NEA).

However, based on the so far developed international experience and consensus, there are criticalities that need to be taken into consideration:

- Many qualified SSCs will be not requalifiable. This combined with obsolescence creates challenges leading to necessity of modernization (big investment);
- Technological obsolescence is particularly demanding for older plants;
- Obsolescence of codes, standards and design;
- Civil structures;
- Knowledge (not only in-house), competences management and supply chain (hardware & services);
- A broader scope leads to larger justification projects for subsequent LTOs.

I’m not getting older, I’m just becoming a classic.

Time for Q/A