

Connecting the dots to support Long Term Operation – What out there and what is needed?

Pål Efsing – Ringhals AB/NUQ

Presented at NRC workshop,

October 1st 2024

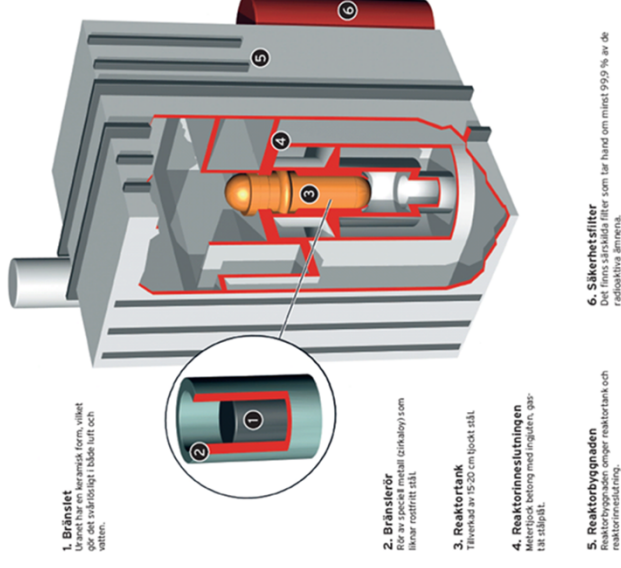
Why do we bother (apart from wanting to operate our plants)?

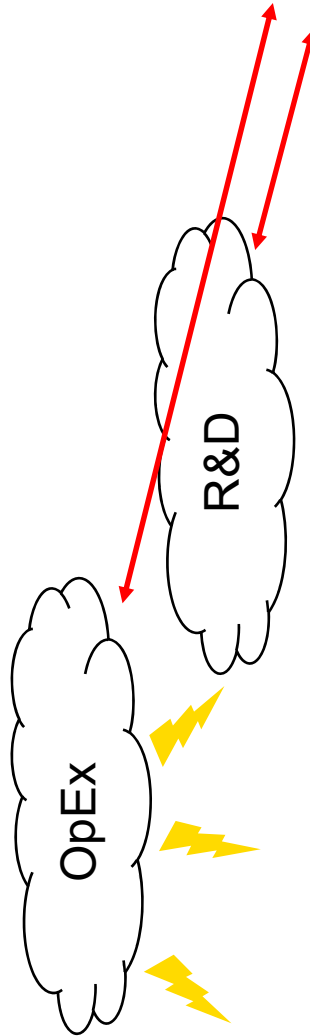
- Design, manufacturing and operation (including shut-down phase) of NPP needs to be readily reviewable and understandable for both internal and external stakeholders!
- Ageing and Ageing management is influenced by, and affects all, of the parts above



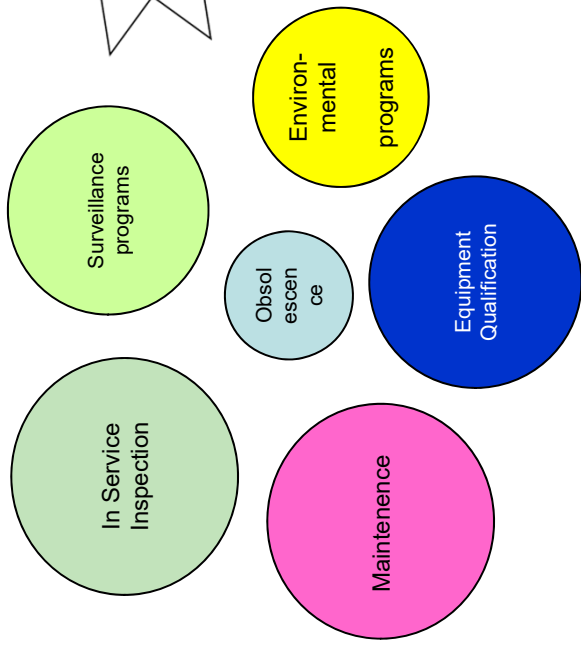
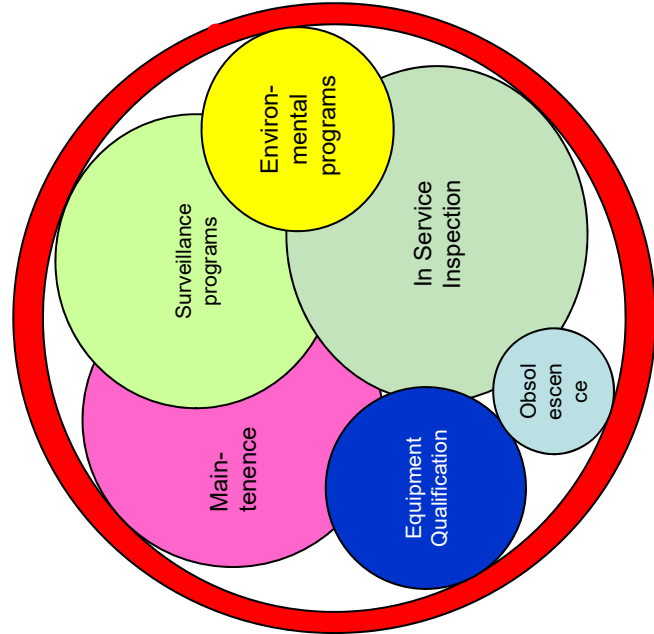
AM ideally starts at the very time when the signature pen is lifted from the contract by the utility

- A crucial part of the plants Defense in Depth
- Operation beyond 60 years a reality for many NPPs – Subsequent License Renewal or just LTO

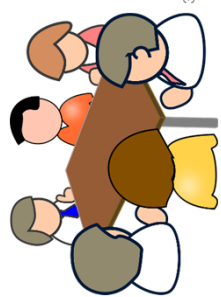




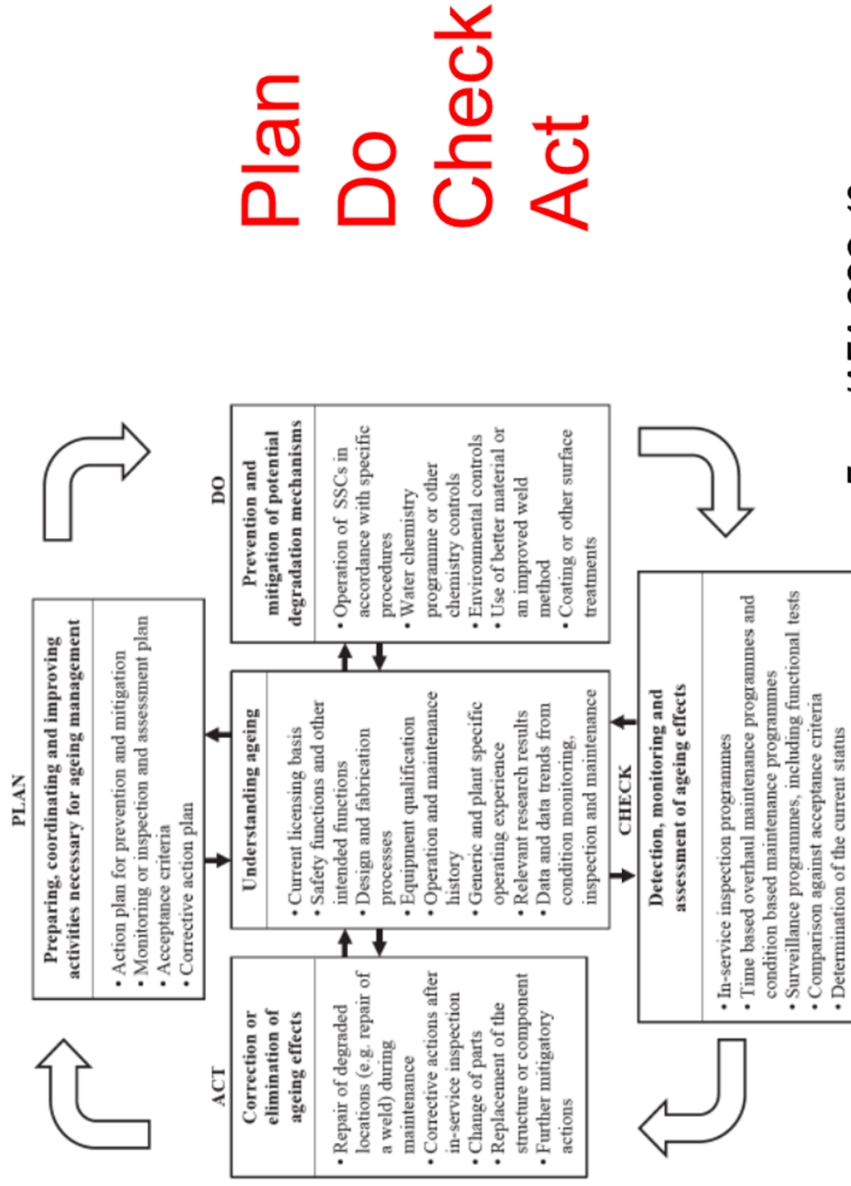
AM structure based on NS-G-2.12



Independent assessment (IAEA Safety report 57/SSG 48)
SALTO review including follow-up



"IAEA way of AM"



From IAEA SSG-48

Ageing management - documentation

1. Collect Operating Experience

EPRI SMEs collect data from field reports and inspection results and assess the efficacy of corrective actions (mitigation, repair, replacement).

2. Review Research Results

Updated research results from EPRI programs, technical literature, and conferences are reviewed by EPRI SMEs.

Materials Degradation Matrix (MDM) Revision 4 (3002013781; May 2018)

3. Evaluate Technical Gaps

Review gaps from previous IMT (close, keep open, re-rank); define new gaps based on OE; prioritize gaps with utility members.

BWR Issue Management Tables BWRVIP-167 Rev. 4 (3002018319; June 2020)
PWR Issue Management Tables MRP-205 Rev. 4 (3002018255; September 2020)
VVER Issue Management Tables MRP-471 (3002021033; September 2021)
CANDU Issue Management Tables IMR-101 (3002031002; September 2024)

4. Address High-Priority Gaps

Conduct research on representative materials, perform simulations, develop new models to address high-priority assessment and degradation mechanism gaps.

5. Calibrate Models

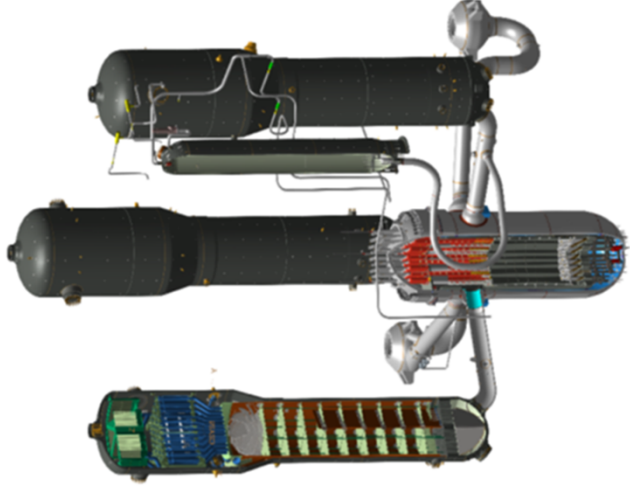
Improve accuracy and technical robustness of databases that provide inputs to materials models; calibrate conservatism applied to ageing management strategies.

6. Optimize Inspections

Increased confidence in ageing management strategies leads to optimized inspection requirements with respect to scope and frequency.

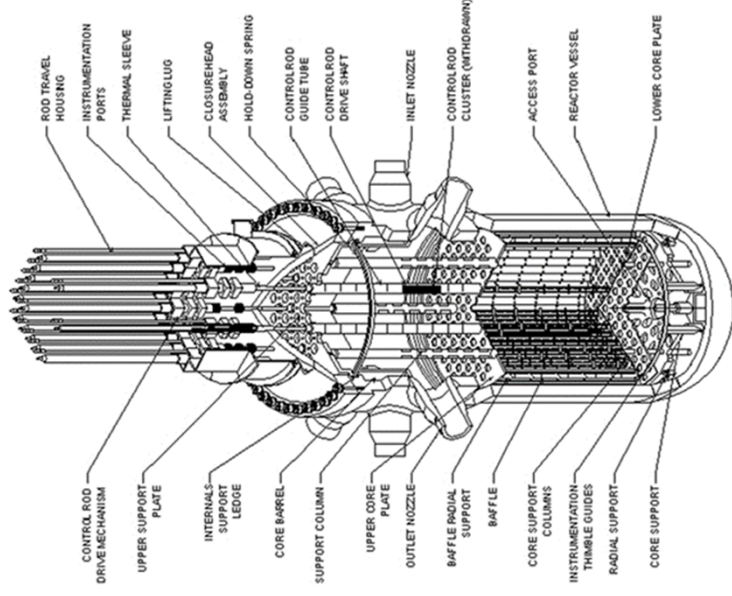


Use of harvesting to enable knowledge building



- Not purely a “primary circuit issue”
- Reactor internals a prime interest while assessing harvesting possibilities
- Mechanical test program often use modelling as a tool to determine the appropriate needs for proof
 - Not only to capture volume of test samples but to understand how we can extend the knowledge base
 - Decreasing the distance of extrapolation!
- Need to assess the correctness of acceleration!

- Irradiation effects:
 - Weld metal and high dose base material harvesting
 - Previous sampling from Zorita indicate a "non-conservatism in assessment basis"
 - Bolting/fasteners
- Thermal ageing and wear
- Hardfacing surfaces
- Core support structures



- Benchmarking of guidance's such as EPRI-MRP 227
- Improvements in non-destructive methods to detect aging (?)
- Assessment of indicators!

Remember this:

Highly unlikely that there will be "new and unknown" relevant degradation mechanisms!

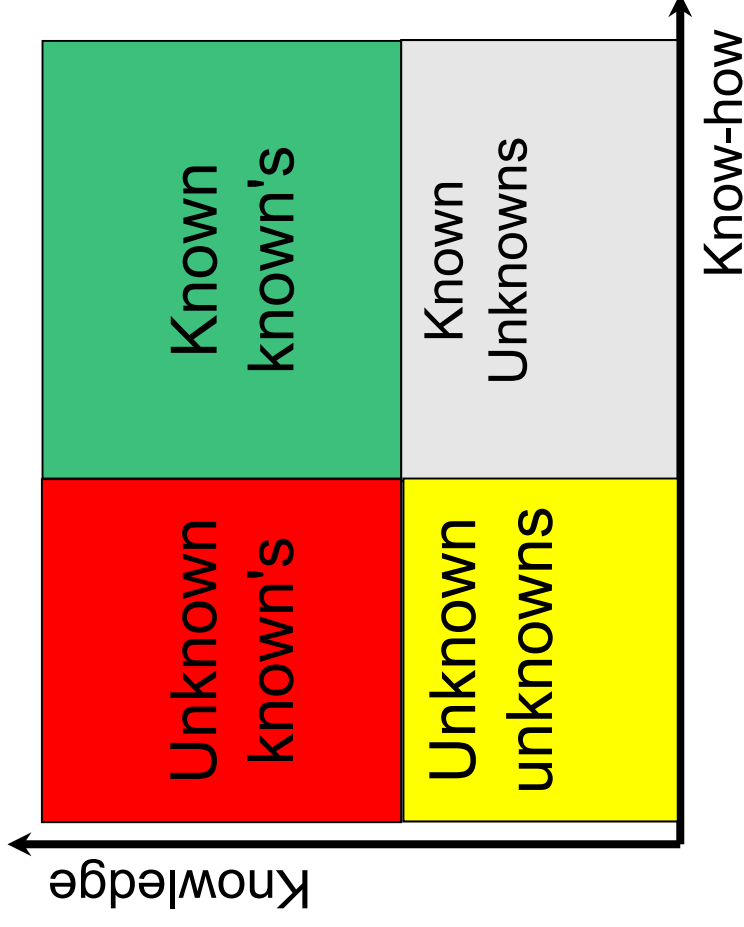
For relevant degradation mechanisms we have:

- Good knowhow (well described)
- A good knowledge on where they occur
- Partially missing high quality data

LTO and AM need to:

- Address the knowledge retention
- Maintain the knowledge warehouse
- Secure knowledge transfer

Maintaining a high level of knowledge of your LTO-documentation is an important part!



Some conclusions:

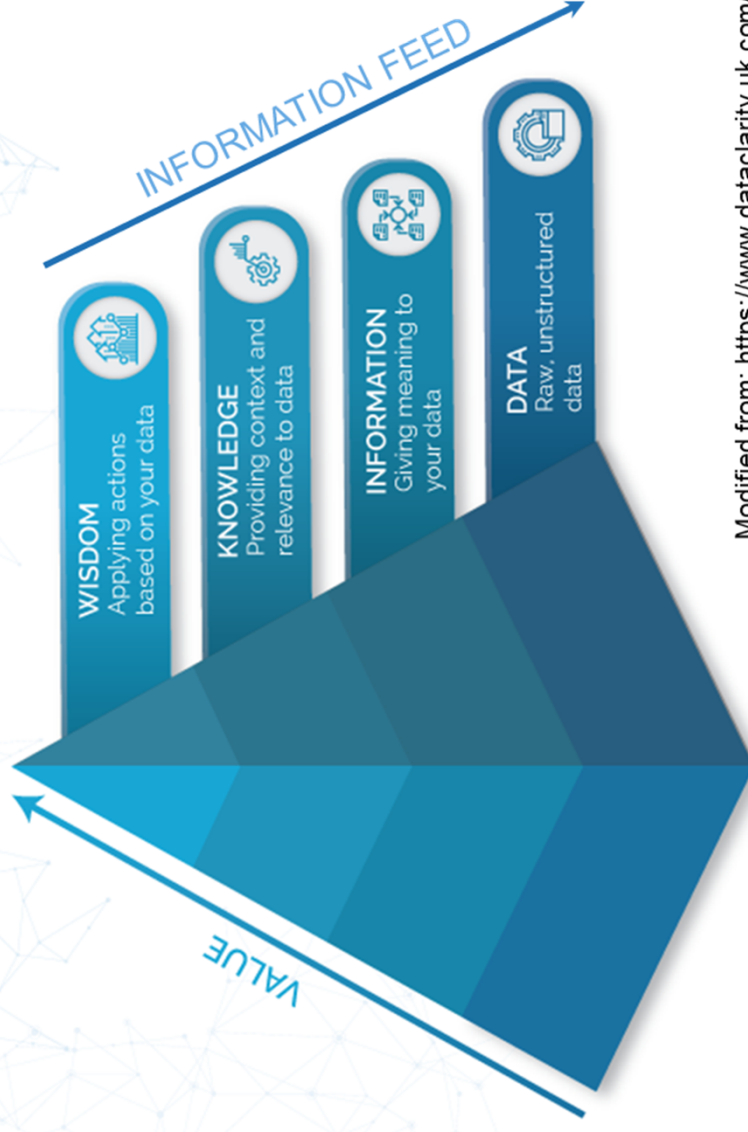
- Ageing start at day 1, the program needs to be assessed from the very signing of a contract of a project!
 - And don't forget: science tell us to continuously re-assess!
- It is always wise to refrain from drawing conclusion before you have a complete set of observation and physical evidence!
- Not all cases of degradation of pressure boundary or service systems are caused by high-profile mechanisms, in fact most are pretty basic, and well known!
- There are virtually no immune materials, everything will crack and/or degrade with time, get over it! Our task is to understand how and when and to suggest mitigative methods!
- It is increasingly important to work with active operating experience exchange to meet demands from all stakeholders
- It is increasingly important that the end-users, i.e. utilities, develop an understanding of possibilities and limitation given manufacturing issues to understand weaknesses and shortcomings!

Conclusions

- Documentation is a key measure for knowledge retention!
- Modelling is a tool to decrease the distance needed while extrapolating
 - Do make the connection between the dots to make the entire scope transparent and comprehensive
 - Important to use good quality data to validate models and tools
 - Using AI and/or machine learning is good, if you understand the limitations (need to be trained and if in doubt, may make up answers)
 - “Group thinking on stereotypes”- Only collect the available known information
- Subsequent/Sequential licensing possible as long as we understand the limitation to current database

Data Value Pyramid

The Four Steps to Getting Value from your Data



Modified from: <https://www.dataclarity.uk.com/solutions/data-quality/>



pal.ersing@vattenfall.com



Questions