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MIRAGLIA,F. Licensing Branch 3

SUBJECT: Forwards responses to addl Equipment Qualification Branch questions re seismic qualification of equipment.Remaining info will be forwarded by 810417.

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K. P. BASKIN
MANAGER OF NUCLEAR ENGINEERING,
SAFETY, AND LICENSING

TELEPHONE
(213) 572-1401

April 6, 1981

RECEIVED
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U.S. NUCLEAR REGULATORY COMMISSION

Director, Office of Nuclear Reactor Regulation
Attention: Mr. Frank Miraglia, Branch Chief
Licensing Branch No. 3
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

Subject: Docket Nos. 50-361 and 50-362
San Onofre Nuclear Generating Station
Units 2 and 3

Enclosed are sixty-three (63) copies of responses to additional NRC Equipment Qualification Branch questions concerning the seismic qualification of equipment. These responses provide additional information requested by the seismic qualification review team during telephone conversations with SCE and SCE consultants on March 19 and 25, 1981. The remaining information requested will be provided by April 17, 1981.

If you have any questions or comments concerning this information, please contact me.

Very truly yours,

K P Baskin

Enclosures

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B001
S
1/63

Response to Questions Raised by NRC in Summary of SQRT Plant Site Review

1. Piping Tunnel Item 2 - 2HV-4714 Control Valve (BOP 19)

   a. Question:

   Provide justification for omission of nozzle loads in seismic qualification of Fisher Valve 2HV-4714 (BOP 19).

   Response:

   As noted in the FSAR, Table 3.9-17, note e.: "Valve nozzle (piping load) stress analysis is not required when both the following conditions are satisfied by calculation: the section modulus and metal area . . . at the valve body crotch . . . is at least 10 percent greater than the section modulus and metal area of the piping connected (or joined) to the valve body inlet and outlet nozzles; and (2) the allowable stress S for the valve body material is equal or greater than the allowable stress S of connected piping material."

   The above conditions have been met for the subject valve.

   b. Provide discussion of method used to establish RRS for in-line piping components and how the criteria is verified in the piping analysis.

   Response:

   The procurement specification for BOP in-line components provided two alternatives for establishing the required seismic qualification level:

   1. When the vendor could demonstrate that the lowest natural frequency of the in-line component is greater than 33 Hz. The in-line component was qualified by an equivalent static analysis using either:

      a. The maximum acceleration taken from the applicable 0.5 percent damping floor response spectra curve for frequencies greater than 7.2 Hz or,

      b. A maximum acceleration of 5.0 gs when the building elevation of the in-line component was not known.

   2. When the vendor could not demonstrate that the lowest natural frequency of the in-line component was greater than 33 Hz, the in-line component was qualified by test. The qualification procedure ensured that either:

      a. The TRS enveloped the applicable RRS at all frequencies or,

      b. A minimum acceleration of 5 gs was obtained at all frequencies.

Response to Additional NRC SQRT Audit Questions

1. Main Control Panel (BOP 7)

Question:

What specifications or requirements were used to determine allowable stresses for the cabinet members? Compare the stresses in the members analyzed to the allowables.

Response:

The design and fabrication of cabinet members of the main control panel are in compliance with the AISC specification for the Design, Fabrication and Erection of Structural Steel for Buildings. Allowable stresses for the DBE design condition must be less than 90 percent of the specified minimum yield of the material. Detailed calculations of member stresses are provided in Section 4 of the seismic qualification report, Wyle Report No. 5449B-2 which was selected by the Audit team for further review.

2. Shutdown Heat Exchanger (NSSS 26)

a. Question:

Is the heat exchanger an ASME coded vessel? If not, what standard was it designed to?

Response:

Sec. III (Shell Class 3 - Tube Class 2) TEMA Class "R."

b. Question:

Is the mass of the shutdown heat exchanger internals and fluid included in the computer model?

Response:

Yes, the mass of the shutdown heat exchanger internals and fluid are included in the computer model.

c. Question:

Provide justification for not evaluating the internal components of the SDHX in the seismic qualification report. Revise the SQRT form to show the correct load combinations as described in the qualification report.

Response:

Seismic forces on the heat exchanger internals are negligible compared to design hydrostatic and hydraulic forces. Specifically, the loads and resultant stresses on the tubesheet due to seismic acceleration of the tube bundle and water are less than 5% of the design loads and stresses. The maximum seismic tube stress is due to out-of-plane bending of the "U" bends which results in a primary membrane plus bending stress of less than 15% of the design allowable of 1.5 S.

Revision 1 of NSSS 26 SQRT form provides the correct loading combinations as described in the NUS qualification reports for the Shutdown Heat Exchanger.

Qualification Summary of Equipment

I. Plant Name: San Onofre Units 2&3 — Type:

1. Utility: Southern California Edison Company — PWR X
2. NSSS: CE — 3. A/E: Bechtel — BWR ______

II. Component Name: Shutdown Heat Exchanger

1. Scope: [X] NSSS [ ] BOP
2. Model Number: DWG CE-16644, 16645 Quantity: 4
3. Vendor: EFCO
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Vertical HX, exterior painted carbon steel
   b. Dimensions 30'1" long x 56" max OD, 32 3/4" tube nozzles, 36" shell nozzles
   c. Weight Dry 42,000 lbs; Operating 61,000 lbs
6. Location: Building: Safety Equipment Building
   Elevation: 15 ft. elev.
7. Field Mounting Conditions [X] Bolt (No. 16, Size 1 1/4" Ø)
   [ ] Weld (Length ______)
   [X] Seismic Lugs
8. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):
   S/S: >33 Hz F/B: >33 Hz
   V: >33 Hz
9. a. Functional Description: cool reactor coolant, cool ECCS sump water
   b. Is the equipment required for [ ] Hot Standby [X] Cold Shutdown
   [ ] Both ______
10. Pertinent Reference Design Specifications: CE Specification No. 1370-PE-301, Revision 03

III. Is Equipment Available for Inspection in the Plant: [X] Yes [ ] No

IV. Equipment Qualification Method: Test: ____

Analysis: X

Combination of Test and Analysis: ____

Test and/or Analysis by NUS Corp. TR-75-74 Report No. 1514 Rev. 1
(Name of Company or Laboratory & Report No.)

V. Vibration Input:

1. Loads considered: 1. [ ] Seismic only 2. [ ] Hydrodynamic only

3. [ ] Explosive only 4. [ ] Other (Specify) ____

5. [X] Combination of Seismic, Nozzle Loads, Hydrodynamic, Dead Weight

6. Method of combining RRS: [X] Absolute Sum [ ] SRSS
[ ] ____
(Other, Specify)

1

2. Required Response Spectra (attach the graphs): NA

3. Required Acceleration in Each Direction: ____

Horiz=DBE ± 1.2g V = DBE ± 1.1g

VI. If Qualification by Test, then Complete: NA

1. [ ] Single Frequency [ ] Multi-Frequency: [ ] random
[ ] sine beat
[ ] ____

2. [ ] Single Axis [ ] Multi-Axis

3. No. of Qualification Tests: OBE ____ SSE ____
Other ____
(Specify)

4. Frequency Range: ____

5. TRS enveloping RRS using Multi-Frequency Test [ ] Yes (plot TRS on RRS graphs)
[ ] No

6. Input g-level Test at:

S/S = ______
F/B = ______
V = ______

7. Laboratory Mounting: ______

1. [ ] Bolt (No. ______, Size ______) [ ] Weld (Length ______)
[ ] ______

8. Functional operability verified: [ ] Yes [ ] No [ ] Not Applicable

9. Test Results including modifications made: ______

10. Other tests performed (such as fragility test, including results): ______

VII. If Qualification by Analysis or by the Combination of Test and Analysis, then Complete:

1. Description of Test including Results: NA

2. Method of Analysis: ______

[X] Static Analysis *
[ ] Dynamic Analysis
[ ] Equivalent Static Analysis
[ ] Time-History
[ ] Response Spectrum

3. Model Type: [X] 3D** [ ] 2D [ ] 1D

[ ] Finite Element [X] Beam [ ] Closed Form Solution

** For Natural Frequency Determination

4. [X] Computer Codes: CDC's ~~Stardyne~~. NUS's PRECOM, COMBINE, and SANSAR

Frequency Range and No. of modes considered: $f_N > 33$ Hz

[ ] Hand Calculations

5. Method of Combining Dynamic Responses: [ ] Absolute Sum [ ] SRSS
[ ] Other: NA
(specify)

6. Damping: NA Basis for the damping used: NA

7. Support Considerations in the model: supports - fixed, seismic lugs - slotted

*Separate analyses were performed to determine the response in the horizontal and vertical directions. The resultant loads were combined on an absolute sum basis (2 components).

8. Critical Structural Elements:

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable
Upper Seismic Lug Bolts 1 1/2" Ø SA-325	Elevation 14' 9 1/8"	Seismic + Deadweight + Nozzle loads + Pressure	***	13911 psi (shear)	15390 psi (shear)

*** Included in Total

B.

Max. Deflection	Location	Effect Upon Functional Operability
NA		

3. Question:

Provide justification for deletion of the In-core Amplifier (NSSS 2g) from the SQRT list.

Response:

The In-Core Amplifier (NSSS Item 2G) is not required for safety as none of the system outputs are used for accident mitigation. The system is currently described in FSAR Section 7.7.1.7 and as such is not safety related. The In-Core Amplifier is wired IE but it will not degrade other IE equipment inside the cabinet enclosure during a seismic event.

4. <u>Question</u>:

Provide seismic qualification for pulsation dampers associated with the charging system (NSSS-25).

<u>Response</u>:

Enclosed you will find SQRT audit forms for the charging pump suction stabilizer and discharge pulsation dampers. These components were included in the piping analysis for the purpose of determining piping stresses and nozzle loads. The seismic qualification was in accordance with our procedure for in-line piping components discussed in our response to SQRT Audit Item BOP 19. Both components were qualified by analysis in accordance with option 1a of that procedure since these components were shown to have fundamental natural frequencies greater than 33 Hz.

Qualification Summary of Equipment

I. Plant Name: San Onofre Units 2&3 Type:

1. Utility: Southern California Edison Company PWR X

2. NSSS: CE 3. A/E: Bechtel BWR ____

II. Component Name: Charging Pump Suction Stabilizer

1. Scope: [ ] NSSS [X] BOP

2. Model Number: 831341 Quantity: 6

3. Vendor: Greer Hydraulics

4. If the component is a cabinet or panel, name and model No. of the devices included: N/A

5. Physical Description a. Appearance Cylinder w/flat heads

   b. Dimensions 10" x 1'-9" height

   c. Weight 168 lbs.

6. Location: Building: Radwaste Area (Control Building)

   Elevation: 9'-0"

7. Field Mounting Conditions [ ] Bolt (No.____, Size____)
   [ ] Weld (Length____)
   [X] In-line piping component, both ends welded

8. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S: 173 Hz, 261 Hz F/B: --
   V: 239 Hz

9. a. Functional Description: Stabilize Suction of Charging Pumps

   b. Is the equipment required for [ ] Hot Standby [ ] Cold Shutdown

   [X] Both

10. Pertinent Reference Design Specifications: SO23-407-14, Pulsation Dampeners for Charging Pumps

III. Is Equipment Available for Inspection in the Plant: [X] Yes [ ] No

IV. Equipment Qualification Method: Test: ______

Analysis: X

Combination of Test and Analysis: ______

Test and/or Analysis by Anamet Laboratories, Inc., Report No. 776.201, Bechtel Log SO23-407-14-23
(Name of Company or Laboratory & Report No.)

V. Vibration Input:

1. Loads considered: 1. [ ] Seismic only 2. [ ] Hydrodynamic only

   3. [ ] Explosive only 4. [ ] Other (Specify) ______

   5. [X] Combination of Seismic and Internal Pressure

   6. Method of combining RRS: [X] Absolute Sum [ ] SRSS
   [ ] ______ (Other, Specify)

2. Required Response Spectra (attach the graphs): X Appendix A

3. Required Acceleration in Each Direction: ______

   S/S = 1.65 g F/B = 1.65 g V = 1.25 g

VI. If Qualification by Test, then Complete: N/A

1. [ ] Single Frequency [ ] Multi-Frequency: [ ] random
   [ ] sine beat
   [ ] ______

2. [ ] Single Axis [ ] Multi-Axis (Bi-Axial)

3. No. of Qualification Tests: OBE ______ SSE ______
   Other ______ (Specify)

4. Frequency Range: ______

5. TRS enveloping RRS using Multi-Frequency Test [ ] Yes (plot TRS on RRS graphs)
   [ ] No

6. Input g-level Test at:

S/S = ______________________
F/B = ______________________
V = ______________________

7. Laboratory Mounting: ______________________

1. [ ] Bolt (No.______, Size______) [ ] Weld (Length____________)
[ ] ______________________

8. Functional operability verified: [ ] Yes [ ] No [ ] Not Applicable

9. Test Results including modifications made: ______________________

10. Other tests performed (such as fragility test, including results):

____

VII. <u>If Qualification by Analysis or by the Combination of Test and Analysis, then Complete</u>:

1. Description of Test including Results: N/A

2. Method of Analysis: ______________________

[X] Static Analysis
[ ] Dynamic Analysis
[ ] Equivalent Static Analysis
[ ] Time-History
[ ] Response Spectrum

3. Model Type: [X] 3D [ ] 2D [ ] 1D

[X] Finite Element [ ] Beam [ ] Closed Form Solution

4. [X] Computer Codes: SAP IV

Frequency Range and No. of modes considered: N/A

[ ] Hand Calculations

5. Method of Combining Dynamic Responses: [X] Absolute Sum [ ] SRSS
[ ] Other: ______________ (specify)

6. Damping: 0.5% Basis for the damping used: Damping in Piping System

7. Support Considerations in the model: Suction stabilizer mounted vertically in horizontal run of pipe. End conditions consistent with piping interface.

8. Critical Structural Elements: See Appendix B

A.

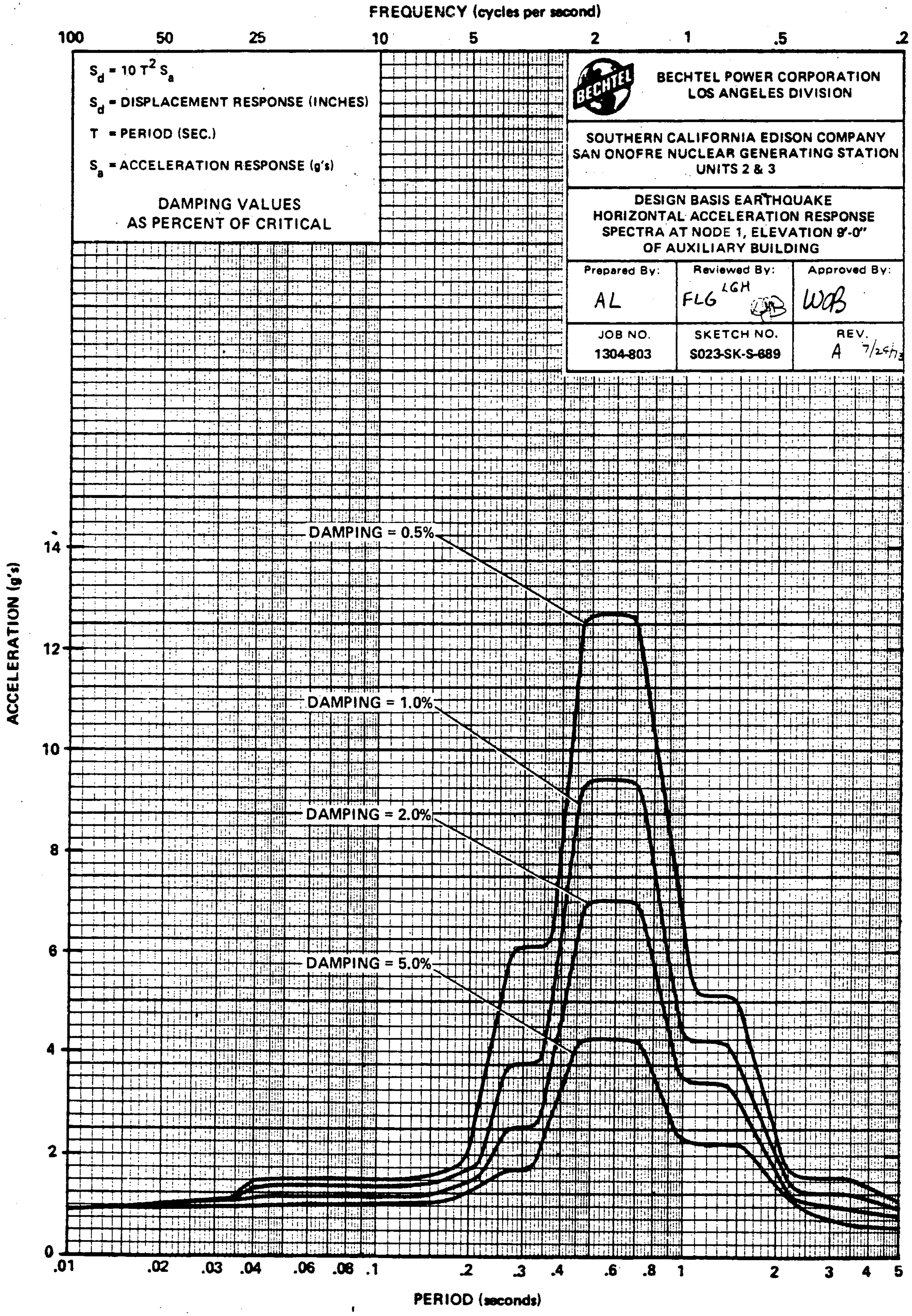
Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable

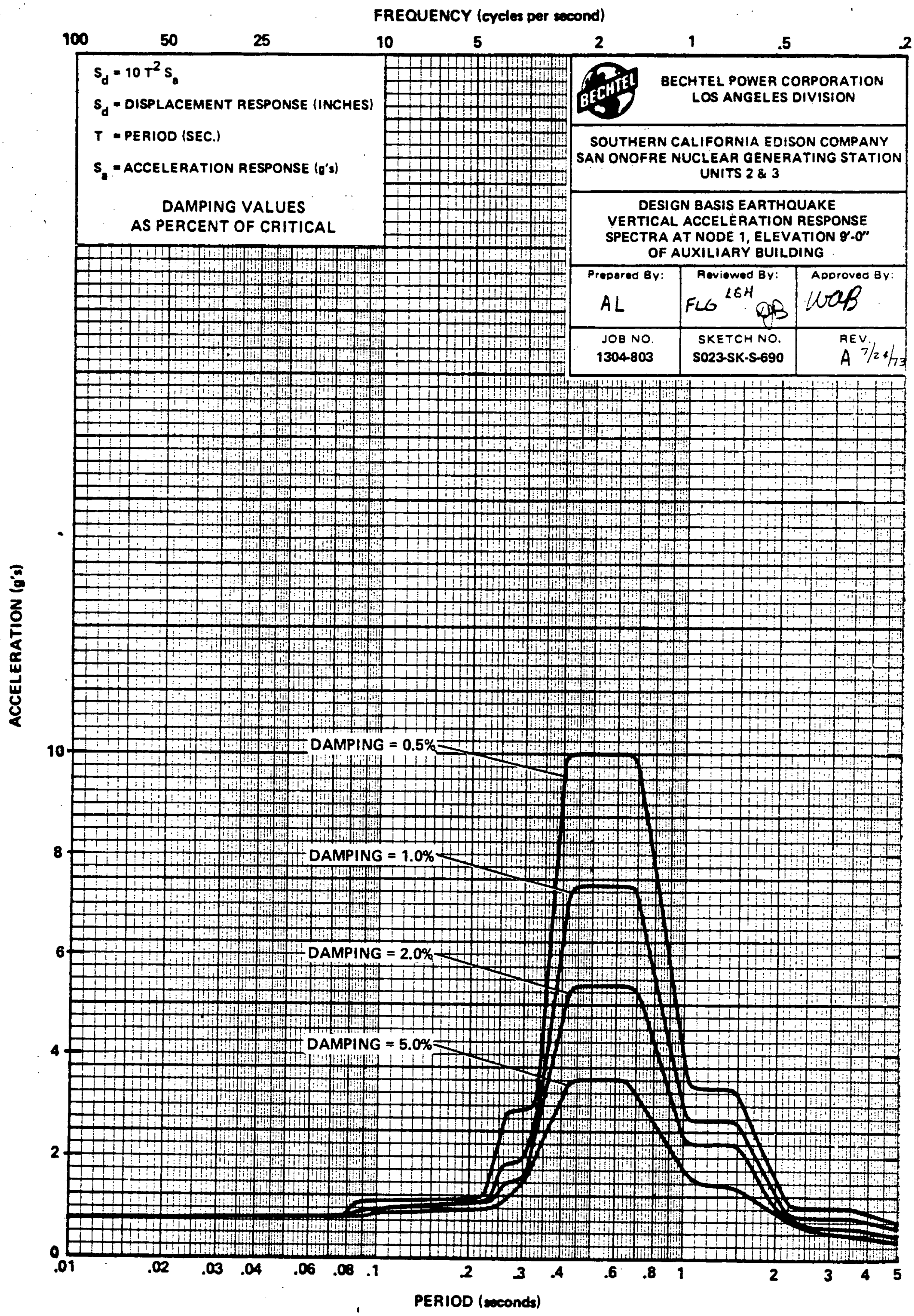
B.

Max. Deflection	Location	Effect Upon Functional Operability

Appendix A

Response Spectra


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
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 1, ELEVATION 9'-0"
OF AUXILIARY BUILDING
Prepared By:
AL
Reviewed By:
FLG LGH
Approved By:
WAB
JOB NO.
1304-803
SKETCH NO.
S023-SK-S-689
REV.
A 7/29/
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
14
12
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)



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
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 1, ELEVATION 9'-0"
OF AUXILIARY BUILDING
Prepared By: AL
Reviewed By: FLG LGH
Approved By: WAB
JOB NO. 1304-803
SKETCH NO. S023-SK-S-690
REV. A 7/24/73
ACCELERATION (g's)
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)

Appendix B

Stress Summary

V. SUMMARY OF MAXIMUM STRESSES

In the preceding sections of this structural report, analytical methods were used to determine the maximum stresses in each component of this Class 2 Nuclear vessel. The analytical methods consist of detailed hand calculations and the three-dimensional finite element computer solution derived on SAP IV. These results are reviewed in accordance with the stress categories of Subsection NA, Article XIII, and summarized in Table 18.

Using the criteria outlined in para. NC-3200 and Article XIII-1000 of Subsection NA, the maximum stresses satisfy the allowable stress limits of 1.0 S_m for the primary membrane (P_m), and 1.5 S_m for primary membrane plus primary bending ($P_L + P_b$) stress categories. Stresses due to gross structural discontinuities are classified to be of the ($P_L + P_b + Q$) stress category and have an allowable stress intensity of 3.0 S_m. Shear stresses have an allowable limit of 0.6 S_m for average shear and 0.8 S_m for maximum primary shear.

Design stress intensity values S_m are cited in the ASME Boiler and Pressure Vessel Code, Tables I-1.1 through I-1.3. Limits for other materials can be established by the rules in Article III-1000 of the ASME Boiler and Pressure Vessel Code.

TABLE 17

Design Stress Intensity S_m

Material	S_m at Metal Temp.
SA312 Gr. 304 pipe	20 ksi. at 250°F
SA240 Gr. 304 plate	20 ksi. at 250°F
Type 304 St. St.	20 ksi. at 250°F
SA106 Gr. B pipe	20 ksi. at 250°F
SA376 TP304 pipe	20 ksi. at 250°F

TABLE 18

Summary of Maximum Stresses

Component	Material	Stress Category	Stress Type	Max. Stress (ksi.)
Bladder Cage	Type 304 Stainless Steel	P_m	τ	0.05
		$P_L + P_b$	σ	1.51
Inlet Nozzle	SA376 TP304	$P_L + P_b$	σ	5.78
		$P_L + P_b$	τ	0.89
Outlet Nozzle	SA376 TP304	$P_L + P_b$	σ	3.94
		$P_L + P_b$	τ	1.19
Shell	SA240 Gr. 304 SA312 Gr. 304	$P_L + P_b + Q$	σ	56.3
End Plate	SA240 Gr. 304	P_b	σ	15.65
Shell End Ring	SA240 Gr. 304	P_m	τ	1.56
		$P_L + P_b$	σ	4.87

The bladder cage can be classified as a non-pressure retaining component and is fabricated by welding Type 304 stainless steel segments. Generally, non-pressure retaining components are considered structurally adequate when the factor of safety exceed 1.5. Factor of safety is defined to be the ratio of minimum yield strength to maximum stress.

TABLE 19

Minimum Tensile and Yield Strength at Room Temperature

	Tensile Strength	Yield Strength
Type 304 stainless steel (a)	85.00 ksi.	30.0 ksi.

(a) ASME Handbook, "Metals Properties", 1st Ed.

Qualification Summary of Equipment

I. Plant Name: San Onofre Units 2&3 — Type:

1. Utility: Southern California Edison Company — PWR X
2. NSSS: CE — 3. A/E: Bechtel — BWR ____

II. Component Name: Charging Pump Discharge Pulsation Damper

1. Scope: [ ] NSSS [X] BOP
2. Model Number: 831342 — Quantity: 6
3. Vendor: Greer Hydraulics
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Cylinder w/hemispherical head
   b. Dimensions 10" x 1'-6" height
   c. Weight 347 lbs.
6. Location: Building: Radwaste Area (Control Building)
   Elevation: 9'-0"
7. Field Mounting Conditions [ ] Bolt (No.____, Size____)
   [ ] Weld (Length____)
   [X] In-line piping component, one end bolted flange & other end welded to process pipe.
8. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S: 62.2 Hz * — F/B: 86.2 Hz
   V: 194 Hz
9. a. Functional Description: Dampen Discharge of Charging Pumps
   b. Is the equipment required for [ ] Hot Standby [ ] Cold Shutdown
   [X] Both
10. Pertinent Reference Design Specifications: S023-407-14, Pulsation Dampeners for Charging Pumps

* Coupled torsion of pipe section (89.7 Hz) and cantilever of shell section (86.2 Hz).

III. Is Equipment Available for Inspection in the Plant: [X] Yes [ ] No

IV. Equipment Qualification Method: Test: ______

Analysis: X

Combination of Test and Analysis: ______

Test and/or Analysis by Anamet Laboratories, Inc., Report No. 676.121, ~~Rev. A, Bechtel Log S023-407-14-22-1~~

(Name of Company or Laboratory & Report No.)

V. Vibration Input:

1. Loads considered: 1. [ ] Seismic only 2. [ ] Hydrodynamic only

   3. [ ] Explosive only 4. [ ] Other (Specify) ______

   5. [X] Combination of Seismic and Internal Pressure

   6. Method of combining RRS: [X] Absolute Sum [ ] SRSS
      [ ] ______
      (Other, Specify)

2. Required Response Spectra (attach the graphs): X Appendix A

3. Required Acceleration in Each Direction: ______

   S/S = 1.65 g F/B = 1.65 g V = 1.25 g

VI. If Qualification by Test, then Complete: N/A

1. [ ] Single Frequency [ ] Multi-Frequency: [ ] random
   [ ] sine beat
   [ ] ______

2. [ ] Single Axis [ ] Multi-Axis (Bi-Axial)

3. No. of Qualification Tests: OBE ______ SSE ______
   Other ______
   (Specify)

4. Frequency Range: ______

5. TRS enveloping RRS using Multi-Frequency Test [ ] Yes (plot TRS on RRS graphs)
   [ ] No

______

6. Input g-level Test at:

S/S = ______
F/B = ______
V = ______

7. Laboratory Mounting: ______

1. [ ] Bolt (No.______, Size______) [ ] Weld (Length______)
[ ] ______

8. Functional operability verified: [ ] Yes [ ] No [ ] Not Applicable

9. Test Results including modifications made: ______

10. Other tests performed (such as fragility test, including results):

______

VII. <u>If Qualification by Analysis or by the Combination of Test and Analysis, then Complete</u>:

1. Description of Test including Results: N/A

2. Method of Analysis: ______

[X] Static Analysis
[ ] Dynamic Analysis
[ ] Equivalent Static Analysis
[ ] Time-History
[ ] Response Spectrum

3. Model Type: [X] 3D [ ] 2D [ ] 1D

[ ] Finite Element [ ] Beam [X] Closed Form Solution

4. [X] Computer Codes: BILAPSS (Local Sections)

Frequency Range and No. of modes considered: N/A

[X] Hand Calculations

5. Method of Combining Dynamic Responses: [X] Absolute Sum [ ] SRSS
[ ] Other: ______ (specify)

6. Damping: 0.5% Basis for the damping used: Damping in Piping System

7. Support Considerations in the model: Pulsation damper mounted vertically in horizontal run of pipe. End conditions consistent with piping interface.

8. Critical Structural Elements: See Appendix B

A.

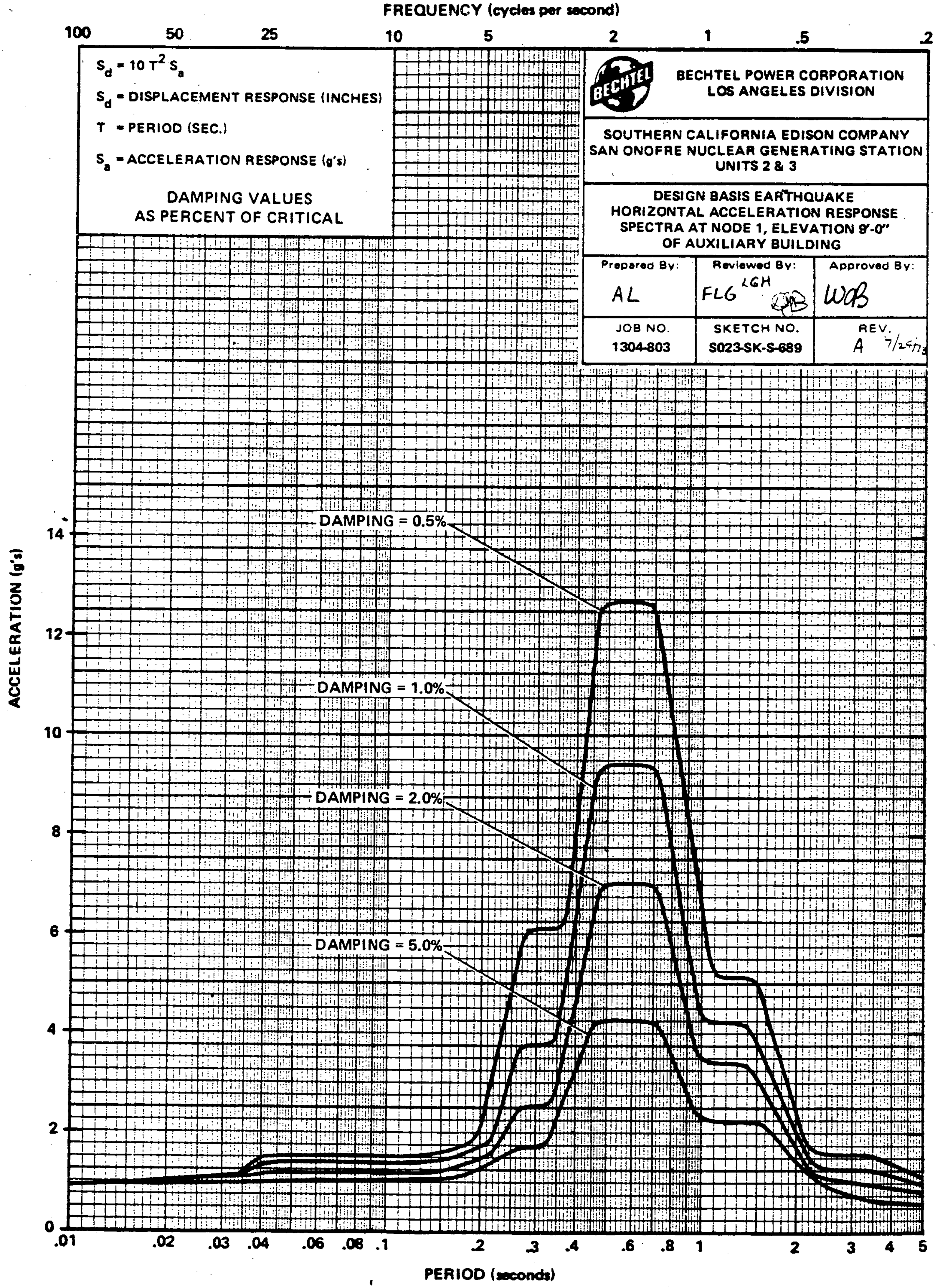
Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable

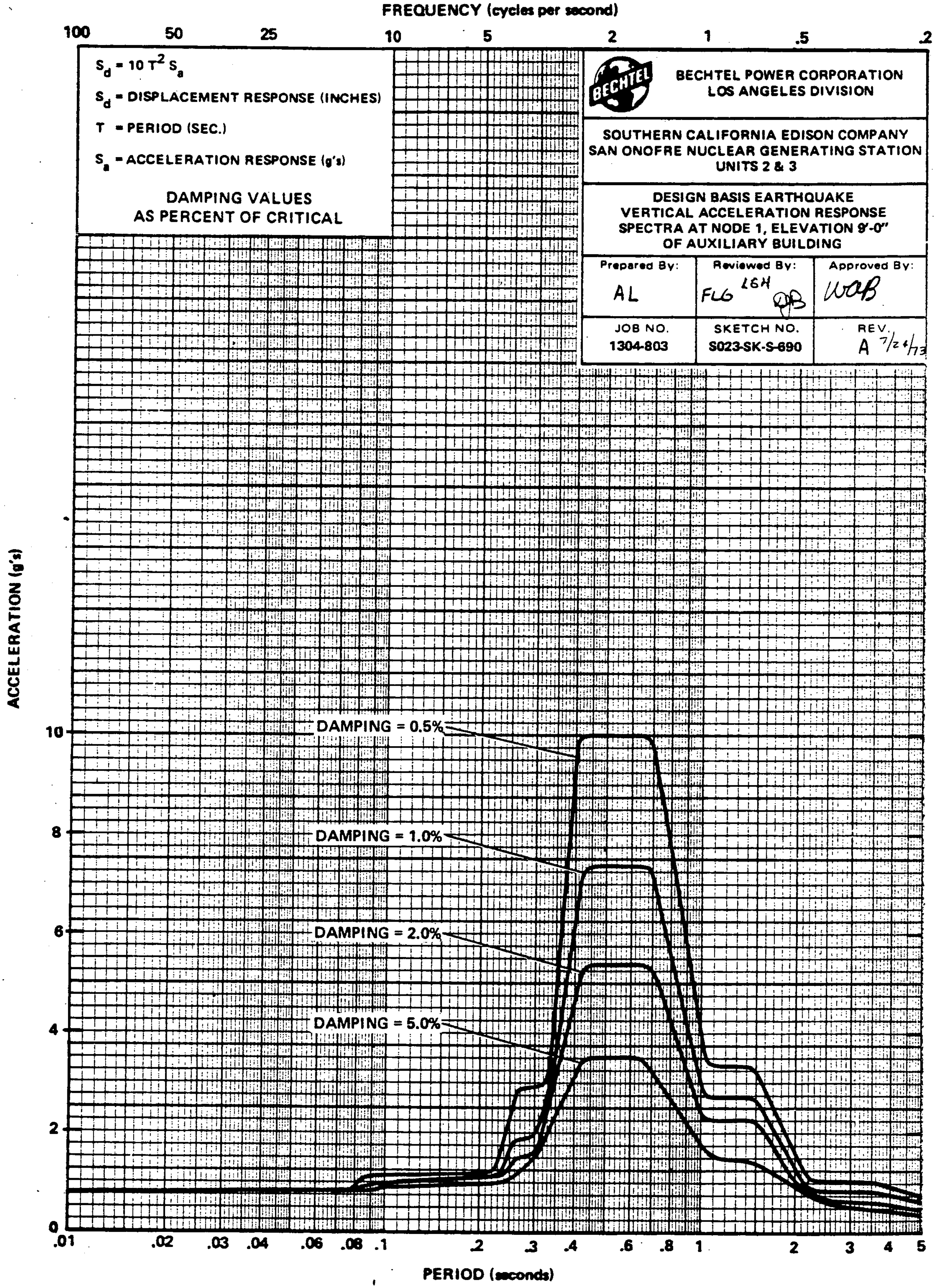
B.

Max. Deflection	Location	Effect Upon Functional Operability

Appendix A

Response Spectra


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
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 1, ELEVATION 9'-0"
OF AUXILIARY BUILDING
Prepared By: AL
Reviewed By: FLG LGH
Approved By: WCB
JOB NO. 1304-803
SKETCH NO. S023-SK-S-689
REV. A
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
14 12 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)



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
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 1, ELEVATION 9'-0"
OF AUXILIARY BUILDING
Prepared By: AL
Reviewed By: FLG LGH
Approved By: WAB
JOB NO. 1304-803
SKETCH NO. S023-SK-S-690
REV. A 7/24/73
ACCELERATION (g's)
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)

Appendix B

Stress Summary

III. SUMMARY OF MAXIMUM STRESSES

In the preceding sections of this structural report, analytical methods were used to determine the maximum stresses in each component of this Class 2 Nuclear vessel. The analytical methods consist of detailed hand calculations and the axi-symmetric finite element computer solution derived on BILAPSS. These results are reviewed in accordance with the stress categories of Subsection NA, Article XIII, and summarized in Table 26.

Using the criteria outlined in para. NC-3200 and Article XIII-1000 of Subsection NA, the maximum stresses satisfy the allowable stress limits of 1.0 S_m for the primary membrane (P_m), and 1.5 S_m for local membrane (P_L) and primary membrane plus primary bending ($P_L + P_b$) stress categories. Stresses due to gross structural discontinuities are classified to be of the ($P_L + P_b + Q$) stress category and have an allowable stress intensity of 3.0 S_m. Shear stresses have an allowable limit of 0.6 S_m for average shear and 0.8 S_m for maximum primary shear. The maximum bearing stress must not exceed S_y.

Design stress intensity values S_m are cited in the ASME Boiler and Pressure Vessel Code, Tables I-1.1 through I-1.3. Limits for other materials can be established by the rules in Article III-1000 of the ASME Boiler and Pressure Vessel Code.

For the bolting, the allowable maximum service stresses are cited in Article XIII-1182 of Subsection NA.

TABLE 25

Design Stress Intensity S_m

Material	S_m at 250°F Metal Temp.
SA182 Gr. F316	20.0 ksi.
SA479 Gr. 304	20.0 ksi.
SA376 Gr. 316	20.0 ksi.
SA240 Gr. 304	20.0 ksi.
SA515 Gr. 70	22.8 ksi.
SA182 Gr. F304	20.0 ksi.
SA312 Gr. 304	20.0 ksi.

TABLE 26

Summary of Maximum Stresses

Component	Material	Stress Category	Stress Type	Max. Stress (ksi.)
Plug	SA182 F304	P_L	σ	25.51
		$P_L + P_b$	σ	13.50
		$P_L + P_b + Q$	σ	25.0
		$P_L + P_b + Q + F$	σ	32.84
		P_m	τ	9.78
Nozzle Flange	SA182 F316	$P_L + P_b$	σ	26.54
Flange Bolts		P_L	σ	21.67
		$P_L + P_b$	σ	32.35
		P_m	τ	2.63
Ports	SA479 Gr.304 SA376 Gr.316	$P_L + P_b$	σ	18.28
		$P_L + P_b$	τ	6.65
Shell	SA240 Gr. 304 SA182 Gr. 304	P_m	σ	13.71
		$P_L + P_b$	σ	27.31
		P_m	τ	3.81

5. Question:

Provide acceptance criteria for output shifts and variations in output bandwidth reported in the seismic qualification of the differential pressure transmitters (BOP-10).

Response:

The transmitters in question, Foxboro Model E13DM, are not required to remain operational during a seismic event since they perform a monitoring function only. Therefore output shifts or variations in output bandwidth during a seismic event are not an issue.

The capability of the transmitters to function after a seismic event is, however, required. The results of the test report indicate that the deviation from the normal functioning capability is insignificant. The effect of the change in the output bandwidth on the amplitude output following a seismic event is minimal. The effect of the change in output shift on the maximum error indicated by the instrument is discussed below. Furthermore, the error in the calibration shift can be checked and reset without any difficulty.

The maximum instrumental error for the model E13DM transmitter after the most representative[1] qualification test (3.5g max, sine beat, 10 beats, 10 cycles/beat) was approximately 0.6 percent for combined horizontal and vertical excitation. This maximum instrumental error would result in a maximum error of 0.3 percent in the indicated flow rate which is well within acceptable limits.

(1) Most representative qualification test since the Model E13DM transmitter has been shown to be rigid and the maximum acceleration from the unamplified region of the applicable floor response spectra would be less than 2 g's.

6. Question:

Provide justification for the differences between the experimental and analytical frequencies for the pressure relief valves for the main steam system (BOP 21).

Response:

The apparent discrepancy between the analytic determination of the fundamental frequency of the valve assembly and the results of the qualification test rests in the fact that the analytic calculations were not carried far enough. Rather than determining the combined system natural frequency, the analysis merely calculated component fundamental frequencies. By combining these component natural frequencies through use of Dunkerley's Equation[(1)] we are able to demonstrate good correlation between the analytic and experimental frequencies as follows:

Fixed Base Single Degree of Freedom Idealization of Bonnet section

$$f_{11} = 58 \text{ Hz}$$

Fixed Base Single Degree of Freedom Idealization of Body section

$$f_{22} = 329 \text{ Hz}$$

Flexibility of inlet nozzle attachment bolts
(Flexural response of bolt group)

$$f_{33} = 40 \text{ Hz}$$

Per DunKerley's Equation

$$\frac{1}{f_1^2} = \frac{1}{f_{11}^2} + \frac{1}{f_{22}^2} + \frac{1}{f_{33}^2}$$

$$f_1 = 32.9 \text{ Hz}$$

Fundamental Frequency from Qualification Test

$$F_1 = 34 \text{ Hz}$$

(1) Vibration Theory and Application by William T. Thompson, Prentice-Hall Inc., page 217

7. Question:

Provide seismic qualification summary forms for the following items; Station Batteries (BOP 5), Controllers (NSSS 10), Containment Purge Radiation Detectors (NSSS 21) and Containment Purge Radiation Transmitters (NSSS 22)

Response:

Attached you will find copies of the requested seismic qualification summary forms. The forms for BOP-5 are for the in-place Exide Model G batteries which have a limited qualification life (3.9 yrs). We plan on replacing these batteries with the Exide Model GN batteries once the current qualification program has been completed. The current forecast for completion of this program is July 27, 1981 with a forecast completion of the revised seismic qualification summary forms by October 2, 1981.

Qualification Summary of Equipment

I. Plant Name: San Onofre Units 2&3 — Type:

1. Utility: Southern California Edison Company — PWR X
2. NSSS: CE — 3. A/E: Bechtel — BWR

II. Component Name: 125 VDC Batteries

1. Scope: [ ] NSSS [X] BOP
2. Model Number: 2GC-13 (4), 2GC-17 (4) (8) Quantity: 8
3. Vendor: Exide
4. If the component is a cabinet or panel, name and model No. of the devices included:
5. Physical Description a. Appearance Two step rack
   b. Dimensions 2GC-13-108" x 49" x 38"/2GC-17-145" x 49" x 38"
   c. Weight
6. Location: Building: Control Bldg.
   Elevation: 50'-0"
7. Field Mounting Conditions [ ] Bolt (No. ____, Size ____)
   [x] Weld (Length 4" *)
   [ ]
8. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):
   S/S: 8.5 HZ F/B: 12 HZ
   V: 26 HZ
9. a. Functional Description: Provides 125 VDC Class 1E Power
   b. Is the equipment required for [ ] Hot Standby [ ] Cold Shutdown
   [X] Both
10. Pertinent Reference Design Specifications: S023-301-2

* Each side both ends at each support location.

III. Is Equipment Available for Inspection in the Plant: [XX] Yes [ ] No

IV. Equipment Qualification Method: Test: Exide Type 2GC-17'

Analysis: ______

Combination of Test and Analysis: Exide 2GC-13 qualified by similarity to 2GC-17

Test and/or Analysis by Wyle Lab Report No. 44426-1 Bechtel Log No. S023-301-2-46

(Name of Company or Laboratory & Report No.)

V. Vibration Input:

1. Loads considered: 1. [X] Seismic only 2. [ ] Hydrodynamic only

   3. [ ] Explosive only 4. [ ] Other (Specify) ______

   5. [ ] Combination of ______

   6. Method of combining RRS: [ ] Absolute Sum [XX] SRSS
   [ ] ______
   (Other, Specify)

2. Required Response Spectra (attach the graphs): S023-SK-S-739, 725

3. Required Acceleration in Each Direction: NRIM 737, 701

   S/S = 1.25 g F/B = 1.1 g V = 0.75 g

VI. If Qualification by Test, then Complete: ______

1. [ ] Single Frequency [X] Multi-Frequency: [X] random
   [ ] sine beat
   [ ] ______

2. [ ] Single Axis [X] Multi-Axis (Bi-Axial)

3. No. of Qualification Tests: OBE 5* SSE 1*
   Other ______
   (Specify)

4. Frequency Range: 1-33 Hz

5. TRS enveloping RRS using Multi-Frequency Test [X] Yes (plot TRS on RRS graphs)
   [ ] No
   See Appendix B

*In each horizontal direction (See Table I)

6. Input g-level Test at:

S/S = ~~4.7~~
F/B = 4.3
V = 3.4 min *

7. Laboratory Mounting: In rack similar to field mount

1. [ ] Bolt (No.______, Size______) [X] Weld (Length________)
[ ] __________

8. Functional operability verified: [ ] Yes [ ] No [ ] Not Applicable

9. Test Results including modifications made: N/A

10. Other tests performed (such as fragility test, including results):
Radiation and thermal aging prior to seismic-Qualified Life 3.9 yrs.

VII. <u>If Qualification by Analysis or by the Combination of Test and Analysis, then Complete</u>:

1. Description of Test including Results: Not Applicable

2. Method of Analysis: __________

[ ] Static Analysis
[ ] Dynamic Analysis
[ ] Equivalent Static Analysis
[ ] Time-History
[ ] Response Spectrum

3. Model Type: [ ] 3D [ ] 2D [ ] 1D
[ ] Finite Element [ ] Beam [ ] Closed Form Solution

4. [ ] Computer Codes: __________

Frequency Range and No. of modes considered: __________

[ ] Hand Calculations

5. Method of Combining Dynamic Responses: [ ] Absolute Sum [ ] SRSS
[ ] Other: __________ (specify)

6. Damping: ______ Basis for the damping used: __________

7. Support Considerations in the model: __________

* See Table I

8. Critical Structural Elements: ______________________

A.

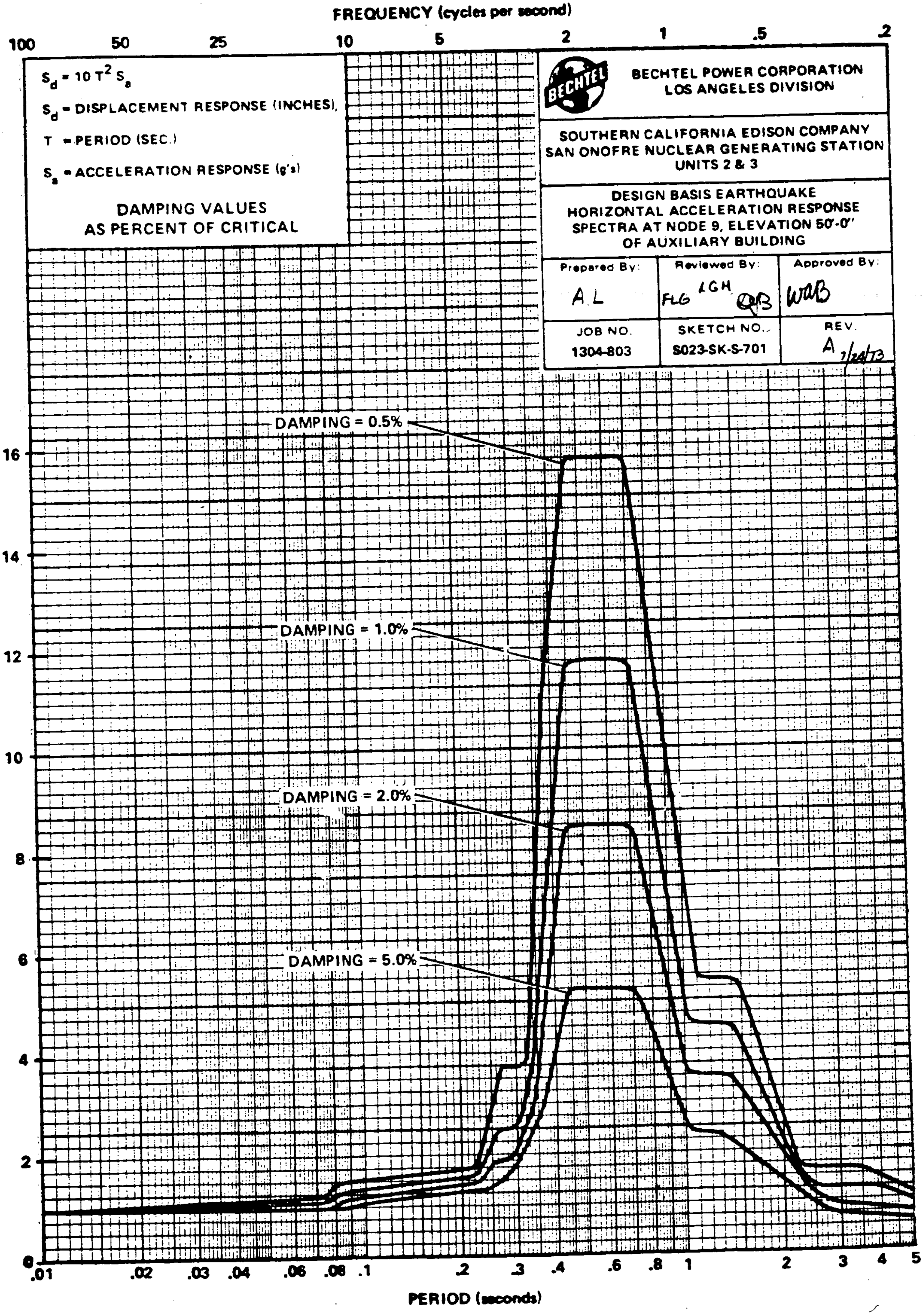
Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable

B.

Max. Deflection	Location	Effect Upon Functional Operability

Appendix A

Response Spectra



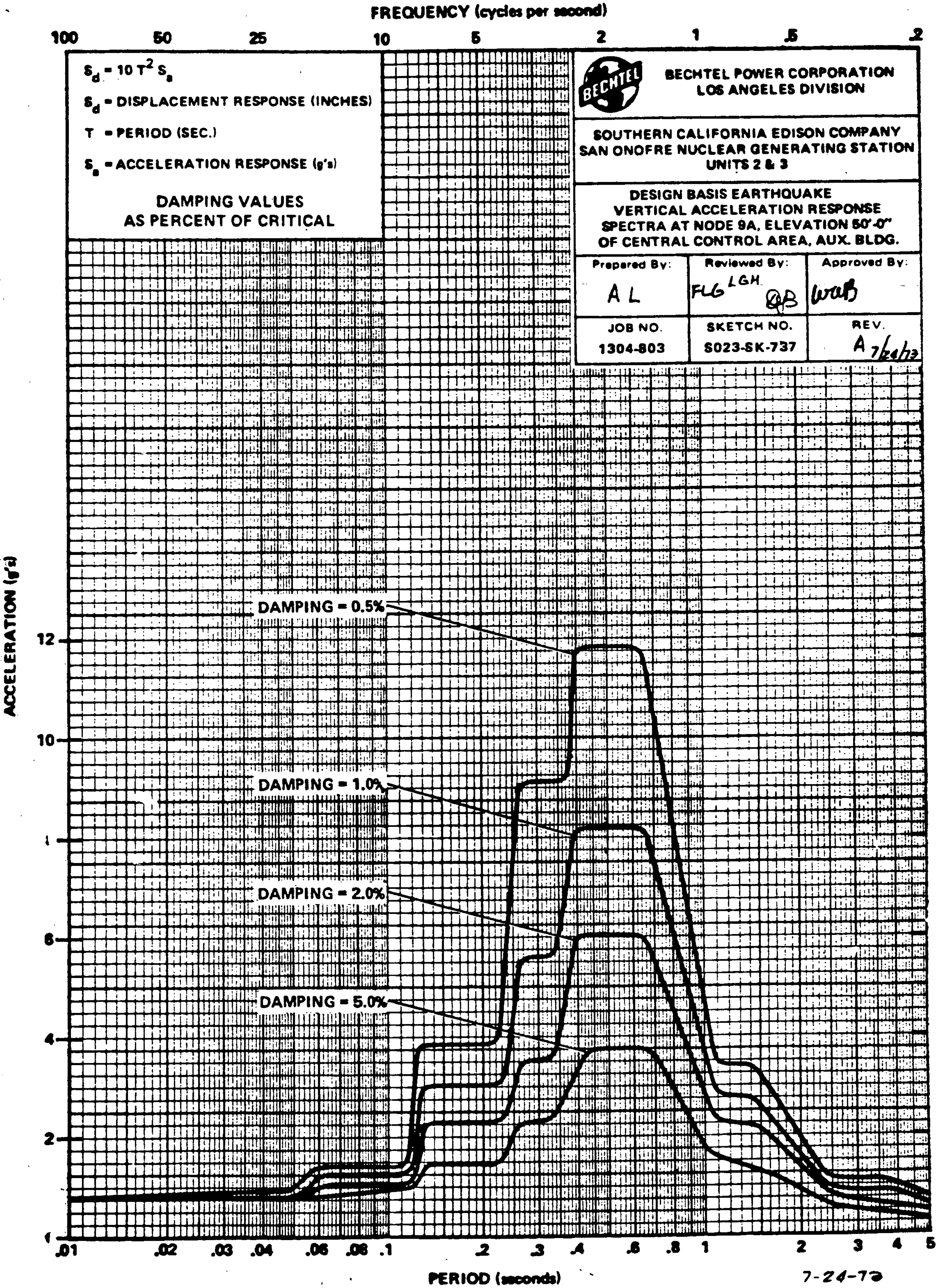
FREQUENCY (cycles per second)
100
50
25
10
5
2
1
.5
.2
$S_d = 10\,T^2\,S_a$
S_d = DISPLACEMENT RESPONSE (INCHES),
T = PERIOD (SEC.)
S_a = ACCELERATION RESPONSE (g's)
DAMPING VALUES
AS PERCENT OF CRITICAL
BECHTEL
BECHTEL POWER CORPORATION
LOS ANGELES DIVISION
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3
DESIGN BASIS EARTHQUAKE
HORIZONTAL ACCELERATION RESPONSE
SPECTRA AT NODE 9, ELEVATION 50'-0"
OF AUXILIARY BUILDING
Prepared By: A.L
Reviewed By: FLG LGH QB
Approved By: WAB
JOB NO. 1304-803
SKETCH NO. S023-SK-S-701
REV. A 7/24/73
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
16
14
12
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
VERTICAL ACCELERATION RESPONSE
SPECTRA AT NODE 9A, ELEVATION 50'-0"
OF CENTRAL CONTROL AREA, AUX. BLDG.

Prepared By:	Reviewed By:	Approved By:
A L	FLG LGH QB	WAB
JOB NO.	SKETCH NO.	REV.
1304-803	S023-SK-737	A 7/24/73



7-24-73

Appendix B

Test Set Up

And Results

TABLE I

TEST RUN DESCRIPTIONS

RUN NO.	TYPE TEST	AXES	LEVEL	INPUT ACCELERATION (g) HZPA	VZPA	REMARKS
1	Sine Sweep	FB	---	0.2	---	
2	Sine Sweep	V	---	---	0.2	
3	Random	FB/V	<OBE	0.74	0.75	
4	Random	FB/V	OBE	1.45	1.4	
5	Random	FB/V	OBE	1.45	1.65	
6	Random	FB/V	OBE	2.1	1.7	
7	Random	FB/V	OBE	2.1	1.65	
8	Random	FB/V	OBE	2.0	1.85	
9	Random	FB/V	SSE	4.3	3.4	
10	Sine Sweep	SS	---	0.2	---	
11	Random	SS/V	OBE	1.55	1.4	
12	Random	SS/V	OBE	1.65	1.4	
13	Random	SS/V	OBE	1.7	1.4	
14	Random	SS/V	OBE	1.65	1.4	
15	Random	SS/V	OBE	1.6	1.4	
16	Random	SS/V	SSE	4.7	4.0	
17*	Random	SS/V	>SSE	4.7	4.7	Cracked housing on the top step 2GN-11 Cell approx. 25 sec. into test (see Photo. 3 and Notice of Anomaly No. 1). The post-test inspection results are described in Para. 6.3.1 and shown in Photos. 3-7.

LEGEND:
FB = Front-to-Back
V = Vertical
SS = Side-to-Side
OBE = Operating Basis Earthquake
SSE = Safe Shutdown Earthquake
HZPA = Horizontal Zero Period Acceleration
VZPA = Vertical Zero Period Acceleration

S023-301-2--6-0

*Increased Level Test - performed at the direction of the Exide Technical Representative, following completion of the prescribed test program.

FULL SCALE SHOCK SPECTRUM (g Peak)

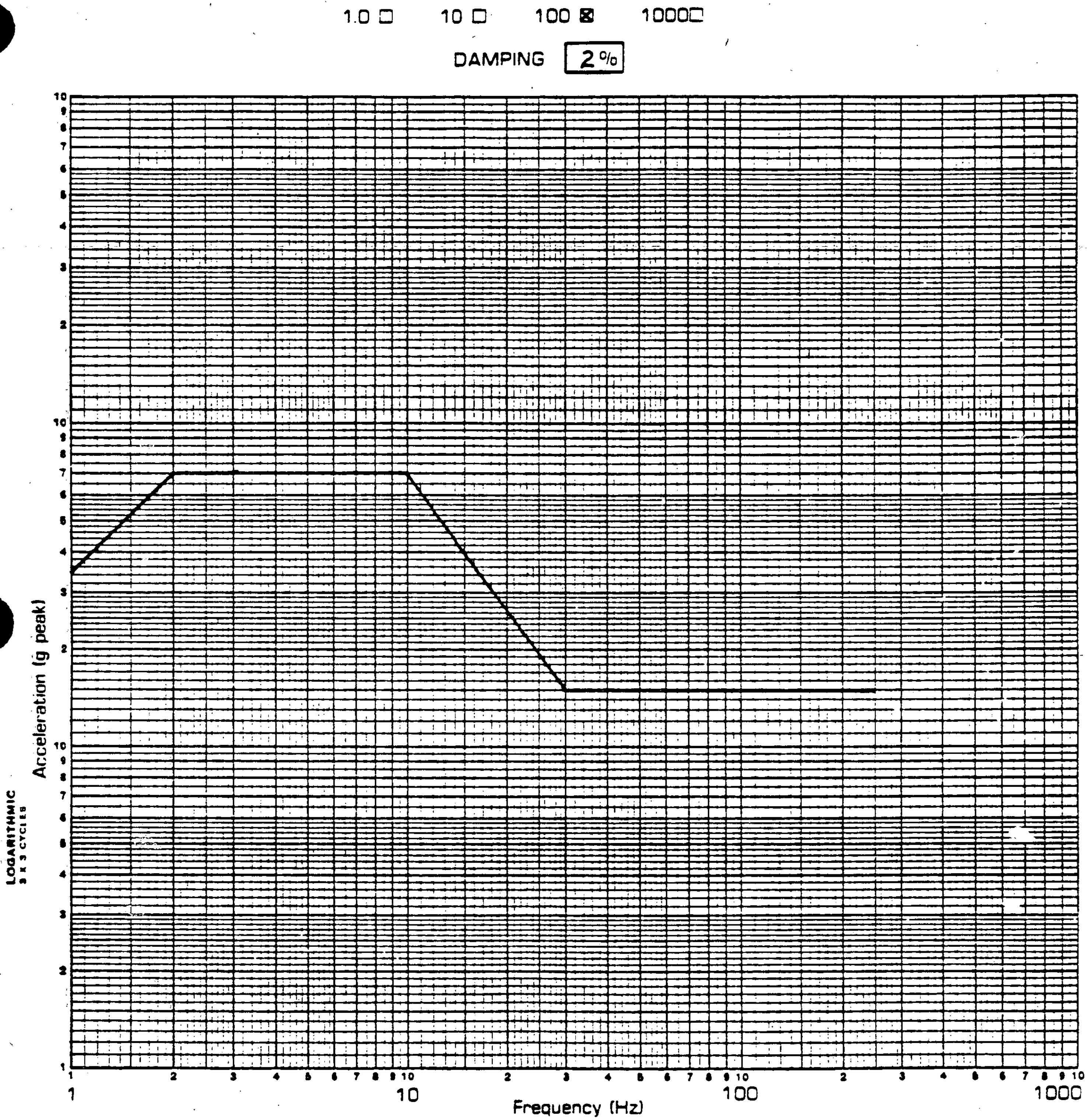
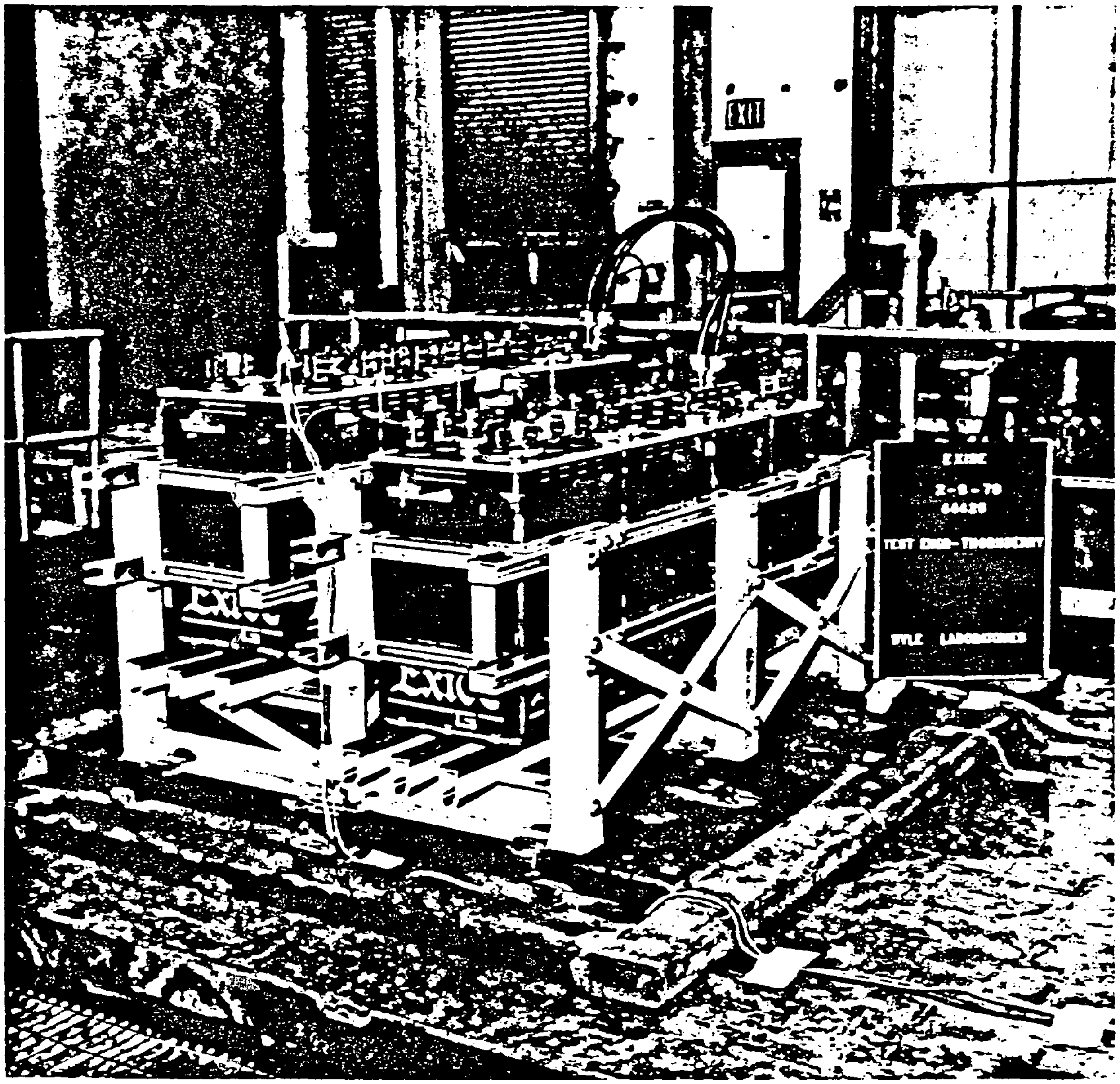


FIGURE 1. APPROXIMATE HORIZONTAL AND VERTICAL SAFE SHUTDOWN EARTHQUAKE REQUIRED RESPONSE SPECTRUM

0023_301-2-46-0



PHOTOGRAPH 1

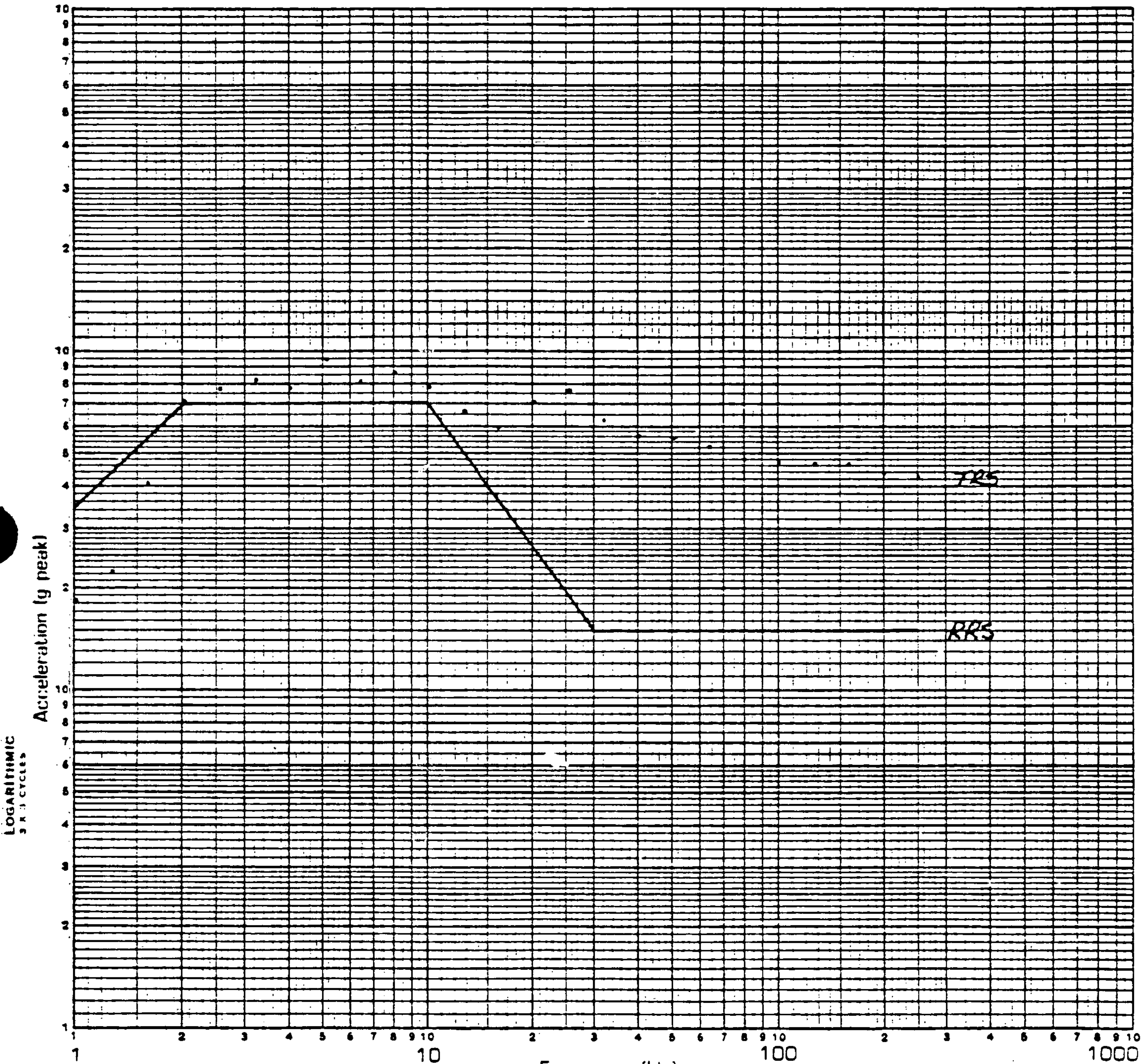
TEST SETUP
AND
MOUNTING WELD LOCATIONS

SO23-301-2-46-0

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 2%



SPECIMEN ______

AXIS FB/V

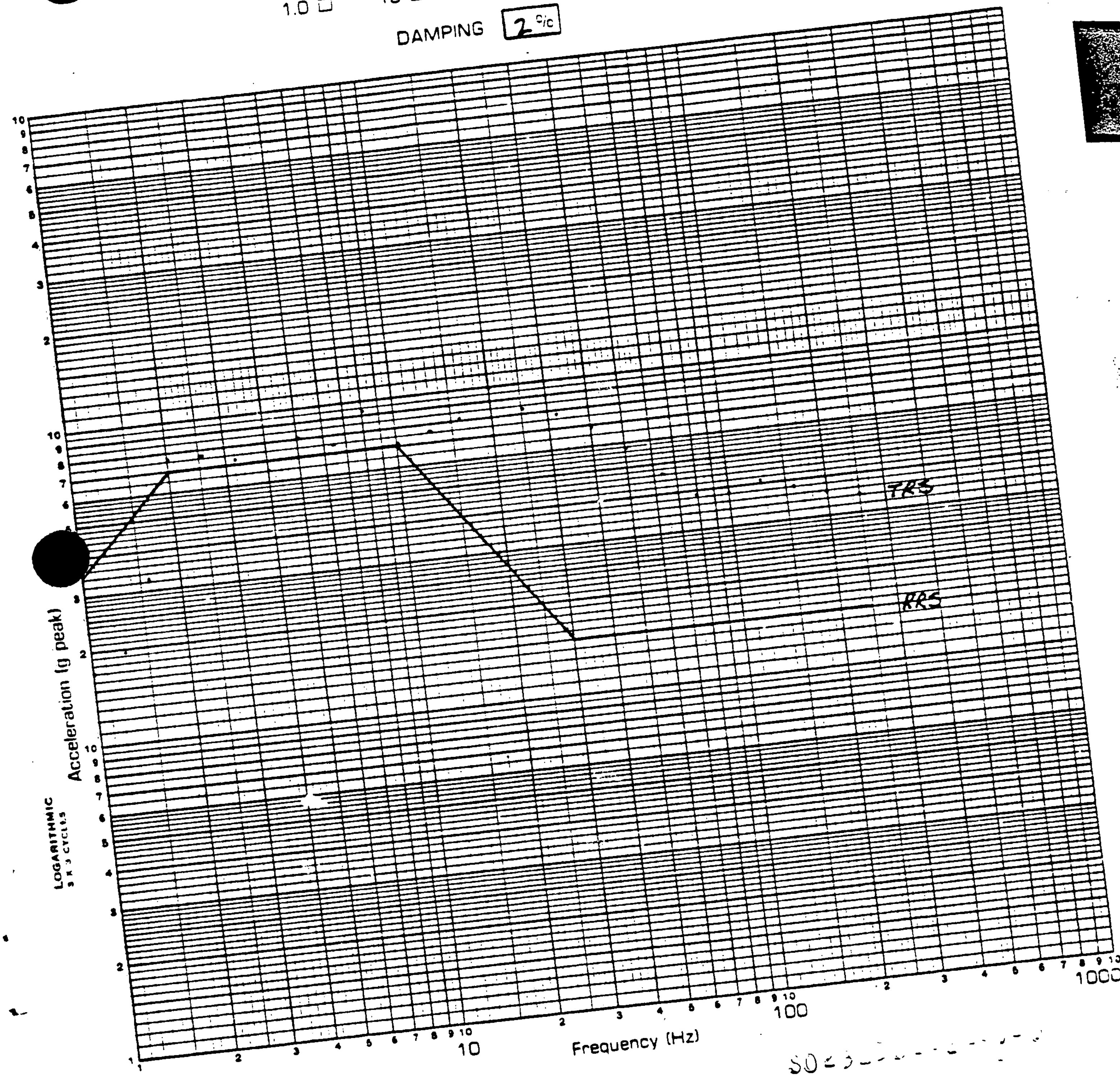
LOCATION NO. HCA

TEST RUN NO. 9

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 2 %



LOCATION NO. VCA

TEST RUN NO. 9

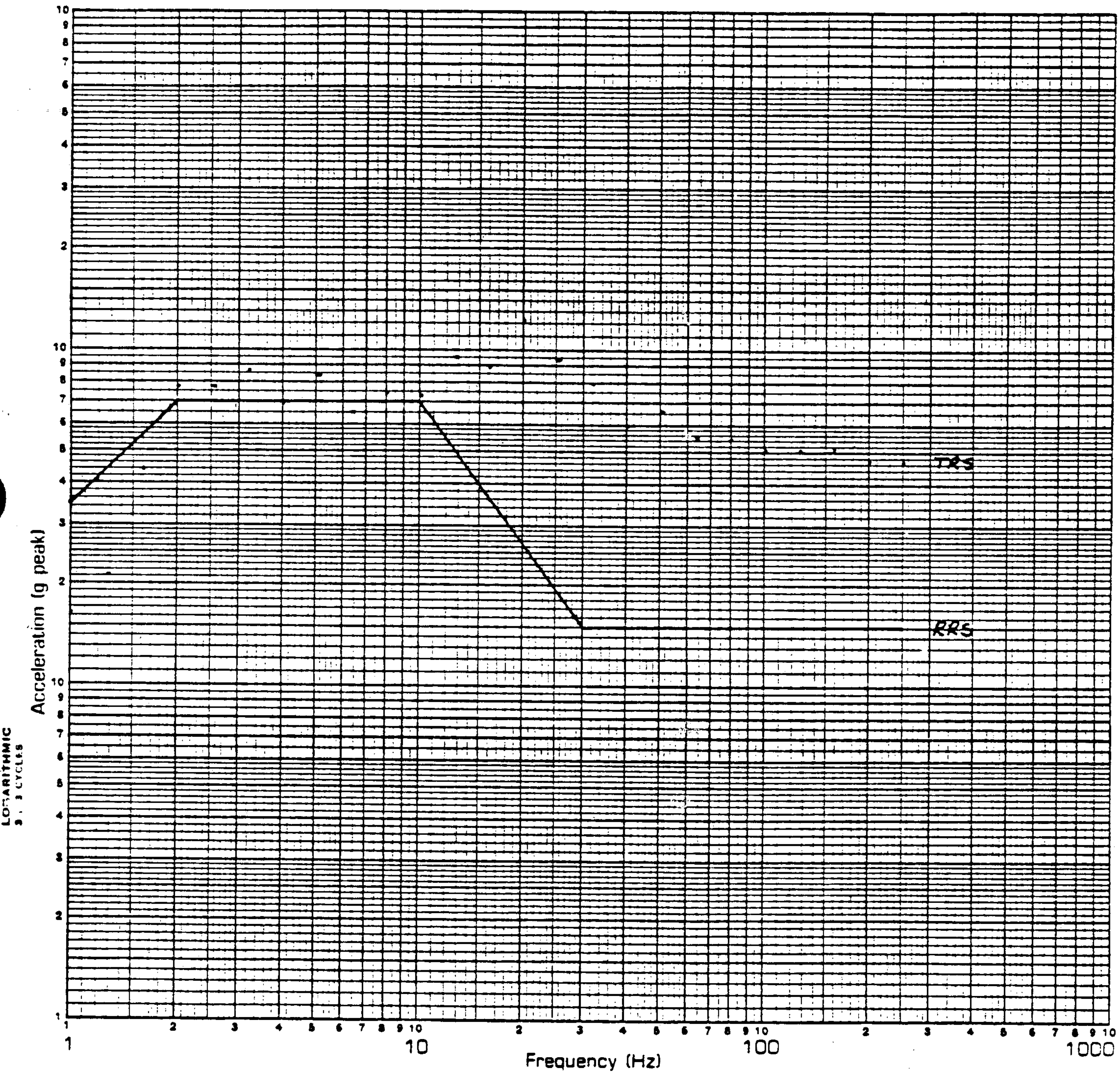
SPECIMEN

AXIS FB/V

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 2 %



S023-301-2-46-0

SPECIMEN ____________

AXIS SS/V

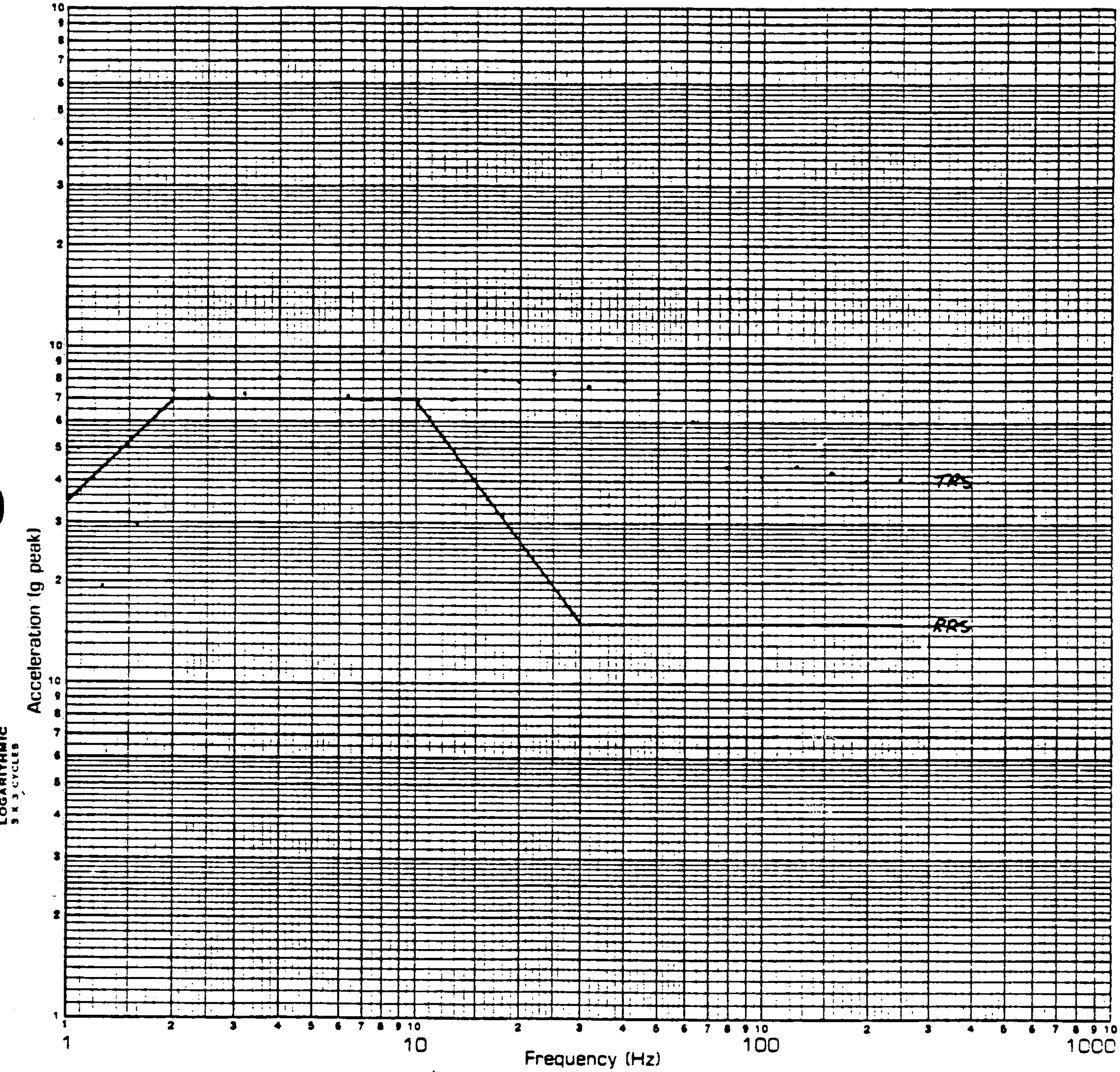
LOCATION NO. HCA

TEST RUN NO. 16

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 2 %



5023-3...-2-46-0

SPECIMEN ______

AXIS SS/V

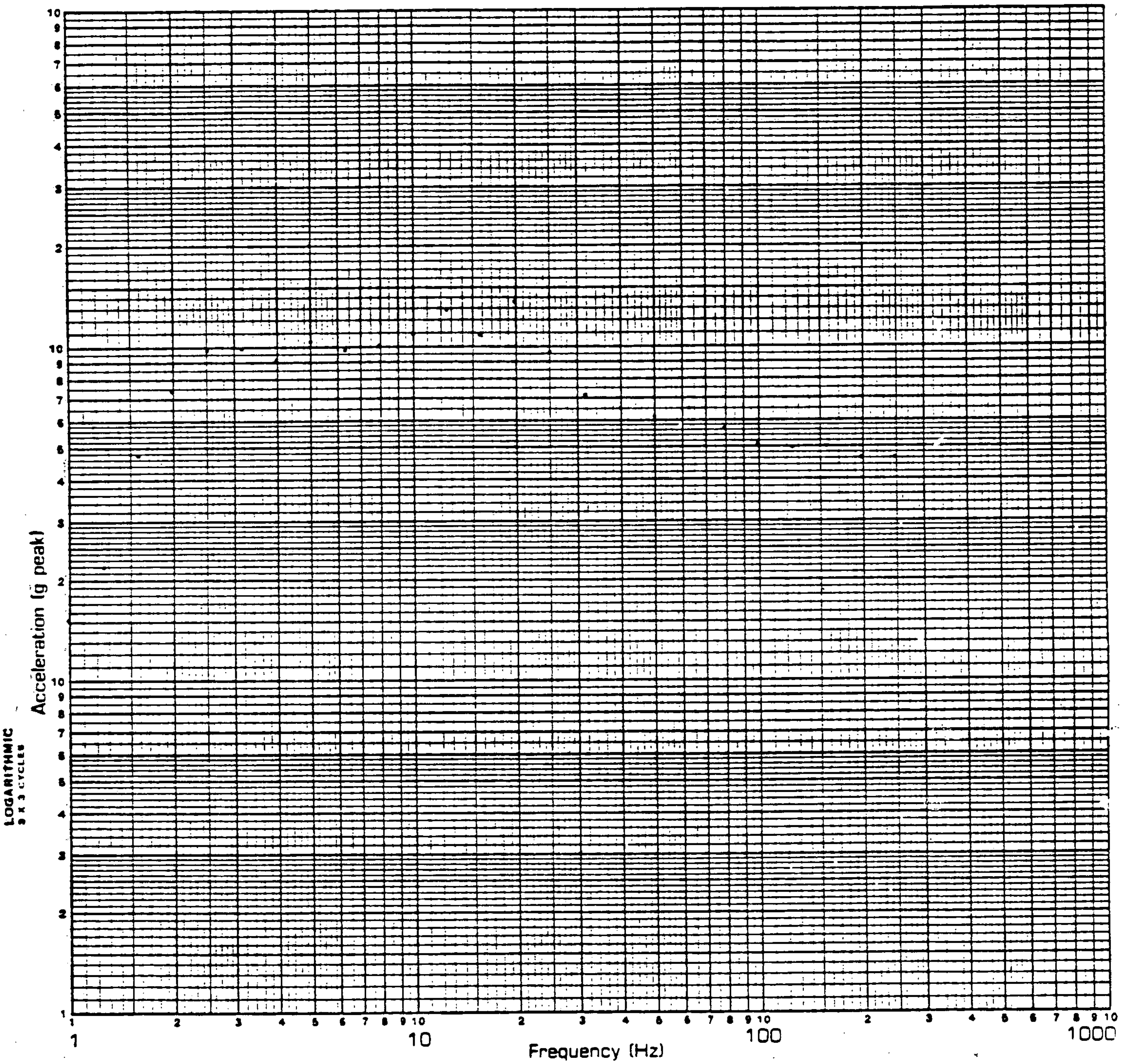
LOCATION NO. VCA

TEST RUN NO. 16

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000☐

DAMPING 2%



SPECIMEN ______________________

AXIS SS/V

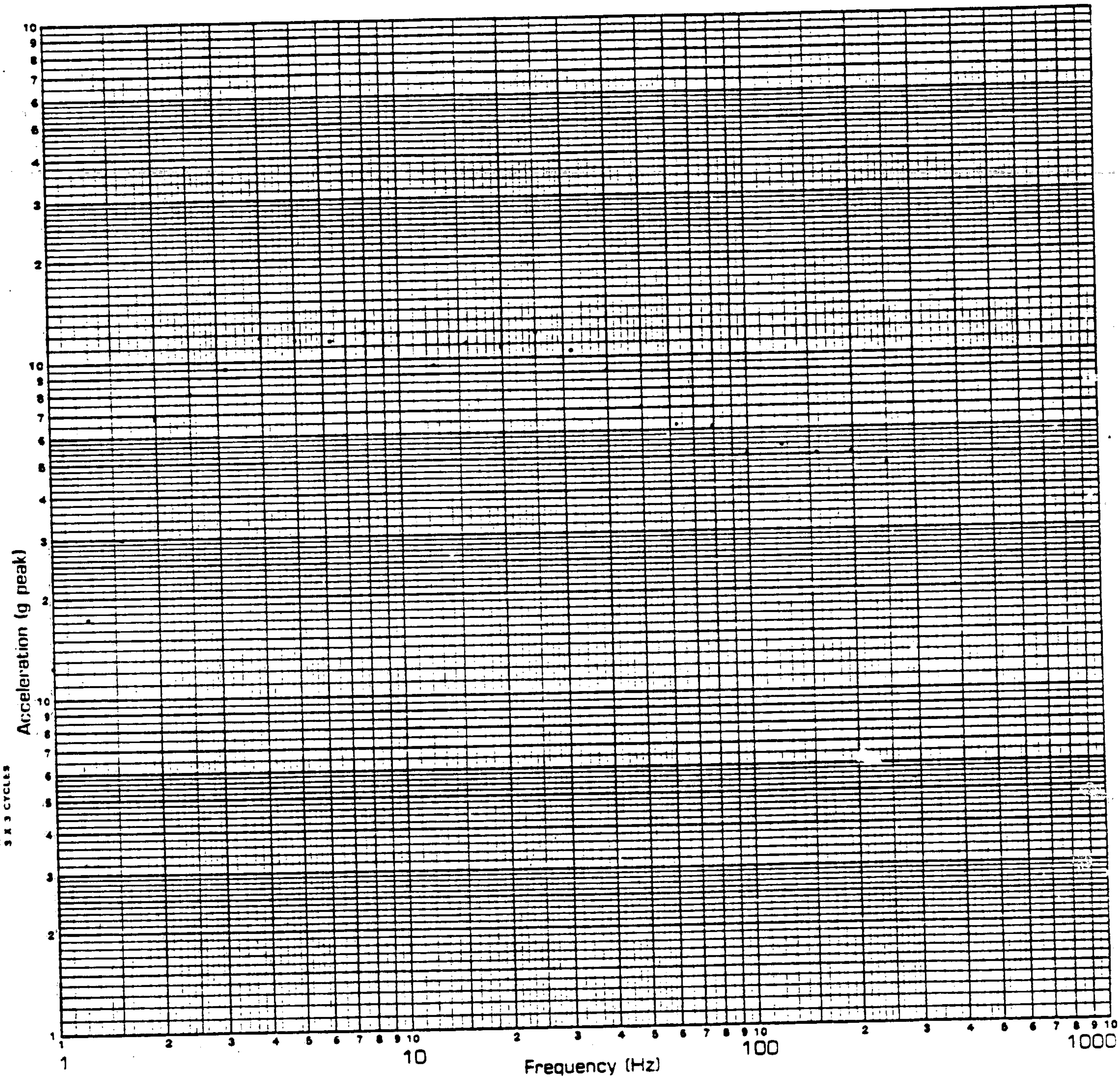
LOCATION NO. HCA

TEST RUN NO. 17

FULL SCALE SHOCK SPECTRUM (g Peak)

1.0 ☐ 10 ☐ 100 ☒ 1000 ☐

DAMPING 2%



SPECIMEN ______________

AXIS SS/V

LOCATION NO. VCA

TEST RUN NO. 17

Qualification Summary of Equipment

I. Plant Name: San Onofre Units 2&3 — Type:

1. Utility: Southern California Edison Company — PWR X
2. NSSS: CE — 3. A/E: Bechtel — BWR

II. Component Name: Indicating Controller

1. Scope: [X] NSSS [ ] BOP
2. Model Number: 250 — Quantity: 2
3. Vendor: Foxboro Co.
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Module for Shelf Mounting
   b. Dimensions 1.89" x 8.56 x 3.6"
   c. Weight 3#
6. Location: Building: Control Area. Aux Bldg.
   Elevation: 30'
7. Field Mounting Conditions [ ] Bolt (No.____, Size____)
   [ ] Weld (Length____)
   [X] In shelves, clamped in both sides
8. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical
   S/S: 37,30 — F/B: 37
   V: >40
9. a. Functional Description: Indication and control of input and setpo
   b. Is the equipment required for [X] Hot Standby [X] Cold Shutdow
   [X] Both
10. Pertinent Reference Design Specifications: 00000-ICE-0005
    1370-ICE-0005 Rev. 1 Sheet 346 Rev. 5

III. Is Equipment Available for Inspection in the Plant: [X] Yes [ ] No

IV. Equipment Qualification Method: Test: X

Analysis: ____

Combination of Test and Analysis: ____

Test and/or Analysis by Foxboro, Report T6-6237 and 80-0104h
(Name of Company or Laboratory & Report No.)
Lab: Acton Lab report number 12283

V. Vibration Input:

1. Loads considered: 1. [X] Seismic only 2. [ ] Hydrodynamic only

3. [ ] Explosive only 4. [ ] Other (Specify) ____

5. [ ] Combination of ____

6. Method of combining RRS: [ ] Absolute Sum [ ] SRSS
[ ] ____
(Other, Specify)

2. Required Response Spectra (attach the graphs): No RRS for panel: floor response attached

3. Required Acceleration in Each Direction: ____

S/S = 3.0 F/B = 3.0 V = 3.0

VI. If Qualification by Test, then Complete: ____

1. [X] Single Frequency [ ] Multi-Frequency: [ ] random
[ ] sine beat
[ ] ____

2. [ ] Single Axis [X] Multi-Axis (bi-axial)

3. No. of Qualification Tests: OBE ____ SSE ____
Other 10 cycles/beat, 5 beats full level at each integer frequency from 1 to 35 Hz.
(Specify)

4. Frequency Range: 1 to 35 Hz.

5. TRS enveloping RRS using Multi-Frequency Test [ ] Yes (plot TRS on RRS graph)
[ ] No N/A

6. Input g-level Test at:

S/S = 3.0
F/B = 3.0
V = 3.0

7. Laboratory Mounting: Standard shelf hardware (to simulate field installation)

1. [ ] Bolt (No.______, Size______) [ ] Weld (Length__________)
[ ] __________

8. Functional operability verified: [X] Yes [ ] No [ ] Not Applicable

9. Test Results including modifications made: See attached sheet.

10. Other tests performed (such as fragility test, including results):

See attached sheet

VII. If Qualification by Analysis or by the Combination of Test and Analysis, then Complete:

1. Description of Test including Results: NA

2. Method of Analysis:

[ ] Static Analysis
[ ] Dynamic Analysis
[ ] Equivalent Static Analysis
[ ] Time-History
[ ] Response Spectrum

3. Model Type: [ ] 3D [ ] 2D [ ] 1D

[ ] Finite Element [ ] Beam [ ] Closed Form Solution

4. [ ] Computer Codes:

Frequency Range and No. of modes considered:

[ ] Hand Calculations

5. Method of Combining Dynamic Responses: [ ] Absolute Sum [ ] SRSS
[ ] Other: __________ (specify)

6. Damping: ______ Basis for the damping used: ______

7. Support Considerations in the model:

8. Critical Structural Elements: ______________________________

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable

B.

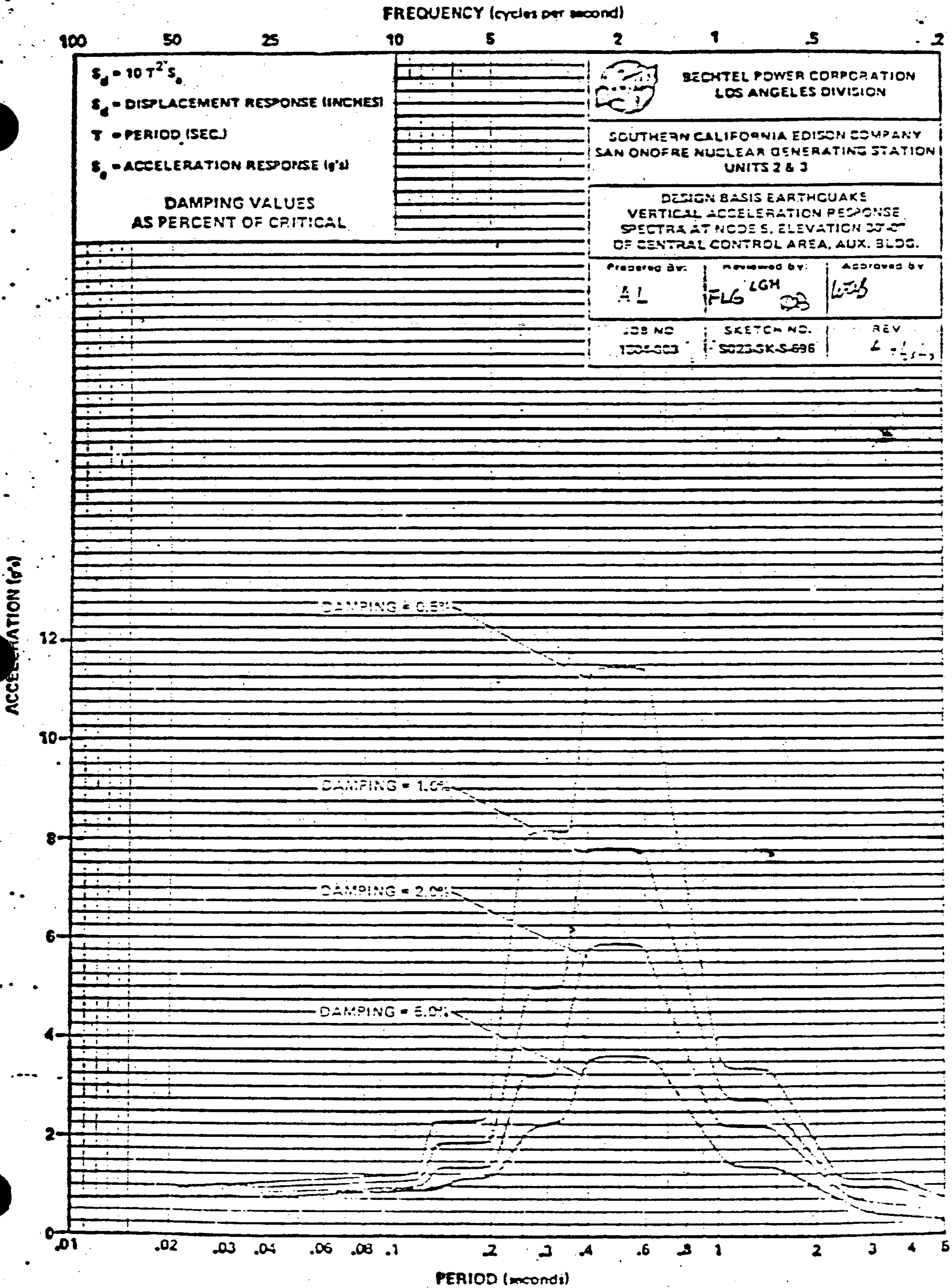
Max. Deflection	Location	Effect Upon Functional Operability

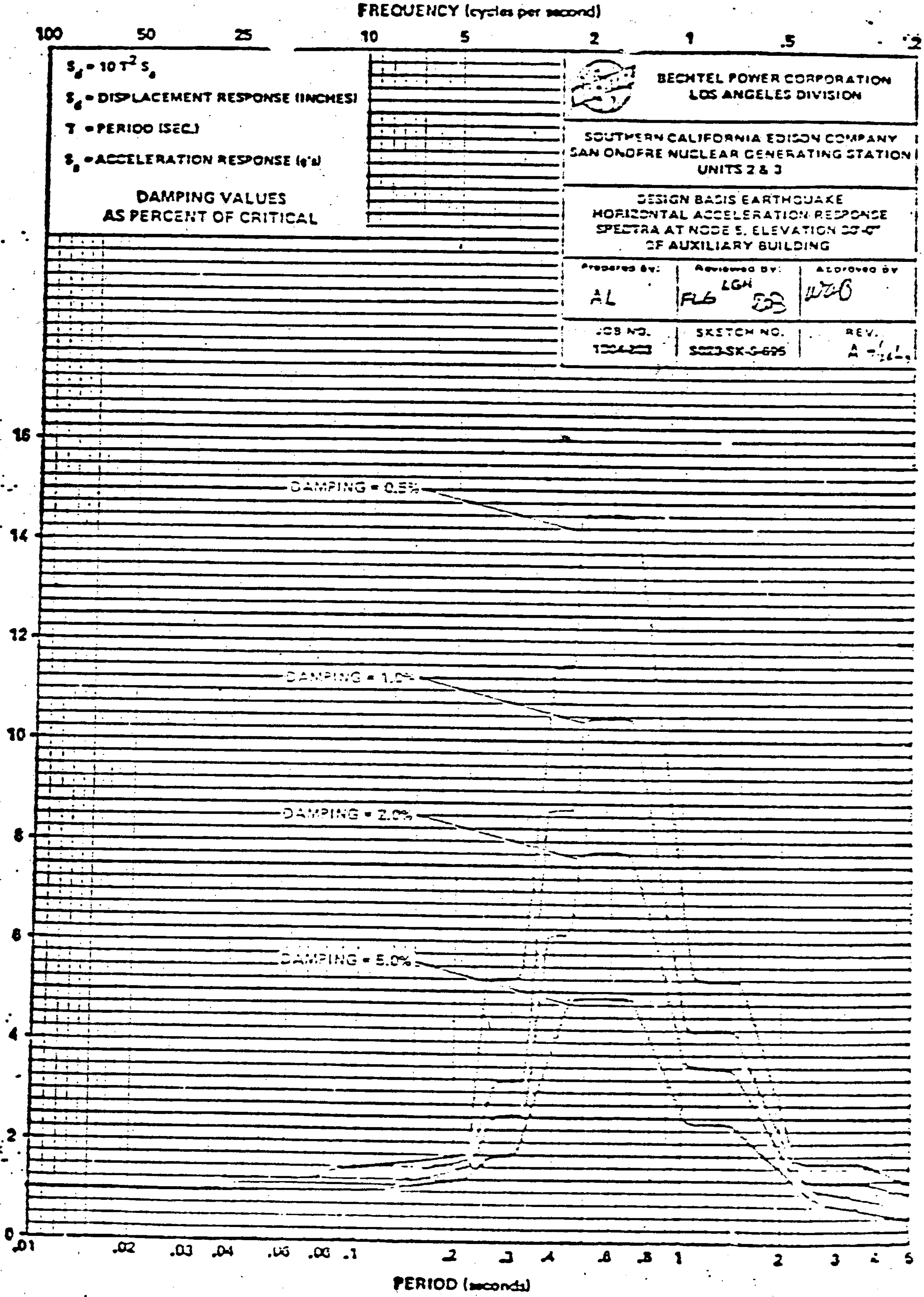
VI. 9. Test Results:

NATURAL FREQUENCIES	VERTICAL ______ SIDE - SIDE ______ FRONT - BACK ______
ELECTRICAL OPERATION	Performance as required: maximum [illegible] output shift of [illegible] during testing; maximum calibration shift of [illegible]; maximum shift in indicator calibration of [illegible]
PHYSICAL INTEGRITY	[illegible] no physical defects

DYNAMIC RESPONSE TO FULL LEVEL TEST (LARGE OR SUPPORT STRUCTURES ONLY)	
MAXIMUM STRUCTURAL STRESS	
MAXIMUM EXTERIOR DEFLECTION	
DYNAMIC LOAD TO MOUNTING	
MAXIMUM TRANSMISSIBILITY TO SUPPORTED DEVICES	

10. Style E control station is the model installed in SONGS 2 and 3. Style B control station was tested by Acton Labs. A vibration comparison test of 250PM+M2N-F, styles B and E control stations was performed to show seismic equivalence. Report number: Foxboro 80-0104b. Comparison of styles B and E control stations indicate that style E's output did not oscillate and the indicator shifts were less than or the same as those of the style B control station.


FREQUENCY (cycles per second)
$S_d = 10 T^2 S_a$
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
OF CENTRAL CONTROL AREA, AUX. BLDG.
Prepared by: AL
Reviewed by: FLG LGH
Approved by
JOB NO
SKETCH NO. SO23-SK-S-696
REV
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
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
HORIZONTAL ACCELERATION RESPONSE
SPECTRA AT NODE 5, ELEVATION
OF AUXILIARY BUILDING
Prepared by:
AL
Reviewed by:
FLG LGH
Approved by
JOB NO.
SKETCH NO.
REV.
A
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
16
14
12
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)

Qualification Summary of Equipment

I. Plant Name: San Onofre Units 2&3 — Type:

1. Utility: Southern California Edison Company — PWR X
2. NSSS: CE — 3. A/E: Bechtel — BWR ____

II. Component Name: Containment Purge Isolation Detector

1. Scope: [X] NSSS [ ] BOP
2. Model Number: GA-3M-652-1-21-X-5-0 Quantity: 2
3. Vendor: Nuclear Measurements Corporation
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Wall mounted detector ass'y
   b. Dimensions 16" x 14" x 5'
   c. Weight ≅10#
6. Location: Building: Penetration Bldg.
   Elevation: 45'
7. Field Mounting Conditions [X] Bolt (No. 4, Size 1/4-20)
   [ ] Weld (Length ____)
   [ ] ____ ____
8. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):
   S/S: 32 F/B: 24
   V: >40
9. a. Functional Description: Detect high radiation level, sends analog signal to transmitter
   b. Is the equipment required for [X] Hot Standby [X] Cold Shutdown
   [X] Both ____
10. Pertinent Reference Design Specifications: 1370-ICE-5003, Rev. 1

III. Is Equipment Available for Inspection in the Plant: [X] Yes [ ] No

IV. Equipment Qualification Method: Test: X

Analysis: ______

Combination of Test and Analysis: ______

Test and/or Analysis by Lab: Wyle #44875-1
(Name of Company or Laboratory & Report No.)

V. Vibration Input:

1. Loads considered: 1. [X] Seismic only 2. [ ] Hydrodynamic only

3. [ ] Explosive only 4. [ ] Other (Specify) ______

5. [ ] Combination of ______

6. Method of combining RRS: [ ] Absolute Sum [ ] SRSS
[ ] ______
(Other, Specify)

2. Required Response Spectra (attach the graphs): Attached.

3. Required Acceleration in Each Direction: ______

S/S = 1.0g input F/B = 1.0g input V = 1.0g input

VI. If Qualification by Test, then Complete: ______

1. [ ] Single Frequency [X] Multi-Frequency: [X] random
[ ] sine beat
[X] Superimposed sine burst.

2. [ ] Single Axis [X] Multi-Axis (Bi-Axial)

3. No. of Qualification Tests: OBE 5 SSE 1
Other Superimposed sine burst at 1,1.25,1.6,2Hz.
(Specify)

4. Frequency Range: See TRS attached.

5. TRS enveloping RRS using Multi-Frequency Test [X] Yes (plot TRS on RRS graphs)
[ ] No

6. Input g-level Test at:

S/S = 4 gs.
F/B = 3.0 gs.
V = 3.0 gs.

7. Laboratory Mounting: Standard shelf hardware (to simulate field installation

1. [x] Bolt (No. 4 , Size ¼"-20 Commercial) [ ] Weld (Length ______)
[ ] ______

8. Functional operability verified: [x] Yes [ ] No [ ] Not Applicable

9. Test Results including modifications made: See attached sheet.

10. Other tests performed (such as fragility test, including results):
N/A

VII. If Qualification by Analysis or by the Combination of Test and Analysis, then Complete:

1. Description of Test including Results: N/A

2. Method of Analysis: ______

[ ] Static Analysis
[ ] Dynamic Analysis
[ ] Equivalent Static Analysis
[ ] Time-History
[ ] Response Spectrum

3. Model Type: [ ] 3D [ ] 2D [ ] 1D

[ ] Finite Element [ ] Beam [ ] Closed Form Solution

4. [ ] Computer Codes: ______

Frequency Range and No. of modes considered: ______

[ ] Hand Calculations

5. Method of Combining Dynamic Responses: [ ] Absolute Sum [ ] SRSS
[ ] Other: ______
(specify)

6. Damping: ______ Basis for the damping used: ______

7. Support Considerations in the model: ______

8. **Critical Structural Elements:** ______________________________

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable

B.

Max. Deflection	Location	Effect Upon Functional Operability

NATURAL FREQUENCIES. VERTICAL > 40 Hz. SIDE / SIDE 32 Hz. FRONT / BACK 24 Hz.

ELECTRICAL OPERATION Proper operation verified, no failures.

PHYSICAL INTEGRITY Intact; no physical effects.

...MIC RESPONSE TO FULL LEVEL TEST (LARGE OR SUPPORT STRUCTURES ONLY)

...MUM STRUCTURAL STRESS

...XIMUM EXTERIOR DEFLECTION

DYNAMIC LOAD TO MOUNTING

MAXIMUM TRANSMISSIBILITY TO SUPPORTED DEVICES

VI. DISCUSSION

NATURAL FREQUENCIES VERTICAL > 40 Hz. SIDE / SIDE 32 Hz. FRONT / BACK 24 Hz.

ELECTRICAL OPERATION Proper operation verified, no failures.

PHYSICAL INTEGRITY Intact; no physical effects.

MIC RESPONSE TO FULL LEVEL TEST (LARGE OR SUPPORT STRUCTURES ONLY)

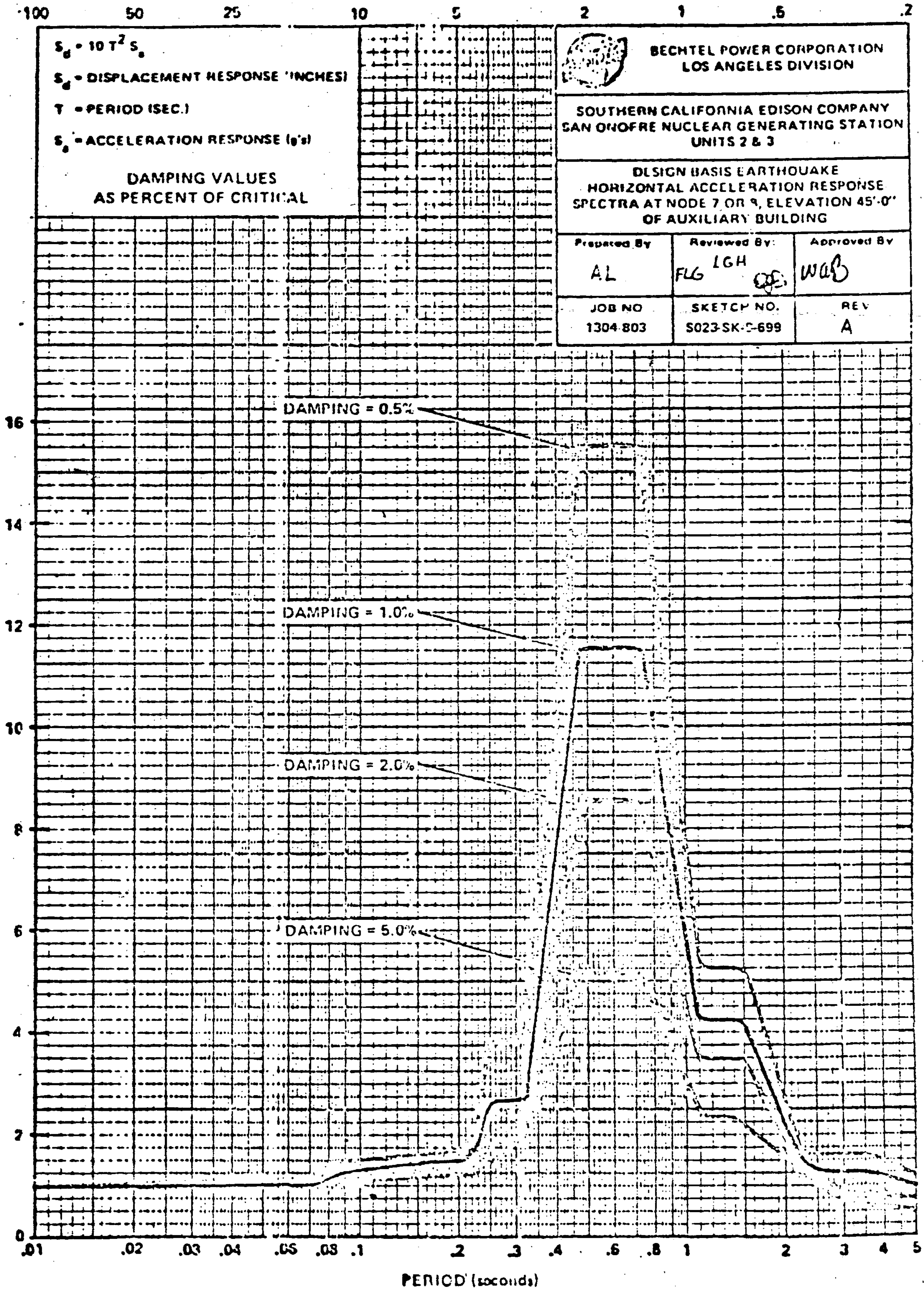
IMUM STRUCTURAL STRESS

IMUM EXTERIOR DEFLECTION

DYNAMIC LOAD TO MOUNTING

MAXIMUM TRANSMISSIBILITY TO SUPPORTED DEVICES

VI. DISCUSSION



$S_d = 10 T^2 S_a$
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 7 OR 9, ELEVATION 45'-0"
OF AUXILIARY BUILDING
Prepared By
AL
Reviewed By:
FLG LGH
Approved By
JOB NO
1304-803
SKETCH NO.
S023-SK-C-699
REV
A
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
100
50
25
10
5
2
1
.5
.2
ACCELERATION (g's)
16
14
12
10
8
6
4
2
0
.01
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.05
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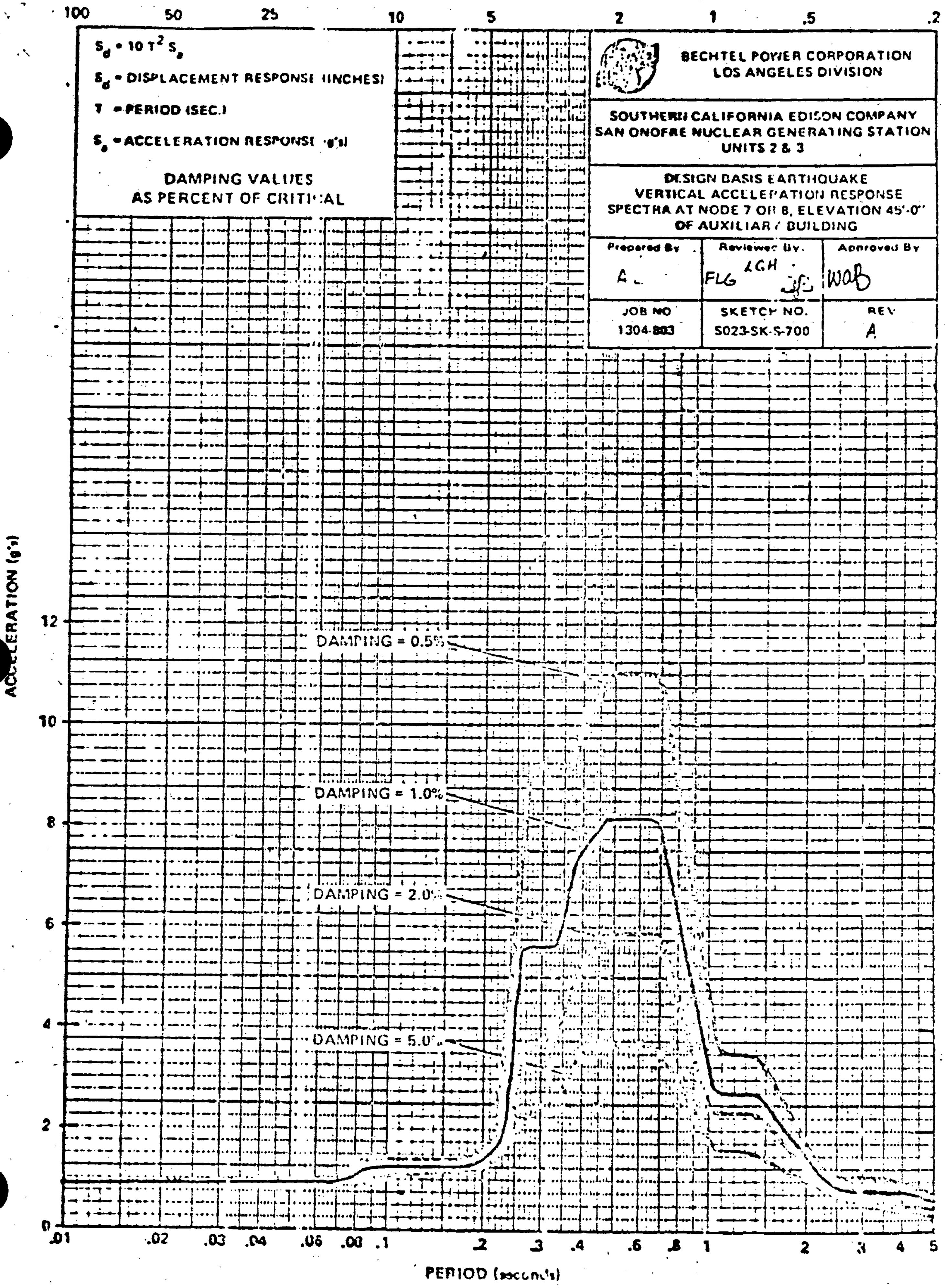
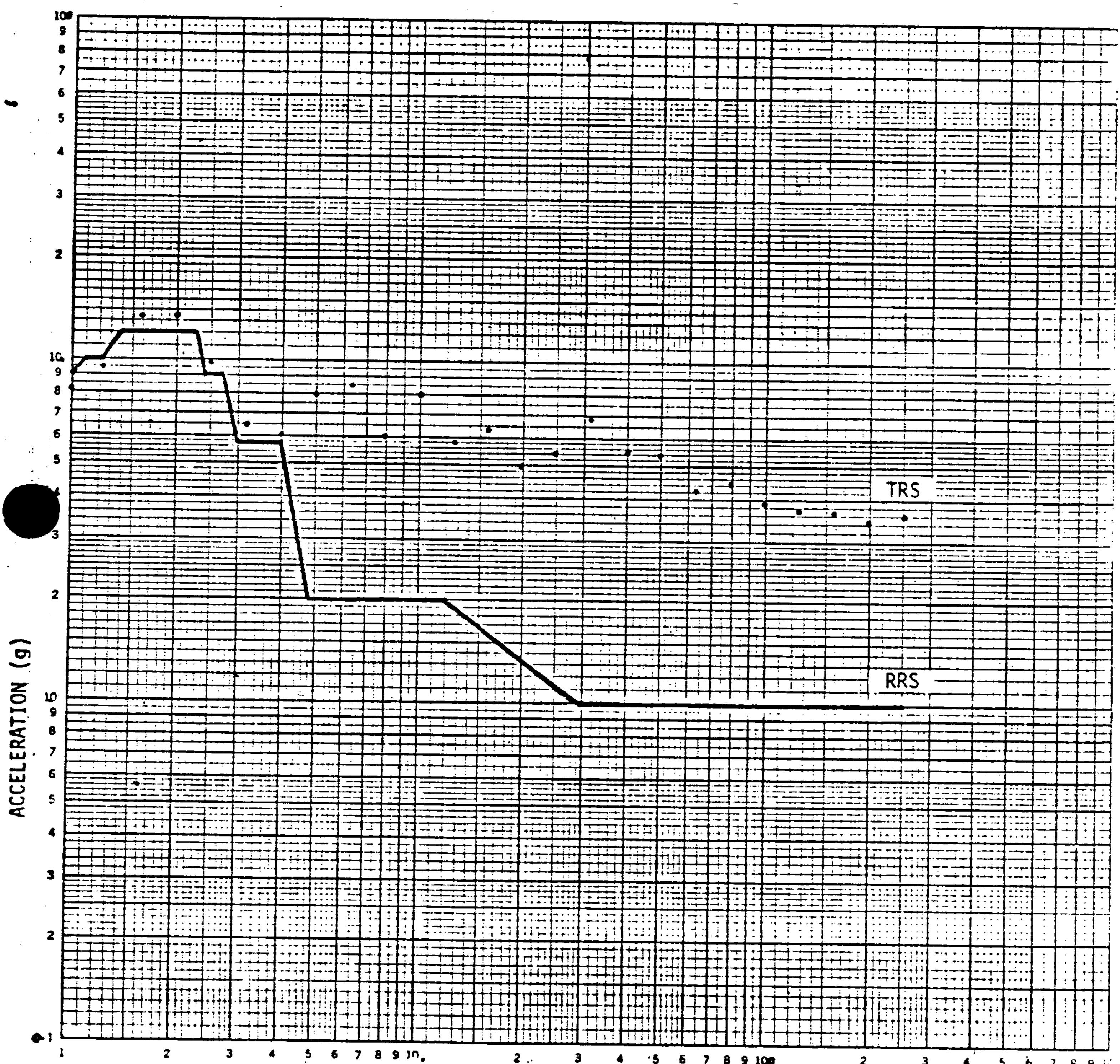
.3
.4
.6
.8
1
2
3
4
5
PERIOD (seconds)



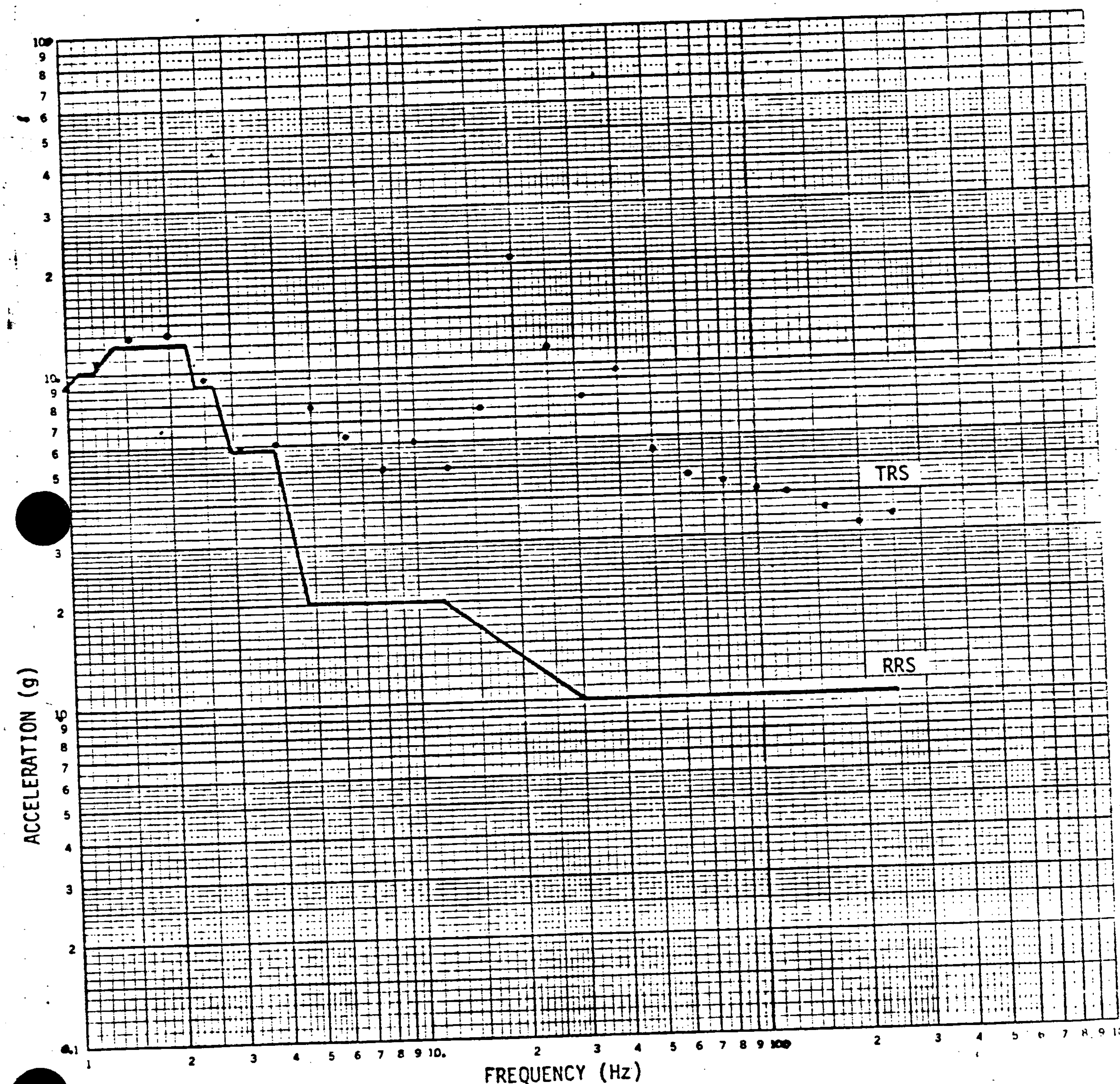
$S_d = 10\,T^2\,S_a$
S_d = DISPLACEMENT RESPONSE (INCHES)
T = PERIOD (SEC.)
S_a = ACCELERATION RESPONSE (g's)
DAMPING VALUES AS PERCENT OF CRITICAL
BECHTEL POWER CORPORATION
LOS ANGELES DIVISION
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3
DESIGN BASIS EARTHQUAKE
VERTICAL ACCELERATION RESPONSE
SPECTRA AT NODE 7 OR 8, ELEVATION 45'-0"
OF AUXILIARY BUILDING
Prepared By
Reviewed By
Approved By
JOB NO
1304-803
SKETCH NO.
S023-SK-S-700
REV
A
100
50
25
10
5
2
1
.5
.2
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
12
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)

CONTAINMENT PURGE ISOLATION DETECTOR & TRANSMITTER
SEISMIC RESPONSE SPECTRA
SSE, HORIZONTAL, 1% DAMPING



MINIMUM OF TWO HORIZONTAL TESTS (F/B & S/S).

CONTAINMENT PURGE ISOLATION DETECTOR & TRANSMITTER
SEISMIC RESPONSE SPECTRA
SSE, VERTICAL, 1% DAMPING



MINIMUM OF TWO VERTICAL TESTS.

Qualification Summary of Equipment

I. Plant Name: San Onofre Units 2&3

Type:

1. Utility: Southern California Edison Company — PWR X

2. NSSS: CE 3. A/E: Bechtel — BWR

II. Component Name: Containment Purge Isolation Transmitter

1. Scope: [X] NSSS [ ] BOP

2. Model Number: GA-3M-652-1-21-X-5-0 Quantity: 2

3. Vendor: Nuclear Measurements Corporation

4. If the component is a cabinet or panel, name and model No. of the devices included: N/A

5. Physical Description a. Appearance Wall mounted assembly

   b. Dimensions 14-1/4" x 17-1/2" x 8"

   c. Weight ≅20#

6. Location: Building: Penetration Bldg.

   Elevation: 45'

7. Field Mounting Conditions [X] Bolt (No. 4, Size ¼"-20)
   [ ] Weld (Length)
   [ ]

8. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical):

   S/S: 32 F/B: 24
   V: >40

9. a. Functional Description: Generate actuation signal from input analog signal

   b. Is the equipment required for [X] Hot Standby [X] Cold Shutdown

   [X] Both

10. Pertinent Reference Design Specifications: 1370-ICE-5003, Rev. 1

III. Is Equipment Available for Inspection in the Plant: [X] Yes [ ] No

IV. Equipment Qualification Method: Test: X

Analysis: ____

Combination of Test and Analysis: ____

Test and/or Analysis by Lab: Wyle #44875-1.
(Name of Company or Laboratory & Report No.)

V. Vibration Input:

1. Loads considered: 1. [X] Seismic only 2. [ ] Hydrodynamic only

3. [ ] Explosive only 4. [ ] Other (Specify) ____

5. [ ] Combination of ____

6. Method of combining RRS: [ ] Absolute Sum [ ] SRSS
[ ] ____
(Other, Specify)

2. Required Response Spectra (attach the graphs): Attached.

3. Required Acceleration in Each Direction: ____

S/S = 1.0g input. F/B = 1.0g input. V = 1.0g input.

VI. If Qualification by Test, then Complete: ____

1. [ ] Single Frequency [X] Multi-Frequency: [X] random
[ ] sine beat
[X] Superimposed sine burst.

2. [ ] Single Axis [X] Multi-Axis

3. No. of Qualification Tests: OBE 5 SSE 1
Other Superimposed sine burst at 1,1.25,1.6,2Hz.
(Specify)

4. Frequency Range: See TRS attached.

5. TRS enveloping RRS using Multi-Frequency Test [X] Yes (plot TRS on RRS graphs)
[ ] No

6. Input g-level Test at:

S/S = 4 gs.
F/B = 3.8 gs.
V = 3.8 gs.

7. Laboratory Mounting: Standard shelf hardware (to simulate field installation)

1. [X] Bolt (No. 4, Size ¼"-20 Commercial) [ ] Weld (Length ______)
[ ] ______

8. Functional operability verified: [X] Yes [ ] No [ ] Not Applicable

9. Test Results including modifications made: See attached sheet.

10. Other tests performed (such as fragility test, including results):

N/A

VII. If Qualification by Analysis or by the Combination of Test and Analysis, then Complete:

1. Description of Test including Results: N/A

2. Method of Analysis: ______

[ ] Static Analysis
[ ] Dynamic Analysis
[ ] Equivalent Static Analysis
[ ] Time-History
[ ] Response Spectrum

3. Model Type: [ ] 3D [ ] 2D [ ] 1D

[ ] Finite Element [ ] Beam [ ] Closed Form Solution

4. [ ] Computer Codes: ______

Frequency Range and No. of modes considered: ______

[ ] Hand Calculations

5. Method of Combining Dynamic Responses: [ ] Absolute Sum [ ] SRSS
[ ] Other: ______ (specify)

6. Damping: ______ Basis for the damping used: ______

7. Support Considerations in the model: ______

8. Critical Structural Elements:____

A.

Identification	Location	Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowable

B.

Max. Deflection	Location	Effect Upon Functional Operability

NATURAL FREQUENCIES VERTICAL	> 40 Hz.
SIDE / SIDE	32 Hz.
FRONT / BACK	24 Hz.
ELECTRICAL OPERATION	The transmitter operated properly except for contact chatter.
PHYSICAL INTEGRITY	Intact; no physical anomalies other than those noted below as electrical anomalies

DYNAMIC RESPONSE TO FULL LEVEL TEST (LARGE OR SUPPORT STRUCTURES ONLY)

MAXIMUM STRUCTURAL STRESS

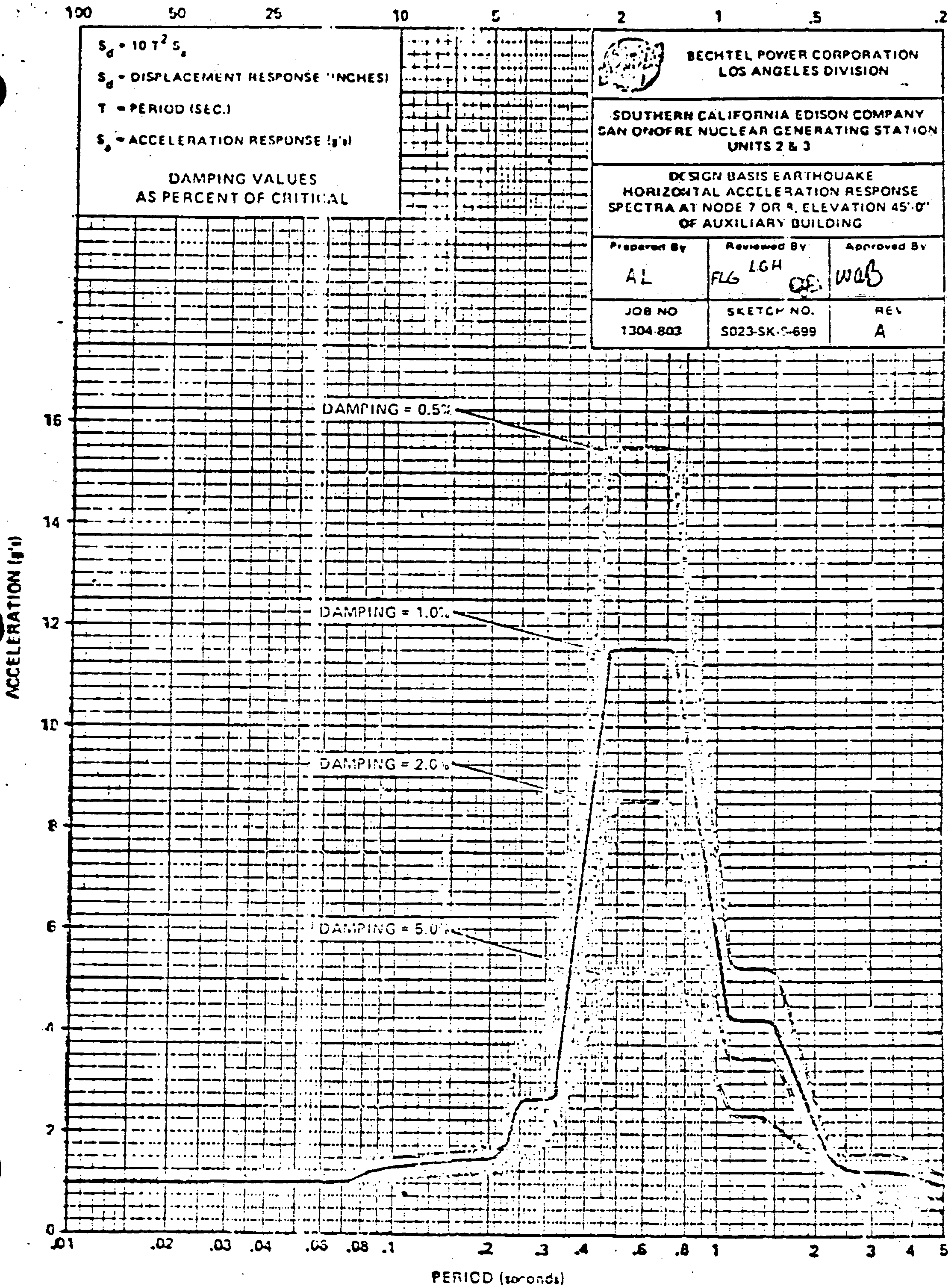
MAXIMUM EXTERIOR DEFLECTION

DYNAMIC LOAD TO MOUNTING

MAXIMUM TRANSMISSIBILITY TO SUPPORTED DEVICES

VI. DISCUSSION

No relay chatter was evident as long as the relay was in the energized mode (alarm not operated, contacts closed). After the alarm is operated (relay de-energized, contacts open) chatter was evident. The function of this relay is to trip electric components downstream to actuate the control components (purge valve operators). Once the relay has tripped (contacts open), it is no longer safety related as it has completed its safety function and will not affect control operation even if the contacts were to re-close. The operation of the relay during the seismic test was successful in that it tripped when required.



BECHTEL POWER CORPORATION
LOS ANGELES DIVISION
SOUTHERN CALIFORNIA EDISON COMPANY
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UNITS 2 & 3
DESIGN BASIS EARTHQUAKE
HORIZONTAL ACCELERATION RESPONSE
SPECTRA AT NODE 7 OR 9, ELEVATION 45'-0"
OF AUXILIARY BUILDING
Prepared By
AL
Reviewed By
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Approved By
JOB NO
1304-803
SKETCH NO.
REV
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$S_d = 10 T^2 S_a$
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
50
25
10
5
2
1
.5
.2
0
2
4
6
8
10
12
14
16
.01
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.6
.8
1
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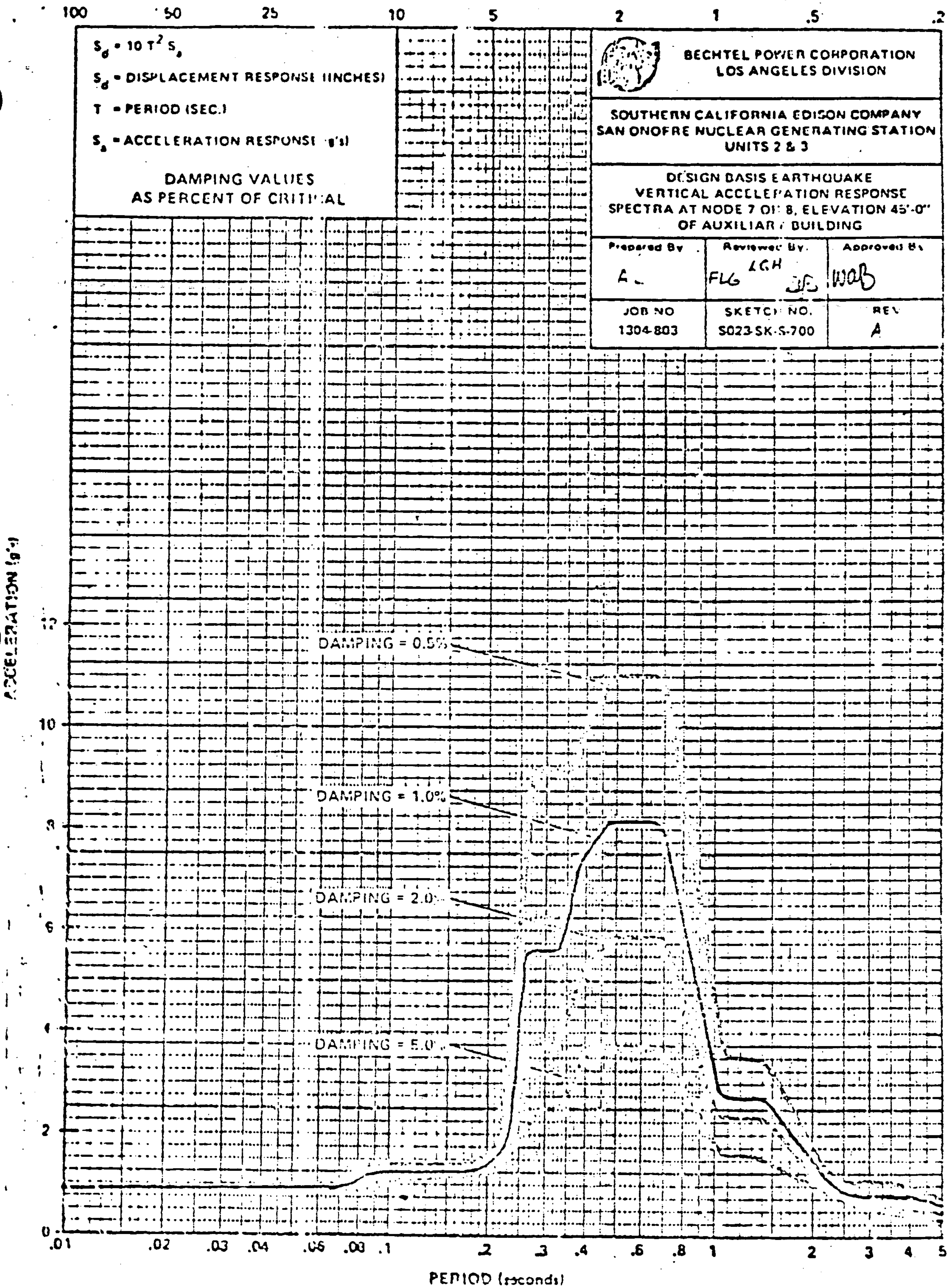
3
4
5



100
50
25
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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
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UNITS 2 & 3
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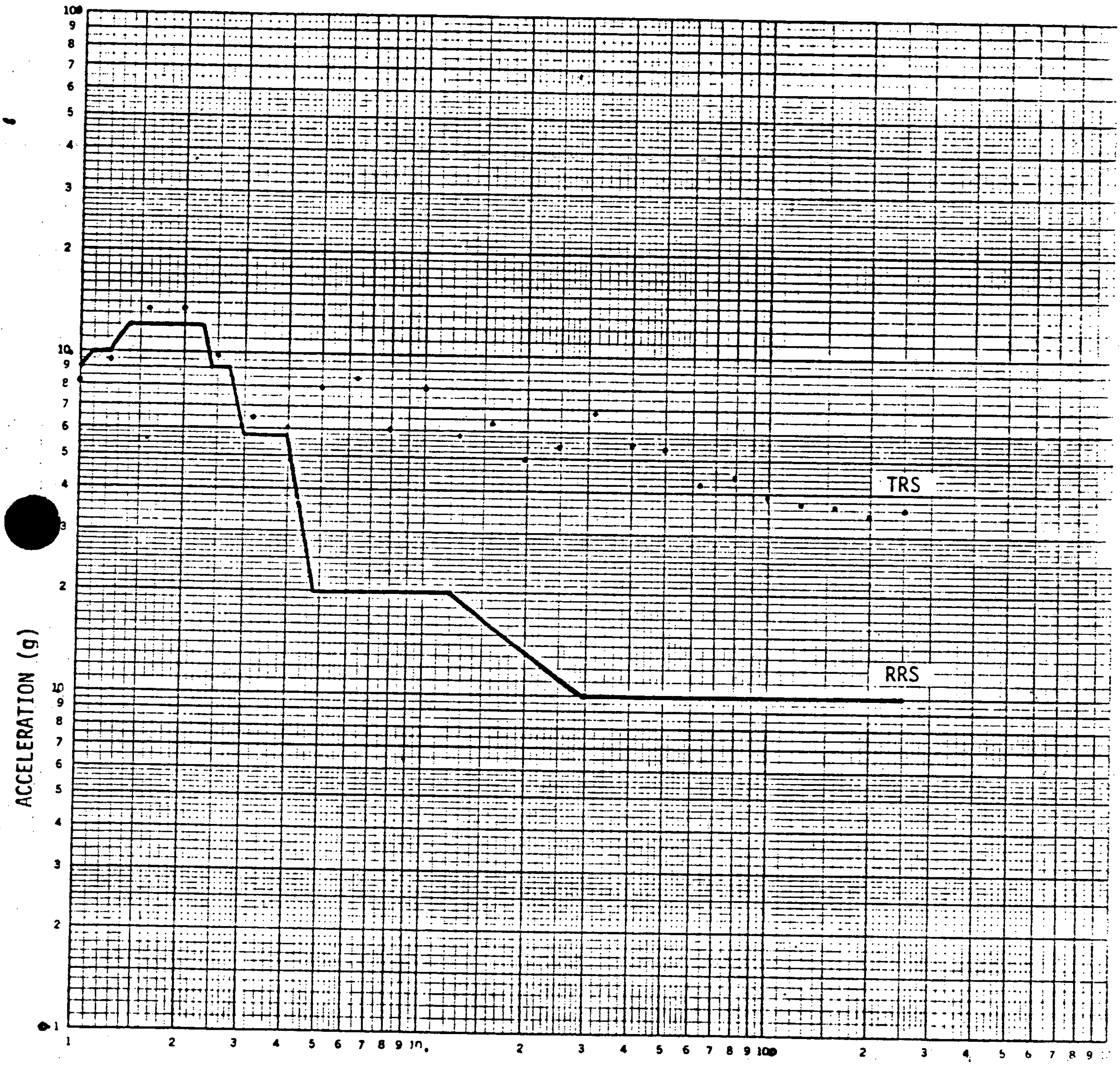
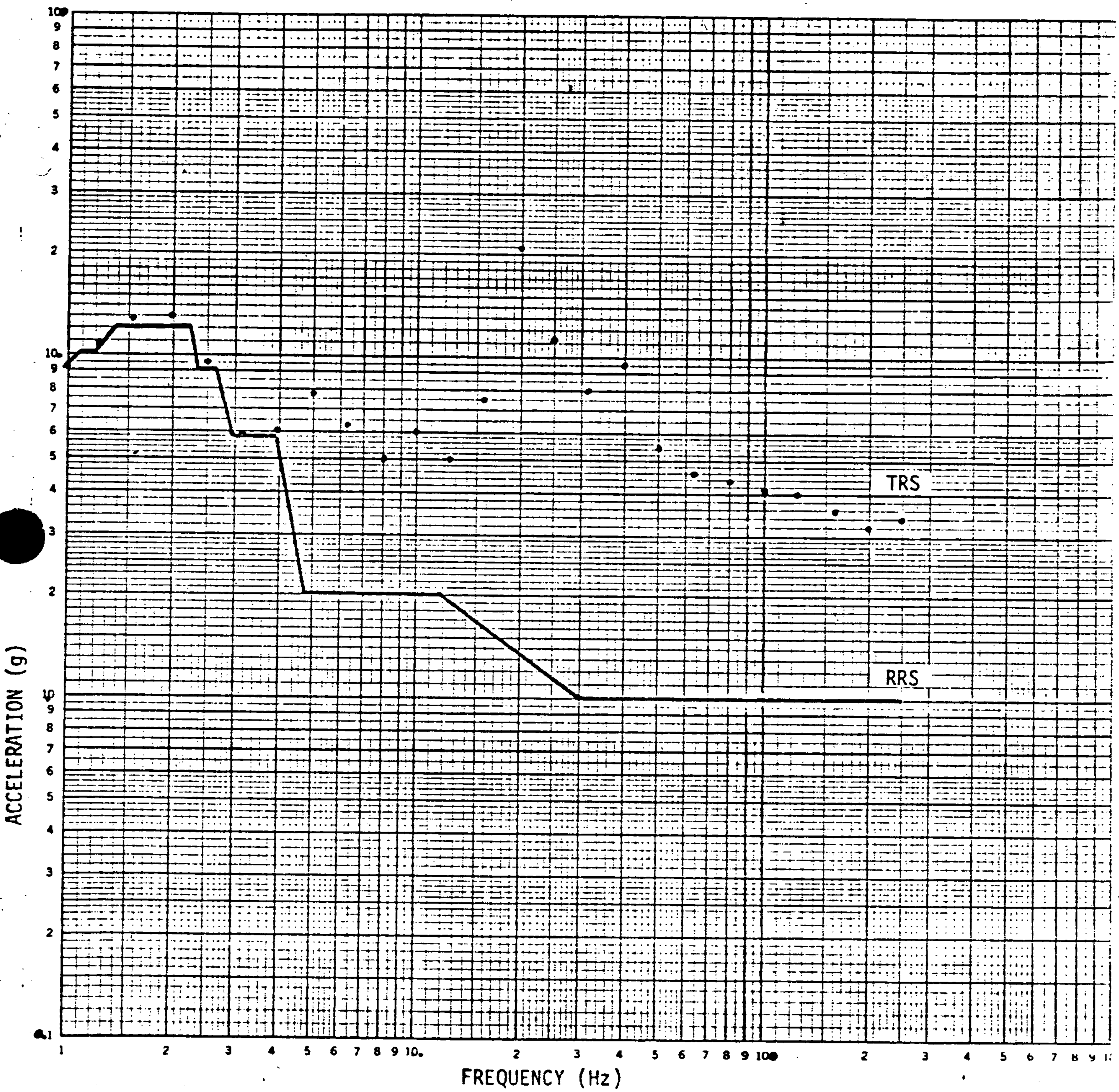
VERTICAL ACCELERATION RESPONSE
SPECTRA AT NODE 7 OF 8, ELEVATION 45'-0"
OF AUXILIARY BUILDING
Prepared By
Reviewed By
Approved By
FLG
LGH
WOB
JOB NO
1304-803
SKETCH NO.
S023-SK-S-700
REV
A
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
10
8
6
4
2
0
.01
.02
.03
.04
.06
.08
.1
.2
.3
.4
.6
.8
1
2
3
4
5
PERIOD (seconds)

CONTAINMENT PURGE ISOLATION DETECTOR & TRANSMITTER
SEISMIC RESPONSE SPECTRA
SSE, HORIZONTAL, 1% DAMPING



MINIMUM OF TWO HORIZONTAL TESTS (F/B & S/S).

CONTAINMENT PURGE ISOLATION DETECTOR & TRANSMITTER
SEISMIC RESPONSE SPECTRA
SSE, VERTICAL, 1% DAMPING



MINIMUM OF TWO VERTICAL TESTS.

8. Question:

A confirmatory statement is needed that no essential devices in the ESFAS cabinet (NSSS-4) have a low natural frequency, less than 7 Hz.

Response:

A review of the ESFAS cabinet internals was performed to ascertain which components could be resonant at low frequencies. Upon review, it was determined that the below items were of possible concern. An analysis of each component was performed and the results follow.

Ground Detector - This item contains a circuit board which could be resonant at low frequencies. Using the same techniques that were previously utilized in the "SONGS SQRT Submittal to the NRC", February 13, 1981, Section 1, the lowest natural frequency of the circuit board with very conservative boundary conditions calculates to be 12.8 Hz.

FPS Power Supply - This item contains one circuit board with a conservately calculated 1st mode of 22.1 Hz.

Test Power Supply - This item also contains circuit boards but is physically much smaller than the above supply. A decrease in circuit board size will cause an increase in the lowest resonant frequency value. Therefore, the lowest resonant frequency of this item must be greater than 22.1 Hz.

Annunciator - This item is the last item in the cabinet which contains a circuit board. Using conservative boundary conditions and previously identified techniques, the lowest resonant frequency calculates to be 14.4 Hz.

Relays - These relays are no larger than 2" square and are plug in type. Due to the physical size of these relays, sensitivity to frequencies below 7 Hz is highly unlikely especially because no contact chatter was evident during functional monitoring.

Rotary Relays - Note that rotary relays are particularly insensitive to linear excitation. The cabinet was considerably overtested above 7 Hz, with excitation extending at least to 30 Hz, and no relay chattering occurred. This more than strongly implies that no flexibility exists in the relays causing sensitivity to frequencies below 7 Hz. If the relays were resonant below 7 Hz, chattering would certainly occur due to excitation of the higher frequencies.

It should be noted that small structures with natural frequencies below 5 Hz are obvious, either visually or to the touch. For example a resonant system at 1 Hz will sag under gravity by 10 inches, 2 Hz at 2.5 inches and 4 Hz at 0.625 inches. This obvious flexibility does not exist in small electronic components.

Based on our review of the devices included in this cabinet, we are convinced that all resonant frequencies of the devices are at least 1 2/3 octaves above the cut off frequency of 4 Hz. Please note that the 1/2 octave (or 70%) criteria is met by a better than 3 to 1 margin.

9. Question:

Demonstrate that the qualification test fixture is representative of the installation for the neutron detector (NSSS-16).

Response:

In the field, the neutron detectors are located within 6 inch diameter schedule 40 pipe which is rigidly attached to the internal surface of the primary shield wall. The detectors are rigidly held in the pipe through the use of wedges which are tightened after the detectors are lowered into the pipe. The seismic test of the detectors used the same 6 inch schedule 40 pipe with the detector lowered and wedged in the same manner used in the field installation.