



U. S. Nuclear Regulatory Commission
Public Workshop
Extended Power Uprates Lessons Learned
March 19, 2002

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Morning Agenda

- 8:30 – 8:45 Opening Remarks
- 8:45 – 9:30 NRC – Lessons Learned
- 9:30 – 9:35 Break
- 9:35 – 10:20 GE/DAEC/Exelon – Lessons Learned
- 10:20 – 10:25 Break
- 10:25 – 11:10 Westinghouse/ANO-2 – Lessons Learned
- 11:10 – 11:15 Break
- 11:15 – 12:00 Framatome – Lessons Learned

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Afternoon Agenda

- 1:00 – 3:00 Breakout Sessions
- 3:00 – 3:15 Break
- 3:15 – 5:15 Presentations from Breakout Groups
- 5:15 – 5:30 Closing Remarks

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Power Uprate Program

*S. Singh Bajwa, Director
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U.S. Nuclear Regulatory Commission*

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Priority of Power Uprates

- High Priority
- Among Most Significant Licensing Actions
- No Unnecessary Delays in Completing Reviews

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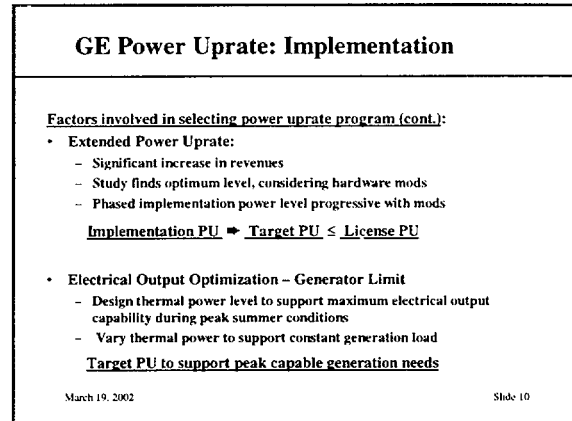
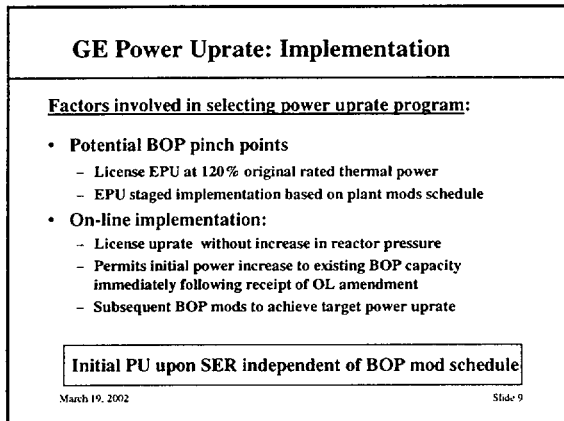
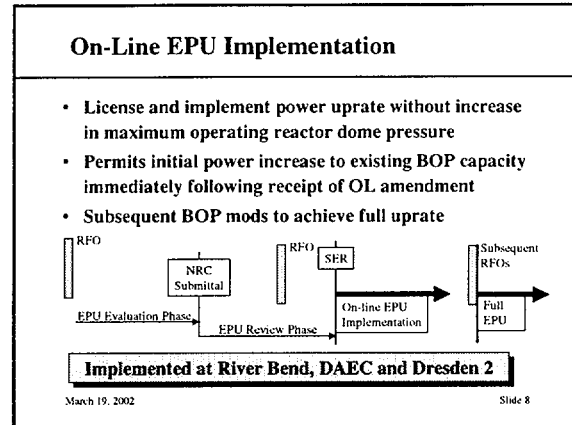
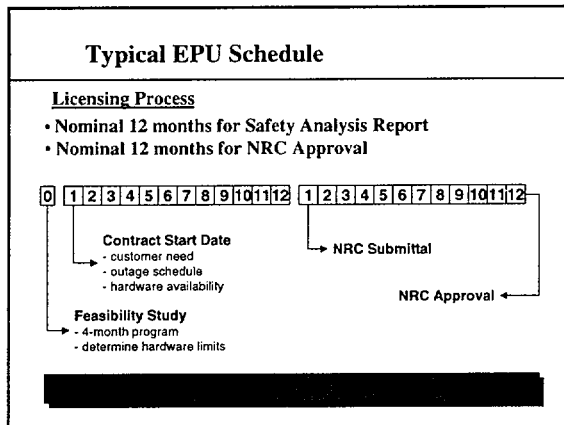


Planning/Scheduling

- 6 Months for MUR Power Uprates
- 9 Months for Stretch Power Uprates
- 12 Months for Extended Power Uprates

MUR – Measurement Uncertainty Recapture

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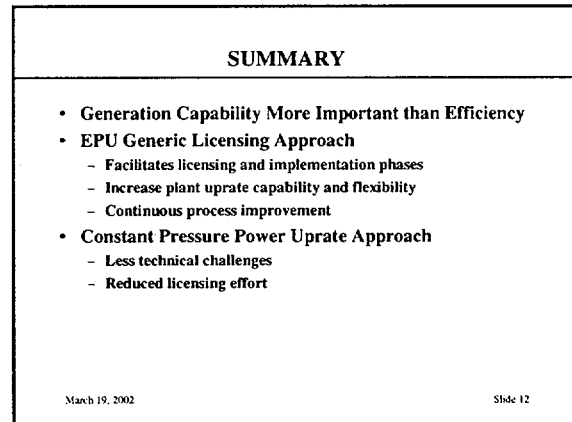
GE Power Uprate Experience

Extended Power Uprate:	105% Power Uprate:	EPU in Progress:
• KKM (114%)	• Susquehanna - 1, 2	• Brunswick-1,2 (120%)
• KKL (112%)	• WNP-2	• Clinton (120%)
• Hatch-1,2 (113%)	• Limerick - 1, 2	• Browns Ferry-2,3 (120%)
• Monticello (112%)	• Peach Bottom - 2, 3	
• Duane Arnold (120%)	• Fermi 2	
• Dresden -2,3 (117%)	• FitzPatrick	
• Quad Cities -1,2 (117%)	• Brunswick - 1, 2	
• Cofrentes (110%)	• NMP-2	
	• Browns Ferry - 2, 3	
	• LaSalle - 1, 2	
	• Laguna Verde	
	• Perry	
	• River Bend	

TPO in Progress:

- River Bend (101.7%)
- Grand Gulf (101.7%)
- Pilgrim (101.5%)
- Peach Bottom (101.7%)

March 19, 2002 Slide 11





Current Status

- 72 Plant-Specific Applications Approved (22 in 2001)
 - 13 Measurement Uncertainty Recapture Power Uprates (12 in 2001)
 - 51 Stretch Power Uprates (5 in 2001)
 - 8 Extended Power Uprates (5 in 2001)
 - Approximately 9800 MWt (3300 MWt in 2001)
- 12 Plant-Specific Applications Under Review
 - 7 Measurement Uncertainty Recapture Power Uprates
 - 1 Stretch Power Uprates
 - 4 Extended Power Uprates
- 2 Generic Topical Reports Under Review

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Looking Ahead

Fiscal Year	Expected Applications	MUR	Stretch	Extended
2002	16	14	0	2
2003	14	5	0	9
2004	5	5	0	0
2005	6	2	2	2
2006	1	0	0	1

- 8 More Power Uprates are Under Consideration
- Expect More Interest as a Result of Existing Potential & Ongoing Work
- NRC Estimates Additional Submittals After FY 2003

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Extended Power Uprates Lessons Learned

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Communication

- Communicate early and often
- Get clear understanding of any RAIs/concerns and the reasons for the RAIs/concerns
- Keep management informed of status

RAIs – Requests for Additional Information

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Handling of RAIs

- Get questions/concerns to licensee as soon as possible (e.g., e-mail)
- Hold teleconferences to ensure common understanding of the questions/concerns
- Prior to submitting responses to RAIs, check with the reviewers (e.g., teleconference) to ensure that the responses are adequate

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Handling of RAIs (Continued)

- Document RAIs and teleconferences in accordance with NRR Office guidance and procedures
- Make submittals available as soon as possible (e.g., e-mail) after being officially signed and dated

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Power Uprate Licensing Process Improvements

NRC Workshop

March 19, 2002

Allan R. Haeger, Exelon Nuclear

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Introduction

- NRC has been responsive to power uprate submittals
- The process has improved with experience
- Major areas for process improvement
 - Reduce RAI volume
 - Improve schedule predictability
 - Reduce discussions regarding proprietary designation

2

Process Improvements

- Opportunity: Reduce review time by reducing the volume of RAIs
- Potential actions
 - Vendors/utilities review RAI patterns; expand standard submittal shells
 - NRC develop guidance for level of detail required
 - Utilities/vendors maximize dialogue prior to RAI response
 - NRC conduct on-site audits for large volume RAIs

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Process Improvements

- Opportunity: Improve schedule predictability
- Potential actions
 - Utilities discuss schedules with NRC in advance
 - Utilities limit concurrent major submittals
 - NRC promptly identify difficult areas
 - NRC and vendors work with ACRS to determine remaining areas of focus

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Process Improvements

- Opportunity: Reduce time spent discussing proprietary designations
- Potential actions
 - Utilities must challenge vendor designations
 - Vendors and NRC continue to meet to resolve remaining issues

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Conclusion

- Experience is improving the process
- Approval of the constant pressure topical report will place focus on resolving RAI volume and proprietary issues

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Duane Arnold Energy Center Extended Power Uprate

Implementation – Lessons Learned

Presented by Tony Browning
Principal Licensing Engineer, NMC

Modifications – Lessons Learned

- Team Focused on PUSAR & NRC Submittal
- BOP System Evaluations treated as routine
 - Lack of Design Basis for BOP - evaluations more difficult than Safety-related Systems

Modifications – Lessons Learned

Result – discovered last minute modifications

- Typically related to a “second order effect”
 - Example – FW Heater tube vibration in drain cooler zone

Lesson Learned – *Get an early jump on BOP System evaluations*

Startup Testing – Lessons Learned

- Test Acceptance Criteria – Original 1973 S/U Test Specifications
- Didn't fully incorporate plant operating experience (internal or external)
- Resulted in unexpected test “failures”

Startup Testing – Lessons Learned

- Examples
 - 1) FW flow controllers upgraded in 1996, – didn't have “classical” response assumed in S/U Test Specification
 - 2) One criterion found to be “obsolete”
- Lesson Learned – *Validate basis for test criteria against current system/component requirements.*



Westinghouse

A BNFL Group company

Combined W/CE Fleet Extended Power Uprate Overview and Lessons Learned

John Fasnacht
Manager - Integrated Plant Engineering Services
Westinghouse Electric Corp, LLC.

1

Presentation Overview

- Overview of Fleet Experience
- EPU Technology and Process
- General Lessons Learned Assessment
- ANO-2 Program
- Questions

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Westinghouse

Well Developed Fleet Experience

- Combined fleet has successfully achieved 56 uprates equivalent to 2450 MWe
- Recent Activity - 9 plant Appendix K and 6 stretch uprates
- Work in Process/Licensing - 7 plant Appendix K, and 5 stretch/EPU uprates
- EPU Activity
 - ANO-2
 - Beaver Valley 1/2
 - Point Beach 1/2
 - Waterford 3
 - Feasibility Assessment for 4 plants
- Fleet wide remaining potential

Licensing
Ongoing
Ongoing
Ongoing
Ongoing

BNFL

3

Westinghouse

EPU Technology for the Future

- Technology platforms for 10% to 20% power uprates
- Systematic review of NSSS fuel, safety analysis, components and systems
- Understanding of key design and licensing basis issues and margins is critical
- Developing new technology to further enhance margins
- Integrated programs and team work

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General Lessons Learned Assessment

- Overall communications enhanced
 - Workshops and guidance document
 - Active communication of expectations/responsiveness
 - Communication between LAR and first set of RAIs
 - Copies of RAIs - promoting dialogue, understanding before formal submittal
 - Review pedigree
- Selected considerations for program
 - Experienced review of required elements and detailed work breakdown structure
 - Develop regulatory communication plan
 - Recognize depth of review and information required for submittal
 - Use precedent recognizing that no two plants are alike

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Westinghouse

Items for Development/Discussion

- Questions regarding current methods and approach
- Internal communications on issues and prior approvals
- Reviewing ongoing/current issues not related to uprate
- Using past precedent and responding to past RAIs vs. additional RAIs
- Overall process is enhanced

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Westinghouse

Westinghouse Overview of ANO-2 Licensing

- PWR EPU licensing approaching mature process in terms of
 - Breadth of issues
 - Technical issues from NRC or ACRS review
 - Use of existing Licensing basis
 - Handling of Generic industry issues
- Extensive reviews with an appropriate level of detail
 - Experienced Reviewers
 - Familiar with approved methodologies
 - Communication and resolution of technical issues

NRC Workshop Power Uprate

ANO-2 Power Uprate
Perspectives and Lessons Learned
March 19, 2002
Bryan Daiber
Roger Wilson



NRC Workshop Power Uprate

Roger Wilson



Presentation Agenda

- (1) ANO-2 Uprate Overview
- (2) Regulatory Process
- (3) ANO-2 Recommendations
 - Lessons Learned

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ANO-2 Overview

- Uprate - extended power uprate (EPU), >5%
 - 7.5% Primary: 2815 → 3026 MWt
 - Follows steam generator replacements by 1 cycle
 - 11% Secondary: 958 → 1065 MWe (+107)
 - Replaced high pressure turbine steam path
 - Replaced 4 low pressure turbine stages
 - Isentropic efficiency increase due to advance design

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ANO-2 Overview

- Key design issue
 - T_{HOT} increase versus PWSCC
 - Alloy 600 RV head penetrations
 - Limits uprate amount
 - "Short term" issue
 - Will be resolved in near future
 - Controlled long-term decisions for uprate
- ANO-2 templates used
 - Farley and other BWR submittals
 - Westinghouse topical
 - GE BWR topical

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Regulatory Process

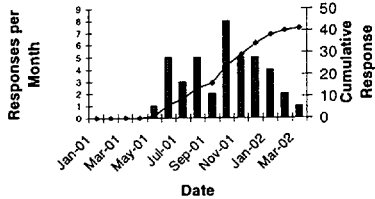
- Schedule
 - Submittal - 12/19/00
 - RAI response history
 - 15 at end of 9/01
 - Multiple questions in each RAI
 - ACRS review of D. Arnold 9/27/01
 - 27 starting 10/01 (into 3/02)
 - Draft SER issued 1/18/02
 - ACRS subcommittee 2/13/02
 - ACRS full committee 3/7/02
 - License amendment about 4/19/02

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Regulatory Process

RAI Responses - Initial Submittal 12/19/00



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Regulatory Process

- ANO-2 initial submittal
 - Level of detail consistent with FSAR
 - Assumed current licensing basis is maintained
 - Current licensing basis maintained with a few exceptions
 - Control room habitability



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NRC Workshop Power Upate

Bryan Daiber



Regulatory Process

- Analysis methods
 - Used approved methods
 - NRR and ACRS questioned underlying assumptions and applicability to an EPU of some of the approved methods
 - Should be resolved earlier for future licensees



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Regulatory Process

- ACRS directs NRR to probe deeply in key areas
 - NRR performed several confirmatory analyses
 - Containment (LOCA/MSLB)
 - PTS reference temperature calculations
 - RV head crack susceptibility
 - Dose calculations for LOCA, SGTR, FHA and CEA Ejection
 - Atmospheric dispersion X/Q calculations
 - Power uprate PSA assessment
 - Identify areas earlier to allow licensee to support



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Regulatory Process

- NRR probed key areas (continued)
 - Most reviewers familiar with ANO-2 FSAR
 - Verbal interfaces productive
 - Minimized RAIs
 - Reviews were very extensive
 - Many questions were standard
 - Reviewer looking for specific information



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Regulatory Process

- Non-uprate issues
 - NRR included issues not part of uprate
 - Control room habitability
 - ECCS long term core cooling assumptions
 - Exclusion area boundary dispersion factors
 - SG level uncertainties
 - Resolving non-uprate issues was biggest challenge of approval process
 - Preclude these issues; if not, identify known issues earlier



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Regulatory Process

- Probabilistic safety assessment (PSA)
 - Large workload item for licensee
 - NRR and ACRS seem at odds over value added by power uprate updates
 - Better guidelines need to be developed



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Regulatory Process

- Guidelines Needed for PWR Uprates
 - Developed by NRR or industry
 - Additional guidance
 - Reaffirm approved methods
 - Transient testing
 - Environmental impact assessment
 - PSA updates
 - Preclude; else identify non-uprate issues earlier
 - Identify confirmatory analyses earlier
 - Specific questions; generic questions
 - Include in submittal content
 - FAC, EQ, MOV program, fire protection program, human factors
 - ATWS



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ANO Recommendations

- Need full 18 months for EPUs
- Submittals should include:
 - Topics in ANO-2 initial submittal, plus:
 - With NRR guidance
 - Detailed environmental impact (12/10/01 RAI)
 - Operation impacts
 - Testing
 - Include more detail in submittal content
 - FAC
 - EQ, MOV program, fire protection, human factors
 - ATWS



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ANO-2 Overview

Additional Topics



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ANO-2 Overview

- Uprate economics favorable
 - ≈ \$35-40M → 107 MWe
 - If accomplished 10 times
 - \$350- 400M → 1070 MWe
 - Reduces station operating costs
 - Without staff (payroll) reductions
 - Favorable to company, site and community



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ANO-2 Overview

- Design, Licensing Basis & Config. Control
 - Improved
 - Recent reviews
 - Revised analyses
 - Modifications
 - Many examples



Extended Power Uprate

Martin Parece
Manager, Project Development
Engineering & Licensing



Features of the B&W-Designed PWR

Parameter	Value
Number of Loops	2 (2 x 4)
Steam Generator Type	Once-Through
Current Rated Thermal Power, MWt	2544 - 2772
Number of Fuel Assemblies	177
Typical Fuel Cycle Length, Months	24
Reactor Coolant System Flowrate, gpm	352,000 (TDF) 390,000 (Act.)
Operating Pressure, psia	2170
Operating Avg RC Temperature, F	579 - 582
Operating Steam Pressure, psia	925
Steam Exit Superheat, F	55 - 62
Feedwater/Steam Flow, Mlb/hr	10.8 - 11.7



Extended Power Uprate Status

- > Currently performing NSSS and BOP engineering & analysis to increase Davis-Besse rated power from 2772 MWt to 3014 MWt.
- > Target uprate for Spring 2004.
- > Other B&W-plant owners considering extended power uprates. No definite plans set. Expect most to do EPU by 2010.



Using Experience to Set The Scope

- > Reviewed Industry Topical Reports on EPU.
- > Reviewed EPU and Calorimetric Uprate Submittals.
- > Factored in Heavy Component (RSG) Licensing Experience.
- > Framatome ANP Turnkey EPU Projects in Europe.
- > Performed Uprate Feasibility Studies With Utilities.
- > Set The Scope.



Simplified EPU Work Breakdown Structure

- > Determination of Operating Conditions
- > Fuel Analysis
- > Core Mechanical Analysis
- > UFSAR Accident Evaluation
- > Post-Accident Containment Evaluation
- > Evaluate NSSS Structural
- > Evaluation of NSSS Components
- > Review of Attached Piping
- > Review and Update Licensing Documents
- > Plant Setpoint Review
- > Evaluation of Plant Systems
- > Procedure Reviews
- > Plant Programs

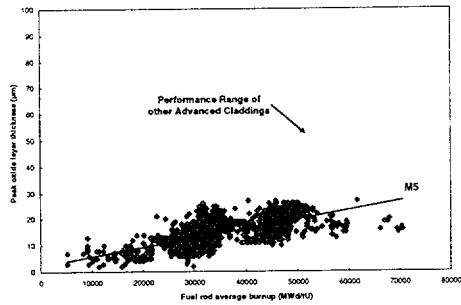


Lessons Learned - NSSS

- > Maximum Power of Approximately 3014 MWt
- > Limited By Fuel Design Parameters
 - Maximum Axial Peaking Limits
 - 24 Month Cycle Design
 - LOCA PCT & kW/ft Limits
 - Requires Advanced M5™ Cladding
- > OTSG Limiting NSSS Component
- > Minor Changes to Accident & Containment Analyses
- > Some Changes to AFW & ECCS

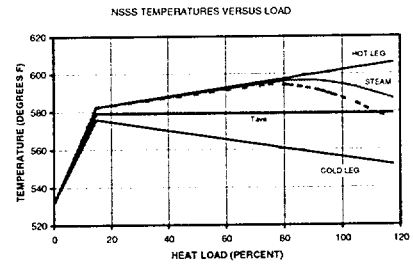


M5™ Provides PWRs with the Lowest Corrosion Rate Available



FRAMATOME ANP

Effect of Tube Plugging On OTSG Superheat



FRAMATOME ANP

BOP Lessons Learned

> Usual Suspects Are Limiting For EPU

- HP/LP Turbines
- Generator
- Moisture Separator Reheaters
- Condenser Tubing
- Heater Drain Pumps
- Feedwater Pumps
- Condensate Pumps
- Ultimate Heat Sink

> In Most Cases, Cost of Secondary Plant Upgrades Will Determine The Up-rated Power Value

FRAMATOME ANP

Summary

- > B&W-Designed NSSS EPU Limited to ~3014 MWt
- > Cost of BOP Upgrades Sets Target Value
- > FENOC and FRA-ANP Up-rating Davis-Besse to ~3014 MWt
- > Other B&W Plant Owners Considering EPU. No set plans.
- > FRA-ANP Prepared to Support All Fuel Clients For EPU.

FRAMATOME ANP