LTO and the role of ageing management at Borssele NPP

Keywords: long term operation, ageing management, knowledge management

NIC, Amsterdam, 8-9 June 2022

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We work safely or not at all.

So… Safety first!

EPZ constantly improving

André de Jong

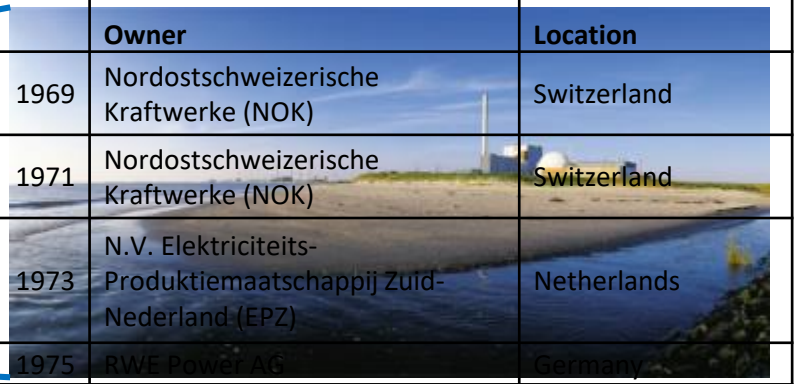
Since 1995 he is working for Borssele NPP in the Netherlands. As a mechanical engineer he was involved in structural analyses of mechanical components and ageing issues. Since 2007 he leads the engineering department responsible for in-service inspection and ageing management.

He was project leader for the LTO assessment project for Borssele NPP which resulted in a renewed license comprising operation until 2034 (60 years of operation).

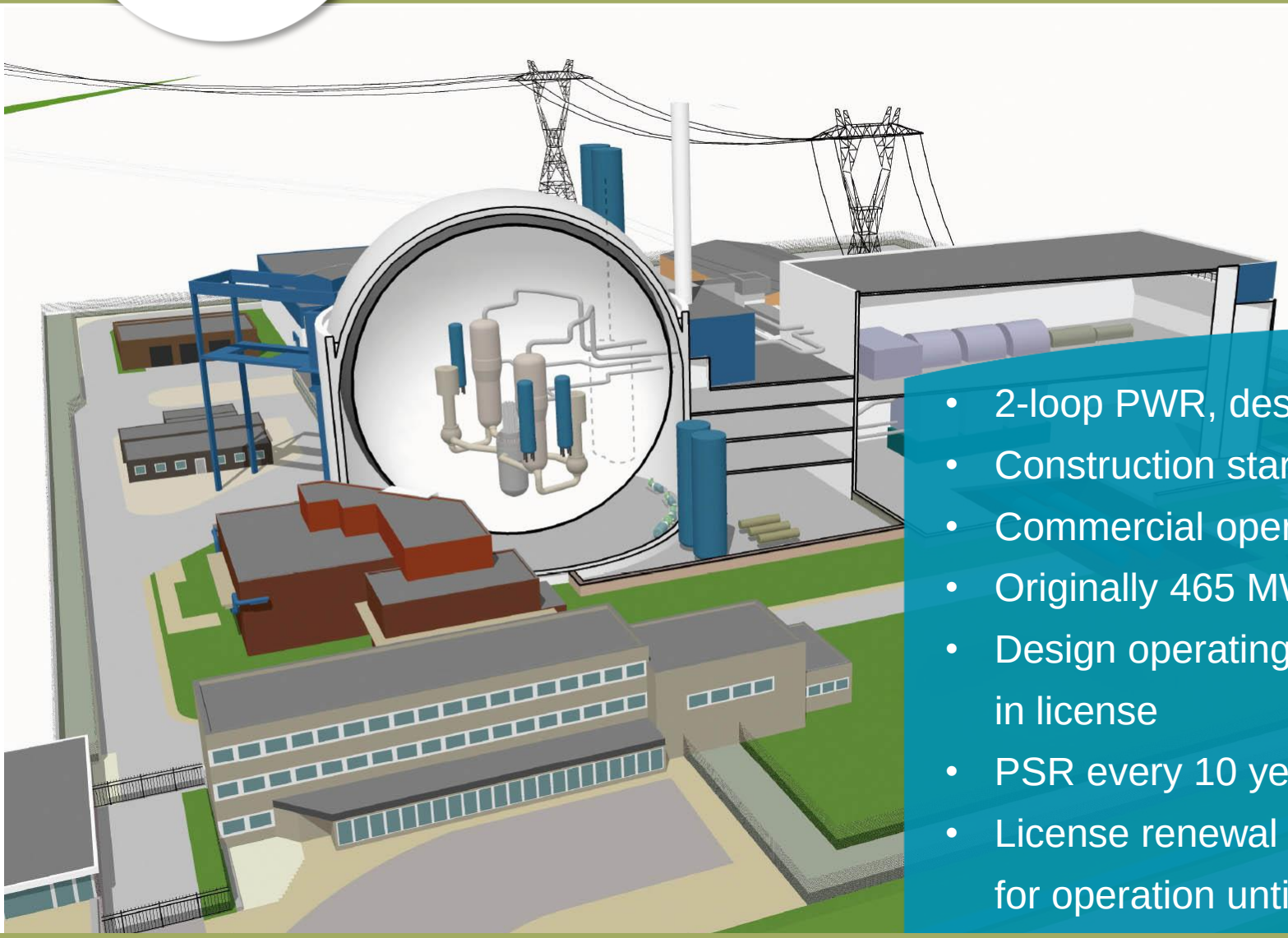
He is involved in several IAEA-activities on Ageing Management and Long Term Operation including as a reviewer in several SALTO Peer Reviews.

PWR's in Europe (build until 1980)

Facility	Process	Mwe net	Current status	Start Year	Owner	Location
Beznau-1	PWR	365	Operating	1969	Nordostschweizerische Kraftwerke (NOK)	Switzerland
Beznau-2	PWR	365	Operating	1971	Nordostschweizerische Kraftwerke (NOK)	Switzerland
Borssele	PWR	512	Operating	1973	N.V. Elektriciteits-Produktiemaatschappij Zuid-Nederland (EPZ)	Netherlands
Biblis-A	PWR	1167	Shut Down	1975	RWE Power AG	Germany
Doel-1	PWR	392	Operating	1975	Indivision Doel (EBES, INTERCOM, UNERG)	Belgium
Doel-2	PWR	392	Operating	1975	Indivision Doel (EBES, INTERCOM, UNERG)	Belgium
Ringhals-2	PWR	870	Shut Down	1975	Swedish State Power Board	Sweden
Tihange-1	PWR	962	Operating	1975	Electrabel	Belgium
Neckarwestheim-1	PWR	785	Shut Down	1976	EnBW Kraftwerk AG	Germany
Biblis-B	PWR	1240	Shut Down	1977	RWE Power AG	Germany
Fessenheim-1	PWR	880	Shut Down	1977	Electricite de France (EdF)	France
Fessenheim-2	PWR	880	Shut Down	1978	Electricite de France (EdF)	France
Bugey-2	PWR	910	Operating	1979	Electricite de France (EdF)	France
Bugey-3	PWR	910	Operating	1979	Electricite de France (EdF)	France
Bugey-4	PWR	880	Operating	1979	Electricite de France (EdF)	France
Gösgen	PWR	970	Operating	1979	Kernkraftwerk	Switzerland
Unterweser	PWR	1345	Shut Down	1979	EON Kernkraft GmbH	Germany



Borssele Nuclear Power Plant



- 2-loop PWR, designed and built by S/KWU (Germany)
- Construction started in 1969
- Commercial operation since October 1973
- Originally 465 MWe, upgraded to 512 MWe (2006)
- Design operating life: 40 years (2013), originally no end-date in license
- PSR every 10 years: several safety upgrades implemented
- License renewal in 2013 based on LTO assessment: license for operation until 2034 (60 years of operation)

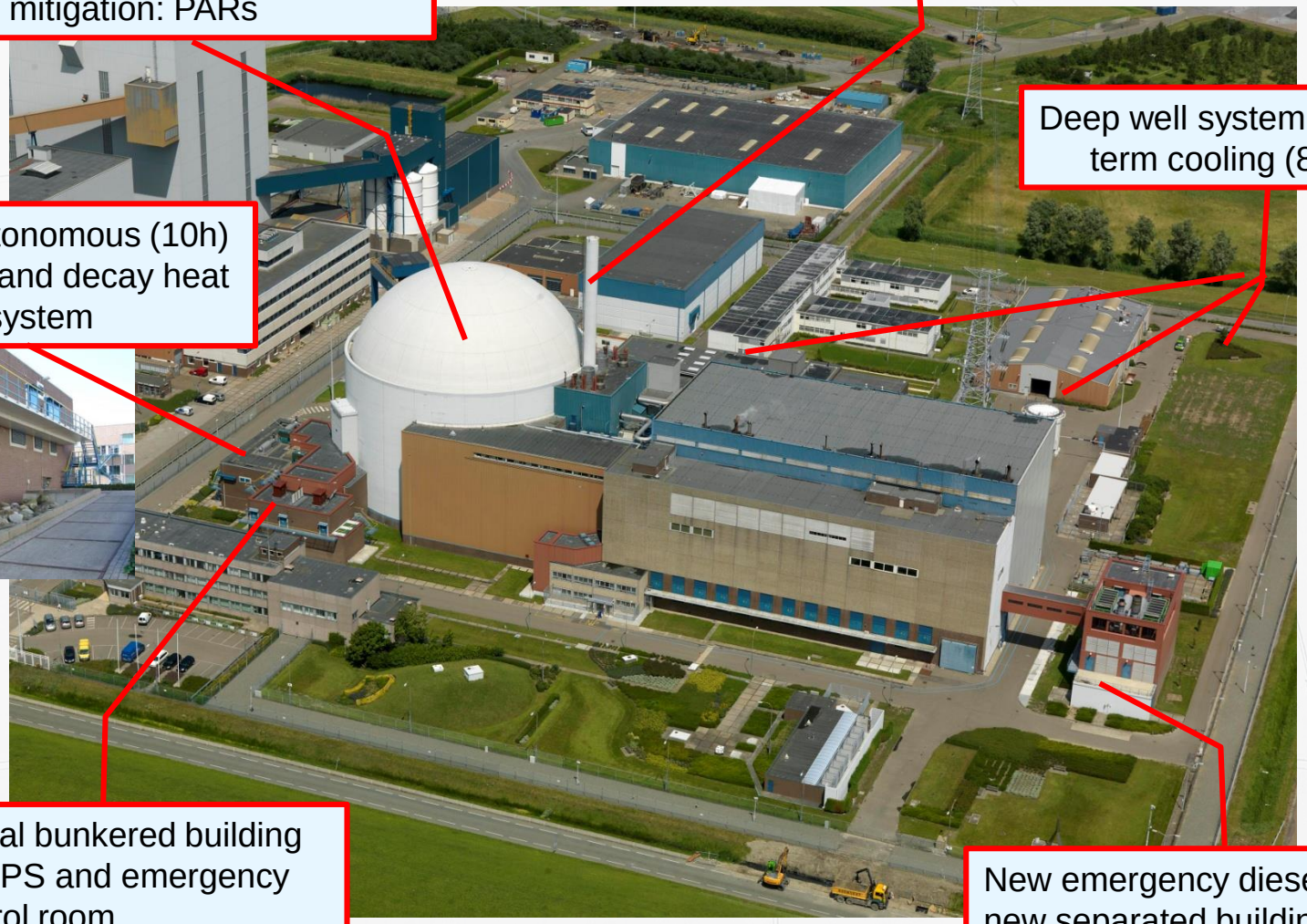
Several safety upgrades

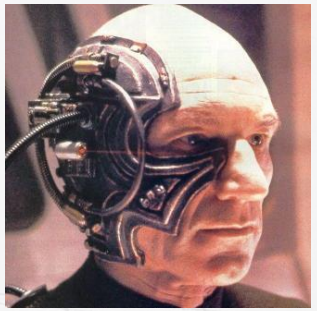
Seismic supports/HELB;
H_2 mitigation: PARs

Filtered containment venting

Deep well system for long term cooling (8)

Two-train autonomous (10h) make-up and decay heat removal system

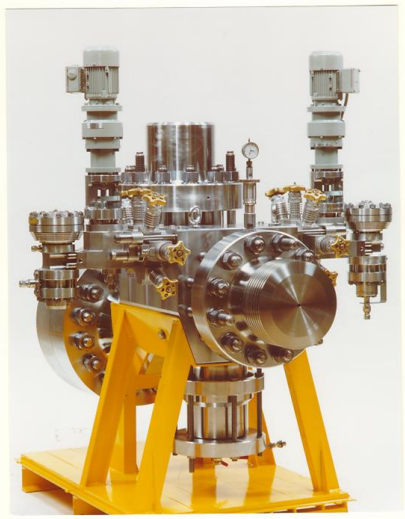




Additional bunkered building for RPS and emergency control room

New emergency diesels in a new separated building

Ageing of equipment

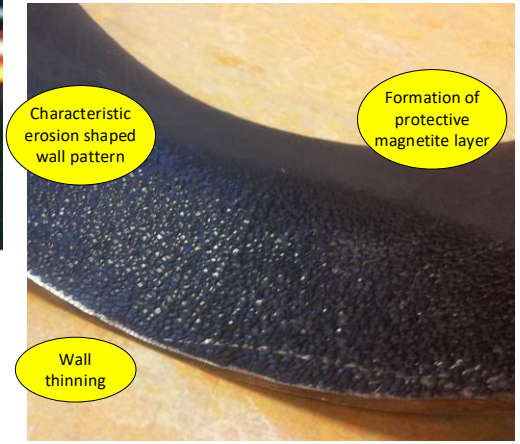


conceptual

Obsolescence

technological

physical

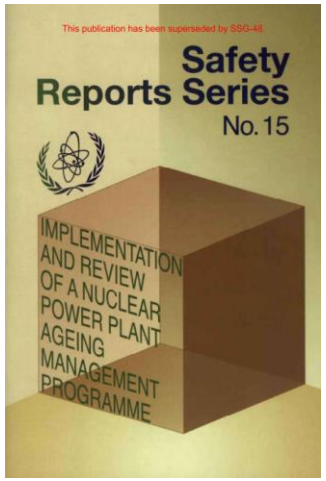


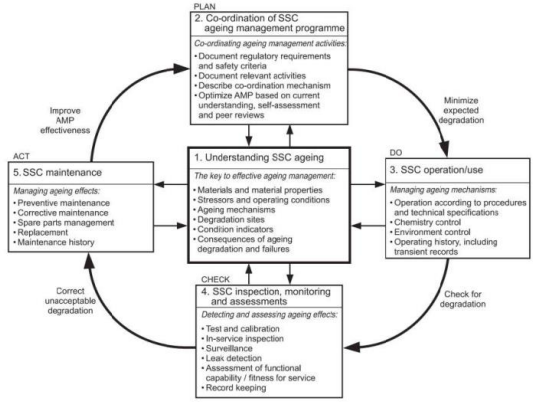
Material degradation by time and/or use

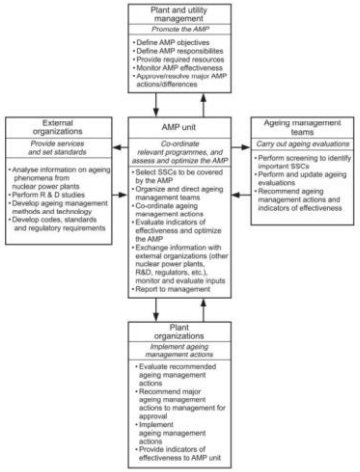
Ageing management: how did we do it? (1)

In the beginning ‘ageing management’ as a term did not exist, we just called it maintenance. ‘Ageing management: do we need to do something else or something different’?’

In the nineties ‘ageing management’ appeared as a term and IAEA guidelines came up.

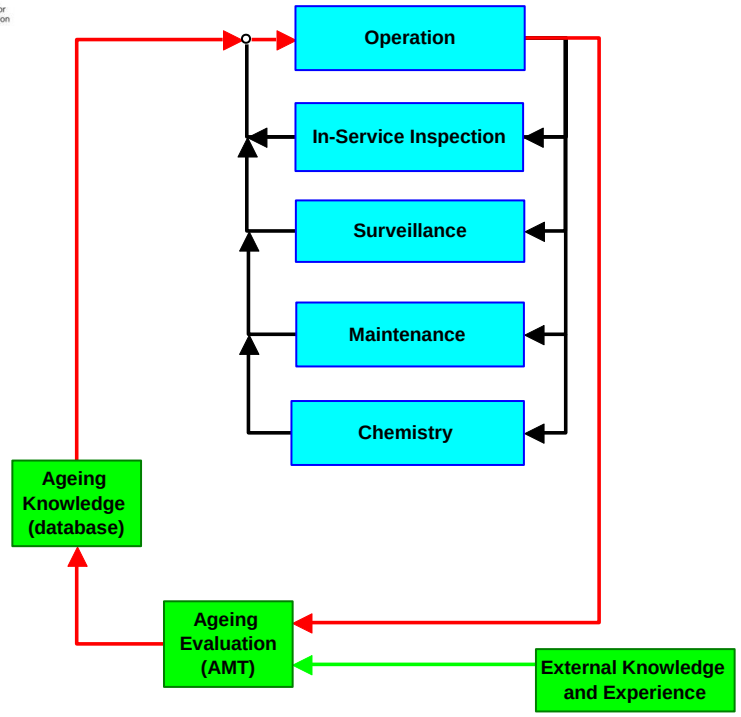






1997: Borssele received a formal license requirement to implement an ageing management system

Ageing experience feedback procedure and
a specific Ageing Management Team (AMT) was introduced

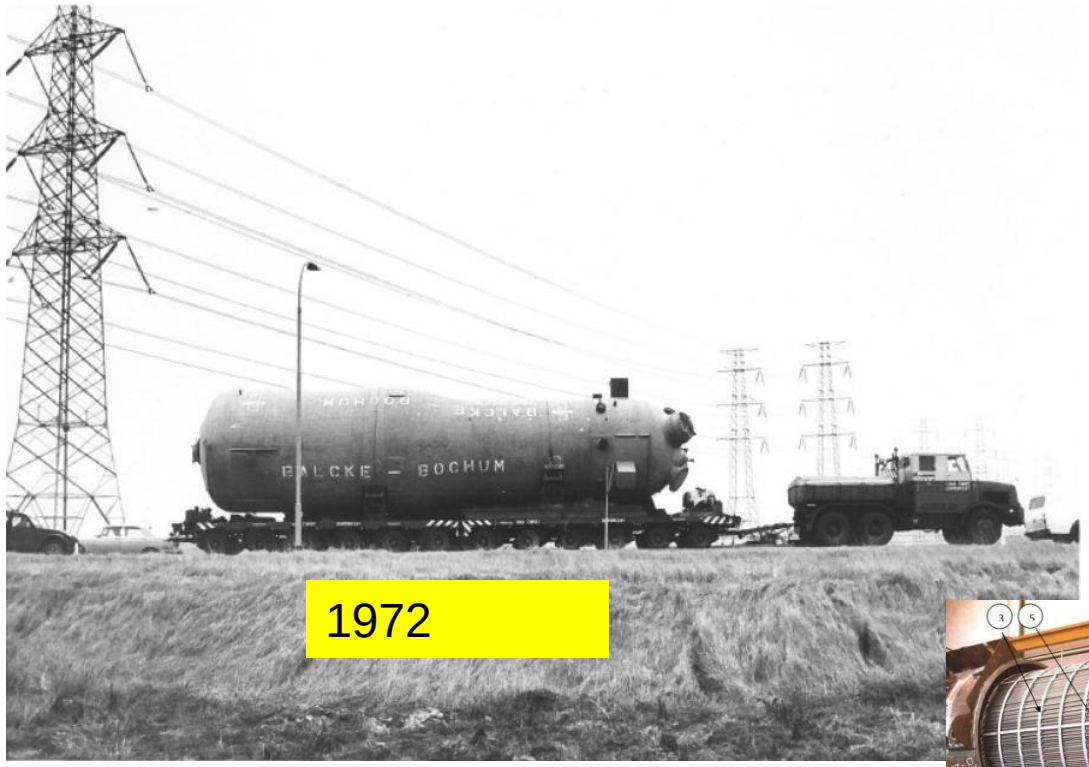


Ageing management: how did we do it so far? (2)

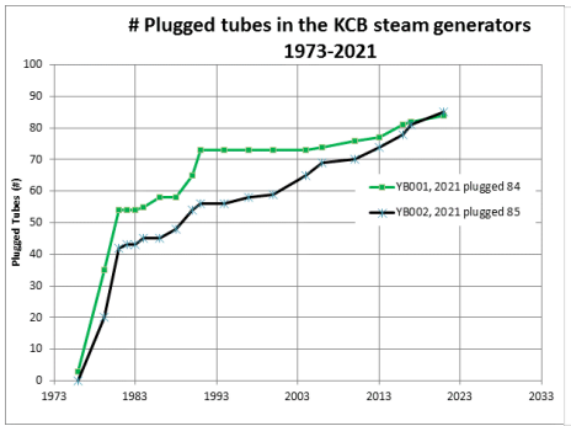
IAEA AMAT Peer Review in 2003
Performance based review on ageing management

‘The safety related SSC are in general in a good condition’

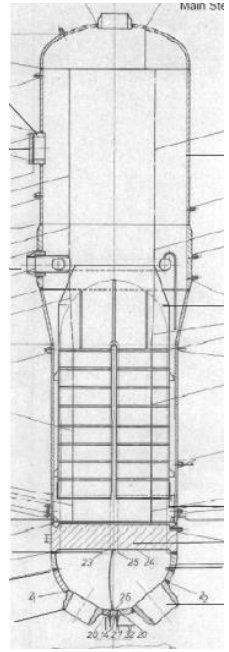
Improvements can be made in documentation and traceability.



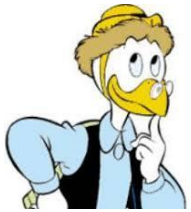
1972



Incaloy 800 tubes



The result of a good (material) design and ageing management by experienced engineers.



LTO assessment: showing good ageing management

USA: License Renewal from 40 to 60 years

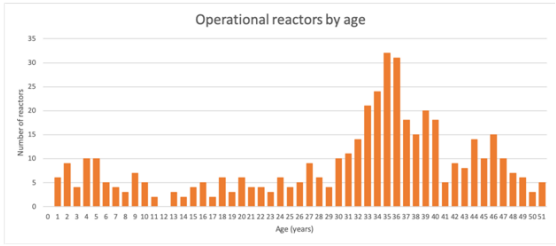
IAEA extrabudgetary programme on Safety Aspects of Long Term Operation (2003-2006):

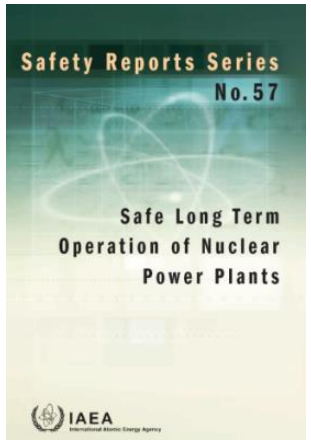
➔ Safety Report 57

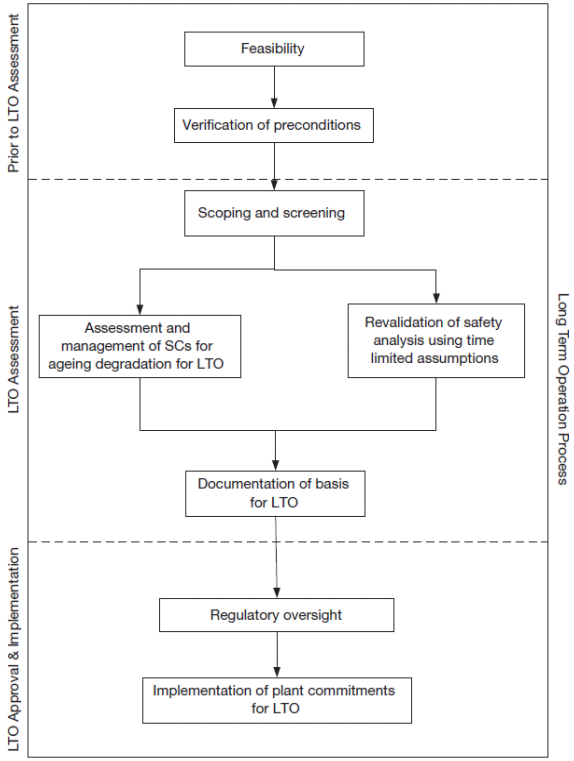
➔ NS-G-2.12 (now superseded by SSG-48)

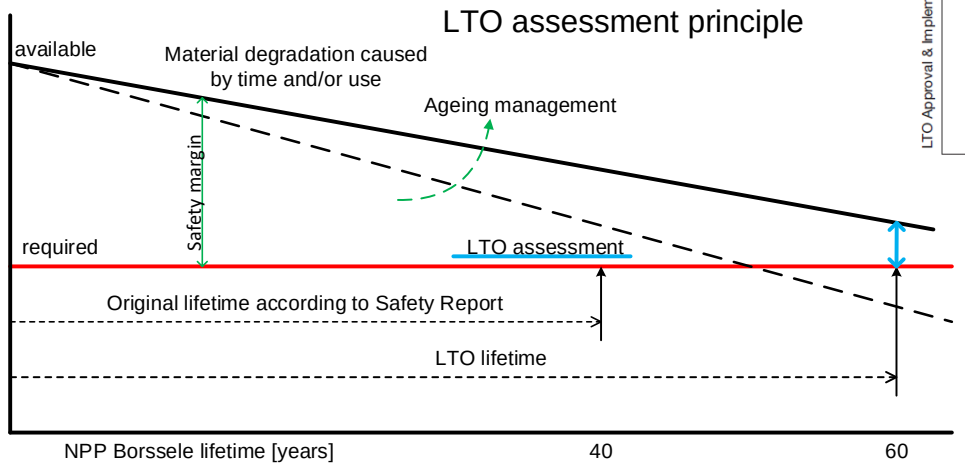
➔ SALTO Peer Review Service was developed

‘Show for a clearly defined scope of SSC important to safety that (physical) ageing is managed and revalidate time limited ageing analyses’







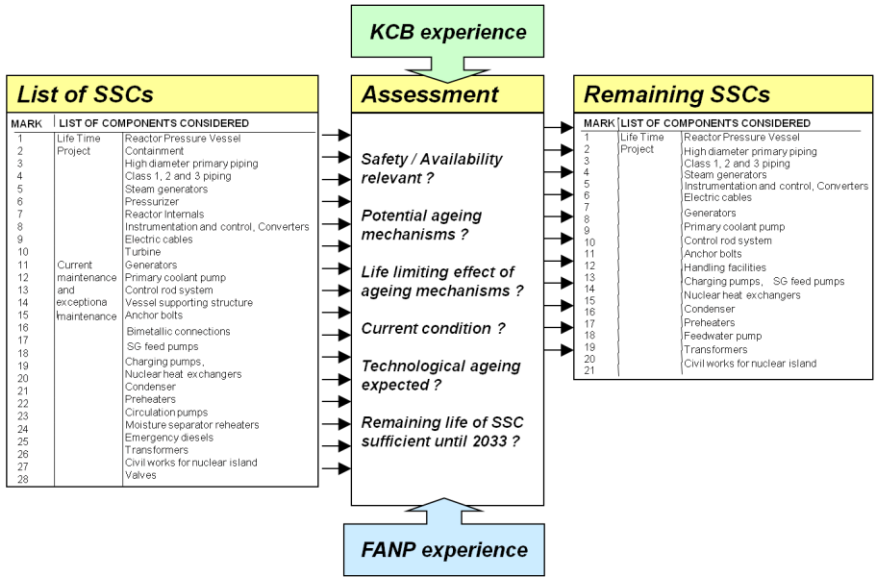


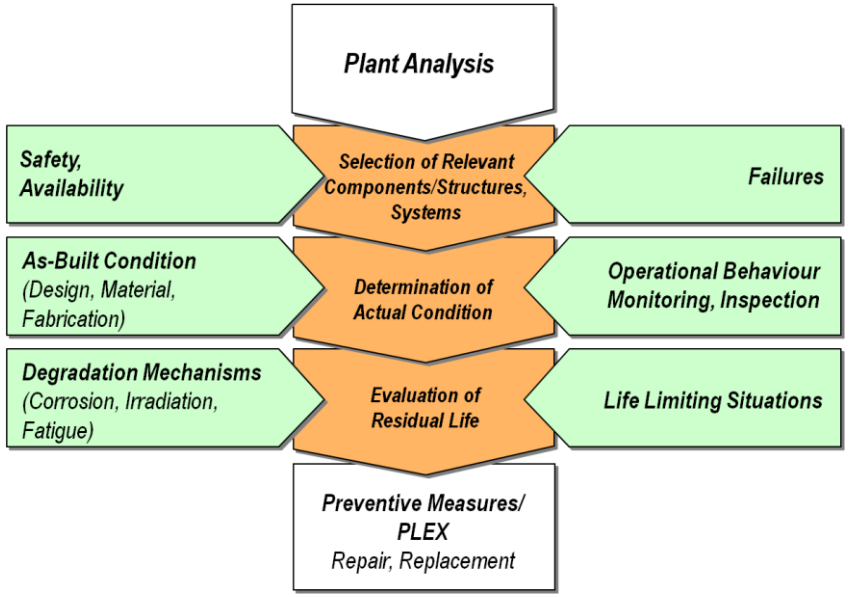
Feasibility study for operating Borssele NPP for 60 years of operation

What investments are necessary because of:

- Physical ageing of SSC
- Technological Obsolescence (spare parts, I&C etc.)
- Need for improved ageing management

Conceptual Obsolescence (safety upgrades) is taken care by 10-yearly PSR





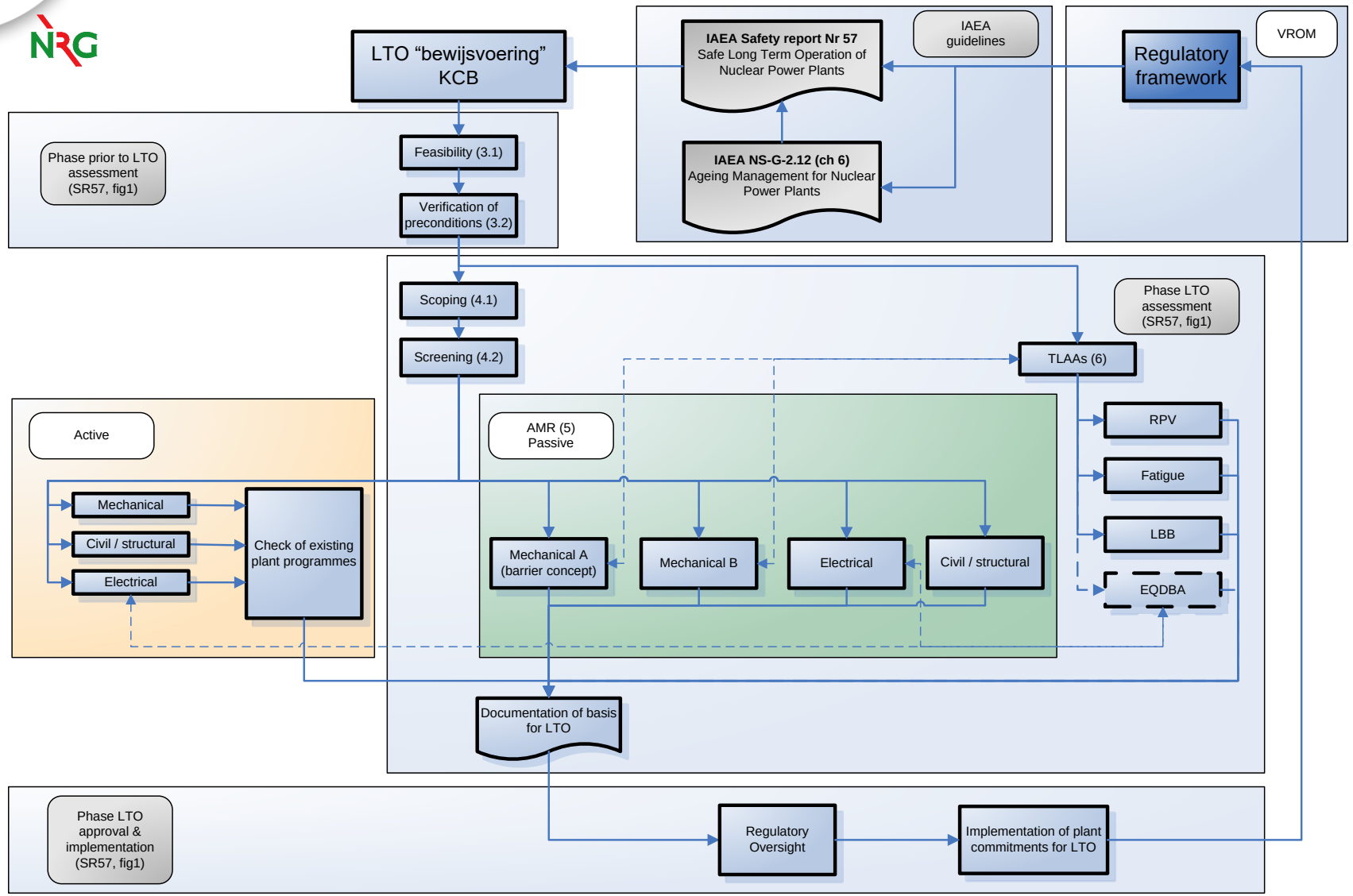
This resulted in a positive business case. In 2006 an agreement with the government was made making operation until 2034 possible.

But of course it still has to be proven that it's safe!

Performed in 2004 by specialists from OEM together with plant engineers

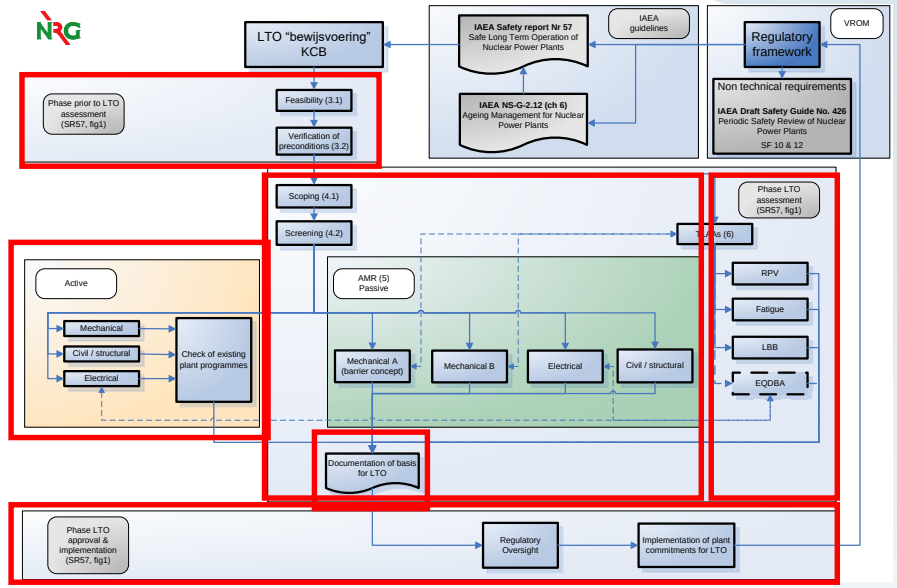
→ LTO assessment

LTO assessement overview

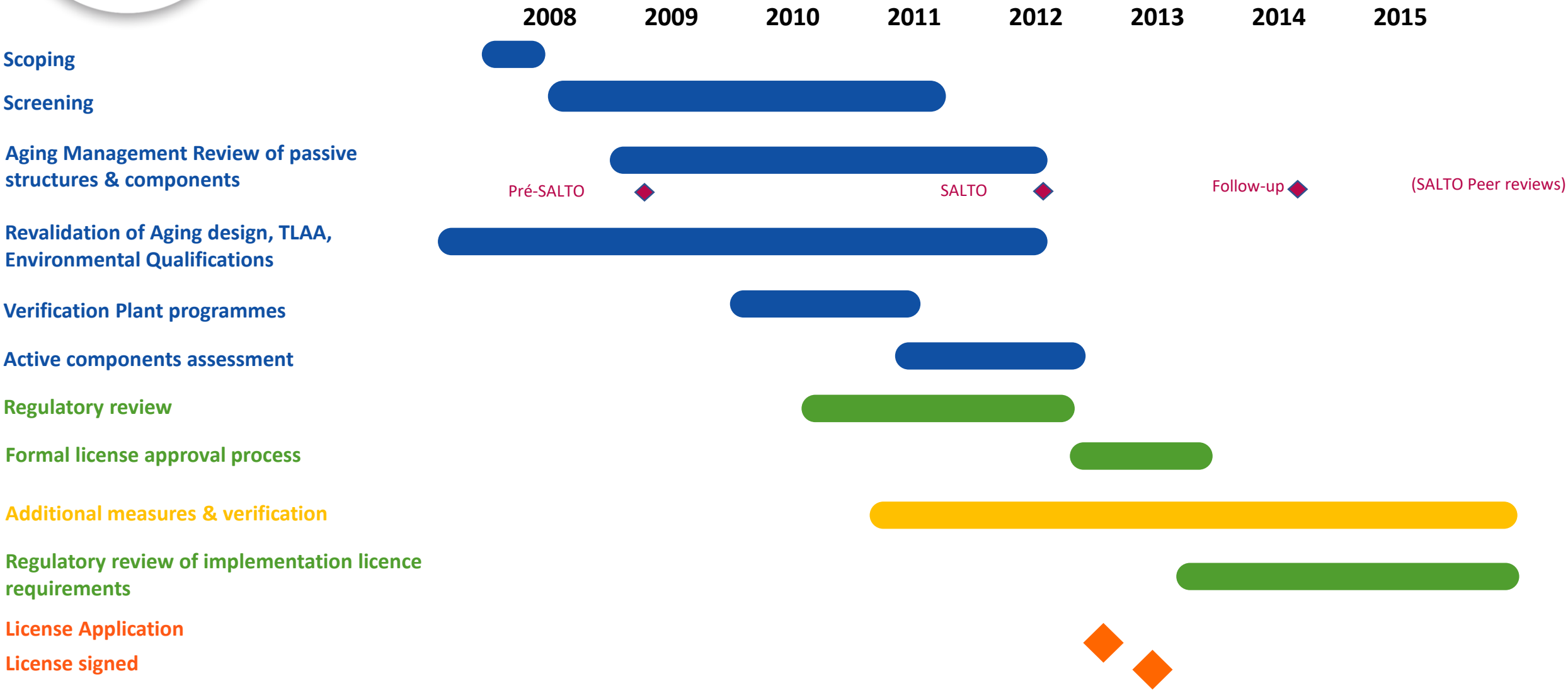


LTO assessement overview

- KCB project LTO “bewijsvoering” based on IAEA Safety Report 57:
- Feasibility and verification of preconditions;
- Scoping, screening and Ageing Management Reviews;
- Revalidation of the following TLAAs:
  - Reactor Pressure Vessel (RPV);
  - Fatigue;
  - Leak Before Break;
  - Qualification of Design Base Accident resistant electrical Equipment.
- Assessment of active components;
- Documentation for LTO basis;
- Regulatory oversight and the KCB implementation of plant commitments.
- The outcome of the project LTO “bewijsvoering” was submitted to the Dutch regulator KFD for a license change procedure for long term operation of KCB until 2034.

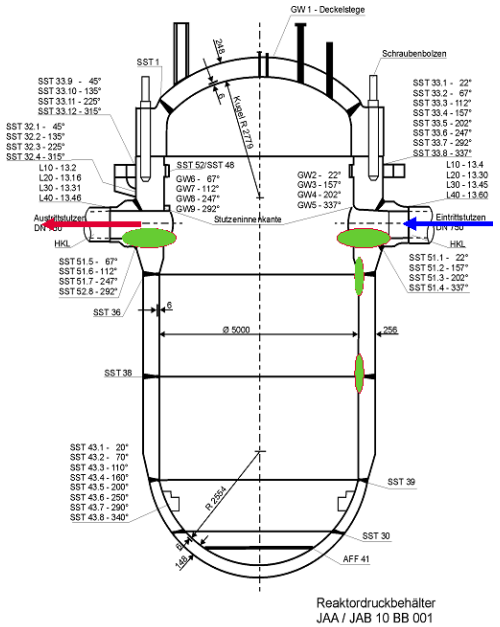


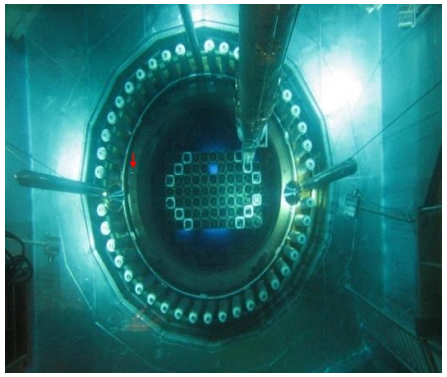
Project overview chronological



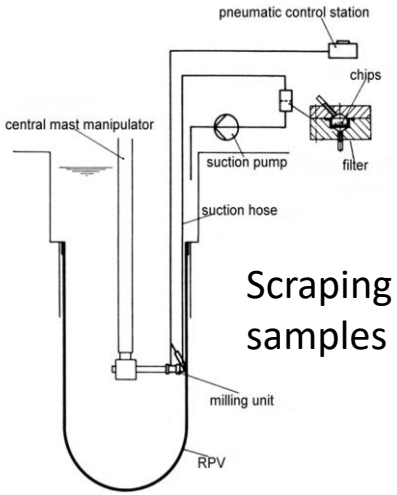
Examples Time Limited Ageing Analyses

RPV integrity

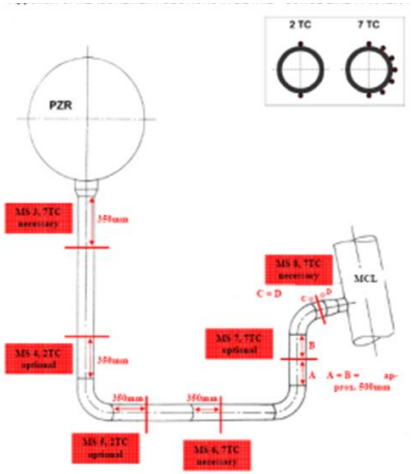




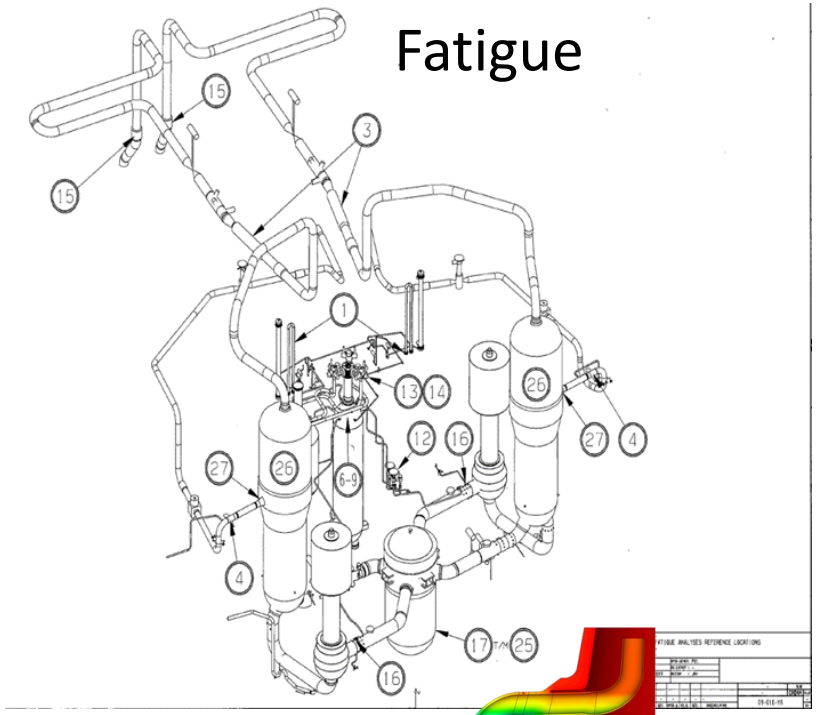
new surveillance specimens



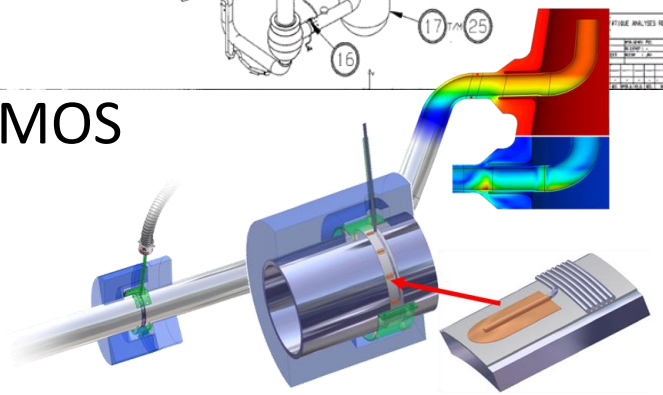
Scraping samples



Fatigue



FAMOS



Team work

- **A joint effort: EPZ – Framatome – NRG**

EPZ

framatome

- Scoping
- RPV Integrity assessment
- AMR
- Fatigue Monitoring

NRG

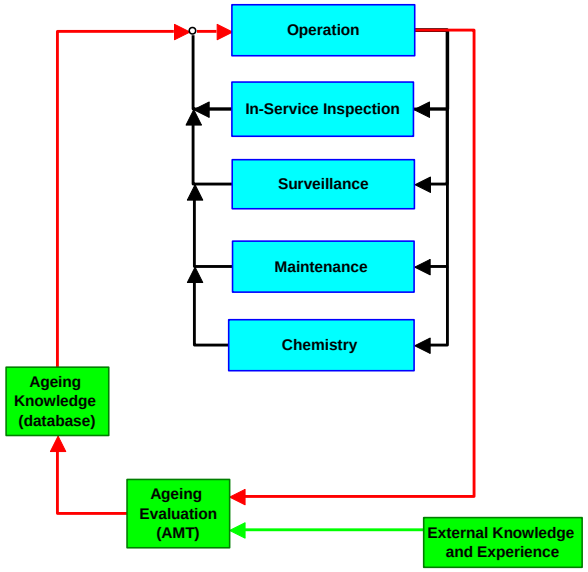
- Fatigue assessment
- Coordination
- Methodology

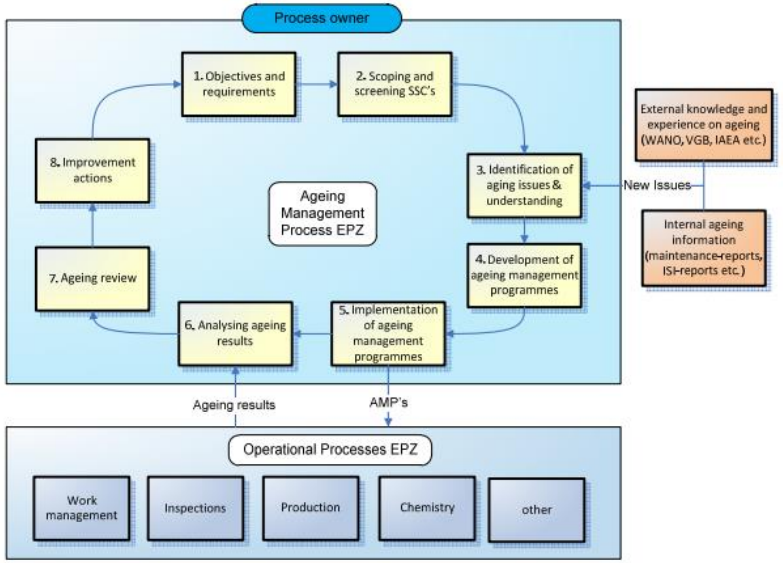
The project gave EPZ a good basis for ageing management and knowledge management.
An important basis for even further operation after 60 years.

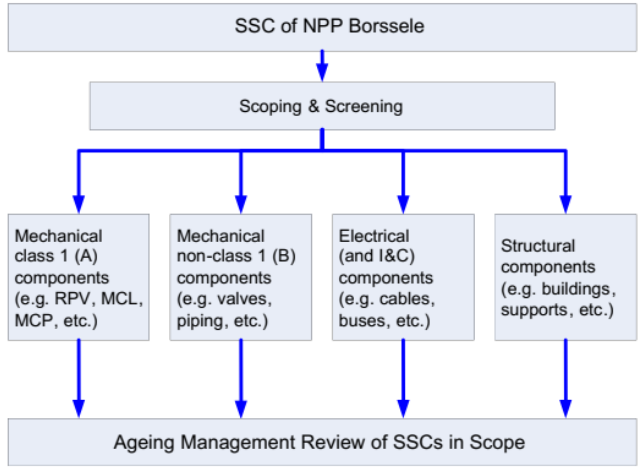
The ‘post-LTO phase’: combining original approach with results of AMR

Ageing management based on good knowledge and adequately acting on experiences

Good performance but still a reactive approach







Ageing management is documented and updated regularly based on modifications and particulary on in- and external ageing experiences.

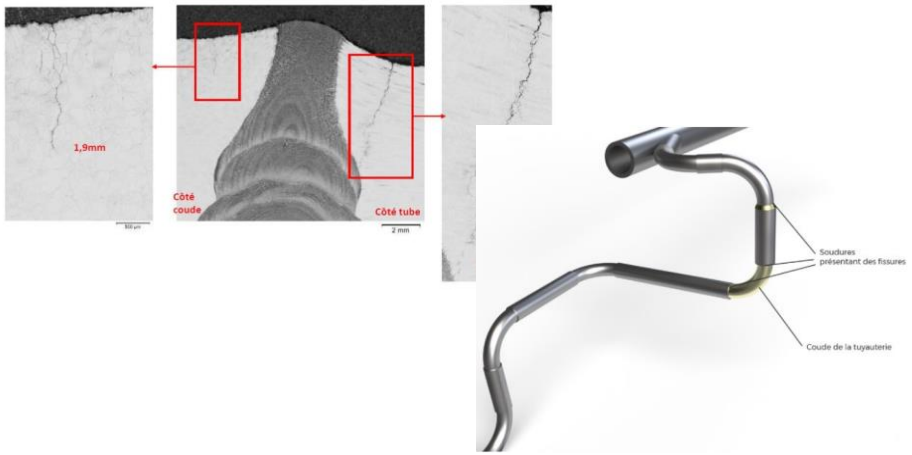
- SSG-48 is used as guideline
- IGALL database is used to benchmark our AMPs
- COMSY is used and will be further developed as a support tool for AM

A comprehensive LTO assessment including a comprehensive ageing management review resulting in explicit AMPs

A well documented ageing management review and a set of AMPs but a risk of doing well on paper but not in the field

Example

Information from France about SSC in welds emergency cooling lines (December 2021)

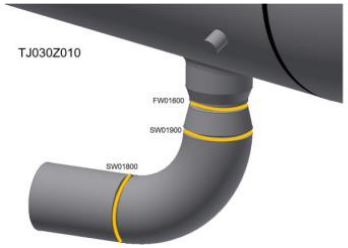


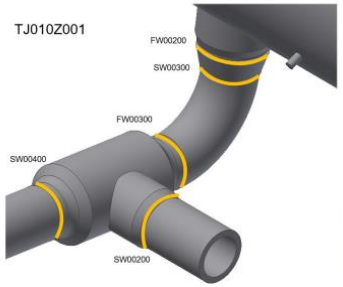
Borssele Ageing Management Team performs ageing analysis:

- Risk of transferability on Borssele is determined: low
- Actions are defined to perform non-destructive testing

Borssele NPP: six ‘Civaux-welds’ investigated during outage april 2022, (qualified) ET and UT:

➔ No reportable indications found





The ageing management document for this piping is updated with this information (refering to the documented ageing ageing analysis)

Future challenges

Safe and reliable operation until 2034!

- Knowledge management
  - Old plant with new staff
  - German phase-out
- Equipment Reliability
- Technological obsolescence

Operation until 2044 or 2054?

- Subsequent Licence Renewal
- New LTO assessment and LTO investments

New built in The Netherlands?

- Commitment of Dutch government
- Public
- Need to avoid nuclear accidents around the globe
- Investors

Thank you

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Have a safe day!

EPZ constantly improving