SAN ONOFRE NUCLEAR GENERATING STATION
UNIT 1

REEVALUATION CRITERIA
FOR
ANCHORAGE AND SUPPORT OF
SAFETY RELATED ELECTRICAL EQUIPMENT

JOB 14000-086
BECHTEL POWER CORPORATION
NORWALK, CALIFORNIA

MAY 1, 1981

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1. INTRODUCTION

This document describes the seismic reevaluation for the anchorage and support of Safety Related Electrical Equipment. The criteria covers the evaluation and modifications as referenced in the NRC letter dated January 1, 1980, from Darrel G. Eisenhut to James H. Drake and IE Information Notice No. 80-21.

2. SCOPE OF WORK

Seismic reevaluation shall be performed on safety related electrical equipment, identified by SCE, to determine the adequacy of their anchorage and support. The analysis and design will be limited to only the structural adequacy of the supports and anchors, and not to the equipments' functional ability. The engineering effort will include record search at the station (BPC and SCE) for pertinent data, field "As-Built" information gathering, as required, and determination of the structural design parameters such as embedment length of the anchorages, concrete strength, etc.

3. GOVERNING CODES, REGULATIONS AND REFERENCE DOCUMENTS

Unless specifically stated otherwise, the design of anchorages and supports shall be based on the following codes, specifications, standards, regulations and other reference documents.

3.1 Governing Codes, Specifications and Standards

The following codes, specifications and standards, when applicable, shall govern the reevaluation and any subsequent design of modifications.

ACI-318-77	Building Code Requirements for Reinforced Concrete.
AISC-1978	Specification for Design, Fabrication and Erection of Structural Steel for Buildings.
AWS D1.1 1980	Structural Welding code.
IEEE 344-1975	Seismic Qualification of Class IE Equipment for Nuclear Power Generating Stations.
Bechtel Design Guide No. C-2.40	Concrete Expansion Anchors
-	Standard Review Plan, Section 3.8.4
ANSI N45-2 1977	Nuclear Quality Assurance Standards
ANSI N45-2-11 1974	Quality Assurance Requirements for the Design of Nuclear Power Plants

3.2 NRC Regulatory Guides.

The following NRC Regulatory Guides shall be implemented.

Guide Number	Title
1.29	Seismic Design Classification.
1.61	Damping values for Seismic Design of Nuclear Power Plants.

4. REEVALUATION AND DESIGN REQUIREMENTS

The reevaluation and design to be accomplished under this criteria shall be subject to the following requirements.

4.1 Seismic Withstand Capability:

Analysis and design of the anchorage and support of safety related electrical equipment will be accomplished using the equivalent static load method of analysis. Provisions of subsections 4.1.1 and 4.1.2 are applicable to the equipment support and anchorages.

4.1.1 Seismic Response Spectra

The design response spectra for horizontal motion for the Design Basis Earthquake (DBE) corresponds to the Housner spectra, as described in Section 9.2 of the San Onofre Unit 1 FSAR, normalized to 0.67 g. The vertical design response spectra are defined as 2/3 of the horizontal spectra.

The spectra to be used for all the items located at or below plant grade and the appropriate floor spectra to be used for all the items located above plant grade are shown in Figures 4.1, 4.2 and 4.3. The recommended damping factors are given in Table 4.1.

4.1.2 Equivalent Static Load Methods of Analysis.

The static load equivalent analysis method involves the multiplication of the total weight of the subsystem by the specified seismic acceleration coefficient. The magnitude of the seismic acceleration coefficient is established on the basis of the fundamental frequency of the system or subsystem. In determining the dynamic characteristics of the system, support base plate flexibility will be taken into account. Structural subsystem which can be adequately characterized as single-degree-of-freedom systems are considered to have a modal participation factor of one. Seismic acceleration coefficients for multi-degree of freedom systems which may be in the resonance region of the amplified response spectra, are increased by 50 percent to account conservatively for the increased modal participation.

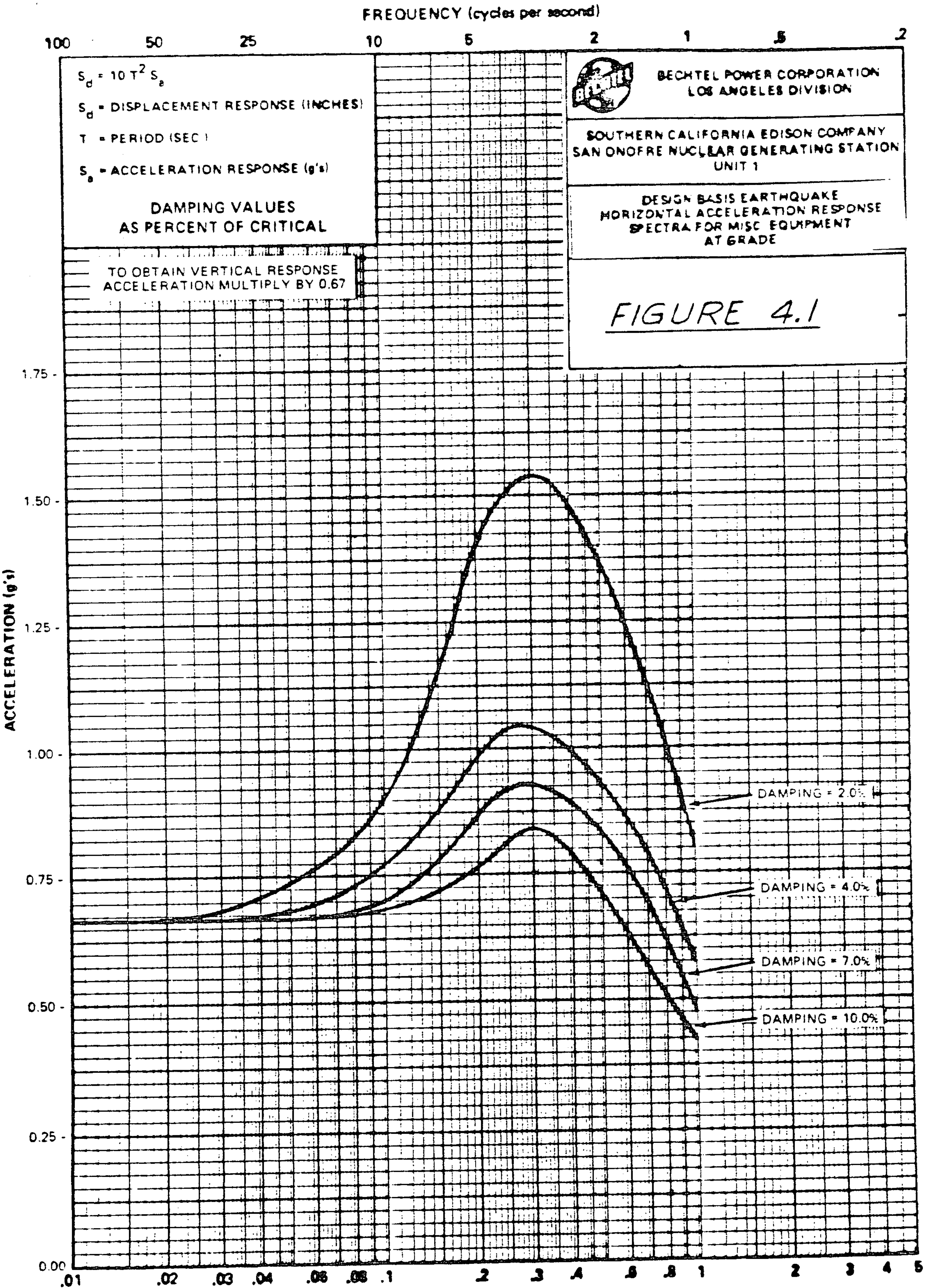
4.2 Design Life

The design life for all items will be 35 years.

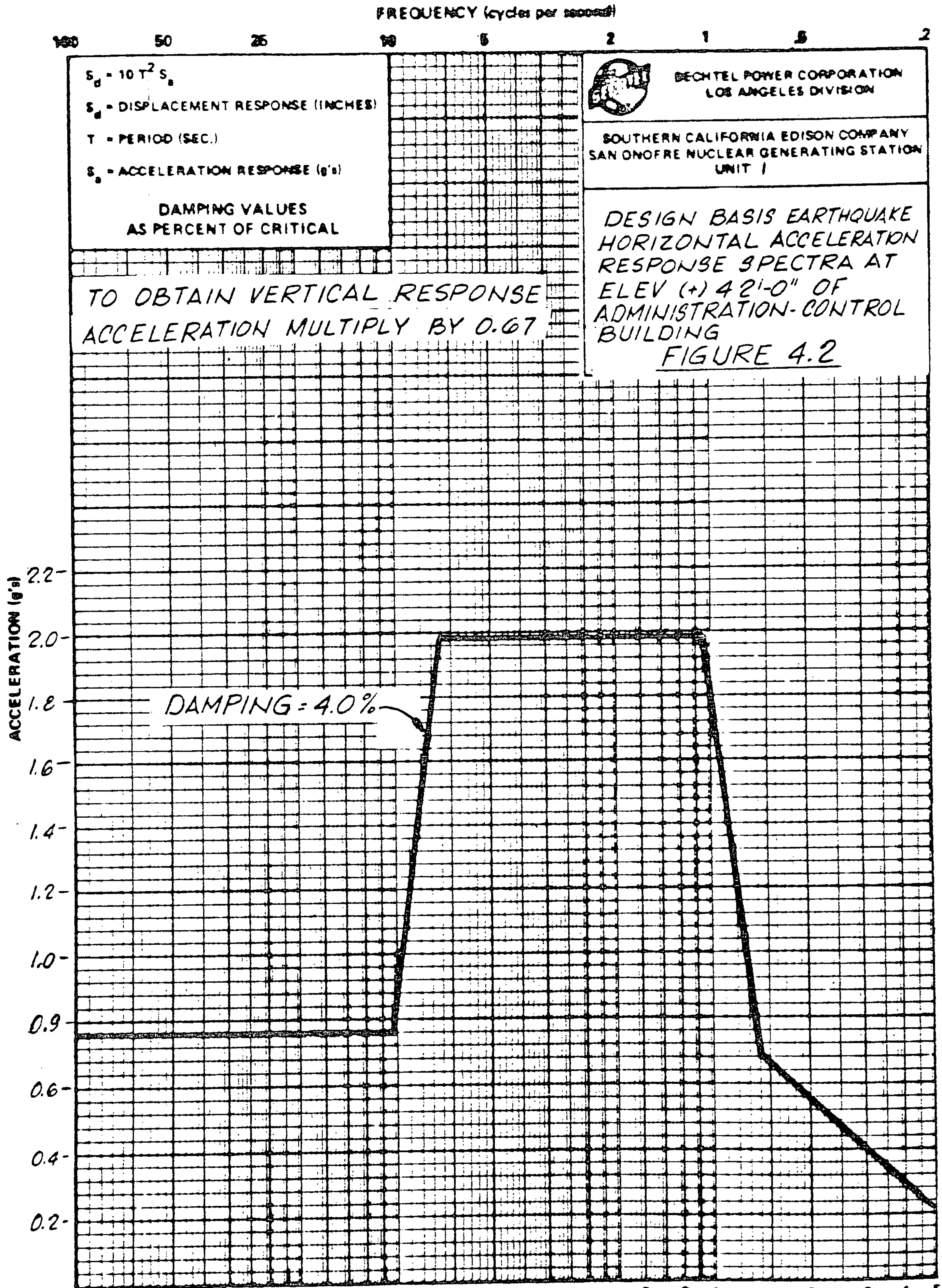
TABLE 4.1

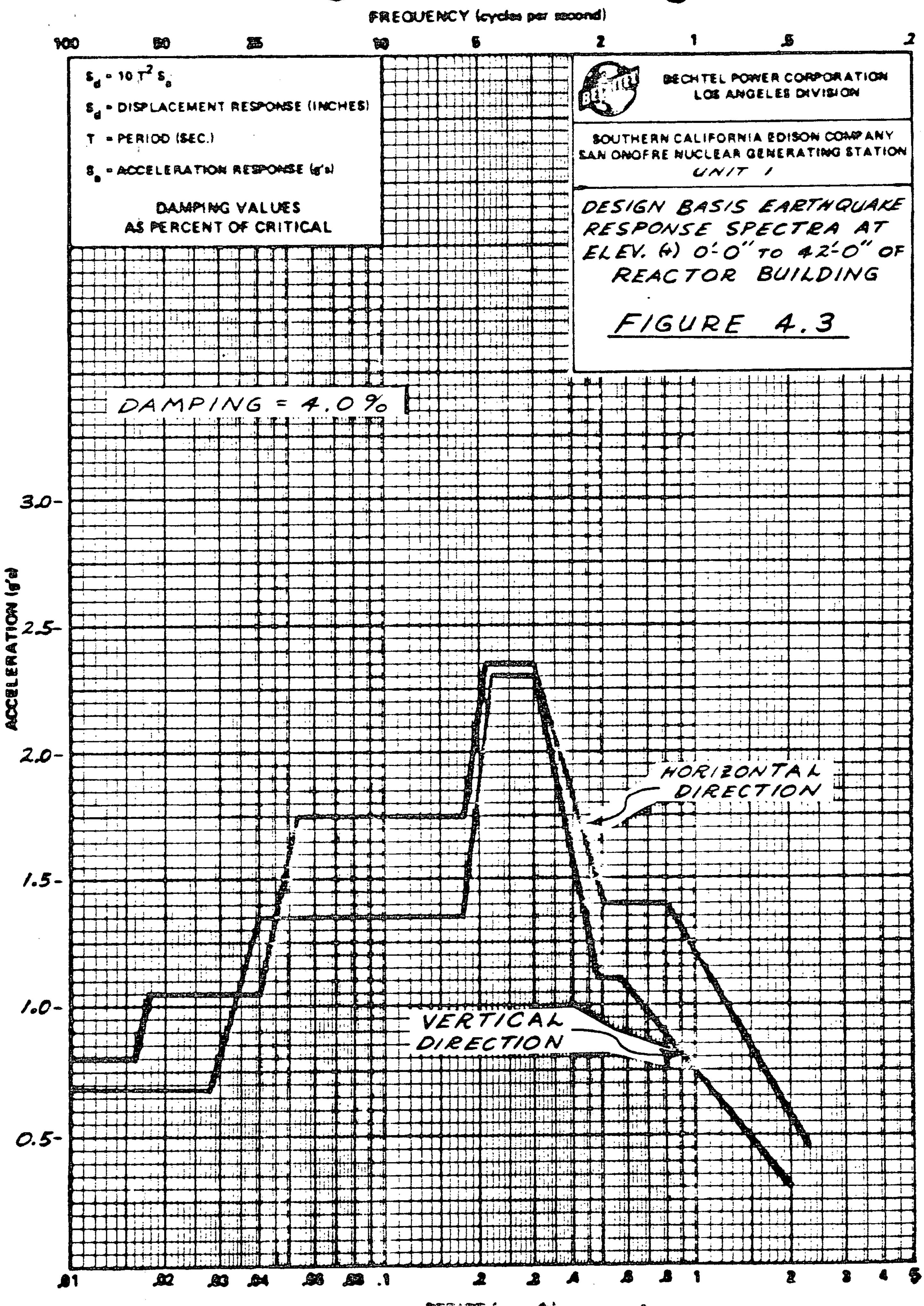
DBE DAMPING VALUES USED FOR SEISMIC REEVALUATION

ITEM	DBE DAMPING (Percent of Critical)
Welded Steel Structures	4
Bolted and/or Riveted Steel Structures	7
Reinforced Concrete Structures	7



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 VERTICAL RESPONSE
ACCELERATION MULTIPLY BY 0.67
BECHTEL POWER CORPORATION
LOS ANGELES DIVISION
SOUTHERN CALIFORNIA EDISON COMPANY
SAN ONOFRE NUCLEAR GENERATING STATION
UNIT 1
DESIGN BASIS EARTHQUAKE
HORIZONTAL ACCELERATION RESPONSE
SPECTRA FOR MISC EQUIPMENT
AT GRADE
FIGURE 4.1
ACCELERATION (g's)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
0.00
DAMPING = 2.0%
DAMPING = 4.0%
DAMPING = 7.0%
DAMPING = 10.0%
.01
.02
.03
.04
.06
.08
.1
.2
.3
.4
.6
.8
1
2
3
4
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
SAN ONOFRE NUCLEAR GENERATING STATION
UNIT I
DESIGN BASIS EARTHQUAKE HORIZONTAL ACCELERATION RESPONSE SPECTRA AT ELEV (+) 42'-0" OF ADMINISTRATION-CONTROL BUILDING
FIGURE 4.2
TO OBTAIN VERTICAL RESPONSE ACCELERATION MULTIPLY BY 0.67
DAMPING = 4.0%
ACCELERATION (g's)
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.9
0.6
0.4
0.2



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
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UNIT 1
DESIGN BASIS EARTHQUAKE
RESPONSE SPECTRA AT
ELEV. (+) 0'-0" TO 42'-0" OF
REACTOR BUILDING
FIGURE 4.3
DAMPING = 4.0%
ACCELERATION (g's)
3.0
2.5
2.0
1.5
1.0
0.5
HORIZONTAL
DIRECTION
VERTICAL
DIRECTION
.01
.02
.03
.04
.06
.08
.1
.2
.3
.4
.6
.8
1
2
3
4
5

5. LOADS AND LOAD COMBINATIONS

The anchorages and supports for safety related electrical equipment will consider the occurrence of a DBE during normal plant operation. The loading combinations that will be considered are shown in Table 5.1. The normal loads and extreme environmental loads are described in the following paragraphs.

5.1 Normal Loads (Loads encountered during normal plant operation.)

Normal load includes dead load (D) and live loads (L) as defined in Table 5.1. The design parameters such as approximate weight, location of center of gravity, and dynamic characteristics of equipment shall be obtained from the following.

A. SONGS 1 BOP Seismic Re-Evaluation Program, Photographic Description of Electrical, Control and Instrumentation Systems, Volume 2.

B. SONGS 1 Seismic Re-Evaluation Program, Phase 1B, Site Survey Reports.

C. When design parameters are not obtainable from A and B, a conservative estimate shall be obtained from the original equipment suppliers and from field surveys.

5.2 Extreme Environmental Loads (Loads that are credible, but are highly improbable).

The extreme environmental loads considered are the Design Basis Earthquake (DBE) loads (E'). The DBE seismic loads will be generated in accordance with the provisions of Section 4.1.

TABLE 5.1
LOADS AND LOAD COMBINATIONS

Definitions and Nomenclature for Load Combination.

D = Dead load of equipment including weight of all permanent attachments.

L = Live load.

E^1 = Loads Generated by the Design Basis Earthquake (DBE).

S = Required section strength based on elastic design method and the allowable stresses defined in Part 1 of the AISC "Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings".

Load Combinations

The following loading combinations shall be satisfied.

$$S \geq D + L$$

$$1.6S \geq D + L + E'$$

6. ALLOWABLE LOADS AND STRESSES

Allowable loads for different types of material are as follows.

6.1 Structural Steel, Cold Form Steel, Bolts.

The allowable stresses are as per AISC specification, depending on type of steel and bolt used.

6.2 Hilti Kwik Concrete Expansion Anchors.

The following criteria should be used in the design. Allowable design loads are shown in Table 6.1.

6.2.1 Expansion anchors shall be at least 1/2 inch diameter, except that 1/4 inch and 3/8 inch diameter expansion anchors may be used for attachment of conduits, instrument sensing lines, or similar lightly loaded installations.

6.2.2 A minimum of two expansion anchors shall be used at each attachment.

6.2.3 The allowable design loads per Table 6.1 shall be reduced to 25 percent of the specified values when designing for dynamic shock or vibratory loads. This reduction does not apply to seismic loads.

6.2.4 A reduction in the minimum center to center spacing and edge distance for anchors is acceptable provided that the allowable design loads (tension and shear) are reduced by the same proportion (i.e.: 25 percent reduction in spacing → 25 percent reduction in allowable design loads). The reduction in spacing may not exceed 50 percent in any case.

6.2.5 A reduction in the minimum embedment for anchors is acceptable provided that the allowable design load (shear and tension) is reduced in proportion to the square of the reduced embedment (i.e.: embedment reduced to 80 percent of minimum specified → allowable design load reduced to $(.80)^2 = 0.64$ times allowable load specified). The reduced embedment may not be less than 70 percent of the specified minimum embedment.

6.2.6 For evaluation of simultaneous tension and shear loading, the loads shall be combined by the following interaction formulas:

$$\left(\frac{t}{T}\right)^2 + \left(\frac{s}{S}\right)^2 \leq 1.0$$

where: (t, s) = actual design (tension, shear) loads, respectively.

(T, S) = specified allowable (tension, shear) loads, respectively.

Table 6-1. Allowable Design Loads for Concrete Expansion Anchors

Anchor Diameter	Allow Design Loads (Kips) (A)	Min. Embed. (inches)*	Min. Edge Dist. (inches)	Min. Spacing (inches)	Torque at Installation (ft. - lb.) (B)		Test Load (Kips)
					Wedge Anchor	Sleeve Anchor	
1/4	0.30	1-1/8	3	3	5-10	5-10	NA
3/8	0.60	1-1/2	4	4-1/2	25-35	20-35	NA
1/2	1.0	2-1/2	6	5	45-65	35-50	2.0
5/8	2.0	3	6	6	80-90	50-75	4.0
3/4	3.0	3-1/2	6	7-1/2	125-175	75-100	6.0
7/8	3.5	4	6	9	200-250	NA	7.0
1	4.0	4-1/2	6	10	250-300	NA	8.0

(A) Load in shear, tension or combined. Allowable design loads are for 4000 psi concrete.

(B) Threads not lubricated.

NA = Not Applicable

* = After tightening.

7. <u>CONSTRUCTION MATERIALS</u>

All construction materials shall be classified Safety Related unless otherwise specified on the design drawing.

7.1 Structural steel shall be ASTM A36.

7.2 Bolts shall be of the following specifications.

7.2.1 Standard connections shall be ASTM A307 or as specified on the design drawing.

7.2.2 Anchor bolts shall be Kwik Bolts manufactured by Hilti Fastening Systems, Inc., or as specified on the design drawing.

7.3 Grout shall be Five Star Non-Shrink grout or approved equal.

7.4 All structural welding shall be done with low hydrogen electrodes E7015, E7016, or E7018 per AWS Code.

7.5 Miscellaneous material not specified in these criteria shall be per design drawing.