Panel: Nuclear Renaissance - New Nuclear Plants
Hot Topics

Decommissioning Considerations in Plant Design

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Note: The views expressed here are those of the author and do not necessarily reflect the views of his employer or the clients.

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Design Features Relevant to Decommissioning

I. Reduction in System Components
II. Reduction in Construction Materials
III. Modular Designs of Systems
IV. Modular Design of Structures
V. Advanced Construction techniques
VI. Better Designs to Avoid Contamination During Operational Phase
VII. Waste Minimization
VIII. Harmonization of International Codes and Standards for Design

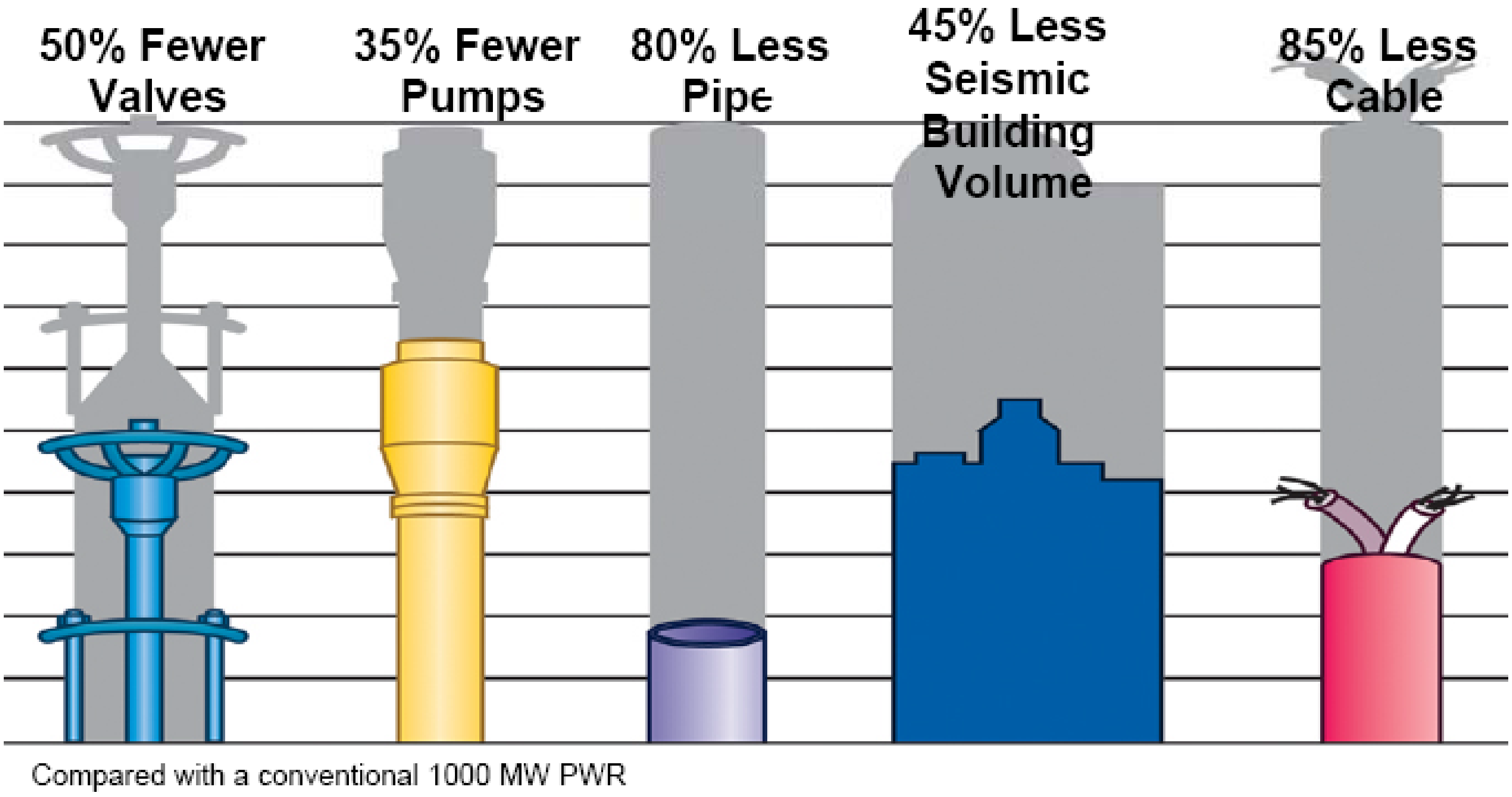
Reduction in Components & Construction Materials
I & II

Reduction in Components for New Reactor Designs

AP1000	ESBWR	US EPR
Design life - 60 years	Design life - 60 years	Design life - 60 years
18 month refuel cycle	24 month refuel cycle	12 to 24 month refuel cycle
Reduction in components • 87% less control cable • 80% less piping • 50% fewer valves • 35% fewer pumps	Reduction in components • 11 systems eliminated • 25% of pumps, valves and motors eliminated	Reduction in components • 44% fewer heat exchangers • 50% fewer tanks • 47%fewer valves • 16% fewer pumps

Reduction in Components

AP1000



Source: Westinghouse

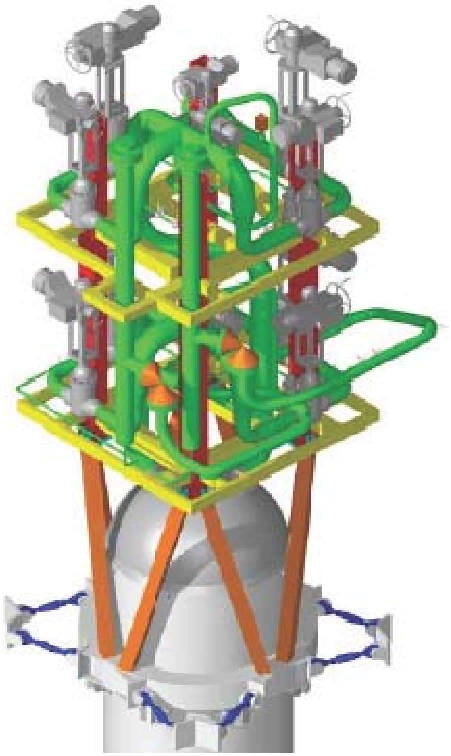
Reduction in Construction Materials

Era	Concrete	Rebar
1970s	m³/MWe installed 190+	t (metric)/MWe installed 40+
Current Designs	90	40
Comparisons Sizewell B (UK) US typical ABWR	Total Concrete m³ 520,000 300,000 351,000	Total Steel t (metric) 65,000 46,000 <12,000
AP1000	<100,000	Approx.10,000

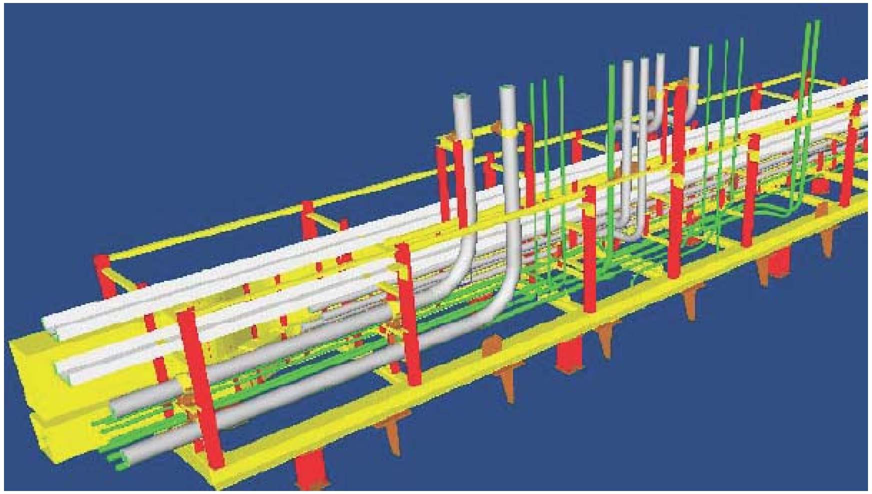
Modular Designs –Systems and Structures

III & IV

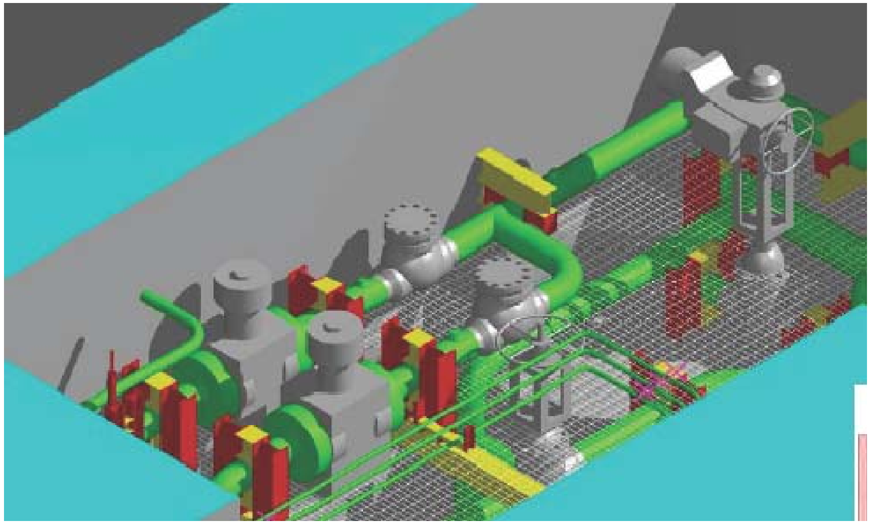
AP-1000 Modular Systems – Approx. 200 System modules



Q6-01 Module –
RCS Stages 1,2,3 ADS
12’ x 12’ x 15’-9”, 50 t



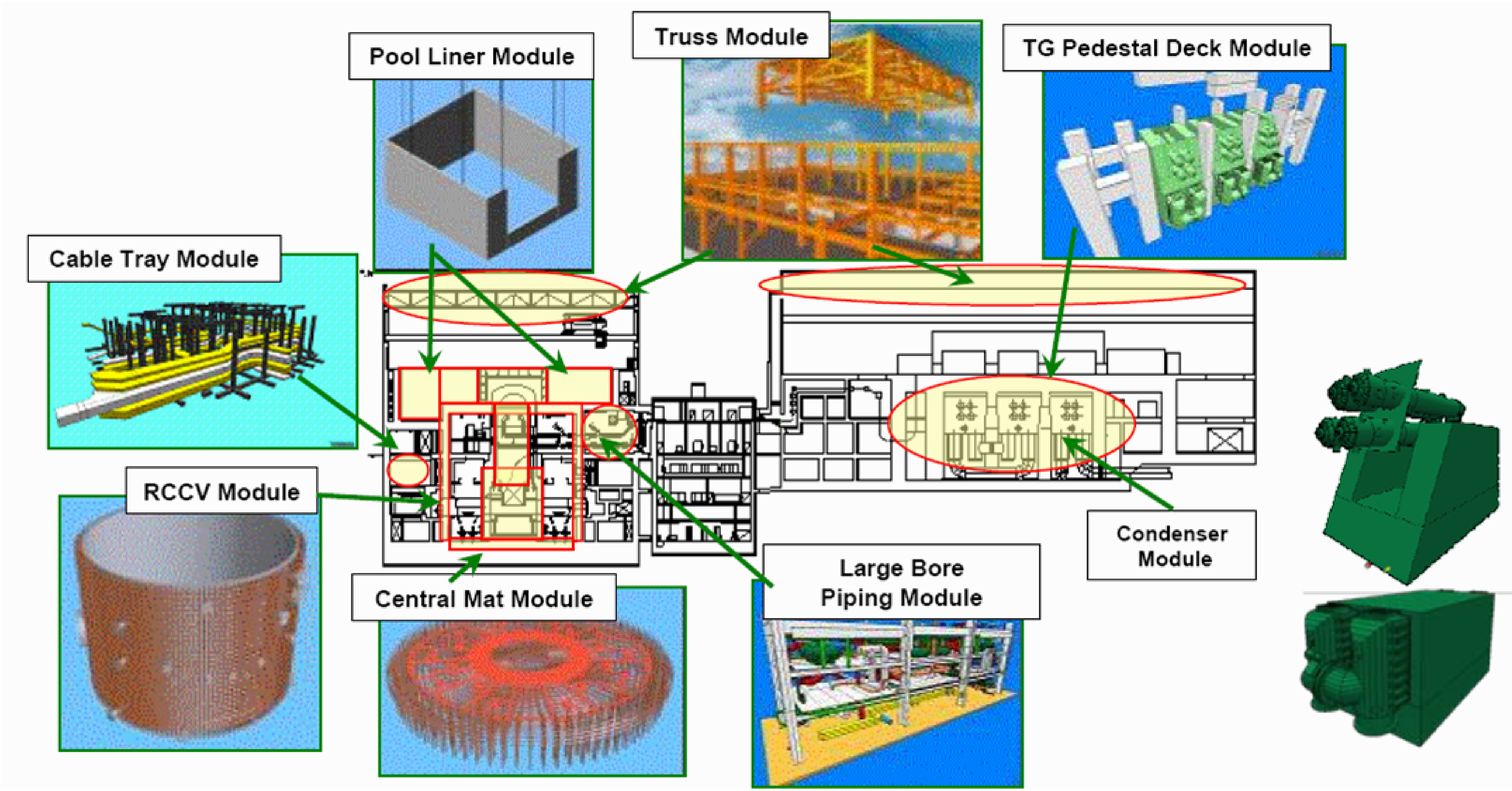
R161-Aux Bldg Piping Module 41’-3” x 6’ x 10’-11”, 4 ½ t



Q223 Module – Direct Vessel Injection B Valve Module, 28’ x 37’-3” x 10’-9”, 15 t

ABWR Design Modularization

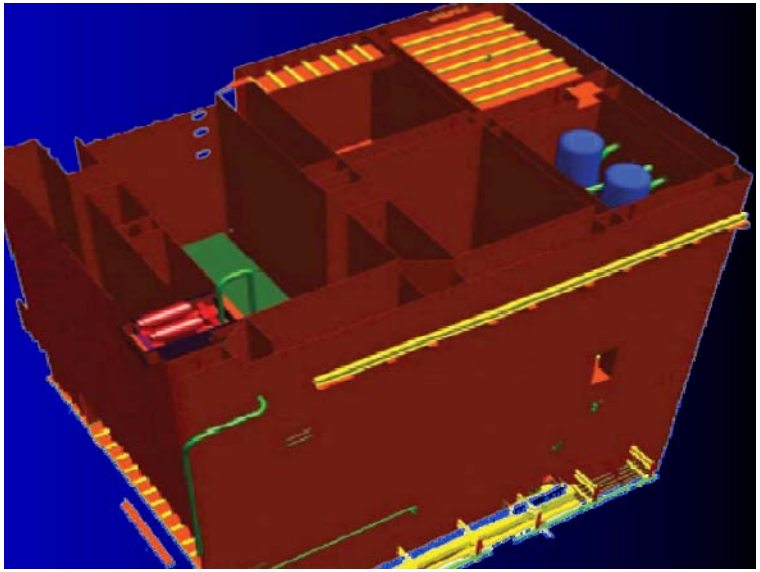
14 Critical Path area Modules
37 Sub Critical Path area modules
130 Other area modules



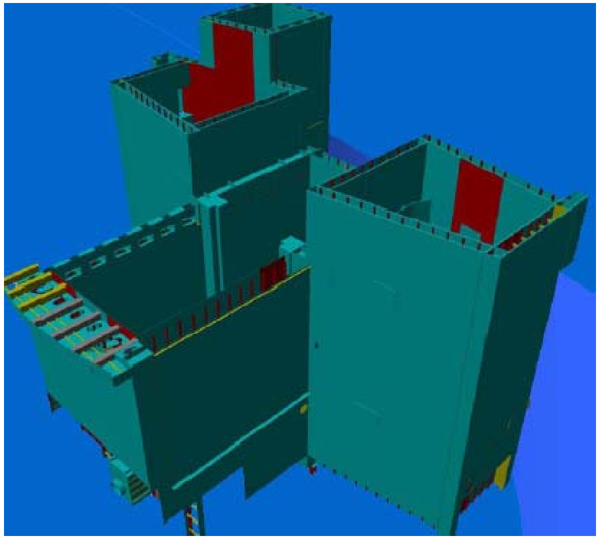
Source:

AP-1000 Modular Structures

Approx 150 structural modules



CA20 21 mX14 mX21 m, 875 t



CA01 25mx29mx26m 750t

Modular Designs –Structures

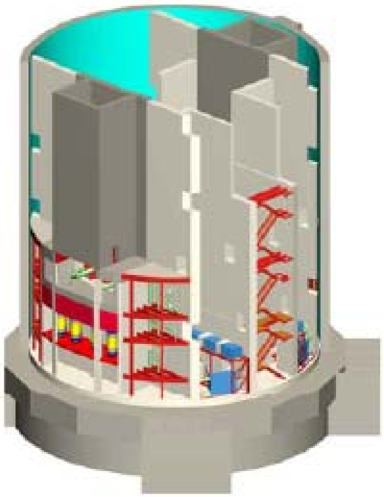
Super Large Scale Upper Drywell Module Kashiwazaki-Kariwa

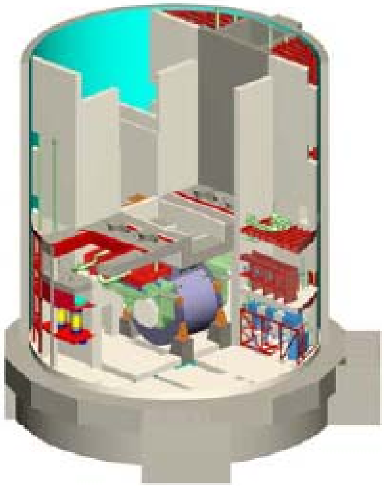
Main Control Room Module - Hitachi

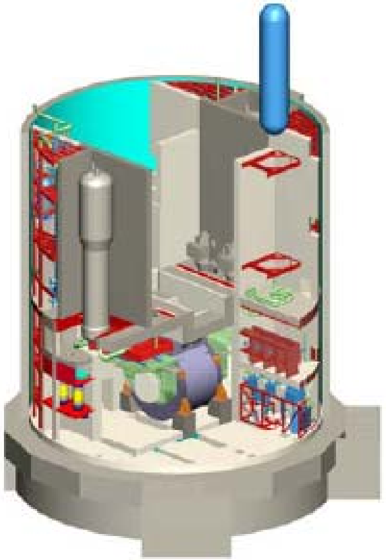
Composite module of piping, valves and structural steel (Toshiba)

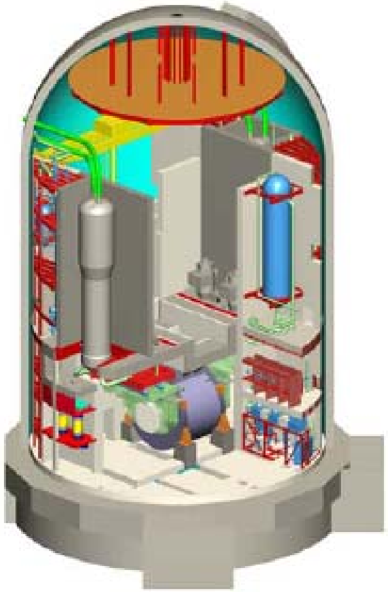
CANDU Design

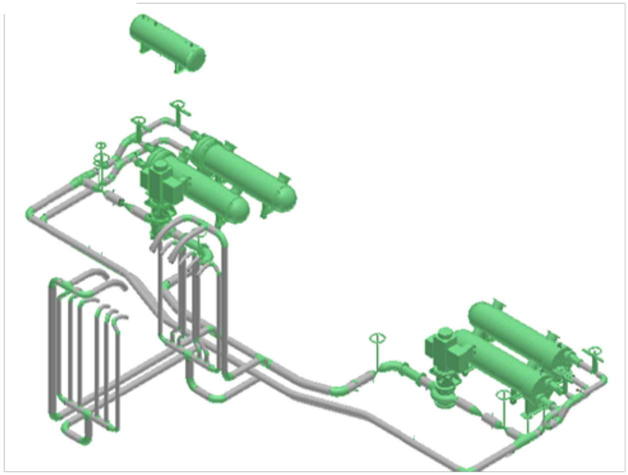
Modular Construction











Modular Construction
Pros & Cons

Pros

- Reduction in schedule
  - parallel construction
- Reduction in manpower needs
- Reduction of work congestion
- Uniformity in systems and structures
- multiple units at the same site
- Uniformity in design
- Better quality control
- Reduction in facility footprint
- Reduction in system components
- Mass production capability
- Significant cost savings

Challenges

- More detailed engineering at early stages
- Infrastructure
- Larger modules as multiple sub-modules
- Early procurement of materials
- Transportation logistics & cost
- Very Heavy Lift capability
- first-of a- kind engineering activity
- temporary weather covers
- regulatory codes and standards
- Module connections

Advanced Construction Techniques & Better Designs
V & VI

- **Modularization**
- **Slip Forming**
- **Open Top Construction**

Advanced Construction Techniques

A Quick Photographic Journey

Shimane-3

Lingao-4

VHL in action-Qinshan

Advanced Construction Techniques

Automatic Welding Machine -Shin-Kori

3D CADD - Courtesy Mitsubishi

Slip forming – CANDU 6

Waste Minimization

VII

Waste Comparison

Waste Volume*	Operational Wastes (Dry and Wet)	Decommissioning Waste (Low Level)
Current PWR 1000 MWe	270 m^3/y (9540 ft^3/y)	18,340 m^3 (647,500 ft^3)
AP1000	163 m^3/y (5760 ft^3/y)	App. 10,000 m^3 (353,000 ft^3)

Comparison: Decommissioning waste (low level) from Main Yankee: 19,800 m3 (700,000 ft3); Double that amount with concrete. 240 Million lbs

Main Yankee: 860MWe PWR; D&D Cost $550 Million

International Codes and Standards for Design VIII

- Greater harmonization of national standards facilitates more uniform regulatory design review and licensing process worldwide
- Current reactor plant designs are developed by international companies who plan to build these units in many different countries
  - In many cases a plant built in one country becomes a reference plant for construction of that design in other countries
- Major components (such as the RPV and the SG) fabrication capability - only a few manufacturers
- Economies of scale through modular system fabrication modular construction
- Activities in this regard:
  - ASME –worldwide application
  - IAEA
  - WENRA

Why is this Important

Cost Savings, Better Quality, Better Safety

Capital Cost Estimates

Estimate Year	Capital Cost per kWe installed	Reference Plant Cost 1100 MWe
2000-2002	$1,200 to $1,500	$2 billion to $4 billion
2006-2007	$3,600 to $4,000	$4 billion to $4.5 billion
2008	$5,500 to $8,100	$6 billion to $9 billion

Discussion: Questions to Consider

- Nuclear renaissance – its success (at least in US) may depend on it public acceptance – addressing waste management and decommissioning issues
- D&D 60 plus years away – why should we still consider it
- D&D features part of new designs – how far to optimize
- ▪ Would new technologies (in next decades) make our features obsolete or redundant
- Nuclear renaissance – cost economics
  - refurbish or rebuild