EPR Pre-Application Review Meeting

Framatome ANP and the NRC
March 24, 2005

Introduction

Ray Ganthner
Senior Vice President
New Plants Deployment
Meeting Objectives

- To communicate FANP plans for the EPR design certification pre-application review and solicit NRC feedback

- To familiarize the NRC with selected key features of the EPR design

AREVA: an industrial group focused on energy

- 10 billion Dollars in sales
- 70,000 employees
Framatome ANP, Inc.
U.S. Executive Team

Fuel America
John Matheson
Senior Vice President

Nuclear Services
George Beam
Senior Vice President

Engineering
Tom Weir
Senior Vice President

Sales & Marketing
Andy Cook
Vice President

Federal Group - Charlotte
Tom Stevens
Senior Vice President

New Plants Deployment
Ray Ganthner
Senior Vice President

Projects & BWR Integration
Don Janeczek
Senior Vice President

Energy & Environmental
Jerry Vargo
Senior Vice President

Steam Generator Team
Bill Fox
President

Framatome ANP in the U.S.
Major Offices

Richland, WA
-750 People
-Fuel

Fort Worth, TX
-45 People
-Engineering
-I&C/Electrical
-Service
-Project Mgmt

Naperville, IL
-40 people
-Engineering
-Service
-Project Mgmt & I&C

Benicia, CA
-50 People
-Service

Lynchburg, VA
-1,300 People
-Engineering
-I&C/Electrical
-Fuel
-Service
-Project Mgmt

Marlborough, MA
-150 people
-Engineering
-Service
-Project Mgmt & I&C
- Lab

Charlotte, NC
-550 People
-Engineering
-Service
-Project Mgmt & I&C/Electrical

Atlanta, GA
-40 People
-I&C/Electrical
-Project Mgmt
New Plants Deployment Organization

U.S. EPR Design Heritage

EPR is an evolutionary plant based on proven technology and global experience.

A mature design based on familiar technology.
Outline

> Overview of EPR Design Certification Project (Rick Bonsall)

> EPR Design Overview (Marty Parece)

> EPR Design Certification Pre-Application Plan (Sandra Sloan)

> Summary and Next Steps (Sandra Sloan)
ALWR Program Mission & Objectives

> **Mission:**
  > * Deploy the EPR in North America

> **Objectives:**
  > * Establish US design authority & project team
  > * Obtain customer endorsement and industry support
  > * Maintain EPR standard plant design features
  > * Attain US NRC Design Certification

Global EPR Standardization

> **Objective is to standardize the global EPR design as much as possible within the constraints of country-specific codes, standards, and regulations**

> **Advantages**
  > * Common design philosophy
  > * Shared lessons learned and good practices
  > * Plant services standardization
  > * Economies of production
  > * Opportunities for international regulatory cooperation

> **Changes for U.S. design must meet specified criteria:**
  > * Changes to meet U.S. codes & standards
  > * Changes to meet U.S. regulatory requirements
  > * Changes to meet U.S. utility market requirements and customer needs
  > * Example: U.S. cycle frequency and grid voltages
EPR DC Project Fundamentals

- Integral part of global deployment of EPR plants
- US design team headquartered in Lynchburg, VA
- Complete conversion to US design codes & standards
- Compliance with NRC regulations and QA requirements
- Use NRC-approved computer codes and methods for safety and fuel analyses
- Comprehensive project management planning and execution

EPR DC Project Organization

[Diagram showing project organization with names and positions]

KEY:
- (B) = Berkeley
- (C) = Charlotte
- (L) = Lynchburg
- (M) = Madison
- (R) = Richmond
- * = Added from outside NPD
- S/G = Subcontractor
- ** = Part-time EPR/HR
Project Management

> FANP Project Management Initiative
> Project Plan
> Integrated Resource Loaded Schedule
> Risk Analysis/Risk Management Plan
> Monthly Project Reviews
> Formal Change Control

EPR Design Conversion

US
QA
Codes & Standards
Design Control
Approved Methods

US EPR Design

U. S. Licensing Basis
DCD
EPR DC Project Summary Schedule

- Phase 1 Pre-application Review
  - Design Description Report Submittal (FANP)
- Phase 2 Pre-application Review
  - 3 Topical Report Submittals (FANP)
  - Topical Report Reviews (NRC)
- Design Tools, Procedures & Training
- EPR Design Conversion
- NSSS Safety Analyses
- DCD Chapter Inputs
- DCD Compilation
- DCD Submittal

EPR Design Hierarchy

- QMM
- Implementing Procedures
- Project Plan
- Plant Technical Requirements Document
- System Design Requirements
- Component Requirements
- Detailed Design Documents, Analyses and Drawings
- Design Records Database (DRDB)
EPR Design Overview

Topics

> EPR Design Participants
> Primary Design Objectives
> General Overview of Design Features
> Selected Key Features of EPR
> Conclusions
EPR Design Participants

> Reactor Designers
  - Framatome (now Framatome ANP, an AREVA and Siemens)
  - Siemens

> French & German Utilities
  - EDF
  - E.ON, EnBW, RWE Power, and others

> French & German Safety Authorities, with the objective of creating common safety requirements for the next generation of PWRs

Primary Design Objectives

> Evolutionary approach based on construction experience, R&D, operating experience and "lessons learned"

> Innovative features for prevention and mitigation of severe accident consequences
  - Practical preclusion of energetic scenarios that could lead to early containment failure
  - Consideration of severe accidents for containment design

> Improvement of defense-in-depth concept on all levels
  - Radiological consequences
  - Initiator frequencies
  - Transient plant behavior
  - Prevention of common cause failures
  - Man-machine interface

> Deterministic safety approach supplemented by probabilistic analyses

> Significant reduction of CDF and LERF

> Consideration of external events
**Major EPR Design Features**

> **Nuclear Island**
> - Proven Four-Loop RCS Design
> - Four-Train Safety Systems
> - Double Containment
> - In-Containment Borated Water Storage
> - Severe Accident Mitigation
> - Separate Safety Buildings
> - Advanced ‘Cockpit’ Control Room

> **Electrical**
> - Can Shed Power to House Load
> - Four Emergency DGs
> - Two Smaller, Diverse SBO DGs

> **Site Characteristics**
> - Airplane Crash (Military or Commercial)
> - Explosion Pressure Wave

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**Primary System Features**

> Conventional 4-loop design proven by decades of design, licensing and operating experience.

> Main components enlarged as compared with existing designs to increase grace period in many transients and accidents.
## Comparison of EPR Plant Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Current US 4-Loop</th>
<th>EPR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design Life</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>Thermal Power, MW</td>
<td>3411</td>
<td>4500</td>
</tr>
<tr>
<td>Electrical Power (Net), MW</td>
<td>1100</td>
<td>1600</td>
</tr>
<tr>
<td>Plant Efficiency, Percent</td>
<td>32</td>
<td>36</td>
</tr>
<tr>
<td>Hot Leg Temperature, F</td>
<td>617</td>
<td>622</td>
</tr>
<tr>
<td>Cold Leg Temperature, F</td>
<td>559</td>
<td>563</td>
</tr>
<tr>
<td>Reactor Coolant Flow Per Loop, gpm</td>
<td>98,000</td>
<td>125,000</td>
</tr>
<tr>
<td>Primary System Operating Pressure, psia</td>
<td>2250</td>
<td>2250</td>
</tr>
<tr>
<td>Steam Pressure, psia</td>
<td>990</td>
<td>1118</td>
</tr>
<tr>
<td>Steam Flow Per Loop, Mlb/hr</td>
<td>3.8</td>
<td>5.1</td>
</tr>
<tr>
<td>Total RCS Volume, cu.ft.</td>
<td>12,600</td>
<td>16,245</td>
</tr>
<tr>
<td>Pressurizer Volume, cu.ft.</td>
<td>1800</td>
<td>2649</td>
</tr>
<tr>
<td>SG Secondary Inventory at Full Power, lbm</td>
<td>106,000</td>
<td>182,000</td>
</tr>
</tbody>
</table>

## EPR Core Design Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Current US 4-Loop</th>
<th>EPR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core Thermal Power, MW</td>
<td>3411</td>
<td>4500</td>
</tr>
<tr>
<td>Number of Fuel Assemblies</td>
<td>193</td>
<td>241</td>
</tr>
<tr>
<td>Fuel Lattice</td>
<td>17x17</td>
<td>17x17</td>
</tr>
<tr>
<td>Active Fuel Length, ft</td>
<td>12</td>
<td>13.78</td>
</tr>
<tr>
<td>Rods Per Assembly</td>
<td>256</td>
<td>264</td>
</tr>
<tr>
<td>Average Linear Heat Rate, kW/ft</td>
<td>5.58</td>
<td>4.99</td>
</tr>
<tr>
<td>Peak Linear Heat Rate, kW/ft</td>
<td>13.95</td>
<td>13.72</td>
</tr>
<tr>
<td>Number of Control Rods</td>
<td>53</td>
<td>89</td>
</tr>
</tbody>
</table>

![Type Of Plant Diagram](Image)
Fuel Design Proven By Operation

- 17x17
- Typical Pitch-to-Diameter Ratio
- M5 Cladding
- Heated Length Similar to N4
- M5 HTP Mixing Vane Grids
- Anti-Debris Lower End Fitting
- Significant Design Margins
- MOX Compatible

Selected Key Features of EPR
Double-Walled Containment

> Inner wall pre-stressed concrete with steel liner
> Outer wall reinforced concrete
> Protection against airplane crash
> Protection against external explosions
> Annulus subatmospheric and filtered to reduce radioisotope release

Four Independent Safety Trains
In Separate Buildings

> Four trains, each 100%, provide redundancy for maintenance or single-failure criterion
> Physical separation against internal hazards (e.g. fire)
> Shield building extends airplane crash and external explosion protection to two safeguard buildings and fuel building
Primary System Safety Trains

- Four-train, independent SIS
- In-containment borated water storage pool
- Combined RHRS/LHSI
- Two-train extra borating system (not shown)
- Containment spray for severe accident only

Secondary Side Safety Systems

- Four separate EFWS
- Separate power supply for each
- 2/4 EFWS also powered by SBO diesels
- Interconnecting headers at EFWS pump suction & discharge normally closed
Safety Injection System Design Philosophy

- Mitigate loss-of-coolant scenarios
- Preclude challenge to main steam safety valve during SGTR
- Medium Head Safety Injection (MHSI) selected

![Pressure Diagram]

Partial Cooldown To Mitigate SGTR & SBLOCA

- Safety-Related System
- Depressurizes SGs to Reduce $T_{sat}$ at 180 F/hr
- Ensures Adequate MHSI Flow For SBLOCA & SGTR

![Partial Cooldown Diagram]
Severe Accident Mitigation

- Minimize probability of severe accident using multiple, independent safety systems
- Mitigate consequences with specific design features:
  - **Primary Depressurization System** prevents high-pressure vessel failure
  - Prevent vapor explosions by maintaining initially dry spreading area
  - Maintain corium inside containment by use of a spreading area, contains corium in coolable configuration
  - **IRWST** provides passive cooling of corium and basemat for 12 hours
  - **Active CHRS** provides long-term cooling (after 12 hrs)
  - 41 passive hydrogen recombiners prevent combustion of hydrogen
  - Regardless, containment designed to withstand hydrogen deflagration
  - Annulus inside double-walled containment maintained at negative pressure and filtered to capture radioisotopes

Severe Accident Mitigation: Views of Corium Spreading Area & IRWST
Severe Accident Mitigation: IRWST Provides Passive Cooling of Corium

Probabilistic Objectives

> Core damage frequency < $10^{-5}$ per year (for all plant states, all types of initiators)

> Core damage frequency for internal events
  * From power states: < $10^{-6}$ per yr
  * From shutdown states: less than power states

> Core melt with large and early releases from containment < $10^{-7}$ per year
CDF For Power And Shutdown States

Total Core Damage Frequency = 1.4 E-06

EPR Digital I&C:
An Operator-Friendly Man-Machine Interface

EPR is capitalizing on N4 digital I&C outstanding operating experience feedback

N4 Control Room   EPR Control Room
Conclusions

> **EPR is evolutionary**
> **Most features are typical of operating PWRs**
> **Features included to**
  - Increase redundancy & separation
  - Reduce core damage frequency
  - Reduce large early release frequency
  - Mitigate severe accident scenarios
  - Protect critical systems from external events
  - Improve human factors
Purpose of the Pre-Application Review

The purpose of the pre-application review is to identify:

- Major safety issues that could require Commission policy guidance to the staff
  - FANP View: Design Certification of the EPR does not require changes in NRC regulation or policy
- Major technical issues that the staff could resolve under existing regulations or NRC policy
  - FANP View: Similarity of major EPR systems with current U.S. plants, and its enhanced safety margins, will enable efficient resolution of any identified technical issues under existing regulations and policies
- Research needed to resolve identified issues
  - FANP View: Use of proven technology and active safety systems precludes the need for additional research to resolve technical issues
  - FANP View: Currently-approved analytical methods will apply directly or will require only minimal modifications
  - FANP View: No new testing is required for qualification of analytical methods or for demonstration of safety system function for design basis accidents
Goals for the EPR Pre-Application Review

> To ensure that the design certification application contains no unexpected issues for the NRC

> To identify the cost and schedule requirements to complete the pre-application review and the review of the design certification application

> To support the preparation of a high-quality DC application

Supporting Objectives for the EPR Pre-Application Review

> Familiarize the NRC with the EPR design, focusing on the new and unique design features

> Identify key technical issues of concern to the NRC and develop plans to address those issues

> Identify key regulatory issues and obtain concurrence on the strategy to address those issues

> Submit changes to analytical methodologies required to support the design and obtain approval for them, or demonstrate the applicability of currently-approved methods

> Develop cost and schedule estimates for the NRC design certification review
Phase 1 Activities

> Phase 1 (2005)

- A series of meetings with the NRC
- No extensive or detailed technical review by the NRC
- Submittal of Design Description Report in August 2005
  - To support the NRC's review of the design and of subsequent topical reports
  - Submitted for information only, not for formal review and approval
- Expected product: NRC documentation of the resource requirements for the agreed-upon schedule of Phase 2 activities

Phase 1 Proposed Meeting Schedule

<table>
<thead>
<tr>
<th>Meeting Subject</th>
<th>Month</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overview of EPR Design Certification Project, EPR Design, and Pre-Application Plan</td>
<td>March 2005</td>
</tr>
<tr>
<td>Design Codes and Standards</td>
<td>May 2005</td>
</tr>
<tr>
<td>Probabilistic Risk Assessment</td>
<td>June 2005</td>
</tr>
<tr>
<td>Plant Design Bases and PRA</td>
<td>July 2005</td>
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<tr>
<td>I&amp;C Design</td>
<td>August 2005</td>
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<tr>
<td>NRC Information Visit to Framatome ANP European Facilities</td>
<td>September 2005</td>
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<tr>
<td>Analytical Methodology Overview</td>
<td>October 2005</td>
</tr>
<tr>
<td>Severe Accidents</td>
<td>November 2005</td>
</tr>
<tr>
<td>Plan for Phase 2 Activities</td>
<td>December 2005</td>
</tr>
</tbody>
</table>
Phase 2 Activities

Phase 2 (2006-2007)

- Meetings with NRC
  - To address items identified as a result of discussions in Phase 1
  - To address issues which arise during preparation of the design certification submittal
  - To support topical report submittals
- Submittal of three topical reports (next slide)
- Expected products:
  - SERs on the three topical reports
  - NRC documentation of the resource requirements and schedule for review of the design certification submittal

Schedule for Topical Report Submittals

<table>
<thead>
<tr>
<th>Topical Report Description</th>
<th>Submittal Date</th>
<th>Requested Approval Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHF Correlation Topical Report</td>
<td>1st Quarter CY 2006</td>
<td>2nd Quarter CY 2007</td>
</tr>
<tr>
<td>EPR Transient and Accident Analysis Code Applicability Report (including fuel mechanical design)</td>
<td>3rd Quarter CY 2006</td>
<td>4th Quarter CY 2007</td>
</tr>
<tr>
<td>Severe Accident Evaluation Topical Report</td>
<td>4th Quarter CY 2006</td>
<td>4th Quarter CY 2007</td>
</tr>
</tbody>
</table>
Design Certification Application

> Design Certification application to be submitted by the end of 2007

> The design will comply with U.S. codes and standards and meet U.S. regulatory requirements

Summary and Next Steps
Summary

> FANP's goal is to deploy EPR plants in the U.S. (This is not a research project, a foreign marketing strategy, or an academic exercise for FANP or the NRC.)

> FANP has a dedicated U.S. organization committed to preparing a high quality design certification application

> The EPR design is evolutionary and the design certification review is expected to be straightforward

> The length of the pre-application period is driven by the engineering work required for U.S. design conversion and the development of a high-quality submittal, not the need for significant NRC involvement

> The EPR design offers safety enhancements consistent with Commission expectations for new reactors

> FANP is committed to an open, engaged, and responsive relationship with the NRC throughout the pre-application review and the design certification

> Domestic utilities support EPR licensing efforts in the U.S.

Next Steps

> Next meeting
  * Summer 2005, Plant Design Bases and PRA

> Initiate development of resource estimate and schedule for Phase 2 activities