
LTO Tihange 1 NPP



LTO Tihange 1 NPP

Forty is the New Twenty



Flash Back

November 26, 2009

“Life Starts at Forty”

- ❖ Start Of Electrabel LTO Study Project
- ❖ Overview of:
 - Global worldwide situation
 - Specific country approaches
 - Feasibility
 - FANC Strategic Document

Questions



Life starts at 40!

BNS Fleming Lecture
BNS
Belgian Nuclear Society

<http://www.bnsorg.eu>

A long time from now in a galaxy far,
far away ...

LONG TERM OPERATION

Contents

1. Reminder – LTO - Some essentials
2. LTO Analysis Project - Methodology and Results
3. LTO Program Tihange 1
4. Lessons Learned
5. Conclusions
6. Questions and Answers

01

Reminder LTO - Some essentials



What is LTO?



IAEA Definition

- ❖ Operation beyond an established time frame,
- ❖ which has been justified by safety assessment
- ❖ with consideration given to life limiting processes and features of systems, structures and components (SSC).

Timeframe set forth by licence term, design, standards, regulation and/or law etc.

What is LTO?



Life Limiting processes and features

- ❖ General process in which the **characteristics** of an SSC gradually change **with time or use**.
- ❖ Nuclear power plants experience **two kinds of time dependent changes**:
 - Physical ageing of SSCs, which results in degradation, i.e. gradual deterioration in their physical characteristics;
 - Obsolescence of SSCs, i.e. their becoming out of date in comparison with current knowledge, standards and technology.

FANC Framework

Position issued by the FANC in October 2009

- ❖ LTO to be evaluated in Safety Evaluation Framework
- ❖ In line with industry practice
- ❖ Besides an evaluation of the preconditions + CK&B for LTO, 2 Areas: Ageing (active and passive SSC) and Design
- ❖ Ageing to be evaluated in accordance with 10CFR54 and IAEA SRS57



02

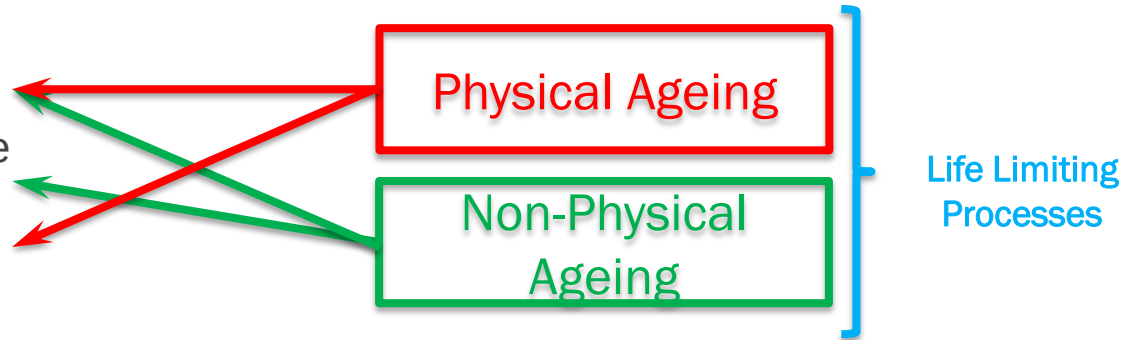
LTO Analysis Project Methodology and Results



Methodology – Global approach

4 domains:

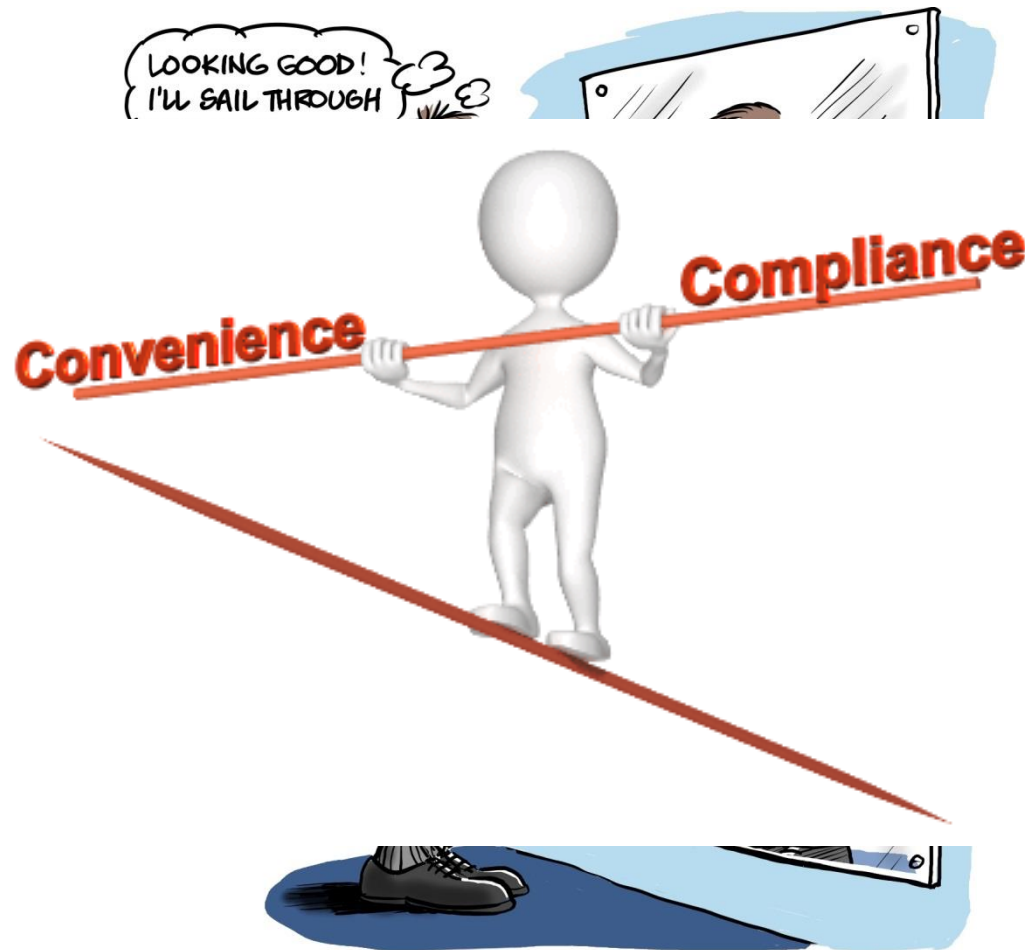
- Pre-Conditions
- Competence and Knowledge Management and Behaviour
- Ageing
- Design



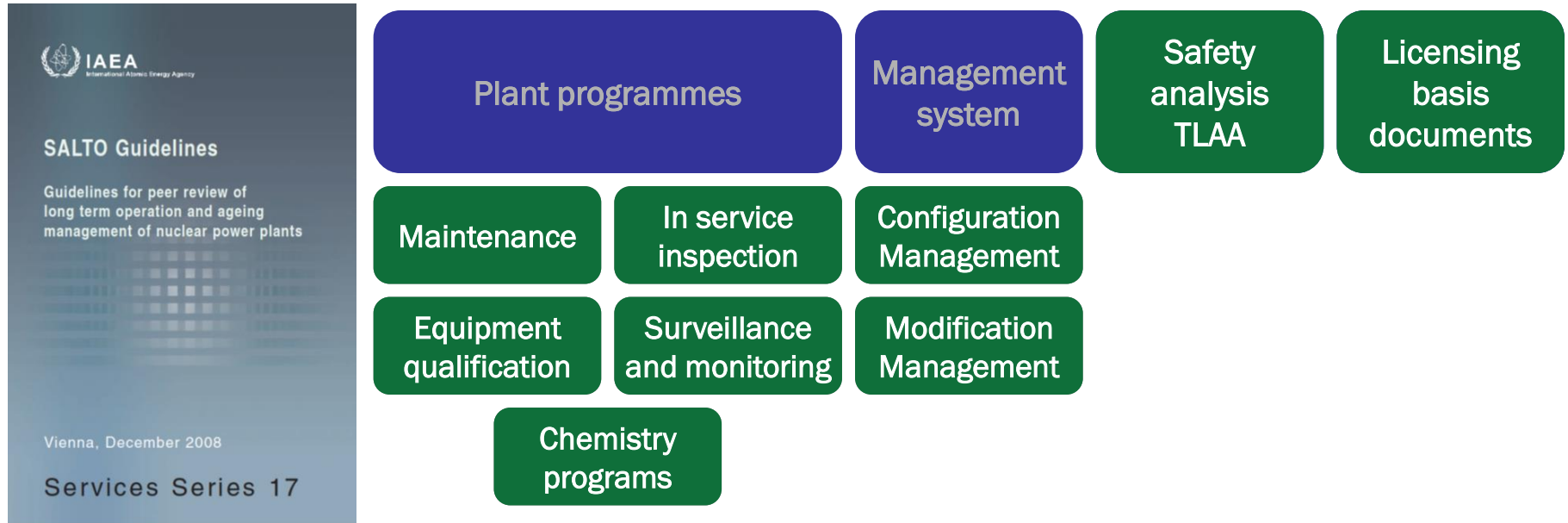
Process



Pre-Conditions – Competence Knowledge and Behaviour Methodology



Pre-Conditions – Competence Knowledge and Behaviour Methodology



Competence,
Knowledge and
Behaviour

LTO-Ageing Methodology

- ❖ **Effective ageing management** is accomplished by **coordinating existing** programs, including maintenance, in-service inspection and surveillance as well as operations, technical support and external programs such as research and development in order to **ensure** that the effects of ageing are adequately **monitored and understood**, and that **repair or replacement** of components takes place **before** the acceptance criteria for safe operation are **exceeded** .

Reference: IAEA NS-G-2.12, Basic concepts 2.5 and 2.6

❖ Methodology – Basic steps

- Identify the systems, structures and components which need to be evaluated for ageing
- Demonstrate that the effects of ageing on the functionality of these SSC are well managed
- Establish plans of on-time-inspections, enhanced plant programs and/or replacements of degraded components and components, losing qualification

LTO-Ageing Methodology – Scoping



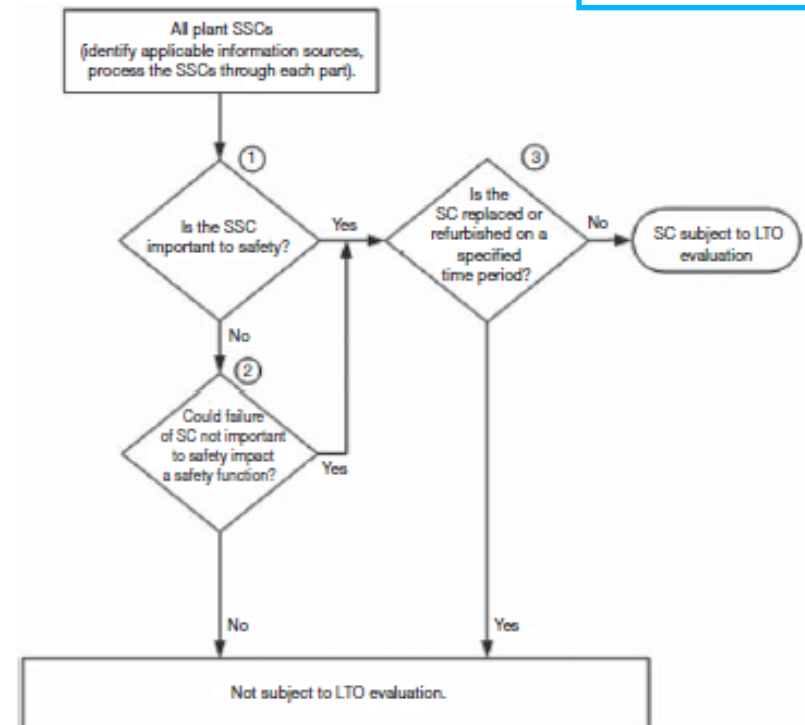
❖ Define scope according to 3 scoping criteria:

- Safety related
- Not safety related but degradation can have impact on safety functions
- Specific function related

❖ 3 Domains

- Mechanical / piping systems
- Electrical Instrumentation and Control
- (Mechanical) Structures and Civil Work

❖ Cross check and Boundary control

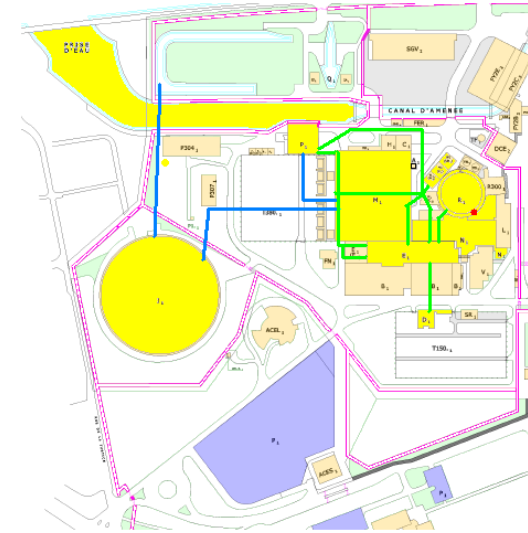
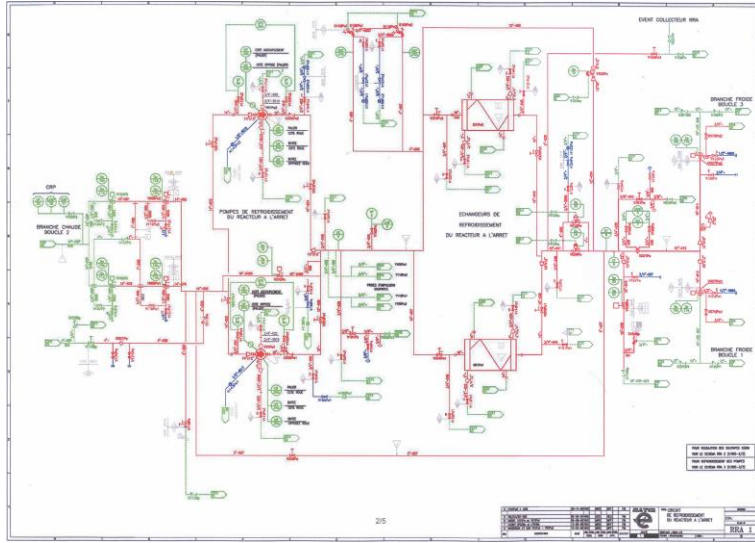


(1) SSCs important to safety that perform the safety functions specified in Section 4.1.

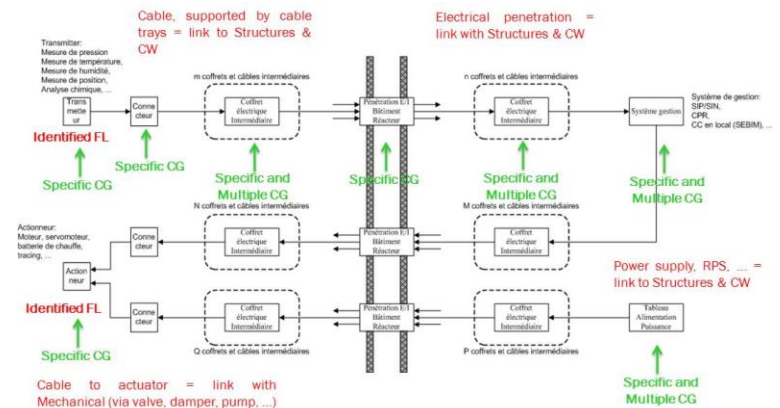
(2) SCs whose failure may impact safety functions specified in Section 4.1.

(3) SCs on a replacement or refurbishment schedule that are replaced based on a qualified life or specified time period; these are not subject to LTO evaluation.

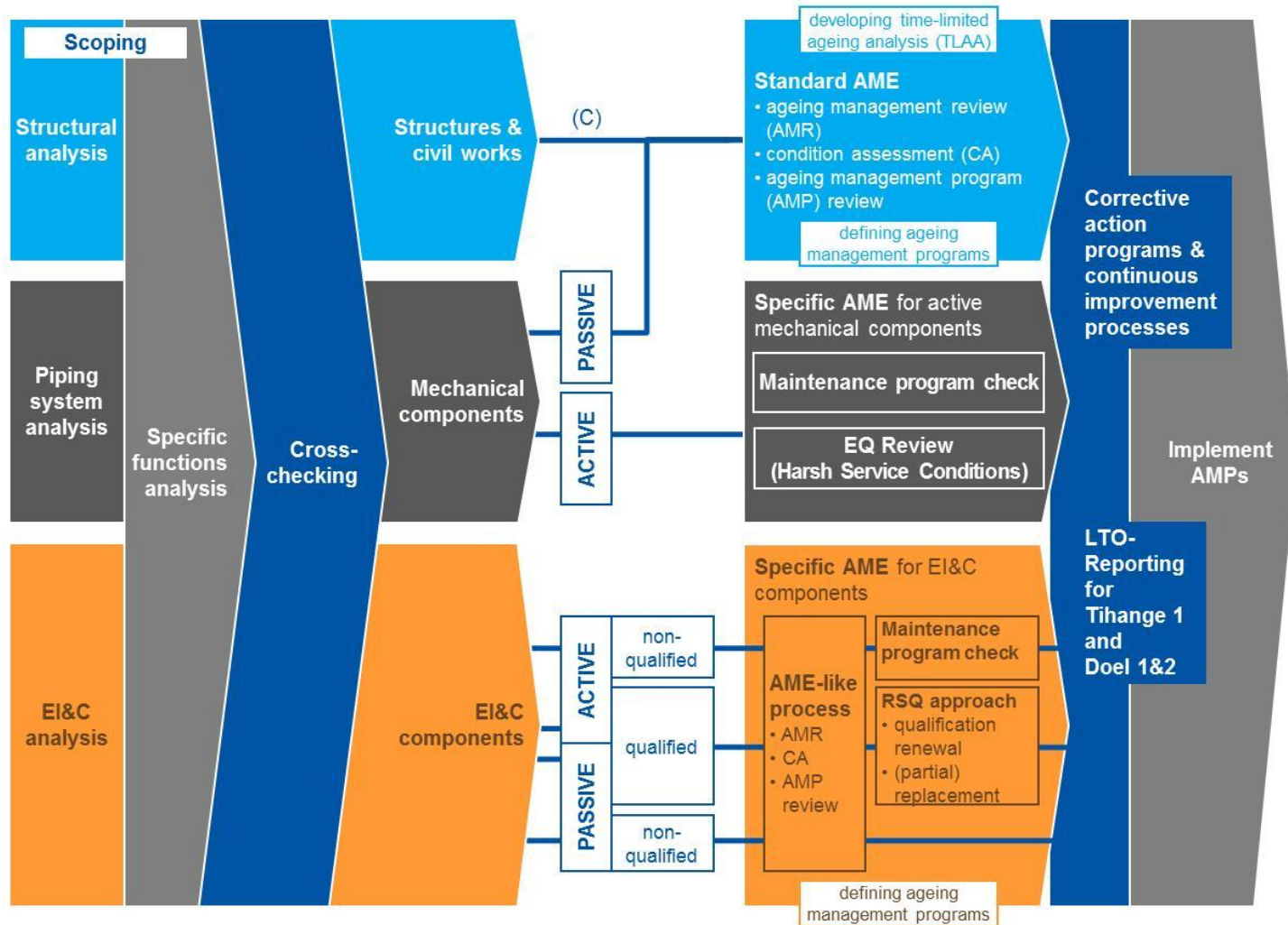
LTO-Ageing Methodology – Scoping



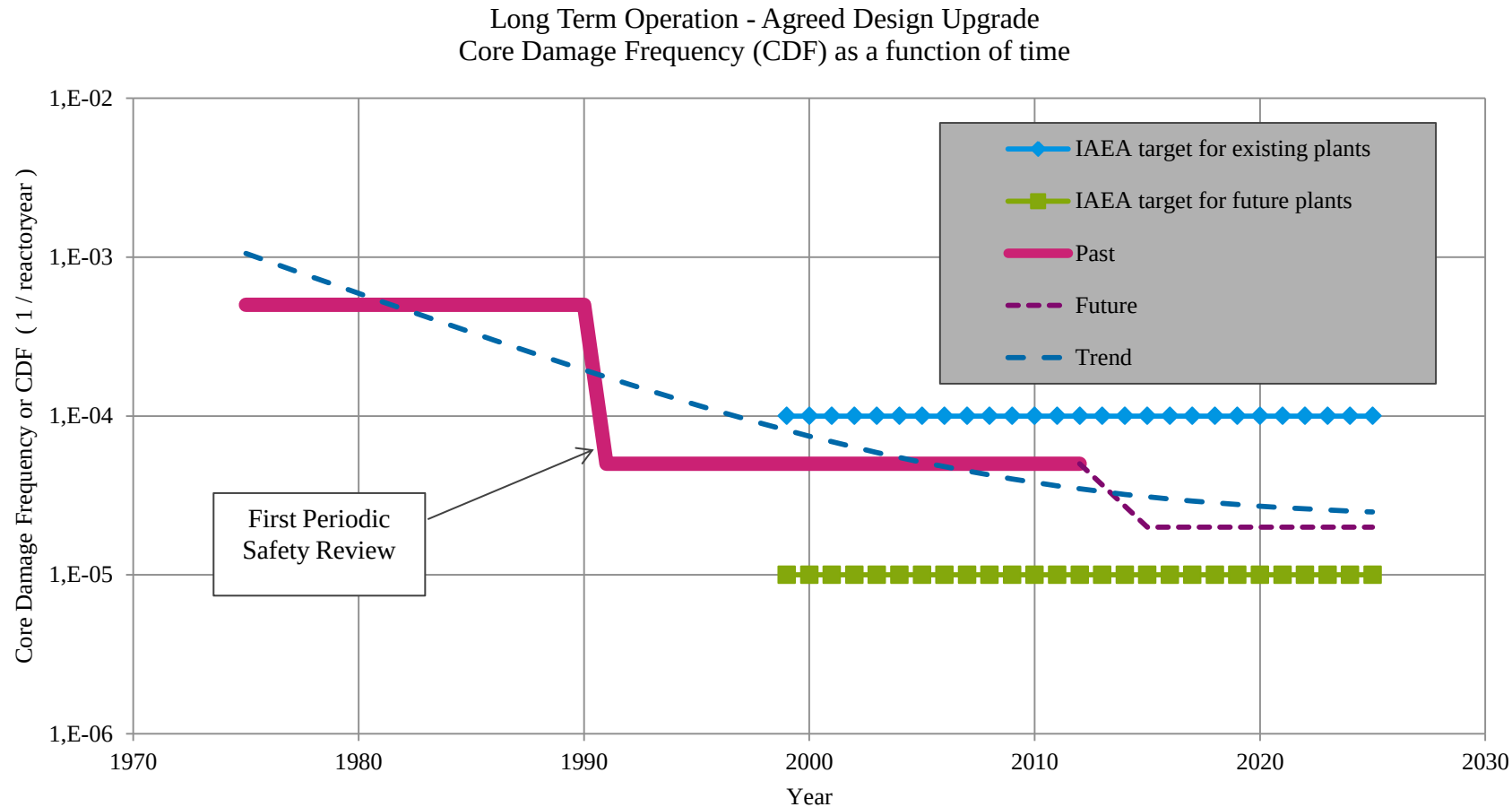
CG 73	Alarm Unit	CG 91	Light Bulbs
CG 74	Analyzers	CG 92	Loop Controllers
CG 75	Annunciators	CG 93	Meters
CG 76	Batteries	CG 94	Power Supplies
CG77	Cables and Connections	CG 95	Radiation Monitors
CG 78	Chargers, Converters, Inverters	CG 96	Recorders
CG 79	Circuit breakers	CG 97	Regulators
CG 80	Communication Equipment	CG 98	Relays
CG 81	Electrical heaters	CG 99	Signal Conditioners
CG 82	Heat tracing	CG 100	Solenoid Operators
CG 83	Electrical Controls and Panel Internal Component Assemblies	CG 101	Solid-State Devices
CG 84	Elements, RTDs, Sensors, Thermocouples, Transducers	CG 102	Switches
CG 85	Fuses and fuseholders	CG 103	Switchgear, load centers, Motor control centers
CG 86	Generator, Motors	CG 104	Transformers
CG 87	High-voltage insulators	CG 105	Transmitters
CG 88	Surge Arresters	CG 128	Pressure reducer
CG 89	Indicators	CG 129	Instrumentation tubing
CG 90	Isolators	CG 131	Packages



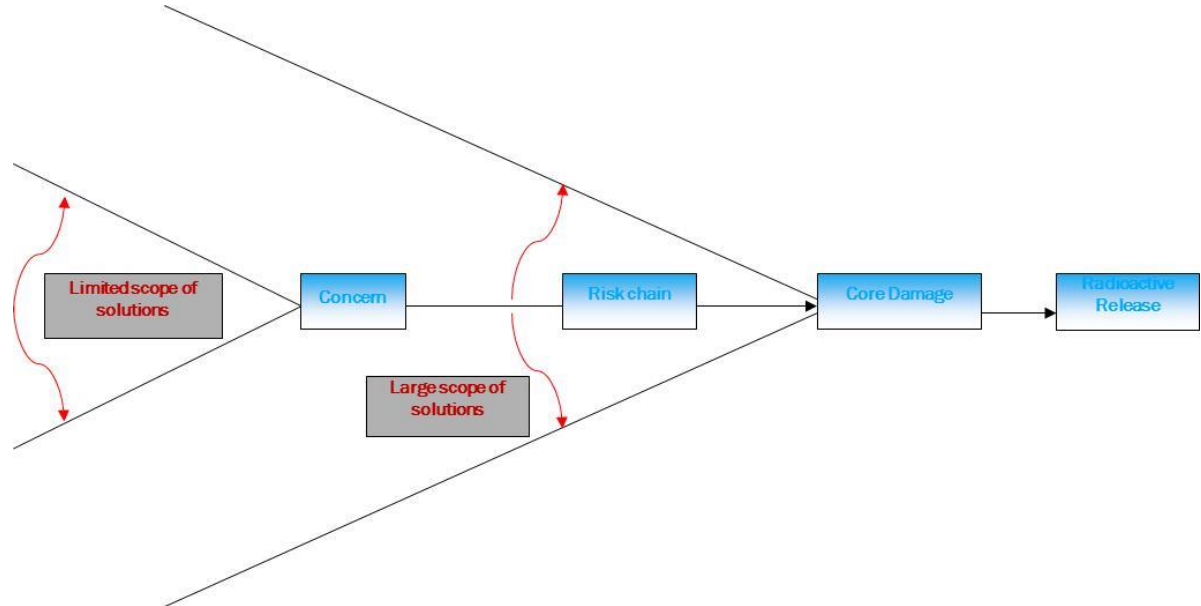
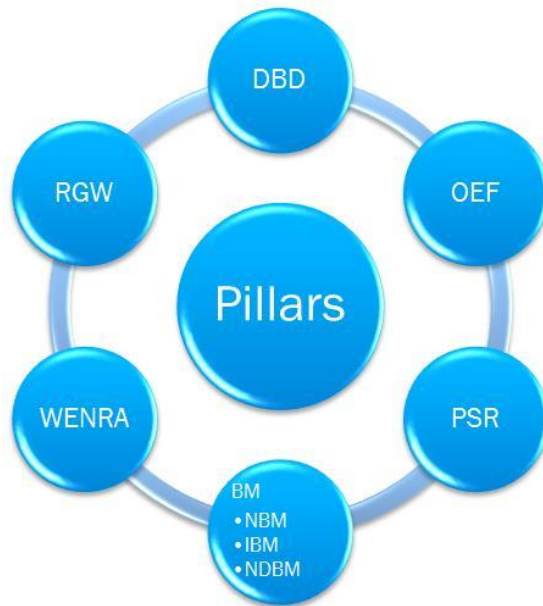
Ageing Methodology – Overview



Design Methodology



Design Methodology



Lexicon

OEF: Operating Experience Feed-back

BM: Benchmark (National International and New Design)

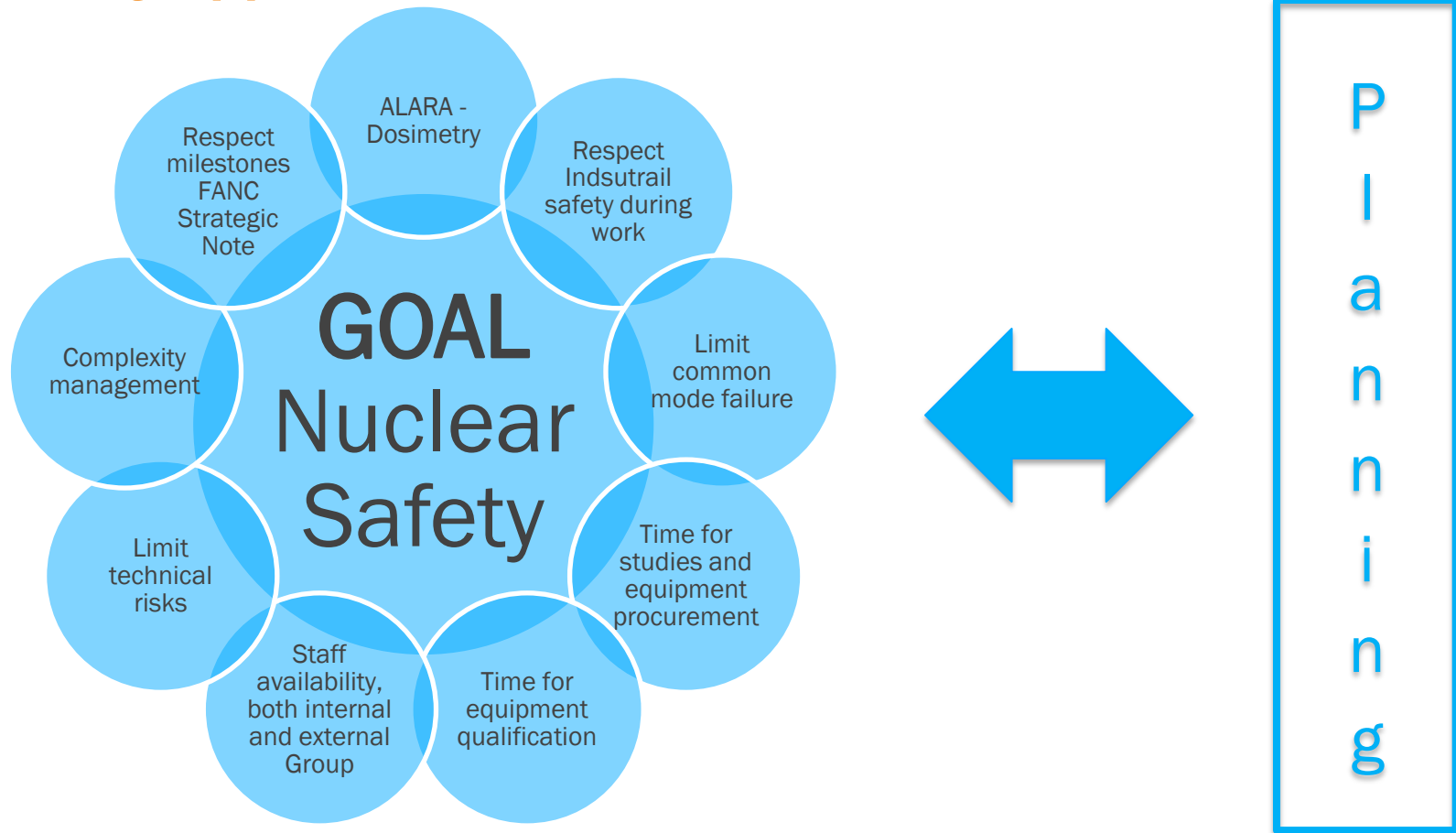
RGW: Regulatory Watch

PSR: Periodic Safety Review

WENRA: Western European Nuclear Regulatory Advisory

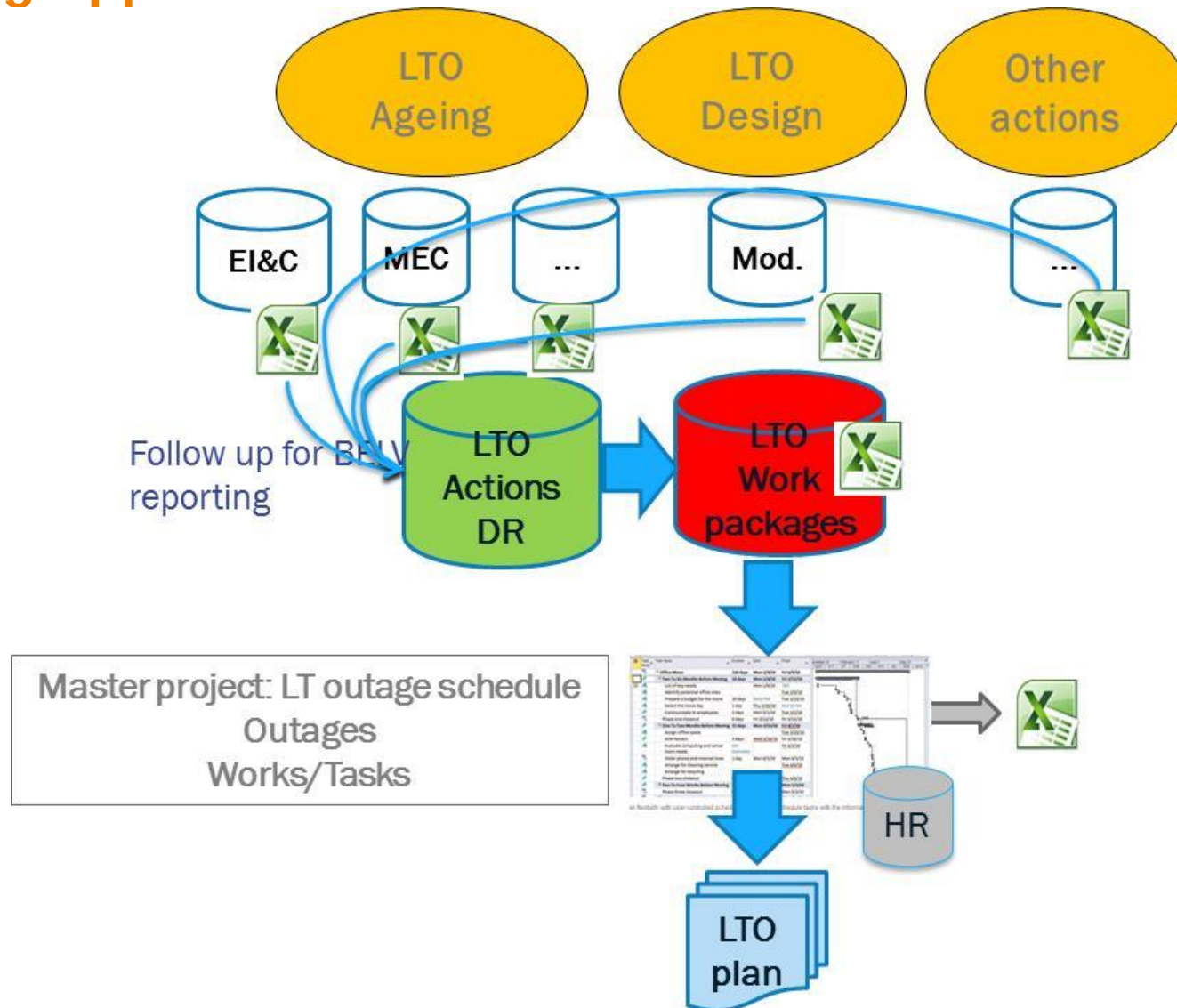
DBD: Design Basis Documents

Planning Approach



- ❖ Consider coherence regarding Strategic Note (= minimize scheduling LTO-Ageing measures after 2016)
- ❖ Minimize # derogations (vessel and internal inspections, ...)
- ❖ Limit risk associated with qualified material/supplier availability

Planning Approach



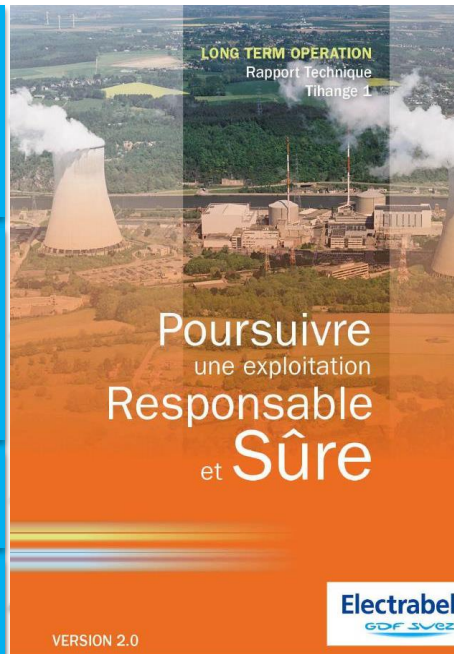
Analysis Project – Summary Report



Physical Ageing
Management

Standards
Regulations

Technology
Knowledge



Ageing

Design

Pre-Conditions

Knowledge

LTO Analysis Project: 3 year project – peak: up to 130 people

For each plant Tihange 1 NPP and Doel1/2 NPP establishment of:

❖ Ageing

— Object of Ageing Management Evaluations

- About 40 fluid systems
- 26 structure types
- 36 EI&C component types

❖ Pre-Conditions & Competence Management

— 12 Self-Assessments

❖ Design

— About 30 Agreed Design Upgrades

❖ Total of 750 documents or about 12500 pages...

03

LTO Program Tihange 1



Significant milestones

- ❖ **25 June 2012:** Positive Advice Scientific Council – FANC – Bel-V
- ❖ **29 June 2012:** Handover Technical Reports KCD1-2 and Tihange 1 to FANC and Bel-V
- ❖ **3 July 2012:** Publication LTO-file CNT1 & KCD1-2 (Technical Report integrating ADU)
- ❖ **4 July 2012:** Political decision
 - LTO Tihange 1: lifetime extension to 2025
 - KCD1-2: to be decommissioned from 2015

GOVERNMENTAL
Start LTO Tihange 1 Program

Advies van de Wetenschappelijke Raad betreffende de aanbevelingen in het LTO-evaluatieverslag van het FANC en Bel V

Gelet op de strategische « Long Term Operation » for the Belgian Nuclear Power Plants : Doel 1&2 and Tihange 1" (n° 008-194) die op 11 september 2009 werd voorgelegd aan de Wetenschappelijke Raad van het FANC en Bel V;

Gelet op de presentatie door Electrabel op de zitting van de Wetenschappelijke Raad van 10 september 2010 betreffende de globale aanpak voor Long Term Operation van Doel 1&2 en Tihange 1;

Gelet op de presentatie door Tractebel en SCN-CEM op de zitting van de Wetenschappelijke Raad van 10 december 2010 betreffende de opvolging van de toestand van reactorkernen in het kader van Long Term Operation;

Gelet op de presentatie door Electrabel op de zitting van de Wetenschappelijke Raad van 9 september 2011 betreffende de stand van zaken van het project "Long Term Operation van Doel 1&2 en Tihange 1";

Gelet op de Electrabel synthesesrapporten "Rapport LTO - Long Term Operation - Centrale Nucleaire de Tihange 1" en "LTO Rapport - Long Term Operation - Centrale Nucleaire Doel 1&2" (revisie 1.0 - december 2011);

Gelet op de presentatie door Electrabel op de zitting van de Wetenschappelijke Raad van 10 februari 2012 over deze synthesesrapporten;

Gelet op het LTO - evaluatieverslag van FANC en Bel V (revisie 0 - maart 2012) dat op 13 april 2012 aan leden van de Raad is voorgelegd en nadien ter beschikking werd gesteld aan de Raad;

Overwegende dat het FANC en Bel V verder technisch overleg gevoerd hebben met Electrabel om te komen tot een voorstel van Agreed Design Upgrade;

Gelet op het LTO - evaluatieverslag van FANC en Bel V (revisie 2 - juni 2012) dat op 25 juni 2012 aan de Raad is voorgelegd en dat een voorstel van Agreed Design Upgrade bevat;

Overwegende dat het LTO-proces kadert in de periodieke veiligheidsbeoordelingen en zich hierdoor beperkt tot de nucleaire veiligheidsaspecten van de verdere uitbating van Doel 1&2 en Tihange 1;

Conclusie:

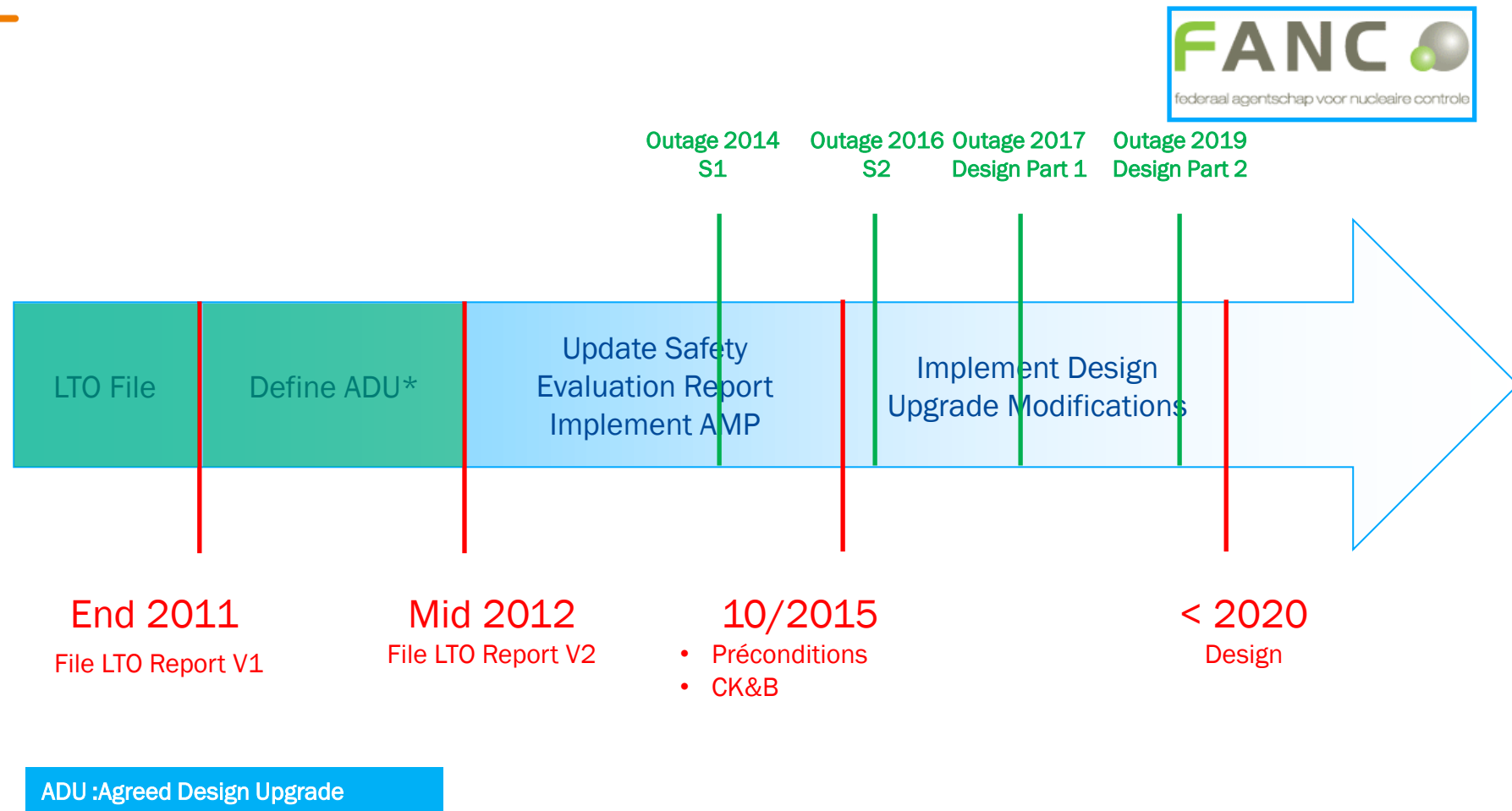
De Wetenschappelijke Raad brengt een gunstig advies uit over het LTO-proces en de grote veiligheidsprincipes zoals beschreven in de conclusies en aanbevelingen vermeld in §3 van het LTO-evaluatieverslag van FANC en Bel V (revisie 2 - juni 2012).

De Raad beveelt het FANC en Bel V aan om de tekst van dit rapport te consolideren in een volledig zelfstandig document.

Brussel, 25 juni 2012



Significant milestones





Program Organization

❖ Program Management

- 1 approach (planning, tools, ...) for all projects and team members (Electrabel, Tractebel and contractors)



❖ Specific structure on-site

- Apply site processes and procedures
- Priorisation on site level by Program Owner

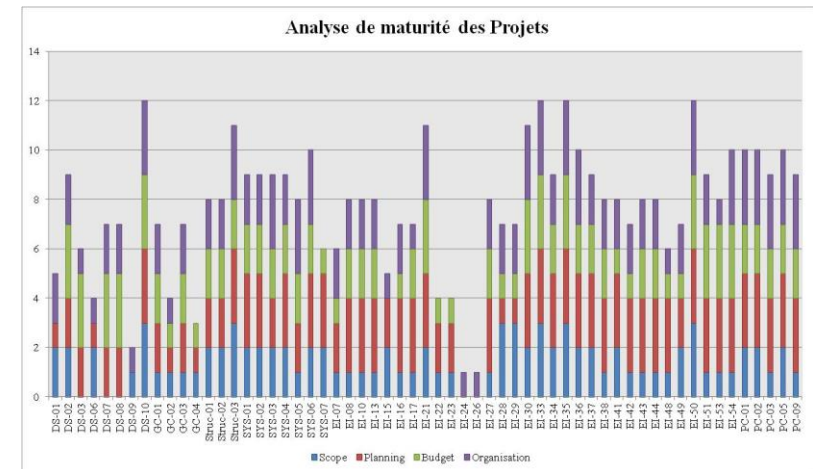
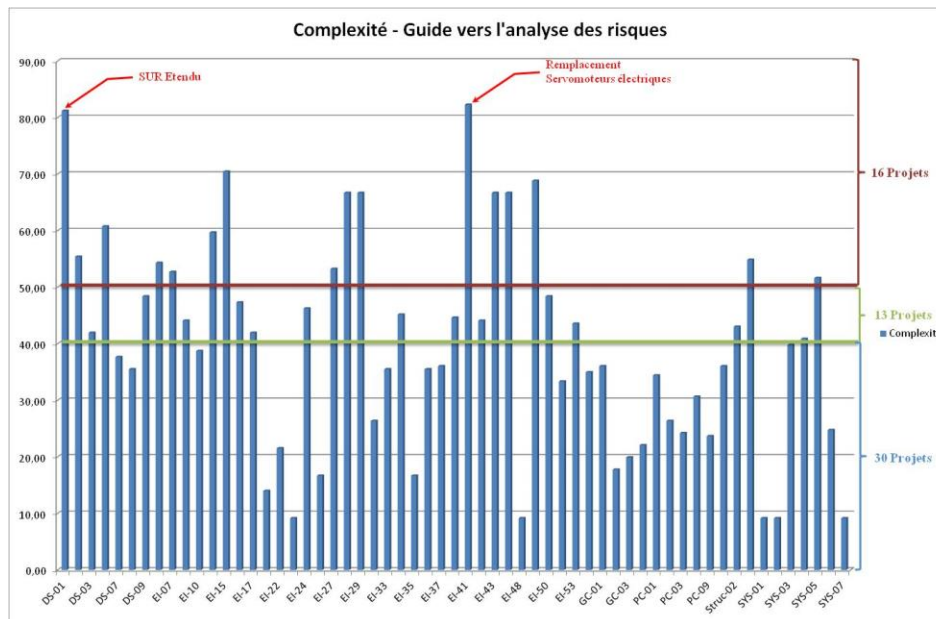
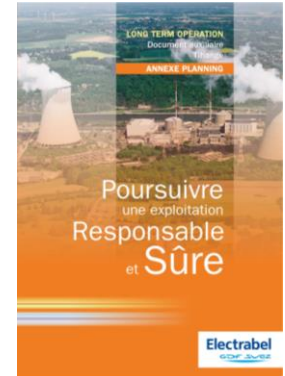
❖ Overview by Corporate Steering Committee

- Continuity with Corporate Programs
- Coherence and optimization on Corporate Level

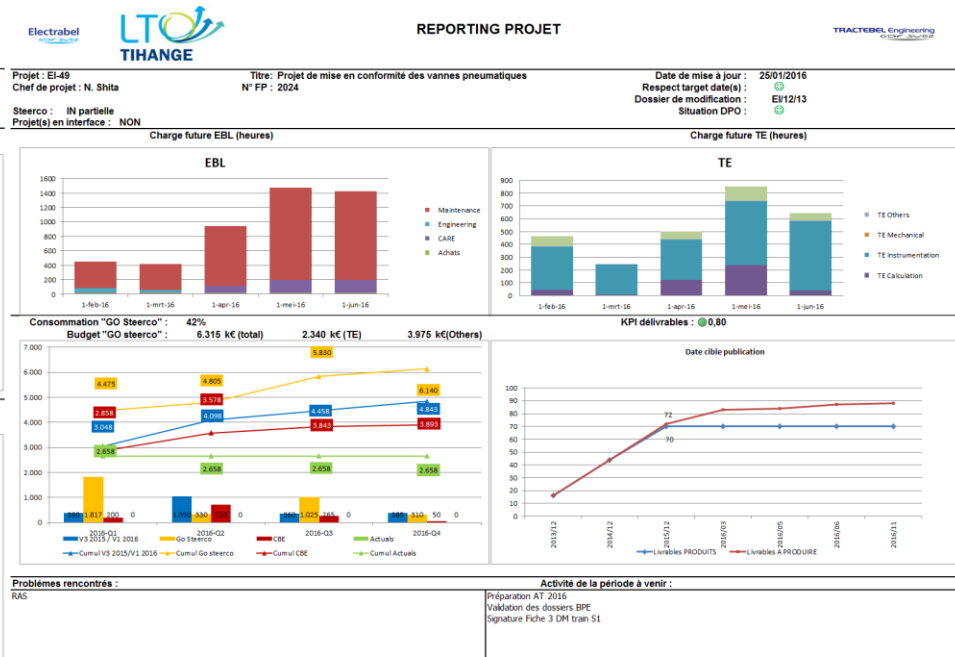
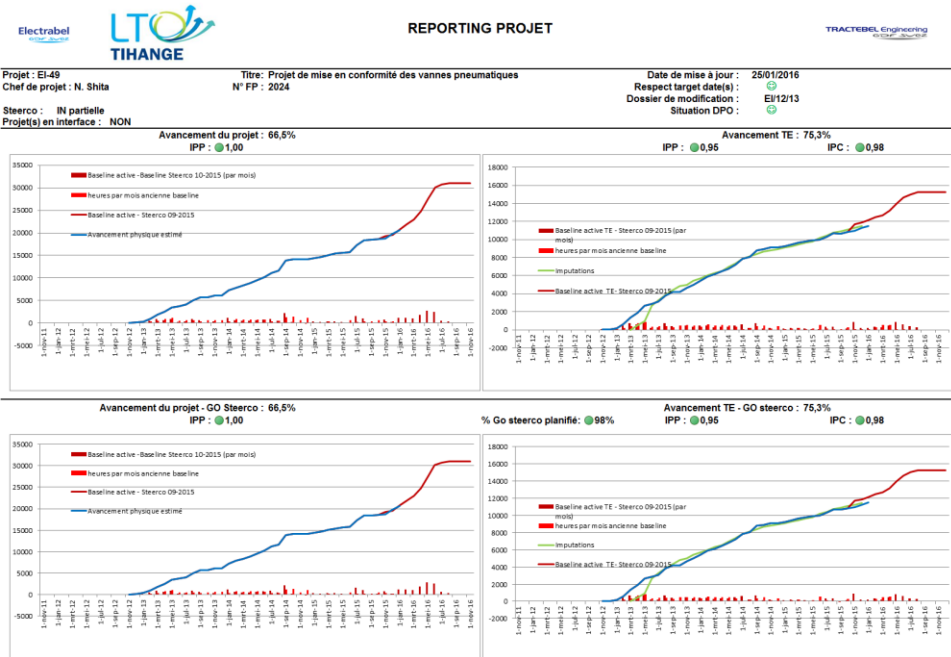


Commitment and Project Management

- ❖ July 2012: 837 commitments, grouped into 101 Projects
- ❖ For each Project:
 - Definition of activities, resources and deliverables
 - Activity planning
 - Key Performance Indicators – Physical Progress

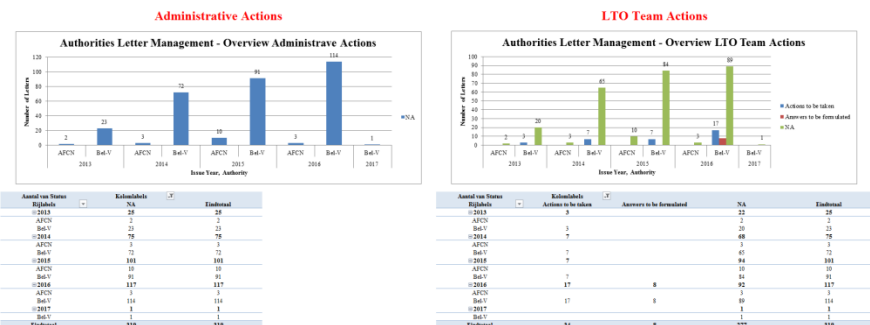


LTO Program Tihange 1



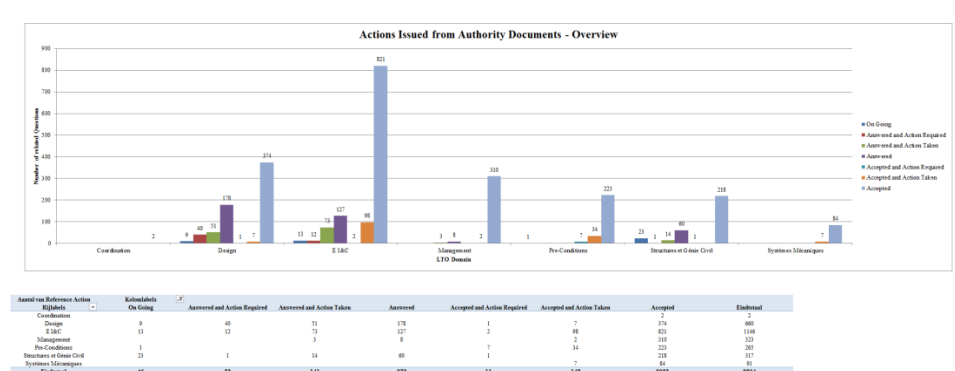
Authority Letters - Status Analysis

Action Status - Year 2017, Week 3



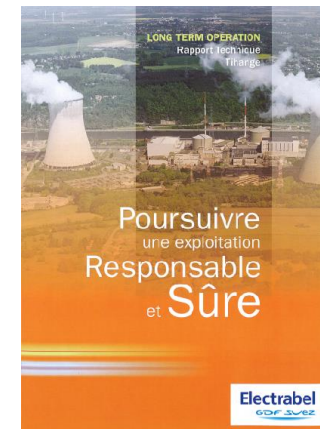
Authority Letters - Action Status Analysis

Action Status - Year 2017, Week 3

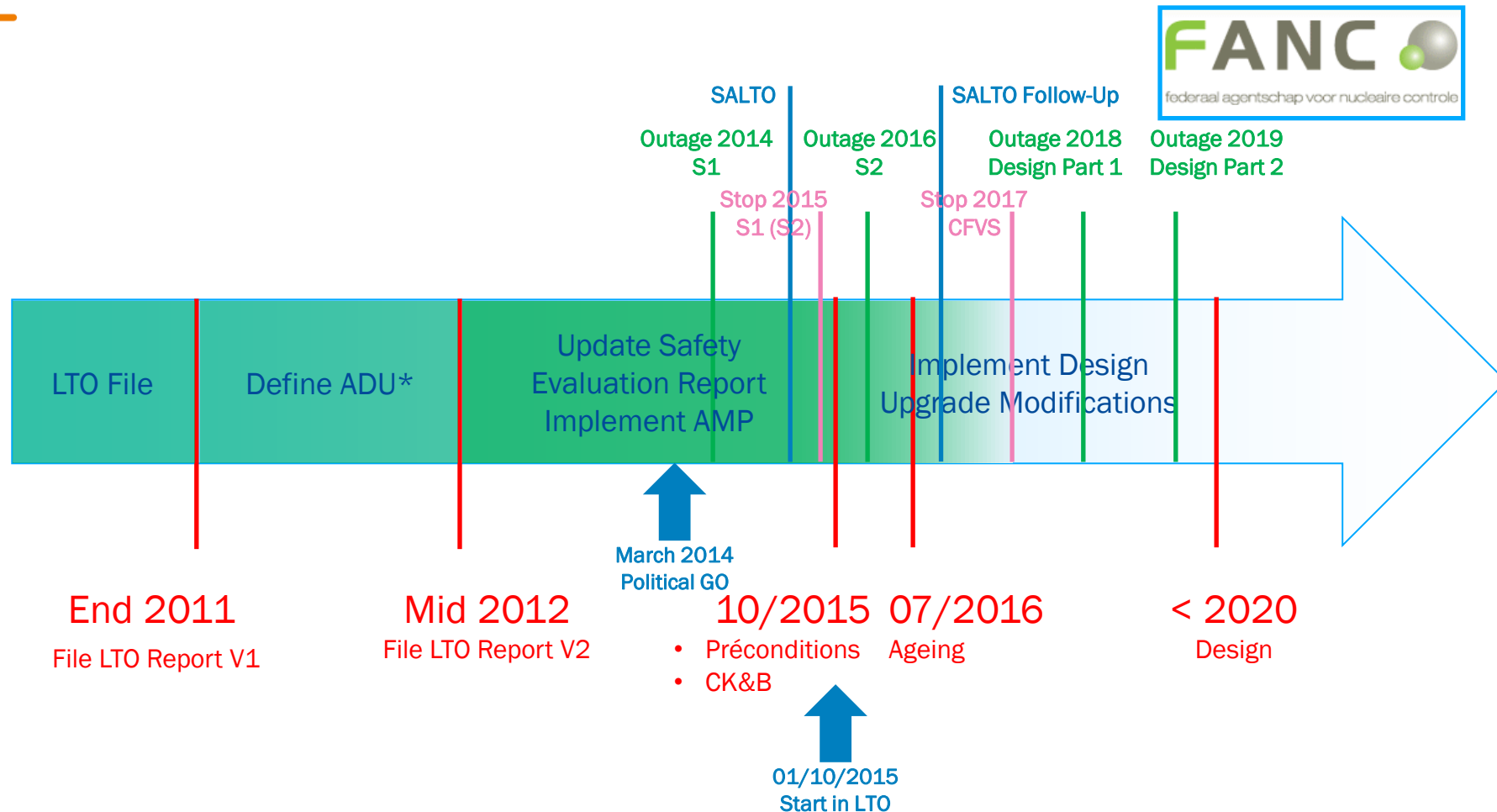


Actual status and Implemented Improvements

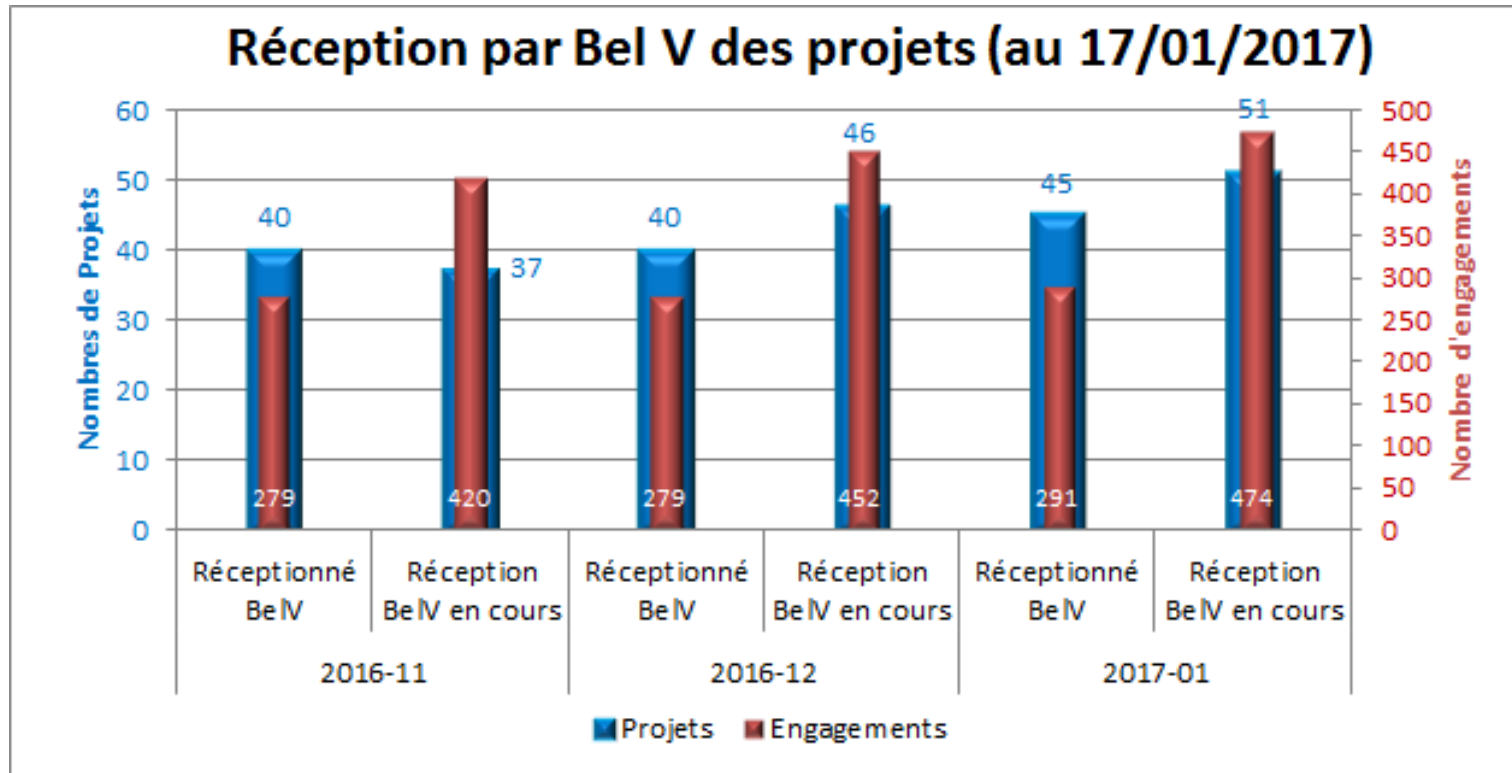
- ❖ **06-14 November 2012:** IAEA Pre-SALTO mission
- ❖ **12 March 2014:** Nuclear Phase Out Law Modified - Agreement Belgian Government – ENGIE Electrabel – EDF signed
- ❖ **15 May 2014:** Official end of Tihange 1 NPP Study Phase
- ❖ **21 August 2014:** Decision for additional stop 2015 - Risk Analysis of grid black-out
- ❖ **September 2014:** 1st “Ageing Outage” – Part 1
- ❖ **13-22 January 2015:** IAEA SALTO mission
- ❖ **June 2015:** 1st “Ageing Outage” – Part 2
- ❖ **June 2016:** 2nd “Ageing Outage”
- ❖ **06-09 December 2016:** IAEA SALTO FU mission



Actual status and Implemented Improvements

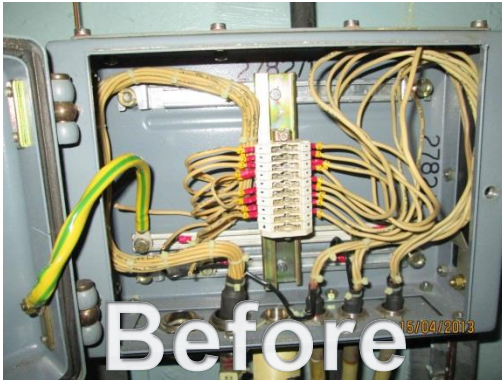


Actual status and Implemented Improvements

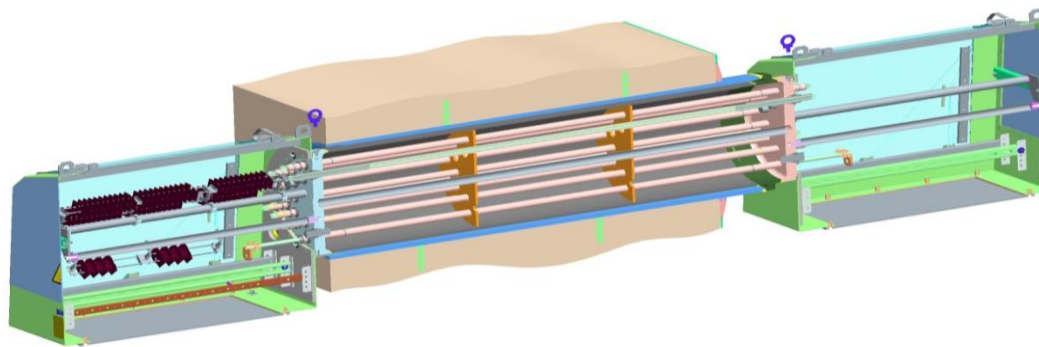
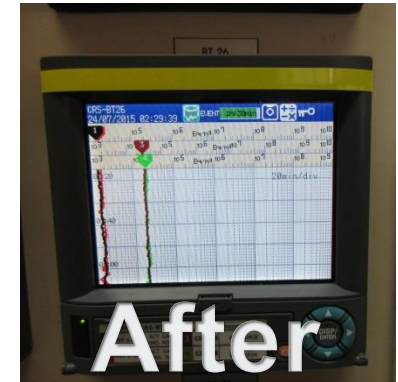
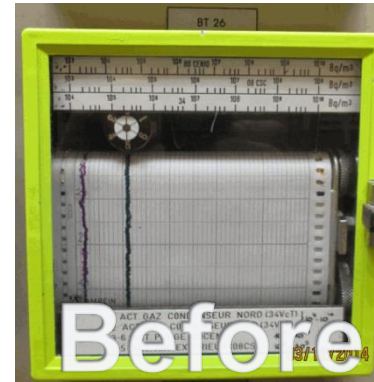
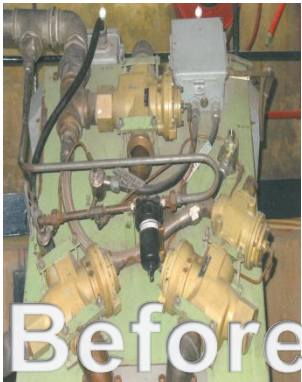


Commitments	Projects
765/871 final	96/119 final

LTO Program Tihange 1



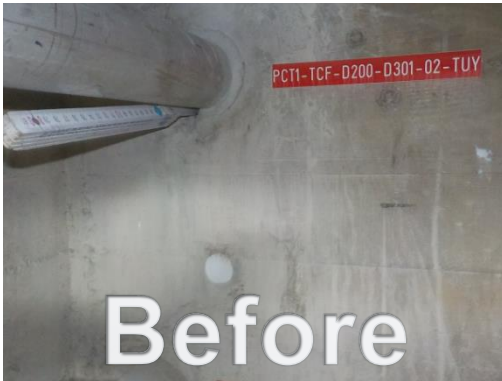
LTO Program Tihange 1



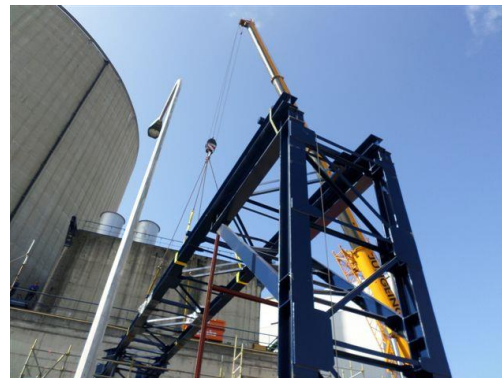
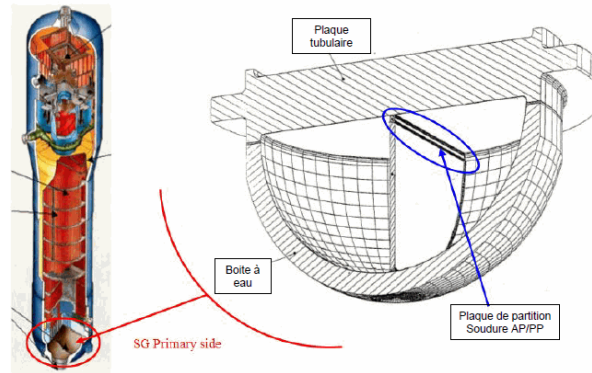
LTO Program Tihange 1

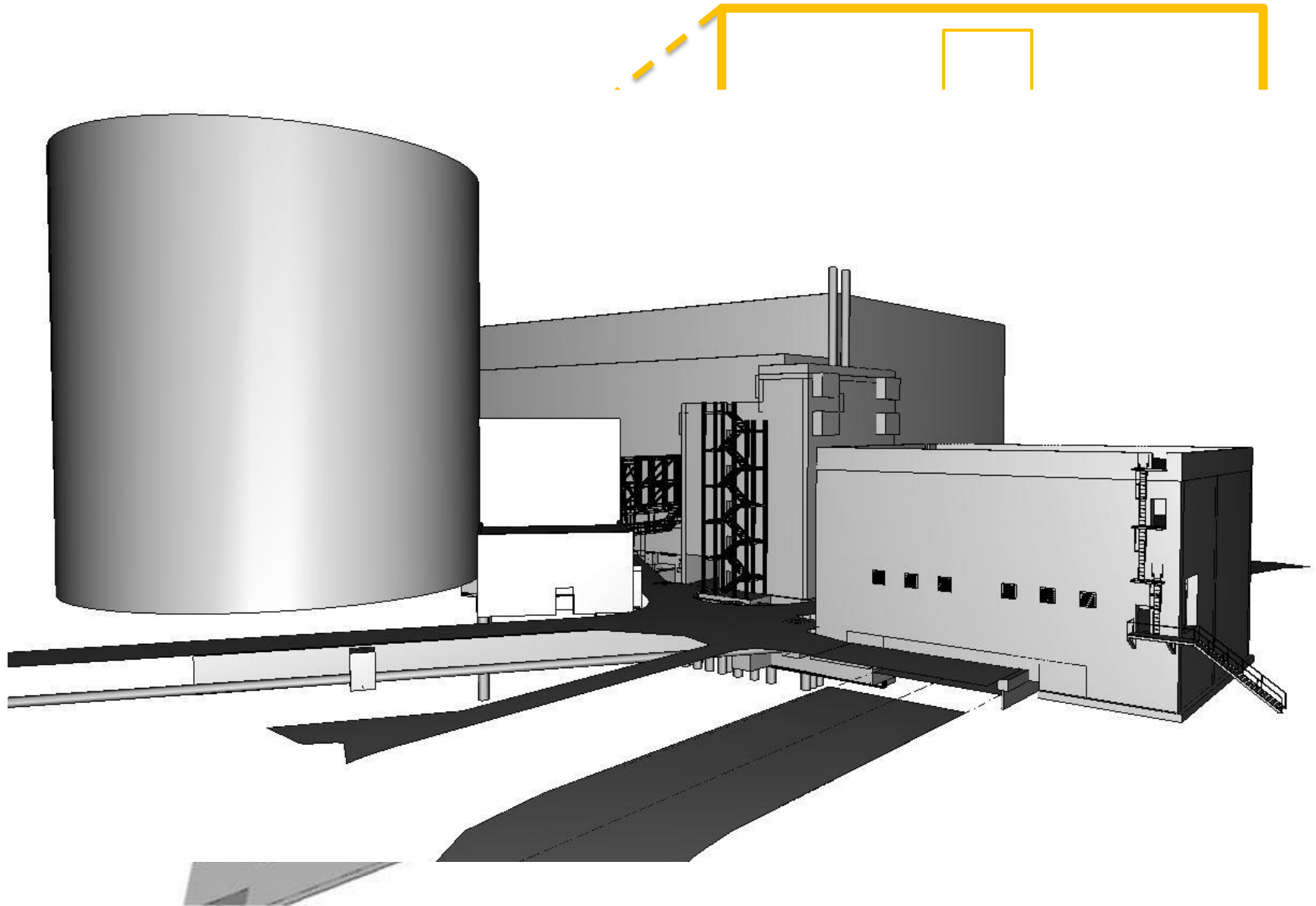


LTO Program Tihange 1



LTO Program Tihange 1





LTO Program Tihange 1

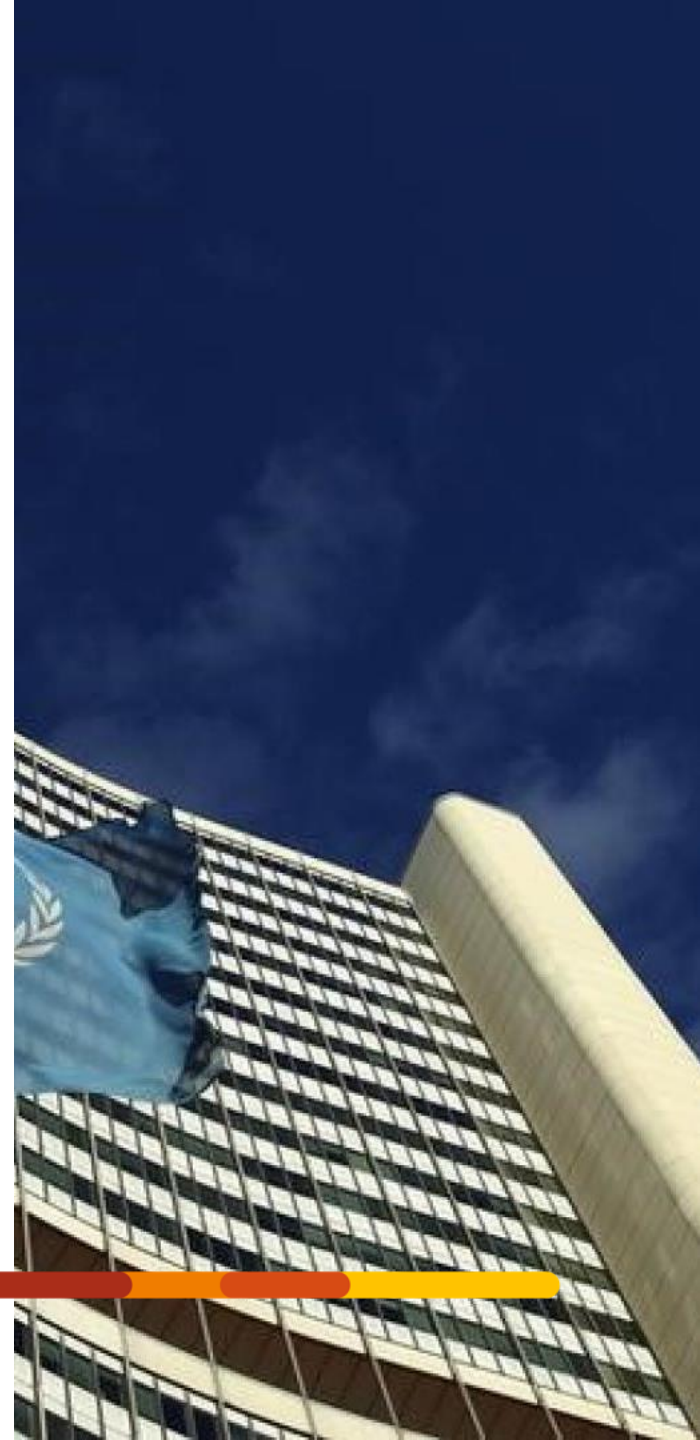


LTO Program Tihange 1



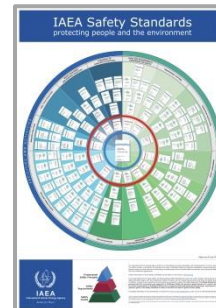
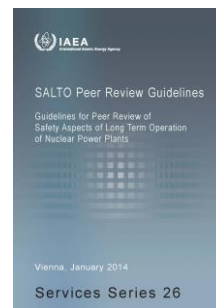
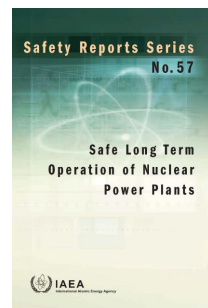
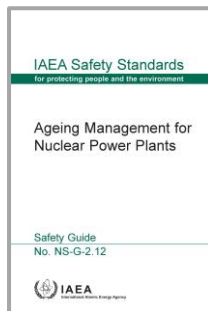
04

Lessons Learned



IAEA SALTO Peer Review

- ❖ Performed by IAEA Staff and International Specialists (1 + 6) + some (3-4) observers
- ❖ Analysis of Ageing Management Program – 1 ½ week
 - Physical and non-physical ageing, incl. preconditions and CK&B ⇒ 6 areas
 - Safety related, safety impacting and Specific Functions SSCs
 - Compliance with international LTO Standards



Article III.A.6 of the IAEA statute:

- “The Agency is authorized to establish or adopt ... standards of safety for protection of health and minimization of danger to life” in connection with peaceful utilization of nuclear energy.

SSR-2/2 Safety of NPP: Commissioning and Operation

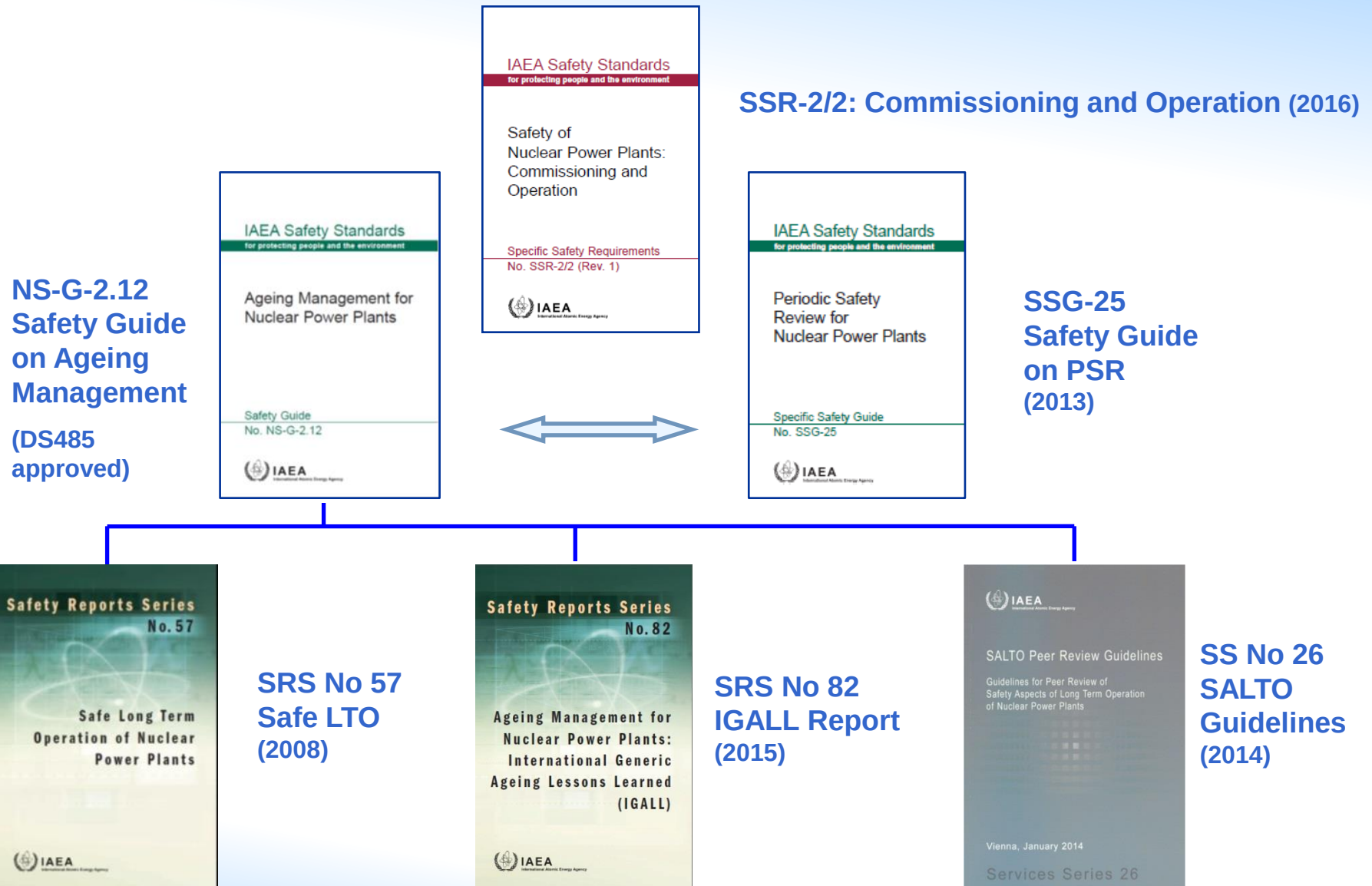
Requirement 14: Ageing management

- The operating organization shall ensure that an effective ageing management programme is implemented to ensure that required safety functions of systems, structures and components are fulfilled over the entire operating lifetime of the plant.

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.

Safety Standards on AM and LTO



Steps of SALTO Peer Review Service

Phase 0: Workshop/seminar on IAEA safety standards and SALTO methodology (optional)

Phase 1: NPP in preparation for LTO – programme, assessment, action items scheduling

Step 1: Preparatory Meeting 1

Step 2: **Pre-SALTO Mission**

(one or more Pre-SALTO missions 10-2 years before entering LTO)

Phase 2: NPP ready for LTO

Step 3: Preparatory Meeting 2

Step 4: **SALTO Mission**

(less than 2 years before entering LTO)

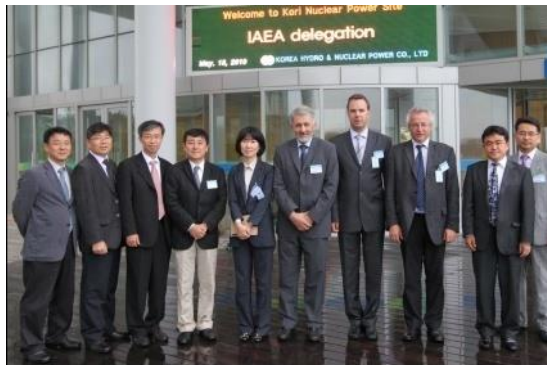
Step 5: **Follow-up SALTO Mission**

(performed after Pre-SALTO or SALTO mission)



Time schedule of SALTO

Step 1: Preparatory Meeting 1	2-3 days	6-9 months prior to the mission
Step 2: Pre-SALTO Mission	8 days	
Step 3: Preparatory Meeting 2	2-3 days	6-9 months prior to the mission
Step 4: SALTO Mission	9 days	
Step 5: Follow-up SALTO Mission	4 days	18-24 months after Pre-SALTO or SALTO mission



Long Term Operation
Tihange 1 NPP, Forty is

Standard SALTO Peer Review scope

- Area A - Organisation and functions, current licensing basis, configuration/modification management;
- Area B - Scoping and screening and plant programmes relevant to LTO;
- Area C - Ageing management review, review of AMPs and related TLAAs for mechanical components;
- Area D - Ageing management review, review of AMPs and related TLAAs for electrical and I&C components;
- Area E - Ageing management review, review of AMPs and related TLAAs for civil structures;
- Area F - Human resources, competence and knowledge management for LTO.

2012 Pre-SALTO Mission - Main results

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P.O. Box 100
A-1400 Vienna, Austria

- ❖ 13 issues (5 recommendations – 8 suggestions)
- ❖ 1 Good Practice
- ❖ 22 Good Performances
- ❖ Global conclusion
 - Good and complete technical analysis; good performance in very short delay;
 - No major findings in analysis and action plans

2015 SALTO Mission - Main results

- ❖ 10 issues (3 recommendations – 7 suggestions)
- ❖ 1 Good Practice
- ❖ 9 Good Performances
- ❖ Evaluation of 2012 Limited Scope SALTO mission
- ❖ Global conclusion
 - Plant in good condition
 - Analysis and action plans in line with IAEA expectations
 - No major findings in analysis and action plans. Good preparation for LTO of the plant

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2016 SALTO Follow-Up Mission - Main results

❖ Evaluation of 2015 SALTO mission

- 8 issues “Resolved”
- 2 issues “Satisfactory Progress to date”

❖ Global conclusion

- The plant has significantly progressed in the field of long-term operation and ageing management.
- The plant activities are consistent with IAEA Safety Standards for safe long-term operation.

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Tihange 1 Pre-SALTO 6-14 November 2012 Results Overview

A - Organisation and functions, current licensing basis, configuration/modification management

A-1 The plant and the involved entities do not have a clear role with regards to the design authority function

A-2 The process of the modifications documentation as part of the current physical configuration documentation of the plant is not properly carried out

B - Scoping and screening and plant programmes relevant to LTO

B-1 Design basis documentation for the plant is difficult to obtain

B-2 The system health reporting process in the plant surveillance and monitoring programme does not include the appropriate SSCs within the scope of LTO

Collaborative and transparent approach to LTO project

C - Ageing management review, review of AMPs and revalidation of TLAAAs for mechanical components

C-1 Ageing management programmes (AMP) do not address all generic IAEA AMP attributes

C-2 Data collection and record keeping do not ensure the consistency and update of data for scoping and screening of SSCs

D - Ageing management review, review of AMPs and revalidation of TLAAAs for electrical and I&C components

D-1 The cable system (cables, cable trays, electrical connections) has a lack of EQ for LTO

D-2 The LTO database containing results of ageing management and environmental qualification (Q-List) is not complete

E - Ageing management review, review of AMPs and revalidation of TLAAAs for civil structures

E-1 Fire protection of cables and masonry partitions qualification has not been revalidated in the LTO process

E-2 Ageing Management Evaluation of components and structures anchorages does not address potential stress corrosion cracking of high-grade steel bolting

F - Human resources, competence and knowledge management for LTO

F-1 Staffing of the LTO project is not adequate

F-2 Systematic approach for Competence and Knowledge management is not implemented for long term operation of the plant

Recommendation

Suggestion

Good Practice



F-3 Staffing plans for the long term operation of the plant are not adequate

Tihange 1 Pre-SALTO 2012 Issues Resolution Degree

A - Organisation and functions, current licensing basis, configuration/modification management

A-1 The plant and the involved entities do not have a clear role with regards to the design authority function

A-2 The process of the modifications documentation as part of the current physical configuration documentation of the plant is not properly carried out

B - Scoping and screening and plant programmes relevant to LTO

B-1 Design basis documentation for the plant is difficult to obtain

B-2 The system health reporting process in the plant surveillance and monitoring programme does not include the appropriate SSCs within the scope of LTO

C - Ageing management review, review of AMPs and revalidation of TLAAAs for mechanical components

C-1 Ageing management programmes (AMP) do not address all generic IAEA AMP attributes

C-2 Data collection and record keeping do not ensure the consistency and update of data for scoping and screening of SSCs

D - Ageing management review, review of AMPs and revalidation of TLAAAs for electrical and I&C components

D-1 The cable system (cables, cable trays, electrical connections) has a lack of EQ for LTO

D-2 The LTO database containing results of ageing management and environmental qualification (Q-List) is not complete

E - Ageing management review, review of AMPs and revalidation of TLAAAs for civil structures

E-1 Fire protection of cables and masonry partitions qualification has not been revalidated in the LTO process

E-2 Ageing Management Evaluation of components and structures anchorages does not address potential stress corrosion cracking of high-grade steel bolting

F - Human resources, competence and knowledge management for LTO

F-1 Staffing of the LTO project is not adequate

F-2 Systematic approach for Competence and Knowledge management is not implemented for long term operation of the plant

Recommendation

Issue resolved

Suggestion

Satisfactory progress to date

Good Practice

Insufficient progress to date



F-3 Staffing plans for the long term operation of the plant are not adequate

Tihange 1 SALTO 13-22 January 2015 Results Overview

A - Organisation and functions, current licensing basis, configuration/modification management

A-1 Lack of programme for sustainable management of ageing for LTO

A-2 Inadequate implementation of ageing management programmes

B - Scoping and screening and plant programmes relevant to LTO

B-1 Lack of comprehensive evaluation of active mechanical components

B-2 Unclear demonstration of mechanical equipment qualification

C – Ageing management review, review of AMPs and revalidation of TLAAs for mechanical components

C-1 Lack of completeness for the ageing management programmes

D - Ageing management review, review of AMPs and revalidation of TLAAs for electrical and I&C components

D-1 Insufficient preservation of 1E cable-system qualification and functionality during LTO

E - Ageing management review, review of AMPs and revalidation of TLAAs for civil structures

E-1 The plant approach to confirmation of containment integrity

E-2 Leaching of Calcium Hydroxide on the floor slab of electrical building basement

E-3 Improper anchoring of supports in relay room of electrical building

F - Human resources, competence and knowledge management for LTO

F-1 Incomplete implementation of competence and knowledge management processes

Management of critical suppliers

Recommendation

Suggestion

Good Practice



Tihange 1 SALTO 2015 Issues Resolution Degree

A - Organisation and functions, current licensing basis, configuration/modification management

A-1 Lack of programme for sustainable management of ageing for LTO

A-2 Inadequate implementation of ageing management programmes

B - Scoping and screening and plant programmes relevant to LTO

B-1 Lack of comprehensive evaluation of active mechanical components

B-2 Unclear demonstration of mechanical equipment qualification

C – Ageing management review, review of AMPs and revalidation of TLAAs for mechanical components

C-1 Lack of completeness for the ageing management programmes

D - Ageing management review, review of AMPs and revalidation of TLAAs for electrical and I&C components

D-1 Insufficient preservation of 1E cable-system qualification and functionality during LTO

E - Ageing management review, review of AMPs and revalidation of TLAAs for civil structures

E-1 The plant approach to confirmation of containment integrity

E-2 Leaching of Calcium Hydroxide on the floor slab of electrical building basement

E-3 Improper anchoring of supports in relay room of electrical building

F - Human resources, competence and knowledge management for LTO

F-1 Incomplete implementation of competence and knowledge management processes

Recommendation

Issue resolved

Suggestion

Satisfactory progress to date

Good Practice

Insufficient progress to date



IAEA SALTO Peer review Missions – Overall Conclusion

- ❖ Approach compliant with IAEA Standards
- ❖ Analysis and action plans in line with IAEA expectations
- ❖ No major findings in analysis and action plans. Good preparation for LTO of the plant
- ❖ Plant in good condition
- ❖ The plant has significantly progressed in the field of long-term operation and ageing management.
- ❖ The plant activities are consistent with IAEA Safety Standards for safe long-term operation.

Tihange 1 LTO Program – Lessons Learned

Positive	To improve
 Efficiency	Communication
 Team composition	Coordination and Integration with Site
 Team Spirit	

05

Conclusions



To keep in mind

- ❖ Tihange 1NPP LTO Program:
 - Processes up to date
 - (Pre-Conditions and Competence/Knowledge Management)
 - Ageing Management: Finalized in 2016
 - Design Planning: On track
 - Investment plan: Respected
- ❖ Site process
 - Improved knowledge and awareness regarding Ageing Management
 - Living and sustainable Ageing Management
- ❖ Assessments
 - Compliant with IAEA expectations and Standards



Conclusion

Tihange 1 NPP:

- ❖ Commissioned in 1975, 40 operation
- ❖ Numerous upgrades and improvements
- ❖ Positive evaluation of International Authorities

Some may say that “Life begins at Forty”, ...

I prefer the statement ...

**40 IS THE
NEW 20**

06

Questions and Answers



Questions - Answers



Questions?

Ask A Scientist!
And F.A.Q...



