OECD/NEA
‘LTO Beyond 60 Years’ project

Project objectives, task team, time schedule, status of action items (report, questionnaire)

Workshop on ‘LTO Beyond 60 Years’
Organized by NRG in cooperation with OECD/NEA
27-28 February 2024, Petten

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Senior Consultant
NRG, the Netherlands

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Ms. Corina Mocanu

Education:
mechanical nuclear engineer (Bucharest Polytechnic University, Nuclear Power Plant Engineering)

Experience:
32 years in Cernavoda NPP Technical Unit (System Engineer and PLiM / R&D Programme Coordinator)

Focus:
Ageing Management/ Long Term Operation of NPPs (2017-2024)

Since 2022:
Joined Nuclear Research and Consultancy Group (NRG), as senior consultant for ageing management and LTO

Contents

- Project objectives, approach, milestones
- Purpose and approach of technical questionnaire
- Draft report status and assigned new contributions
- Conclusions on the ‘LTO Beyond 60 Years’ project

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‘LTO beyond 60 Years’ project

Objectives:

- Map the status of knowledge regarding LTO of NPPs beyond 60 years and identify gaps in knowledge and technology
- Identify possible solutions to disposition the areas that need enhancement

Deliverables: Status report on ‘LTO beyond 60 years’

- The report will focus on technical and safety aspects of safe LTO beyond 60 years for PWRs (including VVERs), but also BWRs and PHWRs (including (CANDUs)

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‘LTO beyond 60’ project approach

- Part of NRG PIONIER research project, funded by the Dutch Government, to collect and analyze available information regarding preparation of NPPs for safe LTO beyond 60 years

- International project under NRG coordination in two phases:

1. Direct collaboration with individual experts/ organizations to assemble the draft report

2. OECD/NEA WGIAGE collaboration project “Status report on LTO Beyond 60 Years” to broaden the expertise and bring new perspectives through a technical questionnaire

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‘LTO beyond 60’ – Phase 1

Phase 1 - direct collaboration with individual experts

- Q4 2022 - NRG developed the structure of the final report, the project planning schedule and drafted the general introductory sections 1 to 3
- Q1 2023 - NRG drafted the core technical sections 4 and 5
- Q2/3 2023 - NRG incorporated individual inputs in the draft report

Contributions received from:

- Canada: CNSC, Atkins-Realis
- Czech Republic: ÚJV Řež, CEZ
- Finland: TVO
- International Atomic Energy Agency (IAEA)
- International Nuclear Utility Obsolescence Group (INUOG)
- The Netherlands: NRG (other teams)
- Sweden: Vattenfall - Ringhals NPPs
- Switzerland: Leibstadt NPP
- USA: EPRI
- World Nuclear Association (WNA)

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‘LTO beyond 60’ – Phase 2

Phase 2 - NEA WGIAGE ‘LTO beyond 60’ project

Focus:

- Broaden the level of expertise with new international perspectives
- Bring new concerns into perspective based on a technical questionnaire
- Balance the content of different subsections to the same level of detail
- Identify suitable solutions to disposition the areas for enhancement (e.g.: more R&D work needed, revision of codes /standards, advanced testing/ inspection tools, or new repair/ refurbishment technologies)

- All contributors from Phase 1 continued to collaborate (Borssele NPP, Atkins-Realis, CEZ, CNSC, EPRI, EU JRC, IAEA, INUOG, Leibstadt NPP, NRG, Ringhalls NPP, SNETP, TVO, UJV Řež, WNA).

- 16 new collaborators from a very diverse spectra: regulatory authorities, international organizations, research institutes and new utilities.

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OECD/NEA project participants

Research institutes:

- Czech Republic: UJV Rez
- Finland: VTT
- France: IRSN
- Sweden: Studsvik Nuclear
- Switzerland: PSI
- USA: EPRI

Nuclear regulators:

- Canada: CNSC
- France: ASN
- The Netherlands: ANVS
- Sweden: SSM
- Switzerland: ENSI
- United Kingdom: ONR
- USA: NRC

Utilities:

- Czech Republic: CEZ (Dukovany and Temelin NPPs)
- Belgium: Electrabel (Doel and Tihange NPPs)
- Finland: TVO (Olkiluoto NPP)
- France: EDF
- Netherlands: EPZ (Borssele NPP)
- Sweden: Vattenfall (Ringhals NPP)
- Switzerland: KKL (Leibstadt NPP)

Other organizations:

- Canada: Atkins Realis
- EU JRC
- IAEA
- INUOG
- OECD/NEA: WGIAGE, SDOCB, WGHOF
- SNETP
- Switzerland: Swissnuclear
- United Kingdom: WNA

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NEA WGIAGE project in numbers

10 countries, 5 international organizations (EU JRC, IAEA, INUOG, SNETP, WNA)
59 Task Team (TT) members and **25 Single Points of Contact** (SPOCs), required when more than 1 TT member /organization.

- Everyone need to create an OECD/NEA account at the link below:
https://www.oecd-nea.org/confdb/confdb/conf?id=750
- Then you should select “create account” on this page and create your account:

All SPOCs must have access to perform their role: to coordinate their organization’s work during TT meetings.

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‘LTO beyond 60’ – milestones

2022:

- Project initiation (Oct 2022)
- Survey to identify available information sources, agree on cooperation with with external contributors (Nov 2022)
- Project planning, structure of the project report (Dec 2022)

2023:

- Development of the initial version of the project report (June 2023)
- Call for collaboration and assignment of roles (July 2023)
- Approval and distribution of the technical questionnaire (Aug 2023)
- Collecting answers to the technical questionnaire and additional inputs to the project report (Dec 2023)

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‘LTO beyond 60’ – milestones

2024:

- Project progress meeting in Petten (27-28 Feb 2024)
- NRG to present the interim report to WGIAGE (March 2024)
- Task Team to review sections 2-5 (Feb-April 2024)
- NRG to compile sections 2-5 (April-May 2024)
- Task Team to draft conclusions in section 6 (June-July 2024)
- Task Team to review conclusions (July-Aug 2024)
- NRG to compile conclusions and finalize section 6 (Sep 2024)
- Task Team to develop proposals for gaps dispositioning (Sep 2024)
- NRG to compile gaps dispositioning (Oct 2024)
- Task Team to review proposals for gaps dispositioning (Nov 2024)
- NRG to finalize Section 7 (Dec 2024)

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‘LTO beyond 60’ – milestones

2025:

- NRG to present the results of the activity to WGIAGE annual meeting (March 2025)
- CSNI to approve the final report: ‘Status on LTO beyond 60 years’ (June 2025)
- NRG to disseminate the results of the final status report nationally and internationally via workshops, NEA and IAEA WG/ SC meetings, to share the findings and the recommendations with all the participants to this project (Q3+Q4 2025)

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Project report structure

1. Introduction

2. LTO perspective and regulatory background

3. Non-technical challenges for safe LTO of NPPs

4. Technical challenges important for LTO beyond 60

5. Safety requirements important for LTO beyond 60

6. Conclusions for NPP operation beyond 60 years
   6.1. Areas properly addressed
   6.2. Identified areas for enhancement

7. Proposed dispositioning of identified areas for enhancement

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Purpose of the survey questionnaire

- To identify additional the technical and safety concerns safe LTO beyond 60 years and broaden the perspective.
- To obtain balance the content and harmonize the technical challenges identified in section 4 by participant organizations.
- To identify the potential safety issues and summarize them at conceptual level in section 5

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Approach for work with questionnaires

1. **Assess** the existing information and the referenced sources;
2. **Provide inputs** on the existing information (including supporting reference);
3. **Answer the supplementary question**(s);
4. At the end of each sub-section**, describe the potential gaps** seen by his organization in knowledge, technology, or standards;
5. **Indicate future actions** (like: more R&D, revision of codes and standards, new inspection/ testing /monitoring tools, or new repair methods).

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Results of survey questionnaire

A few organizations responded to the questionnaire (EDF, ONR, SDOCB, TVO, US NRC, Vattenfall)

The US NRC and Vattenfall provided direct inputs on all technical subsections 4.2 -4.9 and 5.1-5.3 and feedback to the questionnaire, like an overarching document.

The approach of a survey questionnaire was recommended because:

- summarizes the conclusions of the direct contributions
- the concerns of the organization are explained more concisely
- helps in identification of generic concerns in knowledge, technology, regulation
- will be useful in drafting the correct conclusions (areas properly known/ or that need enhancement)

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Current status (as of February 2024)

- The general sections 2, 3 are compiled now, waiting for review

- The collecting phase for sections 4 and 5 is finished:
  - direct inputs: EDF, EPRI, IAEA, PSI, Studsvik, US NRC, Vattenfall
  - answers to the questionnaire: USNRC, Vattenfall (entirely), and EDF, ONR, SDOCB, TVO (partially).

- Now the review phase for sections 4 and 5 is starting:
- - to process the “raw” information, extract the relevant data
- - balance the content
- - identify the concerns, challenges and potential gaps

- The next 9 months will be very challenging:
  - sections 4 and 5 to be reviewed by TT by 30 April 2024
- - section 6 Conclusions to be finalized by 30 September 2024
- - section 7 Dispositioning of gaps to be finalized by 30 November 2024

- TT members connecting in this WS will boost the project to meet the targets

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Draft report status

Section 1. Introduction

- ***Status:*** *draft developed and reviewed*

- ***Still pending:***
  - NRG to update section after completion of sections 6 and 7 in January 2025

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Draft report status

Section 2. LTO perspectives and regulatory background

2.1. Benefits of safe LTO of existing fleet NPPs
2.2. Current LTO perspectives
2.3. US NRC based regulatory framework for LTO beyond 60
2.4. Applicability of IAEA safety standards for LTO beyond 60
2.5. Typical national regulatory frameworks
2.6. CNSC regulatory framework for LTO beyond 60
2.7. Conclusions regulatory framework and licensing process

- ***Status:*** *draft developed by NRG*
  US NRC review incorporated in the section
- ***Still pending:***
  - *NRG to update section after completion of sections 6 and 7 in January 2025*

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Draft report status

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  US NRC review incorporated in the section
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Draft report status

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- ***Status:*** *draft developed by NRG*
  US NRC review incorporated in the section
- ***Still pending:***
  - US NRC to update section after completion of sections 6 and 7 in January 2025

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2.7. Conclusions regulatory framework and licensing process

- ***Status:*** *draft developed by NRG*
  US NRC review incorporated in the section
- ***Still pending:***
  - IAEA to review the section, deadline: ~~15 February~~ 15 March 2024
  - Other volunteers to review and provide updates by 31 March 2024 - ???
  - IAEA to update section after completion of sections 6 and 7 in January 2025

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Draft report status

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2.6. CNSC regulatory framework for LTO beyond 60
2.7. Conclusions regulatory framework and licensing process

- ***Status:*** *draft developed by NRG*
  US NRC review incorporated in the section
- ***Still pending:***
  - IAEA, ASN to review the section, deadline: ~~15 February~~ 15 March 2024
  - Other volunteers to review and provide updates by 31 March 2024 - ???

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Section 2. LTO perspectives and regulatory background

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2.6. CNSC regulatory framework for LTO beyond 60
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- ***Status:*** *draft developed by NRG*
  US NRC review incorporated in the section
- ***Still pending:***
  - *CNSC to review the section, deadline: ~~15 February~~ 15 March 2024*
  - *Other volunteers to review and provide updates by 31 March 2024 - ???*
  - *CNSC to update section after completion of sections 6 and 7 in January 2025*

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2.6. CNSC regulatory framework for LTO beyond 60
2.7. Conclusions regulatory framework and licensing process

- ***Status:*** *draft developed by NRG*
  US NRC review incorporated in the section
- ***Still pending:***
  - ASN, CNSC, IAEA to review the section, deadline: 15 March 2024
  - Other volunteers to review and provide updates by 31 March 2024 - ???

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Section 3. Non-technical challenges for safe LTO of NPPs

3.1. Economic reasons
3.2. Political decisions
3.3. Environmental reasons
3.4. Supply chain issues
3.5. Human resources, knowledge and competence management

- ***Status:*** *draft developed by NRG*
- ***Still pending:***
  - NRG to update section after completion of sections 6 and 7 in January 2025 (if necessary)

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- ***Status:*** *draft developed by NRG*
- ***Still pending:***
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3.5. Human resources, knowledge and competence management

- ***Status:*** *draft developed by NRG*
- ***Still pending:***
  - NRG to update section after completion of sections 6 and 7 in January 2025 (if necessary)

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Section 3. Non-technical challenges for safe LTO of NPPs

3.1. Economic reasons
3.2. Political decisions
3.3. Environmental reasons
3.4. Supply chain issues
3.5. Human resources, knowledge and competence management

- ***Status:*** *draft developed by WNA, to be sent for review*
- ***Still pending:***
  - WNA to review the section, deadline: 15 March 2024
- *- Other volunteers to review and provide updates by 31 March 2024 - ???*

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Section 3. Non-technical challenges for safe LTO of NPPs

3.1. Economic reasons
3.2. Political decisions
3.3. Environmental reasons
3.4. Supply chain issues
3.5. Human resources, knowledge and competence management

- ***Status:*** *draft developed by IAEA, to be sent for review*
- ***Still pending:***
  - *NEA WGHOF, IAEA to review the section, deadline: 15 March 2024*
- *- Other volunteers to review and provide updates by 31 March 2024 - ???*

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4.1. General considerations

Technical approach of mapping the knowledge base:

- In 2010, in USA, an expert panel studied ageing effects could become risk significant for safe operation beyond 60 years, due to the increased time exposure to different stressors.
- The new assessment documents extended EPRI Materials Degradation Matrix (MDM) rev. 2, available at that moment, in four topical reports:
  - Volume 1 – Expanded Materials Degradation Assessment (EMDA): Executive Summary of EMDA Process and Results
  - Volume 2 – EMDA Core internals and piping systems
  - Volume 3 – EMDA Reactor pressure vessel steels (RPV)
  - Volume 4 – EMDA Concrete civil structures
  - Volume 5 – EMDA Electrical power and instrumentation and control (I&C) cabling and insulation
- This extended technical basis for materials degradation was adopted by US NRC in a set of regulations for Subsequent License Renewal (60-80 years): **US-NRC regulation NUREG/CR-7153.**

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4.1. General considerations

- Later, a systematic assessment of the Ageing Related Degradation Mechanisms (ARDM) for critical locations (highly dependent upon specific material and environment combinations), resulted in a quantitative risk-ranking of issues, to prioritize further research needs**.**

- As of 2021 the Issue Management Tables, were revised to reflect operation to 80 years:
  - EPRI 3002018255 **PWR** IMT (MRP-205), Revision 4, 2020;
  - EPRI 3002018319 **BWR** IMT (BWRVIP-167), Revision 4, 2020;
  - EPRI 3002021033 **VVER** IMT (MRP-471), Revision 0, 2021

- The research areas identified as “Issues” were prioritized (high, medium, low):
  - Degradation Mechanism (DM);
  - Assessment (AS);
  - Mitigating Actions (MT);
  - Inspection and examination (IE);
  - Repair and replacement (RR).

- Our project intention is to enlarge this knowledge base with new results of EU JRC, OECD/NEA, SNETP sponsored projects, keep it a living document, avoiding effort duplication or overlaps in addressing the safety issues.

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‘LTO beyond 60’ report structure

Section 4 typical structure and sources of information:

4.x.1 **Component description** (IAEA TECDOC/NP-Ts, EU Topical Peer Review Country National Assessment Reports, direct inputs)

4.x.2 **Physical ageing** (US-NRC EMDA, EPRI IMT, OECD/NEA, EU Cordis reports, IAEA conferences, Science Direct papers, direct inputs, feedback to the questionnaire)

4.x.3 **Inspection and diagnostic methods** (EPRI guides, utilities feedback to the questionnaire)

4.x.4 **Repair, refurbishment and replacement solutions** (US-NRC EMDA, EPRI guides, EU Topical Peer Review Country National Assessment Reports, feedback to the questionnaire)

4.x.5 **Identified gaps for LTO beyond 60** (EPRI IMTs /MRP Reports for specific R&D gaps, US NRC /NEI/ PWROG guidance, NRG reports, feedback to the questionnaire)

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Section 4. Technical challenges important for LTO beyond 60

4.1. General considerations
4.2. Reactor pressure vessel
4.3. RPV internals
4.4. Steam generators
4.5. Class 1 piping
4.6. Buried piping
4.7. Concrete civil structures
4.8. Electrical cable systems
4.9. I&C safety systems and transition to digital

- ***Status:*** *draft developed by NRG and EPRI*
- ***Still pending:***
  - *No update needed*

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Section 4. Technical challenges important for LTO beyond 60

4.1. General considerations
4.2. Reactor pressure vessel
- 4.2.1 Description of RPV
- 4.2.2 Physical ageing
- 4.2.3 Inspection and diagnostic methods
- 4.2.4 Repair, refurbishment, replacement solutions
- 4.2.5 Identified gaps for LTO beyond 60

4.3. RPV internals
4.4. Steam generators
4.5. Class 1 piping

- ***Status:*** *draft developed by NRG*
  contributors - EDF, EPRI, NRG, PSI, UJV, US NRC, Vattenfall
- ***Still pending:***
  - *NRG to incorporate EDF recent inputs: 1 March 2024*
  - *EDF, EPRI, UJV, US NRC to review the section, deadline: 31 March 2024*
  - *Other volunteers to review and provide updates by 15 April 2024 - ???*

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Section 4. Technical challenges important for LTO beyond 60

4.1. General considerations
4.2. Reactor pressure vessel
4.3. RPV internals
4.4. Steam generators
4.5. Class 1 piping

- ***Status:*** *draft developed by NRG contributors - EDF, EPRI, NRG, PSI, Studsvik, TVO, UJV, US NRC, Vattenfall*
- ***Still pending:***
  - NRG to incorporate EDF recent inputs: 1 March 2024
  - EDF, EPRI, Studsvik, UJV, US NRC, Vattenfall to review by: 31 March 2024
  - Other volunteers to review and provide updates by 15 April 2024 - ???

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Section 4. Technical challenges important for LTO beyond 60

4.1. General considerations
4.2. Reactor pressure vessel
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4.4. Steam generators
4.5. Class 1 piping

- ***Status:*** *draft developed by NRG contributors - EPRI, US NRC, Vattenfall*
- ***Still pending:***
  - *EPRI, US NRC, Vattenfall to review the section, deadline: 31 March 2024*
- - *Other volunteers to review and provide updates by 15 April 2024 - ???*

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Section 4. Technical challenges important for LTO beyond 60

4.1. General considerations
4.2. Reactor pressure vessel
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4.4. Steam generators
4.5. Class 1 piping

- ***Status:*** *draft developed by NRG*
  contributors - EDF, EPRI, NRG, PSI, Studsvik, US NRC, Vattenfall
- ***Still pending:***
  - NRG to incorporate EDF recent inputs: 1 March 2024
  - EDF, EPRI, Studsvik, US NRC to review the section by: 31 March 2024
- *- Other volunteers to review and provide updates by 15 April 2024 - ???*

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Section 4. Technical challenges important for LTO beyond 60

4.6. Buried piping
4.7. Concrete civil structures
4.8. Electrical cable systems
4.9. I&C safety systems and transition to digital

- ***Status:*** *draft developed by NRG contributors - EPRI, US NRC, Vattenfall*
- ***Still pending:***
  - *EPRI, US NRC, Vattenfall to review the section, deadline: 31 March 2024*
- *- Other volunteers to review and provide updates by 15 April 2024 - ???*

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Section 4. Technical challenges important for LTO beyond 60

4.6. Buried piping
4.7. Concrete civil structures
4.8. Electrical cable systems
4.9. I&C safety systems and transition to digital

- ***Status:*** *draft developed by NRG contributors - Atkins-Realis, EDF, EPRI, TVO, US NRC, Vattenfall, VTT*
- ***Still pending:***
  - *Atkins-Realis, EPRI, US NRC to provide enhanced inputs 1 March 2024*
  - *NRG to incorporate Atkins-Realis, EDF, EPRI inputs: 5 March 2024*
  - *Atkins-Realis, EDF, EPRI, US NRC, VTT to review the section by: 31 March 2024*
- *- Other volunteers to review and provide updates by 15 April 2024 - ???*

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Section 4. Technical challenges important for LTO beyond 60

4.6. Buried piping
4.7. Concrete civil structures
4.8. Electrical cable systems
4.9. I&C safety systems and transition to digital

- ***Status:*** *draft developed by UJV contributors - EDF, EPRI, US NRC, Vattenfall*
- ***Still pending:***
  - *EDF, EPRI, UJV, US NRC, Vattenfall to review by: 31 March 2024*
- *- Other volunteers to review and provide updates by 15 April 2024 - ???*

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Section 4. Technical challenges important for LTO beyond 60

4.6. Buried piping
4.7. Concrete civil structures
4.8. Electrical cable systems
4.9. I&C safety systems and transition to digital

- ***Status:*** *draft developed by UJV contributors - EPRI, Vattenfall*
- ***Still pending:***
  - EPRI, UJV, Vattenfall to review the section, deadline: 31 March 2024
- *- Other volunteers to review and provide updates by 15 April 2024 - ???*

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Section 5 - Safety requirements important for LTO beyond 60

5.1 Availability of original design basis documentation
5.2 Development of codes, standards and regulations
5.3 Technological obsolescence

- ***Status:*** *draft developed by NRG contributors - EPRI, ONR, Vattenfall*
- ***Still pending:***
  - *EPRI, ONR, Vattenfall to review the section, deadline: 31 March 2024*
- *- Other volunteers to review and provide updates by 15 April 2024 - ???*

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Draft report status

Section 5 - Safety requirements important for LTO beyond 60

5.1 Availability of original design basis documentation
5.2 Development of codes, standards and regulations
5.3 Technological obsolescence

- ***Status:*** *draft developed by NRG*
  contributors - EDF, IAEA, JSME, ONR, US NRC, Vattenfall
- ***Still pending:***
- *- EDF/ IAEA/ JSME/ US NRC to review the section by: 31 March 2024*
- *- Other volunteers to review and provide updates by 15 April 2024 - ???*

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Draft report status

Section 5 - Safety requirements important for LTO beyond 60

5.1 Availability of original design basis documentation
5.2 Development of codes, standards and regulations
5.3 Technological obsolescence

- ***Status:*** *draft developed by NRG*
  contributors - EPRI, INUOG, US NRC, Vattenfall
- ***Still pending:***
  - EPRI, INUOG, USNRC, Vattenfall to review the section by: 31 March 2024
- *- Other volunteers to review and provide updates by 15 April 2024 - ???*

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Draft report status

Section 6 “Conclusions”

6.1. Areas properly addressed
6.2. Identified areas for enhancement

Section 7 “Proposed dispositioning of areas for enhancement” shall determine the knowledge areas properly addressed and areas for enhancement, requiring the following types of actions:

- Further R&D needed
- Development/ revision of codes, standards, regulations, procedures, methodologies
- New/ enhanced testing, monitoring, inspection, diagnostics or repair methods
- Other soft solutions (more training on ageing management and LTO, improvement of operating/ maintenance/ chemistry/ administrative procedures)

To be developed in 2024, based on sections 2, 3, 4 and 5 outcome.

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General rules for work

General rules for work remains applicable also for review phase:

- The text in italic on grey background is used only as guide for development (will disappear in the final document)
- The paragraphs in yellow means information that need validation
- Add text only using track changes
- You can ask or include comments (but the idea is to solve uncertainties, not to raise others)
- Be concise and send to specific references for details
- Attach the list of acronyms and references used, at the end of the section

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Next proposed actions

- NRG to send final draft sections for TT members review: 1 March 2024
  (and present a summary of the report status to WGIAGE annual meeting 2024)

- TT members to review sections 2-5 (March-April 2024)
- NRG to compile final reviewed sections 2-5 (**April-May 2024**)

- TT members to develop the draft conclusions in section 6 (June-July 2024)
- TT members to review the draft conclusions (July–Aug 2024)
- NRG to develop the final conclusions (**September 2024)**

- TT members to develop dispositioning of gaps in section 7 (September 2024)
- NRG to compile dispositioning of gaps (October 2024)
- TT members to review the draft of section 7 (November 2024)
- NRG to finalize section 7 (**December 2024)**

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Thank you for your attention!

Any questions?

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