



Shaw Group Nuclear

Mike O'Connell – Project Manager AP1000 Projects



2011- 2051

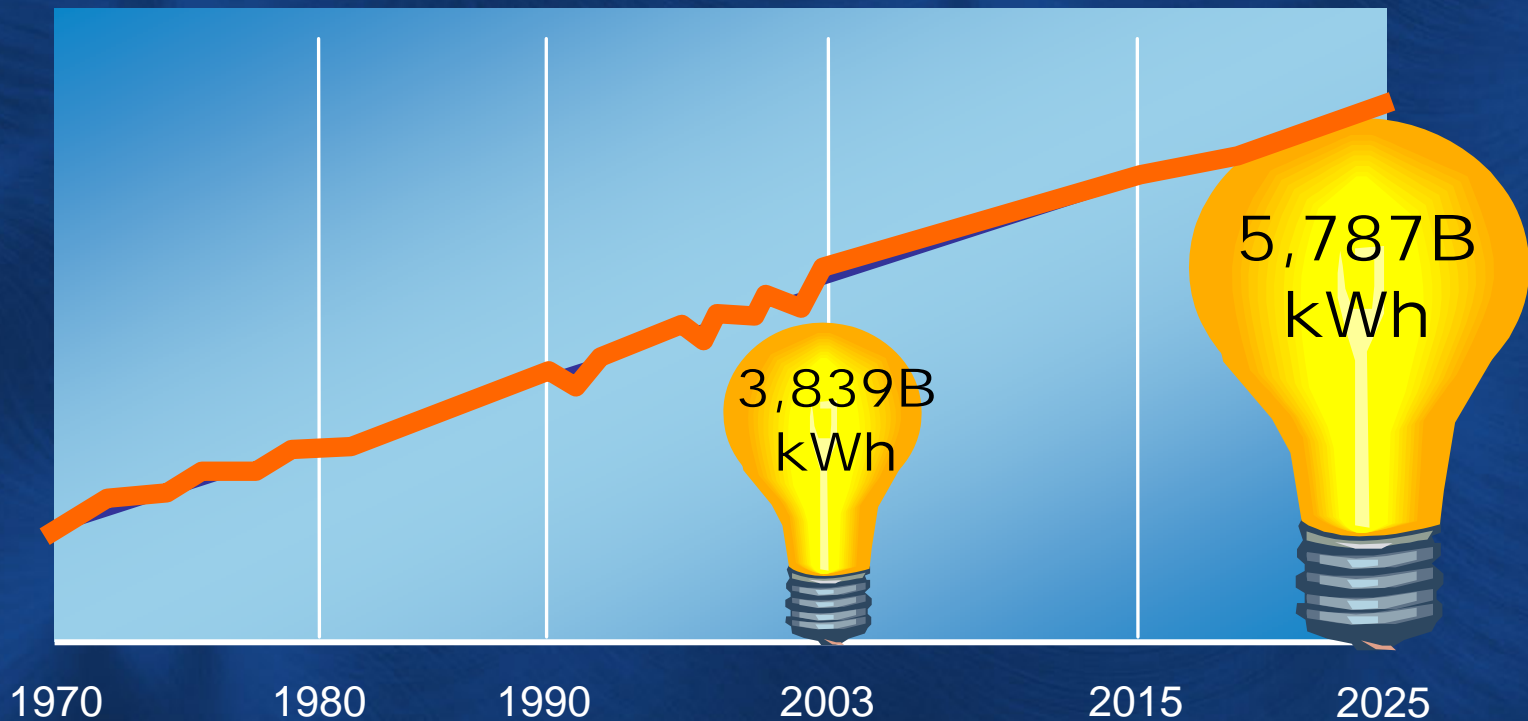
Global Coming Attractions

Energy

Fuel Source	+	-
Coal	Lots of it in ground, cheap	SO ₂ + NO _x + landfills + CO ₂
Oil	Easy to transport	Decreasing amounts, prices going higher + CO ₂
Natural gas	Easy to transport and least polluting of the combustion technologies	Decreasing amounts, prices going higher + CO ₂
Nuclear	No CO ₂ , low fuel cost,	Long term waste handling + high initial cost
Hydro, Solar & Wind	“free” inputs, No CO ₂	Low energy density, NIMBY

U.S. Energy Demand

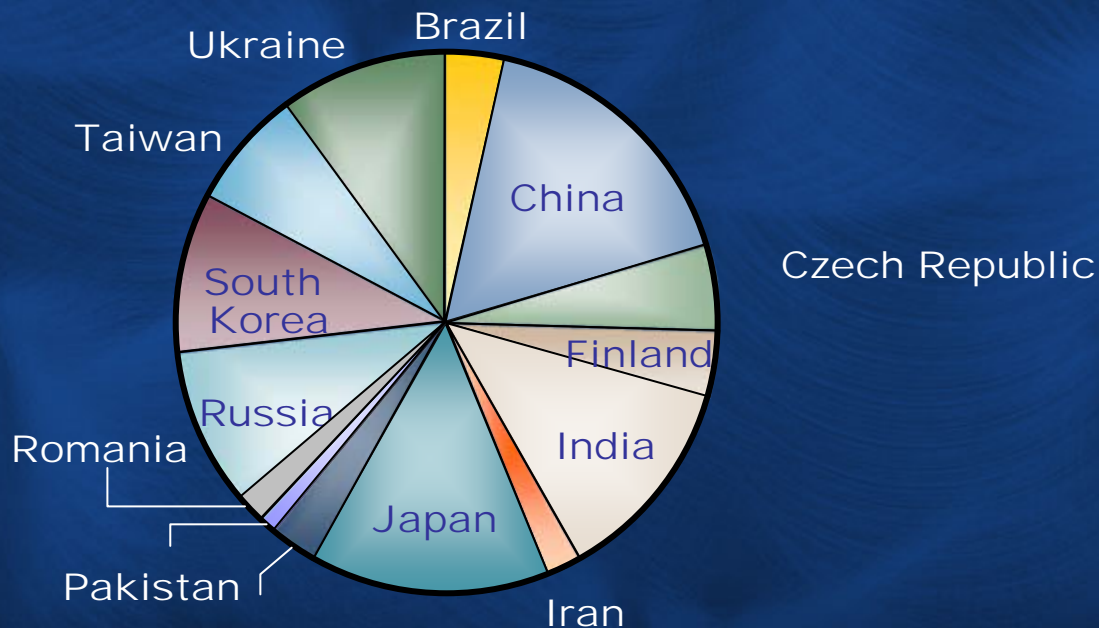
America Is Projected to Need 50% More Electricity by 2025







Source: U.S. Department of Energy

World View

- 440 nuclear power plants → ~367 GWe
- 16% of world's electricity
- Displaces 2.5 billion metric tons of CO₂/year
- 38 GW online since 2000 plus under construction



Current Unit Expansion in Asia/Europe

	Country	Operating Units	Currently Planned & Under Construction	Long-Term Plan (GWe)	By (year)
	India	14	8	29.5	2022
	South Korea	20	6	26.6	2015
	Russia	30	4	40	2020
	Japan	52	3	15	2025
	China	9	20	40	2020
	Ukraine	8	2	22	2030
	Pakistan	2	—	8.5	2030
	Iran	0	1	—	—
	Romania	1	1	—	—
	Finland	4	2	—	—

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U.S. Nuclear Energy

- 104 nuclear plants (1 returned in 2007)
 - 20% of the nation's electricity
 - Power Uprates have added the equivalent of 5 nuclear units over past 20 years
 - Watts Bar 2 setting up for finish of construction
- Displaces 680 million metric tons of CO₂/yr
 - Equivalent to 131 million passenger cars/yr
- Despite low profile, nuclear is strong and about to grow substantially

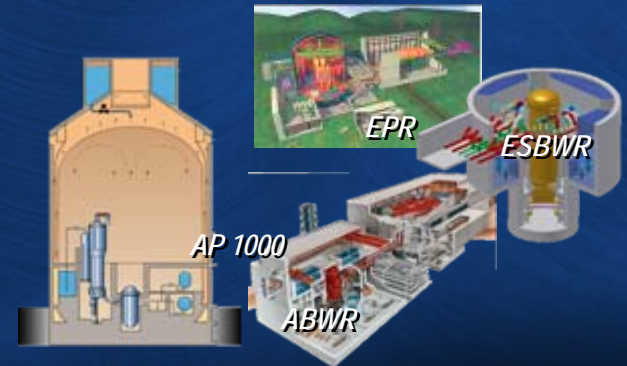


United States New Generation

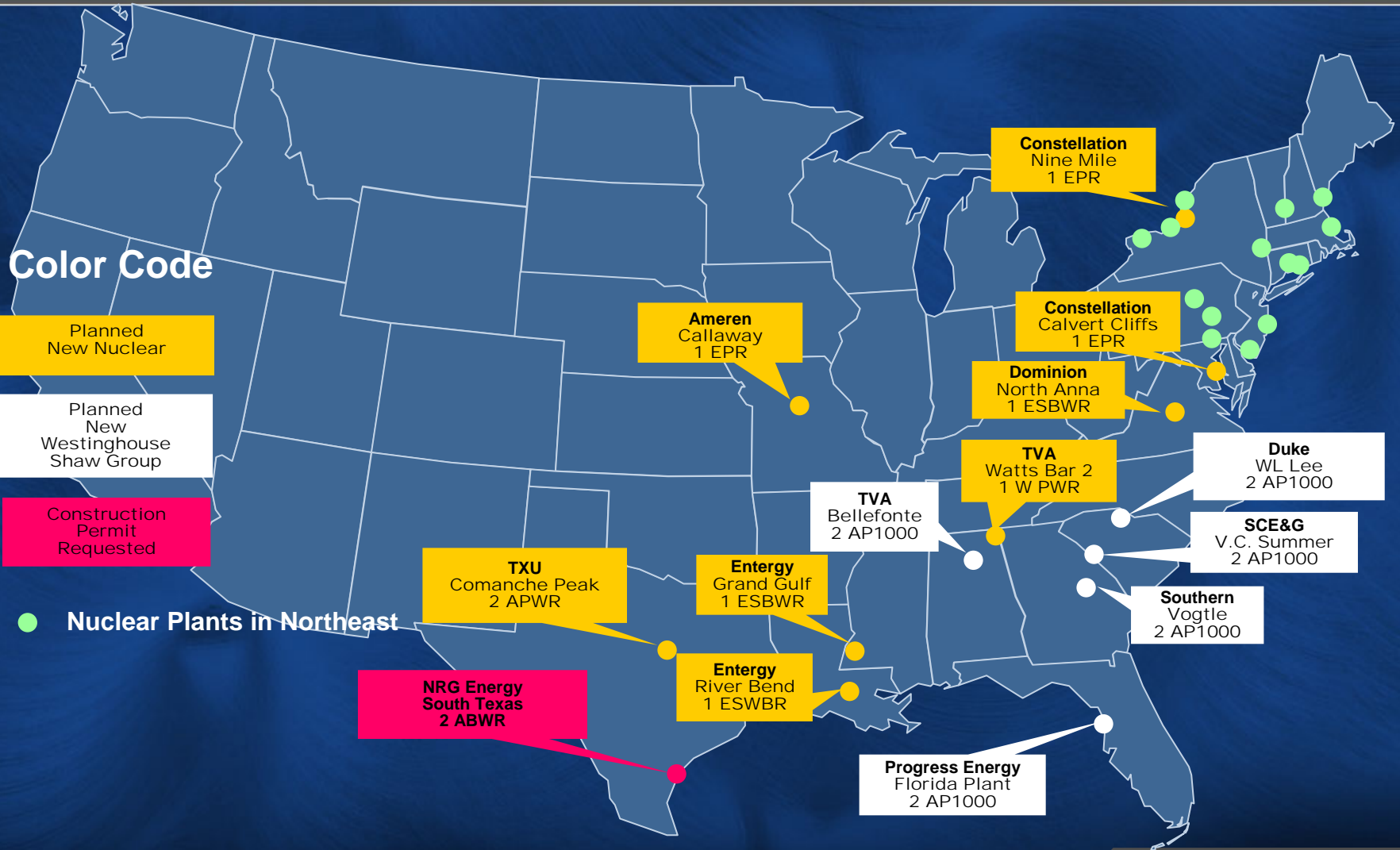


Southern
Constellation
Dominion
SCE&G
Entergy
Duke
Progress Energy
TVA
FPL
NRG

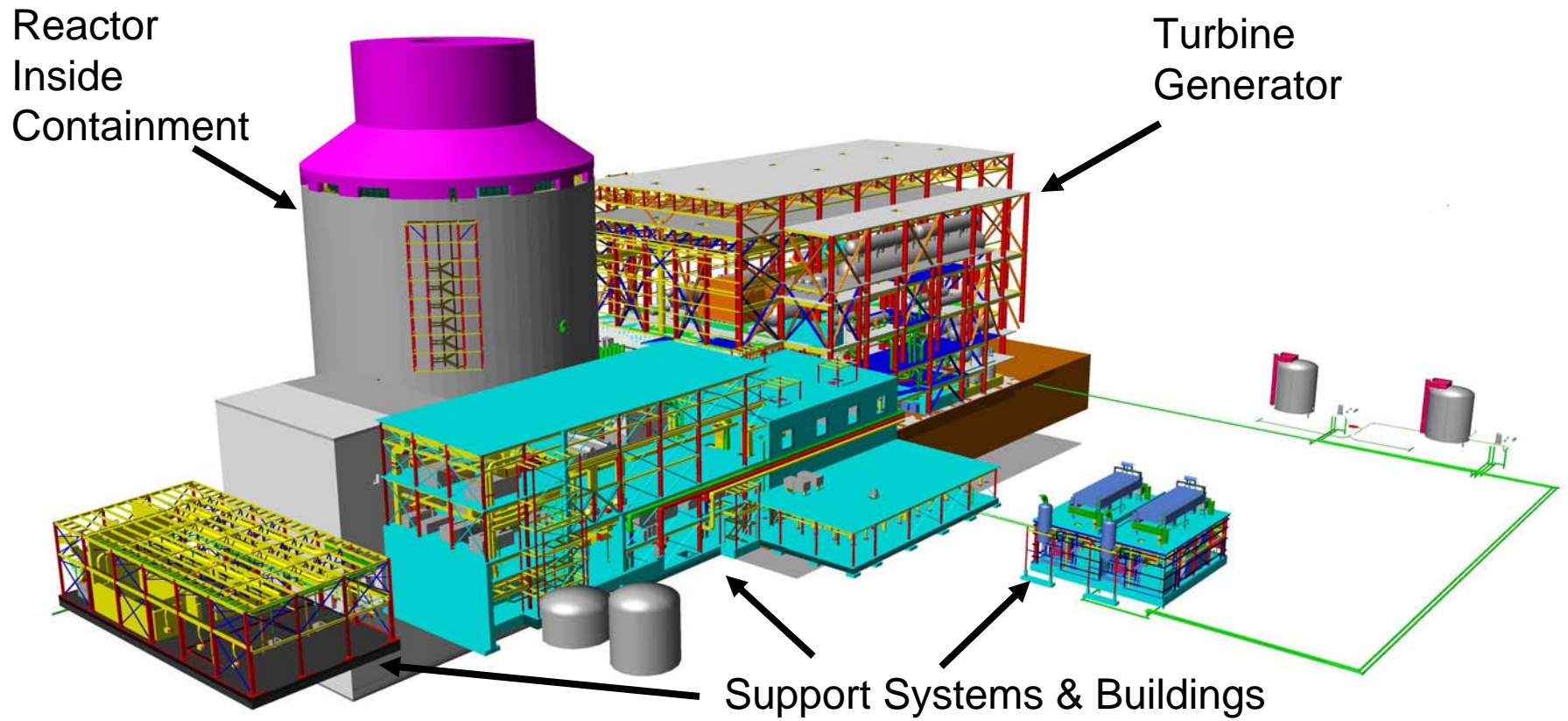
AREVA
Westinghouse
General Electric
Toshiba
MHI



U.S. Nuclear Industry—First Movers



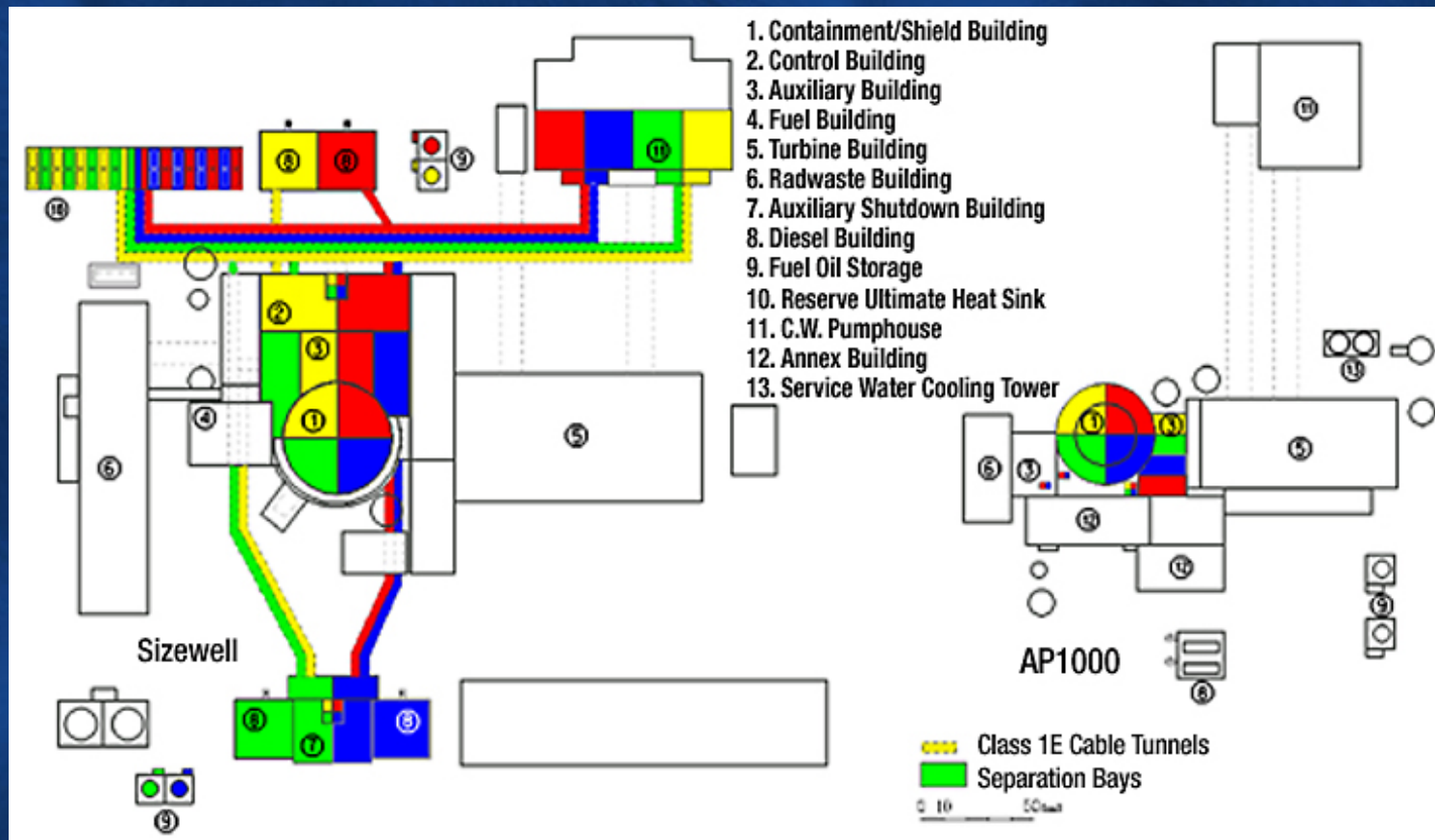
The AP1000 Design



AP1000 Specification

- Approximately 1150 MWe
- 2 Steam Generator Design
- 60 year design life
- No AC driven components needed for immediate accident response
- Passive Safety System/containment design features
- Small safety related foot print

The AP1000 is Smaller and Dramatically Simpler than Evolutionary Plants



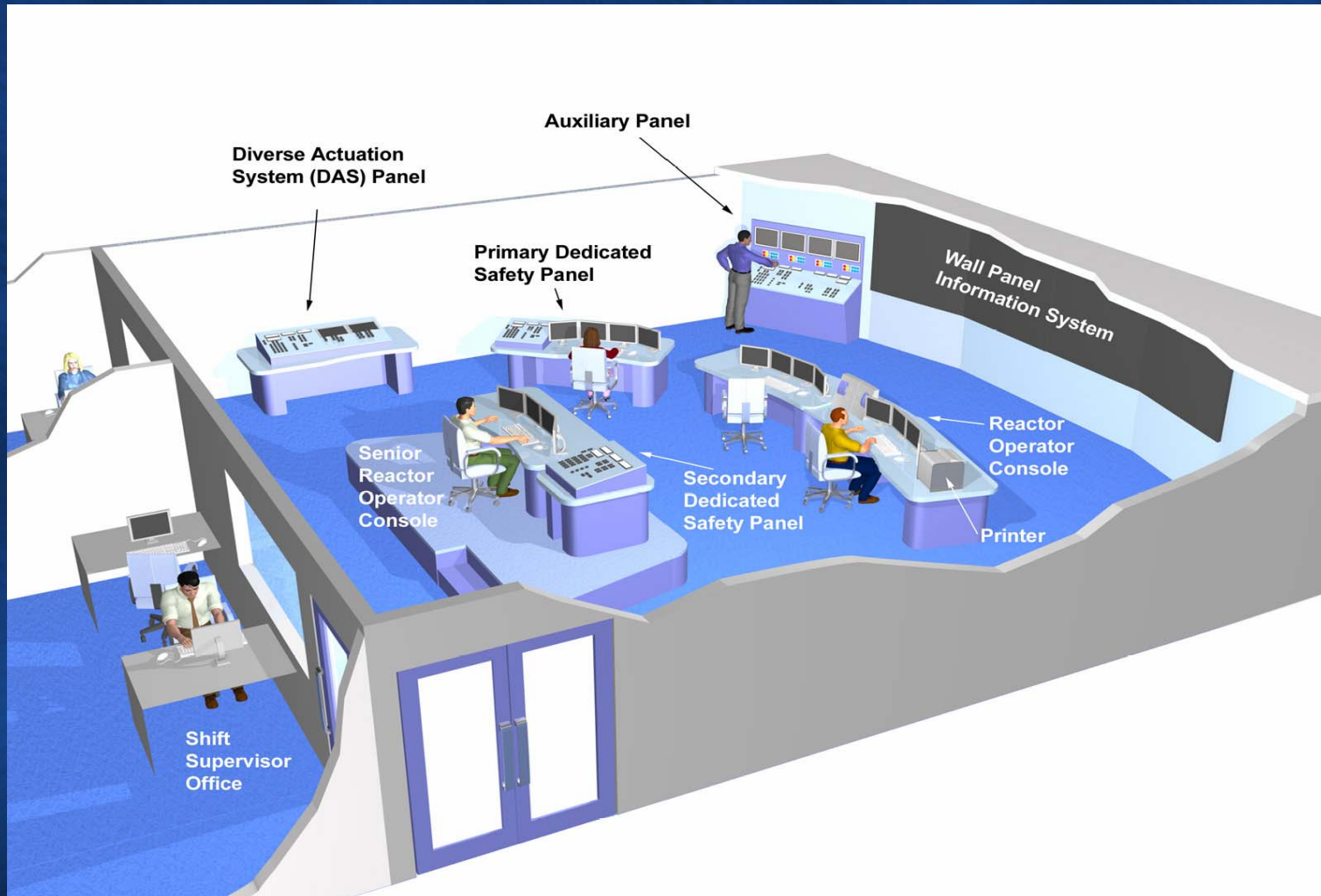
Sizewell B

AP1000

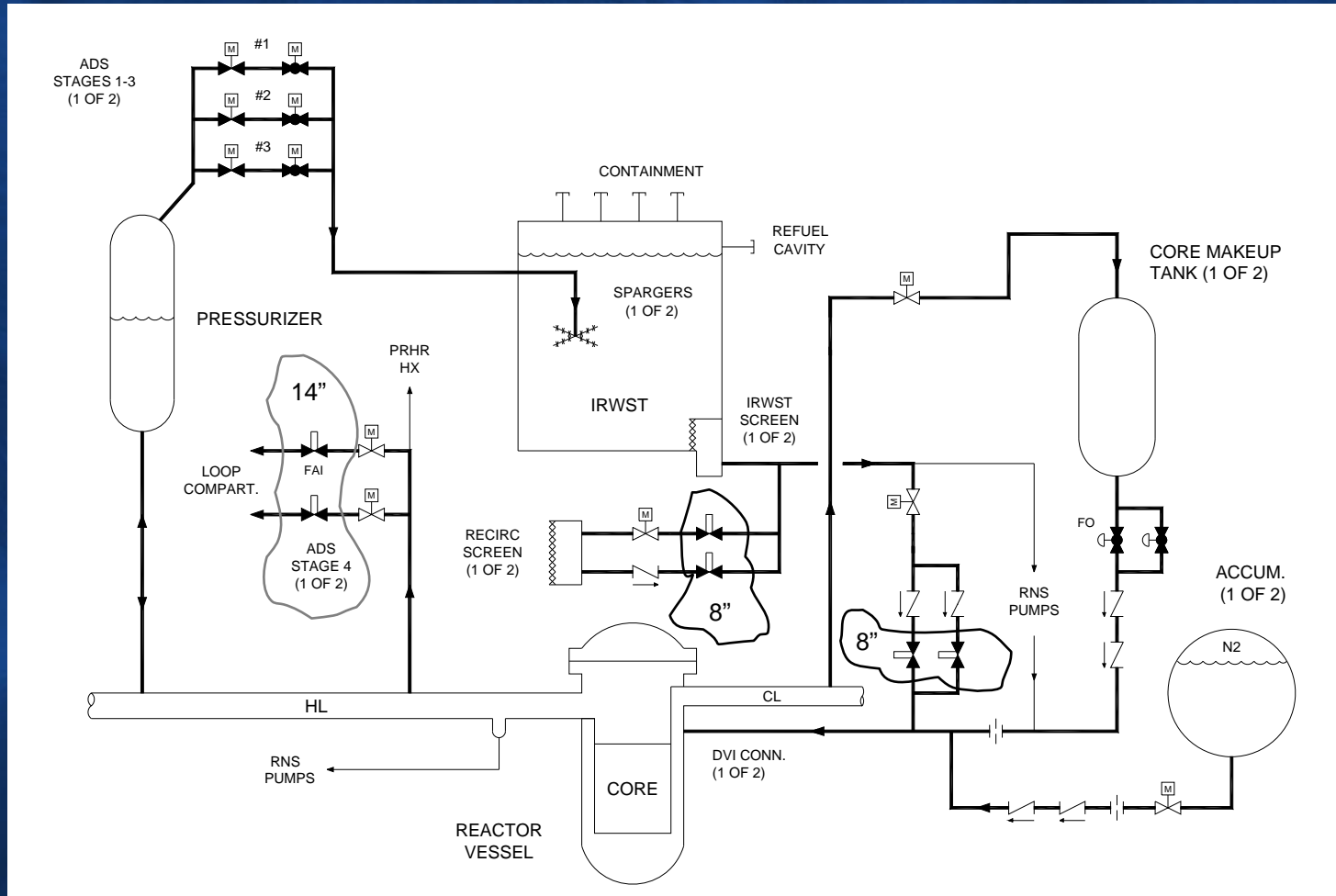
What is different this time around?

- Use passive safety systems to respond to most transients and events
 - Passive technologies give factor of 10^2 improvement in safety
 - Fewer moving parts = less to go wrong + less to buy + less to maintain for 60 years!
- State of the Art methods & components
 - Modular design
 - Fiber optic & digital controls

AP1000 Compact Control Room

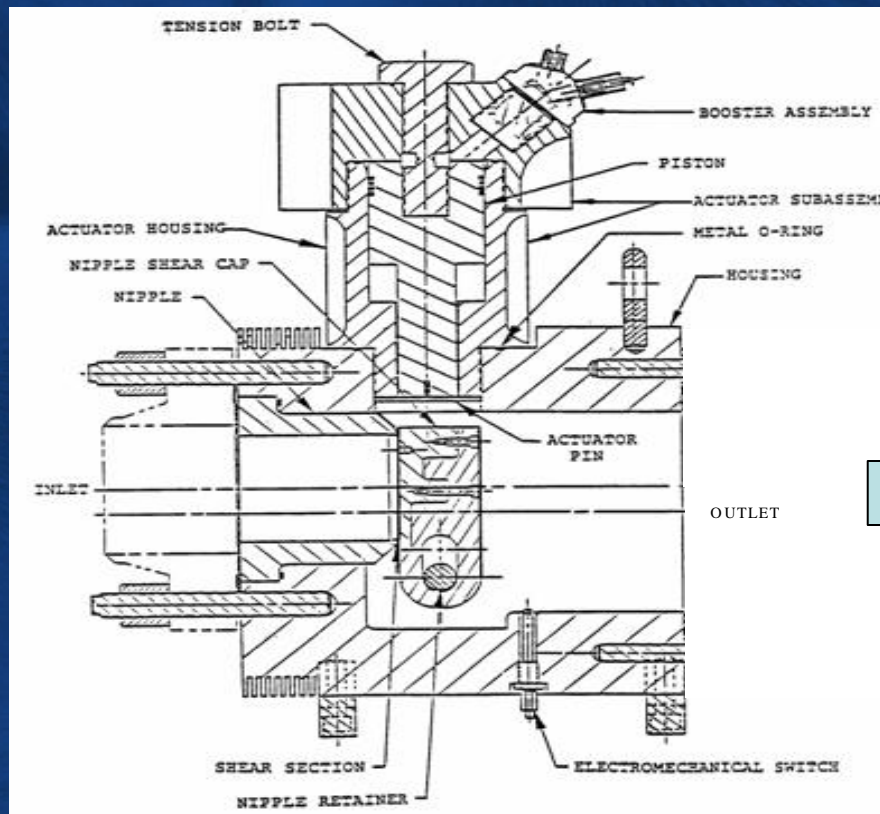


Passive Systems Use Squib Valves

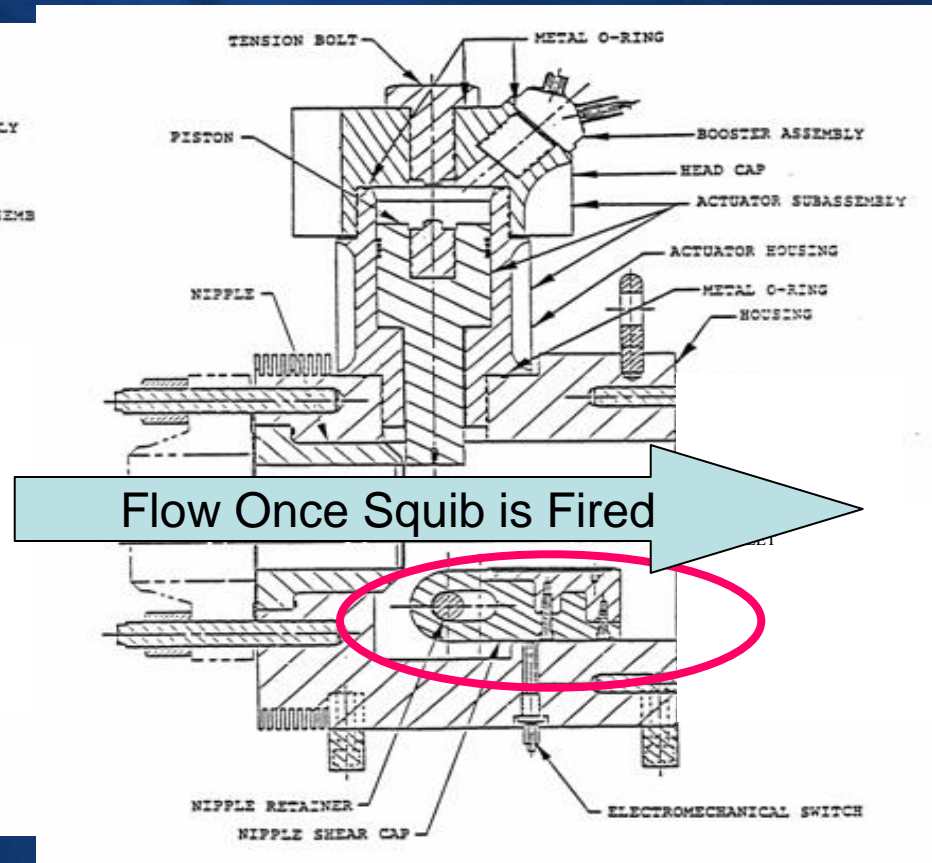


Squib Valve, Closed / Open

Closed



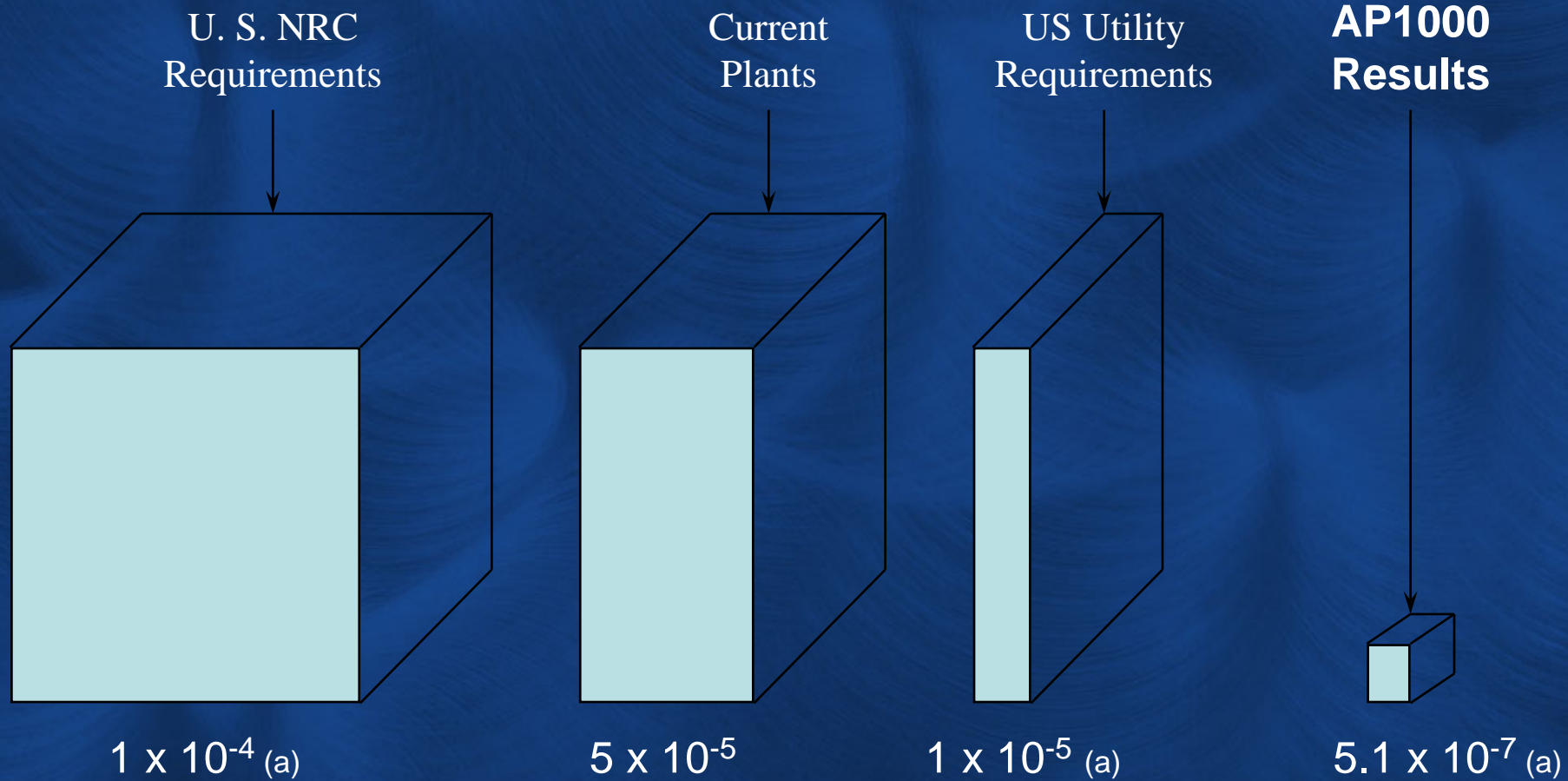
Open



Automatic Depressurization System Use of Squib Valves

- Squib Valves Were Selected for ADS Stage 4
 - Very reliable to open on demand, better than AOVs, MOVs
 - Ability to have independent actuation circuits, has 2 PMS & 1 DAS
 - Diverse from ADS stage 1/2/3 MOVs, improves PRA
 - Very low chance of inadvertent opening
 - Zero leakage during normal operation
 - Simplified IST, ISI, maintenance
 - Reduced capital cost
 - Reduced development costs / uncertainties vs alternative valve
 - Compact size, weight
 - Suggested / supported by U.S. utilities during AP600 design

AP1000 Improvements in Safety



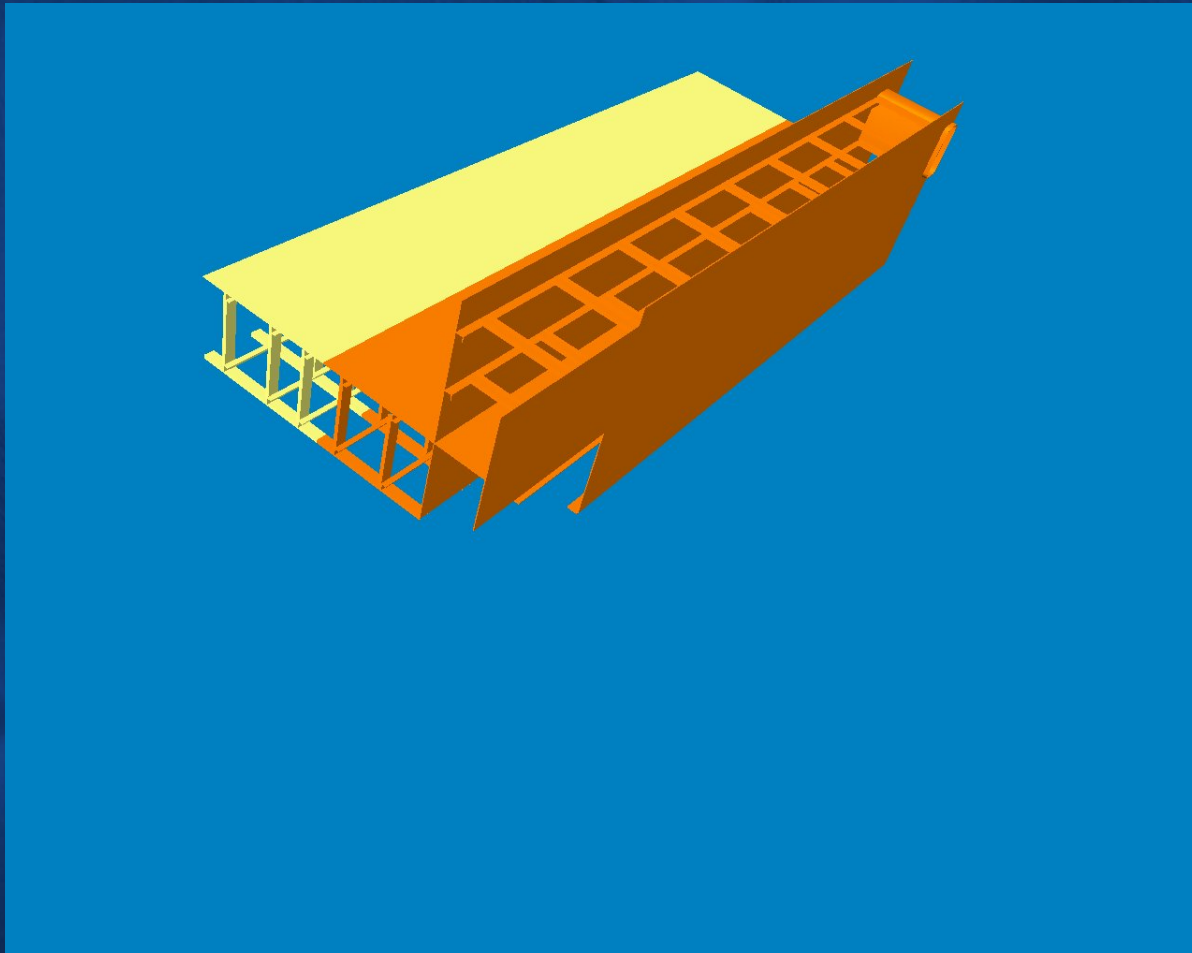
Core Damage Frequency per Year

Note (a) CDF includes random and internal hazard events from at-power and shutdown conditions.

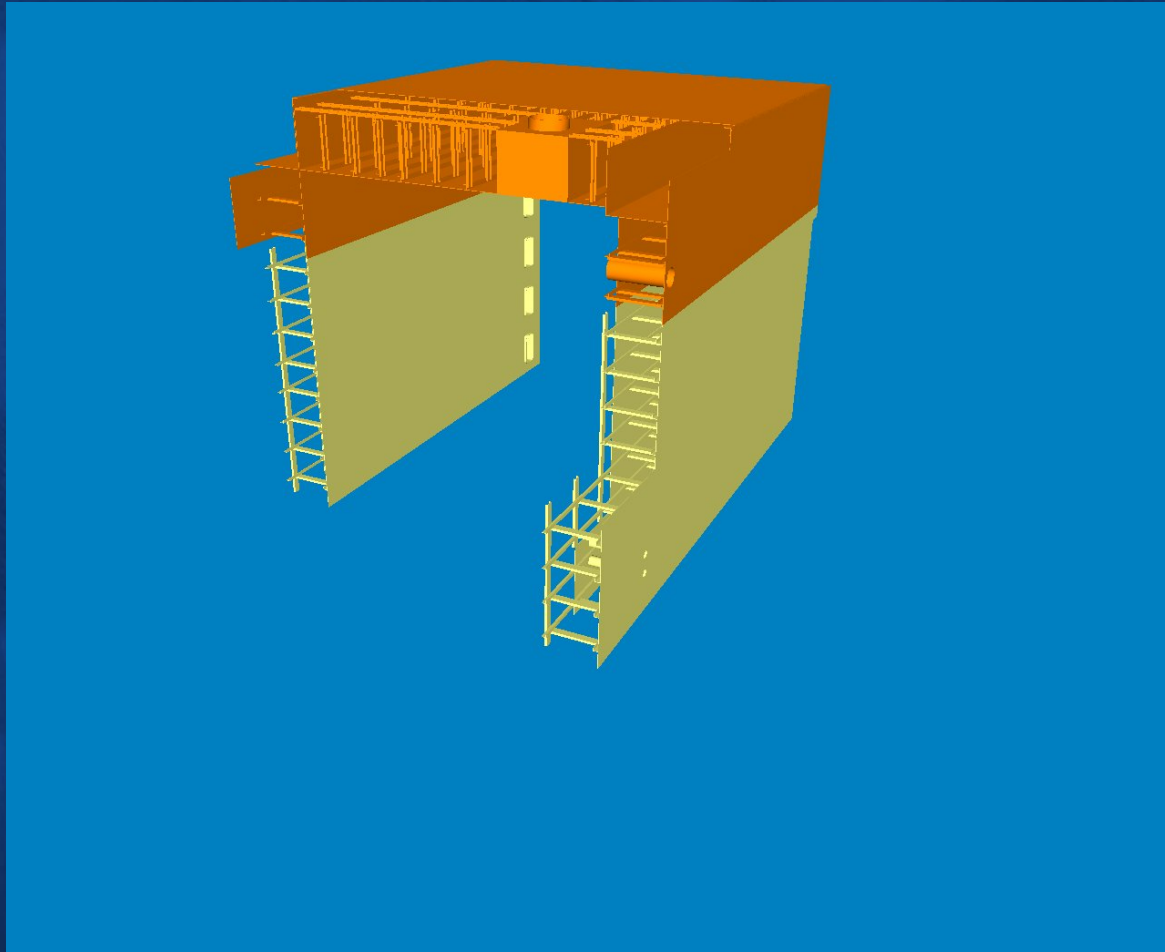
Modular Construction

- Approximately 300 modules
- Some are major structural elements inside the containment
- Some are skid mounted system
- Some are prefabricated elements
- Pipe Racks, etc that have been done before by Shaw for combined cycle plant construction projects

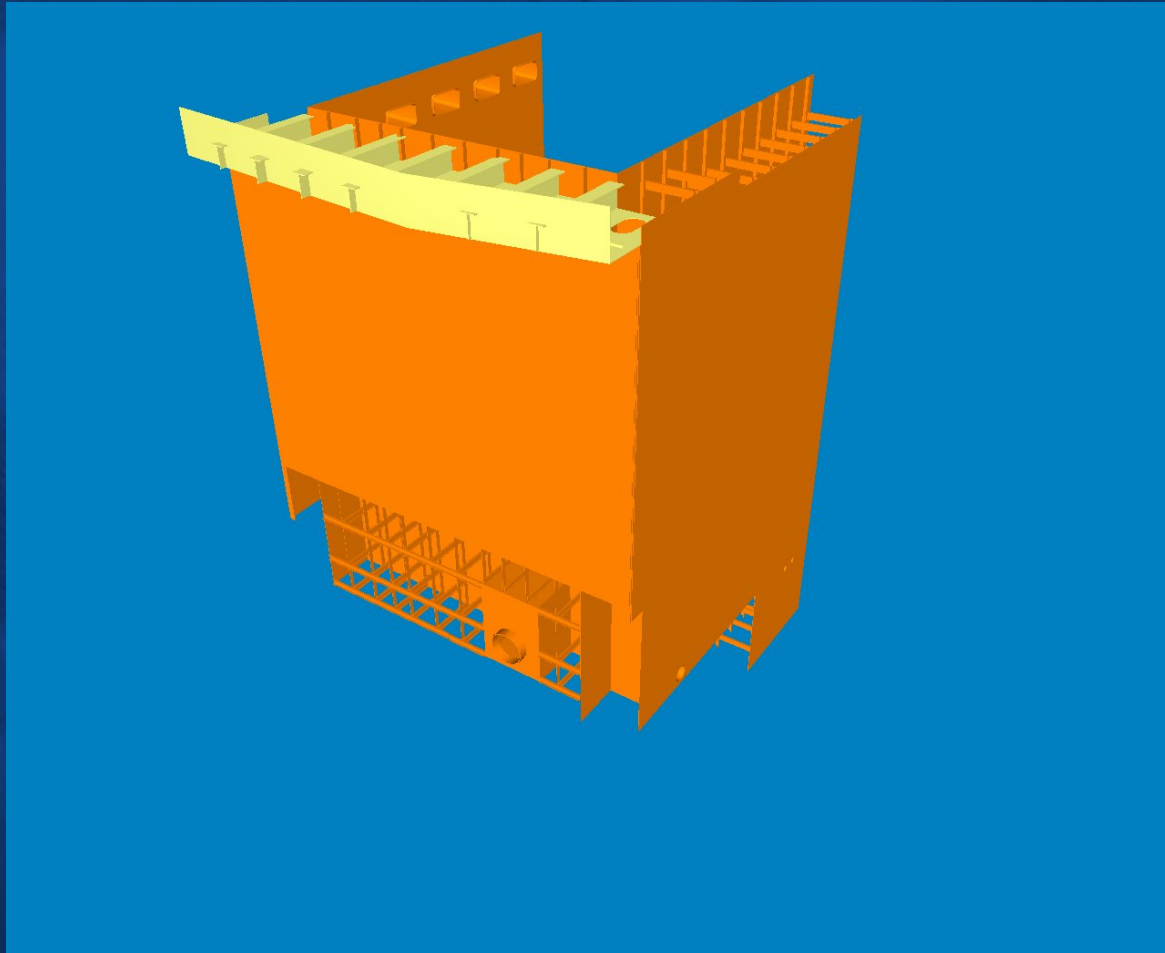
Sections Delivered by Truck or Rail



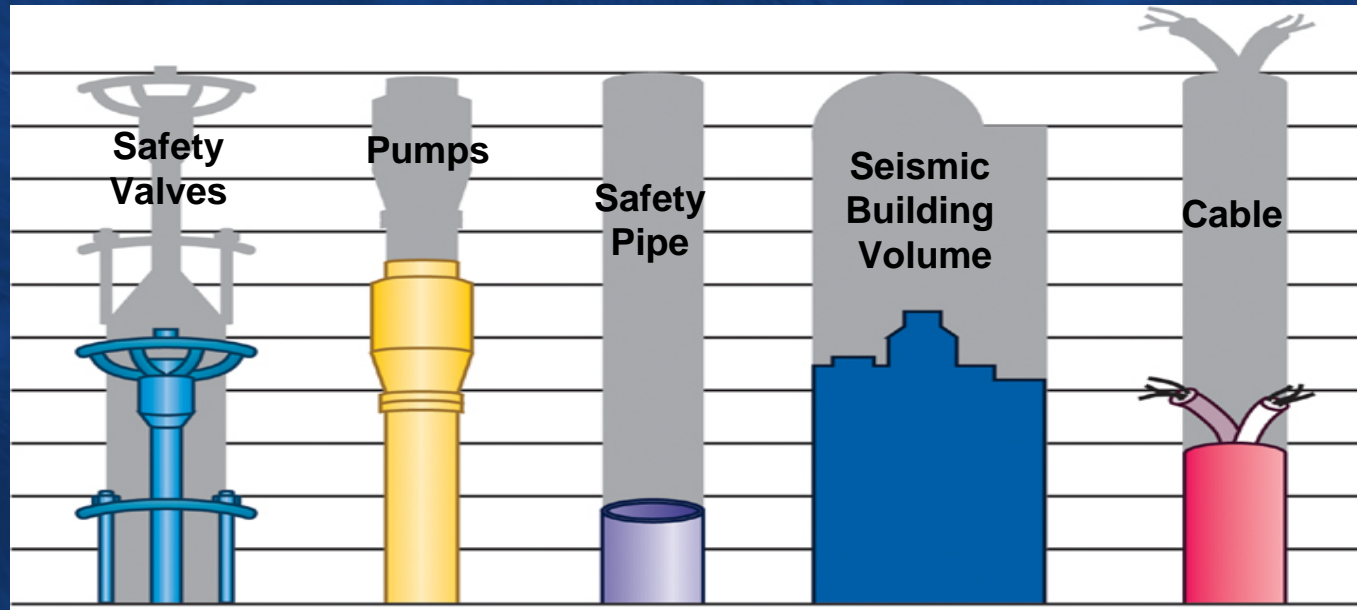
Larger Assemblies Built Up in On Site Fabrication Yard



Major Assembly Ready for Lift



AP1000 Simplifications Benefit Reliability, Availability, Maintainability



Reduced Number of Components:

	1000 MW Reference	AP1000	Reduction
- Safety Valves	2844	1400	51%
- Pumps	280	184	34%
- Safety Piping	11.0 x 10 ⁴ feet	1.9 x 10 ⁴ feet	83%
- Cable	9.1 mil. feet	1.2 mil. feet	87%
- Seismic Building Volume	12.7 mil. ft ³	5.6 mil. ft ³	56%

Reliability in the AP1000

- AP1000 Is Designed for < 1 Reactor Trip / yr
 - Current PWR have been achieving ~ 0.5 RT / yr for many years
 - AP1000 will do better with simplifications, improvements
 - Man-machine interface, engineered / tested to reduce errors
 - I&C improvements incorporated
 - 2 / 4 logic, on-line diagnostics, periodic testing in bypass mode without use of jumpers, “hot swapping” of modules
 - Canned motor Reactor Coolant Pumps are very reliable
 - MFW control improved
 - Redundant instrument inputs, auto control over 0 – 100% power
 - Margins increased
 - Reactor trip parameters selected reduce potential for unnecessary RT

Availability in the AP1000

- AP1000 Is Designed for > 93% Availability
 - Current PWRs are operating close to this goal
 - AP1000 will do better with simplifications, improvements
 - Passive safety systems
 - Greatly reduced safety components with Tech Spec
 - Canned motor RCPs are very reliable
 - Replacement SGs are very reliable
 - Chance of reactor trip greatly reduced
 - Improved materials
 - Short refueling outage

Maintainability in the AP1000

- Improved Maintenance / Inspection
 - Greatly reduced amount of maintenance / inspection required
 - Passive system simplifications
 - No planned maintenance for canned motor RCPs
 - Increased laydown area inside containment
 - Access platforms for equipment maintenance/inspection built into plant
 - Permanent service connections (air, power, computers) provided close by
 - Improved Access to Containment
 - 2 Equipment hatches and personnel airlocks, grade and operating deck levels
 - One equipment hatch has truck access into containment
 - Large staging areas in aux bldg just outside equipment hatches
 - Improved containment laydown areas
 - Non-safety active systems can be maintained at power

Short Refueling Outage Schedule

- Refueling Outage Schedule is 15 Days
 - Breaker to breaker
 - Simplified passive systems eliminate most ISI, IST, maintenance
 - Especially for complex rotating pumps, DG, chillers, ...
 - Nonsafety active systems can be maintained at-power
 - Lessons learned (vacuum refill, effective degas/cleanup, ...)

ID	Task Name	Duration																		
			31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	#1 OFFLINE (T/G OFFLINE/BREAKERS OPEN) TO MODE 5 (<200°F)	9 hrs		■																
2	#2 MODE 5 (< 200°F) TO MODE 6 (FUEL IN RV, DETENSION RV STUD)	48 hrs			■	■	■													
3	#3 MODE 6 TO START CORE OFFLOAD	46 hrs				■	■	■	■											
4	#4 CORE OFFLOAD	38 hrs					■	■	■	■										
5	#5 NO-MODE (CORE OFFLOAD COMPLETE TO 1ST FA XFR'D FROM SFP)	24 hrs						■	■	■										
6	#6 CORE RELOAD (1ST FA INSTALLED IN RV TO LAST FA INSTALLED IN RV)	38 hrs							■	■	■	■								
7	#7 RELOAD COMPLETE TO MODE 5 (RV HEAD TENSIONED, <200°F)	59 hrs								■	■	■	■	■						
8	#8 MODE 5 TO MODE 4 (STUDS TENSIONED TO 200°F)	50 hrs										■	■	■	■	■				
9	#9 MODE 4 TO GENERATOR SYNCHRONIZATION	49 hrs												■	■	■	■	■		
10	#10 SYNCHRONIZATION TO 100% POWER	43 hrs																■	■	■

Nuclear Wrap Up

- Outlook – several southern US utilities in discussions on AP1000 orders
- NRC has three Combined Operating License (COL) applications on the docket
 - Bellefonte 3 & 4 (based on AP1000)
 - Calvert Cliffs 3 (based on EPR)
 - STP 3 & 4 (based on ABWR)
- “the reactor is critical, commencing to raise power to the point of adding heat”