

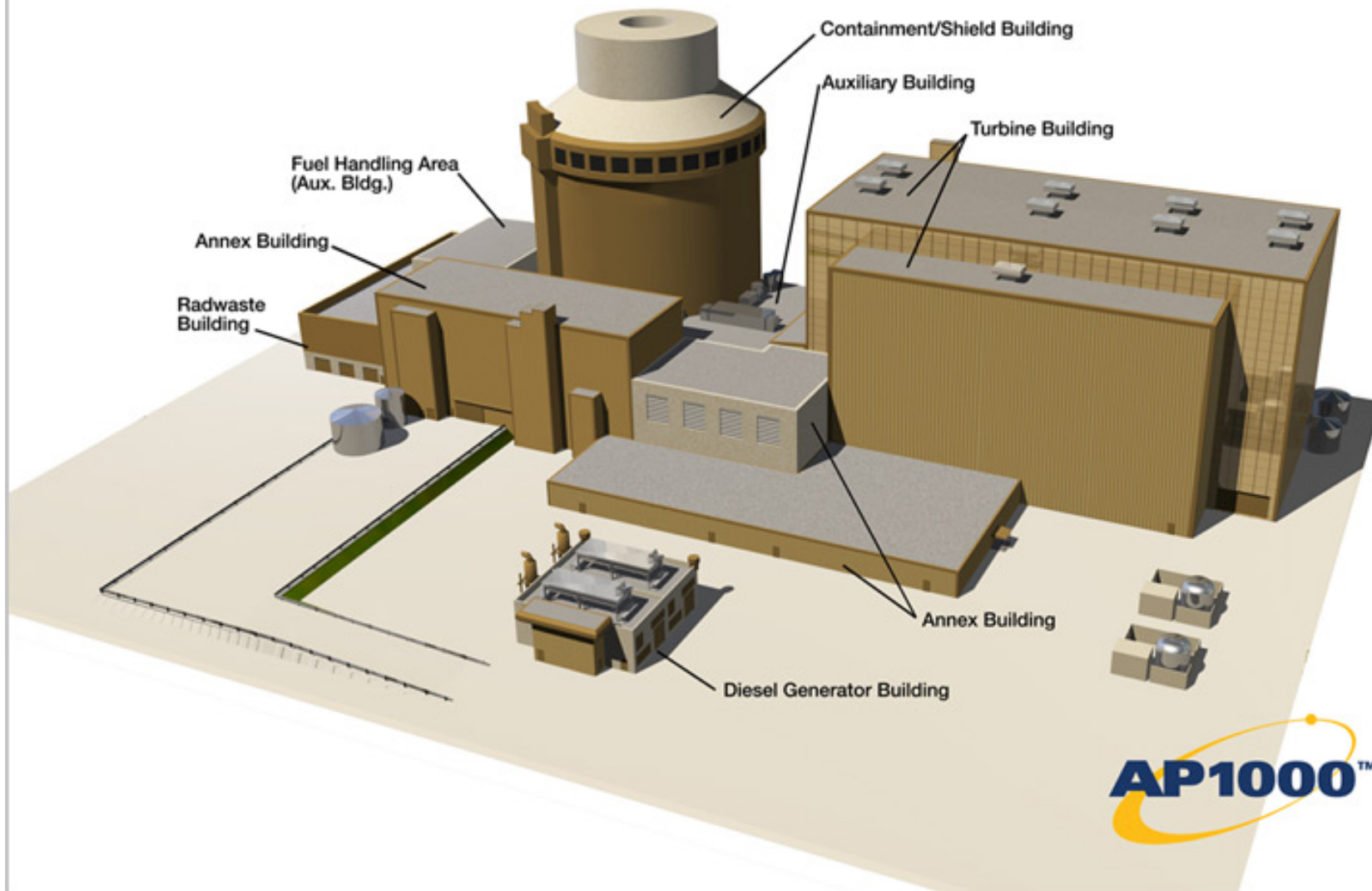


# AP1000 Plant Overview

## AP1000 Technology Chapter 1.0

# AP1000 Site Layout

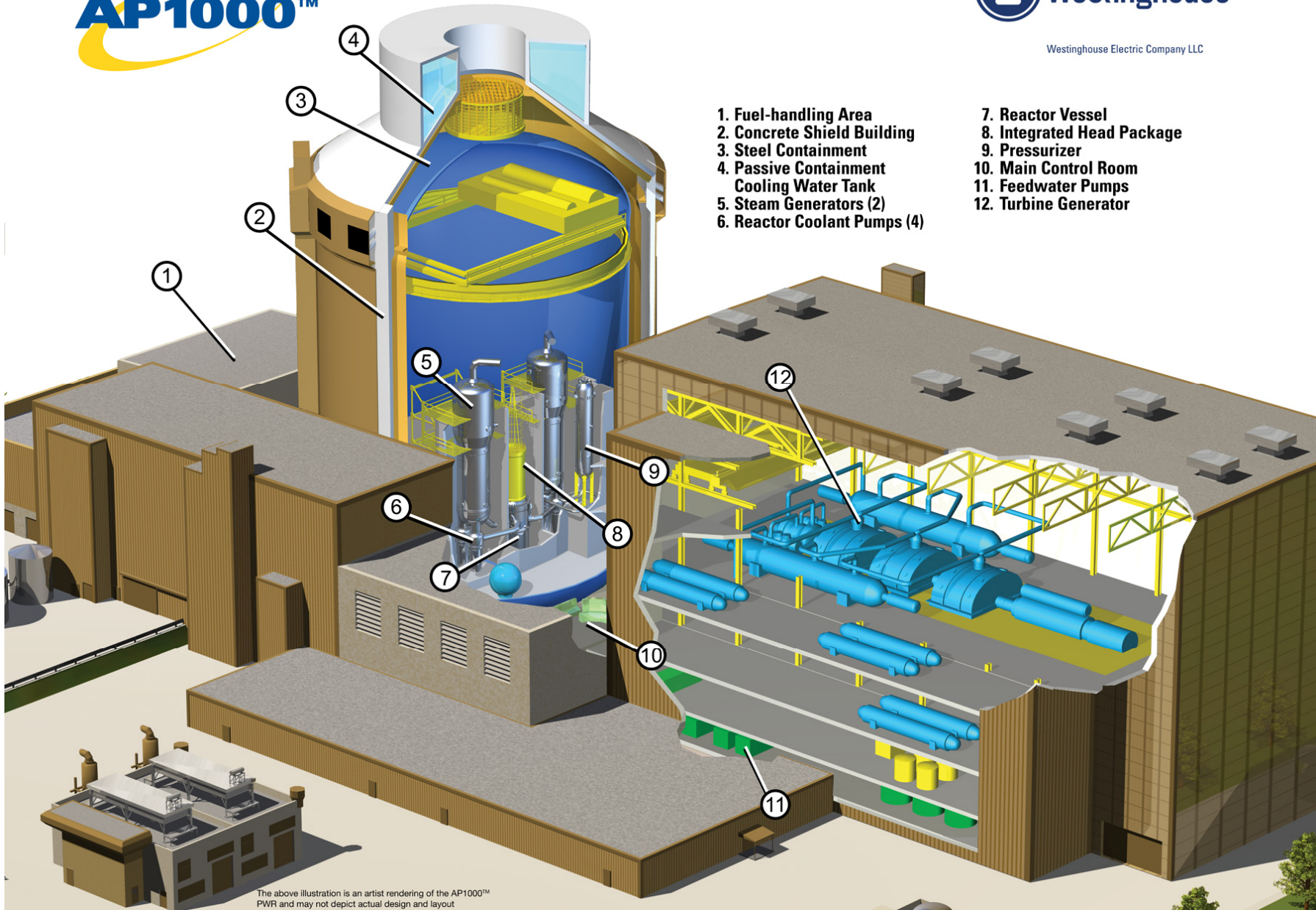
## The Westinghouse AP1000™



# AP1000 Plant Layout

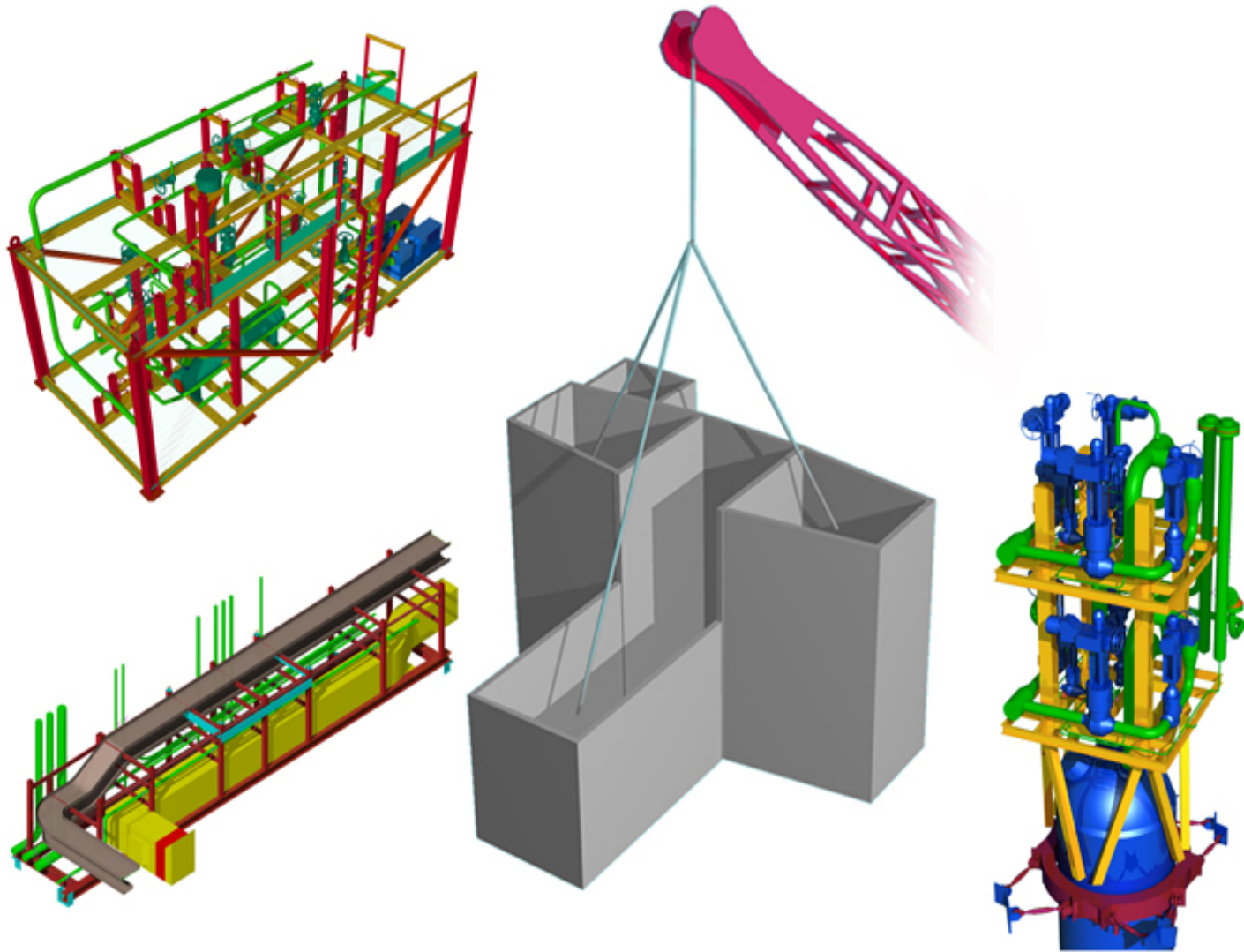


- 1. Fuel-handling Area
- 2. Concrete Shield Building
- 3. Steel Containment
- 4. Passive Containment Cooling Water Tank
- 5. Steam Generators (2)
- 6. Reactor Coolant Pumps (4)
- 7. Reactor Vessel
- 8. Integrated Head Package
- 9. Pressurizer
- 10. Main Control Room
- 11. Feedwater Pumps
- 12. Turbine Generator



The above illustration is an artist rendering of the AP1000™ PWR and may not depict actual design and layout

# Designed For Modular Construction



<u>Module Type</u>	<u>Number</u>
Structural	122
Piping	154
Mechanical Equipment	55
Electrical Equipment	11
<b>TOTAL</b>	<b>342</b>

**Table 1-1 (Sheet 1 of 7)  
AP1000 Plant Comparison With Other Facilities**

<b>System/Component</b>	<b>AP1000</b>	<b>Watts Bar</b>	<b>San Onofre</b>	<b>V. C. Summer</b>
<b>Overall Plant</b>				
Design Life (years)	60	40 <sup>a</sup>	40 <sup>a</sup>	40 <sup>a</sup>
NSSS Power (MWt)	3,415	3,475	3,410	2,912
Core Power	3,400	3,459	3,390	2,900
Net MWe	1,090	1,218	1,100	950
RCS Operating Pressure (psia)	2,250	2,250	2,250	2,250
T <sub>hot</sub> (°F)	615	619	611	622
SG Design Pressure (psia)	1200	1200	1200	1200
Feedwater Temperature (°F)	440	442	445	440

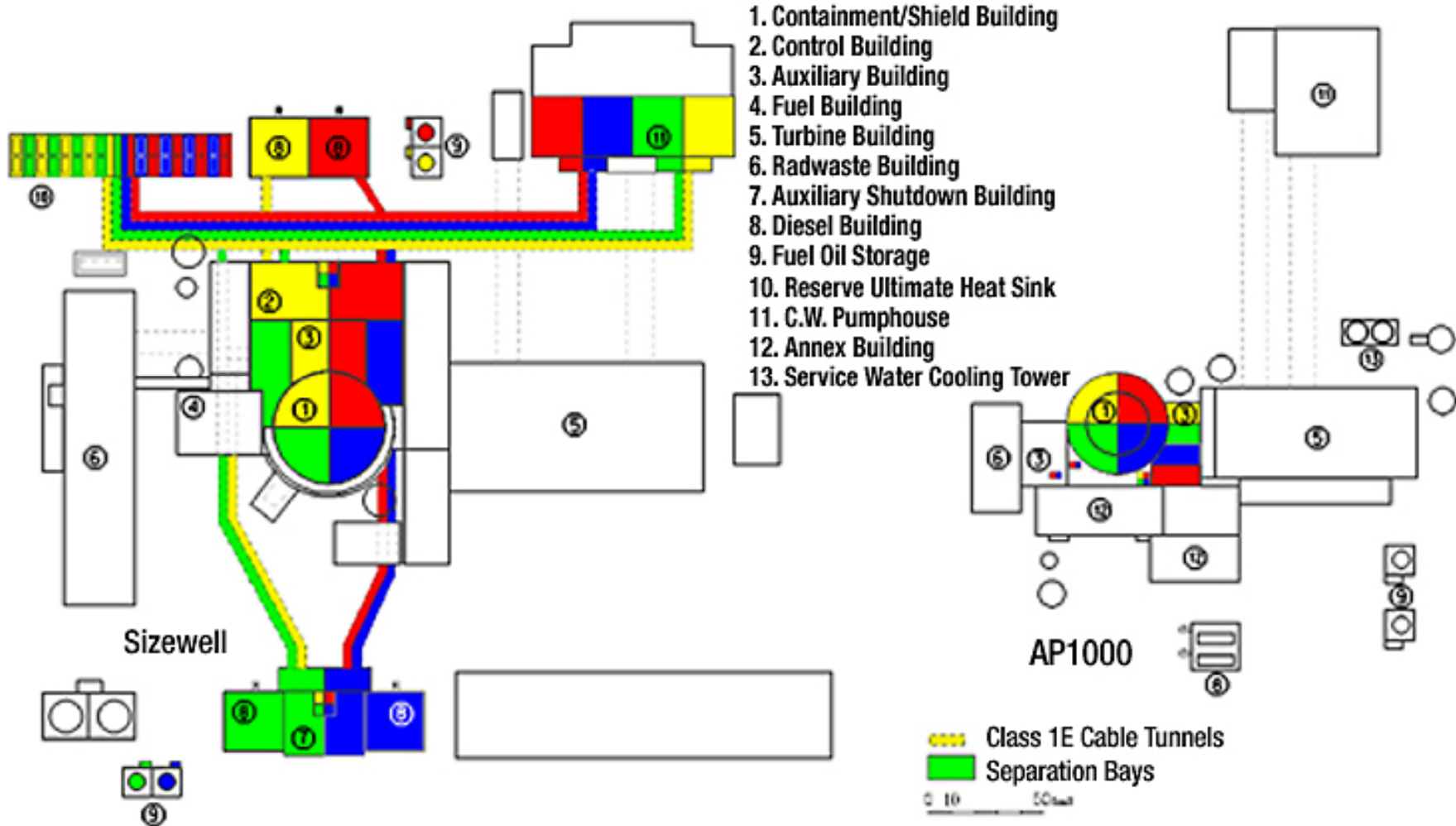
Notes:

a. Plus 20 years life extension

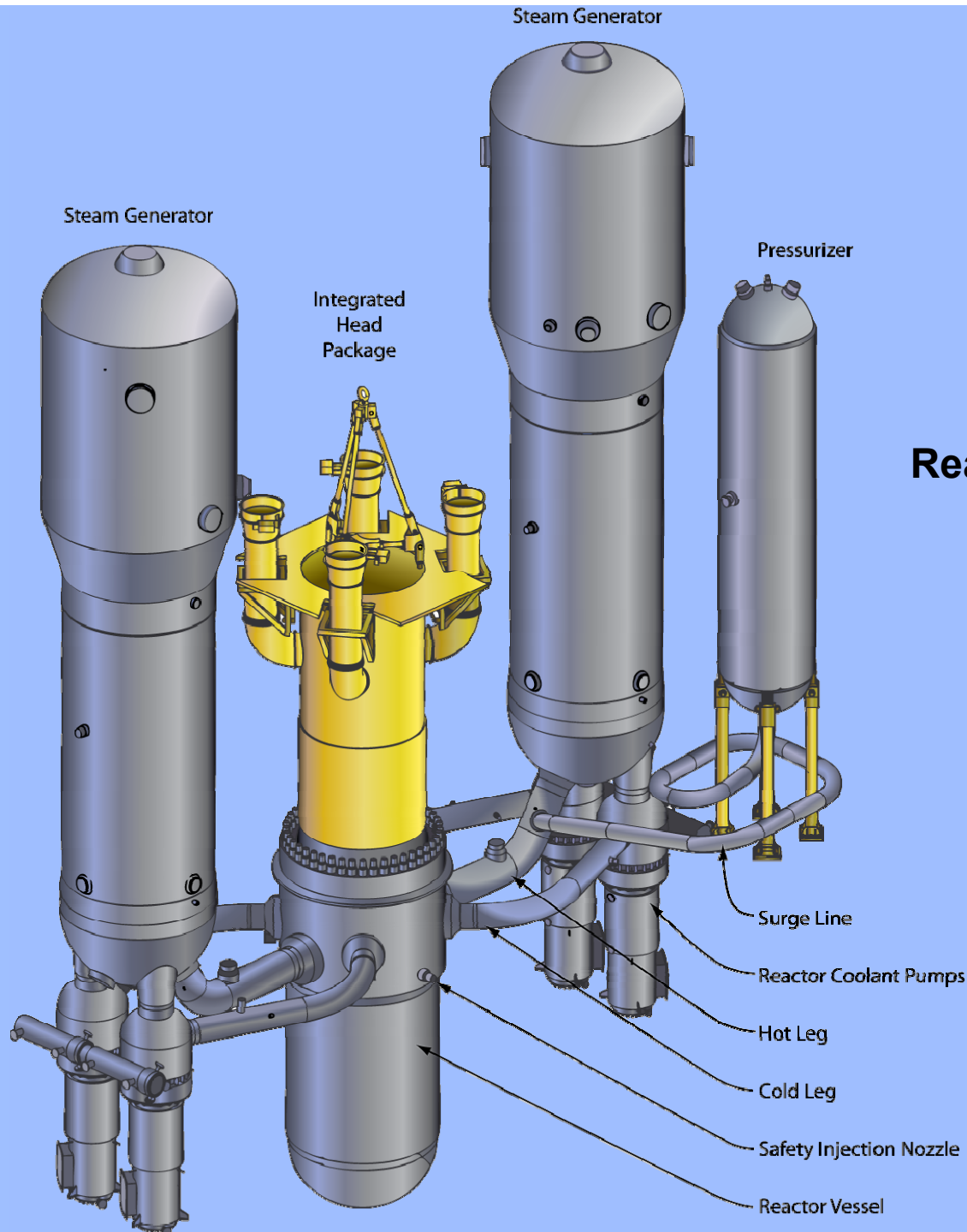
# AP1000 vs Current Site Layouts

Sizewell B

AP1000



74147A



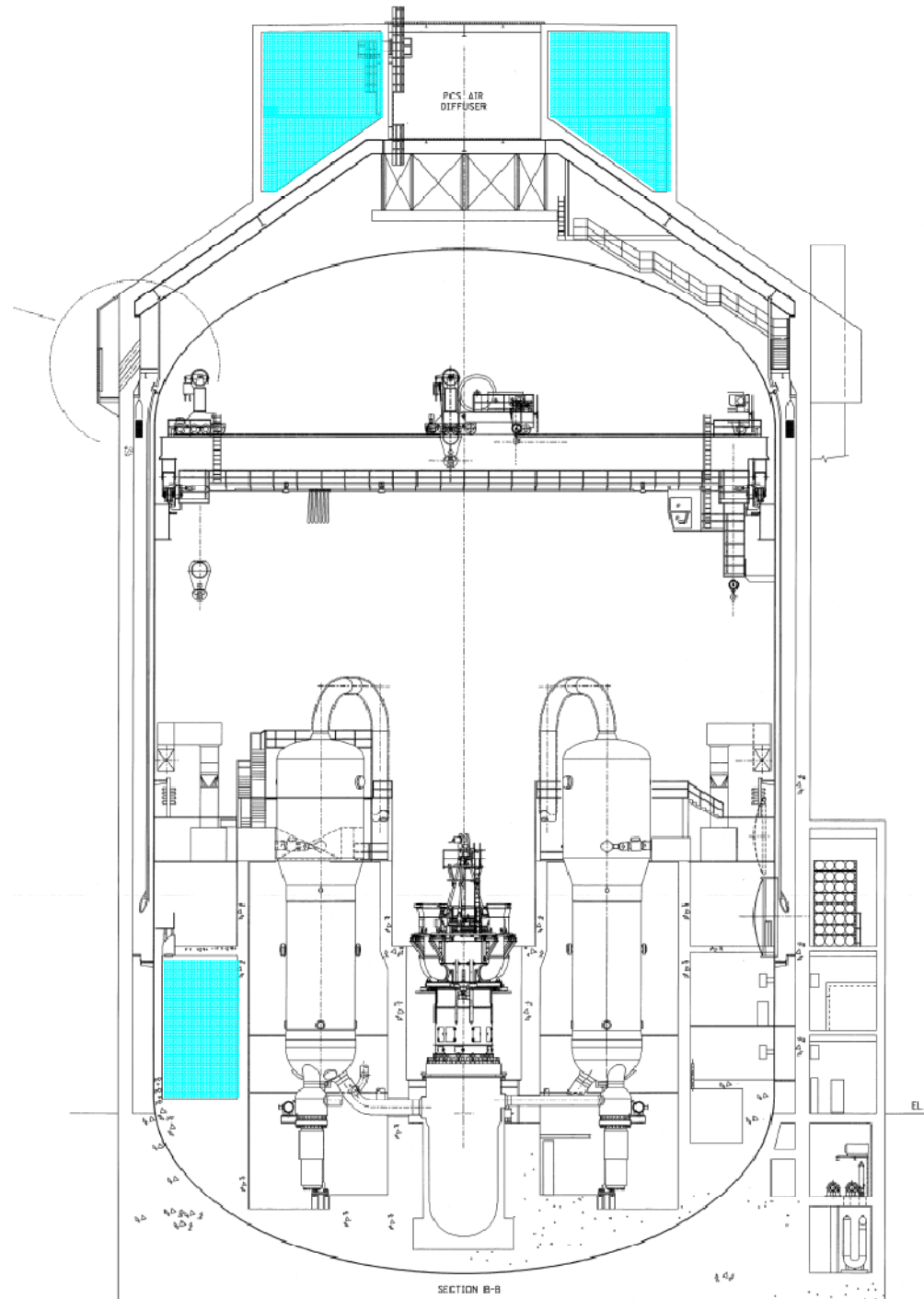
## Reactor Coolant System

# Core and RCS

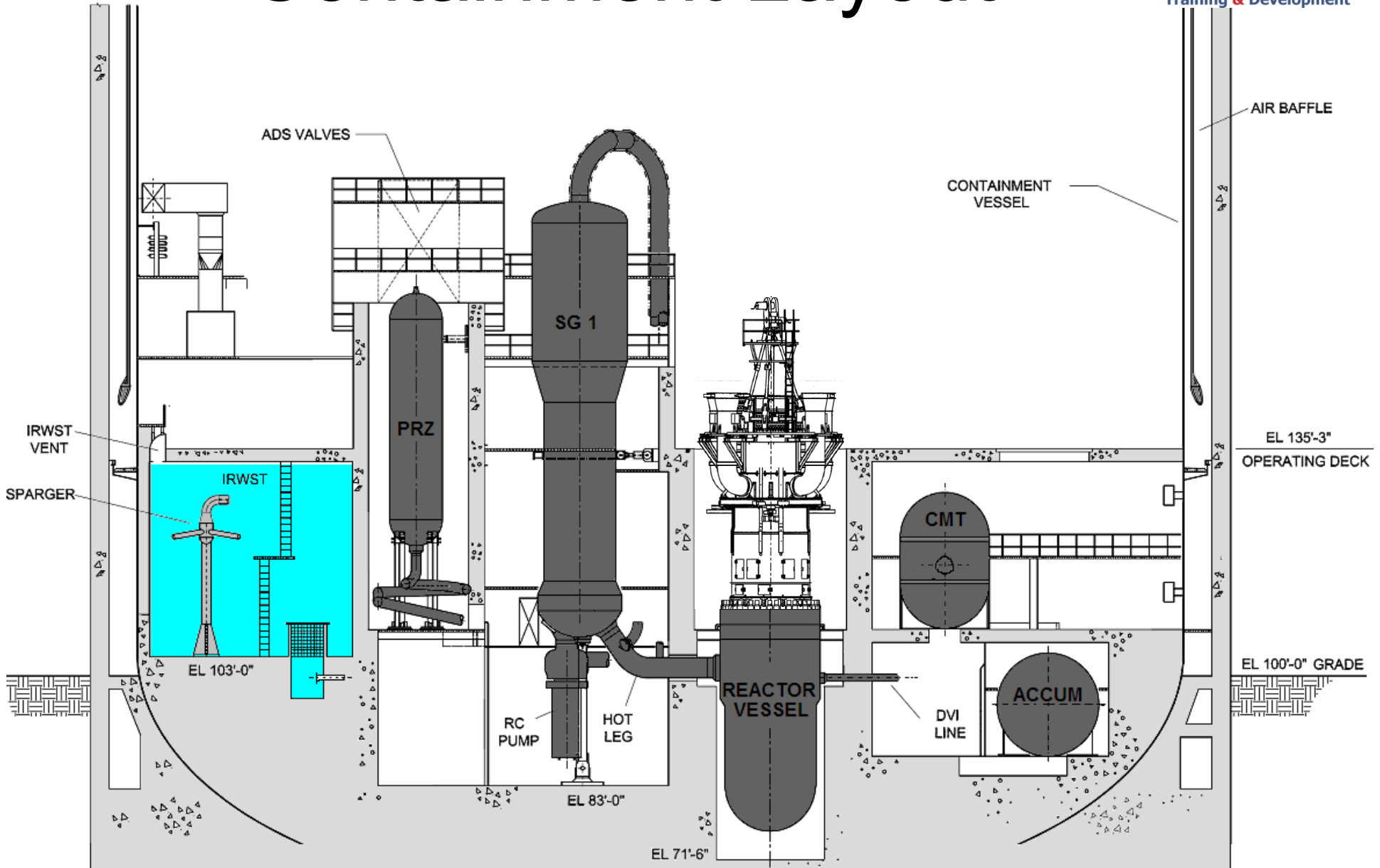
- Fuel, Internals, Reactor Vessel
  - 14-ft XL Robust Fuel
  - No bottom-mounted instrumentation
  - 60-year design life
  
- Steam Generators
  - Similar to large W/CE SGs in operation
    - System 80, ANO RSG
  
- Reactor Coolant Pumps
  - No shaft seals
  
- Simplified 2x4 Main Loop
  - Reduces welds by 50%, pipe supports by 80%
  
- Pressurizer
  - 2100 ft<sup>3</sup> vs. 1800 ft<sup>3</sup> for many existing plants



# Containment Layout

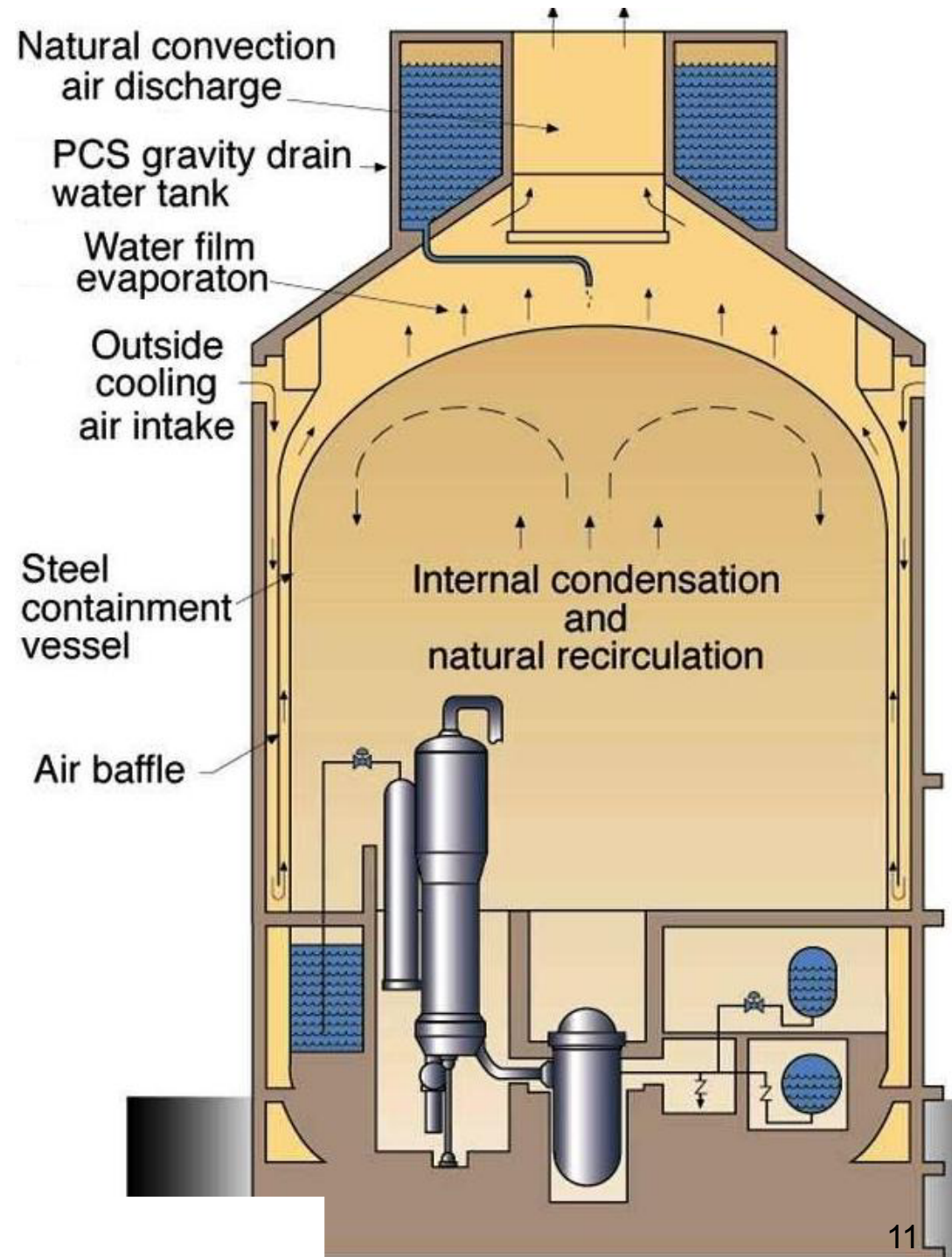


# Containment Layout

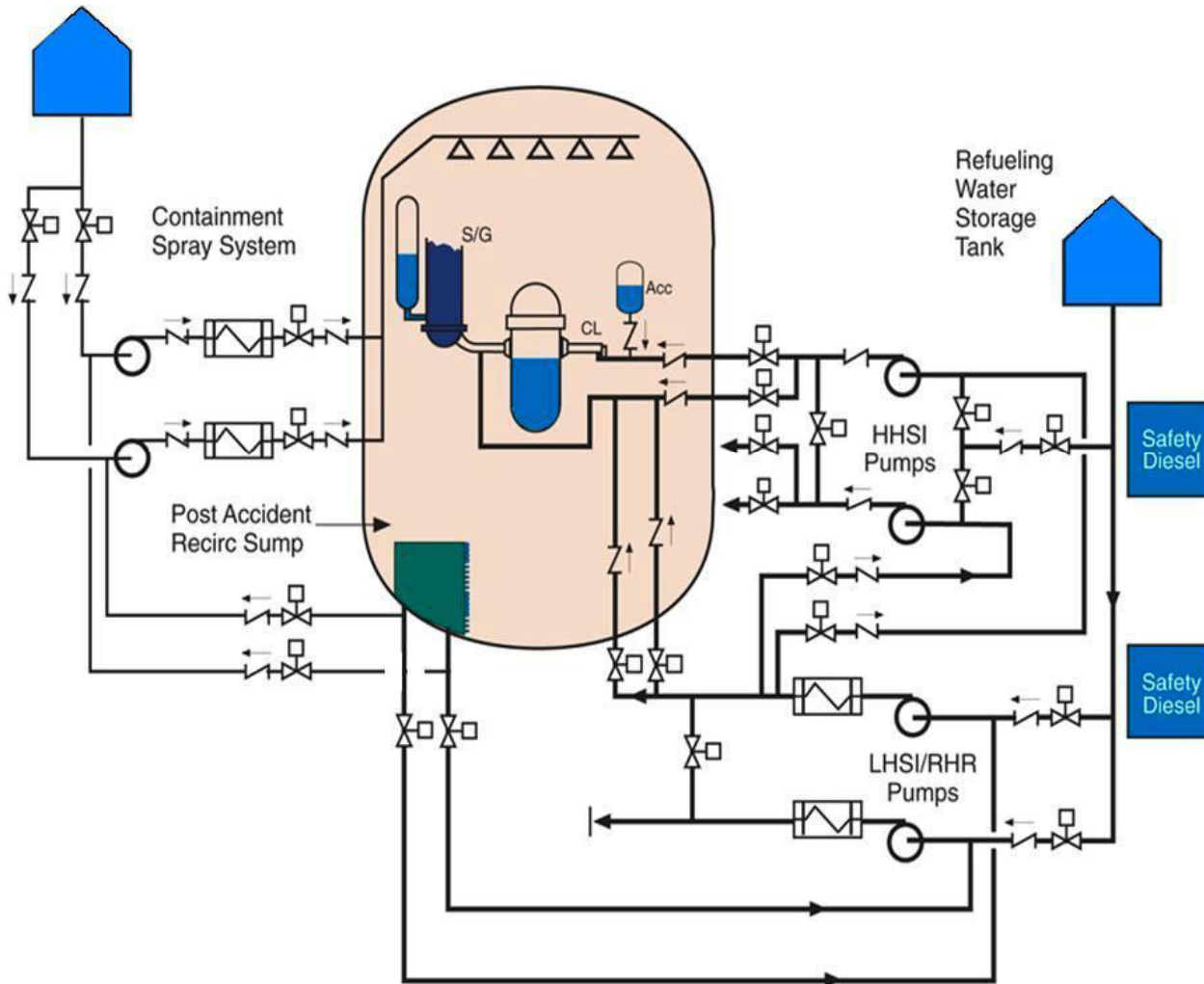


# Passive Containment Cooling System (PCS)

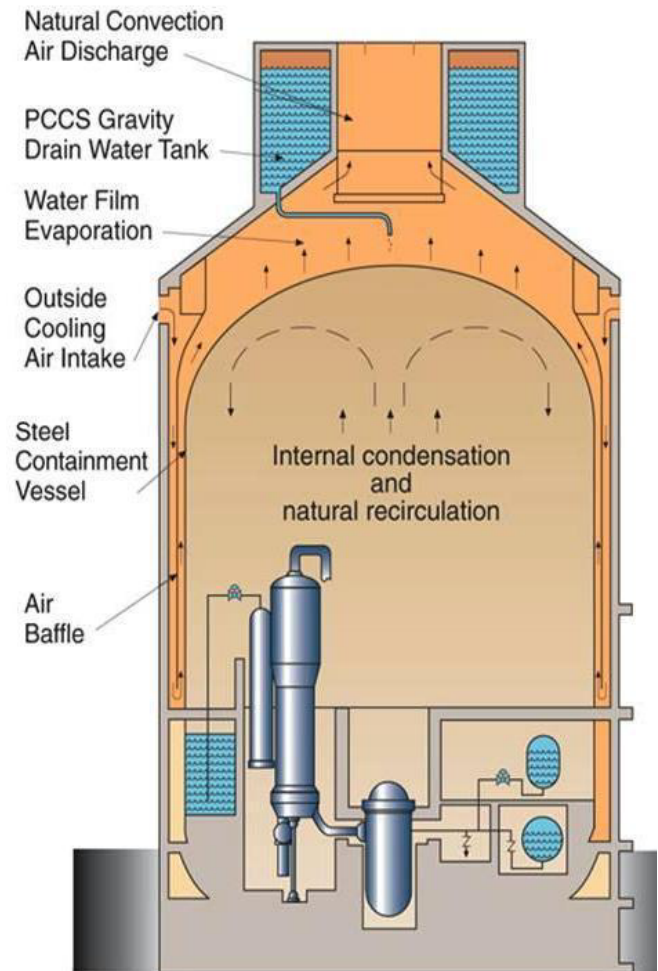
- Steel containment vessel is part of passive safety system.
- PCS transfers heat from the shell to the environment.
- Water from Passive Containment Cooling Water Storage Tank (PCCWST) wets outer shell for 72 hours.
- Natural convection air flow through containment annulus provides additional cooling.



# Simplification of Safety Systems



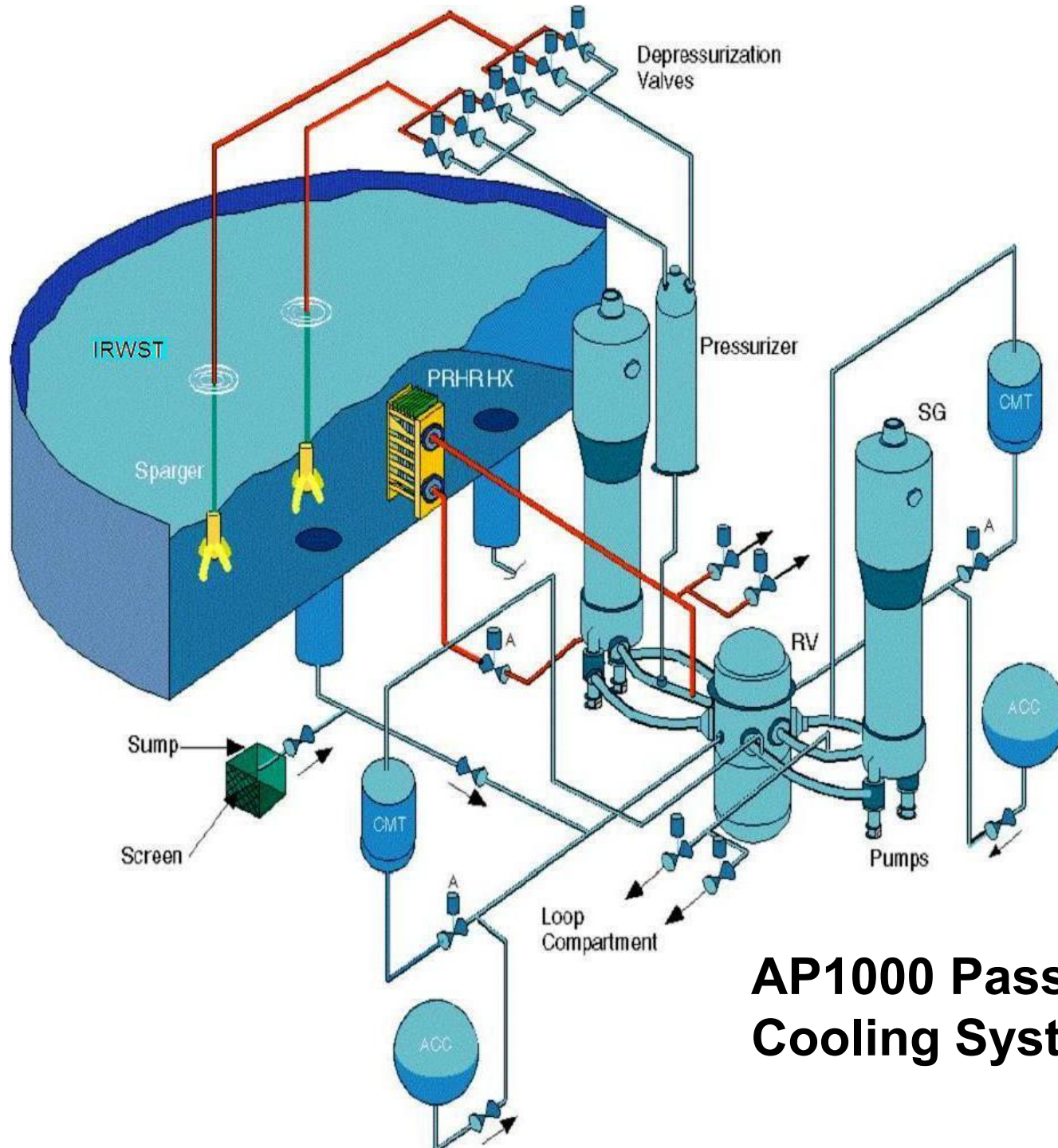
Standard PWR



AP1000

# Passive Safety Features

- Passive Residual Heat Removal Heat Exchanger (**PRHRHX**)
  - Natural circulation HX connected to RCS
- Passive Safety Injection (**PXS**)
  - Core Makeup Tanks (**CMTs**)
  - N<sub>2</sub> pressurized accumulators
  - In-Containment Refueling Water Storage Tank (**IRWST**)
  - Automatic Depressurization System (**ADS**) valves, Pzr & HLs
- Passive Containment Cooling System (**PCS**)
  - Natural circulation of air / evaporation of water on outside surface of steel containment vessel



## AP1000 Passive Core Cooling System

# Passive Cooling Systems

- PRHRHX removes decay heat in event of loss of SGs, transfers heat to IRWST contents.
- CMTs provide borated coolant flow at any system pressure to vessel downcomer through direct vessel injection (DVI) lines.
- ADS actuates when CMT volume decreases to less than 67.5%.

# Passive Cooling Systems (cont'd)

- Two accumulators provide borated coolant via DVI lines at high flow rates when RCS pressure is  $< 700$  psia.
- IRWST supplies borated water to RCS via DVI lines once RCS is sufficiently depressurized.



# Passive Safety Features: No Need for Safety-Related AC Power

- Passive decay heat removal
  - Natural circulation through PRHRHX connected to RCS
- Passive safety injection
  - N<sub>2</sub> pressurized accumulators
  - Density-difference-driven flow from core makeup tanks
  - Gravity drain from refueling water storage tank
  - Automatic RCS depressurization (DC battery-backed electrically operated valves)

# Passive Safety Features: No Need for Safety-Related AC Power (cont'd)

- Passive containment cooling
  - Steel containment shell transfers heat to **natural circulation** of air and evaporation of water drained from storage tank by **gravity**

# Primary Support Systems

- Normal Residual Heat Removal System (**RNS**)
- Component Cooling Water System (**CCS**)
- Service Water System (**SWS**)
- Fuel Handling and Storage System (**FHS**)
- Spent Fuel Pool Cooling System (**SFS**)
- Primary Sampling System (**PSS**)

# Balance of Plant Features

- Turbine Building houses all traditional non-safety steam and power conversion systems
  - Condensate and feedwater system
  - Main steam system
  - Turbine-generator systems
  - Circulating water system
  - Startup feedwater system
- Turbine Building also houses active non-safety support systems
  - Component cooling water system
  - Service water system
  - Compressed and instrument air system
  - Demineralized water system

# Balance of Plant Features (cont'd)

- BOP includes redundant non-safety diesels
  - Backup power to active non-safety systems
- Only a single source of off-site power is required
- No safety-related compressed air system
- All motor-driven HVAC is non-safety
  - Safety-related control room habitability system is passive
- No active safety-related heat sink – ultimate heat sink is passive
- Smaller security perimeter

# Control Room Concepts Show Extensive Use of Digital Technology



# Regulatory Treatment of Non-Safety-Related Systems (RTNSS) Section 1.3



- Safety-related structures, systems, and components (SSCs) handled in similar manner as at current plants.
- Passive safety system performance uncertainties increase the importance of active (non-safety) systems in providing defense-in-depth functions (SECY 94-084).
- The NRC and EPRI developed a process to identify the important active SSCs to maintain appropriate regulatory oversight of those SSCs.

# Non-safety SSCs are risk significant & candidates for RTNSS if:

- Effect on PRA:
  - Needed to meet NRC CDF ( $1E-4/yr$ ) and LRF ( $1E-6/yr$ ) safety goals.
  - Add margin to compensate for PRA uncertainty.
  - Impact initiating event frequencies.
- Needed to meet 10CFR50.62, 50.63 requirements.
- Ensure long-term ( $> 72$ -hr) safety & address seismic events.
- Needed to meet containment performance goal.
- Prevent significant adverse system interactions.



# Regulatory Treatment of Non-Safety-Related Systems (RTNSS) (cont'd)

- AP1000 SSCs identified as subject to RTNSS:
  - Diverse Actuation System (**DAS**)
  - Normal Residual Heat Removal System (**RNS**)
  - Component Cooling Water System (**CCS**)
  - Service Water System (**SWS**)
  - Post-72-Hr Makeup Water Sources
  - MCR & Instrumentation Room Fans
  - Hydrogen Igniters
  - Onsite and Offsite AC Power
  - Ancillary DGs
  - Non-1E DC & UPS for DAS
  - Reactor Vessel Insulation (In-Vessel Retention)

# Regulatory Treatment of Non-Safety-Related Systems (RTNSS) (cont'd)



- Regulatory oversight methods in addition to ITAAC (Inspections, Tests, Analyses, and Acceptance Criteria) were determined as follows:
  - TS with an LCO is the appropriate operational regulatory control for the manual DAS functions.
  - Investment Protection Short-Term Availability Controls (STACs) provide administrative operational controls for the majority of the other SSCs.
  - Design Reliability Assurance Program (D-RAP) - Quality assurance program for risk-important non-safety-related SSCs to provide reasonable assurance that the AP1000 is designed, procured, constructed, maintained, and operated in a manner consistent with the PRA.

# Regulatory Treatment of Non-Safety-Related Systems (RTNSS) (cont'd)



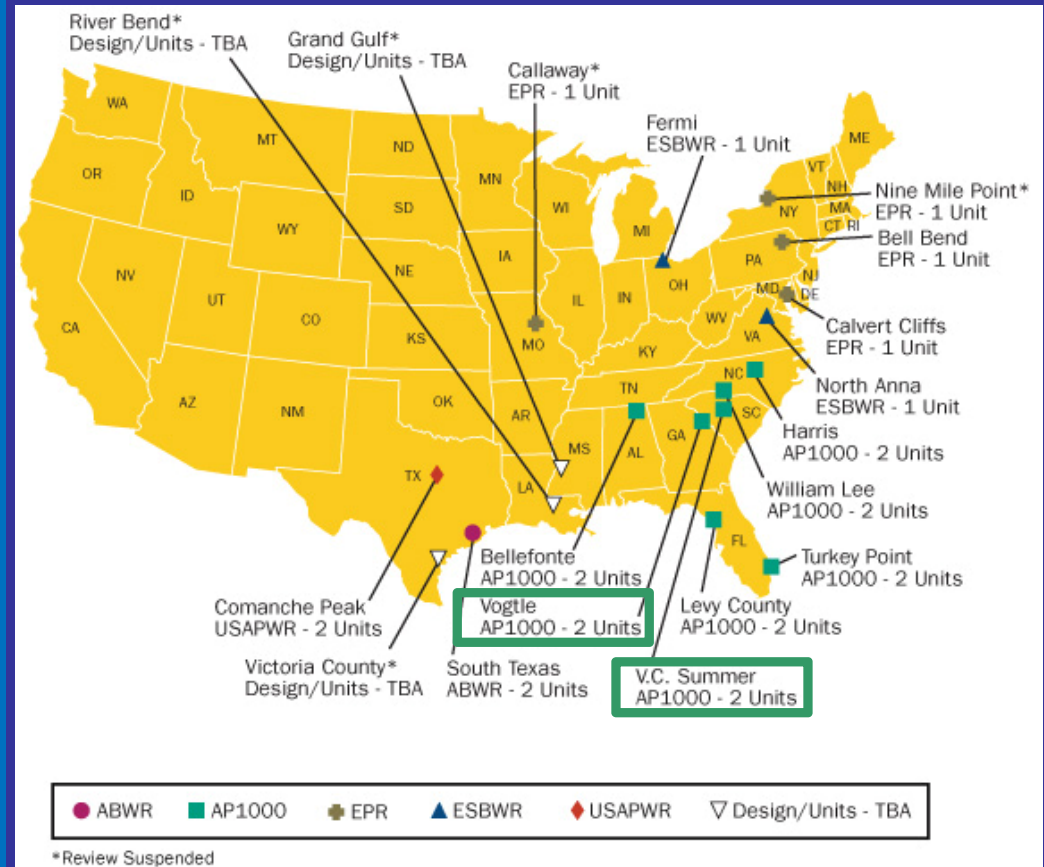
- Inspection Considerations:
  - Inspections will be focused on those SSCs with targeted ITAAC and findings would be documented.
  - For findings associated with safety-related SSCs, enforcement should be documented.
  - Findings associated with non-safety-related SSCs would be considered a failure to meet commitments under the D-RAP.

# Current AP1000 Status

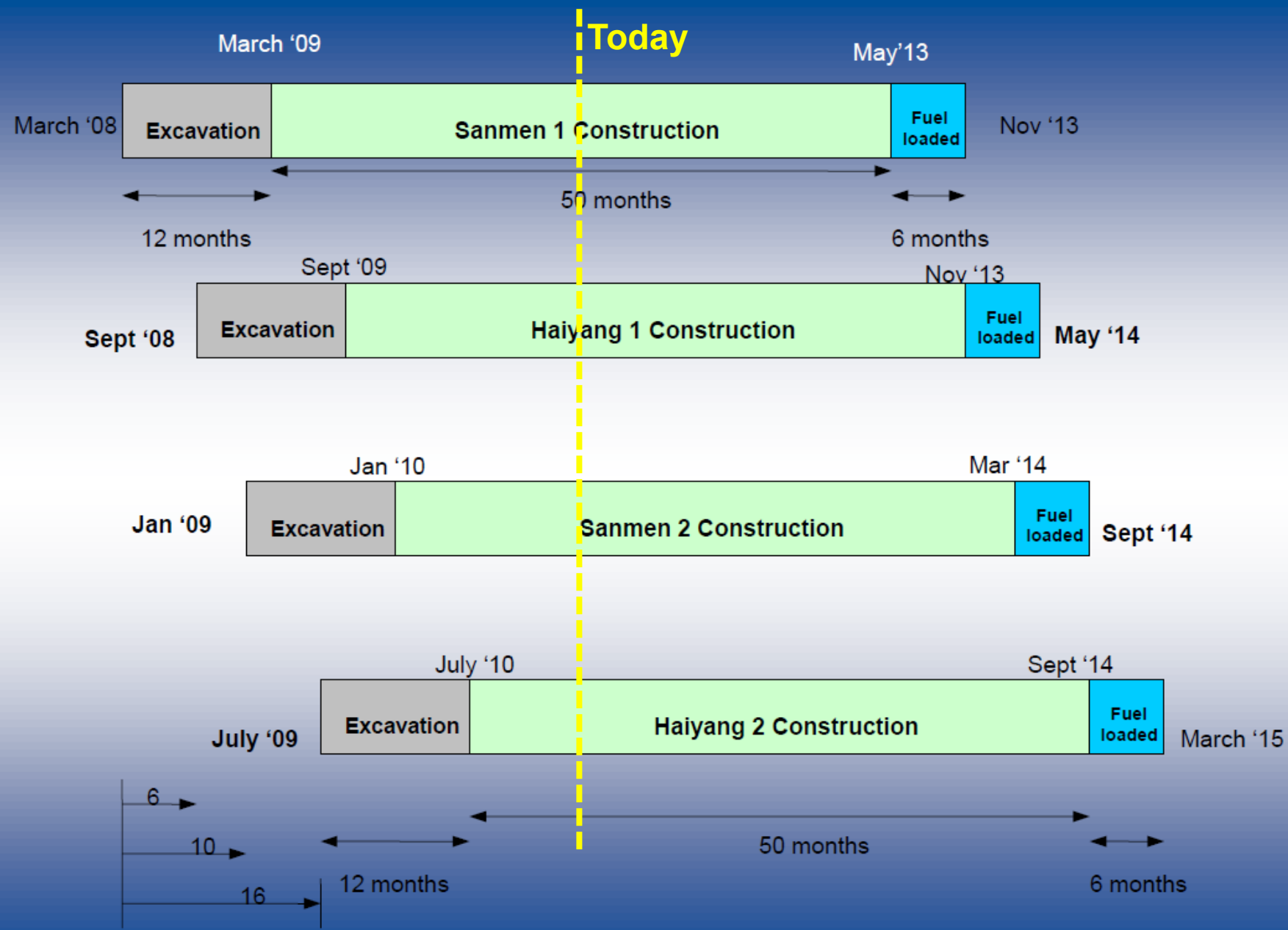
## ✓ China



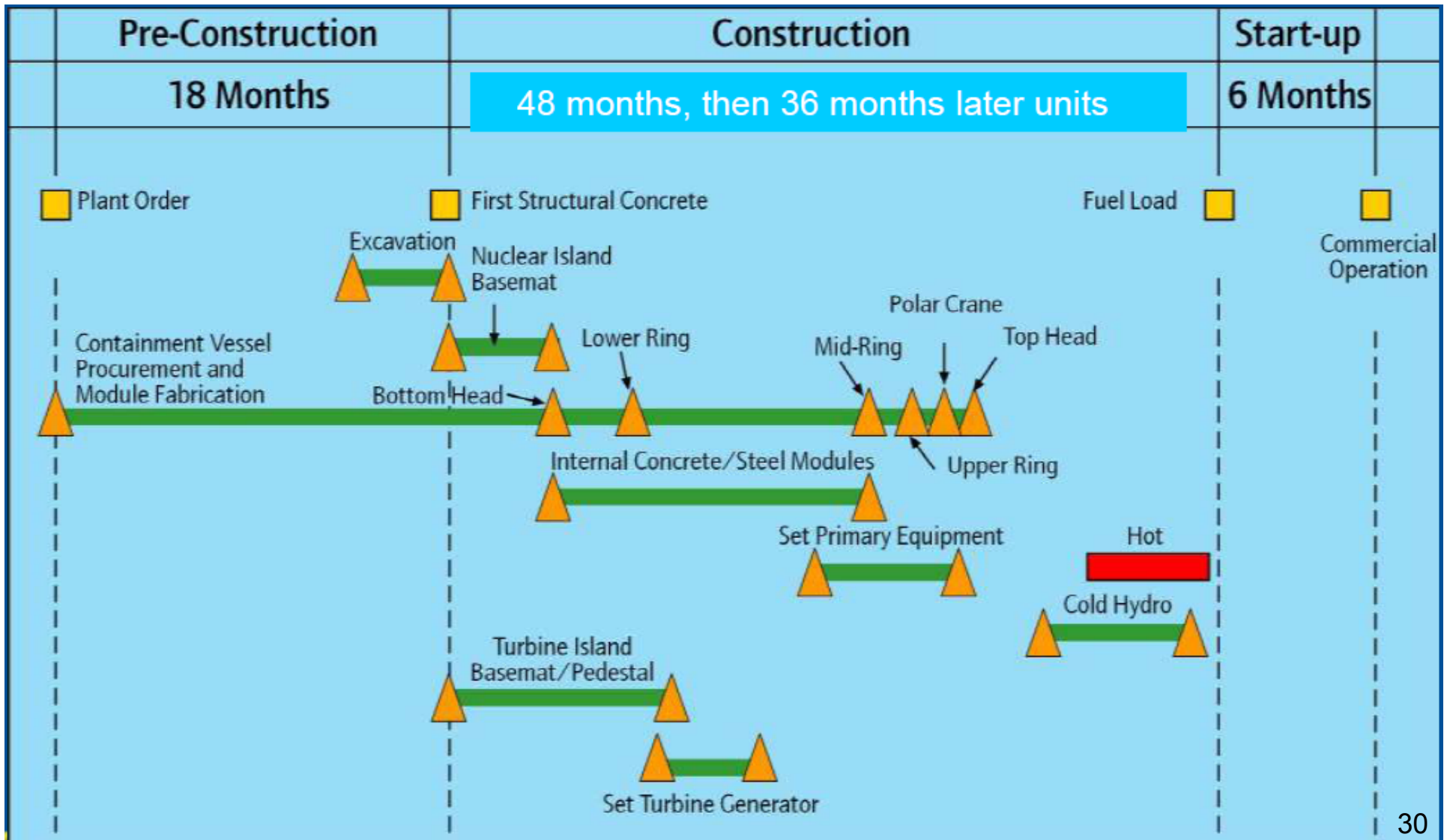
## ✓ USA



# Schedule Overview – All 4 Units



# AP1000 Standard Construction Schedule



# Current US AP1000 Schedules/Plans

Expected New Nuclear Power Plant Applications Updated April 13, 2011								
Company (Project or Docket Numbers)	Date of Application	Design	Date Accepted	Site Under Consideration	Number of Units	State	Existing Operating Plant	Status
<b>Calendar Year (CY) 2007 Applications</b>								
NRG Energy (52-012/013)	09/20/07	ABWR	11/29/07	South Texas Project	2	TX	Y	Accepted/Docketed
NuStart Energy (52-014/015)	10/30/07	AP1000	01/18/08	Bellefonte	2	AL	N	Accepted/Docketed
UNISTAR (52-016)	07/13/07 (Envir.) 03/13/08 (Safety)	EPR	01/25/08 06/03/08	Calvert Cliffs	1	MD	Y	Accepted/Docketed Accepted/Docketed
Dominion (52-017)	11/22/07	ESBWR	01/28/08	North Anna	1	VA	Y	Accepted/Docketed
Duke (52-018/019)	12/13/07	AP1000	02/25/08	William Lee Nuclear Station	2	SC	N	Accepted/Docketed
<b>2007 Total Number of Applications = 5 Total Number of Units = 8</b>								
<b>Calendar Year (CY) 2008 Applications</b>								
Progress Energy (52-022/023)	02/19/08	AP1000	04/17/08	Harris	2	NC	Y	Accepted/Docketed
NuStart Energy (52-024)	02/22/08	ESBWR	04/17/08	Grand Gulf	1	MS	Y	Accepted/Docketed
Southern Nuclear Operating Co. (52-025/026)	03/31/08	AP1000	05/30/08	Vogtle	2	GA	Y	Accepted/Docketed
South Carolina Electric & Gas (52-027/028)	03/31/08	AP1000	07/31/08	Summer	2	SC	Y	Accepted/Docketed
Progress Energy (52-029/030)	07/30/08	AP1000	10/06/08	Levy County	2	FL	N	Accepted/Docketed
Detroit Edison (52-033)	09/18/08	ESBWR	11/25/08	Fermi	1	MI	Y	Accepted/Docketed
Luminant Power (52-034/035)	09/19/08	USAPWR	12/02/08	Comanche Peak	2	TX	Y	Accepted/Docketed
Entergy (52-036)	09/25/08	ESBWR	12/04/08	River Bend	1	LA	Y	Accepted/Docketed
AmerenUE (52-037)	07/24/08	EPR	12/12/08	Callaway	1	MO	Y	Accepted/Docketed
UNISTAR (52-038)	09/29/08	EPR	12/11/08	Nine Mile Point	1	NY	Y	Accepted/Docketed
PPL Generation (52-039)	10/10/08	EPR	12/19/08	Bell Bend	1	PA	Y	Accepted/Docketed
<b>2008 Total Number of Applications = 11 Total Number of Units = 16</b>								
<b>Calendar Year (CY) 2009 Applications</b>								
Florida Power and Light (763)	06/30/09	AP1000	09/04/09	Turkey Point	2	FL	Y	Accepted/Docketed
<b>2009 Total Number of Applications = 1 Total Number of Units = 2</b>								

# Westinghouse's Projected Time Line

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
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