ORGANIZATION: BECHTEL POWER CORPORATION
SAN FRANCISCO POWER DIVISION
SAN FRANCISCO, CALIFORNIA

REPORT NO.: 99900522/82-02	INSPECTION DATE(S) 7/12-15/82	INSPECTION ON-SITE HOURS: 51

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PRINCIPAL PRODUCT: Architect Engineering Services

NUCLEAR INDUSTRY ACTIVITY: The total effort committed to domestic nuclear activities is approximately 92% of the 7000 person staff of the San Francisco Power Division. The division currently provides the principal architect engineering services for four domestic units: Limerick 1 and 2, Susquehanna 2, and Hope Creek 1; has project management for completion of Diablo Canyon 1 and 2; has 12 units under a modification/repair/service-type contract; and an engineering evaluation contract with an NSSS supplier.

ASSIGNED INSPECTOR: J. R. Costello — 9/8/82
J. R. Costello, Reactor Systems Section (RSS) — Date

OTHER INSPECTOR(S): Dr. P. T. Kuo, NRC Division of Engineering

APPROVED BY: C. J. Hale — 9/8/82
C. J. Hale, Chief, RSS — Date

INSPECTION BASES AND SCOPE:

A. BASES: 10 CFR Part 50, Appendix B.

B. SCOPE: This inspection was made as a result of concerns expressed to the NRC by a former Bechtel employee regarding the use of a 2D analytical procedure for the hydrodynamic load analysis of the Susquehanna and Limerick facilities.

PLANT SITE APPLICABILITY: The contents of this report relate to the following dockets: 50-352; 50-353; 50-387; 50-388; and 50-354.

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A. VIOLATIONS:

None

B. NONCONFORMANCES:

None

C. UNRESOLVED ITEMS:

None

D. STATUS OF PREVIOUS INSPECTION FINDINGS:

1. (Closed) Unresolved Item (82-01): It is not apparent that the requirements of EDPI-4.64.1 for reviewing and dispositioning quality surveillance reports are functioning properly. Hope Creek Quality Surveillance Report No. 96 required procurement supplier quality action by July 10, 1981. The inspector was unable to obtain any evidence during this inspection that the required action had been completed.

   It was determined that Quality Surveillance Report No. 96 pertained to hardware for Hope Creek Unit 2 which has been put on hold. No further action will be taken unless Unit 2 is reactivated.

2. (Closed) Unresolved Item (82-01): It is not apparent that the requirements for specificity concerning codes and standards contained in EDP-4.49 are being satisfied. EDP-4.49 required that applicable codes, standards and regulatory requirements have the issue and addenda properly identified and that these requirements be met in the design.

   The inspector examined four Hope Creek project specifications and found that specification 10855-A-075(Q) did not specify the issue and addenda of four out of five codes and standards listed, while specification 10855-J-111(Q) did not specify the issue of ANSI N45.2 in effect.

   Specification 10855-A-075(Q), Revision 3, is in the process of being revised for other reasons and will include correction of these discrepancies. Specification 10855-J-111(Q), Revision 0, Section 11.0, references G-002(Q), General Project Requirements for Supplier Programs. Section 2, of G-002, references ANSI N45.2-1971 issue. Therefore, the QA requirements were not compromised. Specification J-111(Q) has been marked up to correct the noted discrepancy on the next revision.

Also, Manager of Engineering Directive MED 4.49-0 has been revised and reissued as revision 13. This revision requires concise identification of codes and standards revision/edition in the technical specification.

E. OTHER FINDINGS OR COMMENTS:

Hydrodynamic Load Analysis - A former Bechtel employee (alleger) raised questions about the adequacy of 2D versus 3D models used in the analysis of Susquehanna and Limerick containments and reactor buildings for hydrodynamic loads.

The 2D model consists of an axisymmetric finite element model for the containment and its supporting rock foundation, and a stick model supplemented by more refined models at local areas for the reactor building. The 3D model consists of a refined model for the superstructures (containment and reactor building) and a half-space model (impedance function) for the supporting rock foundation.

A review of the available documents and discussions with responsible Bechtel personnel revealed that there were merits and shortcomings in both models. Neither of them completely represent physical reality. The alleger's letter and attachment, "Summary of Critique of Enclosure 1 to BLP-23467 Technical Evaluation of 2D and 3D Models," identified the allegers disagreements with the 2D model used. There were eight major points of disagreement summarized in this critique.

1. The 2D model is an axisymmetric model which cannot properly simulate the response of the building to asymmetric loadings, which constitute a major fraction of the total number of load uses for which the structure will be analyzed. No amount of tuning will alleviate this fundamental limitation.

2. At least one 2D model must be developed and tuned for each direction of response. A minimum of three different models will have to be developed to represent the three component responses to each design loading.

3. Tuning a variety of simplistic models to match the results of a given experimental test for a given direction will not assure that for other postulated loadings the results predicted by the models are applicable to the next loading case, unless the models are tuned in a way which is consistent to each of the models. This is practically impossible.

4. It is impossible to tune a single 2D model to properly predict the response in two or three directions simultaneously. For example, the present vertical 2D model developed for the hydrodynamic load evaluation of the Limerick reactor building is valid only for the predictions of vertical responses due to symmetric vertical loadings. It can be used to predict neither the horizontal components of response due to vertical symmetrical loads, nor the horizontal and vertical components of response due to asymmetric loads.

5. Simultaneous computation of two component responses in the reactor building is believed to be important, as the experimental evidence has shown that the horizontal and vertical accelerations are of the same order of magnitude. The behavior of a structure in one direction cannot be ignored at the expense of another if the magnitude of the responses in both directions is of the same order.

6. The 2D model cannot begin to represent the spatial variation in response of the structure at a given elevation. As such, the global response of the structure, which is influenced by the behavior of the floor and wall components of which it is made, is probably not accurate.

7. Since the 2D model is an axisymmetric one, the spatial variation of hydrodynamic loads around the circumference of the containment cannot be modeled. Instead, either the measured pressures along a given azimuth of the containment pool are effectively applied to the total circumference of the pool, or an "averaged" value of the instantaneous pressure distributions must be calculated and applied.

8. The 2D model cannot transmit the high frequency accelerations that the 3D model can. Estimates of the valid range of frequency fall between 10-15 H_z for the 2D and 45-50 H_z for the 3D. The 2D model must be "tuned" for a wider range of frequencies.

It was found that most of the disagreements expressed above would have been valid if the 2D model had been used throughout for all loading cases. However Bechtel's documents demonstrated that different models had been used for asymmetric load cases and for containment analysis.

Bechtel documented their position concerning this matter in two documents, "Reasons for Selecting 2D Model Over 3D Model" and "Discussion of the Critique of Technical Evaluation of 2D and 3D Models." Both of these documents were dated July 20, 1982, and were submitted for NRC review following this inspection. The first document commented on the rationale for using the 2D model and the second document commented on the alleger's critique, point by point. Bechtel indicated that the 2D model in question was only used for the analysis of vertical responses of the reactor building to axisymmetric loads. It was never used for other purposes, such as horizontal components of response to vertical symmetric or asymmetric loads.

Item 4 of the alleger's critique, listed above, stated that "the present vertical 2D model developed for the hydrodynamic load evaluation of the Limerick reactor building is valid only for the prediction of vertical responses due to symmetric vertical loadings." In fact, this was exactly what the model was used for and no other purpose.

With respect to Item 5 of the alleger's critique, it was found to be valid in view of the inplant test measurements that showed the horizontal and vertical accelerations were of the same order of magnitude. The 2D model used cannot predict the horizontal responses as measured. As described in the same Bechtel documents above, however, the effect of this discrepancy on the final design is likely insignificant considering the relative magnitude of the other components of the design load.

In summary, it is believed that the 2D model along with a 3D model used for the containment and more refined models used for local areas in the reactor building, represents a reasonably adequate approach for design purposes.

It was also alleged that a paper entitled, "Three Dimensional Analysis of Reactor Building and Containment Structures for Hydrodynamic Loads," was submitted to the ASME Winter Annual Meeting and was subsequently withdrawn at the request of PP&L. A letter from PP&L to Bechtel's Project Engineer for the Susquehanna project, dated July 13, 1981, was reviewed. It revealed that the denial of the request to publish the said paper was based on the PP&L's company policy. No technical controversies were involved in that decision.

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ATTENDANCE LIST

COMPANY: Bechtel Power Corp / SFPD DOCKET NO. 99900522

Date: 7/13/82 [X] Pre-Inspection Conference [ ] Post Inspection Conference

NAME (Please Print)	TITLE (Please Print)	ORGANIZATION (Please Print)
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PERSONS CONTACTED

Company Bechtel Power Corp/SFPD

Dates 7/12-16/82

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Inspector J. R. Costello/Dr. P. T. Kuo

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NEIL J TUHALSKI	ENGR SUPERVISOR	" CIVIL LIMERICK
W. S. TSENG	Civil/structural staff	Bechtel - SFPD

Inspector J.R. Costello/P.T. Kuo

Scope/Module 927048

Docket No. 99900522

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DOCUMENTS EXAMINED

1	2	TITLE/SUBJECT	3	4
1	7	Mark II Containment - Adjacent Structure Analyses, Limerick Generating Station - ~~D.M. O'Connor~~ R.H. Elias, Bechtel/SEPD to R.A. Mulford, Philadelphia Electric Co.	5/9/80	-
2	7	Transmittal of Review Comments on Dynamic Modelling of Susquehanna Containment And Reactor And Control Buildings For Hydrodynamic Loads R.P. Kennedy, Structural Mechanics Associates to Dr. G. Abrahamsen Stanford Research International.	12/31/80	-
3	7	Mark II Containment Adjacent Structure Analysis 3D Model Limerick Generating Station - R.H. Elias Bechtel/SEPD to R.A. Mulford Philadelphia Electric Co.	4/8/81	-
4	8	Presentation to Philadelphia Electric Company on use of 2D Model versus 3D Model Adjacent Structure Analysis	4/17/81	-
5	8	Correlation of FESS (Finite Element Soil Structures) Analyses And In-Plant Tests - Limerick Project	5/81	-
6	8	BWR MK-II Adjacent Structure System Hydrodynamic Analysis Limerick Generating Station.	4/30/81	-

Document Types:
1. Drawing
2. Specification
3. Procedure
4. QA Manual
5. Purchas Order
6. Internal Memo
7. Letter
8. Other (Specify-if necessary)

Columns:
1. Sequential Item Number
2. Type of Document
3. Date of Document
4. Revision (If applicable)

Inspector J.R. Costello / P.T. Kuo

Scope/Module 92706B

DOCUMENTS EXAMINED

Docket No. 99900522

Report No. 82-02

1	2	TITLE/SUBJECT	3	4
7	7	Hydrodynamic Load Analysis for the Limerick/Susquehanna Power Stations - A.E. Unemori, Advanced Structural Dynamics to G. Bagchi, USNRC.	11/20/81	—
8	8	Limerick Inplant Dynamic Field Testing.	2/82	—
9	8	Critique Of Enclosure I To BLP-23467 Technical Evaluation Of "2D" & "3D" Models - Alan Unemori.	6/8/81	—
10	7	Susquehanna Steam Electric Station Release of Technical Papers For Publication, T.M. Crimmins, Jr Pennsylvania Power & Light Co. to E.B. Poser Bechtel Power Corporation.	7/13/81	-
11	7	Proposed Technical Paper "Three-dimensional analysis of reactor building and containment structures for hydro dynamic loads."	6/5/81	-
12	8	Meeting Minutes No. 1489 - 3D Model of Reactor/Control Building.	11/12-13/80	-
13	8	Civil Section Manpower Assignment; May 23, 1980 to Oct 23, 1982; issued monthly	—	—

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Inspector J.R. Costello/P.T. Kuo

Scope/Module 92704B

DOCUMENTS EXAMINED

Docket No. 99900522

Report No. 82-02

1	2	TITLE/SUBJECT	3	4
14	7	B.N. Pusheck to E.B. Poser and W. McDaniel, Subject 3D Versus 2D Model	7/26/82	—
15	8	Attachment to B.N Pusheck memo dated 7/26/82, entitled "Reasons for Selecting 2D Model over 3D Model"	7/20/82	—
16	8	Attachment to B.N. Pusheck memo dated 7/26/82, entitled "Discussion of the Critique of Technical Evaluation of 2D and 3D Models."	7/20/82	—

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