The AP1000 Reactor Nuclear Renaissance Option

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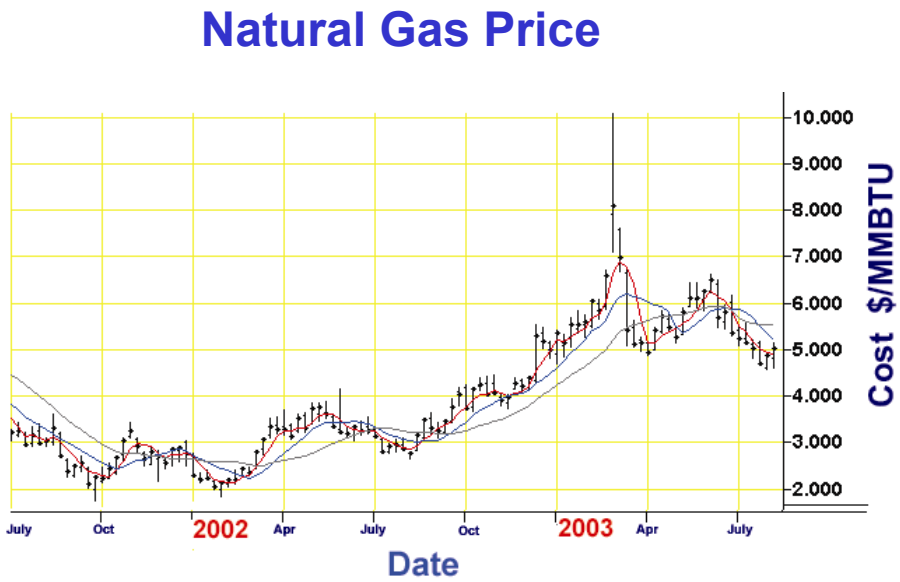
What Will Drive A Nuclear Renaissance?

- Continuing excellent performance of existing reactors
- Need for base load electricity capacity
- Nuclear's contribution to clean air recognized and credited
- Importance of energy security and/or diversity included in capacity planning
- Competitive economics of new nuclear plants compared to alternatives
- Government support and/or incentives for initial projects
- Strong tie between nuclear and hydrogen economy



Critical Issues for New Plants in US

- **Capital Cost of the Plant**
  - **Historical record of meeting project targets sporadic**
  - **Long time since start of last project**
  - **Current lack of skilled workforce**
  - **Complicated design of past plants**
  - **Vast majority of current plants were custom designed**

Reluctance to Accept Current Cost Estimates

Critical Issues for New Plants in US (Cont'd)

- **Perceived Risk of a Construction Project**
  - Local public or anti-nuclear group opposition
  - Permitting delays
  - Design changes after project start
  - First time implementation of new regulatory processes
  - Regulatory changes after construction start
  - Procurement and/or construction delays
  - Increased concerns over fuel disposal issues
  - Latent technical defects found after start of operations
  - Electric market / price fluctuations

Financial Community Concerns Manifested by Unwillingness to Provide Project Financing

Why Was Advanced Passive AP1000 Design Developed?

- Existing designs with incremental improvements could not meet the deregulated electricity generation cost target
- Westinghouse Passive Plant Technology was mature and licensed in US
- Large investment in Passive Plant Technology development could be leveraged to provide a cost competitive design in a relatively short time

Passive Safety Advantages

- No reliance on AC power
- Automatic response to accident condition assures safety
- Long term plant safety assured without active components (natural forces only)
- Containment reliability greatly increased by passive cooling
- In severe accidents, reactor vessel cooling keeps core debris in vessel
- Large margin to safety limits
- Defense in depth - active non-safety systems provide additional first line of defense

Passive Plant Technology is Mature

- **1300 man-year / ~$500 million design and testing effort**
- **More than 12,000 design documents completed**
- **Detailed Bill of Materials developed**
- **3D computer model developed**
  - Includes structures, equipment, small / large pipe, cable trays, ducts ...
- **Very thorough / complete NRC review of AP600**
  - 110 man-year effort (NRC) over 6 years
  - Independent, confirmatory plant testing (ROSA, OSU)
  - 380+ meetings with NRC, 43 meetings with ACRS
- **NRC design certification of AP600 issued December 1999**
- **AP1000 currently under design certification review - draft Safety Evaluation Report already issued**

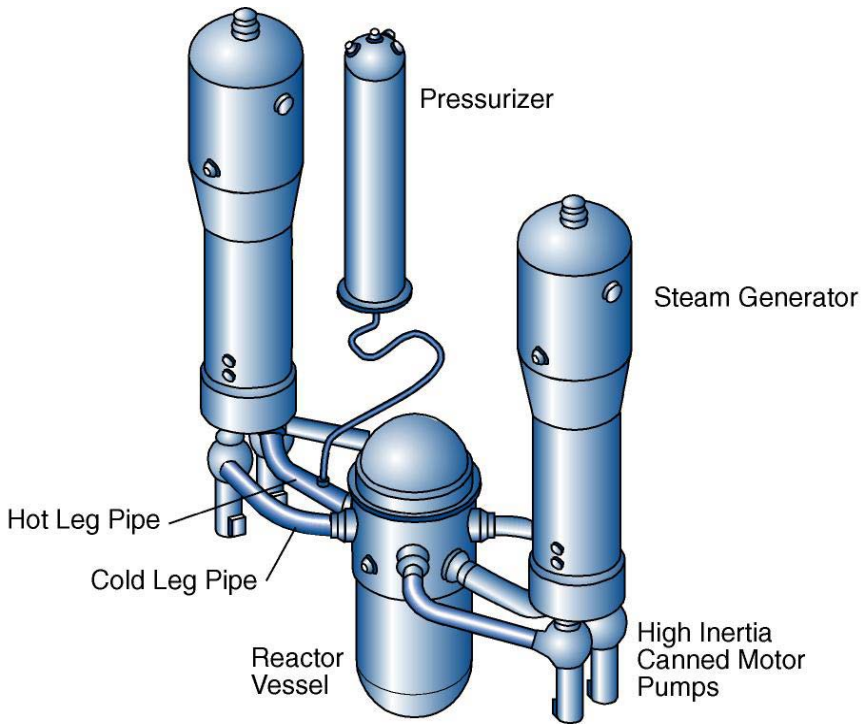
AP1000 Design Objectives

- **Increase Plant Power Rating to Reduce Cost**
  - Obtain capital cost to compete in US deregulated market
- **Retain AP600 Design Basis and Detail**
  - Increase capability/capacity within “space constraints” of AP600
  - Retain credibility of “proven components”
  - Retain basis and pedigree for cost estimate, schedule, modular scheme
- **Retain AP600 Licensing Basis**
  - Meet regulatory requirements for Advanced Passive Plants
  - Demonstrate AP600 Test Program and Safety Codes are applicable to AP1000

Build on AP600 Investment

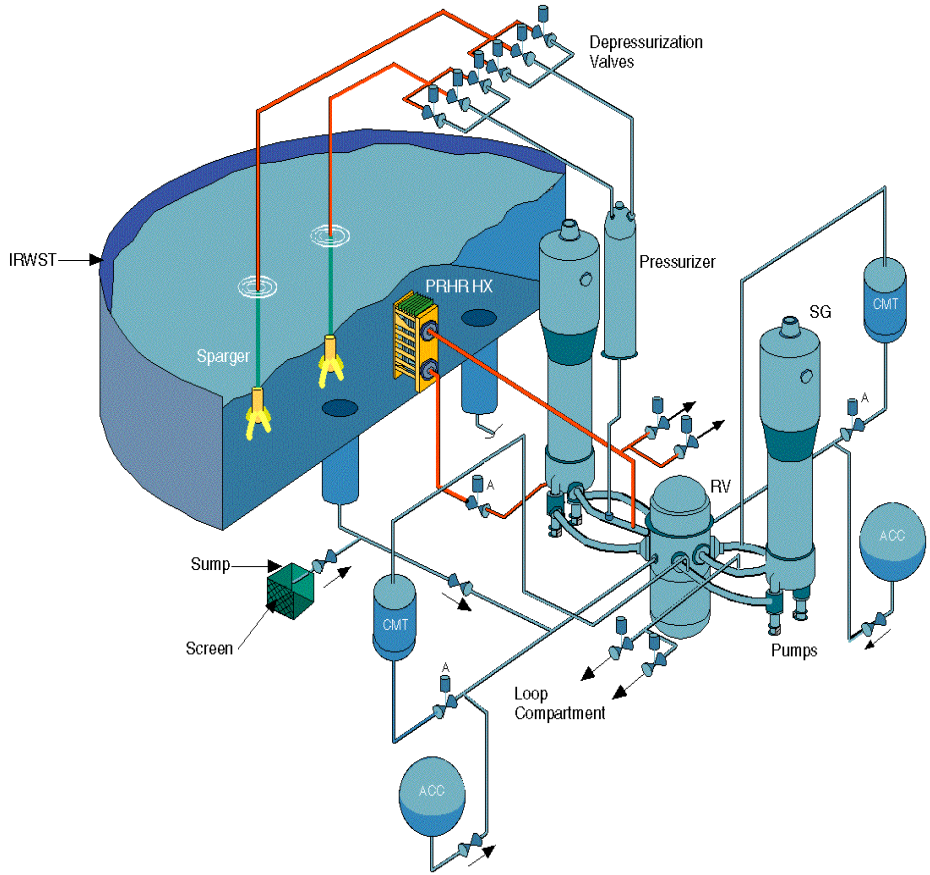
Reactor Coolant System

- Canned motor pumps mounted in steam generator lower vessel head
- Elimination of RCS loop seal
- Large pressurizer
- Top-mounted, fixed in-core detectors
- All-welded core shroud
- Ring-forged reactor vessel

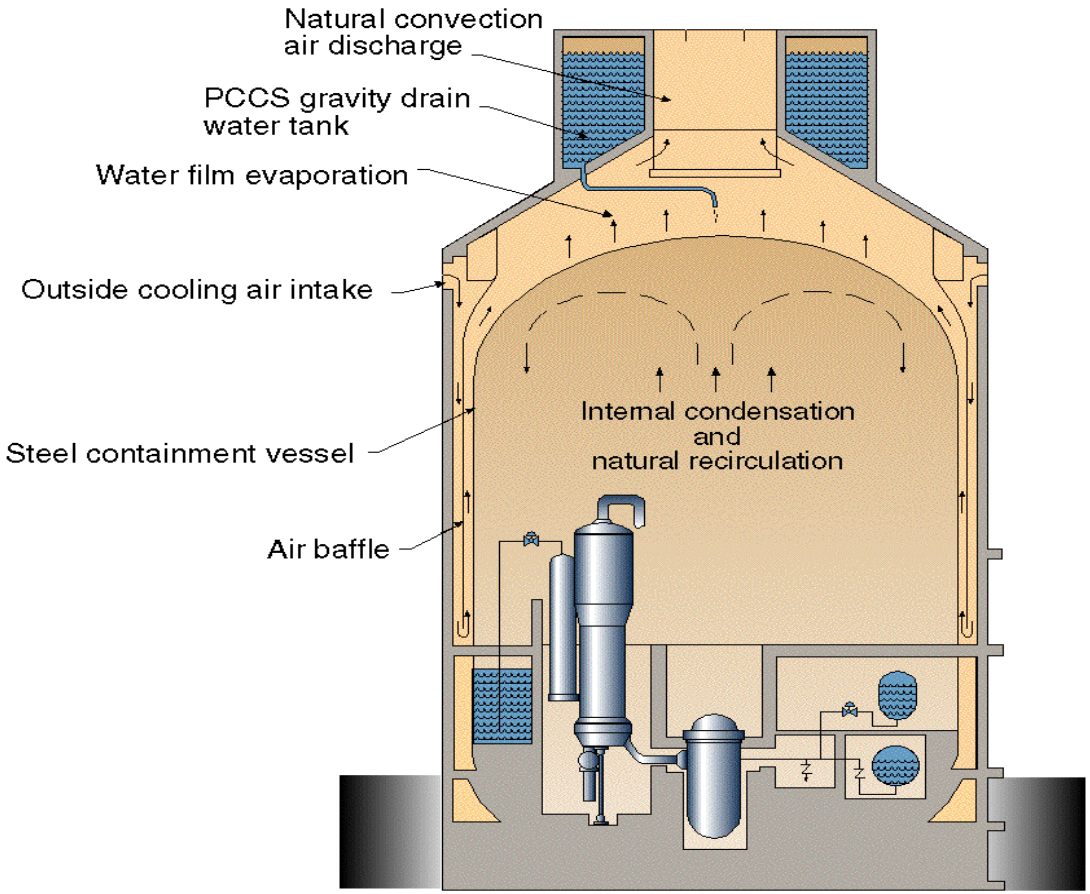


Passive Core Cooling System

- AP1000 has no reliance on AC power
  - Passive Decay Heat Removal
  - Passive Safety Injection
  - Passive Containment Cooling
- Long term safe shutdown state > 72 hours without operator action



Passive Containment Cooling



Passive Plant Test Program

- **Separate Effects Component / Sub-System Tests**
  - **Reactor coolant pump tests**
  - **Passive residual heat removal heat exchanger test**
  - **Core makeup tank test**
  - **Containment water distribution test**
  - **Containment shell heat and mass transfer tests**
  - **Containment cooling wind tunnel tests**
  - **DNB tests**
  - **Automatic depressurization system test (full scale)**
- **Integral Systems Tests**
  - **Long term cooling integral systems test**
  - **Full height, full pressure integral systems test**
  - **Large scale integral PCS test**

The Most Tested of Next Generation Reactors

Advanced I&C Features

- All Digital, microprocessor-based
- Current design uses Advant (for safety) and Ovation (for non-safety)
- Most I&C is non-safety classification
- Safety systems already licensed by US NRC
- Extensive use of multiplexing and fiber optics
- Smart instruments and electrical equipment (MCCs, switchgear)
- Diverse actuation of key passive safety systems
- Compact Advanced Control Room

Advanced Control Room

AP1000 Approach to Safety

- Passive Safety Systems
  - Use “passive” processes only; no safety-grade active pumps, diesels….
  - Dedicated systems; not used for normal operations
  - Reduced dependency on operator actions
  - Mitigate design basis accidents
  - Meet regulatory safety goals
- Active Non-Safety Systems
  - Reliably support normal operation
  - Minimize challenges to passive safety systems
  - Not required to mitigate design basis accidents or meet safety goals
  - Provide plant investment protection

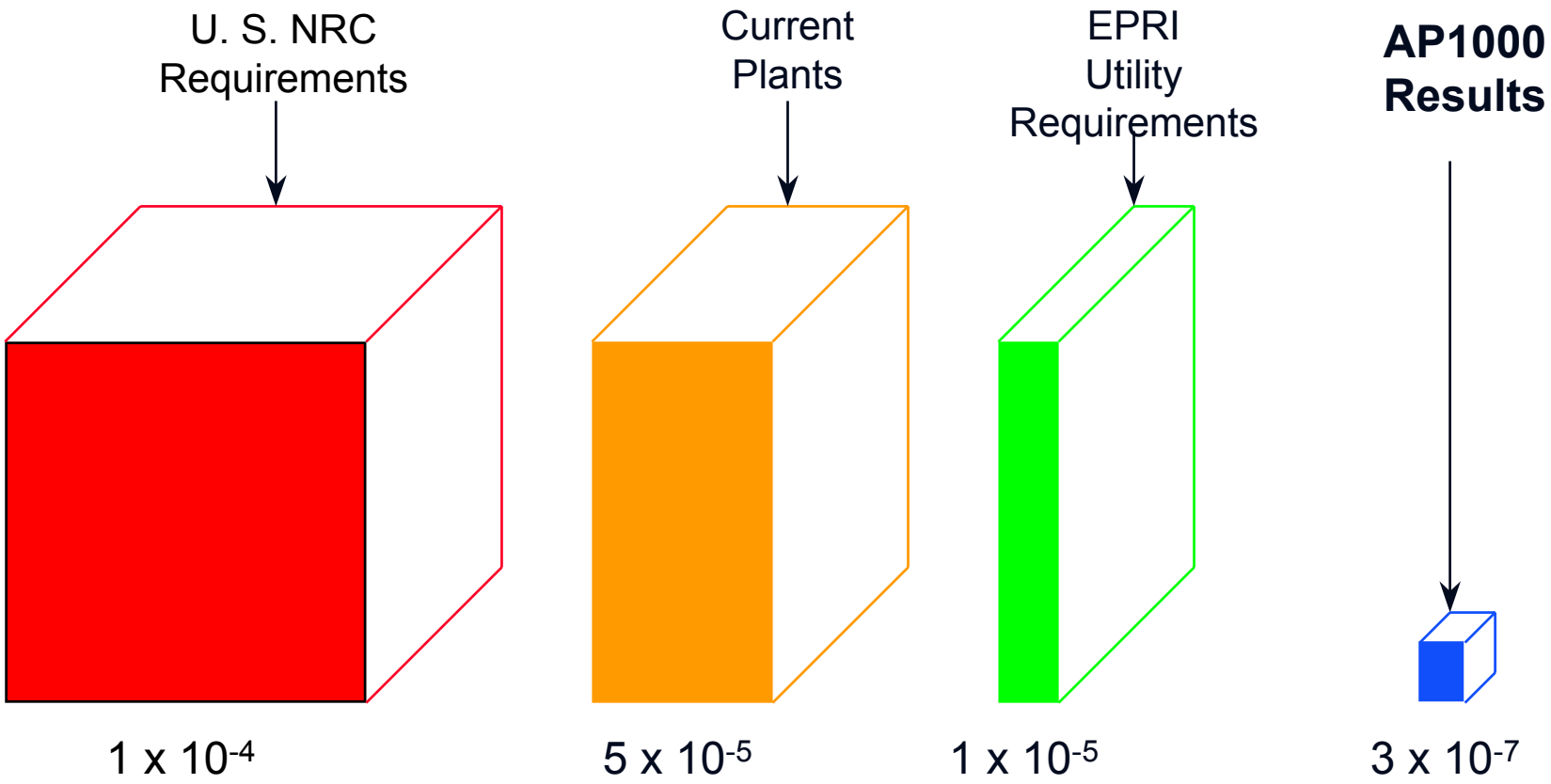
AP1000 Provides Multiple Levels of System Defense In Depth

- First action is usually by non-safety grade active system
  - High quality industrial grade equipment
- Second action is by safety grade passive system
  - Provides safety case for SAR
  - Highest quality nuclear grade equipment
- Other passive systems provide additional defense-in-depth
  - Example; passive feed/bleed backs up PRHR HX
- Available for all shutdown conditions as well as at power
- More likely events have more levels of defense

AP1000 Safety Margins

	Typical Plant	AP1000
Loss Flow Margin to DNBR Limit	1 – 5%	19%
Feedline Break Subcooling Margin	>0°F	140°F
SG Tube Rupture	Operator actions required in 10 min	Operator actions ***NOT*** required
Small LOCA	3" LOCA core uncovers PCT ~1500 °F	≤ 8" LOCA ***NO*** core uncovery
Large LOCA PCT (with uncertainty)	2000 – 2200°F	2124°F

AP1000 Provides Increased Safety and Investment Protection



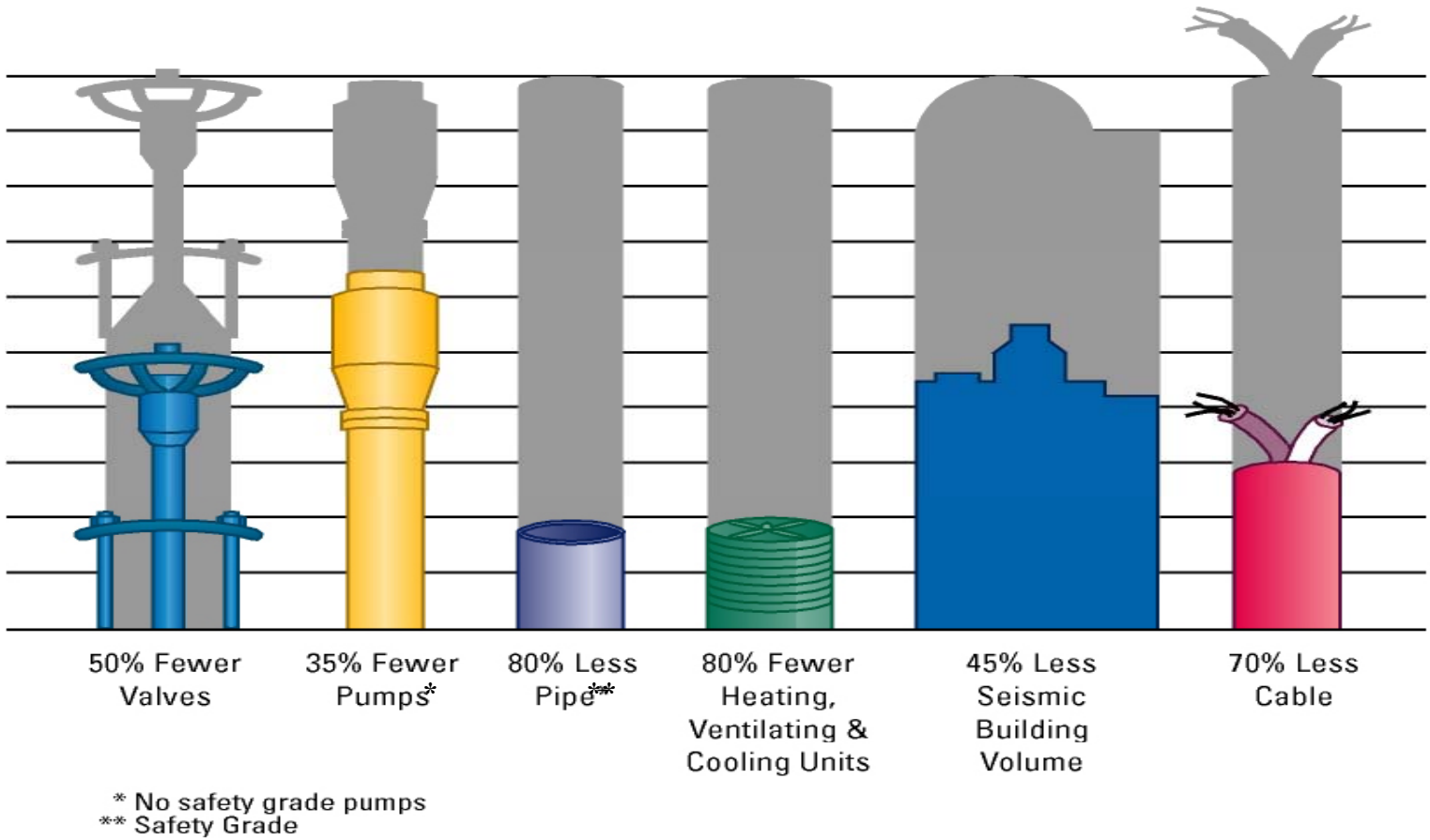
How We Will Achieve a Competitive Capital Cost

- Basic Design - Simplification
- Power Level - Economics of Scale
- Project Schedule - It Must be Short
- Standardization - A Necessary Commitment
- Modularization - An Integral Part of the Design Process
- Information Technology - Use of Advanced Information Management System
- Project Organization and Structure - Sharing Risk and Rewards

Simplicity of Design Drives Economics

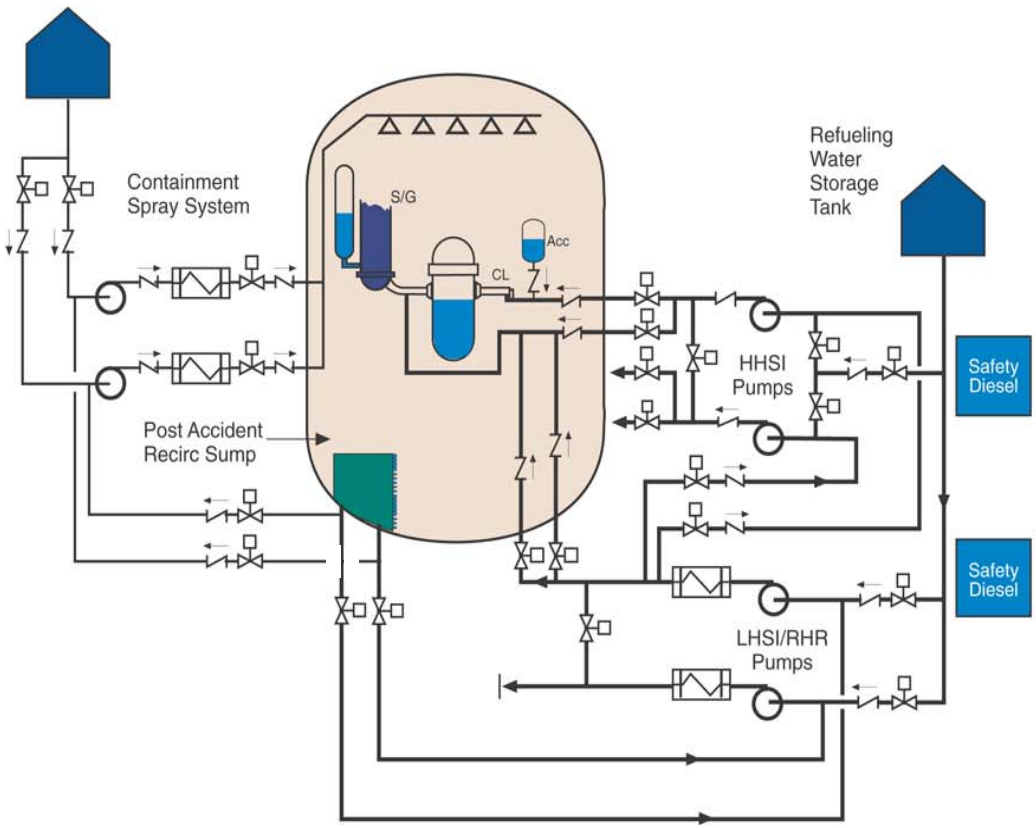
- **Simplicity in Design** through reduced number of components and bulk commodities
- **Simplicity in Safety** through use of passive safety systems
- **Simplicity in Procurement** through standardization of components
- **Simplicity in Operation and Maintenance** through use of proven systems and components, and man-machine interface advancements

Passive Safety Systems Eliminate Components

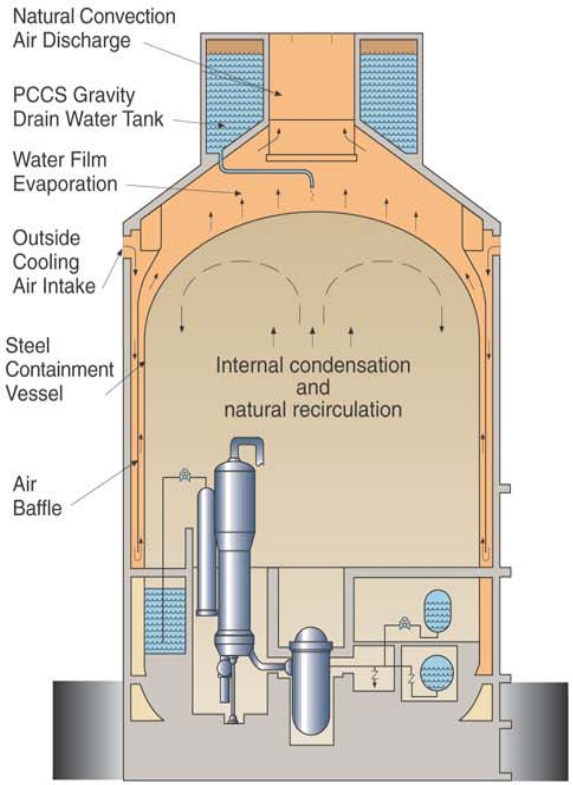


Simplification of Safety Systems Dramatically Reduces Building Volumes

Standard PWR



AP1000



Simplifications Reduce O&M

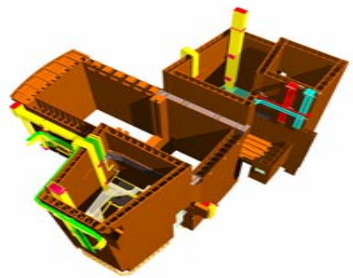
- Reductions in Amount of Safety Equipment
  - Reduces inservice inspections and testing
  - Fewer Technical Specifications
- Use of Non-safety Defense-In-Depth Equipment
  - No ISI / IST or Technical Specifications
  - Most planned maintenance performed at power
- Elimination of Snubbers and Pipe Whip Restraints
- Elimination of Most Charcoal / HEPA Filters
- Advanced Control Room & Remote Shutdown Station
  - Eliminates separate displays, switches, alarms, indicating lights

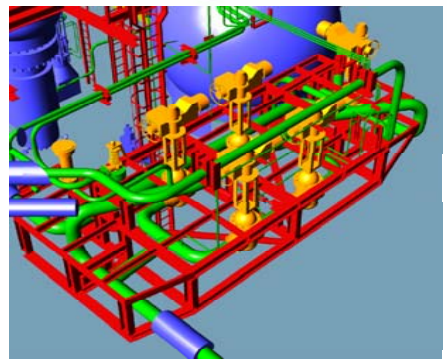
Modularization Impacts Construction Schedule

- Modules developed as an integral part of the detailed design process
- Allows many repetitive construction activities to be performed in a more controlled environment
- Captures experience and lessons learned more easily
- Provides multi-path parallel construction with large reduction in field labor
- Primary benefit is shorter construction schedule but has potential for cost savings on follow-on units

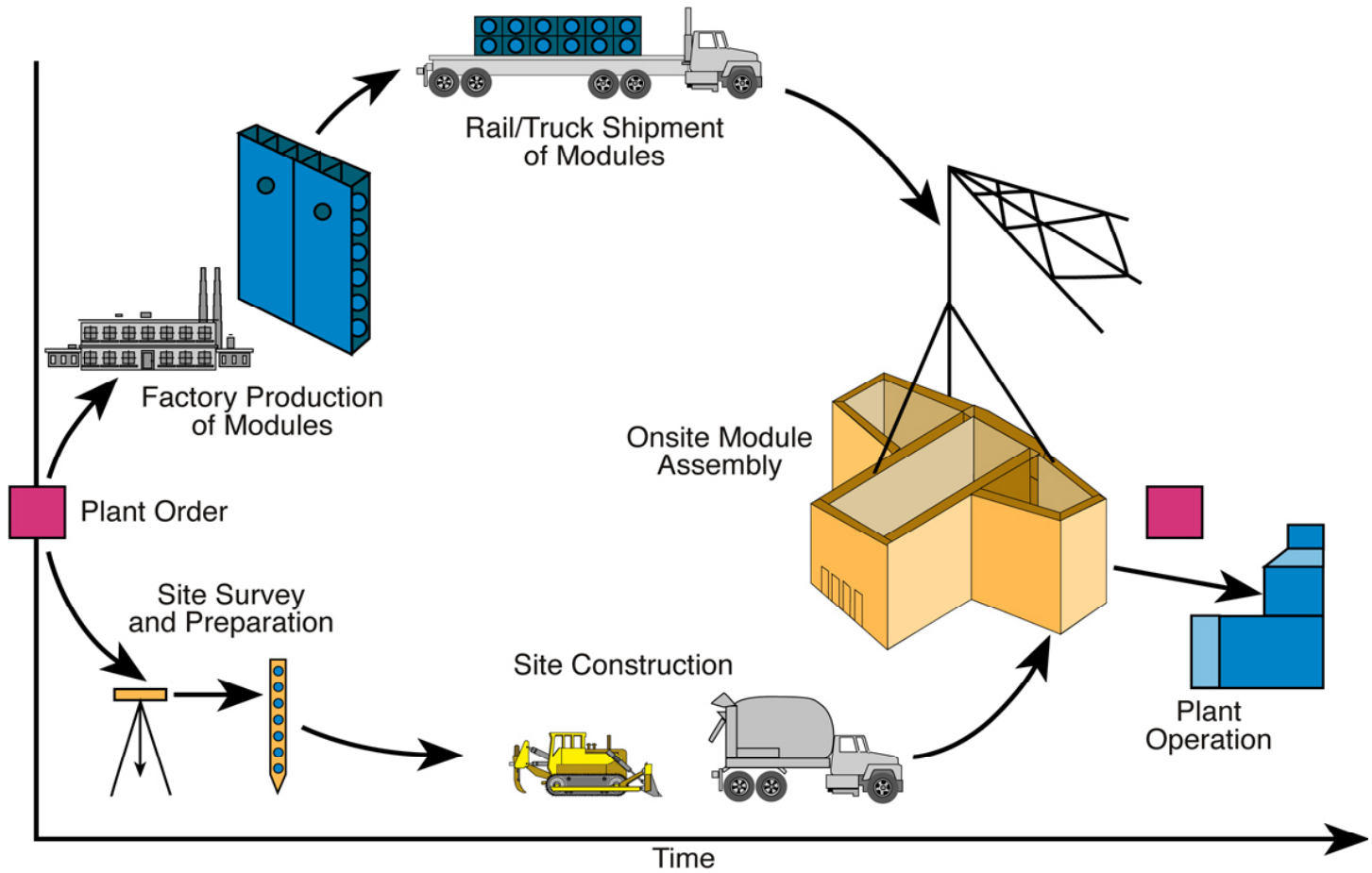
Passive Plant Modules

	STRUCTURAL MODULES	PIPING MODULES	MECHANICAL EQUIPMENT MODULES	TOTAL
Containment	41	20	12	73
Auxiliary Building	42	34	29	105
Turbine Building	29	45	14	88
Annex Building	10			10
Total	122	99	55	276





Parallel Tasks Using Modularization Shorten Construction Schedule



AP1000 Construction Plan

- Detailed Construction Plan with over 5000 activities has been developed
- Schedule is based on working 5 days/week, 10 hours/day
  - Inspections during second shift
  - Third shift and weekends reserved as contingency
- Construction plan has been linked to 3D computer model, creating a 4D virtual reality construction planning tool
- Schedule verified by construction management companies in US, Japan, and UK
- 60 months total schedule with 36 months from first concrete to fuel load

AP1000 Passive Plant Economics

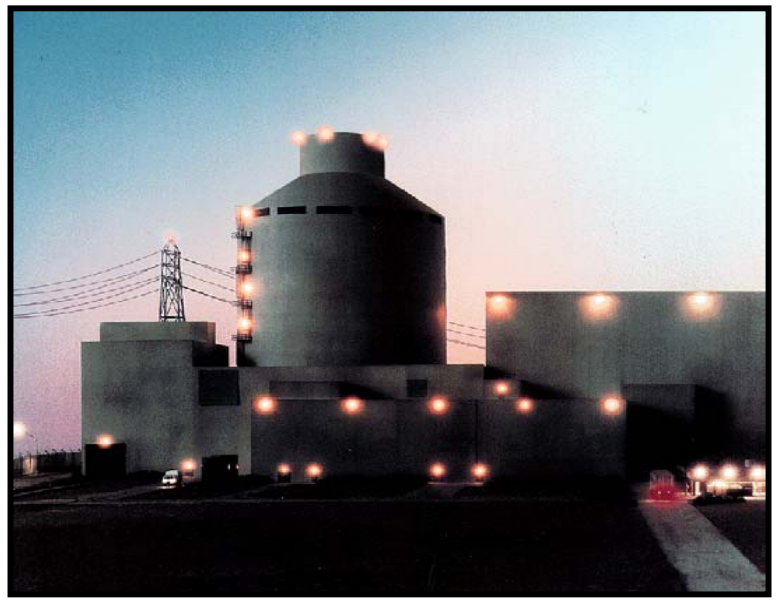
Aspect	AP1000
Overnight Capital Cost ($/kWe)	1000 - 1200
Capital Cost Recovery Charge (¢/kWh)	2.1 – 2.5
Fuel & O&M Charge (¢/kWh)	1.0
Decommissioning Charge (¢/kWh)	0.1
Total Generation Costs (¢/kWh)	3.2 – 3.6

How We Will Reduce the Perceived Risk of a Construction Project

- Improved and Tested Regulatory Processes
  - Standard Plant Licensing Regulation (10CFR52)
  - Implementing Guidance, e.g., Construction Inspection Procedures, ITAAC Procedures
- Government Support for Initial Projects
  - Grants for early activities, e.g., design certification, early site permits, combined construction and operating licenses, and first-of-a-kind engineering
  - Direct loans or loan guarantees (problematic at this time)
  - Accelerating the depreciation schedule
  - Providing investment tax credits
  - Establishing production tax credits
  - Obtaining long-term power purchase agreements

The Path Forward - Standardized ALWRs

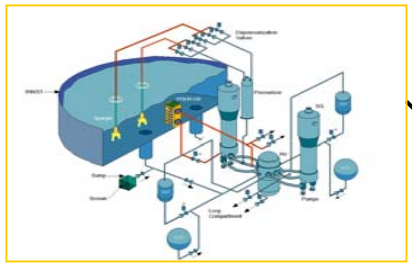
- Maturity of Design
  - High level of design detail
  - Already licensed
- Availability of Components
  - Supply chain exists
  - Competition through worldwide sourcing
- Understanding by Regulator
  - Large body of regulatory guidance
  - Implementing procedures
- Operator Familiarity
  - Operating philosophy well grounded
  - Easy transition from prior LWR experience



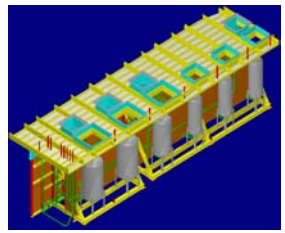
If ALWRs are <u>not</u> built soon, the industry will <u>not</u> be capable of building other plants later

AP1000 - An Advanced Technology Ready for Deployment

URD Requirements

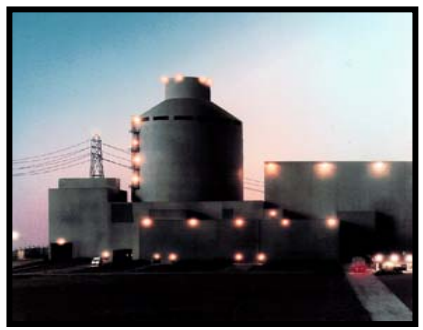


Passive Safety Systems

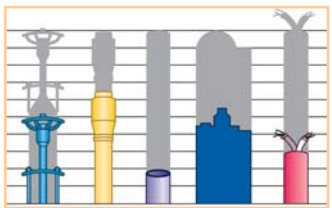


Modular Construction

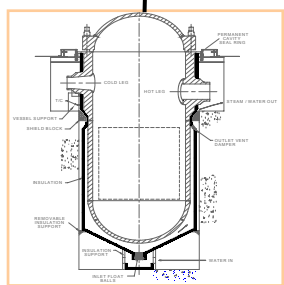
US Licensing Approval



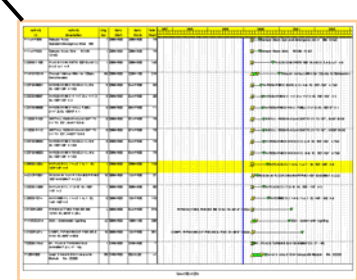
Advanced Features Testing



Reduced Components & Commodity Quantities



Severe Accidents Mitigation Features



Short Engineering and Construction Schedule