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Your ref: Project Number 740
Our ref: DCP/NRC1785

September 29, 2006

Subject: AP1000 COL Standard Technical Report Submittal

In support of Combined License application pre-application activities, Westinghouse is submitting Revision 0 of AP1000 Standard Combined License Technical Report Number 33. This report identifies and justifies standard changes to DCD Section 5.2 in the AP1000 Design Control Document. Changes to the Design Control Document identified in Technical Report Number 33 are intended to be incorporated into FSARs referencing the AP1000 design certification or incorporated into the design certification using supplemental rulemaking if Part 52 is revised to permit revision of the design certification. This report is submitted as part of the NuStart Bellefonte COL Project (NRC Project Number 740). The information included in this report is generic and is expected to apply to all COL applications referencing the AP1000 Design Certification.

The purpose for submittal of this report was explained in a March 8, 2006 letter from NuStart to the U.S. Nuclear Regulatory Commission.

Pursuant to 10 CFR 50.30(b), APP-GW-GLN-009, Revision 0, "Pressure Boundary Material," Technical Report Number 33, is submitted as Enclosure 1 under the attached Oath of Affirmation.

It is expected that when the NRC review of Technical Report Number 33 is complete, the changes to the AP1000 Design Control Document identified in Technical Report 33 will be considered approved generically for COL applicants referencing the AP1000 Design Certification.

D079

Questions or requests for additional information related to the content and preparation of this report should be directed to Westinghouse. Please send copies of such questions or requests to the prospective applicants for combined licenses referencing the AP1000 Design Certification. A representative for each applicant is included on the cc: list of this letter.

Very truly yours,

A. Sterdis, Manager
Licensing and Customer Interface
Regulatory Affairs and Standardization

/Attachment

1. "Oath of Affirmation," dated September 29, 2006

/Enclosure

1. APP-GW-GLN-009, Revision 0, "Pressure Boundary Material Change," Technical Report Number 33, dated September 2006.

cc:	S. Bloom	-	U.S. NRC	1E	1A
	S. Coffin	-	U.S. NRC	1E	1A
	G. Curtis	-	TVA	1E	1A
	P. Grendys	-	Westinghouse	1E	1A
	P. Hastings	-	Duke Power	1E	1A
	C. Ionescu	-	Progress Energy	1E	1A
	D. Lindgren	-	Westinghouse	1E	1A
	A. Monroe	-	SCANA	1E	1A
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	E. Schmiech	-	Westinghouse	1E	1A
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ATTACHMENT 1

"Oath of Affirmation"

ATTACHMENT 1

UNITED STATES OF AMERICA

NUCLEAR REGULATORY COMMISSION

In the Matter of:	)
NuStart Bellefonte COL Project	)
NRC Project Number 740	)

APPLICATION FOR REVIEW OF
"AP1000 GENERAL COMBINED LICENSE INFORMATION"
FOR COL APPLICATION PRE-APPLICATION REVIEW

B. W. Bevilacqua, being duly sworn, states that he is Vice President, New Plants Engineering, for Westinghouse Electric Company; that he is authorized on the part of said company to sign and file with the Nuclear Regulatory Commission this document; that all statements made and matters set forth therein are true and correct to the best of his knowledge, information and belief.

Bruce W. Bevilacqua

B. W. Bevilacqua
Vice President
New Plants Engineering

Subscribed and sworn to
before me this 29th day
of September 2006.

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Debra McCarthy, Notary Public
Monroeville Boro, Allegheny County
My Commission Expires Aug. 31, 2009
Member, Pennsylvania Association of Notaries

Notary Public

ENCLOSURE 1

APP-GW-GLN-009, Revision 0

Pressure Boundary Material Change

Technical Report Number 33

AP1000 DOCUMENT COVER SHEET

TDC: ________ Permanent File: ________ APY: ________

RFS#: ________ RFS ITEM #: ________

AP1000 DOCUMENT NO.	REVISION NO.		ASSIGNED TO
APP-GW-GLN-009	0	Page 1 of 29	W-A. Sterdis

ALTERNATE DOCUMENT NUMBER: WORK BREAKDOWN #:

ORIGINATING ORGANIZATION: Westinghouse Electric Company

TITLE: **Pressure Boundary Material**

ATTACHMENTS:	DCP #/REV. INCORPORATED IN THIS DOCUMENT REVISION:
CALCULATION/ANALYSIS REFERENCE:	

ELECTRONIC FILENAME	ELECTRONIC FILE FORMAT	ELECTRONIC FILE DESCRIPTION
APP-GW-GLN-009 R0.doc	Microsoft Word	

ORIGINATOR M. McCullough	SIGNATURE/DATE [signature] 9/29/06	
REVIEWERS D. Lindgren	SIGNATURE/DATE D. A. Lindgren 9/29/2006	
VERIFIER D. Wiseman	SIGNATURE/DATE D.A. Wiseman 9/29/06	VERIFICATION METHOD PAGE BY PAGE
AP1000 RESPONSIBLE MANAGER K. Quinn	SIGNATURE* [signature] 9/29/06	APPROVAL DATE

* Approval of the responsible manager signifies that document is complete, all required reviews are complete, electronic file is attached and document is released for use.

Document Number: APP-GW-GLN-009 **Revision Number:** 0
Title: Pressure Boundary Material Change

Brief Description of the change (what is being changed and why):
This report summarizes design changes related to the AP1000 pressure boundary materials. The pressure boundary materials selections are identified in the AP1000 Design Control Document (DCD), Tier 2, Subsection 5.2 Table 5.2-1. The pressure boundary materials changes are: 1) revision of some material designators to be consistent with the ASME Code of Record for the reactor coolant system pressure boundary components, which is the 1998 Code and 2000 Addenda; 2) correction of discrepancies in the AP1000 DCD in specification of materials for some components; 3) addition of materials to DCD Table 5.2-1 to address previously identified issues, to provide fabrication flexibility, and to ensure adequate material supply; 4) relaxation of the maximum copper limit allowed in the reactor vessel beltline forging and weld material to reduce schedule risk and cost while maintaining the required performance; and 5) relaxation of the maximum delta ferrite limit in weld materials to reduce schedule risk and cost while maintaining the performance requirements.

I. APPLICABILITY DETERMINATION

This evaluation is prepared to document that the change described above is a departure from Tier 2 information of the AP1000 Design Control Document (DCD) that may be included in plant specific FSARs without prior NRC approval.

A.	Does the proposed change include a change to:		
	1. Tier 1 of the AP1000 Design Control Document APP-GW-GL-700	☒ NO ☐ YES	(If YES prepare a report for NRC review of the changes)
	2. Tier 2* of the AP1000 Design Control Document, APP-GW-GL-700	☒ NO ☐ YES	(If YES prepare a report for NRC review of the changes)
	3. Technical Specification in Chapter 16 of the AP1000 Design Control Document, APP-GW-GL-700	☒ NO ☐ YES	(If YES prepare a report for NRC review of the changes)
B.	Does the proposed change involve:		
	1. Closure of a Combined License Information Item identified in the AP1000 Design Control Document, APP-GW-GL-700	☒ NO ☐ YES	(If YES prepare a COL item closure report for NRC review.)
	2. Completion of an ITAAC item identified in Tier 1 of the AP1000 Design Control Document, APP-GW-GL-700	☒ NO ☐ YES	(If YES prepare an ITAAC completion report for NRC review.)

☒ The questions above are answered no, therefore the departure from the DCD in a COL application does not require prior NRC review unless review is required by the criteria of 10 CFR Part 52 Appendix D Section VIII B.5.b. or B.5c

Document Number: APP-GW-GLN-009 **Revision Number:** 0
Title: Pressure Boundary Material Change

II. TECHNICAL DESCRIPTION AND JUSTIFICATION

1.0 Introduction

During detailed design and manufacturing evaluations of the reactor coolant system components it has been determined that the list of pressure boundary materials provided in AP1000 Design Certification Document (DCD) Revision 15 (Reference 1), Tier 2 Table 5.2-1 should be revised to correct omissions, update the material designators, and add some materials to enhance manufacturing flexibility, reduce costs, and reduce risk relative to material availability. Also, as a result of discussions with material suppliers, maximum copper limits in the reactor vessel beltline material and maximum delta ferrite limits for stainless steel welds and cladding were increased to reduce costs, increase the number of acceptable suppliers, and reduce schedule risk. The revised limits are within current industry practices and maintain the material performance requirements.

1.1 ASME Code of Record Update

Table 5.1-2 of the DCD specifies the material and class, grade or type for the primary pressure boundary components. Some of the current material, class, grade and type designators are not consistent with the 1998 ASME Code, 2000 Addenda, which is the Code of Record for the reactor coolant pressure boundary components. The material designators in the table have been updated to meet the Code of Record as follows:

	Current	Revised
Reactor Vessel Components		
Head Plates	SA-533 GR B or SA-508 CL 1 or CL 3	SA-533 Type B, CL 1 or SA-508 GR 3, CL 1
Shell Courses	SA-508 CL 3	SA-508 GR 3, CL 1
Shell Flange	SA-508 CL 3	SA-508 GR 3, CL 1
Appurtenances	SB-167 TP690	SB-167 N06690
Steam Generator Components		
Pressure Plates	SA-533 GR B	SA-533 Type B, CL 1
Pressure Forgings	SA-508 CL 3A	SA-508 GR 3, CL 2
Channel Heads	SA-508 CL 3A	SA-508 GR 3, CL 2
Tubes	SB-163 TP690TT	SB-163 N06690
Manway nuts	SA-194 GR B7	SA-194 GR 2H
Pressurizer Components		
Pressure Plates	SA-533 GR B, CL 1	SA-533 Type B, CL 1
Pressure Forgings	SA-508 CL 3	SA-508 GR 3, CL 2
Manway nuts	SA-194 GR B7	SA-194 GR 2H
Valves		
Discs	SA-564 GR 630	SA-564 Type 630 (H1100 or H1150)
Stems	SA-564 GR 630	SA-564 Type 630 (H1100 or H1150)
Pressure Retaining Bolts	SA-564 GR 630	SA-564 Type 630 (H1100)
Pressure Retaining Nuts	SA-453 GR 6	SA-453 GR 660
Core Make-up Tank		
Pressure Plates	SA-533 GR B, CL 1	SA-533 Type B, CL 1
Pressure Forgings	SA-508 CL 3	SA-508 GR 3, CL 1
Passive Residual Heat Removal Heat Exchanger		
Tubing	SB-163 TP690	SB-163 N06690

The welding material from each section was moved into one section for easier reference.

1.2 DCD Corrections

In the description for the PRHR heat exchanger material in Tier 2, Section 5.4.14.4 of the AP1000 Design Certification Document (DCD), the portions of material in contact with primary coolant are described as being "fabricated from or clad with corrosion-resistant material". However, in Table 5.2-1 for pressure boundary materials, the only materials specified are 304L, 304LN, F304L, and F304LN. The materials should also include carbon steel grades SA-508, GR 3, CL 2 for the tube sheet and heads and SA-533, Type B, CL 1 as appropriate materials for fabrication with the correct cladding.

Table 5.1-2 shows the reactor coolant loop piping as SA376TP316LN. However, in the description of the resistance of the reactor coolant loop piping to erosion-corrosion in Tier 2, Section 3B.2.1 of

the DCD, the material for the construction of the loop piping and auxiliary piping is described as SA312TP316LN. To correct this inconsistency, the description in Section 3B.2.1 will be changed from "SA312 TP316LN austenitic stainless steel material" to "Series 300 austenitic stainless steel material" since all the Series 300 stainless steels are resistant to erosion-corrosion effects.

In Tier 2, Section 3B.2.1, the auxiliary stainless steel piping is described as SA304TP304L. To correct this typographical error and maintain consistency with the primary loop piping section and Table 5.2-1, the description in Section 3B.2.1 will be changed from "SA312 TP316LN and SA304 TP304L austenitic stainless steel material" to "Series 300 austenitic stainless steel material" since all Series 300 stainless steel materials are resistant to erosion-corrosion effects.

1.3 Material Addition

During detailed design and manufacturing evaluations of the reactor coolant system components it has been determined that the list of pressure boundary materials provided in DCD Revision 15, Tier 2 Table 5.2-1 should be revised to add materials to correct some omissions, enhance fabrication flexibility, reduce costs, and reduce schedule risk and increase flexibility relative to material procurement. In one case, RCP pressure casings, SA-352 was deleted as it has not been used in the past nor planned to be used in AP1000. All of the additional materials have been used in PWR applications and have been reviewed by Westinghouse material experts for compatibility with the proposed application. The following table of material additions is divided into two parts: the first part shows the material added and the associated Class, Grade or Type; the second part shows additions of Class, Grade or Type to materials already listed in Table 5.2-1.

Material Changes		
Component	**Material**	**Class, Grade or Type**
Reactor Vessel Components		
Appurtenances to the CRDM	SB-166	N06690
Instrumentation Tube Appurtenances, Upper Head	SB-166	N06690
Monitor Tubes	SA-182	F304, F304L, F304LN, F316, F316L, F316LN
Reactor Coolant Pump		
Pressure Casting	Deleted SA-352	
Reactor Coolant Piping		
Reactor Coolant Pipe	SA-182	F304, F304L, F304LN, F316, F316L, F316LN
Surge Line	SA-312	TP304, TP304L, TP304LN, TP316, TP316L, TP316LN
Valves		
Stems	SB-637	Alloy N07718
Pressure Retaining Bolting	SA-193	GR B8
Passive Residual Heat Removal Heat Exchanger		
Pressure Plates	SA-533	Type B CL 1
Pressure Forgings	SA-508	GR 3 CL 2

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Title: Pressure Boundary Material Change

Material Class, Grade, or Type Additions		
Component	**Material (Currently in DCD Rev 15)**	**Class, Grade or Type Addition**
Reactor Vessel Components		
Nozzle Safe Ends	SA-182	F316, F316L
Appurtenances to the CRDM	SA-182	F304, F304L, F316, F316L
Instrumentation Tube Appurtenances, Upper Head	SA-182 SA-312 SA-376	F304, F304L, F316, F316L TP304, TP304L, TP304LN, TP316, TP316L, TP316LN TP304, TP304LN, TP316, TP316LN
Monitor Tubes	SA-312 SA-376	TP304,TP304L,TP316, TP316L TP304, TP316
Vent Pipe	SA-312 SA-376	TP304,TP304L,TP316, TP316L TP304, TP316
Steam Generator Components		
Nozzle Safe Ends	SA-182	F316, F316L
Pressurizer Components		
Nozzle Safe Ends	SA-182	F316, F316L
Reactor Coolant Pump		
Pressure Forgings	SA-182 SA-336	F304, F304L, F316, F316L F304, F304L, F316, F316L
Pressure Casting	SA-351	CF8A
Tube and Pipe	SA-213 SA-376 SA-312	TP304, TP304L, TP316, TP316L TP304, TP316 TP304, TP304L, TP316, TP316L
Pressure Plates	SA-240	304, 304L, 316, 316L
Closure Bolting	SA-540	GR B23, CL 3 & 4
Reactor Coolant Piping		
Reactor Coolant Pipe	SA-376	TP304, TP316
Reactor Coolant fittings	SA-376 SA-182	TP304, TP316 F304, F304L, F316, F316L
Surge Line	SA-376	TP304, TP316
RCP piping other than loop and surge line	SA-312 SA-376	TP304, TP304L, TP316, TP316L TP304, TP316
CRDM		
Latch Housing	SA-336	F304, F304L, F316, F316L
Rod Travel Housing	SA-336	F304, F304L, F316, F316L
Valves		

Bodies	SA-182 SA-351	F304, F304L, F316, F316L, CF3M, CF8
Bonnets	SA-182 SA-240 SA-351	F304, F304L, F316, F316L 304, 304L, 316, 316L CF3M, CF8
Discs	SA-182 SA-351	F304, F304L, F316, F316L CF3M, CF8
Stems	SA-479	316, 316LN, XM-19
Pressure retaining nuts	SA-194	GR 6 or 8
Core Makeup Tank		
Pressure Plates	SA-240	304, 316
Pressure Forgings	SA-182 SA-336	F304, F316 F304, F316
Passive Residual Heat Removal Heat Exchanger		
Pressure Plates	SA-240	304
Pressure Forgings	SA-336	F304
Welding Consumables		
Corrosion resistant cladding, buttering, and welds	SFA 5.4 or SFA 5.9 SFA 5.14	E308, E308L, E309, E309L, E316, E316L, ER308, ER308L, ER309, ER309L, ER316, ER316L ERNiCrFe-7/A

1.4 Reactor Vessel Beltline Forging and Weld Chemical Composition

The current AP1000 Design Control Document (Revision 15) specifies maximum 0.03 wt % Cu for reactor pressure vessel beltline forgings and welds (Table 5.3-1). The copper limits were established to address irradiation embrittlement concerns. Although the use of low Cu materials in AP1000 is necessary due to high neutron fluences, extensive research conducted by the industry and the NRC over the past 15 years has significantly improved the understanding of the fundamental mechanisms associated with the embrittlement of reactor vessel materials. Based on this research, Regulatory Guide 1.99 (Reference 2) is expected to be revised from revision 2 to revision 3. The current proposed embrittlement curves for Revision 3 show that the allowable Cu levels in both the forging and welds can be increased up to 0.07 wt % Cu with no impact on the predicted embrittlement.

The copper limit for the reactor vessel beltline forging and weld material is proposed to be increased from the current limit of 0.03 wt % Cu to 0.06 wt % Cu. Increasing the copper limit to 0.06 wt % will increase the number of available suppliers, significantly decrease the procurement time, and decrease the manufacturing costs, without increasing irradiation embrittlement concerns. Forgings with specified maximum Cu limits of 0.03 wt % are outside the current practice for the potential forging suppliers as most specifications are commonly in the range of 0.05 to 0.1 wt %.

Changing the wt % of Cu, impacts the EOL RT_{PTS}. Even though the RT_{PTS} value is increased, there is still substantial margin to the screening criteria limit. This evaluation is based on Regulatory Guide 1.99 "Radiation Embrittlement of Reactor Vessel Materials" Revision 2 (Reference 2). The following is the impact on the EOL RT_{PTS}:

	EOL RT_{PTS} Cu = 0.03 wt% Current Limit	EOL RT_{PTS} Cu = 0.06 wt% Proposed Limit	EOL RT_{PTS} Screening Criteria
Beltline Forging	66 F	94 F	<270 F
Beltline Weld	98 F	148 F	<300 F

The maximum value of 0.06 wt % of Cu was based on recent experience on the System 80 (Korean) reactor vessels. The reactor vessel forging and weld material specifications have included limits of 0.06 wt % copper for both. The resulting actual forging Cu content has ranged from 0.03 to 0.06 wt %. The actual weld material Cu content has been approximately 0.02 wt %.

The impact of the higher copper limit on the pressure/temperature (P/T) curves is to slightly decrease the allowable operating range. However, this will not result in any significant restrictions on plant operations. See Section 5.0 for the comparisons between the current and proposed P/T curves. The LTOPS evaluation and the resulting parameters for the normal residual heat removal system relief valve are unaffected by the P/T curve changes since the lowest Appendix G limit has not changed.

1.5 Delta Ferrite Limits

The paragraph in AP1000 DCD (Revision 15), subsection 5.2.3.4.6 on welding material delta ferrite was revised and expanded to clarify the acceptable methods to verify the delta ferrite content and to increase the acceptable upper delta ferrite limit.

The current AP1000 DCD (Revision 15) specifies an upper limit for the delta ferrite of 13FN. The current EPRI Utilities Requirement Document (Reference 3) upper limit for stainless steel welding materials is 20 FN. Testing and field experience show that an upper delta ferrite limit of 20 FN is sufficient to minimize thermal aging effects on toughness properties in PWR applications. The proposed change to the maximum delta ferrite content is 20 FN for filler metal compositions with low molybdenum contents and 16 FN for weld filler materials with higher molybdenum content such as Types 316/316L, which contain 2.0 to 3.0% molybdenum. These limits are based on consideration of a combination of ASME Code requirements, NRC Regulatory Guide positions, NRC Standard Review Plan guidance, and combined industry positions on addressing material issues for license renewal.

The increase in maximum allowable delta ferrite levels will increase the availability of suppliers and flexibility in fabrication, resulting in a decrease in cost and fabrication time without compromising the material performance.

III. REFERENCES

1. APP-GW-GL-700, AP1000 Design Control Document, Revision 15
2. NUREG 1.99, Radiation Embrittlement of Reactor Vessel Materials, Revision 2
3. EPRI Utilities Requirements Document, Revision 8
4. Design Change Proposal (DCP) APP-GW-GEE-109, Pressure Boundary Material, Revision 1

IV. DCD MARK-UP

The following mark ups of AP1000 DCD Revision 15 Tier 2 identify how COL application FSARs should be prepared to incorporate the subject changes.

The following changes to the DCD are necessary to incorporate the changes in pressure boundary materials, including Table 5.1-2.

- **Section 3.5.1.2.1 Page 3.5-8**

    - Gross failure of a control rod drive mechanism housing, sufficient to create a missile from a piece of the housing or to allow a control rod to be ejected rapidly from the core, is not considered credible. This is because of the same reasons listed above for the reactor vessel and other components and is based on the following:

        - The control rod drive mechanisms are shop hydrotested in excess of 150 percent of system design pressure.

        - The housings are individually hydrotested to 125 percent of system design pressure after they are installed on the reactor vessel to the head adapters. They are checked again during the hydrotest of the completed reactor coolant system.

        - The housings are made of Type 304 **or 316** stainless steels, which exhibits excellent notch toughness.

- **Section 3.9.4.1.1 Page 3.9-67**

    The design and construction of the control rod drive mechanism includes provisions to establish that gross failure of the housing sufficient to allow a control rod to be ejected from the core is not credible. These provisions include the following:

    - Construction of the housing of Type 304 **or 316** stainless steels, which exhibits excellent notch toughness at the temperatures that will be encountered.

- ***Section 4.5.1.1 Page 4.5-1***

  Pressure-containing materials comply with the ASME Code, Section III. The material specifications for portions of the control rod drive mechanism that are reactor coolant pressure boundary are included in Table 5.2-1. These parts are fabricated from austenitic (Type **316**, **316L**, 316LN and Type **304**, **304L**, 304LN) stainless steel. Nickel-chromium-iron alloy (Alloy 690) is used for the reactor vessel head penetration. For pressure boundary parts, austenitic stainless steels are not used in the heat-treated conditions which can cause susceptibility to stress-corrosion cracking or accelerated corrosion in pressurized water reactor coolant chemistry and temperature environments. Pressure boundary parts and components made of stainless steel do not have specified minimum yield strength greater than 90,000 psi.

- **Section 3B.2.1:**

Page 3B-2, Primary Loop Piping

Wall thinning by erosion and erosion-corrosion effects does not occur in the primary loop piping because ~~SA312TP316LN~~ **Series 300** austenitic stainless steel material is highly resistant to these effects.

Page 3B-3, Auxiliary Stainless Steel Piping

Wall thinning by erosion-corrosion effects does not occur in the auxiliary stainless steel piping because ~~SA312TP316LN and SA304TP304L~~ **Series 300** austenitic stainless materials are highly resistant to these effects. The coolant velocity in these systems is lower than in comparable systems in operating Westinghouse-designed pressurized water reactors. There is no record of erosion-corrosion induced wall thinning in the stainless steel piping of operating plants.

- **Section 3B.2.2:**

Page 3B-4, Primary Loop Piping

~~The SA312TP316LN austenitic stainless steel chosen for the AP1000 is resistant to stress corrosion cracking in a low- or no-oxygen environment. The "L" grades of austenitic stainless steel contain low carbon (less than 0.035 weight percent) which mitigates sensitization.~~

Series 300 stainless steel materials have been chosen for AP1000 due to their proven operating experience. These materials have operated in low- or no-oxygen environments with no incidents for a number of years. The requirements of Regulatory Guide 1.44 will be used to maintain the experiences of the PWR applications for the use of Series 300 stainless steel materials.

Page 3B-4, Auxiliary Loop Piping

~~The SA376TP316LN/SA312TP316LN/SA312TP304L austenitic stainless steel chosen for the auxiliary stainless steel piping of the AP1000 is resistant to stress corrosion cracking in a low- or no-oxygen environment. The "L" grades of austenitic stainless steel contain low carbon (less than 0.035 weight percent) which mitigates sensitization.~~

Series 300 stainless steel materials have been chosen for AP1000 due to their proven operating experience. These materials have operated in low- or no-oxygen environments with no incidents for a number of years. The requirements of Regulatory Guide 1.44 will be used to maintain the experiences of the PWR applications for the use of Series 300 stainless steel materials.

- **Section 5.2.3.4.6:**

  The welding materials used for fabrication and installation welds of austenitic stainless steel materials and components meet the requirements of Section III of the ASME Code. For applications using austenitic stainless steel welding material, the material conforms to ASME weld metal analysis A-8, Type 308, 308L, **309, 309L,** 316, or 316L.

- **DCD Section 5.2 Table 5.2-1 (Sheets 1-3)**

Table 5.2-1 (Sheet 1 of 3)

REACTOR COOLANT PRESSURE BOUNDARY MATERIALS SPECIFICATIONS

Component	Material	Class, Grade, or Type
Reactor Vessel Components		
Head plates (other than core region)	SA-533 or SA-508	~~GR~~ Type B, CL 1 or **GR 3 CL 1**~~3~~
Shell courses	SA-508	**GR 3 CL 1**~~3~~
Shell, flange, and nozzle forgings	SA-508	**GR 3 CL 1**~~3~~
Nozzle safe ends	SA-182	**F316, F316L,** F316LN
Appurtenances to the control rod drive mechanism (CRDM)	SB-167 **SB-166** or SA-182	~~TP690~~ **N06690** **N06690** or **F304, F304L,** F304LN, **F316, F316L,** F316LN
Instrumentation tube appurtenances, upper head	SB-167 **SB-166** or	~~TP690~~ **N06690** **N06690** or

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	SA-182,	F304, F304L, F304LN, F316, F316L, F316LN
	SA-312[(1)],	TP304, TP304L, F304LNTP304LN, TP316, TP316L, F316LNTP316LN
	SA-376	TP304, F304LNTP304LN, TP316, F316LNTP316LN
Closure studs	SA-540	GR B23 CL 3 or GR B24, CL 3
Monitor tubes and vent pipe	SA-312[(1)]	TP304, TP304L, TP304LN, TP316, TP316L, TP316LN
	or	
	SA-376	TP304, TP304LN, TP316, TP316LN
	or	
	SB-166, SB-167	TP690
	SA-182	F304, F304L, F304LN, F316, F316L, F316LN,
Vent Pipe	SB-166,	TP690N06690
	SB-167	TP690N06690
	or	
	SA-312[(1)]	TP304, TP304L, TP304LN, TP316, TP316L, TP316LN
	SA-376	TP304, TP304LN, TP316, TP316LN
Cladding, buttering, and welds	SFA-5.4, 5.9, 5.11, and 5.14	308L, 309L, ENiCrFe-7, or ERNiCrFe-7
Pressure boundary welds	Low alloy steel	SFA-5.5, 5.23, 5.28
Steam Generator Components		
Pressure plates	SA-533	GR Type B, CL 1
Pressure forgings (including nozzles and tube sheet)	SA-508	CL 3aGR 3, CL 2

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Nozzle safe ends	SA-182	**F316, F316L,** F316LN
Channel heads	SA-508	~~CL 3a~~**GR 3, CL 2**
Tubes	SB-163	~~TP690TT~~**N06690**
~~Cladding, buttering, and welds~~	~~SFA 5.4, 5.9, 5.11, and 5.14~~	~~308L, 309L, ENiCrFe-7, or ERNiCrFe-7~~
~~Pressure boundary welds~~	~~Low alloy steel~~	~~SFA 5.5, 5.23, 5.28~~
Manway studs~~/~~ ~~nuts~~**Nuts**	SA-193 SA-194	GR B7 **GR 2H**

Table 5.2-1 (Sheet 2 of 3)

REACTOR COOLANT PRESSURE BOUNDARY MATERIALS SPECIFICATIONS

Component	Material	Class, Grade, or Type
Pressurizer Components		
Pressure plates	SA-533	~~GR~~ Type B, CL 1
Pressure forgings	SA-508	**GR 3, CL 2**~~3~~
Nozzle safe ends	SA-182	**F316, F316L,** F316LN
~~Cladding, buttering, and welds~~	~~SFA 5.4, 5.9, 5.11, and 5.14~~	~~308L, 309L, ENiCrFe-7, or ERNiCrFe-7~~
~~Pressure boundary welds~~	~~Low alloy steel~~	~~SFA 5.5, 5.23, 5.28~~
Manway studs /Nnuts	SA-193 SA-194	GR B7 **GR 2H**
Reactor Coolant Pump		
Pressure forgings	SA-182 or SA-336	**F304, F304L,** F304LN, **F316, F316L,** F316LN **F304, F304L,** F304LN, **F316, F316L,** F316LN
Pressure casting	SA-351 ~~or SA-352~~	CF3A or **CF8A**
Tube and pipe	SA-213~~;~~ SA-376 or SA-312(1)	**TP304, TP304L,** TP304LN, **TP316, TP316L,** TP316LN **TP304,** TP304LN, **TP316,** TP316LN **TP304, TP304L,** TP304LN, **TP316, TP316L,** TP316LN
Pressure plates	SA-240	**304, 304L,** 304LN, **316, 316L,** 316LN
Closure bolting	SA-193 or SA-540	GR B7 or GR B24, CL 4, **or GR B23, CL 3 & 4**
~~Pressure boundary welds~~	~~Low alloy steel~~	~~SFA 5.5, 5.23, 5.28~~
Reactor Coolant Piping		

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Reactor coolant pipe	SA-376 SA-182(2)	**TP304**, TP304LN, **TP316**, TP316LN **F304, F304L, F304LN, F316, F316L, F316LN**
Reactor coolant fittings, branch nozzles	SA-376, SA-182	**TP304**, TP304LN, **TP316**, TP316LN **F304, F304L,** 304LN, **F316, F316L,** F316LN
Surge line	SA-376 **or** **SA-312(1)**	**TP304**, TP304LN, **TP316**, TP316LN **TP304, TP304L, TP304LN, TP316, TP316L, TP316LN**
RCP piping other than loop and surge line	SA-312(1) and SA-376	**TP304, TP304L,** TP304LN, **TP316, TP316L,** TP316LN **TP304**, TP304LN, **TP316**, TP316LN
~~Pressure boundary welds~~	~~Low alloy steel~~	~~SFA 5.5, 5.23, 5.28~~
CRDM		
Latch housing	SA-336	**F304, F304L,** F304LN, **F316, F316L,** F316LN
Rod travel housing	SA-336	**F304, F304L,** F304LN, **F316, F316L,** F316LN
~~Welding materials~~	~~SFA 5.4 or 5.9~~	~~308L, 309L~~

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Table 5.2-1 (Sheet 3 of 3)

REACTOR COOLANT PRESSURE BOUNDARY MATERIALS SPECIFICATIONS

Component	Material	Class, Grade, or Type
Valves		
Bodies	SA-182 or SA-351	**F304, F304L, F304LN, F316, F316L, F316LN** or CF3A, **CF3M, CF8**
Bonnets	SA-182; SA-240 or SA-351	**F304, F304L, F304LN, F316, F316L, F316LN** **304, 304L, 304LN, 316, 316L, 316LN** or CF3A, **CF3M, CF8**
Discs	SA-182; SA-564 or SA-351	**F304, F304L, F304LN, F316, F316L, F316LN** ~~or~~ **Type**~~GR~~ 630 **(H1100 or H1150),** or CF3A, **CF3M, CF8**
Stems	SA-479 ~~or~~ SA-564 **or** **SB-637**	316, ~~F~~316LN or **XM-19** ~~GR~~ **Type** 630 **(H1100 or H1150)** **Alloy N07718**
Pressure retaining bolting	SA-453 ~~or~~ SA-564 **SA-193**	GR 660, **Type**~~GR~~ 630 **(H1100)** **GR B8**
Pressure retaining nuts	SA-453	GR 660

	or SA-194	or GR 6 or 8~~TP410~~
Core Makeup Tank		
Pressure plates	SA-533 or SA-240	Type~~GR~~ B, CL 1 or 304, 304L, 304LN, 316, 316L, 316LN
Pressure forgings	SA-508 or SA-182~~,~~ SA-336	GR 3 CL 1~~3~~ or F304,F304L, F316, F316L F304,F304L, F316, F316L
~~Cladding, buttering, and welds~~	~~SFA 5.4, 5.9, 5.11, and 5.14~~	~~308L, 309L, ENiCrFe-7, or ERNiCrFe-7~~
~~Pressure boundary welds~~	~~Low alloy steel~~	~~SFA 5.5, 5.23, 5.28~~
Passive Residual Heat Removal Heat Exchanger		
Pressure plates	SA-533 or SA-240	Type B CL 1 or 304, 304L, 304LN
Pressure forgings	SA-508 or SA-336	GR 3 CL 2 or F304, F304L, F304LN
~~Cladding, buttering, and welds~~	~~SFA 5.4, 5.9, 5.11, and 5.14~~	~~308L, 309L, ENiCrFe-7, or ERNiCrFe-7~~
~~Pressure boundary welds~~	~~Low alloy steel~~	~~SFA 5.5, 5.23, 5.28~~
Tubing	SB-163	~~TP~~ N06690
Welding Consumables		
Corrosion resistant cladding, buttering, and welds	**SFA 5.4 and 5.9** **SFA 5.11**	**E308, E308L, E309, E309L, E316, E316L, ER308, ER308L, ER309, ER309L, ER316, ER316L** **ENiCrFe-7**

	SFA 5.14	ERNiCrFe-7/A
Low Alloy Pressure Boundary welds	SFA 5.5, 5.23, 5.28	To be compatible with base materials

Notes: (1) limited to seamless form only

(2) subject to manufacturing sequence and final finish condition review

- **DCD Table 5.3-1, Page 5.3-24**

Table 5.3-1 MAXIMUM LIMITS FOR ELEMENTS OF THE REACTOR VESSEL		
Element	**Beltline Forging (percent)**	**As Deposited Weld Metal (percent)**
Copper	0.~~03~~06	0.~~03~~06
Phosphorus	0.01	0.01
Vanadium	0.05	0.05
Sulfur	0.01	0.01
Nickel	0.85	0.85

- **DCD Table 5.3-3, Page 5.3-27**

Table 5.3-3 END-OF-LIFE RT_{NDT} AND UPPER SHELF ENERGY PROJECTIONS				
	Unirradiated		**End-of-life (54 EFPY)**	
	RT_{NDT} (°F)	**USE (ft-lb)**	**USE (ft-lb) 1/4T**	**RT_{PTS} (°F)**
Beltline Forging	-10	> 75	> 50	< 270(2)
Head	10	N/A	N/A	N/A

Flange	10	N/A	N/A	N/A
Weld	10	N/A	N/A	N/A
Beltline Weld	-20	> 75	> 50	< 300[2]

Notes:
1) The minimum unirradiated upper shelf energy for beltline base metal is for the transverse direction.
2) End-of-Life RT_{PTS} requirements shown. End-of-Life RT_{PTS} (also equals RT_{NDT}) will be determined for as-built material. The preliminary RT_{PTS} for the AP1000 reactor vessel beltline forging and beltline weld are ~~66~~**94**°F and ~~98~~**148**°F, respectively.

DCD Figure 5.3-2, Page 5.3-31

Current (DCD Revision 15) Figure

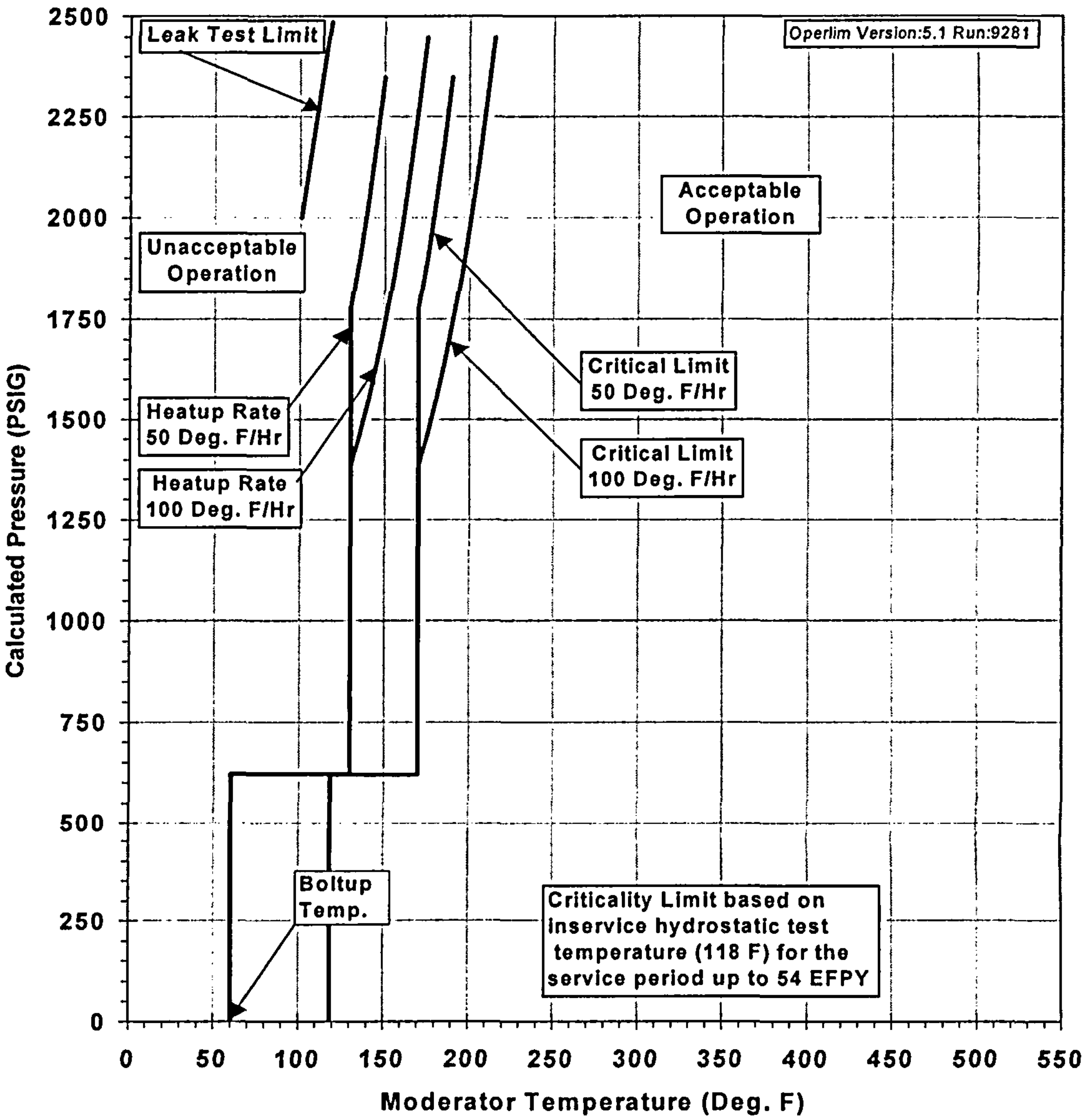

Figure 5.3-2
AP1000 Reactor Coolant System Heatup Limitations (Heatup Rate Up to 50° and 100°F/hour) Representative for the First 54 EFPY (Without Margins for Instrumentation Errors)

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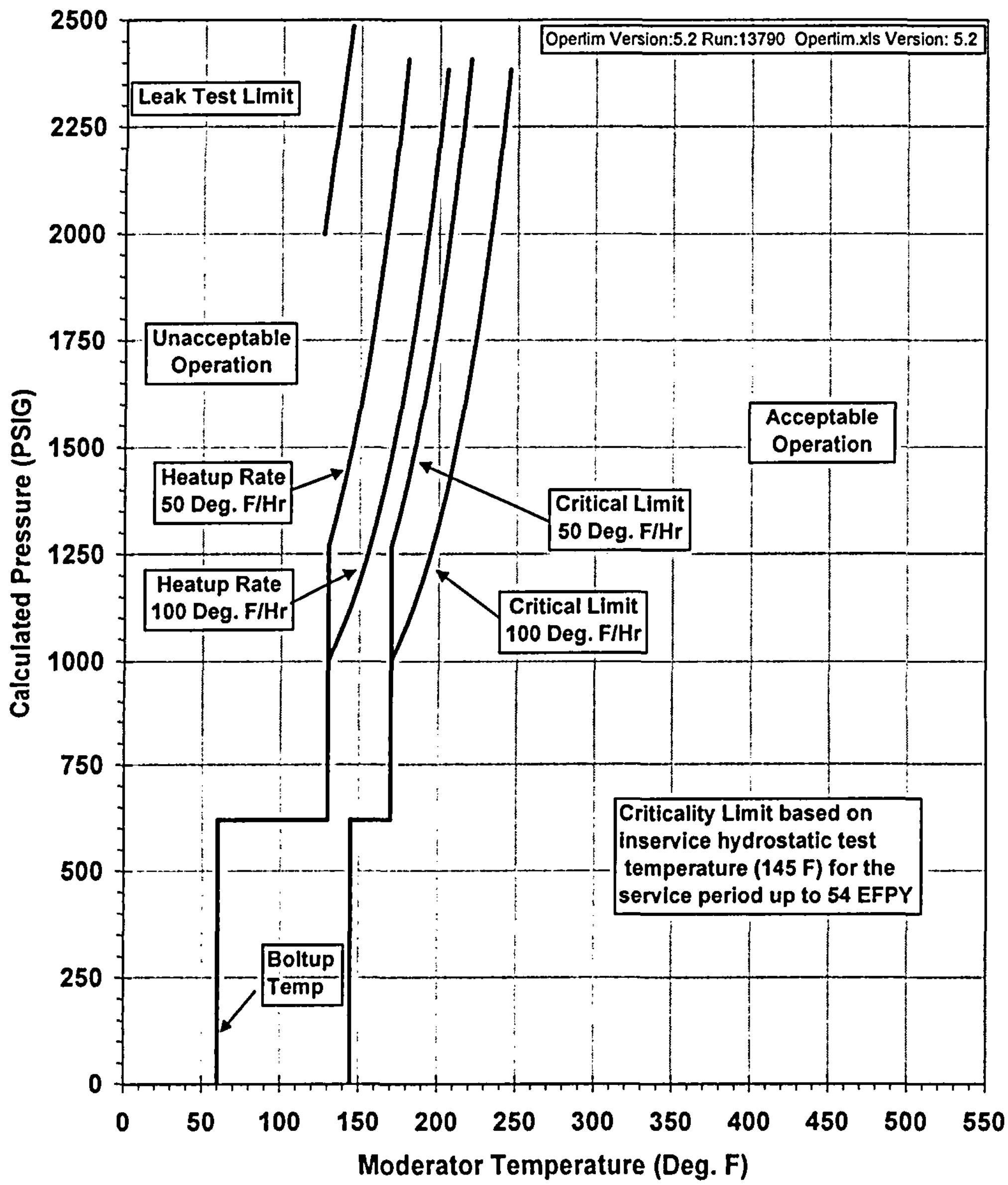
DCD Figure 5.3-2, Page 5.3-31

Revised Figure

AP1000: 54 EFPY Curve, using 1996 App. G w/Kic, w/ flange, w/o margins; dated August 24, 2006



DCD Figure 5.3-3, Page 5.3-32

Current (DCD Revision 15) Figure

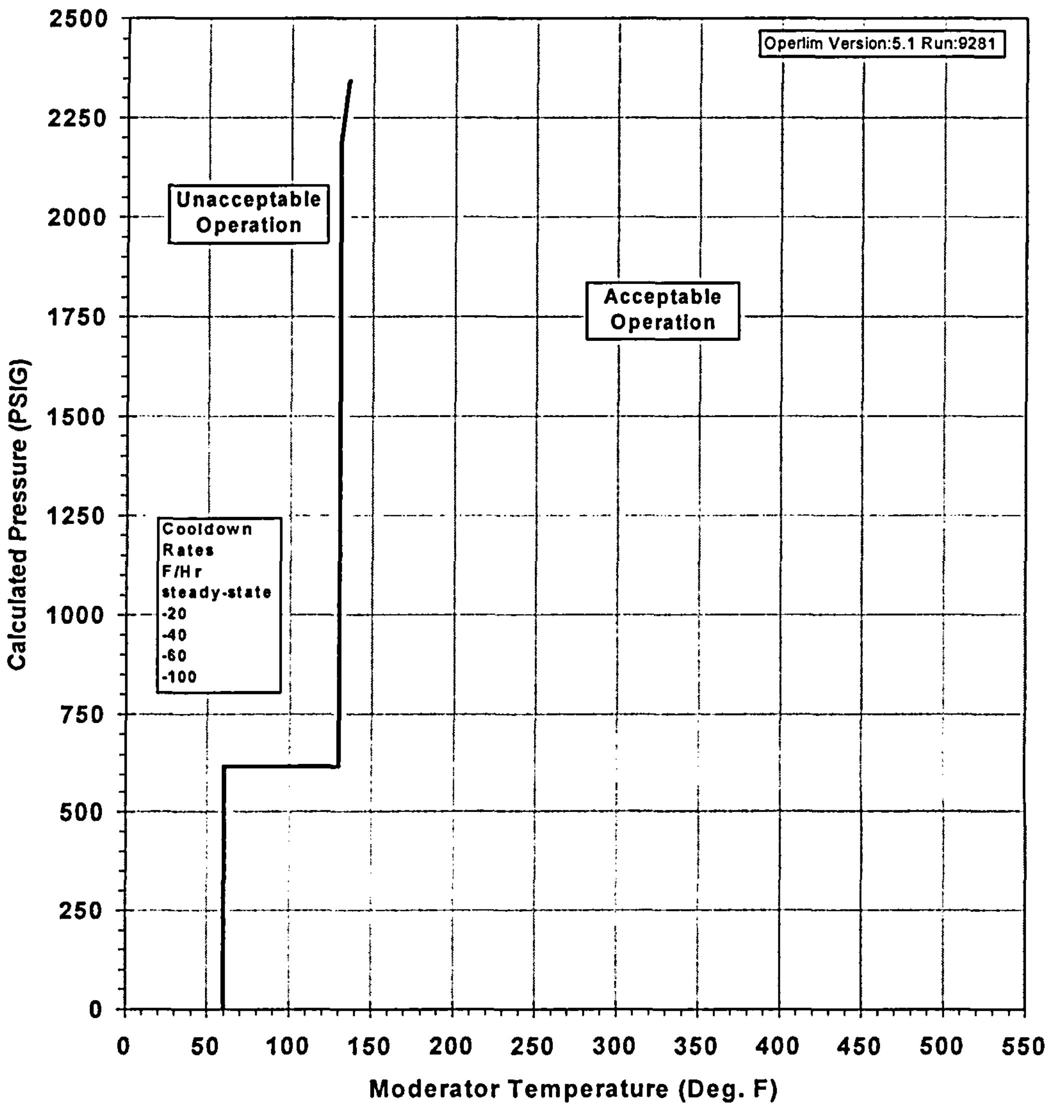


Figure 5.3-3

AP1000 Reactor Coolant System Cooldown Limitations (Cooldown Rates up to 50° and 100°F/hour) Representative for the First 54 EFPY (Without Margins for Instrumentation Errors)

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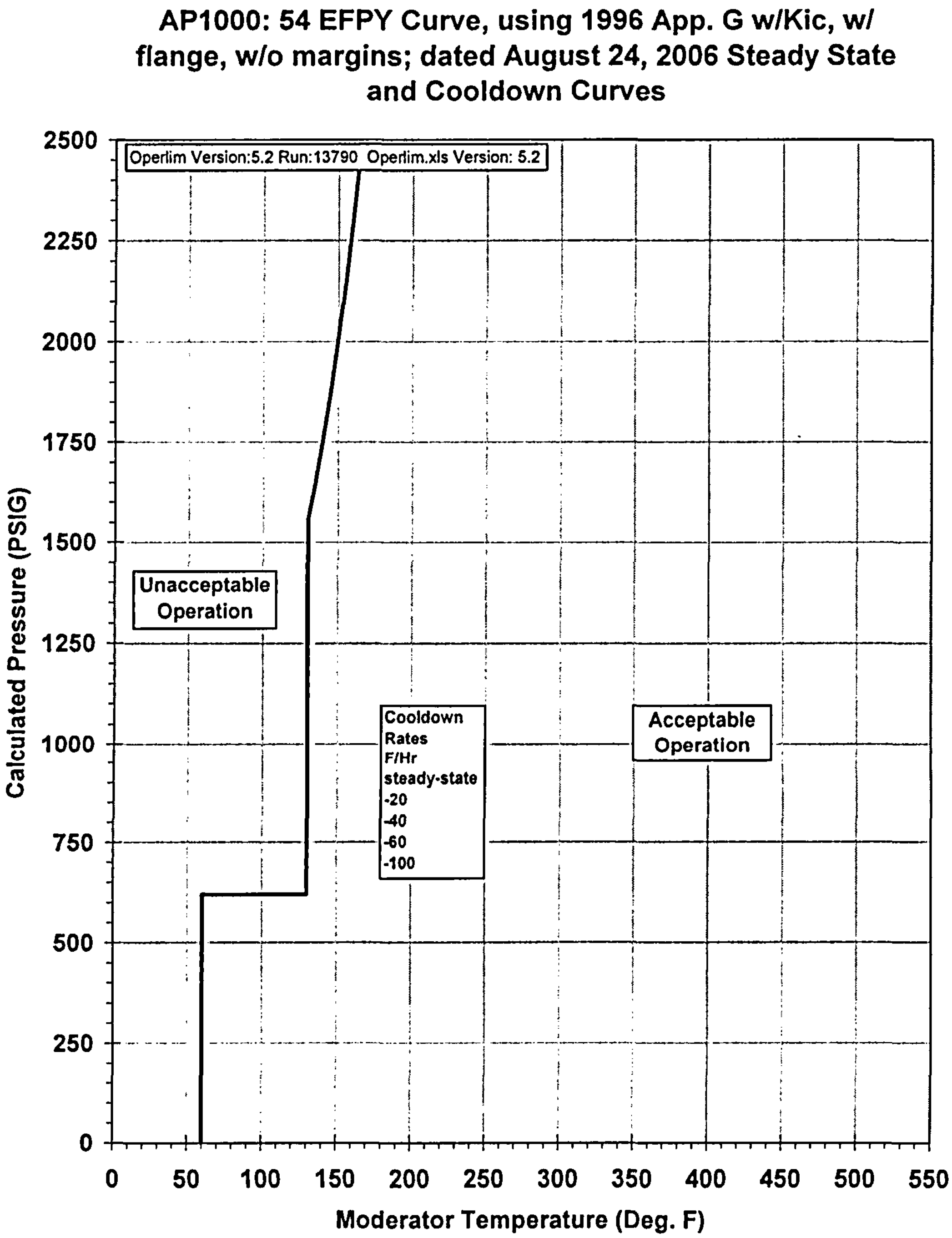
DCD Figure 5.3-3, Page 5.3-32

Revised Figure



Section 5.2.3.4.6, 10th Paragraph, Page 5.2-17

~~Bare weld filler metal, including consumable inserts, used in inert gas welding processes conforms to ASME SFA 5.9. The metal is procured to contain not less than 5 FN or more than 13 FN delta ferrite according to Section III of the ASME Code. Weld filler metal materials used in flux-shielded welding processes conform to ASME SFA 5.4 or 5.9. They are procured in a wire-flux combination to be capable of providing not less than 5 FN or more than 13 FN delta ferrite in the deposit, according to Section III of the ASME Code.~~

Delta ferrite determinations of austenitic stainless steel weld filler materials to be used with gas tungsten arc welding (GTAW) and plasma arc welding (PAW) processes and any other welding material to be used with any GTAW, PAW, or gas metal arc welding (GMAW) process, including consumable insert material, shall be made using a magnetic measuring instrument and weld deposits made in accordance with ASME Code, Section III, NB-2432.1(c) or (d) or, alternatively, the delta ferrite determinations for welding materials may be performed by the use of chemical analysis performed either on the filler metal or on an undiluted weld deposit made in accordance with NB-2432. The allowable delta ferrite range shall be 5 FN to 20 FN for the weld material with low molybdenum content, and 5 FN to 16 FN for weld materials with higher molybdenum content such as Types 316/316L, which contain 2.0 to 3.0% molybdenum.

Delta ferrite determinations of austenitic stainless steel weld filler materials to be used with flux welding processes, such as shielded metal arc welding (SMAW), submerged arc welding (SAW) or for electro-slag weld (ESW) deposited cladding and other welding material to be used with other than the GTAW, PAW, or GMAW process shall be made using a magnetic measuring instrument and weld deposits made in accordance with ASME Code, Section III, NB-2432.1(c) or (d) or, alternatively, the delta ferrite determinations may be performed by the use of chemical analysis of the undiluted weld deposit of NB-2432 in conjunction with Figure NB-2433.1-1. The allowable delta ferrite range shall be 5 FN to 20 FN for the weld material with low molybdenum content, and 5 FN to 16 FN for weld materials with higher molybdenum content such as Types 316/316L, which contain 2.0 to 3.0% molybdenum.

V. REGULATORY IMPACT

A. FSER IMPACT

The pressure boundary material selection is addressed in subsection 5.2.3 of the NRC Final Safety Evaluation Report (FSER). The reactor coolant pump casing material is discussed in subsection 5.2.3.2. Since casing materials SA-351 CF3A and SA-352 are specifically included in the discussion, this discussion would change with the addition of SA-351 CF8A and the deletion of SA-352 materials. The conclusion that thermal aging should not have a significant impact on the integrity of the reactor coolant pump casing is not impacted.

In subsection 5.3.2.2, it is stated that the copper content for welds and forgings is limited to 0.03 percent. *The maximum copper content will need to be revised to 0.06 percent. This change will not* impact the conclusion that the required fracture toughness is provided to ensure structural integrity of the reactor vessel.

In section 5.3.3.1, the maximum limit for the copper is stated as 0.03 wt %. The maximum copper content will need to be revised to 0.06 percent. The revised P/T curves resulting from the increase in copper content have been developed and are included as revisions to the generic curves provided in DCD Tier 2. The conclusion in subsection 5.3.3.3 that the P/T limits imposed on the RCS for operating and testing conditions are in conformance with the fracture toughness criteria of Appendix G to 10 CFR Part 50 is not impacted.

Even though the RT_{PTS} values increase with the revised maximum copper content, the conclusion of subsection 5.3.4.3 that the AP1000 reactor vessel meets the relevant requirements of 10 CFR 50.61 is not impacted.

In subsection 4.5.1.1, there is a discussion of the pressure boundary material for the control rod drive mechanism (CRDM). The materials specified in the discussion are Type 316LN and Type 304LN. Due to the addition of materials, Types 304, 304L, 316 and 316L, the description should be changed to Type 316 and Type 304 stainless steels. This change does not impact the conclusions in the subsection 4.5.1.3 relative to the acceptability of the pressure boundary materials.

B. SCREENING QUESTIONS (Check correct response and provide justification for that determination under each response)

1. Does the proposed change involve a change to an SSC that adversely affects a DCD described design function? ☐ YES ☒ NO

   The pressure boundary design function is not altered by increasing the material choices available for component fabrication, nor by the change in material chemical composition and delta ferrite limits.

2. Does the proposed change involve a change to a procedure that adversely affects how DCD described SSC design functions are performed or controlled? ☐ YES ☒ NO

The additional materials choices and the changes to the chemical composition and delta ferrite limits will not affect the reactor coolant system pressure boundary design function or how the reactor coolant system operates.

3. Does the proposed activity involve revising or replacing an DCD described evaluation methodology that is used in establishing the design bases or used in the safety analyses? ☐ YES ☒ NO

The additional materials choices and the changes to the chemical composition and delta ferrite limits will not change the structural analysis methodology used to ensure the integrity of the reactor coolant system pressure boundary.

4. Does the proposed activity involve a test or experiment not described in the DCD, where an SSC is utilized or controlled in a manner that is outside the reference bounds of the design for that SSC or is inconsistent with analyses or descriptions in the DCD? ☐ YES ☒ NO

The additional materials choices and the changes to the chemical composition and delta ferrite limits will not require an additional test or experiment or changes to completed testing.

C. EVALUATION OF DEPARTURE FROM TIER 2 INFORMATION (Check correct response and provide justification for that determination under each response)

10 CFR Part 52, Appendix D, Section VIII. B.5.a. provides that an applicant for a combined licensee who references the AP1000 design certification may depart from Tier 2 information, without prior NRC approval, if it does not require a license amendment under paragraph B.5.b. The questions below address the criteria of B.5.b.

1. Does the proposed departure result in more than a minimal increase in the frequency of occurrence of an accident previously evaluated in the plant-specific DCD? ☐ YES ☒ NO

The additional materials choices and the changes to the chemical composition and delta ferrite limits will not increase the frequency of occurrence of an accident because there is no significant increase in the probability of failure of the pressure boundary.

2. Does the proposed departure result in more than a minimal increase in the likelihood of occurrence of a malfunction of a structure, system, or component (SSC) important to safety and previously evaluated in the plant-specific DCD? ☐ YES ☒ NO

The strength of the pressure boundary materials is not affected, therefore there is no increase in the probability of failure of the pressure boundary as a result of the additional materials choices and the changes to the chemical composition and delta ferrite limits.

3. Does the proposed departure result in more than a minimal increase in the consequences of an accident previously evaluated in the plant-specific DCD? ☐ YES ☒ NO

   The additional materials choices and the changes to the chemical composition and delta ferrite limits will have no impact on the consequences of an accident.

4. Does the proposed departure result in more than a minimal increase in the consequences of a malfunction of an SSC important to safety previously evaluated in the plant-specific DCD? ☐ YES ☒ NO

   The additional materials choices and the changes to the chemical composition and delta ferrite limits will not impact the integrity of the reactor coolant system pressure boundary and therefore will not increase the consequences of a malfunction of an SSC important to safety.

5. Does the proposed departure create a possibility for an accident of a different type than any evaluated previously in the plant-specific DCD? ☐ YES ☒ NO

   The additional materials choices and the changes to the chemical composition and delta ferrite limits will not impact the response of the reactor coolant system to postulated accident conditions. The changes also do not introduce any additional failure modes. Therefore, these changes will not result in an accident of a type different than what has already been evaluated in the DCD.

6. Does the proposed departure create a possibility for a malfunction of an SSC important to safety with a different result than any evaluated previously in the plant-specific DCD? ☐ YES ☒ NO

   The additional materials choices and the changes to the chemical composition and delta ferrite limits will not result in any impact to the reactor coolant system pressure boundary integrity, and therefore there it will not impact a malfunction of an SSC to cause a different result than what has been evaluated previously.

7. Does the proposed departure result in a design basis limit for a fission product barrier as described in the plant-specific DCD being exceeded or altered? ☐ YES ☒ NO

   The additional materials choices and the changes to the chemical composition and delta ferrite limits will not result in any impact to the reactor coolant system pressure boundary integrity and thus will not result in a design basis limit for a fission product barrier being exceeded.

8. Does the proposed departure result in a departure from a method of evaluation described in the plant-specific DCD used in establishing the design bases or in the safety analyses? ☐ YES ☒ NO

   The additional materials choices and the changes to the chemical composition and delta ferrite limits will not alter the methodology used in verifying the structural integrity of the reactor coolant system pressure boundary or in performing the safety analyses.

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☒ The answers to the evaluation questions above are "NO" and the proposed departure from Tier 2 does not require prior NRC review to be included in plant specific FSARs as provided in 10 CFR Part 52, Appendix D, Section VIII. B.5.b

☐ One or more of the the answers to the evaluation questions above are "YES" and the proposed change requires NRC review.

D. IMPACT ON RESOLUTION OF A SEVERE ACCIDENT ISSUE

10 CFR Part 52, Appendix D, Section VIII. B.5.a. provides that an applicant for a combined licensee who references the AP1000 design certification may depart from Tier 2 information, without prior NRC approval, if it does not require a license amendment under paragraph B.5.c. The questions below address the criteria of B.5.c.

1. Does the proposed activity result in an impact on features that mitigate severe accidents. If the answer is Yes answer Questions 2 and 3 below. ☐ YES ☒ NO

   The additional materials choices and the changes to the chemical composition and delta ferrite limits will not have an impact on the reactor coolant system pressure boundary integrity or any features that mitigate severe accidents.

2. Is there is a substantial increase in the probability of a severe accident such that a particular severe accident previously reviewed and determined to be not credible could become credible? ☐ YES ☐ NO ☒ N/A

3. Is there is a substantial increase in the consequences to the public of a particular severe accident previously reviewed? ☐ YES ☐ NO ☒ N/A

☒ The answers to the evaluation questions above are "NO" or are not applicable and the proposed departure from Tier 2 does not require prior NRC review to be included in plant specific FSARs as provided in 10 CFR Part 52, Appendix D, Section VIII. B.5.c

☐ One or more of the answers to the evaluation questions above are "YES" and the proposed change requires NRC review.

E. SECURITY ASSESSMENT

1. Does the proposed change have an adverse impact on the security assessment of the AP1000. ☐ YES ☒ NO

   The additional materials choices and the changes to the chemical composition and delta ferrite limits will not alter barriers or alarms that control access to protected areas of the plant. The changes to the pressure boundary materials will not alter requirements for security personnel.