Nuclear Engineering Division

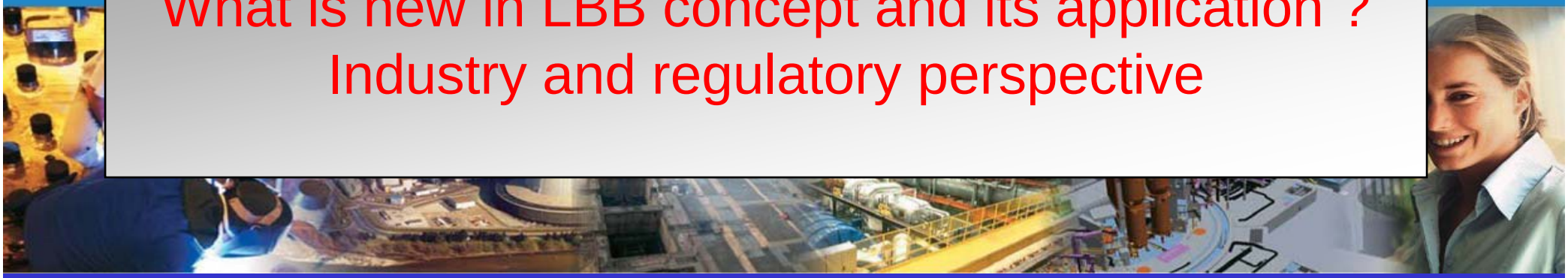
BRANCHE PRODUCTION INGÉNIERIE

SEPTEN

EDF

Plenary session A04-1

What is new in LBB concept and its application ? Industry and regulatory perspective



EPR-FA3 : From LBB to Break Exclusion

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SMIRT 19 Conference August 13-17, 2007 Toronto, ON, CANADA

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- introduction
- "break exclusion" and safety analysis
- practical application for EPR-Fa3
- 3rd level of defense in depth
- final consequences for EPR-Fa3

Introduction (1/2)

- **LBB is not really used on French PWRs, except for :**
  - ✓Steam Generator Tubes
  - ✓ISI defect evaluation and defense in depth in some limited cases

- **HELB :**
  - ✓postulated DEGB in conventional location for primary systems : MCL
  - ✓Postulated DEGB in Steam and Feed water systems
    excepted for the part outside the containment – up to the main anchor point
    US-RG application of "superpipe" concept
  - ✓ANSI-ANS 58-2 (1988) for class 2 and 3 piping

- **Justification through NUREG 1061 requirements has been achieve in different pilot studies**
  - ✓ the "limiting" locations on French operating plants: duplex SS cast elbows, SS DMW, mixing tee thermal fatigue, stratification in feedwater system
- **Methods for justification are available in French Codes :**
  - ✓RCC-MR Appendix A16 (G03-3) usable for PWRs
  - ✓RCCM-RSEM for surface flaw analysis

Introduction (2/2)

- **EPR-Fa3 considers that some piping systems have to be considered as "unbreakable" in different conditions for safety reasons and corresponding consequences in term of margins and operation**

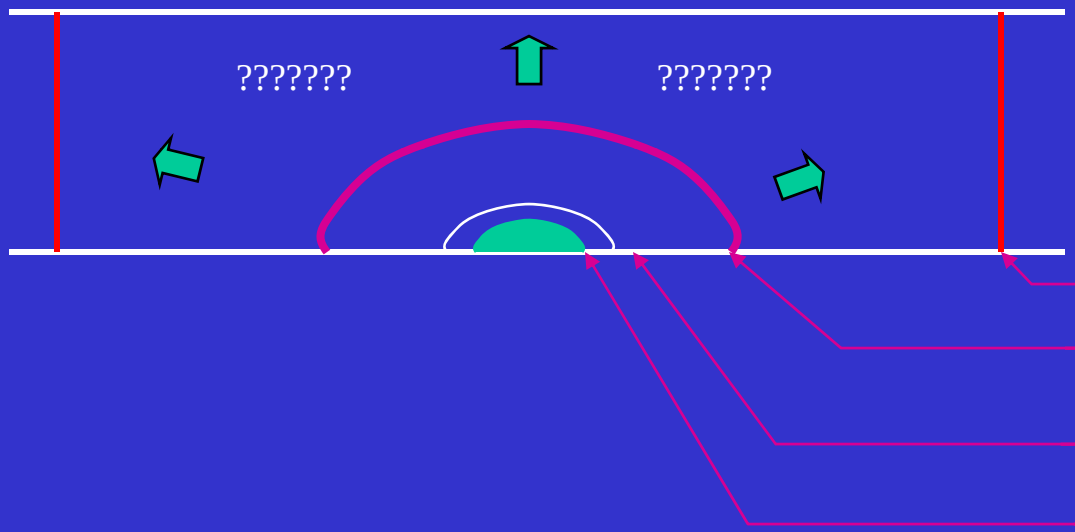
- **In this case :**
  - ✓Defense in depth principles are reviewed for corresponding piping systems
  - ✓Consequences on the other systems and structures is also defined
  - ✓A specific methodology for justification is developed between Utility (EDF) and Vendor (AREVA)
  - ✓Rules and data are collected and specific actions are taken
  - ✓Presentation to Safety Authority

- **Break Exclusion : Not only a piping integrity question but safety consequences are studied**

"break exclusion" and safety analysis

➢Defense in depth principle applied to piping systems :	➢Consequences of "break exclusion"	➢ Consequently
✓1 : no degradation, no break of HE piping systems for all design transients : design, fabrication, NDE, hydrostatic test, overpressure protection	➢ ↗	➢ simple design, limited length, limited number of welds, forged nozzles, HQ material and welding, strong NDE criteria for defects and thickness
✓2 : surveillance and agreement with previous predictions	➢ ↗	➢Many surveillance programs : transient monitoring, chemistry, displacement, material properties
✓3 : HELB consequences : core cooling and containment	➢ ↘	➢No break in design basis transients : replaced by larger connected pipe that does not fulfill BE criteria ➢Flaw tolerance to large through wall cracks inside containment ➢DEGB analysis with realistic data
✓4 : Severe accident sequences	➢ →	➢No major changes

Differences between BE and LBB



- TW critical crack size
- SC critical crack size
- EOL SC crack
- initial crack

Practical application for EPR-FA3 (1/2)

- **Applied to MCL and MSL (inside & outside containment)**

- **Consequently, MCL and MSL will be RCCM class 1+**
  - ✓+ : more stringent criteria compatible with SOA level
    - For design, fabrication, material (and material properties) and NDE
  - ✓ MCL in SS with narrow gap DMW,
  - ✓ MSL in CS

- **Normal design requirements for all class 1 components**
  - ✓Sizing of pipes and supports for static and dynamic loads
  - ✓No active "significant" degradation for 60 years (no cracks, no thinning, no thermal mixing areas)
  - ✓"Large" flaw tolerance : ¼ t with SF of 2 – 1.6 – 1.2 for level A-C-D with EOL material properties
  - ✓ + any crack growth mechanism (fatigue and-or corrosion) has to be evaluated for 60Y on a conventional 5x20mm initial crack

Practical application for EPR-FA3 (2/2)

- **Material mechanical properties**
  - ✓Codified values if available
  - ✓Through "direct" measurements on material if not available in the Code
  - ✓Thermal ageing for 60Y of operation has to be considered
- **Fabrication** : **forged tee, large bend radius, SL anchor point…**
- **NDE** :
  - ✓100% with high performance (without formal performance demonstration) for defects; with 2 independent techniques for DMW
  - ✓All the thickness of components and counter-bore will be checked in accordance with design standards
- **Surveillance** :
  - ✓transient monitoring, displacement, temperature, chemistry…
  - ✓ISI for all welds with a justified performance and frequency
  - ✓All the predictions of potential degradations have to be review and updated maximum every 10Y (in connection with PSR)

3rd level of defense in depth : safety analysis

- **For piping inside the containment, a critical rectangular TWC has to be evaluated and sufficiently large :**
  - ✓Corresponding leak has to be detectable by LDS with SF in normal op.
  - ✓Basic SF of 2 on crack size and 10 on LFR are presently base values
- **For piping outside containment**
  - ✓Corresponding length has to be "larger" the the max length of the EOL critical surface crack
  - ✓No specific LDS added
- **DEGB has to be analyzed with realistic data for safety analysis**

Final consequences for EPR-FA3

- No LBLOCA or SLB in the design transient list for all the mechanical component design stress report and core analysis
- Replaced by the larger diameter connected line (in position)
- No pipe whip restraints
- 2A equivalent static load is considered for all class 1 component supports
- 2A is used for ECCS cooling systems, containment and component qualification to accidental conditions