Palo Verde Nuclear Generating Station License Renewal Application

NRC Working Meeting

Metal Fatigue

May 6, 2010

Agenda

- Introductions
- Amendment 14 Overview
- Review of Amendment 14 (Section 4.3.1)
- Responses to NRC Draft Requests for Additional Information (RAI's)
- Responses to Peer Review Items
- Review of Action Items

Amendment 14 Overview

- **Changes as a result of review of LRA Section 4.3.1**
- **Responsive to NRC concerns/questions**
- **Conforming changes to be submitted by May 28, 2010**
  - Including new PVNGS reactor vessel head information
  - Additional updates including:
    - Updates to LRA Section 4.3.4 based on calculation reviews

Amendment 14 Questions

- **Why were Section 4.3.1 changes necessary?**
  - Original discussion centered on the specifics of the fatigue monitoring software rather than demonstrating how the current licensing basis (CLB) will be satisfied in the period of extended operation (PEO)
- **What changes were made?**
  - Incorporated UFSAR transients by title and clearly indicated which are counted
  - Focused on additional requirements for the PEO (NUREG/CR-6260 locations)

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Changes

- **Standardized references to the current fatigue monitoring program and the enhanced Metal Fatigue of Reactor Coolant Pressure Boundary program (AMP B3.1)**
- **Scope**
  – Confined the discussion to activity that maintains CLB compliance
  – Added NUREG/CR-6260 activities
- **Monitoring methods**
  – Changed “global” to “cycle counting” (CC)
  – Scoped more components into CC
    - removed “bounding” methodology
  – Clarified when each method is used and why

Changes (Cont'd)

- **Table 4.3-2**
  - Aligned transient titles with the UFSAR
  - Added UFSAR references for each transient
  - Expanded to cover UFSAR scope
  - Clarified transient limits
  - Explained not counting some UFSAR transients

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Changes (Cont'd)

- **Table 4.3-3**
  - Aligned transient titles to the UFSAR
  - Incorporated best source totals for each unit
  - Provided a simplified linear projection to the end of the PEO
    - Projections are provided for information only
  - Addressed period (1985 – 1995) transients

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Section 4.3.1 Text Changes

- **Explained the impact of Improved TS implementation on expanding the list of transients required to be tracked**
  - Revised the explanation of recount activities

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Section 4.3.1 Text Changes (Cont’d)

- **Simplified transient projections**
  - Linear projection
  - Explained these provided for information only
- **Actions limits**
  - Current
    - 90% of allowed cycle limit
    - Pressurizer spray nozzle Cumulative Usage Factor (CUF) limit
  - Future – approach identified
    - Specific limits to be developed prior to PEO

Changes (Cont'd)

- **Table 4.3-4**
  - Revised to more clearly demonstrate alignment with CLB
    - Continuation of cycle counting
    - Continuation of pressurizer spray nozzle CUF monitoring
    - NUREG/CR-6260 locations CUF monitoring
    - Changed some locations from CUF to CC

Common Terminology and Definitions

- **Time Limited Aging Analyses (TLAA) defined by 10 CFR 54.3**
  - Within the scope of license renewal
  - Consider the effects of aging
  - Involve time-limited assumptions defined by the current operating term (e.g., 40 years)
  - Were determined to be relevant by the licensee in making a safety determination
  - Involve conclusions or provide the basis for conclusions related to the capability of the SSC to perform its intended functions
  - Are contained or incorporated by reference in the CLB

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Common Terminology and Definitions

- **Dispositions defined by 10 CFR 54.21(c)(1)**
  - (i) Justification for existing analysis by application of simple ratios and factors to show an acceptable result without a formal revision
    - Main steam safety valves
  - (ii) Revise analysis
    - Secondary stress range reduction factor (ASME Section III Class 2 and 3 piping)
  - (iii) Aging management (e.g., tracking cycles or CUF)
    - Pressurizer spray nozzle

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Review of Amendment 14 Changes

LRA Section 4.3.1 Overview

Current Fatigue Monitoring versus Enhanced Metal Fatigue of Reactor Coolant Pressure Boundary Program (AMP B3.1)

Activity	Current Program	Enhanced Program
UFSAR 3.9.1 Transient Counting	YES CC	YES CC
Pressurizer Spray Nozzle CUF Calculation	YES CBF-PC	YES CBF-PC
Class 2 and 3 Components With Class 1 Fatigue Analysis Monitoring	YES CC	YES CC
NUREG/CR-6260 Location CUF Monitoring	Not Applicable	YES CC, CBF & SBF
Fatigue Monitoring Software	NO	YES

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AMP B3.1 Scope

- **ASME Section III Class 1 components**
- **Components with ASME Section III Class 1 fatigue analysis**
- **Non-fatigue cycle-based analyses**
- **NUREG/CR-6260 locations ***
  - Referred to in LRA Amendment 14 as bounding
  - Intended to convey these are designated locations for monitoring environmental fatigue effects

*** New scope beyond the current fatigue monitoring program**

AMP B3.1 Monitoring Methods

- **Cycle Counting**
  - Manual
  - Automated software *
- **CUF Monitoring**
  - Cycle Based Fatigue (CBF)
    - CBF-C CUF calculated per cycle (design cycle) *
    - CBF-PC CUF calculated per partial cycle
    - CBF-EP CUF calculated by event pairing *
  - Stress Based Fatigue (SBF)
    - CUF calculated online by 6-component stress tensor *

*** New activity beyond the current fatigue monitoring program**

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AMP B3.1 Action Limits

- **Act as triggers for corrective action**
- **Separate limits for CUF and CC**
- **Will be established to:**
  - Consider fatigue usage trends
  - Allow adequate time for corrective action prior exceeding a CUF of 1.0
- **Limits will be established no later than 2 years prior to PEO (Commitment 39)**

AMP B3.1 Cycle Counting Corrective Actions

All actions will be considered and appropriate actions will be taken

- **Review CUF calculations for affected CC locations**
  - Identify the components impacted by the transient
  - Determine the fatigue impact of the transient
- **Evaluate remaining CUF margins**
- **Redefine allowed numbers of other transients**
- **Redefine the transient to remove conservatism**
- **Ensure other analyses based on transient totals remain valid**

AMP B3.1 CUF
Corrective Actions

All actions will be considered and appropriate actions will be taken

- **Determine whether program scope must be expanded (e.g., additional CUF locations or EAF locations)**
- **Enhance fatigue monitoring (e.g., change monitoring method from CBF to SBF)**
- **Repair/replace/modify affected component(s)**
- **Reanalyze**
- **Modify plant operating practices**
- **Perform a flaw tolerance evaluation**

Table 4.3-2
PVNGS Units 1, 2 and 3
Licensing Basis Transients

- **Includes transients in UFSAR Section 3.9.1.1 and other UFSAR sections referred to in 3.9.1.1**
- **Limiting number of each transient**
- **UFSAR reference for each transient**
- **UFSAR category**
- **Justification for transients not counted**
- **Special notes**

Table 4.3-2 example

Table 4.3-2 – PVNGS Units 1, 2, and 3 Licensing and Design Basis Transients

1 Row No.	2 Transient Title (Shaded items are not counted)	3 Limiting Value	4 UFSAR Table 3.9.1-1	5 UFSAR Table 3.9-1 (Sheet No. - Item No.)	6 Other UFSAR Reference	7 UFSAR Category	8 Notes
5	10% power step increase, from 90% to 100% power	2000		6-I.C.1.a 15-II.D.1.a		Normal	
6	10% power step decrease, from 100% to 90% power	2000		6-I.C.1.b 15-II.D.1.a		Normal	
7	Normal cyclic variations at 100 % power; +/-80 psi, +/-10F	1.E+06	Sheet 1	6-I.C.1.c 7-I.C.1.d		Normal	Per UFSAR Table 3.9.1-1 "This condition is selected based on 1 million cycles approximating an infinite number of cycles so that the limiting stress is the endurance limit." Therefore the transient does not impact fatigue usage. This item is not counted.
8	Startup of one reactor coolant pump at hot standby conditions	1000		1-I.A.1.e		Normal	
9	Coastdown of one reactor coolant pump at hot standby conditions	1000		1-I.A.1.f		Normal	
10	Adding 40F feedwater at 875 gpm to the steam generator through the downcomer feedwater nozzle when at hot standby conditions	15000			5.4.2.1.C	Normal	
11	Pressurizer heatup from 70F to 653F at a rate of ≤200F/hr	500	Sheet 1	1-I.A.1.a		Normal	

Table 4.3-3
PVNGS Units 1, 2 and 3 Fatigue Cycle Count and Projections

- **Transients and limiting values repeated from Table 4.3-2**
- **Best source totals by unit (1985 – 2005)**
  - 1985 – 1995 reconstructed from records
    - Control room logs
    - NRC Monthly Operating Reports
    - PVNGS procedure (currently 73ST-9RC02) “Reactor Coolant System Transient and Operational Cycles”
    - LERs
    - Personnel interviews
  - Post 1995 data from 73ST-9RC02
- **Linear projection to PEO**
  - Based on highest unit total and shortest unit life
  - Information only, not an action limit
- **Notes incorporated into the table.**

Table 4.3-3 example

Table 4.3-3, PVNGS Units 1, 2, and 3 Fatigue Cycle Count and Projections

1 Row No.	2 Transient Title (Shaded items are not counted)	3 Limiting Value	4 Unit 1 Accumulation as of January 2006	5 Unit 2 Accumulation as of January 2006	6 Unit 3 Accumulation as of January 2006	7 Highest Unit 60 yr Projection (Highest Unit Total X 3.33)	8 Notes
11	Pressurizer heatup from 70F to 653F at a rate of ≤200F/hr	500	86	83	77	286	
12	Pressurizer cooldown from 653F to 70F at a rate of ≤200F/hr	500	85	82	76	285	
13	Shift from normal to maximum purification flow at 100% power	1000	250	250	250	833	
14	Standby to SI cold leg injection check valve stroke test to standby (using charging pumps)	160	0	0	0	0	PVNGS has never done this ASME Section XI test under hot conditions and has no plans to do it at temperature.
15	High-pressure safety injection header check valve test	40	0	0	0	0	PVNGS has never done this ASME Section XI test under hot conditions and has no plans to do it at temperature.
16	Turbine roll test at hot standby	10	3	3	2	10	Recount activities did not identify this test in U2 logs. However, since it is part of initial plant testing a value of 3 was assumed to equal the highest actual count.
17	Initiation of auxiliary spray during cooldown	500	85	82	76	285	This transient is tracked by pressurizer cooldown events.
18	Startup of SDC system from standby to shutdown cooling (RCS >200F) to shutdown cooling (RCS <200F) to standby	500	136	148	145	493	

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Table 4.3-4
Summary of Fatigue Usage from Class 1 Analyses, and Method of Management by the Metal Fatigue of Reactor Coolant Pressure Boundary Program

- **Summarizes AMP B3.1 scope and monitoring methods**
- **CC – cycle counting**
- **CBF and SBF – cycle based fatigue and stress based fatigue**
  - CBF-C and CBF-PC methods use the component ASME Section III design stress analysis as a basis. The calculated CUF is an interpolation of the design CUF. If applied to the design set of transients, the CBF-CUF would equal the design CUF (described in detail in a previous phone conference).
  - CBF-EP pairs events in a lookup table to recognize analyzed stress cycles.
  - SBF software will use a 6-component stress tensor consistent with ASME III NB-3200
- **Amendment 14 revised this table to list NUREG/CR-6260 locations and the pressurizer spray nozzle as the locations monitored by CUF. All other components are monitored by CC.**

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Draft RAIs
4.3-1 Through 4.3-21

PVNGS Responses

DRAI 4.3-1

- **4.3-1 Transients projected to exceed limits**
  - Clarify whether CUF calculations based on these transients have been updated
  - Clarify whether these transients significantly contribute to CUF of any components
  - Clarify if global (CC) is used to monitor any affected components
- **Response:**
  - Normal, upset and test transients are included in ASME III Class 1 fatigue analyses. Cycle counting is used as the primary method to monitor locations other than the NUREG/CR-6260 locations.
  - Projections are for information only:
    - Provide planning input
    - Not intended to initiate corrective actions

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DRAI 4.3-2

- **4.3-2 Contradictory statements in 4.3.1**
  - The text of 4.3.1 and Table 4.3-4 seem contradictory in that high CUF locations are monitored by “global” (CC) methodology
- **Response**
  - CC provides a very conservative trigger
    - Ensures the original analysis assumptions remain valid
    - Action limit based on each transient
  - Amendment 14 clarifies selection of monitoring methods
    - CUF monitoring for NUREG/CR-6260 locations and the pressurizer spray nozzle
    - CC monitoring for all other in-scope components

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DRAI 4.3-3

- **4.3-3 CBF-PC Methodology**
  - Clarify the CBF-PC methodology
  - Justify how the CBF-PC method meets ASME Section III
- **Response**
  - The CBF-C and CBF-PC methods were previously described in detail in a previous conference call
  - Discussed also on Slide 24

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DRAI 4.3-4

- **4.3-4 Margin between action and design limits**
  - Provide the margin between the AMP B3.1 action limits and the design limits
- **Response**
  - RAI B3.1-7 (Amendment 9) response explained that action limits have not yet been established for the AMP B3.1
  - Amendment 14 incorporated the discussion from the RAI B3.1-7 response

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DRAI 4.3-5

- **<u>4.3-5 Table 4.3-2 discrepancies</u>**
  - Explain discrepancies between Table 4.3-2 and UFSAR Table 3.9.1-1
- **<u>Response</u>**
  - LRA Amendment 14 conformed Table 4.3-2 to the UFSAR

DRAI 4.3-6

- **4.3-6 Assumption of 25% of design limits**
  - Explain the basis for assuming 25% of the design limits
- **Response**
  - Originally used to represent 10 years of the 40 year life (25%)
  - The data recovery effort has provided best source values for the period of 1985 – 1995, as reported in LRA Amendment 14 (Table 4.3-3)

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DRAI 4.3-7

- **4.3-7 Items marked "NC" in the recount**
  - Explain why some transients were not counted in the cycle recount
- **Response**
  - Reasons for not recounting transients are included in Table 4.3-2:
    - Some had been counted since plant start up
    - Some could not be identified (e.g., inconsistent log-keeping)
    - Some are not required to be "counted"
  - The data recovery effort has provided best source values for the period of 1985 – 1995, as reported in LRA Amendment 14 (Table 4.3-3)

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DRAI 4.3-8

- **4.3-8 Items not counted in the AMP B3.1**
  - Explain why some items are not counted in AMP B3.1
- **Response**
  - LRA Amendment 14 provides the explanation for UFSAR transients not counted in the AMP B3.1 (see Tables 4.3-2 and Table 4.3-3)

DRAI 4.3-9

- **<u>4.3-9 Items listed in Table 4.3-2 but not the UFSAR</u>**
  - Explain why some items in Table 4.3-2 are not in the UFSAR
- **<u>Response</u>**
  - LRA Amendment 14 conformed Table 4.3-2 to the UFSAR
  - Some items were in other UFSAR locations but cited in Section 3.9.1
  - Additional transients were identified in design analyses during LRA development and are under evaluation for inclusion in the UFSAR (PVAR)

DRAI 4.3-10

- **4.3-10 RPV Instrument Nozzles**
  - Describe the conservative assumptions for Unit 1 and why there is a factor of five difference between the Unit 1 and Units 2 and 3 CUFs.
- **Response**
  - No differences in geometry, materials, loading, or transients.
  - Some analytical differences include:
    - Unit 1 conservative treatment of vortex shedding.
    - Some model differences, slightly different limiting location.
    - Arithmetic instead of vector load addition at limiting Unit 1 location.
    - A small reduction in stress range yields a significant reduction in CUF.
  - All analyses include the same load following cycles (15,000 each way - used for all three units).

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DRAI 4.3-10

- **4.3-10 Clarify why power changes are not counted**
  - Explain why it is not necessary to count power increases and decreases at 5%/min between 15% and 100% power
- **Response**
  - Amendment 14 revised Tables 4.3-2 and 4.3-3 to justify not counting this event. At 90% capacity factor this represents a power change every 31.5 hours. Since the PVNGS units operate base loaded this is not credible so it is not specifically counted.
  - Power changes are documented in control room logs.

DRAI 4.3-11

- **4.3-11 CEDM Pressure Housings**
  - Did the low-CUF-based 10 CFR 54.21(c)(1)(i) validation disposition consider cycle count projections exceeding the 40-year design basis?
- **Response**
  - As stated in the slide on DRAI 4.3-1, "projections are for information only." They are not design or licensing bases for validation.
  - The LRA will be revised for the RV Head project:
    - All three heads, nozzles, and CEDM housings will be replaced by December 31, 2010. The maximum CUF is 0.4210 for the CEDM motor housings.
    - See Amendment 3, Table A4-1, Commitment 51 for Units 1 and 3 RV Head replacement (Unit 2 head had already been replaced).
    - Fatigue analyses of the replacement heads, nozzles, and CEDM housings cover a design life exceeding the period of extended operation; therefore these analyses are not TLAAs.

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DRAI 4.3-12

- **4.3-12 Steam Generator (SG) High-CUF Locations "Bounded" by Economizer and Downcomer Feedwater Nozzles**
  - a, b) Clarify applicable transients and their tracking requirements.
- **Response**
  - At the end of the period of extended operation, Unit 2 SGs will have an installed life of 42 years, and are expected to remain within the 40-year transients, confirmed by Cycle Counting.
  - a,b) The steam generators are designed for the UFSAR Section 3.9.1 transients, plus additional transients described in UFSAR Section 5.4.2. - RSG design reports evaluate Lines 1-10, 29-32, 46, 55, and 77-80; of the Amendment 14 Table 4.3-2 transients required to be tracked.

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DRAI 4.3-12 (cont'd)

- **4.3-12 Steam Generator (SG) High-CUF Locations "Bounded" by Economizer and Downcomer Feedwater Nozzles**
  - c, d) Justify use of the SBF methodology in some locations to track (bound) CUF in these others.
  - e) Is SBF included in the Metal Fatigue of Reactor Coolant Pressure Boundary (B3.1) program?
- **4.3-12 Response**
  - c, d) Amendment 14 Table 4.3-4 revised fatigue monitoring in these locations to use Cycle Counting.
  - With a conforming amendment, LRA 4.3.2.1 will no longer take credit for SBF to manage (bound) fatigue in other locations in the steam generators. (See DRAI 4.3-13)
  - e) SBF is included in the AMP B3.1 program.

DRAI 4.3-13

- **<u>4.3-13 2-inch charging isolation valves</u>**
  a) Which transients are applicable to this location?
  b) Are these transients required to be tracked by TS 5.5.5?
  c) Justify the use of bounding by an SBF-monitored location
- **<u>4.3-13 Response</u>**
  a) The transients from UFSAR Table 3.9-1, Part II (CVCS) are applicable to these valves
  b) These transients are in the program described by TS 5.5.5 and are tracked by the current fatigue monitoring program
  c) As of LRA Amendment 14, these valves are treated as individual locations monitored by cycle counting (CC) method – no reference to a bounding location is used

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DRAI 4.3-13

- **4.3-13 2-inch charging isolation valves**
  - d) Clarify the corrective actions if an action limit is reached.
  - e) Has this methodology been included in the AMP B3.1 program?
- **Response**
  - d) Corrective actions will be determined as described in LRA Section 4.3.1.5, as appropriate for the action limit that is reached
  - e) The CC (valves) and CBF-EP (charging inlet nozzle) monitoring methods are included in the AMP B3.1 program.
    - a) Note – the monitoring method for the nozzle has been corrected to the CBF-EP.

DRAI 4.3-14

- **4.3-14 Table 4.3-9 Valves with Sufficient 40-year CUF Margins to 1.0 for Validation**
  - LRA Table 4.3-3 projects 7 transients to exceed their design basis numbers of events in 40 years.
  - Have the analyses of these valves been updated for these higher rates? For 60 years with these higher rates?
- **Response**
  - As stated in the slide on DRAI 4.3-1, the Table 4.3-3 "…projections are for information only." They are not design or licensing bases for validation.
  - Therefore the 40-year analyses were not updated for this purpose.
  - When action limits are reached, AMP B3.1 corrective actions will be implemented.

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DRAI 4.3-15

- **4.3-15 Class 1 charging paths**
  a) Which transients are applicable to this location?
  b) Are these transients required to be tracked by TS 5.5.5?
  c) Justify the use of bounding by an SBF-monitored location
- **Response**
  a) The same transients from UFSAR Table 3.9-1, part II (CVCS) are applicable to all charging line locations
  b) These transients are in the program described by TS 5.5.5 and are tracked by the current fatigue monitoring program
  c) As of LRA Amendment 14, the charging path components are treated as individual locations monitored by cycle counting (CC) method – no reference to a bounding location is used

DRAI 4.3-15

- **4.3-15 Class 1 charging paths**
  - d) Clarify the corrective actions if an action limit is reached
  - e) Has this methodology been included in the AMP B3.1 program?
- **Response**
  - d) Corrective actions will be determined as described in LRA Section 4.3.1.5, as appropriate for the action limit that is reached
  - e) The CC (path) and CBF-EP (charging inlet nozzle) monitoring methods are included in the AMP B3.1 program.
    - Note – the monitoring method for the nozzle has been corrected to the CBF-EP.

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DRAI 4.3-16

- **4.3-16 Revised Analyses for Stress Range Reduction Factor**
  a) Provide code allowable stress limits and stress ranges obtained in revised analyses
  b) Provide the ASME Code edition and specific subsection used in the revised analyses
- **Response:**
  a) Code allowable stress limits and maximum stress ranges obtained in revised analyses are presented in the following table.

System	Max. Calc. Stress Range	Code Allowable Stress Limit	Max. Calc. Pipe Break Stress	Allowable Pipe Break Stress
SG Downcomer & Feedwater Recirc.	24,552 psi	27,000 psi	20,286 psi	28,440 psi
RCS Hot Leg Sample	36,322 psi	40,628 psi	N/A for NPS ≤ 1 inch	

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DRAI 4.3-16

- Response (cont.)

  b) Revised analyses were performed to the requirements of:

  - ASME Boiler and Pressure Vessel Code, Section III, 1974 up to and including Winter 1975 Addenda
  - Table NC-3611.2(e)-1 for stress range reduction factor
  - Paragraph NC-3652.3 Equations (10) and (11) for calculated vs. allowable stress range
  - UFSAR Section 3.6.2.1.1.2.B.2 (based on NRC Generic Letter 87-11) for postulation of additional High Energy Line Breaks

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DRAI 4.3-17

- **4.3-17 NUREG/CR-6260 Effects of Reactor Coolant Environment on Fatigue**
  - Demonstrate the environmental factor (F_{en}) used for the assessment of the reactor coolant environment impact for select locations is the maximum applicable for a given material. Provide a basis and justification for any assumptions that were made for the parameters in the assessment.

DRAI 4.3-17 Response

- F_{en} formulas taken from NUREGs cited in the GALL Report
  - Special rule for Inconel alloys (from Chopra Paper, 1996) Footnote: Omesh K. Chopra, "Status of Fatigue Issues at Argonne National Laboratory," Presented at EPRI Conference on Operating Nuclear Power Plant Fatigue Issues & Resolutions, Snowbird, UT, August 22–23, 1996.
- All F_{en} values assume dissolved oxygen (DO) < 0.05 ppm, as appropriate for PVNGS PWR water chemistry at T > 200°C (392°F)
- Most conservative values used for all other parameters (S*, T*, ε*)
  - Exception: SI nozzle (SE) uses a detailed analysis to establish a lower F_{en} value

Location	Material	Fen	basis	Calc(s)
Pzr shell/lower head	**Low Alloy**	**2.455**	**NUREG/CR-6583**	**PV-21Q-313**
RPV inlet/outlet nozzles	**Low Alloy**	**2.455**	**NUREG/CR-6583**	**PV-21Q-313**
Surge line HL elbow	**Stainless**	**15.35**	**NUREG/CR-5704**	**PV-30Q-315**
SI nozzle – knuckle	**Low Alloy**	**2.455**	**NUREG/CR-6583**	**PV-21Q-313**
SI nozzle – safe end	**Stainless**	**3.042**	**NUREG/CR-5704**	**PV-30Q-310**
Shutdown cooling line	**Stainless**	**15.35**	**NUREG/CR-5704**	**PV-21Q-313**
Pzr heater penetrations	**Inconel**	**1.49**	**Chopra Paper**	**PV-21Q-313**

DRAI 4.3-18

- **LRA 4.3.4 NUREG/CR-6260 Effects of Reactor Coolant Environment on Fatigue**
  - Basis for 10 CFR 54.21(c)(1)(i) validation of analysis of RPV shell-lower head junction with F_{en}
  - Instead of 10 CFR 54.21(c)(1)(ii) projection to the end of the PEO.
- **Response**
  - F_{en} x 1.5 x 40-year CUF << 1.0 adequately demonstrates the validity of the original fatigue analyses, including F_{en} effects, for the PEO under 10 CFR 54.21(c)(1)(i).
  - No formal revision of the analysis was performed.
  - This interpretation is consistent with prior applications and their SERs.
  - There is no technical objection to classifying the dispositions of these analyses by this method as 10 CFR 54.21(c)(1)(ii) projections.

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DRAI 4.3-19

- **4.3-19 PZR surge line SBF monitoring**
  a) Which transients are applicable to this location?
  b) Are these transients required to be tracked by TS 5.5.5?
  c) Justify the use of bounding by an SBF-monitored location
- **Response**
  a) Local transients are normal RCS transients (UFSAR Table 3.9-1), insurge/outsurge, and thermal stratification
  b) The normal RCS transients are counted directly; the others are accounted for indirectly
  c) With LRA Amendment 14, the pressurizer surge line hot leg elbow is no longer designated as a bounding location. This location was selected per the GALL Report and NUREG /CR-6260.

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DRAI 4.3-19

- **4.3-19 PZR surge line SBF monitoring**
  - d) Clarify the corrective actions if an action limit is reached
  - e) Has this methodology been included into the AMP B3.1 program?
- **Response**
  - d) If the calculated CUF exceeds the action limit, corrective actions will be initiated as described in LRA Section 4.3.1.5
  - e) The SBF methodology is included in the AMP B3.1 program

DRAI 4.3-20

- **<u>4.3-20 Distinction between surge line EAF analyses</u>**

  Clarify which calculations are relied upon for environmental fatigue assessment of the pressurizer surge line hot leg elbow

- **<u>Response</u>**
  - Calculations -314 and -315 were prepared to qualify the surge line under design assumptions; it was not successful (EAF > 1.0)
  - Calculations -317 and -318 were then prepared to qualify it based on projected cycles; still not successful (EAF > 1.0)
  - Since neither evaluation met the ASME Code criterion for EAF-CUF, the location will be managed for the period of extended operation per 10 CFR 54.21(c)(1)(iii)
  - An effort is underway to revise the analysis for this component; the EAF-CUF may lower in a future LRA Amendment, and will not change the disposition (i.e., monitoring).

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DRAI 4.3-21

- **4.3-21 Describe calculation of F_{en} factors**

  Describe in detail the methodology used to compute the F_{en} factor for the charging nozzle and SI nozzle locations

- **Response**
  - F_{en} analysis was performed in calculations PV-30Q-305 and PV-30Q-310
  - F_{en} for stainless steel calculated based on NUREG/CR-5704:
    - Assumed DO < 0.05 ppm (for all T > 200°C [392°F])
    - Used *Integrated Strain Rate* method as described in MRP-47: “Guidelines for Addressing Fatigue Environmental Effects in a License Renewal Application”
      - Calculate $F_{en}(t)$ for each time step during the transients
      - Compute F_{en} per transient pair (strain-weighted average)
      - Overall $F_{en} = \Sigma(Ui*F_{en}) / \Sigma(Ui)$

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NRC Peer Reviewer Items

PVNGS Responses

Peer Reviewer Item 1.A.

- **1. Design Basis Information Inconsistencies:**
  - A. Transients listed in USAR Table 3.9-1 as one type of transient but listed in LRA Tables 4.3-2 and 4.3-3 as a different type of transient
- **Response**
  - LRA Amendment 14 conformed Table 4.3-2 and Table 4.3-3 to the UFSAR

Peer Reviewer Item 1.B.

- **1. Design Basis Information Inconsistencies**
  - B. Normal Operating Condition Transients, Upset Condition, or Test Condition Transients listed in UFSAR Table 3.9-1 which appear to be tracked per TS 5.5.5 but that are not included as transients for monitoring in LRA Tables 4.3-2 or 4.3-3.
- **Response**
  - The tracking status of transients has been updated and justifications for those items not tracked are provided in LRA Amendment 14 (see Tables 4.3-2 and 4.3-3)

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Peer Reviewer Item 1.C.

- **1. Design Basis Information Inconsistencies**
  - C. Transients listed in LRA Table 4.3-3 that were not tracked initially by the counting procedure, but that are required to be tracked by TS 5.5.5 and one or more of the transient tables in USAR Section 3.9.1.1 (UFSAR Table 3.9.1-1 or UFSAR Table 3.9-1, Sections I, II, or III).
- **Response**
  - LRA Amendment 14 revised Table 4.3-3 to conform to the UFSAR and include the transient totals determined from best sources

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Peer Reviewer Item 1.D.

- **1. Design Basis Information Inconsistencies**
  - D. Normal Operating Condition Transients, Upset Condition, or Test Condition Transients listed multiple times in UFSAR Section 3.9.1.1 (i.e., in UFSAR Table 3.9.1-1 or in Table 3.9-1, Section I, II, or III) each with a different design basis allowable, but for which the "Limiting Number of Events" column in LRA Tables 4.3-2 and 4.3-3 list a single value.
- **Response**
  - Amendment 14 revised Tables 4.3-2 and 4.3-3 to conform them to the UFSAR

Peer Reviewer Item 1.E.

- **<u>1. Design Basis Information Inconsistencies</u>**
  - E. Transients required to be counted per Tech Spec 5.5.5 and UFSAR Section 3.9.1.1 but for which footnote 11 of LRA Table 4.3-3 indicates that the transients not accounted for (indicated by "NR" entry in the "1985-1995 25% Assumed" column) in the cycle count Procedure #73ST-9RC02.
- **<u>Response</u>**
  - Amendment 14 revised Table 4.3-3 to conform to the UFSAR and to incorporate best source totals for counted transients and provide justification for those items that are not counted

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Peer Reviewer Item 1.F.

- **1. Design Basis Information Inconsistencies**
  - F. Transients required to be tracked by TS 5.5.5 and UFSAR Section 3.9.1.1 that were not included in the cycle recount verification basis (Transients with "NC" input values -not including those transients tracked since initial startups of Units)
- **Response**
  - Amendment 14 revised Table 4.3-3 to conform to the UFSAR and to incorporate best source totals for counted transients and provide justification for those items that are not counted

Peer Reviewer Item 2.A.

- **<u>2. Inconsistencies Between Different Subsections of LRA Section 4.3:</u>**
  - A. Apparent inconsistencies between LRA Section 4.3 cycle tables (i.e., Information in LRA Table 4.3-2 vs. Information in LRA Table 4.3-3)
- **<u>Response</u>**
  - Amendment 14 revised Tables 4.3-3 and to 4.3-2 to eliminate inconsistencies

Peer Reviewer Item 2.B.

- **2. Inconsistencies Between Different Subsections of LRA Section 4.3:**
  - B. Apparent inconsistencies between text provided in Section 4.3.1.4 and data provided in either LRA Table 4.3-2 or Table 4.3-3
- **Response**
  - Amendment 14 revised section 4.3.1, Table 4.3-3 and Table 4.3-2 to eliminate inconsistencies

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Peer Reviewer Item 2.C.

- **2. Inconsistencies Between Different Subsections of LRA Section 4.3:**
  - C. Inconsistencies with use of fatigue monitoring program methods used to disposition individual TLAA CUF values for Code Class 1 components under 10 CFR 54.21(c)(1)(iii)
- **Response**
  - LRA Amendment 14 revised Section 4.3.1 and Table 4.3-4 to eliminate inconsistencies

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Peer Reviewer Item 3.1

- **<u>3. Other Metal Fatigue Disposition Issues:</u>**
  - Page 4.3-25 – CUF Corrective Action 2), "Enhance fatigue monitoring to confirm continued performance to the code limit" – Staff seeks clarification on what this means.
- **<u>Response</u>**
  - This action is meant to be general. It represents alterations to AMP B3.1 that are not foreseeable at this time. A possible example would be to change the CUF monitoring method at a location from CBF to SBF.

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Peer Reviewer Item 3.2

- **3. Other Metal Fatigue Disposition Issues:**
  - Section 4.3.2.1 basis on page 4.3-33 for support lugs – Staff seeks additional clarification on using monitoring of the RV closure head studs as a bounding method for the RV bottom head support lugs, which have a higher CUF than the RV closure head studs.
- **Response**
  - As of Amendment 14, these components are treated as individual locations monitored by the cycle counting method.
  - Heatups and cooldowns are the most-significant fatigue contributors for both component locations.
  - The analytical limit for the RV closure studs is 250 heatups and cooldowns with a calculated CUF = 0.8236.
  - The analytical limit for the support lugs is 500 heatups and cooldowns with a calculated CUF = 0.9536
  - Therefore (for a limiting example), at 250 heatup-cooldown cycles the studs can have accumulated up to a CUF of 0.8236, compared to a maximum possible CUF of only 0.4768 for the support lugs. Therefore the studs are limiting.

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Peer Reviewer Item 3.3

- **3. Other Metal Fatigue Disposition Issues:**
  - Section 4.3.2.1 basis on page 4.3-33 for RV instrument nozzles. The applicant is required to track Transients 3 and 4 in LRA Tables 4.3-2 and 4.3-3 by TS 5.5.5 and their UFSAR basis. The staff seeks justification why the applicant would not count Transients 3 and 4 for these nozzles when TS 5.5.5 would require them to do this.
- **Response**
  - See the response to DRAI 4.3-10. No significant number of these load-following transients will occur in these base-loaded units.

Peer Reviewer Item 3.4

- **<u>3. Other Metal Fatigue Disposition Issues:</u>**
  - Section 4.3.2.1 basis and revised basis for Unit 2 RV closure head vent pipe (LRA page 4.3-34) – The staff seeks justification why future plans for replacing the head vent pipe are valid to use a basis for dispositioning the TLAA for these components in accordance with 10 CFR 54.21(c)(1)(ii).
- **<u>Response</u>**
  - All three heads will be replaced by December 31, 2010.
  - See Amendment 3, Table A4-1, Commitment 51 for Units 1 and 3 (Unit 2 head had already been replaced).
  - The vent pipe is replaced with the new head
  - The fatigue analysis of the replaced pipe covers a design life exceeding the period of extended operation; therefore the new analysis is not a TLAA.

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Peer Reviewer Item 3.5

- **<u>3. Other Metal Fatigue Disposition Issues:</u>**
  - Section 4.3.2.3 basis for RCP casings closure bolts – The reduction of design limit from 500 cycles to 475 cycles for plant heatups and cooldowns for the CUF calculations of the components appears to be a design basis change for the facility. The staff seeks justification why it is valid to use the Fatigue Monitoring Program as the basis for documenting the change in design basis limit for heatups and cooldowns applied to these bolts without a design change process.
- **<u>Response</u>**
  - The LRA preparation process identified this existing design limit during the review of Class 1 fatigue analyses. Neither the development of AMP B3.1 nor the LRA process made any changes to the design limits. This issue is under evaluation to determine the impact on the UFSAR.

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Peer Reviewer Item 3.6

- **3. Other Metal Fatigue Disposition Issues:**
  - Section 4.3.2.4 basis for pressurizer components, including pressurizer half nozzles and MNSA repairs?
- **Response**
  - John Tsao's items have been resolved.

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Peer Reviewer Item 3.7

- **3. Other Metal Fatigue Disposition Issues:**
  - Section 4.3.2.5 basis (LRA pages 4.3-48 and -49) that SG tube CUF analysis for replaced SG tubes is not a TLAA – The Technical Specification inservice inspection requirements are not a valid replacement for meeting applicable design requirements. Thus, the staff seeks justification why it is valid to use these TS requirements to claim that the CUF calculations are not a TLAA.
- **Response**
  - Complete steam generators were replaced.
  - Other PWR LRAs have proposed the SG tube ISI program as the basis of the safety determination instead of the tube fatigue analysis, and their SERs have concurred.
  - APS has no technical or regulatory objection to classifying the tube fatigue analysis as a TLAA. The CUF = 0 (LRA Table 4.3-8), so the analysis is valid for the PEO under 10 CFR 54.21(c)(1)(i).

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Peer Reviewer Item 3.8

- **3. Other Metal Fatigue Disposition Issues:**

  Section 4.3.2.5 bounding SBF monitoring basis for SG feedwater distribution box, tube-to-tubesheet welds, and tubesheets. The staff seeks additional clarification why the bounding methodology can be used for these components and justification on why the applicant can use SBF-monitoring of the FW economizer and downcomer nozzles as bounding locations for these components, particularly when the cold side of the tubesheet-to-shell junction appears to be a slightly more limiting component that these nozzles.

- **Response**
  - Amendment 14 Table 4.3-4 revised fatigue monitoring in these locations to use only cycle counting (CC).
  - With a conforming amendment, LRA 4.3.2.1 will no longer take credit for SBF to manage (bound) fatigue in other locations in the steam generators.
  - See also DRAIs 4.3-12 and -13, and Peer Reviewer Item 2.C.

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Review of Action Items