

## Chapter 4 From Revision 1 to Revision 2 Change List

Item	Location	Description of Change
1	S4.1	Rewrote second paragraph to eliminate reference to typical fuel and control rod designs.
2	S4.1.2.1.3	Added reference to Subsection 4.1.2.
3	S4.1.5	Changed title to “COL Unit-Specific Information”
4	S4.2.1.1.4	Changed Reference “4.2-2” to “4.2-10”.
5	S4.2.2.2, 2 <sup>nd</sup> paragraph	Added a description of the handle pads on the control rod.
6	S4.2.4.2	Revised to delete reference to Operating Basis Earthquake (OBE) and clarify the details of the SSE analysis.
7	S4.2.4.5	Added clarification of control rod load combinations.
8	S4.2.4.7	Changed “13 years” to “15 years” and deleted citation of Reference 4.2-8.
9	S4.2.4.8	Deleted citation of Reference 4.2-8.
10	S4.2.4.9, 2 <sup>nd</sup> paragraph	Change “17 years” to “18 years”.
11	S4.2.6	Changed title to “COL Unit-Specific Information”
12	S4.2.7	Changed date of Reference 4.2-4 to “January 2006”. Deleted “scheduled” from Reference 4.2-5 Changed date of Reference 4.2-8 to “June 2006”. Changed date of Reference 4.2-9 to “May 2006”. Added new Reference 4.2-10 per RAI 4.2-3.
13	F4.2-3	Figure redrawn.
14	F4.2-4	Control rod configuration data and dimensions updated to reflect current design.
15	S4.3.3.2.3	Subsection completely revised to update the moderator temperature coefficient evaluation discussion per RAI 4.3-5.
16	S4.3.5	Changed title to “COL Unit-Specific Information”

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17	S4.4.2.1.1	<p>Revised as follows per RAI 4.4-5:</p> <p>The bundle critical power performance methodology is described in References 4.4-8 and 4.4-16. These references describe the form of the GEXL correlation and the experimental qualification that demonstrates the GEXL correlation adequately predicts the bundle critical power over a wide range of fluid parameters, axial power shapes and heated lengths. Each fuel bundle design has a specific set of correlation coefficients developed from full-scale test data. The specific GEXL correlation applied in the analysis of GE14E for ESBWR is designated GEXL14. The applicability of GEXL14 to GE14E is addressed in Reference 4.4-12.</p>
18	S4.4.2.1.2, 1 <sup>st</sup> paragraph	<p>Revised the first four sentences as follows per RAI 4.4-56:</p> <p>The statistical analysis utilizes a model of the core that simulates the core monitoring system. The model produces a critical power ratio (CPR) map of the core based on steady-state uncertainties defined in Table 5-1 of Reference 4.4-12. This is coupled with the TRACG <math>\Delta</math>CPR/ICPR results to develop the OLMCPR. Details of the procedure are documented in Section 5.13 of Reference 4.4-12 and Subsection 4.6.3 of Reference 4.4-9.</p>
19	S4.4.2.2	<p>Rewritten as follows for clarity per RAI 4.4-2:</p> <p>The empirical correlations used for the calculation of the void fraction are the GE void fraction correlation that is used in the 3D core simulator and steady state thermal hydraulic calculations and the correlations for the interfacial shear that is used in TRACG. The GE void fraction model is described in Reference 4.4-15, and details on the qualification are contained in Attachment A to Reference 4.4-13. The TRACG void fraction model is described in Reference 4.4-10 and details on the qualification are contained in Reference 4.4-11.</p>
20	S4.4.2.3.3, definition of incremental length	<p>Typographical correction. Changed "<math>\Delta_L</math>" to "<math>\Delta L</math>".</p>

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21	S4.4.3.1.2	Revised as follows per RAI 4.4-19: The Fuel Cladding Integrity Safety Limit (FCISL) is defined as 99.9% of the total fueled rods are expected to avoid boiling transition during normal operation and AOOs. Section 6 of Reference 4.4-12 provides a summary of the basis for the representative operating limit MCPR used for the ESBWR to protect the FCISL. Section 5 of Reference 4.4-12 provides the basis for the uncertainties specific to the ESBWR used in this evaluation.
22	S4.4.3.2, 2 <sup>nd</sup> paragraph	Added “(References 4.4-11 and 4.4-15)” per RAI 4.4-2.
23	S4.4.5	Loose Parts Monitoring System subsection is deleted per RAIs 4.4-7, 4.4-8 and 4.4-9.
24	S4.4.6	Renumbered 4.4.5
25	S4.4.7	Renumbered 4.4.6.
26	S4.4.7	Changed title to “COL Unit-Specific Information”
27	S4.4.8	Renumbered 4.4.7
28	S4.4.8	Revised reference 4.4-10 as follows per per RAI 4.4-2: GE Nuclear Energy, “Licensing Topical Report TRACG Model Description”, NEDE-32176P, Revision 3, Class III (proprietary), April 2006.
29	S4.4.8	Revised reference 4.4-12 as follows per per RAI 4.4-19: Nuclear Energy, “GE14 for ESBWR Critical Power Correlation, Uncertainty, and OLMCPR Development”, NEDC-33237 P, Revision 1, Class III (proprietary), scheduled October 2006.
30	S4.4.8	Added reference 4.4-15 as follows per RAI 4.4-2: “TASC-03A, A Computer Program for Transient Analysis of a Single Channel”, NEDC-32084P-A, Revision 2, Class III (proprietary), July 2002
31	S4.4.8	Added reference 4.4-16 as follows per RAI 4.4-5: Letter, J.S. Charnley (GE) to C. O. Thomas (NRC), Amendment 15 to General Electric Licensing Topical Report NEDE-24011-P-A, January 25, 1986
32	T4.4-6	Typographical correction: superscript “ <sup>3</sup> ” removed from the “Elevation of Bottle Volume (m)” table heading
33	S4.5.1.1, Materials, 2 <sup>nd</sup> paragraph	Changed “Regulatory Guide 1.85” to “Regulatory Guide 1.84” per RAI 4.5-26.

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34	S4.5.1.2.1, 1 <sup>st</sup> paragraph	Revised to clarify CRD practice for routine inspection and delete COL item.
35	S4.5.1.4, 2 <sup>nd</sup> paragraph from the end	Change from “NQA-1, Part 2.2” to “NQA-2-1983, Part 2.2” per RAI 4.5-30.
36	S4.5.2.3	Section title changed to “Non-Destructive Examination” and text changed as follows per RAI 4.5-11: Materials for core support structures will fully conform and be certified to ASME Section III, Subsection NG. Examination of materials (examination methods and acceptance criteria) is specified in NG-2500. Examination methods and acceptance criteria for core support structure weld edge preparations and welds are provided in NG-5000. Tubular products that are pressure boundary components (CRD and in-core housings) will be examined according to ASME Section III, NB-2500, and associated pressure retaining welds will be examined according to NB-5000. For non-ASME Code reactor internal structures and associated welds, examinations are established based on relevant design and analysis information, and take guidance from NG-2500 and NG-5000 respectively.
37	S4.5.2.4, 1 <sup>st</sup> paragraph, following the 4 <sup>th</sup> sentence	Added the following text per RAI 4.5-32: ESBWR will comply fully with Regulatory Guide 1.31, “Control of Ferrite Content in Stainless Steel Weld Metal”, including application of the following provisions to all stainless steel weld filler metal applied to reactor internal components:
38	S4.5.2.4, 1 <sup>st</sup> paragraph, following the 6 <sup>th</sup> sentence	Added the following text per RAI 4.5-32: Ferrite content will be determined by use of magnetic instruments calibrated according to AWS A4.2.
39	S4.5.2.5, following last paragraph	Added the following paragraph per RAI 5.3-2: Use of Alloy 182 is prohibited in contact with reactor water.
40	S4.5.3	Changed title to “COL Unit-Specific Information”.
41	S4.5.3.1	Deleted and replaced with “None.”
42	T4.5-1	Table 4.5-1 replaced in its entirety per RAIs 4.5-1, 4.5-6 and 4.5-13.
43	T4.5-1	Added the following footnotes per RAIs 4.5-4 and 4.5-5: 1) Also called Niobium in countries outside the U.S 2) Maximum carbon content limited to 0.02% except for castings
44	S4.6, last paragraph	Added “GDC 4” per RAI 4.6-5.

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45	S4.6.1.2, end of subsection	<p>Added the following text per RAI 14.3-3:</p> <p>The CRD System is arranged in a manner that separates the safety related equipment from the non-safety related portions of the system. The FMCRDs are mounted to the reactor vessel bottom head inside primary containment. The HCUs are housed in four dedicated rooms located directly outside of the primary containment at the basemat elevation of the reactor building. These rooms are arranged around the periphery of the primary containment wall. Each HCU room serves the FMCRDs associated with one quadrant of the reactor core. The HCUs are connected to the FMCRDs by the scram insert piping that penetrates the primary containment wall.</p> <p>The balance of the non-safety related hydraulic system equipment (pumps, valves, filters, etc.) is physically separated from the HCUs and housed in a separate room in the reactor building. It is connected to the HCUs by the non-safety related FMCRD purge water header, HCU charging water header and scram air header. These headers are classified as Seismic Category II so that they will maintain structural integrity during a seismic event and not degrade the functioning of the HCUs.</p>
46	S4.6.1.2.1, 2 <sup>nd</sup> sentence	<p>Revised as follows per RAI 4.6-21:</p> <p>An electric motor-driven ball-nut and ball screw assembly is capable of positioning the drive at both a minimum of 36.5 mm (1.44 in.) increments and continuously over its entire range at a speed of <math>28 \pm 5</math> mm/sec.</p>
47	S4.6.1.2.5, Scram, 2 <sup>nd</sup> paragraph	<p>Revised as follows per RAI 4.6-24:</p> <p>Table 4.6-2 shows the scram performance provided by the CRD system at full power operation, in terms of the maximum elapsed time for each control rod to attain the listed scram position (percent insertion) after loss of signal to the scram solenoid pilot valves (time zero).</p>
48	S4.6.1.2.5, Alternate Rod Insertion, following the first paragraph	<p>Added the following new paragraph per RAI 4.6-8:</p> <p>The FMCRDs are capable of inserting the control rods hydraulically during ATWS pressure transients with peak reactor pressures of 10.34 MPaG (1500 psig) or less.</p>
49	S4.6.3.5, 1 <sup>st</sup> and 2 <sup>nd</sup> sentences	<p>Changed first sentence to read, "The surveillance requirements for the CRD system are described as follows:" and deleted the second sentence.</p>

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50	S4.6.3.5, 5 <sup>th</sup> bullet	Add the following text at the end per RAI 4.6-33: However, an additional test of a representative sample of the control rods, as defined in the plant Technical Specifications, is performed every 120 days of cumulative operation in Mode 1.
51	S4.6.3.5, following the 5 <sup>th</sup> bullet	Added the following new bullet per RAI 4.6-36: Each affected control rod is subjected to scram tests from the fully withdrawn position following work on the control rod or CRD system that could affect scram time, and after fuel movement has occurred within the affected cell.
52	S4.6.3.5, last bullet	Revised as follows per RAI 4.6-35: The high-pressure makeup mode of operation is tested every refueling outage to verify the automatic response of the system to a simulated or actual initiation signal. Every three months each CRD pump is tested to verify that it can develop the required flow rate for high-pressure makeup against a system head corresponding to the required reactor pressure. This test uses the system test return line to the CST.
53	S4.6.6	Changed title to “COL Unit-Specific Information”.
54	F4.6-8	Revised to move the check valves to the upstream side of the injection valves per RAI 4.6-17.
55	F4.6-9	Revised Note 14 and deleted COL item.
56	S4A.3	Changed title to “COL Unit-Specific Information”.
57	S4B.11	Changed title to “COL Unit-Specific Information”.
58	S4C.3	Changed title to “COL Unit-Specific Information”.
59	S4D.1.1, 2 <sup>nd</sup> paragraph	Per RAI 4.4-10, deleted first sentence and replaced the remainder of the paragraph after the fourth sentence with the following: “Rather than modifying the operating plant stability map, the regional decay ratio will be calculated directly and compared with an acceptance criterion of 0.8. The margin of 0.2 in the calculation of the regional decay ratio is reasonable and consistent with the values for the channel and core decay ratios. Figure 4.D-1 shows the three-dimensional stability map and the design criteria for channel, core and regional stability.”
60	S4D.1.1, 3 <sup>rd</sup> paragraph	Rewritten for consistency with revised design criteria per RAI 4.4-10.

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61	S4D.1.1, 4 <sup>th</sup> paragraph	Rewritten for consistency with revised design criteria per RAI 4.4-10.
62	S4D.1.3.1, 5 <sup>th</sup> paragraph	Deleted first sentence and first four words of second sentence per RAI 4.4-10.
63	S4D.1.3.1, last paragraph	Rewritten for clarity per RAI 4.4-10.
64	S4D.1.4.3	New Section added to respond to NRC RAI 4.4-10.
65	S4D.1.4.4, 1 <sup>st</sup> paragraph	Revised for consistency with revised design criteria per RAI 4.4-10.
66	S4D.2.2.2, last paragraph	Revised for consistency with following section per RAI 4.4-10.
67	S4D.2.2.3	New Section added to respond to NRC RAI 4.4-10.
68	S4D.3	Changed title to “COL Unit-Specific Information”.
69	S4D.3, 1 <sup>st</sup> paragraph	Replaced “4D.1.4.3” by “4D.1.4.4”
70	T4D-2, last row	Replaced “0.37” with “0.40” per RAI 4.4-10
71	T4D-3	Per RAI 4.4-10: Row 1, Replaced “0.51” with “0.50” Row 2, Replaced “0.5” with “0.8” Row 3 added
72	F4D-1	Replaced figure to reflect updated stability criteria per RAI 4.4-10.
73	F4D-3	Replaced figure to reflect updated stability criteria per RAI 4.4-10.
74	F4D-24 through 30	Additional figures that go with new section 4D.2.2.3 per 4.4-10.