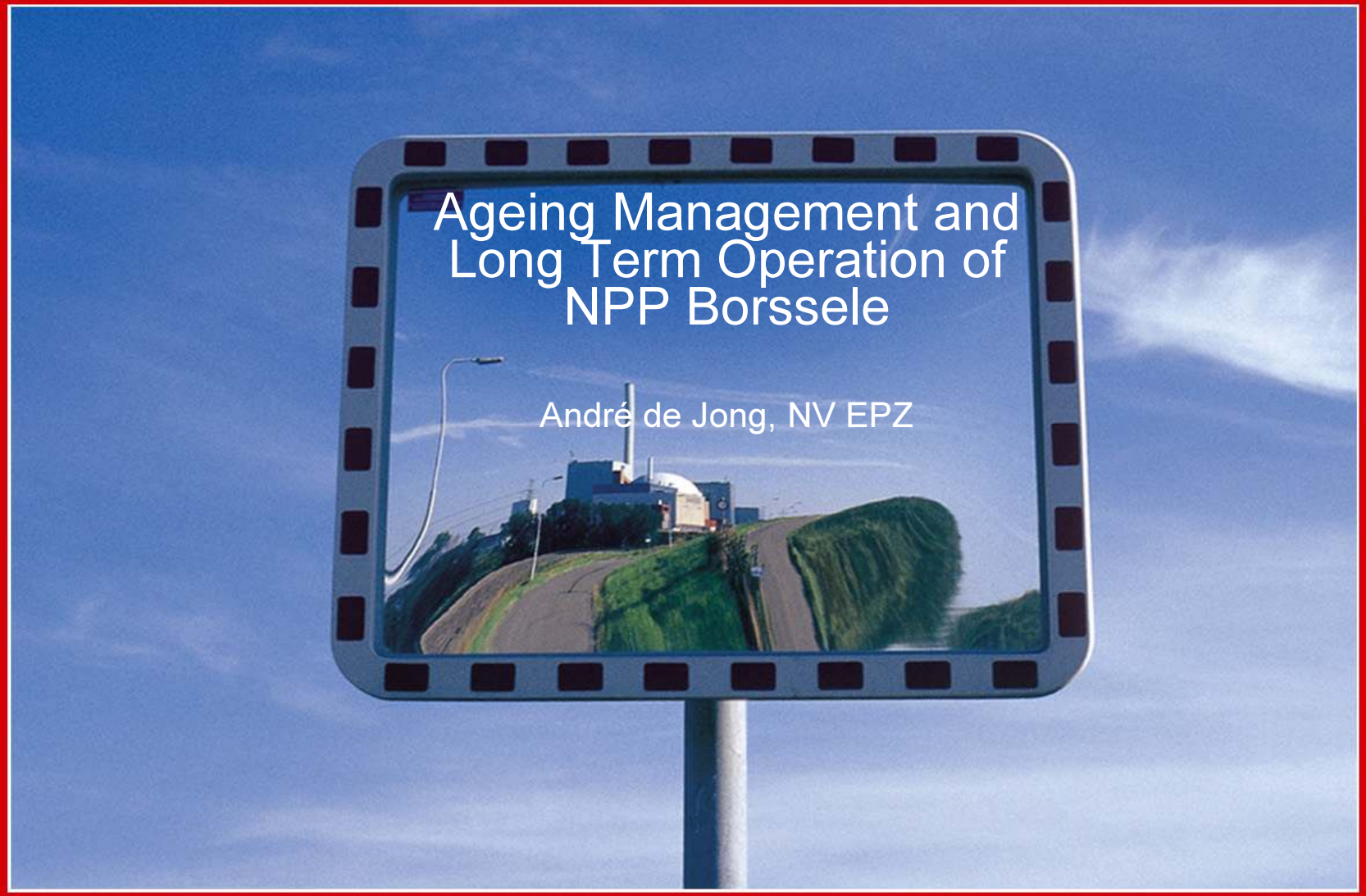


Ageing Management and Long Term Operation of NPP Borssele

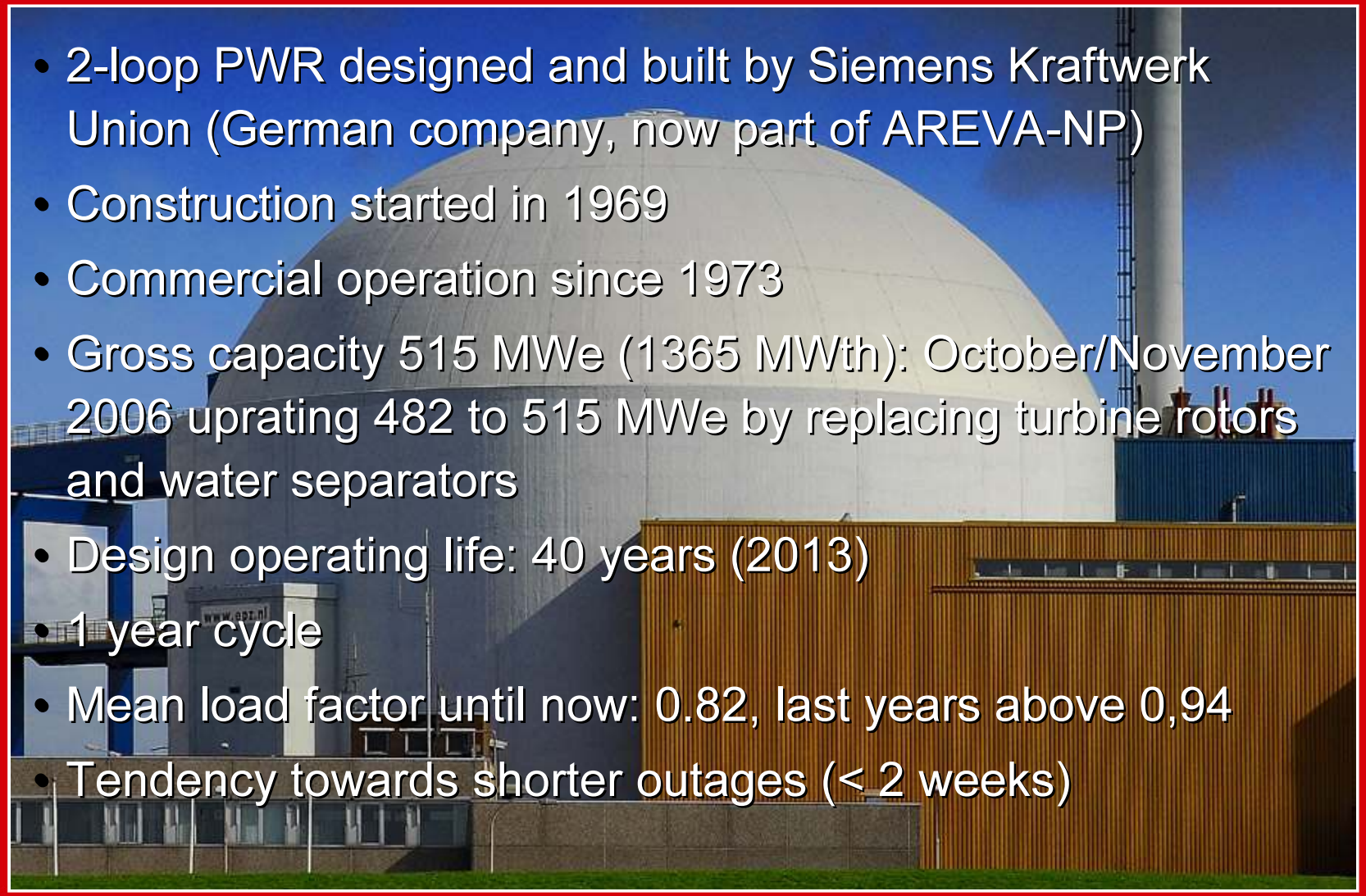
André de Jong, NV EPZ

2nd Int. Symposium on NPP Life Management
15-18 October 2007 Shanghai, China

Topics

- Facts about NPP Borssele
- Current status of LTO: license
- Major upgrades
  - Safety upgrades from PSRs
  - Other important upgrades
- Ageing Management review in last PSR
- LTO activities

Facts about NPP Borssele



- 2-loop PWR designed and built by Siemens Kraftwerk Union (German company, now part of AREVA-NP)
- Construction started in 1969
- Commercial operation since 1973
- Gross capacity 515 MWe (1365 MWth): October/November 2006 uprating 482 to 515 MWe by replacing turbine rotors and water separators
- Design operating life: 40 years (2013)
- 1 year cycle
- Mean load factor until now: 0.82, last years above 0,94
- Tendency towards shorter outages (< 2 weeks)

Current status of LTO: license aspects

- 1973: NPP Borssele in commercial operation: operating license without an end date
- 1994: political agreement closing NPP Borssele in 2003
- 1994-2006: lawsuits and political discussions about closing date of NPP Borssele, no end of license date (politics: 2013?, EPZ: why?)
- 16 June 2006: The Borssele Agreement:
  - ✓ NPP may operate until 2034 (60 years of operation)
  - ✓ NPP should be among the 25% safest Western water cooled NPPs
  - ✓ Immediate dismantling after closure
  - ✓ Shareholders will invest 250M€ in renewable energy projects
  - ✓ The government will invest another 250M€ in renewable energy projects
- From 30 to 40 to 60 years perspective in only a few years time!
- PSR regime: every ten years a Periodic Safety Review: no specific regulator policy on LTO

Safety upgrades: PSR overview

1. First ‘PSR’: Safety evaluation performed during 1982 – 1985 based on Post-TMI (Harrisburg) discussions

Backfitting Note Dutch Nuclear Regulatory Body (KFD):

➔ PSR regulation (reviewing against state of the art)

2. 1989-1997: Modifications project: PSR + implementation of measures in 1997 (budget: 240M€)

3. 2000-2003: PSR, 2006,2007 implementing (minor) upgrades (25M€): hardware ok, only a few minor upgrades

EPZ Safety upgrades 1982-1985

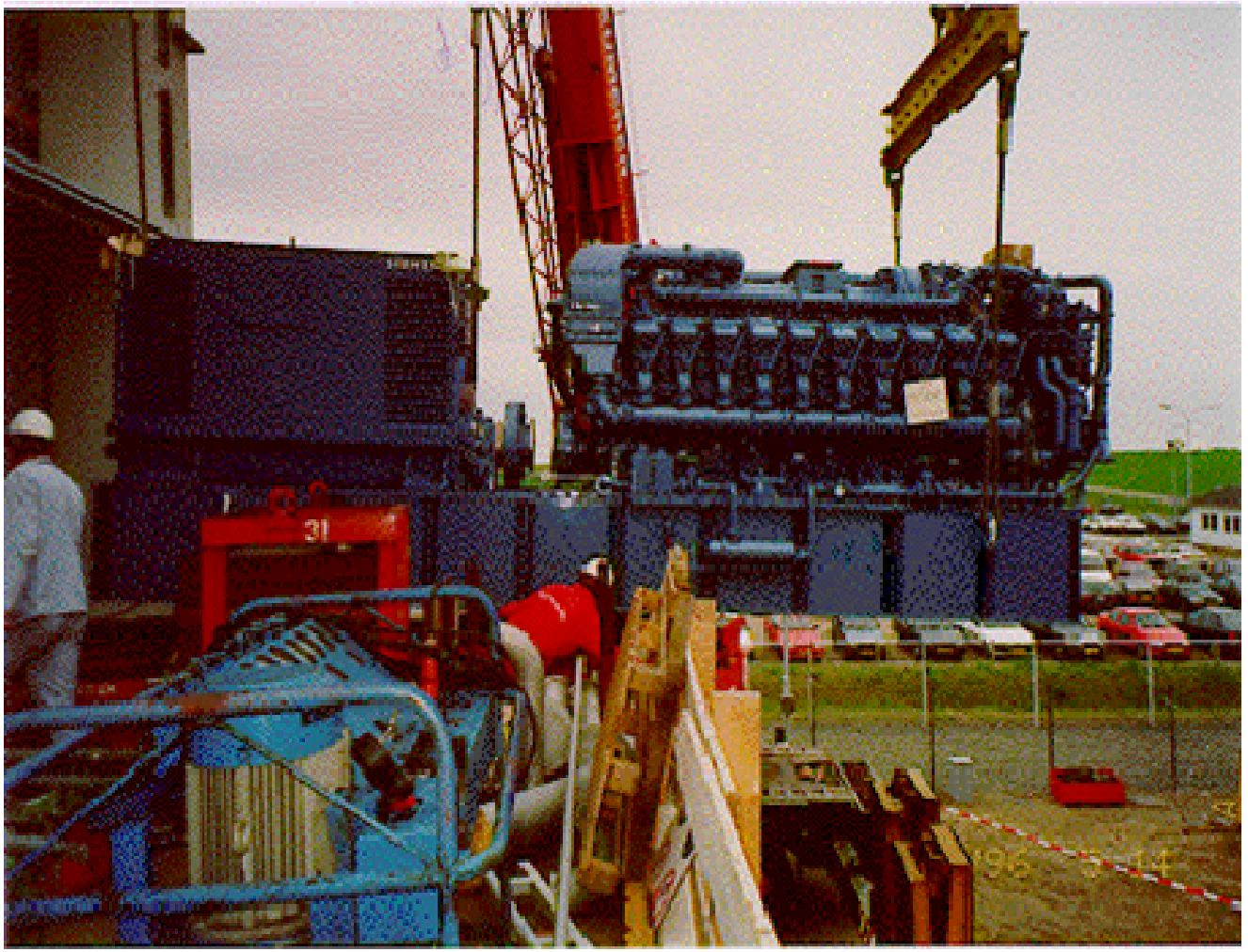
Major:

Implementation of 2-train autonomous (10h) bunkered make-up and decay heat removal system

Other upgrade examples first ‘PSR’:

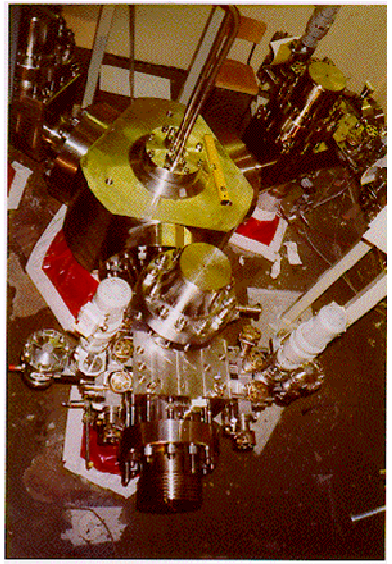
- Automatic test facility reactor protection system
- Modernization fire detection system
- Implementation accident and post-accident instrumentation
- Introduction of Westinghouse symptom based emergency procedures
- Installation active H2-recombiner

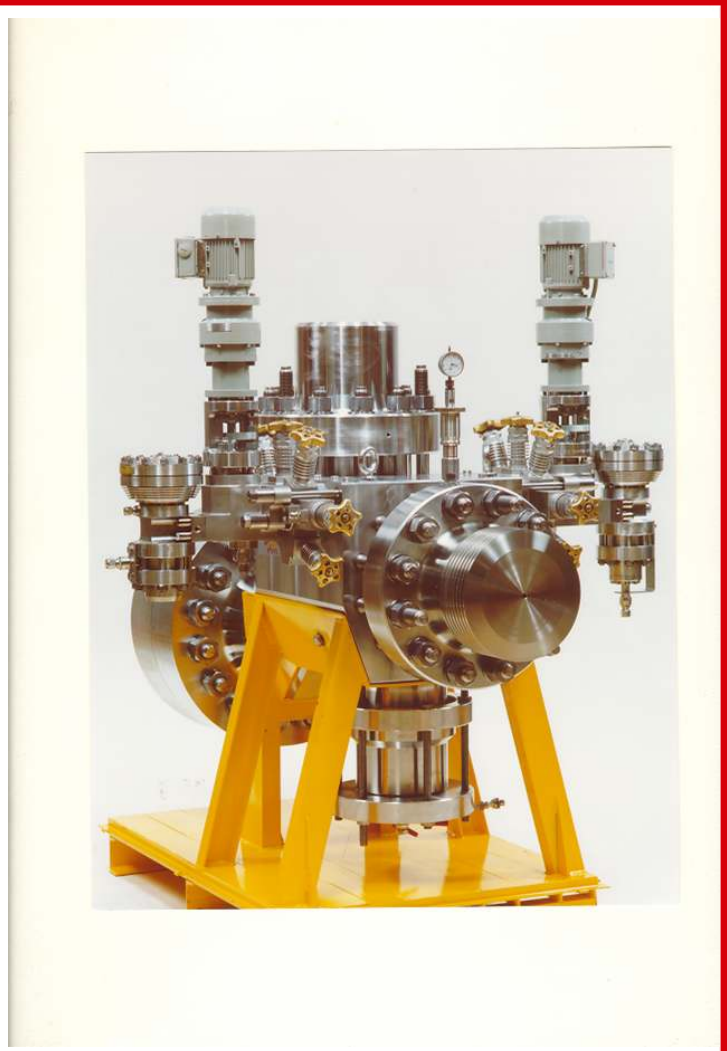
Major safety upgrades implemented in 1997: New emergency diesels in a new separated building



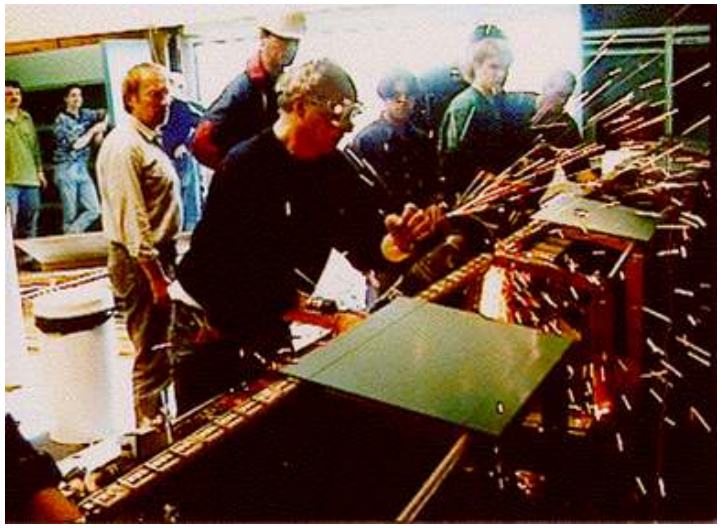
Major safety upgrades implemented in 1997:

- Replacing the primary safety valves by Sebim tandem relief valves directly mounted on pressurizer dome (feed & bleed during severe situations)





Major safety upgrades implemented in 1997: A new control room



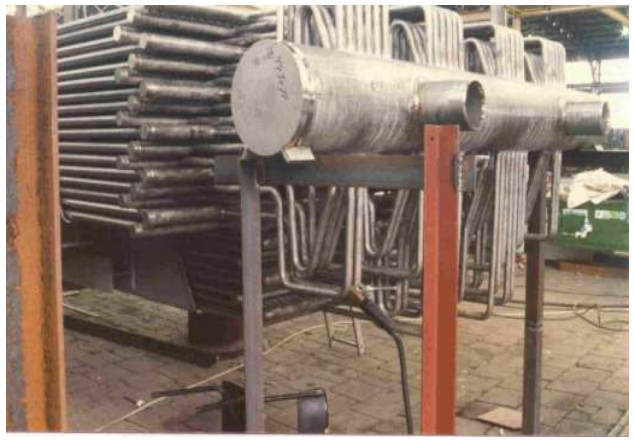
Other safety upgrades implemented in 1997:

- Additional bunkered building accommodating the reactor protection system
- New batteries with increased capacity
- Deep well system for long term cooling
- Seismic supports
- Leak before Break: new steam- and feedwater piping
- H_2-mitigation: passive cathodic recombiners
- Containment pressure relief system (filtered venting)
- Back-up control room and simulator

Major upgrades because of material degradation:

- Erosion-corrosion in steam-water systems in early years: several replacements and repair actions:
  - Heat exchangers
  - Valves
  - Some turbine blades
  - Piping

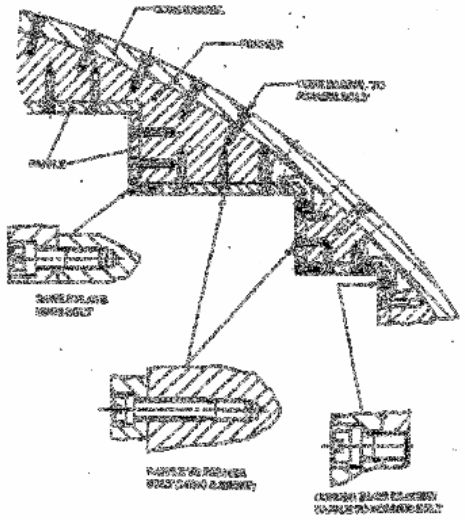
- In 1982 a big improvement was made by replacing the Cu-Ni condenser by a Ti condenser, the chemistry could be changed from phosphate chemistry to AVT chemistry: wastage of steam generator tubes stopped changed



Other upgrades because of material degradation

- Embrittlement of wires (spreader cabinet): in 1997 about 7700 wires were replaced: ‘the red wire project’

- RPV-internals: replacement of several Inconel X-750 baffle-former bolts due to cracking (IGSCC)



Major upgrades in outage 2006

- Replacement of generator stator due to damage as a result of short circuits in the external grid

- New turbine rotors with higher efficiency and a new water separator:

➔ 35 MWe Power Uprate

A changing view on Ageing Management (1995....)

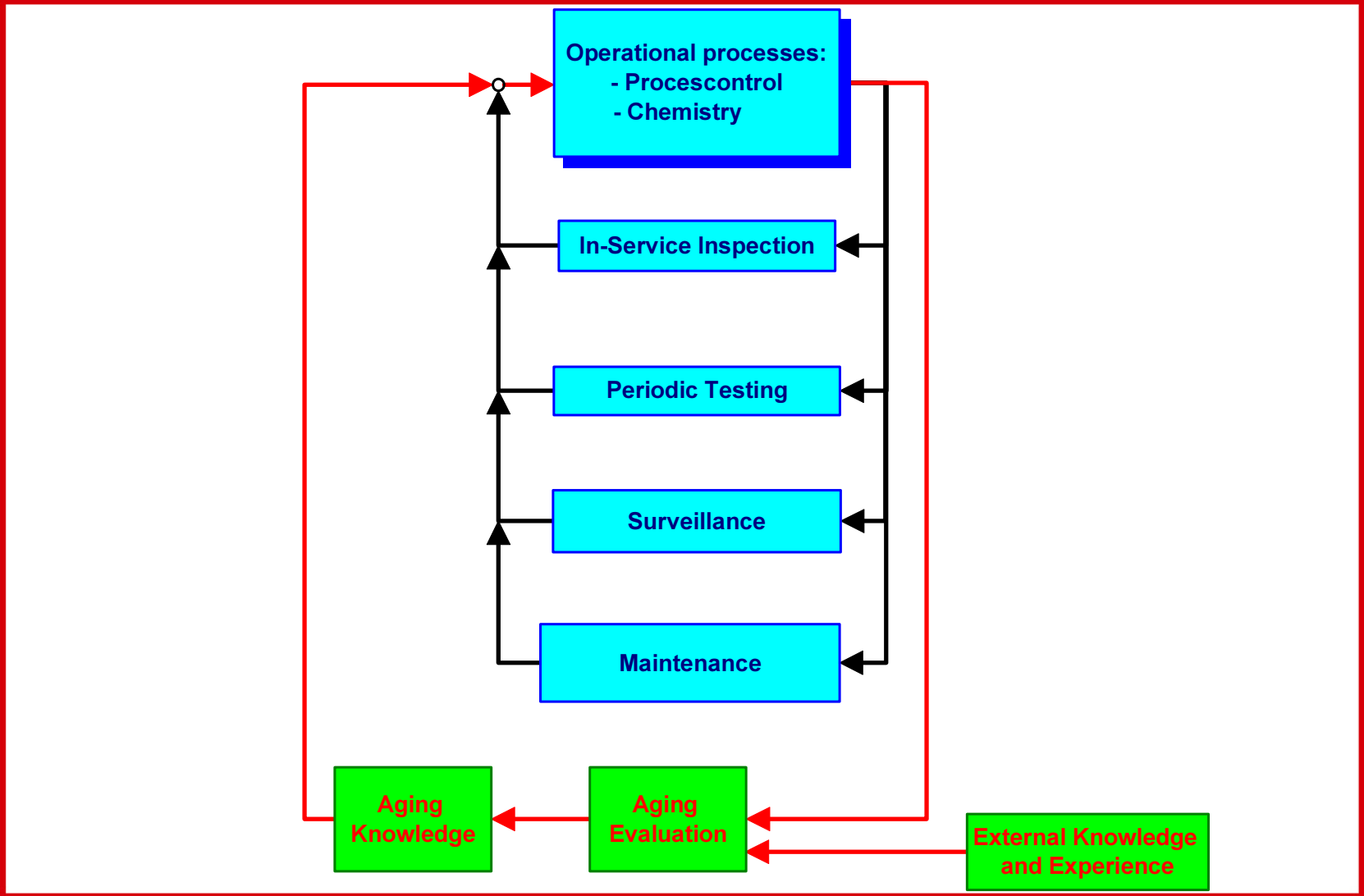
- International awareness of the importance of good ageing management at NPPs
- IAEA guidelines on ageing management
- NPP Borssele: a new license after the 1997 back-fitting project with a requirement on ageing management demanded by the regulator
- Specific attention on ageing and ageing management in the PSR

☺ AM is not a new thing! The way how to do it is new.

Activities in AM after 1998

- AM studies:
  - report on ageing issues
  - interviews with experienced engineers
- implementation of ageing management team
- program for AM experience feedback
- development of AM database (experience feedback database)
- active involvement in several international projects/groups on AM (IAEA, VGB, OECD..)
- PSR (1993-2003) with special project on AM
- AMAT review 2003

AM experience feedback system



Latest PSR

Specific project for review of AM:

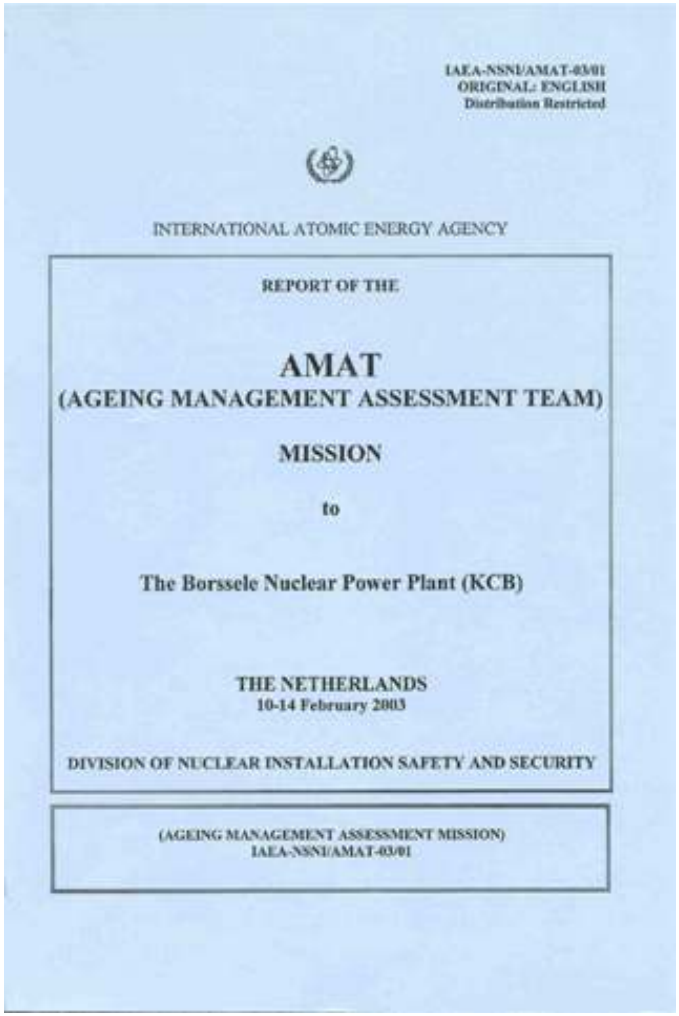
- Screening for long living passive SSC (systems, structures or components) important to safety
- Ageing Management Review of long living passive SSC (RPV, primary piping, containment, SG's, buildings…)
- Comparing AM at KCB to latest IAEA guidelines and best practices

Results SSC studies

- Most SSC in good condition: operation until 2013 is no problem
- Some issues:
  - More study on irradiated assisted ageing for RPV internals
  - Some repair actions on important buildings (coating outside)
  - Some further repair on underground cooling water piping

IAEA AMAT review 2003

- Objective to make an independent review of:
  - The ageing management system
  - The assessment of the ageing status of SSC important to safety (done for the PSR)
- Results:
  - ➢ according to AMAT team the SSC are, in general, in good condition and NPP Borssele has established a working Ageing Management System
  - ➢ recommendations and suggestions for further improvement of the existing ageing management
  - ➢ Identification of some good practices (e.g. the used AM database)



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INTERNATIONAL ATOMIC ENERGY AGENCY

REPORT OF THE

AMAT
(AGEING MANAGEMENT ASSESSMENT TEAM)

MISSION

to

The Borssele Nuclear Power Plant (KCB)

THE NETHERLANDS
10-14 February 2003

DIVISION OF NUCLEAR INSTALLATION SAFETY AND SECURITY

(AGEING MANAGEMENT ASSESSMENT MISSION)
IAEA-NSNI/AMAT-03/01

LTO-activities

- Feasibility study on ageing management investments for 60 years
  - Safety and economics (PLIM)
  - Physical ageing and technological ageing (obsolescence)
  - All SSC involved
  - No detailed assessments: a general engineering view to determine financial consequences of LTO
  - Performed by AREVA in strong cooperation with EPZ-specialists

General results of study

- No replacements of major primary circuit components necessary since e.g.
  - ✓ Sufficient safety margins regarding RPV embrittlement
  - ✓ Appropriate SG tube behaviour without PWSCC
- Civil structures are well maintained and repair programs have been performed
- Some components need extra spares: e.g.
  - ✓ Heater rods pressurizer
  - ✓ CRDM's
- Some BOP heat exchangers need to be replaced
- Major replacements of I&C necessary due to obsolescence
- Scope of investments no threat for economical LTO!

Urgent LTO-activities on safety

- Update of Ageing Management Review

  Reviewing potential ageing issues relating to 60 years of operation (next PSR and partly in progress)

- Update/renewal of Time Limited Ageing Analyses (TLAA's)

TLAA's: main topics

- RPV embrittlement, current TLAA comprises 40 years of operation
  - ➔ New surveillance program starting next outage
  - ➔ State of the art: both old (Charpy-V/RT_{NDT}) and new concept (fracture toughness/Master Curve)
  - ➔ Two new sets of irradiated capsules + new set of unirradiated specimens
- Fatigue assessments of components important to safety, current TLAA's comprise 40 years
  - ➔ Implementing new monitoring systems to determine realistic P,T transients
  - ➔ New state of the art fatigue assessments
- Environmental Qualification of E&I components
  - ➔ Database with residual lifetime calculations of comp's
  - ➔ Implementing monitoring systems for monitoring environmental loads

Thank you for your attention!

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