Entergy

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August 1, 2017

RBG-47773

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Subject: Supplement to License Renewal Application
River Bend Station – Unit 1
Docket No. 50-458
License No. NPF-47

References: 1. License Renewal Application, River Bend Station letter no. RBG-47735, dated May 25, 2017

2. NRC letter dated July 10, 2017, River Bend Station, Unit 1 License Renewal Application – Supplemental Information Needed for Acceptance of Requested Licensing Action (CAC No. MF9747)

Dear Sir or Madam:

By way of Reference 1, Entergy Operations, Inc. submitted an application for renewal of the operating license for River Bend Station, extending its license term to August 29, 2045.

On July 10, 2017, RBS received by way of Reference 2 a request that the application be supplemented with certain information.

Attachments 1 and 2 to this letter contain the requested information. This document contains no commitments. If you require additional information, please contact the Manager – Regulatory Assurance, Mr. Tim Schenk, at 225-381-4177.

I declare under penalty of perjury that the foregoing is true and correct. Executed on August 1, 2017.

Sincerely,

SPV/dhw

Attachments
RBF1-17-0083

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Attachment 1 to
RBG-47773

Supplement to License Renewal Application

Question 1:

The list of transients for Class 1 components in RBS LRA Table 4.3-1 is not consistent with the transient sets defined in the subsections of Updated Safety Analysis Report (UFSAR) Chapter 3.9.1B or in UFSAR Table 3.9B-1. With this inconsistency, the staff is unable to evaluate the fatigue monitoring methodology against specific transient sets defined for components in the UFSAR, or evaluate Entergy's acceptance of fatigue time-limited aging analysis (TLAA) for Class 1 components using 10 CFR § 54.21(c)(1)(iii) and the Fatigue Monitoring AMP.

Response:

Updated Safety Analysis Report (USAR) Section 3.9.1B, including Table 3.9B-1, identifies the transients which were used in the design of major NSSS ASME Section III, Code Class 1 and Class 2 components. RBS LRA Table 4.3-1 defines the transients used in Class 1 fatigue analyses that require tracking. Differences can occur for a number of reasons. For example, emergency and faulted events do not require tracking because they are infrequent events. Therefore, apparent inconsistencies are not unexpected.

LRA Table 4.3-1 summarizes the results from RBS calculation 6247.547-604-014, "Adequacy of Cycles Being Tracked for Fatigue Monitoring," which was generated to determine the transients that must be tracked to ensure the ongoing validity of fatigue analyses during plant operations. This calculation documents the review of reactor pressure vessel thermal cycle diagrams, thermal cycle diagrams for power uprate, reactor pressure vessel nozzle thermal cycle diagrams, piping system histograms, and the USAR, and identifies the transients that are considered in the fatigue analyses. The calculation identifies transients that must be tracked to assure the ongoing validity of the fatigue analyses.

In response to this request for additional information, Entergy is providing a copy of RBS calculation 6247.547-604-014, which contains the comparison between the USAR design transients and the information summarized in LRA Table 4.3-1.

Question 2:

RBS LRA Section 4.3.3 provides the applicant's Environmentally Assisted Fatigue (EAF) analysis for Class 1 components, however the applicant did not include, address, or justify its methodology for identifying plant-specific component locations in the reactor coolant pressure boundary that may be more limiting than the components identified in NUREG/CR-6260 for the assessment. The staff is unable to evaluate the applicant's EAF methodology without the necessary supplemental information.

Response:

General

As indicated in the enhancement to the Fatigue Monitoring Program described in LRA Section B.1.18, Entergy will develop a set of fatigue usage calculations that consider the effects of the reactor water environment for a set of sample reactor coolant system components. In developing the calculations, Entergy will evaluate all of the Class 1 fatigue analyses in order to identify the transients that the Fatigue Monitoring Program must track to ensure that the fatigue usage factors considering environmental effects will not exceed 1.0 without appropriate corrective actions as specified in the program. This will include all of the NUREG-6260 locations.

The EAF evaluation utilizes NUREG/CR-6909 (ANL-06/08), "Effect of LWR Coolant Environments on the Fatigue Life of Reactor Materials," in the evaluation of environmentally assisted fatigue for all materials. (NUREG/CR-6583 and NUREG/CR-5704 will not be used.) Environmental correction factors applied to CUFs with different material types are material-specific environmental correction factors. A cumulative usage factor (CUF) from one material type will not be used to bound a CUF for another material type.

Piping

RBS is a newer vintage plant (BWR-6) that has extensive Class 1 piping fatigue analyses with calculated CUFs. The piping evaluations for RBS are performed using ASME Code NB-3600. The fatigue analyses for Class 1 piping locations throughout the plant are based on the loads experienced at those locations. For purpose of evaluating environmentally assisted fatigue, a thermal zone is a section of piping that experiences the same transients and the transients are the same from a pressure and temperature perspective. A CUF in one thermal zone can only be used to bound a CUF for the same material in other thermal zones if a bounding temperature is used and the transients in the other thermal zones are the same or a subset of the transients in the first thermal zone. The following criteria are used to select the bounding locations in each thermal zone for further consideration of environmentally assisted fatigue.

- The location with the highest CUF.
- The location with the second highest usage if it is at least 50 percent of the highest CUF.
- The location with the third highest usage if it is at least 75 percent of the highest CUF.

The NUREG/CR-6260 locations are evaluated regardless of their CUF.

Reactor Vessel

The reactor vessel fatigue analysis has CUFs calculated for more locations than the locations identified in NUREG/CR-6260. The CUFs for reactor vessel locations that are part of the wetted reactor coolant system pressure boundary are included.

Valves and Pump Casings

The RBS Class 1 valves and the reactor recirculation pump casings have fatigue analyses with CUFs that are included in the review. Class 1 valves in the following systems are included:

- Main steam (including safety relief valves)
- Feedwater
- Residual heat removal
- Reactor recirculation
- High pressure core spray

- Low pressure core spray
- Reactor water cleanup
- Reactor core isolation cooling

Piping Penetrations

The evaluation includes the fatigue analyses for the pressure boundary location on the flued heads of Class 1 piping penetrations.

Conclusion

The environmentally assisted fatigue evaluation for RBS Class 1 components is a comprehensive evaluation of plant-specific component locations in the wetted portions of the reactor coolant pressure boundary. The evaluation includes all NUREG/CR-6260 locations. The completed evaluation will demonstrate that the Fatigue Monitoring Program is monitoring the transients necessary to ensure that fatigue analyses that are adjusted to reflect the effects of the reactor coolant environment remain valid during the period of extended operation. If monitoring indicates that a CUF may exceed 1.0 when considering environmental effects, then appropriate corrective actions will be taken as specified in the Fatigue Monitoring Program.

Question 3:

Certain Class 3 support components, identified in the UFSAR, are assessed for aging effects with a cumulative usage factor (CUF) type of fatigue analysis. RBS LRA Table 3.5.2-1 identifies the analysis as a TLAA for these components, however, Section 4 of the LRA does not include any evaluation of a fatigue analysis for these components. The applicant did not demonstrate that the components were analyzed with a CUF per ASME NB-3200 or NB-3600, and did not identify or evaluate the applicable analysis in accordance with either 10 CFR 54.21(c)(1)(i), (ii), or (iii). The staff is therefore unable to evaluate the TLAAs on these components without the necessary supplemental information.

Response:

Appendix 6A to the USAR contains the details of the containment dynamic loading assessment. Attachment A to Appendix 6A provides additional information for determination of the safety/relief valve discharge loads. Section A.6A.7.2 identifies that the X-quenchers were designed and analyzed as Class 3 piping in accordance with the requirements of Section ND-3600 of the ASME Boiler and Pressure Vessel Code. USAR Section A.6A.7.2 documents a supplemental analysis that was generated in response to an NRC question regarding the X-quencher at the connection to its support bracket. USAR Section A.6A.7.2 identifies that while ND-3645 does not require a separate analysis, the bracket-quencher interface connection was analyzed to the requirements of NB-3600 of the ASME code. Based on 4,200 cycles of the most severe transient of a step change from 70 to 350 degrees F, the resultant usage factor was identified as 0.47.

LRA Table 4.3-1 identifies that safety/relief valve actuations are tracked with limiting values of 1,295 single safety/relief valve actuations and 58 multiple safety/relief valve actuations. The

4,200 cycles used in the analysis identified in USAR Section A.6A.7.2 are far in excess of the limiting values provided in Table 4.3-1. Therefore, the bracket-quencher interface connection fatigue analysis described in the USAR Section A.6A.7.2 will remain valid for the period of extended operation per 10 CFR 54.21(c)(1)(i).

Since the fatigue analysis description in USAR Section A.6A.7.2 is for the X-quencher at the connection to the welded bracket, the analysis is not for a support. Therefore, this line item is removed from LRA Table 3.5.2-1.

LRA Section 4.3.2.2 is amended by adding a new paragraph that discusses the quencher fatigue analysis identified in USAR Section A.6A.7.2.

Additions are underlined and deletions are lined through.

LRA Table 3.5.2-1

~~Steel elements: SRV quencher support and restraint~~	~~SSR~~	~~Stainless steel~~	~~Air – indoor uncontrolled or fluid environment~~	~~Cracking~~	~~TLAA – metal fatigue~~	~~II.B2.2.C-48~~	~~3.5.1-9~~	~~C~~

Add to LRA Section 4.3.2.2 as new paragraph:

USAR Section A.6A.7.2 identifies that an ASME subsection NB-3600 analysis was performed for the bracket-quencher interface connection. The 4,200 cycles used in the analysis identified in USAR Section A.6A.7.2 are far in excess of the limiting values for safety/relief valve actuations provided in Table 4.3-1. Therefore, the analysis identified in USAR Section A.6A.7.2 remains valid in accordance with 10 CFR 54.21(c)(1)(i).

Question 4:

The LRA did not provide information that the staff requires in order to perform an independent review of the applicant's site-specific analysis of potential surface water use conflicts for continued operations during the license renewal term. Specifically, the staff requires the last five years' of surface water withdrawal and associated consumptive water use data in order to perform a projection of operational impacts on surface water flow. The staff cannot perform this review without the necessary supplemental information.

Response:

Mississippi River water withdrawals and blowdown discharges for the years 2012 - 2016 are shown in the following table. Blowdown discharges were obtained from the monthly discharge monitoring reports submitted to the Louisiana Department of Environmental Quality and are based on monitored effluent from Outfall 001 (cooling tower blowdown) which is recorded at the exposed vacuum-break chamber of the buried 30-inch diameter discharge pipeline prior to discharge to the Mississippi River. Outfall 001 also receives previously monitored intermittent effluent from Internal Outfalls 101 (low-volume waste treatment system), 201 (treated sanitary wastewater), 301 (mobile metal-cleaning wastewaters), 401 (low-volume wastewater), 501 (low-volume wastewater), 601 (low-volume wastewater) and 007 (hydrostatic test wastewater).

As shown in the following tables, there were days during which no surface water withdrawals occurred; however, during refueling outages or plant shutdowns, discharges can still occur at Outfall 001 without makeup water.

RBS Surface Water Withdrawals and Blowdown Discharges (2012-2013)

Month/Year	Withdrawals (Average MGD)	Blowdown (Average MGD)	Consumption (MGD)
January 2012	17.10	4.215	12.89
February 2012	15.41	3.989	11.42
March 2012	18.16	4.255	13.91
April 2012	17.83	4.221	13.61
May 2012	9.61 [(a)]	3.396	6.21
June 2012	14.23 [(b)]	3.560	10.67
July 2012	20.16	3.856	16.30
August 2012	19.90	3.570	16.33
September 2012	19.10	3.752	15.35
October 2012	18.71	3.945	14.77
November 2012	19.03	3.794	15.24
December 2012	18.00	3.969	14.03
January 2013	17.81	4.146	13.66
February 2013	10.38 [(c)]	3.782	6.60
March 2013	5.67 [(d)]	4.150	1.52
April 2013	18.34	4.240	14.10
May 2013	19.62	4.295	15.33
June 2013	17.87	4.212	13.66
July 2013	21.44	4.234	17.21
August 2013	21.41	3.922	17.49
September 2013	21.58	3.918	17.66
October 2013	20.72	3.765	16.96
November 2013	19.87	3.916	15.95
December 2013	19.24	3.998	15.24

a. There were 7 days in the month during which no surface water withdrawals occurred.

b. There were 3 days in the month during which no surface water withdrawals occurred.

c. There were 12 days in the month during which no surface water withdrawals occurred.

d. There were 17 days in the month during which no surface water withdrawals occurred.

RBS Surface Water Withdrawals and Blowdown Discharges (2014-2015)

Month/Year	Withdrawals (Average MGD)	Blowdown (Average MGD)	Consumption (MGD)
January 2014	15.29	3.598	11.69
February 2014	15.93	3.557	12.37
March 2014	15.77	3.670	12.10
April 2014	17.53	4.076	13.45
May 2014	18.94	4.165	14.78
June 2014	20.17	4.171	16.00
July 2014	20.00	4.110	15.89
August 2014	20.10	4.111	15.99
September 2014	19.53	3.989	15.54
October 2014	15.19	3.906	11.28
November 2014	18.73	4.051	14.68
December 2014	18.71	4.042	14.67
January 2015	18.71	3.922	14.79
February 2015	15.39 [(e)]	2.837	12.55
March 2015	7.26 [(f)]	3.297	3.96
April 2015	18.73	3.966	14.76
May 2015	18.71	4.104	14.61
June 2015	18.40	3.965	14.44
July 2015	18.71	4.102	14.61
August 2015	19.16	3.998	15.16
September 2015	20.40	4.039	16.36
October 2015	19.68	4.036	15.64
November 2015	16.30 [(g)]	3.787	12.51
December 2015	14.77 [(h)]	3.741	11.03

e. There were 5 days in the month during which no surface water withdrawals occurred.

f. There were 19 days in the month during which no surface water withdrawals occurred.

g. There were 4 days in the month during which no surface water withdrawals occurred.

h. There were 5 days in the month during which no surface water withdrawals occurred.

RBS Surface Water Withdrawals and Blowdown Discharges (2016)

Month/Year	Withdrawals (Average MGD)	Blowdown (Average MGD)	Consumption (MGD)
January 2016	6.16 (i)	2.873	3.29
February 2016	12.97	3.755	9.22
March 2016	18.29	3.952	14.34
April 2016	20.90	4.001	16.90
May 2016	21.52	4.159	17.36
June 2016	11.07 (j)	3.966	7.10
July 2016	22.29	4.226	18.06
August 2016	22.29	4.211	18.08
September 2016	21.83	4.126	17.70
October 2016	20.90	3.995	16.91
November 2016	19.97	3.827	16.14
December 2016	19.48	3.610	15.87

i. There were 18 days in the month during which no surface water withdrawals occurred.

j. There were 15 days in the month during which no surface water withdrawals occurred.

Attachment 2 to
RBG-47773

RBS Calculation No. 6247.547-604-014
(55 pages)

ENTERGY	RIVER BEND STATION	SDDF SUPPLIER'S DOCUMENT DATA FORM

(1) DOCUMENT NO. 6247.547-604-014, Rev. 000	
(3) VENDOR CODE: S981	(4) VENDOR NAME Structural Integrity
(5) Document Title Structural Integrity Calculation associated with Adequacy of Cycles Being Tracked For Fatigue Monitoring	

(6) VENDOR DOC. NO.: 1401192.301	(7) SH. NO.	(8) REV. 000
(9) REFERENCES	(9) REFERENCES	
(10) KEYWORDS Fatigue	(10) KEYWORDS FatiguePro Software	
(11) PREPARER See AS for Electronic Signature	KCN	DATE See AS
(12) SUPERVISOR See AS for Electronic Signature	KCN	DATE See AS
(13) COMMENTS: Original Issue of this SDDF was Generated by EC-63155.		

Entergy	**ENTERGY NUCLEAR MANAGEMENT MANUAL** **EN-DC-149**

VENDOR DOCUMENT REVIEW STATUS

☒ FOR ACCEPTANCE ☐ FOR INFORMATION

☐ IPEC ☐ JAF ☐ PLP ☐ PNPS ☐ ANO ☐ GGNS ☒ RBS ☐ W3 ☐ NP

Document No.: 6247.547-604-014	Rev. No.000
Document Title: Structural Integrity Calculation associated with Adequacy of Cycles Being Tracked For Fatigue Monitoring	
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STATUS NO:

1. ☒ ACCEPTED, WORK MAY PROCEED
2. ☐ ACCEPTED AS NOTED RESUBMITTAL NOT REQUIRED, WORK MAY PROCEED
3. ☐ ACCEPTED AS NOTED RESUBMITTAL REQUIRED
4. ☐ NOT ACCEPTED

Acceptance does not constitute approval of design details, calculations, analyses, test methods, or materials developed or selected by the supplier and does not relieve the supplier from full compliance with contractual negotiations.

	Print Name		Signature	Date
Responsible Engineer	Jordan Carter	/	See AS	See AS
Engineering Supervisor	Paul Matzke	/	See AS	See AS

Structural Integrity Associates, Inc.®

CALCULATION PACKAGE

File No.: 1401192.301

Project No.: 1401192

Quality Program Type: ☒ Nuclear ☐ Commercial

PROJECT NAME:
LRA Support

CONTRACT NO.:
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CLIENT:
Entergy Operations, Inc.

PLANT:
River Bend Station (RBS)

CALCULATION TITLE:
Adequacy of Cycles Being Tracked For Fatigue Monitoring

Document Revision	Affected Pages	Revision Description	Project Manager Approval Signature & Date	Preparer(s) & Checker(s) Signatures & Date
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1.0 OBJECTIVE

The objective of this calculation package is to prepare a list of transients that should be tracked for fatigue monitoring purposes at River Bend Station.

2.0 METHODOLOGY

The cycle counting and cycle-based fatigue report for River Bend Station [1] contains the list of transients that are counted. The transients identified in the cycle counting report [1] are compared with the transients identified in documents that define the design basis transients for the components in the fatigue management program to provide assurance that all applicable transients are identified. Documents that define the design basis transients are:

- Reactor pressure vessel (RPV) thermal cycle diagrams [3].
- RPV thermal cycle diagrams for power uprate [4].
- RPV nozzle thermal cycle diagrams [5].
- Piping system histograms [6].
- Updated safety analysis report (USAR) for RBS [2]

Faulted or emergency events are not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.

3.0 TRANSIENT REVIEW

Design basis transients are defined in RPV thermal cycle diagrams [3] [4], nozzle thermal cycle diagrams [5], piping thermal cycle diagrams [6], and the updated safety analysis report (USAR) [2]. Cycle counts and fatigue usage are tracked using **FatiguePro** [8]. The transients tracked for cycle counts and locations for which fatigue usage is calculated are defined in Reference [1]. The latest update to cycle counts and fatigue usage is contained in Reference [7]. In the following subsections, design basis documents are reviewed to determine if all design transients are being tracked. For those design transients not being tracked, a determination is made whether that transient should be added to the monitoring program.

3.1 Cycle Counting and Cycle Based Fatigue Report

Table 1 lists the transients that are counted [1] and [7, Table 3].

Table 1: Transients Counted

No.	FatiguePro Transient Name[14]	Allowable Cycles	Counting Method
1	Boltup	123	Manual
2	Design Hydrotest	50[1]	Automatic
-	Leak Check (to 400 psig)	360	Automatic
3	Startup	120	Automatic
4	Turbine Roll	120	Automatic
8	Turbine Bypass	10	Automatic
9	Partial FW Heater Bypass	70	Automatic
10 & 11	Scram (Includes Turbine Generator Trip (10) and Other Scrams (11))	180	Automatic
13	Power Reduction to Zero	111	Automatic
14	Hot Standby	111	Automatic
15 & 17	Shutdown (initial and final cooldowns)	111	Automatic
16	Vessel Floodup	111	Automatic
18	Unbolt	123	Manual
20	Loss of Feedpumps	10	Automatic
21	Blowdown Scram	8	Automatic
23	Automatic Blowdown	1[2]	Manual
27	Pipe Rupture	1[3]	Manual
-[4]	LPCS Injection	10[5]	Automatic
-[6]	HPCS Injection	40[7]	Automatic
-[8]	RCIC Injection	181[9]	Automatic
-[10]	SLC Injection	10[11]	Manual
-[12]	LPCI Injection to Vessel (3 separate events)	10/nozzle[13]	Automatic
	LPCI A Injection	10	Automatic
	LPCI B Injection	10	Automatic
	LPCI C Injection	10	Automatic
	SRV Actuation	1800	Automatic

Notes:

(1) Reference [3] indicates 40 cycles for fatigue evaluation and an additional 10 that can occur without being evaluated for fatigue [3, note 2].
(2) This is classified as an emergency condition for the reactor pressure vessel [3] but is evaluated for fatigue at various piping locations [1, Section 4].
(3) This is classified as a faulted condition for the reactor pressure vessel [3] but is evaluated for fatigue at various piping locations [1, Section 4].
(4) Occurs during startup or shutdown [5, sheet 7].
(5) The design number of cycles is indicated on Reference [5, sheet 7]. One additional injection is indicated to occur during a pipe rupture which is a faulted condition [3, sheet 2, event 27] that is counted.
(6) Can occur at any time during rated power normal operation [5, sheet 7] or during a loss of feedpumps event.
(7) The design number of cycles is indicated on Reference [5, sheet 7]. Ten (10) injections at rated power normal operation are indicated along with three (3) injections for every loss of feedpumps event. The total number of design cycles is therefore 10 + 3 x 10 = 40. One additional injection is indicated to occur during a pipe rupture which is a faulted condition [3, sheet 2, event 27] that is counted.
(8) Can occur during shutdown, loss of feedpumps, or normal operation [5, sheet 6].
(9) The design number of cycles is indicated on Reference [5, sheet 6]. One (1) injection is indicated for each shutdown, three (3) injections for each loss of feedpump, and forty (40) injections during normal operation. The total number of design cycles is therefore 111 + 3 x 10 + 40 = 181.
(10) Can occur at any time [5, sheet 9].
(11) The design number of cycles is indicated on Reference [5, sheet 9].
(12) Postulated to occur during startup or shutdown [5, sheet 12]. The automatic cycle counting logic will count these transients regardless of when they occur.

(13) The design number of cycles is indicated on Reference [5, sheet 12]. Each nozzle will be affected by an injection through that nozzle only, therefore each nozzle is designed for 10 cycles.
(14) Normal operation and zero load state are tracked but are load states for which there aren't an allowable number of cycles. Zero load state is used in the fatigue calculation for the HPCS/LPCS nozzle [1, Section 3.3] and RPV support skirt [1, Section 3.6] and therefore is required for the fatigue management program.

3.2 Reactor Pressure Vessel (RPV) Thermal Cycle Diagram (TCD)

The RPV thermal cycle diagrams show the design basis events for the RPV for original licensed power [3] and power uprate [4]. The events shown on the RPV TCD are listed in Table 2. The last column in Table 2 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**). Of the events shown, twelve are not counted. Seven of the twelve events not counted are emergency or faulted events which are not required to be analyzed in the design basis fatigue analyses and therefore not required to be counted. Four of the twelve events (Nos. 5, 6, 7, and 19) not counted show no thermal or pressure change on the RPV TCD and therefore are not required to be counted. The last event, 50% Maximum Seismic Loadings, that is not counted is an upset seismic event which should be added to the transient cycle counting.

Table 2: Transients Shown on RPV TCD

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123(1)	Normal	✓
2	Design Hyd Test	50(2)	Normal	✓
-	Leak Check (to 400 psig)	360(3)	Normal	✓
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated Power)	120	Normal	✓
5	Daily Reduction 75%	10,000	Normal	Not Required(4)
6	Weekly Reduction 50%	2,000	Normal	Not Required(4)
7	Rod Pattern Change	400	Normal	Not Required(4)
8	Turbine Trip with 100% Steam Bypass	10	Upset	✓
9	Partial Feedwater Heater Bypass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On	40	Upset	✓
11	Scram – Other Scrams	140	Upset	✓
12	Rated Power Normal Operation	[4, note 8]	Normal	Not Required(4)
-	50% Maximum Seismic Loadings	(5)	Upset	**Add**
-	100% Maximum Seismic Loadings	(6)	Faulted	Not Required
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓
15	Shut Down (initial cooldown at 100°F/hr)	111	Normal	✓
16	Vessel Flooding	111	Normal	✓
17	Shut Down (final cooldown at 100°F/hr)	111	Normal	✓
18	Unbolt	123(1)	Normal	✓
19	Refueling	---	Normal	Not Required(4)
20	Composite Loss of Feedwater Pumps, Loss of Auxiliary Power & Turbine Generator Trip Without Bypass	10	Upset	✓
21	Turbine By-pass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Recirc Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required

Notes:

(1) Each of the 123 cycles is the complete cycle of operations required for installation or removing the vessel top head.
(2) References [3] and [4] indicates 40 cycles for fatigue evaluation and an additional 10 that can occur without being evaluated for fatigue [3, note 2] [4, note 2].
(3) Leak checks at 400 psig prior to power operation, 3 cycles/start up [3, note 10] [4, note 10].
(4) No thermal or pressure change is indicated.
(5) The occurrence of 50% maximum seismic loadings under event (12) conditions is an upset event.
(6) The occurrence of 100% maximum seismic loadings under event (12) conditions is a faulted event.

3.3 Reactor Pressure Vessel (RPV) Nozzle Thermal Cycle Diagrams (TCDs)

The RPV nozzle thermal cycle diagrams show the design basis events for the RPV nozzles if they have a thermal profile different from the RPV [5]. There are twelve sheets, each covering a different nozzle. When the event for a nozzle is the same as the RPV it is not shown on the nozzle TCD (See Section 3.2 for events shown on the RPV TCD). The events shown on the nozzle TCDs will be reviewed in this section. The following subsections will cover the individual sheets.

3.3.1 Recirculation Outlet

The recirculation outlet nozzle TCD [5, Sheet 1] shows one event with a thermal profile different from the RPV, No. 24. As already indicated in Table 2, event 24 is an emergency event and therefore not required to be counted.

3.3.2 Recirculation Inlet

The recirculation inlet nozzle TCD [5, Sheet 2] shows one event with a thermal profile different from the RPV, No. 25, which is an emergency event, see Table 2, and therefore not required to be counted. It also shows event numbers 14 to 17, which are counted, with a thermal profile different from the RPV. Events 18 and 19 are shown but do not show a thermal change and therefore are not required to be counted for this nozzle.

3.3.3 Steam Outlet

The steam outlet nozzle TCD [5, Sheet 3] does not show any events with a thermal profile different from the RPV.

3.3.4 Feedwater

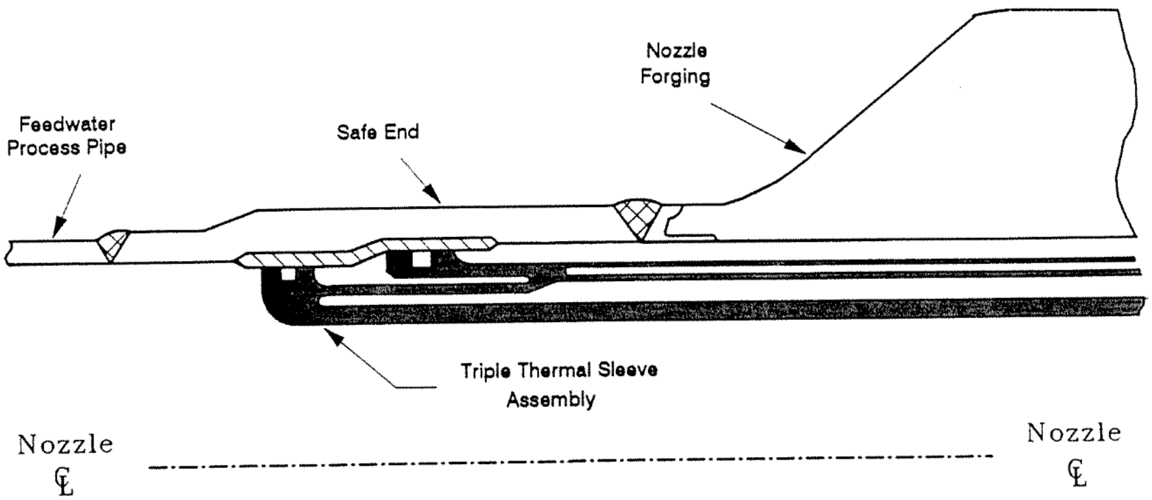
The feedwater nozzle TCD [5, Sheets 4 and 5] shows all events as having a thermal profile different from the RPV. The events shown on the feedwater nozzle TCD are listed in Table 3. The last column in Table 3 indicates whether the event is counted (✓), is not required to be counted (Not required), or should be added to the event cycle counting (**Add**). One event, rod pattern change, is not counted.

There is one feedwater nozzle that is different than the rest as it is a tuning fork design (see Figure 1) [14] rather than a triple sleeve (see Figure 1) [15].

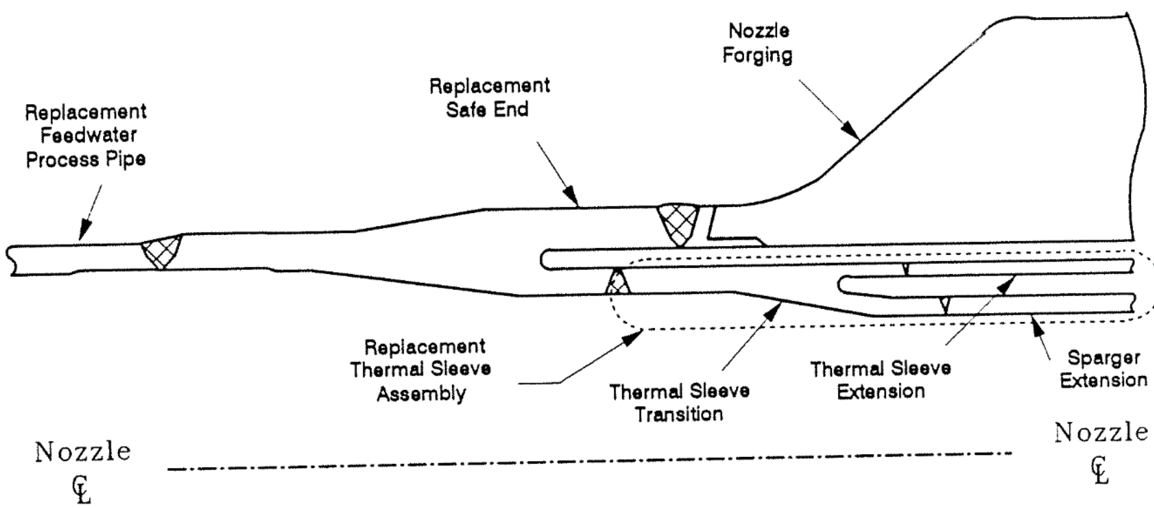
The fatigue evaluation for the tuning fork design is contained in Reference [14]. Reference [14, Table 4-1] indicates that rod pattern change, daily reduction, and weekly reduction were lumped together and evaluated as the most severe of the three transients which is the weekly reduction. The three transients are grouped together in family number 7 [14, Table 5-1] for fatigue analysis. Fatigue results for normal and upset events are presented in Reference [14, Sheets 67 to 69]. Based on those results, family 7 which contains rod pattern change does not show up as specifically contributing to fatigue for location A which is the only location for which detailed fatigue results are presented. The second highest location, location B, has a total usage slightly less than location A. Because this event is only expected to occur quarterly [24], and the analyzed number of cycles is 12,400 [14, Table 5-1, family 7] due to lumping with transients that will not occur (RBS is not a load following plant), there is sufficient margin between the anticipated number of cycles (240) and the analyzed number of cycles (12,400) such that tracking of this event is not required.

The fatigue evaluation for the triple sleeve design is contained in Reference [15]. Reference [15, sheet 26] indicates that rod pattern change, daily reduction, and weekly reduction were lumped together and evaluated as the most severe of the three transients which is the weekly reduction. The three transients are grouped together in family number 3 [15, sheet 93] for fatigue analysis. Fatigue results are presented in Reference [15, Sheets 222 to 252]. Reference [15, Sheet 79] presents the normal and upset stress analysis cases which abbreviates the weekly reduction transient as "WR15.0" and "WR50.0" for the cooldown and heatup portions of the transient. The total number of cycles analyzed for the "WR15.0" and "WR50.0" stress analysis cases is the summation of daily reduction, weekly reduction, and rod pattern change. Even with the conservative methodology applied, point 228 [15, Sheet 225] is the only location for which load cases "WR15.0" or "WR50.0" contribute to fatigue. Since the rod pattern change is conservatively accounted for as a weekly reduction transient and still only contributes 0.00005 [15, Sheet 225] to fatigue at one location, there is no need to count the transient for the nozzle with the triple sleeve design.

It is also noted that the feedwater nozzles are monitored for fatigue using stress based fatigue methodology [35].



Triple Sleeve Design



Tuning Fork Design

Figure 1. Feedwater Nozzle Safe End Designs

Table 3: Transients Shown on Feedwater Nozzle TCD

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hyd Test	50(1)	Normal	✓
-	Leak Check (to 400 psig)	360(2)	Normal	✓
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated Power)	120	Normal	✓
5	Daily Reduction 75%	10,000	Normal	Not Required(3)
6	Weekly Reduction 50%	2,000	Normal	Not Required(3)
7	Rod Pattern Change	400	Normal	Not Required(6)
8	Turbine Trip with 100% Steam Bypass	10	Upset	✓
9	Partial Feedwater Heater Bypass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On	40	Upset	✓
11	Scram – Other Scrams	140	Upset	✓
12	Rated Power Normal Operation	[4, note 8]	Normal	Not Required(5)
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓
15	Shut Down (initial cooldown at 100°F/hr)	555(4)	Normal	✓
16	Vessel Flooding	111	Normal	✓
17	Shut Down (final cooldown at 100°F/hr)	111	Normal	✓
18	Unbolt	123	Normal	✓
19	Refueling	---	Normal	Not Required(5)
20	Composite Loss of Feedwater Pumps, Loss of Auxiliary Power & Turbine Generator Trip Without Bypass	10	Upset	✓
21	Turbine By-pass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Recirc Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required

Notes:

(1) References [3] and [4] indicate 40 cycles for fatigue evaluation and an additional 10 that can occur without being evaluated for fatigue [3, note 2] [4, note 2].

(2) Leak checks at 400 psig prior to power operation, 3 cycles/start up [3, note 10] [4, note 10].

(3) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].

(4) The TCD indicates 5 cycles during the first 2 hours of shutdown for a total of 555 cycles (111x5).

(5) No thermal or pressure change is indicated.

(6) A rod pattern change occurs on a scheduled basis quarterly [24] and therefore would occur 240 times over a 60 year lifetime. Since rod pattern change was lumped with daily and weekly reduction for fatigue analysis (see Section 3.3.4 discussion), and those transients don't apply since RBS is not a load following plant, there is sufficient margin between the anticipated number of cycles (240) and the analyzed number of cycles (12,400) such that tracking of this event is not required.

3.3.5 Drain

The drain nozzle TCD [5, Sheet 6] does not show any events with a thermal profile different from the RPV.

3.3.6 Head Cooling Spray

The head cooling spray nozzle TCD [5, Sheet 6] shows events 15 to 20 as having a thermal profile different from the RPV (See Table 4). The last column in Table 4 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**). There are no events shown on the head cooling spray nozzle TCD that require addition to the fatigue monitoring program.

Table 4: Transients Shown on Head Cooling Spray Nozzle TCD

No.	Transient Name	Design Cycles	Type	Counted?
-	RCIC Injection	181(1)	Normal	✓
15	Shut Down (initial cooldown at 100°F/hr)	(2)	Normal	✓
16	Vessel Flooding	(2)	Normal	✓
17	Shut Down (final cooldown at 100°F/hr)	(2)	Normal	✓
18	Unbolt	(2)	Normal	✓
19	Refueling	(2)	Normal	Not Required(3)
20	Composite Loss of Feedwater Pumps, Loss of Auxiliary Power & Turbine Generator Trip Without Bypass	(2) (4)	Upset	✓

Notes:
(1) See Table 1, note 9. Also note that RCIC was rerouted to the feedwater system [36].
(2) See Table 2.
(3) No thermal or pressure change is indicated.
(4) The TCD for this nozzle shows three injections for every event 20. The actual number of RCIC injections during any event is tracked separately, see the first row of this table.

3.3.7 Low Pressure Core Spray (LPCS)

The LPCS nozzle TCD [5, Sheet 7] shows event 27 as having a thermal profile different from the RPV and 10 cycles of LPCS injection that can occur during start up (event 3) or shutdown (events 15 to 18). Since event 27 is a faulted event, it does not require counting. As shown in Table 1, LPCS injection is a counted transient with an allowable of 10. There are no events shown on the LPCS nozzle TCD that require addition to the fatigue monitoring program.

3.3.8 High Pressure Core Spray (HPCS)

The HPCS nozzle TCD [5, Sheet 7] shows events 20, 27, and 10 cycles of HPCS injection that can occur at any time during rated power normal operation having a thermal profile different from the RPV. Since event 27 is a faulted event, it does not require counting. Event 20 is a counted event. As shown in Table 1, HPCS injection is a counted transient with an allowable of 40 which accounts for the 10 during rated power normal operation and 30 (3 injections per event) during event 20. There are no events shown on the HPCS nozzle TCD that require addition to the fatigue monitoring program.

3.3.9 Control Rod Drive Hydraulic System Return (CRDHSR) Nozzle

The CRDHSR nozzle TCD [5, Sheet 8] indicates that for nozzles that have been capped there are no transients that have a thermal profile different from the RPV. The RBS updated safety analysis report (USAR) [2, Chapter 4.6.1.1.2.4.2.4] indicates that the CRDHSR has been capped and there are therefore no transients shown on the CRDHSR nozzle TCD that require addition to the fatigue monitoring program.

3.3.10 Instrumentation Nozzle

The instrumentation nozzle TCD [5, Sheet 9] indicates that event 2 has a thermal profile different from the RPV. Since event 2 is counted, there are no events shown on the instrumentation nozzle TCD that require addition to the fatigue monitoring program.

3.3.11 Core Differential Pressure & Liquid Control (CDP&LC)

The CDP&LC nozzle TCD [5, Sheet 9] indicates that event 19 has a thermal profile different from the RPV and that liquid control system operation can occur during normal operation. Since event 19 is only shown as a 20°F change, the event is insignificant and does not require counting. Liquid control system operation is a counted transient, see SLC injection in Table 1. There are no events shown on the CDP&LC nozzle TCD that require addition to the fatigue monitoring program.

3.3.12 Control Rod Drive (CRD) Nozzle

The control rod drive nozzle TCD [5, Sheet 10] shows multiple events having a thermal profile different from the RPV. The events shown on the CRD nozzle TCD are listed in Table 5**.** The last column in Table 5 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**).

There are two events for the control rod drive nozzle that are postulated to occur during rated power normal operation. The two events are "C. R. Drive Isolation at Rated Power Normal Operation" and "Single C.R.D. Scram". In the thermal analysis of this component, the CRD isolation event was selected as a limiting transient [10, sheet 10 of T5]. The single CRD scram event was not listed as a transient [10, sheets 10 to 13 of T5] but was referred to as one of the events which had a 2.3 second change in temperature which would not affect the CRD housing [10, sheet 27 of T5]. This is due to the fact that the transient only lasts for 2.3 seconds [10, sheet 27 of T5] and occurs between the control rod drive and innermost thermal sleeve as seen in Figure 2 [10, sheet 4 of T5]. Single CRD Scram therefore has no effect on the analyzed CRD tube and does not require tracking.

In the subsequent stress analysis, CRD isolation was analyzed as cases 5, 6, and 7 [11, sheet 11 of S5]. Stress results for what were determined to be limiting transients are presented in the stress analysis [11]. In the fatigue analysis, all cycles were lumped together with 50 cycles of CRD drive isolation and 10 cycles of single CRD scram included in the lumping of cycles [12, sheet 4 of F5]. Two locations were evaluated for fatigue [12, sheet 5 of F5], point 185 which is an SB-166 location and point 504 which is an SA508 Class II location. The worst stress pairing was used to evaluate all cycles.

While CRD isolation is a severe event for this location, it is not an event that is expected to occur with any frequency [32] and therefore does not require tracking.

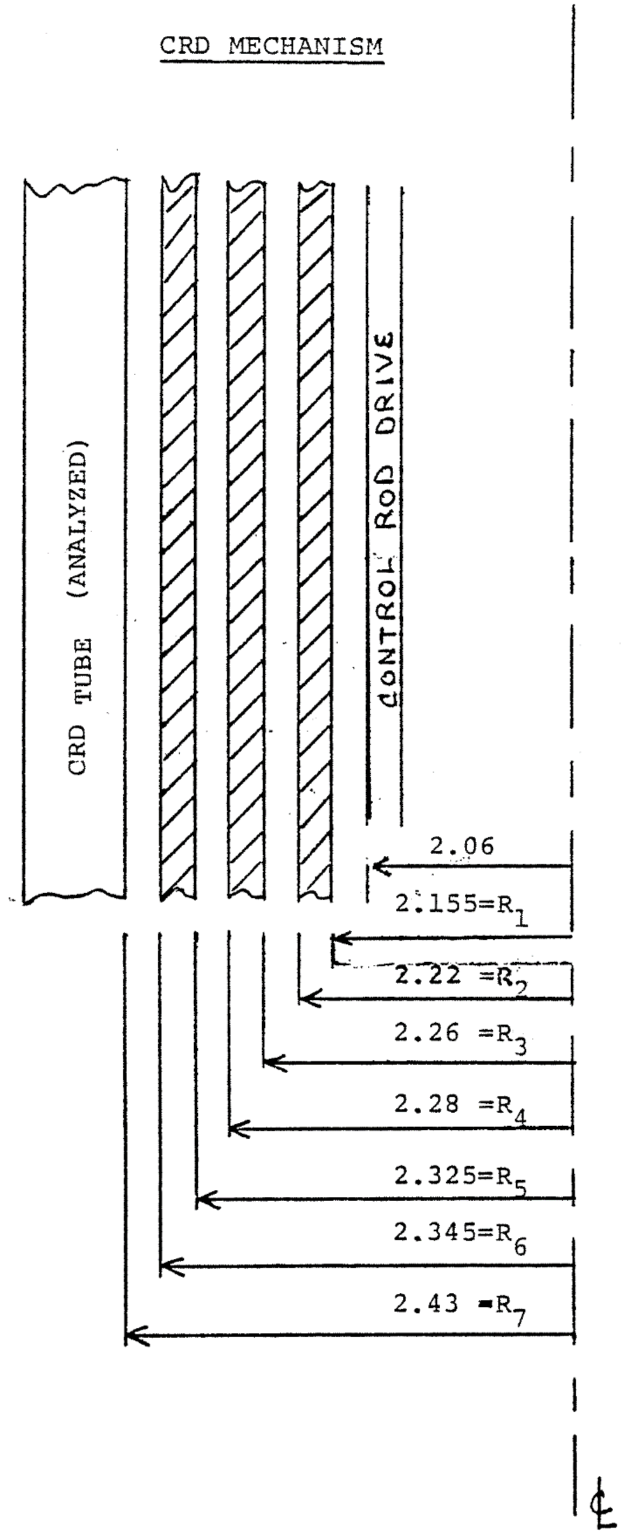


Figure 2. CRD Housing and Thermal Sleeve Configuration

Table 5: Transients Shown on CRD Nozzle TCD

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	(1)	Normal	✓
2	Design Hyd Test	(1)	Normal	✓
3	Start Up	(1)	Normal	✓
4	Turbine Roll (Increase to Rated Power)	(1)	Normal	✓
-	Leak Check (to 400 psig)	(1)	Normal	✓
5	Daily Reduction 75%	(1)	Normal	Not Required(2)
6	Weekly Reduction 50%	(1)	Normal	Not Required(2)
7	Rod Pattern Change	(1)	Normal	Not Required(2)
8	Turbine Trip with 100% Steam Bypass	(1)	Upset	✓
9	Partial Feedwater Heater Bypass	(1)	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On	(1)	Upset	✓
11	Scram – Other Scrams	(1)	Upset	✓
12	Rated Power Normal Operation	(1)	Normal	Not Required(2)
-	C. R. Drive Isolation at Rated Power Normal Operation	50	Normal	Not Required(3)
-	Single C.R.D. Scram	10	Normal	Not Required(4)
13	Reduction to 0% Power	(1)	Normal	✓
14	Hot Stand-by	(1)	Normal	✓
15	Shut Down (initial cooldown at 100°F/hr)	(1)	Normal	✓
16	Vessel Flooding	(1)	Normal	✓
17	Shut Down (final cooldown at 100°F/hr)	(1)	Normal	✓
18	Unbolt	(1)	Normal	✓
19	Refueling	300	Normal	Not Required(5)
20	Composite Loss of Feedwater Pumps, Loss of Auxiliary Power & Turbine Generator Trip Without Bypass	(1)	Upset	✓
21	Turbine By-pass Single Relief or Safety Valve Blowdown	(1)	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	(1)	Emergency	Not Required
23	Automatic Blowdown	(1)	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	(1)	Emergency	Not Required
25	Sudden Start of Pump in Cold Recirc Loop	(1)	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	(1)	Emergency	Not Required
27	Pipe Rupture & Blow down	(1)	Faulted	Not Required

Notes:

(1) See Table 2.
(2) No thermal or pressure change is indicated.
(3) While CRD isolation is a severe event for this location, it is not an event that is expected to occur with any frequency [32] and therefore does not require tracking.
(4) See Section 3.3.12 discussion.
(5) Since only a 10°F temperature change is shown and the transient only lasts 2.3 seconds, this event is insignificant from a thermal stress standpoint. Mechanical loads and resulting stresses [11, sheets 11, 12, and 96 to 102 of S5] would occur but would not be significant enough by themselves to result in any fatigue usage. This event therefore does not require counting.

3.3.13 Jet Pump Diffuser

The jet pump diffuser TCD [5, Sheet 11] indicates that events 15 to 19 and 25 have a thermal profile different from the RPV. Events 15 to 18 are counted, see Table 1 and Table 2. Since event 19 is shown at a constant temperature, the event is insignificant and does not require counting. Event 25 is an emergency event, see Table 2. There are no events shown on the jet pump diffuser TCD that require addition to the fatigue monitoring program.

3.3.14 Low Pressure Coolant Injection (LPCI)

The low pressure coolant injection (LPCI) nozzle TCD [5, Sheet 12] indicates that event 27 has a thermal profile different from the RPV and that injections can occur during start up or shut down. The injections during start up or shut down are counted, see Table 1 events LPCI A Injection, LPCI B Injection, and LPCI C Injection. Event 27 is a faulted event. There are no events shown on the low pressure coolant injection nozzle TCD that require addition to the fatigue monitoring program.

3.4 Class 1 Piping Thermal Cycle Diagrams (TCDs)

The Class 1 piping thermal and pressure histograms show the design basis events for the Class 1 piping for original licensed power [6]. References [6.a] to [6.aa] are the histograms for individual Class 1 piping systems. The following subsections will cover the individual sheets.

3.4.1 Main Steam Supply System & RPV Vent Lines

The main steam histogram [6.a] [6.b] shows multiple unique events. The events shown on the main steam histogram are listed in Table 6. The last column in Table 6 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**). The shutdown vessel flooding event for the main steam piping was split into a normal and alternate type with the alternate being more severe. The fatigue tracking for main steam locations conservatively accounts for both event types when a vessel flooding event occurs [1, Sections 4.4, 4.8, and 4.13] [13]. To reduce conservatism, separate tracking of the normal and alternate vessel flooding events could be implemented.

Table 6: Transients Shown on Main Steam Supply System & RPV Vent Lines Histogram

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360	Normal	✓
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated)	120	Normal	✓
5	Daily Reduction 75%	10,000	Normal	Not Required(1)
6	Weekly Reduction 50%	2,000	Normal	Not Required(1)
7	Rod Pattern Change	400	Normal	Not Required(1)
8	Turbine Trip 100% Steam By-pass	N/A(2)	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10 & 11	Scram – Turbine Generator Trip Feedwater On Isolation Valves Stay Open & Other Scram	190	Upset	✓
12	Rated Power Normal Operation	N/A(3)	Normal	Not Required(1)
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓
15	Shut Down Vessel Flooding	111	Normal	✓
16	Shutdown Vessel Flooding Case A	91	Normal	✓
17	Shutdown Vessel Flooding Case B	20	Normal	Not Required(4)
17	Shut Down (final cooldown at 100°F/hr)	111	Normal	✓
18	Unbolt	123	Normal	✓
19	Refueling	40	Normal	Not Required(1)
20	Composite Loss of Feedwater Loss of Auxiliary Power & Turbine Trip Without Bypass	10	Upset	✓
21	Turbine Bypass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stays Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required

Notes:

(1) No thermal or pressure change is indicated.
(2) Histogram indicates that this event is not applicable to RBS.
(3) The histogram does not indicate a number of cycles.
(4) The cycle counting doesn't distinguish between case A and case B. Case B is more severe. Fatigue tracking [1, Sections 4.4, 4.8, and 4.13] [13] accounts for both cases when vessel flooding occurs which is conservative. To reduce conservatism, separate tracking of the normal and alternate vessel flooding events could be implemented.

3.4.2 RCIC Pump Turbine System Steam Line (RCIC)

The RCIC steam system histogram [6.c] shows multiple unique events. The events shown on the main steam histogram are listed in Table 7. The last column in Table 7 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**). There are alternate, more severe, cases of shutdown and vessel flooding events that are counted. A review of the stress report [16] for this piping indicates that the alternate, more severe, events do have more of a fatigue impact and were analyzed for 20 cycles. An example of this is for Valve 50 [16, p. 2086 to 2087] which has a load pair with 20 cycles (E, 6-16) which shows up higher in the fatigue table than a load pair with 91 cycles (E, 8-14). The cycle counting doesn't distinguish between case A and case B. Case B is more severe. Similar to other locations already tracked for fatigue, all cycles of this type should be assumed to be of the more severe type if fatigue tracking is performed for this location.

Table 7: Transients Shown on RCIC Pump Turbine System Steam Line Histogram

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360	Normal	✓
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated)	120	Normal	✓
5	Daily Reduction 75%	10,000	Normal	Not Required(1)
6	Weekly Reduction 50%	2,000	Normal	Not Required(1)
7	Rod Pattern Change	400	Normal	Not Required(1)
8	Turbine Trip 100% Steam By-pass	N/A(2)	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On Isolation Valves Stay Open	50	Upset	✓
11	Other Scrams	140	Upset	✓
12	Rated Power Normal Operation	N/A(3)	Normal	Not Required(1)
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓
15	Shut Down – (Initial Phase) with RCIC Head Spray – Case A and Case B	111(4)	Normal	✓
16	Vessel Flooding Case A	91	Normal	✓
16	Vessel Flooding Case B	20	Normal	Not Required(5)
17	Shut Down – Case A	91	Normal	✓
17	Shut Down – Case B	20	Normal	Not Required(5)
18	Unbolt	123	Normal	✓
19	Refueling	40	Normal	Not Required(1)
20	Composite Loss of Feedwater Loss of Auxiliary Power & Turbine Trip Without Bypass	10	Upset	✓
21	Turbine Bypass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required
28	Rated Power Accidental Trip and RCIC	40	Upset	Not Required(1)
29	RCIC System Test	480	Upset	Not Required(1)

Notes:
1. No thermal or pressure change is indicated.
2. Histogram indicates that this event is not applicable to RBS.
3. The histogram does not indicate a number of cycles.
4. The histogram shows 91 cycles of Case A and 20 cycles of Case B. Since both transients are represented identically on the histogram, Case A and Case B do not require separate tracking.
5. The cycle counting doesn't distinguish between case A and case B. Case B is more severe. Similar to other locations already tracked for fatigue, all cycles of this type should be assumed to be of the more severe type if fatigue tracking is performed for this location.

3.4.3 Feedwater System (FWS)

The FWS histogram [6.d] shows multiple unique events. The events shown on the FWS histogram are listed in Table 8. The last column in Table 8 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**). There are alternate forms of events which are not explicitly counted but which are accounted for in the fatigue formulas for the monitored feedwater system locations [1] [13]. There are no unique events for the feedwater system that require addition to the fatigue monitoring program.

Table 8: Transients Shown on FWS Histogram

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360	Normal	✓
3	Start Up	105	Normal	✓
3	Alternate Start Up RPV-RWCU Heatup	15	Normal	Not Required(1)
4	Turbine Roll (Increase to Rated)	105	Normal	✓
4	Alternate Turbine Roll	15	Normal	Not Required(1)
5	Daily Power Reduction	10,000	Normal	Not Required(2)
6	Weekly Power Reduction	2,000	Normal	Not Required(2)
7	Rod Pattern Change	400	Normal	Not Required(3)
8	Turbine Trip 100% Steam By-pass	N/A(4)	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On Isolation Valves Stay Open	40	Upset	✓
11	Other Scrams	140	Upset	✓
12	Rated Power Normal Operation	12,800(8)	Normal	Not Required(7)
13	Reduction to 0% Power	111	Normal	✓
14A	Hot Stand-by Case A	96	Normal	Not Required(1) (5)
14B	Hot Stand-by Case B	15	Normal	✓(5)
15A	Shut Down Initiation Case A	96	Normal	✓
15B	Shut Down Initiation Case B	15	Normal	✓(6)
16A	Vessel Flooding Case A	96	Normal	✓
16B	Vessel Flooding Case B	15	Normal	Not Required(1)
17A	Shut Down – Case A	91	Normal	✓
17B	Shut Down – Case B	20	Normal	Not Required(1)
18	Unbolt	123	Normal	✓
19	Refueling	40	Normal	Not Required(7)
20	Composite Loss of Feedwater Loss of Auxiliary Power & Turbine Trip Without Bypass	10	Upset	✓
-	RCIC Injection (During Loss of Feedwater)	30(9)	Upset	✓
21	Turbine Bypass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required

Notes:

(1) The cycle counting doesn't distinguish between the normal and alternate cases. Two limiting locations in this system are monitored [1] with the first having an allowable usage of 0.1 and the second having an allowable usage of 1.0 [1, Table 4-1]. Loads due to normal and alternate event types are accounted for in the cycle based fatigue calculations for feedwater piping locations [1] [13].
(2) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].
(3) Rod pattern change is accounted for in the cycle based fatigue calculations for feedwater piping locations [1] [13].
(4) Histogram indicates that this event is not applicable to RBS.
(5) The cycle counting counts a hot standby when feedwater flow is cycled. Case A does not involve feedwater flow cycling and is not counted [6.d, event no. 14-A].
(6) Event 15B involves feedwater flow cycling and is monitored as combined with Event 14B [1, p. 2-16].
(7) No thermal or pressure change is indicated.
(8) Since RCIC was rerouted to feedwater [36], a spurious injection resulting in an insignificant transient in feedwater loop A is also included in the design transients during normal operation [37, PICL No. AP-17, Attachment A, p. 7].
(9) Thirty (30) RCIC injections [37, PICL No. AP-17, Attachment A] into the FW system during loss of FW are accounted for since the reroute.

3.4.4 Main Steam Isolation Valve Drain Piping (DTM)

The DTM histogram [6.e] shows multiple unique events. The events shown on the DTM histogram are listed in Table 9. The last column in Table 9 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**).

Table 9: Transients Shown on DTM Histogram

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360	Normal	✓
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated Power)	120	Normal	✓
5	Daily Power Reduction to 75%	10,000	Normal	Not Required(1)
6	Weekly Power Reduction to 50%	2,000	Normal	Not Required(1)
7	Rod Pattern Change	400	Normal	Not Required(2)
8	Turbine Trip 100% Steam By-pass	N/A(3)	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On Isolation Valves Stay Open	50	Upset	✓
11	Other Scrams	140	Upset	✓
12	Rated Power Normal Operation	N/A(4)	Normal	Not Required(2)
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓(2)
15	Shut Down Vessel Flooding	111	Normal	✓
16	Vessel Flooding Case A	91	Normal	✓
17	Vessel Flooding Case B	20	Normal	Not Required(5)
18	Unbolt	123	Normal	✓
19	Refueling	40	Normal	Not Required(2)
20	Composite Loss of Feedwater Loss of Auxiliary Power & Turbine Trip Without Bypass	10	Upset	✓
21	Turbine Bypass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required

Notes:
(1) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].
(2) No thermal or pressure change is indicated.
(3) Histogram indicates that this event is not applicable to RBS.
(4) Histogram indicates that a number of cycles is not applicable.
(5) The cycle counting doesn't distinguish between the normal and alternate cases. For every vessel flooding event, the normal and alternate loads are conservatively accounted for [1, Section 4.4] [13, Appendix C] so the alternate case does not require counting.

3.4.5 LPCI Injection Lines (RHR)

The RHR histograms [6.f] [6.g] [6.h] show multiple events. The events shown on the RHR histogram are listed in Table 10. The last column in Table 10 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**).

Table 10: Transients Shown on RHR Histograms

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360	Normal	✓
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated Power)	120	Normal	✓
5	Daily Power Reduction to 75%	10,000	Normal	Not Required(1)
6	Weekly Power Reduction to 50%	2,000	Normal	Not Required(1)
7	Rod Pattern Change	400	Normal	Not Required(2)
8	Turbine Trip 100% Steam By-pass	10	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On Isolation Valves Stay Open	40	Upset	✓
11	Other Scrams	140	Upset	✓
12-1	Rated Power Normal Operation with Leak	10	Normal	Not Required(3)
12-2	Rated Power Normal Operation with Pump Test	500	Normal	Not Required(2)
12-3	Monthly Injection Valve Test	500	Normal	Not Required(2)
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓(2)
15A	Shut Down – Blowdown to the Condenser & RHR Initiation Case A	106	Normal	✓
15B	Shut Down – Blowdown to the Condenser & RHR Initiation Case B	5	Normal	Not Required(4)
16	Vessel Flooding	111	Normal	✓(5)
17	Shutdown	111	Normal	✓(5)
18	Unbolt	123	Normal	✓
19	Refueling RHR Pump Test	100	Normal	Not Required(6)
20	Composite Loss of Feedwater Pumps, Loss of Auxiliary Power & Turbine Trip Without Bypass	10	Upset	✓
21	Turbine Bypass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required

Notes:

(1) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].

(2) No thermal or pressure change is indicated.

(3) This is the largest contributor to fatigue at one location [1, Section 4.3] [13, Appendix B] and ten are assumed to have occurred already in fatigue monitoring for that location. Because this event has never occurred and it isn't expected to occur in the future [31], assuming the design basis number of cycles is sufficient for 60 years of operation and this event therefore does not require tracking.

(4) The cycle counting doesn't distinguish between the normal and alternate cases. The fatigue analysis for this piping treated the normal and alternate events types as the same severity so separate counting of the alternate event is not required [13, Appendices B and D].

(5) The histogram shows 106 cycles of the normal case and 5 cycles of an alternate case. Since both transients are represented identically on the histogram, the two cases do not require separate tracking.

(6) The histogram indicates a transient with a temperature delta of only 30°F. In addition, the event does not show up as contributing to fatigue and therefore does not require counting [1, Sections 4.3 and 4.5] [13, Appendices B and D].

3.4.6 RHR Suction Piping

The RHR suction histograms [6.i] [6.j] [6.k] show multiple events. The events shown on the RHR suction histograms are listed in Table 11. The last column in Table 11 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**).

Table 11: Transients Shown on RHR Suction Histograms

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360	Normal	✓(1)
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated Power)	120	Normal	✓
5	Daily Power Reduction to 75%	10,000	Normal	Not Required(2)
6	Weekly Power Reduction to 50%	2,000	Normal	Not Required(2)
7	Rod Pattern Change	400	Normal	Not Required(3)
8	Turbine Trip 100% Steam By-pass	10	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On Isolation Valves Stay Open	40	Upset	✓
11	Other Scrams	140	Upset	✓
12	Rated Power Normal Operation	-	Normal	Not Required(4)
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓(4)
15A	Shut Down – Early Blowdown to the Condenser & RHR Initiation Case A	91(5)	Normal	✓(5)
15B	Shut Down – Early Blowdown to the Condenser & RHR Initiation Case B	20(5)	Normal	Not Required(5)
16	Vessel Flooding	111(6)	Normal	✓(6)
17	Shutdown	111(6)	Normal	✓(6)
18	Unbolt	123(7)	Normal	✓(7)
19	Refueling	40	Normal	Not Required(4)
20	Composite Loss of Feedwater Pumps Including Loss of Auxiliary Power & Turbine Trip Without Bypass	10	Upset	✓
21	Turbine Bypass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required

Notes:

(1) Leak checks at 400 psig prior to startup and power operation (listed under the startup transient in [6.i]), 3 cycles/start up [3, note 10] [4, note 10].
(2) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].
(3) No thermal change is indicated and only a 30 psi pressure change is indicated.
(4) No thermal or pressure change is indicated.
(5) The histograms show 91 cycles of Case A and 20 cycles of Case B. The cycle counting doesn't distinguish between the normal and alternate cases. Since Case A is more severe, accounting for all events as Case A is conservative and counting of the alternate case is not required.
(6) The histograms show 91 cycles of Case A and 20 cycles of Case B. Since both transients are represented identically on the histograms, Case A and Case B do not require separate tracking.
(7) [6.i] indicates 123 cycles, [6.j] [6.k] show 91 cycles of Case A and 20 cycles of Case B which do not sum to 123 cycles. Since both transients on [6.j] [6.k] are represented identically on the histograms, Case A and Case B do not require separate tracking.

3.4.7 Reactor Water Cleanup (RWCU) and Drain Piping

The RWCU and Drain piping histograms [6.l] [6.m] show multiple events. The events shown on the RWCU and Drain piping histograms are listed in Table 12. The last column in Table 12 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**).

Table 12: Transients Shown on RWCU and Drain Piping Histograms

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360(1)	Normal	✓(1)
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated Power)	120	Normal	✓
5	Daily Power Reduction to 75%	10,000	Normal	Not Required(2)
6	Weekly Power Reduction to 50%	2,000	Normal	Not Required(2)
7	Rod Pattern Change	400	Normal	Not Required(3)
8	Turbine Trip 100% Steam By-pass	10	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater	40	Upset	✓
11	Other Scrams	140	Upset	✓
12A	Rated Power Normal Operation – RWCU Pumps On	-	Normal	Not Required(4)
12B	Rated Power Normal Operation – RWCU System Trip	250		**Add**
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓
15	Shut Down – Shut-Down Initiate	111	Normal	✓
16	Shut Down – Vessel Flooding	111	Normal	✓
17	Shut Down – Shutdown Complete	111	Normal	✓
18	Unbolt	123	Normal	✓
19	Refueling	40	Normal	Not Required(4)
20	Composite Loss of Feedwater Pumps, Loss of Auxiliary Power & Turbine Trip Without Bypass	10	Upset	✓
21	Turbine Bypass Single SRV Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Recirc Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required

Notes:

(1) Leak checks at 400 psig prior to startup and power operation (listed under the startup transient in [6.l] [6.m]), 3 cycles/start up [3, note 10] [4, note 10].

(2) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].

(3) No thermal change is indicated and only a 30 psi pressure change is indicated.

(4) No thermal or pressure change is indicated.

3.4.8 Standby Liquid Control (SLC) Piping

The SLC histograms [6.n] [6.o] [6.p] show multiple events. The events shown on the SLC histograms are listed in Table 13. The last column in Table 13 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**).

Table 13: Transients Shown on SLC Piping Histograms

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360(1)	Normal	✓(1)
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated Power)	120	Normal	✓
5	Daily Power Reduction	10,000	Normal	Not Required(2)(3)
6	Weekly Power Reduction	2,000	Normal	Not Required(2)(3)
7	Rod Pattern Change	400	Normal	Not Required(3)
8	Turbine Trip 100% Steam By-pass	N/A	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On Isolation Valves Stay Open	50	Upset	✓
11	Other Scrams	140	Upset	✓
12A	Rated Power Normal Operation	-	Normal	Not Required(3)
12B-C	Rated Power Normal Operation – SLC Injection	10		✓
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓(3)
15	Shut Down – Vessel Flooding	111	Normal	✓
16	Vessel Flooding	111	Normal	✓
17	Shut Down	111	Normal	✓
18	Unbolt	123	Normal	✓
19	Refueling – SLC Injection	40	Normal	Not Required(4)
20	Composite Loss of Feedwater Loss of Auxiliary Power & Turbine Trip Without Bypass	10	Upset	✓
21	Turbine Bypass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required

Notes:

(1) Leak checks at 400 psig prior to startup and power operation (listed under the startup transient in [6.n]), 3 cycles/start up [3, note 10] [4, note 10].

(2) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].

(3) No thermal or pressure change is indicated.

(4) An injection during a refueling outage is postulated but only involves a 20°F temperature change and no pressure change. The injection is therefore insignificant from a thermal transient standpoint. Activation of the system is key locked and therefore highly unlikely to occur accidentally [25, Section 3.2.1]. Technical specification surveillance 3.1.7.8 requires demonstration that the SLC system can inject the proper amount of water into the RPV every 2 years [26]. This is accomplished via STP-201-6601 [27]. Even if it was assumed that the test is performed every 18 months, the design basis number of cycles (40) would not be exceeded for a 60 year plant life [26].

3.4.9 Reactor Core Isolation Cooling (RCIC) Head Spray Piping

The RCIC histograms [6.q] [6.r] [6.s] [6.t] show multiple events. The events shown on the RCIC histograms are listed in Table 14. The last column in Table 14 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**).

Table 14: Transients Shown on RCIC Head Spray Piping Histograms

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360(1)	Normal	✓(1)
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated PWR)	120	Normal	✓
5	Daily Power Reduction to 75%	10,000	Normal	Not Required(2)(3)
6	Weekly Power Reduction to 50%	2,000	Normal	Not Required(2)(3)
7	Rod Pattern Change	400	Normal	Not Required(3)
8	Turbine Trip 100% Steam By-pass	N/A	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On Isolation Valves Stay Open	50	Upset	✓
11	Other Scrams	140	Upset	✓
12A	Rated Power Normal Operation	40	Normal	Not Required(3)
12B-C	Rated Power – Accidental Trip – RCIC Injection	40	Normal	✓(4)
13	Reduction to 0% Power	111	Normal	✓(3)
14	Hot Stand-by	111	Normal	✓
15	Shut Down – RCIC Injection	111	Normal	✓(4)
16	Shutdown Vessel Flooding	111	Normal	✓
17	Shutdown Vessel Flooding	111	Normal	✓
18	Unbolt	123	Normal	✓
19	Refueling	40	Normal	Not Required(3)
20	Composite Loss of Feedwater Pumps, Loss of Auxiliary Power & Turbine Trip Without Bypass – RCIC Injection	10(4)	Upset	✓(4)
21	Turbine Bypass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required

Notes:
(1) Leak checks at 400 psig prior to startup and power operation (listed under the startup transient in [6.q] [6.r] [6.s] [6.t]), 3 cycles/start up [3, note 10] [4, note 10].
(2) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].
(3) No thermal or pressure change is indicated.
(4) [6.q] [6.r] [6.s] [6.t] define three RCIC injections per Loss of FW Pumps, 40 RCIC injections during normal operation, and one injection during shutdown (See note 9 in Table 1).

3.4.10 Low Pressure Core Spray (LPCS) Piping

The LPCS histograms [6.u] [6.v] [6.w] show multiple events. The events shown on the LPCS histograms are listed in Table 15. The last column in Table 15 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**).

Table 15: Transients Shown on LPCS Piping Histograms

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360(1)	Normal	✓(1)
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated Power)	120	Normal	✓
5	Daily Power Reduction	10,000	Normal	Not Required(2)(3)
6	Weekly Power Reduction	2,000	Normal	Not Required(2)(3)
7	Rod Pattern Change	400	Normal	Not Required(3)
8	Turbine Trip 100% Steam By-pass	10	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On Isolation Valves Stay Open	40	Upset	✓
11	Other Scrams	140	Upset	✓
12A	Normal Operation with Leak	10	Normal	Not Required(4)
12B	Normal Operation with Pump	500	Normal	Not Required(3)
12C	Normal Operation – Monthly Injection Test	500	Normal	Not Required (5)
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓(3)
15A	Shut Down - Normal	101	Normal	✓
15B	Shutdown – LPCS Injection	10	Normal	✓
16	Shutdown - Flooding	111	Normal	✓
17	Shutdown - Flooding	111	Normal	✓
18	Unbolt	123	Normal	✓
19	Refueling – Pump Test	40	Normal	Not Required(6)
20	Composite Loss of Feedwater Pumps, Loss of Auxiliary Power & Turbine Trip Without Bypass	10	Upset	✓
21	Turbine Bypass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down – LPCS Injection	1	Faulted	Not Required

Notes:

(1) Leak checks at 400 psig prior to startup and power operation (listed under the startup transient in [6.u] [6.v] [6.w]), 3 cycles/start up [3, note 10] [4, note 10].

(2) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].

(3) No thermal or pressure change is indicated.

(4) This event has never occurred and it isn't expected to occur in the future [30]. Assuming the design basis number of cycles is sufficient for 60 years of operation and this event therefore does not require tracking.

(5) No thermal transient is indicated, however a pressure transient is present for event 12C indicating system pressurization and depressurization. Per Reference [22, Section 4.2.2], the injection shutoff valve is not permitted to open unless the reactor pressure is less than or equal to 487 psig. Injection test at full reactor pressure therefore cannot occur and does not require tracking.

(6) Although this is a very minor thermal transient, it is one of the lowest temperatures reached by this system and shows up in the top load pairs in the design fatigue analysis for one bounding location [13, Appendix F]. Since this test was only performed 2 to 3 times in the past and is no longer performed [29], assuming the design basis number of cycles for 60 years of operation is conservative. This event does not require tracking.

3.4.11 High Pressure Core Spray (HPCS) Piping

The HPCS histograms [6.x] [6.y] [6.z] show multiple events. The events shown on the HPCS histograms are listed in Table 16. The last column in Table 16 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**).

Table 16: Transients Shown on HPCS Piping Histograms

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360(1)	Normal	✓(1)
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated Power)	120	Normal	✓
5	Daily Power Reduction to 75%	10,000	Normal	Not Required(2)(3)
6	Weekly Power Reduction to 50%	2,000	Normal	Not Required(2)(3)
7	Rod Pattern Change	400	Normal	Not Required(3)
8	Turbine Trip 100% Steam By-pass	10	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On Isolation Valves Stay Open	40	Upset	✓
11	Other Scrams	140	Upset	✓
12A-1	Injection Valve Leaks	10	Normal	Not Required(4)
12A-2	Motor Operated Pump Test	500	Normal	Not Required(3)
12A-3	Motor Operated Injection Valve test	500	Normal	Not Required(5)
12A-4	HPCS Pump Accidental On	10	Normal	✓
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓(3)
15	Shutdown Vessel Flooding	111	Normal	✓
16	Shutdown Vessel Flooding	111	Normal	✓
17	Shutdown Vessel Flooding	111	Normal	✓
18	Unbolt	123	Normal	✓
19-1	Normal Refuel	20	Normal	Not Required(3)
19-2	Refuel Pump Trip	20	Normal	Not Required(6)
20	Composite Loss of Feedwater Loss of Auxiliary Power & Turbine Trip Without Bypass – HPCS Injection	10(7)	Upset	✓
21	Turbine Bypass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down – HPCS Injection	1	Faulted	Not Required

Notes:

(1) Leak checks at 400 psig prior to startup and power operation (listed under the startup transient in [6.x] [6.y] [6.z]), 3 cycles/start up [3, note 10] [4, note 10].
(2) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].
(3) No thermal or pressure change is indicated.
(4) Only one of these events has occurred to date and the projected number of cycles is therefore expected to stay well below the design number of cycles of 10 [28].
(5) A large pressure transient is indicated for Region C. The usage for location 199 [19], which is in Region C, is affected by this transient. This valve is only tested during cold shutdown so this transient will not occur [28].
(6) This is not an event that will occur frequently and it does not affect the bounding Node 45 location [13, Appendix A] within this piping system. It therefore does not require tracking.
(7) [6.x] [6.y] [6.z] define three HPCS injections per Loss of FW Pumps.

3.4.12 Recirculation Piping

The recirculation histogram [6.aa] shows multiple events. The events shown on the recirculation histogram are listed in Table 17. The last column in Table 17 indicates whether the event is counted (✓), is not required to be counted (Not Required), or should be added to the event cycle counting (**Add**).

Table 17: Transients Shown on Recirculation Piping Histogram

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hydro Test	40	Normal	✓
-	Leak Check (to 400 psig)	360(1)	Normal	✓(1)
3	Start Up	120	Normal	✓
4	Turbine Roll (Increase to Rated Power)	120	Normal	✓
5	Daily Power Reduction 75%	10,000	Normal	Not Required(2)
6	Weekly Power Reduction 50%	2,000	Normal	Not Required(2)
7	Rod Pattern Change	400	Normal	Not Required(3)
8	Turbine Trip 100% Steam By-pass	10	Upset	✓
9	Partial Feedwater Heater By-pass	70	Upset	✓
10	Scram – Turbine Generator Trip Feedwater On Isolation Valves Stay Open	40	Upset	✓
11	Other Scrams	140	Upset	✓
12	Rated Power Normal Operation	111	Normal	Not Required(3)
-	Rated Power Normal Operation - RWCU System Trip	250(4)	Normal	**Add**
13	Reduction to 0% Power	111	Normal	✓
14	Hot Stand-by	111	Normal	✓(3)
15	Shutdown Vessel Flooding	111	Normal	✓
16	Shutdown Vessel Flooding	111	Normal	✓
17	Shutdown Vessel Flooding	111	Normal	✓
18	Unbolt	123	Normal	✓
19	Refueling	40	Normal	Not Required(3)
20	Composite Loss of Feedwater Pumps Loss of Auxiliary Power & Turbine Generator Trip Without Bypass	10	Upset	✓
21	Turbine Bypass Single Relief or Safety Valve Blowdown	8	Upset	✓
22	Reactor Overpressure with Delayed Scram, Feedwater Stays On, Isolation Valves Stay Open	1	Emergency	Not Required
23	Automatic Blowdown	1	Emergency	Not Required
24	Improper Start of Cold Recirc Loop	1	Emergency	Not Required
25	Sudden Start of Pump in Cold Loop	1	Emergency	Not Required
26	Hot Standby-Drain Shut-Off – Pump Restart	1	Emergency	Not Required
27	Pipe Rupture & Blow down	1	Faulted	Not Required

Notes:

(1) Leak checks at 400 psig prior to startup and power operation, 3 cycles/start up [6.aa, note 5].

(2) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].

(3) No thermal or pressure change is indicated.

(4) 250 RWCU system trips are assumed to occur during rated power normal operation [6.aa, note 7]

3.5 USAR Design Transients

USAR Appendix 6A [2] contains the containment dynamic loading assessment. USAR Appendix A, Section 6A.16.2.5, indicates that total SRV discharges are split into 1500 single and 300 multiple discharges. It is therefore recommended that the counting of SRV actuations be split into single and multiple categories.

Safe shutdown (SSE) and operational basis (OBE) seismic events are list in USAR Appendix A [2], Table 6A.15-1 for the containment system. One SSE and five OBE events are assumed to occur in a 40 year plant life with 20 cycles per event assumed. OBE events are tracked and SSE is an emergency type event.

Location specific transients are listed in the USAR [2, Sections 3.9.1.1.1.1 through 3.9.1.1.1.12 and Table 3.9-1]. The Tables within this calculation list the location specific transients and correlate them to counted transients listed in Table 1 when possible. If a matching counted transient cannot be determined, an explanation is provided in the table.

Table 18: USAR Section 3.9.1.1.1B (CRD Transients)

USAR Transient Name	Design Cycles	Type	Counted Transient(s) (Transient #)?
1. Reactor startup/shutdown	120	normal/upset	Startup (3), Shutdown (13-17), and Blowdown Scram (21)
2. Vessel pressure tests	130	normal/upset	Design Hydrotest (2)
3. Vessel overpressure	10	normal/upset	See Note 1
4. Scram tests	140	normal/upset	See Note 1
5. Startup scrams	160	normal/upset	See Note 1
6. Operational scrams	300	normal/upset	Turbine Generator Trip (10), Other Scrams (11), Shutdown (13-17), and Blowdown Scram (21)
7. Jog cycles	30,000	normal/upset	See Note 1.
8. Shim/drive cycles	1,000	normal/upset	See Note 1
9. Scram with inoperative buffer	24	normal/upset	See Note 1
10. Operating Basis Earthquake (OBE)	10	normal/upset	Not counted, **Add**
11. Safe Shutdown Earthquake	1	faulted	N/A, faulted event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
12. Scram with stuck control blade	1	faulted	N/A, faulted event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
13. Control rod ejection accident	1	faulted	N/A, faulted event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.

Notes:

(1) In the design basis evaluation [9], the only transients causing any amount of fatigue are Scrams (Items 4, 5, and 6 in Table 18) and the Scram w/inoperative Buffer. The analysis was performed in a conservative manner by assuming that worst case loadings occurred together and therefore assumed more cycles than specified. For instance, at the highest fatigue location [9, Sht. No. 1-8], Scrams were grouped together (Items 4, 5, and 6 in Table 18) [9, Sht. 10-6] and they were all assumed to include an inoperative buffer [9, Sht. 10-2]. The counting of Operational Scrams is therefore considered adequate to ensure that the CRD remains within the design basis from a cycle count perspective.

Table 19: USAR Section 3.9.1.1.2B (CRD Housing and Incore Housing Transients)

USAR Transient Name	Design Cycles	Type	Counted Transient(s) (Transient #)?
1. Startup and Shutdown	120	normal/upset	Startup (3), Shutdown (13-17), and Blowdown Scram (21)
2. Design pressure tests	403	normal/upset	Design Hydrotest (2), and Leak Check (-)
3. Loss of feedwater pumps	10	normal/upset	Loss of Feedpumps (20)
4. Relief or safety valve blowdown	8	normal/upset	Blowdown Scram (21)
5. Scrams	180	normal/upset	Turbine Generator Trip (10) and Other Scrams (11)
6. Operation Basis Earthquake (OBE)	10	normal/upset	**Add**
7. Safe Shutdown Earthquake (SSE)	1	Emergency/faulted	N/A, faulted or emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
8. Stuck rod scram – CRD HSG only	1	normal/upset	See Note 1
9. Scram no buffer – CRD HSG only	1	normal/upset	See Note 1

Notes:
(1) See Note 1 of Table 18.

Table 20: USAR Section 3.9.1.1.3B (Hydraulic Control Unit Transients)

USAR Transient Name	Design Cycles	Type	Counted Transient(s) (Transient #)?
1. Reactor startup/shutdown	120	normal/upset	Startup (3), Shutdown (13-17), and Blowdown Scram (21)
2. Scram tests	140	normal/upset	(1)
3. Startup scrams	160	normal/upset	(1)
4. Operational scrams	300	normal/upset	Turbine Generator Trip (10), Other Scrams (11), Shutdown (13-17), and Blowdown Scram (21)
5. Jog cycles	30,000	normal/upset	(1)
6. Shim/drive cycles	1,000	normal/upset	(1)
7. Scram with stuck scram discharge valve	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
8. OBE	10	normal/upset	(1)
9. SSE	1	faulted	N/A, faulted event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.

Notes:
(1) As shown on Reference [21], the hydraulic control unit [21, H8] is a Class 2 [21, C7] component which is not subject to a Class 1 fatigue analysis. Therefore, no cycle counting is required for this location.

Table 21: USAR Section 3.9.1.1.4B (Core Support and Reactor Internals Transients)

The cycles listed in [2, Table 3.9B-1] were considered in the design and fatigue analysis for the reactor internals. Refer to Table 24 for an evaluation of those transients.

Table 22: USAR Section 3.9.1.1.5B (Main Steam System Transients)

USAR Transient Name	Design Cycles	Type	Counted Transient(s) (Transient #)?
1. Hydrotest	40	test	Design Hydrotest (2)
2. Leaktest	360	Test	Leak Check (-)
3. Startup	120	normal	Startup (3)
4. Turbine trip	10	upset	Turbine Bypass (8)
5. Scram and trip isolation valves open	40	upset	Turbine Generator Trip (10)
6. Scram	140	upset	Other Scrams (11)
7. Shutdown	111	normal	Shutdown (13-17)
8. Loss of feedwater pumps isolation valves closed	10	upset	Loss of Feedpumps (20)
9. Turbine bypass single relief of safety valve	8	upset	Blowdown Scram (21)
10. Reactor over pressure delayed scram	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
11. Automatic blowdown	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
12. Operating basis earthquake (OBE)	50	upset/normal	**Add**
13. Turbine stop valve closure (TSV)	600	upset	This event is a short duration pressure pulse that occurs during other transients and is therefore accounted for already as a part of other transients.
14. Relief valve lift (RVL)	5433	upset	SRV Actuation

Table 23: USAR Section 3.9.1.1.6B (Recirculation System Transients)

USAR Transient Name	Design Cycles	Type	Counted Transient(s) (Transient #)?
1. Hydrotest	40	test	Design Hydrotest (2)
2. Startup	120	normal	Startup (3)
3. Turbine trip	10	upset	Turbine Bypass (8)
4. Partial feedwater heater bypass	70	upset	Partial FW Heater Bypass (9)
5. Turbine generator trip F.W. on isolation valves open	40	upset	Turbine Generator Trip (10)
6. Scram	140	upset	Other Scrams (11)
7. Shutdown	111	normal	Shutdown (13-17)
8. Loss of feedwater pumps isolation valves closed	10	upset	Loss of Feedpumps (20)
9. Turbine bypass single S/RV blowdown	8	upset	Blowdown Scram (21)
10. Reactor over pressure with delayed scram	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
11. Automatic blowdown	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
12. Operating basis earthquake (OBE)	50	upset/normal	**Add**
13. Single Loop Operation	25	normal	Not Required[(1)]

Notes:

(1) See Table 28, Note 3.

Table 24: USAR Section 3.9.1.1.7B, Table 3.9B-1 (Reactor Assembly Transients)

No.	Event Name	Design Cycles	Type	Counted?
1	Bolt Up	123	Normal	✓
2	Design Hyd Test	40	Normal	✓
2a	Leak Check (to 400 psig)	360(1)	Normal	✓
3	Startup	120	Normal	✓
4	Daily Reduction 75%	10,000	Normal	Not Required
5	Weekly Reduction 50%	2,000	Normal	Not Required
6	Rod Pattern Change	400	Normal	Not Required
7	Loss of feedwater heaters (80 cycles total)	80	Upset	✓
8	50% safe shutdown earthquake event at rate operating conditions	10/50(2)	Upset	**Add**
9a	Scram: Turbine generator trip, feedwater on, isolation valves stay open	40	Upset	✓
9b	Scram: Other scrams	140	Upset	✓
9c	Scram: Loss of feedwater pumps, isolation valves closed	10	Upset	✓
9d	Scram: Turbine bypass, single safety or relief valve blowdown	8	Upset	✓
10	Reduction to 0% power, hot standby, shutdown	111	Normal	✓
11	Unbolt	123	Normal	✓
12	Single Loop Operation (Recirculation)	25	Upset	Not Required(3)
13a	Reactor overpressure with delayed scram, feedwater stays on, isolation valves stay open	1	Emergency	Not Required
13b	Automatic blowdown	1	Emergency	Not Required
14	Improper start of cold recirculation loop	1	Emergency	Not Required
15	Sudden start of pump in cold recirculation loop	1	Emergency	Not Required
16	Hot standby with reactor drain shut off followed by pump restart	1	Emergency	Not Required
17	Pipe rupture and blowdown	1	Faulted	Not Required
18	Safe shutdown earthquake at rated operating conditions	1	Faulted	Not Required
19	Safe shutdown earthquake during refueling	1	Faulted	Not Required

Notes:

(1) Leak checks at 400 psig prior to power operation, 3 cycles/startup [2, Table 3.9B-1].
(2) Fifty peak OBE cycles for NSSS piping, 10 peak OBE cycles for other NSSS equipment and components.
(3) See Table 28, Note 3.

Table 25: USAR Section 3.9.1.1.8B (Main Steam Isolation Valve Transients)

USAR Transient Name	Design Cycles	Type	Counted Transient(s) (Transient #)?
1a. Heating cycle @ 100°F/hr	300	normal/upset	Startup (3), Turbine Generator Trip (10), and Other Scrams (11)
1b. Cooling cycle @ 100°F/hr	300	normal/upset	Turbine Generator Trip (10), Other Scrams (11), Shutdown (13-17), and Blowdown Scram (21)
1c. 29°F between 70°F and 552°F	600	normal/upset	Not explicitly counted, but is part of transients 1a and 1b (1)
1d. 50°F step change between 70°F and 552°F	200	normal/upset	Not explicitly counted, but is part of transients 1a and 1b (1)
2. Loss of feedwater pump/MSLIV closure	10	normal/upset	Loss of Feedpumps (20)
3. Single relief valve blowdown	8	normal/upset	Blowdown Scram (21)
4. Reactor overpressure with delayed scram	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
5. Automatic and blowdown (ADS)	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
6. Pipe rupture and blowdown	1	faulted	N/A, faulted event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.

Notes:

(1) These small temperature fluctuations would have an insignificant impact on fatigue. The reported fatigue usage (It) for this component is 0.0168 [2, Table 3.9B-2h, Item Number 1.11].

Table 26: USAR Section 3.9.1.1.9B (Safety/Relief Valve Transients)

USAR Transient Name	Design Cycles	Type	Counted Transient(s) (Transient #)?
1. Heating and cooldown – within the temperature limits of 70°F and 552°F at a rate of 100°F/hr	300	normal/upset	Startup (3), Turbine Generator Trip (10), Other Scrams (11), Shutdown (13-17), and Blowdown Scram (21)
2. Small temperature changes- of 29°F (either increase or decrease) at any temperature between the limits of 70°F and 552°F	600	normal/upset	Not explicitly counted, but is part of transient 1 (1)
3. 50°F temperature changes- (either increase or decrease) at any temperature between the limits of 70°F and 552°F	200	normal/upset	Not explicitly counted, but is part of transient 1 (1)
4. Loss of feedwater pumps, isolation valve closure	10	normal/upset	Loss of Feedpumps (20)
5. Turbine bypass, single relief or safety valve blowdown (temperature drops from 552°F to 375°F in 10 minutes	8	normal/upset	Blowdown Scram (21)
6. Reactor overpressure with delayed scram	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
7. Automatic blowdown	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
8. Pipe rupture and blowdown	1	faulted	N/A, faulted event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
9a. Hydrotests to 1045 psig at 100°F	120	testing	Design Hydrotest (2)
9b. Steam line flooding during plant shutdown	120	other	Vessel Floodup (16)

Notes:

(1) These small temperature fluctuations would have an insignificant impact on fatigue. The reported fatigue usage (It) for this component is 0.0003 [2, Table 3.9B-2g].

Table 27: USAR Section 3.9.1.1.10B (Recirculation Flow Control Valve Transients)

USAR Transient Name	Design Cycles	Type	Counted Transient(s) (Transient #)?
1. Startup (100°F/hr heatup rate 70°F to design temperature)	300	normal/upset	Startup (3), Turbine Generator Trip (10), and Other Scrams (11)
2. Small temperature changes (29°F step)	600	normal/upset	Not explicitly counted, but is part of transient 1 (1)
3. 50°F step changes	200	normal/upset	Not explicitly counted, but is part of transient 1 (1)
4. Safety/relief valve blowdowns (single valve)	8	normal/upset	Blowdown Scram (21)
5. Safety valve transient (110% of design pressure)	1	normal/upset	Since there is only one design cycle specified, it is assumed that this is an emergency event which does not require counting.
6a. Installed hydrotest, 1300 psig	130	testing	Design Hydrotest (2)
6b. Installed hydrotest, 1670 psig	3	testing	Hydrostatic Test (Not counted, only occurs during original plant fabrication and startup)
7. Automatic blowdown	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
8. Improper start of pump in cold loop	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.

Notes:

(1) These small temperature fluctuations would have an insignificant impact on fatigue. The reported fatigue usage (It) for this component is 0.0018 [2, Table 3.9B-2f, Item Number 1.10].

Table 28: USAR Section 3.9.1.1.11B (Recirculation Pump Transients)

USAR Transient Name	Design Cycles	Type	Counted Transient(s) (Transient #)?
1. Bolt up	123	normal-upset	Bolt up (1)
2. Design hydrotest	40	testing	Design Hydrotest (2)
3. Startup, turbine roll and increase to rated power	120	normal-upset	Startup (3), Turbine Roll (4)
4. Daily power reduction – 75%	10,000	normal+upset	Not required(1) (2)
5. Weekly power reduction – 50%	2,000	normal+upset	Not required(1) (2)
6. Rod pattern change	400	normal+upset	Not Required(2)
7. Loss of feedwater heaters	80	normal+upset	Turbine Bypass (8), Partial FW Heater Bypass (9)
8. Scrams	180	normal+upset	Turbine Generator Trip (10), Other Scrams (11)
9. Special normal operation transients	20	normal+upset	Not Required(3)
10. Shutdown	111	normal+upset	Shutdown (13-17)
11. Unbolt	123	normal+upset	Unbolt (18)
12. Scram – Loss of feedwater pumps	10	normal+upset	Loss of Feedpumps (20)
13. Scram – turbine bypass single relief or safety relief valve blowdown	8	normal+upset	Blowdown Scram (21)
14. Reactor overpressure	1	emergency	N/A(4)
15. Scram – Automatic blowdown	1	emergency	N/A(4)
16. Improper start of pump in cold loop	2	emergency	N/A(4)
17. Improper startup with reactor drain shutoff	1	emergency	N/A(4)
18. Pipe rupture and blowdown	1	faulted	N/A(4)

Notes:

(1) Daily and weekly power reductions are associated with load following. Since RBS is not a load-following unit, these transients do not apply [34].

(2) No pressure or temperature change is shown for these events [17].

(3) This event is associated with single recirculation loop operation as specified in the pressure temperature cycles [17] for the recirculation pump [18, Table 1.3-1] where the recirculation suction and discharge valves are closed [17, Note 13]. Since those valves are not kept closed long enough for the recirculation line to cool off [20, Section 5.9] and the idle loop is kept within 50°F of the running loop, this transient will never occur.

(4) Emergency or faulted event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.

Table 29: USAR Section 3.9.1.1.12B (Recirculation Gate Valve Transients)

USAR Transient Name	Design Cycles	Type(1)	Counted Transient(s) (Transient #)?
1. 70°F-575°F-70°F of 100°F/hr	300	normal/upset	Startup (3), Turbine Generator Trip (10), Other Scrams (11)
2. +/-29°F between limits of 70°F and 575°F	600	normal/upset	Not explicitly counted, but is part of transient 1 (2)
3. +/-50°F between limits of 70°F and 575°F	200	normal/upset	Not explicitly counted, but is part of transient 1 (2)
4. 552°F to 375°F, in 10 min	8	normal/upset	Blowdown Scram (21)
5. 552°F to 281°F, in 22.3 min	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
6. 100°F to 552°F, in 15 sec	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
7. 110% of design pressure at 575°F	1	emergency	N/A, emergency event not required to be included in design basis fatigue evaluations due to the low probability that one will occur. If one of these events does occur then the fatigue contribution will have to be evaluated.
8. 1300 psi at 100°F installed hydrostatic test	130	test	Design Hydrotest (2)
9. 1670 psi at 100°F installed hydrostatic test	3	test	Hydrostatic Test (Not counted, only occurs during original plant fabrication and startup)

Notes:

(1) USAR section 3.9.1.1.12B does not provide a category (referred to as type in this table) for the transients listed. The type of transient is determined based on similarity to transients listed in USAR table 3.9.1.1.10B.

(2) These small temperature fluctuations would have an insignificant impact on fatigue. The reported fatigue usage (It) is 0.0023 [2, Table 3.9B-2j, Item Number 1.10] for the gate valve on the suction side of the recirculation pump and 0.0012 [2, Table 3.9B-2j, Item Number 1.10] for the gate valve on the discharge side of the recirculation pump.

3.6 Class MC Penetrations

Penetrations at RBS have usage calculations performed according to Class 1 and ASME Code Class MC rules. The boundary between the Class 1 and Class MC region is shown in Figure 3 [23, p. 21]. The fatigue analysis for the Class 1 portion of the penetration is included in the fatigue analysis for the piping system to which it is attached [23, p. 37 and Attachment E] and the cycles to be tracked have already been evaluated in Section 3.4 of this calculation. The thermal cycle diagrams for the Class MC portion are defined in the USAR [23, pp. 224, C2] and the cycles to be tracked have already been evaluated in Section 3.5 of this calculation. The steel containment has an additional leakage rate test that is specified as being performed 3 times in every 10 years at 7.6 psig [23, p. 225] for a total of 13 cycles. As shown in Figure 4 [23, p. 238], six cuts through the steel containment were evaluated for stress. Cuts 1 and 6 were determined to be bounding from a fatigue standpoint [23, p. 237]. Cut 1 has a usage of 0.014 and the fatigue contribution due to the leakage rate test is 13 / 489647 = 0.00003 [23, p. 386]. Cut 6 has negligible usage [23, p. 532]. Since the usage contribution due to leakage rate test is so small, it does not require tracking. In addition, the leakage rate test occurs once every 10 years at the most [33] so assuming 13 cycles in the fatigue analyses is sufficient for a 60 year operating period.

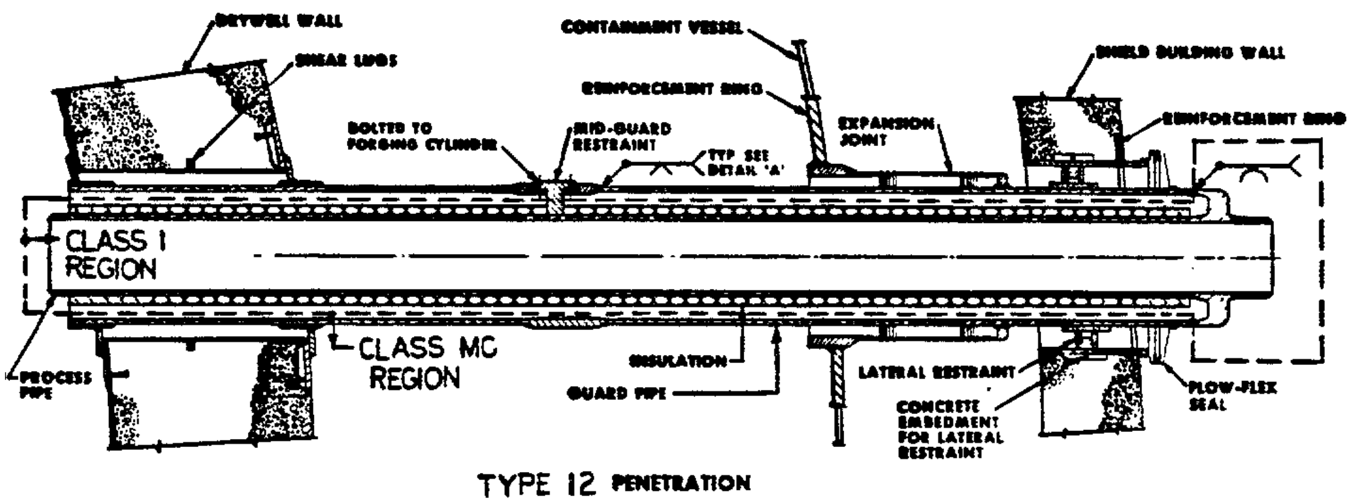


Figure 3. Penetration ASME Code Class Regions

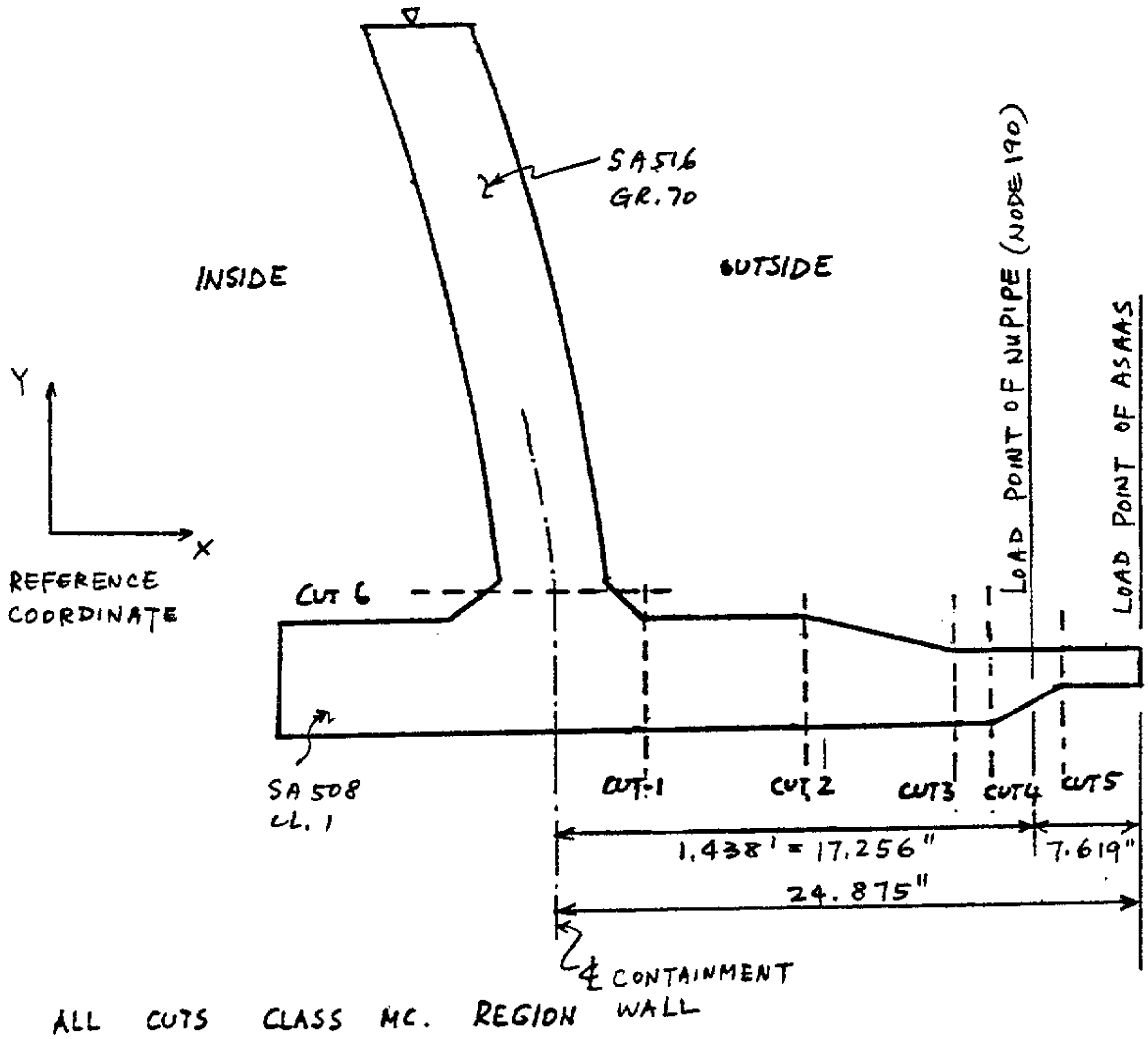


Figure 4. Steel Containment Stress Evaluation Locations

4.0 CONCLUSIONS AND DISCUSSION

Table 30 presents the results of the review performed in Section 3.0 of this calculation. Transients listed in Table 30 are either already tracked automatically (Automatic), already tracked manually (Manual), or require addition to the fatigue monitoring program (**Add**).

Table 30: Transients Required For Fatigue Monitoring

No.	FatiguePro Transient Name	Allowable Cycles	Tracking Status
1	Boltup	123	Manual
2	Design Hydrotest	50	Automatic
-	Leak Check (to 400 psig)	360	Automatic
3	Startup	120	Automatic
4	Turbine Roll	120	Automatic
8	Turbine Bypass (Turbine Trip with 100% Steam Bypass)	10	Automatic
9	Partial FW Heater Bypass	70	Automatic
10 & 11	Scram (Includes Turbine Generator Trip (10) and Other Scrams (11))	180	Automatic
	50% Maximum Seismic Loadings, Operational Basis Earthquake (OBE)	5	**Add, Manual**
	RWCU System Trip(2)	250	**Add, Automatic**
13	Power Reduction to Zero	111	Automatic
14	Hot Standby	111	Automatic
15 & 17	Shutdown (initial and final cooldowns)	111	Automatic
16	Vessel Floodup	111	Automatic
18	Unbolt	123	Manual
20	Loss of Feedpumps	10	Automatic
21	Blowdown Scram	8	Automatic
	LPCS Injection	10	Automatic
	HPCS Injection	40	Automatic
	RCIC Injection	181/30(3)	Automatic
	SLC Injection During Normal Operation	10	Manual
	LPCI Injection to Vessel (3 separate events)	10/nozzle	Automatic
	LPCI A Injection	10	Automatic
	LPCI B Injection	10	Automatic
	LPCI C Injection	10	Automatic
	Single SRV Actuation	1500	Automatic(1)
34	Multiple SRV Actuation	300	Automatic(1)

Notes:

(1) The automatic counting lumps single and multiple SRV actuations together. It is recommended that these be split into two categories with an allowable of 1500 for single SRV actuation and an allowable of 300 for multiple SRV actuation.

(2) See Table 12 and Table 17.

(3) RCIC was rerouted from the head spray to the feedwater system [36]. An allowable of 181 cycles applies to the time period prior to the reroute. Thirty (30) cycles of RCIC injection during Loss of Feedpumps are specified after the reroute [37, PICL No. AP-17, Attachment A]. Note that RCIC injections to feedwater during normal operation (with feedwater flowing) were deemed insignificant for the feedwater piping [37, PICL No. AP-17, Attachment A, p. 7].

5.0 REFERENCES

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2. River Bend Updated Safety Analysis Report (specific sections only, not complete), SI File No. 1401192.205.

3. GE Drawing No. 762E458, Revision 7, Sheets 1 and 2, *Reactor Cycles*, SI File No. RBS-01Q-225

4. GE Drawing No. 105E2945, Revision 0, Sheets 1 and 2, *Reactor Cycles River Bend 1 Power Uprate*, SI File No. RBS-09Q-210 (Entergy File Nos. 0222.250-000-200 and 0222.250-000-201).

5. GE Drawing No. 166B7307, Revision 6, Sheets 1 to 12, *Reactor Vessel Nozzle Thermal Cycles*, SI File No. RBS-08Q-209 (Entergy File No. 0221.110-000-128 to 0221.110-000-139).

6. Piping System Histograms:
    a. 12210-SK-TR2-A-1, sheets 1 to 3, *Thermal Transients for Main Steam Supply System & RPV Vent Lines*, SI File No. RBS-01Q-203.
    b. 12210-SK-TR2-A-2, sheets 1 to 3, *Thermal Transients for Main Steam Supply System & RPV Vent Lines*, SI File No. RBS-01Q-203.
    c. 12210-SK-TR13-A-2, sheets 1 to 4, *Thermal Transient for RCIC Pump Turbine System Steam Line (RCIC)*, SI File No. RBS-01Q-203.
    d. 12210-SK-TR17-A-1, sheets 1 to 5, *Thermal Transients Feedwater System (FWS)*, SI File No. RBS-01Q-203.
    e. 12210-SK-TR31-A-2, sheets 1 to 3, *Thermal Transient Main Steam Isolation Valve Drain Piping (DTM)*, SI File No. RBS-01Q-548.
    f. 12210-SK-TR71-A-1, sheets 1 to 4, *Thermal Transients for LPCI Injection Lines (RHR) (Region Close to RPV)*, SI File No. RBS-01Q-203.
    g. 12210-SK-TR71-B-1, sheet 1, *Thermal Transients for LPCI Injection Lines (RHR) (VF041 to Drywell Penetration)*, SI File No. RBS-01Q-203.
    h. 12210-SK-TR71-C-1, sheet 1, *Thermal Transients for LPCI Injection Lines (RHR) (Drywell Penetration to MOV F042)*, SI File No. RBS-01Q-203.
    i. 12210-SK-TR71-D-1, sheets 1 to 3, *Thermal Transient for Shutdown Suction Line Only Residual Heat Removal System (Region Near Recirc Lines)*, SI File No. RBS-01Q-203.
    j. 12210-SK-TR71-E-1, sheet 1, *Thermal Transient for Shutdown Suction Line Only Residual Heat Removal System (Region from Inboard Containment Isolation Valve to Penetration at Drywell Wall)*, SI File No. RBS-01Q-203.
    k. 12210-SK-TR71-F-1, sheet 1, *Thermal Transient for Shutdown Suction Line Only Residual Heat Removal System (Region from Penetration at Drywell Wall to Outboard Containment Isolation Valve)*, SI File No. RBS-01Q-203.

l. 12210-SK-TR74-A-3, sheets 1 to 3, *Thermal Transients for Reactor Water Cleanup Line (WCS, Regions 2 and 3)*, SI File No. RBS-01Q-203.
m. 12210-SK-TR74-B-3, sheets 1 to 3, *Thermal Transients for RPV Drain Line (WCS, Region 1)*, SI File No. RBS-01Q-203.
n. 12210-SK-TR75-A-1, sheets 1 to 4, *Thermal Transients for Standby Liquid Control System Inside Drywell Wall at RPV End*, SI File No. RBS-01Q-203.
o. 12210-SK-TR75-B-1, sheet 1, *Thermal Transients for Standby Liquid Control System Inside Drywell Wall Remote from RPV*, SI File No. RBS-01Q-203.
p. 12210-SK-TR75-C-1, sheet 1, *Thermal Transients for Standby Liquid Control System Outside Drywell Wall*, SI File No. RBS-01Q-203.
q. 12210-SK-TR76-A-2, sheet 1 to 3, *Thermal Cycles for Reactor Core Isolation Head Spray Line (RCIC)*, SI File No. RBS-01Q-203.
r. 12210-SK-TR-76A-2, sheet 1 to 2, *Thermal Cycles for Reactor Core Isolation Head Spray Line (RCIC)*, SI File No. RBS-01Q-203.
s. 12210-SK-TR-76A-2, sheet 1 to 2, *Thermal Cycles for Reactor Core Isolation Head Spray Line (RCIC)*, SI File No. RBS-01Q-203.
t. 12210-SK-TR-76B-2, sheet 1 to 2, *Thermal Cycles for Reactor Core Isolation Head Spray Line (RCIC)*, SI File No. RBS-01Q-203.
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v. 12210-SK-TR-78-B-1, sheets 1 to 2, *Thermal Transients Low Pressure Core Spray Region-2*, SI File No. RBS-01Q-203.
w. 12210-SK-TR-78-C-1, sheets 1 to 2, *Thermal Transients Low Pressure Core Spray Region-3*, SI File No. RBS-01Q-203.
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