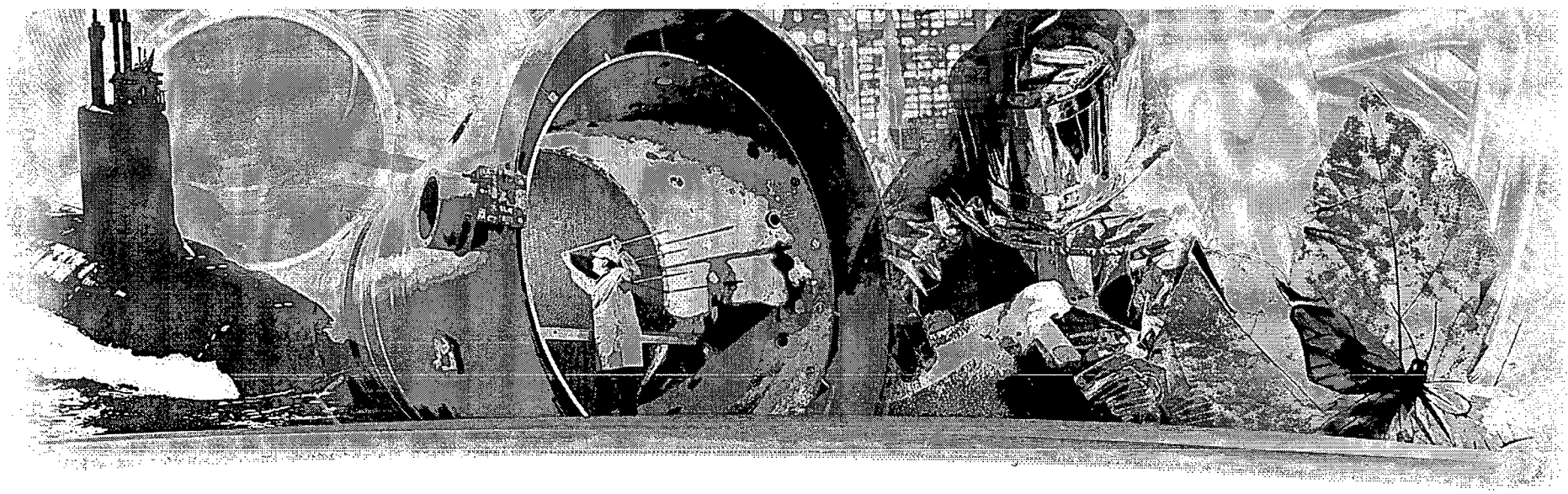
The attached 47 pages of meeting slides were for the presentation by the Babcock & Wilcox (B&W) Company at the pre-application meeting held on July 7, 2009, with the Nuclear Regulatory Commission, on B&W mPower Design, a medium size nuclear reactor plant.

Two notices for the meeting were issued on June 24 and July 7, 2009 (Agencywide Documents Access and Management System (ADAMS) Accession Nos. ML091740724 and ML091870226, respectively).

babcock & wilcox modular nuclear energy



mPower™
a progressive energy solution

A practical, scalable, modular PWR

July 7, 2009

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Agenda

8:30 a.m. – 8:40 a.m.	**Introduction and opening remarks**	NRC/B&W
8:40 a.m. – 9:30 a.m.	**Overview of B&W and Utility Support**	B&W Team
9:30 a.m. – 10:30 a.m.	**Introduction to B&W mPower Design**	B&W
10:30 a.m. – 10:45 a.m.	**Break**	
10:45 a.m. – 11:15 a.m.	**Design status, licensing approach, schedule**	B&W
11:15 a.m. – 11:30 a.m.	**NRC feedback & next steps**	All
11:30 a.m. – 11:45 a.m.	**Opportunity for Public Comment**	Public
11:45 a.m.	**Adjourn**	

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B&W mPower™ Design Overview

- Favorable regulatory, geopolitical and market realities
- Broad B&W capabilities, workforce and American infrastructure
- Strong nuclear utility interest
- Practical design, aligned to existing nuclear infrastructure
- Robust licensing philosophy, facilitating NRC review

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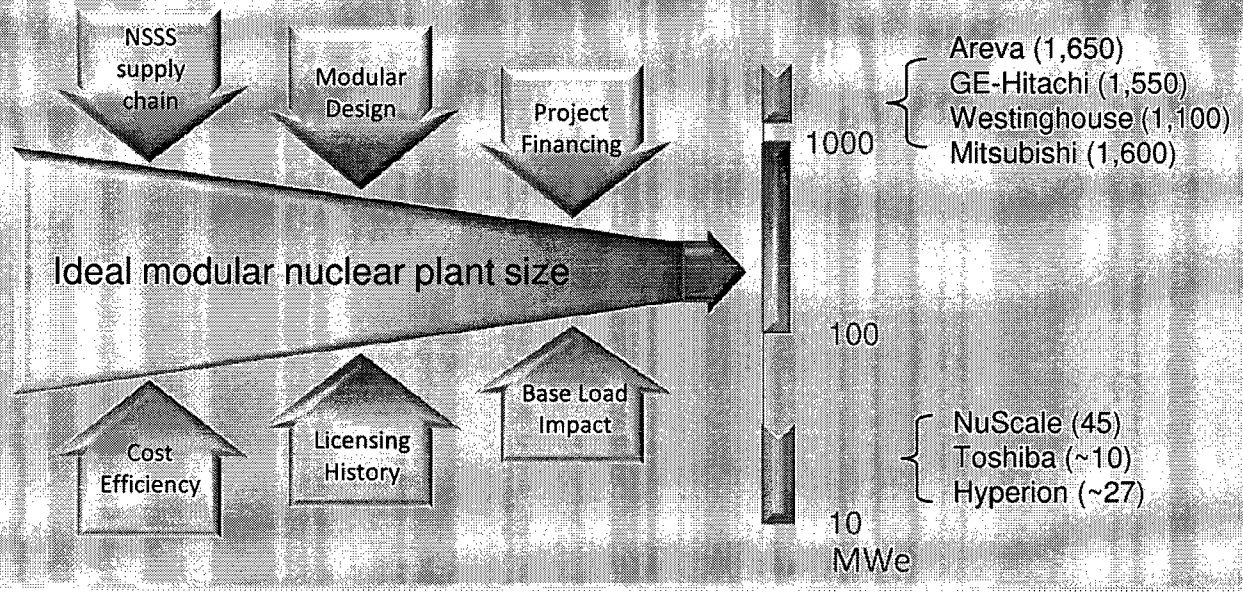
A Shifting Nuclear Landscape

Geopolitical Motivators

- Climate Change legislation
- Energy independence
- Strained supply chain
- Field craft labor availability
- Transmission capacity
- Water and land rights
- Tight capital markets



Emerging Industry Imperatives

- Don't "bet the company" on one project
- Practical, proven technology
- Utilize existing nuclear infrastructure
- "Repower" carbon-intensive facilities
- Incremental power additions

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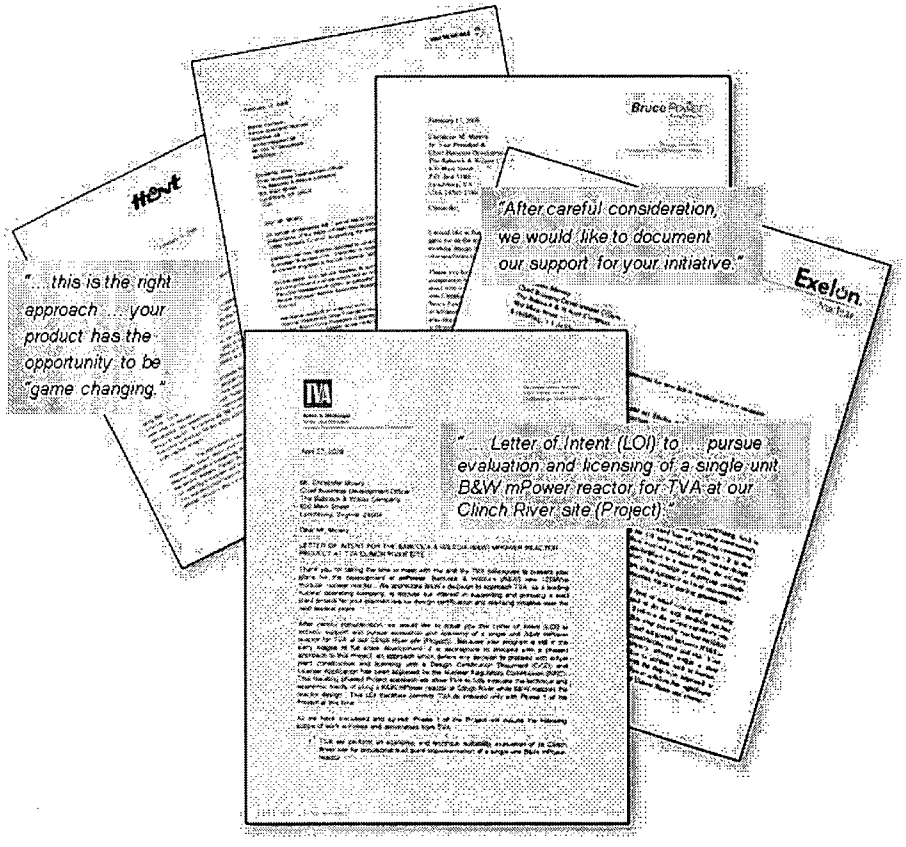
Significant B&W mPower Industry Interest

Support



Engagement

- Industry Advisory Council
  - TVA
  - Exelon
  - Dominion
  - Vattenfall
  - Bruce Power
- DCWG-style review & input
- MOU for regional utility application
  - 7 muni & coop utilities
  - Non-traditional licensee

Broad industry support for B&W mPower ... LOI for Clinch River lead plant phase-1

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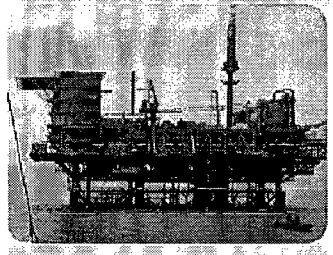
Leading the Energy Transformation

McDermott International

J. Ray McDermott



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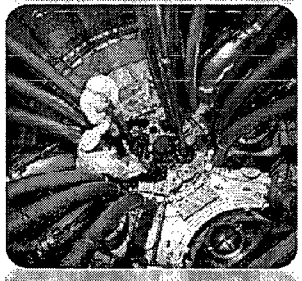
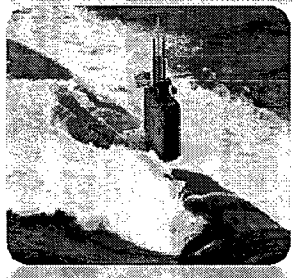
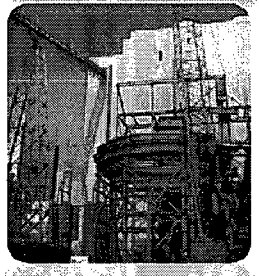
B&W Technical Services Group, Inc.



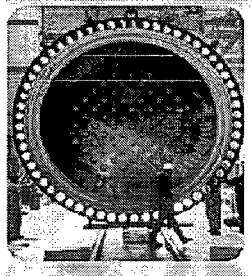
B&W Nuclear Operations Group, Inc.



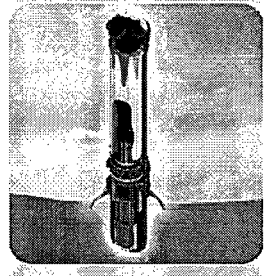
B&W Power Generation Group, Inc.



B&W Nuclear Power Generation Group, Inc.



B&W Modular Nuclear Energy, LLC



Clean Power Technologies

High-Consequence DOE Operations

Advanced Engineering and Manufacturing

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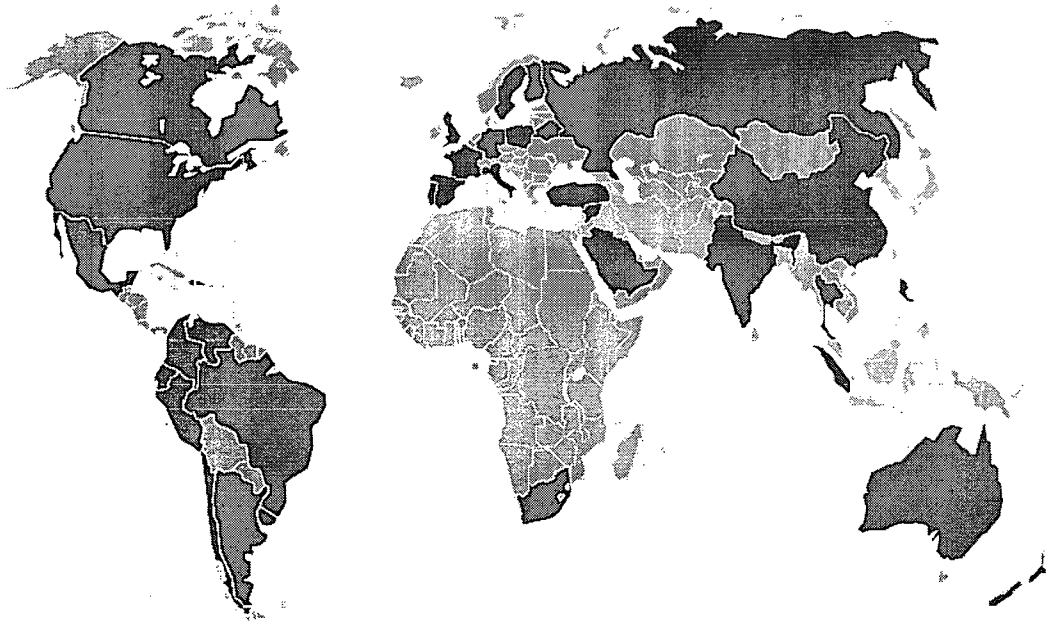
A Global Business

B&W Nuclear Experience

- 50+ years of continuous nuclear engineering and manufacturing
- 12,000 nuclear professionals
- Only U.S. NRC Category 1 license
- Only U.S. company with N-Stamp for NSSS vessel manufacturing
- Fabricated >1,100 NSSS components and pressure vessels
- Manufactured more than 290 steam generators worldwide
- U.S. nuclear manufacturing in Indiana, Ohio, Tennessee, Virginia



$4.7B* sales. $6.7B* backlog. 23,300 employees. 32 countries.

** Approximate equivalent 2008 revenues, including unconsolidated operations*

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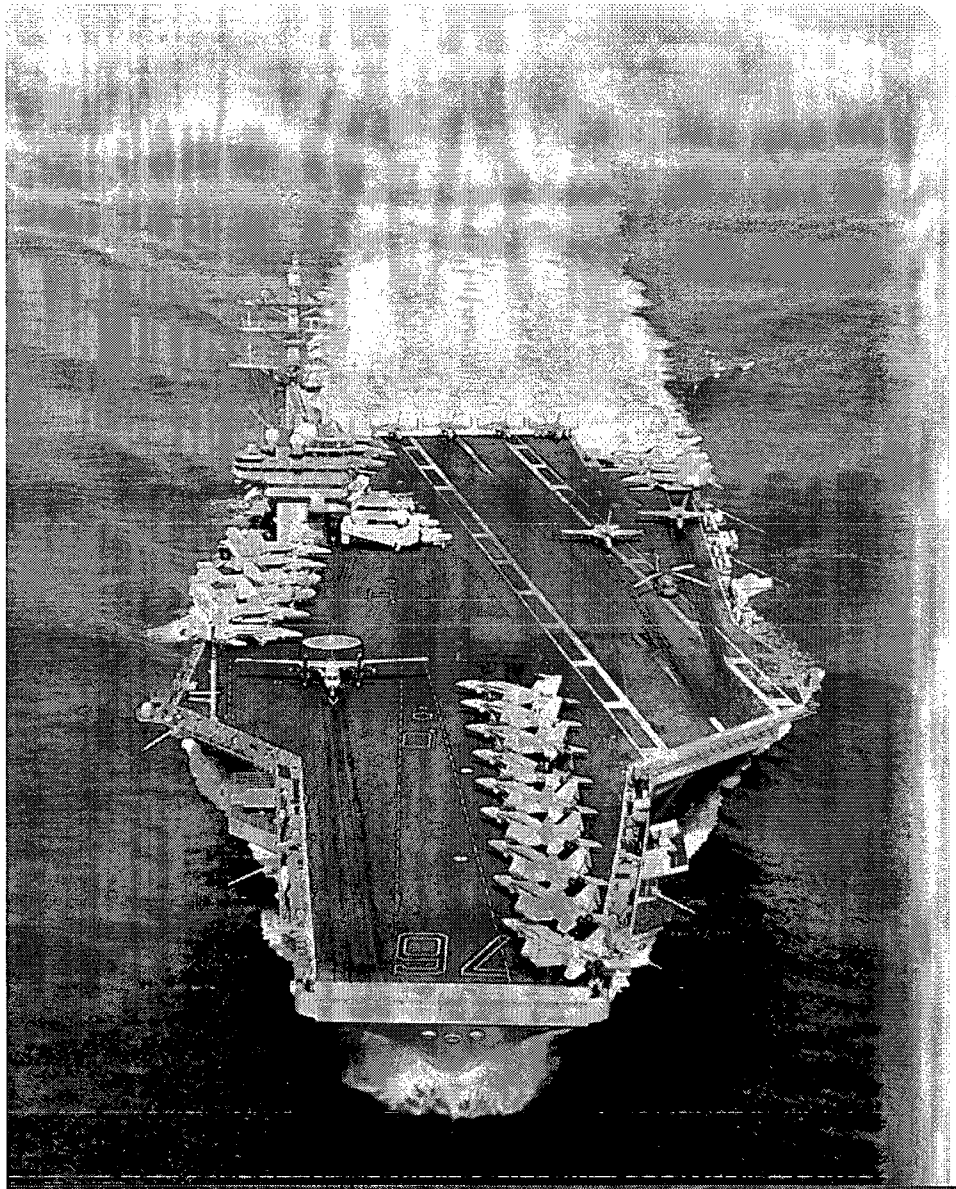

Babcock & Wilcox Nuclear Operations Group (NOG)

- Supplies components for Department of Energy programs
- Manufactures research test reactor fuel elements for colleges/universities and national laboratories
- Supports nuclear nonproliferation efforts

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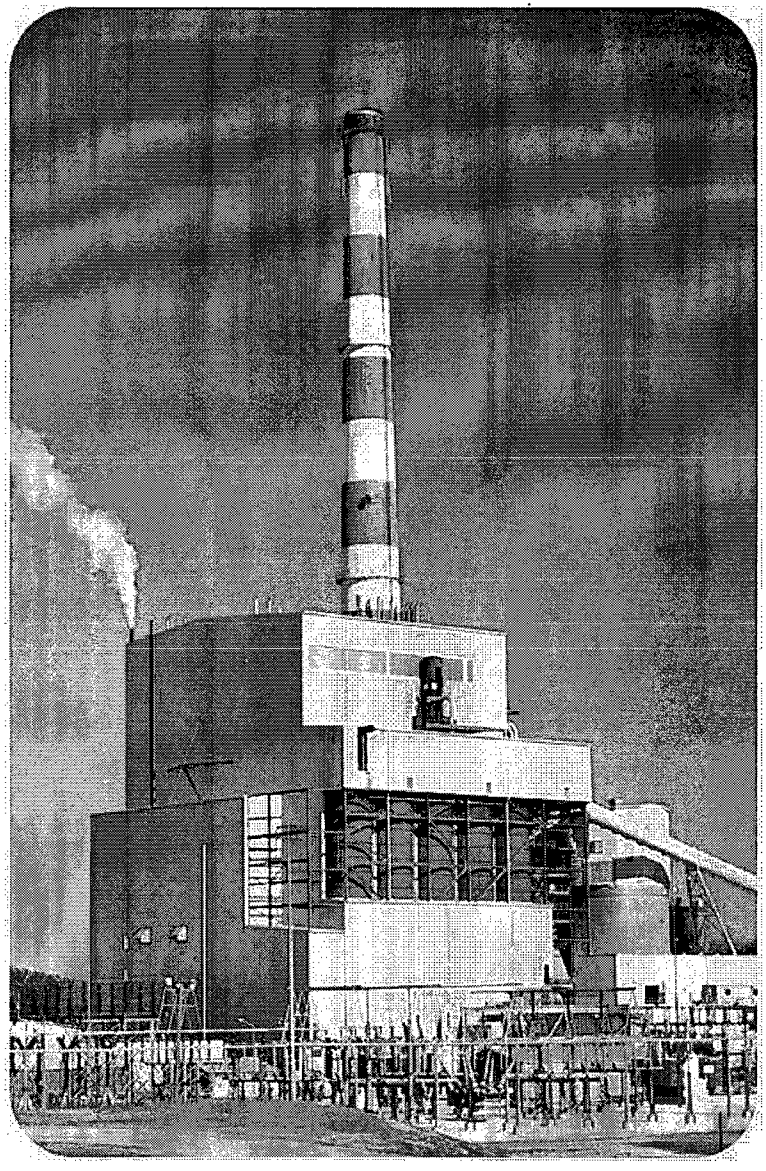

B&W Power Generation Group (PGG)

- Provides boilers and steam generating equipment
- Provides environmental equipment for emission control
- Offers services and replacement parts for existing fleet of fossil-fueled power plants
- Research & Development for advanced technology

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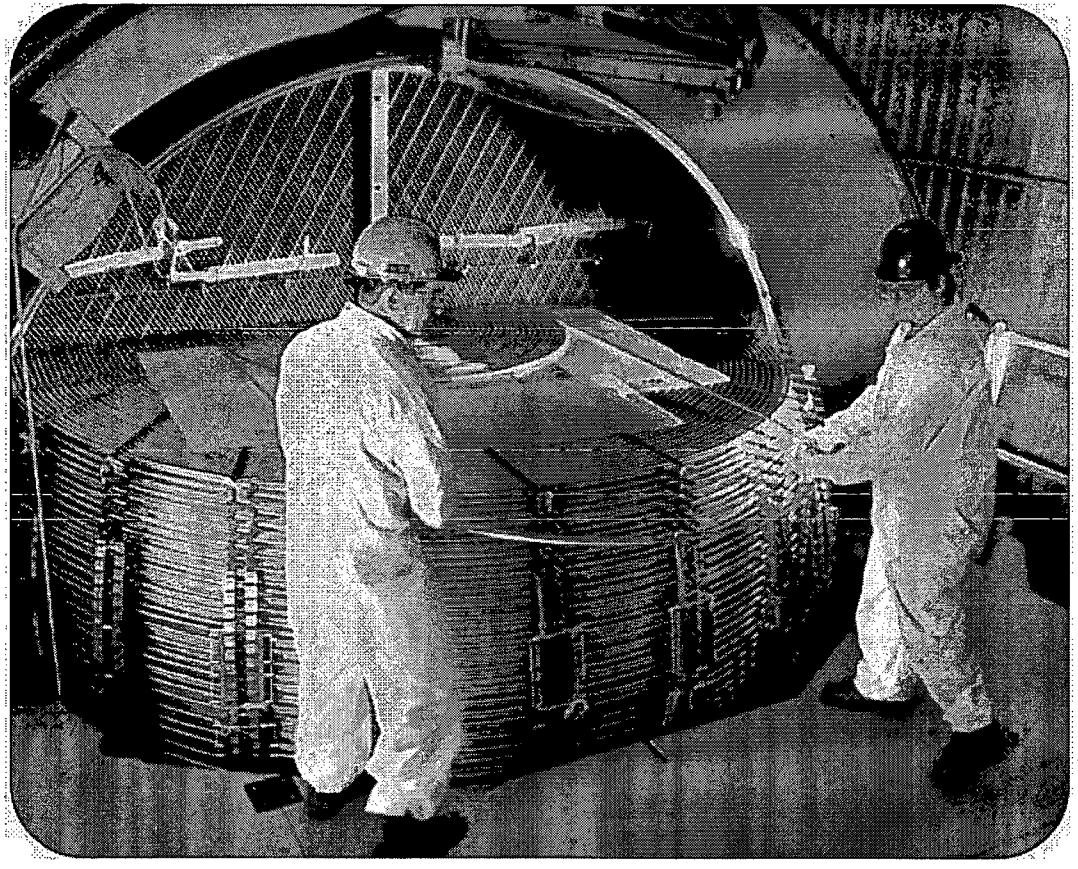

Babcock & Wilcox Nuclear Power Generation Group (NPG)

- Provides design, engineering, manufacturing, construction, laboratory analyses and field services capabilities.

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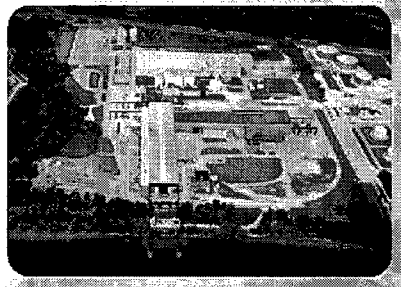
Domestic Component Design & Manufacturing

Mount Vernon, Indiana

- Originally built to support commercial nuclear industry
- 99-acre, secured site
- 580,000 square feet of modernized operating plant
- Strategically located on Ohio River
- Over 100 heavy commercial nuclear components fabricated



Barberton, Ohio

- 69-acre, secured site
- 548,000 square feet of modernized operating plant

Euclid, Ohio

- Design engineering, manufacturing, testing of electro-mechanical equipment for U.S. Government Programs

Cambridge, Ontario

- Steam Generators, Heat Exchangers, Pressurizers, Tanks
- Supplied more than 290 nuclear SGs worldwide
- Began producing first six replacement OTSGs ordered in U.S.

Lynchburg, Virginia

- NRC Category I fabrication facility
- Downblending
- Integrated laboratories

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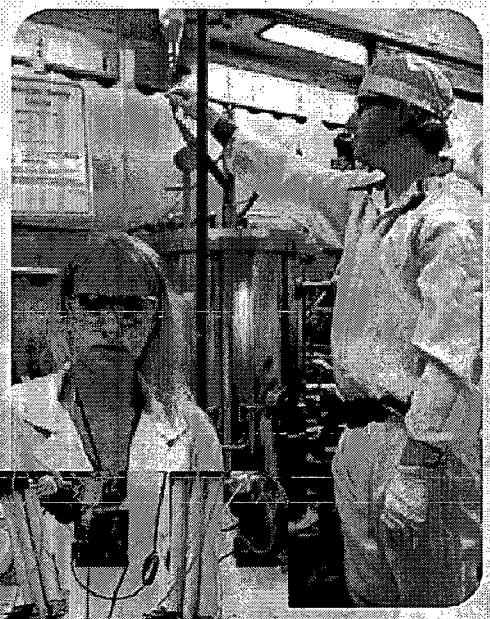
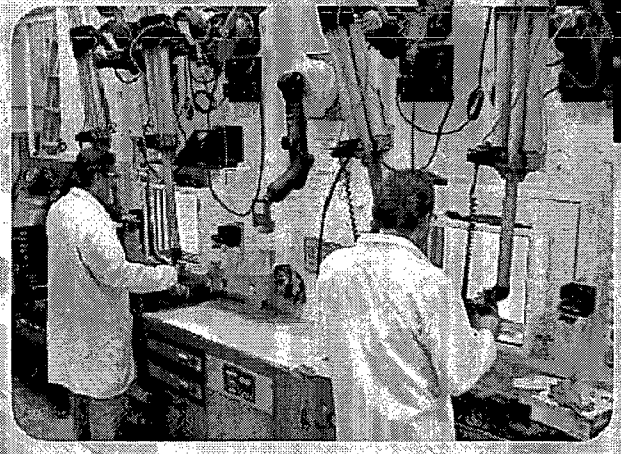
Nuclear Fuel Manufacturing and R&D

- Only U.S. NRC 100% enrichment licensee
- Single source for HEU downblending
- Advanced LEU fuel development
- Research reactor fuel for Oak Ridge and Idaho National Lab and universities
- Commercial nuclear laboratory (Hot Cell, Automated NDE, R&D)





U.S. leader for advanced and high-enriched fuel

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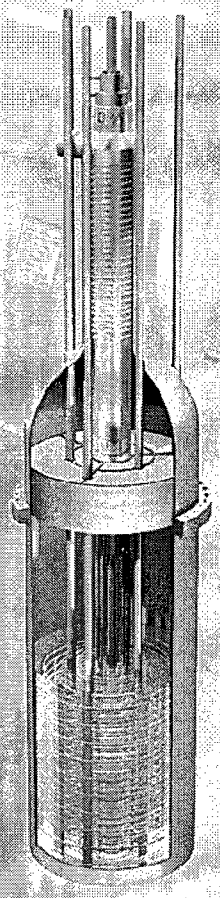
Medical Isotope Production System (MIPS)

- Becoming only domestic supplier of medical isotopes
- Partnership with radiopharmaceutical Covidien
- Potential for 50 percent of U.S. Mo-99 demand
- LEU generates no nuclear weapons-grade waste
- 200 kW reactors in state-of-the-art facility



B&W technology establishing key source of medical isotopes

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B&W

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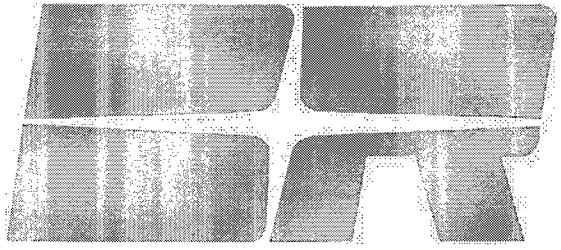
a McDermott company



ENERCON
Excellence—Every project. Every day.

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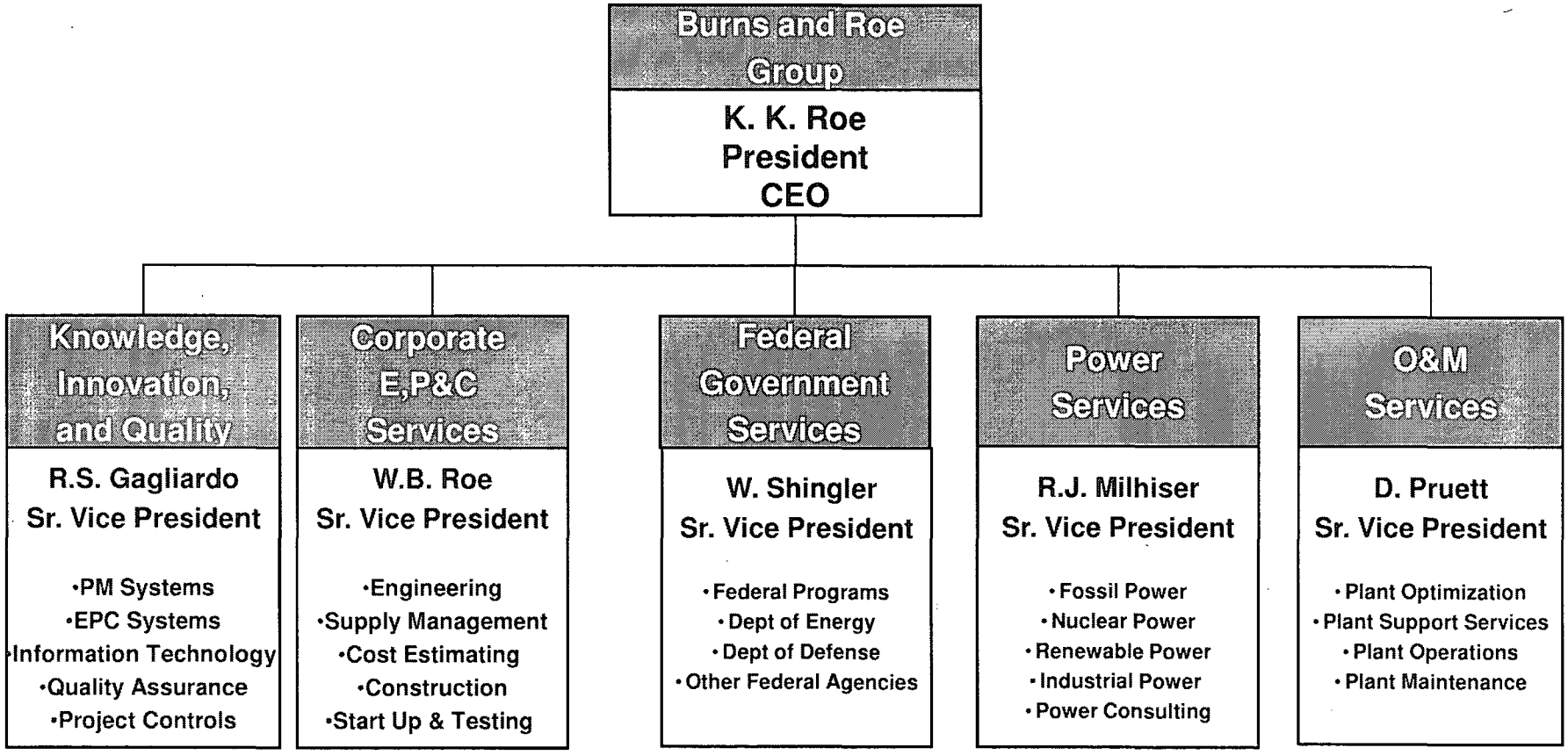
Burns and Roe Corporate Organization



Direct and flat organizational structure

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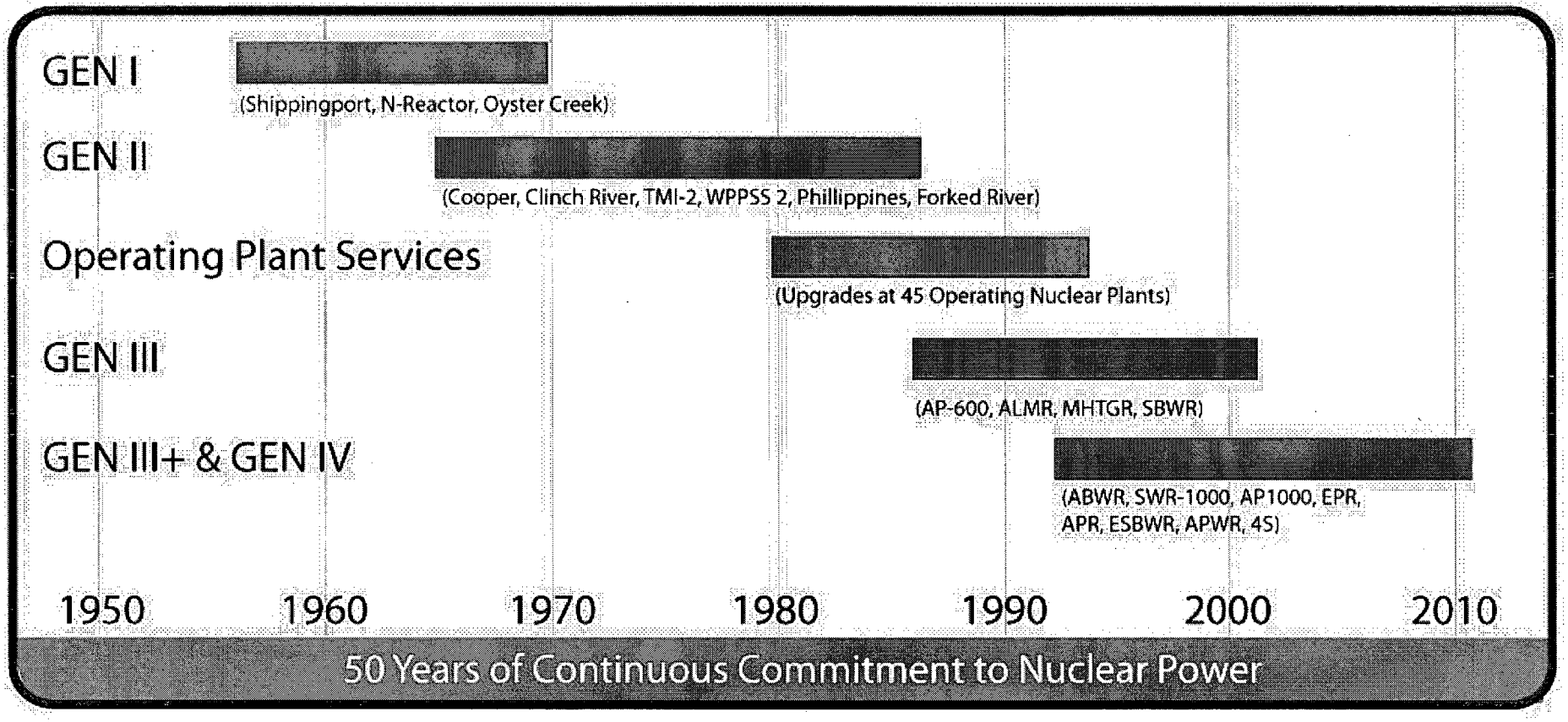
Burns and Roe Nuclear History



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ENERCON

- Employee owned, full-service A/E company
- Four Business Units
  - Nuclear Power Generation Engineering Services
  - New Nuclear Plant Services
  - Environmental & Industrial Services
  - Radiation Protection and Decommissioning Services
- Dedicated to supporting the nuclear power industry
  - ~75% of personnel supporting commercial nuclear power
- Engineer of Choice (EOC) contracts at ~75% of the operating nuclear power plants

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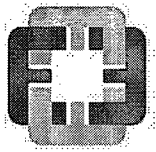

ENERCON

- 8 years experience in supporting new nuclear plant deployment efforts
- New Plant License Applications Development
  - Entergy ESP Application for GGNS
  - NuStart Bellefonte COL Application, AP1000 Reference Plant
  - NuStart GGNS COL Application, ESBWR
  - Duke Energy W.S. Lee COL Application, AP1000
  - Luminant Comanche Peak COL Application, USAPWR Reference Plant
- Participated in 3 Design Centered Working Groups
- Participated extensively in industry review of draft Regulatory Guide DG-1145
- Currently supporting NRC review of 3 COL applications

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Utility Working Group Comments

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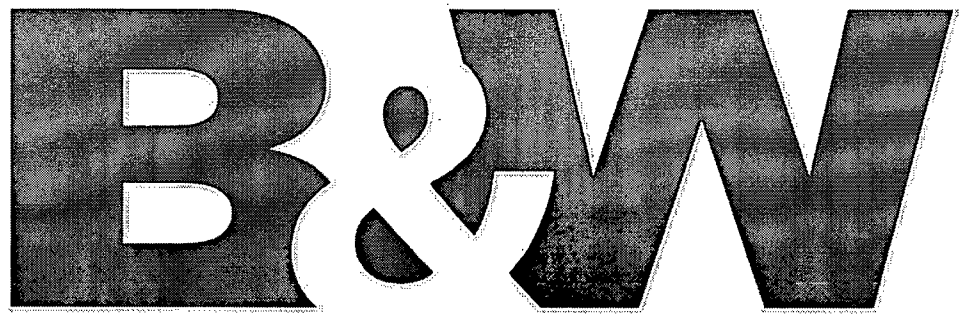


nuclear power generation

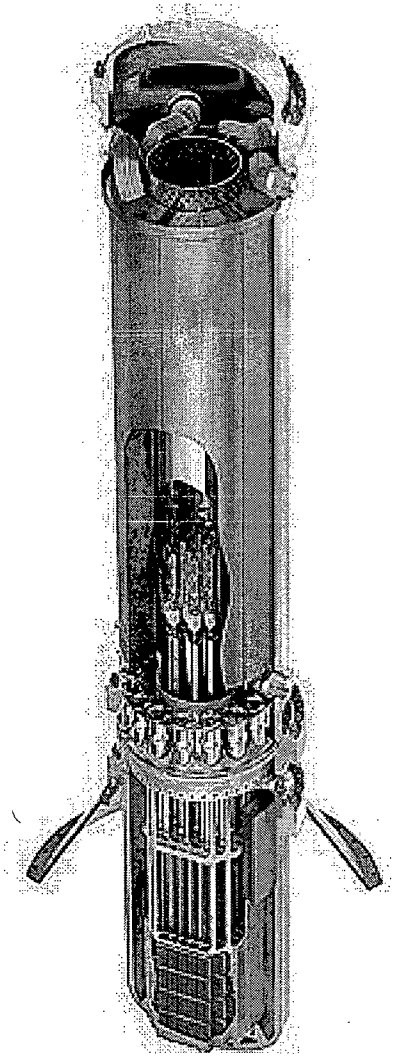
Introduction to the B&W mPower Design

B&W Nuclear Power Generation Group

July 7, 2009

What is the B&W *mPower* Design?

- Product History
- Overall Design Approach
- Integral Nuclear Steam Supply System (NSSS)
  - Design Characteristics
  - Steam Generator
  - Core & Fuel Assemblies
- Safety Philosophy
- Balance of Plant Overview
- Summary



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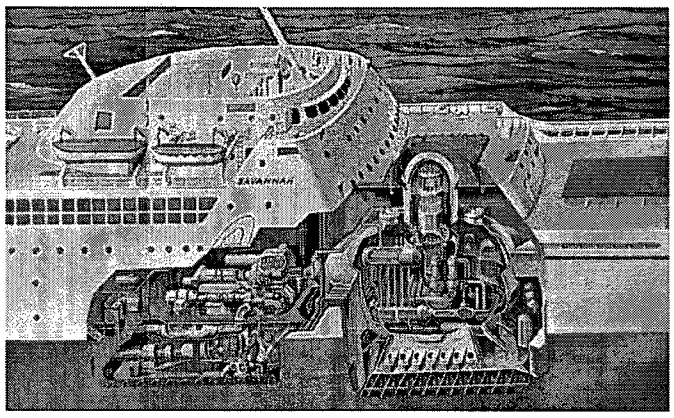
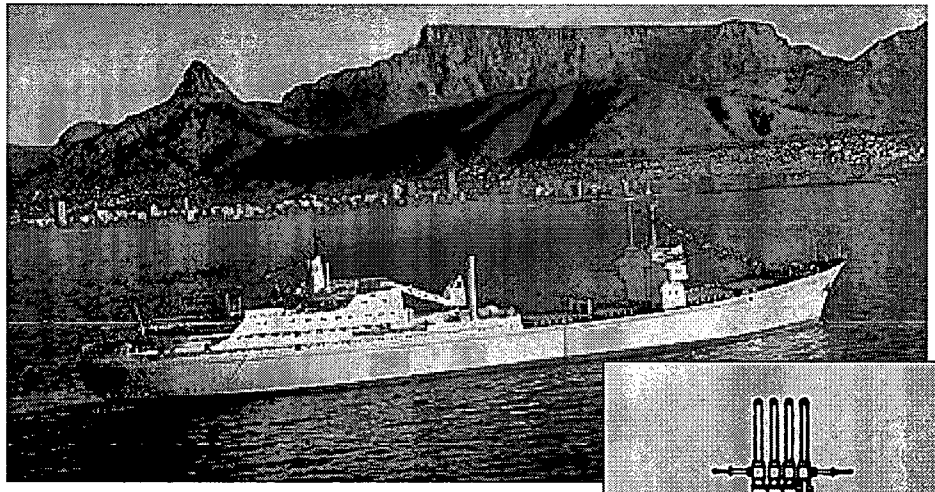
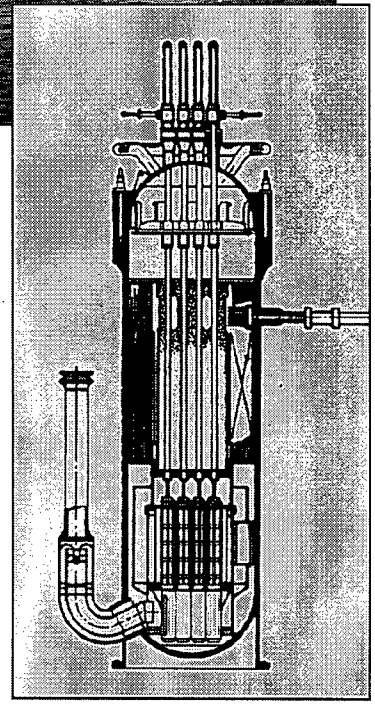
Early Integral PWRs at B&W







- B&W designed and fabricated NSSS for NS Savannah
- Began development of integral consolidated nuclear steam generator (CNSG) in 1959 for new generation of nuclear merchant ships
  - CNSG I design used in German nuclear ship Otto Hahn
    - Reactor built by B&W – Interatom consortium
    - Reactor began operation in 1968, refueled in 1972, decommissioned in 1979

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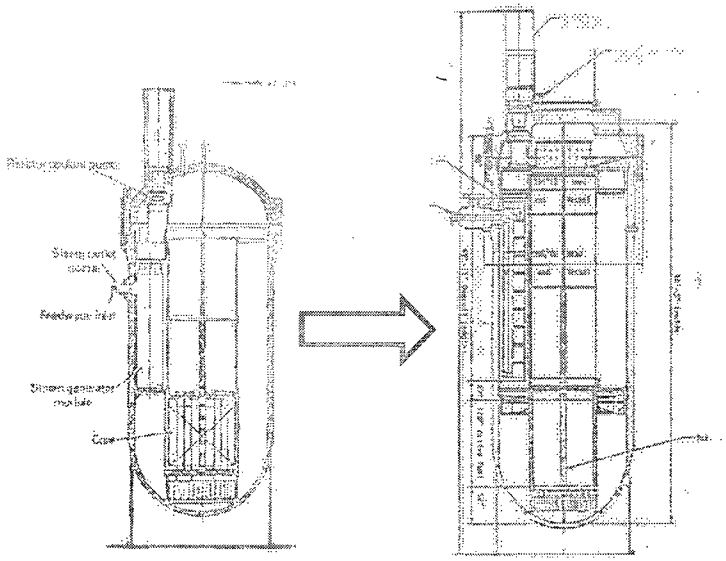
Evolution of CNSG to Land-Based Power

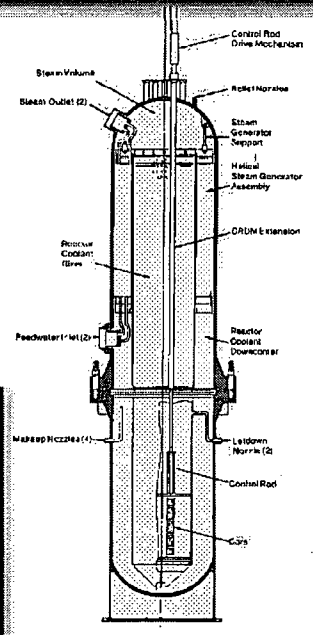


365 MW_{th} CNSG III
(1976)

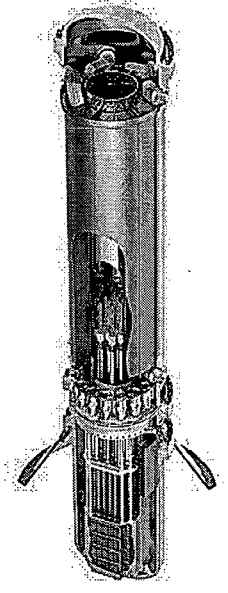
1200 MW_{th} CNSS
(1978)

Systems designed to enhance safety and reduce system complexity

- Core power density decreased
- Coolant volume increased (per MW_{th})
- Passive cooling systems added



40 MW_{th} SMPP
(1984)



400 MW_{th} B&W *mPower* Reactor (2008)

Systems designed to maximize power density to reduce plant size

- Core power density increased
- Coolant volume decreased (per MW_{th})

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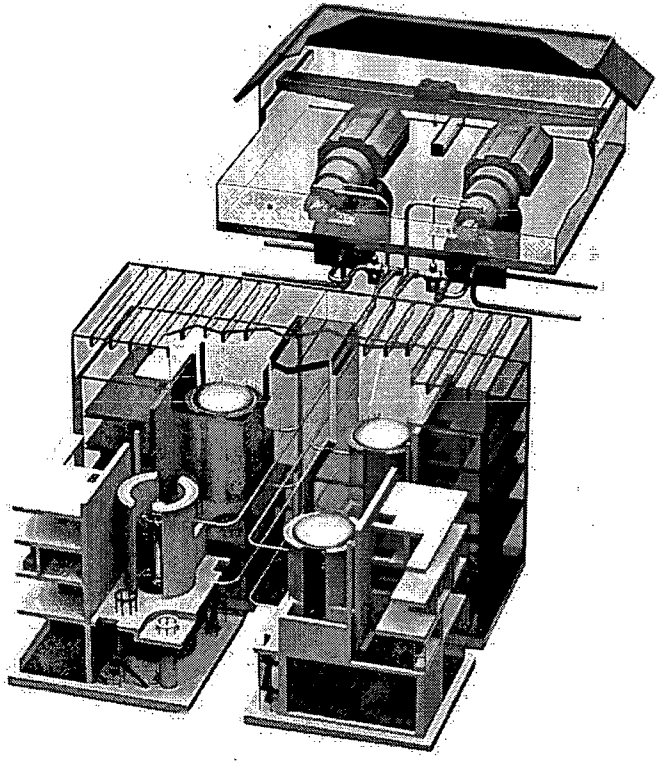
B&W *mPower* Overall Design Approach



- 400 MW_{th} Integral NSSS based on B&W CNSG PWR experience
- Standard PWR fuel assemblies
- Passive decay heat removal system
- Reactor Building housing the NSSS, the reactor coolant purification system, and spent fuel storage
- No soluble poison
- Control rods used for reactivity control
- No Class 1E emergency diesel generators
- Traditional turbine-generator and BOP (~125 MWe)

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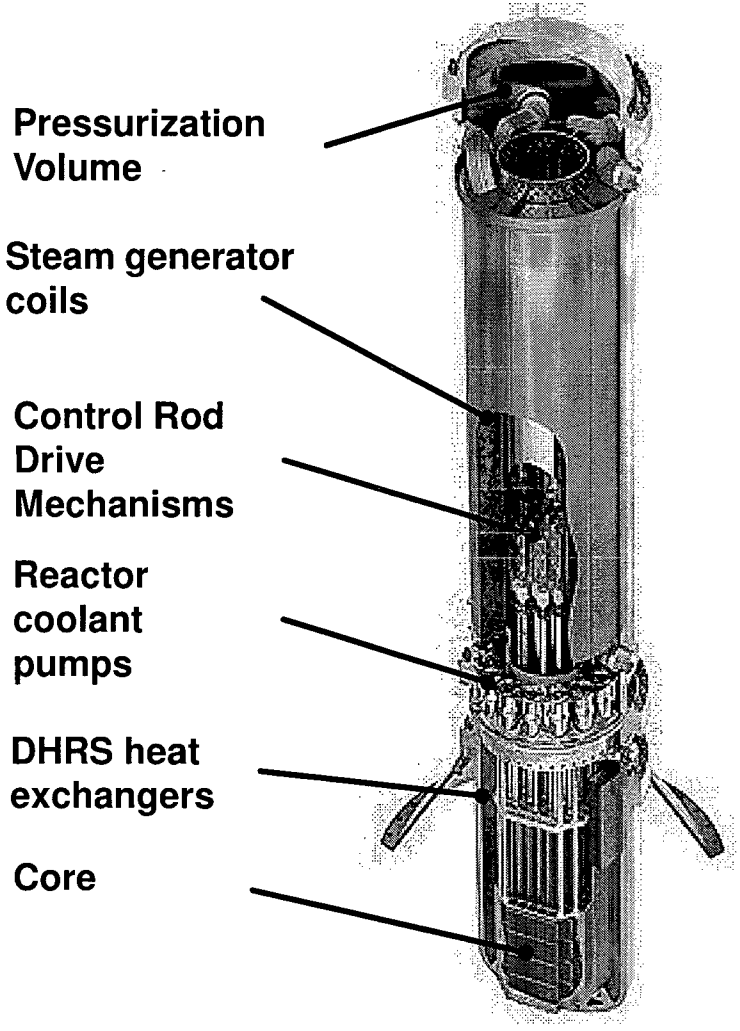
Integral Nuclear Steam Supply System



- Integrates core, steam generator, and pressurizer into a single vessel
- Control rod drive mechanisms (CRDMs) and primary coolant pumps inside vessel
- Decay heat removal system (DHRS) heat exchangers inside pressure vessel
- Reactor coolant pressure boundary penetration size and location minimize coolant loss during LOCA
- Core remains covered throughout design basis LOCA blowdown without coolant addition

Integral design enhances safety

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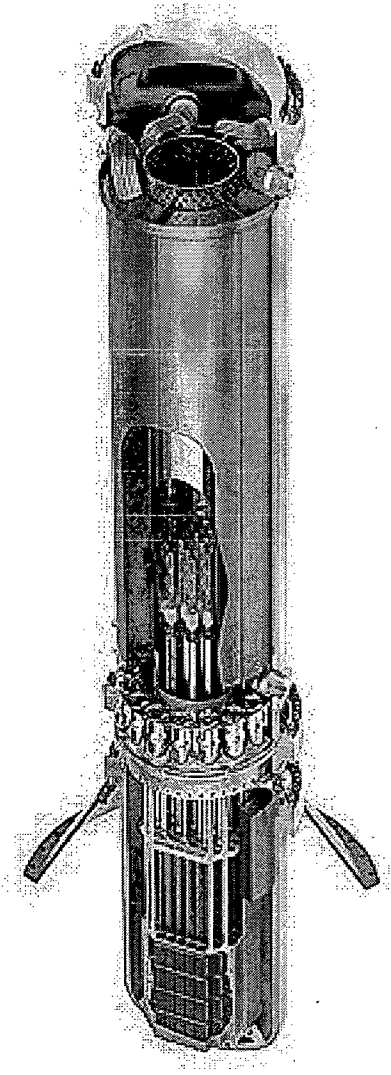
Design Characteristics

Design Characteristic	Value
Reactor Type	PWR
Thermal Power	400 MW
Reactor Coolant	< 14 MPa (2000 psia) ~ 600 K (620 °F) Core outlet
Steam Conditions	< 7 MPa (1000 psia) Superheated
Reactor Vessel	Diameter ~ 3.6 m (12 ft) Height ~ 22 m (70 ft)
Fuel Assemblies	69 - 17x17 fuel assemblies Height ~ ½ of Standard FA



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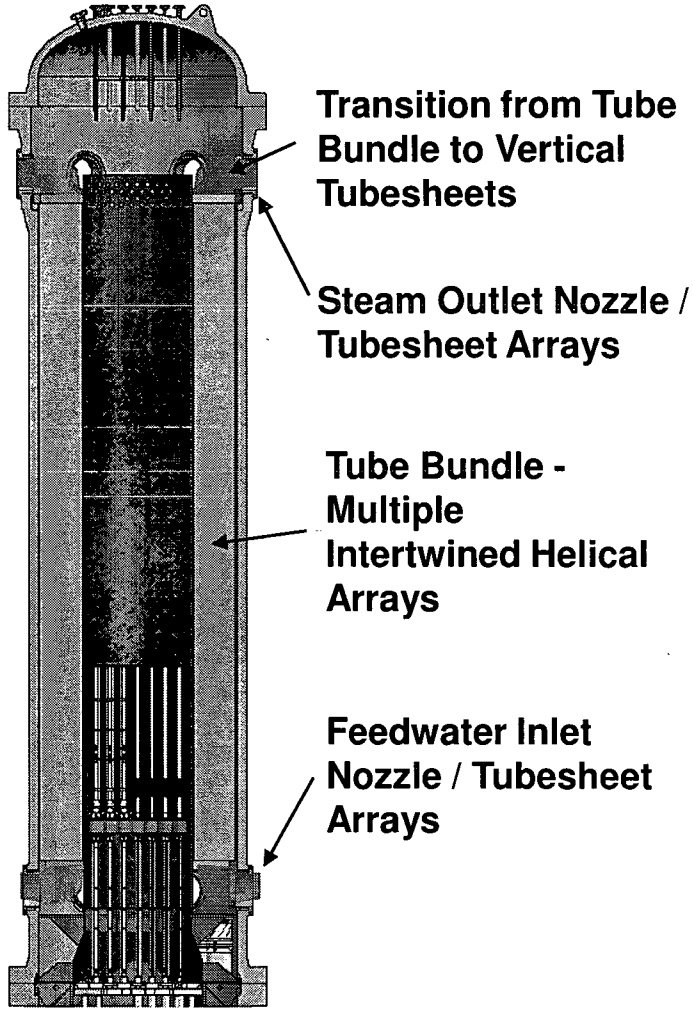
Steam Generator

- Once-Through Steam Generator with superheat
- Same design basis as CNSG reactor designs including Otto Hahn
- SG components are designed to primary pressure
- SG can be isolated immediately for postulated accidents
- Energy release into containment in a steam line break is small because of limited secondary inventory



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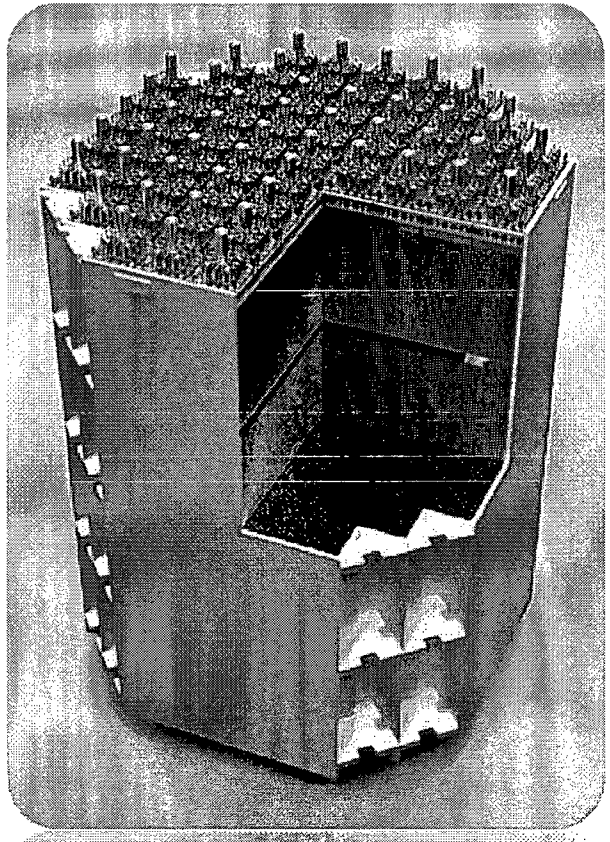
Reactor Core Characteristics

Reactor Core Parameters	
Number of Fuel Assemblies	69
Fuel Assembly Pitch	21.5 cm
Active Core Height	~ 200 cm
Core Diameter (Flat-To-Flat)	~ 200 cm
Fuel Inventory	< 20 MT
Average Specific Power	~20 kW/kgU
Core Average Fuel Burnup	<40 GWd/MTU
Target Fuel Cycle Length	~ 5 yrs
Maximum Enrichment	< 5%



Conventional Core Design with Low Power Density

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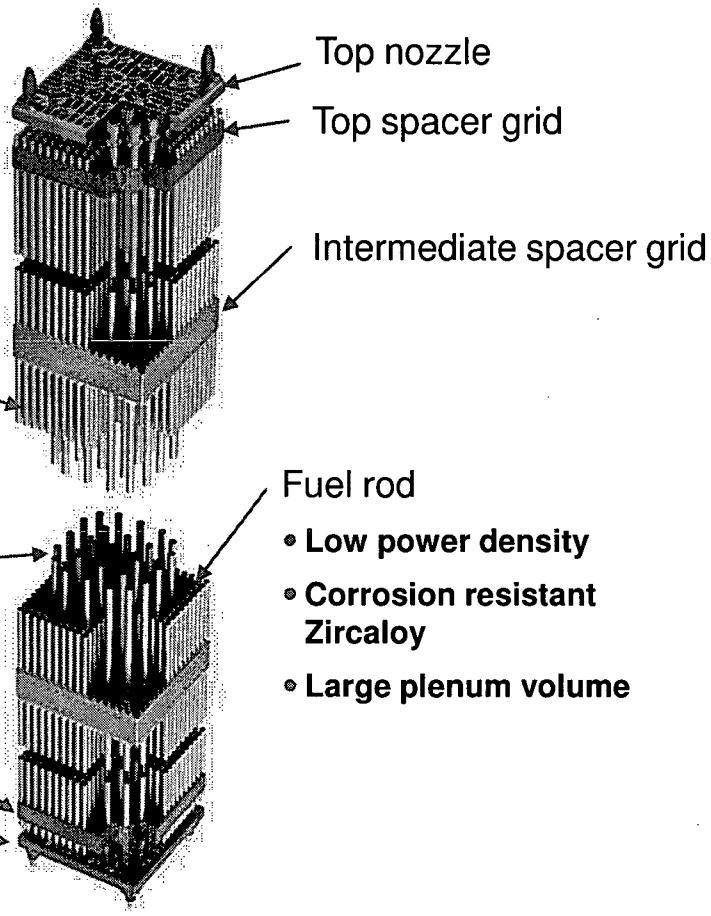
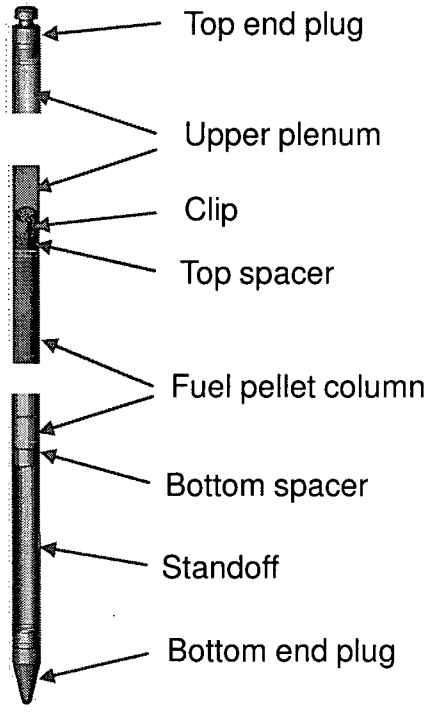
Fuel Assembly Characteristics



Fuel rod

- **Low power density**
- **Corrosion resistant Zircaloy**
- **Large plenum volume**



Shortened and Simplified Conventional Fuel Assembly Design

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B&W *mPower* Design Safety Philosophy

- Conventional defense in depth for fission product release
- Inherent design features preclude need for active engineered safeguards
  - Passive core and containment cooling
  - No large-break LOCA
  - No RCS penetrations below top of core
  - Large coolant inventory (*Core remains covered in design basis LOCA blowdown)*
- Maximize containment of radioactive materials
  - RCS purification system piping inside containment
  - Spent fuel stored inside containment
  - Below-grade containment

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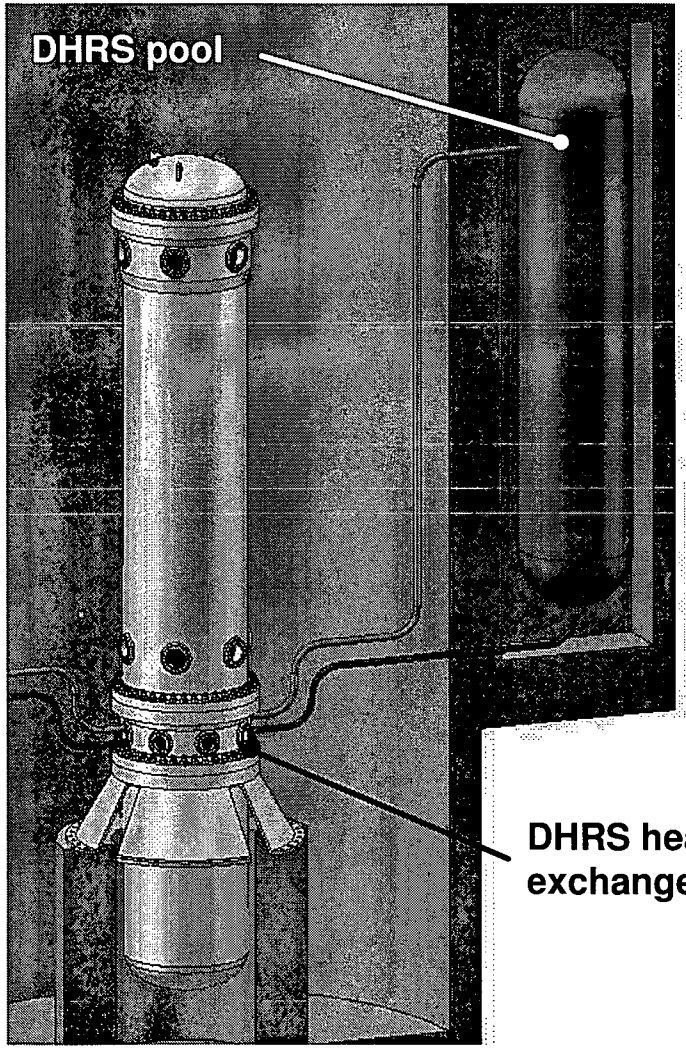
Natural Circulation DHRS



- Decay heat removal system (DHRS) serves as emergency core cooling system
- Multiple independent heat exchanger loops fed from stored water source(s)
- System is operational at all reactor pressures and temperatures
- Passive heat removal without makeup for more than 72 hours

Provides passive decay heat removal when steam generator is not available

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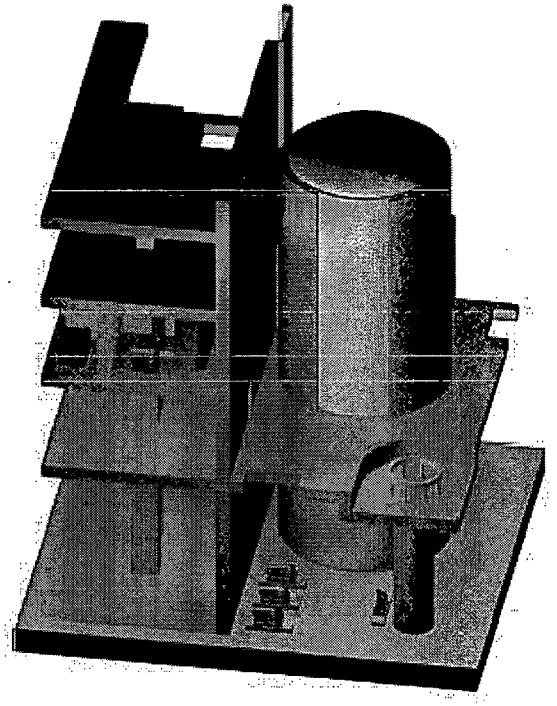
Containment Functional Requirements

- Allow for installation of reactor vessel after containment construction
- Allow maintenance and inspection of reactor safety and support systems to occur while plant is operating
- Allow for steam generator, CRDM and pump maintenance and inspection to occur simultaneously with refueling operations
- Accommodate storage of spent fuel for 60 years of normal operation
- Accommodate design basis LOCA and steam line break without use of active cooling systems
- Low-leakage containment



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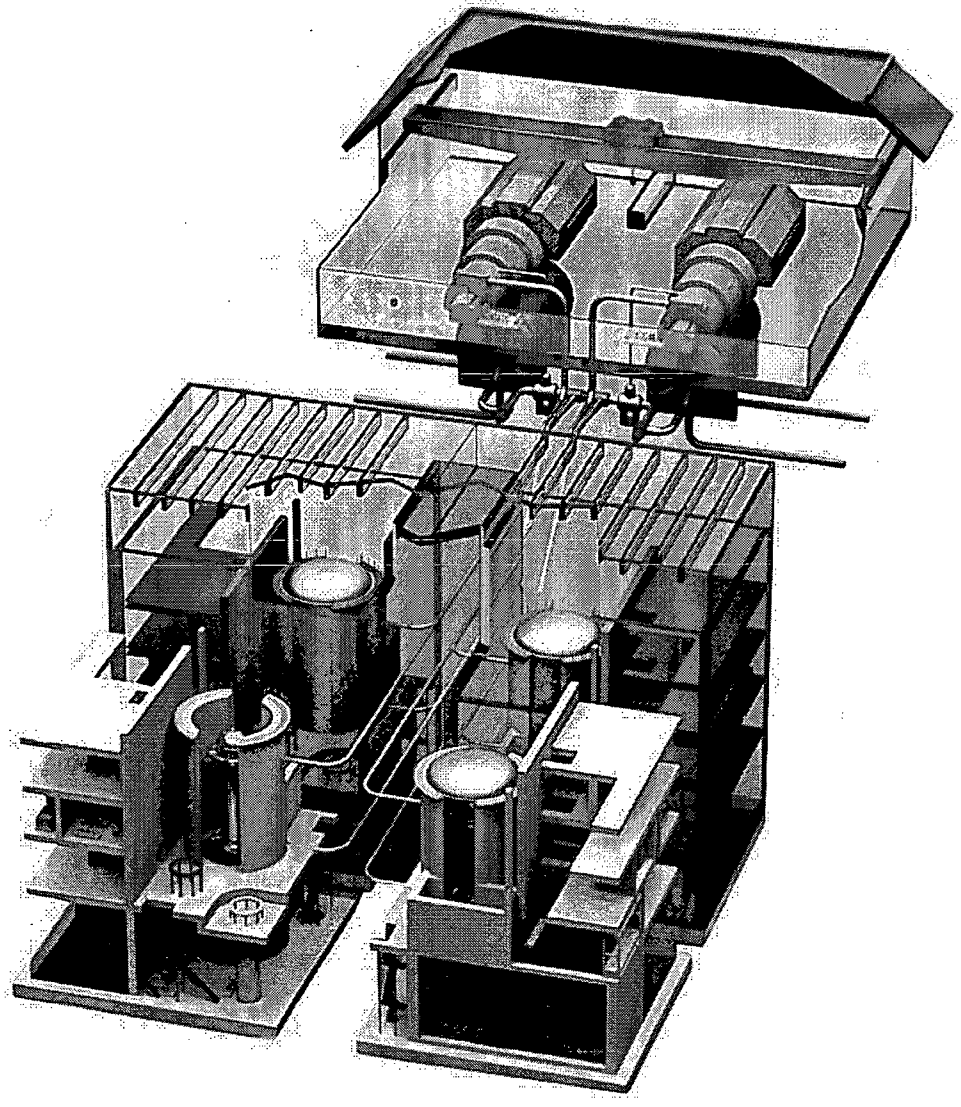
Balance of Plant Overview

- Steam Cycle
- Instrumentation and Controls
- No shared safety systems



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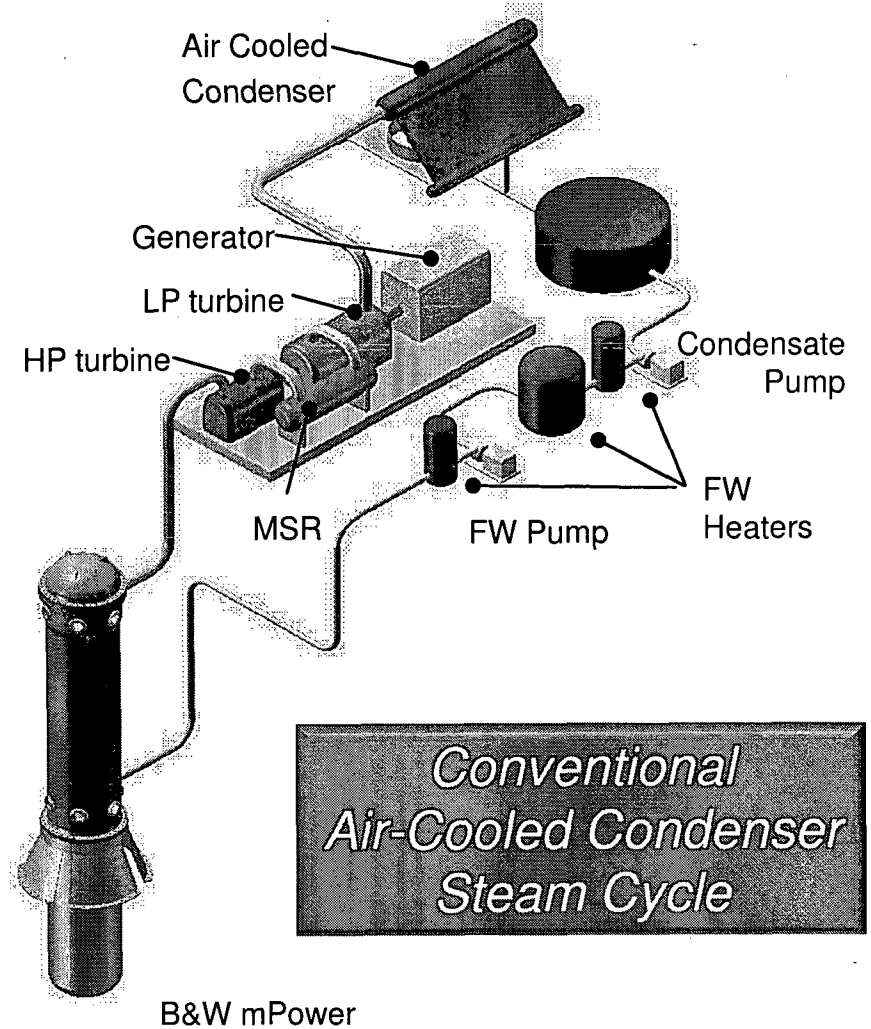
Balance of Plant Design

- Plant designed to produce a nominal 125 MWe gross
  - Air-cooled condenser (Baseline)
  - Water-cooled condenser
- Conventional steam cycle equipment
- BOP operation not credited for design basis accidents
  - Reactor can be cooled without feedwater flow to the steam generator
  - All fuel can be cooled for a minimum of 72 hours without any BOP system
- Option of feeding steam from multiple reactors to a single turbine



B&W mPower
125 MWe Module

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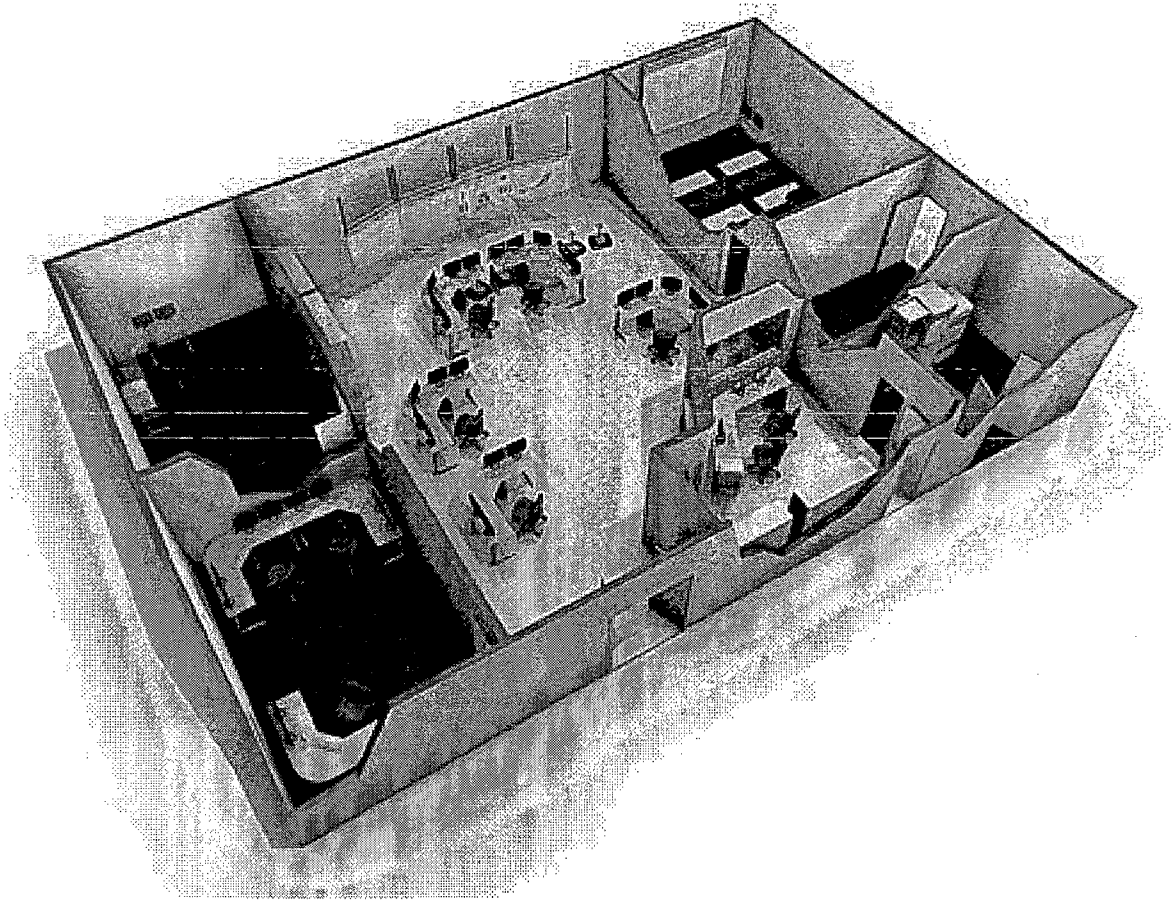
Instrumentation and Controls

- State of the art digital system
- Provides monitoring, control, and protection functions
- Separate safety and non-safety systems
- Implement lessons learned from current licensing activities



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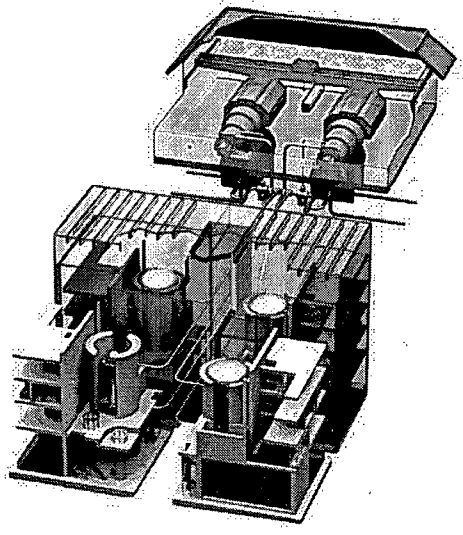
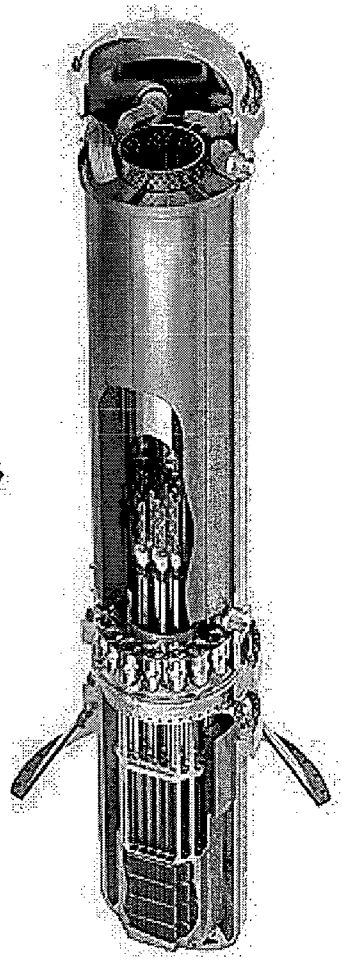
Summary

- B&W *mPower* reactor based on demonstrated B&W technology
- B&W *mPower* design provides significant benefits
  - Integral reactor allows improved safety position
    - Core remains covered and cooled in postulated design basis accidents
    - Core cooling provided by passive safety systems and features
  - Conventional core design with low power density
  - No reliance on emergency diesel generators
  - Containment integrity ensured by passive cooling
  - No soluble boron used for reactivity control
  - Extended fuel cycle
  - 60-year fuel storage in containment
  - Below grade containment
- Incorporates conventional BOP design
- Uses digital I&C architecture





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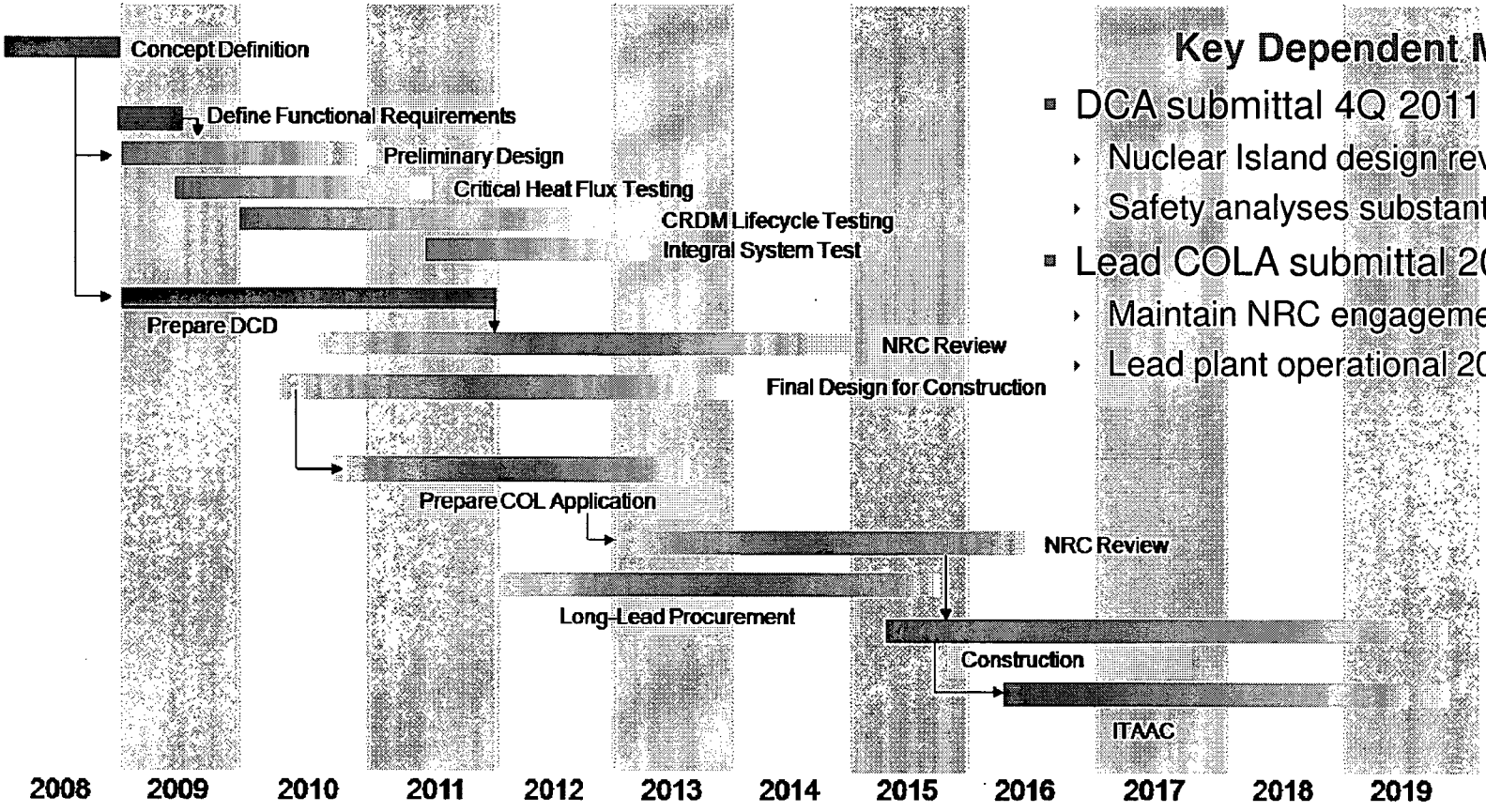
B&W mPower™ Lead Plant Schedule



Key Dependent Milestones

- DCA submittal 4Q 2011
  - Nuclear Island design review-ready
  - Safety analyses substantially complete
- Lead COLA submittal 2013
  - Maintain NRC engagement
  - Lead plant operational 2018-20

Critical external constraints ... NRC review window and initial New Build viability

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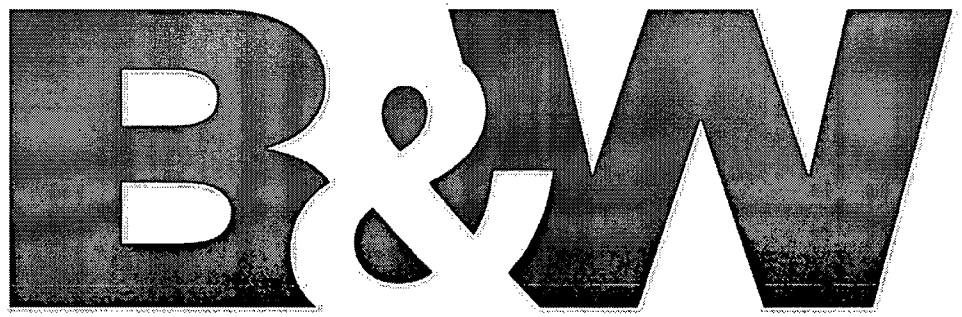

nuclear power generation

Licensing Approach

Licensing Approach Agenda

- Licensing approach
- NRC pre-application support
- Topical Report submittals planned
- Design verification programs

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Licensing Approach

- 10 CFR 52 process for design certification and licensing
  - Subpart B—Standard Design Certifications
    - 52.47, Contents of applications; technical information
  - Subpart C—Combined Licenses
    - 52.79, Contents of applications; technical information in final safety analysis report
    - 52.80, Contents of applications; additional technical information
- Minimize exemptions to 10 CFR Part 50

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Regulatory Guidance / Requirements

- Regulatory Guide 1.206 guidance for COLA FSAR content
- NUREG-0800 revisions to align with RG 1.206 and general updates
- Maturity of 10 CFR 52 regulations related to design certification

B&W mPower will take advantage of recent revisions to regulations and guidance

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NRC Pre-Application Support

- Pre-application meetings
  - Policy issues (none known currently)
  - Technology issues
- Routine Status update
  - Teleconferences
  - Meetings
- Topical Report reviews
- Site visits
  - Manufacturing development
  - Design verification / testing activities
- DCA pre-submittal review

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Topical Report Submittals

- Potential areas for topical and technical report submittal in pre-application phase
  - DC Quality Assurance program description — Dec 2009
  - HFE program plan — Dec 2009
  - Core and fuel design criteria and analysis methodology — Mar 2010
  - Reactivity control — Jun 2010
  - Multi-module Control Room and Operations staffing — Jun 2010
  - Safety analysis — Sep 2010
    - LOCA mass and energy release
    - Containment analysis methodology and codes
  - Design verification testing program plan — Sep 2010
    - SG performance
    - Fuel qualification
    - Integral systems test

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Design Verification Testing

- Planned component testing
  - SG performance
  - Fuel CHF
  - Fuel qualification
  - CRDMs
  - Reactor coolant pumps
- Integral systems test program

Schedule being developed

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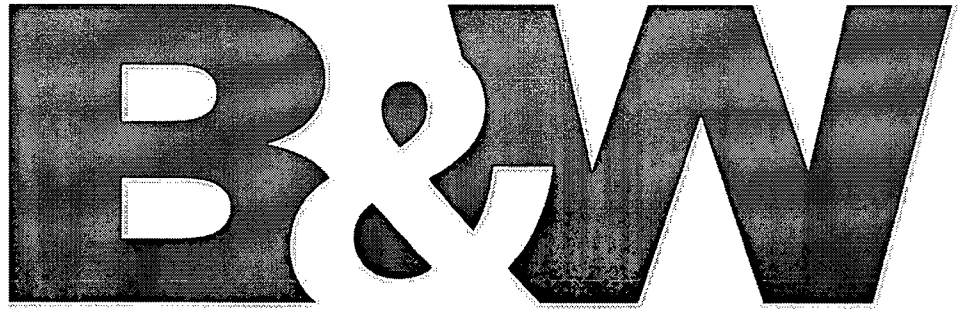

nuclear power generation

DCD Lessons Learned

DCD Lessons Learned

- Design Maturity and Level of Detail
  - Mature design – minimize changes during NRC staff review
  - Design detail sufficient to support NRC review
  - Incorporate appropriate margins into design
  - Establish early PRA input and interface
  - Early identification and design for RTNSS systems
- Design and DCD Development Interactions
  - Early NRC technical staff review of potential issues – topical reports
  - Pre-application meetings and discussions with NRC staff
  - Industry interactions early – Utility Advisory Committee and/or DCWG
- DCD Content and Level of Detail
  - Start from current DCAs – consider RAI traffic and changes
  - RG 1.206 guidance for content and format
  - Clear identification of COL requirements (COL Information items, CDI)

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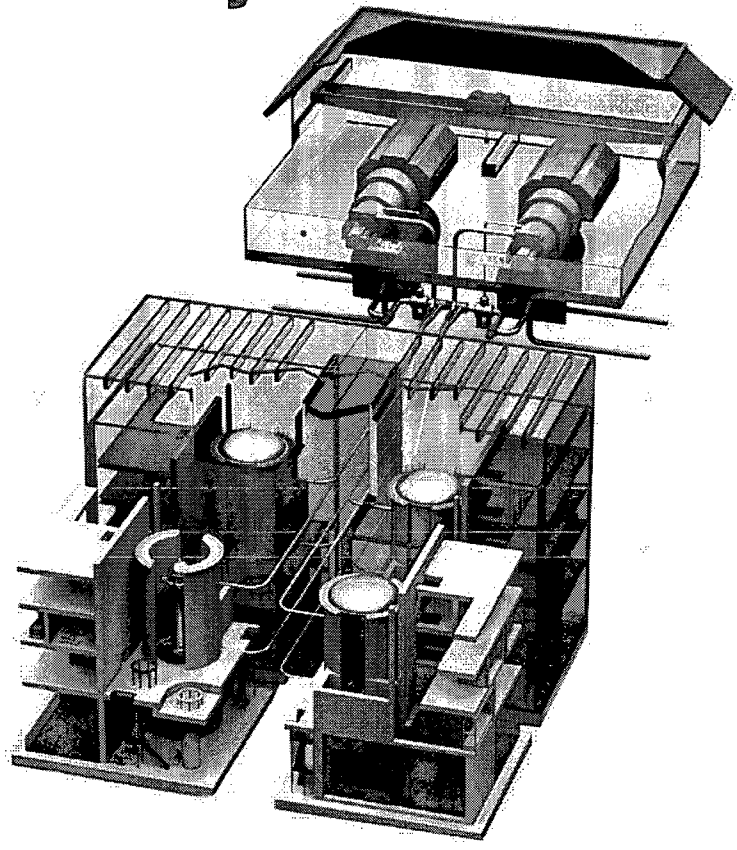
Meeting Summary

- Experienced team
- Strong utility interest
- Practical design, utilizing mature PWR technology
- Robust licensing philosophy, facilitating NRC review



B&W mPower technology matches the shifting nuclear landscape

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