Modular Design and Benefits

ASME Nuclear Technical Seminars: Blueprint for New Build
June 5-8, 2011 • Columbia, SC

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Agenda

• Module Methodology

• Mechanical Modules

• Structural Modules

• After this session, you will be able to:
  – Recognize extensive use of modularization in AP1000
  – Identify key benefits of modular construction
  – Be familiar with module design considerations and fabrication sequencing
AP1000 Modularization

• Small compilations of almost all other engineering disciplines’ designs - combined into a shippable unit. They incorporate:
  • System Designs
  • Equipment Specs
  • Plant Layout
  • Structural Analysis
  • Piping Analysis
  • Pipe Supports
  • Valve Specs
  • I&C

• Combined engineering effort
Location in Plant

Containment (NI)
Auxiliary Building (NI)
Turbine Building
AP1000 Construction Approach

• Designed to achieve a short 36 month construction schedule from first concrete to core load ($n^{th}$ plant)
• Utilize proven techniques
• Maximize use of modularization
  – Designed Rail Shipment for 12’ x 12’ x 80’ (80 Ton) [3.6mx3.6mx24.4m]
  – Barge shipment where available
• Construction Cost (1/3/7 Rule)
AP1000 Construction Approach

KB13 (left) and KB10 (right) preparation for shipment to construction site.
# Modularization Impact

## PLUS
- Reduce Construction Schedule
- Reduce Field Work and On-site Manpower During Construction
- Increased Productivity and Quality Control at Module Fabrication Facilities
- Standardization Reduces Costs for Multiple Plant Orders

## DELTA
- Increased Engineering for Modules
- Increase Temporary Support Structure / Lifting and Rigging Requirements
- Early Material Requirements
- Additional Transportation Cost (Large trailer truck, Barge)

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**Reducions in Construction Cost and Schedule Demonstrate Net Savings**
AP1000 Mechanical Modules

There are three basic types of mechanical modules:

- **Equipment Modules**: consisting of equipment, valves and piping on a structural steel framework

- **Piping and Valve Modules**: consisting of piping, valves and in-line piping components on a structural steel framework

- **Commodity Module**: consisting of piping, cable tray and HVAC ductwork on a structural steel frame.
Mechanical Modules Types

- Equipment
- Composite
- Piping
Mechanical Modules

- Inside Containment: 12
- Auxiliary Building: 41
- Turbine Building: 3

TOTAL: 56
Containment Piping Module
Q223: DVI B Valve Module

Size (N x E x Height): 28' x 37'-3” x 10’-9”
[8.5mx11.3mx3.3m]

Dry Weight:
33,000 lbs. [15 Mg]

Classification:
Safety
Containment Piping Module
Q601: RCS Stages 1, 2, 3 ADS Module

Size (N x E x Height):
12’ x 12’ x 15’-9”
[3.6mx3.6mx4.8m]

Dry Weight:
110,000 lbs. [50 Mg]

Classification:
Safety
Aux. Building Equipment Modules
KB11: WLS Filter/Ion Exchange

Size (N x E x Height):
33'-3” x 8’-6” x 12’
[10.1mx2.6mx3.6m]

Dry Weight:
102,000 lbs. [46 Mg]

Classification:
Non-safety
Aux. Building Equipment Modules
KB13: WLS Sump Pump

Size (N x E x Height): 6’-5” x 8’-5” x 10’-6”
[2mx2.6mx3.2m]

Dry Weight: 10,000 lbs. [4.6 Mg]

Classification: Non-safety
Aux. Building Equipment Modules
KB23: WLS Monitor Pump C

Size (N x E x Height):
3'-0” x 7’-7” x 6’-3”

[1mx2.3mx2m]

Dry Weight:
2200 lbs. [1.0 Mg]

Classification:
Non-safety
Aux. Building Piping Modules
R161: Commodity Module

Size (N x E x Height): 41’-3” x 6’ x 10’-11”
[12.5mx1.8mx3.3m]

Dry Weight: 10,176 lbs. [4.6 Mg]

Classification: Non-safety
Structural Modules: Types

• CA/CB Type: Steel formwork modules
  – Concrete-filled or poured around steel frame
  – CA modules take structural credit for steel
  – CB modules no structural credit, concrete forms

• CG/CH Type: Set in place as part of building structure
  – CH modules outfit mechanical commodities (i.e. grating)
  – CG modules have no outfitting

• CS Type: Stairway modules
Structural Module Types

CA Composite Wall

CA Floor

CB Module
Structural Modules: By Location

- Inside Containment: 66
- Auxiliary Building: 32
- Turbine Building: 52
- Annex Building: 10

TOTAL: 160
AP1000 Major Structural Modules

- CA20
- CA04,05
- CA01
- Containment Vessel
CA20 Structural Module

CA20 comprised of 72 Sub-Modules:

Size (N x E x Height):
44’-0” x 68’-9” x 68’-0”
[13mx21mx20.7m]

Dry Weight:
1,712,000 lbs. [777 Mg]
Structural Modules

CA20 Sub-module being shipped from China module fabrication facility.
CA20 Outfitting - 115 tons

HVAC duct
Piping
Conduit
Tanks
CA20 Outfitting - 115 tons

Outfitted CA20 Lift:
- 5 Piping Modules
- 8 Equipment Modules
- 2 Pipe Assemblies
CA 20 Lift, Sanmen China
Containment Vessel Bottom Head
Containment Vessel Bottom Head Lift and Set

CVBH at Sanmen, China successfully set on December 21, 2009.
Containment Vessel Rings
CA04/CB65/CB66 Structural Modules

CA04

CB66

CB65

Reactor Vessel Cavity/
Reactor Coolant Drain Tank
CA04 Lift and Set

CA04 and CB65-66

CA04 being set in CVBH
CA05 – CVS / Access Tunnel / PXS-B Walls
CA05, which forms the walls around the demineralizers and other components, was successfully set on February 28, 2010.
CA01 Structural Module

Steam Generator & Refueling Canal

CA01 comprised of 47 Sub-Modules:
Size (N x E x Height):
92’-0” x 96’-0” x 76’-0”
[28mx29mx23m]

Dry Weight:
1,600,000 lbs. [725 Mg]

Silver components are not part of the module
CA01 Assembly
CA01 Lift & Setting

CA01, the Steam Generator & Refueling Canal Module, was successfully set on March 27, 2010.
AP1000 Module Construction at Sanmen, China Summary

- CV bottom head: 900 tons
- CA 04: 45 tons
- CA 05: 50 tons
- CV Ring 1: 600 tons
- CA 01: 950 tons

Major Modules: 2500 tons placed into the plant in less than 100 days!
CA02 – IRWST / Pressurizer Wall Module

CA02 comprised of 5 Sub-Modules:

Size (N x E x Height):
24’ x 6’ x 37’
[7mx2mx13m]

Dry Weight:
61,500 lbs. [28.3Mg]
CA03 Structural Module

IRWST Wall (In-containment Refueling Water Storage Tank)

CA03 comprised of 17 Sub-Modules:

Size (N x E x Height):
116’ x 46’ x 42’
[35mx14mx13m]

Dry Weight:
420,000 lbs. [191Mg]
CA03 Structural Module

Module is all stainless steel
CA22 Structural Module

CA22 comprised of 7 Sub-Modules:

Size (N x E x Height):
49’-0” x 16’-0” x 2’-0”
[15mx4.9mx0.6m]

Dry Weight:
80,000 lbs. [36 Mg]

Classification:
Seismic Category I
Summary - Advantages

• Cost
  – Major reduction in bulk materials
  – Reduce field work and on-site manpower

• Streamlined Construction Schedule
  – Predictable and shorter manufacturing
  – Pre-assembly and testing of major components
  – Parallel construction activities

• Quality
  – Work performed in optimal conditions/techniques