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SUBJECT: Forwards response to Equipment Qualification Branch request for info re seismic qualification of equipment.Justification provided for test response data not completely enveloping required response spectra at lower frequencies.

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February 15, 1981

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 Equipment Qualification Branch questions and comments concerning the seismic qualification of equipment, Licensing Open Item No. 6. Enclosure 1 is a list of the responses which are included in Enclosure 2.

Please let me know if you have any questions or need any additional information.

Very truly yours,

K P Baskin

Enclosures

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RESPONSE TO QUESTIONS RAISED BY NRC AS SQRT GENERAL CONCERNS FOR SAN ONOFRE UNITS 2 & 3

1. Among the equipment selected for review during the plant visit, it was observed that in many cases the test response spectra (TRS) do not completely envelope the required response spectra (RRS) at lower frequencies. Identify all equipment in this category and provide justification for the incomplete envelopment for those equipment selected for review. Verify that other equipment in the plant having a similar problem has been evaluated and describe the procedures used to demonstrate that their seismic qualification is adequate.

Response:

A generic response to the issue of the condition when the TRS does not envelope the RRS at low frequencies is provided in the report "A Formal Examination of the Frequency Cut-off Issue on a Preliminary Basis Using Response Spectra" by J. Leung of Robert Cloud Associates. A more detailed evaluation of the issue is provided in the Wyle Report No. 26321, Review of Seismic Qualification Documentation for Certain BOP and NSSS Items for the San Onofre Nuclear Generating Station. Copies of both of these reports are provided as Attachments A and B to this document.

Specific responses for NSSS and BOP components are provided as follows:

NSSS

General Approach

It has been shown elsewhere and generally accepted that if the TRS is greater than the RRS for all frequencies above a certain value then the maximum response of a structure having all natural frequencies above this same value will be greater for the TRS than for the RRS. Thus, the general approach used in addressing this concern was to verify that all natural frequencies for the subject equipment, including individual internal components, were indeed well above the lowest frequency at which the TRS envelops the RRS.

To ascertain the natural frequencies of the equipment, including components, the following procedure was employed. In NSSS numbers 1a, 2a, 2b, 2c, 2d, 2e and 2f, the pertinent test report was reviewed and each internal component was subjected to a visual and tactile inspection. This procedure indicated that only the circuit boards, where present, were of possible concern since the remaining internal components either had accelerometers attached to them during the structural test or were, in our professional opinion, rigid with respect to the associated cutoff frequencies. A detailed discussion is provided below for the circuit boards contained in each of these components. Finally, in the case of NSSS numbers 1, 16 and 17, individual procedures were employed which are discussed in subsequent sections of this report.

The structural response data presented earlier in the Qualification Summmary of Equipment Sheets and Test Reports is summarized in Table 1. Inspection of the data in Table 1 shows that the lowest measured (structural) natural frequency of each equipment is more than 2 times the lowest enveloped (by test response spectrum (TRS)) frequency of the required response spectrum (RRS), with the exception of NSSS 1 and NSSS 16 which are discussed herein and found to be acceptable.

Specific Approach

a. NSSS 1 - Plant Protection Systems Cabinet

As shown in Wyle Report 42836-1 in photographs 9 through 35, this item was extensively instrumented (30 accelerometers). A low level (approximately 0.2g horizontally and 0.1g vertically) biaxial sine sweep was then performed from 1 Hz to 33 Hz to establish major resonances in the side-to-side/vertical orientation and the front-to-back/vertical orientation. The lowest natural frequency was found to be 8.5 Hz in the front-to-back/vertical orientation. In our professional opinion, because of the detailed response mapping, this experimentally determined value is indeed the first cabinet mode and therefore adequate margin with respect to the 4.5 Hz cutoff is assured.

TABLE 1

Item	Structural Frequencies (Hz) S/S	F/B	V	TRS > RRS Above	Test Report
NSSS 1	11, 32	8.5	Various 10-33	4.5 Hz	WYLE 42836-1
NSSS 1a	26, 33	32	29	5 Hz	WYLE 54406
NSSS 2a	26	> 40	26	8 Hz	WYLE 42915-1
NSSS 2b	> 40	30	30, 32	8 Hz	WYLE 42915-1
NSSS 2c	29, 37	30, 33	26, 30, 34, 38	8 Hz	WYLE 42915-1
NSSS 2d	25, 33, 39	> 40	26, 35, 39	8 Hz	WYLE 42915-1
NSSS 2e	> 40	> 40	> 40	2.5 Hz	WYLE 43349-1
NSSS 2f	35	35	35	9 Hz	WYLE 54602
NSSS 16	16 - 33	6, 10, 14-33	31	4 Hz	WYLE 54534
NSSS 17	16 - 33	14 - 33	31	4 Hz	WYLE 54534

b. NSSS 1a - Nuclear Instrument Safety Channels

An actual circuit board was measured (6.00 inches by 4.00 inches by 0.062 inches) and weighed (0.3666 pounds). The boundary conditions were modeled as clamped on the boundary with plug end attachments and free on the remaining boundaries. This model contains appreciable conservatism since in actuality, tracks on two sides of the plates provide significant stiffness not assumed in the model. Utilizing the following References (relevant pages from these texts are included in an Attachment C).

1. Belvins, R.D., "Formulas for Natural Frequency and Mode Shape" Van Nostrand Reinhold Company, New York, 1979.

2. Steinberg, D.S., "Vibration Analysis for Electronic Equipment", John Wiley and Sons, New York, 1973.

The natural frequency of the circuit board was calculated as shown below:

From Reference 1, page 254

$$f_{11} = \frac{\lambda_{11}^2}{2\pi a^2}\left[\frac{E h^3}{12\gamma(1-\nu^2)}\right]^{1/2}$$

where

f_{11} = natural frequency in Hz, $F^\circ L^\circ T^{-1}$

λ_{11}^2 = numerical factor, $F^\circ L^\circ T^\circ$

E = Young's modulus, $F'L^{-2}T^\circ$

h = thickness of plate, $F^\circ L'T^\circ$

a = length of plate, $F^\circ L'T^\circ$

b = width of plate, $F^\circ L'T^\circ$

γ = mass per unit ar-a of plate, $F'T^2L^{-3}$

ν = Poisson's ratio, $F^\circ L^\circ T^\circ$

For the representative circuit board in NSSS 1a, F is specified in pounds, L in inches and T in seconds.

E (See Reference 2, page 301) = 2×10^6 $F'L^{-2}T^\circ$

h = 0.062 $F^\circ L'T^\circ$

a = 6.00 $F^\circ L'T^\circ$

b = 4.00 $F^\circ L'T^\circ$

γ (See [2], page 302) = $\frac{W}{gab} = \frac{0.366}{(386)\ (6)\ (4)} = 3.95 \times 10^{-5}\ F'T^2L^{-3}$

ν (See Reference 2, page 301) = 0.12

For a/b = 1.5, from [Reference1], page 254, Case 3, $\lambda_{11}^2 = 3.48$

Hence

$$f_{11} = \left[\frac{3.48}{2(3.14)\ (6.00)^2}\right] \cdot \left[\frac{(2 \times 10^6)\ (0.062)^2}{12\ (3.95 \times 10^{-5}\ [1 - (.12)^2}\right]^{0.5}$$

$$f_{11} = 15.5 \text{ Hertz}$$

This better than 3 to 1 margin between the actual and cutoff frequencies eliminates the circuit boards as possible internal components subject to resonance effects in the region below 5 Hz.

c. NSSS 2a - CPC Mass Storage Unit

The function of the Mass Storage Unit is for initial startup and troubleshooting the CPC. During the normal operation of the CPC, the Mass Storage Unit is not used or powered. Therefore, this item is not safety related in its operation. The only other hazard of this unit during a seismic event would be a physical separation of the components of the structure striking and damaging safety related equipment. This requirement was satisfied since the structural integrity of the Mass Storage Unit was maintained during testing. Based on this evidence, it is our professional opinion that the CPC Mass Storage unit is not safety related and should be considered qualified.

d. NSSS 2b - Central Processing Unit

Several circuit boards were instrumented by attaching an accelerometer to a two channel storage oscilloscope supplemented with a charge amplifier and a high-low filter. The boards were then plucked to determine their natural frequencies. The frequencies found from the oscilloscope traces were 40 Hz $\pm$ 1 Hz (photographs are provided for inspection). These values are well above the cutoff of 8 Hz. Additional previously determined experimental support (See Wyle Report 42915-1) for the design adequacy of items NSSS 2b, c, d and f is that sine beat single frequency testing was conducted at frequencies below 8 Hz where complete envelopment of the RRS by the TRS was not possible in the high frequency range. In all cases, this testing demonstrated the conservation of the cutoff frequency of 8 Hz since substantial envelopment at high frequencies was achieved at these lower frequencies.

e. NSSS 2c - CPC MACS Chassis

The same test procedure as used for NSSS 2b was employed with resulting natural frequencies of 20 Hz $\pm$ 1 Hz. This eliminates any concern since this provides a better than 2 to 1 margin over the cutoff frequency of 8 Hz.

f. NSSS 2d - CPC Power Supply

This item contains no large circuit board (i.e., greater than 3" x 4") which as stated in the General Approach, eliminated the need for detailed information.

g. NSSS 2e - CEA Position Isolation Assembly

Actual circuit boards representative of the 12 boards mounted in tracks along two edges were subjected to uninstrumented pluck tests and, because of the tightness of the mounting tracks, the natural frequencies were clearly higher than the circuit boards in NSSS 2b. This indicates natural frequencies in excess of 40 Hz and eliminates any concern about the cutoff frequency of 2 Hz. This item also contains two additional circuit boards which are secured by 5 bolts (one at each corner and one in the center). This mounting insures that the response of these boards is not design limiting.

h. NSSS 2f - RCP SSSS Signal Processor

Three types of components are contained in this unit. They are a power supply, regulator boards and pulse shaper boards. The rigidity of the power supply and its mounting eliminates it as an item of concern. An actual regulator board was measured (7.125 inches by 5.25 inches by 0.062 inches) and weighed (0.220 pounds). The boundary conditions were conservatively modeled as two opposite edges simply supported (ends attached with screws) and two edges free. From Reference 1 (See NSSS 1a) the natural frequency is calculated as shown below:

Take F = pounds, L = inches, T = seconds and set

$$E = 2 \times 10^6 \; F^1L^{-2}T^0$$

$$h = 0.062 \; F^0L^1T^0$$

$$a = 7.125 \; F^0L^1T^0$$

$$b = 5.25 \; F^0L^1T^0$$

$$\gamma = \frac{.220}{(386)\,(7.125)\,(5.25)} = 1.52 \times 10^{-3} \; F^1T^2L^{-3}$$

$$\nu = 0.12$$

For a/b = 1.36, from [Reference 1] Case 5, page 254, $\lambda_{11}^2 = 9.56$. This value of λ_{11}^2 is conservative since it corresponds to a/b = 1.50 and thus is smaller than the untabulated value for a/b = 1.36. Hence

$$f_{11} = \left[\frac{9.56}{2(3.14)\,(7.125)^2}\right] \left[\frac{(2 \times 10^6)\,(0.062)^3}{12\,(1.52 \times 10^{-5})\,[1 - (.12)^2]}\right]^{1/2}$$

$$f_{11} = 48.83 \text{ Hz}$$

This better than 5 to 1 margin between the actual and cutoff frequencies eliminates the curcuit boards as possible internal components subject to resonance effects in the region below the cutoff frequency of 9 Hz.

The other circuit board in this unit is the pulse shaper which is identical in size, but slightly heavier (0.231 pounds) than the regulator board (0.220 pounds). This additional weight has negligible effect since the corresponding calculated natural frequency using previously indicated techniques is 41.46 Hz.

i. NSSS 16 - Excore Detector

As mentioned in the General Approach, the 6 Hz frequency measured in the F/B response does not provide adequate margin with respect to the cutoff frequency of 4 Hz. This is a result of the geometry of the specimen tested. The actual field installation, as explained below, has a much higher F/B response which does provide the needed margin.

First, with reference to Wyle Report 54534, it should be noted that accelerometer number 5 was mounted internally during the test as shown on page 65 and not externally as shown on page 57. Inspection of drawings disclosed that with exception of the 1 inch by 1 1/2 inch aluminum tube attached to the bottom of the detector assembly, the remaining components are essentially rigid. The length of this tube was 36 inches with accelerometer number 6 mounted at the end not adjacent to the detector assembly (See page 12 of Wyle Report 54534).

From Reference [1] (See NSSS 1a), page 108, the natural frequency of the cantilevered tube is

$$f_1 = (0.56/L^2)\ (EI/m)^{0.5}$$

where

L = length of the beam, $F^{\circ}L^{1}T^{\circ}$

E = Young's modulus, $F^{1}L^{-2}T^{\circ}$

I = area moment of inertia, $F^{\circ}L^{4}T^{\circ}$

M = mass per unit length of beam, $F^{1}T^{2}L^{-2}$

However, in the actual field installation, this tube, subject to the same boundary conditions, was reduced in length to only 6 inches. Inspection of the above formula indicates that the natural frequency of the field installation is 36 times greater. The natural frequency of the tube tested was 6 Hz and, therefore, the corresponding frequency of the actual hardware is 216 Hz. Clearly, this tube is not design limiting since the cutoff frequency is 4 Hz.

j. NSSS 17 - Excore Preamplifier

The excore preamplifier contains two separate components designated as the upper and lower units. The lower unit contains a circuit board 7.3 inches by 4.5 inches by 0.062 inches. Inspection of drawings indicated that the appropriate boundary conditions for this board are clamped along the long edges and free on the shorter side. The weight of the board was estimated as 0.220 pounds because of its similarity to the regulator board in Item 8 - RCPSSSS Signal Processor.

From Reference 1 (See NSSS 1a), the natural frequency is calculated as follows:

Take F = pounds, L = inches, T = seconds and set

$E = 2 \times 10^6\ F^{1}L^{-2}T^{\circ}$

$H = 0.062\ F^{\circ}l^{1}T^{\circ}$

$a = 4.5\ F°L'T°$

$b = 7.3\ F°L'T°$

$$\gamma = \frac{0.220}{386(4.5)\ (7.3)} = 1.74 \times 10^{-5} F'T^2L^{-3}$$

$\nu = 0.12$

For a/b = 0.62, from Reference 1, Case 8, page 256 $\lambda_{11}^2 = 22.31$. This value is conservative since it corresponds to a/b = 0.67 and thus is smaller than the untabulated value for a/b = 0.62. Hence

$$f_{11} = \left[\frac{22.31}{2\ (3.14)\ (4.5)^2}\right] \left[\frac{(2 \times 10^6)\ (0.062)^3}{12\ (1.74 \times 10^{-5})\ [1 - (.12)^2]}\right]^{0.5}$$

$f_{11} = 266$ Hz

This high frequency demonstrates that the circuit board can be considered rigid. It should be noted that the presence of a ground strap support in the center of the plate has an additional stiffening effect not considered in the analysis.

The upper unit contains a circuit board of the same dimensions and mounting as the lower unit, but is of lighter weight and therefore has a higher natural frequency.

BOP

For BOP supplied equipment, the cases where the TRS do not envelope the RRS at all frequencies are limited to the low frequency region of the response spectra (i.e., $f \leq 4$ Hz). In all such cases, the minimum system natural frequency is at least 60 percent above the identified cutoff frequency. Therefore, the actual test conditions adequately bound the specified seismic environment (RRS) with ample margin in the frequency range of concern to the equipment in question. For a more detailed itemization of this condition for BOP supplied equipment, please refer to Section 5 of Attachment B.

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A FORMAL EXAMINATION OF THE FREQUENCY CUT-OFF ISSUE ON A PRELIMINARY BASIS USING RESPONSE SPECTRA

Introduction

Seismic qualifications of the San Onofre Nuclear Generating Systems (SONGS) NSSS electrical equipment are obtained by vibration tests which simulate the required design seismic response spectra (RRS). However, it is generally impractical to generate test loadings that have response spectra matching precisely with the RRS. In particular, the test machine capabilities are limited that the test response spectra (TRS) are lower in the low frequency range (approximately between 1 Hz and 5 Hz) and higher in the high frequency range (usually higher than 5 Hz) than those of the RRS. This descrepancy has led to the concern that the NSSS vibration tests may not have provide the required loadings to the electrical equipments; and consequently the qualifications are questionable.

The purpose of this discussion is to address this concern and to assess the validity of using the TRS to qualify the NSSS electrical equipment. In this discussion, it is proven that since the fundamental frequencies of the NSSS electrical equipments are, in all cases, higher than the frequencies where the TRS deviate from the RRS, then the maximum responses of the equipment

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due to TRS will always be higher than the maximum responses resulting from the corresponding RRS.

The proof is presented first by an analytical assessment where the solution procedures of typical seismic response analysis are examined. Then, numerical examples are demonstrated by evaluating mathematical models which characterize a typical NSSS electrical equipment. Computer simulations using the TRS and the RRS are conducted and compared. Results clearly show that in all cases the TRS provide more severe load inputs than the RRS.

Statement

Given the two response spectra RRS and TRS as illustrated in Figure 1, and the condition that TRS is greater than RRS for all frequencies $\omega > \omega_D$; then it can be stated that the maximum spectral response of a multi-degrees-of-freedom structure resulting from the TRS spectrum will always be greater than or equal to the corresponding spectral response due to the RRS spectrum if the lowest frequency (ω_1) of the structure is greater than or equal to ω_D.

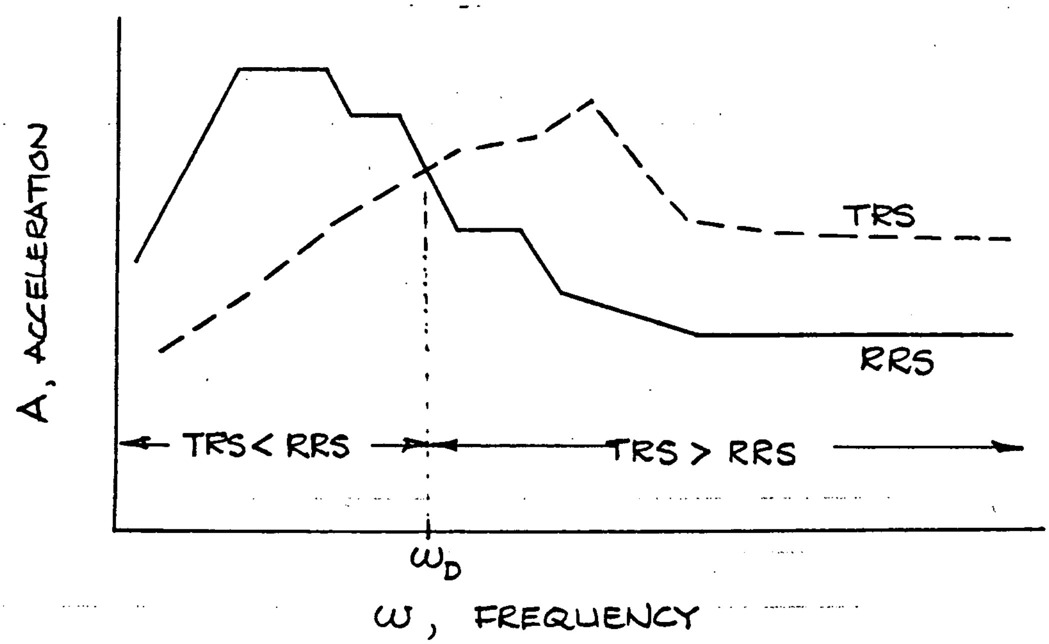

Figure 1. Typical RRS & TRS Response Spectra

Discussion

In order to show the validity of the above statement, let's begin by examining the solution procedures of response spectrum analysis of a multi-degree-of-freedom structure whose modal characteristics are known. For most structural analysis computer programs, the total maximum spectral response is usually approximated by a number of summing methods. If the structural modes are well separated, the sum can be determined by the algebric sum, i.e.

$$\{u\}_T = \sum_{i=1}^{N} \{u\}_i \qquad (1)$$

where

$\{u\}_T$ = total maximum displacement response of the structure

$\{u\}_i$ = maximum response of the i^{th} mode

N = number of modes being summed

Or by the absolute sum (conservative), i.e.

$$\{u\}_T = \sum_{i=1}^{N} \left| \{u\}_i \right| \qquad (2)$$

or by the more common square-root-of-the-sum-squares method, i.e.

$$\{u\}_T = \left(\sum_{i=1}^{N} \{u\}_i^2 \right)^{1/2} \qquad (3)$$

If the modes are closely spaced, then the double sum method is often used to include the coupling effects, i.e.

$$\{u\}_T = \left(\sum_{i=1}^{N} \sum_{j=1}^{N} \{u\}_i \{u\}_j \{\epsilon\}_{ij} \right)^{1/2} \qquad (4)$$

where

$\{u\}_j$ = response of the j^{th} mode

$\{\epsilon\}_{ij}$ = the coupling coefficient between the modes i and j.

The modal displacement response is determined by

$$\{u\}_i = A_i \{\phi\}_i \qquad (5)$$

where

$\{\phi\}_i$ = normalized vector of the i^{th} mode

A_i = mode coefficient for i^{th} mode

If the input is an acceleration spectrum, then the mode coefficient is defined as

$$A_i = \frac{Sa_i \gamma_i}{\omega_i^2} \qquad (6)$$

where

γ_i = participation factor for i^{th} mode

ω_i = the i^{th} natural frequency

Sa_i = spectral acceleration for the i^{th} mode and is obtained from the input acceleration spectrum at $\omega = \omega_i$.

Now, if the input spectrum is defined by either the TRS or the RRS spectra shown in Figure 1 which indicates

$$TRS > RRS \quad \text{for } \omega > \omega_D \qquad (7)$$

and if it is known that the lowest frequency of the structure is greater than or equal to ω_D, i.e.

$$\omega_i \geq \omega_D \quad \text{for } i = 1, \cdots \text{to } N \qquad (8)$$

then according to Eq. (7), it can be stated that all spectral acceleration values from TRS spectrum, $(Sa_i)_{TRS}$, must be greater than or equal to all corresponding spectral accelerations from the RRS Spectrum, $(Sa_i)_{RRS}$, that is,

$$(Sa_i)_{TRS} \geq (Sa_i)_{RRS} \qquad (9)$$

$$\text{for } i = 1, \cdots N$$

From Eq. (6), it also follows that

$$(A_i)_{TRS} = \frac{(Sa_i)_{TRS}\,\gamma_i}{\omega_i^2} \geq (A_i)_{RRS} = \frac{(Sa_i)_{RRS}\,\gamma_i}{\omega_i^2} \qquad (10)$$

$$\text{for } i = 1, \cdots N$$

and the modal displacement responses are,

$$(A_i)_{TRS}\{\phi\}_i \geq (A_i)_{RRS}\{\phi\}_i$$

or

$$\{u\}_{i_{TRS}} \geq \{u\}_{i_{RRS}} \qquad (11)$$

for $i = 1, \cdots N$

Hence, for any of the summing methods defined by Eqs (1), (2), (3) or (4), if Eq. (11) is true for all i, then it is also true for the summation of all i, i.e.

$$\sum_{i=1}^{N}\{u\}_{i_{TRS}} \geq \sum_{i=1}^{N}\{u\}_{i_{RRS}} \qquad (12)$$

or simply,

$$\{u\}_{T_{TRS}} \geq \{u\}_{T_{RRS}}$$

for $\omega_i \geq \omega_D$

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Examples

Consider the ESFAS Auxiliary Relay Cabinet (NSSS4) which is mounted in the Control Room and weighs 13,000 lbs as an equivalent cantilever beam as shown in Figure 2,

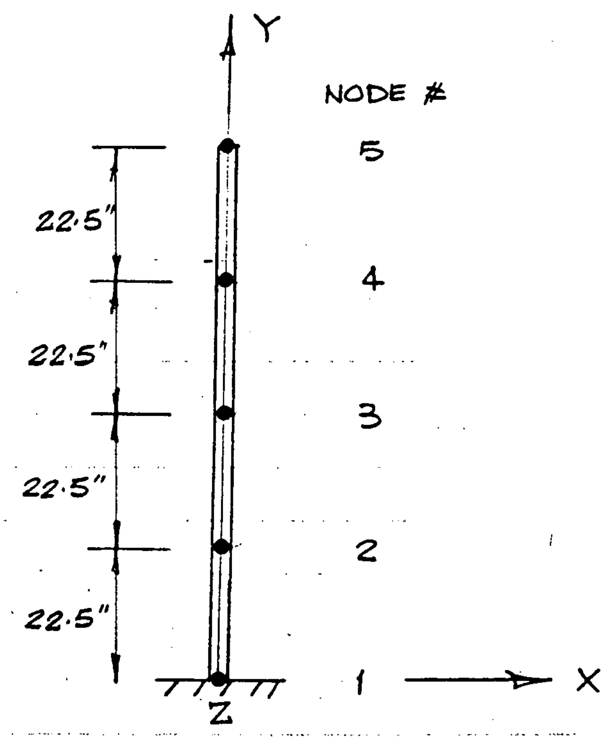

Figure 2. Equivalent Beam Model for NSSS4.

The beam properties are chosen such that the lowest natural frequencies in the three orthogonal directions

are approximated. No attempt is made to simulate the high frequencies accurately since such task is quite complex and time consuming and is not necessary for the present purpose. SONGS document indicates that the natural frequencies of the NSSS4 cabinet are:

side-to-side : 12 Hz

front-to-back : 9.5, 10.5, 13, 18, 27, 34, 39 Hz

and vertical : 18, 25, 27, 34, 39 Hz

The beam model of Figure 2 is represented by the STIF4 finite elements of the ANSYS computer program. Uniform beam properties are used for the sake of simplicity; and the modal characteristics are determined as:

side-to-side :

mode NO.	frequency (Hz)
1	8.5
2	35.9
3	75.8
4	116.2
5	166.9
6	220.5
7	285.3
8	341.4

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Front-to-back :

mode no.	frequency (Hz)
1	10.1
2	38.9
3	79.8
4	119.8
5	169.9
6	223.2
7	287.7
8	343.1

and

vertical :

mode no.	frequency (Hz)
1	18.1
2	57.2
3	103.8
4	150.2

Seismic response spectrum analysis is conducted for the beam model in the three excitation directions, side-to-side (i.e X-axis), front-to-back (i.e. Z-axis), and vertical (i.e. Y-axis). Mode summation is performed using the SRSS method. TRS and RRS spectra, given in Figures 3 and 4 are used. Comparisions of the TRS and RRS maximum responses are summarized in Tables 1 to 3 in terms of displacements at Node 5 and reactions at Node 1.

SSE Control Room Response Spectra

San Onofre Station

SSE - Horizontal - 1% β

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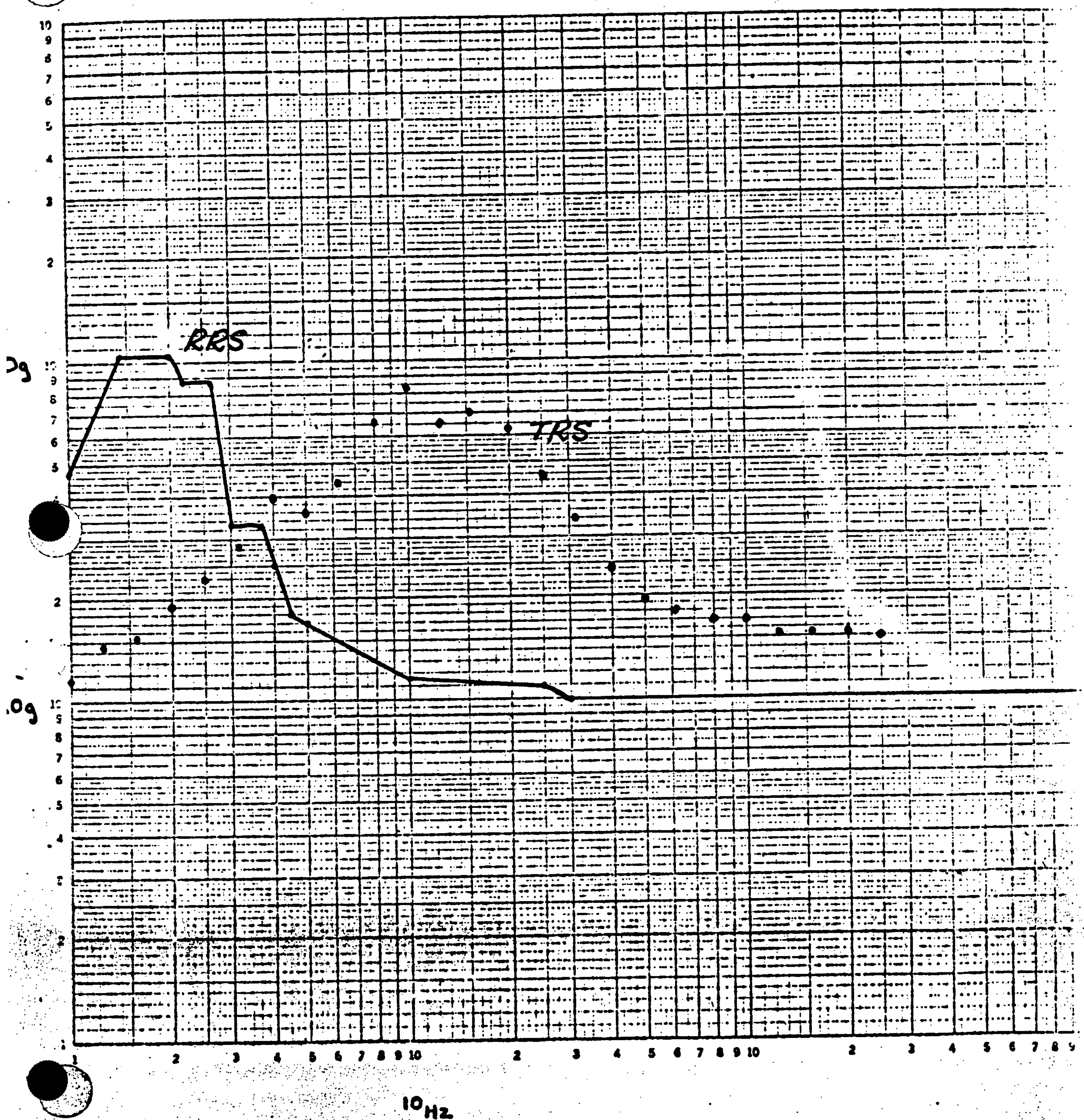

ARC: minimum of two horizontal tests (F/E 1 S/S)

Figure 3. Horizontal Spectra

SCE Control Room Response Spectra

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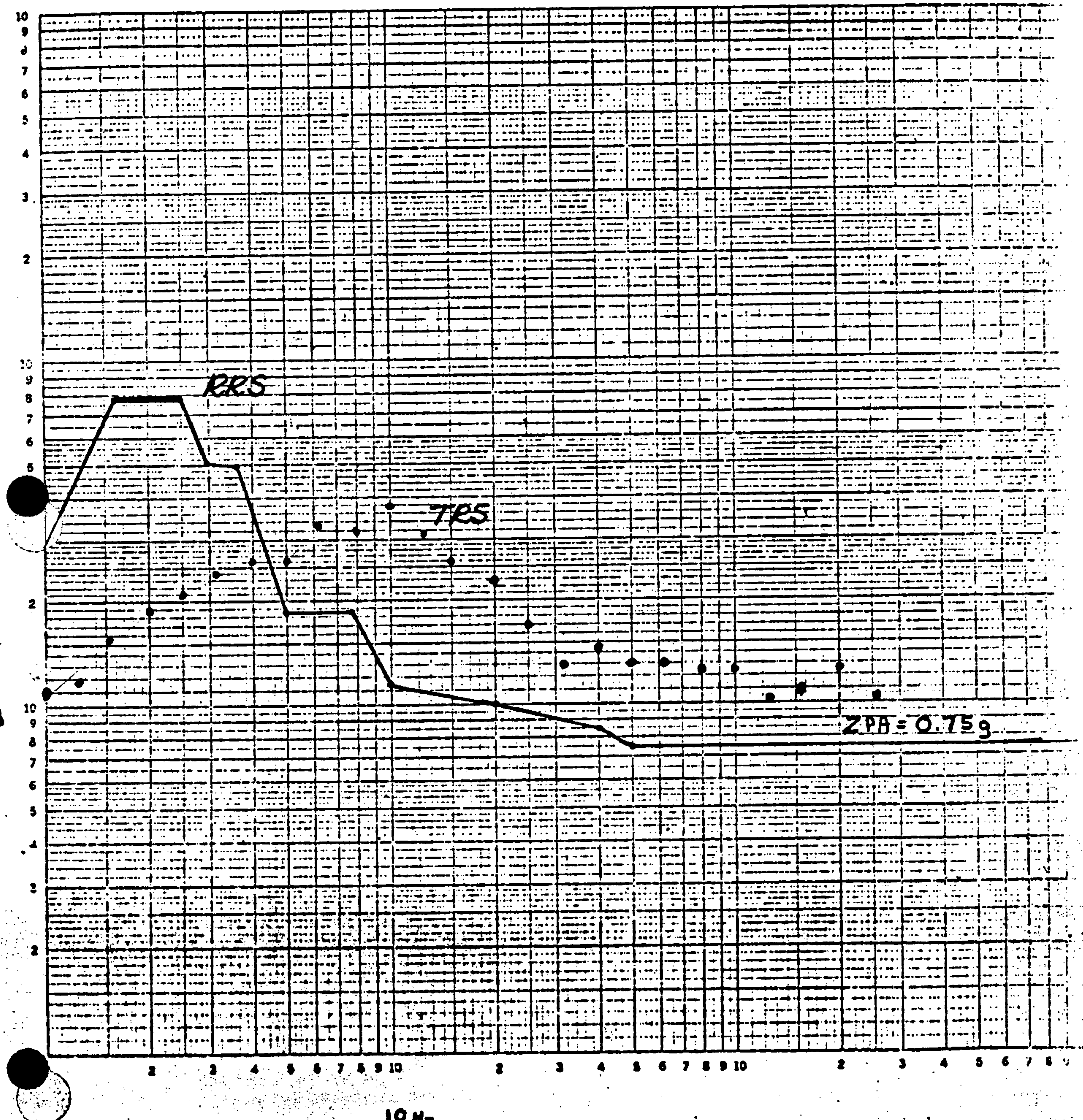
SSE - Vertical - 1% β



ARC: minimum of two vertical tests.

Figure 4. Vertical Spectra

Table 1. Comparisons of TRS and RRS Side/Side Responses for NSSS4.

Response Parameters	TRS Results	RRS Results
U_{X_5} (IN.)	0.9495	0.1321
θ_{Z_5} (rad.)	0.0151	0.0021
F_{X_1} (lbs)	55042.	9029.
M_{Z_1} (IN-lbs)	4267536.	601212.

Table 2. Comparison of TRS and RRS Front/Back Responses for NSSS4.

Response Parameters	TRS Results	RRS Results
U_{Z_5} (IN)	1.2226	0.2376
θ_{X_5} (rad)	0.0193	0.0037
F_{Z_1} (lbs)	49099.	10019.
M_{X_1} (IN-lbs)	3542378.	690627.

Table 3. Comparisons of TRS and RRS Vertical Responses for NSSS4.

Response Parameters		TRS Results	RRS Results
Uy_5	(IN.)	0.1059	0.0385
Fy_1	(lbs)	28267.	10282.

ATTACHMENT B

ANALYSIS REPORT

REPORT NO.	26321
OUR JOB NO.	ND26321
CONTRACT	N/A
YOUR P. O. NO.	S1709902

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
WESTERN OPERATIONS, NORCO FACILITY

SOUTHERN CALIFORNIA EDISON
P. O. Box 800
Rosemead, CA 91770

14-Page Report

DATE 23 September 1980

REVIEW

OF

SEISMIC QUALIFICATION DOCUMENTATION

FOR

CERTAIN BOP AND NSSS ITEMS

FOR THE

SAN ONOFRE NUCLEAR GENERATING STATION

REGISTERED PROFESSIONAL ENGINEER
GEORGE D. SHIPWAY
No. 12157
MECHANICAL
STATE OF CALIFORNIA

STATE OF CALIFORNIA }
COUNTY OF RIVERSIDE } ss.

Ray C. Myrick, being duly sworn, deposes and says: That the information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

SUBSCRIBED and sworn to before me this 25th day of September, 19 80

Notary Public in and for the County of Riverside, State of California

My Commission expires 14 July, 19 83

OFFICIAL SEAL
CATHERINE C KELTY
NOTARY PUBLIC - CALIFORNIA
RIVERSIDE COUNTY
My comm. expires JUL 14, 1983

W-867A

DYNAMICS DEPARTMENT

PROJECT ENGINEER G. Shipway

DEPARTMENT MGR. J. Anderson

REGISTERED PROFESSIONAL ENGINEER G. Shipway

QUALITY CONTROL A. Heeseman

1.0 SUMMARY

The documentation for 14 Balance of Plant (BOP) and 28 Nuclear Steam Supply System (NSSS) items has been reviewed for the adequacy of the seismic qualification. The review to date has found the documentation for all 14 of the BOP items to be satisfactory. The documentation for 7 of the NSSS items is not yet complete. The documentation for the other 21 items has been found to be satisfactory.

2.0 REFERENCES

2.1 Southern California Edison Purchase Order #S1709902, Change Order No. 2, dated 3-18-80.

2.2 IEEE 344-1975: Recommended Practices for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations.

2.3 Qualification summary of equipment sheets for all listed items.

3.0 GENERAL APPROACH

The Required Response Spectra (RRS) for the San Onofre Nuclear Generating Station (SONGS) require relatively high acceleration levels at low frequencies. These high levels, and corresponding high displacements, have exceeded test lab capabilities in many cases, with the result that the Test Response Spectra (TRS) did not envelop the RRS at the lowest frequencies.

It is generally accepted that such a deviation is acceptable, when it can be demonstrated that the test item includes no resonances at the low frequencies. Paragraph 6.6.3.1 of Reference 2.2 states "For assemblies or devices where the dynamic response results from numerous interacting modes, the shake-table input excitation must be adjusted such that the TRS envelops the RRS over a frequency range which includes all natural frequencies of the equipment up to 33 Hz."

Further, the next version of Reference 2.2 is expected to explicitly address the low frequency cut-off situation. A draft wording for the next version states "RRS's occasionally require high acceleration levels at the lowest frequencies which require very high displacement capability. In those cases where any resonances at or below 5 Hz can be clearly shown, it is required to envelop the RRS only above 70% of the lowest resonance frequency or above 3.5 Hz, whichever is lower. A higher cut-off frequency can be justified when it can be demonstrated that the lowest resonance frequency is correspondingly higher."

For this project it is considered acceptable for the TRS to envelop the RRS above 70% of the lowest resonance frequency.

4.0 SPECIFIC APPROACH

For each item of equipment designated by SCE (the list is included in the Appendix), a review of the test documentation was performed as follows:

a. The enveloping of the RRS by the TRS was checked.

b. For some cases, the source and validity of the RRS was reviewed.

c. The lowest resonance frequency was determined.

4.0 (Cont'd.)

d. The location of accelerometers for response measurement was checked for adequate detection of resonances.

e. For some cases, the adequacy of the test procedure was reviewed.

These items plus a general review of the documentation led to a judgment as to the adequacy of the qualification program and the documentation thereon.

5.0 REVIEW OF BALANCE OF PLANT ITEMS

The following presents the pertinent comments on each of the Balance of Plant (BOP) items:

5.1 BOP 2 - 480 Volt Motor Control Center

The TRS enveloped the RRS above 2.5 Hz. Wyle report 43220-1 checked. The accelerometer locations are acceptable. The lowest resonance frequency was 4 Hz in the F-B direction.

The test program is acceptable.

5.2 BOP 3 - 125 VDC Distribution Switchboard

The TRS enveloped the RRS above 3 Hz. Wyle report 58026 checked. The lowest resonance frequency was 15 Hz in the side-side direction. The accelerometer locations are acceptable.

The test program is acceptable.

5.3 BOP 4 - 600 V Electrical Penetration Assembly

The outboard termination box must maintain structural integrity only. The lowest resonance frequency indicated was 18 Hz which is above any significant amplification in the RRS which would jeopardize the structural integrity of the box.

The terminal straps were adequately tested.

The modules were adequately tested.

5.3 (Cont'd.)

The analysis of the other components adequately shows structural integrity which is all that is required for operability.

This analysis/test program is acceptable.

5.4 BOP 5 - 125 V Batteries

The TRS enveloped the RRS above approximately 3 Hz. The lowest resonance frequency was approximately 8 Hz. Wyle report 44426-1 was checked. The accelerometer locations are acceptable.

The test program is acceptable.

5.5 BOP 6 - Battery Charger

Model ARR130K400 was tested per Wyle report 43330-1. ARR130K300 is being qualified by similarity. A review by Bechtel shows that the two cabinets are structurally similar.

For the tested unit, the TRS enveloped the RRS above 4 Hz.

Wyle report 43330-1 checked. The lowest resonance frequency was 8 Hz. The accelerometer locations are acceptable.

The test program is acceptable.

5.6 BOP 7 - Main Control Panel

The TRS enveloped the RRS above 4 Hz. The test program included both single section testing and in-situ testing.

The lowest resonance frequency was 17.5 Hz. The accelerometer locations were acceptable.

The test program is acceptable.

5.7 BOP 8 - Inverters

The TRS enveloped the RRS above 2.5 Hz. Wyle report 58145 checked. The lowest frequency was 13 Hz. The accelerometer locations are acceptable.

The test program is acceptable.

5.8 BOP 9 - Remote Shutdown Panel

Panel 2CR-62 was tested.

Panel 2L-42 is being qualified by similarity.

The TRS enveloped the RRS above 3.5 Hz.

Wyle report 54498 checked. The lowest resonance frequency was 18 Hz. The accelerometer locations are acceptable.

The test program is acceptable.

5.9 BOP 10 - Transmitters

Test was single frequency and single axis. But test levels were high enough to envelop, with considerable margin, the required levels at frequencies above 2 Hz.

The lowest resonance frequency was 3.5 Hz.

The test program is acceptable.

5.10 BOP 15 - Solenoid Valves

The TRS enveloped the RRS above 4 Hz.

The lowest resonance frequency was above 33 Hz.

The test program is acceptable.

5.11 BOP 17 - Control Valve

The TRS enveloped the RRS above 3 Hz.

The lowest resonance frequency was 19 Hz.

The test program is acceptable.

5.12 BOP 18 - Control Valve

The TRS enveloped the RRS above 2.5 Hz.

Wyle report 44242-1 checked. The lowest frequency was 13 Hz. The accelerometer locations are acceptable.

The test program is acceptable.

5.13 BOP 19 - Control Valve

The TRS enveloped the RRS above 3 Hz. Wyle report 58171-2 was checked. The lowest resonance frequency was above 33 Hz.

The test program is acceptable.

5.14 BOP 21 - Relief Valve

Crosby reports 3718 and 3719 and engineering calculations EC 187 and 276 were reviewed.

The resonance frequency determination was performed adequately, with the lowest resonance frequency being 34 Hz.

The seismic test and the operability were performed in an acceptable manner.

6.0 REVIEW OF NSSS ITEMS

The following presents the pertinent comments on each of the NSSS items.

6.1 NSSS 1 - Plant Protection System Cabinet

The TRS enveloped the RRS above 4.5 Hz.

Wyle report 42836-1 was checked. The lowest resonance frequency was 8.5 Hz. The accelerometer locations are acceptable.

The test program is acceptable.

6.2 NSSS 1a - Nuclear Instrument Safety Channels

The TRS enveloped the RRS above 5 Hz. Wyle report 54406 was checked. The lowest resonance frequency was 26 Hz. The accelerometer locations were acceptable.

The test program was acceptable.

6.3 NSSS 2 - Auxiliary Protective Cabinet

Wyle report 43482 was reviewed. This test program is acceptable. The item is included here as a reference for the following items 2a through 2g.

6.4 NSSS 2a - CPC Mass Storage Unit

The TRS enveloped the RRS above 8 Hz, except in the F-B direction at 25 Hz. At 25 Hz the TRS was 12% below the RRS; however, the adjacent analysis points at 20 and 32 Hz each exceeded the RRS by over 200%. The lowest resonance frequency was above 30 Hz in the F-B direction. The accelerometer locations were acceptable.

The test program is acceptable.

6.5 NSSS 2b - CPC CPU

Same as 2a.

6.6 NSSS 2c - CP MACS Chassis

Same as 2a.

6.7 NSSS 2d - CPC Power Supply

Same as 2a.

6.8 NSSS 2e - CEA Position Isolation Assembly

The TRS enveloped the RRS above 2.5 Hz.

Wyle report 43349-1 was checked. The lowest resonance frequency was greater than 40 Hz. The accelerometer locations are acceptable.

The test program is acceptable.

6.9 NSSS 2f - RCP SSSS Signal Processor

Review incomplete.

6.10 NSSS 2g - In-Core Amplifier

Review incomplete.

6.11 NSSS 3 - Reactor Trip Switchgear Cabinet

The TRS enveloped the RRS above 5 Hz. Wyle report 42835-1 was checked. The lowest resonance frequency was 12 Hz. The acclerometer locations are acceptable.

The test program is acceptable.

6.12 NSSS 4 - ESFAS Auxiliary Relay Cabinet

The TRS enveloped the RRS above 5 Hz.

Wyle report 52913-1 was checked. The lowest resonance frequency was 9.5 Hz. The accelerometer locations are acceptable.

The test program is acceptable.

6.13 NSSS 5 - Process Instrument Rack

Foxboro report T-1025, Rev. 1 was reviewed. Sine beat tests at 1 and 2 g's were performed with dummy components. Response measurements were taken to provide data for component tests.

The test program is acceptable.

6.14 NSSS 5a - Current to Voltage Converter

Foxboro report 75-113 was reviewed. The sine beat tests were applied at levels high enough to envelop, with considerable margin, the required levels as determined during test of NSSS 5.

The test program is acceptable.

6.15 NSSS 5b - 51

Same review as for Item 5a.

6.16 NSSS 5m - Temperature Transmitter

This is a small unit with no resonances below 35 Hz. The TRS exceeds the input levels from the test of Item 5 by a comfortable margin above 3 Hz.

The test program is acceptable.

6.17 NSSS 6 - Vital Bus Power Supply

Wyle report 43474 was reviewed. The TRS envelops the RRS above 3 Hz. The lowest resonance frequency was 12.5 Hz. The accelerometer locations are acceptable.

The test program is acceptable.

6.18 NSSS 7 - CPC Operators Module

Wyle report 43130-1 was checked. The lowest resonance frequency was 24 Hz. The sine beat tests were performed at enough frequencies and a high enough level to comfortably envelop the control panel levels.

The test program is acceptable.

6.19 NSSS 8 - PPS Remote Control Module

The TRS enveloped the floor RRS by a wide margin above 2 Hz. Wyle report 43386-1 was checked. The lowest resonance frequency was above 20 Hz. The accelerometer locations are acceptable.

6.20 NSSS 10 - Indicating Controller

Review incomplete.

6.21 NSSS 12-1 and 12-2 - Temperature Sensors

Small sensor inside of deep well. Sine dwell tests were performed at several frequencies. The test levels were well above required levels.

The test program is acceptable.

6.22 NSSS 15-1 - Pulse Transmitter and 15-2 Proximity Probe

Wyle report 54602 was checked. The 16 Hz sine beat TRS envelops the RRS above 13 Hz. The lowest resonance frequency was 30 Hz.

The test program is acceptable.

6.23 NSSS 16 - Detector

Review incomplete.

6.24 NSSS 17 - Preamplifier/Filter

Review incomplete.

6.25 NSSS 18 - CEDM Transmitter

The TRS enveloped the RRS above 2.25 Hz. The lowest resonance frequency of the CEDM was 3.5 Hz.

The test program is acceptable.

6.26 NSSS 21 - Isolation Detector

Review incomplete.

6.27 NSSS 22 - Isolation Transmitter

Review incomplete.

6.28 NSSS 25 - Charging Pump

The lowest resonance frequency found was above 35 Hz. Sine dwells at 1.5 g were applied at four frequencies. Nozzle loads were applied and the pump was operated during and after the sine dwells.

The test program is acceptable.

APPENDIX

BOP Equipment on SONGS 2&3 SQRT Audit List Not Seismically Excited at Qualifying Levels in all of 1-33 Hz Spectrum

Item No.	System	Component	Natural Frequencies (Hz)	Cut Off Frequency (Hz)
2	480v MCC	Switchgear	7 - 32	4
3	125v VDC	Switchboard	No Report	1.25
4	600v Penetration	680#	18 and Above	5
5	125v Batteries	Cells and Rack	No Report	-
6	Battery Charger	Cabinet&Equip.	8 - 23	4
7	Main Control Panel	Cubicles	7.8 & 17.5	2
8	Motor Operated Valve Inverter	Cabinet	13, 28, 29 & 35	1.2
9	Remote Shutdown Panel	Cubicle	17.8, 28.6 & 29.4	2
10	Transmitter	25# Unit	3.5, 14 & 35	1.2
15	2HV-0352 Solenoid Valves	21# Unit	Higher than 33	3.5
17	2HV-4712 Control Valve	340# Unit	19.5, 26 & 57	2.5
18	2HV-9300 Control Valve	2840# Unit	13, 17, 29	2.5
19	2HV-4714 Control Valve	1500# Unit	Higher than 52	2.7
21	2PSV-8401 Relief Valve (No Stack)	1550# Unit	34, 36	Sine Dwell only at 28, 32 & 35

SQRT Audit List Items
Supplied by CE
Not Seismically Excited at Required Levels
from 1 to 33 Hz

Item No.	System	Component	Natural Frequencies (Hz)	Cut Off Frequency (Hz)
1	Plant Protection System	Cabinets	8.5 to 33	4.5
1a	Nuclear Instrument	Chassis	26 to 33	4
2	Auxiliary Protective Cabinet			
2a	CPC Mass Storage Unit	Chassis	26	6-7
2b	CPC Central Processing Unit	Chassis	30 to 40	8
2c	CPC MACS	Chassis	26 to 38	8
2d	CPC Power Supply	Chassis	25 to 40	8
2e	CEA Position Isolation Assy.	Chassis	Higher than 40	2.5
2f	RCP SSSS Signal Processor	Chassis	35	12
2g	In Core Amplifier	Panel	No Report	
3	Reactor Trip Switchgear	Cabinet	12 to 30	4
4	ESFAS Aux. Relay Cabinets	---	9.5 to 39	4
5	Process Instrumentation Rack	Cabinet	10 to 35	Only at resonance
5m	Temperature Transmitter	Module	Higher than 35	2Hz
6	Vital Bus Power Supply	Cabinet	12.5 to 20	Between 3 & 9 Hz
7	CPC Operators Console	Module	10 to 35 Hz	Test only at Nat. Freq.
8	PPS Remote Control Module	Drawer	Not Known	2Hz
10	Controller, Indicating	Module	Not Known	No Test Data
12-1	Temperature Sensor	Narrow RTD	20, 25, 33, 44	Continuous Sine at Resonance Only
12-2	Temperature Sensor	Narrow RTD	20, 25, 33, 44	Continuous Sine at Resonance Only
15-1	RCP SSSS Pulse Transmitter	Module	30	12Hz
15-2	Prox. Probe & Connector	2 oz. Probe	Not Measured	12Hz
16	Nuclear Instrument Detector	155# Cylinder	6 to 33	4Hz
17	Nuclear Instrument Preamp.	Module	14 to 33	4Hz
18	CEDM Reed Switch Position Transmitter	15# Tube	Higher than 33 Hz	15 Hz Vert.
21	Containment Purge Isolation Detector	10# Module	No Report	No Report
22	Containment Purge Isolation Transmitter	20# Unit	No Report	No Report
25	Charging Pump	8400#	Higher than 35 Hz	Tests Only at 2.5, 10, 20 & 30

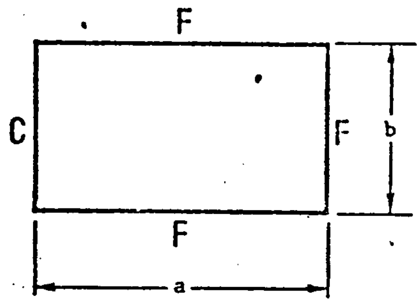
ATTACHMENT C

Table 11-4. Rectangular Plates. *(Continued)*

Natural Frequency (hertz), $f_{ij} = \frac{\lambda_{ij}^2}{2\pi a^2}\left[\frac{Eh^3}{12\gamma(1-\nu^2)}\right]^{1/2}$; i=1,2,3...; j=1,2,3...

Description	λ_{ij}^2 and (ij)

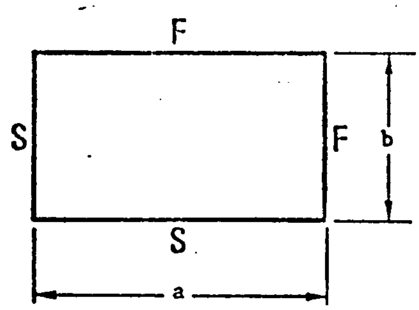
3. Clamped-Free-Free-Free



a/b	Mode Sequence 1	2	3	4	5	6
0.40	3.511 (11)	4.786 (12)	8.115 (13)	13.88 (14)	21.64 (21)	23.73 (22)
2/3	3.502 (11)	6.406 (12)	14.54 (13)	22.04 (21)	26.07 (22)	31.62 (14)
1.0	3.492 (11)	8.525 (12)	21.43 (21)	27.33 (13)	31.11 (22)	54.44 (23)
1.5	3.477 (11)	11.68 (12)	21.62 (21)	39.49 (22)	53.88 (13)	61.99 (31)
2.5	3.456 (11)	17.99 (12)	21.56 (21)	57.46 (22)	60.58 (31)	106.5 (32)

$\nu = 0.3$

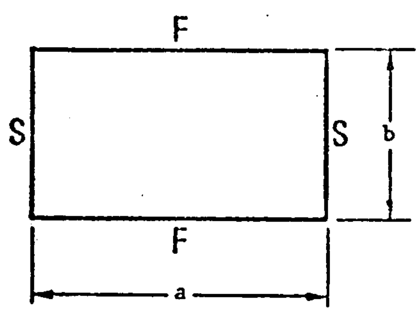
4. Simply Supported-Free-Free-Simply Supported



a/b	Mode Shape 1	2	3	4	5	6
0.4	1.320 (11)	4.743 (12)	10.36 (13)	15.87 (21)	18.93 (14)	20.17 (22)
2/3	2.234 (11)	9.575 (12)	16.76 (21)	24.66 (13)	27.06 (22)	44.17 (23)
1.0	3.369 (11)	17.41 (12)	19.37 (21)	38.29 (22)	51.32 (13)	53.74 (31)
1.5	5.026 (11)	21.54 (21)	37.72 (12)	55.49 (31)	60.88 (22)	99.39 (32)
2.5	8.251 (11)	29.65 (21)	64.76 (31)	99.21 (12)	118.3 (41)	126.1 (22)

$\nu = 0.3$

5. Simply Supported-Free-Simply Supported-Free



a/b	Mode Sequence 1	2	3	4	5	6
0.4	9.760 (11)	11.04 (12)	15.06 (13)	21.71 (14)	31.18 (15)	39.24 (21)
2/3	9.698 (11)	12.98 (12)	22.95 (13)	39.11 (21)	40.36 (14)	42.69 (22)
1.0	9.631 (11)	16.14 (12)	36.73 (13)	38.95 (21)	46.74 (22)	70.74 (23)
1.5	9.558 (11)	21.62 (12)	38.72 (21)	54.84 (22)	65.79 (13)	87.63 (31)
2.5	9.484 (11)	33.62 (12)	38.36 (21)	75.20 (22)	86.97 (31)	130.4 (32)

$\nu = 0.3$

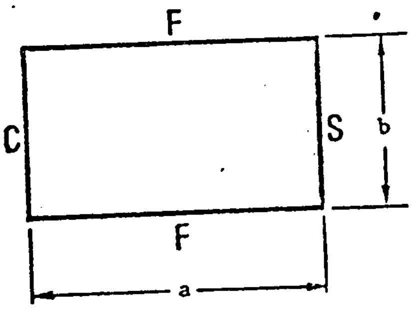
POOR ORIGINAL

Table 11-4. Rectangular Plates. *(Continued)*

Natural Frequency (hertz), $f_{ij} = \frac{\lambda_{ij}^2}{2\pi a^2}\left[\frac{Eh^3}{12\gamma(1-\nu^2)}\right]^{1/2}$; i=1,2,3...; j=1,2,3...

Description	λ_{ij}^2 and (ij)

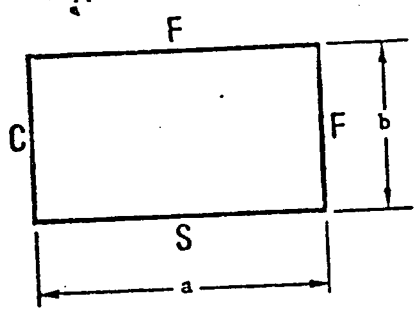
6. Clamped-Free - Simply Supported-Free



a/b	Mode Sequence 1	2	3	4	5	6
0.4	15.38 (11)	16.37 (12)	19.66 (13)	25.55 (14)	34.51 (15)	46.44 (16)
2/3	15.34 (11)	17.95 (12)	26.73 (13)	43.19 (14)	49.84 (21)	53.01 (22)
1.0	15.29 (11)	20.67 (12)	39.78 (13)	49.73 (21)	56.62 (22)	77.37 (14)
1.5	15.22 (11)	25.71 (12)	49.55 (21)	64.01 (22)	68.13 (13)	103.7 (31)
2.5	15.13 (11)	37.29 (12)	49.23 (21)	83.33 (22)	103.1 (31)	143.7 (32)

$\nu = 0.3$

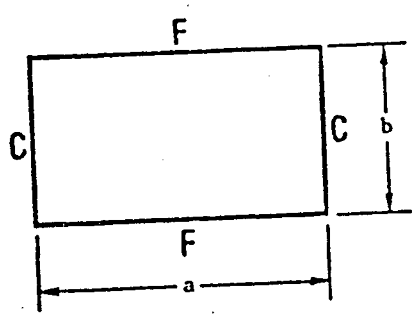
7. Clamped-Free - Free-Simply Supported



a/b	Mode Sequence 1	2	3	4	5	6
0.4	3.854 (11)	6.420 (12)	11.58 (13)	19.77 (14)	22.52 (21)	26.02 (22)
2/3	4.425 (11)	10.91 (12)	22.96 (21)	25.70 (13)	32.43 (22)	48.47 (23)
1.0	5.364 (11)	19.17 (12)	24.77 (21)	43.19 (22)	53.00 (13)	64.05 (31)
1.5	6.931 (11)	27.29 (21)	38.59 (12)	64.25 (22)	67.47 (31)	108.0 (32)
2.5	10.10 (11)	35.16 (21)	74.99 (31)	99.93 (12)	127.7 (22)	135.5 (41)

$\nu = 0.3$

8. Clamped-Free - Clamped-Free



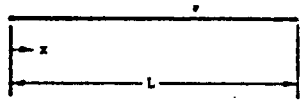
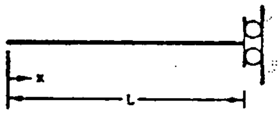
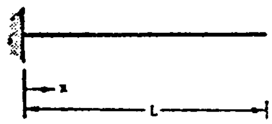
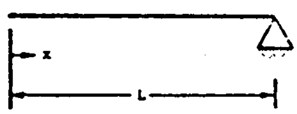
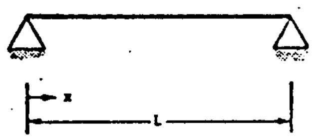
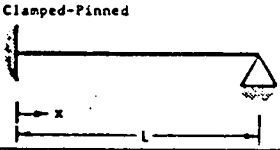
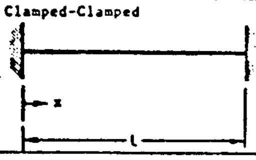
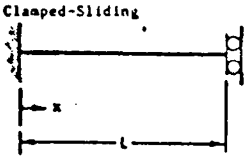
a/b	Mode Sequence 1	2	3	4	5	6
0.4	22.35 (11)	23.09 (12)	25.67 (13)	30.63 (14)	38.69 (15)	49.86 (16)
2/3	22.31 (11)	24.31 (12)	31.70 (13)	46.82 (14)	61.57 (21)	64.34 (22)
1.0	22.27 (11)	26.53 (12)	43.66 (13)	61.47 (21)	67.55 (22)	79.90 (14)
1.5	22.21 (11)	30.90 (12)	61.30 (21)	70.96 (13)	74.26 (22)	118.3 (23)
2.5	22.13 (11)	41.69 (12)	61.00 (21)	92.38 (22)	119.9 (31)	157.8 (32)

$\nu = 0.3$

Table 8-1. Single-Span Beams.

Notation: x = distance along span of beam; m = mass per unit length of beam; E = modulus of elasticity; I = area moment of inertia of beam about neutral axis (Table 5-1); L = span of beam; see Table 3-1 for consistent sets of units

Natural Frequency (hertz); $f_i = \frac{\lambda_i^2}{2\pi L^2}\left(\frac{EI}{m}\right)^{1/2}$; i=1,2,3...

Description[a]	λ_i; i=1,2,3...	Mode Shape, $\tilde{y}_i\left(\frac{x}{L}\right)$	σ_i; i=1,2,3...
1. Free-Free 	4.73004074 7.85320462 10.9956078 14.1371655 17.2787597 $(2i+1)\frac{\pi}{2}$; i>5	$\cosh\frac{\lambda_i x}{L} + \cos\frac{\lambda_i x}{L} - \sigma_i\left(\sinh\frac{\lambda_i x}{L} + \sin\frac{\lambda_i x}{L}\right)$	0.982502215 1.000777312 0.999966450 1.000001450 0.999999937 ≈1.0 for i>5 See Ref. 8-2
2. Free-Sliding 	2.36502037 5.49780392 8.63937983 11.78097245 14.92256510 $(4i-1)\frac{\pi}{4}$; i>5	$\cosh\frac{\lambda_i x}{L} + \cos\frac{\lambda_i x}{L} - \sigma_i\left(\sinh\frac{\lambda_i x}{L} + \sin\frac{\lambda_i x}{L}\right)$	0.982502207 0.999966450 0.999999933 0.999999993 0.999999993 1.0; i>5
3. Clamped-Free 	1.87510407 4.69409113 7.85475744 10.99554073 14.13716839 $(2i-1)\frac{\pi}{2}$; i>5	$\cosh\frac{\lambda_i x}{L} - \cos\frac{\lambda_i x}{L} - \sigma_i\left(\sinh\frac{\lambda_i x}{L} - \sin\frac{\lambda_i x}{L}\right)$	0.734095514 1.018467319 0.999224497 1.000033553 0.999998550 ≈1.0; i>5 See Ref. 8-2
4. Free-Pinned 	3.92660231 7.06858275 10.21017612 13.35176878 16.49336143 $(4i+1)\frac{\pi}{4}$; i>5	$\cosh\frac{\lambda_i x}{L} + \cos\frac{\lambda_i x}{L} - \sigma_i\left(\sinh\frac{\lambda_i x}{L} + \sin\frac{\lambda_i x}{L}\right)$	1.000777304 1.000001445 1.000000000 1.000000000 1.000000000 1.0; i>5
5. Pinned-Pinned 	$i\pi$	$\sin\frac{i\pi x}{L}$	--
6. Clamped-Pinned 	3.92660231 7.06858275 10.21017612 13.35176878 16.49336143 $(4i+1)\frac{\pi}{4}$; i>5	$\cosh\frac{\lambda_i x}{L} - \cos\frac{\lambda_i x}{L} - \sigma_i\left(\sinh\frac{\lambda_i x}{L} - \sin\frac{\lambda_i x}{L}\right)$	1.000777304 1.000001445 1.000000000 1.000000000 1.000000000 1.0; i>5
7. Clamped-Clamped 	4.73004074 7.85320462 10.9956079 14.1371655 17.2787597 $(2i+1)\frac{\pi}{2}$; i>5	$\cosh\frac{\lambda_i x}{L} - \cos\frac{\lambda_i x}{L} - \sigma_i\left(\sinh\frac{\lambda_i x}{L} - \sin\frac{\lambda_i x}{L}\right)$	0.982502215 1.000777312 0.999966450 1.000001450 0.999999937 1.0; i>5 See Ref. 8-2
8. Clamped-Sliding 	2.36502037 5.49780392 8.63937983 11.78097245 14.92256510 $(4i-1)\frac{\pi}{4}$; i>5	$\cosh\frac{\lambda_i x}{L} - \cos\frac{\lambda_i x}{L} - \sigma_i\left(\sinh\frac{\lambda_i x}{L} - \sin\frac{\lambda_i x}{L}\right)$	0.982502207 0.999966450 0.999999933 0.999999993 0.999999993 1.0; i>5

The centroid of the T section is at

$$\bar{Z} = \frac{\sum AEZ}{\sum AE} = \frac{0.1244 \times 10^6}{0.875 \times 10^6} = 0.142 \text{ in.}$$

The bending stiffness of the T section is

$$\sum EI = EI_0 + AEc^2 = 5.450 \times 10^3 + 10.68 \times 10^3$$

$$\sum EI = 16.13 \times 10^3 \text{ lb in.}^2 \tag{6.89}$$

The bending stiffness of the circuit board along the X axis, with the ribs, is

$$D_X = \frac{EI}{d} \tag{6.90}$$

where $EI = 16.13 \times 10^3$ lb in.² (see Eq. 6.89)

$d = \frac{b}{2} = 3.5$ in. (see Fig. 6.26)

Substituting into the above equation

$$D_X = \frac{16.13 \times 10^3}{3.5} = 4610 \text{ lb in.} \tag{6.91}$$

The bending stiffness along the Y axis will be approximately the same as the epoxy board:

$$D_Y = \frac{Eh^3}{12(1-\mu^2)} \tag{6.92}$$

where $E = 2 \times 10^6$ lb/in.² G-10 epoxy fiberglass

$h = 0.062$ in. circuit board thickness

$\mu = 0.12$ Poisson's ratio

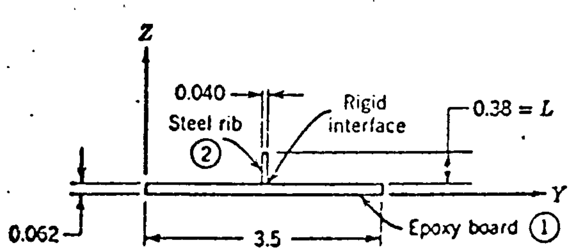


FIGURE 6.27. Dimensions for a rib section soldered to a circuit board.

Substituting into the above equation:

$$D_Y = \frac{(2 \times 10^6)(0.062)^3}{12[1-(0.12)^2]} = 40.2 \text{ lb in.} \tag{6.93}$$

The torsional stiffness can be determined by considering a unit board width along with one rib (Fig. 6.27). The subscripts e and r refer to the epoxy board and to the rib, respectively.

$$D_{XY} = G_e J_e + \frac{G_r J_r}{2d} \tag{6.94}$$

where $G_e = 0.90 \times 10^6$ lb/in.^{2} shear modulus, epoxy fiberglass

$J_e = \frac{1}{3} h^3$ unit torsional stiffness, epoxy fiberglass

$J_e = \frac{1}{3}(0.062)^3 = 79.3 \times 10^{-6}$ in.^{3}

$G_r = 12 \times 10^6$ lb/in.^{2} shear modulus, steel rib

$J_r = \frac{1}{3} Lt^3$ torsional stiffness, steel rib

$J_r = \frac{1}{3}(0.38)(0.040)^3 = 8.10 \times 10^{-6}$ in.^{4}

$d = \frac{b}{2} = 3.5$ in. rib spacing (see Fig. 6.26)

Substituting into the above equation

$$D_{XY} = (0.90 \times 10^6)(79.3 \times 10^{-6}) + \frac{(12 \times 10^6)(8.10 \times 10^{-6})}{2(3.5)}$$

$$D_{XY} = 85.3 \text{ lb in.} \tag{6.95}$$

With the addition of the two steel ribs, the circuit-board weight will increase to about 1.06 lb. The mass per unit area will then be:

$$\rho = \frac{\text{mass}}{\text{area}} = \frac{W}{gab} = \frac{1.06}{(386)(8.0)(7.0)}$$

$$\rho = 0.490 \times 10^{-4} \text{ lb sec}^2/\text{in.}^3 \tag{6.96}$$

The natural frequency of the circuit board with the two ribs can be determined by substituting Eqs. 6.91, 6.93, 6.95, and 6.96 into Eq. 6.88.

$$f_n = \frac{\pi}{2}\left\{\frac{1}{0.490 \times 10^{-4}}\left[\frac{4610}{(8.0)^4} + \frac{4(85.3)}{(8.0)^2(7.0)^2} + \frac{40.2}{(7.0)^4}\right]\right\}^{1/2}$$

$$f_n = 251 \text{ Hz} \tag{6.97}$$

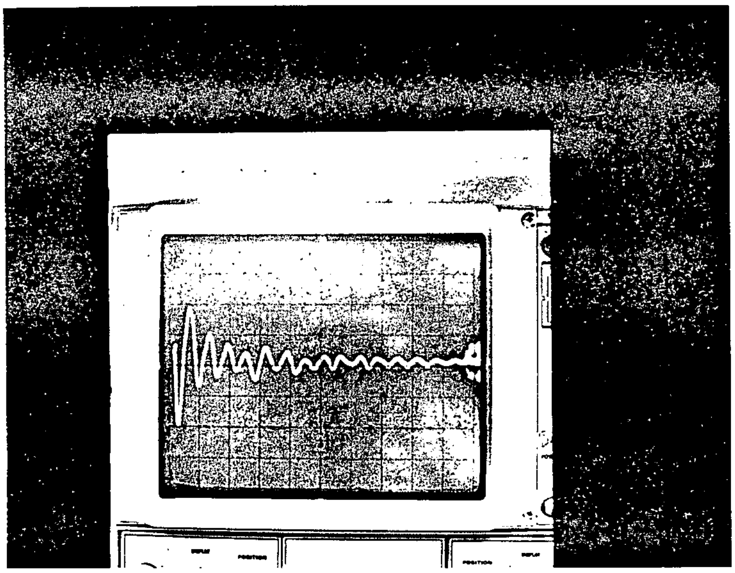
It would appear from Eq. 6.97 that the natural frequency of the circuit board with two ribs will be about 251 Hz. However, since the center section of the circuit board, between the ribs, is only 0.062 in. thick, as shown in Fig. 6.26, it may be possible for this section to develop a resonance

ATTACHMENT D

PHOTOGRAPHS - RESULTS OF INSITU TESTING

CPC CPU (NSSS 2b)

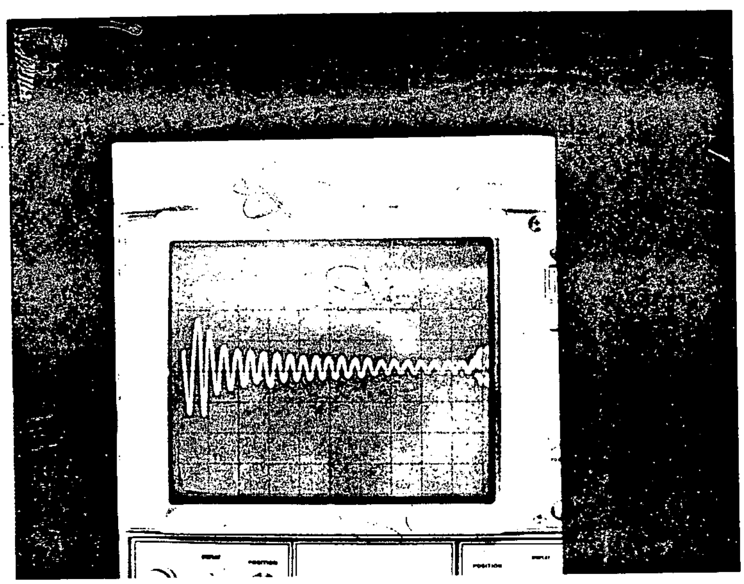
CPC MACS (NSSS 2c)



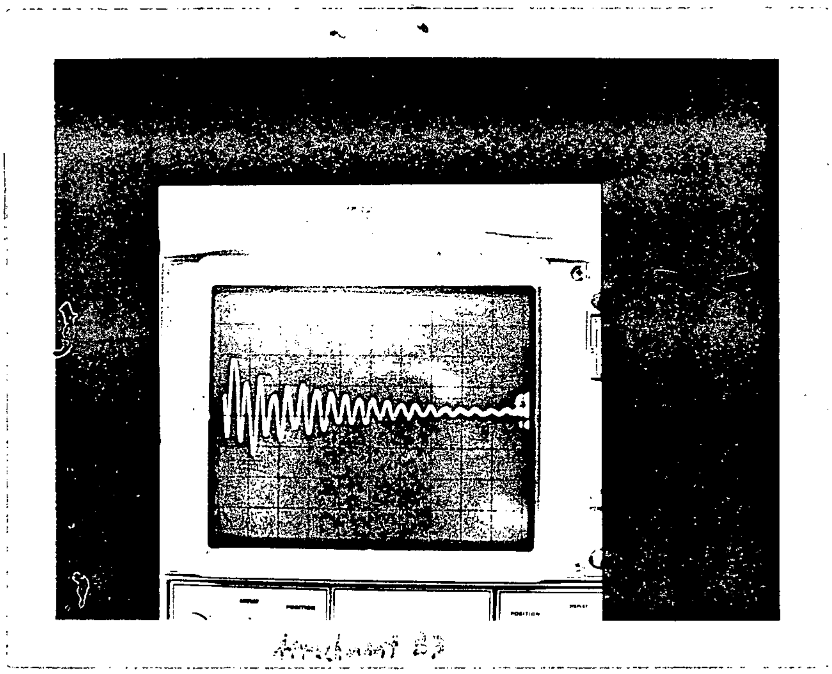
CIRCUIT BOARD NUMBER 1

CPU

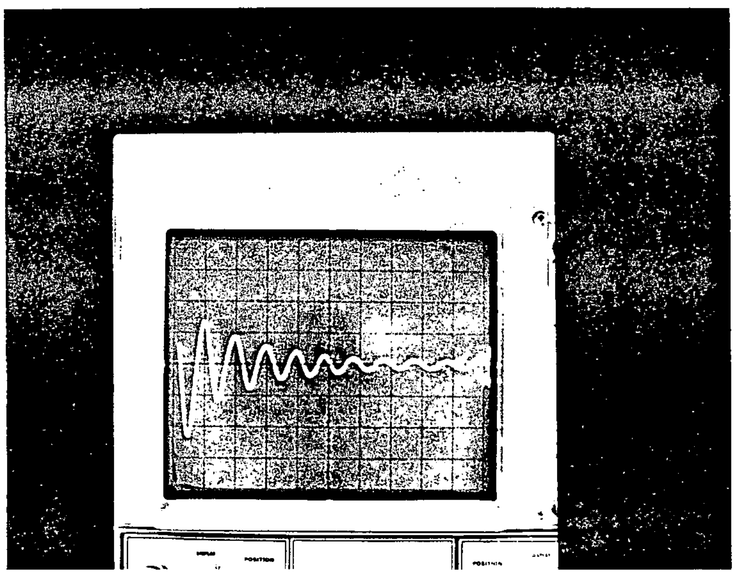
1 DIVISION=50 MILLISECONDS



CIRCUIT BOARD NUMBER 2
CPU
1 DIVISION=50 MILLISECONDS



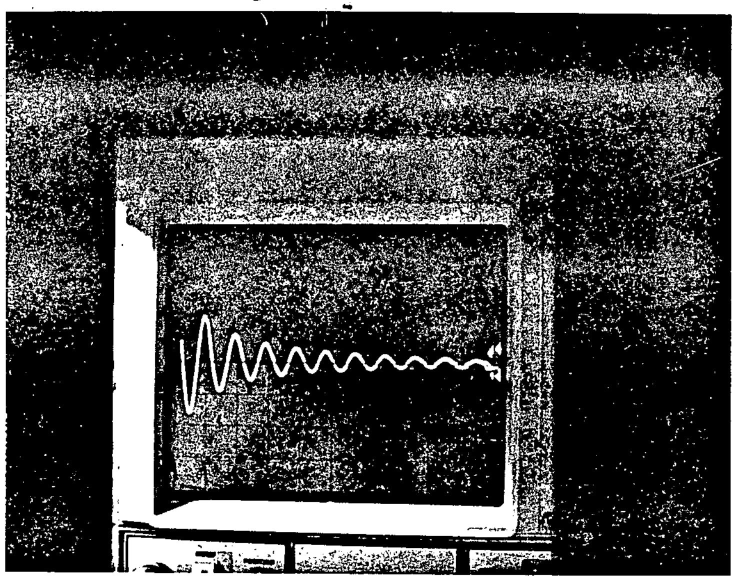
CIRCUIT BOARD NUMBER 3
CPU
1 DIVISION=50 MILLISECONDS



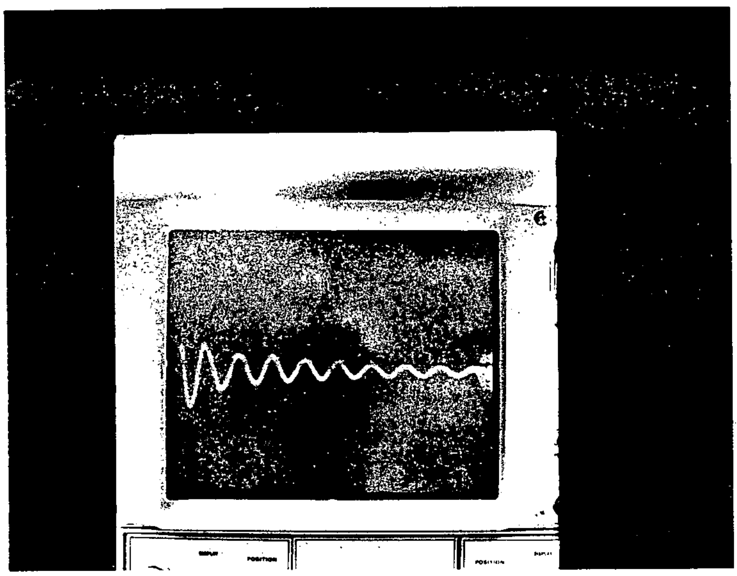
CIRCUIT BOARD NUMBER 1

CPC MACS CHASSIS

1 DIVISION=50 MILLISECONDS



CIRCUIT BOARD NUMBER 2
CPC MACS CHASSIS
1 DIVISION=50 MILLISECONDS



CIRCUIT BOARD NUMBER 3

CPC MACS CHASSIS

1 DIVISION=50 MILLISECONDS

2. Provide justification for equipment qualification which used a single frequency TRS to envelope a multifrequency RRS (e.g., NSSS 2, Auxiliary Protective cabinet).

Response

It was interpreted that this concern was applicable to the equipment qualification tests for NSSS items 2a, 2b, 2c, 2d and 2f located in the Auxiliary Protective cabinet. Justification for the adequacy of NSSS 2a on the basis of it not being safety related is presented in the response to item 1 of the SORT Audit General Concerns.

As part of the qualification testing, this equipment was subjected to seven series of full level biaxial (horizontal and vertical) sine beat tests for each of the two horizontal directions. All natural frequencies for this equipment were determined from the tests to be greater than 25 Hz.

The justification for the acceptability of the qualification tests for this equipment is based on the following two reasons:

1. Although sine beat test excitation is theoretically single frequency excitation, the actual applied excitation for these tests contained multifrequency components which enveloped the RRS as a result of test table and fixture noise. This is shown in the actual TRS plots.

2. The RRS for this equipment contains multi-frequency components which were artificially and over-conservatively introduced by the tests for the Auxiliary Protective Cabinet. These RRS were derived from random multi-frequency tests of the Auxiliary Protective Cabinet presented in Wyle Laboratories Test Report 43482-1 dated April 18, 1977. Comparison of the RRS and actual TRS for the control accelerometers from their tests shows the introduction of amplified response in the higher frequency range above 20 Hz. This amplified response introduced by the test equipment is considered to be artificial and over conservative. The floor response spectra which is the RRS for the Auxiliary Protective Cabinet contains very little amplified response above 10 Hz.

3. Provide justification for the adequacy of sine sweep testing as a qualification method for those items listed in sheets 6 and 7 of Table 3.10B-1 of the FSAR.

Response:

The issue addressed by this concern arises from some confusion as to the specific technique used in the seismic qualification of the components in question. Fisher valves were typically qualified by analysis using an equivalent static technique since the natural frequency of the valve assemblies exceed 33 Hz. A confirmatory frequency check was performed to substantiate the system natural frequencies for selected, representative models. This frequency verification test utilized the single axis sine sweep technique. Operators or operator components (Limitorque, ACSO solenoid valves and Namco Limit Switches) were qualified independently by the subtier suppliers by test to meet the seismic environment compatible with the rigid characteristics of the valve assemblies. These operators or operator components were also shown to be rigid and were qualified by the single axis sine dwell technique. Some Fisher valves were qualified by test utilizing either a single axis single dwell technique (valve natural frequencies shown to exceed 33 Hz) or a random multi-frequency biaxial test procedure. The attached pages are a proposed revision to the applicable entries in Table 3.10B-1 of the SAR to clarify this issue.

NON-NSSS SEISMIC CATEGORY I ELECTRICAL AND INSTRUMENTATION EQUIPMENT QUALIFICATION

Equipment	Manufacturer (Model No.)	Location[a]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[b] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[c] Verified by	Summary of Results/Comments
Pneumatic Control Valves (includes solenoid operator); Electro Hydraulic Valves	Fisher (ASCO NP 8320, NP 8321 Western Hydraulic 7-4058 operators)	Process Piping	Process System Isolation and Control	1975	Analysis and Test				Test	Fisher Reports FQP-2A-1 thru 7, 9, 12, 13, 15, 16, 17 & 19 verify by analysis that equipment is qualified for intended SONGS 2&3 use.
				1975	Test	1-33 Hz	Sine Dwell	Single	Test	ASCO Report ASQ 21678/TR verifies by test that operator control valve is qualified for intended SONGS 2&3 use.
				1975	Test	1-35 Hz	Sine Dwell	Single	Test	Namco Report EA-180 verifies by test that operator limit switch is qualified for intended SONGS 2&3 use.
				1975	Test		Sine Dwell	Single	Test	Fisher Reports FQP-2A-18 & 20 verify by test that equipment is qualified for intended SONGS 2&3 use. Operator controls listed above are also applicable for these valves.
				1975	Test	1-60 Hz	Random	Biaxial	Test	Fisher Reports FQP-2A-8, 10, 11, 12 & 14 verify by test that equipment is qualified for intended SONGS 2&3 use.
Butterfly Valves (Motor Operated)	Fisher (Limitorque SMB-000 SMB-00 SMB-0)	Process Piping	Process System Isolation and Control	1975	Anlaysis and Test	5-50 Hz	Sine Sweep	Single	Test	Fisher Reports CD75-157, 158, 220, 221, 222, 223 & CD76-16 verify by analysis that equipment is qualified for intended SONGS 2&3 use. Fisher Report 250-439 substantiates modeling techniques for establishing system natural frequencies.

NON-NSSS SEISMIC CATEGORY I ELECTRICAL [illegible] INSTRUMENTATION EQUIPMENT QUALIFICATION

Equipment	Manufacturer (Model No.)	Location[a]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[b] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[c] Verified by	Summary of Results/Comments
				1975	Test	5 to 33 Hz	Sine Dwell	Single	Test	Limitorque Report B0003 verifies by test that the operator is qualified for intended SONGS 2&3 use.
Butterfly Valves (Pneumatic Operated)	Fisher (ASCO NP 8344 NP 8320 NAMCO EA-180)	Process Piping	Process System Isolation and Control	1975	Analysis and Test	5-50 Hz	Sine Sweep	Single	Test	Fisher Reports CD75-156, 157, 158, 161, 220 & 223 verify by analysis that equipment is qualified for intended SONGS 2&3 use. Fisher Report 210-437 substantiates modeling technique for establishing system natural frequencies.
				1975	Test	1 to 33 Hz	Sine Dwell	Single	Test	ASCO Report AQS 21678/TR verifies by test that operator control valve is qualified for intended SONGS 2&3 use.
				1975	Test	1 to 35 Hz	Sine Dwell	Single	Test	Namco Report EA-180 verifies by test that operator limit switch is qualified for intended SONGS 2&3 use.

4. Provide the complete list of mechanical equipment according to the SQRT procedures. Identify all equipment (both mechanical and electrical) for which the seismic qualification program has not been completed and provide the schedule for completion.

Response

The attached table provides a summary of the seismic qualification of all BOP Seismic Category I mechanical equipment.

The only equipment for which the seismic qualification test program has not been completed is the Exide Model GN 125V dc Station Batteries. The forecast completion for this program is July 27, 1981. Exide Model G batteries are currently installed in the plant but only have a qualified life of 3.9 years. The Model G batteries will be replaced by the Model GN batteries once the current qualification program has been successfully completed.

Equipment	Manufacturer (Model No.)	Location[a]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[b] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[c] Verified by	Summary of Results/Comments
Waste Gas Compressor	Pressure Products Incorporated (Model -180128)	Radwaste Building El 63'-6"	Transfer and compress waste gas from the waste gas surge tank to the waste gas decay tank	1971	Analysis ⟶				N/A	Pressure products stress calculation for Model 3-180128 (Bechtel Log S023-403-4-14) documents that the equipment is qualified for intended SONGS 2&3 use.
Component Cooling Water Heat Exchangers	Struthers Wells, TEMA Type AEL, Class R	Safety Equipment Building El 8'-0" (CCW HX Rooms)	Single pass counter flow heat exchanger; transfer component cooling water the salt water cooling system	1971	Analysis ⟶				N/A	Struthers Wells component cooling water heat exchanger seismic analysis (Bechtel Log S023-404-4-79) documents that the equipment is qualified for intended SONGS 2&3 use.
Spent Fuel Pool Heat Exchangers	Struthers Wells, TEMA Type AEL, Class R	Fuel Handling Building El 30'	Single pass, counter flow heat exchanger; transfers spent fuel pool heat to the component cooling water system	1971	Analysis ⟶				N/A	Struthers Wells spent fuel pool heat exchanger seismic analysis (Bechtel Log S023-404-4-78) documents that the equipment is qualified for intended SONGS 2&3 use.

Equipment	Manufacturer (Model No.)	Location[a]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[b] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[c] Verified by	Summary of Results/Comments
Salt Water Cooling Pumps	Byron Jackson (33WX)	Intake Structure El 9'-0"	Pump seawater through the tube side of component cooling water heat exchanger to transfer heat to the ultimate heat sink	1971	Analysis →					Byron Jackson seismic analysis (Bechtel Log S023-405-3A-7) of the salt water cooling pumps documents that the equipment is qualified for intended SONGS 2&3 use.
Auxiliary Feedwater Pumps	Byron Jackson (8-stage DVMX 4X6X9D)	Storage Tank Area El 28'-0"	Provide feedwater to the steam generator during emergency conditions and hot standby	1971	Analysis →					Byron Jackson Report No. DC-1102 (Bechtel Log S023-405-6-41) documents that the equipment is qualified for intended SONGS 2&3 use.
Auxiliary Feedwater Pump Turbine	Terry Turbine (GS-2N, F-40101)	Storage Tank Area El 28'-0"	Auxiliary feedwater pump driver	1975	Analysis and Test (Both)	1-35 Hz	Random Multi. Freq. & Sine Beats	Biaxial	Test	Terry Report G-S-2 (Bechtel Log S023-405-6-7) documents that equipment is qualified for intended SONGS 2&3 use.
Component Cooling Water Pumps	Goulds (Model 3415 18X20-22H)	Safety equipment Building El (-) 5'-3"	Circulate treated condensate through radioactive and potentially radioactive plant components in a closed pressurized cooling water system	1971	Analysis →					Goulds seismic - stress analysis ME-302 (Bechtel Log S023-405-9-53) documents that the equipment is qualified for intended SONGS 2&3 use.

Equipment	Manufacturer (Model No.)	Location[a]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[b] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[c] Verified by	Summary of Results/Comments
Condensate Storage Tank	Brown Minn. Tank	Tank Building El 30'-0"	Store condensate for the auxiliary feedwater system	N/A	Analysis →	→	→	→	N/A	BMT Design Report for the 150,000 gallon condensate storage tank (Bechtel Log No. S023-407-13-117) documents that equipment is qualified for intended SONGS 2&3 use.
Spent Fuel Pool Cooling Pumps	Goulds (3405M Size 8X10-12)	Fuel Handling Building El 17'-6"	Circulate treated condensate from the spent fuel pool to heat exchanger and back to the spent fuel pool	1971	Analysis →	→	→	→	→	Goulds seismic - stress analysis ME-301 (Bechtel Log S023-405-9-52) documents that equipment is qualified for intended SONGS 2&3 use.
Component Cooling Water Surge Tanks	Process Equipm[illegible]	[illegible]afety [illegible]uip- [illegible]lding [illegible] 8'-0"	Acts as a head tank for the component cooling water system	1971	Analysis →	→	→	→	N/A	Process Equipment Report No. ACR-SA-53 (Bechtel Log S023-407-4-24) documents that equipment is qualified for intended SONGS 2&3 use.
Refueling Water Storage Tanks	Brown Minn. Tank	Tank Building El 30'-0"	Stores borated water for refueling and emergency operations	N/A	Analysis →	→	→	→	N/A	BMT Design Report for the 245,000 gallon refueling water storage tanks (Bechtel Log No. S023-407-13-110) documents that equipment is qualified for intended SONGS 2&3 use.

Equipment	Manufacturer (Model No.)	Location[a]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[b] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[c] Verified by	Summary of Results/Comments
Charging Pump Accumulators Discharge	Greer Hydraulics	Radwaste Building 30'-0"	Modulate pressure pulse in discharge of charging pumps to reduce to allowable amplitude	N/A	Analysis →	→	→	→	N/A	Anamet Lab. Report No. 676.121 (Bechtel Log S023-407-14-22) verifies that this component complies with seismic requirements of SONGS 2&3.
Charging Pump Accumulators	Greer Hydraulics	Radwaste Building El 30'-0"	Modulate pressure pulses in suction of charging pumps to ensure adequate NPSH & prevent cavitation	N/A	Analysis →	→	→	→	N/A	Anamet Lab. Report No. 776.201 (Bechtel Log S023-407-14-23) verifies that this component complies with siesmic requirements of SONGS 2&3.
Salt Water Cyclone Separators	Byron Jackson	Intake Structure El 9'-0"	Filter seawater as a backup lubrication source for the salt water cooling pumps	1971	Analysis →	→	→	→	N/A	Byron Jackson seismic analysis (Bechtel Log S023-405-34-7) of salt water cooling pumps documents that the equipment is qualified for intended SONGS 2&3 use.
Diesel Fuel Oil Storage Tanks	Process Equipment	Yard	Store fuel for the emergency diesel generators	1971	Analysis →	→	→	→	N/A	Process Equipment Report No. ARE-SA-105 (Bechtel Log S023-407-7-9) documents that the equipment is qualified for intended SONGS 2&3 use.

Equipment	Manufacturer (Model No.)	Location[a]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[b] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[c] Verified by	Summary of Results/Comments
Waste Gas Surge Tank	Process Equipment	Radwaste Building El 63'-6"	Collects radioactive waste gas for processing	1971	Analysis →				N/A	Process Equipment Report No. AER-SA-55 (Bechtel Log S023-407-4-26) documents that the equipment is qualified for
Waste Gas Decay Tanks	Process Equipment	Radwaste Building El 63'-6"	Store radioactive waste gas	1971	Analysis →				N/A	Process Equipment Report No. AER-SA-54 (Bechtel Log S023-407-4-25) documents that the equipment is qualified for intended SONGS 2&3 use.
Diesel Fuel Oil Transfer Pumps	Goulds VPD	Yard	Transfer fuel oil from diesel fuel oil storage tank to fuel oil day tank	1971	Analysis →					McDonald Engineering Analysis Company Report ME275 (Bechtel Log No. S023-405-12-26-1) documents that equipment is qualified for intended SONGS 2&3 use.
Diesel Generator Exhaust Silencer	Stewart & Stevenson	Diesel Generator Building El 48'-9"	Reduce engine exhaust noise	1975	Analysis →				N/A	Stewart and Stevenson Seismic analysis and stress calculation (Bechtel Log No. S023-403-12-272 and 273) documents that the exhaust silencer qualified for SONGS 2&3 use.

Equipment	Manufacturer (Model No.)	Location[(a)]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[(b)] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[(c)] Verified by	Summary of Results/Comments
Diesel Generator Assembly	Stewart & Stevenson General Motors - Electro-Motive Division Ideal ([illegible]), 16, 20-645E4, SAB)	Diesel Generator Building El 30'-6"	Provide standby electric power for SONGS 2&3	1975	Gen. by Analysis →				N/A	S&S Generator Seismic Qualification Report Vol. B (Bechtel Log S023-403-12-218) documents that the equipment is qualified for SONGS 2&3 use.
					Diesels by Test & Analysis	0-100Hz	Explosion	Multi-Axis	Navy High Shock Test	Diesel Seismic Qualification Report (Bechtel Log S023-403-12-134) documents that the equipment is qualified for Songs 2&3 use.
Diesel Fuel Priming Pump	General Motors - Electro-Motive-Division	Diesel Generator Building El 30'-6"	Provide fuel to diesel engines during starting	1975	By Test	1-35 Hz	Random Multi. Freq.	Biaxial	Visual inspection, meggered, and energized and run	S&S Seismic Qualification Report (Bechtel Log S023-403-12-271) documents that the equipment is qualified for SONGS 2&3 use.
Diesel Soak Back Pump	General Motors - Electro-Division	Diesel Generator Building El 30'-6"	Provide lubrication and cooling to turbo charger	1975	By Test	1-35 Hz	Random Multi. Freq.	Biaxial	Same as above	Same as Priming Pump
Diesel Circulating Pump	General Motors - Electro-Motive Division	Diesel Generator Building El 30'-6"	Circulates lube oil through the lube oil cooler and filter	1975	By Test	1-35 Hz	Random Multi. Freq.	Biaxial	Same as above	Same as Priming Pump

Equipment	Manufacturer (Model No.)	Location[a]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[b] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[c] Verified by	Summary of Results/Comments
Diesel Generator Cooling Water Expansion Tank	Stewart & Stevenson	Diesel Generator Building El 48'-9"	Keeps cooling water system full	1975	Analysis →				N/A	S&S Seismic Qualification Report (Bechtel Log S023-403-12-216) documents that the equipment is qualified for SONGS 2&3 use.
Diesel Fuel Oil Day Tank	Stewart & Stevenson	Diesel Generator Building El 30'-6"	Temporarily store diesel fuel and supply it directly to the engines	1975	Analysis →				N/A	S&S Seismic Qualification Report (Bechtel Log S023-403-12-216) documents that the equipment is qualified for SONGS 2&3 use.
Diesel Generator Air Start Package	Ingersoll-Rand, (Model 253T) Various	Diesel Generator Building El 30'-6"	Supply starting air for diesel generators	1975	[illegible] →				N/A	Permutit Corp. Technical Report Seismic Analysis No. 13978 (Bechtel Log S023-403-12-257) documents that equipment is qualified for SONGS 2&3 use. S&S Seismic Qualification Report (Bechtel Log S023-403-12-216) documents equipment is qualified for SONGS 2&3 use.
Diesel Generator Fan Cooled Radiator	Hudson Products Corp (11.8-164)	Diesel Generator Building El 48'-9"	Removes heat from diesel engine cooling water	1975	Analysis →				N/A	Stewart and Stevenson Seismic Qualification Report (Bechtel Log S023-403-12-216) documents that equipment is qualified for SONGS 2&3 use.
Diesel Generator Air Intake Silencer	FARR (DH-31 Dry Type) General Motors - Electro-Motive Division	Diesel Generator Building El 48'-9" Diesel Generator Building El 30'-6"	Filters particulates from combustion air Reduce intake air noise	1975	By Test Analysis →				N/A	S&S Seismic Testing Report (Bechtel Log S023-403-12-274) documents that equipment is qualified for SONGS 2&3 use. S&S Seismic Qualification Report (Bechtel Log S023-403-12-216) documents that equipment is qualified for SONGS 2&3 use.

Equipment	Manufacturer (Model No.)	Location[a]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[b] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[c] Verified by	Summary of Results/Comments
Containment Dome Circulating fan	Joy	Containment Dome El.130' -0"	Containment Dome Air circulation	1971	← B Y A	N A L Y S	I S ——	——→	N/A	Calculations prepared by Joy Manufacturing Company documents that the equipment is qualified for intended SONGS 2&3 use. (Bechtel Log No. S023-410-2-22)
Containment Building Emergency AC Units	American Air Filter/ Joy	Containment El. 63' -6"	Containment heat removal during DBA	1971	← B Y A	N A L Y S	I S ——	——→	N/A	AAF Seismic Analysis Report NESE-165 & Joy Seismic Analysis Report S-1 & S-72 (Bechtel Log No.'s S023-410-1-349 and S023-410-1-348) documents that the equipment is qualified for intended SONGS 2&3 use.
Diesel Generator Building Emergency Supply Fan	Joy	Diesel Generator Building El. 30'-0"	Maintains design ambient Temperature	1971	← B Y A	N A L Y S	I S ——	——→	N/A	Joy Manufacturing Co. Seismic Analysis Report S-1 & S-188 (Bechtel Log No.'s S023-410-8-04 and S023-410-8-39) documents that the equipment is qualified for intended SONGS 2&3 use.
Fuel handling Building Post Accident Cleanup Units	American Air Filter/ Joy	Fuel handling building El. 45-0"	Clean-up FH Bldg. Environment in the event of a fuel handling accident	1971	← B Y A	N A L Y S	I S ——	——→	N/A	AAF Seismic analysis report NESE-165 & Joy Seismic analysis Report S-1, S-76 & S-77 (Bechtel Log S023-410-1-3A8) documents that the equipment is qualified for intended SONGS 2&3 use.
Fuel handling Building Pump Room Emergency Cooling Units	Carrier Air Conditioning Corp.	Fuel handling Building El. 17'-6"	Maintains design ambient temperature of the pump room	1971	← B Y A	N A L Y S	I S ——	——→	N/A	NUS Corporation Technical Report No. 1510 & Mason Industries Report No. WF-25285 (Bechtel Log No.'s S023-410-6-249 and S023-410-6-D43) documents that the equipment is qualified for intended SONGS 2&3 use.

Equipment	Manufacturer (Model No.)	Location[(a)]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[(b)] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[(c)] Verified by	Summary of Results/Comments
Intake Structure Normal and Emergency Fans	Joy	Intake Structure El. 9'-0"	Maintains design ambient temperature of the Intake Structure area.	1971	← BY ANALYSIS →				N/A	Joy Manufacturing Co. Seismic Analysis Report S-1 & S-12, (Bechtel Log No.'s S023-410-6-A30 and S023-410-6-A52) documents that the equipment is qualified for intended SONGS 2&3 use.
Battery Rooms Emergency Exhaust Fans	Joy	Auxiliary Building El. 85'-0"	Maintains design ambient temperature and limits hydrogen concentration of the battery rooms.	1971	← BY ANALYSIS →				N/A	Joy Manufacturing Co. Seismic analysis Report S-1 & S-15 (Bechtel Log No.'s S023-410-6-A30 and S023-410-6-A55) documents that the equipment is qualified for intended SONGS 2&3 use.
Control Room Cabinet Emergency AC Units	CVI/JOY	Auxiliary Building El. 50'-0"	Maintain design ambient temperature for the control room Cabinet area.	1971	← BY ANALYSIS →				N/A	CVI seismic qualification Report No. B319-9922 (Bechtel Log S023-410-6-941) documents that the equipment is qualified for intended SONGS 2&3 use.
Chiller Rooms Emergency Supply Fans	Joy	Auxiliary Building El. 9'-0"	Provides ventilation for the chiller rooms.	1971	← BY ANALYSIS →				N/A	Joy Manufacturing Co. Seismic Analysis Report S-1 & S-5 (Bechtel Log No.'s S023-410-6-A30 and S023-410-6-A34) documents that the equipment is qualified for intended SONGS 2&3 use.
Chiller Rooms Emergency Exhaust Fans.	Joy	Auxiliary Building El. 9'-0"	Provides ventilation for the chiller rooms.	1971	← BY ANALYSIS →				N/A	Joy Manufacturing Co. Seismic Analysis Report S-1 & S-6 (Bechtel Log No.'s S023-410-6-A30 and S023-410-6-A35) documents that the equipment is qualified for intended SONGS 2&3 use.

Equipment	Manufacturer (Model No.)	Location[a]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[b] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[c] Verified by	Summary of Results/Comments
Control Room Complex Emergency AC Units.	AAF/JOY	Control area El. 30'-0"	Maintain design ambient temperature and habitability of control room.	1971	← B Y A N A L Y S I S →				N/A	AAF Seismic Analysis Report NESE-165 & Joy Seismic Analysis Report S-1 & S-75 (Bechtel Log S023-410-1-348) documents that the equipment are qualified for for intended SONGS 2&3 use.
Auxiliary Feedwater Pump Room Exhaust Fans	Joy	Auxiliary Feedwater Pump Room El 29'-6"	Maintain design ambient temperature of the auxiliary Feedwater Pump Room	1971	← B Y A N A L Y S I S →				N/A	Joy Manufacturing Co. Seismic Analysis Report S-1 & S-138 (Bechtel Log No.'s S023-410-4-411 and S023-410-4-625) documents that the equipment is qualified for intended SONGS 2&3 use.
Pump Rooms Emergency AC Units	Carrier Air Conditioning Corp.	Safety Equipment Bldg. El (-)5'-6" and El (-)5'-3"	Maintains design ambient temperature of the rooms	1971	← B Y A N A L Y S I S →				N/A	NUS Corp. Technical Report No.'s 1508, 1510, 1511, & Mason Industries Report No. WF-2586, WF-2587 & WF-2588 (Bechtel Log No.'s S023-410-6-247, S023-410-6-248 and S023-410-6-249) documents that the equipment is qualified for intended SONGS 2&3 use.
Changing Pump Room Emergency AC Units	Carrier Air Conditioning Corp.	Auxiliary Bldg. El 9'-0"	Maintains design ambient temperature of the room	1971	← B Y A N A L Y S I S →				N/A	NUS Corp. Technical Report No. 1510 and Mason Industries Report No. WF-25285 (Bechtel Log No.'s S023-410-6-249 and S023-410-6-D43) documents that the equipment is qualified for intended SONGS 2&3 use.
Boric Acid Makeup Pump Room Emergency AC Units	Carrier Air Conditioning Co.	Auxiliary Bldg. El 9'-0"	Maintain and design ambient temperature of the room	1971	← B Y A N A L Y S I S →				N/A	NUS Corp. Technical Report No. 1510 & Mason Industries Report No. WF-25285 (Bechtel Log No.'s S023-410-6-249 and S023-410-6-D43) documents that the equipment is qualified for intended SONGS 2&3 use.

Equipment	Manufacturer (Model No.)	Location[a]	Function	Conformance to IEEE 344 1971 or 1975	Qualification by Test or Analysis or both	Frequency[b] Range Tested	Seismic Excitation Waveform Input	Simul Biaxial or Single Axis Input	Operability[c] Verified by	Summary of Results/Comments
Switchgear Rooms Emergency AC Units	Carrier Air Conditioning Co.	Auxiliary Bldg. El 50'-0"	Maintains design ambient temperature for the Switchgear Rooms	1971	← BY ANALYSIS →				N/A	NUS Corp. Technical Report No. 1615 and Mason Industries Report No. WF-25288 (Bechtel Log S023-410-6-A91) documents that the equipment is qualified for intended SONGS 2&3 use.
Control Room Complex Emergency	American Air Filter/ Buffalo Forge Co.	Auxiliary Bldg. El 30'-0" Room	Outside air supply for Control	1971	← BY ANALYSIS →				N/A	AAF Seismic Analysis Report NESE-165 (Bechtel Log S023-410-1-394) documents that the equipment is qualified for intended SONGS 2&3 use.
Emergency Water Chillers	Carrier Air Conditioning Co.	Auxiliary Bldg. El 9'-0"	Chilled water supply to AC Units	1971	← BY ANALYSIS →				N/A	NUS Corp. Technical Report No. 1451 & No. 1507 (Bechtel Log No.'s S023-410-7-111, S023-410-7-147 and S023-410-7-160) documents that the equipment is qualified for intended SONGS 2&3 use.
Emergency Chilled Water Pumps	Union Pump Co.	Auxiliary Bldg. El 9'-0"	Chilled water supply to AC Units	1971	← BY ANALYSIS →				N/A	Union Pump Co. Eng. Record No. 761-57 (Bechtel Log S023-410-6-H03) documents that the equipment is qualified for intended SONGS 2&3 use.

a. See Seismic Response Spectra in appendix 3.7C for required seismic qualification levels.
b. Resonant frequencies below 33Hz are listed where equipment is qualified by analysis.
c. Valves, pump, and damper operability tests satisfy requirements of paragraph 3.9.3.2.1.2.

5. Provide the completed SQRT forms for the following components which were incomplete at the time of the site visit.

   a. BOP 5, 125V dc Batteries

   b. NSSS 10, Controller

   c. NSSS 21, Containment Purge Isolation Detector

   d. NSSS 22, Containment Purge Isolation Transmitter

   e. NSSS 2g, In-core Amplifiers

Response:

The following list provides a forecast for completion of the SQRT forms which were incomplete at the time of the SQRT Audit site visit.

a. BOP-5: Exide Model GN 125V dc Station Battery

   Qualification test program still in progress. Forecast completion of SQRT forms by October 2, 1981.

b. NSSS-10: Foxboro, Indicating Controller, Model 250 SQRT forms in preparation - to be provided by February 13, 1981.

c. NSSS-21 & 22: NMC, Containment Purge Area Radiation Detectors and Transmitter

   Qualification Report Resubmittal received and under final review by C-E. Anticipate approval by February 23, 1981 and SQRT form completion by March 2, 1981.

d. NSSS 2g (E-M, In-Core Amplifier)

   Qualification Report returned to American Environmental Laboratory for resolution of C-E comments. Expect to receive corrected report in mid-March for final approval. Would anticipate completing SQRT form by April 3, 1981.

Response to Questions Raised by NRC in Summary of SQRT Plant Site Review
San Onofre Units 2 & 3

1. Containment Bldg. Item 3 - Nuclear Instrument Preamplifier/Filter (NSSS 17)

Question:

Justify the Required Response Spectra (RRS) for cabinet mounted ex-core detector preamplifiers (NSSS-17).

Response:

The preamplifiers in question are mounted on the back face of a standard NEMA 6 electrical cabinet (5'-0" x 6'-0" w/ 3/16" plate thickness typical). The cabinet, in turn, is mounted on the secondary shield wall of the containment structure and the mounting attachment is uniform around the perimeter of the cabinet. The weight of the preamplifier is then five percent of the total weight of the cabinet support plate. The minimum natural frequency of the cabinet support plate with the preamplifier mounted is approximately 30 Hz, well within the unamplified region of the RRS. Therefore, the cabinet support plate can be considered to be rigid and the qualification of the preamplifiers using the floor response spectra of the containment interior structure as the RRS is justified.

2. Control Bldg. Item 1 - Plant Protection System Cabinet (NSSS 1)

Question:

Provide justification for electrical anomalies identified in seismic qualification of the Plant Protection System Cabinet (NSSS 1).

The following are justifications to comments listed in Table II of Wyle Laboratories Seismic Simulation Test Report Number 43386-1. Responses reference equipment under test; test number as listed in Table II, Column 1 (type of deviation found), channels and measurements being recorded (if electrical in nature), and justification for the deviation.

I. REMOTE CONTROL MODULE

Seismic Test Runs 22, 23 and 24

The Wyle Report incorrectly refers to the electrical deviation occurring on Channel 2, the RPS/ESFAS Pressurizer Pressure Bypass Signal, during the tests. The deviations actually occurred on the High Log Power Bypass Signal on Channel 1 according to visicorder charts taken during testing. This is a clerical error in the Wyle Report.

Channel 1 was monitoring electrical continuity of the High Log Power Bypass switch contacts. The visicorder charts indicated voltage deviations, i.e., intermittent transfer of the normally closed switch contacts in each of the above seismic tests.

The transfer was within the defined acceptance criteria, with respect to time, and therefore could not affect circuit operation.

II. POWER SUPPLY ASSEMBLY

Seismic Test Runs 55, 56, 58, 63, 64, and 65

Mechanical and electrical anomalies encountered during testing included: the cable harness chafing on the power supply input fuses; the loosening of various screws and nuts throughout the assembly (seismic test runs 55 and 56); and excessive flexing of the assembly panel (seismic test run 63), to the point where power supply output voltages were affected (seismic test runs 58, 64, and 65).

Cable harness chafing was solved during testing by pulling the harness away from the fuses. Although the problem did not reoccur, wire harness standoffs were incorporated as a design modification.

Screw loosening will be prevented by the use of Loctite on all Power Supply Panel screws, except those used to mount the power supplies and the terminal boards, where screw loosening was not a problem.

Panel flexing was solved by securing the bottom of the panel to the cabinet frame with a length of angle iron (Photograph 18, Wyle Test Report 43386-1). A similar method of anchoring the panel was included into the system design.

Power supply voltage deviations monitored on Channels 3 and 8 in seismic test runs 58 and 64 and the blown fuse found on power supply 25 in test run 65 were resolved by preventing the wire harness chafing and panel flexing as discussed previously. Subsequent test runs proved the adequacy of the modifications.

III. MATRIX TEST MODULE

A. Seismic Test Runs 64, 65, 66, 67, and 68
Wyle Test Report 43386-1

B. Seismic Test Runs 102 through 122
Wyle Test Report 43386-2

Data taken during the seismic test runs A, above, on the matrix test module did not conclusively show what component was being affected. The module was retested as shown in Wyle Laboratories Seismic Simulation Test Report Number 43386-2, with the test results shown in Table I, Seismic Test Runs 102 through 122.

Electrical deviations were observed in Test Runs 104, 110, 113, 115, 119, and 122 on Channel 12. This channel was monitoring an alternate matrix test module circuit design in the event the present design proved to be unsatisfactory. Therefore, the results obtained on this channel were irrelevant. No failures occurred in the original design. Therefore, the alternate design was not incorporated.

Electrical deviations also occurred in Tests 114, 115, 116, and 121 on Channels 6 and 7. The channels monitored the normally closed contacts of the Relay Hold pushbutton. The intermittent opening of the contacts would prevent testing in an adjacent channel but cannot affect system protective response. Therefore, results are acceptable.

IV. CABINET COOLER ASSEMBLY

Seismic Test Runs 71, 73, 74, and 75

Channel 13 was monitoring continuity through the air flow switch annunciator contacts in the assembly. Voltage readings deviated from 12 volts in each of the above test runs. Since the switch is an air flow activated device, it is extremely sensitive to air turbulence and vibration. The reduced voltage readings were attributed to the chattering air flow switch contacts during the seismic simulation. The air flow switches do not affect the system protective response. They are provided to annunciate an inoperative cooling fan only. No fan operating problems were observed during the testing which indicated the air switch alone was affected by the vibrations. Therefore, the deviation is acceptable.

V. BISTABLE CONTROL PANEL

Seismic Test Run 88

The screws holding the rear mounting bracket came loose during the test. The screws were retightened during testing. The problem was remedied by applying Loctite to the mounting bracket screws on all production units and by use of a retaining rod clamp, or spring clip. When the retaining rod is lowered, it fits firmly into the spring clip, thereby reducing vibration.

3. Control Bldg. Item 3 - ESFAS Auxiliary Relay Cabinet (NSSS 4)

Question:

Address why resonant frequencies of the devices mounted within the ESFAS Auxiliary Relay Cabinet were not determined.

Response:

This item was resolved at the exit interview. The NRC reviewer was concerned that the internal components (relays, in particular) may have resonant frequencies below which testing was performed. A typical rotary relay was produced for inspection. The relay operation was described in that these relays are particularly insensitive to linear excitation. The reviewer agreed that such relays would not be a concern for seismic. By mutual agreement with the NRC reviewer this concern was removed from the list of open items.

4. Control Bldg. Item 4 - Process Instrument Rack (NSSS 5)

a. Question:

Provide justification for use of single axis testing to qualify devices in Process Instrument Racks (NSSS 5) for the case of unbalanced loading since unbalanced loading results in off-axis coupling.

RESPONSE

Analysis

The effect of cross coupling seen in the response curves of graphs 1 - 12 of the Foxboro Report No. T4-1025 may be accounted for by using the SRSS Method of NRC Regulatory Guide 1.92, Rev. 1, Section 2.1. This procedure requires taking the square root of the sum of the squares of the codirectional responses caused by each of the three components of excitation to obtain the combined effect of the input forcing function.

Comparing the combined response level, which is:

$$R_c = \sqrt{\Sigma R_{ij}}$$

where: R_{ij} = Response in the i direction due to excitation in the j direction.

R_c = Combined response in i direction

with the maximum directional response will show the ratio by which the original 1.0g input should be increased to provide for the increased combined response. Mathematically:

$$g' = \left[\frac{R_c}{(R_{ij})_{max}} \right] \times 1.0g$$

where: g' = Required 'g' input to obtain combined response levels in the i direction.

1.0g = original 1.0g test input

R_c, R_{ij} = as defined above.

Table A shows the combined response and required input values calculated from the test data in Foxboro Report No. T4-1025. Three locations on the equipment rack have been examined where cross coupling was seen to occur.

Results and Conclusions

1. The required inputs calculated in Table A are all greater than the 1.0g input levels due to the cross coupling.

2. The 2.0g seismic testing done and described in Foxboro Report No. T4-1025 is more severe than any of the required inputs calculated due to cross coupling would produce, i.e. Required Inputs < 2.0g.

3. The report notes that "no slipping or sliding of the rack-mounted equipment or internal mechanical failures of individual modules were noted" during the 2.0g testing.

4. It is felt that the 2.0g testing has shown the equipment rack capable of withstanding the elevated levels of excitation that would be experienced under increased inputs that would account for cross coupling response.

TABLE A

Input Direction	Response 'g' (1)	(2)	(3)	Graph	Location
(1) Front - Back	6.0	3.1	2.2	26	Front Top Center of Rack
(2) Side - Side	3.8	8.4	1.5	25	
(3) Vertical+	.9	.9	1.7	27	
Combined Response	7.15	9.0	3.1		
*Required Input	1.19	1.07	1.07		
(1) Front - Back	4.1	1.5	1.8	28	Center Side of Rack
(2) Side - Side	2.3	4.5	1.7	29	
(3) Vertical+	.57	.57	1.8	30	
Combined Response	4.74	4.78	3.06		
*Required Input	1.15	1.06	1.28		
(1) Front - Back	4.0	1.7	2.7	34	Rear of Power Supply
(2) Side - Side	4.2	6.6	5.0	35	
(3) Vertical+	3.5	1.5	6.0	6	
Combined Response	6.77	6.98	8.26		
*Required Input	1.61	1.06	1.04		

All calculated "required inputs" are less than the 2.0g input used in the later series of seismic tests in Foxboro Test Report No. T4-1025

+ Required Qualification Level = 0.75g

* Required Input = $\left[\frac{\text{Combined Response}}{\text{Max. Response Comp.}}\right] \times$ (1.0g input)

b. Question:

Verify whether the design modifications suggested in the qualification of devices mounted in the Process Instrument Racks (NSSS 5) were implemented.

Response:

The design modifications suggested in Section 4.0 of Foxboro Test Report T3-1077 are addressed in Foxboro letter of December 30, 1976, Page 2. See Attachment following.

SOAAF89

The Foxboro Company Foxboro, Massachusetts, U.S.A. 02035 • Telephone (617) 543-8750

30 December 1976

Transmittal Letter: Product Engineering Report No. PERS 75-113; Seismic Qualification Report on SPEC 200 Nests and Nest-Mounted Modules --- as extracted from Department 383 Test Report No. T3-1077

The attached report presents information on seismic tests of SPEC 200 nests and nest-mounted modules, conducted in accordance with procedures of IEEE 344-1971, as originally documented in Foxboro Company Test Report T3-1077. Excluded are data from the original report on SPEC 200 power supplies and panel-mounted displays which are no longer applicable, since these devices have been extensively redesigned and retested since test T3-1077 was run.

This report may be used in conjunction with Test Report No. T4-1025, Rev. 1, Seismic Test of N-2ES, Style A SPEC 200 Rack and Test Report No. T6-6020, Seismic Testing of 2ARPS Power Supplies (Styles C&D) to correlate seismic qualification data for SPEC 200 racks and rack-mounted modules.

The following discussion is provided to correlate the test levels applied to the nests and nest-mounted modules, per subject test report, with acceleration levels obtained during testing of the N-2ES Rack in Test No. T4-1025. The discussion assumes that all nest-mounted modules will in some application be located in the top nest location of the rack, where the highest acceleration levels were obtained in testing of the rack. It also assumes a peak acceleration requirement at the base of the rack in each horizontal and vertical direction (or a maximum zero period acceleration of the applicable floor response spectra) of 1.0g.

Therefore, it follows that each module must be qualified to the peak acceleration response of the top nest, at each test frequency, during the 1.0g test of the rack.

Foxboro has reduced additional data from oscillograph recordings of acceleration response of a nest assembly tested per subject test report. This data is shown on graphs identified as Enclosures 1, 2, and 3. On these graphs the in-axis peak acceleration response of the nest at each test frequency, as obtained during the 5.0g and 10.0g tests of the nest, is plotted as is the response of the nest during the 1.0g test of the rack (per Graphs Nos. 31, 32, and 33 of Test Report T4-1025, Rev. 1).

POOR ORIGINAL

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As seen, the nests and the nest-mounted modules were subjected to acceleration levels which conservatively exceed those obtained during the 1.0g test of the rack.

From the above, it is concluded that the results of the tests of the nests and the nest-mounted modules of the subject report represent a valid basis for qualification of the nest-mounted modules for operation at the top nest location of the rack for applications where the peak S.S.E. floor acceleration, horizontal and/or vertical, is specified as 1.0g or less.

The following additional information and comments apply to specific statements of Section 4.0, Observations and Conclusions of subject report:

Paragraph 1 - Implementation of only one of the recommendations of this paragraph (the use of all-metal locking hardware for mounting the nests) was found to benecessary to achieve the desired mechanical integrity of the 2ANU nests. This was established during the 1.0g and 2.0g test of the N-2ES rack as documented in Report No. T4-1025, Rev. 1.

In support of the above, three additional graphs have been prepared, and are provided as Enclosures 4,5, and 6. These graphs plot the ratio of the in-axis acceleration response at the rear of the top front nest to that of the mounting surface at the top front nest location of the rack. This ratio is plotted as a function of test frequency for both the 1.0g and 2.0g tests of the rack.

The plots of the above ratio for the 1.0g and 2.0g test "track" each other well in each of the three test axes, demonstrating that the response of the nest to acceleration applied at its mounting surfaces was essentially unchanged, throughout the test.

The above is considered to be strong evidence in support of the visual observations that the structural integrity of the nest and its mounting hardware were maintained throughout the test of the rack.

Paragraph 2 - Integrator power drivers, 2AO-IPD-R's, are not considered to be useable on applications where chattering of the mercury-wetted relays during seismic would be a problem. In such cases, 2AO-IPD-A's should be used.

Paragraph 3.a. - The "output spikes" during seismic, as reported in 3.a, can be disregarded since it has been established that these resulted from intermittent electrostatic effects produced by oscillatory motion of signal leads between the Test Items on the seismic table and output monitoring test equipment which was located several feet from the seismic table. (See Test Report No. T5-6089).

Paragraph 3.b. - This paragraph reports the breaking of two wires to a relay socket of a 2AO-L2C-R Contact Isolator.

The current production design of the 2AO-L2C-R includes seven cable clamps at specific locations to support the wiring in the vicinity of the relay sockets. These were not included in the design of the unit tested per the subject test report.

FOXBORO

Resonant searches have been conducted on the current design at both low and high acceleration levels, in which the wiring of the 2AO-L2C-R was observed using a stroboscope to detect any resonant motion of the wiring. No resonant modes were detected. (See Enclosure 7.)

It should also be kept in mind that this failure (breaking of two of a total of eighty-four leads to relay sockets on the two units tested) occurred towards the end of a series of tests in which the unit was subjected to more than 1000 sine beats, subjecting the comparatively unsupported leads to a considerable amount of fatigue.

Foxboro believes that the potential for the above mode of failure has been eliminated by the cable clamping arrangement of the present design, as indicated by the results of the resonant searches documented by Enclosure 7.

Paragraph 3.c. - The failure mode of the operational amplifier, U2 (LM301A), has been classified as a random failure. It was caused by a loose particle of conducting material resting on the chip inside of the amplifier case, which caused a short circuit between the minus supply terminal and the output terminal. The amplifier functioned properly after the particle was removed.

Normally, we would expect a problem of this type to be detected during inspection by the vendor, and also in functional testing by Foxboro. A total of 208 LM301A operational amplifiers were included in the instruments subjected to the subject seismic test, with occurrence of the single failure, above. Therefore, this failure was classified as a random failure with a low probability of recurrence.

Paragraph 3.d. - As stated, the failure mode of Diode CR2 (IN914) was a short circuit. A review of the modules included in the seismic test indicates that a total of 140 IN914 diodes were present, with occurrence of the single failure, above.

On this basis and Foxboro's extensive experience with diodes of this construction, this occurrence has been classified as a random failure.

Paragraph 3.e. - Suitcase jumpers have been replaced by a spring clip with higher retention force and lower mass. The spring clip captures a male pin mounted upon the board, and is not free to "rock" under vibration as was the suitcase jumper. Thus this mode of failure has been eliminated.

Paragraph 3.f. - With respect to the apparent malfunction of the 2AP-ALM-AS alarm card at the 3.5g level, it has been considered that the two alarm cards which were tested included a total of four alarm set point mechanisms. The mis-firing of one of the four alarms at 3.5g is considered to have been a spurious occurrence in view of the fact that it did not reoccur during the 5g and 10g testing of the same unit, and that no malfunction occurred in any of the other three units which were tested.

It is possible that the set point value was initially set closer than intended to the input signal level, or that the adjustment was changed inadvertently from its initial setting prior to the test.

Nonetheless, it is Foxboro's view that the tests at the higher 5g and 10g levels, which were performed without incident, constitute a successful re-test of the alarm card.

Paragraph 3.g. - Control of alignment of retaining clips relative to the corresponding holes in the 2AP modules will assure retention of the cards within the module under seismic vibration.

J.C. Childs

Foxboro, J.C. Childs, Dept. 162
Staff Engineer, Nuclear Power Products and Standards
Corporate Quality Assurance Department

joy
1/3/77

Enclosures (7)

POOR ORIGINAL

FOXBORO

c. Question:

Provide the current Acton Lab qualification test report for the Foxboro Spec 200 Process Instrumentation (NSSS 5).

Response:

The Acton test report 11977 contained in The Foxboro Product Engineering Report Number PERS-113, Revision 1 is a source document for Foxboro test report T5-6089. The objective of this test was to determine the cause of output spikes produced during earlier seismic testing. See letter following. Foxboro test report T5-6089 and Acton test report 11977 were included here only to justify the problem of output spikes mentioned in Foxboro test report T3-1077 page 12 item 3a. Other testing included in Acton test report 11977 is of no concern with respect to Foxboro test report T3-1077. The correct Acton report for Foxboro test report T3-1077 is not really necessary since Foxboro test reports are based on Acton reports and may be considered to stand alone. Probably for this reason we don't see the Acton report for T3-1077 in document PERS 75-113.

13 February 1976

Transmittal Letter: Test Report No. T5-6089, Seismic Testing of 2AO-V2I, 2AI-I3V Converters and 2AP+SUM Summer

The attached report documents the results of a "diagnostic test" which was run on the subject SPEC 200 modules. The objective of the test was to determine the cause of output spikes produced during earlier seismic testing of these and other SPEC 200 modules as documented in Product Engineering Report No. PERS 75-113 and Test Reports Nos. T5-6059 and T3-1077.

As further discussed in the attached report, it was determined that the output spikes resulted from intermittent electrostatic effects produced by motion of signal leads connecting the test modules on the seismic table to output monitoring test equipment.

Copies of this report should accompany transmittals of Reports Nos. T5-6059 and PERS 75-113.

J C Childs

FOXBORO, J. C. Childs, Dept. 370
Staff Engineer
Nuclear Power Products & Standards

cmt
Attachment

d. Question:

Justify the method of qualifying the Rosemount 442 Temperature Transmitters. Specifically explain how the TRS was developed from the floor RRS considering cabinet dynamics.

RESPONSE

Analysis

The process instrument rack in which this device is mounted was qualified by single frequency single axis tests. Therefore, an RRS was not available for the transmitter. From the qualification report, Foxboro T4-1025, the cabinet resonance frequencies are all above the predominant frequencies in the motion of the floor to which the cabinet is mounted, to the extent that little dynamic coupling will occur between the cabinet and floor. In other words, the floor motions will not be significantly amplified at the transmitter location. Plots have been made of the transmitter TRS vs the cabinet floor response spectra (Fig. I & II). It can be seen from the curves that more than sufficient margin is present to account for any small amount of amplification which may occur in the cabinet due to the light coupling.

The incomplete enveloping of the RRS brings in another SQRT concern. Dayton T. Brown Laboratories ascertained the lowest measured (structural) natural frequency to be greater than 35 Hz. This is obviously not a problem compared to the 2 Hz cutoff. This leaves the internals of the component of possible concern. A visual inspection of the internals reveals two circuit boards 2" wide by 3" long. These two boards are constrained on their boundary by tight plastic tracks. In our professional opinion, the rigidity of the mounting of these two circuit boards eliminates any concern about the cutoff frequency of 2 Hz.

Conclusions

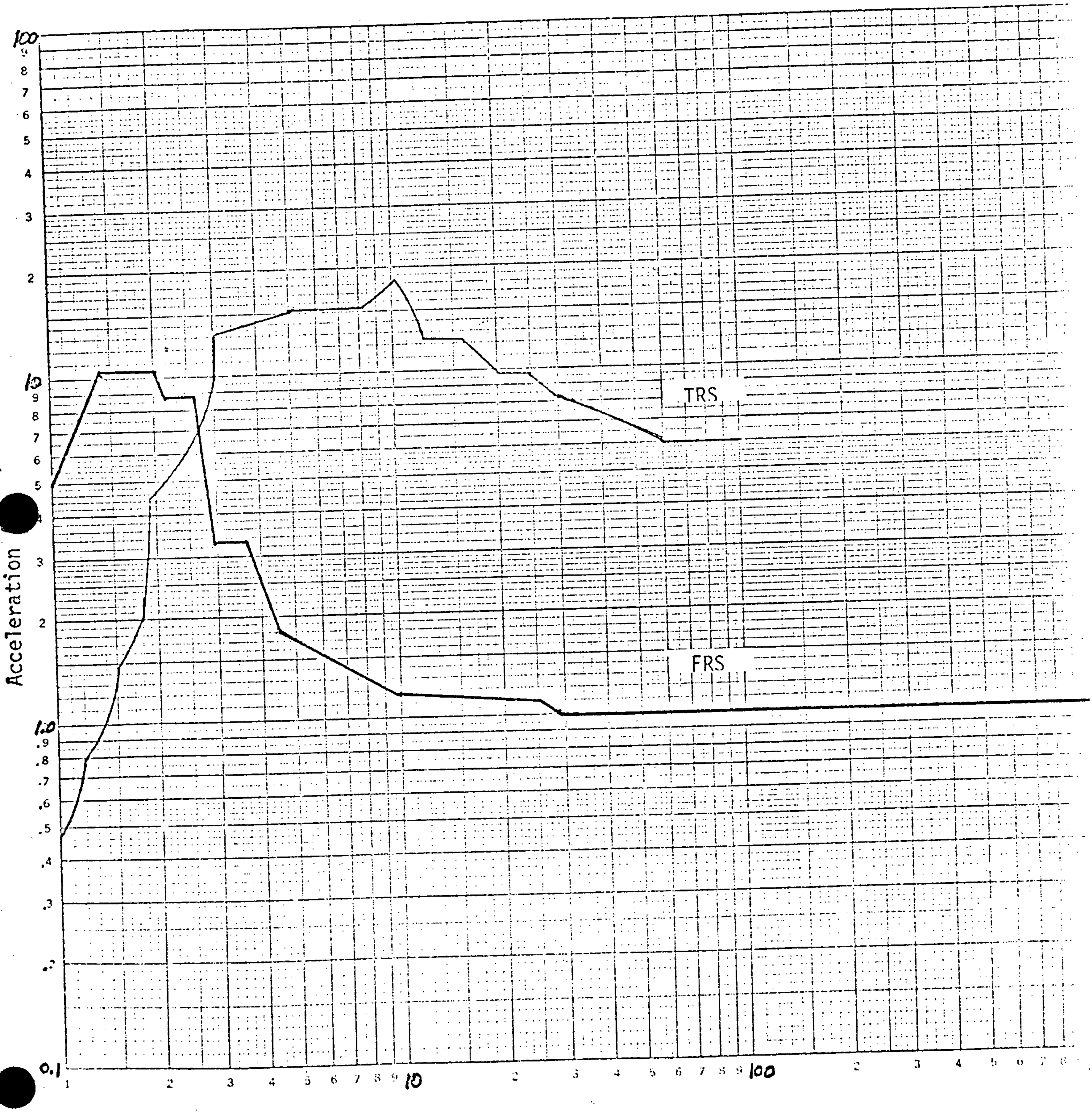
1. Figures I and II indicate that sufficient margin is present to account for any small amount of amplification which might occur in the cabinet due to the light coupling involved.

2. The rigidity of circuit board mounting is considered sufficient to eliminate any concerns relative to the enveloping of the RRS.

FIGURE I

COMPARISON OF TRS OF ROSEMOUNT TEMPERATURE TRANSMITTER
TO FLOOR RESPONSE SPECTRUM (FRS)
IN SONGS 2 AND 3 AUXILIARY BUILDING (ELEVATION 30')

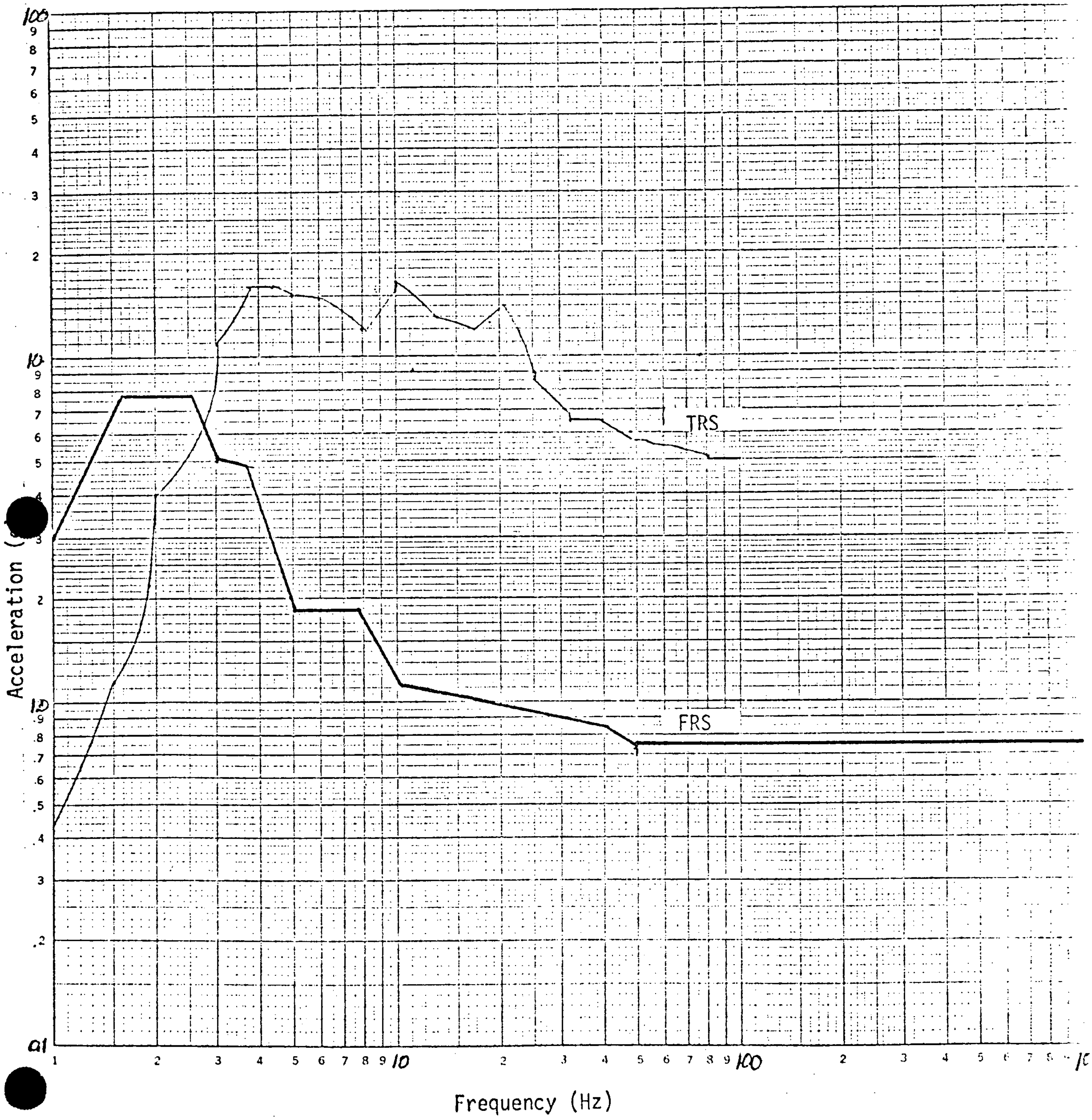
CRITICAL DAMPING 5%, SSE, HORIZONTAL



POOR ORIGINAL

FIGURE II

COMPARISON OF TRS OF ROSEMOUNT TEMPERATURE TRANSMITTER
TO FLOOR RESPONSE SPECTRUM (FRS)
IN SONGS 2 AND 3 AUXILIARY BUILDING (ELEVATION 30')
CRITICAL DAMPING 5%, SSE, VERTICAL



5. Control Bldg. Item 5 - CPC Operator's Module (NSSS 7)

<u>Question</u>:

Provide justification for equivalence between the test configuration and the actual installed configuration for CPC Operators Module (NSSS 7).

RESPONSE

General Approach

The supporting structure used to excite the CPC Operator's Module is shown in the Wyle Report No. 43130-1. The actual field installation mounting structure is somewhat different from that used during the Seismic Test Program. Modal Analysis of the two structures is used to compare the mountings and assess the dynamic response that is experienced by the module in each configuration.

Analysis

Finite element models of the test structure and field installation, including the module, were made to perform the modal analysis. Sketches of the models are shown in Figures III and IV. The SAPIV computer code was used to determine the first 5 modeshapes and frequencies in each case. These are listed in Table B.

Comparison of the modeshapes and frequencies shows the first mode in each case to represent the mounting structures while the others indicate local responses of the sides, top and bottom of the CPC module. The test structure has a frequency slightly higher than that of the field installation (109.5 Hz and 100 Hz, respectively). The field installation response is primarily motion of the rear struts while the test structure modeshape includes significant motion of the module as well.

Testing performed was in the range of 1 - 35 Hz which is considerably below the resonances found for the two structures.

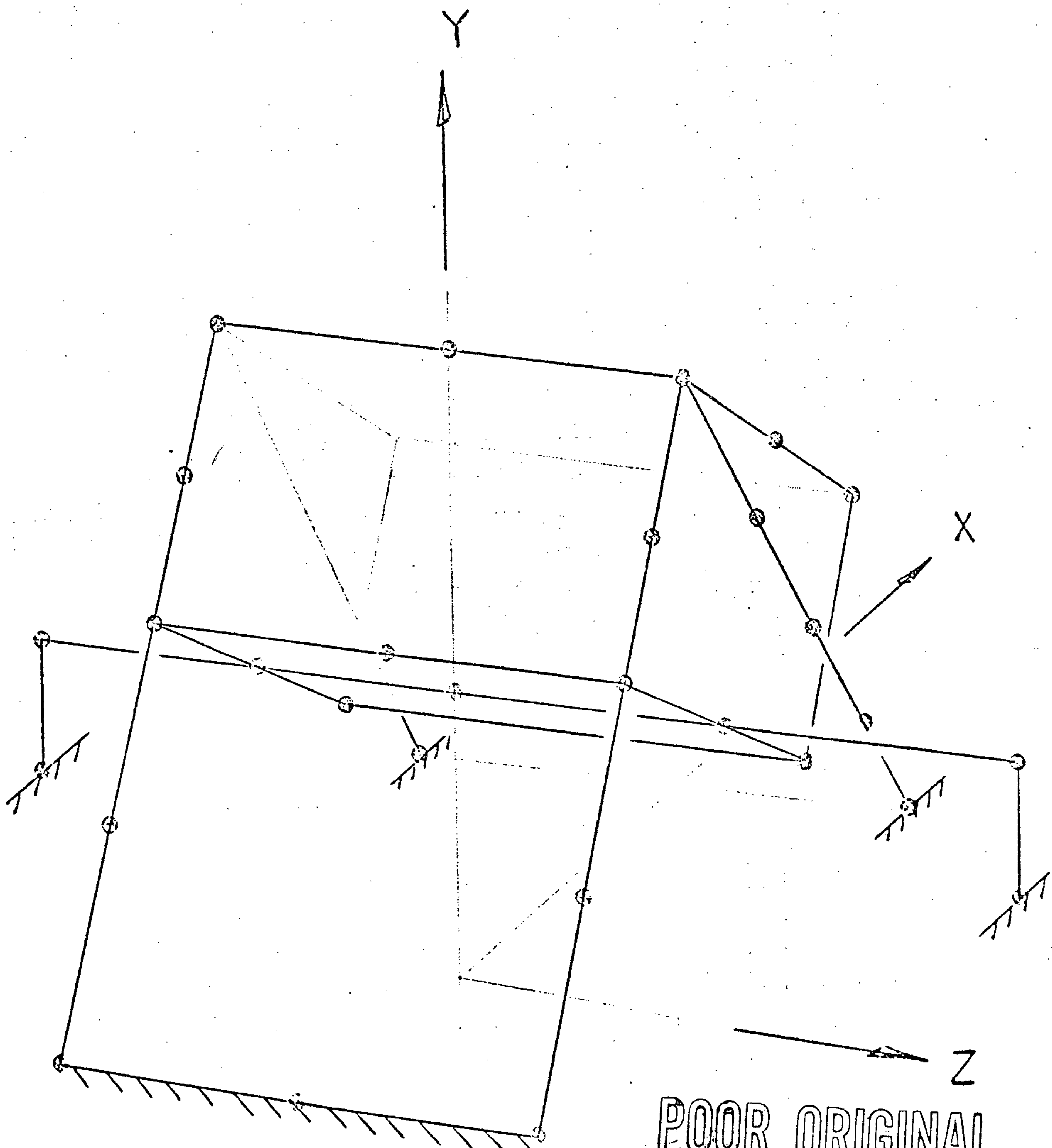
Conclusions

1. Based upon the assumption of a single degree-of-freedom system, the ratio of forcing frequency to response frequency indicates the magnification factor of both structural mountings to be virtually the same.

2. Motion of the module is not significant in the first mode of the field installation but is significant in the test configuration. We may therefore say that the module was more severely excited during the test than it would be during field installation under the same dynamic conditions.

FIGURE III

TEST MOUNTING CONFIGURATION



FIELD MOUNTING CONFIGURATION

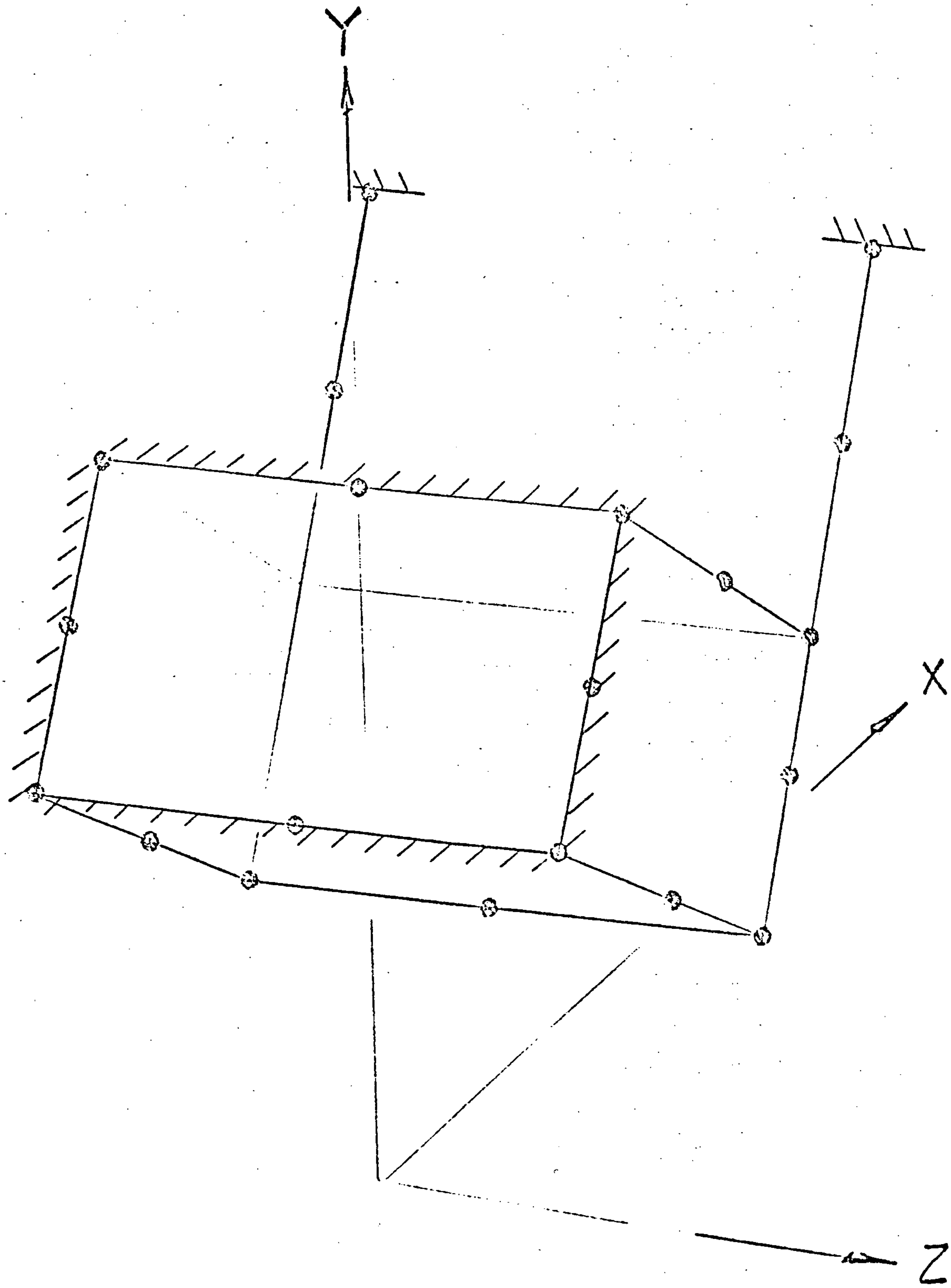


TABLE B

MODAL ANALYSIS RESULTS

Mode	Test Structure Freq.	Test Structure Mode Description	Field Installation Freq.	Field Installation Mode Description
1	109.5	Front Panel & Horizontal Sup't	100.2	Rear Strut Motion
2	165.	Module Top & Bottom	100.3	
3	174.5	" " "	160.7	Module Top & Bottom
4	201.2	Module Top	165.5	" " "
5	317.	Module & Sup't Structure	198.1	Module Top
	(Hz.)		(Hz.)	

6. Control Bldg. Item 6 - Main Control Panel (BOP 7)

Question:

Provide insitu test and any other seismic qualification data for the main control panel. Provide a list of all seismic Category I equipment mounted in the main control panel.

Response:

The following three additional seismic qualification documents were provided by the vendor in support of the seismic qualification of the main control panel:

1. Wyle Laboratories Test Report 58334, dated October 12, 1978, Study of Main Control Consoles for Circle AW Products Company.

2. Wyle Laboratories Test Report 58379, dated February 16, 1979, Seismic Testing of Sections 1 and 2 of Main Console for Circle AW Products.

3. Circle AW Products Company Engineering Report 79060, dated March 22, 1979, Effect of Increased Instrument Loading on Resonant Frequency of Main Control Consoles.

The conclusions from these reports are as follows:

1. The panel skin can be considered to be rigid for all credible instrumentation arrays.

2. The natural frequency of the complete panel assembly is higher than the individual shipping sections and can be considered to be rigid.

3. The lowest projected natural frequency for saturated panels is safely outside the major amplified region of the RRS.

Enclosed you will also find a list of all Seismic Category I mounted in the main control panels. Components with specification numbers 5XX are Bechtel supplied components whereas components with specification numbers 9XX are CE supplied components. The BOP supplied components fall into five basic categories: 1) Hand switches, 2) Indicating lights, 3) Position indicators, 4) Process controllers, and 5) Recorders. Seismic qualification of each of these components were performed by the subtier supplier to a seismic environment compatible with the predicted environment with the control panel.

1.0 REFERENCES

1.1 Circle A W Products Co. Purchase Order No. 3259 dated 6 July 1978.

1.2 Wyle Laboratories "Test Plan for Study of Main Control Consoles for Circle A W Corporation", dated 14 September 1978.

2.0 TEST PROCEDURES

2.1 Purpose

The purpose of this test program was to demonstrate and document that the main control consoles for the San Onofre Nuclear Generating Station could be modified by installation of additional devices without impairing the console capability to withstand the required seismic environment. Testing was conducted at the San Onofre Nuclear Generating Station on five panels, as described below.

SS 1	Upper right hand
SS 3	Left hand and second from left
SS 4	Left and right hand
SS 6	Left hand
SS 7	Right hand at mid-point

2.2 Panel Selection

Console drawings were studied qualitatively by means of drawing study and inspection of the consoles at the job site to determine the range of unsupported panel sizes, cutouts, and weight of devices installed. In this context, panels were defined as the unsupported sections of the one-quarter inch steel sheet in which the various instruments were mounted. Panels near the extremes of the ranges were selected as candidates for in-situ testing. The objective was to determine panel first mode frequencies as a function of size, cutouts, and weight of installed components.

2.3 In-Situ Testing

The panels described in Paragraph 2.1 were inspected on site to confirm that they met the selection criteria as test panels. The test consisted of a first mode frequency determination for each panel. A small, relatively long period impulse was applied by hand to each panel. A hand-held velocity pickup was placed on

2.3 (continued)

the panel in the area of maximum response (Reference Figures 1 through 5). The output of the velocity pickup was recorded on a direct readout recorder.

3.0 TEST RESULTS

Examination of the oscillograph records revealed the following natural frequencies of the panels tested.

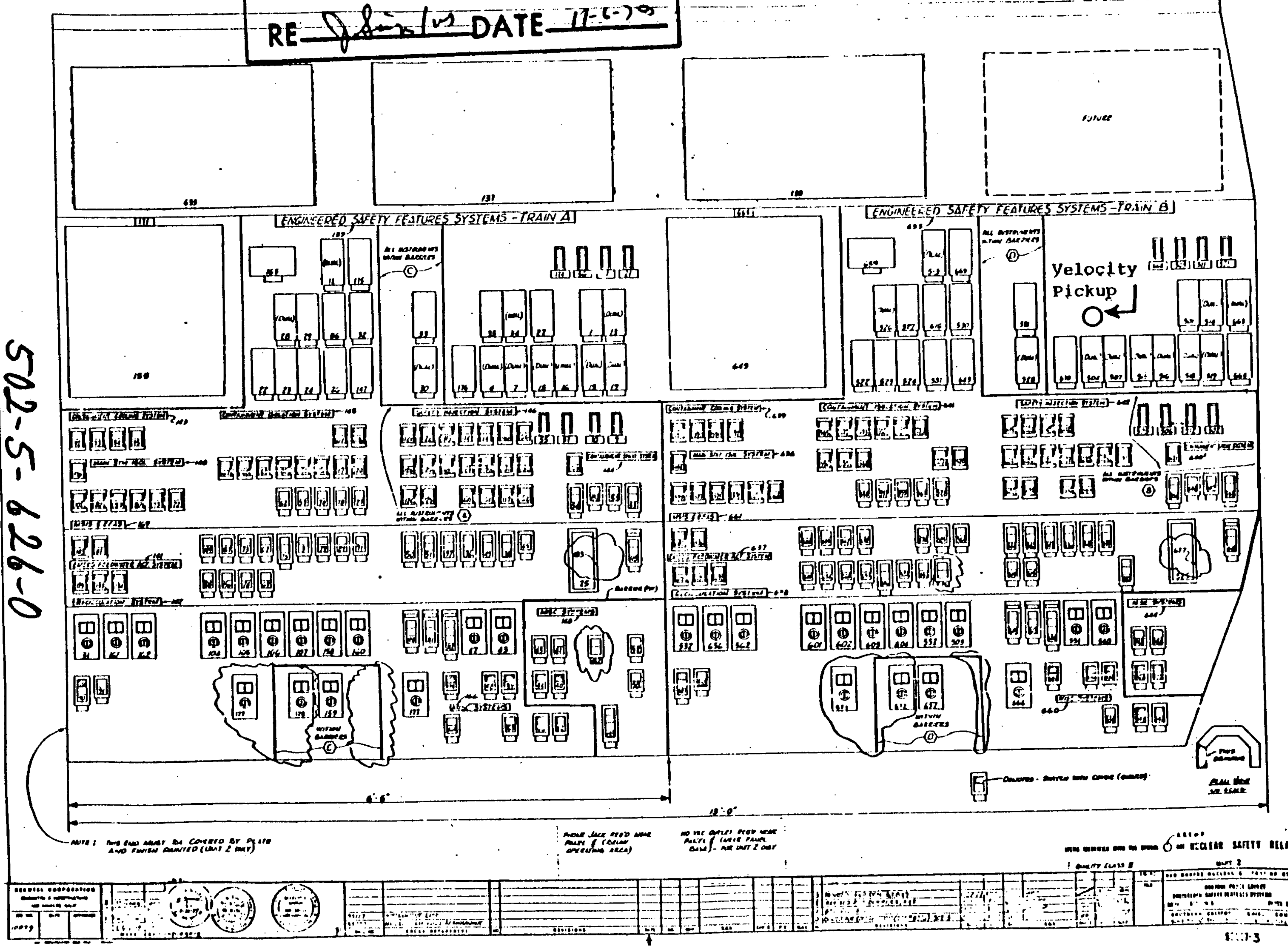
Shipping Section	Panel	Frequency (Hz)
No. 1	Upper right hand side	50.0
No. 3	Second panel from left side	30.0
No. 3	Left hand side	28.5
No. 4	Right hand side	30.0
No. 4	Left hand side	30.0
No. 6	Left hand side	25.0
No. 7	Right hand side mid-point	Note
No. 7	Lower right hand side	72.0

Note: Unable to determine frequency from data but was in excess of 70 Hz.

For additional information, refer to the oscillograph records and equipment list included in this report.

PERTINENT DATA LEGIBLE

RE ________ DATE 11-6-79



502-5-626-0

FIGURE 1

POOR ORIGINAL

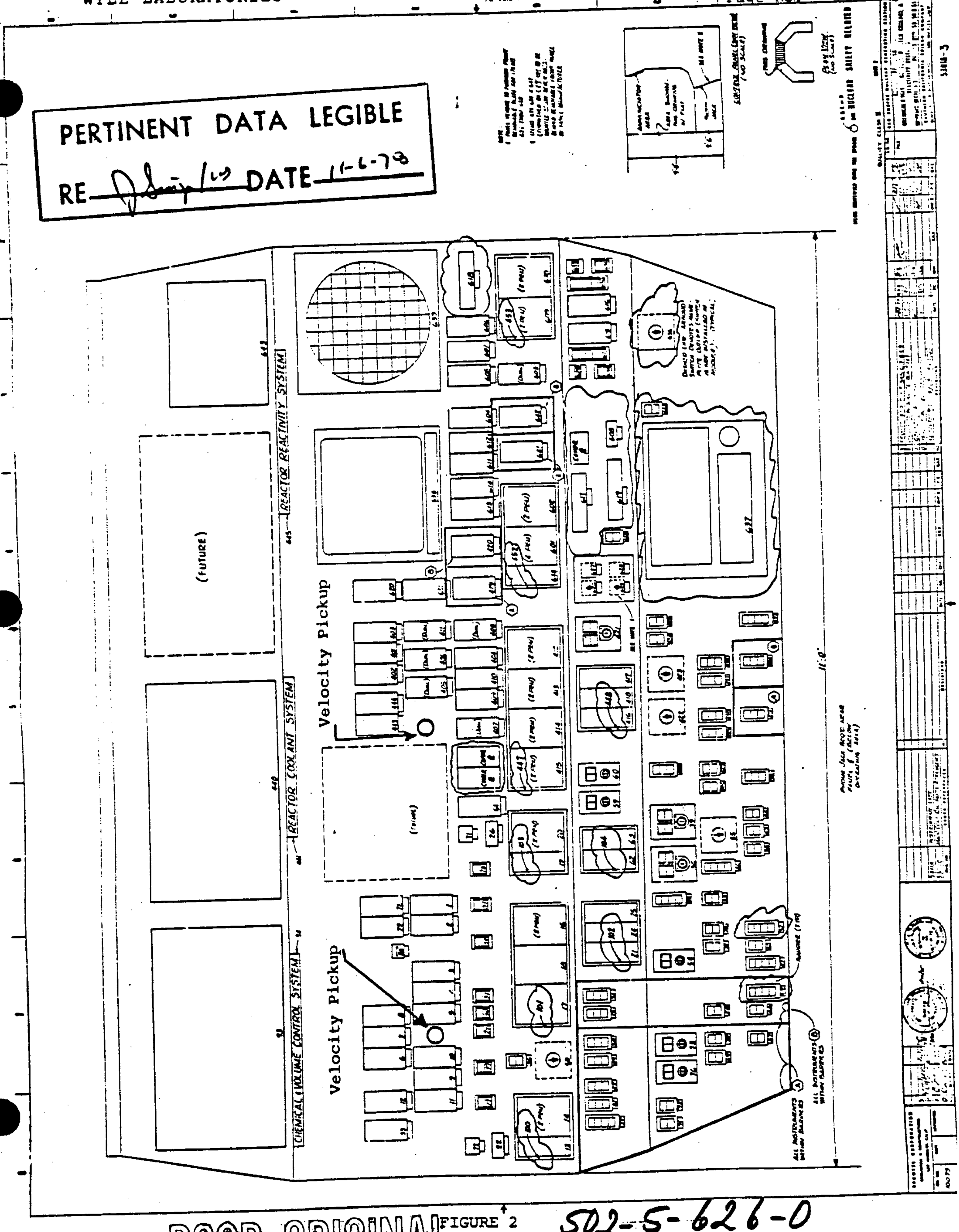


FIGURE 2

502-5-626-0

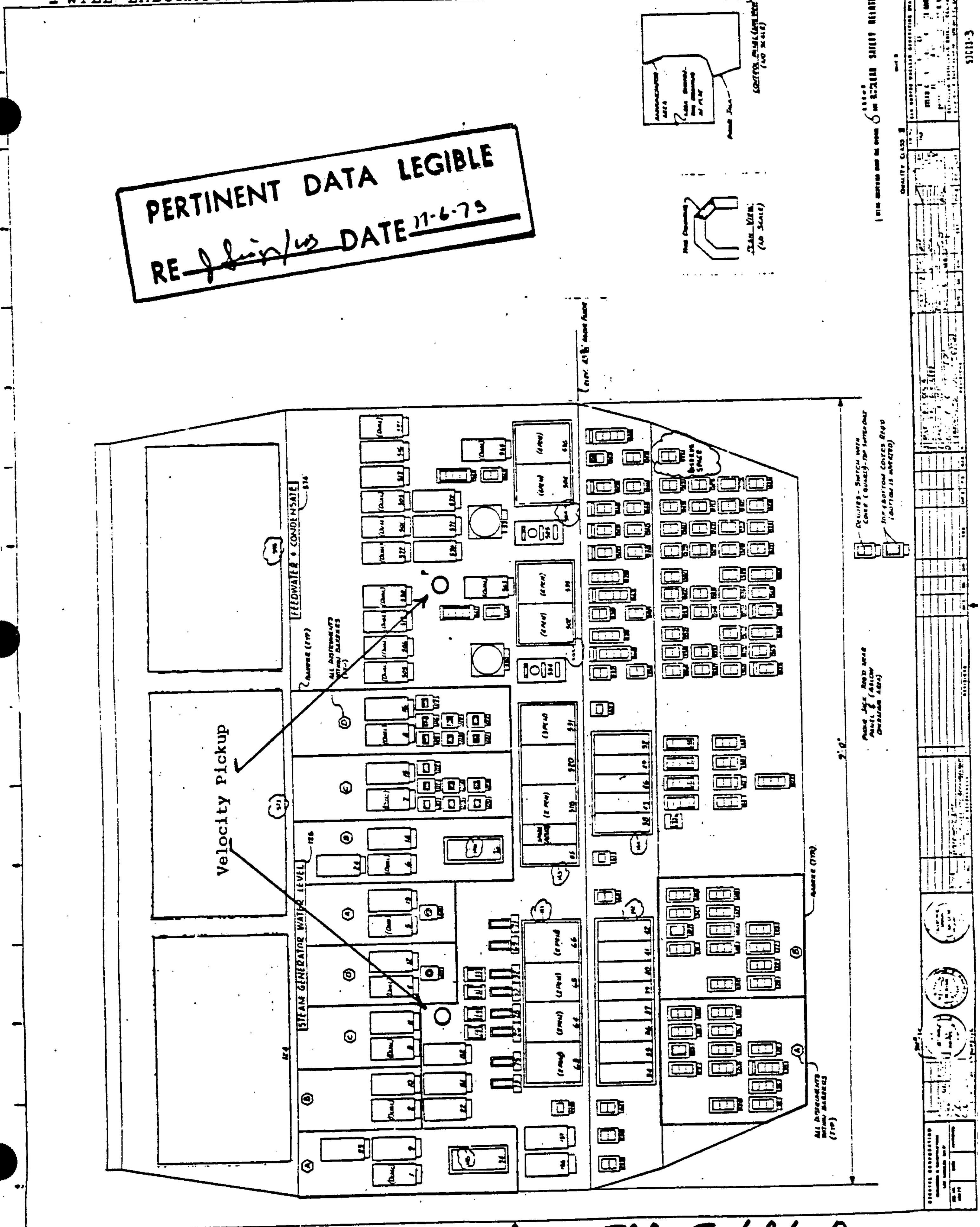


FIGURE 3

502-5 626-0

POOR ORIGINAL

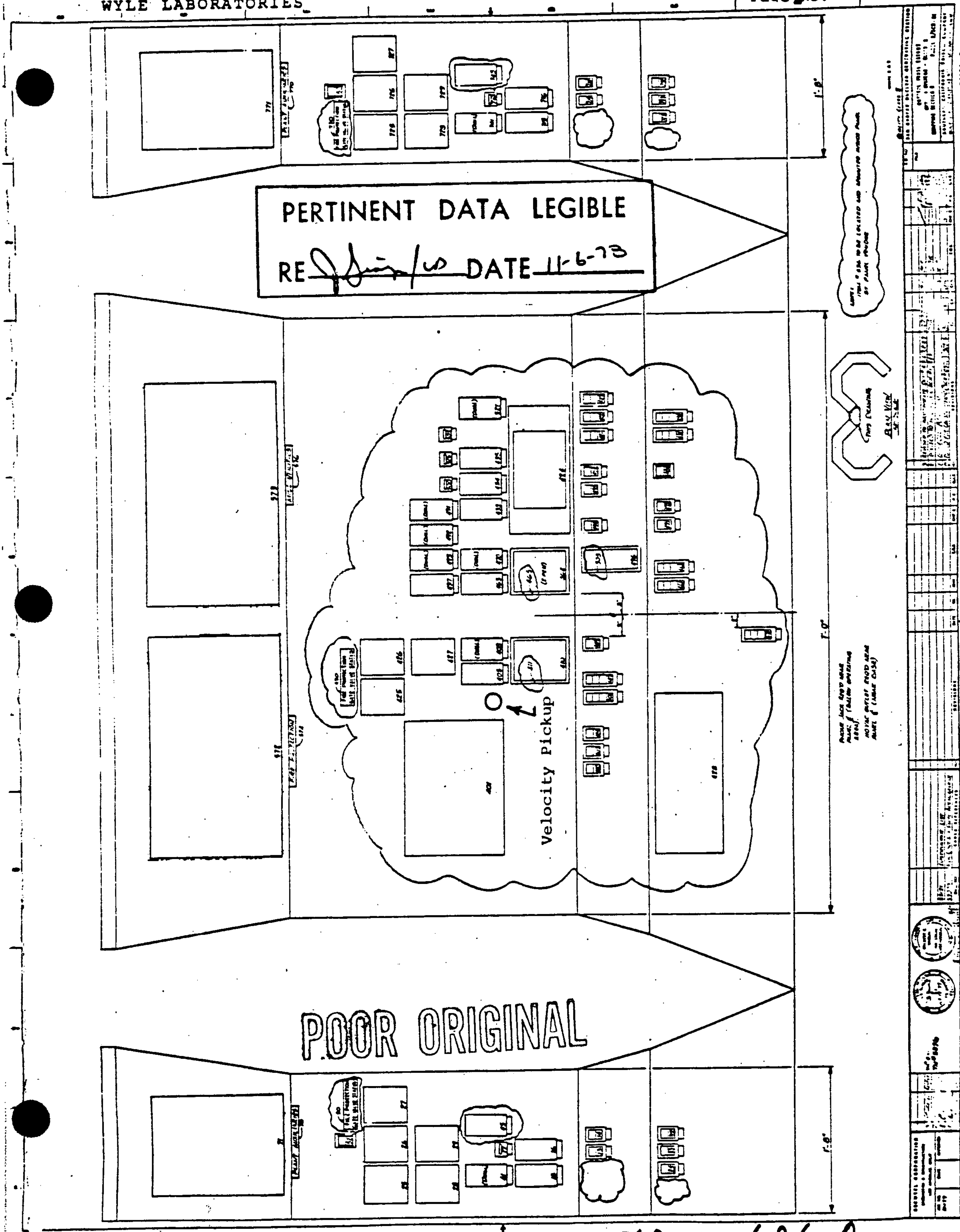


FIGURE 4

502-5-626-0

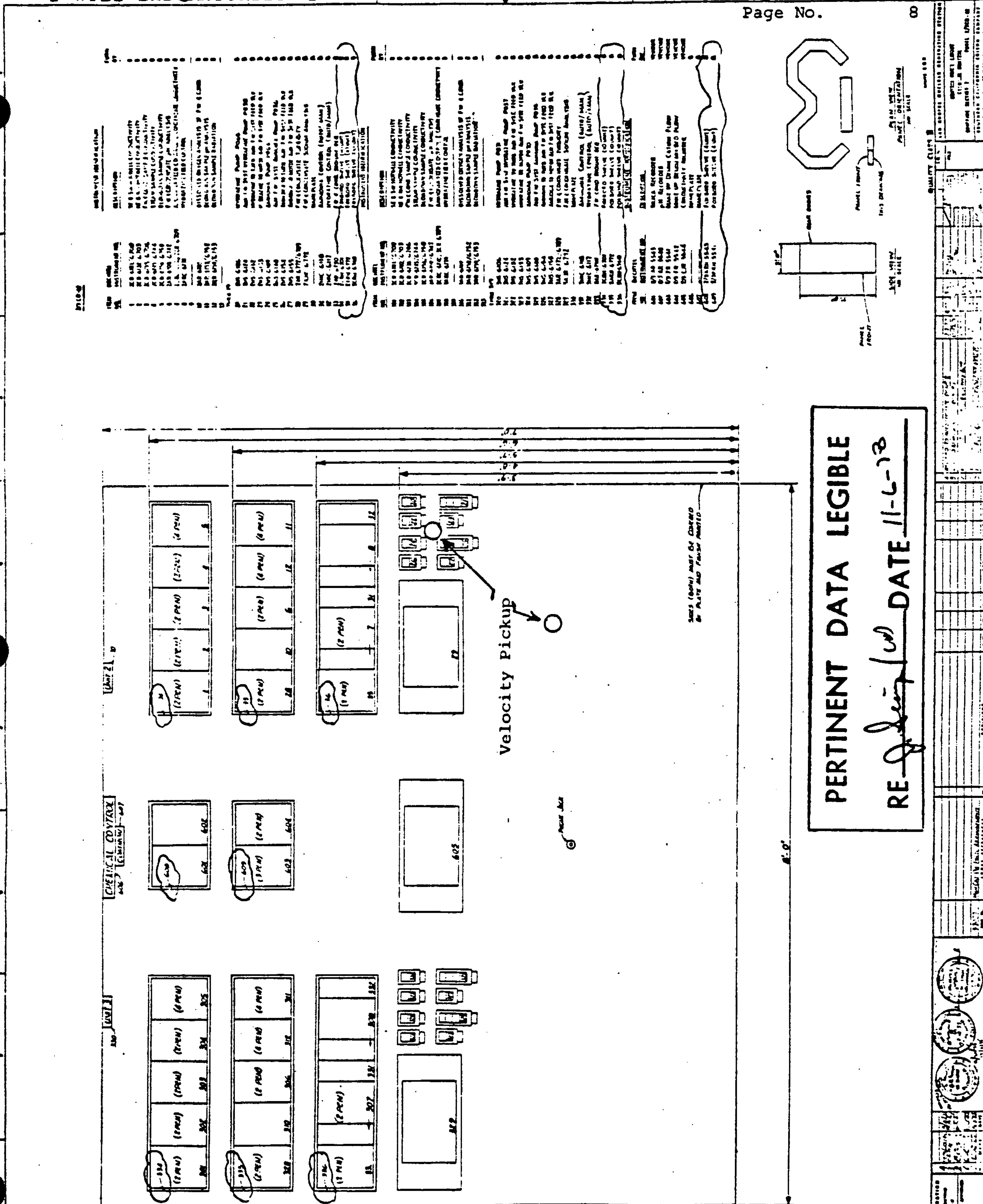
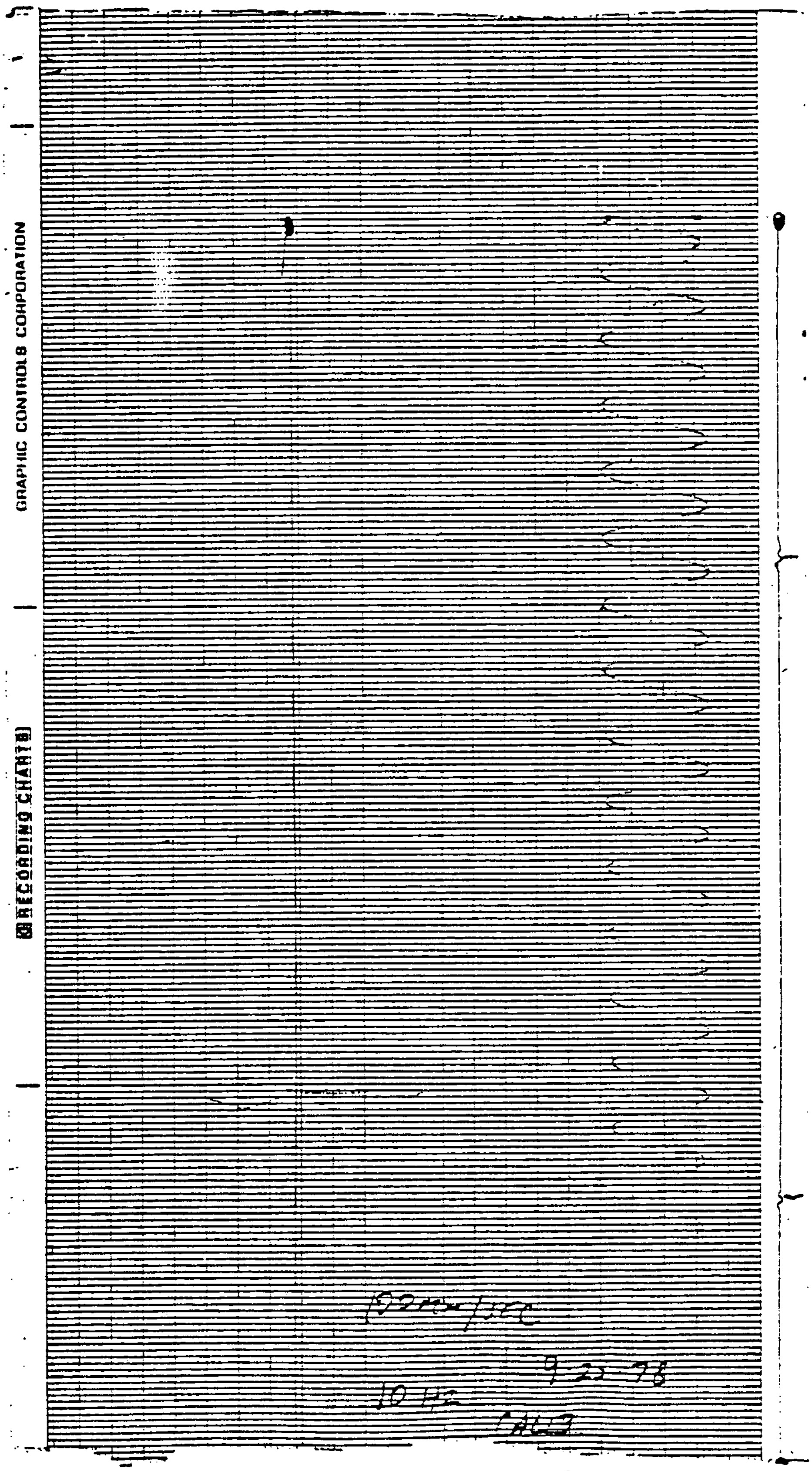


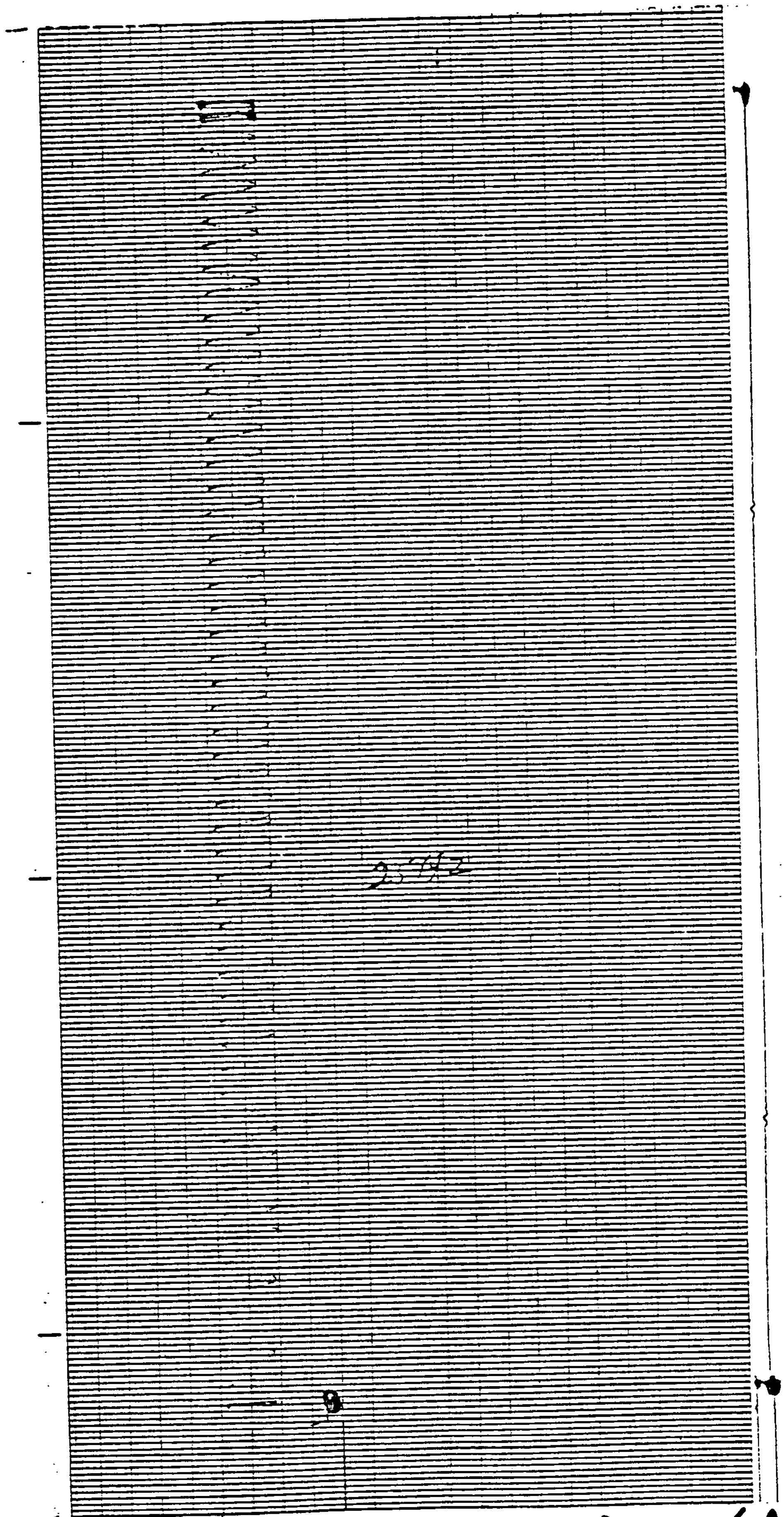
FIGURE 5

502-5-626-0



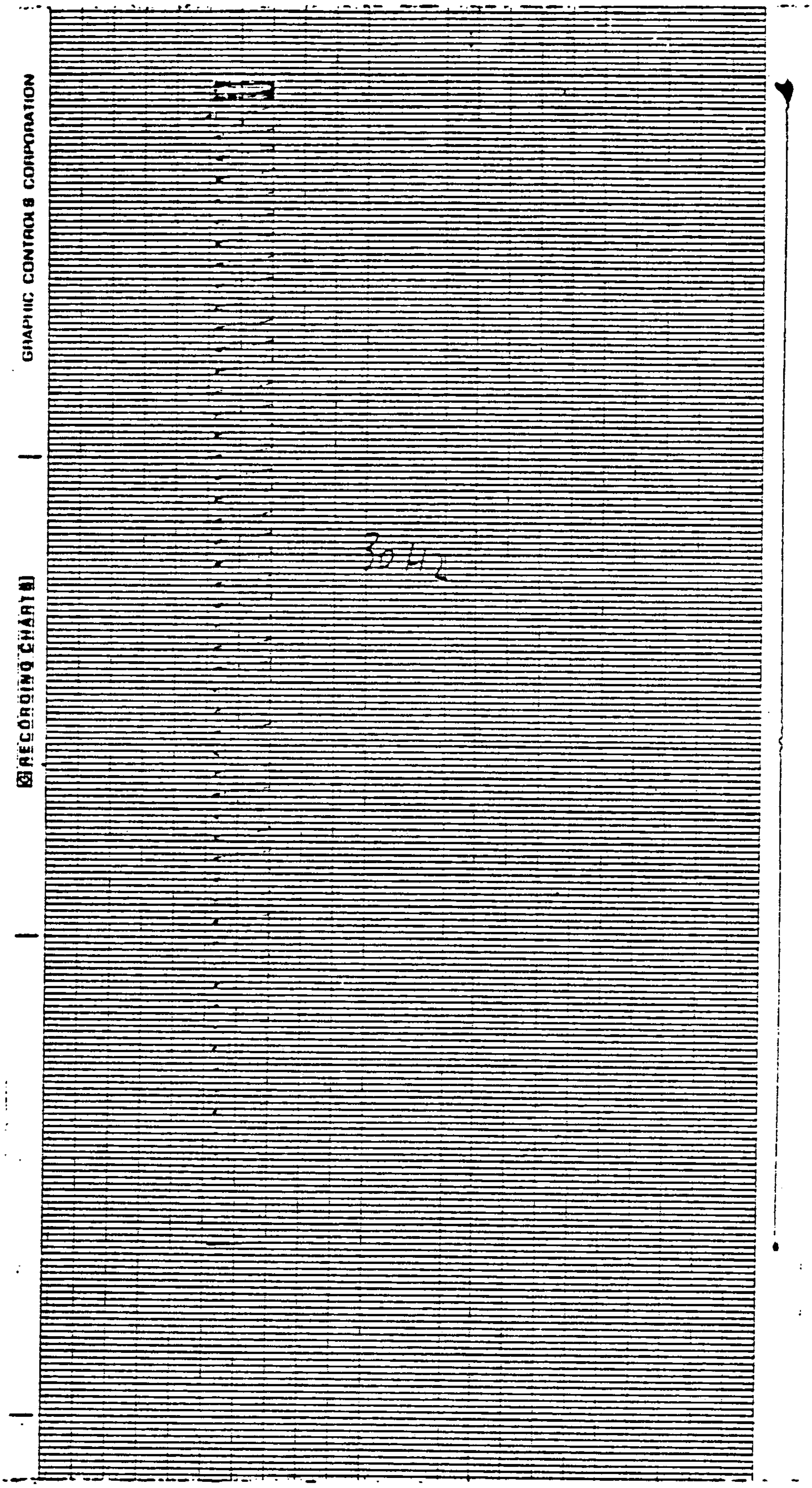
10 Hz Calibration Signal
Paper Speed 100mm/sec

502-5-626-0



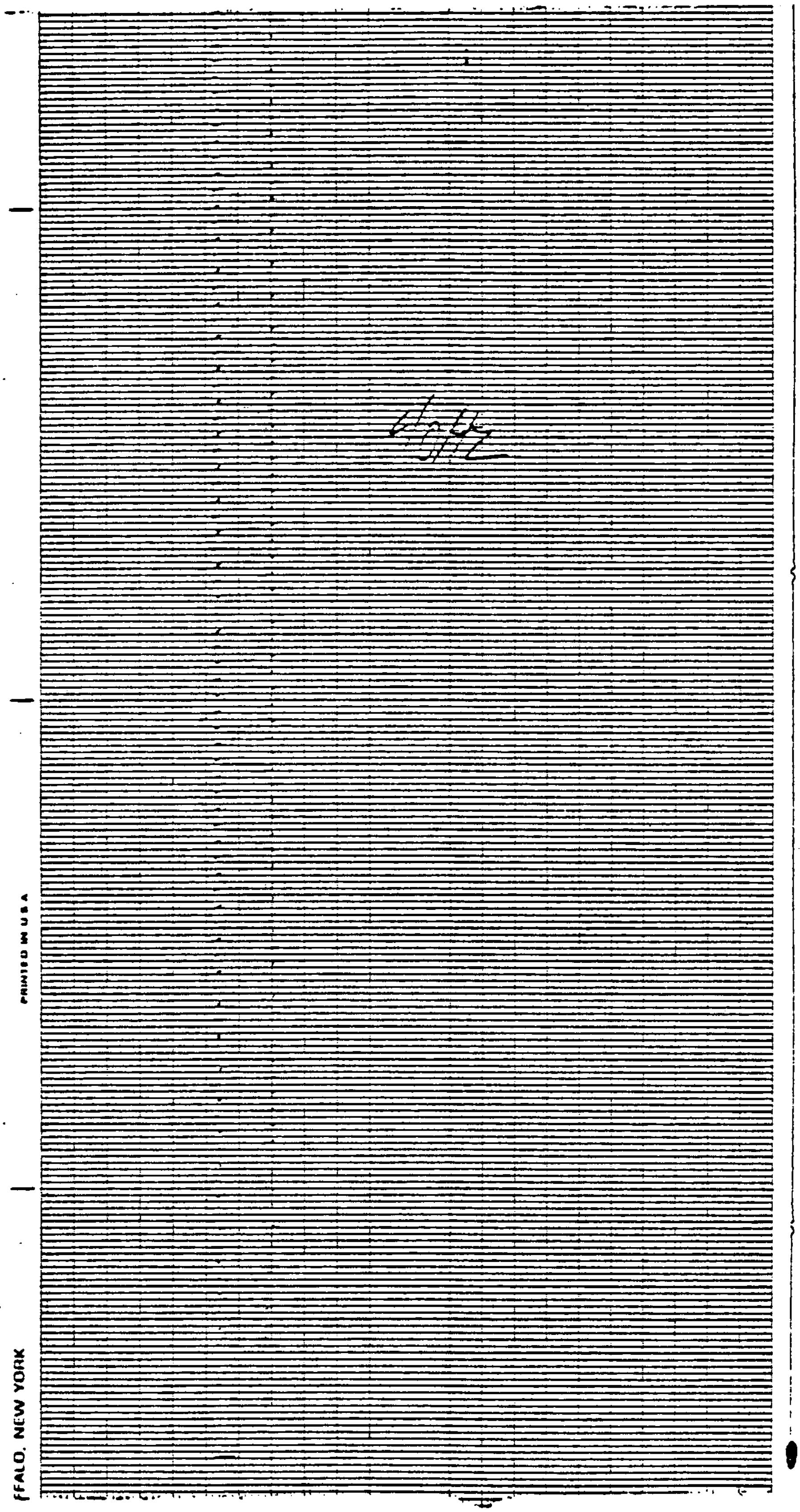
25 Hz Calibration Signal
Paper Speed 100mm/sec

502-5-626-0



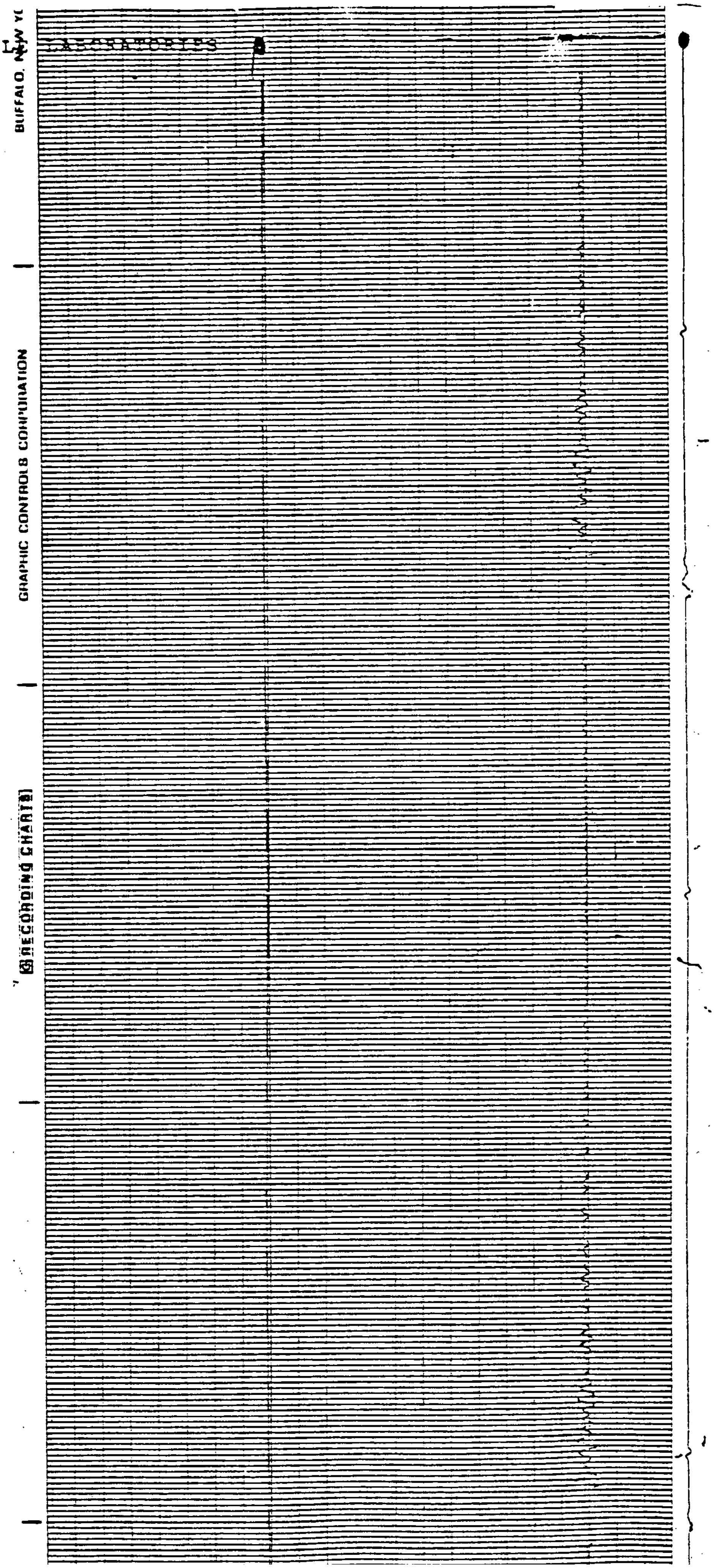
30 Hz Calibration Signal
Paper Speed 100mm/sec

502-5-626-0



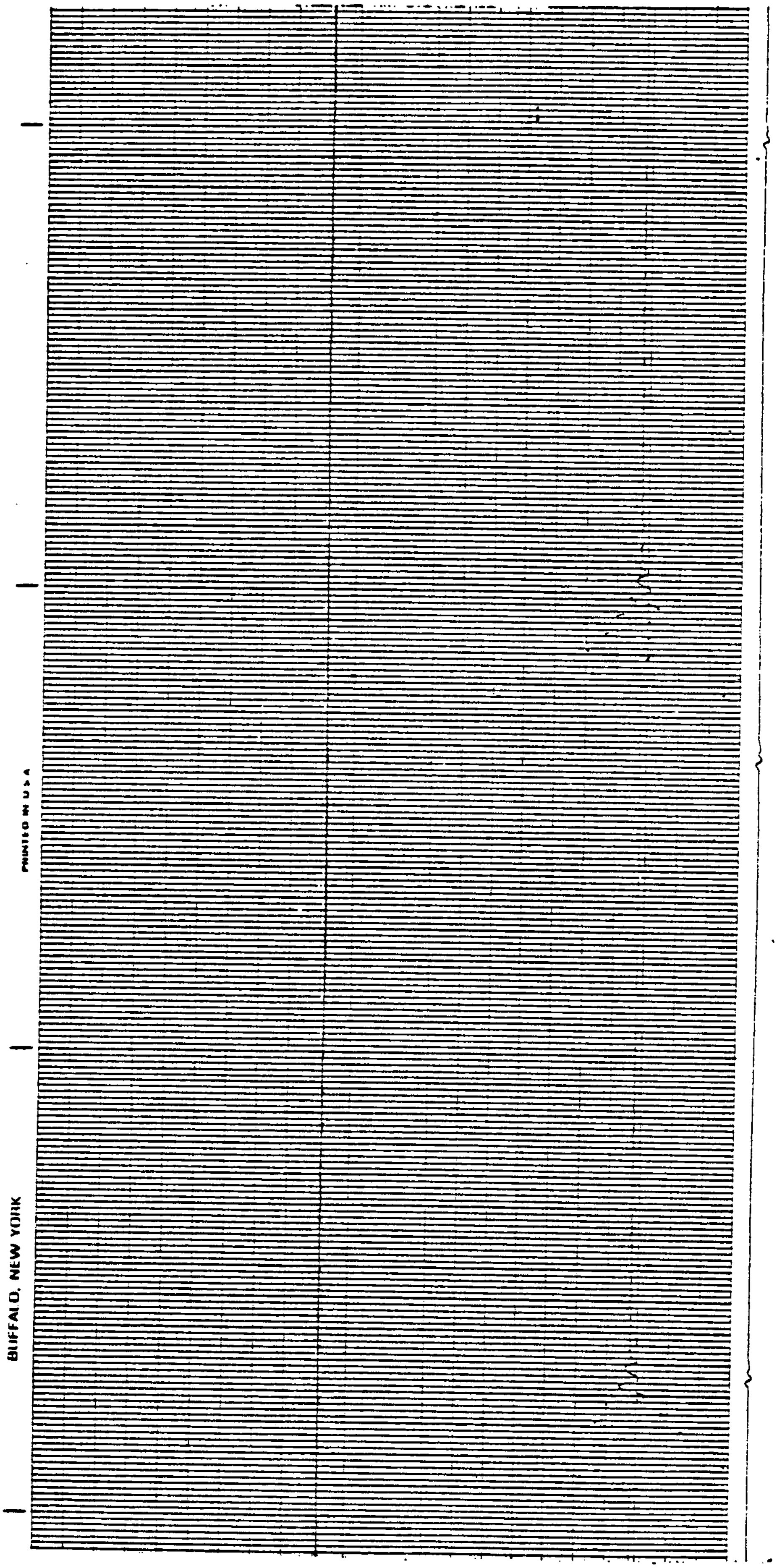
40 Hz Calibration Signal
Paper Speed 100mm/sec

502-5-626-0



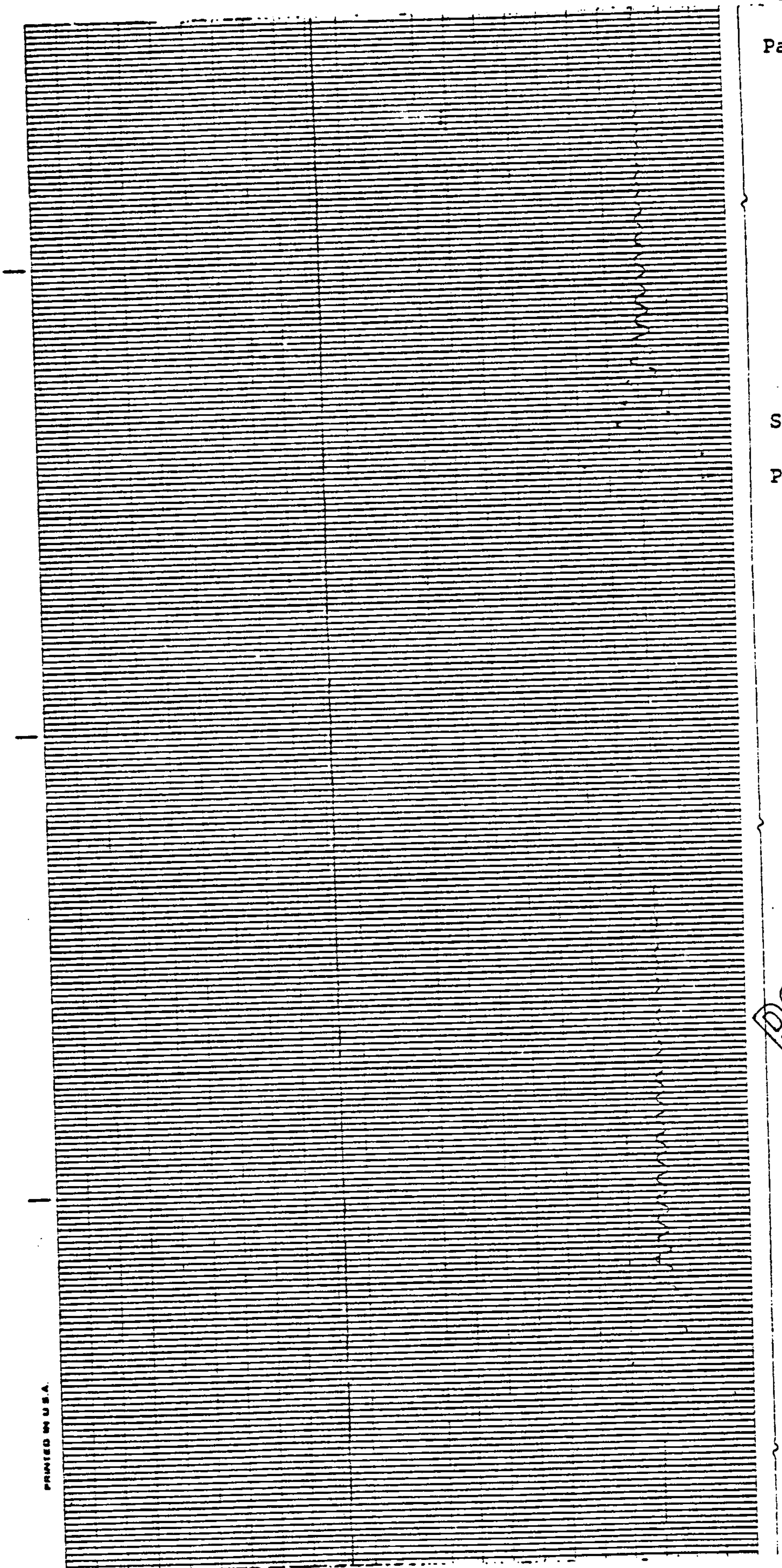
Shipping Section No. 1
Right Hand Side
Paper Speed 100mm/sec
50 Hz

502-5-626-0



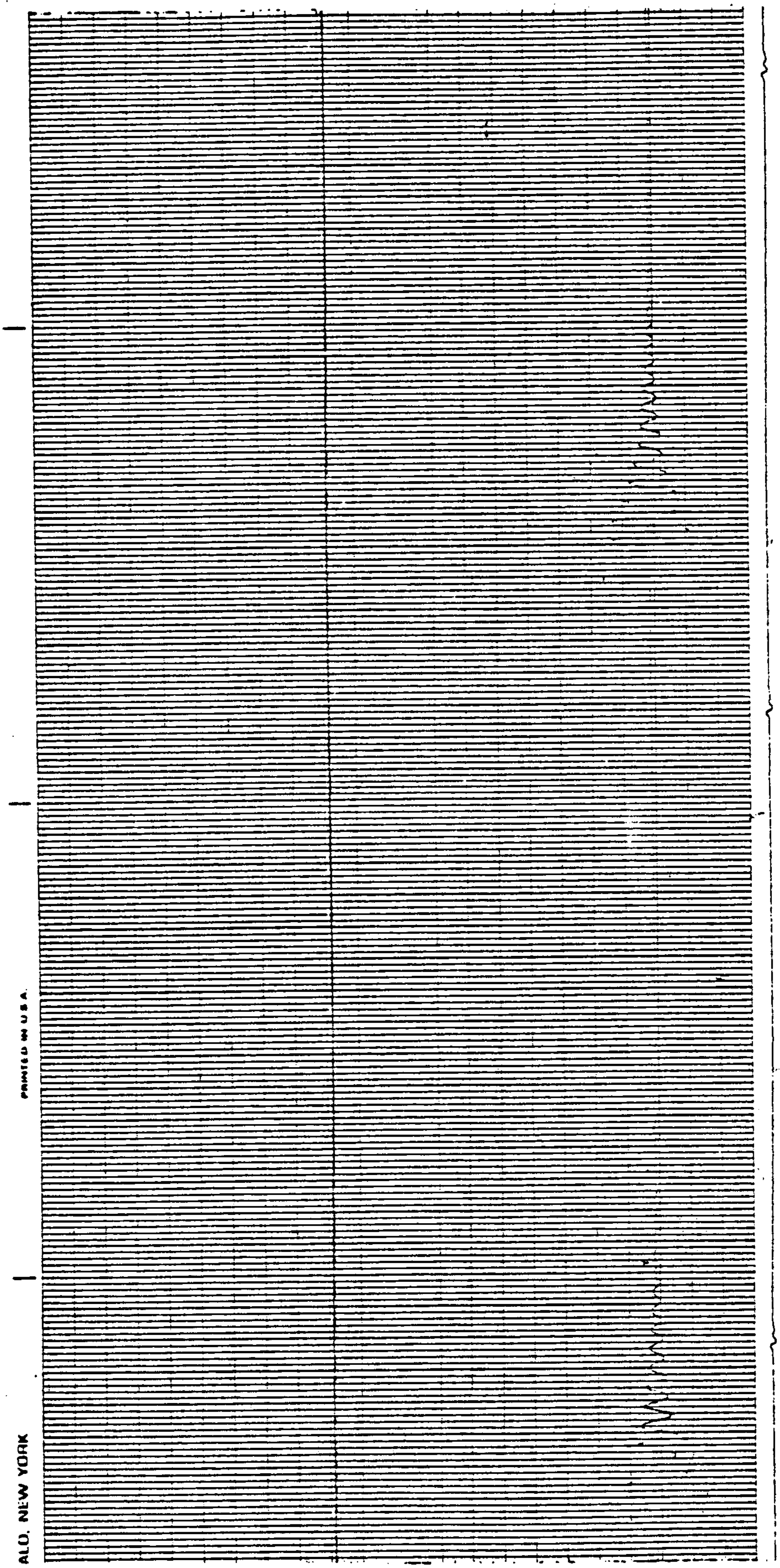
Shipping Section No. 3
Second panel from left
Paper Speed 100mm/sec
30 Hz

502-5-626-0



Shipping Section No. 3
Left Hand Side
Paper Speed 100mm/sec
28.5 Hz

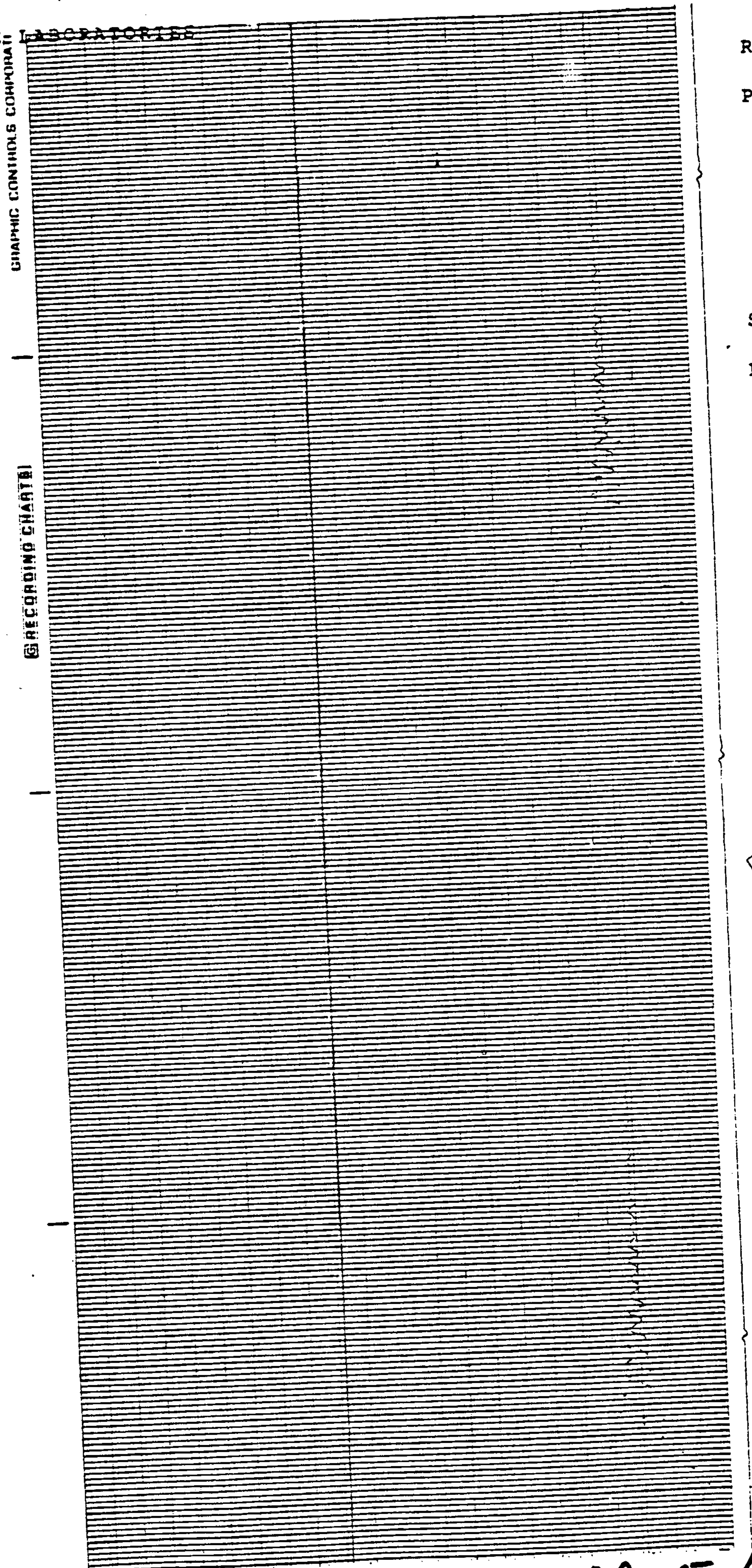
502-5-626-0



Shipping Section No. 4
Right Hand Side
Paper Speed 100mm/sec
30 Hz

POOR ORIGINAL

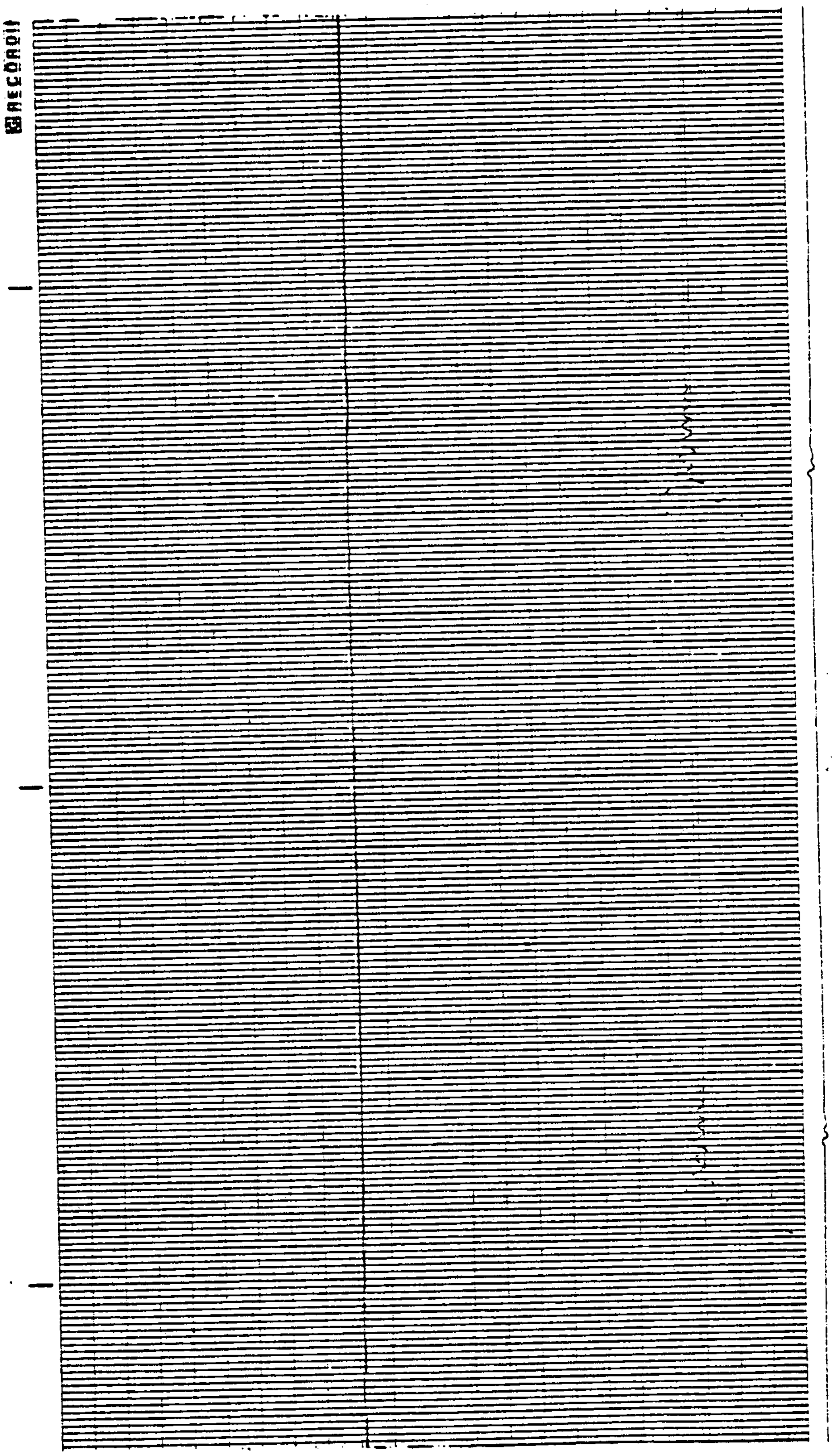
502-5-626-0



Shipping Section No. 4
Left Hand Side
Paper Speed 100mm/sec
30 Hz

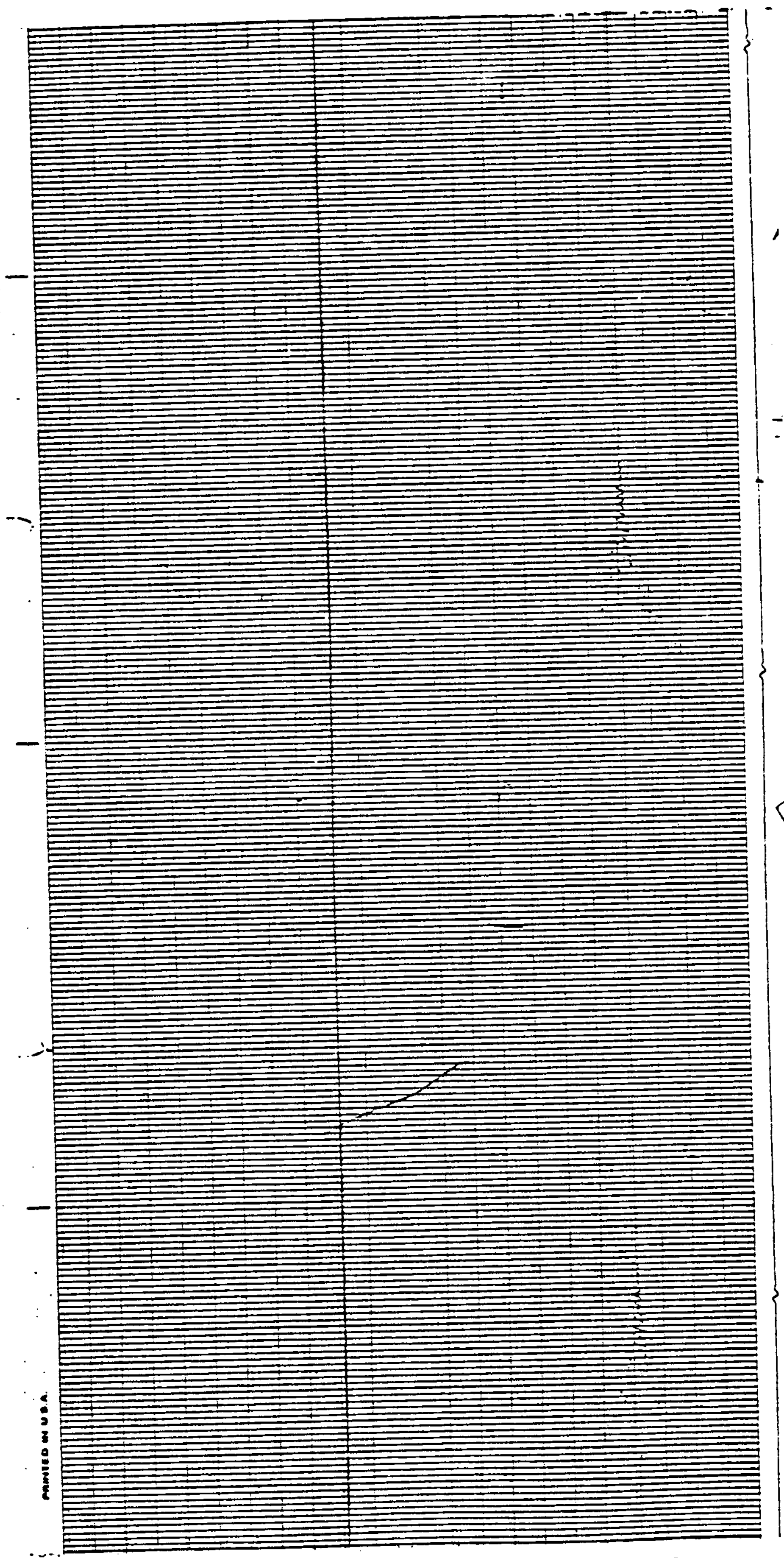
POOR ORIGINAL

502-5-626-0



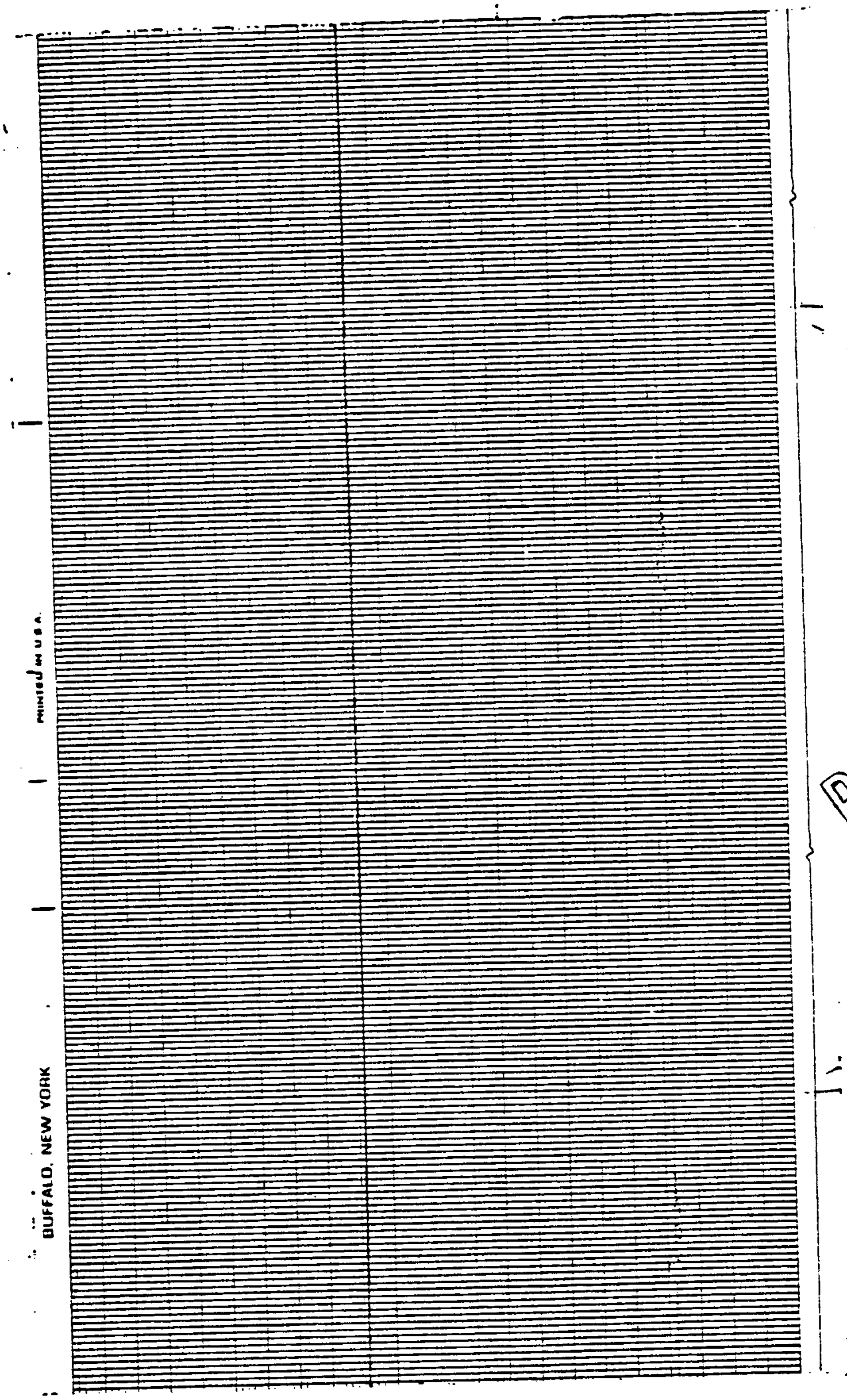
Shipping Section No. 6
Left Hand Side
Paper Speed 100mm/sec
25 Hz

502-5-626-0



Shipping Section No. 7
Lower Right Side
Paper Speed 100mm/sec
72 Hz

502-5-626-0



Shipping Section No. 7
Mid Point Right Hand Side
Paper Speed 100mm/sec

Unable to determine frequency from data.

POOR ORIGINAL

502-5-626-0

SPECIMEN CONTROL ROOM CONSOLES
CUSTOMER CIRCLE A.W.
PART NO. SHIPPING SECTIONS,
S/N 1, 3, 4, 6 & 7
TEST: FREQUENCY RESPONSE

JOB NO. 58344
DATE 9-25-78
TEST BY [signature]
WITNESS

WYLE LABORATORIES

EQUIPMENT	MANUFACTURER	MODEL NO.	RANGE	WYLE NO.	CALIBRATION		ACCY.
					LAST	DUE	
RECORDER	SANBORN	322	DUAL CHANNEL	G50168	9-22-78	3-27-79	± 2%
ACCELEROMETER	C.E.C	4-102 A	5 TO 200 HZ	1088	9-22-78	12-24-78	± 5%
OSCILLATOR	H.P.	200CD	5 TO 600K HZ	30691	3-28-78	10-2-78	± 1%

0-626-5-205

Report No. 58344
Page No. 21

W 614 C Q.C. Approval [initials]

SHEET OF

TEST REPORT

REPORT NO. 58379

WYLE LABORATORIES SCIENTIFIC SERVICES & SYSTEMS GROUP
WESTERN OPERATIONS, NORCO FACILITY

OUR JOB NO. ND 58379

CONTRACT ---

YOUR P. O. NO. 3775

CIRCLE AW PRODUCTS
P. O. Box 2248
2420 South Reservoir Street
Pomona, California 91766

POOR ORIGINAL

8 - Page Report

DATE 16 February 1979

QUALITY CONTROL DEPT.
CIRCLE AW PRODUCTS
APPROVED
SIGNED BY
DATE 3-19-79

5023-502-5-629-0
SCE# 0376

VENDOR PRINT
ENGINEERING
FILE

SEISMIC TESTING
OF
SECTIONS 1 AND 2 OF MAIN CONSOLE
FOR
CIRCLE AW PRODUCTS

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REGISTERED PROFESSIONAL ENGINEER
GEORGE D. SHIPWAY
No. 12157
MECHANICAL
STATE OF CALIFORNIA

STATE OF CALIFORNIA }
COUNTY OF RIVERSIDE } ss.

Ray C. Myrick, being duly sworn, deposes and says: That the information contained in this report is the result of complete and carefully conducted tests and is to the best of his knowledge true and correct in all respects.

SUBSCRIBED and sworn to before me this 16th day of February, 19 79

Notary Public in and for the County of Riverside, State of California

My Commission expires 14 July, 19 79

OFFICIAL SEAL
CATHERINE C. KELTY
NOTARY PUBLIC - CALIFORNIA
RIVERSIDE COUNTY
My comm. expires JUL 14, 1979

W-867A

DEPARTMENT DYNAMICS

DEPT. MGR. J. J. Anderson

TEST ENGINEER Philip Knoll

Registered Professional Engineer G. D. Shipway

DCAS-QAR VERIFICATION

QUALITY CONTROL A. Heeseman

1.0 SUMMARY

Two sections of the main console (Sections 1 and 3) were subjected to seismic testing. Testing was performed at San Onofre Nuclear Generating Stations 2 and 3.

2.0 REFERENCES

2.1 Circle AW Products Purchase Order No. 3775, dated 4 December 1978.

2.2 Wyle Laboratories Test Plan 781213, dated 8 November 1978.

2.3 Wyle Laboratories Test Report No. 54498-1.

3.0 TEST PROCEDURES

3.1 Cabinet Selection

Two sections of the main console (Sections 1 and 3) were chosen for this testing. Along with these two sections, two panels were instrumented and monitored for local resonances. This information was also used for comparison with data accumulated during previous testing. (Reference 1.3)

3.2 Test Setup

The cabinet assembly was tested utilizing an electrodynamic shaker (25 pound force-pound). The shaker was attached to the cabinet utilizing the existing holes in the cabinet to which the cabinet door hinges are attached. At a point of sufficient rigidity that local deflection due to input loads is minimized, and near to the side to side center of gravity of the consoles, a load cell was attached in series with the shaker/shaker to cabinet fixture (stinger). A typical test setup is shown in Figure 1, Page 4.

An accelerometer was attached to the cabinet section adjacent to the shaker stinger attach point. The load cell was used to control the input excitation to the cabinet section. The accelerometer was used to monitor the input motion. A steady state sinusoidal sweep test was performed in the frequency range of 5 to 50 Hz at an input force sufficient to excite the cabinet modes but not cause damage to the test cabinet section.

3.2 (continued)

Two response accelerometers were attached to selected panels and at locations determined by Circle AW and Wyle Laboratories personnel to monitor local panel resonances.

3.3 Test Sequence

Two sine sweeps from 5 to 25 Hz, and from 20 to 50 Hz were performed on each section to acquire data from which the resonance frequencies of the consoles after installation of additional instruments may be extrapolated by the buyer.

3.4 Data Acquisition

The input accelerometer, load cell, and the two response accelerometers were monitored and recorded on a direct readout recorder. The input control accelerometer and load cell were used to monitor the input to the cabinet section, and the response accelerometer to determine the first mode of the cabinet section.

4.0 TEST RESULTS

4.1 A review of the test records showed the first mode of shipping section 1 to be 28 Hz on both the No. 2 and No. 3 accelerometer. (Reference Drawing No. 1, Page 5.)

4.2 A review of the test records for shipping section 3 showed its first mode to be 33 Hz on both No. 2 and No. 3 accelerometers. (Reference Drawing No. 2, Page 6.)

4.3 Test equipment used in this testing is recorded on equipment lists included in this report as Pages 7 and 8.

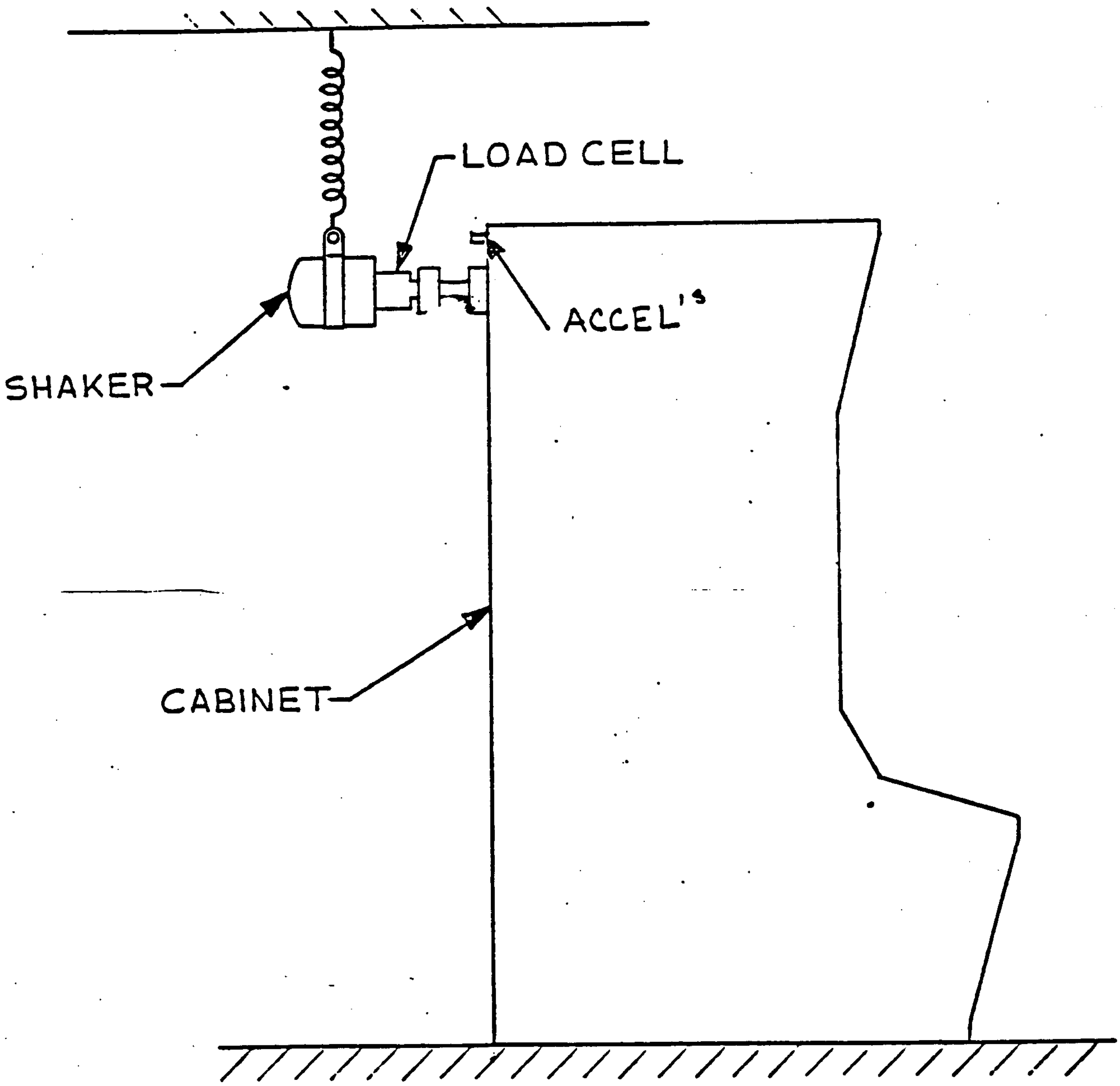
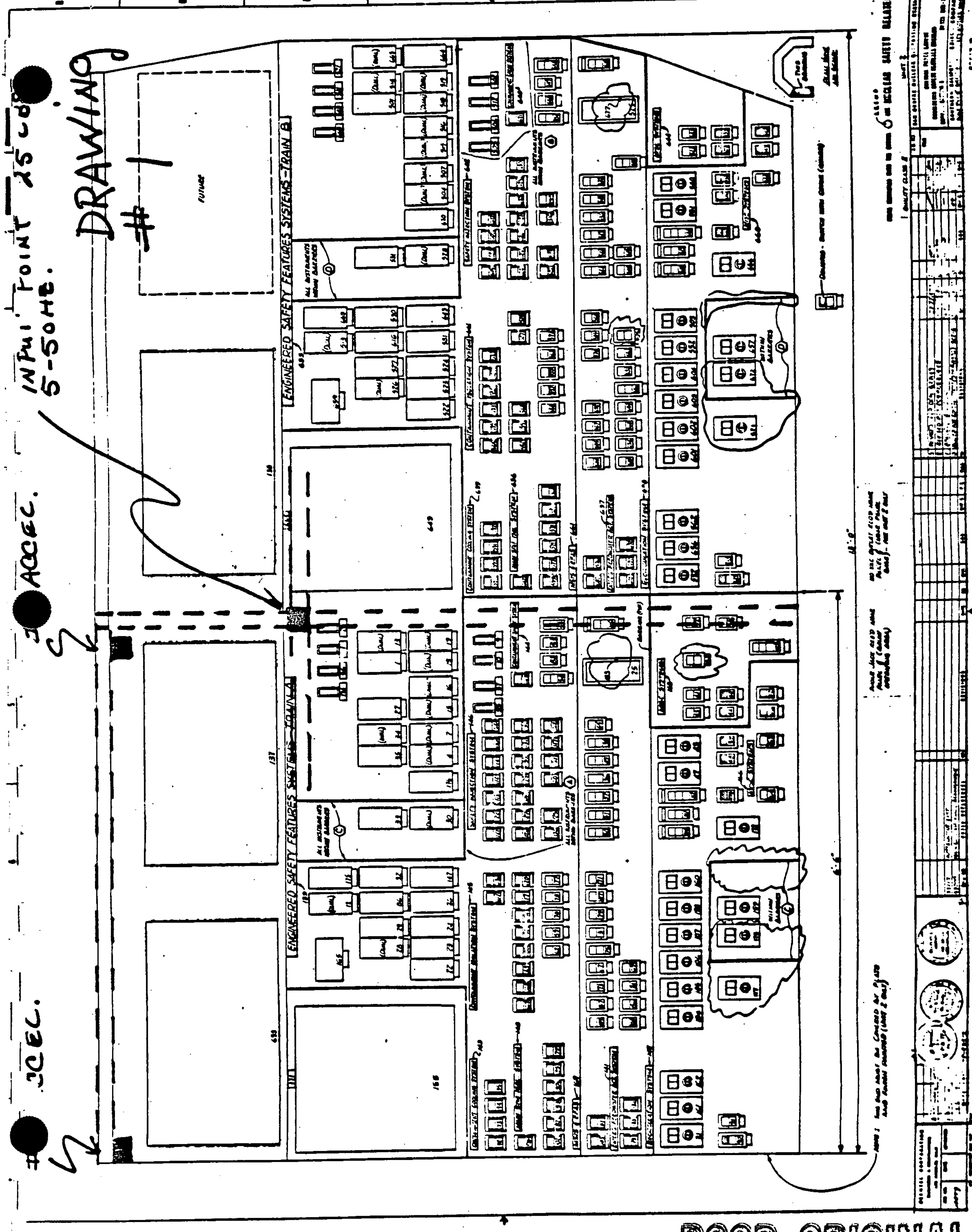
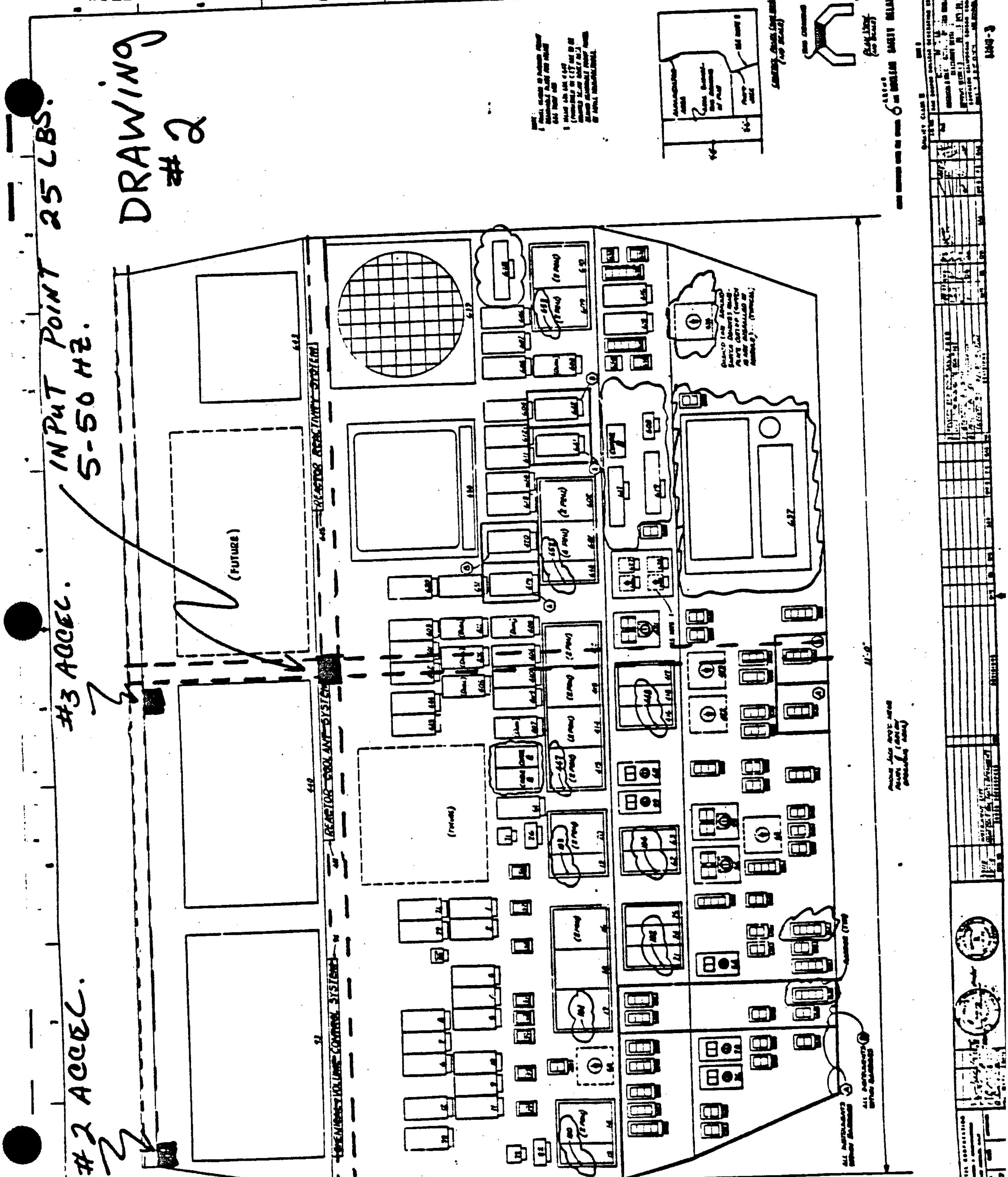


FIG 1

502-5-629-0


INPUT POINT 25 - CB
5-50HE.
DRAWING #1
ACCEL.
ACCEL.
#1
ENGINEERED SAFETY FEATURES SYSTEMS - TRAIN B
ENGINEERED SAFETY FEATURES SYSTEMS - TRAIN A
FUTURE

502-5-629-0


#2 ACCEL.
#3 ACCEL.
INPUT POINT 25 LBS.
5-50 HZ.
DRAWING #2
(FUTURE)
REACTOR COOLANT SYSTEM
REACTOR REACTIVITY SYSTEM

502-5-629-0

SPECIMEN Shipping Sections 1&2

CUSTOMER Circle A W

PART NO.

S/N

JOB NO. 58379

DATE 1-15-79

TEST BY P. Knoll

WITNESS

TEST: Sine Testing

WYLE LABORATORIES

EQUIPMENT	MANUFACTURER	MODEL NO.	RANGE	WYLE NO.	CALIBRATION LAST	CALIBRATION DUE	ACCY.
EXCITER	MB ELECTRONICS	PM25	25 FT LBS	—	SYSTEM	CALIB.	N/A
AMPLIFIER	MB ELECTRONICS	2125	N/A	—	SYSTEM	CALIB.	N/A
LOAD CELL	B.L.H.	VIBDB	0-50 LBS.	RENTAL	11, DEC.	1978	.1%
VISICORDER	HONEYWELL	1108	14 CHANNEL	6695	10-6-78	4-8-79	±2% TIME ±5% PAPER SPEED
ACCELEROMETER	UNHOLTZ DICKIE	75D21	0-1000 g	7567	1-15-79	4-15-79	±2%
ACCELEROMETER	UNHOLTZ DICKIE	75D21	0-1000 g	7155	1-15-79	4-15-79	±2%
ACCELEROMETER	UNHOLTZ DICKIE	75D21	0-1000 g	7302	1-15-79	4-15-79	±2%
ACCELEROMETER	UNHOLTZ DICKIE	2213	0-1000 g	31023	1-12-79	4-12-79	±2%
CHARGE AMP	UNHOLTZ DICKIE	11	0-1000 g	31406	11-30-78	5-27-79	±2%
CHARGE AMP	UNHOLTZ DICKIE	11	0-1000 g	31404	9-18-78	3-18-79	±2%
CHARGE AMP	UNHOLTZ DICKIE	11	0-1000 g	31407	12-1-78	6-3-79	±2%
CHARGE AMP	UNHOLTZ DICKIE	11	0-1000 g	31493	9-18-78	3-18-79	±2%
D.C. MILLIVOLT STANDARD	E.D.C.	E10D	.001 TO 10 VDC	7169	6-29-78	7-1-79	±.01%
SWEEP OSCILLATOR	SPECTRAL DYNAMICS	SD104A-5	.1 TO 5 KHZ	8015	11-1-78	4-29-79	±2%
ELECTRONIC VOLTMETER	B&K	2416	.01 TO 1000 VOLTS	30606	1-3-79	5-6-79	±5%
OSCILLOSCOPE	HEWLETT PACKARD	122AR	DUAL TRACE	5548	9-3-78	3-18-79	±5%
DIGITAL MULTIMETER	NON-LINEAR SYSTEMS	LM-4	1-1000 VOLTS	7808	1-9-79	6-10-79	±.07%

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W 614 C Q.C. Approval AW

SHEET OF

SPECIMEN Shipping SECTIONS 1&2

CUSTOMER CIRCLE AW

PART NO. —

S/N —

TEST: SINE TESTING

JOB NO. 58379

DATE 1-15-79

TEST BY D. KNOLL

WITNESS

WYLE LABORATORIES

EQUIPMENT	MANUFACTURER	MODEL NO.	RANGE	WYLE NO.	CALIBRATION LAST	CALIBRATION DUE	ACCY.
DECADE RESISTOR	GENERAL RADIO	19169	0-40K ohm	7369	10-3-78	4-3-79	± 5%

502-5-629-0

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Page No. 8

W 614 C Q.C. Approval Awt SHEET OF

CIRCLE AW PRODUCTS COMPANY

ENGINEERING REPORT

79060	Approved by [signature]
Page No. 1 of 4 Rev. No. Date 3/22/79	

VENDOR PRINT
ENGINEERING
FILE

EFFECT OF INCREASED INSTRUMENT LOADING ON RESONANT FREQUENCY OF MAIN CONTROL CONSOLES

SAN ONOFRE NUCLEAR GENERATING STATION - UNITS NO. 2 AND NO. 3

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DATE 4-9-79

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QUALITY CONTROL DEPT.
CIRCLE AW PRODUCTS
APPROVED
SIGNED BY [signature]
DATE 3-22-79

PREPARED BY:

[signature]
JOHN A.L. WALKER
PROJECT ENGINEER
CIRCLE A W PRODUCTS CO.

SCE#0376

SO23-502-5-628-0

1.0 PURPOSE

The in-situ impedance tests of reference 2.3 were performed to determine the first-mode resonant frequencies of main control sonsoles identified as Shipping Sections 1 and 3. The data so derived are used below as models for calculations predicting the change in the resonant frequencies resulting from the installation of a maximum number of instruments, a condition hereinafter described as "saturation".

2.0 REFERENCES

2.1 Wyle Laboratories Test Report 54498-1 dated 6/29/76
2.2 Wyle Laboratories Test Report 58344 dated 10/12/78
2.3 Wyle Laboratories Test Report 58379 dated 2/16/79
2.4 Circle A W Products letter 78109 dated 11/15/78
2.5 Circle A W Products letter 79059 dated 3/22/79
2.6 "Theory of Plates and Shells", Timoshenko and Woinowsky-Krieger, Second Edition
2.7 "Shock and Vibration Handbook", Harris and Crede
2.8 "Formulas for Stress and Strain", Roark, Third Edition.

3.0 CONCLUSIONS

Extrapolation from the data of reference 2.3 indicates that the lowest resonant frequency that can be expected from a saturated console is greater than 27hz in the front-to-back axis. Since the amplified portion of the RRS is below 10hz, the frequency design factor is 2.7, or taken as a function of load ÷ stiffness, the structural design factor is $2.7^2 = 7.3$. Only resonances in the front-to-back axis are studied; para. 4.4.1 of reference 2.1 indicates that there are no resonant frequencies of interest in the other axes.

It is important to note here that the local resonances predicted in reference 2.4 are as low as 19.5hz for saturated panels, and it is therefore these resonances which may be the limiting parameter when considering increased instrument loads. In either case the lowest frequency to be expected, as long as the basic structural integrity of the consoles is not diminished, is safely outside the <10hz range of the RRS.

4.0 SHIPPING SECTION 3

Shipping Section 3 was chosen for impedance testing as being a typical panel in regard to proportions, support and loading, and because of the availability of data from previous tests for comparison. The shaker table test of reference 2.1 showed resonance at 10hz, while 33hz was recorded in the impedance test of reference 2.3. These data may be compared by modeling SS3 as a homogeneous rectangular slab. In reference 2.1 there is fixity only at the base, so that the slab acts as a cantilever beam; in reference 2.3 the slab also has support of indeterminate fixity along the vertical edges, being bolted to the adjacent panels. The beam deflection equation is:

$$\delta = \frac{1}{8}\,\frac{Wl^3}{EI} = \frac{1}{8}\,\frac{qab^4}{Eat^3/12} = 1.5\,\frac{qb^4}{Et^3}$$

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where q is the load per unit frontal area, and a and b the width and height. Reference 2.6 gives the deflection of the plate with vertical edge fixity = 0 as:

$$\delta = .019 \frac{qb^4}{Et^3/12(1-\nu^2)}$$

where the coefficient is that for a plate aspect ratio of 0.82, and ν is Poisson's ratio = 0.3. From these equations the ratio of beam to plate deflection is 7.246, so the ratio of frequencies would be expected to be $\sqrt{7.246} = 2.69$. Similar analysis with edge fixity taken as 1.0 gives a frequency ratio of 4.45. The actual ratio of recorded frequencies is 3.3, falling midway between the analytical frequency limits determined by the extremes of the edge fixity conditions. This supports the validity of the modeling and provides a basis for an estimate of change in frequency resulting from saturated instrument loading.

Assuming the width of SS3 to be the median width at mid-height, q is 0.339 lb/in^2. Summing by parts the individual increments of instrument weight as a function of the third power of their height above the base gives

$$M'' = \Sigma Wb^3 = 66097040 \text{ lb in}^3$$

Equating this against the summation of q by integration from the expression in the panel deflection equation gives

$$66097040 \text{ lb in}^3 = \int_0^{108} qb^4 \, db = \left[\frac{1}{5} qb^5\right]_0^{108} = 2938656000 \text{ q in}^5$$

so that the incremental loading, noted as Δq, becomes 0.02239 lb/in^2. The effect on the resonant frequency is $\sqrt{q/q+\Delta q} = 0.968$. This would cause the resonant frequency of SS3 under saturated loading to drop to $33 \times 0.968 \approx 31.9$hz.

5.0 SHIPPING SECTION 1

Shipping Section 1 was chosen for in-situ testing as being atypical in having (as does its structurally symmetrical twin) one unsupported vertical edge. This lack of support also makes SS1 a worst case as regards deflection of the unsupported upper corner. The loss of rigidity is reflected in a lower resonant frequency of 28hz. If SS1 is also modeled as a homogeneous rectangular slab, and assuming no support from the fixed edge, a vertical element at the free edge will deflect according to the equation

$$\delta = \frac{W}{a} \frac{b^3}{8EI} = \frac{6592.5}{a} \frac{108^3}{8EI} = \frac{103808160}{aEI} \text{ in.}$$

Total increment in deflection due to saturation is obtained by summing the deflections caused by each group of added instruments, assuming that they are distributed uniformly across the width of the panel:

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$$\Sigma\delta = \Sigma \frac{W}{a} \frac{(3y^2b - y^3)}{6EI} = \frac{35423390}{aEI} \text{ in.}$$

where y is the distance from the floor to the c.g. of the instrument group. Here the effect of saturation on the resonant frequency is $\sqrt{\delta/\delta + \Sigma\delta} = 0.983$. Applying this factor to the recorded resonant frequency of SS1 gives a reduction in frequency to 28 x 0.983 ≈ 27.5hz.

6.0 OTHER SHIPPING SECTIONS

The other edge-supported panels, having similar structure, proportions, support and loading, would be expected to exhibit similar frequency characteristics. The one exception is SS 6, which is considerably narrower in width; however, a qualitative examination of the equations of reference 2.6 indicates that the resulting higher aspect ratio will increase the resonant frequency, so no analytical study is considered necessary.

502-5-628-0

JOB TITLE: SAN ONOFRE UNITS 2&3
JOB NUMBER: 10079003
DATE: 11/03/80
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PAGE BREAK WORD: 58 59
REPORT TITLE:

SAN ONOFRE UNITS 2 & 3
BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN MAIN CONTROL PANELS

SAN ONOFRE UNITS 2 & 3
BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN MAIN CONTROL PANELS

PANEL NUMBER		INSTRUMENT TAG NUMBER			SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-50	419	2	LI	0110A1	PRESSURIZER LEVEL	924	2XXXHA	SIGMA	9270
2CR-50	420	2	LI	0110A2	PRESSURIZER LEVEL	924	2XXXHA	SIGMA	9270
2CR-50	431	2	HS	0100F1	IE PRZ BACK-UP HEATER E-128	506-2A	21C*HA	MSC	
2CR-50	434	2	HS	010012	IE PRZ BACK-UP HEATER E-129	506-2A	21C*HA	MSC	
2CR-50	447	2	TRN	0111	SHELF	505-10B	21C*HA	FOXBORO	202S-8

OV0002 11/79

SAN ONOFRE UNITS 2 & 3
BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN MAIN CONTROL PANELS

PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-51 641	2 JI 9153-1	RATE OF CHANGE OF POWER	924	2XXXHA	SIGMA	9270
2CR-51 642	2 JI 9153-2	RATE OF CHANGE OF POWER	924	2XXXHA	SIGMA	9270
2CR-51 643	2 UI 9157	REACTOR TRIP STATUS PANEL	944	1XXX	ELTRO MECH	N/A
2CR-51 653	2 TRN 0111A	SHELF	505-10B	21C*HA	FOXBORO	2025-4

SAN ONOFRE UNITS 2 & 3
BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN MAIN CONTROL PANELS

PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-52 001	2 PI 1023A1	STEAM GENERATOR E088 PRESSURE	944	2XXX	SIGMA	9270
2CR-52 001	2 PI 1023B1	STEAM GENERATOR E088 SET POINT	924	2XXX	SIGMA	9270
2CR-52 002	2 PI 1023A2	STEAM GENERATOR E088 PRESSURE	944	2XXX	SIGMA	9270
2CR-52 002	2 PI 1023B2	STEAM GENERATOR E088 SET POINT	924	2XXX	SIGMA	9270
2CR-52 003	2 PI 1023A3	STEAM GENERATOR E088 PRESSURE	944	2XXX	SIGMA	9270
2CR-52 003	2 PI 1023B3	STEAM GENERATOR E088 SET POINT	924	2XXX	SIGMA	9270
2CR-52 004	2 PI 1023A4	STEAM GENERATOR E088 PRESSURE	944	2XXX	SIGMA	9270
2CR-52 004	2 PI 1023B4	STEAM GENERATOR E088 SET POINT	924	2XXX	SIGMA	9270
2CR-52 005	2 PI 1013A1	STEAM GENERATOR E089 PRESSURE	944	2XXX	SIGMA	9270
2CR-52 005	2 PI 1013B1	STEAM GENERATOR E089 SET POINT	924	2XXX	SIGMA	9270
2CR-52 006	2 PI 1013A2	STEAM GENERATOR E089 PRESSURE	944	2XXX	SIGMA	9270
2CR-52 006	2 PI 1013B2	STEAM GENERATOR E089 SET POINT	924	2XXX	SIGMA	9270
2CR-52 007	2 PI 1013A3	STEAM GENERATOR E089 PRESSURE	944	2XXX	SIGMA	9270
2CR-52 007	2 PI 1013B3	STEAM GENERATOR E089 SET POINT	924	2XXX	SIGMA	9270
2CR-52 008	2 PI 1013A4	STEAM GENERATOR E089 PRESSURE	944	2XXX	SIGMA	9270
2CR-52 008	2 PI 1013B4	STEAM GENERATOR E089 SET POINT	944	2XXX	SIGMA	9270
2CR-52 009	2 LI 1123-1	STEAM GENERATOR E088 LEVEL	924	2XXX	SIGMA	9270
2CR-52 009	2 LI 1125-1	STEAM GEN E088 W/RANGE LEVEL IND	924	2XXX	SIGMA	9270
2CR-52 010	2 LI 1123-2	STEAM GENERATOR E088 LEVEL	924	2XXX	SIGMA	9270
2CR-52 010	2 LI 1125-2	STEAM GEN E088 W/RANGE LEVEL IND	924	2XXX	SIGMA	9270
2CR-52 011	2 LI 1123-3	STEAM GENERATOR E088 LEVEL	924	2XXX	SIGMA	9270
2CR-52 012	2 LI 1123A4	STEAM GENERATOR E088 LEVEL	924	2XXX	SIGMA	9270
2CR-52 013	2 LI 1113-1	STEAM GENERATOR E089 LEVEL	924	2XXX	SIGMA	9270
2CR-52 013	2 LI 1115-1	STEAM GEN E089 W/RANGE LEVEL IND	924	2XXX	SIGMA	9270
2CR-52 014	2 LI 1113-2	STEAM GENERATOR E089 LEVEL	924	2XXX	SIGMA	9270
2CR-52 014	2 LI 1115-2	STEAM GEN E089 W/RANGE LEVEL IND	924	2XXX	SIGMA	9270
2CR-52 015	2 LI 1113A3	STEAM GENERATOR E089 LEVEL	924	2XXX	SIGMA	9270
2CR-52 016	2 LI 1113-4	STEAM GENERATOR E089 LEVEL	924	2XXX	SIGMA	9270
2CR-52 017	2 HS 8205A1	MAIN STEAM ISOLATION VALVE	506-2A	21C*HA		
2CR-52 018	2 HS 8203-1	MAIN STEAM ISOL VALVE BYPASS	506-2A	21C*HA		
2CR-52 019	2 HS 8201-1	STM FROM STM GEN TO AUX TURBINE	506-2A	21C*HA		
2CR-52 021	2 HS 4714-2	AUX FEEDWATER TO STM GEN E088 ISOL	506-2A	21C*HA		
2CR-52 021	2 HS 4731-1	AUX FEEDWATER TO STM GEN E-089	506-2A	21C*HA		
2CR-52 021	3 HS 4731-1	AUX FEEDWATER TO STM GEN E-089	506-2A	21C*HA		
2CR-52 023	2 FI 4720-1	AUX FEEDWATER TO STM GEN E088	505-7	21C*HA	SIGMA	9270
2CR-52 024	2 FI 4725-2	AUX FEEDWATER TO STM GEN E089	505-7	21C*HA	SIGMA	9270
2CR-52 070	2 HS 4705-1	AUX FW PUMP P140 DISCH TO SG E088	506-2A	21C*HA		
2CR-52 072	2 HS 4706-2	AUX FW PUMP P140 DISCH TO SG E089	506-2A	21C*HA		
2CR-52 074	2 HS 4712-2	AUX FW PUMP P141 DISCH TO SG E088	506-2A	21C*HA		
2CR-52 076	2 HS 4713-1	AUX FW PUMP P141 DISCH TO SG E089	506-2A	21C*HA		
2CR-52 077	2 HS 4716-2	AUX FW PUMP TURB STOP VALVE	506-2A	21C*HA		
2CR-52 077	2 HS 4733-2	AUX FW PUMP P504	506-2	21C*HA	MSC	
2CR-52 078	2 HS 4707-1	AUX. FEEDWATER PUMP P141	506-2A	21C*HA		
2CR-52 088	2 HS 4730-2	AUX FEEDWATER TO STM GEN E-088	506-2A	21C*HA		

SAN ONOFRE UNITS 2 & 3
BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN MAIN CONTROL PANELS

PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-52 089	2 HS 4715-2	AUX FEEDWATER TO STM GEN E089 ISOL	506-2A	21C*HA		
2CR-52 091	2 HS 8205B2	STM GEN E088 MAIN STM ISO VALVE	506-2A	21C*HA	MSC	
2CR-52 092	2 HS 8202-2	MAIN STEAM ISOL VALVE BYPASS	506-2A	21C*HA		
2CR-52 093	2 HS 8200-2	STM FROM STM GEN TO AUX TURBINE	506-2A	21C*HA		
2CR-52 094	2 HIC 8419A1	MAIN STEAM DUMP TO ATMOSPHERE	505-10A	21C*HA	FOXBORO	255PM+M2N
2CR-52 095	2 HS 8419A1	MAIN STM DUMP TO ATM	506-2A	21C*HA		
2CR-52 096	2 HIC 8421A2	MAIN STEAM DUMP TO ATMOSPHERE	505-10A	21C*HA	FOXBORO	255PM+M2N
2CR-52 097	2 HS 8421A2	MAIN STM DUMP TO ATM	506-2A	21C*HA		
2CR-52 098	2 HS 4054-1	STM GEN E088 BLOWDOWN ISOL	506-2A	21C*HA		
2CR-52 100	2 HS 4053-2	STM GEN E089 BLOWDOWN ISOL	506-2A	21C*HA		
2CR-52 102	2 HS 4058-1	STM GEN E088 WTR SAMPLE ISOL	506-2A	21C*HA		
2CR-52 103	2 HS 4057-2	STM GEN E089 WTR SAMPLE ISOL	506-2A	21C*HA		
2CR-52 108	2 HS 9132-1	REACTOR TRIP	506-2A	21C*HA		
2CR-52 109	2 HS 9132-4	REACTOR TRIP	506-2A	21C*HA		
2CR-52 110	2 HS 9135-3	SIAS ACTUATION	506-2A	21C*HA		
2CR-52 111	2 HS 9136-3	CIAS ACTUATION	506-2A	21C*HA		
2CR-52 112	2 HS 9137-3	MSIS ACTUATION	506-2A	21C*HA		
2CR-52 113	2 HS 9138-3	CCAS ACTUATION	506-2A	21C*HA		
2CR-52 114	2 HS 9139-3	CSAS ACTUATION	506-2A	21C*HA		
2CR-52 115	2 HS 9135-4	SIAS ACTUATION	506-2A	21C*HA		
2CR-52 116	2 HS 9136-4	CIAS ACTUATION	506-2A	21C*HA		
2CR-52 117	2 HS 9137-4	MSIS ACTUATION	506-2A	21C*HA		
2CR-52 118	2 HS 9138-4	CCAS ACTUATION	506-2A	21C*HA		
2CR-52 119	2 HS 9139-4	CSAS ACTUATION	506-2A	21C*HA		
2CR-52 120	2 HS 9140-3	EFAS-1 ACTUATION	506-2A	21C*HA		
2CR-52 121	2 HS 9141-4	EFAS-2 ACTUATION	506-2A	21C*HA		
2CR-52 122	2 HS 9140-4	EFAS-1 ACTUATION	506-2A	21C*HA		
2CR-52 123	2 HS 9141-3	EFAS-2 ACTUATION	506-2A	21C*HA		
2CR-52 126	2 HS 8204B1	STM GEN E089 MAIN STM ISO VALVE	506-2A	21C*HA	MSC	
2CR-52 127	2 HS 8204A2	MAIN STEAM ISOLATION VALVE	506-2A	21C*HA		
2CR-52 135	2 HS 4048-2	STM GEN E088 FW ISO VALVE	506-2A	21C*HA	MSC	
2CR-52 145	2 HCN 8419A1	SHELF	505-10B	21C*HA	FOXBORO	202S-1
2CR-52 146	2 HCN 8421A2	SHELF	505-10B	21C*HA	FOXBORO	202S-1
2CR-52 151	2 HS 8248-1	STM GEN E088 MAIN STM DRAIN LINES	506-2A	21C*HA		
2CR-52 152	2 HS 4052-1	STM GEN E089 FW ISO VALVE	506-2A	21C*HA	MSC	
2CR-52 153	2 HS 8249-2	STM GEN E089 MAIN STM DRAIN LINES	506-2A	21C*HA		
2CR-52 154	2 HS 4052-2	STM GEN E089 FW ISOLATION VALVE	506-2A	21C*HA	MSC	

SAN ONOFRE UNITS 2 & 3
BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN MAIN CONTROL PANELS

PANEL NUMBER		INSTRUMENT TAG NUMBER			SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-56	002	2	HS	9132-3	REACTOR TRIP	506-2A	21C*HA		
2CR-56	003	2	PI	0102A1	PRESSURIZER PRESS	924	2XXXHA	SIGMA	9270
2CR-56	003	2	PI	0102B1	PRESSURIZER PRESS	924	2XXXHA	SIGMA	9270
2CR-56	004	2	JI	0001-1	LOG POWER LEVEL	924	2XXXHA	SIGMA	9270
2CR-56	006	2	HS	9132-2	REACTOR TRIP	506-2A	21C*HA		
2CR-56	007	2	PI	0102A2	PRESSURIZER PRESS	924	2XXXHA	SIGMA	9270
2CR-56	007	2	PI	0102B2	PZR PRESS	924	2XXXHA	SIGMA	9270
2CR-56	008	2	JI	0001-2	LOG POWER LEVEL	924	2XXXHA	SIGMA	9270
2CR-56	011	2	PI	0102A3	PRESSURIZER PRESS	924	2XXXHA	SIGMA	9270
2CR-56	011	2	PI	0102B3	PZR PRESS	924	2XXXHA	SIGMA	9270
2CR-56	012	2	JI	0001A3	LOG POWER LEVEL	924	2XXXHA	SIGMA	9270
2CR-56	015	2	PI	0102A4	PRESSURIZER PRESS	924	2XXXHA	SIGMA	9270
2CR-56	015	2	PI	0102B4	PZR PRESS	924	2XXXHA	SIGMA	9270
2CR-56	016	2	JI	0001A4	LOG POWER LEVEL	924	2XXXHA	SIGMA	9270
2CR-56	018	2	TI	0112-1	LOOP 1 HOT LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	018	2	TI	0122-1	LOOP 2 HOT LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	019	2	TI	9178-1	LOOP 1A COLD LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	019	2	TI	9179-1	LOOP 2A COLD LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	020	2	JI	0003-1	LOCAL POWER DENSI TY MARGIN	924	2XXXHA	SIGMA	9270
2CR-56	021	2	JI	0004-1	DNBR MARGIN	924	2XXXHA	SIGMA	9270
2CR-56	022	2	TI	0112-2	LOOP 1 HOT LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	022	2	TI	0122-2	LOOP 2 HOT LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	023	2	TI	9178-2	LOOP 1B COLD LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	023	2	TI	9179-2	LOOP 2B COLD LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	024	2	JI	0003-2	LOCAL POWER DENSI TY MARGIN	924	2XXXHA	SIGMA	9270
2CR-56	025	2	JI	0004-2	DNBR MARGIN	924	2XXXHA	SIGMA	9270
2CR-56	026	2	TI	0112-3	LOOP 1 HOT LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	026	2	TI	0122-3	LOOP 2 HOT LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	027	2	TI	9178-3	LOOP 1A COLD LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	027	2	TI	9179-3	LOOP 2A COLD LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	028	2	JI	0003-3	LOCAL POWER DENSI TY MARGIN	924	2XXXHA	SIGMA	9270
2CR-56	029	2	JI	0004-3	DNBR MARGIN	924	2XXXHA	SIGMA	9270
2CR-56	030	2	TI	0112-4	LOOP 1 HOT LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	030	2	TI	0122-4	LOOP 2 HOT LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	031	2	TI	9178-4	LOOP 1B COLD LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	031	2	TI	9179-4	LOOP 2B COLD LEG TEMPERATURE	924	2XXXHA	SIGMA	9270
2CR-56	032	2	JI	0003-4	LOCAL POWER DENSI	924	2XXXHA	SIGMA	9270
2CR-56	033	2	JI	0004-4	DNBR MARGIN	924	2XXXHA	SIGMA	9270
2CR-56	034	2	JR	0002A1	EX-CORE LINEAR POWER	924	2XXXHA	FOXBORO	220S-2
2CR-56	034	2	JR	0002B1	CALIBRATED LINEAR POWER	924	2XXXHA	FOXBORO	220S-2
2CR-56	035	2	JR	0002A2	EX-CORE LINEAR POWER	924	2XXXHA	FOXBORO	220S-2
2CR-56	035	2	JR	0002B2	CALIBRATED LINEAR POWER	924	2XXXHA	FOXBORO	220S-2
2CR-56	036	2	JR	0002A3	EX-CORE LINEAR POWER	924	2XXXHA	FOXBORO	220S-2
2CR-56	036	2	JR	0002B3	CALIBRATED LINEAR POWER	924	2XXXHA	FOXBORO	220S-2

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-56 037	2 JR 0002A4	EX-CORE LINEAR POWER	924	2XXXHA	FOXBORO	220S-2
2CR-56 037	2 JR 0002B4	CALIBRATED LINEAR POWER	924	2XXXHA	FOXBORO	220S-2
2CR-56 038	2 UI 9145-1	CORE PROTECTION CALC. MODULE	944	1XXX	SEL	DWG #179100439000
2CR-56 039	2 UI 9146-2	CORE PROTECTION CALC. MODULE	944	1XXX	SEL	DWG #179100439000
2CR-56 040	2 UI 9147-3	CORE PROTECTION CALC. MODULE	944	1XXX	SEL	DWG #179100439000
2CR-56 041	2 UI 9148-4	CORE PROTECTION CALC. MODULE	944	1XXX	SEL	DWG #179100439000
2CR-56 042	2 UI 9149-1	P P S REMOTE CONTROL MODULE	944	1XXX	ELTRO MECH	DWG # 30853
2CR-56 043	2 UI 9150-2	P P S REMOTE CONTROL	944	1XXX	ELTRO MECH	DWG # 30853
2CR-56 044	2 UI 9151-3	P P S REMOTE CONTROL MODULE	944	1XXX	ELTRO MECH	DWG # 30853
2CR-56 045	2 UI 9152-4	P P S REMOTE CONTROL MODULE	944	1XXX	ELTRO MECH	DWG # 30853
2CR-56 046	2 HS 9135-1	SIAS ACTUATION	506-2A	21C*HA		
2CR-56 047	2 HS 9136-1	CIAS ACTUATION	506-2A	21C*HA		
2CR-56 048	2 HS 9137-1	MSIS ACTUATION	506-2A	21C*HA		
2CR-56 049	2 HS 9138-1	CCAS ACTUATION	506-2A	21C*HA		
2CR-56 050	2 HS 9139-1	CSAS ACTUATION	506-2A	21C*HA		
2CR-56 051	2 HS 9135-2	SIAS ACTUATION	506-2A	21C*HA		
2CR-56 052	2 HS 9136-2	CIAS ACTUATION	506-2A	21C*HA		
2CR-56 053	2 HS 9137-2	MSIS ACTUATION	506-2A	21C*HA		
2CR-56 054	2 HS 9138-2	CCAS ACTUATION	506-2A	21C*HA		
2CR-56 055	2 HS 9139-2	CSAS ACTUATION	506-2A	21C*HA		
2CR-56 056	2 HS 9140-1	EFAS-1 ACTUATION	506-2A	21C*HA		
2CR-56 057	2 HS 9141-2	EFAS-2 ACTUATION	506-2A	21C*HA		
2CR-56 058	2 HS 9140-2	EFAS-1 ACTUATION	506-2A	21C*HA		
2CR-56 059	2 HS 9141-1	EFAS-2 ACTUATION	506-2A	21C*HA		
2CR-56 060	2 PI 0101-1	PRESSURIZER PRESS	924	2XXXHA	SIGMA	9270
2CR-56 061	2 PI 0101-2	PRESSURIZER PRESS	924	2XXXHA	SIGMA	9270
2CR-56 062	2 PI 0101-3	PRESSURIZER PRESS	924	2XXXHA	SIGMA	9270
2CR-56 063	2 PI 0101-4	PRESSURIZER PRESS	924	2XXXHA	SIGMA	9270
2CR-56 067	2 JRN 0002-1	RECORDER SHELF	924	2XXX	FOXBORO	202S-5
2CR-56 068	2 JRN 0002-2	RECORDER SHELF	924	2XXX	FOXBORO	202S-5
2CR-56 069	2 JRN 0002-3	RECORDER SHELF	924	2XXX	FOXBORO	202S-5
2CR-56 070	2 JRN 0002-4	RECORDER SHELF	924	2XXX	FOXBORO	202S-5
2CR-56 071	2 PDI 0978-1	STEAM GENERATOR E089 AP	924	2XXX	SIGMA	9270
2CR-56 071	2 PDI 0979-1	STEAM GENERATOR E088 AP	924	2XXX	SIGMA	9270
2CR-56 072	2 PDI 0978-2	STEAM GENERATOR E089 AP	924	2XXX	SIGMA	9270
2CR-56 072	2 PDI 0979-2	STEAM GENERATOR E088 AP	924	2XXX	SIGMA	9270
2CR-56 073	2 PDI 0978-3	STEAM GENERATOR E089 AP	924	2XXX	SIGMA	9270
2CR-56 073	2 PDI 0979-3	STEAM GENERATOR E088 AP	924	2XXX	SIGMA	9270
2CR-56 074	2 PDI 0978-4	STEAM GENERATOR E089 AP	924	2XXX	SIGMA	9270
2CR-56 074	2 PDI 0979-4	STEAM GENERATOR E088 AP	924	2XXX	SIGMA	9270

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-57 003	2 HS 9334-1	SI TANK DRN HDR TO REFUEL WTR TK	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 009	2 ZI 9333-1	HPSI HDR #1 TO RC LOOP 2B	924	2XXX	SIGMA	1136 OOE
2CR-57 010	2 ZI 9330-1	HPSI HDR #1 TO RC LOOP 2A	924	2XXX	SIGMA	1136 OOE
2CR-57 012	2 FI 0321-1	HP SAFETY INJECT FLOW TO TANK #2	924	2XXX	SIGMA	9270 OOE
2CR-57 012	2 FI 0331-1	HP SAFETY INJECT FLOW TO TANK #3	924	2XXX	SIGMA	9270 OOE
2CR-57 014	2 ZL 9369-1	SHUTDOWN COOLER BYPASS VALVE	505-5	21C*HA		
2CR-57 022	2 TI 0303-1	SHUTDOWN COOLING HX #1 OUTLET TEMP	924	2XXX	SIGMA	9270
2CR-57 023	2 PI 0303-1	SHUTDOWN COOLING HX #1 INLET PRESS	924	2XXX	SIGMA	9270
2CR-57 024	2 FI 0338-1	CNTMT SPRAY PUMP DIS FLOW	924	2XXX	SIGMA	9270
2CR-57 025	2 FIC 0318-1	CNTMT SPRAY CHEM STORAGE TK FLOW	924	2XXX	FOXBORO	250-PF-M2N-S
2CR-57 026	2 LI 0348B1	CHEMICAL STORAGE TANK LEVEL	924	2XXX	SIGMA	9270
2CR-57 028	2 PI 0351-1	CONTAINMENT PRESS FOR ESF CONTROL	924	2XXX	SIGMA	9270
2CR-57 028	2 PI 0352-1	CONTAINMENT PRESS FOR ESF CONTROL	924	2XXX	SIGMA	9270
2CR-57 029	2 TI 9903-1	CONTAINMENT ATMOS TEMP IND-EMERG	505-7	21C*HA	SIGMA	9270
2CR-57 030	2 PI 0351-3	CONTAINMENT PRESS FOR ESF CONTROL	924	2XXX	SIGMA	9270
2CR-57 030	2 PI 0352-3	CONTAINMENT PRESS FOR ESF CONTROL	924	2XXX	SIGMA	9270
2CR-57 031	2 HS 9300-1	REFUELING WTR TK OUTLET VALVE	506-2B	21C*HA	MSC	
2CR-57 032	2 LI 0305-1	REFUELING WTR TKS T005&T006 LEVEL	924	2XXX	SIGMA	9270 OOD
2CR-57 033	2 LI 0305-3	REFUELING WTR TKS T005&T006 LEVEL	924	2XXX	SIGMA	9270 OOD
2CR-57 036	2 HS 9333-1	HPSI HDR #1 TO RC LOOP 2B	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 037	2 HS 9330-1	HPSI HDR #1 TO RC LOOP 2A	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 038	2 HS 9328-1	LPSI HEADER TO RC LOOP 2A	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 039	2 HS 9361-1	SI TANK LEAKAGE DRAIN VALVE	506-2A	21C*HA		
2CR-57 042	2 HS 9375-1	SAFETY INJECTION TANK T010 VENT	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 043	2 HS 9360A1	SAFETY INJECT. TK T009 OUTLET VALVE	506-2B	21C*HA	MSC	MCROSW/PTK SERIES
2CR-57 046	2 HS 9345-1	SAFETY INJECTION TANK T008 VENT	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 047	2 HS 9350A1	SAFETY INJECT. TK T007 OUTLET VALVE	506-2B	21C*HA	MSC	MCROSW/PTK SERIES
2CR-57 048	2 HS 9351-1	SI TANK LEAKAGE DRAIN VALVE	506-2A	21C*HA		
2CR-57 049	2 HS 9325-1	LPSI HEADER TO RC LOOP 1B	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 050	2 HS 9324-1	HPSI HDR #1 TO RC LOOP 1A	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 051	2 HS 9327-1	HPSI HDR #1 TO RC LOOP 1B	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 053	2 HS 9367-1	SHUTDN HT EXCH TO CONTMT SP HDR #1	506-2A	21C*HA		
2CR-57 054	2 HS 0318-1	SPRAY CHEM FLOW CONTROL VALVE	506-2A	21C*HA	MSC	
2CR-57 055	2 ZI 9324-1	HPSI HDR #1 TO RC LOOP 1A	924	2XXX	SIGMA	1136 OOE
2CR-57 057	2 ZI 9327-1	HPSI HDR #1 TO RC LOOP 1B	924	2XXX	SIGMA	1136 OOE
2CR-57 059	2 HS 0511A1	PRES'ZR STEAM SAMPLE ISOL VALVE	506-2A	21C*HA		
2CR-57 060	2 ZL 0221-1	LETDOWN TO LETDWN HT XCHNGR VALVE	505-5	21C*HA		
2CR-57 061	2 ZL 9253-1	MAKE-UP WTR TO VOL CONTROL TANK	505-5	21C*HA		
2CR-57 062	2 HS 0509A1	RC HOT LEG SAMPLE ISOLATION VALVE	506-2A	21C*HA		
2CR-57 063	2 ZL 9218-1	RC PMP BLEED OFF TO VOL CONTROL TK	505-5	21C*HA		
2CR-57 064	2 ZL 9236-1	BORIC ACID MAKEUP TK T071 RECIRC.	505-5	21C*HA		
2CR-57 065	2 HS 9247-1	BA PUMPS TO CHG PUMPS SUCTION	506-2A	21C*HA		
2CR-57 066	2 ZL 9242-1	BORIC ACID MAKE-UP PUMP P174	505-5	21C*HA		
2CR-57 067	2 HS 9920-1	CONTAINMENT NORM COOL SUP ISO VV	506-2A	21C*HA		

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-57 069	2 HS 9921-1	CONTAINMENT NORM COOL RET ISO VV	506-2A	21C*HA		
2CR-57 070	2 HS 0513A1	PRES'ZR SURGE LN SAMPLE ISOL VALVE	506-2A	21C*HA		
2CR-57 071	2 HS 5803-1	COMTAINMENT SUMP TO RADWASTE SUMP	506-2A	21C*HA		
2CR-57 072	2 ZL 4058-1	STM GEN E088 WTR SAMPLE ISOL	505-5	21C*HA		
2CR-57 073	2 HS 9949-1	CONTAINMENT PURGE SUP UNIT A374 ISO	506-2A	21C*HA		
2CR-57 074	2 HS 9951-1	CONTAINMENT PURGE EXH UNIT A060 ISO	506-2A	21C*HA		
2CR-57 075	2 HS 5388-1	INSTRUMENT AIR ISOLATION VALVE	506-2A	21C*HA		
2CR-57 077	2 HS 0516A1	GAS SAMPLE ISOLATION VALVE	506-2A	21C*HA		
2CR-57 078	2 HS 0514A1	GAS SAMPLE ISOLATION VALVE	506-2A	21C*HA		
2CR-57 079	2 HS 7512-1	CONTAINMENT ISOL RC DRN TO RDW SYS	506-2A	21C*HA		
2CR-57 080	2 ZL 8419-1	MAIN STEAM DUMP TO ATMOS.	505-5	21C*HA		
2CR-57 081	2 ZL 8201-1	MAIN STM TO AUX FW PUMP	505-5	21C*HA		
2CR-57 082	2 ZL 8205-1	MAIN STEAM ISOL VALVE	505-5	21C*HA		
2CR-57 083	2 ZL 8203-1	MAIN STM ISOL. VALVE BYPASS	505-5	21C*HA		
2CR-57 085	2 ZL 4054-1	STM GEN E088 BLOWDOWN ISOL	505-5	21C*HA		
2CR-57 086	2 LI 9386-1	CONTAINMENT EMERG SUMP	505-7B	21C*HA	SIGMA	9270
2CR-57 086	2 LI 9387-1	CONTAINMENT AREA LEVEL	505-7B*	21C*HA	SIGMA	9270
2CR-57 087	2 ZL 4871-1	AUX STEAM CNTMT ISO VV (OUTSIDE)	505-5	21C*HA		
2CR-57 088	2 ZL 9205-1	REGULAR HT EXCH TO LETDWN HT EXCH	505-5	21C*HA		
2CR-57 089	2 HS 7259-1	CONTAINMENT ISOL SI TANK VENT HDR	506-2A	21C*HA		
2CR-57 090	2 HS 9303-1	CONTAINMENT EMER SUMP OUTLET VALVE	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 091	2 HS 9305-1	CONTAINMENT EMER SUMP OUTLET VALVE	506-2A	21C*HA		
2CR-57 092	2 ZL 6366-1	CCW TO EMERGENCY COOLING UNIT E401	505-5	21C*HA		
2CR-57 093	2 ZL 6370-1	CCW TO EMERGENCY COOLING UNIT E399	505-5	21C*HA		
2CR-57 094	2 ZL 6371-1	CCW FRM EMERGENCY COOLING UNIT E399	505-5	21C*HA		
2CR-57 095	2 ZL 6367-1	CCW FRM EMERGENCY COOLING UNIT E401	505-5	21C*HA		
2CR-57 096	2 ZL 4731-1	AUX FEEDWATER TO STM GEN E-089	505-5	21C*HA	MSC	
2CR-57 097	2 HS 9823-1	CONT PURGE SPLY ISO VALVE	506-2A	21C*HA	MSC	
2CR-57 098	2 HS 9825-1	CONT MINI-PURGE EXH ISO VALVE	506-2A	21C*HA	MSC	
2CR-57 102	2 ZL 4048-1	STM GEN E088 FW ISOLATION VALVE	505-5	21C*HA		
2CR-57 103	2 ZL 4714-1	AUX FEEDWATER TO STM GEN E088	505-5	21C*HA		
2CR-57 108	2 HS 7801-1	CNTMT AIRBORNE RAD MON TRN A-ISO	506-2A	21C*HA		
2CR-57 109	2 HS 7802-1	CNTMT AIRBORNE RAD MON TRN A-ISO	506-2A	21C*HA		
2CR-57 110	2 HS 9392-1	HPSI PUMP P017	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 111	2 HS 9393-1	H.P.S.I. PUMP P018	506-2A	21C*HA		
2CR-57 112	2 HS 9390-1	LPSI PUMP P015	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 113	2 ZL 9228-1	CHARGING PUMP P190	505-5	21C*HA		
2CR-57 114	2 ZL 9229-1	CHARGING PUMP P191	505-5	21C*HA		
2CR-57 115	2 HS 9395-1	CONTAINMENT SPRAY PUMP P012	506-2A	21C*HA		
2CR-57 116	2 ZL 9241-1	BORIC ACID MAKE-UP PUMP P175	505-5	21C*HA		
2CR-57 117	2 ZL 9231-1	BORIC ACID MAKEUP TK T072 RECIRC.	505-5	21C*HA		
2CR-57 119	2 ZL 4707-1	AUX FW PUMP P141	505-5	21C*HA		
2CR-57 121	2 ZL 6314-1	C.C. WATER PUMP P024	505-5	21C*HA		
2CR-57 122	2 ZL 6320-1	C.C. WTR PUMP P025	505-5	21C*HA		

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-57 123	2 ZL 6501-1	CCW FROM SHUTDOWN HT. EXCH. E004	505-5	21C*HA		
2CR-57 124	2 ZL 6218-1	C.C. WTR NON-CRIT LOOP A RETURN VAL	505-5	21C*HA		
2CR-57 125	2 ZL 6212-1	CCW NON-CRITICAL LOOP A INLET VV.	505-5	21C*HA		
2CR-57 126	2 ZL 6497-1	SALT WTR. FROM CCW HT EXCH E001	505-5	21C*HA		
2CR-57 127	2 ZL 6380-1	SALT WTR. COOL. PUMP P112	505-5	21C*HA		
2CR-57 128	2 ZL 6382-1	SALT WTR. COOL. PUMP P307	505-5	21C*HA		
2CR-57 129	2 ZL 6200-1	SALT WTR CLG PUMP P112 DISCH VALVE	505-5	21C*HA		
2CR-57 130	2 ZL 6202-1	SALT WTR CLG PUMP P307 DISCH VALVE	505-5	21C*HA		
2CR-57 131	2 ZL 6376-1	SALT WTR COOLING PUMP P112 BRG WTR	505-5	21C*HA		
2CR-57 132	2 ZL 6378-1	SALT WTR COOLING PUMP P307 BRG WTR	505-5	21C*HA		
2CR-57 133	2 ZL 4713-1	MOTOR DR AUX FW PMP P141 DISCH VV	505-5	21C*HA		
2CR-57 134	2 HS 4048-1	STM GEN E088 ISOLATION VALVE	506-2A	21C*HA		
2CR-57 134	2 ZL 4712-2	AUX FW PUMP P141 DISCH TO SG E088	505-5	21C*HA		
2CR-57 136	2 ZL 4870-1	AUX STEAM CNTMT ISO VV (INSIDE)	505-5	21C*HA		
2CR-57 147	2 TI 0351-1	LOW PRESS SAFETY INJECTION TEMP	924	2XXXHA	SIGMA	9270
2CR-57 150	2 ZL 9945-1	HYD. PURGE SUPPLY UNIT A080 ISO VV	505-5	21C*HA		
2CR-57 151	2 ZL 9918-1	HYD. PURGE EXHST UNIT A082 ISO VV	505-5	21C*HA		
2CR-57 152	2 HS 9407-1	SPRAY CHEM ADD PUMP	506-2A	21C*HA	MSC	
2CR-57 153	2 HS 9399-1	SPRAY CHEM. ADD. PMP DISCH VALVE	506-2A	21C*HA		
2CR-57 156	2 HS 7810-1	CNTMT AIRBORNE RAD MON TRN A-ISO	506-2A	21C*HA		
2CR-57 157	2 HS 7811-1	CNTMT AIRBORNE RAD MON TRN B-ISO	506-2A	21C*HA		
2CR-57 158	2 HS 9379-1	S.D. COOL SYSTEM FROM RC LOOP (N)	506-2B	21C*HA	MSC	MCROSW/PTK SERIES
2CR-57 159	2 HS 9377A3	S.D. COOL SYSTEM FROM RC LOOP (N)	506-2B	21C*HA	MSC	MCROSW/PTK SERIES
2CR-57 160	2 HS 8150-1	SHUTDN COOL FLOW FROM RC LOOP 2	506-2B	21C*HA	MSC	PT SERIES
2CR-57 160	2 HS 9337A1	SHUTON COOL FLOW FROM RC LOOP 2	506-2B	21C*HA	MSC	MCROSW/PTK SERIES
2CR-57 161	2 HS 9306-1	SAFETY INJ & CONT SPRAY PP MINI-FLO	506-2B	21C*HA	MSC	
2CR-57 162	2 HS 9307-1	SAFETY INJ & CONT SPRAY PP MINI-FLO	506-2B	21C*HA	MSC	
2CR-57 163	2 HS 9353-1	S.D. COOL SYSTEM WARM UP BYPASS	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 164	2 HS 7890-1	EMERGENCY EVACUATION SIREN	506-2A	21C*HA		
2CR-57 165	2 ZL 9480-1	AREA FLOODING INDICATION	505-5	21C*HA	MSC	
2CR-57 167	2 ZL 6223-1	CCW NON-CRITICAL INLET ISOL. VALVE	505-5	21C*HA		
2CR-57 168	2 ZL 6236-1	CCW NON-CRITICAL OUTLET VALVE	505-5	21C*HA		
2CR-57 170	2 ZL 8248-1	STM GEN E088 MAIN STM DRAIN LINES	505-5	21C*HA		
2CR-57 172	2 HS 8152-1	HPSI TO RC LOOP 2 HOT LEG	506-2B	21C*HA	MSC	
2CR-57 172	2 HS 9420-1	HPSI TO RC LOOP 2 HOT LEG	506-2B	21C*HA	MSC	
2CR-57 173	2 HS 9433-1	RC LOOP 2 HOT LEG INJECTION DRAIN	506-2A	21C*HA		
2CR-57 175	2 FI 9421-1	HPSI FLOW TO RC LOOP 2 HOT LEG	924	2XXX	SIGMA	9270
2CR-57 177	2 HS 0352-1	CONTAINMENT PRESS SENSE LINE ISO VV	506-2B	21C*HA	MSC	
2CR-57 178	2 HS 0352-3	CONTAINMENT PRESS SENSE LINE ISO VV	506-2B	21C*HA	MSC	
2CR-57 183	2 FCN 0318-1	SHELF	924	2XXX		
2CR-57 191	2 HS 9092-1	CONT. SUMP DISCH VALVE	506-2A	21C*HA	MSC	
2CR-57 191	3 HS 9092-1	CONT. SUMP DISCH VALVE	506-2A	21C*HA	MSC	
2CR-57 192	2 HS 9090-1	CHILLED WATR FROM AND TO CONTAINMNT	506-2A	21C*HA	MSC	
2CR-57 193	2 HS 0590-1	SAMPLING SYSTEMS	506-2	21C*HA	MSC	

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PANEL NUMBER		INSTRUMENT TAG NUMBER			SERVICE DESCRIPTION		SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-57	193	3	HS	0590-1	SAMPLING SYSTEMS		506-2	21C*HA	MSC	
2CR-57	194	2	HS	7861-1	RAD MONITORING	SYSTEMS	506-2	21C*HA	MSC	SYSTEM
2CR-57	194	3	HS	7861-1	RAD MONITORING	SYSTEMS	506-2	21C*HA	MSC	SYSTEM
2CR-57	196	2	HS	9093-2	NUCLEAR SERVICE	WATER	506-2A	21C*HA	MSC	
2CR-57	197	2	HS	9092-2	CONT. SUMP DISCH	VALVE	506-2A	21C*HA	MSC	
2CR-57	198	2	HS	9090-2	CHILLED WATR FROM	AND TO CONTAINMNT	506-2A	21C*HA	MSC	
2CR-57	199	2	HS	0590-2	SAMPLING SYSTEMS		506-2	21C*HA	MSC	
2CR-57	206	2	AI	8108A1	CONT POST LOCA H2	CONCENTRATION	505-7	21C*HA	SIGMA	9270
2CR-57	207	2	HS	8107A1	CONT POST LOCA H2	MON SYS ON-OFF	506-2A	21C*HA	MSC	
2CR-57	502	2	ZI	9332-2	HPSI HDR #2 TO	RC LOOP 2B	924	2XXX	SIGMA	1136 OOE
2CR-57	503	2	HS	8151-2	SHUTDN COOL FLOW	FROM RC LOOP 2	506-2B	21C*HA	MSC	
2CR-57	503	2	HS	9339A2	SHUTON COOL FLOW	FROM RC LOOP 2	506-2B	21C*HA	MSC	MCROSW/PTK SERIES
2CR-57	505	2	ZI	9323-2	HPSI HDR #2 TO	RC LOOP 1A	924	2XXX	SIGMA	1136 OOE
2CR-57	506	2	ZI	9326-2	HPSI HDR #2 TO	RC LOOP 1B	924	2XXX	SIGMA	1136 OOE
2CR-57	510	2	ZL	9204-2	LETDOWN TO REGEN.	HEAT EXCHANGER	505-5	21C*HA		
2CR-57	512	2	ZI	9329-2	HPSI HDR #2 TO	RC LOOP 2A	924	2XXX	SIGMA	1136 OOE
2CR-57	513	2	FI	0311-2	HP SAFETY INJECT	FLOW TO TANK #1	924	2XXX	SIGMA	9270 OOE
2CR-57	513	2	FI	0341-2	HP SAFETY INJECT	FLOW TO TANK #4	924	2XXX	SIGMA	9270 OOE
2CR-57	517	2	ZL	9946-2	HYD. PURGE SUPPLY	UNIT A080 ISO VV	505-5	21C*HA		
2CR-57	520	2	ZL	9917-2	HYD. PURGE EXHST	UNIT A082-ISO VV	505-5	21C*HA		
2CR-57	522	2	TI	0303-2	SHUTDOWN COOLING	HX #2 OUTLET TEMP	924	2XXX	SIGMA	9270
2CR-57	523	2	PI	0303-2	SHUTDOWN COOLING	HX #2 INLET PRESS	924	2XXX	SIGMA	9270
2CR-57	524	2	FI	0348-2	CNTMT SPRAY PUMP	DIS FLOW	924	2XXX	SIGMA	9270
2CR-57	525	2	FIC	0328-2	CNTMT SPRAY CHEM	STORAGE TK FLOW	924	2XXX	FOXBORO	2 AC 230 SF
2CR-57	526	2	PI	0351-2	CONTAINMENT PRESS	FOR ESF CONTROL	924	2XXX	SIGMA	9270
2CR-57	526	2	PI	0352-2	CONTAINMENT PRESS	FOR ESF CONTROL	924	2XXX	SIGMA	9270
2CR-57	527	2	TI	9911-2	CONTAINMENT ATMOS	TEMP IND-EMERG	505-7	21C*HA	SIGMA	9270
2CR-57	528	2	PI	0351-4	CONTAINMENT PRESS	FOR ESF CONTROL	924	2XXX	SIGMA	9270
2CR-57	528	2	PI	0352-4	CONTAINMENT PRESS	FOR ESF CONTROL	924	2XXX	SIGMA	9270
2CR-57	530	2	LI	0305-2	REFUELING WTR TKS	T005&T006 LEVEL	924	2XXX	SIGMA	9270 OOD
2CR-57	531	2	LI	0305-4	REFUELING WTR TKS	T005&T006 LEVEL	924	2XXX	SIGMA	9270 OOD
2CR-57	532	2	HS	9301-2	REFUELING WTR TK	OUTLET VALVE	506-2B	21C*HA	MSC	
2CR-57	536	2	HS	9332-2	HPSI HDR #2 TO	RC LOOP 2B	506-2A	21C*HA	MSC	SERIES 10H
2CR-57	537	2	HS	9331-2	LPSI HEADER TO	RC LOOP 2B	506-2A	21C*HA	MSC	SERIES 10H
2CR-57	537	2	HS	9371-2	SI TANK LEAKAGE	DRAIN VALVE	506-2A	21C*HA		
2CR-57	540	2	HS	9370A2	SAFETY INJECT. TK	T010 OUTLET VALVE	506-2B	21C*HA	MSC	MCROSW/PTK SERIES
2CR-57	542	2	HS	9365-2	SAFETY INJECTION	TANK T009 VENT	506-2A	21C*HA	MSC	SERIES 10H
2CR-57	543	2	HS	9329-2	HPSI HDR #2 TO	RC LOOP 2A	506-2A	21C*HA	MSC	SERIES 10H
2CR-57	544	2	HS	9323-2	HPSI HDR #2 TO	RC LOOP 1A	506-2A	21C*HA	MSC	SERIES 10H
2CR-57	545	2	HS	9322-2	LPSI HEADER TO	RC LOOP 1A	506-2A	21C*HA	MSC	SERIES 10H
2CR-57	546	2	HS	9326-2	HPSI HDR #2 TO	RC LOOP 1B	506-2A	21C*HA	MSC	SERIES 10H
2CR-57	549	2	HS	9355-2	SAFETY INJECTION	TANK T007 VENT	506-2A	21C*HA	MSC	SERIES 10H
2CR-57	550	2	HS	9341-2	SI TANK LEAKAGE	DRAIN VALVE	506-2A	21C*HA		
2CR-57	551	2	HS	9340A2	SAFETY INJECT. TK	T008 OUTLET VALVE	506-2B	21C*HA	MSC	MCROSW/PTK SERIES

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-57 552	2 HS 9336-2	SHUTDN COOL FLOW TO LPSI PUMP SUCT	506-2B	21C*HA	MSC	MCROSW/PTK SERIES
2CR-57 553	2 HS 9368-2	SHUTDN HT EXCH TO CONTMT SP HDR #2	506-2A	21C*HA		
2CR-57 554	2 HS 0328-2	SPRAY CHEM FLOW CONTROL VALVE	506-2A	21C*HA	MSC	
2CR-57 555	2 HS 0510A2	PRES'ZR STEAM SAMPLE ISOL VALVE	506-2A	21C*HA		
2CR-57 556	2 ZL 6211-2	CCW TO CNTMT ISOLATION VALVE	505-5	21C*HA		
2CR-57 557	2 HS 0508A2	RC HOT LEG SAMPLE ISOLATION VALVE	506-2A	21C*HA		
2CR-57 558	2 ZL 9349-2	SAFETY INJ DRAIN HDR TO REFUEL TK	505-5	21C*HA	MSC	SERIES 10H
2CR-57 559	2 ZL 6216-2	C.C. WTR NON-CRIT OUTLET ISOL VALVE	505-5	21C*HA		
2CR-57 560	2 ZL 9217-2	R. C. BLEED OFF TO VOL CONTROL TK	505-5	21C*HA		
2CR-57 561	2 ZL 0227B2	VOLUME CONTROL TK OUTLET VALVE	505-5	21C*HA		
2CR-57 562	2 HS 9348-2	SAFETY INJ. PUMP MIN FLOW ISOL VAL	506-2B	21C*HA	MSC	
2CR-57 563	2 HS 0512A2	PRES'ZR SURGE LN SAMPLE ISOL VALVE	506-2A	21C*HA		
2CR-57 564	2 HS 5804-2	CONTAINMENT SUMP TO RADWASTE SUMP	506-2A	21C*HA		
2CR-57 565	2 ZL 7750-2	SPENT FUEL POOL FUEL TRANSF TUBE	505-5	21C*HA		
2CR-57 566	2 ZL 4057-2	STM GEN E089 WTR SAMPLE ISOL	505-5	21C*HA		
2CR-57 567	2 HS 9948-2	CONTAINMENT PURGE SUP UNIT A374-ISO	506-2A	21C*HA		
2CR-57 568	2 HS 9950-2	CONTAINMENT PURGE EXH UNIT A060 ISO	506-2A	21C*HA		
2CR-57 570	2 ZL 5357-2	SERVICE AIR TO CONT. ISOL. VALVE	505-5	21C*HA		
2CR-57 571	2 HS 0515A2	QUENCH TANK GAS SAMPLE ISOL VALVE	506-2A	21C*HA		
2CR-57 572	2 ZL 7751-2	REFUELING CAVITY FILL LINE ISOL	505-5	21C*HA		
2CR-57 573	2 ZL 7752-2	REFUELING CAVITY FILL LINE ISOL	505-5	21C*HA		
2CR-57 574	2 HS 7513-2	CONTAINMENT ISOL RC DRN TO RDW SYS	506-2A	21C*HA		
2CR-57 575	2 ZL 8421-2	MAIN STEAM DUMP TO ATMOS	505-5	21C*HA		
2CR-57 576	2 ZL 8200-2	MAIN STM TO AUX FW PUMP	505-5	21C*HA		
2CR-57 577	2 ZL 8204-2	MAIN STEAM ISOL. VALVE	505-5	21C*HA		
2CR-57 578	2 ZL 8202-2	MAIN STM ISOL. VALVE BYPASS	505-5	21C*HA		
2CR-57 580	2 ZL 4053-2	STM GEN E089 BLOWDOWN ISOL	505-5	21C*HA		
2CR-57 581	2 LI 0349-2	CNTMT SPRAY CHEM STORAGE TK LEVEL	924	2XXX	SIGMA	9270
2CR-57 582	2 HS 5434-2	NITRO. TO SAFETY INJECTION TANKS	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 584	2 HS 7911-2	NUCL SERV WATER CONTAINMENT ISOL	506-2A	21C*HA		
2CR-57 585	2 HS 7258-2	CONTAINMENT ISOL SI TANK VENT HDR	506-2A	21C*HA		
2CR-57 586	2 HS 5437-2	NITROGEN SUPPLY ISOLATION VALVE	506-2A	21C*HA		
2CR-57 587	2 HS 9302-2	CONTAINMENT EMER SUMP OUTLET VALVE	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 588	2 HS 9304-2	CONTAINMENT EMER SUMP OUTLET VALVE	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 589	2 ZL 6368-2	CCW TO EMERGENCY COOLING UNIT E400	505-5	21C*HA		
2CR-57 590	2 ZL 6372-2	CCW TO EMERGENCY COOLING UNIT E402	505-5	21C*HA		
2CR-57 591	2 ZL 6373-2	CCW FRM EMERGENCY COOLING UNIT E402	505-5	21C*HA		
2CR-57 592	2 ZL 6369-2	CCW FRM EMERGENCY COOLING UNIT E400	505-5	21C*HA		
2CR-57 593	2 ZL 9267-2	REACTOR COOLANT LETDOWN HE	505-5	21C*	MSC	
2CR-57 594	2 HS 4730-1	AUX FEEDWATER TO STM GEN E-088	505-5	21C*HA	MSC	
2CR-57 595	2 XL 4729-2	AUX FW TURBINE TRIPPED	505-5	21C*HA	MSC	
2CR-57 596	2 HS 9821-2	CONT MINI-PURGE SPLY ISO VALVE	506-2A	21C*HA	MSC	
2CR-57 597	2 HS 9824-2	CONT PURGE EXH ISO VALVE	506-2A	21C*HA	MSC	
2CR-57 599	2 ZL 4052-2	STM GEN E089 FW ISOLATION VALVE	505-5	21C*HA		

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-57 600	2 ZL 4715-2	AUX FEEDWATER TO STM GEN E089	505-5	21C*HA		
2CR-57 601	2 HS 0500-2	CONTAINMENT ATMOS SAMPLE ISOLATION	506-2B	21C*HA	MSC	
2CR-57 602	2 HS 0502-1	CONTAINMENT ATMOS SAMPLE ISOLATION	506-2B	21C*HA	MSC	
2CR-57 603	2 HS 0501-2	CONTAINMENT ATMOS SAMPLE ISOLATION	506-2B	21C*HA	MSC	
2CR-57 604	2 HS 0503-1	CONTAINMENT ATMOS SAMPLE ISOLATION	506-2B	21C*HA	MSC	
2CR-57 605	2 HS 7800-2	CNTMT AIRBORNE RAD MON TRN B-ISO	506-2A	21C*HA		
2CR-57 606	2 HS 7803-2	CNTMT AIRBORNE RAD MON TRN B-ISO	506-2A	21C*HA		
2CR-57 607	2 HS 9394-2	HPSI PUMP P019	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 608	2 HS 9391-2	LPSI PUMP P016	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 609	2 ZL 9230-2	CHARGING PUMP P192	505-5	21C*HA		
2CR-57 610	2 HS 9396-2	CONTAINMENT SPRAY PUMP P013	506-2A	21C*HA		
2CR-57 612	2 ZL 9229-2	CHARGING PUMP P191	505-5	21C*HA		
2CR-57 613	2 HS 9393-2	HPSI PUMP P018	506-2A	21C*HA		
2CR-57 614	2 HS 9235-2	BA MAKE-UP TK TO CHARGE PUMP SUCT.	506-2A	21C*HA		
2CR-57 615	2 HS 9240-2	BA MAKE-UP TK TO CHARGE PUMP SUCT.	506-2A	21C*HA		
2CR-57 616	2 LI 9388-2	CONTAINMENT AREA LEVEL	505-7B*	21C*HA	SIGMA	9270
2CR-57 618	2 ZL 4716-3	TURB DR AUX FW PUMP	505-5	21C*HA		
2CR-57 619	2 ZL 6324-2	C.C. WATER PUMP P026	505-5	21C*HA		
2CR-57 620	2 ZL 6320-2	C.C. WTR. PUMP P025	505-5	21C*HA		
2CR-57 621	2 ZL 6500-2	CCW FROM SHUTDOWN HT. EXCH. E003	505-5	21C*HA		
2CR-57 622	2 ZL 6219-2	C.C. WTR NON-CRIT LOOP B RETURN VAL	505-5	21C*HA		
2CR-57 623	2 ZL 6213-2	CCW NON-CRITICAL LOOP B INLET VV.	505-5	21C*HA		
2CR-57 624	2 ZL 6495-2	SALT WTR FROM CCW HEAT EXCH.	505-5	21C*HA		
2CR-57 625	2 ZL 6381-2	SALT WTR. COOL. PUMP P113	505-5	21C*HA		
2CR-57 626	2 ZL 6383-2	SALT WTR. COOL. PUMP P114	505-5	21C*HA		
2CR-57 627	2 ZL 6201-2	SALT WTR CLG PUMP P113 DISCH VALVE	505-5	21C*HA		
2CR-57 628	2 ZL 6203-2	SALT WTR CLG PUMP P114 DISCH VALVE	505-5	21C*HA		
2CR-57 629	2 ZL 6377-2	SALT WTR COOLING PUMP P113 BRG WTR	505-5	21C*HA		
2CR-57 630	2 ZL 6379-2	SALT WTR COOLING PUMP P114 BRG WTR	505-5	21C*HA		
2CR-57 631	2 ZL 4706-2	AUX FW PUMP P140 DISCH TO SG E089	505-5	21C*HA		
2CR-57 632	2 ZL 4705-2	AUX FW PUMP P140 DISCH TO SG E088	505-5	21C*HA		
2CR-57 643	2 TI 0352-2	LPSI FLOW TEMP	924	2XXXHA	SIGMA	9270
2CR-57 646	2 HS 9406-2	SPRAY CHEM ADD PUMP	506-2A	21C*HA	MSC	
2CR-57 647	2 HS 9398-2	SPRAY CHEM. ADD. PMP DISCH VALVE	506-2A	21C*HA		
2CR-57 650	2 HS 0517A2	RC HOT LEG SAMPLE ISOLATION VALVE	506-2A	21C*HA		
2CR-57 651	2 HS 5686A2	FIRE WATER TO CONTAIN. ISO VAL	506-2A	21C*HA		
2CR-57 652	2 HS 9900-2	CONTAINMENT NORM COOL SUP ISO VV	506-2A	21C*HA		
2CR-57 653	2 HS 9971-2	CONTAINMENT NORM COOL RET ISO VV	506-2A	21C*HA		
2CR-57 654	2 HS 7805-2	CNTMT AIRBORNE RAD MON TRN B ISO	506-2A	21C*HA		
2CR-57 655	2 HS 7806-2	CNTMT AIRBORNE RAD MON TRN B ISO	506-2A	21C*HA		
2CR-57 656	2 HS 9347-2	SAFETY INJ. PUMP MIN FLOW ISOL VAL	506-2B	21C*HA	MSC	
2CR-57 657	2 HS 9378A4	S.D. COOL SYSTEM FROM RC LOOP (N)	506-2B	21C*HA	MSC	MCROSW/PTK SERIES
2CR-57 658	2 HS 9359-2	S.D. COOL SYSTEM WARM UP BYPASS	506-2A	21C*HA	MSC	SERIES 10H
2CR-57 659	2 ZL 9481-2	AREA FLOODING INDICATION	505-5	21C*HA	MSC	

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-57 662	2 ZL 8249-2	STM GEN E089 MAIN STM DRAIN LINES	505-5	21C*HA		
2CR-57 666	2 HS 8153-2	HPSI TO RC LOOP 1 HOT LEG	506-2B	21C*HA	MSC	
2CR-57 666	2 HS 9434-2	HPSI TO RC LOOP 1 HOT LEG	506-2B	21C*HA	MSC	
2CR-57 667	2 HS 9437-2	RC LOOP 1 HOT LEG INJECTION DRAIN	506-2A	21C*HA		
2CR-57 669	2 FI 9435-2	HPSI FLOW TO RC LOOP 1 HOT LEG	924	2XXX	SIGMA	9270
2CR-57 671	2 HS 0352-2	CONTAINMENT PRESS SENSE LINE ISO VV	506-2B	21C*HA	MSC	
2CR-57 672	2 HS 0352-4	CONTAINMENT PRESS SENSE LINE ISO VV	506-2B	21C*HA	MSC	
2CR-57 676	2 HS 5686D2	FIRE WATER CONT. ISOL VLV(SWITCH2)	506-2A	21C*HA	MSC	
2CR-57 677	2 FCN 0328-2	SHELF	924	2XXX	FOXBORO	202S-2
2CR-57 681	2 AI 8118A2	CONT POST LOCA H2 CONCENTRATION	505-7	21C*HA	SIGMA	9270
2CR-57 682	2 HS 8117A2	CONT POST LOCA H2 MON SYS ON-OFF	506-2A	21C*HA	MSC	

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PANEL NUMBER		INSTRUMENT TAG NUMBER			SERVICE DESCRIPTION		SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-58	015	2	HS	9229-2	CHARGING PUMP	P191	506-2A	21C*HA		
2CR-58	023	2	HS	9204-2	RC LOOP 2B LETDN	TO REGEN HT EXCH	506-2A	21C*HA		
2CR-58	027	2	ZL	0210-Y	BORIC-ACID MAKEUP	CONTROL VALVE	505-5	21C*HA		
2CR-58	028	2	ZL	0210-X	REACTOR MAKEUP	WTR FLOW CONT VAL	505-5	21C*HA		
2CR-58	033	2	HS	9267-2	REACTOR COOLANT	LETDOWN H.E.	506-2A	21C*HA		
2CR-58	037	2	HS	9095-2	LETDOWN SYSTEMS		506-2A	21C*HA	MSC	
2CR-58	038	2	HS	9096-1	REACTOR COOLANT	PUMP BLEED-OFF	506-2	21C*HA		
2CR-58	038	2	HS	9096-2	REACTOR COOLANT	PUMP BLEED-OFF	506-2	21C*HA		
2CR-58	041	2	HS	9241-1	BORIC ACID MAKE-	UP PUMP P175	506-2A	21C*HA		
2CR-58	042	2	HS	9242-1	BORIC ACID MAKE-	UP PUMP P174	506-2A	21C*HA		
2CR-58	049	2	HS	9228-1	CHARGING PUMP	P190	506-2A	21C*HA		
2CR-58	050	2	HS	9229-1	CHARGING PUMP	P191	506-2A	21C*HA		
2CR-58	051	2	HS	9230-2	CHARGING PUMP	P192	506-2A	21C*HA		
2CR-58	066	2	HS	9217-2	RC PUMP BLEED OFF	TO VOL CONTROL TK	506-2A	21C*HA		
2CR-58	067	2	HS	9218-1	RC PUMP BLEED OFF	TO VOL CONTROL TK	506-2A	21C*HA		
2CR-58	068	2	HS	0227B2	VOLUME CONTROL TK	OUTLET VALVE	506-2A	21C*HA	MSC	
2CR-58	069	2	HS	9205-1	REGEN HT EXCH TO	LETDOWN HT EXCH	506-2A	21C*HA		
2CR-58	070	2	HS	0221-1	LETDWN TO LETDWN	HT. EXCHANGER VAL	506-2A	21C*HA		
2CR-58	073	2	HS	9200-1	CHARGING PUMPS TO	REGEN HEAT EXCH	506-2B	21C*HA	MSC	
2CR-58	076	2	HS	9201A1	AUX SPRAY TO	PRESSURIZER	506-2B	21C*HA	MSC	
2CR-58	077	2	HS	9253-1	REACTOR MU WTR TO	VOL CONTROL TANK	506-2A	21C*HA		
2CR-58	081	2	HS	9095-1	LETDOWN SYSTEMS		506-2A	21C*HA	MSC	
2CR-58	091	2	HS	9231-1	BA MAKE-UP PUMP	RECIRC TO BA TANK	506-2A	21C*HA		
2CR-58	092	2	HS	9236-1	BA MAKE-UP PUMP	RECIRC TO BA TANK	506-2A	21C*HA		
2CR-58	100	2	FCN	0210Y	SHELF		505-10B	21C*HA	FOXBORO	202S-3
2CR-58	101	2	RRN	0202	SHELF		505-10B	21C*HA	FOXBORO	202S-6
2CR-58	102	2	HCN	0110	SHELF		505-10B	21C*HA	FOXBORO	202S-3
2CR-58	103	2	FCN	0210X	SHELF		505-10B	21C*HA	FOXBORO	202S-3
2CR-58	448	2	PCN	0100	SHELF		505-10B	21C*HA	FOXBORO	202S-3

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-59 014	2 LR 1115-1	STEAM GEN E089 W/RANGE LEVEL RDR	924	2XXX	FOXBORO	226-2
2CR-59 014	2 LR 1125-1	STEAM GEN E088 W/RANGE LEVEL RDR	924	2XXX	FOXBORO	226-2
2CR-59 015	2 LR 9386-1	CONT. EMER. SUMP LEVEL	505-10	21C*HA	FOXBORO	E226
2CR-59 019	2 PR 0303-1	SHUTDOWN COOLING PRESS	924	2XXX	FOXBORO	226S
2CR-59 019	2 TR 0303-1	SHUTDOWN COOLING TEMP	924	2XXX	FOXBORO	226S
2CR-59 020	2 PR 0102-1	PRESSURIZER PRESS	924	2XXXHA	FOXBORO	226S
2CR-59 021	2 TR 9178-1	LOOP 1A COLD LEG TEMPERATURE	924	2XXXHA	FOXBORO	226S 2
2CR-59 021	2 TR 9179-1	LOOP 2A COLD LEG TEMPERATURE	924	2XXXHA	FOXBORO	226S
2CR-59 022	2 FR 4720-1	AUX FEEDWATER TO STEAM GEN E088	505-10	21C*HA	FOXBORO	226-1
2CR-59 023	2 PR 1013-1	STEAM GENERATOR E089 PRESSURE	924	2XXX	FOXBORO	226S 2
2CR-59 023	2 PR 1023-1	STEAM GENERATOR E088 PRESSURE	924	2XXX	FOXBORO	226S 2
2CR-59 024	2 LR 1113-1	STEAM GENERATOR E089 LEVEL	924	2XXX	FOXBORO	226S 2
2CR-59 024	2 LR 1123-1	STEAM GENERATOR E088 LEVEL	924	2XXX	FOXBORO	226S 2
2CR-59 025	2 LR 0305-1	REFUELING WATER TANK LVL	924	2XXX	FOXBORO	226S
2CR-59 025	2 PR 0352-1	CONTAINMENT PRESSURE	924	2XXX	FOXBORO	226S
2CR-59 027	2 TR 9903-1	CONTAINMENT ATMOS TEMP RECORD EMERG	505-10	21C*HA	FOXBORO	226-1
2CR-59 033	2 LR 0110-1	PZR LEVEL	924	2XXXHA	FOXBORO	226S
2CR-59 035	2 TR 0351-1	LOW PRESS SAFETY INJECTION TEMP.	924	2XXXHA	FOXBORO	226S
2CR-59 038	2 TRN 0351-1	SHELF	505-10B	2XXX	FOXBORO	202S-6
2CR-59 039	2 FRN 4720-1	SHELF	505-10B	21C*HA	FOXBORO	202S-6
2CR-59 040	2 PRN 1013-1	SHELF	505-10B	2XXX	FOXBORO	202S-6
2CR-59 041	2 TRN 0303-1	SHELF	505-10B	21C*HA	FOXBORO	202S-6

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BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN MAIN CONTROL PANELS

PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2CR-64 701	2 HS 6380-1	SALTWATER COOLING PUMP P112	506-2A	21C*HA		
2CR-64 702	2 HS 6200-1	SALT WTR CLG PUMP P112 DISCH VALVE	506-2A	21C*HA		
2CR-64 703	2 HS 6376-1	SALT WTR COOL PMP P112 BEARING WTR.	506-2A	21C*HA		
2CR-64 704	2 HS 6382-1	SALTWATER COOLING PUMP P307	506-2A	21C*HA		
2CR-64 705	2 HS 6202-1	SALT WTR CLG PUMP P307 DISCH VALVE	506-2A	21C*HA		
2CR-64 706	2 HS 6378-1	SALT WTR COOL PMP P307 BEARING WTR.	506-2A	21C*HA		
2CR-64 707	2 HS 6381-2	SALTWATER COOLING PUMP P113	506-2A	21C*HA		
2CR-64 708	2 HS 6201-2	SALT WTR CLG PUMP P113 DISCH VALVE	506-2A	21C*HA		
2CR-64 709	2 HS 6377-2	SALT WTR COOL PMP P113 BEARING WTR.	506-2A	21C*HA		
2CR-64 710	2 HS 6383-2	SALTWATER COOLING PUMP P114	506-2A	21C*HA		
2CR-64 711	2 HS 6203-2	SALT WTR CLG PUMP P114 DISCH VALVE	506-2A	21C*HA		
2CR-64 712	2 HS 6379-2	SALT WTR COOL PMP P114 BEARING WTR.	506-2A	21C*HA		
2CR-64 717	2 HS 6497-1	SALT WATER FROM CCW HT EXCH E001	506-2A	21C*HA		
2CR-64 718	2 HS 6495-2	SALT WATER FROM CCW HT EXCH E002	506-2A	21C*HA		
2CR-64 720	2 HS 6397-1	CCW TO RCP SUPPLY AND RETURN	506-2A	21C*HA	MSC	
2CR-64 721	2 HS 6211-2	COMP CLG WTR TO CONT ISOL VALVE	506-2A	21C*HA		
2CR-64 724	2 HS 6212-1	CCW NON-CRITICAL LOOP A INLET VAL.	506-2A	21C*HA		
2CR-64 725	2 HS 6213-2	CCW NON-CRITICAL LOOP B INLET VAL.	506-2A	21C*HA		
2CR-64 726	2 HS 6397-2	CCW TO RCP SUPPLY AND RETURN	506-2A	21C*HA	MSC	
2CR-64 740	2 HS 6216-2	CCW NON-CRITICAL LOOP ISOL VALVE	506-2A	21C*HA		
2CR-64 744	2 HS 6218-1	CCW PUMP SUCTION VALVE	506-2A	21C*HA		
2CR-64 745	2 HS 6219-2	CCW PUMP SUCTION VALVE	506-2A	21C*HA		2907RU
2CR-64 750	2 HS 6501-1	CCW FROM SHUTDOWN HEAT EXCHANGER	506-2A	21C*HA		
2CR-64 751	2 HS 6500-2	CCW FROM SHUTDOWN HEAT EXCHANGER	506-2A	21C*HA		
2CR-64 756	2 HS 6314-1	COMPONENT COOLING WTR PUMP P024	506-2A	21C*HA		
2CR-64 757	2 HS 6320-1	COMPONENT COOLING WTR PUMP P025	506-2A	21C*HA		
2CR-64 758	2 HS 6320-2	COMPONENT COOLING WTR PUMP P025	506-2A	21C*HA		
2CR-64 759	2 HS 6324-2	COMPONENT COOLING WTR PUMP P026	506-2A	21C*HA		
2CR-64 789	2 HS 6236-1	CCW NON-CRITICAL OUTLET ISO VALVE	506-2A	21C*HA		
2CR-64 790	2 HS 6223-1	CCW NON-CRITICAL INLET ISO VALVE	506-2A	21C*HA		
2CR-64 791	2 HS 7705-1	SPENT FUEL POOL PUMP P009	506-2A	21C*HA		
2CR-64 792	2 HS 7704-2	SPENT FUEL POOL PUMP P010	506-2A	21C*HA		

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2/3CR-60 003	2 HS 9813-1	ESF SWGR RM EAST EMER AC UNIT E255	506-2A	21C*HA		
2/3CR-60 005	2 HS 9829-2	ESF SWGR RM WEST EMER AC UNIT E257	506-2A	21C*HA		
2/3CR-60 006	2 HS 9965-1	CONTAINMENT DOME AIR CIRC UNT A071	506-2A	21C*HA		
2/3CR-60 007	2 HS 9967-1	CONTAINMENT DOME AIR CIRC UNT A074	506-2A	21C*HA		
2/3CR-60 008	2 HS 9966-2	CONTAINMENT DOME AIR CIRC UNT A072	506-2A	21C*HA		
2/3CR-60 009	2 HS 9968-2	CONTAINMENT DOME AIR CIRC UNT A073	506-2A	21C*HA		
2/3CR-60 012	2 HS 9917-2	HYD. PURGE EXHST UNIT A082-ISO VV	506-2B	21C*HA	MSC	
2/3CR-60 013	2 HS 9946-2	HYD. PURGE SUPPLY UNIT A080-ISO VV	506-2B	21C*HA	MSC	
2/3CR-60 014	2 HS 9947-1	CONTAINMENT EMERG COOLING UNIT E401	506-2A	21C*HA		
2/3CR-60 015	2 HS 9953-1	CONTAINMENT EMERG COOLING UNIT E399	506-2A	21C*HA		
2/3CR-60 016	2 HS 9939-2	CONTAINMENT EMERG COOLING UNIT E400	506-2A	21C*HA		
2/3CR-60 017	2 HS 9955-2	CONTAINMENT EMERG COOLING UNIT E402	506-2A	21C*HA		
2/3CR-60 018	2 HS 6366-1	CCW TO EMERGENCY COOLING UNIT E401	506-2A	21C*HA		
2/3CR-60 019	2 HS 6367-1	CCW FRM EMERGENCY COOLING UNIT E401	506-2A	21C*HA		
2/3CR-60 020	2 HS 6368-2	CCW TO EMERGENCY COOLING UNIT E400	506-2A	21C*HA		
2/3CR-60 021	2 HS 6369-2	CCW FRM EMERGENCY COOLING UNIT E400	506-2A	21C*HA		
2/3CR-60 022	2 HS 6370-1	CCW TO EMERGENCY COOLING UNIT E399	506-2A	21C*HA		
2/3CR-60 023	2 HS 6371-1	CCW FRM EMERGENCY COOLING UNIT E399	506-2A	21C*HA		
2/3CR-60 024	2 HS 6372-2	CCW TO EMERGENCY COOLING UNIT E402	506-2A	21C*HA		
2/3CR-60 025	2 HS 6373-2	CCW FRM EMERGENCY COOLING UNIT E402	506-2A	21C*HA		
2/3CR-60 026	2 HS 9624-1	SAFETY EQUIP BLDG EM COOL UNIT E417	506-2A	21C*HA		
2/3CR-60 027	2 HS 9652-1	SAFETY EQUIP BLDG EM COOL UNIT E453	506-2A	21C*HA		
2/3CR-60 028	2 HS 9656-1	SAFETY EQUIP BLDG EM COOL UNIT E454	506-2A	21C*HA		
2/3CR-60 029	2 HS 9651-1	SAFETY EQUIP BLDG PMP ROOM 015 E517	506-2A	21C*HA		
2/3CR-60 030	2 HS 9659-2	SAFETY EQUIP BLDG EM COOL UNIT E518	506-2A	21C*HA		
2/3CR-60 031	2 HS 9623-2	SAFETY EQUIP BLDG EM COOL UNIT E445	506-2A	21C*HA		
2/3CR-60 032	2 HS 9622-2	SAFETY EQUIP BLDG EM COOL UNIT E416	506-2A	21C*HA		
2/3CR-60 033	2 HS 9655-2	SAFETY EQUIP BLDG PMP ROOM 007 E518	506-2A	21C*HA		
2/3CR-60 034	2 HS 9671-1	CHARG. ROOM EMERG COOL UNIT E438	506-2A	21C*HA		
2/3CR-60 035	2 HS 9670-1	CHARG. ROOM EMERG COOL UNIT E435	506-2A	21C*HA		
2/3CR-60 036	2 HS 9667-2	CHARGING PUMP RM EM COOL UNIT E436	506-2A	21C*HA		
2/3CR-60 037	2 HS 9660-2	CHARGING PUMP RM EM COOL UNIT E435	506-2A	21C*HA		
2/3CR-60 038	2 HS 6374-2	CCW TO EMERG CLR IN CONT.	506-2A	21C*HA	MSC	IN CONT.
2/3CR-60 039	2 HS 6374-1	CCW TO EMERG CLR IN CONT.	506-2A	21C*HA	MSC	
2/3CR-60 044	2 HS 9850-1	FUEL HANDLING BLD CLEANUP UNIT E370	506-2A	21C*HA		
2/3CR-60 045	2 HS 9836-1	FUEL HANDLING BLD PP RM AC UNT E441	506-2A	21C*HA		
2/3CR-60 046	2 HS 9851-2	FUEL HANDLING BLD CLEANUP UNIT E371	506-2A	21C*HA		
2/3CR-60 047	2 HS 9837-2	FUEL HANDLING BLD PP RM AC UNT E442	506-2A	21C*HA		
2/3CR-60 048	2 HS 9846-1	FUEL HANDLING BLD ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 049	2 HS 9847-1	FUEL HANDLING BLD ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 050	2 HS 9674-1	BA MAKEUP PUMP RM COOLING UNIT E439	506-2A	21C*HA		
2/3CR-60 051	2 HS 9684-1	BA MAKEUP PUMP RM COOLING UNIT E440	506-2A	21C*HA		
2/3CR-60 056	2 HS 9738-1	CABINET AREA EMER AC UNIT E424	506-2A	21C*HA		
2/3CR-60 057	2 HS 9739-2	CABINET AREA EMER AC UNIT E423	506-2A	21C*HA		

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PANEL NUMBER	INSTRUMENT TAG NUMBER		SERVICE DESCRIPTION		SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2/3CR-60 063	2/3HS	9720-2	CONTROL RM COMPLX	EMER AC UNIT E419	506-2A	21C*HA		
2/3CR-60 064	2/3HS	9749-1	CONTROL RM COMPLX	EM AC UNIT E418	506-2A	21C*HA		
2/3CR-60 065	2/3HS	9740-2	CONTROL RM COMPLX	EM VENT SUP A206	506-2A	21C*HA	MSC	
2/3CR-60 066	2/3HS	9760-1	CONTROL RM COMPLX	EM VENT SUP A207	506-2A	21C*HA	MSC	
2/3CR-60 067	2/3HS	9703-2	CONTROL ROOM	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 068	2/3HS	9711-2	CONTROL ROOM	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 069	2/3HS	9702-1	CONTROL ROOM	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 070	2/3HS	9712-1	CONTROL ROOM	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 071	2/3HS	9758-2	CONTROL RM COMPLX	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 072	2/3HS	9757-2	CONTROL RM COMPLX	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 073	2/3HS	9717-1	CONTROL ROOM	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 074	2/3HS	9756-1	CONTROL RM COMPLX	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 075	2/3HS	9779-2	CONTROL RM COMPLX	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 076	2/3HS	9892-2	EMERG CHILLED WTR	LOOP B-PUMP P160	506-2A	21C*HA		
2/3CR-60 077	2/3HS	9895-2	EMERG CHILLED WTR	LOOP B-CHILL E335	506-2A	21C*HA		
2/3CR-60 078	2/3FI	9894-2	EMERG CHILLED WTR	LOOP B-FLOW	505-7	21C*HA	SIGMA	9270
2/3CR-60 079	2/3PI	9896-2	EMERG CHILLED WTR	LOOP B-CHILLER-OT	505-7	21C*HA	SIGMA	9270
2/3CR-60 081	2/3HS	9872-1	EMERG CHILLED WTR	LOOP A-PUMP P162	506-2A	21C*HA		
2/3CR-60 082	2/3HS	9875-1	EMERG CHILLED WTR	LOOP A-CHILL E336	506-2A	21C*HA		
2/3CR-60 083	2/3FI	9874-1	EMERG CHILLED WTR	LOOP A-FLOW	505-7	21C*HA	SIGMA	9270
2/3CR-60 084	2/3PI	9877-1	EMERG CHILLED WTR	LOOP A-CHILLER-OT	505-7	21C*HA	SIGMA	9270
2/3CR-60 085	2/3HS	9776-2	EMER CHILLER ROOM	VENT UNIT A054	506-2A	21C*HA		
2/3CR-60 086	2/3HS	9777-2	EMER CHILLER ROOM	VENT UNIT A055	506-2A	21C*HA		
2/3CR-60 087	2/3HS	9774-1	EMER CHILLER ROOM	VENT UNIT A053	506-2A	21C*HA		
2/3CR-60 088	2/3HS	9775-1	EMER CHILLER ROOM	VENT UNIT A056	506-2A	21C*HA		
2/3CR-60 093	2 HS	9844-2	FUEL HANDLING BLD	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 094	2 HS	9845-2	FUEL HANDLING BLD	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 095	2/3HS	9769-1	CONTROL RM COMPLX	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 102	2 ZL	9823-1	CONT PURGE	SPLY ISO VALVE	505-5	21C*	MSC	
2/3CR-60 104	2 ZL	9821-2	CONT MINI-PURGE	SPLY ISO VALVE	505-5	21C*	MSC	
2/3CR-60 105	2 ZL	9824-2	CONT PURGE	EXH ISO VALVE	505-5	21C*	MSC	
2/3CR-60 110	2 HS	9847B1	FUEL HANDLING BLD	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 111	2 HS	9847C1	FUEL HANDLING BLD	ISOLATION DAMPER	506-2A	21C*HA		
2/3CR-60 112	2 ZL	9865B1	FHB CLEANUP UNIT	E370 HEATER E652	505-5	21C*HA	MSC	
2/3CR-60 115	2 HS	7804A1	CPIS	MANUAL ACTUATION	506-2A	21C*HA		
2/3CR-60 116	2 HS	7807A2	CPIS	MANUAL ACTUATION	506-2A	21C*HA		
2/3CR-60 117	2 HS	7822A1	FHIS	MANUAL ACTUATION	506-2A	21C*HA		
2/3CR-60 118	2 HS	7823A2	FHIS	MANUAL ACTUATION	506-2A	21C*HA		
2/3CR-60 119	2/3HS	7824A1	CRIS	MANUAL ACTUATION	506-2A	21C*HA		
2/3CR-60 120	2/3HS	7825A2	CRIS	MANUAL ACTUATION	506-2A	21C*HA		
2/3CR-60 129	2 ZL	9738A1	CONTROL ROOM CAB.	AREA EMERG A/C VV	505-5	21C*HA	MSC	
2/3CR-60 130	2 ZL	9739A2	CONTROL ROOM CAB.	AREA EMERG A/C VV	505-5	21C*HA	MSC	
2/3CR-60 131	2 ZL	9949-1	CNTMT PURGE	SUPPLY VALVE	505-5	21C*HA	MSC	
2/3CR-60 132	2 ZL	9951-1	CNTMT PURGE	EXHAUST VALVE	505-5	21C*HA	MSC	

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2/3CR-60 133	2 ZL 9948-2	CNTMT PURGE SUPPLY VALVE	505-5	21C*HA	MSC	
2/3CR-60 134	2 ZL 9950-2	CNTMT PURGE EXHAUST VALVE	505-5	21C*HA	MSC	
2/3CR-60 135	2 ZL 9865A1	FHB POST ACDT CLN UP E370 HEATER	505-5	21C*HA	MSC	
2/3CR-60 136	2 ZL 9850A1	FHB POST ACDT CLN UP E370 DAMPER	505-5	21C*HA	MSC	
2/3CR-60 137	2 ZL 9866A2	FHB POST ACDT CLN UP E371 HEATER	505-5	21C*HA	MSC	
2/3CR-60 138	2 ZL 9851A2	FHB POST ACDT CLN UP E371 DAMPER	505-5	21C*HA	MSC	
2/3CR-60 139	2/3ZL 9759A1	CONTROL ROOM EMER VENTING A HEATER	505-5	21C*HA	MSC	
2/3CR-60 140	2/3ZL 9761A1	CONTROL ROOM EMER VENTING A DAMPER	505-5	21C*HA	MSC	
2/3CR-60 141	2/3ZL 9753A2	CONTROL ROOM EMER VENTING B HEATER	505-5	21C*HA	MSC	
2/3CR-60 142	2/3ZL 9742A2	CONTROL ROOM EMER VENTING B DAMPER	505-5	21C*HA	MSC	
2/3CR-60 143	2/3ZL 9732A2	CR EMERG A/C UNIT E419 DAMPER	505-5	21C*HA	MSC	
2/3CR-60 144	2/3ZL 9733A2	CR EMERG A/C UNIT E419 DAMPER	505-5	21C*HA	MSC	
2/3CR-60 145	2/3ZL 9778A2	CR EMERG A/C UNIT E419 DAMPER	505-5	21C*HA	MSC	
2/3CR-60 146	2/3HS 9875C1	AUX. BLDG. EMER. CHILLER	506-2A	21C*HA	MSC	
2/3CR-60 147	2/3HS 9895C2	AUX. BLDG. EMER. CHILLER	506-2A	21C*HA	MSC	
2/3CR-60 148	2/3HS 9720B2	CONTROL ROOM EMER A.C. UNIT E-419	506-2A	21C*HA	MSC	
2/3CR-60 149	2/3HS 9749B1	CONTROL ROOM EMER A.C. UNIT E-418	506-2A	21C*HA	MSC	
2/3CR-60 152	2 HS 5901-1	DIESEL FUEL TRANSFER PUMP P93	506-2A	21C*PA	MSC	
2/3CR-60 153	2 HS 5902-1	DIESEL FUEL TRANSFER PUMP P96	506-2A	21C*PA	MSC	
2/3CR-60 154	2 LI 5903-1	9270 L FUEL STOR. TANK TO-35 LEVEL	505-7	21C*HA	SIGMA	9207
2/3CR-60 155	2 HS 5904-2	DIESEL FUEL TRANSFER PUMP P94	506-2A	21C*PA	MSC	
2/3CR-60 156	2 HS 5905-2	DIESEL FUEL TRANSFER PUMP P95	506-2A	21C*PA	MSC	
2/3CR-60 157	2 LI 5906-2	DIESEL FUEL STOR. TANK TO-36 LEVEL	505-7	21C*HA	SIGMA	9270
2/3CR-60 158	2 HS 9581-1	AUX FW PUMP AREA EMERG FAN A394	506-2A	21C*HA		
2/3CR-60 160	2 HS 9537A1	DIESEL GEN BLDG EMER FAN A274	506-2A	21C*HA	MSC	10H
2/3CR-60 161	2 HS 9537B1	DIESEL GEN BLDG EMER FAN A275	506-2A	21C*HA	MSC	10H
2/3CR-60 162	2 HS 9538A2	DIESEL GEN BLDG EMER FAN A276	506-2A	21C*HA	MSC	10H
2/3CR-60 163	2 HS 9538B2	DIESEL GEN BLDG EMER FAN A277	506-2A	21C*HA	MSC	10H
2/3CR-60 164	2 HS 9532-2	AUX FW PUMP AREA EMERG FAN A443	506-2A	21C*HA		

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2/3CR-61 023	2 HS 5849	TURB. PLT. SUMP TO OIL SEPARATOR	506-2A	21C*HA		
2/3CR-61 723	3 HS 5849	TURB. PLT. SUMP TO OIL SEPARATOR	506-2A	21C*HA		

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2/3CR-62 020	2 HS 6106	HYDRAZINE PUMP P065	506-2A	21C*HA		
2/3CR-62 024	2 HS 6109	AMMONIA PUMP P064	506-2A	21C*HA	MSC	
2/3CR-62 320	3 HS 6106	HYDRAZINE PUMP P071	506-2A	21C*HA		
2/3CR-62 324	3 HS 6109	AMMONIA PUMP P070	506-2A	21C*HA	MSC	

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PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2/3CR-63 032	3 ZL 1627-1	ESF A SYNC MASTER CONTROL	505-5	21C*HA		
2/3CR-63 033	3 HS 1627-1	ESF A SYNC MASTER CONTROL	506-2B	21C*HA	MSC	
2/3CR-63 034	3 ZL 1627-2	ESF B SYNC MASTER CONTROL	505-5	21C*HA		
2/3CR-63 035	3 HS 1627-2	ESF B SYNC MASTER CONTROL	506-2B	21C*HA	MSC	
2/3CR-63 049	3 ZL 1617B	220KV SWYD SE BUS PCB 32 POS 16	505-5	21C*HA		
2/3CR-63 132	3 HS 1638-2	4.16KV BUS 3A06 3XU1 UNIT FDR BKR	506-2A	21C*HA		
2/3CR-63 134	3 HS 1637-2	4.16KV BUS 2A06 3XR2 RES FDR BKR	506-2A	21C*HA		
2/3CR-63 136	3 HS 1639A2	4.16KV BUS 3A06 - 2A06 TIE FDR BKR	506-2A	21C*HA		
2/3CR-63 140	3 HS 1642-2	4.16KV BUS 3A06 DSL GEN 3G003 BKR	506-2A	21C*HA		
2/3CR-63 141	3 HS 1643-2	4.16KV BUS 3A06 L CTR 3B06 FDR BKR	506-2A	21C*HA		
2/3CR-63 143	3 HS 1644-2	DIESEL GEN 3G003 MODE SELECTOR	506-2A	21C*HA		
2/3CR-63 144	3 HS 1645-2	DIESEL GEN 3G003 LOCKOUT RESET	506-2A	21C*HA		
2/3CR-63 145	3 HS 1646A2	DIESEL GEN 3G003 SIAS OVERRIDE	506-2A	21C*HA		
2/3CR-63 146	3 HS 1646B2	DIESEL GEN 3G003 SIAS OVERRIDE	506-2A	21C*HA		
2/3CR-63 147	3 HS 1647-2	DIESEL GEN 3G003 VOLT REG CONTROL	506-2A	21C*HA		
2/3CR-63 148	3 HS 1648-2	DIESEL GEN 3G003 VOLT REG CONTROL	506-2A	21C*HA		
2/3CR-63 149	3 HS 1649-2	DIESEL GEN 3G003 MANUAL START	506-2A	21C*HA		
2/3CR-63 150	3 HS 1650-2	DIESEL GEN 3G003 GOVERNOR CONTROL	506-2A	21C*HA		
2/3CR-63 171	3 HS 1661-1	4.16KV BUS 2A04 3XU1 UNIT FDR BKR	506-2A	21C*HA		
2/3CR-63 173	3 HS 1659-1	4.16KV BUS 3A04 3XR1 UNIT FDR BKR	506-2A	21C*HA		
2/3CR-63 175	3 HS 1660A1	4.16KV BUS 3A04 - 2A04 TIE FDR BKR	506-2A	21C*HA		
2/3CR-63 177	3 HS 1663-1	4.16KV BUS 3A04 L CTR 3B04 FDR BKR	506-2A	21C*HA		
2/3CR-63 179	3 HS 1664-1	4.16KV BUS 3A04 DSL GEN 3G002 BKR	506-2A	21C*HA		
2/3CR-63 180	3 HS 1665-1	DIESEL GEN 3G002 MODE SELECTOR	506-2A	21C*HA		
2/3CR-63 181	3 HS 1666-1	DIESEL GEN 3G002 LOCKOUT RESET	506-2A	21C*HA		
2/3CR-63 182	3 HS 1667A1	DIESEL GEN 3G002 SIAS OVERRIDE	506-2A	21C*HA		
2/3CR-63 183	3 HS 1667B1	DIESEL GEN 3G002 SIAS OVERRIDE	506-2A	21C*HA		
2/3CR-63 184	3 HS 1668-1	DIESEL GEN 3G002 VOLT REG CONTROL	506-2A	21C*HA		
2/3CR-63 185	3 HS 1669-1	DIESEL GEN 3G002 VOLT REG CONTROL	506-2A	21C*HA		
2/3CR-63 186	3 HS 1670-1	DIESEL GEN 3G002 MANUAL START	506-2A	21C*HA		
2/3CR-63 187	3 HS 1671-1	DIESEL GEN 3G002 GOVERNOR CONTROL	506-2A	21C*HA		
2/3CR-63 224	3 HS 1639B2	4.16KV BUS 3A06- 2A06 TIE FDR BKR	506-2A	21C*HA		
2/3CR-63 225	3 HS 1660B1	4.16KV BUS 3A04- 2A04 TIE FDR BKR	506-2A	21C*HA		
2/3CR-63 249	3 HS 1699B2	480V BUS GND VOLT SCALE SELECTOR	506-2A	21C*HA		
2/3CR-63 251	3 HS 1697-2	480V BUS 3B06 FDR BKR	506-2A	21C*HA		
2/3CR-63 254	3 EI 1757-1	125 VDC BUS 3D1 VOLTS	505-7	21C*HA	SIGMA	9270
2/3CR-63 255	3 II 1757-1	125VDC BATTERY 3B007 AMPS	505-7	21C*HA	SIGMA	9270
2/3CR-63 256	3 EI 1757-2	125VDC BUS 3D2 VOLTS	505-7	21C*HA	SIGMA	9270
2/3CR-63 257	3 II 1757-2	125VDC BATTERY 3B008 AMPS	505-7	21C*HA	SIGMA	9270
2/3CR-63 260	3 HS 1706B1	480V BUS GND VOLT SCALE SELECTOR	506-2A	21C*HA		
2/3CR-63 263	3 HS 1705-1	480V BUS 3B04 FDR BKR	506-2A	21C*HA		
2/3CR-63 288	3 EI 1757-3	125VDC BUS 3D3 VOLTS	505-7	21C*HA	SIGMA	9270
2/3CR-63 289	3 II 1757-3	125VDC BATTERY 3B009 AMPS	505-7	21C*HA	SIGMA	9270
2/3CR-63 290	3 EI 1757-4	125VDC BUS 3D4 VOLTS	505-7	21C*HA	SIGMA	9270

SAN ONOFRE UNITS 2 & 3
BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN MAIN CONTROL PANELS

PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2/3CR-63 291	3 II 1757-4	125VDC BATTERY 3B010 AMPS	505-7	21C*HA	SIGMA	9270
2/3CR-63 295	3 ZL 1621B	220KV SWYD SW BUS PCB 24 POS 12	505-5	21C*HA	MSC	
2/3CR-63 304	3 ZL 1729-1	DIESEL GEN. 3G002 START STATUS	505-5	21C*HA		
2/3CR-63 307	3 ZL 1730-2	DIESEL GEN. 3G003 START STATUS	505-5	21C*HA		
2/3CR-63 308	3 ZL 1768-1	DIESEL GEN. 3G002 BRG. & L.O. TEMP	505-5	21C*HA		
2/3CR-63 309	3 HS 1767-1	DIESEL GEN 3G002 MAINTENANCE	506-2B	21C*HA	MSC	
2/3CR-63 310	3 ZL 1769-2	DIESEL GEN. 3G003 BRG. & L.O. TEMP.	505-5	21C*HA		
2/3CR-63 311	3 HS 1770-2	DIESEL GEN 3G003 MAINTENANCE	506-2B	21C*HA	MSC	
2/3CR-63 607	2 HS 1660A1	4.16KV BUS 2A04 - 3A04 TIE FDR BKR	506-2A	21C*HA		
2/3CR-63 609	2 HS 1661-1	4.16KV BUS 2A04 2XU1 UNIT FDR BKR	506-2A	21C*HA		
2/3CR-63 611	2 HS 1659-1	4.16KV BUS 2A04 2XR1 RES FDR BKR	506-2A	21C*HA		
2/3CR-63 615	2 HS 1664-1	4.16KV BUS 2A04 DSL GEN 2G002 BKR	506-2A	21C*HA		
2/3CR-63 616	2 HS 1663-1	4.16KV BUS 2A04 L CTR 2B04 FDR BKR	506-2A	21C*HA		
2/3CR-63 618	2 HS 1665-1	DIESEL GEN 2G002 MODE SELECTOR	506-2A	21C*HA		
2/3CR-63 619	2 HS 1666-1	DIESEL GEN 2G002 LOCKOUT RESET	506-2A	21C*HA		
2/3CR-63 620	2 HS 1667A1	DIESEL GEN 2G002 SIAS OVERRIDE	506-2A	21C*HA		
2/3CR-63 621	2 HS 1667B1	DIESEL GEN 2G002 SIAS OVERRIDE	506-2A	21C*HA		
2/3CR-63 622	2 HS 1668-1	DIESEL GEN 2G002 VOLT REG CONTROL	506-2A	21C*HA		
2/3CR-63 623	2 HS 1669-1	DIESEL GEN 2G002 VOLT REG CONTROL	506-2A	21C*HA		
2/3CR-63 624	2 HS 1670-1	DIESEL GEN 2G002 MANUAL START	506-2A	21C*HA		
2/3CR-63 625	2 HS 1671-1	DIESEL GEN 2G002 GOVERNOR CONTROL	506-2A	21C*HA		
2/3CR-63 646	2 HS 1639A2	4.16KV BUS 2A06 - 3A06 TIE FDR BKR	506-2A	21C*HA		
2/3CR-63 648	2 HS 1638-2	4.16KV BUS 2A06 2XU1 UNIT FDR BKR	506-2A	21C*HA		
2/3CR-63 650	2 HS 1637-2	4.16KV BUS 2A06 2XR2 RES FDR BKR	506-2A	21C*HA		
2/3CR-63 652	2 HS 1643-2	4.16KV BUS 2A06 L CTR 2B06 FDR BKR	506-2A	21C*HA		
2/3CR-63 654	2 HS 1642-2	4.16KV BUS 2A06 DSL GEN 2G003 BKR	506-2A	21C*HA		
2/3CR-63 655	2 HS 1644-2	DIESEL GEN 2G003 MODE SELECTOR	506-2A	21C*HA		
2/3CR-63 656	2 HS 1645-2	DIESEL GEN 2G003 LOCKOUT RESET	506-2A	21C*HA		
2/3CR-63 657	2 HS 1646A2	DIESEL GEN 2G003 SIAS OVERRIDE	506-2A	21C*HA		
2/3CR-63 658	2 HS 1646B2	DIESEL GEN 2G003 SIAS OVERRIDE	506-2A	21C*HA		
2/3CR-63 659	2 HS 1647-2	DIESEL GEN 2G003 VOLT REG CONTROL	506-2A	21C*HA		
2/3CR-63 660	2 HS 1648-2	DIESEL GEN 2G003 VOLT REG CONTROL	506-2A	21C*HA		
2/3CR-63 661	2 HS 1649-2	DIESEL GEN 2G003 MANUAL START	506-2A	21C*HA		
2/3CR-63 662	2 HS 1650-2	DIESEL GEN 2G003 GOVERNOR CONTROL	506-2A	21C*HA		
2/3CR-63 712	2 HS 1706B1	480V BUS GND VOLT SCALE SELECTOR	506-2A	21C*HA		
2/3CR-63 714	2 HS 1705-1	480V BUS 2B04 FDR BKR	506-2A	21C*HA		
2/3CR-63 720	2 HS 1639B2	4.16KV BUS 2A06- 3A06 TIE FDR BKR	506-2A	21C*HA		
2/3CR-63 721	2 HS 1660B1	4.16KV BUS 2A04- 3A04 TIE FDR BKR	506-2A	21C*HA		
2/3CR-63 723	2 HS 1699B2	480V BUS GND VOLT SCALE SELECTOR	506-2A	21C*HA		
2/3CR-63 726	2 HS 1697-2	480V BUS 2B06 FDR BKR	506-2A	21C*HA		
2/3CR-63 757	2 EI 1757-1	125 VDC BUS 2D1 VOLTS	505-7	21C*HA	SIGMA	9270
2/3CR-63 758	2 II 1757-1	125VDC BATTERY 2B007 AMPS	505-7	21C*HA	SIGMA	9270
2/3CR-63 759	2 EI 1757-2	125VDC BUS 2D2 VOLTS	505-7	21C*HA	SIGMA	9270
2/3CR-63 760	2 II 1757-2	125VDC BATTERY 2B008 AMPS	505-7	21C*HA	SIGMA	9270

SAN ONOFRE UNITS 2 & 3

BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN MAIN CONTROL PANELS

PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION		SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2/3CR-63 761	2 EI 1757-3	125VDC BUS 2D3	VOLTS	505-7	21C*HA	SIGMA	9270
2/3CR-63 762	2 II 1757-3	125VDC BATTERY	2B009 AMPS	505-7	21C*HA	SIGMA	9270
2/3CR-63 763	2 EI 1757-4	125VDC BUS 2D4	VOLTS	505-7	21C*HA	SIGMA	9270
2/3CR-63 764	2 II 1757-4	125VDC BATTERY	2B010 AMPS	505-7	21C*HA	SIGMA	9270
2/3CR-63 771	2 ZL 1729-1	DIESEL GEN. 2G002	START STATUS	505-5	21C*HA		
2/3CR-63 774	2 ZL 1730-2	DIESEL GEN. 2G003	START STATUS	505-5	21C*HA		
2/3CR-63 775	2 ZL 1768-1	DIESEL GEN. 2G002	BRG. & L.O. TEMP	505-5	21C*HA		
2/3CR-63 776	2 HS 1767-1	DIESEL GEN 2G002	MAINTENANCE	506-2B	21C*HA	MSC	
2/3CR-63 777	2 ZL 1769-2	DIESEL GEN. 2G003	BRG. & L.O. TEMP.	505-5	21C*HA		
2/3CR-63 778	2 HS 1770-2	DIESEL GEN 2G003	MAINTENANCE	506-2B	21C*HA	MSC	
2/3CR-63 784	2 ZL 1627-1	ESF A SYNC	MASTER CONTROL	505-5	21C*HA		
2/3CR-63 785	2 HS 1627-1	ESF A SYNC	MASTER CONTROL	506-2B	21C*HA	MSC	
2/3CR-63 786	2 ZL 1627-2	ESF B SYNC	MASTER CONTROL	505-5	21C*HA		
2/3CR-63 787	2 HS 1627-2	ESF B SYNC	MASTER CONTROL	506-2B	21C*HA	MSC	

7. Control Bldg. Item 7 - Electronic Converters in Panel 2L-188 (BOP 11)

Question:

Provide justification for anomalies identified in seismic qualification of converter panel 2L-188 (BOP 11). Provide a list of equipment included within the cabinet and make sure all components are seismically qualified.

Response:

The anomalies identified in Section 4.0 of Foxboro Test Report T3-1077 are addresses in Foxboro letter of February 10, 1976. See attachment following. Also enclosed is a bill of material for all Seismic Category I components mounted within the cabinet.

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MAY 4 1976

DEPT. ...

The Foxboro Company Foxboro, Massachusetts, U.S.A. 02035 • Telephone (617) 543 8750

February 10, 1976

Transmittal Letter: Product Engineering Report No. PERS 75-113; Seismic Qualification Report on SPEC 200 Nests and Nest-Mounted Modules --- as extracted from Department 383 Test Report No. T3-1077

The attached report presents information on SPEC 200 nests and nest-mounted modules per Department 383 Test Report No. T3-1077. Excluded from the report are data, etc. on other SPEC 200 devices which are no longer applicable on the basis that these devices have been extensively redesigned since test T3-1077 was run.

The following comments apply to specific statements of Section 4.0, Observations and Conclusions:

Paragraph 1 - The mechanical integrity of the 2ANU nests has been established to be satisfactory with the use of all metal locking hardware per Test Report No. T4-1025.

Paragraph 2 - Integrator power drivers, 2AO-IPD-R's, are not considered to be useable on applications where chattering of the mercury-wetted relays during seismic would be a problem. In such cases, 2AO-IPD-A's should be used.

Paragraph 3 - The "output spikes" during seismic, as reported in 3.a, can be disregarded since it has been established that these resulted from intermittent electrostatic effects produced by oscillatory motion of signal leads between the Test Items on the seismic table and output monitoring test equipment which was located several feet from the seismic table. (See Test Report No. T5-6089)

Relative to statement 3.b. the number and arrangement of cable clamps now used for the wiring in the vicinity of relay socket for K1 is expected to prevent recurrence of the problem (breaking of two of forty-two leads to relay sockets on two units tested). It should be kept in mind that this failure occurred at the 10.0g level towards the end of three series of single frequency tests which had subjected the equipment to more than 1000 sine beats. Tests at the 3.5g and 5.0g levels were performed without incident.

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With respect to paragraph 4.e. the suitcase jumpers have been replaced by a spring clip with higher retention force and lower mass. The spring clip captures a male pin mounted upon the board, and is not free to "rock" under vibration as was the suitcase jumper.

With respect to paragraph 4.g. control of alignment of retaining clips on the cards relative to the corresponding holes in the 2AP modules will assure retention of the cards within the modules under seismic vibration.

Other one-of-a-kind component failures referred to in Paragraph 3 are regarded to be random failures.

J. C. Childs

FOXBORO - J. C. Childs - D370
Staff Engineer
Nuclear Power Products and Standards

jd

POOR ORIGINAL

504-3-23-0

FOXBORO

JOB TITLE: SAN ONOFRE UNITS 2&3
JOB NUMBER: 10079003
DATE: 11/03/80
OUTPUT MASTER FILE NOT CREATED
SORT WORDS: 58 59 6 5 4 0 0
REPORT TITLE:

SAN ONOFRE UNITS 2 & 3
BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN CONVERTER PANEL 2L-188

SAN ONOFRE UNITS 2 & 3
BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN CONVERTER PANEL 2L-188

PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2L-188	2 FY 4720A1	AUX FEEDWATER TO STEAM GEN E088	504-3	21C*HA	FOXBORO	2AI-I3V
2L-188	2 FY 4720-1	AUX FEEDWATER TO STEAM GEN E088	504-3C	21C*HA	FOXBORO	2AP+SQE
2L-188	2 FY 4725-2	AUX FEEDWATER TO STEAM GEN E089	504-3C	21C*HA	FOXBORO	2AP+SQE
2L-188	2 LY 5903A1	DIESEL FUEL STORAGE TANKS	504-3	21C*HA	GEMS	RE-36562
2L-188	2 LY 5903B1	DIESEL FUEL STORAGE TANKS	504-3	21C*HA	FOXBORO	2AI-I3V
2L-188	2 LY 5903C1	DIESEL FUEL STORAGE TANKS	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 LY 5903D1	DIESEL FUEL STORAGE TANK	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 LSH 5903-1	DIESEL FUEL STOR TANK T035	504-3A	21C*HA	FOXBORO	2AP+ALM-AR
2L-188	2 LSL 5903-1	DIESEL FUEL STOR TANK T035	504-3A	21C*HA	FOXBORO	2AP+ALM-AR
2L-188	2 LSLL 5903-1	DIESEL FUEL STORAGE TANK T035	504-3A	21C*HA	FOXBORO	2AP+ALM-AR
2L-188	2 LY 5903-1	DIESEL FUEL STORAGE TANKS	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 LY 5906A2	DIESEL FUEL STORAGE TANKS	504-3	21C*HA	FOXBORO	2AI-I3V
2L-188	2 LY 5906B2	DIESEL FUEL STORAGE TANKS	504-3	21C*HA	GEMS	RE-36562
2L-188	2 LY 5906C2	DIESEL FUEL STORAGE TANKS	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 LY 5906D2	DIESEL FUEL STORAGE TANK	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 LSH 5906-2	DIESEL FUEL STOR TANK T036	504-3A	21C*HA	FOXBORO	2AP+ALM-AR
2L-188	2 LSL 5906-2	DIESEL FUEL STOR TANK T036	504-3A	21C*HA	FOXBORO	2AP+ALM-AR
2L-188	2 LSLL 5906-2	DIESEL FUEL STORAGE TANK T036	504-3A	21C*HA	FOXBORO	2AP+ALM-AR
2L-188	2 LY 5906-2	DIESEL FUEL STORAGE TANKS	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 PY 6362A2	CCW PUMP DISCH TO CRITICAL LOOP A	504-3	21C*HA	FOXBORO	2AI-I3V
2L-188	2 PY 6362B2	CCW PUMP DISCH TO CRITICAL LOOP A	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 PY 6362C2	CCW PUMP DISCH TO CRIT LOOP AOP A	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 PCL 6362-2	CCW PUMP DISCH TO CRITICAL LOOP A	504-3A	21C*HA	FOXBORO	2AP+ALM-AR
2L-188	2 PY 6363A1	CCW PUMP DISCH TO CRIT LOOP B	504-3	21C*HA	FOXBORO	2AI-I3V
2L-188	2 PY 6363B1	CCW PUMP DISCH TO CRIT LOOP B	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 PY 6363C1	CCW PUMP DISCH TO CRIT LOOP BOP B	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 PCL 6363-1	CCW PUMP DISCH TO CRITICAL LOOP B	504-3A	21C*HA	FOXBORO	2AP+ALM-AR
2L-188	2 HY 8419A1	STEAM DUMP TO ATMOSPHERE	504-3	21C*HA	FOXBORO	2AO-V2I
2L-188	2 HY 8419B1	STEAM DUMP TO ATMOSPHERE	504-3	21C*HA	FOXBORO	2AO-V2I
2L-188	2 HY 8421A2	MAIN STEAM DUMP TO ATMOSPHERE	504-3	21C*HA	FOXBORO	2AO-V2I
2L-188	2 HY 8421B2	MAIN STEAM DUMP TO ATMOSPHERE	504-3	21C*HA	FOXBORO	2AO-V2I
2L-188	2 LY 9386A1	CONTAINMENT EMERGENCY SUMP	504-3	21C*HA	FOXBORO	2AI-I3V
2L-188	2 LY 9386B1	CONTAINMENT EMERGENCY SUMP	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 LSH 9386-1	CONTAINMENT EMERG SUMP HIGH LEVEL	504-3A	21C*HA	FOXBORO	2AP+ALM-AR
2L-188	2 LY 9386-1	CONTAINMENT EMERGENCY SUMP	504-3	21C*HA	GEMS	RE-36562
2L-188	2 LY 9387-1	CONTAINMENT AREA LEVEL	504-3	21C*HA	FOXBORO	2A1-13V
2L-188	2 LY 9388-2	CONTAINMENT AREA LEVEL	504-3	21C*HA	FOXBORO	2A1-13V
2L-188	2 LY 9389A2	CONTAINMENT EMERGENCY SUMP	504-3	21C*HA	FOXBORO	2AI-I3V
2L-188	2 LY 9389B2	CONTAINMENT EMERGENCY SUMP	504-3	21C*HA	FOXBORO	2AO-L2C-R
2L-188	2 LSH 9389-2	CONTAINMENT EMERG SUMP HIGH LEVEL	504-3A	21C*HA	FOXBORO	2AP+ALM-AR
2L-188	2 LY 9389-2	CONTAINMENT EMERGENCY SUMP	504-3	21C*HA	GEMS	RE-36562
2L-188	2 TY 9903A1	CONTAINMENT ATMOS TEMP-EMERG	504-3	21C*HA	FOXBORO	2AO-V2I
2L-188	2 TT 9903-1	CONTAINMENT ATMOS TEMP TRANS EMERG	504-3B	21C*HA	FOXBORO	2AI-T2V
2L-188	2 TY 9911A2	CONTAINMENT ATMOS TEMP-EMERG	504-3	21C*HA	FOXBORO	2AO-V2I

SAN ONOFRE UNITS 2 & 3
BILL OF MATERIAL FOR SEISMIC CLASS I EQUIPMENT LOCATED IN CONVERTER PANEL 2L-188

PANEL NUMBER	INSTRUMENT TAG NUMBER	SERVICE DESCRIPTION	SPEC NUMBER	PROJECT CLASS	MANUFACTURER	MODEL NUMBER
2L-188	2 TT 9911-2	CONTAINMENT ATMOS TEMP TRANS EMERG	504-3B	21C*HA	FOXBORO	2AI-T2V

8. Control Bldg. Item 8 - NSSS Auxiliary Relay Cabinet (BOP 22)

Question:

Provide a summary of the seismic qualification of the Agastat Series 7000 Timing Relays.

Response:

Generic seismic qualification has been performed by the instrument supplier to a seismic environment in excess of the environment identified for the NSSS Auxiliary Relay Cabinet. The instrument supplier's qualification is a biaxial, random frequency qualification with a TRS in excess of 10 gs for all frequencies above approximately 2 Hz.

9. Control Bldg. Item 9 - 4160V Class 1E Switchgear (BOP 1)

Question:

Review seismic qualification and provide justification for 2 panels (Panel Numbers: 2A0413 and 240414) on north end of 4160V Switchgear Set 2A04 (BOP 1), which appear to be different than cabinet sections tested. Provide justification for anomalies identified in seismic qualification of components.

Response:

A. The reason why the two panels in question appear to be different than the cabinet sections tested is the number of display instruments mounted on the front face of these panels. However, the actual stiffness characteristics and mass distribution of these cabinets are not markedly different than the typical panels included in the seismic qualification test. The major portion of the weight for these switchgear panels are associated with the rigid bus, circuit breakers and cabinet frames. The weight of the additional instrumentation in these two panels represents less than 5 percent of the total weight of these panels. Panel 2A0414 (northernmost panel of long run) actually weighs slightly less than the typical panel since it does not include a circuit breaker but does include an additional amount of rigid bus associated with the unit intertie. Qualification of this additional rigid bus intertie was documented by analysis and was included with the documentation package. Therefore, the seismic qualification of the typical switchgear panels included in the test are applicable for the two panels on the north end of 4160V Switchgear Set 2A04, as well as the balance of the switchgear modules.

B. The anomalies identified in the seismic qualification report have no impact on the San Onofre Units 2&3 4160V Switchgear since alternate instrumentation was substituted for the suspect GE SAM Timing Relays as identified in the associate Bill of Materials. The substitute relays, Agastat Series 7000 Timing Relays, were qualified by both the switchgear vendor and by the instrument supplier to a seismic environment in excess of the environment identified for instruments mounted within the subject switchgear panels. The instrument supplier's qualification is a biaxial, random frequency qualification with a TRS in excess of 10 gs for all frequencies above approximately 2 Hz.

10. Radwaste Bldg. Item 1 - Charging Pump (NSSS 25)

a. Question:

Provide justification for anomalies identified in seismic qualification test report of the Charging Pumps (i.e., packing cooling system bolts loosening, sight glass failure, and cracked welds, etc.).

Response:

All of these anomalies occurred in the packing cooling system which is non-safety related. The charging pump can perform its safety functions for the maximum required time duration, up to 24 hours for safe shutdown, without the packing cooling system. (Section III, para. 3.1.4 of the instruction manual states that ".....continuous operation for approximately 15 hours without packing lubrication is possible without serious loss of pump capacity." The 15 hours is too conservative and the vendor, Gaulin, will revise this number to at least 100 hours which is still conservative.)

The test pump was a machine for Jersey Central P&L's Forked River plant. Subsequent to the test, modifications were made to the packing cooling system so that the modified system as designed and built for the San Onofre pumps will preclude the test anomalies in the event of a seismic occurrence.

All parties to the test agreed that it was a very severe test of greater total duration than would be expected during an actual seismic event.

b. Question:

The test report indicates several resonances exist below 35 Hz although the SQRT form indicates there are no natural frequencies below 35 Hz. Provide an explanation of this inconsistency.

Response:

The natural frequencies indicated in the SQRT Form as greater than 35 Hz are based on an analysis of the charging pump assembly that includes those components vital to pump operation. All of the resonances, except one, that were below 35 Hz were associated with the packing cooling system that is not vital to pump operation.

The one resonancce below 35 Hz and not associated with the packing cooling system was read from one of two accelerometers mounted adjacent to each other on the top of the motor housing. This resonance, 20 Hz, appeared with the pump assembly in only one of two side-to-side positions and only during the resonance survey and sine sweep with the pump non-operating. Since the complete pump assembly is one "system," the exact source from whence this particular resonance emanated was unknown. Based on the success of the tests, both operating and non-operating, this one lone low resonance does not affect the qualification of this equipment. Note that the maximum acceleration indicated for the DBE at 0.5% damping is 1.5 g at 20 Hertz.

c. Question:

Justify the adequacy of single frequency tests.

Response:

Resonance searches and sine sweeps were conducted over the range from 1 to 35 Hz and only one resonance below 35 Hz (packing cooling system excepted) and was found as discussed above. No problem resulting from mutual excitation of parts in close proximity was anticipated. This was demonstrated by the dwell tests at several frequencies in each of the four pump positions on the shake table.

d. <u>Question</u>:

Verify that pulsation damper for charging pump was included in piping analysis/nozzle loads.

<u>Response</u>:

The pulsation dampeners, on both the suction and discharge, of all charging pumps were modeled as in-line components in the piping analysis per the vendor prints. This is reflected in the computer analyses for Thermal, Weight and Seismic Loadings and contributes to the piping stresses and the pump nozzle loads.

11. Tank Structure Item 1 - Auxiliary Feedwater Pump Motor (BOP 13)

Question:

Provide copy of qualification report of Auxiliary Feedwater pump motor for subsequent detailed review.

Response:

Copies of the seismic qualification report for the auxiliary feedwater pump motor performed by Allis Chalmers Corporation are enclosed for your review.

Seismic Withstand Capability Calculations for:

BYRON JACKSON PUMP DIV.
2300 E. VERNON AVE.
VERNON, CALIFORNIA
CUSTOMER ORDER V-191858
A.C. ORDER 62-08-5116-EL 90247
JOB 10079

Calculations are Made in Accordance with:

BECHTEL POWER CORPORATION "QUALITY CLASS II
SPECIFICATION S023-405-6 SPECIFICATION FOR
SCE No. 4079 AUXILIARY FEEDWATER PUMPS AND DRIVERS FOR THE SOUTHERN CALIFORNIA EDISON COMPANY SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 & 3"

Equipment Description:

Frame 3020 SSG Type AZ
Horsepower 800 Speed 3600 RPM
4160 VOLTS 60 CYCLE 3 PHASE
Total Weight 9700 LBS.

Predicted Possible Failure Modes:

1) Anchorage system
2) Excessive rotor deflection
3) Premature bearing failure
4) Conduit box

POOR ORIGINAL

Adequacy Criterion:

The first step in qualifying a piece of equipment is to determine the rigidity. Verification that the machine is "rigid" permits the manufacturer qualification through static seismic analysis.

Static stress analysis is then performed on each critical component to demonstrate capability to withstand the possible modes of failure. Forces imposed by normal operation as well as those produced as a result of seismic accelerations are applied and analyzed. The seismic withstand capability of the anchorage system is based on a comparison of calculated bolt stressed to allowable unit stresses as determined by A.I.S.C.:

20,000 PSI IN TENSION
10,000 PSI IN SHEAR

The rotor seismic withstand capability is based on the ability of the rotor assembly to resist deflection: the rotor core striking the stator bore would cause malfunction or loss of function. Continuous exposure to seismic applied

SUPERSEDES LOG #10

S023-405-6-38-0 SCE # 4079

forces, having minimal effect on life expectance, yields an indication of bearing withstand capability.

These components are deemed critical by the Allis-Chalmers Corporation concerning uninterrupted operation during a seismic event. Further analysis will be performed upon customer request and engineering evaluation of necessity.

IMPORTANT
If the price or schedule is affected by this document approval, Bechtel must be notified prior to fabrication or such claims are waived.
Approval of documents involving calculation, analysis or test report is only an acceptance of the method used by the supplier. Supplier retains full responsibility for design.
Approval of this document does not relieve the supplier from full responsibility for contract or purchase order requirements including, but not limited to, adequacy and suitability of materials and/or equipment represented thereon for the intended function.

DATE RECEIVED 1-4-77

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BECHTEL
PF-1218 (10079) 12/75

... QUALITY ACCEPTABLE

405-6-38-0

②

Determining the Motor Rigidity

An indication of the rigidity of an electric motor is based on the lowest natural frequency observed. However, the complexity of a piece of equipment such as a motor does not permit easy modeling of the entire unit for natural frequency determination. In an attempt to simplify this problem, the Allis-Chalmers Corporation uses two computer programs which calculate the critical rotor speed and the "reed" natural frequency. The critical speed is usually the lowest natural frequency in horizontal motors, and the "reed" frequency or critical speed the lowest in vertical motors.

A general outline of the critical rotor speed calculation method is given in the rotor response section. ~~The method used in determining "reed" frequency is attached~~.

A natural frequency greater than 33 Hz. is generally accepted as an indication that the equipment is rigid. For the motor specified on the title page, our Critical Speed computer program determined the fundamental natural frequency to be 5550 RPM or 92.5 HZ.

"G" levels for qualification.

In accordance with Bechtel Power Corp. Spec. S023-405-6 Appendix 4F

this natural frequency qualifies the unit for static seismic analysis. Seismic withstand capability will then be demonstrated using acceleration levels per Sketch Nos. S023-SK-S-756 and S023-SK-S-757

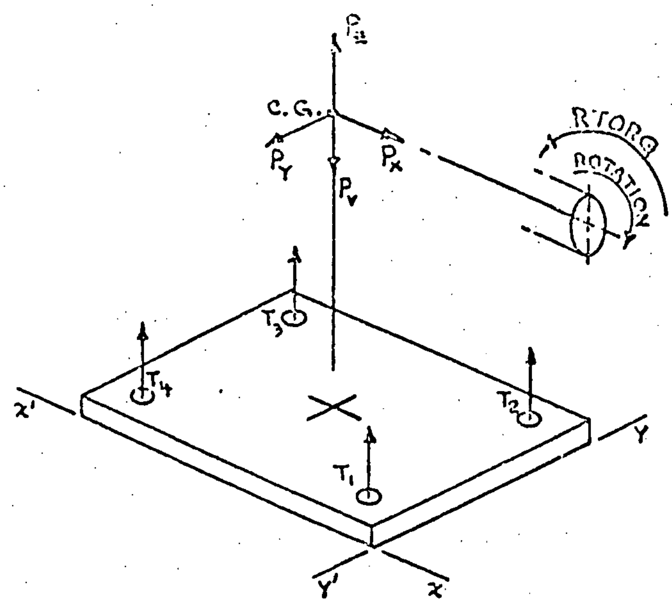
which are: For frequencies above 33 Hz.

Horizontal 0.85 g
Vertical 0.64 g

POOR ORIGINAL

405-6-38-0

MOUNTING BASE



FRAME 3020 SS6

TYPE AZ

HORSEPOWER 800

SPEED 3600 RPM

WEIGHT 9700 lbs.

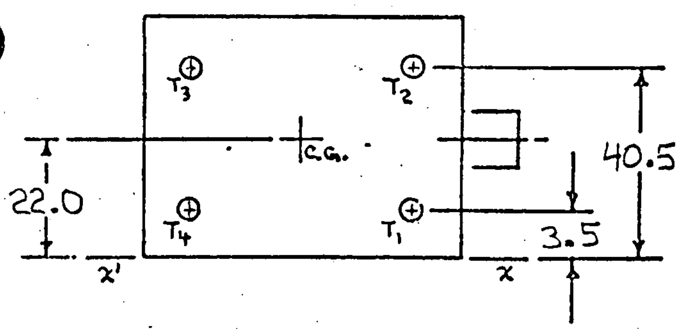
REACTION TORQUE,

$$RTORQ = \frac{HP \times 63025}{RPM}$$

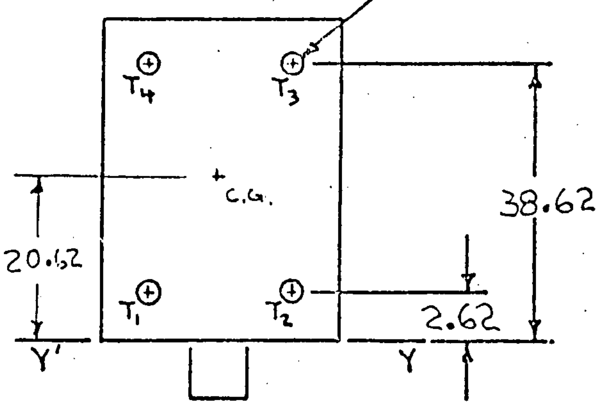
OVERTURNING MOMENTS DUE TO HORIZONTAL SEISMIC ACCELERATION

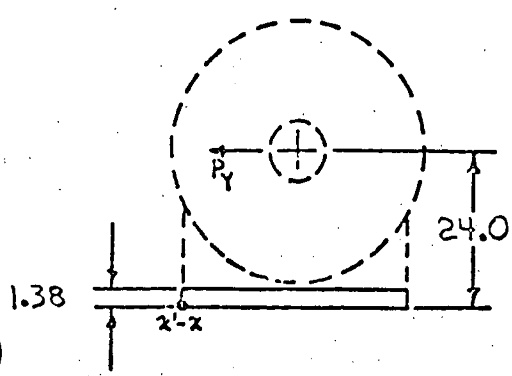
$$M_{x'-x} = P_y \times \text{(DISTANCE FROM BASE TO C.G.)}$$

$$M_{y'-y} = M_{x'-x}$$



BOLT TYPE 1¼-7 UNC
STRESS AREA 0.969 IN.²





405-6-38-0

FIGURE 1

I. Anchorage System (see figure 1)

POOR ORIGINAL

No. of Bolts, N = 4
Type 1¼-7 UNC
Stress Area, A = 0.969 in.^{2} per bolt
Motor Weight, W = 9700 lbs.

A. Tensile stress due to upward vertical acceleration (0.64 g) plus the overturning moment resulting from the reaction torque in the normal mode of operation at 800 HP and 3600 RPM.

Reaction torque, RTORQ = (HP x 63025)/RPM
= 14006 in.-lbs.

$P_z = -W + 0.64\ W = -3492$ lbs.

$T_3 = T_2$, $T_4 = T_1$, $T_1 = (3.5/40.5)\ T_2$
$= 0.086\ T_2$

$\Sigma M_{x',-x} = 0 = RTORQ + (22.0 \times -3492) - (3.5 \times 2T_1) - (40.5 \times 2T_2)$
$= 14006 - 76824 - (3.5 \times 2(0.086T_2)) - 81\ T_2$

$T_2 = -769.8$ lbs.

$S_v = T_2/A = -794.4$ PSI PER BOLT IN TENSION

The negative indicates that the force due to the weight is greater than the seismic force and overturning moment combined. Therefore, there is NO LOAD on the bolts.

B. Tensile stress due to downward vertical acceleration (0.64 g) plus the overturning moment resulting from the reaction torque.

$P_v = W + .64\ W = 15908$ lbs.

$\Sigma M_{x',-x} = 0 = 14006 - (22.0 \times 15908) - 81.6\ T_2$
$= -335970 - 81.6\ T_2$

$T_2 = -4117.3$ lbs.

$S_v = T_2/A = -4249.0$ PSI PER BOLT IN TENSION

The negative indicates NO LOAD on the bolts.

405-6-38-0

C. Shear stress due to horizontal acceleration (0.85g). The shear stress will be the same in each bolt regardless of the direction of the horizontal earthquake input.

P_y = 0.35 W = 8245 lbs.

$S_s = P_y/(N \times A)$ = 2127 PSI PER BOLT IN SHEAR

2127 PSI is less than 10,000 PSI (max. permissible working shear stress)

D. Tensile stress due to the overturning moment as a result of horizontal acceleration (0.85 g) acting at the center of gravity plus the reaction torque.

$$\Sigma M_{x'-x} = 0 = (8245 \times 24.0) + 14006 - (9700 \times 22.0) - 3.5(2T_1) - 40.5(2T_2)$$
$$= 1.9788 \times 10^5 + 14006 - 2.134 \times 10^5 - 81.6\ T_2$$
$$= -1.514 \times 10^3 - 81.6\ T_2$$

T_2 = − 18.55 lbs.

$S_T = T_2/A$ = −19.1 PSI PER BOLT IN TENSION

E. Tensile stress due to the overturning moment as a result of horizontal acceleration (0.85g) acting at the center of gravity. The reaction torque has no effect when considering moments about the Y′ - Y axis.

$P_x = P_y$ = 8245 lbs

$T_4 = T_3$, $T_1 = T_2$, $T_2 = (2.62/38.62)\ T_3$
$= 0.068\ T_3$

$$\Sigma M_{y'-y} = 0 = (24.0 \times 8245) - (20.62 \times 9700) - 2.62(2T_2) - 38.62(2T_3)$$
$$= -2.134 \times 10^3 - (2.62 \times 2(0.068T_3)) - 77.24T_3$$

T_3 = − 27.5 lbs.

$S_T = T_3/A$ = − 28.4 PSI PER BOLT IN TENSION

The stresses in D., − 19.1 PSI and E., − 28.4 PSI are ~~each less than 20,000 PSI (max. permissible working tensile stress)~~, negative and indicate that there is NO LOAD on the bolts.

405-6-38-0

POOR ORIGINAL

F. Combined stresses

The maximum horizontal tensile stress is imposed in two directions and superimposed upon the vertical tensile stress. Applying all three simultaneously and perpendicular to one another, they are combined vectorially to produce the following resultant magnitude:

$$\text{Resultant stress,} \quad S_R = \sqrt{S_T^2 + S_T^2 + S_v^2} = 0$$
$$= 0$$

Using this resultant, a conservative treatment of combined tensile and shear stresses acting simultaneously will be employed as given in Mechanical Engineering Design by Shigley, 1972 Edition, page 30, McGraw-Hill Inc. Publishers. This will then show the capability of the specified equipment to withstand both horizontal and vertical earthquake motions occuring simultaneously.

Combined tensile stress,

$$\sigma = S_R/2 + \sqrt{S_S^2 + S_R^2/4} = 0 + \sqrt{(2127)^2 + 0}$$

$= 2127$ PSI IN TENSION

Combined shear stress,

$$\tau = \sqrt{S_S^2 + S_R^2/4}$$

$= 2127$ PSI IN SHEAR

NOTE- The combined stresses in both tension and shear are less than the maximum allowable working stressed (20,000 PSI tension, 10,000 PSI shear) under the given seismic accelerations.

POOR ORIGINAL

405-6-38-0

II. Rotor Response (see drawing & print-out)

General assembly 51-363-826
Rotor core 723 lbs.
~~Aluminum~~
Shaft 540 lbs.

Total 1263 lbs.

Air gap flux density 27700 lines/in.^{2}
Nominal air gap 0.140 in.

The force due to the vertical seismic acceleration (0.64 g) is:

Total weight x (0.64) + (Total weight − shaft weight) (1.0 g) = 1531 lbs.

The original weight of the shaft (540 lbs.) is not included in the total force because it is calculated by the computer program and applied at each station. The effective weight, vertical force, applied to the shaft is then distributed equally along the shaft at the locations occupied by the rotor core.

Using this rotor data, we determine the rotor response by means of an "in-house" computer program of the Rayleigh Principle.* This method is based on modeling the shaft as a series of lumped masses and imposed forces. Treating each increment of shaft length as a classical beam and using continuity of slope and deflection at each interface, the program determines the maximum strain energy and includes functions to permit calculation of critical speed, bearing reactions, identification of shaft deflection and stress at any station, and the effect of unbalanced magnetic pull resulting from a possible eccentric air gap (initial rotor off-set).

So that the effect of unbalanced magnetic pull due to possible initial rotor off-set can be evaluated, computations are made for a concentric air gap (0.000 in. initial rotor off-set), 10% off-set (0.014 in.), and 20% off-set (0.028 in.). Ten percent initial rotor off-set is the maximum permitted in our manufacturing process; however, considering the exaggerated, 20% off-set, condition reveals that even under this abnormal condition the rotor will not strike the stator bore causing malfunction or loss of function:

1) The maximum deflection occurs at station 12 and is 0.0053 in.

2) The minimum air gap between the rotor and stator is then:

POOR ORIGINAL

405-6-38-0

Nominal air gap - initial off-set - magnetic pull deflection
0.140 - 0.028 - 0.0053 = 0.1067

This is 24 % of the deflection that would cause loss of function.

3) The bearing reactions are 2419 lbs. at the shaft end, and 2447 lbs. at the front end.

4) Deflection at the end of the shaft extension is 0.0063 in.

Recall that since these calculations are based on the 20% initial rotor off-set condition, which is abnormal, they are conservative figures.

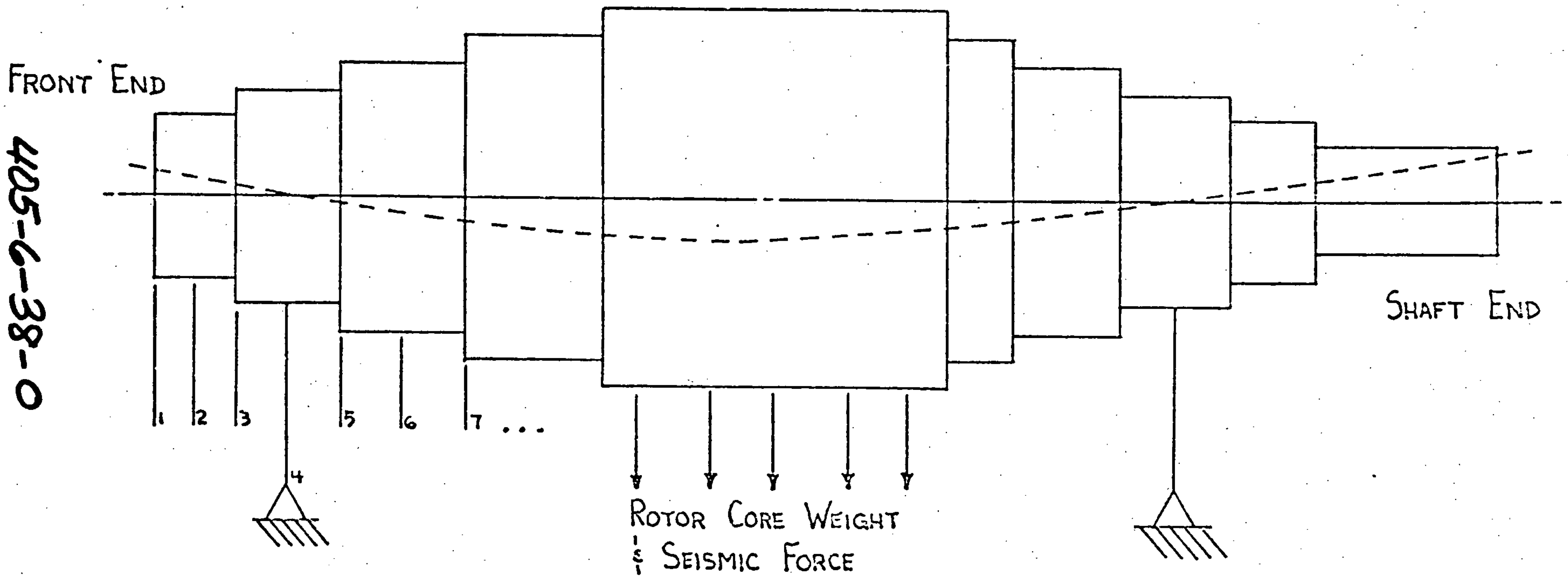
POOR ORIGINAL

* Theory of Vibrations with Applications, by William T. Thomson, ©1972 Prentice-Hall Inc. Publishers.

405-6-38-0

Rotor Response Model

405-6-38-0



Critical Rotor Speed

FRAME 3020SS6 AZ POLES 2 800 HP FL8-90247-1
ROTOR ASSEMBLY 51-363-826 SHAFT DRAWING 51-811-559

AIR GAP	INITIAL OFFSET	FLUX DENSITY	CORE DIAMETER
0.140	0.0	30470.	15.220

SPAN	DIA.	LENGTH	WEIGHT	INERTIA
1	2.375	2.688	0.0	0.0
2	3.000	4.750	0.0	0.0
3	3.000	2.625	0.0	0.0
4	3.000	2.625	0.0	0.0
5	4.125	1.000	0.0	0.0
6	4.500	1.875	0.0	0.0
7	5.000	5.125	0.0	0.0
8	5.625	2.000	0.0	0.0
9	5.875	2.312	0.0	0.0
10	7.410	5.175	144.600	0.0
11	7.410	5.175	144.600	0.0
12	7.410	5.175	144.600	0.0
13	7.410	5.175	144.600	0.0
14	7.410	5.175	144.600	0.0
15	5.875	2.312	0.0	0.0
16	5.625	2.000	0.0	0.0
17	5.000	5.375	0.0	0.0
18	4.500	1.875	0.0	0.0
19	4.125	1.000	0.0	0.0
20	3.000	2.875	0.0	0.0
21	3.000	2.875	0.0	0.0
22	3.750	0.500	0.0	0.0
23	3.000	4.625	0.0	0.0
24	2.875	5.750	0.0	0.0

FRAME 3020SS6 AZ POLES 2 800 HP FL8-90247-1
ROTOR ASSEMBLY 51-363-826 SHAFT DRAWING 51-811-559

	FIT	BEND STRESS	SHEAR STRESS	DEFLECTION
	1	-3.	-1.	0.0007659
	2	-16.	-2.	0.0002745
BEARING	3	-32.	85.	0.
	4	561.	84.	-0.0002638
	5	302.	44.	-0.0003517
	6	356.	37.	-0.0005053
	7	497.	28.	-0.0008431
	8	412.	22.	-0.0009376
	9	423.	19.	-0.0010245
	10	265.	7.	-0.0011639
	11	293.	2.	-0.0012309
	12	293.	-2.	-0.0012459
	13	267.	-7.	-0.0011819
	14	429.	-19.	-0.0010542
	15	418.	-21.	-0.0009722
	16	507.	-28.	-0.0008817
	17	358.	-36.	-0.0005324
	18	306.	-44.	-0.0003792
	19	574.	-83.	-0.0002914
BEARING	20	-69.	4.	0.
	21	-42.	3.	0.0002994
	22	-38.	3.	0.0003507
	23	-13.	2.	0.0008175
	24	0.	0.	0.0013898

CRITICAL SPEED 5550.
BEARING REACTION 619. 623.

POOR ORIGINAL

405-6-38-0

	24	1.	0.	0.0062579
BEARING REACTION		2447.	2419.	

FRAME 3020SS6 AZ POLES 2 800 HP EL8-90247-1
ROTOR ASSEMBLY 51-363-826 SHAFT DRAWING 51-811-559

AIR GAP	INITIAL OFFSET	FLUX DENSITY	CORE DIAMETER
0.140	0.014	30470.	15.220

SPAN	DIA.	LENGTH	WEIGHT	INERTIA
1	2.375	2.688	0.0	0.0
2	3.000	4.750	0.0	0.0
3	3.000	2.625	0.0	0.0
4	3.000	2.625	0.0	0.0
5	4.125	1.000	0.0	0.0
6	4.500	1.875	0.0	0.0
7	5.000	5.125	0.0	0.0
8	5.625	2.000	0.0	0.0
9	5.875	2.312	0.0	0.0
10	7.410	5.175	306.200	0.0
11	7.410	5.175	306.200	0.0
12	7.410	5.175	306.200	0.0
13	7.410	5.175	306.200	0.0
14	7.410	5.175	306.200	0.0
15	5.875	2.312	0.0	0.0
16	5.625	2.000	0.0	0.0
17	5.000	5.375	0.0	0.0
18	4.500	1.875	0.0	0.0
19	4.125	1.000	0.0	0.0
20	3.000	2.875	0.0	0.0
21	3.000	2.875	0.0	0.0
22	3.750	0.500	0.0	0.0
23	3.000	4.625	0.0	0.0
24	2.875	5.750	0.0	0.0

POOR ORIGINAL

FRAME 3020SS6 AZ POLES 2 800 HP EL8-90247-1
ROTOR ASSEMBLY 51-363-826 SHAFT DRAWING 51-811-559

0 % Offset

	FIT	BEND STRESS	SHEAR STRESS	DEFLECTION
	1	-3.	-1.	0.0013301
	2	-16.	-2.	0.0004754
BEARING	3	-32.	143.	0.
	4	964.	142.	-0.0004543
	5	516.	75.	-0.0006056
	6	606.	62.	-0.0008699
	7	850.	49.	-0.0014527
	8	706.	38.	-0.0016163
	9	729.	34.	-0.0017671
	10	460.	13.	-0.0020096
	11	509.	4.	-0.0021423
	12	510.	-4.	-0.0021533
	13	463.	-13.	-0.0020425
	14	738.	-34.	-0.0018212
	15	719.	-38.	-0.0016793
	16	870.	-48.	-0.0015229
	17	615.	-62.	-0.0009204
	18	531.	-74.	-0.0006564
	19	1009.	-140.	-0.0005050
BEARING	20	-68.	4.	0.
	21	-42.	3.	0.0005264
	22	-38.	3.	0.0006171
	23	-13.	2.	0.0014490
	24	0.	0.	0.0024751

[illegible]

10 % Offset

	FIT	BEND STRESS	SHEAR STRESS	DEFLECTION
BEARING REACTION		1027.	1023.	
	1	-3.	-1.	0.0023793
	2	-16.	-2.	0.0008488
BEARING	3	-32.	250.	0.
	4	1715.	249.	-0.0008086
	5	915.	132.	-0.0010776
	6	1072.	110.	-0.0015478
	7	1506.	88.	-0.0025961
	8	1254.	69.	-0.0023792
	9	1298.	62.	-0.0031479
	10	822.	24.	-0.0035822
	11	911.	8.	-0.0038202
	12	912.	-7.	-0.0038405
	13	827.	-23.	-0.0036427
	14	1316.	-61.	-0.0032472
	15	1278.	-69.	-0.0029939
	16	1545.	-86.	-0.0027148
	17	1094.	-108.	-0.0016417
	18	950.	-130.	-0.0011717
	19	1816.	-246.	-0.0009021
BEARING	20	-68.	4.	0.

Magnetic Pull Deflection

FRAME 3020SS6 AZ POLES 2 800 HP FL8-90247-1
ROTOR ASSEMBLY 51-363-826 SHAFT DRAWING 51-811-559

AIR GAP	INITIAL OFFSET	FLUX DENSITY	CORE DIAMETER
0.140	0.028	30470.	15.220

SPAN	DIA.	LENGTH	WEIGHT	INERTIA
1	2.375	2.688	0.0	0.0
2	3.000	4.750	0.0	0.0
3	3.000	2.625	0.0	0.0
4	3.000	2.625	0.0	0.0
5	4.125	1.000	0.0	0.0
6	4.500	1.875	0.0	0.0
7	5.000	5.125	0.0	0.0
8	5.625	2.000	0.0	0.0
9	5.875	2.312	0.0	0.0
10	7.410	5.175	306.200	0.0
11	7.410	5.175	306.200	0.0
12	7.410	5.175	306.200	0.0
13	7.410	5.175	306.200	0.0
14	7.410	5.175	306.200	0.0
15	5.875	2.312	0.0	0.0
16	5.625	2.000	0.0	0.0
17	5.000	5.375	0.0	0.0
18	4.500	1.875	0.0	0.0
19	4.125	1.000	0.0	0.0
20	3.000	2.975	0.0	0.0
21	3.000	2.875	0.0	0.0
22	3.750	0.500	0.0	0.0
23	3.000	4.625	0.0	0.0
24	2.875	5.750	0.0	0.0

POOR ORIGINAL

FRAME 3020SS6 AZ POLES 2 800 HP FL8-90247-1
ROTOR ASSEMBLY 51-363-826 SHAFT DRAWING 51-811-559

0% Offset

	FIT	BEND STRESS	SHEAR STRESS	DEFLECTION
	1	-3.	-1.	0.0013391
	2	-16.	-2.	0.0004754
BEARING	3	-32.	143.	0.
	4	964.	142.	-0.0004543
	5	516.	75.	-0.0006056
	6	606.	62.	-0.0008699
	7	850.	49.	-0.0014527
	8	706.	38.	-0.0016163
	9	729.	34.	-0.0017671
	10	460.	13.	-0.0020096
	11	502.	4.	-0.0021423
	12	510.	-4.	-0.0021522
	13	463.	-13.	-0.0020425
	14	733.	-34.	-0.0018212
	15	719.	-38.	-0.0016792
	16	870.	-48.	-0.0015228
	17	615.	-62.	-0.0009204
	18	531.	-74.	-0.0006564
	19	1009.	-140.	-0.0005050
BEARING	20	-68.	4.	0.
	21	-42.	3.	0.0005264
	22	-38.	3.	0.0006171
	23	-13.	2.	0.0014490
	24	0.	0.	0.0024751

[redacted]

BEARING REACTION		1027.	1023.	

20 % offset

	FIT	BEND STRESS	SHEAR STRESS	DEFLECTION
	1	-3.	-1.	0.0032969
	2	-16.	-2.	0.0011754
BEARING	3	-32.	344.	0.
	4	2371.	343.	-0.0011184
	5	1264.	181.	-0.0014904
	6	1480.	152.	-0.0021406
	7	2080.	121.	-0.0035773
	8	1733.	95.	-0.0039817
	9	1795.	87.	-0.0043554
	10	1139.	33.	-0.0049574
	11	1262.	11.	-0.0052874
	12	1265.	-10.	-0.0053158
	13	1146.	-32.	-0.0050419
	14	1820.	-85.	-0.0044242
	15	1767.	-94.	-0.0041424
	16	2135.	-119.	-0.0037571
	17	1512.	-149.	-0.0022725
	18	1316.	-178.	-0.0016222
	19	2522.	-338.	-0.0012494
BEARING	20	-68.	4.	0.
	21	[illegible]	[illegible]	[illegible]

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III) Bearings Split Sleeve (3.0 x 5.25)

Front End 2447 lbs
Shaft End 2419 lbs.
Rotor Weight 1263 lbs.

The total effective force due to vertical seismic acceleration plus magnetic pull resulting from initial rotor off-set is obtained from the computer print-out. Using the exaggerated 20% initial rotor off-set data, the bearing reactions are 2447 lbs. on the front end bearing and 2419 lbs. on the shaft end bearing.

The thrust load due to horizontal acceleration (0.85 g) applied along the shaft axis is:

ROTOR WEIGHT x (0.85 g) = 1074 lbs.

The thrust load given by the customer is : 0 lbs.
Therefore, the total thrust load is: 1074 lbs. This thrust load is absorbed by the housings of both bearings and will have no effect on performance.
Summarizing, the bearing loads are then:

FRONT END BEARING			SHAFT END BEARING		
RADIAL LOAD	2447	lbs.	RADIAL LOAD	2419	lbs.
THRUST LOAD	0	lbs.	THRUST LOAD	0	lbs.

The following calculations for determining minimum or expected bearing life represent evaluations using continuous exposure to the seismic event. Since the time duration of an earthquake is short, it will have little effect on the actual performance of the bearings.

SPLIT SLEEVE BEARING

Shaft 51-811-559
Bearing Bushing 51-800-896-501

Journal diameter 3.000 / 2.999
Bore diameter 3.008 / 3.006
Bearing length 5.25

Lubricating oil viscosity, t = 150 SSU @ 100°F
Gravity A.P.I. @ 60°F ≅ 30.3

To determine the seismic capability of the sleeve bearings, the maximum deflection of the shaft at the bearing location due to a seismic event will be shown not to exceed the minimum oil film necessary for uninterupted operation. The minimum oil film thickness is determined by the method recommended by R. R. Slaymaker's Bearing Lubrication Analysis, © 1955 John Wiley & Sons, publisher:

specific gravity @ 60°F, ρ_{60}

$$\rho_{60} = \frac{141.5}{131.5 + \text{gravity API @ } 60^{\circ}F} = 0.875$$

specific gravity @ 100°F, ρ_{100}

$$\rho_{100} = \rho_{60} - 0.00035(100^{\circ} - 60^{\circ}) = 0.861$$

absolute viscosity, Z centipoises

$$Z = \rho\left(0.22\ t - \frac{180}{t}\right) = 0.861\left(0.22\ (150) - \frac{180}{150}\right)$$

$$= 27.365 \quad \text{centipoises}$$

absolute viscosity, μ reyns

$$\mu = \frac{Z}{6.9\times10^{6}} = 3.966 \times 10^{-6} \text{ reyns}$$

minimum radius of journal, r = 1.4995 in.
maximum radius of bore, R = 1.504 in.

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maximum radial clearance, $C = 0.0045$ in.

The reciprocal of the Sommerfield number is a measure of the load carrying capacity of a bearing and will be called the capacity number.

the load on the bearing,* P

$$P = \frac{\text{radial load}}{\text{projected load bearing area}}$$

$$= \frac{2447}{3.0 \times 5.25}$$

$$P = 155 \text{ PSI}$$

rotational speed, N = 3600 RPM

POOR ORIGINAL

the capacity number then,

$$\frac{P}{\mu N}\left(\frac{C}{r}\right)^2 = \frac{155}{(3.966\times10^{-5})(3600)}\left(\frac{0.0045}{1.4995}\right)^2$$

$$= 0.098$$

Figure 3.7, page 25, Bearing Lubrication Analysis relates capacity number to film thickness ratio, $(C/h_0) = 1.15$

the minimum oil film thickness, $h_0 = 0.0039$ in.

This is the minimum film thickness assuming that there is no shaft deflection in the region of the bearing. With the exaggerated initial rotor off-set of 20%, the rotor shaft bearing journal maximum deflection occurs at the edge of the bearing (fit 21) and is 0.0013 in. With this added deflection, the minimum oil film thickness then becomes, $h_0 - 0.0013$ or 0.0026 in.

Due to the nature of a sleeve bearing, then, the only wear between journal and bore will occur during start-up. Therefore, the seismic event has no effect on the life of the bearings.

* The maximum radial load, observed on the front bearing, is used to qualify both front and shaft end bearings.

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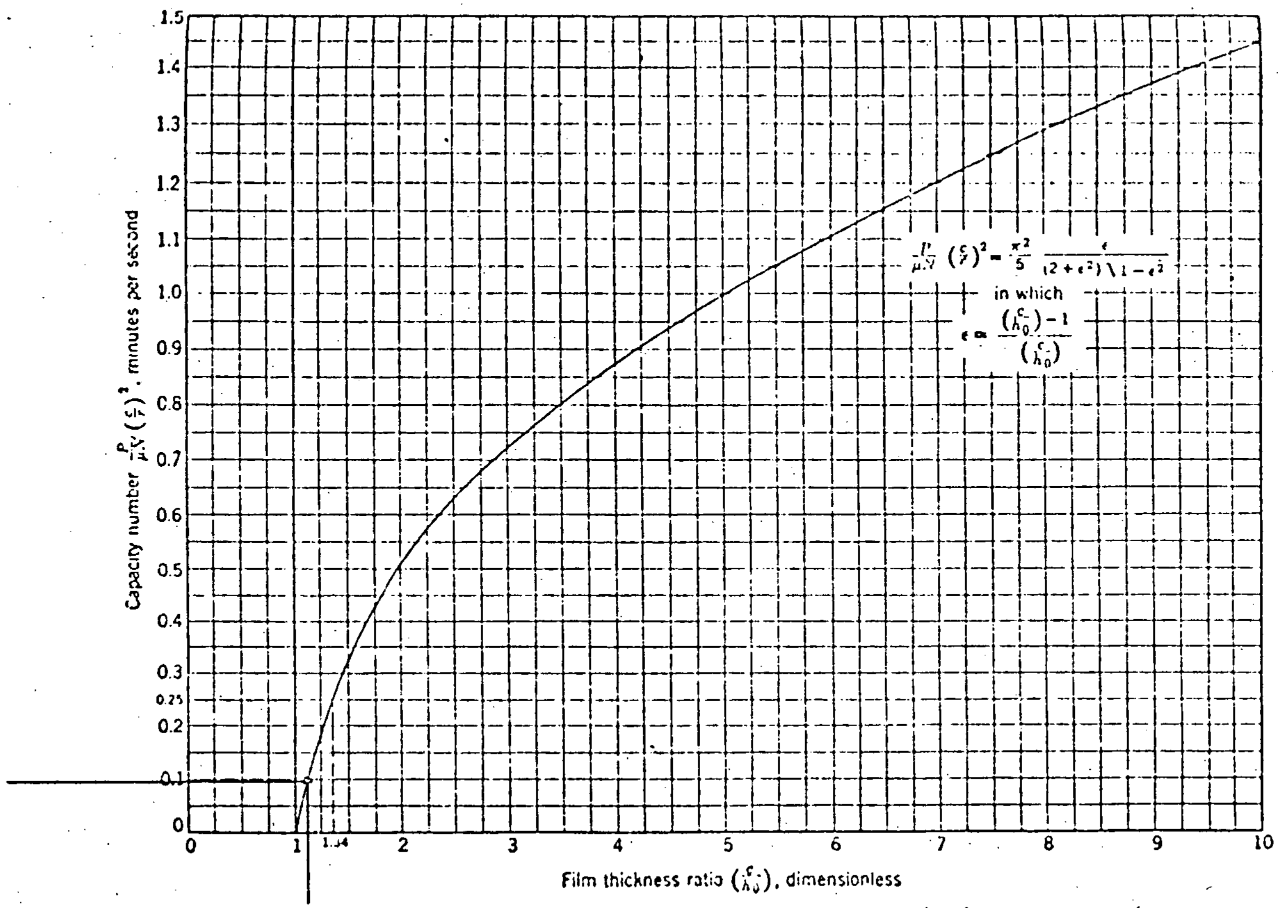
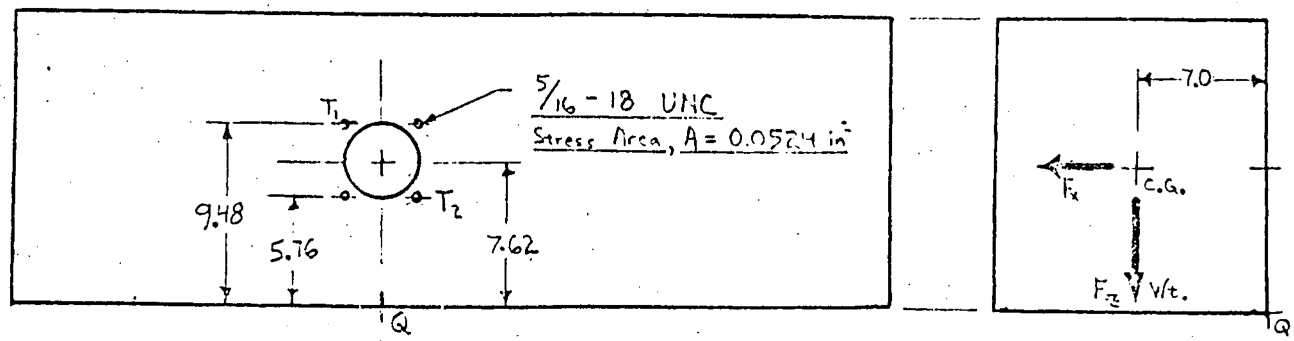


Fig. 3.7. Capacity number vs. thickness ratio for ideal bearing.

(16)

IV) Conduit Box

POOR ORIGINAL



As a conservative measure, the conduit box will be analyzed assuming that the bolting arrangement is the only means of support. Furthermore, the moments will be taken about the extreme fiber, point "Q." The vertical and horizontal seismic forces will be applied simultaneously. Under these conditions it will be shown that the bolt stresses do not exceed the allowable maximums and hence the seismic event will have no effect on the conduit box.

$Wt. \cong 130$ lbs.

$F_x = 130 \times 0.85_g = 110.5$ lbs.

$F_z = 130 \times 0.64_g = 83.2$ lbs.

$T_2 = (5.76 / 9.48)\, T_1 = 0.61\, T_1$

The maximum stress will occur in T_1

$$\Sigma M_Q = 0 = (7.62 \times F_x) + (7.0 \times F_z) + (7.0 \times Wt.) - (5.76 \times 2T_2) - (9.48 \times 2T_1)$$

$$= (842.) + (582.4) + (910.) - (11.52\,(.61T_1)) - (18.96\,T_1)$$

$$= 2334.4 - 25.99\,T_1$$

$T_1 = 89.8$ lbs

$S_{T_1} = 89.8 / 0.0524\ in^2 =$ 1714 PSI in tension

$S_s = (Wt. + F_z) / (4 \times A) = (130 + 83.2) / (4 \times 0.0524)$

$=$ 1017 PSI in shear

405-6-38-0

IV) Summary

The attached calculations verify that the subject motor is capable of continuous operation under normal operating loads acting simultaneously with two horizontal components and one vertical component of the previously described seismic event.

Calculation of minimum bearing life when exposed to the seismic event indicates no malfunction or loss of function due to the seismic loading.

The most serious condition is the possibility of the rotor striking the stator bore. This will not happen since, even under exaggerated conditions (20% initial rotor off-set and continuous seismic force), rotor deflection does not exceed 24 % of that necessary to cause loss of function. It should be noted that this is a stiff rotor; having a critical speed of 92.5 Hz.

These calculations were performed by the static analysis method in accordance with

Bechtel Power Corporation Specification SO23-405-6 Appendix 4F

and certify that the subject motor complies with the conditions described on the title page of these attached computations.

SIGNED Paul Ernest McCalmont DATE 12-9-76

TITLE Product Engineer

ALLIS-CHALMERS CORPORATION
4620 Forest Avenue, Norwood Ohio 45212

405-6-38-0

ALLIS-CHALMERS

4620 FOREST AVENUE • NORWOOD, OHIO 45212/513-351-6700

CERTIFICATE OF COMPLIANCE

Customer: Byron Jackson Pump Div.

Purchase Order No.: V-191858

A-C Order No.: 62-08-5116-EL 90247

Customer Specification: Bechtel Power Corporation S023-405-6

Equipment Description:

Frame 3020 SS6 Type Az

Horsepower 800 Speed 3600 rpm

The method employed to assure seismic withstand adequacy is a static stress analysis performed on critical components. Static analysis is justified by determining natural frequencies which reflect the rigidity of the described equipment. Two computer programs are employed by Allis-Chalmers to determine natural frequencies: In vertical motors, the "reed" frequency is determined by modeling the motor as a cantilever beam and analyzing deflection; and in vertical and horizontal motors the rotor response is determined through Rayleigh principle.

Seismic accelerations are applied to component masses and the resulting forces applied to the center of gravity of the piece in question. By considering exaggerated tolerance and load conditions, the equipment is shown to be well within the adequacy requirements for the specific seismic event.

It is hereby certified that the method employed is adequate for establishing that the seismic design requirements have been met.

F. J. Glandorf
F. J. Glandorf
Senior Mechanical Engineer

STATE OF OHIO
FRANKLIN H.
GROOMS
27554
REGISTERED
PROFESSIONAL ENGINEER

Franklin H Grooms
F. H. Grooms
Registered Professional Engineer

405-6-38-0

12. Tank Bldg. Item 2 - 2HV-4712 Control Valve (BOP 17)

Question:

Provide justification for omission of nozzle loads in seismic qualification of W-K-M MOV Globe Valve 2HV-4712 (BOP 17).

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.

13. Tank Bldg. Item 3 - Auxiliary Feedwater Pumps (BOP 24)

Question:

Provide seismic qualification for the peripheral skid mounted equipment on the Auxiliary Feedwater Pump Skids (BOP 24).

Response:

A seismic analysis was performed by the vendor to identify the seismic mounting requirements for the peripheral skid mounted equipment on the Auxiliary Feedwater Pump skid as documented in the attached vendor package. As noted in this package, the resulting seismic supports are specified as purchaser supplied. These seismic supports were not installed at the time of the NRC seismic review. The current scheduled completion date is June 5, 1981.

TERRY CORPORATION

BY: CH DEAN DATE: 3-4-78
CHKD BY: [signature] DATE: 3/6/78
SUBJECT: LUBE PIPING

LUBE PIPING

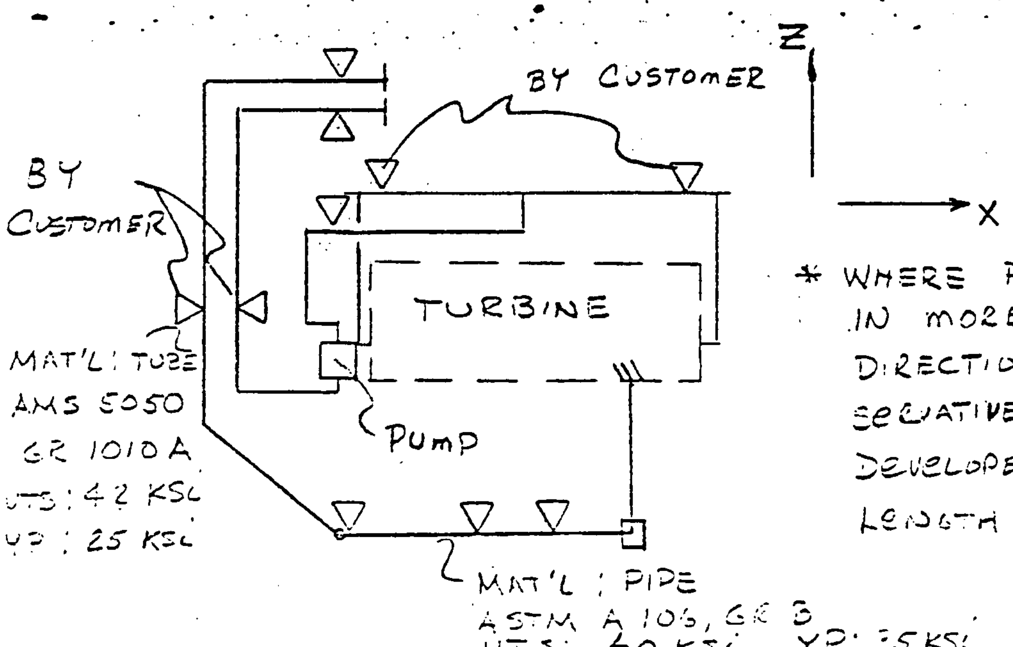
POOR ORIGINAL

STATIC ANALYSIS & RIGIDITY OF THE PIPE SYSTEM WAS BASED ON STRUCTURAL RESONANT FREQUENCIES ≥ 33 HZ

MAXIMUM UNSUPPORTED SPAN LENGTHS WHICH SATISFY THE ABOVE REQUIREMENT ARE LISTED. BENDING STRESS INDUCED IN SUCH A SPAN BY A 3 PLANE, 1.5 g ACCELERATION IS ALSO PRESENTED.

ALL PIPE SPANS* FOR FOR F-40101 ARE LESS THAN THE MAXIMUM ALLOWABLE.

PIPE BENDING STRESS IS WELL WITHIN LIMITS & REQUIREMENTS FOR RIGIDITY ARE MET.



* WHERE PIPE SPANS PROCEED IN MORE THAN ONE DIRECTION, THE SPAN CONSEQUATIVELY REFERS TO THE DEVELOPED OR ACTUAL LENGTH BETWEEN SUPPORTS.

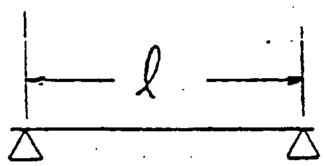
TERRY CORPORATION

BY: C. Dean DATE: 3-4-78 SUBJECT: Lube Piping PAGE 19 OF 22
CHKD BY: [illegible] DATE: 3/6/78

3/8 X .049 TUBE

POOR ORIGINAL

$$f = \frac{1}{2\pi}\sqrt{\frac{K}{M}}$$



$$k = \frac{384\,EI}{5\,l^3}$$

$I = .00068\ in^4$

WT. = .0161 LB/IN (WT. OF PIPE + OIL)

$$f = \frac{1}{2\pi}\sqrt{\frac{384\,EI}{5\,l^3} \Big/ \frac{(WT)\,l}{386}} = 33\ HZ$$

∴ l = 30.05" (MAX. UNSUPPORTED LENGTH)

$$\sigma = \frac{M c_2}{I} = \frac{(3.28)^{*}\ \frac{WT. \times l^2}{8}\ c_2}{I}$$

∴ σ = 1643 PSI

* RESULTANT SEISMIC (g) ACCELERATION

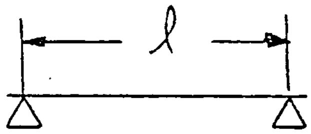
$\sigma_{ALL} = .9(\sigma_y) = 22500$ PSI

NOTE:

THE ABOVE TUBING QUALIFICATION IS VALID FOR UNSUPPORTED SPANS NOT TO EXCEED 30".

½ SCH. 40 PIPE

$$f = \frac{1}{2\pi}\sqrt{\frac{384\,EI}{5\,l^3} \Big/ \frac{(WT)\,l}{386}} = 33\ Hz$$



$I = .01709\ in^4$

$WT = .0807\ LB/IN$

$\therefore\ l = \underline{44.9}''$

$\sigma = \underline{1643}\ PSI$

$\sigma_{ALL} = .9(\sigma_y) = 31{,}500\ PSI$

NOTE: ACTUAL MAX. LENGTH USED ON LUBE SYSTEM = 8".

14. MSIV Enclosure Item 1 - 2PSV-8401 Relief Valve (BOP 21)

Question:

Provide justification for anomalies identified in seismic qualification of Crosby pressure relief valves (BOP 21). Review SQRT Audit forms for consistency.

Response:

The function of the subject pressure relief valves is to provide overpressure protection for the main steam system. The presence of "excessive seat leakage" following the seismic qualification test should not be considered as an adverse effect on plant safety for the following reasons:

1. The inadvertent full opening of one main steam pressure relief valve is a design basis for the plant (FSAR Paragraphs 15.1.1.4 and 15.1.2.4).

2. The cumulative volume of seat leakage from all nine valves on a given steam line system would not exceed the full flow volume of a single valve.

3. The valves are still able to perform their stated function of overpressure protection at the specified pressure levels as demonstrated in the seismic qualification report.

The "excessive seat leakage" should be considered as nothing more than a nuisance or inconvenience for continued plant operation. The situation would be monitored following a seismic event and the appropriate seat repair initiated as required. It should be noted that the actual maximum seismic environment for the subject relief valves as determined from the piping stress analysis would be 2.83 gs whereas the seismic qualification wherein the "excess seat leakage" was identified was in excess of 5 gs.

The second anomaly identified during the test was associated with the test equipment itself (lack of system pressure source capacity) and not with the relief valve or its operation.

A revised SQRT Audit Form is provided to clarify this issue.

15. Piping Tunnel Item 1 - 2FIT-4720 Transmitters (BOP 10)

Question:

Clarify resonant frequency conditions identified in the seismic qualification report for Foxboro E10 series transmitters. (BOP-10)

Response:

The test summary to the same seismic qualification document which reports the existence of low frequency resonant conditions indicates that these "resonant" frequencies were determined with a maximum transmissibility of 1.3:1. Normal industry practice would require a minimum transmissibility of 2:1 and/or a phase shift before a resonant condition was identified. This practice ensures that the data are not merely background noise from the test setup. Furthermore, as noted by members of the audit team, the presence of such low frequency resonant conditions are inconsistent with the apparent rigid nature of these components.