FRAMATOME'S LESSONS LEARNED ON RISK-INFORMED APPLICATIONS (RIA)

THE EXPERIENCE GAINED FROM OLKILUOTO 3 EPR PROJECT

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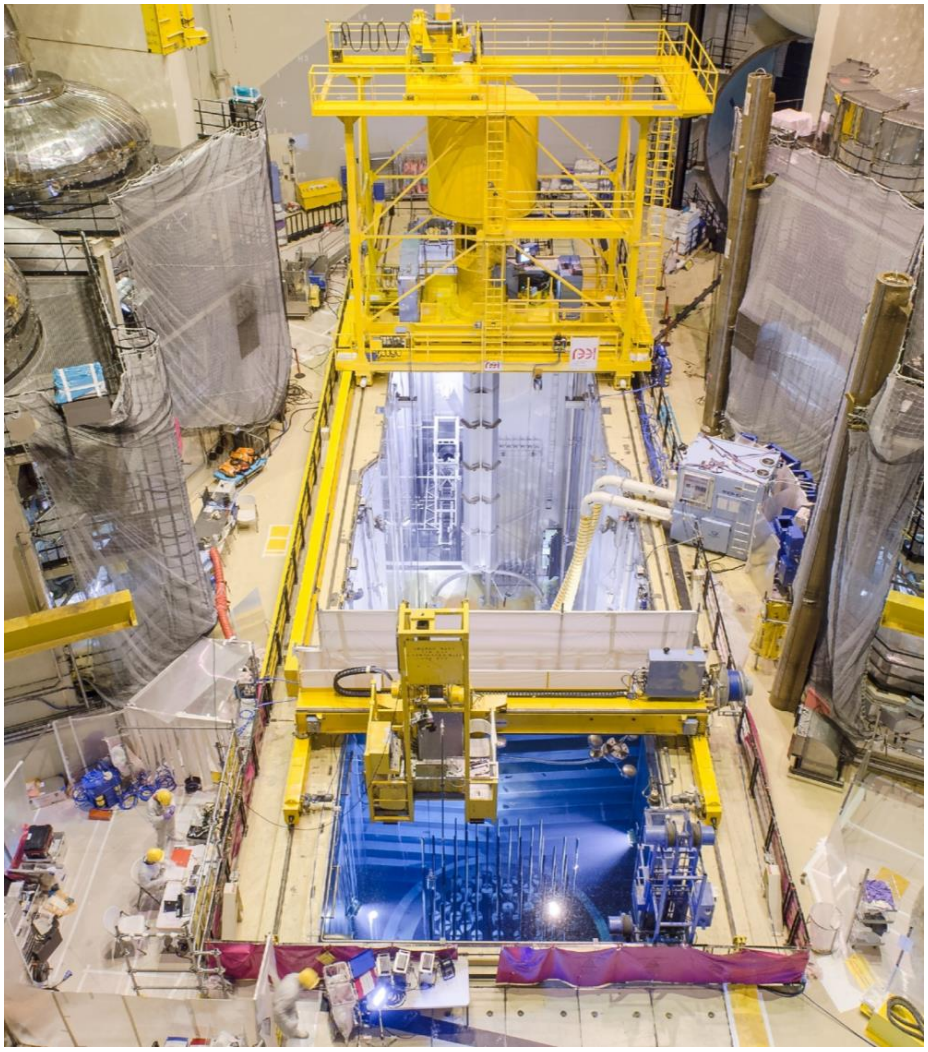
1. ABOUT FRAMATOME

About Framatome



- Framatome (formerly AREVA NP) is a major international player in the nuclear energy market.
- The company designs, manufactures, and installs components and fuel for nuclear power plants and offers a full range of reactor services.
- Framatome is owned by the EDF Group (75.5%), Mitsubishi Heavy Industries (MHI – 19.5%) and Assystem (5%).

Framatome Key figures *(July, 2018)*


Finland, Olkiluoto unit 3 - EPR Reactor

14,000 employees worldwide

3,3 billions annual revenue

58 locations

14 billions backlog

- **June 29, 2018, Taishan Nuclear Power Plant Unit 1 has been successfully connected to the Chinese grid.**
- **This is the first EPR reactor worldwide to be producing electricity.**


China, Taishan units 1&2 - EPR Reactor

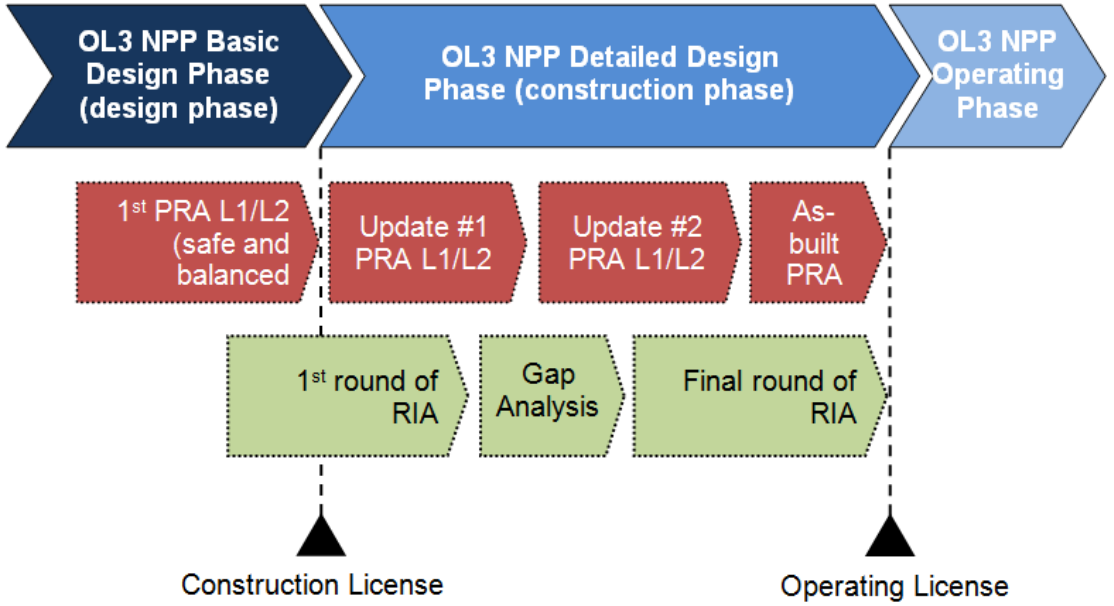
TVO framatome

2. FRAMATOME'S LESSONS LEARNED ON RISK-INFORMED APPLICATIONS (RIA)

THE EXPERIENCE GAINED FROM OLKILUOTO 3 EPR PROJECT

Specific context of a developmental NPP

- **Foreword : Olkiluoto 3 EPR was ordered in 2003 by TVO as a turnkey delivery. Electricity generation will start in September 2019.**
- **Usually RIA implemented on already operating plants**
  - Stable plant design and PRA models
  - Available operating experience feedback
- **Whereas, on OL3 EPR, RIA implemented from design and construction phases**
  - Follow the development of PRA models Level 1 and Level 2
  - RIA linked with the licensing schedule



Risk Informed Applications scope on OL3 NPP

- **Finnish regulatory guide YVL A.7 explicitly depicts the required RIA.**
- **The development of such Risk-Informed Applications at the design stage is a first-of-a-kind for a GEN III+ PWR in Europe.**
  - *"The PRA shall be used in the risk-informed development of the in-service inspection programmes of Safety Class 1, 2 and 3 as well as Class EYT system piping."* **RI-In-Service Inspection**
  - *"The PRA shall be used in the risk-informed development of testing procedures for systems and components important to safety."* **RI-Periodic Testing**
  - *"The PRA shall be used in the risk-informed development of the Operational Limits and Conditions (OLC) to assess their coverage and balance."* **RI-Technical Specification**
  - *"The PRA shall be applied to* determine the safety classification of structures, systems and components." **RI-Classification/categorization**
  - *"The PRA shall be used … to develop preventive maintenance programmes."* **RI-Maintenance**

RI-In-Service Inspection

- **Insights & Conclusion**
  - Out of the main coolant system only few systems show “high risk” areas.
  - Gave real benefits already at design stage
    - Allocating of inspections and justifications for reduction of inspections as well radiation doses
    - Risk ranking shows also the need of lower safety classified piping to be included in inspection program - only few cases are recognized
    - Using operating experience assessment (OPEX) supported final RI-ISI scope definition

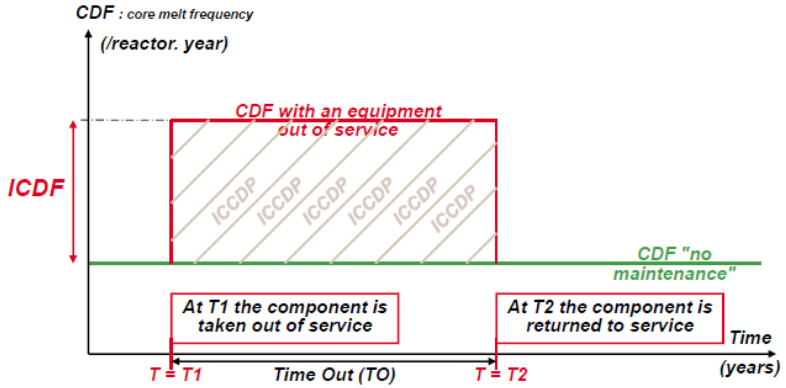
RI-Periodic Testing

Insights & Conclusion

- It optimizes test interval and strategy by focusing resources on high risk items and relaxing testing requirements for less important items.
- At design stage, the gain offered by this application is limited
  - At design stage, reliability data of SSCs modeled in the PRA could use “theoretical test interval”
  - Requires updates considering real feedback of operating experience

RI-Technical Specification

- **Insights & Conclusion**
  - Gave real benefits already at design stage
    - 4 times redundant safety trains (possibility to relax)
    - TS in electrical systems (reduced AOT in order to improve safety)



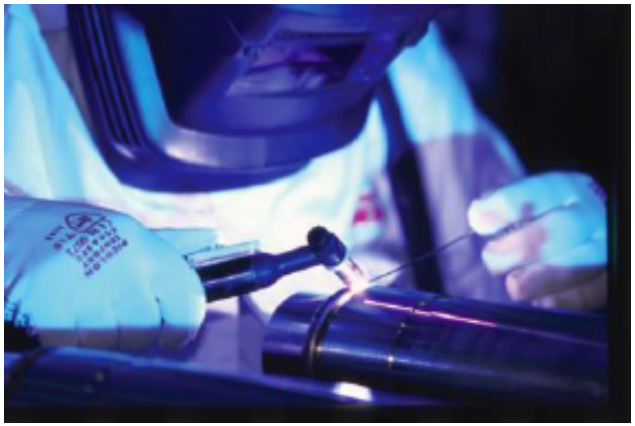
  - OL3 PRA model includes modeling of the transition from power to cold shutdown mode
    - Allows the assessment of CCDP due to the transition.
    - Comes from TVO and STUK experience .
    - Identification of situations for which transition to another operating mode may cause higher risk than continued operation in the current mode.

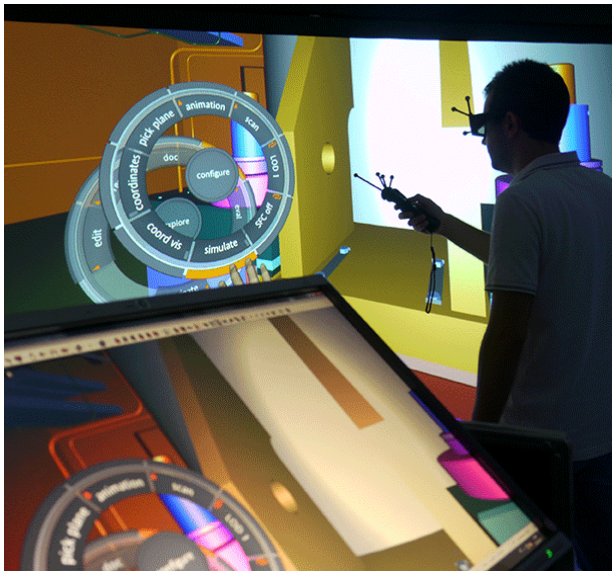
RI-Classification/categorization

- **Insights & Conclusion**
  - Gave real benefits already at early design stage.
  - PRA supporting determination of safety classification (quality grade) of SSC resulted in upgrading some items to a higher safety class.
    - CCWS pumps and isolation valves for RHR/LHSI coolers, as well as ESWS pumps are upgraded from SC3 to SC2.
    - RCP trip breakers are upgraded from SC4 to SC2.
    - Demineralized Water System is upgraded from EYT to SC4.

RI-Maintenance

- **Insights & Conclusion**
  - Gave real benefits already at design stage.
    - Systematic and documented means to determine maintenance plan
    - Combined safety, availability and experts considerations to define recommended activities
      - Decrease of number of unnecessary PM activities on less important items
      - Increase or confirmation of number of necessary PM activities on important items
      - Experts to give reasoning to increase maintenance effort e.g. due to damage potential of components ("expert significant components")
  - It shows clear benefits for 4 times redundant safety trains (relax)





3. CONCLUSION

Conclusion & Lessons Learned 1/2

- **RIA requires full consent of the country regulator. In Finland, STUK is clearly promoting and supporting RIA.**
- **Safety Benefit: identification of possible improvements of deterministic design (e.g. supporting systems).**
- **Operational benefit: reduction of effort on less important items while maintaining the safety level (graded approach).**
- **RIA are conducted by combining both deterministic and probabilistic (risk) insights; ensuring that safety is always put first.**
  - Balance deterministic rules by providing “risk insight”,
  - Governed by an expert panel that ensures an independent review and the final decision.
- **Major importance of Expert Panel gathering relevant competencies (depending on the application).**

Conclusion & Lessons Learned 2/2

- **Specifically to PRA experts, it is of major importance to keep critical awareness with regards to our PRA insights (PRA experts are part of Expert Panel).**
- **Unique PRA model combining level 1 and level 2 is strongly recommended (importance measures, e.g. RIF/FV).**
- **As much as possible, realistic PRA model shall be developed: symmetry modelling, level of detail to avoid unnecessary conservatism, splitting of plant operating modes to be consistent with TS mode definitions, etc…**

- **At the design stage, the development of such Risk-Informed Applications is a first-of-a-kind for a GEN III+ PWR in Europe.**
- **It offered STUK, TVO and Framatome the opportunity to learn from a fruitful collaboration.**

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Questions ?

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