
eDF


AREVA

Session I: Regulatory Cooperation on Generic and Design Specific Issues MDEP Working Groups

EPR Family presentation

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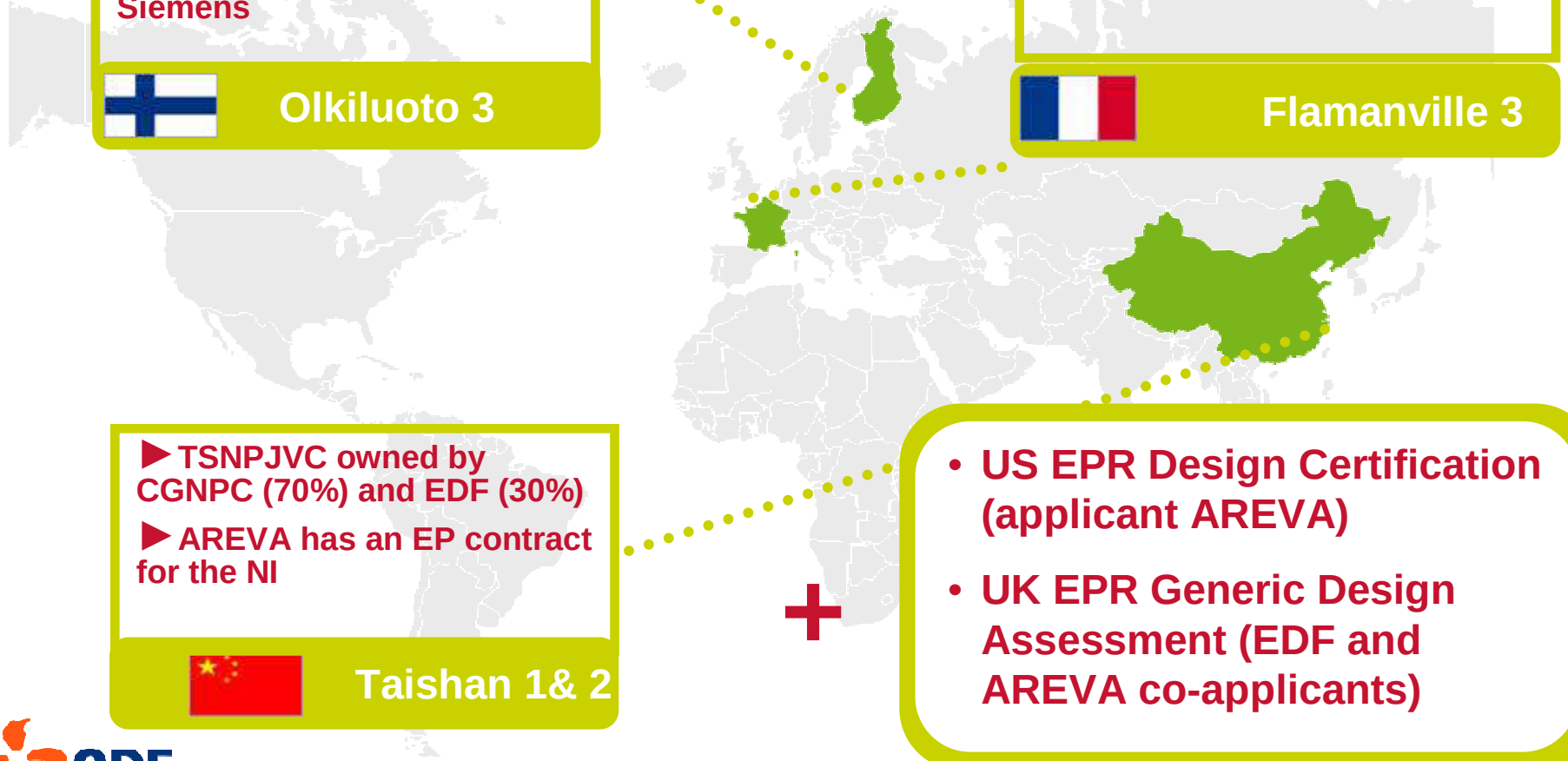
4 EPR NPPs under Construction
2 licensing process under progress



- ▶ TVO Owner Operator
- ▶ Turnkey contract
- ▶ Consortium AREVA-Siemens

Olkiluoto 3

- ▶ EDF Owner operator and architect engineer
- ▶ AREVA NSSS supplier

Flamanville 3

- ▶ TSNPJVC owned by CGNPC (70%) and EDF (30%)
- ▶ AREVA has an EP contract for the NI

Taishan 1& 2

+

- US EPR Design Certification (applicant AREVA)
- UK EPR Generic Design Assessment (EDF and AREVA co-applicants)

EPR Family targets

- Sharing best practices for construction
- Managing critical supplies and spare parts
- Capitalizing on licensing experiences
- Preparing for commissioning and operation
- Ensuring consistency and reliability for the public information

Synergies and series effect between the different EPR projects

EPR Family charter

- **EPR Family has been set up as a community of EPR operators and AREVA sharing experience and good practices through specific working groups**
  - **Safety and Fukushima follow-up**
  - **Preparation for Operations**
  - **Equipment Qualification**
  - **Start-up tests and Commissioning**
  - **Construction Feedback experience**
- **EDF and AREVA have more specific cooperation on design and engineering**
- **Cooperation programs are in place within EDF between TSN, HPC and FLA3 operators to prepare commissioning and align operating principles**
  - **Cross peer-reviews, secondees…**
  - **Systematic Approach to Training,**
  - **Maintenance (INPO AP 913),**
  - **OTS**

Harmonization of International Practices

- **MDEP initiatives for harmonization of practices aiming at**
  - **Harmonizing regulatory frameworks**
  - **Harmonizing Codes and Standards**
  - **Sharing of resources and experience among regulators**
- **But efforts are still necessary to move towards mutual recognition mechanisms between nuclear regulators and international certification process**
  - **Reduction of uncertainties in licensing process**
  - **Homogeneous safety level worldwide**
  - **Facilitation for standardization of reactor designs**
    - Licensable and constructible in every country with limited adjustments related to site specificities
- **This work should be extended to manufacturing activities**
  - **Implementation of common international requirements for QA systems in the nuclear field, independent certification of QA systems recognized by "all"**
  - **Methodology for surveillance of manufacturing to be defined in common, then performed by a third party and recognized by all – with preparation of the corresponding file**
- **Other important harmonization initiatives are progressing in parallel**
  - **WENRA RHWG: Safety of new NPP designs booklet**
  - **IAEA standards**
  - **EDF and AREVA contributes as industry stakeholders**

Stabilized Industrial Process

- **Experience acquired for the EPR main primary components manufacturing over the last decade allows**
  - **Definition of "Best Practices" for manufacturing**
  - **Definition of reference procedures and documents**
  - **For the whole set of components manufactured by AREVA**
    - Large forged, molded and machined parts
    - Heavy components
    - Mobile components

Reactor Pressure Vessel – St-Marcel

For an optimized manufacturing process meeting high-quality requirements, in particular for forging of large ingots

Quality and Safety Processes

- Nuclear safety requires no compromise on quality
  - From Design to in-service inspection
- Quality requirements
  - Applied to our own processes
  - Extended to our partners and contractors
  - All over the supply chain

- Development of safety culture internally and externally
- AREVA Qualification process for contractors and suppliers
  - Quality management
  - Awareness of responsibility
- International recognition of competence of AREVA's inspection body

Joint EDF-AREVA actions on construction

IAEA
International Atomic Energy Agency

IAEA Construction Workshop
Paris, 12 – 16 December 2011

Construction Experience Feedback
Lessons Learned

Ph. Riou - AREVA
Ph. Leigné - EDF
Paris, 13th of December 2011

AREVA

EDF
CHANGER L'ÉNERGIE ENSEMBLE

Workforce Exchanges between EDF / AREVA / Taïshan Customer

- **Workforce exchange**

- Chinese construction manager on Taishan spent 1 year within AREVA.
- Chinese delegations regularly visit OL3 site and several groups of Chinese engineers have spent 3 months on OL3 site.
- EDF organizes similar exchanges between TSN and FA3,
- 5 EDF experts assigned in OL3 commissioning team.

Exchange of Construction Experiences → Capitalization of Knowledge

EDF Experience Feedback - IAEA Workshop December 2011 - p. 12

Lessons Learned
Construction Examples

- **Reactor Building (RB) - Liner Cup**
  - Delivery of the L-Shaped Liner Cup on site in two parts assembled together
  - Installation of liner Cup in one element on the Base Slab
  - No welding and inspection in situ
  - Support frame to avoid unacceptable deformations of the Liner Cup during lifting

Total prefabrication of the liner cup
Capitalization of OL3 good practice

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Lessons Learned
Construction Examples

- **Reactor Building (RB) raft: Taishan experience feedback**
  - Massive concrete pour (4m thickness at FA3 and TSN)
  - One-step pouring is challenging, but has been mastered on Taishan:
    - Use of ice, integrated piping, heating cover.
  - 1 concrete step => 1 month saved compared to a 2-lift sequence

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Lessons Learned
Construction Examples

- **Fuel Building (FB) - Civil Works sequence**
  - Construction in zones to avoid critical interface with Outer Containment
  - Priority to pools & level +19.50m
  - Detailed and optimized construction sequence

Reduce the impact of FB construction on critical path

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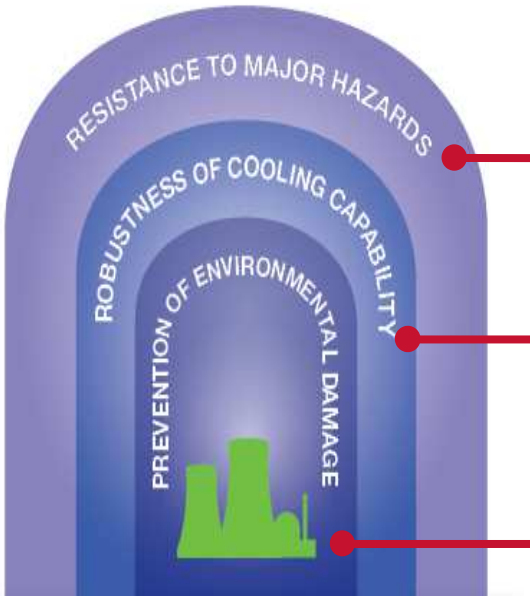
Aiming at Standardized EPR Nuclear Islands

- AREVA has developed a standard EPR™ concept combining
  - Reference design defined by technical features
  - Compliant with European Utilities Requirements
  - The unique AREVA licensing experience
  - Experience feedback from previous and current projects

- Cooperative work between EDF and AREVA for future common projects on this sound basis with focus on specific adaptation studies
- Potential for large scale effects for improved quality through stabilized industrial processes
  - AREVA manufactured primary components + subcontracted equipment
  - Reduction in lead time and construction durations
  - Possible anticipation of standard components' production
  - Strategic partnerships, qualification of local subcontractors to ensure a more dynamic response to market needs

Assessment of EPR Robustness

analyzing safety issues after Fukushima, and assembling the solutions to address them



Step 1

RESISTANCE TO MAJOR HAZARDS

EVENT:
External hazard: Earthquake, Flooding, Extreme Temperature
Internal hazard: broken pipe or valve, fire
Combination of hazards

OBJECTIVE:
Preserve plant safety

Step 2

ROBUSTNESS OF COOLING CAPABILITY

EVENT:
External hazards beyond plant design (worse case scenario)

CONSEQUENCE:
Damage to cooling capability

OBJECTIVES:
Provide sufficient time to restore cooling capability
Avoid cliff edge effects (fuel damage) in reactor (incl. pools)
Preserve assets

Step 3

PREVENTION OF ENVIRONMENTAL DAMAGE

EVENT:
Unforeseen event(s) creating extreme conditions

CONSEQUENCE:
Loss of safety functions, leading to hydrogen production, and fuel damage

OBJECTIVE:
Minimize external radioactive release

Robustness of cooling capability

Behavior of the EPR (at power) Improvements & variants

- **The initial post-Fukushima assessment of EPR shows good resistance to « beyond-design » earthquake or flooding events**
- **Potential improvements are identified to further enhance the EPR robustness:**
  1. **Means to connect mobile equipment for:**
     1. **Spraying cold water into containment**
     2. **Refilling EDG tanks and refilling SBO diesel tank from EDG tanks**
     3. **Refilling EFW tank**
     4. **Refilling the spent fuel pool (SFP)**
  2. **Provide electrical/manual device to down-lift the fuel assembly in the racks**
  3. **Provide adequate information for the SFP (additional instrumentation, qualified instrumentation, availability in control room)**
  4. **Means to permit external power supply (mobile generators): dedicated switchgears, cables**
  5. **Increase the 12-hour battery autonomy under investigation (to improve accident monitoring)**
  6. **Hydrogen control in the SFP hall under investigation (H2 production and distribution ?)**
- **Variants**
  1. **Containment venting as implemented on OL3 enabling to control releases. EDF assessment is ongoing**

Total loss of AC power supply discussion (1/2)

- ***WENRA : "… a loss of all AC power supply should be considered in the design. The nuclear power plant shall have arrangements to enable the decay heat removal in this situation".***

- ***AREVA/EDF proposal : "either the protection of the required electrical power supply is ensured against rare and severe hazards or a loss of all AC electrical power supply should be considered in the design for rare and severe hazards".***

Ongoing discussion with WENRA RHWG

Total loss of AC power supply discussion (2/2)

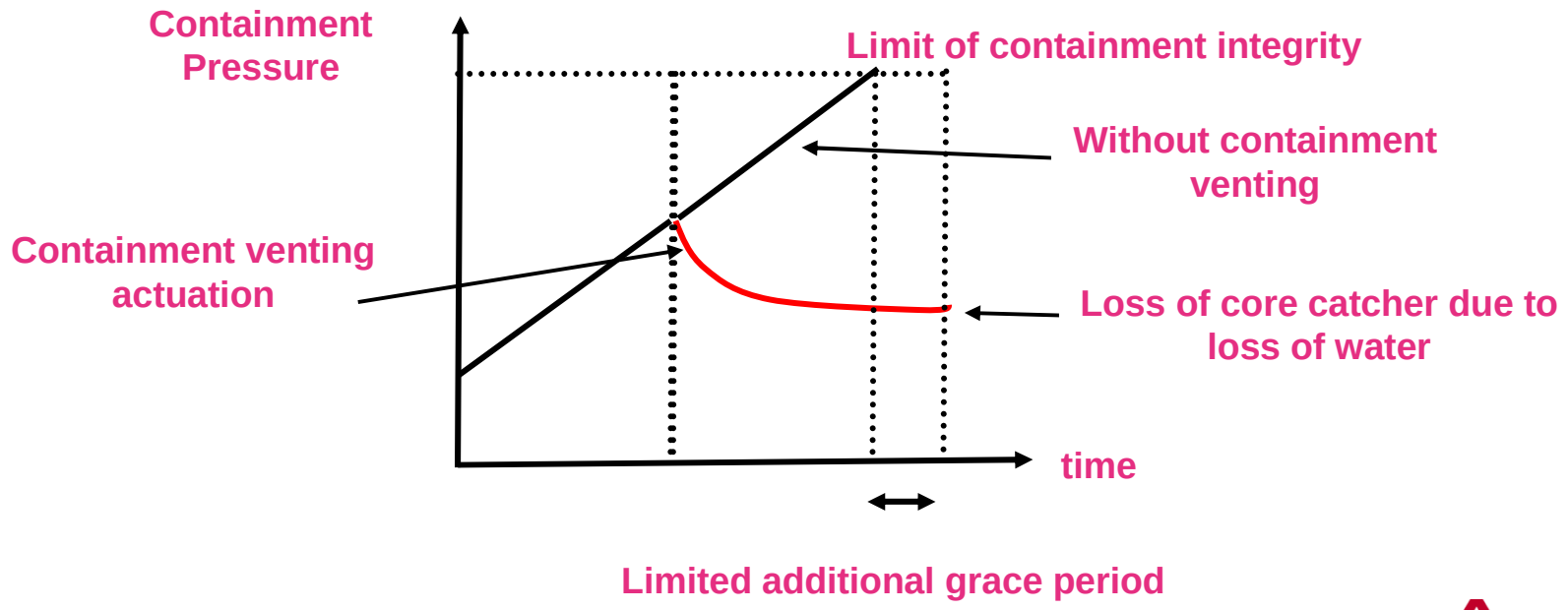
Context :

- ***Fukushima: core melt of 3 reactors with passive systems.***
- ***Essential cause : I&C loss because of DC power failure***
- ***All non protected systems could have been defeated.***
- ***Necessity to upgrade the protection against extreme external hazards***
- ***Bunkered electrical AC sources are foreseen as an additional line of defense in several countries***
- ***The industry must keep the responsibility of the technological solutions. Ex steam driven pumps vs. electrical pumps***

Discussion is taking place within the WENRA RHWG

Containment venting system(1/2)

- **Preliminary assessment performed shows:**
  - **Large releases (containment failure) are prevented but EPR radiological targets are challenged after 3 days of operation possibly impairing emergency team work on site**
  - **The system does not increase significantly the grace period**



Containment venting system (2/2)

- The original safety objectives set by the French and German Regulators in 1993 was to warrant containment integrity in case of low pressure core melt on the long term. Thus containment venting was not an “acceptable” design option
- For the EPR reactor the use of spray with the modification proposed for Flamanville 3 is preferred to containment venting as a baseline
- Provisions can be taken to implement a containment venting if it is required

Towards harmonized safety positions

- **EPR Family is committed to develop harmonized positions**
  - **Post Fukushima measures and modifications**
  - **…**
- **…but different regulatory practices and positions result in differences between EPR projects**
- **Convergence on safety standards will foster harmonization for future projects**
  - **WENRA Safety Objectives for New Power Reactors,**
  - **IAEA DS 367 on Safety Classification**
  - **…**
- **…but still more detailed work will be always needed by MDEP EPRWG to address design issues and avoid undue departures between projects**

Conclusion

- **EPR Family experience benefits today to current and future EPR projects in terms of design, construction and preparation of operation,**
- **EPR Family welcomes MDEP EPRWG initiatives to promote harmonization of EPR safety features and mutual recognition mechanisms that would benefit to safety worldwide,**
- **Standardized reactor design accepted worldwide would reflect a mature technology with high quality and safety level.**

EPR reactor construction site, Flamanville (France). 2012, September

EPR™ reactor construction site, Olkiluoto (Finland). 2012, September

AREVA and EDF are supporting MDEP work to strengthen its organization and other regulator initiatives to promote international harmonization