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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*



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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
 - ✓ *“Basic Design Report” - submitted in 1997.*

- **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



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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”
- **Oct. 1997: Submission of the Basic Design Report**
- **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

EPR safety objectives : severe accidents management (1)

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**



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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.”**



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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**



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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



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Contents of the “Technical Guidelines”

- **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



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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...**