50-277
50-278

JUL 24 1985

DMB 01

LICENSEE: Philadelphia Electric Company

FACILITY: Peach Bottom Atomic Power Station, Units 2 and 3

SUBJECT: SUMMARY OF MEETING BETWEEN THE NRC STAFF, THE PHILADELPHIA ELECTRIC COMPANY AND BECHTEL HELD ON MAY 30,1985 RELATING TO "ENERGY ABSORBERS"

INTRODUCTION

A meeting was held in Bethesda on May 30, 1985 at the request of the NRC staff relating to memorandum subject. A list of the attendees is enclosed.

The meeting was requested by the NRC staff to discuss the proposed use of "energy absorbers" at the Peach Bottom facility as a superior replacement for conventional snubbers.

DISCUSSION

Philadelphia Electric in its presentation indicated that it was preparing to utilize 'energy absorbers' on a case-by-case basis during the upcoming Unit 3 reload (August/September).

Bechtel presented a technical review of its 'energy absorbers'including laboratory experiments, analytical correlations, linearization methology, and design. A summary of the Bechtel presentation is enclosed.

Philadelphia Electric indicated that it sought guidance on the need for NRC review and approval on the use of 'energy absorbers' at Unit 3. Most specifically, Philadelphia Electric inquired into the use of these absorbers in the place of conventional snubbers and the effect of this proposed change on the Peach Bottom Technical Specifications. The NRC Project Manager (G.Gears) indicated that this issue would be discussed between the NRC Technical and Legal staffs and a decision or approach would be conveyed to Philadelphia Electric. The Philadelphia Electric and Bechtel meeting participants indicated that they would provide the NRC technical staff with more detailed test data as well as the plant specific report for the Peach Bottom facility for staff review and comment.

Summary

It was agreed that the NRC staff had a better understanding on the use of 'energy absorbers' as a replacement for conventional snubbers. The staff wished to further review more technical data on the absorbers as well the supporting documentation for plant specific applications. Philadelphia Electric and Bechtel agreed to provide this information to the staff. The staff agreed to review and comment on this additional technical information. In addition, the staff indicated that it would pursue the question of the potential effects of the use of 'energy absorbers' on the present Peach Bottom Technical Specifications.

"ORIGINAL SIGNED BY:"
Gerald E. Gears, Project Manager
Operating Reactors Branch #4, DL

Enclosures:
As Stated

cc w/enclosures:
See next page

ORB#4:DL
GGears;cf
7/ /85

MEETING SUMMARY DISTRIBUTION

Licensee: Philadelphia Electric Company

*Copies also sent to those people on service (cc) list for subject plant(s).

Docket File
NRC PDR
L PDR
ORB#4 Rdg
Project Manager -GGears
JStolz
BGrimes (Emerg. Preparedness only)
OELD
EJordan, IE
ACRS-10
PMorriette
NRC Meeting Participants:
HShaw
FCherny
RBosnak
DTerao

Enclosure

MEETING ON ENERGY ABSORBERS FOR PEACH BOTTOM
MAY 30, 1985
BETHESDA, MARYLAND

Name	Organization	Phone Number
Ronald Hess	Philadelphia Electric Co.	215-841-4523
William Alden	Philadelphia Electric Co.	215-841-5022
Joseph Cratic, III	Philadelphia Electric Co.	215-841-4546
John O'Rourke	Philadelphia Electric. Co.	215-841-4575
Horance Shaw	NRC	301-492-4420
Frank Cherny	NRC	301-492-8437
Robert Bosnak	NRC	301-492-7733
David Terao	NRC	301-492-4421
Gerry Gears	NRC	301-492-8362
G. Butler	Baltimore Gas and Electric Co.	301-234-5747
Don Ward	Baltimore Gas and Electric Co.	301-234-5420
(Kaly) Kalyanam	Bechtel/Gaithersburg, MD	301-258-3167
Ran Patel	Bechtel/Gaithersburg, MD	301-234-4433
Glenn Wang	Bechtel/Gaithersburg, MD	301-258-3574
Hong-Ming Lee	Bechtel/San Francisco, CA	415-882-2773
Mohamed Khalfallah	Bechtel/San Francisco, CA	415-882-2778
Larry Shipley	Bechtel/San Francisco, CA	415-768-7706
Richard Schlueter	Bechtel/San Francisco, CA	415-768-2023
Karl Wiedner	Bechtel/TPM	415-768-4602
William Lapay	Westinghouse/PED, Pitts.	412-825-6166

BECHTEL DEVELOPMENT PROGRAM

FOR

ENERGY ABSORBERS

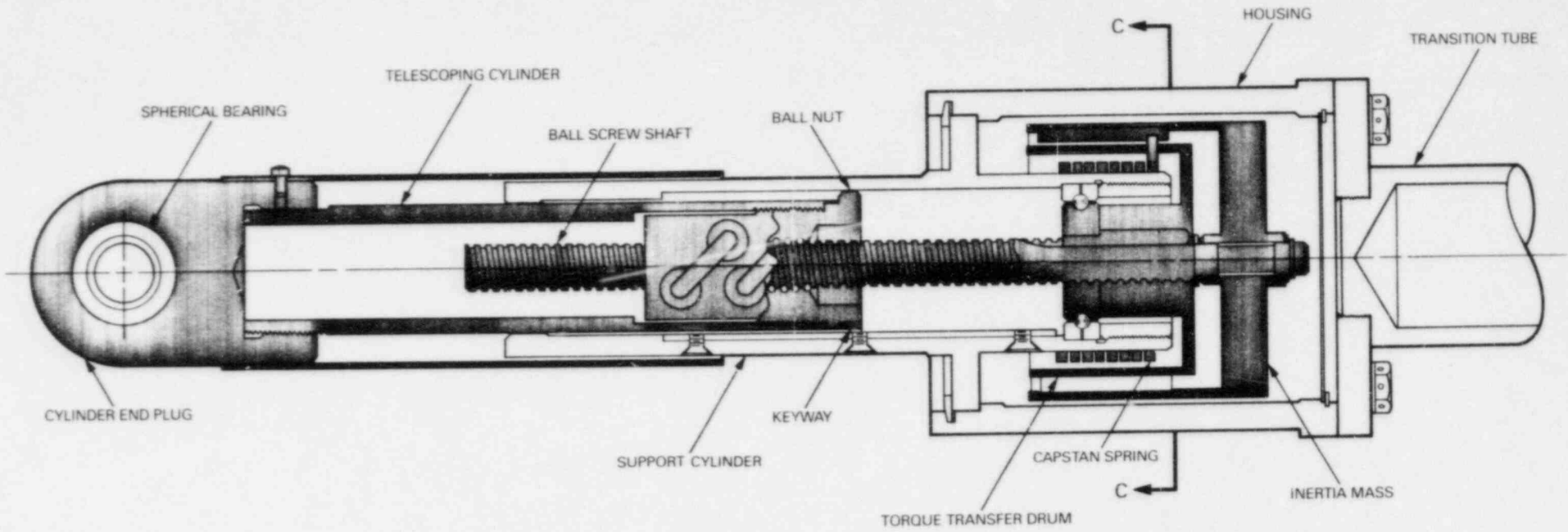
TYPES OF CONVENTIONAL PIPE SUPPORTS

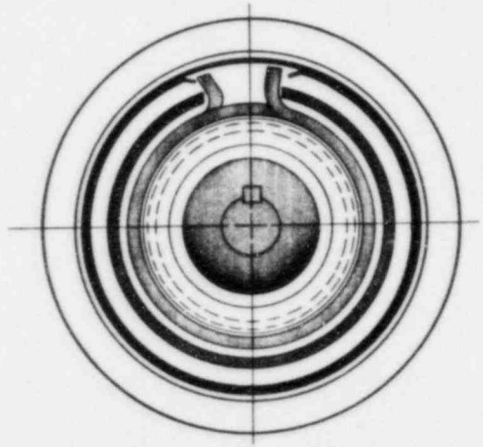
- SPRING TYPE SUPPORTS
- RIGID TYPE SUPPORTS
- SNUBBERS

SNUBBERS

- COMPLEX APPARATUS
  - HYDRAULIC TYPES
  - MECHANICAL TYPES
- HISTORICAL PERFORMANCE RECORDS
- EXPENSIVE ... INITIAL COST
  ... INSERVICE INSPECTION

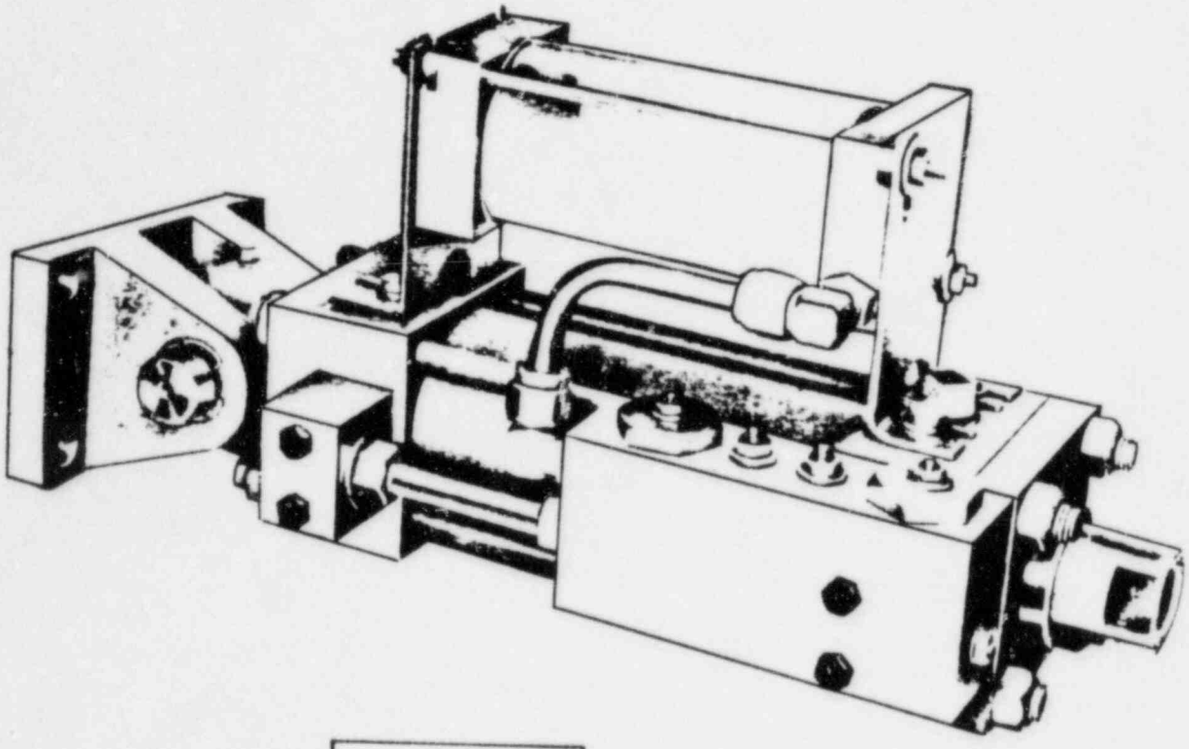
MECHANICAL SNUBBER

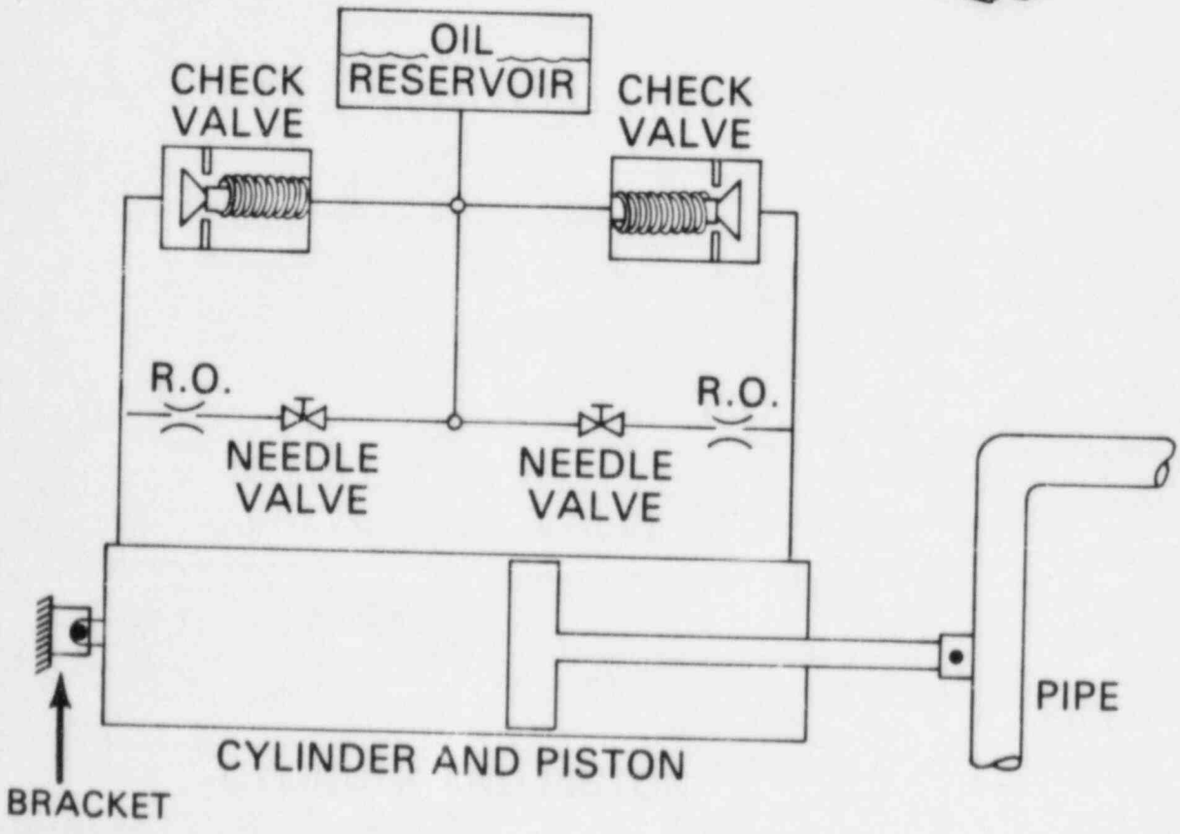




SECTIONAL VIEW C-C

HYDRAULIC SNUBBERS





CURRENT DYNAMIC ANALYSIS OF PIPING SYSTEMS

SEISMIC

- BASIC APPROACH IS TO USE RESPONSE SPECTRA METHOD.
  (DAMPING SPECIFIED BY OTHERS)

- OUTCOME
  - REQUIRE LARGE NUMBERS OF SNUBBERS
  - RESULTS IN RIGID PIPING SYSTEM DESIGN

ALTERNATIVES

- REDUCE CONSERVATISM IN ANALYSIS
  - USE TIME HISTORY METHODS
  - USE MULTIPLE RESPONSE SPECTRA
  - ...ETC.
  - RESULTS...INCREASED COST WITHOUT SIGNIFICANT BENEFIT
- BASIC RESEARCH INTO FLEXIBLE SYSTEM DESIGN
  - REQUIRE NEW ANALYTICAL METHODS
  - EMPHASIS ON DAMPING

DAMPING

- DIRECTLY RELATES TO THE DEGREE OF CONSERVATISM IN RESPONSE SPECTRA TYPE ANALYSIS
- RELATES TO NUMBER OF SUPPORTS AND SNUBBERS
- VALUES USED IN PIPING ANALYSIS TO-DATE ARE EMPIRICAL AND ARE BASED ON ASSUMPTIONS.
  - 1/2%
  - REG. GUIDE 1.61
  - PVRC/CODE CASE N-411
- SOURCES OF SYSTEM DAMPING
  - INHERENT SYSTEM DAMPING ASSOCIATED WITH
    - MATERIAL YIELDING OF PIPE OR SUPPORT STRUCTURES --- "SMALL"
    - ENERGY DISSIPATION MECHANISMS IN SUPPORTS --- "DEPENDS ON TYPES --- VARIES"
  - ENGINEERED DAMPING ASSOCIATED WITH ENERGY ABSORBERS
    - ADDS PREDICTABLE AMOUNTS OF HIGH DAMPING
    - ELIMINATES THE NEED FOR SNUBBERS

DESIRABLE FEATURES

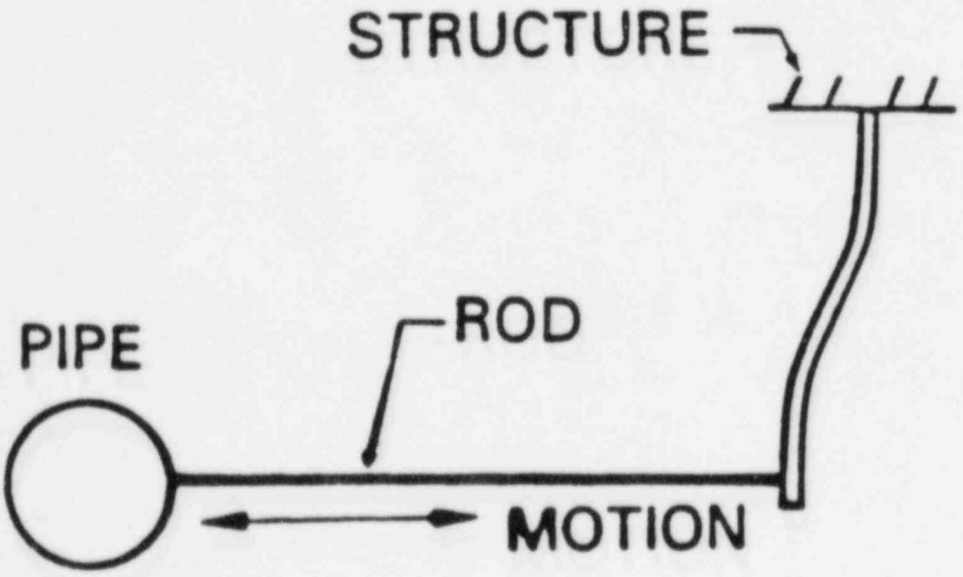
- LARGE ENERGY ABSORPTION
- WELL-DEFINED HYSTERESIS
- MAINTENANCE FREE
- LOW SENSITIVITY
- ACCOMMODATION OF THERMAL AND DYNAMIC LOADINGS

X-SHAPE ENERGY ABSORBER

- MEETS DESIRABLE FEATURES
- ADDED ADVANTAGES
  - SIMPLE/INEXPENSIVE
  - EASE OF VISUAL INSPECTION
  - SIMPLE CONNECTIONS

DEVICE

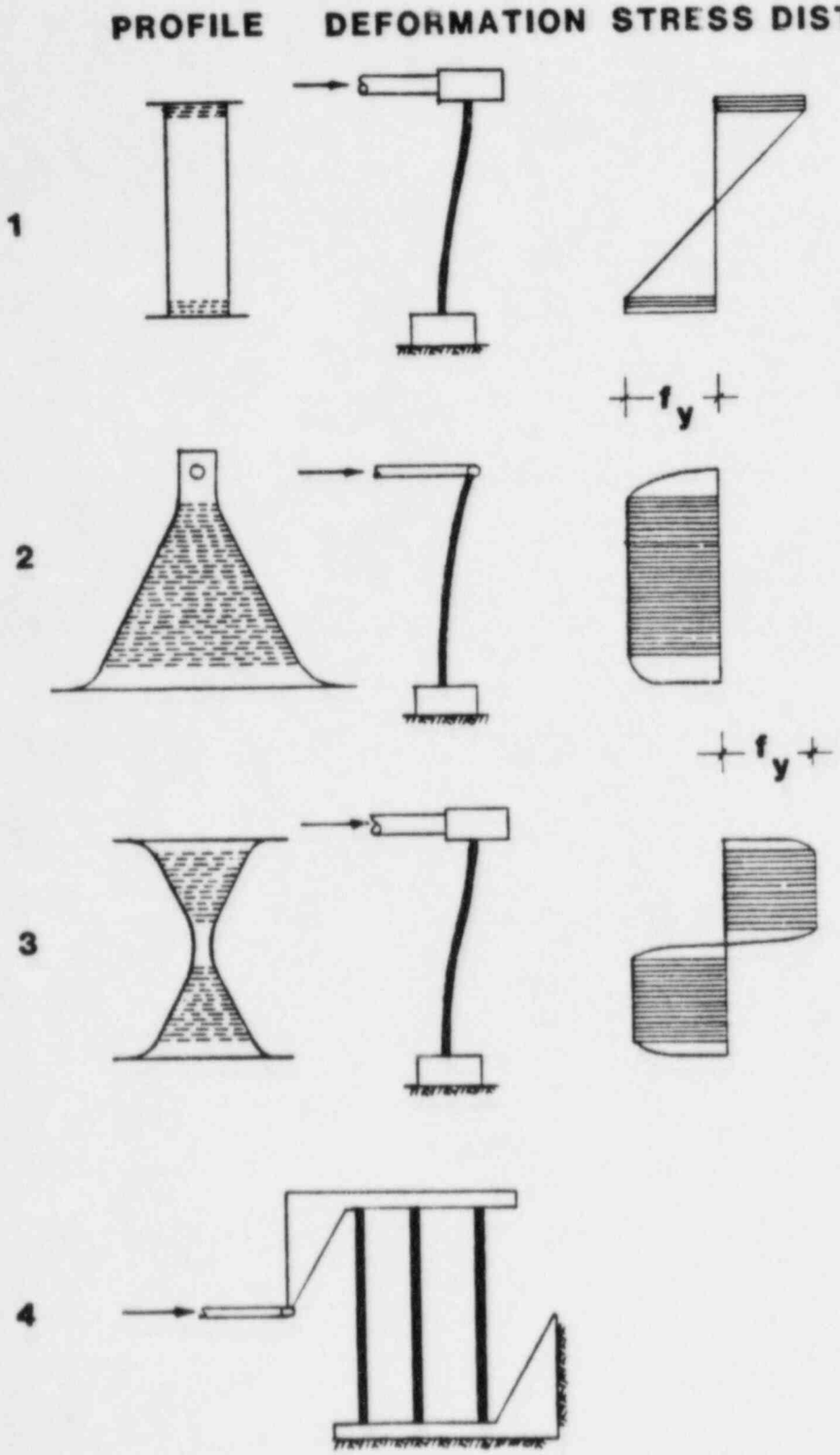
- NO MOVING/INTERNAL PARTS
- SIMPLE DUCTILE STEEL MEMBERS WITH LOW STIFFNESS TO ALLOW FOR THERMAL EXPANSION
  - TRAPEZOIDAL SHAPES
  - X SHAPES
  - THICKNESS OF 1/16" +



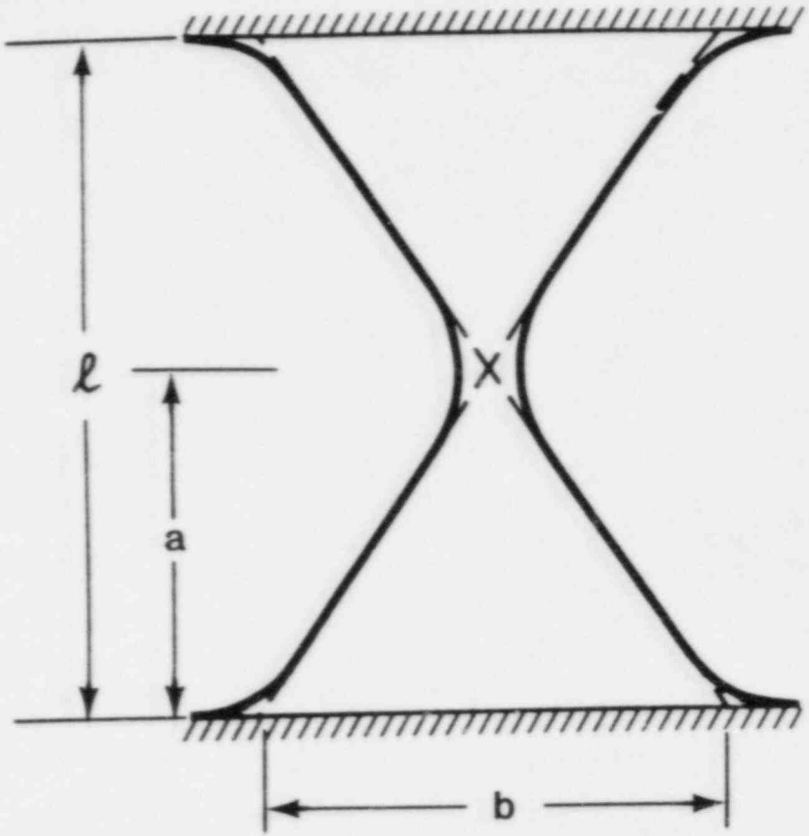
EARLY CONCEPT INVESTIGATIONS

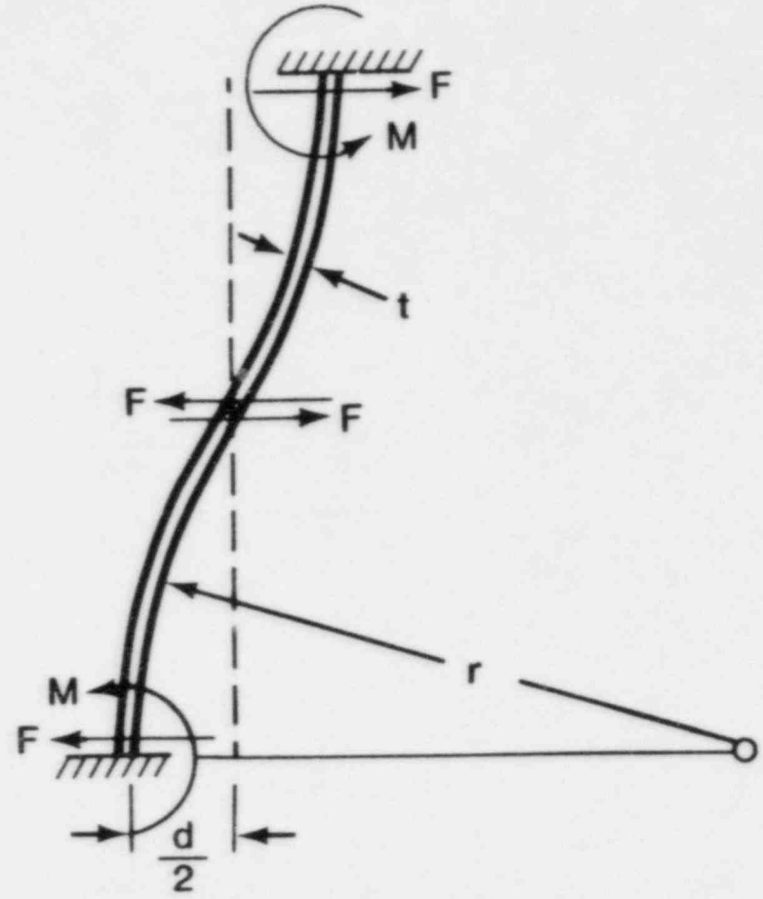
- MATERIAL
- MECHANISM
  - ENERGY ABSORPTION THROUGH TORSION AND/OR
  - ABSORPTION THROUGH BENDING
- CONFIGURATION
  - ONE-DIMENSIONAL
  - MULTI-DIMENSIONAL

DEVELOPMENT OF DUCTILE STEEL ENERGY ABSORBERS



DEFORMATION MODEL FOR X-TYPE ENERGY ABSORBER





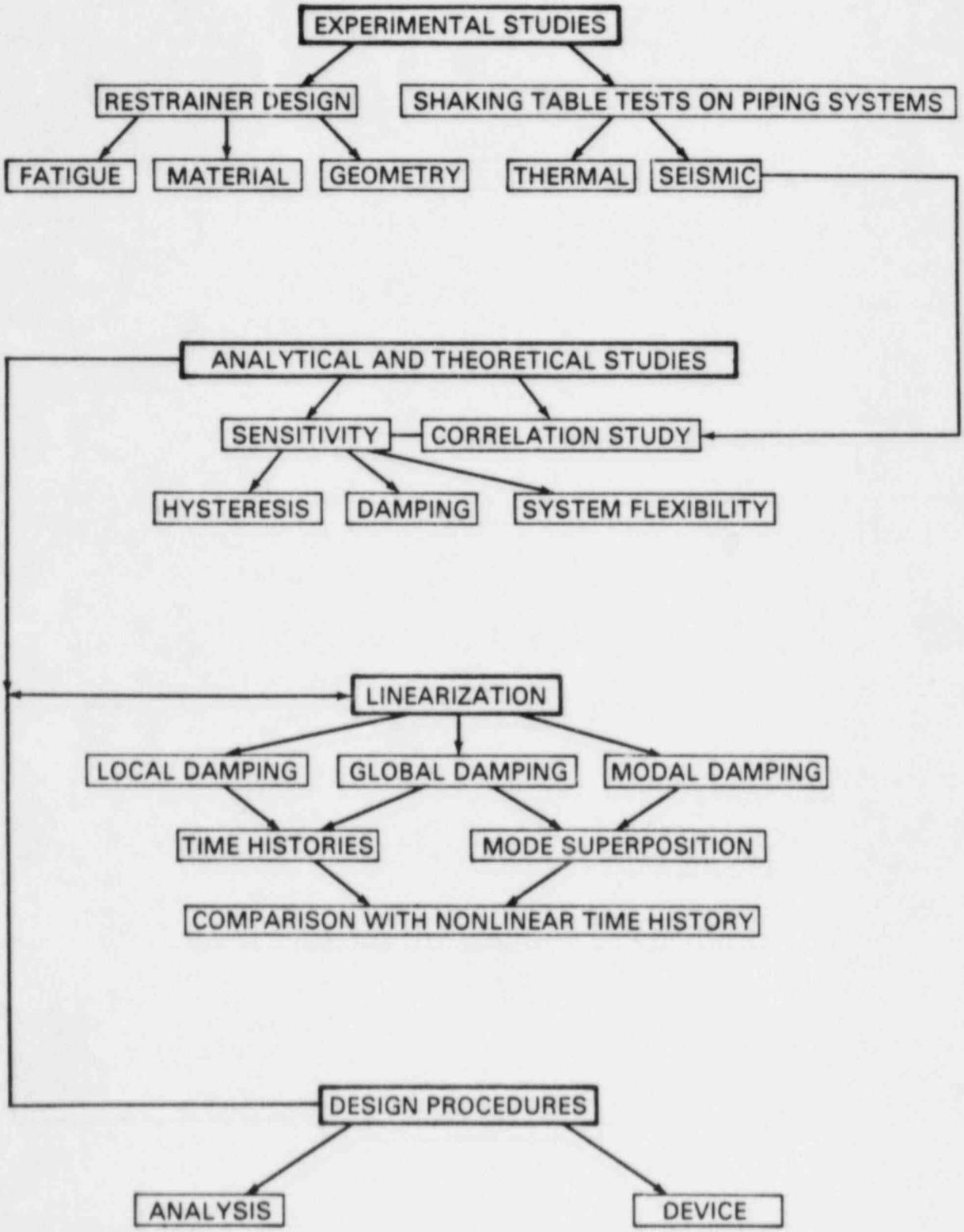
POTENTIAL SAVINGS

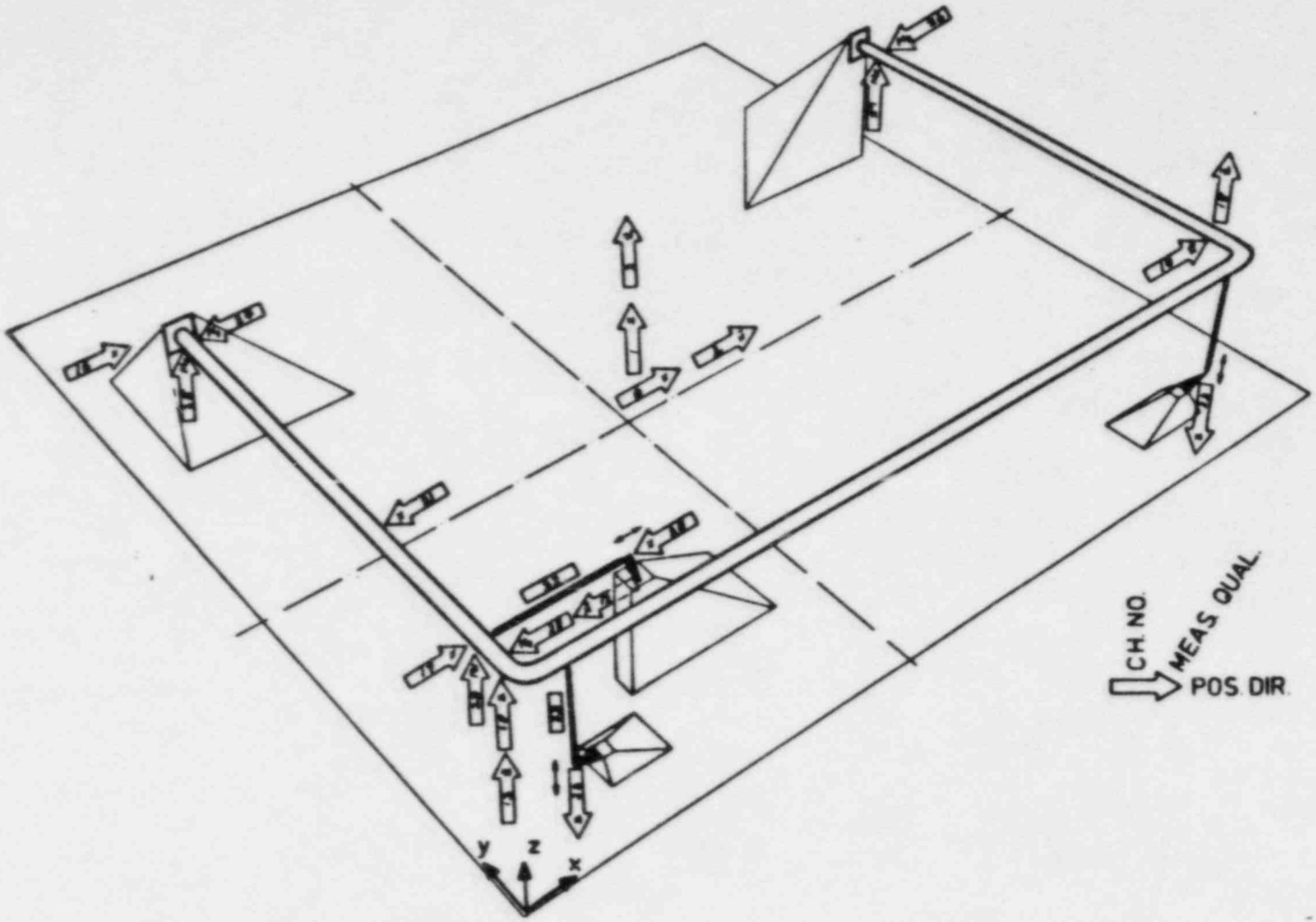
- REDUCED INSTALLATION COST.
  NO TESTING, ADJUSTING OR PRECISION INSTALLATION COMPARED TO SNUBBERS
- REDUCED INSERVICE INSPECTION COST
- REDUCED PLANT DOWNTIME COST
- SIGNIFICANT REDUCTION IN HARDWARE COST
- REDUCTION IN INTERFACE LOADS TO BUILDING STRUCTURES

RESEARCH PROGRAM

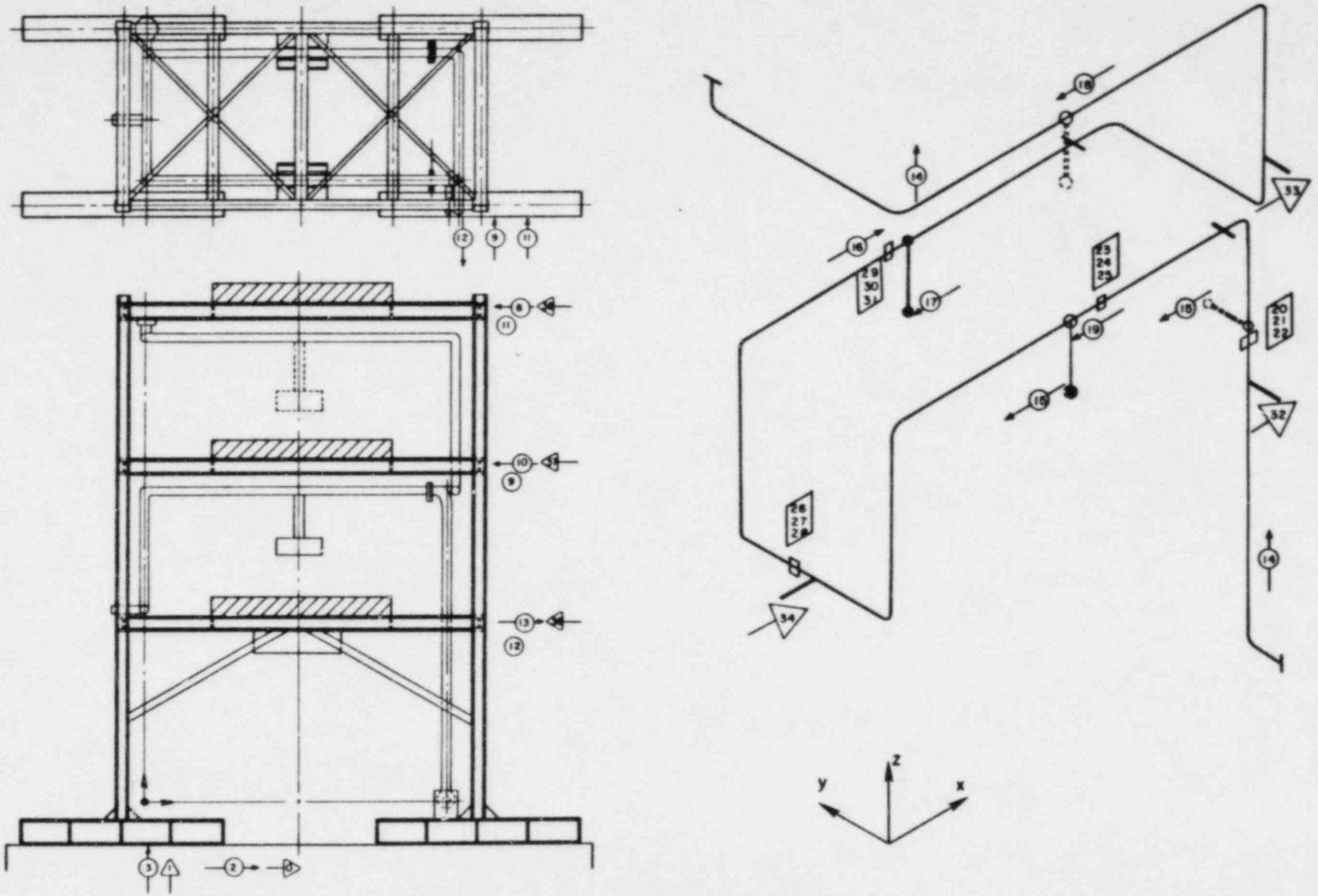
- PERFORM TESTS TO PROVE THE CONCEPT
- PERFORM NONLINEAR ANALYSIS TO CORRELATE TEST RESULTS
- PERFORM SENSITIVITY STUDIES
- DEVELOP RELIABLE ANALYTICAL DESIGN METHOD THAT IS ECONOMICAL
- DESIGN THE DEVICE

DEVELOPMENT FLOW CHART

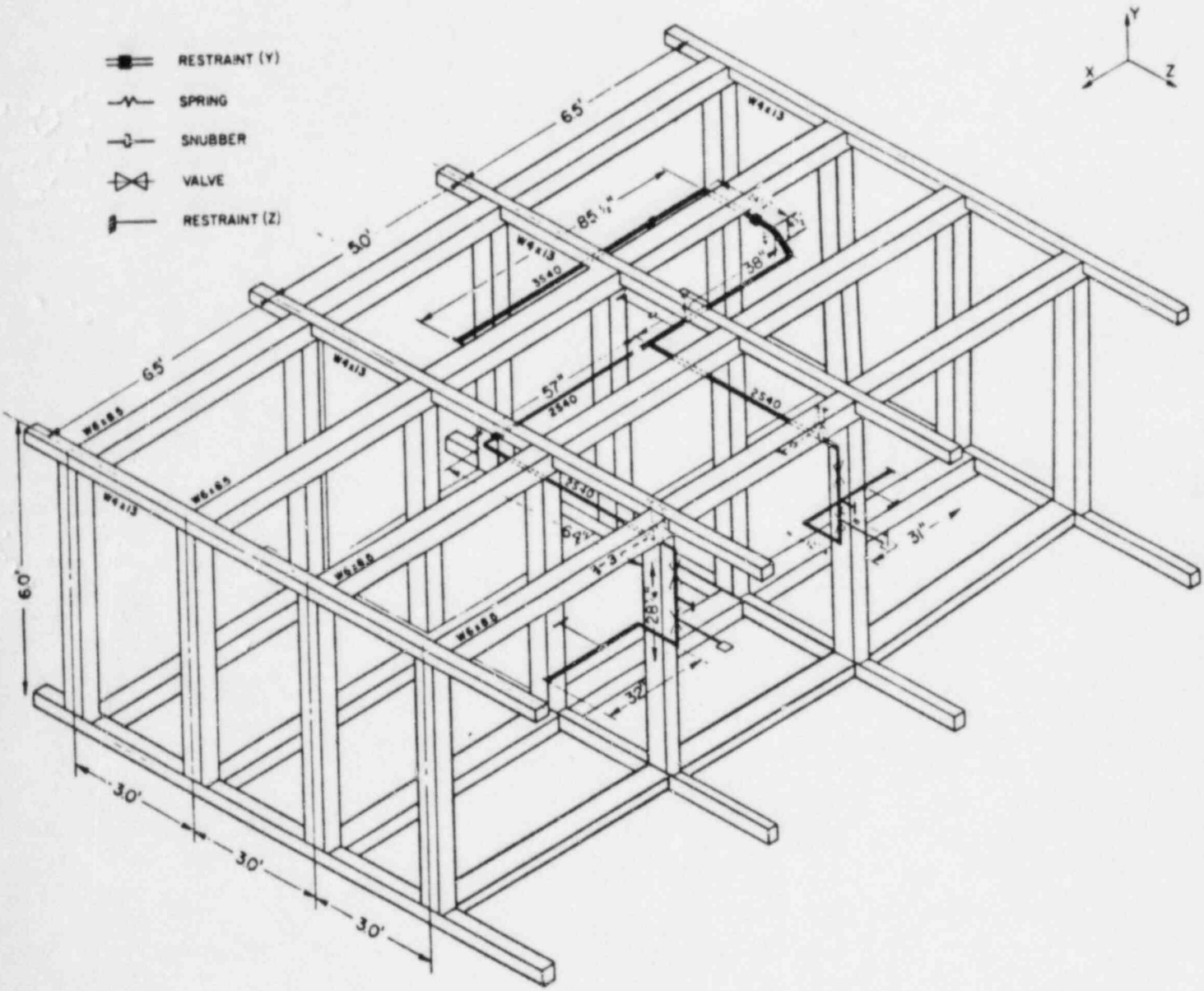




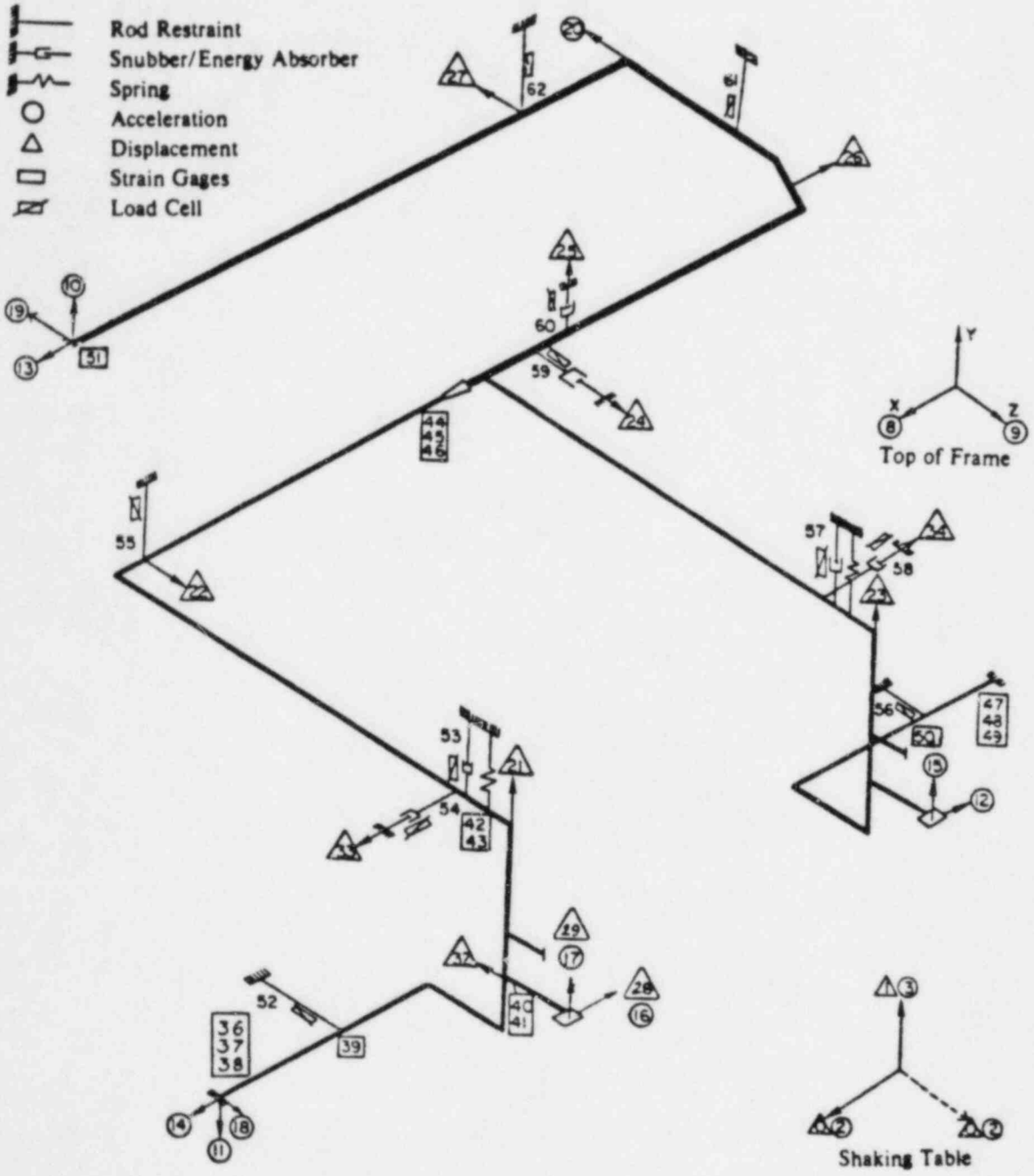
PLAN OF MEASUREMENT POINTS, TEST SERIES I AND II



Instrumentation Plan



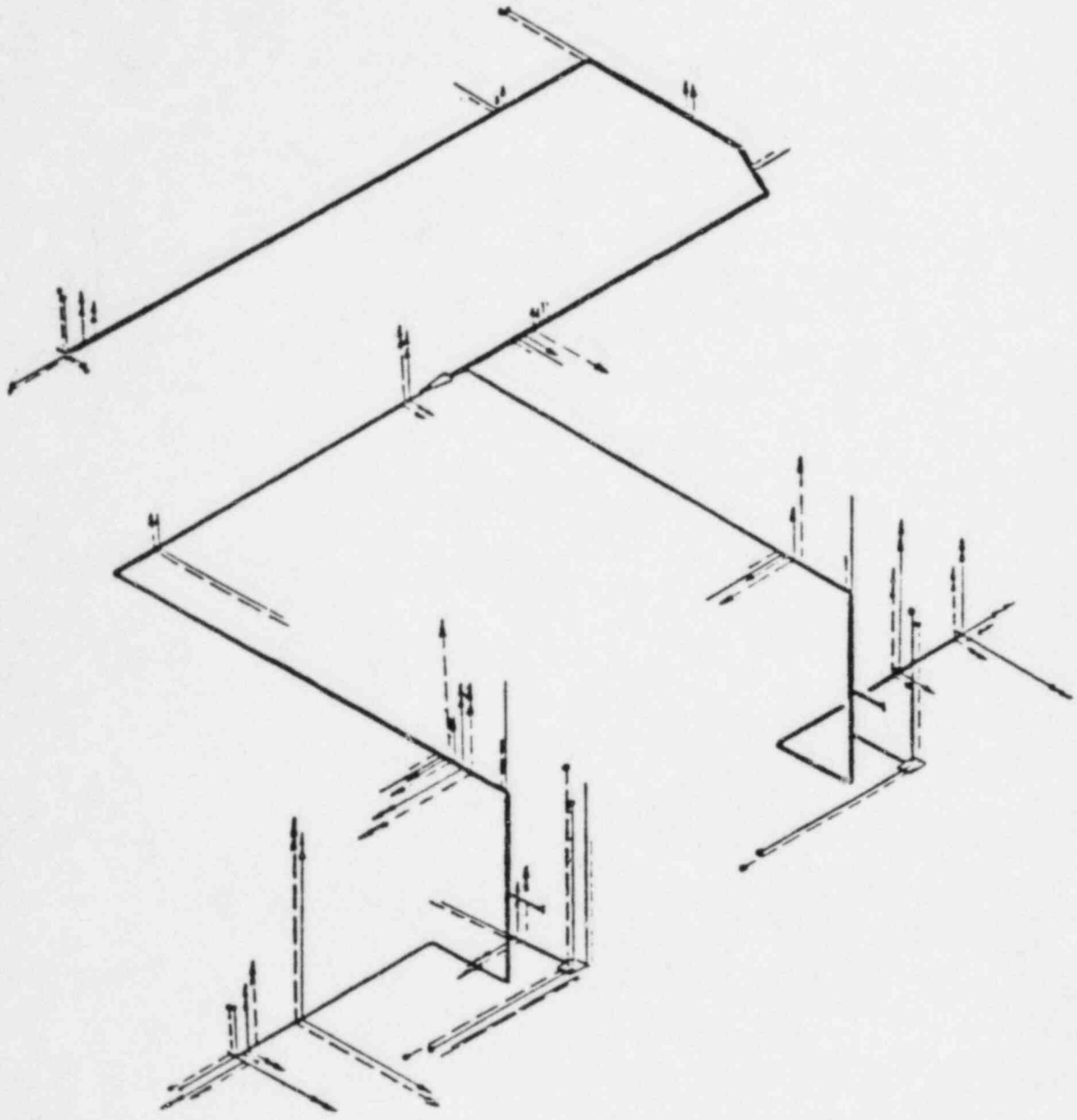
Pipe Model Supported by Steel Frame



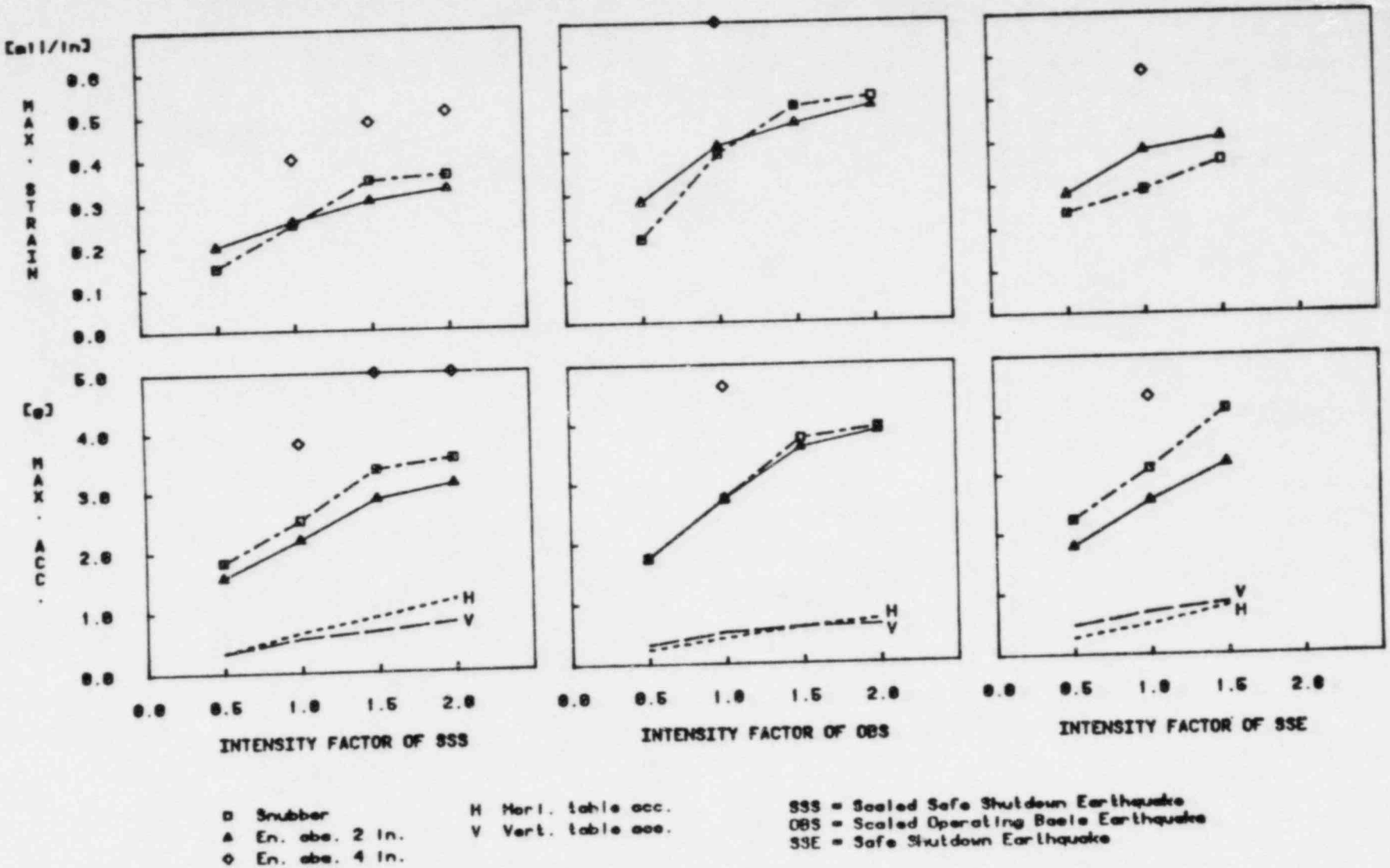
Pipe with Instrumentation. Snubbers Subsequently Replaced with Energy Absorbers

COMPARISON OF SNUBBER PERFORMANCE VS. ENERGY ABSORBERS

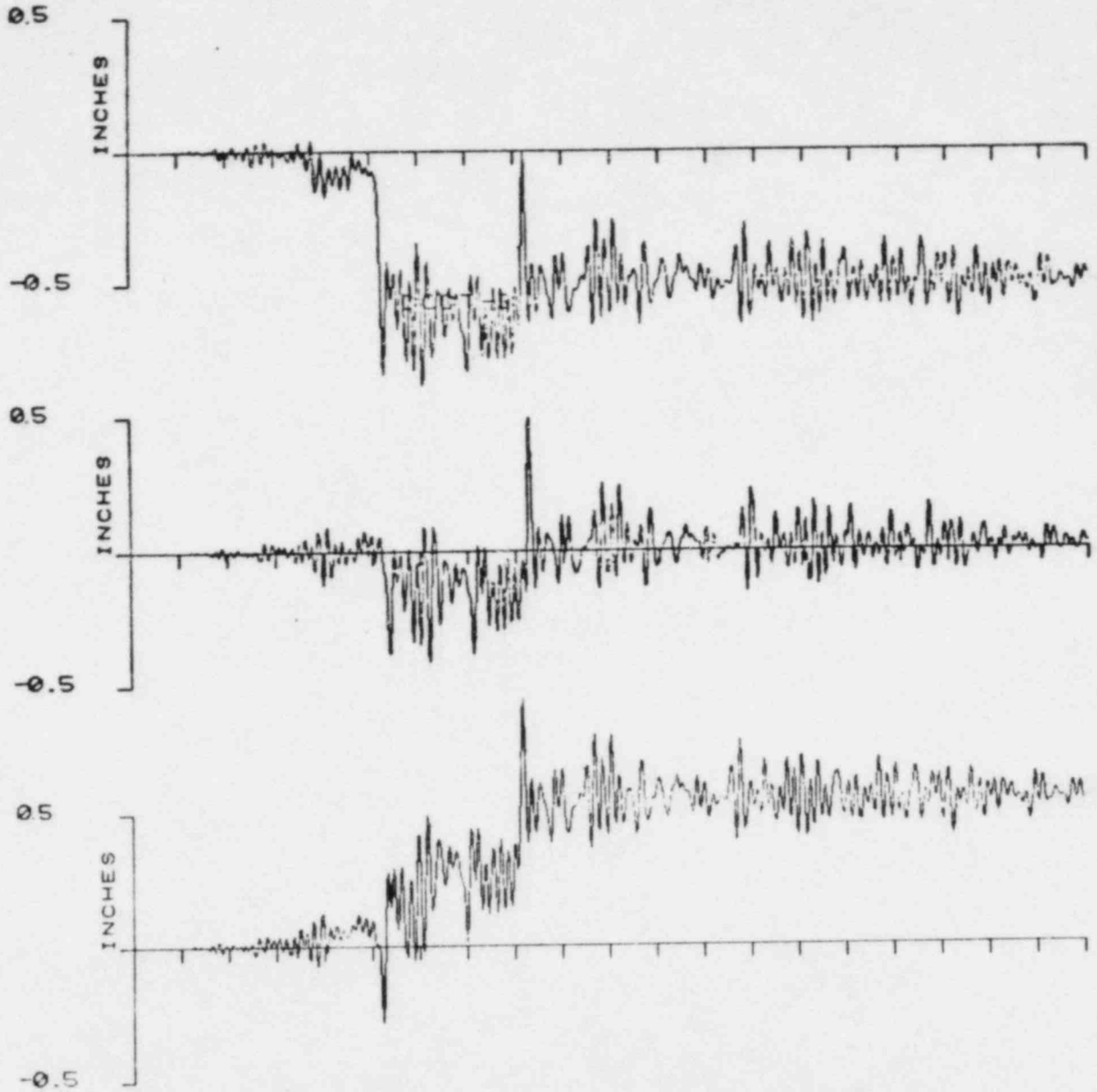
SSE RESPONSE COMPARISON
SNUBBERS VS ENERGY ABSORBERS



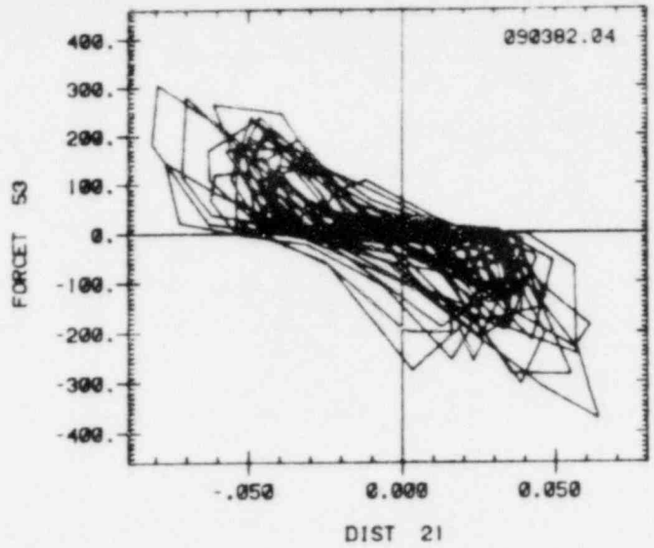
SNUBBERS
2″ × 1/8″
1.0 g
0.1 IN
0.1 MIL/IN
200 LBS

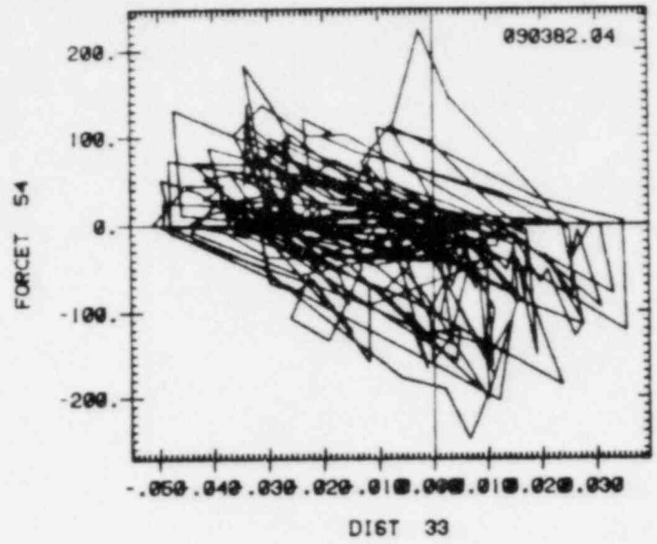


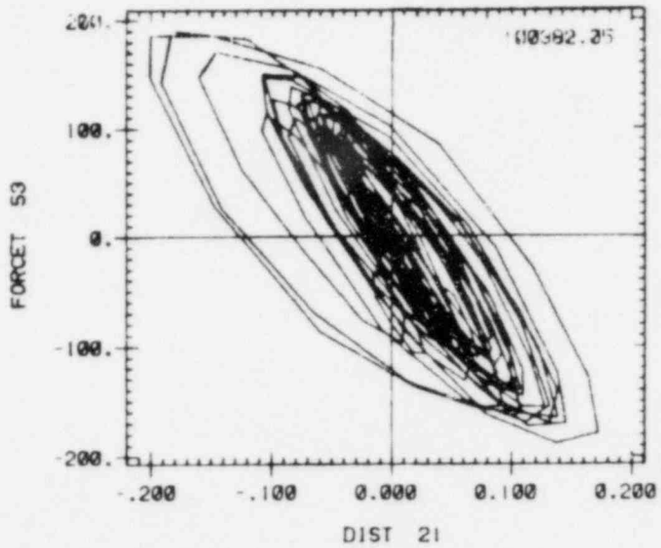
Extreme Values of Pipe Strains, Accelerations of the Valve Operator, and Corresponding Shaker Table Response for Increasing Earthquake Intensities

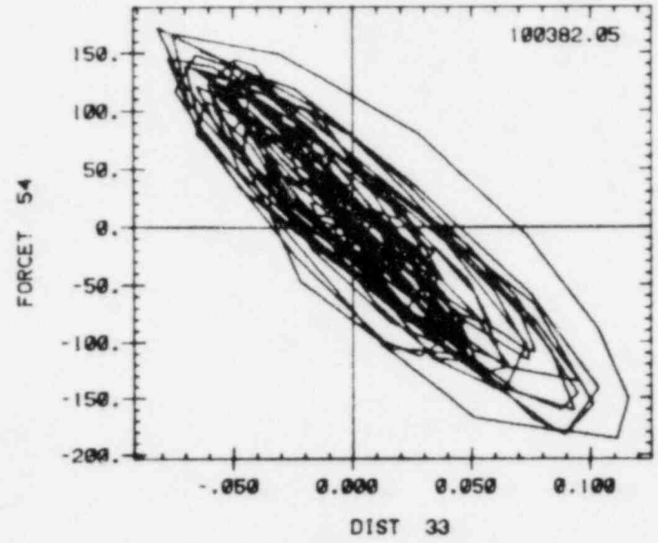

0.5
INCHES
-0.5
0.5
INCHES
-0.5
0.5
INCHES
-0.5

RESPONSES OF SNUBBERS (TOP) AND ENERGY ABSORBERS (BOTTOM) SUBJECTED TO SAME EARTHQUAKES

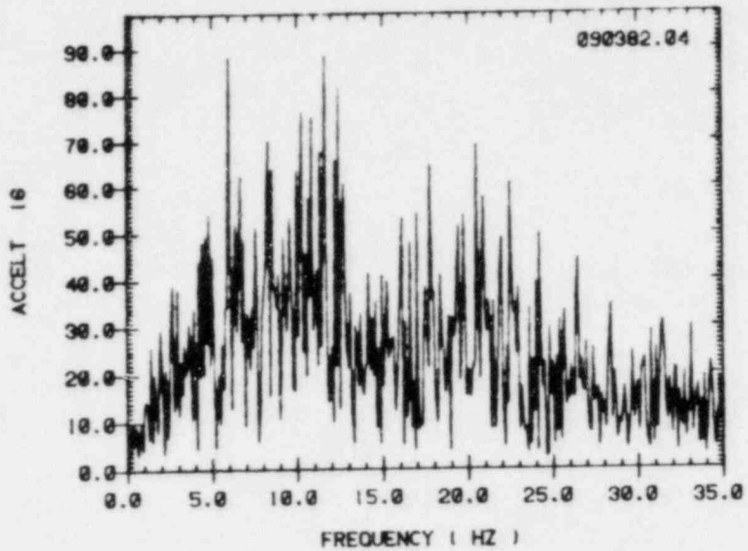


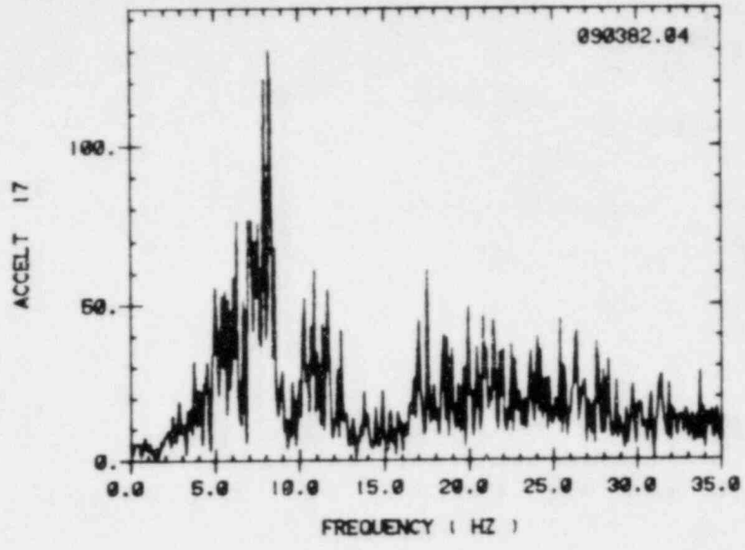


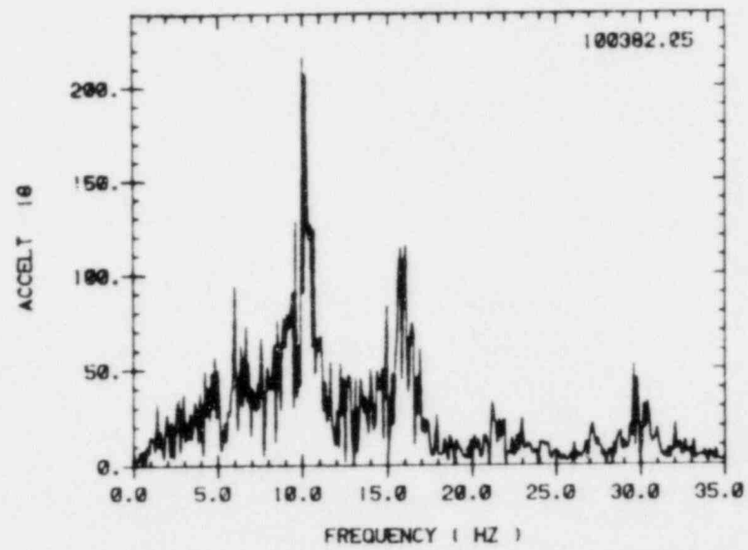


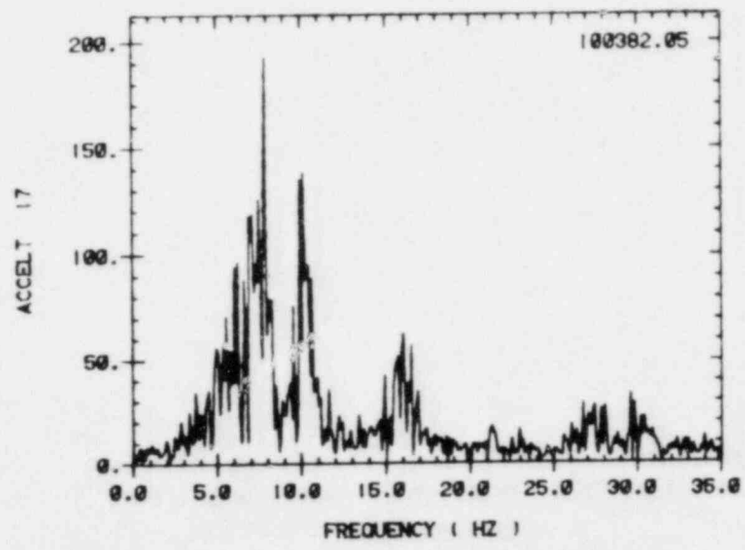


FOURIER SPECTRA OF SNUBBERS (TOP) AND ENERGY ABSORBERS (BOTTOM) SUBJECTED TO SAME EARTHQUAKES

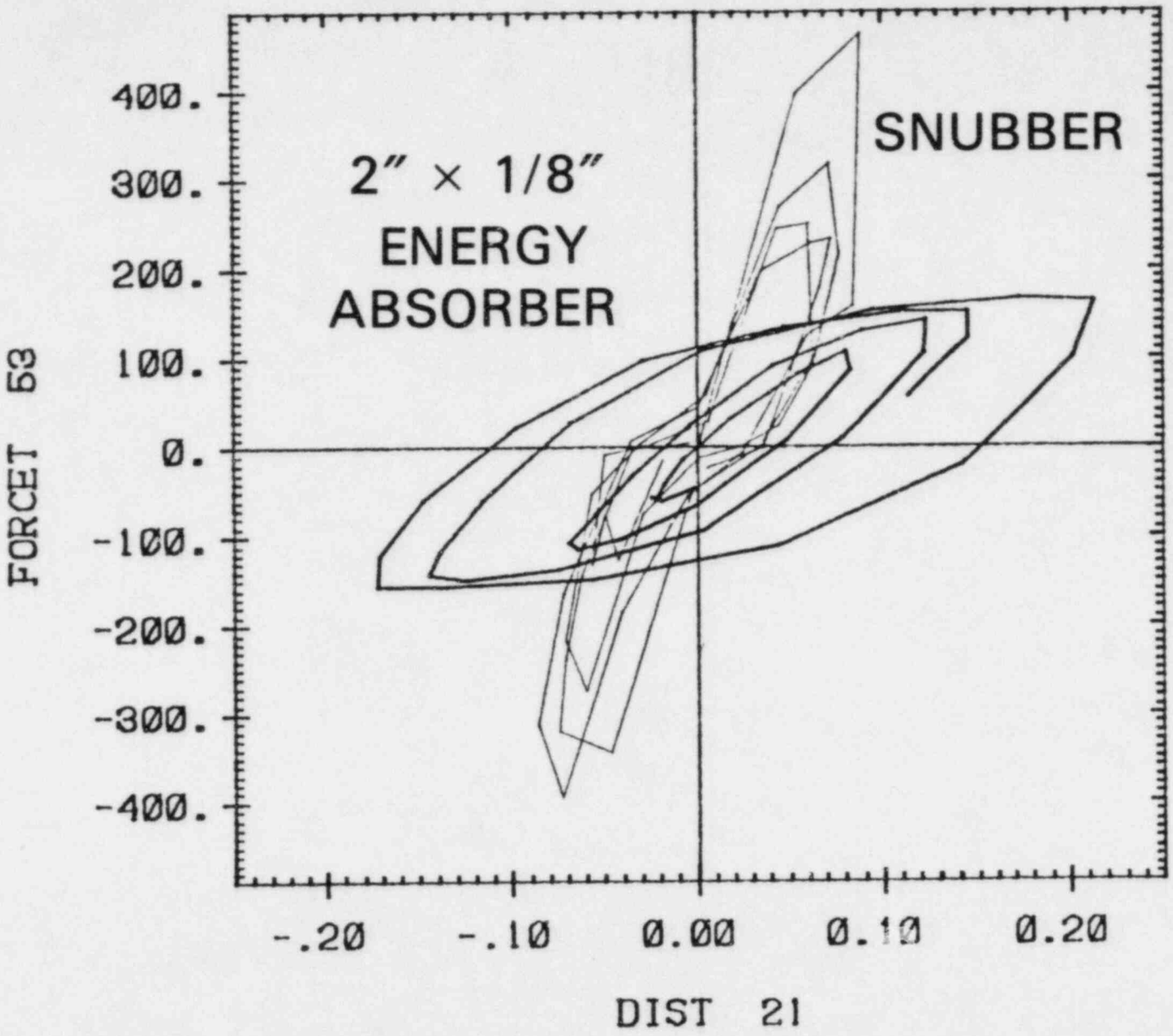


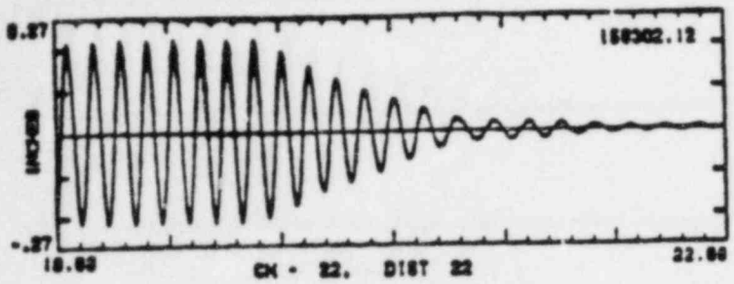






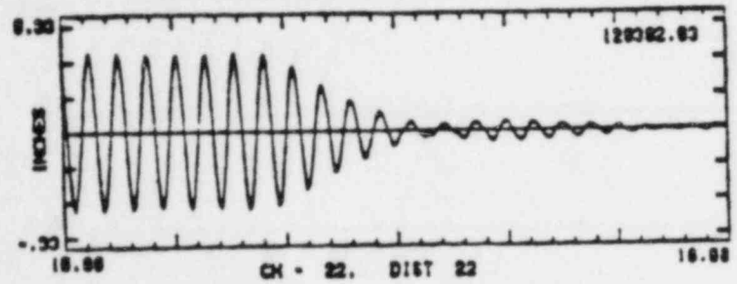
FORCE — DISPLACEMENT BEHAVIOR
SNUBBER VS ENERGY ABSORBER





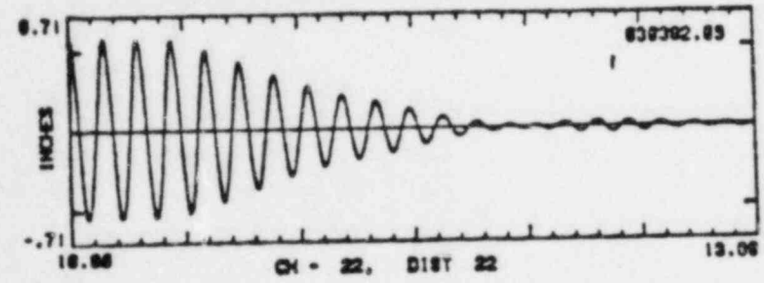
SNUBBER

ζ = 5.7 %
δ = 36.0 %
f = 8.3 Hz



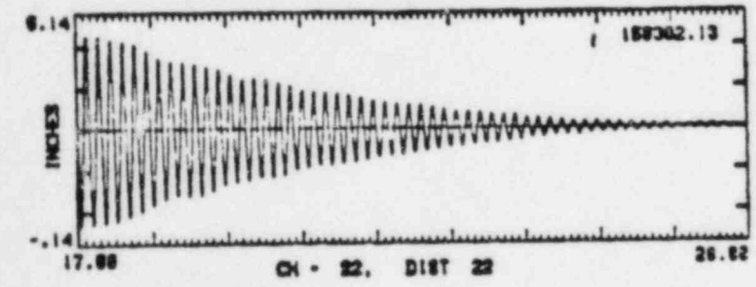
2"x1/8" ENERGY ABSORBER

ζ = 7.9 %
δ = 49.5 %
f = 7.5 Hz



5"x1/8" ENERGY ABSORBER

ζ = 5.6 %
δ = 35.2 %
f = 6.65 Hz



NO DEVICE

ζ = 1.2 %
δ = 7.5 %
f = 6.15 Hz

Damping Ratio of System IV with Different Support Devices in Position and Corresponding First Natural Frequencies

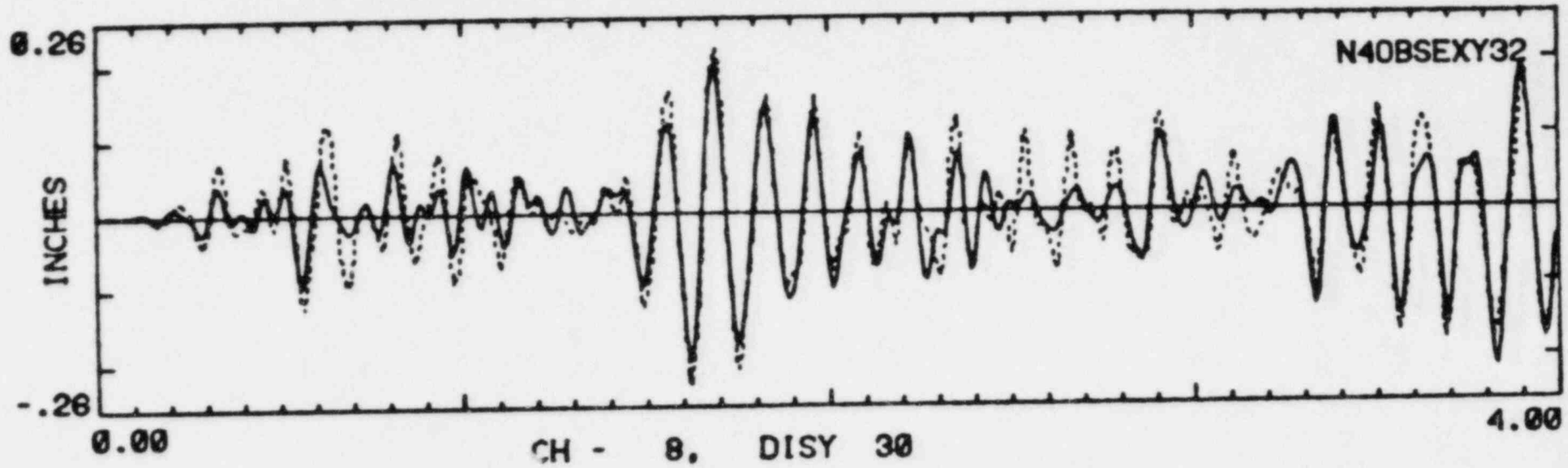
CONCLUSIONS

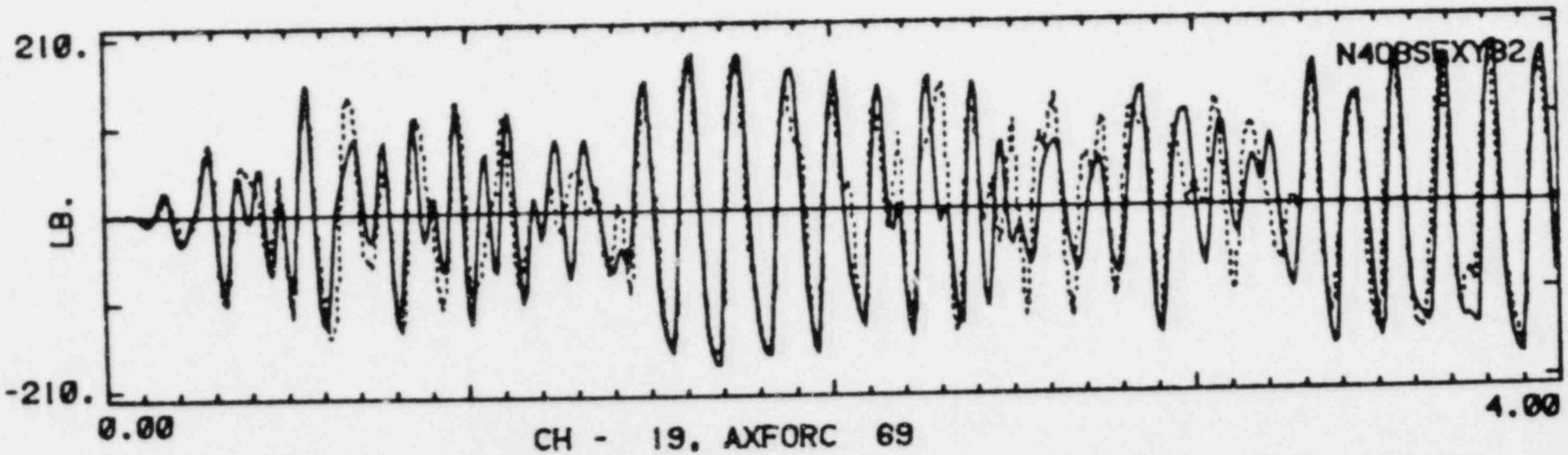
- SUPERIOR TO SNUBBERS
- GOOD CONTROL
- HIGH DAMPING
- LOCAL DECOUPLING
- THERMAL AND SEISMIC RESPONSE NOT ADDITIVE
- RELIABILITY AND REPEATABILITY OF RESPONSE
- MAINTENANCE-FREE

CORRELATION

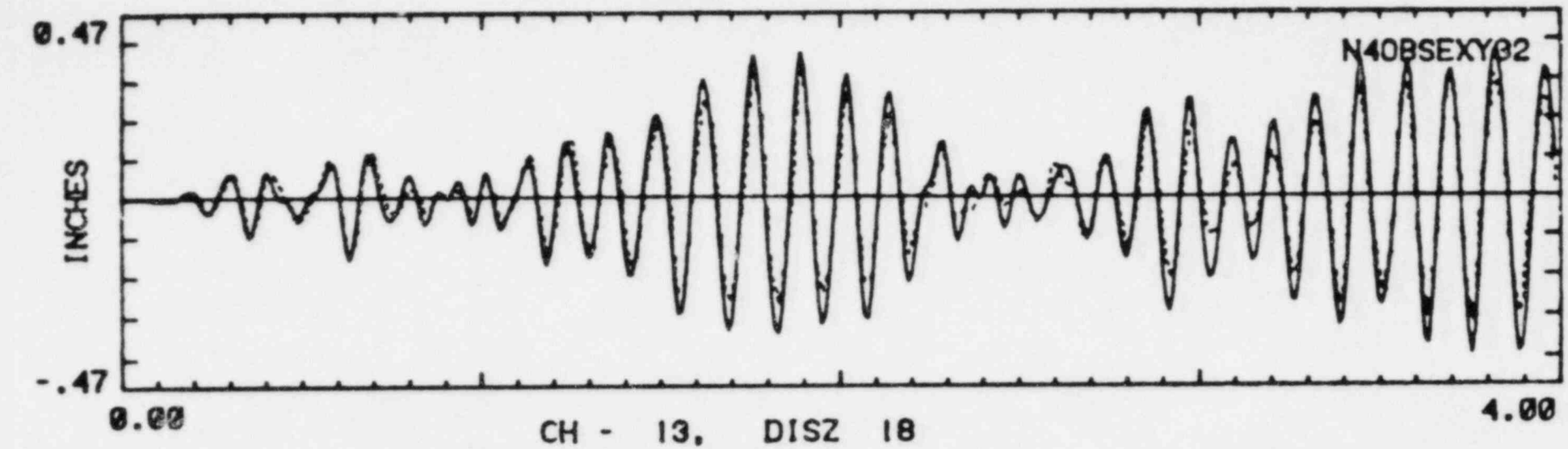
- NONLINEAR TIME HISTORY ANALYSIS
  - PROGRAMS USED
    - ABAQS
    - ANSR II
    - ACCELERATED NONLINEAR CODE
  - HYSTERESIS LOOP MODELING
  - SPATIAL SYSTEM
  - U-LOOP SYSTEM
- CONCLUSIONS
  - SUCCESSFUL ANALYSIS
  - VERIFICATION OF ANSR II, ACCELERATED CODE AGAINST TEST RESULTS

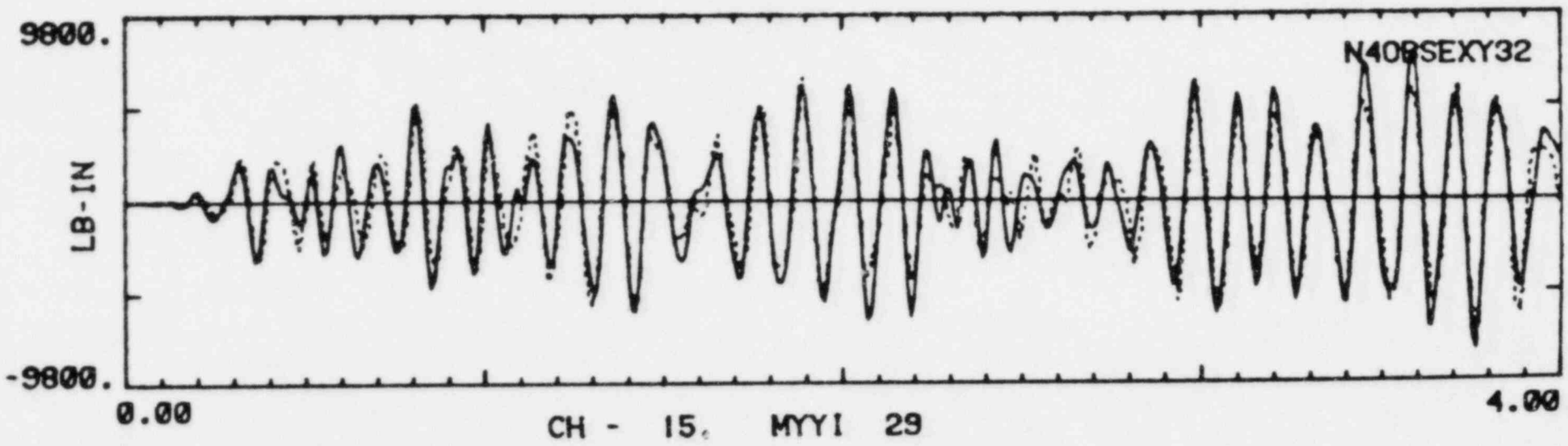
CORRELATION
NONLINEAR TIME HISTORIES VS TEST



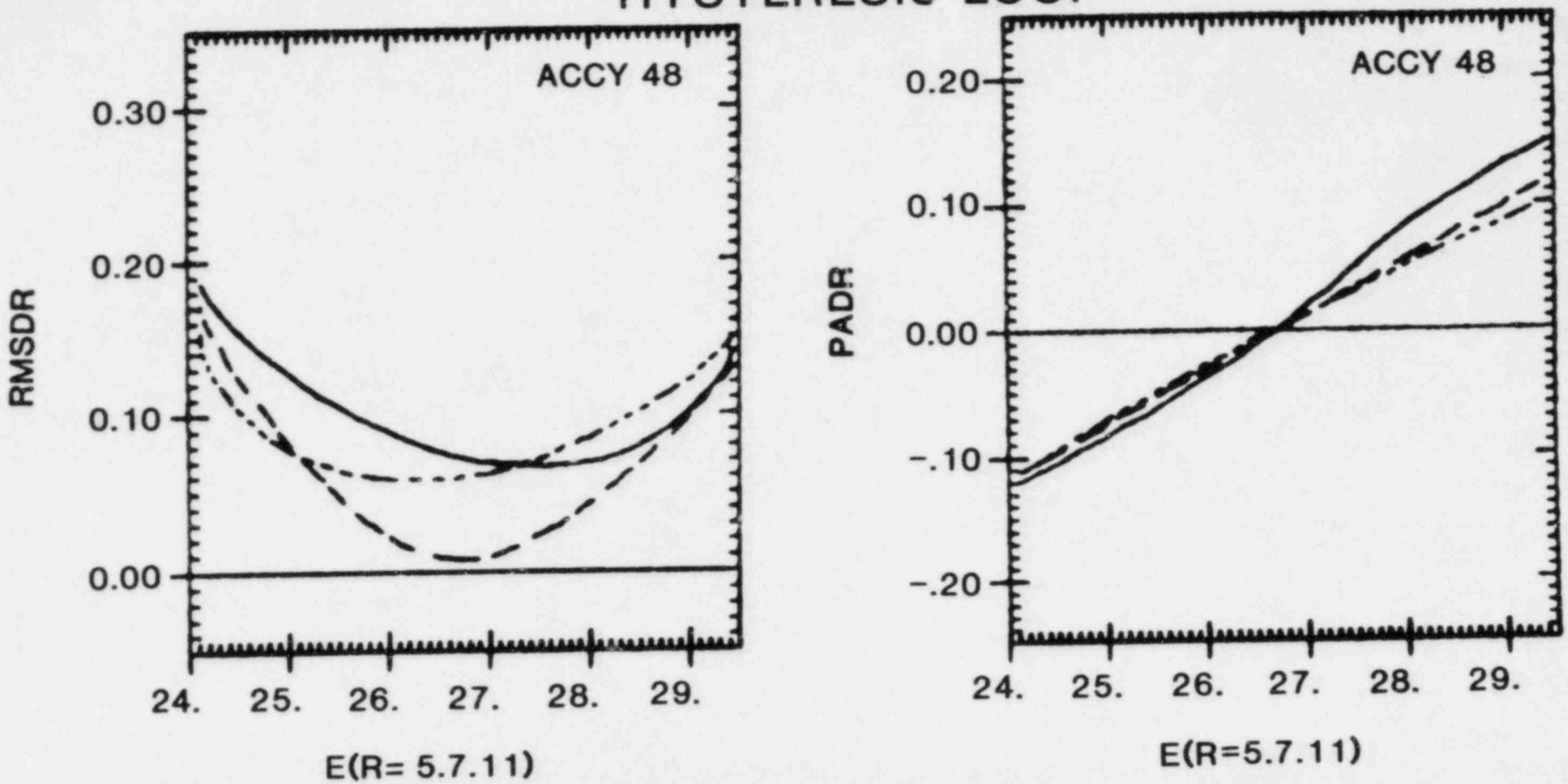


CORRELATION
NONLINEAR TIME HISTORIES VS TEST



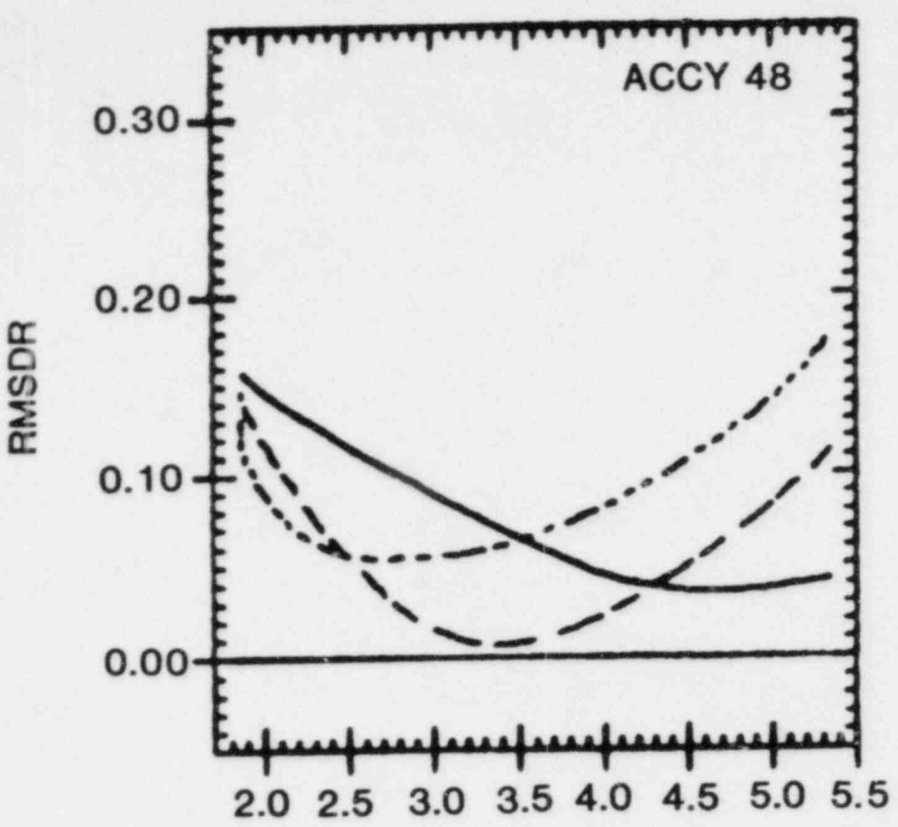


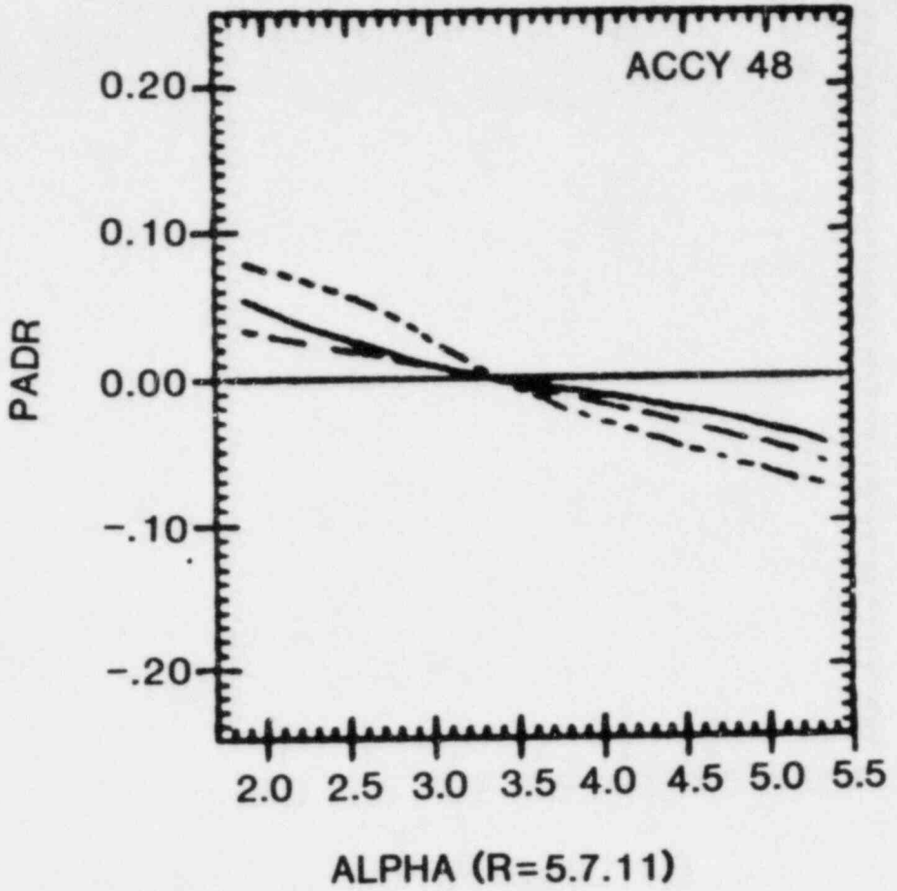
SENSITIVITY TO CHANGES IN SYSTEM FLEXIBILITY AND ENERGY ABSORBER HYSTERESIS LOOP



LEGEND: RED LINE: R = 5, GREEN LINE: R = 7, YELLOW LINE: R = 11
RMSDR = ROOT MEAN SQUARE DIFFERENCE RATIO
PADR = PEAK AREA DIFFERENCE RATIO

SENSITIVITY TO CHANGES IN THE ENERGY ABSORBER HYSTERESIS LOOP





LEGEND: RED LINE: R = 5, GREEN LINE: R = 7, YELLOW LINE: R = 11
RMSDR = ROOT MEAN SQUARE DIFFERENCE RATIO
PADR = PEAK AREA DIFFERENCE RATIO

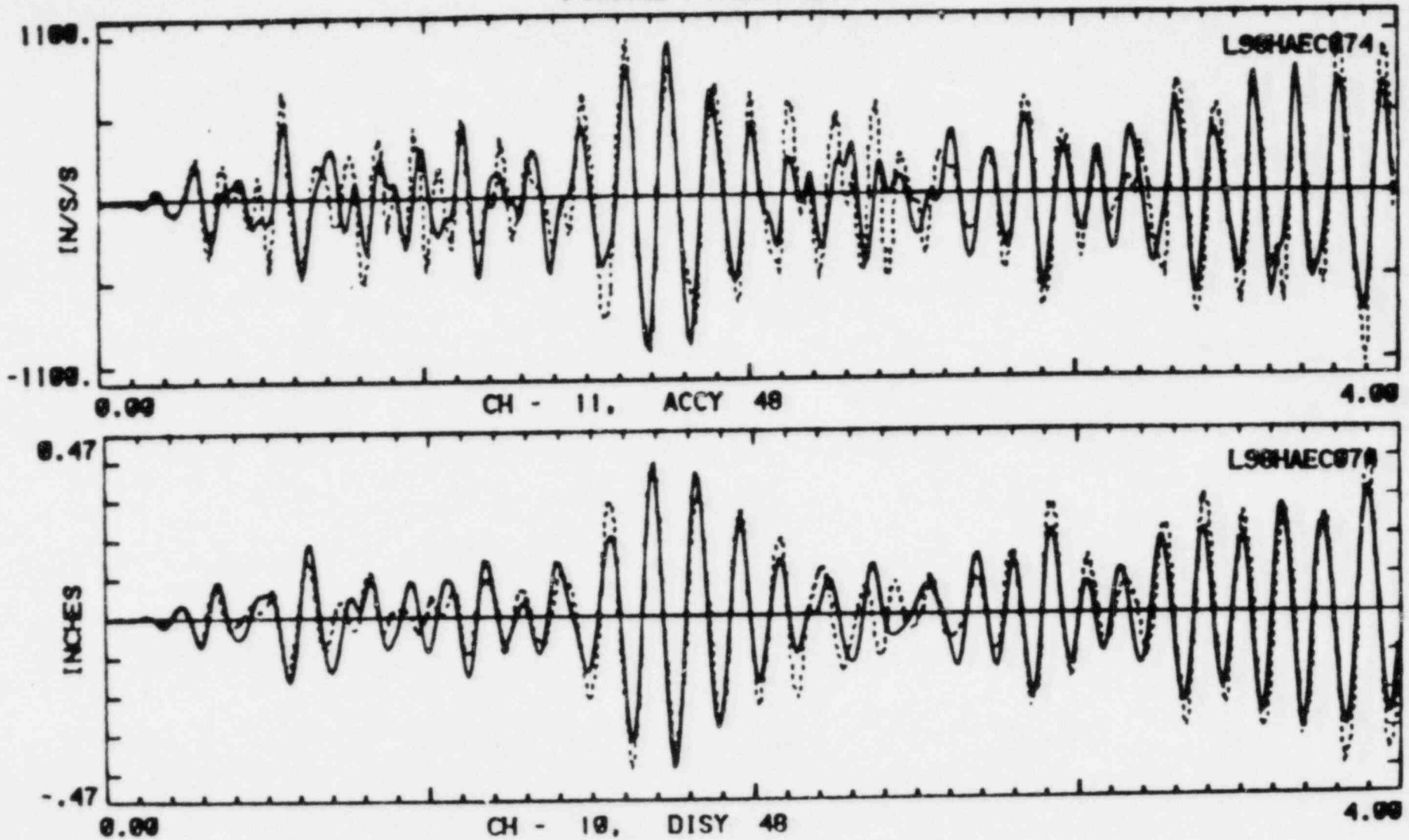
REG. GUIDE POSITIONS

- 1.61 SEC. C

  "2. DAMPING VALUES HIGHER THAN THE ONES DELINEATED IN TABLE 1 OF THIS GUIDE MAY BE USED IN A DYNAMIC SEISMIC ANALYSIS IF DOCUMENTED TEST DATA ARE PROVIDED TO SUPPORT HIGHER VALUES."

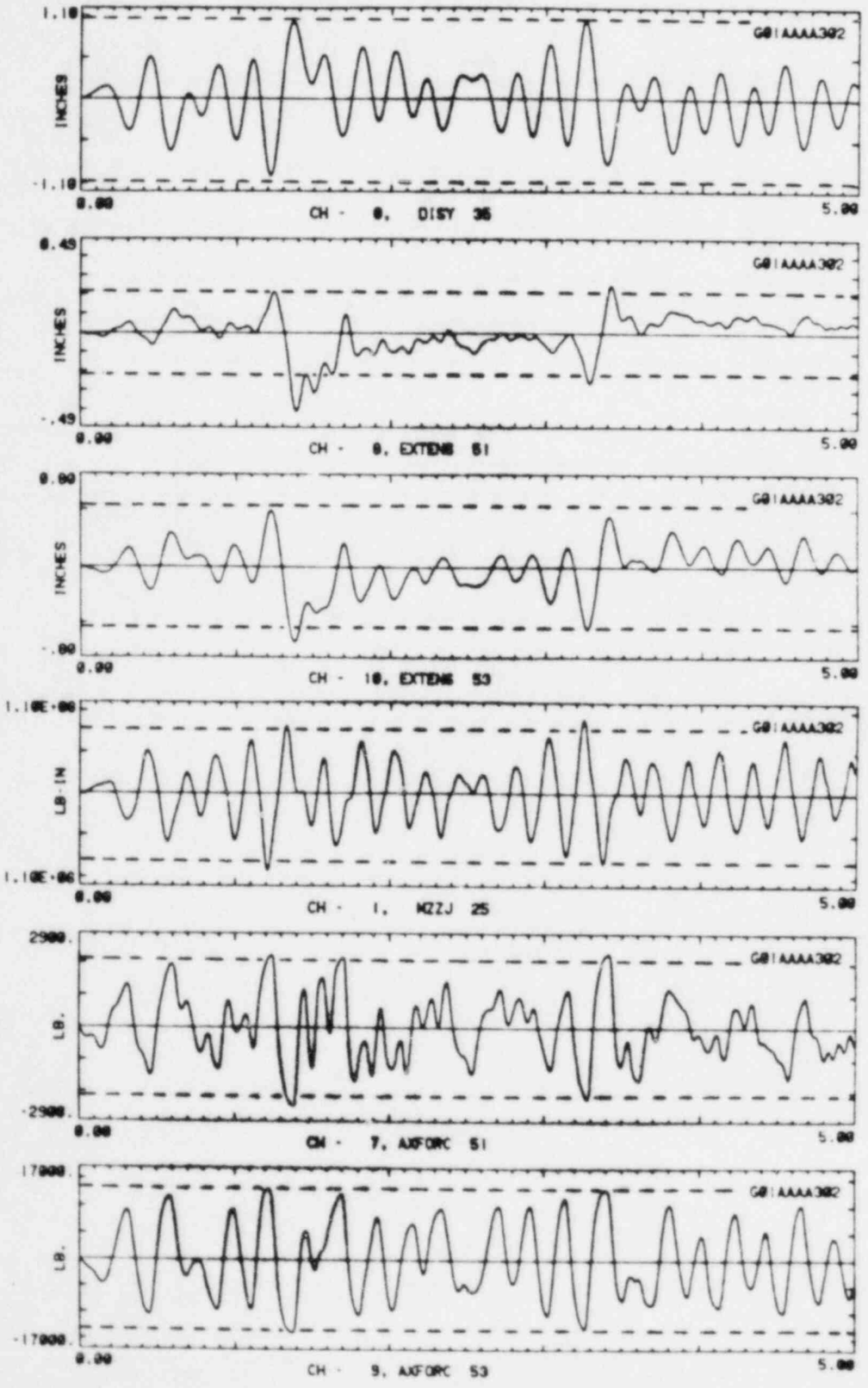
- 1.92 SEC. 1.2.3. INFERS THAT USE OF DIFFERENT MODAL DAMPING RATIOS FOR DIFFERENT MODES IS ALLOWED.

LINEARIZATION
LINEAR TIME HISTORY VS NONLINEAR TIME HISTORY



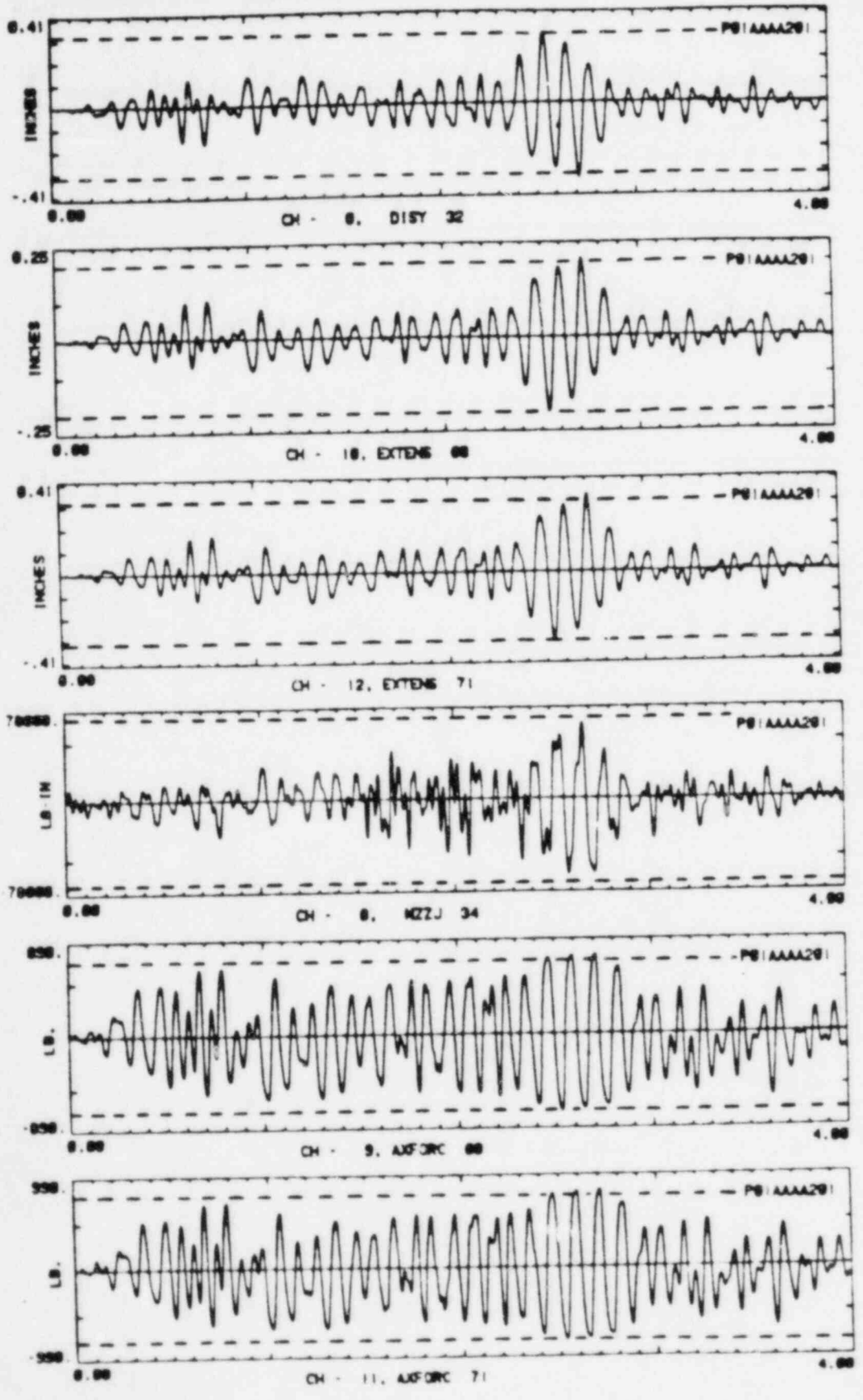
LINEARIZATION

RESULTS FROM MODE SUPERPOSITION METHOD COMPARED WITH NONLINEAR TIME HISTORIES



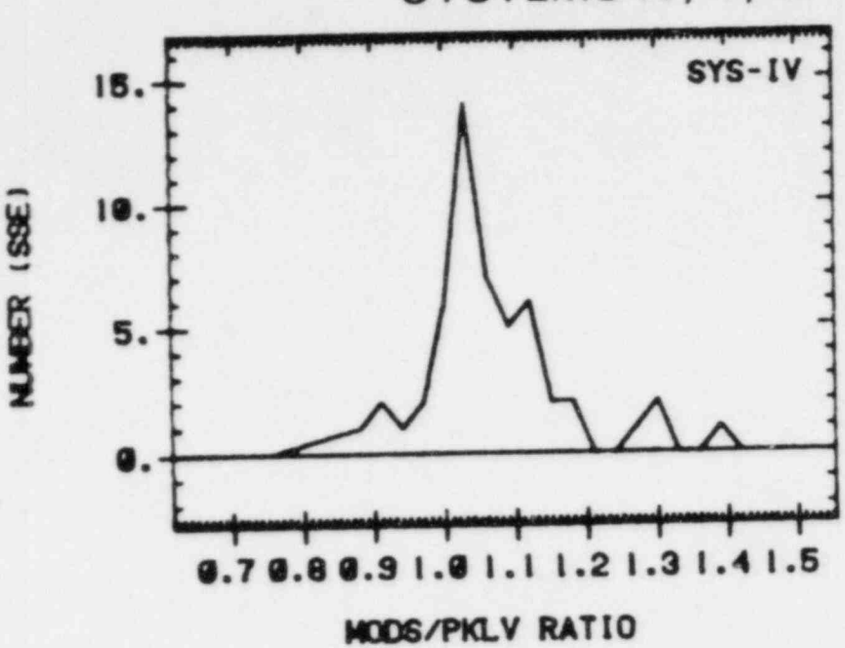
LINEARIZATION

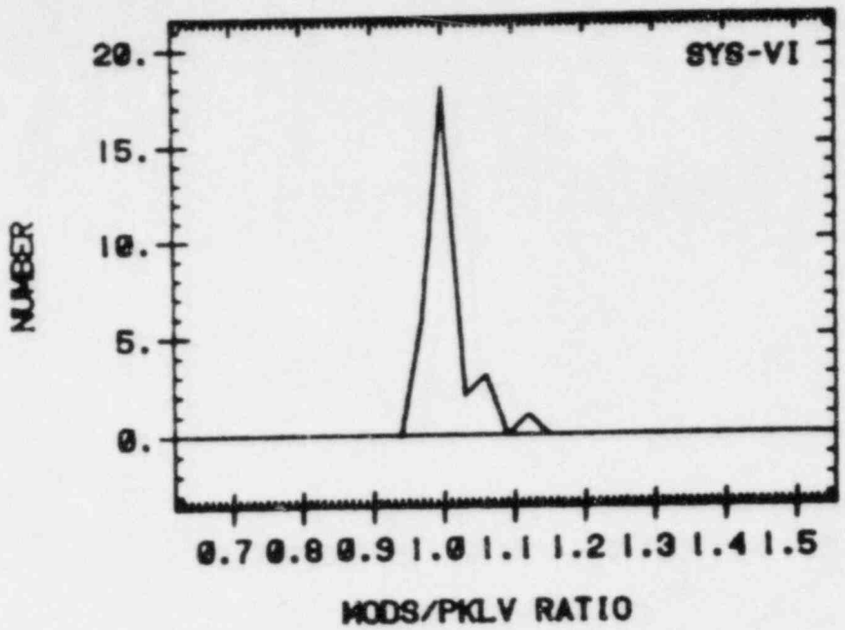
RESULTS FROM MODE SUPERPOSITION METHOD COMPARED WITH NONLINEAR TIME HISTORIES

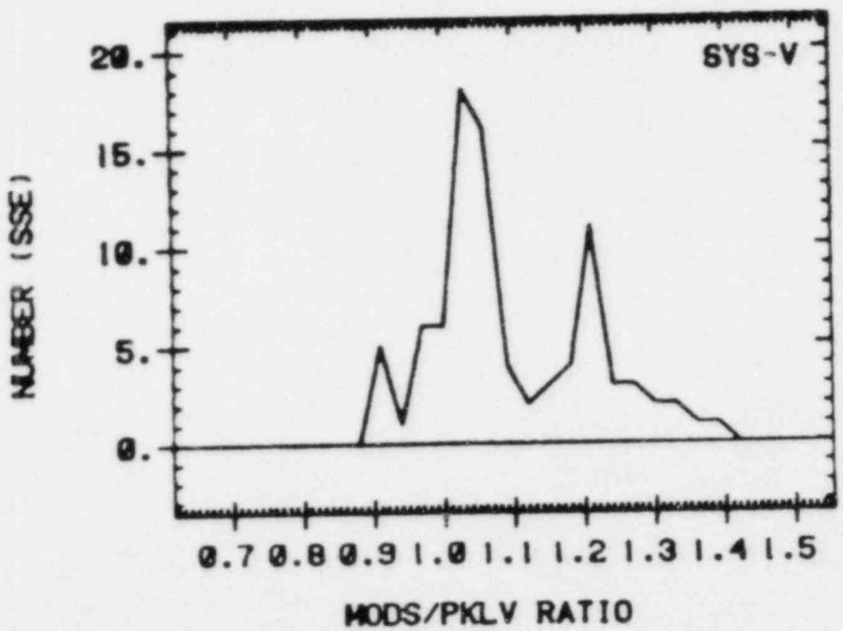


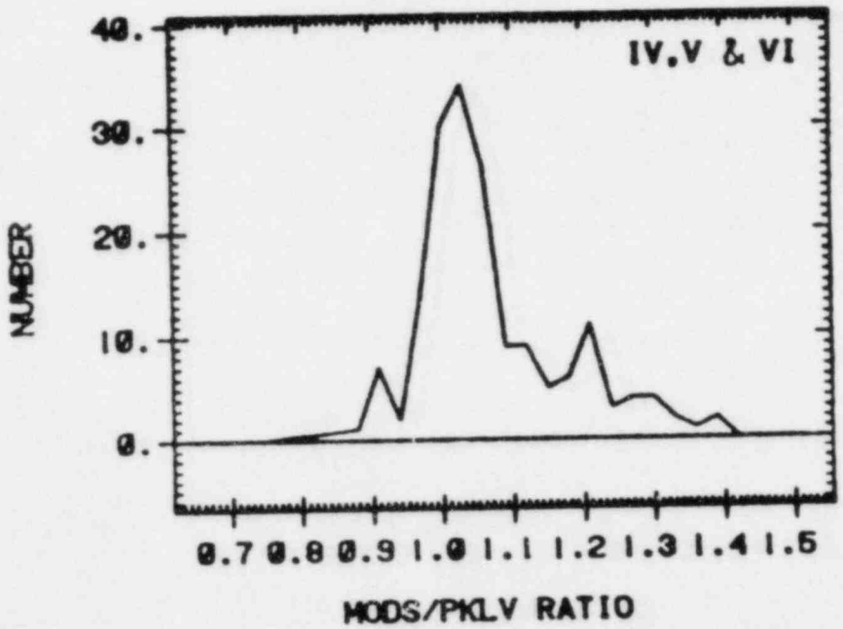
LINEARIZATION

DISTRIBUTION OF MODS/PKLV RATIOS OF PIPE SYSTEMS IV, V, VI AND THEIR COMBINATIONS









INSERVICE INSPECTION

REQUIREMENTS

- o VISUAL IN-PLACE EXAMINATION
- o VT-3

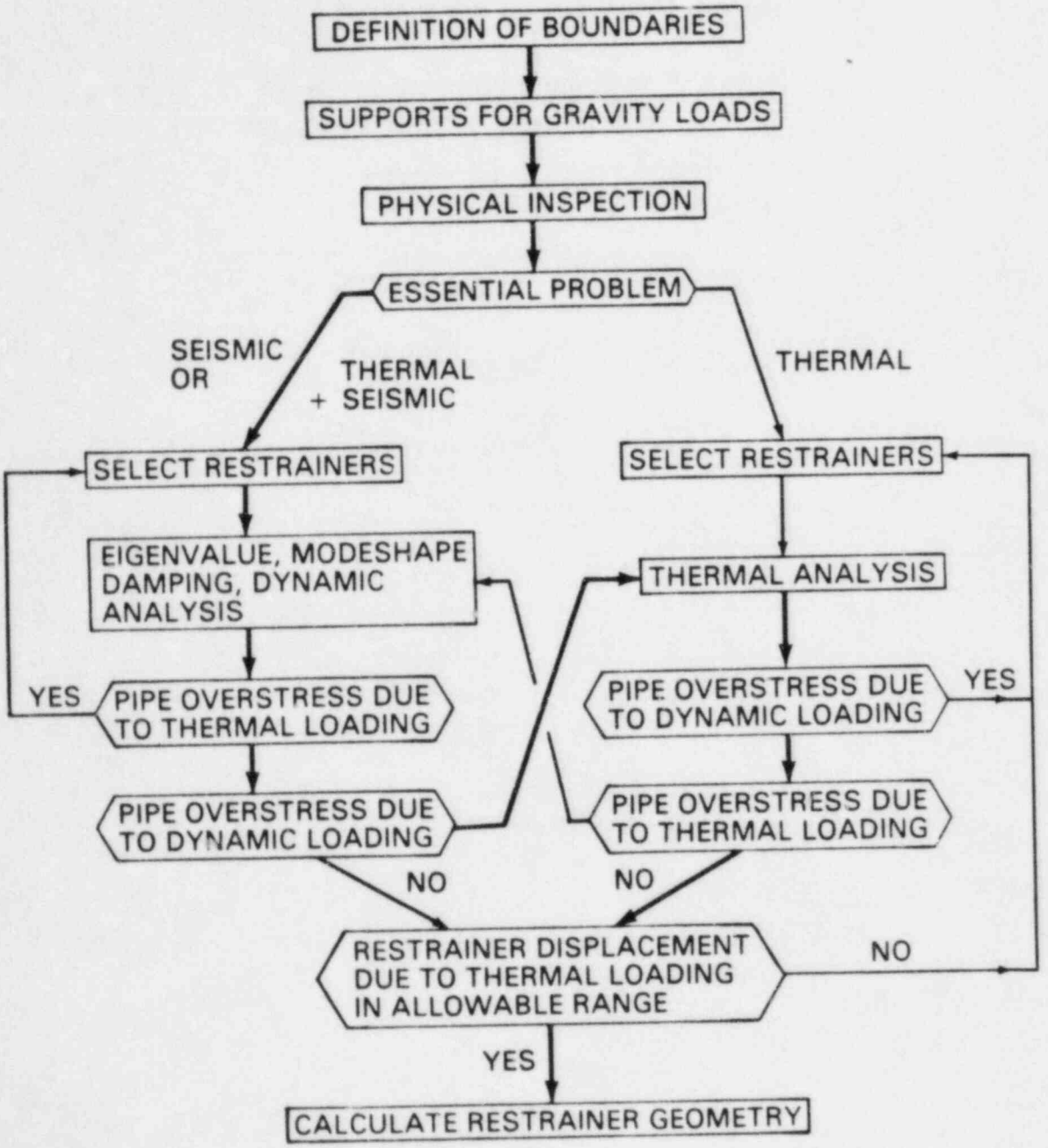
I S I

JUSTIFICATION

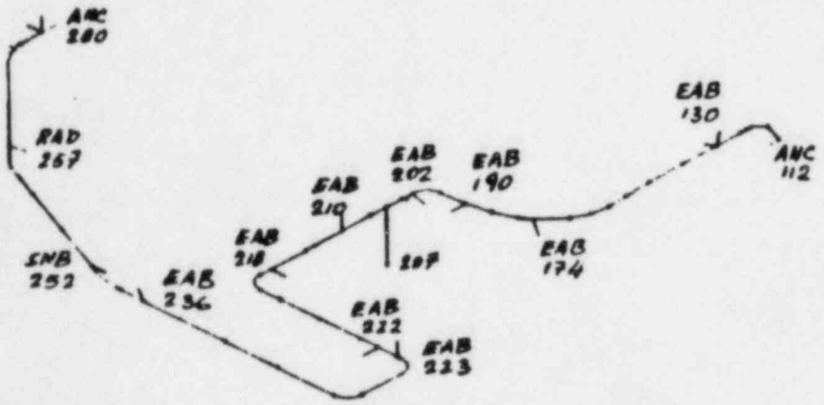
- SIMPLICITY OF CONCEPT/DESIGN
  - NO ACTIVATION MECHANISMS
  - PLATES/BOLTS ARE ACCESSIBLE TO INPLACE VISUAL VIEWING
  - BASIC FAILURE MODE IS COMPLETE FATIGUE CRACKING OF ONE OR MORE PLATES

- EXTENSIVE PROTOTYPICAL FATIGUE TESTING OF ENERGY ABSORBERS DEMONSTRATED THAT:
  - DEVELOPING CRACKS ARE EXTREMELY VISIBLE
  - SIGNIFICANT NUMBER OF CYCLES ARE NEEDED TO PROPAGATE A DEVELOPING CRACK INTO COMPLETE FATIGUE FAILURE
    - TENS IN HIGH STRAINS
    - HUNDREDS IN LOW STRAINS
  - ONE PLATE PER ASSEMBLY COMPLETELY FAILS FIRST WITH REMAINING PLATES INTACT.

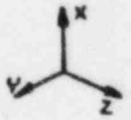
DESIGN PROCEDURE



ME101 Verification
November 30, 1984



BECHTEL PIPING ANALYSIS PROGRAM----ME101
ANA HEAD SPRAY SR-M-1550REV M-VER27
DANG TIEP 08091 1-10-09 010785 182648



PROBLEM: ME101VER28

Finally the new responses are

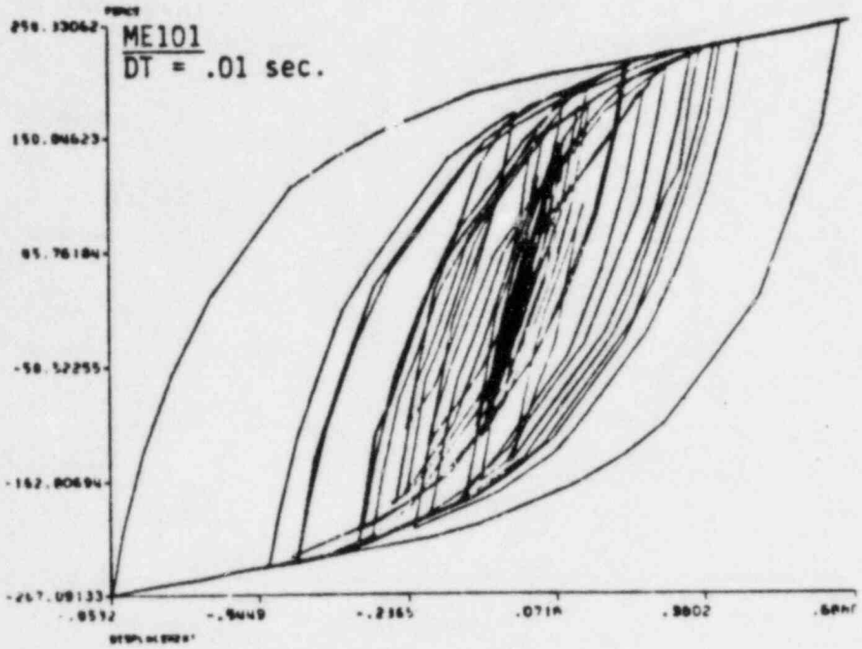
Mode	MFw	Acc. Resp* (g)	Damped Acc. Resp (g) Hand Calc.	ME101-EAB(K2)
1	.8725	9.1559	7.9885	7.9879
6	.3795	15.9572	6.0558	6.0553
12	1.002	21.8034	21.8034	21.8034

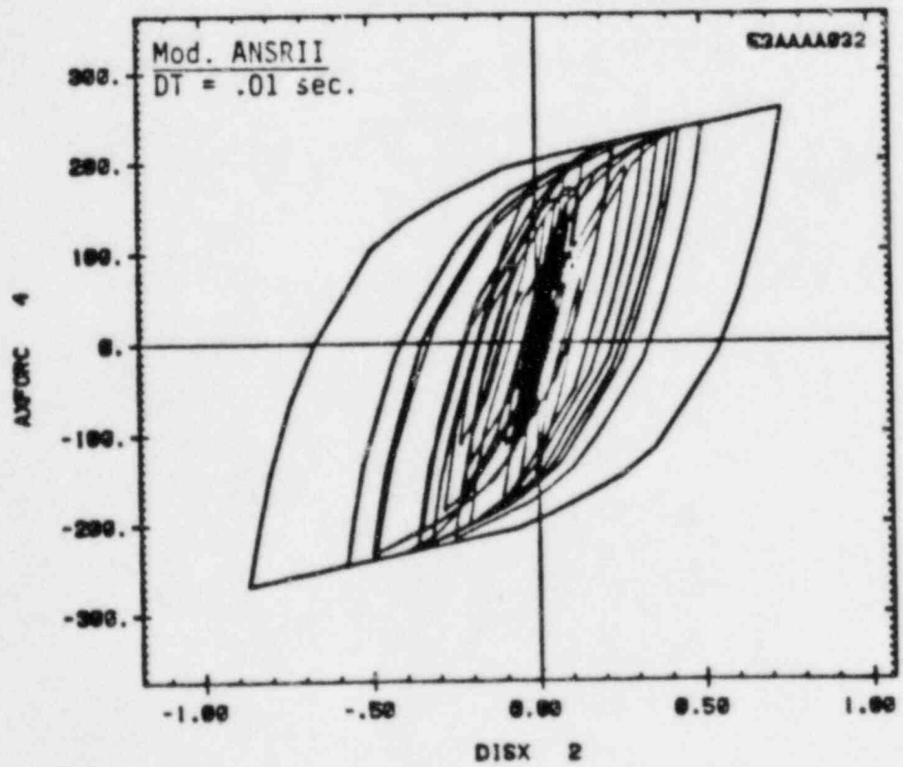
The computed response is compared with ME101 run, hereafter identified as hand calc., with input of modified spectral curves for given frequencies and using SNB of the replaced EAB stiffness. The results are compared as follows:

	Hand Calc. ME101-SNB	GLOBAL FORCES ME101-EAB		Hand Calc. ME101-SNB	ME101-EAB
112 ANC FX	1150	1150	MA	5462	5462
130 EAB FX	2592	2592	FZ	485	485
130 EAB FX	1244	1244	FZ	2946	2946
218 EAB FZ	4236	4236			
236 EAB FX	4931	4931	FY	1695	1695
252 EAB FZ	5414	5414			

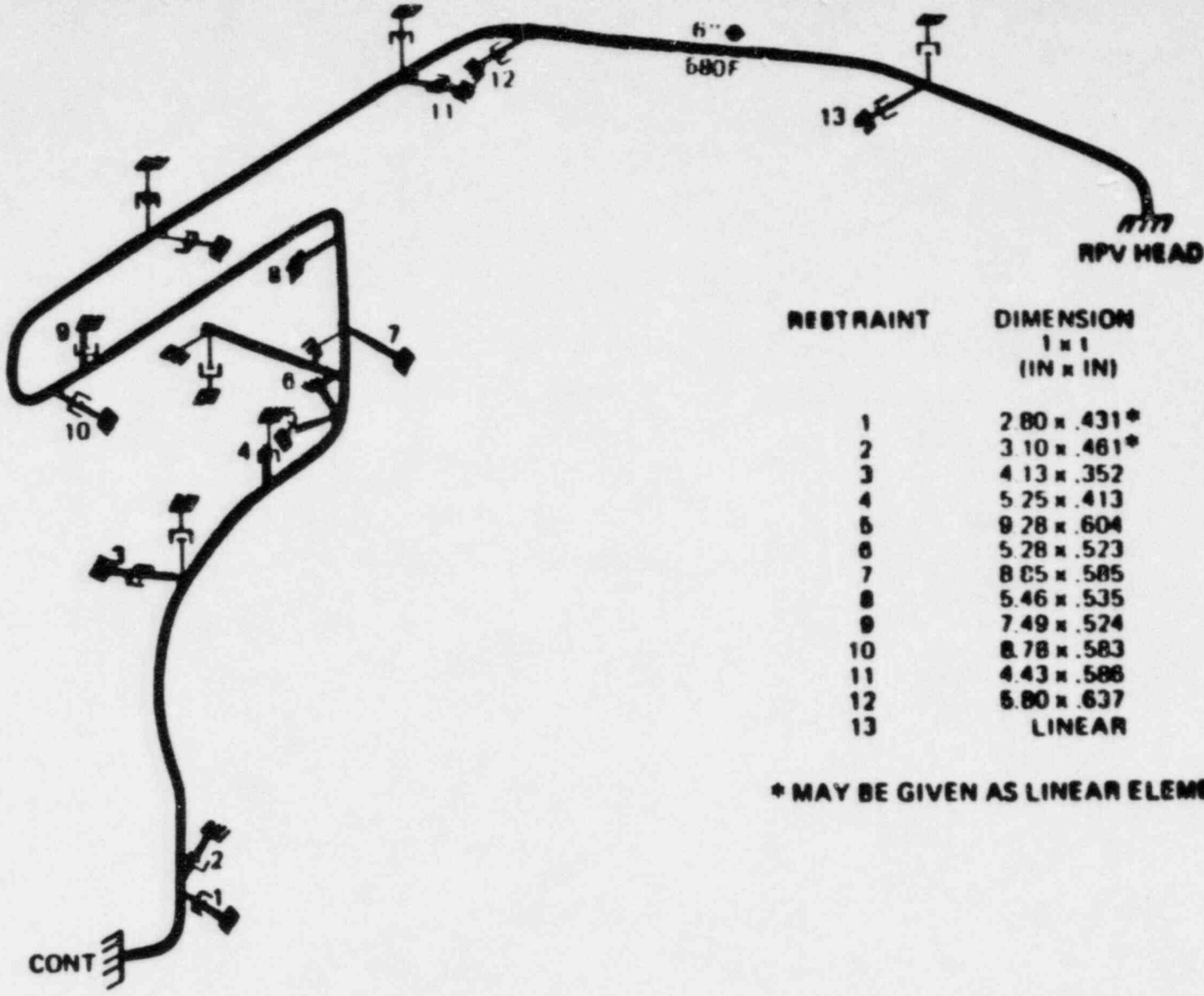
DATA PT	DISPLACEMENTS (IN) Hand Calc.	ME101-EAB(K2)
215 DX	1.133	1.133
215 DY	1.494	1.494
215 DZ	.519	.519
215 RX	.007823	.007823
215 RY	.015733	.015733
215 RZ	.014115	.014115
236 DY	3.675	3.675
23c RZ	.022974	.022974

HYSTERESIS COMPARISON





COMPARISON OF RESULTS IN RHR HEAD SPRAY SYSTEM.



RESTRAINT	DIMENSION 1 x 1 (IN x IN)
1	2.80 x .431*
2	3.10 x .461*
3	4.13 x .352
4	5.25 x .413
5	9.28 x .604
6	5.28 x .523
7	8.05 x .585
8	5.46 x .535
9	7.49 x .524
10	8.78 x .583
11	4.43 x .586
12	6.80 x .637
13	LINEAR

* MAY BE GIVEN AS LINEAR ELEMENT

SNUBBER
• ENERGY ABSORBER
RIGID

RHR DESIGN WITH SNUBBERS

RHR DESIGN WITH ENERGY ABSORBERS

RHR CASE COMPARISON

ITEM COMPARED	SNUBBER CASE	ENERGY ABSORBER CASE
• FUNDAMENTAL FREQUENCY	23 HZ.	4 HZ.
• DAMPING FACTORS	1%	2.5% TO 25%
• MAXIMUM STRESSES		
• THERMAL	9,600 PSI	15,400 PSI
• SSE	17,900 PSI	18,400 PSI
• VALVE ACCELERATION		
• RESULTANT	8.3 G's	5.8 G's
• NOZZLE LOADS (SSE)		
• RESULTANT FORCE	3,200 LB.	5,600 LB.
• RESULTANT MOMENT	55,000 IN. LB.	178,000 IN. LB.
• SUPPORT LOADS (SSE)		
• TOTAL NUMBER OF SEISMIC SUPPORTS	21	13
• LOAD RANGE	1 KIP TO 9 KIPS	1.5 KIPS TO 5.7 KIPS
• TOTAL LOAD	57 KIPS	43 KIPS