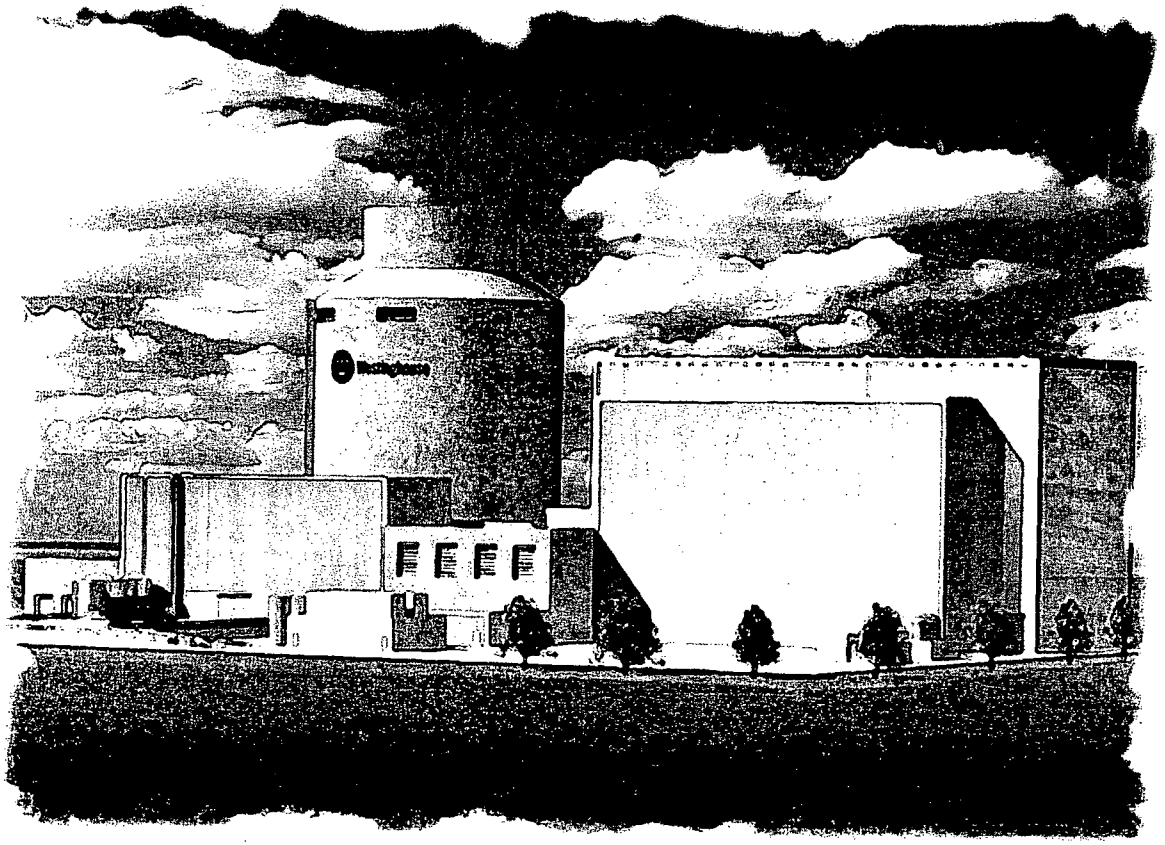
AP1000 PIPING DESIGN ACCEPTANCE CRITERIA

AP1000



Meeting with NRC
December 18, 2006

Westinghouse

AP1000 PIPING DESIGN ACCEPTANCE CRITERIA

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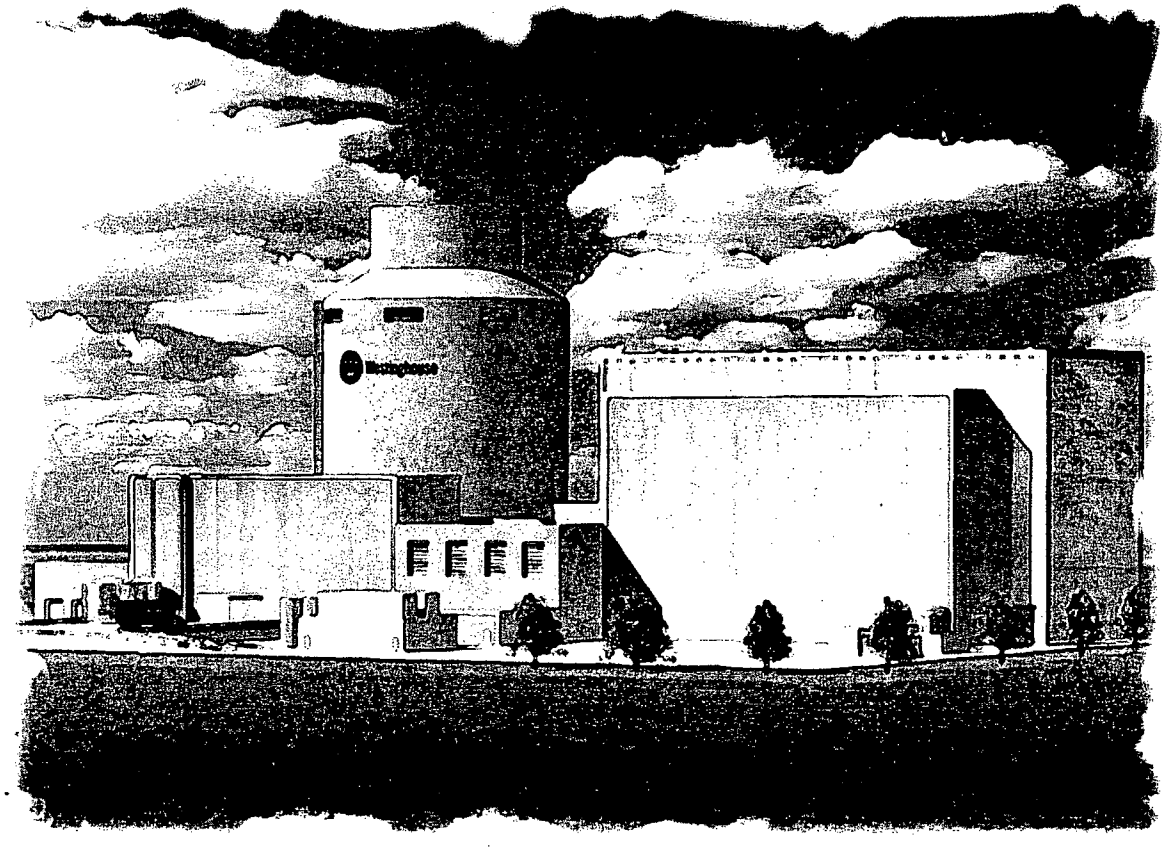

Andrea L. Sterdis, Mgr.
AP1000 Licensing and Customer Interface

Westinghouse

Agenda

- Introduction and Purpose
- Overview of Westinghouse DAC Strategy
- Discussion of DAC Closure and Remaining ITAAC
- Detailed Discussion of Piping Analysis Status
- Conclusion/Actions Going Forward

Introduction and Purpose

- Communicate Westinghouse DAC Strategy
- Discuss the Piping Analysis Currently Available for NRC Audit/Inspection
- Provide Mapping of DAC Items to the Piping Documentation
- Establish Date for Piping Audit

Piping DAC Completion

AP1000

- At Design Certification for AP1000, only one line had piping analysis
- Result: A piping DAC was included in the AP1000 Design Certification
- No DAC were required for AP600 since sufficient calculations were available at AP600 Design Certification
- Westinghouse position is that sufficient AP1000 lines have now been analyzed to allow for closure of the Piping DAC

Piping DAC

AP1000

- A review of the Piping DAC in Table 1-2 of the AP1000 DCD Introduction focuses on Process and Methodology
  - Analysis methods
  - Criteria
  - Piping design procedures
- Westinghouse Piping Design and Analysis Process is established
- Class 1 Design Specification includes the DAC criteria

Piping DAC

AP1000

- AP1000 FSER provides staff's evaluation in the following areas of the piping DAC:
  - Applicable Codes and Standards
  - Analysis methods to be used for completing the piping design
  - Modeling techniques
  - Pipe stress analysis criteria
  - Pipe support design criteria

Piping DAC

AP1000

- DAC can be closed provided the following occurs:
  - Westinghouse process and methodology address the DAC criteria
  - NRC reviews and accepts the process and methodology
  - Westinghouse provides a sufficient set of calculations consistent with the methodology and with the DAC criteria
  - Favorable NRC audit/inspection of the calculations

Piping DAC

AP1000

- Final calculations for ALL lines should not be required to close DAC—why?
  - Safety significant lines have ITAAC to verify completion and acceptability
  - All piping DAC items exist as Tier 2* DCD material requiring NRC prior approval for changes
  - Safety class piping must meet DAC criteria to be stamped as meeting the Design Specification

ITAAC Verify As-Built Piping Design

- Systems containing ASME Code Section III Piping have ITAAC on Piping Analysis Criteria
-

	Table	System Name
RCS	2.1.2-3	Reactor Coolant System
CNS	2.2.1-3	Containment System
PCS	2.2.2-3	Passive containment Cooling System
PXS	2.2.3-4	Passive core cooling system
SGS	2.2.4-4	Steam Generator System
VES	2.2.5-4	MCR Emergency Habitability System
CVS	2.3.2-4	Chemical and Volume Control System

ITAAC Verify As-Built Piping Design

- Systems containing ITAAC on Piping Analysis Criteria (continued)

	Table	System Name
RNS	2.3.6-4	Normal Residual Heat Removal
SFS	2.3.7-4	Spent Fuel Cooling System
WLS	2.3.10-4	Liquid Radwaste System
PSS	2.3.13-3	Primary Sampling System

ITAAC Applicable to Piping Design Verification

- Item 2b-Designed and constructed in accordance with ASME Code
  - An ASME Section III Design Report Exists
- Item 3b-Welds meet ASME III Requirements
  - NDE Requirements are met
- Item 4b-Pressure boundary integrity
  - Hydro test completed
- Item 5b or 5-Seismic Capability (As applicable)
  - Normal and seismic loads functional capability satisfied
- Leak-Before-Break (As applicable)
  - LBB Evaluation complete

Substantial Portions of the AP1000 Safety Related Piping Design are Complete

AP1000

- Lines are routed and sized
- Isometric Drawing Prepared
- Piping Analysis Performed
- Seismic Analysis Performed
- LBB evaluation performed
- Fabrication Evaluations underway

Licensing Goal

AP1000

- Establish an acceptable process and methodology
- Perform sufficient design/analyses to demonstrate the process and methodology
- Gain NRC acceptance

Close DAC to support Design Certification Amendment or COLAs

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AP1000 PIPING DESIGN ACCEPTANCE CRITERIA

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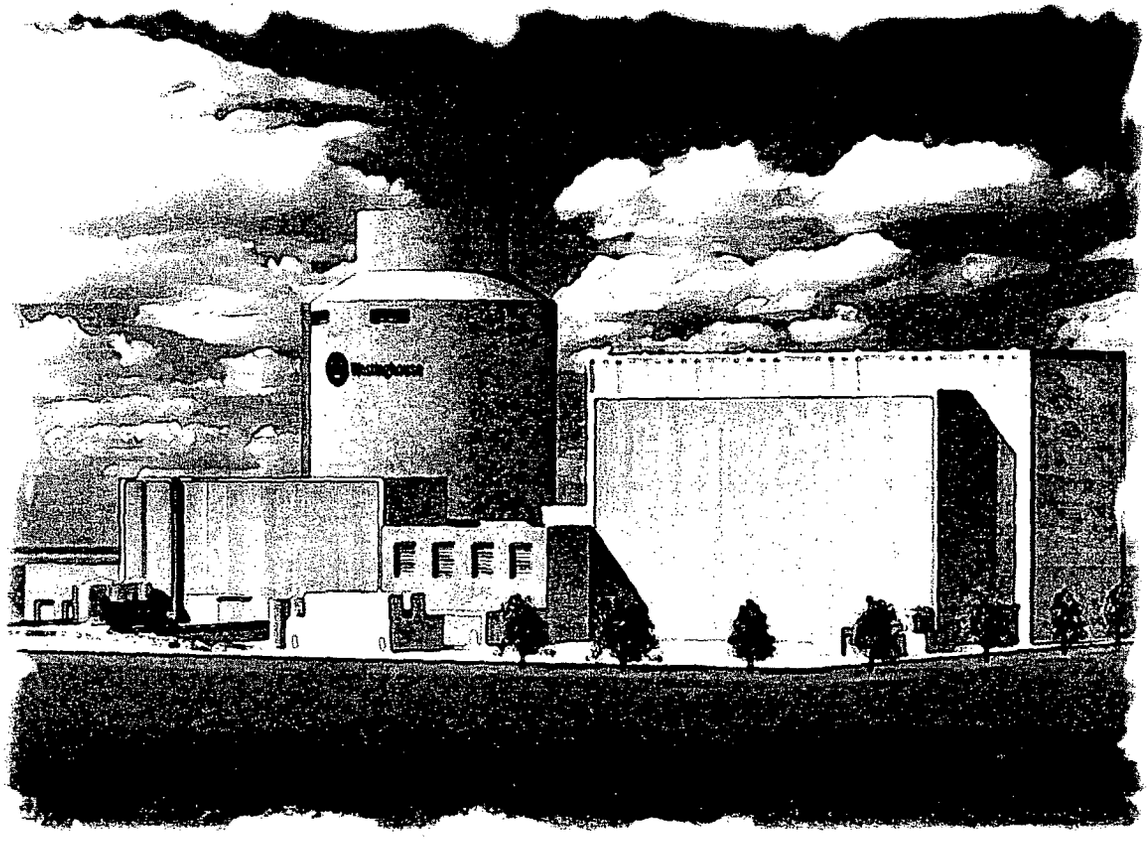

Phil Kotwicki
AP1000 Piping Lead

Westinghouse

STATUS OF W PIPING DESIGN

AP1000

- The major safety-related lines have been analyzed
- The rest of the AP1000 piping design is ongoing
- Analysis performed for inputs available at time of analysis
- Inputs to the piping design may change as part of the design process
- If inputs change, design iterations would be required if updated results are required
- Reconciliation of the existing packages is continuously evaluated to consider changes; Timing determined by a variety of factors including impact significance as well as schedule and economic risks
- Each analysis package includes piping isometrics and pipe support calculations and drawings

STATUS OF W PIPING DESIGN

AP1000

- The ASME design report will include the summary results from several analysis package stress reports
  - all class 1 packages in one design report
  - all class 2,3 packages in one design report
- An as-designed report is planned to support COL application schedule (COL Information Item 3.9.8-2 covers safety class piping)
- As-designed report will include:
  - LBB piping
  - Large bore class 1 lines
  - Representative large bore class 2/3 lines
  - Sample small bore lines
  - Conceptual support designs for the piping analyzed
  - Representative detailed support designs
  - Reconciliation

AP1000 PIPING DESIGN ACCEPTANCE CRITERIA

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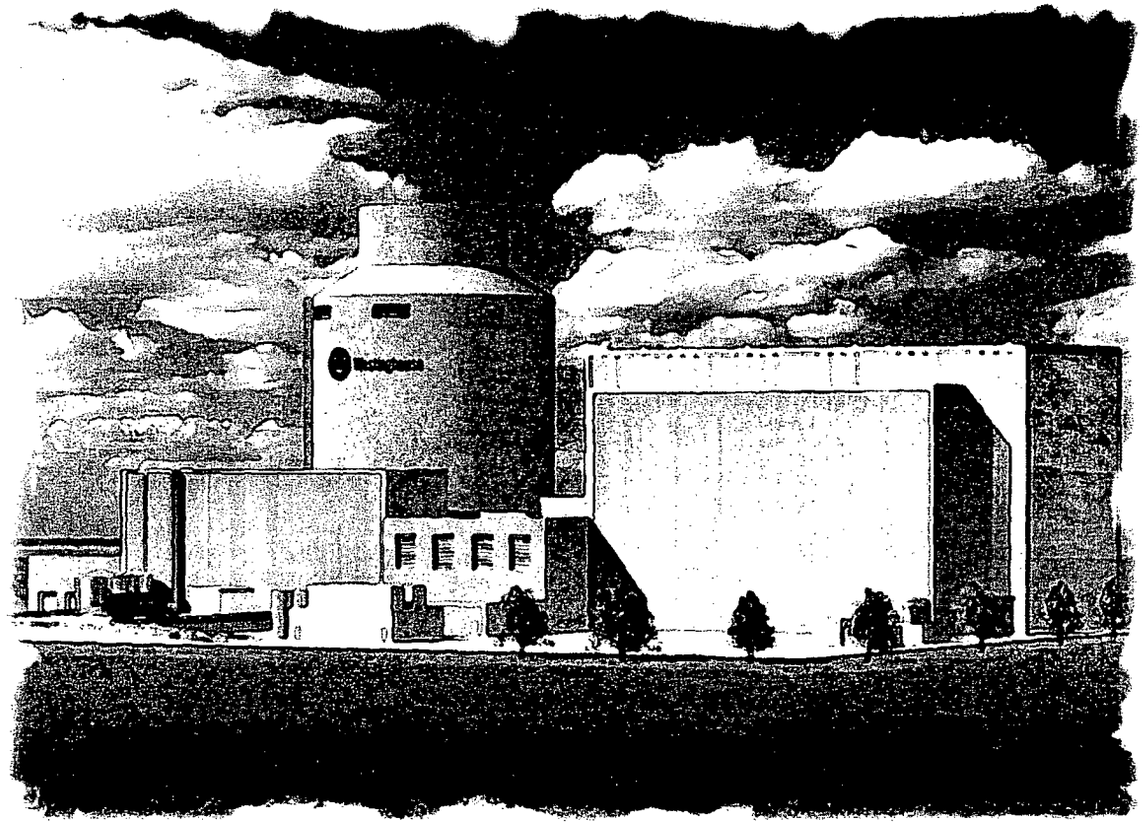


Pat Strauch

AP1000 Piping Design

Westinghouse

AP1000 Safety Class Piping Analysis Summary

Class 1 Piping:

70% of the routing packages with Class 1 piping have been assigned to 15 analyses
The remaining 30% are small bore

Large Bore Piping:

70% of the routing packages containing large bore piping have been assigned to 50 analyses

Analysis Status:

74 total analyses assigned (54 issued, 9 in progress, 11 not yet started)

11 Class 1 analyses issued
4 Class 1 analyses pending (pzr spray, head vent and CVS purification supply and return)

35 large bore piping analyses issued

13 leak-before-break (LBB) analyses issued

Current available analyses include a wide range of pipe sizes and systems

AP1000 Leak-Before-Break Piping Analyses

- Reactor Coolant Loop Piping
- Direct Vessel Injection Line A
- Direct Vessel Injection Line B
- Normal Residual Heat Removal Suction Line
- Automatic Depressurization System (ADS) Stage 4 East
- ADS Stage 4 West & Passive Residual Heat Removal (PRHR) Supply
- PRHR Return
- Core Makeup Tank 2A Supply Line
- Core Makeup Tank 2B Supply Line
- Pressurizer Safety Lines and ADS Stages 1, 2 and 3 Lines
- Pressurizer Surge Line

Class 1 Lines

- Main Steam Line A
- Main Steam Line B

class 2 Lines

AP1000 Direct Vessel Injection Line B – Compliance to Piping Design Acceptance Criteria

Item	Commitment	Analysis Page No.
1	ASME Code and Code Cases for AP1000 piping and pipe support design	ASME Code (p. 160) ASME Code Eqns (p. 137) ASME Code Cases (NA)
2	Analysis Methods; experimental stress analysis, independent support motion, inelastic analysis, non-seismic/seismic interaction, buried piping	Abs Σ SSE and SAM (p. 79) Load definitions (p. 136) Seismic interaction (p. 157, 361, 376) Exp. stress analysis (NA) Buried pipe (NA)
3	Piping Modeling; piping benchmark program, decoupling criteria	Modeling (p. 22 – 33) Line is coupled to RPV and Accumulator tank (p. 117 - 131)
4	Pipe stress analysis criteria; loading and load combinations, damping values, combination of modal responses, high frequency modes, thermal oscillations in piping connected to the reactor coolant system, thermal stratification, safety-related valve design, installation and testing, functional capability, combination of inertial and seismic motion effects, welded attachments, modal damping for composite structures, minimum temperature for thermal analysis	Damping (p. 70) Piping requirement (p. 135 - 140) Functional capability (p. 141, 232, 233)
5	Pipe support criteria; applicable codes, jurisdictional boundaries, pipe support baseplate and anchor bolt design, use of energy absorbers and limit stops, pipe support stiffnesses, seismic self-weight excitation, design of supplementary steel, considerations of friction forces, pipe support gaps and clearances, instrument line support criteria	Design, Service limits (p. 138 - 141) Support design data (p. 84 – 93)
6	Equivalent Static Load Method of Analysis	NA
7	Three Components of Earthquake Motion	p. 70
8	Left-Out-Force Method Used in PIPESTRESS Program	Described in PIPESTRESS manual
9	SRP 3.7.2 Method for High-Frequency Modes	Described in PIPESTRESS manual
10	Combination of Low-Frequency Modes	Reg. Guide 1.92 (p. 70)

AP1000 Direct Vessel Injection Line B – Compliance to Piping Design Acceptance Criteria (Cont.)

Item	Commitment	Analysis Page No.
11	Modeling Methods and Analytical Procedures for Piping Systems	p. 22 – 33 (no gapped supports)
12	Seismic Anchor Motions	p. 79 - 83
13	Methods Used to Account for Torsional Effects of Eccentric Masses	Valve CGs are modeled (e.g., p. 246)
14	Design Methods of Piping to Prevent Adverse Spatial Interactions	p. 157, 361, 376
15	Analysis Procedure for Damping	p. 70
16	Time History Analysis of Piping Systems	NA
17	Design Transients - Use of NRC Bulletins 88-08 and 88-11	p. 70
18	Loads for Class 1 Components and Core/Component Supports	p. 33 - 83
19	Use of Square-Root-Sum-of-the-Squares Method for SSE plus Pipe Rupture	NA (Break loads negligible per p. 83)
20	Analysis of Reactor Coolant Loop Piping	NA
21	ASME Classes 1, 2, and 3 Piping - Use of ASME Code, Section III	p. 223 - 231
22	Design of Spring-Loaded Safety Valves	NA (Pertains to lines attached to Pzr)
23	Design and Analysis Requirement for Open and Closed Discharge Systems	NA
24	Component and Piping Supports for Dynamic Loading	Support stiffness (p. 84 - 86)
25	Class 2 and 3 Component Supports - Use of ASME Section III	Support design later
26	Piping System Seismic Stress Analysis	Snubber stiffness (p. 85)
27	Design Report for ASME Class 1, 2, and 3 Piping	Later, after final design analysis
28	Integrity of Nonsafety-Related CVS Piping Inside Containment. Compliance with 10 CFR 50.55a and ASME B31.1 Code.	NA

AP1000 Main Steam Line B - Compliance to Piping Design Acceptance Criteria

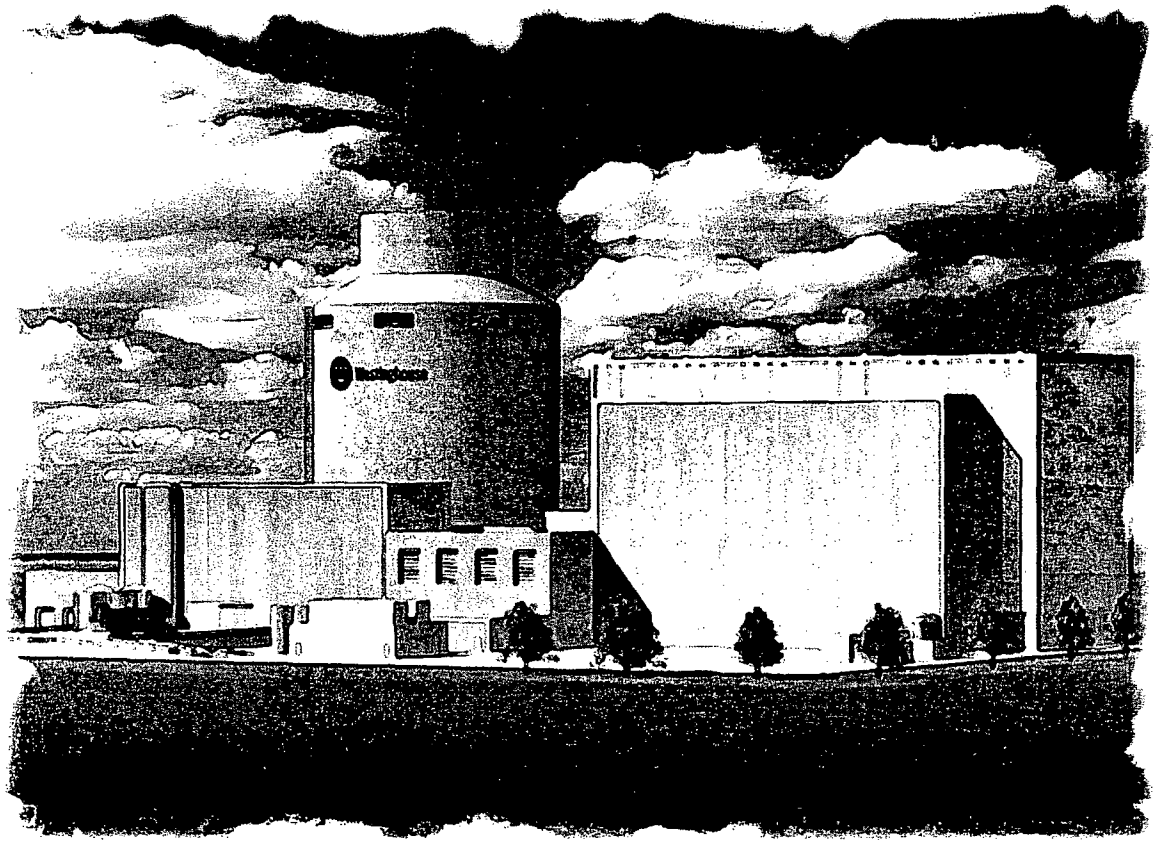
Item	Commitment	Analysis Page No.
1	ASME Code and Code Cases for AP1000 piping and pipe support design	ASME Code (p. 74) ASME Code Eqns (p. 103) ASME Code Cases (NA)
2	Analysis Methods; experimental stress analysis, independent support motion, inelastic analysis, non-seismic/seismic interaction, buried piping	Abs Σ SSE and SAM (p. 25) Load definitions (p. 74) Seismic interaction (p. 86) Exp. stress analysis (NA) Buried pipe (NA)
3	Piping Modeling; piping benchmark program, decoupling criteria	Modeling, coupling (p. 15, 25)
4	Pipe stress analysis criteria; loading and load combinations, damping values, combination of modal responses, high frequency modes, thermal oscillations in piping connected to the reactor coolant system, thermal stratification, safety-related valve design, installation and testing, functional capability, combination of inertial and seismic motion effects, welded attachments, modal damping for composite structures, minimum temperature for thermal analysis	Damping (p. 25) Piping requirements (p. 77) Functional capability (p. 78, 118)
5	Pipe support criteria; applicable codes, jurisdictional boundaries, pipe support baseplate and anchor bolt design, use of energy absorbers and limit stops, pipe support stiffnesses, seismic self-weight excitation, design of supplementary steel, considerations of friction forces, pipe support gaps and clearances, instrument line support criteria	Design, Service limits (p. 76) Support design data (p. 44 – 52)
6	Equivalent Static Load Method of Analysis	NA
7	Three Components of Earthquake Motion	p. 25 - 32
8	Left-Out-Force Method Used in PIPESTRESS Program	Described in PIPESTRESS manual
9	SRP 3.7.2 Method for High-Frequency Modes	Described in PIPESTRESS manual
10	Combination of Low-Frequency Modes	Reg. Guide 1.92 (p. 25)

AP1000 Main Steam Line B - Compliance to Piping Design Acceptance Criteria (Continued)

Item	Commitment	Analysis Page No.
11	Modeling Methods and Analytical Procedures for Piping Systems	p. 15 – 19 There are no gapped supports
12	Seismic Anchor Motions	p. 33 - 34
13	Methods Used to Account for Torsional Effects of Eccentric Masses	Valve CGs are modeled
14	Design Methods of Piping to Prevent Adverse Spatial Interactions	p. 86
15	Analysis Procedure for Damping	p. 25
16	Time History Analysis of Piping Systems	MSIV closure (p. 40)
17	Design Transients - Use of NRC Bulletins 88-08 and 88-11	NA
18	Loads for Class 1 Components and Core/Component Supports	NA
19	Use of Square-Root-Sum-of-the-Squares Method for SSE plus Pipe Rupture	p. 182
20	Analysis of Reactor Coolant Loop Piping	NA
21	ASME Classes 1, 2, and 3 Piping - Use of ASME Code, Section III	p. 74, 77, 78
22	Design of Spring-Loaded Safety Valves	NA (Pertains to lines attached to Pzr)
23	Design and Analysis Requirement for Open and Closed Discharge Systems	p. 35
24	Component and Piping Supports for Dynamic Loading	Support stiffness (p. 46)
25	Class 2 and 3 Component Supports - Use of ASME Section III	p. 74
26	Piping System Seismic Stress Analysis	Snubber stiffness (p. 46, 47)
27	Design Report for ASME Class 1, 2, and 3 Piping	Later, after final design analysis
28	Integrity of Nonsafety-Related CVS Piping Inside Containment Compliance with 10 CFR 50.55a and ASME B31.1 Code	NA

AP1000 PIPING DESIGN ACCEPTANCE CRITERIA

AP1000



Conclusion and Actions Going Forward

Westinghouse

Conclusion

AP1000

- Westinghouse position is that sufficient calculations are available for NRC immediate review
- Successful NRC review of the existing piping analysis calculations and design specification will allow for DAC closure
- Why?
  - Safety Significant Lines Available Now
  - Piping Analysis for AP1000 has greater detail than AP600
  - Piping supports were not designed for AP600 but have detailed designs for AP1000
  - Piping design specification significantly more detailed for AP1000

Actions Going Forward

AP1000

- Schedule audit/inspection of existing calculations and design specification
- NRC to review list provided today to determine sufficiency
- Westinghouse to submit TR 13 (COL Information Item 3.9.8-2), which will expand list of completed lines
- Westinghouse to provide a list of representative small bore lines that will be done to support design certification amendment and/or COL schedule