

March 29, 2000

MEMORANDUM TO: Susan F. Shankman, Deputy Director
Licensing and Inspection Directorate
Spent Fuel Project Office, NMSS

FROM: Steven Baggett, Project Manager /RA/
Licensing Section
Spent Fuel Project Office, NMSS

SUBJECT: SUMMARY OF MARCH 23, 2000, MEETING WITH TRANSNUCLEAR WEST
INC., REGARDING SEISMIC ANALYSIS OF A DRY CASK STORAGE
SYSTEM DESIGN

On March 23, 2000, staff from the U.S. Nuclear Regulatory Commission's (NRC) Office of Nuclear Material Safety and Safeguards met with representatives from Transnuclear West Inc. (TN West) to discuss the preliminary results of their seismic analysis of the Advanced NUHOMS® storage system. The Advanced NUHOMS® is a robust design similar to the Standardized NUHOMS® storage system but modified for use in high seismic applications. Attachment 1 is the attendance list. Attachment 2 is the non-proprietary handouts used at the meeting. A seismic specialist from the Office of Nuclear Reactor Regulation was in attendance. This meeting was a follow-up to the January 20, 2000, meeting. The meeting was noticed on March 15, 2000.

Additional discussions focused on the following:

- ◆ Summary of TN West's analytical approach
- ◆ Response modes of the cask design during a seismic event
- ◆ Validation and verification of the DYNA analytical model
- ◆ The need for sensitivity studies to bound the calculation parameters and the reliance of one-time history to support the analysis
- ◆ Challenges to TN West to provide an application that requires no request for additional information and to determine if the seismic design spectra to be used will bound as many U.S. sites as possible to reduce the need for future amendments
- ◆ Submittal of an application in August 2000
- ◆ TN West's request for NRC to complete its technical evaluation by August 2001 and issue a final Certificate of Compliance in August 2002
- ◆ A future technical meeting to be held in June 20

No proprietary information was disseminated, and no regulatory decisions were requested or made.

Docket No. 72-1029

Attachment: 1) Attendance List
2) Handouts

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DATE:	3/24/00		3/24/00		3/25/00	

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UNITED STATES
NUCLEAR REGULATORY COMMISSION

WASHINGTON, D.C. 20555-0001

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**March 23, 2000, Meeting
between the Nuclear Regulatory Commission and
Transnuclear West Inc.**

ATTENDANCE LIST

<u>Name</u>	<u>Affiliation</u>
Randy Hall	NRC/NMSS/SFPO
Lawrence Kokajko	NRC/NMSS/SFPO
Steven Baggett	NRC/NMSS/SFPO
David Tang	NRC/NMSS/SFPO
Henry Lee	NRC/NMSS/SFPO
Mahendra Shah	NRC/NMSS/SFPO
Li Yang	NRC/NMSS/SFPO
Kirke Lathrop	NRC/NMSS/SFPO
Goutam Bagchi	NRC/NRR/DE
Bill Huffman	NRC/NRR
Robert Grubb	Transnuclear West Inc.
Usama Farradj	Transnuclear West Inc.
Miguel Manrique	Transnuclear West Inc.
Robert Kennedy	Structural Mechanics Consulting
David Pilmer	Southern California Edison Co.
Jeff Summy	Southern California Edison Co.
Jorge Morales	Southern California Edison Co.
Torrey Yee	Southern California Edison Co.
Roger Johnson	PG&E
Steve Schulin	The IBEX Group
Sidney Crawford	Consultant

Seismic Analysis of the Dry Cask Storage System Design

*Meeting with
Transnuclear West Inc. (TNW) and the
Nuclear Regulatory Commission
March 23, 2000*

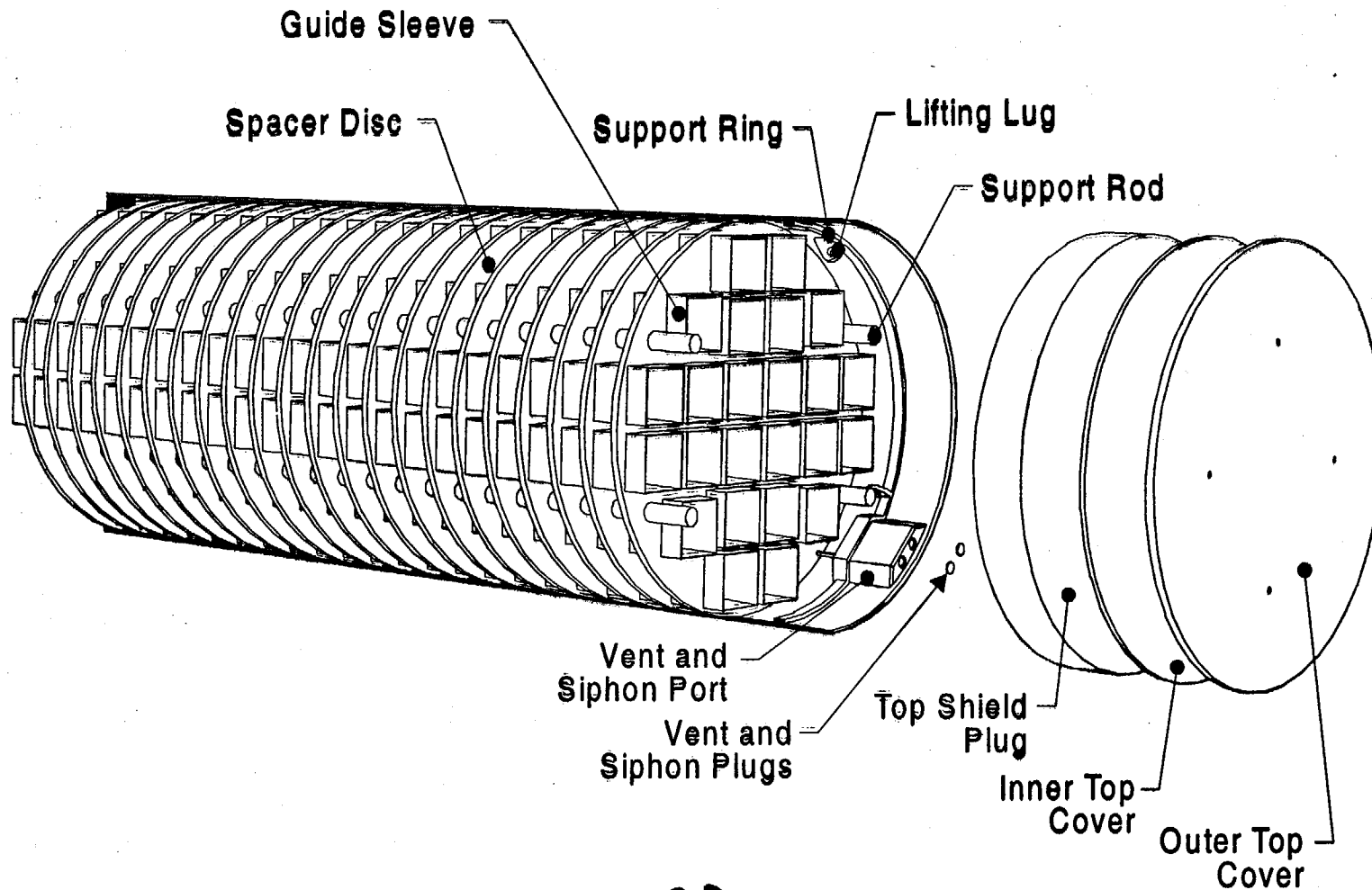


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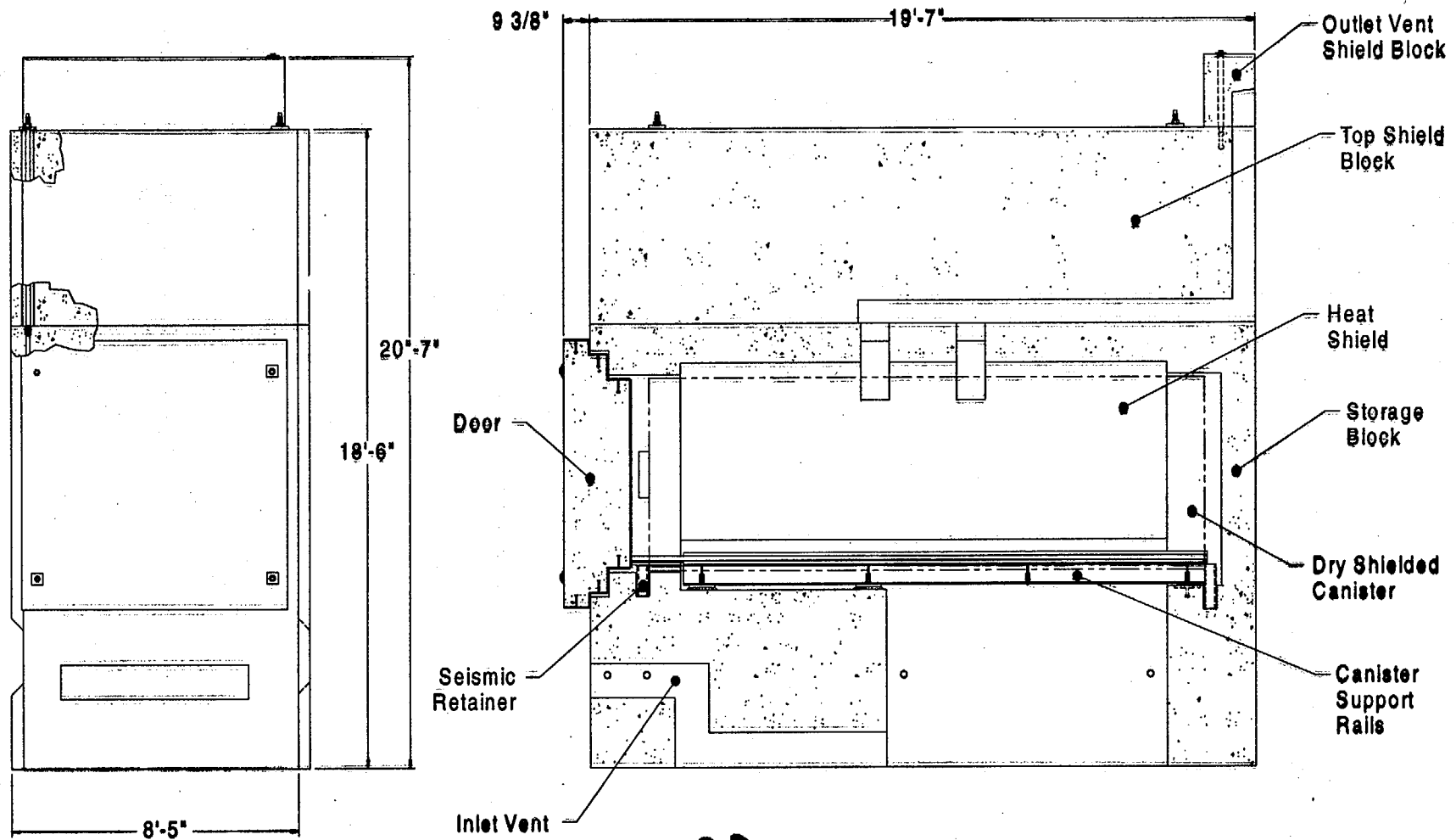
Agenda

- **LS-DYNA Validation and Verification**
- **Non-linear Analysis Model**
- **Preliminary Non-linear Analysis Results**
- **Linear Analysis Model**
- **Preliminary Linear Analysis Results**
- **Acceptance Criteria**
- **Summary and Conclusions**

Dry Shielded Canister (DSC)

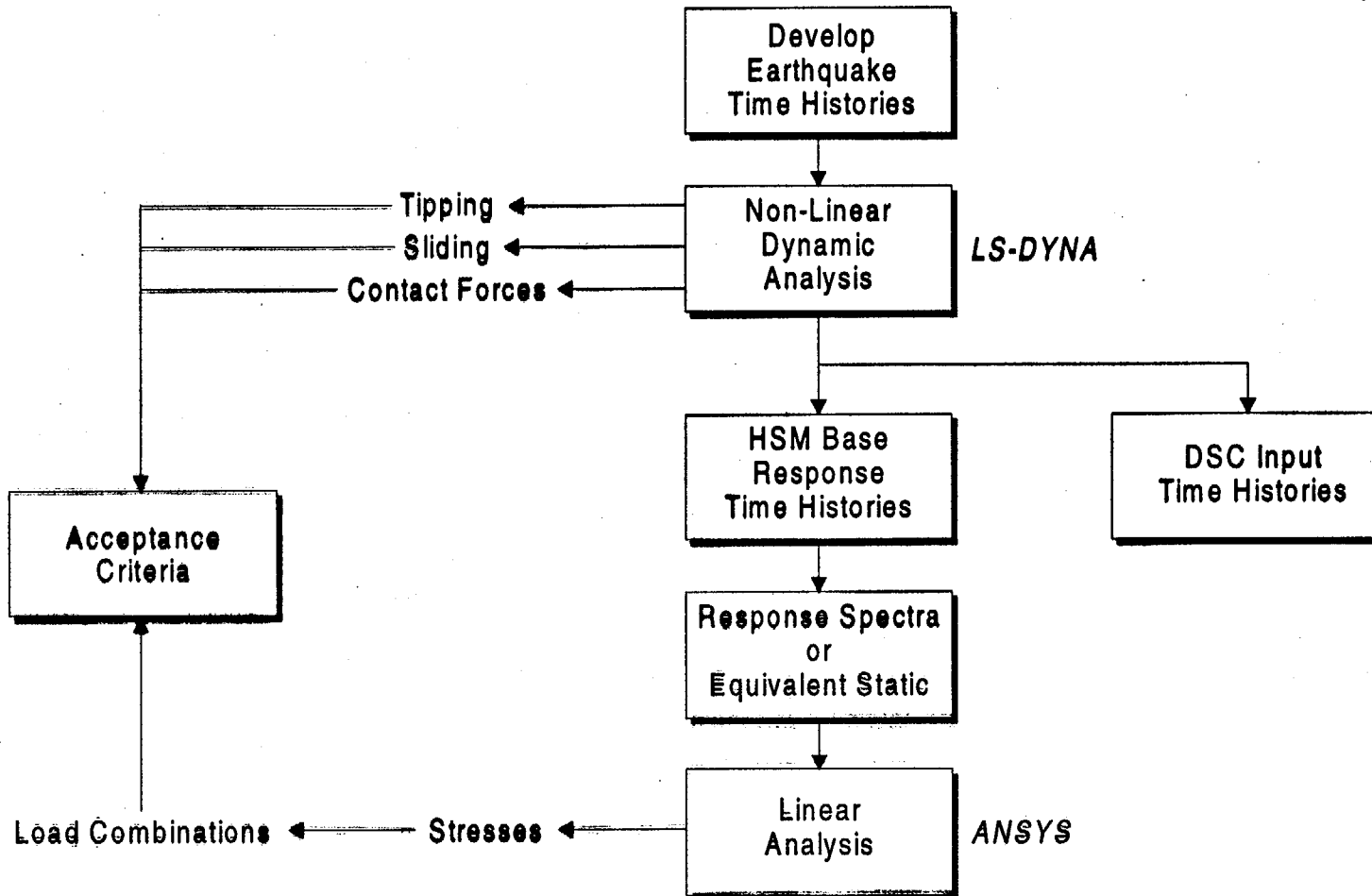


Horizontal Storage Module (HSM)



TRANSNUCLEAR WEST

Summary of Analytical Approach

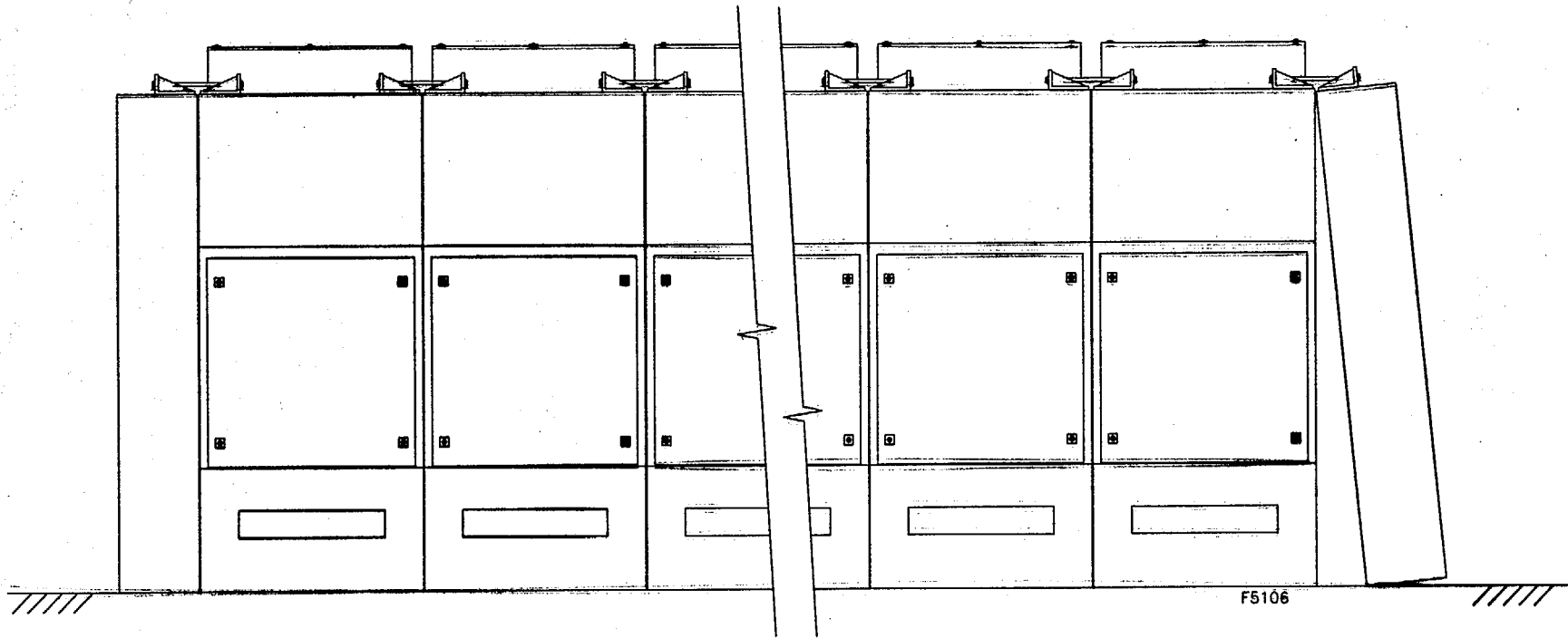


Acceptance Criteria

- **Tipping**
 - No tip-over
 - Large factor of safety relative to critical tip angle
- **Sliding**
 - Limited to maintain retrievability
- **Stress**
 - Maintain geometry and confinement boundary
 - ACI 349 and ASME Section III

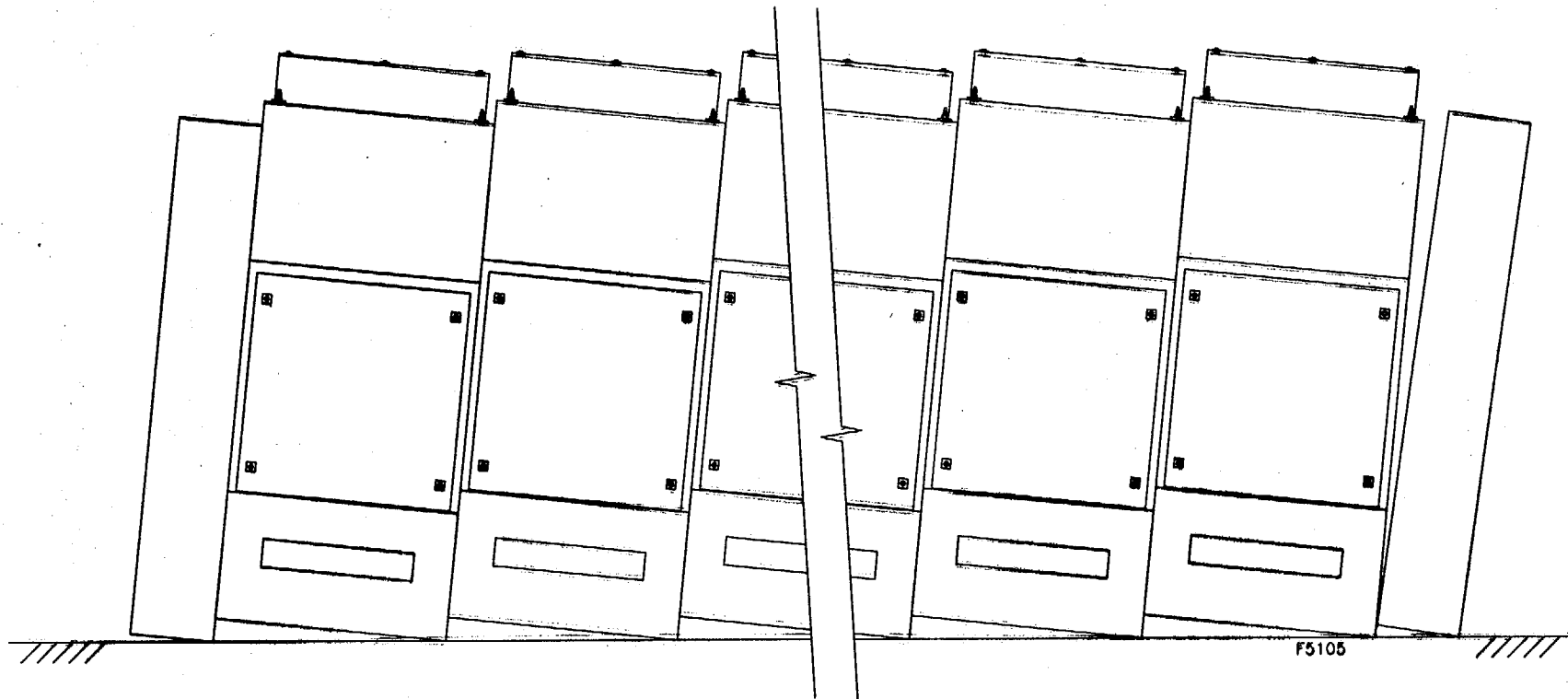
Response Modes

Base Separation Tipping

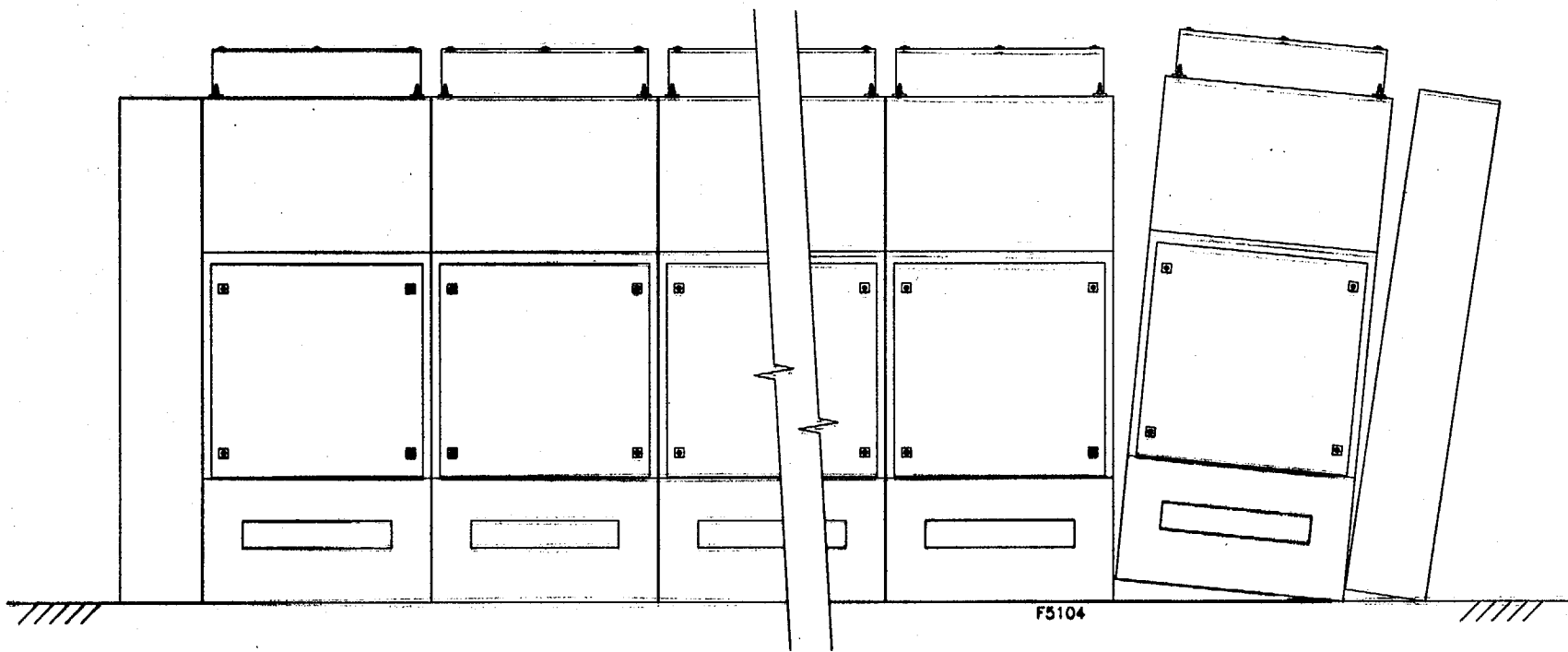


TRANSNUCLEAR WEST

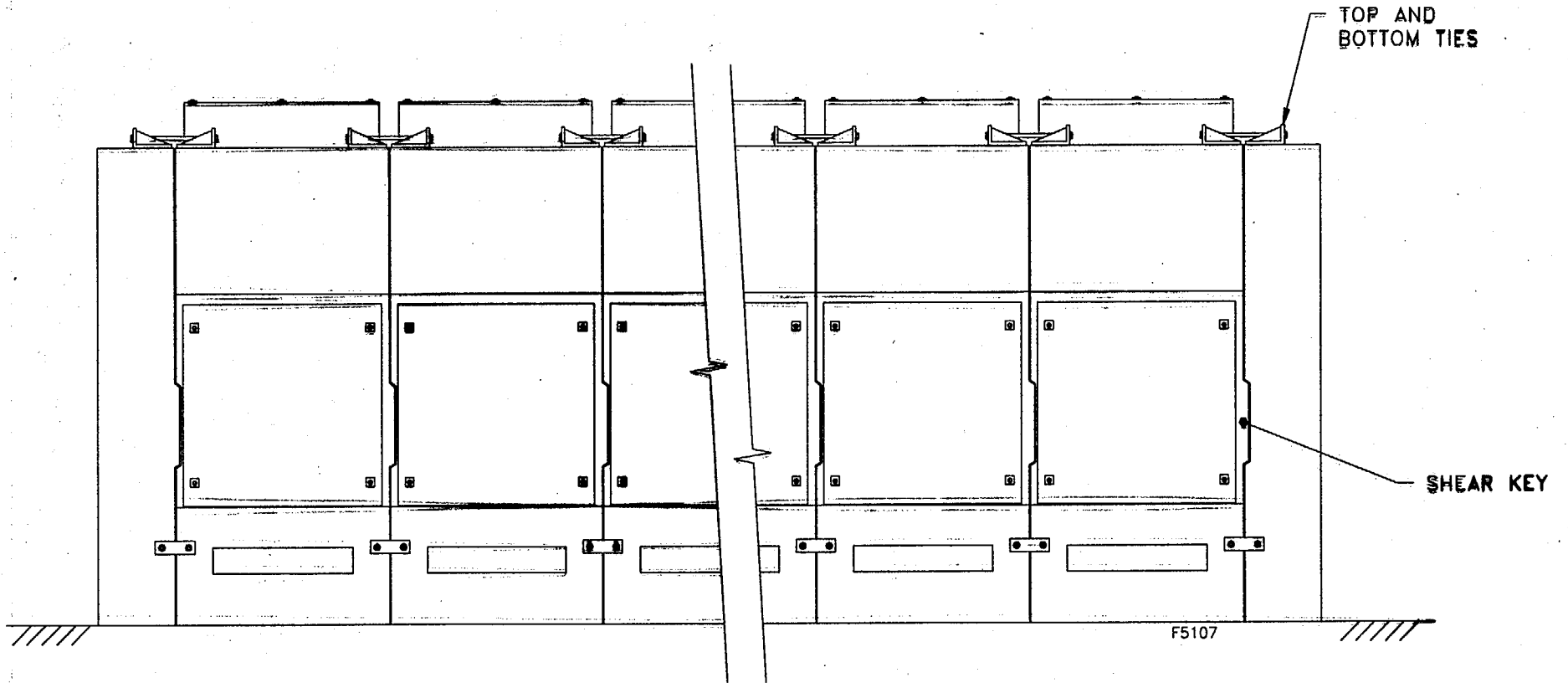
Response Modes In Phase Tipping



Response Modes Out of Phase Tipping



Tie Concepts



LS-DYNA Validation and Verification

- **In accordance with Transnuclear West's (TNW) Part 72 QA Program**
- **LS-DYNA specific test problems verify installation on TNW platform**
 - 10 problems provided by LSTC to verify correct installation in TNW platform
 - Problem solutions on TNW version are identical to LSTC
- **Open literature/close form/solution test problems**
 - 5 problems selected to exercise features related to gap/impact response
 - LS-DYNA solutions essentially identical to close form solutions
- **Use specific test problems**
 - Test problems to validate application to specific project use

LS-DYNA Specific Installation Verification Problems

- **Sample Problem 1: Bar impacting a rigid wall**
- **Sample Problem 2: Impact of cylinder into a rail**
- **Sample Problem 3: Impact of two elastic bodies**
- **Sample Problem 4: Square plate impacted by a rod**
- **Sample Problem 5: Box beam buckling**
- **Sample Problem 6: Space frame impact**
- **Sample Problem 7: Thin beam subjected to an impact**
- **Sample Problem 8: Impact on a cylindrical shell**
- **Sample Problem 9: Simply supported flat plate**
- **Sample Problem 10: Hourglassing of simply supported plate**

Open Literature/Close Form Solution Test Problems

- **VM56: Hyperelastic thick cylinder under internal pressure**
- **VM64: Thermal expansion to close a gap at a rigid surface**
- **VM65: Transient response of a ball impacting a flexible surface**
- **VM73: Free vibration with coulomb damping**
- **VM85: Transient displacements in a suddenly stopped moving bar**

Use Specific Test Problems

- **Problem 1: Free vibration rocking response**
- **Problem 2: Free vibration vertical drop**
- **Problem 3: Pure sliding response of rigid body under sinusoidal loading**
- **Problem 4: Seismic response of AHSM under horizontal and vertical loading**

Conclusions

- **LS-DYNA is verified and validated for project use**

Figure 1: LS-DYNA Simplified AHSM Model

2D-20 SEC. EQ. 1.5G H/1.0G V (MU-61.4)
Time =




TRANSCLEAR WEST

Figure 2: Free Vibration Rocking Response

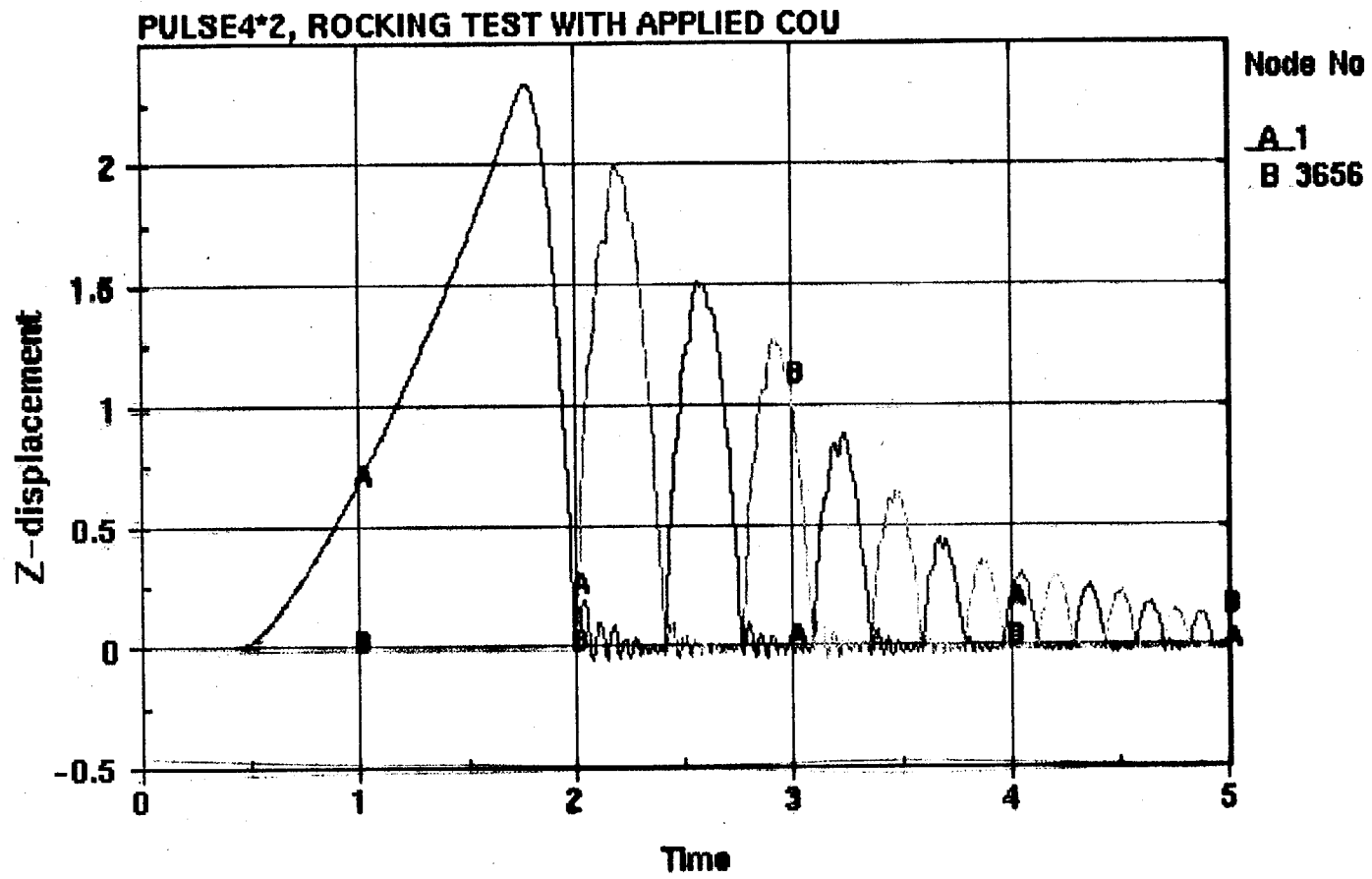


Figure 3: Vertical Drop Free Vibration Displacement Response - $e = 1.0$

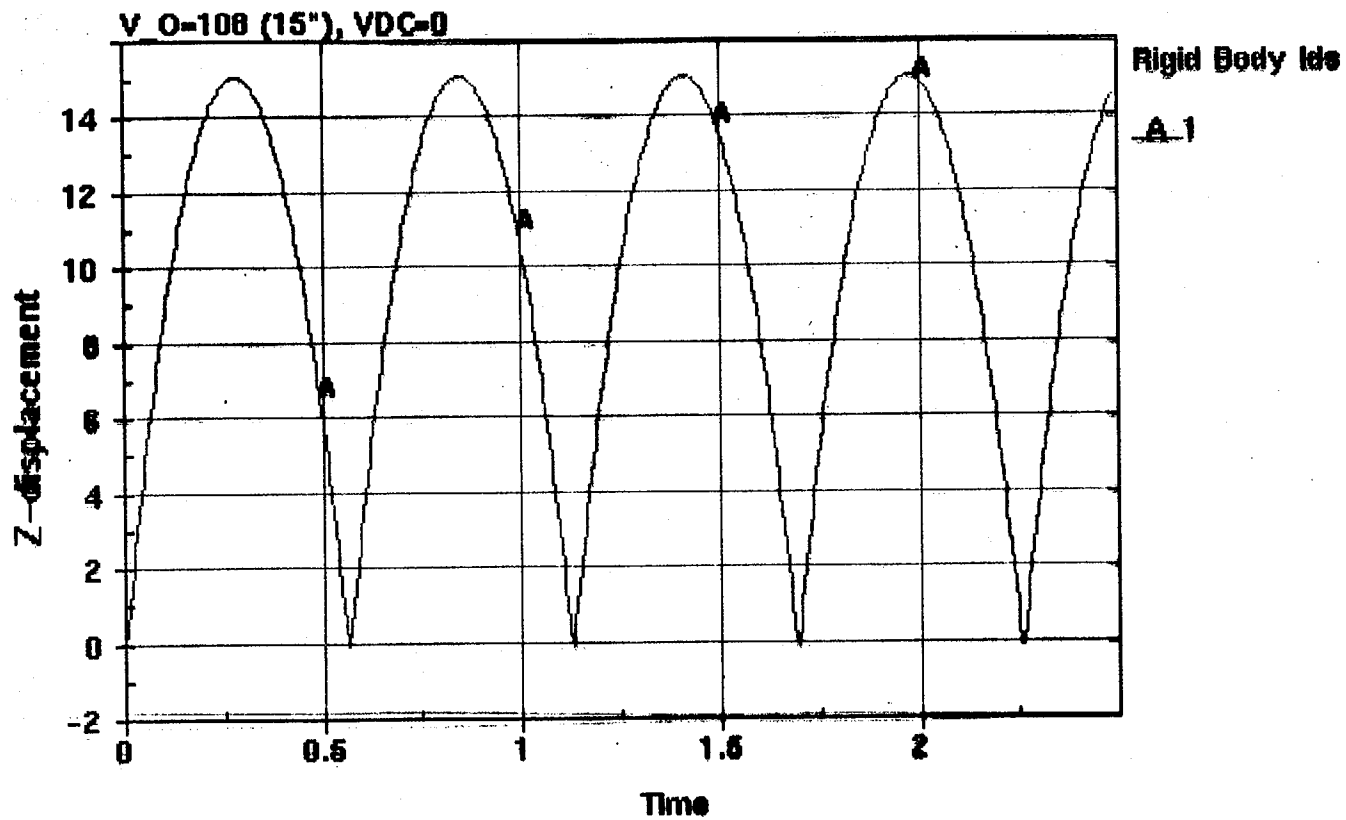


Figure 4: Vertical Drop Free Vibration Velocity Response - $e = 1.0$

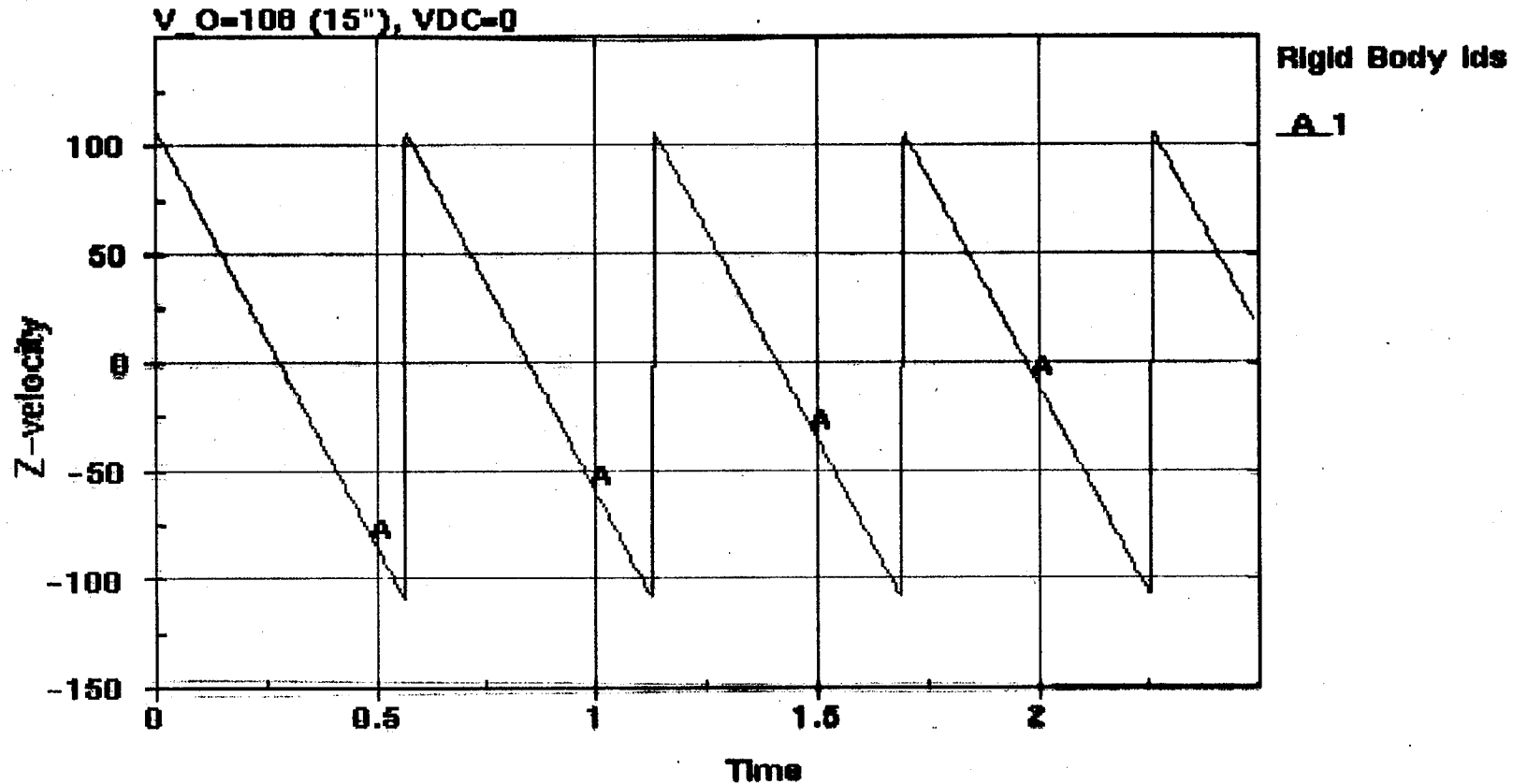


Figure 5: Vertical Drop Free Vibration Displacement Response - $e = 0.80$

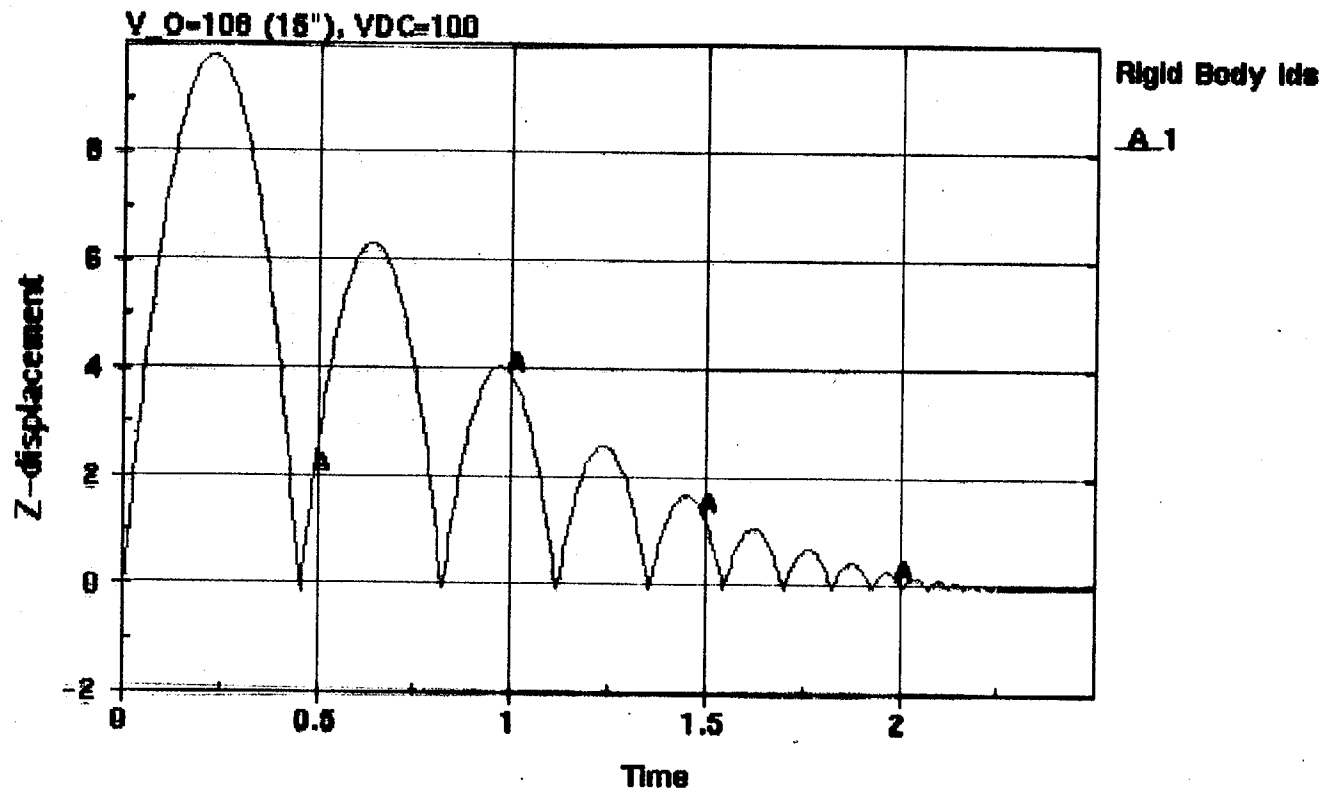


Figure 6: Vertical Drop Free Vibration Velocity Response - $e = 0.80$

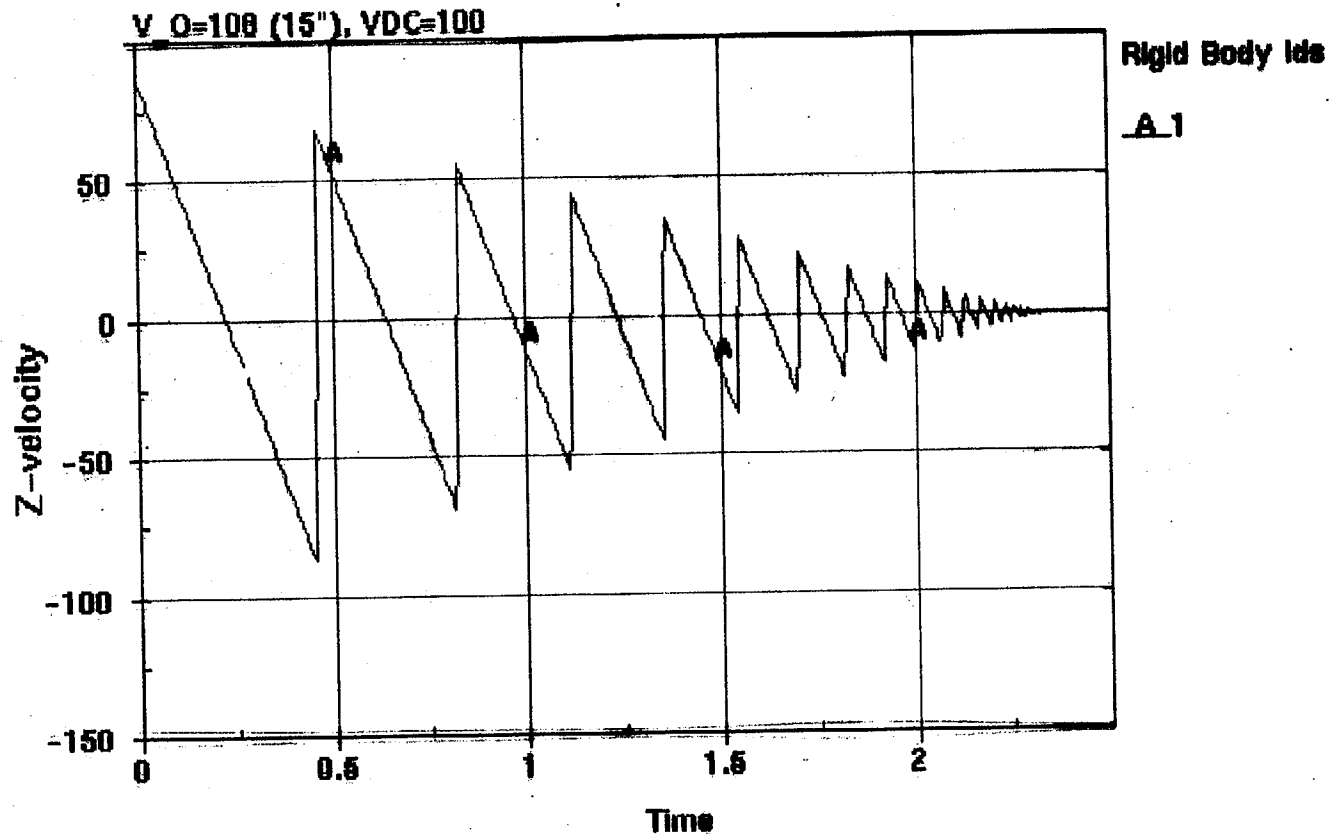


Figure 7: Vertical Drop Free Vibration Displacement Response - $e = 0.66$

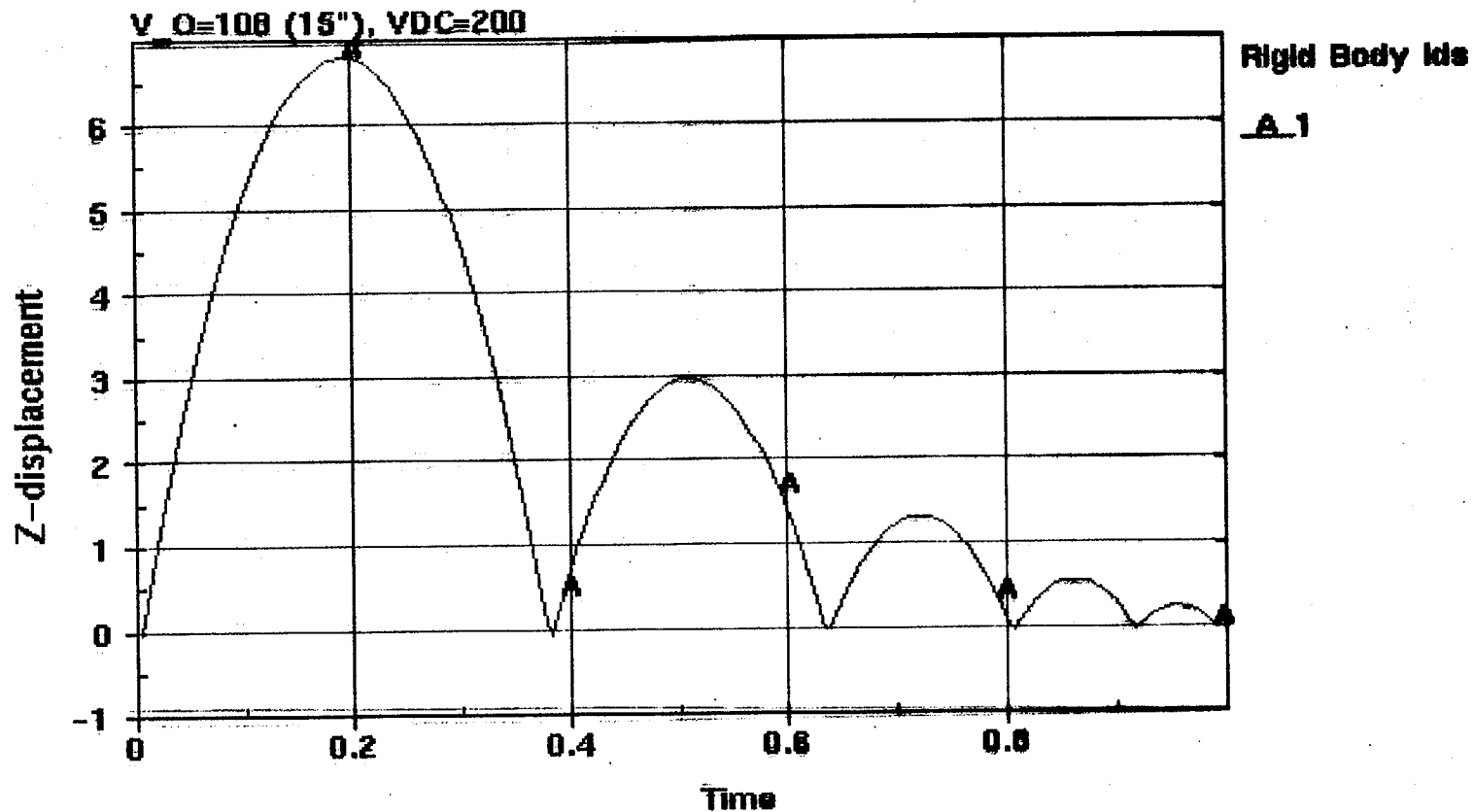


Figure 8: Vertical Drop Free Vibration Velocity Response - $e = 0.66$

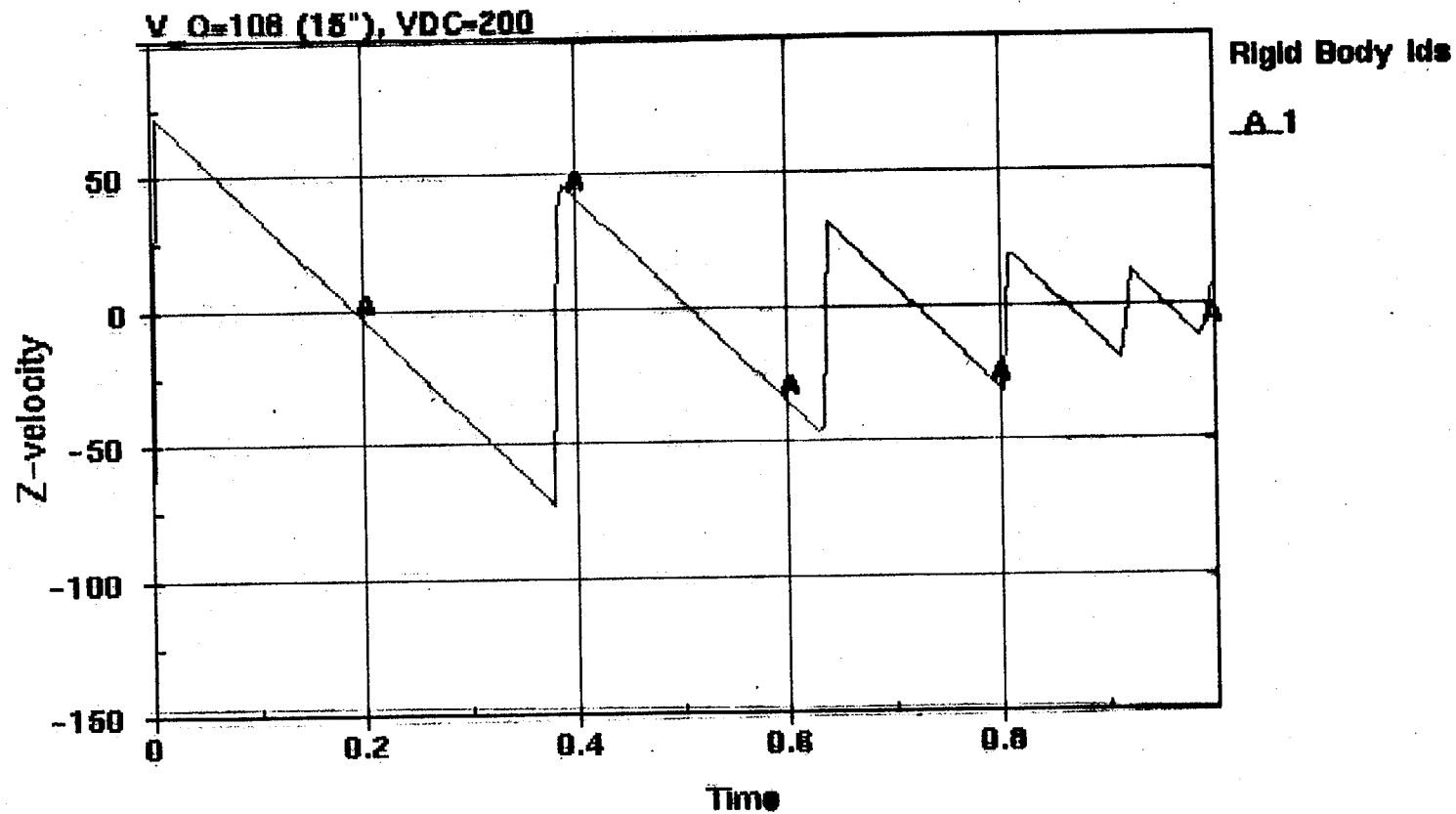


Figure 9: Vertical Drop Free Vibration Displacement Response - $e = 0.25$

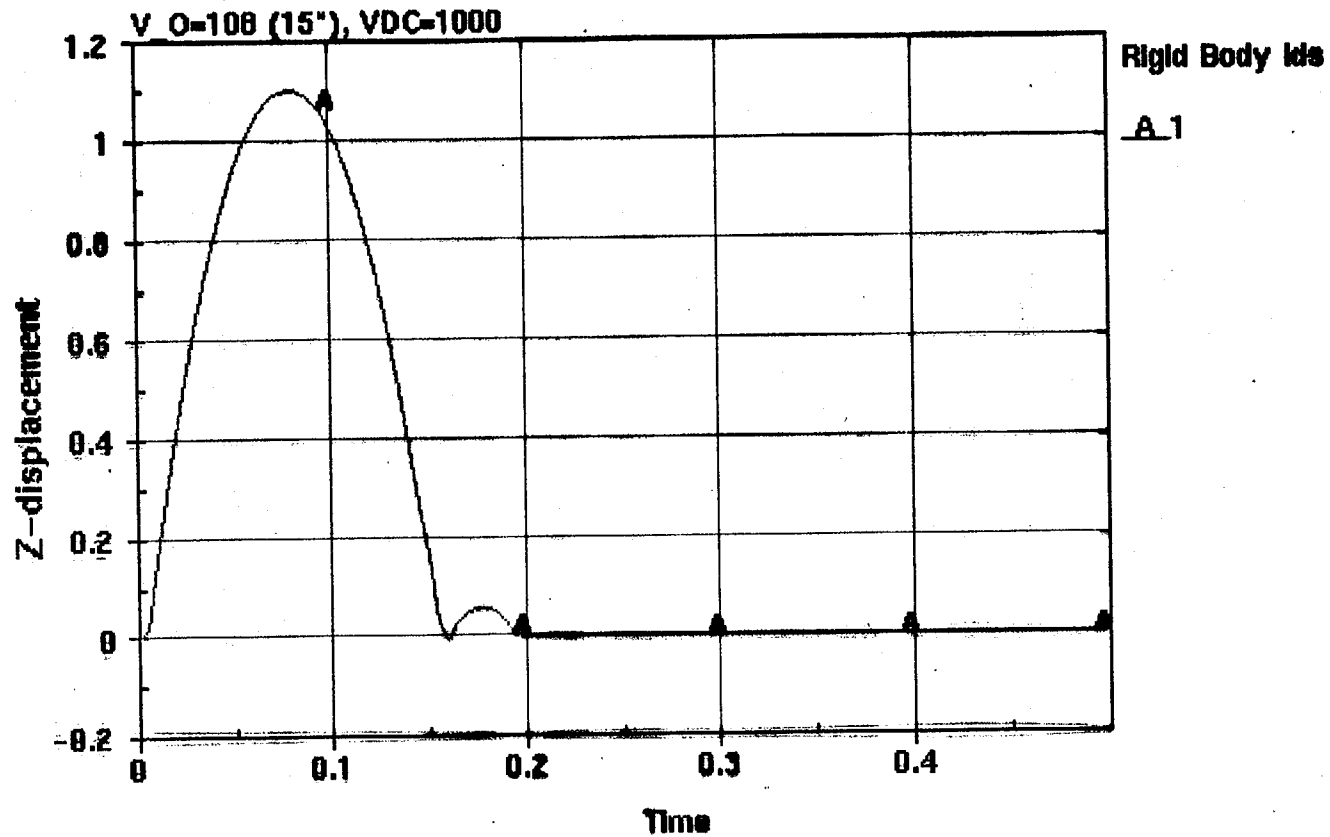


Figure 10: Vertical Drop Free Vibration Velocity Response - $e = 0.25$

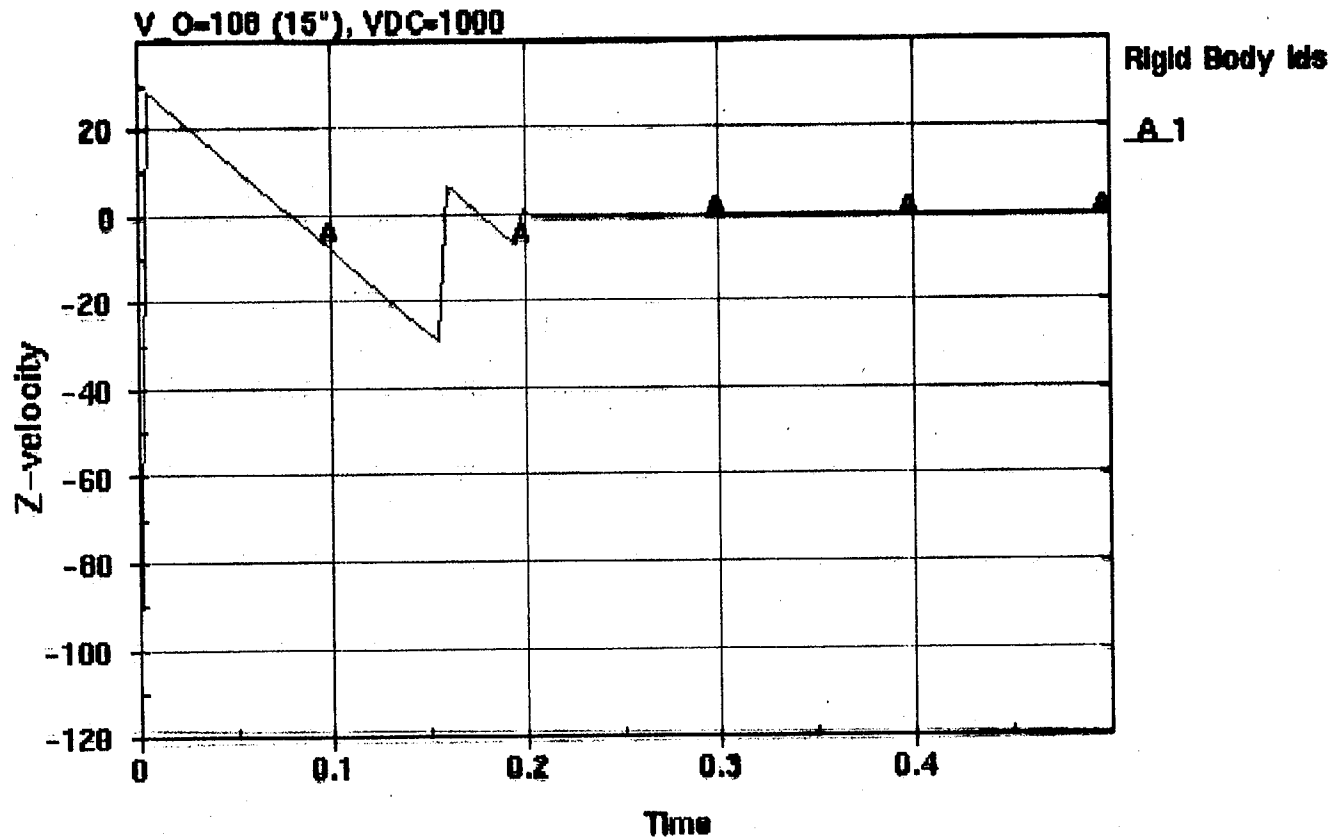


Figure 11: Correlation Between Coefficient of Restitution and LS-DYNA Contact Damping Coefficient

Relationship Between LS-DYNA Contact Damping and Coefficient of Restitution

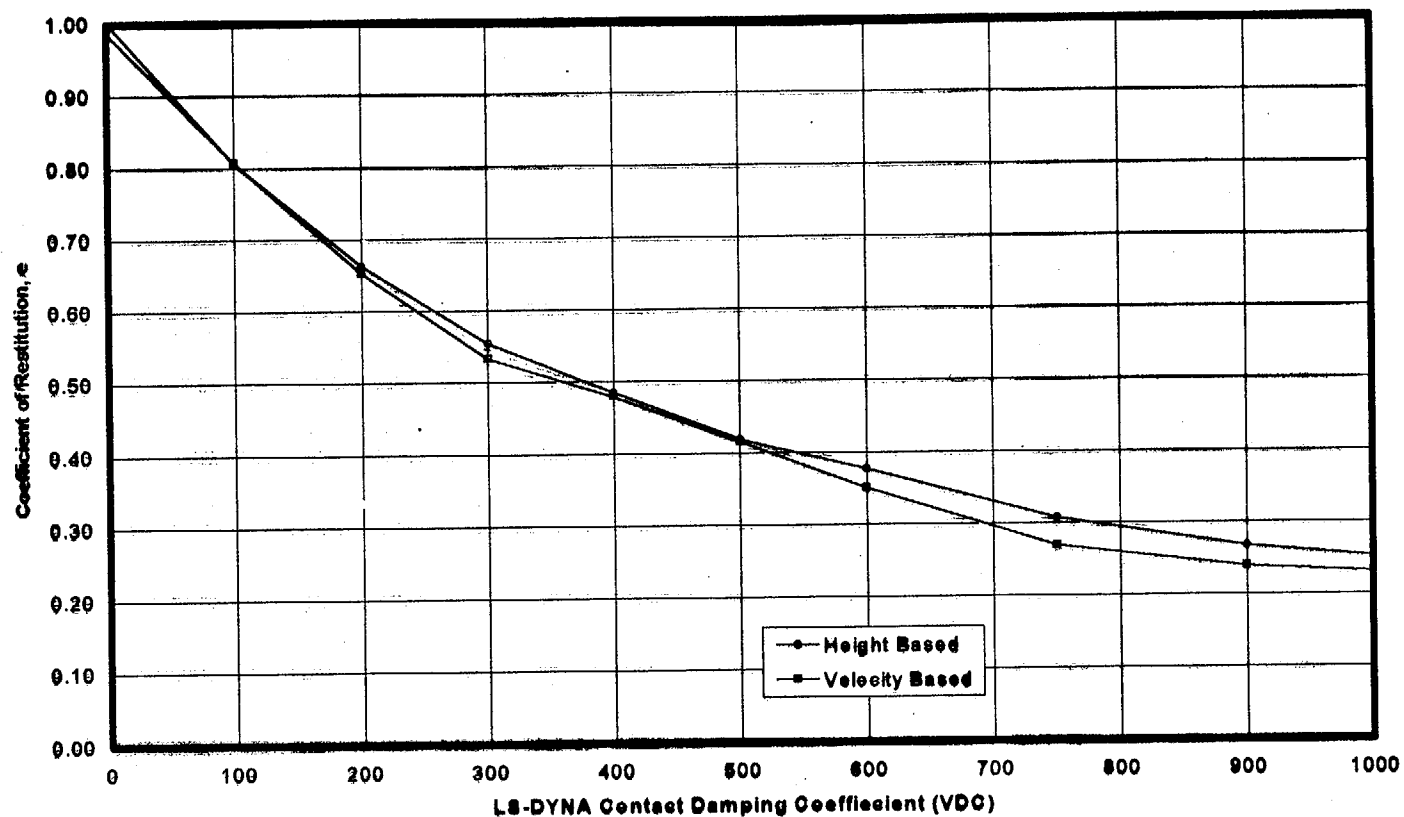


Figure 12: Sliding Response Under Sinusoidal Loads $\mu_s = \mu_d = 0.4$

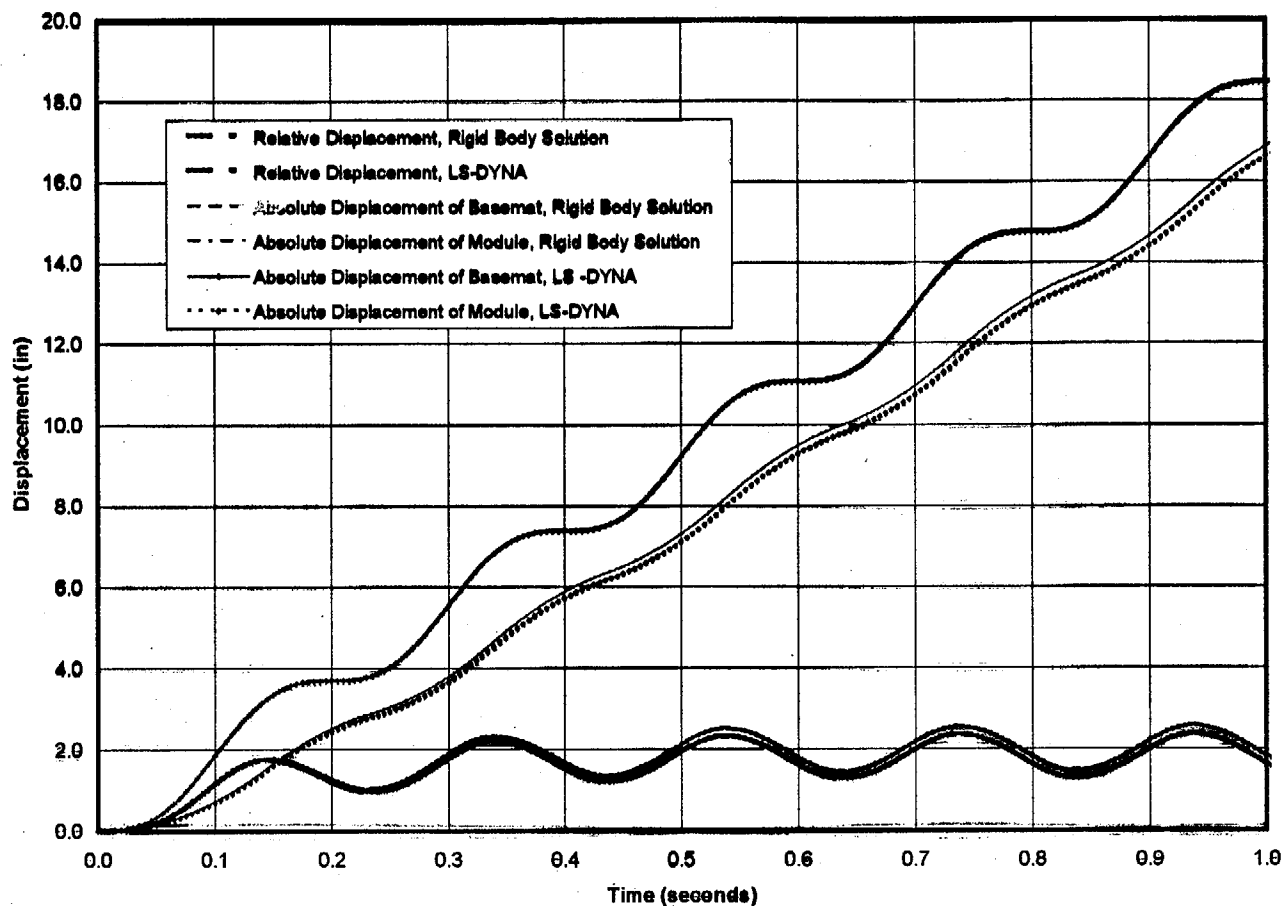
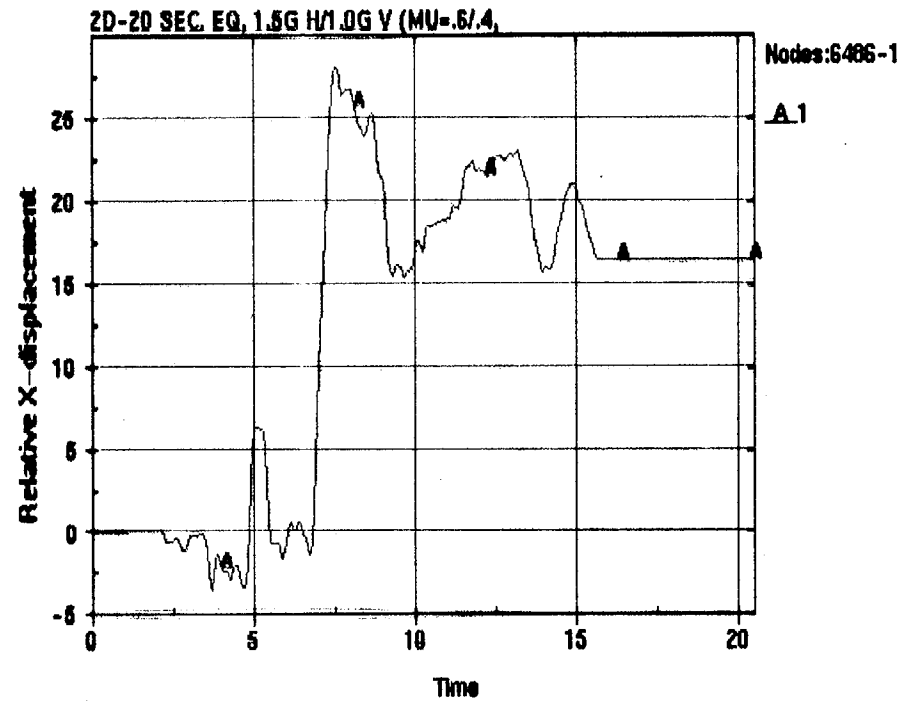
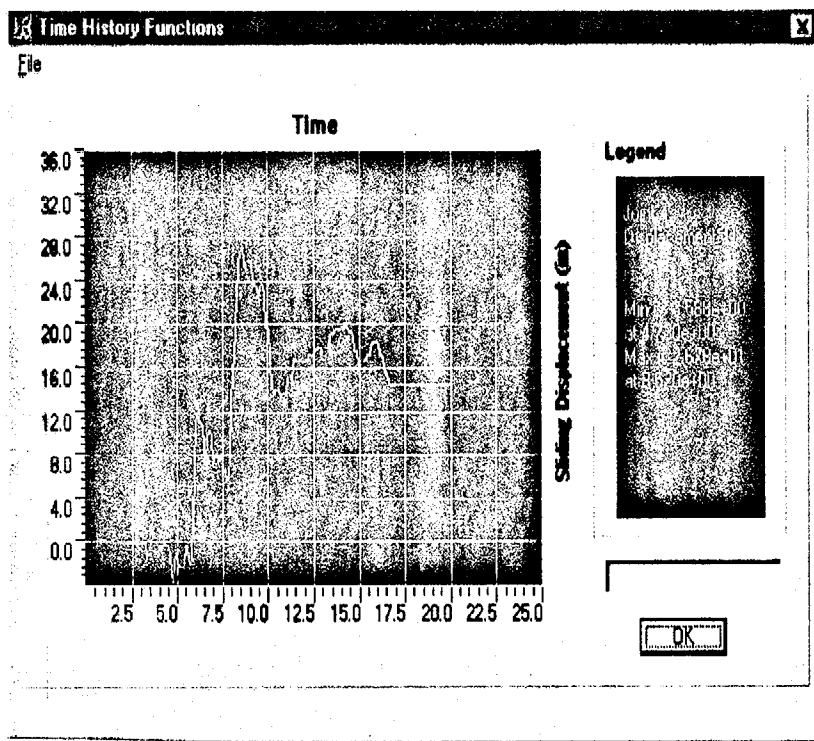


Figure 13: SAP2000 Sliding Response - Earthquake Loads



Current Schedule / Look Forward

- **Licensing Schedule**

- Submittal in August 2000
- NRC Staff Review Completion and Initiate Rulemaking August 2001
- CofC Issued by August 2002

- **Next Meeting**

- Topic(s)
- Date