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AP1000® Design Certification Amendment Application

Presentation to the Nuclear Regulatory Commission
by Westinghouse Electric Company LLC
June 30, 2011

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AP1000 Design Certification Amendment Application

Discussion Topics

- Background: Westinghouse and the Certified ***AP1000*** Design
- ***AP1000*** Design Certification Amendment Application
  - Reasons for changes
  - Amendment review history and status
  - Summary of changes in Design Control Document Rev 19
- Development and Preparation of the Design Control Document
- Summary and Conclusions

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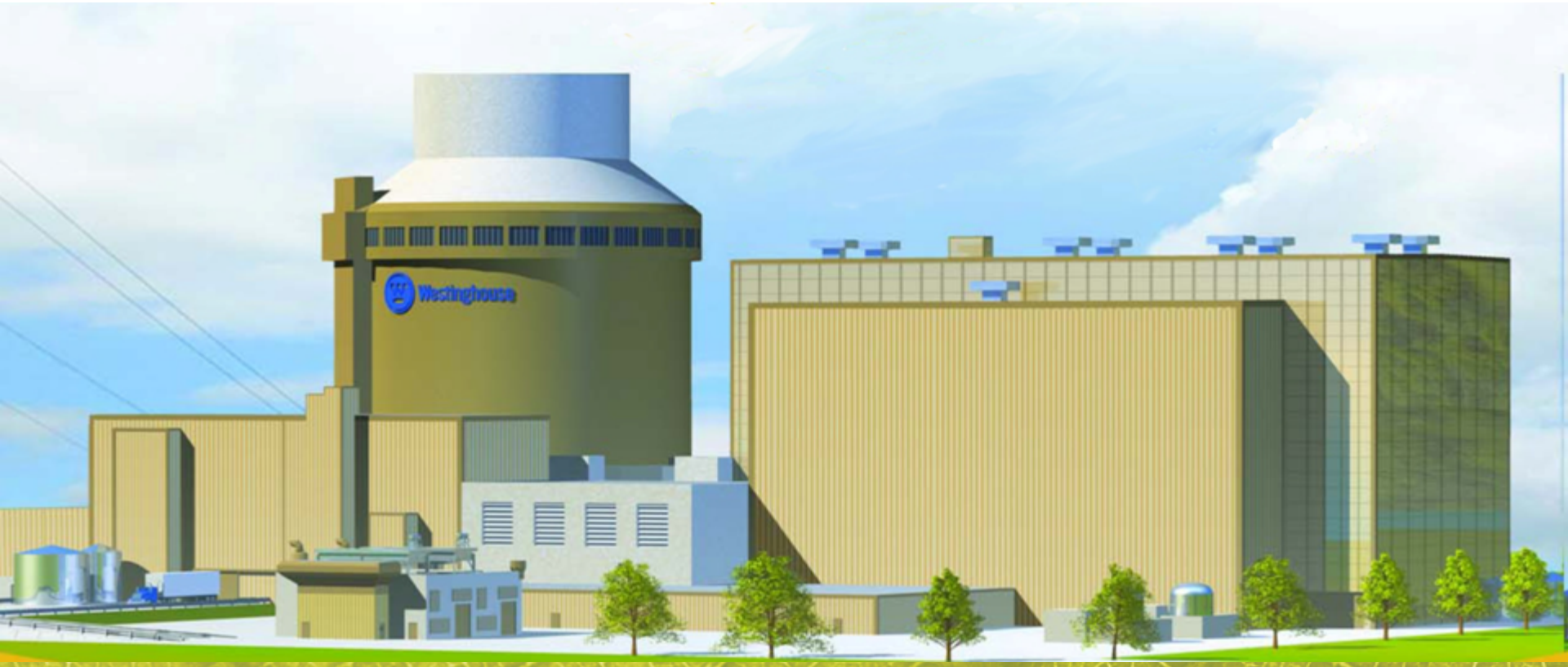
Background



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Nuclear Services

Focused on operating plant success through reliable operation, maximized power output and better (shorter, more predictable) outages

Nuclear Power Plants

Specializing in technology and design of new nuclear power plants and component manufacturing

Nuclear Fuel

A single-source fuel provider for PWR, BWR, VVER, AGR and Magnox reactors worldwide

Nuclear Automation

Instrumentation and control solutions to enhance the reliability of nuclear plant control and safety systems

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More than 15,000 People in 17 Countries Around the World

A company and its people committed to safe reliable nuclear power

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Certified *AP1000* Design: Rulemaking History

- Westinghouse submitted the original application for ***AP1000*** design certification on March 28, 2002

- ***AP1000*** Design Certification rule was approved by the NRC Commissioners December 30, 2005 based on DCD Rev 15

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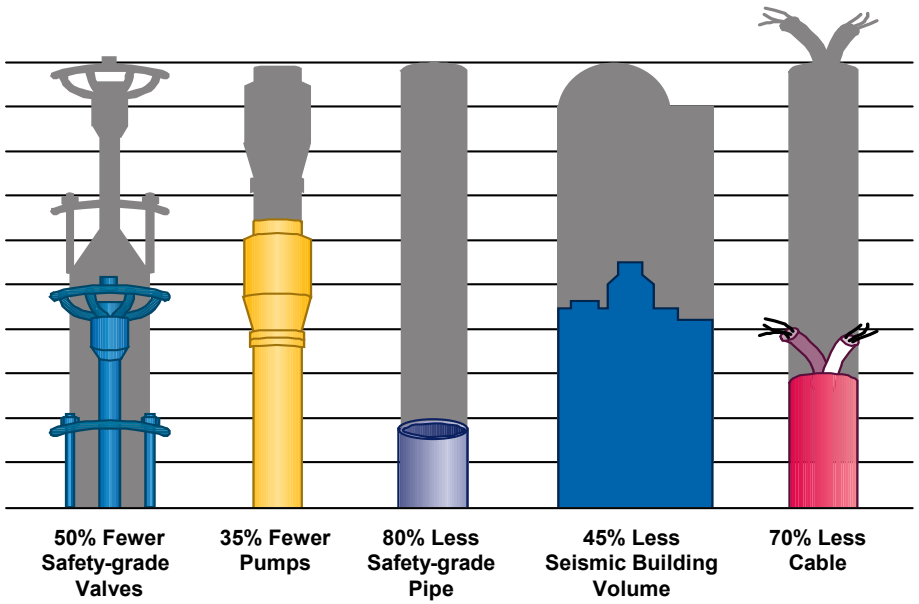
Certified *AP1000* Design: Simple, Practical, Standardized and Innovative

Features:

- 3415 MWt; 1117 Mwe
- Two loops, two steam generators
- Simplified design / compact footprint
- 80% less safety grade piping
- 70% less cable
- 50% fewer safety grade valves
- Digital I&C / advanced control room



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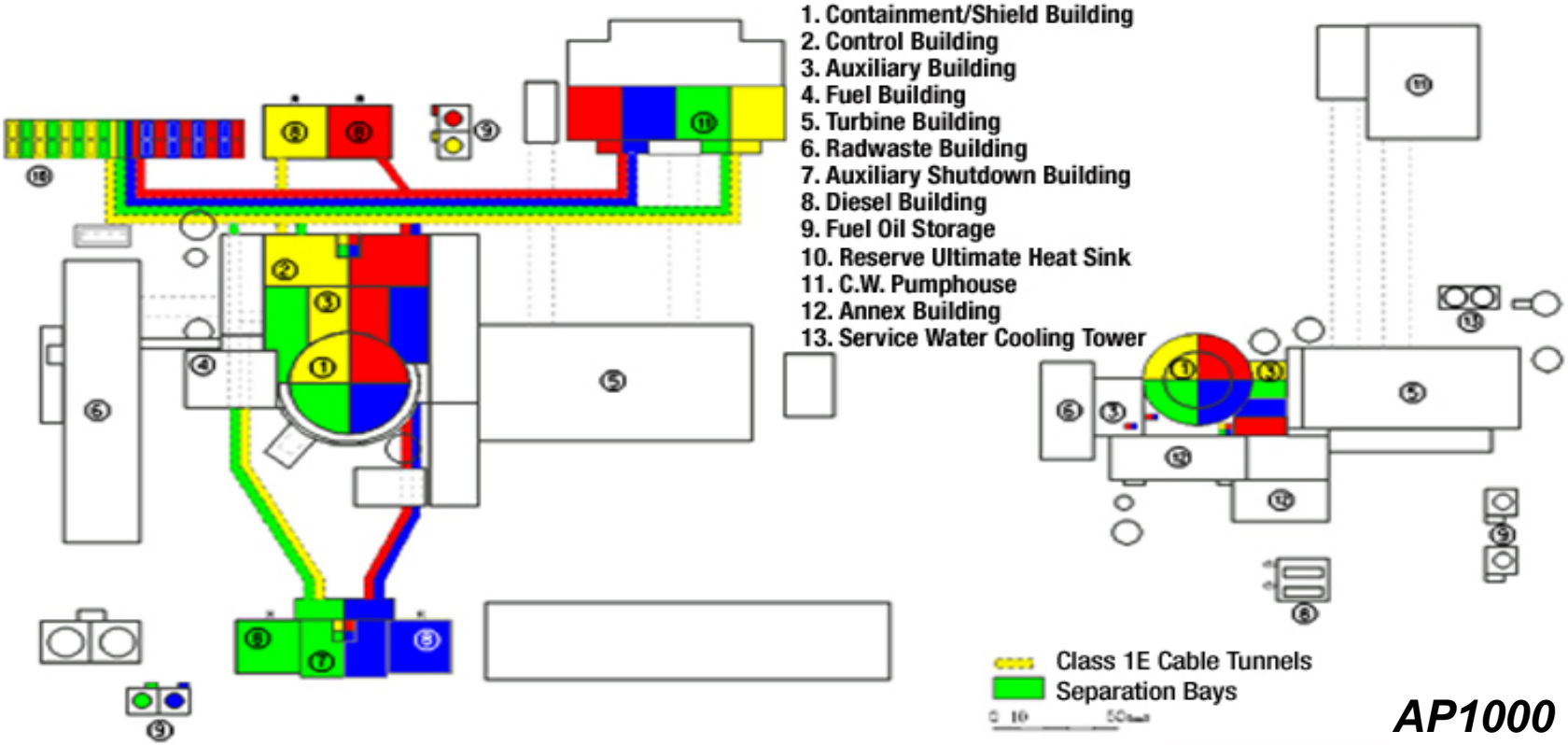
Certified *AP1000* Design: Comparatively Simpler and Safer Footprint



Evolutionary PWR

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Certified *AP1000* Design: Incorporates Reliable Components Proven and in Use

Reactor Vessel and Internals	Doel 4, Tihange 3
CRDMs	Westinghouse plants worldwide
Fuel	South Texas 1&2, Doel 4, Tihange 3
Large Model F Steam Generators	ANO-2, San Onofre, Waterford, Palo Verde
Canned Motor Reactor Coolant Pumps	Fossil boilers and other industrial applications (inverted canned motor pumps)
Pressurizer	Westinghouse plants worldwide

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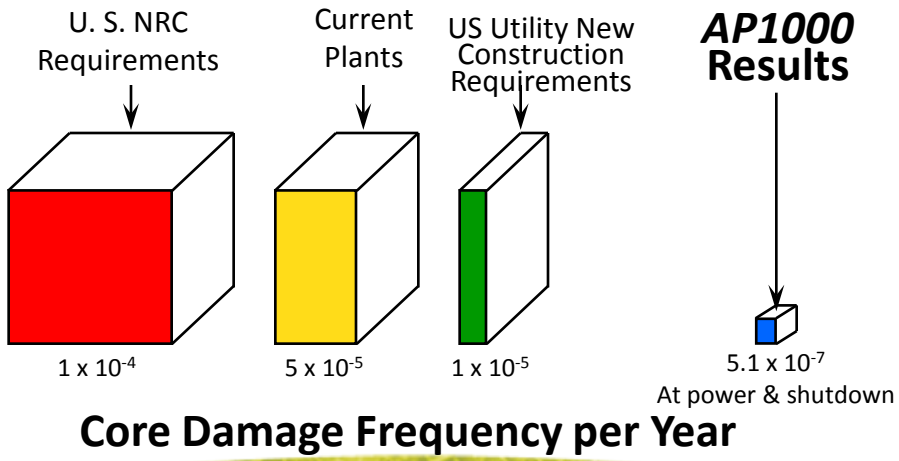
Certified *AP1000* Design: Passive Containment Safety System

- ***AP1000*** does not rely on safety-grade AC power
- Passive residual heat removal
- Passive safety injection
- Passive containment cooling
- Long term safe shutdown state: 72 hours without operator action



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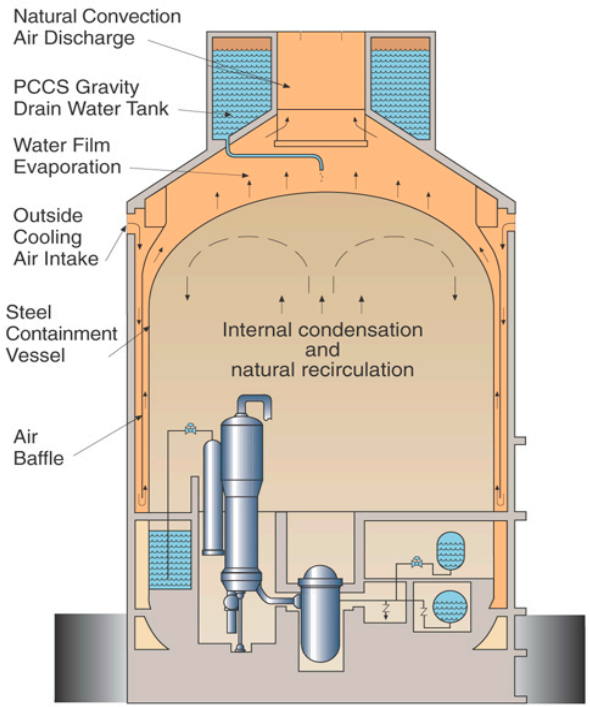

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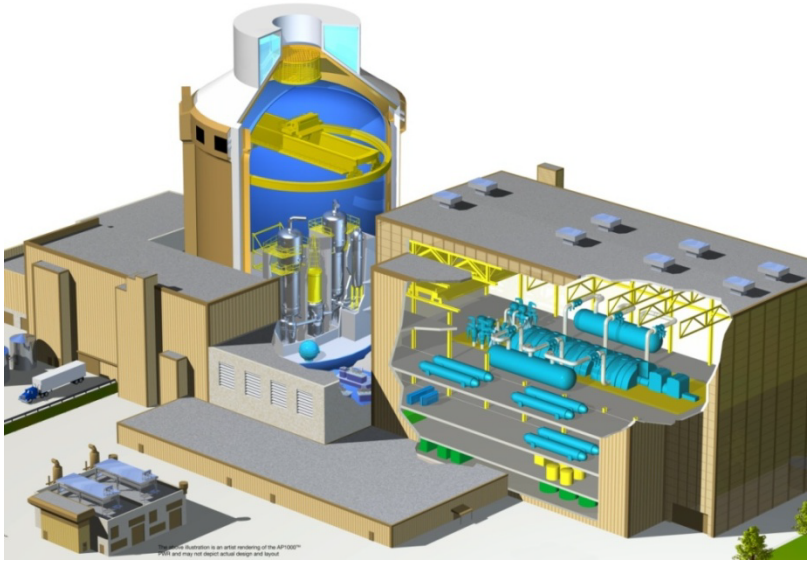
Certified *AP1000* Design: Shield Building

- Shields the containment vessel and systems within the containment from external events, such as tornados and tornado-driven objects
- Supports the passive containment cooling water storage tank (PCCWST)
- Provides for natural air circulation cooling of the containment vessel
- Provides radiation shielding from radioactive systems and components inside the containment vessel



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AP1000 Design Certification Amendment Application

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Design Certification Amendment Application

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Amendment Application: Objectives

- **Increase Standardization** – Reduce COL applicant licensing risks by closing design-related COL open items and Design Acceptance Criteria
  - NuStart created to lead development of the reference Combined Operating License. Standardization concept reinforced by active AP1000 Design Center Working Group.
- **Increase Site Applicability** – Expanded site environmental parameters and site interface to include additional soil types
- **Shield Building Design Improvements** – Modifications to comply with new regulations to ensure design resistance to malicious aircraft impact
- **Incorporate Changes Due to Design Finalization** – Design improvements were incorporated pursuant to 10 CFR Part 52.63(a)

Note: There is only one AP1000 design certification amendment application. Updates to the Design Control Document reflect an inherent outcome of the safety review process.

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Amendment Application: History

- DCD Rev 16 was submitted for NRC review on May 2007
- DCD Rev 17 was submitted September 2008
- NRC completed the Advance Final Safety Evaluation Report (AFSER)
- DCD Rev 18 was submitted on December 1, 2010, for the NRC Advance Final Safety Evaluation Confirmatory Review
- ACRS completed review of DCD, AIA and GSI-191
- DCD Rev 19 was submitted on June 13, 2011 with changes conforming to the AFSER

In support of the NRC safety evaluation of the amendment application, Westinghouse participated in more than 45 noticed public NRC meetings and 24 public meetings of the ACRS and its sub-committees

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Amendment Application: *AP1000* Design and DCD Improvements

DCD Revisions 16, 17 and 18 – selected examples

- Shield Building Design for AIA regulation
- Integrated Head Package
- Reduction in Head Penetrations
- Reactor Coolant Pump Design
- Reactor Vessel Supports
- Containment Vessel Vacuum Relief
- Main Control Room Habitability

DCD Revision 19

- Revisions to the DCD (text, tables, figures), and associated supporting analysis, to address NRC FSER confirmatory review comments related to previously identified design improvements, and ACRS comments.

No design changes were included in DCD Revision 19

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Amendment Application: DCD Rev 19

- Summary examples of Rev 19 changes:
  - Designation of certain existing DCD content with Tier 2* controls
  - Editorial improvements to Chapter 16 Technical Specifications
  - Editorial improvements to Tier 1
  - Consistency changes for referenced document citations
  - Clarifications of licensing basis information for the following subject areas:
    - Shield Building Load Combination
    - PCS Tank Analysis Methodology
    - Containment Vessel Calculated Peak Internal Pressure

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Amendment Application: Examples of Rev 19 Changes

Tier 2*

- To resolve a confirmatory item, additional structural design information was added and designated as Tier 2* information. For example information on the large containment penetrations was added. In 3.8.2.1:

> "[*The information in Figure 3.8.2-2 that is considered to be Tier 2* information is the minimum thickness of the hatch cover, the inside diameter of the sleeve, the diameter of the insert plate, the minimum thickness of the insert plate, and the nominal spherical radius of the hatch cover .*]*"

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Amendment Application: Examples of Rev 19 Changes

Tier 2*

- Existing structural design information was designated as Tier 2* information. For example, information on an insert plate for containment penetrations was made Tier 2*.

"[*The main steam and feedwater penetrations are combined into a common 3-3/4-inch-thick insert plate.*]*"

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Amendment Application: Examples of DCD Rev 19 Changes

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Tier 2*

- Tier 2* structural design information contained in figures was defined more specifically.

> "[*The information in Figure 3.8.3-8, Sheet 1 that is considered to be Tier 2* information is the maximum design spacing of the faceplates, trusses, channels in the trusses and the minimum size and maximum design spacing of the headed studs for the modular wall in the containment internal structure….*]*"

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Amendment Application: Examples of DCD Rev 19 Changes

Tier 2*

- Reference to Shield Building connection information in APP-GW-GLR-602 was added and designated as Tier 2* information.

"[*These RC-to-SC connections are shown in Figures 1, 2, 3, and 4 of APP-GW-GLR-602 (Reference 57).*]*"

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Amendment Application: Examples of DCD Rev 19 Changes

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Shield Building

- Two additional "critical sections" to document the licensing basis of the existing design analysis.

"[*Shield building SC cylinder – see subsection 3H.5.7.1, Figure 3H.5-16, and Figures 5 and 6 of APP-GW-GLR-602 (Reference 57)*

Shield building SC to RC connection – see subsection 3H.5.7.2, Figure 3H.5-16, and Figures 1, 2, 3, and 4 of APP-GW-GLR-602 (Reference 57)]*"

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Amendment Application: Examples of DCD Rev 19 Changes

Shield Building

- Additional shield building PCS tank / roof interface information was provided to resolve NRC confirmatory items.

Table 3H.5-15 :
SHIELD BUILDING ROOF REINFORCEMENT RATIO OF CODE REQUIRED VERSUS PROVIDED

Critical Sections	Stress Component	Required in^2/ft	Provided (Minimum) in^2/ft	Reinforcement Ratio
[*Conical Roof Steel Beams*]* (1)	Axial + Bending	-	[*Radial Beams W36 X 393*]*	1.33
	Shear	-		8.33
[*Conical Roof Near Tension Ring*]*	Radial	1.80	[*1.96*]*	1.09
	Hoop	4.31	[*4.68*]*	1.09
[*Knuckle Region*]*	Vertical	1.37	[*1.72*]*	1.25
	Radial	1.52	[*2.23*]*	1.47
	Hoop	1.37	[*3.12*]*	2.28
[*Compression Ring*]*	Vertical	1.04	[*1.48*]*	1.42
	Radial	3.09	[*4.42*]*	1.43
	Hoop	2.14	[*3.12*]*	1.45

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Amendment Application: Examples of DCD Rev 19 Changes

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Technical Specifications

- Spelled out acronyms
- Used appropriate capital or lower case letters
- Added footnotes to table for post accident monitoring instrumentation
- Reformatted and renumbered requirements
- Calculated peak containment internal pressure

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Amendment Application: Examples of DCD Rev 19 Changes

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DCD Chapter 1

- Updates to list of documents incorporated by reference
- Update to Regulatory Guide conformance

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Amendment Application: Examples of DCD Rev 19 Changes

DCD Tier 1

- Component identifying numbers
- Editorial, for example, replace “grey” with “gray”
- Renumbering of crane and hoist ITAAC
- Conforming changes to the list of critical sections

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Amendment Application: Summary of DCD Rev 19 Changes

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Shield Building Load Combination Topic

- This issue involved the Westinghouse practice for considering load combinations including thermal loads for structures (in particular the shield building) designed to ACI-349 criteria.
- Westinghouse considered thermal loads and implemented a long-established practice to determine when thermal loads are explicitly included in load combination calculations.
- Westinghouse resolved the NRC questions by performing additional analysis, which validated the existing design.
- DCD text changes are included in Revision 19 to clarify the licensing basis and support completion of the FSER.

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Amendment Application: Examples of DCD Rev 19 Changes

Shield Building Load Combination Topic

- "Critical Section" tables were updated to include the thermal plus seismic load combination.

Table 3H.5-14 (Sheet 2 of 3)

DESIGN SUMMARY OF ENHANCED SHIELD BUILDING LOAD COMBINATIONS, AND COMPARISON TO ACCEPTANCE CRITERIA ELEVATION 175 FEET NEAR INTERSECTION WITH WALL 7.3

Load/Combination	TX kip/ft	TY kip/ft	TXY kip/ft	MX k-ft/ft	MY k-ft/ft	MXY k-ft/ft	NX kip/ft	NY kip/ft	Comments
Dead	-6	-105	12	-6	5	1	0	2	
Live	0	-1	0	0	0	0	0	0	
Seismic	34	325	176	38	25	13	2	8	
19(2)	77	227	186	36	-58	7	3	11	D + L + E's + αTo(W1)
37(2)	77	238	186	36	-58	7	3	11	0.9 D + E's + αTo(W2)

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Amendment Application: Examples of DCD Rev 19 Changes

Shield Building PCS Tank Topic

- This issue involved ensuring the licensing basis reflected appropriate methods for evaluating hydrodynamic loads in the design of the PCS tank, and corrects an inconsistency with information in the Shield Building Report and the DCD.
- The change involved including a previously committed-to description of the equivalent static method to evaluate hydrodynamic loads in the PCS tank.
- Westinghouse performed additional analysis to demonstrate the acceptability of the existing design.
- Westinghouse incorporated changes into DCD Rev 19 to ensure the appropriate methodology was captured in the licensing basis.

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Amendment Application: Examples of DCD Rev 19 Changes

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Shield Building PCS Tank Topic

- The quadrant model description is updated in Section 3G.

> *"The one quadrant model of the shield building roof is shown in Figure 3G.2-16. The model is constructed with solid and shell elements and contains structures from the exposed shield wall through the top of the shield building roof. The quadrant model is used for the equivalent static analysis of the shield building roof. The results from the more detailed analysis are used in the design of the shield building roof and radial roof beams, tension ring, air inlet structure, and PCS tank."*

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Amendment Application: Examples of DCD Rev 19 Changes

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Containment Vessel (CV) Calculated Internal Peak Pressure

- This issue involved the revision to the calculated peak containment pressure.
- As part of the effort to address an ACRS comment in January 2011 on CV water film coverage, the internal peak pressure calculation needed to be updated.
- When the internal peak pressure calculation related to the water film coverage item was recalculated, Westinghouse also included additional updates to the pressure calculation.
- The new peak pressure included in DCD Rev 19 remains below the design pressure and is consistent with prior NRC acceptance (NUREG-1793).

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Amendment Application: Examples of DCD Rev 19 Changes

Containment Vessel Calculated Internal Peak Pressure

- Section 6.2 is revised to address updated CV peak pressure

Table 6.2.1.1-1

SUMMARY OF CALCULATED PRESSURES AND TEMPERATURES

Break	Peak Pressure (psig)	Available[1] Margin (psi)	Peak Temperature (°F)
Double-ended hot leg guillotine	50.4	8.6	411.3
Double-ended cold leg guillotine	58.3	0.7	295.7
Full main steam line DER, 30% power, MSIV failure	58.2	0.8	373.2
Full main steam line DER, 101% power, MSIV failure	54.2	4.8	374.7

[1] Design pressure is 59.0 psi

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Design Control Document Revision

Summary of DCD Revision 19 Changes

- DCD Revision 19 changes are primarily clarifications in response to NRC questions and requests related to the confirmatory review process.
  - Tier 2* confirmatory review of structures design.
  - Shield Building Load combination.
  - PCS tank design for hydrodynamic loads.
  - Update of containment pressure.

No design changes were included in DCD Revision 19

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Development and Preparation of the Design Control Document

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Development and Preparation of the Design Control Document

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Key Processes and Activities

- Westinghouse Quality Management System
- Design and Licensing Change Control Process
- DCD Preparation and Oversight
  - Internal preparations to assure the DCD is ready for docketing under oath of affirmation
  - Included completion of extent of condition reviews

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Development and Preparation of the Design Control Document

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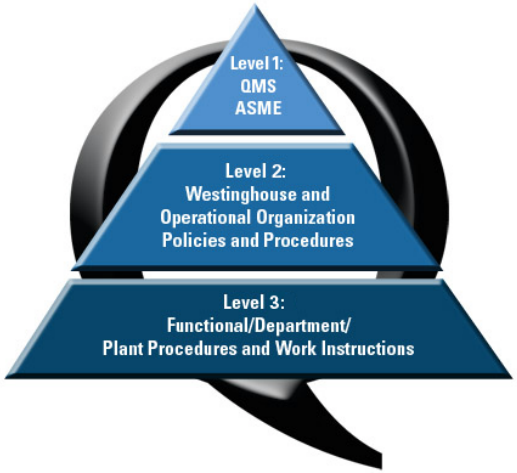
Quality Management System Effectiveness



- Westinghouse Quality Management System
  - NRC approved 10 CFR 50 Appendix B Quality Program
  - ASME NQA-1
  - ISO9001 Certification
  - GS-R-3 IAEA Safety Standard for European Union
  - JEAC 4111 – JEAC Standards of Japan
  - HSE Safety Assessment Principles for Nuclear Facilities – United Kingdom
  - CSA N286-05 Canadian Standards
- Comprehensive and Mature Policies and Procedures, including the design configuration control process
- Corrective Action Process
- Frequent compliance audits by numerous oversight organizations

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Development and Preparation of the Design Control Document

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Project Management of RAIs, OIs and CIs

- DCD Revision 18
  - Responded to NRC RAIs and OIs
  - Developed and managed fully integrated schedule for Westinghouse, Customer and NRC actions required to submit DCD Revision 18
  - Communicated schedule status to NRC

- DCD Revision 19
  - No new NRC RAIs or OIs
  - Tracked confirmatory items to closure

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Development and Preparation of the Design Control Document

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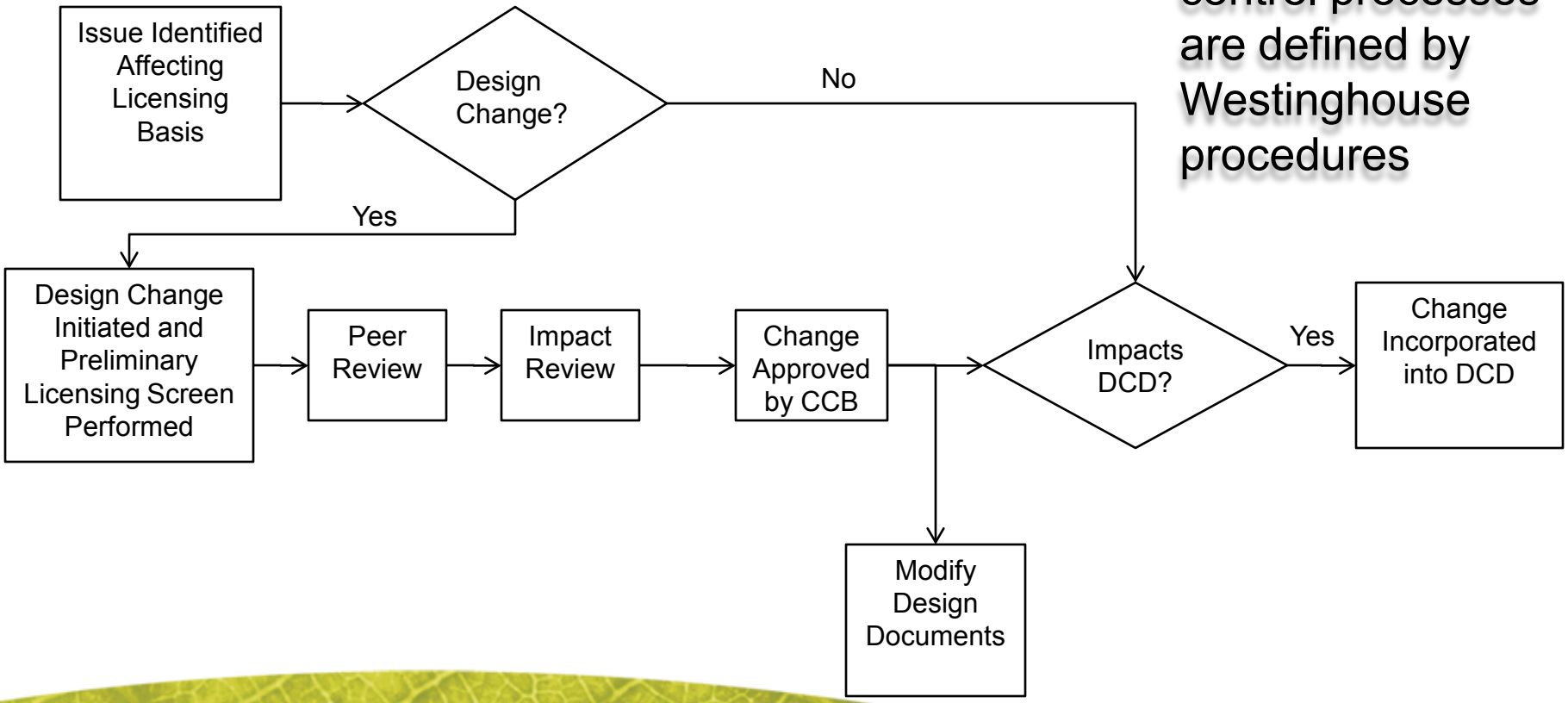
Design and Licensing Configuration Control



Configuration control processes are defined by Westinghouse procedures

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Development and Preparation of the Design Control Document

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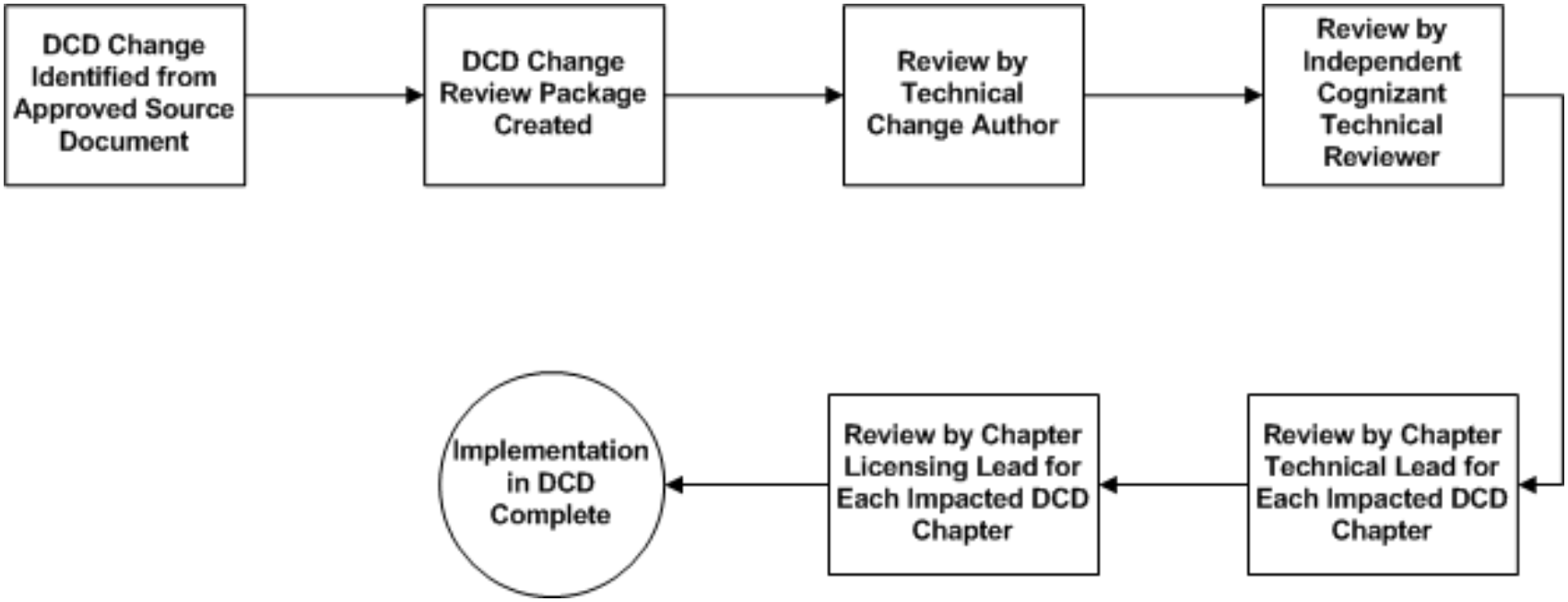
Design Control Document Change Control Process



NOTE: Any change identified at any phase during the internal review process requires the internal DCD change package to be reviewed again.

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Development and Preparation of the Design Control Document

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Effectiveness of the Westinghouse Quality Program

- Issues addressed as part of the Westinghouse Corrective Action Process.
- The current issues demonstrated the effectiveness of quality processes to identify and resolve issues.
- Extent-of-condition reviews have been conducted. No additional issues identified.
- Conclusions have been independently validated.
- The Westinghouse Quality Program is effective and provides assurance of the quality of the Design Control Document.

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Design and Licensing Configuration Control Process

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Preparation and Validation of the Design Control Document, Rev 18

- DCD Content
  - Adhered to the DCD change control procedure
  - Initial draft of DCD Rev 18 validated by joint multidisciplinary team
  - Finalized draft of DCD Rev 18 reviewed again by DCWG and Westinghouse "Red Team"
  - Final Chapter Sign-off by Westinghouse Licensing Lead, Subject Matter Expert and Engineering Contributors for specific sections

- Assessment of Design Finalization Activities
  - Completed a real-time assessment of work in progress prior to submitting DCD Rev 18 to provide confidence that required changes have been incorporated into the DCD

- DCD Production
  - Working files converted to 'pdf' format to support compilation of DCD Revision 18 ready for docketing – 'pdf' version checked to ensure absence of conversion errors

Similar process used to prepare DCD Revision 19 for submittal

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Conclusions

- Westinghouse commitment to safety of the ***AP1000*** design and the quality of the Design Control Document is a top priority.
- ***AP1000*** Design Certification Amendment has been thoroughly reviewed over the course of four years.
- DCD Revision 19 does not include design changes.
- Production of the DCD involves significant quality checks to ensure correctness. Pedigree and quality assurance of the DCD established through formal processes and independent oversight activities.
- The Design Control Document, as docketed, provides a sound basis to proceed with completing the FSER and rulemaking activities.

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