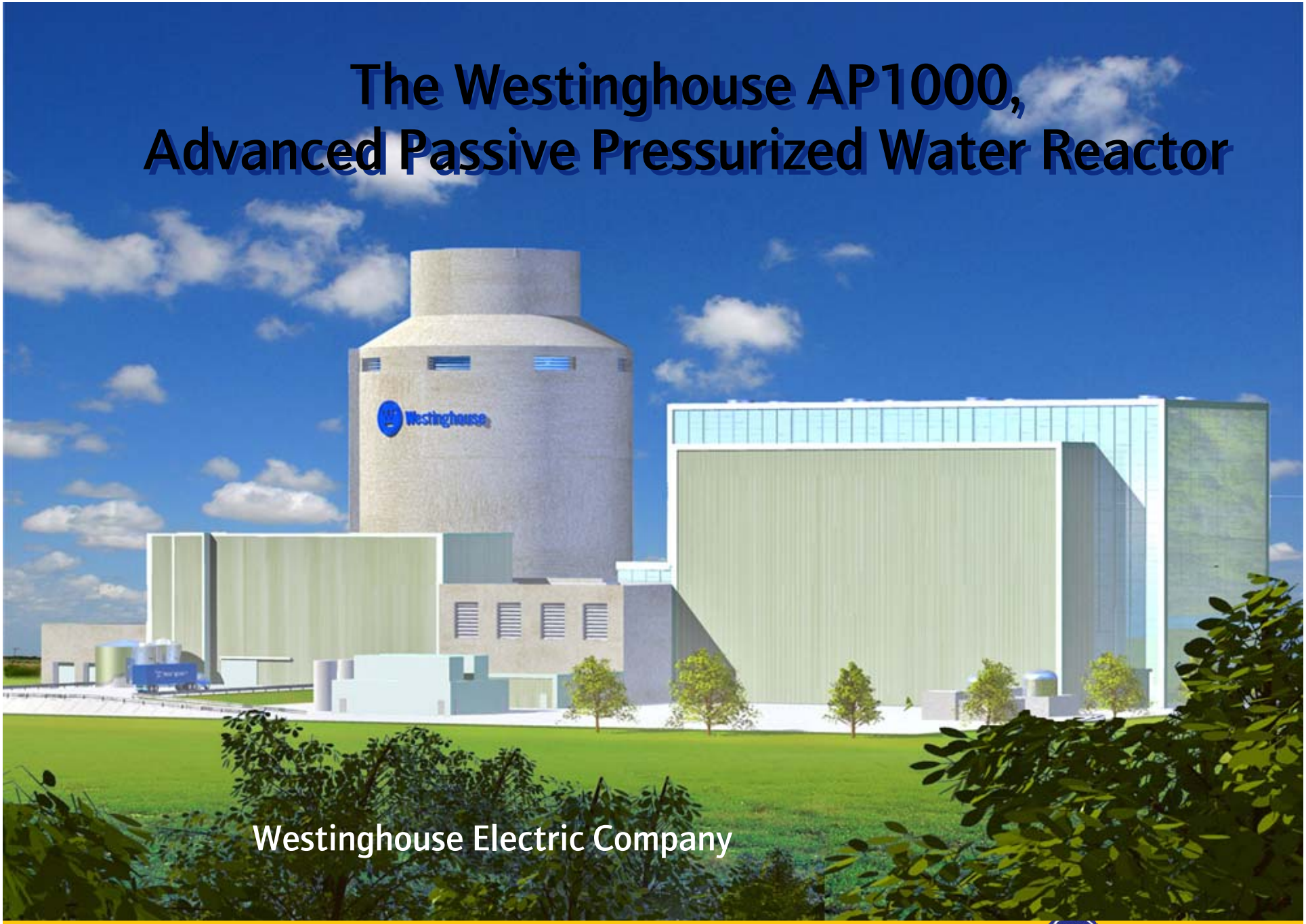
The Westinghouse AP1000, Advanced Passive Pressurized Water Reactor



Westinghouse Electric Company

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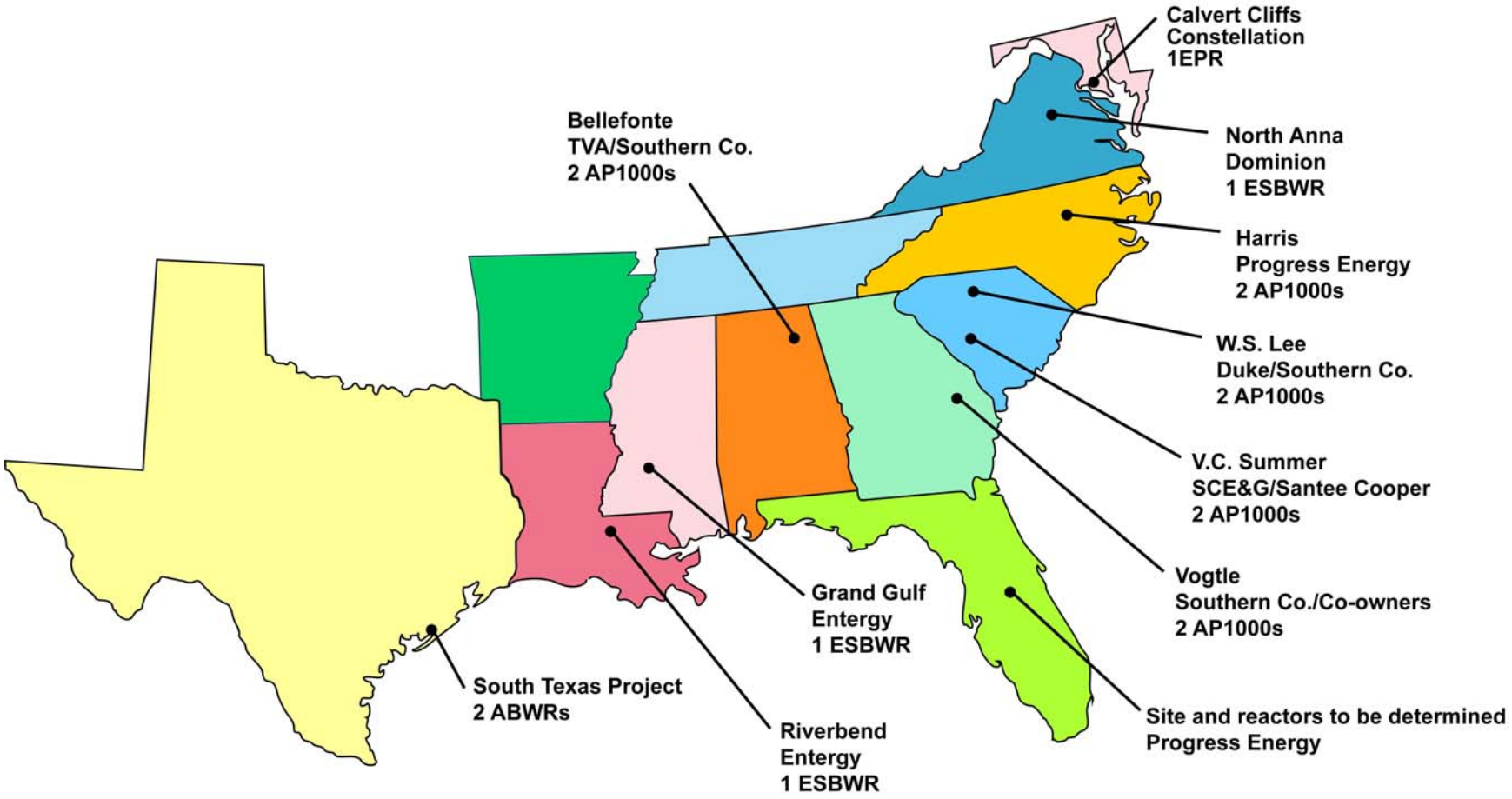
Nuclear Power 2010 and the 2005 Energy Policy Act Have Launched Market for New U.S. Units



NuStart Consortium

Consortium consists of:

- NuStart Energy Development, LLC includes 9 members:
  - Constellation, Duke Energy, EDF-North America, Entergy, Exelon, Florida Power & Light, Progress Energy, Southern Co., and South Carolina Electric & Gas
- Tennessee Valley Authority
- Reactor Suppliers (passive designs):
  - Westinghouse (AP1000 Design)
  - General Electric (ESBWR)

Today's Agenda

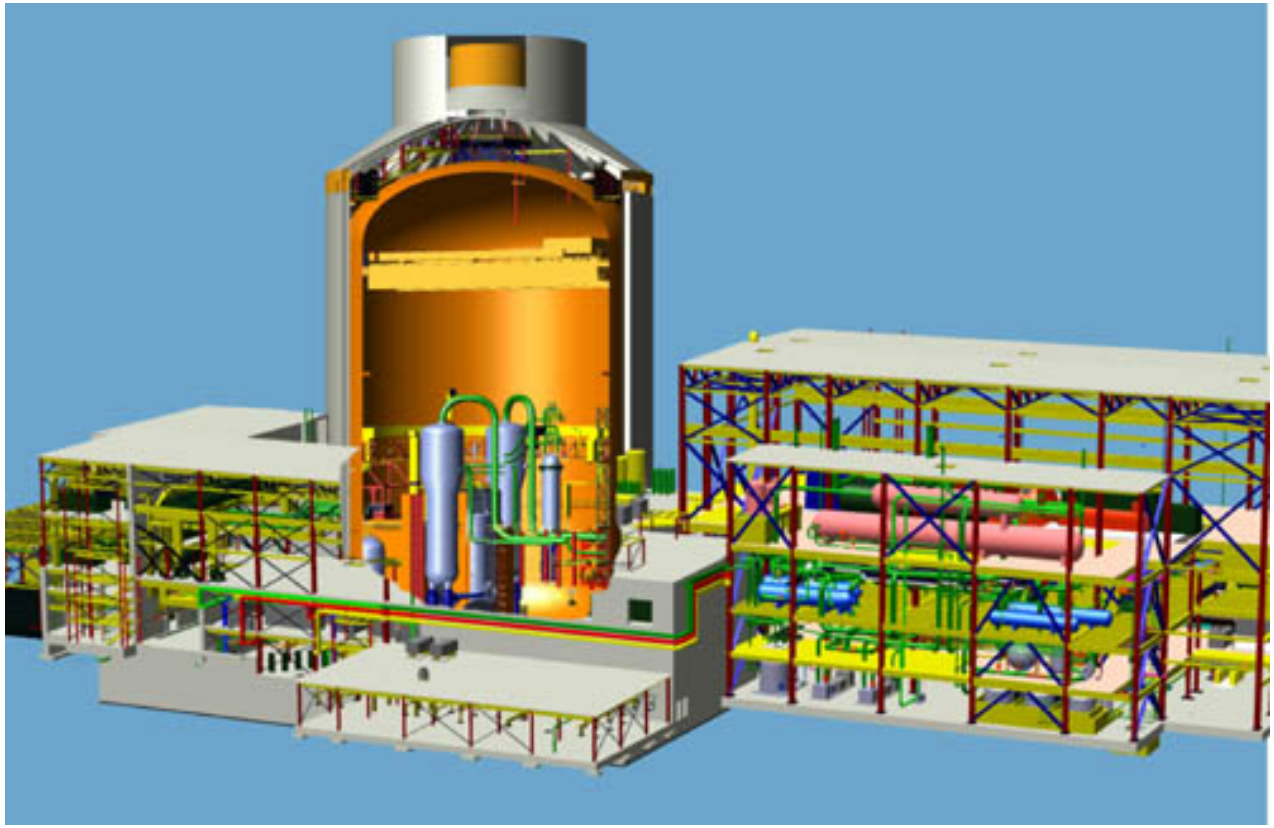
9:00 – 9:15	Introduction	George Davis
9:15 – 10:15	AP1000 Technology Overview	Andrea Sterdis
10:15 – 10:30	Break	
10:30 – 11:00	Part 52 Licensing Process and Status	Andrea Sterdis
11:00 – 11:30	Passive Systems	Jim Winters
11:30 – 12:00	Defense-in-Depth Systems	Jim Winters
12:00 – 12:30	Safety Analysis / PRA Overview	Jim Winters
12:30 – 14:00	Lunch	
14:00 – 14:30	Plant Layout and Construction	Jim Winters
14:30 – 15:00	Instrumentation and Controls	Jim Winters
15:00 – 15:30	Secondary Systems & Fire Protection	Don Hutchings
15:30 – 15:45	Electrical Systems	Don Hutchings
15:45 – 16:00	Final Q&A / Adjourn	

AP1000 Technology Overview

Andrea L. Sterdis
AP1000 Licensing and Customer Interface

AP1000 … The New Westinghouse Standard 1000 MWe Plant

- Simple
- Safe
- Mature
- Competitive



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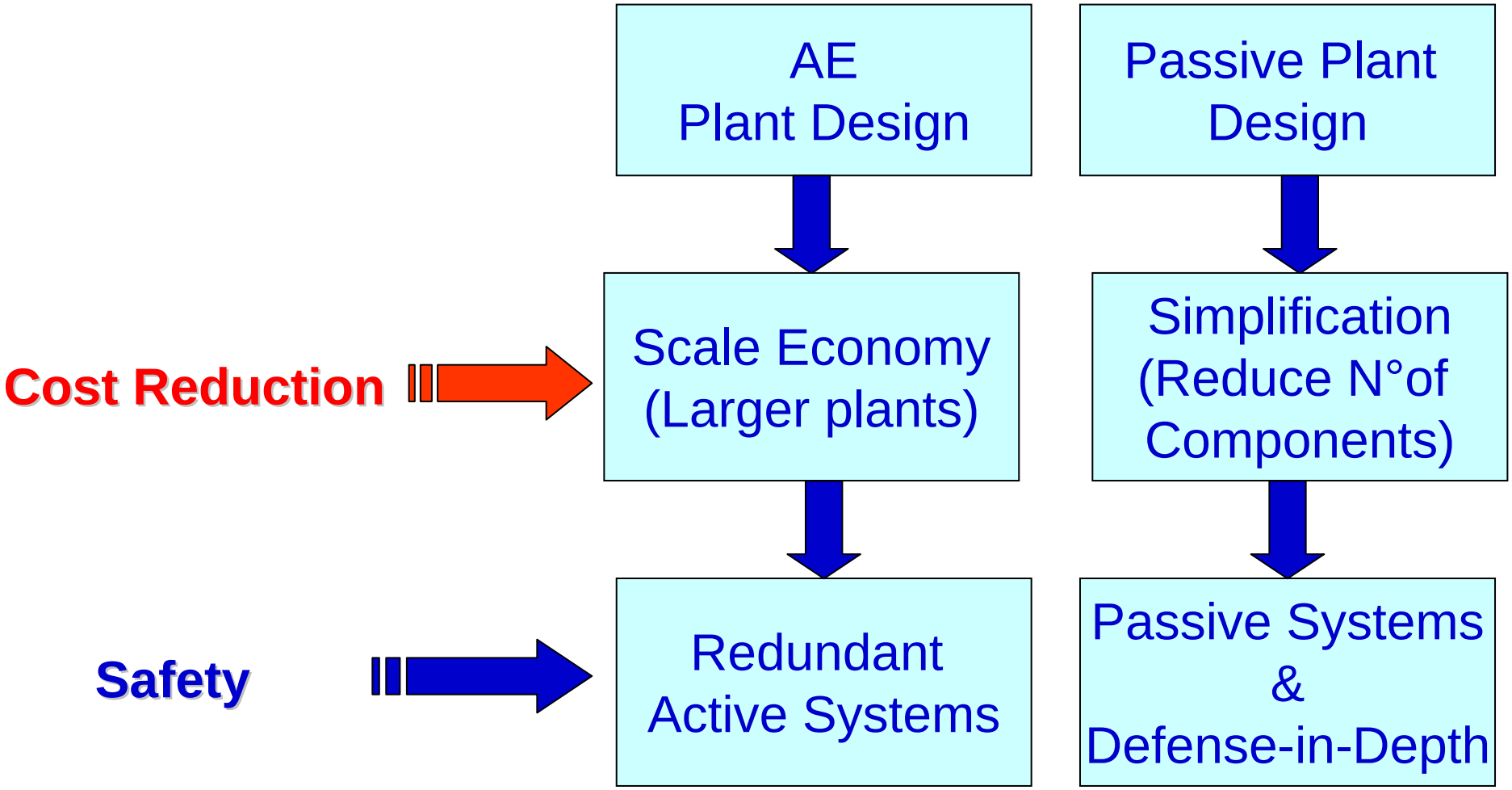
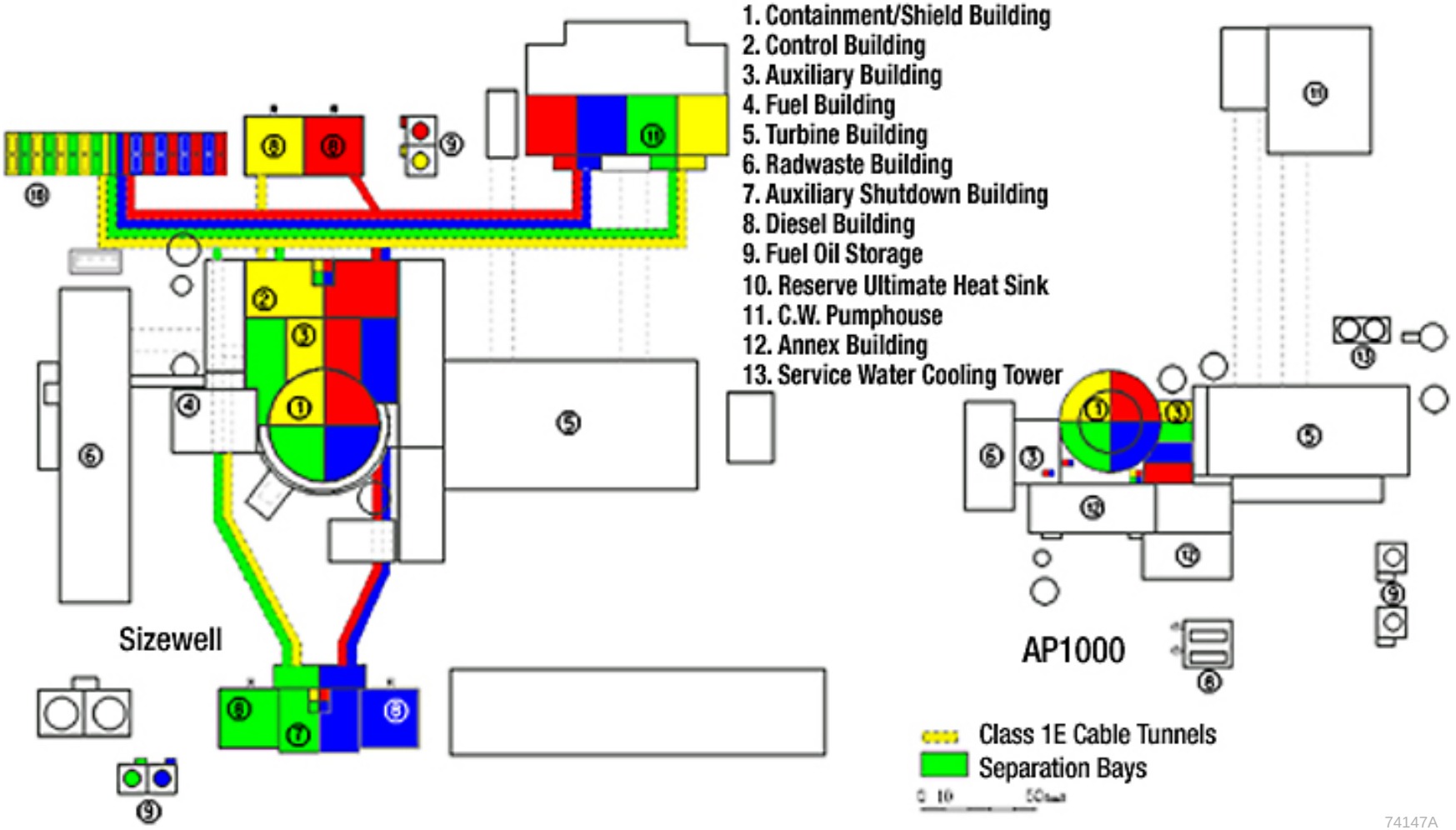
Generation III+ Design Objectives

- Increased Plant Design Life – 60 years
- Reduce Costs – Larger Plant Rating *or* Simplifications
- Increased Plant Safety
  - Additional redundancy *or* passive features
  - Reduced operator actions, more time
  - Reduced risk of core damage (CMF) and large release (LRF)
  - Severe accident features incorporated
    - Maintain containment integrity after core melt
- Digital I&C and Compact Main Control Room
- Shorter Construction Schedules
- Operational Lessons Learned

Design Approach Comparison



AP1000 is Smaller and Dramatically Simpler than Evolutionary Plants



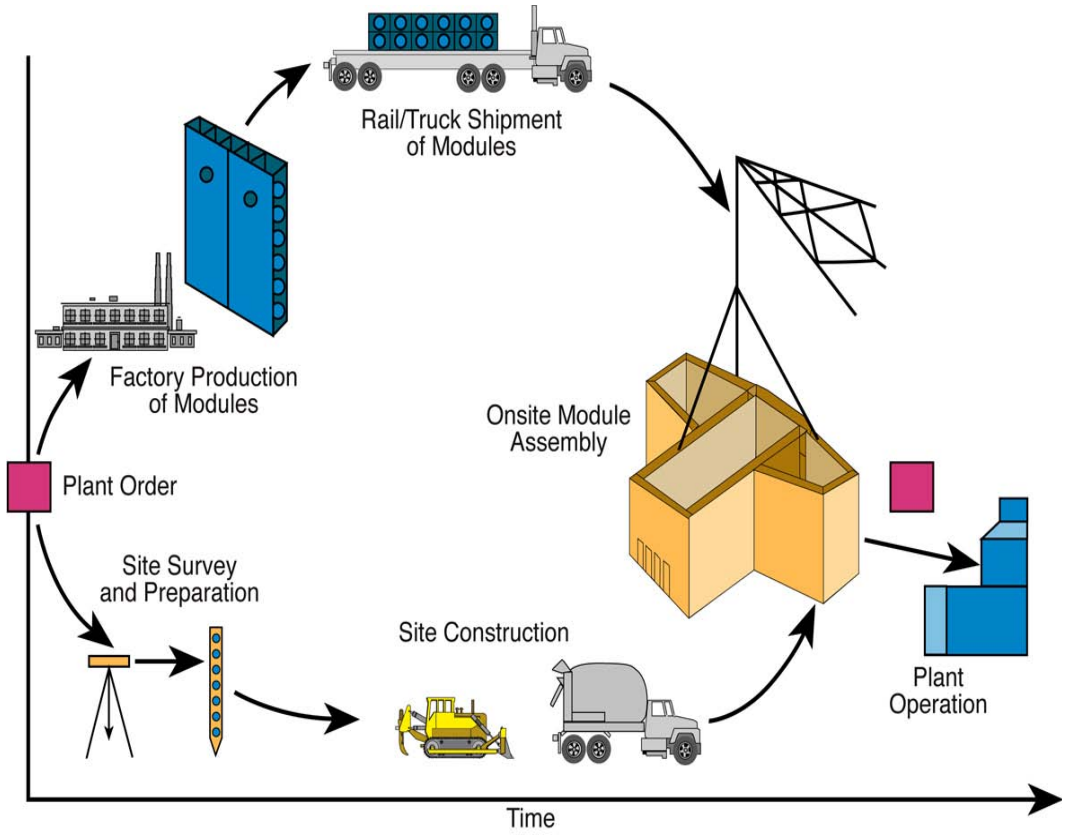
AP1000 Simplicity

- Simplicity in Safety Assessment
  - Use of passive safety systems
- Simplicity in Design
  - Reduced number of components and bulk commodities
- Simplicity in Procurement
  - Standardization of components
- Simplicity in Construction
  - Extensive use of modules reduces on-site construction
  - Multiplexed I&C communication reduces cables
- Simplicity in Operation and Maintenance
  - Use of proven systems and components
  - Man-machine interface advancements

Best Solution for New Plants– Simplification and Standardization

Simplicity in:

- Design
- Safety
- Construction
- Procurement
- Operations
- Maintenance



AP1000 Standardization

- Standardization Built into AP1000 Design Process
  - Simplifies initial procurement and later maintenance / spare parts
- Examples of Plant Standardization
  - Valve application guide developed / used
    - Greatly reduces number different types of valves
    - Ensures use of best proven technology
  - Pump designs
    - 1 air diaphragm pump design replaces 16 different centrifugal pump designs
  - Air handling unit designs
    - Reduced from 44 to 16 different designs
  - Plant I&C systems
    - Uses one plant wide control I&C system

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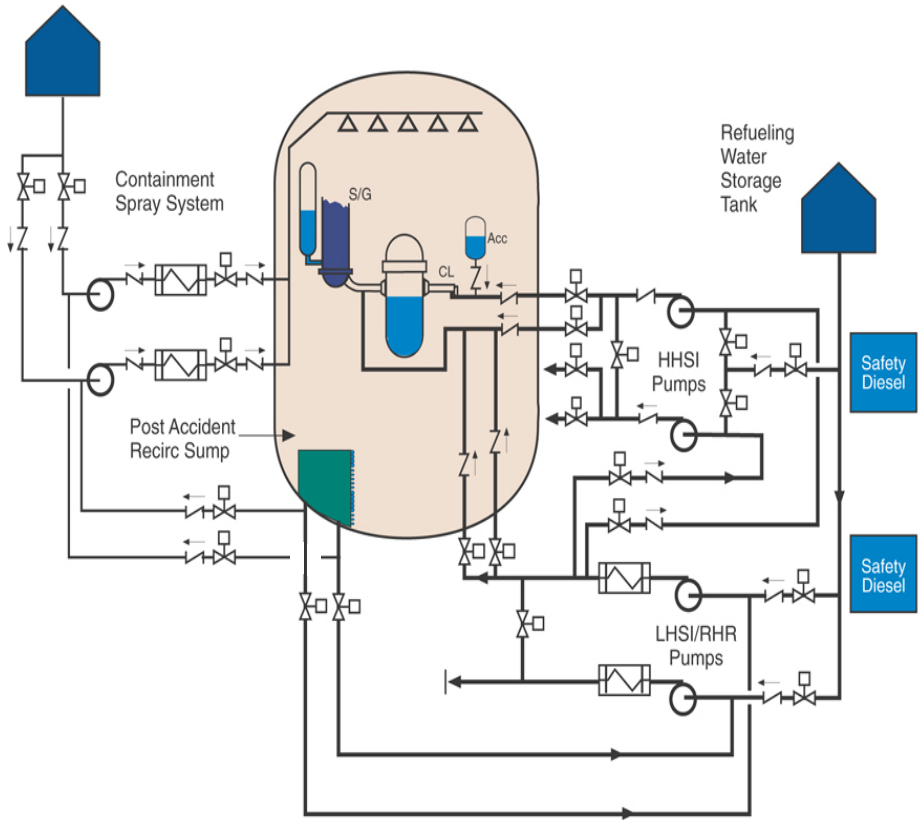
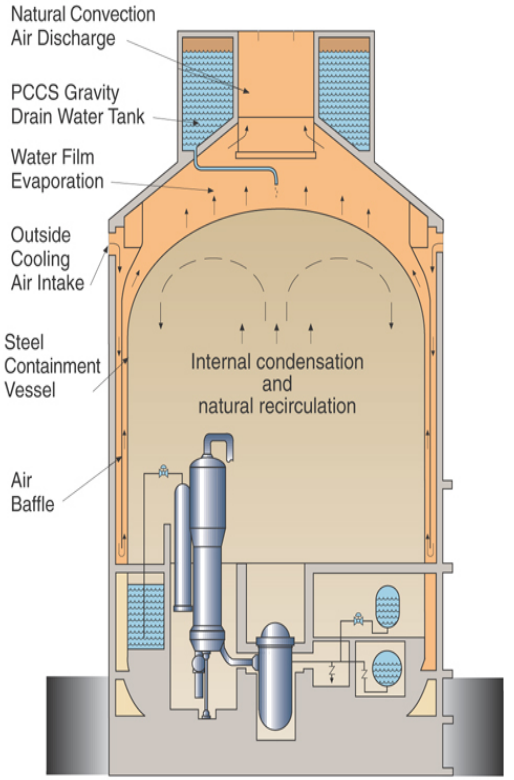
How is Simplification of Design Achieved for AP1000?

Standard PWR

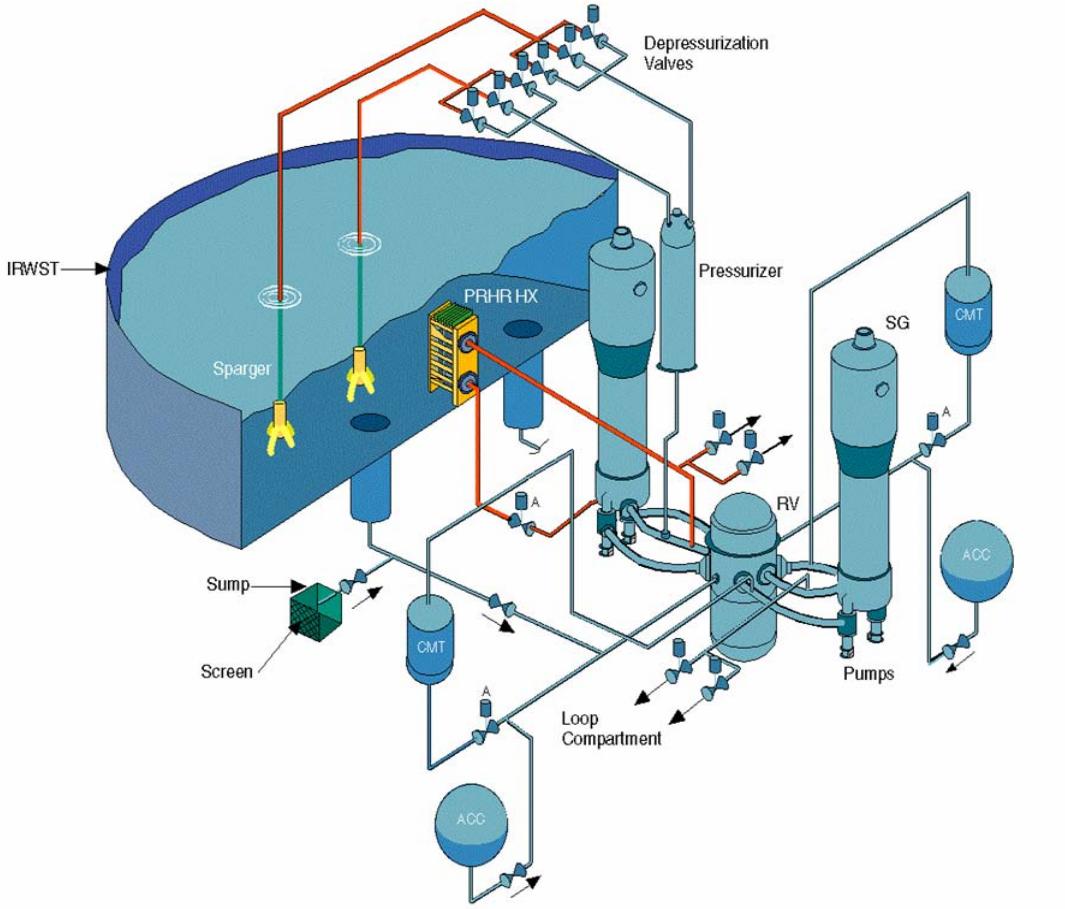


AP1000

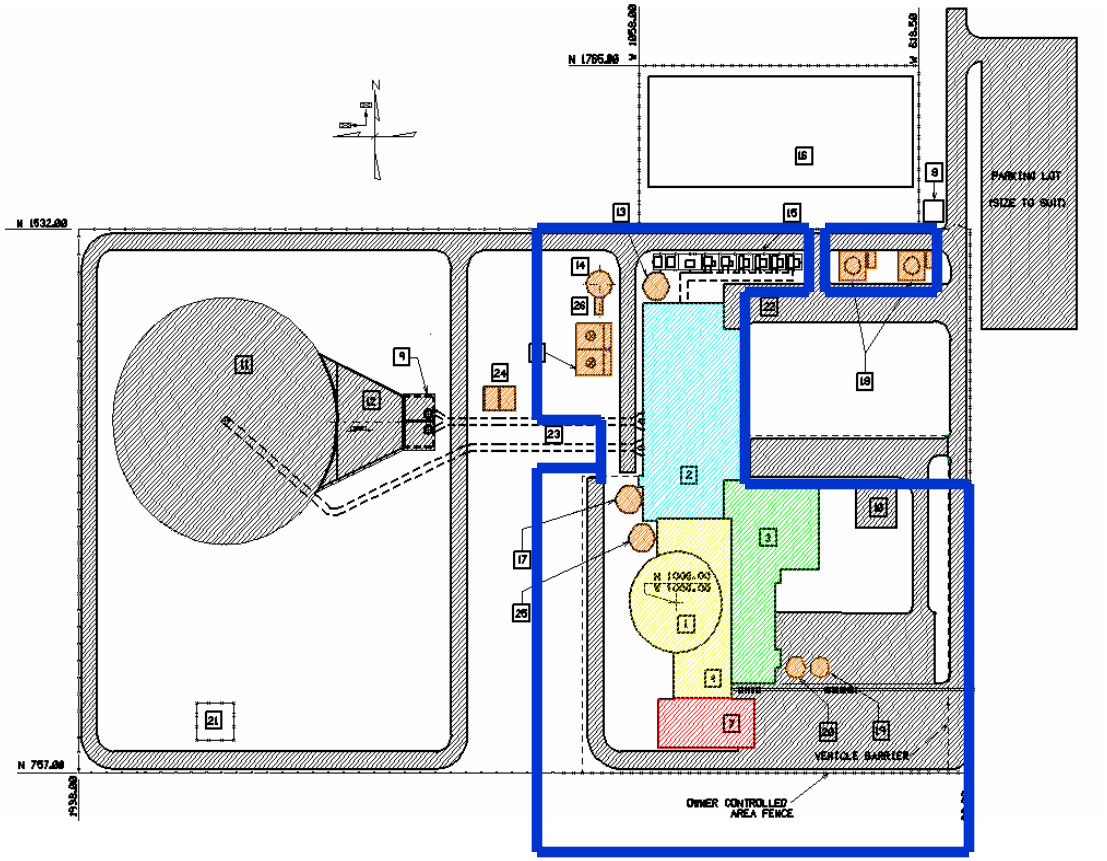


How is Simplification of Design Achieved for AP1000?

- Simple 2-loop reactor coolant system with canned motor pumps
- Use of passive safety systems
- No reliance on safety grade AC power

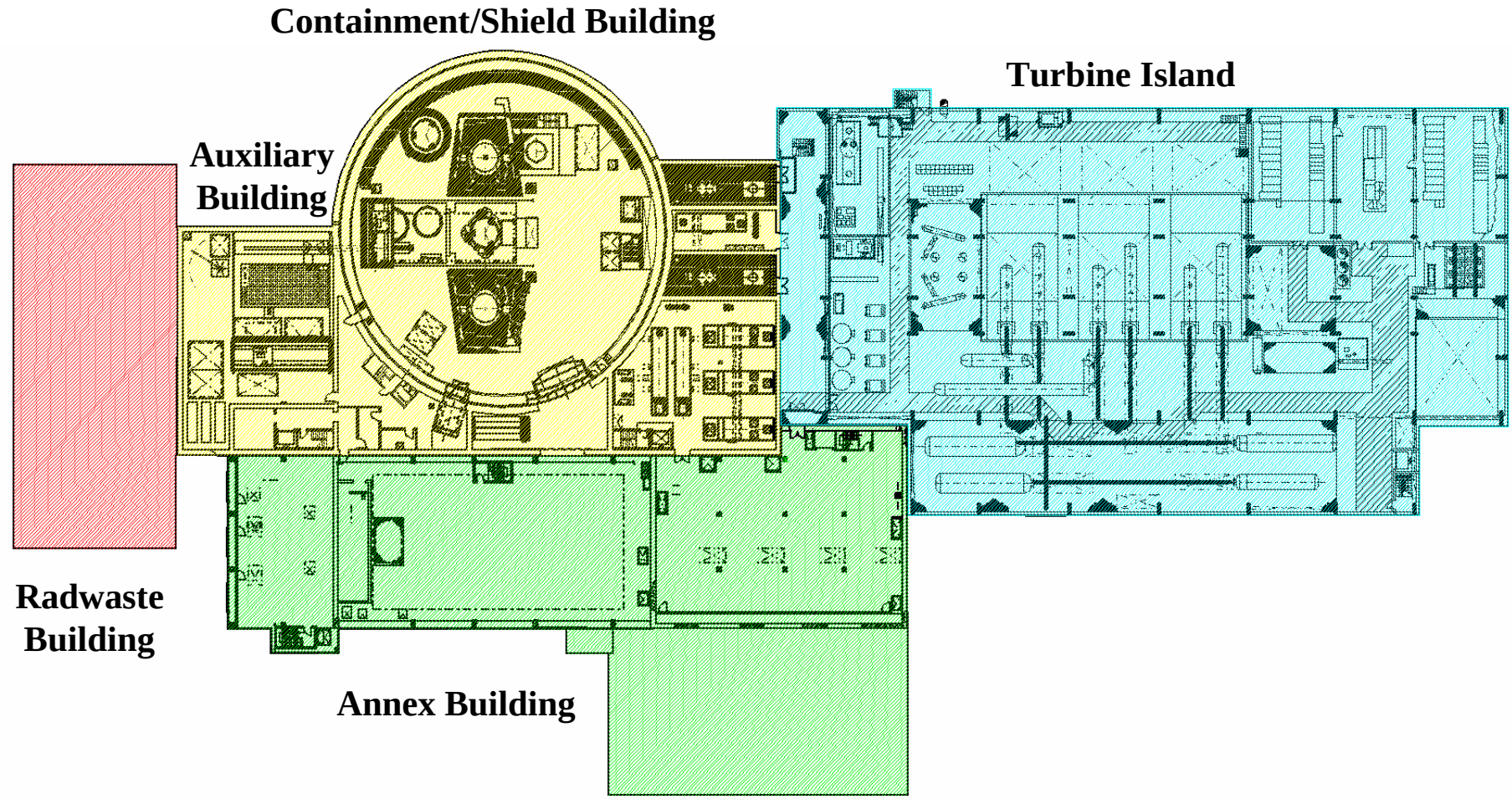


Standard Plant Scope

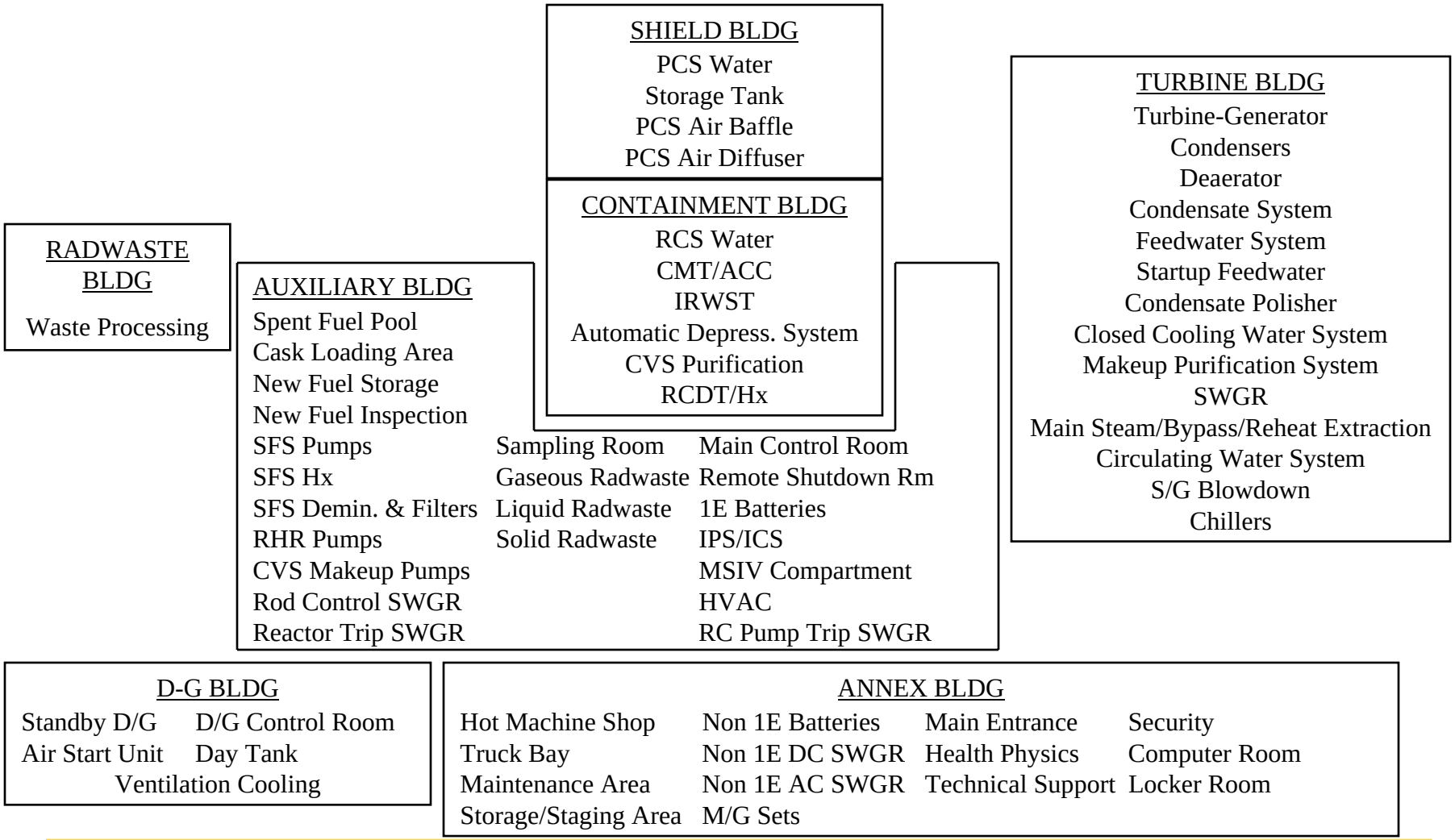


AP1000 Plant General Arrangement

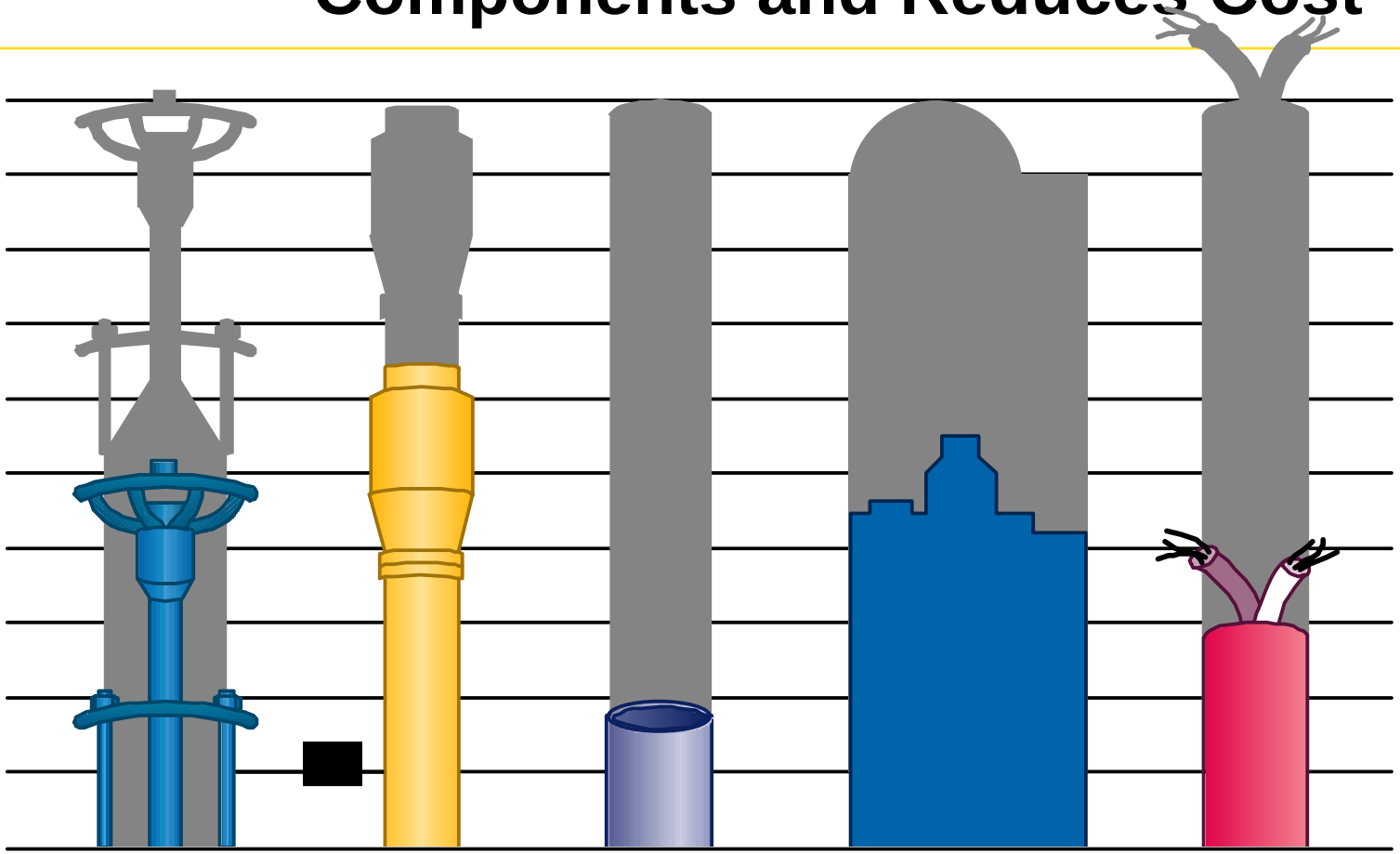
Plant Elevation 135'-3"



Functional Allocation of System Components



Simplification of Design Eliminates Components and Reduces Cost



51% Fewer Safety Valves

34% Fewer Pumps

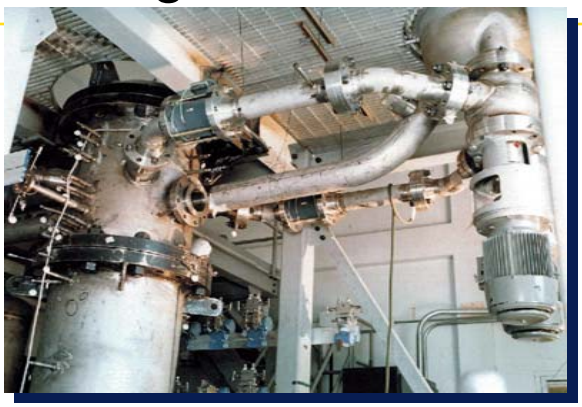
83% Less Safety-Related Piping

56% Less Seismic Building Volume

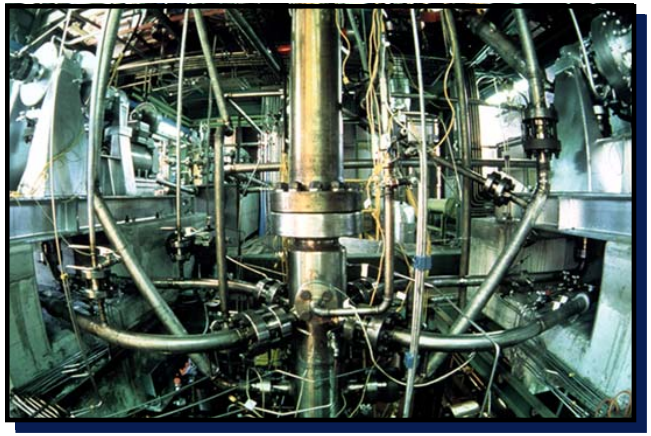
87% Less Cable

Simplifications Impact O&M

Thorough Testing of AP1000 Passive Systems Completed



Oregon State ¼ Scale, Long Term Integral Systems Test



Full Height, Full Pressure, Integral Systems Test (SPES)

Large-Scale Heat Transfer PCS Test

AP600 Development

- Initiated in 1985 Under EPRI & U.S. DOE Contracts
  - U.S. utilities requested a simplified, mid-sized PWR
- Design Developed During Next 13 years
  - Detailed ALWR utility requirements (URD) were developed
  - Extensive review / input from experienced utility engineering and operations staff
  - Comprehensive testing program completed in 1994
    - Supported design and licensing efforts
- U.S. NRC Reviewed and Approved Design
  - Review conducted during 1992 to 1998
  - Final Design Approval issued September 3, 1998

AP600 Design Objectives

- Greatly Simplified Plant
  - Construction, Maintenance, Operation, Safety
- Increased Operation and Safety Margins
  - Design Basis Accidents, PRA (core melt prevention & mitigation)
- Competitive Cost of Power
- Short Construction Schedule; 3 Years
- Licensing Certainty
  - NRC Final Design Approval / Certification
- No Plant Prototype; Proven Components / Systems
- Improved Availability, Maintenance, Inspection, ORE
- Pre-Engineered / Pre-Licensed Standard Design

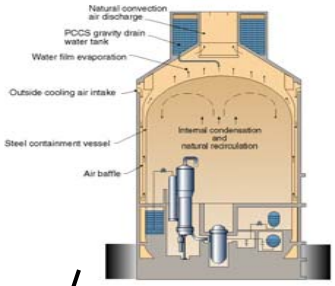
AP600 Design Process

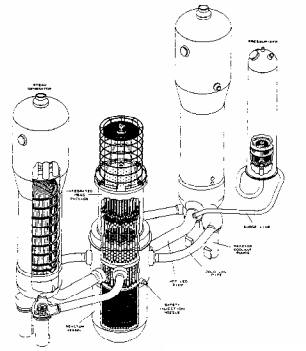
- Plant Design Objectives
  - **Utility (URD), Industry, NRC**
- Design Certification Testing
  - Component, system, integral
- Safety Analysis / Evaluations
  - Safety - single failure, conservative assumptions
  - PRA - multiple failures, realistic assumptions
- Constructability, Operability, Maintainability Studies
  - Extensive utility contribution
- Several Design Iterations Completed (1985 - 97)

Westinghouse 19 Year / $500M Investment in Passive Technology

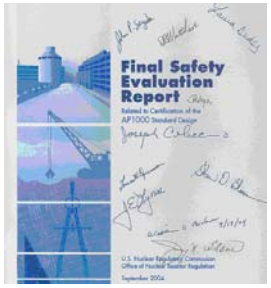
Extensive Testing of Passive Safety Systems

Simplified Passive Safety Systems

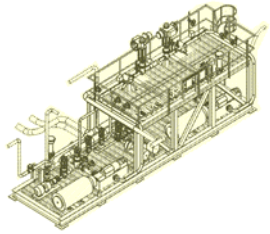




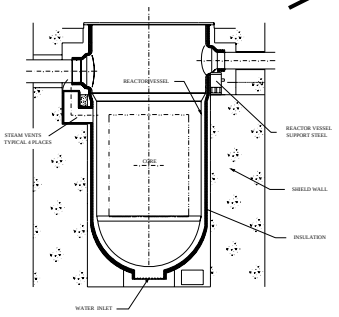
Proven Advanced Design Features



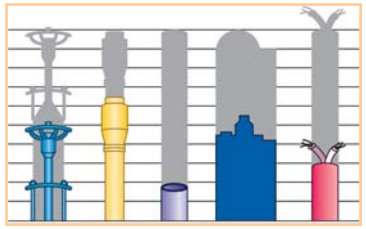
US Licensing Approval



Modular Construction



PRA and Severe Accident Mitigation Features



Reduced Components and Commodities

Short Engineering and Construction Schedule

AP600 Development Milestones

- 1985 EPRI and U.S. DOE / EPRI contracts for conceptual design of a simplified, mid-size PWR
- 1990 U.S. DOE / EPRI contract for Design Certification $120M
- 1992 AP600 SSAR and PRA reports submitted to NRC
- 1993 Advanced Reactor Corporation contract for First-of-a-Kind Engineering program $158M
- 1994 Draft Safety Evaluation Report received
- 1996 Supplemental Draft Safety Evaluation Report received
- 1998 *Final Design Approval (FDA) received – safety review*
- 1999 *Design Certification (DC) received – legal process in U.S.*

AP600/AP1000 Are Mature Designs

- Design Maturity
  - 1300 man-year / $400 million design and testing effort over 18 yr
  - More than 12,000 design documents completed
  - Detailed 3D computer model developed
    - Structures, equipment, small / large pipe, cable trays, HVAC ducts ...
  - Detailed construction schedule, costs (bottom up), operations
- Licensing Maturity
  - Very thorough / complete NRC review of AP600
  - Design Certification Achieved for AP600
  - Design Certification Achieved for AP1000

AP1000 Development

- AP600 Was Successfully Developed 1987 – 1999
  - AP600 meets all industry objectives defined in EPRI ALWR Utility Requirements Document
    - Including generation costs <4.3 ¢/kwh
  - Was successfully licensed with US NRC (FDA in 9/98, DC in 12/99)
- Electric Generation Environment Has Significantly Changed in U.S. Due To Deregulation
  - New target generation cost < 3 ¢/kwh
- AP600 Cannot Achieve This New Target Even With Incremental Improvements
- Westinghouse Adopted Major Plant Uprate Approach

AP1000 Design Approach

- Reduce Cost by Increasing Plant Power Rating
  - Obtain a capital cost that can compete in U.S. market $1000/KWe for n^{th} twin plant
- Retain AP600 Objectives and Design Detail
  - Increase capability/capacity within “space constraints” of AP600
  - Retain credibility of “proven components”
  - Retain the basis for the cost estimate, construction schedule and modularization scheme
- Retain AP600 Licensing Basis
  - Meet regulatory requirements for Advanced Passive Plants
  - Accept AP600 policy issues

AP600/AP1000 Design Features

- Integrated Power Plant Design
- Proven Power Producing Components (Reactor, Fuel, …)
- Simplified RCS Loops with Canned Motor Pumps
- Simplified Passive Safety Systems
  - Increase safety margins and address severe accidents
- Simplified Nonsafety Systems

AP600/AP1000
Design Features (cont'd)

- Microprocessor, Digital Technology Based I&C
- Compact Control Room, Electronic Operator Interface
- Optimized Plant Arrangement
  - Construction, Operation, Maintenance, Safety, Cost
- Extensive Use of Modular Construction

AP600 to AP1000 Design Changes

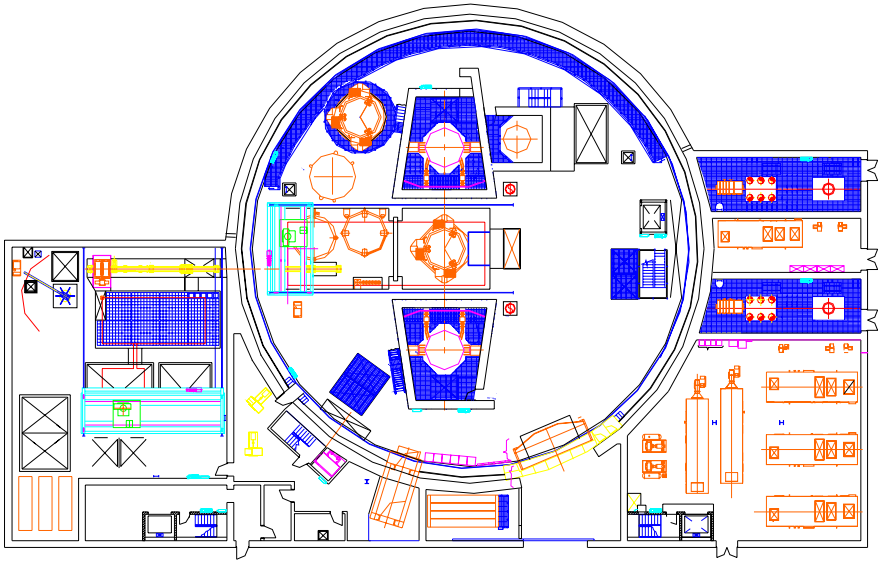
- Increase Core Length & Number of Assemblies
- Increase Size of Key NSSS Components
  - Increased height of Reactor Vessel
  - Larger Steam Generators (similar to W/CE SGs)
  - Larger canned RCPs (variable speed controller)
  - Larger Pressurizer
- Increase Containment Height & Design Pressure
- Some Capacity Increases in Passive Safety System Components
- Turbine Island Capacity Increased for Power Rating

Retained Nuclear Island Footprint

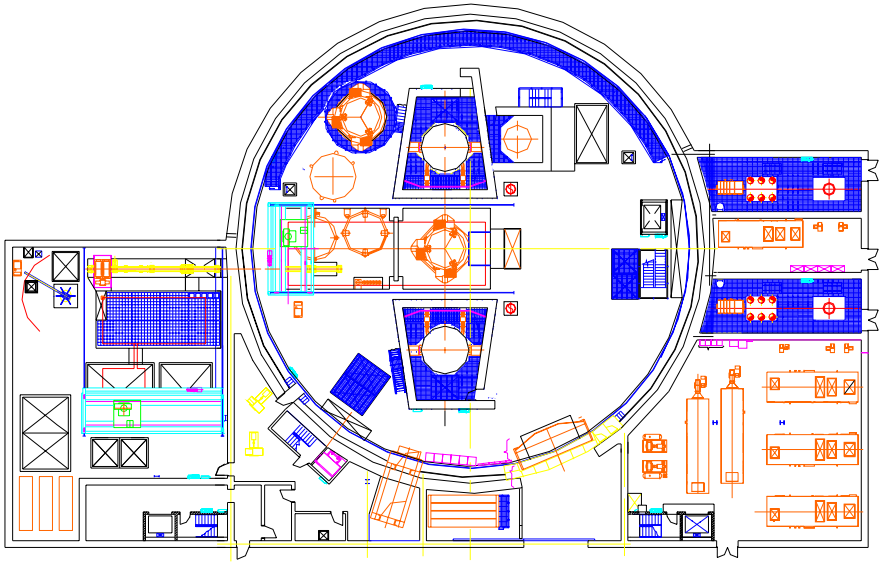
AP1000 General Arrangement

Plan at Elevation 135’

AP600



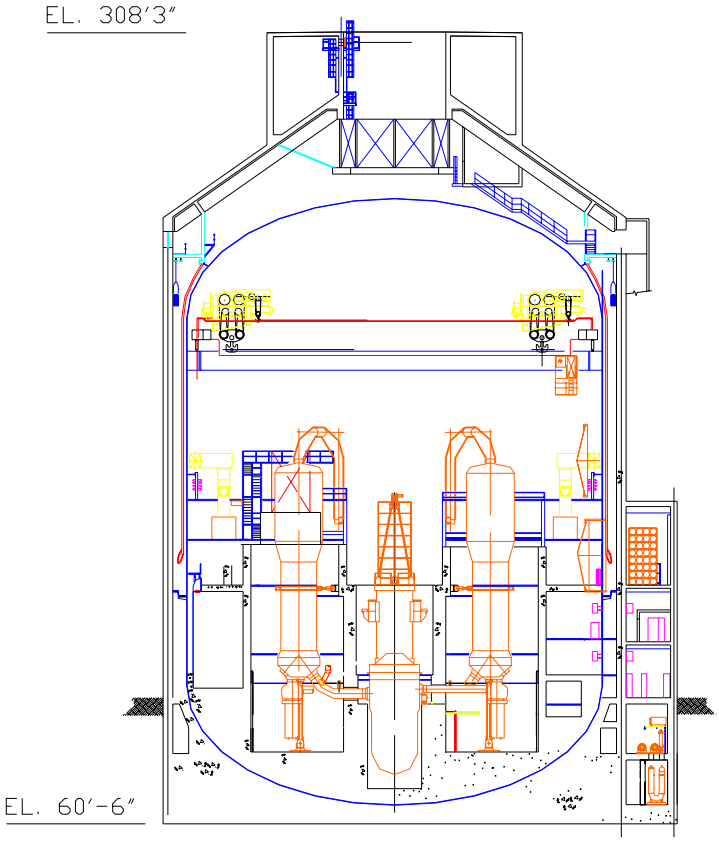
AP1000



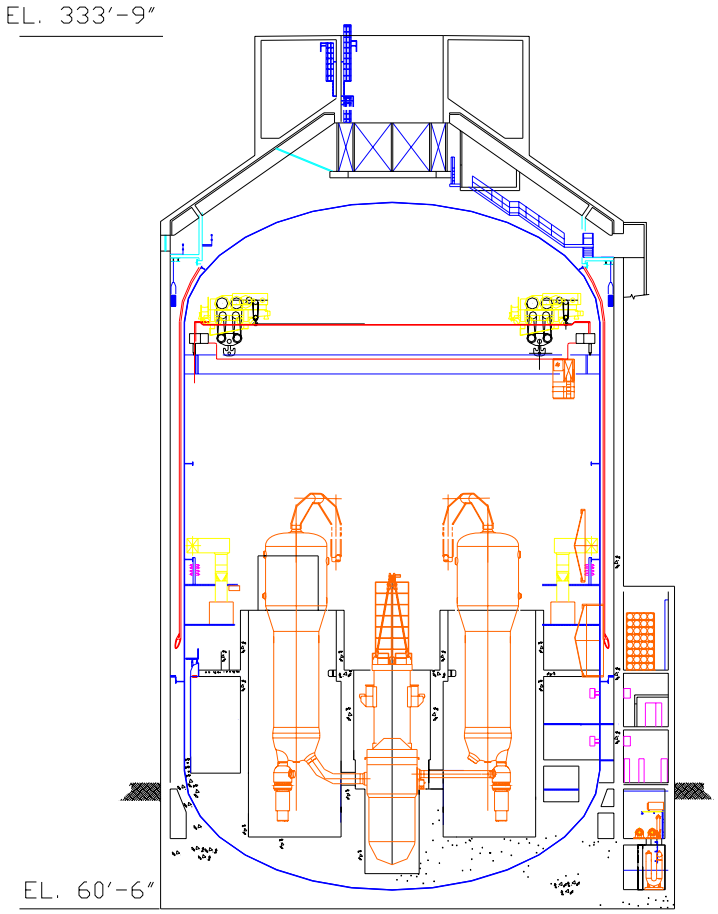
AP1000 General Arrangement

Containment Section View

AP600



AP1000



Comparison of Selected Parameters

Parameter	Doel 4/Tihange 3	AP600	AP1000
Net Electric Output, MWe	985	610	1117
Reactor Power, MWt	2988	1933	3400
Hot Leg Temperature, ^{o}F	626	600	610
Number of Fuel Assemblies	157	145	157
Type of Fuel Assembly	17x17	17x17	17x17
Active Fuel Length, ft	14	12	14
Linear Hear Rating, kw/ft	5.02	4.1	5.71
Control Rods / Gray Rods	52 / 0	45 / 16	53 / 16
R/V I.D., inches	157	157	157
Vessel Flow, Thermal Design, gpm	295,500	194,200	300,000
Steam Generator Surface Area, ft2	68,000	75,000	125,000
Pressurizer Volume, ft3	1400	1600	2100

Market Signals Are Clear

Utility	Site	Submittal	Technology
NuStart *	Bellefonte	2007	AP1000 (2)
Duke	Cherokee	2007	AP1000 (2)
Southern Co.	Vogtle	2008	AP1000 (2)
Progress #1	Shearon Harris	2007	AP1000 (2)
SCANA	V.C. Summer	2007	AP1000 (2)

"We believe the Westinghouse AP1000 is the best nuclear technology option available at this time. Our decision comes after researching the next generation of nuclear reactors available."

- Louis Long, vice president of Technical Support for Southern Nuclear

U.S. Utilities are Overwhelmingly Choosing Passive Reactor Technology

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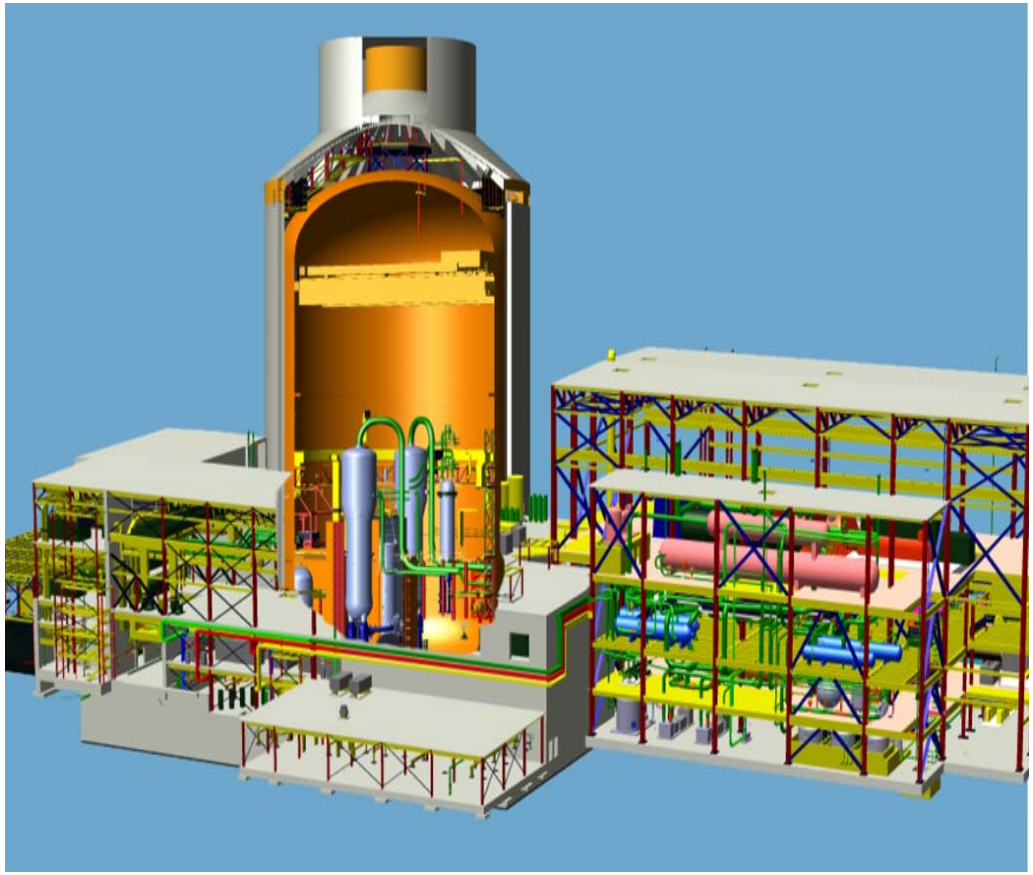
Worldwide AP1000 New Nuclear Plant Activity

- US Power Company COL preparations
- Four AP1000 Nuclear Units Bid in China (Sanmen and Yangjiang)
- AP1000 Design being studied for European application through EPP Program



AP1000 … A New Generation of Nuclear Power

Westinghouse