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ADDENDUM

TO

PLANT UNIQUE ANALYSIS REPORT

(DATED OCTOBER 1, 1982)

ON

SRV ACTUATION CONCURRENT WITH A LOCA

(CASES C3.2 AND C3.3)

for

CAROLINA POWER & LIGHT COMPANY

BRUNSWICK STEAM ELECTRIC PLANT

UNITS 1 AND 2

REPORT NO. 7453-119-S-S-009

REVISIONS							
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ADDENDUM

1. INTRODUCTION

Originally, it was proposed that Load Cases C3.2 and C3.3 be eliminated by lowering the MSIV isolation water level trip and modifying the SRV logic as reported in the Plant Unique Analysis Report (PUAR). However, due to the complexity and corresponding difficulty of installation, testing and maintenance of these modifications, CP&L instead performed analyses as outlined in Reference 1 to prove the present SRV discharge lines and their supports could withstand second pop loads concurrent with a LOCA. The purpose of this addendum is to present the final results of the Load Cases C3.2 and C3.3 analyses and to report the evaluation of the Mark I Containment, internal structures and piping affected by these load cases.

In Load Case C3.2, the primary concern is the potentially high frequency loading on the containment. In Load Case C3.3, the concern is the potentially large water clearing thrust loads on the SRV discharge piping. As such, torus shell pressures and SRV air bubble induced drag loads were calculated for Load Case C3.2 and SRV discharge line thrust loads were calculated for Load Case C3.3. As justified in Section 4, SRV Discharge Line 59 (F013-L) and Line 34 (F013-H) were selected for the new load definition.

Structural elements and piping systems which are affected most by these new load cases were re-evaluated. These include the torus

1. INTRODUCTION (Continued)

shell, the SRV discharge lines and supports, vent header columns, the downcomer/ vent header intersection and the SRV discharge line penetration of the vent/vent header intersection.

In the following, load calculations and structural evaluations are reported in accordance with the order in which they appear in the text of the PUAR. For reference, the original section number in the text is identified in parentheses following the subject title.

2. SUMMARY

Subsequent SRV actuations concurrent with a LOCA (Cases C3.2 and C3.3) have been evaluated. Load definitions were developed based on the two SRV discharge lines which earlier analysis had shown to be the governing lines. Analysis was performed to evaluate the SRV discharge lines and supports, the torus internal structures and the torus shell for the additional load cases. The evaluation has shown that these structures, as modified by the Mark I Containment Program, are acceptable for the two additional SRV load cases.

3. EVALUATION OF SUPPRESSION CHAMBER (1.3.4)

The SRV load caused by actuating one or more safety/relief valves is an oscillatory, attenuated pressure which is applied to the torus shell. A discussion of the load definition is provided in Section 4.2. For the C3.2 Load Case (which bounds the C3.3 Load Case) the pressure amplitudes are less than or equal to the previously analyzed A1.2 Load Case. The maximum frequency for the two additional cases is 14.5 Hz (C3.2) compared with 11 Hz for the previously evaluated load cases. However, since the torus frequencies that will be excited by SRV loads are greater than 30 Hz and since the torus was conservatively evaluated for all safety relief valves actuating simultaneously it is still reasonable to treat the SRV load on the torus shell as a static load. Therefore, the C3.2 and C3.3 Load Cases are bounded by the original torus shell evaluation for SRV loads.

4. SRV DISCHARGE LOADS (2.2.2)

Loads induced by SRV subsequent actuations during a postulated small break LOCA event were calculated based on References 2 and 3. Load Cases C3.2 (with air in the drywell) and C3.3 (with steam in the drywell) were evaluated. Because of the thrust loads associated with water clearing, the most critical items for this evaluation are the SRV discharge line supports in the torus. A review of the previous evaluation (Table 2.3.2-1) reveals that for a small break accident the most critical support elements are the 1" x 6" x 3'-8" strap plates in the support immediately below the penetration of the vent header.

4. SRV DISCHARGE LOADS (2.2.2) (Continued)

Based on the previous analysis the most significant SRV thrust loads resulted from Line 59 (F013-L). Thus, loads resulting from actuations of SRV Discharge Line 59 were computed. In addition, Line 34 was also selected because it has the highest water reflood height of all lines (Reference 2). The larger loads from these two SRV discharge lines form the design basis for work reported in this addendum.

4.1 SRV Discharge Line Clearing Transient Loads (2.2.2.1)

SRV discharge line clearing transient loads were calculated by General Electric's Computer Code RVFOR05 for Load Cases C3.2 and C3.3 using a worst case maximum water reflood height of 21 ft. per Reference 2. The results were used in the SRV discharge line and T-quencher support analysis and in the development of torus shell pressures and air bubble induced drag loads on submerged structures.

4.2 Torus Shell Loads (2.2.2.2)

Torus shell pressures for Load Case C3.2 due to SRV actuations from Discharge Lines 34 and 59 were calculated by General Electric's computer code QBUBS02. According to the Load Definition Report (LDR) (Reference 5), the pressures of subsequent actuations are bounded by first actuation pressures. Therefore, the pressure amplitudes of Case A1.2 were used in conjunction with the frequency range of Case C3.2. The predicted frequency ranges were adjusted by ±40 percent as required by the LDR. The calculated frequency ranges are between 5.95 Hz and 14.5 Hz.

4.3 SRV Reflood Transient (2.2.2.3)

SRV reflood transient analysis is reported in Reference 2. SRV Discharge Line 34 was chosen and Load Case C3.3 was analyzed by General Electric's computer code RVRIZ02. This line was chosen after length and loss coefficient calculations were performed for each SRV discharge line. Line 34 is approximately the longest line and has the largest losses among the SRV discharge lines, which would minimize the line pressurization and thus maximize the reflood height and residence time. The calculated maximum reflood height is 21 linear ft. of pipe above the top of the ramshead. This water level is below the elevation of the vacuum breakers.

4.4 T-Quencher Bubble Induced Drag Loads (2.2.2.5)

T-Quencher SRV bubble induced loads (Load Case C3.2) on the submerged SRV piping, header columns and downcomers were calculated using General Electric's computer program TQFOR03. In accordance with Reference 5, the load amplitudes of Case A1.2 were used in conjunction with the calculated frequency range of Case C3.2 broadened by ±40 percent.

4.5 Thrust Loads on T-Quencher Arms (2.2.2.6)

The calculated axial thrust load (C3.3) along the axis of the T-Quencher arms for SRV Discharge Line 59 is 4,000 lb which is less than the design load of 4,400 lb. The calculated water clearing thrust load (C3.3) perpendicular to the T-Quencher arms is 14,200 lb which is slightly greater than the design load of 14,040 lb. In

4.5 Thrust Loads on T-Quencher Arms (2.2.2.6) (Continued)

view of the small differences in these loads, the design loads calculated previously were used for combination with other loads in the structural evaluation.

4.6 Maximum SRV Discharge Line Wall Temperature (2.2.2.7)

The calculated maximum wall temperature for Load Case C3.3 is 479°F in the submerged SRV discharge line and is 493°F at the safety relief valve. The design temperature for the SRV discharge lines is 560°F.

5. EVALUATION OF SUBMERGED STRUCTURES AND SRV DISCHARGE LINE (2.3)

Structural analyses were conducted for SRV line supports in the wetwell and header columns considering SRV Load Cases C3.2 and C3.3. Structures were evaluated in accordance with NUREG-0661 (Reference 6).

5.1 Method of Analysis (2.3.1)

Dynamic analysis using the normal mode method was performed for SRV thrust loads to determine the transient responses of the SRV discharge line. SRV bubble induced drag loads (Load Case C3.2) were treated as sinusoidal loads. The maximum dynamic load factors (DLF) corresponding to the specified frequency ranges were calculated. They were then used to determine the structural responses for SRV bubble loads C3.2 by ratioing the results of Load Case A1.2 which have been calculated before.

5.2 Results of Analysis (2.3.2)

The load combination number and service level referred to in this addendum conform with Reference 6.

5.2.1 T-Quencher Supports (2.3.2.1)

Results of the two most critical support elements (strap plates and U-Bolts) are presented in Table 5.2.1-1. The stresses (loads) resulting from SRV and chugging were combined by the SRSS method in accordance with Reference 6.

As seen in Table 5.2.1-1 the computed stresses (loads) are within allowable for the new load cases.

5.2.2 Vent Header Support Columns (2.3.2.2)

The evaluation of vent header support columns is presented in Table 5.2.2-1. Bending stresses resulted from SRV and chugging were combined by the SRSS method. Table 5.2.2-1 shows the columns and connections are acceptable for the new load case.

5.2.3 SRV Discharge Line and Supports

SRV Discharge Line 59 below the vent header intersection was evaluated using Equations (9), (10) and (11) of the ASME Code Subsection NC (Reference 8). Load combination No. 11 and No. 15 were considered. Results given in Table 5.2.3-1 show that the piping stresses are within code allowables.

5.2.3 SRV Discharge Line and Supports (Continued)

SRV Discharge Line 59 above the vent header intersection was analyzed for the SRV thrust loads for Load Case C3.3. This line has previously been analyzed for Load Cases A1.1, A1.2 and C3.1. A comparison of Load Case C3.3 with these results revealed that the piping loads are bounded by the previously computed loads. Pipe support reaction loads resulting from Load Case C3.3 were also found to be bounded by results from other load cases with a maximum ratio of 92 percent (Reference 9).

6. EVALUATION OF VENT SYSTEM (3.0)

6.1 SRVDL Penetration of Vent/Vent Header Intersection (3.7.6)

SRV thrust discharge loads for Line 59 Load Case C3.3 were combined with other loads and the most severe load cases were obtained. By comparison with the governing load combinations used earlier for the analysis, the changes in the individual load components were found to vary between 1% to 10% in all cases except one load component in which the change was 18.5%. The stress intensity in the most critical elements were conservatively increased by 18.5%. These estimated maximum stress intensities are shown in Table 6.1-1. As shown in the table, the stress intensity in the header is still governed by a non-LOCA load case (GE Load Case 2). Therefore, the maximum stress intensity in the header (16.5 Ksi in element TRIA 97) is not affected by the additional SRV load cases. The maximum stress intensity calculated for any element in the model was 31.4 Ksi and occurred in TRIA 408. The allowable stress intensity is 69.3 Ksi. Because the stress levels remain far below the allowable, it was concluded that the cumulative fatigue results are not changed by the additional SRV load cases.

6.2 Downcomer/Vent Header Intersection

The SRV air bubble induced drag loads on the downcomers were calculated for Load Case C3.2 (which bounds Load Case C3.3) and compared with the governing SRV load (A3.2S) on the downcomers in the original Plant Unique Analysis evaluation. The peak amplitudes for Case C3.2 are lower than for Case A3.2S. The frequency of the A3.2S load was adjusted to match the structural frequencies of the downcomers thereby maximizing the dynamic load factor. Since both the amplitude and the dynamic load factor for the additional SRV load cases are less than or equal to the corresponding values of the governing SRV load case originally evaluated, it is concluded that the submerged structure loads on the downcomers for SRV Cases C3.2 and C3.3 are bounded by those previously addressed.

REFERENCES

1 CP&L letter to the NRC, Serial NLS-84-309, dated August 1, 1984, Subject: Mark I Containment Long-Term Program - Second S/RV Actuation in Relief Valve Discharge Lines.

2 Safety Relief Valve Discharge Line Reflood Transient and Water Clearing Thrust Load Analysis, NUTECH Engineers, Inc., xcp-03-102, Rev. 0, September 1983.

3 General Electric Letter MI-G-03, May 25, 1984, Subject: Mark I Containment Program - Errors in RVFOR and RVRIZ Computer Programs.

4 General Electric Letter MI-G-05, June 15, 1984, Subject: Mark I Containment Program - Responses to Utility/AE Question #328.

5 Mark I Containment Program, Load Definition Report, General Electric Company, Report No. NEDO-21888, November, 1981.

6 Safety Evaluation Report, Mark I Containment Long-Term Program, Resolution of Generic Technical Activity A-7, Office of Nuclear Reactor Regulation, U. S. Nuclear Regulatory Commission, Report No. NUREG-0661, July, 1980.

7 NRC letter, March 10, 1983, Subject: Acceptability of SRSS Method for Combining Dynamic Responses in Mark I Piping Systems, from D. B. Vassallo (NRC) to H. C. Pfefferlen (GE).

8 ASME Boiler & Pressure Vessel Code, Section III, Division 1 - Subsection NC, 1977 Edition including addenda thru Summer 1977.

REFERENCES (Continued)

9 Calculation Set No. 9527-E-SC-DL-5-F

10 Mark I Containment Program Structural Acceptance Criteria, Plant Unique Analysis Application Guide, Task 3.1.3, General Electric Company, Report No. NEDO-24583-1, October, 1979.

TABLE 5.2.1-1

EVALUATION OF T-QUENCHER SUPPORTS

Structure and Component	Service Level (Load Case)	Load Comb. No.*	Stress Type	Stress (KSI) Unless Noted: 1 Computed	2 Allowable	1/2 Ratio	Remarks
Strap Plates	B	15	Tension	5.73	20.8	0.28	SRSS
2-1" x 6"	(SBA)		Flexure	12.74	20.8	0.62	SRSS
SA516 GR.70						0.90	
U-Bolts	B	15	Tension	37.2k	86.1k	0.43	SRSS
1-1/2" diam.	(SBA)		Shear	10.9k	27.1k	0.40	SRSS
						0.83	
SA193 GR. B7							

*Reference 10

TABLE 5.2.2-1

EVALUATION OF VENT HEADER SUPPORT COLUMNS

6" DIAMETER SCHEDULE 80

Structure and Component	Service Level (Load Case)	Load* Comb. No.	Stress Type	Stress (KSI) 1 Computed	2 Allowable	Combined 1/2 Ratio	Remarks
Support	B	14	Axial &	1.22	12.6	0.10	
Column		(SBA)	Bending	14.75	18.6	0.79	SRSS
(SA333)						0.89	
Connection	B	14	Bearing	2.58	31.14	0.08	
Plates (SA516) & Pin (SA36)		(SBA)	Shear	1.40	9.84	0.14	
			Axial &	0.74	25.95	0.03	
			Bending	14.16	25.95	0.55	SRSS
						0.58	

*Reference 10

TABLE 5.2.3-1

EVALUATION OF WETWELL SRV DISCHARGE LINE AND T-QUENCHER

Structure and Component	Load Comb. No.*	Stress (KSI)					
		Eq. (9)**		Eq. (10)**		Eq. (11)**	
		Computed/Allowable	Ratio	Computed/Allowable	Ratio	Computed/Allowable	Ratio
Pipe Elbow	11	16.6/27.0	0.62	15.1/22.5	0.67	17.8/37.5	0.48
Reducer	11	12.4/27.0	0.46	13.5/22.5	0.60	16.3/37.5	0.43
Ramshead	11	17.7/26.9	0.66	6.72/23.4	0.29	9.31/38.3	0.24

* Reference 10
** Reference 8

TABLE 6.1-1

EVALUATION OF SRV DISCHARGE LINE PENETRATION

OF VENT/VENT HEADER INTERSECTION

Critical Element	Location	Max. Stress Intensity (Ksi)	Load Comb. No.*	Max. Allowable Stress Intensity (Ksi)	Qualification
TRIA 97	Header	16.5	2	69.3	OK
TRIA 408	Support Cyl.	31.4	14/26	69.3	OK
QUAD 2456	SRV Line	29.6	2	69.3	OK

* Reference 10