VIRGINIA ELECTRIC AND POWER COMPANY
RICHMOND, VIRGINIA 23261

June 13, 2002

United States Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, DC 20555-0001

Serial No.: 02-332
LR/DEA R0
Docket Nos.: 50-280/281
50-338/339
License Nos.: DPR-32/37
NPF-4/7

Gentlemen:

VIRGINIA ELECTRIC AND POWER COMPANY (DOMINION)
SURRY AND NORTH ANNA POWER STATIONS UNITS 1 AND 2
REQUEST FOR ADDITIONAL INFORMATION
LICENSE RENEWAL APPLICATIONS

Based on several conversations with the NRC during March and April 2002, the staff requested supplemental information related to certain responses previously provided to Requests for Additional Information (RAIs) concerning the Surry and North Anna license renewal applications (LRAs). The attachment to this letter contains the supplemental information for RAIs 4.3-4 and 4.3-6 as requested by the staff.

Should you have any questions regarding this submittal, please contact Mr. J. E. Wroniewicz at (804) 273-2186.

Very truly yours,

David A. Christian
Senior Vice President – Nuclear Operations and Chief Nuclear Officer

Attachment

Commitments made in this letter: None

A086

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Serial No.: 02-332
SPS/NAPS
LR – Response to RAI

COMMONWEALTH OF VIRGINIA)
)
COUNTY OF HENRICO)

The foregoing document was acknowledged before me, in and for the County and Commonwealth aforesaid, today by David A. Christian who is Senior Vice President and Chief Nuclear Officer of Virginia Electric and Power Company. He has affirmed before me that he is duly authorized to execute and file the foregoing document in behalf of that Company, and that the statements in the document are true to the best of his knowledge and belief.

Acknowledged before me this 13th day of June, 2002.

My Commission Expires: 3-31-04.

Maggie McClure
Notary Public

(SEAL)

Attachment

License Renewal – Response to RAI
Serial No. 02-332

Response to Request for Supplemental Information
Surry and North Anna Power Stations, Units 1 and 2
License Renewal Applications
RAIs 4.3-4 and 4.3-6

Virginia Electric and Power Company
(Dominion)

RAI 4.3-4:

The Westinghouse Owners Group issued Topical Report WCAP-14575-A, "Aging Management Evaluation for Class 1 Piping and Associated Pressure Boundary Components," to address aging management of the RCS piping. In both LRAs, Section 3.1.1, the applicant addresses the applicability of WCAP-14575-A to North Anna and Surry. Table 3.1.1-W1 of the LRAs contain the response to the renewal applicant action items developed as a result of the staff review of the topical report. Renewal Applicant Action Item 8 requests that applicants address components labeled I-M and I-RA in Tables 3-2 through 3-16 of WCAP-14575-A. The applicant indicates that the components in Tables 3-2 through 3-16 were addressed by an aging management activity, plant-specific fatigue evaluation, or code evaluation. However, the applicant did not provide specific details for each component. Provide a summary of the resolution for each of the components labeled I-M and I-RA in Tables 3-2 through 3-16.

Dominion Response:

The components labeled I-M and I-RA in Tables 3-2 through 3-16 are all piping components such as elbows, nozzles, straight pipe etc., which are Class 1 piping and associated pressure boundary components. These components are analyzed in accordance with the rules of B31.7 for NAPS and the rules of B31.1 for SPS, satisfying the requirements of the appropriate code.

Supplemental Information:

RAI 4.3-4, Supplemental Request

Since the original analyses were performed for forty years, provide an explanation how the analyses were extended for sixty years. Also provide an explanation how environmentally assisted fatigue was addressed.

Response

As identified in Section 4.3.1 of the application, the number of transients used in the original design analyses of the piping components envelop the projected number of transients for sixty years of operation. The continuation of the cycle counting activity during the period of extended operation will assure that the design cycle limits are not exceeded. As for the effects of environmentally assisted fatigue, these are addressed in Section 4.3-4 of the application.

RAI 4.3-6:

In both LRAs, Section 4.3.4, the applicant discusses the impact of the reactor water environment on the fatigue life of components. The applicant references the fatigue sensitive component locations for an early vintage Westinghouse plant identified in NUREG/CR-6260, "Application of NUREG/CR-5999 Interim Fatigue Curves to Selected Nuclear Power Plant Components." The LRAs indicates that the results of the NUREG/CR-6260 studies were used to scale up the North Anna and Surry plant-specific usage factors for the same locations to account for environmental effects. The LRAs also indicates that the later environmental fatigue correlations contained in NUREG/CR-6583, "Effects of LWR Coolant Environments on Fatigue Design Curves of Carbon and Low-Alloy Steels," and NUREG/CR-5704, "Effects of LWR Coolant Environments on Fatigue on Fatigue Design Curves of Austenitic Stainless Steels," were considered in the evaluation. Provide the results of the usage factor evaluation for each of the six component locations listed in NUREG/CR-6260. Discuss how the factors used to scale up the North Anna and Surry plant-specific usage factors were derived. Also discuss how the later environmental data provided in NUREG/CR-6583 and NUREG/CR-5704 were factored in the evaluations. Discuss the how the North Anna charging line flow transients monitored by the TCCP are factored in these evaluations.

Dominion Response:

Section 4.3.4 of the LRA describes Dominion's evaluation of the impact of the reactor water environment on the fatigue life of the components identified in NUREG/CR-6260, "Application of NUREG/CR-5999 Interim Fatigue Curves to Selected Nuclear Power Plant Components." In particular, that evaluation relies on several industry background studies that have been performed to address EAF effects in RCS components. Those studies have been used to provide an assessment of NAPS and SPS environmental effects on the locations identified in NUREG/CR-6260, using a scaling factor approach. These locations are identified in Table 4.3-6-1.

Table 4.3-6-1. Older Vintage Westinghouse Plant Locations Identified in NUREG 6260

Reactor vessel	At core support guide weld
	Inlet Nozzle
	Outlet Nozzle
Surge line	Hot leg nozzle safe end
Charging nozzle	Nozzle
Safety injection nozzle	Nozzle
Residual heat removal line	Tee

Because of the more recent issues raised by the NRC staff relative to the use of the EPRI/GE F_{en} methodology (Reference EPRI Report No. TR-105759, "An Environmental Factor Approach to Account for Reactor Water Effects in Light Water Reactor Pressure Vessel and Piping Fatigue Evaluations") in various industry applications as well as additional laboratory fatigue data in simulated LWR environments that have been generated by Argonne National Laboratory (ANL) for carbon, low-alloy, and stainless steels, calculations have been revised since the original submittal of the LRA, for the seven locations identified in NUREG/CR-6260 for NAPS and SPS. These calculations are summarized below, and utilize the most recent F_{en} methodology, as published in NUREG/CR-6583 and NUREG/CR-5704. The conclusions identified in the LRA for NAPS and SPS, which were reached based on the original calculations have been validated by the revised calculations.

RPV Locations

The environmental fatigue calculations for the three RPV components identified in NUREG/CR-6260 (RPV shell at core support pads, RPV inlet nozzle, and RPV outlet nozzle) are shown in Table 4.3-6-2. The results show EAF-adjusted CUF values for these three locations of less than 1.0, which are acceptable. The results shown in Table 4.3-6-2 are very conservative, in that the maximum bounding F_{en} multiplier was conservatively used.

Table 4.3-6-2. Plant-Specific EAF Evaluation for RPV Locations and Surge Line

Location	Original Design Basis CUFs		Maximum F_{en}	Environmental CUFs	
	U_{NAPS}	U_{SPS}		U_{NAPS}	U_{SPS}
RPV Shell at Core Support Pads	0.092	0.01	2.53	0.233	0.025
RPV Inlet Nozzle	0.022	0.011	2.53	0.056	0.028
RPV Outlet Nozzle	0.074	0.256	2.53	0.187	0.648
Surge Line Hot Leg Nozzle	0.966	0.861	See Note 1	N/A	N/A

Note: 1. Inspection aging management will be used for this location.

Table 4.3-6-2. Plant-Specific EAF Evaluation for RPV Locations and Surge Line (cont.)

Low Alloy Steel

$F_{en} = \exp(0.929 - 0.00124T - 0.101S^*T^*O^*\varepsilon^*)$

For a PWR environment, DO < 0.05, so O* = 0.

Therefore, F_{en} is only dependent upon T.

T (°C)	F_{en}
0	2.53
50	2.38
100	2.24
150	2.10
200	1.98
250	1.86
300	1.75
Thus, maximum F_{en} = 2.53	

Carbon Steel

$F_{en} = \exp(0.585 - 0.00124T - 0.101S^*T^*O^*\varepsilon^*)$

For a PWR environment, DO < 0.05, so O* = 0.

Therefore, F_{en} is only dependent upon T.

T (°C)	F_{en}
0	1.79
50	1.69
100	1.59
150	1.49
200	1.40
250	1.32
300	1.24
Thus, maximum F_{en} = 1.79	

Stainless Steel

$F_{en} = \exp(0.935 - T^*\varepsilon^*O^*)$

For a PWR environment, DO < 0.05, so O* = 0.260

T* = 0 for T < 200°C or T* = 1 for T > 200°C. Conservatively use T* = 1

Therefore, F_{en} is only dependent upon the strain rate parameter, ε*.

ε* = 0 for ε > 0.4%/sec so F_{en} = 2.55

ε* = ln(ε/0.4) for 0.0004 <= ε <= 0.4%/sec so F_{en} = 2.55 to 15.35

ε* = ln(0.0004/0.4) for ε < 0.0004%/sec so F_{en} = 15.35

Thus, maximum F_{en} = 15.35

Charging Nozzle Location

For the charging nozzle, CUF results exist only for NAPS, because the design basis for the SPS piping is USAS B31.1, which does not require explicit fatigue analysis. However, the detailed plant-specific charging nozzle fatigue calculations for NAPS are not readily retrievable. Therefore, NAPS plant-specific fatigue calculations have been reconstituted based on the inputs used in NUREG/CR-6260. A detailed EAF evaluation for this location was subsequently performed.

The environmental fatigue charging nozzle calculations are shown in Table 4.3-6-3. The results show an EAF adjusted CUF value of less than 1.0, which is acceptable.

Since the SPS design code for the charging piping is USAS B31.1, no explicit fatigue analysis has been performed. However, since the physical attributes of the SPS piping, nozzles, and transient characteristics are similar to those at NAPS, it is concluded that the SPS charging nozzles are likewise acceptable with consideration of EAF.

Table 4.3-6-3. Plant-Specific EAF Evaluation for Charging Nozzle

Step #1: Reproduce NUREG/CR-6260 Calculations from Table 5-90
Note 1: $S_{alt} = S_{alt\text{-}NB\text{-}3600}$ since this is the limiting NB-3600 CUF location.

Branch connection/nozzle body	S_{alt}	N_{allow}	n	U	Comments
(NB-3600)	363.53	44	20	0.452	
	46.00	51,814	80	0.002	Note 2
	46.00	51,814	120	0.002	Note 2
			Total = 0.456		

Note 2: Small difference from NUREG/CR-6260; neglected.

Nozzle-to-pipe weld	S_{alt}	N_{allow}	n	U	
(NB-3600)	84.62	3,340	20	0.006	
	70.04	6,951	80	0.012	
	52.11	27,505	120	0.004	
			Total = 0.022		Note 3

Note 3: $S_{alt} = S_{alt\text{-}NB\text{-}3200}$. Although this is not the limiting NB-3200 CUF location (by only a very small amount), the strain rate is lower than for the nozzle-to-pipe weld location, so this location becomes limiting when environmental effects are considered.

Table 4.3-6-3. Plant-Specific EAF Evaluation for Charging Nozzle (cont.)

Branch connection/nozzle body	S_{alt}	N_{allow}	n	U	
(NB-3200)	87.69	2,922	20	0.007	
	80.94	3,947	80	0.020	
	29.47	724,304	120	0.000	
			Total = 0.027		Note 4

Note 4: Limiting NB-3200 location; see note 3 above.

Nozzle region upstream of thermal sleeve	S_{alt}	N_{allow}	n	U	Note 5
(NB-3200)	84.79	3,314	20	0.006	
	82.86	3,614	80	0.022	
	46.15	50,897	120	0.002	
			Total = 0.031		

Conclusions:

1. **NUREG/CR-6260 calculations are reproduced.**
2. **Appropriate values of "n" are obtained.**

Step #2: Reproduce NAPS CUF by scaling up S_{alt} for Limiting NB-3600 Location

Note 5: $S_{alt} = S_{alt\text{-}NB\text{-}3600\text{-}NAPS}$

	Multiplier for S_{alt} = 1.313				
Branch connection/nozzle body:	S_{alt}	N_{allow}	n	U	
(NB-3600)	477.31	24	20	0.850	
	60.40	13,253	80	0.006	
	60.40	13,253	120	0.009	
			Total = 0.8647		Note 6

Note 6: The difference is insignificant between this value and NAPS design basis CUF of 0.8646

Conclusion:

1. Above calculation is a reconstituted calculation for NAPS.

Table 4.3-6-3. Plant-Specific EAF Evaluation for Charging Nozzle (cont.)

Step #3: Create a NAPS NB-3200 CUF from the NB-3600 Calculation					
Note 7: $S_{alt} = S_{alt\text{-}NB\text{-}3600\text{-}NAPS} * (S_{alt\text{-}NB\text{-}3200}/S_{alt\text{-}NB\text{-}3600})$					
Branch connection/nozzle body:	**S_{alt}**	**N_{allow}**	**n**	**U**	Note 7
(NB-3200)	115.14	1,118	20	0.018	
	106.27	1,468	80	0.055	
	38.69	133,333	120	0.001	
			Total = 0.0733		Note 8
Note 8: Predicted $U_{NB\text{-}3200}$ for NAPS					
Conclusion: 1. Above calculation is reconstituted for NAPS.					
Step #4: Determine F_{en} Multiplier and Environmental CUF					
F_{en} for Stainless Steel:	**$F_{en} = \exp(0.935 - T^*\varepsilon^*O^*)$**				
For a PWR environment, DO < 0.05, so O* = 0.260 T* = 0 for T < 200°C or = 1 for T > 200°C. Conservatively use T* = 1 ε = 0.08%/sec per strain rate calculation, so $\varepsilon^* = \ln(\varepsilon/0.4)$ for $0.0004 < \varepsilon < 0.4$ %/s. Calculated F_{en} = 3.87 Environmental CUF for NAPS = $F_{en} * U_{NB\text{-}3200}$ for NAPS = 0.284					

Safety Injection Nozzle Location

For the safety injection nozzle, CUF results exist only for NAPS, because the design basis for the SPS piping is USAS B31.1, which does not require explicit fatigue analysis. However, the detailed plant-specific safety injection nozzle fatigue calculations for NAPS are not readily retrievable. Therefore, plant-specific fatigue calculations have been reconstituted for NAPS based on the inputs used in NUREG/CR-6260. A detailed EAF evaluation was subsequently performed for this location.

The environmental fatigue calculations for the safety injection nozzles are shown in Table 4.3-6-4. The results show an EAF adjusted CUF value of less than 1.0, which is acceptable.

Since the design code for the safety injection piping is USAS B31.1 for SPS, no explicit fatigue analysis has been performed. However, since the physical attributes of the SPS piping, nozzles, and transient characteristics are similar to those at NAPS, it is concluded that the SPS Safety Injection nozzles are likewise acceptable with consideration of EAF.

Table 4.3-6-4. Plant-Specific EAF Evaluation for Safety Injection Nozzle

Step #1: Reproduce NUREG/CR-6260 Calculations from Tables 5-93 and 5-94					
Note 1: $S_{alt} = S_{alt\text{-}NB\text{-}3600}$ since this is the limiting NB-3600 CUF location.					
Branch connection/nozzle body	**S_{alt}**	**N_{allow}**	**n**	**U**	**Note 1**
(NB-3600)	400.22	35	70	1.976	
					Note 2
			Total = 1.976		
Note 2:The S_{alt} values for the two other load pairs are unknown; however, the CUF matches so their contribution is negligible.					
Nozzle-to-pipe weld	**S_{alt}**	**N_{allow}**	**N**	**U**	
(NB-3600)	102.57	1,655	70	0.042	
	46.79	47,408	50	0.001	Note 3
	45.49	55,079	150	0.003	Note 3
			Total = 0.046		
Note 3: S_{alt} and n values obtained from Table 5-94.					
Branch connection/nozzle body	**S_{alt}**	**N_{allow}**	**N**	**U**	
(NB-3200)	32.88	346,189	70	0.000	
				0.002	Note 4
			Total = 0.002		
Note 4: The S_{alt} values for the two other load pairs are unknown; this equivalent incremental CUF is chosen so the total CUF results agree.					
Nozzle region upstream of thermal sleeve	S_{alt}	N_{allow}	N	U	
(NB-3200)	92.48	2,393	70	0.029	
				0.002	Note 5
			Total = 0.031		Note 6
Note 5: The S_{alt} values for the two other load pairs are unknown; this equivalent incremental CUF is chosen so the total CUF results agree.					
Note 6: $S_{alt} = S_{alt\text{-}NB\text{-}3200}$ since this is the limiting NB-3200 CUF location.					

Table 4.3-6-4. Plant-Specific EAF Evaluation for Safety Injection Nozzle (cont.)

Nozzle-to-pipe weld	S_{alt}	N_{allow}	N	U	
(NB-3200)	125.14	852	70	0.082	
				0.013	Note 7
			Total = 0.095		

Note 7: The S_{alt} values for the two other load pairs are unknown; this equivalent incremental CUF is chosen so the total CUF results agree.

Conclusions:

1. NUREG/CR-6260 calculations are reproduced.
2. Appropriate values of "n" are obtained.

Step #2: Reproduce NAPS CUF by scaling up S_{alt} for Limiting NB-3600 Location

	multiplier for S_{alt} = 0.669				

Note 8: $S_{alt} = S_{alt\text{-}NB\text{-}3600\text{-}NAPS}$

Branch connection/nozzle body:	S_{alt}	N_{allow}	n	U	Note 8
(NB-3600)	267.75	94	70	0.746	
			Total = 0.746		Note 9

Note 9: Matches NAPS design basis CUF of 0.746.= $U_{NB\text{-}3600}$ for NAPS

Conclusion:

1. Above calculation is a reconstituted for NAPS.

Step #3: Create a NAPS NB-3200 CUF from the NB-3600 Calculation

Note 10: $S_{alt} = S_{alt\text{-}NB\text{-}3600\text{-}NAPS} * (S_{alt\text{-}NB\text{-}3200}/S_{alt\text{-}NB\text{-}3600})$

Branch connection/nozzle body:	S_{alt}	N_{allow}	n	U	Note 10
(NB-3200)	83.72	3,477	70	0.020	
				0.013	Note 11
			Total = 0.033		Note 12

Note 11: Conservatively use this incremental CUF.

Note 12: Predicted $U_{NB\text{-}3200}$ for NAPS

Conclusion:

1. Above calculation is a reconstituted for NAPS.

Table 4.3-6-4. Plant-Specific EAF Evaluation for Safety Injection Nozzle (cont.)
Step #4: Determine F_{en} Multiplier and Environmental CUF:
F_{en} for Stainless Steel: $F_{en} = \exp(0.935 - T^*\varepsilon^*O^*)$
For a PWR environment, DO < 0.05, so O* = 0.260 T* = 0 for T < 200°C or = 1 for T > 200°C. Conservatively use T* = 1 ε = 1.23%/sec per strain rate calculation, so ε^* = 0 for ε > 0.4 %/s. Calculated F_{en} = 2.55 Environmental CUF for NAPS = 0.084 = F_{en} * $U_{NB-3200}$ for NAPS

RHR Tee Location

Detailed plant-specific fatigue calculations are available for the NAPS RHR tee. Therefore, appropriate detailed F_{en} factors have been calculated for this location to apply to the individual fatigue contributing load pairs and a resulting EAF-adjusted CUF value has been determined.

The environmental fatigue calculations for the RHR tee shown in Table 4.3-6-5 are based on NAPS plant-specific input. The results show an EAF adjusted CUF value of less than 1.0, which is acceptable. Since the design code for the SPS RHR piping is USAS B31.1, no explicit fatigue analysis has been performed. Transient stresses are expected to be similar for NAPS and SPS, since the geometry and material are similar for all four units. Therefore, the results are considered to apply to SPS as well.

Table 4.3-6-5. Plant-Specific EAF Evaluation for RHR Tee

Step #1: Reproduce design basis fatigue calculation

Note 1: NUREG-6260 calculations are not required for this location since a plant-specific calculation exists.

Tee	S_{alt}	N_{allow}	n	U	
(NB-3600)	126.161	657	200	0.304	
			Total = 0.304		

Conclusion:

1. Design basis fatigue calculation is adequately reproduced.

Step #2: Determine F_{en} Multiplier and Environmental CUF:

F_{en} for Stainless Steel:

$$F_{en} = \exp(0.935 - T^*\varepsilon^*O^*)$$

For a PWR environment, DO < 0.05, so O* = 0.260.

T* = 0 for T < 200°C or = 1 for T > 200°C.
All temperatures for the controlling RHR transient are less than 200°C (392°F), so T* = 0.

ε* does not matter when T* = 0.

Calculated F_{en} = 2.55

Environmental CUF for NAPS = 0.775

Surge Line/Nozzle Location

For the surge line, which is a high CUF location, an aging management program that includes inspection has already been planned to satisfy EAF considerations, as discussed in Sections 4.3.4 and B4.0 of the LRA. Therefore, additional EAF evaluation for this location has not been performed.

Summary of Results for EAF Evaluation

The EAF results for all NAPS/SPS locations evaluated above are summarized in Table 4.3-6-6. The results demonstrate that the CUFs for all locations, including postulated environmental effects, remain within the allowable value of 1.0 for 60 years.

Table 4.3-6-6.Summary of NAPS/SPS Environmental Fatigue Calculations				
No.	**Component**	**Maximum Design CUF**	**Multiplier**	**Environmental CUF**
1	RPV Shell at Core Support Pads	0.092	2.53	0.233
2	RPV Inlet Nozzle	0.022	2.53	0.056
3	RPV Outlet Nozzle	0.256	2.53	0.648
4	Charging Nozzle	0.073	3.87	0.283
5	Safety Injection Nozzle	0.033	2.55	0.084
6	RHR Tee	0.304	2.55	0.775

Charging Line Flow Transients

Temperature data (as an indication of flow transients) from the existing plant instrumentation is being collected so that a comparison of operating and design transients for the charging nozzles can be made to validate the design transients. These data are planned to be used only for validating the design transients. They are not included in the above evaluations.

Supplemental Information:

RAI 4.3-6, Supplemental Request

Explain how the results of NUREG-6260 analyses were used in evaluating environmentally assisted fatigue (EAF) for charging and SI nozzles. Since the analyses for an older vintage Westinghouse plant in the NUREG/CR-6260 were for Turkey Point Nuclear Power Plant, provide a comparison of the geometry and material of components justifying the approach used in assessing EAF for these nozzles for SPS and NAPS.

Response

NAPS Charging and Safety Injection Nozzles:

In order to evaluate EAF in the previous response to this RAI, the usage factors for individual load pairs were reconstituted by applying a scaling factor to the alternating stresses identified in NUREG/CR-6260 to match the final cumulative usage factor (CUF) values available from the stress reports. These stresses were reduced based on the ratios of NB-3200 stresses to the NB-3600 stresses contained in NUREG/CR-6260. An appropriate F_{en} multiplier was computed and applied to the CUF values derived for NAPS using NB-3200 methodology. The resulting CUF, with F_{en} applied, represented

the environmentally adjusted CUF value for 60 years for NAPS. The CUF values calculated for charging and SI nozzles were considered acceptable since they were less than the allowable value of 1.0.

Comparisons of the localized geometry of the nozzles of NAPS with those of NUREG/CR-6260 were performed to confirm the applicability of the above approach. Even though the configurations for these nozzles at North Anna are similar to those of NUREG/CR-6260, there are some differences. Hence, the charging and SI nozzles for NAPS were re-analyzed using a simplified NB-3200 methodology.

Simplified NB-3200 Analyses:

This methodology employed finite element analyses to obtain stresses for various loads, particularly thermal transients. However, the stress intensities due to each load (e.g., pressure, moment, thermal transients) were first determined separately, and then combined to determine total stress in a manner similar to the NB-3600 approach. This produces conservative results compared to combining load stress components, and then calculating stress intensity, as in a detailed NB-3200 evaluation. The CUFs for charging and SI nozzles were recalculated using plant design transients. The fatigue calculation methodology was based on the 1977 Edition through Summer 1979 Addenda of the ASME code. The CUFs with EAF have been calculated at the safe ends, which are the most limiting locations and are presented below:

Table 4.3-6-3A. Plant-Specific EAF Evaluation for Charging Nozzles

Event	Occurrences
Charging trip with delayed return to service	10
Normal charging and letdown Shutdown and return to service	10
Charging rate increase by 50%	24000
Charging rate decrease by 50%	24000
Letdown rate increase by 50%	24000
Letdown rate decrease by 50%	2000

Load pairs	Transient Events	Cycles
First	Charging trip with delayed return to service, and Normal charging and letdown Shutdown and return to service – paired between the shutoff and return conditions. (Note: They have identical transient conditions.)	20
Second	All others including Charging rate increase by 50%, Charging rate decrease by 50%, Letdown rate increase by 50%, and Letdown rate decrease by 50%	74000+

Load Pair	$S_{alt\ (psi)}$	N_{allow}	N	U	ε'	T(°F)	F_{en}	U_{en}
First	163.3	290	20	0.069	0.093	560	2.481	0.172
Second	**See Note 1**	**See Note 1**	**See Note 1**	0.097	0.002	560	6.548	0.636
			CUF = 0.166				CUF_{en} = 0.808	

Note 1: The 0.097 usage factor is included to account for a group of contributing transient combinations, which include auxiliary line flow changes and loop transients.

F_{en} for Stainless Steel: $F_{en} = \exp(0.935 - T^*\varepsilon^*O^*)$

For a PWR environment, DO < 0.05, so O* = 0.260

$T^* = (T-180)/40$	($180°C < T \leq 220°C$)
$T^* = 1.0$	($T > 220°C$)
$\varepsilon'^* = 0$	($\varepsilon' > 0.4$%/sec)
$\varepsilon'^* = \ln(\varepsilon'/0.4)$	($0.0004 \leq \varepsilon' \leq 0.4$%/sec)
$\varepsilon'^* = \ln(0.0004/0.4)$	($\varepsilon' < 0.0004$%/sec)

Table 4.3-6-4A. Plant-Specific EAF Evaluation for Accumulator/Safety Injection Nozzles**

Event	Occurrences
Inadvertent RCS Depressurization	20
Accumulator nozzle SI	5
SI return	5
OBE	5

Load pairs	Transient Events	Cycles
First	Inadvertent RCS depress – Return of SI	5
Second	Inadvertent RCS depress – OBE	5
Third	Inadvertent RCS depress - zero load	10
Fourth	Accumulator nozzle SI - zero load	5

Load Pair	$S_{alt\ (psi)}$	N_{allow}	N	U	ε'	T(°F)	F_{en}	U_{en}
First	327.4	46	5	0.109	0.026	560	3.442	0.375
Second	269.6	74	5	0.068	0.026	560	3.442	0.234
Third	193.7	176	10	0.057	0.026	560	3.442	0.196
Fourth	79.3	3106	5	0.002	0.014	400	2.890	0.005
			CUF = 0.236				CUF_{en} = 0.810	

F_{en} for Stainless Steel: $F_{en} = \exp(0.935 - T^*\varepsilon^*O^*)$

For a PWR environment, DO < 0.05, so O* = 0.260

T* = (T-180)/40 (180°C < T ≤ 220°C)
T* = 1.0 (T > 220°C)
ε'* = 0 (ε' > 0.4%/sec)
ε'* = ln(□'/0.4) (0.0004 ≤ ε' ≤ 0.4%/sec)
ε'* = ln(0.0004/0.4) (ε' < 0.0004%/sec)
** Only the contributing transients are listed.

Since the CUFs with EAF for charging and SI nozzles are less than 1.0, they are acceptable. The CUF values of Tables 4.3-6-3A and 4.3-6-4A are higher than the values of Tables 4.3-6-3 and 4.3-6-4 because the former are based upon simplified NB-3200 analyses whereas the latter are based on more detailed NB-3200 analysis reductions of NUREG/CR-6260.

Conclusion:

NAPS charging and SI nozzles are considered to be acceptable based on the EAF CUF calculations performed in Tables 4.3-6-3A and 4.3-6-4A, respectively.

SPS CHARGING AND SAFETY INJECTION NOZZLES:

SPS, being a B31.1-designed plant, had no explicit fatigue usage analyses performed for the charging nozzles and the safety injection nozzles. Since the physical attributes of the SPS piping, nozzles, and operating characteristics are similar to those at NAPS,

it was concluded that the SPS charging and SI nozzles are likewise acceptable with consideration of EAF based on the calculations performed for NAPS.

Comparisons of the localized geometry of the SPS nozzles with those of NUREG/CR-6260 were also performed to confirm the applicability of the above approach and conclusion. The comparisons for SPS nozzles showed that they are similar to NUREG/CR-6260 as described in the following sections.

A comparison of the nozzle geometry between the Surry, North Anna, and NUREG/CR-6260 locations is given in Table 4.3-6-7. The original design vendor (Westinghouse) was requested to compare the configurations of the charging and Safety Injection/Accumulator reactor coolant loop (RCL) nozzles of Surry to those of Turkey Point, with respect to the applicability of evaluations performed in NUREG/CR-6260 to address reactor water environmental effects on fatigue, since the analyses for an older vintage Westinghouse plant performed in NUREG/CR-6260 were for the Turkey Point plant. The comparisons were based on material and geometric effects on stresses that influence the fatigue evaluations of the controlling locations in the nozzles.

The material properties of the Surry nozzles are the same as those of the corresponding Turkey Point nozzles. Therefore, the influence of the material properties on stress and fatigue evaluations would be the same. The results for the geometrical comparison are discussed below.

SPS CHARGING NOZZLE GEOMETRY EVALUATION:

The Surry 1 & 2 charging nozzles and the Turkey Point 4 charging nozzle were built to the same nozzle drawing. Hence, they are identical.

- Loop thicknesses are slightly different from Turkey Point, but the geometric discontinuity (t_a/t_b) at the branch is enveloped by Turkey Point.

Therefore, the NUREG/CR-6260 evaluation applies to Surry 1 & 2 charging nozzles.

SPS SI/ACCUMULATOR NOZZLE GEOMETRY EVALUATION:

The Surry 1 & 2 SI/accumulator nozzles are 12"-140 vs. 10"-140 on Turkey Point. The 10"-140 SI/accumulator nozzle evaluation for Turkey Point is applicable to the Surry 12"-140 SI/accumulator nozzles for the following reasons.

<u>Branch region:</u>

- The nozzle reinforcement is thicker. However, this results in less discontinuity (t_a/t_b) effect for the branch location. Since there is a thermal sleeve, the discontinuity effect (vs. through wall effect) will control the stresses in the nozzle reinforcement region. Therefore, the NUREG/CR-6260 evaluation is representative, if not conservative.

Safe End Region:

- The safe end region of the Surry SI nozzle is only about 13% thicker than Turkey Point. This will have a negligible impact on through wall stress. This is reinforced by the fact that Westinghouse generic analyses were done for 10"-140 nozzles, and were applied to both 10"-140 and 12"-140 nozzles for plant specific fatigue conformance evaluations, including those done for North Anna 12"-140 nozzles. In addition, the discontinuity (t_a/t_b) effect is close to that of Turkey Point 3, and enveloped by Turkey Point 4. Therefore, the NUREG/CR-6260 evaluation is representative.

Transition Region:

- The through wall effect at the transition is the same as for the safe end, and the effect on stress remains negligible. The geometric discontinuity (t_a/t_b) at the transition is only 5% more than Turkey Point, which will also have an insignificant impact on the discontinuity stresses. Given the margin in the NUREG/CR-6260 results after accounting for environmental effects, it can be concluded that the NUREG results are applicable for the Surry nozzles.

Table 4.3-6-7
Comparison of Nozzle Geometry for Surry, North Anna, and NUREG/CR-6260

Piping	Plant	Diameter	Thickness
Charging Line	NUREG/CR-6260	Nominal Diameter = 3"	0.4375"
Charging Line	Surry	Nominal Diameter = 3"	0.4375"
Charging Line	North Anna	Nominal Diameter = 3"	0.4375"
Safety Injection (Accumulator)	NUREG/CR-6260	Nominal Diameter = 10"	1.000"
Safety Injection (Accumulator)	Surry	Nominal Diameter = 12"	1.13"
Safety Injection (Accumulator)	North Anna	Nominal Diameter = 12"	1.01"
Cold Leg	NUREG/CR-6260	ID = 27.5"	2.375"
Cold Leg	Surry	ID = 27.5"	2.215"
Cold Leg	North Anna	ID = 27.5"	2.211"
Hot Leg	NUREG/CR-6260	ID = 29"	2.50"
Hot Leg	Surry	ID = 29"	2.50"
Hot Leg	North Anna	ID = 29"	2.50"

Conclusion:

The geometry and material for SPS are very similar to those of NUREG/CR-6260 (i. e. Turkey Point), and it can be concluded that the conclusions of NUREG/CR-6260 are applicable, and therefore the SPS nozzles are acceptable. In addition, differences between the SPS and NAPS nozzles are insignificant at the safe ends, which are the most limiting locations for these nozzles. Since the operation of SPS and NAPS are similar, it can also be concluded that the SPS nozzles are acceptable based on the detailed EAF CUF calculations performed for NAPS. Based on these comparisons to both the NUREG/CR-6260 nozzles and the NAPS nozzles, the SPS charging and SI nozzles are considered acceptable with regards to EAF.