



LOUISIANA
POWER & LIGHT

142 DELARONDE STREET
P. O. BOX 6708 • NEW ORLEANS, LOUISIANA 70174 • (504) 366-2345

January 21, 1982

L. V. MAURIN
Vice President Nuclear Operations

W3P83-0251
A-A1.01.04
3-A20.08

Mr. Thomas H. Novak
Assistant Director for Licensing
U. S Nuclear Regulatory Commission
Washington, D. C. 20555

SUBJECT: Waterford SES 3
Docket No. 50-382
Formal submittal of follow up items from SQRT audit

Dear Mr. Novak:

Please find enclosed documentation of the progress and/or completion of all confirmatory items identified in the Seismic Qualification Review Team audit for Waterford 3 SES.

A review of these documents; as agreed upon in a January 18, 1983, telecon with Messrs. Jim Wilson, Jerry Jackson, and Jack Singh; should be sufficient to show that NSSS-PE-25, Boric Acid Tank Circulating Valve, is the only remaining confirmatory item.

Resolution of Generic Issues is in progress. Reports/Analyses pertaining to these issues will be submitted as they are completed.

If you have any questions, please advise.

Sincerely,

L. V. Maurin

LVM/SMJ/jcb

Attachments

cc: Jim Wilson, Jerry Jackson, Jack Singh (EG&G), E. L. Blake, W. M. Stevenson

8302030532 850121
PDR ADDCK 05000382
A PDR

Boo!
Limited Dist

bcc: (w/o Attachments): R. P. Barkhurst, F. J. Drummond, D. B. Lester,
T. E. Gerrets, G. B. Rogers, R. W. Prados, C. J. Decareaux, R. F. Bruski,
P. V. Prasankumar, J. R. McGaha, S. A. Alleman, G. R. Peeler,
T. K. Armington, K. R. Iyengar, M. I. Meyer, L. L. Bass, Richard Hymes,
M. G. Williams, S. M. Jones, Kanti Gala, H. B. Mulliken (CE), John Hart
(Ebasco), John Tompeck (Ebasco), John Zudans (NUS), Central Records,
Nuclear Records (3), Licensing Library

Before the

UNITED STATES NUCLEAR REGULATORY COMMISSION

DOCKET NO. 50-382

In the Matter of

LOUISIANA POWER & LIGHT COMPANY

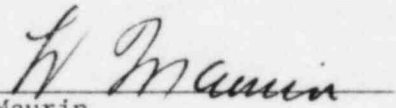
RESPONSE TO SORT ADIT

Louisiana Power & Light Company, Applicant in the above captioned proceeding,
hereby files a Response to Seismic Qualification Review Team Audit.

Respectfully submitted,

LOUISIANA POWER & LIGHT COMPANY

BY:


L.V. Maurin
Vice President
Nuclear Operations

DATE:

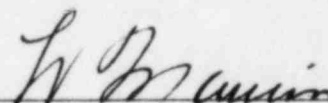
²⁵
1-24-83

STATE OF LOUISIANA)

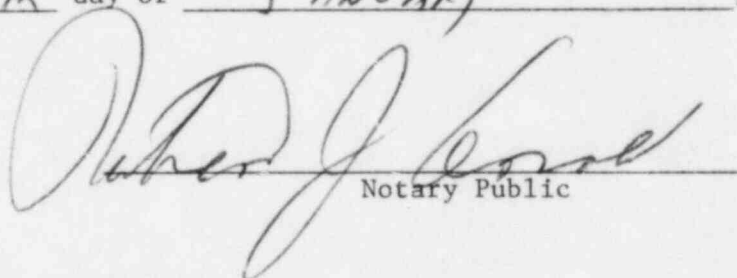
) SS

PARISH OF ORLEANS)

L. V. Maurin, being duly sworn, states that he is Vice President-Nuclear Operations of Louisiana Power & Light Company and that he is authorized on the part of said company to sign and file with the Nuclear Regulatory Commission this report.


L.V. Maurin

SUBSCRIBED AND SWORN to before me, a Notary Public, in and for the Parish and State above named, this 25th day of JANUARY, 1983.


Notary Public

MY COMMISSION EXPIRES:

WITH LIFE

"LIST OF ENCLOSURES"

<u>ENCLOSURE</u>	<u>ATTACHMENTS</u>	<u>CURRENT AS OF</u>
1	(1) Response to PE-31 (2) Response to BOP E-68	9/17/82
2	(1) Status of Confirmatory Items (2) Seismic Qualification Completion Schedule	10/4/82
3	(1) Seismic Qualification Completion Schedule	10/15/82
4	(1) Status of PE Confirmatory Items (2) Seismic Qualification Completion Schedule (3) Seismic Analyses of Muellor 3" Y-Type Strainer (4) ME-894 Certified Design Report of Horizontal Pump	11/10/82
5	(1) Status of PE Confirmatory Items (2) Seismic Qualification Completion Schedule	12/3/82
6	(1) Documentation of Telephone Conversation	1/18/83

CONFIRMATORY ITEMS

Item Description	SQRT NO.	Answered by
1. Control Components	BOP-E-68	Enclosure 1
2. Pressure Switch Low Oil Pressure Switch	NSSS-ICE-16 NSSS-PE-13	Enclosure 1
3. Boric Acid Make up Pump	NSSS-PE-14	Enclosure 2
4. Boric Acid Tank Circulating Valve	NSSS-PE-25	Response expected 1/24/83
5. Holdup Tank C	NSSS-PE-33	Modification in progress
6. Resister input card	NSSS-ICE-5a	Enclosure 3
7. 1151 Indicator	NSSS-ICE-8-1	Analysis in progress
8. CEDM Reed Switch Position	NSSS-ICE-15	Enclosure 2

NOTE: Items 1, 2, 3, and 8 closed by above mentioned telecon.
Generic Issue 5 (neglected nozzle loads in stress analysis) closed by telecon and Enclosure 5.

Documentation of Telephone Conversation, January 18, 1983 Enclosure 6

ENCLOSURE 1

SEISMIC QUALIFICATION REVIEW TEAM

RE-AUDIT FOLLOW UP

Attachment (1) LW3-1196-82
Attachment (2) LW3-1174-82

September 17, 1982

September 14, 1982

LW3- 1174-82

File: 7Q-C-5 (1-S-1)
7-D-1

Mr G B Rogers, Site Director
Louisiana Power & Light Company
P O Box B
Killona, Louisiana 70066

RE: WATERFORD SES UNIT NO. 3
SQRT AUDIT FOLLOW-UP CONFIRMATORY ITEMS -
BOP E-68

Ref: LP&L Seismic Qualification Audit - Summary sheet used at
NRC exit interview on September 3, 1982

Dear Mr Rogers:

Please transmit the following information to Mr R Macek of EG&G
with regards to BOP Item E-68:

Via telephone conversation with Mr W W Schaff of Dayton T Brown
Labs, Inc., Ebasco was advised that all control components tested
did pass the seismic testing program. The anomalies noted were
not malfunctions as all components were operable during and after
the seismic testing and this determines whether or not the item
is seismically qualified.

If you have any questions, please contact A DeVito on (212) 839-3861.

Very truly yours,

R K Stampley
R K Stampley
Project Manager

AD:as

cc: Central Records - W3 (2)
Nuclear Records - G0 (2)
D C Gibbs
L V Maurin

RECEIVED
NUCLEAR RECORDS

SEP 22 1982

ILN: 82-5162

EBASCO SERVICES INCORPORATED

EBASCO

Two World Trade Center, New York, N.Y. 10048

September 17, 1982
LW3-1196-82
File: 2Q-A-3C

Mr G B Rogers, Site Director
Louisiana Power & Light Company
P O Box B
Killona, Louisiana

SUBJECT: WATERFORD SES UNIT NO. 3
SQRT AUDIT - RESPONSE TO CONFIRMATORY ITEM
PE-31 FROM ORIGINAL SEPTEMBER, 1981 AUDIT

Ref: 1. C-CE-7358, dated 10-26-81
2. LW3-120-82, dated 2-2-82
3. C-CE-7541, dated 2-24-82

Dear Mr Rogers:

The NRC and their consultant EG&G decided during the audit held August 31-September 3, 1982 that the subject confirmatory item would have to be reviewed by EG&G's INEL group to close out this item. The information provided below should be forwarded to EG&G to assist them in that review.

In Reference 1, it was proposed by CE to eliminate the charging pump lube oil switch from the protective circuit of that pump on account of their inability to establish seismic qualification for the pressure switch. In the same referenced letter, it was assumed that the pressure switch would develop a chatter in its contact during the seismic event that will result in automatic tripping of the pump.

Our detailed review of the charging pump protective circuit indicates that it is not necessary to expose the charging pump to the damage on loss of lube oil, through elimination of pressure switch, since the circuitry is of such a nature that the chattering contact, due to the seismic event, will not be able to trip the charging pump.

Our reasoning in arriving to that conclusion is as outlined below:

Please refer to the attached Control Wiring Diagram Dwg No. LOU 1564B-424, Sheet E365.

RECEIVED
NUCLEAR RECORDS

SEP 28 1982

ILN: 82-5250

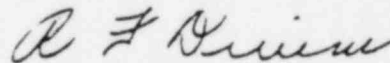
The N.O. contact of lube oil pressure switch is closed when lube oil pressure is normal and is keeping coil of relay PX continuously energized. On loss of lube oil pressure, the pressure switch contact will drop off the relay PX, and provided the charging pump is in operation, will energize the coil of time delay relay 2-2. A time delay of up to 15 seconds may be established on relay 2-2 before it will pick up and close a contact to trip the charging pump. This time delay of between 10 and 15 seconds will be a positive indication that the contact on lube oil pressure switch opened because of loss in pressure rather than because of chatter.

Furthermore, we have suggested that the wiring of the tripping contact 2-2 be modified to connect contact 2-2 in series with N.O. of SIS relay, this will prevent 2-2 from tripping the charging pump during the emergency operation, at the same time we will not suspend the protective function of the lube oil pressure switch. The existing lube oil pressure low alarm remains active during normal and emergency operation of the charging pump.

The above reasoning was reviewed and concurred to by CE in their Reference 3 letter.

If you have any questions, please advise.

Very truly yours,



be R K Stampley
Project Manager

RKS:JKT:as

cc: Central Records - W3 (2)
Nuclear Records - G0 (2)
D C Gibbs
L V Maurin
M Williams (LP&L)

5. BC 10. 10

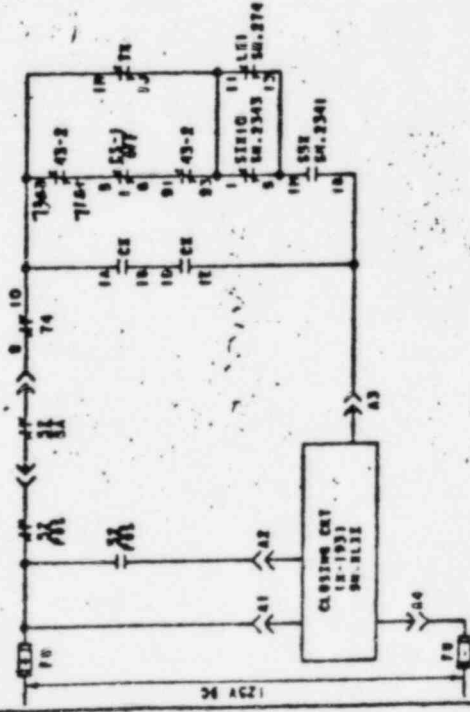
**MASTER
COPY**

23-100700

CONTACTS	POSITION				COP SH.
	STOP	12 MORN	START		
			9	3	
1-2	X				
3-4				X	
5-6				X	
7-8	X				

SPRING RETURN TO NORMAL

I & C DESIGN DB:
 RECEIVED
 JAN 10 1980



LOUISIANA POWER & LIGHT CO.
BATERFORD S.E. 3. UNIT NO. 3
CONTROL WIRING DIAGRAM

ENCLOSURE 2

SEISMIC QUALIFICATION REVIEW TEAM

RE-AUDIT FOLLOW UP

Attachment (1) Status of Confirmatory Items
Attachment (2) Seismic Qualification Completion
Schedule

October 4, 1982

Revision 1
10/15/82

NSSS-ICE

SEISMIC QUALIFICATION
COMPLETION SCHEDULE

P.O./SPEC	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
9403341 (P.O.) 9270-ICE-0005 Rev.01 (Spec.)	See attachment A1	NSSS-ICE-5 NSSS-ICE-5a thru 5h	Equipment has been qualified according to vendor (Westinghouse). Proprietary reports will be released to LP&L pending resolution of proprietary agreement between Westinghouse and LP&L. (See C-CE-7987 of 10/4/82)	Equipment installed
same P.O. and Spec. as above	See attachment A2	NSSS-ICE-9-1 NSSS-ICE-9-2	Original seismic test (Westinghouse # EL991) not approved- Westinghouse resubmitted with new test report (#EL1348) C-E technical review completed but administrative work not completed. QTR-1010 and QTR-1008 should replace EL991 as the applicable qualification references for the Veri-Trak Recorders. EL1348 is contained in QTR-1010. Retesting by Westinghouse is required. Testing completion is scheduled for May 1, 1983.	Equipment installed.

NSSS-
Plant Engineering (PE)

SEISMIC QUALIFICATION
COMPLETION SCHEDULE

P.O./SPEC	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
910204 9270-PE 704 Rev 04	BM 307 (CE Tag) Fisher 3" valve	NSSS-PE-36 Rev 1	Oct. 30, 1982	
9102040 9270-PE 704 Rev. 04	CH 210 Y Fisher 1" valve	NSSS-PE-26 Rev 1	Oct. 30, 1982	
9102040 9270-PE 704, Rev. 04	CH 512 Fisher 3" Valve	NSSS-PE-27 Rev 1	Oct. 30, 1982	
9204018 9270-PE 404 Rev. 2	Fuel Pool Pump	NSSS-PE-38	Jan. 1, 1983	
Not Available	3" "Y" Type Strainer	NSSS-PE-16	Oct. 30, 1982	

SEISMIC QUALIFICATION
COMPLETION SCHEDULE

P.O./SPEC	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
403641	FE-HV 5294S 5294S 5295S (Air Flow Measuerment station-Pitot Tube)	File no not assigned	Revised Test Report expected by 11/15/82.	Installed
403485	See attachment A3	SQ-IC-4 SQ-IC-4A	Report received. Review in progress.	Installed
403642	See attachment A4	SQ-IC-4B	By 9/83	Installed

BOP-Electrical

SEISMIC QUALIFICATION COMPLETION SCHEDULE

P.O./SPEC	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
403657 LOU 1564 279C	(1) 120V & 125 VDC POP's 390-SA; 391-SB 394-SA; 395-SB 3A1-DC-S 3B1-DC-S	SQ-E-15	Received copy of Seismic Report 8/20/82. To be reviewed for approval. Review in progress.	Installed
	(2) Battery Disconnect Panels 3A-S 3B-S 3AB-S	SQ-E-15A	Received report approval letter not written - will be complete by 9/15/82 - Complete	Installed
403659 LOU 1564-99D	Refueling Disconnect Assemblies; Reactor Vessel Head Assemblies; Cable Seal Assemblies	SQ-E-86	Received copy of report from BIW. SAG group reviewed with comments on 8/25. To resolve open items before report is accepted	Installed

SEISMIC QUALIFICATION
COMPLETION SCHEDULE

BOP - Mechanical

P.O./SPEC	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
NT-403458 LOU-1564099A 267	2CS-V311 2CS-V312	No File Established Yet " "	Schedule for report submittal by 9/10/82 Certification Received. Review in Progress.	

**SEISMIC QUALIFICATION
COMPLETION SCHEDULE**

BOP - Mechanical

P.O./SPEC	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
NY-403501 LOU-1564.102				
1	5MS-V650 (8)	No File Established Yet	Report SR-6684 R2 has been reviewed with comments. Awaiting supplier response.	
3	5MS-V652 (2)	"		
53	3EG-V616B	"		
265	5FW-V1522	"		
352	6AC-V721	"		
395	3AE-V615	"		
421	3CC-V642 (4)	"		
444	5FW-V1522 (g)	"		
447	2FW-V1531 (6)	"		
494	3AC-V778A	"		
	3AC-V779A	"		
	3AC-V780A/B	"		
	3AC-V781A/B	"		
	3AC-V782	"		
	3AC-V783	"		
498	2CC-V652 (14)	"		

BOP - Mechanical

SEISMIC QUALIFICATION COMPLETION SCHEDULE

P.O./SPEC	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
577	6AC-V785 6XX-V316 V317 V318 V319 V320 V321	No File Established Yet " " " " " "	Report has been reviewed with comments " " " " " "	
578	7CF-V640 7CF-V642 7XX-V322	" " "	" " "	
628	2MS-V1524 (8)	"	"	
629	3NG-V684 (8) 3IA-V613 3IA-V611	" " "	" " "	
630	3AC-V809 (g)	"	"	
631	2XX-V700 thru V809 (110)	" "	" "	
632	2XX-V810 thru V849 (40)	" "	" "	
633	2XX-V850 thru V-860 (10)	" "	" "	
634	2XX-V860 thru V-863 (4)	" "	" "	

BOP - Mechanical

SEISMIC QUALIFICATION COMPLETION SCHEDULE

P.O./SPEC / Item	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
NY-403506 LOU-1564.083B				
246	ISI-V2510 (2)	No File Established Yet	Report has been reviewed with	
247	ISI-V1592 (6)	"	comments "	
248	2CH-V1530	"	"	
249	2CH-V1542	"	"	
250	2XX-V500 (59)	"	"	
	thru V558	"	"	
251	2XX-V559	"	"	
	thru V583	"	"	
252	1XX-V900 (27)	"	"	
	thru V926	"	"	
NY-403522 LOU-1564.103A				
219A	3WM-V223 (2)	No File Established Yet	Seismic report received.	
226A	3WM-V224	"	Review in progress.	

**SEISMIC QUALIFICATION
COMPLETION SCHEDULE**

BOP - Mechanical

P.O./SPEC	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
NY-403572 LOU-1564.089A 5	Dry Clg. Twr. Area Sump Pump Motors (2)	No File Established Yet	Report being reviewed.	

**SEISMIC QUALIFICATION
COMPLETION SCHEDULE**

BOP - Mechanical

P.O./SPEC Item	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
NY-403661 LOU-1564.105A 1	2MS-R613A 2MS-R614A 2MS-R615A 2MS-R616A 2MS-R617A 2MS-R618A 2MS-R619B 2MS-R620B 2MS-R621B 2MS-R622B 2MS-R623B 2MS-R624B	No File Established	Report being reviewed.	
NY-403674 LOU-1564.068 5	2SI-E1587A 2SI-E1588B	No File Established "	Report being reviewed. "	

SYSTEM: Plant Protection

<u>ITEM</u>	<u>TAG OR IDENTIFICATION</u>	<u>EQUIPMENT AVAILABILITY FOR INSPECTION IN FIELD</u>	<u>SQ REPORT FILE NO.</u>	<u>ACCESSORIES</u>
16	CPC/CEAC Central Processing Unit	Later	NSSS-ICE-2b	
17	CPC/CEAC MACS Chassis	Later	NSSS-ICE-2c	
18	CPC/CEAC Power Supply	Later	NSSS-ICE-2d	
19	CEA Position Isolation Amplifiers	Later	NSSS-ICE-2e	
20	SY-103A, B, C, D	Yes	NSSS-ICE-2f	
21	RY-010A, B, C, D	Later	NSSS-ICE-2g	
22	Reactor Trip Switchgear Cabinet	Yes	NSSS-ICE-3	
23	ESFAS Auxiliary Relay Cabinet	Yes	NSSS-ICE-4	
24	Process Instrument Rack	Yes	NSSS-ICE-5	
25	TY-112CA-1/TY-112HA-1/ TY-122CA-1/TY-122HA-1/ PY-1013A-1/PY-1013A-2/ PY-1023A-1/PY-1023A-2/ LY-305A-1/PY-352A-1/SPARES PY-101A-1/PY-101A-2/ PY-102A-1/PY-102A-2/ LY-1113A-1/LY-1113A-2/ LY-1123A-1/LY-1123A-2/ PY-351A-1/SPARES TY-112CB-1/TY-112HB-1/ TY-122CB-1/TY-122HB-1/ PY-1013B-1/PY-1013B-2/ PY-1023B-1/PY-1023B-2/ PY-101B-1/PY-101B-2/ PY-102B-1/PY-102B-2/ LY-1113B-1/LY-1113B-2/ LY-1123B-1/LY-1123B-2/ PY-351B-1/SPARES TY-112CC-1/TY-112HC-1/ TY-122CC-1/TY-122HC-1/	Yes	NSSS-ICE-5a	

SYSTEM: Plant Protection

<u>ITEM</u>	<u>TAG OR IDENTIFICATION</u>	<u>EQUIPMENT AVAILABILITY FOR INSPECTION IN FIELD</u>	<u>SQ REPORT FILE NO.</u>	<u>ACCESSORIES</u>
25 (Cont'd)	PY-101C-1/PY-101C-2/ PY-102C-1/PY-102C-2/ LY-305C-1/PY-352C-1/SPARES PY-1013C-1/PY-1013C-2/ PY-1023C-1/PY-1023C-2/ LY-1113C-1/LY-1113C-2/ LY-1123C-1/LY-1123C-2/ PY-351C-1/SPARES TY-112CD-1/TY-112HD-1/ TY-122CD-1/TY-122HD-1/ PY-1013D-1/PY-1013D-2/ PY-1023D-1/PY-1023D-2/ LY-305D-1/PY-352D-1/SPARES PY-101D-1/PY-101D-2/ PY-102D-1/PY-102D-2/ LY-1123D-1/LY-1123D-2 PY-351D-1/SPARES	Later		
26	TY-303X, TY-303Y, TY-351X, TY-352X, TY-351Y, TY-352Y	Later	NSSS-ICE-5b	
27	TY-112CA, TY-112CB, TY-112CC, TY-112CD, TY-122CA, TY-122CB, TY-122CC, TY-122CD, TY-112HA, TY-112HB, TY-112HC, TY-112HD, TY-122HA, TY-122HB, TY-122HC, TY-122HD, PY-101A, PY-101B, PY-101C, PY-101D, PY-103, PY-104, PY-303X, PY-303Y, PY-102A, PY-102B, PY-102C, PY-102D, LY-305A, LY-305B, LY-305C, LY-305D, PY-1013A, PY-1013B, PY-1013C, PY-1013D, PY-1023A, PY-1023B, PY-1023C, PY-1023D, LY-1113A, LY-1113B, LY-1113C, LY-1113D, LY-1123A, LY-1123B, LY-1123C, LY-1123D, LY-110X, LY-110Y, PY-105, PY-106, PY-351A, B, C, D PY-352A, B, C, C	Later	NSSS-ICE-5c	

SYSTEM: Plant Protection

<u>ITEM</u>	<u>TAG OR IDENTIFICATION</u>	<u>EQUIPMENT AVAILABILITY FOR INSPECTION IN FIELD</u>	<u>SQ REPORT FILE NO.</u>	<u>ACCESSORIES</u>
28	JC-002A/JC-002A-1/ PC-103/PC-103-1/SPARE/ PSFA-A, JC-002B/JC-002B-1/ PC-104/PC-104-1/SPARE/PSFA-B JC-002C/JC-002C-1/PC-105/ SPARE/SPARE/PSFA-C, JC-002D/ JC-002D-1/PC-106/SPARE/SPARE/ PSFA-D	Later	NSSS-ICE-5d	
29	JA-002A/JA-002A-1 JA-002B/JA-002B-1 JA-002C/JA-002C-1 JA-002D/JA-002D-1	Later	NSSS-ICE-5e	
30	PA-103/PA-103-1, PA-105 PA-104/PA-104-1, PA-106	Later	NSSS-ICE-5f	
31	TY-351X-1, TY-351Y-1, TY-303X-1, TY-303Y-1 PY-1023A-3, PY-1023A-4 LY-110Y-1, LY-101Y-2 PY-1013B-3, PY-1013B-4 TY-352Y-1, TY-352X-1, PY-102A-3, PY-102A-4 LY-1113A-3, LY-1113A-4 JY-001A, JY-001A-1 PY-102B-3, PY-103B-4 PY-1013A-3, PY-1013A-4 LY-1123B-3, LY-1123B-4	Later	NSSS-ICE-5g	
32	JY-001C, JY-001D JY-002A, JY-002A-1 LY-1123A-3, LY-1123A-4 LY-110X-1, LY-110X-2 LY-113B-3, LY-113B-4 PY-1023B-3, PY-1023B-4 JY-002B, JY-002B-1 JY-002C, JY-002C-1 JY-002D, JY-002D-1	Later	NSSS-ICE-5h	

LOUISIANA POWER & LIGHT COMPANY
WATERFORD SES UNIT NO. 3
SEISMIC QUALIFICATION SUMMARY

SYSTEM: Nuclear Instrumentation

<u>ITEM</u>	<u>TAG OR IDENTIFICATION</u>	<u>EQUIPMENT AVAILABILITY FOR INSPECTION IN FIELD</u>	<u>SQ REPORT FILE NO.</u>	<u>ACCESSORIES</u>
1	J1-RC-0003A J1-RC-0004A J1-RC-0003B J1-RC-0004B J1-RC-0003C J1-RC-0004C J1-RC-0003D J1-RC-0004D J1-RC-0001A J1-RC-0001B J1-RC-0001C J1-RC-0001D	Yes	NSSS-ICE-8-2	
2	JR-RC-0002A JR-RC-0002B JR-RC-0002C JR-RC-0002D	Yes	NSSS-ICE-9-1	
3	JR-RC-0001	Yes	NSSS-ICE-9-2	
4	Nuclear Instrument Detector	Later	NSSS-ICE-13	
5	Nuclear Instrument Preamplifier	Later	NSSS-ICE-14	

LOUISIANA POWER & LIGHT COMPANY
WATERFORD SES UNIT NO. 3
SEISMIC QUALIFICATION SUMMARY

SYSTEM: Reactor Coolant

<u>ITEM</u>	<u>TAG OR IDENTIFICATION</u>	<u>EQUIPMENT AVAILABILITY FOR INSPECTION IN FIELD</u>	<u>SQ REPORT FILE NO.</u>	<u>ACCESSORIES</u>
1	TT-112CA, CB, CC, CD TT-122CA, CB, CC, CD TT-112HA, HB, HC, HD TT-122HA, HB, HC, HD	No	NSSS-ICE-51	
2	PI-101A, PI-101B, PI-101C PI-101D, LI-110X, LI-110Y	Yes	NSSS-ICE-8-1	
3	TI-102HA, TI-102HB, TI-102HC, TI-102HD TI-102CA, TI-102CB TI-102CC, TI-102CD PI-102A, PI-102B, PI-102C, PI-102D	Yes	NSSS-ICE-8-2	
4	TR-102HA, TR-102CA	Yes	NSSS-ICE-9-1	
5	LR-110X, PR-102A	Yes	NSSS-ICE-9-2	
6	TE-111X, TE-121X TE-112CA, CB, CC, CD TE-122CA, CB, CC, CD TE-112HA, HB, HC, HD TE-122HA, HB, HC, HD	Yes	NSSS-ICE-10-1	
7	PT-100X, Y PT-101A, B, C, D PT-102A, B, C, D PT-103, 105	Yes	NSSS-ICE-11-1	
8	LT-110X, Y	Yes	NSSS-ICE-11-2	
9	PT-104, 106	Yes	NSSS-ICE-11-6	
10	PS-224X, Y, Z	Yes	NSSS-ICE-16	

SPECIFICATION: 1564.421
PURCHASE ORDER: NY 403485
VENDOR: ITT BARTON

Attachment A3

SHEET 1 OF 10

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LWJ ACCEPTANCE NO.	TAG NO.
B6	Flow Indicating Switch	SQ-IC-4 SQ-IC-4A	Qualification Testing in Progress Test Report R3-580-1 R3-288A-1	LWJ-1855-79 (Waiver) LWJ-1345-81 December 24, 1981 LWJ-818-80 August 12, 1980	FIS-FW-8331-AS
B7	"	"	"	"	FIS-FW-8331 BS
A66	"	"	"	"	FIS-FW-8330 AS
A67	"	"	"	"	FIS-FW-8330 BS
A8	Differential Pressure Indicating Switch	"	"	"	DPIS-FW-8320 AS
A9	"	"	"	"	DPIS-FW-8320 BS
A10	"	"	"	"	DPIS-HV-5051 AS
A11	"	"	"	"	DPIS-HV-5051 BS
A12	"	"	"	"	DPIS-HV-5055 AS
A13	"	"	"	"	DPIS-HV-5055 BS
A14	"	"	"	"	DPIS-HV-5056 AS

SPECIFICATION: 1564.421
PURCHASE ORDER: NY 403485
VENDOR: ITT BARTON

SHEET 2 OF 10

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LW3 ACCEPTANCE NO.	TAG NO.
A15	Differential Pressure Indicating Switch	SQ-1C-4 SQ-1C-4A	Qualification Testing in Progress Test Report R3-580-1 R3-288A-1	LW3-1855-79 (Waiver) LW3-1345-81 December 24, 1981 LW3-818-80 August 12, 1980	DPIS-HV-5050 BS
A16	"	"	"	"	DPIS-HV-5061 AS
A17	"	"	"	"	DPIS-HV-5061 BS
A18	"	"	"	"	DPIS-HV-5220 AS
A19	"	"	"	"	DPIS-HV-5220 BS
A20	"	"	"	"	DPIS-HV-5221 AS
A21	"	"	"	"	DPIS-HV-5221 BS
A22	"	"	"	"	DPIS-HV-5257 AS
A23	"	"	"	"	DPIS-HV-5257 BS
A28	Flow Indicating Switch	"	"	"	FIS-AC-5001 S
A29	"	"	"	"	FIS-AC-5002 S

SPECIFICATION: 1564.421
PURCHASE ORDER: NY 403485
VENDOR: ITT BARTON

SHEET 3 OF 10

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LW3 ACCEPTANCE NO.	TAG NO.
A30	Flow Indicating Switch	SQ-IC-4 SQ-IC-4A	Qualification Testing in Progress Test Report R3-580-1 R3-288A-1	LW3-1855-79 (Waiver) LW3-1345-81 December 24, 1981 LW3-818-80 August 12, 1980	FIS-AC-5004-S
A31	"	"	"	"	FIS-AC-5006 S
A32	"	"	"	"	FIS-AC-5010 S
A33	"	"	"	"	FIS-AC-5011 S
A34	"	"	"	"	FIS-AC-5012 S
A35	"	"	"	"	FIS-AC-5013 S
A36	"	"	"	"	FIS-AC-5030 AS
A37	"	"	"	"	FIS-AC-5030 BS
A38	"	"	"	"	FIS-AC-5030 CS
C1	"	"	"	"	FIS-AC-5040 AS
C2	"	"	"	"	FIS-AC-5040 BS

SPECIFICATION: 1564.421
PURCHASE ORDER: NY 403485
VENDOR: ITT BARTON

SHEET 4 OF 10

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LW3 ACCEPTANCE NO.	TAG NO.
A39	Flow Indicating Switch	SQ-IC-4 SQ-IC-4A	Qualification Testing in Progress Test Report R3-580-1 R3-288A-1	LW3-1855-79 (Waiver) LW3-1345-81 December 24, 1981 LW3-818-80 August 12, 1980	FIS-CC-5070 AS
A40	"	"	"	"	FIS-CC-5070 BS
A41	"	"	"	"	FIS-CC-5070 CS
A42	"	"	"	"	FIS-CC-5770 AS
A43	"	"	"	"	FIS-CC-5770 AIS
A44	"	"	"	"	FIS-CC-5770 A2S
A45	"	"	"	"	FIS-CC-5770 BS
A46	"	"	"	"	FIS-CC-5770 B1S
A47	"	"	"	"	FIS-CC-5770 B2S
A48	"	"	"	"	FIS-CC-5770 CS
A4	"	"	"	"	FIS-CC-5770 C1S

SPECIFICATION: 1564.421
PURCHASE ORDER: NY 403485
VENDOR: ITT BARTON

SHEET 5 OF 10

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LW3 ACCEPTANCE NO.	TAG NO.
A50	Flow Indicating Switch	SQ-IC-4 SQ-IC-4A	Qualification Testing in Progress Test Report RJ-580-1 RJ-288A-1	LW3-1855-79 (Waiver) LW3-1345-81 December 24, 1981 LW3-818-80 August 12, 1980	FIS-CC-5770 C2S
A51	"	"	"	"	FIS-CC-5770 DS
A52	"	"	"	"	FIS-CC-5770 D1S
A53	"	"	"	"	FIS-CC-5770 D2S
A80	Level Switch	"	"	"	LS-MS-0311 S
A81	"	"	"	"	LS-MS-0312 AS
A82	"	"	"	"	LS-MS-0312 BS
A83	"	"	"	"	LS-MS-0313 AS
A84	"	"	"	"	LS-MS-0313 BS
C3	Pressure Switch	"	"	"	PS-NC-0940 AS
C4	"	"	"	"	PS-NC-0941 BS

SPECIFICATION: 1564.421
PURCHASE ORDER: NY 403485
VENDOR: ITT BARTON

SHEET 6 OF 10

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LW3 ACCEPTANCE NO.	TAG NO.
C5	Pressure Switch	SQ-1C-4 SQ-1C-4A	Qualification Testing in Progress Test Report R3-580-1 R3-288A-1	LW3-1855-79 (Waiver) LW3-1345-81 December 24, 1981 LW3-818-80 August 12, 1980	PS-NG-0942 AS
C6	"	"	"	"	PS-NG-0943 BS
C7	"	"	"	"	PS-NG-0944 AS
C8	"	"	"	"	PS-NG-0945 BS
C9	"	"	"	"	PS-NG-0946 AS
C10	"	"	"	"	PS-NG-0947 BS
E1	"	"	"	"	PS-CC-3081
E2	"	"	"	"	PS-CC-3082
E3	"	"	"	"	PS-CC-3083 A
E4	"	"	"	"	PS-CC-3083 B
E5	"	"	"	"	PS-CC-3083 C

SPECIFICATION: 1564.421
 PURCHASE ORDER: NY 40348
 VENDOR: ITT BARTON

SHEET 7 OF 10

NO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LW3 ACCEPTANCE NO.	TAG NO.
E6	Pressure Switch	SQ-IC-4 SQ-IC-4A	Qualification Testing in Progress Test Report R3-580-1 R3-288A-1	LW3-1855-79 (Waiver) LW3-1345-81 December 24, 1981 LW3-818-80 August 12, 1980	PS-CC-3083 D
E7	"	"	"	"	PS-CC-3084 A
E8	"	"	"	"	PS-CC-3084 B
E9	"	"	"	"	PS-CC-3084 C
E10	"	"	"	"	PS-CC-3084 D
E11	"	"	"	"	PS-CC-3086
E12	"	"	"	"	PSIA-9740 A
E13	"	"	"	"	PSIA-9740 B
1	Level Indicator	"	"	"	LI-CS-7123 AS
2	"	"	"	"	LI-CS-7123 BS

SPECIFICATION: N: 1564.421
 PURCHASE ORDER: NY 403485
 VENDOR: ITT BARTON

SHEET 8 OF 10

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LW3 ACCEPTANCE NO.	TAG NO.
A57	Flow Indicating Switch	SQ-IC-4 SQ-IC-4A	Qualification Testing in Progress Test Report R3-580-1 R3-288A-1	WJ-1855-79 (Waiver) LW3-1345-81 December 24, 1981 LW3-818-80 August 12, 1980	FIS-CC-7651 AS
A58	"	"	"	"	FIS-CC-7651 BS
A59	"	"	"	"	FIS-CC-7750 AS
A60	"	"	"	"	FIS-CC-7750 BS
A61	"	"	"	"	FIS-CC-7850 AS
A62	"	"	"	"	FIS-CC-7850 BS
A63	"	"	"	"	FIS-CC-7850 CS
A64	"	"	"	"	FIS-CD-2202 A
A65	"	"	"	"	FIS-CD-2202 B
	Pressure Switch	"	"	"	PS-SI-3149 A
	"	"	"	"	PS-SI-3149 B

SPECIFICATION: 1564.421
PURCHASE ORDER: NY 403485
VENDOR: ITT BARTON

SHEET 9 OF 10

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LW3 ACCEPTANCE NO.	TAG NO.
	Pressure Switch	SQ-1G-4 SQ-1C-4A	Qualification Testing in Progress Test Report R3-580-1 R3-288A-1	LW3-1855-79 (Waiver) LW3-1345-81 December 24, 1981 LW3-818-80 August 12, 1980	PS-SI-3148 A
	"	"	"	"	PS-SI-3148 B
	"	"	"	"	PS-CH-0206
	"	"	"	"	PS-CH-0208
	"	"	"	"	PS-CH-0224 X
	"	"	"	"	PS-CH-0224 Y
	"	"	"	"	PS-CH-0224 Z
	"	"	"	"	PS-CH-0229 X
	"	"	"	"	PS-CH-0229 Y
	"	"	"	"	PS-CH-0229 Z
	"	"	"	"	PS-CH-0234 X

SPECIFICATION: 1564.421
PURCHASE ORDER: NY 403485
VENDOR: ITT BARTON

SHEET 10 OF 10

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LW3 ACCEPTANCE NO.	TAG NO.
	Pressure Switch	SQ-IC-4 SQ-IC-4A	Qualification Testing in Progress Test Report R3-580-1 R3-288A-1	LW3-1855-79 (Waiver) LW3-1345-81 December 24, 1981 LW3-818-80 August 12, 1980	PS-CH-0234 Y
	"	"	"	"	PS-CH-0234 Z
	"	"	"	"	
	"	"	"	"	
D3	"	"	"	"	PS-CC-7032 A
D4	"	"	"	"	PS-CC-7032 B
D45	"	"	"	"	PS-SI-7140 AS
D46	"	"	"	"	PS-SI-7140 BS
E3	Level Switch	"	"	"	LS-EG-1979 AS
E4	"	"	"	"	LS-EG-1979 BS

SPECIFICATION 1564.402A
 PURCHASE ORDER: NY 403642
 VENDOR: ITT BARTON

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LW3 ACCEPTANCE NO.	TAG NO.
A01	Low Differential Pressure Transmitter	SQ-IC-49	Qualification Testing in Progress Seismic Qualif. Test Procedure Code IND N05991 Document Number 999.5002.2	Attachment to Letter LW3-111-78	DPT-HV-5067 AS
A02	"	"	"	"	DPT-HV-5067 BS
A03	"	"	"	"	DPT-HV-5068 AS
A04	"	"	"	"	DPT-HV-5068 BS
A05	"	"	"	"	DPT-HV-5105 AS
A06	"	"	"	"	DPT-HV-5105 BS
A09	"	"	"	"	DPT-HV-5270
A10	"	"	"	"	DPT-HV-5271 AS
A11	"	"	"	"	DPT-HV-5271 BS
A12	"	"	"	"	DPT-HV-5272 AS

SPECIFICATION: 1564.402A
PURCHASE ORDER: NY 403642
VENDOR: ITT BARTON

SHEET 2 OF 3

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LWJ ACCEPTANCE NO.	TAG NO.
A13	Low Differential Pressure Transmitter	SQ-IC-4B	Qualification Testing in Progress Seismic Qualif. Test Procedure Code IND N05991 Document Number 999.5002.2	Attachment to Letter LWJ-111-78	DPT-HV-5272 BS
A14	"	"	"	"	DPT-HV-5273 AS
A15	"	"	"	"	DPT-HV-5273 BS
A16	"	"	"	"	DPT-HV-5274 AS
A17	"	"	"	"	DPT-HV-5274 BS
A18	"	"	"	"	DPT-HV-5275 AS
A19	"	"	"	"	DPT-HV-5275 BS
A20	"	"	"	"	DPT-HV-5276 AS
A21	"	"	"	"	DPT-HV-5276 BS
A22	"	"	"	"	DPT-HV-5277 AS

SPECIFICATION: 1564.402A
PURCHASE ORDER: NY 403642
VENDOR: ITT BARTON

SHEET 3 OF 3

PO ITEM NO.	GENERAL DESCRIPTION OF EQUIPMENT	SQRT FILE NO.	VENDOR SEISMIC REPORT NO.	LW3 ACCEPTANCE NO.	TAG NO.
A23	Low Differential Pressure trans- mitter	SQ-1C-4B	Qualification Testing in Progress Seismic Qualif. Test Procedure Code IND N05991 Document Number 999.5002.2	Attachment to Letter LW3-111-78	DPT-HV-5277 BS
A24	"	"	"	"	FT-HV-5065 AS
A25	"	"	"	"	FT-HV-5065 BS
A26	"	"	"	"	FT-HV-5066 AS
A27	"	"	"	"	FT-HV-5066 BS
A28	"	"	"	"	FT-HV-5294 S

ENCLOSURE 3

SEISMIC QUALIFICATION REVIEW TEAM

RE-AUDIT FOLLOW UP

Attachment (1) Seismic Qualification Completion Schedule

October 15, 1982

RESPONSE TO CE/PLANT ENGINEERING
CONFIRMATORY ITEMS FROM WATERFORD UNIT #3
SQRT RE-AUDIT

ITEM	COMMENTS/RESPONSE
GENERIC	<u>Comment:</u>
	It was noticed that during the review of NSSS-PE-10 (Deborating Ion Exchanger), NSSS-PE-15 (Purification Filter) and NSSS-PE-33 (Holdup Tank), nozzle loads were negelected in the stress analysis. This seems to be a generic pattern.
	<u>Response</u>
	Nozzle loads for this equipment (seismic category tanks, HXS, Filters and Ion Exchangers) were originally simulated in the seismic analyses by increasing the sesimic accelleration loading imposed on these components. This simulation was considered to be conservative because the component supports were judged to be more highly loaded than they would be if the appropriate seismic and nozzle loads were considered. In response to the SQRT audit concern, a follow-on effort has been initiated to confirm that the original approach was conservative. All of the design reports for the applicable CE equipment have been reviewed and nozzle loads have been directly evaluated to determine their effect on component supports. In all cases, the original support loadings were more severe. All components are also being evaluated to confirm that nozzle-to-shell juncture stresses are within acceptable levels. This effort will be completed shortly and the results of the evaluation will be forwarded.
GENERIC	<u>Comment</u>
	Status of equipment not yet seismically qualified and their qualification schedule should be provided to NRC. This status should be submitted monthly until completion of qualification of all safety related equipment.
	<u>Response</u>
	Status is given on Attachment (2)

ITEM	COMMENTS/RESPONSE
ITEM NO. <u>NSSS-1</u> SQRT NO. <u>NSSS-PE-14</u> BA MAKEUP PUMP SPECIFIC ITEM: <u>PUMP 8</u>	<u>Comment</u> 1. Explain basis for load cases 4 & 5 and show that they are conservative.
	<u>Response</u> Load Case 4 is "nozzle plus impeller loads in the x-direction". Load Case 5 is "nozzle plus impeller loads in the z-direction". CE has reviewed these loading cases in detail and confirms that these loadings encompass the most severe direction possible for the application of nozzle loads
	<u>Comment</u> 2. Explain load combinations used for computing bolting stress and show that they are conservative.
	<u>Response</u> The load combinations used for computing bolt stresses include those loads from seismic accelerations in both transverse directions (note that a vertical acceleration would have no effect on the bolts), impeller loads, and nozzle loads in the most severe direction. CE has reviewed these loads and confirms that they are conservative.
ITEM NO. <u>NSSS 2</u> SQRT NO. <u>NSSS-PE-25</u> BORIC ACID TANK CIRC. VALVE SPECIFIC ITEM: <u>3CH-F171B</u>	<u>Comment</u> 1. Provide certification that the computer calculations based on Engineering Standard ES100 Rev. B dated 4/8/75 have been verified.
	<u>Response</u> CE has contacted the vendor on this issue and is currently awaiting a reply. This reply is expected before 10/31/82.
	<u>Comment</u> 2. Confirm that deflections calculated in Seismic Analysis for Order 1-46610 dated April 3, 1976 for tag number CH-511 will not interfere with valve closure.
	<u>Response</u> Same as Previous Response.

ITEM	COMMENTS/RESPONSE
ITEM NO. <u>NSSS 5</u> SQRT No. <u>NSSS-PE-52</u> FW CONTROL VALVE SPECIFIED ITEM: <u>5FW-FM834</u> .	<u>Comment</u> Verification of computer program ES100, Rev. B (4/8/75) is being performed for Item NSSS-PE-25. Results will also be applicable here. <u>Response</u> CE has contacted the vendor on this issue and is currently awaiting a reply. This reply is expected before 10/31/82.

RESPONSE TO OUTSTANDING ISSUES DEVELOPED AT
THE LP&L SQRT AUDIT FOR NSSS I&C EQUIPMENT

ITEM	COMMENTS/RESPONSE
ITEM NO. <u>NSSS-7</u> SQRT NO. <u>NSSS-ICE-8-1</u> 1151 INDICATOR SPECIFIC ITEM: <u>PI-101B</u>	<u>Comment</u> 1. The test on the indicator shows a 5% variation between the reading before and after test. The spec required 1.5% variation. Why was the indicator operability variation accepted? <u>Response</u> As explained at the SQRT Audit, the specified 1 1/2% required accuracy is a purchase specification, but is not meant to account for earthquake - induced uncertainties. These uncertainties are reviewed for acceptability by an Instrument Uncertainty Analysis. This analysis is to be performed on all safety-related applications of the Sigma 1151 and 1251 indicators. This analysis will be performed using the 5% uncertainty found in the current documentation. The Uncertainty Analysis will be completed for the Sigma indicators by January 14, 1983. <u>Comment</u> 2. Provide $\bar{f}$ spectra at the location of the instrument in the panel. <u>Response</u> Closed - See Ebasco Letter LW3-1131-82 dated 8/31/82.
ITEM NO. <u>NSSS-6</u> SQRT NO. <u>NSSS-ICE-5a</u> RESISTOR INPUT CARD SPECIFIED ITEM:	<u>Comment</u> 1. Verify by means of test data that operability of resistor input card was demonstrated during the test. <u>Response</u> Letter, W. J. Ritter - Westinghouse, Industry Electronics Division, to T. A. MacNair - Combustion Engineering, I&CE Department; Subject - NCI Resistor Card Seismic Operability Documentation, dated September 10, 1982 (attached). <u>Comment</u> 2. Determine if loose cables in cabinet will be tied down at a later date (supply date). Indicate procedures to secure cables in cabinet. <u>Response</u> Closed. See Fishback & Moore procedure CP-307 page 5 of 23. Also, Ebasco letter from Wills to DeBevin dated 9/2/82.

ITEM	COMMENTS/RESPONSE
ITEM NO. <u>NSSS-12</u> SORT NO. <u>NSSS-ICE-15</u> CEDM REED SWITCH POSITION INDICATOR SPECIFIED ITEM:	<u>Comment</u> 1. The CEDM which houses the transmitter was tested biaxially, but only in one horizontal axis. This was based on the assumption that the CEDM is symmetrical about the vertical axis. While this may be true for the CEDM, it is not true for the transmitter, and there is no assurance of seismic qualification. An investigation revealed that this oversight was caught and transmitter qualification for subsequent nuclear projects included testing in two arthogonal horizontal axes. These subsequent tests were performed at levels substantially higher than those required for Waterford 3. The reed switch design was the same as Waterford 3. This strongly suggests an adequate seismic design for the Waterford 3 transmitter. Receipt of a test report confirming the above will close this issue. <u>Response</u> Combustion Engineering Nuclear Laboratories Seismic Test Report #TR-ESE-442 for ANPP 150" Reed Switch Position Transmitter.



Westinghouse
Electric Corporation

Industrial Control
Divisions

September 10, 1982

Industry Electronics Division

200 Beta Drive
O'Hara Township
Pittsburgh Pennsylvania 15238
(412) 782 1730

Combustion Engineering, Inc.
Nuclear Division
1000 Prospect Hill Rd.
Windsor, CT. 06095

Attention: Mr. T. MacNair

Subject: Louisiana Power & Light
Waterford SES Unit No. 3
C.E. P.O. 9403341-9270
(W) IED W8000
Seismic Qualification Review
Team Audit
Item NSSS 6 NCI
SQRT No. NSSS ICE-5A Resistor Card
Reviewer: R. W. Macek
Audit Date: Sept. 1, 1982

Reference: Westinghouse Electric Corp. Seismic
Test Report - WCAP 8828 Seismic
Operability Demonstration Testing of the
Westinghouse IED 7300 Series Process Instrumentation Bistables

Gentlemen:

The subject audit concluded with one action for Westinghouse Industry
Electronics Division (WIED) as follows:

"Verify by means of test data that operability of resistor input card
was demonstrated during the test".

Mr. Macek noted that WCAP 8828 included the NCI card in its equipment listing,
Table 2-1, demonstrating the cards inclusion in the test. He also noted there
was no direct mention of, or data to show, the cards operability during the
test.

Westinghouse stated that the evidence of NCI operability could be provided but
it would be in the nature of raw data, i.e. block diagram sketches, schematic
sketches, copies of strip chart recordings and explanations showing linkage bet-
ween WCAP 8828, the NCI card, signal names, sketches and recordings.

Combustion Engineering
Page - 2 -
September 10, 1982

The following is a list of attachments to this letter which will serve to demonstrate operability of the NCI card:

- Attachment A. Block diagram of circuitry in Card Frame #1
- Attachment B. Schematic of Card Frame #1 Wiring
- Attachment C. Strip Chart recording of NCI outputs

Attachment A defines, in block diagram form, the circuitry of card frame #1. Attachment B defines the hardware and wiring which implements the block diagram. Attachment C shows strip chart recordings of signals described in Attachments A & B.

The relationship of NCI card output, signal name and recorder/pen number are as follows:

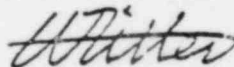
<u>NCI Output</u>	<u>Signal</u>	<u>Recorder No.</u>	<u>Pen No.</u>
TD/411A	Δ TLL	2	3
TD/411E	TC	2	4
TD/412A	TAVG	2	5
TD/411B	OPSP	2	6
TD/411C	OTSP	2	7

In Attachment C, the signal on Pen #2 was purposely changed in order to vary the input to bistables to demonstrate that they change state. The signals on recorder pens 3,4,5 & 6 are not functionally affected by the signal on Pen #2, and therefore, remain at a steady state value. The signal on Pen #7 is functionally affected and, therefore, moves as expected. The Attachment C recording was run during the seismic test and showed no anomalies.

Therefore, the operability of the NCI card is demonstrated.

If I can be of any further service, please advise.

Very truly yours,



W. J. Ritter
Projects Director

WJR:msb

cc: Mr. J. W. Veirs - Combustion Engineering
Mr. L. Karl - (W) IED

RECORDED 2
PEAS 3

TY-411R
 $V_{AT} = 1.414(V_{IN} - V_{IC}) + 1.667$

TY-411P
 $V_{IN} = 0.4(V_{AT} - V_{IC}) - 1.667$

TY-411H
 $V_{IN} = 0.667(0.1)(V_{AT}) - 0.718$

TY-412A
 $V_{IN} = 0.667(V_{AT}) - 0.718$

TY-411A
 $V_{IN} = 0.667(V_{AT}) - 0.718$

TY-411B
 $V_{IN} = 0.667(V_{AT}) - 0.718$

TY-411C
 $V_{IN} = 0.667(V_{AT}) - 0.718$

TY-411D
 $V_{IN} = 0.667(V_{AT}) - 0.718$

TY-411E
 $V_{IN} = 0.667(V_{AT}) - 0.718$

TY-411F
 $V_{IN} = 0.667(V_{AT}) - 0.718$

TY-411G
 $V_{IN} = 0.667(V_{AT}) - 0.718$

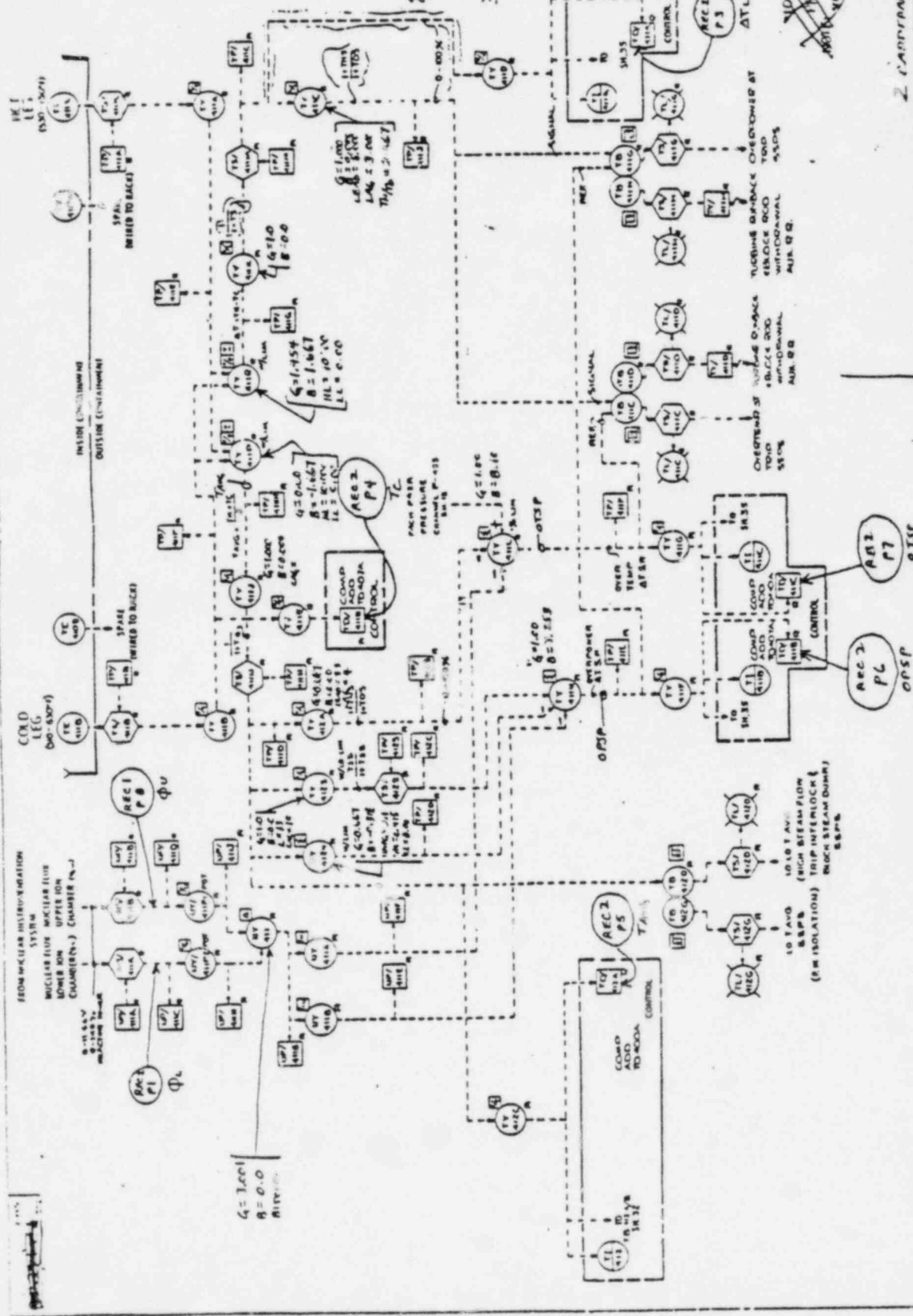
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TY-411I
 $V_{IN} = 0.667(V_{AT}) - 0.718$

TY-411J
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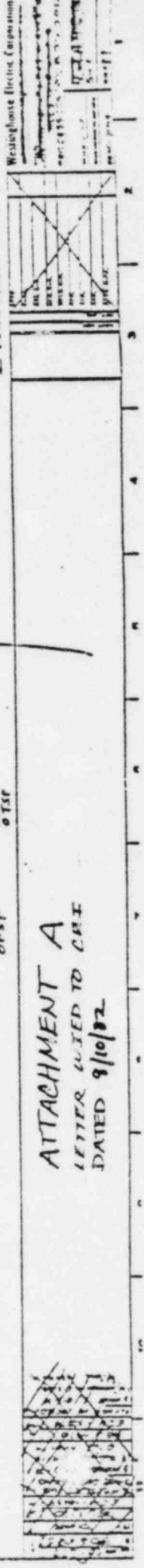
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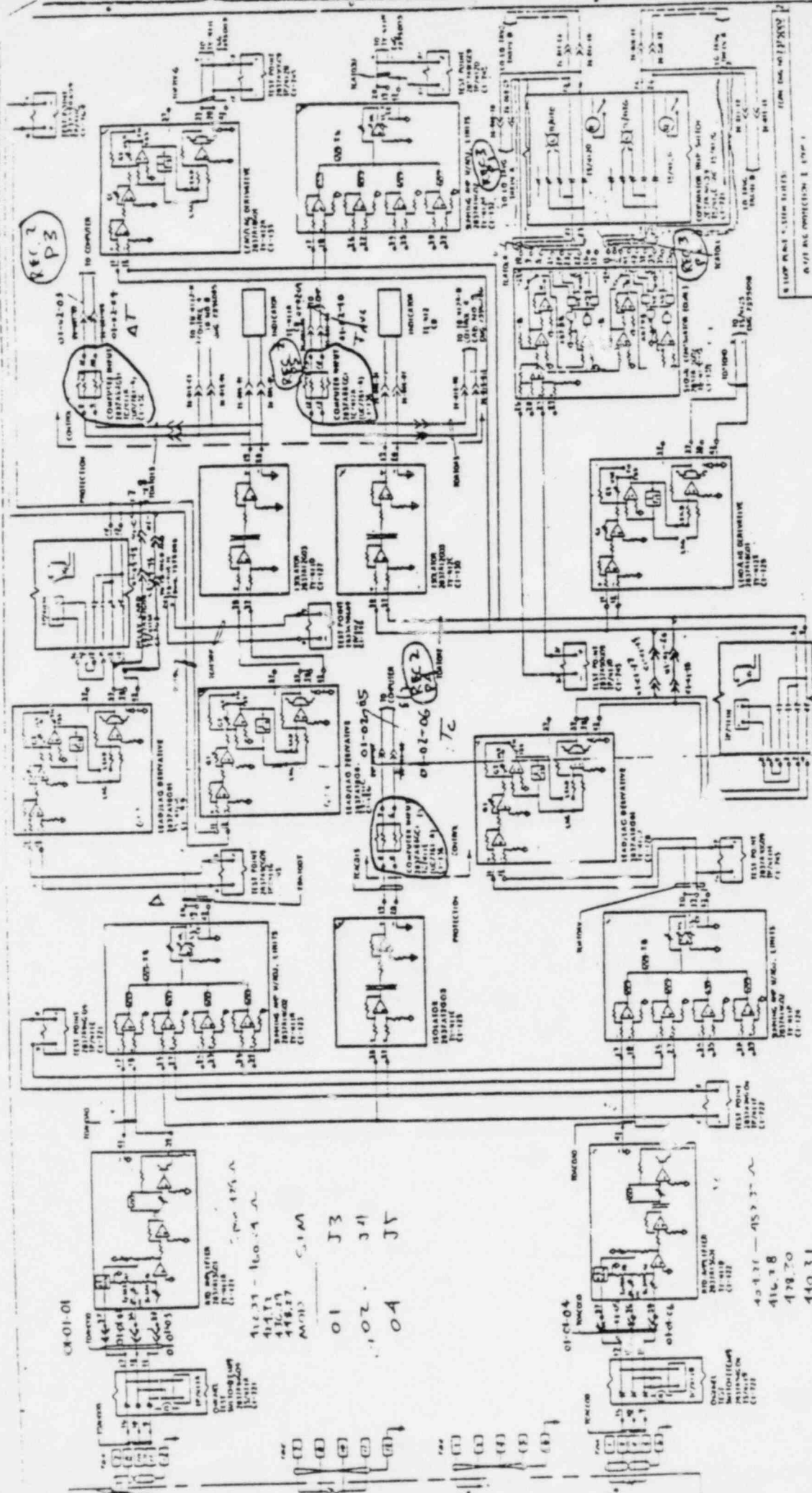
TY-411L
 $V_{IN} = 0.667(V_{AT}) - 0.718$



ATTACHMENT A
LETTER WITNESSED TO CASE
DATED 9/10/82

2. LADDER LOGIC SEQUENCE TEST (CONTINUED)





Westinghouse Electric Corporation
 100 WEST 17TH STREET
 NEW YORK, N.Y. 10011
 TELEPHONE 212-512-2000
 CABLE: WESTEL
 RADIO: 212-512-2000

ATTACHMENT B SHIT 1 OF 2
 LETTER WRIED TO CEI
 DATED 9/10/92

TA 34.3
 TC 404.3

ATTACHMENT C
LETTER U I E D TO CEI
DATED 9/10/82

2/1/82

2/1/82

PV2 V
PRESS OUT
A. Ross 2500

PEN #1

PEN #2

PEN #3

2/1/82

TE

2/1/82

TAW

2/1/82

DPBP

2/1/82

OTSP

2/1/82

PUSV
PRESS OUT

PEN #8

PEN #7

PEN #6

PEN #5

PEN #4

PEN #3

PEN #2

PEN #1

RECORDED # 2

RECORDED # 1

H.V.L. NOV 30 1981

ARIZONA NUCLEAR POWER PROJECT

**150" Reed Switch Position Transmitter
and Litton Electrical Connector**

**SEISMIC QUALIFICATION TEST
(Sine Sweep Testing)**

**Test Report
TR-ESE-442
NUCLEAR LABORATORY**

COMBUSTION ENGINEERING
DEVELOPMENT DEPARTMENT

TEST REPORT

SEISMIC QUALIFICATION TESTING
SYSTEM 80 REEF SWITCH POSITION TRANSMITTER
AND LITTON ELECTRICAL CONNECTOR

ARIZONA NUCLEAR POWER PROJECT - PALO VERDE
NUCLEAR GENERATING STATIONS 1, 2, AND 3

777009

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Quality Assurance

DOCUMENT NO.: TR-ESE-442 DATE OF ISSUE: 10/9/1981

Test Request No. SF40

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1.0 INTRODUCTION

The 150" Reed Switch Position Transmitter (RSPT) and the Litton connector are electrical devices which must function in an environment of high temperature, radiation, humidity and vibration during normal plant operation. In addition, as a Class 1E electrical component, the instrument must perform adequately during seismic environments up to SSE intensities as transmitted up to its mounting location (namely, the CEDM shroud) in a plant.

The subject report describes the procedures which were undertaken to demonstrate the RSPT's ability to withstand the seismic intensities stipulated for the ANPP reactor when it is installed in a representative CEDM. The test specimens had already undergone temperature and radiation aging.

2.0 SUMMARY

2.1 Sine Sweep Testing

Sine sweep tests confirmed the analytically predicted dynamic behavior (natural frequencies) of the ANPP type CEDM. This fact gave assurance that the subsequently conducted qualification effort would address the worst seismic response condition for the ANPP reactor.

The large amount of frequency, damping and mode shape data reported in this document will serve for future correlation efforts with analytical models.

2.2 Seismic Qualification Testing

The two RSPT samples as installed in a representative ANPP type CEDM were exposed to a sufficient number of biaxial "random" multi-frequency input motions of intensities greater than the required OBE and SSE response spectra. The RSPTs were tested in four orientations to allow for their asymmetric design. No adverse transients of failure modes in the electrical performance of the RSPTs were observed in any of the numerous tests. Therefore, the conducted test is proof that the RSPT assembly meets the seismic requirements imposed by the References 2 and 10.

3.0 OBJECTIVES

3.1 Sine Sweep Testing

The objective of the sine sweep test was to identify the dynamic characteristics of the RSPT support structure; namely, of the ANPP type CEDM with the longest nozzle. Natural frequencies and associated mode shapes, as well as modal damping parameters were to be obtained prior to the qualification tests for correlation with analytical predictions.

3.2 Seismic Qualification Testing

The objective of this program was to seismically qualify the ANPP RSPT and the associated Litton electrical connector for commercial service in accordance with the purchaser's requirements of References 3 and 4. Proof was to be established that the RSPT design would remain functional when installed at its permanent location during or following a seismic event of an intensity up to SSE magnitudes. The RSPT was to be exposed to a minimum of five OBE events and one DBE event following the appropriate temperature and radiation aging test programs.

4.0 EQUIPMENT DESCRIPTION

4.1 RSPT

The production RSPT is a transducer device used to determine the position of the CEA within the reactor core. The instrument is housed in a stainless steel tube within the shroud which is positioned adjacent to the extension shaft upper pressure housing of a CEDM.

The production RSPT is essentially a voltage divider network comprised of an array of magnetically actuated reed switches wired to a series chain of resistors. The reed switches, resistors, and wire are mounted on an extruded plastic strip at precise 1.5 inch intervals. A permanent magnet attached to the top of the extension shaft generates the magnetic flux necessary to actuate and deactuate the switches yielding voltage signals proportional to the CEA position. Three additional separate circuits provide contact closures which indicate the Upper Electrical Limit, Lower Electrical Limit, and Dropped CEA position. The RSPT is fabricated in compliance with the drawing of Reference 8 and specifications of Reference 7.

A 150" full length RSPT has been randomly selected from the production line for qualification testing. This test specimen has already undergone thermal and radiation aging.

4.2 Litton Electrical Connectors

The component is a bayonet locking electrical connector providing the interface connection between the head area cabling and the RSPT. The cable penetrations are designed to seal against fluid entry into the connector. The head area cabling connector is the Litton CIR06-CE-20-33S straight plug. The mating box mounting receptacle which is attached to the RSPT is the Litton CIR02-CE-20-33P.

5.0 TEST DESCRIPTION

5.1 Mechanical Test Set-Up

A full-size 150-inch Control Rod Drive Mechanism (representative of the ANPP design), including the drive shaft, water, conduit and

2 RSPTs (Serial Nos. 597 and 604), were assembled onto the seismic simulation fixture. For this purpose, a special test nozzle had been designed and fabricated. The test set-up simulated the longest CEDM nozzle which, by analysis, had been shown to yield the highest CEDM response characteristics.

For the sine sweep, as well as the seismic qualification tests, the hydraulic actuator of the seismic shaker system was set at a 45° angle, thus providing excitations of similar magnitudes to both axes. Although the CEDM itself is symmetric about its vertical axis, the RSPTs are not, thus, in accordance with the Guidelines of Reference 2, four test orientations were required. This was accomplished by rotating the test nozzle plus CEDM structure once by 90° and by switching the two RSPT samples in each of the two nozzle orientations. Figure 16 depicts the four test orientations. The two RSPT samples provided for the test were inserted in the CEDM shroud and clamped into place. The actuating magnet was attached to the drive shaft and was located near the top position inside the upper pressure housing.

5.2 Instrumentation Set-Up

Two control accelerometers, mounted in a mutually perpendicular arrangement to the base plate (which simulated the reactor head elevation) were used to monitor the excitation levels in the horizontal and vertical axes. Figure 1 indicates the strain gauge locations at the test nozzle which is the highest stressed component of the CEDM design. The stress levels at this location, although not a criterion for the RSPT qualification, were used as an index for the intensity of the seismic event and to help avoid overtesting (failure) by correlating measured stress values to analytically predicted ones.

The response accelerometers indicated in Figure 1 were used to monitor CEDM deflections during sine sweep testing. Accelerometer locations 9, 7, 5, and 3 were also recorded on magnetic tape during the seismic qualification program to be later displayed in the form of time histories and/or response spectra.

All strain gauges (1/4 Bridge Hook-up) and accelerometers were connected over the replay panel to the patch panel of the Digital Vibration Control System. For signal conditioning of the strain gauges, the Unholtz Dickie, Type R, Charge/Voltage Amplifiers were used. Unholtz Dickie, Type H, Charge Amplifiers were used for the response accelerometers and the model 2216-X units for the two control accelerometers.

Selected CEDM nozzle strain gauges were monitored on the visicorder during preliminary and actual test runs. The RSPT electrical performance was monitored on the visicorder during all qualification phases.

For the sine sweep testing, the "SN21T Version - 04" software package of the digital vibration control system was used. This program allows the monitoring of 4 channels of data simultaneously.

For synthesis and on-line analysis of the generated seismic environments, the "SS20T, 3.0 Decade" software package of the digital vibration control system was used. During the tests, selected transducer signals were recorded on a 7-channel tape recorder. Test response spectra of the table input or CEDM component motions were then developed off the tape by playback into analysis software portion of the "SS20T" package.

Documented strain measurements are accurate within 5%, and the acceleration measurements within 10% of indication. All accelerometers had been calibrated within the last 12 months of testing. One non-critical response accelerometer, which showed erroneous indications, was replaced during the early phase of the test program.

5.3 Sine Sweep Test Procedure

The "SN21T Version - 04" software package of the digital vibration control system was employed for the tests. Figure 4 is a typical listing of an input file. For interpretation of the various input parameters, Reference 12 is to be used.

The C-E sinusoidal vibration control system, in conjunction with the MTS hydraulic actuator and control units (See Figure 3), is a closed loop, digital system that provides four-channel, multi-strategy control for performing a variety of swept-sine vibration tests. The system accepts analog input from the seismic table, digitizes the analog data, and continuously controls the amplitude of the resulting control signal so that it matches the amplitude of the specified reference spectrum. The control signal amplitude is regulated by controlling the amplitude and frequency of a sinusoidal drive signal that is generated by a programmable frequency synthesizer.

During the test program, the horizontal table motion was controlled using channel A of the D.V.C. system. The remaining channels B, C, and D monitored selected, calibrated transducer signals and stored them on disc. In this fashion, while maintaining constant acceleration input amplitude over a frequency range as wide as 1 to 33 Hertz, frequency response data was accumulated for all

monitoring locations in consecutive sweep cycles. The data was later retrieved from the disc and displayed in a suited manner as phase, response amplitude or transfer function versus frequency. At the completion of the test program, all pertinent files were transferred to tape NL-014 and stored at the Bldg. 5 data center. The developed hard copies, along with the reduced data, are stored in the Nuclear Laboratories, Bldg. 2, Records Room.

5.4 RSPT Electrical Performance Monitoring

With the magnet held in a fixed position (close to the full withdrawn position of CEA travel), the voltage output signals of both RSPTs were recorded on a Visicorder oscillograph and also stored on tape during all seismic test phases of test orientations 3 and 4. Figure 14 renders a block diagram of the basic monitoring scheme. The resolution of the oscillograph recorder was sufficient to detect any transient upset conditions or voltage signal changes down to five millivolts.

5.5 RSPT Inspection Requirements

The operational specifications and the inspection requirements of the RSPT position indication and the limit switch circuits are outlined in Sections 4.0 and 6.5 of Reference 10, respectively. Prior to and following the seismic qualification test programs, the electrical and functional characteristics of the RSPT assembly were inspected under laboratory ambient conditions in compliance with Section 6.5 of the reference test procedure. The results of inspections were recorded on the pertinent data sheets and are included in Appendix A of this report.

5.6 Simulation of Seismic Test Environment

The test specimens were subjected to 32 seconds of simultaneous horizontal and vertical inputs of random waveform motion. This random waveform consisted of frequencies spaced $1/6$ octave apart over the frequency range of 1 Hertz to 25 Hertz as necessary, to envelope the Required Response Spectra of Figures 11 & 12. The technique used to synthesize the shock spectrum was to generate a series of wavelets at discrete frequencies (spaced $1/6$ octave apart within the desired frequency range). The occurrence of these wavelets at each frequency (within the available time frame of 32 seconds) was specified in an arbitrary (random) fashion and the amplitude in g's for each wavelet was controlled by the Required Response Spectrum (RRS). At least 3 wavelets, spaced randomly throughout the event, were used at each sixth octave frequency close to the CEDM natural frequencies. The Digital Vibration Control System was used to sum up all the wavelet parameters and to produce a composite waveform that contained energy at all frequencies across the band. At a low test level, this waveform was then converted into shaker table motion by the shaker control units. Initially, the program automatically approximated the amplitude of each wavelet assuming that the transfer function of the shaker system is flat. The shock response spectrum of the table response waveform (in horizontal axis only) was then analyzed and compared with the specified RRS. The difference between the two spectra was then used to adjust automatically the wavelet amplitudes and to thereby compensate the drive waveform. This process was repeated until acceptable agreement had been demonstrated. Next, the output level was increased to arrive at the OBE and the DBE test levels. Following each increase in test level, several steps of synthesis were normally required to arrive at a satisfactory drive signal.

In addition to the on-line analysis of the horizontal table motions, both horizontal and vertical control accelerometer response signals were stored on tape and analyzed later over a frequency range of 1-50 Hertz using the "SS20T, 3.0 Decade" software package. Figure 15 shows a listing of the input file for the SSE event analysis. For interpretation of the various input parameters, Reference 14 is to be used. The software capabilities were verified in accordance with the Q.A. requirements as documented in Reference 15.

Figure 17 depicts a horizontal table time history for Test Run 26 (SSE event). The duration of this event was 32 seconds. The maximum value of this acceleration time history (approximately 0.7 g's) is representative of the actual Zero Period Amplitude (ZPA) level reached during this event which easily exceeded the requirements of 0.4 g's (see Figure 12). The character of the wave form reflects the superposition of low, medium, and high frequency pulses which resulted in the generation of a "random" type, multifrequency waveform similar to those of actual earthquakes. The required low frequency excitations for the high ANPT response spectrum peak (at about 2 Hertz) are noticeable even in this acceleration trace.

5.7 Test Procedure, Test Matrix

For more detailed guidelines about the test performance, refer to the test procedure of Reference 10. A listing of all data runs is enclosed as Appendix B to this test report.

6.0 DISCUSSION AND RESULTS

6.1 Sine Sweep Testing

Tables 1 through 5, along with Figures 5 through 10, summarize the results obtained from the sine sweep test. Appendix B renders the complete Test Matrix.

Initial low level sine sweep testing verified the analytically predicted natural frequencies of interest. The experimental frequencies of 2.32, ~ 9.2 , and ~ 11.6 Hertz compare favorably with the theoretical values of 2.39, 10.08 and 11 Hertz for vibration modes 1, 2, and 3, respectively. Slight variations in these experimental frequencies with test level were observed especially for the somewhat non-linearly responding vibration modes 2 and 3. Figure 5 exhibits a series of transfer function plots developed for all 9 accelerometer locations along the CEDM height. The three resonance modes can clearly be discerned. The transfer function amplitudes at these resonances were taken from all available frequency response graphs and are listed in Tables 1, 2, and 3, along with damping and strain level information. Figures 8, 9, and 10 render comparisons of experimental and analytical mode shapes. For the purpose of this illustration, the deflections are shown with similar amplitudes. However, no attempt was made here to match the actual test levels analytically. Generally, the mode shapes agree quite well. But, it is also noted that the transfer function levels vary with test intensity, a fact which reflects the variation of damping with test level (especially modes two and three), as well as a certain amount of scatter between repeat test runs. For these reasons, one must view the entire range of test results, rather than using a single test run for possible input to model correlation efforts or

extrapolation of results to other plants or higher excitation levels.

Figure 7 shows some blown-up plots of resonance peaks. These graphs were used to determine the modal critical damping properties employing the half-power point technique.

$$c/c_r = \frac{\Delta f}{2f_n} \times 100$$

where

c/c_r = Critical Damping Ratio in (%)

Δf = Width (in Hertz) of Resonance Peak at 0.707 times
Peak Amplitude Value

f_n = Resonance Frequency in (Hertz)

For a variety of transducer locations, modal damping properties were obtained, averaged, and listed in Tables 1, 2, and 5. First mode damping values varied between 2.2 and 3.09 percent of critical. The two percent value assumed in the CEDM analyses appears somewhat conservative, however, based on this data, three percent could not be justified.

Second mode damping ranged between 3.5 and almost 6 percent. Surprisingly, this variation showed up when results taken on different test days were compared. The damping values obtained for a wide range of excitation levels (.05 to .25 g's - Table 5), on a single day, is quite consistent. Apparently, the CEDM structure condition (e.g. looseness of coilstack and rotation) as affected by test levels, can change.

Third mode damping values ranged from 2.2 to 3.3 percent of critical. It is of interest to note here that the ANPP CEDM has no additional tie between the upper pressure housing and shroud. This tie, which exists for the TVA and WPPSS plant, has the effect of eliminating one mode and combining the second and third ANPP modes into one.

Modal Strain levels are summarized in Tables 1, 2, and 4. For correlation with analytically predicted stress levels, one must determine the associated deflections by converting transfer function levels into displacements. Considering test file RSSN02 (Table 1), this is done as follows:

$$\begin{aligned} \text{ACC/9/Horizontal Control Acc} &= 59.39 \text{ (g/g)} \\ \text{Acceleration Level} &= \text{Transfer Fct} \times \text{Excitation} \\ &= 59.39 \times 0.02 = 1.19 \text{ (g's)} \\ \text{Deflection Amplitude} &= \frac{9.8 \times g}{f^2} = \frac{9.8 \times 1.19}{2.32^2} = 2.16 \text{ (inches)} \end{aligned}$$

The associated maximum nozzle strain = 175 $\mu\epsilon$ or 81 $\mu\epsilon$ /inch deflection at CEDM Top (First Mode).

Following the seismic qualification program, static load deflection tests (incrementally deflect CEDM top and monitor strain gauges 7 & 8), as well as simple dynamic tests (manually excite first mode), were conducted to verify the observed CEDM strain versus deflection ratio. The detailed results given in Appendix C confirm the shaker table data.

6.2 Seismic Qualification Testing

The ANPP reactor design calls for 87 CEDMs with 16 different nozzle lengths. Earlier analyses has shown that the CEDM type with the longest nozzle would tend to respond in the most critical manner. Therefore, this nozzle condition was selected for testing. The stipulated seismic intensities for the reactor head elevation are shown in Figures 11 and 12 for the OBE and the SSE event, respectively. It had been decided earlier to perform the tests with the hydraulic actuator set up at a 45° angle with the horizontal plane, thereby providing equal input motions in the vertical axis and in the horizontal axis. During the tests, the horizontal control accelerometer was used for the synthesis of the random type waveforms. The Required Response Spectra (RRS) used for the synthesis represented the envelope of the vertical RRS and the horizontal RRS, whereby the latter was constructed from two horizontal spectra (using the Root-Sum-of-the-Square technique). ²

Figure 13 shows a diagram of the instrumentation hook-up and control logic. The RSPTs were placed inside the CEDM shroud and connected to recording equipment as shown in Figure 14. The RSPT locations during the four test orientations are identified on Figure 16.

During the course of the test program, the RSPTs were exposed to at least 30 and 10 seismic disturbances, each intensity range equal to at least that of the OBE and the SSE type earthquakes, respectively. The official test log is enclosed as Appendix B, which includes a minimum of 5 OBE and 1 SSE events in each test orientation. In all test cases, no transient upset or anomalous conditions were found in the RSPT signal traces.

The signal loss observed during one test run was due to a monitoring cable break (cable was inadequately secured at power supply). The inspections conducted prior to and following the seismic qualification tests revealed no changes in the functional characteristics of the two specimens as provided for testing (Appendix A).

Figure 17 shows the synthesized table acceleration time history for an SSE event. Since the Required Response Spectrum has a high spectrum peak at about 2 Hertz, the waveform clearly reflects these large, low frequency components superimposed by higher frequency contributions. Typical strain and RSPT time histories are shown for the OBE and the SSE events in Figures 18 and 19, respectively. With the exception of a small "ripple" (less than 3 milliseconds), all RSPT monitoring traces are undisturbed. The strain gauges reflect the response characteristics of the CEDM and reveal an overwhelming response (proportional to deflection) at its fundamental frequency. Peak CEDM component strain levels are listed in Table 6 for all test runs. The maximum values (635 $\mu\epsilon$ for OBE and 770 $\mu\epsilon$ for SSE events) are well within material allowables.

Figure 20 renders OBE Test Response Spectra for all four test orientations. The analyses of the table motions was performed at 1/6th octave increments over a frequency range of 1 to 50 Hertz. In all cases, the graphs demonstrate complete envelopment of the Required Response Spectra (vertical lines show actual test intensity, spectrum curve reflects RRS). A seismic table resonance was responsible for the high spectrum peak above 30 Hertz.

Horizontal and Vertical Test Response Spectra are shown in Figure 21 for the SSE event. Again, complete envelopment of the requirement is demonstrated. Additional table acceleration time histories are given in Figure 22.

In order to capture the resulting seismic intensities at the RSPT mounting locations (CEDM shroud), four response accelerometers Nos. 3, 5, 7, and 9 were monitored and recorded on tape. Unfortunately, the tape channel recording the CEDM top motions was set up improperly which resulted in attenuation of higher frequency signal components. The test response spectra shown in Figures 23 and 24 capture the true seismic intensities at all four shroud elevations, whereby the Acc 9 curve was extrapolated using data from the other 3 locations. These response spectra (2% damping) exemplify the large CEDM response at about 2.3 Hertz. Some contribution from CEDM Mode 2 is apparent at 10 Hertz. The response spectrum peaks above 30 Hertz are due to the table resonance mentioned earlier.

Figures 25 and 26 summarize the acceleration time histories as recorded at the four shroud elevations during OBE and SSE event simulations. Accelerometer 3, 5, and 7 traces are basically unfiltered and some of the higher acceleration spikes may actually be caused by impacts (e.g. coilstack shifting at Acc 3 location). However, this fact would not influence the response spectrum character across the frequency range of interest (1-30 Hertz) which is shown in Figures 23 and 24.

Prior to seismic testing, RSPT Sample No. 604 was removed from test Loop 7A after 1730 hours of thermal aging at 375°C for a performance check and a visual inspection. The visual inspection showed some deterioration of the silgard encapsulant and the diallyl phthalate mounting strip. Based on this inspection, it

was decided to waive future visual inspections of both RSPT's until the entire qualification program had been completed. Therefore, details of the above visual inspection and the final visual inspection will be documented in the final qualification report.

7.0 REFERENCES

1. IEEE Standard Number 323, 1974, General Guide for Qualifying Class 1 Electrical Equipment for Nuclear Power Generating Stations.
2. IEEE Standard Number 344, 1975, Guide for Seismic Qualification of Class 1 Electrical Equipment for Nuclear Power Generating Stations.
3. Specification Number SYS80-MD-0311, Revision 02, Design Specification for Control Element Drive Mechanism.
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8. Drawing CEDM-E-R1000, Revision 02, Reed Switch Assembly.

9. Drawing D-STD-162-003, Revision 01, Magnet Assembly and Details.
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11. Test Report TR-ESE-285, "SCE CEDM-RSPT Seismic Qualification Test," K. H. Haslinger, May 15, 1979.
12. Operating Manual for Sinusoidal Vibration Control System," Time/Data Division. Document 1923-5124, December, 1977.
13. Q.A. Verification of Time/Data Sinusoidal Vibration Control Code Version 04, C-E Analysis Report Nos. S669-100 and S669-101.
14. Operating Manual for Shock Spectrum Synthesis and Analysis System, Time/Data Division, Document 1973-5127, July, 1977, TR-ESE-424.
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FIGURE 1
REED SWITCH
POSITION TRANSMITTER

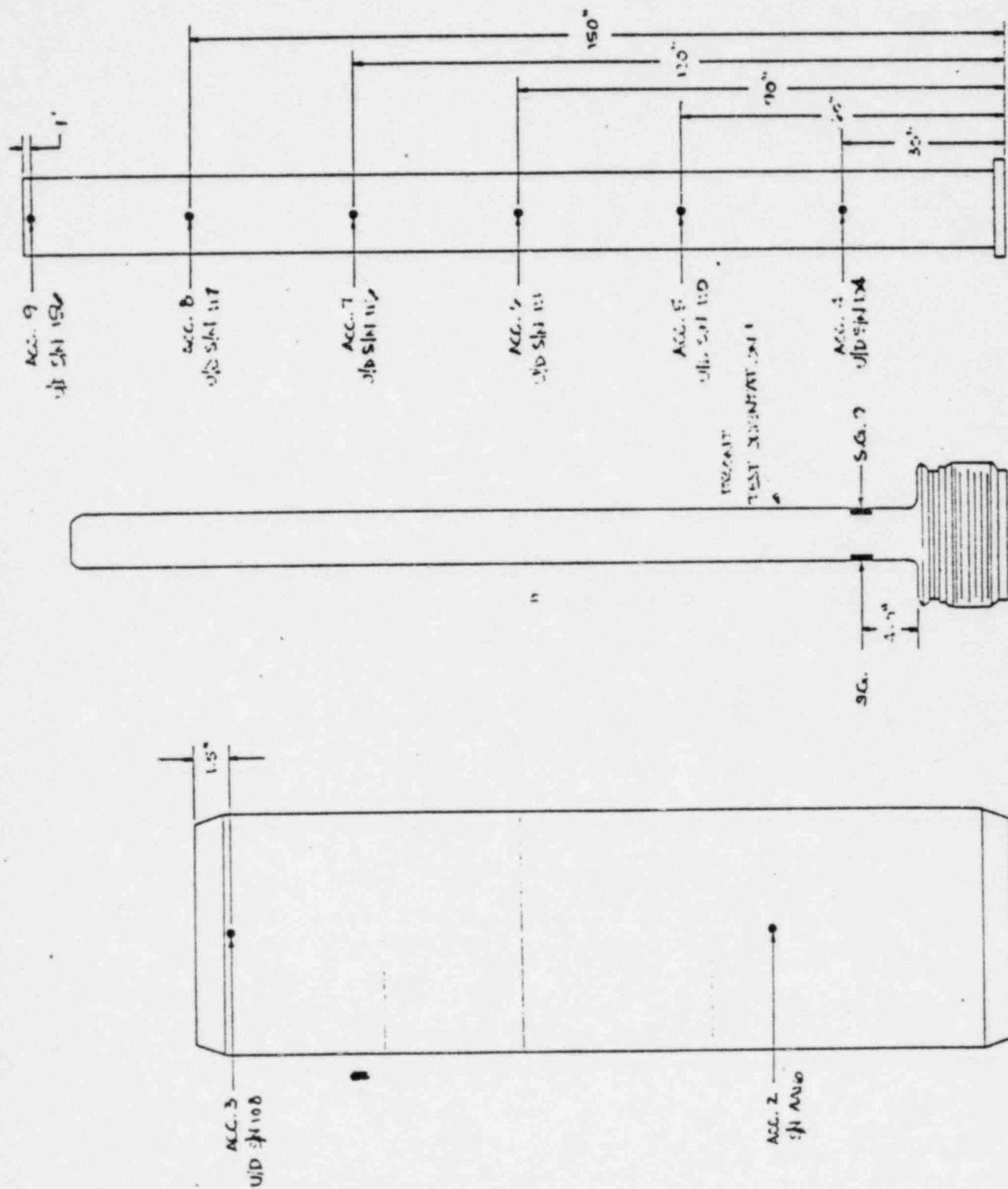


FIGURE 2A ANPP PSPT SEISMIC QUALIFICATION TEST - INSTRUMENT LOCATIONS

CEMA TEST NOZZLE INSTRUMENTATION

LOWER PRESSURE HOUSING

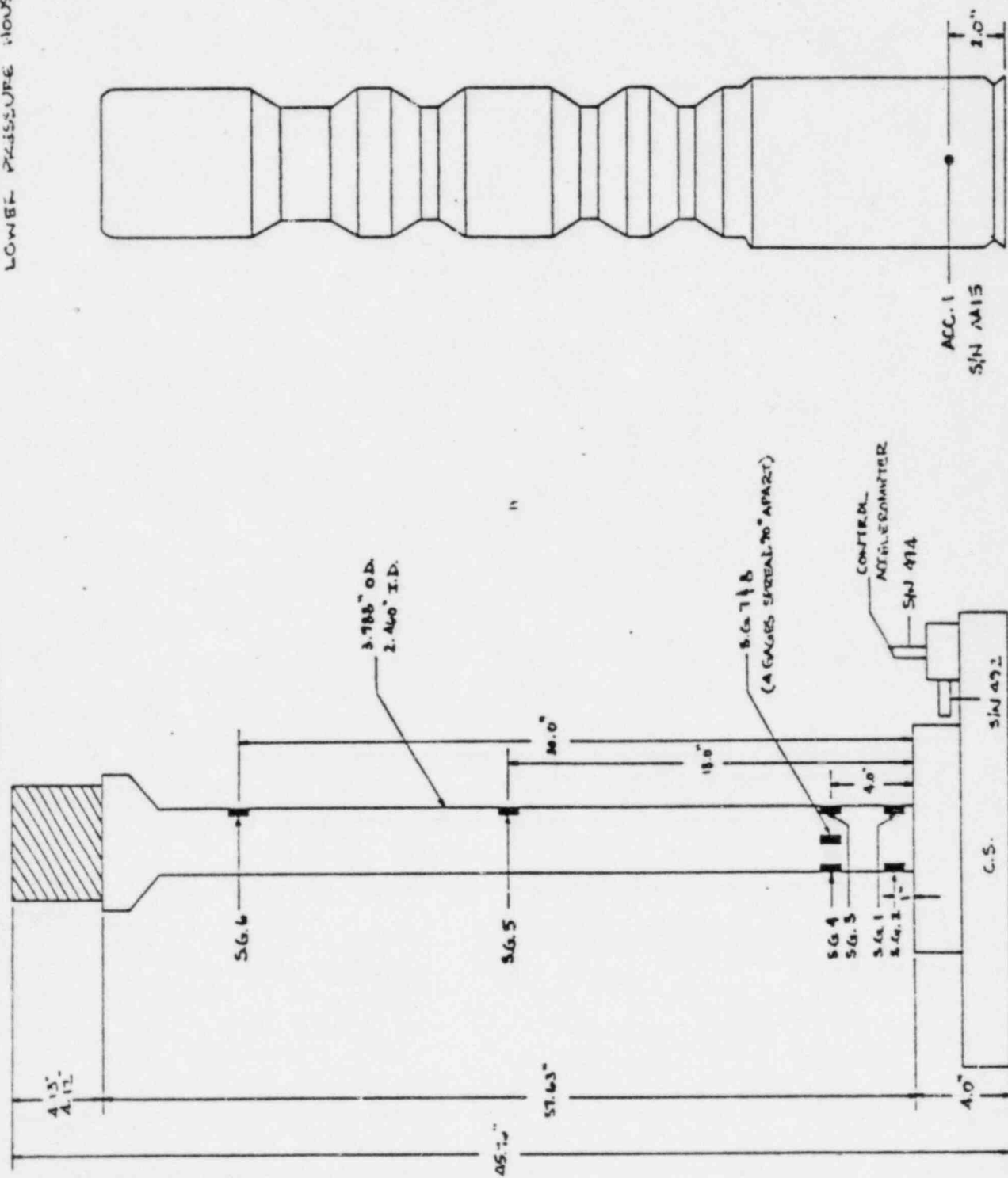


FIGURE 2B AHP RSPT SEISMIC QUALIFICATION TEST - INSTRUMENT LOCATIONS

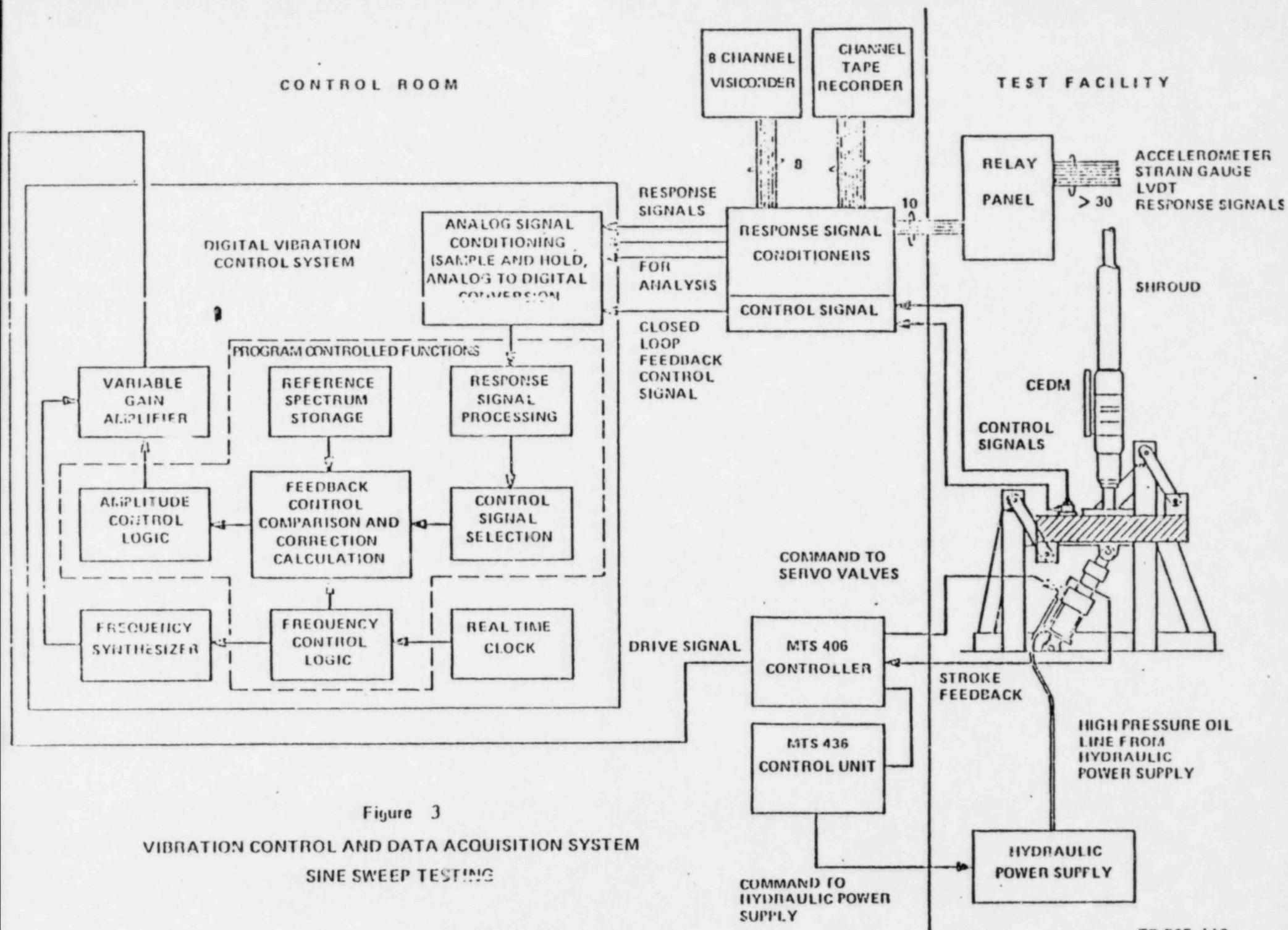


Figure 3
VIBRATION CONTROL AND DATA ACQUISITION SYSTEM
SINE SWEEP TESTING

```

1 TEST ID: RSSN02
2 HEADING: ANPP RSPT TIME SWEEP

SWEEP PARAMETERS:
3 MODE 2-LOG(DEC), 1-LOG(OCT), 0-LIN: 2
4 START, END FREQ, HZ: 1.000,28.00
FREQ RANGE, DEC=1.447
5 SPECIFICATION 1-RATE, 0-DURATION: 1
  RATE, DEC/MIN: .2000
SWEEP DURATION — HRS, MIN, SEC: 0,7,14

TEST LENGTH:
6 SPECIFICATION 1-TIME, 0-SWEEP CYCLES: 0
  CYCLES: 1.000
TEST TIME — HRS, MIN, SEC: 0,7,14
7 START-UP TIME, SEC: 15.00
8 SHUT-DOWN TIME, SEC: 5.000

REFERENCE SPECTRUM:
9 UNITS 1-METRIC, 0-NON-METRIC: 0
10 SPECTRUM LIMITS:
  DISPLACEMENT, IN(P-P): 4.000
  VELOCITY, IN/SEC: 12.50
  ACCELERATION, G: .2500

11 TYPE, VALUE, FREQ: 2,.02000,28.00
  ALARM LIMIT +DB, -DB: 3.000,-3.000
  ABORT LIMIT +DB, -DB: 10.00,-10.00

12 TEST LEVEL (DB BELOW REF): 0.

13 CONTROL CHANNELS: 1
  PROCESS 3-AVG ABS, 2-FUND, 1-PEAK, 0-RMS: 2

14 LIMIT CHANNELS: 0
15 AUXILIARY CHANNELS: 2,3,4
  PROCESS 3-AVG ABS, 2-FUND, 1-PEAK, 0-RMS: 2
  MAXIMUM EXPECTED G: 3.000
16 ACCEL SENS, MV/G:
  CH 1: 10000.
  CH 2: 10000.
  CH 3: 10000.
  CH 4: 10000.
17 FILTER 1-PROPORTIONAL BW, 0-FIXED BW: 1
  BW, %: 50.00

18 REFERENCE CHANNEL: 1
19 RESPONSE CHANNEL: 2
20 MONITOR CHANNEL: 1

21 COMPRESSION SPEED 2-HIGH, 1-NORMAL, 0-LOW: 2
22 LOOP-CHECK FREQ(HZ), MAX DRIVE(VOLTS): 5.000,.2000

REFERENCE LEVELS:
  MAX DISPLACEMENT, IN(P-P): .3914
  MAX VELOCITY, IN/SEC: 1.230
  MAX ACCELERATION, G: .02000
  MIN ACCELERATION, G: .02000
  ACCELERATION RANGE, DB: 0.

CORRECTIONS? N
SAVE? Y
1-RT11, 0-PUNCH: 1
DEVICE: RX0

```

STORED RSSN02

>

FIGURE 4

TYPICAL INPUT LISTING - SINE SWEEP TEST

APPENDIX B

LOG SHEETS

TAPE DATA LOG SHEET

TEST ANPP RSPT SEIS. QUAL

DATE 7/31/81

RECORDED BY S. K

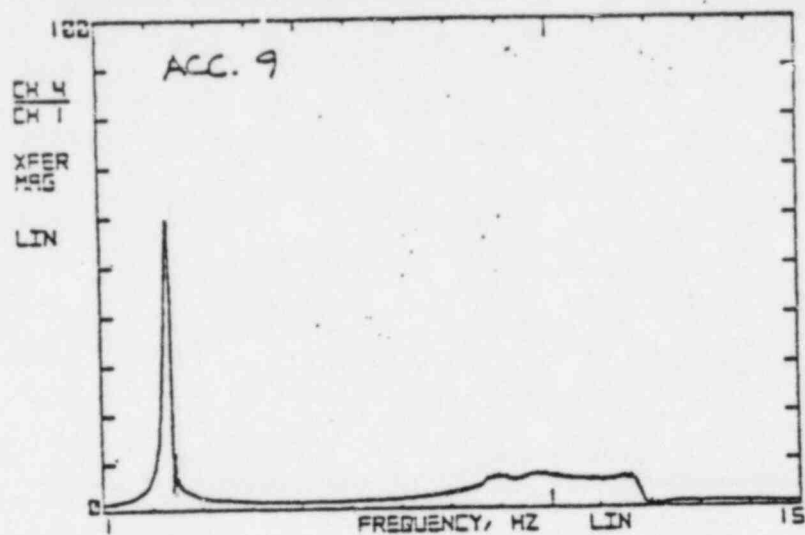
LOG SHEET NO. 01

HOOKUP SHEET NO.

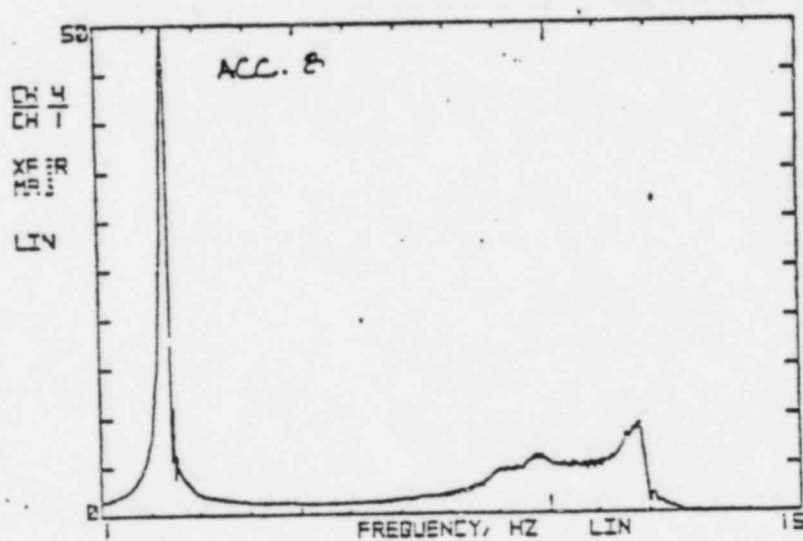
RECORD SPEED 3 3/4

RECORD BAND WB

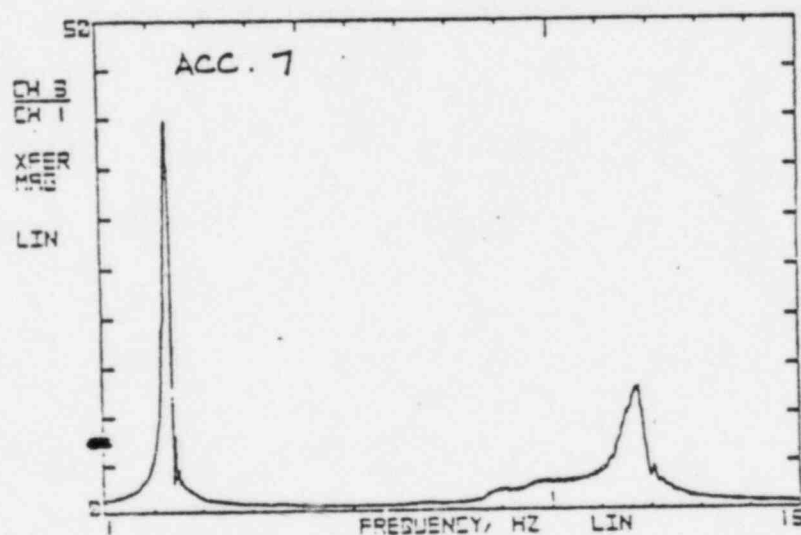
REEL NO.	RUN NO. TAPE FT.	FOOTAGE	ATTENUATOR/AMP. SETTING							COMMENTS
			1	2	3	4	5	6	7	
S-01		—	H.C	V.C.	Acc 9	Acc 7	Acc 5	Acc 3	1/100	Transducers
		—	10V 1G	10V	10V	10V	10V	10V	10V	1/100 1/100
	1	50								50V SHORTED INPUTS CAL
	2	65	#1 only: 9.4 PK 100 Hz [CAL ONLY]							ALL INPUTS F.S. CAL SIGNAL 2-6: 100 PK 100 Hz 7:
	3	90	10V	10V	10V	10V	10V	10V	NSV	ALL INPUTS F.S. CAL NSV 10V PK, 100 Hz ORIENTATION 1:
	4	108								OBE 1
	5	124								ORT 1 OBE 2
	6	141								ORT 1 OBE 3
	7	161								ORT 1 OBE 4
	8	179								ORT 1 OBE 5
	9	199								ORT 1 SSE 1
	10	226								ORT 2 ABORT SSE 1
	11	238								ORT 2: SSE 1
	12	259								ORT 2 SSE ORT 1 1, 2nd WU.
	13	278								OBE 1 SSE ORT 2



RUN 1 RSSN02
ANPP RSPT SINE SWEEP

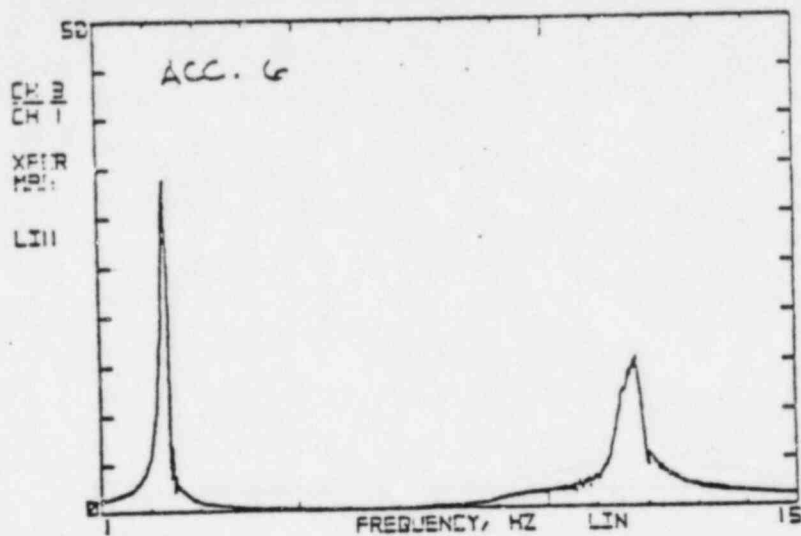


RUN 2 RSSN02
ANPP RSPT SINE SWEEP

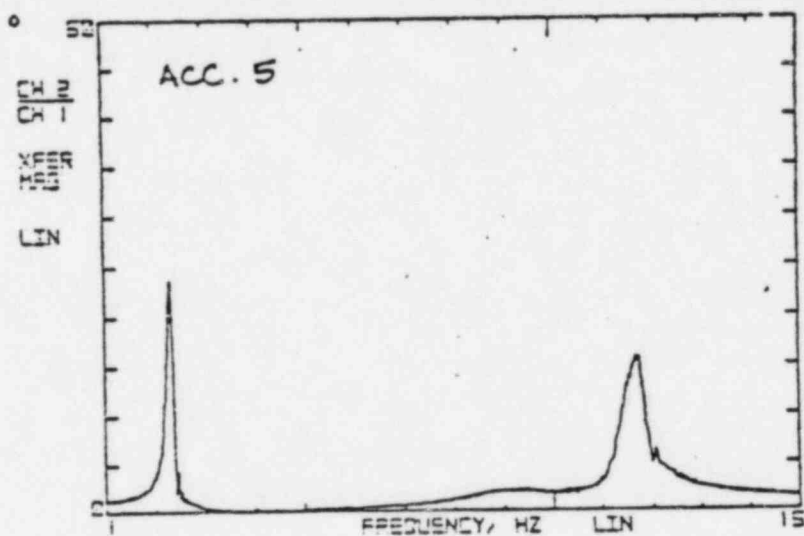


RUN 1 RSSN02
ANPP RSPT SINE SWEEP

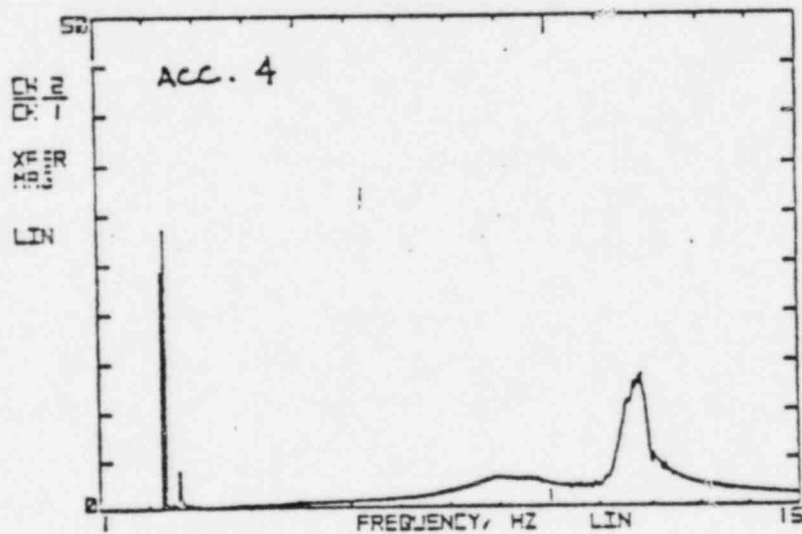
FIGURE 5A TYPICAL SINE SWEEP TRACES - TRANSFER FUNCTION
TEST FILE RSSN02 - 0.02 g's EXCITATION



RUN 2 RSSN02
ANPP RSPT SINE SWEEP

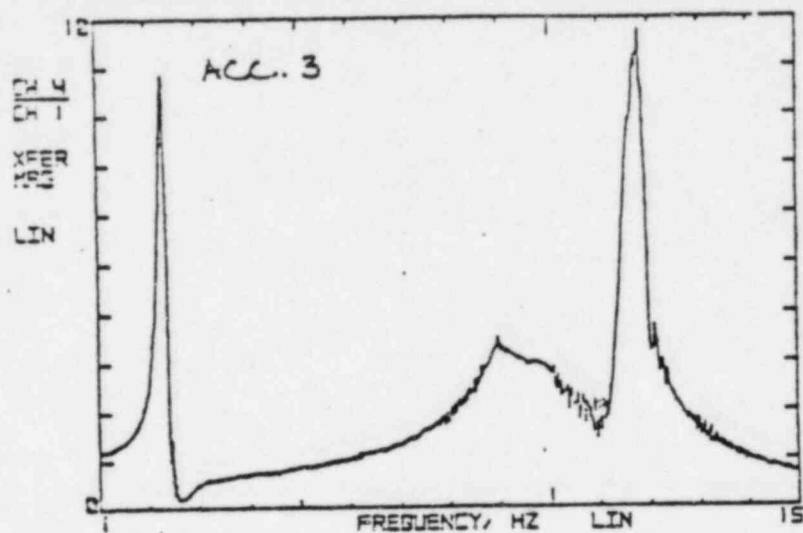


RUN 1 RSSN02
ANPP RSPT SINE SWEEP

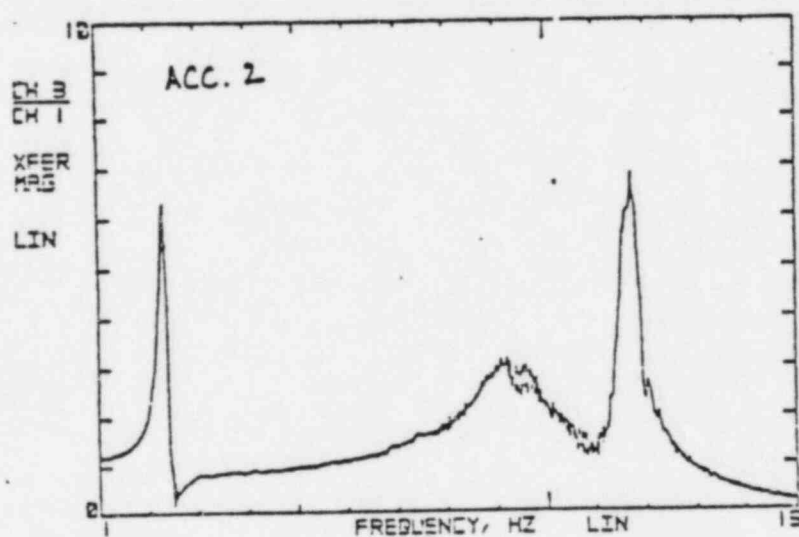


RUN 2 RSSN02
ANPP RSPT SINE SWEEP

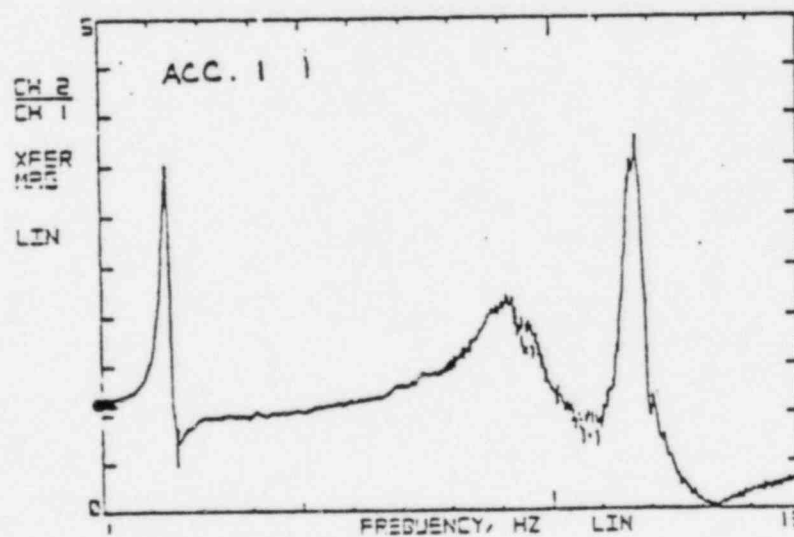
FIGURE 5B TYPICAL SINE SWEEP TRACES - TRANSFER FUNCTION
TEST FILE RSSN02 - 0.02 g's EXCITATION



RUN 3 RSSNO2
ANPP RSPT SINE SWEEP

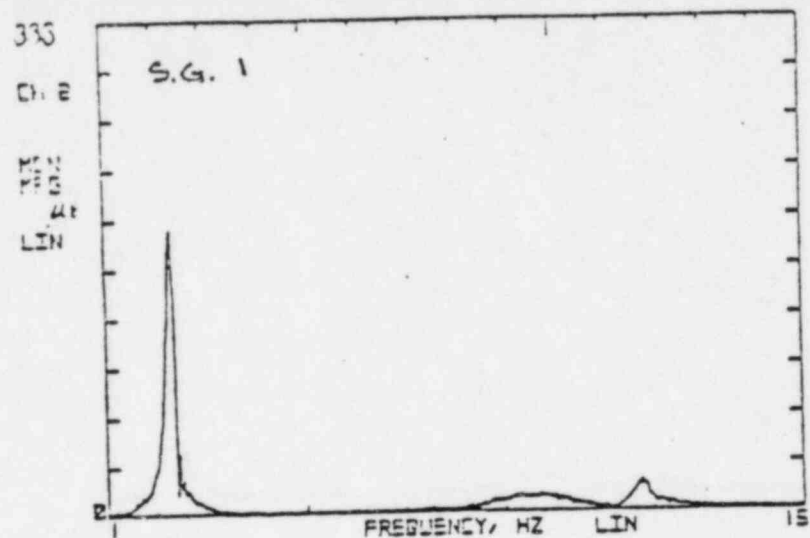


RUN 7 RSSNO2
ANPP RSPT SINE SWEEP

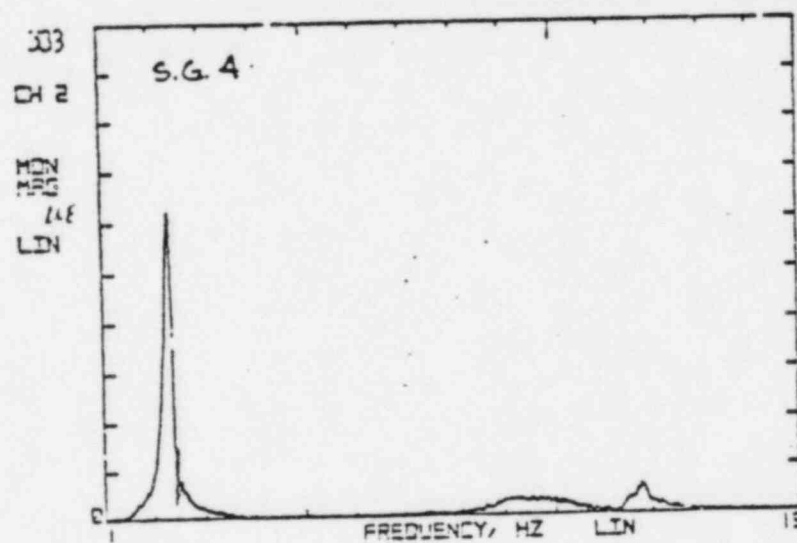


RUN 7 RSSNO2
ANPP RSPT SINE SWEEP

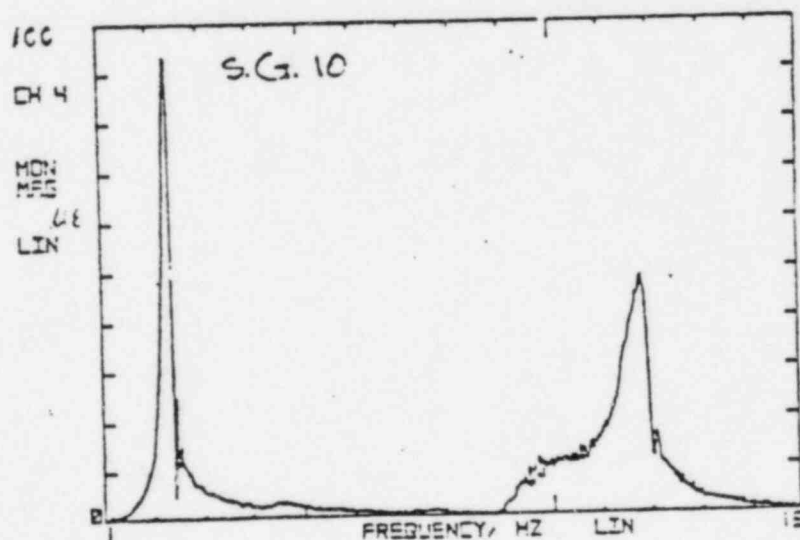
FIGURE 5C TYPICAL SINE SWEEP TRACES - TRANSFER FUNCTION
TEST FILE RS3NO2 - 0.02 g's EXCITATION



RUN 4 RSSNO2
ANPP RSPT SINE SWEEP



RUN 5 RSSNO2
ANPP RSPT SINE SWEEP



RUN 6 RSSNO2
ANPP RSPT SINE SWEEP

FIGURE 6 TYPICAL SINE SWEEP TRACES - STRAIN FREQUENCY RESPONSE PLOTS
0.02 g's EXCITATION

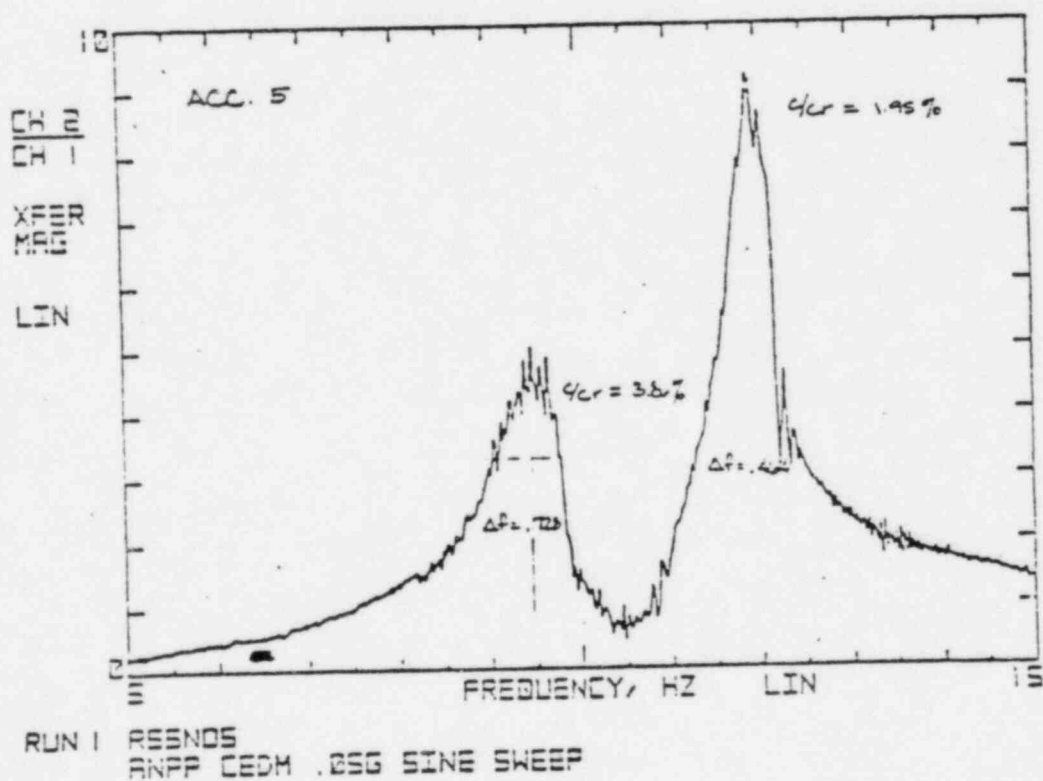
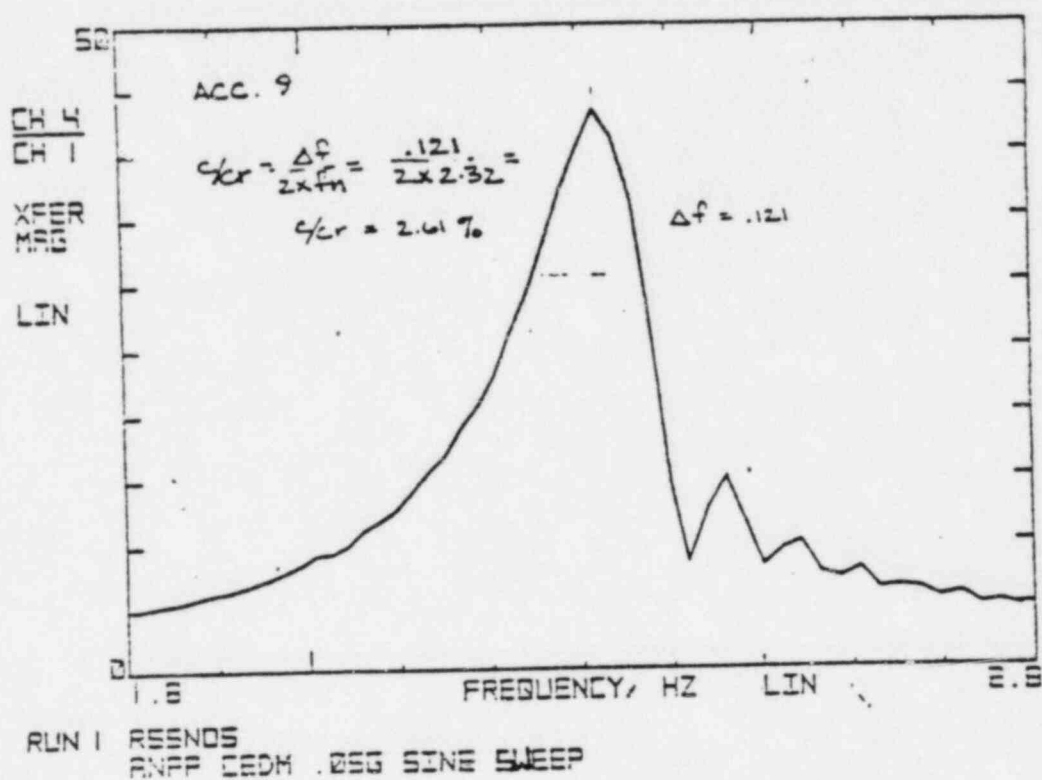


FIGURE 7

DETERMINATION OF MODAL DAMPING PROPERTIES FROM
BLOW-UP SINE SWEEP TRACES

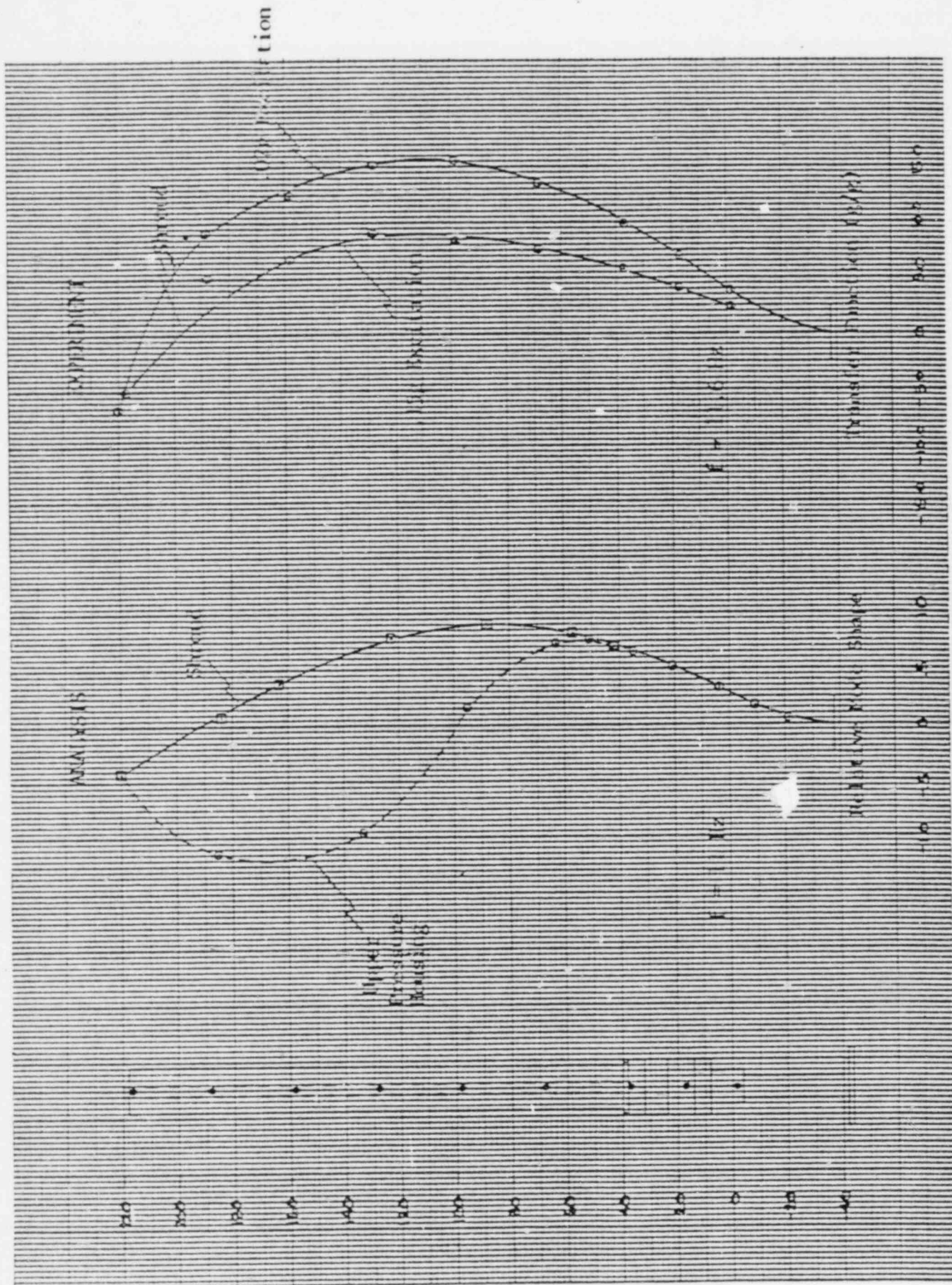


FIGURE 10 COMPARISON OF EXPERIMENTAL AND ANALYTICAL MODE SHAPES - THIRD MODE

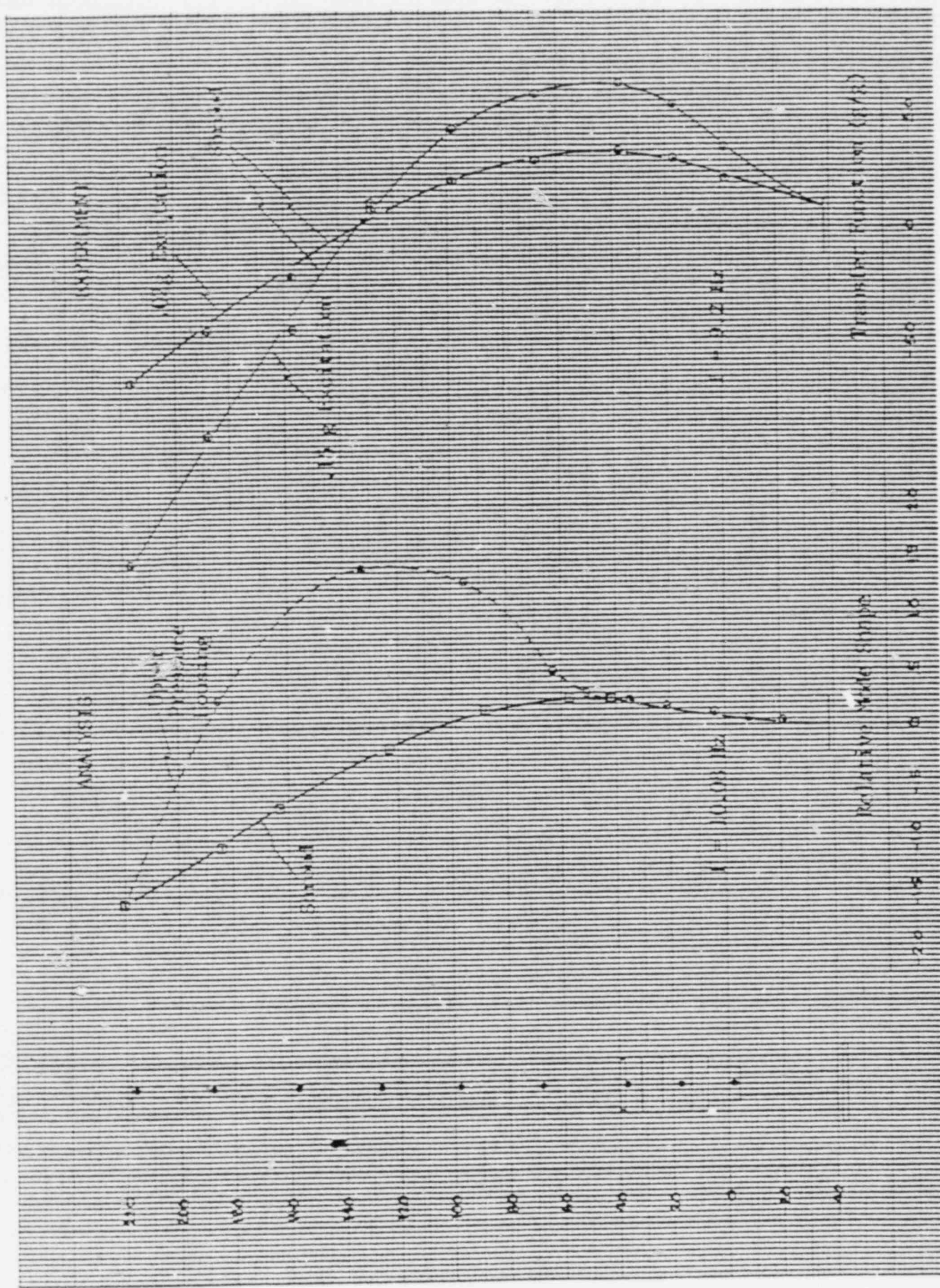


FIGURE 9 COMPARISON OF EXPERIMENTAL, AND ANALYTICAL, MODE SHAPES - SECOND MODE

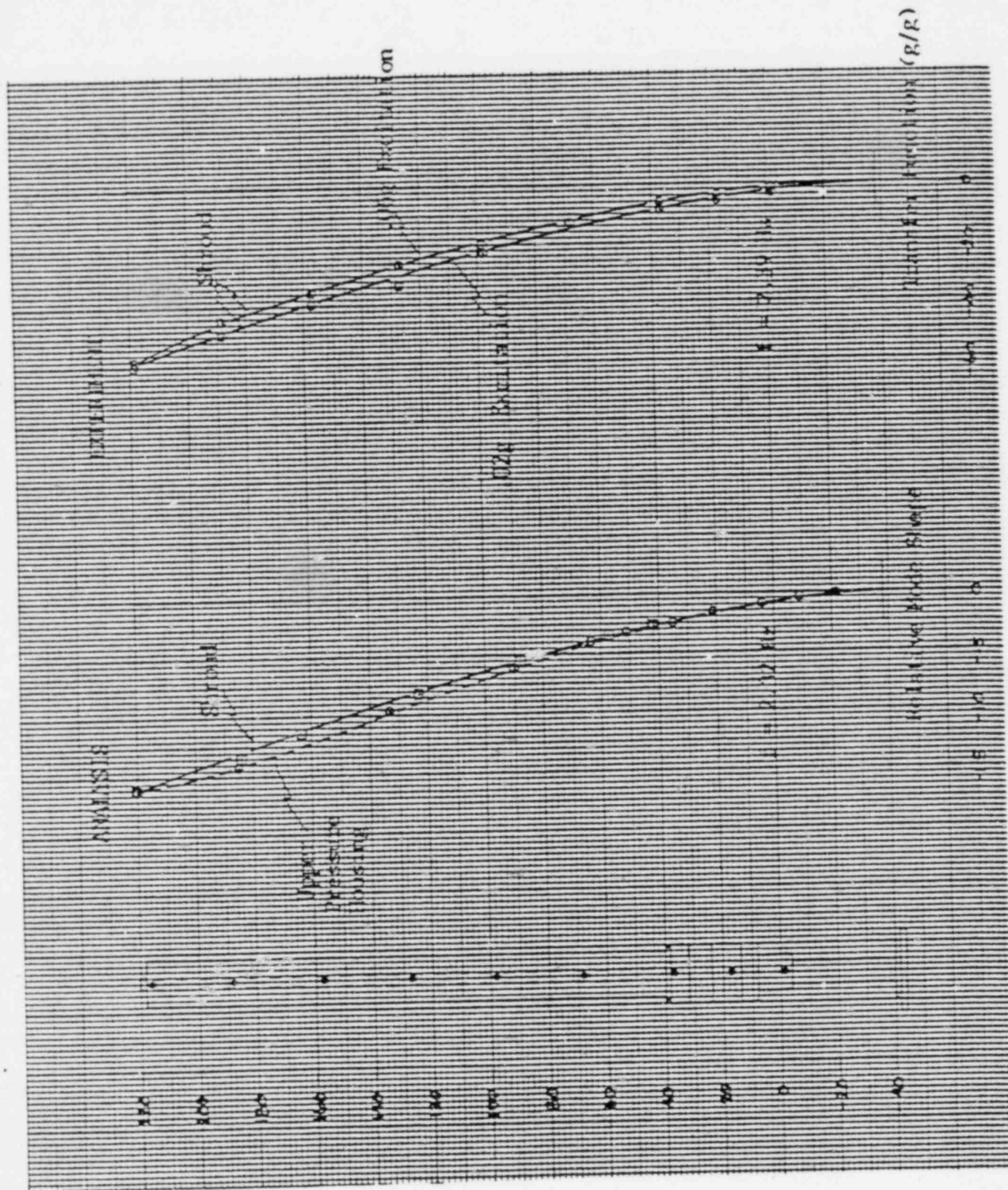


FIGURE 8 COMPARISON OF EXPERIMENTAL AND ANALYTICAL MODE SHAPES - FIRST NODE

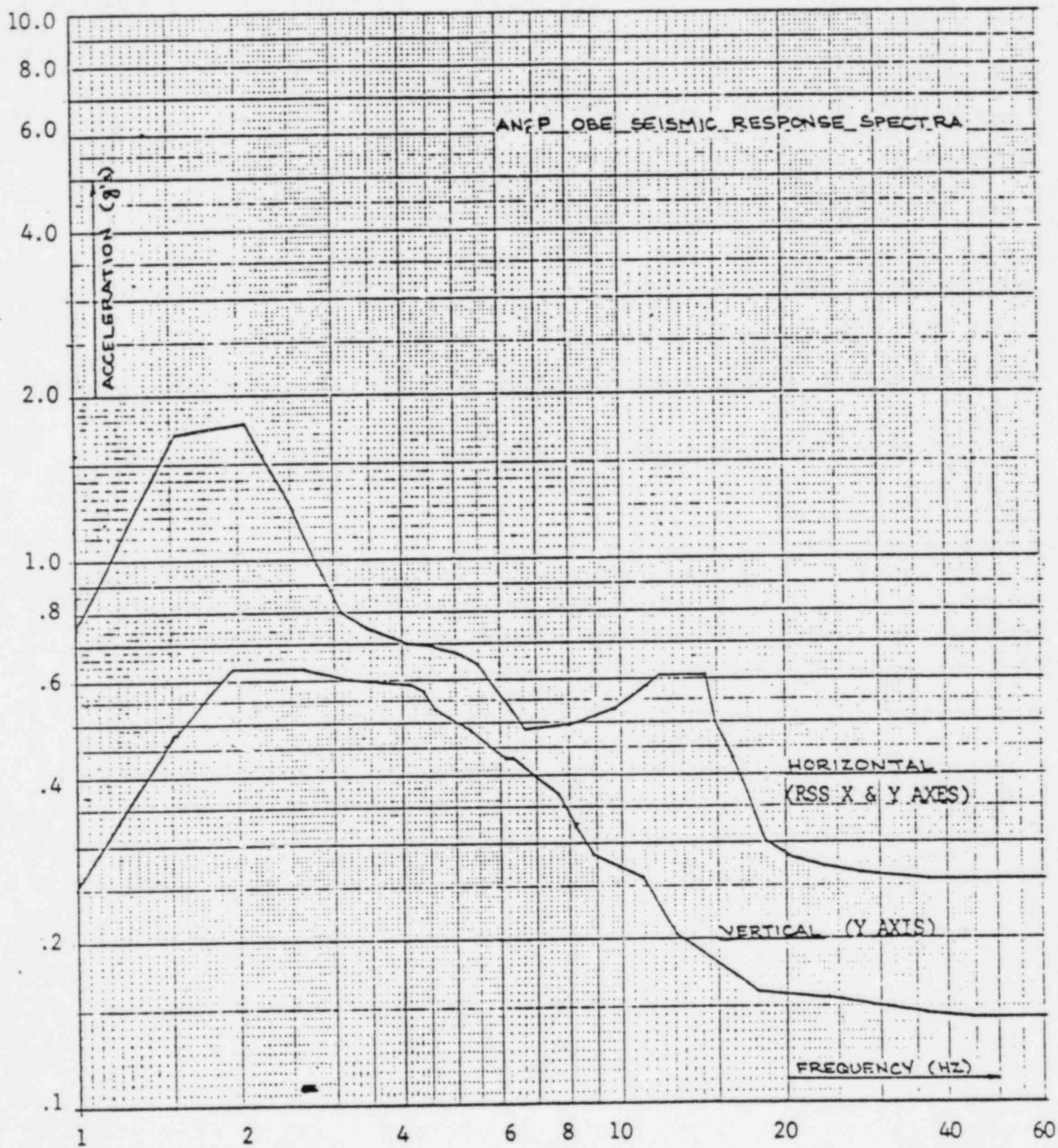


FIGURE 11 OBE REQUIRED RESPONSE SPECTRA - ANPP RSPT QUALIFICATION TEST, 2% DAMPING

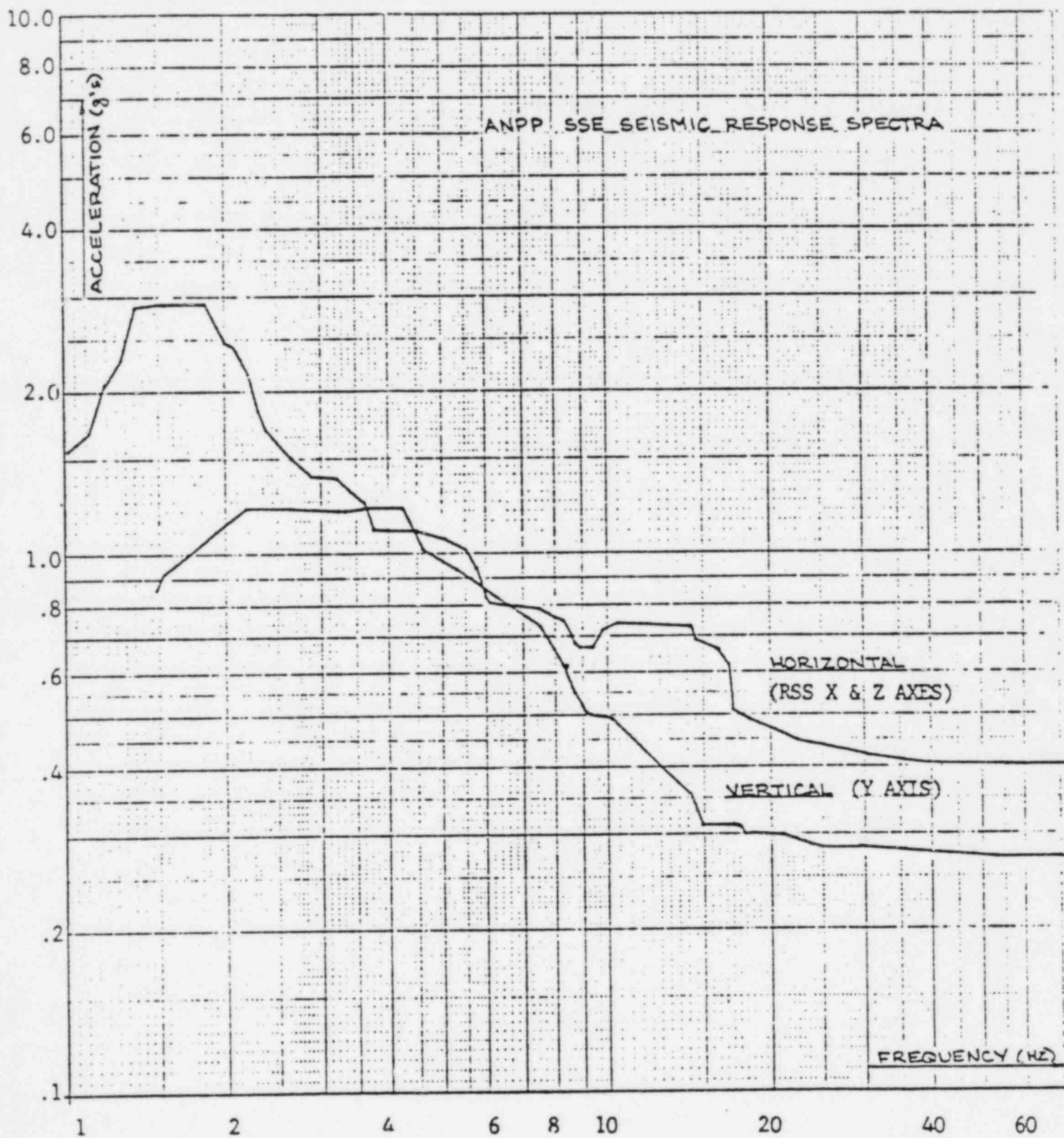


FIGURE 12 SSE REQUIRED RESPONSE SPECTRA - ANPP RSPT QUALIFICATION TEST, 2% DAMPING

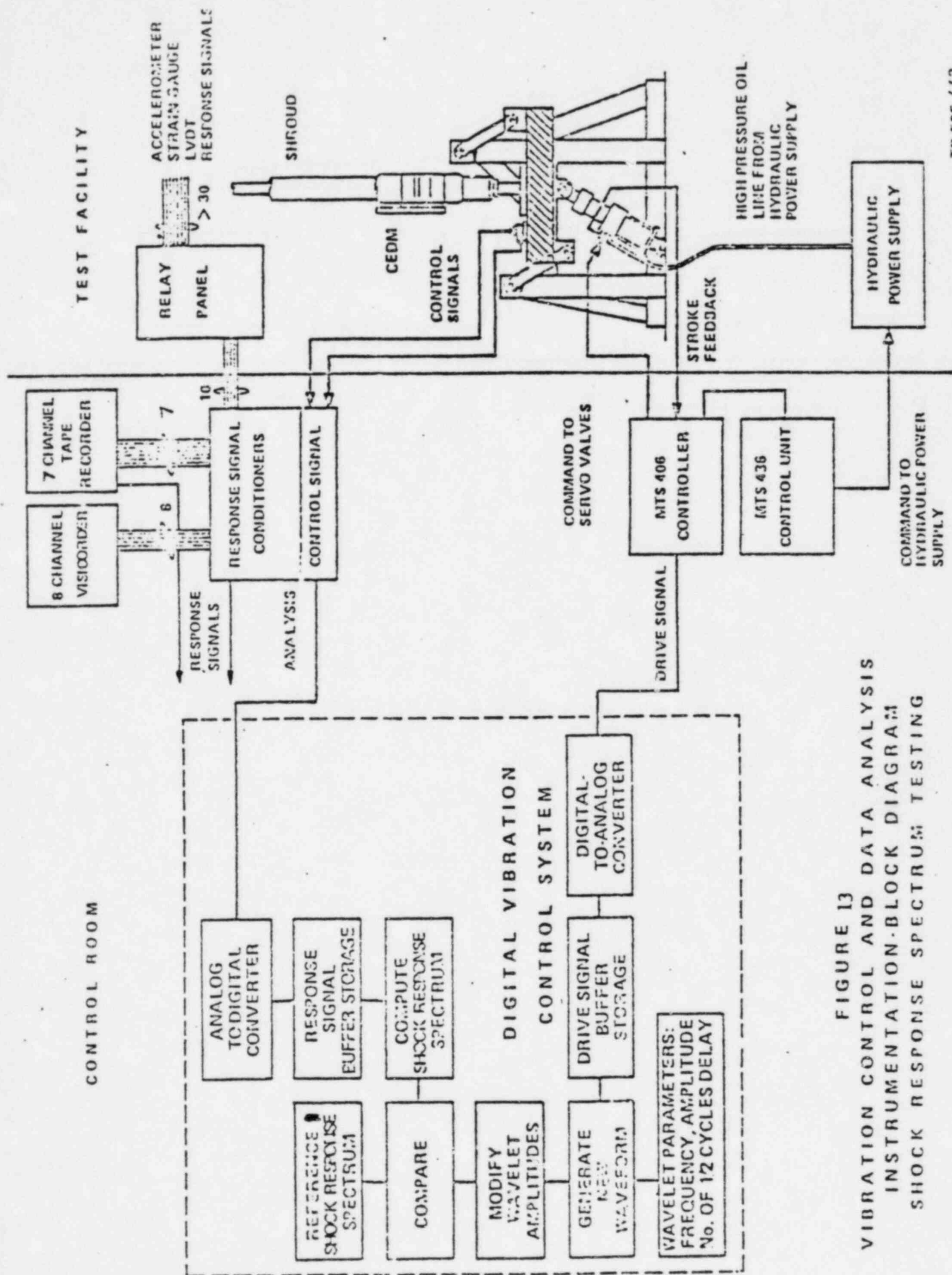


FIGURE 13
VIBRATION CONTROL AND DATA ANALYSIS
INSTRUMENTATION-BLOCK DIAGRAM
SHOCK RESPONSE SPECTRUM TESTING

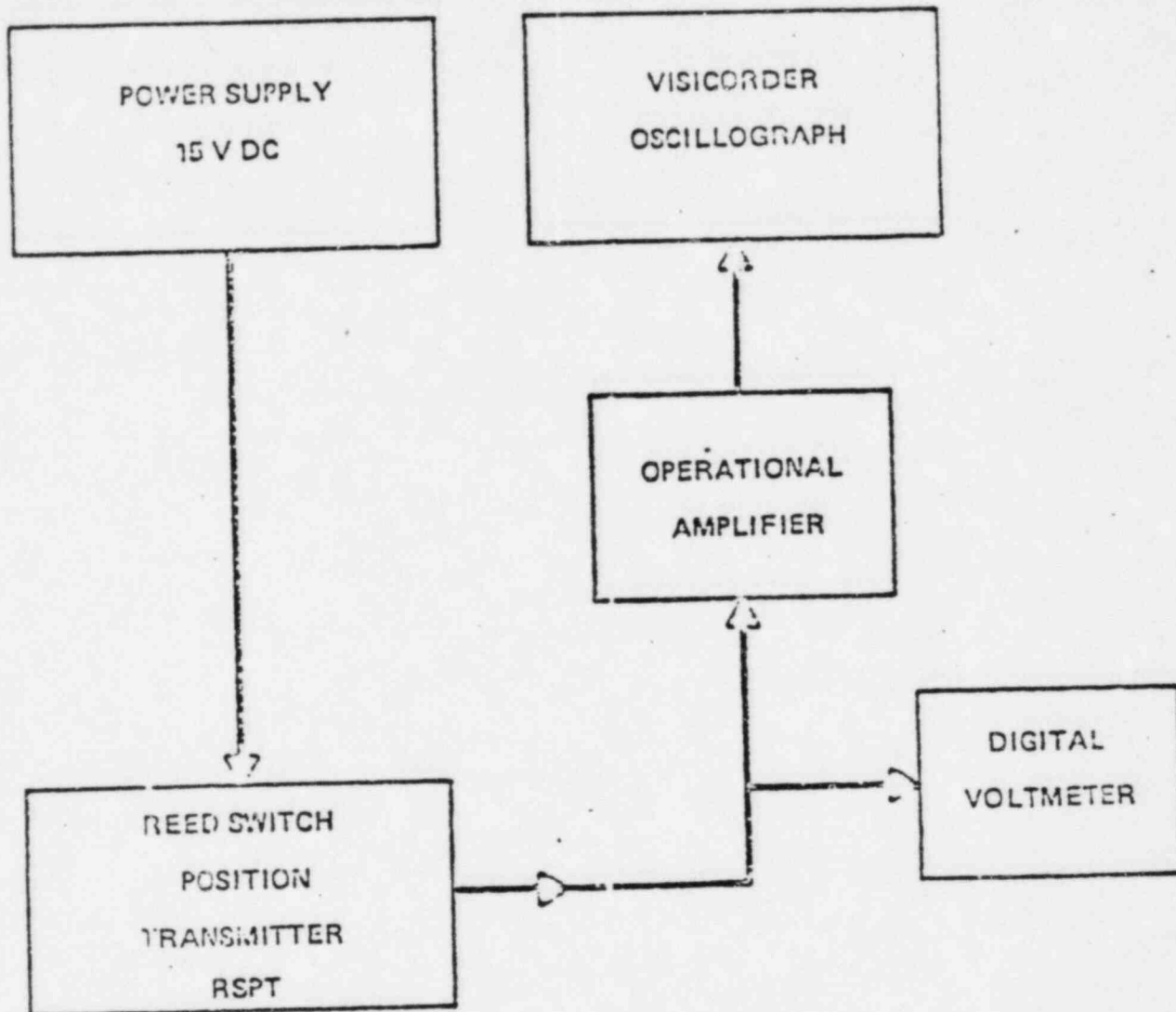


FIGURE 14
BLOCK DIAGRAM FOR MONITORING OF RSPT
ELECTRIC OUTPUT DURING SEISMIC
QUALIFICATION TEST

1 HEADING:ANPP SSE
 2 SENSITIVITY(MU/G):990.
 3 SHOCK RESP DEFN 0-ABS ACCEL 1-REL DISPL:0
 4 DAMPING COEFF:1.02
 5 MAX FREQ:50
 6 # OF DECADES 0-2 1-2.3 2-2.6 3-3:3
 7 WAVE PARAMETERS

	FREQ	AMPL
1	1.	1.53
2	1.12	1.95
3	1.25	2.21
4	1.41	2.87
5	1.58	2.92
6	1.77	2.92
7	1.99	2.5
8	2.23	2.07
9	2.51	1.61
10	2.81	1.42
11	3.16	1.38
12	3.54	1.26
13	3.98	1.21
14	4.46	1.1
15	5.01	1.07
16	5.62	.98
17	6.3	.83
18	7.07	.79
19	7.94	.76
20	8.91	.66
21	10.	.72
22	11.21	.73
23	12.58	.73
24	14.12	.73
25	15.84	.66
26	17.78	.49
27	19.95	.47
28	22.38	.44
29	25.11	.44
30	28.17	.44
31	31.62	.44
32	35.48	.44
33	39.81	.44
34	44.65	.44
35	50.1	.44

8 PEAK WAVELET AMPL(U):10.

9 AUTO MODE LEVEL SEQ 0-FULL 1-1/2 2-1/4 3-1/8 4-1/16 5-DONE
 FIRST:5

10 EXTERNAL TRIGGER MODE 0-NO 1-YES:1

11 ALARM BAND 1

+DB LIMIT:3.

-DB LIMIT:-3.

UPPER FREQ, HZ:50.

FIGURE 15 TYPICAL INPUT LISTING - SHOCK RESPONSE SPECTRUM TEST
 ANPP - SSE EVENT

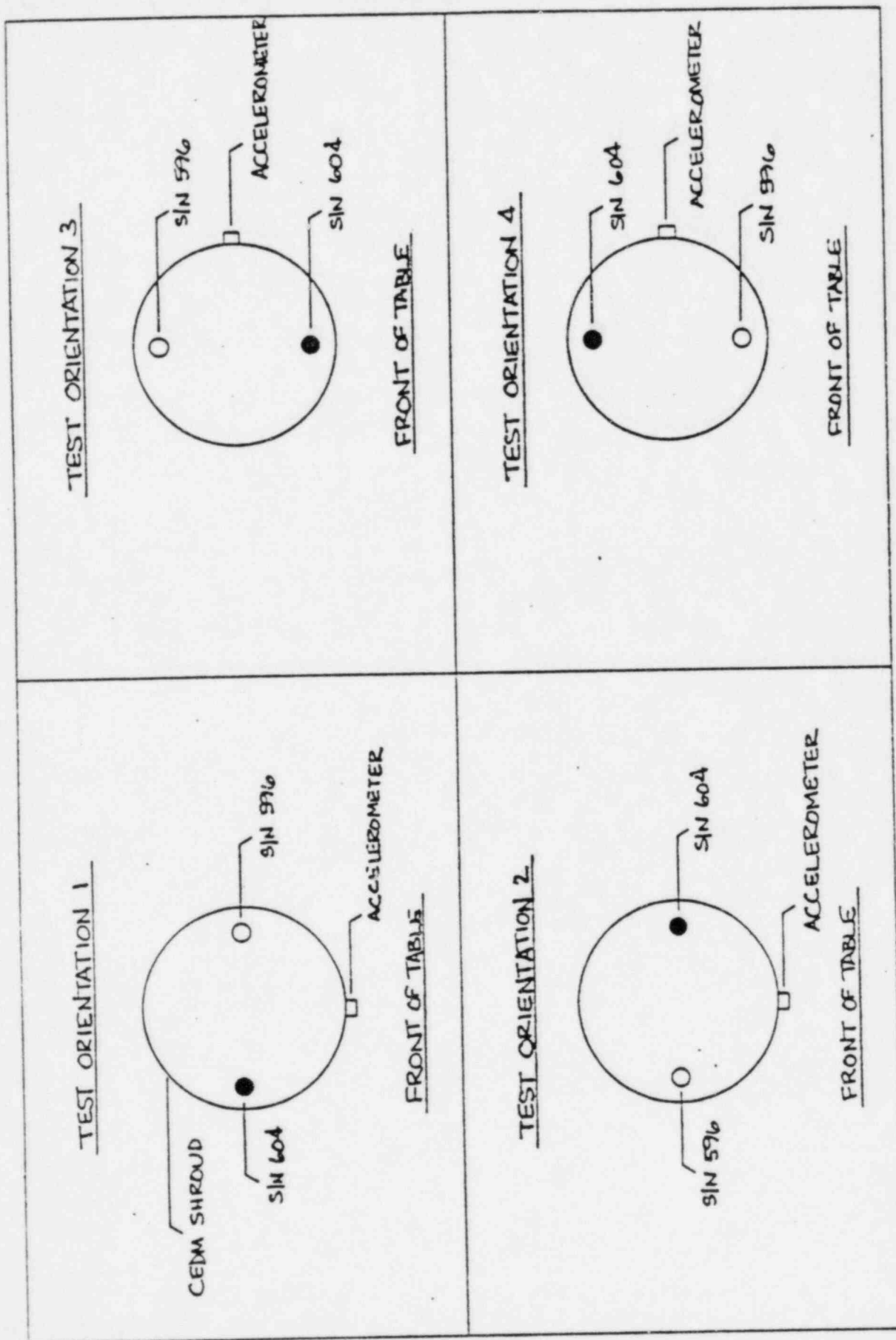
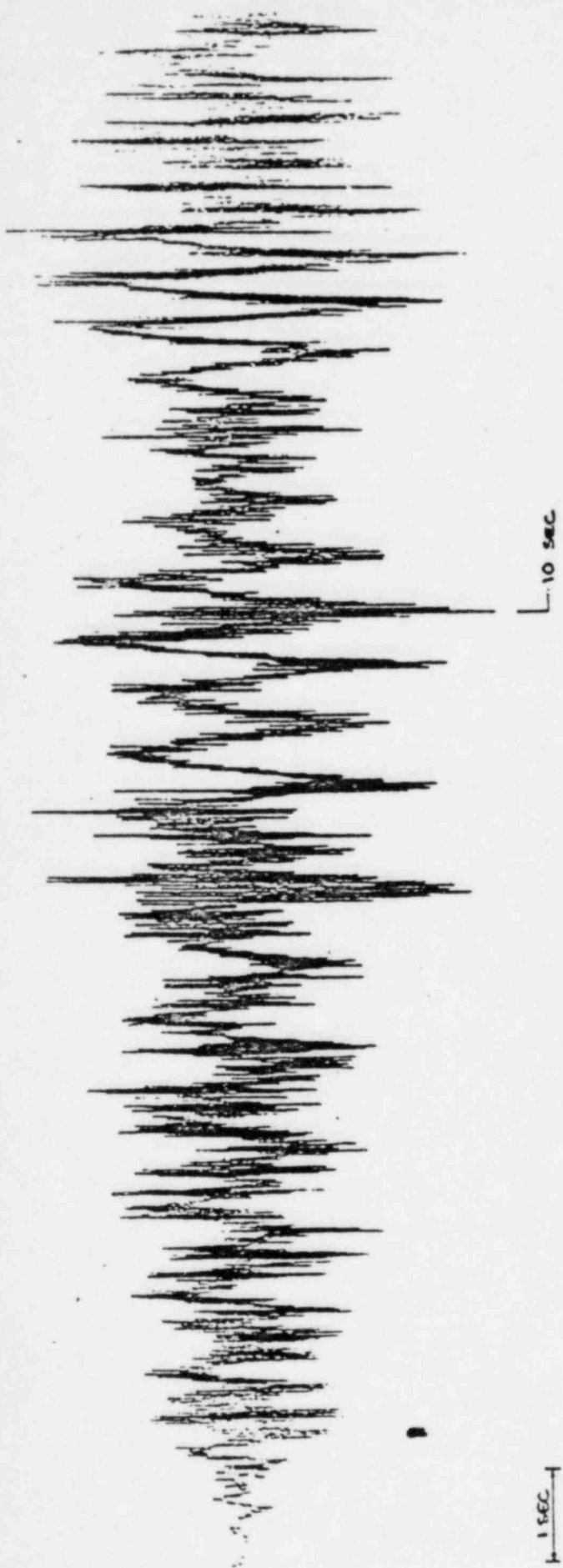


FIGURE 16

POSITION OF TEST SPECIMENS DURING TEST ORIENTATIONS 1 THROUGH 4 - TOP VIEW



10 SEC

1 SEC



10 SEC

30 SEC

FIGURE 17 HORIZONTAL TABLE TIME HISTORY RUN 26 SSE EVENT

TR-FSF-442

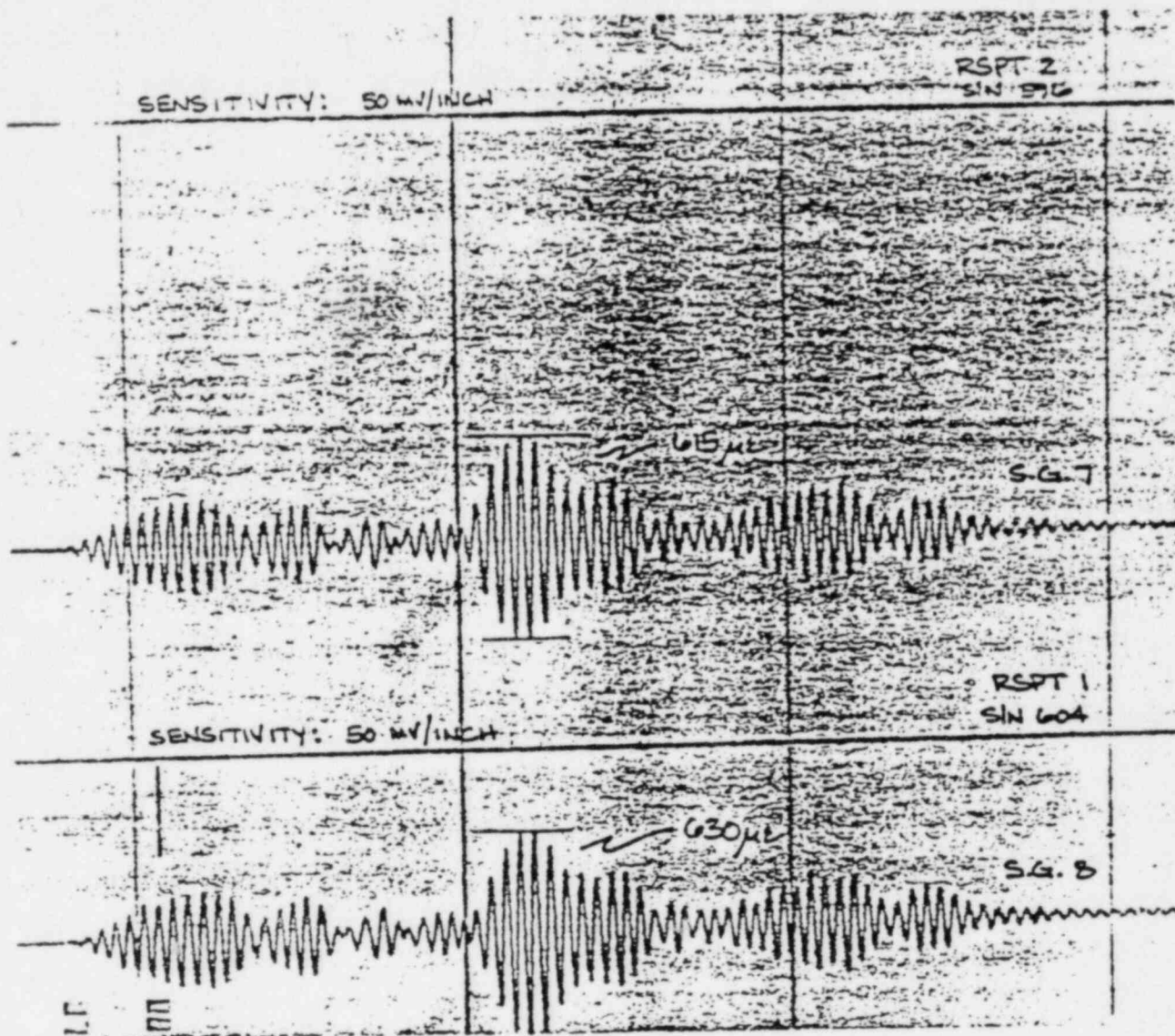


FIGURE 18

STRAIN AND RSPT TIME HISTORIES
OBE EVENT TEST ORIENTATION 3

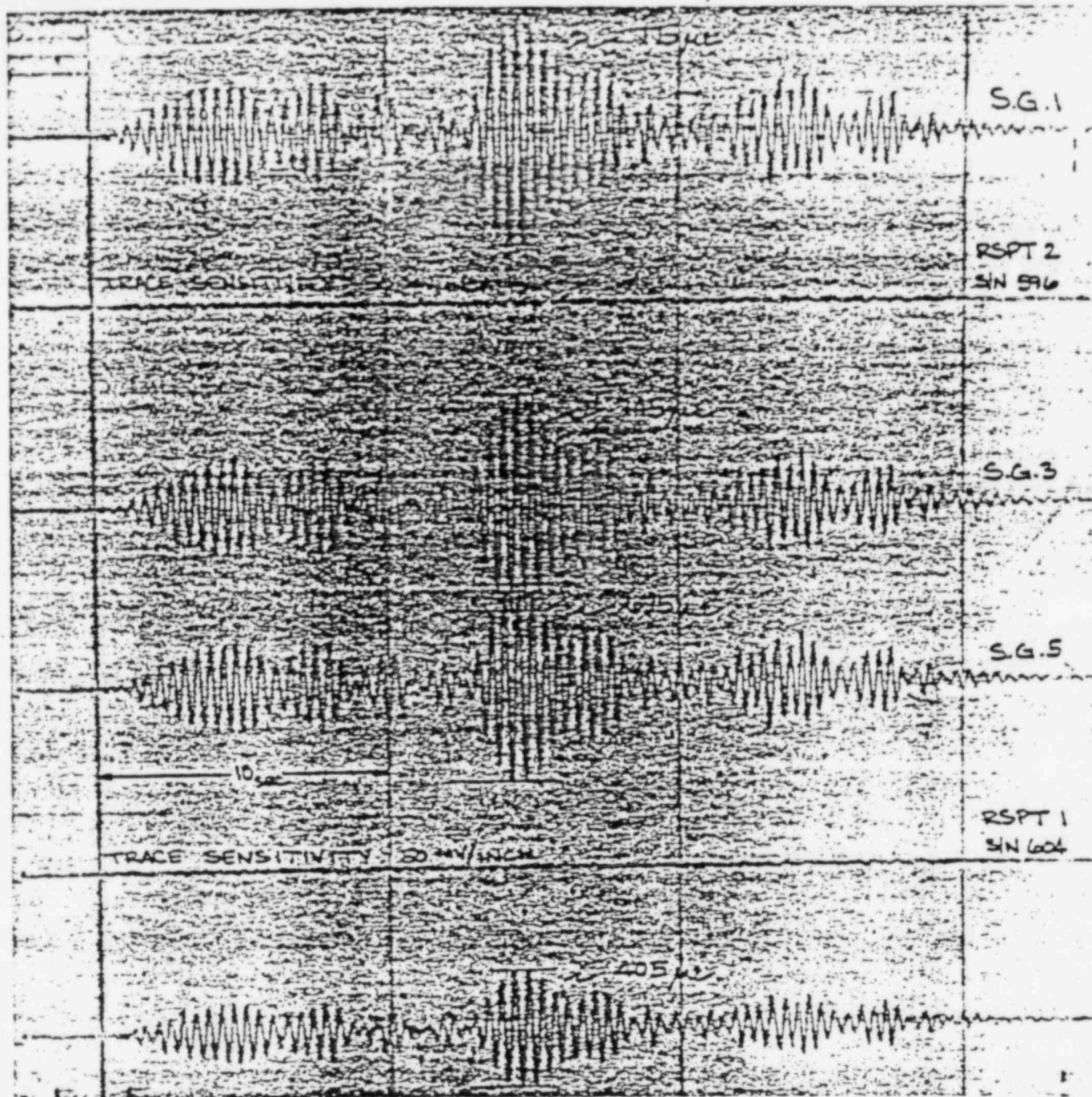


FIGURE 19

STRAIN AND RSPT TIME HISTORIES
SSE EVENT TEST ORIENTATION 1

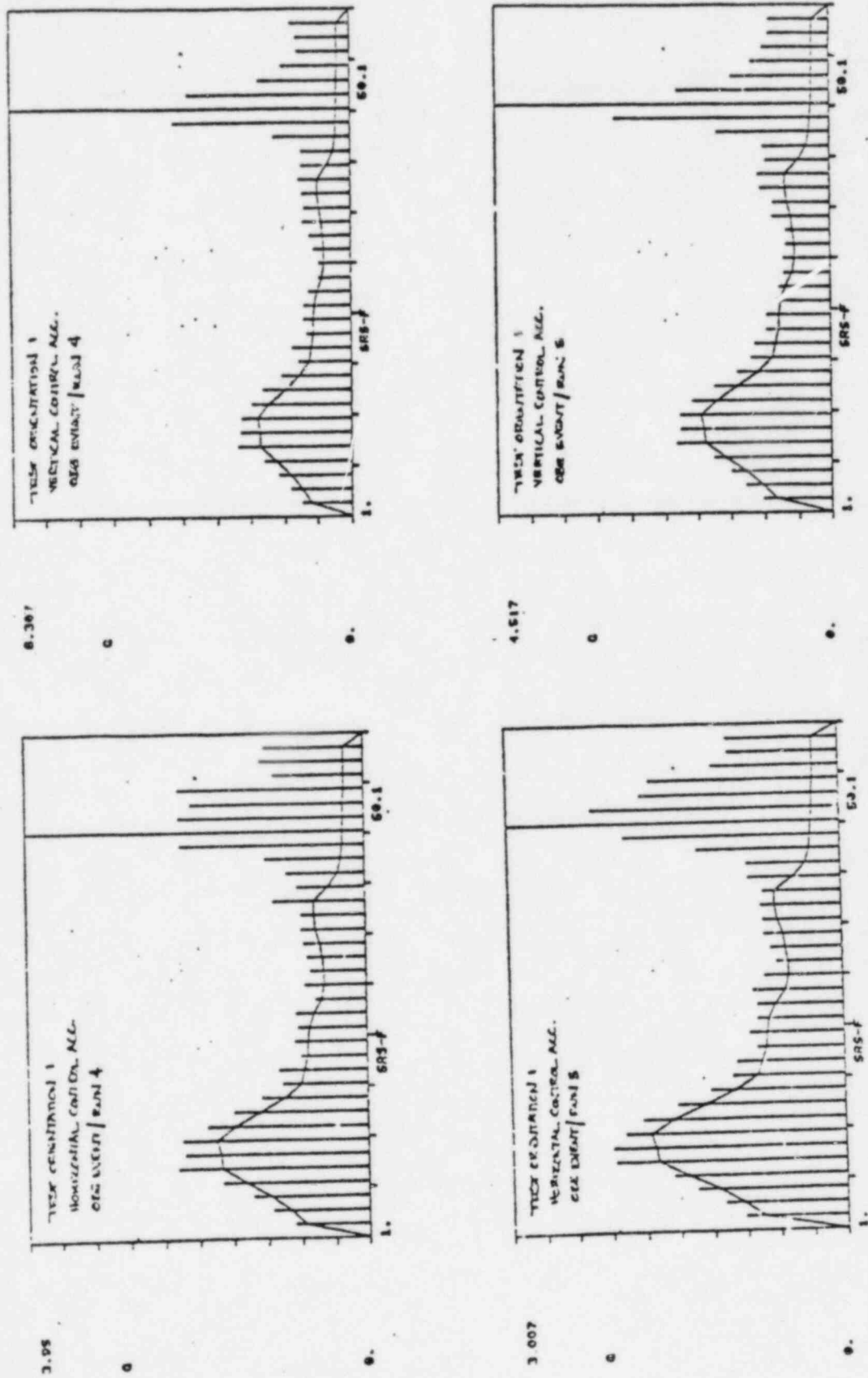
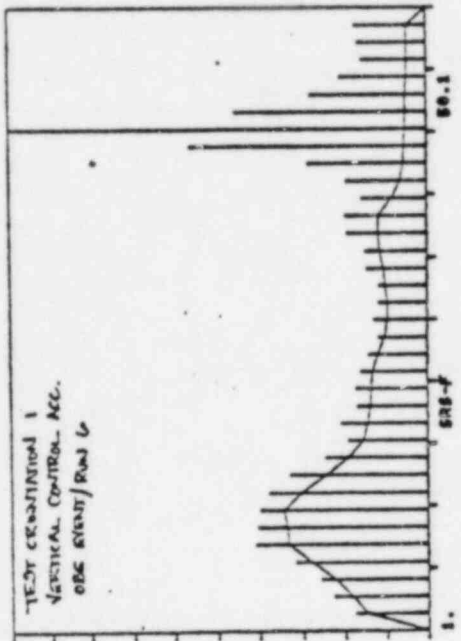
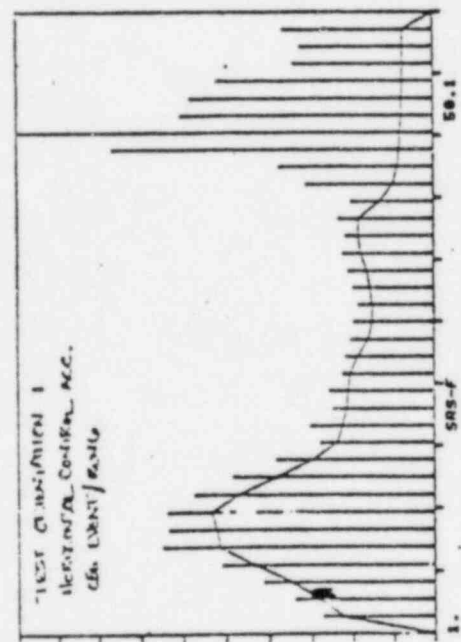


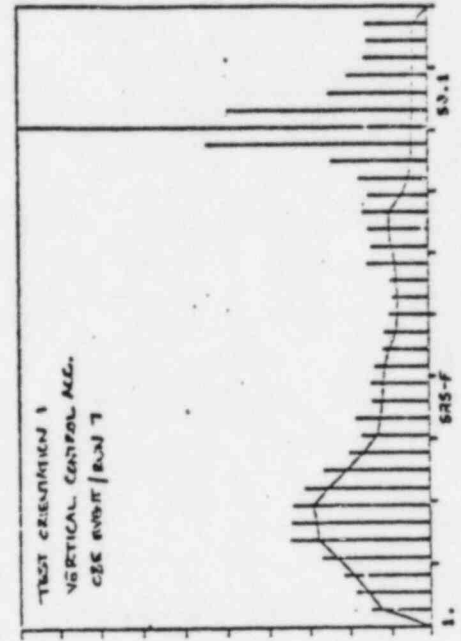
FIGURE 20A HORIZONTAL AND VERTICAL, TEST RESPONSE SPECTRA - OBE EVENT
TEST ORIENTATION 1 - RUN NOS. 4 & 5



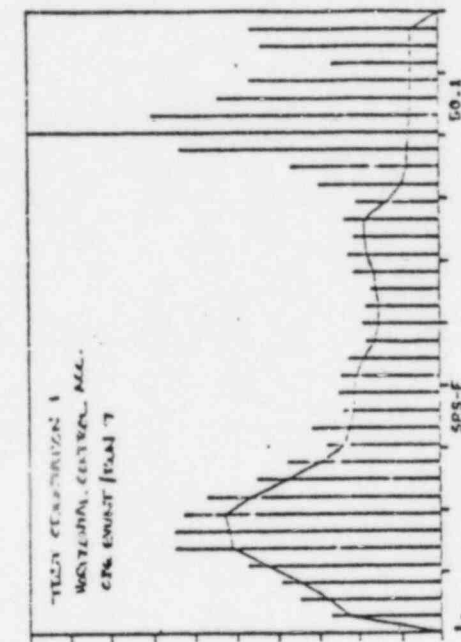
5.108



3.2



6.078



3.338

FIGURE 20B HORIZONTAL AND VERTICAL TEST RESPONSE SPECTRA - OBE EVENT
TEST ORIENTATION 1 - RUN NOS. 6 & 7

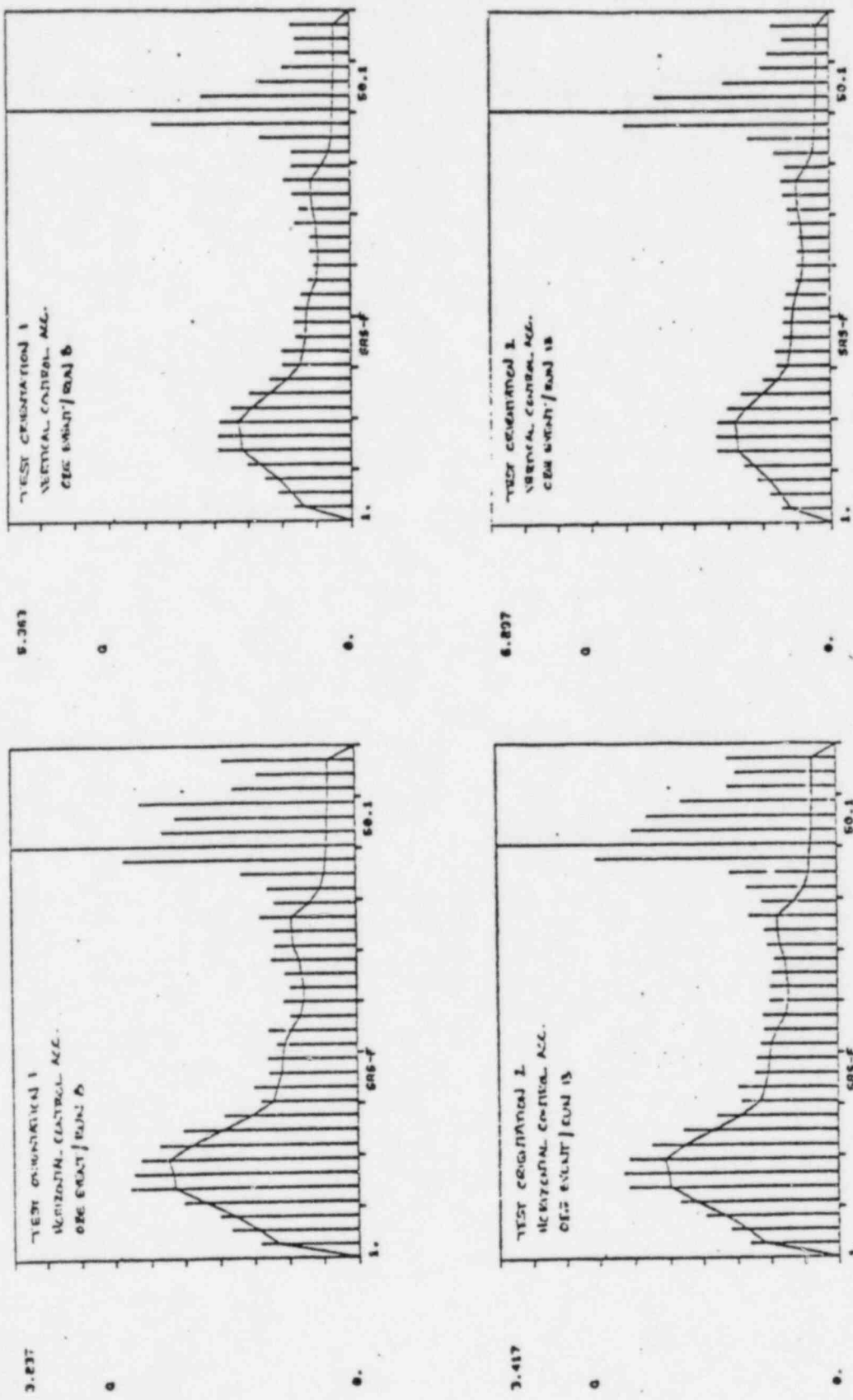


FIGURE 20C HORIZONTAL AND VERTICAL TEST RESPONSE SPECTRA - OBE EVENT
TEST ORIENTATION 1 - RUN NO. 8, TEST ORIENTATION 2 - RUN NO. 13

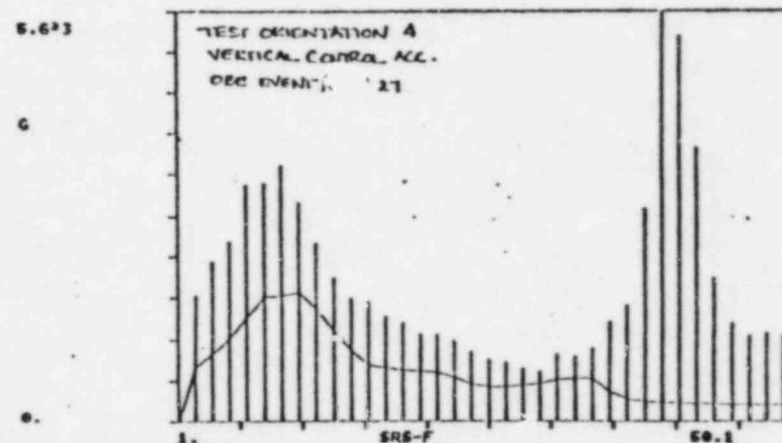
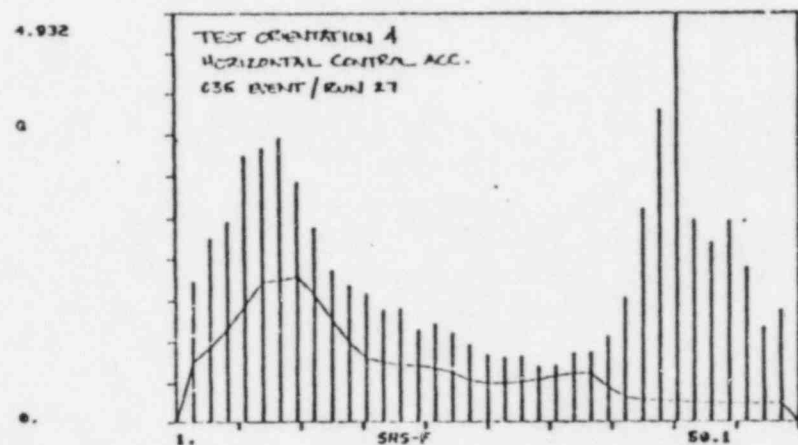
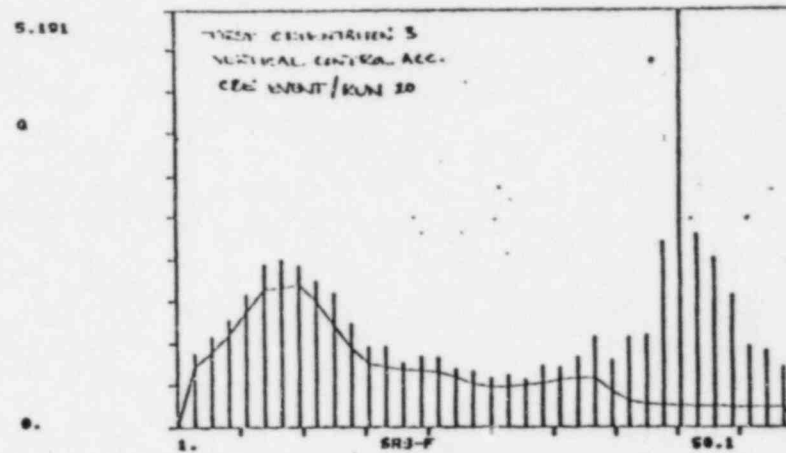
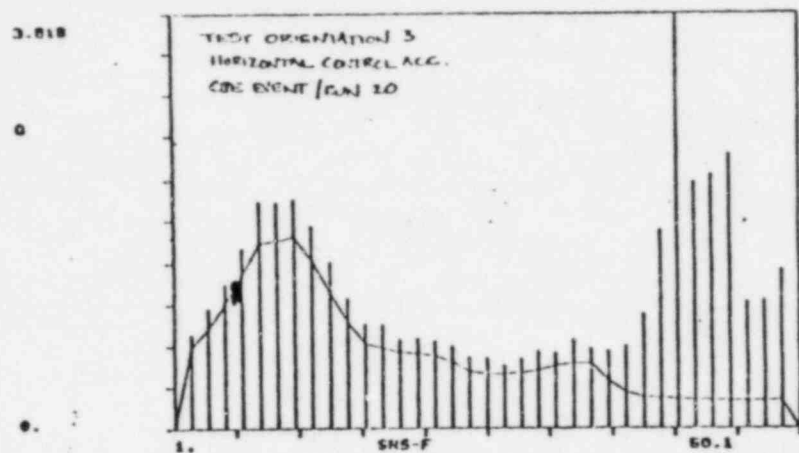
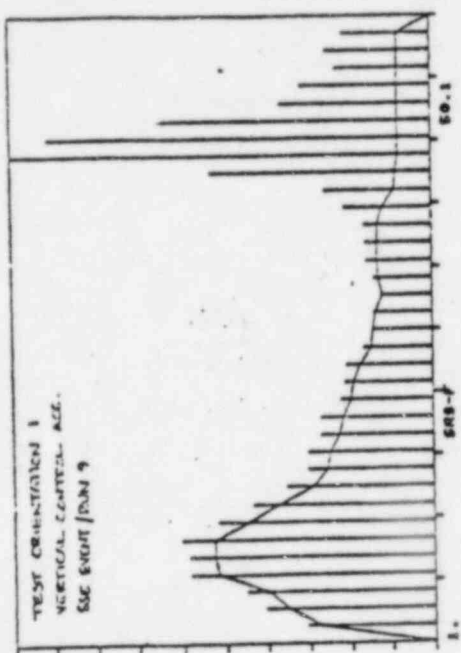


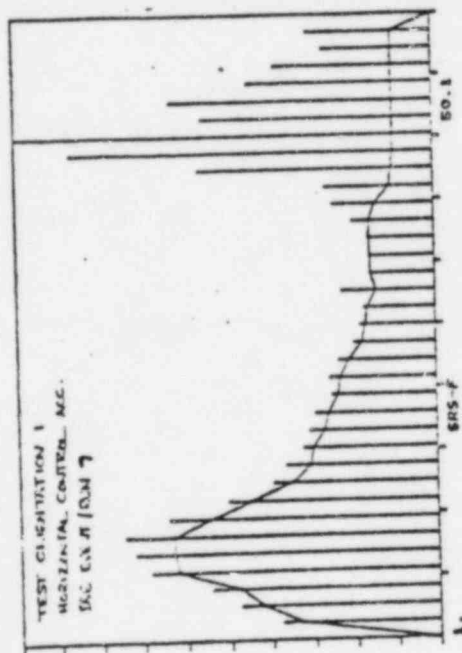
FIGURE 20D HORIZONTAL AND VERTICAL TEST RESPONSE SPECTRA - OBE EVENT
TEST ORIENTATION 3 - RUN NO. 20, TEST ORIENTATION 4 - RUN NO. 27



5.567

g

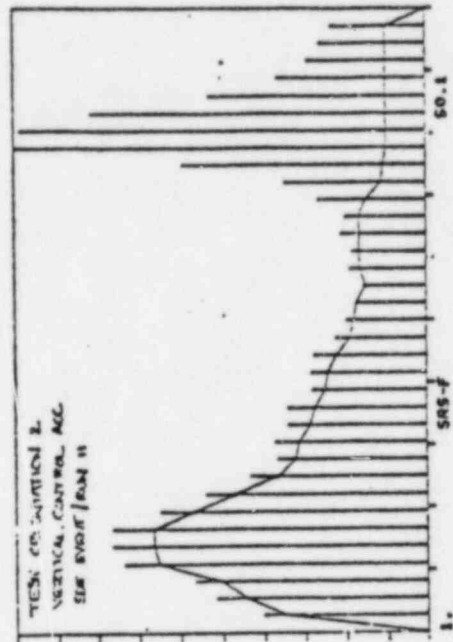
0.



4.628

g

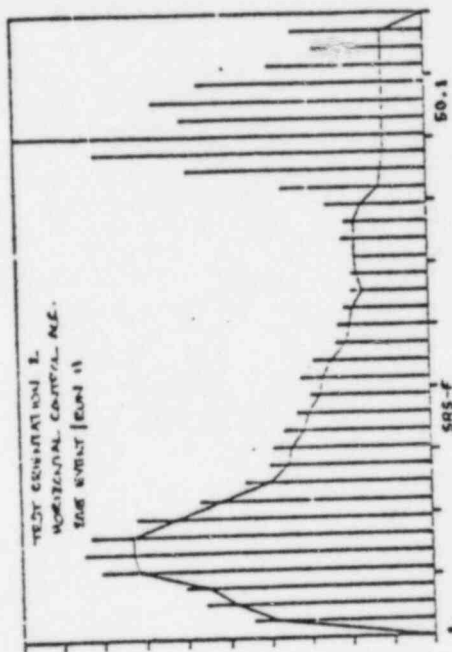
0.



4.38

g

0.



4.607

g

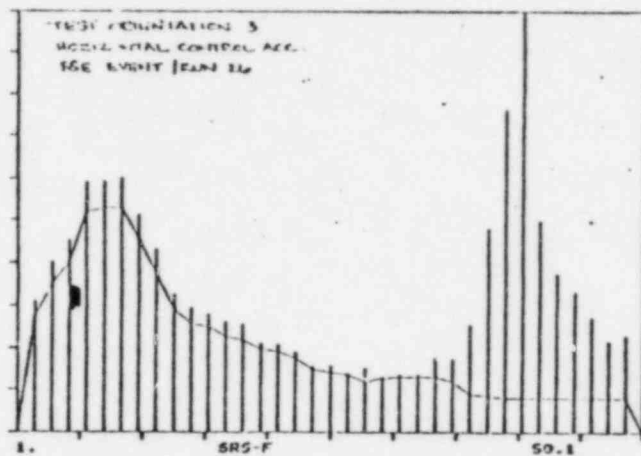
0.

FIGURE 21A HORIZONTAL AND VERTICAL TEST RESPONSE SPECTRA SSE EVENT
TEST ORIENTATION 1 - RUN NO. 9, TEST ORIENTATION 2 - RUN NO. 11

5.517

g

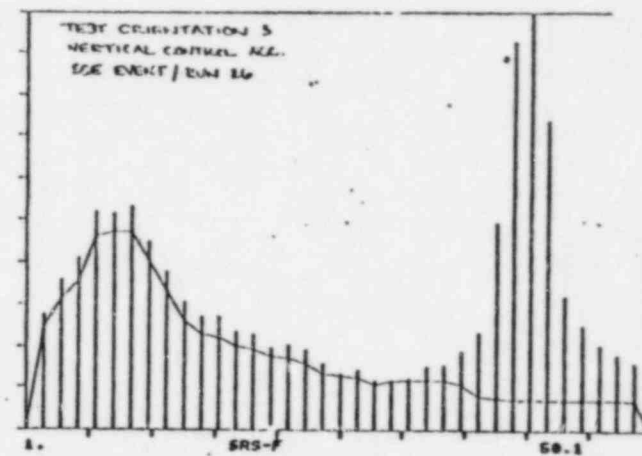
0.



6.19

g

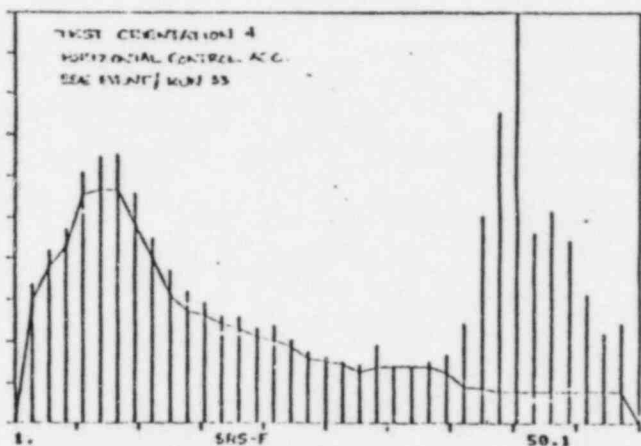
0.



5.114

g

0.



6.079

g

0.

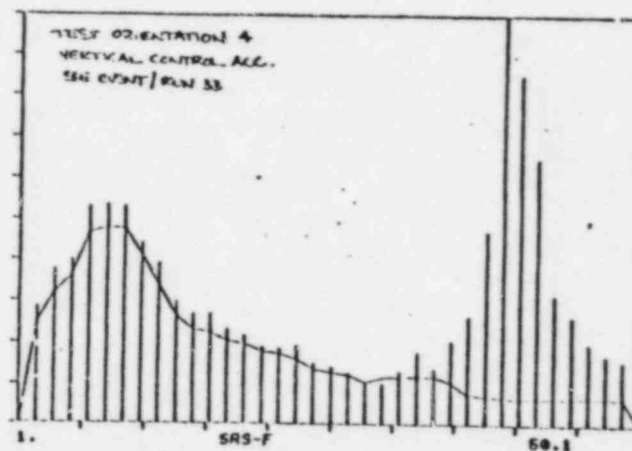


FIGURE 21B HORIZONTAL AND VERTICAL TEST RESPONSE SPECTRA SSE EVENT
TEST ORIENTATION 3 - RUN NO. 26, TEST ORIENTATION 4 - RUN NO. 33

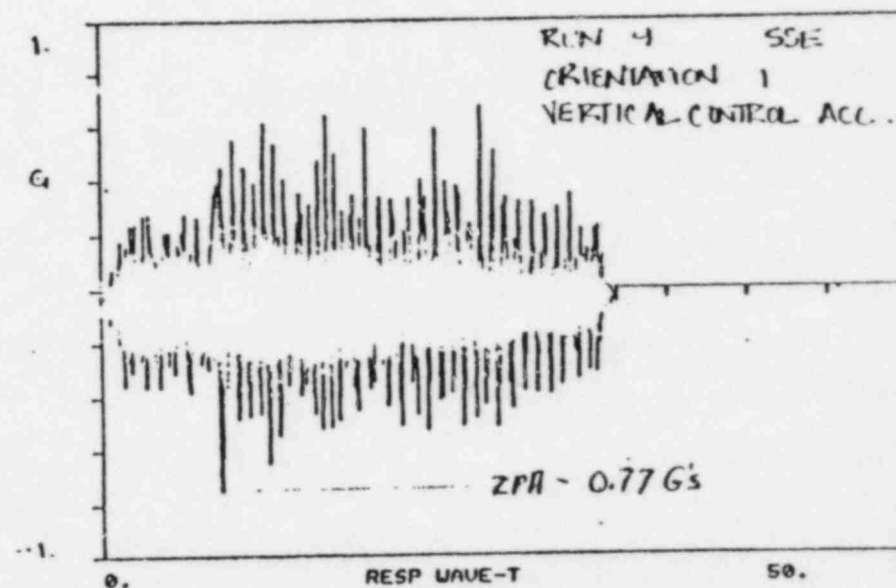
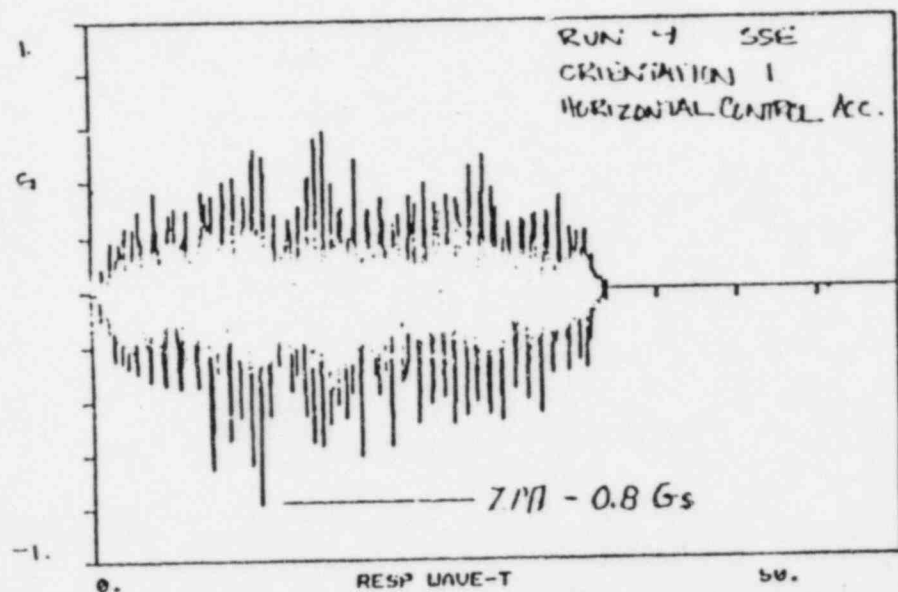
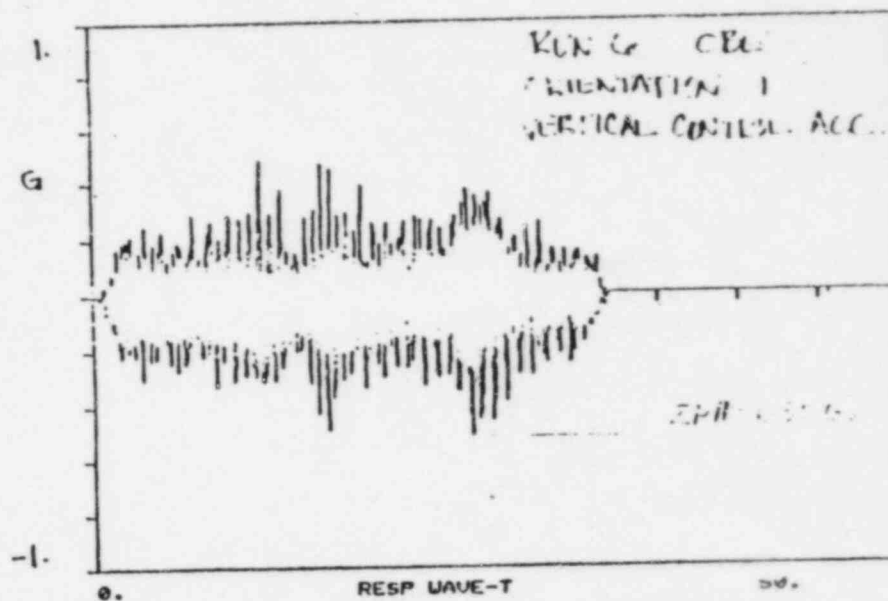
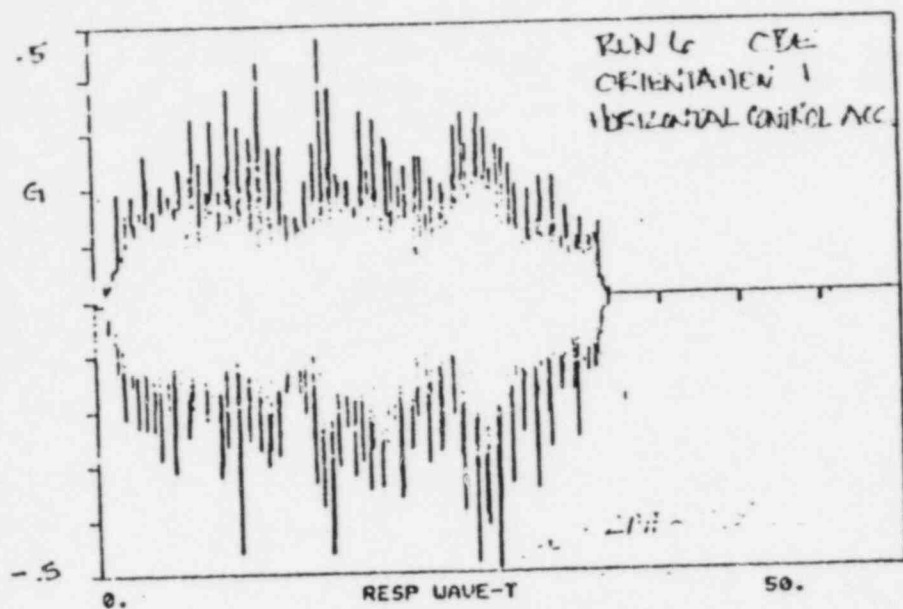


FIGURE 22 HORIZONTAL AND VERTICAL TABLE TIME HISTORIES, OBE AND SSE EVENT TEST ORIENTATION 1

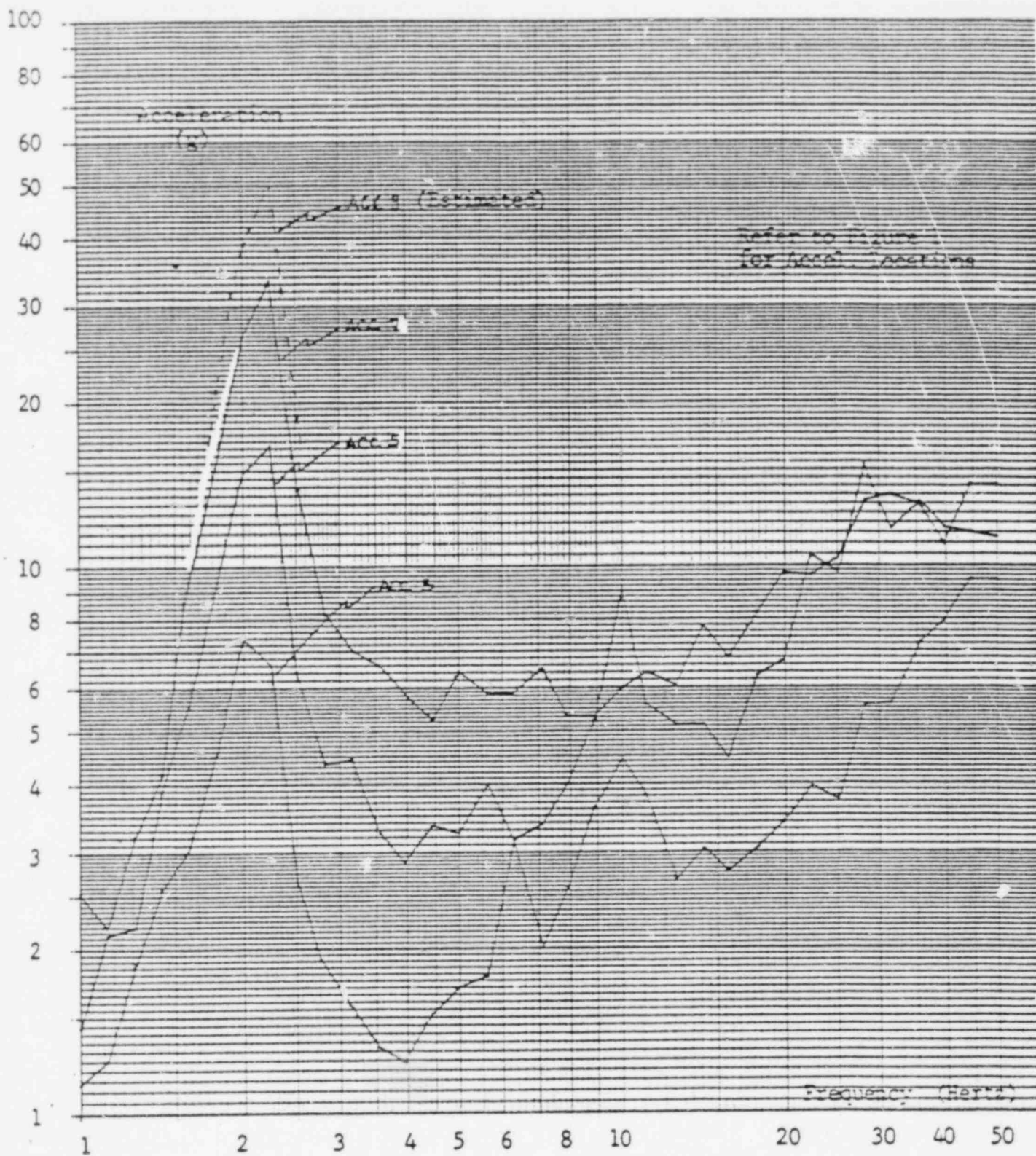


FIGURE 23

RESPONSE SPECTRA OF DIFFERENT SHROUD ELEVATIONS
OBE EVENT ORIENTATION 1 2% DAMPING

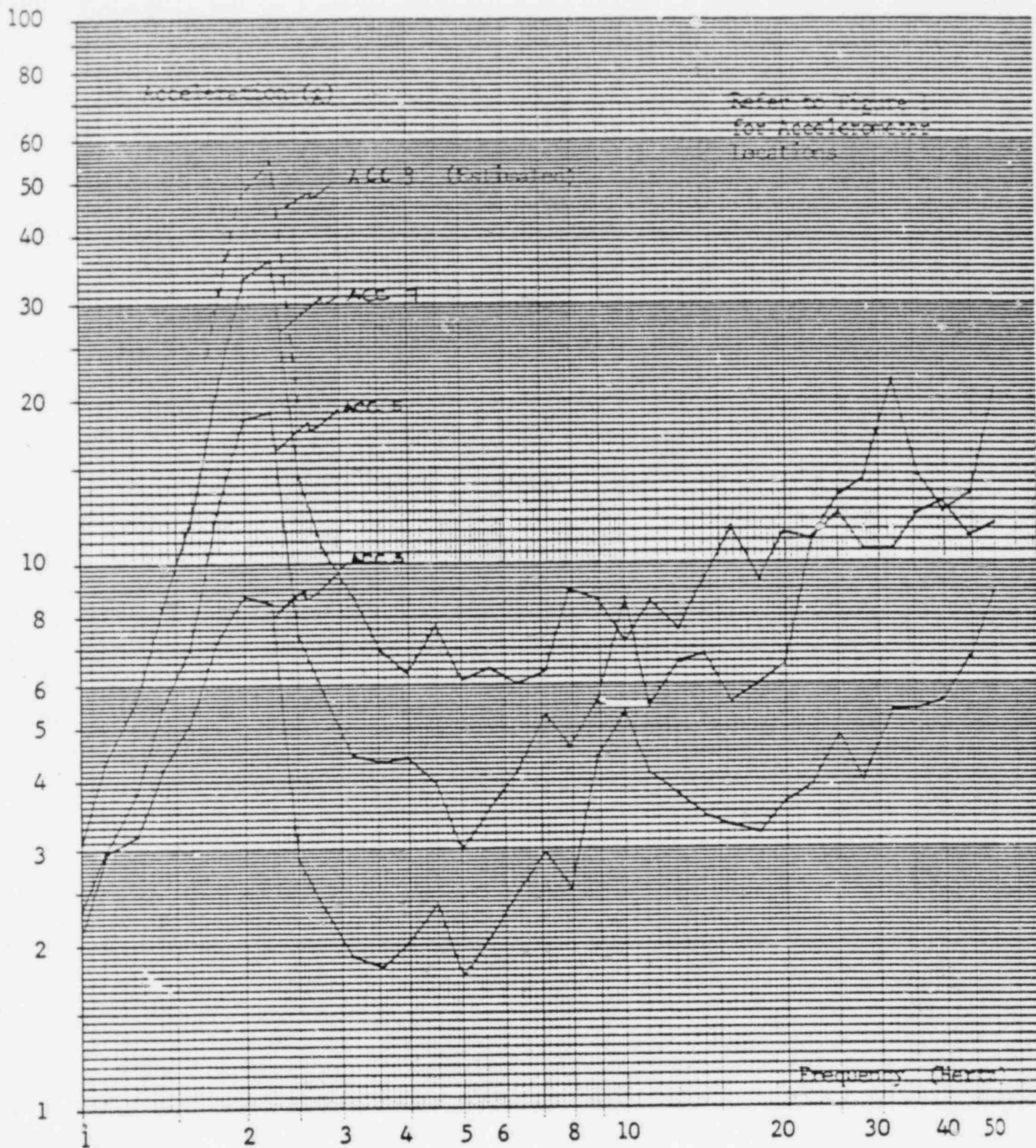


FIGURE 24
RESPONSE SPECTRA AT DIFFERENT SHROUD ELEVATIONS
SSE EVENT ORIENTATION 1 2% DAMPING

APPENDIX C

RESULTS: STATIC LOAD DEFLECTION TESTS
AND FIRST MODE DYNAMIC TEST

Static Deflection Tests

Using a pull wire arrangement (connected to the CEDM top), the CEDM was deflected incrementally up to 5 inch total displacement. The deflection at the CEDM top was measured by an LVDT with ± 5 inch travel. The strain gauges (Nos. 7 and 8) were connected to a balance box and measured by a digital readout unit. The results from the static load deflection tests are summarized on page C-3. A linear deflection characteristic was observed with a strain to deflection ratio of about 111 $\mu\epsilon$ /in, whereby the strain was measured 4 inches above the base plate and the deflection at the CEDM top.

First Mode Dynamic Test

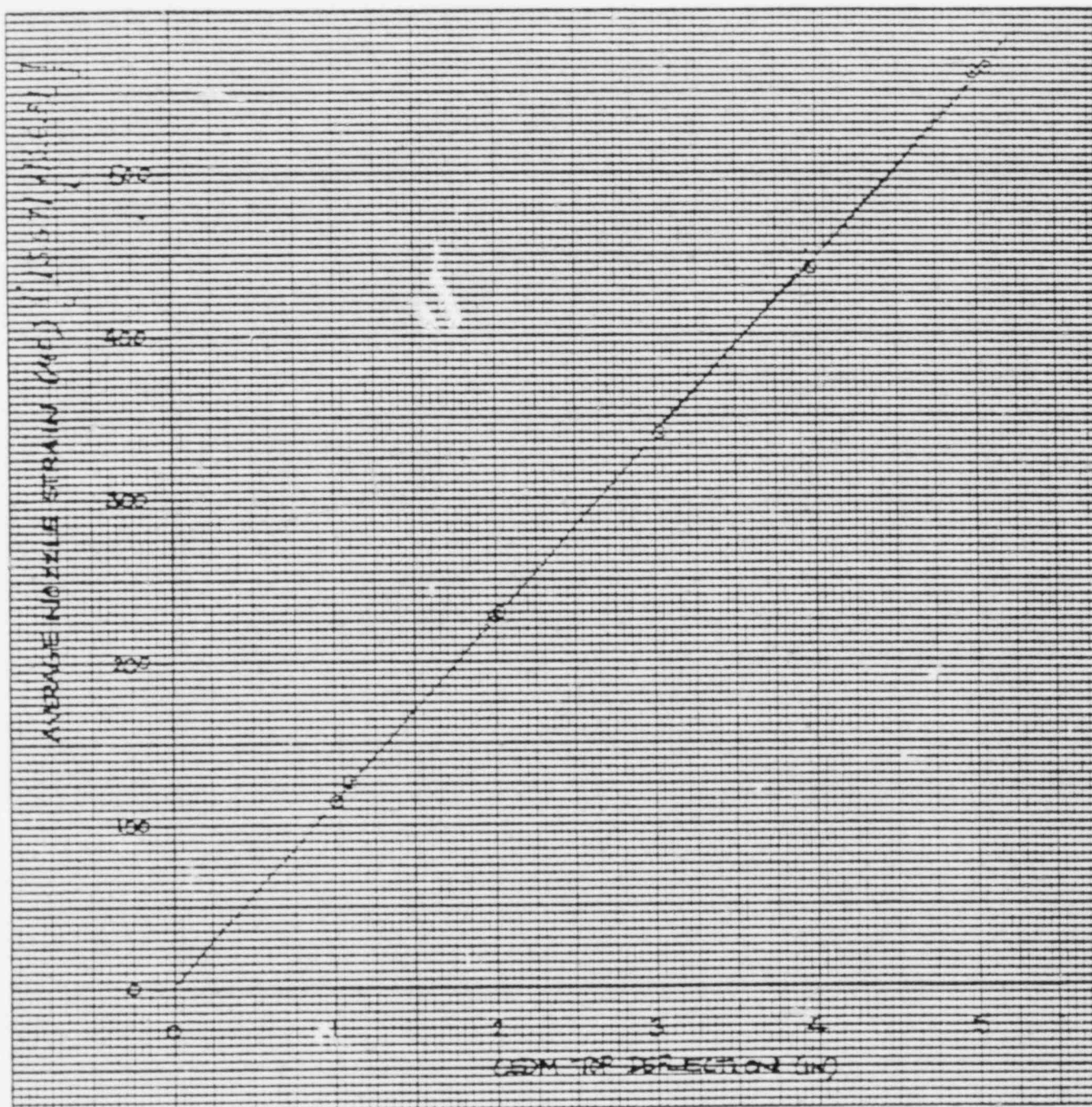
Strain gauges 7 and 8 were connected over two dynamic signal conditioning units (same as described in main report) to the visicorder readout device. The 5" stroke LVDT was displayed on a third visicorder channel. The CEDM was set into vibratory motion by exciting it manually above the coilstack. The resulting CEDM top motions, as well as the nozzle strain levels were then recorded on calibrated visicorder traces and converted into engineering units. The figure on page C-4 shows a typical visicorder trace and an average nozzle strain of about 240 $\mu\epsilon$ per 2.41 inch top deflection (or 100 $\mu\epsilon$ /in) is observed. This value is slightly higher than those recorded for strain gauges 1 through 4 of the shaker table tests. The differences may be explained by the fact that these two tests were run with the CEDM set-up in two different orientations and/or by some flexibility of the shaker table suspension system.

List of Test Equipment in addition to items listed in Table 7.

LVDT Schaevitz Model M/N 5000 HPD, S/N 192, Calibrated 1/16/80.

Digital Voltmeter MM200, C-E EL-259, Calibrated 2/10/81.

Strain Read-Out Unit Vishay VE-20A, S/N 25026, Performance
Check 9/81.



STATIC DEFLECTION TEST
 NOZZLE STRAIN (4" ABOVE BASE PLATE)
 VERSUS CEDM TOP DEFLECTION



SEISMIC QUALIFICATION COMPLETION SCHEDULE

NSSS-ICE

P.O./SPEC	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
9403341 (P.O.) 9270-ICE-0005 Rev.01 (Spec.)	See attachment A1	NSSS-ICE-5 NSSS-ICE-5a thru 5h	Equipment has been qualified according to vendor (Westinghouse). Proprietary reports will be released to LP&L pending resolution of proprietary agreement between Westinghouse and LP&L. (See C-CE-7987 of 10/4/82)	Equipment installed
same P.O. and Spec. as above	See attachment A2	NSSS-ICE-9-1 NSSS-ICE-9-2	Original seismic test (Westinghouse / EL991) not approved- Westinghouse resubmitted with new test report (EL1348) C-E technical review completed but administrative work not completed. QTR-1010 and QTR-1008 should replace EL991 as the applicable qualification references for the Veri-Trak Recorders. EL1348 is contained in QTR-1010. Retesting by Westinghouse is required. Testing completion is scheduled for May 1, 1983..	Equipment installed.

SEISMIC QUALIFICATION
COMPLETION SCHEDULE

P.O./SPEC	EQUIPMENT (TAG NO.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
910204 9270-PE 704 Rev 04	BM 307 (CE Tag) Fisher 3" valve	NSSS-PE-36 Rev 1	Oct. 30, 1982	
9102040 9270-PE 704 Rev. 04	CH 210 Y Fisher 1" valve	NSSS-PE-26 Rev 1	Oct. 30, 1982	
9102040 9270-PE 704, Rev. 04	CH 512 Fisher 3" Valve	NSSS-PE-27 Rev 1	Oct. 30, 1982	
9204018 9270-PE 404 Rev. 2	Fuel Pool Pump	NSSS-PE-38	Jan. 1, 1983	
Not Available	3" "Y" Type Strainer	NSSS-PE-16	Oct. 30, 1982	

TAPE DATA LOG SHEET

TEST ANPP RSPT SEIS. QUAL

DATE 7/31/81

RECORDED BY S. S.

LOG SHEET NO. 02

HOOKUP SHEET NO. _____

RECORD SPEED 3 3/4

RECORD BAND WBI

[illegible]

Test ID: M01502 Data Sheet Sine Sweep Test

Date: 7/29/21

Test Description: ANPP CEOM 1st Mode Sweeps. 02g Observer: KUH. HN

Run No.	DVC System Channel				Amplifier				Transducer Sens.				Comments
	A	B	C	D	A	B	C	D	A	B	C	D	
1	H.C.	Acc 9 ✓	Acc 7 ✓	Acc 5 ✓	H/c	14	15	16	1.	61.2	70.5	70.5	
2	"	Acc 8 ✓	Acc 6 ✓	Acc 3 ✓	H/c	"	"	"	1.0	69.5	70.5	70.1	
3	"	Acc 1 ✓	Acc 2	Acc 4	H/c	"	"	"	1.0	89.	85.6	70.9	
4													
5													
6													
7													
8													
9													

Amplifier No:	Control Horiz.	Control Vertical	1	2	3	4	5	6	13	14	15	16	17
Full Scale Range or Range	1		300 SG. 1	300 2	300 3	300 5	300 6	100 10	3	3	3		

Test ID: H01504 Data Sheet Sine Sweep Test

Date: 7/29/91

Test Description: ANPP CE011 1st Mode, 04g

Observer: Shirley K. H. H.

Run No.	DVC System Channel				Amplifier				Transducer Sens.				Comments
	H	B	C	D	A	B	C	D	A	B	C	D	
✓1	H.C.	Acc 1	Acc 2	Acc 4	H/C	14	15	16	1	89	83	70.3	
✓2	H.C.	Acc 9	Acc 7	Acc 5	"	"	"	"	1	61.2	71.5	70.5	
✓3	H.C.	Acc 8	Acc 6	Acc 3	"	"	"	"	1	69.5	70.5	70.1	
4													
5													
6													
7													
8													
9													

Amplifier No:																	
Full Scale Range 50.0 W/g	Control Hertz.	Control Vertical	1	2	3	4	5	6	13	14	15	16	17				

Test ID: 1101506

Data Sheet Sine Sweep Test

Date: 7/29/81

Test Description: ANPP CERM 1 ST MOISE .06g

Observer: S. KIMOSE

Run No.	DVC System Channel				Amplifier				Transducer Sens.				Comments
	H	B	C	D	A	B	C	D	A	B	C	D	
1	H.C	Acc 8	Acc 6	Acc 3	H/C	14	15	16	1	69.5	70.5	70.1	
2	H.C	Acc 1	Acc 2	Acc 4	H/C	"	"	"	1	89.0	89.6	70.8	
3	H.C	Acc 9	Acc 7	Acc 5	H/C	"	"	"	1	61.2	71.5	70.5	
4													
5													
6													
7													
8													
9													

Amplifier No:	Control Hyst.	Control Vertical	1	2	3	4	5	6	13	14	15	16	17
Full Scale Range or Wavg	16		300	←				→		36	36	36	

Test ID: M0150 XX Data Sheet Sine Sweep Test Date: 7/29/81

Test Description: ANPP CERM 1ST MODE Observer: S. Krause

Run No.	DVC System Channel			Amplifier				Transducer S/W.				Comments
	H	B	C	A	B	C	D	A	B	C	D	
1	H.C	Acc 9	Acc 7	Acc 5	H/C	14	15	16	61.2	71.5	70.5	M01508
2		Acc 9	Acc 7	Acc 5		"	"	"	"	"	"	M01518
3		Acc 9	Acc 7	Acc 5								M01512
4												M23505
5												
6												
7												
8												
9												

Amplifier No:	1	2	3	4	5	6	13	14	15	16	17
Full Scale Range S. Wig	Control Horiz.	Control Vertical	1000µE	1000µE	1000µE	1000µE	1000µE	1000µE	1000µE	1000µE	1000µE

Test ID: M235 XX Data Sheet Sine Sweep Test

Date: 7/29/81

Test Description: ANPP CEDM 2ND MODE

Observer: _____

Run No.	DVC System Channel				Amplifier				Transducer Sens.				Comments
	A	B	C	D	A	B	C	D	A	B	C	D	
✓1	H.C.	Acc 9	Acc 7	Acc 5	H/C	14	15	16	1	61.2	71.5	70.5	M23505
✓2	H.C.	8	6	3	"	"	"	"					
✓3	H.C.	1	2	4	"	"	"	"		89.0	89.6	70.8	
4	H.C.	1	2	4	"	"	"	"		89.0	89.6	70.8	M23510
5	H.C.	9	7	5	"	"	"	"		61.2	71.5	70.5	
6	H.C.	8	6	3	"	"	"	"		69.5	70.5	70.1	
7	H.C.	8	6	3	"	"	"	"		69.5	70.5	70.1	M23515
8	H.C.	1	2	4	"	"	"	"		89.0	89.6	70.8	
9	H.C.	9	7	5	"	"	"	"		61.2	71.5	70.5	

Amplifier No:	Control Horiz.	Control Vertical	1	2	3	4	5	6	13	14	15	16	17
Full Scale Range Gr. Horiz										10g	10g	10g	

Test ID: M235xx Data Sheet Sine Sweep Test Date: 7/29/81

Test Description: AMP CEM 2+3RD MODE Observer:

Run No.	DVC System Channel			Amplifier				Transducer Sens.				Comments
	A	B	C	A	B	C	D	A	B	C	D	
1	H/C	ACC 9	ACC 7	H/C	14	15	16	1	61.2	71.5	70.1	M23520
2	H/C	ACC 9	ACC 7	H/C	14	15	16	1	61.2	71.5	70.1	M23525
3												
4												
5												
6												
7												
8												
9												

Amplifier No:	1	2	3	4	5	6	13	14	15	16	17
Control Horiz.											
Control Vertical											
Full Scale Range 50.0 W/g											

Test ID: RSSN05 Data Sheet Sine Sweep Test

Date: 7/23/23/81

Test Description: Sine Sweep .05g Input.

Observer: W. K. H. H.
KKH

Run No.	DVC System Channel				Amplifier				Transducer Sens.				Comments
	H	I	B	C	D	H	B	C	D	H	B	C	D
1✓	H.1C	Acc 5	Acc 7	Acc 9	H.C.	14	15	16	1.0	70.5	71.5	61.2	
2✓		Acc 4	Acc 6	Acc 8	H.C.	"	"	"		70.8	70.5	69.5	Hbute, 1
3✓		(11)	"	"	H.C.	"	"	"					
4✓		ACC 1✓	ACC 2✓	ACC 3✓	H.C.	"	"	"		89.00	89.63	70.1	
5✓		S.G. 1	S.G. 2	S.G. 3	H.C.	1	2	3		72.5	72.5	72.5	INCORRECT SENSITIVITY SETTINGS REASON. 7/23/81
6 ^{2/3}		S.G. 1	S.G. 2	S.G. 3	"	"	"	"		"	"	"	
7		S.G. 4	S.G. 5	S.G. 6	H.C.					72.5	72.5	72.5	
8		S.G. 7	S.G. 8	S.G. 9	H.C.					72.5	72.5	72.5	
9		Acc 4	Acc 5	Acc 6	H.C.	70.8 14	70.5 15	70.5 16		70.8	70.5	70.5	REPLACE AC CABLE - 4

Amplifier No:	Control Horiz.	Control Vertical	1	2	3	4	5	6	13	14	15	16	17
Full Scale Range S. King	16									36	36	36	

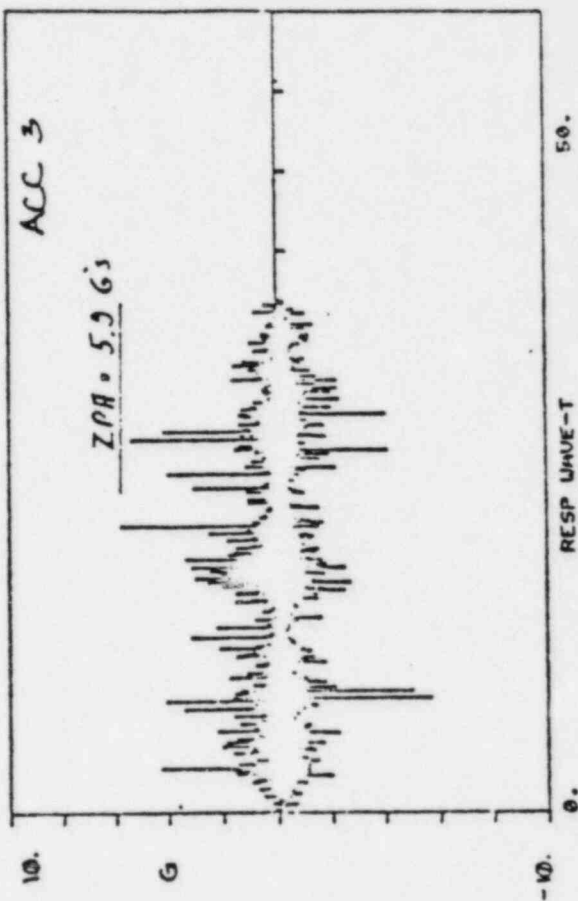
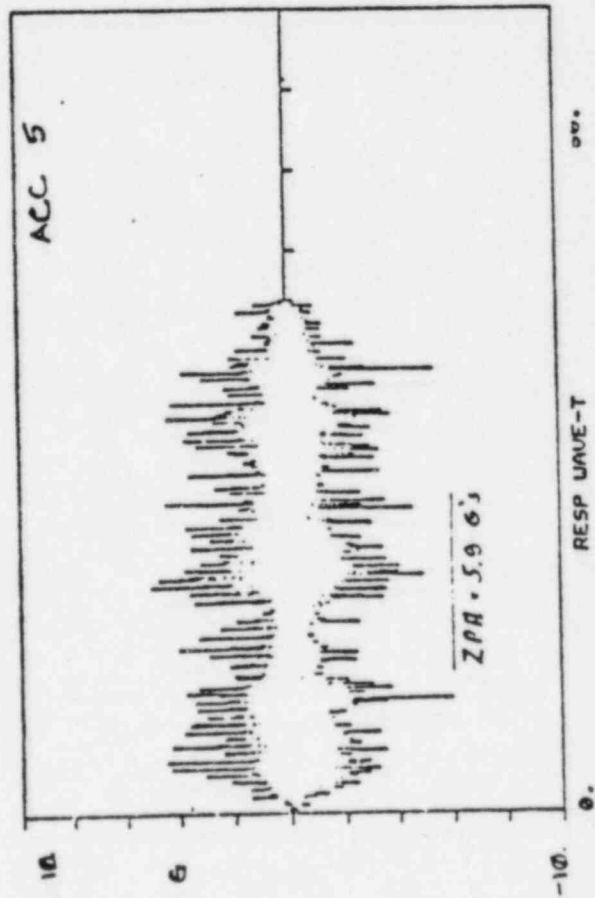
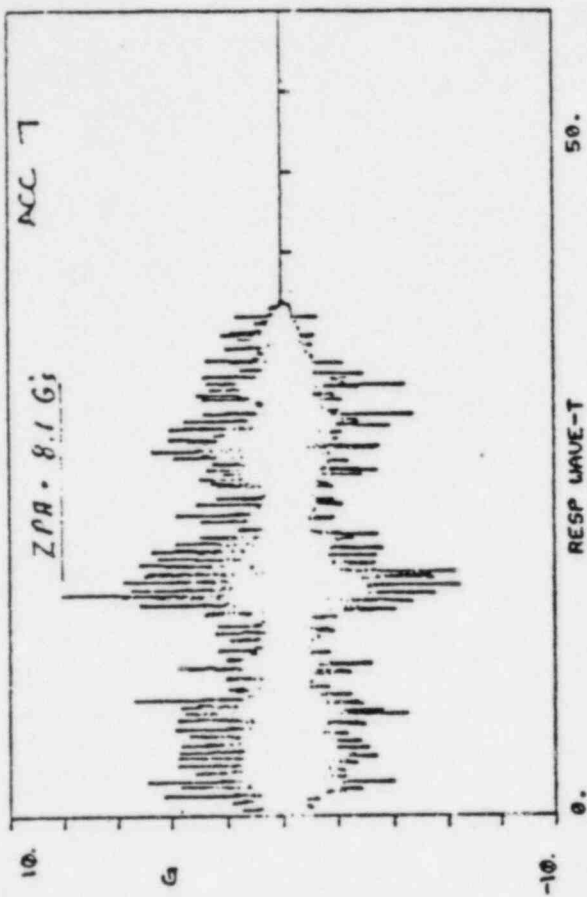
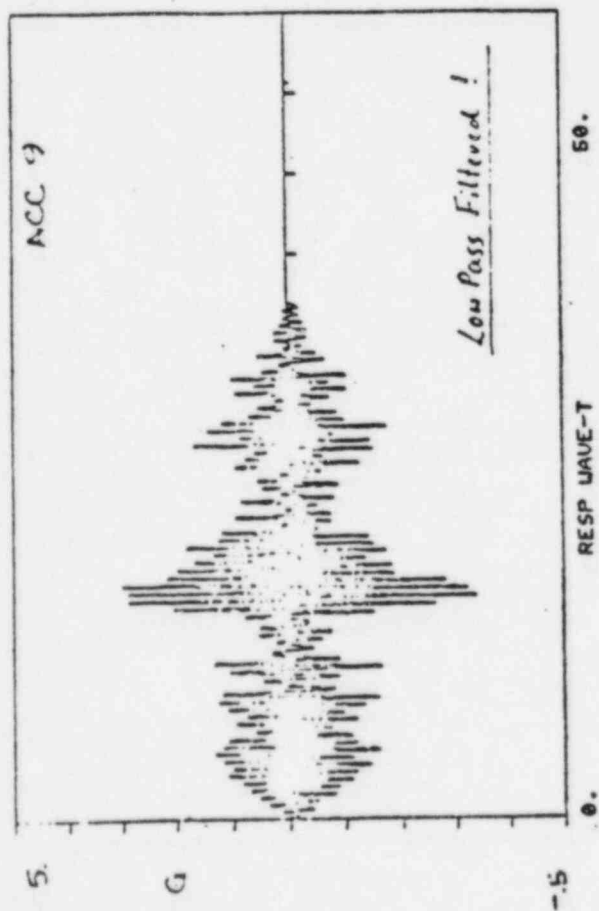


FIGURE 26 ACCELERATION TIME HISTORIES AT DIFFERENT SHROUD ELEVATIONS, SSE EVENT ORIENTATION 1

TABLE 1

SUMMARY OF RESULTS .02g EXCITATION SWEEPS

TEST FILE: RSSN02

MODAL STRAIN AMPLITUDES

		MODES		
		1	2	3
STRAIN GAUGE ($\mu\epsilon$)		2.3 Hz	- 9 Hz	-12 Hz
S.G. 10		93.51	10.11	48.09
S.G. 9				36.55
S.G. 6		141.7		
S.G. 5				
S.G. 4		186.07	9.16	18.89
S.G. 3		164.31	9.16	18.32
S.G. 2		171.76	10.31	18.32
S.G. 1		174.62	10.31	18.89

<u>MODAL TRANSFER FUNCTIONS</u> (g/g)					FIRST MODE DAMPING (%)
ACC 9		59.39	6.90	6.70	2.7
ACC 8		50.0	4.58	9.06	
ACC 7		39.79	2.19	12.40	2.6
ACC 6		33.87	.95	15.08	
ACC 5		23.38	2.19	15.46	2.4
ACC 4			3.05	13.36	
ACC 3		8.87	3.45	9.77	
ACC 2		6.32	3.07	6.86	
ACC 1		3.54	2.20	3.80	

TABLE 2

SUMMARY OF RESULTS .05g EXCITATION SWEEPS
TEST FILE: RSSN05

MODAL TRANSFER FUNCTION AMPLITUDES

MODE	ACC 1	ACC 2	ACC 3	ACC 4	ACC 5	ACC 6	ACC 7	ACC 8	ACC 9
1	2.8	4.6	7.0	—	17.4	25.5	30.1	38.8	43.3
2	2.9	4.9	5.3	—	4.8	.5	6.3	7.7	18.9
3	2.3	3.9	5.4	—	9.2	9.1	8.8	7.5	6.7

MODAL DAMPING VALUES

MODE	ACC 5	ACC 6	ACC 7	ACC 8	ACC 9	AVG.
1	2.54	2.69	2.54	2.65	2.61	2.61
2	3.86	—	2.76	4.04	3.39	3.51
3	1.95	2.11	2.51	—	—	2.19

MODAL STRAIN AMPLITUDES

MODE	S.G. 1	S.G. 2	S.G. 3	S.G. 4	S.G. 6	S.G. 9
1	360	367	347	377	293	61
2	37	43	37	40	—	—
3	23	23	23	23	—	25

TABLE 3

SUMMARY OF MODAL TRANSFER FUNCTIONS - SINE SWEEP TESTING

MODE	EXCITATION LEVEL (g)	ACC 1	ACC 2	ACC 3	ACC 4	ACC 5	ACC 6	ACC 7	ACC 8	ACC 9
1	.02	2.77	4.43	6.41	10.80	15.77	22.28	27.44	34.13	41.49
	.04	2.42	3.90	5.93	9.56	14.72	20.55	26.10	31.84	38.43
	.06	2.95	5.11	7.40	13.58	20.08	27.15	35.85	45.22	60.61
	.08					20.36		34.23		52.01
	.10					19.60		33.27		46.18
	.12					18.83		31.74		40.15
2	.05	2.87	4.33	5.0	4.04	2.31	1.25	3.81	8.10	11.35
	.10	3.44	5.48	6.53	5.69	3.72	.98	3.97	9.31	13.31
	.15	3.50	5.58	6.50	6.12	4.48	.86	4.52	9.29	15.16
	.20			5.77				3.81		12.88
	.25			5.66				3.37		11.73
3	.05	2.12	3.85	5.75	7.87	8.94	8.35	6.71	4.52	2.69
	.10	1.79	3.13	4.61	6.19	7.16	6.87	6.03	4.32	3.74
	.15	2.29	3.88	5.77	7.60	8.33	8.87	6.63	4.99	5.09
	.20			4.62				5.19		3.75
	.25			3.69				4.25		2.60

Note: The Transfer Functions are defined by the Ratio of Acceleration Levels of the monitored Accelerometer over the Horizontal Control Accelerometer.

TABLE 4

SUMMARY OF MODAL STRAIN LEVELS SINE SWEEP TESTING

MODE	EXCITATION LEVEL (g)	S.G. 1	S.G. 2	S.G. 3	S.G. 5	S.G. 6	S.G. 10
1	.02	132	136.5	127	117	101.7	76
	.04	236	241	228	212	183	149
	.06	472	492	460	427	366	283
	.08	640	660	600	560	480	350
	.10	790	810	740	690	580	420
	.12	910	920	860	790	660	480
2	.05	47	47	43	28	19	26
	.10	93	96	88	55	34	46
	.15	138	144	131	79	41	64
	.20	162	165	150	96	51	90
	.25	207	210	192	120	60	110
3	.05	29	29	26	15	9	69
	.10	42	44	40	27	15	121
	.15	74	75	70	43	21	203
	.20	87	90	81	48	27	240
	.25	96	99	84	51	27	230

Note: Strain values are listed in microinch/inch

TABLE 5

MODAL DAMPING PROPERTIES - SINE SWEEP TESTING

MODE	EXCITATION LEVEL (g)	ACC 1	ACC 2	ACC 3	ACC 4	ACC 5	ACC 6	ACC 7	ACC 8	ACC 9	AVERAGE
1	.02					3.15	3.05	3.10	3.05	3.12	3.09
	.04				2.93	2.80	2.94	2.73	2.72	2.77	2.82
	.06				2.32	2.32	2.38	2.14	2.07	1.97	2.20
	.08					2.43		2.41		2.34	2.39
	.10					2.32		2.48		2.74	2.51
	.12					2.52		2.48		3.14	2.71
2	.05	8.32	6.63	5.17	5.48	4.48			5.04		5.85
	.10										
	.15	4.93	4.82	5.09	4.86	5.05					4.95
	.20			5.96							5.96
	.25			5.65							5.65
3	.05		3.45	3.33	3.08	3.08	3.48				3.28
	.10		3.14	3.19	3.47	3.28	3.19	3.17			3.24
	.15	3.19		2.54	2.61	3.10	3.20	3.58			3.04
	.20			2.19							2.19
	.25			3.12							3.12

Damping values are listed in Percent of Critical

TABLE 6

STRAIN LEVELS AND RSPT ELECTRICAL PERFORMANCE
SEISMIC OBE AND SSE TESTING

TEST ORIEN.	TEST DESCRIPTION	TAPE RUN NO.	MEASURED STRAIN DATA-VISICORDER				ELECTRICAL PERFORMANCE	
			S.G. 1 μE	S.G. 3 μE	S.G. 5 μE	S.G. 10 μE	RSPT 1 S/N 604	RSPT 2 S/N 596
1	OBE 1	4	625	600	550	340	OK	OK
1	OBE 2	5	625	600	550	350	OK	OK
1	OBE 3	6	625	605	550	340	OK	OK
1	OBE 4	7	635	605	550	335	OK	OK
1	OBE 5	8	625	605	550	340	OK	OK
1	SSE 1	9	775	745	675	405	OK	OK
2	SSE 1	11	755	745	680	405	OK	OK
2	SSE 2	12	775	745	675	400	OK	OK
2	OBE 1	13	620	600	550	335	OK	OK
2	OBE 2	14	625	600	555	335	OK	OK
2	OBE 3	15	625	600	550	330	OK	OK
2	OBE 4	16	625	600	550	340	OK	OK
3	OBE 5	17	625	605	555	335	OK	OK
			S.G. 7 μE	S.G. 8 μE				
3	OBE 1	20	600	615			OK	OK
3	OBE 2	21	600	625			LOOSE CABLE	
3	OBE 3	22	610	635			OK	OK
3	OBE 4	23	620	630			OK	OK
3	OBE 5	24	615	630			OK	OK
3	OBE 6	25	615	630			OK	OK
3	SSE	26	755	740			OK	OK
4	OBE 1	27	760	740			OK	OK
4	OBE 2	28	760	750			OK	OK
4	OBE 3	29	765	760			OK	OK
4	OBE 4	30	770	760			OK	OK
4	OBE 5	31	770	750			OK	OK
4	OBE 6	32	770	750			OK	OK
4	SSE	33	765	750			OK	OK

Note: OBE Events for Test Orientation 4 inadvertently were run at SSE Intensity.

TABLE 7

LIST OF EQUIPMENT AND INSTRUMENTATION

<u>Instrument</u>	<u>Manufacturer</u>	<u>Model Number</u>	<u>Serial Number</u>	<u>Calibration Requirements</u>	
Seismic Shaker Table	M/Rad	—	—	—	
Hydraulic Shaker	MIS	204.63	299	—	
Shaker Controller	MIS	406.11B	1094	—	
Shaker Control Unit	MIS	436.11AB	463	—	
Digital Vibration Control System	—	P/N 2931-973	Unit C-E	QA Verification of software used	
Control System	Time Data Corp.	TDV-25P			
Control Accelerometers	Unholtz Dickie	100-PA	492/493	Per Manufacturer	Check calibrated within last 12 months
Response Accelerometers	Unholtz Dickie	75 D2/PA	156/104-117	Per Manufacturer	
Response Accelerometers	Endevco	7701-100	AA15, AA16	Per Manufacturer	
Signal Conditioners	Unholtz Dickie	2216x	145/146	Performance Check	
Charge Amplifiers	Unholtz Dickie	D-22 II Type	2024-2027	Performance Check	
Charge/Voltage Amps	Unholtz Dickie	D-22 R Type	2048-2053	Performance Check	
Oscilloscope	Tektronix	5000 Series	B117232	Performance Check	
Strain Gauges	Micro Measurement	WK-06-125AD-350	—	—	
Visicorder	Honeywell	1858-07906	1704DH77	Signal Calibration	
Power Supply	Power Mate or equal	QRD15-1	IL-113	—	
Tape Recorder	Racal Store 7D	D7 690/S		Signal Calibration	

APPENDIX A

ELECTRICAL AND FUNCTIONAL INSPECTION SHEETS

"SM 576

W. H. L. John F. Kowalski

7/25/87

Latistch

Electrical and Functional
Inspection Sheet

is. ted By: D.A. STORY D.A. Story

Date: 8/7/91

RSPT S/N 596

After Seismic Testing

Ref. Para.	Pins	Measured Resistance (Ohms) & Remarks									
4.3.1	A-B	3,132 Ω * *									
4.3.2	A-C	1000	1110	12 21	13 31	15 43	16 54	17 64	18 84	19 85	21 03
		1010	11 21	12 31	13 41	15 54	16 64	17 74	18 85	20 06	21 13
		1020	11 31	12 41	13 51	15 64	16 74	17 84	18 95	20 06	21 23
		1030	11 41	12 51	13 61	15 74	16 84	17 95	19 05	20 16	21 33
		1043	11 51	12 61	13 71	15 84	16 94	18 04	19 15	20 26	21 43
		1052	11 61	12 71	13 81	15 94	17 04	18 14	19 25	20 36	21 53
		1060	11 71	12 81	13 91	16 04	17 14	18 24	19 35	20 46	
		1070	11 81	12 91	14 01	16 14	17 24	18 34	19 45	20 56	
		1080	11 91	13 01	14 11	16 24	17 34	18 44	19 58	20 66	
		1090	12 02	13 11	14 21	16 34	17 44	18 55	19 65	20 93	
		1100	12 11	13 21	14 31	16 44	17 55	18 65	19 75	20 93	
4.3.3	A-C	21 53	20 36	19 35	18 24	17 14	16 04	13 91	12 81	11 71	10 60
		21 43	20 26	19 25	18 14	17 04	15 94	13 81	12 71	11 61	10 51
		21 33	20 16	19 15	18 04	16 94	15 84	13 71	12 61	11 51	10 42
		21 23	20 06	19 05	17 96	16 84	15 74	13 61	12 51	11 41	10 30
		21 13	20 00	18 95	17 84	16 74	15 64	13 51	12 41	11 31	10 20
		21 03	19 96	18 85	17 74	16 64	15 54	13 41	12 31	11 22	10 10
		20 93	19 85	18 80	17 64	16 54	15 44	13 31	12 21	11 10	10 00
		20 83	19 75	18 65	17 54	16 44	14 31	13 21	12 11	11 00	
		20 66	19 65	18 55	17 44	16 34	14 21	13 11	12 01	10 90	
		20 56	19 56	18 45	17 34	16 24	14 11	13 01	11 91	10 80	
		20 46	19 45	18 34	17 24	16 14	14 01	12 91	11 81	10 70	
3.4	D-E	0.9 Ω									
	F-H	1.0 Ω									
	J-K	0.6 Ω									
4.3.5	A thru K	} INFINITY									

5N 604

W. S. Slater John Salt House

Date: 7/24/88

Ref. Para.	Pins	Measured Resistance (ohms) & Remarks									
7.1.2.1	A-B	3018 - After Switch Aging									
7.1.2.2	A-C	0.997	1108	1219	1328	1428	1538	1648	1758	1869	1977
		1.008	1126	1238	1347	1458	1568	1658	1718	1878	1987
		1018	1129	1240	1349	1458	1559	1669	1779	1888	1997
		1028	1138	1249	1358	1458	1558	1678	1788	1897	2009
		1038	1149	1258	1358	1458	1558	1688	1798	1908	2019
		1048	1158	1269	1378	1478	1578	1688	1808	1918	2028
		1058	1169	1278	1378	1478	1578	1708	1818	1928	2038
		1068	1180	1289	1388	1488	1588	1718	1828	1938	2048
		1078	1189	1298	1398	1498	1598	1728	1838	1948	2058
		1088	1198	1308	1408	1508	1608	1738	1848	1958	2068
Bottom to Top ↑											
7.1.2.3	A-C	2038	1928	1818	1708	1598	1508	1398	1288	1178	1068
		2038	1918	1808	1698	1588	1478	1368	1258	1148	1038
		2019	1898	1788	1678	1568	1458	1348	1238	1128	1018
		2009	1888	1778	1668	1558	1448	1338	1228	1118	1008
		2000	1878	1768	1658	1548	1438	1328	1218	1108	998
		1998	1868	1758	1648	1538	1428	1318	1208	1098	988
		1978	1848	1738	1628	1518	1408	1298	1188	1078	968
		1968	1838	1728	1618	1508	1398	1288	1178	1068	958
		1958	1828	1718	1608	1498	1388	1278	1168	1058	948
		1948	1818	1708	1598	1488	1378	1268	1158	1048	938
Top to Bottom ↓											
8.1.2.4	D-E F-H J-K	0.000 0.000 0.000									
8.1.2.5	A thru K	satisfactory									

DATA SHEET NO. 1
Electrical and Functional
Inspection Sheet

is ted By: D. A. STORY

D. A. Loring

Date: 8/7/81

RSPT

S/N 604

After Seismic Testing

Ref. Para.	Pins	After Seismic Testing Measured Resistance (Ohms) & Remarks									
4.3.1	A-B	3019 Ω									
4.3.2	A-C	1000	1109	1219	1329	1439	1547	1659	1768	1879	1988
		1009	1120	1229	1339	1449	1559	1669	1779	1888	2000
		19	1129	1241	1349	1459	1569	1679	1789	1898	2009
		29	1139	1250	1359	1469	1579	1689	1799	1908	2019
		39	1151	1259	1369	1479	1589	1699	1809	1918	2039
		49	1159	1269	1379	1490	1599	1709	1819	1928	
		59	1169	1279	1389	1499	1609	1719	1829	1938	
		69	1183	1284	1399	1509	1619	1729	1839	1949	
		79	1184	1299	1409	1519	1629	1739	1849	1959	
		89	1199	1309	1419	1529	1639	1749	1859	1968	
		99	1209	1319	1429	1539	1649	1759	1868	1978	
4.3.3	A-C	2039	1929	1819	1709	1599	1490	1379	1269	1150	1039
		2029	1918	1809	1699	1589	1479	1370	1259	1134	1029
		2019	1909	1799	1689	1579	1469	1354	1250	1129	1019
		2009	1898	1784	1679	1569	1459	1344	1241	1120	1009
		2000	1888	1779	1669	1559	1449	1339	1230	1109	1000
		1998	1879	1769	1659	1549	1439	1329	1219	1100	
		1978	1869	1754	1649	1539	1429	1319	1209	1089	
		1968	1859	1744	1639	1529	1419	1310	1200	1079	
		1954	1849	1739	1629	1519	1409	1300	1189	1069	
		1947	1839	1729	1619	1509	1400	1289	1181	1059	
		1938	1829	1719	1609	1499	1389	1279	1164	1049	
3.4	D-E	1.1 Ω									
	F-H	1.0 Ω									
	J-K	0.5 Ω									
4.3.5	A thru	INFINITY									

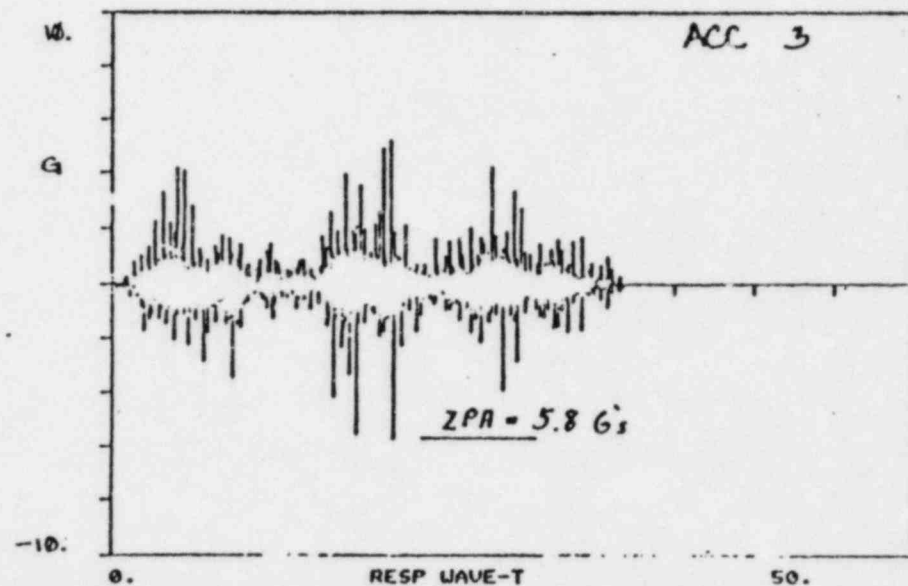
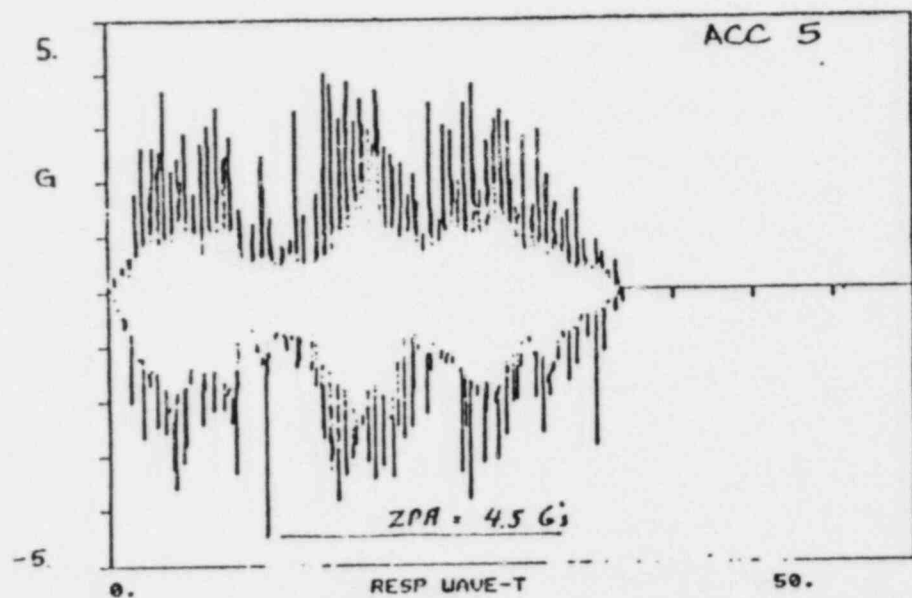
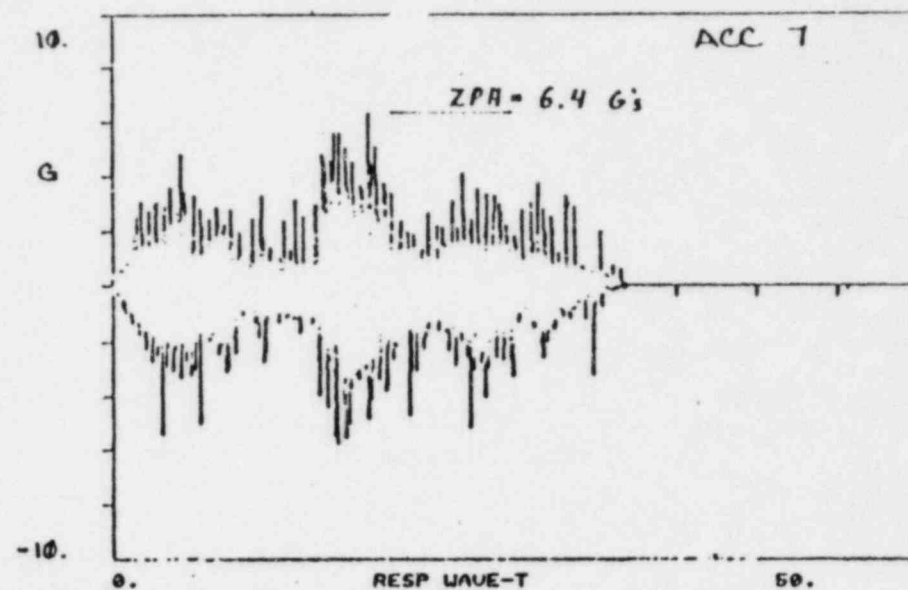
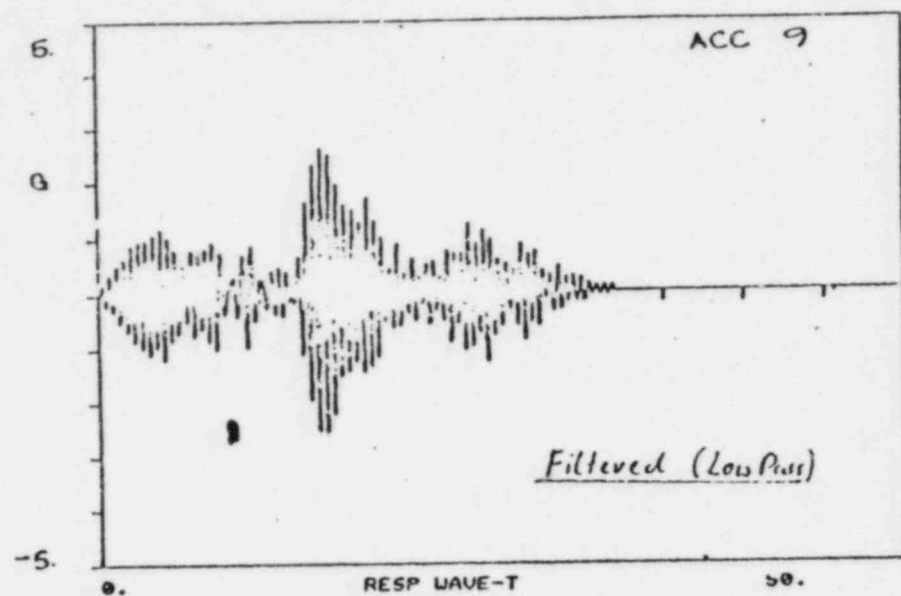


FIGURE 25 ACCELERATION TIME HISTORIES AT DIFFERENT SHROUD ELEVATIONS, OBE EVENT ORIENTATION 1

ENCLOSURE 4

SEISMIC QUALIFICATION REVIEW TEAM

RE-AUDIT FOLLOW UP

- Attachment (1) Status of PE Confirmatory Items
- Attachment (2) Seismic Qualification Completion
Schedule
- Attachment (3) Seismic Analyses of Mueller 3" Y-Type
Strainer
- Attachment (4) ME-894 Certified Design Report of
Horizontal Pump

November 10, 1982

RESPONSE TO CE/PLANT ENGINEERING
CONFIRMATORY ITEMS FROM WATERFORD UNIT #3
SQRT RE-AUDIT

ITEM	COMMENTS/RESPONSE
GENERIC	<u>Comment:</u> It was noticed that during the review of NSS-PE-10 (Deborating Ion Exchanger), NSSS-PE-15 (Purification Filter) and NSSS-PE-33 (Holdup Tank), nozzle loads were negelected in the stress analysis. This seems to be a generic pattern. <u>Response</u> Nozzle loads for this equipment (seismic category tanks, HXS, Filters and Ion Exchangers) were originally simulated in the seismic analyses by increasing the seismic acceleration loading imposed on these components. This simulation was considered to be conservative because the component supports were judged to be more highly loaded than they would be if the appropriate siesmic and nozzle loads were considered. In response to the SQRT audit concern, a follow-on effort has been initiated to confirm that the original approach was conservative. All of the design reports for the applicable CE equipment have been reviewed and nozzle loads have been directly evaluated to determine their effect on component supports. In all cases, the original support loadings were more severe. All nozzle-to-shell juncture stresses were also evaluted and found to be within acceptable levels.
GENERIC	<u>Comments</u> Status of equipment not yet seismically qualified and their qualification schedule should be provided to NRC. This status should be submitted monthly until completion of qualification of all safety related equipment. <u>Response</u> Status is given on Atcthment (2)

ITEM	COMMENTS/RESPONSE
ITEM NO. <u>NSSS-1</u> SQRT NO. <u>NSSS-PE-14</u> BA MAKEUP PUMP SPECIFIC ITEM: <u>PUMP 8</u>	<u>COMMENT</u> 1. Explain basis for load cases 4 & 5 and show that they are conservative. <u>Response</u> Load Case 4 is "nozzle plus impeller loads in the x-direction". Load Case 5 is "nozzle plus impeller loads in the z-direction". CE has reviewed these loading cases in detail and confirms that these loadings encompass the most severe direction possible for the application of nozzle loads. <u>Comment</u> 2. Explain load combinations used for computing bolting stress and show that they are conservative. <u>Response</u> The load combinations used for computing bolt stresses include those loads from seismic accelerations in both transverse directions (note that a vertical acceleration would have no effect on the bolts), impeller loads, and nozzle loads in the most severe direction. CE has reviewed these loads and confirms that they are conservative.
Item No. <u>NSSS-2</u> SQRT NO. <u>NSSS-PE-25</u> BORIC ACID TANK CIRC. VALVE SPECIFIC ITEM: <u>3CH-F171B</u>	<u>Comment</u> 1. Provide certification that the computer calculation based on Engineering Standard ES100, Rev. B dated 4/8/75 have been verified. <u>Response</u> CE has contacted the vendor on this issue and is currently awaiting a reply. This reply is expected before 11/30/82. <u>Comment</u> 2. Confirm that deflections calculated in Seismic Analysis for Order 1-46610 dated April 3, 1976 for tag number CH-511 will not interfere with valve closure. <u>Response</u> Same as Previous Response.

ITEM	COMMENTS/RESPONSE
ITEM NO. <u>NSSS-1</u> SQRT NO. <u>NSSS-PE-14</u> BA MAKEUP PUMP SPECIFIC ITEM: <u>PUMP B</u>	<u>COMMENT</u> 1. Explain basis for load cases 4 & 5 and show that they are conservative. <u>Response</u> Load Case 4 is "nozzle plus impeller loads in the x-direction". Load Case 5 is "nozzle plus impeller loads in the z-direction". CE has reviewed these loading cases in detail and confirms that these loadings encompass the most severe direction possible for the application of nozzle loads. <u>Comment</u> 2. Explain load combinations used for computing bolting stress and show that they are conservative. <u>Response</u> The load combinations used for computing bolt stresses include those loads from seismic accelerations in both transverse directions (note that a vertical acceleration would have no effect on the bolts), impeller loads, and nozzle loads in the most severe direction. CE has reviewed these loads and confirms that they are conservative.
Item No. <u>NSSS-2</u> SQRT NO. <u>NSSS-PE-25</u> BORIC ACID TANK CIRC. VALVE SPECIFIC ITEM: <u>3CH-F171B</u>	<u>Comment</u> 1. Provide certification that the computer calculation based on Engineering Standard ES100, Rev. B dated 4/8/75 have been verified. <u>Response</u> CE has contacted the vendor on this issue and is currently awaiting a reply. This reply is expected before 11/30/82. <u>Comment</u> 2. Confirm that deflections calculated in Seismic Analysis for Order 1-46610 dated April 3, 1976 for tag number CH-511 will not interfere with valve closure. <u>Response</u> Same as Previous Response.

ITEM	COMMENTS/RESPONSE
ITEM NO. <u>NSSS-5</u> SQRT NO. <u>NSSS-PE-52</u> FW CONTROL VALVE SPECIFIC ITEM: <u>5FW-FM834</u>	<u>Comment</u> Verification of computer program ES100, Rev. B (4/8/75) performed for Item NSSS-PE-25. Results will also be applicable here. <u>Response</u> CE has contacted the vendor on this issue and is currently awaiting a reply. This reply is expected before 11/30/82.

SEISMIC QUALIFICATION COMPLETION SCHEDULE

ATTACHMENT 2

Page 1 of 1

INSTALLATION
SCHEDULE

QUALIFICATION
SCHEDULE

SQRT FILE NO.

EQUIPMENT
(TAG NOS.)

P.O./SPEC

January 1, 1983

NSSS-PE-36 Rev 1

BH 307
(CE Tag)
Fisher 3" valve

910204
9270-PE
704 Rev 04

January 1, 1983

NSSS-PE-26 Rev 1

CH 210 Y
Fisher 1" valve

9102040
9270-PE
704 Rev. 04

January 1, 1983

NSSS-PE-27 Rev 1

CH 512
Fisher 3" Valve

9102040
9270-PE
704, Rev. 04

Contract LOUISIANA P&L - WATERFORD STATION UNIT #3

Calculation 10 Pages

Appendix 0 Pages

Calculation Number C-PAC-010

Revision 0

Title MUELLER STEAM SPECIALTY 3" Y-TYPE STRAINER
SEISMIC ANALYSIS

Author V. TOKARZ

Date 10/22/82

Calculation contains safety related design information: Yes X No

The safety related design information contained in this document has been reviewed and satisfies where applicable the items contained on checklist(s) # 2 of the Quality Assurance of Design Manual. This review is certified to have been so accomplished.

Independently Reviewed by EA SIEGEL *Ea Siegel*

Date 10-26-82

Approved by *TE Spinner*

Date 10-26-82

Distribution EA SIEGEL, A PASCENTE, D J. LIEBRO

Summary Purpose:

TO ESTABLISH THE STRUCTURAL ADEQUACY OF THE 3" Y-TYPE STRAINER UNDER SEISMIC ACCELERATIONS OF 3 g's.

Method and Results of Review:

THIS CALCULATION WAS VERIFIED BY THE METHOD OF DESIGN REVIEW AND SATISFIES WHERE APPLICABLE THE ITEMS ON CHECKLIST #2 OF THE QUALITY ASSURANCE OF DESIGN MANUAL.

1.0 ABSTRACT

1.1 PURPOSE

THE PURPOSE OF THIS CALCULATION IS TO VERIFY THE STRUCTURAL INTEGRITY OF THE MUELLER 3" Y-TYPE STRAINER UNDER 3.9 SEISMIC ACCELERATIONS IN THREE ORTHOGONAL DIRECTIONS APPLIED SIMULTANEOUSLY.

1.2 SCOPE

THIS CALCULATION APPLIES TO THE LETDOWN STRAINER, TAG NO. 2CH-SIS1A/B FURNISHED TO LOUISIANA POWER AND LIGHT COMPANY FOR THEIR WATERFORD STEAM ELECTRIC STATION UNIT NO. 3.

1.3 REFERENCES

- 1.3.1 MUESSCO PIPE LINE STRAINERS AND SILENT CHECK VALVES CATALOG No. 71-R-1
- 1.3.2 ROARK, FORMULAS FOR STRESS AND STRAIN, 5TH ED.
- 1.3.3 BLODGETT, DESIGN OF WELDED STRUCTURES, THE LINCOLN ARC WELDING FOUNDATION, 1966.
- 1.3.4 LESLIE SELF CLEANING STRAINER ANALYSIS, FILE M-193, DTD. 4-24-78.

1.4 METHOD OF ANALYSIS AND ASSUMPTIONS

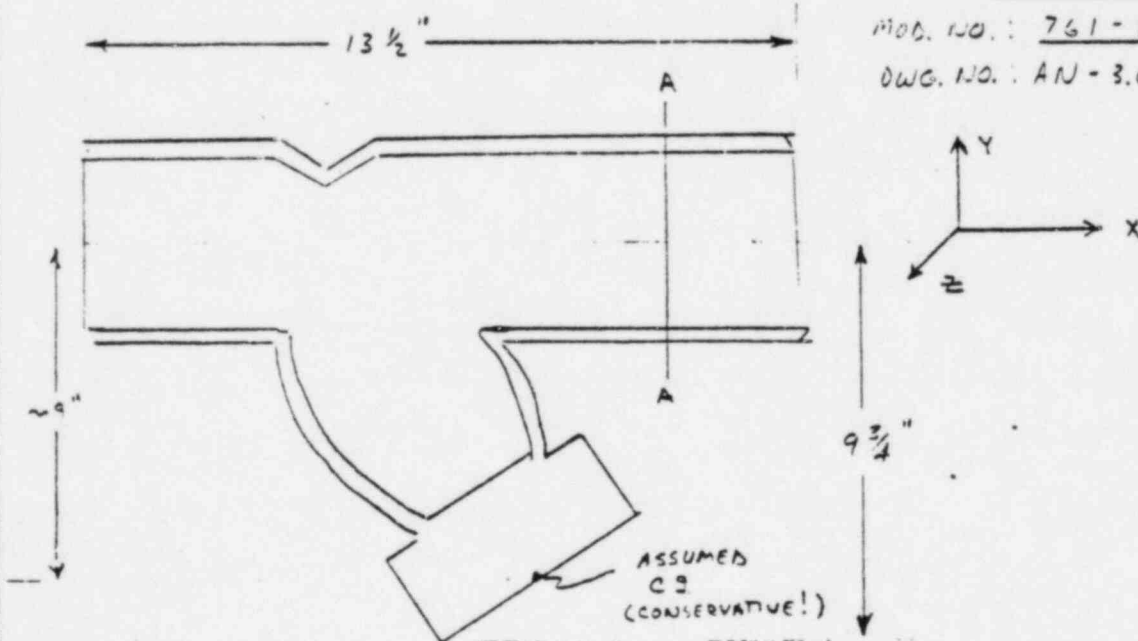
BASIC BEAM THEORY AND VERY CONSERVATIVE ASSUMPTIONS WERE USED IN FINDING THE SEISMIC STRESSES AND NATURAL FREQUENCY OF THE 3" Y-TYPE STRAINER. 39 LOADS WERE ASSUMED TO ACT SIMULTANEOUSLY IN THREE ORTHOGONAL DIRECTIONS. STRESSES WERE CONSERVATIVELY COMBINED BY USING AN ABSOLUTE SUMMATION.

1.5 CONCLUSIONS

THE STRAINER IS STRUCTURALLY ADEQUATE TO WITHSTAND A 3.9 SEISMIC ACCELERATION APPLIED SIMULTANEOUSLY IN 3 ORTHOGONAL DIRECTIONS AT THE PIPING CONNECTIONS.

SEISMIC STRESS ANALYSIS
FOR Y-TYPE STRAINER (3")

PO NO. 9402242
ITEM # 1
MFG: MUELLER STM. SPECIALLY
MOD. NO.: 761-SS-WF
DWG. NO.: AN-3.0-761SSWE
Rev 1



BASIC ASSUMPTIONS TO BE MADE:

- 1) ASSUME C.G. @ 9" OFF CL OF PIPE (CONSERVATIVE!)
- 2) STRAINER CROSS-SECTION TO BE EQUAL TO THAT OF SCHEDULE 40S PIPE

O.D. = 3.5"	A = 2.226 in ²
I.D. = 3.068"	I = 3.017 in ⁴
t = .216"	Z = 1.721 in ³

SEISMIC LOADS

- FOR THE LOADING ON THIS STRAINER, A 3g ACCELERATION IN THREE ORTHOGONAL DIRECTIONS WILL BE USED. THE METHOD OF "ABSOLUTE SUM" WILL BE USED TO DETERMINE ALL STRESSES AT SECTION A-A.

STRAINER WEIGHT

REF 1.2.1

STRAINER WT = 43 LBS

WATER WT = 10 LBS

TOTAL WEIGHT = 53 LBS

APPLY LOADS

- SHOCK IN X-DIRECTION

$$F_x = 3.0(53) = 159$$

$$M_z = 3.0(7") (53) = 1431 \text{ in} \cdot \text{lb}$$

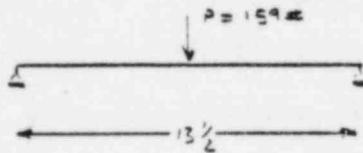
$$F_y = \frac{1431}{12.5} = 114.1$$

$$\sigma_x = \frac{159}{2.228} + \frac{1431}{1.724} = 901.4 \text{ PSI}$$

$$\tau_y = \frac{106}{2.228} = 47.6 \text{ PSI}$$

• SHOCK IN Y-DIRECTION

ASSUME BEAM IS RIGID



$$M_{PAC} = \frac{P}{4} = \frac{53(3+1)(13 \frac{1}{2})}{4} = 715.5 \text{ k-ft}$$

$$F_y = \frac{53(4)}{2} = 106 \text{ k}$$

$$\sigma_v = \frac{715.5}{1.724} = 415.0 \text{ ksi}$$

$$\tau_y = \frac{106}{2.228} = 47.6 \text{ ksi}$$

• SHOCK IN Z-DIRECTION

$$M_z = 53(3)(0) = 1431 \text{ k-ft}$$

$$F_z = 53(0) = 15 \text{ k}$$

$$\tau = \frac{16 M_z + J_z}{\pi (d_1^4 - d_2^4)} + \frac{F_z}{2A}$$

$$d_2 = \text{O.D.} \\ d_1 = \text{I.D.}$$

$$\tau = \frac{16 (1431) (3.5)}{\pi (3.5^4 - 3.015^4)} + \frac{15}{2(2.228)} = 460.7 \text{ ksi}$$

3
C

STRESS DUE TO PRESSURE

INITIAL σ $\left\{ \begin{array}{l} \sigma_1 = \text{LONGITUDINAL STRESS} \\ \sigma_2 = \text{CIRCUMFERENTIAL STRESS} \\ \sigma_3 = \text{RADIAL STRESS} \end{array} \right. \quad \begin{array}{l} \sigma_1 = 300 \text{ PSI} \\ \sigma_2 = 300 \text{ PSI} \\ \sigma_3 = 0 \end{array}$

• USE TABLE 5TH ED " TABLE 32 " $\sigma_{2 \text{ max}} = 1$;

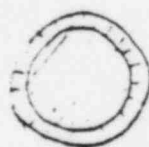
$$\begin{aligned} \sigma_{2 \text{ max}} &= 3 \frac{a^2 + b^2}{a^2 - b^2} \\ &= 300 \frac{1.75^2 + 1.534^2}{1.75^2 - 1.534^2} \\ &= 2590.6 \text{ PSI} \end{aligned}$$

$$\begin{aligned} a &= \frac{D}{2} = \frac{3.5}{2} = 1.75" \\ b &= \frac{ID}{2} = \frac{3.668}{2} = 1.534" \\ r &= \text{RADIUS OF CURVATURE} (1614 \text{ IN}) \end{aligned}$$

$$\sigma_{3 \text{ max}} = -p = -300 \text{ PSI}$$

$$\sigma_{\text{Tot (due to p)}} = \sigma_2 - \sigma_3 = \underline{\underline{2590.6 \text{ PSI}}}$$

• EFFECT OF THERMAL STRESS DUE TO 300 PSI AT 1000°F



$$\sigma = \text{STRESS} \times \text{AREA} \quad (7.21 \text{ IN}^2)$$

$$\text{WILL BE IN TENSION} \quad (3.122 \text{ IN}^2)$$

$$\begin{aligned} \text{FOR } \sigma &= \text{STRESS} \times \text{AREA} = 300 \times (3.122 \text{ IN}^2) \\ &= 936.6 \text{ PSI} \end{aligned}$$

• LONGITUDINAL STRESS (FOR T/D)

$$\text{CONCENTRICALLY ALIGNED } \sigma_L = \frac{P_L}{A} = \frac{1317}{1.338} = \underline{\underline{992 \text{ PSI}}}$$

COMBINE ALL STRESSES (USE ABSOLUTE VMP)

$$J_{x \text{ TOT}} = 101.4 - 415.0 + 992 = \underline{\underline{271.4 \text{ PSI}}}$$

$$\tau_{\text{TOT}} = 47.4 - 47.6 + 899.7 - 2090.6 = \underline{\underline{758.9 \text{ PSI}}}$$

SA-351 GR CF8M

• (S_H) PIPING ALLOWABLE STRESS VALUE @ 600°F = 16.5 KSI

LEVEL 3 SERVICE ALLOWABLE = 1.2 (S_H) = 20.16 KSI
(ASME CODE SECTION III)

• PIPE WALL THICKNESS DETERMINATION

$$t_{\text{MAX}} = \frac{271.4}{S} + \sqrt{\left(\frac{758.9}{S}\right)^2 + 3.5^2} = 4122.2 \text{ PSI}$$

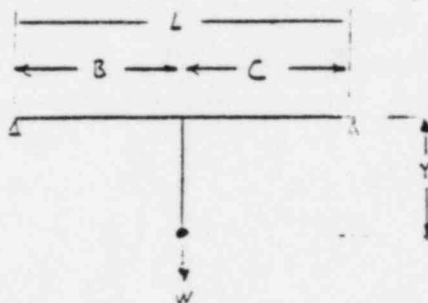
$$\tau_{\text{MAX}} = 3766 \text{ PSI}$$

RESULTS → THE STRESS VALUES SHOW ADEQUATE MARGIN OF SAFETY IN ACTUAL STRESSES AND ALLOWABLE STRESS!

NATURAL FREQUENCY ANALYSIS

DUE TO VERTICAL MOTION

ASSUME THE FOLLOWING DATA:



$$B = C = 6.75 \text{ (ASSUMED)}$$

$$L = 13.5$$

$$W = 53 \# \text{ LWT}$$

$$r_1 = \frac{I \cdot \Delta}{2} = 1.534$$

$$r_2 = \frac{3 \cdot \Delta}{2} = 1.75$$

$$F_v = \frac{1}{2\pi} \sqrt{\frac{386}{Y}}$$

REF. THOMPSON VIBRATION THEORY
2ND EDITION PG 5, EQ 1.2-9

$$Y = \frac{W B^3 C^3}{3 E I L}$$

REF. MACH. 403K 17TH ED.
PG 250 TABLE 3

$$Y = \frac{53 (6.75)^4}{3 (30 \times 10^9) (2.017) (13.5)}$$

$$Y = 3.0 \times 10^{-5}$$

$$F_v = \frac{1}{2\pi} \sqrt{\frac{386}{.00003}} = \underline{\underline{570.6 \text{ CPS}}}$$

NATURAL FREQUENCY

DUE TO HORIZONTAL ACCELERATION

$$W = 53 \#$$

$$Y = 7" \text{ (PERMANENT DEF.)}$$

$$F_H = \frac{1}{2\pi} V \sqrt{\frac{W}{J_0 L}}$$

$$G = 11.2 \times 10^6$$

J = POLAR MOMENT OF INERTIA

$$J = 1.57 (R_2^4 - R_1^4)$$

REF. PAGE 410
17E PL. 10.122

$$J = 1.57 (1.75^4 - 1.534^4) = 6.03 \text{ in}^4$$

J_0 = MASS MOMENT OF INERTIA

$$J_0 = J_c + M X^2$$

REF. REER/LOHMEYER
MECHANICAL DESIGN
2ND ED. PL. 10.242

$$J_0 = \frac{M}{12} [3(R_2^2 - R_1^2) + L^2] + M Y^2$$

$$M = \frac{W}{g} = \frac{53}{32.2 \text{ ft/sec}^2} = 1.65$$

$$J_0 = \frac{1.65}{12} [3(1.75^2 - 1.534^2) + 13.5^2] + 1.65(1)^2 = 13.23$$

$$F_H = \frac{1}{2\pi} V \sqrt{\frac{6.03 (11.2 \times 10^6)}{13.23 (13.5)}} = \underline{\underline{78 \text{ LBS}}}$$

CERTIFIED DESIGN REPORT

OF

HORIZONTAL PUMP

Figure 4066

Size 8x8x12

CUSTOMER: COMBUSTION ENGINEERING COMPANY, INC.P. O.: 9204018CRANE-DEMING SHOP ORDER: 03677SPECIFICATION NOS.: SYS 80-PE-404 REV. #00SERIAL NOS.: NDC-000566, 567

CERTIFIED BY:

C. K. McDONALD, P. E., Ph.D.
ALABAMA REGISTRATION NO. 9586SIGNED: C. K. McDonaldDATE: 9/25/81

REVIEWED BY CRANE-DEMING PUMPS:

POSITION: QUALITY ASSURANCE MANAGERSIGNED: Robert Joff

ROBERT JOFF

DATE: 10/1/81

APPROVED BY CRANE-DEMING PUMPS:

POSITION: MANAGER OF ENGINEERINGSIGNED: Edward Allis

EDWARD ALLIS

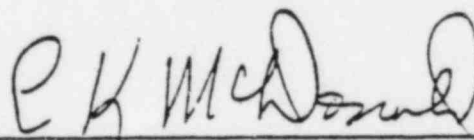
DATE: 10/31/81

DEMING DIVISION - CRANE COMPANY

CERTIFICATION STATEMENT

This Crane-Deming Figure 4066 Size 8x8x12 pump has been analyzed in accordance with Combustion Engineering Specification No. SYS 80-PE-404 Rev. #00; ASME Boiler and Pressure Vessel Code, Section III, Class 3, 1974 Edition including Winter '75 Addenda; and accepted good practice in seismic stress analysis.

The analysis shows that the pump is structurally adequate to withstand the specified loads and will perform its intended function during Upset and Faulted loads. Please note the limitation on resultant nozzle loads given in Section 4.6 of the report.



C. K. McDonald, Ph.D., P. E.

Alabama Registration No. 9586

September 25, 1981



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1. INTRODUCTION

This report covers the seismic, stress, and deflection analysis of Crane-Deming Figure 4066 Size 8 x 8 x 12 Pump. The analysis is directed toward proving both the structural integrity and functional capability of the pump.

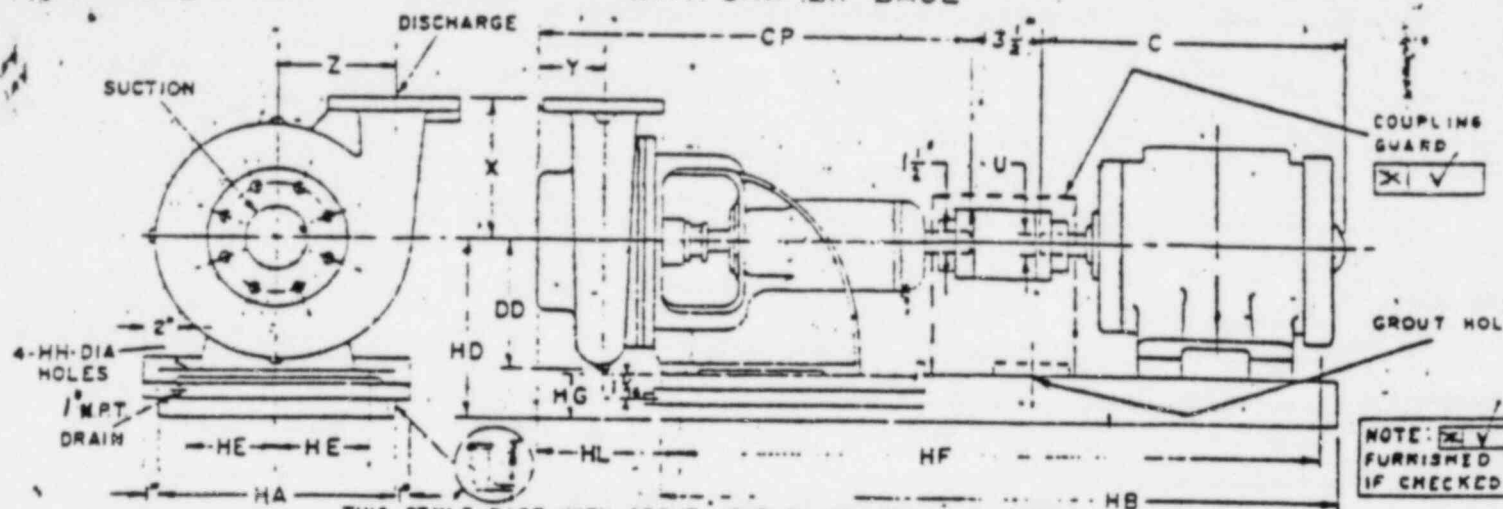
A dynamic model is developed and a computer frequency analysis is made to obtain the frequencies of the assembly, as required by the specification. The pump is shown to be rigid.

The nozzle loads are imposed on the computer model of the assembly and the resulting stresses and deflections are calculated. The stresses are then compared to the allowables given in the ASME Code. The deflections are compared to operating clearances or other limiting criteria.

The nozzles are analyzed for the max. nozzle loads. The loads given in the specification were reduced somewhat, see Section 4.2 of the report.

This pump casing is of complex geometry and has been well verified for normal operation by service experience and hydrostatic tests. The seismic and nozzle loads impose negligible stress in the casing except at nozzle penetrations and flanges which have been analyzed in this report.

This pump has a cast iron frame that cannot withstand nozzle loads. Thus, although the casing will withstand the individual nozzle loads given in Section 4.2, the resultant nozzle loads resolved to the intersection of the discharge/suction centerlines must be zero.



THIS STYLE BASE WITH GROUT HOLE ON 404 FRAME & LARGER

DIMENSIONS IN INCHES

PUMP SIZE	SUCTION (150°)				DISCHARGE (150°)				X	Y	Z	CP	DD	HL
	SIZE	DIA FLG	BOLTS	BC	SIZE	DIA FLG	BOLTS	BC						
4X3X12	4	9	8-1/2	7 1/2	3	7 1/2	4-1/2	6	8 1/2	2 1/2	7 1/2	27 1/2	8 1/2	7 1/2
6X4X12	6	11	8-1/2	9 1/2	4	9	8-1/2	7 1/2	9	2 1/2	7 1/2	28 1/2	9 1/2	7 1/2
6X6X12	6	11	8-1/2	9 1/2	6	11	8-1/2	9 1/2	9	3 1/2	18 1/2	28 1/2	10 1/2	8 1/2
8X6X12	8	13 1/2	8-1/2	11 1/2	6	11	8-1/2	9 1/2	9 1/2	3 1/2	8 1/2	28 1/2	10 1/2	9
8X8X12	8	13 1/2	8-1/2	11 1/2	8	13 1/2	8-1/2	11 1/2	11	4 1/2	10 1/2	30 1/2	13 1/2	10 1/2
10X8X12	10	16	12-1/2	14 1/2	8	13 1/2	8-1/2	11 1/2	11	4 1/2	10 1/2	30 1/2	13 1/2	10 1/2
10X10X12	10	16	12-1/2	14 1/2	10	16	12-1/2	14 1/2	11	5 1/2	10 1/2	32 1/2	13 1/2	12 1/2
4X4X12	4	9	8-1/2	7 1/2	4	9	8-1/2	7 1/2	9	2 1/2	7 1/2	27 1/2	8 1/2	7 1/2

LOCATION OF DISCHARGE (WHEN FACING SUCTION)

WEIGHTS

PUMP	WEIGHTS
PUMP	465
MOTOR	630
BASEPLATE	228
TOTAL	1323

RH PUMP POSITION

SUCTION

BOTTOM HORIZONTAL & VERTICAL AVAILABLE ONLY WITH SPECIAL FABRICATED BASES

† FOR 404 FR & LARGER ADD 1/2" TO HL

FRAME NO	213T	215T	254T	256T	284TS	284T	286TS	286T	324TS	324T	326TS	326T	364TS	364T	365TS	365T	404TS	404T	405TS	405T
BASE NO	27504	27504	27505	27506	27506	27506	27506	27506	27508	27508	27508	27508	27508	27508	27508	27508	27510	27511	27510	27511
C	17 1/2	19 1/2	22 1/2	24 1/2	24 1/2	25 1/2	26 1/2	27 1/2	27 1/2	28 1/2	28 1/2	30 1/2	26 1/2	33 1/2	32 1/2	34 1/2	34 1/2	37 1/2	36 1/2	38 1/2
HA	15	15	15	15	15	15	15	15	18	18	18	18	18	18	18	18	25	25	25	25
HB	40	40	43	47	47	47	47	47	51	51	51	51	51	51	51	51	50	57	50	57
HD	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	13 1/2	14 1/2	14 1/2	14 1/2	14 1/2
HE	6	6	6	6	6	6	6	6	7 1/2	7 1/2	7 1/2	7 1/2	7 1/2	7 1/2	7 1/2	7 1/2	11 1/2	11 1/2	11 1/2	11 1/2
HF	37 1/2	37 1/2	40 1/2	44 1/2	44 1/2	44 1/2	44 1/2	44 1/2	48 1/2	48 1/2	48 1/2	48 1/2	48 1/2	48 1/2	48 1/2	48 1/2	47	54	47	54
HG	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	3 1/2	4	4	4	4	4	4	4	4	4 1/2	4 1/2	4 1/2	4 1/2
HH	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2	1 1/2
U	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2	12 1/2

REV. ②

CUSTOMER COMBUSTION ENGINEERING, INC.

CO NO 9204018

PROJECT NAME LOUISIANA POWER & LIGHT

CONTRACTOR ENGINEER C.E. CONTRACT # 9270-PE-404

CUSTOMER IDENT. NO. FUEL POOL PUMPS - QUANT. 2 ①

31-76-54-4022-00

PUMP DATA	FIG NO.	SIZE	CURVE NO	GPM	HEAD	SP GR	TEMP	ROTATION	SEAL
4066	8X8X12	PC. 2471	2000	76'	.96-1.0	90-200°F	CW	J.C. TYPE 1	O40F31D1
MOTOR DATA	MFGR	H.P.	RPM	PHASE-CYCLE-VOLTAGE	FRAME	ENCLOSURE	INSULATION	FURNISHED BY	MOUNTED BY
WSTGHS	GO	1800	3-60-460	364TS	DP	B	DEMING	DEMING	

SERIAL NO. -NDC-000566, 567

CERTIFIED BY R.D. J. J. J.

S0#03677 DATE 3-3-75

① NUCLEAR CLASS 3

REFERENCE PP-03677-2; SEAL GLAND 28009-4

DP-03677-3

2. SUMMARY OF RESULTS

A summary of the stresses, deflections, and loads are given here. The actual values are given and compared to the allowable values.

<u>Components</u>	<u>Actual</u>	<u>Allowable</u>
Motor Hold Down Bolts Stress, PSI - Shear	4,010	10,000
- Tensile	7,436	20,000
Pump Hold Down Bolt Stress, PSI - Tensile	8,021	20,000
- Shear	2,202	10,000
Anchor Bolt Stress, PSI - Shear	3,530	10,000
- Tensile	4,969	20,000
Shaft Stress, PSI	12,272	26,250
Frame Stress, PSI	11,344	21,600
Pump Foot Stress, PSI	8,501	12,500*
Maximum Nozzle Stress, PSI - Discharge	8,030	19,800
- Suction	11,667	19,800
Pump Bearing Loads, Lbs. - Inboard	816	20,253
- Outboard	5,435	27,000
Flexible Coupling Misalignment, Radians	.001	.017
Impeller Key Stress, PSI - Shear	2,489	12,000
Impeller Clearance, Inches	.0062	.0065
Nozzle Flange Moment, In-lbs.	75,648	123,212*

* Faulted allowables given here, see detailed calculations for Upset Case. All other allowables are Upset allowables and are compared to Faulted actual values.

3. FREQUENCY ANALYSIS

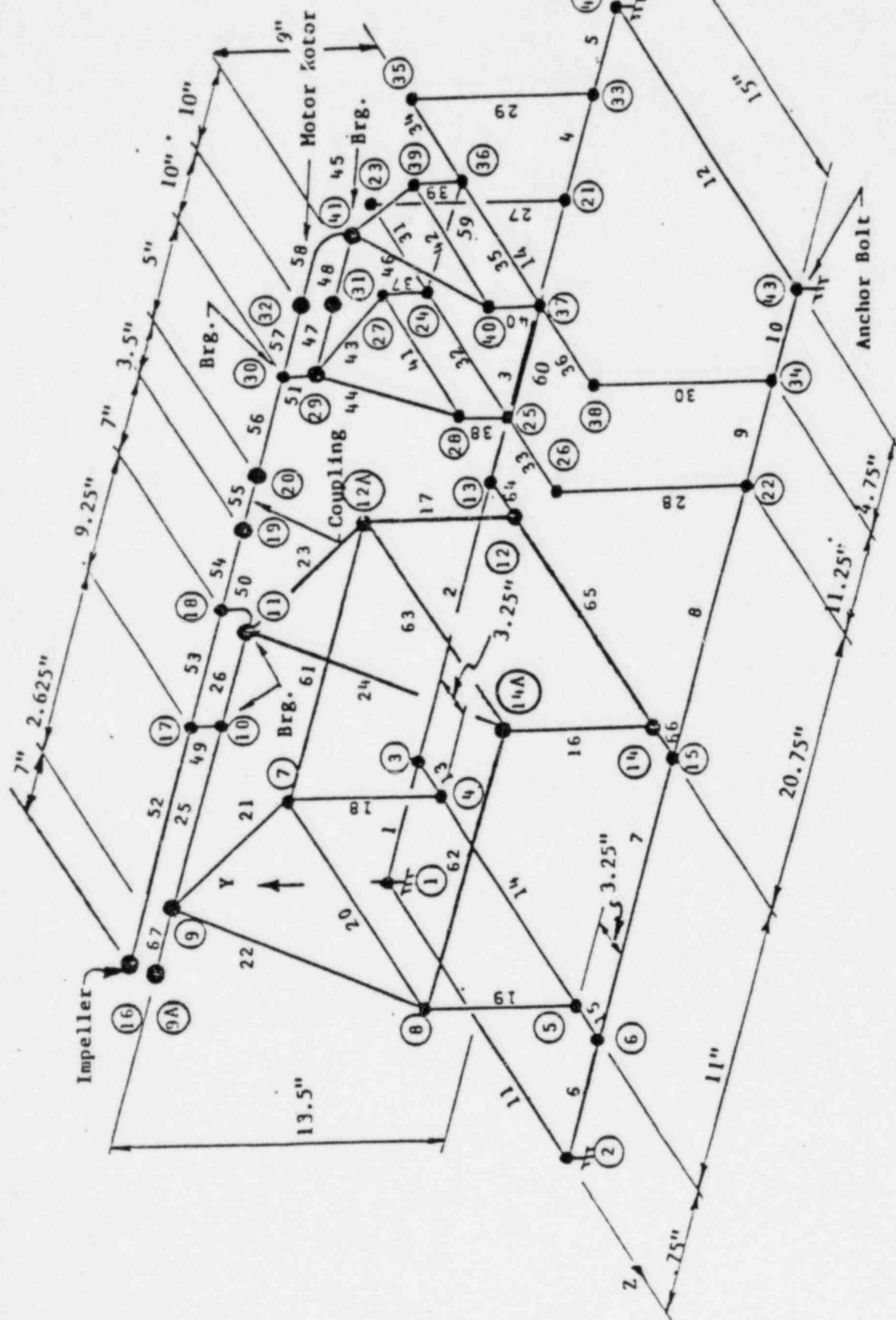
A dynamic model is prepared and a computer frequency analysis is made to determine the assembly frequencies as required by the specification. A detailed discussion of the dynamic model and computer analysis is given below.

3.1 Dynamic Model

The dynamic model which was developed for the frequency analysis is shown in Figure 2, page 5. The joint numbers (enclosed in circles) and member numbers are included to facilitate the computer input. Several assumptions were made in developing the model. These assumptions were made such that the model would be more flexible than the actual assembly. Thus, the frequencies predicted by the model will be lower than the actual frequencies.

Some of these assumptions are:

1. The bedplate is assumed to be supported only at the foundation bolts. This is true for upward forces but for downward forces the bedplate channel flanges are continuously supported.
2. The motor could help restrain the pump in the direction parallel to the shaft centerline by transmitting forces through the coupling.
 - This is not included in the model since the coupling connection is not positive in that direction. This is also not desirable since this would impose thrust loads on the pump and motor bearings.



3. The bearing stiffness is difficult to determine precisely. Thus, the shaft is assumed to be pinned at the inner pump bearing(Joint 17) and at both motor bearings(Joints 30 and 45).

Masses are lumped at joints in accordance with good practice in seismic analysis. Most of the mass of the pump is lumped at Joints 9A and 11. Joint 9A is the centerline of the nozzles, i.e. where the discharge and suction nozzle centerlines intersect.

The pump and motor casings are modeled by equivalent hollow beam sections. Members 27 through 48 represent the motor casing and Members 20 through 26 and 61, 62, 63, and 67 represent the pump casing.

3.2 Computer Analysis

The computer analysis for the frequencies is performed by use of the ICES-STRU DL computer program operating on an IBM 370/158 computer. Users manuals on the STRU DL program can be obtained from the Massachusetts Institute of Technology. The code has been well verified for frequency calculations. These verification checks will be made available upon request*.

The detailed input data sheets are given on pages 8 through 11. These are believed to be self-explanatory. The motor and pump shaft vary in cross section and are input accordingly.

The analysis is made for the three dimensional frame. Thus, the model is assigned 15 degrees of freedom. However, only the first two frequencies are calculated since the objective is to obtain the frequencies of interest in seismic conditions.

The computer output is shown below. The lowest frequency is seen to be 40 C.P.S. The mode shapes for the two modes are given in Appendix C.

JOB ID - ME-894 JOB TITLE - CRANE DEMING FIGURE 4066 PUMP
ACTIVE UNITS - LENGTH FORCE ANGLE TEMPERATURE TIME
 INCH LB RAD DEGF SEC
ACTIVE STRUCTURE TYPE - SPACE FRAME
ACTIVE COORDINATES AXES X Y Z

EIGENVALUES				
MODE	EIGENVALUE	FREQUENCY	PERIOD	RADIANS
1	0.632167D 05	0.400162D 02	0.249899D-01	0.251429D 03
2	0.445553D 06	0.106235D 03	0.941305D-02	0.667497D 03

* Notes for Dynamic Seismic Analysis Course, by C. K. McDonald
University of Alabama in Birmingham

STRAUDL 'ME-89A' CRANE DERING FIGURE 4066 PUMP

ICES STRAUDL-II
THE STRUCTURAL DESIGN LANGUAGE
IUG VERSION 3.00, JUNE 1976
SITE OF POOL 9/21/81
10114123

TYPE SPACE FRAME

UNITS INCHES POUNDS SECONDS

JOINT COORDINATES

1 0. 0. 0. SUPPORT

2 0. 0. 15. SUPPORT

3 .75 0. 0.

4 .75 0. 3.25

5 .75 0. 11.75

6 .75 0. 15.

7 .75 .01 3.25

8 .75 .01 11.75

9 .75 13.5 7.5

9A -6.25 13.5 7.5

10 3.375 13.5 7.5

11 12.625 13.5 7.5

12 11.75 0. 3.25

12A 11.75 .01 3.25

13 11.75 0. 0.

14 11.75 0. 11.75

14A 11.75 .01 11.75

15 11.75 0. 15.

16 -6.25 13.51 7.5

17 3.375 13.51 7.5

18 12.625 13.51 7.5

19 19.625 13.51 7.5

20 23.125 13.51 7.5

21 32.5 0. 0.

22 32.5 0. 15.

23 32.5 4.49 0.

24 32.5 4.49 .5

25 32.5 4.49 14.5

26 32.5 4.49 15.

27 32.5 4.5 .5

28 32.5 4.50 16.5

29 28.125 13.5 7.5

30 28.125 13.51 7.5
31 38.125 13.5 7.5
32 38.125 13.51 7.5
33 43.75 0. 0.
34 43.75 0. 15.
35 43.75 4.49 0.
36 43.75 4.49 .5
37 43.75 4.49 14.5
38 43.75 4.49 15.
39 43.75 4.50 .5
40 43.75 4.50 14.5
41 48.125 13.51 7.5
42 48.5 0. 0. SUPPORT
43 48.5 0. 15. SUPPORT
JOINT RELEASE
1 2 42 43 MOM X Y Z
MEMBER INCIDENCES
1 1 1 3
2 2 3 13
3 13 21
4 21 31
5 31 42
6 2 6
7 6 15
8 15 22
9 22 34
10 34 43
11 1 2
12 42 43
13 3 4
14 4 5
15 5 6
16 14 14A
17 12 12A
18 4 7
19 5 8
20 7 8
21 7 9
22 8 9
23 12A 11
24 14A 11
25 9 10
26 10 11
27 21 23

28 22 24
29 33 35
30 34 38
31 23 24
32 24 25
33 24 25
34 35 36
35 34 37
36 38 37
37 24 27
38 25 28
39 34 39
40 37 40
41 27 28
42 39 40
43 27 29
44 28 29
45 39 41
46 40 41
47 29 31
48 31 41
49 10 17
50 11 18
51 29 30
52 16 17
53 17 18
54 18 19
55 19 20
56 20 30
57 30 32
58 32 41
59 24 34
60 25 37
61 7 '12A'
62 8 '14A'
63 '12A' '14A'
64 13 12
65 12 14
66 15 14
67 9 '9A'
MEMBER RELEASE
35 END FORCE X
37 18 39 40 START MOM X Y Z
16 11 19 END MOM X Y Z


```

49 51 END MOM X Y Z
58 END MOM Y Z
49 END FORCE Y
56 START MOM Y Z
54 START MOM X
CONSTANTS
E 2900000.0 ALL
MEMBER PROPERTIES
1 10 10 PRIS AX 6.75 IX .73 IV 289. 12 7.55 SV 32.15 SZ 2.41
11 12 PRIS AX .875 IX .1 IV .0046 12 .89 SV .036 SZ .309
13 14 15 31 10 36 65 66 PRIS AX 3. IX .1 IV .0625 12 9. SV .25 SZ 3.
16 10 19 37 10 40 PRIS AX .226 AY .226 AZ .226 IX 1. IV 1. 12 1. SV 1. SZ 1.
20 20 26 61 62 63 67 PRIS AX 9.5 IX 65. IV 42.5 12 42.5 SV 13. SZ 13.
27 10 30 PRIS AX 10. IX 20. IV 10. 12 10. SV 5. SZ 5.
41 10 40 59 60 PRIS AX 7. IX 560. IV 280. 12 280. SV 31. SZ 31.
49 50 51 PRIS AX .1 IX .1 IV .1 12 .1 SV .1 SZ .1
52 VARIABLE
SEG 1 AX 2.40 IX .96 IV .46 12 .46 SV .526 SZ .526 L 6.125
SEG 2 AX 3.02 IX 1.44 IV .72 12 .72 SV .72 SZ .370 L 3.5
53 PRIS AX 3.98 IX 2.92 IV 1.26 12 1.26 SV 1.12 SZ 1.12
54 PRIS AX 1.76 IX .497 IV .25 12 .25 SV .331 SZ .331
55 10 58 PRIS AX 2.76 IX 1.21 IV .60 12 .60 SV .667 SZ .667
DYNAMIC DEGREES OF FREEDOM
JOINTS '9A' 11 16 19 31 DISP X Y Z
INERTIA OF JOINTS '9A' LINEAR ALL .78
INERTIA CF JOINTS 11 LINEAR ALL .69
INERTIA OF JOINT 16 LINEAR ALL .078
INERTIA CF JOINTS 19 LINEAR ALL .065
INERTIA CF JOINTS 31 LINEAR ALL 1.93
DYNAMIC ANALYSIS ITERATION EIGENVALUE 2
LIST DYNAMIC EIGENVALUES EIGENVECTORS

```

4. LOADING CRITERIA

4.1 Seismic Loading

The lowest natural frequency of the pump system, including bedplate is 40 cps. The following loads exceed those given by the specification.

	<u>OBE</u>	<u>SSE</u>
Horizontal, X and Z	1.0g	1.5g
Vertical	.7g	1.0g

The loads were applied to the center of mass of each individual pump component. The loads for all three directions are applied, as required by the specification. The stresses are then combined directly for all three directions, which is more conservative than the square-root-of-the-sum-of-the-squares method. The SRSS method is used in some cases.

A computer analysis for the loading condition is made. The computer input is shown on page 14. The analysis is made for the following load cases.

1. 1.5g Lateral X Seismic
2. 1.5g Lateral Z Seismic
3. 1g Vertical Seismic
4. Nozzle plus Impeller Loads

Load case 3 is ratioed by the proper factor to obtain net upward or downward loads, as appropriate.

The computer model shown in Figure 2, page 5, which was used for the frequency analysis is also used for the static seismic and nozzle load analysis. The joint and member input data is the same as for the frequency analysis and is not repeated. The computer output data is given in Appendix A.

4.2 Individual Nozzle Loads

The nozzle loads for the individual nozzles, suction and discharge, are given in Paragraph 4.2.8 of the specification. These loads are listed below. However, it should be noted here that the combined resultant loads at the centerline of the suction/discharge intersection must be limited as shown in Section 4.6 below.

	<u>8" Suction</u>	<u>8" Discharge</u>
Resultant Force, F_R , lbs	2,520	2,520
Resultant Moment, Ft-lbs	6,304	6,304

4.3 Internal Pressure Loading

The internal pressure design conditions are 150 psig at 200°F.

4.4 Shaft Torsional Loading

The motor horsepower is 60 at 1800 R.P.M. Thus, the shaft torque is:

$$T = \frac{63000(60)}{1800} \quad 2,100 \text{ in-lbs}$$

4.5 Other Pump Normal Loads

The pump impeller is subjected to a 300 lbs radial and a 1000 lbs axial load during normal operation.

4.6 Resultant Nozzle Loads

The pump was analyzed for a set of resultant nozzle loads, resolved to the nozzle centerline at Joint 9A on the computer model. However, it was found that the pump foot would be overstressed with these loads. Thus, the resultant nozzle loads at Joint 9A must be zero. Note that the pump foot, Section 5.9, is fully stressed with no resultant nozzle loads.

LOADING 1 '1.5 G LATERAL X'

JOINT LOADS

'9A' FORCE X 450.

11 FORCE X 375.

16 FORCE X 45.

19 FORCE X 38.

31 FORCE X 1118.

LOADING 2 '1.5 G LATERAL Z'

JOINT LOADS

'9A' FORCE Z 450.

11 FORCE Z 375.

16 FORCE Z 45.

19 FORCE Z 38.

31 FORCE Z 1118.

LOADING 3 '1 G VERTICAL'

JOINT LOADS

'9A' FORCE Y 300.

11 FORCE Y 250.

16 FORCE Y 30.

19 FORCE Y 25.

31 FORCE Y 745.

LOADING 4 ' NOZZLE + IMPELLER LOADS'

JOINT LOADS

'9A' FORCE Z 5040.

'9A' MOMENT X 35000. Y 35000. Z -35000.

16 FORCE X 1000. Z 300.

LOADING LIST ALL

STIFFNESS ANALYSIS

OUTPUT DECIMAL 5

LIST FORCES DISPLACEMENTS

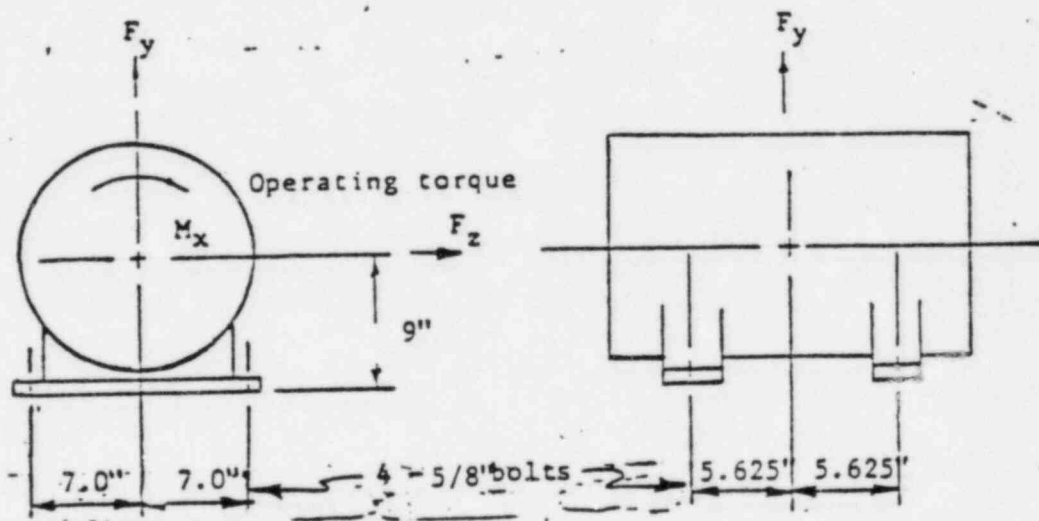
5. STRUCTURAL INTEGRITY ANALYSIS

The detailed stress analysis of the pump, supports, and motor is contained in this section. The stresses are obtained for the two horizontal and the vertical direction and combined directly.

A computer analysis for the pump is contained in App. A. Some of the pertinent stresses are obtained directly from the computer analysis. All of the important stresses could not conveniently be obtained from the computer analysis. Thus, some of the stresses are hand calculated.

5.1 Motor Hold Down Bolts

A sketch of the motor is shown below:



The stress due to operating torque is:

$$S = \frac{2100}{2(14.0)(.226)} = 332 \text{ psi tensile}$$

The total stresses are obtained by adding the stress from the computer output to the stress caused by operating torque. The highest motor bolt stress occurs in the bolt represented by Member 39 (see page A-1). Thus, the total stresses are:

$$C = \sqrt{23 + 3940 + 12.5} = 64.5$$

$$= 10.46 \text{ psi tensile}$$

$$V = \sqrt{(1185 + 1940 + 197)} = 55.0$$

$$= \sqrt{2500 + 145} = 50.10 \text{ psi shear}$$

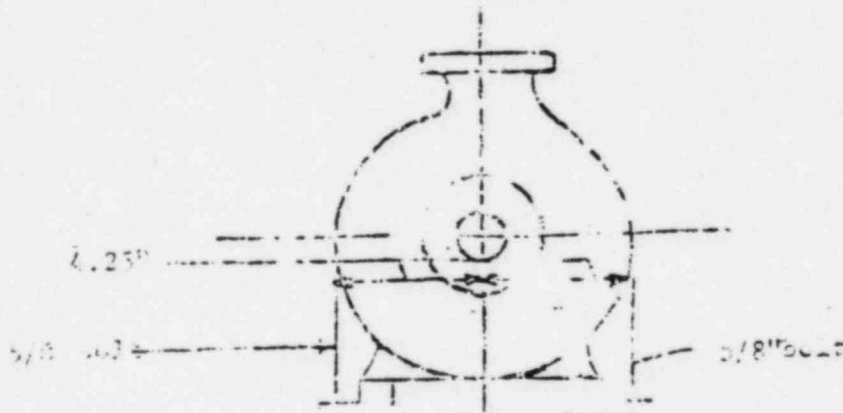
The allowable stresses are 10,000 psi

in shear or 15,000 psi in tension

bolts or equivalent, per subsection NF of ASME Sec. VIII, Div. 1

3.2 Pump House Bolt Down Bolts

A sketch of the pump is shown below:



$$\begin{aligned}
 & \text{The stress on the bolts is } \sigma = \frac{F}{A} = \frac{10,000 \text{ psi} \times 1.57 \text{ in}^2}{1.57 \text{ in}^2} = 10,000 \text{ psi} \\
 & \text{The shear stress on the bolts is } \tau = \frac{V}{A} = \frac{50.10 \text{ psi} \times 1.57 \text{ in}^2}{1.57 \text{ in}^2} = 50.10 \text{ psi} \\
 & \text{The resultant stress on the bolts is } \sigma_r = \sqrt{\sigma^2 + \tau^2} = \sqrt{10,000^2 + 50.10^2} = 10,000.25 \text{ psi} \\
 & \text{The allowable stress on the bolts is } \sigma_a = 15,000 \text{ psi} \\
 & \text{The stress on the bolts is less than the allowable stress, so the bolts are safe.}
 \end{aligned}$$

Not Drawn

The support reaction is shown in the sketch. The anchor bolts are 5/8"

in diameter. The shear stress on the bolts is 50.10 psi. The tensile stress on the bolts is 10,000 psi.

The resultant stress on the bolts is 10,000.25 psi. The allowable stress on the bolts is 15,000 psi.

$$S = (2/3(282 + 841))/ .226$$

$$= 3,313 \text{ psi tensile Upset}$$

$$S = \frac{282 + 841}{.226}$$

$$= 969 \text{ psi Faulted}$$

$$V = \sqrt{(544 + 10)^2 + (98 +)^2} / .226 = 3,530 \text{ psi shear}$$

The allowable stresses are 10,000 psi shear and 20,000 psi tensile for A-307 bolts per Upset.

5.4 Shaft Stresses

The shaft is shown on the computer model, page 5, as members 52 through 54. The computer output for stresses is given on pages A-4 through A-6. The maximum combined stress occurs in member 52 at the end. (see page 11 for properties).

The shearing stress due to torque is

$$= \frac{2100}{2(.370)} = 2,838 \text{ psi}$$

Thus, the maximum stresses are:

$$V = 2,838 \text{ psi shear}$$

$$S_a = 15 + 1171 + 2(730) + 810$$

$$= 10,881 \text{ psi Bending Stress}$$

$$S = \sqrt{(2(2838))^2 + (10881)^2}$$

$$= 12,272 \text{ psi Combined Stress}$$

The allowable stress is 1.5(17500) = 26,250 psi for the Tp 416 S.S. shaft.

5.5 Stresses in Support Frame

The maximum stress in the lower endplate occurs in member 8 (page A-7) and is

$$S = 1118 + 106 + 2(624) + 870 = 11,314 \text{ psi}$$

The allowable stress is 21,600 psi for the A-36 steel per Subsection NF.

5.6 Casing/Frame Flange Analysis

The casing/frame flange is a flat face flange with a full face gasket. There is no method given by the ASME Code to evaluate this type flange. However, the flange has been qualified for internal pressure by hydrostatic tests and service experience. Since the resultant nozzle loads must be zero due to the pump foot stress, see Section 5.9 for foot stress with zero nozzle loads, there are negligible loads on this flange other than internal pressure.

5.7 Nozzle Analysis

The 8" discharge and 8" suction nozzles must be checked for their ability to withstand the external loads.

1. Discharge Nozzle

The discharge nozzle-casing intersection is closely approximated as a tee. The methods of ASME Code ND -3652 are used to perform the analysis. The tee is contoured similar to a welding tee but it is not exactly the same as a welding tee. Thus, to be conservative, the stress intensification factor used for this analysis will be the average between a welding tee and a fabricated tee. (The nomenclature used is that of the ASME Code).

For a welding tee:

$$h = \frac{4.4(.625)}{8.5} = .324$$

$$i = \frac{.9}{(.324)^{2/3}} = 1.91$$

For a fabricated tee:

$$h = \frac{.625}{8.5} = .074$$

$$i = \frac{.9}{(.074)^{2/3}} = 5.11$$

Average Stress Intensification Factor

$$i_{avg} = \frac{1.91 + 5.11}{2} = 3.51$$

$$Z = 3.1416(4.31)^2(.625) = 36.4 \text{ in.}^3$$

$$M_b = 75648 \text{ in-lbs. bending moment; } M_t = 0 \text{ in-lbs. torsional moment}$$

$$P = 0 \text{ lbs. axial } V = 2520 \text{ lbs. shear}$$

The moment is resolved to the centerline of the tee:

$$M = 75648 + 11(2520) = 103,368 \text{ in-lbs.}$$

Equation (8) of ND-3652.1 gives:

$$\frac{150(9.25)}{4(.625)} + \frac{.75(3.51)(103368)}{36.4} = 8,030 < 1.5(16500)(.8) = 19,800 \text{ psi}$$

(SA-351 CF8M at 200° F.)

2. Suction Nozzle

The suction nozzle is treated as a nozzle in a flat plate, Cases 10 and 20 of Roark's Formulas for Stress and Strain, 4th Edition, where for this case:

$$r_o = 6.75" \quad a = 8" \quad t = .625"$$

The stress coefficients are given on pages 241 and 242 of Roark's Formulas for Stress and Strain, 4th Edition and are:

$$B_M = .45$$

$$B_P = .12$$

$$M_b = 75648 \text{ in-lbs.}$$

$$M_t = 0 \text{ in-lbs.}$$

$$P = 2,520 \text{ lbs.}$$

$$V = 0 \text{ lbs.}$$

The stresses are:

$$S_R = \frac{.12(2520)}{(.625)^2} + \frac{.45(75648)}{8(.625)^2} = 11,667 \text{ psi bending}$$

$$V = 0 \text{ psi}$$

The maximum stress by the shear stress theory is:

$$S = \sqrt{(2(0))^2 + (11667)^2} = 11,667 \text{ psi}$$

The allowable stress for SA-351 CF8M material is $1.5(16500)(.8) = 19,800 \text{ psi}$

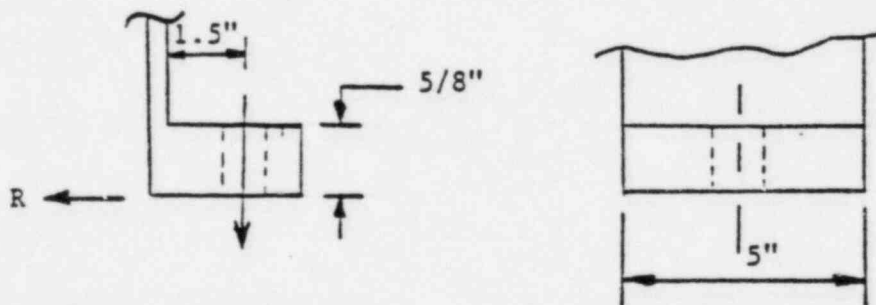
5.8 Nozzle Flange Analysis

The 8" flanges are ANSI 150# type. Thus, since there are no other known methods of analysis of flanges for external loads, ND-3658.3 (Summer 1978 Addenda) Equation (12) will be used.

The allowable moment on the flange is: $M = 6250(25/36)(11.75)(8)(.302) = 123,212 \text{ in-lbs}$
 The actual moment is 75,648 in-lbs., thus acceptable. Note that high strength bolts must be used for these connections.

5.9 Pump Foot Stress

The pump foot is as shown below:



The foot properties are:

$$A = .625(5) = 3.125 \text{ in.}^2$$

$$B = \frac{5(.625)^2}{6} = .326 \text{ in.}^3$$

The bolt loads are obtained from Section 5.2 and are:

$$F = \frac{74194}{8021(.226)} = \frac{16790}{1,813 \text{ lbs. Faulted}}$$

$$= 5530(.226) = 1,250 \text{ lbs. Upset}$$

$$R = \frac{2202(.226)}{1468(.226)} = \frac{498 \text{ lbs. Faulted}}{332 \text{ lbs. Upset}}$$

$$S = \frac{1813(1.5)}{.326} + \frac{498}{3.125} = 8,501 \text{ psi Faulted}$$

$$= \frac{1250(1.5)}{.326} + \frac{332}{3.125} = 5,858 \text{ psi Upset}$$

The allowable for Class 25 Cast iron is 6,250 psi Upset and 12,500 psi Faulted.

6. FUNCTIONAL CAPABILITY ANALYSIS

The detailed functional analysis (deflection, rotations, etc.) is contained in this section. The following load conditions is considered:

Normal Operating loads + Maximum Nozzle Loads + SSE Loads.

The computer analysis is contained in Appendix A.

6.1 Pump Bearing Loads

The pump bearing loads are given on pages A-8 and A-9. The outboard bearing is double row type. Thus, the moment acting on the bearing is converted to an equivalent load by dividing the moment by the centerline distance between rows. Member 49 represents the inboard bearing and member 50 the outboard bearing.

(a) <u>Inboard</u> Member 49, Joint 17	<u>Total</u>	
	Axial	Z
Loading 1	4	0
Loading 2	0	111
Loading 3 (2)	152	0
Loading 4	<u>5</u>	<u>689</u>
Total	161	800
Resultant	816 lbs.	

The inboard bearing is a ND-7610 which has an allowable of 20,253 lbs.

(h) Outboard	Total				
	Force		Moment		Thrust
Member 50, Joint 18	Axial	Z	X	Z	Y
Loading 1	28	0	0	366	83
Loading 2	0	39	314	0	0
Loading 3(2)	65	0	0	376	0
Loading 4	105	385	742	1204	1000
Totals	198	424	1056	1946	1083

Resultants 468 lbs. 2,214 in-lbs. 1,083 lbs.

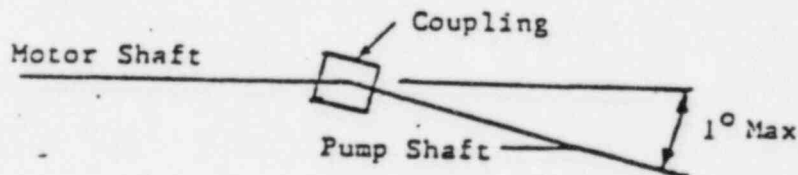
Equivalent loads = $468 + \frac{2214}{.53} = 4,645$ radial + 1083 thrust

The combined loads are: $P = 1.17(4645) = 5,435$ lbs.

The outboard bearing is an ND-5511 which has a specific dynamic capacity of 27,000 lbs., see Appendix D.

6.2 Flexible Coupling Analysis

The coupling is adequate for the normal torsional loads. The seismic and nozzle loads do not impose any additional torsional loads. However, the seismic and nozzle loads do cause bending of the pump and motor shaft, which in turn causes coupling misalignment as shown below:

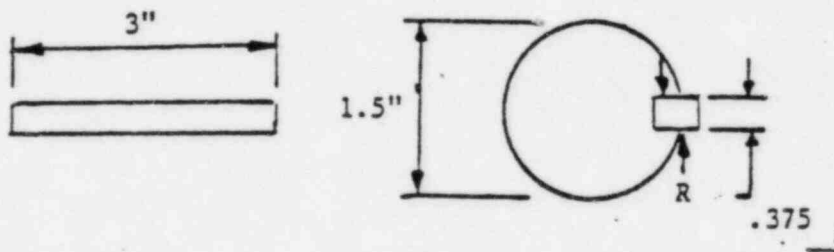


The maximum misalignment must not exceed one degree (.017 radian). This misalignment can be obtained from the computer output as the vector sum of joint 19 (worst case), rotations Y and Z. These rotations are tabulated below, see pages A-10 and A-11.

(joint 19)	Total	
	Y	Z
Loading Case 1	.00000	.00015
Loading 2	.00006	.00000
Loading Case 3(2)	.00000	.00028
Loading Case 4	<u>.00011</u>	<u>.00029</u>
Totals	.00017	.00072
Resultant	.001 radian	

6.3 Impeller Key Analysis

The torque that the impeller key must transmit is practically the same for all loading conditions. This is 2100 in-lbs. operating torque (pg. 13). The forces on the key are shown below:



$$R = \frac{2100 (2)}{1.5} = 2,800 \text{ lbs.}$$

The shearing stress in the key is:

$$V = \frac{2800}{.375(3)} = 2,489 \text{ psi}$$

The yield stress for the steel key will equal or exceed 40,000 psi. Thus, for shear the allowable stress is: $F_v = .3(40000) = 12,000 \text{ psi}$.

6.4 Impeller Clearance

The relative deflection between the impeller and pump casing is found by taking the difference of the deflections of joints 9A and 16. The worst case deflections are tabulated below (see pages A-10 & A-11):

Joint 16	Total	
	Y	Z
Loading 1	-.00049	.00000
Loading 2	.00000	.00134
Loading 3 (2)	.00016	.00000
Loading 5	<u>-.00679</u>	<u>.01154</u>
Totals	-.00712	.01288

Joint 9A

	Total	
	Y	Z
Loading 1	-.00054	.00000
Loading 2	.00000	.00044
Loading 3(4)	-.00138	.00000
Loading 5	<u>-.00802</u>	<u>.00692</u>
Totals	-.00994	.00736
Difference (Joint 16 - 9)	.00282	.00552

The total vector deflection is: $D = \sqrt{(.00282)^2 + (.00552)^2} = .0062"$

The clearance on the impeller is .0065". Thus the clearance is adequate.

6.5 Shaft Mechanical Seals

The deflection of the shaft at the mechanical seal is less than .003". Experience indicates that the construction of this seal is such that leakage will not occur when subjected to this small amount of shaft deflection.

APPENDIX A - COMPUTER OUTPUT FOR STRESSES, FORCES, DISPLACEMENTS

MEMBER 39

```

.....
* LOADING - 1 .....
* 1.5 G LATERAL .....
* .....
DISTANCE FROM START / AXIAL Y SHEAR Z SHEAR STRESS Y BENDING Z BENDING MAX NORMAL MIN NORMAL
0.0 FR -1922.72217 -1185.44971 61.54852 -0.00000 0.00000 -1922.72217 -1922.72217
* .....
* LOADING - 2 .....
* 1.5 G LATERAL .....
* .....
DISTANCE FROM START / AXIAL Y SHEAR Z SHEAR STRESS Y BENDING Z BENDING MAX NORMAL MIN NORMAL
0.0 FR 3942.78442 1339.87427 2540.26416 0.00000 0.00000 3942.78442 3942.78442
* .....
* LOADING - 3 .....
* 1 G VERTICAL .....
* .....
DISTANCE FROM START / AXIAL Y SHEAR Z SHEAR STRESS Y BENDING Z BENDING MAX NORMAL MIN NORMAL
0.0 FR 802.73218 142.53601 32.33104 -0.00000 -0.00000 802.73218 802.73218
* .....
* LOADING - 4 .....
* UPSET NOZZLE + IMPELLER LOADS .....
* .....
DISTANCE FROM START / AXIAL Y SHEAR Z SHEAR STRESS Y BENDING Z BENDING MAX NORMAL MIN NORMAL
0.0 FR 1238.14966 -397.61113 -145.30745 -0.00000 0.00000 1238.14966 1238.14966

```

MEMBER 10

DISTANCE FROM START		AXIAL		Y SHEAR		Z SHEAR		STRESS		Z BENDING		MAX NORMAL		MIN NORMAL	
1.000 FM		2391.47876		-1012.98779		210.34350		0.0		0.0		2391.47876		2391.47876	
LOADING - 1		1.5 G LATERAL													
1.000 FM		2391.47876		-1012.98779		210.34350		0.0		0.0		2391.47876		2391.47876	
LOADING - 2		1.5 G LATERAL													
DISTANCE FROM START		AXIAL		Y SHEAR		Z SHEAR		STRESS		Z BENDING		MAX NORMAL		MIN NORMAL	
1.000 FM		7081.07422		-33.86034		1720.06055		0.0		0.0		7081.07422		7081.07422	
LOADING - 3		1.5 G VERTICAL													
DISTANCE FROM START		AXIAL		Y SHEAR		Z SHEAR		STRESS		Z BENDING		MAX NORMAL		MIN NORMAL	
1.000 FM		1137.63062		-1.99727		109.85068		0.0		0.0		1137.63062		1137.63062	
LOADING - 4		UPSET NOZZLE / IMPELLER LOADS													
DISTANCE FROM START		AXIAL		Y SHEAR		Z SHEAR		STRESS		Z BENDING		MAX NORMAL		MIN NORMAL	
1.000 FM		46272.56250		22.59938		28360.15625		0.0		0.0		46272.56250		46272.56250	

 RESULTS OF LATEST ANALYSES

JOB ID - ME-894 JOB TITLE - CRANE DEMING FIGURE 4066 PUMP

ACTIVE UNITS - LENGTH FORCE ANGLE TEMPERATURE TIME
 INCH LB RAD DEGF SEC

ACTIVE STRUCTURE TYPE - SPACE FRAME

ACTIVE COORDINATES AXES X Y Z

LOADING - 1

1.5 G LATERAL

RESULTANT JOINT LOADS - SUPPORTS

JOINT	X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
GLOBAL	-21.81224	-21.81224	-98.10873	-0.00000	-0.00000	-0.00000
GLOBAL	-21.81224	-21.81224	-98.10873	-0.00000	-0.00000	-0.00000
GLOBAL	-21.81224	-21.81224	-98.10873	-0.00000	-0.00000	-0.00000

LOADING - 2

1.5 G LATERAL

RESULTANT JOINT LOADS - SUPPORTS

JOINT	X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
GLOBAL	-10.48480	-40.68018	-476.38843	-0.00000	-0.00000	-0.00000
GLOBAL	-10.48480	-40.68018	-476.38843	-0.00000	-0.00000	-0.00000
GLOBAL	-10.48480	-40.68018	-476.38843	-0.00000	-0.00000	-0.00000

LOADING - 3

1 G VERTICAL

RESULTANT JOINT LOADS - SUPPORTS

JOINT	X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
GLOBAL	-86.60847	-163.85034	-10.18211	-0.00000	-0.00000	-0.00000
GLOBAL	-86.60847	-163.85034	-10.18211	-0.00000	-0.00000	-0.00000
GLOBAL	-86.60847	-163.85034	-10.18211	-0.00000	-0.00000	-0.00000

LOADING - 4

UPSET NOZZLE + IMPELLER LOADS

RESULTANT JOINT LOADS - SUPPORTS

JOINT	X FORCE	Y FORCE	Z FORCE	X MOMENT	Y MOMENT	Z MOMENT
GLOBAL	99.19222	-1488.37102	-1450.40141	-0.00000	-0.00000	-0.00000
GLOBAL	99.19222	-1488.37102	-1450.40141	-0.00000	-0.00000	-0.00000
GLOBAL	99.19222	-1488.37102	-1450.40141	-0.00000	-0.00000	-0.00000

RESULTS OF LATEST ANALYSIS

JOB ID - ME-894	JOB TITLE - CRANE DEMING FIGURE 4044 PUMP	ANGLE RAD	TEMPERATURE DEGF	TIME SEC
ACTIVE UNITS -	FORCE LB			
LENGTH INCH				
ACTIVE STRUCTURE TYPE -	SPACE	FRAME		
ACTIVE COORDINATES AXES X Y Z				

INTERNAL MEMBER RESULTS

MEMBER NORMAL STRESS

MEMBER 92

DISTANCE FROM START	AXIAL		SHEAR		STRESS		NORMAL	
	AXIAL	Y SHEAR	Z SHEAR	Y BENDING	Z BENDING	MAX	MIN	
6.120	-18.75000	0.0	0.0	0.00000	-0.00000	-18.75000	-0.50000	
				0.00000	0.00000	-4.90066	-4.90066	

DISTANCE FROM STAIR	AXIAL		V SHEAR		T BENDING		Y BENDING		Z BENDING		MAX NORMAL		MIN NORMAL	
	1	2	1	2	1	2	1	2	1	2	1	2	1	2
6.120	0.0	0.0	0.0	0.0	-323.3739	-0.0000	-323.3739	-0.0000	173.3739	0.0000	173.3739	-323.3739	-173.3739	
	0.0	0.0	0.0	0.0	-173.3739	-0.0000	-173.3739	-0.0000	173.3739	0.0000	173.3739	-173.3739	-173.3739	

DISTANCE FROM START	/			STRESS			/	
	AXIAL	Y SHEAR	Z SHEAR	Y BENDING	Z BENDING	MAX NORMAL	MIN NORMAL	
0.120	0.0	0.0	0.0	-0.00000	19.04933	19.04933	-19.04933	
				0.0	10.40333	10.40333	-10.40333	

DISTANCE FROM STR.	AXIAL		SHEAR		STRESS BENDING		MAX. NORMAL		MIN. NORMAL	
	Y	Z	Y	Z	Y	Z	Y	Z	Y	Z
0.120	-916.66670	0.0	0.0	0.0	-390.16187	1073.62446	-390.16187	1073.62446	-390.16187	1073.62446
0.120	-916.66670	0.0	0.0	0.0	-390.16187	1073.62446	-390.16187	1073.62446	-390.16187	1073.62446

MEMBER 33

LOADING - 1									
1.5 G LATERAL									
DISTANCE FROM START	AXIAL	Y SHEAR	Z SHEAR	STRESS		Z BENDING	MAX NORMAL		MIN NORMAL
				Y BENDING	Z BENDING		MAX NORMAL	MIN NORMAL	
0.0 FM	-1.10633	0.0	0.0	0.0000	0.0000	-0.0000	-1.10633	-1.10633	-1.10633
1.000	-1.10633	0.0	0.0	0.0000	0.0000	-30.38475	19.07822	-1.10633	-1.10633
LOADING - 2									
1.5 G LATERAL									
DISTANCE FROM START	AXIAL	Y SHEAR	Z SHEAR	STRESS		Z BENDING	MAX NORMAL		MIN NORMAL
				Y BENDING	Z BENDING		MAX NORMAL	MIN NORMAL	
0.0 FM	-0.00000	0.0	0.0	-184.71891	0.00000	0.00000	184.71891	-386.71891	-386.71891
1.000	-0.00000	0.0	0.0	154.81378	-0.00000	-0.00000	154.81378	-154.81378	-154.81378
LOADING - 3									
1 G VERTICAL									
DISTANCE FROM START	AXIAL	Y SHEAR	Z SHEAR	STRESS		Z BENDING	MAX NORMAL		MIN NORMAL
				Y BENDING	Z BENDING		MAX NORMAL	MIN NORMAL	
0.0 FM	-0.00000	0.0	0.0	-0.00000	0.00000	0.00000	0.00000	-237.81229	-237.81229
1.000	-0.00000	0.0	0.0	-0.00000	-120.11959	-120.11959	120.11959	-120.11959	-120.11959
LOADING - 4									
UPSET NOZZLE + IMPELLER LOADS									
DISTANCE FROM START	AXIAL	Y SHEAR	Z SHEAR	STRESS		Z BENDING	MAX NORMAL		MIN NORMAL
				Y BENDING	Z BENDING		MAX NORMAL	MIN NORMAL	
0.0 FM	-251.25674	0.0	0.0	-2578.12407	0.00001	0.00001	2326.86748	-2829.38013	-2829.38013
1.000	-251.25674	0.0	0.0	631.32411	-44.15070	-44.15070	426.21899	-926.73143	-926.73143

MEMBER 5A

LOADING - 1
 1.5 G LATERAL
 DISTANCE FROM START
 0.0 FR 1.000
 AXIAL 21.39091
 Y SHEAR 0.0
 Z SHEAR 0.0
 STRESS
 Y BENDING -0.00000
 Z BENDING 1002.03037
 MAX NORMAL 1023.62939
 MIN NORMAL -980.44731
 355.60376
 312.42188

LOADING - 2
 1.5 G LATERAL
 DISTANCE FROM START
 0.0 FR 1.000
 AXIAL 0.00000
 Y SHEAR 0.0
 Z SHEAR 0.0
 STRESS
 Y BENDING -425.16235
 Z BENDING -0.00000
 MAX NORMAL 425.16235
 MIN NORMAL -126.15424
 126.15424

LOADING - 3
 1 G VERTICAL
 DISTANCE FROM START
 0.0 FR 1.000
 AXIAL 0.00000
 Y SHEAR 0.0
 Z SHEAR 0.0
 STRESS
 Y BENDING -0.00000
 Z BENDING 160.78496
 MAX NORMAL 160.78496
 MIN NORMAL -122.61863
 122.61863

LOADING - 4
 UPSET NOZZLE IMPELLER LOADS
 DISTANCE FROM START
 0.0 FR 1.000
 AXIAL -0.00000
 Y SHEAR 0.0
 Z SHEAR 0.0
 STRESS
 Y BENDING -104.96804
 Z BENDING 1486.90503
 MAX NORMAL 3391.87303
 MIN NORMAL -2591.87303
 1191.26102
 -1191.26102

MEMBER 8

.....									
* LOADING - 1.....									
1.5 G LATERAL N.....									
.....									
DISTANCE	AXIAL	Y SHEAR	Z SHEAR	Y BENDING	Z BENDING	STRESS	MAX NORMAL	MIN NORMAL	
FROM START									
0.0 FM	13.30533	0.0	0.0	11.07279	1093.98973	0.01833	1118.34792	-1091.73484	
1.000	13.30553	0.0	0.0	0.01833	-1197.03765		1211.18140	-1104.57011	
.....									
* LOADING - 2.....									
1.5 G LATERAL Z.....									
.....									
DISTANCE	AXIAL	Y SHEAR	Z SHEAR	Y BENDING	Z BENDING	STRESS	MAX NORMAL	MIN NORMAL	
FROM START									
0.0 FM	0.30902	0.0	0.0	40.73349	-45.16414	58.55238	103.72263	-103.19769	
1.000	0.30902	0.0	0.0	58.55238	213.98392		274.84497	-274.22705	
.....									
* LOADING - 3.....									
1 G VERTICAL.....									
.....									
DISTANCE	AXIAL	Y SHEAR	Z SHEAR	Y BENDING	Z BENDING	STRESS	MAX NORMAL	MIN NORMAL	
FROM START									
0.0 FM	12.27087	0.0	0.0	0.01043	-410.40186	-4.38170	473.96499	-594.20313	
1.000	12.27088	0.0	0.0	-4.38170	-1205.57886		1222.99126	-1107.12619	
.....									
* LOADING - 4.....									
UPSET NOZZLE + IMPELLER LOADS.....									
.....									
DISTANCE	AXIAL	Y SHEAR	Z SHEAR	Y BENDING	Z BENDING	STRESS	MAX NORMAL	MIN NORMAL	
FROM START									
0.0 FM	-47.42711	0.0	0.0	-723.14773	9101.47264	-723.14773	9111.30281	-9072.23028	
1.000	-47.42711	0.0	0.0	-309.01455	2990.38301	-309.01455	3255.07031	-3341.92456	

RESULTS OF LATEST ANALYSIS*****

JOB ID - ME-894 JOB TITLE - CRANE DURING FIGURE 4066 PUMP
ACTIVE UNITS - LENGTH INCH ANGLE DEGT TEMPERATURE DEGT
ACTIVE STRUCTURE TYPE - SPACE FRAME
ACTIVE COORDINATES AXES X Y Z

LOADING - 1.5 G LATERAL

MEMBER FORCES

MEMBER	JOINT	AXIAL	FORCE SHEAR Y	SHEAR Z	TORSIONAL	MOMENT BENDING Y	BENDING Z
23	9	-1.35019	-403.83208	-0.00000	-0.00001	0.00002	-2227.52433
25	10	-1.35019	403.83208	-0.00000	0.00001	-0.00001	1367.88963
29	10	-1.35019	0.0	-0.00000	0.0	0.00000	0.0
49	11	-1.35019	0.0	-0.00000	0.0	0.0	0.0
50	11	-1.35019	-82.99998	-0.00000	-0.00000	0.00000	-365.87373
50	18	21.99998	-82.99998	0.00000	-0.00000	0.00000	-365.87373

LOADING - 1.5 G LATERAL

MEMBER FORCES

MEMBER	JOINT	AXIAL	FORCE SHEAR Y	SHEAR Z	TORSIONAL	MOMENT BENDING Y	BENDING Z
23	9	-0.00000	-0.00000	-13.45479	-12.31842	-2498.78979	-0.00000
25	10	-0.00000	0.00000	13.45479	-12.31842	-2498.78979	-0.00000
29	10	-0.00000	0.0	-13.45479	0.0	0.0	0.0
49	11	-0.00000	0.0	-13.45479	0.0	0.0	0.0
50	11	-0.00000	-0.00000	-13.45479	-14.12013	-0.39497	-0.00000
50	18	-0.00000	0.00000	-13.45479	-14.12013	-0.39497	-0.00000

LOADING - 3
1 G VERTICAL

MEMBER FORCES

MEMBER	JOINT	AXIAL	FORCE SHEAR Y	SHEAR Z	TORSIONAL	MOMENT BENDING Y	BENDING Z
23	9	48.1297	-148.03408	-0.00000	-0.00000	0.00000	-1044.70048
49	0	-48.1297	148.03408	0.00000	0.00000	-0.00000	403.55859
49	1	-48.1297	0.0	0.00000	0.0	0.0	0.0
50	1	15.16248	0.0	-0.00000	0.0	0.0	-181.82081
50	0	-15.16248	0.00000	0.00000	-0.00000	-0.00000	0.0

LOADING - 4
LPJET NOZZLE + IMPELLER LOADS

MEMBER FORCES

MEMBER	JOINT	AXIAL	FORCE SHEAR Y	SHEAR Z	TORSIONAL	MOMENT BENDING Y	BENDING Z
23	9	533.29136	-2001.28461	-2187.07617	-15213.48828	29804.37891	-20433.22246
49	0	-533.29136	2001.28461	2187.07617	15213.48828	-29804.37891	13804.46166
49	1	-53.44581	0.0	-488.8035	0.0	0.0	0.0
50	1	104.53112	959.29916	185.29443	-741.82813	-1.82246	-1193.41323
50	0	-104.53112	-959.29916	-185.29443	741.82813	1.82246	0.0

RESULTS OF LATEST ANALYSES.

JOB ID - ME-994

JOB TITLE - CRANE DEMING FIGURE 4066 PUMP

FORCE

ANGLE

TEMPERATURE

DEG F

TIME

FRAME - SPACE FRAME

ACTIVE COORDINATES AXES X Y Z

.....LOADING - 1.....
.....1.5 GALLONS.....
.....TITANIUM.....

RESULTANT JOINT DISPLACEMENTS - SUPPORTS	DISPLACEMENT		ROTATION	
	X DISP.	Y DISP.	X ROT.	Y ROT.
JOINT				

JOINT	RESULTANT JOINT DISPLACEMENTS - FREE JOINTS			ROTATION	
	X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.
94	0.00191	0.00034	-0.00000	-0.00000	-0.00001
96	0.00191	-0.00076	-0.00000	-0.00000	-0.00004
	0.00191	-0.00026	-0.00000	-0.00000	-0.00015

JOINT	RESULTANT JOINT DISPLACEMENTS - SUPPORTS		ROTATION	
	DISPLACEMENT Y DISP.	DISPLACEMENT X DISP.	Y ROT.	X ROT.
1	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000
31	0.000	0.000	0.000	0.000
32	0.000	0.000	0.000	0.000
33	0.000	0.000	0.000	0.000
34	0.000	0.000	0.000	0.000
35	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.000
38	0.000	0.000	0.000	0.000
39	0.000	0.000	0.000	0.000
40	0.000	0.000	0.000	0.000
41	0.000	0.000	0.000	0.000
42	0.000	0.000	0.000	0.000
43	0.000	0.000	0.000	0.000
44	0.000	0.000	0.000	0.000
45	0.000	0.000	0.000	0.000
46	0.000	0.000	0.000	0.000
47	0.000	0.000	0.000	0.000
48	0.000	0.000	0.000	0.000
49	0.000	0.000	0.000	0.000
50	0.000	0.000	0.000	0.000
51	0.000	0.000	0.000	0.000
52	0.000	0.000	0.000	0.000
53	0.000	0.000	0.000	0.000
54	0.000	0.000	0.000	0.000
55	0.000	0.000	0.000	0.000
56	0.000	0.000	0.000	0.000
57	0.000	0.000	0.000	0.000
58	0.000	0.000	0.000	0.000
59	0.000	0.000	0.000	0.000
60	0.000	0.000	0.000	0.000
61	0.000	0.000	0.000	0.000
62	0.000	0.000	0.000	0.000
63	0.000	0.000	0.000	0.000
64	0.000	0.000	0.000	0.000
65	0.000	0.000	0.000	0.000
66	0.000	0.000	0.000	0.000
67	0.000	0.000	0.000	0.000
68	0.000	0.000	0.00	

RESULTANT JOINT DISPLACEMENTS - FREE JOINTS									
JOINT	DISPLACEMENT		ROTATION	X ROT.		Y ROT.		Z ROT.	
	U DISP.	V DISP.		U ROT.	V ROT.	U ROT.	V ROT.	U ROT.	V ROT.
94	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
95	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
96	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
97	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
98	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
99	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
100	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
101	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
102	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
103	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
104	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
105	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
106	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
107	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
108	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
109	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
110	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
111	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
112	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
113	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
114	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
115	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
116	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
117	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
118	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
119	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
120	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
121	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
122	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000
123	0.00000	0.00000	0.00000	0.000					

.....
 * LOADING - 1 *
 * * * * *
 * * * * *
 * * * * *

RESULTANT JOINT DISPLACEMENTS - SUPPORTS

JOINT	X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.
-------	---------	---------	---------	--------	--------	--------

RESULTANT JOINT DISPLACEMENTS - FREE JOINTS

JOINT	X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.
74	GLOBAL	-0.00009	-0.00000	-0.00000	-0.00000	0.00012
16	GLOBAL	-0.00000	-0.00000	-0.00000	-0.00000	0.00003
19	GLOBAL	-0.00214	-0.00000	-0.00000	-0.00000	0.00014

.....
 * LOADING - 2 *
 * * * * *
 * * * * *
 * * * * *

RESULTANT JOINT DISPLACEMENTS - SUPPORTS

JOINT	X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.
-------	---------	---------	---------	--------	--------	--------

RESULTANT JOINT DISPLACEMENTS - FREE JOINTS

JOINT	X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.
74	GLOBAL	0.01233	0.00092	0.00076	0.00042	-0.00129
16	GLOBAL	0.01331	0.01134	0.00019	0.00019	-0.00123
19	GLOBAL	-0.01331	-0.01693	-0.00002	-0.00011	-0.00009

APPENDIX B - NOMENCLATURE AND FORMULAS

S = Tensile Stress

V = Shearing Stress

$S_{\max}$ = The maximum combined stress, combined by the maximum shear stress theory

S_b = A bending stress, usually equal to M/Z ; M = moment, Z = Sect. Modulus

R = A shearing force

Y = The vertical direction

X = Direction parallel to the shaft centerline

$V = T/J$, shaft shearing stress where T = torque and $J = 2Z$ = torsional modulus

F_v = Allowable shearing stress for bolts:

F_v = 10,000 psi for A 307 bolts per the AISC Code and NF-3281 & Appendix XVII of the ASME Section III Code.

F_v = 12,320 psi for A 325 bolts per above references.

F_t = Allowable tensile stress for combined loading per the AISC Code and also per Appendix XVII-2461.3 of the ASME Section III Code.

APPENDIX C - FREQUENCIES AND MODE SHAPES

RESULTS OF LATEST ANALYSES

JOB ID - ME-894 JOB TITLE - CRANE DEMING FIGURE 406A PUMP
ACTIVE UNITS - LENGTH FORCE ANGLE TEMPERATURE TIME
INCH LB DEG SEC
ACTIVE STRUCTURE TYPE - SPACE FRAME
ACTIVE COORDINATES AXES X Y Z

EIGENVALUES

MODE	EIGENVALUE	FREQUENCY	PERIOD	RADIANS
1	0.021170 03	0.4001420 03	0.249890-01	0.2314290 03
2	0.0455530 04	0.1062330 03	0.941330-02	0.6614410 03

EIGENVECTORS

JOINT	MODE 1	X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.
-------	--------	---------	---------	---------	--------	--------	--------

9A	GLOBAL	-0.4674302	-0.3630221	0.0000000			
1A	GLOBAL	-0.4674302	-0.3630221	0.0000000			
1B	GLOBAL	-0.4674302	-0.3630221	0.0000000			
1C	GLOBAL	-0.4674302	-0.3630221	0.0000000			

JOINT	MODE 2	X DISP.	Y DISP.	Z DISP.	X ROT.	Y ROT.	Z ROT.
-------	--------	---------	---------	---------	--------	--------	--------

9A	GLOBAL	0.9999999	0.2242014	0.0000000			
1A	GLOBAL	0.9999999	0.2242014	0.0000000			
1B	GLOBAL	0.9999999	0.2242014	0.0000000			
1C	GLOBAL	0.9999999	0.2242014	0.0000000			

APPENDIX D - NEW DEPARTURE BEARING ALLOWABLE LOADS

The allowable loads for Delco New Departure bearings subjected to short term seismic plus nozzle imposed loads are established in accordance with the method outlined below. New Departure Catalog 2C-110, pages 58 to 62, gives:

$$\text{Average Life, } L = 3800 \left(\frac{R_R}{R_E} \right)^4$$

$$\begin{aligned} R_R &= .86(4000) = 3,440 \text{ lbs. (ND-5511)} \\ &= .86(3000) = 2,580 \text{ lbs. (ND-7610)} \end{aligned}$$

$$R_E = \text{Allowable Equivalent Radial Load, Lbs.}$$

Since the maximum duration of an earthquake is no more than one minute, it is conservative to set the life, L , to be equal to one hour. Thus, solving for the maximum allowable seismic load:

$$\begin{aligned} R_E &= R_R(3800)^{\frac{1}{4}} = 3440(7.85) = 27,000 \text{ lbs. (ND-5511)} \\ &= 2580(7.85) = 20,253 \text{ lbs. (ND-7610)} \end{aligned}$$

Appendix E - Member Properties

Members
1 TO 10

$\frac{1}{2}$ of 18" Channel @ 45.8#

Members
11 12

$\frac{1}{4}$ " x $3\frac{1}{2}$ " bars

$$A = .875 \quad I_y = .0046 \text{ in}^4 \quad I_z = .89$$

$$S_y = .036 \text{ in}^3 \quad S_z = .509 \text{ in}^4$$

Members
13 14 15 64, 65, 66 & 31 TO 36

.5" web x 12t = .5 x 6"

$$A = 3 \text{ in}^2$$

$$I_y = .0625 \quad I_z = 9.$$

$$S_y = .25 \quad S_z = 3.$$

Members 16 TO 19, 37 TO 40

BOLTS $5/8"$ ϕ $A = .226$

E-2

Members 20 to 26 61 62 63 67

CASING & FRAME

Conservatively $6\frac{1}{2}"$ O.D. x $5\frac{1}{2}"$ I.D.

$$A = 9.4 \quad I_x = 85 \quad I_y = I_z = 42.5 \text{ in}^4$$

$$S_y = S_z = 13.1 \text{ in}^3$$

NOTE: FRAME PROPERTIES REDUCED TO CONSERVATIVELY ACCOUNT FOR CAST IRON MODULUS OF ELASTICITY.

27 TO 30

Shim for Motor

Assume RIGID

41 TO 48 MOTOR

18" O.D. x $\frac{1}{8}"$ THICK

$$A = 7. \quad I_x = 560 \quad I_y = I_z = 280$$

$$S_y = S_z = 31$$

49 TO 51

Dummy Members for Bearings

52 SHAFT

Seg 1 $D = 1.75"$ $L = 6.125"$

$$A = 2.40 \quad I_x = .96 \quad I_y = I_z = .46 \text{ in}^4$$

$$S_y = S_z = .526 \text{ in}^3$$

E-3

SEG 2 $D = 1.96''$ $L = 3.25''$

$$A = 3.02 \quad I_X = 1.44 \quad I_Y = .72 \quad I_Z = .72$$

$$S_Y = S_Z = .370$$

Membr 53 SHAFT

$$2.25'' \phi \quad A = 3.98 \quad I_X = 2.52 \quad I_Y = I_Z = 1.26$$

$$S_Y = S_Z = 1.12$$

Membr 54 SHAFT

1.5'' ϕ

$$A = 1.76 \quad I_X = .497 \quad I_Y = I_Z = .25$$

$$S_Y = S_Z = .331$$

Membs 55 TO 58 Motor SHAFT & Cplg

1.875'' ϕ

$$A = 2.76 \quad I_X = 1.21 \quad I_Y = I_Z = .60$$

$$S_Y = S_Z = .647 \text{ in}^3$$

ENCLOSURE 5

SEISMIC QUALIFICATION REVIEW TEAM

RE-AUDIT FOLLOW UP

Attachment (1) Status of PE Confirmatory Items
Attachment (2) Seismic Qualification Completion
Schedule

December 3, 1982

RESPONSE TO CE/PLANT ENGINEERING
CONFIRMATORY ITEMS FROM WATERFORD UNIT #3
SQRT RE-AUDIT

ITEM	COMMENTS/RESPONSE
GENERIC	<u>Comment:</u> It was noticed that during the review of NSS-PE-10 (Deborating Ion Exchanger), NSSS-PE-15 (Purification Filter) and NSSS-PE-33 (Holdup Tank), nozzle loads were negelected in the stress analysis. This seems to be a generic pattern. <u>Response</u> Nozzle loads for this equipment (seismic category tanks, HXS, Filters and Ion Exchangers) were originally simulated in the seismic analyses by increasing the seismic acceleration loading imposed on these components. This simulation was considered to be conservative because the component supports were judged to be more highly loaded than they would be if the appropriate siesmic and nozzle loads were considered. In response to the SQRT audit concern, a follow-on effort has been initiated to confirm that the original approach was conservative. All of the design reports for the applicable CE equipment have been reviewed and nozzle loads have been directly evaluated to determine their effect on component supports. In all cases, the original support loadings were more severe. All nozzle-to-shell juncture stresses were also evaluted and found to be within acceptable levels.
GENERIC	<u>Comments</u> Status or equipment not yet seismically qualified and their qualification schedule should be provided to NRC. This status should be submitted monthly until completion of qualification of all safety related equipment. <u>Response</u> Status is given on Attchment (2)

ITEM	COMMENTS/RESPONSE
ITEM NO. <u>NSSS-1</u> SQRT NO. <u>NSSS-PE-14</u> BA MAKEUP PUMP SPECIFIC ITEM: <u>PUMP B</u>	<u>COMMENT</u> 1. Explain basis for load cases 4 & 5 and show that they are conservative. <u>Response</u> Load Case 4 is "nozzle plus impeller loads in the x-direction". Load Case 5 is "nozzle plus impeller loads in the z-direction". CE has reviewed these loading cases in detail and confirms that these loadings encompass the most severe direction possible for the application of nozzle loads. <u>Comment</u> 2. Explain load combinations used for computing bolting stress and show that they are conservative. <u>Response</u> The load combinations used for computing bolt stresses include those loads from seismic accelerations in both transverse directions (note that a vertical acceleration would have no effect on the bolts), impeller loads, and nozzle loads in the most severe direction. CE has reviewed these loads and confirms that they are conservative.
Item No. <u>NSSS-2</u> SQRT NO. <u>NSSS-PE-25</u> BORIC ACID TANK CIRC. VALVE SPECIFIC ITEM: <u>3CH-F171B</u>	<u>Comment</u> 1. Provide certification that the computer calculation based on Engineering Standard ES100, Rev. B dated 4/8/75 have been verified. <u>Response</u> CE has contacted the vendor on this issue and is currently awaiting a reply. This reply is expected before January 1, 1983 <u>Comment</u> 2. Confirm that deflections calculated in Seismic Analysis for Order 1-46610 dated April 3, 1976 for tag number CH-511 will not interfere with valve closure. <u>Response</u> Same as Previous Response.

ITEM	COMMENTS/RESPONSE
ITEM NO. <u>NSSS-5</u> SQRT NO. <u>NSSS-PE-52</u> FW CONTROL VALVE SPECIFIC ITEM: <u>SFW-FM834</u>	<u>Comment</u> Verification of computer program ES100, Rev. B (4/8/75) performed for Item NSSS-PE-25. Results will also be applicable here. <u>Response</u> CE has contacted the vendor on this issue and is currently awaiting a reply. This reply is expected before January 1, 1983

SEISMIC QUALIFICATION COMPLETION SCHEDULE

885-
Plant Engineering (PE)

P.O./SPEC	EQUIPMENT (TAG NOS.)	SQRT FILE NO.	QUALIFICATION SCHEDULE	INSTALLATION SCHEDULE
910204 9270-PE 704 Rev 04	BH 307 (CE Tag) Fisher 3" valve	N555-PE-36 Rev 1	*	
9102040 9270-PE 704 Rev. 04	CH 210 Y Fisher 1" valve	N555-PE-26 Rev 1	*	
9102040 9270-PE 704, Rev. 04	CH 312 Fisher 3" Valve	N555-PE-77 Rev 1	*	

* See CE Letter FJM-553-82 dated Nov. 4, 1982

ENCLOSURE 6

SEISMIC QUALIFICATION REVIEW TEAM

RE-AUDIT FOLLOW UP

Attachment (1) Documentation of Telephone Conversation

January 18, 1983

DOCUMENTATION OF
TELEPHONE COMMUNICATIONS

Page 1 of 3

DATE: 1/18/83 TIME: 10:00 A.M., ~~PM~~

PARTY CALLING: Jim Wilson NRC
(Name) (Company)

PARTY ANSWERING: Sharon Jones LP&L
(Name) (Company)

SUBJECT: Seismic Qualification Review FILE: 3-A20.18
Team Second Audit Trip 3-A1.04.02
Report

SUMMARY: (INCLUDING DECISIONS AND OR COMMENTS)

Participating in the conference call were:

Jim Wilson	NRC	Dick Macek	EG&G
Jerry Jackson	NRC	Mark Williams	LP&L
Jag Singh	EG&G	Bob Foley	LP&L
Mark Russell	EG&G	Sharon Jones	LP&L

The purpose of this call is to reach an agreement by all parties to know "where we stand" on generic issues and specific items relating to seismic qualification.

REFERENCE: Second Trip Report for Seismic Criteria Implementation Review Meeting with Louisiana Power & Light Company (LP&L) on Waterford Nuclear Power Station Unit 3: T. Y. Chang to Vincent S. Noonan - December 13, 1982.

The eight (8) specific open items in the referenced document were discussed as follows:

1. Control Components (BOP-E-68) Closed
2. Pressure Switch (NSSS-ICE-16) Closed
Low Oil Pressure Switch (NSSS-PE-31)

ACTION REQUIRED:

DISTRIBUTION: R. W. Prados, R. M. Foley, M. G. Williams, S. M. Jones, Kanti Gala,
H. B. Mulliken (CE), John Hart (Ebasco), John Tompeck (Ebasco), John Zudans (NUS)
Jerry Jackson (NRC), Jim Wilson (NRC), Jag Singh (EG&G)

DOCUMENTATION OF
TELEPHONE COMMUNICATIONS

Page 2 of 3

DATE: 1/18/83 TIME: 10:00 A.M., XPMM

PARTY CALLING: Jim Wilson NRC
(Name) (Company)

PARTY ANSWERING: Sharon Jones LP&L
(Name) (Company)

SUBJECT: Seismic Qualification Review FILE: _____
Team Second Audit Trip _____
Report _____

(Cont'd) SUMMARY: (INCLUDING DECISIONS AND OR COMMENTS)

- | | |
|--|--------------|
| 3. Boric Acid Makeup Pump (NSSS-PE-14) | Closed |
| 4. Boric Acid Tank Circulating Valve (NSSS-PE-25)
LP&L is awaiting a vendor reponse. Sharon
will try to have a telecopy sent to NRC and
EG&G this week. | Confirmatory |
| 5. Holdup Tank C (NSSS-PE-33)
LP&L will confirm that modifications have
been made. May/may not be tagged as a
confirmatory item. | ? |
| 6. Resister Input Card (NSSS-ICE-5a)
Under EG&G review. Should be completed
by next SER. | EG&G |
| 7. 1151 Indicator (NSSS-ICE-8-1)
LP&L will submit analyses when it is
complete. May/may not be tagged as a
confirmatory item. | ? |
| 8. CEDM Reed Switch Position Transmitter
(NSSS-ICE-15) | Closed |

ACTION REQUIRED:

DISTRIBUTION: _____

DOCUMENTATION OF
TELEPHONE COMMUNICATIONS

Page 3 of 3

DATE: 1/18/83 TIME: 10:00 A.M., P.M.

PARTY CALLING: Jim Wilson NRC
(Name) (Company)

PARTY ANSWERING: Sharon Jones LP&L
(Name) (Company)

SUBJECT: Seismic Qualification Review FILE: _____
Team Second Audit Trip _____
Report _____

(Cont'd) SUMMARY: (INCLUDING DECISIONS AND OR COMMENTS)

Six generic issues were mentioned in the report discussion:

1. Next status report will be issued 1/21/83. Closed
2. Ebasco is re-verifying. Work should be complete mid-February.
3. In Service Inspection Programs will be submitted to a different branch of NRC.
4. LP&L will respond when review is complete.
5. Closed.
6. Will be followed up by NRC resident inspector.

It is our understanding that there are no "open" items remaining, and that the next SER supplement will reflect this position.

ACTION REQUIRED:

As mentioned in Specific Items 4, 5, 7 and Generic Issues 1, 2, 4.

DISTRIBUTION: _____