Southern California Edison Company

23 PARKER STREET

IRVINE, CALIFORNIA 92718

R. M. ROSENBLUM
MANAGER OF
NUCLEAR REGULATORY AFFAIRS

TELEPHONE
(714) 587-5420

July 12, 1990

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D. C. 20555

Gentlemen:

Subject: Docket No. 50-206
Flexure Fatigue Analysis
Thermal Shield Support System Replacement
San Onofre Nuclear Generating Station
Unit 1

The enclosure to this letter provides the preliminary results of the new flexure fatigue analysis requested by the NRC in our meetings of June 25 to 27, 1990. The results of the analysis give the factor that would have to be applied to the flow induced vibrational (FIV) loads to obtain a usage factor of approximately 0.99 after 50 months of operation using a failure fatigue curve rather than the design fatigue curve. This analysis enables a one to one comparison of the original flexure to the new flexure using the same criteria.

The results presented in the enclosure are preliminary, since they need to be documented and verified. Westinghouse expects to complete the verification and documentation by July 20, 1990. If the verification results in any changes, you will be promptly notified.

If you have any questions or desire further information, please let me know.

Very truly yours,

RM Rosenblum

Enclosure:

cc: J. B. Martin, Regional Administrator, NRC Region V
C. Caldwell, NRC Senior Resident Inspector, San Onofre
Units 1, 2 and 3

A001
1/1

Enclosure

Westinghouse Proprietary Class 2
(Preliminary results)

Flexure Fatigue Analysis

This evaluation was performed in response to the NRC request for a one to one comparison of the original flexure to the new flexure using the same criteria. The results of the evaluation give the factor that would have to be applied to the FIV loads to obtain a usage factor of approximately 0.99 after 50 months of operation using a failure fatigue curve rather than the design fatigue curve.

During the verification of the finite element model for the original flexure, the FIV adjustment factor was recalculated to reflect more accurate boundary conditions. This resulted in an increase in the adjustment factor used in the evaluation of the new flexure. The factor was 0.615, it is now 0.685. The maximum alternating stress intensity, based on 4.45 Sigma FIV loads, for the flexure assuming the limiter keys are intact is 25.5 Ksi. The fatigue evaluations presented to the NRC were based on an alternating stress intensity (Sa) value of 25.5 Ksi, which results in a usage factor of 0.3 for FIV loads for 15 years of operation at 10 Hz.

Westinghouse Proprietary Class 2
(preliminary results)
(NEW)
F. I. V. FLEXURE Sa VALUES

NODE 112

W/ KEYS (646) LOCATION	Sa (ksi)	W/O KEYS (606) LOCATION	Sa (ksi)
325	18.61	325	29.85
244	25.52	244	28.88
204	25.23	204	29.41
124	19.01	124	30.67
85	19.21	85	25.65
0	19.08	0	24.74

BASED ON 4.45 SIGMA AND A .685 FACTOR*

UPDATE TO Sa VALUES PRESENTED AT NRC MTG.

* Factor by which model-generated FIV loads would have to be multiplied to produce a usage factor approaching 1.00.

Westinghouse Proprietary Class 2
(preliminary results)

COMPARISON OF ORIGINAL TO NEW FLEXURE FIV LOADS

WITH LIMITER KEYS (646)

ORIGINAL FLEXURE			NEW FLEXURE		
LOCATION	FACTOR*	USAGE	LOCATION	FACTOR*	USAGE
325	0.857	0.99	325	1.495	0.99
244	0.685	0.98	244	1.090	1.00
204	0.702	0.98	204	1.100	0.99
124	0.913	0.99	124	1.465	0.99
85	0.772	1.00	85	1.450	1.00
21	0.798	0.99	0	1.460	1.00

BASED ON 50 MONTHS OF OPERATION AT 10 HZ, APPROX. 1.3E9 CYCLES

* Factor by which model-generated FIV loads would have to be multiplied to produce a usage factor approaching 1.00.

Westinghouse Proprietary Class 2
(preliminary results)

COMPARISON OF ORIGINAL TO NEW FLEXURE FIV LOADS

NO LIMITER KEYS (606)

ORIGINAL FLEXURE			NEW FLEXURE		
LOCATION	FACTOR *	USAGE	LOCATION	FACTOR *	USAGE
325	0.438	0.99	325	0.930	0.99
244	0.610	0.99	244	0.960	0.98
204	0.608	0.98	204	0.945	1.00
124	0.496	0.98	124	0.905	0.99
85	0.667	1.00	85	1.084	1.00
21	0.508	0.98	0	1.124	1.00

BASED ON 50 MONTHS OF OPERATION AT 10 HZ, APPROX. 1.3E9 CYCLES

* Factor by which model-generated FIV loads would have to be multiplied to produce a usage factor approaching 1.00.

Westinghouse Proprietary Class 2
(preliminary results)

ORIGINAL FLEXURE ASSUMPTIONS

1. EVALUATION ASSUMES FLEXURES FAILED AFTER 50 MONTHS OF OPERATION (USAGE FACTOR OF APPROXIMATELY .99)

2. THE EVALUATION IS BASED STRICTLY ON F.I.V. LOADINGS ASSUMING A RAYLEIGH DISTRIBUTION OF LOADS

3. THE MEAN ASME FATIGUE (FAILURE) CURVE WAS USED FOR THE EVALUATION

   - UP TO 1E+6 CYCLES, AT 70 DEG F

     Sa(1) = (9159*N^-.5 + 47.35) KSI

   - FROM 1E+6 TO 1E+11 CYCLES, AT 70 DEG F

     THE Sa VALUES OF CURVE "B" OF THE ASME CODE ARE INCREASED BY A FACTOR OF 2

4. A SIMIPLIED ELASTIC PLASTIC EVALUATION IS PERFORMED PER THE ASME CODE (Ke FACTOR) TO ADJUST THE ALTERNATING STRESS WHEN 3Sm (49.2 KSI AT 600 DEG F) IS EXCEEDED

5. THE Sa STRESS IS MODIFIED FOR THE EFFECTS OF MEAN STRESS WHEN THE (P + Q) STRESS INTENSITY RANGE OF 44 KSI IS EXCEEDED. THIS IS ONLY DONE FOR Sa VALUES UP TO THE 3Sm LIMIT. ONCE A Ke FACTOR IS APPLIED THE SA VALUES ARE NO LONGER ADJUSTED FOR THE EFFECTS OF MEAN STRESS.

   THE FOLLOWING EQUATION IS USED TO ACCOUNT FOR THE EFFECTS OF MEAN STRESS

   $$Sa'(1) = Sa/(1-(Sy-Sa)/Su)$$

   WHERE: SY = 44 KSI (1)
   Su = 94 KSI (1)

(1) REFERENCE, "FATIGUE DESIGN CRITERIA FOR PRESSURE VESSEL ALLOYS", C E JASKE AND W J O'DONNELL, JOURNAL OF PRESSURE VESSEL TECHNOLOGY, NOV 1977

Westinghouse Proprietary Class 2
(preliminary results)

NEW FLEXURE ASSUMPTIONS

1. EVALUATION ASSUMES FLEXURES FAILED AFTER 50 MONTHS OF OPERATION (USAGE FACTOR OF APPROXIMATELY .99)

2. THE EVALUATION IS BASED STRICTLY ON F.I.V. LOADINGS ASSUMING A RAYLEIGH DISTRIBUTION OF LOADS

3. THE MEAN ASME FATIGUE (FAILURE) CURVE WAS USED FOR THE EVALUATION

   - UP TO 1E+6 CYCLES, AT 70 DEG F

     $Sa(1) = (9159*N^{-.5} + 47.35)$ KSI

   - FROM 1E+6 TO 1E+11 CYCLES, AT 70 DEG F

     THE Sa VALUES OF CURVE "B" OF THE ASME CODE ARE INCREASED BY A FACTOR OF 2

4. A SIMIPLIED ELASTIC PLASTIC EVALUATION IS PERFORMED PER THE ASME CODE (Ke FACTOR) TO ADJUST THE ALTERNATING STRESS WHEN 3Sm (87.6 KSI AT 600 DEG F) IS EXCEEDED

5. THE Sa STRESS IS MODIFIED FOR THE EFFECTS OF MEAN STRESS WHEN THE (P + Q) STRESS INTENSITY RANGE OF 44 KSI IS EXCEEDED. THIS IS ONLY DONE FOR Sa VALUES UP TO THE CYCLIC YIELD VALUE OF 44 KSI

   THE FOLLOWING EQUATION IS USED TO ACCOUNT FOR THE EFFECTS OF MEAN STRESS

   $Sa'(1) = Sa/(1-(Sy-Sa)/Su)$

   WHERE: SY = 44 KSI (1)
   Su = 94 KSI (1)

   FOR Sa > 44 KSI NO ADJUSTMENT IS MADE

(1) REFERENCE, "FATIGUE DESIGN CRITERIA FOR PRESSURE VESSEL ALLOYS", C E JASKE AND W J O'DONNELL, JOURNAL OF PRESSURE VESSEL TECHNOLOGY, NOV 1977