KANE

Hello

FYI

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

AUG 19 1981

Docket Nos.: 50-361/362

APPLICANTS: SOUTHERN CALIFORNIA EDISON COMPANY (SCE)
SAN DIEGO GAS AND ELECTRIC COMPANY (SDG&E)
CITY OF ANAHEIM, CALIFORNIA (ANAHEIM)
CITY OF RIVERSIDE, CALIFORNIA (RIVERSIDE)

FACILITY: SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3

SUBJECT: SUMMARY OF SAN ONOFRE MEETING ON CONFIRMATORY ANALYSIS OF PIPING SYSTEM DESIGN

On July 21, 1981, members of the NRC staff met with the applicant in Bethesda, Maryland to discuss the above subject. Attendees at the meeting are given in Enclosure 1. Material presented at the meeting by the applicants is given in Enclosure 2. In addition to the information presented in Enclosure 2, the applicants stated that the specific piping system analyzed (the shutdown cooling system, or SDCS) is representative of other safety-related piping systems attached to the NSSS. This conclusion is based on the fact that the first mode frequency of safety-related piping systems attached to the NSSS is 8 Hz or greater. Therefore, the results of the SCDS analysis are applicable to these systems. Further, the applicants stated that consideration of pipe support flexibility will not significantly shift the piping frequency into the range of the amplified building response spectra.

Harry Rood

Harry Rood, Project Manager
Licensing Branch #3
Division of Licensing

cc: w/enclosure
See next page.

Joe: This is an interesting Summary. apparently Bechtel is offering "hand-waving" analyses in piping systems above ground. This is consistent with the problems we are having with soils/foundations area.

Lyman

ENCLOSURE 1

AUG 19 1981

ATTENDEES

SAN ONOFRE 2 and 3 MTG - 7/21/81

NAME	ORGANIZATION
H. Rood	NRC/LB3
A. Cappucci	NRC/MEB
M. Hartzman	NRC/MEB
H. Fleck	ETEC
Bob Bosnak	NRC/DE/MEB
Derrick Mercurio	SCE/Licensing
R. L. Cloud	Consultant to SCE
R. P. Ellis	Bechtel-Plant Design Staff
Salah Mohamed	Bechtel/SO 2&3
Ed. Richardson	Bechtel
L. G. Hersh	Bechtel
H. L. Brammer	NRC/MEB

ENCLOSURE 2

AUG 1 3 1981

by Bechtel

CONFIRMATORY ANALYSIS OF PIPING SYSTEM DESIGN FOR SAN ONOFRE UNITS 2 & 3

INTRODUCTION

The NRC engaged ETEC to perform an independent analysis of one of the piping systems for San Onofre Units 2 & 3. ETEC's charter was to perform a confirmatory analysis utilizing the SRP criteria and analytic techniques.

The piping system selected for this analysis was the shutdown cooling system from the containment penetration to the reactor coolant system hot leg (See Figure 1).

Bechtel provided ETEC with the system design specification, response spectra, histogram of temperature and pressure conditions, isometrics and as-built support configurations.

ORIGINAL DESIGN BASIS

The design basis and analytic techniques utilized by Bechtel are summarized in the SAR in Section 3.9.3 and Appendix 3.7B. The three issues of particular concern are the seismic modal response combination technique, the method of modeling supports, and the approach for accommodating multiple support excitation. For seismic modal response combination, the square root of sum of squares (SRSS) technique was used (Paragraph 3.7B.5.1 of Appendix 3.7B). For support modeling, the Rigid Support Method was used with the design of the support structure being limited by a deflection criteria. Mechanical snubber supports were also modeled as rigid supports (Paragraph 3.9.3.4). Multiple support excitation was accommodated by providing a single system support response spectra which enveloped the various independent support response spectra (Paragraph 3.7B.3.3 of Appendix 3.7B).

ETEC ANALYSIS

ETEC has performed their analysis utilizing the Regulatory Guide 1.92 seismic modal response combination technique (absolute summation of closely spaced modes), considering snubbers to be flexible and structural steel supports rigid, and using each of the various separate support response spectra independently but applied to all system supports simultaneously. ETEC's position on the use of flexible snubbers is based on an ancillary statement in the project SAR which states "Where necessary, the snubber spring rates are incorporated into the analysis". The purpose of this statement was to cover a one time application of snubber flexibilities in the analysis of seismic anchor motion for the main steam line.

An additional item included in the ETEC analysis was the use of final as-built support configurations. This resulted in the identification of three eccentric snubber installations which were not included in the original Bechtel analysis. This is not unusual in as much as at the time of the initial analysis the actual system supports have not been designed. Many times, during the detailed support design and/or installation procedure, variations in design concept are dictated by physical constraints within the plant. These variations are subsequently evaluated by the analyst for their impact on local stress conditions as well as overall system response. Such variations can have a significant influence on local stress conditions, and in all cases a detailed local analysis is performed. However, for the as-built changes judged to be significant to the overall system response, a system reanalysis was performed.

One final difference between the two analyses is that the Bechtel model includes all tributary or branch line and one blind flange which were all excluded from the ETEC model. This is judged to have little overall affect but results in some variation in system response characteristics.

ETEC's analysis considering as-built support configurations, Regulatory Guide 1.92 combination techniques, snubber flexibilities and the NSSS nozzle response spectra results in 2 elbows being overstressed and 9 snubbers exceeding rated capacities for DBE conditions.

DISCUSSION

A parametric study to determine the influence of the various alternatives in analytic approach indicated that when the response spectra was decoupled to accurately model support excitation, the inclusion of support flexibilities had little affect on the overall system response. This is consistent with various studies reported in the literature which conclude that piping systems and supports designed by either the Rigid Support Method or the Flexible Support Method would be adequate to resist the predicted response patterns during a seismic event "without any anticipated failures being predicted using either analysis technique".[1]

The reason for this conclusion rests with the particular characteristics of the response spectra used in this analysis as shown in Figures 2 through 10. The typical building response spectra is characterized by a single band, low frequency, high amplitude response between 1 hz and 4 hz, a secondary moderate amplified region between 4 hz and 12 hz and little or no amplified response above 15 hz. On the other hand, the NSSS nozzle interface response spectra exhibit a secondary amplified response region of between 2 to 6 times the ZPA levels between 14 hz and 25 hz.

Clearly, utilizing a single enveloped response spectra (Bechtel Approach) or NSSS response spectra applied to all support points simultaneously (ETEC Approach) unduly penalize the results since the point of application of the NSSS response spectra is in fact limited to the single nozzle interface and its degree of influence is greatly reduced as you move away from this interface point. This phenomenon is further accentuated by the fact that as support flexibilities are introduced into the analysis the overall system frequencies are reduced, thereby increasing the number of system frequencies which could interact with this secondary amplified region.

The incorporation of only the snubber flexibilities into the analysis for this system is inappropriate since the stiffness characteristics of the remaining system supports are of the same order of magnitude as the snubber stiffnesses. Therefore if snubber flexibilities are to be included in analysis, all support flexibilities should be included for consistent methodology. The significance of this fact can be seen in Figure (9).

The parametric study also showed that incorporation of Regulatory Guide 1.92 modal response combination criteria or as-built support configurations into the analysis had significantly less affect on the total system response than the use of snubber/support flexibilities in conjuntion with the application of a response spectra with the NSSS spectral shape at all support points.

The following additional conservatisms in the original initial design analysis should also be taken into consideration:

1. Defined Allowable Stress Level

   The original piping system design was based on an allowable stress level of 1.80 S_h for equation (9) of NC and ND-3600 of the ASME Code for the

DBE condition. Code Case 1606, applicable to all projects since June 1974, specifies an allowable stress for the DBE condition of 2.4 S_h. This means that an inherent 33 percent margin exists in the original design.

2. Use of 2X OBE Response as DBE Response

In general, DBE responses were taken to be twice the calculated OBE response. This is conservative since the DBE ground motion input level is twice the OBE input level while at the same time the associated DBE damping levels (soil-structure interaction, structural and subsystem) are also higher. Therefore the resulting DBE response would be less than twice the corresponding OBE response (Refer to Figure 10). The implication of this conservatism is a minimum of 10 percent additional margin in the original design and a potential range as high as 40 percent depending upon the subsystem damping and the applicable frequency range.

3. Thermal Stresses

Assuming rigid supports in a thermal analysis results in higher thermal loads than when support flexibility is considered. If actual support stiffnesses are included in the model, deflection of the support would occur and the resulting load would be reduced proportionally. Also thermal analyses generally use the design temperatures which would result in higher loads than would be obtained if maximum operating temperatures were used.

4. Seismic Anchor Motions

Seismic anchor motions are typically established for the worst case combination of anchorage attachment points on adjacent structures. This results in an overstatement of the stresses and support loads resulting from seismic anchor motions. Consideration of actual support flexibilities would further reduce the stress levels and support loads resulting from seismically induced differential building motions.

In order to present the conclusions of the parametric studies several figures are included to summarize these results. A comparison of the design bases used in the state of the art analysis to those used in either the original project analysis or the ETEC confirmatory analysis are provided in Figure 11. In brief, the state of the art analysis utilized as-built support configurations, Regulatory Guide 1.92 combination techniques, support flexibilities for all supports and independent multiple support excitation techniques. The results of this analysis are presented in Figures 12 through 17.

CONCLUSIONS

ETEC's confirmatory analysis utilized a different approach and results in different answers. A reanalysis using current day state of the art techniques show that ETEC's analysis overstates the actual stress conditions. This reanalysis further shows that all the ASME portions of the shutdown cooling system, both piping system and supports, meet the specified design criteria. Two small snubbers on a connected none-safety related ANSI B31.1 line have design loads slightly in excess of rated capacities. The worst of these is a 184 lb. overload of a 2100 lb. capacity snubber. Stresses in the associated ANSI B31.1 line and all other supports and snubbers meet the specified design criteria.

The principal factor influencing the differences in results between the original analysis and the ETEC confirmatory analysis is the application of the NSSS nozzle response spectra simultaneously at all support points, which is excessively conservative. Incorporation of Regulatory Guide 1.92 modal response combination techniques or as-built support configurations or the incorporation of snubber flexibility each have significantly less influence on the total system response.

The results of the state of the art analysis of the shutdown cooling line would be applicable to all other ASME piping systems attached to reactor coolant system because of the following reasons:

1. The same design basis and analytic techniques were used for all ASME piping systems.
2. Similar margins to allowable exist for all ASME piping systems. i.e. Localized maximum primary stresses have 10 percent or more margin to allowable whereas in general the primary stresses have 40 to 60 percent margin to allowable.
3. Seismic stresses typically represent less than 10 percent of the total piping system primary stress and in all cases less than 30 percent of the total piping system primary stress. Therefore variations in seismic response levels of the magnitude shown have minimal effect on the overall piping system response levels.
4. Structural steel supports tend not to be affected by variations in analytic assumptions due to the self compensating nature of the load distribution i.e. high support stiffness results in higher thermal loads and lower seismic loads while lower support stiffness results in lower thermal loads and higher seismic loads.
5. As shown in Figure 17, the imposed loads on the large highly loaded snubbers changed very little between the original analysis and the state of the art analysis. Further, the large snubbers all have significant margins to rated capacity.

As is clearly shown by Figures 14, 15, and 17, the stresses and loads developed by a recent state of the art analysis using consistent methodology differ but little from the loads and stresses calculated in the original design analysis.

Therefore, the results of this work serve to verify the original analysis.

In conclusion, the specified design for the San Onofre Units 2 & 3 project is sufficient basis to assure public health and safety under all credible design basis events.

References:

1. H. Suryoutomo and R. Bacher, "Dynamic Analysis Techniques - A Sensitivity Study for Piping Systems at a Nuclear Power Plant," the ASME Joint Conference, Denver, Colorado, June 21-25, 1981, Publication PVP-Vol. 53, pp. 159-171.
2. T. Y. Chow, C. H. Chen and O. Bilgin, "Evaluation of Pipe Support Stiffness and its Effect on Piping Response", the ASME Joint Conference, Denver, Colorado, June 21-25, 1981, Publication PVP-Vol. 53, pp. 105-115.
3. M. Z. Lee, "Effects of Support Stiffness on Pipe Vibration", the ASME Joint Conference, Denver, Colorado, June 21-25, 1981, pp. 31-38.
4. P. J. Kotwicki, K. C. Chang and E. R. Johnson, "Effects of Restraint Stiffness and Gap on the Dynamic Response of Piping Systems," The Third U.S. National Congress on Pressure Vessels and Piping, ASME, San Francisco, California, June 25-29, 1979, pp. 91-106.

LIST OF FIGURES

Fig.1 - System ISO

Fig.2 - Building DBE Horizontal Spectra

Fig.3 - Building DBE Vertical Spectra

Fig.4 - Building OBE Horizontal Spectra

Fig.5 - Building OBE Vertical Spectra

Fig.6 - NSSS OBE N-S Spectra

Fig.7 - NSSS OBE E-W Spectra

Fig.8 - NSSS OBE Vert Spectra

Fig.9 - Frequency comparison

Fig.10 - OBE-DBE Building Spectra

Fig.11 - Comparison of Design Basis/Assumptions

Fig.12 - OBE Inertial

Fig.13 - DBE Inertial

Fig.14 - OBE - Eq.9

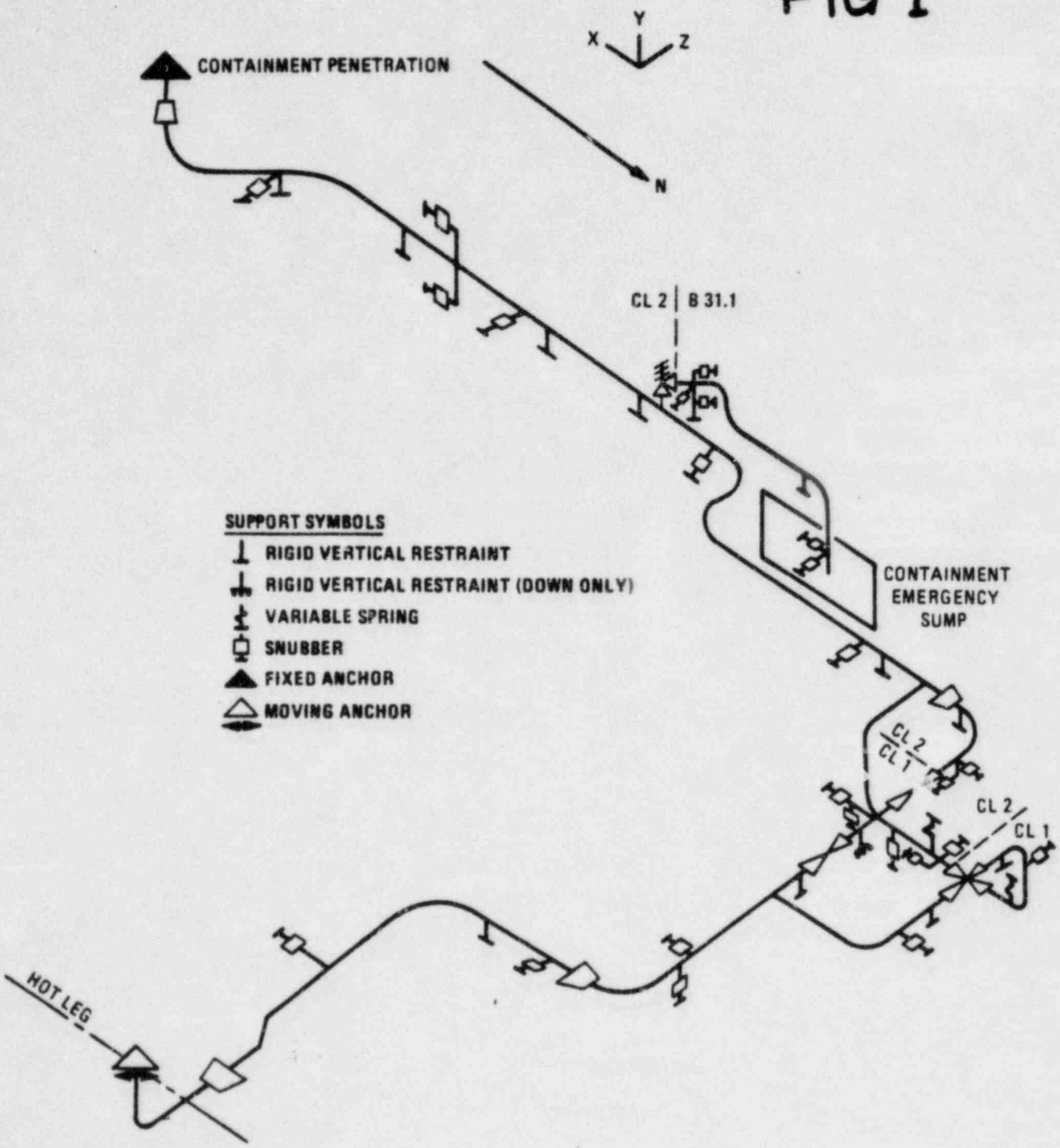
Fig.15 - DBE - Eq.9

Fig.16 - Not Used

Fig.17 - Support Loads

**CONFIRMATORY ANALYSIS
SHUTDOWN COOLING LINE
SAN ONOFRE UNITS 2 AND 3**

FIG 1



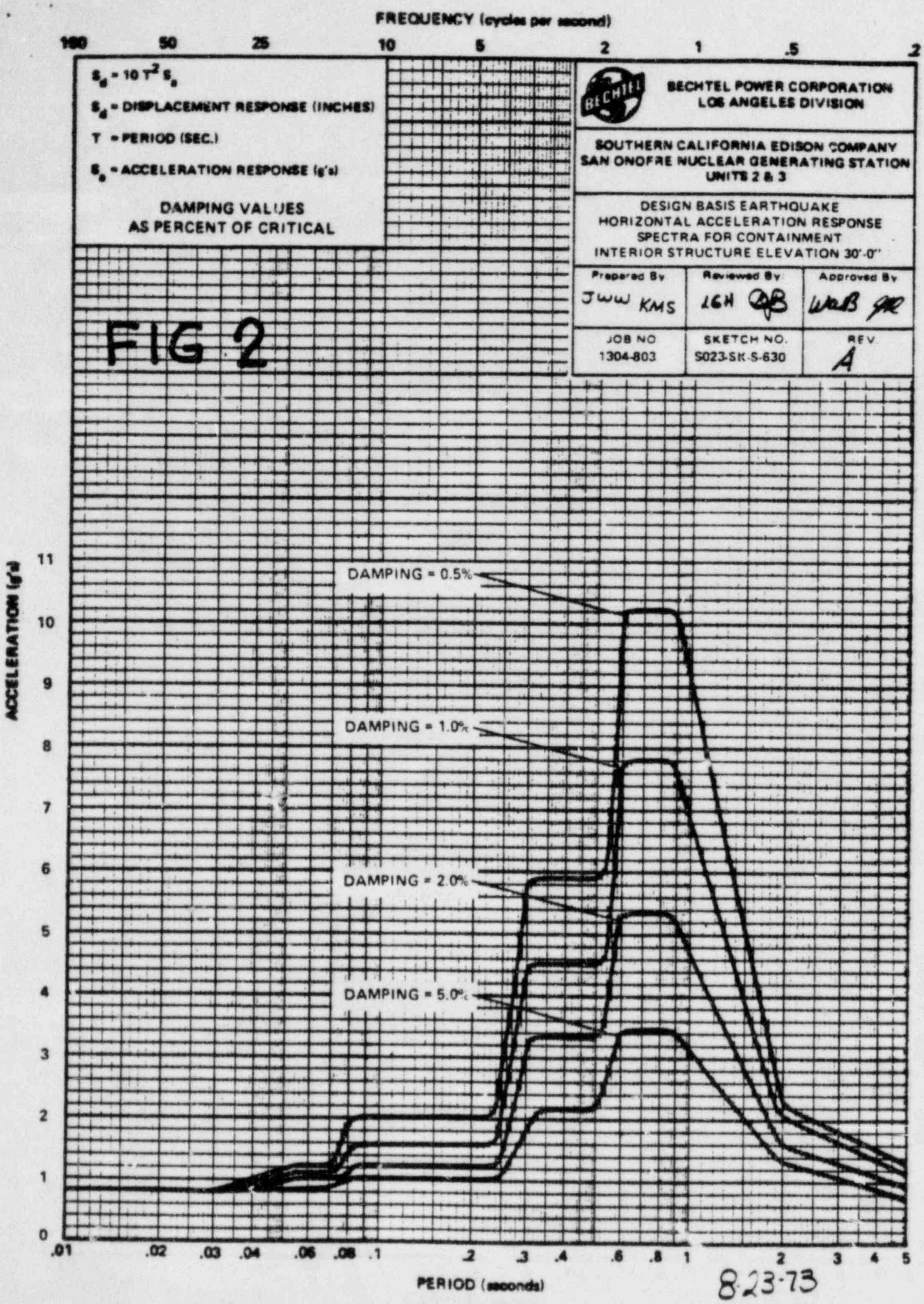
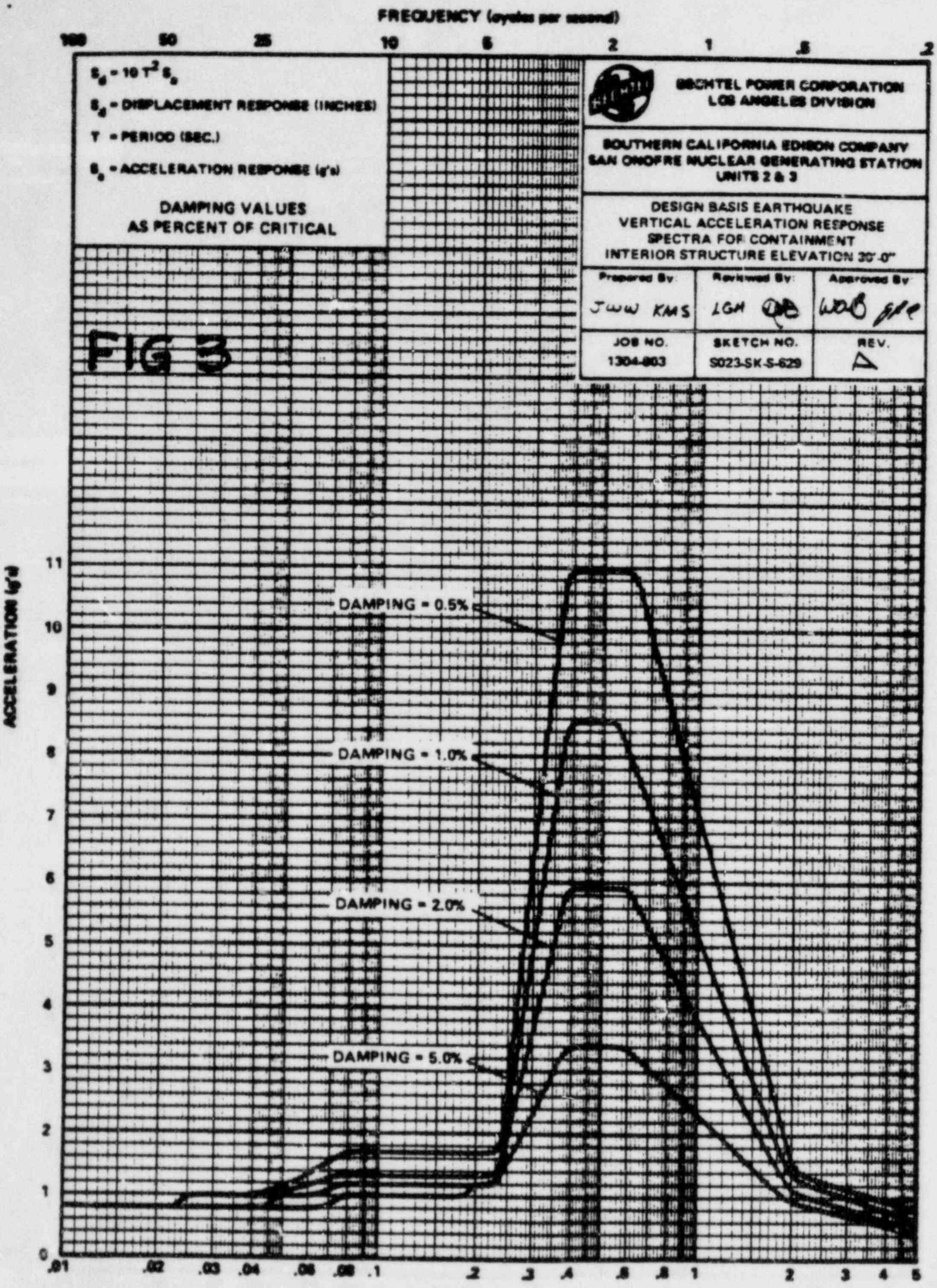
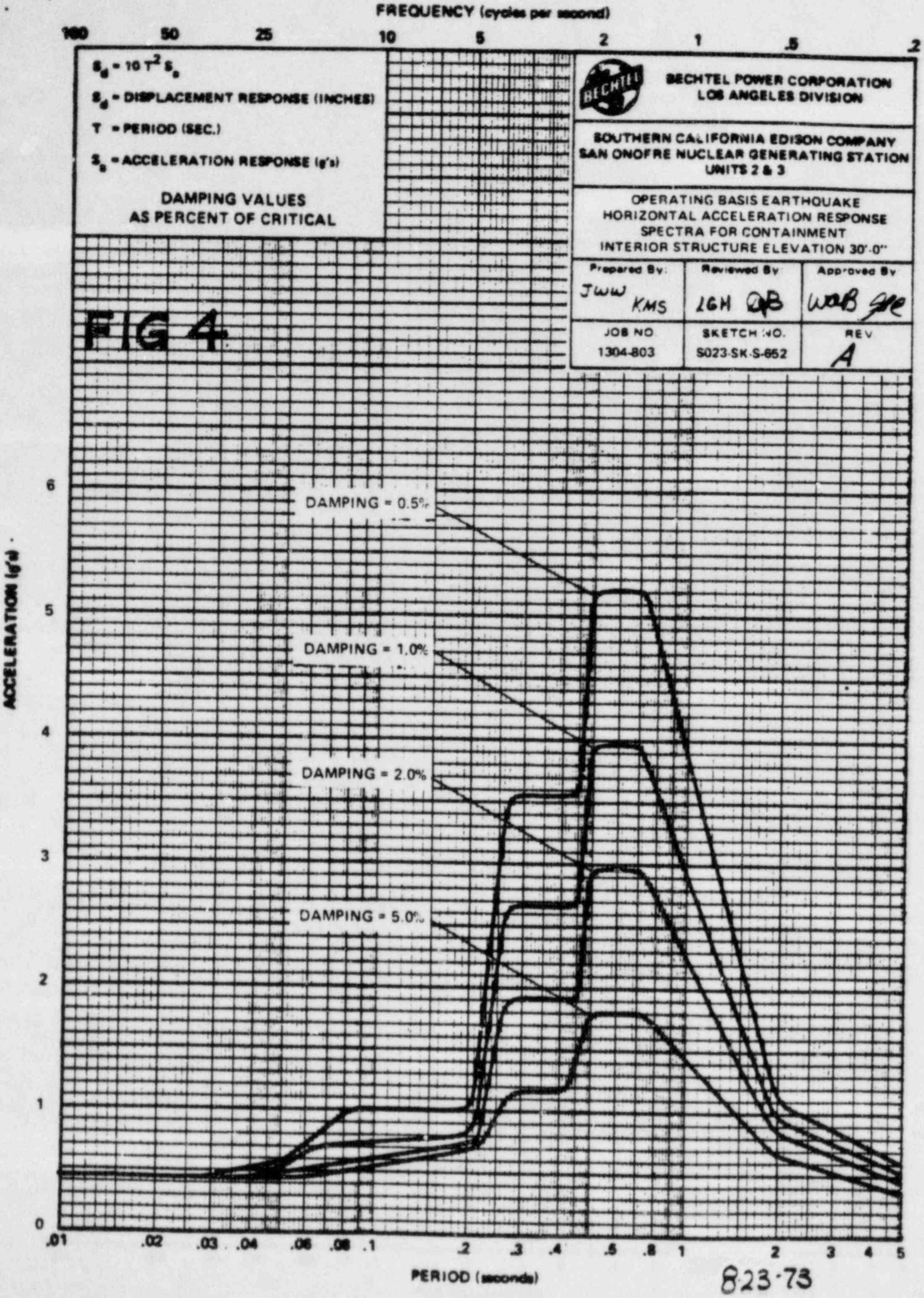

FREQUENCY (cycles per second)
100
50
25
10
5
2
1
.5
.2
$S_d = 10\,T^2\,S_a$
S_d = DISPLACEMENT RESPONSE (INCHES)
T = PERIOD (SEC.)
S_a = ACCELERATION RESPONSE (g's)
DAMPING VALUES
AS PERCENT OF CRITICAL
BECHTEL
BECHTEL POWER CORPORATION
LOS ANGELES DIVISION
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNITS 2 & 3
DESIGN BASIS EARTHQUAKE
HORIZONTAL ACCELERATION RESPONSE
SPECTRA FOR CONTAINMENT
INTERIOR STRUCTURE ELEVATION 30'-0"
Prepared By
JWW KMS
Reviewed By
LGH
Approved By
JOB NO
1304-803
SKETCH NO.
S023-SK-S-630
REV.
A
ACCELERATION (g's)
11
10
9
8
7
6
5
4
3
2
1
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)
8-23-73

FIG 2


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 FOR CONTAINMENT
INTERIOR STRUCTURE ELEVATION 30'-0"
Prepared By:
Reviewed By:
Approved By:
JWW KMS
LGH
JOB NO.
1304-003
SKETCH NO.
S023-SK-S-629
REV.
FIG 3
ACCELERATION (g's)
0
1
2
3
4
5
6
7
8
9
10
11
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)

8·23·73


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
OPERATING BASIS EARTHQUAKE
HORIZONTAL ACCELERATION RESPONSE
SPECTRA FOR CONTAINMENT
INTERIOR STRUCTURE ELEVATION 30'-0"
Prepared By: JWW KMS
Reviewed By: LGH
Approved By: WAB
JOB NO. 1304-803
SKETCH NO. S023-SK-S-652
REV A
FIG 4
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
0
1
2
3
4
5
6
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.04
.06
.08
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.4
.6
.8
1
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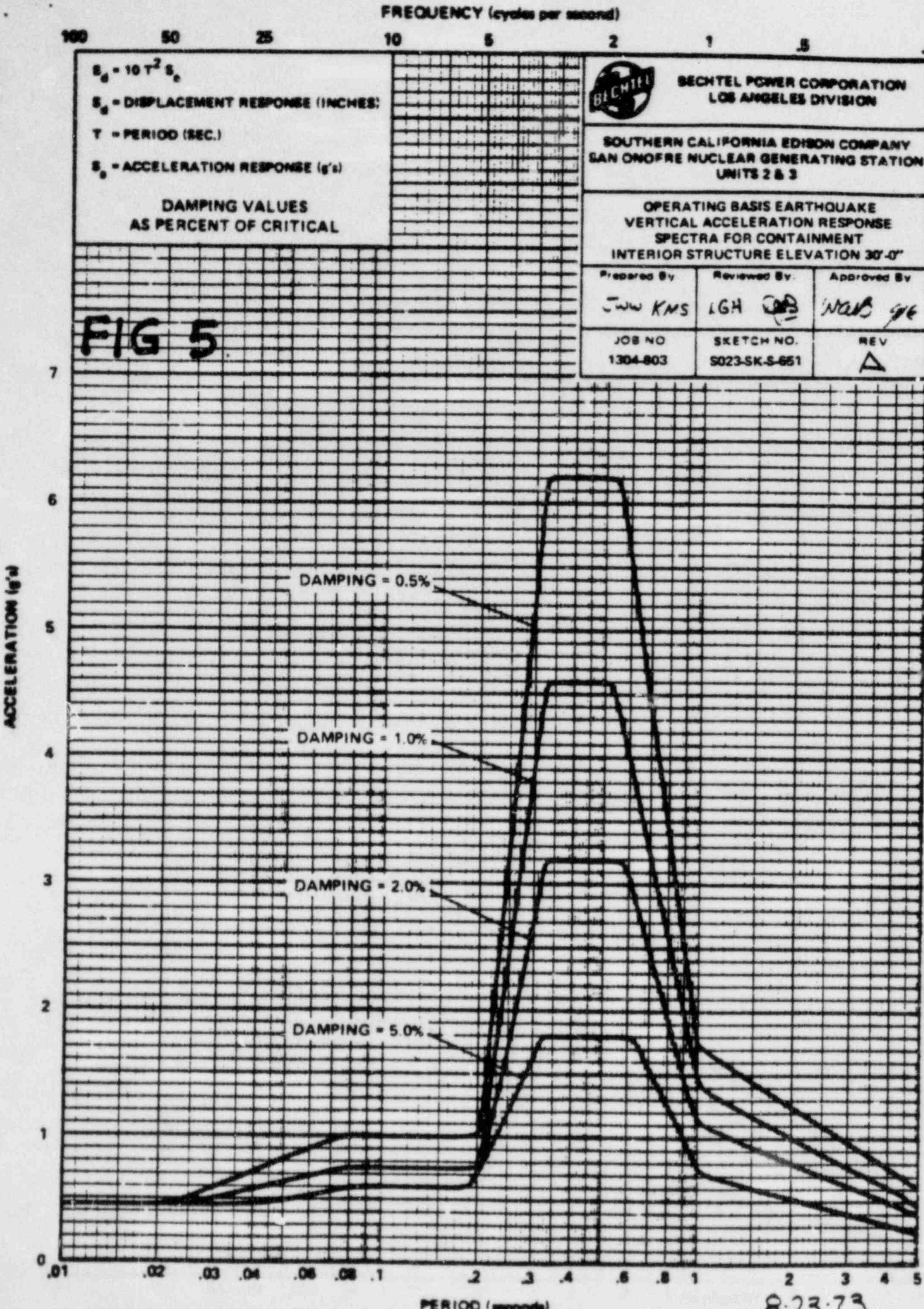
3
4
5
PERIOD (seconds)

8-23-73

FIG 5



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
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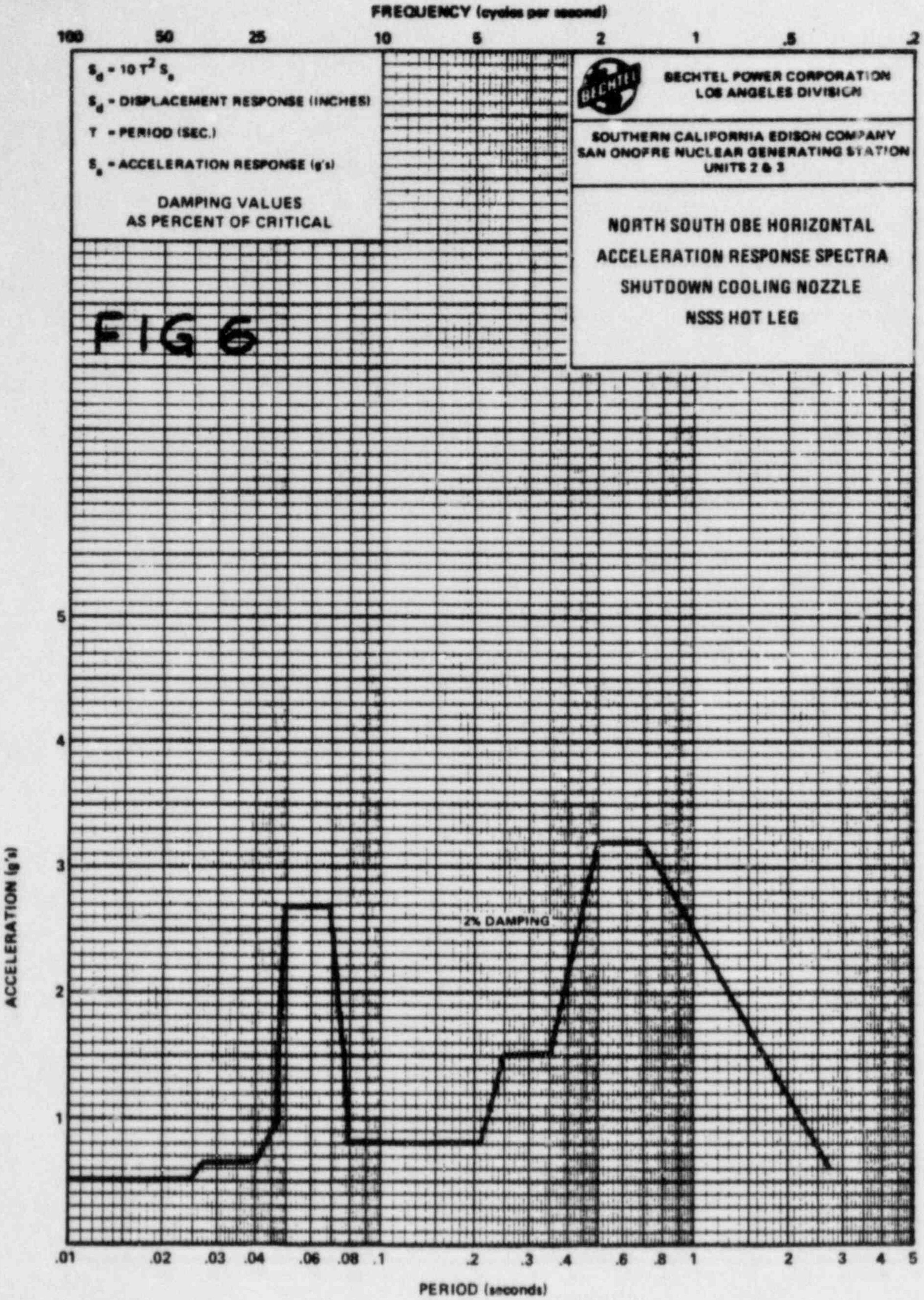
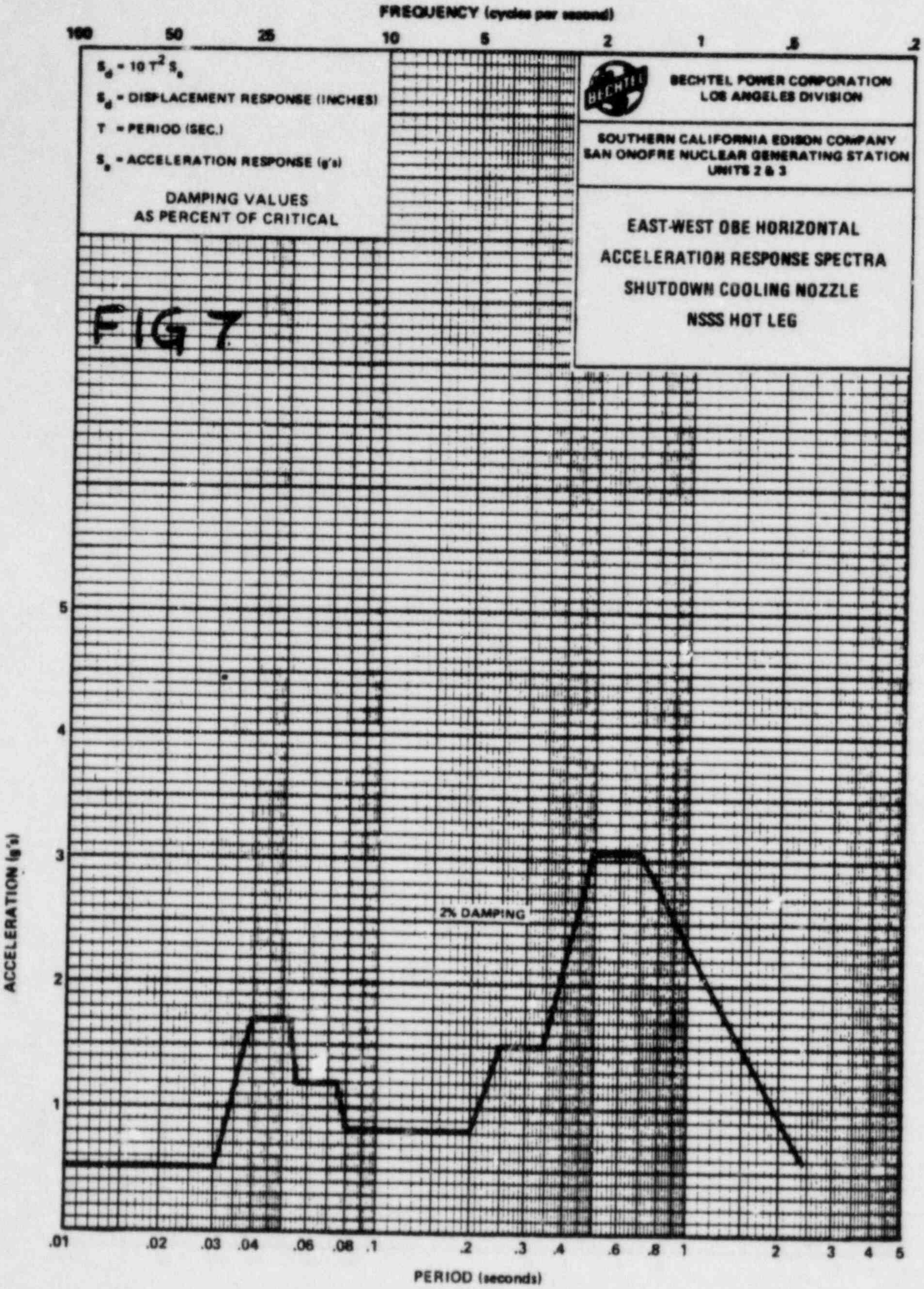
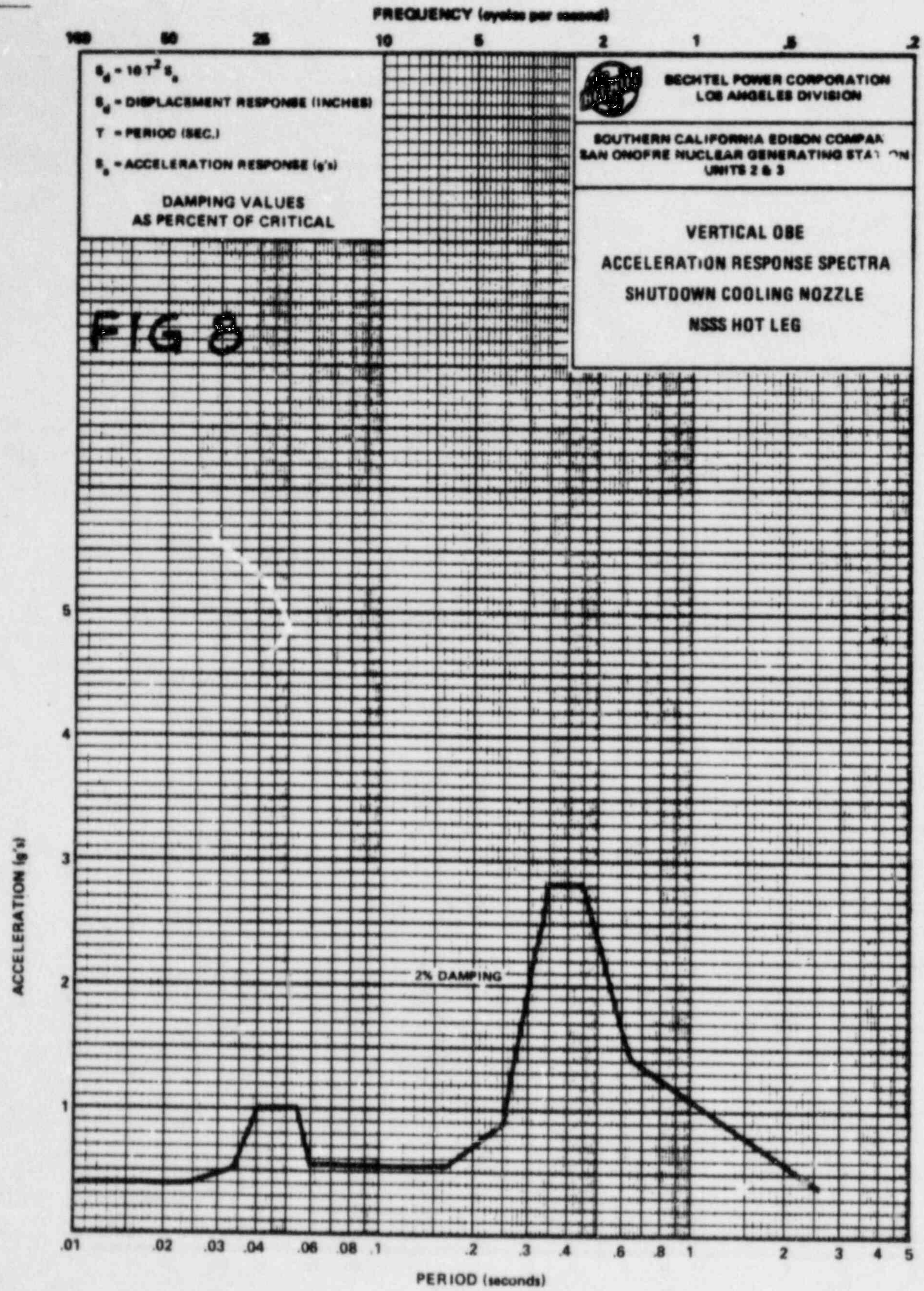
SPECTRA FOR CONTAINMENT
INTERIOR STRUCTURE ELEVATION 30'-0"
Prepared By
Reviewed By
Approved By
JOB NO
1304-803
SKETCH NO.
S023-SK-S-651
REV
DAMPING = 0.5%
DAMPING = 1.0%
DAMPING = 2.0%
DAMPING = 5.0%
ACCELERATION (g's)
0
1
2
3
4
5
6
7
.01
.02
.03
.04
.06
.08
.1
.2
.3
.4
.6
.8
1
2
3
4
5
PERIOD (seconds)

8-23-73


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
NORTH SOUTH OBE HORIZONTAL
ACCELERATION RESPONSE SPECTRA
SHUTDOWN COOLING NOZZLE
NSSS HOT LEG
FIG 6
2% DAMPING
ACCELERATION (g's)
5
4
3
2
1
.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
EAST-WEST OBE HORIZONTAL
ACCELERATION RESPONSE SPECTRA
SHUTDOWN COOLING NOZZLE
NSSS HOT LEG
FIG 7
2% DAMPING
ACCELERATION (g's)
1 2 3 4 5
.01 .02 .03 .04 .06 .08 .1 .2 .3 .4 .6 .8 1 2 3 4 5
PERIOD (seconds)


FREQUENCY (cycles per second)
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.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
VERTICAL OBE
ACCELERATION RESPONSE SPECTRA
SHUTDOWN COOLING NOZZLE
NSSS HOT LEG
FIG 8
ACCELERATION (g's)
5
4
3
2
1
2% DAMPING
.01
.02
.03
.04
.06
.08
.1
.2
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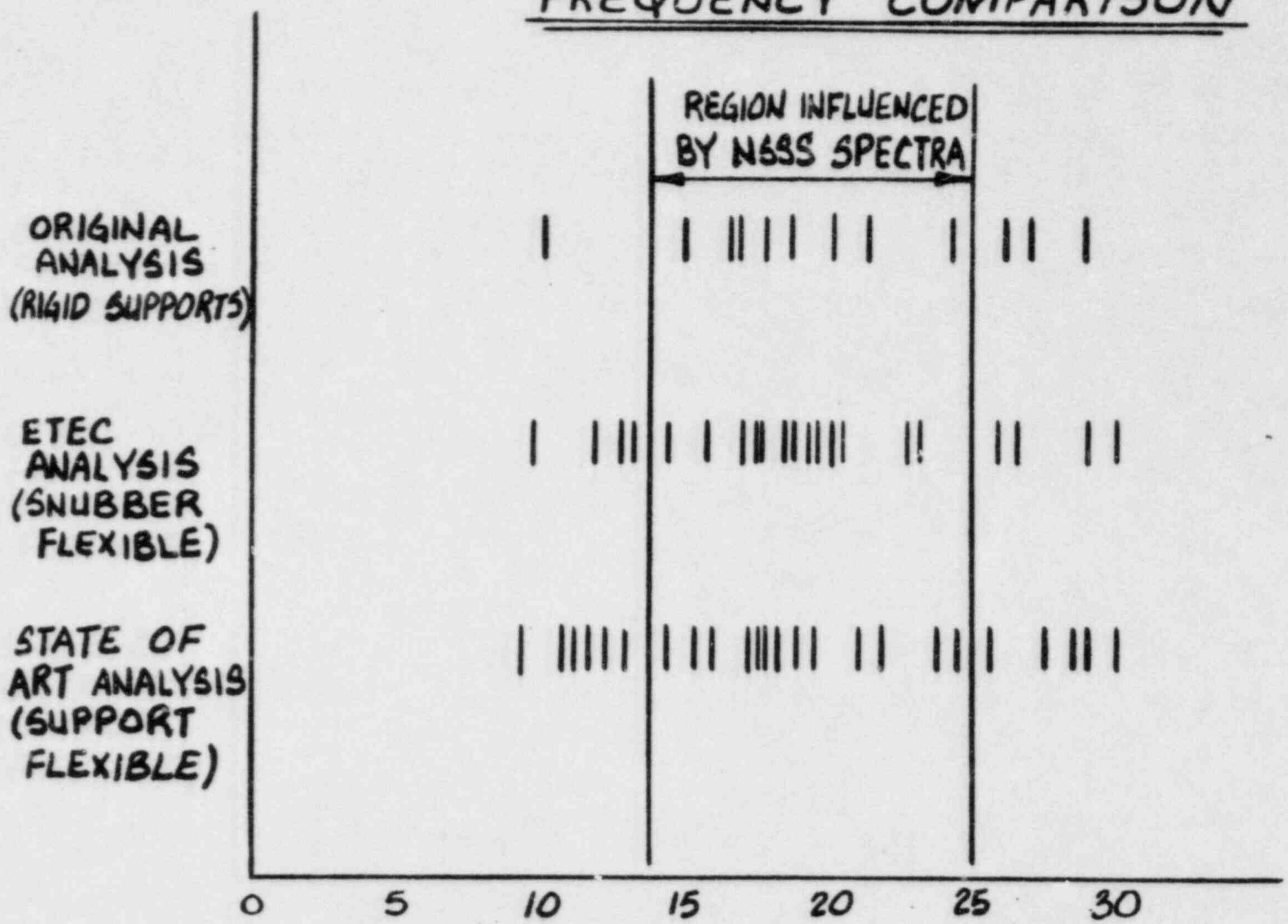
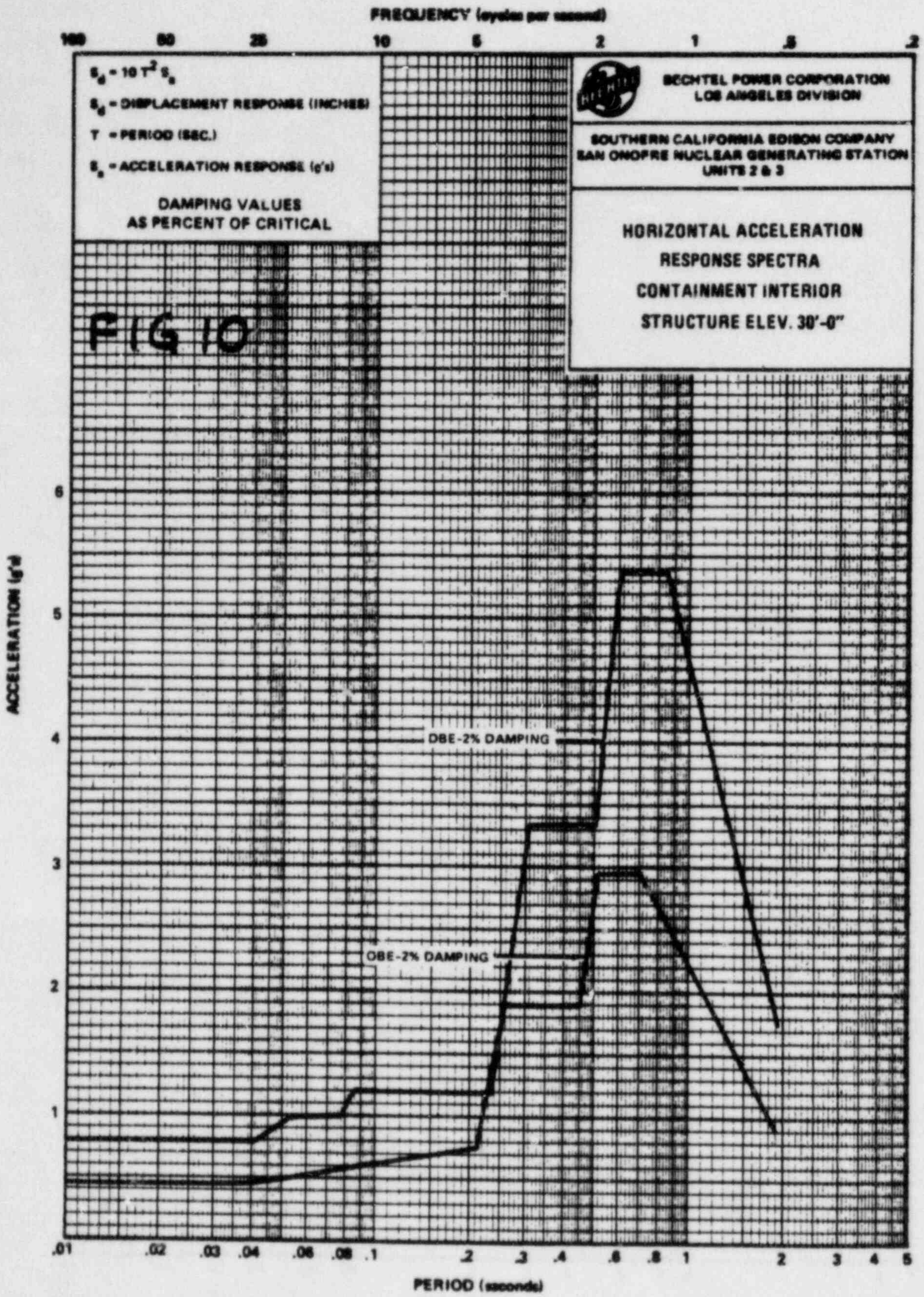
.4
.6
.8
1
2
3
4
5
PERIOD (seconds)

FIG 9

FREQUENCY COMPARISON





FREQUENCY (cycles per second)
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
HORIZONTAL ACCELERATION
RESPONSE SPECTRA
CONTAINMENT INTERIOR
STRUCTURE ELEV. 30'-0"
FIG 10
ACCELERATION (g's)
6
5
4
3
2
1
DBE-2% DAMPING
OBE-2% DAMPING
.01
.02
.03
.04
.06
.08
.1
.2
.3
.4
.6
.8
1
2
3
4
5
PERIOD (seconds)

FIG 11

SUMMARY OF CRITERIA AND ASSUMPTIONS

	BECHTEL SAN ONOFRE 2 & 3	ETEC	STATE-OF-ART PRESENT DAY CRITERIA
Support and Snubber Stiffness	All snubbers and structrual steel supports assumed rigid.	Considered minimum stiffness of snubbers (supplied by vendors). All structural steel supports assumed rigid.	Considered minimum stiffness of snubbers (supplied by vendor). All structural steel supports used actual stiffness.
Seismic Inertial Modal Response Combination	Square Root of Sum of Squares (SRSS) of all modal responses	Absolute sum for closely spaced modes only. SRSS of balance of modal response with Pseudo modes created by absolute sum. (Reg. Guide 1.92)	Absolute sum for closely spaced modes only. SRSS of balance of modes with Pseudo modes created by absolute sum. (Reg. Guide 1.92)
Spectrum Curves Used in Seismic Inertial Analysis	Envelope of the building and the Reactor Coolant System spectrum curves.	Separate Building or Reactor Coolant System Spectrum Curves applied indepentently to all supports (worst case considered).	Used two spectrum curves, one for RCS interface and the other an envelope of building spectrum curves. The absolute sum of the two responses is used.
Damping Values Used in Inertial Seismic	R.G. 1.61 damping values used for OBE. For DBE, the OBE load values were doubled without consideration of higher damping.	R.G. 1.61 damping values used for OBE or DBE as applicable. (DBE NSSS not considered)	R.G. 1.61 damping values used for OBE and DBE. However, no DBE spectrum curve is availiable for the RCS and accordingly double OBE is used with lower damping than allowed by R.G. 1.61.
Thermal, SAM DW Analyses	Assumed rigid supports.	Utilized stiffnesses as described above.	Utilized stiffness as described above.
Eccentric Snubbers	Are not considered in the model. Local stress check is performed at interface.	Are considered in model.	Are considered in model.

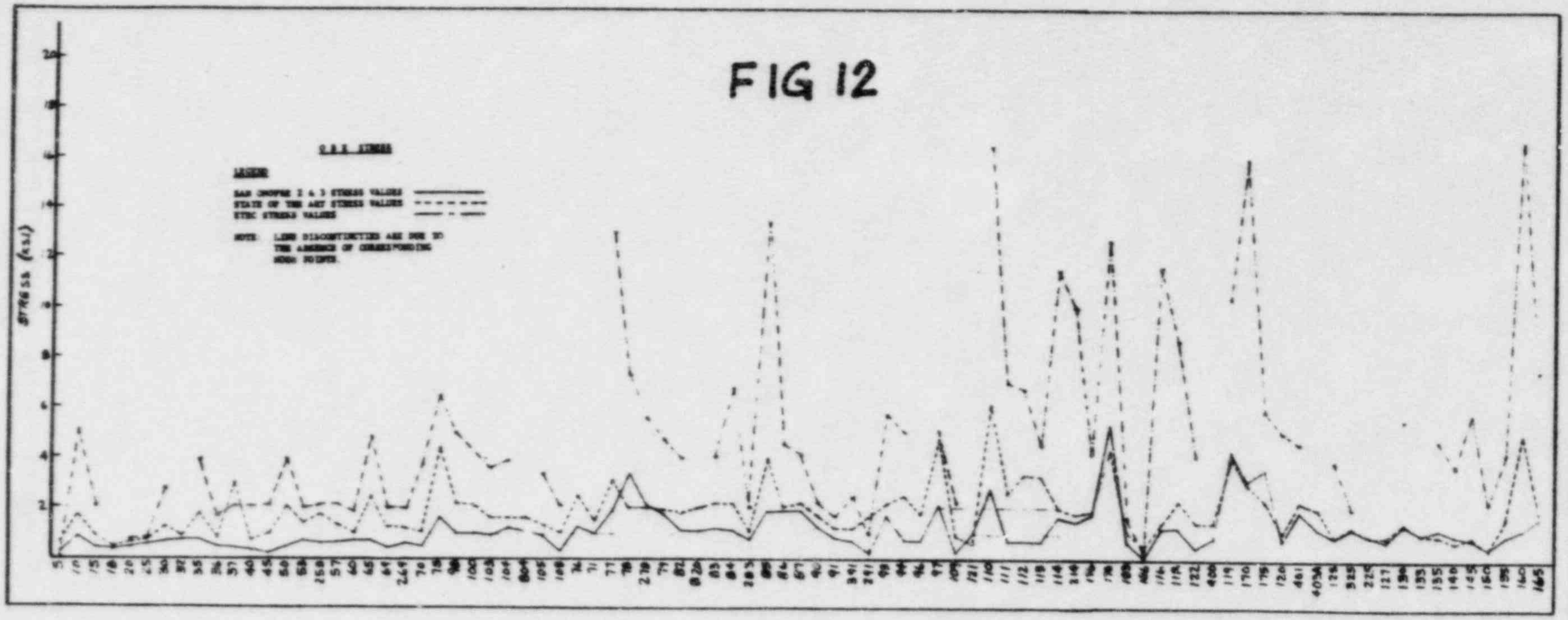
O B E STRESS
LEGEND
SAN ONOFRE 2 & 3 STRESS VALUES
STATE OF THE ART STRESS VALUES
ETEC STRESS VALUES
NOTE: LINE DISCONTINUITIES ARE DUE TO THE ABSENCE OF CORRESPONDING NODE POINTS.
STRESS (ksi)

FIG 12

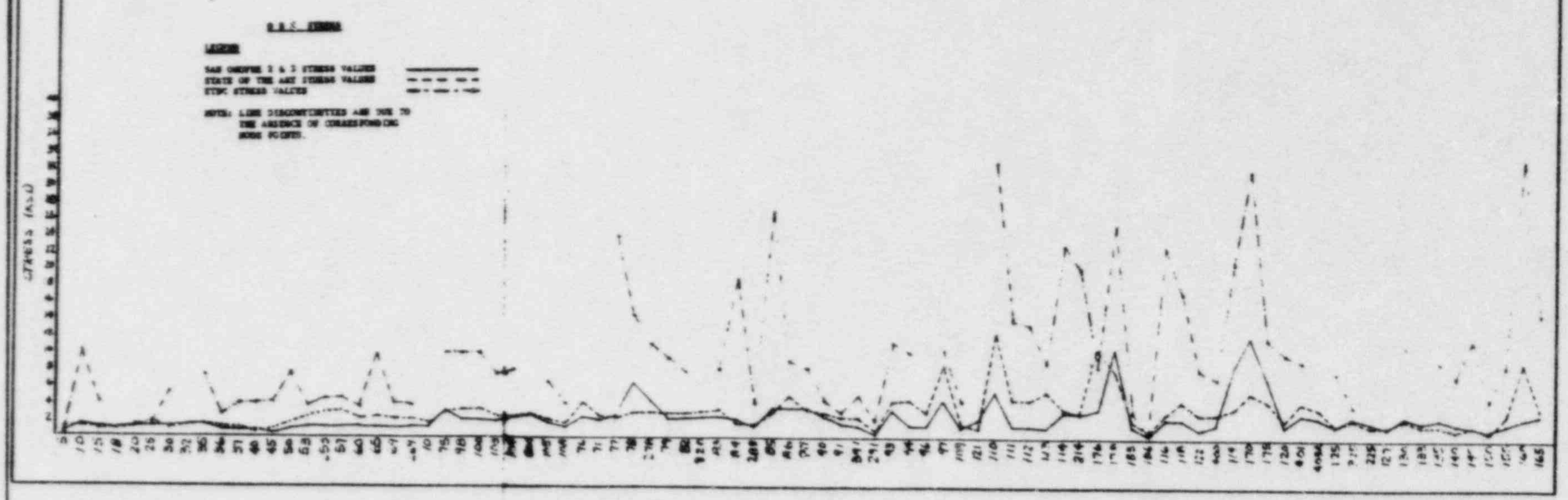
LEGEND
SAN ONOFRE 2 & 3 STRESS VALUES
STATE OF THE ART STRESS VALUES
NOTE: LINE DISCONTINUITIES ARE DUE TO
THE ABSENCE OF CORRESPONDING
NODE POINTS.

FIG 13

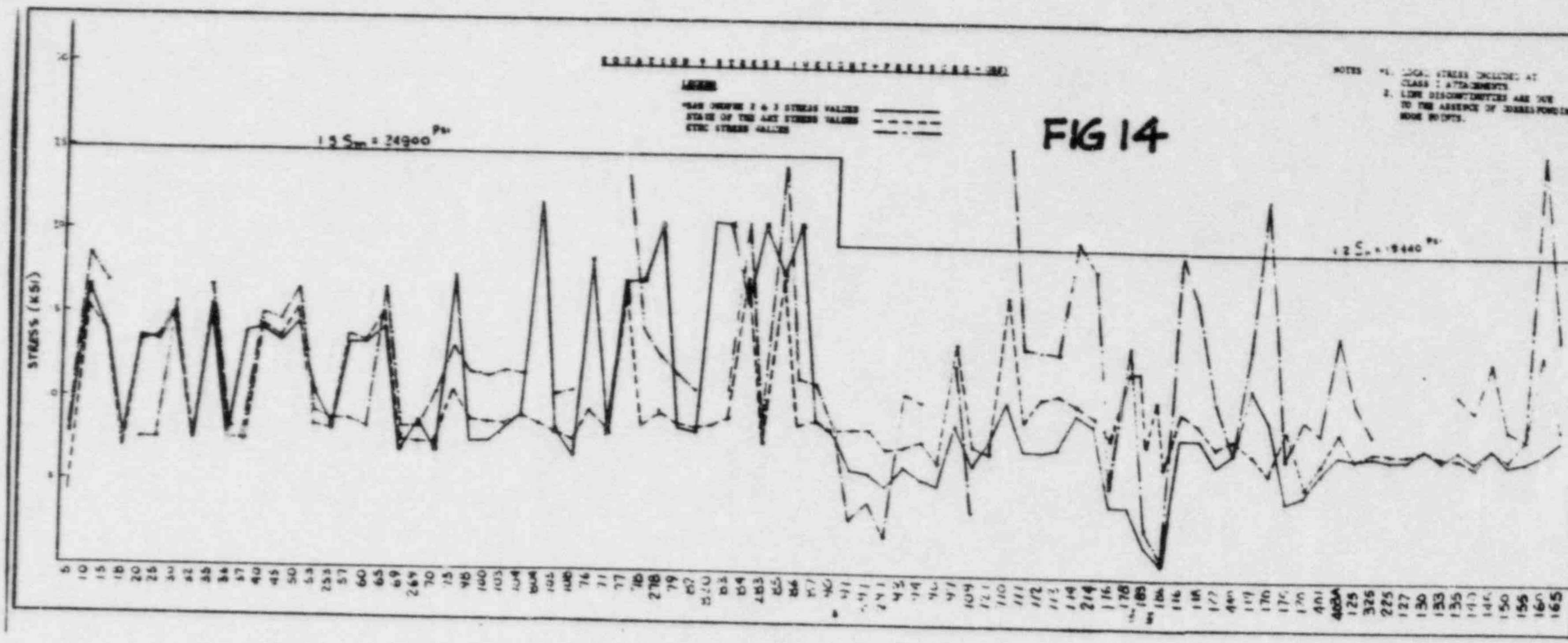

FIG 14

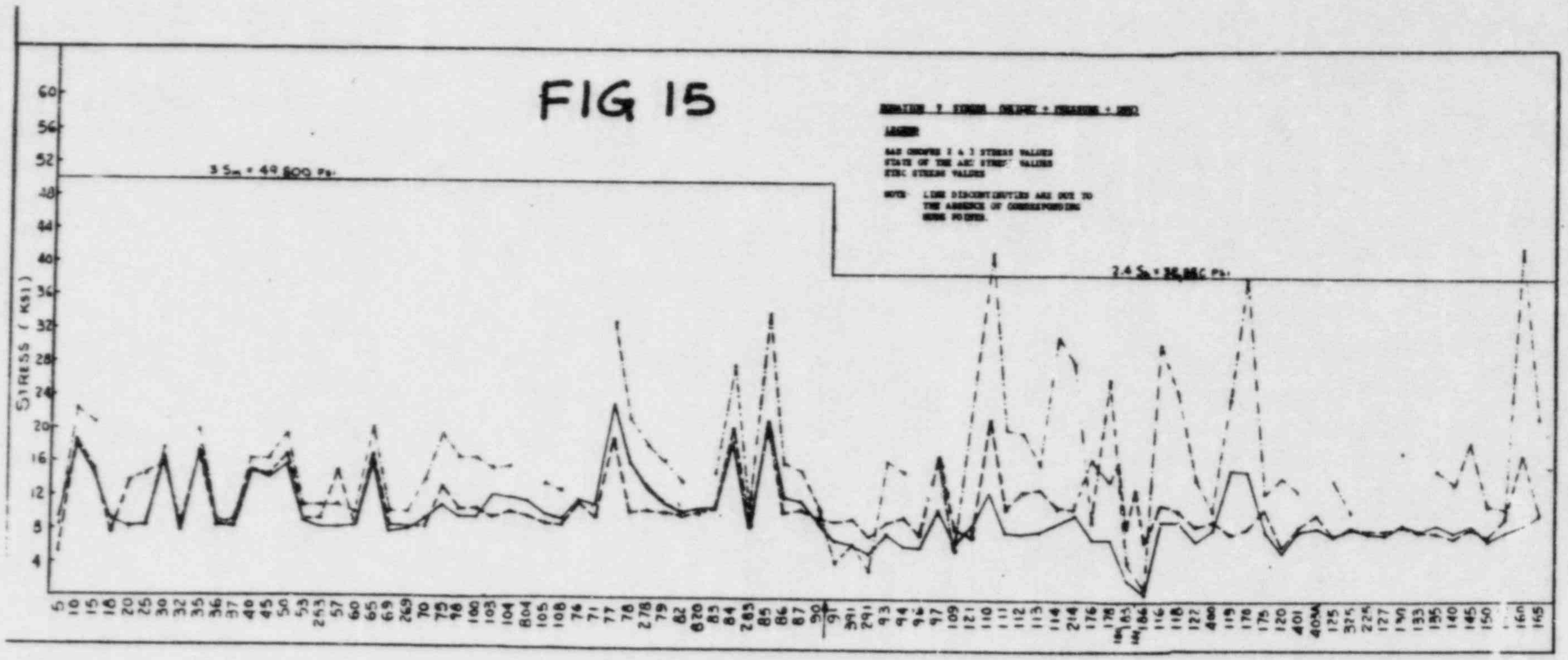

FIG 15

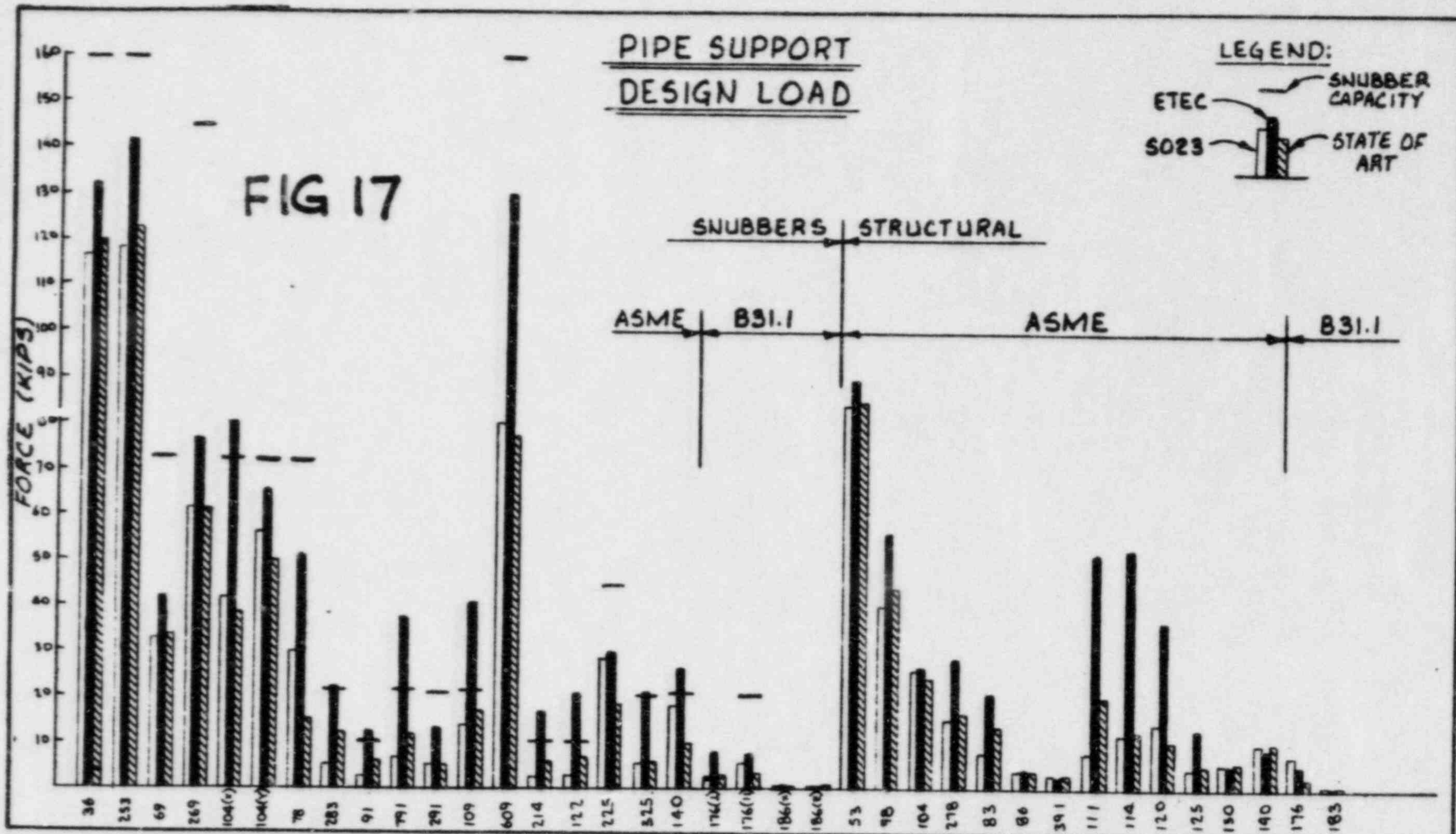
PIPE SUPPORT
DESIGN LOAD
LEGEND:
SNUBBER CAPACITY
ETEC
SO23
STATE OF ART
SNUBBERS
STRUCTURAL
ASME
B31.1
ASME
B31.1
FORCE (KIPS)

FIG 17

AUG 1 9 1981

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