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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	Docket Nos. 50-275 50-323-OLA
PACIFIC GAS AND ELECTRIC COMPANY	(Reracking of Spent Fuel Pools)
(Diablo Canyon Nuclear Power Plant Units 1 and 2)	

LICENSEE PACIFIC GAS AND ELECTRIC COMPANY'S
ANSWERS TO FIRST SET OF INTERROGATORIES
OF THE SIERRA CLUB, DATED SEPTEMBER 15, 1986

INTERROGATORY NO. I:

Identify all records and documents relating to theoretical work regarding the displacements of high density spent fuel racks at Diablo Canyon resulting from hypothetical seismic excitation of the the spent fuel pools. Such documents should include, but are not limited to, any reports of calculations regarding:

1) the displacement of any rack toward a wall or another rack;

2) displacements resulting in collisions between a rack and a wall;

3) the nearest approach of a rack to a wall;

4) the presentation made by PGandE to the NRC at the meeting of February 20, 1986;

5) the claim reported in the Safety Evaluation, Appendix A,

D503

page 49, regarding rack displacements.

RESPONSE TO INTERROGATORY NO. I:

Theoretical work related to displacements are contained in Documents 4, 7, 8, 9, 10, 11, 12, 13, 14, 16, 18, (Section 6), 19, 24, 27, 28, 29, 33, 35, 36, and 37, and Documents A, B, and E which are identified in Attachment I.

INTERROGATORY NO. II:

Identify all records and documents relating to experimental studies which serve to verify theoretical rack displacement calculations.

RESPONSE TO INTERROGATORY NO. II:

Experimental studies were not performed specifically to verify theoretical calculations for the high density racks. However, related experimental studies have been conducted which serve to verify portions of the rack analysis they are contained in Documents 3, 17, and 22, and Document C which are identified in Attachment I.

INTERROGATORY NO. III:

Identify all records and documents relating to theoretical work

regarding impact forces and/or fluid coupling forces exerted on spent fuel racks as a result of interactions between racks or between a rack and a wall in response to hypothetical seismic excitation of the spent fuel pools. Such documents should include, but are not limited to, all reports of calculations involving:

1) the forces on a rack arising from rack-rack interactions, including collisions;
2) the forces on a rack arising from rack-wall interactions, including collisions;
3) interaction forces reported or discussed by PGandE to the NRC at the meeting of February 20, 1986;
4) the claim reported in the Safety Evaluation, Appendix A, page 49 regarding rack forces ("Safety Evaluation By The Office of Nuclear Regulation Relating to the Reracking of the Spent Fuel Pools At the Diablo Canyon Nuclear Power Plant, Units 1 and 2, ...," U.S.N.R.C., Washington, D.C., May 30, 1986.);
5) the claim made in the Safety Evaluation, Appendix A, page 24, that the fluid coupling method conservatively underestimates the coupling forces.

RESPONSE TO INTERROGATORY NO. III:

Records and documents relating to theoretical work regarding impact forces and/or fluid coupling forces exerted on the racks are included in Documents 1, 4, 5, 6, 8, 9, 10, 13, 15, 16, 18, 20, 21, 22, 23, 24, 30, 34,

36, and 37, and Documents A, B, D, and H (Chapter 9) which are identified in Attachment I.

INTERROGATORY NO. IV:

Identify all records and documents relating to experimental studies which serve to verify theoretical calculations regarding rack forces, including impact and fluid coupling forces.

RESPONSE TO INTERROGATORY NO. IV:

See response to Interrogatory No. II.

INTERROGATORY NO. V:

Identify all records and documents relating to theoretical analysis of rack strength. Such documents should include, but are not limited to, reports of calculations involving both impact loads and fluid coupling loads.

RESPONSE TO INTERROGATORY NO. V:

Records and documents relating to theoretical analysis or rack strength are included in Documents 1, 2, 4, 5, 6, 11, 15, 18 (Part I and Section 6), 20, 25, 26, 30, and 32, and Documents A, B, and E which are

identified in Attachment I.

INTERROGATORY NO. VI:

Identify all records and documents relating to experimental studies which serve to verify predicted rack strengths. Such documents should include, but are not limited to, reports of experiments involving both impact loads and fluid coupling loads.

RESPONSE TO INTERROGATORY NO. VI:

See response to Interrogatory No. II.

INTERROGATORY NO. VII:

Identify all records and documents relating to the fluid coupling coefficients used in the time-history analysis, as discussed in section 6.2.3 of the Reracking Report. ("Reracking of Spent Fuel Pools Diablo Canyon Units 1 and 2", PGandE, September, 1985.) Such documents should include, but are not limited to, reports of calculations involving:

1) a complete description of the fluid coupling coefficients;
2) the theoretical derivation of the fluid coupling coefficients;
3) experimental verification of the fluid coupling coefficients;

4) limiting values attained by the fluid coupling coefficients during time-history analysis of rack behavior during seismic excitation.

RESPONSE TO INTERROGATORY NO. VII:

Records and documents relating to fluid coupling coefficients are included in Documents 5, 16, 18, and 37, and Documents A, B, and H which are identified in Attachment I.

INTERROGATORY NO. VIII:

Identify all records and documents relating to theoretical analysis of the fluid coupling between racks.

RESPONSE TO INTERROGATORY NO. VIII:

Records and documents related to fluid coupling between racks are included in Documents 4, 5, and 15 through 24, and cited in Document H which are identified in Attachment I.

INTERROGATORY NO. IX:

Identify all records and documents relating to experimental studies

performed to verify the theoretical analysis of fluid coupling between racks.

RESPONSE TO INTERROGATORY NO. IX:

See response to Interrogatory No. II.

INTERROGATORY NO. X:

Identify all records and documents relating to theoretical analysis of fluid coupling between a fuel rack and a wall of the spent fuel pool.

RESPONSE TO INTERROGATORY NO. X:

See response to Interrogatory No. VIII. Additional references are provided in Documents A and B which are identified in Attachment I.

INTERROGATORY NO. XI:

Identify all records and documents relating to experimental studies performed to verify the theoretical analysis of fluid coupling between a rack and a wall.

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RESPONSE TO INTERROGATORY NO. XI:

See response to Interrogatory No. II.

INTERROGATORY NO. XII:

Identify all records and documents relating to the density of the racks and/or the bouyant force on racks under water. Such documents should include, but are not limited to, any discussion of the effect of rack bouyancy on rack behavior during seismic excitation.

RESPONSE TO INTERROGATORY NO. XII:

The documents used for analysis of the racks are included as Documents 4, 5, and 15 through 24 which are identified in Attachment I.

INTERROGATORY NO. XIII:

Identify all records and documents relating to the velocity dependence of the coefficient of friction between stainless steels.

RESPONSE TO INTERROGATORY NO. XIII:

Documents relating to the velocity dependence of the coefficient of

friction between stainless steels are Document 3 and Document C which are identified in Attachment I.

INTERROGATORY NO. XIV:

Identify all records and documents relating to the time during which a rack may be in contact with another rack during a collision with another rack or in contact with a wall during a rack-wall collision. Such documents should include, but are not limited to, reports of calculations involving:

1) velocity and/or displacement time-histories for racks undergoing collisions;
2) typical or average times during which a rack is expected to be in contact with another rack or with a wall during a collision.

RESPONSE TO INTERROGATORY NO. XIV:

During time history analyses, displacements are computed at each time step; however, only maximum values for the entire event are stored and printed. Therefore, no detailed results are included herein. See Documents 15 and 20 and Document E which are identified in Attachment I.

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INTERROGATORY NO. XV:

Identify all records and documents relating to the possibility of and/or consequences of two or more racks colliding with a third rack or with a wall. Such documents should include, but are not limited to, reports of calculations involving:

1) the frequency of such three-body collisions;
2) typical velocity and/or displacement time-histories of such collisions;
3) maximum impact and fluid coupling loads on racks involved in multiple collisions.

RESPONSE TO INTERROGATORY NO. XV:

The possibility of two or more racks colliding with a third rack or with a wall is discussed in Documents 15, 22, and 37, and Document B which are identified in Attachment I.

INTERROGATORY NO. XVI:

It appears from the Reracking Report that the time-history analyses performed assume that a rack will collide with another rack "out of phase" whenever it has moved a distance of 0.125 inches relative to the pool floor from its equilibrium position. In other words, it appears that the

time-history analyses assume as a constraint that the maximum displacement of a rack relative to the pool floor is 0.125 inches. Is it true that such a assumption was made for the purposes of the time-history analyses?

RESPONSE TO INTERROGATORY NO. XVI:

Such an assumption was not made. The assumption is that for a rack adjacent to another rack, the free movement is 0.125" before any force develops in the gap element (simulating the adjacent rack). The subsequent compression of the gap element yields the value of the developed impact force. There is no absolute constraint imposed except when contact occurs with the stiff non-linear spring (gap element).

INTERROGATORY NO. XVII:

If the assumption in XVI was made, identify all records and documents relating to the verification of the validity of this assumption. Such documents should include, but are not limited to, reports of calculations involving the change in the average separation between racks during seismic activity.

RESPONSE TO INTERROGATORY NO. XVII:

Not applicable based on the response to Interrogatory No. XVI.

INTERROGATORY NO. XVIII:

If the assumption discussed in XVI was made, identify all reports and documents relating to the examination of the consequences of this assumption. Such documents should include, but are not limited to, reports of calculations involving the effect of changes in the value of 0.125 inches on rack behavior, including rack velocity, maximum impact loading and maximum fluid coupling loads.

RESPONSE TO INTERROGATORY NO. XVIII:

Not applicable based on response to Interrogatory No. XVI.

INTERROGATORY NO. XIX:

If the assumption discussed in XVI was not made, describe when and where collisions between racks are expected to occur in the time-history analyses.

RESPONSE TO INTERROGATORY NO. XIX:

Collisions occur at corners of racks (nearly always at top of racks where girdle bars are present). Tables in Document 18, Section 6 (Attachment I) , provide a listing of maximum values. Each computer output presents a summary of maximum impact forces occurring on each non-linear

spring element and the time step where it occurs. Documents 15 and 20 (Attachment I) also contain some information dealing with impact forces.

INTERROGATORY NO. XX:

Identify all records and documents containing evidence that sliding and tilting motion will be contained within suitable geometric constraints such as thermal clearances, and that any impact due to the clearances is incorporated.

RESPONSE TO INTERROGATORY NO. XX:

Document 19 (computer outputs) (Attachment I) provides details of the maximum displacements for all racks studied. They are presented in a summary table at the end of the computer printout. Document 18 (Attachment I) also contains similar data in Section 6. All adjacent structures (walls, other racks) are simulated by impact springs (gap elements) which have gaps that reflect the assumed clearances. Other reports providing information on sliding and tilting evaluations include Documents 1, 2, 15, 18, 20, and 31, and Documents B, F, and G (Attachment I).

INTERROGATORY NO. XXI:

What equations of motions were used for the time-history analyses in

the eight degree of freedom model? If the equations of motion were transformed before being solved, give both the original and transformed equations. All parameters in these equations should be fully identified.

RESPONSE TO INTERROGATORY NO. XXI:

Documents 16 and 18 (Attachment I) contain the derivation of the equations of motion. All transformations of subsequent equations (matrix manipulations, etc.) are carried out within the simulation code.

INTERROGATORY NO. XXII:

What is the maximum allowable impact force on a fuel assembly? Identify all records and documents related to the experimental and/or theoretical derivation of this value.

RESPONSE TO INTERROGATORY NO. XXII:

Unknown.

INTERROGATORY NO. XXIII:

Identify all records and documents relating to the damage sustained by a fuel element if the maximum allowable impact force is exceeded.

RESPONSE TO INTERROGATORY NO. XXIII:

Unknown.

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FIRST SET OF INTERROGATORIES
PROPOUNDED TO PACIFIC GAS AND ELECTRIC COMPANY
BY THE SIERRA CLUB

I have assisted in preparing the answers to Interrogatory Nos. I through XXIII. Said answers are true and correct to the best of my knowledge and belief.

JOHN K. McCALL

Subscribed and sworn to
before me this 3rd day
of October, 1986

Nancy J. Lemaster, Notary Public
in and for the City and County
of San Francisco, State of
California

SEAL

My Commission expires April 27, 1990

OFFICIAL SEAL
NANCY J. LEMASTER
NOTARY PUBLIC - CALIFORNIA
CITY & COUNTY OF SAN FRANCISCO
My Commission Expires April 27, 1990

	List of Documents Produced	Interrogatory
1.	NRC Policy Paper on Study on Significant Hazards (SECY-83-337), August 15, 1983	SC-III, XX, V
2.	NRC Guidance Paper on Review and Acceptance of Spent Fuel Storage and Handling Applications, April 14, 1978	SC-XX, V
3.	Report to General Electric Nuclear Energy Programs Division, E. Rabinowicz, (G.E. P.O. 529-CC084X), November 23, 1977	SC-XIII
4.	"Seismic Response of a Free Standing Fuel Rack Construction to 3-D Floor Motion," K. P. Singh and A. I. Soler, Nuclear Engineering and Design 80, 1984, 315-329, January 1984	SC-I, III, V, VIII, XII
5.	"Dynamic Coupling in a Closely Spaced Two-Body System Vibrating in a Liquid Medium: The Case of Fuel Racks," K. P. Singh and A. I. Soler, Proc. of the Third Conference on Vibration in Nuclear Plant-1982, (British Nuclear Energy Society (1983)	SC-III, V, VII, VIII, X, XII
6.	Reracking Meeting Notes, PGandE, December 11, 1985	SC-III, V
7.	Memo on NRC Visit to Joseph Oat Corp., Camden, NJ, PGandE, February 7, 1986	SC-I
8.	Reracking Meeting Notes, PGandE, February 24, 1986	SC-I, III
9.	Telephone Call Record, H. Schierling and D. Jeng (NRC) to E. Connell et al. (PGandE), June 19, 1986	SC-I, III
10.	Telephone Call Record, D. Jeng and C. Herrick (NRC) to E. Connell et al. (PGandE), June 20, 1986	SC-I, III

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	List of Documents Produced	Interrogatory
11.	Structural Evaluation of High Density Spent Fuel Racks for Diablo Canyon - Review Comments, dated February 13, 1986	SC-V
12.	Draft Meeting Notes: Seismic Analysis Review - High Density Fuel Racks, July 3, 1985 (3 copies)	SC-I
13.	Memos from E. Connell/S. Johnson to J. McCall/M. Yan dated June 10, 1985, Re: Licensing (Reracking) Report	SC-I, III
14.	Memo from A. Ariey to R. Shah (Oat), dated August 12, 1985 (Final Version of Item 12)	SC-I
15.	Joseph Oat Corporation Responses to Comments/Questions, undated	SC-III, V, VIII, XII, XIV, XV, XIX, XX
16.	"Information Manual for DYNAHIS (Version for 8DOF Analysis)" Oat STD-28 Rev. 4, March 1, 1986 - (Proprietary) Computer Code listing removed	SC-I, III, VII VIII, XII, XXI
17.	"Planning Study for Experimental Measurements and Analytical Correlations of Fluid Drag of Fuel Assemblies in Fuel Rack Storage Locations," K. P. Singh and T. L. Ng, November 1982	SC-II, VIII, XII
18.	"Seismic Analysis of High Density Fuel Racks for Pacific Gas and Electric for Diablo Canyon Nuclear Power Station," Rev. 3, September 3, 1986, A. Soler, TM #779	SC-I, III, V, VII, VIII, XII, XIX, XX, XXI

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	List of Documents Produced	Interrogatory
19.	Computer Outputs from DYNAHIS simulations for Diablo Canyon a. ee01 j. aa003 b. ee02 k. aa004 c. ee03 l. ac13aa1 d. 3304 m. ac33ab e. ee05 n. ac13ab f. aa001 o. ac33b g. aa002 p. ac33aa h. acorn10 q tt04 i. acorn12 r. tt15	SC-I, III, VIII, XII, XX
20.	J. Oat Corp. responses to comments/questions, Supplment 1	SC-III, V, VIII, XIV, XII, XIV, XV, XIX, XX
21.	Chapter 16, Mechanical Design of Heat Exchangers and Pressure Vessel Components, by K. P. Singh and A. I. Soler, Arcturus Publishing, 1984.	SC-VIII, XII
22.	Verification Runs on DYNAHIS, A. I. Soler, January 29, 1986, Solution of Test Problem #2, Oat Report TM-780.	SC-III, VIII, XII
23.	Joseph Oat Corporation transmittal entitled "Copy of Items Reported in Other Documents,"	SC-III, VIII, XII
24.	Copy of transparencies and notes by K. P. Singh from presentation to NRC in Camden, N.J., February 20, 1986	SC-I, III, VIII, XII
25.	High Density Racks Seismic Analysis Independent Review, M. R. Khan, PGandE, undated	SC-V
26.	J. Oat Corp. Letter to PGandE, May 9, 1986	SC-V
27.	PGandE Memorandum on Spent Fuel Racks - Review of J. Oat's Submittals, November 21, 1985	SC-I

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	List of Documents Produced	Interrogatory
28.	PGandE Meeting Agenda for July 3, 1985	SC-I
29.	PGandE Memorandum, Spent Fuel Pool High Density Racks, Units 1 and 2, January 10, 1986	SC-I, III
30.	J. Oat Corp. responses to issues raised in Sierra Club March 6, 1986 letter, May 5, 1986	SC-III, V
31.	Two memoranda, J. Oat Corp. to PGandE on NRC O.T. Position Paper, undated.	SC-XX
32.	J. Oat Corp. Memorandum to PGandE on Preliminary Calculations, September 3, 1986	SC-V
33.	J. Oat Corp. letter to PGandE, Bridge Plates, April 4, 1986	SC-I
34.	Impact Analysis, undated	SC-III
35.	Sketch from J. Oat Corp. to PGandE, June 18, 1986	SC-I
36.	Telephone conversations between J. Oat Corp. and PGandE, March 8, 1985; March 19, 1985; August 9, 1985	SC-I, III
37.	Affidavit of NRC Consultant, R. Clyde Herrick, June 25, 1986	SC-I, III, VII, XV

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List of Reference Documents (Not Produced)	Interrogatory
A. PGandE Reracking Report, DCL-85-306, September 19, 1986, Section 6	SC-I, III, V, VII, X
B. NRC Safety Evaluation Report, May 30, 1986 Section 4 Appendix A	 SC-I, III SC-I, III, V, VII, X, XV, XX
C. "Friction Coefficients of Water-Lubricated Stainless Steels for a Spent Fuel Rack Facility," E. Rabinowicz, November 5, 1976	SC-XIII
D. "Effect of Liquids on Dynamic Motions of Immersed Solids," R. Fritz, February 1972	SC-III
E. PGandE Letter DCL-86-019, January 28, 1986	SC-I, V, XIV
F. PGandE Letter DCL-86-067, March 11, 1986	SC-XX
G. PGandE Letter DCL-86-108, April 24, 1986	SC-XX
H. A. S. Levy and J. Wilkinson, The Component Element Method in Dynamics, McGraw Hill, 1976	SC-III, VII, VIII through XIII.

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

In the Matter of	)	Docket Nos. 50-275 50-323
PACIFIC GAS AND ELECTRIC COMPANY	)	(Reracking of Spent Fuel Pools)
(Diablo Canyon Nuclear Power Plant Units 1 and 2)	)	

CERTIFICATE OF SERVICE

I hereby certify that on October 3, 1986, copies of the following documents in the above-captioned proceeding have been served on the following by deposit in the United States mail, first class: (1) LICENSEE PACIFIC GAS AND ELECTRIC COMPANY'S ANSWERS TO FIRST SET OF INTERROGATORIES OF THE SAN LUIS OBISPO MOTHERS FOR PEACE, DATED SEPTEMBER 15, 1986; (2) LICENSEE PACIFIC GAS AND ELECTRIC COMPANY'S ANSWERS TO FIRST SET OF INTERROGATORIES OF CONSUMERS ORGANIZED FOR DEFENSE OF ENVIRONMENTAL SAFETY, DATED SEPTEMBER 16, 1986; and (3) LICENSEE PACIFIC GAS AND ELECTRIC COMPANY'S ANSWERS TO FIRST SET OF INTERROGATORIES OF THE SIERRA CLUB, DATED SEPTEMBER 15, 1986. The production of documents associated with the interrogatories have been served on only those indicated by an asterisk.

B. Paul Cotter, Jr., Chairman
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Dated at San Francisco, California, this 3rd day of October, 1986.