UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

April 15, 1992

Docket No. 50-482

LICENSEE: Wolf Creek Nuclear Operating Corporation

FACILITY: Wolf Creek Generating Station

SUBJECT: SUMMARY OF MEETING HELD ON MARCH 24, 1992, REGARDING ISSUES ASSOCIATED WITH NOISE EVENTS AT WOLF CREEK (TAC NO. M82999)

On March 24, 1992, members of the NRC staff met with representatives of Wolf Creek Nuclear Operating Corporation and their contractors to discuss the investigation and resolution of issues associated with noises and seismic/loose parts monitors alarms experienced during the heatup of the Wolf Creek Generating Station. A list of the attendees is provided as Enclosure 1. The meeting handouts provided by the licensee are provided as Enclosures 2 and 3.

The morning segment of the meeting consisted of the licensee providing general background information regarding the chronology of the "noise events", the related investigations, resolution of the probable cause and the analyses performed to demonstrate that the events had not resulted in exceeding plant design limits (see Enclosure 2). The licensee's investigation had concluded that the cause of the events was contact of the Reactor Coolant System (RCS) piping with the cross-over leg saddle-block pipe restraints at a temperature below the normal operating temperature. The earlier than desired contact resulted in friction forces between the pipe restraints and the floor and walls. The thermal expansion of the RCS piping during heatup created a point where the expansion forces exceeded the friction forces and a sudden movement of the piping and saddle-block restraints would occur. This sudden movement resulted in the seismic and loose parts monitors alarms and the noise which was heard by personnel in containment. Resolution of the condition involved reducing the thickness of shims placed between the saddle-block restraints and the floor and walls in order to achieve the desired clearances at normal operating temperatures. At the time of the meeting, a heatup of the unit following modifications to the shims had been performed and the event had not recurred. A short video was shown which displayed the removal and machining of the shims. A copy of this video was provided to the NRR Project Manager.

The afternoon segment of the meeting involved the licensee's supporting evidence that the cause of the events had been identified and that the events had not resulted in exceeding plant design limits (see Enclosure 3). Analysis of the loose parts monitor data for the March 16 event was given by Joe Thie, a contractor for the licensee, and supported the conclusion that the origin of the movement was a location near the steam generators. Analysis of the seismic monitor data related to the investigation into the cause and the evaluation of potential concerns regarding structural integrity was provided by Eugene Thomas of Bechtel. The licensee subsequently provided additional information regarding the thermal growth of the RCS and measurements taken which supported the thermal expansion/saddle-block displacement mechanism as

Df01
111

the cause of the noise and alarms. Ken Chang (Westinghouse) provided a description of the stress and fatigue analyses which had been performed to demonstrate the design parameters associated with the RCS had not been exceeded. The final presentation discussed the measurements taken during the March 16 event which supported the conclusion that no significant thermal-hydraulic transient had occurred in the safety injection piping at the time the noise and alarms were recorded.

A subsequent meeting was announced for March 26, 1992, and was held at the Dwight D. Eisenhower Training and Education Center located near the Wolf Creek Generating Station. Following the March 26, 1992, meeting and completion of modifications to the shims associated with the saddle-block pipe restraints, the unit was restarted and has since been operating at 100% rated thermal power.

Original Signed By

William D. Reckley, Project Manager
Project Directorate IV-2
Division of Reactor Projects III/IV/V
Office of Nuclear Reactor Regulation

Enclosures:
1. List of Attendees
2. Licensee Handout
   Meeting on Recent
   Noise Events
3. Licensee Handout
   Technical Presentation/
   Discussion

cc w/enclosures:
See next page

DISTRIBUTION:
Docket File
NRC/PDR
Local PDR
PDIV-2 RF
PDIV-2 PF
BBoger
FMiraglia
SBlack
JPartlow
MVirgilio
EPeyton
WReckley
OGC
EJordan
ACRS(10)
AHowell, Region IV
SShankman
NRC Participants

OFFICE	PDIV-2/LA	PDIV-2/PM	PDIV-2/D		
NAME	EPeyton	WReckley:nb	SBlack		
DATE	4/14/92	4/15/92	4/ /92	/ /	/ /

cc w/enclosures:
Jay Silberg, Esq.
Shaw, Pittman, Potts & Trowbridge
2300 N Street, NW
Washington, D.C. 20037

Mr. Jim Durand
Public Service Commission
P. O. Box 360
Jefferson City, Missouri 65102

Regional Administrator, Region III
U.S. Nuclear Regulatory Commission
799 Roosevelt Road
Glen Ellyn, Illinois 60137

Senior Resident Inspector
U.S. Nuclear Regulatory Commission
P. O. Box 311
Burlington, Kansas 66839

Mr. Robert Eilliot, Chief Engineer
Utilities Division
Kansas Corporation Commission
1500 SW Arrowhead Road
Topeka, Kansas 66604-4027

Office of the Governor
State of Kansas
Topeka, Kansas 66612

Attorney General
1st Floor - The Statehouse
Topeka, Kansas 66612

Chairman, Coffey County Commission
Coffey County Courthouse
Burlington, Kansas 66839

Mr. Gerald Allen
Public Health Physicist
Bureau of Environmental Health Services
Division of Health
Kansas Department of Health
and Environment
109 SW Ninth
Topeka, Kansas 66612

Mr. Otto Maynard
Director Plant Operations
Wolf Creek Nuclear Operating Corporation
P. O. Box 411
Burlington, Kansas 66839

Regional Administrator, Region IV
U.S. Nuclear Regulatory Commission
611 Ryan Plaza Drive, Suite 1000
Arlington, Texas 76011

Mr. Steven G. Wideman
Supervisor Licensing
Wolf Creek Nuclear Operating Corporation
P. O. Box 411
Burlington, Kansas 66839

Robert Fye, General Council
Kansas Department of Health
and Environment
LSOB, 9th Floor
900 SW Jackson
Topeka, Kansas 66612

Mr. Bart D. Withers
President and Chief Executive Officer
Wolf Creek Nuclear Operating Corporation
P. O. Box 411
Burlington, Kansas 66839

Lewis Peoples
RCG/Hagler, Bailly, Inc.
50 California Street, Suite 400
San Francisco, California 94111

Heidi Rosenfield
Knopf & Burka
2033 M Street, N.W., Suite 400
Washington, D.C. 20006

Anne Dauphin
c/o Jeanne Carpenter
McDermott, Will & Emery
1850 K Street, N.W., Suite 500
Washington, D.C. 20036

cc w/enclosures:
Frank Wilks
Bechtel Power Corporation
P.O. Box 42
New Strawn, KS 66839

George Johnson
Swidler & Berlin
3000 K Street, NW
Suite 300
Washington, DC 20007

Allen Vieira
Bechtel Power Corporation
9801 Washington Blvd
Gaithersburg, MD 20877

Mary Pelletter
Fried Frank Harris Shriver & Jacobson
1001 Pennsylvania Avenue, Suite 800
Washington, D.C. 20004

LIST OF ATTENDEES

NRC	ORGANIZATION
Suzanne Black	NRR/PDIV-2
Terrance Chan	NRR/EMEB
Samuel Collins	Region IV
David Gamberoni	NRR/DOEA
William Reckley	NRR/PDIV-2
Horace Shaw	NRR/EMEB
Thomas Stetka	Region IV
Marty Virgilio	NRR/DRP
John Whittemore	Region IV

LICENSEE/CONTRACTORS

Richard Flannigan	Wolf Creek Nuclear Operating Corporation (WCNOC)
Fred Hall	WCNOC
Tom Hood	WCNOC
Brad Norton	WCNOC
Jack Pippin	WCNOC
John Stamm	WCNOC
Steve Wideman	WCNOC
Bart Withers	WCNOC
Eugene Thomas	Bechtel
Allen Vieira	Bechtel
Frank Wilks	Bechtel
Ken Chang	Westinghouse
Gary Ellis	Westinghouse
Daniel Lipman	Westinghouse
Howard Ott	Westinghouse
Joe Thie	
Earl Creel	Kansas Gas & Electric
Barbara Bauman	Kansas City Power & Light
Charles Ross	Kansas City Power & Light
Charles Terrill	Kansas Electric Power Cooperative

OBSERVERS

Tom Bellet	Swidler & Berlin
George Johnson	Swidler & Berlin
Mary Pelletter	Fried Frank Harris Shriver & Jacobson

Enclosure 1

LIST OF ATTENDEES (Cont.)

OBSERVERS	ORGANIZATION
Jennifer Komosa	Cahill Gordan & Reindel
Heidi Rosenfeld	Knopf & Burka
Louis Sarkes, Jr.	Chesapeake Partners
Ashby Beal	Stewart & Smith, Inc.
Anne Dauphin	McDermott, Will & Emery
William Scott Hylae	
Rebecca Tauber	Topeka Capital-Journal
Jake Thompson	Kansas City Star
STATE	
Robert Elliot	Kansas Corporation Commission
Robert Eye	Kansas Department of Health & Environment

ENCLOSURE 2

Meeting on Recent Noise Events

March 24, 1992

WOLF CREEK
NUCLEAR OPERATING CORPORATION

Agenda

Introduction	Bart Withers
I. Objectives of Meeting	Jack Pippin
II. Noise Event of February 28 - Initial Actions and Investigation	Jack Pippin
III. Description of the WCNOC Investigation	Rich Flannigan
Loose Parts	Brad Norton
Thermal Growth	John Stamm
Thermal-Hydraulic Mechanisms	Tom Hood
IV. Identification and Correction of the Cause	John Stamm
V. Safety Impact and Plant Operability	Jack Pippin
VI. Summary	Bart Withers
VII. Technical Presentations/Discussions	

I. Objectives of Meeting

Purpose of the meeting:

- demonstrate that noise events caused no damage
- demonstrate a reasonable assurance that there will be no damage to the reactor coolant system and attached safety systems

The presentation will describe the following:

- the noise events and immediate actions;
- the investigation that has been undertaken;
- the identification and correction of the cause;
- the results of safety impact and operability analyses; and
- anticipated longer term actions

II. The Noise Event of February 28 and Immediate Actions

- During conduct of containment walkdown at pressure for a reactor mode change

- [illegible]d canopy seal weld weepage and commenced an [illegible]ant evaluation

- While conducting seal weld evaluation, the noise occurred with accompanying control room alarms

- Held plant conditions constant and conducted containment walkdown to look for obvious damage

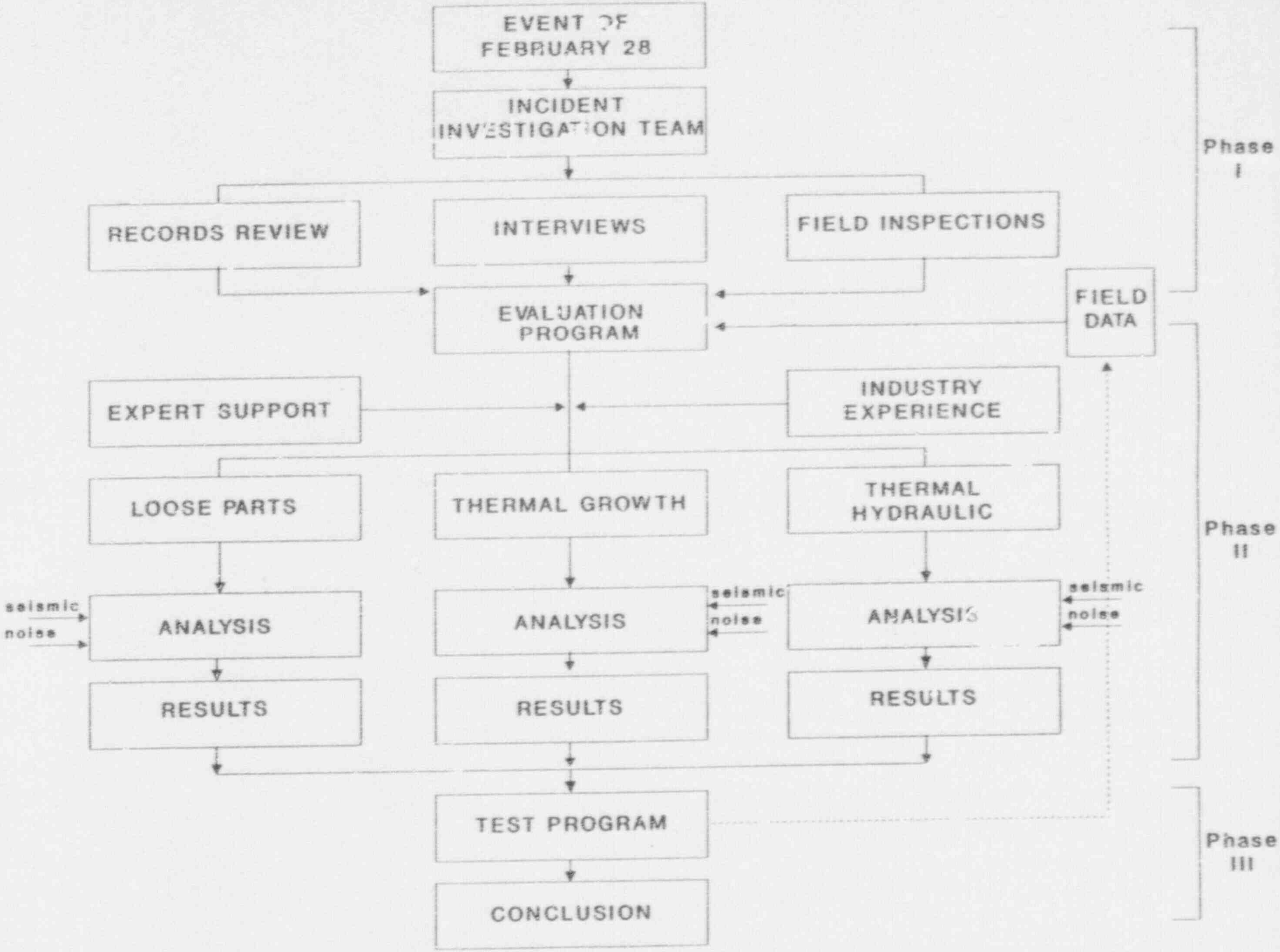
- Conducted the following actions in the morning of the first day
  - Initiated a company Incident Investigation Team (IIT) review
  - Began on-going information exchange with NRC Region IV
    Sent letter to RIV committing to keep them informed of our intentions
  - Sent Loose Parts Monitor Tapes off for analysis
  - Checked reactor coolant system leakage rate
  - Began a detailed containment walkdown - confirmed ECCS availability

II. The Noise Event of February 28 and Immediate Actions
(continued)

- Without immediate discovery of a cause or apparent effects, went to cold shutdown and conducted an additional walkdown

- Began root cause investigation using change analysis methodology

WOLF CREEK NUCLEAR OPERATING CORPORATION
FEBRUARY 28 NOISE EVENT INVESTIGATION OVERVIEW



III. Description of WCNOC Investigation

The investigation involved in-house expertise supplemented by outside experts. Contributions were as follows:

- WCNOC Staff - approximately 125 persons - engineering, maintenance, instrument and control, operations, health physics, quality control, quality assurance, and management
- Westinghouse - provided assistance with: piping stress analysis, bounding calculations; loose parts noise analysis; and safety evaluation
- Bechtel - provided assistance with: seismic analysis; pipe load analysis; and thermal-hydraulic investigation
- MIT - provided assistance with thermal-hydraulic modeling
- Failure Prevention, Inc. - provides assistance with root cause analysis

III. Description of the WCNOC Investigation
(continued)

The IIT used a variety of means to gather information including:

- records review
- interviews
- field inspections
- major modifications
- industry experience
- RCS check valve testing

Within 48 hours, identified the event of January 9 and determined that it was similar to the February event - began to focus on commonality

Used coarse screening criteria (unexplained control room seismic alarm and confirming report of personnel in control room logs) to identify other possibly similar events

Attributes of Noise Events

Date	Witnessed/ Felt*	Accumulator Isolation Valve/Level Deviation	Loose Parts Alarm	Seismic Alarms* 98C	98E	Accumulator Check Valve Testing	Engdahl Seismic Inst.	Temperature Pressure	B RCP Vibration
May 1990	Yes	Open/Yes	No	No	Yes	Testing in progress	Not Available	Steady 450°F Rising 1100 psig	No
Jan 1992	Yes	Open/No	Yes	Yes	Yes	Complete (6 hrs)	32 hz E-W	Rising 512°F 1830 psig	Yes
Feb 1992	Yes	Open/No	Yes	Yes	Yes	Complete (9 hrs)	32 hz E-W	Steady 537°F 2235 psig	Yes
Mar 1992	Yes	Open/No	Yes	Yes	Yes	Complete (48 hrs)	32 hz E-W	Rising 551°F 2235 psig	Yes

The dissimilarity of the May 1990 to the other three events lead to the conclusion that the event is not related.

* screening criteria

III. Description of the WCNOC Investigation
(continued)

The inquiry focused on three possible mechanisms that could cause noise in the reactor coolant system:

- loose parts
- thermal-hydraulic transient
- thermal growth binding/interference

III. Description of the WCNOC Investigation
(continued)

Loose Parts Analysis

The postulated event is a component or part internal to the reactor coolant system suddenly dislodged and impacted the system.

The investigation concluded that loose parts were not the initiator of the event.

- No further indication of loose parts (no rattling)
- Seismic data is inconsistent with any postulated loose part
- No changes in primary chemistry
- No additional reactor plant damage - incore detector and control rod functions are normal, reactor flow normal, RCP motor amps normal

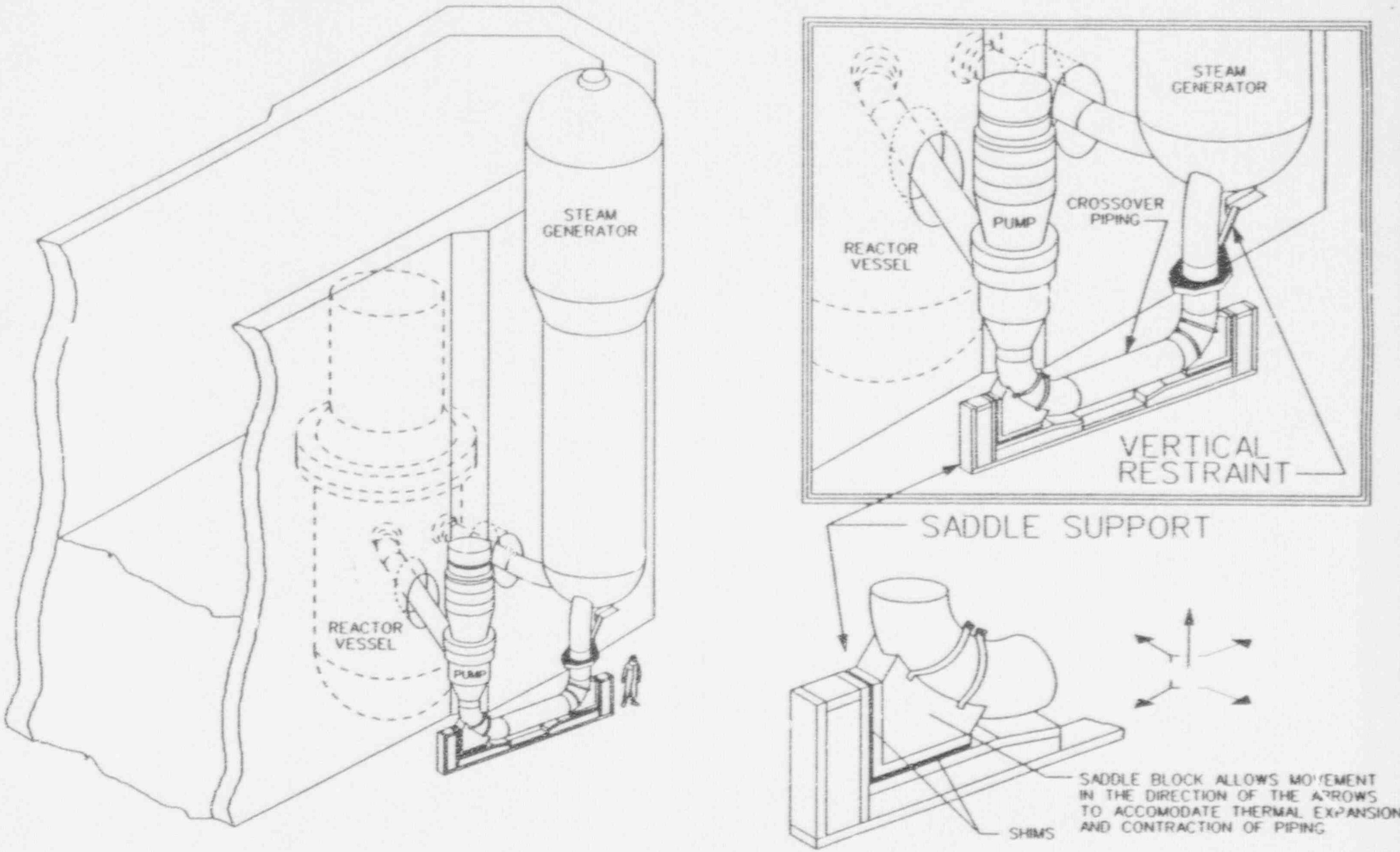
III. Description of the WCNOC Investigation
(continued)

Thermal Growth

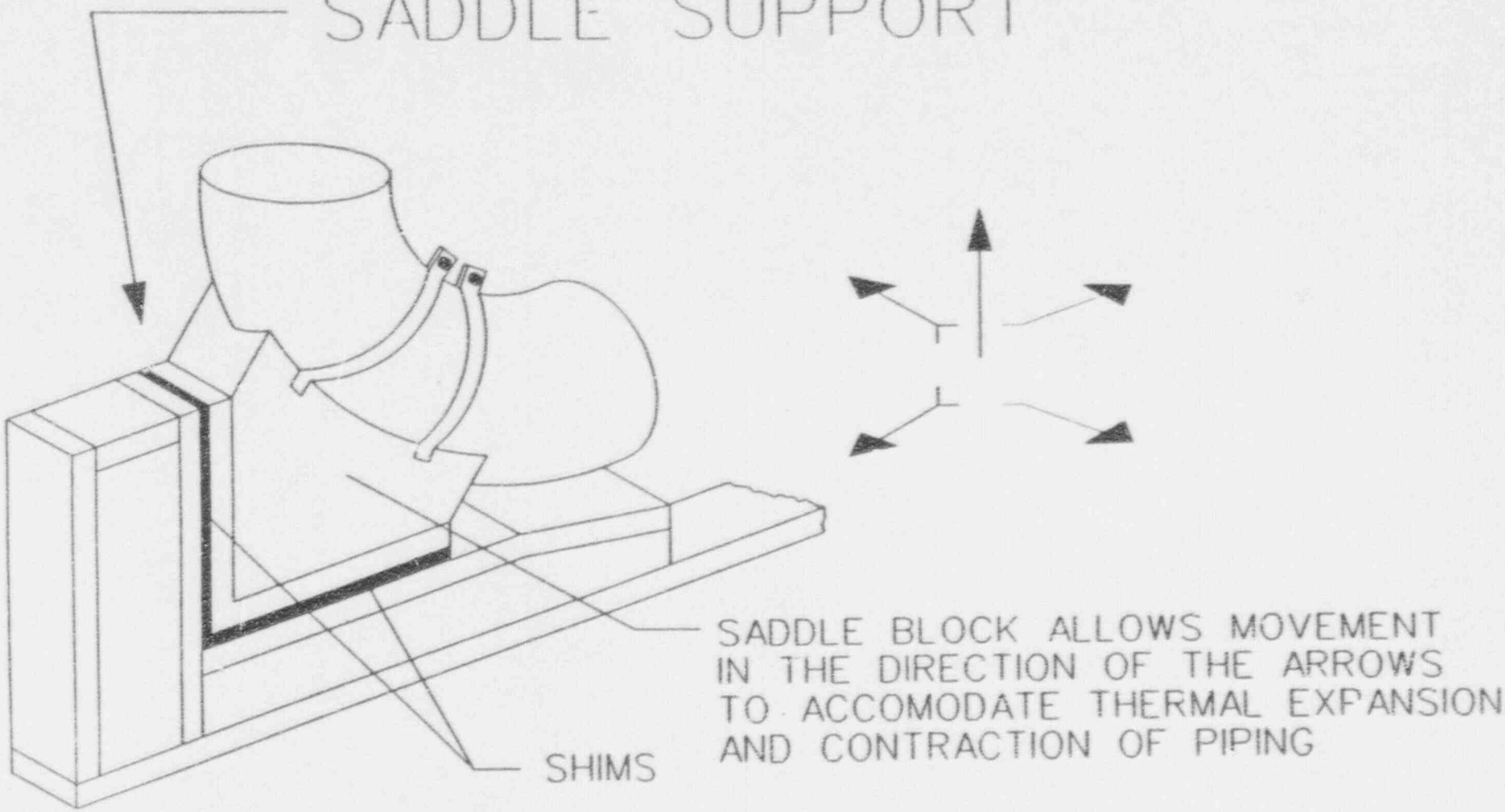
> The postulated event here is a pipe, component, or support of the primary system, as it expanded during heatup, came into contact with another component of the system or containment structure and bound up. The resulting "give" caused the noise.

The investigation included a detailed inspection of the primary system and its support structures to identify interference points, as well as indications of mis-aligned supports. Evidence of damage or contact would be the key indicator that this mechanism initiated the noise.

The similarities of the January '92, February '92 and March '92 events (nearly same temperature and pressure, no other activities going on) suggest that pipe growth was a very likely initiator of the noises.


STEAM GENERATOR
REACTOR VESSEL
PUMP
STEAM GENERATOR
CROSSOVER PIPING
REACTOR VESSEL
PUMP
VERTICAL RESTRAINT
SADDLE SUPPORT
SADDLE BLOCK ALLOWS MOVEMENT IN THE DIRECTION OF THE ARROWS TO ACCOMODATE THERMAL EXPANSION AND CONTRACTION OF PIPING
SHIMS

SADDLE SUPPORT



III. Description of the WCNOC Investigation
(continued)

Investigation of Thermal Growth found:

- Pressurizer relief discharge line spring hanger questionable setting
- Cocked snubber clamp (snubber verified operable)
- Clamp for cold leg crossover pipe whip restraint tie bar had slipped downward by up to six inches on three loops (moved back into position prior to March 16 noise)
- Evidence of contact between the crossover leg pipe whip restraint saddle block and shims
  - contact determined to occur at approximately 500°F - should only close to zero clearance at NOT

Engineering analyzed the impact of these nonconformances and determined that they did not challenge the reactor coolant system integrity.

III. Description of the WCNOC Investigation
(continued)

Thermal-hydraulic Event

The postulated event is that a pressure wave propagated through the primary system. The wave was caused by the collapse of a saturated or superheated steam bubble.

To test this mechanism

- installed additional pressure instrumentation on the safety injection system to measure conditions in the system and possible impacts on the reactor coolant system (provided data on conditions during the March 16 noise event)
- performing modelling of the saturated and superheated steam bubble situations
- tested check valves during restart (no problems noted)

Based on the data provided from the above, concluded that this was not the mechanism that caused the noise.

Changed check valve test program to lessen the possibility of a thermal hydraulic event when restoring the accumulators to service. The March heatup confirmed the effectiveness of these measures.

IV. The Identification and Correction of the Cause

An inspection of the shims in the crossover leg pipe whip restraint revealed evidence of hard contact.

To eliminate this as a cause, the shims were removed and milled to restore the desired clearance.

V. Safety Impact and Plant Operability

The noise events did not cause damage to the plant or its components.

- Detailed visual inspections found no damage
- Loose parts analysis revealed no loose parts
- Calculated loadings and stresses well within safety margins

Required systems are operable

- Performed required surveillances

No damage can result from noise events of this type

- Performed bounding calculations
  - Additional seismic loading from RCS system shake
  - Maximum water hammer forces from accumulator discharge
  - Reestablish or verify support clearances

VI. Summary

- Performed an exhaustive investigation assisted by outside experts
- Verified no damage occurred - verified reactor coolant system integrity
- Verified similar noise events would not cause damage
- Long term monitoring and action plan

Initial Potential Causes that were Investigated

Began the inquiry with an investigation of possible specific noise initiators associated with the current outage or the most recent refueling. Investigated:

- Feedwater transient with steam generator level excursion
- Check valve slam
- Reactor coolant pump motor changeout
- RTD bypass manifold removal
- Cavity seal ring modifications
- Interferences with pipe whip restraints at vessel ("wagon wheels")

It was determined that none of these could have caused a noise of the magnitude and nature of the February 28 noise event

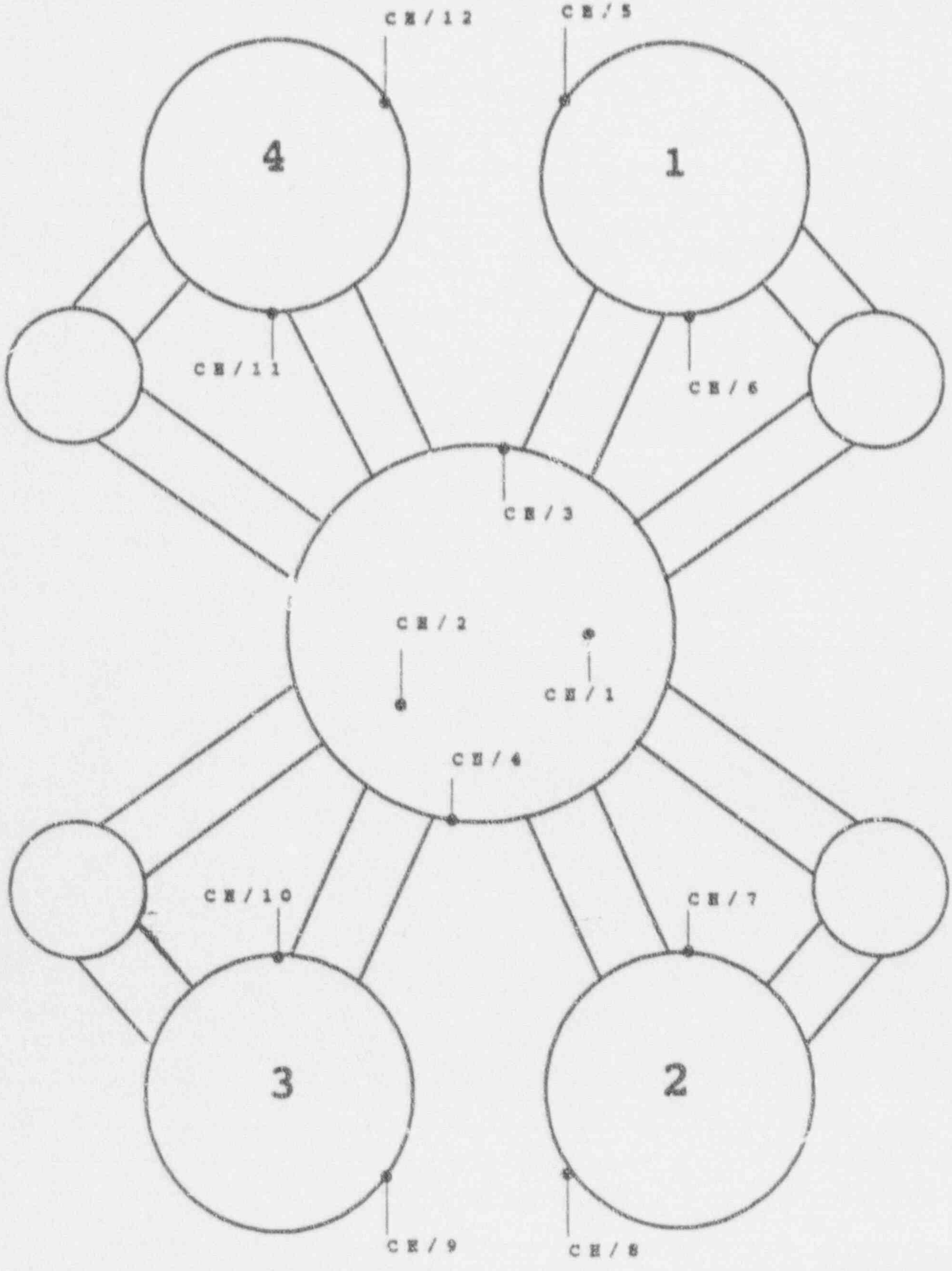
Technical Presentation/Discussion

March 24, 1992

WOLF CREEK
NUCLEAR OPERATING CORPORATION

Loose Parts/Structural Dynamic Analysis

LPM SENSORS



Vibration and Loose Part System

Tape Turn-On Switching Sequence

First-On Alarmed Channel	Tape Recorder Channel A	B	C	D
1	1	2	3	4
2	2	3	4	1
3	3	4	1	2
4	4	1	2	3
5	5	2	4	6
6	6	1	3	5
7	7	2	4	8
8	8	1	3	7
9	9	2	4	10
10	10	1	3	9
11	11	2	4	12
12	12	1	3	11

Vibration and Loose Part System

Channel Number and Sensor Location

Channel Definition:

Channel 1	Lower Vessel A
Channel 2	Lower Vessel B
Channel 3	Upper Vessel A
Channel 4	Upper Vessel B
Channel 5	Steam Generator Inlet 1-A
Channel 6	Steam Generator Inlet 1-B
Channel 7	Steam Generator Inlet 2-A
Channel 8	Steam Generator Inlet 2-B
Channel 9	Steam Generator Inlet 3-A
Channel 10	Steam Generator Inlet 3-B
Channel 11	Steam Generator Inlet 4-A
Channel 12	Steam Generator Inlet 4-B

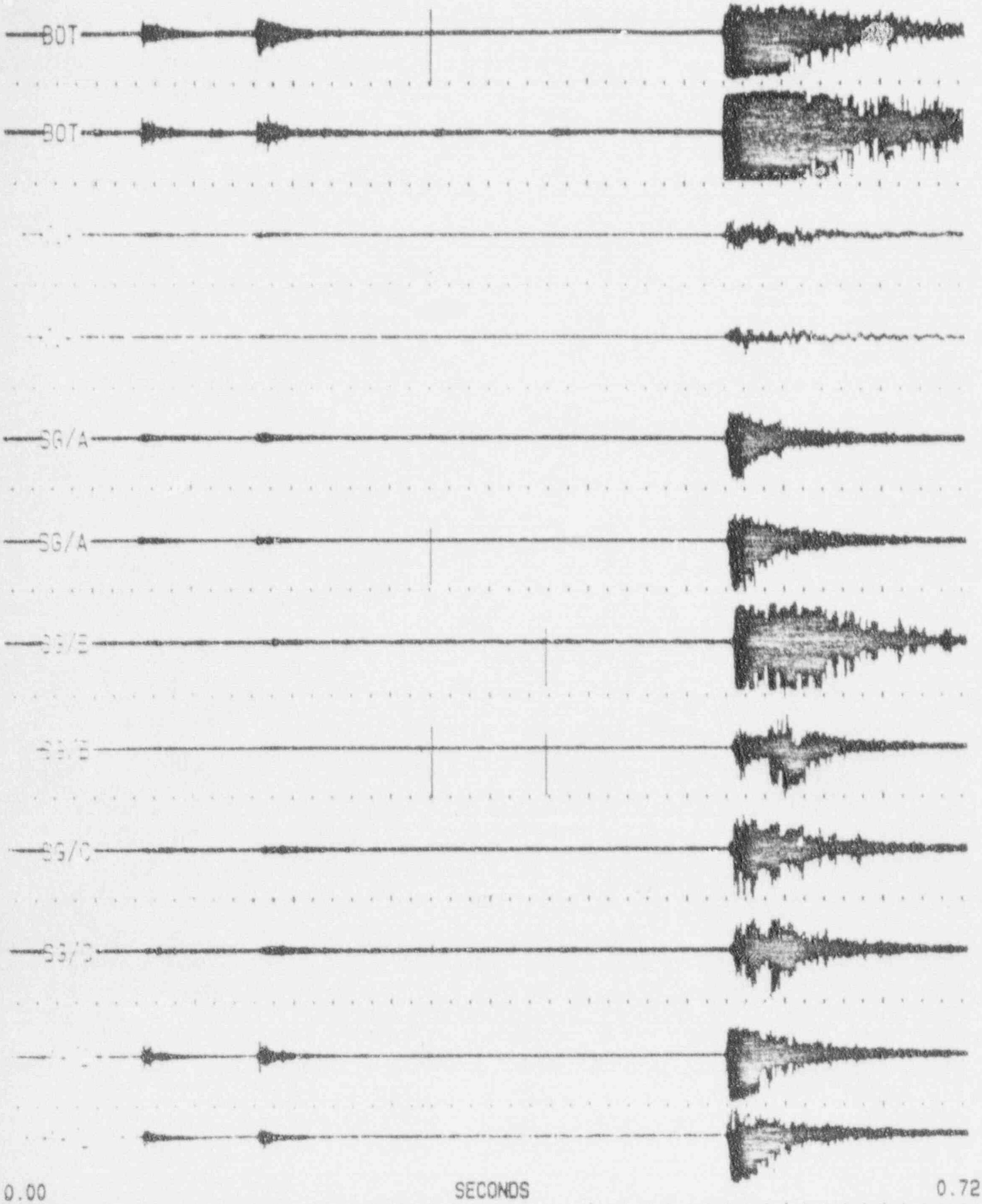
Loose Parts Data Analysis

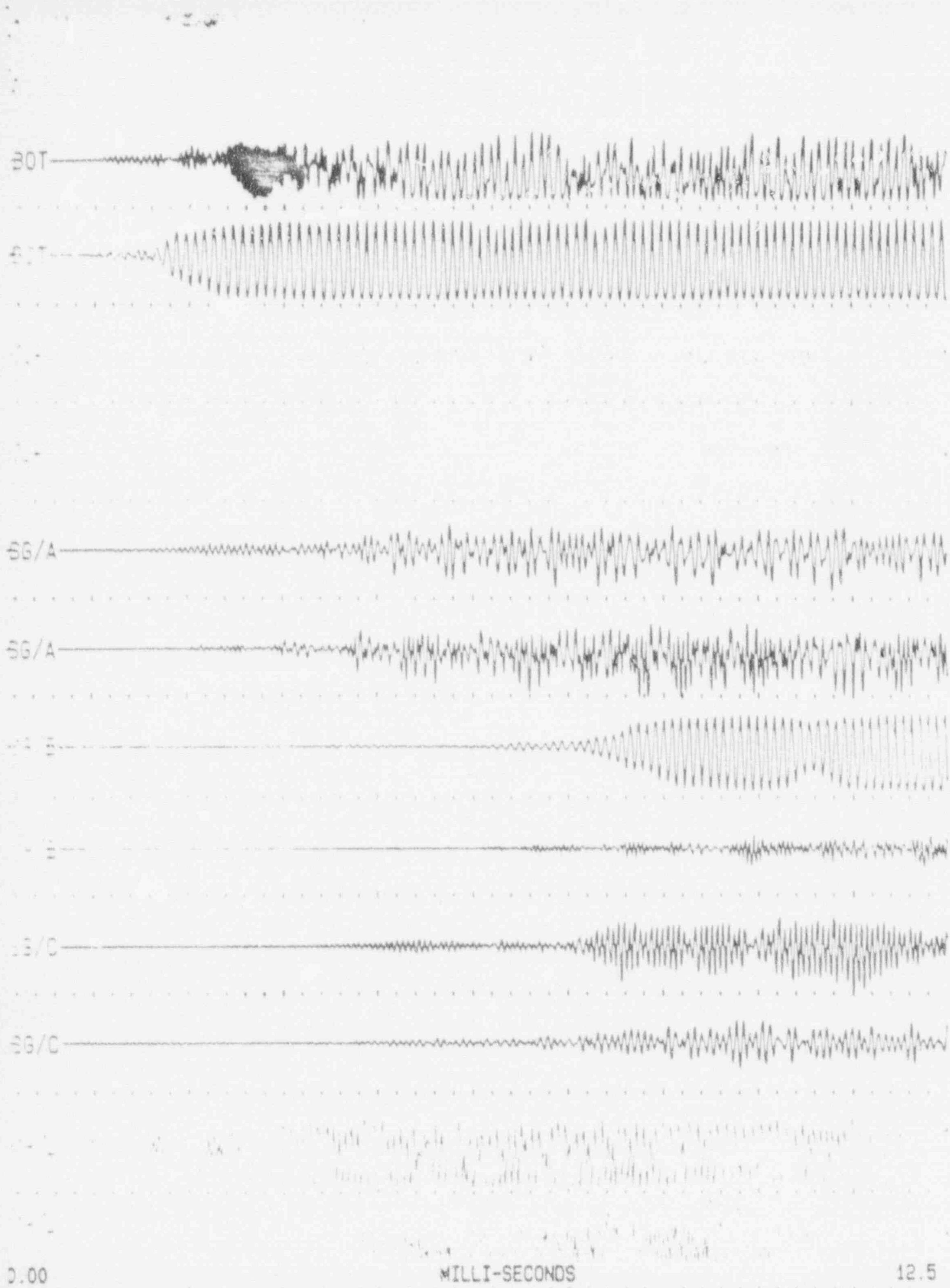
Methods

- Time Delays
- Spectra
- Frequency Band Selection

Equipment

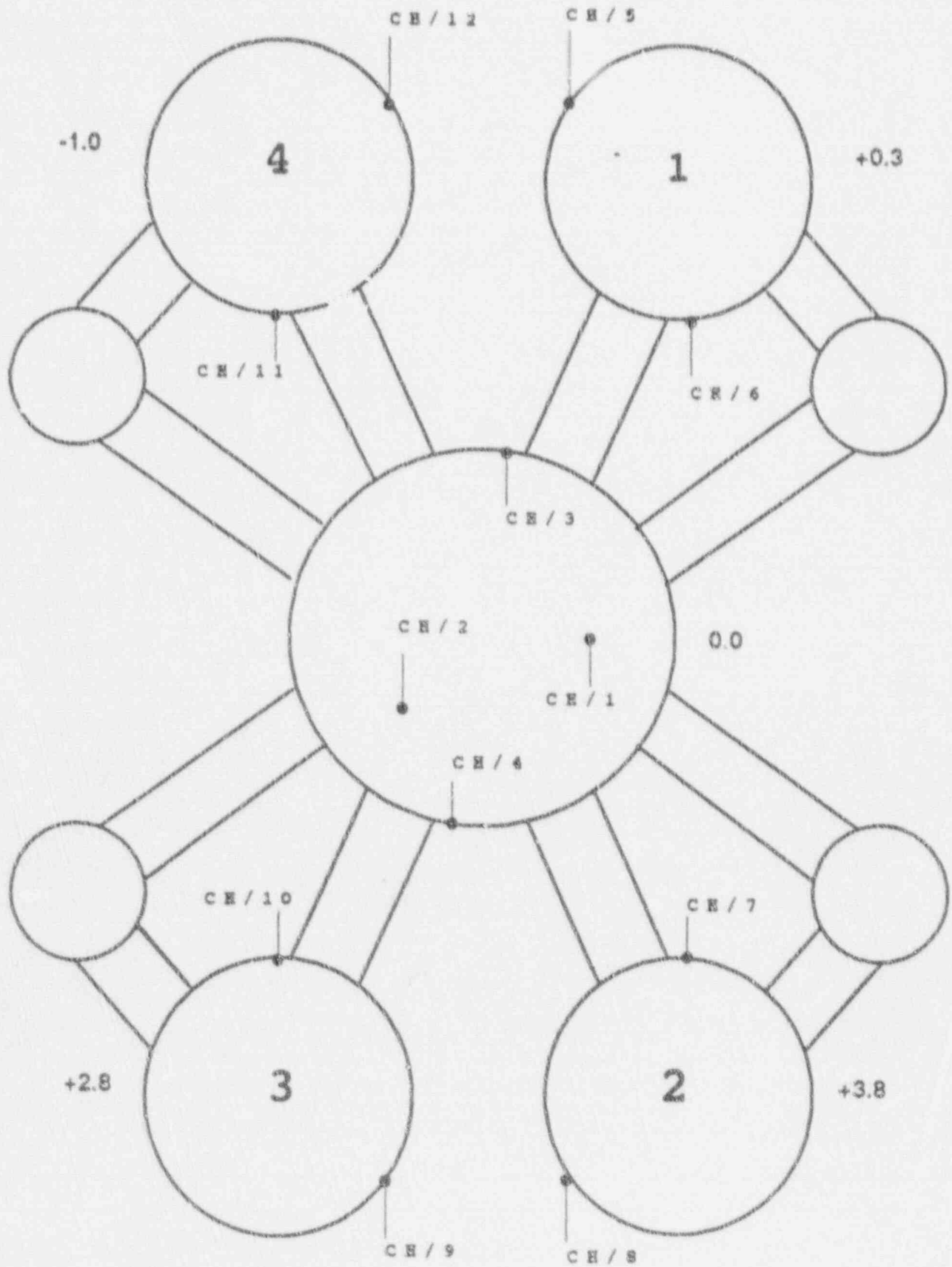
- WCNOC: DADISP Software on PC
- Westinghouse: Analyzer and Visicorder


BOT
BOT
SG/A
SG/A
SG/C
0.00
SECONDS
0.72



BOT
SG/A
SG/A
SG/C
0.00
MILLI-SECONDS
12.5

LPM SENSORS



CH/12
CH/5
-1.0
4
1
+0.3
CH/11
CH/6
CH/3
CH/2
0.0
CH/1
CH/4
CH/10
CH/7
+2.8
3
2
+3.8
CH/9
CH/8

Loose Parts Data Analysis

Concern: Loose Part in Either Reactor Vessel (RV) or Steam Generator (SG)

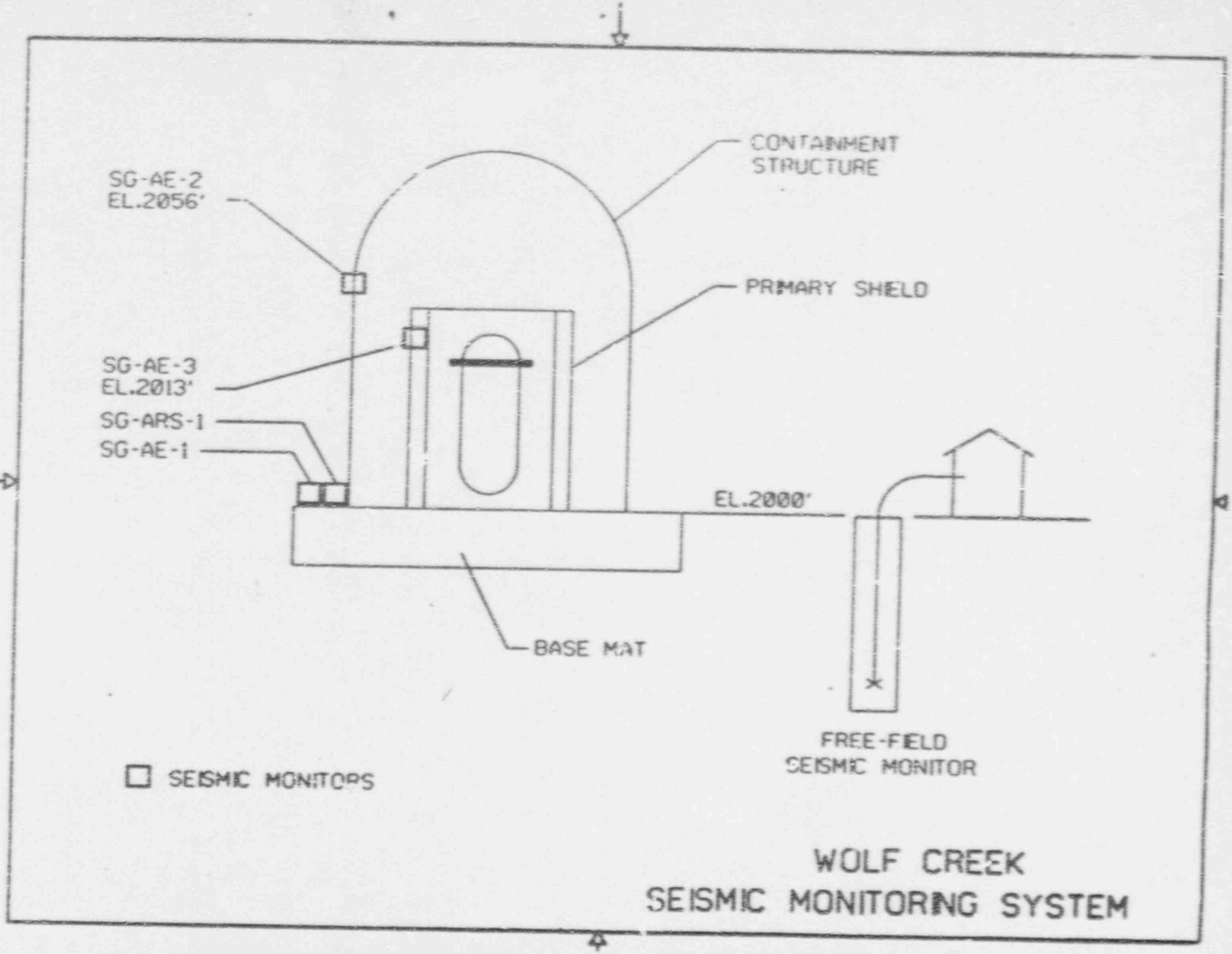
Item	Data	Conclusions	
		RV	SG
Arrival Times	SG D: 1 ms before RV	No	Possible near SG D
Repetition Rate	No Continuous Repetition	No	No
Signal Character	Initial Exponential Rise Often Sustained Constant Amplitude	No	No
Flow Changes	No Big Noise	No	No
Integrity Checks	Incore Detector Movement - Normal Control Rod Movement - Normal 9 HZ ~ Core Barrel <u>Normal</u> Frequency (On Accelerometers)	No	—

Loose Parts Data Analysis

Conclusion

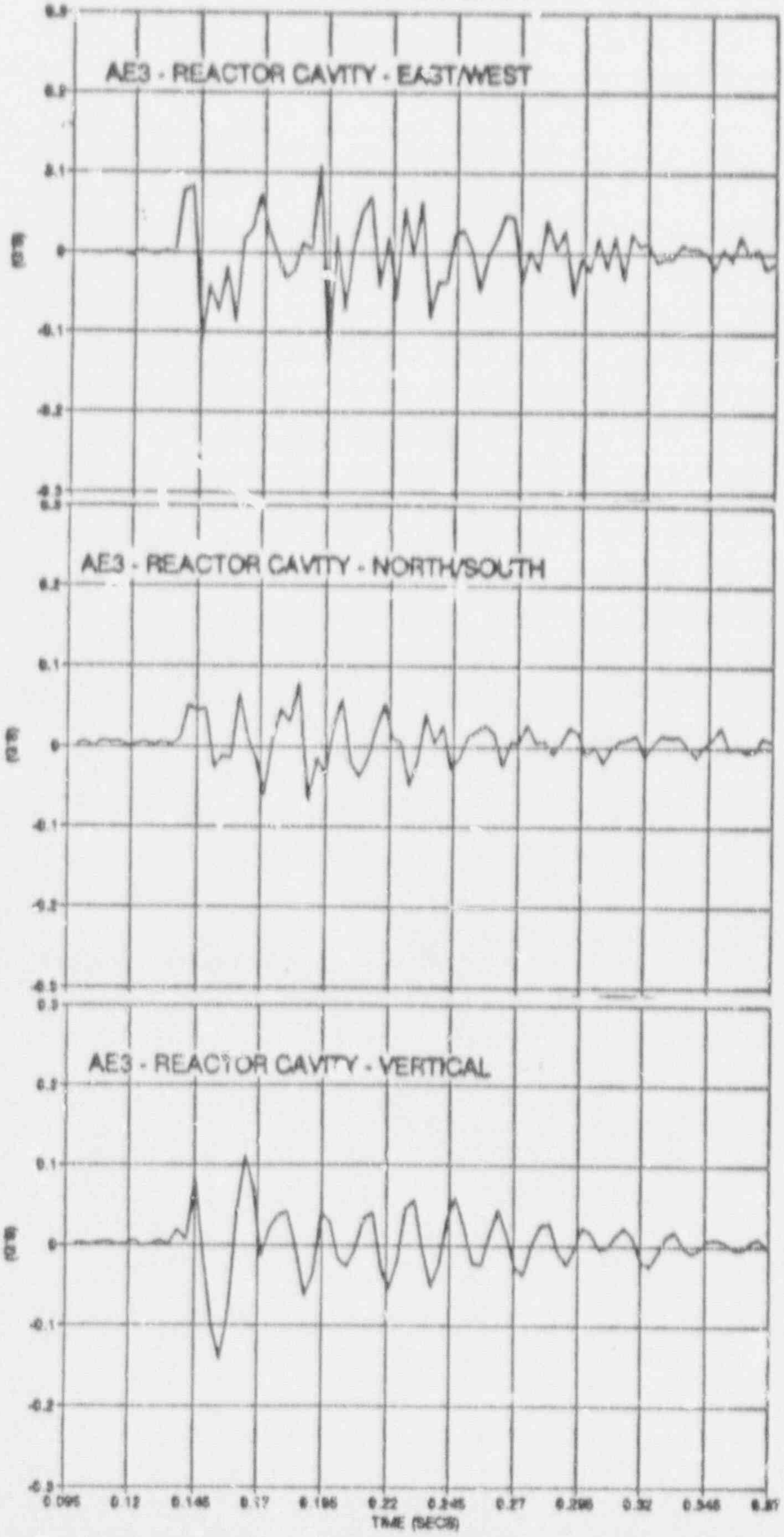
- No Loose Parts in Reactor Vessel or Steam Generators
  - Timing
  - Repetition Rate
  - Signal Character
  - Initiation Mechanism
  - Integrity Checks
- Timing Traces Suggest 3/92 Event Initiated in Reactor Coolant Loop 4

SEISMIC INSTRUMENTATION DATA


CONTAINMENT
STRUCTURE
SG-AE-2
EL.2056'
PRIMARY SHIELD
SG-AE-3
EL.2013'
SG-ARS-1
SG-AE-1
EL.2000'
BASE MAT
FREE-FIELD
SEISMIC MONITOR
SEISMIC MONITORS
WOLF CREEK
SEISMIC MONITORING SYSTEM

DIRECTION OF INITIAL DISPLACEMENT

MARCH EVENT



SUMMARY OF

SEISMIC INSTRUMENTATION

RESPONSE

TRIAXIAL ACCELEROMETERS:

REACTOR CAVITY

	MAR.16	FEB 28	JAN 9
VERT.			
PEAK "Gs"	.16	.16	.22
EST. DISPL. (mils)	.4	.8	1
E/W			
PEAK "Gs"	.135	.25	.22
EST. DISPL (mils)	.5	1	1
N/S			
PEAK "Gs"	.08	.16	.11
EST. DISPL (mils)	.2	.9	2

SUMMARY OF

SEISMIC INSTRUMENTATION

RESPONSE

	MAR.16	FEB 28	JAN 9
TRIAXIAL ACCELEROMETERS:			
<u>CONTAINMENT BASEMAT</u>			
VERT.			
PEAK "Gs"	.015	.004	.005
EST. DISPL. (mils)	.2	.05	.1
E/W			
PEAK "Gs"	.029	.026	.013
EST. DISPL. (mils)	.3	.4	.3
N/S			
PEAK "Gs"	.018	.008	.015
EST. DISPL (mils)	.05	.04	.1

SUMMARY OF

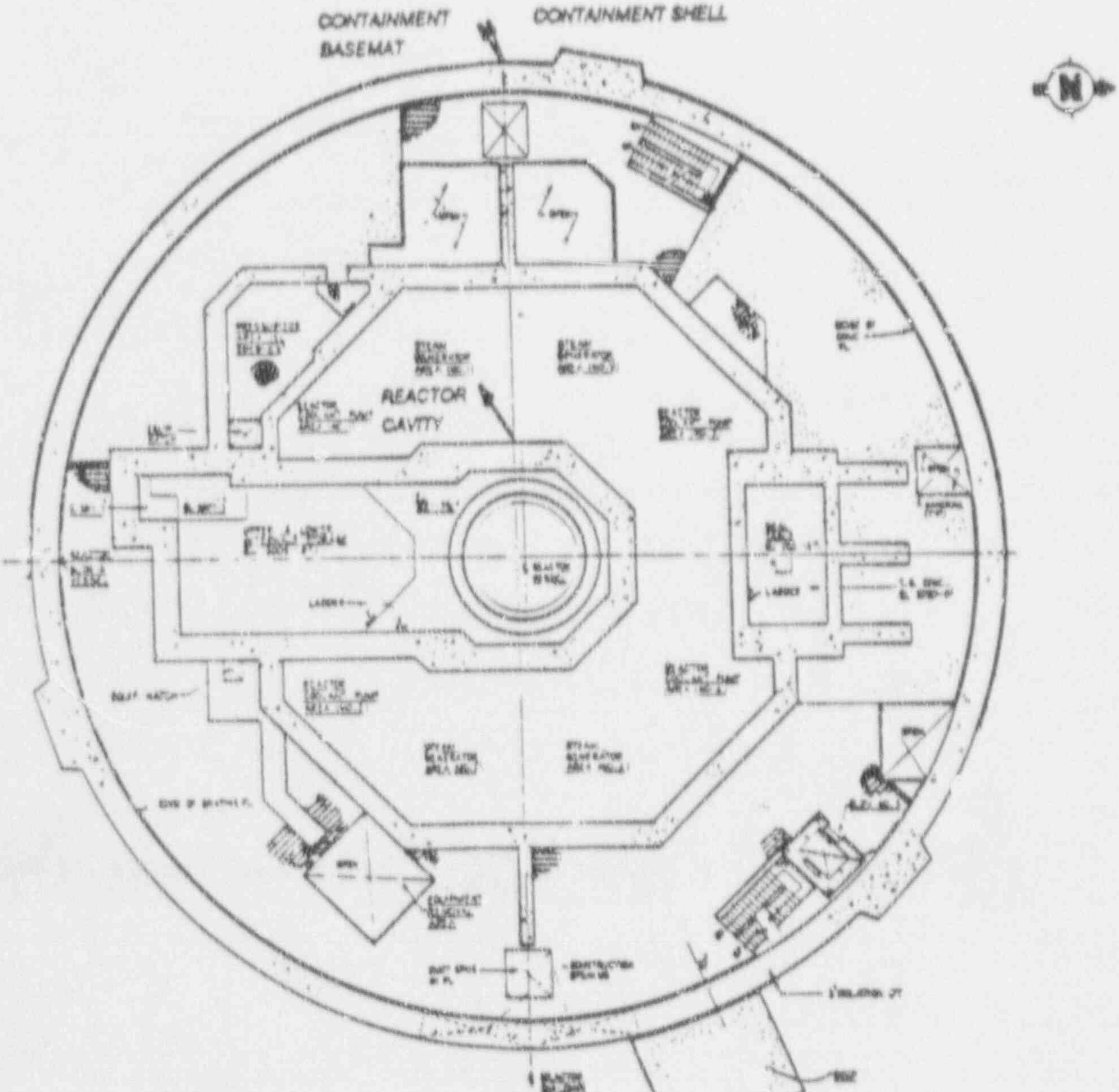
SEISMIC INSTRUMENTATION

RESPONSE

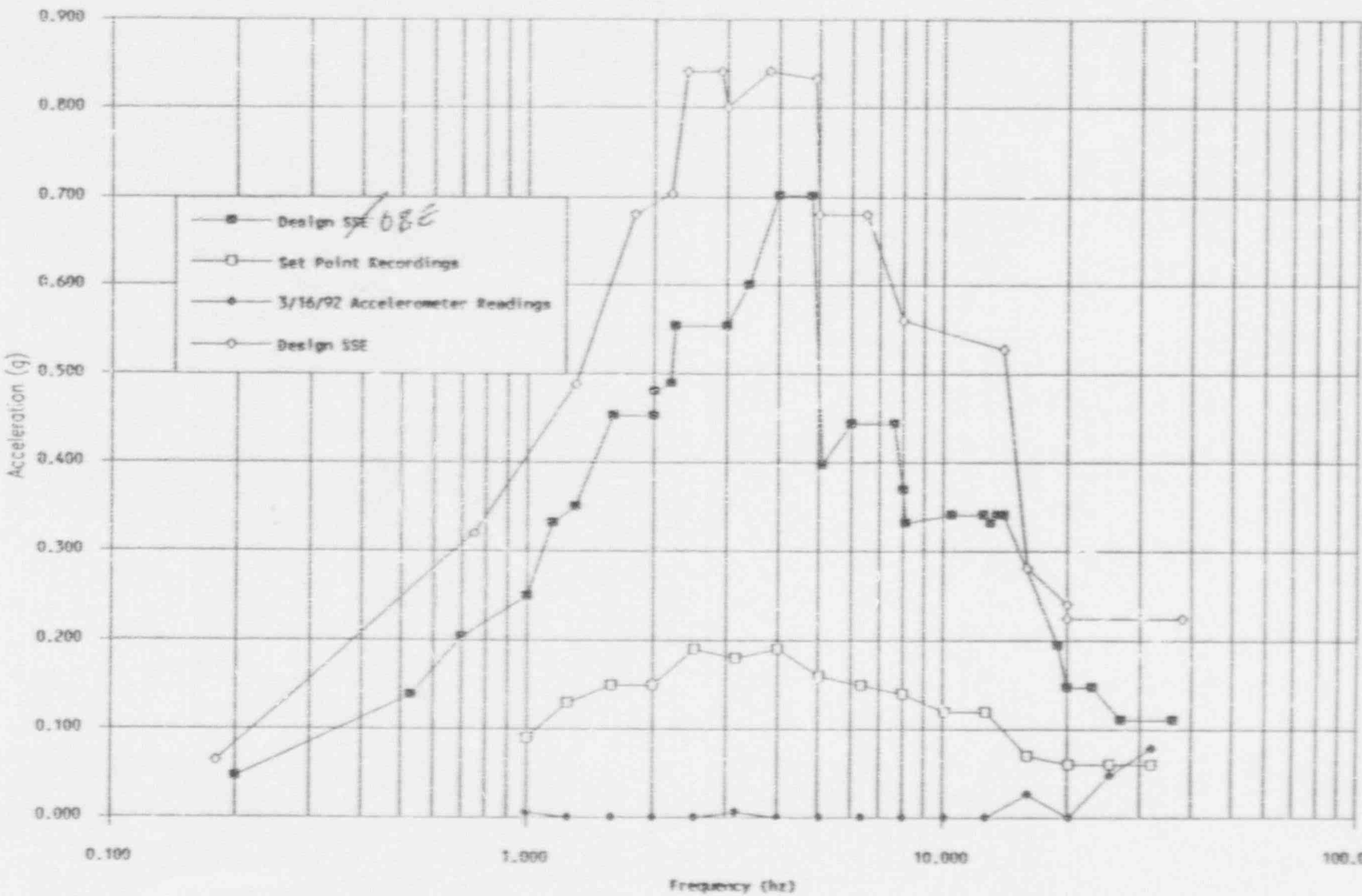
	MAR.16	FEB 28	JAN 9
TRIAXIAL ACCELEROMETERS:			
<u>CONTAINMENT SHELL</u>			
VERT.			
PEAK "Gs"	.015	.017	.012
EST. DISPL. (mils)	.6	.4	.3
E/W			
PEAK "Gs"	.027	.049	.02
EST. DISPL. (mils)	.3	.5	.3
N/S			
PEAK "Gs"	.011	.011	.009
EST. DISPL (mils)	.1	.2	.03

DIRECTION OF INITIAL DISPLACEMENT

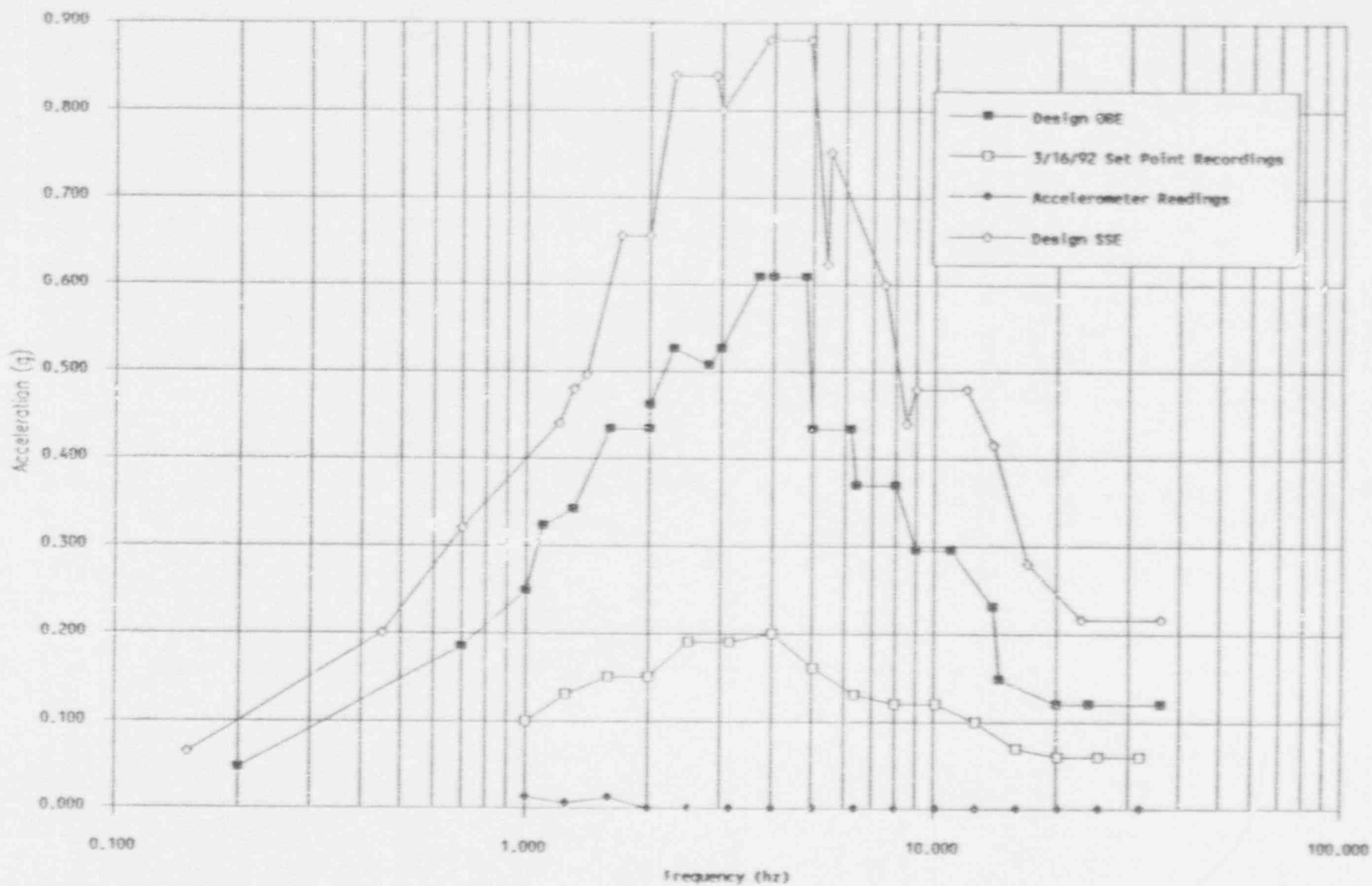
MARCH EVENT



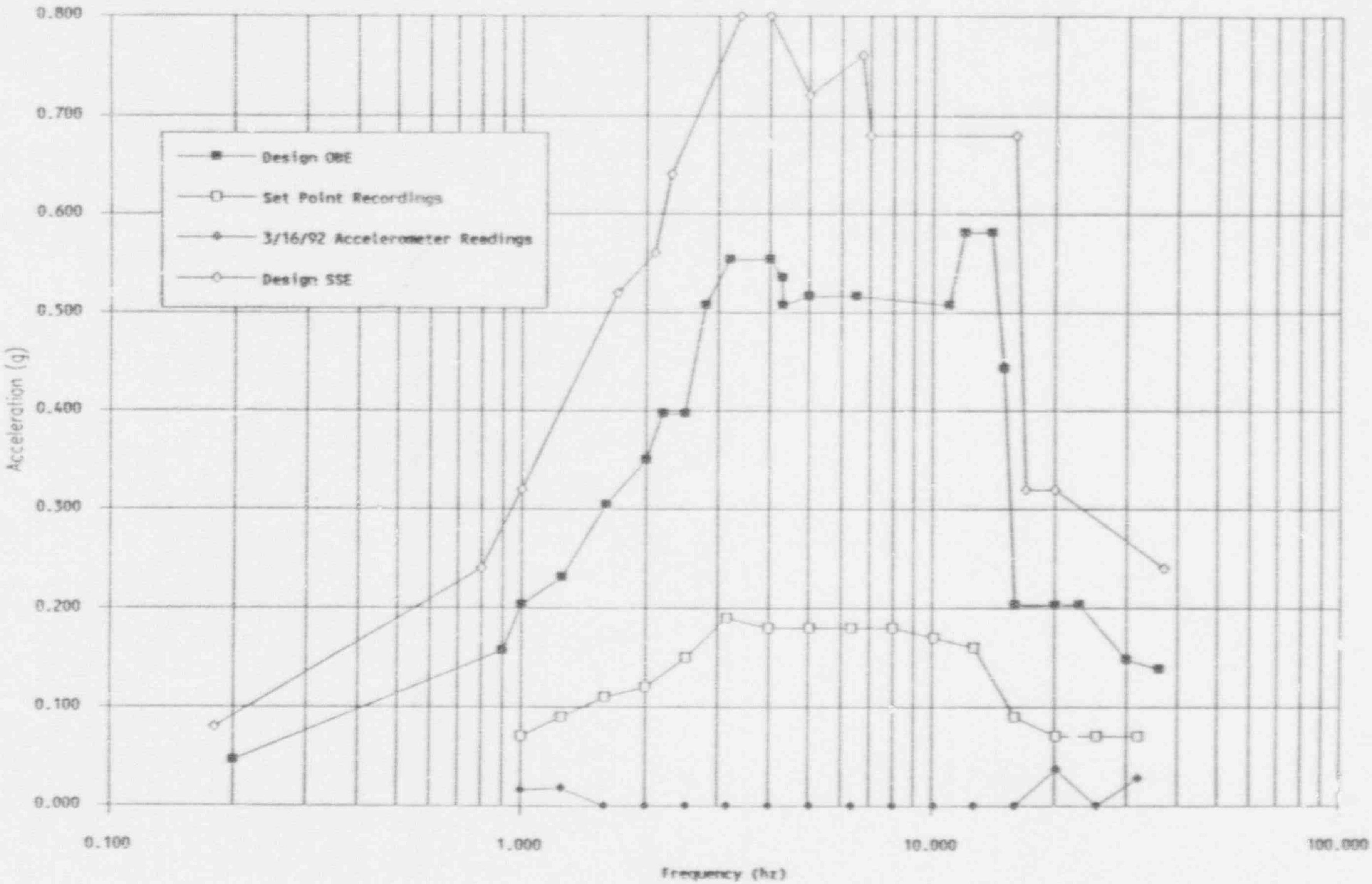
COMPARISON OF DESIGN RESPONSE SPECTRA WITH RECORDED DATA - E/W DIRECTION - EL. 2000



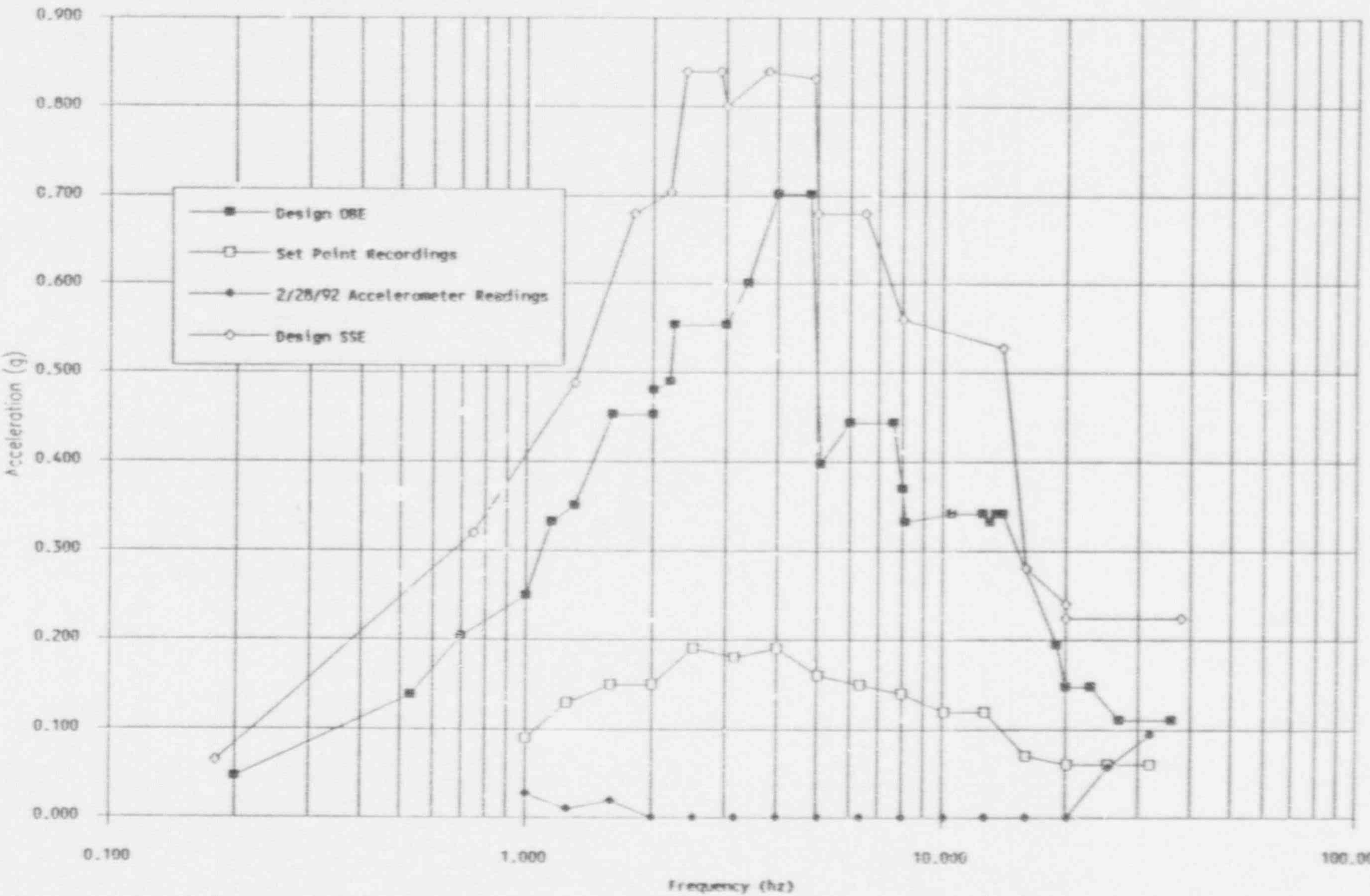
COMPARISON OF DESIGN RESPONSE SPECTRA WITH RECORDED DATA - N/S DIRECTION - EL. 2000



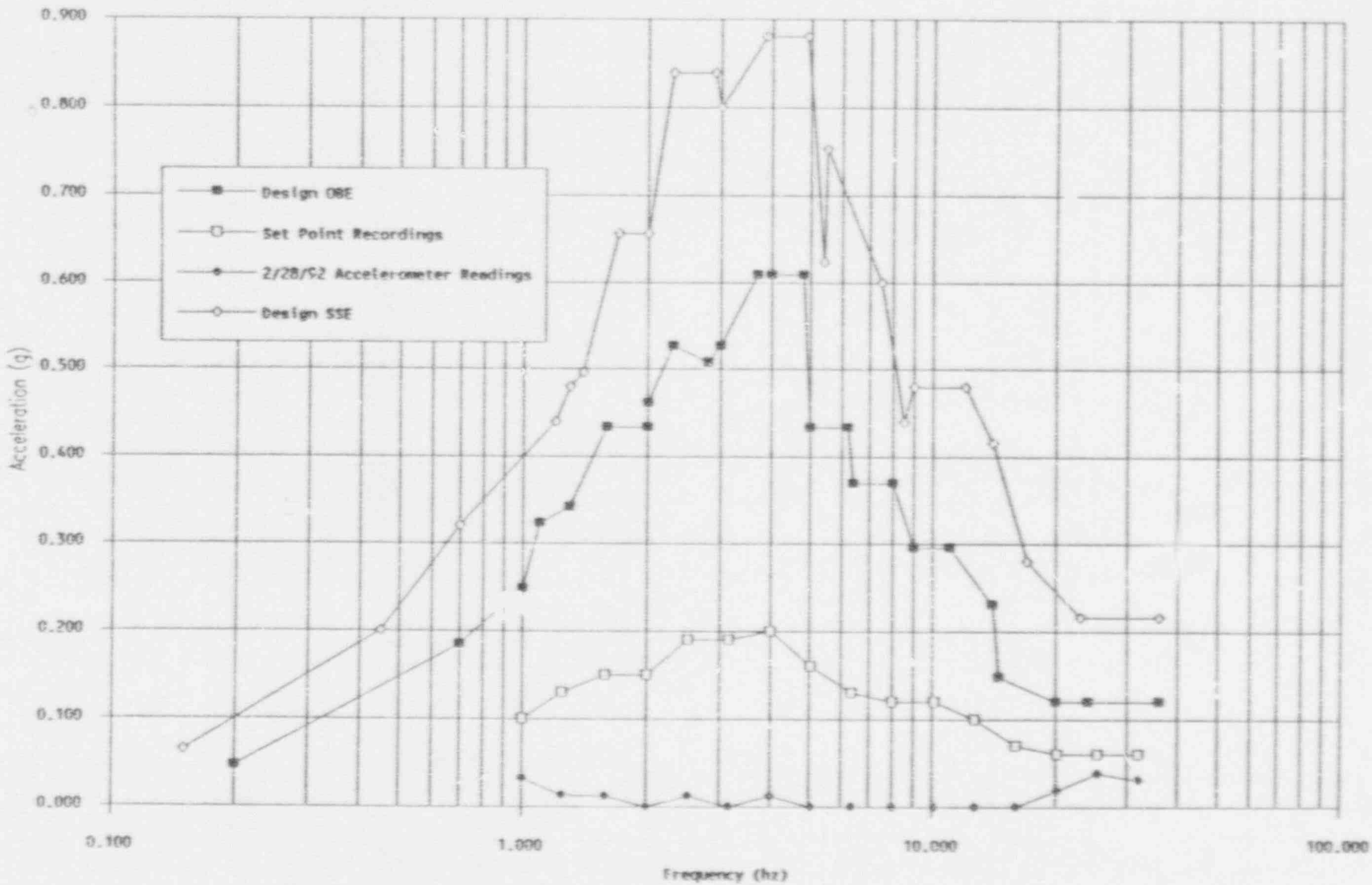
COMPARISON OF DESIGN RESPONSE SPECTRA WITH RECORDED DATA - VERTICAL DIRECTION - EL. 2000



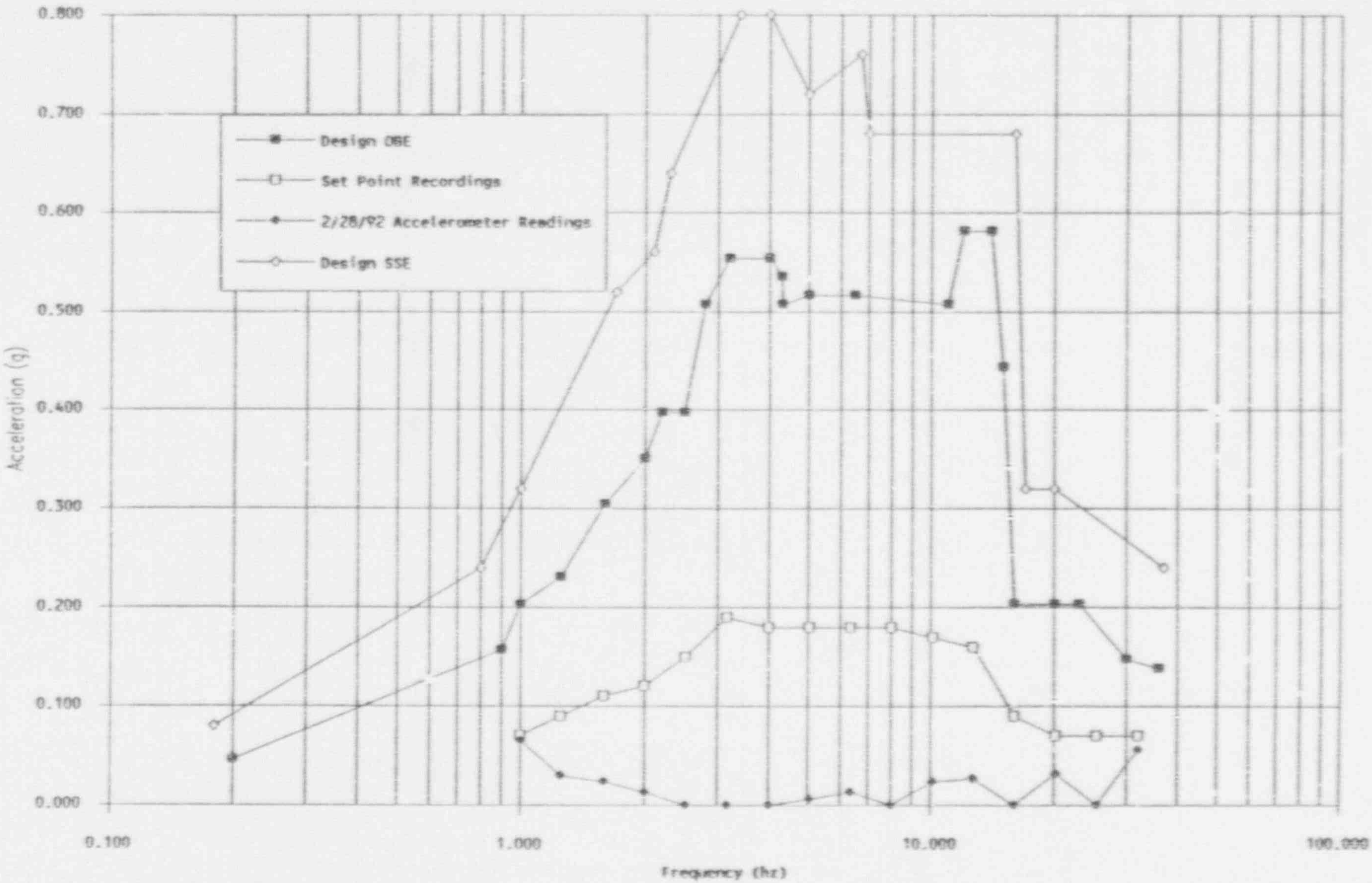
COMPARISON OF DESIGN RESPONSE SPECTRA WITH RECORDED DATA - E/W DIRECTION - EL. 2000



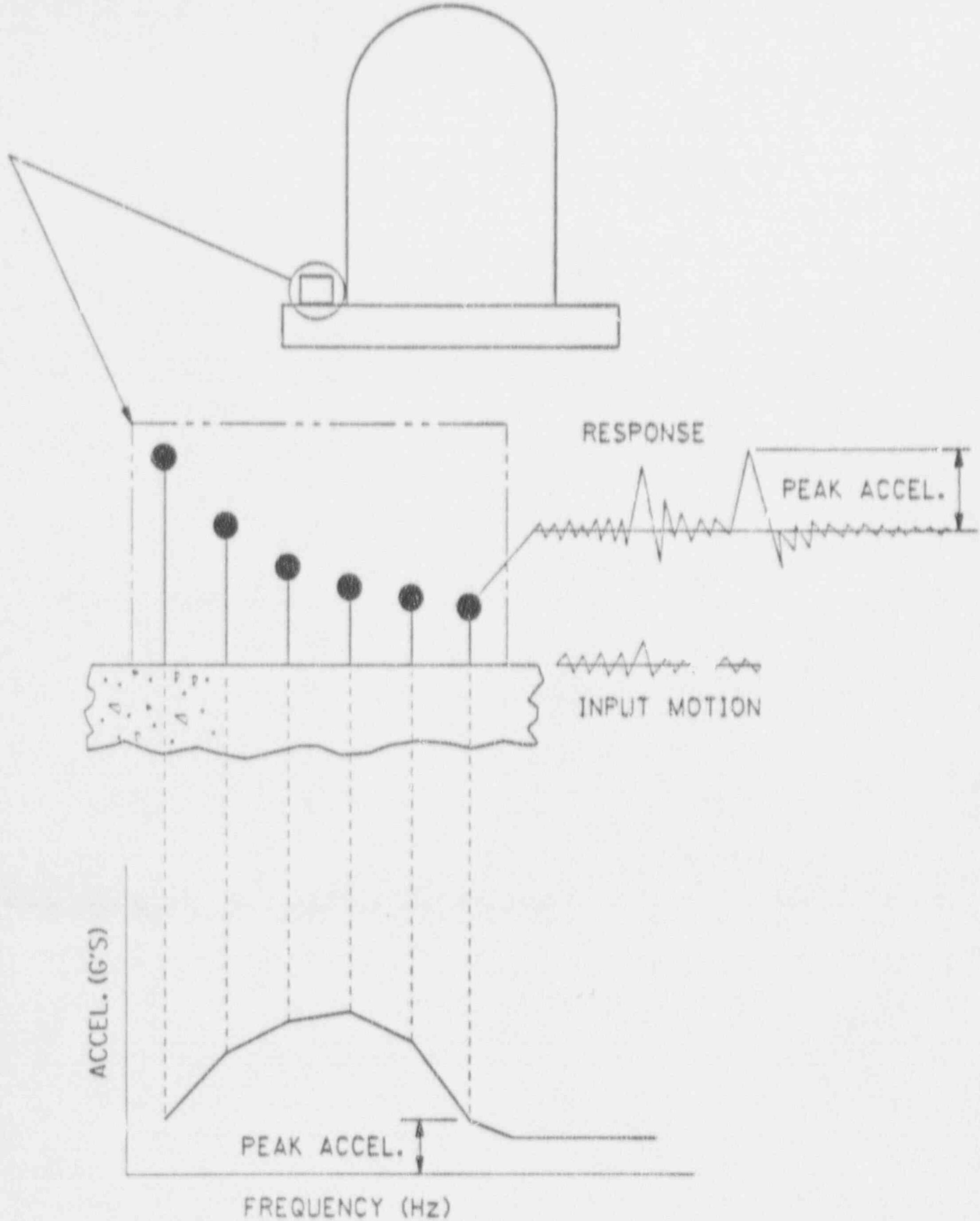
COMPARISON OF DESIGN RESPONSE SPECTRA WITH RECORDED DATA - N/S DIRECTION - EL. 2000



COMPARISON OF DESIGN RESPONSE SPECTPA WITH RECORDED DATA - VERTICAL DIRECTION - EL. 2000



RESPONSE SPECTRA BEHAVIOR



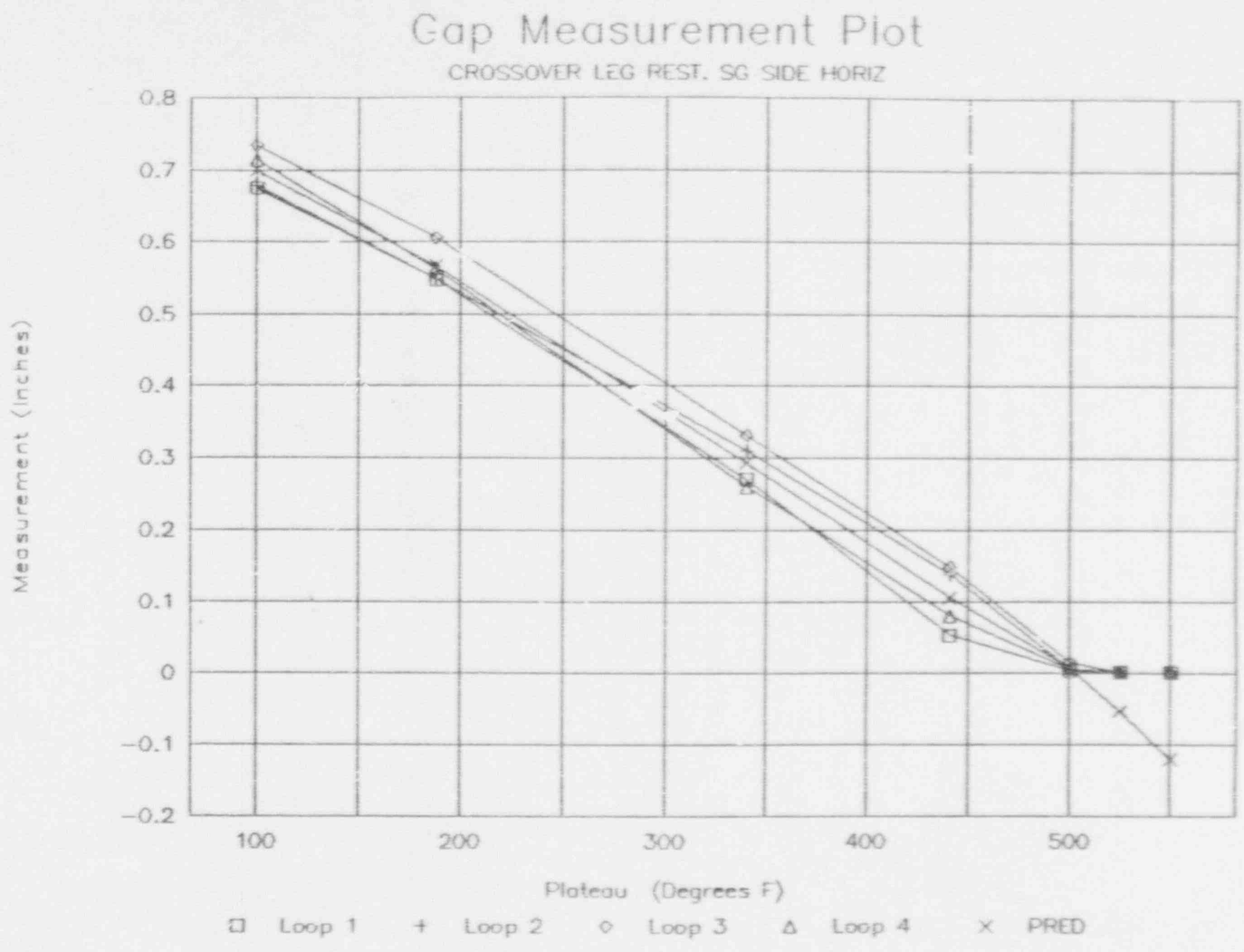
CONCLUSIONS

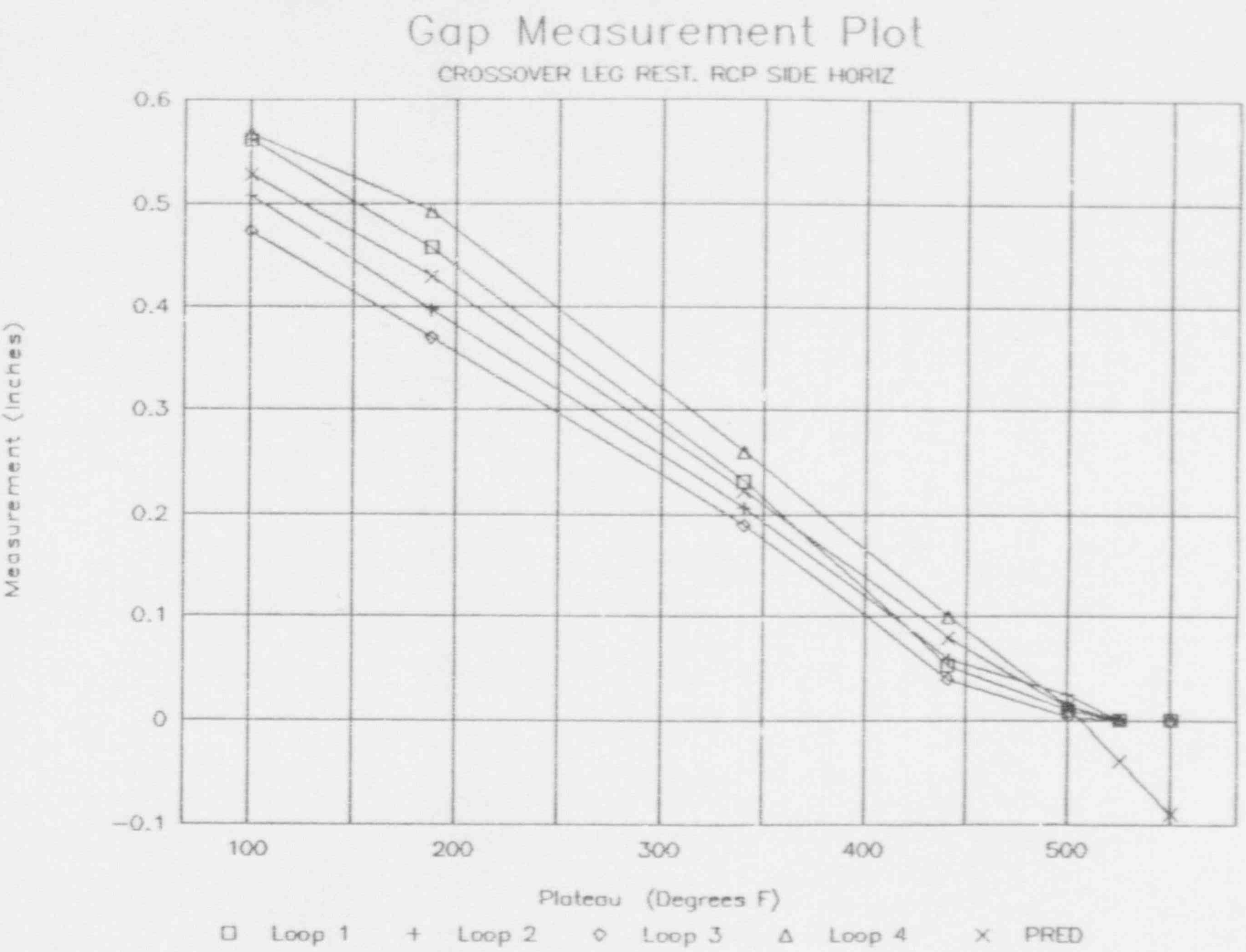
- LOADS PRIMARILY TRANSMITTED TO THE SHIELD WALL

- INITIAL MOVEMENT TOWARD WEST-SOUTHWEST

- NO STRUCTURAL DISTRESS IS INDICATED

Thermal Growth Mechanism

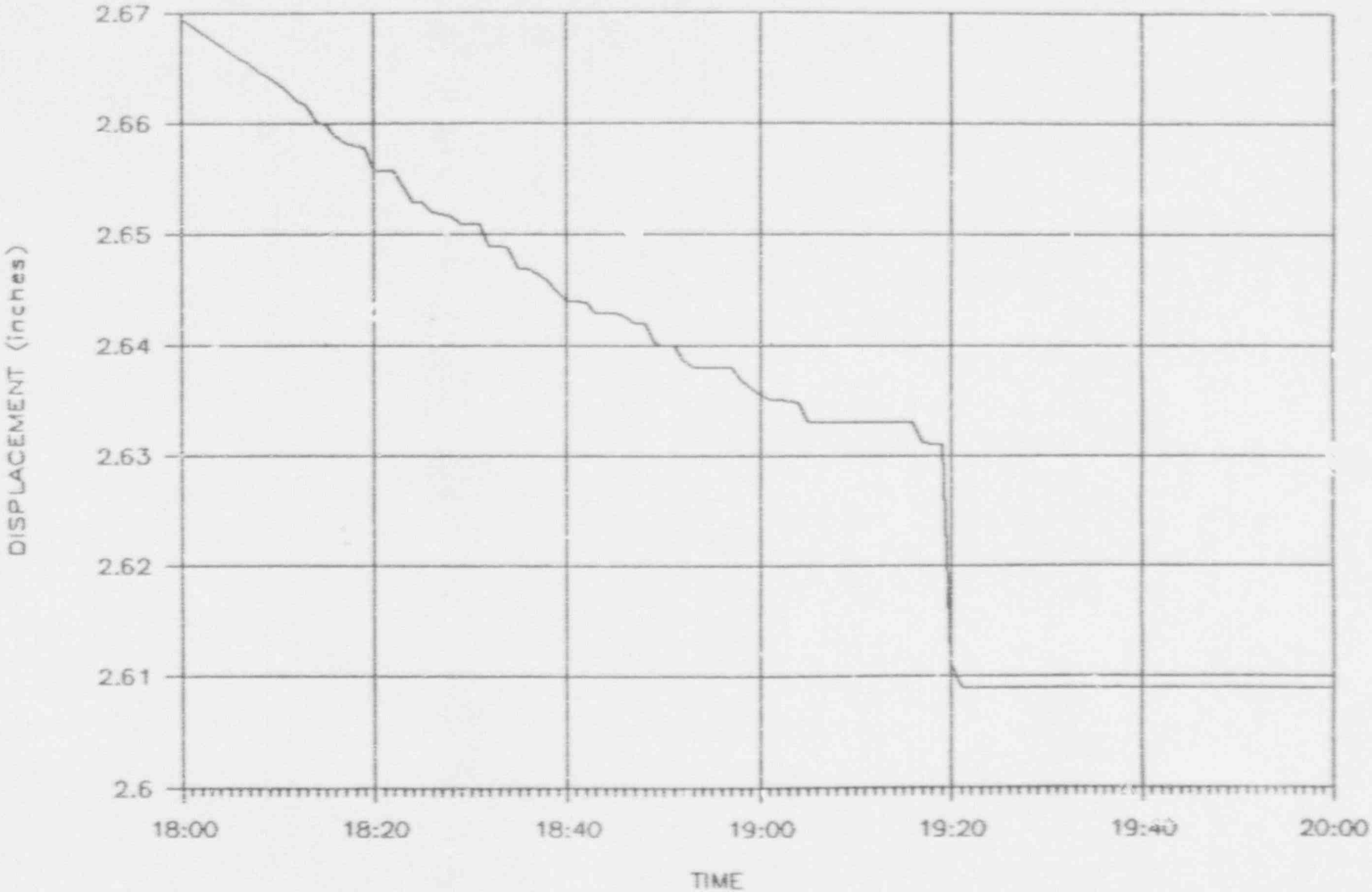

Gap Measurement Plot
CROSSOVER LEG REST. SG SIDE HORIZ
Measurement (Inches)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
-0.2
100
200
300
400
500
Plateau (Degrees F)
□ Loop 1
+ Loop 2
◇ Loop 3
△ Loop 4
× PRED

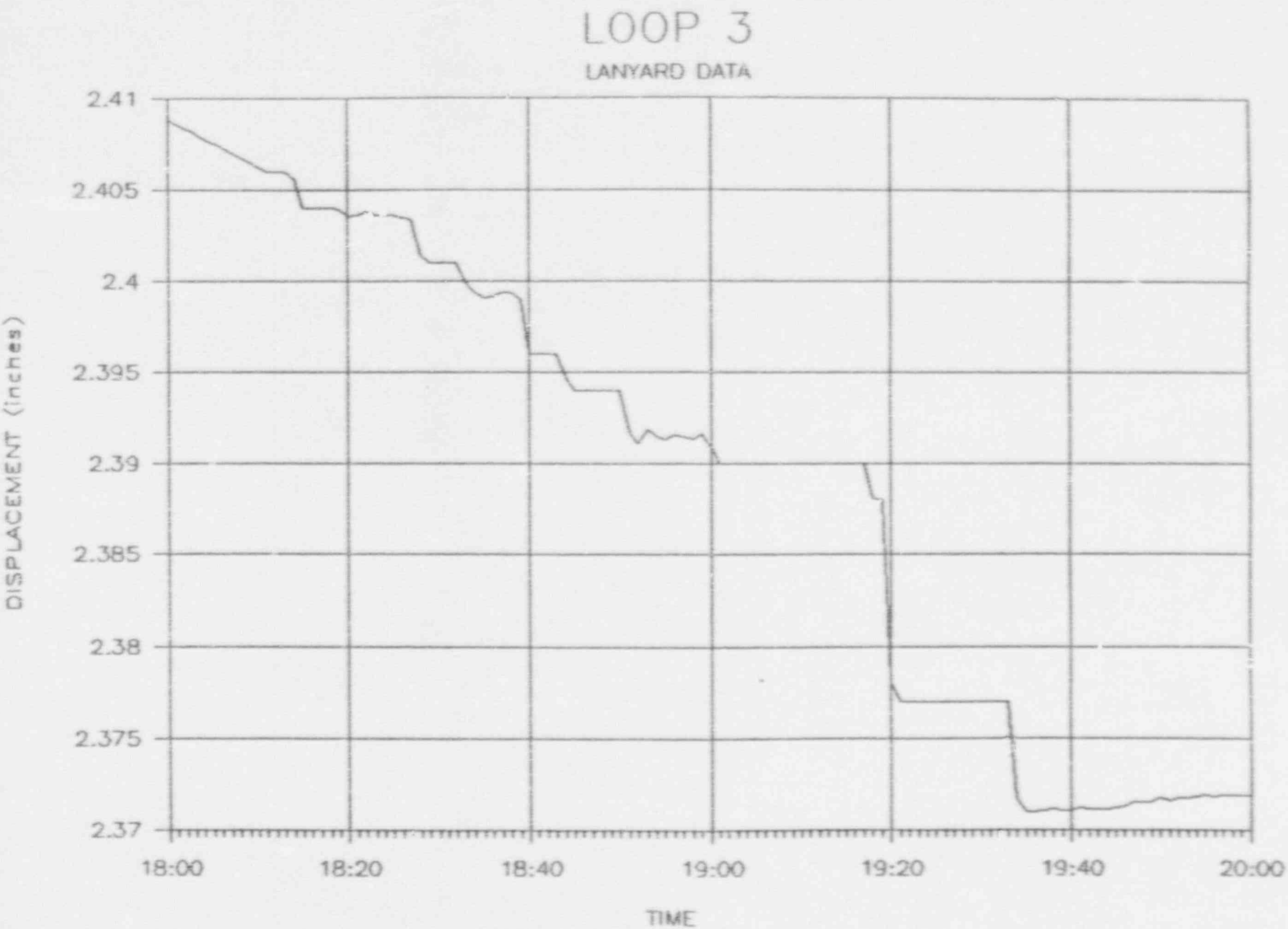


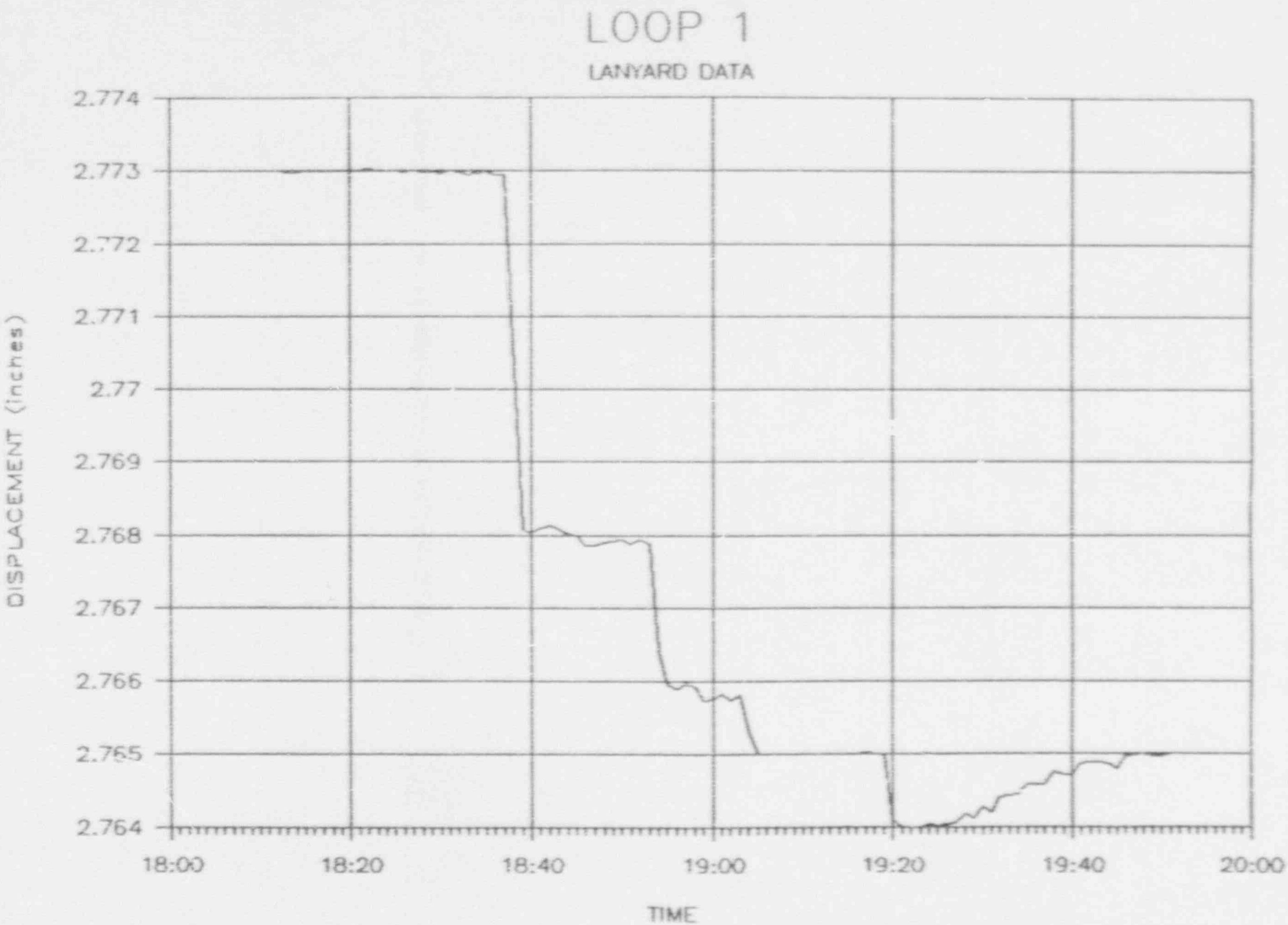
Gap Measurement Plot
CROSSOVER LEG REST. RCP SIDE HORIZ
Measurement (Inches)
0.6
0.5
0.4
0.3
0.2
0.1
0
-0.1
100
200
300
400
500
Plateau (Degrees F)
□ Loop 1
+ Loop 2
◇ Loop 3
△ Loop 4
× PRED

LOOP 2

LANYARD DATA

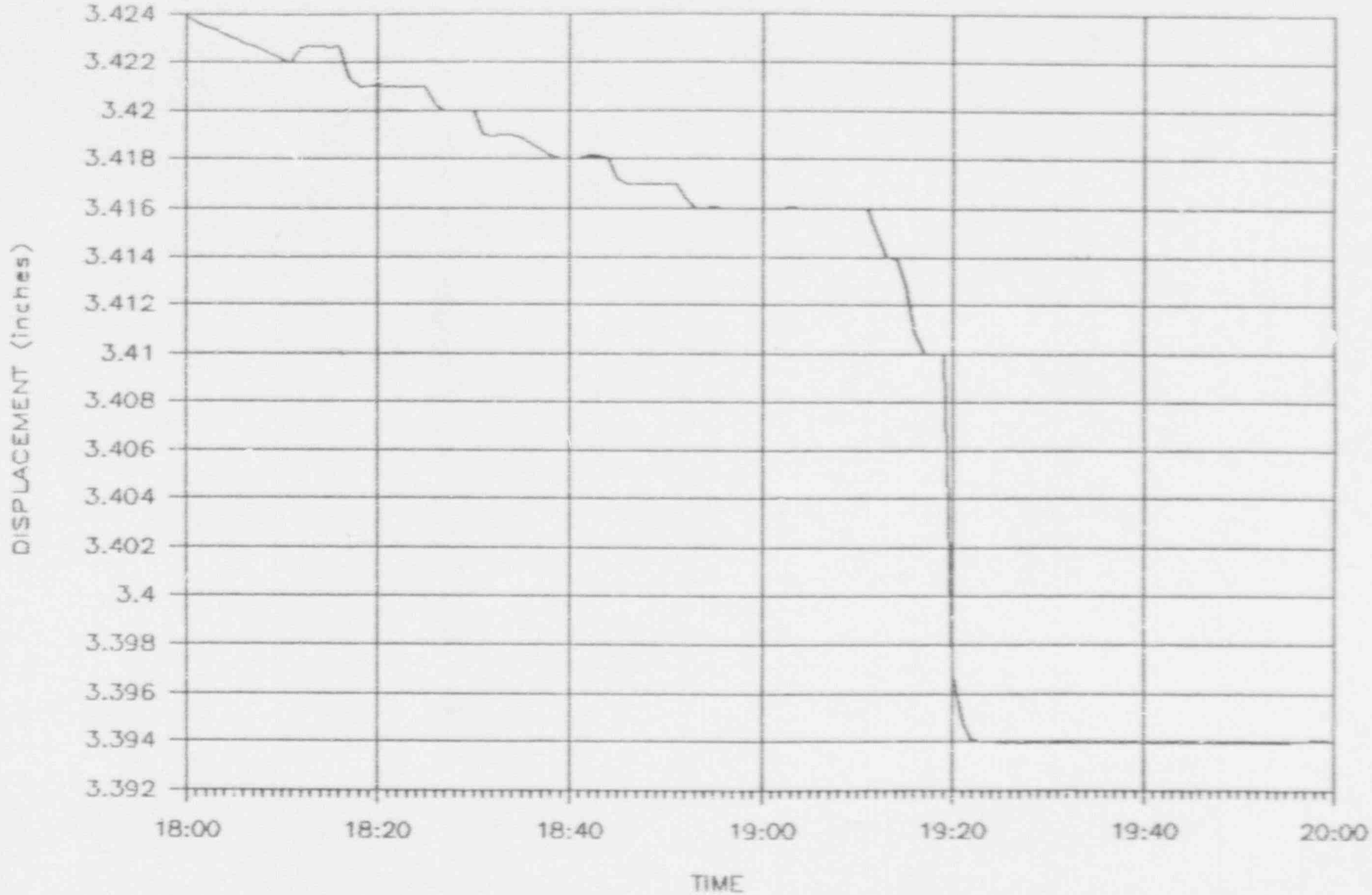



LOOP 3
LANYARD DATA
DISPLACEMENT (inches)
2.41
2.405
2.4
2.395
2.39
2.385
2.38
2.375
2.37
18:00
18:20
18:40
19:00
19:20
19:40
20:00
TIME


LOOP 1
LANYARD DATA
DISPLACEMENT (inches)
2.774
2.773
2.772
2.771
2.77
2.769
2.768
2.767
2.766
2.765
2.764
18:00
18:20
18:40
19:00
19:20
19:40
20:00
TIME

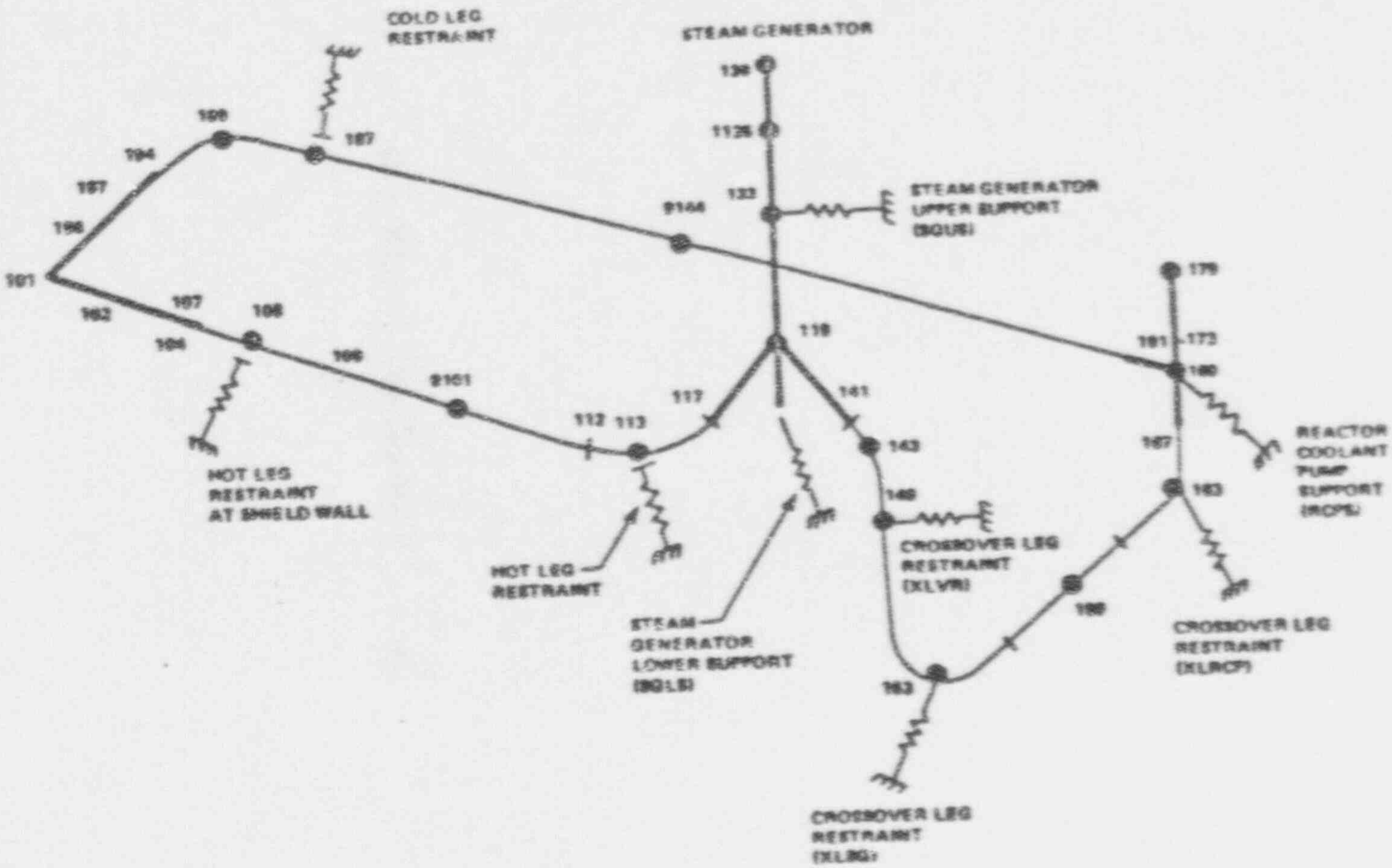
LOOP 4

LANYARD DATA



RCS Integrity Evaluation

- Piecewise Linear Thermal Expansion Analysis
- RCL Snapping Analysis for Potential Energy Release
- Accumulator Line Check Valve Testing Hydraulic Loads
- Reshimming of Crossover Leg Bumpers
- Over Temperature Transients and RCS Integrity
- Primary Equipment Support Qualification
- Fatigue Analysis
- Primary Equipment Nozzle Loads



Reactor Coolant Loop Model

Piecewise Linear Thermal

Expansion Analysis

- Wolf Creek RCL Model Update
- Gaps at 440°F Plateau as Initial Condition
- One Thermal Expansion Analysis Performed Between each Temperature Plateau
- Gaps were Closed as Appropriate for the Next Plateau
- Pipe Stresses Meet ASME Code Allowable
- Support Loads are Less than Allowable
- Equipment Nozzle Loads within Umbrella Loads
- Cumulative Fatigue Usage Factor Including Past Events Less than 1.0

RCL Snapping Analysis for Potential Energy Release

- Crossover Leg Bumper Gaps Determined by Field Data
- Conservative Engineering Calculation Performed
- RCL Piping can Withstand at Least Twenty-Five Cycles of Snapping Loads

Accumulator Line Check Valve Testing
Hydraulic Loads

- Unit Axial Load
- Evaluation Performed up to Double Ended Break
- RCL Stresses Meet All Code Allowables
- Based on the Very Low RCL Stresses, these Hydraulic Loads Cannot Move RPV
- The Accumulator Line and Supports Should be Damaged, Would the Loads Really be that High
- Accumulator Line Cannot Transmit More than the Upper Bound Hinge Moment

Reshimming of Crossover Leg Bumpers

- Not Required by RCL Stresses
- Good Practice to Avoid Acceptable Interferences
- Shim Sizes Determined at Hot Standby Measurements
- A Hot Gap will be Maintained in Future Operation

Over Temperature Transients and RCL Integrity

- Over Temperature Transients are Part of the Design Basis Which Cause Restrained RCS Expansion

- Wolf Creek RCL Experienced Restrained RCS Expansion at Crossover Leg Bumpers Before Normal Operating Temperature (NOT)

- Wolf Creek did not Experience Significant Over Temperature Transient in Past Operation

- No Hard Contact at Crossover Leg Bumper at NOT After Reshimming

- All Past Occurrences Conservatively Analyzed and all code Requirements are Met

Primary Equipment Support Qualification

- No Hard Contact up to 525°F
- Crossover Leg Bumpers Return to Design Configuration
- Loads in Tie Rods within Level B Allowable
- Loadings in all other RCL Supports Reconciled

RCP Front Tie Rod Loads (KIPS)

Temperature (°F)	Load (KIPS)
525	0
557	668
NOT	614
Over Temperature	459
OBE	245
Total	1318
Level B Limit	1385
Level D Limit	2000

Fatigue Analysis

- Reference Fatigue Analysis use Conservative Enveloping Loads

- Hot Leg Stress Changes are Insignificant

- Maximum $\Sigma U = 0.2$ in Crossover Leg and 0.45 in Cold Leg

- Cumulative Usage Factor Recalculated and Meets ASME Code Requirements Including Past Interferences and Over Temperature Transients

Primary Equipment Nozzle Loads

- Existing Margin
- Additional Loads Due to Crossover Leg Bumper Plate and Saddle Contact at 525°F
- No Over Temperature Transient (23°F)
- Little Net Impact on Equipment Nozzle Loads
- Primary Equipment Nozzle Loads are Acceptable

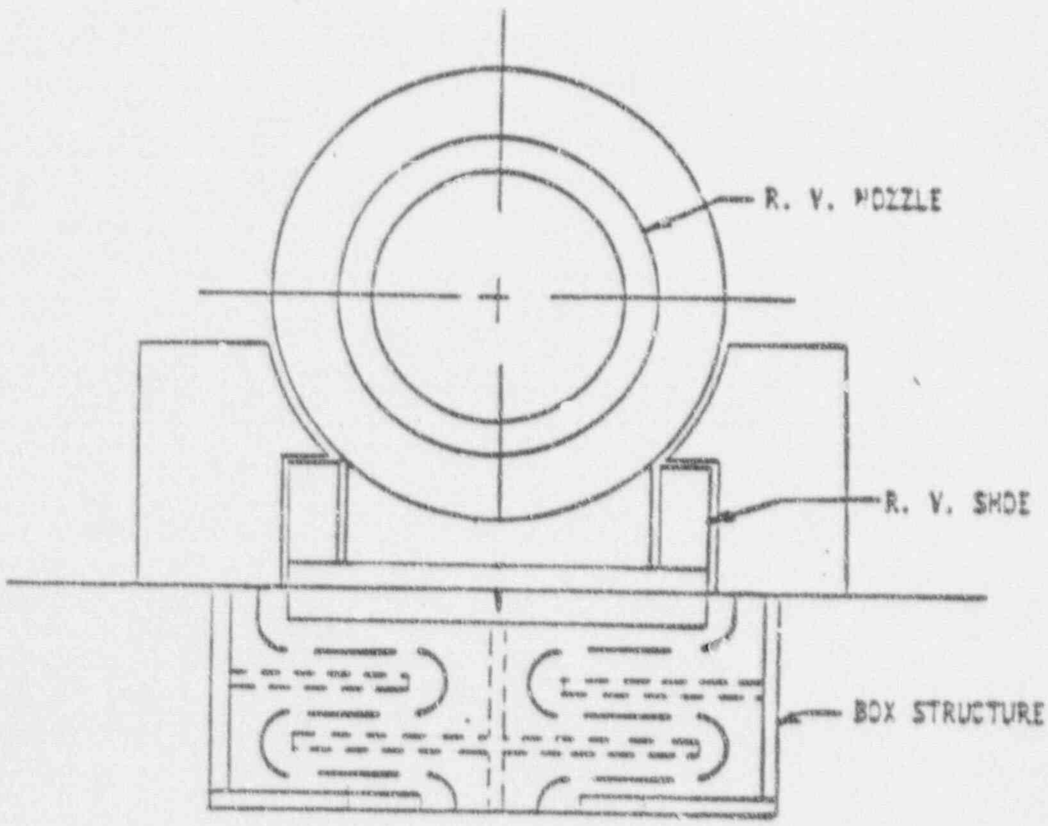
Ther..ıal-Hydraulic Mechanisms

Thermal Hydraulic Issue

Scope of Evaluation

1.) Can accumulator piping physically move the RCS causing future heatups to bind?

2.) Is a thermal hydraulic transient in the accumulator the cause of the event?



REACTOR VESSEL SUPPORT

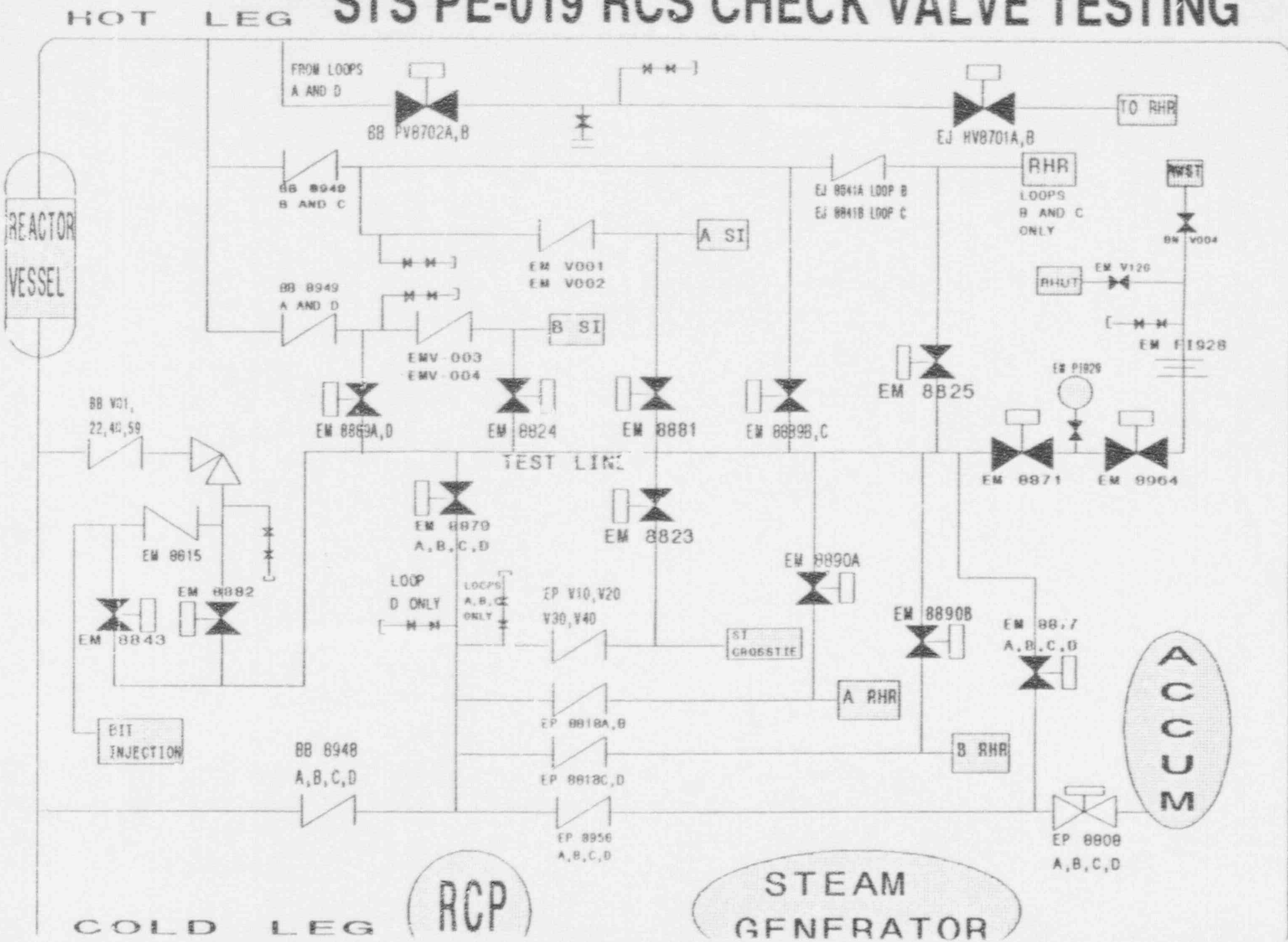
Facts Related To Check Valve Testing

Accumulator Piping Layout

Check Valve Testing Sequence

Research/Special Test Results

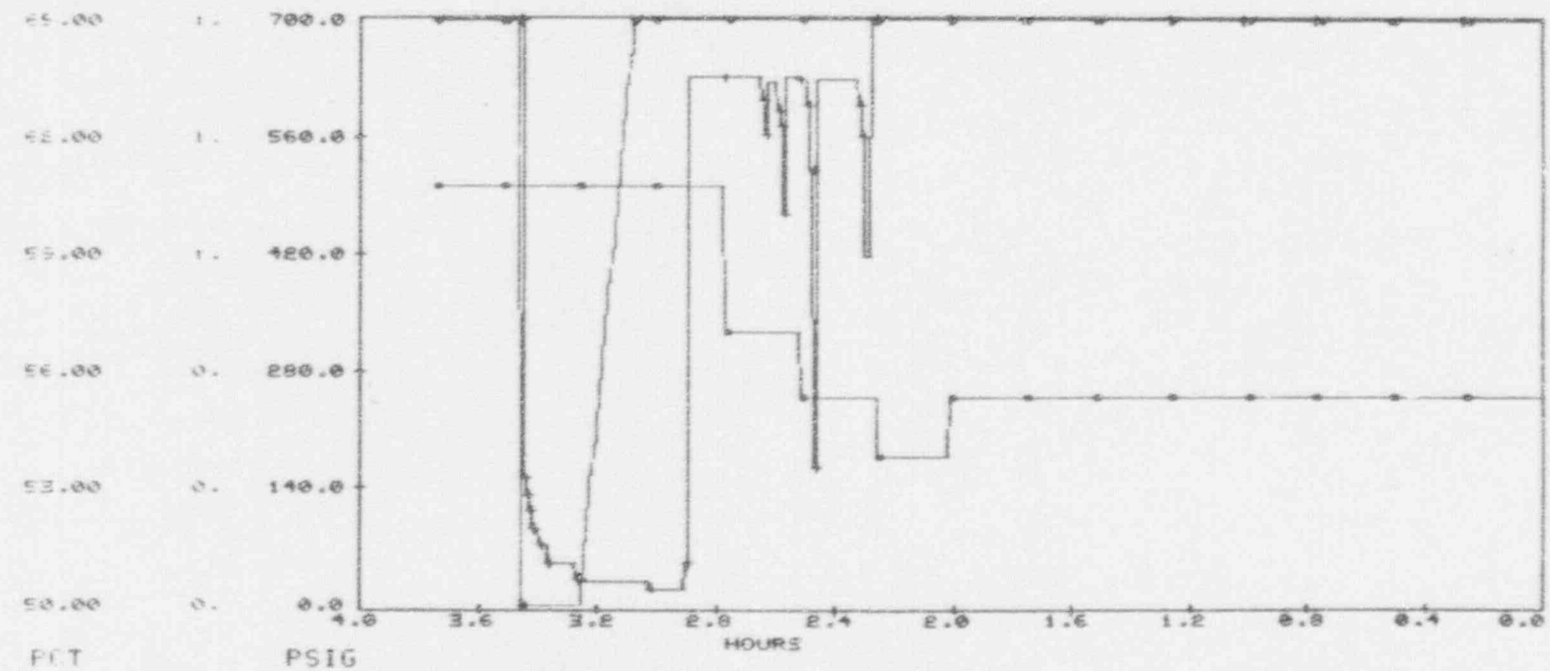
STS PE-019 RCS CHECK VALVE TESTING



SELECT FUNCTION KEY TH: [redacted] | 3/14/92 11:13:35 [redacted]

14-MAR-1992
06:31:42

POINT ID	SYMB	DESCRIPTION	QUAL	CFIT	CURRENT	MAXIMUM	MINIMUM
BBL0053A	++	RCS LEVEL LOOP1 WR MIDLOOP ONLY	GOOD	PGAT	1817.3	1820.9	21.8
[illegible]	**	ACC TK A TO SIS [illegible]	GOOD	[illegible]	1.00	1.00	0.00
EPL0951	--	RCL1 ACCUMULATOR TANK NO.1 B L	GOOD	PGAT	55.38	60.80	53.78



[redacted]

F1= F2=PAUSE F3=FAST FORW F4=REWIND F5=NEW TIME F6=NEW PLOT

W.C. TERM=TT18 CPU=B CONSOLE=PRIM/BAC MODE=HOT STBY EVENT=AUTO

VIDEO COPY

Evidence Surrounding January, February and March Events

Relationship to check valve testing/Plant condition

Accumulator levels

Accumulator piping pressures

Field inspection of Accumulator lines

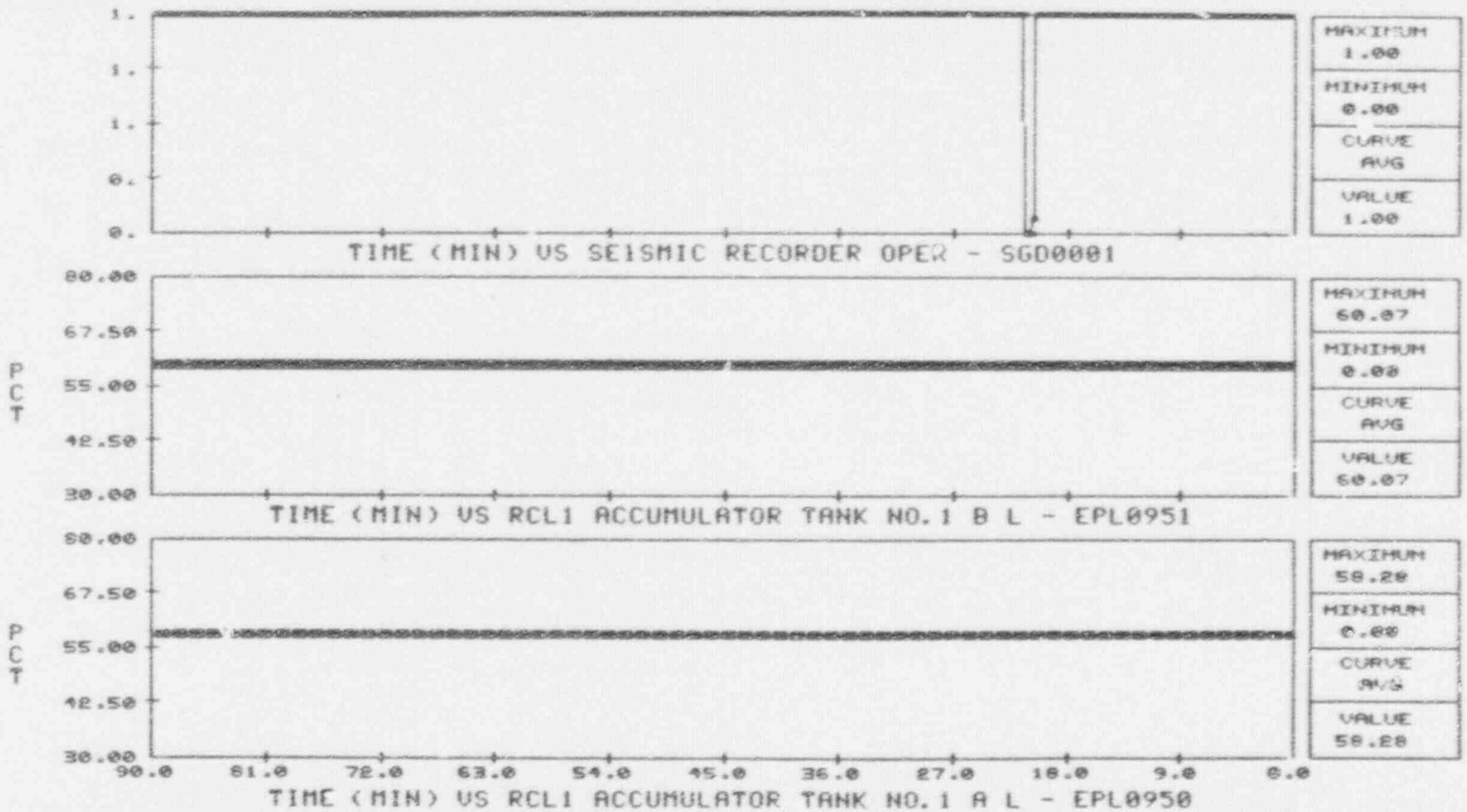
Conclusions concerning thermal hydraulic transient

Accumulator Line Check Valve Testing

CHECK VALVE GROUP	2" SI Valves	BIT Valves	Accumulator checks	First off hot leg checks	First off cold leg checks	Hot leg SI and/or RHR checks	RHR cold leg checks
MAY 1990	1st on 5/6 350 psig	2nd In 5/7 350 psig	3rd on 5/9 870 psig 450°F Event occurred 55 minutes after isolation valves were opened.	4th on 5/10 1800 psig	5th on 5/10 1800 psig These were started 4 1/2 hours after the event.	6th on 5/11 2300 psig	7th on 5/11 2300 psig
JANUARY 1992	5th on 1/9 1850 psig 512°F Event occurred while depressur-izing upstream of SI second off checks.	1st on 12/2 350 psig	2nd of 1/6 880 psig	3rd on 1/8 1800 psig	4th on 1/8 1800 psig Completed 6 hours prior to event.	6th on 1/10 2340 psig	7th on 1/10 2340 psig
FEBRUARY 1992	1st on 2/25 346 psig Retest on 2/27	N/A	N/A	N/A	2nd on 2/27 1800 psig Completed 12 hours prior to event	N/A	4th on 2/27 1850 psig 537°F Event occurred 9 hours after testing completed.
MARCH 1992	N/A	N/A	4th on 3/14 1814 psig	1st on 3/13 1814 psig	2nd on 3/314 1815 psig Completed 60 hours prior to event	3rd on 3/14 1814 psig	5th on 3/14 1813 psig 550°F Event occurred 48 hours after testing completed.

SELECT FUNC. KEY OR TURN-ON CODE TT: [redacted] 1/ 9/92 03:27:00

TIME TREND FOR TPHEPA

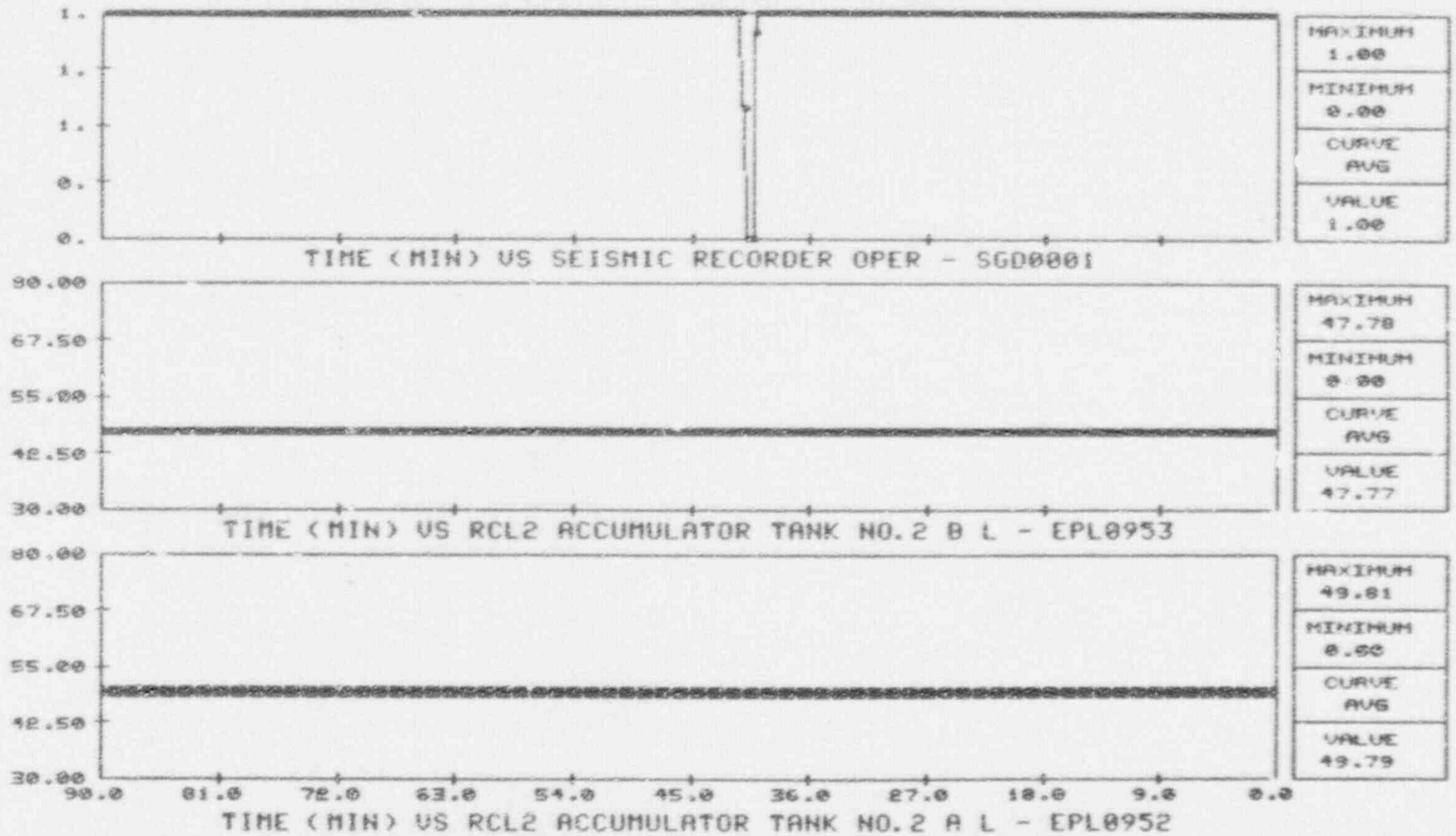


F =NEW PLOT F2=RESCALE X F3=RESCALE Y F4=QUICK PLT F5=NEXT PLOT F6=PLOT DEF.
W.C. TERM=TT17 CPU=A CONSOLE=PLAYBACK MODE=HOT STBY EVENT=AUTO

VIDEO COPY

SELECT FUNC. KEY OR TURN-ON CODE TT: [redacted] 2/28/92 02:34:25 [redacted]

TIME TREND FOR TPHEPB



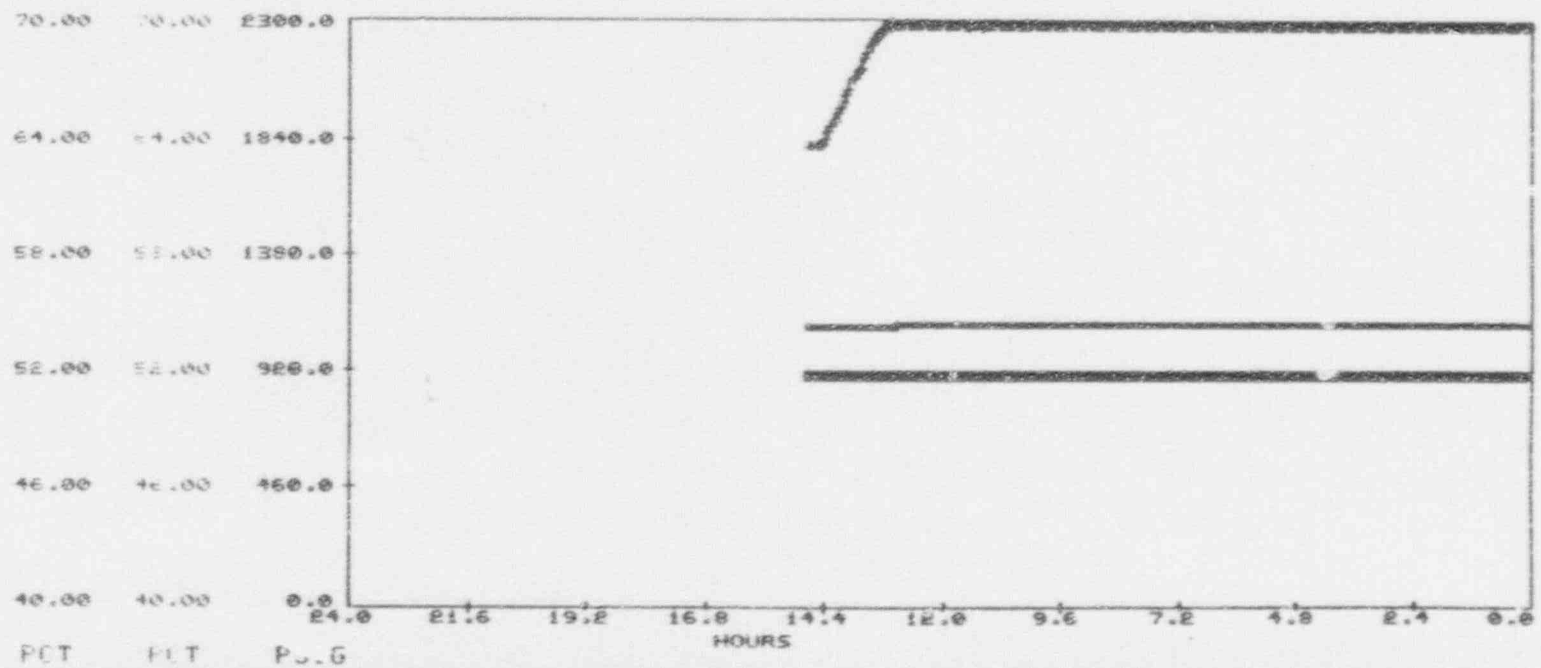
[redacted]

F1=NEW PLOT F2=RESCALE X F3=RESCALE Y F4=QUICK PLT F5=NEXT PLOT F6=PLOT DEF.
PREV CANC W.C. TERM=TT18 CPU=A CONSOLE=PLAYBACK MODE=HOT SHDN EVENT=AUTO
VIDEO COPY

SELECT FUNC. KEY OR TURN-ON CODE TT: | 3/17/92 06:37:10

TIME TREND FOR TPHEPC

POINT ID	SYMB	DESCRIPTION	QUAL	CFIT	CURRENT	MAXIMUM	MINIMUM
BBL0054A	++	RCS LEVEL LOOP1 WR MIDLOOP ONLY	GOOD	AVG	2293.8	2301.4	1813.0
EPL0954	**	RCL3 ACCUMULATOR TANK NO.3 A L	GOOD	AVG	51.87	51.89	51.77
EPL0955	--	RCL3 ACCUMULATOR TANK NO.3 B L	GOOD	AVG	54.42	54.44	54.37



F1=NEW PLOT F2=RESCALE X F3=RESCALE Y F4=QUICK PLT F5=NEXT PLOT F6=PLOT DEF.
PREV CANC W.C. TERM=TT20 CPU=B CONSOLE=PRIM/BAC MODE=HOT STBY EVENT=AUTO

VIDEO COPY