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U.S. House of Representatives
Subcommittee on Oversight and Investigations
of the
Committee on Energy and Commerce
Washington, DC 20515-6116

March 21, 1994

Dr. Ivan Selin
 Chairman
 Nuclear Regulatory Commission
 Washington, D.C. 20555

Dear Chairman Selin:

As you know, an accident resulting from a turbine failure occurred at Detroit Edison Company's Fermi II Plant on December 25, 1993. I was pleased to learn from the February 7, 1994 final Nuclear Regulatory Commission (NRC) Augmented Inspection Team (AIT) report on the incident (Docket Number 50-341) that the safety related/safe shutdown equipment performed properly and that the NRC determined that the event ultimately posed no threat to public health and safety. However, I am troubled by a number of events surrounding the incident and would appreciate your assistance in answering the following questions:

1. According to a Preliminary Notification of Event or Unusual Occurrence Dated December 30, 1993, from the Region III NRC office on December 28, 1993 (PNO-III-93-69), Detroit Edison was to submit its investigation of the review of the incident to the NRC. Was this submittal completed? If so, has the NRC reviewed it and what were the findings?
2. The AIT report states that a inspector from the turbine manufacturer approved turbine blade #27 under the condition that it be changed at a scheduled refueling in September, 1992. Instead, Detroit Edison decided to delay blade replacement for another cycle, until March of 1994. Has Detroit Edison offered an explanation for that decision to the NRC? Did the NRC concur with that determination? Was Detroit Edison in violation of NRC rules or an agreement with the turbine manufacturer when it decided to not replace the blades in 1992?
3. The AIT report states that when the turbine manufacturer was informed of Detroit Edison's decision to not replace the blade in question, it requested that an inspection be performed during the September 1992 outage. Was the inspection required for

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Dr. Ivan Selin
Page 2

operation? Did Detroit Edison perform the inspection? If so, in your opinion was the inspection adequate?

4. According to the chronology of events in the AIT report, Detroit Edison first identified problems with the turbine blades during a routine outage in September 1989. Further, the AIT report states that at the time of the accident, the plant was operating at 93% power because Detroit Edison had identified problems with the turbine. Detroit Edison clearly was aware that there was some difficulty with the turbine. Why did the company not address the problem and replace the blade? In your assessment, could the accident have been avoided if the blade had been replaced?

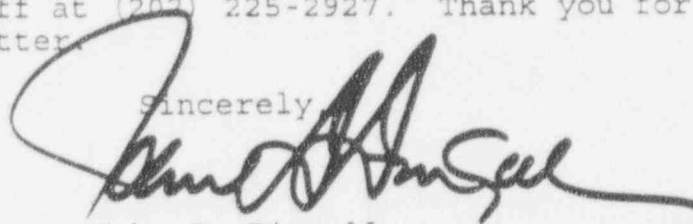
5. The AIT report states that "the root cause of this event and the full extent of damage to the turbine-generator system has not been determined." Since that document was prepared, has the NRC determined the cause of the turbine-generator damage and the incident? Has Detroit Edison Company?

6. I further understand that the NRC is awaiting a response from Detroit Edison Company on questions raised by the NRC in the Confirmatory Action Letter (CAL-3-93-018). I would like to receive a copy of that response when it is prepared and would like to know what action, if any, the NRC decides to take as a result. Based on the findings of the AIT report or other material is the NRC examining the incident for possible violations?

Additionally, please send me all relevant material on this accident, including but not limited to: any interim reports prepared by the NRC; any correspondence between the manufacturer of the blades and Detroit Edison; and any correspondence between the NRC and Detroit Edison in which the accident or the initial discovery of turbine blade damage was discussed.

I would appreciate your prompt response to the issues and questions raised in this correspondence. If you or your staff have any questions regarding this letter, please contact Lisa M. Kountoupes of my staff at (202) 225-2927. Thank you for your attention to this matter.

Sincerely,



John D. Dingell
Chairman

Subcommittee on Oversight
and Investigations

ENCLOSURES 1-18

IN RESPONSE TO QUESTION 7

- Enclosure
1. Director highlight reports to NRC management related to the event
 2. Licensee event report 93-014 of January 24, 1994
 3. Licensee event report 93-015 of January 25, 1994
 4. Slides used in the staff's weekly events briefing of January 5, 1994
 5. Slides used in Advisory Committee on Reactor Safeguards briefing on March 11, 1994
 6. Records of reportable events 26536, 26540, 26709 and 27056
 7. January 4, 1994, special report from the licensee
 8. February 4, 1994, Hopper and Associates report to Detroit Edison on the turbine failure
 9. Licensee's recovery plan
 10. Letter from the turbine manufacturer (GEC ALSTHOM) to the licensee dated February 21, 1992
 11. Letter from GEC ALSTHOM to the licensee dated January 10, 1994 (proprietary)
 12. Letter from GEC ALSTHOM to the licensee dated January 14, 1994 (proprietary)
 13. Licensee procedure 35.109.005, Revision 21
 14. Related work request D739920312
 15. April 14, 1991, record of the LP3 eighth stage blade inspection data

16. March 27, 1993, letter from the licensee to the turbine manufacturer
17. NRC inspection report 50-341/93028 dated February 24, 1994
18. NRC inspection report 50-341/94004 dated March 18, 1994

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DIRECTOR'S HIGHLIGHT
PROJECT DIRECTORATE III-1
DECEMBER 29, 1993

Fermi-2

On December 25, 1993, the unit experienced a catastrophic failure of the main turbine. A turbine trip followed by a reactor trip occurred. All safety systems were operable; however, when placing division 2 of shutdown cooling in service, the B recirculation pump loop discharge valve failed to indicate fully closed. There appeared to be possible blading or other component failure in the area of the third stage low pressure turbine. There was extensive damage to the exciter, the main condenser tubing, the generator, the turbine casing and several coolant supply line, lube oil line and other secondary side equipment. The licensee declared an ALERT due to a small fire which began in the vicinity of the brushes of the main turbine generator. The fire was quickly extinguished. There were no injuries or radioactive releases associated with this event. In addition to the extensive damage and potential fire hazards associated with the oil/water residue, high conductivity (180 micro mhos peak) in the reactor is a concern. A Commission's Assistant briefing was conducted at 8 PM on the 25th by Mr. Greenman of Region III. The Project Manager and Assistant Director for Region III Projects participated.

The plant is currently in cold shutdown, and is being cooled via division 1 of shutdown cooling. The licensee has stationed additional fire watches to augment their fire protection detection system and is proceeding to reduce the high conductivity in the reactor (currently 114 micro mhos). The drywell is being deinerted in preparation for entry to inspect the B recirculation pump discharge valve.

An Augmented Inspection Team (AIT) has been formed (Ron Gardner, Region III as team leader) and the team leader and some team members are onsite. Region III issued a confirmatory action letter (CAL) on December 28, 1993, to alert the licensee of the AIT and to ensure in-situ quarantining of the area. The AIT charter will be issued later today. The remainder of the AIT team plans to be onsite January 10, 1994. The licensee is proceeding slowly and deliberately to develop a course of action for assessment of damage and investigation of the root cause of the event. Three headquarters personnel are on the AIT.

Contact: T. Colburn
504-1341

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DIRECTOR'S HIGHLIGHT
PROJECT DIRECTORATE III-1
JANUARY 4, 1994

Fermi-2

This is an update to the December 29, 1993 Director Highlight. Messrs. Ed Greenman and Jack Martin visited the Fermi site on January 4, 1994. Mr. Martin also held a press conference at 2:30 PM that afternoon at the site. The AIT leader, Mr. Ron Gardner has been onsite with selected Region III support personnel to conduct interviews and begin the AIT assessment of the licensee's root cause investigation and recovery planning prior to the arrival of the full AIT team on January 10, 1994. Messrs. Colburn, Stang and Ornstein from HQ will be on site Wednesday and Thursday (January 5-6) to assist the team leader.

Contact: T. Colburn
504-1341

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DIRECTOR'S HIGHLIGHT
PROJECT DIRECTORATE III-1
JANUARY 11, 1994

Fermi-2

This is an update to the December 29, 1993 Director Highlight. The reactor is being cooled via the Division I loop of shutdown cooling. There is still a large quantity of oil and water in the Radwaste and Turbine Building basements. The FSAR Chapter 15 analysis for a seismic event concludes that if a seismic event were to occur, the activity at the Monroe water intake structure would be $3E-3$ of the maximum permissible concentration (MPC). The licensee has recalculated the results for the volume and activity of water if the event were to occur today and the results approach $6E-2$ MPC. The licensee is evaluating the potential for water to seep into the ground water system.

The turbine vendor, English Electric, has also performed an analysis indicating that there may be potential hydrogen pockets in the generator which could ignite. The licensee is currently trying to restore their CO₂ system in order to purge the generator prior to allowing access to the immediate generator vicinity. The licensee will be entering the hotwell of the main condenser to remove debris and prepare for transfer of Radwaste Building basement water to the hotwell.

An additional problem arose with reactor coolant conductivity cleanup efforts. The licensee had estimated that it would take about 2 weeks to reach the administrative limit of 2R/hr. contact dose reading on the portable demineralizers in use to restore conductivity. The limit was exceeded (2.2R/hr. contact) during the first 12 hours of operation. The licensee has temporarily suspended the cleanup operation until they can investigate further.

The full AIT team arrived onsite Monday, January 10, 1993. They are continuing to monitor the licensee's actions for water management and investigation of the event. A member of the Michigan Public Service Commission is onsite to observe.

Contact: T. Colburn
504-1341

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DIRECTOR'S HIGHLIGHT
PROJECT DIRECTORATE III-1
JANUARY 26, 1994

Ferri-2

A public exit meeting of the Ferri AIT inspection was held onsite in the Nuclear Operations Center at 1:00 PM on Wednesday, January 19, 1994. Several members of the public and media were in attendance. Preliminary team findings indicated that while the sequence of events resulted in severe damage to the turbine, generator and exciter, there was no serious threat to public health and safety. Overall, the plant operators responded properly to a challenging event which included fire in the turbine building. There were no immediate precursors which could have signaled a pending turbine failure and the turbine failure does not appear to be the result of a grid disturbance or an overspeed condition. Early liquid releases were not radioactive and gaseous releases (mostly steam and smoke through the turbine building roof vents) were within allowable parameters. The root cause of the event has not yet been determined, and the NRC is continuing to monitor the progress and results of the licensee's investigation.

Some weaknesses in offsite notification, personnel accountability, and firefighting were observed. Some procedural deficiencies were also noted. The licensee committed to followup on these issues. NRC opening and closing remarks were provided by Mr. Edward Greenman of Region III. The team leader, Mr. Ron Gardner, assisted by other team members, presented team findings and were available for public questions. Mr. Jack Martin, Region III Administrator, and various other NRR and Region III personnel were in attendance.

Contact: T. Colburn
504-1341

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DIRECTOR'S HIGHLIGHT

PROJECT DIRECTORATE III-1

February 2, 1994

Fermi-2

Last week, Fermi 2 experienced a 57 minute loss of shutdown cooling and a 20 minute fire in an elevator shaft. Neither had adverse safety consequences.

On January 27, 1994, at 1:05 PM, a loss of offsite power to Division I occurred causing a loss of the Division I reactor protection system (RPS) motor-generator (MG) set resulting in a Group IV isolation signal and a loss of shutdown cooling. The inboard suction valve for shutdown cooling closes as part of the Group IV isolation. The area had been experiencing an ice storm with freezing rain at the time. Shutdown cooling was restored after 57 minutes by restoring power to the RPS MG set, clearing isolations and filling/venting the RHR pump in service for shutdown cooling. The RCS temperature increased 15 degrees F during this time. Fermi's Group IV isolation scheme is a generic BWR design.

On January 29, 1994, at 6:54 AM, a fire occurred in the turbine building passenger elevator shaft. The fire was extinguished at 7:14 AM by the licensee's onsite fire brigade. The licensee declared an Unusual Event because the fire duration was greater than 10 minutes. One security guard (assisting the brigade) suffered smoke inhalation and was transferred offsite by ambulance.

The fire was caused by two elevator power cables in the shaft rubbing together. The cloth fire protection wrapping on the cables was degraded due to oil/water contamination from the December 25, 1993 turbine failure. The elevator was empty at the time and no plant safety systems were affected by the fire. The licensee terminated the Unusual Event at 7:53 AM and later issued a press release.

UPDATE ON THE DECEMBER 25, 1993 TURBINE FAILURE

The licensee is working to clean up water in their condensate storage tank in preparation for discharge later this week. The licensee plans to remove the hood of the No. 3 low pressure turbine over the weekend for inspection. Reactor coolant has been restored to Technical Specification chemistry limits although still slightly higher than normal conductivity. The majority of water in the turbine and radwaste building sumps has been pumped to the hotwell.

Contact: T. Colburn
504-1341

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DIRECTOR'S HIGHLIGHT
PROJECT DIRECTORATE III-1
February 16, 1994

Fermi-2

Turbine Failure Update

The licensee has completed temporary modifications to the condensate storage tank (CST) in preparation for discharge to Lake Erie later this week. The licensee plans to discharge the entire CST contents (about 600,000 gal.) from the CST through a filter media, to a neutralization tank, then to the circulating water decant line and from that point to Lake Erie. There will be flow rate monitoring, temporary radiation monitoring, sampling, and isolation capability available on the discharge line. The discharge will be within the licensee's offsite dose calculation manual (ODCM) limits. The licensee will recirc the CST, sample and perform a release rate calculation. The NRC independent measurements van will confirm the licensee's results. Region III will approve the licensee's plans prior to discharge. The licensee also plans to issue a press release prior to discharge.

The licensee has pulled the rotor from the damaged No. 3 low pressure (LP) turbine and may begin non destructive examination as early as Thursday. The preliminary assessment of damage to the turbine does not appear as extensive as originally thought based on visual observations. At least 5 blades (approximately 120 lbs. each) are completely gone from the eighth stage of No. 3 LP turbine. All 64 of the fixed blades appear to have suffered some damage. The No. 1 and 2 LP turbines do not appear to be significantly damaged. The exciter and generator have suffered significant damage and will probably have to be replaced.

Contact: T. Colburn
504-1341

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DIRECTOR'S HIGHLIGHT
PROJECT DIRECTORATE III-1

March 1, 1994

Fermi-2

Turbine Failure Update

The licensee completed the first discharge of water to Lake Erie from the condensate storage tank on Friday, February 25, 1994. This water had originally been scheduled for discharge on February 17, 1994 but was delayed in order to hold a public meeting on February 23 at the request of local officials. The licensee began discharge of approximately 600,000 gallons of slightly radioactive (about $10E-7$ microcuries per milliliter) water on February 24 after independent NRC Region III measurement confirmed the activity levels were well within discharge limits. NRC monitoring of the discharge point and the Monroe water intake showed less than detectable activity. There has been considerable media and Congressional interest in the discharge to date. The next scheduled discharge is expected to take place in approximately 3 weeks.

Management Changes

The licensee is planning several management changes at Fermi. On March 1, 1994, Anthony F. Earley Jr. joins the licensee as President, Chief Operating Officer and Director. Mr. Earley formerly held these same positions with Long Island Lighting Company (LILCO). John Lobbia, formerly President, retains his position as Chairman and Chief Executive Officer.

Mr. Robert McKeon, formerly Plant Manager, has been promoted to Assistant Vice President and Manager, Operations. Mr. McKeon will retain his present duties and organization. Wayne D. Romberg, formerly Vice President, Nuclear Operations Services at Northeast Utilities, has been hired as Assistant Vice President and Manager, Technical. Mr. Romberg will manage the technical aspects of plant support and licensing. Mr. Paul Fessler, Technical Manager will report directly to Mr. Romberg.

Contact: T. Colburn
504-1341

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DIRECTOR'S HIGHLIGHT
PROJECT DIRECTORATE III-1

March 15, 1994

Fermi-2

The licensee plans to begin the second of three expected discharges from the condensate storage tank to Lake Erie this evening. A Region III inspector has taken a confirmatory split sample with the licensee from the condensate storage tank and will complete a confirmatory independent analysis of the sample at the Region III laboratory prior to actual discharge. The inspector will verify agreement with the licensee's sample and that the sample is within the regulatory limits for unrestricted discharge.

The resident inspector will observe the discharge, however, the Region does not plan to monitor the discharge point and Monroe water intake as was done during the initial discharge on February 24-25, 1994. All initial discharge monitoring samples showed less than minimum detectable activity except for naturally occurring potassium. The Region had offered to the Monroe city officials to monitor the city water intake for this discharge, but their offer was declined. The State of Michigan has also declined to perform a confirmatory split sample with the Region and the licensee, as was done for the initial discharge.

Contact: T. Colburn
504-1341

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DIRECTOR'S HIGHLIGHT
PROJECT DIRECTORATE III-1
April 6, 1994

Fermi-2

Update on Turbine Failure

The turbines have been discovered to be more significantly damaged than originally thought. All three low pressure turbine rotors have exhibited indications of bowing and will need to be shipped off site for repair. Additionally, crack indications have been found at the base of eleven 7th stage blades of low pressure turbine number 2 (LP 2). An unspecified number of blades in the 7th stage of LP 3 may also have crack indications. The 7th stage rotors of the low pressure turbines need to be debladed in order to complete the inspection. Based on the foregoing, the licensee plans to reinspect the high pressure turbine to determine if it is damaged.

In addition to the turbine damage, the beam box that the turbine rests on within the condenser appears to be significantly damaged. The initial tube inspections have indicated that 5200 condenser tubes will require repair.

The generator rotor has been shipped to Siemens Company in Milwaukee for inspection and repair. The generator hydrogen coolers have been shipped to Toledo, Ohio for repair. The new excitor is expected to arrive on site in July.

Contact: T. Colburn
504-1341

Detroit
Edison

Douglas R. Gipson
Senior Vice President
Nuclear Generation

Fermi 2
6400 North Dixie Highway
Newport, Michigan 48166
(313) 586-5249

Enclosure 2

10CFR50.73

January 24, 1994
NRC-94-0006

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

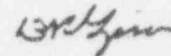
Reference: Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

Subject: Licensee Event Report (LER) No. 93-014

Please find enclosed LER No. 93-014, dated January 24, 1994, for a reportable event that occurred on December 25, 1993. A copy of this LER is also being sent to the Regional Administrator, USNRC Region III.

If you have any questions, please contact John A. Tibai, Principal Compliance Engineer, at (313) 586-4289.

Sincerely,



Enclosure: NRC Forms 366, 366A

cc: T. G. Colburn
W. J. Kropp
J. B. Martin
M. P. Phillips
P. L. Torpey

Wayne County Emergency
Management Division

9402020185 8pp

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001; AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1) Fermi 2		DOCKET NUMBER (2) 05000341	PAGE (3) 1 OF 7
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TITLE (4)
Automatic Reactor Shutdown Following Failure of the Main Turbine

EVENT DATE (5)			LER NUMBER (6)			REPORT NUMBER (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
12	25	93	93	014	00	01	24	94		05000
									FACILITY NAME	DOCKET NUMBER
										05000

OPERATING MODE (9) 1	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §: (Check one or more) (11)									
POWER LEVEL (10) 93%	<input type="checkbox"/> 20.402(b)	<input type="checkbox"/> 20.405(c)	<input checked="" type="checkbox"/> 50.73(a)(2)(iv)	<input type="checkbox"/> 73.71(b)						
	<input type="checkbox"/> 20.405(a)(1)(i)	<input type="checkbox"/> 50.36(c)(1)	<input type="checkbox"/> 50.73(a)(2)(v)	<input type="checkbox"/> 73.71(c)						
	<input type="checkbox"/> 20.405(a)(1)(ii)	<input type="checkbox"/> 50.36(c)(2)	<input type="checkbox"/> 50.73(a)(2)(vii)	<input type="checkbox"/> OTHER						
	<input type="checkbox"/> 20.405(a)(1)(iii)	<input type="checkbox"/> 50.73(a)(2)(i)	<input type="checkbox"/> 50.73(a)(2)(viii)(A)	(Specify in Abstract below and in Text, NRC Form 366A)						
	<input type="checkbox"/> 20.405(a)(1)(iv)	<input type="checkbox"/> 50.73(a)(2)(ii)	<input type="checkbox"/> 50.73(a)(2)(viii)(B)							
<input type="checkbox"/> 20.405(a)(1)(v)	<input type="checkbox"/> 50.73(a)(2)(iii)	<input type="checkbox"/> 50.73(a)(2)(x)								

CONTACT NAME (12)
John A. Tibai, Compliance Engineer

TELEPHONE NUMBER (include Area Code)
(313) 586-4289

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRRDS
B	TA	TRB	E275	Y					

SUPPLEMENTAL REPORT EXPECTED (14)

YES (If yes, complete EXPECTED SUBMISSION DATE)

NO

EXPECTED SUBMISSION DATE (15)
04 25 94

ABSTRACT (Limit to 1400 spaces, i.e. approximately 15 single-spaced typewritten lines) (16)

On December 25, 1993 at 1315 hours an automatic reactor shutdown occurred when the main turbine tripped off line. The turbine generator tripped when the mechanical overspeed device was activated. This was most likely due to high vibration levels and was not due to an actual overspeed condition. The turbine generator unit and associated support systems sustained significant damage. All safety systems and isolations performed as designed during the event. An Unusual Event was declared at 1352 hours. This was upgraded to an Alert at 1357 hours. The presence of a fire at the main generator exciter was extinguished by the plant fire brigade using hand held extinguishers.

The probable cause of the high turbine vibration was due to a loss of material from a turbine rotor in low pressure section number 3. The exact source of the material and the root cause of the failure are under investigation.

Turbine/generator repairs will be determined based on the results of the investigation. Other corrective actions needed to return the plant to power operation are being formulated. A supplement to this LER will be submitted by April 25, 1994.

**LICENSEE EVENT REPORT (LER)
 TEXT CONTINUATION**

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 500 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNB 7714) U.S. NUCLEAR REGULATORY COMMISSION WASHINGTON, DC 20555-0001 AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)		DOCKET NUMBER (2)		LER NUMBER (6)			PAGE (3)
FERMI 2		05000 341		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	02 OF 07
				93	- 014	- 00	

TEXT (If more space is required, use additional copies of NRC Form 366A, (17))

Initial Plant Conditions:

Operational Condition: 1 - Power Operation
 Reactor Power: 93.5 Percent
 Reactor Pressure: 1020 psig
 Reactor Temperature: 535 degrees Fahrenheit

Description of Event:

On December 25, 1993 at 1315 hours an automatic reactor shutdown [JC] occurred in response to a main turbine [TA] trip. The specific cause of the reactor automatic shutdown was fast closure of the turbine control [JJ] valves. The main turbine generator [TB] tripped off line due to activation of the mechanical overspeed trip device. This most likely was caused by very high vibration levels and not by an actual overspeed condition. Control room operators [Utility-Licensed] heard a loud noise from the turbine deck followed by heavy rumbling. A number of alarms were received in the control room [NA] including the seismic monitoring alarm, turbine vibration alarms [VA], turbine tripped alarm and alarms from turbine auxiliary systems. Control Room operators noted that the oil supply pressure to the main turbine indicated 0 psig.

Twenty five (25) seconds into the event the main steam isolation valves (MSIV)[ISV] automatically closed due to high condenser [SC] pressure (Group 1 isolation). A Group 13 isolation (Drywell Sumps) [WK] occurred when reactor water level decreased to level 3, which normally occurs during an automatic shutdown from power operation. Reactor pressure was controlled by manually opening safety relief valves [RV] and water level was controlled by manual operation of the reactor core isolation cooling (RCIC)[BN] and standby feedwater (SBFW)[SK] systems.

The Nuclear Shift Supervisor [Utility-Licensed] declared an Unusual Event at 1352 hours based on fire alarms and potential fire hazards from turbine lubricating oil. The emergency classification was upgraded to an Alert at 1357 hours based on a report of a fire on the second floor of the turbine

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)		DOCKET NUMBER (2)		LER NUMBER (4)			PAGE (3)
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TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

building in the area of the lubricating oil reservoir. The fire brigade was assembled and assistance, although not utilized, was requested from the local fire department. At 1400 hours it was determined that a fire in the lubricating oil area had not occurred. The previous communication to the control room operators had been misunderstood. The misunderstood communication was attributed to the difficulty of communicating with hand held radios while wearing self contained breathing equipment. At 1405 hours a small fire was identified in the exciter area. This was extinguished with portable fire extinguishers.

A review of the event determined that the initial fire alarms were caused by a rapid hydrogen burn around the generator. The source of hydrogen was that used to cool the internals of the generator. The automatic fire suppression systems operated as designed.

Significant damage was sustained by the turbine/generator and the auxiliary systems. The exciter rotor [TL] had become disconnected from the turbine/generator shaft. A hole measuring approximately 18" x 30" was found in the northwest corner of the number 3 low pressure turbine hood. General Service Water [KG] and Turbine Building Closed Cooling Water [KB] Systems, which cool hydrogen [LJ] in the main generator and air within the exciter, respectively, were breached. Approximately 550,000 gallons of water from these two systems and the fire suppression system flooded the radwaste building [NE] and turbine building [NM] basement areas disabling the radwaste systems.

The turbine lubricating oil system [TD] also suffered significant damage. An estimated 17,000 gallons of turbine lubricating oil was spilled onto the turbine building floor areas and mixed with water in these areas.

The main condenser also sustained damage. An unknown number of condenser tubes were severed resulting in approximately 250,000 gallons of circulating water flowing into the condenser hotwell. This water was subsequently discharged through the condensate polishing demineralizers, compromising the effectiveness of the demineralizers. The water was discharged to the condensate storage tank [KA] as the hotwell level control system functioned to compensate for increasing hotwell water level. Reactor water quality deteriorated as the RCIC and SBFW systems utilized water from the condensate storage tank to maintain reactor water level.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST 500 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503

FACILITY NAME (1)		DOCKET NUMBER (2)		LER NUMBER (6)			PAGE (3)
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				93	- 014	- 00	

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

All safety systems [JE] and isolations performed as designed. All safety systems were available throughout the event. Standby gas treatment [WF] was manually started in response to the loss of the reactor building HVAC [VA] system.

At 1722 hours the Emergency Director downgraded the emergency status to an Unusual Event based on stable plant conditions. The Unusual Event was terminated at 2052 hours based on the plant being in a stable condition.

On December 26, 1993, while preparing to place the reactor into cold shutdown, reactor recirculation discharge [AD] valve B3105-F031B failed to close. Had the reactor coolant level dropped to level 2 during the December 25, 1993 event, the low pressure coolant injection [(LPCI)(BO)] path through division 2 of the residual heat removal system might not have been available. LER 93-015 will be submitted concerning this valve failure.

The plant was placed in cold shutdown at 2251 hours on December 26, 1993.

Cause of Event

The reactor scram was caused by the closure of the turbine control valves when the main turbine generator (MTG) tripped off line. The turbine trip was caused by the activation of the mechanical overspeed trip device. Activation of the mechanical overspeed trip device was most likely due to severe vibration and not from an actual overspeed condition. The high vibration of the main turbine was most probably the result of mass loss from a turbine rotor from Low Pressure Turbine Section Number 3. The cause of the mass loss is still under investigation. Results of this investigation will be provided in a supplement to this LER.

Analysis of Event:

An automatic reactor shutdown was initiated by the closure of the main turbine control valves. A turbine trip was initiated by the activation of the mechanical overspeed trip mechanism. Analysis of the turbine vibration

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNRB 7714), U.S. NUCLEAR REGULATORY COMMISSION WASHINGTON, DC 20555-0001 AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET WASHINGTON, DC 20503

FACILITY NAME (1)		DOCKET NUMBER (2)		LER NUMBER (6)			PAGE (3)
FERMI 2		05000 341		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	OF
				93	- 014	- 00	5 OF 7

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

data determined that this trip most likely initiated due to high vibration on the main turbine unit and was not due to an actual overspeed condition. A loss of mass on the low pressure turbine number 3, 8th stage blading, north side was discovered. The impact on turbine vibration of that mass loss plus other damage to the turbine is under active investigation. The investigation will determine the root cause for the event.

Plant response following the automatic shutdown, including the low level 3 actuation was normal. The turbine failure did not result in any abnormal releases of radioactive material.

A comparison of the event against the UFSAR turbine missile analysis was made by Engineering and it was determined that the event was bounded by the UFSAR analysis.

The dynamic response of the reactor/auxiliary building to the MTG failure induced excitation was measured by earthquake recording devices located in the reactor/auxiliary building. The data from these devices show that the reactor/auxiliary building was not significantly excited or displaced by the MTG failure event. Detailed data evaluation and documentation activities are in progress and a formal assessment report is being prepared.

There are three triaxial passive peak shock recorders installed in the following reactor/auxiliary building locations; High Pressure Coolant Injection (HPCI) room floor (El. 540'-0"), relay room floor (El. 613'-6"), refueling floor (El. 684'-6"). These devices are capable of recording accelerations in the frequency range of 2-25 Hz and fully characterize the structural dynamic environment in the reactor/auxiliary building. Data from the relay room and refueling room recorders show no significant response resulted from the turbine event. Data from the HPCI room is now being evaluated.

There are also two triaxial accelerometers located on the HPCI room floor and at the top of the reactor pedestal. The accelographs indicated three short duration acceleration excursions. The first and second were separated by approximately 2 seconds and the second and third were separated by approximately one minute. Preliminary review indicates these to be at frequencies greater than 25 Hz and are not anticipated to be structurally significant. Further, there is no evidence that the four inch seismic isolation gap between the turbine and auxiliary building was infringed on during the turbine event.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503

FACILITY NAME (1)		DOCKET NUMBER (2)		LER NUMBER (6)			PAGE (3)
Fermi 2		05000 341		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	6 OF 7
				93	- 014 -	00	

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

The fire protection system performance during the event was reviewed by Plant Engineering. Although there was some damage to the fire suppression system, the system responded as designed.

Corrective Actions:

Detroit Edison will complete those actions agreed to by the NRC and Detroit Edison management and specified in the Confirmatory Action Letter dated December 28, 1993. These actions will be completed prior to returning the unit to power operations.

An investigation of the event was initiated by the Plant Manager. A turbine-generator assessment team (TGAT) was given the responsibility to determine the root cause of the main turbine generator trip and develop a plan for damage assessment, repair options, reassembly, startup, and monitoring turbine performance following implementation of the corrective action. Specifically the TGAT will:

Develop a sequence of events leading to the failure.

Determine the root cause of the turbine/generator failure.

Develop lessons learned

Publish a final report.

In addition, before the plant returns to power operation the following actions are planned.

A walkdown of the turbine building structure to assess any damage, and identify needed repairs.

A walkdown of systems located in the turbine building to assess any damage, and identify needed repairs.

A review of the effects of the poor reactor water quality on the fuel assemblies and other incore components.

A review of the effects of the poor reactor water quality on the reactor pressure vessel internals.

An assessment of the structural integrity of the main turbine generator pedestal, and specification of repairs as necessary.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 1.00 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503

FACILITY NAME (1)		DOCKET NUMBER (2)		LER NUMBER (4)			PAGE (3)	
FERMI 2		05000 341		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	OF	
				93	014	00	5 7	

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

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Douglas R. Gipson
Senior Vice President
Nuclear Generation

Ferri 2
440 North Dixie Highway
Newport, Michigan 48166
313-666-4121

Detroit
 Edison

10CFR50.73

January 25, 1994
NRC-94-0005

U. S. Nuclear Regulatory Commission
Attention: Document Control Desk
Washington, D.C. 20555

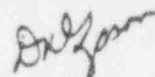
Reference: Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43

Subject: Licensee Event Report (LER) No. 93-015

Please find enclosed LER No. 93-015, dated January 25, 1994, for a reportable event that occurred on December 26, 1993. A copy of this LER is also being sent to the Regional Administrator, USNRC Region III.

If you have any questions, please contact Joseph M. Pendergast, Compliance Engineer, at (313) 586-1682.

Sincerely,



Enclosure: NRC Forms 366, 366A

cc: T. G. Colburn
W. J. Kropp
J. B. Martin
M. P. Phillips
P. L. Torpey

Wayne County Emergency
Management Division

9402030002 5pp

LICENSEE EVENT REPORT (LER)

(See reverse for required number of digits/characters for each block)

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THE INFORMATION COLLECTION REQUEST: 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNRB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001 AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1) Fermi 2		DOCKET NUMBER (2) 05000 341	PAGE (3) 1 OF 6
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TITLE (4) Failure of Reactor Recirculation Pump B Discharge Valve B3105-F031B to Close

EVENT DATE (5)			LER NUMBER (6)			REPORT NUMBER (7)			OTHER FACILITIES INVOLVED (8)	
MONTH	DAY	YEAR	YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	MONTH	DAY	YEAR	FACILITY NAME	DOCKET NUMBER
12	26	93	93	015	00	01	25	94		05000
									FACILITY NAME	DOCKET NUMBER
										05000

OPERATING MODE (9) 3	THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR §. (Check one or more) (11)									
POWER LEVEL (10) 0	20 402(b)	20 405(c)	50 73(a)(2)(iv)	73 71(b)						
	20 405(a)(1)(i)	50 36(c)(1)	x 50 73(a)(2)(v)	73 71(c)						
	20 405(a)(1)(ii)	50 36(c)(2)	50 73(a)(2)(vii)	OTHER						
	20 405(a)(1)(iii)	50 73(a)(2)(i)	50 73(a)(2)(viii)(A)	(Specify in Abstract below and in Text, NRC Form 366A,						
	20 405(a)(1)(iv)	50 73(a)(2)(iii)	50 73(a)(2)(viii)(B)							
	20 405(a)(1)(v)	50 73(a)(2)(iii)	50 73(a)(2)(x)							

LICENSEE CONTACT FOR THIS LER (12)
Joseph M. Pendergast, Compliance Engineer
TELEPHONE NUMBER (include Area Code)
(313) 586-1682

COMPLETE ONE LINE FOR EACH COMPONENT FAILURE DESCRIBED IN THIS REPORT (13)

CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRRDS	CAUSE	SYSTEM	COMPONENT	MANUFACTURER	REPORTABLE TO NRRDS

SUPPLEMENTAL REPORT EXPECTED (14)

YES X	NO	EXPECTED SUBMISSION DATE (15)	MONTH	DAY	YEAR
			04	07	94

ABSTRACT (Limit to 1400 spaces, i.e., approximately 15 single-spaced typewritten lines) (16)

On December 26, 1993 at 0520 hours while preparing to place division 2 of the Residual Heat Removal [RHR] system into service for the Shutdown Cooling [SDC] mode of operation, valve B3105-F031B, the "B" loop recirculation pump discharge valve, failed to indicate fully closed. Technical Specification Action Statement 3.5.1.b.4 was entered. The plant was brought to Cold Shutdown within the 24 hours as required by the Technical Specification Action Statement and SDC was established using division 1 SDC. On December 28, maintenance personnel inspected the valve's limit switch compartment and found three wires from the torque switch to the limit switch broken at the crimp of their respective lugs, located at the limit switch upper fingerboard. The three wires were relugged and reconnected. On December 29, at 0235 hours the valve was successfully stroked and declared operable.

The cause of the event was three wires at the limit switch upper fingerboard terminations broken from their lugs. Test results to date indicate the failure mechanism to be vibration induced fatigue. An investigation into the root cause of this event is still proceeding. A supplement to this Licensee Event Report will be submitted when the investigation is complete.

LICENSEE EVENT REPORT (LER)
 TEXT CONTINUATION

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 500 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNB 7714, U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001) AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104, OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503).

FACILITY NAME (1)		DOCKET NUMBER (2)		LER NUMBER (5)			PAGE (3)
Fermi 2		05000 341		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	2 OF 6
				93	- 015	- 00	

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

Initial Plant Conditions:

Operational Condition: 3 (Hot Shutdown)
 Reactor Power: 0 percent
 Reactor Pressure: 110 psi
 Reactor Temperature: 330 degrees Fahrenheit

Description of the Event:

On December 25, 1993 at 1315 hours an automatic Reactor shutdown occurred following a failure of the Main Turbine [JJ]/Generator [EL] system.

On December 26, at 0520 hours while preparing to place division 2 of the Residual Heat Removal [(RHR)(BO)] system into service for the Shutdown Cooling [SDC] mode of operation, valve [V] B3105-F031B, the "B" loop recirculation [AD] pump [P] discharge valve, failed to indicate fully closed after attempting to close the valve. Operations personnel [Utility Licensed] were unable to verify that the discharge valve was open or closed from the control panel indication. The valve's control panel indication was in the mid-position.

Initial troubleshooting at the motor control center indicated that the problem was in the Drywell [NG] where the valve is located. Low Pressure Coolant Injection [(LPCI)(BO)] loop selection depends on valve B3105-F031B being able to close and therefore both LPCI subsystems were considered inoperable. Technical Specification Action Statement 3.5.1.b.4 was entered. Operations personnel forced the LPCI loop select logic to select the "A" loop in order to establish an operable injection flow path. The "B" loop is the normal flow path. The "A" loop of RHR was then placed in SDC and the plant was brought to Cold Shutdown within the twenty-four hours required by Technical Specifications.

On December 28, following de-inerting of the Drywell, valve B3105-F031B was visually verified not fully closed. The valve was approximately two-thirds open. Subsequently, maintenance personnel [Utility Non-Licensed] inspected the valve's limit switch compartment and found three out of four wires from the torque switch to the limit switch broken at the crimp of their respective lugs, located at the limit switch upper fingerboard. The wires

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST 50.0 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20545-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)		DOCKET NUMBER (2)		LER NUMBER (8)			PAGE (3)
Fermi 2		05000 341		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	3 OF 6
				93	- 015	- 00	

TEXT (If more space is required use additional copies of NRC Form 366A) (17)

were relugged and reconnected. On December 29, at 0235 hours the valve was successfully stroked and declared operable.

Cause of the Event:

This event occurred because three of the four wires between the torque switch and the limit switch fingerboard were broken. Open circuit wires numbered, 45, 43 and close circuit wire numbered 55, at the limit switch upper fingerboard terminations numbered, 5, 5C and 1C (i.e., located on the upper limit switch outer edge terminals) were broken at the crimp of their lugs. This condition disabled the opening and closing circuits of this valve.

When access to the Drywell [NG] was made available, the limit switch compartment was inspected. There was no indication of arcing or heat residue. The limit switches were inspected and no damage was found. One limit switch rotor had some loose movement but was within nominal tolerance. The torque switch was inspected and no discrepancies in functionality or setting were found. All wiring and terminations in the limit switch compartment were inspected and no other discrepancies were observed.

Subsequent to the initial inspection, all four wires between the torque and limit switches (i.e., the three broken wires and one that was not broken) were removed. The limit switch upper fingerboard wires together with one of the lugs from which the wire was detached were sent to the test lab of the Technical and Engineering Services department of Detroit Edison for physical and chemical testing. The wire failures occurred inside the lugs, just at the edge of the crimp. There was no evidence of cracking at any other location on the strands. The fingerboard end lug was removed from the unbroken fourth wire; the wire was examined and found to have one strand which had fractured.

The other six strands of the unbroken wire had no visible signs of distress. The lugs were the proper size and the crimp was the proper size and properly compressed.

LICENSEE EVENT REPORT (LER)
TEXT CONTINUATION

ESTIMATED BURDEN PER RESPONSE TO COMPLY WITH THIS INFORMATION COLLECTION REQUEST: 900 HRS. FORWARD COMMENTS REGARDING BURDEN ESTIMATE TO THE INFORMATION AND RECORDS MANAGEMENT BRANCH (MNBB 7714), U.S. NUCLEAR REGULATORY COMMISSION, WASHINGTON, DC 20555-0001, AND TO THE PAPERWORK REDUCTION PROJECT (3150-0104), OFFICE OF MANAGEMENT AND BUDGET, WASHINGTON, DC 20503.

FACILITY NAME (1)		DOCKET NUMBER (2)		LER NUMBER (6)			PAGE (3)
Fermi 2		05000 341		YEAR	SEQUENTIAL NUMBER	REVISION NUMBER	4 OF 6
				93	- 015 -	00	

TEXT (If more space is required, use additional copies of NRC Form 366A) (17)

Examination of the failure ends in the scanning electron microscope revealed that the mode of failure was reverse bending fatigue. All strands in the wires had similar failure characteristics; the predominant fracture area was fatigue with a narrow band, on the ridge of the final fracture, characterized as ductile. Examination of the fractures through a wide field microscope revealed that the fracture propagated over a period of time. This was evident mainly by discoloration on portions of the fracture, progressively less toward the final fracture zone. This examination also revealed other fracture characteristics that strongly suggested that the fatigue was high cycle, low stress.

There was no sign of environmentally induced (e.g., corrosion assisted) fatigue. There was no nicking or cutting of the wire that would indicate a crimping problem. Hardness and bend tests were performed. The hardness was similar to that of new wire. Chemical tests were also performed and the chemical composition was similar in the old and new wire tested. Overall, results to date indicate vibration induced fatigue to be the failure mechanism.

As described in the corrective actions section, the current plan is to relug and replace similar switch compartment internal wires of the suction and discharge valves of both recirculation loops. Further tests and analyses of these wires will be performed to identify the root cause of the vibration fatigue failure mechanism. A supplement to this LER will be provided following completion of this investigation.

Analysis of the Event:

The failure of valve B3105-F031B to close is bounded by the Updated Final Safety Analysis Report section 6.3.3 for a large break Loss of Coolant Accident coincident with a LPCI injection valve failure. This single failure leaves two Core Spray [BM] divisions, the High Pressure Coolant Injection [BJ] and the Automatic Depressurization [RV] systems operable. The peak cladding temperature result for the design basis accident is 2084 degrees Fahrenheit.

An analysis was performed and was described by Licensee Event Report 88-032, "Recirculation Pump B Discharge Valve Failure to Close". The analysis did not take credit for the B3105-F031B valve closure. The analysis concluded

**PREBRIEFING WILL BE HELD ON TUESDAY, JANUARY 4, 1994
AT 1:15 IN ROOM 10B11**

OPERATING REACTORS EVENTS BRIEFING 94-01

**LOCATION: 10 B11, WHITE FLINT
WEDNESDAY, JANUARY 5, 1994 11:00 A.M.**

FERMI, UNIT 2

**CATASTROPHIC TURBINE FAILURE
(AIT)**

MCGUIRE, UNIT 2

**LOSS OF OFFSITE POWER WITH
COMPLICATIONS (AIT)**

**PRESENTED BY: EVENTS ASSESSMENT BRANCH
DIVISION OF OPERATING REACTOR
SUPPORT, NRR**

FERMI, UNIT 2
CATASTROPHIC TURBINE FAILURE
DECEMBER 25, 1993

PROBLEM

WHILE OPERATING AT 93% POWER, A SUDDEN CATASTROPHIC FAILURE OF THE TURBINE OCCURRED. IT APPEARS THAT A TURBINE BLADE OR BLADES BROKE LOOSE FROM THE TURBINE ROTOR. PIECES OF MATERIAL WERE EJECTED THROUGH THE CASING OF THE NUMBER 3 LOW PRESSURE TURBINE. A SMALL FIRE ENSUED NEAR THE GENERATOR EXCITER.

CAUSE

THE ROOT CAUSE OF THE CATASTROPHIC FAILURE OF THE TURBINE IS BEING INVESTIGATED BY THE LICENSEE. REPRESENTATIVES FROM ENGLISH ELECTRIC, GENERAL ELECTRIC, SALEM AND SAN ONOFRE ARE ONSITE. THE FIRE APPEARS TO HAVE BEEN THE RESULT OF A RAPID BURN OF THE HYDROGEN ASSOCIATED WITH THE GENERATOR.

SAFETY SIGNIFICANCE

BROKEN ROTOR AND LOOSE TURBINE BLADES CAN BECOME MISSILES AND CAUSE SUBSTANTIAL DAMAGE. THE FIRE PUT PERSONNEL AND EQUIPMENT AT RISK.

CONTACT: T. GREENE, NRR/OEAB AIT: YES
REFERENCES: 10 CFR 50.72 #26536, #26538, SIGEVENT: TBD
#26540, PN 3-93-0354,
MORNING REPORTS DATED 12/27/93,
12/28/93, & 12/30/93 + 1/3/94

DISCUSSION

- ON DECEMBER 25, 1993, THE PLANT RECEIVED MULTIPLE TURBINE VIBRATION ALARMS AND A SEISMIC ALARM. VIBRATIONS WERE FELT IN THE CONTROL ROOM AND THROUGHOUT THE PLANT. THERE WERE LOUD SOUNDS ASSOCIATED WITH THE VIBRATIONS.
- GENERATOR HYDROGEN GAS PRESSURE DROPPED TO ZERO.
- THE TURBINE TRIPPED AND THE REACTOR SCRAMMED. ALL SAFETY SYSTEMS FUNCTIONED AS EXPECTED.
- MAIN STEAM ISOLATION VALVES CLOSED ON CONDENSER HIGH PRESSURE.
- REACTOR PRESSURE WAS CONTROLLED VIA SRVs AND REACTOR VESSEL WATER LEVEL VIA RCIC AND STANDBY FEEDWATER SYSTEM.
- SMOKE AND STEAM WERE NOTICED IN THE TURBINE ROOM. LICENSEE DECLARED AN ALERT AND SUSPENDED SECURITY REQUIREMENTS FOR SOME PERSONNEL RESPONDING TO THE EVENT (PERSONNEL NOT SEARCHED).
- THE LOCAL FIRE DEPARTMENT WAS SUMMONED TO THE SITE, BUT IT WAS NOT NECESSARY FOR THEM TO ENTER THE PLANT.
- A SMALL FIRE AT THE BRUSHES OF THE GENERATOR EXCITER WAS PUT OUT USING FIRE EXTINGUISHERS.

- A 2 INCH TURBINE BUILDING EQUIPMENT COOLING LINE WAS SEVERED DURING EVENT. THIS AND THE ACTIVATION OF THE SPRINKLER SYSTEM RELEASED A LARGE AMOUNT OF WATER MIXED WITH OIL ON THE MAIN AND LOWER TURBINE DECK. ABOUT 17,000 GAL OF TURBINE LUBRICATION OIL AND HYDROGEN SEAL OIL WAS RELEASED.
- CONDUCTIVITY IN THE REACTOR INCREASED, DUE TO SEVERED CONDENSER TUBES. THE MAXIMUM VALUE WAS 180 MICROMHOS (T.S. LIMIT IS 10 MICROMHOS).
- PLANT COMMENCED A COOLDOWN RATE OF 15 DEGREES FAHRENHEIT PER HOUR.
- ALERT CLASSIFICATION WAS DOWNGRADED TO AN UNUSUAL EVENT CLASSIFICATION, APPROXIMATELY 7 1/2 HOURS AFTER THE START OF THE EVENT.
- WHEN ATTEMPTING TO PLACE DIVISION II SHUTDOWN COOLING IN SERVICE, THE "B" RECIRCULATION PUMP DISCHARGE VALVE WOULD NOT FULLY CLOSE. SHUTDOWN COOLING USING THE "A" LOOP WAS INITIATED.
- ON 12/26/93 PLANT ENTERED COLD SHUTDOWN.

FOLLOWUP

- LICENSEE FOUND A PIECES OF MATERIAL THAT BROKE THROUGH THE TURBINE CASING OF THE NUMBER 3 LOW PRESSURE TURBINE. THE MATERIAL IS ASSUMED TO BE PART OF A TURBINE BLADE.

- THERE WAS EVIDENCE THAT THE HYDROGEN USED FOR COOLING THE MAIN GENERATOR HAD BURNED AND DAMAGED GENERATOR COMPONENTS.
- THERE IS LARGE AMOUNT OF OIL THROUGHOUT THE TURBINE BUILDING. THE LICENSEE HAS POSTED FIRE WATCHES.
- A BROKEN WIRE WAS FOUND IN THE LIMITORQUE HOUSING OF THE "B" RECIRCULATION PUMP DISCHARGE VALVE.
- LEAD STAFF FOR AN AUGMENTED INSPECTION TEAM WERE DISPATCHED TO THE SITE. TEAM LEADER IS RON GARDNER. MAJORITY OF THE TEAM WILL BE ONSITE 01/10/94 WHEN TURBINE INVESTIGATION BEGINS.

NRC STAFF PRESENTATION TO THE ACRS



SUBJECT: FERMII 2 CATASTROPHIC
TURBINE-GENERATOR FAILURE

DATE: MARCH 11, 1994

PRESENTER: RONALD N. GARDNER, CHIEF
PLANT SYSTEMS SECTION
ENGINEERING BRANCH
DIVISION OF REACTOR SAFETY
REGION III

TELEPHONE NO.: (708) 829-9751

PROBLEM

1. CATASTROPHIC TURBINE FAILURE
2. HYDROGEN/LUBE OIL FIRE
3. RADWASTE BASEMENT FLOODING
4. REACTOR COOLANT SYSTEM (RCS) CHEMISTRY

CAUSE

1. TURBINE
 - A. LICENSEE INVESTIGATING
 - B. POTENTIAL HIGH CYCLE FATIGUE

2. FIRE
 - A. HYDROGEN LEAKAGE
 - B. SIGNIFICANT GENERATOR SHAFT/INTERNALSDISPLACEMENT

3. FLOODING
 - A. FIRE PROTECTION SYSTEM ACTUATION/DAMAGE
 - B. GENERAL SERVICE WATER PIPE TO HYDROGEN COOLERS
 - C. TURBINE BUILDING CLOSED COOLING WATER LINE
 - D. LUBE OIL LINE

4. CHEMISTRY
 - A. CONDENSER TUBES RUPTURED
 - B. HOTWELL REJECT TO CONDENSATE STORAGE TANK
 - C. STANDBY FEEDWATER SUCTION FROM CONDENSATE STORAGE TANK

SAFETY SIGNIFICANCE

1. SAFETY RELATED/SAFE SHUTDOWN PERFORMANCE NOT AFFECTED
2. GASEOUS RELEASES WITHIN NORMAL RANGE
3. LIQUID RELEASES CONTAINED NO DETECTABLE CONTAMINATION

NRC ACTION

1. SENIOR RESIDENT INSPECTOR RESPONDED IMMEDIATELY
2. AUGMENTED INSPECTION TEAM (AIT)
3. EXPANDED AIT TO PROVIDE WATER MANAGEMENT OVERSIGHT

DISCUSSION

- * DECEMBER 25, 1993 - TURBINE FAILURE
- * REACTOR SCRAMMED - ALL SAFETY SYSTEMS FUNCTIONED AS EXPECTED
- * MAIN STEAM ISOLATION VALVES CLOSED
- * REACTOR PRESSURE CONTROLLED VIA SAFETY RELIEF VALVES AND REACTOR CORE ISOLATION COOLANT (RCIC)
- * OPERATOR ERROR CAUSED DELAY IN PLACING RCIC IN SERVICE
- * ALERT DECLARED
- * LOCAL FIRE DEPARTMENT SUMMONED TO SITE
- * APPROXIMATELY 500,000 GALLONS OF WATER AND 17,000 OF OIL RELEASED TO TURBINE BUILDING FLOORS
- * WATER AND OIL OVERFLOWED TO RADWASTE BASEMENT
- * RCS CONDUCTIVITY INCREASED DUE TO SEVERED CONDENSER TUBES

DISCUSSION (CONT'D)

- * OPERATORS SLOW TO RECOGNIZE SIGNIFICANCE OF HIGH HOTWELL LEVEL

- * WHEN ATTEMPTING TO PLACE DIVISION II SHUTDOWN COOLING IN SERVICE, THE "B" RECIRCULATION PUMP DISCHARGE VALVE WOULD NOT CLOSE.

- * RESIDUAL HEAT REMOVAL (RHR) WARMUP VALVE FAILED TO CLOSE WHEN PLANT WAS BEING PLACED IN RHR SHUTDOWN COOLING MODE

- * ON DECEMBER 26, 1993, THE PLANT ENTERED COLD SHUTDOWN

INSPECTION RESULTS

TURBINE FAILURE

- * NO INDICATION OF PENDING TURBINE-GENERATOR FAILURE
- * ROOT CAUSE BEING INVESTIGATED BY LICENSEE
- * NO INDICATION FAILURE WAS DUE TO TURBINE OVERSPEED OR ELECTRICAL GRID DISTURBANCES
- * FERMI PRECURSOR EVENTS:

SEPTEMBER 1989 - REFUELING OUTAGE (RFO) 1

- * FAILED BLADES FOUND IN 5TH STAGE OF LOW PRESSURE (LP) 2
- * ALL LP TURBINE EIGHTH STAGE BLADES SUSTAINED EXCESSIVE WEAR OF LACING RODS AND LACING HOLES DUE TO TIP ROCK

DECEMBER 1990

- * FIVE STAGE 4 BLADES OF LP3 EXPERIENCED FATIGUE FAILURE

APRIL 1991 - RF02

- * ALL LP TURBINE STAGE 4 BLADES REPLACED
- * ALL LP 5TH STAGE BLADES REINSTALLED
- * REFURBISHED EIGHTH STAGE LP1 BLADES
INSTALLED IN LP2

SEPTEMBER 1992 - RF03

- * BASED ON VISUAL INSPECTION, LICENSEE DID NOT
REPLACE EIGHTH STAGE BLADES IN LP3

INSPECTION RESULTS

RCS CHEMISTRY

* HIGH CONDUCTIVITY

- PRIOR 0.08 μ MHOS
- AFTER 185.0 μ MHOS

* HIGH CHLORIDES

- PRIOR < 2 PPB
- AFTER 10 PPM

* CONCERNS

1. CONTROL ROD DRIVE (CRD) SEALS
2. REACTOR INTERNALS

* TEMPORARY MODIFICATIONS

1. CONDENSATE RETURN TANK (CRT) TO CRD FOR CRD SEALS BACK TO CRT VIA REACTOR WATER CLEANUP (RWCU) AND PORTABLE DEMINERALIZERS
2. RWCU TO PORTABLE DEMINERALIZERS (HIGHER FLOWS)

INSPECTION RESULTS

FIRE PROTECTION SYSTEM

- * AUTOMATIC SUPPRESSION AND FIRE ALARM SYSTEMS OPERATED AS DESIGNED
- * FULL FIRE BRIGADE RESPONDED AS A TEAM APPROXIMATELY 37 MINUTES AFTER THE EVENT
- * COMMUNICATIONS PROBLEMS CAUSED DELAYS IN ASSESSING FIRE'S EXTENT
- * NO ABNORMAL PROCEDURE FOR TURBINE BUILDING FLOODING
- * DIFFICULTY IN SECURING SYSTEMS CAUSING FLOODING

INSPECTION RESULTS

WATER MANAGEMENT

1. RADWASTE BUILDING

- * 500,000 GALLONS OF WATER AND 17,000 GALLONS OF OIL FLOODED RADWASTE BUILDING BASEMENT
- * WATER BECAME CONTAMINATED AFTER MIXING WITH CONTENTS OF TANKS AND SUMPS
- * NORMAL RADWASTE PROCESSING EQUIPMENT INOPERABLE
- * PRESENT DESIGN INADEQUATE TO PREVENT FUTURE FLOODING
- * TEMPORARY MODIFICATION TRANSFERRED WATER TO HOTWELL

2. REACTOR BUILDING

- * CORNER ROOMS 40 FT. BELOW RADWASTE BUILDING BASEMENT
- * NO TESTING OR PREVENTIVE MAINTENANCE ON CHECK VALVES DESIGNED TO PREVENT CORNER ROOM FLOODING

3. CONDENSATE STORAGE TANK

- * DAMAGE TO MAIN CONDENSER RESULTED IN LAKE WATER ENTERING CONDENSER HOTWELL AND BEING PUMPED TO CONDENSATE STORAGE TANK
- * TEMPORARY MODIFICATION INSTALLED TEMPORARY DEMINERALIZER SYSTEM TO RECIRCULATE AND TREAT WATER PRIOR TO DISCHARGE

POWER REACTOR				EVENT NUMBER: 26536			
FACILITY: FERMI		REGION: 3		NOTIFICATION DATE: 12/25/93			
UNIT: [2] [] []		STATE: MI		NOTIFICATION TIME: 14:25 [ET]			
RX TYPE: [2] GE-4				EVENT DATE: 12/25/93			
NRC NOTIFIED BY: POUPARD/KIEL				EVENT TIME: 13:57[EST]			
HQ OPS OFFICER: JOHN MacKINNON				LAST UPDATE DATE: 12/25/93			
EMERGENCY CLASS: ALERT				NOTIFICATIONS			
10 CFR SECTION:				JOHN JACOBSON RDO			
AAEC 50.72(a)(1)(i) EMERGENCY DECLARED				BRAIN GRIMES EO			
				CARR FEMA			
				KEN BROCKMAN AEOD			
				ED JORDAN AEOD			
UNIT	SCRAM CODE	RX CRIT	INIT PWR	INIT RX MODE	CURR PWR	CURR RX MODE	
2	A/R	Y	93	POWER OPERATION	0	HOT SHUTDOWN	

EVENT TEXT

LOSS OF OIL SUPPLY PRESSURE TO MAIN TURBINE BEARINGS CAUSED REACTOR SCRAM AND DAMAGE TO MAIN GENERATOR.

LICENSEE HAD HIGH VIBRATION OF THEIR MAIN TURBINE (RECEIVED SEISMIC ALARM) AND THEY FOUND OUT THAT THEY HAD LOST OIL SUPPLY PRESSURE TO THE MAIN TURBINE BEARINGS. LICENSEE THINKS THAT THE HIGH VIBRATION OF THE MAIN TURBINE CAUSED THE HIGH PRESSURE TURBINE STOP VALVES TO COME OFF THEIR OPEN SEAT AND CLOSE ENOUGH TO CAUSE A TURBINE TRIP SIGNAL. THIS CAUSED A TURBINE TRIP AND A REACTOR SCRAM. ALL RODS FULLY INSERTED. LICENSEE IMMEDIATELY BROKE VACUUM TO STOP THE TURBINE (DONE WITHIN A FEW SECONDS OF THE REACTOR SCRAM). MAIN STEAM ISOLATION VALVES CLOSED ON CONDENSER HIGH PRESSURE (LICENSEE SAID THAT THEY SOMEHOW LOST SOME MAIN CONDENSER VACUUM PRIOR TO STOPPING THE MAIN TURBINE, POSSIBLY A SEAL PROBLEM ON THE MAIN TURBINE). CONTROL ROOM OPERATORS ARE CONTROLLING REACTOR PRESSURE WITH SRVs AND CONTROLLING REACTOR VESSEL WATER LEVEL VIA RCIC AND STANDBY FEEDWATER SYSTEM. ALL ECCS AND EDGs ARE FULLY OPERABLE. LICENSEE DECLARED AN ALERT WHEN THEY SAW STEAM/SMOKE IN THE GENERAL LOCATION OF THE OIL PURIFICATION ROOM (ASSOCIATED WITH MAIN TURBINE) WHICH IS LOCATED IN THE TURBINE BUILDING. LICENSEE FOUND A SMALL FIRE AT THE BRUSHES OF THE MAIN TURBINE GENERATOR AND IT WAS IMMEDIATELY EXTINGUISHED. NOBODY HAS BEEN INJURED. LICENSEE CALLED FRENCH TOWN FIRE DEPARTMENT AND THREE FIRE TRUCKS SHOWED UP AT THEIR MAIN GATE BUT THEY WERE NOT USED. OPERATIONS ENTERED EMERGENCY OPERATING PROCEDURE FOR PRIMARY CONTAINMENT CONTROL WHEN SUPPRESSION POOL TEMPERATURE EXCEEDED 95 DEGREES F. LICENSEE SAID THAT ARE IN SUPPRESSION POOL COOLING MODE AND SUPPRESSION POOL TEMPERATURE IS NOW 95 DEGREES.

GENERATOR HYDROGEN GAS PRESSURE WENT TO ZERO AT THE START OF THIS EVENT. LICENSEE SAID THAT IT APPEARS THAT THEY HAD A RAPID HYDROGEN BURN OR A HYDROGEN EXPLOSION BECAUSE THE SEAL ON THE MAIN GENERATOR IS NO LONGER ATTACHED TO ITS CASING, EXCITER CASING IS NOT ATTACHED TO THE EXCITER, AND EXCITER BRUSH HOUSING IS DESTROYED (THERE IS NO INDICATION OF HYDROGEN GAS IN THE TURBINE BUILDING AT THE TIME OF THIS CALL). LICENSEE SAID THAT 100 TO 200 GALLONS OF TURBINE LUBRICATING OIL IS MIXED WITH WATER (FROM RUPTURED TURBINE COOLING WATER PIPES) ON THE MAIN TURBINE DECK AND ON THE LOWER TURBINE DECK. LICENSEE HAS FIRE WATCHES STATIONED AND DOES NOT CONSIDER THE OIL AND WATER MIXTURE A FIRE HAZARD. LICENSEE NOTIFIED STATE AND LOCAL OFFICIALS OF THIS EVENT.

RESIDENT INSPECTOR WAS CALLED BY LICENSEE.

UPDATE @ 1752EST BY REITH TAKEN BY MACKINNON

ALERT CLASSIFICATION WAS DOWNGRADED TO AN UNUSUAL EVENT CLASSIFICATION AT 1722EST BASED ON STABLE PLANT CONDITIONS (FIRE IS EXTINGUISHED, REACTOR IS SHUTDOWN AND IS BEING COOLDOWN, AND FRENCH TOWN FIRE DEPARTMENT FIRE TRUCKS WENT BACK TO THEIR FIRE STATION). R3DO (JOHN JACOBSON), EO (BRIAN GRIMES), FEMA (MOSTELLER) NOTIFIED.

Mr IVAN VAJCOVEC OF THE CANADIAN ATOMIC ENERGY CONTROL BOARD WAS NOTIFIED OF THIS EVENT AT 1945EST.

COMMISSIONERS ASSISTANCE BRIEFING @ 2000EST BY ED GREENMAN

BRIEFING PARTICIPANTS WERE KEN BROCKMAN (AEOD), SUE GAGNER (PUBLIC AFFAIRS), DICK BANGART (STATE PROGRAMS), BILL UPSHAW (INTERNATIONAL PROGRAMS), BILL HILL (SECY), TOM MADDEN (CONGRESSIONAL AFFAIRS), JACK SCARBOROUGH (COMM. ROGERS ASSIST.), JOSE IBARRA (CHAIRMAN SELIN ASSIST.), JACK GUTTMANN (COMM. REMICK'S ASSIST.), JOEL LUBENAU (COMM. de Planque's ASSIST.), TIM COLBURN (PM), & SENIOR RESIDENT INSPECTOR (KROPP) NOTIFIED.

UPDATE @2107EST BY OPLAND TAKEN BY MACKINNON

UNUSUAL EVENT TERMINATED AT 2052EST BASED ON PLANT BEING IN A STABLE CONDITION. LICENSEE IS GOING TO A COLD SHUTDOWN CONDITION. THEY HAVE EXTENSIVE DAMAGE TO THEIR MAIN GENERATOR. LICENSEE NOTIFIED STATE & LOCAL OFFICIALS OF THIS EVENT. R3DO (JOHN JACOBSON), EO (BRIAN GRIMES), & FEMA (SHULL) NOTIFIED.

**** FEDERAL AGENCIES NOTIFIED OF ABOVE EVENT****

FEMA (CARR/MOSTELLER/SHULL), DOT (PETTY OFFICER DEEGAN), DOE (THOMAS TANNER), HHS (KENT GRAY), EPA (CRAIG CONKLIN), & USDA (GEORGE BICKERTON).

RESIDENT INSPECTOR WAS INFORMED OF THIS EVENT BY LICENSEE.

POWER REACTOR				EVENT NUMBER: 26540			
FACILITY: FERMI		REGION: 3		NOTIFICATION DATE: 12/26/93			
UNIT: [2] [] []		STATE: MI		NOTIFICATION TIME: 14:09 [ET]			
RX TYPE: [2] GE-4				EVENT DATE: 12/26/93			
NRC NOTIFIED BY: KIEL				EVENT TIME: 05:20[EST]			
HQ OPS OFFICER: JOHN MacKINNON				LAST UPDATE DATE: 12/26/93			
EMERGENCY CLASS: NOT APPLICABLE				NOTIFICATIONS			
10 CFR SECTION:				JOHN JACOBSON RDO			
AIND 50.72(b)(2)(iii)(D) ACCIDENT MITIGATION							
NLCO TECH SPEC LCO A/S							
UNIT	SCRAM CODE	RX CRIT	INIT PWR	INIT RX MODE	CURR PWR	CURR RX MODE	
2	N	N	0	HOT SHUTDOWN	0	HOT SHUTDOWN	

EVENT TEXT

WHILE PLACING DIVISION 2 OF RHR INTO SERVICE FOR SHUTDOWN COOLING (SDC) MODE OF OPERATION THE "B" RECIRCULATION PUMP DISCHARGE VALVE (B31-F031) FAILED TO CLOSE.

WHILE PLACING RHR DIVISION 2 INTO SDC MODE OF OPERATION, "B" RECIRCULATION PUMP LOOP DISCHARGE VALVE (B31-F031) FAILED TO INDICATE FULLY CLOSED. LICENSEE IS UNABLE TO OPEN OR CLOSE THIS LIMITORQUE VALVE (THINK THAT THEY MAY HAVE A LIMIT SWITCH PROBLEM ASSOCIATED WITH THIS VALVE). THIS PLACED LICENSEE IN TECH SPEC ACTION STATEMENTS 3.5.1 (ECCS OPERATION), 3.5.2 (ECCS SHUTDOWN), & 3.4.9.1 (RHR SDC OPERATION). LICENSEE IS STILL IN TECH SPEC 3.5.1 ACTION STATEMENT (HAVE 24 HOURS TO BE IN A COLD SHUTDOWN CONDITION).

LICENSEE SHUT RHR CROSS CONNECT VALVE (E11-F010, CROSS TIE VALVE BETWEEN DIVISION 1 & 2 OF RHR) AND FAILED THE "A" SIDE OF LPCI LOOP SELECTION LOGIC (PREVENTS LPCI TRANSFERRING ITS INJECTION PATH TO THE "B" RECIRCULATION PUMP LOOP IN CASE "A" RECIRCULATION LOOP DEVELOPED A LARGE LEAK). LICENSEE SECURED PLACING DIVISION 2 OF RHR INTO SERVICE AND ARE PLACING DIVISION 1 OF RHR INTO SDC MODE OF OPERATION. LICENSEE CONSIDERS DIVISION 2 OF RHR FUNCTIONAL BUT INOPERABLE (INOPERABLE PER TECH SPECS). LICENSEE WILL BE IN A COLD SHUTDOWN CONDITION WITHIN TECH SPEC ACTION STATEMENT TIME LIMIT OF 24 HOURS. REACTOR VESSEL PRESSURE IS CURRENTLY 130psi AND REACTOR VESSEL WATER TEMPERATURE IS 310 DEGREES F. ALL OTHER ECCS SYSTEMS ARE FULLY OPERABLE IF NEEDED (SINCE STEAM DOME PRESSURE IS BELOW 150psi RCIC AND HPCI ARE NOT REQUIRED TO BE OPERABLE).

LICENSEE DETERMINED THIS TO BE A REPORTABLE EVENT AT 1030 EST 12/26/93.
THE RESIDENT INSPECTOR WAS INFORMED AND THE LICENSEE WILL ISSUE A PRESS
RELEASE ABOUT THIS EVENT.

POWER REACTOR		EVENT NUMBER: 26709				
FACILITY: FERMI		REGION: 3	NOTIFICATION DATE: 01/29/94			
UNIT: [2] [] []		STATE: MI	NOTIFICATION TIME: 07:56 [ET]			
RX TYPE: [2] GE-4			EVENT DATE: 01/29/94			
NRC NOTIFIED BY: SNYDER			EVENT TIME: 07:04[EST]			
HQ OPS OFFICER: JOHN MacKINNON			LAST UPDATE DATE: 01/29/94			
EMERGENCY CLASS: UNUSUAL EVENT		NOTIFICATIONS				
10 CFR SECTION:		JIM CREED	RDO			
AAEC 50.72(a)(1)(i) EMERGENCY DECLARED		STEVE VARGA	EO			
		SHULL	FEMA			
		ED JORDAN	AEOD			
		BILL BEECHER	PAO			
		ED GREENMAN	REG3			
UNIT	SCRAM CODE	RX CRIT	INIT FWR	INIT RX MODE	CURR PWR	CURR RX MODE
2	N	N	0	COLD SHUTDOWN	0	COLD SHUTDOWN

EVENT TEXT

FIRE LASTED 20 MINUTES IN TURBINE BUILDING PASSENGER ELEVATOR SHAFT BEFORE IT WAS EXTINGUISHED.

FIRE IN TURBINE BUILDING PASSENGER ELEVATOR SHAFT LASTED FROM 0654EST UNTIL IT WAS EXTINGUISHED AT 0714EST. LICENSEE'S ONSITE FIRE BRIGADE EXTINGUISHED THE FIRE USING FIRE EXTINGUISHERS AND USING FIRE RETARDANT CHEMICAL "PKP" (LICENSEE DID NOT HAVE TO CALL LOCAL FIRE DEPARTMENT FOR HELP). ONE OF LICENSEE'S FIRE FIGHTERS WAS OVERCOME BY SMOKE INHALATION WHILE FIGHTING THE FIRE. THE FIRE FIGHTER RECOVERED AND WAS LATER TRANSFERRED OFFSITE IN AN AMBULANCE FOR OBSERVATION (LICENSEE HAD CALLED FOR THE AMBULANCE). LICENSEE THINKS THE FIRE IN THE ELEVATOR SHAFT WAS CAUSED BY THE RUBBING TOGETHER OF TWO 1.25" DIAMETER ELEVATOR POWER CABLES LOCATED IN THE ELEVATOR SHAFT BETWEEN THE FIRST AND SECOND FLOOR OF THE TURBINE BUILDING. FLAMES COULD BE SEEN SHOOTING UP THE ELEVATOR SHAFT THROUGH THE ELEVATOR DOORS ON THE SECOND AND THIRD FLOOR OF THE TURBINE BUILDING. LICENSEE SAID THE THE FIRE WAS NOT CAUSED BY RESIDUAL MAIN TURBINE LUBRICATING OIL OR MAIN TURBINE EHC OIL FROM 12/25/93 EVENT. SMOKE FROM THE FIRE ACCUMULATED IN THE THIRD FLOOR OF THE TURBINE BUILDING. ALL THE SMOKE FROM THE FIRE HAS BEEN VENTILATED FROM THE TURBINE BUILDING. LICENSEE TERMINATED THE UNUSUAL EVENT AT 0753EST AFTER THEY MADE SURE THE FIRE WAS OUT. ELEVATOR HAD NOBODY IN IT WHEN THE FIRE STARTED. NO SAFETY SYSTEMS IN THE PLANT WERE AFFECTED BY THIS FIRE. LICENSEE NOTIFIED STATE AND LOCAL OFFICIALS OF THIS EVENT. A PRESS RELEASE WILL BE MADE BY LICENSEE LATER TODAY ABOUT THIS FIRE.

LICENSEE WILL NOTIFY THEIR RESIDENT INSPECTOR OF THIS EVENT.

POWER REACTOR

EVENT NUMBER: 27056

FACILITY: FERMI
UNIT: [2] [] []
RX TYPE: [2] GE-4

REGION: 3
STATE: MI

NOTIFICATION DATE: 04/07/94
NOTIFICATION TIME: 17:57 [ET]
EVENT DATE: 04/07/94
EVENT TIME: 17:30[EDT]
LAST UPDATE DATE: 04/07/94

NRC NOTIFIED BY: HOSKINS
HQ OPS OFFICER: CHAUNCEY GOULD

NOTIFICATIONS

EMERGENCY CLASS: NOT APPLICABLE
10 CFR SECTION:
APRE 50.72(b)(2)(vi) OFFSITE NOTIFICATION

BRUCE BURGESS RDO

UNIT	SCRAM CODE	RX CRIT	INIT PWR	INIT RX MODE	CURR PWR	CURR RX MODE
2	N	N	0	COLD SHUTDOWN	0	COLD SHUTDOWN

EVENT TEXT

THE LICENSEE ISSUED A PRESS RELEASE CONCERNING CURRENT STATUS ON THREE ITEMS.

THE FIRST WAS THE INVESTIGATION INTO THE ROOT CAUSE OF THE 12/25/93 MAIN TURBINE FAILURE. DURING AN INVESTIGATION FOCUSING ON THE 8TH STAGE OF THE #3 LOW PRESSURE TURBINE, THEY DISCOVERED ADDITIONAL CRACKS IN THE ROOT OF 12 SEVENTH STAGE BLADES OF LOW PRESSURE TURBINES 2 & 3. PRELIMINARY TESTS INDICATE THAT THESE CRACKS MAY HAVE EXISTED BEFORE THE 12/25/93 EVENT. THE FINDING OF THESE ADDITIONAL BLADE CRACKS HAS PROMPTED THE LICENSEE TO CONSIDER WHETHER TO REPLACE PART OR ALL OF THE TURBINE. MINOR DISTORTIONS HAVE ALSO BEEN FOUND IN ALL 3 LOW PRESSURE TURBINE ROTORS.

THE SECOND ITEM WAS THAT THE LICENSEE PLANS TO RELEASE THE REMAINING 500,000 GALS OF EXCESS WATER WHICH ACCUMULATED AFTER THE ACCIDENT. THE QUALITY OF THE WATER MEETS ALL STATE AND FEDERAL ENVIRONMENTAL STANDARDS FOR DISCHARGE.

THE THIRD ITEM IS THAT THE LICENSEE IS MOVING AHEAD WITH ARRANGEMENTS TO REFUEL THE REACTOR. THE RI WILL BE INFORMED.

Douglas R. Gipson
Senior Vice President
Nuclear Generation

Fermi 2
6400 North Dixie Highway
Newport, Michigan 48166
(313) 586-5249

Detroit
Edison

January 4, 1994
NRC-94-0001

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555
Attn: Document Control Desk

References: 1) Fermi 2
NRC Docket No. 50-341
NRC License No. NPF-43
2) Technical Specification
Surveillance Requirement
4.3.7.2.2

Subject: Technical Specification Special Report of the Actuation of
Active Seismic Monitoring Instrumentation

On December 25, 1993 the Fermi 2 Plant experienced a failure of the turbine generator. A reactor scram occurred as a result of the turbine trip and was reported as required by 10 CFR 50.72. The Licensee Event Report for this event is being prepared and will be submitted as LER No. 93-014. Because this event also involved the actuation of plant seismic monitoring instrumentation, this Special Report is being submitted as discussed in Reference 2 for seismic events.

Information collected from the seismic monitoring instrumentation is still being evaluated. A discussion of the magnitude and frequency spectrum of the event will be included in LER 93-014.

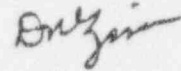
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USNRC
January 4, 1994
NRC-94-0001
Page 2

The effects of the December 25, 1993 event are being thoroughly evaluated and will also be addressed in LER 93-014. Preliminary walkdowns of the Reactor Building and the Auxiliary Building were performed on December 29, 1993 and did not identify any adverse effect on structures, systems, or components important to safety. Plans are currently being developed to conduct more detailed walkdowns of plant structures and systems. The results of these walkdowns will be discussed with the NRC's Augmented Inspection Team when they are completed.

Should you have any questions concerning this report, please contact Joseph M. Pendergast, Compliance Engineer at (313) 586-1682.

Sincerely,



cc: T. G. Colburn
W. J. Kropp
J. B. Martin
M. P. Phillips

FORD 1

Enclosure 8

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	NRR/PMAS/ILPB1	1		NRR/PMAS/ILPB2	1
	NUDOCS-ABSTRACT	1		OE DIR	1
	OGC/HDS2	1		REG FILE 02	1
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ENGINEERS

DCA/DCB
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FERMI 2 TURBINE FAILURE
POST EVENT EARTHQUAKE INSTRUMENTATION DATA EVALUATION

Prepared for: Detroit Edison Company
Enrico Fermi 2 Job Site
6400 North Dixie Highway
Newport, MI 48166

0
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Prepared by: Hopper and Associates
300 Vista Del Mar
Redondo Beach, CA 90277

February 4, 1994

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1.0 INTRODUCTION

1.1 Fermi 2 History

The Enrico Fermi Unit 2 Nuclear Power Plant is a 1,203-MV gross Boiling Water Reactor located outside Detroit, Michigan on Lake Erie. Fermi 2 has been in commercial operation since 1988, using a turbine manufactured by English Electric of Rugby, England, now part of G.E.C.-Alsthom. The facility site is located on stable land, and few large intensity earthquakes have occurred in the facility vicinity throughout documented history.

1.2 Turbine Failure

At approximately 13:15 on December 25, 1993, the turbine at the Enrico Fermi Unit 2 Nuclear Power Plant failed. The turbine failure included thrown blades, severed cooling system piping, turbine lubricating system failures, and a hydrogen explosion. Vibration imbalance in the main turbine generator activated a turbine alarm. Almost simultaneously, numerous alarms were received, including seismic event, additional turbine alarms, and reactor scram. Upon receiving the reactor scram alarm, the operator immediately began shutdown procedures of the turbine and reactor.

1.3 Shock Incident

Personal observations attest to a loud noise followed by a rumbling sound which lasted two to three minutes. The seismic event alarm and the reactor scram alarm were noticed concurrent with the loud noise and rumbling. Although the root failure cause is unclear at this time, the rumbling sound was attributed to vibration.

The passive peak shock record plates on the second and fifth floors of the Reactor/Auxiliary building recorded insignificant accelerations, or accelerations below the Operating Basis Earthquake (OBE).

The active strong motion time history accelerometers in the HPCI room and at the reactor pressure vessel (RPV) pedestal base recorded measurable accelerations. The accelerometers were preset to activate at a 0.01 g level. Subsequent to this activation, two impulsive acceleration excitation spikes were recorded after approximately two and sixty-three seconds. The passive peak shock record plates in the sub-basement of the Reactor/Auxiliary building (HPCI room) also recorded measurable accelerations.

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Instrumentation data from both active and passive sensors were evaluated and compared to those excitation levels in the Fermi 2 Updated Final Safety Analysis Report (UFSAR) to verify the continuing structural integrity of the Reactor/Auxiliary building and the equipment inside the building.

1.4 Seismic Event Procedure Requirements

Section 3.7.4.4 of the UFSAR states an earthquake has occurred if the seismic trigger is activated. If the seismic event exceeds the OBE, the reactor must be shut down as quickly as possible. Before normal operation can commence, the UFSAR requires data reduction, analysis, and interpretation of time histories and response spectra from instrumentation; and structure, system, and component inspection.

1.5 Results

Globally, the building did not experience an OBE event, and consequently, the Reactor/Auxiliary building was never exercised near OBE excitation levels as evidenced by the insignificant accelerations measured on the second and fifth floors of the building. Likewise, the equipment on the second and higher floors was never exercised near OBE excitation levels.

Below the second floor, at the RPV pedestal, the active instrumentation show OBE exceedences at high frequencies and both active and passive instrumentation exhibit OBE exceedences in the HPCI room. However, no anomalies were observed during the event, and a cursory inspection of both building and equipment after the event indicates there to be no apparent problems.

The two distinct tremors recorded by the active instrumentation mounted to the structural foundation exhibit those characteristics that would be anticipated from a surface wave system emanating from an impact at an adjacent surface location. These waves locally pass through the structural foundation with the path of the particle motion theoretically describing a single retrograde ellipse. They possess none of the energy characteristics of tectonic earthquake waves and do not result in the global structural excitation experienced during a traditional seismic event.

2.0 HISTORY

2.1 Seismic Events

2.1.1 Previous Seismic Events

Fermi 2 is located in a relatively seismic stable area. Approximately fifteen intensity VI (Modified Mercalli Scale) or greater earthquakes have occurred within a two hundred mile radius in the last two hundred years (Figure 2.1.1.1). Additionally, nine earthquakes of intensity V or less have occurred within a fifty mile radius of the facility (Figure 2.1.1.2). Although the Fermi 2 OBE is associated with an intensity VI seismic event, it is unlikely the facility will experience such an earthquake within its lifetime.

2.1.2 December 25, 1993

The National Geophysics Data Center and the National Oceanic and Atmospheric Administration show no seismic activity for December 25, 1993, within a five hundred km (310 mile) radius of Detroit. The center has immediate knowledge of all seismic activity in the Detroit vicinity of intensity III or greater.

The most recent seismic event within two hundred miles of the facility site had an intensity of approximately I and occurred in April of 1993. The passive peak shock recorder plates were calibrated and installed in July of 1993 (second and fifth floors) and September of 1993 (HPCI room). This evidence indicates the passive plate records contained only the turbine failure incident.

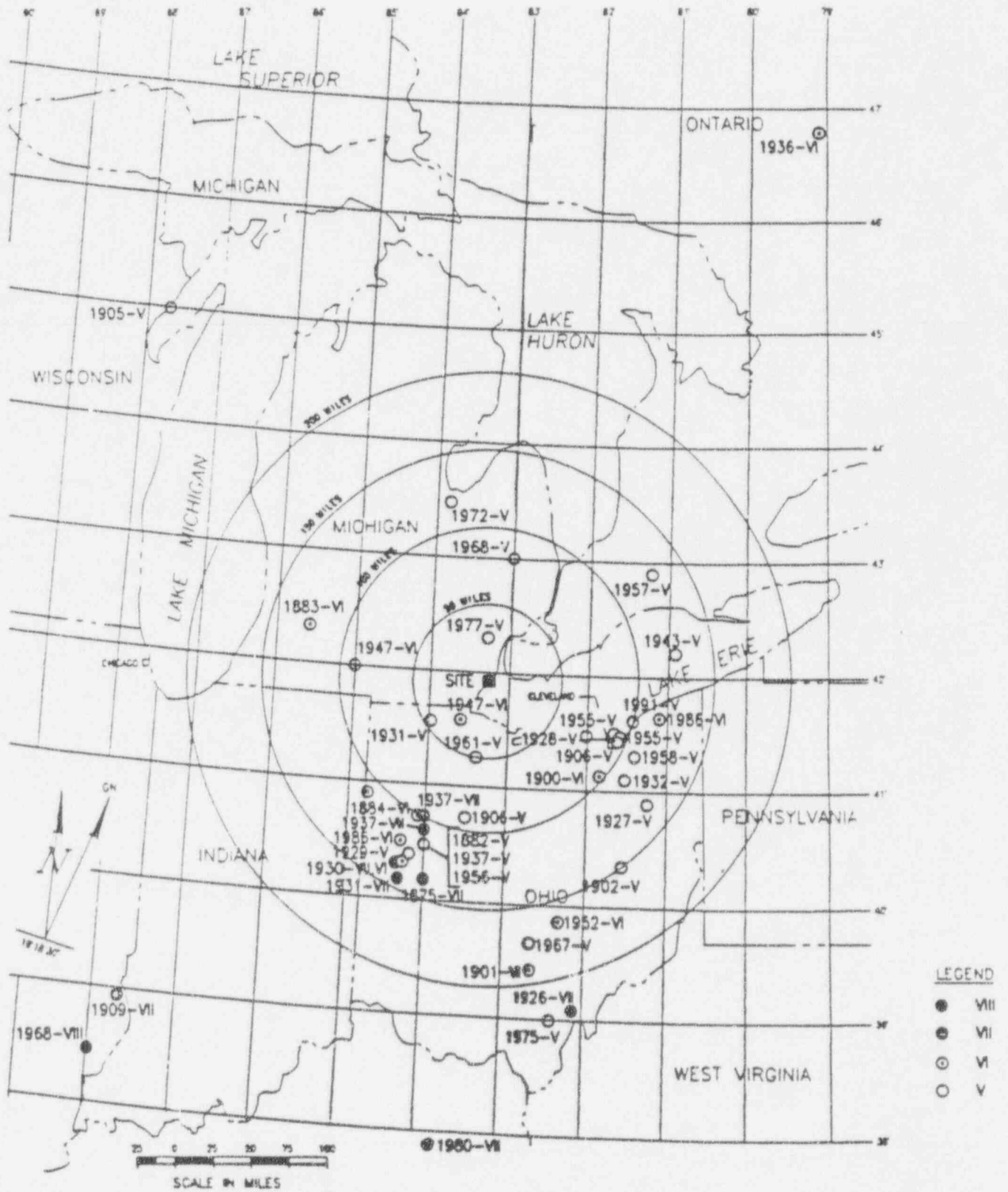
2.2 Sequence of Events

2.2.1 Turbine Failure and Damage

It is beyond the scope of this document to chronically arrange the events of the turbine failure on December 25, 1993.

At approximately 13:15 on December 25, 1993, the number 3 low-pressure turbine at Fermi 2 failed catastrophically. The turbine threw several blades. One blade ripped through the steel turbine casing. The other blades are believed to be in-

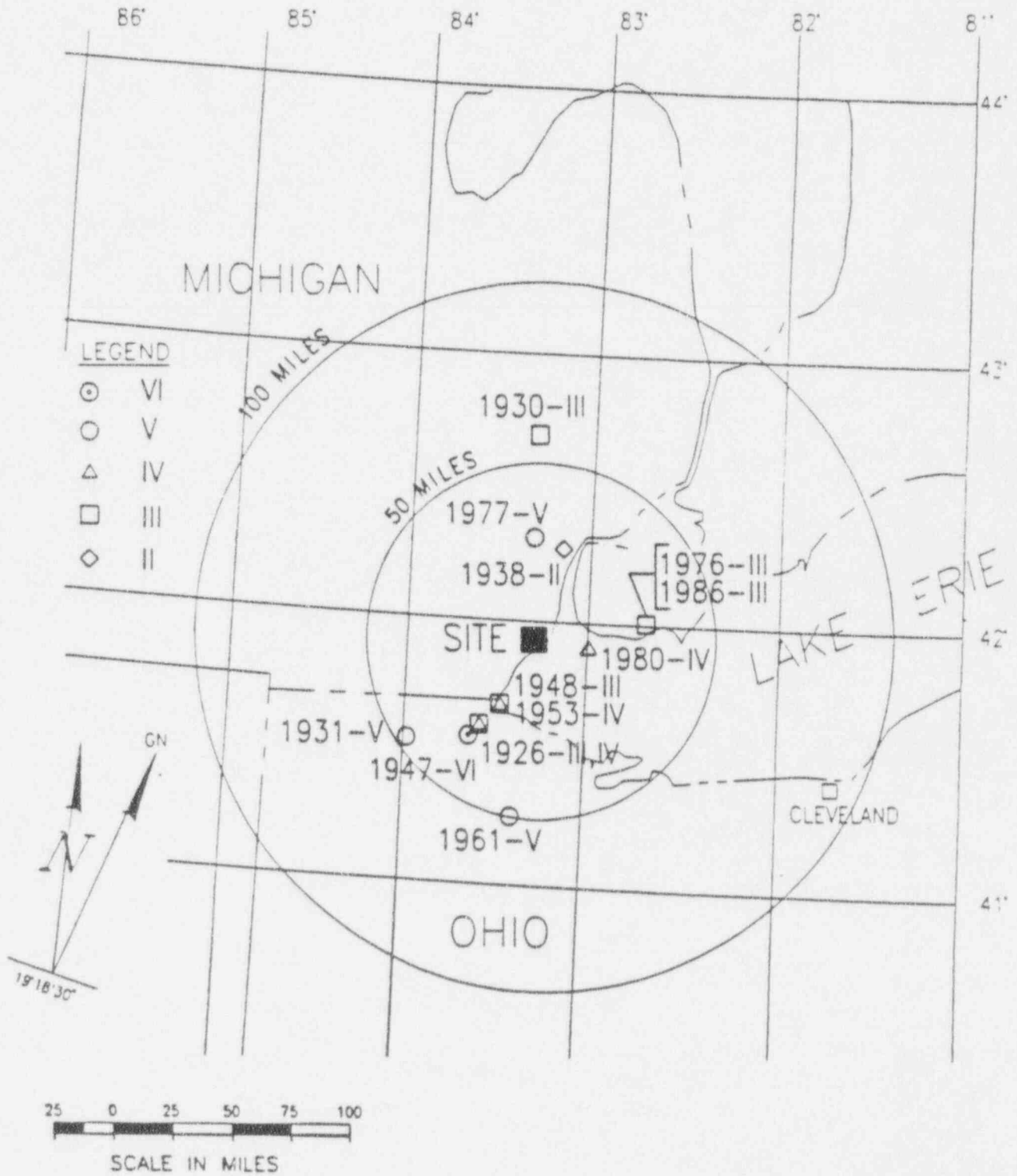
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ENGINEERS



Epicenter Map, Detroit Area, intensity V or Greater, 200 Mile Radius

Figure 2.1.1.1

HOPPER AND ASSOCIATES
ENGINEERS



Epicenter Map, Detroit Area, All Earthquakes, 50 Mile Radius

Figure 2.1.1.2

side the condenser. Vibration caused measurements in excess of 37.5 mils peak-to-peak at the turbine bearings, recorded by the Diagnostic Vibration Analysis (DVA) System.

A small hydrogen explosion occurred near the number 9 bearing, and the resulting fire charred the shield wall. The fire or the steam from the turbine casing activated the fire protection system. Approximately six hundred thousand gallons of water poured into the turbine building. Additionally, a 2" cooling system pipe was severed, adding more water. The turbine lubricating system also failed, and approximately seventeen thousand gallons of oil poured onto the floor. The ensuing mixture drained into the turbine building basement.

Turbine vibration tore couplings, sheared bolts, and loosened the excitor from the main turbine generator.

2.2.2 Shutdown

The turbine failure activated the turbine, seismic event, and reactor scram alarms, and both the turbine and the reactor proceeded to shutdown. All safety systems responded to achieve a satisfactory shutdown of the turbine and the reactor. The event was declared an alert at approximately 13:52 due to fire potential, and later downgraded to an unusual event.

2.2.3 Observations

No personnel were in the vicinity of the turbine failure. Almost all personnel nearby heard a loud noise, followed by a rumbling, which lasted two to three minutes. Some personnel felt vibrations through the building. Almost simultaneously, personnel in the buildings heard the reactor scram alarm. Those near the turbine building reported heavy smoke.

Several personnel were directed to inspect the turbine building for fire. They noted damaged parts on the third floor, and a small fire at the generator brushes, which they extinguished with a CO2 fire extinguisher.

Remaining personnel proceeded in duties as directed to facilitate the reactor shutdown.

2.2.4 Human Sensitivity to Vibration

Work conducted by numerous researchers have established physiological limits of human perceptibility to vibration. The studies demonstrate humans can detect vibrations well below the current instrument sensitivity at Fermi 2 (Figure 2.2.4.1).

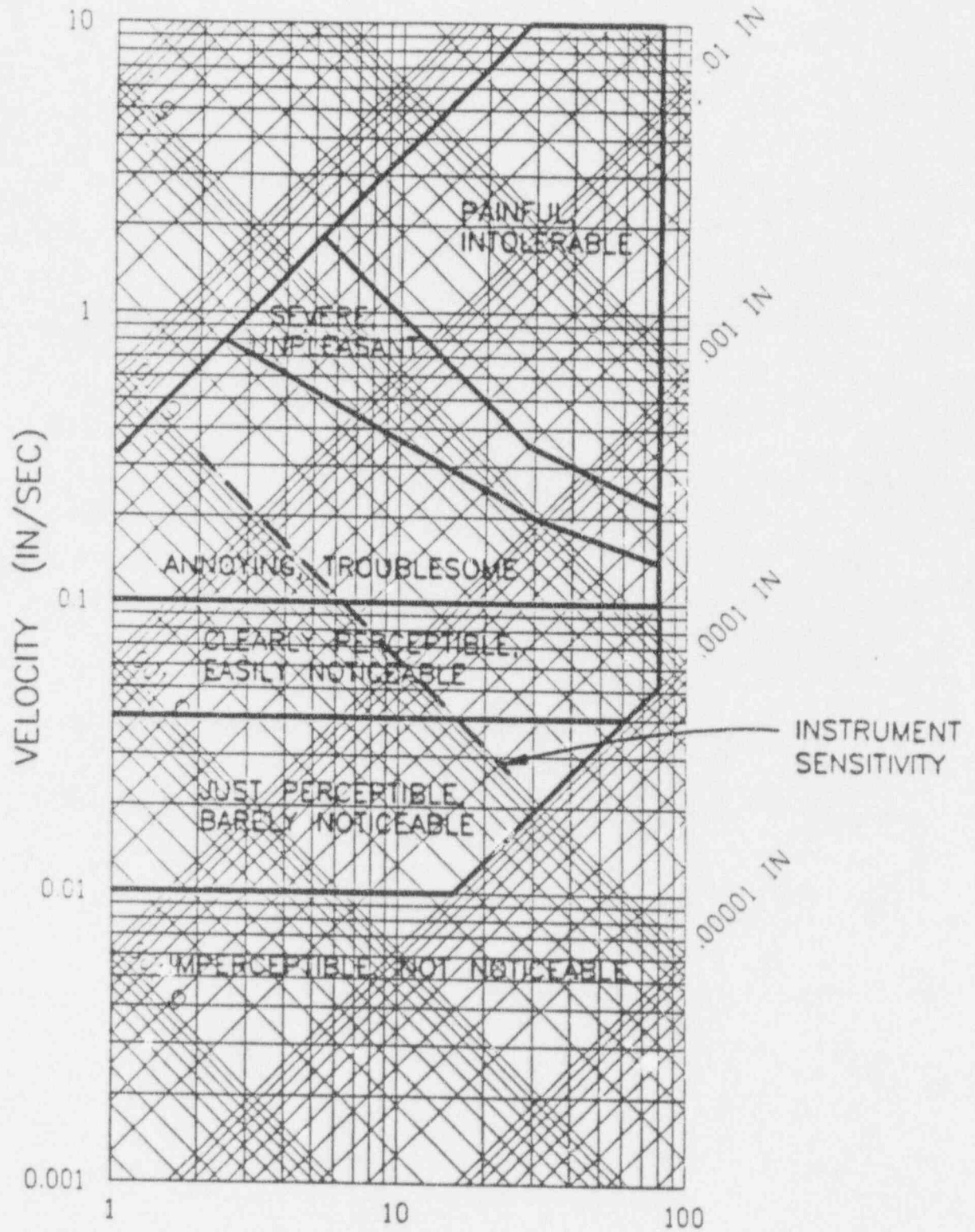
2.2.5 Fermi 2 Seismic Event Procedure Requirements

The turbine failure activated the seismic alarm and necessitated the reactor shutdown. The Fermi 2 UFSAR includes a required response when the seismic event alarm is activated (Figure 2.2.5.1). If the seismic event exceeds the OBE, the reactor must be shutdown as quickly as possible. The decision to shutdown involves examining the active traces from the HPCI room, utilizing the playback mode of recording instrumentation, and removing the HPCI room record plates and examining the data compared to the OBE. If the seismic event produced a horizontal acceleration greater than 0.05 g, or the relevant OBE is exceeded, the facility is shutdown, and further operation is not resumed until analysis and/or refurbishing of necessary structures, systems, or components is completed.

The turbine failure necessitated the reactor shutdown immediately, precluding the shutdown operating decision described above.

Additionally, the UFSAR requires data reduction, analysis, and interpretation of accelerometer time histories and response spectra from active instruments; response spectra from passive instruments; and physical facility structures, systems, and components inspection. If the event does not exceed Safe Shutdown Earthquake (SSE) validation levels, the item is considered safe for further operation. If the event exceeds validation levels, further investigation is required.

Investigation may include establishing realistic equipment fragility levels, detailed dynamic response analysis, or inspection. The investigation results in the item proclaimed acceptable, or the item refurbished, for normal facility operation to commence.



FREQUENCY (HERTZ)
Human Vibration Sensitivity

Figure 2.2.4.1

3.0 DATA

3.1 Instrumentation and Location

3.1.1 Passive Sensors

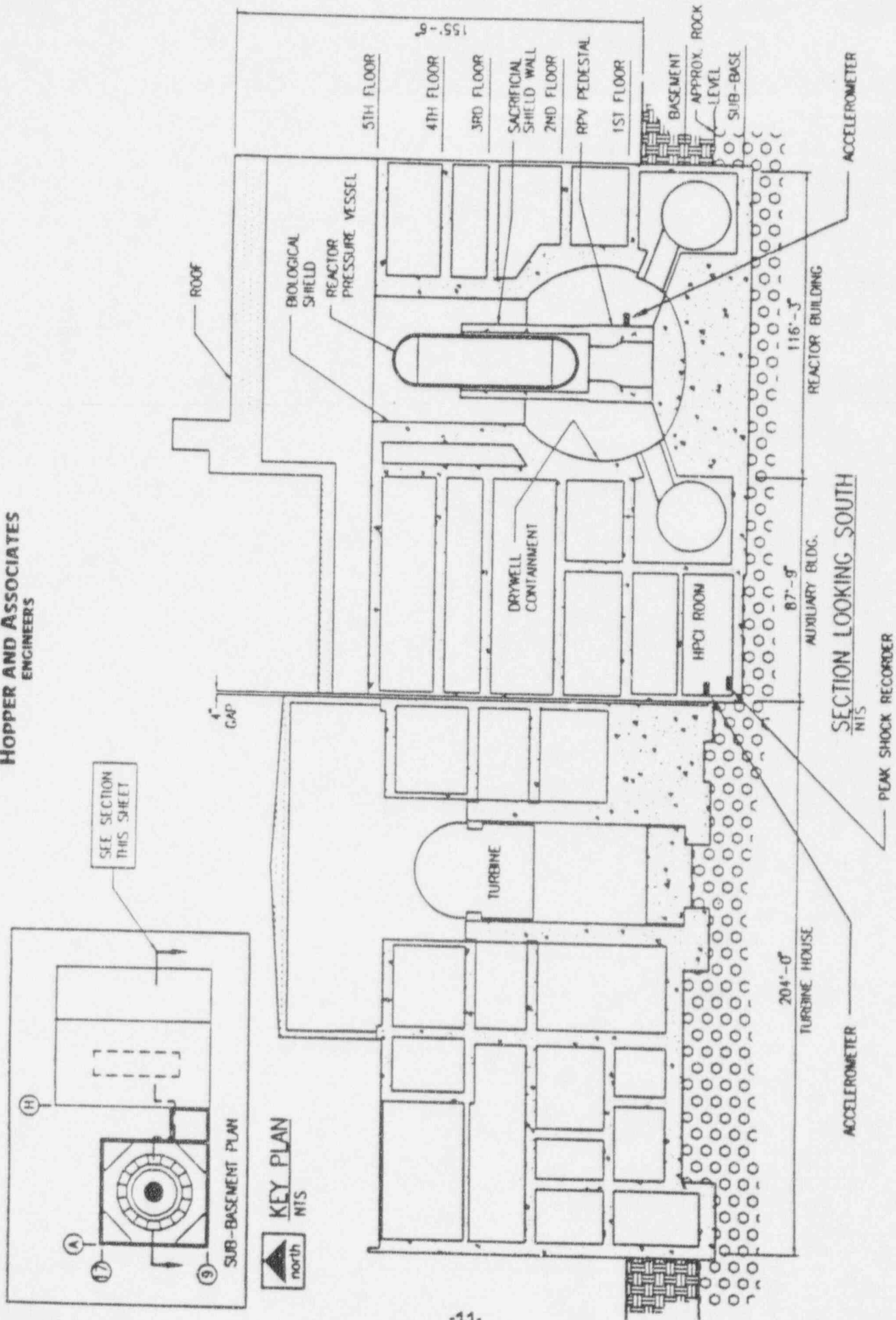
Engdahl PSR1200 peak shock recorders are the passive recording instrumentation located in the Reactor/Auxiliary building. The sensors record various ground motion and in-structure response shock spectra in three orthogonal directions. The sensors contain twelve reeds, each with a diamond tipped stylus, which etches a scribe mark on a metal record plate. Each reed is tuned to a predominant structural frequency, ranging from approximately two to twenty-five Hz. The record plate and the scribe mark provide a permanent indication of the dynamic excitation at a particular frequency. Reed deflection is calibrated as a linear function of acceleration. After a seismic event, the plates are removed and the reduced data establishes the response spectra.

Three Engdahl recorders are located in the Reactor/Auxiliary building, in the HPCI room, the second floor, and the fifth floor (Figures 3.1.1.1 through 3.1.1.3). The recorders are positioned to measure accelerations in the vertical, north/south, and east/west directions at each sensor.

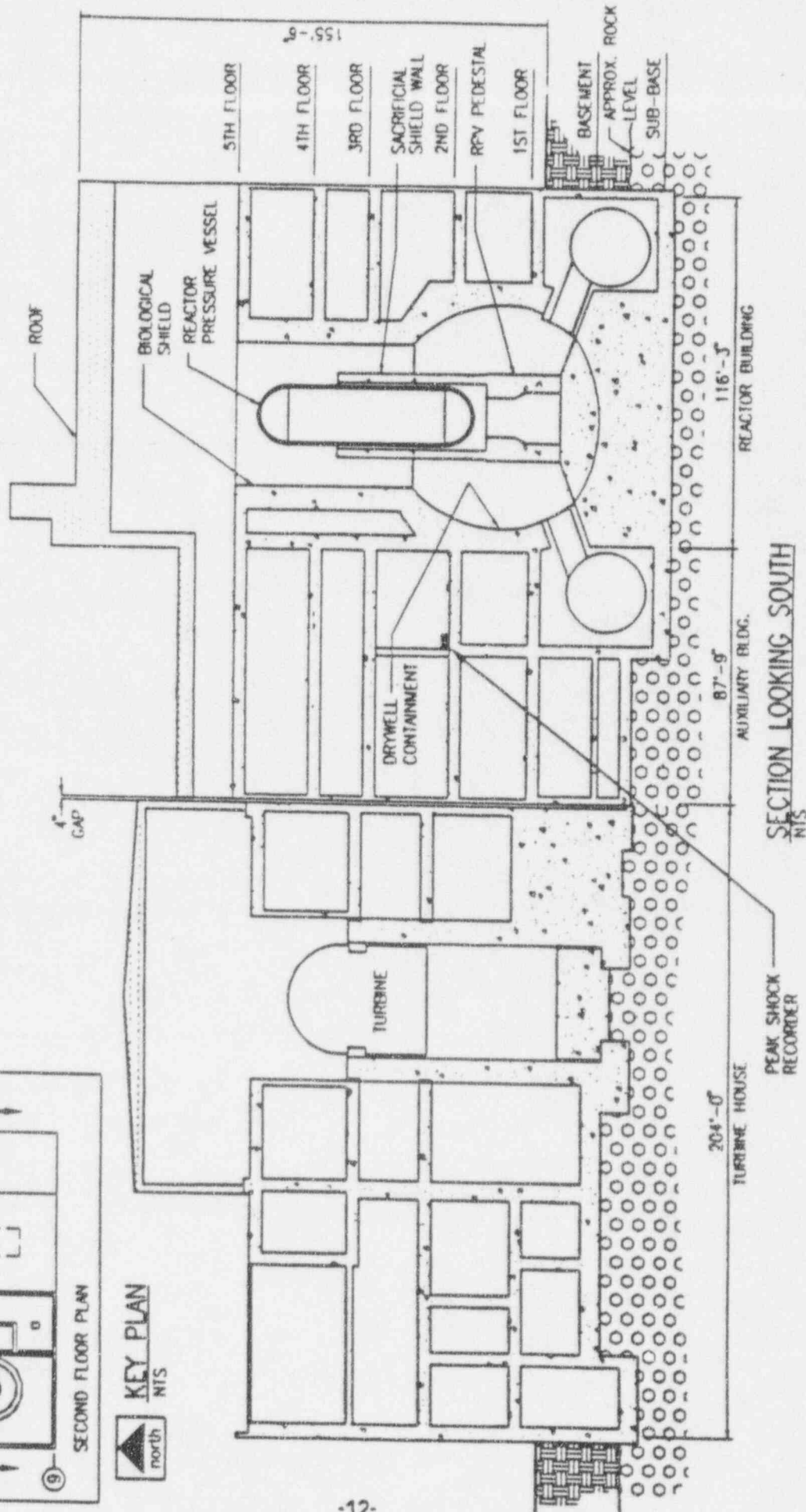
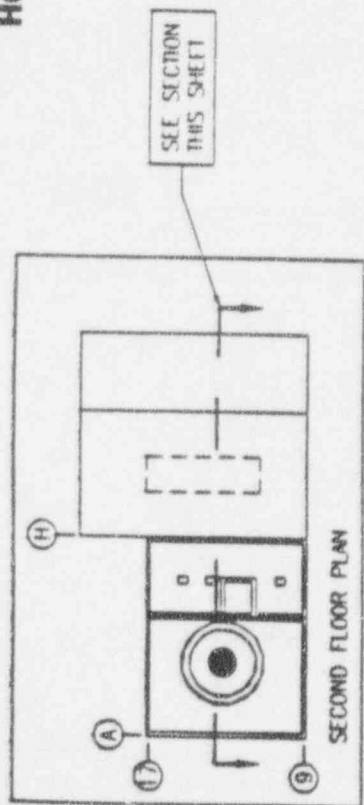
Passive sensors are calibrated and the plates replaced after a seismic event or approximately every 18 months. The plates for the Reactor/Auxiliary building were last calibrated and replaced in July of 1993 on the second and fifth floors, and September of 1993 in the HPCI room.

3.1.2 Active Sensors

Teledyne/Geotech Model 37800 strong motion triaxial time history accelerometers are the active recording instrumentation located in the Reactor/Auxiliary building. The active system includes the accelerometer sensors, seismic triggers, MTS-1008 monitor and recorder, PMO-101/201 playback system, and an alarm panel. The accelerometers have a preset event trigger at 0.01 g, which energizes and activates the recording system. The system records over a frequency range of 0 to 40 Hz for a specified time length after motion has stopped. The output



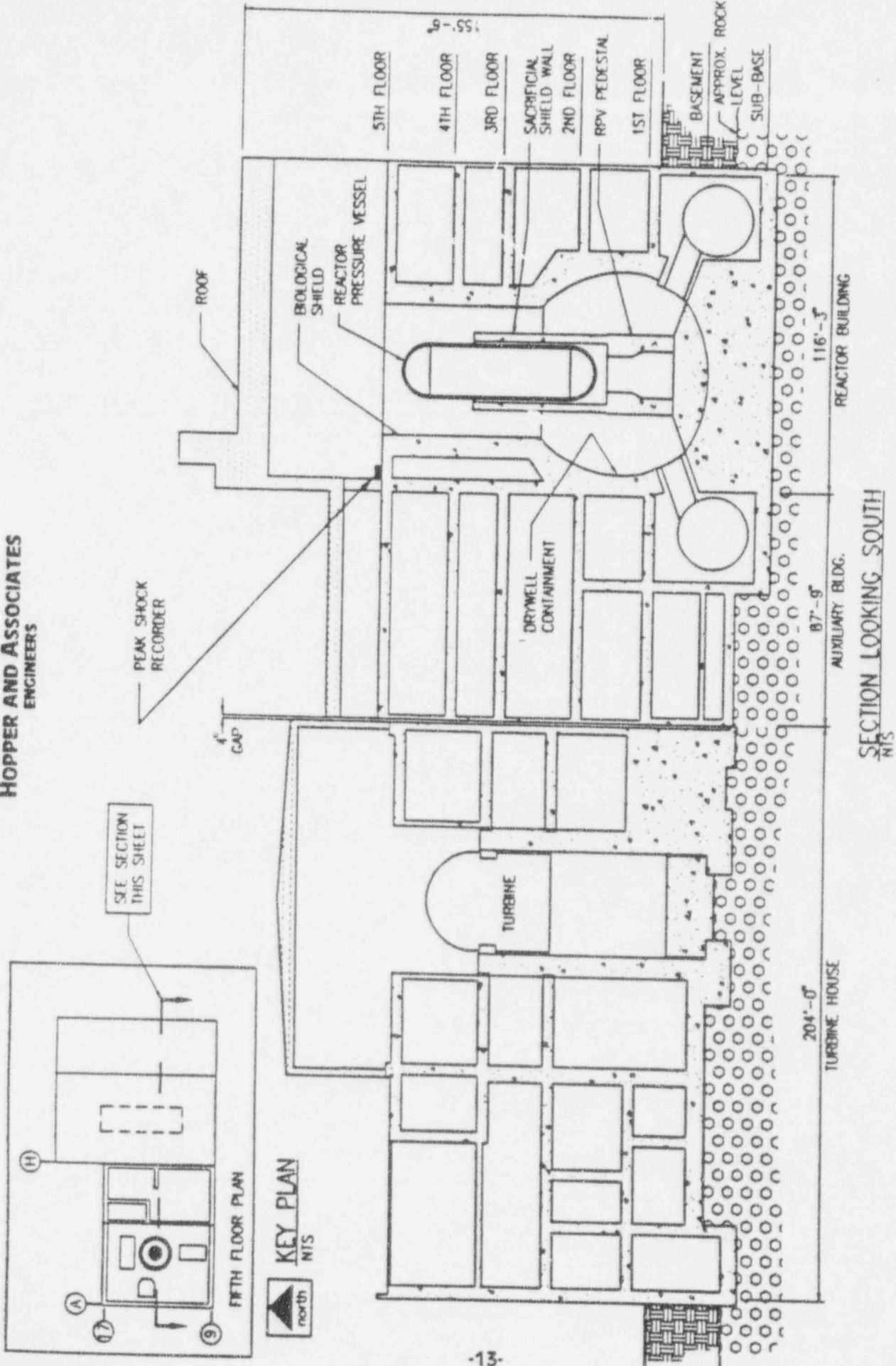
Passive and Active Instrumentation Location at HPCI Room and RPV Pedestal
Figure 3.1.1.1



Passive Instrumentation Location at Second Floor

Figure 3.1.1.2

HOPPER AND ASSOCIATES
ENGINEERS



Passive Instrumentation Location at Fifth Floor

Figure 3.1.1.3

produces a time history strip chart and a magnetic data tape of the event. The active instrumentation provides time histories from which response spectra may be generated.

Two Teledyne/Geotech accelerometers are located in the Reactor/Auxiliary building, in the HPCI room sub-basement and at the RPV pedestal (Figure 3.1.1.1). The accelerometers measure longitudinal, transverse, and vertical acceleration, which correspond to the vertical, north/south, and east/west directions of the passive recorders.

3.2 Data Reduction

3.2.1 Passive Sensors

The record plates from the three passive sensors in the Reactor/Auxiliary building were removed for data reduction. The plates were inspected for scribe marks, and the calculated accelerations were plotted against the relevant OBE and SSE response spectra (Tables 3.2.1.1 through 3.2.1.9 and Figures 3.2.1.1 through 3.2.1.9). Additionally, the instrument sensitivity was plotted. The passive sensor is capable of measuring accelerations greater than 0.01 g. The Engdahl peak shock recorders have 2% damping, and have $\pm 3\%$ accuracy at 1 g.

The sensors were last calibrated and the plates replaced in July of 1993 (second and fifth floors) and in September of 1993 (HPCI room).

3.2.2 Active Sensors

Subsequent to the activation of the instrumentation, two distinct tremors were recorded. The first event occurred at approximately two seconds, with a duration of approximately 0.1 second, and the second event occurred at approximately one minute, also with a duration of approximately 0.1 second.

Time history acceleration data recorded by the two active sensors in the Reactor/Auxiliary building were digitized by Detroit Edison Company (Figures 3.2.2.1 through 3.2.2.6). A simple Fortran routine was used to produce the response spectra. The generated response spectra were plotted against the relevant OBE and SSE response spectra (Figure 3.2.2.7 through 3.2.2.12).

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Reed No.	Hz	Measured mm	Inch	g/Inch	g
1	2.11	2.5	0.098	0.349	0.034
2	2.54	4.25	0.167	0.528	0.088
3	3.45	4.5	0.177	0.865	0.153
4	4.07	6.25	0.25	1.24	0.31
5	5.1	2.5	0.10	1.98	0.19
6	6.36	1.0	0.04	3.14	0.12
7	7.95	0.25	0.01	5.18	0.05
8	10.16	0.25	0.01	7.26	0.07
9	12.75	0.5	0.02	13.61	0.27
10	15.5 ^R	0.25	0.01	18.10	0.18
11	20.33	-		30.66	
12	25.25	-		46.98	

D30-N005 Passive Instrumentation, Vertical Direction Records - HPCI Room

Table 3.2.1.1

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ENGINEERS

Reed No.	Hz	Measured mm	Inch	g/Inch	g
1	2	-		0.357	
2	2.5	0.5	0.02	0.52	0.01
3	3.17	-		0.84	
4	4.15	-		1.35	
5	4.95	-		1.90	
6	6.4	-		3.26	
7	7.75	-		4.69	
8	9.8	1.0	0.04	7.38	0.29
9	12.65	-		12.39	
10	15.9	-		18.11	
11	20.29	-		29.40	
12	25.41	-		45.50	

D30-N005 Passive Instrumentation, North/South Direction Records - HPCI Room

Table 3.2.1.2

HOPPER AND ASSOCIATES
ENGINEERS

Reed No.	Hz	Measured mm	Inch	g/Inch	g
1	1.96	2.75	0.108	0.376	0.041
2	2.39	6.0	0.236	0.556	0.131
3	3.16	6.5	0.256	0.89	0.23
4	3.96	3.2	0.126	1.29	0.16
5	5.05	2.0	0.079	2.10	0.17
6	6.32	-		3.18	
7	7.9	3.25	0.128	4.86	0.62
8	9.89	-		7.58	
9	12.27	-		11.58	
10	15.7	0.5	0.02	18.87	0.37
11	19.67	1.5	0.059	30.08	1.78
12	25.71	-		48.78	

D30-N005 Passive Instrumentation, East/West Direction Records - HPCI Room

Table S.2.1.3

HOPPER AND ASSOCIATES
ENGINEERS

Reed No.	Hz	Measured mm	Inch	g/Inch	g
1	2.05	-		0.322	
2	2.45	-		0.494	
3	3.21	-		0.784	
4	3.96	-		1.243	
5	4.86	-		1.918	
6	6.35	-		3.101	
7	7.84	-		4.9	
8	10.08	-		7.85	
9	12.59	-		11.7	
10	15.98	-		19.23	
11	20.49	-		29.85	
12	25.18	-		45.72	

D30-N601 Passive Instrumentation, Vertical Direction Records - Second Floor

Table 3.2.1.4

HOPPER AND ASSOCIATES
ENGINEERS

Reed No.	Hz	Measured mm	Inch	g/inch	g
1	1.99	-		0.362	
2	2.59	0.13	0.005	0.536	0.003
3	3.11	-		0.821	
4	3.93	-		1.31	
5	5.03	-		1.99	
6	6.39	-		3.21	
7	7.96	-		4.86	
8	10.13	-		7.44	
9	12.54	-		12.31	
10	15.88	-		18.35	
11	19.91	-		28.73	
12	25.04	-		47.04	

D30-N601 Passive Instrumentation, North/South Direction Records - Second Floor

Table 3.2.1.5

HOPPER AND ASSOCIATES
ENGINEERS

Reed No.	Hz	Measured mm	Inch	g/Inch	g
1	2.14	-		0.372	
2	2.54	-		0.524	
3	3.29	-		0.831	
4	3.95	-		1.32	
5	5.12	-		1.95	
6	6.33	-		3.17	
7	7.78	-		4.82	
8	9.92	-		7.48	
9	12.91	-		12.27	
10	15.89	-		18.61	
11	20.19	-		29.63	
12	25.53	-		45.99	

D30-N601 Passive Instrumentation, East/West Direction Records - Second Floor

Table 3.2.1.6

HOPPER AND ASSOCIATES
ENGINEERS

Reed No.	Hz	Measured mm	Inch	g/Inch	g
1	2	-		0.306	
2	2.58	-		0.508	
3	3.25	0.15	0.006	0.819	0.005
4	4.05	-		1.29	
5	5.05	-		2.01	
6	6.5	-		3.16	
7	7.85	-		5.5	
8	9.8	-		7.06	
9	12.8	-		11.96	
10	15.8	-		20.42	
11	20.2	-		28.99	
12	25.2	-		44.42	

D30-N006 Passive Instrumentation, Vertical Direction Records - Fifth Floor

Table 3.2.1.7

HOPPER AND ASSOCIATES
ENGINEERS

Reed No.	Hz	Measured mm	Inch	g/Inch	g
1	2.14	-		0.4	
2	2.38	-		0.518	
3	3.2	-		0.843	
4	4	-		1.29	
5	5.1	-		2.07	
6	6.45	-		3.28	
7	7.95	-		4.84	
8	10.05	-		7.75	
9	12.57	0.13	0.005	11.90	0.06
10	15.7	-		19.05	
11	20.3	-		29.2	
12	25.2	-		47.07	

D30-N006 Passive Instrumentation, North/South Direction Records - Fifth Floor

Table 3.2.1.8

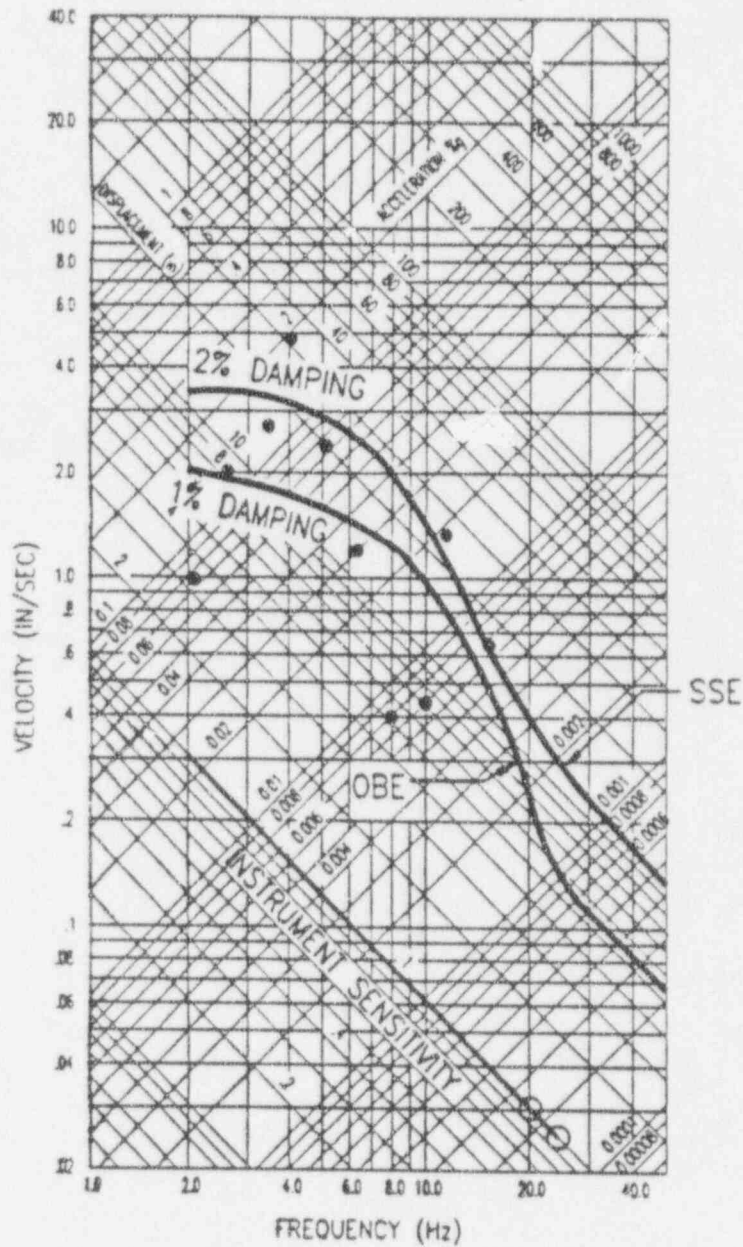
HOPPER AND ASSOCIATES
ENGINEERS

Reed No.	Hz	Measured mm	Inch	g/Inch	g
1	2.11	-		0.371	
2	2.58	-		0.522	
3	3.25	-		0.833	
4	4.15	-		1.33	
5	4.9	-		1.85	
6	6.3	0.25	0.01	3.11	0.03
7	7.9	-		4.84	
8	10.2	-		7.31	
9	12.5	-		11.68	
10	15.8	0.125	0.005	17.62	0.09
11	20.1	-		28.59	
12	25.1	-		48.21	

D30-N006 Passive Instrumentation, East/West Direction Records - Fifth Floor

Table 3.2.1.9

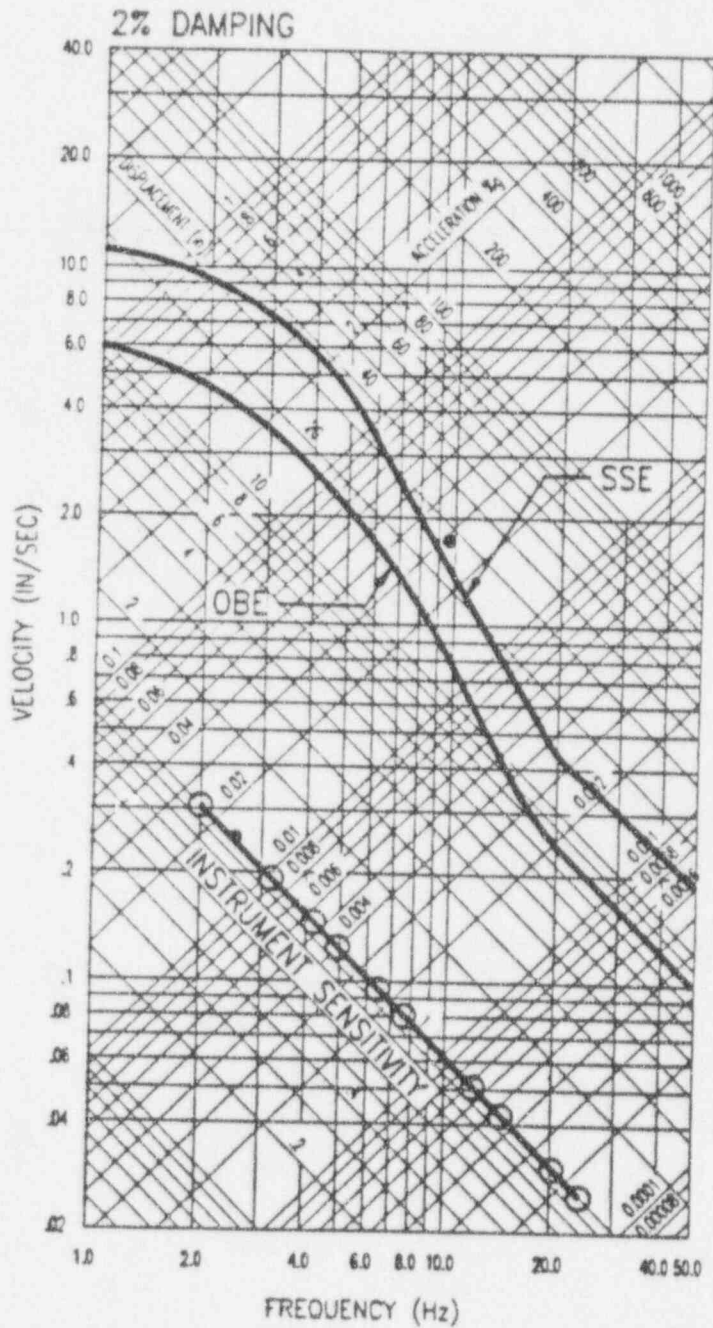
HOPPER AND ASSOCIATES
ENGINEERS



D30-N005 Passive Instrumentation, Vertical Response Spectra - HPCI Room

Figure 3.2.1.1

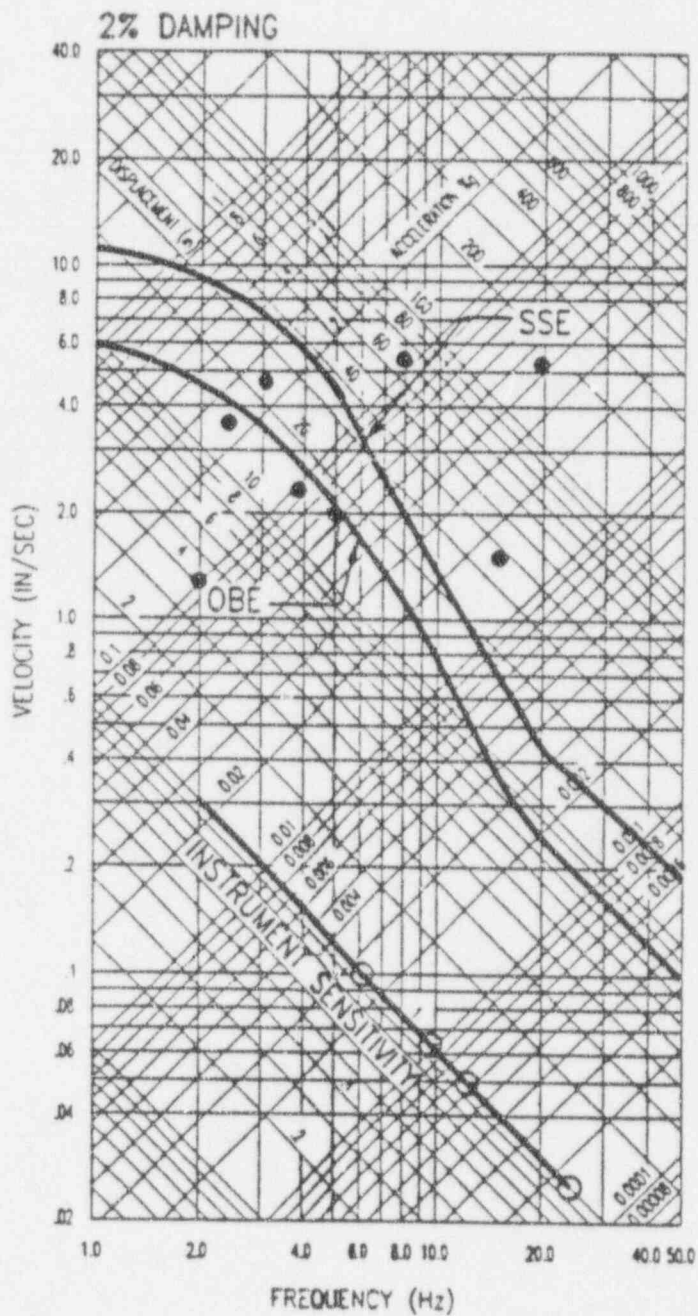
HOPPER AND ASSOCIATES
ENGINEERS



D30-N003 Passive Instrumentation, North/South Response Spectra - HPCI Room

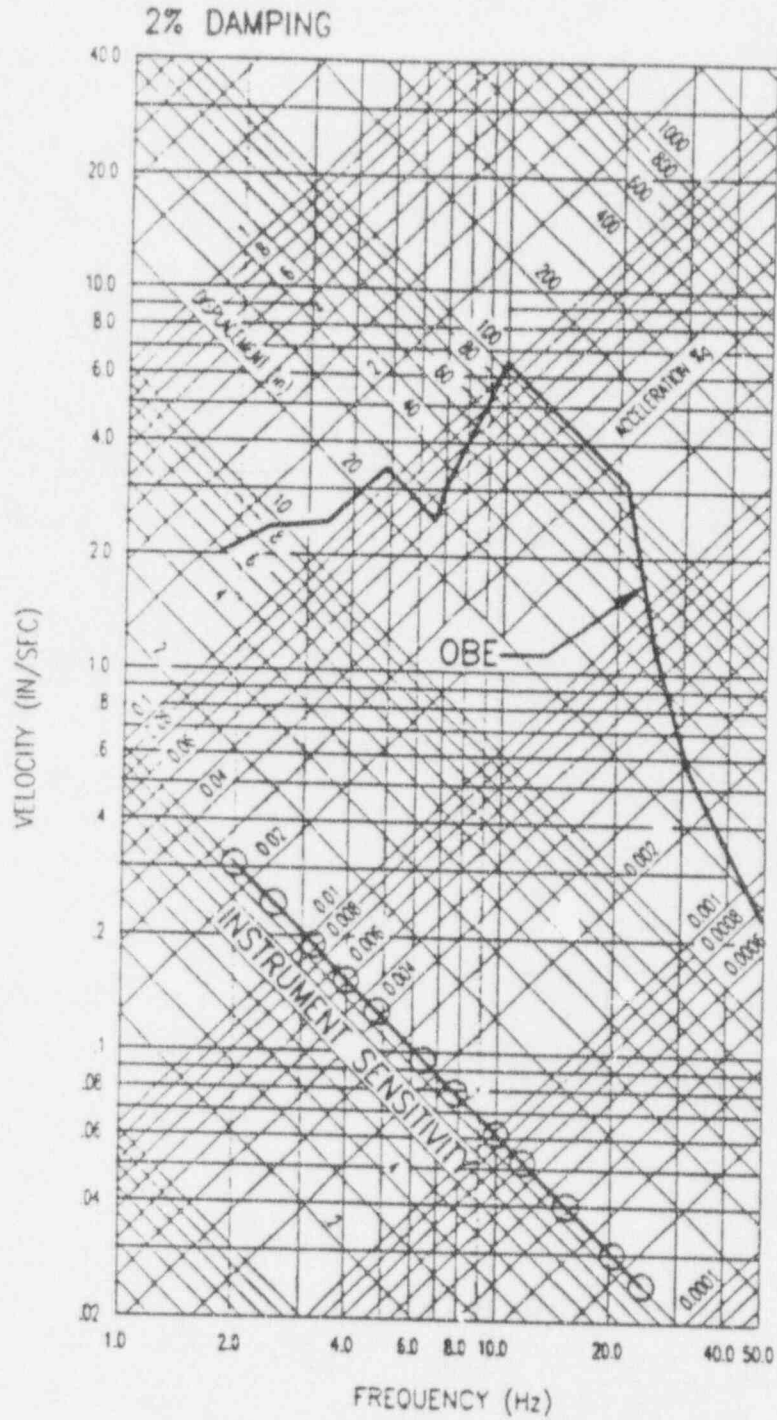
Figure 3.2.1.2

HOPPER AND ASSOCIATES
ENGINEERS



D30-N005 Passive Instrumentation, East/West Response Spectra - HPCI Room

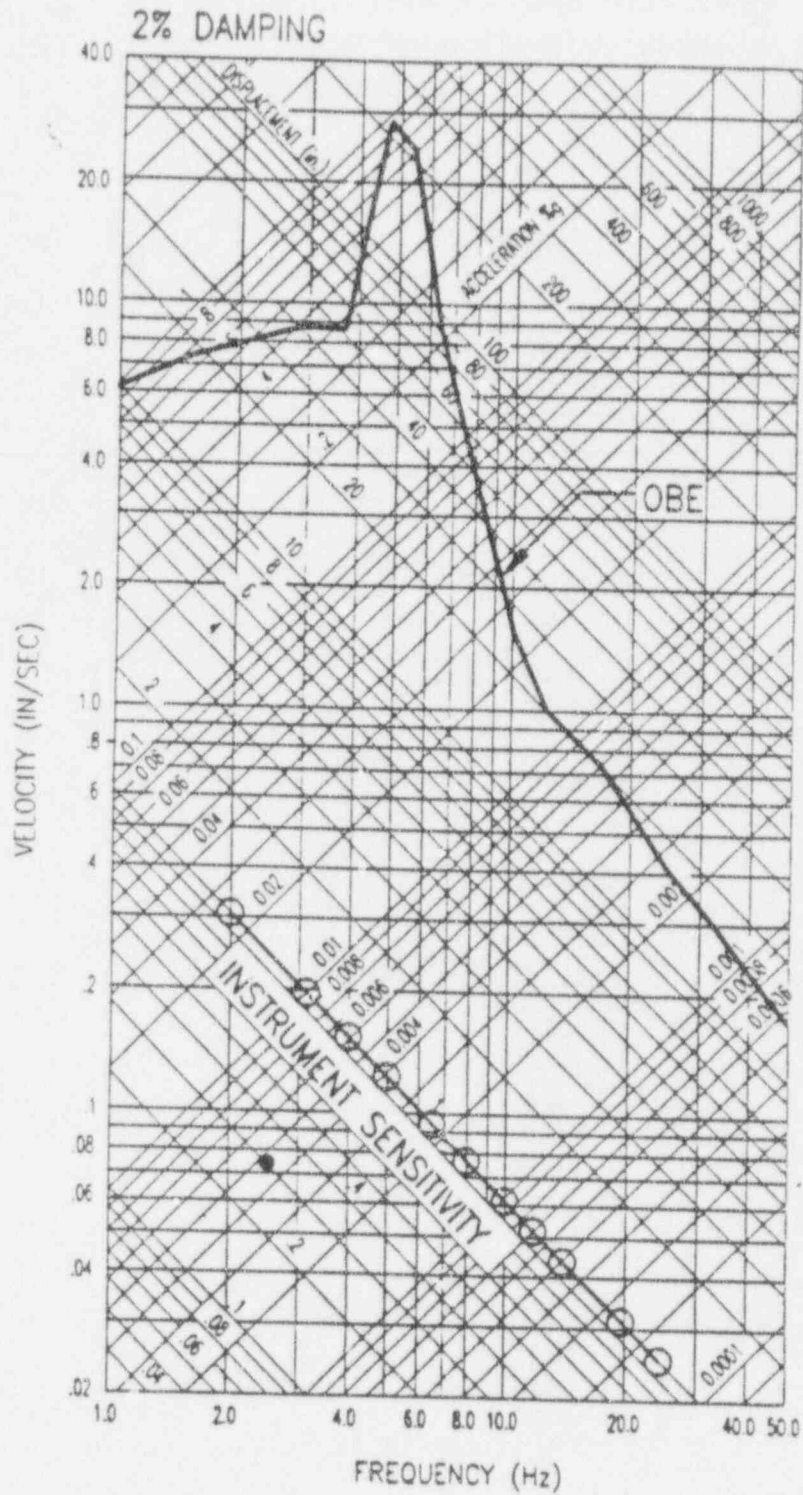
Figure 3.2.1.3



D30-N601 Passive Instrumentation, Vertical Response Spectra - Second Floor

Figure 3.2.1.4

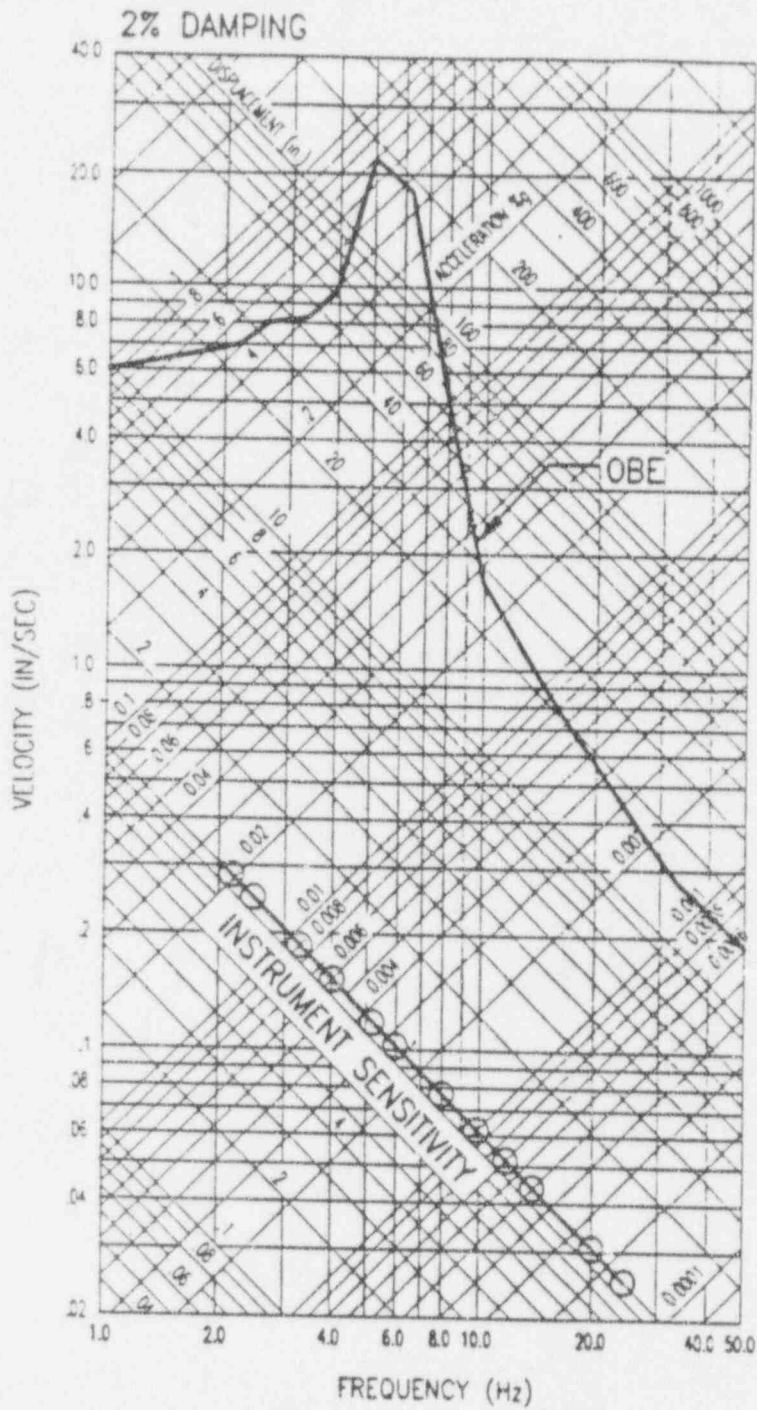
HOPPER AND ASSOCIATES
ENGINEERS



D30-N601 Passive instrumentation, North/South Response Spectra - Second Floor

Figure 3.2.1.5

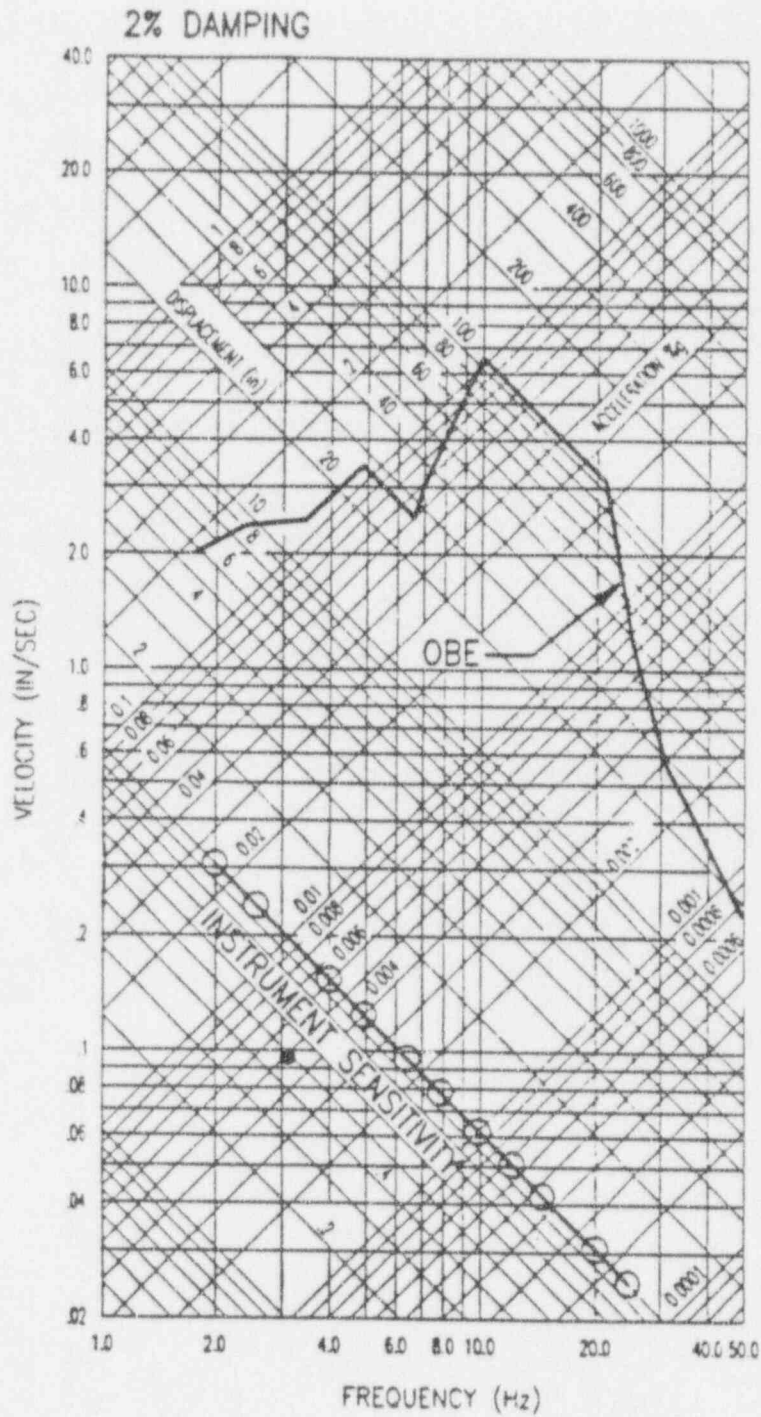
HOPPER AND ASSOCIATES
ENGINEERS



D30-N601 Passive Instrumentation, East/West Response Spectra - Second Floor

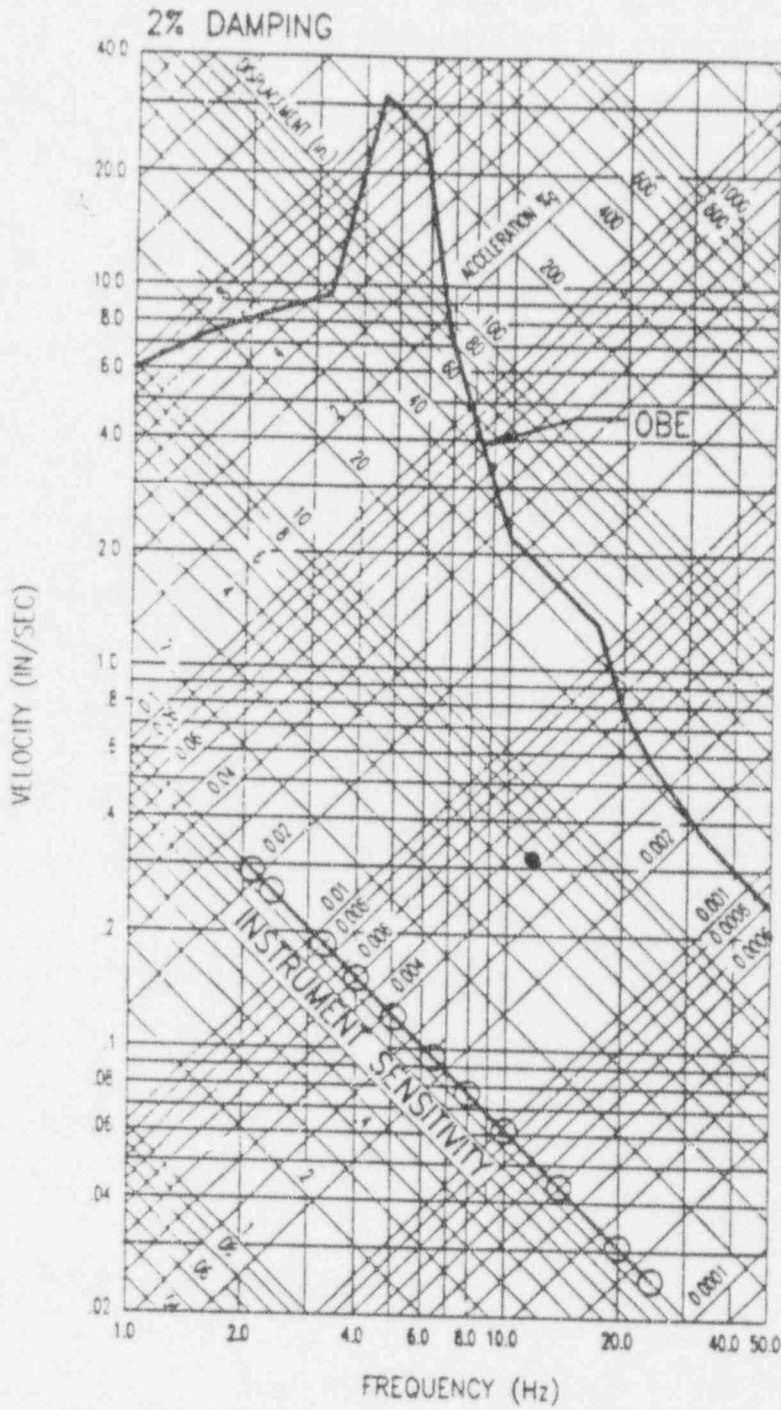
Figure 3.2.1.6

HOPPER AND ASSOCIATES
ENGINEERS



D30-N006 Passive Instrumentation, Vertical Response Spectra - Fifth Floor

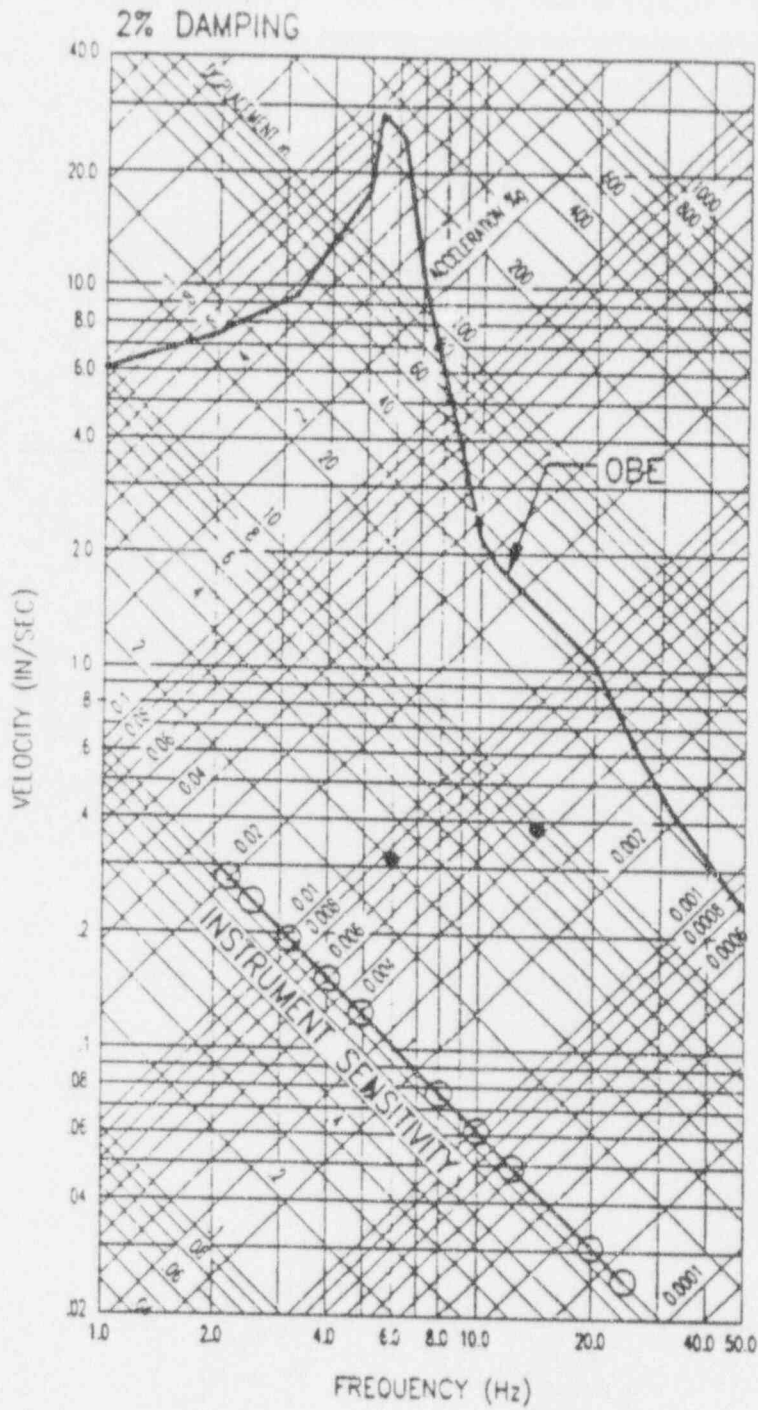
Figure 3.2.1.7



D30-N006 Passive Instrumentation, North/South Response Spectra - Fifth Floor

Figure 3.2.1.8

HOPPER AND ASSOCIATES
ENGINEERS

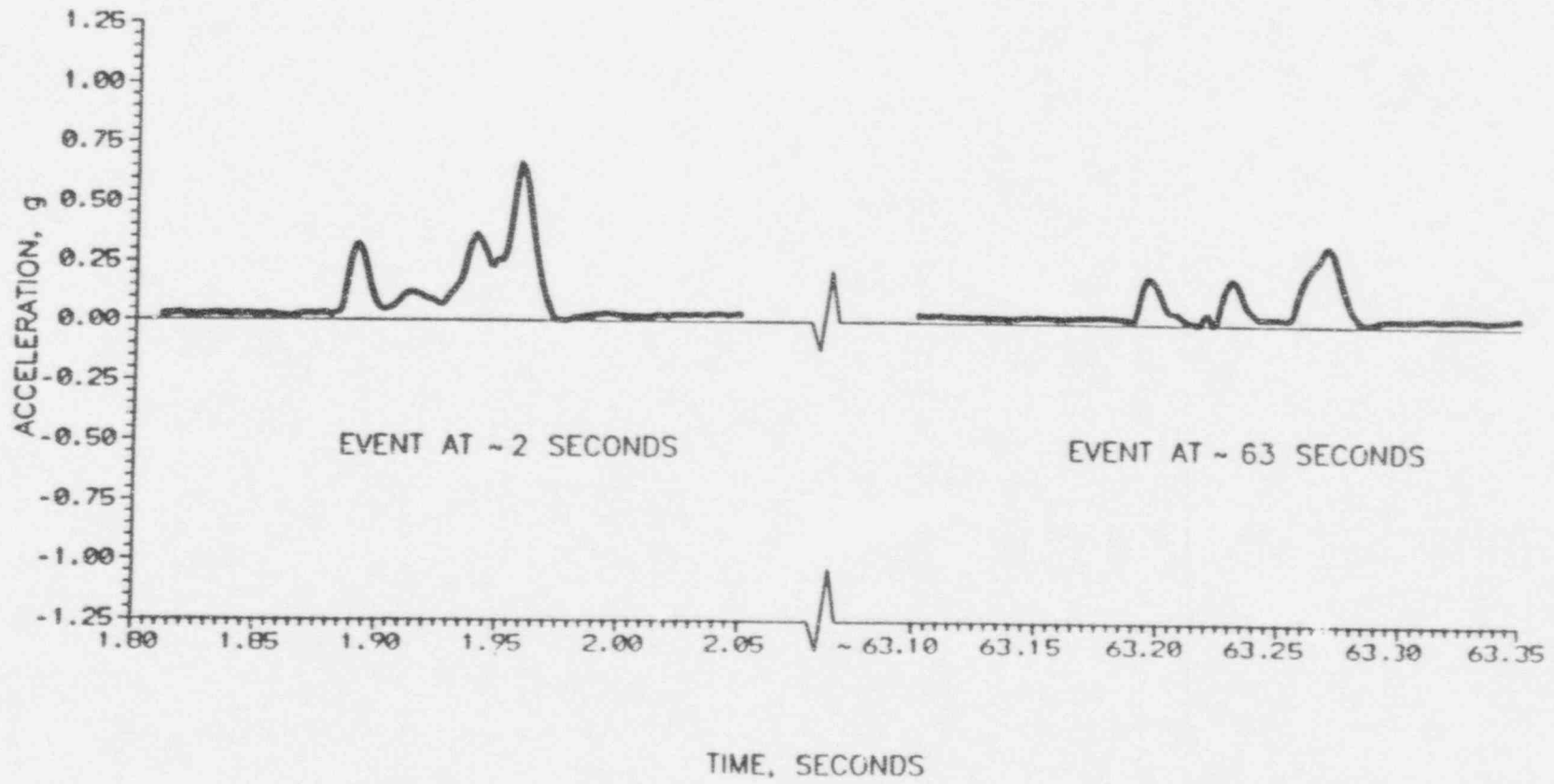


D30-N006 Passive Instrumentation, East/West Response Spectra - Fifth Floor

Figure 3.2.1.9

HOPPER AND ASSOCIATES
ENGINEERS

-33-

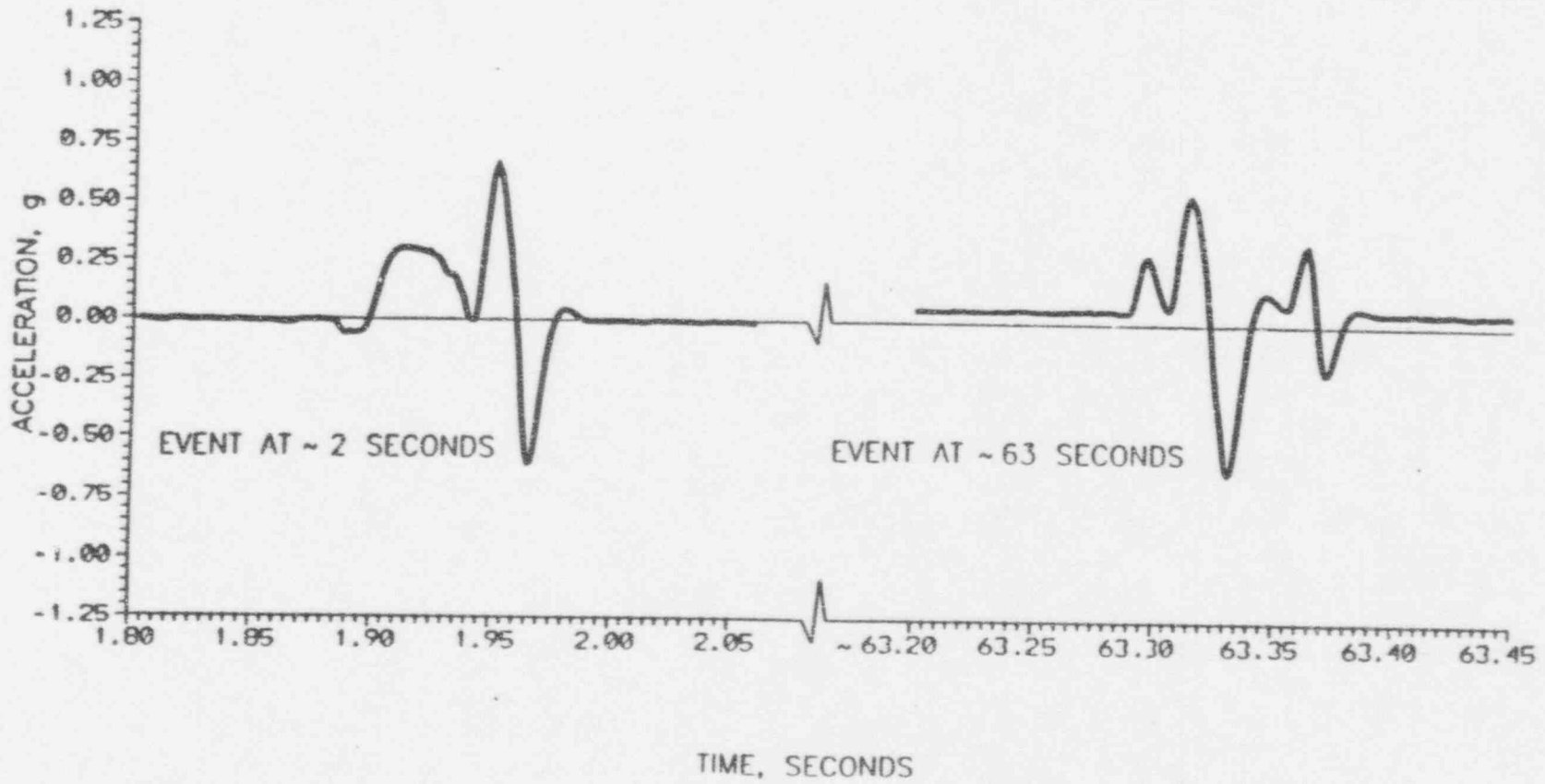


D30-N003 Accelerometer, Vertical Direction Time History - HPCI Room

Figure 3.2.2.1

HOPPER AND ASSOCIATES
ENGINEERS

-34-

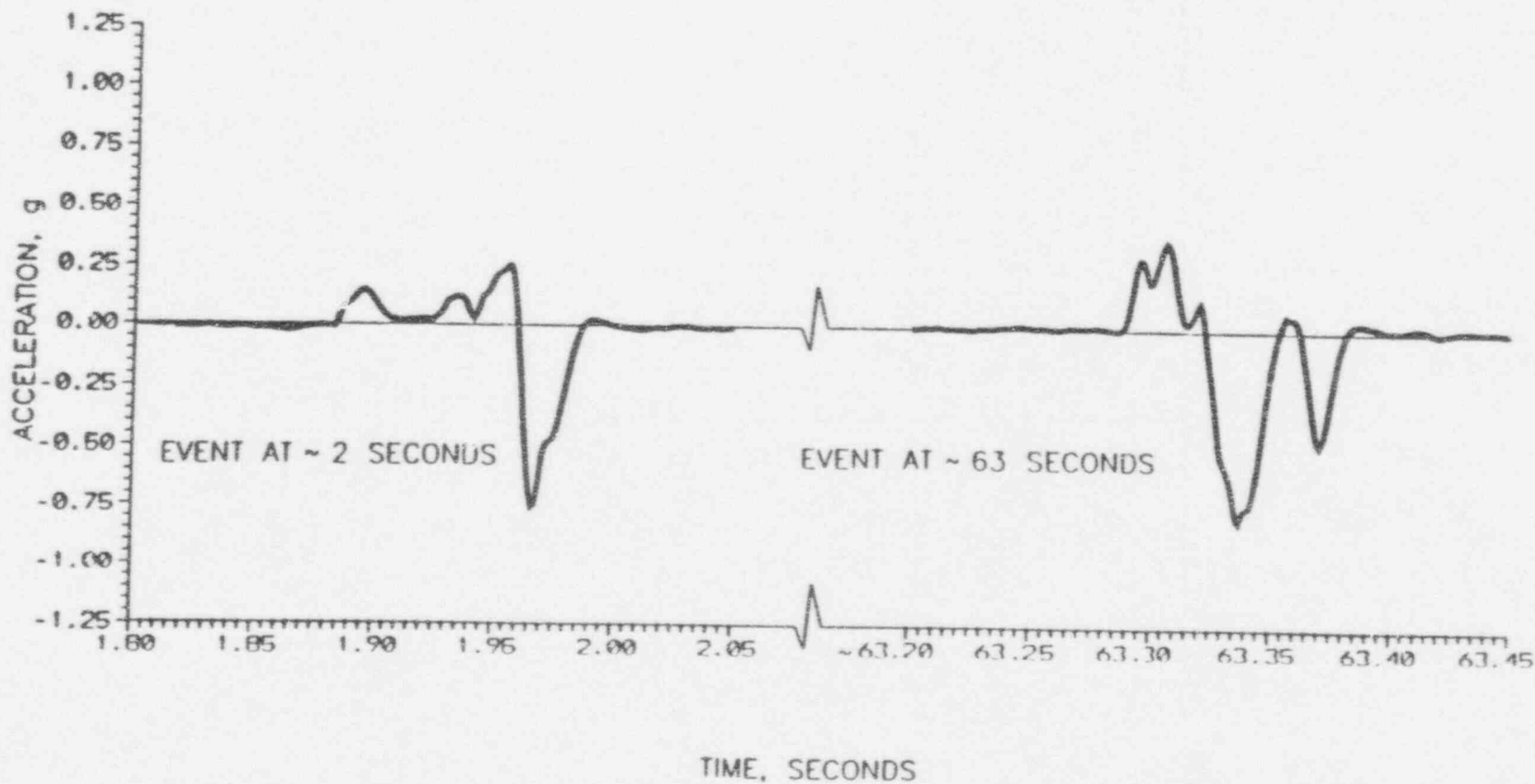


D30-N003 Accelerometer, North/South Direction Time History - HPCI Room

Figure 3.2.2.2

HOPPER AND ASSOCIATES
ENGINEERS

-35-

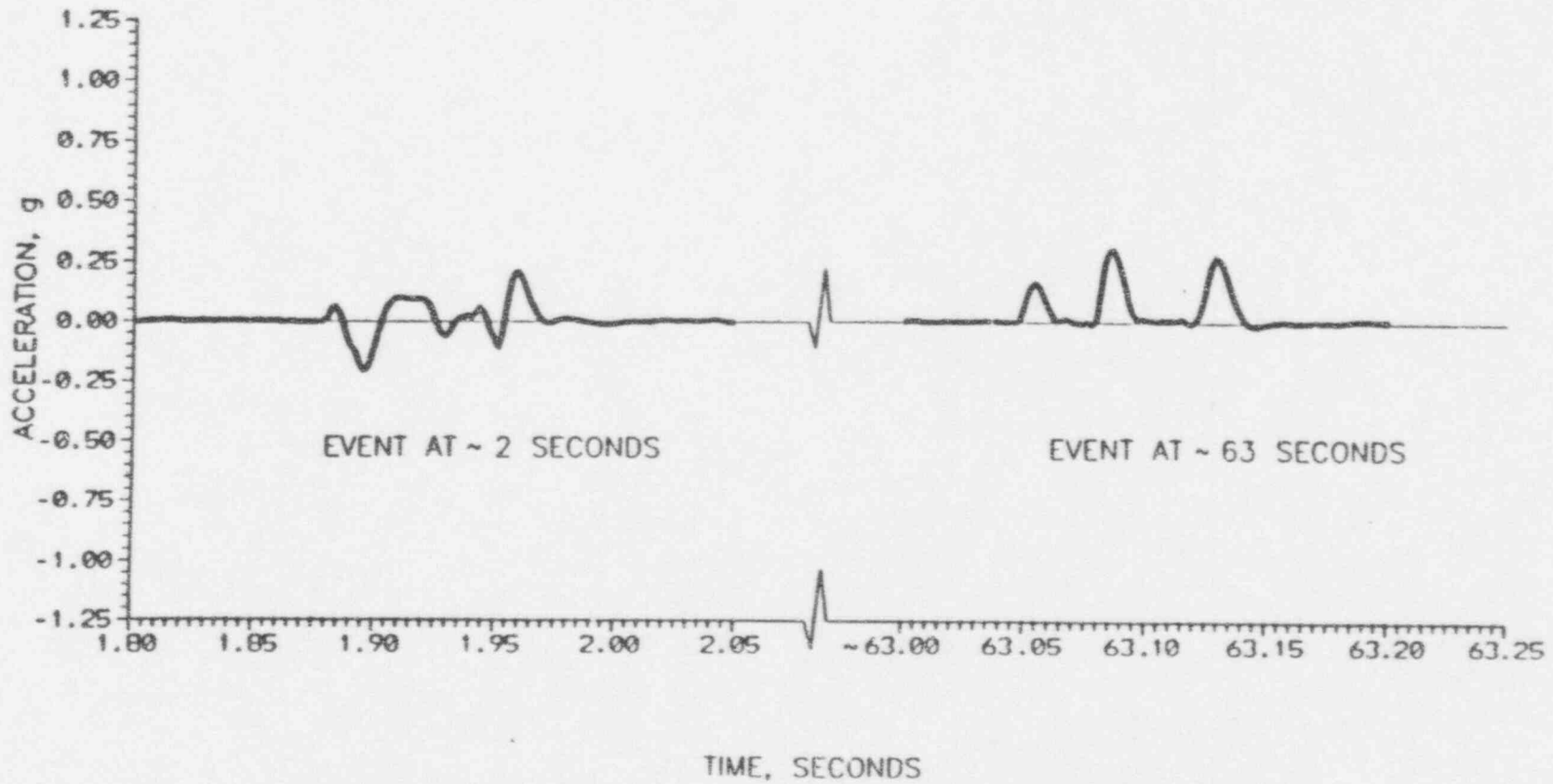


D30-N003 Accelerometer, East/West Direction Time History - HPCI Room

Figure 3.2.2.3

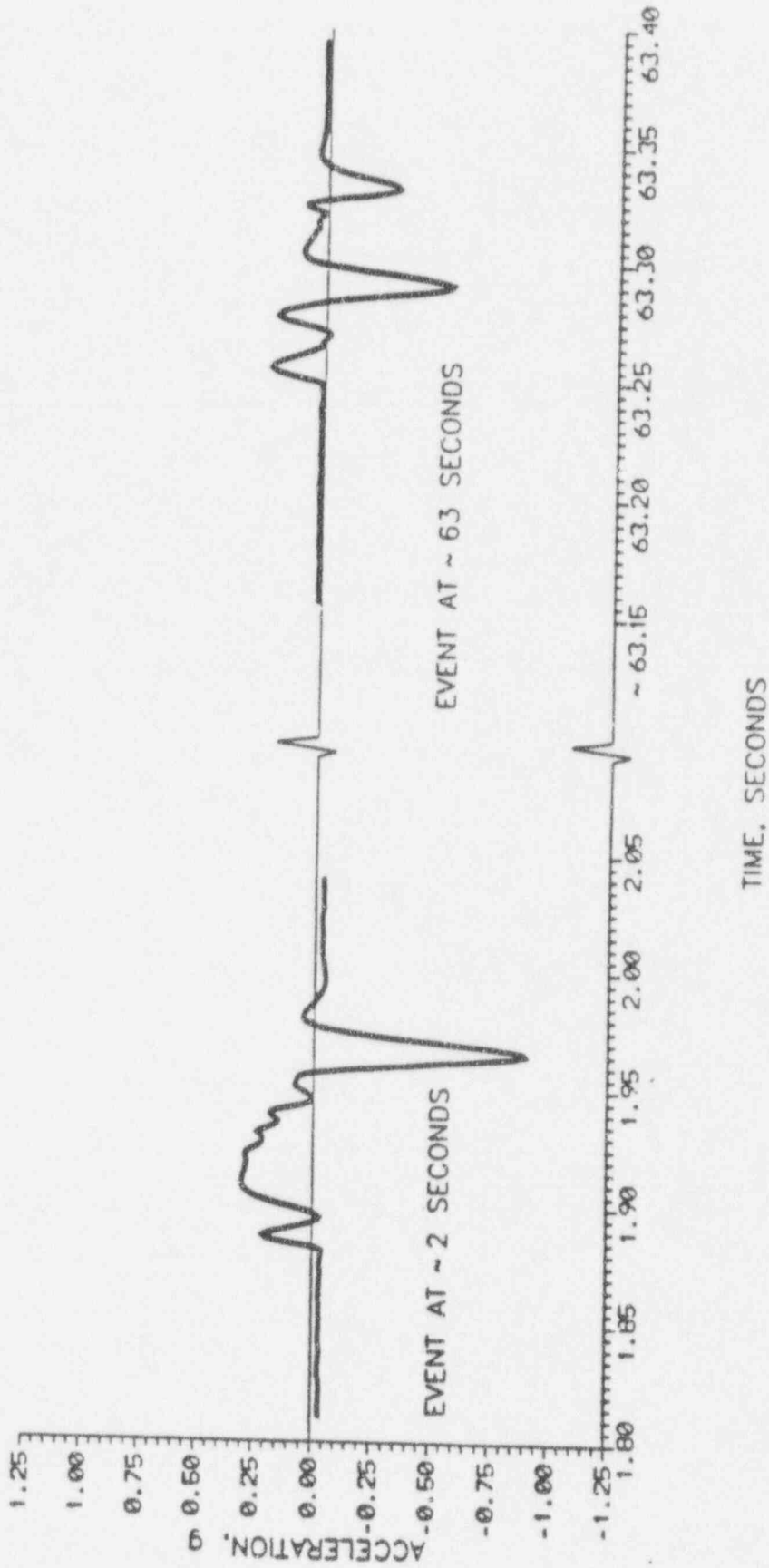
HOPPER AND ASSOCIATES
ENGINEERS

-36-



DSO-N002 Accelerometer, Vertical Direction Time History - RPV Pedestal

Figure 3.2.2.4

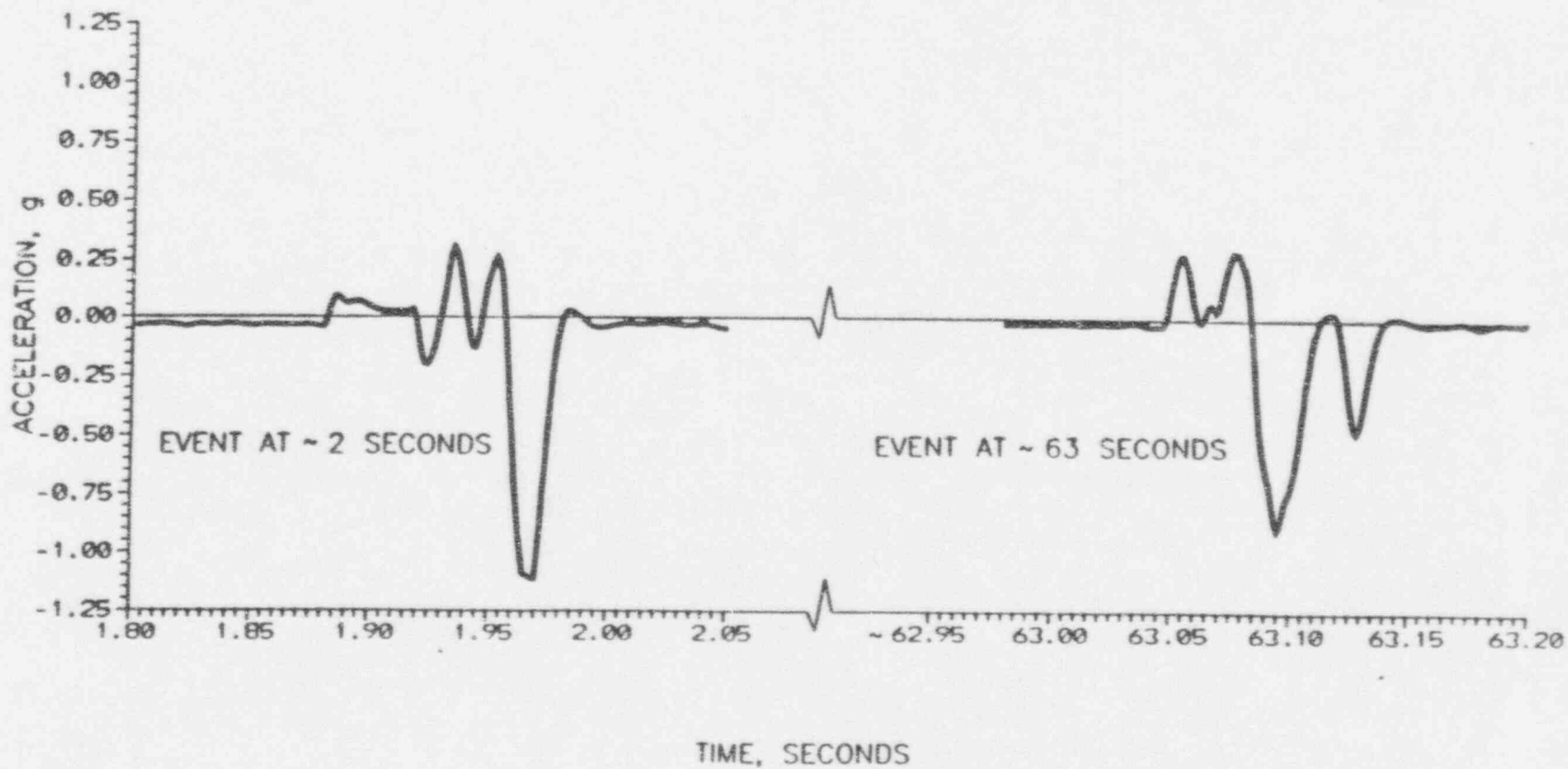


D30-N002 Accelerometer, North/South Direction Time History - RPV Pedestal

Figure 3.2.2.5

HOPPER AND ASSOCIATES
ENGINEERS

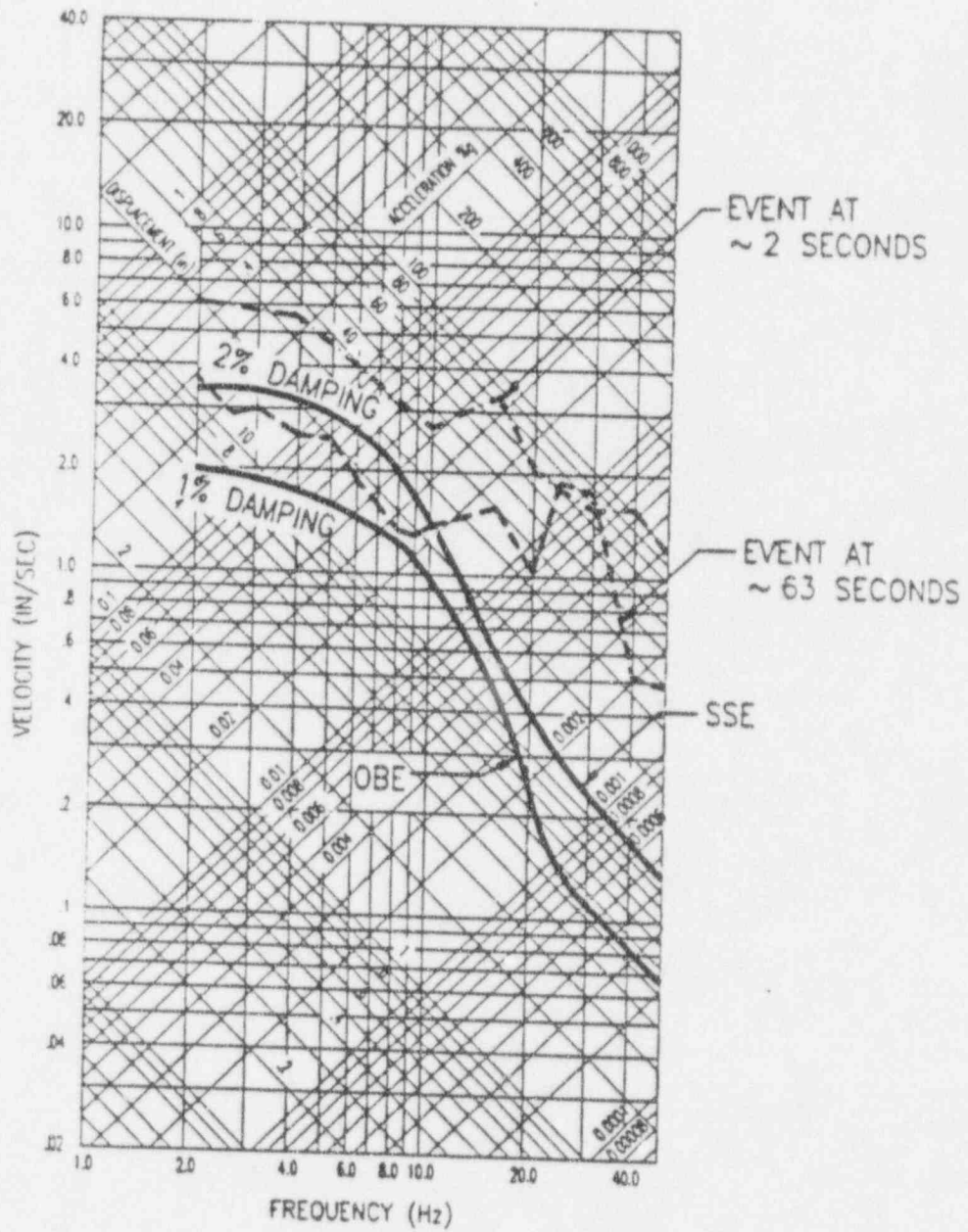
-38-



D30-N002 Accelerometer, East/West Direction Time History - RPV Pedestal

Figure 3.2.2.6

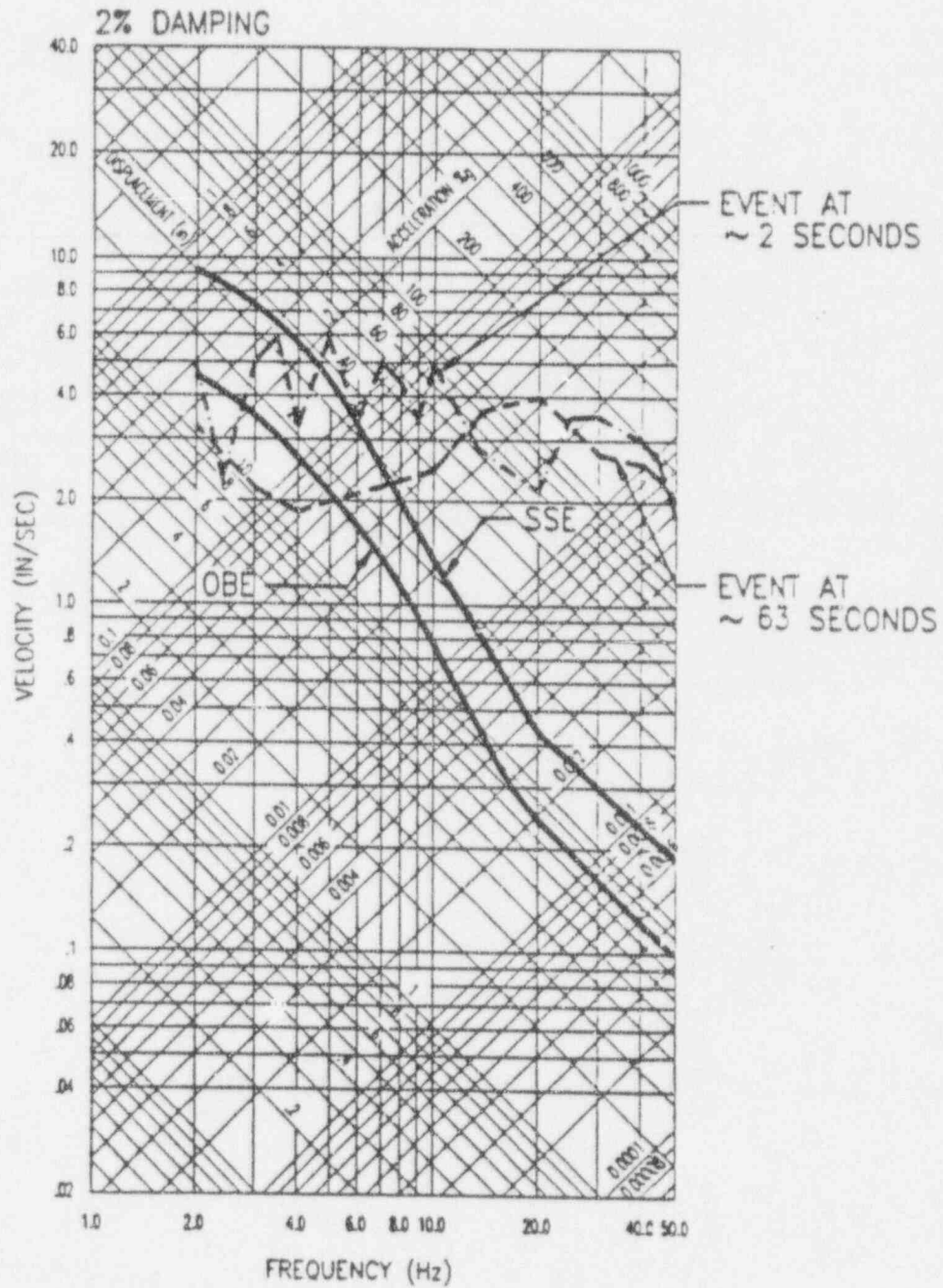
HOPPER AND ASSOCIATES
ENGINEERS



D30-N003 Accelerometer, Vertical Response Spectra - MPC Room

Figure 3.2.2.7

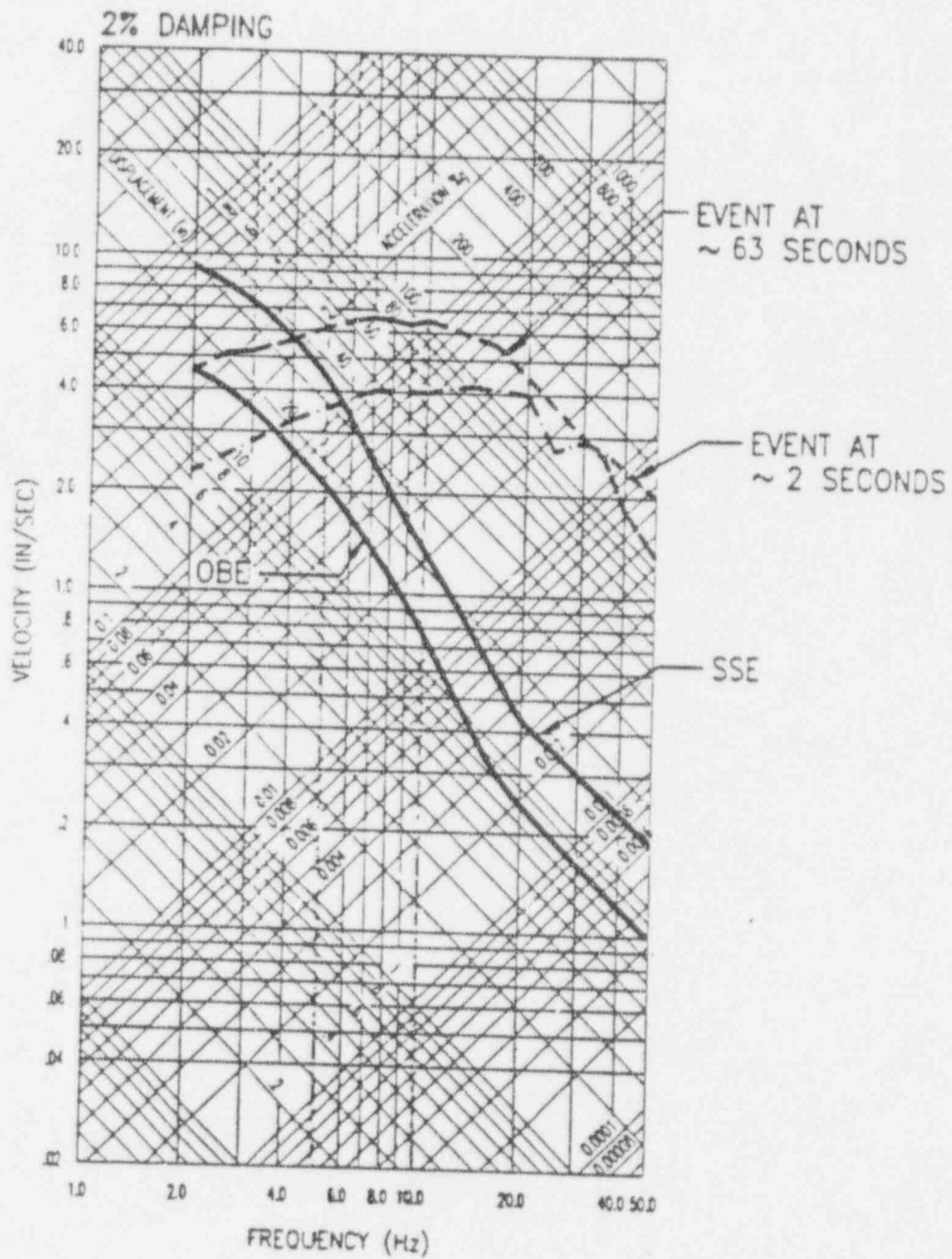
HOPPER AND ASSOCIATES
ENGINEERS



D30-N003 Accelerometer, North/South Response Spectra - HPCI Room

Figure 3.2.2.8

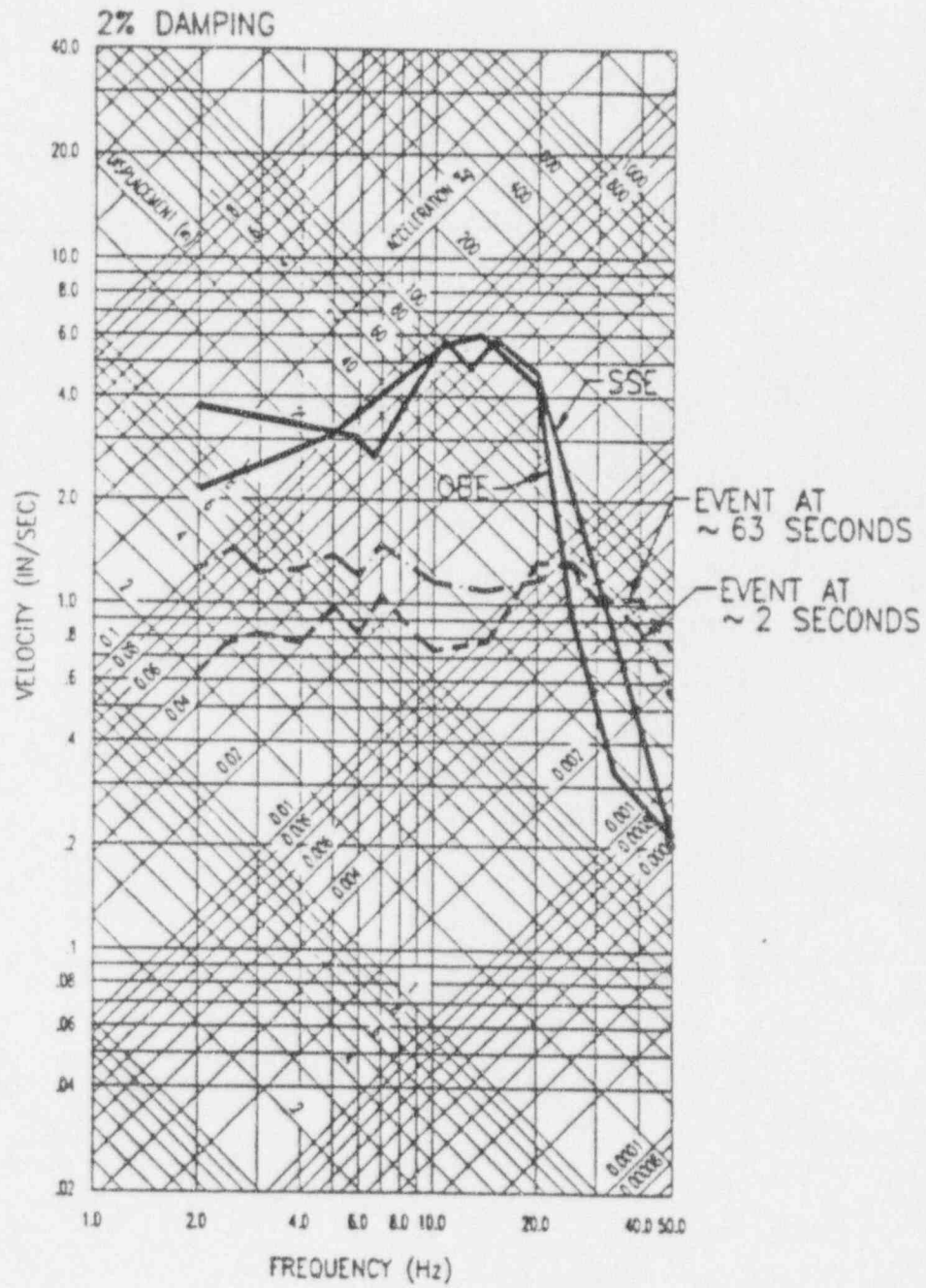
HOPPER AND ASSOCIATES
ENGINEERS



D30-N003 Accelerometer, East/West Response Spectra - HPCI Room

Figure 3.2.2.9

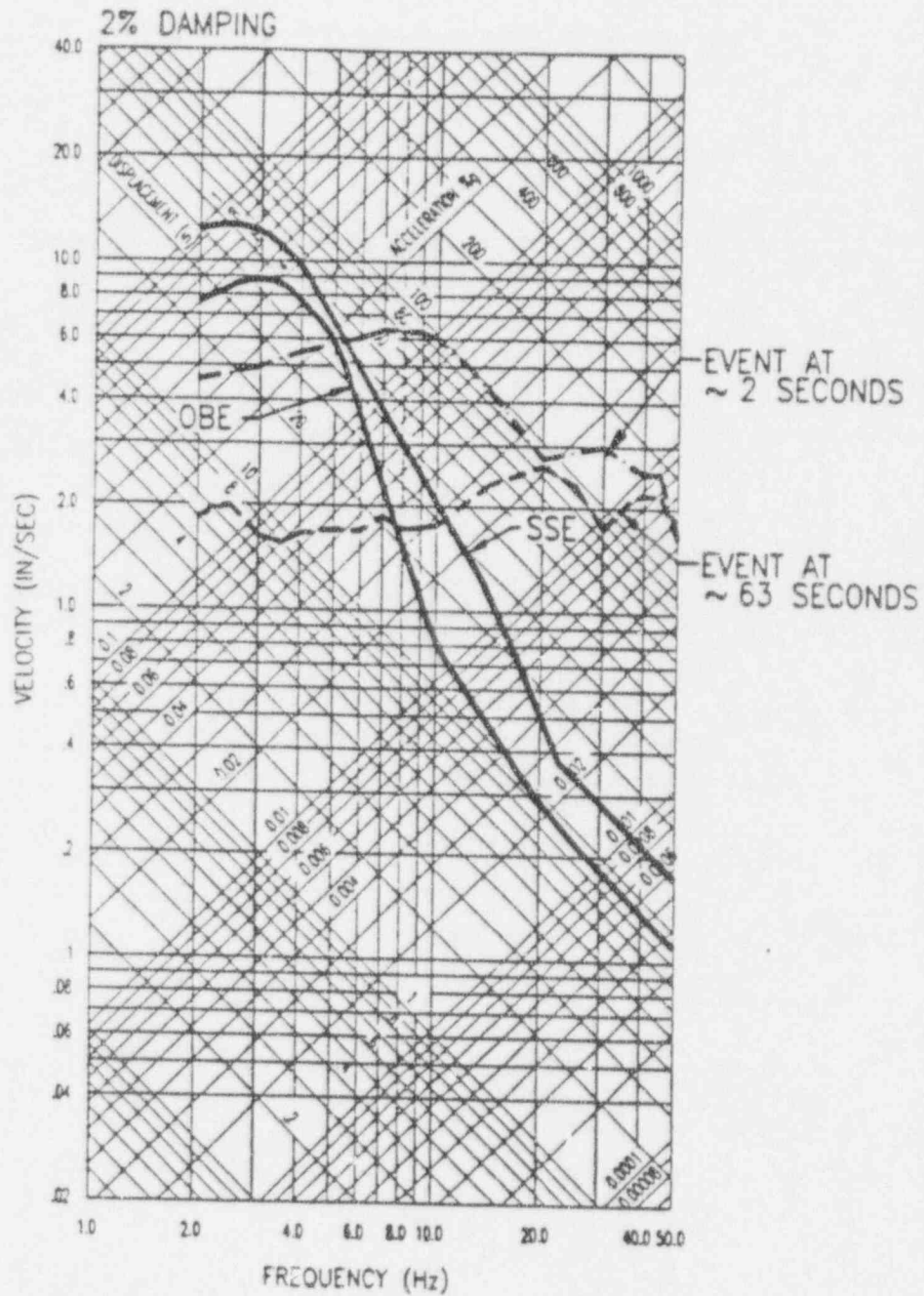
HOPPER AND ASSOCIATES
ENGINEERS



D30-N002 Accelerometer, Vertical Response Spectra - RPV Pedestal

Figure 3.2.2.10

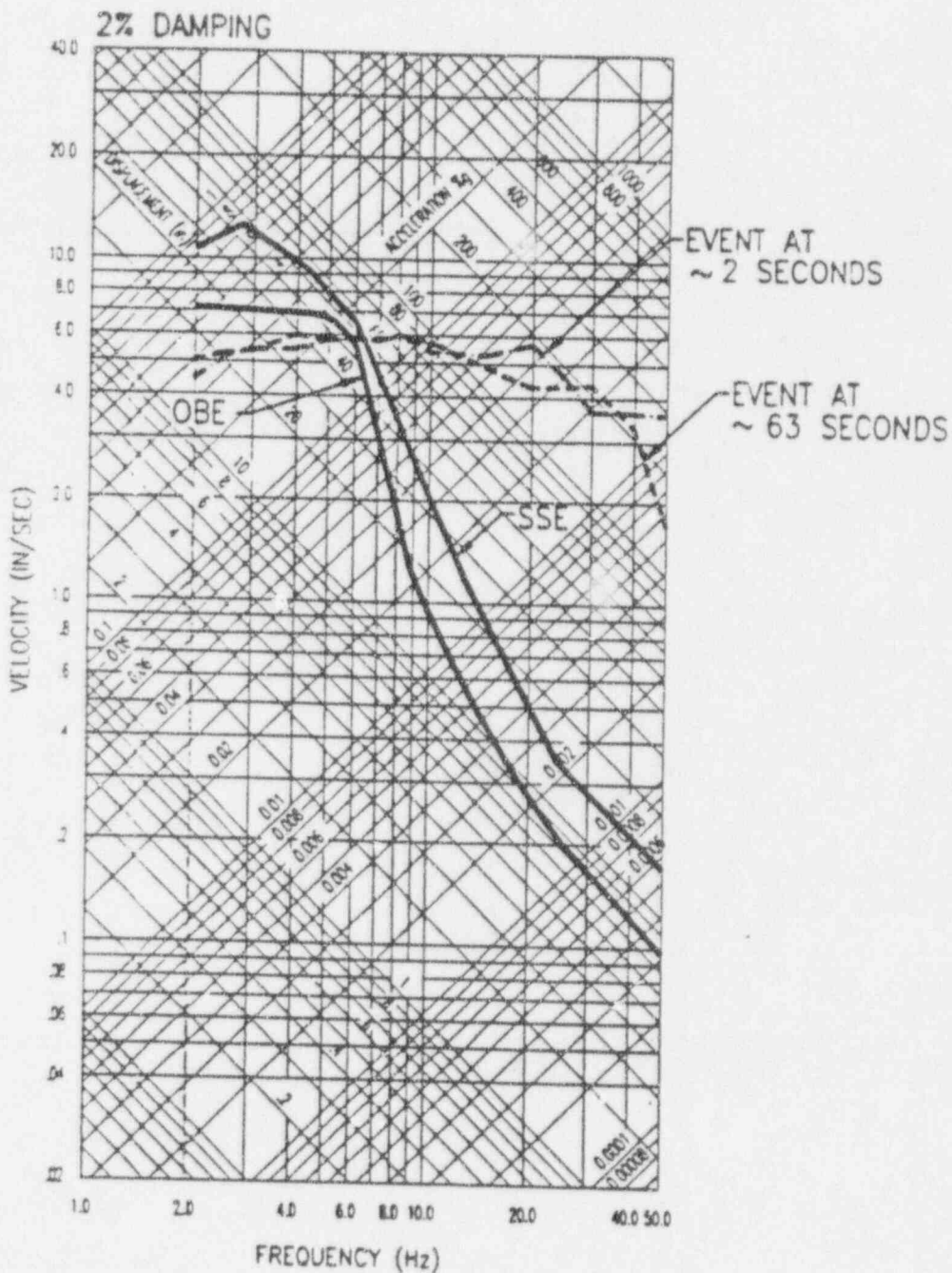
HOPPER AND ASSOCIATES
ENGINEERS



D30-N002 Accelerometer, North/South Response Spectra - RPV Pedestal

Figure 3.2.2.11

HOPPER AND ASSOCIATES
ENGINEERS



D30-N002 Accelerometer, East/West Response Spectra - RPV Pedestal

Figure 3.2.2.12

3.2.3 Active and Passive Data Correlation Comparison

The HPCI room passive instrumentation data for the vertical and east/west directions exhibited similar data trends and acceleration magnitudes compared to the active instrumentation. However, precise amplitude correlation at all frequencies was not possible.

Reasons for the anomalies likely are associated with the short duration of the events, and the intrinsic differences between the recording methods of the two instrumentation systems.

To fully understand the discrepancies, a further comprehensive study would need to be undertaken. However, the phenomenological similarity of the data is sufficient quantitatively to establish essential structural and equipment response characteristics at this time.

3.3 Results

The turbine failure on December 25, 1993, did not result in a significant Reactor/Auxiliary building dynamic excitation or a building global exceedence of the OBE. This was demonstrated by the insignificant accelerations recorded by the passive sensors on the second and fifth floors of the Reactor/Auxiliary building.

Below the second floor in the foundation, the building and equipment experienced local OBE and SSE exceedences recorded by the active and passive sensors located at the RPV pedestal and the HPCI room sub-basement.

The active instrumentation at the RPV pedestal exhibit OBE and SSE exceedences at higher frequencies in all directions. The RPV pedestal sensor in the vertical direction is less severe than the HPCI room vertical direction, while the other directions are similar.

Instrumentation in the HPCI room also experienced local OBE and SSE exceedences. The active instrumentation exhibit OBE and SSE exceedences in the vertical direction, and OBE exceedences in the high frequencies in the north/south and east/west directions. The passive exhibit OBE exceedences in the low and high frequencies. The HPCI room vertical and east/west passive plates show very similar data trends and acceleration magnitudes compared to the HPCI room active vertical and east/west data records.

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Generally, the event at time two seconds was more severe than the event at time one minute.

All equipment in the building functioned as expected during the turbine failure and reactor shutdown. An inspection after the event produced no indications of structural damage. Furthermore, the extant safe shutdown equipment adequacy was proven by the satisfactory safe shutdown experience.

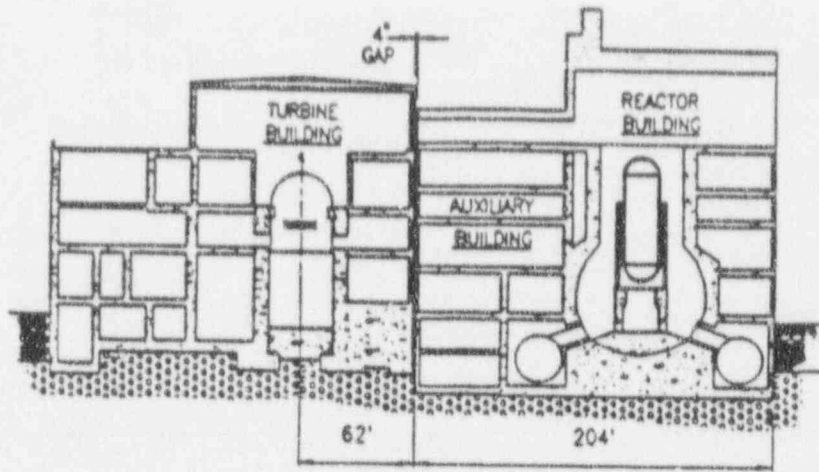
4.0 CONCLUSION

The turbine failure at Fermi 2 on December 25, 1993, should not be compared with a tectonic earthquake, and globally, the Reactor/Auxiliary building did not experience OBE excitation levels. The turbine failure was a shock incident, resulting in dynamic response phenomena or two single cycle waves propagating through the building foundation without exciting the structure above (Figure 4.0.1).

An earthquake imparts long duration, broad range frequencies, and high energy into a structure, while a shock impulse imparts short duration, high amplitude, and low energy into a structure. Industry standards recognize shock impulses do not cause significant structural stresses (Figure 4.0.2).

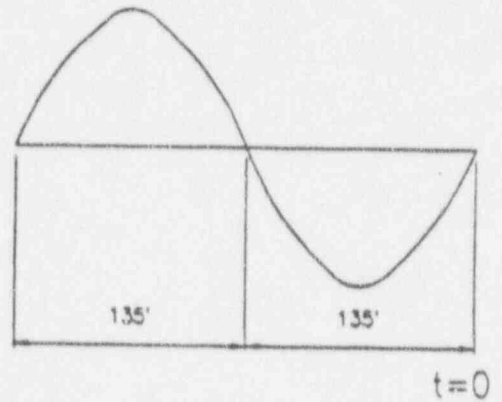
The shock wave length resulting from the turbine event at Fermi 2 was small compared to the building, and therefore produced local high accelerations, but the short duration, low energy, and small deformations associated with these high frequency accelerations did not compromise the structural integrity of the Reactor/Auxiliary building or the equipment therein.

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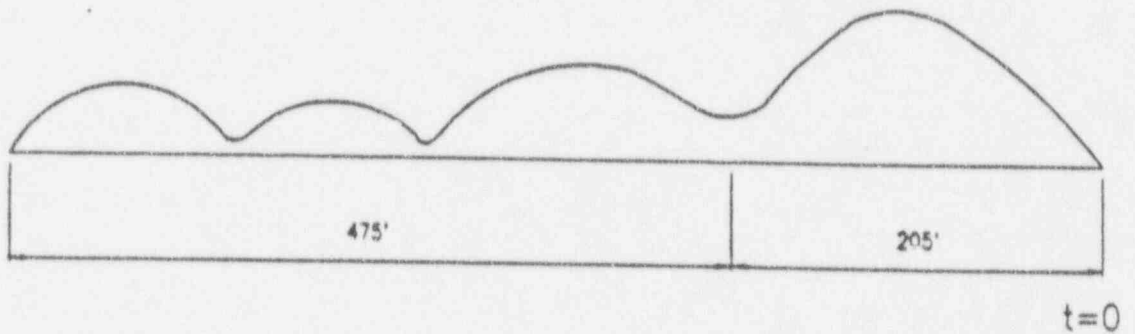


SECTION LOOKING SOUTH

HORIZONTAL

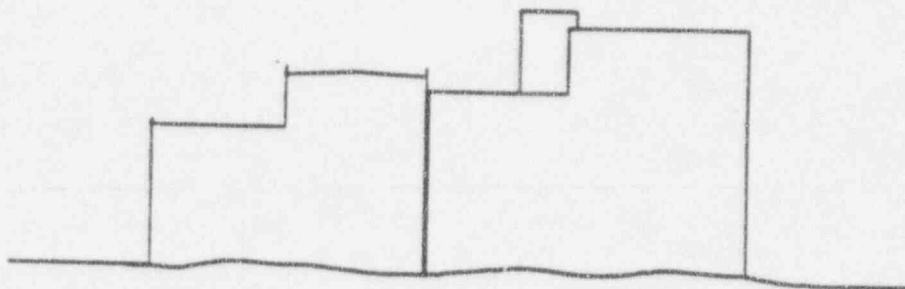


VERTICAL

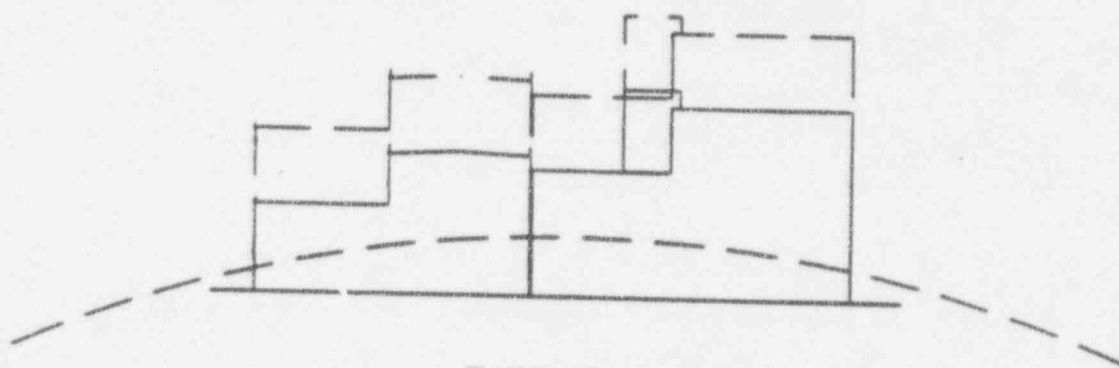


**Schematic Representation of Shock impulse Wave Length
Compared to Building Dimension**

Figure 4.0.1



IMPULSE TREMOR



EARTHQUAKE

Schematic Representation of Impulse Tremor Versus
Earthquake Wave - Vertical Direction

Figure 4.0.2

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