



Pre-Submittal Meeting: Management of Environmentally-Assisted Fatigue of Pressurizer Surge Line

May 25, 2023



Agenda

- Introduction
- License Renewal Commitment
- Pressurizer Surge Line Fatigue Monitoring and Projections
- ASME Section XI, Appendix L Evaluation
- Precedents
- Submittal Timeline



License Renewal Commitment

UFSAR 19.2.1

Monitor the effects of environmentally assisted fatigue (EAF) of the Reactor Coolant Pressure Boundary (RCPB) in the Period of Extended Operation. When any monitored location fatigue usage including EAF projects to exceed 1.0 corrective actions will be established using one or more of the following:

- 1) Determine whether the scope of the enhanced Metal Fatigue of Reactor Coolant Pressure Boundary program must be enlarged to include additional affected reactor coolant pressure boundary locations. This determination will ensure that other locations do not approach design limits without an appropriate action.
- 2) Adjust fatigue monitoring methods to confirm continued conformance to the code limit.
- 3) Repair/modify the component.
- 4) Replace the component.
- 5) Perform a more rigorous analysis of the component to demonstrate that the design code limit will not be exceeded.
- 6) Modify plant operating practices to reduce the fatigue usage accumulation rate.
- 7) Perform a flaw tolerance evaluation and impose component-specific inspections, under ASME Section XI, Appendices A or C (or their successors) and obtain required approvals from the regulatory agency.**



Pressurizer Surge Line Fatigue Monitoring and Projections

- Palo Verde utilizes FatiguePro4 (FP4) software provided by Structural Integrity Associates to monitor fatigue of the RCPB, including the effects of EAF.
- The surge line is monitored using the FP4 Stress-based Fatigue (SBF) module for the surge line hot leg elbow sentinel location.
- Most recent surge line elbow cumulative usage (Uen) 60-year projections:
 - Unit 1 - 4.27
 - Unit 2 - 4.66
 - Unit 3 - 5.86



ASME Section XI, Appendix L Evaluation

Palo Verde intends to manage the fatigue effects of the surge line by periodic inspections at a frequency determined by an Appendix L, “Operating Plant Fatigue Assessment” evaluation.

- Establish loading conditions and 3-D finite element model.
- Determine allowable flaw sizes (Section XI, Appendix C) for surge line welds.
- Establish postulated initial flaw sizes per Appendix L.
- Perform fatigue crack growth analyses using linear elastic fracture mechanics (LEFM) techniques to determine the time for the postulated initial flaw to grow to the allowable flaw size.
- Set inspection intervals based on the crack growth analyses.
- Using similar methodology, demonstrate fatigue crack growth and inspection intervals for elbow base metal are bounded by the Appendix L evaluation of the surge line welds.



Appendix L Evaluation Results

Weld ID	Paths	Semi-Elliptical Axial Flaw					360-Degree Circumferential Flaw			
		Flaw size in 10 Years			Allowable a/t*	N, years	Flaw size in 10 Years		Allowable a/t*	N, years
		a, inch	c, inch**	a/t			a, inch	a/t		
20B	P1	0.2336	0.5972	0.1781	0.75	≥100	0.2500	0.1906	0.2523	22
	P2	0.2321	0.5963	0.1769	0.75	≥100	0.2513	0.1915	0.2523	21
	P3	0.2443	0.6037	0.1862	0.75	≥100	0.2660	0.2027	0.2523	17
	P4	0.2332	0.5966	0.1778	0.75	≥100	0.2475	0.1886	0.2523	22
20E	P1	0.2575	0.6158	0.1963	0.75	≥100	0.2466	0.1879	0.3155	34
	P2	0.2324	0.5978	0.1772	0.75	≥100	0.2702	0.2059	0.3155	24
	P3	0.2537	0.6128	0.1934	0.75	≥100	0.3173	0.2418	0.3155	15
	P4	0.2603	0.6183	0.1984	0.75	≥100	0.3296	0.2512	0.3155	14
27	P1	0.2302	0.5953	0.1755	0.75	≥100	0.2505	0.1909	0.4282	52
	P2	0.2304	0.5954	0.1756	0.75	≥100	0.2474	0.1885	0.4282	57
	P3	0.2274	0.5930	0.1733	0.75	≥100	0.2474	0.1885	0.4282	57
	P4	0.2316	0.5962	0.1765	0.75	≥100	0.2833	0.2159	0.4282	29
30B	P1	0.2635	0.6213	0.2008	0.75	99	0.2487	0.1896	0.3117	32
	P2	0.2455	0.6068	0.1871	0.75	≥100	0.2474	0.1886	0.3117	34
	P3	0.2447	0.6057	0.1865	0.75	≥100	0.2474	0.1886	0.3117	34
	P4	0.2469	0.6074	0.1882	0.75	≥100	0.3236	0.2466	0.3117	14
30E	P1	0.2623	0.6203	0.1999	0.75	≥100	0.2485	0.1894	0.2957	29
	P2	0.2456	0.6068	0.1872	0.75	≥100	0.2661	0.2028	0.2957	23
	P3	0.2471	0.6076	0.1883	0.75	≥100	0.3191	0.2432	0.2957	13
	P4	0.2490	0.6091	0.1898	0.75	≥100	0.3206	0.2444	0.2957	13
50B	P1	0.2389	0.6009	0.1821	0.75	≥100	0.2464	0.1878	0.4238	56
	P2	0.2357	0.5994	0.1796	0.75	≥100	0.2537	0.1934	0.4238	49
	P3	0.2511	0.6102	0.1914	0.75	≥100	0.2487	0.1896	0.4238	52
	P4	0.2471	0.6074	0.1884	0.75	≥100	0.2978	0.2270	0.4238	25
50E	P1	0.2437	0.6042	0.1858	0.75	≥100	0.2468	0.1881	0.4314	57
	P2	0.2358	0.5994	0.1797	0.75	≥100	0.2474	0.1886	0.4314	57
	P3	0.2517	0.6107	0.1918	0.75	≥100	0.2482	0.1891	0.4314	55
	P4	0.2469	0.6073	0.1882	0.75	≥100	0.2999	0.2286	0.4314	25
60B	P1	0.2415	0.6029	0.1841	0.75	≥100	0.2539	0.1935	0.4512	51
	P2	0.2373	0.6000	0.1808	0.75	≥100	0.2522	0.1922	0.4512	55
	P3	0.2385	0.6009	0.1818	0.75	≥100	0.2488	0.1896	0.4512	60
	P4	0.2304	0.5949	0.1756	0.75	≥100	0.2808	0.2141	0.4512	30
60E	P1	0.2317	0.5964	0.1766	0.75	≥100	0.2543	0.1938	0.4207	47
	P2	0.2315	0.5959	0.1764	0.75	≥100	0.2609	0.1989	0.4207	38
	P3	0.2453	0.6052	0.1870	0.75	≥100	0.2504	0.1909	0.4207	51
	P4	0.2406	0.6022	0.1834	0.75	≥100	0.2584	0.1969	0.4207	40



Elbow Base Metal Evaluation Results

Location (Elbow Flank)	Semi-Elliptical Axial Flaw (Flank)				
	Flaw size in 10 years			Allowable a/t*	N, years
	a, inch	C, inch	a/t		
Elbow 60	0.3520	0.7192	0.2683	0.75	50
Elbow 30	0.2982	0.6548	0.2273	0.74	72

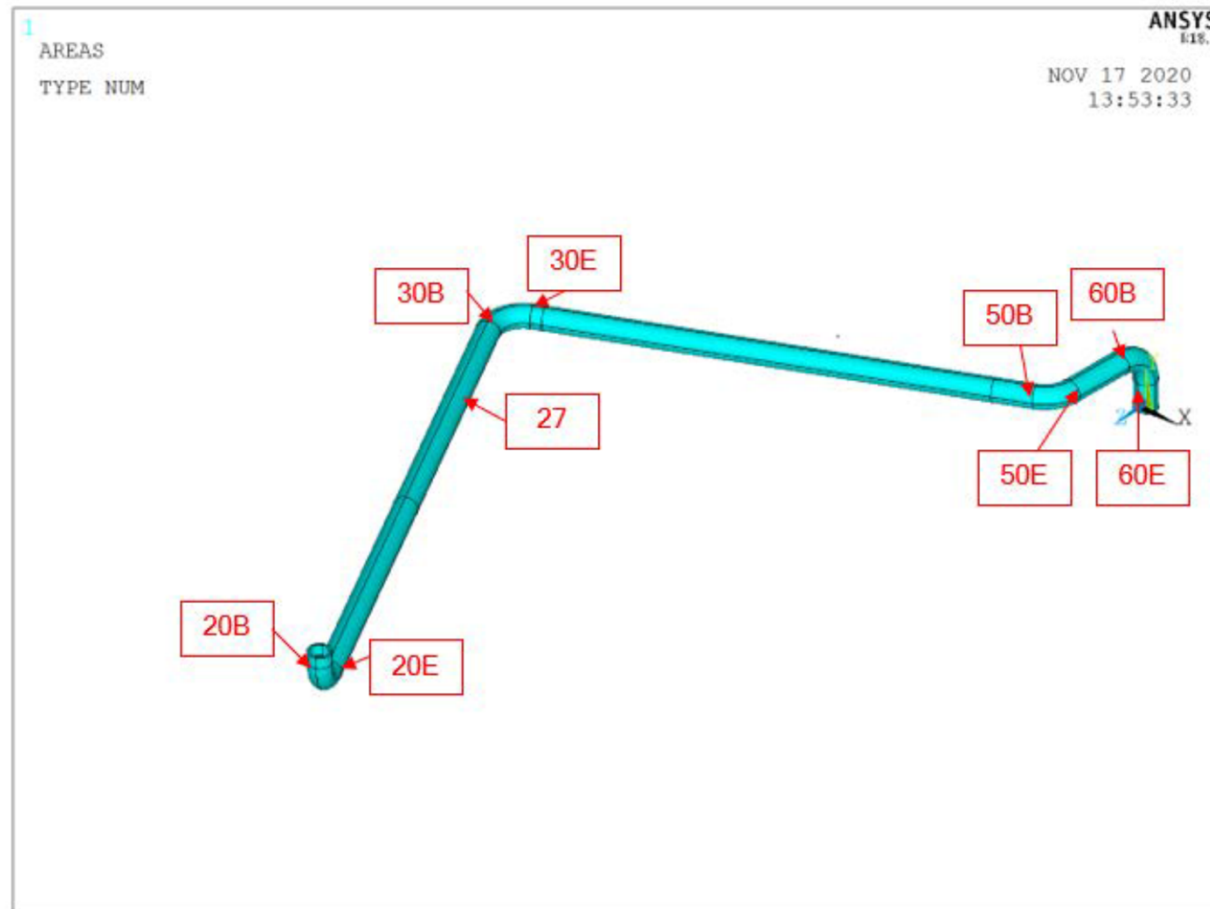


Periodic Inspection Program

- All surge line welds and elbows will be inspected at a 10-year frequency (the maximum allowed by Appendix L).
- Volumetric examinations using Acceptance Criteria established in ASME Section XI, Subsection IWB, for welds and Section III, NB-2500, for elbow base metal.



Surge Line Elbow and Weld Locations



Precedents

- Turkey Point, Units 3 and 4, License Renewal Commitment, Submittal of Pressurizer Surge Line Welds Inspection Program (ADAMS Accession Numbers ML12152A156 and ML13141A595).
- St. Lucie, Units 1 and 2 – License Renewal Commitment, Submittal of Pressurizer Surge Line Welds Inspection Program (ADAMS Accession Numbers ML15314A160 and ML16235A138).
- Arkansas Nuclear One, Unit 2, License Renewal Pressurizer Surge Line and Safety Injection Nozzle Inspection (ADAMS Accession Number ML18144A970 and ML19074A028).



Submittal Timeline

- Submit to NRC June 2023
- Estimated 1-yr NRC review time
- Implement within 120-days of NRC approval

Period of Extended Operation

Unit 1: June 1, 2025

Unit 2: April 24, 2026

Unit 3: November 25, 2027



Questions