SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE BOX 764
COLUMBIA, SOUTH CAROLINA 29218

T. C. NICHOLS, JR.
VICE PRESIDENT AND GROUP EXECUTIVE
NUCLEAR OPERATIONS

April 28, 1982

RECEIVED
MAY 3 1982

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Virgil C. Summer Nuclear Station
Docket No. 50/395
SQRT-Additional Questions

Dear Mr. Denton:

In follow-up to NRC questions regarding South Carolina Electric and Gas Company (SCE&G) Seismic Qualification Review Team (SQRT) sheets, SCE&G hereby provides responses to previously requested information concerning the Brookhaven National Laboratory (BNL) reviews.

Attachment I, provides the latest response to BNL questions regarding the seismic qualification fo the Diesel Generator Neutral Grounding Resistor and the Hydrogen Analyzer Panels. Attachment II provides a comprehensive listing of all previous SCE&G responses accepted by BNL on Virgil C. Summer Nuclear Station equipment.

In addition, the NRC staff requested a clarification of the previously supplied SQRT sheets for the Core Subcooling Monitor cabinet as transmitted to the NRC on October 6, 1981. Specifically, the SQRT sheets provide for the qualification of the cabinet structure and all internal electronics as listed in Table 1 (attachment to SQRT sheets).

SCE&G considers this letter to provide a final resolution to all NRC/BNL questions regarding SCE&G supplied SQRT sheets.

If you have any questions, please let us know.

Very truly yours,

T. C. Nichols, Jr.

T. C. Nichols, Jr.

SHB:TCN:lkb

Attachment

cc: See Page 2

B001
51/45 on Shelf

cc: V. C. Summer (w/o attachment)
G. H. Fischer (w/o attachment)
H. N. Cyrus
T. C. Nichols, Jr. (w/o attachment)
M. B. Whitaker, Jr.
J. P. O'Reilly
H. T. Babb
D. A. Nauman
C. L. Ligon (NSRC)
W. A. Williams, Jr.
R. B. Clary
O. S. Bradham
A. R. Koon
M. N. Browne
G. J. Braddick
J. C. Ruoff
J. L. Skolds
J. B. Knotts
B. A. Bursey
NPCF
File

Attachment I
Denton Letter
April 28, 1982

RESPONSE TO SQRT CONCERNS EXPRESSED BY BNL

1. Diesel Generator Neutral Grounding Resistor:

In the original review BNL requested an evaluation of the effect of the dimensional differences on the dynamic response of the contract resistor as compared with a similar resistor that was actually tested.

In response to this request an evaluation was made to show the possible differences in natural frequency between the tested resistor and the contract resistors. This evaluation also showed that the available test data was adequate to justify acceptance of the contract resistors even when considering the differences in natural frequency. However, the presentation of this evaluation with respect to the vertical axis of the resistor was somewhat ambiguous.

Therefore, BNL requested a clarification of the acceptability of the vertical response of the neutral grounding resistor.

SCE&G considers the contract resistors acceptable because the test input acceleration was several time higher than the required input acceleration. Specifically, the required ZPA acceleration, for the vertical direction, is 0.173g; the minimum test input acceleration was 0.65g between 1 and 25 Hz. Thus the test resistor experienced accelerations several times higher than it would experience even if the natural frequency of the resistor corresponded to either of the peaks of the required response spectra. Therfore, the contract resistors are acceptable even though their natural frequency (in the vertical axis) may be different from that of the tested resistors.

The discussion of damping in the previous response was intended to be supplemental to the rationale that the test accelerations were several times higher than the required acceleration, and the acceptability of the contract resistors does not depend on this discussion of damping factors.

2. Hydrogen Analyzer Panels:

The following provides the methodology used by SCE&G and the Architect Engineer, Gilbert Associates (GAI) which provided the basis for the acceptance of the Comsip Reports 1035-1, 2, and 5.

A) The hydrogen analyzers were qualified by Engineering Analysis and Test Company, Inc. through a combination of test and analysis. As summarized on page 68 of Comsip report 1035-2, force vibration tests identified resonant frequencies of 29.6 Hz along the lateral (Y-direction) axis were and 19 Hz along the longitudinal (X-direction) axis. No resonances were found in the vertical direction. The accelerations at the resonant frequencies were then used in the static analysis as shown on page 23 of report 1035-2. The components within the hydrogen analyzer were qualified by vibration testing as subunits and then as an assembled panel. The attached revised SQRT sheets provide a clarification of this qualification.

B) As identified in paragraph 4.6.9 (page 8) of Comsip report 1035-1, all instruments were energized (as applicable) during the performance of the seismic tests and their output responses monitored throughout the test. This data is not included within the test report, but this is considered acceptable since the hydrogen analyzer is not required to operate during a seismic event.

C) Data for the functioning of the hydrogen analyzers before and after seismic testing is provided in Table C-II on page 25 of report 1035-1. In Table C-II, run 4 represents pre-seismic test data and run 5 represents post-seismic test data. SCE&G and GAI have reviewed this data with Comsip and have concluded that this table provides acceptable summary results to demonstrate the capability of the Hydrogen Analyzer Panels to function before and after seismic qualification testing for the Virgil C. Summer Nuclear Station. As stated previously, these panels are not required to function during a seismic event, but must be capable of functioning after such a design basis event. The attached revised SQRT sheets provide a clarification of this statement.

Qualification Summary of Equipment

I. Plant Name: V. C. Summer Nuclear Station

Type:

PWR X

BWR ____

1. Utility: SCE&G
2. NSSS: Westinghouse 3. A/E: GAI

II. Component Name: Hydrogen Analyzer and Analyzer Remote Control Panel

1. Scope: [ ] NSSS [x] BOP
2. Model Number: K-III Quantity: 2-Analyzers 2-Remote Contro
3. Vendor: Comsip, Inc.
4. If the component is a cabinet or panel, name and model No. of the devices included: See Attached "Bill of Materials," document #05450, Rev. 1.
5. Physical Description a. Appearance Free Standing Panels

   b. Dimensions Analyzer - 30"W x 30"D x 72"H
   Remote Control - 24"W x 30"D x 60"H

   c. Weight Analyzer - 1,470 lbs
   Remote Control - 96.4 lbs
6. Location: Building: XPN-7215A - Aux. Bldg. XPN-7258A - Aux. Bldg.
   XPN-7215B - Fuel Bldg. XPN-7258B - Aux. Bldg.

   Elevation: All - 463' - 0"
7. Field Mounting Conditions [x] Bolt (No. 6, Size 5/8") - XPN-7215A XPN-7215B
   [ ] Weld (Length ____)
   [x] Bolt (No. 8, Size 1/4" Dia.) - XPN-7258A XPN-7258B
8. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical)

   S/S: 19 Hz (x) F/B: 29.6 Hz (Y) Y: No Resonances
9. a. Functional Description: Analyze hydrogen concentration of reactor building atmosphere post-accident.

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

   [ ] Both None
10. Pertinent Reference Design Specifications: SP-702

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

IV. Equipment Qualification Method: Test: ______

Analysis: ______

Combination of Test and Analysis: Yes

Test and/or Analysis by Engineering Analysis and Test Co., Inc. 1035-1, 1035-2, 1035-5 (Rev. 1)
(name of Company or Laboratory & Report No.)

V. Vibration Input:

1. Loads considered: 1.[x] Seismic only 2.[ ] Hydrodynamic only 3.[ ] Explosive only

4.[ ] Other (Specify) ______ 5.[ ] Combination of ______

6. Method of combining RRS: [x] Absolute Sum [ ] SRSS [ ] ______ (other, specify)

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

3. Required Acceleration in Each Direction:

S/S = .501 g F/B = .501 g V = .501 g

VI. If Qualification by Test, then Complete:

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

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

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

4. Frequency Range: .35 Hz to 35 Hz

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

6. Input g-level Test at S/S = 2 g's ZPA F/B = 2 g's ZPA V = 2 g's ZPA

7. Laboratory Mounting: Normal mounting attachments

1. [ ] Bolt (No.____, Size____) [ ] Weld (Length____) [ ] ______

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

9. Test Results including modifications made: The test demonstrates the adequacy of the H_2 Analyzer to operate before and after the application of the R.R.S.

10. Other tests performed (such as fragility test, including results): Pump motor tested in accordance with Reliance Electric Company Report NUC-9 dated July 1, 1978. (See SQRT form for Reliance Fan Motors, PO 10222).

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

1. Description of Test including Results: Forced Vibration Test defining Resonant frequencies of 29.2 Hz (X) 34.4 Hz (Y) and 34.4 Hz (Z)

2. Method of Analysis:

   [x] Static Analysis   [ ] Equivalent Static Analysis

   [ ] Dynamic Analysis: [ ] Time-History
   [ ] Response Spectrum

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

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

4. [ ] Computer Codes: ______

   Frequency Range and No. of modes considered: ______

   [X] Hand Calculations

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

6. Damping: 5% Basis for the damping used: Not Available

7. Support Considerations in the model: Bolted

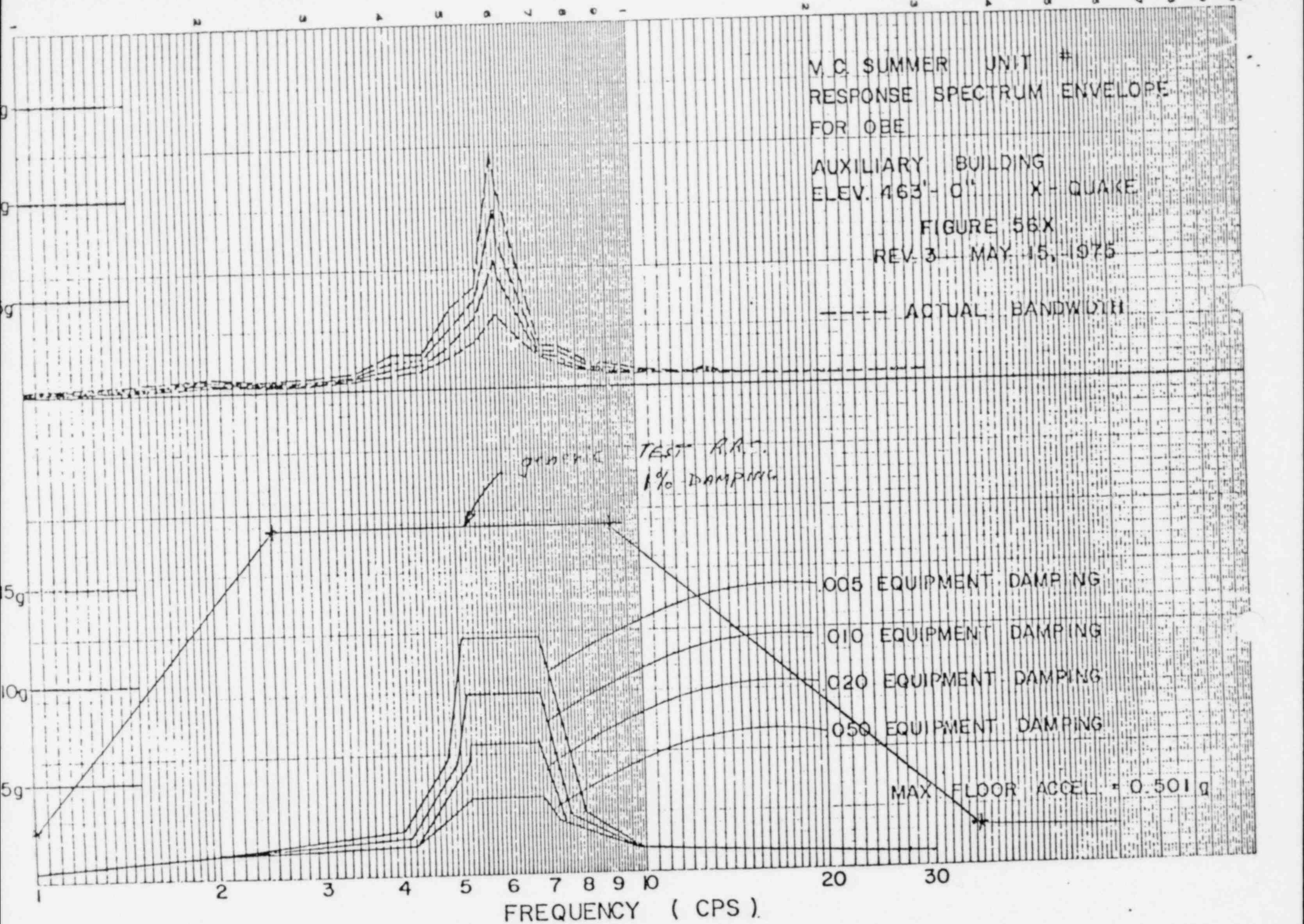
8. Critical Structural Elements:

A.

Identification — Location		Governing Load or Response Combination	Seismic Stress	Total Stress	Stress Allowa
Rack	Mounting Bolt	tensile	2966#/bolt	2966#/bolt	4520
		shear	478#/bolt	478#/bolt	3070
Local Panel	Mounting Bolt	tensile	65#/bolt	65#/bolt	634
		shear	26.3#/bolt	26.3#/bolt	490#

B.

Max. Deflection	Location	Effect Upon Functional Operability
Not available		



V.C. SUMMER UNIT #1
RESPONSE SPECTRUM ENVELOPE
FOR OBE
AUXILIARY BUILDING
ELEV. 463'- 0" X - QUAKE
FIGURE 56X
REV 3 MAY 15, 1975
---- ACTUAL BANDWIDTH
generic TEST R.R.S.
1% DAMPING
.005 EQUIPMENT DAMPING
.010 EQUIPMENT DAMPING
.020 EQUIPMENT DAMPING
.050 EQUIPMENT DAMPING
MAX FLOOR ACCEL = 0.501 g
1.5g
1.0g
.5g
1
2
3
4
5
6
7
8
9
10
20
30
FREQUENCY (CPS)

COMSIP, INC.

WHITTIER, CALIFORNIA

80054

BILL OF MATERIALS

DOCUMENT NUMBER 05450

REVISION 1, MAY 7, 1981

POST-ACCIDENT ANALYZER SYSTEM

VCS NUCLEAR STATION

SOUTH CAROLINA ELECTRIC AND GAS COMPANY

PURCHASE ORDER NUMBER Q2625-84

CLASS 1E HYDROGEN ANALYZERS

PRODUCTION MANAGER Susan McIntire DATE 05/12/81

PROJECT MANAGER Sid Rohmeyer, Jr. DATE 5-12-81

QUALITY ASSURANCE [illegible] Jr. DATE 5-12-81

LIST OF REVISIONS

REVISIONS	DESCRIPTION	PROD. MGR.	PROJ. MGR.	Q.A.
1	"As Built"	[signature]	[signature]	[signature]

DWG. NO. 05[illegible]0
FOR
K-III POST-LOCA
HYDROGEN MONITORING SYSTEM

REV.	DATE	BY	DCS	ENG.	PROD.

ITEM NUMBER	QTY. PER SYSTEM	EQUIPMENT DESCRIPTION	MATERIAL CERTIFICATE REQUIRED:
1	2	API, mdl. no. 7045-N5-4702-0000, Indicating meter. Range: 0-200μA, blank scale, (Comsip, Inc. fabricates the % H_2 scale).	
2	2	ASCO, mdl. no. THT-8262C7N, 2-way solenoid valve. Normally closed, ¼" NPT, 120VAC., 60Hz. (Reagent-Calibration)	Body: GR.303SS Seals: Buna "N" Insulation: Class H
3	1	ASCO, mdl. no. THT-8262A138N, 2-way solenoid valve. Normally open, ¼" NPT, 120VAC., 60Hz. (Reagent gas pressure relief)	Body: GR.303SS Seals: Ethylene Propylene Insulation: Class H
4	1	Brooks, mdl. no. 1350-VR-2-15D, Flowmeter. Scale; 196A, Tube; 0-65mm., Range; 20-250 ccm (air), (Analyzer bypass)	Seals: Viton Float: GR.316SS Fittings: GR.316SS
5	2	Cinch-Jones, mdl. no.'s TS-6-141 and TS-12-141, 6 point and 12 point terminal strips, respectively.	
6	1	Comsip, Inc. mdl. no. 11719, Moisture Separator. (Comsip, Inc. modifies a Armstrong mdl. no. 11AV for this service).	Body: ASTM-A240, GR.304 Fittings: ASTM-A479, GR.[illegible]

REV.	DATE	BY	DCS	ENG.	PROD.	Q

ITEM NUMBER	QTY. PER SYSTEM	EQUIPMENT DESCRIPTION	MATERIAL CERTIFICATE REQUIRED:
7	1	Comsip, Inc. mdl. no. 11706, Sample Pump-Motor Assembly. Reliance motor spec's; 1Hp., 460VAC, 60Hz., 3Ø, and 1.7 AMP	Motor: Certified to IEEE-3 (74) Pumpheads: ASTM-A351, GR.3 Diaphragms: Nylon re[illegible]forc
8	1	Comsip, Inc. mdl. no. 11749, Air Cooled Heat Exchanger.	Tubing: ASME-SA213, GR.316 Fittings: ASTM-A479,GR.316
9	1	Comsip, Inc. mdl. no. 11750, Sample Hot Box Assembly.	
10	1	Comsip, Inc. mdl. 37009, Local Analyzer Meter Trim Assembly. (Comsip, Inc. fabricates this trim assembly to conver the 0-1VDC analyzer output to 0-200 μA, for meter input.	
11	1	Comsip, Inc. mdl. no. 11727 (R_1), Downstream pressure regulator. Set at 14.7 psia, 1" NPT. (Comsip, Inc. modifies a Conoflow mdl. no. H21XT-XXXK for this service.)	Body: ASTM-A351, GR.316 Diaphragm: GR.301SS
12	1	Comsip, Inc. mdl. no. 11728 (R_2), Downstream pressure regulator. Set at -11 to -13in. Hg, 1" NPT. (Comsip, Inc. modifies a Conoflow mdl. no. H21XT-XXXK for this service).	Body: ASTM-A351, GR. 316 Diaphragm: GR.301SS

REV.	DATE	BY	DCS	ENG.	PROD.

ITEM NUMBER	QTY. PER SYSTEM	EQUIPMENT DESCRIPTION	MATERIAL CERTIFICATE REQUIRED:
13	1	Comsip, Inc. mdl. no. 11729 (R_3), Differential pressure regulator and Fixed Orifice. Regulator set at 3 psig, ¼" NPT. (Comsip, Inc. modifies a Conoflow mdl. no. H21XT-XXXK for this service). Fixed Orifice flow; 180 cc/min at 3 psid.	Body: ASTM-A351, GR.316 Diaphragm: GR.301SS F.O. Assembly: GR.316SS
14	2	Conoflow, mdl. no. H21XT-XDXK/SSN, Differential Pressure Regulator. Set at 3 psig., ¼" NPT.	Body: ASTM-A351, GR.316 Diaphragm: Neoprene rubber
15a 15b	1	Delphi Instruments, mdl. no. B5 Hydrogen analyzer, (Thermal conductivity type). Consisting of the analyzer cell (15A) and analyzer indicating transmitter (15b). Dual range; 0-10% and 0-20% including calibration potentiometers, 0-1VDC output. (with additional AGM module)	Tubing: ASTM-A213, GR.316 Cell Block: ASTM-A479, GR. AMP Board: I.R.T. certs
16	25	General Electric, mdl. no. ET-16, Indicating lamps. 17 with red lens and 8 with amber lens. 115VAC, 60Hz.	
17	8	General Electric, mdl. no.'s CR2940-UB203F (2), CR2940-UB203D (1), CR2940-UB 203G (1), CR2940-WA202C (4). 115VAC, 60 Hz. with 10 AMP continuous rating.	
18	10	General Electric, mdl. no. EB25-A12WC, Terminal Block. 600V, 30AMP continuous rating.	

DWG. NO. 05450
FOR
K-III POST-LOCA
HYDROGEN MONITORING SYSTEM

REV.	DATE	BY	DCS	ENG.	PROD.	Q

ITEM NUMBER	QTY. PER SYSTEM	EQUIPMENT DESCRIPTION	MATERIAL CERTIFICATE REQUIRED:
19	1	General Electric, mdl. no. CR206B102, magnetic motor starter. 460VAC, 60Hz., 3Ø, 18AMP. continuous rating, 5Hp. (maximum).	
20	1	General Electric, mdl. no. CR2810A14AJ, Relay. 600V, 60Hz., 10AMP. continuous rating.	
21	2	Hoke, mdl. no. SS-4212F4Y, Bellows seal valve.	Bellows and Plug: GR.316SS Body: ASTM-A276, GR.316
22	1	I.T.E. - Gould, mdl. no. P1515 and PL-2S, Breaker and breaker box, respectively. 15 AMP rating.	
23	1	Marshalltown, mdl. no. 52B, Compound pressure indicator. Range; 30 In. Hg to 60psig.	Bourdon Tube and Stem: GR.316SS
24	1	Matheson, mdl. no. FM-1050-V1, Flowmeter. Inlet mounted high performance value, size no. 1 glass tube, Float; no. 1 glass, Range; 0-60 ccm (air), direct reading tube, ¼" tube compression fittings, (Reagent gas)	End Blocks and Fittings: GR.316SS Seals: Viton

DWG. NO. 05450
FOR
K-III POST-LOCA
HYDROGEN MONITORING SYSTEM

REV.	DATE	BY	DCS	ENG.	PROD.

ITEM NUMBER	QTY. PER SYSTEM	EQUIPMENT DESCRIPTION	MATERIAL CERTIFICATE REQUIRED:
25	1	Matheson, mdl. no. FM-1050-V1, Flowmeter. Drilled and tapped end blocks with plug, size no. 2 glass tube, Range; 0-270 ccm (air), direct reading tube, ¼" tube compression fittings. (cell flow).	End Blocks, Float and Fittings: GR.316SS Seals: Viton
26	1	Matheson, mdl. no. FM-1050-V1, Flowmeter. Inlet mounted utility valve, size no. 2. glass tube, Range; 0-270 ccm (air), direct reading tube, ¼" tube compression fittings,(calibration gas).	End Blocks, Float and Fittings: GR.316SS Seals: Viton
27	1	Matheson, mdl. no. FM-1050-1V, Flowmeter. Drilled and tapped end block with plug, size. no. 8 glass tube, Range; 5-50 SCFH (air), direct reading tube, ¼" tube compression fittings, (Bypass flow).	End Blocks, Float and Fittings: GR.316SS Seals: Viton
28	3	Nupro, mdl. no. SS-4CA-3, Check valve. Adjustable range; 3 to 50 psig. (Comsip, Inc. modifies this check valve for this service).	Body and Components: ASTM A479, GR.316 "O" Ring: Viton
29	6	Potter and Brumfield, mdl. no.'s KRP-11AG and KRP-14AG, (5) DPDT and (1) 3PDT relays, respectively. 115VAC, and 5AMP. rating.	
30	2	Static "O" Ring, mdl. no.4N3-K5-MX-C1A Pressure switch. Set at 20 psig decreasing, ¼" NPT.	Pressure Part, Diaphragm and Fittings: GR.316SS "O" Ring: Viton

DWG. NO. 054[illegible]0
FOR
K-III POST-LOCA
HYDROGEN MONITORING SYSTEM

REV.	DATE	BY	DCS	ENG.	PROD.

EM MBER	QTY. PER SYSTEM	EQUIPMENT DESCRIPTION	MATERIAL CERTIFICATE REQUIRED:
31	1	Static "O" Ring, mdl. no. 54N3-K411-MX-C1A Vacuum switch. Set at 0 psig, ¼" NPT.	Pressure Part and Fitting: GR.316SS
32	1	Nupro, mdl. no. SS-4CA-50, Check Valve. Adjustable range: 50 to 150 psig. Set at 85 psig. (Comsip, Inc. modifies this check valve for this service.)	Body and Components: ASTM - A479, GR.316 "O" RING: Viton

P.O. BOX 1498
READING, PA 19603

SEIS
221

001931

DATE 07-01-81

LETTER NO. CCGS 23946

Mr. C. A. Price , Manager
PRODUCTION ENGINEERING
SOUTH CAROLINA ELECTRIC & GAS CO.
P.O. BOX 764
COLUMBIA, SOUTH CAROLINA 29218

Re. VIRGIL C. SUMMER NUCLEAR STATION
UNIT NO. 1
GAI NO. 4461-00 FILE 18 PUR-G

SUBJ: ACCEPTED VENDOR IEEE QUAL.
or SEISMIC REPT.

Dear Mr. Price:

ATTACHED PLEASE FIND THE ITEMS LISTED BELOW FOR THE PURPOSES INDICATED:

____	FOR INFORMATION	____	MARKED BY GAI
____	FOR COMMENTS	____	APPROVED BY GAI
____	FOR APPROVAL	____	APPROVED AS CORRECTED BY GAI
____	FOR DISTRIBUTION	XX	ACCEPTED SEISMIC REPT. for PRS
____	PRELIMINARY	XX	ACCEPTED IEEE QUAL. for PRS
		XX	SQRT

ITEM DESCRIPTION (TITLE, NUMBER OR SUBJECT) P.O. # Q26584 262584 SPEC # 636

ATTACHED IS A VENDOR IEEE QUALIFICATION REPORT/ VENDOR SEISMIC REPORT, ACCEPTED BY GAI ENGINEERING ON June 9, 1981

SUBJECT/TITLE Hydrogen Analyzer K-IV Remote Control Panel
IMS # 92-38430-0 92-3875-0 92-3874-0 92-3871-0
VENDOR REPORT # 1035-1 1035-2 1035-5 REV. 1 NUC-9
GAI CONTROL # 9550
VENDOR Comsip
VENDOR SUBMITTAL DATE 12-22-80

LOGGED

S. C. ELECTRIC & GAS, CO.
RECEIVED
JUL 13 1981
QUALITY CONTROL

☐ RETURN ____ COPIES OF THE ABOVE WITH APPROVAL OR COMMENTS BY ____

REMARKS: ____

VERY TRULY YOURS,

BY G. A. Greenwood for

H. E. Yocom
Project Manager

cc: C. A. Price (orig. + 1)
V. C. Summer
D. R. Moore
O. S. Bradham
NPCF/Whitaker
M. B. Whitaker
PRS/Woods/Encl.
R. J. Hoffert
H. E. Yocom
E. H. Crews, Jr.
G. A. Greenwood/E. H. Riehl

cc: C. G. KRAMER
S. BAILEY
J. W. FOSTER

ATTACHMENT II

1. Reactor Building Cooling Unit, Damper Actuators

QUESTION:

Provide clarification of natural frequencies on SQRT forms, the SQRT forms indicate that the frequencies in three principal directions are 17 Hz in S/S and F/B, and 42 Hz in vertical direction. The results presented in the test reports did not correspond to any of these values.

RESPONSE:

The above frequencies were supplied in error and are not correct. Attached is a revised and corrected SQRT form for the damper actuators with the corrected frequencies.

2. Main Steam Isolation Valve

QUESTION:

Provide the reason for not superimposing the effects of both the sonic flow and pipe load conditions. The reports provided do not address the sonic flow test performance.

RESPONSE:

This item is still in review, a final response is expected to be completed by 9/11/81.

3. 480 Volt Unit Sub-stations

No open items.

4. Accumulator Tank

No open item.

5. Diesel Generator and Associated Equipment

a. Exhaust Silencer

QUESTIONS

1. To clarify whether the direction of loading considered in frequency calculation by Raleigh method coincides that of the first-mode shape of the equipment response.

2. Assess the discrepancy in frequency calculation using a one-degree-of-freedon system as reported against a combined three-degree system.

3. Provide justification that the equipment is still qualified, with due consideration of items 1 and 2, if the equipment natural frequency is proved to have been overestimated.

RESPONSES:

1. The first significant mode shape for seismic analyses approximates the displaced shape due to gravitational loading in the direction of interest. The use of finite elements provides this displaced shape and includes additional secondary displacement due to ovalling and discontinuities.

2. The shell is uncoupled in the three directions of interest. This means that a vertically applied gravitational load does not cause significant axial or Internal displacements. Therefore, the use of independent frequency calculation for the three directions is appropriate.

3. A 10% margin is provided for the frequency calculations to account for over and under estimation effects. A 15% maring is provided in the design response spectra for similar purposes. These margins provide satisfactory conservatism for uncertainties in approximations.

b. Exciter Cabinet

QUESTION:

In light of the structural damage of the cabinet observed during the test, provide Basler and/or Gilbert Associates (GAI) assurance that any potential structural damages on the cabinet will not affect the electrical function of the device.

RESPONSE:

Although structural damage was observed during the test, the equipment within the cabinet continued to function throughout the test with one exception. This exception was the contacts with the potential transformer drawout mechanism. After proper adjustment these contacts performed satisfactorily for the remainder of the test. As a result an inspection for proper adjustment of the contacts has been added to the inspection and maintenance program for the equipment. This continued operation of the equipment throughout the seismic test demonstrated that the structural damage that did occur did not and will not affect the electrical function of the excitor.

In addition, none of the critical electrical components are mounted directly to the cabinet, each assembly or component has its own base which in turn is mounted to the main cabinet. Therefore, structural damage to the cabinet cannot directly affect any of the electrical components.

c. Neutral Grounding Resistor

QUESTIONS:

1. Provide justification that the separate sine wave tests conducted satisfy the multidimensional excitation requirements.

2. Assess the effect of the smaller clearance of the installed resistor as compared to the larger clearance of the test items.

3. Assess the effect of dimensional differences in the dynamic response of the installed resistor in the light of the required response spectra.

RESPONSES:

1. The use of separate sine wave tests is acceptable for several reasons. The required response spectrum as a significant response at one predominant frequency in each axis with a somewhat lower response at a second and distinct frequency. Therefore, the input to the resistor in the event of an earthquake will be essentially at two discrete frequencies at each access.

   In addition, the acceptance criteria is limited to the maintainence of structural integrity since there are no moving parts or other complex functions to the resistor. Also the long dwell at each frequency produced a more severe response than would be expected from a multi-directional random motion input.

2. The tests data indicates that the maximum responses of the resistors for side-to-side and front-to-back motion respectively were 4g at 5 Hz and 6.5g at 6Hz. These responses are both equivalent to a 4 inch displacement. Since this displacement is significantly less than the available 10 inch clearance between the resistor and its enclosure no interference or other degradation is anticipated.

3. On page one of the report GE states that their experience with several tests of similar resistors has produced similar results. Therefore, we would not expect the dimensional

differences to have a significant effect on a dynamic response of the installed resistor.

6. Electrical Containment Penetration

QUESTIONS:

a. Provide GAI letter CGGS-14262, December 20, 1977

b. Provide GAI evaluation of D. G. O'Brien reply document.

c. Provide clarification of D. G. O'Brien reply 3.0

RESPONSES:

a. A copy of the requested letter is provided as Attachment A.

b. A copy of the GAI evaluation of the D. G. O'Brien reply is provided as Attachment B.

c. A clarification of D. G. O'Brien's paragraph 3.0 of their letter of 2/17/78 can be found in paragraph 3, of GAI letter of 4/27/78 (Attachment B) in D. G. O'Brien letter of 7/6/78 which is provided as Attachment C.

Qualification Summary of Equipment

I. Plant Name: Virgil C. Summer Nuclear Station Unit 1

Type:

PWR X

BWR ____

1. Utility: SCE&G
2. NSSS: Westinghouse 3. A/E: GAI

II. Component Name: Reactor Building Cooling Unit Damper Actuators

1. Scope: [ ] NSSS [X] BOP
2. Model Number: NT 312B-SR4-12 Quantity: 4
3. Vendor: Bettis
4. If the component is a cabinet or panel, name and model No. of the devices included: N/A
5. Physical Description a. Appearance Pneumatic Actuator
   b. Dimensions 7.2 in long x 15 in max. diameter
   c. Weight 393 lb
6. Location: Building: Reactor building
   Elevation: 543 Ft
7. Field Mounting Conditions [ ] Bolt (No. 4, Size 3/4")
   [ ] Weld (Length ____)
   [ ] ____
8. Natural Frequencies in Each Direction (Side/Side, Front/Back, Vertical)
   (X) S/S: 24, 63.5 Hz (Y) F/B: 99 Hz (Z) V: 37.5, 41.5 Hz
9. a. Functional Description: Open and Close HEPA Filter Bypass Dampers
   b. Is the equipment required for [ ] Hot Standby [ ] Cold Shutdown
   [ ] Both Post Accident
10. Pertinent Reference Design Specifications:
    SP-534-044461-000, SP-702-4461-00

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

IV. Equipment Qualification Method: Test: X

Analysis: ______

Combination of Test and Analysis: ______

Test and/or Analysis by Southwest Research Institute
(name of Company or Laboratory & Report No.
Report No. 02-4854-RPT-1

V. Vibration Input:

1. Loads considered: 1.[x]Seismic only 2.[ ]Hydrodynamic only 3.[ ]Explosive only

   4.[ ] Other (Specify)______ 5.[ ] Combination of______

   6. Method of combining RRS: [x] Absolute Sum [ ] SRSS [ ]______ (other, specify)

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

3. Required Acceleration in Each Direction:

   S/S = .525 g ZPA (SSE) F/B = .525 g ZPA (SSE) V = .400 g ZPA (SSE)

VI. If Qualification by Test, then Complete:

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

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

3. No. of Qualification Tests: OBE 5 SSE 1 Other______ (specify)

4. Frequency Range: .5 Hz to 35 Hz

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

6. Input g-level Test at S/S = 7 g's ZPA F/B = 7 g's ZPA V = 9.5 g's ZPA

7. Laboratory Mounting: Representative of plant installation

   1. [ ] Bolt (No.____, Size____) [ ] Weld (Length____) [ ]______

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

9. Test Results including modifications made: Test demonstrated structural integrity and functional operability.

10. Other tests performed (such as fragility test, including results):______
    Plant induced vibration - 10^6 cycles at .75 g

T. A. Schlegel GIII 2200

A TACHMENT A

Gilbert/Commonwealth engineers and consultants

GILBERT ASSOCIATES, INC., P. O. Box 1498, Reading, PA 19603/Tel. 215 775-2600/Cable Gilasoc/Telex 836-431

December 20, 1977

CGGS-14262

D. G. O'Brien, Inc.
500 Cochituate Road
Framingham, MA 01701

Attention: Mr. H. P. Hilberg

Re: V. C. Summer Station
Electrical Penetrations, Seismic Qualification
D. G. O'Brien Report, Appendix K
of ER-252, dated 11/8/77
File: 18.10249

Gentlemen:

The attached memorandum (same subject) summarizes our comments to your seismic qualification report referenced above.

Your timely resubmittal of this report will be appreciated.
Attachment: GAI Memo from D. K. Kelly to D. K. McIntire dated 12/14/77.

Very truly yours,

David K. McIntire

D. K. McIntire
Electrical Engineer

H. E. Yocom, Jr.

E. Wielkopolski/H. E. Yocom, Jr.
Project Manager

DKM:EW:HEY:mhm

cc: T. A. Schlegel
H. T. Babb
NPCF/Babb
O. W. Dixon, Jr.
E. H. Crews, Jr.
D. A. Nauman
V. C. Summer
C. M. Reynolds
C. A. Price
A. W. Grammes

memorandum Gilbert/Commonwealth

December 14, 1977

to: D. K. McIntire

from: D. K. Kelly

subject: V. C. Summer Nuclear Station
Electrical Penetrations, Seismic Qualification
D. G. O'Brien Co. Report, Appendix K of ER-252, Dated 11/8/77

I have reviewed this report with the help of Te-Hung Chen and in my opinion, an acceptable qualification can be achieved based on the data in this report. However, the report as it stands does not adequately demonstrate the seismic qualification of the electrical penetrations for V. C. Summer Nuclear Station.

My specific technical comments are as follows:

1. The report apparently covers low voltage power, control, and instrument penetrations. Other data is needed for the qualification of the medium voltage penetrations for reactor coolant pump power.

2. From the report, it is not clear that the test penetration and test fixture were representative of the V. C. Summer Nuclear Station penetrations and their installed configuration. The final report should include drawings of the test unit and test fixture and of the penetrations for the V. C. Summer Nuclear Station including the containment nozzles and field cables. The report should specifically address the comparability of the test penetration to the V. C. Summer penetrations and discuss any differences between the two. In particular, the photographs suggest that the V. C. Summer Station nozzle projection was not modeled by the test fixture.

3. The photographs indicate that a very limited number of field cables were simulated. These cables were also taken out of the top of the penetration. A final qualification report should include calculations to justify the integrity of the junction boxes with a cable quantity representative of the worst case on V. C. Summer Station with these cables exiting from the bottom of the box.

4. The calculational method for developing a required power density spectrum from a required response spectrum appears to be valid, however, I know of no published literature or textbook material to support this procedure (or provide an alternate procedure). I understand that to date the NRC has not reviewed any equipment qualification based on the power density

spectrum and has no expertise in this area of qualification. Therefore, SCE&G Co. should be cautioned that the licenseability of this qualification cannot be predicted. I do not recommend preceeding with any requalification at this time on the basis that qualification using a power density spectrum appears to be valid and requalification in the future, if required by the NRC, would not be more difficult or costly than requalification at this time.

5. The report did not include calculations of the required power density spectrum for V. C. Summer Nuclear Station or compare the required power density spectrum to the test power density spectrum. This calculation and comparison must be included in the final report to provide qualification for V. C. Summer Nuclear Station.

6. The purpose of the material on shock spectrum plots is unclear. Also, the method of calculation is not given and the results are so poorly labeled that I am not able to interpret them. Therefore, this section does not contribute to the qualification and should be either upgraded to meet the requirements of SP-702 for clarity or should be deleted.

7. The comparison made on the last two sheets on the report is so brief that it is meaningless. As these comparisons stand, they do not support the stated conclusions.

My specific editorial comments are as follows:

1. The report does not contain a table of contents or introduction to coordinate the various sections of the report. The final report should include both a table of contents and short introduction.

2. The labels and scales on the various graphs and plots in the report are mostly illeligible. These graphs and plots in the final report should be completely legible.

3. The picture quality in the report is good and the final report should include the same quality of photo reproduction.

4. The final report should clearly state that it applies to the V. C. Summer Nuclear Station and list the appropriate contract and order numbers.

D. K. Kelly

D. K. Kelly

DKK:mhm

cc: T. M. McMahon
E. Wielkopolski/H. E. Yocom, Jr.
T. A. Schlegel
R. P. Cronk
T. H. Chen

Gilbert/Commonwealth engineers and consultants

GILBERT ASSOCIATES, INC., P. O. Box 1498, Reading, PA 19603, Tel. 215 775-2600/Cable Gasco/Telex 836-431

April 27, 1978

D. G. O'Brien, Inc.
One Chase Park
Seabrook, New Hampshire 03874

Attention: Mr. H. P. Hilberg

Re: South Carolina Electric & Gas Company
V. C. Summer Nuclear Station - Unit 1
GAI 04-44461-000
Electrical Penetrations
Seismic Qualification
File Code: EL-2

Gentlemen:

Your letter of February 17, 1978 answering our questions is appreciated and appears to generally resolve the concerns expressed in our letter of December 20, 1977.

As a result of our review of your letter, we have the following comments which should be considered when you prepare the final report:

1. Enclosure 3 and your conclusions indicate that the qualification of the penetration design is now being demonstrated by comparison of the test response spectra to the required response spectra. This is acceptable to us and we believe it is more readily licensable then comparison of power spectral density spectra. However, with this approach, the final report needs to contain a description of the computer program or computing devices used to obtain the test response spectra from the test power spectral density spectra. Conversely, the discussion of converting the required response spectra to a required power spectral density spectra in the original report is no longer germane.

2. The description of the test fixture and prototype penetration is a suitable substitute for drawings of these devices. However, this description of the fixture and prototype penetration should be included in the final report.

Gilbert/Commonwealth engineers and consultants
GILBERT ASSOCIATES, INC., P. O. Box 1498, Reading, PA 19603

3. Junction box integrity is significant to the functional integrity of the penetration. Failure of the box, particularly failure of the attachment of the box to header plate, could put a severe loading on the field cables which, in turn, could cause failure of the cables or the cable connector interface. Although D. G. O'Brien, Inc. Report ER-257 addresses the structural capability of the penetration, it does not discuss the structural adequacy of the junction box or the junction box to header plate interface. Therefore, we are still concerned about the structural integrity of the junction boxes loaded with field cable representative of the worst case for V. C. Summer station.

4. If D. G. O'Brien, Inc. prefers to identify the reports applicability to V. C. Summer Station by the use of a cover letter, this is acceptable to us. However, a transmittal form is not generally acceptable and in some previous cases, reports have been received without any cover letter or transmittal letter of any sort.

If you would like to discuss any of these comments, please feel free to call.

Very truly yours,

David K. McIntire

D. K. McIntire
Electrical Engineer

DKM:hgc

E. Wielkopolski

E. Wielkopolski/H. E. Yocom
Project Manager

cc: O. W. Dixon, Jr. (2)
H. T. Babb
E. H. Crews, Jr.
T. C. Nichols, Jr.
V. C. Summer
R. P. Cronk
D. K. Kelly

10249

ATTACHMENT C

D. G. O'Brien, Inc.

N-1308-69005
South Carolina Elec. & Gas Co.
Virgil C. Summer Station
P.O. No. SN-10249-SR

July 6, 1978/July 7

Gilbert Associates, Inc.
P.O. Box 1498
Reading, PA 19603

Attn: E.Wielkopolski/H.E. Yocom
Project Manager

Gentlemen:

The enclosures with this letter should clarify your items 1 and 3 in your letter of April 27, 1978. Enclosure 1 covers the method of calculation used to convert power spectral density test information to the more easily understood, acceleration vs frequency seismic curves. Enclosure 2 is Appendix H taken from the stress report, DGO, Inc. ER-257.

Thank you for your patience in this matter.

Yours very truly,

D.G. O'BRIEN, INC.

H.R. Hilberg
Manager,
Energy Components

HPH:cfr

cc: *C.A. Price, SCE & G
D.A. Nauman, SCE & G
*D.K. McIntire, GAI ← Has copy
P.C. Doringer, DGO
R.B. Henderson, DGO

RECEIVED
JUL 10 1978
E. WIELKOPOLSKI

FILE: 18.10249			
I	A	BY	NAME
			BRADDICK
			NODLAND
			HETTINGER
			CRONK
			PAOLINI
			GOLDSTEIN
			LANOUETTE
			SHELDON
			SETLOCK
			SMITH
			FOSTER

DISPOSITION
ACTION:
DATE: BY:
ACTION PARTY RETURN SIGNED ORIG. TO PM

1.0 INTRODUCTION

1.1 The assignment for this computation concerned the random vibration seismic exposure data plots in AETC Report 11180. These data plots were presented in a form which was difficult to compare with the specification requirements. The assignment required that this existing data be translated:

From - Power Spectral Density, g^2/Hz vs frequency

To - Acceleration Level, g vs frequency

1.2 Two resources were necessary for this computation:

1.2.1 A record of the several Random Vibration Test Spectra which were used during the 11180 testing. This record was available at AETC ' stored on magnetic tape.

1.2.2 A specialized computer, Time Data Model TDV-20. The computer was also available at AETC and provided the features and capabilities indicated below.

2.0 COMPUTER SET-UP

2.1 The computer contained a large number of second-order resonant circuits. Adjustments were provided so that each resonant circuit could be characterized by:

1) a value for its resonant frequency, and
2) a value for its damping ratio or Q.

The number of resonant circuits and their individual frequencies were chosen so that:

1) The separation between adjacent frequencies was 1/3 octave, and
2) The pattern of resonant circuits spanned the entire frequency range of interest, ie, 1 through 100 Hertz.

2.2 It must be emphasized that this pattern of resonant circuits has no correlation with the test specimen, has no correlation with the test setup, and has no correlation with any physical hardware. It is simply part of a tool which translates the random vibration data to acceleration vs frequency display which can be readily compared with seismic specification curves.

3.0 COMPUTATION

3.1 The computer was programmed so that these second-order resonant circuits could be utilized individually, ie, one at a time and in sequence. During the utilization, the resonant circuit received an input and delivered an output.

3.2 The input to a resonant circuit was the random vibration test data from the magnetic tape. This input was sustained for a controlled time duration of 30 seconds (that is, for a computing time which corresponded to 30 seconds of test exposure).

3.3 The output from a resonant circuit contains information from the random vibration test data ; but the information has been filtered because this individual, resonant circuit has characteristic values for resonant frequency and for Q.

3.4 The computer is able to interpret this output in either of two formats:

a) Power Spectral Density, g^2/Hertz, or

b) Acceleration level, g.

The acceleration level interpretation was used for this computation.

3.5 The interpreted output is stored in a two-dimensional memory -- in our case as Acceleration Level vs Frequency. The frequency increment was 0.25 Hertz. It will be easier to visualize this computation process if we say there are several memories and assign one memory to each individual second-order resonant circuit.

3.6 This process is repeated for each resonant circuit. Each resonant circuit receives its 30 second dose of random vibration. Each memory receives interum-translated information, Acceleration Level vs Frequency.

3.7 After these several interum-translations are completed, the several memories are combined. The Acceleration Level signals are added.

3.8 This combined signal is plotted and displayed as the computation result.

1 TEST ID: D.G.OBRIEN RANDOM DATA
2 HEADING: CHANGE TO SHOCK SPECTRUM

3 BANDWIDTH: 50.00
4 RESOLUTION 100/200/400/600/800: 200GRMS=1.579
FREQUENCY INCREMENT, HZ=.2500

REFERENCE SPECTRUM:
5 INITIAL SLOPE, DB/OCT: 24.00
ALARM LIMITS +DB,-DB:3.000,-3.000
ABORT LIMITS +DB,-DB:6.000,-6.000

6 FREQUENCY HZ.: 1.000
LEVEL GSQR/HZ.: .002000
ALARM LIMITS +DB,-DB:3.000,-3.000
ABORT LIMITS +DB,-DB:6.000,-6.000

7 FREQUENCY HZ.: 6.000
LEVEL GSQR/HZ.: .2000
ALARM LIMITS +DB,-DB:3.000,-3.000
ABORT LIMITS +DB,-DB:6.000,-6.000

8 FREQUENCY HZ.: 10.00
LEVEL GSQR/HZ.: .2000
ALARM LIMITS +DB,-DB:3.000,-3.000
ABORT LIMITS +DB,-DB:6.000,-6.000

9 FREQUENCY HZ.: 30.00
LEVEL GSQR/HZ.: .02000
ALARM LIMITS +DB,-DB:3.000,-3.000
ABORT LIMITS +DB,-DB:6.000,-6.000

10 FREQUENCY HZ.: 40.00
LEVEL GSQR/HZ.: .002000
ALARM LIMITS +DB,-DB:3.000,-3.000
ABORT LIMITS +DB,-DB:6.000,-6.000

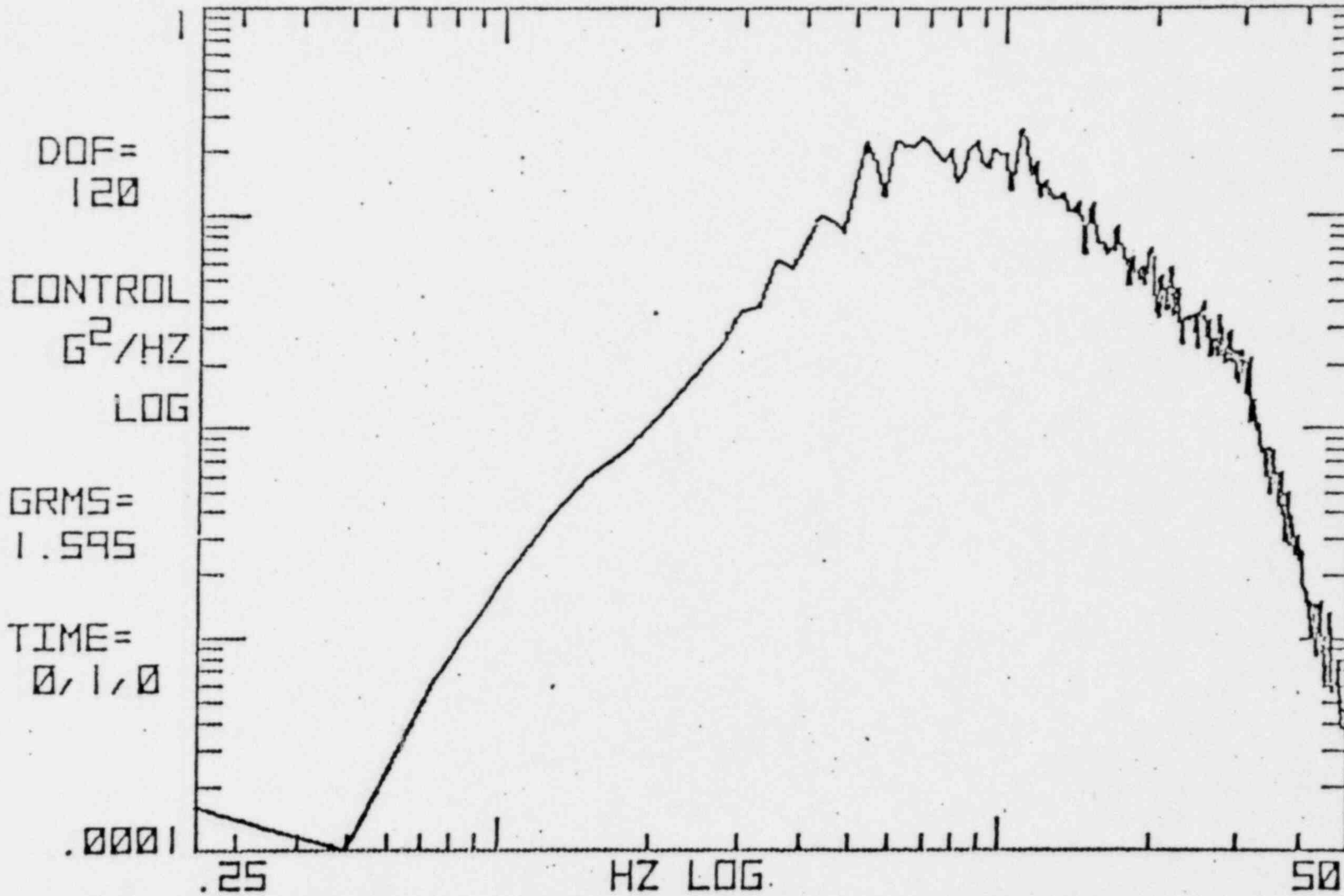
11 FINAL SLOPE, DB/OCT: -24.00

12 ALARM/ABORT RANGE:
LOW,HIGH FREQ: 1.000,40.00
LINES TO TRIGGER ALARM: 3
LINES TO TRIGGER ABORT: 6
13 LOW LEVEL, -DB: -10.00
14 LEVEL INCREMENT, DB: 2.000
15 START-UP TIME SEC: 20.00
16 SHUT-DOWN TIME SEC: 60.01
17 TEST TIME HRS, MIN, SEC: 0,1,0
18 AUTOMATIC INCREASE, 1=YES 0=NO: 0
19 CONTROL CHANNELS: 1
20 AUXILIARY CHANNEL: 0
21 ACCEL SENS MV/G:
CH 1: 100.0
22 DRIVE CLIPPING 1=YES, 0=NO: 0
23 ALARM LEVEL GRMS: 2.000
ABORT LEVEL GRMS: 2.500
24 LOOP-CHECK MAX DRIVE(VOLTS): .2000

CORRECTIONS 1=YES, 0=NO:

FRONT-TO-BACK

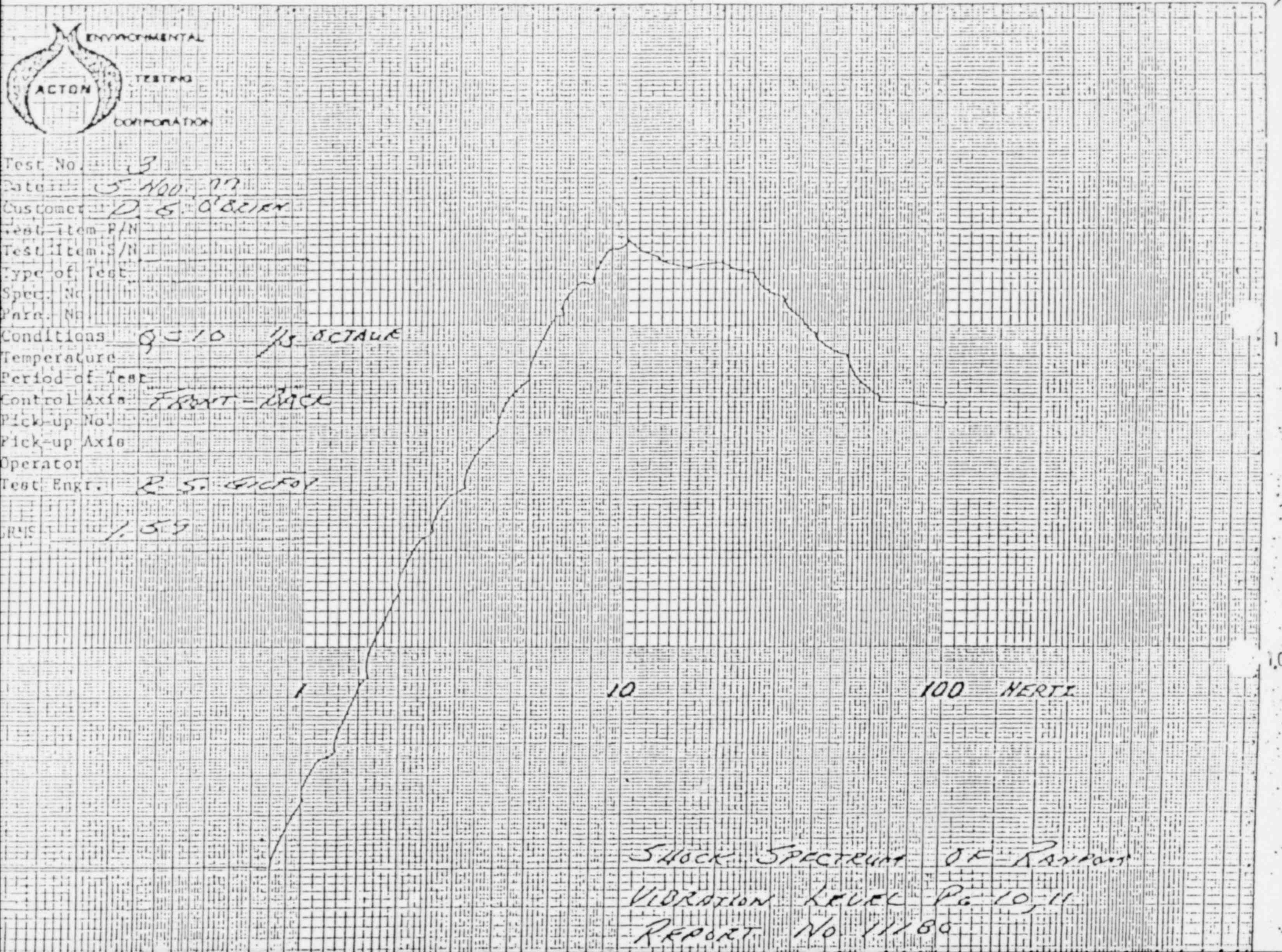
FRONT- BACK.



D.G.OBRIEN RANDOM DATA
CHANGE TO SHOCK SPECTRUM
TEST 3

FRONT TO BACK

FRONT-TO-BACK
TEST 3


ENVIRONMENTAL ACTON TESTING CORPORATION
Test No. 3
Date 5 NOV 77
Customer D. E. O'BRIEN
Test Item P/N
Test Item S/N
Type of Test
Spec. No
Para. No
Conditions Q=10 1/3 OCTAVE
Temperature
Period of Test
Control Axis FRONT-BACK
Pick-up No
Pick-up Axis
Operator
Test Engr. R. S. GILROY
GRMS 1.55
1
10
100 HERTZ
10
1.0
SHOCK SPECTRUM OF RANDOM
VIBRATION LEVEL PG 10, 11
REPORT NO 11180

Component Weights & Center-of-gravity Locations
Worst Case at the 12 inch Nozzles

By 'worst case' we mean that the heavist compliment of field cables exits from the Junction Box at either 3 o'clock or at 9 o'clock.

Values tabulated here are collected from the component weights tabulation in Appendix A.

The Gas Barrier thickness is $1\frac{1}{4}$ inches.

The Junction Box Mounting Ring thickness is 2 inches.

Center-of-Gravity locations measured in the axial direction from the welds and from the studs are

$$l_w = l_A - 1\tfrac{1}{4}$$
$$l_s = l_A - 3\tfrac{1}{4} \quad \text{inches}$$

Center-of-Gravity locations measured in the lateral and horizontal direction from the Penetration centerline are designated s.

Appx A item	Callout	W lbs	l_w in	l_s in	s in
N/A	Junction Box Mounting Ring	8.	1	n/a	0
2 OR 9	Junction Box (either end)	133	14	12	0
3 OR 10	Internal Cables 32 in. @ 16.565 lb/ft	44.	$13\frac{3}{4}$	$11\frac{3}{4}$	5
4 OR 11	External Cables 5 ft @ 16.565 lb/ft.	83	$24\frac{3}{4}$	$22\frac{3}{4}$	42

Estimated Acceleration Levels -- 12 inch Nozzles

These values are also from Appendix A.

In the axial or end-to-end direction, a = 8.43 (g)

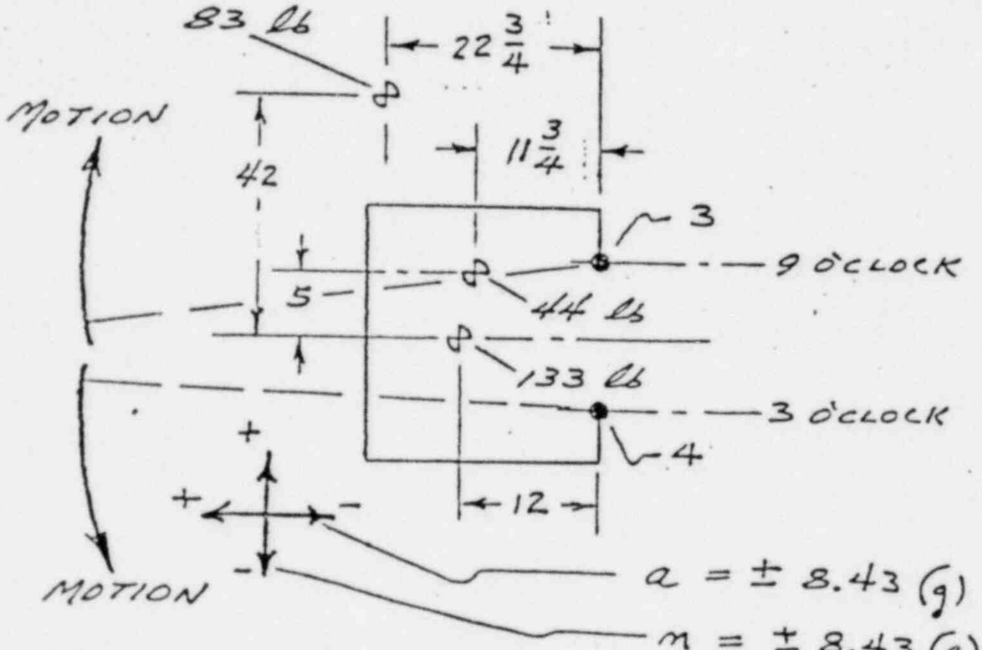
In the vertical direction, v = 4.77 (g)

In the lateral or side-to-side direction, n = 8.43 (g)

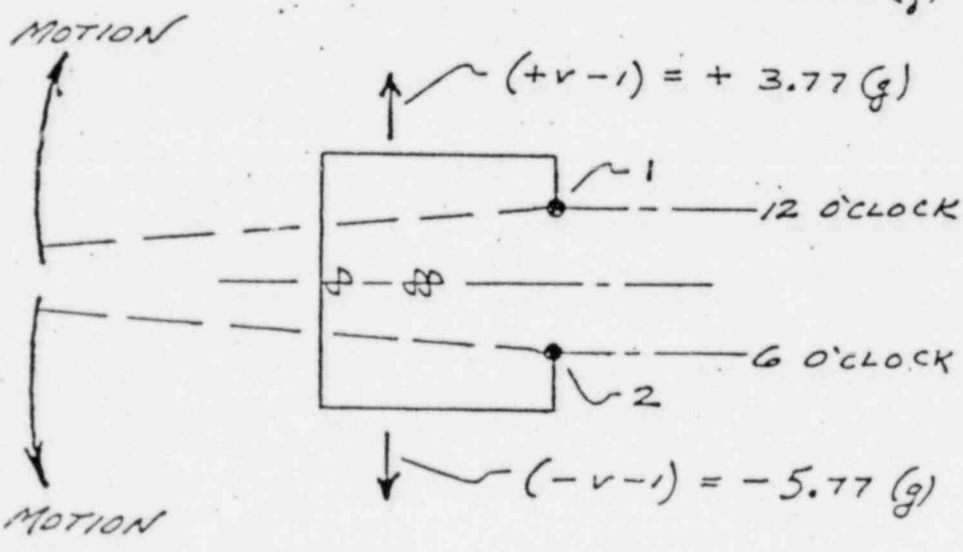
Calculated By CM CHARLES E. MARTIN Date MAY 18 1978
Checked By Date

CONFIGURATION: 24 x 24 x 24 Junction Box with internal & external cable compliments. Worst case (as selected in Appendix A) for the 12 inch Nozzles - Seismic and Dead Weight accelerations referenced to the Junction Box Mounting Studs.

Since the Channel Ring is substantially stiffer than the pattern of studs, an angular vibration mode may have two "Pivot Lines".

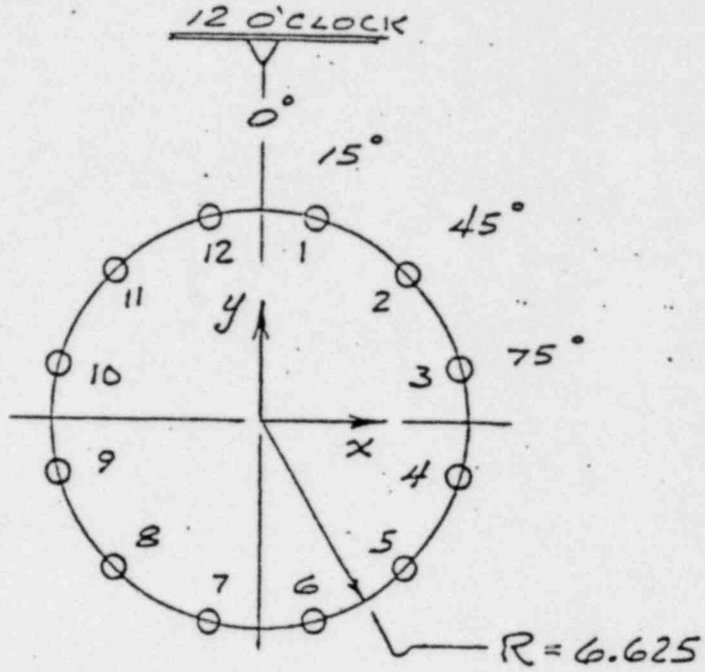


JUNCTION BOX
TOP VIEW
Axial Vibration and Lateral Vibration



JUNCTION BOX
SIDE VIEW
Vertical Vibration and Dead Weight

STUD PATTERN for mounting the 12 inch Junction Box.



12 Studs $\frac{3}{8}$ -16 UNC-2A × 1 equispaced on a $13\frac{1}{4}$ dia B.C.

We shall need the properties I and $\left(\frac{I}{A}\right)$ and (nA) where

$I = I_x = I_y$ is the second area moment about any pattern diameter for the entire pattern, and

A is the sectional area at the minor diameter for any one stud.

Ref Dwg R31C2016G

STUD	x	y	x^2
1	1.715	6.399	2.940 114
2	4.685	4.685	21.945 313
3	6.399	1.715	40.950 511
⋮			
12			

$\sum_{1}^{12}(x^2) = 263.34 \text{ in}^2$

$$\left(\frac{I}{A}\right) = \left(\frac{I_y}{A}\right) = \Sigma(x^2) = \left(\frac{I_x}{A}\right) = \Sigma(y^2) \doteq 263.34 \text{ in}^2$$

From Handbook H28 Part I Table 2.8, the sectional area at the minor diam is $A = 0.0678 \text{ in}^2$

$$\therefore I = \left(\frac{I}{A}\right)A = (263.34)\,0.0678 = 17.854 \text{ in}^4$$

and the combined area is $(nA) = 12(.0678) = 0.8136 \text{ in}^2$

Stud Pattern calculations continue on the next sheet.

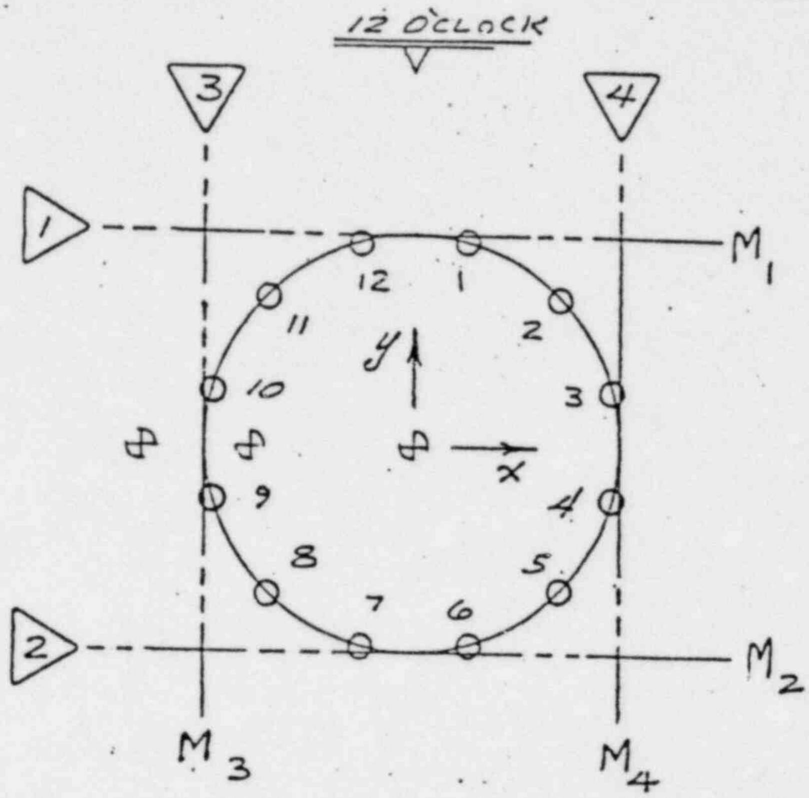
Calculated By CM CHARLES E. MARTIN Date MAY 18 1978
Checked By Date

continue

STUD PATTERN

This sketch shows the 'Pivot Lines' for the several reaction moments.

The moments arising from the several sources will be collected for each 'Pivot Line'.



For each of these 'Pivot Lines' we need the property $\left(\frac{I}{A}\right)_N$ where I refers to the entire pattern and A is the sectional area at the minor diameter for any one stud.

$$I_1 = I_2 = I_3 = I_4 = I + (12A)\,R^2$$

where (12 A) is the total of the stud areas, and R = 6.625 inches measures from the 'Pivot Line' to the pattern centroid.

Dividing thru by A;

$$\left(\frac{I}{A}\right)_1 = \left(\frac{I}{A}\right)_2 = \left(\frac{I}{A}\right)_3 = \left(\frac{I}{A}\right)_4 = \left(\frac{I}{A}\right) + 12\,R^2$$

$$= 263.34 + 12\,(6.625)^2 = 790. \ \text{in}^2$$

Calculated By CM CHARLES E. MARTIN Date MAY 23 1978
Checked By Date

G. O'BRIEN, INC.

TITLE CALCULATION REPORT

REPORT NO. ____
SHEET H5 OF ____

REACTION Ref J.B. Mount Studs	Vert Bending ± in-lb	Lateral Bending ± in-lb	Axial Thrust ± lbs	Vert Thrust ± lbs	Lateral Thrust ± lbs	Twist ± in-lb
Max stress location or Type stress ...	12 & 6 o'clock	3 & 9 o'clock	uniform normal	vert shear	Lateral shear	torisional shear
2 or 9 – W = 133 lbs						
Wa = W(8.43)						
Wm = W(8.43)			1121.			
W(m × l_s)		13454				
Wv = W(4.77)					1121.	
W(v × l_s)	7613			634.		
3 or 11 – W = 44 lbs						
Wa						
W(a × s)			371			
Wm		1855.				
W(m × l_s)		4358				
Wv					371.	
W(v × l_s)	2466			210		
W(v × s)						
4 or 11 – W = 83 lbs						
Wa						1049.
W(a × s)			700			
Wm		29387.				
W(m × l_s)						
Wv		15918.			700	
W(v × l_s)	9.007			396		
W(v × s)						
Reaction Totals Ref J.B. Mounting Studs	19086 ± in-lb	64972 ± in-lb	2192. ± lbs	1240. ± lbs	2192. ± lbs	16628 17677. ± in-lb

Seismic Reactions – Reference Junction Box Mounting Studs, 12 inch Nozzle

Calculated By CM CHARLES E. MARTIN MAY 18 1978
Checked By
Date

Dead Weight Reactions
Reference Junction Box Mounting Studs
12 inch Nozzles

acceleration levels; v ≡ 1 m=0 a=0

l_s in	s in	Dead Weight Reaction Ref J.B. Mount Studs / Max stress location or Type of stress	Vert Bending in-lb / 12 & 6 o'clock	Vert Thrust lb / vert shear	Twist in-lb / Torsional shear
12	0	Item 2 or 9. W = 133 lb W v = W(1) W (v × l_s)	1596	133.	
11 3/4	5	Item 3 or 10, W = 44 lb W v W (v × l_s) W (v × s)	517	44	220.
22 3/4	42	Item 4 or 11. W = 83 lb W v W (v × l_s) W (v × s)	1888	83	3486
		Total Dead Weight Reactions. Reference Junction Box Mounting Studs	4001. in-lb.	260. pounds	3706. in-lb

Calculated By CM CHARLES E. MARTIN Date MAY 18 1978
Checked By Date

Combined Seismic and Dead Weight Reactions
Reference Junction Box Mounting Studs & 12 in Nozzles.

Source		Reactions (The moment subscripts refer to the 'Pivot Lines')
Seismic	Dead Wt	
v = ± 4.77	yes	M_1 = 19 086 − 4001 = 15 085 in-lb M_2 = 19 086 + 4001 = 23 087 in-lb
a = ± 8.43 and m = ± 8.43	no	M_3 = 64 972 in-lb M_4 = 64 972 in-lb
a = ± 8.43	no.	$\mathcal{F}_{(+)}$ = 2192 pounds $\mathcal{F}_{(-)}$ = −2192 pounds

Calculation Method for Reaction Forces at the Studs:

The moment loading M_2 about Pivot Line 2 causes an equivalent stress s_m and a reaction force F_m at stud number m.

$$s_m = \frac{M_2 (R + y_m)}{I_2}$$

$$F_m = s_m A = \frac{M_2 (R + y_m)}{\left(\frac{I}{A}\right)_2}$$

Note that F_m is the maximum value for a dynamic quantity. It will be a positive or tensile reaction during that portion of the vibration cycle when $M_2 > M_1$ and the reaction moment acts about Pivot Line 2.

Similar reasoning provides the following Calculation Expressions.

Calculation Expressions for Reaction Forces at The Studs. Junction Box Mounting & 12 in Nozzles.

(1) $$F = \frac{M_1 (R - y_m)}{\left(\frac{I}{A}\right)_1} = \frac{15085 (6.625 - y_m)}{790}$$

(2) $$F = \frac{M_2 (R + y_m)}{\left(\frac{I}{A}\right)_2} = \frac{23087 (6.625 + y_m)}{790}$$

(3) $$F = \frac{M_3 (R + x_m)}{\left(\frac{I}{A}\right)_3} = \frac{64972 (6.625 + x_m)}{790}$$

(4) $$F = \frac{M_4 (R - x_m)}{\left(\frac{I}{A}\right)_4} = \frac{64972 (6.625 - x_m)}{790}$$

(5) $$F = \frac{\mathcal{F}_{(+)}}{12} = \frac{2192}{12}$$

Note at all these expressions; the polarities will be chosen so as to calculate tensile forces at the studs.

Note at expressions (1) and (2); The reaction moments M_1 and M_2 cannot occur simultaneously. We will ignore small values and tabulate only the largest force which can be calculated from either expression.

Note at expressions (3) and (4); the reaction moments M_3 and M_4 cannot occur simultaneously. We will ignore small values and tabulate only the largest force which can be calculated from either expression.

Reaction Forces at the $\frac{3}{8}$-16 UNC Studs.

Junction Box Mounting & 12 inch Nozzles.

These stud reactions arise from the combination of Seismic reactions and Dead Weight reactions.

The calculation method for the final column assumes the unlikely worst case where the Axial, Vertical, and Lateral vibrations are simultaneously maximum and in phase with additive polarity. ie, assumes the reactions from the several sources are cumulative. This method is conservative.

stud	Reaction Force calculated from expression (1) or (2) pounds	(3) or (4) pounds	(5) pounds	Combinations. Conservatively Sum the rank values
1 or 12	380.6	685.9	182.7	F_1 = 1249.2
2 or 11	330.5	930.2	182.7	F_2 = 1443.4
3 or 10	244.6	1071.1	182.7	F_3 = 1498.4
4 or 9	159.3	1071.1	182.7	F_4 = 1413.1
5 or 8	216.0	930.2	182.7	F_5 = 1328.9
6 or 7	248.7	685.9	182.7	F_6 = 1117.3

Thus, conservatively, the criteria for a steady-value operating load at any stud is that the preload tensile force caused by torque at the mounting nut must be larger than 1498.4 pounds.

Calculated By CM CHARLES E. MARTIN Date MAY 23 1978
Checked By Date

Junction Box Mounting Studs

Tensile Reaction Forces and Stresses caused by the Installation Torques.

The reference used for these calculations is Kent's Mechanical Engineering Handbook, Twelfth Edition Design and Production Volume. The expression relating torque and axial force is on page 10-04. The coefficient of friction value is from Table 4 on page 7-28. The friction coefficient is for steel on steel, dry with no lubrication. The static value is chosen because the manual wrenching will be slow and intermittent.

$$\frac{T}{F_T r} = \frac{\frac{f_1}{\cos\phi} + \tan\lambda}{1 - \frac{f_1 \tan\lambda}{\cos\phi}} + f_2 \frac{r_c}{r}$$

$$\tan\lambda = \frac{L}{2\pi r}$$

where
- T is the applied torque ----- in-lb
- F_T is the axial force ----- lb
- r is the pitch radius of the bolt --- in.
- r_c is the mean radius of the seating --- in. shoulder on the bolt head or nut
- λ is the helix angle at the bolt's pitch cylinder
- L is the thread lead ------ in/turn
- ϕ is the pressure flank angle
- $\phi = 30°$ for Unified series threads
- f_1 is the coefficient of friction between the bolt and the nut
- f_2 is the coefficient of friction at the seating shoulder.

Calculated By CM CHARLES E. MARTIN Date OCT 13 1977
Checked By Date

continue Junction Box Mounting Studs at 12 in & 18 in Nozzles —
Tensile Loading Forces & Stresses caused by Inst'n Torques —

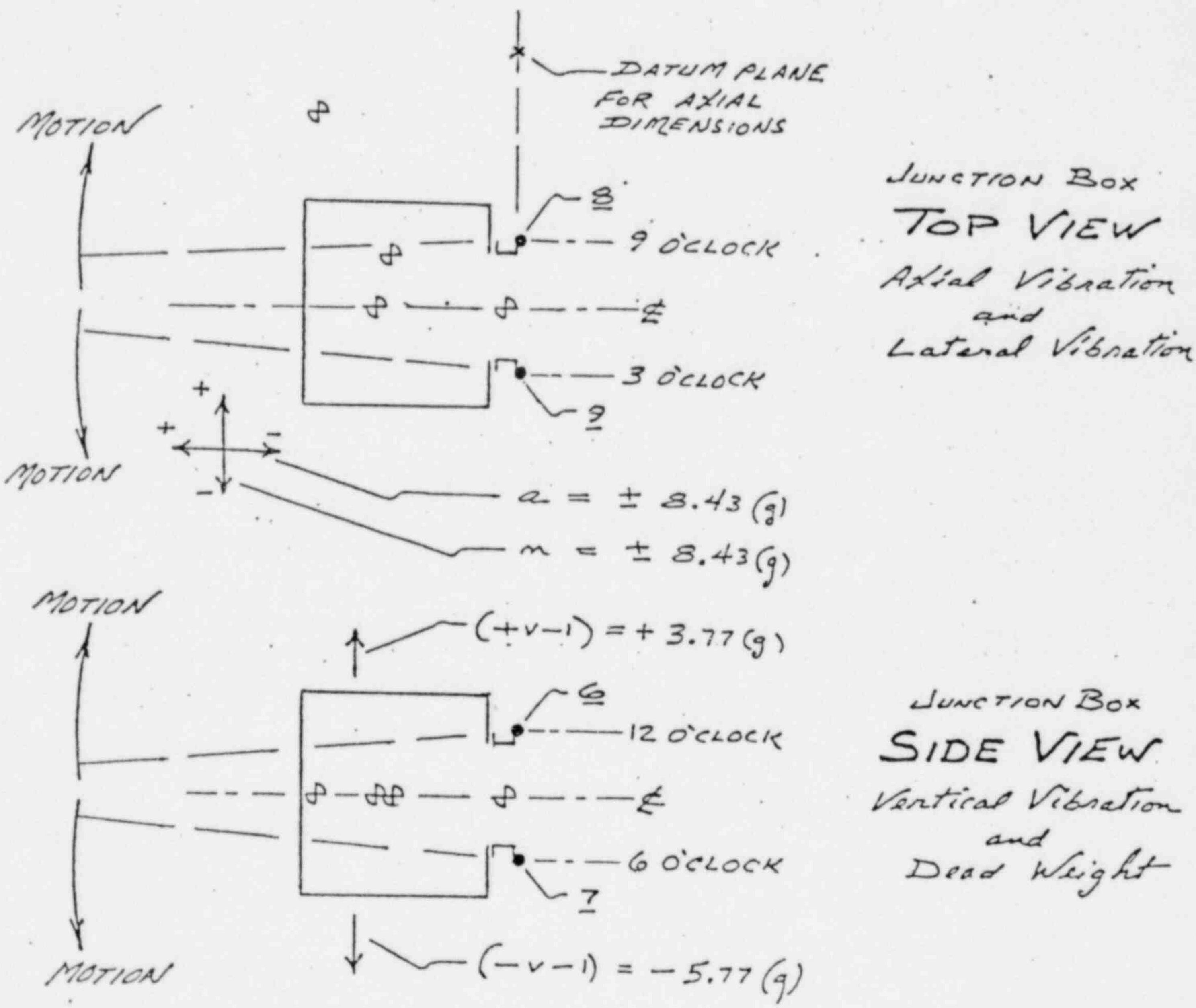
NOZZLE SIZE →	12 inch	18 inch
Stud threads	$\frac{3}{8}$ -16 UNC	$\frac{5}{8}$ - 11 UNC
Stud count	12	18
lead L, inch/turn	1/16	1/11
thread flanks, $\cos\phi$ =	0.866025	0.866025
basic pitch diam, inches	0.3344	0.5660
∴ pitch radius, r =	0.1672	0.2830
$\tan\lambda = \frac{L}{2\pi r}$ =	0.059493	0.051126
mean radius of seating shoulder, r_c =	0.234	0.391 in
friction coefficients, steel on steel, static and dry — f_1 =	0.149	0.149
f_2 =	0.149	0.149
$\boxed{N} = \frac{f_1}{\cos\phi} + \tan\lambda$ =	0.231543	0.223176
$\boxed{D} = 1 - \frac{f_1 \tan\lambda}{\cos\phi}$ =	0.989764	0.991204
$\boxed{A} = f_2 \frac{r_c}{r}$ =	0.208529	0.205862
$\frac{T}{F_T r} = \frac{\boxed{N}}{\boxed{D}} + \boxed{A}$ =	0.4424	0.4310
Choose Installation Torques at the nuts: T =	10 ft-lb 120 in-lb	30 ft-lb 360 in-lb
Stud tensile preload as torqued — $F_T = \frac{T}{\left(\frac{T}{F_T r}\right) r}$ =	1622.2 pounds	2951. pounds
Stud's sectional area at its minor diam - - - - A =	0.0678 in^2	0.2020 in^2
Tensile stress, $s = \frac{F_T}{A}$ =	23,928. psi	14611. psi

Calculated By CM CHARLES E. MARTIN Date MAY 25 1978
Checked By Date

CONFIGURATION: 24 x 24 x 24 Junction Box with internal & external cable compliments. Worst case (as selected in Appendix A) for the 12 inch Nozzles.

Seismic and Dead Weight accelerations referenced to Welds at the Junction Box Mounting Ring.

Since the Channel Ring and the Gas Barrier are both substantially stiffer than the weld pattern, an angular vibration mode may have two "Pivot Lines".



Calculated By CHARLES E. MARTIN Date MAY 24 1978

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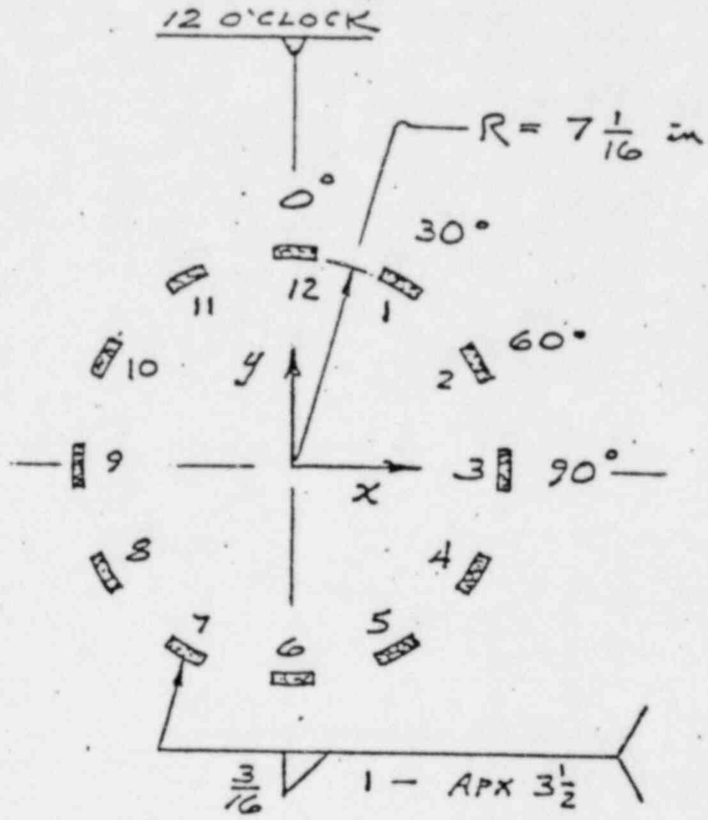
WELD PATTERN

Junction Box Mtg. Ring,
12 in Junction Boxes –



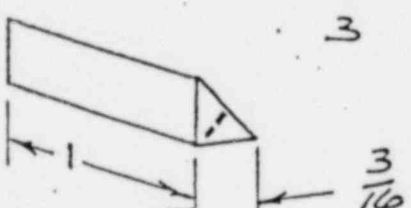
12 Fillet weld increments spaced between the J-Box mounting studs. Reference drawings R31C2016G & R31E5003G.

We shall need the properties I and $\left(\frac{I}{A}\right)$ and (nA) where

$I = I_x = I_y$ is the second area moment about any pattern diameter for the entire pattern, and A is the effective area for any one weld increment.

WELD INCREMENT	x	y	x^2
12	0.000	7.062	0.000 000
1	3.531	6.116	12.467 961
2	6.116	3.531	37.403 883
3	7.062	0.000	49.871 844

$${}_1\Sigma_{12}(x)^2 = 299.23 \text{ in}^2$$



Assign a weld efficiency of 80%.

The effective area for one weld increment is

$$A = \frac{3}{16}(.707)\,1\,(0.8) = 0.106 \text{ inches}^2.$$

$$\left(\frac{I}{A}\right) = \left(\frac{I_y}{A}\right) = \Sigma(x^2) = \left(\frac{I_x}{A}\right) = \Sigma(y^2) = 299.73 \text{ in}^2$$

$$\therefore I = \left(\frac{I}{A}\right)A = 299.73\,(0.106) = 31.771 \text{ in}^4$$

and the combined effective area is

$$(nA) = 12\,(0.106) = 1.272 \text{ in}^2$$

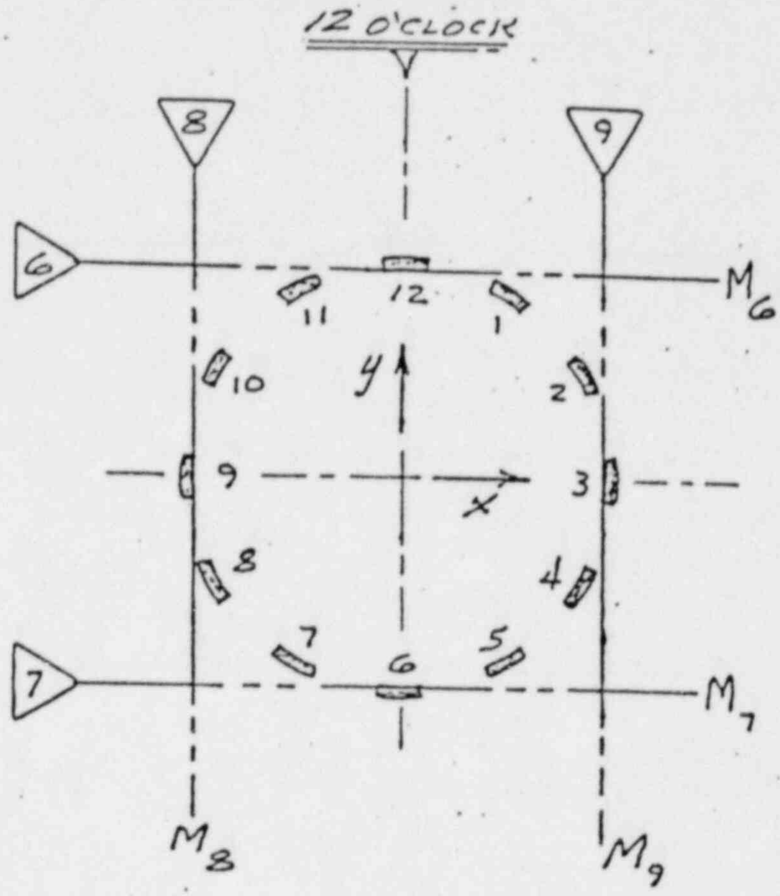
continue

WELD PATTERN

Ref
12 inch Nozzles

This sketch shows the 'Pivot Lines' for the several reaction moments.

The moments arising from the several sources will be collected for each 'Pivot Line.'



For each of these 'Pivot Lines' we need the property $\left(\frac{I}{A}\right)_N$ where I refers to the entire weld pattern and A is the effective stress area for any one weld increment.

$$I_6 = I_7 = I_8 = I_9 = I + (12A)R^2$$

where (12 A) is the total of the effective weld areas, and R = 7.062 inches measures from the 'Pivot Line' to the pattern centroid.

Dividing thru by A;

$$\left(\frac{I}{A}\right)_6 = \left(\frac{I}{A}\right)_7 = \left(\frac{I}{A}\right)_8 = \left(\frac{I}{A}\right)_9 = \left(\frac{I}{A}\right) + 12R^2$$

$$= 299.73 + 12(7.062)^2 = 898. \text{ in}^2$$

TITLE CALCULATION REPORT

REACTION Ref: Welds at the J. B. Mount Ring	Vert Bending ± in-lb	Lateral Bending ± in-lb	Axial Thrust ± lbs	Vert Thrust ± lbs	Lateral Thrust ± lbs	Twist ± in-lb
Max stress location or Type stress ...	12 & 6 o'clock	3 & 9 o'clock	uniform normal	vert shear	Lateral shear	torsional shear
J. B. Mount Ring, 8 lbs						
Wa = W(8.43)			67			
Wn = W(8.43)					67	
W(m × lw)		67				
Wv = W(4.77)				38		
W(v × lw)	38					
2 on 9. W = 133 lb						
Wa			1121			
Wn					1121	
W(m × lw)		15697				
Wv				634		
W(v × lw)	8882					
3 on 11. W = 44 lb						
Wa			371			
W(a × s)		1855				
Wn					371	
W(m × lw)		5100				
Wv				210		
W(v × lw)	2886					
W(v × s)						1049
REACTION SUBTOTALS carry forward →	11806	22719	1559	882	1559	1049

Seismic Reactions - Reference Welds at the Junction Box Mounting Ring, 12 inch Nozzles

Calculated By CHARLES E. MARTIN Date MAY 19 1978

Checked By Date

CONTINUES NEXT SHEET →

Dead Weight Reactions

Ref -- Welds at the Junction Box Mounting Ring — 12 inch Nozzles

acceleration levels; v = 1   m = 0   a = 0

l_w in	s in	Dead Weight Reaction Ref- Weld Increments / Max stress location or Type of stress	Vert Bending in-lb (12 & 6 o'clock)	Vert Thrust lb (vert shear)	Twist in-lb (Torsional shear)
1	0	Jct Box Mounting Ring W = 8 lbs W (v) = W(1) W(v × l_w)	8	8.	
14	0	Item 2 on 9 W = 133 lb W v W (v × l_w)	1 862.	133	
$13\frac{3}{4}$	5	Item 3 on 10 W = 44 lb W v W (v × l_w) W (v × s)	605	44	220
$24\frac{3}{4}$	42	Item 4 on 11 W = 83 lb W v W (v × l_w) W (v × s)	2 054	83.	3 486
		TOTAL Dead Weight Reactions ... Refer Welds at the Junction Box Mounting Ring	4 529 in-lb	268 pounds	3 706 in-lb.

Combined Seismic and Dead Weight Reactions-
Reference - Welds at the Jet Box Mounting Ring & 12 inch Nozzles.

Source: Seismic	Source: Dead Wt	Reactions. (The moment subscripts refer to the 'Pivot Lines')
$v = \pm 4.77$	yes	$M_6 = 21\,605 - 4529 = 17\,076$ in-lb $M_7 = 21\,605 + 4529 = 26\,134$ in-lb
$a = \pm 8.43$ and $n = \pm 8.43$	no	$M_8 = 69\,423$ in-lb $M_9 = 69\,423$ in-lb
$a = \pm 8.43$	no	$\mathcal{F}_{(+)} = +2\,259$ pounds $\mathcal{F}_{(-)} = -2\,259$ pounds

Calculation Method for Reaction Forces at the Weld Increments:

The moment loading M_7 about Pivot Line 7 causes causes a stress s_m and a reaction force F_m at weld increment number m.

$$s_m = \frac{M_7 (R + y_m)}{I_7}$$

$$F_m = s_m A = \frac{M_7 (R + y_m)}{\left(\frac{I}{A}\right)_7}$$

Note that F_m is the maximum value for a dynamic quantity. It will be a positive or tensile reaction during that portion of the vibration cycle when $M_7 > M_6$ and the reaction moment acts about Pivot Line 7.

Similar reasoning provides the following Calculation Expressions.

Calculated By CM CHARLES E. MARTIN Date MAY 24 1978
Checked By Date

Calculation Expressions for Reaction Forces at the Weld Increments – Box Mounting Ring & 12 in Nozzles –

(6) $$F = \frac{M_6 (R - y_m)}{\left(\frac{I}{A}\right)_6} = \frac{17076 (7.062 - y_m)}{898}$$

(7) $$F = \frac{M_7 (R + y_m)}{\left(\frac{I}{A}\right)_7} = \frac{26134 (7.062 + y_m)}{898}$$

(8) $$F = \frac{M_8 (R + x_m)}{\left(\frac{I}{A}\right)_8} = \frac{69423 (7.062 + x_m)}{898}$$

(9) $$F = \frac{M_9 (R - x_m)}{\left(\frac{I}{A}\right)_9} = \frac{69423 (7.062 - x_m)}{898}$$

(10) $$F = \frac{\mathcal{F}_{(+)}}{12} = \frac{2259}{12}$$

Note at all these expressions: the polarities will be chosen so as to calculate tensile forces at the weld increments.

Note at expressions (6) and (7); the reaction moments M_6 and M_7 cannot occur simultaneously. We will ignore small values and tabulate only the largest force which can be calculated from either expression.

Note at expressions (8) and (9); the reaction moments M_8 and M_9 cannot occur simultaneously. We will ignore small values and tabulate only the largest force which can be calculated from either expression.

Calculated By CM CHARLES E. MARTIN Date MAY 24 1972

QUESTION: (MAIN STEAM ISOLATION VALVE)

Provide the reason for not superimposing the effects of both the sonic flow and pipe flow conditions. The reports provided do not address the sonic flow test performance.

RESPONSE:

A. It must be recognized that the testing performed (circa 1977) was a "state-of-the art" effort. It was a pioneering test never before attempted - at least as far as we know - by any other valve manufacturer on such a large scale. It was Atwood and Morrill's (A&M) contention that full scale testing was the only way to properly verify performance.

B. There were then, and continue to be, no nationally recognized standards for generic qualification of valve assemblies. Although the standard effort was underway then, it is still not finished today. (A&M)recognized a need to proceed without such standards.

C. The requirements of NRC Regulatory Guide 1.48 do not specifically deliniate what combinations of analysis and tests are appropriate to qualify valve assemblies.

D. The feasibility of performing a combined flow interruption and bend test was evaluated. There was then no single facility capable of performing combined tests on such a large scale, so (A&M) built two facilities to do each test separately.

E. Although not yet complete, the standard for qualification of valve assemblies (which is being prepared under the direction of Manufacturers Standardization Society), allows separate flow interruption and bend tests on valve assemblies. We offer this as an example of current industry thinking.

F. It is our opinion that since the MSIV can be demonstrated to function before, during, and after the limiting pipe bending and seismic loads tests, deflections caused by such loads have no effect on valve operation. It is therefore logical to conclude that separate demonstration of the flow interruption closure should qualify the valve design for the simultaneous full flow and pipe load conditions as referenced in the (A&M) qualification report (No. 44 Bend Test).

Response
to
Seismic Qualification Review Team
Concerns Expressed
by
Brookhaven National Laboratory

1. Diesel generator exhaust silencer:

   In their original review reports, BNL expressed several concerns about the natural frequency calculations for the diesel generator exhaust silencers.

   Gilbert/Commonwealth (G/C) has reviewed these concerns and concluded that the silencers are adequate, although certain inconsistencies were found in the original Colt Industries calculations. Attachments #1 through #4 are the G/C analysis which are provided for your information.

2. Diesel generator excitor cabinet:

   In their original review report, BNL expressed a request that an evaluation of the structural damage that occurred during the seismic testing of the equipment be made by Bassler and/or by G/C.

   G/C carefully evaluated the significance of the structural damage that occurred during the test as a part of the evaluation of the qualification prior to its original acceptance. Although structural damage was observed during the test, the equipment within the cabinet continued to function throughout the test with one major exception. This exception was the contacts for the potential transformer draw out mechanism. With the proper adjustment these contacts performed satisfactorily for the remainder of the test. As a result, an inspection procedure for proper adjustment of the contacts has been added to the inspection and maintenance program for the equipment. Attachment #6 is a copy of this procedure. This continued operation of the equipment throughout the seismic test demonstrated that the structural damage which did occur, did not and will not, effect the electrical function of the excitor. In addition, none of the critical electrical components are mounted directly to the cabinet. Each assembly or component has its own base which in turn is mounted to the main cabinet. Therefore, structural damage to the cabinet cannot directly affect any of the critical electrical components.

3. Diesel generator neutral grounding resistor:

   In their original review report BNL expressed several concerns about the differences between the tested resistor and the contract resistor, as well as a concern about the use of single axis testing versus the multi-axes input from an actual earthquake.

   The neutral grounding resistor is a very simple structure which consists of an assembly of ceramic tubes supported by simple steel framework. This framework is supported in turn on 4 porcelain insulators. It is the opinion of G/C that the geometry of this structure is such that response in axes perpendicular to the input motion (cross axis coupling) will be negligible. On this basis single axis testing was accepted.

The test data indicates that the maximum responses of the resistors for side to side and front to back motion respectively were 4G at 5Hz and 6.5G at 6Hz. These responses are both equivalent to a 4 inch displacement. The displacement of the enclosure cannot be established from the available data, however, experience indicates that the displacement will be about 2 to 3 inches. Since the combination of the enclosure and the resistor displacements are significantly less than the available 10 inch clearance between the resistor and its enclosure, no interference or other degradation would be anticipated.

G/C has estimated that the natural frequencies (in the horizontal directions) of the contract resistor are approximately 1½ times that of the tested resistor. The analysis used to make this estimate is Attachment #5. In reviewing the significance of this shift with respect to the required response spectra, it can be seen that the tested resistor had natural frequencies which lay within the range of expected building resonant frequencies. Therefore, any shift in frequency between the tested and contract resistors would only tend to lower the response at the contract resistor.

4. Containment electrical penetrations:

In their original review report, BNL requested various materials which were not included in the materials available to them.

These materials were provided to BNL and in a subsequent review dated 9/24/81, BNL expressed a specific concern about the change in resonant frequency of the junction box panels during sine dwell testing.

The single frequency tests (linear tests), including both the sine surveys and the resonant dwells, can be considered as exploratory tests intended to find inherent structural weaknesses. The seismic "qualification" is based on the random frequency tests which are also reported in the Acton report #11180. The response spectra from these random motion tests, which are included in the back of D. G. O'Brien report ER252K, envelope the V. C. Summer Station required response spectra with a test response acceleration of at least twice the required response accelerations. Therefore, the change in resonant frequency in the junction box panels during sine dwell testing does not imply any inadequacy in the seismic "qualification" of the penetration assemblies.

I DIESEL GENERATOR

A. Direction of loading assumed by Colt Industries was that of a static dead weight, i.e. overhangs deflected in same direction as center span. This shape approximates the first mode shape since the overhangs have little effect on the center deflection of the shell. This is because the overhangs are 9.6 % of the total length of the silencer. In addition the shell has a large diameter of 90 inches.

In the calculations by the Brookhaven National Laboratory from their evaluation report, the following equation was shown:

$$y_{TOTAL} = \frac{W_1 L_1^3}{96EI}\left[1 \pm 4\,\frac{W_2 L_2}{W_1 L_1}\right]$$

For the silencer this works out to be:

$$y_{TOTAL} = \frac{W_1 L_1}{96EI}\left[1 \pm 0.025\right]$$

where, $\frac{W_2}{W_1} = \frac{950^{\#}}{15980^{\#}} = 0.0595$ $\quad W_2 = \left[Seg^{\#}1 + Seg^{\#}2 + \frac{Seg^{\#}3}{2}\right]\frac{17880}{17620}$

COLT IND. CALC. pg. 11

$$\frac{L_2}{L_1} = \frac{24}{228} = 0.1053$$

Overhangs have a, $\frac{0.025}{1.000} \times 100 = 2.5\%$ effect on deflection of silencer.

The ratio of natural frequencies is $\sqrt{\frac{1.025}{0.975}} = 1.025$ which means the frequency is about 2.5% less if direction of overhangs are reversed.

B. Error in dead weight calculation from 17620# to 17880#

1. Change in Colt Industries' vertical frequency calculation;

$$\frac{17880^{\#}}{17620^{\#}} = 1.015$$

$$P.E. = 29.316\,(1.015)^2 = 30.20$$

$$K.E.C. = 71.25\times10^{-6}\,(1.015)^3 = 74.50\times10^{-6}$$

$$f = \frac{1}{2\pi}\sqrt{\frac{30.20}{74.50\times10^{-6}}} = 101.3\ Hz$$

2.5% decrease due to reversal of overhang defl.

$$f = 98.7\ Hz$$

Decrease due to change in Modulus of Elasticity

$$98.7\ Hz \times \sqrt{\frac{24}{29}} = 89.7\ Hz$$

For a frequency range of ± 10%

80 Hz TO 99 Hz > Threshold frequency = 27 Hz

2. Change in Colt Industries' S.S. frequency calculation;

Following same procedure as above.

Frequency range:

26 Hz TO 32 Hz > Threshold frequency = 24 Hz

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	MICROFILMED				
	ORIGINATOR R. BATOR				
	DATE 10/12/81				

3. Change in Colt Industries' Axial frequency calculation;

Overhang deflection not applicable. Therefore, frequency range is:

30 Hz To 33 Hz – Threshold frequency = 27 Hz

Therefore, the frequencies are still above the threshold frequencies which shows the silencer to still move rigidly with the floor.

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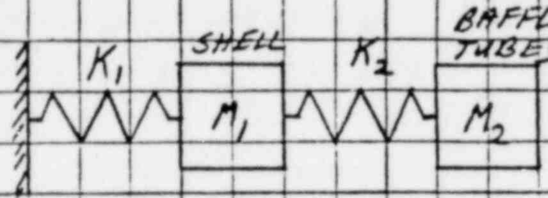
C. Axial frequency calculation assuming a two-degree-of-freedom system.



$M_1 = \frac{17880}{386.4} = 46.27 \frac{\#\text{-SEC}^2}{\text{IN}}$

$M_2 = \frac{1430}{386.4} = 3.70 \frac{\#\text{-SEC}^2}{\text{IN}}$

FOR $E = 24 \times 10^6$ psi:

$K_2 = (2)\ 54800 = 1.096 \times 10^5$ #/IN.

Following the calculations on pages 18 through 22 in Colt Industries report, for $E = 24 \times 10^6$ psi.

$K_1 = 1.73 \times 10^6$ psi

FOR $E = 29 \times 10^6$ psi:

$K_1 = 1.99 \times 10^6$ psi

Following the calculations on pages 33 and 34 for $E = 29 \times 10^6$ psi

$K_2 = 1.326 \times 10^5$ psi

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$$2\pi f^2 = \frac{1}{2}\left(\frac{K_1+K_2}{M_1}+\frac{K_2}{M_2}\right) \pm \frac{1}{2}\left[\left(\frac{K_1+K_2}{M_1}+\frac{K_2}{M_2}\right)^2 - 4\frac{K_1K_2}{M_1M_2}\right]^{1/2}$$

FOR $E = 24 \times 10^6$ psi

$f_1 = 25.1$ Hz $\quad f_2 = 33.6$ Hz

FOR $E = 29 \times 10^6$ psi

$f_1 = 27.4$ Hz $\quad f_2 = 36.4$ Hz

For a frequency range of ± 10%

22.6 Hz TO 40.0 Hz

The fundamental axial frequency is lower than the threshold frequency which is at 27 Hz.

Colt Industries analyzed the silencer for a frequency of 24 Hz, which corresponds to an acceleration of 1.26 g. This frequency lies at the right edge of the second peak on the response spectrum. A frequency down to 14 Hz would still correspond to an acceleration of 1.26 g and a higher frequency would result in a lower acceleration. (Response spectrum for 2% equipment damping.) See Attachment #2.

The side-to-side direction used the peak acceleration and the vertical direction used the second peak acceleration. Any increase or decrease in frequency would result in an acceleration equal to or less than that used by Colt Industries for these directions. See Attachments #3 and #4 respectively.

ATTACHMENT #1

Gilbert Associates, Inc. Reading, Pennsylvania ANALYSIS/CALCULATION	SUBJECT REPLY TO BNL. EVALUATION REPORT, V.C. SUMMER #1		CISID		PAGE 6 OF 6 PAGES
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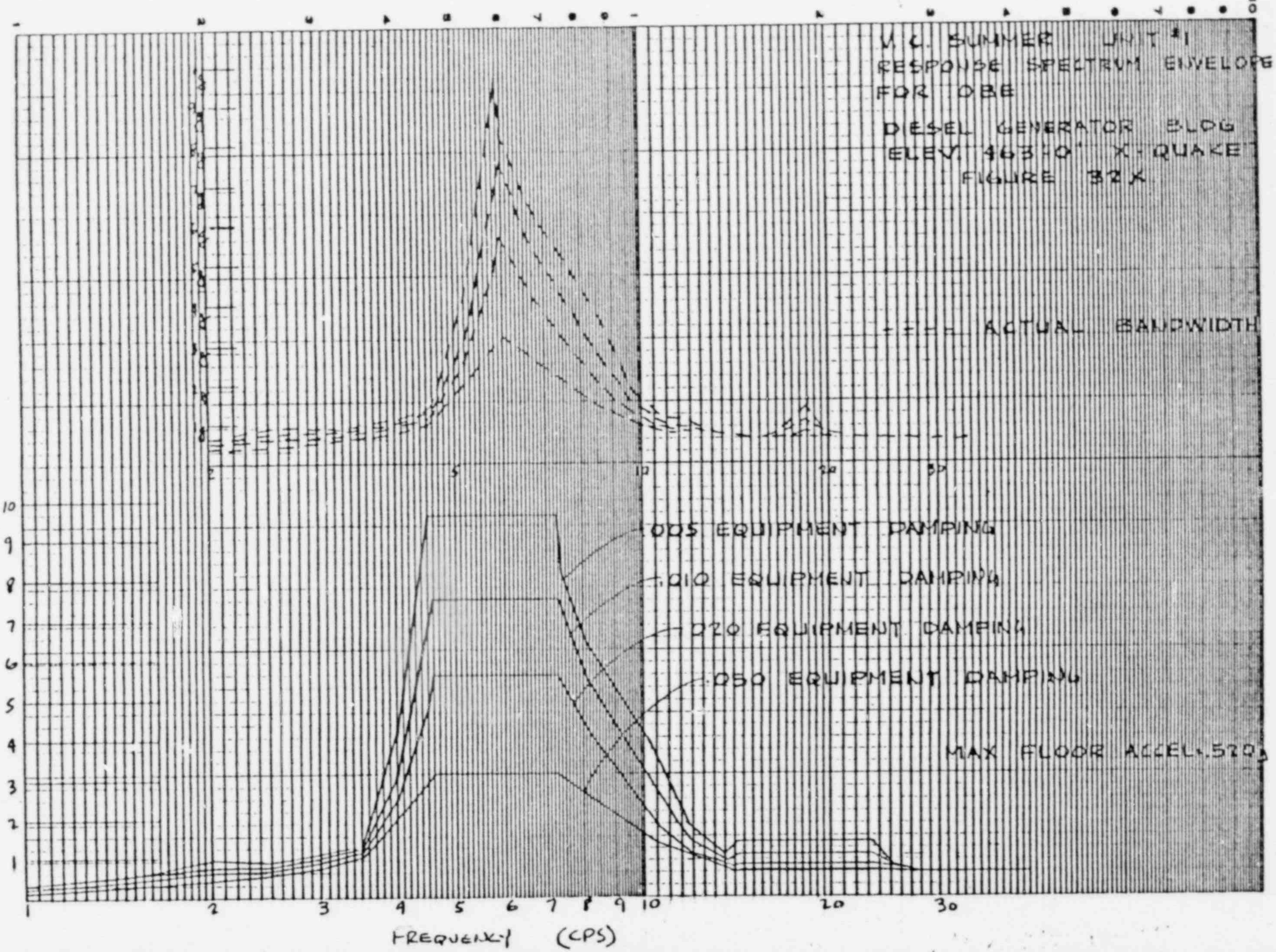
	DATE 10/30/81				

therefore Colt Industries' calculations for the exhaust silencer are found to be adequate and the equipment is still qualified.

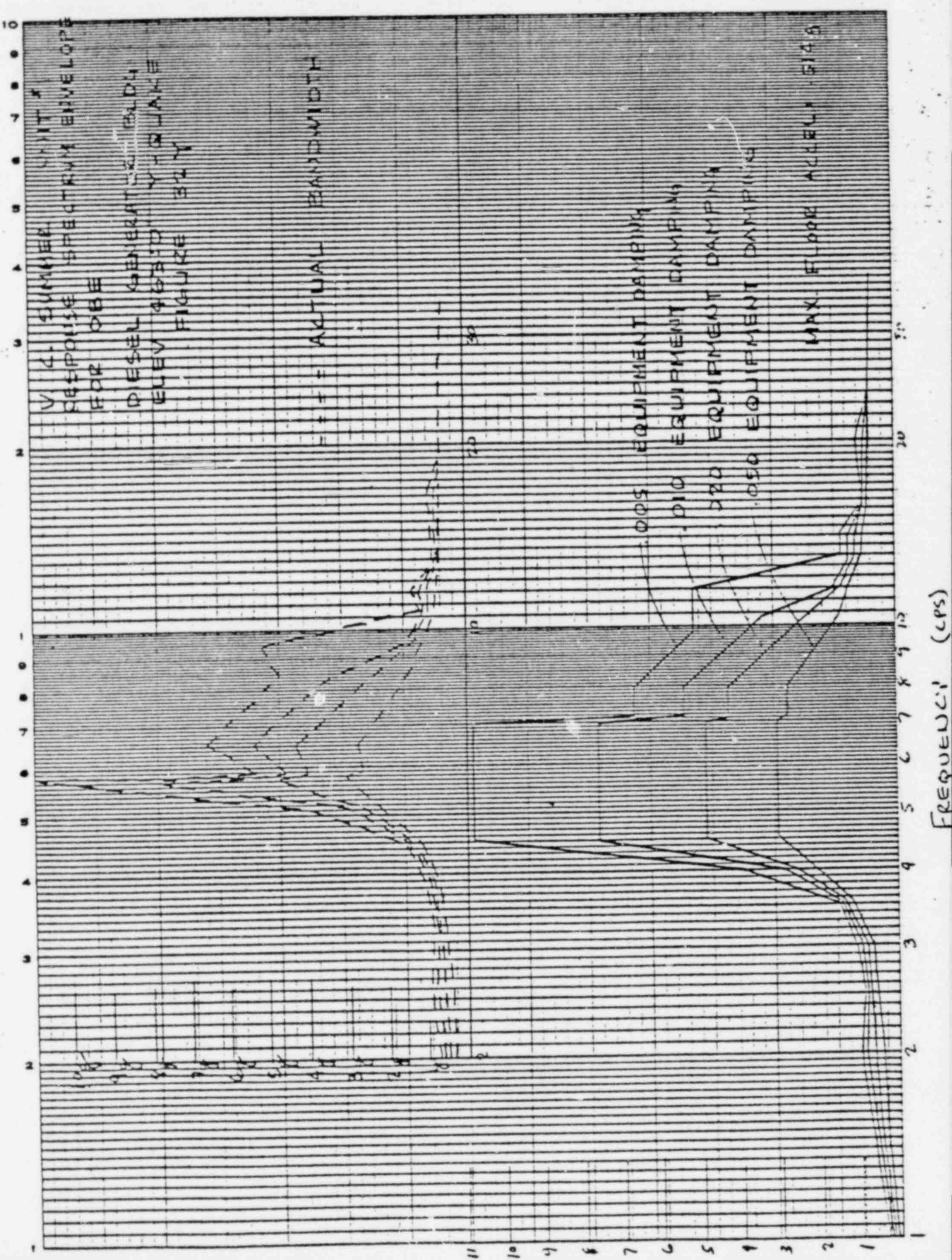
ATTACHMENT 2

EXHAUST SILENCER AXIAL DIRECTION



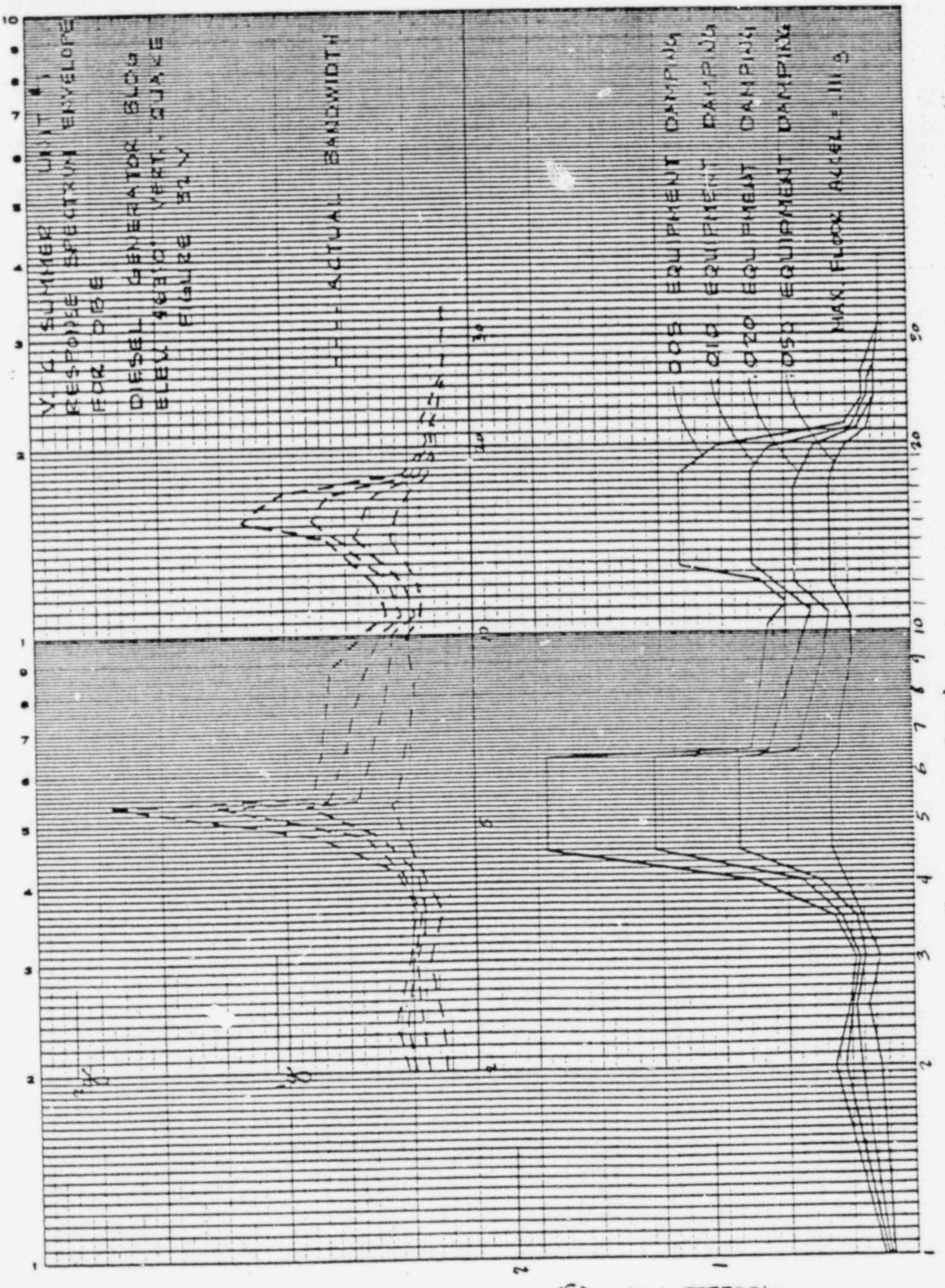
ATTACHMENT #3

EXHAUST SILENCER SIDE-TO-SIDE DIRECTION



ATTACHMENT #4

EXHAUST SILENCER VERTICAL DIRECTION



Gilbert Associates, Inc. Reading, Pennsylvania ANALYSIS/CALCULATION	SUBJECT REPLY TO B.N.L. EVALUATION REPORT, V.C. SUMMER #1		CISID		PAGE 1 OF 2 PAGES
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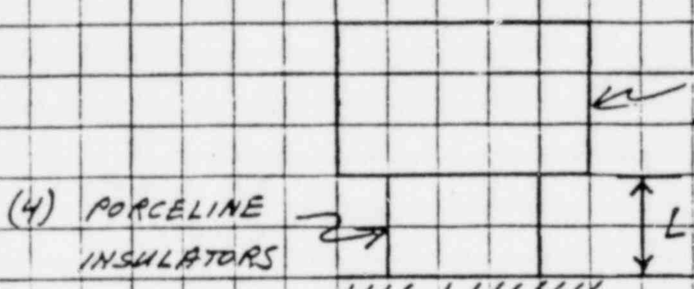
	MICROFILMED				
	ORIGINATOR R. BATOR				
	DATE 11/5/81				

II DIESEL GENERATOR NEUTRAL GROUNDING RESISTOR

GENERALIZED STRUCTURE



TESTED RESISTOR	CONTRACT RESISTOR
$L_T = 10''$	$L_C = 7.5''$
$W_T = 750^{\#} \times \frac{36}{46} = 590^{\#}$	$W_C = 750^{\#}$ /46 UNITS

Assuming both resistors to have similar type support connections, the stiffness would increase by:

$$F_k = \frac{L_T^3}{L_C^3} = \frac{10^3}{7.5^3} = 2.37$$

The mass would increase by:

$$F_m = \frac{750}{590} = 1.27$$

Therefore the frequency for the contract resistor would increase by a factor of:

$$\sqrt{\frac{2.37}{1.27}} = 1.37$$

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	DATE 11/5/81				

Since the tested resistor frequency occured at the peak of the response spectra, for both horizontal directions, a shift in frequency corresponding to the contract resistor, would tend to lower the response.

The frequency of the tested resistor in the vertical direction fell between the two peaks of the required spectrum. Therefore a shift in frequency of the contract resistor could tend to increase the response. But the test response spectrum developed by Colt Industries for an oscillator with 5% damping shows the response to be about ten times the input spectrum. The response of the test resistor was well below this response showing that the resistor had a damping value much greater than 5%. Therefore the test applied to the test resistor was very conservative since it used the 5% required response spectrum.

Both the above and the fact that the contract resistor frequency would increase suggest a lower response of the contract resistor. Therefore since the test resistor qualified so would the contract resistor.

ATTACHMENT # 6

REVISIONS			
SYM	DESCRIPTION	DATE	APPROVED

ORIGINAL DATE OF DRAWING 5-23-78	**BASLER ELECTRIC CO.** HIGHLAND, ILLINOIS		
DRAFTSMAN M. Wegman M. SCHOTT			
CHECKER M. SCHOTT	FIELD INSPECTION OF THE LOW AND HIGH VOLTAGE CONTACT FINGERS OF THE 9 1157 00 100 STATIC EXCITER.		
APPD J. [illegible] 30-MAY 78			
APPD			
APPD	CODE IDENT NO. 97520	SIZE A	DRAWING NO. 99-0547
APPD	SCALE	WT	SHEET 1 of 4

ATTACHMENT #6

DRAWN BY	DATE	TITLE Field Inspection of the Low and High Voltage Contact Fingers	DWG N
APPR. BY	DATE	DEPT	99-0847
REVISION		BASLER ELEC. CO. HIGHLAND, ILL.	SHEET 2 OF 4

PURPOSE: To ensure proper alignment of the low and high voltage contact fingers of the drawout assembly.

SPECIAL EQUIPMENT REQUIRED: Crane with at least 500 lbs. capacity.

CAUTION

ENSURE ALL OPERATING AND SOURCE POWER IS REMOVED BEFORE PROCEDING

1. Open the low voltage compartment door directly below the drawout assembly compartment and remove four (4) red bolts from the inside top panel.

2. Unlock and open the drawout compartment doors.

3. Disconnect the ground strap at upper right front corner of drawout assembly.

4. Attach lifting chains to two (2) reinforcing holes on top of drawout assembly (Ensure lifting chains are slack to avoid damage to cubicle).

5. Remove door latching, and drawout assembly connecting rod hardware.

CAUTION

DRAWOUT ASSEMBLY WEIGHS APPROXIMATELY 500 POUNDS, EXTREME CAUTION MUST BE OBSERVED WHEN REMOVING OR POSITIONING ASSEMBLY.

6. Remove the ground bus attached at the inside top panel of the drawout assembly compartment (Observe position for re-installation before removing).

7. Slowly take up lifting chain slack as drawout assembly is pulled outward.

8. Ensure lifting chain is taut before finally removing drawout assembly.

9. Lower the drawout assembly onto a structure that will safely support the assembly's weight, yet provide easy access to the four contact fingers located on the bottom of the drawout assembly.

ATTACHMENT #6

DRAWN BY	DATE	TITLE Field Inspection of the Low and High Voltage Contact Fingers	DWG
APPR. BY	DATE	DEPT	99-0847
REVISION		BASLER ELEC. CO. HIGHLAND, ILL.	SHEET 3 OF 4

10. Inspect the four (4) Low Voltage Contact Fingers attached to the bottom of the drawout assembly by performing the following steps: (See attached drawing 9 1157 15 100 sheet 3).

a). Compare the contact fingers with Figure 1 below.

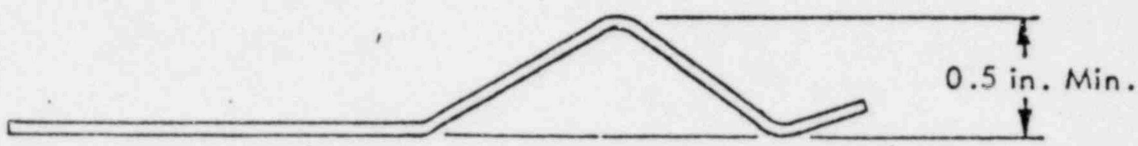


Figure 1

b). Replace the contact fingers if necessary by performing the following steps:

1). Remove four (4) bolts from the contact finger insulator block assembly.

2). Remove two (2) nuts and associated hardware from each contact finger.

3). Install new contact fingers with original hardware.

4). Re-assemble and install the contact finger assembly.

11. Inspect the three (3) High Voltage Contact Fingers attached to the back wall by performing the following steps:

a). Compare the contact fingers with Figure 2 below.

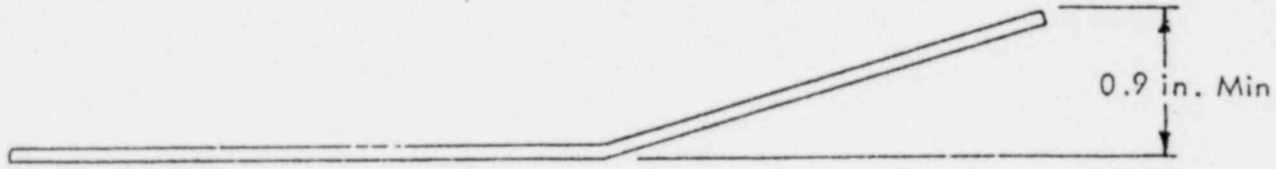


Figure 2

ATTACHMENT #6

DRAWN BY	DATE	TITLE Field Inspection of the Low and High Voltage Contact Fingers	99-0847
APPR BY	DATE	DEPT	
REVISION		BASLER ELEC. CO. HIGHLAND, ILL.	SHEET 4 OF 4

b). Replace the contact fingers if necessary by performing the following steps:

1). Remove two (2) bolts and associated hardware from each contact finger.

2). Install new contact fingers with original hardware.

12. Ensure door latching parts are clear of drawout area and re-install drawout assembly.

13. Re-install the ground bus (Ensure the three (3) High Voltage Contact Fingers are behind the ground bus).

14. Re-install door latching hardware and remove lifting chains.

15. Reconnect ground strap to upper right front corner of drawout assembly and carefully slide the drawout assembly into position.

16. Inspect cabinet and drawout area for foreign objects and dust accumulation.

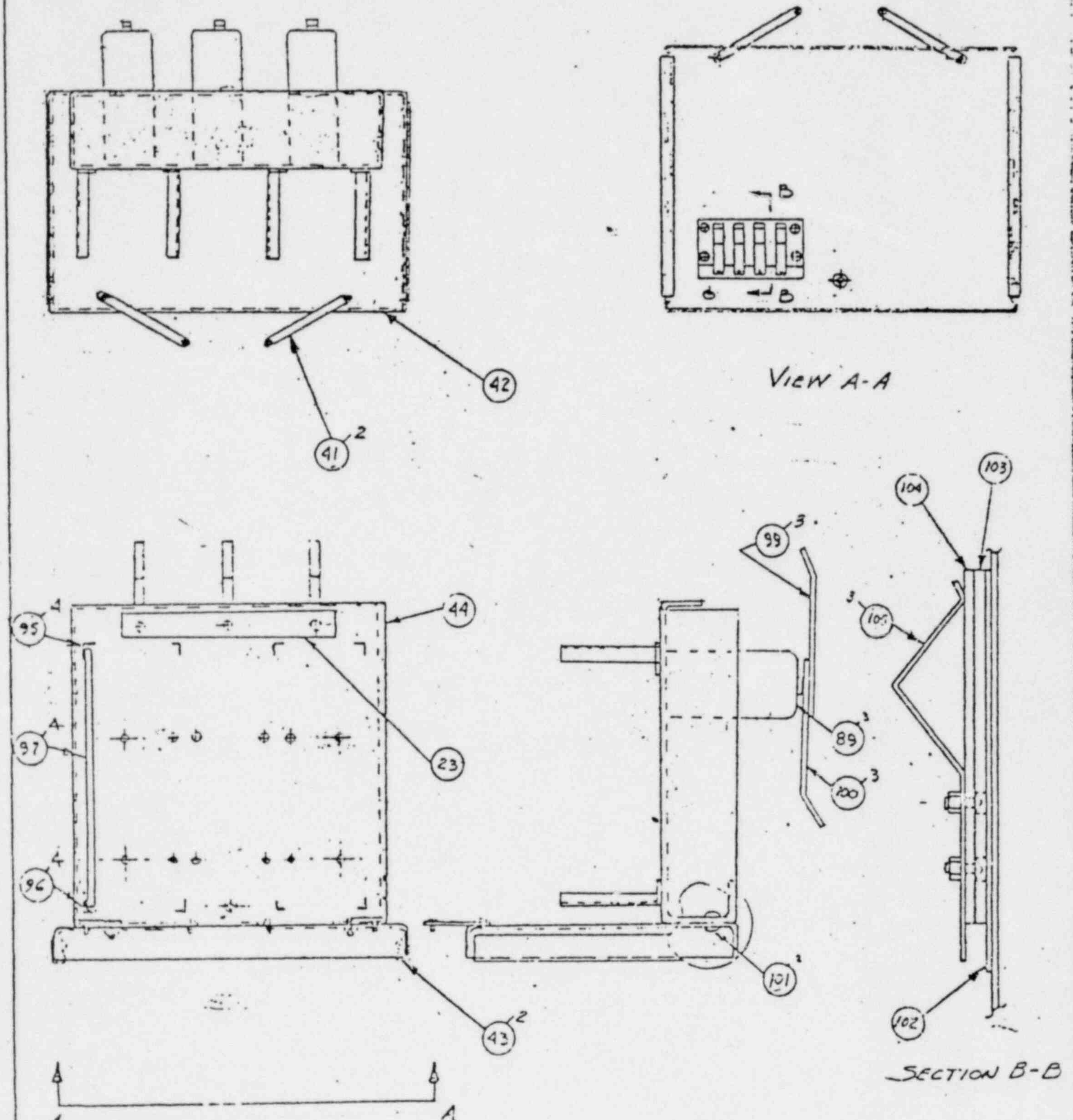
17. Secure and lock the drawout assembly doors.

18. Re-install the four (4) red bolts removed from the top panel of the low voltage compartment.

Attachments:

Drawing - C9 1157 15 100 (sheet 3)

ATTACHMENT #6



MODEL 100

DRAW OUT ASSY

TITLE CALCULATION REPORT

REACTION Ref: Welds at the J.B. Mount Ring	Vent Bending ± in-lb	Lateral Bending ± in-lb	Axial Thrust ± lbs	Vent Thrust ± lbs	Lateral Thrust ± lbs	Twist: ± in-lb
Max stress location or Type stress ...	12 & 6 o'clock	3 & 9 o'clock	uniform normal	vent shear	Lateral shear	torsional shear
SUBTOTALS Brought Forward..	11 806	22 719	1 559	882	1 559	1049
Elm 4 or 11 W = 83 lb						
W a = W(8.43)			700			
W (a × s)		29 387				
W m = W(8.43)					700	
W (m × l_w)		17 317				
W v = W(4.77)				396		
W (v × l_w)	9 799					
W (v × s)						16 628
Reaction TOTALS Ref Welds at the J.B. Mount Ring	21 605 ± in-lb.	69 423 ± in-lb	2 259 ± lbs	1 278 ± in-lb	2 259 ± lbs	17 677 ± in-lb

Seismic Reactions ~ Reference Welds at the Junction Box Mounting Ring, 12 inch Nozzles...

Calculated By CHARLES E. MARTIN Date MAY 1 9 1978

Checked By ______ Date ______