March 19, 1981
L-LOU-81- 86
File: 14Q-R-9C

TO: S Keblusek (NRC)
D Terao (NRC)
S Moore (Oak Ridge)

FROM: G G Hofer

SUBJECT: LOUISIANA POWER & LIGHT COMPANY
WATERFORD SES UNIT NO. 3
CLARIFICATION OF MEB ITEMS 50,
52 and 56

Please find attached additional information for MEB Items 50, 52 and 56. This submittal should close out these items.

If there are any questions, please do not hesitate to call me at (212) 839-3806.

GH:eco
Attachment.

cc: R K Stampley
R F Devine
J P Padalino
J K Tompeck
J C Saldarini
M P Horrell
J B Hart
R M Foley
M Farr
M A Pierson
K Fojt
W Wittich
R W Prados (LPL)
H B Mulliken (CE)
R Simeti (L-LOU-81-86)
Daybook
E Olizon (C.18.9)

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Reply to Additional NRC Comments
on Waterford-3 FSAR Relative to
CEDM's

(112240)

The following information responds to additional NRC comments covering the design, analysis, and testing of the CEDM's as described in the Louisiana Waterford-3 FSAR. The "Item" numbers are SER references.

A. Additional NRC Comment on Item 50:

At the meeting with C-E and Ebasco on October 2, a copy of calculated stresses and code allowable stresses was shown to us. The highest value of stress limit shown was 99.9 ksi for the motor housing.

1. What is the value of Sm on which this is based?

2. Can we have a copy of the data that was shown to us, so we can review it?

3. What are the materials?

The last sentence of the proposal resolution should include the following words: "for non-pressure parts."

Reply:

1. Subparagraph NB-3222.2 of Section III of the ASME Boiler and Pressure Vessel Code requires that the stress intensity derived from the primary-plus-secondary stresses be less than the limit of 3 Sm. The design stress intensity Sm is given in Tables I-1.1 and I-1.2 of Section III of the ASME Boiler and Pressure Vessel Code. The values of Sm for the material of the motor housing and temperatures encountered in this analysis are also given in the following table:

Design Stress Intensity, Sm (ksi)

Material Type	Temperature, ^{o}F							
	70°	100°	200°	300°	400°	500°	600°	615°
SA 182 F403	33.3	33.3	33.3	33.3	32.5	31.4	30.6	30.4

2. A copy of the data that was shown at the meeting with C-E, NRC and Ebasco on October 2 is attached to this memo as Appendix A and B.

3. The materials for the various CEDM components are listed in Section 4.5.1 of the Louisiana Waterford-3 FSAR.

4. The revised FSAR Subsection 3.9.4.2 still retains a description of the requirements for pressure boundary materials in addition to the revised sentence on non-pressure boundary materials. Therefore, it is suggested that the words: "for further discussion of design requirements on CEDM pressure boundary and non-pressure boundary components", be added to the last sentence of C-E's response to Item 50.

B. Additional NRC Comment on Item 52:

The proposed resolution covers the effects of distortion. What are the effects of changes in pressure drop?

Reply:

As already described in the resolution for Item 52, changes in pressure drop will not affect operation of the rod drives. The calculations of the magnitude and duration of the pressure wave associated with a small break shows that the pressure wave pulse lasts less than .03 seconds.

C. Additional NRC Comment on Item 56:

The proposed resolution covers lifetime. What is the effects of the increased travel on the drop time?

Reply:

The response to Item 55 describes scram times for the 150" motor assembly. All scram times for the 150" motor assembly were less than the allowed maximum of 3 seconds.

RFZ/dy
Attach.

APPENDIX A

Contents:

Pages

1. ABSTRACT

Presented in this report are the tentative sizing calculations for all pressure containing parts of the CEDM housing assembly for design, emergency, faulted and test conditions. These calculations are basically a determination of the primary membrane and primary membrane plus bending stress intensities. The results are evaluated by comparing these stress intensities with the limits of the 1971 ASME Boiler and Pressure Vessel Code, Section III for Nuclear Vessels. All stresses are satisfactory and meet the appropriate allowables in the ASME Code.

2. SIGNIFICANT RESULTS

Omega Seals

The table on the next page summarizes the results for the four omega seals on the CEDM housing. The omega seals are labeled as follows:

A. The seal between the ball seal housing and the housing nut.

B. The seal between the ball seal housing and the upper housing assembly.

C. The seal between the upper housing assembly and the motor housing assembly.

D. The seal between the motor housing assembly and the CEDM nozzle.

2. SIGNIFICANT RESULTS (CONT'D)

OMEGA SEALS (CONT'D)

OMEGA SEALS (STRESS IN KSI)

LOCATION	CONDITION	DESIGN	EMERGENCY (1)	TEST
	ASME III REF	NB-3221	NB-3223	NB-3226
SEAL "A"	STRESS INTENSITY (2)	10.85	9.76	13.58
	P_m ALLOWABLE	S_m = 16.60	$1.2S_m$ = 20.26	$.9S_y$ = 19.26
	P_L+P_b ALLOWABLE	$1.5S_m$ = 24.90	$1.8S_m$ = 30.38	$1.35S_y$ = 28.89
SEAL "B"	STRESS INTENSITY (2)	11.77	10.56	17.69
	P_m ALLOWABLE	S_m = 16.60	$1.2S_m$ = 20.26	$.9S_y$ = 19.26
	P_L+P_b ALLOWABLE	$1.5S_m$ = 24.90	$1.8S_m$ = 30.38	$1.35S_y$ = 28.89
SEAL "C"	STRESS INTENSITY (2)	11.77	10.56	17.67
	P_m ALLOWABLE	S_m = 23.30	$1.2S_m$ = 27.96	$.9S_y$ = 26.82
	P_L+P_b ALLOWABLE	$1.5S_m$ = 34.95	$1.8S_m$ = 41.94	$1.35S_y$ = 40.23
SEAL "D"	STRESS INTENSITY (2)	11.77	10.56	17.67
	P_m ALLOWABLE	S_m = 23.30	$1.2S_m$ = 27.96	$.9S_y$ = 26.82
	P_L+P_b ALLOWABLE	$1.5S_m$ = 34.95	$1.8S_m$ = 41.94	$1.35S_y$ = 40.23

NOTES: (1) STRESS INTENSITY ALSO APPLIES TO THE FAULT CONDITION; FAULT ALLOWABLES ARE HIGHER.

(2) P_L+P_b IS REPORTED, $P_m \le P_L+P_b$

SCREW THREADS

SCREW THREADS (STRESS IN KSI)

LOCATION	CONDITIONS	DESIGN	EMERGENCY	TEST
	ASME III REF	NB-3227.2	NB-3227.2	NB-3227.2
THREAD "A"	STRESS INTENSITY	1.34	1.21	1.65
	ALLOWABLE	$.6S_m$ = 9.96	$.6S_m$ = 10.13	$.6S_m$ = 11.52
THREAD "B"	STRESS INTENSITY	1.53	1.37	1.65
	ALLOWABLE	$.6S_m$ = 9.96	$.6S_m$ = 10.13	$.6S_m$ = 11.52
THREAD "C"	STRESS INTENSITY	4.20	3.23	7.67
	ALLOWABLE	$.6S_m$ = 13.98	$.6S_m$ = 13.96	$.6S_m$ = 13.96
THREAD "D"	STRESS INTENSITY	2.33	2.07	3.04
	ALLOWABLE	$.6S_m$ = 13.96	$.6S_m$ = 13.98	[illegible]

2. SIGNIFICANT RESULTS (CONT'D)

HOUSING WALLS

THE TABLE BELOW SUMMARIZES THE RESULTS FOR THE FIVE MOST CRITICAL SECTIONS OF THE CEDM HOUSING.

HOUSING SECTIONS (STRESS IN KSI)

LOCATION	CONDITION	DESIGN	EMERGENCY (1)	TEST
	ASME III REF.	NB-3221	NB-3223	NB-3226
SECTION I	STRESS INTENSITY (2)	9.92	8.92	10.70
	P_m ALLOWABLE	S_m = 18.60	$1.2S_m$ = 22.26	$0.9S_y$ = 19.26
	P_L+P_b ALLOWABLE	$1.5S_m$ = 27.90	$1.8S_m$ = 33.38	$1.35S_y$ = 28.89
SECTION II	STRESS INTENSITY (2)	15.01	18.81	13.76
	P_m ALLOWABLE	S_m = 18.60	$1.2S_m$ = 20.26	$0.9S_y$ = 19.26
	P_L+P_b ALLOWABLE	$1.5S_m$ = 27.90	$1.8S_m$ = 33.38	$1.35S_y$ = 28.89
SECTION III	STRESS INTENSITY (2)	17.13	12.71	17.69
	P_m ALLOWABLE	S_m = 23.30	$1.2S_m$ = 27.96	$0.9S_y$ = 26.83
	P_L+P_b ALLOWABLE	$1.5S_m$ = 34.95	$1.8S_m$ = 41.94	$1.35S_y$ = 40.23
SECTION IV	STRESS INTENSITY (2)	34.67	33.76	30.46
	P_m ALLOWABLE	S_m = 23.90	$1.2S_m$ = 35.47	$0.9S_y$ = 57.22
	P_L+P_b ALLOWABLE	$1.5S_m$ = 77.85	$1.8S_m$ = 57.70	$1.35S_y$ = 76.32
SECTION V	STRESS INTENSITY (2)	11.44	10.58	17.30
	P_m ALLOWABLE	S_m = 23.30	$1.2S_m$ = 27.96	$0.9S_y$ = 26.83
	P_L+P_b ALLOWABLE	$1.5S_m$ = 34.95	$1.8S_m$ = 41.94	$1.35S_y$ = 40.23

NOTES: (1) FAULT COND. HAS SAME STRESSES AND HIGHER ALLOWABLES.
(2) P_L+P_b IS REPORTED; $P_m \le P_L+P_b$.

SPECIAL STRESS LIMITS

BEARING STRESS ON MOTOR HOUSING LEDGE

σ_B = 4.38 KSI < S_y = 66.55 KSI @ 650 °F

STABILITY UNDER COMPRESSIVE LOAD

$$\frac{P_{CRITICAL}}{P_{APPLIED}} = \lambda \ge 1.68 > 1.00$$

I. INTRODUCTION

The pressure retaining components of the control element drive mechanism (CEDM) are designed according to the rules of the ASME Code. Under these rules primary stress intensity is limited for design, emergency, faulted and test conditions, while primary-plus-secondary stress intensities and peak stress intensities are limited only for normal and upset conditions. Consequently, it is convenient to separate the analysis and evaluation of the CEDM housing into two distinct tasks: (1) a hand calculation of the primary stresses in the housing and an evaluation of the resulting stress intensities; and (2) a finite element analysis of the primary-plus-secondary stresses and peak stresses due to normal and upset conditions and an evaluation of the resulting stress intensities.

Furthermore, the geometry of the CEDM assembly makes it possible to divide the structure into three regions, separated by long cylinder distances, and to independently calculate the primary-plus-secondary (and peak) stresses in each region. As a result of these considerations, the analysis of the CEDM assembly is presented in four distinct calculations. Calculation RS-001, is a tentative sizing and primary stress analysis for the entire CEDM assembly. Calculations RS-003 and RS-004, are primary-plus-secondary stress analyses of two of these three independent regions: (1) the motor-housing-to-upper-pressure-housing-fitting region, and (2) motor-housing-to-lower-end-fitting transition region.

In this report, CE Calculation RS-002, the third independent region noted above, the ball seal housing and upper pressure housing region, is analyzed for primary-plus-secondary stresses and peak stresses due to the normal and upset conditions. Internal operating pressure, operating temperatures, operating basis earthquake (OBE) loads, dead weight, and mechanical excitation loads are considered. The resulting stress intensities are evaluated according to the applicable criteria.

The significant results of this investigation are summarized in Section II of this report. Section III describes the structural geometry and loading of the CEDM assembly and summarizes the applicable design criteria.

II. SIGNIFICANT RESULTS

The stress evaluation shows that all stress intensities and usage factors meet the requirements of Section III of the 1971 ASME Boiler and Pressure Vessel Code, for the normal and upset conditions.

The table below summarizes the results of the primary-plus-secondary stress analysis and evaluation.

Summary of Primary-Plus-Secondary Stress Intensities

Structural Region	Primary-Plus-Secondary Stress (ksi): Max. Stress Int.	Primary-Plus-Secondary Stress (ksi): Loc.	Stress Intensity Limits: Allowable	Stress Intensity Limits: ASME Code Ref.
Upper Pressure Housing	11.96	Cut 1 Inside	$3S_m = 60.0$	NB-3222.2
Lower Omega Seal	17.13	Cut 6 Inside	$3S_m = 60.0$	
Ball Seal Housing	11.07	Cut 11 Inside	$3S_m = 60.0$	
Upper Omega Seal	14.11	Cut 16 Inside	$3S_m = 60.0$	
Threaded Connection Ball-Seal-To-Upper Pressure Housing	8.41	Element 125	$S_y = 30.0$	NB-3227.3
Threaded Connection Vent-Stem-To-Ball Seal Housing	5.41	Element 378	$S_y = 30.0$	
Threaded Connection Housing-Nut-To-Ball-Seal-Housing	8.33	Element 441	$S_y = 30.0$	

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The peak stress analysis and fatigue usage factor calculation is summarized in the table below:

Summary of Peak Stress Intensities and Fatigue Usage Factors

Structural Region	Total Stress (ksi)		Fatigue Usage	
	Max. Stress Int.	Location	Usage Factor U	Allowable
Upper Pressure Housing	17.69	Cut 5 Inside	.00	1.00
Lower Omega Seal	23.38	Cut 6 Inside	.00	1.00
Ball Seal Housing	22.10	Cut 11 Inside	.00	1.00
Upper Omega Seal	23.60	Cut 16 Inside	.00	1.00

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I. INTRODUCTION

The pressure retaining components of the control element drive mechanism (CEDM) are designed according to the rules of *the ASME Code*. Under these rules primary stress intensity is limited for design, emergency, faulted and test conditions, while primary-plus-secondary stress intensities and peak stress intensities are limited only for normal and upset conditions. Consequently, it is convenient to separate the analysis and evaluation of the CEDM housing into two distinct tasks: (1) a hand calculation of the primary stresses in the housing and an evaluation of the resulting stress intensities; and (2) a finite element analysis of the primary-plus-secondary stresses and peak stresses due to normal and upset conditions and an evaluation of the resulting stress intensities.

Furthermore, the geometry of the CEDM assembly makes it possible to divide the structure into three regions, separated by long cylinder distances, and to independently calculate the primary-plus-secondary (and peak) stresses in each region. As a result of these considerations, the analysis of the CEDM assembly is presented in four distinct calculations. Calculation RS-001, is a tentative sizing and primary stress analysis for the entire CEDM assembly. Calculations RS-002 and RS-004, are primary-plus-secondary stress analyses of two of these three independent regions: (1) the ball seal housing and ball-seal-housing-to-upper-pressure-housing transition, and (2) the motor-housing-to-lower-end-fitting transition region.

In this report, CE Calculation RS-003, the third independent region noted above, the motor-housing-to-upper-pressure-housing-transition region, is analyzed for primary-plus-secondary stresses and peak stresses due to the normal and upset conditions. Internal operating pressure, operating temperatures, operating basis earthquake (OBE) loads, dead weight (DW), pump-induced mechanical excitation (ME) loads and motor driving impulse (DI) loads are considered. The resulting stress intensities and fatigue usage factors are evaluated according to the applicable criteria.

The significant results of this investigation are summarized in Section II of this report.

II. SIGNIFICANT RESULTS

The stress evaluation shows that all stress intensities and usage factors meet the requirements of Section III of the 1971 ASME Boiler and Pressure Vessel Code for the normal and upset conditions.

The table below summarizes the results of the primary-plus-secondary stress analysis and evaluation.

Summary of Primary-Plus-Secondary Stress Intensities

Structural Region	Primary-Plus-Secondary Stress (ksi)		Stress Intensity Limits	
	Max. Stress Int. Range	Loc.	Allowable	ASME Code Ref.
Motor Housing Tube	37.48	Cut 1 Inside	99.9	NB-3222.2
Motor Housing Upper End Fitting	23.17	Cut 11 Inside	69.9	
Omega Seal	49.54	Cut 12 Outside	69.9	
Upper Pressure Housing Tube	45.91	Cut 18 Inside	60.0	
Threaded Connection	20.74	Element 1705	35.0	NB-3227.2

AB

The peak stress analysis and fatigue usage factor calculation is summarized in the table below:

Summary of Peak Stress Intensities and Fatigue Usage Factors

Structural Region	Total Stress (ksi)		Fatigue Usage	
	Alt. Stress Int.	Loc.	Usage Factor U	Allowable
Motor Housing Tube	25.42	Cut 7 Inside	.000	1.000
Motor Housing Upper End Fitting	32.11	Cut 9 Inside	.002	1.000
Omega Seal	28.85	Cut 12 Inside	.001	1.000
Upper Pressure Housing	18.53	Cut 16 Outside	.000	1.000

COMBUSTION ENGINEERING, INC.
ENGINEERING DEPARTMENT, CHATTANOOGA, TENN.

CHARGE NO. 74670-8

DESCRIPTION STRUCTURAL ANALYSIS OF THE CEDM HOUSING

NUMBER RS-004

SHEET 1 OF 40

DATE [illegible] BY [illegible]

CHECK DATE [illegible] BY [illegible]

I. INTRODUCTION

The pressure retaining components of the control element drive mechanism (CEDM) are designed according to the rules of *the ASME Code.* Under these rules primary stress intensity is limited for design, emergency, faulted and test conditions, while primary-plus-secondary stress intensities and peak stress intensities are limited only for normal and upset conditions. Consequently, it is convenient to separate the analysis and evaluation of the CEDM housing into two distinct tasks: (1) a hand calculation of the primary stresses in the housing and an evaluation of the resulting stress intensities; and (2) a finite element analysis of the primary-plus-secondary stresses and peak stresses due to normal and upset conditions and an evaluation of the resulting stress intensities.

Furthermore, the geometry of the CEDM assembly makes it possible to divide the structure into three regions, separated by long cylinder distances, and to independently calculate the primary-plus-secondary (and peak) stresses in each region. As a result of these considerations, the analysis of the CEDM assembly is presented in four distinct calculations. Calculation RS-001, is a tentative sizing and primary stress analysis for the entire CEDM assembly. Calculations RS-002 and RS-003, are primary-plus-secondary stress analyses of two of these three independent regions: (1) the ball seal housing and ball-seal-housing-to-upper-pressure-housing transition, and (2) the upper-pressure housing-to-motor-housing transition region.

In this report, C-E Calculation RS-004, the third independent region noted above, the motor-housing-lower-end-fitting-to-CEDM-nozzle transition region, is analyzed for primary-plus-secondary stresses and peak stresses due to the normal and upset conditions.
Internal operating pressure, operating temperatures, operating basis earthquake (OBE) loads, dead weight (DW), pump-induced mechanical excitation (ME) loads and motor driving impulse (DI) loads are considered. The resulting stress intensities and fatigue usage factors are evaluated according to the applicable criteria.

A1

The significant results of this investigation are summarized in Section II of this report.

II. SIGNIFICANT RESULTS

The stress evaluation shows that all stress intensities and usage factor meet the requirements of Section III of the 1971 ASME Boiler and Pressure Vessel Code for the normal and upset conditions.

The table below summarizes the results of the primary-plus-secondary stress analysis and evaluation.

Summary of Primary-Plus-Secondary Stress Intensities

Structural Region	Primary-Plus-Secondary Stress (ksi)		Stress Intensity Limits	
	Max. Stress Int. Range	Loc.	Allowable	ASME Code Ref.
Motor Housing Tube	13.48	Cut 1 Inside	91.2	NB-3222.2
Motor Housing Lower End Fitting	17.64	Cut 4 Outside	69.9	
Omega Seal	31.97	Cut 6 Inside	69.9	
Threaded Connection	14.52	Element No. 314	27.7	NB-3227.3

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The peak stress analysis and fatigue usage factor calculation is summarized in the table below:

Summary of Peak Stress Intensities and Fatigue Usage Factors

Structural Location	Stress Intensity (ksi)	Fatigue Usage	
	Alt. Stress Int.	Usage Factor	Allowable
Cut 1 Outside	7.85	.000	1.000
Cut 3 Inside	23.10	.000	1.000
Cut 4 Inside	17.86	.000	1.000
Cut 5 Inside	13.36	.000	1.000
Cut 6 Inside	17.02	.000	1.000

APPENDIX B

Contents:

4.0 RESULTS

The worst thermal transient was Reactor Trip, Loss of Flow, Loss of Load. The times evaluated in the structural analyses were times with pressure peaks as well as times with the largest thermal gradients. The significant radial gradients were encountered at 2.0 sec. with axial gradients peaking at 200 sec.

The following table shows the time steps used with the iteration and printout intervals.

Transient: Reactor Trip, Loss of Flow, Loss of Load		
Time(Sec.)	Number of Iterations	Number of Printouts
.225	3	1
.375	3	1
.5	3	1
.7	3	1
1.35	3	1
1.5	3	1
2.0	1	1
20.0	12	12
25.0	1	1
30.0	1	1
50.0	4	4
100.0	2	2
300.0	4	4
1000.0	7	7

5.0 METHOD OF SOLUTION

The model was analyzed using the ANSYS finite element computer program.