TORREY PINES TECHNOLOGY
P.O. Box 81608
San Diego, California 92138
Telephone: (714) 455-2654

A DIVISION OF GENERAL ATOMIC COMPANY

GEORGE L. WESSMAN
Director

March 24, 1982

Mr. D. J. Fogarty
Executive Vice President
Southern California Edison
P. O. Box 800
Rosemead, CA 91770

Dear Mr. Fogarty:

In our March 16th meeting two questions were raised by the NRC staff that I did not answer. The answers are as follows:

1) How does the use of a factor of 2.5 instead of 1.5, as raised in PFR-F032, account for both D (dead load) and L (live load)?

Answer: f = E'+D+L

= (D+L) a'+D+L where a' = seismic acceleration = 1.5g

= (D+L) 2.5

and D+L = 56lbs/ft

2) Why aren't the calculations for the OBE reviewed?

Answer: As indicated in the program plan and during the NRC review meetings in San Diego, the design review under TASK C is a selective review which is added to the reviews done in TASK B and TASK A to arrive at the comprehensive assessment of the seismic design. The selection criteria used for TASK C in general indicated review of the design for the SSE, not the OBE In certain cases where the OBE was clearly governing it was reviewed in addition to the SSE. However in this case, the design criteria specifically excludes the OBE since the SSE requirements are more stringent for the cable tray support design.

Sincerely,

George Wessman /lk

George L. Wessman
Project Manager

cc: Jack Adrian

1.0 INTRODUCTION & CRITERIA

THE BASIC CRITERIA AND METHODS OF ANALYSIS USED FOR ANALYZING THE SONGS 2 & 3 CONTAINMENT STRUCTURE ARE PRESENTED IN CALCULATION PACKAGE C-257-1.01. THE ASHSD MODEL HAS BEEN DESCRIBED IN THAT PACKAGE. THIS CALCULATION PACKAGE CONTAINS CALCULATIONS FOR DETERMINING THE 'DYNAMIC SOIL MODULUS' TO BE USED IN THE SEISMIC ANALYSIS USING THE ASHSD 'SMALL GRID' COMPUTER MODEL.

THE COMPUTER MODEL HAS BEEN DESCRIBED IN C-257-1.01, SECTION 3.0. THE ANALYSIS WAS DONE USING THE ASHSD CODE'S 'DYNAMIC RESPONSE ANALYSIS' CAPABILITY. THE ANALYSIS GIVES THE MAXIMUM STRUCTURAL RESPONSE DUE TO HORIZONTAL AND VERTICAL EXCITATIONS.

TO DETERMINE THE STRESSES IN THE STRUCTURE, THE NODAL FORCES & MOMENTS DUE TO HORIZONTAL & VERTICAL EXCITATIONS WERE ADDED. THIS PROCEDURE RESULTS IN UPPER BOUND FORCES & MOMENTS. SINCE THE VALUES THUS OBTAINED DO NOT HAVE A POSITIVE OR NEGATIVE SIGN, SIGNS WERE ASSIGNED TO THESE FORCES & MOMENTS TAKING INTO CONSIDERATION THE SIGNS ASSOCIATED WITH THE FIRST MODE RESPONSE DUE TO HORIZONTAL EXCITATION. (THE SRSS RESPONSE UNDER HORIZONTAL SEISMIC EXCITATION IS GREATER THAN THAT OF THE VERTICAL SEISMIC EXCITATION. ALSO, THE PARTICIPATION FACTOR OF THE FIRST MODE IS SIGNIFICANTLY GREATER THAN THE HIGHER MODES. THUS, USING SIGNS ASSOCIATED WITH FIRST MODE RESPONSE UNDER HORIZONTAL EXCITATION PROVIDES A REASONABLE APPROXIMATION).

COMPUTER RUNS USED IN DESIGN:

DBE	HORIZ.	F5742B6S	(E_s = 795 KSF)
"	VERT.	F694B20	(E_s = 627 KSF)
OBE	HORIZ.	F958B6N	(E_s = 1092 KSF)
"	VERT.	F964B6X	(E_s = 886 KSF)

2408 PFR NO. F 024

REVISION A F024A

POTENTIAL FINDING REPORT
SONGS 2&3 SEISMIC DESIGN VERIFICATION

A. PREPARATION BY GA INITIATOR

AFFECTED ITEMS:

Piping Analysis for Segments 82, 78

REQUIREMENT REFERENCE DOCUMENTS:

Bechtel's PIPM Section 14.8, Filing, (Rev. 10 date 3-9-81)

A - SONGS FSAR 14.2.1 Prerequisite (to startup testing)

BASIC REQUIREMENT:

The original of completed calculations will be retained in the Project Calculation file.

A - Systems shall be complete and verified prior to startup testing.

DESCRIPTION OF POTENTIAL FINDING:

The original of 78 and 82 were not in the files.

A - Bechtel's comment, C, states that PSG 78 and PSG 82 calculations are under revision by responsible engineer. The calculations do not meet the basic requirement.

PREPARED BY: H C Hopkins DATE: 2-19-82 (Task B Procedural Review)

REJECTION OF GA TASK LEADER COMMENTS BY: ____________ DATE: ________

REJECTION OF ORIGINAL DESIGN ORG. COMMENTS BY: ____________ DATE: ________

B. REVIEW BY GA TASK LEADER COMMENTS

In addition to the Bechtel comments their letter of 3/19/82 states they are revising the calculations as a result of the Load Verification Check. While this work is being done in accordance with procedures the nature of the revision seems to violate the Basic Requirement of "complete + verified prior to startup." JB 3/19/82

☒ AGREE PF IS VALID BY [signature] DATE 2/24/82

☐ REQUEST RE-REVIEW BY ____________ DATE ________

☐ DISAGREE BY ____________ DATE ________

☒ REVIEW OF ORIGINAL DESIGN ORGS. COMMENTS BY: [signature] DATE: 3/19/82

C. REVIEW BY ORIGINAL DESIGN ORGANIZATION — COMMENTS

The subject calculations were completed by originator and checker prior to system startup. Group Leader and EGS were amiss in not signing in a timely manner.

☒ AGREE PF IS VALID

☐ DISAGREE

BY: Fred B Ward DATE: 3/11/82

D. RECOMMENDATION BY FINDINGS REVIEW COMMITTEE

DEFINITION ADEQUACY:	☒ ADEQUATE	☐ INADEQUATE
VALIDITY:	☒ VALID	☐ INVALID
CLASSIFICATION:	☒ OBSERVATION	☐ FINDING

JUSTIFICATION:

CLASSIFICATION CRITERION NO. RESULTING IN "FINDING" ________

COMMENT ON "OBSERVATION" CLASSIFICATION

Minor procedural violation

BY: S. L. Koutz DATE: 3/22/82

E. GA PROJECT MANAGER

☒ ACCEPT

☐ REJECT

BY: [signature] DATE: 3/24/82

IMPACT ASSESSMENT

2408 PFR NO. F024A

AFFECTED ITEM: Piping Analysis for Segments 78, 82

1. IS THERE THE POTENTIAL FOR REDUCING DESIGN MARGINS TO THE EXTENT DESIGN ALLOWABLES ARE EXCEEDED OR DESIGN REQUIREMENTS ARE NOT MET?

   N/A

2. IS THERE THE POTENTIAL THAT THE ITEM MIGHT FAIL OR ENDANGER OTHER ITEMS DURING AN SSE?

   N/A

3. COULD THE FAILURE OF THIS ITEM DURING AN SSE CREATE A SUBSTANTIAL SAFETY HAZARD?

   N/A

4. COULD THE PROCEDURAL VIOLATION CREATE A SUBSTANTIAL SAFETY HAZARD?

   Unlikely

5. ARE OTHER SIMILAR DEVIATIONS LIKELY TO EXIST?

   Yes, see PFR F097

6. OTHER COMMENTS: The procedural violation is caused by an overcheck by Bechtel, see Attached telecopies (3/16/82, Part B and 3/19/82). This overcheck activity is not covered by Bechtel procedures but should enhance safety.

PREPARED BY: W C Hopkins Jr DATE: 3-22-82

COMMENTS:

BY: J. Barnd DATE: 3/24/82

PFR F024A

General Atomic Company

QUALITY ASSURANCE DEPARTMENT

Record of Long Distance Telephone Call

Party: Called ☐ Calling ☐

Date: 3-12-92

Time: Completed 1100

Started 1050

On-line 10 min

Name Mith Mitchhart

Company Bechtel

Location Whittier

Telephone No: A/C 213 No. 946 1819 x352

Discussion Re: PFR F024A Impact Assessment

Line Busy NH

1. F024A - Calculations under revision - Hopkins reviewed Impact Assessment to assure that Bechtel's verbal description of the nature of the revisions was ~~actual~~ accurately summarized.
— Mitchhart agree.

Other Items Re PFR F056 & F097.

2. Comments and disposition ~~F097~~ F024A also apply to F097. Bechtel will not make an additional reply.

3. F056 - The PFR review ~~commented~~ committee questioned the invalidation of F056 on the basis that the Bechtel signature authorization List did not explicitly state that a single individual may sign once for EGS + PE.
— Bechtel declined to provide additional data.
Hopkins is recommending that F056 be an observation

Record Made by H C Hopkins

Distribution: Bresnick, Sharmahd, Larcher

PFR F024A

General Atomic Company

QUALITY ASSURANCE DEPARTMENT

Record of Long Distance Telephone Call

Party: Called ☒ Calling ☐

Date: 3-12-82

Time: Completed 8:20

Started 8:15

On-line 5 min

Name Mitch Mitchhart

Company Bechtel

Location Whittier

Telephone No: A/C 213 No. 946 1819 x352

Discussion Re: PFR F097, Also PFR F024A

Hopkins 1. Had Bechtel responded to concern that calculation were being revised at this late date?

Mitchhart 2. Bechtel is preparing a response ~~but~~ and it is expected to be completed soon. Bechtel understands Hopkins' concern.

3. Mitchhart will tell Hopkins as soon as the Bechtel management prepares a response.

Record Made by H C Hopkins

Brernick Shamnabd Laushais

2408-PFR-F027

General Atomic Company

QUALITY ASSURANCE DEPARTMENT

Record of Long Distance Telephone Call

Party: Called ☒ Calling ☐

Date: Feb 17, 1982

Time: Completed 8:40

Started 8:05

On-line 35 min

Name Mitch Mitchhart

Company Bechtel

Location Whittier - SONG Project Office

Telephone No: A/C 213 No. 946 1819 x 352

Discussion - Review of facts, procedures and disagreements on subject PFR's F020, 23, 24 25, 26, & 27. per GA Project Procedure #9 (1-19-82)

F020 - Mitchhart to check why stated Qual. Class I procedures should not apply.

F023 - Right of Chief Mechanical Engineer to change PIPM procedure and responsibility by memo only. No written authority cited. Contrary statements in Section 1 of PIPM. No resolution

F024 - Calculation revision at this Late date. - verbal assurances that these were minor clear-up of calculations. No resolution

F025 - Internal revisions not shown on title sheet Agreed that final approval covered these

F026 - not required form and Incomplete sheet Labling - agreed that Labling not per PIPM on some sheets. Considering Manual change.

F027 - Page numbering form and intent not followed. Procedures do not forbid present practice but create potential weakness - actual practice needs to be stated so improvement - GA may be instituted

Record Made by N C Hopkins

Distribution: J. Sharmahd, B. Larcher, S Brenick

Sent 2:20
3/16/82

TO: Mr. Fred Marsh
Bechtel Power Corp.
Telecopy: 213/946-1644

FROM: Mr. George Wessman
Torrey Pines Technology
Telecopy: 714/455-2132

We are requesting the following information:

A. In response to PFR-F073 related to the three subject junction boxes and GA comment on the inadequacy of attachment to structural steel supports, Bechtel has stated that the rigidity is shown to be adequate, etc. as shown by their calculations.

1. We need copies of Bechtel calculations related to the adequacy of supports for the following junction boxes.

   a. 2XB5RZTD03
   b. 2BB4RZTB03
   c. 2AB5RZTB03

B. To aid evaluation of PFR's please send documentation that describes the nature of the current revisions and completion date for the calculations that are identified in PFR F024A and F097. This documentation should describe current revisions to piping analysis for segments 78 and 82 and pipe support analysis for 167, 203, 826, 152, 200, 52, 116, 178, 93, 77, 466 and 146.

This documents a verbal request to M. Mitchhart. If practical, suggest documents be telecopied to GA to the attention of H. C. Hopkins.

RGW:cc

RECEIVED
MAR 19 1982

Bechtel Power Corporation

Engineers — Constructors

12400 East Imperial Highway
Norwalk, California [illegible]
Mail Address
P.O. [illegible], LOS ANGELES, CALIFORNIA 90060
Telephone [illegible]

F/ 24

March 19, 1982
Log BL-7035

Mr. George Wessman
Director of Torrey Pines Technology
Post Office Box 81608
San Diego, California 92138

Subject: Southern California Edison Company
San Onofre Nuclear Generating Station, Units 2 & 3
Bechtel Job 10079
TPT Independent Review of SONGS 2 & 3 Seismic
Design
File: S023-722-[illegible]

Dear Mr. Wessman:

The following is in response to your item "B" of the Telecopy request for information on March 16, 1982. Please see that this information is given to R. C. Hopkins as soon as possible.

Current revisions to the calculations cited in item "B" is being done to document the activity of our task force who went through each start-up system and did a load verification check.

[illegible]e results of this activity required that the calculations be revised [illegible]o evaluate the effect of load increases. This evaluation has required only three changes to the supports data previously produced. This change was documented on a Deficiency Evaluation Report and is currently under a significance assessment review. This task force activity was part of an on going verification program initiated by Bechtel.

Response to your item "A" will follow later.

Very truly yours,

BECHTEL POWER CORPORATION

F. W. Marsh

F. W. Marsh
Project Engineer
Los Angeles Power Division

CEM:dds

cc: Mr. J. J. Adrian, SCE

PFR NO. [illegible]
REVISION F055 A

POTENTIAL FINDING REPORT
SONGS 2&3 SEISMIC DESIGN VERIFICATION

A. PREPARATION BY GA INITIATOR

AFFECTED ITEMS: Control Room Panels 2L-71 and 3L-71

REQUIREMENT REFERENCE DOCUMENTS: Quality Class II Specification for Quality Class II Panels, Relays, and Devices for the Southern California Edision Company San Onofre Generating Station, Units 2 and 3, San Onofre, California. Specification Number SO23306-1, SCE Number 3274, July 31, 1975.

BASIC REQUIREMENT: All SEismic Class I equipment must be qualified by analysis or test for the maximum design loading conditions to which it may be subjected.

DESCRIPTION OF POTENTIAL FINDING: Addendum No. 2 to the referenced specification identifies equipment to be supplied by the vendor for field modifications by the Purchaser. Field modifications identified on the drawings do not provide for use of all such equipment, but and do identify some open spaces. There is no requirement that the panel be qualified for all equipment that could be used on the panel during all future field modifications.

PREPARED BY: A. Schwartz *A. Schwartz* DATE: 3/22/82

REJECTION OF GA TASK LEADER COMMENTS BY: ________ DATE: ________

REJECTION OF ORIGINAL DESIGN ORG. COMMENTS BY: *A. Schwartz* DATE: 3.22.82

B. REVIEW BY GA TASK LEADER

COMMENTS

Of the 4 concerns identified in the original PFR, 3 have been resolved by BPC's response and recommended to be invalidated. The remaining concern is the subject of this revision

☑ AGREE PF IS VALID BY *[signature]* DATE 3/23/82

☐ REQUEST RE-REVIEW BY ________ DATE ________

☐ DISAGREE BY ________ DATE ________

☑ REVIEW OF ORIGINAL DESIGN ORGS. COMMENTS BY: *[signature]* DATE: [illegible]

PFR NO. ____

REVISION A

C. REVIEW BY ORIGINAL DESIGN ORGANIZATION COMMENTS

Based on the information supplied by the original design organization that these panels were qualified for the equipment in place at the current time, and there is no requirement to qualify the panels for future modifications which may or may not occur, this PFR may be considered invalid.

A [signature] 3/23/82

☐ AGREE PF IS VALID

☐ DISAGREE

Concur with the recommendation to invalidate this PFR.

[initials] 3/23/82

BY: ____ DATE: ____

D. RECOMMENDATION BY FINDINGS REVIEW COMMITTEE

DEFINITION ADEQUACY:	☒ ADEQUATE	☐ INADEQUATE
VALIDITY:	☐ VALID	☒ INVALID
CLASSIFICATION:	☐ OBSERVATION	☐ FINDING

JUSTIFICATION:

CLASSIFICATION CRITERION NO. RESULTING IN "FINDING" ____

COMMENT ON "OBSERVATION" CLASSIFICATION

BY: S. L. Koutz DATE: 3/23/82

E. GA PROJECT MANAGER

☒ ACCEPT

☐ REJECT

BY: [signature] DATE: 3/24/82

PFR NO. 2408-PFR-F038

REVISION ____________

POTENTIAL FINDING REPORT
SONGS 2&3 SEISMIC DESIGN VERIFICATION

PREPARATION BY GA INITIATOR

AFFECTED ITEMS: Control Room Relay Panels 2L-71 and 3L-71

REQUIREMENT REFERENCE DOCUMENTS: Quality Class II Specification for Quality Class II Panels, Relays, and Devices for the Southern California Edison Company San Onofre Generating Station, Units 2 & 3, San Onofre, California. Specification Number SO23-306-1, SCE Number 3274, July 31, 1975.

BASIC REQUIREMENT: All Seismic Class I equipment must be qualified by analysis or test.

DESCRIPTION OF POTENTIAL FINDING: Paragraph 4.6.3.5 of the referenced specification states that the Purchaser will determine the specific panel configuration to be tested and will supply a representative sample of panel mounted equipment to be included in the panel test program.

1. There is no requirement or information furnished to assure that qualification of the representitive equipment can be extended to cover all Seismic Category 1 equipment in the panel.
2, For the resistor sub-panels specified in Section 4.8.6 of Addendum No. 2 of the specification:
) there is no requirement for their qualification as part of the panel 2L071, nor is there

PREPARED BY: J. Rakowski [signature] DATE: 2/25/82

REJECTION OF GA TASK LEADER COMMENTS BY: ____________ DATE: ____________

REJECTION OF ORIGINAL DESIGN ORG. COMMENTS BY: ____________ DATE: ____________

B. REVIEW BY GA TASK LEADER

COMMENTS

☒ AGREE PF IS VALID BY [signature] DATE 2/24/82

☐ REQUEST RE-REVIEW BY ____________ DATE ____________

☐ DISAGREE BY ____________ DATE ____________

☐ REVIEW OF ORIGINAL DESIGN ORGS. COMMENTS BY: ____________ DATE: ____________

C. REVIEW BY ORIGINAL DESIGN ORGANIZATION

COMMENTS

See attached sheet.

Evaluation of BPC's response to this PFR is attached. FBO 3/23

☐ AGREE PF IS VALID

☒ DISAGREE

BY: Fred B Marsh DATE: 3/3/83

D. RECOMMENDATION BY FINDINGS REVIEW COMMITTEE

DEFINITION ADEQUACY: ☐ ADEQUATE ☐ INADEQUATE

VALIDITY: ☐ VALID ☐ INVALID

CLASSIFICATION: ☐ OBSERVATION ☐ FINDING

JUSTIFICATION:

CLASSIFICATION CRITERION NO. RESULTING IN "FINDING" ______

COMMENT ON "OBSERVATION" CLASSIFICATION

BY: ______ DATE: ______

E. GA PROJECT MANAGER

☐ ACCEPT

☐ REJECT

BY: ______ DATE: ______

Description of Potential Findings (Continued)

b) a required maximum in-panel g-level for separate seismic qualification of these panels.

3. There is no requirement in this specification that the vendor mount the representative equipment at the cabinet locations having the highest response for all of the equipment which it represents. Therefore, this vendor could have placed it in a low response region of the structure and met the specification requirements while not properly exciting the equipment.

4. There are no requirements for minimum contact chatter duration to be verified during qualification testing.

References

(Attachments are excerpts from references and have the same number as references)

1. Spec. S023-306-1 dated July 31, 1975 (Sheet 1 of 2)
   Spec. S023-306-1, Add. 2 dated Feb. 2, 1978 (Sheet 1 of 2)

2. Not Used

3. Seismic Qualification of Relay Panels 2L-71 and 3L-71 NMC Control, Inc. - S023-306-1-37-1

4. Procedure for the Seismic Qualification of NMC Control, Inc. (with Field Changes 1) Control Room Relay Panels, 27-71 and 3L-71 - S023-306-1-43-0 Acton Procedure No. 13844

5. Acton Technical Report "Seismic Vibration Analysis of NMC Controls, Inc. Control Room Relay Panels, 2L-71 and 3L-71 (with Field Changes 1)" - S023-306-1-44-0 Acton Report No. 13844

6. "Functional Testing of Components Relay Panels 2L-71 and 3L-71" - S023-306-1-32-0

7. Spec. S023-306-1, Add. 2 SCN E-02 dated 7/18/77

8. Component Layout of Panel Load GRP "B" - S023-306-1-34-6

Responses

1. Attachment 4, Sheet 8 furnishes the basic requirement for Seismic Category I qualification. Attachment 3, Sheet 2 shows the panel mounted equipment that were tested.

   Attachment 8, Sheet 1 and Attachment 7, Sheet 2 shows equipment that are actually mounted on the panels. The tested equipment are identical or similar to those installed on the panels, and are representative of all Seismic Category 1 equipment in the panel test program. Test plan (including specimen for testing) have to be approved by design engineer prior to test.

2. Attachment 4, Sheet 2 and Attachment 7, Sheets 1 and 3 shows that there is such a requirement. Attachment 5 Sheet 1 shows that the resistor panel was included in the analysis.

   Attachment 5, Sheet 4 provides the results of the analysis and tests and shows the G-level for the resistors.

3. Attachment 4, Sheet 7, Sections 2.7 and 2.8 shows that there are requirements for the structure excitation. Attachment 5, Sheet 4 shows that the tested G-levels of the components in the panel at various critical locations are equal to or greater than the response level computed from the analysis.

4. Attachment 6, Sheet 2 provides the basic requirements for verifying relay chatter. Attachment 3, Sheet 3 provides test procedures and criteria for monitoring contact chatter.

Additionally, the relays with the chattering problem are not installed in the safety related sections ("A" and "B") of the panel but are actually installed in the non-safety related section (X) which should be excluded in the qualification test.

[illegible] 3/3/82

I agree with the original design organization that the requirement for resistor sub-panel qualification were adequately specified prior to testing, as was the requirement to test for chatter, and the proper location of as-installed equipment. Thus potential findings 2, 3, and 4 are considered invalid. ~~[illegible]~~

However if potential finding 1 is restated to require that panel qualification consider all equipment, it is valid. See attachment for more detail.

A Schwartz (for J. Rakowski)
3/16/82

Concur with the recommendation to invalidate items 2, 3, & 4 per above. Note that the initiator of the PFR (J. Rakowski) is offsite; processing of this PFR has been re-assigned to A. Schwartz.

[illegible] 3/23/82

Attachment to PFR-F058

The original PFR was based on paragraph 4.6.3.5 of the specification, which states that Purchaser will determine the specific panel configuration to be tested and will supply representative panel mounted equipment to be included in the panel test program. However, the specification also states that the vendor will supply and test all panel mounted equipment. Conversations with the original design organization and documents supplied as part of the response to this PFR and to PFR-059 (which covers the same panels) show the following:

F al

a) The purchaser did not supply representative panel mounted equipment for testing. All equipment was vendor supplied.

b) The purchaser did not determine the specific panel configuration to be tested. All panels were qualified by analysis based on the as-installed equipment locations.

c) The vendor qualification procedure specified that testing was to be performed for chattering. This was done.

d) The vendor requalified the panel in response to Addendum No. 2 and preceeding documents for all equipment installed on the panel in the field, including the resistor sub-panels.

On the basis of a) and b) above, potential finding 3 can be considered invalid . On the basis of c) above, potential finding 4 can be considered invalid. On the basis of d) above, potential finding 2 can be considered invalid.

will be valid - al

As originally written, potential finding 1 can be considered invalid, but al if ~~must be~~ restated to require that the panel qualification consider all equipment which may be mounted on the panel. This is particularly true since these panels are auxiliary and likely to undergo modification with time. Thus, the qualification should have been required to consider equipment on all mounting locations. The qualification procedure and report indicate that the panel was qualified only with the as-installed equipment. Fortunately, this filled up most, but not all, of the panel.

A. Schwartz
3/22/82

PFR NO. 2408-PFP-F083

REVISION

POTENTIAL FINDING REPORT
SONGS 2&3 SEISMIC DESIGN VERIFICATION

A. PREPARATION BY GA INITIATOR

AFFECTED ITEMS: CE Local Panels 2L123, 2L127, and 2L147

REQUIREMENT REFERENCE DOCUMENTS:

IEEE 344-1971 ; Section 3.2.1

BASIC REQUIREMENT: Seismic tests should be performed by subjecting equipment to vibratory motion which conservatively simulates that to be seen at the equipment mounting during a DBE.

DESCRIPTION OF POTENTIAL FINDING:

CE specification 1370 ICE 0005 specifies a 2g input in the range 5 - 35 Hz. CE document CEN-94S shows a summary that the representative cabinet was tested to 1g.

PREPARED BY: J. Rakowski *J Rakowski* DATE: 2/26/82

REJECTION OF GA TASK LEADER COMMENTS BY: ______ DATE: ______

REJECTION OF ORIGINAL DESIGN ORG. COMMENTS BY: ______ DATE: ______

B. REVIEW BY GA TASK LEADER

COMMENTS

☒ AGREE PF IS VALID BY *[signature]* DATE 3/3/82

☐ REQUEST RE-REVIEW BY ______ DATE ______

☐ DISAGREE BY ______ DATE ______

☐ REVIEW OF ORIGINAL DESIGN ORGS. COMMENTS BY: ______ DATE: ______

PFR NO. 2408-MFR-083

REVISION

C. REVIEW BY ORIGINAL DESIGN ORGANIZATION — COMMENTS

The rack was tested to a 2g level (see Foxboro Test Report #1025 Attached). The Foxboro report shows a slight deformation of the rack base and the external base mounting plate occurred during testing of a single rack in the side-to-side direction at 2g's. This would not be expected to occur in installations where two or more racks are joined together side by side. The SONGS racks are joined side-by-side, so this deformation is not expected to occur.

☐ AGREE PF IS VALID

☒ DISAGREE

The SONGS seismic requirements for this equipment are dictated by the plant specific curves #'s SO23-SK-S-695, 696 Rev. A, transmitted in letter #LOG BC-2/3 Southern Cal. Edison to C-E, Response Spectra for Aux. Bldg., 7/24/73. These curves require testing to a 1g level.

BY: V C Hall DATE: 3/15/82

D. RECOMMENDATION BY FINDINGS REVIEW COMMITTEE

DEFINITION ADEQUACY: ☒ ADEQUATE ☐ INADEQUATE

VALIDITY: ☐ VALID ☒ INVALID

CLASSIFICATION: ☐ OBSERVATION ☐ FINDING

JUSTIFICATION:

CLASSIFICATION CRITERION NO. RESULTING IN "FINDING" ____________

COMMENT ON "OBSERVATION" CLASSIFICATION

BY: S. L. Koutz DATE: 3/23/82

E. GA PROJECT MANAGER

☒ ACCEPT

☐ REJECT

BY: [signature] DATE: 3/24/82

PFR No. 2408-PFR-083 (Continued)

Therefore, the seismic documentation required for SONGS 2 & 3 (CEN94S) reported only results to the 1g level. However, the 2g input requirement of the C-E specification was also met by the additional testing at 2g's.

We have evaluated CE's response to this PFR and recommend that the PFR be invalidate (see attachment prepared by A. Middleton). Note that originator of PFR (J. Rakowski) is offsite. Processing of the PFR was re-assigned to A. Middleton.

[signature]

3/22/82

The Foxboro Company
Test Report No. T4-1025
Revision 1
Seismic Vibration Test
of
N-2ES Style A SPEC 200 Rack

- Tested at -
Acton Environmental Testing
Corporation, Acton, Mass.

Date of Test: Aug. 1974
Date of Revision: June 1976

RAR-28

Requested by: J. C. Childs, Dept. 162
F. Riggs, Dept. 368

Report Written by: L. W. Hewey

Reviewed by: J. C. Childs, Staff Engineer
Nuclear Power Products

Tests Conducted by:
L. W. Hewey and J. A. Sears
Senior Test & Evaluation Engineers
Quality Assurance Laboratory
Dept. 163

Approved by: K. G. McCasland, Supervisor
Quality Assurance Laboratory
Dept. 162

INDEX

Revision 1:

(a) Modified Graph Nos. 1 through 48 to Acceleration Ratios vs. Frequency to correct for Seismic Table Variations and Errors in reduction of data.

(b) Changed Model No. to conform to latest Model No. coding (no design change).

F083

1.0 Description of Items Tested

Seismic design, double sided SPEC 200 Rack, Model N-2ES Style A, capable of mounting 19" equipment on both front and back.

2.0 Objective

Determine the effect of seismic vibration on a dummy loaded N-2ES rack.

3.0 Test Procedure

3.1 Stage 1 -- Resonance Search

a. The dummy loaded rack was vibrated at a constant acceleration of 0.5g at 1 octave/min from 1 to 35 Hz in three mutually perpendicular axes. The rack and its load were monitored with triaxial accelerometers located as in Diagram No. 4. Two load configurations were tested in each plane. See Diagram No. 1 for a drawing of both loads.

3.2 Stage 2 -- Sine Beat

a. This test consists of vibrating the rack in three mutually perpendicular axes from 1 to 35 Hz. At each test frequency, sine beats (amplitude modulation of the test frequency) of peak acceleration corresponding to levels shown in Diagram No. 2 are applied such that each beat contains ten cycles of the test frequency.

The test period for each frequency was 10 beats followed by a pause between beats of 10 times the beat period. See Diagram No. 3. The rack was loaded in the unbalanced configuration for all sine beat tests. All tests were monitored with a video tape system.

FE63

4.0 Conclusions and Recommendations

The rack was subjected to a resonant search at 0.5g, 1 to 35 Hz, and to sine beat acceleration of 1.0 and 2.0g peak amplitude applied at the base of the rack.

Test results at the 1.0g level were satisfactory in all respects.

The results indicate that with minor modifications the rack will be suitable for seismic environments of up to 2.0g's for the loading configurations tested.

Slight deformation of the rack base and of the external base mounting plate occurred during testing in the side-to-side direction at 2g's. This would not be expected to occur in installations where two or more racks are joined together side-by-side.

Strengthening of these members may be required. Alternatively, redimensioning the external base mounting plate such that the plate covers the complete base mounting area and moving the outside mounting holes further outward (towards the side of the rack) are suggested for consideration.

Also, the door latching mechanisms proved to be a problem as well as the doors themselves. The latching mechanisms at the top and bottom of the door became bent. Spot welds on the door stiffener broke due to fatigue under vibration, necessitating removal of the doors for the remaining tests.

Other than the above, the integrity of the rack structure, of the mounting hardware for the rack-mounted modules, and of the modules (nests, cards, power supplies) was maintained throughout the test. That is, no slipping or sliding of the rack-mounted equipment or internal mechanical failures of individual modules were noted.

The predominant resonance of the rack in the front-to-back and side-to-side directions occurred at 22 Hz and 13 Hz, respectively, during the resonant search at 0.5g input. There was no obvious resonance in the vertical plane within the 1 to 35 Hz frequency range. The maximum amplification factor as measured at the top of the rack itself was 10, occurring at 13 Hz.

The continuous sine input applied during the resonant search would, of course, be expected to produce greater amplification factors than the sine beat inputs applied at the 1.0 and 2.0g levels.

During the tests at the 1.0g level, the predominant resonant frequencies in the front-to-back and side-to-side directions dropped to 18 Hz and 10 to 11 Hz, respectively. The maximum amplification factor measured at the top of the rack itself was 6 and 8 at these frequencies, respectively. At the rear of a nest located at the top level of the rack, amplification factors of 8.5 (front-to-back) and 10.0 (side-to-side) were obtained.

4.0 Conclusions and Recommendations (Cont.)

Significant amplification factors were also measured at 1.0g input at the rear of a power supply located at the 3rd level front location of the rack. This is the highest position anticipated for location of power supplies in racks for seismic applications. Amplification factors measured were 4.0 (front-to-back, 18 Hz), 6.7 (side-to-side, 11 Hz), and 6.0 (vertical, 22 Hz).

Testing at the 2.0g level produced a marked lowering of resonant frequencies measured on the rack itself. The predominant resonance in the front-to-back direction occurred at 15 Hz with an amplification factor of 6 measured at the top of the rack.

In the side-to-side direction the most significant resonance occurred at 8 Hz with an amplification factor of 5.3 at the top of the rack. On the nest located at the top level of the rack, amplification factors of 6.0 (front-to-back) and 6.5 (side-to-side) were obtained. The maximum amplification factor measured on the power supply was 4.5 (in the Front-to-Back direction).

The damping of the rack was found to be approximately 0.05 during the resonant search and approximately .08 during the sine beat tests at 1 and 2g's.

It should be noted that one rack was subjected to the entire testing sequence (three series of single frequency tests in each of three axis at three acceleration levels). The endurance testing aspect of this sequence of tests should be taken into account in evaluating these test results relative to a short duration seismic event.

5.0 Summary of Test Results

5.1 Resonance Search

a. Vertical Plane

1. Balanced Configuration (refer to Diagram No. 1)

   Refer to Graph No's. 6, 12, 18 & 24

2. Unbalanced Configuration (refer to Diagram No. 1)

   Refer to Graph No's. 5, 11, 17 & 23

b. Horizontal Plane (Front-to-Back)

1. Balanced Configuration

   Refer to Graph No's. 2, 8, 14 & 20

2. Unbalanced Configuration

   Refer to Graph No's. 1, 7, 13 & 19

c. Horizontal Plane (Side-to-Side)

1. Balanced Configuration

   Refer to Graph No's. 4, 10, 16 & 22

2. Unbalanced Configuration

   Refer to Graph No's. 3, 9, 15 & 21

5.2 Sine Beat at 1g

a. Horizontal Plane (Front-to-Back)

Refer to Graph No's. 25, 28, 31 & 34

b. Horizontal Plane (Side-to-Side)

Refer to Graph No's. 26, 29, 32 & 35

c. Vertical Plane

Refer to Graph No's. 27, 30, 33 & 36

5.0 Summary of Test Results (Cont.)

5.3 Sine Beat at 2g's

a. Horizontal Plane (Front-to-Back)

Refer to Graph No's. 37, 40, 43 & 46

b. Horizontal Plane (Side-to-Side)

Refer to Graph No's. 38, 41, 44 & 47

c. Vertical Plane

Refer to Graph No's. 39, 42, 45 & 48

6.0 GRAPH NO. INDEX

Point of Acceleration Measurement	Table Excitation	Graph No. at the following Acceleration Levels 0.5g	1.0g	2.0g
Front Top Center of Rack	F-B	1, 2	25	37
Front Top Center of Rack	S-S	3, 4	26	38
Front Top Center of Rack	V	5, 6	27	39
Center Side of Rack	F-B	7, 8	28	40
Center Side of Rack	S-S	9, 10	29	41
Center Side of Rack	V	11, 12	30	42
Rear of Top Nests	F-B	13, 14	31	43
Rear of Top Nests	S-S	15, 16	32	44
Rear of Top Nests	V	17, 18	33	45
Rear of Power Supply	F-B	19, 20	34	46
Rear of Power Supply	S-S	21, 22	35	47
Rear of Power Supply	V	23, 24	36	48

F083

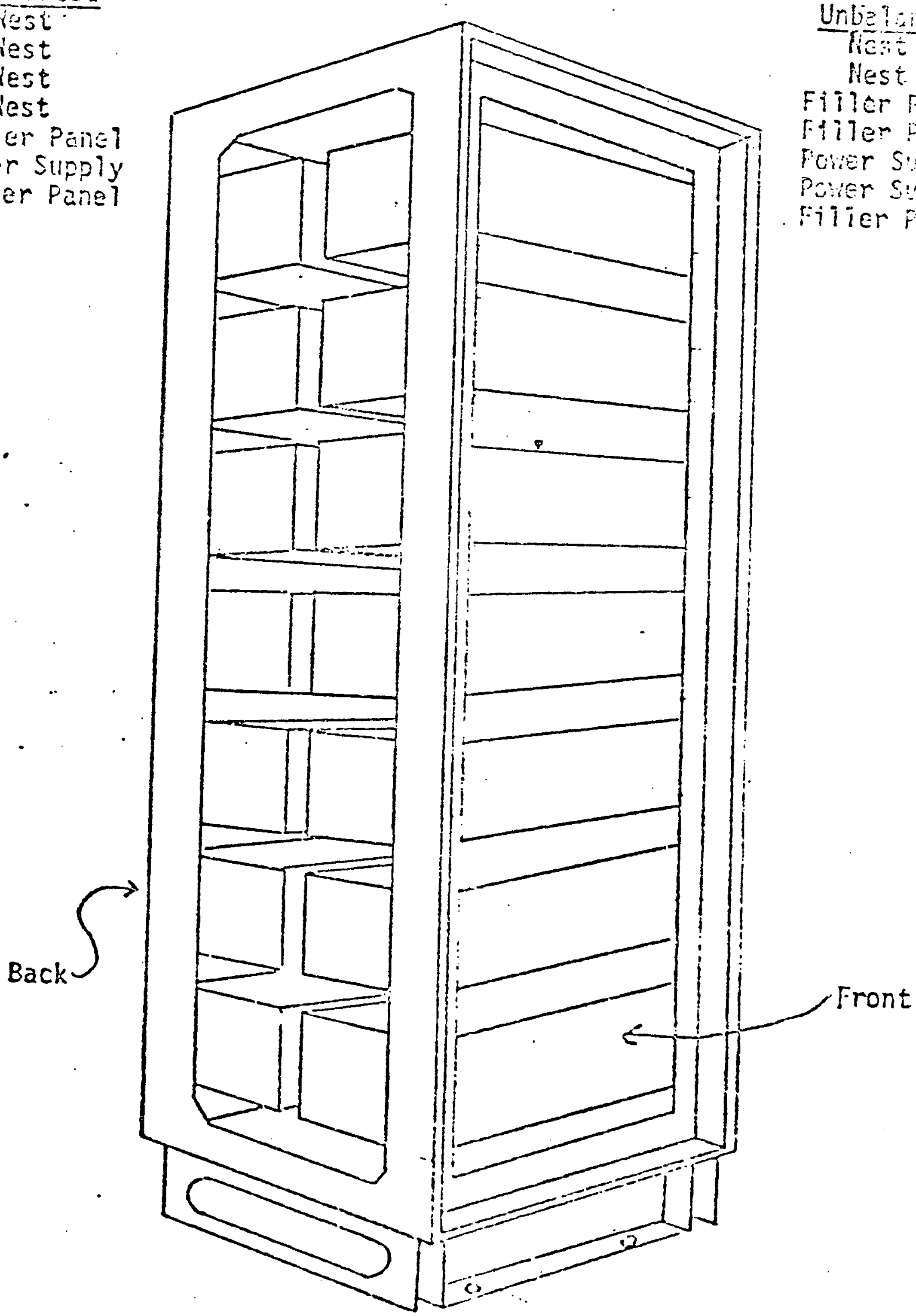
DIAGRAM NO. 1
RACK LOADING CONFIGURATIONS
TEST NO. T4-1025 SEPT. 24, 1974

Back Side Loading Top-to-Bottom

Unbalanced	Balanced
Nest	Nest
Nest	Nest
Nest	Nest
Nest	Nest
Nest	Filler Panel
Nest	Power Supply
Nest	Filler Panel

Front Loading Top-to-Bottom

Unbalanced	Bala[illegible]
Nest	Nest
Nest	Nest
Filler Panel	Nest
Filler Panel	Nest
Power Supply	Filler [illegible]
Power Supply	Power [illegible]
Filler Panel	Filler [illegible]



F083

Attachment to 2408-PFR-F083

CE Specification 1370 ICE 0005 gives "Generic" site seismic requirements for all CE supplied instrumentation and controls.

CE received a set of response spectra for the Auxiliary Building 7/24/73 (transmittal letter No. Log BC-2/3, SCE to CE). The specific curves for the 30' level of the control area of the Auxiliary Building are S0230-SK-S-695, 696, 719 and 720 Revision A (i.e., Node 5).

Per Foxboro Seismic Test Report T4-1025, the panels were tested in August 1974. A resonance search was conducted over the frequency range 1-35 Hz with a constant acceleration input of 0.5g in three axes. The predominant resonance of the panel when vibrated in the front to back mode was 23 Hz, and 13 Hz in the side to side mode. There was no obvious resonance in the vertical plane within the 1 to 35 Hz frequency range. The damping of the rack was found to be approximately 0.05 (i.e., 5%) during the resonant search.

The panels were then tested at 1g (sine beat) over the frequency range 1 to 35 Hz in three axes. The panel and contents performed satisfactorily throughout the 1g test (i.e., no apparent damage of any kind).

Since all of predominant resonances are above 10 Hz, examination of the specific response spectra (S023-SK-S 695 and 696, Rev. A) show the curves for 5% damping are down essentially to the ZPA (i.e., approximately 1g). Thus, the panels have been qualified to operate in this specific location.

Further testing was carried out, with 2g (sine beat) from 1-35 Hz and three axes. During the side to side test, some slight deformation of the panel base occurred. Also, a weld failed on a door stiffener and the top and bottom door latches became bent. The door was removed for the remaining vertical test. Apart from the slight damage, the integrity of the rack structure, of the mounting hardware for the rack-mounted modules, and of the modules (nests, cards, Power Supplies) was maintained throughout the test.

Although there was no redesign of the panels, they are mounted in plant in pairs side by side (i.e., bolted together). They are also bolted to mounting racks in the control room floor.

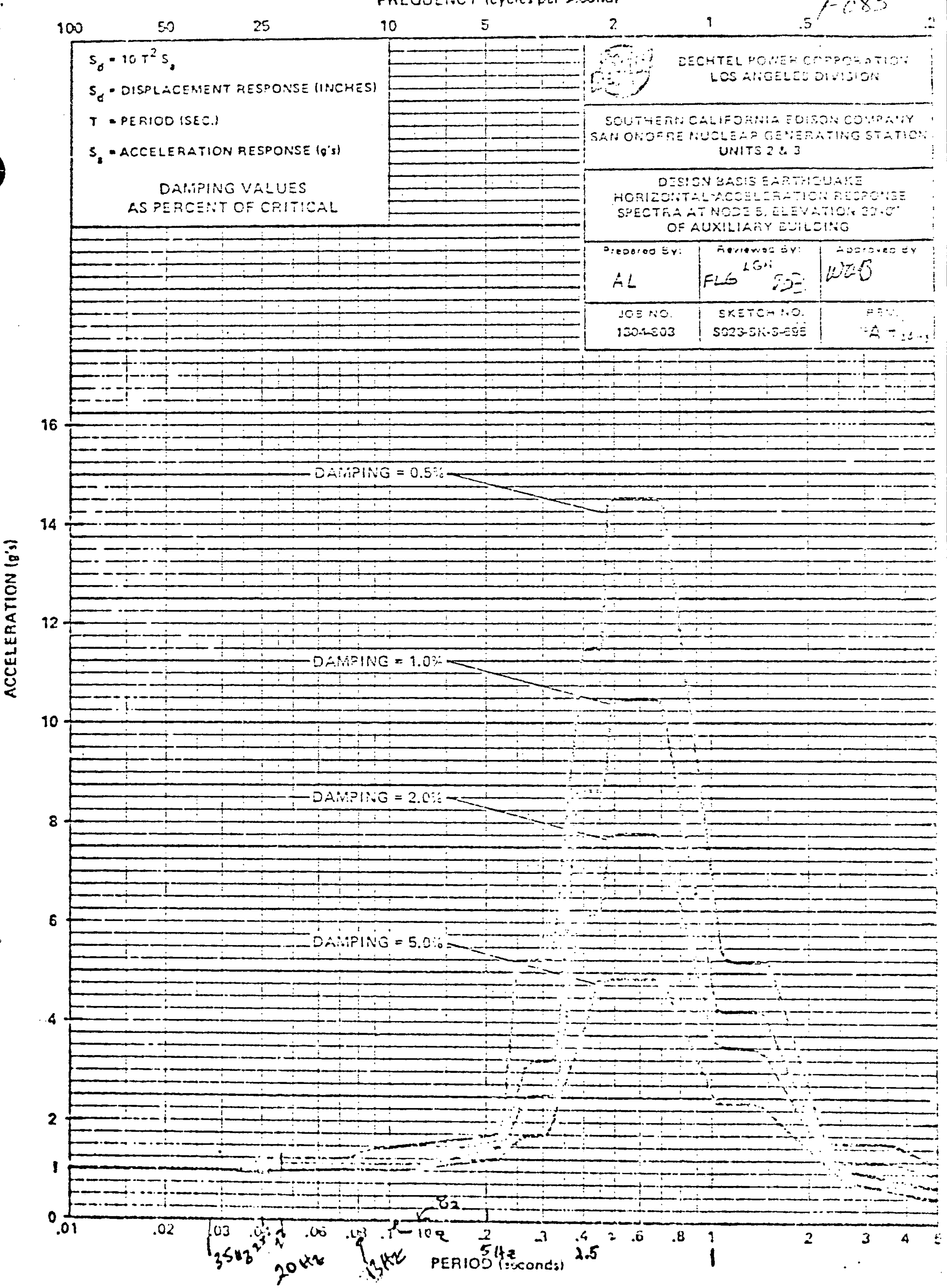
I believe these panels are reasonably conservatively designed for their specific location in the Auxiliary Bldg. Also CE summary document CEN-94S (Data Sheet 6), that these panels are qualified to 1g is correct.

I believe we should declare this PFR invalid.

AM

Alan Middleton 3/22/82

Concur with recommendation to invalidate PFR. [signature] 3/22/82



FREQUENCY (cycles per second)
100
50
25
10
5
2
1
.5
$S_d = 10 T^2 S_a$
S_d = DISPLACEMENT RESPONSE (INCHES)
T = PERIOD (SEC.)
S_a = ACCELERATION RESPONSE (g's)
DAMPING VALUES
AS PERCENT OF CRITICAL
BECHTEL POWER CORPORATION
LOS ANGELES DIVISION
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3
DESIGN BASIS EARTHQUAKE
HORIZONTAL ACCELERATION RESPONSE
SPECTRA AT NODE 5, ELEVATION
OF AUXILIARY BUILDING
Prepared By:
AL
Reviewed By:
FLG
Approved By:
JOB NO.
1304-303
SKETCH NO.
S023-SK-S-695
REV.
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
16
14
12
10
8
6
4
2
1
0
.01
.02
.03
.06
.08
.1
.2
.3
.4
.6
.8
1
2
3
4
5
PERIOD (seconds)
20Hz
13Hz
5Hz
2.5

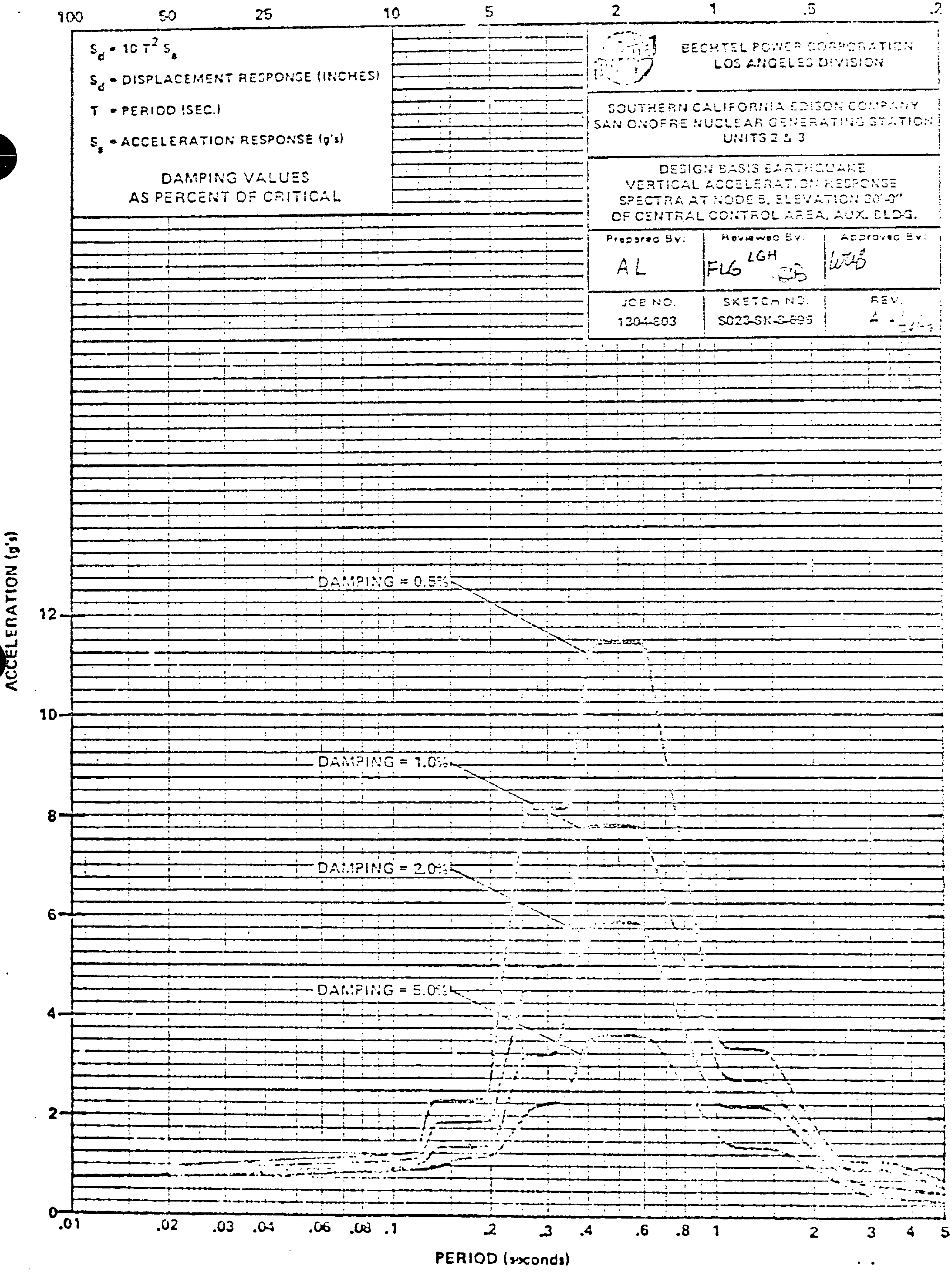
FREQUENCY (cycles per second)

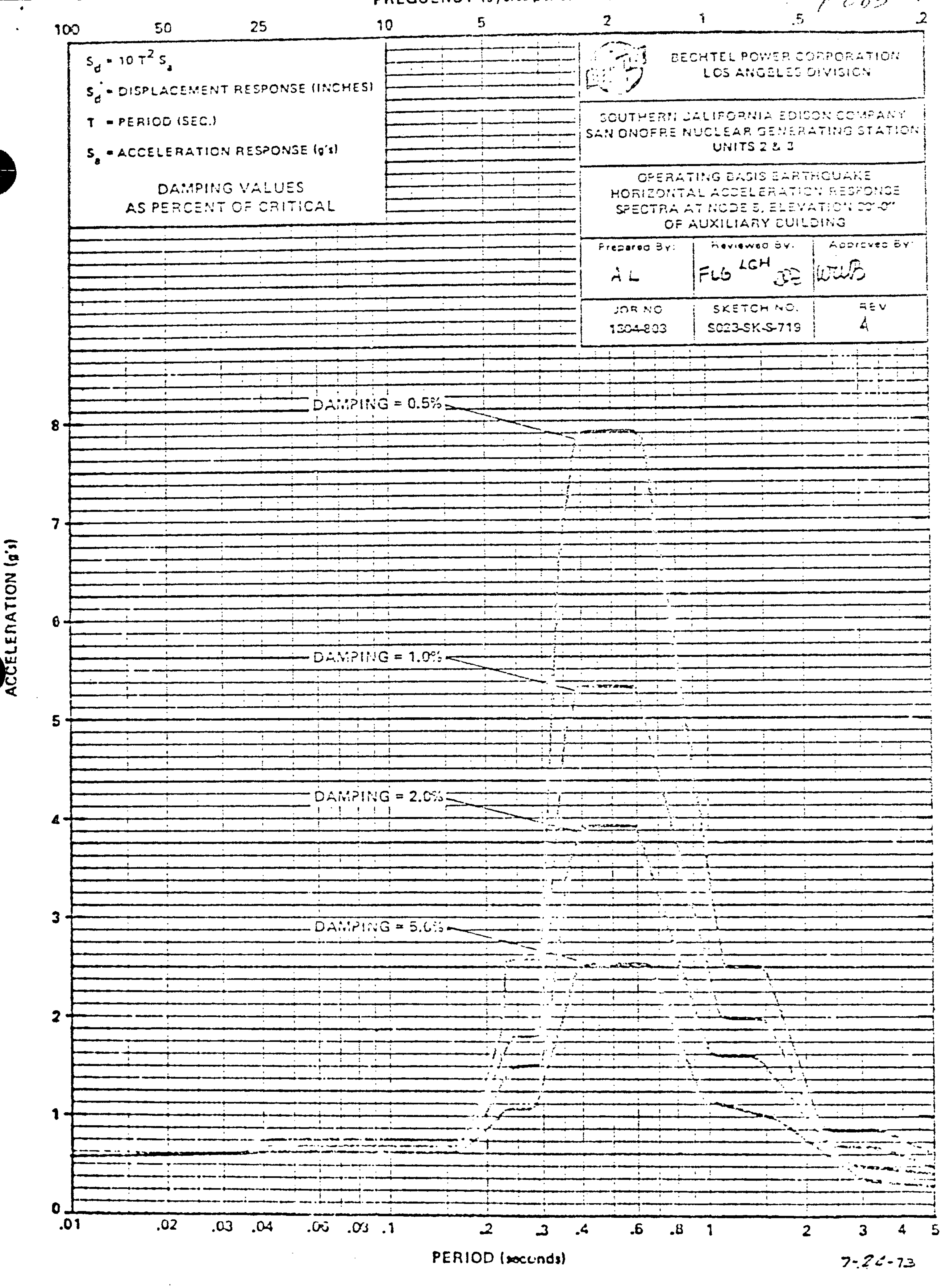
BECHTEL POWER CORPORATION
LOS ANGELES DIVISION

SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3

DESIGN BASIS EARTHQUAKE
VERTICAL ACCELERATION RESPONSE
SPECTRA AT NODE 5, ELEVATION 30'-0"
OF CENTRAL CONTROL AREA, AUX. BLDG.

Prepared By:	Reviewed By:	Approved By:
AL	FLG LGH	
JOB NO.	SKETCH NO.	REV.
1304-803	S023-SK-S-695	




FREQUENCY
100
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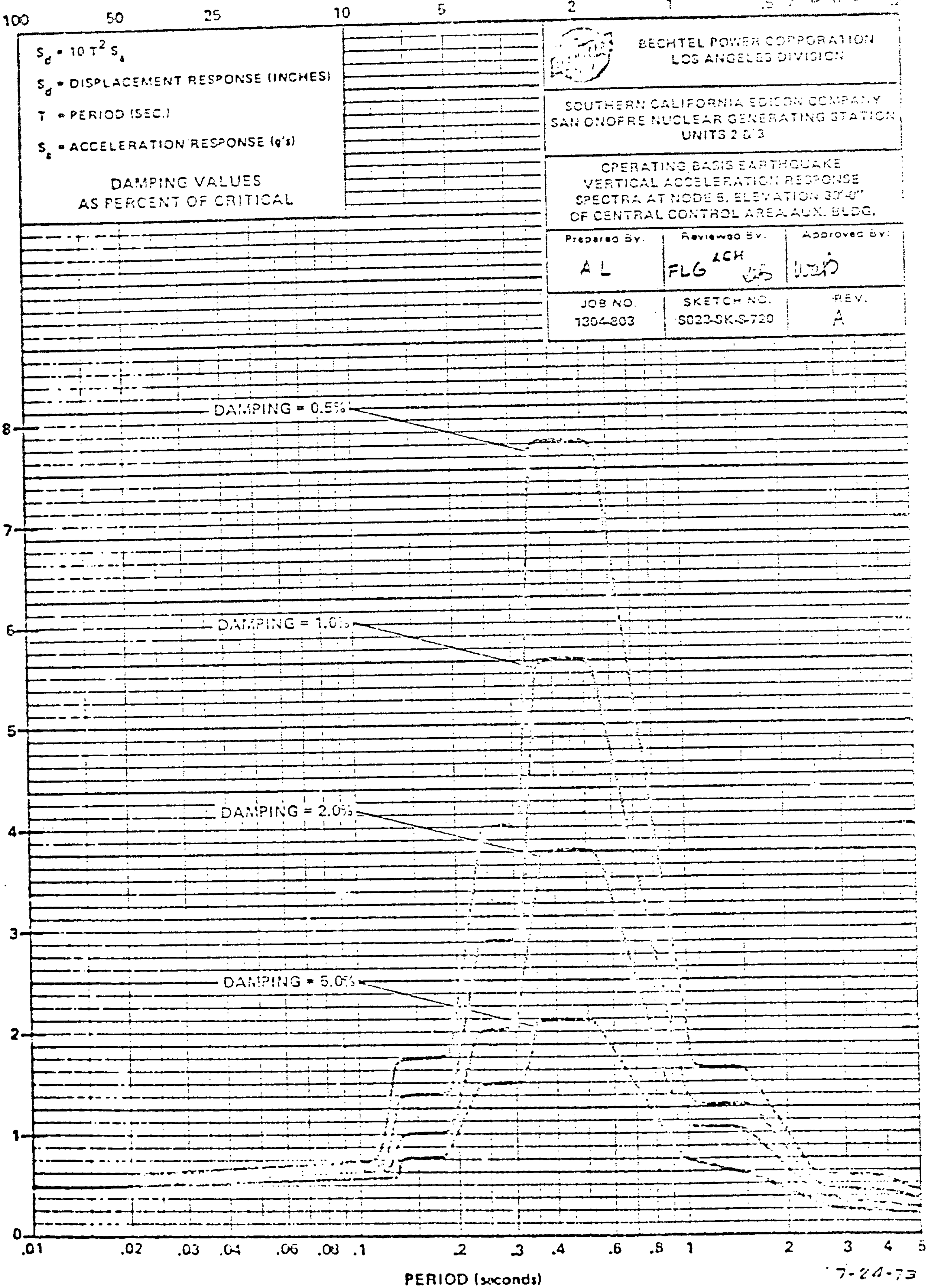
25
10
5
2
1
.5
.2
$S_d = 10 T^2 S_a$
S_d = DISPLACEMENT RESPONSE (INCHES)
T = PERIOD (SEC.)
S_a = ACCELERATION RESPONSE (g's)
DAMPING VALUES AS PERCENT OF CRITICAL
BECHTEL POWER CORPORATION
LOS ANGELES DIVISION
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3
OPERATING BASIS EARTHQUAKE
HORIZONTAL ACCELERATION RESPONSE
SPECTRA AT NODE 5, ELEVATION
OF AUXILIARY BUILDING
Prepared By:
A L
Reviewed By:
FLG LGH
Approved By:
JOB NO
1304-803
SKETCH NO.
S023-SK-S-719
REV
4
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
8
7
6
5
4
3
2
1
0
.01
.02
.03
.04
.1
.2
.3
.4
.6
.8
1
2
3
4
5
PERIOD (seconds)
7-26-73



BECHTEL POWER CORPORATION
LOS ANGELES DIVISION
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3
OPERATING BASIS EARTHQUAKE
VERTICAL ACCELERATION RESPONSE
SPECTRA AT NODE 5, ELEVATION 30'-0"
OF CENTRAL CONTROL AREA AUX. BLDG.
Prepared By: A L
Reviewed By: FLG LCH
Approved By:
JOB NO. 1304-803
SKETCH NO. S023-SK-S-720
REV. A
$S_d = 10 T^2 S_a$
S_d = DISPLACEMENT RESPONSE (INCHES)
T = PERIOD (SEC.)
S_a = ACCELERATION RESPONSE (g's)
DAMPING VALUES
AS PERCENT OF CRITICAL
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
PERIOD (seconds)
100
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7-24-73

GENERAL ATOMIC COMPANY

F083

From: ALAN MIDDLETON Date: 3/20/82

To:

TELEPHONE COMMUNICATION RECORD

(Please hand letter legibly in black or red ink)

Call Initiated by: JAKE WESTOVEN / JOHN SPITZ at GA — Other C.E

Call Received by: ALAN MIDDLETON at GA ✓ Other —

Other Participants: TERRY McNAIR - C.E. PART TIME

Date 3/20/82 Time 10.35am to 11.05am Program Name/No. SCE SEISMIC REVIEW Task or 189 No. 2408 / 24127 / 24123

Subject: SONGS UNITS 2 & 3 SEISMIC REVIEW - PER 2408 - F083. LOCAL PANELS 2L123

Summary C.E PERSONNEL CALLED TO HELP CLARIFY SEVERAL POINTS OF CONCERN ON SEISMIC QUALIFICATION OF SUBJECT PANEL

THE MAIN POINTS ARE TABULATED BELOW:

1. THE EQUIPMENT IS QUALIFIED TO IEEE 344, 1971.
2. C.E DOCUMENT 1370-ICE-0005 "SEISMIC REQUIREMENTS FOR INSTR. & CONTROLS IS A GENERIC DOCUMENT FOR ALL SONGS UNITS 2 & 3 C.E. PROCURED EQUIPMENT.
3. LETTER # LOG SC-2/3 S. CAL. ED. TO C.E (7/24/73) GIVES RESPONSE SPECTRA. C.E INTERPRETES THE SPECIFIC RESPONSE CURVES FOR NODE 5, 30' LEVEL AS REQUIRING TESTING TO 1g.
4. PER TEST RPT. T4-1025 THE TESTING OF THE PANELS WAS PERFORMED AUG. 1974 (i.e. AFTER THE SPECIFIC REQ. WERE CHANGED.
5. THE PANELS FUNCTIONED SATISFACTORYLY WHEN TESTED AT THE 1g. LEVEL.
6. WHEN TESTED TO THE 2g LEVEL SOME MINOR DAMAGE OCCURED ~~WHEN~~ DURING TESTING IN THE SIDE TO SIDE MODE (i.e. TWISTING OF BASE, DOOR STIFFENER BROKE, DOOR HANDLES FAILED TO FUNCTION CORRECTLY, THE DOOR WAS REMOVED & TESTING COMPLETED)

~~Action Items~~ ~~Date Req'd~~ ~~Responsible~~

Info cc: File No.

CONT. PAGE 2.

GA 1615

GENERAL ATOMIC COMPANY

PAGE 2.

From: Date: 3/20/82

To:

TELEPHONE COMMUNICATION RECORD

(Please hand letter legibly in black or red ink)

Call Initiated by: at GA Other

Call Received by: at GA Other

Other Participants:

Date Time Program Name/No. Task or 189 No.

Subject:

Summary

7. FOLLOWING THE TESTS THE DESIGN WAS NOT STRENGTHENED

8. THE PANELS ARE MOUNTED (BOLTED) SIDE BY SIDE IN UNITS OF TWO.

9. THE PANELS ARE BOLTED TO THE FLOOR IN PLANT.

10. DURING THE TEST (RESONCE SEARCH) NO PREDOMINANT PEAKS WERE FOUND BELOW 10 HZ.
[FRONT / BACK 22 HZ, SIDE/SIDE 13 HZ, VERT. NOTHING UPTO 35 HZ.

Action Items:	Date Req'd	Responsible
.CE WILL SEND COPY OF LETTER LOG#	3/22/82	JAKE WESTBROOK
BC-2/3 DATED 7-24-73 & RELEVANT TIME HISTORY		

Info cc: File No.

A 1615

2408 PFR NO. F097

REVISION --

POTENTIAL FINDING REPORT
SONGS 2&3 SEISMIC DESIGN VERIFICATION

A. PREPARATION BY GA INITIATOR

AFFECTED ITEMS: Pipe Support 167, 203, 826, 152, 200, 52, 116, 178, 93, 77, 466, 146 PFR No. F068 and Bechtel's comment.

REQUIREMENT REFERENCE DOCUMENTS:

PIPM Section 14.6 Checking and Review, Last Paragraph

BASIC REQUIREMENT: "Prior to system startup, pipe-routing changes and pipe-support interface modifications will be documented on updated isometrics, and a final stress-analysis calculation will be completed, including detailed, independent check"

DESCRIPTION OF POTENTIAL FINDING:
Bechtel's comment to PFR F068 states that "Calculation P-450-1.44 and P-450-1.50 are currently under revision". This violates the requirement that calculations will be complete prior to startup. A similar concern is noted in PFR 024A for specific piping analyses.

PREPARED BY: H C Hopkins DATE: 3-4-82

REJECTION OF GA TASK LEADER COMMENTS BY: ____ DATE: ____

REJECTION OF ORIGINAL DESIGN ORG. COMMENTS BY: H C Hopkins DATE: 3-19-82

B. REVIEW BY GA TASK LEADER COMMENTS

The Bechtel "load verification check" goes beyond the Basic Requirement above and therefore this PFR should be Invalid, since the calculations were "complete" prior to startup as defined in the Basic Requirement
JB 3/22/82

☒ AGREE PF IS VALID BY J. Brown DATE 3/4/82

☐ REQUEST RE-REVIEW BY ____ DATE ____

☐ DISAGREE BY ____ DATE ____

☒ REVIEW OF ORIGINAL DESIGN ORGS. COMMENTS BY: J. Brown DATE: 3/22/82

2408 PFR NO. F027

REVISION ________

C. REVIEW BY ORIGINAL DESIGN ORGANIZATION — **COMMENTS**

The subject calculations were completed prior to system startup. There is no requirement in the PIPM prohibiting calculation revisions after system startup since design changes in [illegible] system do occur after the system has been turned over to startup.

The calculations were complete on 7/3/80 for both systems BBB and BHA. Both systems were turned over for system startup after this date; system BHA on 7/8/80 and system BBB on 9/6/80.

☐ AGREE PF IS VALID

☒ DISAGREE

BY: [signature] DATE: 3/9/82

D. RECOMMENDATION BY FINDINGS REVIEW COMMITTEE

DEFINITION ADEQUACY:	☒ ADEQUATE	☐ INADEQUATE
VALIDITY:	☒ VALID	☐ INVALID
~~10 CFR 21:~~	~~☐ NOT APPLICABLE~~	~~☐ APPLICABLE~~ SLK 3/22/82
~~10 CRF 50.55(e):~~	~~☐ NOT APPLICABLE~~	~~☐ APPLICABLE~~
CLASSIFICATION:	☒ OBSERVATION	☐ FINDING

[illegible]TIFICATION:

CLASSIFICATION CRITERION NO. RESULTING IN "FINDING" ________

COMMENT ON "OBSERVATION" CLASSIFICATION

Procedural "trap" with no apparent safety implication. PIPM apparently does not allow for design changes after startup but sometimes changes must be made.

BY: [signature] DATE: 3/22/82

E. TPT PROJECT MANAGER

☒ ACCEPT

☐ REJECT

BY: [signature] DATE: 3/24/82

IMPACT ASSESSMENT

2408 PFR NO. F097

AFFECTED ITEM: Pipe Support: 167, 203, 826, 152, 200, 52, 116, 178, 93, 77, 466, 146, PFR F068 and Bechtel's Comment

1. IS THERE THE POTENTIAL FOR REDUCING DESIGN MARGINS TO THE EXTENT DESIGN ALLOWABLES ARE EXCEEDED OR DESIGN REQUIREMENTS ARE NOT MET ?

   N/A

2. IS THERE THE POTENTIAL THAT THE ITEM MIGHT FAIL OR ENDANGER OTHER ITEMS DURING AN SSE ?

   N/A

3. COULD THE FAILURE OF THIS ITEM DURING AN SSE CREATE A SUBSTANTIAL SAFETY HAZARD ?

   N/A

4. COULD THE PROCEDURAL VIOLATION CREATE A SUBSTANTIAL SAFETY HAZARD ?

   Unlikely

5. ARE OTHER SIMILAR DEVIATIONS LIKELY TO EXIST ?

   Yes, see PFR F024

6. OTHER COMMENTS: The procedural violation is caused by an overcheck by Bechtel, see Attached telecopies (3/16/82, Part B and 3/19/82). This overcheck activity is not covered by Bechtel procedures but should enhance safety.

PREPARED BY: [signature] DATE: 3-22-82

COMMENTS:

BY: [signature] DATE: 3/22/82

Bechtel Power Corporation

Engineers – Constructors

12400 East Imperial Highway
Norwalk, California 90650

MAIL ADDRESS
P.O. BOX 60860 TERMINAL ANNEX LOS ANGELES, CALIFORNIA 90060
TELEPHONE (213) 864-6011

RECEIVED MAR 1 9 1982

March 19, 1982
Log BX-7085

Mr. George Wessman
Director of Torrey Pines Technology
Post Office Box 81608
San Diego, California 92138

Subject: Southern California Edison Company
San Onofre Nuclear Generating Station, Units 2 & 3
Bechtel Job 10079
TPT Independent Review of SONGS 2 & 3 Seismic Design
File: SO23-722-G

Dear Mr. Wessman:

The following is in response to your item "B" of the Telecopy request for information on March 16, 1982. Please see that this information is given to H. C. Hopkins as soon as possible.

Current revisions to the calculations cited in item "B" is being done to document the activity of our task force who went through each start-up system and did a load verification check.

The results of this activity required that the calculations be revised to evaluate the effect of load increases. This evaluation has required only three changes to the supports data previously produced. This change was documented on a Deficiency Evaluation Report and is currently under a significance assessment review. This task force activity was part of an on going verification program initiated by Bechtel.

Response to your item "A" will follow later.

Very truly yours,

BECHTEL POWER CORPORATION

F.B. Marsh /[illegible]

F. B. Marsh
Project Engineer
Los Angeles Power Division

CEM:dds

cc: Mr. J. J. Adrian, SCE

F097

TO: Mr. Fred Marsh
Bechtel Power Corp.
Telecopy: 213/946-1644

3/16/82

Sent 2:30
3/16/82

FROM: Mr. George Wessman
Torrey Pines Technology
Telecopy: 714/455-2132

We are requesting the following information:

A. In response to PFR-F073 related to the three subject junction boxes and GA comment on the inadequacy of attachment to structural steel supports, Bechtel has stated that the rigidity is shown to be adequate, etc. as shown by their calculations.

1. We need copies of Bechtel calculations related to the adequacy of supports for the following junction boxes.

a. 2XB5RZTD03
b. 2BB4RZTB03
c. 2AB5RZTB03

B. To aid evaluation of PFR's please send documentation that describes the nature of the current revisions and completion date for the calculations that are identified in PFR F024A and F097. This documentation should describe current revisions to piping analysis for segments 78 and 82 and pipe support analysis for 167, 203, 826, 152, 200, 52, 116, 178, 93, 77, 466 and 146.

This documents a verbal request to M. Mitchhart. If practical, suggest documents be telecopied to GA to the attention of H. C. Hopkins.

RGW:cc

2908-111-097

Genoral Atomic Company

QUALITY ASSURANCE DEPARTMENT

Record of Long Distance Telephone Call

Party: Called ☐ Calling ☐

Date: 3-12-92

Time: Completed 1100

Started 1050

On-line 10 min

Name Mitch Mitchhart

Company Bechtel

Location Whittier

Telephone No: A/C 213 No. 946 1819 x352

Discussion Re: PFR F024A Impact Assessment

Line Busy NII

1. F024A - Calculations under revision - Hopkins reviewed Impact Assessment to assure that Bechtel's verbal description of the nature of the revisions was ~~actual~~ accurately summarized. - Mitchhart agree.

Other Items Re PFR F056 & F097.

2. Comments and disposition ~~F097~~ F024A also apply to F097. Bechtel will not make an additional reply.

3. F056 - The PFR review committee ~~commented~~ questioned the invalidation of F056 on the basis that the Bechtel signature authorization List did not explicitly state that a single individual may sign once for EGS+PE.

- Bechtel declined to provide additional data.

Hopkins is recommending that F056 be an observation

Record Made by A C Hopkins

Bresnick, Sharmahd, Larcher

1408-[illegible]
file

General Atomic Company

QUALITY ASSURANCE DEPARTMENT

Record of Long Distance Telephone Call

Party: Called ☐ Calling ☐

Date: 3-12-82

Time: Completed 1100

Started 1050

On-line 10 min

Name Mitch Mitchhart

Company Bechtel

Location Whittier

Telephone No: A/C 213 No. 946 1819 x 352

Discussion Re: PFR F024A Impact Assessment

Line Busy NII

1. F024A - Calculations under revision - Hopkins reviewed Impact Assessment to assure that Bechtel's verbal description of the nature of the revisions was ~~actual~~ accurately summarized. - Mitchhart agree.

Other Items Re PFR F056 & F097.

2. Comments and disposition of ~~F097~~ F024A also apply to F097. Bechtel will not make an additional reply.

3. F056 - The PFR review ~~commented~~ committee questioned the invalidation of F056 on the basis that the Bechtel signature authorization List did not explicitly state that a single individual may sign once for EGS + PE.
- Bechtel declined to provide additional data.
Hopkins is recommending that F056 be an observation

Record Made by H C Hopkins

Bresnick, Sharmahd, Larcher

F097

General Atomic Company

QUALITY ASSURANCE DEPARTMENT

Record of Long Distance Telephone Call

Party: Called ☒ Calling ☐

Date: 3-12-82

Time: Completed 8:20

Started 8:15

On-line 5 min

Name Mitch Mitchhart

Company Bechtel

Location Whittier

Telephone No: A/C 213 No. 946 1819 x 352

Discussion Re. PFR F097, Also PFR F024A

Hopkins 1. Had Bechtel responded to my concern that calculation were being revised at this late date?

Mitchhart 2. Bechtel is preparing a response ~~but~~ and it is expected to be completed soon. Bechtel understands Hopkins' concern.

3. Mitchhart will tell Hopkins as soon as the Bechtel management prepares a response.

Record Made by H C Hopkins

PFR NO. 2408-PFR -F 104

REVISION ______

POTENTIAL FINDING REPORT
SONGS 2&3 SEISMIC DESIGN VERIFICATION

A. PREPARATION BY GA INITIATOR

AFFECTED ITEMS: Low Pressure Safety Injection Pump 8x20WDF

REQUIREMENT REFERENCE DOCUMENTS: Project Specification for Safeguard Pumps for Southern California Edison Company San Onofre Units 2 and 3, Specification No. 1370-PE-410, Rev. 7, Nuclear Power Systems Combustion Engineering, In. Section 4.2.7.2.

BASIC REQUIREMENT: 4.2.7.2 The lowest natural frequency vibration of the pump assembly and its components that are necessary for pump operability shall be greater than 33 cps. The Seller shall demonstrate this by analysis.

DESCRIPTION OF POTENTIAL FINDING: The independent modal analysis performed by TPT of the LPSI pump support mount with a rigid model of the LPSI pump indicates a fundamental frequency of 24 Hz. This differs substantially from the 112 Hz originally calculated by BPC*. Due to the flexibility of the support mount and the possible coupling motion with the pump assembly, the resulting lower natural frequency (less than 33 Hz) is not consistent with the CE-prepared pump specification requirement.

* S.E.B. Structural Design-Equipment Supports, File No. C-259, Calc No. C-259-2.03.14.

PREPARED BY: Fu Kong Tzung *Fu Kong Tzung* DATE: 3-5-82

REJECTION OF GA TASK LEADER COMMENTS BY: ______ DATE: ______

REJECTION OF ORIGINAL DESIGN ORG. COMMENTS BY: ______ DATE: ______

B. REVIEW BY GA TASK LEADER

COMMENTS

☑ AGREE PF IS VALID BY *[signature]* DATE 3/9/82

☐ REQUEST RE-REVIEW BY ______ DATE ______

☐ DISAGREE BY ______ DATE ______

☐ REVIEW OF ORIGINAL DESIGN ORGS. COMMENTS BY: ______ DATE: ______

PFR NO. 2406-PFR-E [illegible]

REVISION ____________

C. REVIEW BY ORIGINAL DESIGN ORGANIZATION

COMMENTS

SEE ATTACHMENT I

☒ AGREE PF IS VALID , however, no impact on design.

☐ DISAGREE

SHF

BY: F.M. Marsh [signature] DATE: ____________

D. RECOMMENDATION BY FINDINGS REVIEW COMMITTEE

DEFINITION ADEQUACY: ☒ ADEQUATE ☐ INADEQUATE

VALIDITY: ☒ VALID ☐ INVALID

CLASSIFICATION: ☒ OBSERVATION ☐ FINDING

JUSTIFICATION:

CLASSIFICATION CRITERION NO. RESULTING IN "FINDING" ____________

COMMENT ON "OBSERVATION" CLASSIFICATION

Incorrect calculation, However, design allowables are not exceeded.

BY: S. L. Koutz DATE: 3/22/82

E. GA PROJECT MANAGER

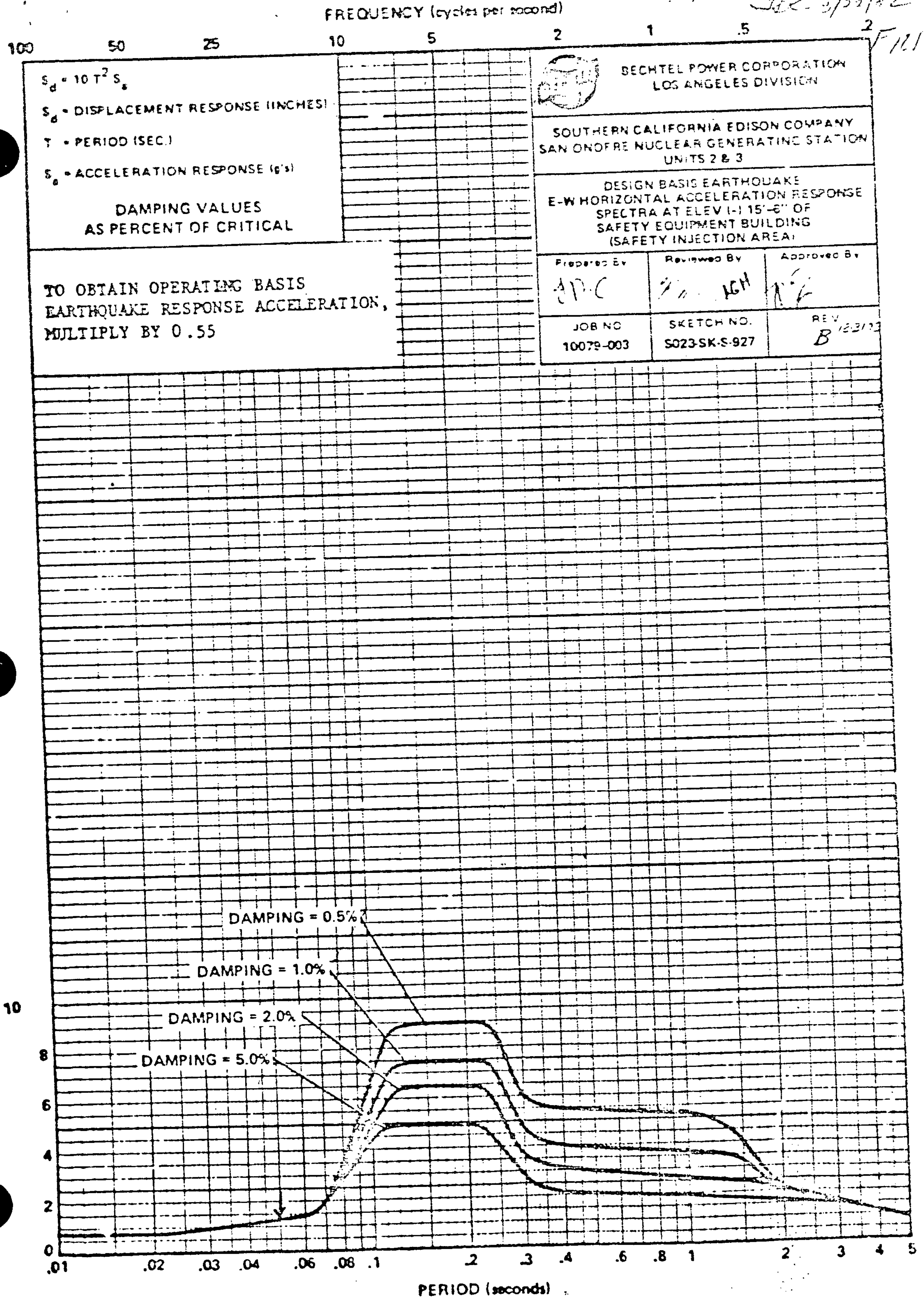
☒ ACCEPT

☐ REJECT

BY: [signature] DATE: 3/24/82

A more rigorous analysis of the LPSI pump support confirms the TPT observation that the fundamental frequency of 112 Hz as originally calculated is too high and not valid.

The new analysis by BPC consists of an eigenvalue solution through a finite element model of the support instead of the original hand calculation. The three columns and beams of the support were represented by beam elements, incorporating the diaphragm action of the pump by rigid plate elements which are pin-connected to the upper end of the columns. The masses considered were the mass of the pump lumped at the top and the mass of the structure uniformly distributed at each element. The fundamental frequencies calculated for lateral modes were 33 Hz and 12 Hz considering the boundary condition at the column base as fixed and pinned, respectively. The accepted approach is to consider the lateral stiffness to be in between the fixed and pinned extremes, so that the actual frequency is estimated as 20 Hz (considering freq. as proportional to sq. rt. of stiffness). This frequency is outside the region of amplification exhibited by the floor response spectra (FRS) per Sketches No. SO23-SK-S-927, -932 and -937 (attached). Therefore the seismic response for the pump-support system, which in the lateral direction may be properly idealized as a single degree of freedom system, is estimated from the FRS at 20 Hz to be less than 1.5 g's. This low amplification with respect to the ZPA is deemed to be consistent with the purpose of the CE-specified requirement for support frequencies $\gtrsim$ 33 Hz. The lower frequency of 20 Hz is not in close proximity to the fundamental frequencies of the piping connecting to the pump which are 8.0, 10.2, 11.4, 12.2, 12.6 and 15.5 Hz. Furthermore, if it were the case that the system/subsystem frequencies became closely spaced, such proximity of frequencies does not imply adverse amplification from system/subsystem coupling provided that the frequencies are outside the high-energy-content range of the FRS, as it is the case. This characteristic of the system/subsystem coupling related to the FRS frequency range of amplification was presented by BPC in the supplementary response to PFR-0017.


FREQUENCY (cycles per second)
100 50 25 10 5 2 1 .5 .2
$S_d = 10\,T^2\,S_a$
S_d = DISPLACEMENT RESPONSE (INCHES)
T = PERIOD (SEC.)
S_a = ACCELERATION RESPONSE (g's)
DAMPING VALUES AS PERCENT OF CRITICAL
TO OBTAIN OPERATING BASIS EARTHQUAKE RESPONSE ACCELERATION, MULTIPLY BY 0.55
BECHTEL POWER CORPORATION
LOS ANGELES DIVISION
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3
DESIGN BASIS EARTHQUAKE
E-W HORIZONTAL ACCELERATION RESPONSE
SPECTRA AT ELEV (-) 15'-6" OF
SAFETY EQUIPMENT BUILDING
(SAFETY INJECTION AREA)
Prepared By
Reviewed By
Approved By
JOB NO
10079-003
SKETCH NO.
S023-SK-S-927
REV
B
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
10
8
6
4
2
0
.01 .02 .03 .04 .06 .08 .1 .2 .3 .4 .6 .8 1 2 3 4 5
PERIOD (seconds)

BECHTEL POWER CORPORATION
LOS ANGELES DIVISION

SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3

DESIGN BASIS EARTHQUAKE
N-S HORIZONTAL ACCELERATION RESPONSE
SPECTRA AT ELEV (-) 15'-6" OF
SAFETY EQUIPMENT BUILDING
(SAFETY INJECTION AREA)

Prepared By	Reviewed By	Approved By
JOB NO	SKETCH NO.	REV
10079-003	S023-SK-S-932	B

$S_d = 10\,T^2\,S_a$

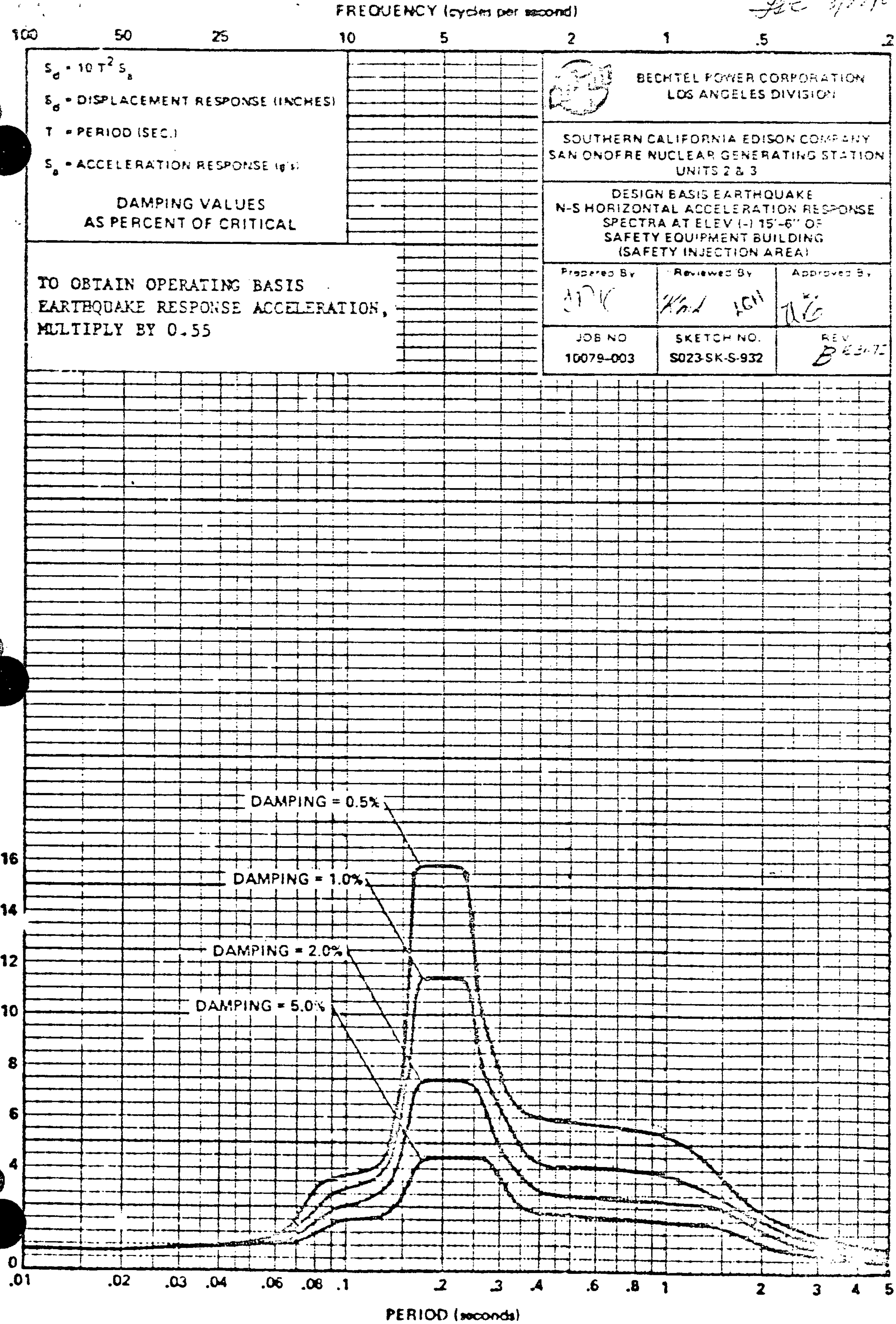
S_d = DISPLACEMENT RESPONSE (INCHES)

T = PERIOD (SEC.)

S_a = ACCELERATION RESPONSE (g's)

DAMPING VALUES
AS PERCENT OF CRITICAL

TO OBTAIN OPERATING BASIS EARTHQUAKE RESPONSE ACCELERATION, MULTIPLY BY 0.55



BECHTEL POWER CORPORATION
LOS ANGELES DIVISION

SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3

DESIGN BASIS EARTHQUAKE
VERTICAL ACCELERATION RESPONSE
SPECTRA AT ELEV (-) 15'-6" OF
SAFETY EQUIPMENT BUILDING
(SAFETY INJECTION AREA)

Prepared By	Reviewed By	Approved By
JOB NO	SKETCH NO.	REV
10079-003	S023-SK-S-937	B

$S_d = 10 T^2 S_a$

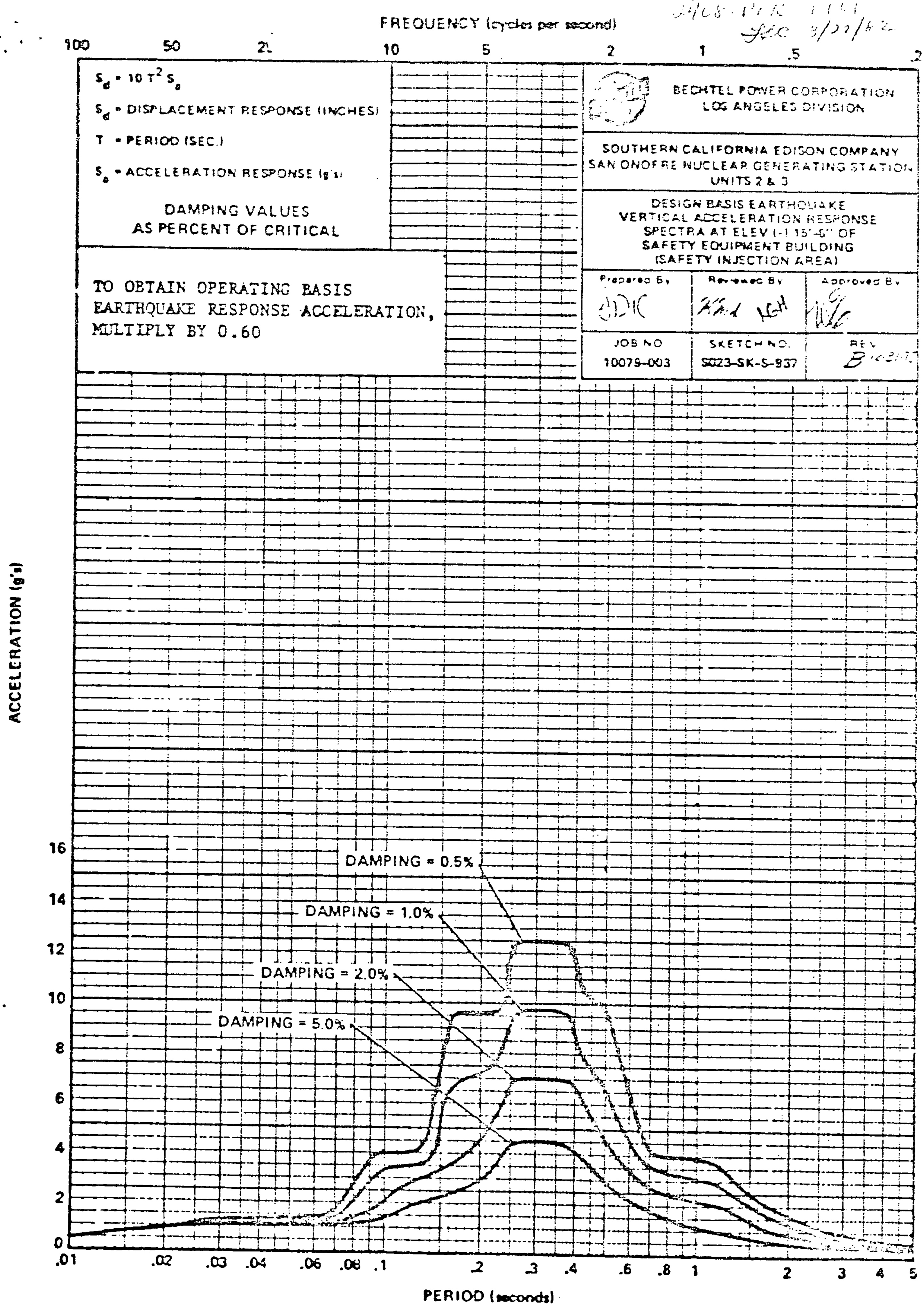
S_d = DISPLACEMENT RESPONSE (INCHES)

T = PERIOD (SEC.)

S_a = ACCELERATION RESPONSE (g's)

DAMPING VALUES
AS PERCENT OF CRITICAL

TO OBTAIN OPERATING BASIS
EARTHQUAKE RESPONSE ACCELERATION,
MULTIPLY BY 0.60



IMPACT ASSESSMENT

2408-PFR-F0101
PFR NO. ________

AFFECTED ITEM: LPSI Pump 8 x 20 WDF

1. IS THERE THE POTENTIAL FOR REDUCING DESIGN MARGINS TO THE EXTENT DESIGN ALLOWABLES ARE EXCEEDED OR DESIGN REQUIREMENTS ARE NOT MET ?

No. Although the low frequency of 20 Hz violates the CE-specified requirement for support frequency ≳ 33Hz, it does not appear that this will reduce design margins to the extent design allowables are exceeded.

2. IS THERE THE POTENTIAL THAT THE ITEM MIGHT FAIL OR ENDANGER OTHER ITEMS DURING AN SSE ?

No. BPC's response appears to be valid.

3. COULD THE FAILURE OF THIS ITEM DURING AN SSE CREATE A SUBSTANTIAL SAFETY HAZARD ?

Not known

4. COULD THE PROCEDURAL VIOLATION CREATE A SUBSTANTIAL SAFETY HAZARD ?

Not applicable

5. ARE OTHER SIMILAR DEVIATIONS LIKELY TO EXIST ?

Not known

6. OTHER COMMENTS:

PREPARED BY: F. Tzung F. Tzung DATE: 3-18-82

COMMENTS: We are in basic agreement with BPC's response to the PFR. Though the pump/pump support has a lateral natural frequency below the CE-specified requirement of 33 Hz, this frequency remains outside the region of amplification. Therefore, the seismic design requirements called out by CE and the design loads computed by Ingersoll-Rand will remain unchanged. W.D. Rickard

Concur.

BY: [signature] DATE: 3/19/82

PFR NO. 2408-PFR-F105

REVISION A

POTENTIAL FINDING REPORT
SONGS 2&3 SEISMIC DESIGN VERIFICATION

PREPARATION BY GA INITIATOR

AFFECTED ITEMS:

Containment Structure Seismic Analysis

REQUIREMENT REFERENCE DOCUMENTS:

FSAR SEc. 3.7.2.1.1 Seismic Analysis Methods for Structures

BASIC REQUIREMENT:

Seismic analysis method and dynamic modeling feature should be consistent with the methodology described in the above requirement reference document.

DESCRIPTION OF POTENTIAL FINDING:

BPC used non-standard modeling feature (basemat-tracking technique) which is not explicitly cited in the FSAR.
(see attachment for details)

T.H. Lee R. W. Thompson

PREPARED BY: T.H.Lee/R. W. Thompson DATE: 3/22/82

REJECTION OF GA TASK LEADER COMMENTS BY: ______ DATE: ______

REJECTION OF ORIGINAL DESIGN ORG. COMMENTS BY: T. H. Lee DATE: 3/23/82

B. REVIEW BY GA TASK LEADER

COMMENTS

The PFR description was revised as a consequence of BPC's response to the original PFR.

☑ AGREE PF IS VALID BY [signature] DATE 3/23/82

☐ REQUEST RE-REVIEW BY ______ DATE ______

☐ DISAGREE BY ______ DATE ______

☑ REVIEW OF ORIGINAL DESIGN ORGS. COMMENTS BY: [signature] DATE: 3/23/82

C. REVIEW BY ORIGINAL DESIGN ORGANIZATION

COMMENTS

☐ AGREE PF IS VALID

☐ DISAGREE

BY: ______________________ DATE: __________

D. RECOMMENDATION BY FINDINGS REVIEW COMMITTEE

DEFINITION ADEQUACY:	☒ ADEQUATE	☐ INADEQUATE
VALIDITY:	☒ VALID	☐ INVALID
CLASSIFICATION:	☒ OBSERVATION	☐ FINDING

JUSTIFICATION:

CLASSIFICATION CRITERION NO. RESULTING IN "FINDING" __________

COMMENT ON "OBSERVATION" CLASSIFICATION

Calculation method is not consistent with FSAR. However, both calculation method and result are acceptable.

BY: S. L. Koutz DATE: 3/23/82

E. GA PROJECT MANAGER

☒ ACCEPT

☐ REJECT

BY: GhWeisman DATE: 3/24/82

ATTACHMENT TO REVISION A

This is a revision to the original PFR where the basic requirement has been changed as a result of the BPC's clarification. The reviewers have incorporated the basemat-tracking feature into the MODSAP model according to the descriptions as given by Mr. A. Lopez of BPC. The acceleration response values obtained by using the modified MODSAP model were compared with the more accurate numerical values of SMIS analysis presented in Table 3.7-19 of FSAR. The new values computed by MODSAP with basemat-tracking feature are in close agreement with the values of SMIS at all elevations. The comparison is displayed in the following table.

Elevation (ft)	Horizontal Acceleration (g) SMIS (BPC)	MODSAP (TPT)
10.5 (basemat center)	0.685	0.681
35.875	0.750	0.809
61.25	0.896	0.939
86.625	1.042	1.083
112.00	1.183	1.258
140.39	1.369	1.454
177.50	1.630	1.707

The slight increase in MODSAP values is reasonable because these minor deviations reflect the effects due to the difference in damping simulation. The BPC SMIS used the non-proportional damping which can be shown to possess slightly larger amount of energy dissipation as compared to the equivalent modal damping used in MODSAP model. It should also be pointed out that parameter modifications have been made to the MODSAP model based upon the reviewers' calculations and judgement, therefore the two models do not have exactly the same set of input parameter values. Furthermore, the multi-point constraint feature used in the SMIS model is approximately simulated in the MODSAP model.

Apparently the deviation in response value observed previously does not exist when all the key modeling features used by SMIS have been incorporated into the MODSAP model. The basemat-tracking feature forces the basemat to track the free-field motion in the absence of the superstructure and thereby achieves reduction in response. In the opinion of the reviewers, the theory is valid for embedded basemats and is therefore acceptable for seismic analysis of the containment structure of SONGS2 & 3. The concern expressed in the original PFR is resolved.

The free-field ground motion tracking technique used by BPC for time-history analysis is a non-classical method not cited in the FSAR. The design seismic analysis methods used for SONGS2 & 3 are therefore not compatible with the approved design-basis methodology. This inconsistency should be eliminated by an appropriate amendment to the Section 3.7 of the FSAR.

T H Lee R. W. Thompson
BY: T. H. Lee /R. W. Thompson DATE: 3-23-82

PFR NO. 2408-PFR-F105

REVISION ____________

POTENTIAL FINDING REPORT
SONGS 2&3 SEISMIC DESIGN VERIFICATION

PREPARATION BY GA INITIATOR

AFFECTED ITEMS: Containment Structure Seismic Analysis

REQUIREMENT REFERENCE DOCUMENTS:

Not Applicable

BASIC REQUIREMENT:

The basemat should have reasonable amplification when the building is on soil.

DESCRIPTION OF POTENTIAL FINDING:

The acceleration response values obtained from a simplified MODSAP model are in general agreement with those obtained by SMIS model at all levels except the basemat elevation where the response computed by MODSAP is about 30% higher. (see attachment for details).

PREPARED BY: T.H.Lee/R.W. Thompson DATE: ~~3/5/82~~ 3/8/82

REJECTION OF GA TASK LEADER COMMENTS BY: ____________ DATE: ________

REJECTION OF ORIGINAL DESIGN ORG. COMMENTS BY: ____________ DATE: ________

B. REVIEW BY GA TASK LEADER

COMMENTS

☑ AGREE PF IS VALID BY [signature] DATE 3/8/82

☐ REQUEST RE-REVIEW BY ____________ DATE ________

☐ DISAGREE BY ____________ DATE ________

☐ REVIEW OF ORIGINAL DESIGN ORGS. COMMENTS BY: ____________ DATE: ________

PFR NO. 2404-PFR-F 105
REVISION ______

C. REVIEW BY ORIGINAL DESIGN ORGANIZATION

COMMENTS

SEE ATTACHMENT I

☐ AGREE PF IS VALID

☒ DISAGREE

BY: Fred B Mead DATE: 3/15/82

D. RECOMMENDATION BY FINDINGS REVIEW COMMITTEE

DEFINITION ADEQUACY:	☐ ADEQUATE	☐ INADEQUATE
VALIDITY:	☐ VALID	☐ INVALID
CLASSIFICATION:	☐ OBSERVATION	☐ FINDING

JUSTIFICATION:

CLASSIFICATION CRITERION NO. RESULTING IN "FINDING" ______

COMMENT ON "OBSERVATION" CLASSIFICATION

BY: ______ DATE: ______

E. GA PROJECT MANAGER

☐ ACCEPT

☐ REJECT

BY: ______ DATE: ______

PFR.NO. 2408-PFR-[illegible]

DESCRIPTION OF POTENTIAL FINDING:

References

1. FSAR, Table 3.7-8
2. Final In-structure Response Spectra For The Containment and Interior Structure, C-257-3.01, Figures D-1 thru D-5.
3. SMIS Finite Element Model For Time-History Analysis of Containment With NSSS Equipment, Figures A-4 and A-5
4. FSAR Figure 3.7A-6, 3.7-2, 3.7A-64.

As part of the review of the containment structure seismic analysis, output from a simplified two-dimensional dynamic model using the MODSAP computer code has been compared with corresponding SMIS model output. The natural frequencies, mode shapes and damping factors for the first five lower modes are in accord with the those of SMIS model given in References 1 and 2. It is believed that this MODSAP model is dynamically equivalent to the SMIS model shown in Ref.3 except that the agreement in modal participation factors has not yet been established because the two models use different normalization factors for mode shapes. The initiators have compared the results for the case parallel to hot leg. The maximum acceleration response values (ZPA) at various levels of the model under DBE input of 0.67g are given as follows:

SMIS Model Node Number (Ref.3)	Description	Maximum Acceleration(ZPA) in unit of g	
		MODSAP	SMIS
23	Exterior Shell 177'-6"	2.28	2.00
27	Steam Gen. Snubber Support	1.12	1.00
1	Reactor Vessel Column Suppt (basemat level)	0.98	0.75

(From Ref.4)

The above comparison shows that agreement is reasonable at all elevations except the basemat level where the SMIS value shows smaller amplification. In clarifying the concern associated with the base response, BPC's explanations should address the following:

a. Integration method and time step used by SMIS to determine the time-history input for generating in-structure response spectra.
b. numerical values of mode shapes and their normalization factors.
c. procedures for computing participation factors.
d. numerical values of participation factors and generalized masses.
e. number of modes considered in integration of modal equations.
f. procedures and method of handling damping in direct integration.
g. other modeling features and solution techniques which may influence base response.

INITIATORS T.H. Lee R.W. Thompson

BY: T. H. Lee/ R. W. Thompson DATE: March 5, 1982

Based on the limited description of the TPT MODSAP model of the containment structure, as given by C. Charman and T. Lee of TPT, it is judged that basically the model is dynamically equivalent to the BPC SMIS model. Therefore it is valid to expect comparable seismic response characteristics from both models provided that certain modeling features used in the original SMIS model are incorporated into the MODSAP model. These features are described under item (g) below.

The following clarifications are submitted in accordance with the itemization presented in the PFR:

(a) The direct integration method used in SMIS's DYNCPL routine is the Newmark-Beta Method. The time-history record was digitized at 0.01 second intervals, and the integration time interval was specified as 0.005 second. The Newmark Method used in SMIS is unconditionally stable with respect to time interval. In addition the DYNCPL time interval was checked through time-history analyses using the SMIS model solutions by normal-mode and by direct-integration methods. The calculated response spectra from both solutions were found to be in agreement.

(b) The numerical values of the mode shapes are printed as the eigenvectors normalized with respect to mass so that the generalized mass matrix is the identity matrix [I]. Therefore for simple comparison of mode shapes the same normalization would be desirable. It is noted that the eigenvectors were used only to develop the coupled damping matrix, and are presented only as part of the dynamic characteristics of the model. For the direct integration solution, which of course is not a normal mode solution, the eigenvectors are irrelevant.

(c) The participation factors are calculated as follows:

$$PF_i = \frac{\{\phi_i\}^T [M]}{\{\phi_i\}^T [M] \{\phi_i\}} \quad \text{for } i \text{ th mode}$$

$$\text{percentage } PF_i = \frac{|PF_i|}{\sum_{1}^{n} |PF_i|} \times 100,$$ where n is the total number of modes.

(d) The numerical values tabulated for the participation factors correspond to the percentage PF defined above. It is noted that the participation factors were given only to illustrate the modal characteristics of the model, and of course are irrelevant for the direct-integration solution.

The generalized masses are unity since they are the elements of the identity matrix as described under (b) above.

(e) When normal mode time-history analyses or response spectrum analyses are performed the number of modes considered is limited to the number of modes which have frequencies lower than 33 cps.

(f) The procedure for incorporation of damping is described in the BPC report entitled "Methods of Direct Application of Element Damping, San Onofre Units 2 & 3", January, 1972, submitted to TPT by letter dated 12/23/82.

(g) The key modeling feature to which the higher acceleration response of the MODSAP model is attributable is the method of excitation used in SMIS. This method is defined in Section 3.6 of Volume I of Reference 2 cited in the PFR. The equation of motion described therein was adopted to develop a solution where the embedded basemat would track the free-field motion if the superstructure were absent from the basemat. An equivalent concept can be introduced in the MODSAP model without resorting to the free-free system and the more involved equation of motion used in the SMIS model. In the MODSAP model the basemat-tracking feature can be effectively simulated by applying forcing function at the basemat level equal to the basemat mass times the ground acceleration. This forcing function is in addition to the classical inertial forcing function represented by the negative of the ground acceleration times the masses along the degrees of freedom corresponding to the direction of the ground acceleration. BPC has incorporated this approach into BSAP models of the containment to successfully demonstrate that the SMIS and BSAP models yield comparable response. It is suggested that the MODSAP model be modified accordingly by TPT in order to obtain a more meaningful comparison between models.

The characteristic equation of motion used in the SMIS model was documented in the report per Reference 2 of the PFR. The report is an integral part of the Project Calculation No. C-257-3.01 and is also documented in the Project Report File No. SO23-280-F. The above report and calculation are not specifically cited in the FSAR, but the documents were presented and accepted by the NRC Staff during the NRC Structural Audit of 1978.

(h) The "no apparent phasing shift" mentioned under the steady-state response analyses described in the report referenced in item (f) above pertains simply to the observation that the frequency of peak response was not shifted upon introducing several different values of non-proportional and proportional damping.

IMPACT ASSESSMENT

2408-PFR-F105
PFR NO. Rev. A

AFFECTED ITEM: Containment Structure Seismic Analysis

1. IS THERE THE POTENTIAL FOR REDUCING DESIGN MARGINS TO THE EXTENT DESIGN ALLOWABLES ARE EXCEEDED OR DESIGN REQUIREMENTS ARE NOT MET?

   No

2. IS THERE THE POTENTIAL THAT THE ITEM MIGHT FAIL OR ENDANGER OTHER ITEMS DURING AN SSE?

   No

3. COULD THE FAILURE OF THIS ITEM DURING AN SSE CREATE A SUBSTANTIAL SAFETY HAZARD?

   Failure of the containment structure could.

4. COULD THE PROCEDURAL VIOLATION CREATE A SUBSTANTIAL SAFETY HAZARD?

   No

5. ARE OTHER SIMILAR DEVIATIONS LIKELY TO EXIST?

   BPC also used the basemat-tracking feature for other buildings.

6. OTHER COMMENTS:

T.H. Lee / R.W. Thompson

PREPARED BY: T.H.Lee/R.W.Thompson DATE: 3-23-82

COMMENTS:

Agree with impact assessment.

BY: [signature] DATE: 3/23/82

FROM: T. H. Lee LOCATION: GA DATE: 3-[illegible]

TO: Finding Review Committee LOCATION: GA DATE:

F105A

TELEPHONE COMMUNICATION RECORD

(PLEASE HAND LETTER LEGIBLY IN BLACK OR RED INK)

CALL INITIATED BY: T. H. Lee AT GAC [X] OTHER:

CALL RECEIVED BY: Alfredo Lopez AT GAC [ ] OTHER: BPC, Whittier

OTHER PARTICIPANTS: None

DATE: 3/23/82 TIME: 8:00 am	PROGRAM NAME	PROGRAM NUMBER

SUBJECT: PFR-No. 2408-PFR-F105, Revision A

SUMMARY: This phone call was made to obtain clarification from BPC whether the basemat-tracking feature has also been used for other buildings.

Mr. Alfredo Lopez confirmed that the feature was also used for other buildings (in addition to containment structure).

The initiator also informed Mr. Lopez that we have incorporated the basemat-tracking feature into the MODSAP model and obtained new results in close agreement with BPC's values. We accept the feature as a valid technique for embedded basemats. Since the feature is not explicitly cited in the FSAR, we have revised the PFR and changed the basic requirement. The revised version will be processed as a ~~xxx~~ valid PFR.

ACTION ITEMS:	Date Required	Person Responsible

DISTRIBUTION:

File No.:

PFR NO. 2408-PFR-F0109

REVISION ______________

POTENTIAL FINDING REPORT
SONGS 2&3 SEISMIC DESIGN VERIFICATION

PREPARATION BY GA INITIATOR

AFFECTED ITEMS: Inlet Nozzle of Reactor Vessel

REQUIREMENT REFERENCE DOCUMENTS:

1. Analytical report for Southern California San Onofre Unit 2 Reactor Vessel. C.E. Incl, Report No.. CENC-1269

LEP

BASIC REQUIREMENT: ~~[illegible] should be justified.~~

The basis of approximate method of analyses should be justified.

DESCRIPTION OF POTENTIAL FINDING: The calculation (CENC-1269) provides no justification for the method of analysis (replacement with equivalent spherical shell) used to determine combined stresses in the reactor vessel inlet nozzle.

LE Penzes

PREPARED BY: L. Penzes DATE: 3/6/82

REJECTION OF GA TASK LEADER COMMENTS BY: ______________ DATE: ______

REJECTION OF ORIGINAL DESIGN ORG. COMMENTS BY: ______________ DATE: ______

B. REVIEW BY GA TASK LEADER

COMMENTS

☑ AGREE PF IS VALID BY [signature] DATE 3/8/82

☐ REQUEST RE-REVIEW BY ______________ DATE ______

☐ DISAGREE BY ______________ DATE ______

☐ REVIEW OF ORIGINAL DESIGN ORGS. COMMENTS BY: ______________ DATE: ______

PFR NO. 2408-PFR-F0109

REVISION

C. REVIEW BY ORIGINAL DESIGN ORGANIZATION

See attached sheet.

☐ AGREE PF IS VALID

☒ DISAGREE

BY: V C Hall DATE: 3/18/82

COMMENTS

CE's response has been evaluated; the recommendation is to invalidate this PFR (see attached). Concur with the recommendation.

[signature] 3/23/82

D. RECOMMENDATION BY FINDINGS REVIEW COMMITTEE

DEFINITION ADEQUACY: ☒ ADEQUATE ☐ INADEQUATE

VALIDITY: ☐ VALID ☒ INVALID

CLASSIFICATION: ☐ OBSERVATION ☐ FINDING

JUSTIFICATION:

CLASSIFICATION CRITERION NO. RESULTING IN "FINDING" ______

COMMENT ON "OBSERVATION" CLASSIFICATION

BY: S. L. Koutz DATE: 3/23/82

E. GA PROJECT MANAGER

☒ ACCEPT

☐ REJECT

BY: [signature] DATE: 3/24/82

Reply: The inlet nozzle is located in a cylindrical shell of radius R. However, an interaction model of the nozzle to shell juncture, which was used in conjunction with the stress analysis, utilizes an axisymmetric simplification which consists of replacing the cylindrical vessel shell with a spherical shell of radius 1.5R. This simplification permits the average pressure stress to be maintained and provides a mathematically acceptable model for analysis. CE recognizes that such an assumption produces approximate solutions and accordingly utilizes the results of such an analysis to a limited extent.

The results of the interaction analysis is used in the following manner:

I. Range of Stress Considerations:

The redundant moment, force and displacements are determined from the interaction analysis for the thermal and pressure conditions at the shell to nozzle juncture.

The appropriate equations for the state of stress at the nozzle to shell juncture are presented on pages A-536 and A-539 of the Reactor Vessel report (CENC-1269) for two distinct locations. One at the intersection of the nozzle and shell in the longitudinal direction and the other in the circumferential direction.

For the pressure conditions, one should note that the shell pressure stress expression is from classical theory while the stress expressions which use the redundant loads yield approximate answers due to the 1.5 x radius assumption in the interaction analysis.

For the thermal condition, the portion of stress due to the linear radial gradient is not dependent on the redundant load coefficients. The portion of the thermal stress due to redundance is theoretically correct at both locations, however, the same approximations of redundant loads as previously described are used.

The stresses resulting from external loads were calculated using the methods described in Welding Research Bulletin No. 107. This procedure is independent of the interaction considerations.

The 1.5 R assumption is used in the analysis is deemed to be reasonable considering that the range of stress criteria itself only establishes that the vessel will shake down to approximately an elastic action and the greatest range of stress calculated was 59.3 ksi versus an allowable of 80.1 ksi (see page A-540), thus, a margin of 34% exists in the analysis.

II. Fatigue Evaluation

The peak pressure stresses at the vessel to shell juncture is calculated utilizing the stress indices method. (See pages A-546 to A-547). This method results in reasonable accurate stresses since the indices are empirically determined.

The calculated peak thermal stresses due to both the linear and non-linear portion of the thermal stress due to thermal redundance is determined in the same manner as for the range of stress consideration.

The portion of the peak stress due to external loads are determined by the methods of WRC Bulletin 107 and are independent of the interaction assumption.

Attachment to 2408-PFR-F0109

I. Fatigue Evaluation (Cont'd)

For the nozzle/shell junction the maximum stress intensity due to pressure is approximately 68.4 ksi (see page A-551) versus the maximum thermal stress intensity of approximately 29.4 ksi and the maximum total combined stress intensity is 90.0 ksi. Thus, the dominant contributor to fatigue damage is the pressure stresses which are theoretically correct as is a major protion of the thermal stresses and all the external load stresses.

From page A-550 of the report, the maximum usage factor is 0.18 versus an allowable of 1.0 which again demonstrates the nozzle/shell junction has a substantial margin of safety relative to fatigue. Accordingly, CE concludes that the analysis demonstrates compliance to the ASME Code and reasonable engineering analysis procedures.

The CE response explains that the assumption made to simulate the cylindrical Reactor vessel by a spherical shell vessel with 1.5 R* in the calculation of nozzle/vessel stresses is more sensitive to the evaluation of low cycle fatigue damage than the calculation of primary membrane stresses resulting from the loading combination of design pressure and the OBE and DBE for upset and faulted conditions. It is recommended, with the agreement of the initiator, that the PFR-F0109 should be reclassified as an invalid, potential finding.

Kai J. Tong 3/22/82

Leslie E Pemes

3/22/82

* The configurations of inlet nozzle/reaction vessel and the mathematical model are attached in (A) and (B) respectively

Concur with the recommendation [illegible]

A

6.0 Detailed Analysis

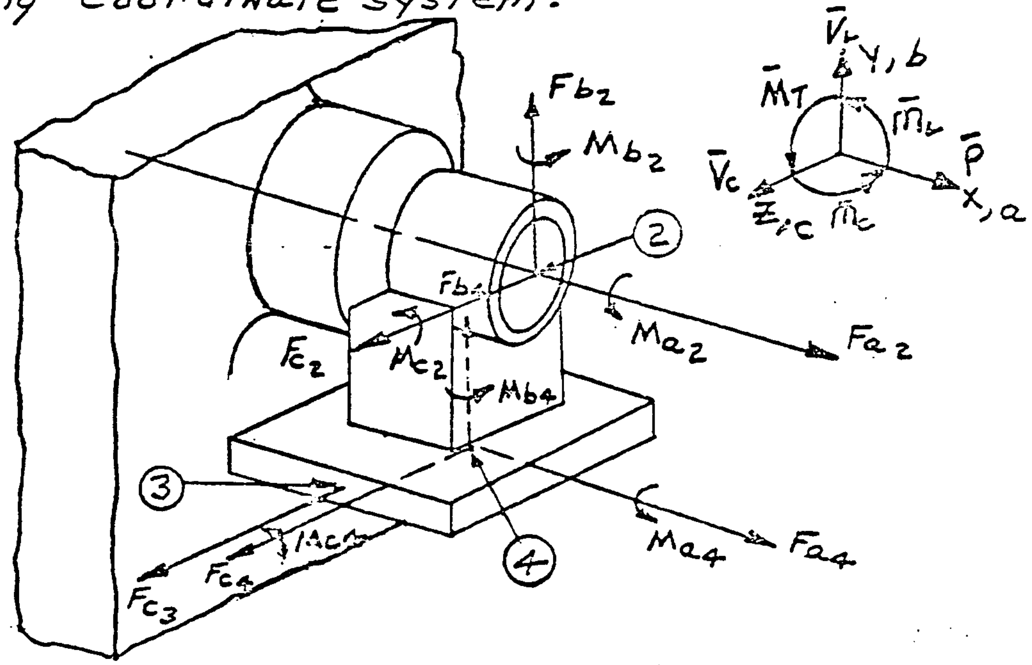
A. Nozzle Geometry

1. Dimensions

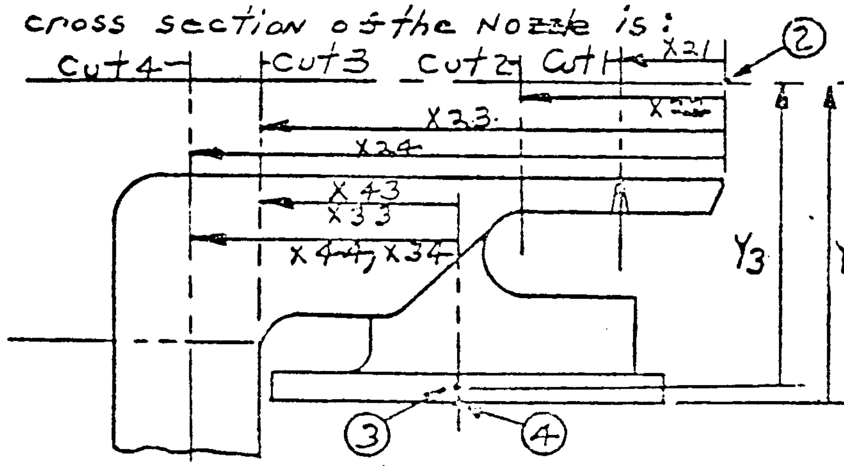
Dimensions of the inlet nozzle are shown in RS-201 (Ref. 33)

2. Load Coordinate System

External Loads are applied to the nozzle in the following coordinate system.



A cross section of the nozzle is:



$X_{21} = 6.602$
$X_{22} = 10.914$
$X_{23} = 28.602$
$X_{24} = 33.977$
$X_{43}, X_{33} = 16.486$
$X_{44}, X_{34} = 21.861$
$Y_3 = 37.020$
$Y_4 = 39.12$

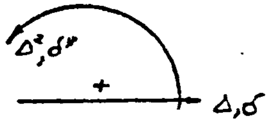
B

6. DETAILED ANALYSIS

D. INTERACTION ANALYSIS

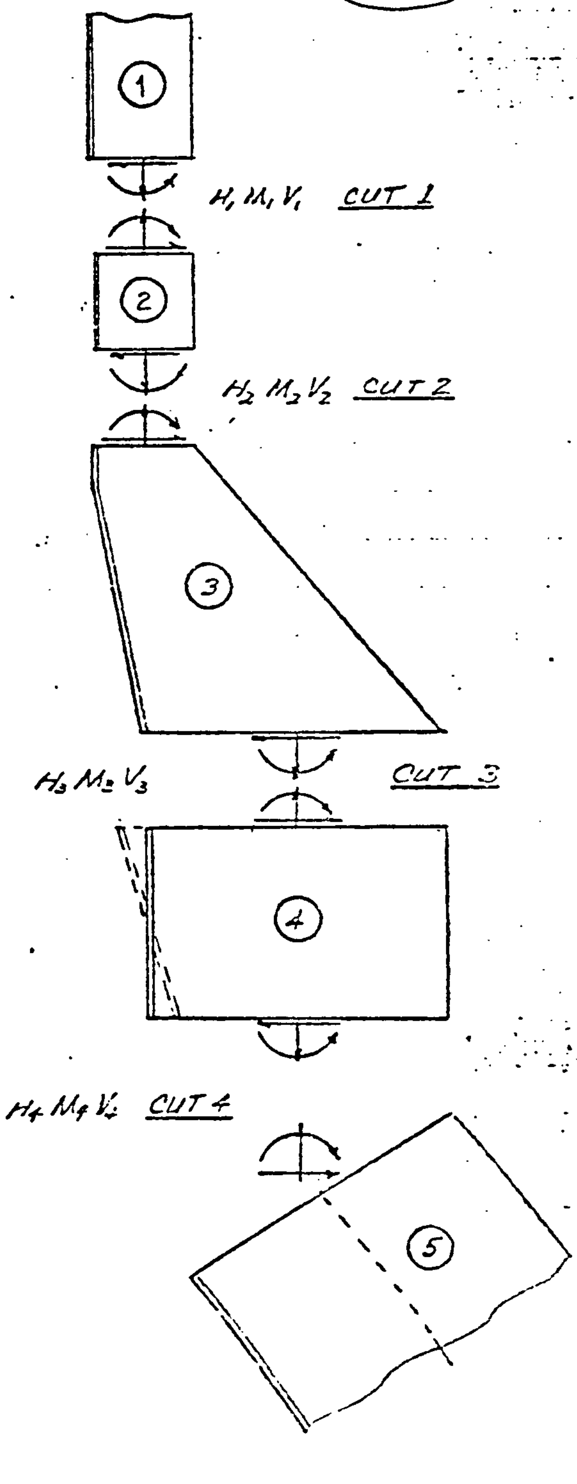
1. ANALYTICAL MODEL

THE ACTUAL STRUCTURE IS DIVIDED INTO THE ANALYTICAL MODEL SHOWN. THE ASSUMED DIRECTIONS OF REDUNDANTS ARE SHOWN BELOW.



ELEMENT (1) — LONG CYLINDER
ELEMENT (2) — SHORT CYLINDER
ELEMENT (3) — RING
ELEMENT (4) — SHORT CYLINDER
ELEMENT (5) — LONG SPHERE

H_1 THRU H_4 AND M_1 THRU M_4 ARE REDUNDANT FORCES NECESSARY FOR ELASTIC CONTINUITY OF THE NOZZLE. THESE FORCES ARE DETERMINED BY THE INTERACTION ANALYSIS.



PFR NO. 240[illegible]-[illegible]-0017

REVISION -

POTENTIAL FINDING REPORT
SONGS 2&3 SEISMIC DESIGN VERIFICATION

A. PREPARATION BY GA INITIATOR

AFFECTED ITEMS: The engineered safety features system control panel (panel 2CR57) of the I&C System.

REQUIREMENT REFERENCE DOCUMENTS: The Bechtel Power Corporation specification for control room and field mounted panels, specification number SO23-502-5 with Addenda I, II, and III.

BASIC REQUIREMENT: That the acceleration level at device mounting points on the panel not exceed 3 "G" in any direction when the panel is exposed to the control room floor (30' elevation) DBE response spectra (section 4.6.5.4 of Addendum I to the specification).

DESCRIPTION OF POTENTIAL FINDING: The specification fails to require the vendor to consider the dynamic interaction of cabinets arranged in the specific manner of the San Onofre Control Room cabinets. Such dynamic interaction may produce mode shapes resulting in excessive g levels during seismic excitation.

PREPARED BY: Stan Rodkin DATE: 1-17-82

REJECTION OF GA TASK LEADER COMMENTS BY: ____ DATE: ____

REJECTION OF ORIGINAL DESIGN ORG. COMMENTS BY: ____ DATE: 3-18-82

B. REVIEW BY GA TASK LEADER

COMMENTS

☑ AGREE PF IS VALID BY ____ DATE 1/18/82

☐ REQUEST RE-REVIEW BY ____ DATE ____

☐ DISAGREE BY ____ DATE ____

☑ REVIEW OF ORIGINAL DESIGN ORGS. COMMENTS BY: ____ DATE: 3/17/82

PFR NO. 2408-PFR-0017
REVISION ______

C. REVIEW BY ORIGINAL DESIGN ORGANIZATION — COMMENTS

See attached sheet.

☐ AGREE PF IS VALID

☒ DISAGREE

AEM SNF

BY: A K Rogers DATE: 1/21/82

D. RECOMMENDATION BY FINDINGS REVIEW COMMITTEE

DEFINITION ADEQUACY:	☒ ADEQUATE	☐ INADEQUATE
VALIDITY:	☒ VALID	☐ INVALID
~~10 CFR 21:~~	~~☐ NOT APPLICABLE~~	~~☐ APPLICABLE~~ SLK 3/24/82
~~10 CRF 50.55(e):~~	~~☐ NOT APPLICABLE~~	~~☐ APPLICABLE~~
CLASSIFICATION:	☒ OBSERVATION	☐ FINDING

JUSTIFICATION:

CLASSIFICATION CRITERION NO. RESULTING IN "FINDING" ______

COMMENT ON "OBSERVATION" CLASSIFICATION

Apparent deficiency in specification. However, based on recent analysis there is no safety problem

BY: S. L. Koutz DATE: 3/24/82

E. TPT PROJECT MANAGER

☒ ACCEPT

☐ REJECT

BY: GK Weisman DATE: 3/25/82

Specification S023-502-5 requires the vendor to consider the dynamic interaction of cabinets arranged in the specific manner of the San Onofre control room cabinets. The following paragraphs of the specification and addenda substantiate this statement: 4.9.1.1 (drawing number 53000 included with specification) and Appendix 4F, section C.3.2. Conference notes numbers 1466 and 1475 provide additional clarification.

Vendor understanding of this requirement is documented in the "Jelco Qualification Approach" attached to Wyle Test Procedure No. 3570 (Log No. S023-502-5-12), and in Wyle Report No. 54498-2 (Log No. S023-502-5-501), page 5, article 3.0; pages 6 through 9K; and page 15, Figure 1.

In conclusion, Wyle Test Report No. 58379 (Log No. S023-502-5-679) documents in-situ testing performed on control panel CR-57 installed at the San Onofre Nuclear Generating Station, bolted to the other control panels to form the horseshoe configuration. The test results show the first mode of CR-57 to be 28 hz.

Attachment to 2408-PFR-0017

Bechtel Power Corporation

Engineers – Constructors

12400 East Imperial Highway
Norwalk, California 90650
MAIL ADDRESS
P.O. BOX 60860 - TERMINAL ANNEX, LOS ANGELES, CALIFORNIA 90060
TELEPHONE (213) 864-6011

February 5, 1982
Log BX-7017

RECEIVED
G. L. WESSMAN
FEB 10 1982

FILE
COPY

Mr. George Wessman
Director of Torrey Pines Technology
Post Office Box 81608
San Diego, California 92138

Subject: Southern California Edison Company
San Onofre Nuclear Generating Station, Units 2 & 3
Bechtel Job 10079
TPT Independent Review of SONGS 2 & 3 Seismic Design
File: SO23-722-G

Enclosure: (1) Addendum 1 to Potential Finding Reports 2408-PFR-0015 and 2408-PFR-0017

Dear Mr. Wessman:

The enclosures are Bechtel's response to your Potential Finding Reports.

If you have any questions, please refer them through J. Hempe.

Very truly yours,

BECHTEL POWER CORPORATION

for H. F. McCluskey
Project Management
Los Angeles Power Division

CEM:jv

cc: Mr. J. J. Adrian, SCE

Attachment to
2408-PFR-0017
Addendum 1

Transmitted per BPC letter dated 2/5/1982 (Log BX-7017)

Specification S023-502-5 requires the vendor to consider the dynamic interaction of cabinets arranged in the specific manner of the San Onofre control room cabinets. The following paragraphs of the specification and addenda substantiate this statement: 4.9.1.1 (drawing number 53000 included with specification) and Appendix 4F, section C.3.2. Conference notes numbers 1466 and 1475 provide additional clarification.

Vendor understanding of this requirement is documented in the "Jelco Qualification Approach" attached to Wyle Test Procedure No. 3570 (Log No. S023-502-5-12), and in Wyle Report No. 54498-2 (Log No. S023-502-5-501), page 5, article 3.0; pages 6 through 9K; and page 15, Figure 1.

Bechtel reviewed and approved the Wyle Test Procedure including Jelco's Qualification Approach and the Wyle Report. A Bechtel comment on an earlier submittal of the Test Report No. 54498-1 (Log No. S023-502-5-167 which is included in and superceeded by Log No. S023-502-5-501) addressed the particular concerns: "The seismic qualification of the complete set of cabinets attached together must be presented before approval of this document can be given." The final submittal of the Wyle Report No. 54498-2 addresses the dynamic interaction of the control panels arranged in the specific arrangement of the San Onofre Control Room. This report was reviewed by Bechtel and the statement that adjacent sections will add stiffness and tend to reduce the response of the cabinet was consistent with Bechtel's experience. Consequently the report was accepted.

Wyle Test Report No. 58379 (Log No. S023-502-5-629) documents in-situ testing performed on control panel CR-57 installed at the San Onofre Nuclear Generating Station, bolted to the other control panels to form the horseshoe configuration. This in-situ testing was performed to provide assurance that the final as-built panels would remain acceptable following necessary field modifications and with the specific objective to determine panel first mode frequencies. This test program confirmed the previous Bechtel and Wyle experience that the earlier seismic testing of a single panel section was conservative. The test results show the first mode of CR-57 to be 28 hz.

Attachment to 2408-PFR-0017

Supplementary Analysis in Response to PFR-0017

1. The floor response spectra (FRS) exhibit amplification (high energy content) within the following frequency ranges

   a) 0.5 to 5 cps, horizontal FRS with ZPA = 1.0g
   b) 0.5 to 7.5 cps, vertical FRS with ZPA = 0.75g

   This indicates that the input motion to the control cabinets does not contain driving frequencies higher than about 10 cps (see attached sketches no. SO23-SK-S-695 and 696). The discrete frequency content (.5 to 7.5 cps) of the floor acceleration response is derived from the "filtering effect" of the building response dominated by soil/structure interaction, and results in motion with no driving energy at the high frequency range, i.e., $f \geq 10$ cps.

2. In-situ testing, Wyle Test Report No. 58379 (Log No. SO23-502-5-629), has demonstrated that the first mode frequency of the shipping section 1 is 28 Hz and that the first mode frequency of the shipping section 3 is 33 Hz. This means that both shipping sections can be considered as rigid under seismic event, particularly for the seismic input defined above. Therefore, from the tested frequency characteristics and given input it can be concluded that the amplification of the floor acceleration input through the cabinet structural system interaction with the instrument panel subsystems will be insignificant even when the subsystem/system high-valued frequencies are closely spaced and the mass ratios are low. Considering the panel subsystem frequency of 22.5 Hz, the responses at instrument mounting locations are predicated to be about 1g horizontal and 0.75g vertical, and certainly less than the stipulated 3g's.

3. A study was undertaken to demonstrate the foregoing assertions on insignificant interaction amplifications for the cabinets in question. The modal time-history method of analysis was used because the alternative response spectrum analysis is not adequate to recognize the phasing and algebraic sign of the modal responses which are relevant for this type of study.

   The model selected for the time-history analyses was a 2 DOF system with individual-mass frequencies of 22.5 and 28 cps representing the panel and the supporting structure, respectively. For the mass ratio a parametric evaluation was done utilizing values of 0.05, 0.005 and 0.0005. Table I gives the mass values and ratios derived from the components as described below:

   a) Primary mass = Shipping sections 1, 2, 3, 4, 5 and half of shipping section 6 = 21509

      Secondary mass = Panel and instruments of shipping section 3 = 1186

      Ratio = 0.0551

   b) Primary mass = Shipping sections 1, 2 and half of shipping section 3 = 10100

      Secondary mass = Panel of shipping section 3 = 551

      Ratio = 0.0545

1384-9724

c) Primary mass = Same as b above = 10100

Secondary mass = Panel of shipping section 3 scaled by total front panel area = 551 (36/84) = 236

Ratio = 0.023

Therefore, the mass ratios of 0.05, 0.005 and 0.0005 as selected conservatively encompass the actual mass ratios.

The time-history input used was the Auxiliary Building Control Area at elevation 30 acceleration records in X and Y directions.

Modal damping value was set at 2%.

The results of the analysis are shown in Table II. As expected the maximum acceleration of secondary mass is about 1.3g < 3.0 for a mass ratio of 0.0005. This mass ratio is estimated to be considerably lower than the actual mass ratios within the cabinets.

In addition to the above analysis utilizing actual frequencies that are characterized as a rigid system, another analysis was performed utilizing system frequencies shifted towards the amplification range of the floor response spectra. This shift was introduced by dividing the frequencies by ten. Table III gives the corresponding responses calculated for the same mass ratios considered before. Also given are the responses calculated by response spectrum analyses. The results confirm that significant amplification associated with system/subsystem interaction is relevant when the closely spaced frequencies are within the driving or amplification frequency range of the input motion. Also, it is evident that for response spectrum analysis in this case the combination of modal responses by algebraic summation rather than SRSS gives a more realistic evaluation.

2408-PTR-0017
3/22/82

TABLE I

Weights

Shipping Section	Weight of Instrument Panel No. (1)	Weight of Instrument No. (2)	Weight of Structure No. (3)	Mass Ratio (1) + (2) / (3)
1	719	659	4677	.29
2	454	643	3476	.32
3	551	635	3894	.30
4	442	578	3709	.28
5	698	828	4499	.34
6	703	459	7507	.46

From Wyle Test Report No. 54498-2

TABLE II

Results of Time History Analysis
$f_1 = 22.5$ cps, $f_2 = 28.0$ cps

a) X direction (horizontal) floor acceleration time history, ZPA = 0.908g, input

Mass Ratio	Subsystem (Secondary) Mass Response	
	Max. Acceleration (g)	Amplification Ratio
0.05	1.029	1.13
0.005	1.179	1.30
0.0005	1.215	1.34

b) Y direction (horizontal) floor acceleration time history, ZPA = 0.943g, input

Mass Ratio	Subsystem (Secondary) Mass Response	
	Max. Acceleration (g)	Amplification Ratio
0.05	1.107	1.17
0.005	1.226	1.30
0.0005	1.271	1.35

c) Vertical direction was not considered since the modal shapes of the closely spaced modes/frequencies do not suggest interaction in the vertical direction.

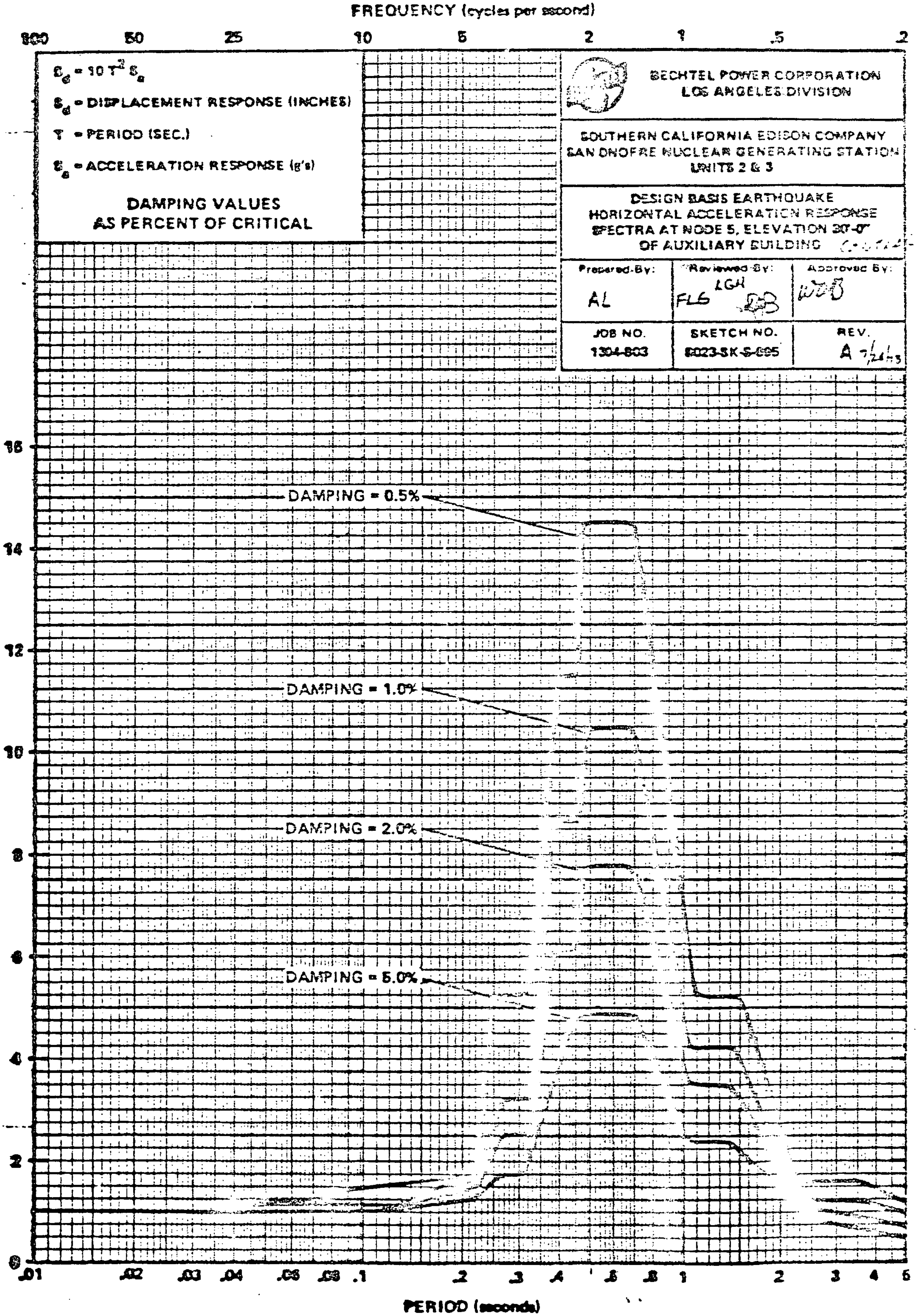
2408-14K-0011 3/22/82

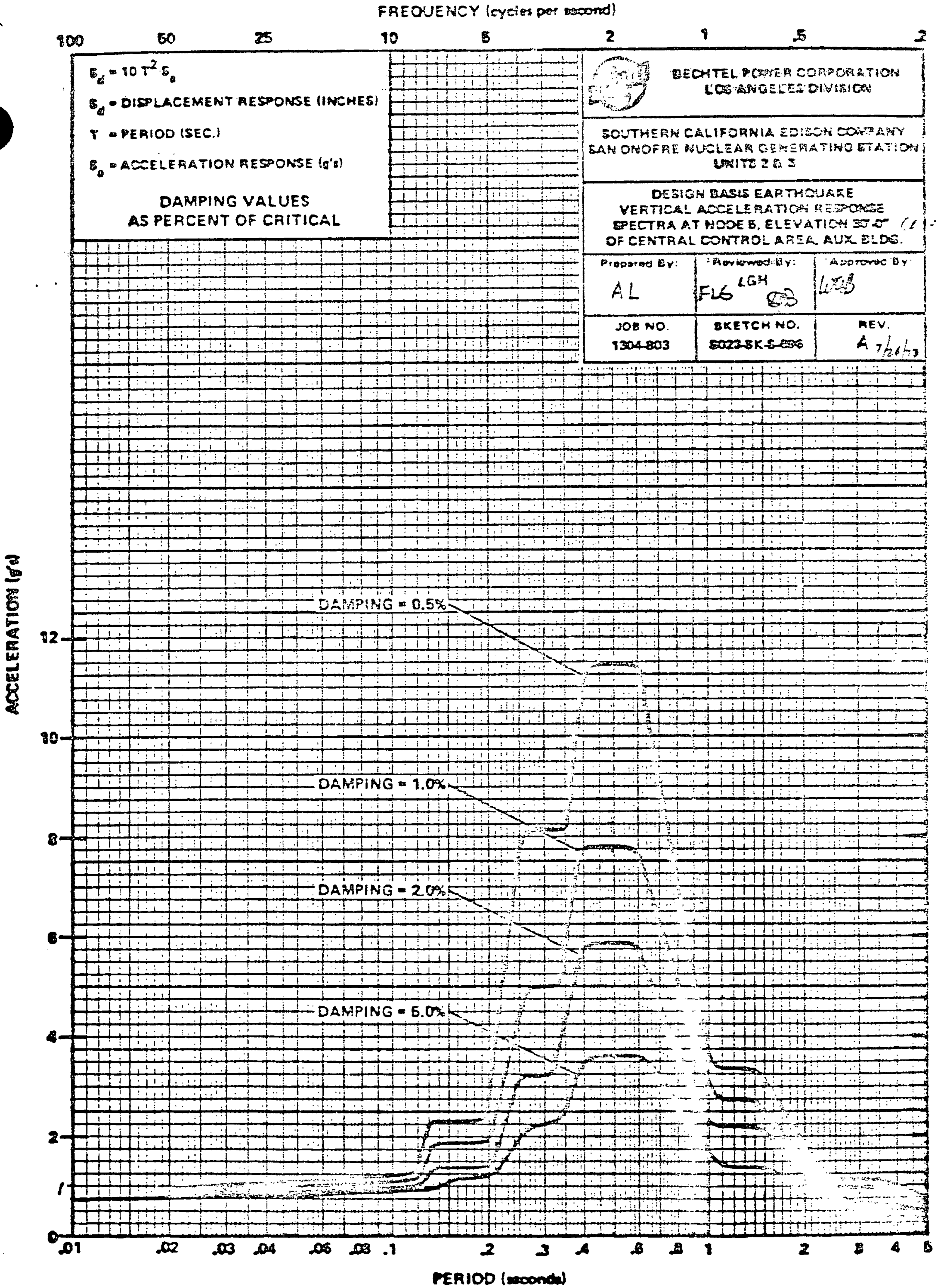
TABLE III

Results of Time History Analysis
f_1 = 2.25 cps, f_2 = 2.80 cps

a) Y direction (horizontal) floor acceleration time history, ZPA = 0.943g, input

Mass Ratio	Subsystem (Secondary) Mass Response		
	Time History Analysis Max. Acceleration (g)	Response Spectrum Analysis (g)	
		Algebraic Summation	SRSS
0.05	4.00	3.28	5.47
0.005	4.055	3.69	6.80
0.0005	4.175 4.43	3.74	7.01
		6.0 approx. from FRS @ 2.5 cps	


FREQUENCY (cycles per second)
100
50
25
10
5
2
1
.5
.2
$S_d = 10\,T^2\,S_a$
S_d = DISPLACEMENT RESPONSE (INCHES)
T = PERIOD (SEC.)
S_a = ACCELERATION RESPONSE (g's)
DAMPING VALUES
AS PERCENT OF CRITICAL
BECHTEL POWER CORPORATION
LOS ANGELES DIVISION
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3
DESIGN BASIS EARTHQUAKE
HORIZONTAL ACCELERATION RESPONSE
SPECTRA AT NODE 5, ELEVATION 30'-0"
OF AUXILIARY BUILDING
Prepared By:
AL
Reviewed By:
Approved By:
JOB NO.
1304-803
SKETCH NO.
8023-SK-S-695
REV.
A
ACCELERATION (g's)
16
14
12
10
8
6
4
2
0
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
.01
.02
.03
.04
.06
.08
.1
.2
.3
.4
.6
.8
1
2
3
4
5
PERIOD (seconds)



FREQUENCY (cycles per second)
100 50 25 10 5 2 1 .5 .2
$S_d = 10 T^2 S_a$
S_d = DISPLACEMENT RESPONSE (INCHES)
T = PERIOD (SEC.)
S_a = ACCELERATION RESPONSE (g's)
DAMPING VALUES AS PERCENT OF CRITICAL
BECHTEL POWER CORPORATION
LOS ANGELES DIVISION
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3
DESIGN BASIS EARTHQUAKE
VERTICAL ACCELERATION RESPONSE
SPECTRA AT NODE 5, ELEVATION 30'-0"
OF CENTRAL CONTROL AREA, AUX. BLDG.
Prepared By: AL
Reviewed By: FLG LGH
Approved By:
JOB NO. 1304-803
SKETCH NO. S023-SK-S-096
REV. A
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
12
10
8
6
4
2
1
0
.01 .02 .03 .04 .06 .08 .1 .2 .3 .4 .6 .8 1 2 3 4 5
PERIOD (seconds)

IMPACT ASSESSMENT

2403-PFR-F0017

PFR NO. ________

AFFECTED ITEM: Engineered Safety Systems Control Panel (CR-57)

1. IS THERE THE POTENTIAL FOR REDUCING DESIGN MARGINS TO THE EXTENT DESIGN ALLOWABLES ARE EXCEEDED OR DESIGN REQUIREMENTS ARE NOT MET?

   No

2. IS THERE THE POTENTIAL THAT THE ITEM MIGHT FAIL OR ENDANGER OTHER ITEMS DURING AN SSE?

   No

3. COULD THE FAILURE OF THIS ITEM DURING AN SSE CREATE A SUBSTANTIAL SAFETY HAZARD?

   Yes

4. COULD THE PROCEDURAL VIOLATION CREATE A SUBSTANTIAL SAFETY HAZARD?

   No

5. ARE OTHER SIMILAR DEVIATIONS LIKELY TO EXIST?

   No

6. OTHER COMMENTS: It is fortuitous that the cabinet does not appear to have a problem based upon subsequent analysis performed by BPC during their response to this PFR. Thus, there is no safety problem for the Engineered Safety Systems Control Cabinet CR-57. However, it is TPT's opinion that the PFR written against the design specification is valid because there are no instructions which lead the vendor to more specific requirements. It is TPT's opinion that the seismic qualification program performed by GELCO on this cabinet is of poor quality and may not meet industry standards.

PREPARED BY: R.E. Vollman DATE: 3-24-81

COMMENTS:

Agree with impact assessment.

Note that the initiator of the PFR (S. Rodkin) is offsite. Processing of this PFR was re-assigned to R. Vollman.

BY: [signature] DATE: 3/24/82

PFR-0017

INTERNAL CORRESPONDENCE
GA-1076

FROM:	R. Vollman	IN REPLY REFER TO:
TO:	Potential Findings Committee	DATE: March 24, 1982
SUBJECT:	PFR-0017 Impact Assessment on Seismic Qualification of Control Cabinet CR-57	

SUMMARY

A time history analysis of a 2 DOF model of the cabinet shows that amplified subsystem response is less than the required 3g's. Thus, there is no safety problem for the Engineered Safety Systems Control Cabinet CR-57. However, it is TPT's opinion that the PFR as written against the design spec is valid because there are no instructions in the specification which lead the vendor to more specific requirements. It is TPT's opinion that the seismic qualification program performed by GELCO on this cabinet is of poor quality and may not meet industry standards. The seismic qualification report was incomplete, and difficult to follow and interpret.

DISCUSSION

The description of the potential finding is repeated in what follows for reference purposes.

> "The specification fails to require the vendor to consider the dynamic interaction of cabinets arranged in the specific manner of the San Onofre Control Room cabinets. Such dynamic interaction may produce mode shapes resulting in excessive g levels during seismic excitation."

Excessive g levels are greater than 3g's.

The vendor who constructs these control cabinets is GELCO, formerly known as Circle A-W Products. They certified that the control cabinet met all the seismic requirements specified by Bechtel in the design specification based upon seismic testing performed at Wyle Labs under contract to GELCO.

The assertion of the PFR was based upon TPT's review of the design specification. BPC's response to this assertion is that it is their practice to write general design specifications for equipment and follow up later with specific instructions to the vendor relevant to the particular piece of equipment. In this case, BPC had two meetings with GELCO on January 6 and 28, 1976 to discuss these and other details. These meetings are documented in

conference notes 1466 and 1475 which were supplied to TPT in BPC's response to this PFR. BPC claims that this practice constitutes a complete specification since it was stipulated in these conference notes, among other things, that the whole horseshoe arrangement must be seismically qualified (ietm 4.(6) of CN No. 1475).

TPT disagrees with this assertion and feels that the specification does not lead to the conference notes. Thus, the thread of continuity is lacking. If the design specification stated that BPC must review and approve seismic qualification test plans and procedures, then the thread of continuity would exist. Thus, it is TPT's contention that the PFR is valid.

The configurations tested were portions of the total assembly, specifically shipping unit 3 of the double horseshoe arrangement shown in Figure 1. Shipping unit 3 with dummy weights attached to simulate internal equipment and guages was attached to a dynamic shaker table in the same manner as the actual installation in the Reactor Auxiliary Building. The first structural mode (front to back vibration) natural frequency was found to be 10 Hz. Two subsystems (Panels) modes were identified at 7.8 and 22.5 Hz. The maximum acceleration in the cabinet was found to be 2.2g's.

It was argued that the 10 Hz natural frequency was high enough to be outside the amplified response regions of the floor response spectra where the control cabinet was located. In fact, it was stated that when the cabinet pieces were assembled into the horseshoe arrangement the frequency would most assuredly increase lending further confidence that there would be no masses being vibrated above 3g's. This, is the extent of GELCO's work to satisfy Item 4.(6) of CN 1475 in which BPC instructed them to qualify the total horseshoe panel configuration.

The 22.5 Hz panel mode was not considered to be a problem because the frequency was to far into the near rigid zone of the floor response spectra. There does not appear to be any considertions of coupled vibration effects at the unknown higher installed frequencies.

The seismic qualification of the whole double horseshoe cabinet was based on the test and evaluation described above. There does not appear to be an approval by BPC's technical staff of this seismic qualification program. Acceptance appears to have been made at the project engineering level without staff reviews.

Later, after the cabinets were installed in the Auxiliary Building, BPC asked GELCO if additional equipment could be added to the cabinets without affecting the seismic qualification. The concern was that additional mass would lower the 10 Hz natural frequency into the amplified response region.

GELCO maintained that an in-situ test would need to be performed to find out. The in-situ test showed that cabinet 3 had a 33 Hz first fundamental frequency in the forward and backward mode and the cabinet 1 (Figure 1) had a corresponding frequency of 28 Hz. This raised the question by the reviewer as to whether the 22.5 Hz panel could be amplified beyond what the response spectra indicated by coubling with the 28 HZ structural mode assuming the same panel existed in shipping unit No. 1. Initial estimates indicated that the 3g limit could be exceeded if the mass ratio of the submass to the structural mass was low enough (about .01). Estimated values ranged from ~ .055 to ~ .02.

It was not clear from the poorly executed seismic test program and evaluation if this was a problem. BPC's feeling was that it is not a problem. However, quantifiable evidence was not available.

In BPC's response to this PFR an analysis was performed to quantify the amount of added amplification the panels experienced during a seismic event due to coupling. A two-degree-of-freedom model was made with frequencies tuned to 28 Hz and 22.5 Hz as shown in Figure 2. The acceleration time history used to generate the response spectra at the floor location nearest the cabinets was input. The mass ratio was varied in 3 steps of .05, .005, and .0005 to bound all possibilities. The highest amplified acceleration experienced by the small mass was 1.35g's at the smallest mass ratio. The lowest was 1.13g's. Assuming the cabinet was rigid and entering the response spectra at 22.5 Hz would have given a response of about 1.2g's. Thus, some coupling is occuring, but it is small because the energy level of the components of the earthquake in the neighborhood of 22.5 Hz at the floor of interest are low and do not excite the cabinets to a significant level.

To illustrate that low frequency systems are amplified, the 22.5 and 28 Hz frequencies were divided by 10 to give 2.25 and 2.8 Hz. The highest amplified response was 4.43g's from the time history analysis and 7.01g's using the floor response spectra. This shows the conservativeness generally found in the response spectra technique when compared with the more accurate time history results.

CONCLUSION

The PFR as written against the design specification is valid in TPT's opinion.

It is to be noted that during the review of this item it was judged by TPT that the seismic qualification program performed by GELCO is of poor quality and is probably not acceptable based on standards set by the industry. However, it is found by analysis that the cabinet subsystem response in qustion is below 3g's and meets the design specification requirements. Thus, there is no safety problem.

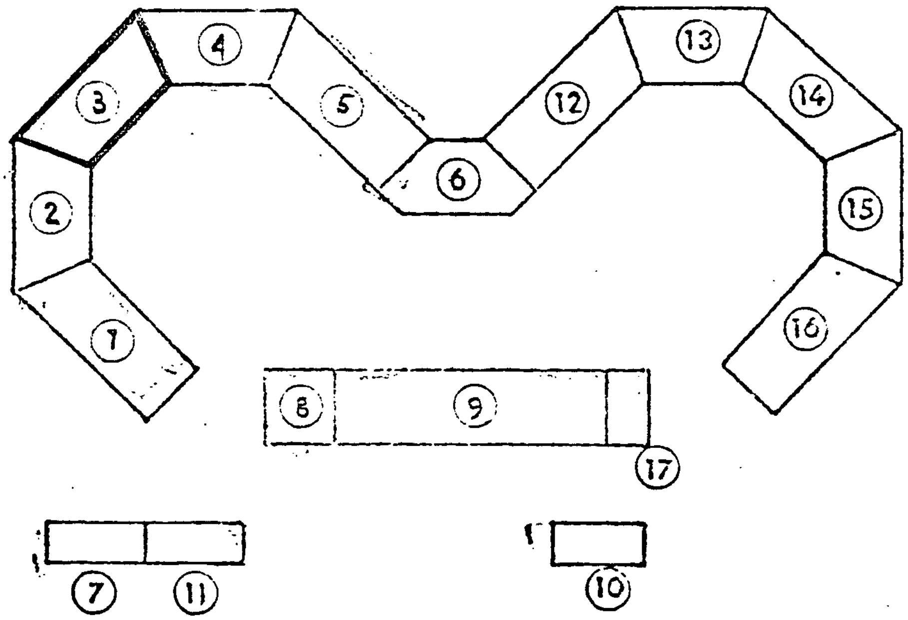
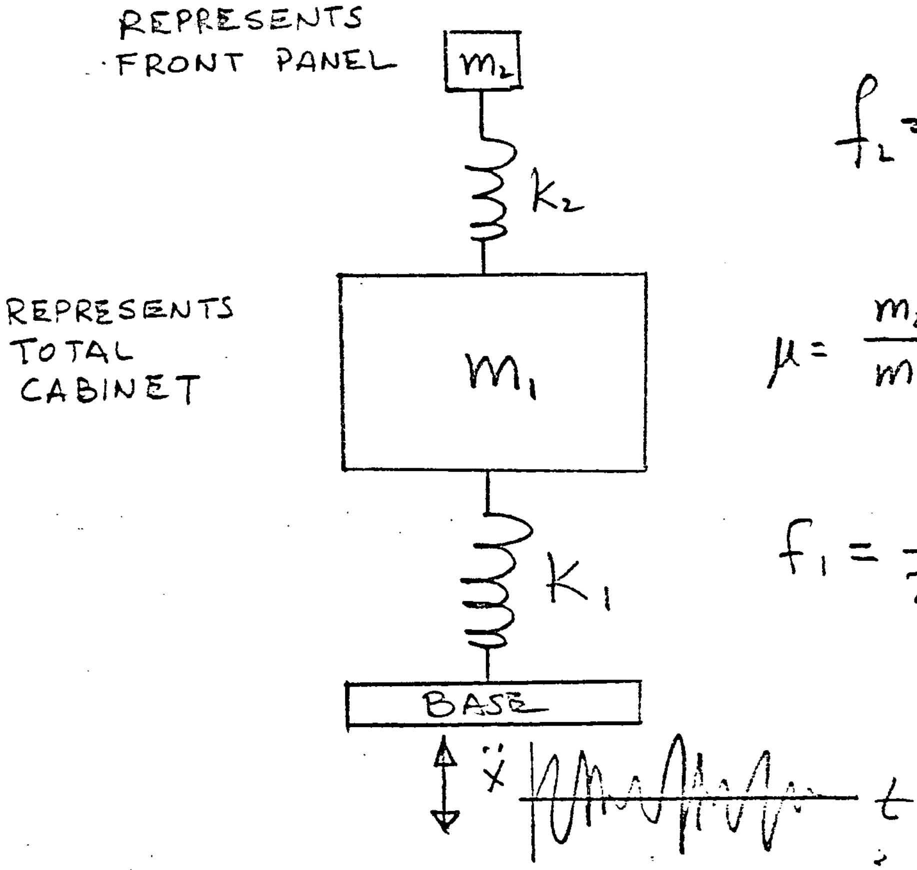


FIGURE 1

PLAN VIEW OF CONTROL CONSOLE

3408-PFR-C017
3/22/82



$$f_2 = \frac{1}{2\pi}\sqrt{\frac{k_2}{m_2}} = 22.5 \text{ hz}$$

$$\mu = \frac{m_2}{m_1} = \begin{cases} .05 \\ .005 \\ .0005 \end{cases}$$

$$f_1 = \frac{1}{2\pi}\sqrt{\frac{k_1}{m_1}} = 28 \text{ hz}$$

FIGURE 2

TWO DEGREE OF FREEDOM MODEL
SUBJECTED TO EARTQUAKE TIME HISTORY

GA-2077

TORREY PINES TECHNOLOGY A Division of General Atomic Company

Title: PROCEDURE FOR SEISMIC DESIGN TECHNICAL REVIEW (TASK C)

Doc. No. 2408-PD-6	Issue B	Date 1/25/82	Page 1 of 35

Issue Summary

Issue	Date	Prepared by	Department Approvals	Purpose of Issue/ Sections Changed
A	1/5/82	A. Veca/C. Dahms ARV CEO 1/5/82 1/5/82	F. S. Ople S. Bresnick G. L. Wessman	Original issue
B	1/25/82	A. Veca/C. Dahms ARV CEO 1/25/82 1/26/82	F. S. Ople S. Bresnick G. L. Wessman	General Revision

Notations in this column indicate where changes have been made

TABLE OF CONTENTS

Notations in this column indicate where changes have been made

I. Introduction

A. Purpose

To establish a uniform and comprehensive method to perform the seismic design technical review of selected safety-related structures, components, and systems of San Onofre Nuclear Generating Station Units 2 and 3. The objective of the review is to ascertain if the seismic design of the selected features is consistent with the NRC approved design basis and methodology specified in Sections 3.7 and 3.8 of the Final Safety Analysis Report (FSAR). As a guideline in the development of these procedures the following questions, as they relate to seismic design, from Section 6.3.1 of ANSI Standard N45.2.11-1974, "Quality Assurance Requirements for the Design of Nuclear Power Plants", were used: 1, 2, 3, 4, 6, 7, 8, 9, 15 (see Appendix A).

B. Design Documents

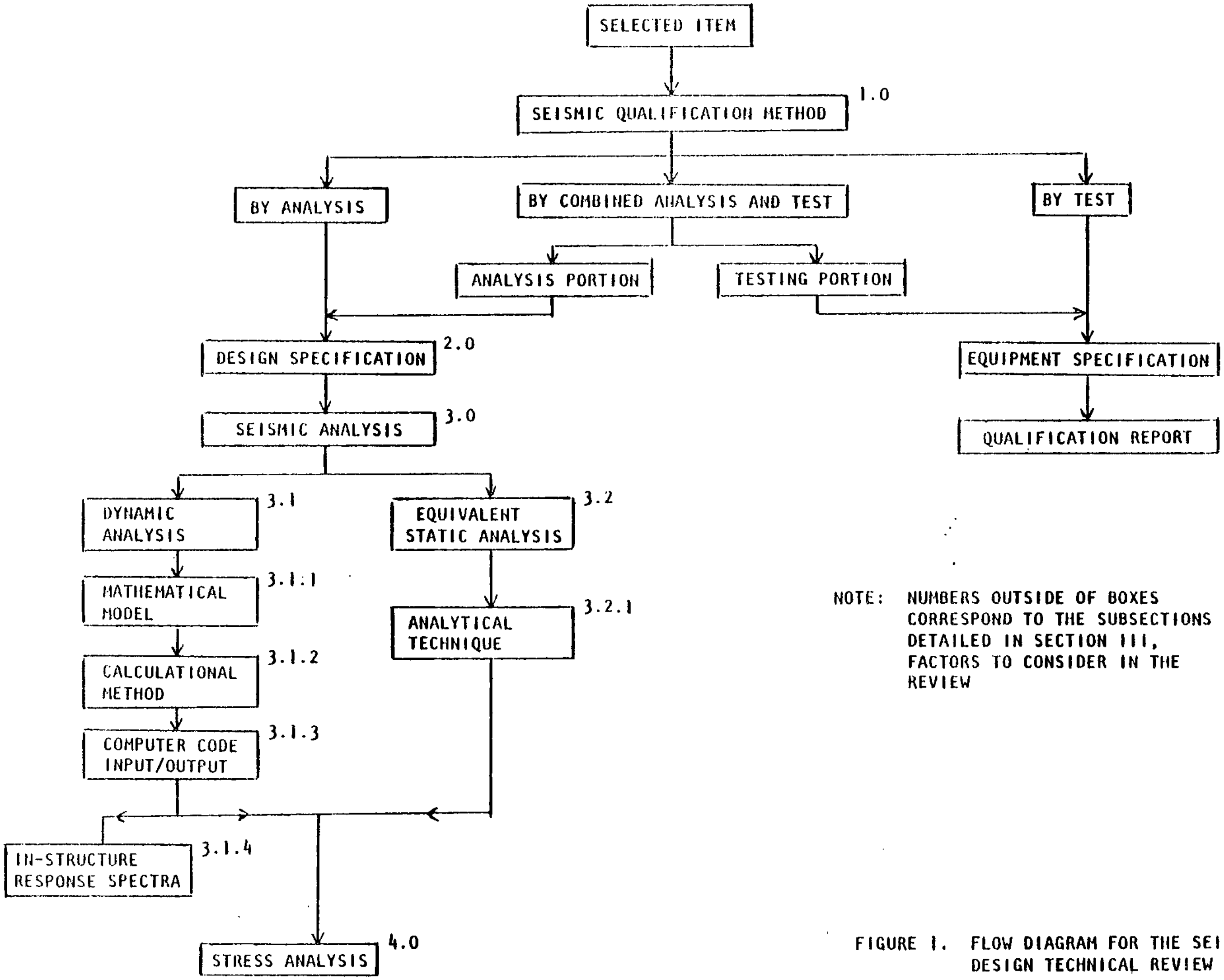
Design documents applicable to the item being reviewed shall be provided to the reviewer by the cognizant task leader. These consist of specifications, calculations, drawings, and design or qualification reports (including supporting documents and references, if necessary). All documents used in the review shall be obtained thru the Records Control Branch (RCB).

II. Instructions for Using the Procedure

A. Instructions

The reviewer shall use this procedure in conjunction with the flow diagram illustrated in Fig. 1. For the specific item to be reviewed, the reviewer shall determine the method of seismic qualification used, i.e., by analysis, by test, or by combined analysis and test. The reviewer shall proceed with the review following the steps applicable to the method of seismic qualification shown on the flow diagram.

The reviewer shall address the questions given in Appendix A, as they apply to each step of the review process, by utilizing a list of factors considered important in a technical review of seismic design. Section III provides the lists of factors under six categories: structures, piping and supports, cable raceways and supports, components, equipment, and cables. The lists of factors are cross-referenced to the flow diagram and the ANSI N45.2.11-1974, Section 6.3.1 basic questions, where applicable.



NOTE: NUMBERS OUTSIDE OF BOXES CORRESPOND TO THE SUBSECTIONS DETAILED IN SECTION III, FACTORS TO CONSIDER IN THE REVIEW

FIGURE I. FLOW DIAGRAM FOR THE SEISMIC DESIGN TECHNICAL REVIEW

Unless otherwise specified by the cognizant task leader the scope of the review of procured items (i.e. items supplied by vendors or subcontractors to BPC, CE or SCE) shall be limited to the review of seismic requirements in the equipment specification or equivalent document.

A check list for performing the review is included in Appendix B. The check list is applicable to all categories of review items and is consistent with the list of factors in Section III. The check list shall be updated and kept current by checking the appropriate columns as the review of each factor is completed.

B. Potential Findings

If a discrepancy is detected as a result of work performed under this Procedure, a Potential Finding Report (PFR) shall be initiated in accordance with Document No. 2408-PD-3, unless the discrepancy is so insignificant that it could not conceivably directly or indirectly create a substantial safety hazard.

Notations in this column indicate where changes have been made

III. Factors to Consider in the Review

ANSI N45.2.11 Basic Questions (Appendix A)

A. Structures

This section provides the list of factors to be considered in the review of structures. Included within the category are buildings, structural frames, equipment supports, racks and panels.

1.0 Seismic Qualification Method

The commonly used method of seismic qualification for structures is by analysis.

2.0 Seismic Design Specification

Review the design specification or equivalent document for the following: 1,3,4,6,15

2.1 Seismic requirements comply with applicable codes, regulations and standards (e.g. FSAR, AISC, Reg. Guides).

2.2 Input seismic motion in terms of time history or response spectra is correctly specified.

2.2.1 Enveloping method

2.2.2 Peak widening

2.2.3 Traceability to a source document

2.3 Damping

2.3.1 Bases for damping values used.

2.3.2 Compliance with applicable regulations and standards.

Notations in this column indicate where changes have been made

ANSI N45.2.11
Basic
Questions
(Appendix A)

3.0 Seismic Analysis — 7

Determine method used in performing the seismic analysis, i.e., dynamic analysis or equivalent static analysis.

3.1 Dynamic Analysis

3.1.1 Mathematical Model — 1,2,6

Review the mathematical model for reasonableness of:

3.1.1.1 Parameters of structures.

3.1.1.1.1 Mass distribution.

3.1.1.1.2 Stiffness.

3.1.1.1.3 Damping.

3.1.1.1.4 Non-symmetric torsional effects.

3.1.1.1.5 Coupling of internal structures.

3.1.1.1.6 Decoupling criteria.

3.1.1.2 Soil modeling characteristics (where soil-structure interaction applies).

3.1.1.2.1 Soil medium parameters, shear modulus, shear wave velocity and modulus-strain relation.

3.1.1.2.2 Methods in computing soil spring stiffness.

.2.11

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3.1.1.2.3

3.1.1.2.4

3.1.1.3 Supp
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3.1.1.3.1

3.1.1.3.2

3.1.1.4 Mate

3.1.1.5 Assum
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3.1.2 Calculati

3.1.2.1 Revie
perfo

3.1.2.1.1

3.1.2.1.2

3.1.2.1.3

3.1.2.1.4

Notations in this column indicate where changes have been made

ANSI N45.2.11
Basic
Questions
(Appendix A)

3.1.2.2 Review hand calculations.

3.1.2.2.1 Purpose and scope of hand calculations.

3.1.2.2.2 Assumptions.

3.1.2.2.3 Accuracy.

3.1.2.2.4 Validity.

3.1.3 Computer Code Input/Output 1,6,8

3.1.3.1 Review input data for consistency with the mathematical model.

3.1.3.1.1 Assumptions.

3.1.3.1.2 Peak input acceleration (g-level).

3.1.3.1.3 Design response spectra and time history.

3.1.3.1.4 Directional components of ground motion.

3.1.3.1.5 Elevation of seismic input specified.

3.1.3.2 Review output for reasonableness when compared with input data.

3.1.3.2.1 Natural frequencies.

3.1.3.2.2 Mode shapes.

3.1.3.2.3 Maximum relative displacement.

3.1.3.2.4 Maximum acceleration.

Notations in this column indicate where changes have been made

ANSI N45.2.11 Basic Questions (Appendix A)

3.1.3.2.5 Structural member forces (moments and shears).

3.1.3.2.6 Time histories and in-structure response spectra.

3.1.3.2.7 Conclusions.

3.2 Equivalent Static Analysis

3.2.1 Analytical Technique — 1,2,6,7

3.2.1.1 Mathematical Model, refer to 3.1.1.

3.2.1.2 Review the justification for equivalent static analysis method as applicable.

3.2.1.3 Review basis for equivalent "g" loading or ZPA with scale factor as appropriate.

4.0 Stress Analysis

For the selected critical areas and support, review: — 4,6,9,15

4.1 Loading combinations comply with FSAR, and AISC and ACI guidelines (assume all non-seismic loads are correct).

4.2 Calculated stresses comply with codes and standards (ASME, AISC, ACI or FSAR).

4.2.1 Stress combinations.

4.2.2 Code allowables and margins.

4.2.3 Conclusions and compliance to code requirements.

Notations in this column indicate where changes have been made

ANSI N45.2.11
Basic
Questions
(Appendix A)

4.3 Structural design of support anchor locations for selected components, piping and equipment, etc. to assure loads have been properly accounted.

4.4 Wherever applicable the feedback loads from component seismic analysis.

Notations in this column indicate where changes have been made

Notations in this column indicate where changes have been made

ANSI N45.2.11 Basic Questions (Appendix A)

B. Piping and Supports

This section provides the list of factors to be considered in the review for piping. Selected pipe supports will be reviewed for structural adequacy.

1.0 Seismic Qualification Method

The commonly used method of seismic qualification for piping and supports is by analysis.

2.0 Seismic Design Specification — 1,3,4,6,15

Review the design specification or equivalent document for the following:

2.1 Seismic requirements comply with applicable codes, regulations and standards (e.g., FSAR, ASME).

2.2 Input in-structure response spectra.

2.2.1 Enveloping method.

2.2.2 Peak widening.

2.2.3 Traceability to a source document.

2.3 Damping

2.3.1 Bases for damping values used.

2.3.2 Compliance with applicable regulations and standards.

Notations in this column indicate where changes have been made

ANSI N45.2.11
Basic
Questions
(Appendix A)

2.4 Anchor movements.

2.4.1 Movements are correctly specified.

2.4.2 Movements are traceable to a source document.

2.5 Piping class.

3.0 Seismic Analysis 7

Determine method used in performing the seismic analysis, i.e., dynamic analysis or equivalent static analysis.

3.1 Dynamic Analysis

3.1.1 Mathematical Model 1,2,6

Review the mathematical model for the bases and reasonableness of:

3.1.1.1 Boundaries of the selected piping system.

3.1.1.1.1 Branches.

3.1.1.1.2 Piping line designation.

3.1.1.2 Piping isometric comparison with piping layout drawings.

3.1.1.3 Physical properties.

3.1.1.3.1 Pipe size, diameter, wall thickness, insulation.

3.1.1.3.2 Weights (including water).

Notations in this column indicate where changes have been made

ANSI N45.2.11 Basic Questions (Appendix A)

3.1.1.4 Piping supports.

3.1.1.4.1 Location.

3.1.1.4.2 Type.

3.1.1.4.3 Direction.

3.1.1.5 Valves.

3.1.1.5.1 Location.

3.1.1.5.2 Mass distribution.

3.1.1.6 Material properties.

3.1.1.7 Assumptions and/or simplifications in developing the model.

3.1.2 Calculational Method 1,2,7

3.1.2.1 Review the code(s) used in performing the analysis.

3.1.2.1.1 Capabilities of the code.

3.1.2.1.2 Limitations of the code.

3.1.2.1.3 Applicability of the code.

3.1.2.1.4 Validation documentation. (For computer codes used in several analyses under review, only one reviewer shall review the validation documentation. This review shall then be referenced by the other reviewers.)

ANSI N45.2.11
Basic
Questions
(Appendix A)

3.1.2.2 Review hand calculations.

3.1.2.2.1 Purpose and scope of hand calculations.

3.1.2.2.2 Assumptions.

3.1.2.2.3 Accuracy.

3.1.2.2.4 Validity.

3.1.3 Computer Code Input/Output — 1,6,8

3.1.3.1 Review input data for consistency with the mathematical model.

3.1.3.1.1 Assumptions

3.1.3.1.2 Peak acceleration.

3.1.3.1.3 In-structure response spectra.

3.1.3.2 Review output for reasonableness when compared with input data.

3.1.3.2.1 Modes analyzed.

3.1.3.2.2 Frequency range.

3.1.3.2.3 Loads.

3.1.3.2.4 Displacements

3.1.3.2.5 Conclusions.

Notations in this column indicate where changes have been made

ANSI N45.2.11 Basic Questions (Appendix A)

3.2 Equivalent Static Analysis

3.2.1 Analytical Technique — 1,2,6,7

3.2.1.1 Mathematical Model, refer to 3.1.1.

3.2.1.2 Review the justification for the equivalent static analysis method.

3.2.1.3 Review basis for the equivalent "g" loading or ZPA as appropriate.

4.0 Stress Analysis — 4,6,9,15

For the selected critical areas and supports, review:

4.1 Calculated loads comply with FSAR and ASME code (assume all non-seismic loads are correct).

4.1.1 Loading tables.

4.1.2 Allowable loads.

4.1.3 Conclusion and compliance with code requirements.

4.2 Calculated stresses comply with codes and standards (ASME or FSAR).

4.2.1 Stress tables.

4.2.2 Code allowables.

4.2.3 Conclusions and compliance to code requirements.

Notations in this column indicate where changes have been made

ANSI N45.2.11
Basic
Questions
(Appendix A)

4.3 Pipe support anchor loads have been properly integrated into the building structural design.

Notations in this column indicate where changes have been made

Notations in this column indicate where changes have been made

ANSI N45.2.11
Basic
Questions
(Appendix A)

C. Cable Raceways and Supports

This section provides the list of factors to be considered in the review of cable raceways and supports.

1.0 Seismic Qualification Method

The commonly used method for the seismic qualification of cable raceways and supports is by analysis.

2.0 Seismic Design Specification — 1,3,4,6,15

Review the design specification or equivalent document for the following:

2.1 Seismic requirements comply with codes, regulations and standards (e.g., FSAR, ASME).

2.2 Input in-structure response spectra.

2.2.1 Enveloping method.

2.2.2 Peak widening.

2.2.3 Traceability to a source document.

2.3 Damping

2.3.1 Bases for damping values used.

2.3.2 Compliance with applicable regulations and standards.

Notations in this column indicate where changes have been made

	ANSI N45.2.11 Basic Questions (Appendix A)
3.0 <u>Seismic Analysis</u>	7

Determine method used in performing the seismic analysis, i.e., dynamic analysis or equivalent static analysis.

3.1 Dynamic Analysis

3.1.1 Mathematical Model — 1,2,6

Review the mathematical model for reasonableness of:

3.1.1.1 Boundaries of the selected cable raceway system.

3.1.1.2 Physical properties.

3.1.1.2.1 Raceway size, thickness, diameter.

3.1.1.2.2 Weights.

3.1.1.3 Location of supports.

3.1.1.4 Material properties.

3.1.1.5 Assumptions and/or simplifications in developing the model.

3.1.2 Calculational Method — 1,2,7

3.1.2.1 Review the code(s) used in performing the analysis.

3.1.2.1.1 Capabilities of the code.

3.1.2.1.2 Limitations of the code.

3.1.2.1.3 Applicability of the code.

ANSI N45.2.11
Basic
Questions
(Appendix A)

3.1.2.1.4 Validation documentation. (For computer codes used in several analyses under review, only one reviewer shall review the validation documentation. This review shall then be referenced by the other reviewers.)

3.1.2.2 Review hand calculations.

3.1.2.2.1 Purpose and scope of hand calculations.

3.1.2.2.2 Assumptions.

3.1.2.2.3 Accuracy.

3.1.2.2.4 Validity.

3.1.3 Computer Code Input/Output — 1,6,8

3.1.3.1 Review input data for consistency with the mathematical model.

3.1.3.1.1 Assumptions.

3.1.3.1.2 Peak acceleration.

3.1.3.1.3 In-structure response spectra.

3.1.3.2 Review output for reasonableness when compared with input data.

3.1.3.2.1 Modes analyzed.

3.1.3.2.2 Frequency range.

3.1.3.2.3 Loads.

Notations in this column indicate where changes have been made

	ANSI N45.2.11 Basic Questions (Appendix A)
3.1.3.2.4 Displacements.	
3.1.3.2.5 Conclusions.	
3.2 <u>Equivalent Static Analysis</u>	
3.2.1 Analytical Technique	1,2,6,7
3.2.1.1 Mathematical Model, refer to 3.1.1.	
3.2.1.2 Review the justification for the equivalent static analysis method.	
3.2.1.3 Review basis for the equivalent "g" loading or ZPA as appropriate.	
4.0 <u>Stress Analysis</u>	4,6,9,15

For the selected critical areas and supports, review:

4.1 Calculated loads comply with FSAR and AISC code (assume all non-seismic loads are correct).

4.1.1 Loading tables.

4.1.2 Code allowable.

4.1.3 Conclusion and compliance to code requirements.

4.2 Calculated stresses comply with codes and standards (AISC or FSAR).

4.2.1 Stress combinations.

4.2.2 Code allowables.

4.2.3 Conclusions and compliance to code requirements.

ANSI N45.2.11
Basic
Questions
(Appendix A)

4.3 Cable raceway support loads have been properly integrated into the building structural design.

Notations in this column indicate where changes have been made

Notations in this column indicate where changes have been made

ANSI N45.2.11
Basic
Questions
(Appendix A)

D. Components

This section provides list of factors to be considered in the review of mechanical components. Included in this category are valves, pressure vessels, tanks, pumps, steam generators, etc.

1.0 Seismic Qualification Method

The commonly used method for the seismic qualification of major mechanical components is by analysis. Where qualification by test is used for mechanical components, Section III-E shall apply.

2.0 Seismic Design Specification — 1,3,4,6,15

Review the design specification or equivalent document for the following:

2.1 Seismic requirements comply with codes, regulations and standards (e.g., FSAR, ASME).

2.2 Input in-structure response spectra is correctly specified.

2.2.1 Enveloping method.

2.2.2 Peak widening.

2.2.3 Traceability to a source document.

2.3 Damping

2.3.1 Bases for damping values used.

2.3.2 Compliance with applicable regulations and standards.

Notations in this column indicate where changes have been made

ANSI N45.2.11
Basic
Questions
(Appendix A)

3.0 Seismic Analysis 7

Determine method used in performing the seismic analysis, i.e., dynamic analysis or equivalent static analysis.

3.1 Dynamic Analysis

3.1.1 Mathematical Model 1,2,6

Review the mathematical model for reasonableness of:

3.1.1.1 Physical properties

3.1.1.1.1 Weight
3.1.1.1.2 Stiffness
3.1.1.1.3 Damping
3.1.1.1.4 Location of supports
3.1.1.1.5 Geometry
3.1.1.1.6 Boundary conditions.

3.1.1.2 Material properties.

3.1.1.3 Assumptions and/or simplifications in developing the model.

3.1.2 Calculational Method 1,2,7

3.1.2.1 Review the computer code(s) used in performing the analysis.

3.1.2.1.1 Capabilities of the code(s).

3.1.2.1.2 Limitations of the code(s).

3.1.2.1.3 Applicability of the code(s).

ANSI N45.2-11
Basic
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(Appendix A)

3.1.2.1.4 Validation documentation. (For computer codes used in several analyses under review, only one reviewer shall review the validation documentation. This review shall then be referenced by the other reviewers.)

3.1.2.2 Review hand calculations.

3.1.2.2.1 Purpose and scope of hand calculations.

3.1.2.2.2 Assumptions.

3.1.2.2.3 Accuracy.

3.1.2.2.4 Validity.

3.1.3 Computer Code Input/Output 1,6,8

3.1.3.1 Review input data for consistency with mathematical model.

3.1.3.1.1 Assumptions.

3.1.3.1.2 Peak acceleration.

3.1.3.1.3 In-structure response spectra.

3.1.3.2 Review output for reasonable when compared with input data.

3.1.3.2.1 Natural frequencies.

3.1.3.2.2 Mode shapes.

3.1.3.2.3 Maximum relative displacement.

Notations in this column indicate where changes have been made

Notations in this column indicate where changes have been made

ANSI N45.2.11 Basic Questions (Appendix A)

3.1.3.2.4 Structure member forces (moments and shears)

3.1.3.2.5 Conclusions.

3.2 Equivalent Static Analysis

3.2.1 Analytical Techniques — 1,2,6,7

3.2.1.1 Mathematical Model, refer to 3.1.1.

3.2.1.2 Review the justification for equivalent static analysis method as applicable.

3.2.1.3 Review basis for equivalent "g" loading or ZPA as appropriate.

4.0 Stress Analysis

For the selected critical areas, review: — 4,6,9,15

4.1 Loading combinations and loading tables comply with FSAR and ASME guidelines (assume all non-seismic loads are correct).

4.2 Calculated stresses comply with codes and standards (ASME, AISC or FSAR).

4.2.1 Stress combinations.

4.2.2 Code allowables and margins.

4.2.3 Conclusions and compliance to code requirements.

4.3 That support loads have been properly integrated into the building structural design.

Notations in this column indicate where changes have been made

ANSI N45.2.11 Basic Questions (Appendix A)

E. Equipment

This section provides the list of factors to be considered in the review of instruments, controls and electrical equipment.

1.0 Seismic Qualification Method

The commonly used method of seismic qualification for equipment is by test. Two types of test approaches utilized are (1) test to equipment level response spectra and (2) test to a maximum specified seismic level.

2.0 Seismic Equipment Specification — 1,2,3,4,6, 7,9,15

2.1 Equipment Tested to Equipment Level Response Spectra

Review the equipment specification or equivalent document for the following:

2.1.1 Seismic requirements comply with applicable codes, regulations and standards (e.g., FSAR, IEEE-344).

2.1.2 Specified equipment level response spectra is consistent with the in-structure response spectra taking into account mount design.

2.1.3 Input response spectra is traceable to a controlled source document.

2.1.4 Appropriate mounting interfaces are specified.

2.1.5 Operability requirements specified for active equipment.

ANSI N45.2-11
Basic
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(Appendix A)

2.2 Equipment tested to maximum seismic level.

Review the equipment specification or equivalent document for the following:

2.2.1 Seismic requirements comply with applicable codes, regulations and standards (e.g., FSAR, IEEE-344).

2.2.2 Selected item is listed.

2.3 For selected items, review that the mount design does not result in seismic response at the equipment level exceeding the test specification. Review the mount design using procedure for structures (Section III-A).

Notations in this column indicate where changes have been made

Notations in this column indicate where changes have been made

ANSI N45.2.11
Basic
Questions
(Appendix A)

F. Cables

This section provides the procedure for performing the review of control, instrumentation and electrical cables.

1.0 Seismic Review Method — 1,2,3,4,6, 9,15

Review the cable routing for selected safety related cables to insure that they are routed in Seismic Category 1 raceways.

Notations in this column indicate where changes have been made

IV. Review Evaluation Report

A Review Evaluation Report (RER) shall be prepared by the reviewer for the item reviewed. The report shall have a unique number assigned by the project manager. Prior to issue, the report shall be approved by the appropriate cognizant task leader and the project manager. The report shall be written as soon as the review is complete and shall be revised based on the resolution of the Potential Findings and Impact Assessment Report if required.

A. Cover Page

Use form GA-2077.

B. Description

Give item name and identifying number(s).

Briefly describe the item and identify the organization responsible for the feature, i.e., CE, BPC, and if sub-contracted, identify vendor and/or subcontractor.

C. Documents Reviewed

List all documents including specifications, calculations, reports, drawings, sketches, references, etc. Revision number and GAC log number shall also be noted.

D. References

List all documents, drawings, reports, books, etc. used as references in performing the review.

E. Computer Codes

List all computer codes and versions that were used in performing the analysis that was reviewed. Reference of the review of the validation documentation for the codes shall be included.

F. Discussion

Briefly describe the manner in which the review was carried out highlighting any assumptions, simplifications, analytical checks, etc. made during the review. Include any hand calculations made during the review. Refer to specific factors to be considered under the appropriate category in Section III of this procedure.

G. Potential Findings

Discuss and attach each Potential Finding made during the review.

H. Conclusion

This will take one of two forms depending on the results of the review.

1. If the review resulted in no Potential Findings, the conclusion is simply a statement saying that based on the review performed per the above discussion it is believed that the seismic design of the item in question is adequate within the bounds of the review.

2. If the review resulted in a Potential Finding(s), the Potential Finding(s) should be listed with a reference to the appropriate Potential Finding Report (PFR)* for processing and resolution. Conclusion will be based on the resolution of the Potential Finding and the Impact Assessment Report.

I. Review Check List

Include the review check list per Appendix B.

*See Document No. 2408-PD-3, Processing of Findings.

Notations in this column indicate where changes have been made

Notations in this column indicate where changes have been made

Appendix A - ANSI N45.2-11-1974, Section 6.3.1 Basic Questions

1. Were the inputs correctly selected and incorporated into design?

2. Are assumptions necessary to perform the design activity adequately described and reasonable? Where necessary, are the assumptions identified for subsequent re-verifications when the detailed design activities are completed?

3. Are the appropriate quality and quality assurance requirements specified?

4. Are the applicable codes, standards and regulatory requirements including issue and addenda properly identified and are their requirements for design met?

6. Have the design interface requirements been satisifed?

7. Was an appropriate design method used?

8. Is the output reasonable compared to inputs?

9. Are the specified parts, equipment, and processes suitable for the required application?

15. Are the acceptance criteria incorporated in the design documents sufficient to allow verification that design requirements have been satisfactorily accomplished?

GA 2076

I. Item Reviewed ______________________

II. Category ______________________

III. Checklist

Factor(1)	Review(2) Yes	No	N/A	PFR Item(3)	Remarks
1.0					
2.1					
2.1.1					
2.1.2					
2.1.3					
2.1.4					
2.1.5					
2.2.1					
2.2.2					
2.2.3					
2.3					
2.3.1					
2.3.2					
2.4.1					
2.4.2					
2.5					
3.1.1.1					
3.1.1.1.1					
3.1.1.1.2					
3.1.1.1.3					
3.1.1.1.4					
3.1.1.1.5					
3.1.1.1.6					
3.1.1.2					
3.1.1.2.1					
3.1.1.2.2					
3.1.1.2.3					
3.1.1.2.4					
3.1.1.3					
3.1.1.3.1					
3.1.1.3.2					
3.1.1.4					
3.1.1.4.1					
3.1.1.4.2					
3.1.1.4.3					
3.1.1.5					
3.1.1.5.1					
3.1.1.5.2					
3.1.1.6					

Notations in this column indicate where changes have been made

Notations in this column indicate where changes have been made

Factor(1)	Review(2)			PFR Item(3)	Remarks
	Yes	No	N/A		
3.1.1.7					
3.1.2.1.1					
3.1.2.1.2					
3.1.2.1.3					
3.1.2.1.4					
3.2.1.4					
3.1.2.2.1					
3.1.2.2.2					
3.1.2.2.3					
3.1.2.2.4					
3.1.3.1.1					
3.1.3.1.2					
3.1.3.1.3					
3.1.3.1.4					
3.1.3.1.5					
3.1.3.2.1					
3.1.3.2.2					
3.1.3.2.3					
3.1.3.2.4					
3.1.3.2.5					
3.1.3.2.6					
3.1.3.2.7					
3.2.1.1					
3.2.1.2					
3.2.1.3					
4.1					
4.1.1					
4.1.2					
4.1.3					
4.2.1					
4.2.2					
4.2.3					
4.3					
4.4					

Notes:

(1) Numbers correspond directly with factors listed in Section III.
(2) Check appropriate column - provide remarks is applicable.
(3) Identify items for which a PFR has been issued.

Reviewer Signature________________ Date(s) of Review________________

APPENDIX B- Seismic Design Technical Review Checklist

Notes

(1) Numbers correspond directly with factors listed in Section III.
(2) Check appropriate column - provide remarks is applicable.
(3) Identify items for which a PFR has been issued.

Reviewer Signature ______________________ Date(s) of Review ______________________

Notations in this column indicate where changes have been made