EUROPEAN PRESSURIZED REACTOR (EPR)

Directorate General for Nuclear Safety and Radiation Protection (DGSNR) Point of View

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DGSNR’s point of view on the EPR project

- **Historical milestones**
  - ✔ The set-up of French-German organisations
  - ✔ Development of the EPR project
  - ✔ The successive steps in the safety analysis

- **The EPR safety approach**
  - ✔ EPR safety objectives
  - ✔ Key subjects examined by the Safety Authorities
  - ✔ Contents of the Basic Design Report and of the EPR Technical codes
  - ✔ Contents of the “Technical guidelines”

- **State of instruction - Prospective aspects**
Historical milestones (1)
The set-up of French-German joint organisations

Safety organisations:

1989:
✔ Common declaration by BMU and the French Ministry of Industry.
✔ Agreement between GRS and IPSN.

1990:
✔ Creation of the DFD (Deutsch-Französischer Direktionsausschuss)
Historical milestones (2)
The set-up of French-German joint organisations

- Nuclear industry and customers:
  1989:
  - ✔ Creation of NPI by Framatome and Siemens/KWU.
  - ✔ Three different R&D programs for future PWRs developed separately:
    - NPI common product
    - EDF-Framatome REP 2000 N4+program
    - Siemens-German utilities “Planungsauftrag”
  1992:
  - ✔ NPI, EDF and German utilities R&D programs merged into the EPR program. Creation of the EPR Project Directorate
  - ✔ First mission: developing the nuclear island of EPR.
  - ✔ Aim: ensure that the same PWR design be licensable in both countries
Historical milestones (3)
Development of the EPR project

- **1992-1995: Conceptual Phase**
  - nuclear island only
  - *EPR “Conceptual Safety Features Review File” (Sept 1993).*

- **1995-1997: Basic Design Phase**
  - nuclear island only

- **1997-1999: Basic Design Optimisation Phase**
  - examination of the possibility of increasing plant power, reduction of investment and generation cost, complying with the safety requirements.
  - Updated “*Basic Design Report*” (February 1999).
The successive steps in the safety analysis (1) : the safety goals

- **1991:** DSIN letter to EDF on the safety of future PWRs

- **1993:** DFD “joint declaration by the French and German safety authorities on a Common Safety Approach for Future PWRs”

- **Iterative procedure between the industrial design development and the safety approach:**
  - ✔ potential inconsistencies identified early
  - ✔ extend of necessary refinement within the safety approach easier to estimate
The successive steps in the safety analysis (2) : the joint examination process

*Up to 1999:*

- Examination by the technical supports IPSN - GRS
  => common reports
- Examination by the expert groups GPR - RSK
  => common positions transmitted to DFD
- Adoption of these positions by DFD (co-signed letters)

*Since 1999:*

- Examination by the technical supports IPSN - GRS
  => common reports
- Examination by the expert group GPR, including invited German experts
The successive steps in the safety analysis (3) : synopsis

- Sept 1993: Conceptual Safety Features Review File (CSFRF)
- From 1995 on:
  - Basic design studies
  - "EPR Technical codes"
- 1997-1999: BDR optimisation phase
- 1999: Submission of the Optimised Basic Design Report
- June 1993: Joint declaration on a common safety approach for future PWRs
- 1993-95: Investigation of 5 key subjects from the CSFRF
- Feb 1995: DFD joint recommendations on the CSFRF key subjects
- 1995-2000: Joint examination of the basic design studies
- Oct 2000: adoption by GPR of the "EPR Technical guidelines"
The EPR safety approach: Strategy - Safety objectives

- Safety approach applicable to PWRs to be built at the beginning of the 21st century => evolutionary approach (>1000 r.y of operating experience in both countries)

- These reactors may still be in operation in 2070-2080 => ambitious safety objectives
EPR safety objectives: an evolutionary strategy

- An “evolutionary” strategy, grounded on:
  - ✔ Existing reactor operating know-how, feedback and results of in-depth safety studies (eg., PSAs)
  - ✔ A reinforcement of the defence-in-depth. 
    *(eg., significant improvement of the containment function)*
  - ✔ A deterministic design basis, supplemented by the use of probabilistic methods
Objectives for severe accidents:

- **Prevention of accidents:**
  - ✔ Significant reduction of the probability of core meltdown.

- **Mitigation of the consequences of accidents:**
  - ✔ “Practical elimination” of accidents likely to lead to large early releases of radioactivity.
  - ✔ The maximum potential releases for a core meltdown accident should only require very limited protective measures in space and time.
  - ✔ No protective measures should be needed for accidents without core meltdown.
EPR safety objectives: severe accidents management (2)

- **Practical elimination of:**
  - ✔ high pressure core melt
  - ✔ early bypass of the containment
  - ✔ vapour explosion
  - ✔ global hydrogen detonation

- **Mitigation of:**
  - ✔ low pressure core melt
  - ✔ hydrogen deflagration
EPR safety objectives: normal operation and maintenance

- Objectives for normal operation and maintenance:
  ✔ simplification of operation, maintenance, inspection.
  ✔ reduction of incidents, occupational exposure, effluents etc.
  ...to be duly studied at the design stage.
The 5 key subjects from the CSFRF investigated by the safety Authorities

- Severe accidents: radiological consequences; approach and main orientations for the preventive and mitigating features.
- Probabilistic goals; system design
- Implementation of the break preclusion concept on the main primary coolant lines
- External hazards (earthquake, explosion, aircraft crash)
- Radiological consequences of incidents and accidents, excluding severe accidents; design basis accidents
Scope of the EPR Basic Design Report

- Site dependant aspects and conventional part of the plant not addressed.

- Equivalent to the standard part of the French “Preliminary Safety Analysis Report” used for “Authorisation of creation.”

- Relevant to establish the German “Safety Report.”
EPR design options

- **1500 MWe PWR**
- **Safety redundancy: 4**
- **Corium spreading and cooling system**
- **Protection against military aircraft crash**
- **Double wall containment with partial liner**
  ✓ designed for LOCA and hydrogen explosion
  ✓ no direct leak
- **Water pool inside containment**
Scope of the EPR Technical Codes (ETC) (1)

- Elaboration of a set of industrial rules common to the French and German nuclear industry.

- Contribution to the safety demonstration in the licensing process.
  - ✔ Supports the elaboration of the results of the Basic Design.

- Approach following the French practice (RCC)
  - ✔ ETC will not be binding
Scope of the EPR Technical Codes (ETC) (2)

- 6 documents scheduled to cover:
  - ✔ Safety and process
  - ✔ Mechanical components
  - ✔ Electrical equipment
  - ✔ Instrumentation and control
  - ✔ Civil works
  - ✔ Fire protection
  - ✔ + Common requirements for handling devices/ventilating
The recommendations continuously developed by GPR and RSK have been structured into a complete set of technical guidelines, adopted by GPR and German experts.

Contents:

- Principle of the safety concept
- Conceptual safety features
- Accident prevention and plant safety characteristics
- Control of reference transients, incidents and accidents
- Control of multiple failure conditions and core melt accidents
- Protection against hazards
- System design requirements and effectiveness of the safety functions
State of the project
Prospective aspects

● DGSNR is able to take position on EPR safety options
● EDF’s goal: issuing a “Preliminary Safety Report” by end 2002.
● Further investigations will be necessary at the detailed design stage

● Considerable progress in the harmonisation of requirements between France and Germany
  ✔ well balanced approach rather than adding up all sets of requirements
● Further development is needed along the path to achieve a European approach on future PWRs...