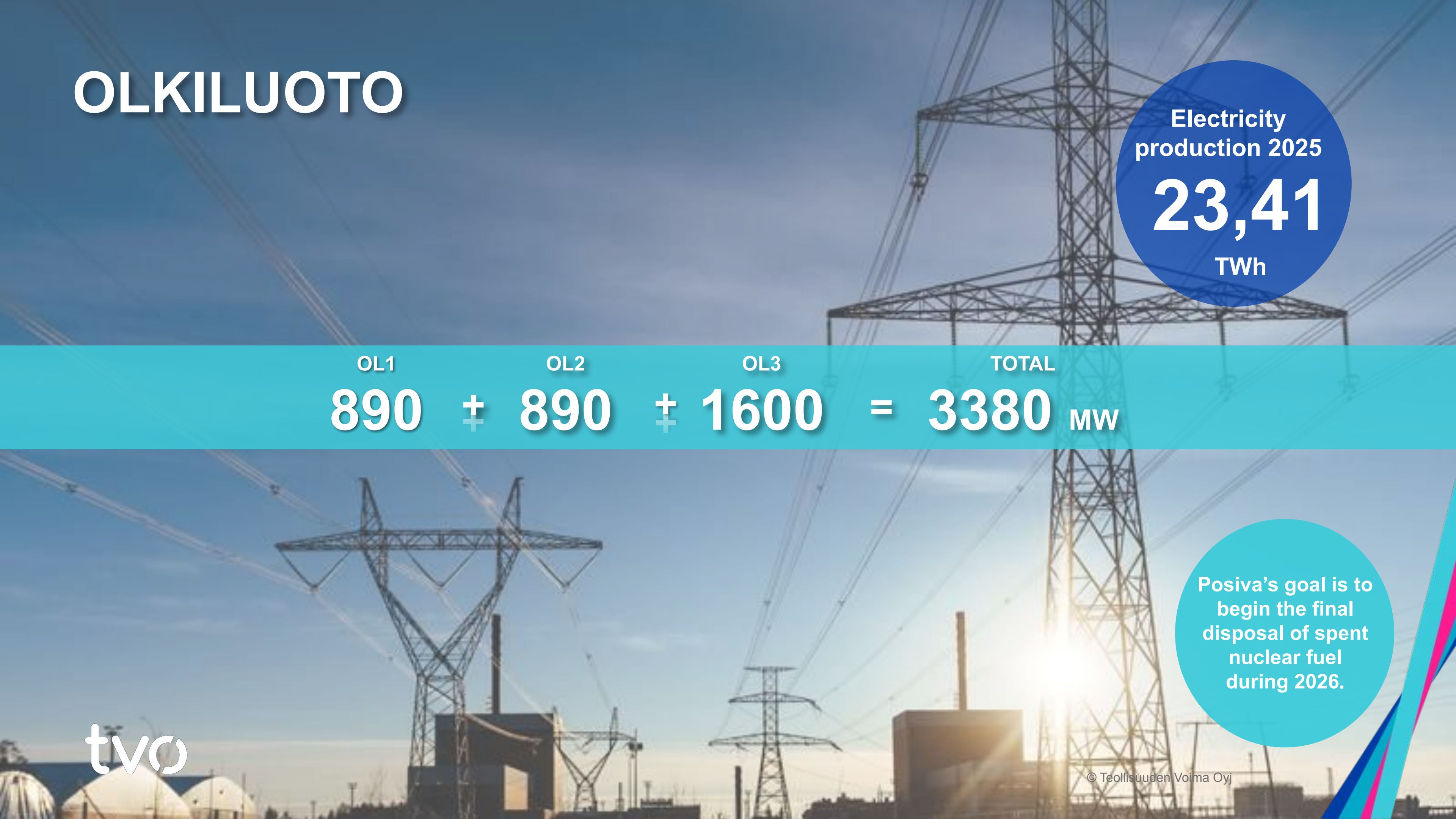
General Ageing management approach in early operation in TVO OL3

NIC2026

OLKILUOTO

4/2026



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Electricity production 2025

23,41 TWh

OL1		OL2		OL3		TOTAL
890	+	890	+	1600	=	3380 MW

Posiva's goal is to begin the final disposal of spent nuclear fuel during 2026.

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Purpose of the Presentation

To describe how ageing management is developed and implemented for a new nuclear power plant

To demonstrate a lifecycle-based approach from design to operation

Explain how ageing management becomes operational and value-adding

Key message: Ageing management is not a single programme – it is a structured way to manage the entire plant lifecycle.

Ageing management bases in Finland

The basis of the ageing management guideline YVL A.8 are coming from:

– Nuclear energy and other legislation

– IAEA Safety Standard Series No. NS-G-2.12, Aging Management for Nuclear Power plants, Safety guide, Vienna (2009)

– IAEA Safety Standard Series No. NS-G-2.6, Maintenance, Control and Internal Maintenance inspection in nuclear power plants, safety manual, Vienna (2002)

– WENRA Reactor Safety Reference Levels, May 2014, Issue I: Aging Administration

– WENRA Reactor Safety Reference Levels, May 2014, Issue K: Maintenance, Internal maintenance inspection and functional testing

– IAEA Safety Standards No. SSR-2/1, Safety of Nuclear Power Plants: Design (Vienna 2012)

– IAEA Safety Standards No. SSR-2/2, Safety of Nuclear Power Plants: Commissioning and Operation (Vienna 2011)

- IAEA guideline SSG 13 Chemistry

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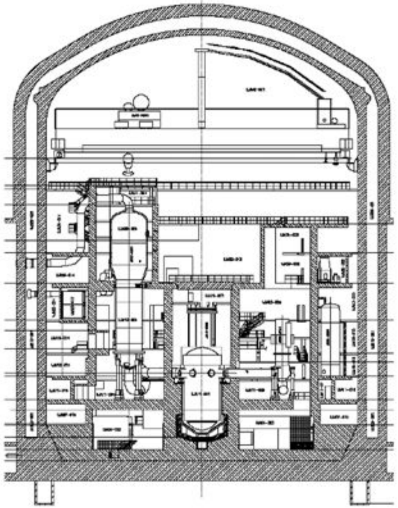
Near future ageing management guidelines will be updated

2019 ->	2028 ? ->
Exist A.8 emphasis	**New emphasis (direction)**
Document-based approach	Demonstrable effectiveness
Component-by-component	System- and phenomenon-based approach
Historical data	Predictive analytics
Physical ageing	Physical **and** technological ageing

Lifecycle Timeline of Ageing Management



Design → Construction → Early operation → Long-term opera

- Design bases and lifetime assumptions
- Supplier input and preservation, SAMP
- First licence-holder AMPs
- Continuous monitoring and feedback

Key principle:

Ageing management starts at design and matures during operation.

Connections

1. Connecting Nuclear to Industry: tailoring to applications

Industry requirements are embedded already in design and maintained through SAMP & AMPs

2. Connecting Nuclear to other Innovations

Innovation is integrated via continuous AM digital monitoring and diagnostics feedback loop over lifecycle

3. Connecting Nuclear to Investors

Systematic ageing management enables bankability and lifecycle value

4. Connecting Nuclear Generations

Connection: Operational AMPs and monitoring experience feeds next-generation designs

Design Basis: 60-Year Operating Lifetime

Design assumptions

- 60 years for non-replaceable SSCs:
  - Reactor Pressure Vessel
  - Containment
- Heavy, difficult-to-replace components also designed for long life
- Nuclear island buildings designed for long-term operation

Design measures

- Conservative margins
- Material selection
- Fatigue, corrosion and irradiation considered

Supplier Input: SAMPs as Design Baseline

Supplier role

- Special Ageing Management Programs (6 SAMPs)
- Focus on most critical, non-replaceable components
- Cover identified ageing mechanisms for 60 years

Licensee principle

- SAMPs are reference documents
- Not living operational programmes
- Ownership transfers to the licensee

Construction Phase: Preservation as Ageing Management

Challenge

- Long construction periods
- Long idle times for installed systems

Solution

- Systematic preservation (dry / wet)
- Corrosion prevention
- Preservation integrated into ageing management

Key message: Ageing must be managed even before operation starts.

Identification of Ageing Phenomena

Systematic approach

- Applied to all safety-classified and production-critical equipment (Scope 72000 lines)
- Physical (16 el. 45 mech. 11 component, 5 plant level AMPs) and technological (Obs. AMP) ageing considered
- AMPs are based on IAEA 9 attributes but not IGALL

Cross-check

- Maintenance programmes
- Inspection programmes
- Monitoring arrangements

Outcome

- Gap identification
- Improvement actions defined

Organisation and Training

Organisational model

- AMPs distributed to ~25 technical working groups
- Each group responsible for its technology lifecycle
- Same ER/AM process in OL1/2/3, only difference is focus;
  - OL1/2 physical ageing and (obsolescence)
  - OL3 obsolescence, the first time inspections and manage design weakness.

Critical success factor: Training

- Ageing management training starts early
  - General – for everybody
  - Special for elec. and automation, Special for mechanical, Special for civil
- Already during commissioning and early operation
- Personnel understand:
  - Ageing phenomena
  - Importance of trends, not only alarms
  - Long-term impact of daily actions

Key message

Ageing management works only if people understand it. Plan-Do-Check-Act

Primary Components
Valves, Actuators
Pumps, Fans, Compressors, Motors
Pressure Equipment, Hx
Piping
Switchgear (MV, LV, DC)
Uninteruptible Power Supply (UPS)
Cabling inc. Penetrations and junction boxe
TXS
TXP inc. SICS/PICS, HMI
SSS I&C
Instrumentation (CFI)
Nuclear Instrumentation
Radiation Monitoring
Chemistry
Process

Digital Foundation: Phenomena in Maintenance Systems

Implementation

- Potential ageing phenomena defined for all equipment locations
- Stored in maintenance management system

Used for

- about 4 % (2025) of failure reports are linked to the AMPs
- Trend analysis across similar components and similar phenomena
- Early weak-signal detection

Key message: Failures are events – ageing is a trend.

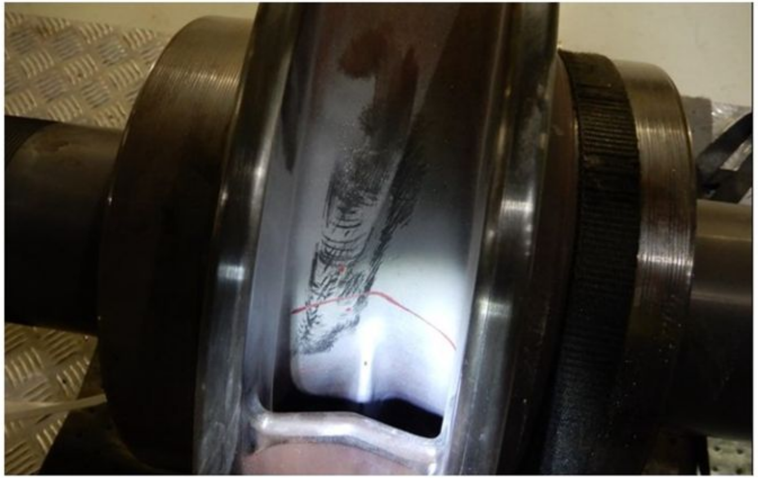


Figure 8. PT indication on the suspected crack.

Continuous Improvement During Operation

Information sources

- Monitoring
- Inspections
- Maintenance findings
- Failure analyses
- Transient budjet and other analyses
- Operating experience

AMP updates

- Effectiveness reviewed regularly – part of Equipment Reliabilty (ER) work
- Programmes updated based on evidence
- Demonstrate the closed loop: Design → Monitoring → Failure → Improvement

Final message: Effective ageing management does not prevent all failures –it prevents severe consequences and enables learning.

Conclusions

Without a well-defined ageing management concept already in the design phase, the development of AMPs becomes a major effort, and achieving sufficient quality is difficult.

Preventive maintenance programmes and inspection programmes should be based also on ageing management and identified ageing phenomena. Creating this linkage retrospectively is extremely difficult, if not practically impossible.

Early development of AMPs provides an effective framework for documenting identified gaps, weaknesses and improvement needs in a structured and traceable manner.

For OL3, the main challenges are related to technological ageing, while relatively few issues are linked to classical physical ageing. Those physical ageing issues that have occurred are largely related to design deficiencies or installation-phase errors, rather than ageing mechanisms themselves.

“There is never a good time for an organisation to develop ageing management programmes” —nevertheless, they must be developed before the plant is taken into operation.

Define clear responsibilities for AMPs and train the AM process (as a part of ER process)

Thank you!