SMA 12109.01-R001

STUDY TO DEMONSTRATE THE GENERIC APPLICABILITY OF SRSS COMBINATION OF DYNAMIC RESPONSES FOR MARK III NUCLEAR STEAM SUPPLY SYSTEM AND BALANCE-OF-PLANT PIPING AND EQUIPMENT COMPONENTS

prepared for

GENERAL ELECTRIC COMPANY
NUCLEAR ENERGY DIVISION
San Jose, California

Purchase Order 205-XI193

November, 1981

STRUCTURAL MECHANICS ASSOCIATES
A Calif. Corp.

5160 Birch Street, Newport Beach, Calif. 92660 (714) 833-7552

D. S. Lin

SMA 12109.01-R001

STUDY TO DEMONSTRATE THE GENERIC APPLICABILITY OF SRSS COMBINATION OF DYNAMIC RESPONSES FOR MARK III NUCLEAR STEAM SUPPLY SYSTEM AND BALANCE OF PLANT PIPING AND EQUIPMENT COMPONENTS

by

Robert P. Kennedy
Thomas R. Kipp
Robert D. Thrasher

APPROVED: Robert P. Kennedy
Robert P. Kennedy
President

APPROVED: Robert B. Narver
Robert B. Narver
Acting Manager,
Quality Assurance

prepared for

GENERAL ELECTRIC COMPANY
NUCLEAR ENERGY DIVISION
San Jose, California

Purchase Order 205-XI193

November, 1981

STRUCTURAL MECHANICS ASSOCIATES
A Calif. Corp.
5160 Birch Street, Newport Beach, Calif. 92660 (714) 833-7552

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF FIGURES (Continued)

NOMENCLATURE

Acronym	Definition
ABS	Absolute Summation
BOP	Balance-of-Plant
BWR	Boiling Water Reactor
CDF	Cumulative Distribution Function
CHUG	CHUGGING Load Associated with LOCA
IBA	Intermediate Break Accident
LOCA	Loss-of-Coolant-Accident
NEP	Non-Exceedance Probability
NRC	Nuclear Regulatory Commission
NSSS	Nuclear Steam Supply System
OBE	Operational Basis Earthquake
PDF	Probability Density Function
R_{50}	50% NEP Combined Response Value
R_{85}	85% NEP Combined Response Value
SBA	Small Break Accident
SRSS	Square-Root-Sum-of-the-Squares
SRV_1	Safety Relief Valve Discharge (1 Valve, 2nd Actuation)
SRV_{ADS}	Safety Relief Valve Discharge (Automatic Depressurization System)
SRV_{ALL}	Safety Relief Valve Discharge (All Valves)
SSE	Safe Shutdown Earthquake

ACKNOWLEDGMENT

This study to demonstrate the generic applicability of the SRSS combination of dynamic responses for Mark III Nuclear Steam Supply System and Balance-of-Plant piping and equipment components was funded by the following utilities under the auspices of the Mark III Containment Owners SRSS Subgroup:

1. Cleveland Electric Illuminating Co.
2. Gulf States Utilities Co.
3. Houston Lighting and Power Co.
4. Illinois Power Co.
5. Mississippi Power and Light Co.

The technical data and response time histories used in conducting these analyses were provided by the General Electric Company and the following Architect-Engineer firms:

1. Gilbert Associates
2. Stone & Webster
3. Ebasco Services
4. Sargent & Lundy
5. Bechtel Corporation

Structural Mechanics Associates, Inc. gratefully acknowledges the effort of these firms in providing the necessary data and in the review of this report.

EXECUTIVE SUMMARY

The Nuclear Regulatory Commission (NRC) has historically required that structural/mechanical responses due to various accident or anticipated loads and loads caused by natural phenomena (such as earthquakes) be combined when analyzing structures, systems and components important to safety. As a result, structures and components of nuclear power plant facilities are designed for a large number of load combinations which include both multiple dynamic loads and static loads. Peak responses from each of the dynamic loads are generally calculated elastically and combined to obtain a resultant peak combined dynamic response. The resultant is then added absolutely to the elastically calculated static response to obtain a combined maximum response which is then compared to code allowable stress or response levels.

The question of how the several multiple peak dynamic responses should be combined has been studied extensively over the past years with both the absolute summation (ABS) and square-root-sum-of-the-squares (SRSS) methods being historically employed.

The SRSS method for combining peak dynamic responses has been justified on several bases, including:

1. Reliability Basis
2. Optimum Design Basis
3. Dynamic Margin Basis
4. Statistical Basis

The statistical basis for the SRSS method is that the SRSS combined peak response should have as great a non-exceedance probability as that required for the individual responses being combined. Employing the statistical basis, this study is concerned with providing generic

justification for the use of the SRSS method for piping and equipment components (both ASME and non-ASME) located within Mark III Boiling Water Reactor facilities.

The Newmark-Kennedy Criteria (Reference 2) were developed to provide a means for judging whether the statistical basis is met for the combination of peak responses from multiple dynamic loadings. The intent of the Newmark-Kennedy Criteria is to provide reasonable confidence that the SRSS combined response has an 84 percent non-exceedance probability (NEP) or greater when the individual responses are conservatively defined at the 84 percent NEP level or 1.15 times the median, whichever is greater.

The NRC has taken the position that loadings involving the combination of SSE + LOCA and the combination of three or more multiple dynamic responses may be combined by the SRSS method without further justification (Reference 11). Therefore, this study is concerned with providing justification for use of the SRSS method of response combination for the following three important loadings:

1. OBE + SRV
2. SSE + SRV
3. SRV + LOCA (SBA/IBA)

A series of demonstration analyses using 167 actual Mark III combination cases were conducted involving the generation of Cumulative Distribution Function (CDF) curves accounting only for time phasing of the individual responses. Conservative assumptions were made in establishing the relative time phasing between the earthquake and SRV responses and in the characterization of the repeatable nature of the CHUGGING load used to represent the LOCA. The results of these conservative analyses were then compared to the requirements of Newmark-Kennedy Criterion 2 for the justification of the use of the SRSS methodology. The response data included in these analyses were taken from a wide variety of response locations from six different Mark III plants and included responses associated with Nuclear Steam Supply System (NSSS)-RPV and internals, piping, and components, Balance-of-Plant (BOP) piping, and Balance-of-Plant equipment.

It was found that the non-exceedance probability associated with the SRSS calculated response tended to be lower for cases where the magnitude of the short duration, high-frequency response (i.e., SRV discharge) was predominant over the magnitude of the longer duration, low-frequency response (i.e., earthquake). The maximum exceedance of the 50 percent response value relative to the SRSS calculated response was less than 10 percent.

All 167 response combination analyses considered satisfy the requirements of Newmark-Kennedy Criterion 2 and therefore, the SRSS method of response combination is appropriate for the loadings investigated in this study. Further, it is concluded that the response history data sample was taken from a sufficient variety of response locations that the results may be considered to be generic and that the SRSS method is appropriate for the combination of responses for all locations within Mark III plants for the load combinations considered.

1. INTRODUCTION

1.1 BACKGROUND

The Nuclear Regulatory Commission (NRC) has historically required that structural/mechanical responses due to various accident or anticipated loads and loads caused by natural phenomena (such as earthquakes) be combined when analyzing structures, systems and components important to safety. As a result, structures and components of nuclear power plant facilities are designed for a large number of load combinations which include both multiple dynamic loads and static loads. Peak responses from each of the dynamic loads are generally calculated elastically and combined to obtain a resultant peak combined dynamic response. The resultant is then added absolutely to the elastically calculated static response to obtain a combined maximum response which is then compared to code allowable stress or response levels.

The question of how the several multiple peak dynamic responses should be combined has been studied extensively over the past years with both the absolute summation (ABS) and square-root-sum-of-the-squares (SRSS) methods being historically employed. The SRSS method for combining peak dynamic seismic responses was first proposed by Rosenblueth (Reference 1) in 1951 and, with a few well defined exceptions, has been accepted as the preferred method for response combination in the field of earthquake response of structures. As other transient dynamic loadings have been defined for nuclear facilities, it has become necessary to combine the peak responses from these as well. A number of studies (References 2 through 10) address the acceptability of combining multiple independent dynamic load time-histories using the SRSS method. Essentially these studies have concluded that there are several bases for accepting the SRSS combination of peak dynamic responses, including:

a. Reliability Basis
b. Optimum Design Basis
c. Dynamic Margin Basis
d. Statistical Basis

The statistical basis for the SRSS method states that the SRSS combined peak response value should have at least as great a non-exceedance probability (NEP) as the individual responses being combined.

The current NRC position (References 9 and 11) concerning combination of dynamic loads is as follows:

1. The SRSS response combination method cannot be universally applied without justification.

2. Such justification must be based upon a case investigation of response functions and not based on loading functions.

3. The SRSS combination of dynamic response may be used when it can be shown that approximately the SRSS value is at or exceeds the 84% NEP.

4. If SRSS combination cannot be justified for a given case, responses must be combined by absolute summation.

Criterion 2 of the Newmark-Kennedy criteria (Reference 2) provides an approach acceptable to the NRC to statistically demonstrate that approximately the SRSS response value is at or exceeds the 84% NEP. Reference 10 presents the results of a study which demonstrated that approximately the SRSS combined response has greater than an 84% NEP when the Newmark-Kennedy Criteria are satisfied. Newmark-Kennedy Criterion 2 is based upon the development of response level Cumulative Distribution Function (CDF) curves employing the response time-histories for the multiple dynamic loadings being combined and using appropriate assumptions concerning the range of possible time lags between these response time-histories. In order to justify the use of the SRSS combination method, Newmark-Kennedy Criterion 2 requires the meeting of the following conditions:

1. Intensity of the individual dynamic loadings must be conservatively represented, being defined at approximately the 84th percentile or 1.15 times the median value, whichever is greater.

2. Assuming only time phasing randomness of the response parameters, approximately the SRSS calculated peak response value must be at or exceed the 50% NEP.

3. Assuming only time phasing randomness of the response parameters, approximately 1.2 times the SRSS calculated peak response value must be at or exceed the 85% NEP.

Stated simply, if it can be shown that approximately the SRSS calculated peak response is at or exceeds the median value (50% NEP) of time phased combinations of the dynamic responses and approximately 1.2 times the SRSS value is at or exceeds about one standard deviation beyond the median ($\approx$85% NEP), it can be concluded that the SRSS value has at least as great a non-exceedance probability as that used to define the individual responses being combined. As stated above, this forms the statistical basis for accepting the SRSS method for combination of multiple dynamic responses.

In order to demonstrate the generic applicability of the SRSS response combination method for both ASME and non-ASME components for dynamic load combinations involving earthquake and certain hydrodynamic events for Mark III Boiling Water Reactor (BWR) plants, the Mark III Containment Owners SRSS Subgroup commissioned the statistical evaluation described in this report. The statistical analysis effort involved the development of 167 load combination CDF curves which have been constructed in accordance with methods acceptable to the NRC (Reference 8) and which are compared to the Newmark-Kennedy Criterion 2 requirements discussed above. Several important conclusions are drawn concerning trends noted in the CDF curves based upon the relationship between the responses being combined.

1.2 PURPOSE AND SCOPE

The purpose of this study is to demonstrate by statistical means the applicability of the SRSS dynamic response combination method for piping and equipment associated with Mark III plants. It is intended that the results and conclusions drawn from this analytical effort will be generically applicable to both ASME and non-ASME components mounted at a variety of locations within a Mark III plant. Therefore, in defining the scope of effort for this program, great care has been taken by the Mark III Containment Owners SRSS Subgroup to assure that it is broad enough for the results to be considered generic.

1.2.1 Plants Represented

The Mark III Owners Subgroup consists of five utility companies representing five different Mark III nuclear power facilities which have been designed and constructed by five different Architect/Engineer firms. The makeup of the Owners Subgroup is shown in Table 1-1. The nuclear plants represented cover the three types of Mark III containment designs. These include:

1. Freestanding Steel Containment
2. Freestanding Steel Containment - Concrete Backed
3. Concrete Containment

The nuclear power facilities represented also cover two foundation designs including:

1. Reactor Building Set on Own Foundation
2. Reactor Building Set on Integral Foundation with Auxiliary Building

A freestanding steel containment design set on its own foundation is schematically illustrated in Figure 1-1. A concrete containment design set on an integral foundation with the auxiliary building is similarly illustrated in Figure 1-2.

1.2.2 Locations Evaluated

In addition to covering a variety of Mark III containment designs, the SRSS evaluation program has been scoped to evaluate response data from numerous locations within the containment structure including locations associated with Nuclear Steam Supply System (NSSS) components, Balance-of-Plant (BOP) piping, and BOP equipment. The Mark III SRSS Evaluation Matrix is presented in Table 1-2 and is referred to throughout this report pertaining to data locations and load combinations considered in this study.

1.2.2.1 NSSS-RPV and Internals, Piping and Equipment

Response data associated with NSSS components have been gathered for selected locations within the Reactor Pressure Vessel (RPV) and its internals, for various piping elements of the Main Steam and Recirculation piping systems, and for selected pipe mounted equipment locations associated with the Main Steam and Recirculation piping loops. Each CDF curve represented in the evaluation matrix is identified by a location descriptor (i.e., 5-5) which defines the location and the response parameter (i.e., RPV Skirt, Vertical Force). The interested reader is directed to Appendix A which details the location and response parameter for each location descriptor given in the evaluation matrix. Figure 1-3 schematically depicts the reactor pressure vessel and internals of a boiling water reactor and identifies the data locations considered in this evaluation. Similarly, Figures 1-4 and 1-5 present simplified line drawings of typical Main Steam and Recirculation piping systems, respectively, and indicate the location of NSSS piping elements and pipe mounted equipment considered in this study.

From Table 1-2, it can be seen that response time-history data from 24 locations were used to generate 40 time phased response combination CDF curves associated with the NSSS components and piping. The NSSS response data provided by the General Electric Company were derived from the evaluation of equipment associated with the three different Mark III containment configurations (freestanding steel containment, freestanding steel containment-concrete backed, and concrete containment) designed by three different A-E's. At least 11 response combinations were chosen for each of the three plants. The response time histories include reaction force (9 cases), bending moment (22 cases), and acceleration response (9 cases). The various locations, response parameters, and nuclear power facilities have been included to assure that the results of this evaluation are applicable to all NSSS systems within Mark III plants.

1.2.2.2 Balance-of-Plant Piping

A total of 82 response combination CDF curves have been prepared representing typical Balance-of-Plant piping systems including supports. Table 1-2 indicates that the response data from which the curves were generated represent 42 piping locations from ten different piping systems. The Architect-Engineer firms associated with each of the five nuclear plants represented by the Mark III Owners Subgroup have each provided representative response time-history data for two piping systems. A minimum of 12 response combinations were used from piping systems in each of the five plants. The ten piping systems used to represent typical BOP piping are listed in Table 1-3 together with the nominal diameter of each and the structure or structures to which they are anchored or supported. In addition, Figures 1-6 and 1-7 schematically illustrate the relative location of each system within the plant while Figures 1-8 through 1-17 present isometric line drawings of each piping loop identifying the response locations. Figure 1-6 depicts six piping systems associated with both freestanding steel and freestanding steel-concrete backed containment configurations while Figure 1-7 depicts four piping systems associated with concrete containment designs. Referring to Figures 1-6 and 1-7, it can be seen that the ten selected piping systems cover attachment locations, ranging from low to high within containment. The piping loops are each anchored to at least one of the major plant structures including the drywell, containment vessel (either freestanding steel, freestanding steel-concrete backed, or concrete), shield building, and/or auxiliary building. From Table 1-3, the size of the selected piping systems can be seen to range from the relatively small 3" FPC & CU Refueling Water line, to the intermediate 12" High Pressure Core Spray lines, to the relatively large 20" and 24" Residual Heat Removal lines.

Balance-of-Plant piping response time-histories for a wide range of response parameters including support reaction (8 cases), bending moment (37 cases), axial force (7 cases), shear force (14 cases), and acceleration (16 cases) were used. Again, the wide variety of piping locations, pipe diameters, anchoring structures, and response parameters were chosen to assure that the results obtained from this evaluation are generically applicable to piping found throughout Mark III Plants.

1.2.2.3 Balance-of-Plant Equipment

Typical balance-of-plant equipment are supported from, or closely coupled with, the major structural elements of the Mark III containment systems consisting of the drywell, containment vessel (including all three types), shield building, and auxiliary building. Typical equipment components can be divided into two types: relatively flexible equipment, and relatively rigid equipment. The response of relatively flexible equipment exhibits characteristics similar to that of piping systems which have already been considered. Under the category of Balance-of-Plant equipment, it is desired to study the response characteristics of relatively rigid equipment. Due to the relatively high fundamental frequency of rigid equipment components and the relatively low frequency of the structural elements, the response of such equipment to various dynamic loadings is very similar to the response of the structures (at the equipment support locations) to those same loadings. As a result, the statistical response combination evaluation for BOP equipment has been based upon the acceleration response of the important structural elements at equipment attachment points. It can be seen from Table 1-2 that the 45 CDF curves applicable to BOP equipment were generated from response time-histories representing 22 response locations. These are also depicted in Figures 1-18 and 1-19 which show that equipment response locations have been selected which cover a wide range of elevations (both high and low) for each of the structural elements. The BOP equipment response time-histories have been provided by the Architect-Engineer firms responsible for the five nuclear power facilities represented on the Mark III Containment Owners SRSS Subgroup and have been selected as representing typical response associated with the three containment designs and two foundation designs currently employed for the construction of Mark III plants. At least five response combinations were chosen from each of the five plants.

1.2.3 Load Combinations Evaluated

For the Mark III operating system, the eight dynamic loading cases are:

1. OBE
2. SRV
3. OBE + SRV
4. SSE + SRV
5. SRV + LOCA (SBA/IBA)
6. OBE + SRV + LOCA (SBA/IBA)
7. SSE + SRV + LOCA (SBA/IBA)
8. SSE + LOCA

The resultant peak response from each of these dynamic loads or dynamic load combinations is combined with the normal static loads (i.e., pressure, dead weight) by absolute summation.

Since Cases 1 and 2 involve only one dynamic loading, no justification for the method of dynamic load combination is necessary and therefore Cases 1 and 2 were not included in this study. In addition, as discussed in Reference 9, the NRC has taken the position that the probability of the simultaneous occurrence of the SSE and LOCA is extremely low and therefore, the dynamic responses for this load combination may be combined by the SRSS method. Similarly, the NRC has taken the position that the SRSS method of response combination may be employed for load cases involving the combination of three or more dynamic loadings since it is extremely unlikely that the peak response of three or more unrelated dynamic loadings will occur simultaneously (Reference 11). Since the NRC has accepted the SRSS combination of response for SSE + LOCA and for loadings involving three or more dynamic loads, Cases 6, 7, and 8 listed above were also not included in this evaluation effort. As a result, the statistical demonstration of the adequacy of the SRSS combination methodology for Mark III plants is centered around the evaluation of Load Cases 3, 4, and 5 in which the response from the Safety Relief Valve discharge (SRV) hydrodynamic loading is combined with the response from the Operational Basis Earthquake (OBE) or Safe Shutdown Earthquake (SSE) seismic events or the Loss-of-Coolant-Accident (LOCA). In this study, the LOCA is represented by the high frequency CHUG hydrodynamic loading.

The Mark III SRSS Evaluation Matrix (Table 1-2) presents the nine response combinations evaluated in this study to demonstrate the generic applicability of the SRSS response combination for Mark III plants. Three types of the SRV dynamic loading have been considered when combining the SRV loading with the two levels of earthquake and with the CHUG loading to form the critical load combinations addressed in this study. The three types of SRV are:

SRV_1 - SRV (1 Valve, 2nd Actuation)

SRV_{ADS} - SRV (Automatic Depressurization System)

SRV_{ALL} - SRV (All Valves)

These have all been included in order to provide results for a range of magnitudes of the short duration, high-frequency, hydrodynamic loading. Similarly, both OBE and SSE (defined in this study as 2 times the OBE) load combinations have been included in order to assess the effect of the magnitude of the longer duration, low-frequency, seismic event.

As mentioned at the beginning of this section, great care has been taken in the definition of the scope of this effort to assure the generic nature of the results. This goal has been achieved by the selection of a wide range of load combinations, piping and equipment locations, and response parameters together with the number and types of Mark III plants involved.

TABLE 1-1

MARK III CONTAINMENT OWNERS SRSS SUBGROUP

Utility	Mark III Plant	Architect/Engineer
Cleveland Electric Illuminating Co.	Perry	Gilbert Associates
Gulf States Utilities Co.	River Bend	Stone & Webster
Houston Lighting and Power Co.	Allens Creek	Ebasco Services
Illinois Power Co.	Clinton	Sargent & Lundy
Mississippi Power and Light Co.	Grand Gulf	Bechtel Corporation
General Electric Co.	Generic	—
Structural Mechanics Associates, Inc. (Dynamic Analysis Consultant)	—	—

TABLE 1-2: MARK III SRSS EVALUATION MATRIX

	NSSS				BOP PIPING							BOP EQUIPMENT							
	RPV & INTERNALS	MAIN STEAM PIPING	RECIRCULATION PIPING	PIPE MOUNTED EQUIPMENT	DRYWELL	CONTAINMENT (FREESTANDING STEEL)	CONTAINMENT (STEEL - CONCRETE BACKED)	CONTAINMENT (CONCRETE)	SHIELD BUILDING FREESTANDING STEEL)	SHIELD BUILDING (STEEL - CONCRETE BACKED)	AUXILIARY BUILDING (CONCRETE)	DRYWELL	CONTAINMENT (FREESTANDING STEEL)	CONTAINMENT (STEEL - CONCRETE BACKED)	CONTAINMENT (CONCRETE)	SHIELD BUILDING (FREESTANDING STEEL)	SHIELD BUILDING (STEEL - CONCRETE BACKED)	AUXILIARY BUILDING (CONCRETE)	TOTALS
OBE + SRV_1	5-5	6-4 6-5 6-7	4-8 4-10 4-11 4-12	6-2 4-6	1-2 1-3 2-5 2-8		4-18 4-21	5-17 5-14		4-17 4-15	5-7 5-10	1-9 1-13			5-23 2-9		4-25	5-29	28
OBE + SRV_{ALL}	5-4	6-5 6-6 6-9	4-9 4-12 4-13	6-3 4-7	1-1 1-4 2-6 2-7	3-1 3-3	4-20 4-19	2-2 2-3	3-8 3-6	4-14 4-16		1-6	3-12	4-23	2-9	3-10	4-25		29
OBE + SRV_{ADS}	5-5					3-1 3-3		5-16 5-18	3-4 3-7 3-6		5-11 5-12		3-11 3-12		5-23 5-26	3-9 3-10		5-29 5-22	18
SSE + SRV_1	5-5	6-4 6-8 6-9	4-9	6-1 4-5	1-1 1-4 2-8		4-18	5-15 2-1 2-4		4-17	5-13				2-9 5-23		4-25		19
SSE + SRV_{ALL}	5-4	6-8	4-10 4-11	6-1	1-3 1-4 2-8		4-20	5-19 2-2 2-3		4-14	5-8	1-11		4-23	2-9			5-29	18
SSE + SRV_{ADS}						3-1 3-2			3-4				3-11			3-9			5
CHUG + SRV_1	5-5 4-4		4-9	4-6	1-2 1-4 2-7 2-8			5-15 5-16			5-8 5-12	1-5		4-22	5-26 2-9		4-26	5-22	18
CHUG + SRV_{ADS}	5-6 4-3 4-2					3-1 3-2		5-17 5-14	3-5 3-6		5-13 5-11		3-11 3-12		5-24 5-27	3-9 3-10		5-22	18
CHUG + SRV_{ALL}				6-3	1-1 1-4	3-1 3-2		5-16 5-20	3-4 3-5		5-7 5-9	1-9 1-12						5-21	14
Totals	10	10	11	9	20	10	6	18	10	6	12	7	6	3	12	6	4	7	167

TABLE 1-3

BALANCE-OF-PLANT PIPING SYSTEMS

Piping System	Nominal Diameter (in)	Anchor/Support Structure(s)
1. Feedwater Line	20	Drywell, Auxiliary Building
2. Reactor Water Cleanup Line (RWCU)	4	Drywell
3. FPC & CU Refueling Water Line	3	Containment (C), Drywell
4. Low Pressure Core Spray Line (LPCS)	14	Drywell, Containment (C)
5. HPCS Test Line	12	Containment (FS), Shield Building
6. HPCS Pump Discharge Line	12	Shield Building, Drywell
7. Combustible Gas Control Line (CGC)	4	Containment (CBFS), Drywell
8. Residual Heat Removal Line (RHR)	24	Shield Building, Containment (CBFS)
9. Fire Protection Line (FP)	6	Containment (C)
10. Residual Heat Removal Line (RHR)	20	Auxiliary Building, Containment (C)

Legend

(FS) Freestanding Steel Containment

(CBFS) Freestanding Steel Containment - Concrete Backed

(C) Concrete Containment

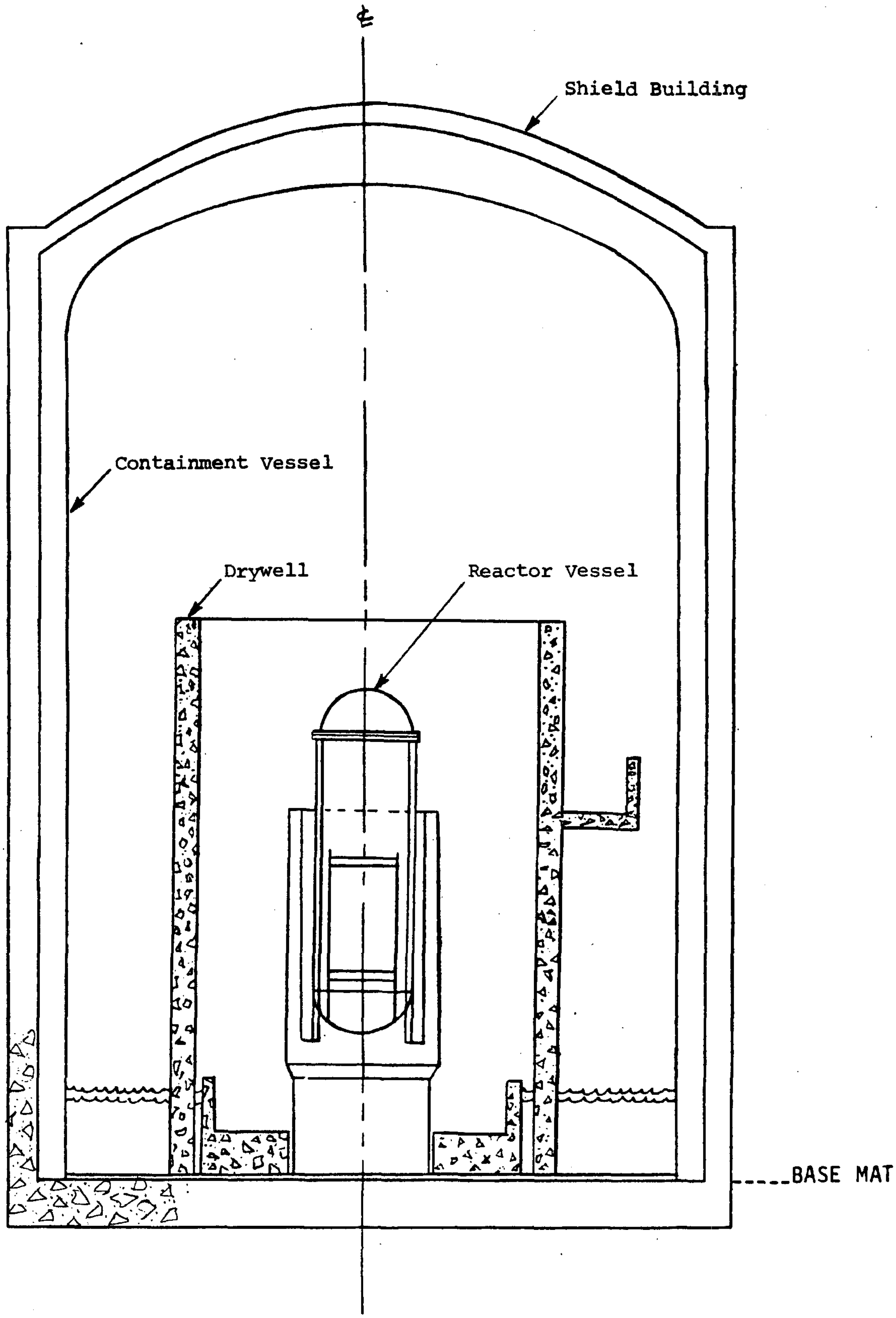


FIGURE 1-1. FREE-STANDING STEEL CONTAINMENT ON OWN FOUNDATION

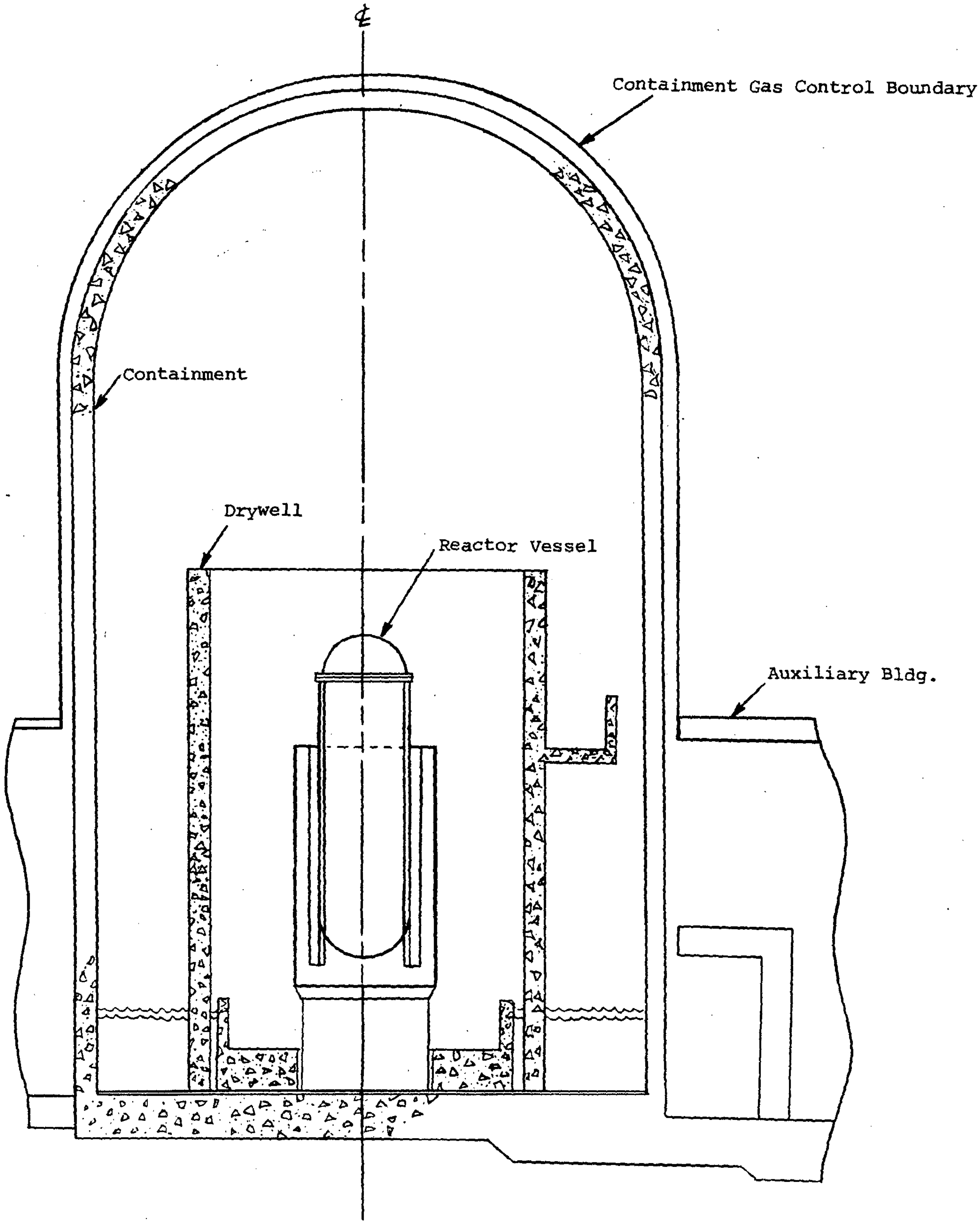


FIGURE 1-2. CONCRETE CONTAINMENT ON INTEGRAL FOUNDATION WITH AUXILIARY BUILDING

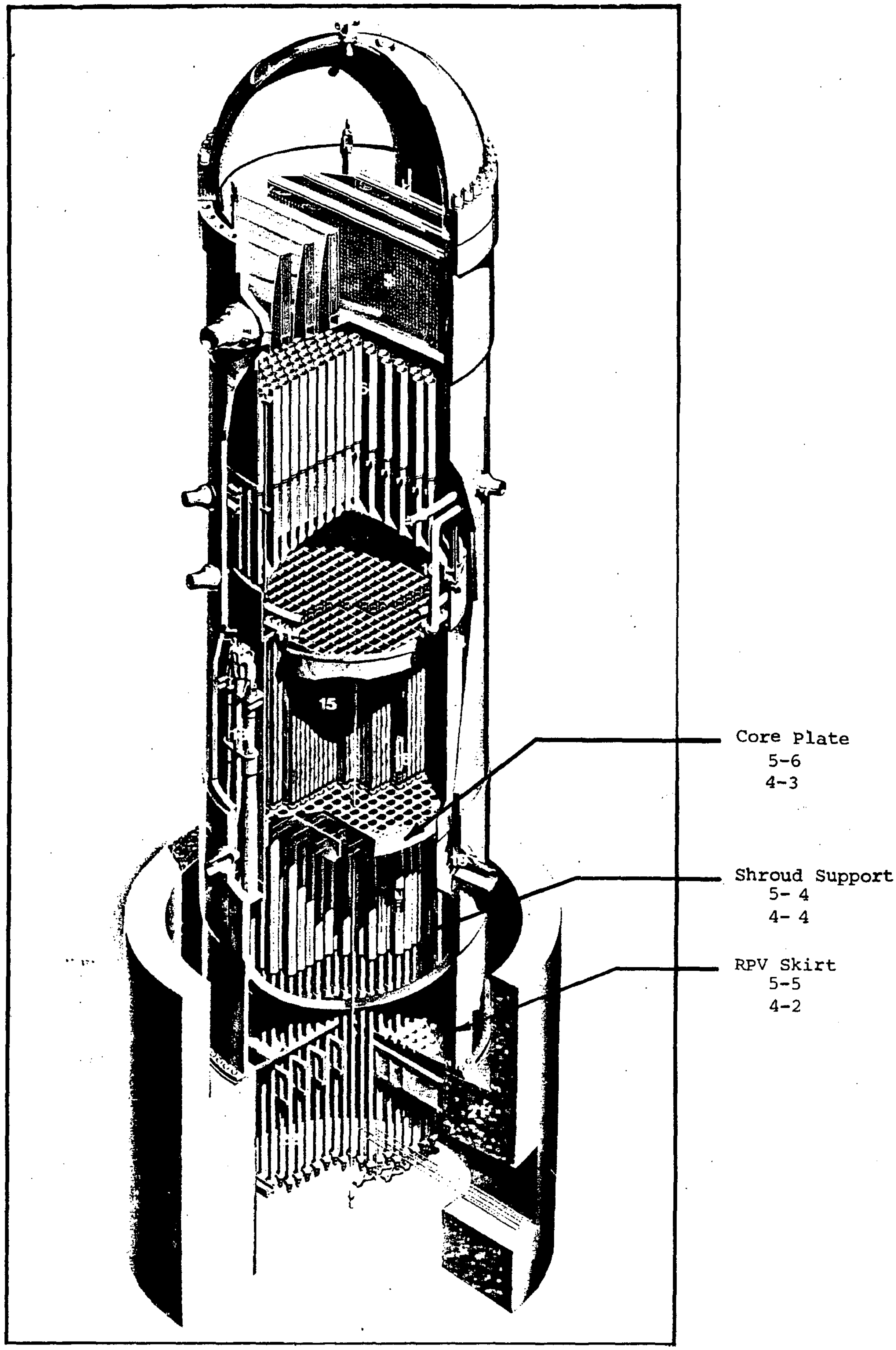


FIGURE 1-3. BOILING WATER REACTOR PRESSURE VESSEL AND INTERNALS

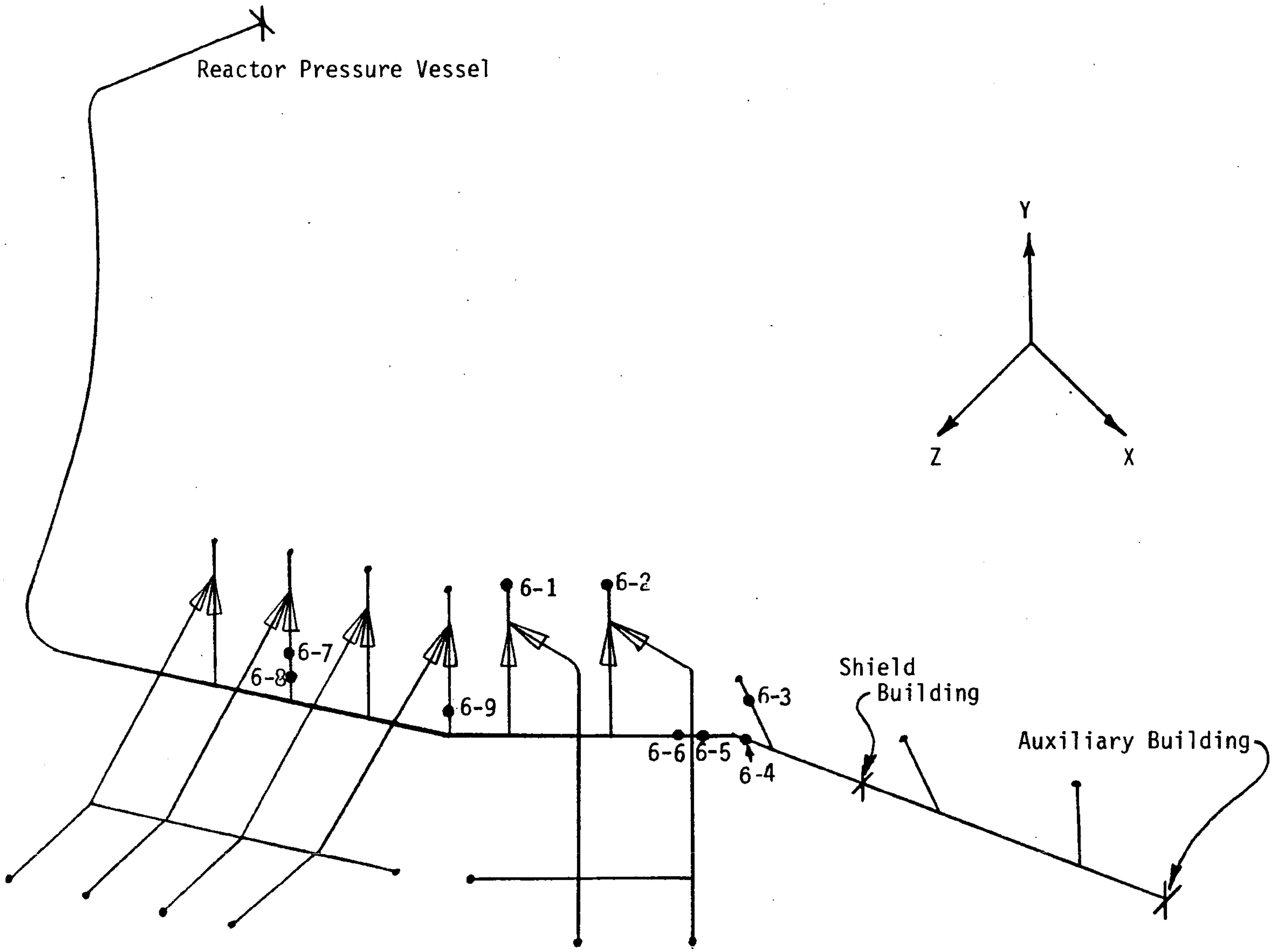


FIGURE 1-4. TYPICAL MAIN STEAM PIPING SYSTEM

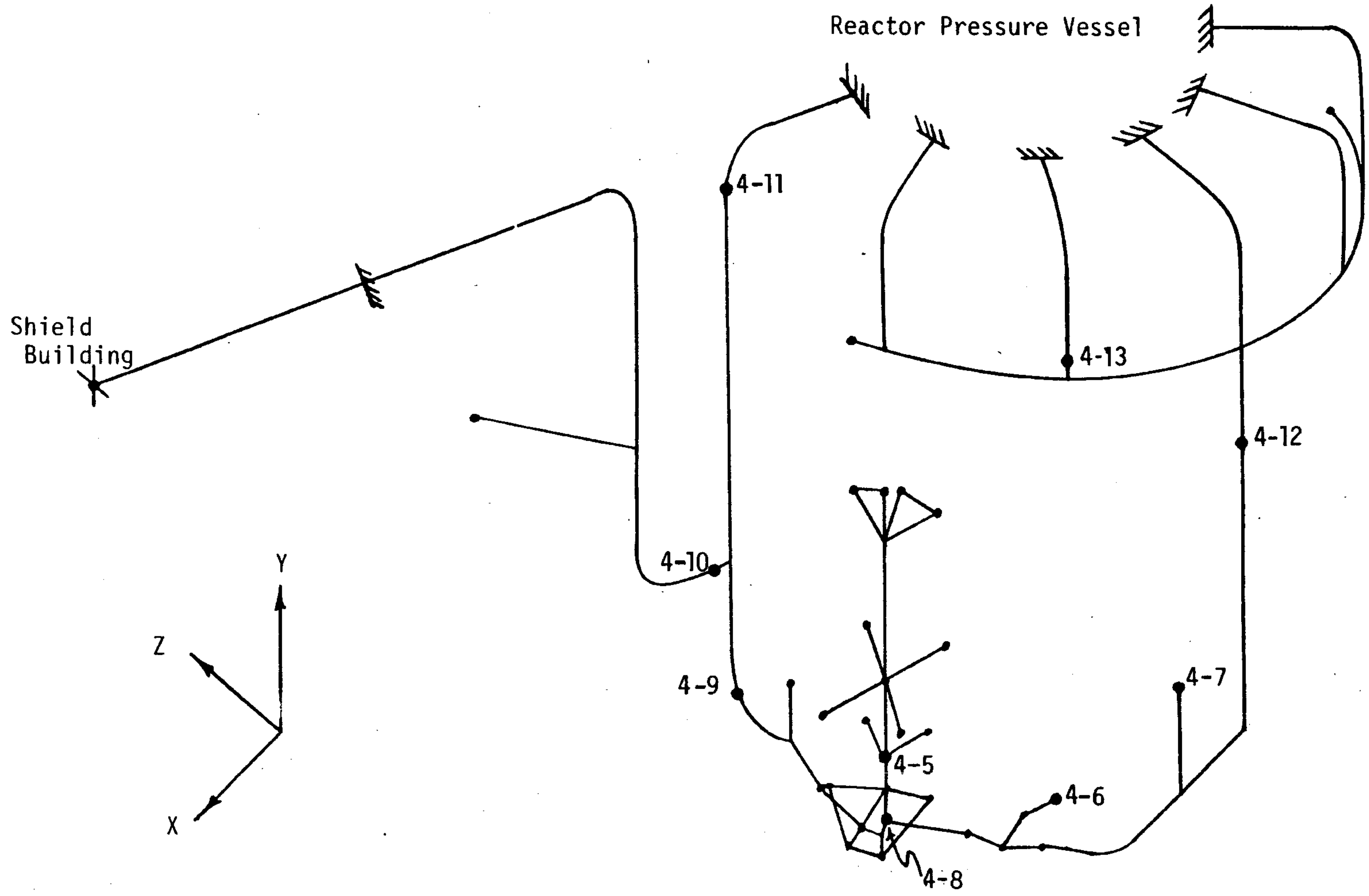


FIGURE 1-5. TYPICAL RECIRCULATION LOOP PIPING SYSTEM

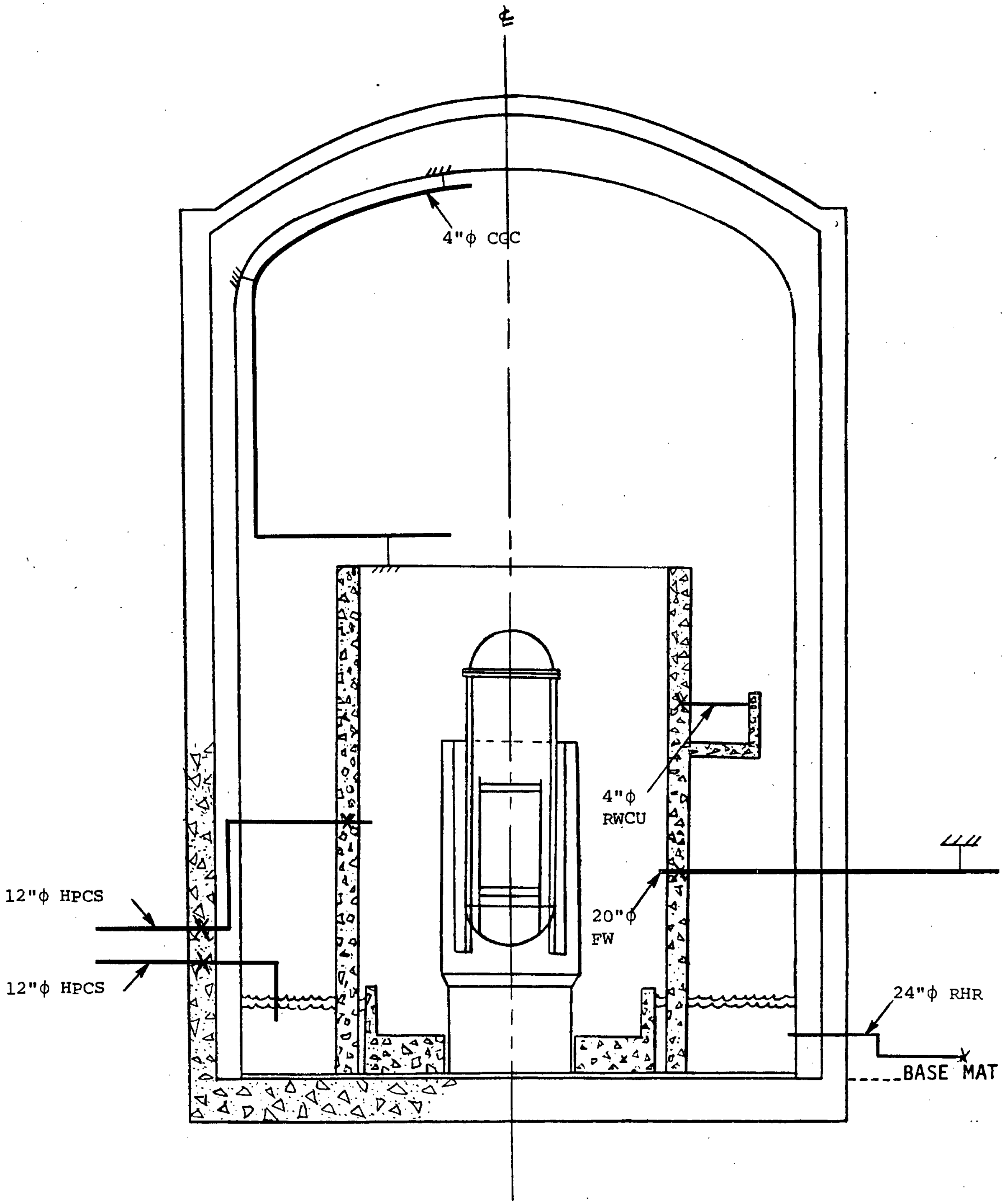


FIGURE 1-6A. BALANCE-OF-PLANT PIPING IN STEEL CONTAINMENT PLANTS

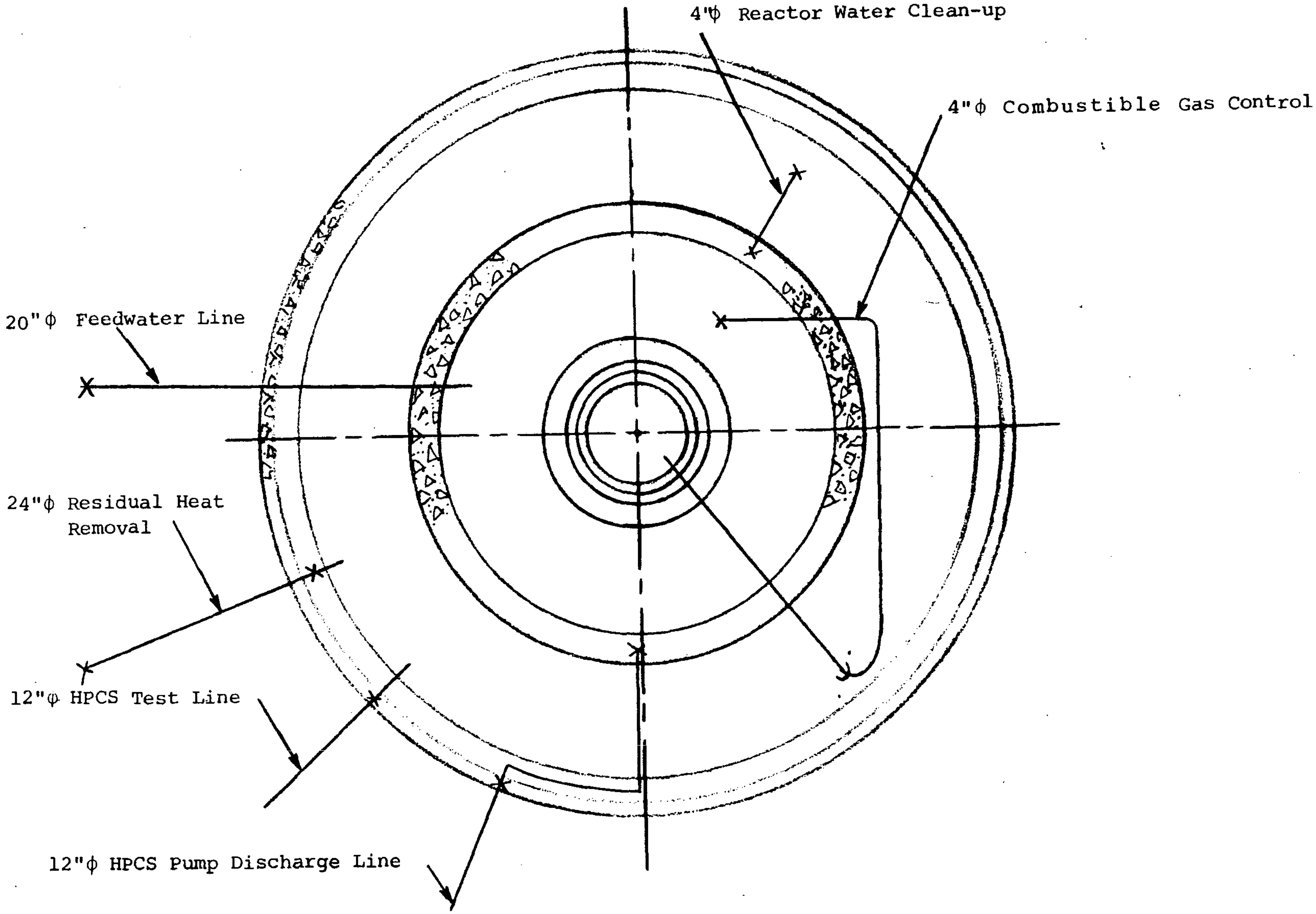


FIGURE 1-6B. BALANCE-OF-PLANT PIPING IN STEEL CONTAINMENT PLANTS

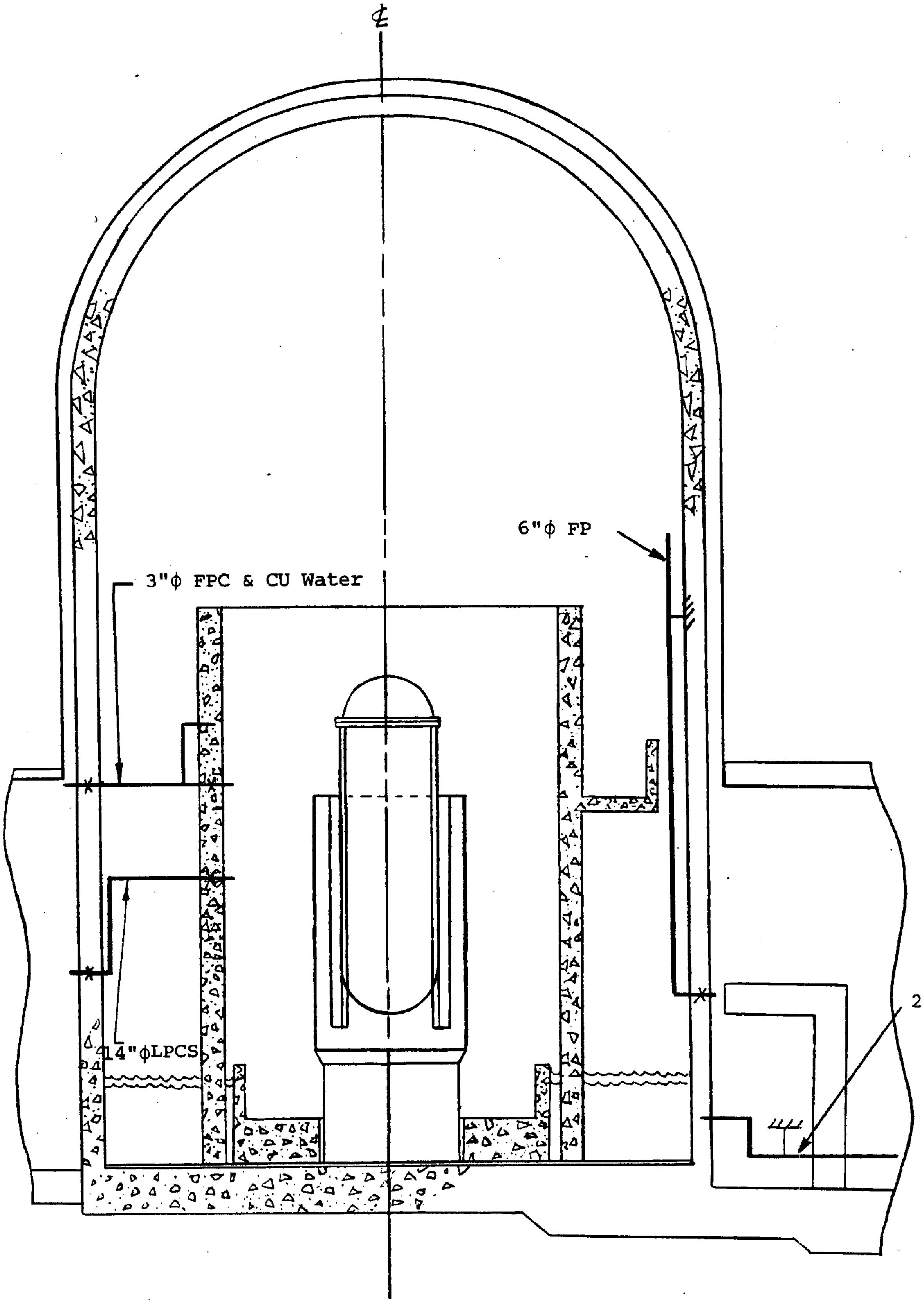


FIGURE 1-7A. BALANCE-OF-PLANT PIPING IN CONCRETE CONTAINMENT PLANTS

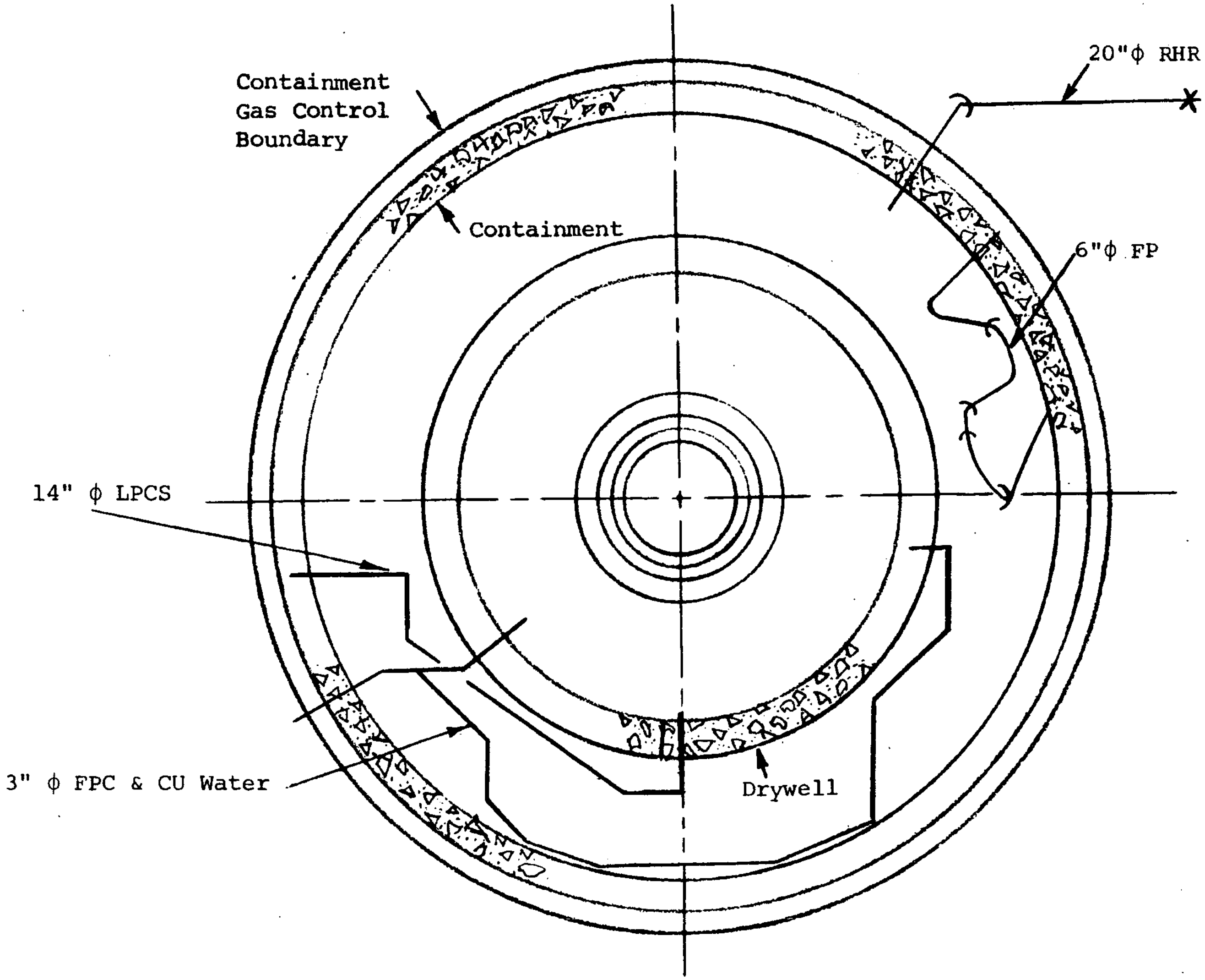


FIGURE 1-7B. BALANCE-OF-PLANT PIPING IN CONCRETE CONTAINMENT PLANTS

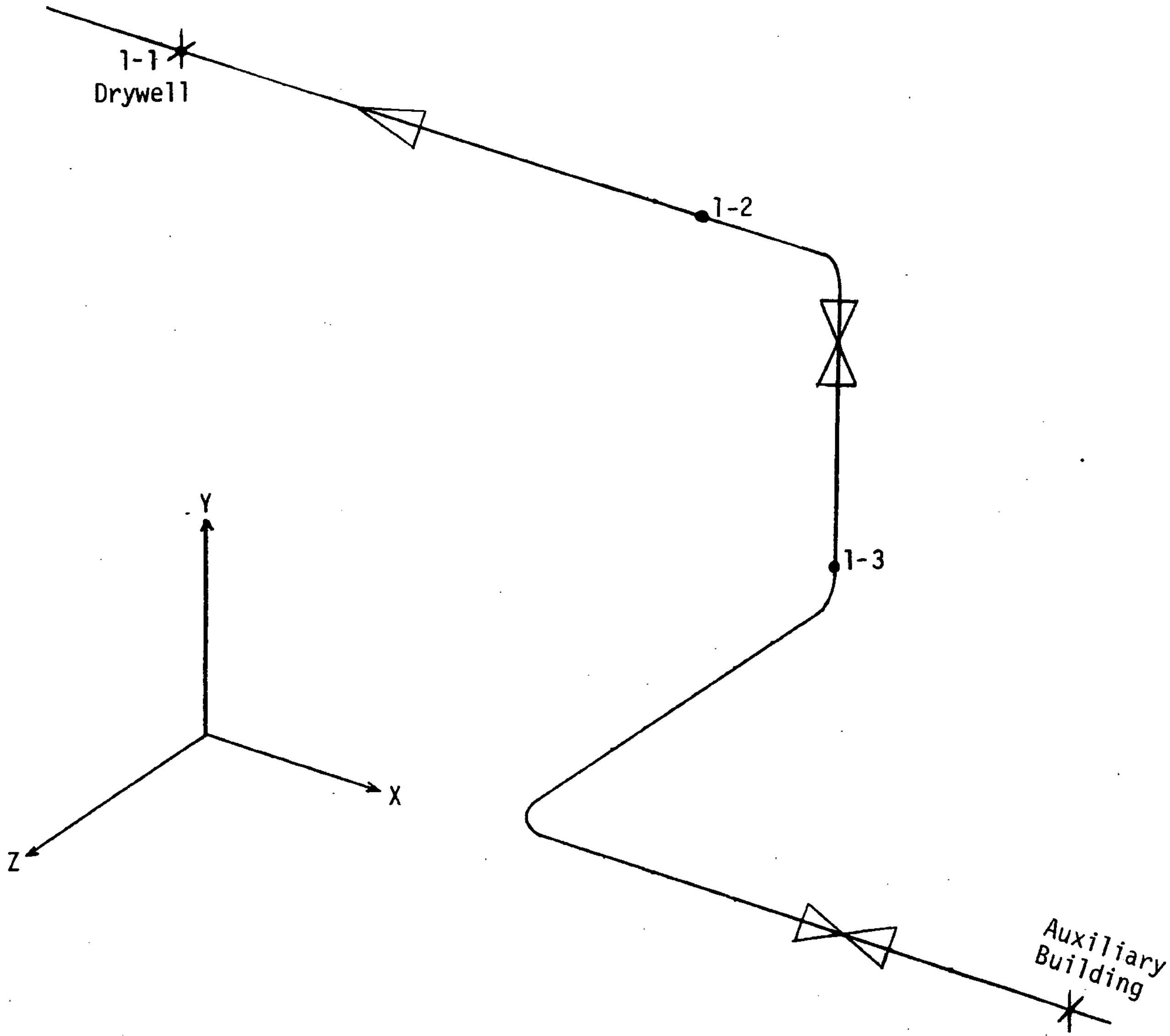


FIGURE 1-8.   FEEDWATER PIPING ISOMETRIC

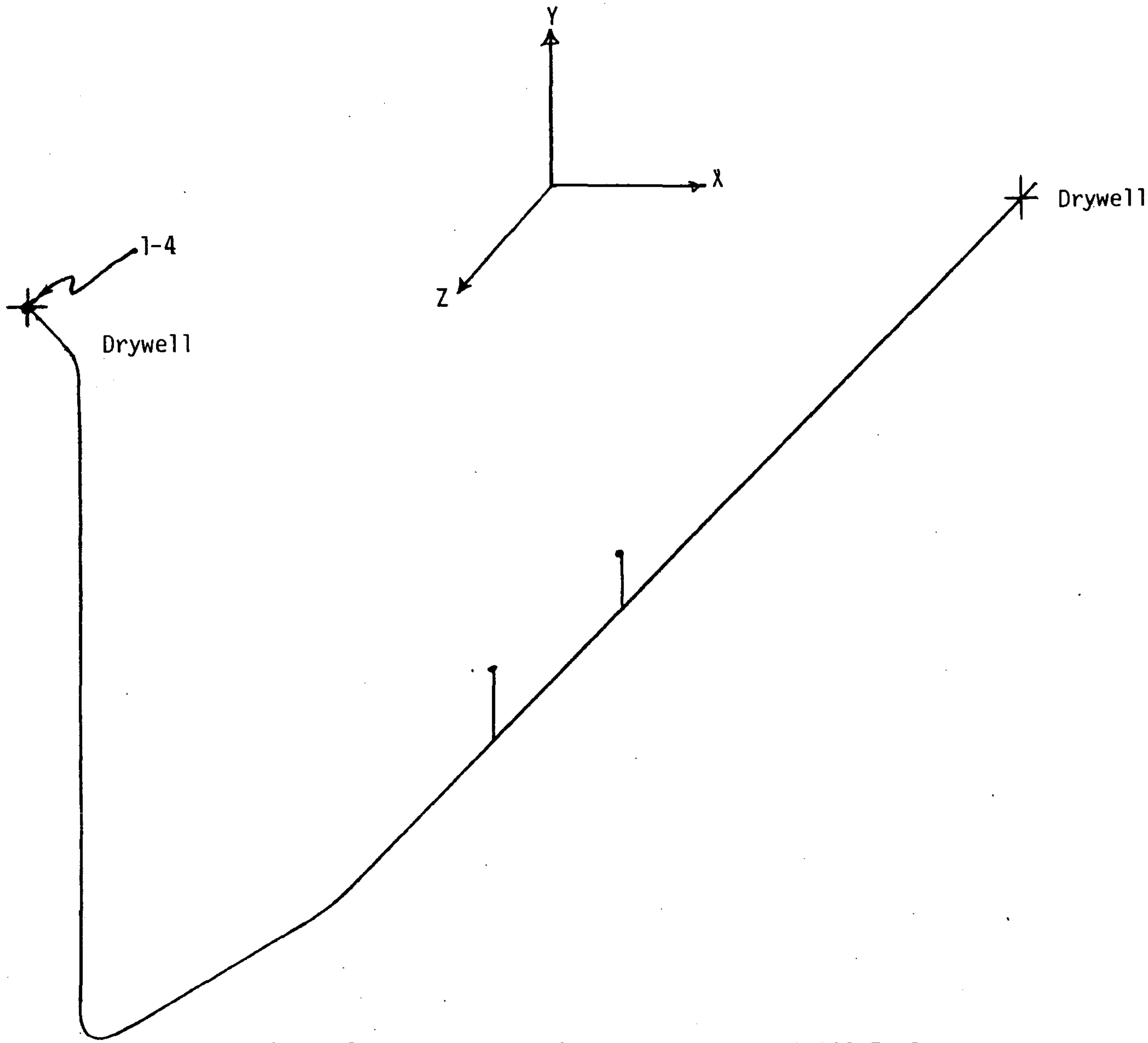


FIGURE 1-9. REACTOR WATER CLEANUP PIPING ISOMETRIC

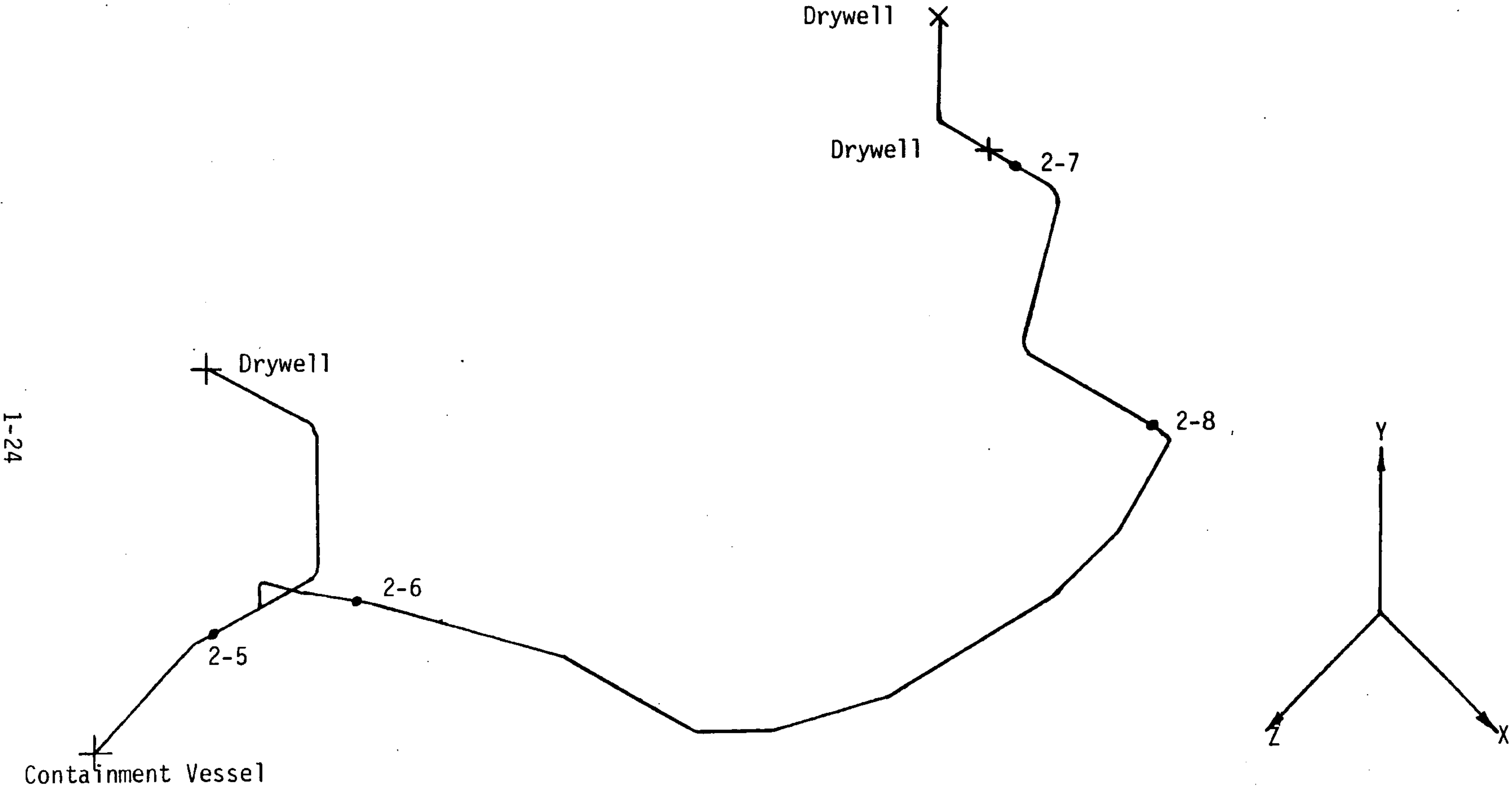


FIGURE 1-10. FPC AND CU REFUELING WATER PIPING ISOMETRIC

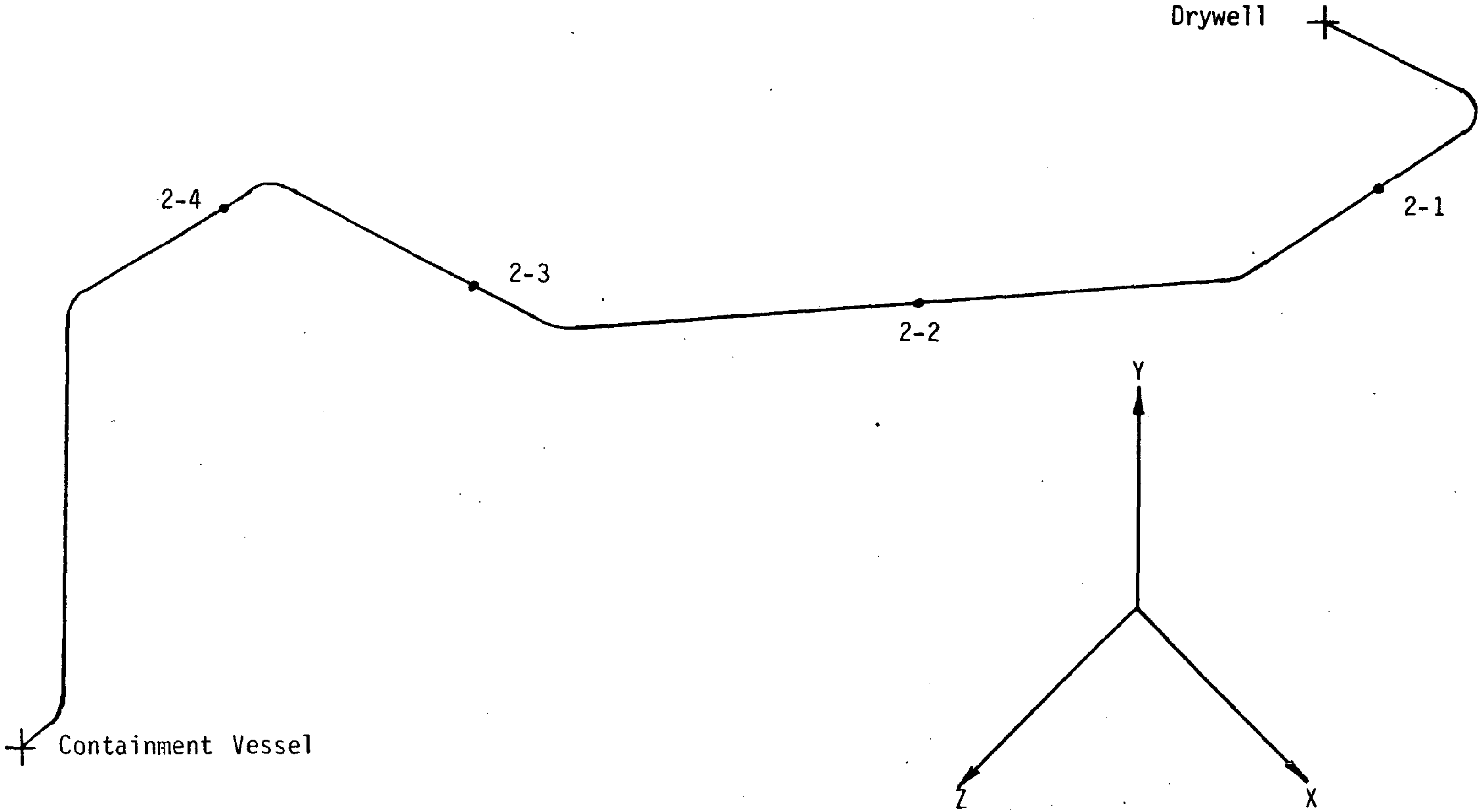


FIGURE 1-11. LOW PRESSURE CORE SPRAY PIPING ISOMETRIC

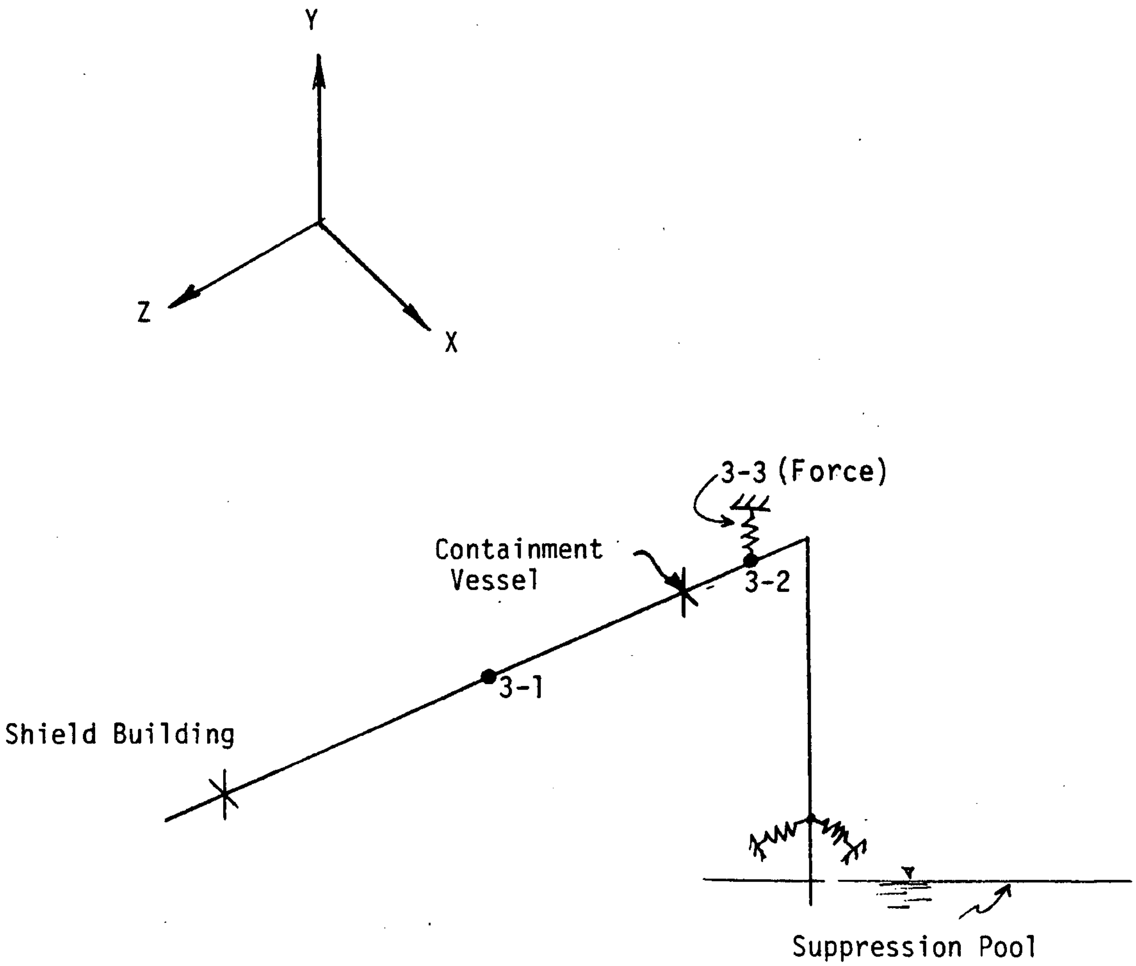


FIGURE 1-12. HIGH PRESSURE CORE SPRAY TEST PIPING ISOMETRIC

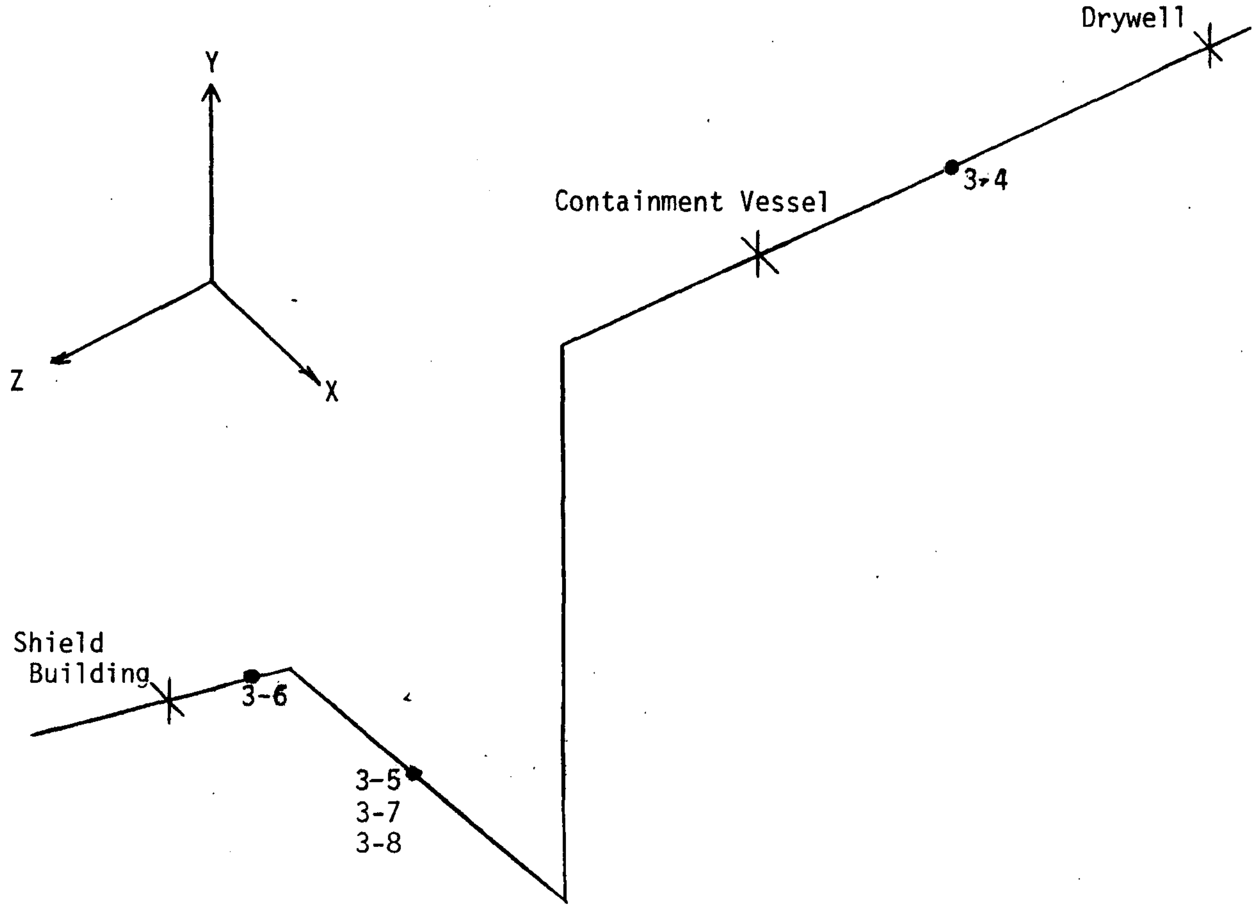


FIGURE 1-13. HIGH PRESSURE CORE SPRAY PUMP DISCHARGE PIPING ISOMETRIC

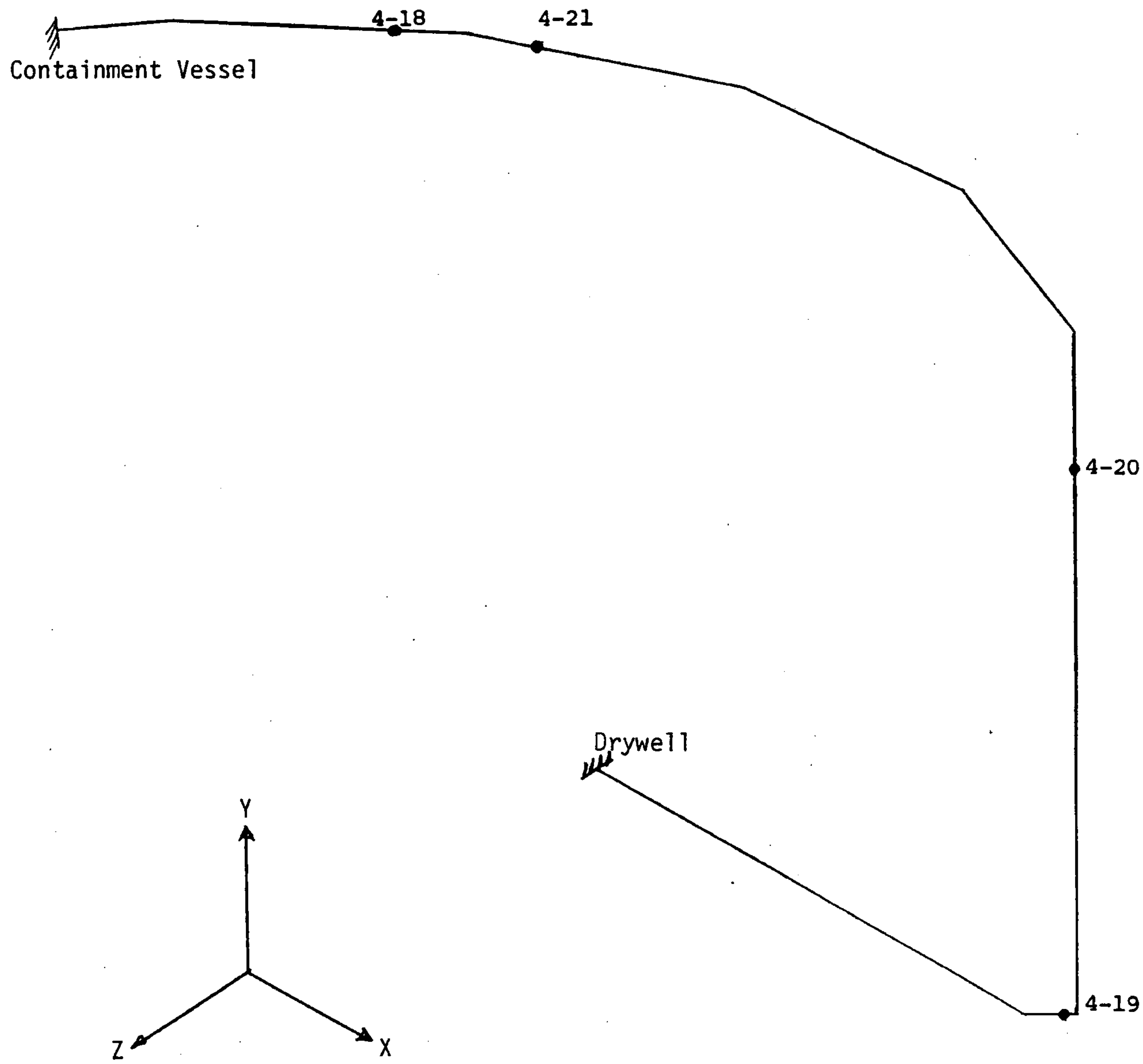


FIGURE 1-14. COMBUSTIBLE GAS CONTROL PIPING ISOMETRIC

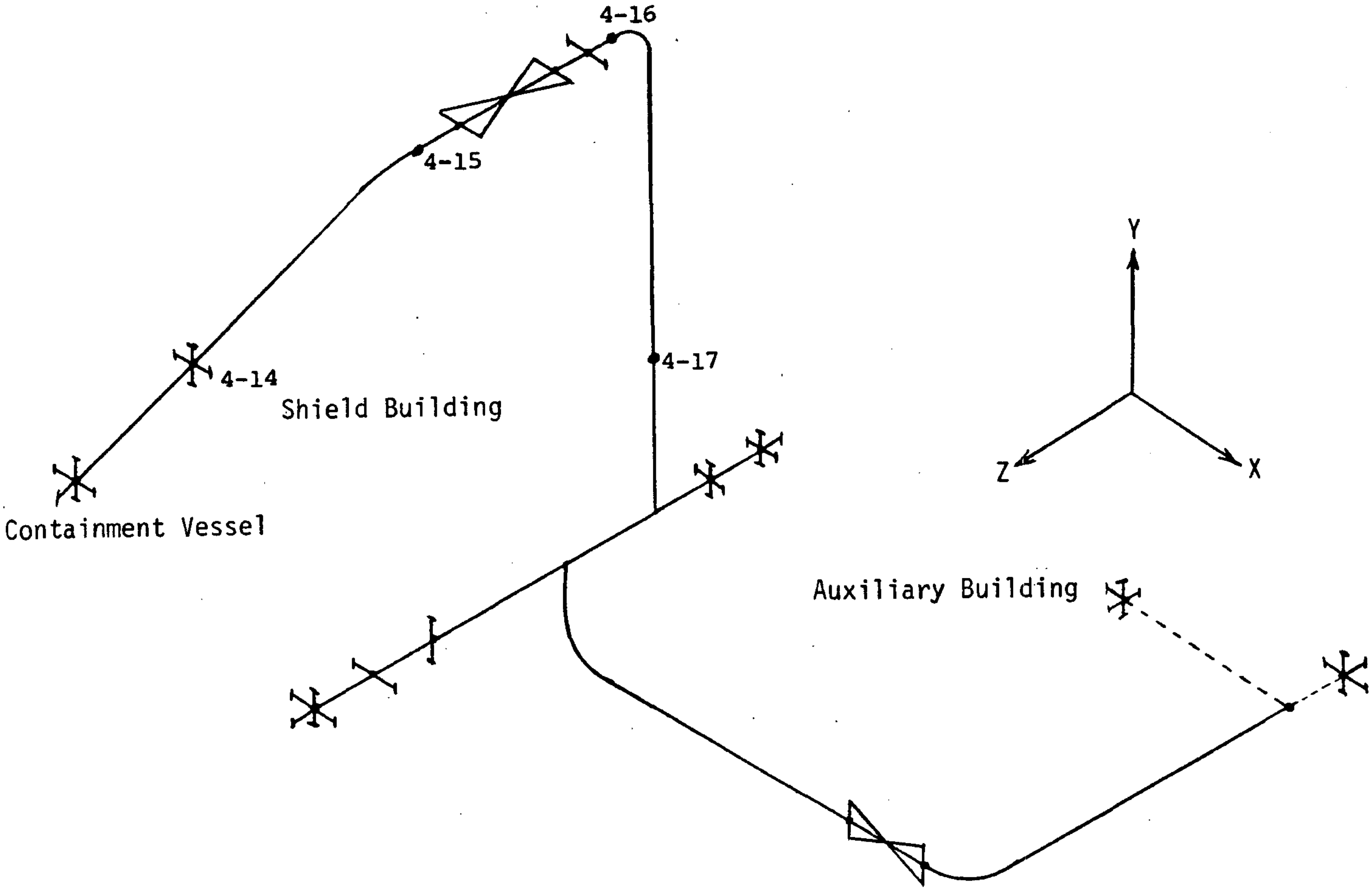


FIGURE 1-15. RESIDUAL HEAT REMOVAL PIPING ISOMETRIC (STEEL CONTAINMENT)

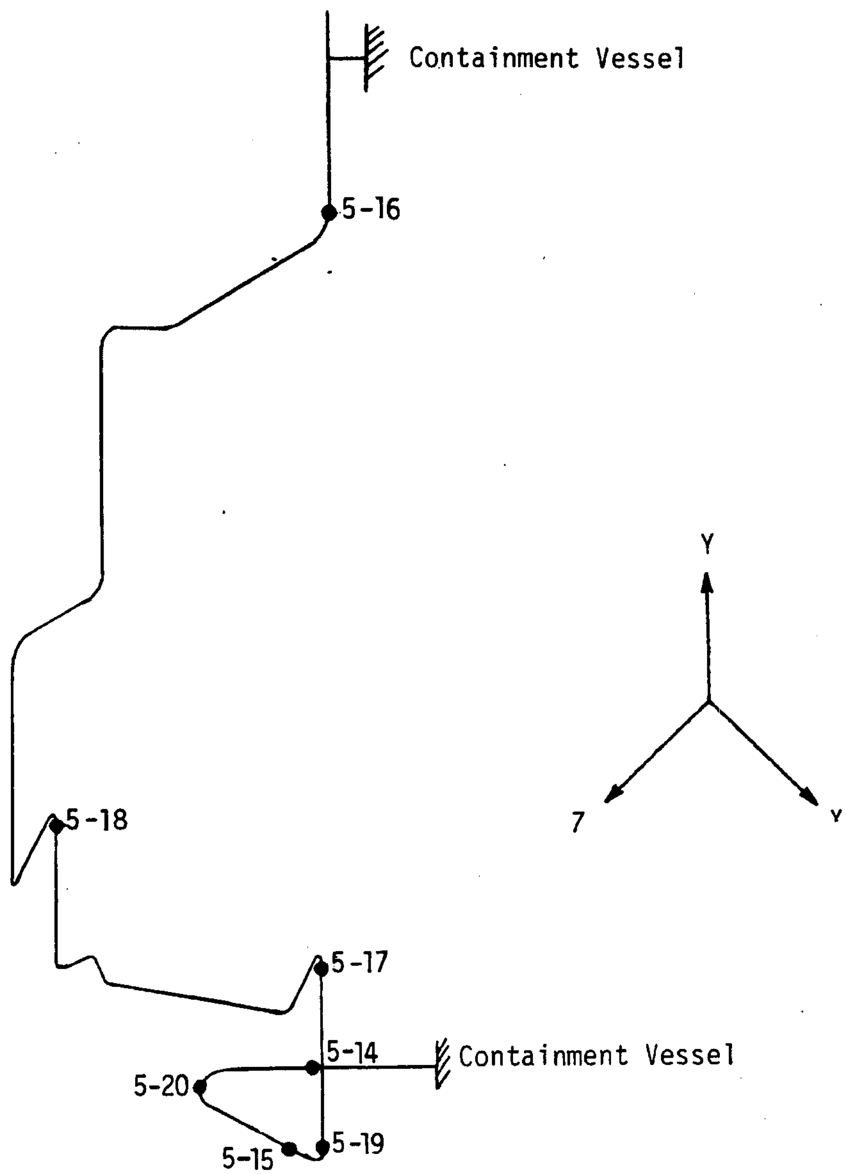


FIGURE 1-16. FIRE PROTECTION PIPING ISOMETRIC

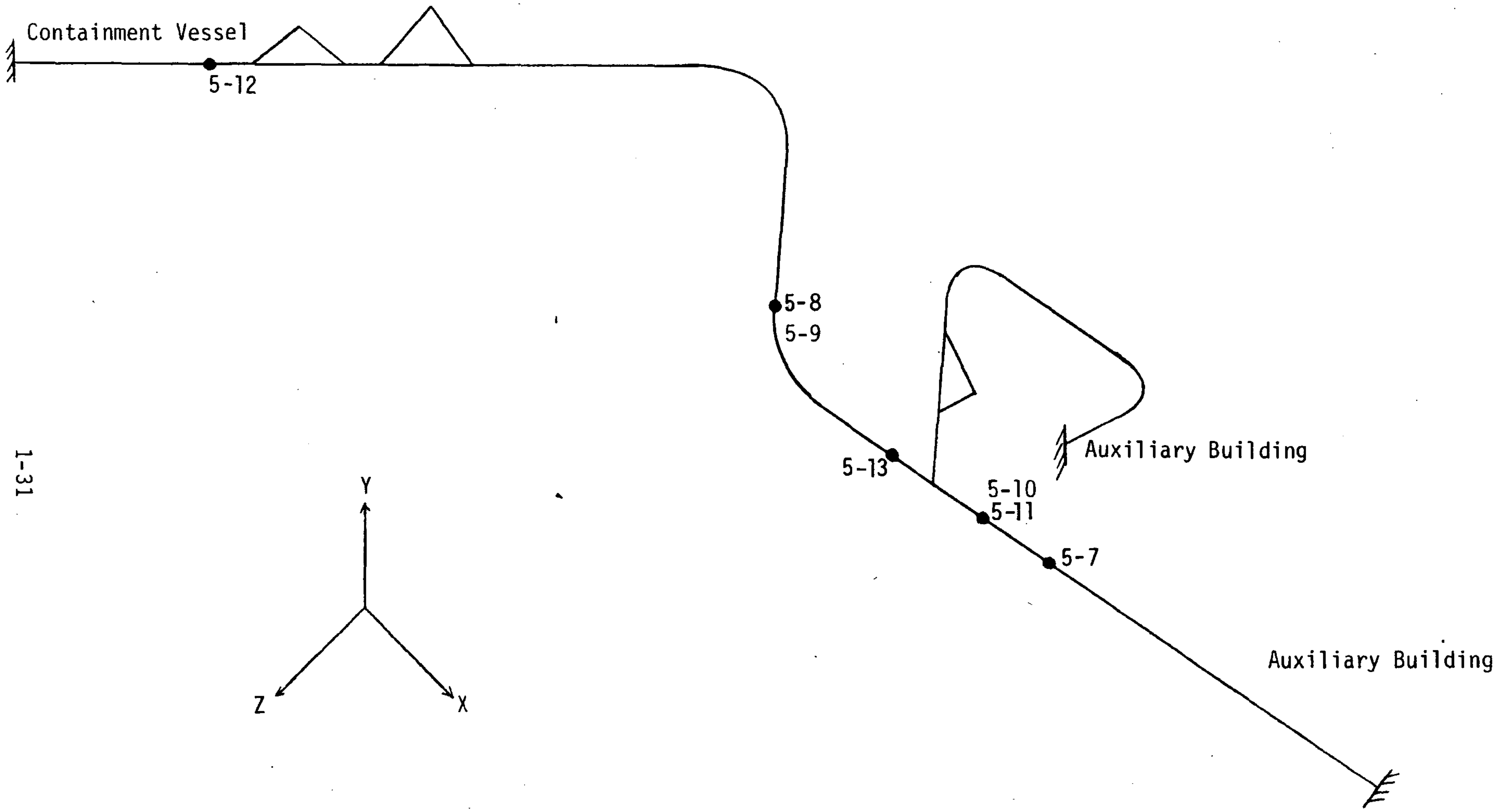


FIGURE 1-17. RESIDUAL HEAT REMOVAL PIPING ISOMETRIC (CONCRETE CONTAINMENT)

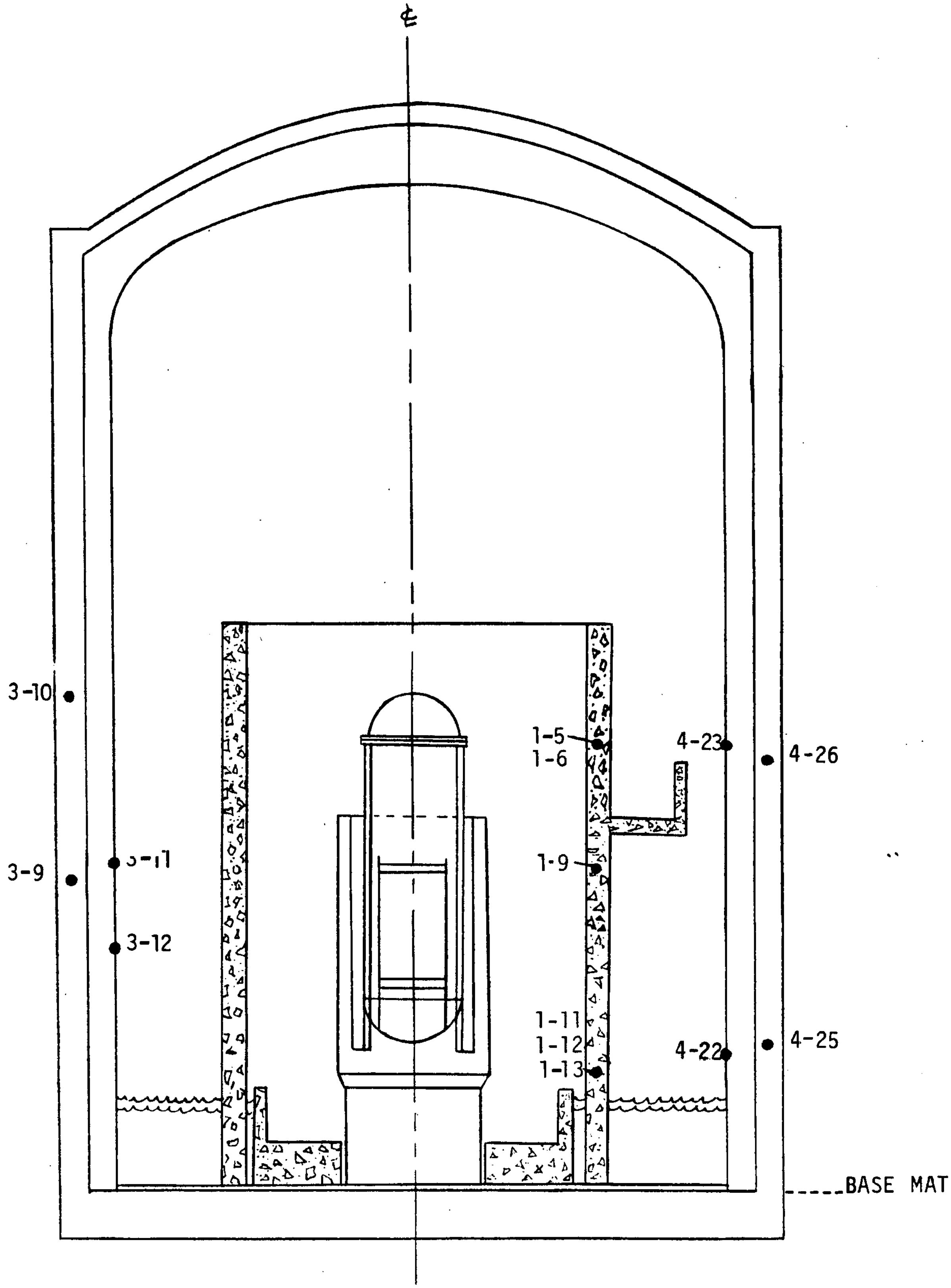


FIGURE 1-18. BALANCE-OF-PLANT EQUIPMENT IN STEEL CONTAINMENT PLANTS

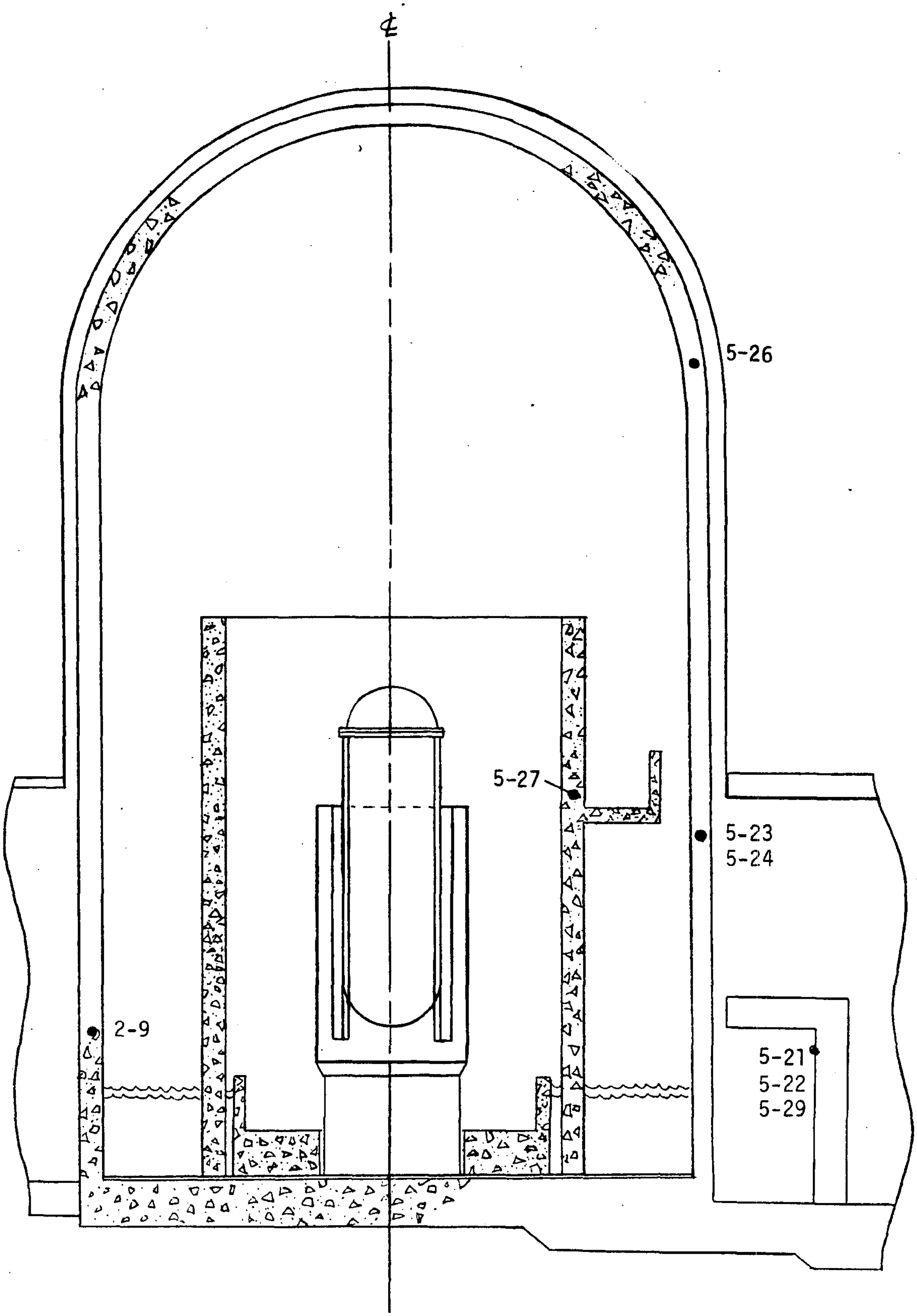


FIGURE 1-19. BALANCE-OF-PLANT EQUIPMENT IN CONCRETE CONTAINMENT PLANTS

2.0 TECHNICAL APPROACH

2.1 GENERAL APPROACH

The demonstration of the applicability of the SRSS response combination method for Mark III piping and equipment is based upon the statistical argument which states that the SRSS peak combined response should have at least as high a non-exceedance probability (NEP) as that of the individual dynamic loadings being combined. For a given load combination and response location, Newmark-Kennedy Criterion 2 (Reference 2) is used to validate this premise based upon the generation of a Cumulative Distribution Function (CDF) curve for peak response considering appropriate assumptions concerning the relative time-phasing of the response time-histories being combined. When only time-phasing is considered, the resulting NEP of the SRSS response value is a conditional probability which is conditional upon assuming known peak individual response amplitudes. The Mark III suppression pool loads used in this study have been defined by the General Electric Company to be at the greater of approximately the 84th percentile or 1.15 times the median value in accordance with the requirements of the Newmark-Kennedy criteria. Similarly, the process used to establish seismic loadings for a given facility results in earthquake loads defined at approximately the 84th percentile or greater. This being the case, if it can be shown that approximately the SRSS combined value is at or exceeds the 50% NEP and approximately 1.2 times the SRSS combined value is at or exceeds the 85% NEP, the use of the SRSS method of response combination is then appropriate. The emphasis in this study has been to demonstrate that the SRSS method of response combination for the loadings considered is applicable for all locations within Mark III nuclear facilities.

The response CDF curves presented in this report have been generated in accordance with the methodology outlined in NUREG/CR-1330 (Reference 8) and as illustrated in the following example. Figure 2-1 schematically illustrates two response time-histories which potentially overlap in time and which then must be combined to obtain a peak combined response. It is judged that both of these two individual response time-histories have been conservatively represented, being defined at the 84th percentile or 1.15 times the median, whichever is greater. The relative time lag, τ, between the time-histories is assumed to be random with a specific uniform Probability Density Function (PDF) defining the possible values of this time lag. For a given value of τ, which defines a unique possible relationship between the response histories, the combined response is determined by algebraic summation of the individual responses over the duration of the combined loading. The peak combined response is then taken as the absolute value of the maximum combined response (either positive or negative). This procedure is repeated for a sufficient number of Monte Carlo trials each defining a different random value for τ consistent with the time-phasing PDF. By ordering the peak combined responses from each independent trial from the lowest to the highest, the best estimate of the non-exceedance probability (NEP) associated with the response from ordered trial n, is calculated to be:

$$\text{NEP} = \frac{n}{N+1} \quad (100\%) \qquad (2\text{-}1)$$

where N equals the total number of Monte Carlo trials. A total of 200 Monte Carlo trials were used in the generation of the CDF curves presented in this report. This number was found to be more than sufficient to accurately define the CDF curve over the region of interest (i.e., between the 10% and 90% NEP). The CDF curve then is the plot of the NEP versus the corresponding peak combined response value plotted for the 200 trials ordered from the lowest to the highest computed peak combined response. The computer program MODSTAG, which is a version of STAGAR code developed for General Electric, was used to perform the necessary CDF computations. The time-history pairs used to generate the response combination CDF curves are included in Appendix C.

2.2 SPECIFIC ASSUMPTIONS AND RESPONSE TIME-HISTORY CRITERIA

Several specific assumptions were made concerning the relative time-phasing of the SRV hydrodynamic loading and the seismic events and concerning the nature of the CHUG loading used to represent the LOCA. These assumptions were made to assure that the results of these analyses are conservative. In addition, the response time-histories used in the study were required to meet certain criteria to assure that only important and/or non-trivial response combinations were evaluated. The specific assumptions and response time-history criteria used are illustrated in the discussion which follows.

The OBE or SSE response time-histories generally cover a period of between 10 and 20 seconds which is long in comparison to the high frequency, short duration, hydrodynamic loads which typically range from 0.5 to 2.0 seconds duration. To cover the potential phasing between the seismic events and the SRV discharge, it has been conservatively assumed that the SRV response time-history must begin at some time during the strong motion portion of the earthquake response. For purposes of definition, the strong motion portion of the earthquake has been assumed to be the time frame between the first and last times that the response amplitude reaches approximately 50 percent of its peak value. Referring again to Figure 2-1, T_L and T_U define the range of strong motion for the reference time-history and are used to establish the lower bound and upper bound time values for the PDF defining the possible beginning times of the combining time-history. It is clear that this approach is conservative in comparison to the alternative of allowing the SRV response time-history to begin at any time during the earthquake since the latter assumption would result in an increased probability that the SRV response would combine with a non-critical portion of the earthquake.

Only OBE response time-histories were provided for use in this study. However, since SSE + SRV is an important load case and since it is of interest to determine the effect of the magnitude of the low frequency response, the SSE response at a given location was established by multiplying the OBE response history by a factor of 2.0.

As previously mentioned, the CHUG time-history has been used to represent the Loss-of-Coolant-Accident (LOCA). The CHUG results from pressure pulses in the suppression pool which can be repeatable at relatively short time intervals ranging from about one to five seconds. Therefore, depending upon the length of the SRV used to define the SRV + CHUG event, the SRV response time-history may combine with more than one cycle of the CHUG. For conservatism, it has been assumed that the CHUG time-history repeats at one-second intervals. The amplitude of the repeated CHUG cycles tends to be highly random. However, since the amplitude of the CHUG time-history used for design purposes has been conservatively established, the design CHUG time-history has been used to conservatively represent all repeated cycles of the CHUG response rather than characterizing the repeated CHUG response by a random amplitude variation. The exact time-phasing of the CHUG time-history relative to the SRV time-history is random and the CHUG can begin either prior to or subsequent to the SRV. This randomnesss has been conservatively represented by assuming that the CHUG has an equal probability of initiating at any time within one second prior to the beginning of the SRV with repeated cycles occurring at one-second intervals. This conservative combination procedure is illustrated in Figure 2-2. The SRV time-history is assumed to begin at zero time while the first cycle of the repeatable CHUG history is assumed to have an equal probability (uniform PDF) of beginning at any time during the one second prior to the beginning of the SRV. As a result, the SRV will combine with at least one, and maybe more than one, cycle of the CHUG.

Two criteria were established by which the time-histories to be included in this study were to be screened. These criteria, which were specified to assure conservatism of the results and to assure that only important load combination cases were investigated, are listed as follows:

1. The duration of the individual time-histories should be computed well beyond the time of peak response such that the response amplitude at the end of the history is less than about 50% of the peak value.

2. The ratio of the peak response values of any two response time-histories being combined should generally be less than approximately 3 with ratios on the order of 4 or 5 acceptable in a few cases.

The first time-history criterion was included to assure that the combination of near peak excursions occurring subsequent to the time of peak response are properly included in the calculation of peak combined response. The peak combined response is frequently associated with a time other than the times when the peak individual responses occur. This can be illustrated by again referring to Figure 2-1 where it can be seen that combined response at time X exceeds the combined response associated with the peak response of either time-history.

The second time-history criterion is the more important of the two to this evaluation effort assuring that trivial load combinations were not included in the demonstration data set. It can be seen from the table below that the amount of conservatism introduced by the Absolute Sum (ABS) method of response combination over that of the SRSS method is dependent upon the ratio of the peak value of the individual responses being combined. This ratio is represented by A'/A" where A' is defined as the peak value of the predominant response and A" is defined as the peak value of the lesser response.

A'/A"	1.0	2.0	3.0	4.0	5.0	10.0	20.0	50.0
ABS/SRSS	1.414	1.342	1.265	1.213	1.177	1.095	1.049	1.020

If the peak amplitudes of two responses being combined are equal (A'/A" = 1.0) the ABS method introduces the maximum factor of conservatism of 1.414 over that of the SRSS method of response combination. For peak amplitude ratios of 3.0 and 5.0, the factor of conservatism reduces to 1.265 and 1.177, respectively. As the amplitude ratio increases further, the factor of conservatism introduced by the ABS method continues to reduce asymptotically approaching 1.0. Therefore, for large peak amplitude ratios, the difference between the response values computed by ABS and SRSS is small. As a result, cases with peak amplitude ratios, A'/A", greater than about 5.0 were not included in this study. The second time-history criterion was specified in order that there would be a significant difference between the ABS and SRSS combined response values for all cases studied. Figure 2-3 presents the distribution of the peak response amplitude ratios for the 167 response combinations evaluated in this study. It can be seen that for 28 of the combinations the amplitude ratio was between 1.0 and 1.1 while better than 87% of the load combinations evaluated exhibited an amplitude ratio less than 3.0 and only 2.4% (4 cases) exhibited a ratio greater than 4.0.

In addition, defining A_1 as the peak amplitude of the longer duration, lower frequency response, and A_2 as the peak amplitude of the shorter duration, higher frequency response, it was of interest in this study to assure that cases were selected where A_1 was greater than A_2 and where A_2 was greater than A_1. Figure 2-4 presents the distribution of the amplitude ratio A_1/A_2 for the 114 cases where A_1 was greater than A_2 and the amplitude ratio A_2/A_1 for the 53 cases where A_2 was greater than A_1. It can be seen that for over 30% of the cases the peak amplitude of the higher frequency response was greater than the peak amplitude of the lower frequency response. In both cases ($A_1 > A_2$ and $A_2 > A_1$), it can be seen that only important cases exhibiting a significant difference between ABS and SRSS combined response were investigated.

Conservative assumptions have been made concerning the approach used to generate the response combination CDF curves, the restraints placed on the time-lag relationship between the SRV and earthquake events, and the representation of the amplitude and repeatable nature of the CHUG loading. Therefore, the conclusions of this study are conservatively biased.

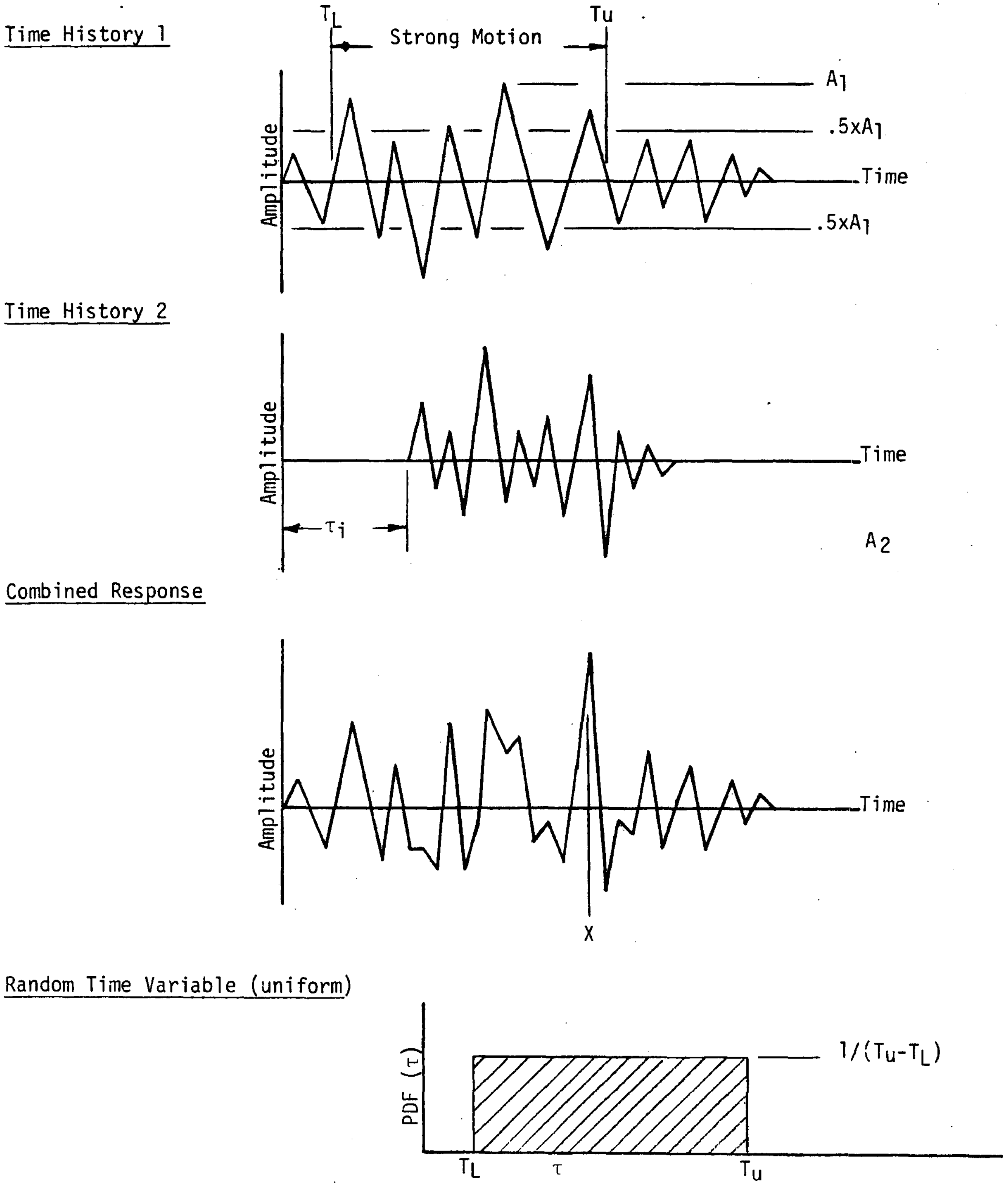


FIGURE 2-1. METHOD OF TIME PHASED RESPONSE COMBINATION

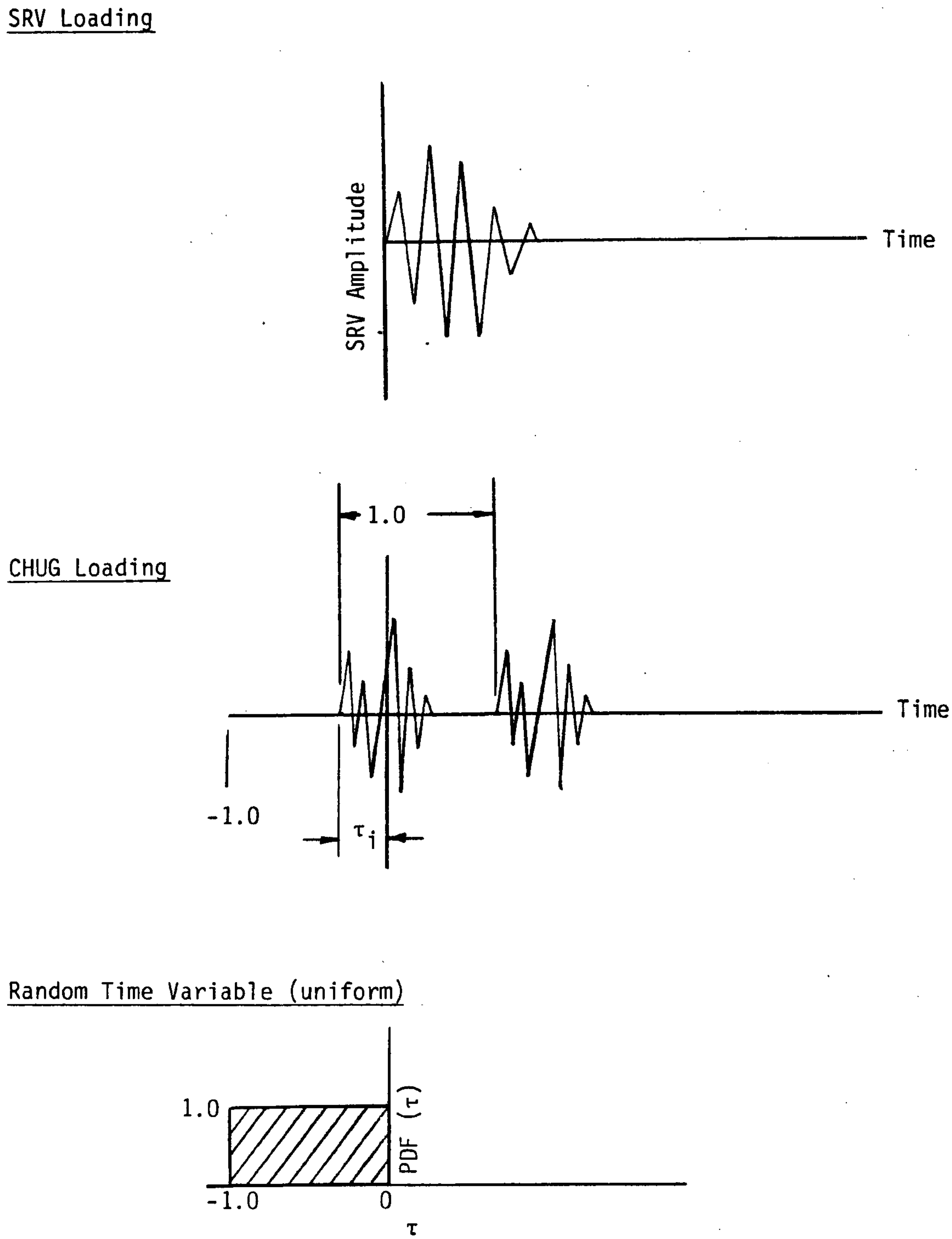


FIGURE 2-2. RESPONSE COMBINATION OF SRV + CHUG LOADINGS

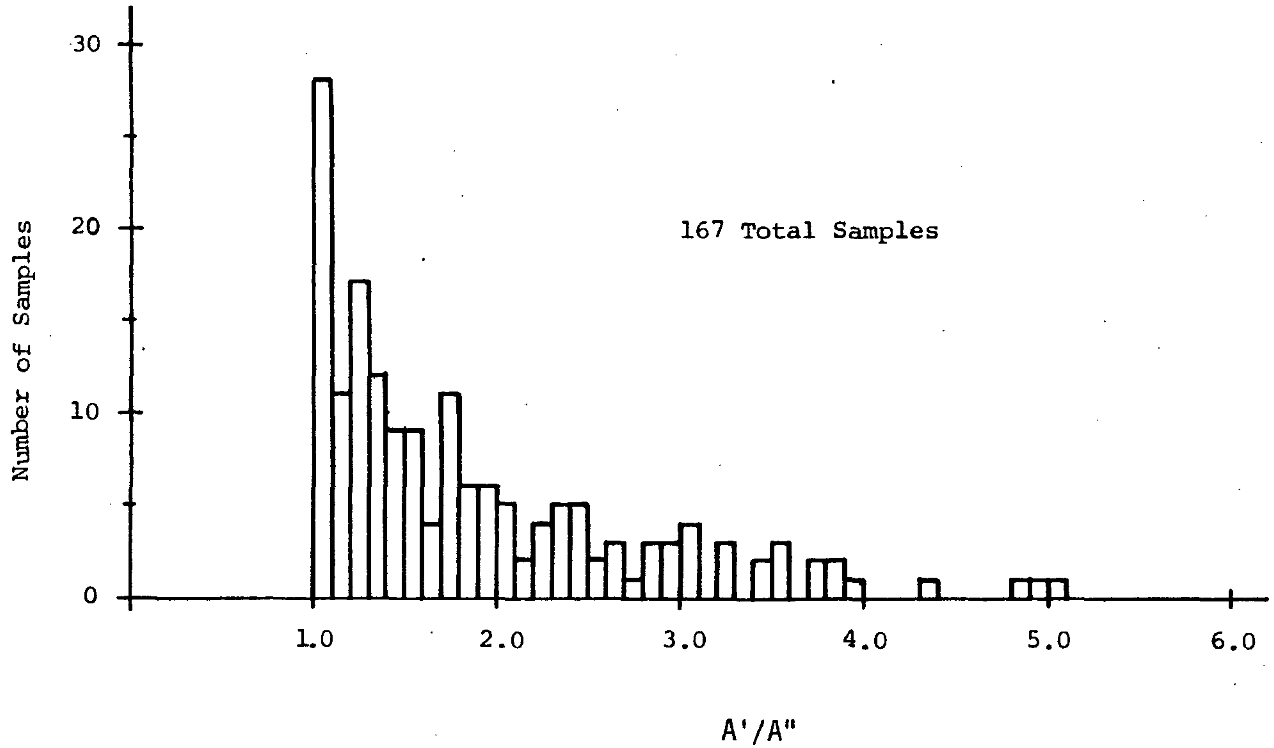


FIGURE 2-3. DISTRIBUTION OF LOAD COMBINATION TIME-HISTORY PEAK RESPONSE RATIO

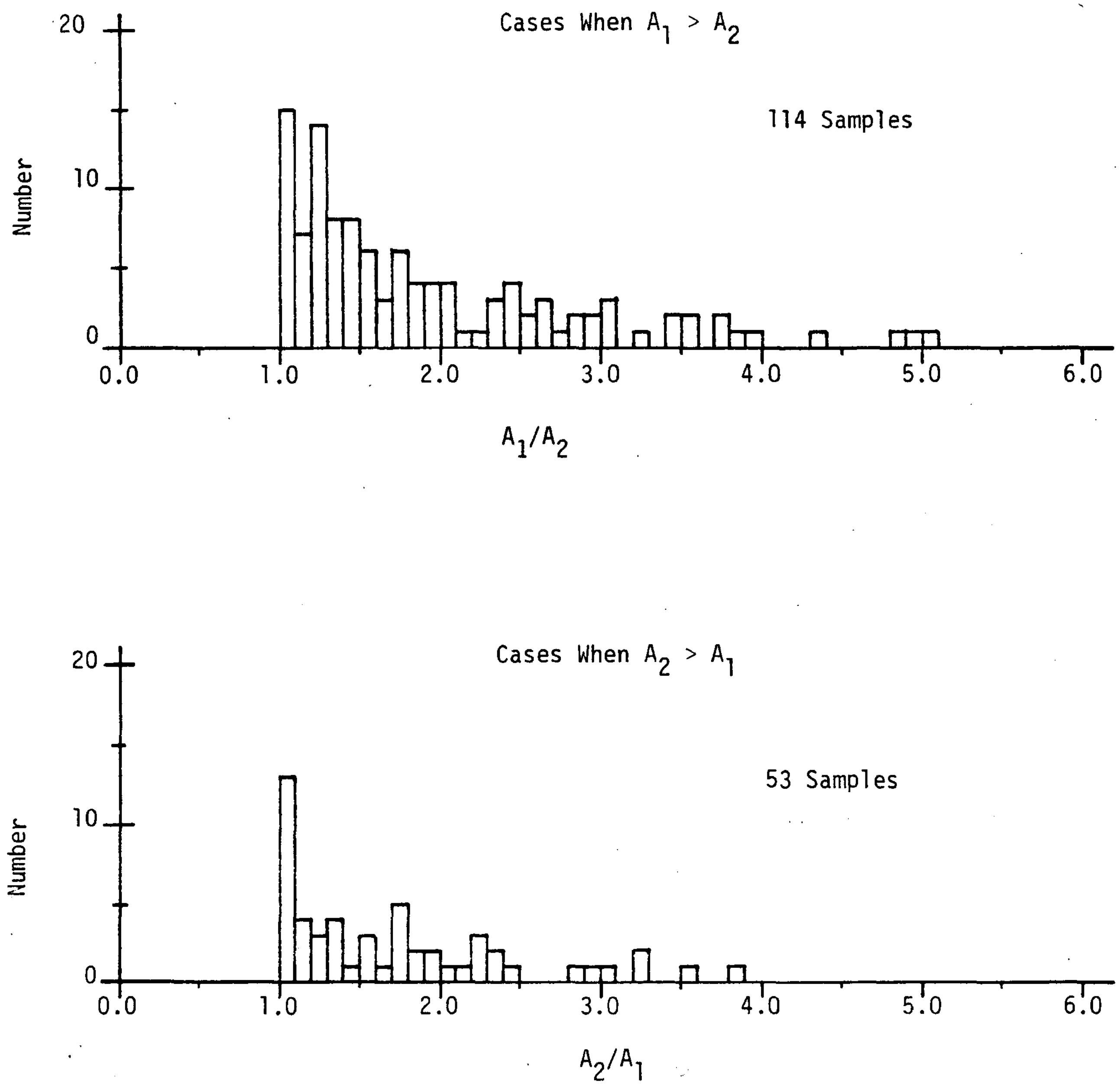


FIGURE 2-4. COMPARISON OF PEAK RESPONSE RATIOS WHEN $A_1 > A_2$ AND WHEN $A_2 > A_1$

3. RESULTS

3.1 GENERAL PRESENTATION OF RESULTS

A total of 167 response combination CDF curves have been generated for the appropriate response combinations and a wide variety of response locations within six different Mark III plants. A total of nine load combinations involving two levels of earthquake, three types of SRV actuation and the CHUG load were investigated as shown in the Mark III SRSS Evaluation Matrix (Table 1-2). In addition to covering several important load combinations for which justification of the SRSS method was desired, the selection of the nine cases resulted in the response combination of time-histories exhibiting a relatively wide range of frequency content. The combinations included both cases where the low frequency response was predominant and cases where the high frequency response was predominant.

The 167 response combintation cases as defined in Table 1-2 also represent three major categories of piping and equipment found in a Mark III nuclear power facility including:

1. Nuclear Steam Supply System-RPV and Internals, Piping, and Components
2. Balance-of-Plant Piping including supports
3. Balance-of-Plant Equipment

Hypothesis testing was conducted to investigate the nature of the 167 sample data set. It was found that the mean value and standard deviation remained stable when comparing the results from the entire data set to the results from each of the three major categories. The mean value and standard deviation were also stable when comparing the results from the entire set to the results from each of the three response combinations (OBE + SRV, SSE + SRV and SRV + CHUG) and from two classifications of response parameters (Acceleration, Force and Moment).

Therefore, the results of this study are presented as a uniform data set consisting of 167 samples. It was also found that the results from both the entire data set as well as randomly selected smaller sets tended to be normally distributed. Based upon the hypothesis testing and the normal distribution of the results, 167 samples are considered to represent a very good estimate of the behavior of the whole population of possible samples.

The data are presented in a tabular form which summarizes the key response values and the response value ratios obtained from the CDF evaluation of each load combination. The 167 CDF curves are included as Appendix B of this report and are numbered and identified in accordance with the SRSS Evaluation Matrix (Table 1-2). Similarly, the time-history pairs used to generate the CDF curves are included as Appendix C and are numbered consistent with the corresponding CDF curve from Appendix B. It should be noted that SSE time histories were taken as 2 times the corresponding OBE time history for this study.

Tables 3-1 through 3-18 present the tabulated results from the response combination analyses associated with each of the 18 equipment/location category columns of the Evaluation Matrix. For each response combination analysis, the location identifier, which is consistent with the Matrix, is given together with the associated response parameter (i.e., vertical force, moment, acceleration). The loading is also specified along with the peak response amplitudes associated with the two time-histories combined. The results are then presented in terms of 1) the computed SRSS peak response value and its non-exceedance probability (NEP) from the response combination analysis, 2) the 1.2xSRSS value and its NEP, 3) the ratio of the 50% NEP value (R_{50}) to the SRSS value, 4) the ratio of the 85% NEP value (R_{85}) to the SRSS value, and 5) the ratio of the absolute sum (ABS) value to the SRSS response value. Since Newmark-Kennedy Criterion 2 has been employed as the basis for acceptability of the SRSS response combination method, the response ratios, (R_{50}/SRSS and R_{85}/SRSS), are of prime importance. Additional insight into the behavior of the load combination can also be attained by referring to the appropriate CDF curve presented in Appendix B.

Reiterating the requirements of Newmark-Kennedy Criterion 2 for the combination of conservatively defined loads; the SRSS method of response combination is applicable if,

1. There is estimated to be less than approximately a 50% conditional probability that the actual peak combined response exceeds approximately the SRSS calculated peak response, and

2. There is estimated to be less than approximately a 15% conditional probability that the actual peak combined response exceeds approximately 1.2 times the SRSS calculated peak response.

In order to meet Part 1 of Newmark-Kennedy Criterion 2, the ratio R_{50}/SRSS must be approximately equal to or less than 1.0. Similarly, in order to meet Part 2, the ratio R_{85}/SRSS must be approximately equal to or less than 1.2. The response ratios are underlined in Tables 3-1 through 3-18 for those cases for which R_{50} exceeds the SRSS value by more than one percent and for which R_{85} exceeds 1.2 times the SRSS value. These exceedances, which are discussed further in Section 3.3, are primarily due to the conservatisms introduced by the characterization of the CHUG response and the phasing relationship established between the earthquake and SRV responses.

Figure 3-1 presents histograms of the distribution of the R_{50}/SRSS and R_{85}/SRSS response ratios for the entire set of response combination analyses. Cumulative Distribution Functions (CDF) for these ratios are presented in Figures 3-2 and 3-3, respectively. It can be seen that the ratio R_{85}/SRSS is less than 1.2 for 163, or 97.6%, of the 167 load combination cases. For the remaining four cases, the actual 85% NEP value exceeds 1.2 times the calculated SRSS response value by 2.3% or less with the maximum value of R_{85}/SRSS for the 167 cases being 1.228. Figure 3-1 also shows that the ratio R_{85}/SRSS tends to be approximately normally distributed. The mean value, $\bar{x}$, of R_{85}/SRSS for the 167 cases was computed to be 1.048 with a standard deviation, σ, of 0.085. Based upon the properties of a normal distribution, one would expect 96.3% of the cases to have a ratio R_{85}/SRSS less than 1.2 with this mean and standard deviation. This expectation is close to the 97.6% observed for the 167 cases investigated in this study.

Even assuming very conservative distribution-free confidence limits, the number of observations required so that the confidence is γ that at least $100x(1-\alpha)$ % of the distribution will be less than the largest observation of the sample is given by:

$$n = \frac{\log (1 - \gamma)}{\log (1 - \alpha)} \tag{3-1}$$

Thus, the percentage of the distribution at any confidence level γ which is less than the largest observation is given by:

$$\log (1 - \alpha) = \log \frac{(1 - \gamma)}{n} \tag{3-2}$$

Using Equation 3-2, there is a 90% confidence that 98.6% of all samples would have a ratio R_{85}/SRSS less than 1.228. Based upon these observations, one would conclude that all 167 Mark III SRSS response combination cases satisfy Part 2 of Newmark-Kennedy Criterion 2 which is that the ratio R_{85}/SRSS should be approximately 1.2 or less.

Similarly, Figure 3-1 and the table below show that R_{50}/SRSS is less than or equal to 1.0 for 83.2% of the 167 load combination cases. In addition, the 50% NEP value is less than 1.01 times the SRSS calculated response value for 89.8% of the cases and is less than 1.05 times the SRSS value for 95.8% of the cases investigated.

	Value of R_{50}/SRSS				
	≤ 1.0	≤ 1.01	≤ 1.03	≤ 1.05	< 1.10
Number of Cases % of All Cases	139 83.2	150 89.8	156 93.4	160 95.8	167 100.0

The highest ratio of R_{50}/SRSS involved the combination of response from an SRV_{ADS} + CHUG loading. It can be seen from Figure 3-1 that the R_{50}/SRSS ratio also tends to be normally distributed. The mean value of R_{50}/SRSS for the 167 cases evaluated was calculated to be 0.930 with a standard deviation of 0.069. Based upon the properties of a normal distribution, one would expect 84.4% of the cases to have a ratio R_{50}/SRSS less than 1.0 and 99.3% of all cases to have a ratio less than 1.1. Again, assuming very conservative distribution-free confidence limits, there is a 90% confidence that 98.6% of all samples would have a ratio R_{50}/SRSS less than 1.095 which is the largest ratio of all 167 samples tested. Based upon these observations, one would also conclude that all 167 Mark III SRSS response combination cases satisfy Part I of the Newmark-Kennedy Criterion 2 which is that the ratio R_{50}/SRSS should be approximately 1.0 or less.

All 167 response combination cases considered in this SRSS justification effort meet the load definition requirement of the Newmark-Kennedy Criteria and satisfy both Part 1 and Part 2 of Newmark-Kennedy Criterion 2. The cases considered cover a sufficiently wide variety of plants, response locations, response parameters, and categories of equipment such that the results may be considered to be generic. It is therefore concluded that the SRSS method of response combination is applicable for all locations within Mark III plants when considering the combination of responses resulting from the following loadings:

1. OBE + SRV
2. SSE + SRV
3 SRV + LOCA (SBA/IBA)

The acceptability of the SRSS response combination of these loadings is in addition to the following for which the SRSS combination method has previously been accepted by the NRC and does not require further justification.

1. SSE + LOCA
2. Any combination involving 3 or more dynamic responses.

3.2 TRENDS AND OBSERVATIONS

The results of the 167 response combinations were broken down into several subsets in order to determine if any particular trends were to be noted. The subsets included breakdowns by:

1. Load Combination (OBE+SRV, SSE+SRV, SRV+CHUG)
2. Response Quantity (Acceleration, Force and Moment)
3. Equipment Category (NSSS System, BOP Piping, BOP Equipment)
4. Ratio of A_2/A_1 (Ratio of Higher Frequency Amplitude to Lower Frequency Amplitude)

The detailed analyses of these subsets are included as Appendix D of this report. As mentioned above, no particular trends were noted for subsets 1 through 3. For these subsets, the mean values and standard deviations were stable and the results exhibited the characteristics of a normal distribution. The analysis of subset 4 indicated that the response ratio R_{50}/SRSS was influenced by the ratio of the peak amplitude of the higher frequency response to the amplitude of the lower frequency response (A_2/A_1). It was found that the SRSS method of response combination is a conservative approach for cases where A_2/A_1 is less than 2.0, with the degree of conservatism decreasing with increasing values of A_2/A_1. The SRSS method was also found to be an accurate approach for the computing of combined response for cases where A_2/A_1 is greater than 2.0.

3.3 EFFECTS OF TIME-PHASING ON R_{50}/SRSS

A conservative assumption was made pertaining to the relative time-phasing of the earthquake and SRV time-histories. This conservatism lies in the definition of the "strong motion" portion of the earthquake as being the time frame between the first and last time the earthquake amplitude reached 50% of its peak value. In order to assess the affect of this assumption, the 15 earthquake plus SRV cases where the 50% NEP combined response value exceeded the SRSS calculated response by more than one percent were reevaluated defining the strong motion portion of the earthquake as being the time frame between the first and last time the response amplitude exceeded 10% of its peak value. Such a definition, constitutes a less restrictive but yet, conservative assumption.

This change in the definition of earthquake strong motion resulted in a reduction in the value of the R_{50}/SRSS and R_{85}/SRSS combined response ratios. The response ratios for the 15 cases are presented in Table 3-19 for both the 50% amplitude and 10% amplitude definitions of strong motion. It can be seen that the reduction of the R_{50}/SRSS response ratio ranges from one to nine percent and that only nine cases exhibit an R_{50}/SRSS ratio greater than 1.0. This is in contrast to 28 cases for which the R_{50}/SRSS value exceeded 1.0 when the 50% amplitude strong motion definition was used. The highest ratio of R_{50}/SRSS was less than 1.05 using the 10% amplitude strong motion definition. Similarly, the highest value of the R_{85}/SRSS response ratio is only 1.219 and is the only case where R_{85}/SRSS exceed 1.2. The comparative Cumulative Distribution Function (CDF) curves for the earthquake + SRV case exhibiting the highest value for the R_{50}/SRSS response ratio are shown in Figure 3-4.

Conservative assumptions were also made concerning the repeatable nature of the CHUG response. As noted, the CHUG loading is known to be repeatable at intervals from one to five seconds. The conservatism lies in the use of the minimum one-second interval for this study. To assess the affect of this conservatism, the two SRV + CHUG response combination cases where the 50% NEP combined response value exceeded the SRSS calculated response by more than one percent were reevaluated establishing the interval between the beginning of adjacent CHUG cycles to be two seconds. This definition of the CHUG cycle interval also constitutes a less restrictive, but yet conservative, assumption.

As shown in Table 3-20, the use of this less restrictive assumption results in a significant reduction in the R_{50}/SRSS response ratio. The reduction of R_{50}/SRSS is on the order of 13 percent such that no SRV + CHUG cases results in a value of R_{50}/SRSS greater than 1.0. The comparative Cumulative Distribution Function curves for the SRV + CHUG case exhibiting the highest response ratio are shown in Figure 3-5.

TABLE 3-1 CDF ANALYSIS RESULTS FOR NSSS - RPV AND INTERNALS

NUCLEAR STEAM SUPPLY SYSTEM - RPV AND INTERNALS

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
5-5	Vert. Force	OBE+SRV-1	4.302 E+05	2.668 E+05	5.062 E+05	53.2%	6.075 E+05	90.2%	.988	1.149	1.377
5-4	Vert. Force	OBE+SRV-ALL	4.430 E+04	8.770 E+04	9.833 E+04	63.0%	1.180 E+05	96.1%	.954	1.092	1.343
5-5	Vert. Force	OBE+SRV-ADS	4.302 E+05	2.966 E+05	5.225 E+05	78.6%	6.270 E+06	97.1%	.900	1.041	1.391
5-5	Vert. Force	SSE+SRV-1	8.604 E+05	2.668 E+05	9.008 E+05	77.7%	1.081 E+06	97.4%	.955	1.031	1.251
5-4	Vert. Force	SSE+SRV-ALL	8.860 E+04	8.779 E+04	1.247 E+05	75.7%	1.497 E+05	97.8%	.910	1.037	1.414
5-5	Vert. Force	SRV-1+CHUG	2.668 E+05	2.643 E+05	3.755 E+05	71.0%	4.507 E+05	90.6%	.839	1.126	1.414
5-6	Vert. Force	SRV-ADS+CHUG	6.855 E+04	7.246 E+04	9.975 E+04	75.5%	1.197 E+05	94.2%	.819	1.070	1.414
4-4	Moment	SRV-1+CHUG 12	1.612 E+06	4.105 E+05	1.663 E+06	42.5%	1.996 E+06	99.4%	1.010	1.075	1.216
4-3	Vert. Force	SRV-ADS+CHUG10	4.871 E+04	1.673 E+04	5.150 E+04	62.6%	6.180 E+04	98.3%	.961	1.060	1.271
4-2	Horiz. Force	SRV-ADS+CHUG10	9.672 E+04	3.811 E+04	1.040 E+05	75.2%	1.247 E+05	97.5%	.946	1.056	1.296

TABLE 3-2 CDF ANALYSIS RESULTS FOR NSSS - MAIN STEAM PIPING

NUCLEAR STEAM SUPPLY SYSTEM: MAIN STEAM PIPING

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
6-4	Moment	OBE+SRV-1	1.150 E+05	9.488 E+04	1.491 E+05	78.8%	1.789 E+05	96.7%	.878	1.032	1.408
6-5	Moment	OBE+SRV-1	1.217 E+05	8.025 E+04	1.458 E+05	73.7%	1.749 E+05	95.2%	.880	1.071	1.385
6-7	Moment	OBE+SRV-1	1.735 E+05	1.268 E+05	2.149 E+05	71.7%	2.579 E+05	96.2%	.864	1.074	1.397
6-5	Moment	OBE+SRV-ALL	1.217 E+05	1.233 E+05	1.732 E+05	66.4%	2.079 E+05	96.5%	.948	1.088	1.414
6-6	Moment	OBE+SRV-ALL	1.261 E+05	8.666 E+04	1.530 E+05	76.6%	1.836 E+05	94.5%	.891	1.069	1.391
6-9	Moment	OBE+SRV-ALL	5.071 E+04	6.574 E+04	8.303 E+04	37.9%	9.963 E+04	94.2%	1.030	1.137	1.403
6-4	Moment	SSE+SRV-1	2.300 E+05	9.488 E+04	2.488 E+05	85.0%	2.986 E+05	99.0%	.924	.993	1.306
6-8	Moment	SSE+SRV-1	1.310 E+05	4.974 E+04	1.401 E+05	91.7%	1.681 E+05	99.0%	.935	.955	1.290
6-9	Moment	SSE+SRV-1	1.014 E+05	6.014 E+04	1.179 E+05	79.7%	1.415 E+05	97.2%	.863	1.046	1.370
6-8	Moment	SSE+SRV-ALL	1.310 E+05	9.703 E+04	1.630 E+05	84.1%	1.956 E+05	98.5%	.850	.998	1.399

TABLE 3-3 CDF ANALYSIS RESULTS FOR NSSS - RECIRCULATION PIPING

NUCLEAR STEAM SUPPLY SYSTEM: RECIRCULATION PIPING

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
4-8	Moment	OBE+SRV-1	8.714 E+04	3.019 E+04	9.222 E+04	94.1%	1.107 E+05	> 99.5%	.945	.945	1.272
4-10	Moment	OBE+SRV-1	5.639 E+04	3.786 E+04	6.792 E+04	94.5%	8.150 E+04	97.8%	.830	.896	1.388
4-11	Moment	OBE+SRV-1	4.735 E+04	2.297 E+04	5.263 E+04	86.8%	6.315 E+04	97.8%	.900	.979	1.336
4-12	Moment	OBE+SRV-1	5.941 E+04	2.209 E+04	6.338 E+04	90.6%	7.606 E+04	98.7%	.937	.937	1.286
4-9	Moment	OBE+SRV-ALL	1.240 E+04	1.888 E+04	2.259 E+04	71.0%	2.711 E+04	96.7%	.920	1.050	1.385
4-12	Moment	OBE+SRV-ALL	5.941 E+04	2.377 E+04	6.399 E+04	91.1%	7.679 E+04	99.3%	.928	.953	1.300
4-13	Moment	OBE+SRV-ALL	1.274 E+04	6.975 E+03	1.452 E+04	83.7%	1.743 E+04	98.0%	.877	1.003	1.358
4-9	Moment	SSE+SRV-1	2.480 E+04	1.002 E+04	2.675 E+04	86.1%	3.210 E+04	> 99.5%	.927	.980	1.302
4-10	Moment	SSE+SRV-ALL	1.128 E+05	5.133 E+04	1.239 E+05	97.2%	1.487 E=05	99.4%	.910	.910	1.325
4-11	Moment	SSE+SRV-ALL	9.470 E+04	4.738 E+04	1.059 E+05	90.7%	1.271 E+05	99.2%	.894	.961	1.342
4-9	Moment	SRV-1+CHUG	1.002 E+04	2.681 E+03	1.037 E+04	82.5%	1.245 E+04	98.4%	.966	1.002	1.225

TABLE 3-4 CDF ANALYSIS RESULTS FOR NSSS - PIPE MOUNTED EQUIPMENT

NUCLEAR STEAM SUPPLY SYSTEM: PIPE MOUNTED EQUIPMENT

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
4-6	Acceleration	OBE+SRV-1	.2424	.1089	.2657	96.5%	.3189	> 99.5%	.912	.912	1.320
4-7	Acceleration	OBE+SRV-ALL	.5128	.4048	.6533	93.1%	.7840	99.4%	.785	.886	1.405
4-5	Acceleration	SSE+SRV-1	.04252	.01204	.04419	96.1%	.05303	99.5%	.962	.962	1.235
4-6	Acceleration	SRV-1+CHUG	.1089	.03110	.1133	88.9%	.1359	> 99.5%	.962	.981	1.236
6-2	Acceleration	OBE+SRV-1	.1557	.2730	.3143	59.6%	.3771	93.6%	.967	1.129	1.364
6-3	Acceleration	OBE+SRV-ALL	.08918	.1236	.1524	61.8%	.1829	97.1%	.972	1.092	1.396
6-1	Acceleration	SSE+SRV-1	.2858	.3038	.4171	70.6%	.5005	97.0%	.875	1.077	1.414
6-1	Acceleration	SSE+SRV-ALL	.2858	.5637	.6320	46.9%	.7584	95.1%	1.008	1.115	1.344
6-3	Acceleration	SRV-ALL+CHUG	.1236	.07681	.1455	78.7%	.1746	98.6%	.869	1.030	1.377

TABLE 3-5 CDF ANALYSIS RESULTS FOR BOP PIPING - DRYWELL

BOP PIPING: DRYWELL												
Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
1-2	Force	OBE+SRV-1	1.171 E+04	9.267 E+03	1.493 E+04	60.4%	1.792 E+04	86.9%	.924	1.191	1.405
1-3	Moment	OBE+SRV-1	5.994 E+03	7.669 E+03	9.734 E+03	44.2%	1.168 E+04	82.6%	1.020	1.222	1.404
1-1	Moment	OBE+SRV-ALL	5.259 E+03	3.382 E+03	6.253 E+03	72.3%	7.503 E+03	95.5%	.883	1.040	1.382
1-4	Moment	OBE+SRV-ALL	1.768 E+01	3.178 E+01	3.637 E+01	60.8%	4.364 E+01	96.6%	.972	1.082	1.360
1-1	Moment	SSE+SRV-1	1.052 E+04	8.107 E+03	1.328 E+04	67.0%	1.594 E+04	91.9%	.940	1.076	1.403
1-4	Moment	SSE+SRV-1	3.536 E+01	3.222 E+01	4.784 E+01	67.3%	5.741 E+01	94.9%	.912	1.098	1.413
1-3	Moment	SSE+SRV-ALL	1.199 E+04	1.113 E+04	1.636 E+04	65.1%	1.963 E+04	92.1%	.913	1.124	1.413
1-4	Moment	SSE+SRV-ALL	3.536 E+01	3.178 E+01	4.754 E+01	69.7%	5.705 E+01	97.1%	.925	1.079	1.412
1-2	Force	SRV-1+CHUG	9.267 E+03	5.041 E+03	1.055 E+04	81.4%	1.266 E+04	99.1%	.878	1.009	1.356
1-4	Moment	SRV-1+CHUG	3.222 E+01	2.206 E+01	3.905 E+01	70.3%	4.686 E+01	96.9%	.877	1.103	1.390
1-1	Moment	SRV-ALL+CHUG	3.382 E+03	6.084 E+03	6.961 E+03	55.2%	8.353 E+03	98.2%	.989	1.081	1.360
1-4	Moment	SRV-ALL+CHUG	3.178 E+01	2.206 E+01	3.869 E+01	58.8%	4.642 E+01	92.5%	.971	1.112	1.392
2-5	Moment	OBE+SRV-1	5.772 E+02	1.924 E+02	6.084 E+02	92.7%	7.301 E+02	99.0%	.949	.949	1.265
2-8	Force	OBE+SRV-1	4.546 E+00	3.020 E+00	5.458 E+00	91.0%	6.549 E+00	99.1%	.833	.872	1.386
2-6	Moment	OBE+SRV-ALL	8.709 E+01	3.737 E+01	9.477 E+01	> 99.5%	1.137 E+02	> 99.5%	.919	.919	1.313
2-7	Moment	OBE+SRV-ALL	7.366 E+01	2.588 E+01	7.788 E+01	90.8%	9.345 E+01	99.5%	.946	.946	1.270
2-8	Force	SSE+SRV-1	9.092 E+00	3.020 E+00	9.508 E+00	88.0%	1.150 E+01	> 99.5%	.949	.949	1.264
2-8	Force	SSE+SRV-ALL	9.092 E+00	2.159 E+01	2.343 E+01	79.0%	2.811 E+01	98.4%	.941	1.020	1.310
2-7	Moment	SRV-1+CHUG	5.692 E+00	1.526 E+00	5.893 E+00	65.6%	7.072 E+00	98.0%	.966	1.056	1.225
2-8	Force	SRV-1+CHUG	3.020 E+00	2.888 E+00	4.137 E+00	69.6%	4.965 E+00	98.1%	.940	1.075	1.414

TABLE 3-6 CDF ANALYSIS RESULTS FOR BOP PIPING - CONTAINMENT (FREESTANDING STEEL)

BOP PIPING: CONTAINMENT (FREESTANDING STEEL)

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
3-1	Acceleration	OBE+SRV-ALL	.04968	.1236	.1332	46.4%	.1599	96.2%	1.024	1.143	1.311
3-3	Force	OBE+SRV-ALL	.1604 E+03	.6244 E+03	.6427 E+03	53.4%	.7713 E+03	> 99.5%	.988	1.077	1.218
3-1	Acceleration	OBE+SRV-ADS	.04968	.1126	.1231	27.2%	.1477	94.2%	1.056	1.151	1.318
3-3	Force	OBE+SRV-ADS	.1604 E+03	.5275 E+03	.5513 E+03	16.1%	.6616 E+03	97.9%	1.057	1.102	1.248
3-1	Acceleration	SSE+SRV-ADS	.09940	.1126	.1502	47.4%	.1802	90.8%	1.009	1.166	1.411
3-2	Acceleration	SSE+SRV-ADS	.1166	.2599	.2848	41.0%	.3418	95.8%	1.029	1.119	1.402
3-1	Acceleration	SRV-ADS+CHUG	.1126	.08660	.1421	67.7%	.1705	88.6%	.894	1.172	1.402
3-2	Acceleration	SRV-ADS+CHUG	.2599	.1370	.2938	65.2%	.3526	87.1%	.946	1.188	1.351
3-1	Acceleration	SRV-ADS+CHUG	.1236	.08660	.1509	69.4%	.1811	95.0%	.923	1.093	1.393
3-2	Acceleration	SRV-ALL+CHUG	.3599	.1370	.3851	76.0%	.4621	97.0%	.939	1.043	1.290

TABLE 3-7 CDF ANALYSIS RESULTS FOR BOP PIPING - CONTAINMENT (CONCRETE BACKED)

BOP PIPING: CONTAINMENT (CONCRETE BACKED)

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
4-18	Force	OBE+SRV-1	4.744 E+01	2.496 E+01	5.361 E+01	86.5%	6.433 E+01	98.3%	.885	.988	1.351
4-21	Force	OBE+SRV-1	1.083 E+02	3.972 E+01	1.154 E+02	85.5%	1.384 E+02	98.7%	.939	.983	1.283
4-20	Moment	OBE+SRV-ALL	7.879 E+01	6.361 E+01	1.013 E+02	63.3%	1.215 E+02	93.1%	.952	1.118	1.406
4-19	Force	OBE+SRV-ALL	9.183 E+01	5.909 E+01	1.092 E+02	75.6%	1.310 E+02	97.7%	.895	1.056	1.382
4-18	Force	SSE+SRV-1	9.488 E+01	2.496 E+01	9.811 E+01	92.6%	1.177 E+02	> 99.5%	.967	.967	1.222
4-20	Moment	SSE+SRV-ALL	1.576 E+02	6.361 E+01	1.700 E+02	85.8%	2.039 E+02	> 99.5%	.927	.982	1.301

TABLE 3-8 CDF ANALYSIS RESULTS FOR BOP PIPING - CONTAINMENT (CONCRETE)

BOP PIPING: CONTAINMENT (CONCRETE)

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
5-17	Moment	OBE+SRV-1	6.297 E+02	6.724 E+02	9.212 E+02	89.9%	1.105 E+03	98.4%	.777	.930	1.414
5-14	Force	OBE+SRV-1	7.350 E+01	6.448 E+01	9.777 E+01	97.6%	1.173 E+02	98.9%	.752	.811	1.411
5-16	Moment	OBE+SRV-ADS	1.979 E+03	2.226 E+03	2.979 E+03	50.0%	3.574 E+03	91.0%	1.000	1.154	1.412
5-18	Moment	OBE+SRV-ADS	1.387 E+03	7.936 E+02	1.598 E+03	94.5%	1.918 E+03	98.7%	.868	.868	1.365
5-15	Force	SSE+SRV-1	8.792 E+01	8.771 E+01	1.242 E+02	62.9%	1.490 E+02	89.2%	.966	1.172	1.414
5-19	Force	SSE+SRV-ALL	4.966 E+02	4.415 E+02	6.645 E+02	42.5%	7.974 E+02	77.5%	1.048	1.221	1.412
5-16	Moment	SRV-1+CHUG	8.038 E+02	4.639 E+02	9.281 E+02	70.9%	1.114 E+03	98.5%	.921	1.064	1.366
5-15	Force	SRV-1+CHUG	8.771 E+01	7.205 E+01	1.135 E+02	51.3%	1.362 E+02	89.9%	.996	1.163	1.408
5-14	Force	SRV-ADS+CHUG	4.588 E+01	4.623 E+01	6.513 E+01	64.4%	7.816 E+01	93.7%	.956	1.120	1.414
5-17	Moment	SRV-ADS+CHUG	3.501 E+02	2.059 E+02	4.062 E+02	48.8%	4.874 E+02	92.9%	1.005	1.129	1.369
5-16	Moment	SRV-ALL+CHUG	3.472 E+02	4.639 E+02	5.794 E+02	56.2%	6.953 E+02	97.4%	.982	1.152	1.400
5-20	Force	SRV-ALL+CHUG	2.009 E+01	1.950 E+01	2.800 E+01	74.5%	3.360 E+01	95.1%	.916	1.059	1.414
2-2	Moment	OBE+SRV-ALL	8.405 E+03	8.619 E+03	1.209 E+04	92.9%	1.451 E+04	> 99.5%	.763	.920	1.414
2-3	Moment	OBE+SRV-ALL	3.467 E+03	5.822 E+03	6.776 E+03	78.0%	8.131 E+03	97.3%	.899	1.040	1.371
2-1	Moment	SSE+SRV-1	2.246 E+03	3.117 E+03	3.842 E+03	77.0%	4.610 E+03	94.4%	.914	1.067	1.396
2-4	Force	SSE+SRV-1	3.094 E+03	2.553 E+03	4.011 E+03	90.3%	4.814 E+03	98.5%	.771	.917	1.408
2-2	Moment	SSE+SRV-ALL	1.680 E+04	8.619 E+03	1.903 E+04	93.7%	2.284 E+04	99.0%	.892	.892	1.346
2-3	Moment	SSE+SRV-ALL	6.934 E+03	5.822 E+03	9.054 E+03	82.2%	1.086 E+04	96.0%	.766	1.019	1.409

TABLE 3-9 CDF ANALYSIS RESULTS FOR BOP PIPING - SHIELD BLDG. (FREESTANDING STEEL)

BOP PIPING: SHIELD BUILDING (FREESTANDING STEEL)

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
3-8	Force	OBE+SRV-ALL	2.616 E+02	8.601 E+02	8.990 E+02	43.4%	1.079 E+03	> 99.5%	1.009	1.073	1.248
3-6	Acceleration	OBE+SRV-ALL	.05667	.1995	.2074	19.8%	.2489	96.8%	1.059	1.137	1.235
3-4	Acceleration	OBE+SRV-ADS	.07475	.1502	.1678	65.2%	.2013	96.6%	.949	1.075	1.341
3-7	Moment	OBE+SRV-ADS	3.962 E+02	1.129 E+03	1.197 E+03	26.3%	1.436 E+03	97.5%	1.035	1.114	1.274
3-6	Acceleration	OBE+SRV-ADS	.05667	.1021	.1168	41.0%	.1401	93.8%	1.042	1.154	1.359
3-4	Acceleration	SSE+SRV-ADS	.1495	.1502	.2119	74.8%	.2543	96.6%	.932	1.053	1.414
3-5	Acceleration	SRV-ADS+CHUG	.1653	.1518	.2244	30.9%	.2693	88.7%	1.061	1.170	1.413
3-6	Acceleration	SRV-ADS+CHUG	.1021	.1178	.1559	24.4%	.1871	79.1%	1.095	1.216	1.411
3-4	Acceleration	SRV-ALL+CHUG	.3428	.2457	.4218	74.6%	.5061	91.6%	.931	1.070	1.395
3-5	Acceleration	SRV-ALL+CHUG	.2589	.1518	.3001	56.5%	.3601	91.3%	.967	1.135	1.369

TABLE 3-10 CDF ANALYSIS RESULTS FOR BOP PIPING - SHIELD BLDG. (CONCRETE BACKED)

BOP PIPING: SHIELD BUILDING (CONCRETE BACKED)												
Location	Response	Loading	Peak Response Amplitude AMP1	Peak Response Amplitude AMP2	SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
4-17	Moment	OBE+SRV-1	1.200 E+03	1.307 E+03	1.774 E+03	72.3%	2.129 E+03	97.3%	.946	1.051	1.413
4-15	Moment	OBE+SRV-1	2.756 E+03	2.743 E+03	3.888 E+03	79.8%	4.666 E+03	99.2%	.921	1.024	1.414
4-14	Force	OBE+SRV-ALL	1.062 E+03	1.038 E+03	1.485 E+03	84.5%	1.782 E+03	97.8%	.871	.992	1.414
4-16	Force	OBE+SRV-ALL	1.408 E+03	1.073 E+03	1.770 E+03	85.9%	2.124 E+03	97.8%	.832	.980	1.402
4-17	Moment	SSE+SRV-1	2.400 E+03	1.307 E+03	2.733 E+03	90.8%	3.279 E+03	99.4%	.878	.933	1.356
4-14	Force	SSE+SRV-ALL	2.124 E+03	1.038 E+03	2.364 E+03	96.5%	2.837 E+03	> 99.5%	.898	.898	1.338

TABLE 3-11 CDF ANALYSIS RESULTS FOR BOP PIPING - AUXILIARY BLDG. (CONCRETE)

BOP PIPING: AUXILIARY BUILDING (CONCRETE)											
Location	Response	Loading	Peak Response Amplitude AMP1	Peak Response Amplitude AMP2	SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
5-7	Force Z-Axis	OBE+SRV-1	5.085 E+02	3.928 E+02	6.425 E+02	73.5%	7.711 E+02	96.2%	.891	1.047	1.403
5-10	Moment Y-Axis	OBE+SRV-1	1.235 E+04	1.217 E+04	1.734 E+04	72.1%	2.081 E+04	92.6%	.924	1.080	1.414
5-11	Moment Z-Axis	OBE+SRV-ADS	4.067 E+03	3.245 E+03	5.203 E+03	81.3%	6.244 E+03	95.6%	.855	1.028	1.405
5-12	Force Y-Axis	OBE+SRV-ADS	2.157 E+03	1.836 E+03	2.833 E+03	82.6%	3.399 E+03	95.1%	.853	1.015	1.409
5-13	Force Y-Axis	SSE+SRV-1	6.798 E+02	5.215 E+02	8.568 E+02	80.6%	1.028 E+03	93.7%	.833	1.036	1.402
5-8	Moment Y-Axis	SSE+SRV-ALL	4.634 E+03	4.996 E+03	6.814 E+03	78.7%	8.177 E+03	91.1%	.914	1.065	1.413
5-8	Moment Y-Axis	SRV-1+CHUG	2.496 E+03	1.837 E+03	3.099 E+03	82.6%	3.719 E+03	98.3%	.826	1.020	1.398
5-13	Force Y-Axis	SRV-ADS+CHUG	3.101 E+02	2.265 E+02	3.840 E+02	71.2%	4.608 E+02	94.1%	.881	1.105	1.397
5-12	Force Y-Axis	SRV-1+CHUG	8.340 E+02	4.711 E+02	9.579 E+02	78.3%	1.149 E+03	97.2%	.898	1.044	1.362
5-11	Moment Z-Axis	SRV-ADS+CHUG	3.245 E+03	2.971 E+03	4.400 E+03	75.5%	5.280 E+03	91.4%	.895	1.110	1.413
5-7	Force Z-Axis	SRV-ALL+CHUG	2.584 E+02	2.484 E+02	3.584 E+02	76.4%	4.301 E+02	94.0%	.849	1.059	1.414
5-9	Moment Z-Axis	SRV-ALL+CHUG	1.802 E+03	1.500 E+03	2.345 E+03	85.2%	2.814 E+03	97.6%	.802	.995	1.408

TABLE 3-12 CDF ANALYSIS RESULTS FOR BOP EQUIPMENT - DRYWELL

BOP EQUIPMENT: DRYWELL

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
1-9	Vert. Accel.	OBE+SRV-1	.1307	.1419	.1929	51.5%	.2315	90.6%	.995	1.159	1.413
1-13	Tang. Accel.	OBE+SRV-1	.1220	.09524	.1548	38.6%	.1857	80.7%	1.063	1.228	1.403
1-6	Vert. Accel.	OBE+SRV-ALL	.1323	.2004	.2401	45.6%	.2882	89.9%	1.008	1.141	1.386
1-11	Radial Accel.	SSE+SRV-ALL	.2224	.2323	.3216	67.1%	.3859	95.8%	.907	1.073	1.414
1-5	Radial Accel.	SRV-1+CHUG	.08744	.1112	.1415	49.4%	.1698	90.3%	1.001	1.158	1.404
1-9	Vert. Accel.	SRV-ALL+CHUG	.1689	.1140	.2038	68.7%	.2445	94.5%	.885	1.108	1.388
1-12	Vert. Accel.	SRV-ALL+CHUG	.1139	.1698	.2045	77.0%	.2454	93.7%	.834	1.063	1.387

TABLE 3-13 CDF ANALYSIS RESULTS FOR BOP EQUIPMENT - CONTAINMENT (FREESTANDING STEEL)

BOP EQUIPMENT: CONTAINMENT (FREESTANDING STEEL)

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
3-12	Acceleration	OBE+SRV-ALL	.04807	.1463	.1540	45.0%	.1848	97.7%	1.009	1.090	1.262
3-11	Acceleration	OBE+SRV-ADS	.04980	.1085	.1194	20.4%	.1433	91.5%	1.069	1.164	1.326
3-12	Acceleration	OBE+SRV-ADS	.04807	.09030	.1023	50.0%	.1228	95.3%	1.000	1.123	1.353
3-11	Acceleration	SSE+SRV-ADS	.09960	.1085	.1473	39.8%	.1767	84.6%	1.024	1.195	1.413
3-11	Acceleration	SRV-ADS+CHUG	.1085	.08894	.1403	69.5%	.1684	89.7%	.924	1.137	1.407
3-12	Acceleration	SRV-ADS+CHUG	.09030	.07944	.1203	74.5%	.1443	95.1%	.894	1.084	1.411

TABLE 3-14 CDF ANALYSIS RESULTS FOR BOP EQUIPMENT - CONTAINMENT (CONCRETE BACKED)

BOP EQUIPMENT: CONTAINMENT (CONCRETE BACKED)

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
4-23	Acceleration	OBE+SRV-ALL	.1595	.1246	.2024	88.3%	.2429	98.8%	.807	.963	1.404
4-23	Acceleration	SSE+SRV-ALL	.3190	.1246	.3425	92.8%	.4110	> 99.5%	.931	.931	1.295
4-22	Acceleration	SRV-1+CHUG	.03228	.009459	.03364	96.6%	.04036	> 99.5%	.960	.962	1.241

TABLE 3-15 CDF ANALYSIS RESULTS FOR BOP EQUIPMENT - CONTAINMENT (CONCRETE)

BOP EQUIPMENT: CONTAINMENT (CONCRETE)

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{86}/SRSS	ABS/SRSS
			AMP1	AMP2							
5-23	Horiz.Accel.(NS)	OBE+SRV-1	.1256	.1253	.1774	66.9%	.2129	95.5%	.926	1.096	1.414
5-23	Horiz.Accel.(EW)	OBE+SRV-ADS	.1305	.1716	.2156	70.7%	.2587	95.3%	.917	1.104	1.401
5-26	Vert. Accel.	OBE+SRV-ADS	.1539	.1073	.1876	98.7%	.2251	99.3%	.820	.820	1.392
5-23	Horiz.Accel.(NS)	SSE+SRV-1	.2512	.1253	.2807	81.1%	.3369	97.2%	.895	1.021	1.341
5-26	Vert. Accel.	SRV-1+CHUG	.03080	.02030	.03689	49.0%	.04427	92.5%	1.003	1.123	1.385
5-24	Vert. Accel.	SRV-ADS+CHUG	.06312	.03540	.07237	92.7%	.08684	99.3%	.872	.954	1.361
5-27	Horiz. Accel.	SRV-ADS+CHUG	.04947	.04650	.06789	89.6%	.08147	> 99.5%	.797	.947	1.414
2-9	Radial Accel.	OBE+SRV-1	.1406	.1434	.2008	80.2%	.2410	90.8%	.816	1.018	1.414
2-9	Radial Accel.	OBE+SRV-ALL	.1406	.3336	.3620	62.0%	.4344	96.3%	.974	1.064	1.310
2-9	Radial Accel.	SSE+SRV-1	.2812	.1434	.3157	91.9%	.3788	96.2%	.891	.891	1.345
2-9	Radial Accel.	SSE+SRV-ALL	.2812	.3336	.4363	78.1%	.5236	95.7%	.880	1.022	1.409
2-9	Radial Accel.	SRV-1+CHUG	.1434	.02964	.1464	92.6%	.1757	100.0%	.979	.991	1.182

TABLE 3-16 CDF ANALYSIS RESULTS FOR BOP EQUIPMENT - SHIELD BLDG. (FREESTANDING STEEL)

BOP EQUIPMENT: SHIELD BUILDING (FREESTANDING STEEL)

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
3-10	Acceleration	OBE+SRV-ALL	.07810	.2273	.2403	65.8%	.2884	98.7%	.954	1.059	1.271
3-9	Acceleration	OBE+SRV-ADS	.06402	.1105	.1277	36.9%	.1532	88.9%	1.032	1.176	1.367
3-10	Acceleration	OBE+SRV-ADS	.07810	.1389	.1594	49.1%	.1912	92.6%	1.002	1.144	1.361
3-9	Acceleration	SSE+SRV-ADS	.1280	.1105	.1691	54.8%	.2030	89.2%	.987	1.134	1.410
3-9	Acceleration	SRV-ADS+CHUG	.1105	.04624	.1198	81.0%	.1437	98.1%	.936	1.015	1.308
3-10	Acceleration	SRV-ADS+CHUG	.1389	.02830	.1418	70.4%	.1701	100.0%	.983	1.020	1.179

TABLE 3-17 CDF ANALYSIS RESULTS FOR BOP EQUIPMENT - SHIELD BLDG. (CONCRETE BACKED)

BOP EQUIPMENT: SHIELD BUILDING (CONCRETE BACKED)

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
4-25	Acceleration	OBE+SRV-1	.1073	.1710	.2019	49.9%	.2423	95.0%	1.001	1.108	1.378
4-25	Acceleration	OBE+SRV-ALL	.1073	.2371	.2602	35.8%	.3123	94.9%	1.029	1.116	1.324
4-25	Acceleration	SSE+SRV-1	.2146	.1710	.2744	71.5%	.3293	94.5%	.925	1.093	1.405
4-26	Acceleration	SRV-1+CHUG	.01326	.002607	.01351	87.2%	.01622	100.0%	.981	.991	1.174

TABLE 3-18 CDF ANALYSIS FOR BOP EQUIPMENT - AUXILIARY BLDG. (CONCRETE)

BOP EQUIPMENT: AUXILIARY BUILDING (CONCRETE)

Location	Response	Loading	Peak Response Amplitude		SRSS	NEP_{SRSS}	1.2 SRSS	$NEP_{1.2SRSS}$	R_{50}/SRSS	R_{85}/SRSS	ABS/SRSS
			AMP1	AMP2							
5-29	Vert. Slab Accel	OBE+SRV-1	.3490	.1184	.3685	87.7%	.4422	99.2%	.947	.947	1.268
5-29	Vert. Slab Accel	OBE+SRV-ADS	.3490	.1718	.3890	83.7%	.4668	97.7%	.897	1.001	1.339
5-22	Vert. Wall Accel	OBE+SRV-ADS	.1116	.03237	.1162	94.1%	.1394	> 99.5%	.960	.960	1.239
5-29	Vert. Slab Accel	SSE+SRV-ALL	.6980	.4508	.8309	86.6%	.9971	94.9%	.840	.986	1.383
5-22	Vert. Wall Accel	SRV-1+CHUG	.02510	.01060	.02725	78.5%	.03270	96.9%	.951	1.008	1.310
5-22	Vert. Wall Accel	SRV-ADS+CHUG	.03237	.01060	.03406	84.5%	.04087	99.2%	.956	.999	1.262
5-21	Horiz. Accel.	SRV-ALL+CHUG	.01521	.00350	.01561	94.8%	.01873	100.0%	.975	.980	1.199

TABLE 3-19

EFFECT OF STRONG MOTION DEFINITION ON RESPONSE RATIOS FOR EARTHQUAKE + SRV CASES

Location	Loading	R_{50}/SRSS		R_{85}/SRSS	
		50% Amplitude	10% Amplitude	50% Amplitude	10% Amplitude
6-9	OBE + SRV-ALL	1.030	.942	1.137	1.084
1-3	OBE + SRV-1	1.020	.983	1.222	1.149
3-1	OBE + SRV-ALL	1.024	.999	1.143	1.110
3-1	OBE + SRV-ADS	1.056	1.020	1.151	1.129
3-3	OBE + SRV-ADS	1.057	1.025	1.102	1.092
3-2	SSE + SRV-ADS	1.029	1.022	1.119	1.119
5-19	SSE + SRV-ALL	1.048	1.019	1.221	1.219
3-6	OBE + SRV-ALL	1.059	1.038	1.137	1.101
3-7	OBE + SRV-ADS	1.035	1.025	1.114	1.113
3-6	OBE + SRV-ADS	1.042	1.011	1.154	1.122
1-13	OBE + SRV-1	1.063	.991	1.228	1.198
3-11	OBE + SRV-ADS	1.069	1.047	1.164	1.156
3-11	SSE + SRV-ADS	1.024	.976	1.195	1.160
3-9	OBE + SRV-ADS	1.032	.994	1.176	1.104
4-25	OBE + SRV-ALL	1.029	1.017	1.116	1.086

TABLE 3-20

EFFECT OF CHUG INTERVAL ON RESPONSE RATIOS FOR SRV + CHUG CASES

Location	Loading	R_{50}/SRSS		R_{85}/SRSS	
		1 Sec. Interval	2 Sec. Interval	1 Sec. Interval	2 Sec. Interval
3-5	SRV-ADS + CHUG	1.061	.933	1.170	1.149
3-6	SRV-ADS + CHUG	1.095	.956	1.216	1.178

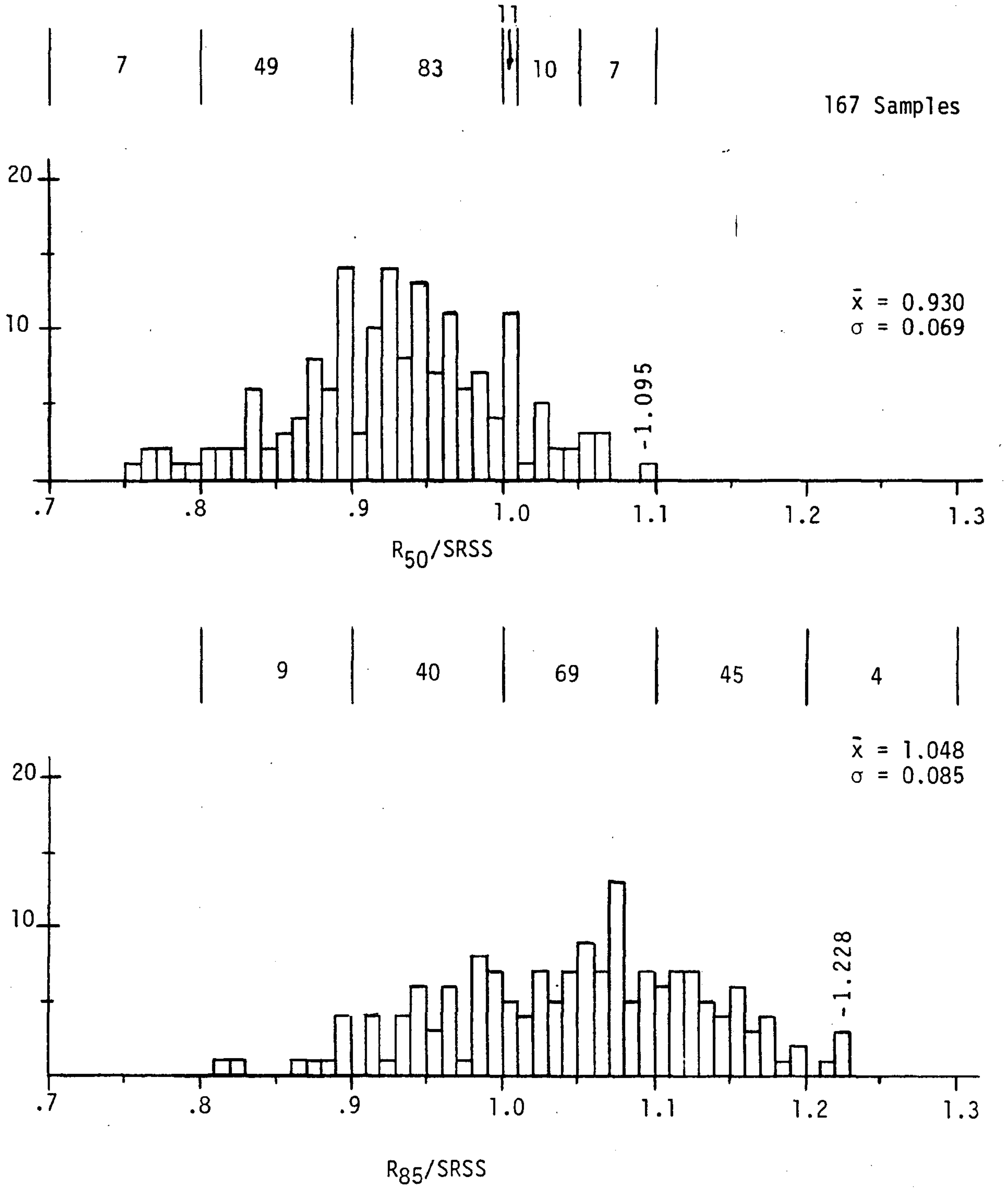


FIGURE 3-1. DISTRIBUTION OF R_{50}/SRSS AND R_{85}/SRSS FOR 167 RESPONSE COMBINATIONS

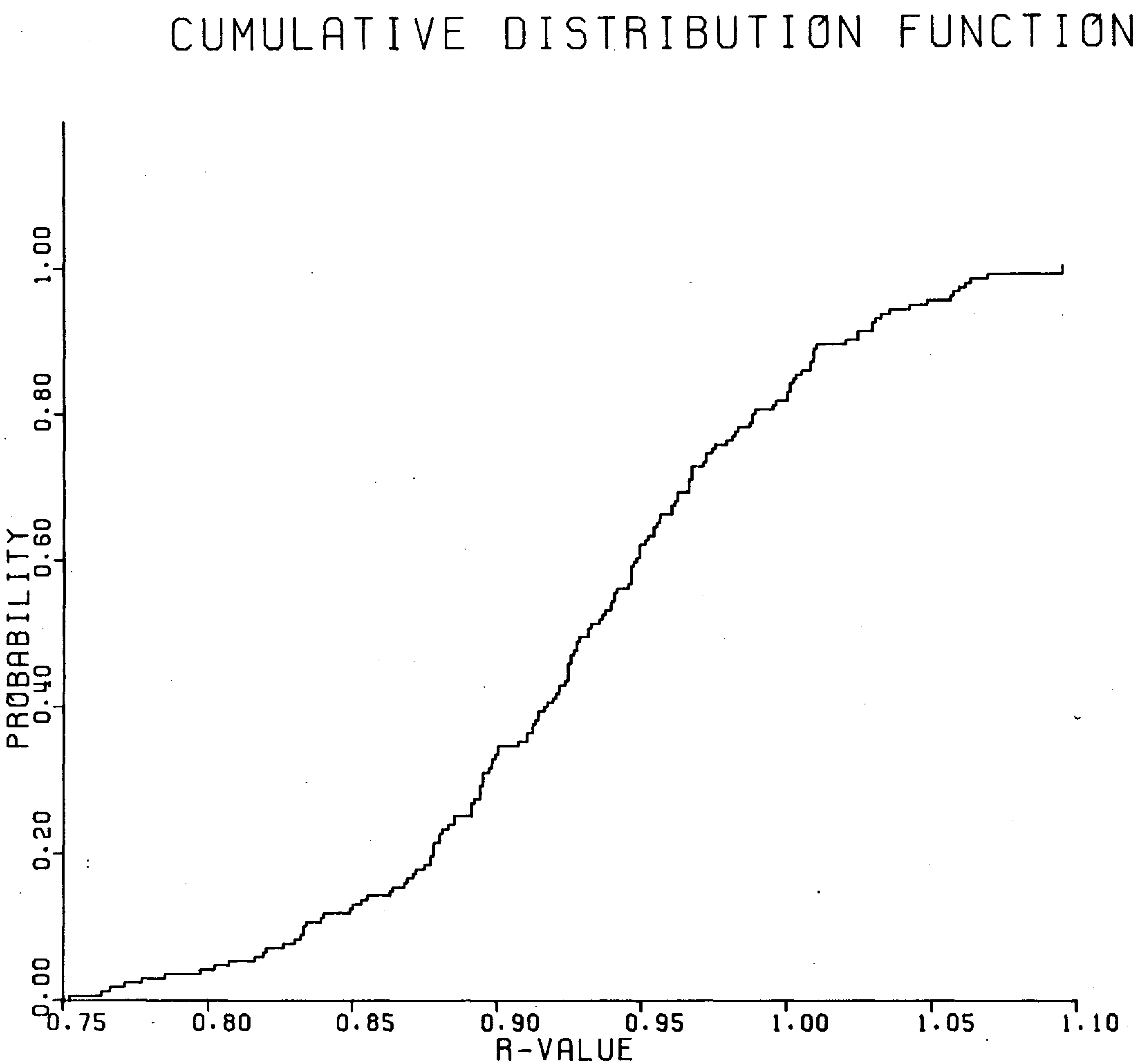


FIGURE 3-2. CUMULATIVE DISTRIBUTION FUNCTION OF THE R_{50}/SRSS RESPONSE PARAMETER

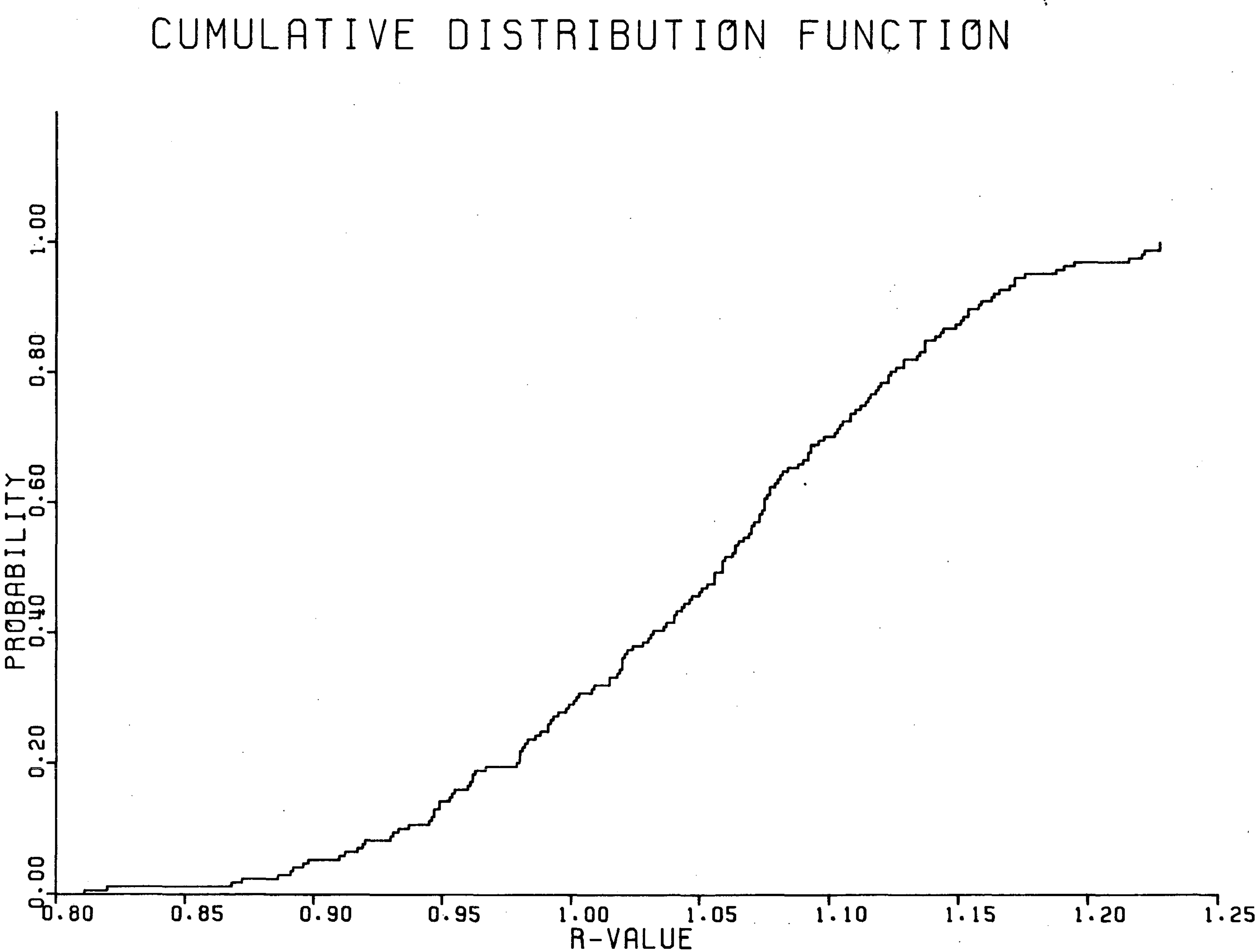


FIGURE 3-3. CUMULATIVE DISTRIBUTION FUNCTION FOR THE R_{85}/SRSS RESPONSE PARAMETER

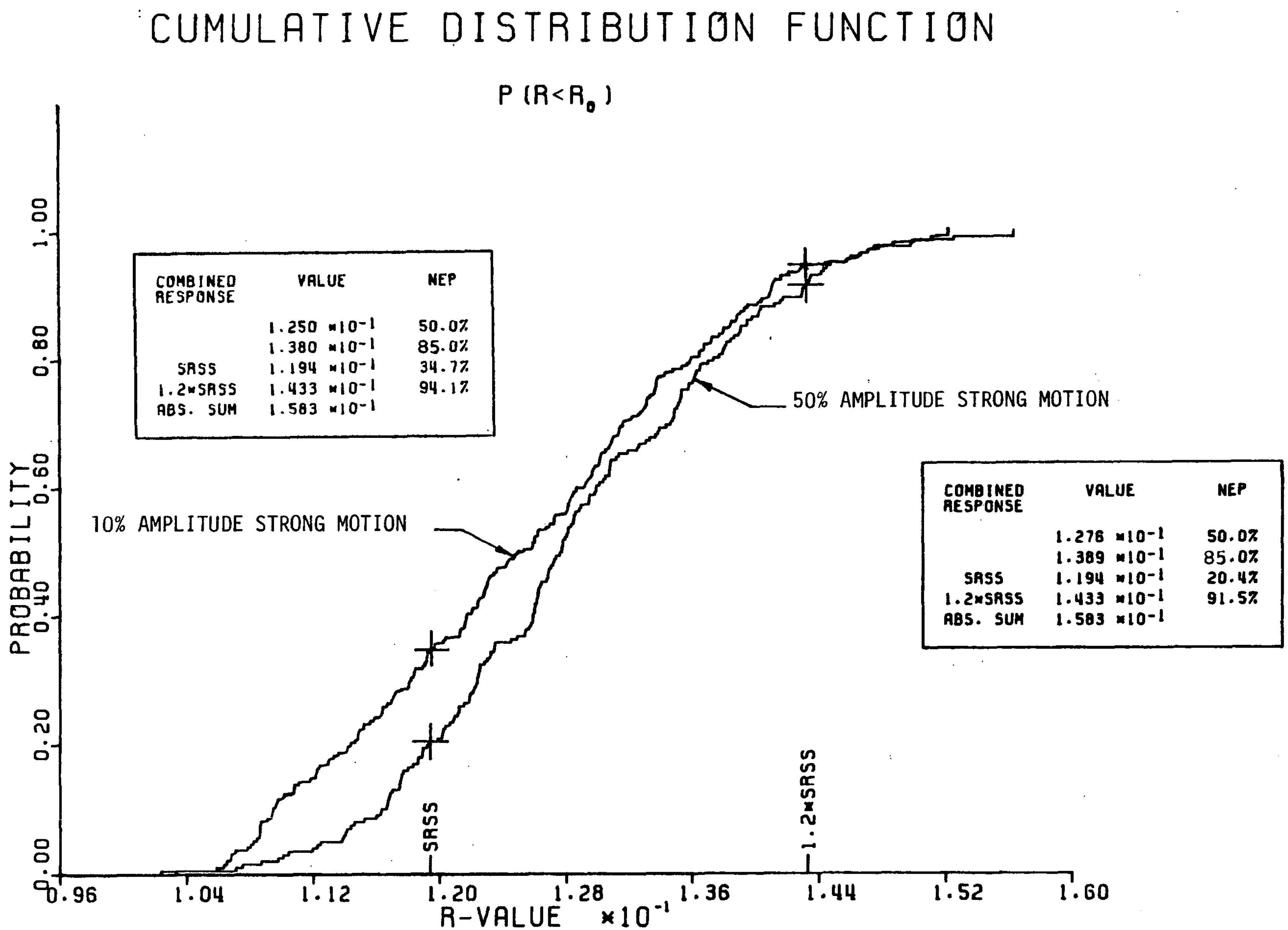


FIGURE 3-4. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 3-11
OBE + SRV-ADS LOAD COMBINATION, VERTICAL ACCELERATION (G)

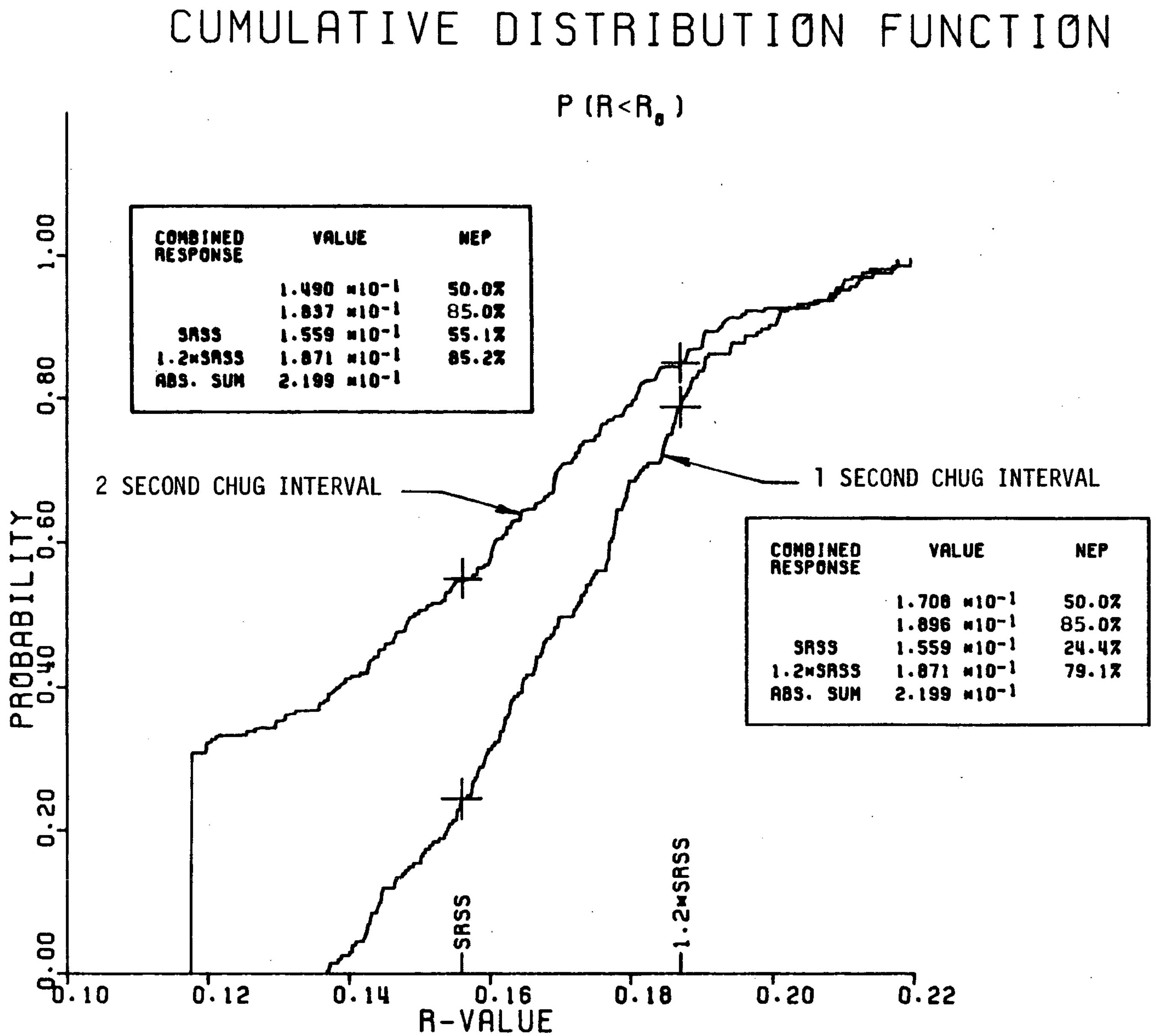


FIGURE 3-5. BOP PIPING CDF CURVE, HPCS PUMP DISCHARGE LINE LOCATION 3-6
SRV-ADS + CHUG LOAD COMBINATION, ACCELERATION (G)

4. SUMMARY AND CONCLUSIONS

The applicability of the SRSS response combination methodology for Mark III plants has been established by comparsion of the response ratios R_{50}/SRSS and R_{85}/SRSS obtained from the CDF analyses with the requirements of Newmark-Kennedy Criterion 2.

It was found that the response ratios for the 167 response combinations tended to be normally distributed and that the 167 cases represented a very good measure of the behavior of the whole population. For better than 83% of the cases, R_{50}/SRSS was less than 1.0 and was less than 1.01 and 1.05 for almost 90% and 96% of the cases, respectively. The maximum value of R_{50}/SRSS was found to be only 1.095. Similarly, the response ratio R_{85}/SRSS was less than 1.2 for almost 98% of the cases with the maximum value of R_{85}/SRSS being 1.228.

The effect of the conservative assumption concerning the definition of earthquake strong motion on the resulting R_{50}/SRSS and R_{85}/SRSS response ratios was investigated for the 15 earthquake + SRV response combination cases where the 50% NEP response value exceeded the SRSS calculated response by more than one percent. Using a less restrictive but yet conservative definition for earthquake strong motion, it was found that the R_{50}/SRSS ratio for these cases reduced from one to nine percent. Similarly, the effect of the conservative assumption concerning the time interval between repeated CHUG cycles was also investigated for the two SRV + CHUG response combination cases where the 50% NEP response value exceeded the SRSS calculated response by more than one percent. Again, using a less restrictive but yet conservative time interval, the R_{50}/SRSS ratio reduced by approximately 13 percent.

Had these two less restrictive but conservative assumptions been used throughout the study, R_{50}/SRSS would be less than 1.0 for almost 95% of the cases. In no case, would the 50% NEP response value exceed the SRSS calculated response by more than five percent with the maximum value of R_{50}/SRSS being only 1.047. Similarly, the response ratio R_{85}/SRSS would be less than 1.2 for better than 99% of the cases with the maximum value of R_{85}/SRSS being 1.219.

Based upon the conservatively biased results of these analyses and the observed trends, it is concluded that the SRSS method of response combination is justified for all 167 response combination cases evaluated in this study. It is further concluded, that the SRSS method is conservative in most cases, is a realistic approach for those cases where the high frequency response is predominant, and is in no case, unconservative. The 167 response combination cases evaluated in this study represent a generic data set. Therefore, it is also concluded that the use of the SRSS response combination method for both ASME and non-ASME components is generically applicable for all locations within Mark III plants for the loadings considered.

5. REFERENCES

1. E. Rosenblueth, "A Basis for Aseismic Design", Ph.D. Thesis, University of Illinois, Urbana, Illinois, 1951.

2. R. P. Kennedy and N. M. Newmark, "Bases for Criteria for Combination of Earthquake and Other Transient Responses by the Square-Root-Sum-of-the-Squares Method", NEDO-24010-2, December, 1978.

3. A. K. Singh, S. W. Tagart and C. V. Subramanian, "Technical Basis for the Use of the Square-Root-Sum-of-the-Squares (SRSS) Method for Combining Dynamic Loads for Mark II Plants", NEDE-24010-P, July, 1977.

4. A. K. Singh and C. V. Subramanian, "SRSS Application Criteria as Applied to Mark II Load Combination Cases", NEDO-24010-1, October, 1978.

5. Testimony of Robert P. Kennedy concerning Load Combination Methodology, Public Service Company of Oklahoma Construction Permit Hearings, Docket Nos. 50-566, 50-567, Nuclear Regulatory Commission, February, 1979.

6. R. P. Kennedy, R. D. Campbell, K. L. Merz and R. B. Narver, "Combining Multiple Dynamic Responses by the Square-Root-Sum-of-the Squares Method", Engineering Decision Analysis Company, Inc., EDAC 134-240.7R, May, 1978.

7. C. V. Subramanian and R. P. Kennedy, "Executive Summary Report and Supplement, Technical Basis for the SRSS Method of Combining Dynamic Responses", April, 1978.

8. "Review of Methods and Criteria for Dynamic Combinations in Piping Systems", Brookhaven National Laboratory, NUREG/CR-1330, April, 1980.

9. R. K. Mattu, "Methodology for Combining Dynamic Responses", Nuclear Regulatory Commission, NUREG-0484, Revision 1, May, 1980.

REFERENCES (Continued)

10. R. P. Kennedy, W. H. Tong and N. M. Newmark, "Study to Demonstrate the SRSS Combined Response Has Greater than 84 Percent Non-Exceedance Probability When the Newmark-Kennedy Criteria Are Satisfied", NEDO-24010-03, August, 1979.

11. Meeting between the U.S. Nuclear Regulatory Commission and the Mark III Containment Owners SRSS Subgroup held in Bethesda, Maryland, on April 14, 1981.

APPENDIX A

DESCRIPTION OF RESPONSE LOCATIONS

The locations and descriptions of the following points are given for the various plants as they occur on the Mark III SRSS Evaluation Matrix (left to right).

I. Nuclear Steam Supply System (NSSS)

A. RPV & Internals

Location	Description
5-4	Shroud Support, Vertical Force (lbs)
5-5	RPV Skirt, Vertical Force (lbs)
5-6	Core Plate, Vertical Force (lbs)
4-2	RPV Skirt, Horizontal Force (lbs)
4-3	Core Plate, Vertical Force (lbs)
4-4	Shroud Support, Horizontal Moment (in-lbs)

B. Recirculation Piping and Pipe Mounted Equipment

Location	Description
4-5	Pump C.G., Acceleration (G)
4-6	Flow Control Valve, Acceleration (G)
4-7	Discharge Valve, Acceleration (G)
4-8	Pump Inlet, Node 22, Moment (ft-lbs)
4-9	Elbow, Node 46, Moment (ft-lbs)
4-10	Tee, Node 64, Moment (ft-lbs)
4-11	Elbow, Node 90, Moment (ft-lbs)
4-12	Pipe Element, Node 93, Moment (ft-lbs)
4-13	Sweepolet, Node 144, Moment (ft-lbs)

C. Main Steam Piping and Pipe Mounted Equipment

Location	Description
6-1	SRV C.G., Node 148, Acceleration (G)
6-2	SRV C.G., Node 164, Acceleration (G)
6-3	MSIV C.G., Node 176, Acceleration (G)
6-4	MSIV Inlet, Node 37, Moment (in-lbs)
6-5	Elbow, Node 39, Moment (in-lbs)
6-6	Pipe Element, Node 40, Moment (in-lbs)
6-7	Elbow, Node 67, Moment (in-lbs)
6-8	Sweepolet, Node 96, Moment (in-lbs)
6-9	Sweepolet, Node 128, Moment (in-lbs)

II. Balance-of-Plant Piping

A. Drywell

Location	Description
1-1	Feedwater Line, Node 300, Moment (ft-lbs)
1-2	Feedwater Line, Node 285, Support Force (lbs)
1-3	Feedwater Line, Node 168, Moment (ft-lbs)
1-4	RWCU Piping, Node 30, Moment (ft-lbs)
2-5	FPC & CU Refueling Water Line, Node 45, Moment (ft-lbs)
2-6	FPC & CU Refueling Water Line, Node 120, Moment (ft-lbs)
2-7	FPC & CU Refueling Water Line, Node 525, Moment (ft-lbs)
2-8	FPC & CU Refueling Water Line, Node 450, Axial Force (lbs)

B. Containment (Freestanding Steel) and Shield Building

Location	Description	
3-1	HPCS Test Line between Containment Vessel and Shield Building, Accel. (G)	
3-2 3-3	HPCS Test Line Support at Containment Vessel,	Acceleration (G) Support Force (lbs)
3-4	HPCS Pump Discharge Line between Drywell and Containment Vessel, Acceleration (G)	
3-5 3-7 3-8	HPCS Pump Discharge Line between Containment Vessel and Shield Building	Acceleration (G) Moment (ft-lbs) Force (lbs)
3-6	HPCS Pump Discharge Line, Support Point on Shield Building, Acceleration (G)	

II. Balance-of-Plant Piping (Continued)

C. Containment (Freestanding Steel - Concrete Backed) and Shield Building

Location	Description	
4-14	Residual Heat Removal Line, Support Reaction (lbs)	Node 4
4-15	Residual Heat Removal Line, Moment Y-Axis (ft-lbs)	Element 9
4-16	Residual Heat Removal Line, Shear Y-Axis (lbs)	Element 11
4-17	Residual Heat Removal Line, Moment Y-Axis (ft-lbs)	Element 15
4-18	Combustible Gas Control Line, Support Reaction (lbs)	Node 42
4-19	Combustible Gas Control Line, Shear Y-Axis (lbs)	Element 15
4-20	Combustible Gas Control Line, Moment Y-Axis (ft-lbs)	Element 26
4-21	Combustible Gas Control Line, Axial Force (lbs)	Element 40

D. Containment (Concrete) and Auxiliary Building

Location	Description
2-1	Low Pressure Core Spray Line, Node 92, Moment (ft-lbs)
2-2	Low Pressure Core Spray Line, Node 110, Moment (ft-lbs)
2-3	Low Pressure Core Spray Line, Node 132, Moment (ft-lbs)
2-4	Low Pressure Core Spray Line, Node 126, Axial Force (lbs)

II. Balance-of-Plant Piping (Cont.)

D. Containment (Concrete) and Auxiliary Building

Location	Description
5-7	RH-10 Line, Node 66, Force Z-Axis (lbs)
5-8	RH-10 Line, End I of Element 20, Moment Y-Axis (in-lbs)
5-9	RH-10 Line, End I of Element 20, Moment Z-Axis (in-lbs)
5-10	RH-10 Line, End J of Element 28, Moment Y-Axis (in-lbs)
5-11	RH-10 Line, End J of Element 28, Moment Z-Axis (in-lbs)
5-12	RH-10 Line, Node 7, Force Y-Axis (lbs)
5-13	RH-10 Line, Node 42, Force Y-Axis (lbs)
5-14	FP-18 Line, Node 42, Force Y-Axis (lbs)
5-15	FP-18 Line, Node 95, Force Y-Axis (lbs)
5-16	FP-18 Line, End I of Element 24, Moment Y-Axis (in-lbs)
5-17	FP-18 Line, End J of Element 52, Moment Y-Axis (in-lbs)
5-18	FP-18 Line, End J of Element 76, Moment Y-Axis (in-lbs)
5-19	FP-18 Line, Node 105B, Force X-Axis (lbs)
5-20	FP-18 Line, Node 60B, Force Y-Axis (lbs)

III. Balance-of-Plant Equipment

A. Drywell

Location	Description	
1-5 1-6	Drywell Elevation 160 ft.,	Radial Acceleration (G) Vertical Acceleration (G)
1-9	Drywell Elevation 133 ft.,	Vertical Acceleration (G)
1-11 1-12 1-13	Drywell Elevation 95 ft.,	Radial Acceleration (G) Vertical Acceleration (G) Tangential Acceleration (G)

B. Containment (Freestanding Steel) and Shield Building

Location	Description
3-9	Shield Building, 176 ft., Vertical Acceleration (G)
3-10	Shield Building, 216 ft., Vertical Acceleration (G)
3-11	Containment Vessel, 179 ft., Vertical Acceleration (G)
3-12	Containment Vessel, 162 ft., Vertical Acceleration (G)

C. Containment (Freestanding Steel - Concrete Backed) and Shield Building

Location	Description
4-22	Containment Vessel, 604 ft., Vertical Acceleration (G)
4-23	Containment Vessel, 665 ft., Vertical Acceleration (G)
4-25	Shield Building, 606 ft., Vertical Acceleration (G)
4-26	Shield Building, 663 ft., Vertical Acceleration (G)

III. Balance-of-Plant Equipment (Continued)

D. Containment (Concrete) and Auxiliary Building

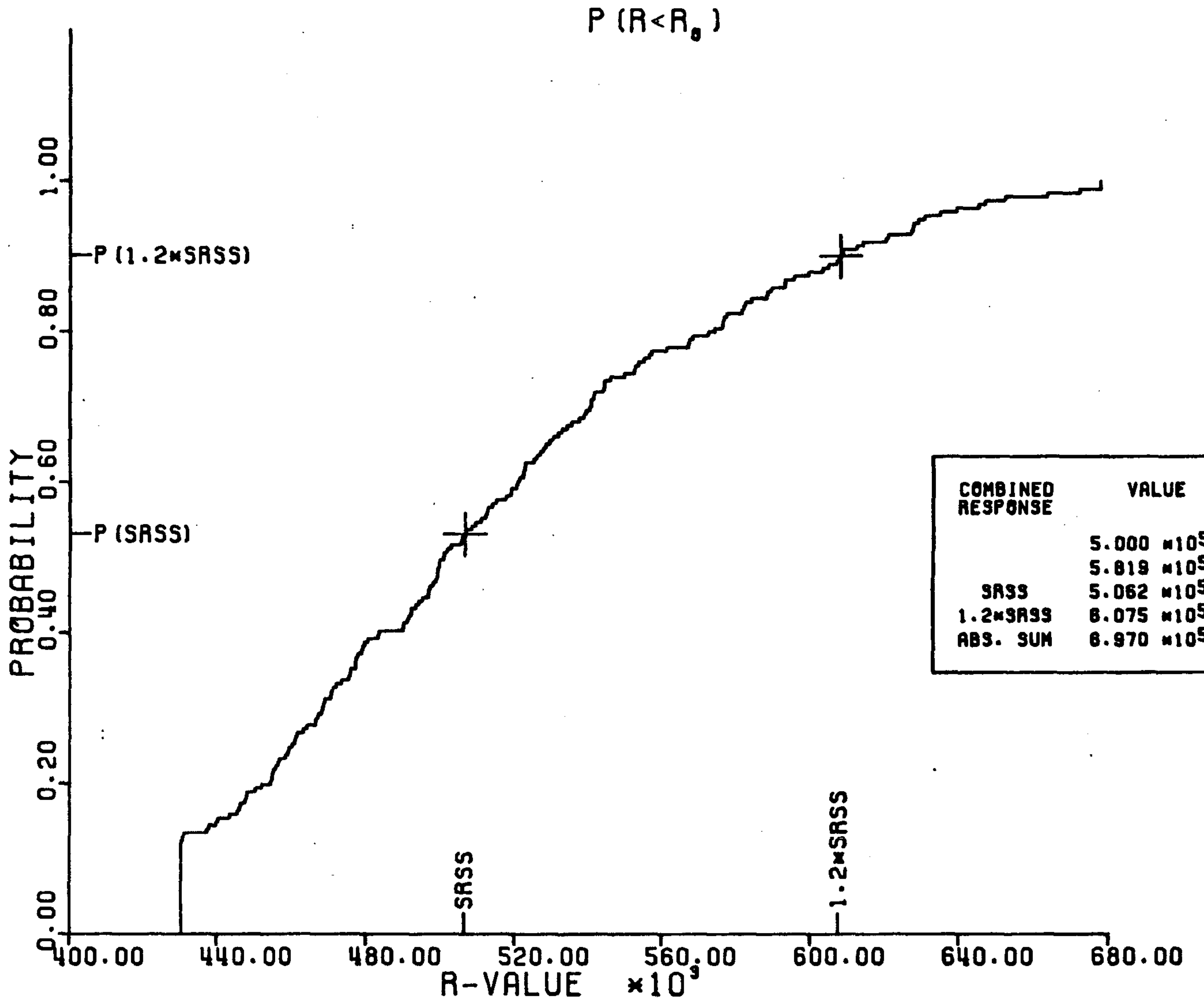
Location	Description	
2-9	Containment Shell, 120 ft.-10 in. Radial Acceleration	
5-21, 5-22, 5-29	Auxiliary Building, 734 ft.	Horizontal Accel. (G) Vertical Wall Accel. (G) Vertical Slab Accel. (G)
5-23, 5-24	Containment Building, 770 ft.	Horizontal Accel. (G) Vertical Wall Accel. (G)
5-26	Containment Building, 856 ft.	Vertical Wall Accel. (G)
5-27	Drywell, 778 ft.	Horizontal Accel. (G)

APPENDIX B

CUMULATIVE DISTRIBUTION FUNCTION CURVES

FROM 167 RESPONSE ANALYSES

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	5.000×10^5	50.0%
	5.819×10^5	85.0%
SRSS	5.062×10^5	53.2%
1.2*SRSS	6.075×10^5	90.2%
ABS. SUM	6.970×10^5	

FIGURE B-1. NUCLEAR STEAM SUPPLY SYSTEM CDF CURVE, RPV SKIRT , LOCATION 5-5
OBE + SRV-1 LOAD COMBINATION, VERTICAL FORCE (LBS)

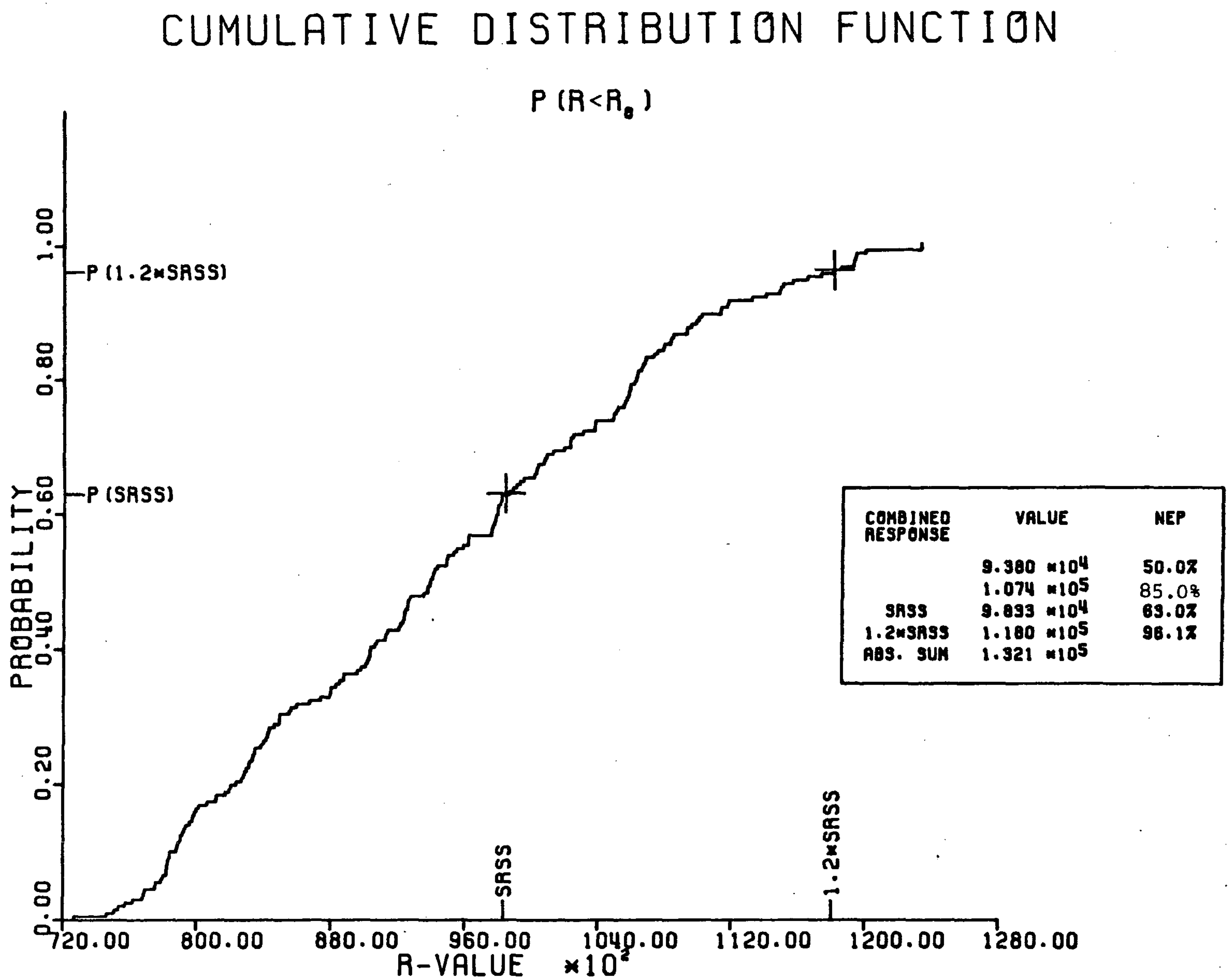


FIGURE B-2. NUCLEAR STEAM SUPPLY SYSTEM CDF CURVE, SHROUD SUPPORT, LOCATION 5-4
OBE + SRV-ALL LOAD COMBINATION, VERTICAL FORCE (LBS)

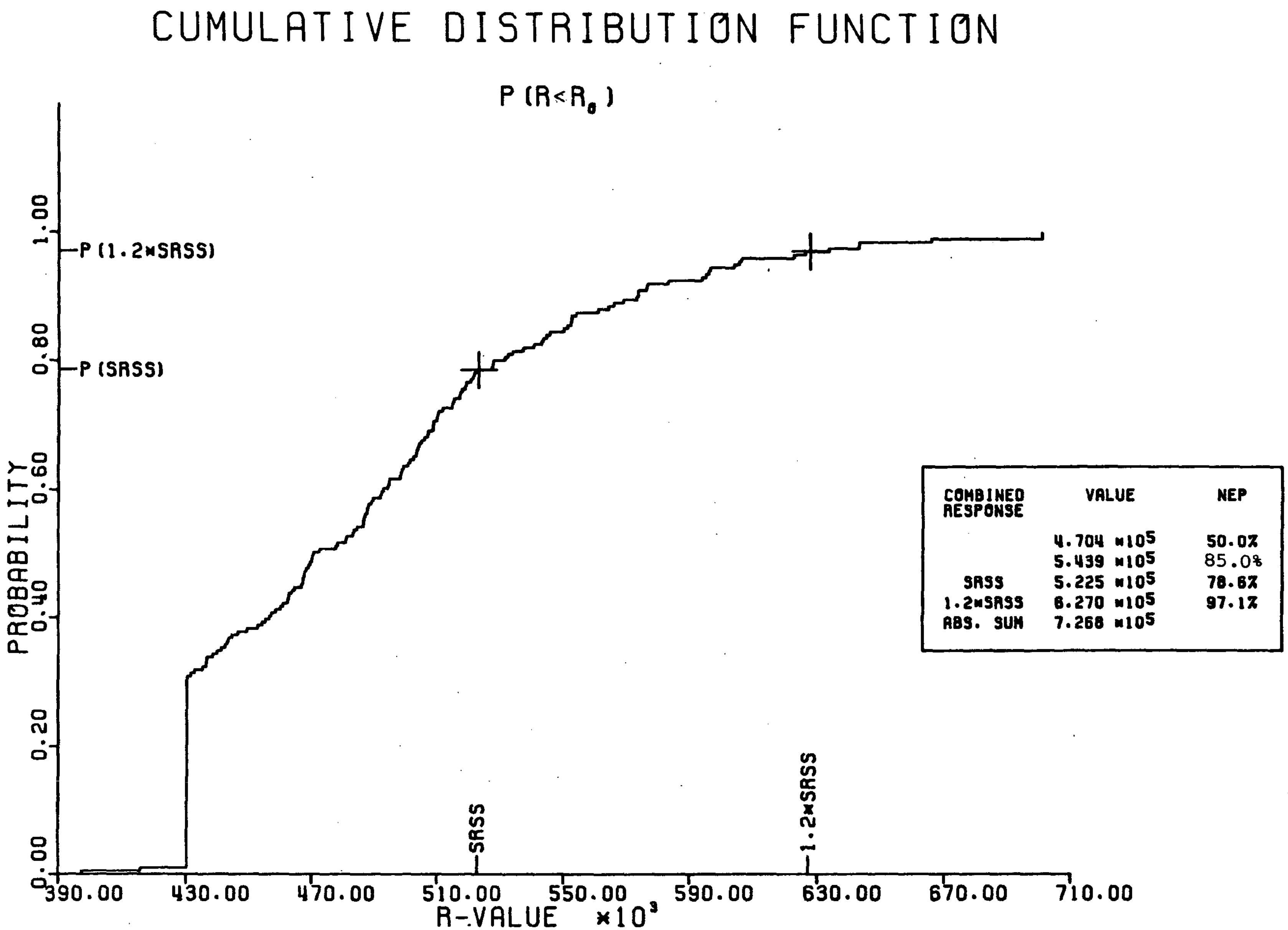
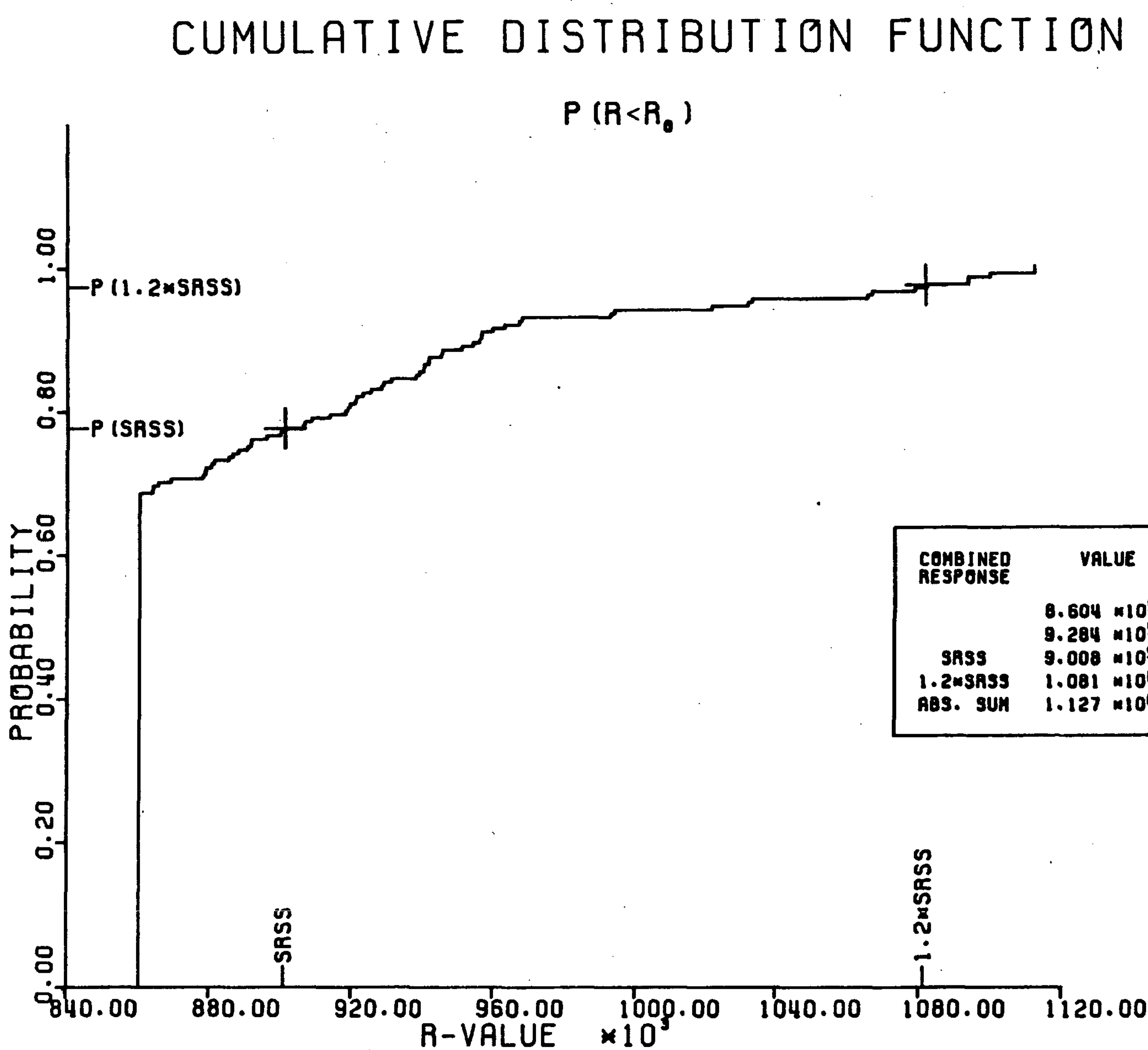
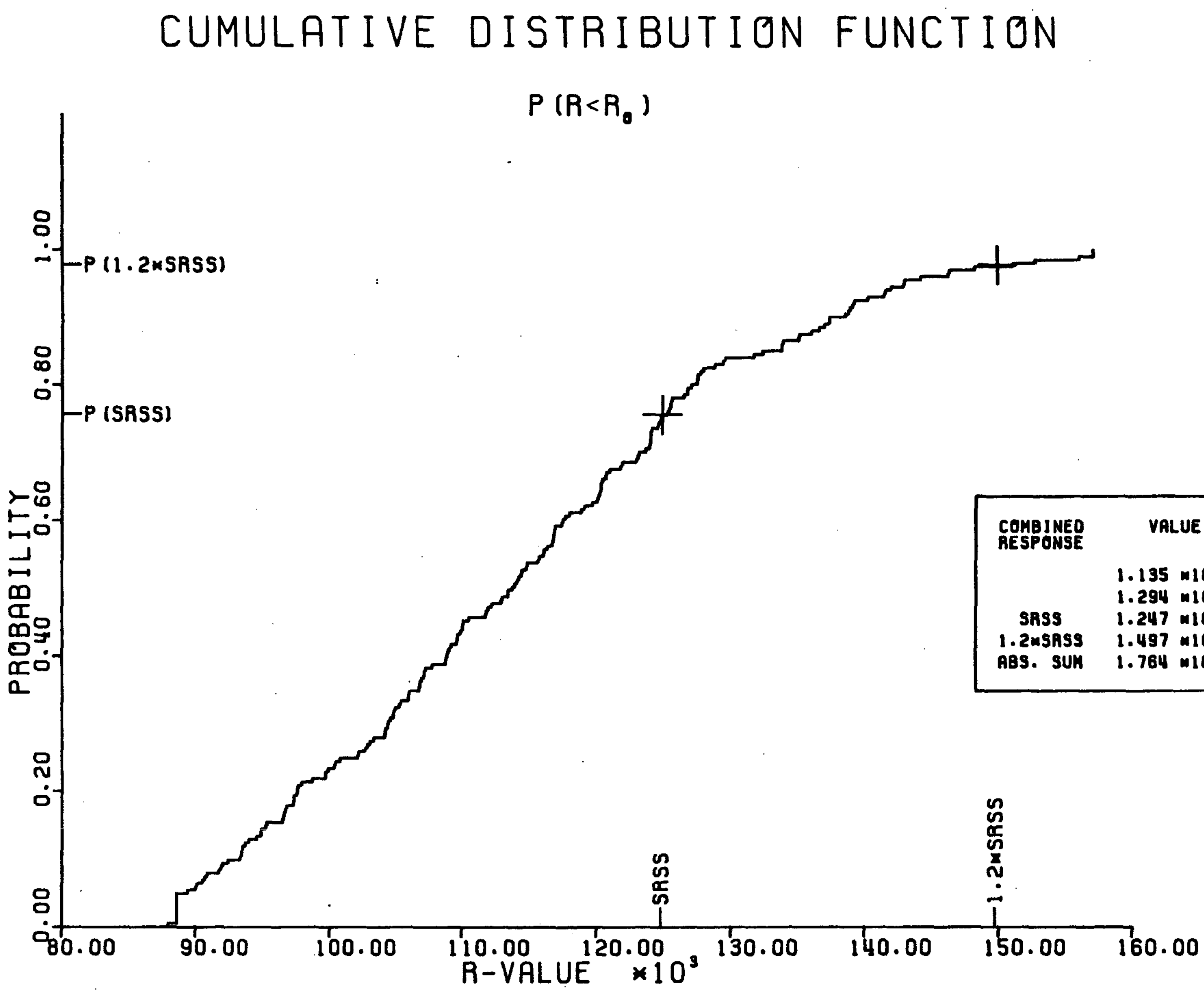


FIGURE B-3. NUCLEAR STEAM SUPPLY SYSTEM CDF CURVE, RPV SKIRT , LOCATION 5-5
OBE + SRV-ADS LOAD COMBINATION, VERTICAL FORCE (LBS)



COMBINED RESPONSE	VALUE	NEP
	8.604×10^5	50.0%
	9.284×10^5	85.0%
SRSS	9.008×10^5	77.7%
1.2×SRSS	1.081×10^6	97.4%
ABS. SUM	1.127×10^6	

FIGURE B-4. NUCLEAR STEAM SUPPLY SYSTEM CDF CURVE, RPV SKIRT , LOCATION 5-5
SSE + SRV-1 LOAD COMBINATION, VERTICAL FORCE (LBS)



COMBINED RESPONSE	VALUE	NEP
	1.135×10^5	50.0%
	1.294×10^5	85.0%
SRSS	1.247×10^5	75.7%
1.2×SRSS	1.497×10^5	97.8%
ABS. SUM	1.764×10^5	

FIGURE B-5. NUCLEAR STEAM SUPPLY SYSTEM CDF CURVE, SHROUD SUPPORT, LOCATION 5-4
SSE + SRV-ALL LOAD COMBINATION, VERTICAL FORCE (LBS)

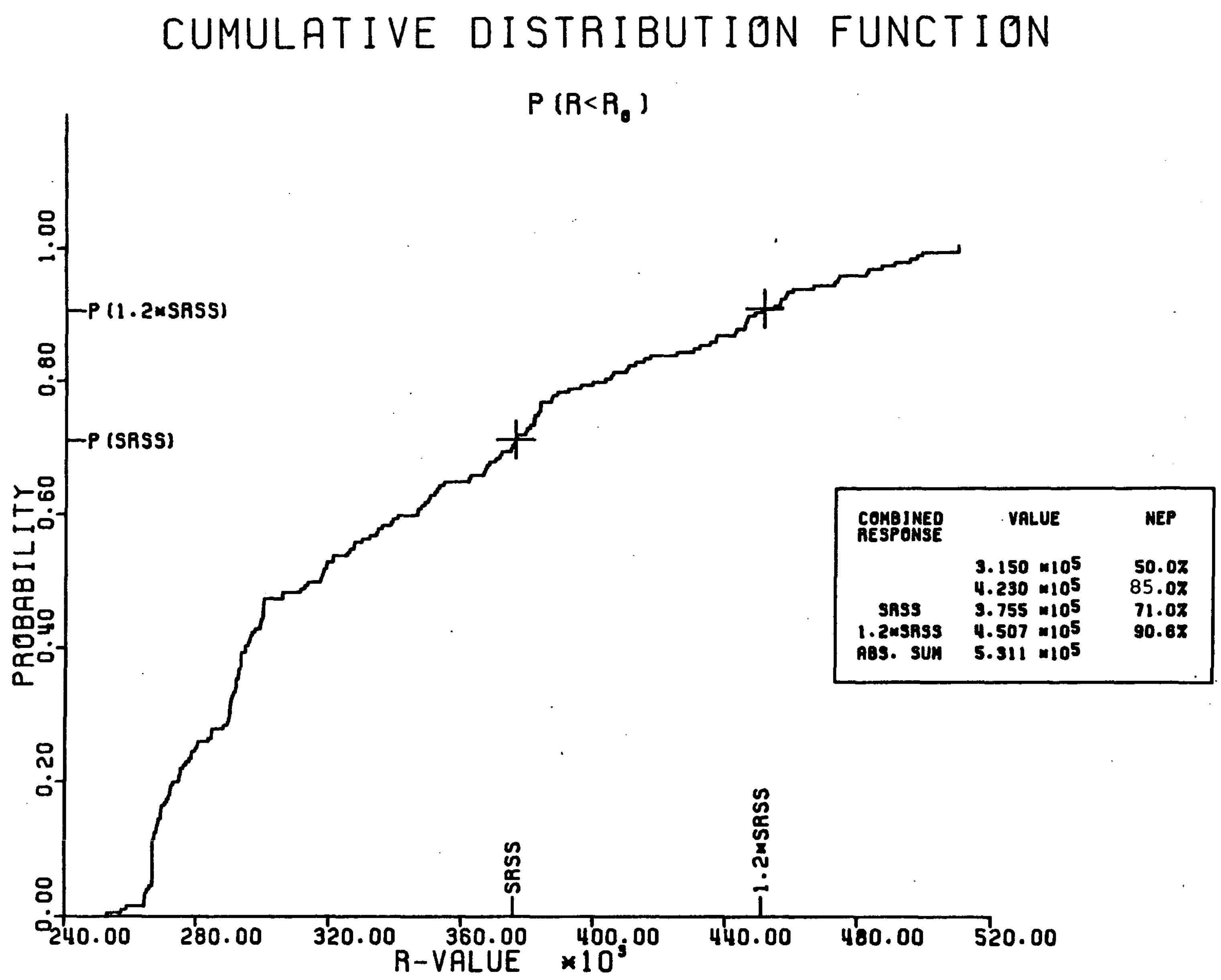


FIGURE B-6. NUCLEAR STEAM SUPPLY SYSTEM CDF CURVE, RPV SKIRT , LOCATION 5-5
SRV-1 + CHUG LOAD COMBINATION, VERTICAL FORCE (LBS)

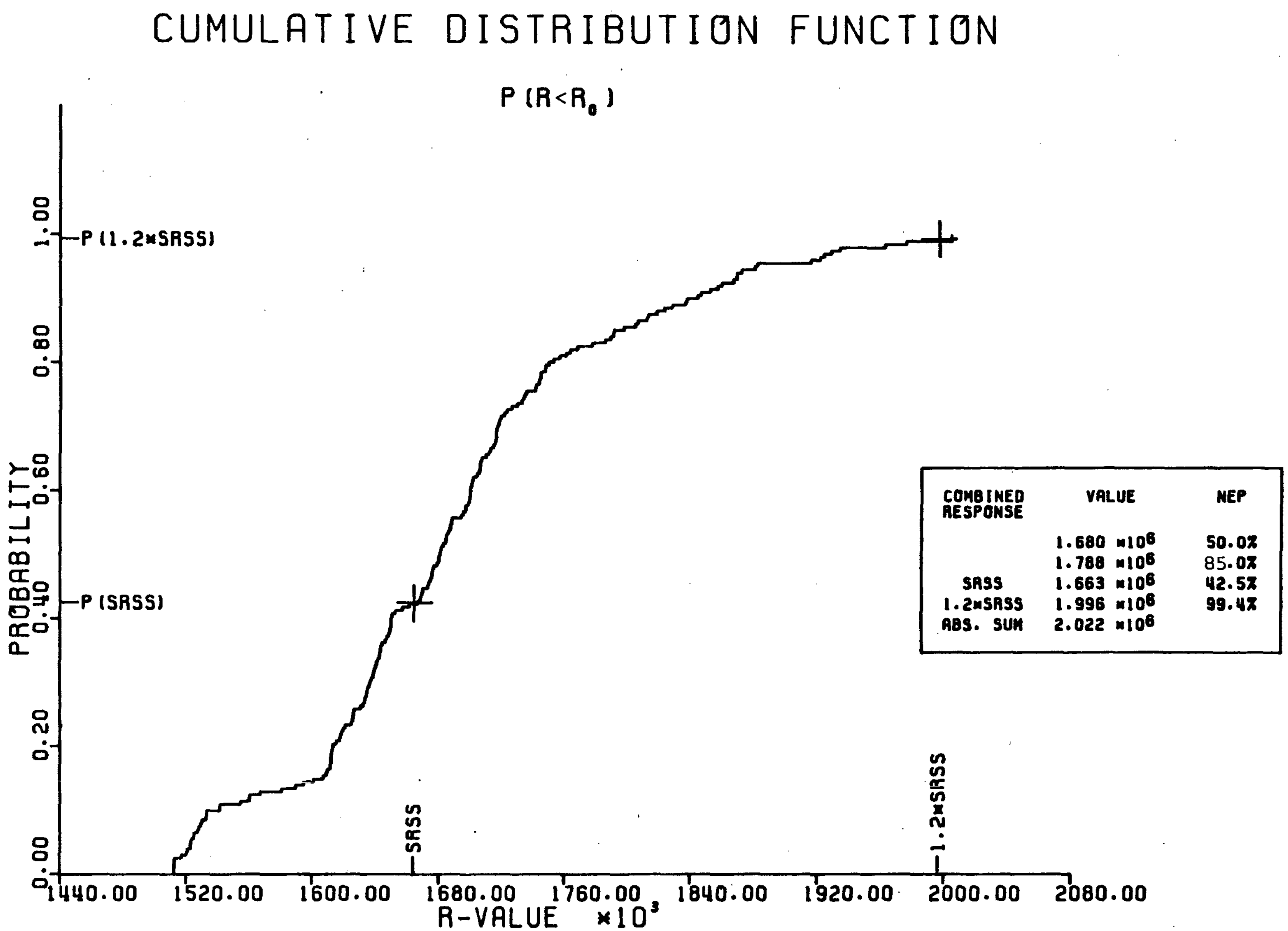


FIGURE B-7. NUCLEAR STEAM SUPPLY SYSTEM, SHROUD SUPPORT, LOCATION 4-4
SRV-1 + CHUG12 LOAD COMBINATION, HORIZONTAL MOMENT (IN-LBS)

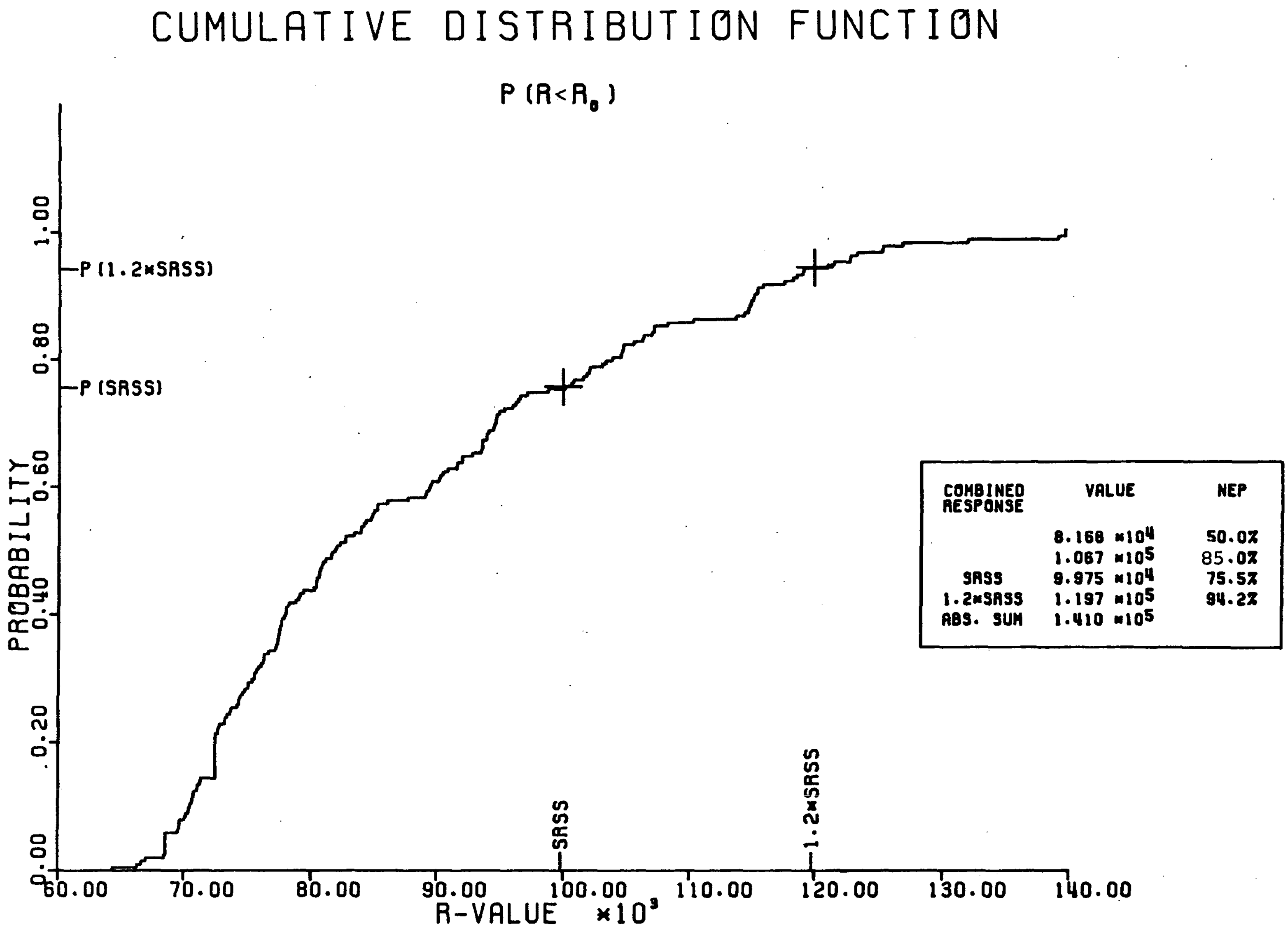


FIGURE B-8. NUCLEAR STEAM SUPPLY SYSTEM CDF CURVE, CORE PLATE , LOCATION 5-6
SRV-ADS + CHUG LOAD COMBINATION, VERTICAL FORCE (LBS)

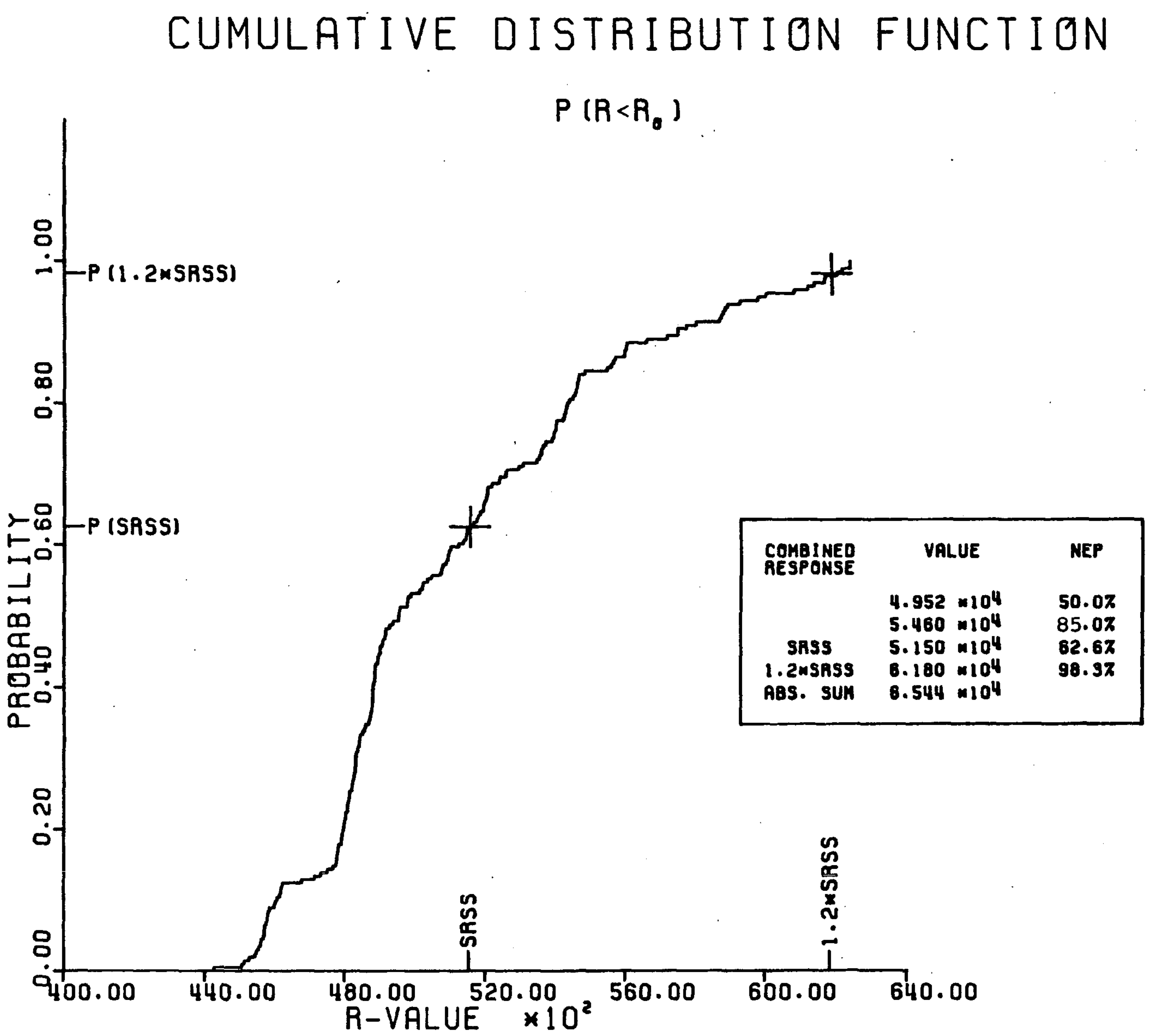


FIGURE B-9. NUCLEAR STEAM SUPPLY SYSTEM, CORE PLATE , LOCATION 4-3
SRV-ADS + CHUG10 LOAD COMBINATION, VERTICAL FORCE (LBS)

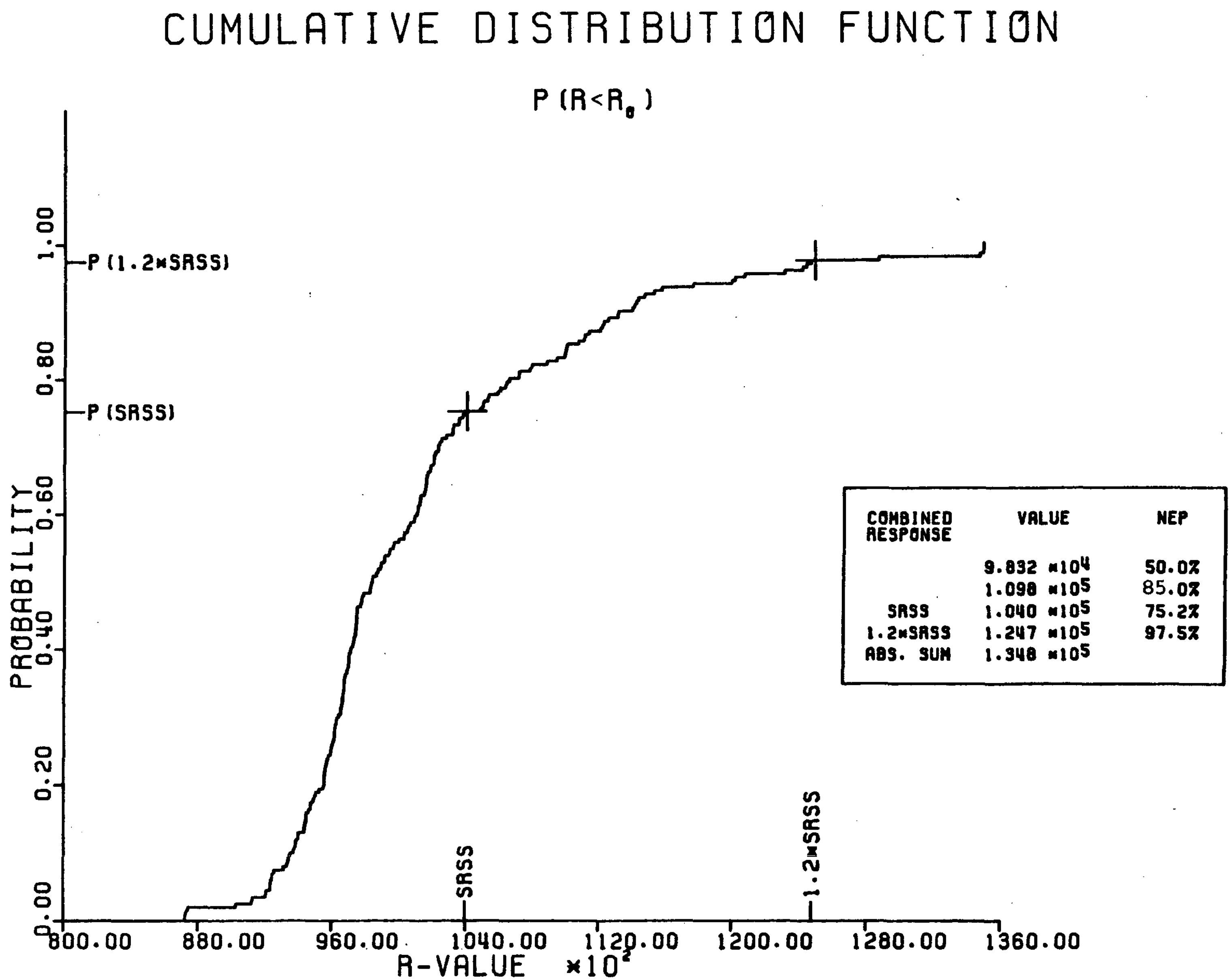
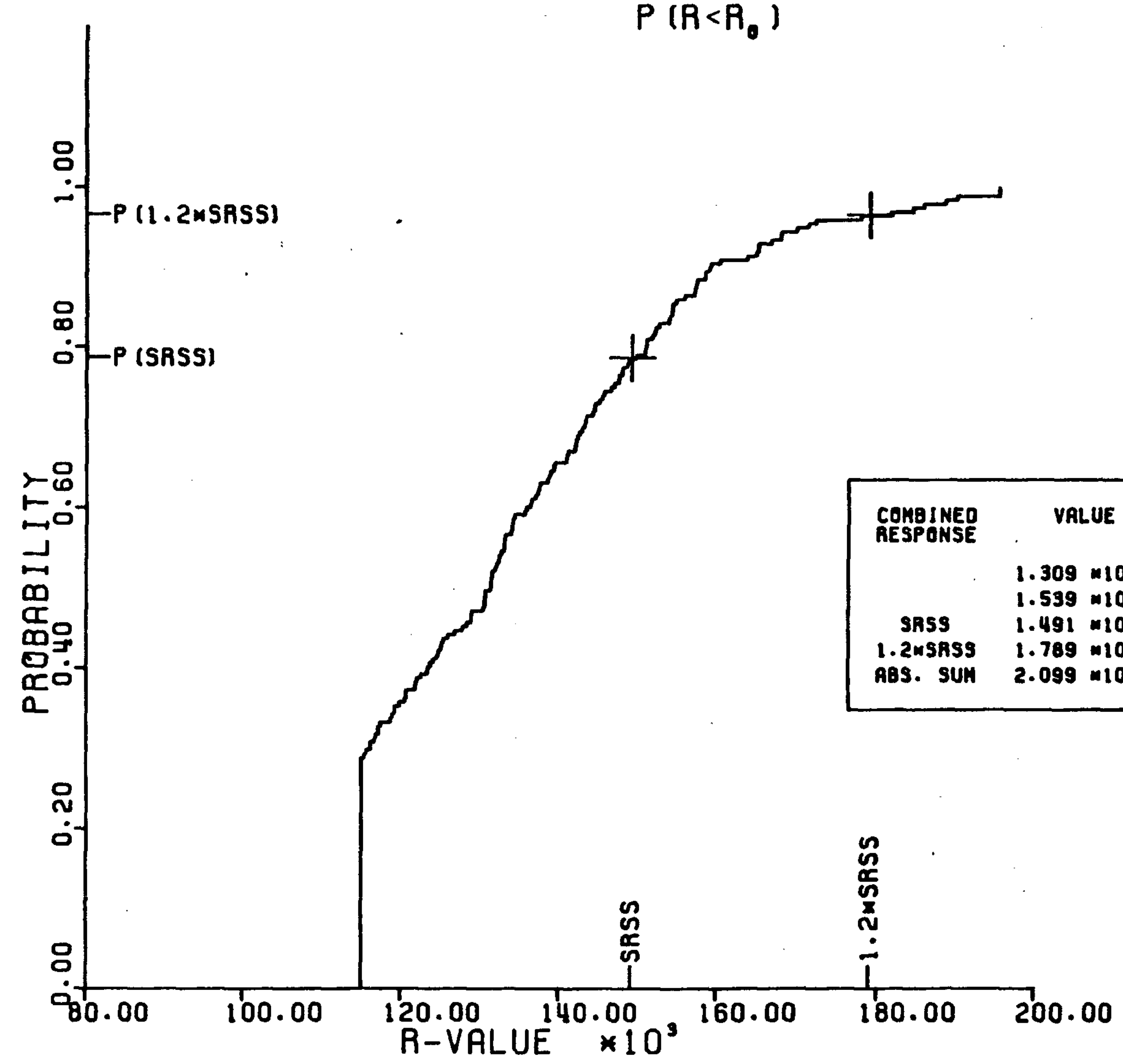


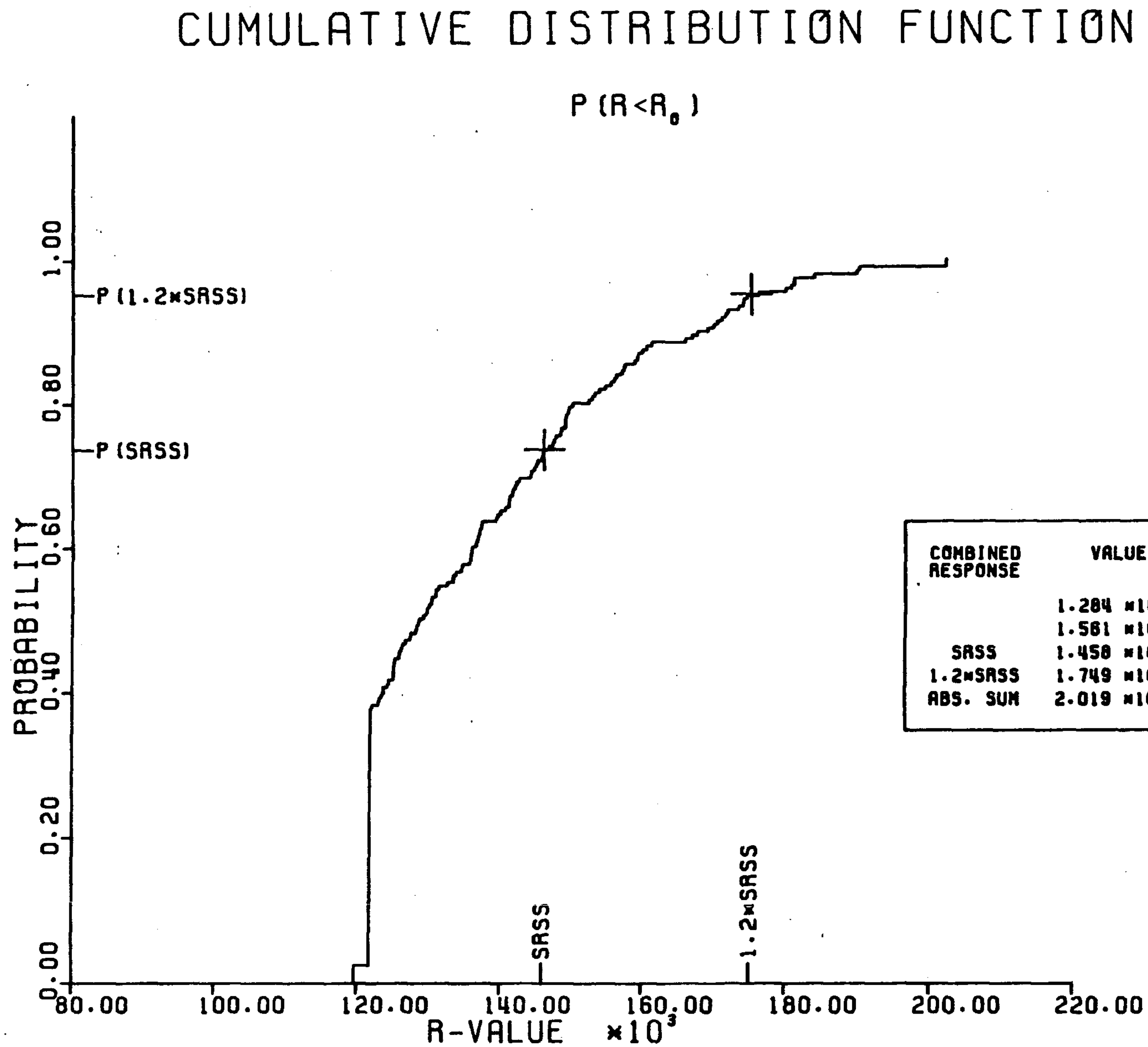
FIGURE B-10. NUCLEAR STEAM SUPPLY SYSTEM, RPV SKIRT , LOCATION 4-2
SRV-ADS + CHUG10 LOAD COMBINATION, HORIZONTAL FORCE (LBS)

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	1.309 *10⁵	50.0%
	1.539 *10⁵	85.0%
SRSS	1.491 *10⁵	78.8%
1.2*SRSS	1.789 *10⁵	96.7%
ABS. SUM	2.099 *10⁵	

FIGURE B-11. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-4
OBE + SRV-1 LOAD COMBINATION, MOMENT (IN-LBS)



COMBINED RESPONSE	VALUE	NEP
	1.284×10^5	50.0%
	1.581×10^5	85.0%
SRSS	1.458×10^5	73.7%
1.2*SRSS	1.749×10^5	95.2%
ABS. SUM	2.019×10^5	

FIGURE B-12. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-5
OBE + SRV-1 LOAD COMBINATION, MOMENT (IN-LBS)

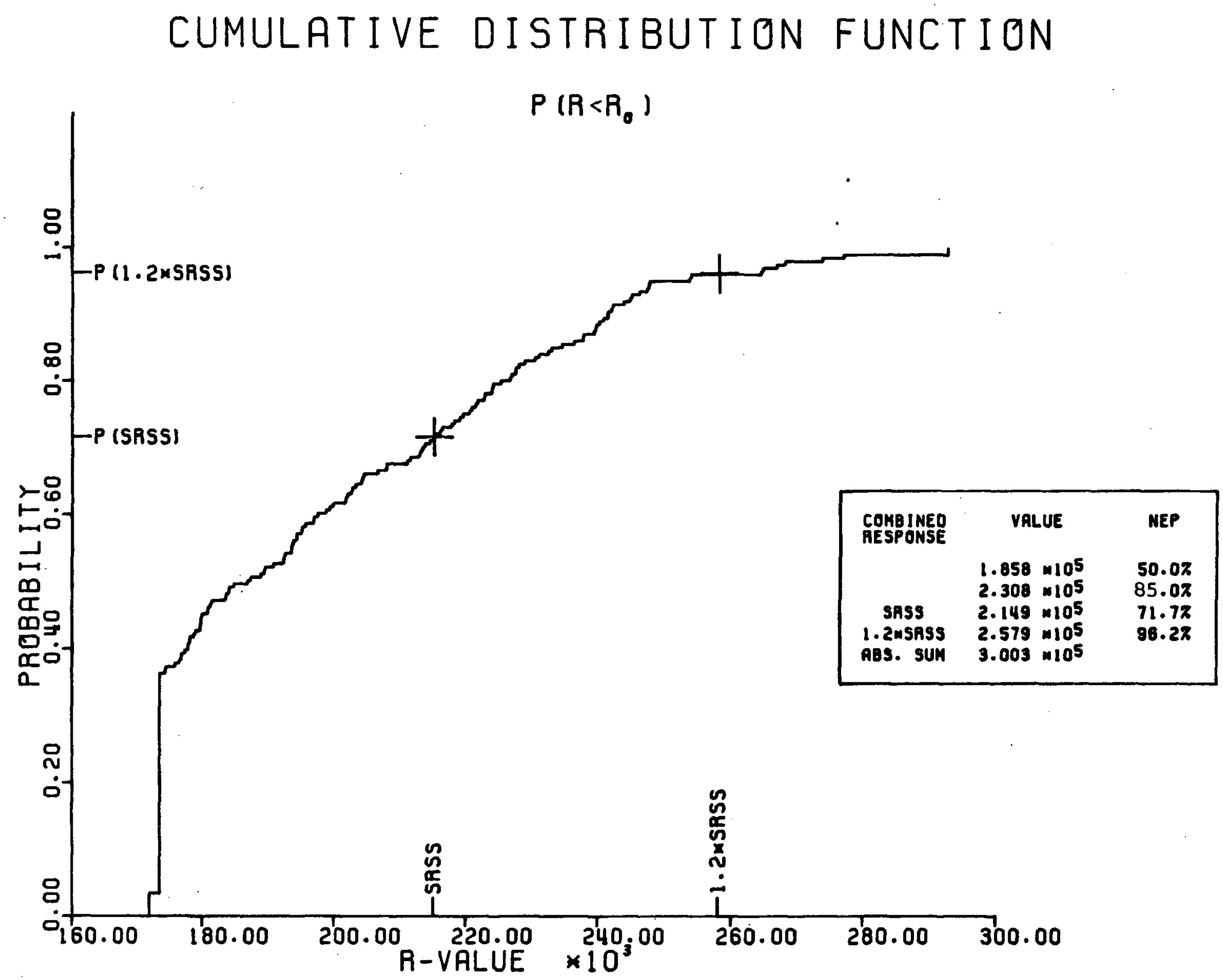


FIGURE B-13. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-7
OBE + SRV-1 LOAD COMBINATION, MOMENT (IN-LBS)

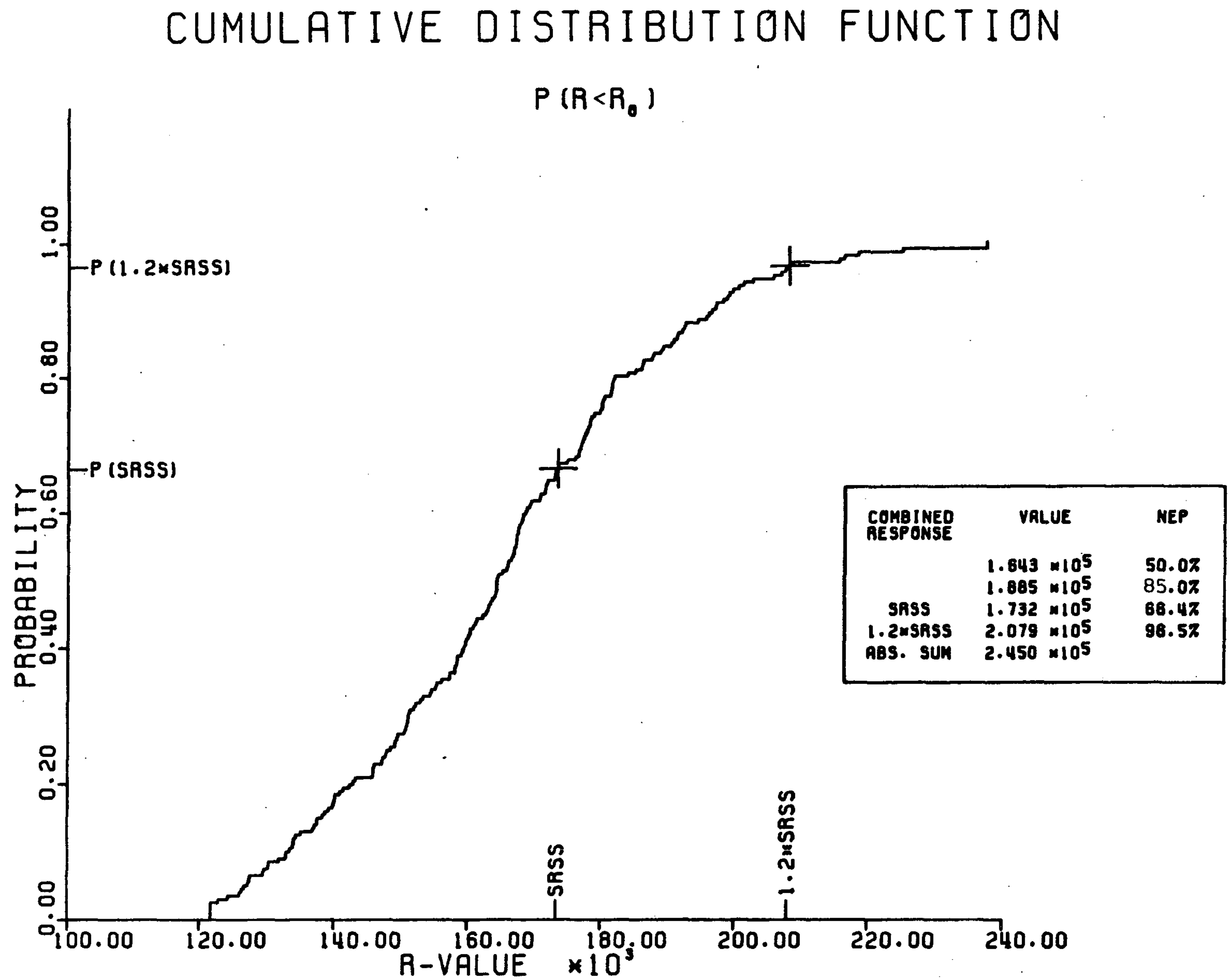


FIGURE B-14. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-5
OBE + SRV-ALL LOAD COMBINATION, MOMENT (IN-LBS)

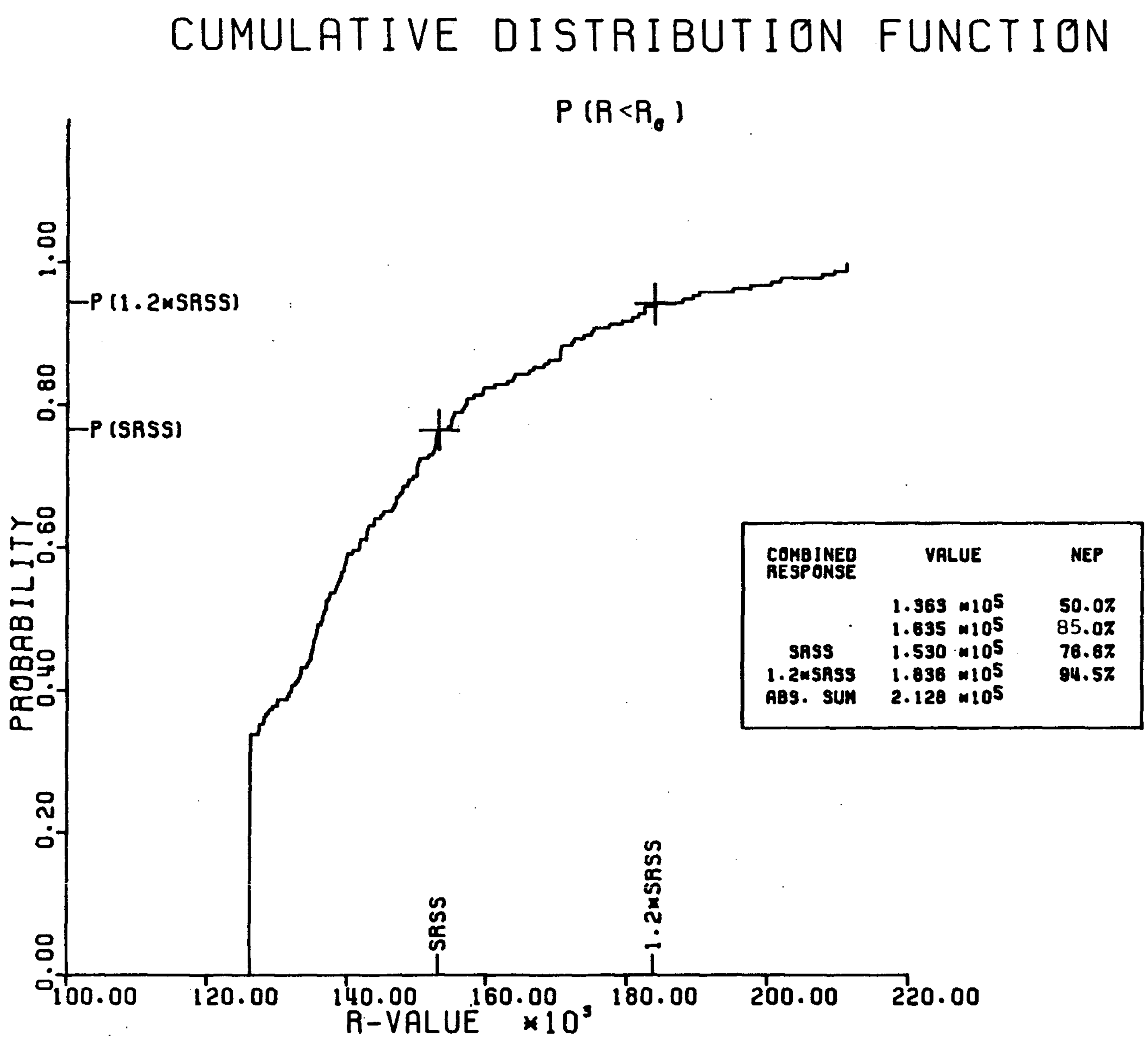
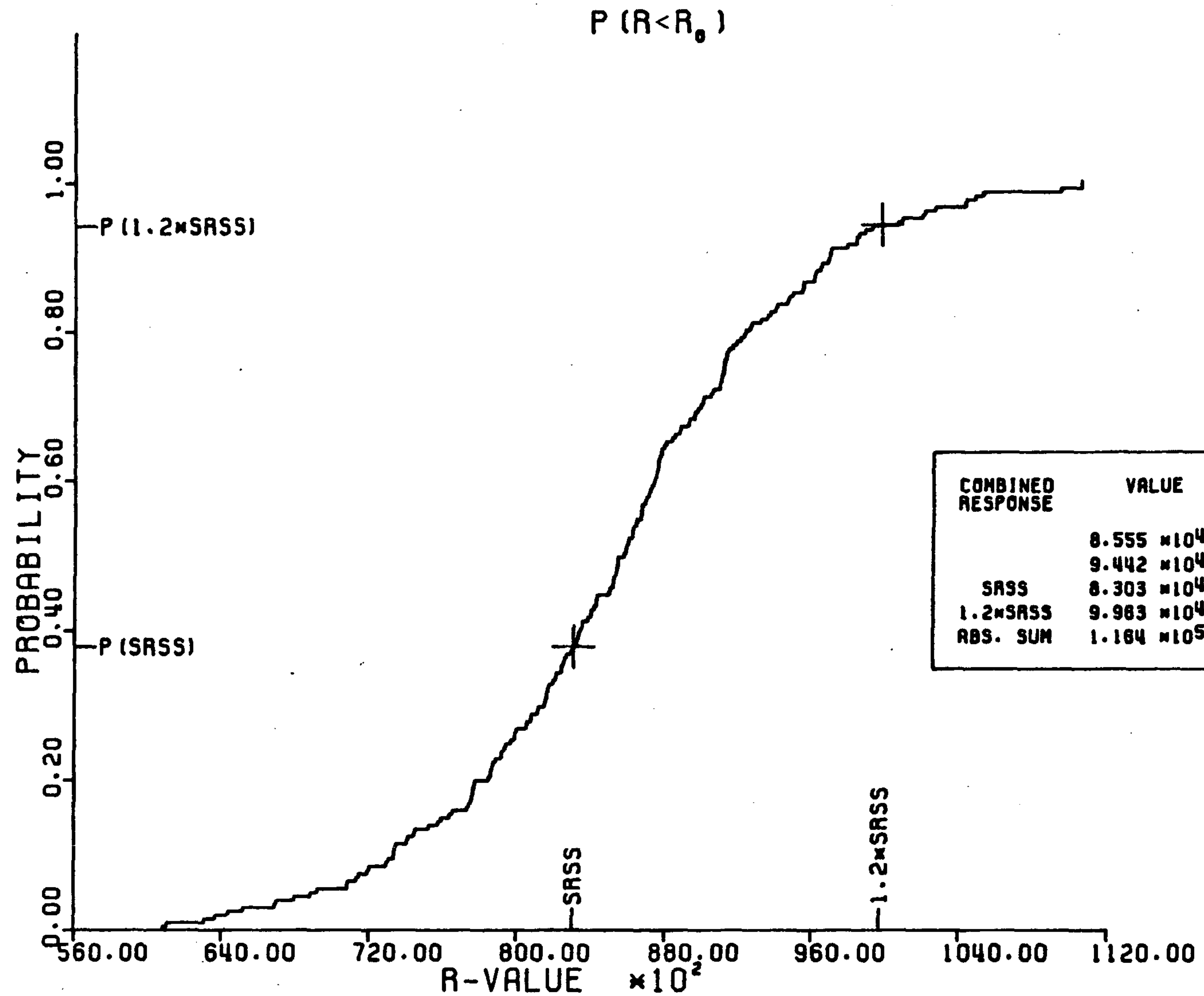


FIGURE B-15. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-6
OBE + SAV-ALL LOAD COMBINATION, MOMENT (IN-LBS)

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	8.555 ×10⁴	50.0%
	9.442 ×10⁴	85.0%
SRSS	8.303 ×10⁴	37.9%
1.2×SRSS	9.963 ×10⁴	94.2%
ABS. SUM	1.164 ×10⁵	

FIGURE B-16. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-9
OBE + SRV-ALL LOAD COMBINATION, MOMENT (IN-LBS)

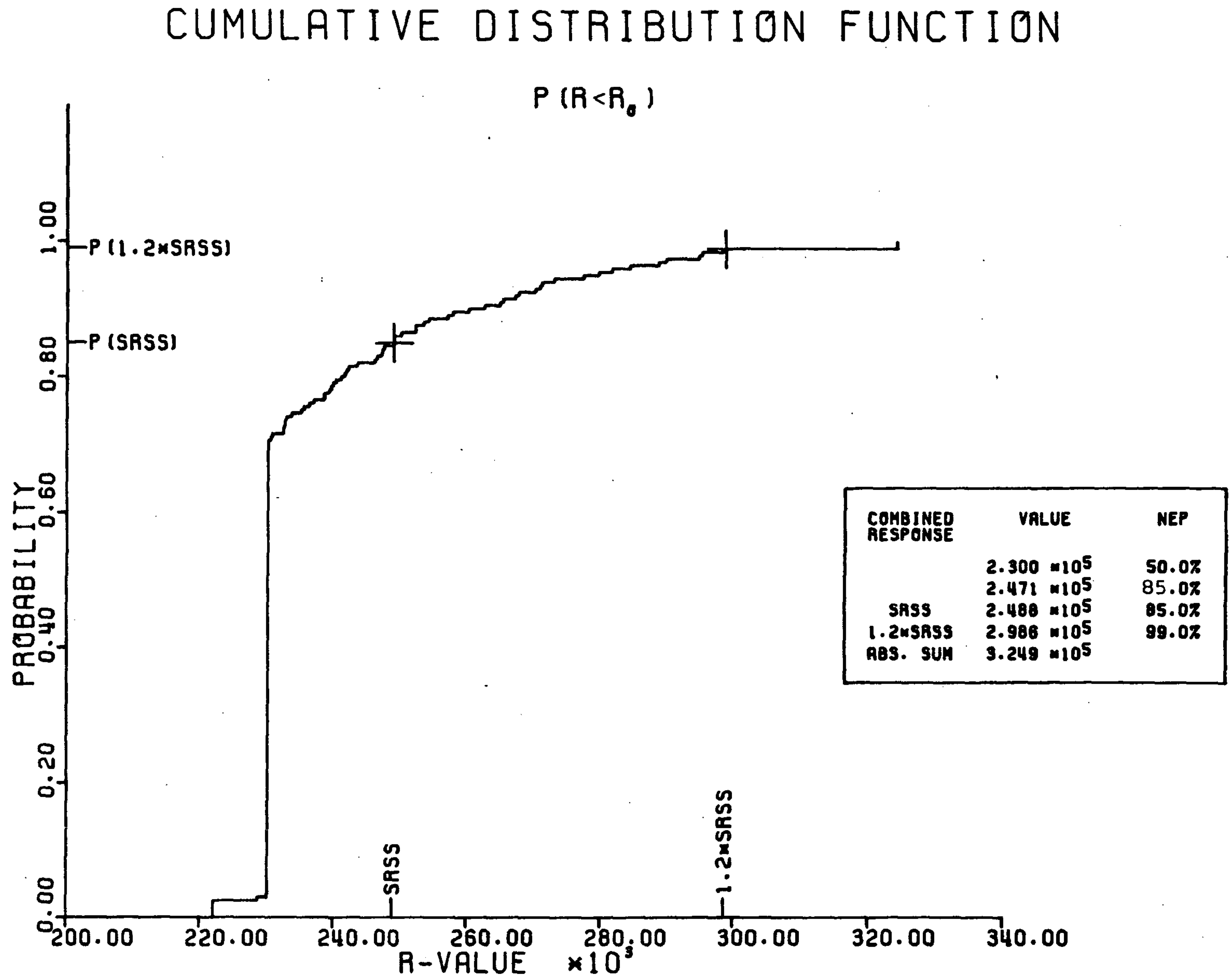


FIGURE B-17. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-4
SSE + SRV-1 LOAD COMBINATION, MOMENT (IN-LBS)

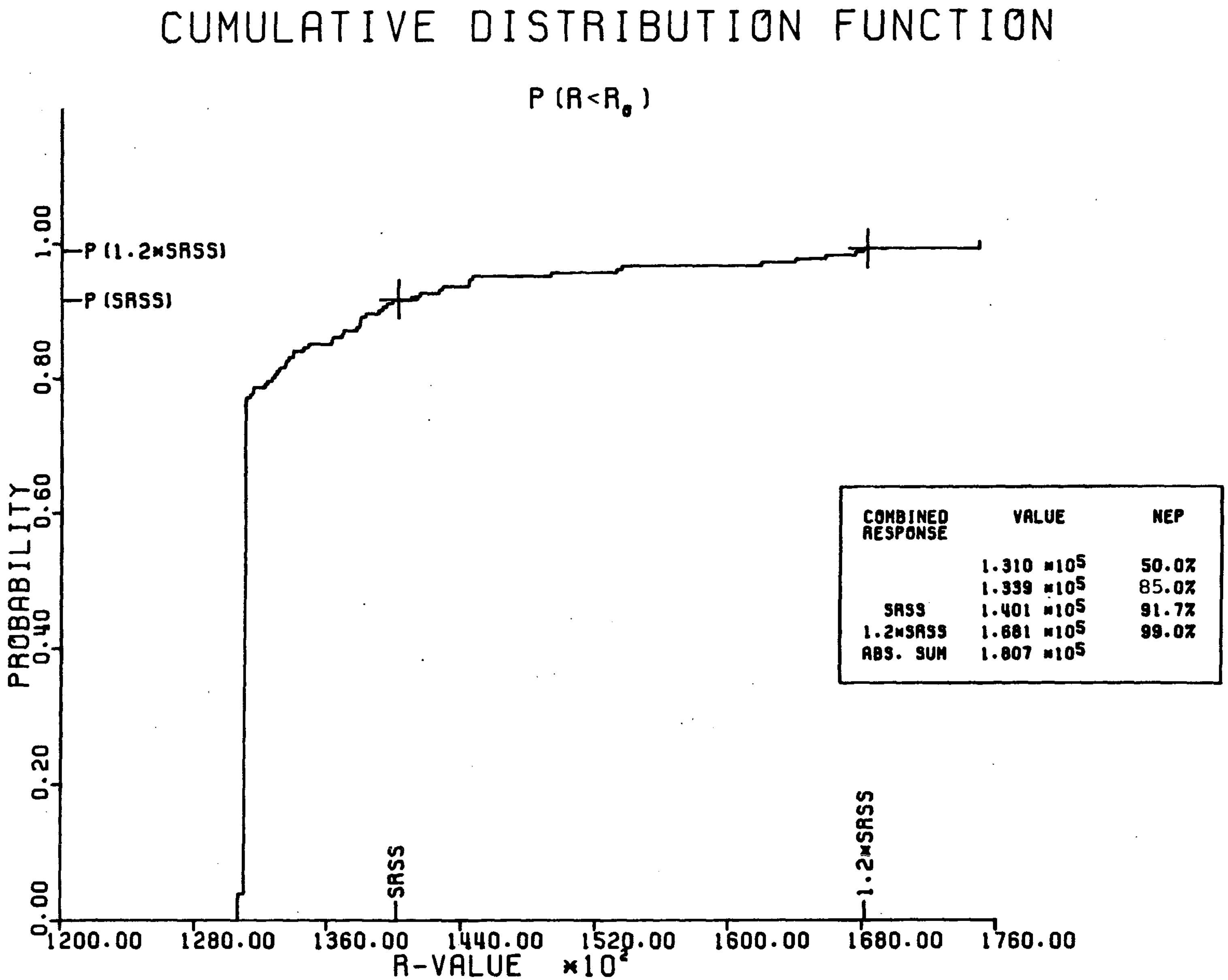


FIGURE B-18. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-8
SSE + SRV-1 LOAD COMBINATION, MOMENT (IN-LBS)

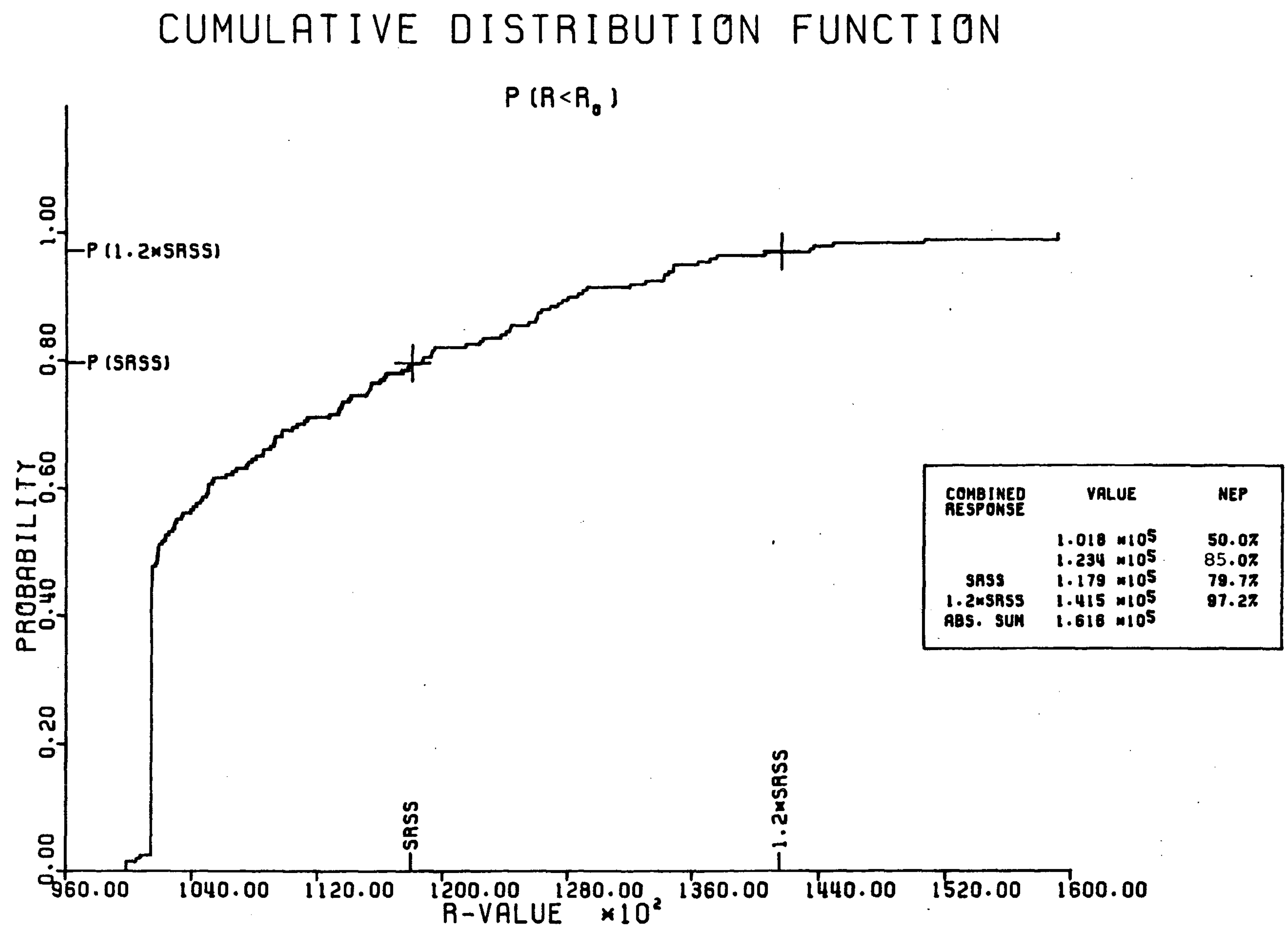


FIGURE B-19. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-9
SSE + SRV-1 LOAD COMBINATION, MOMENT (IN-LBS)

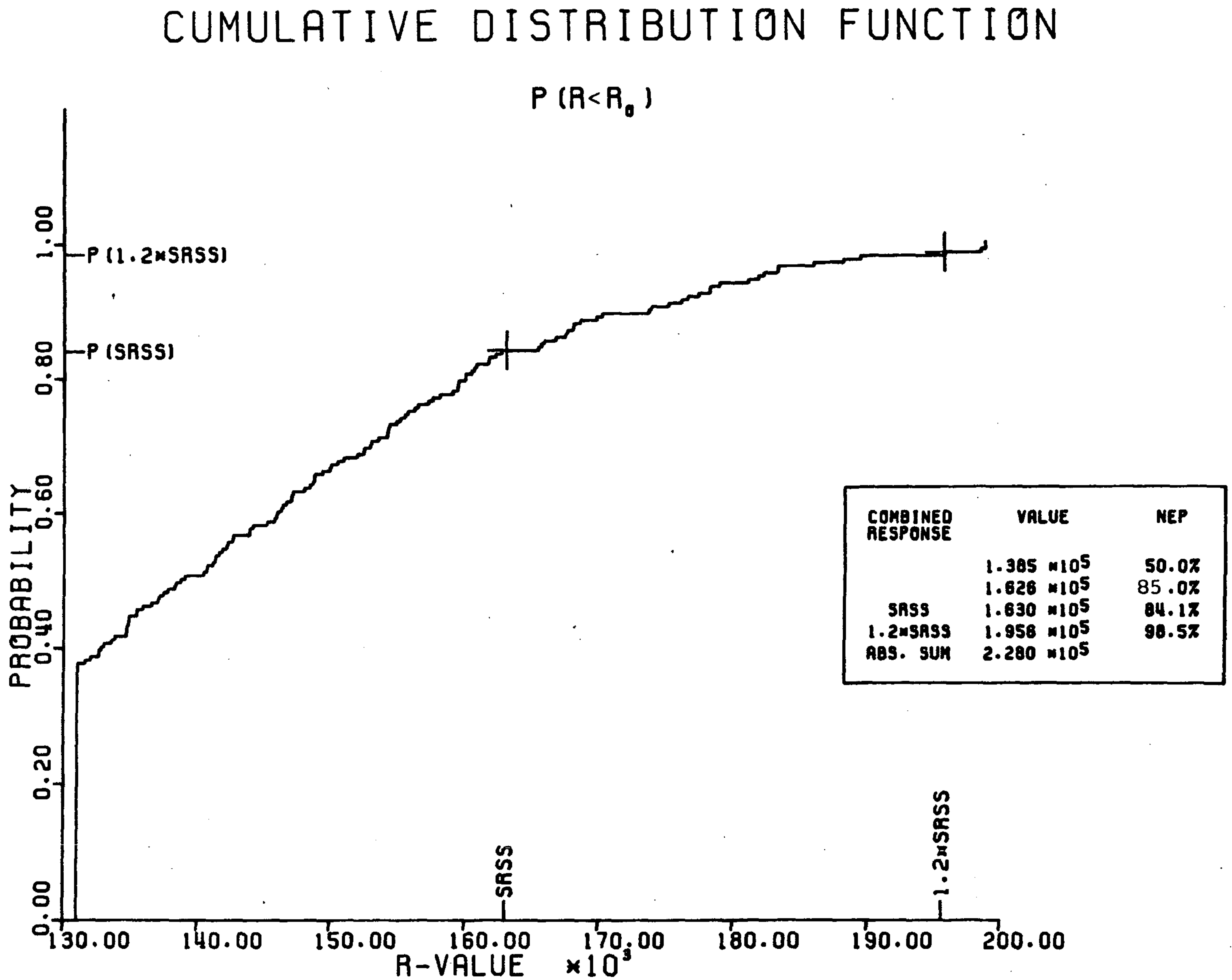


FIGURE B-20. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-8
SSE + SRV-ALL LOAD COMBINATION, MOMENT (IN-LBS)

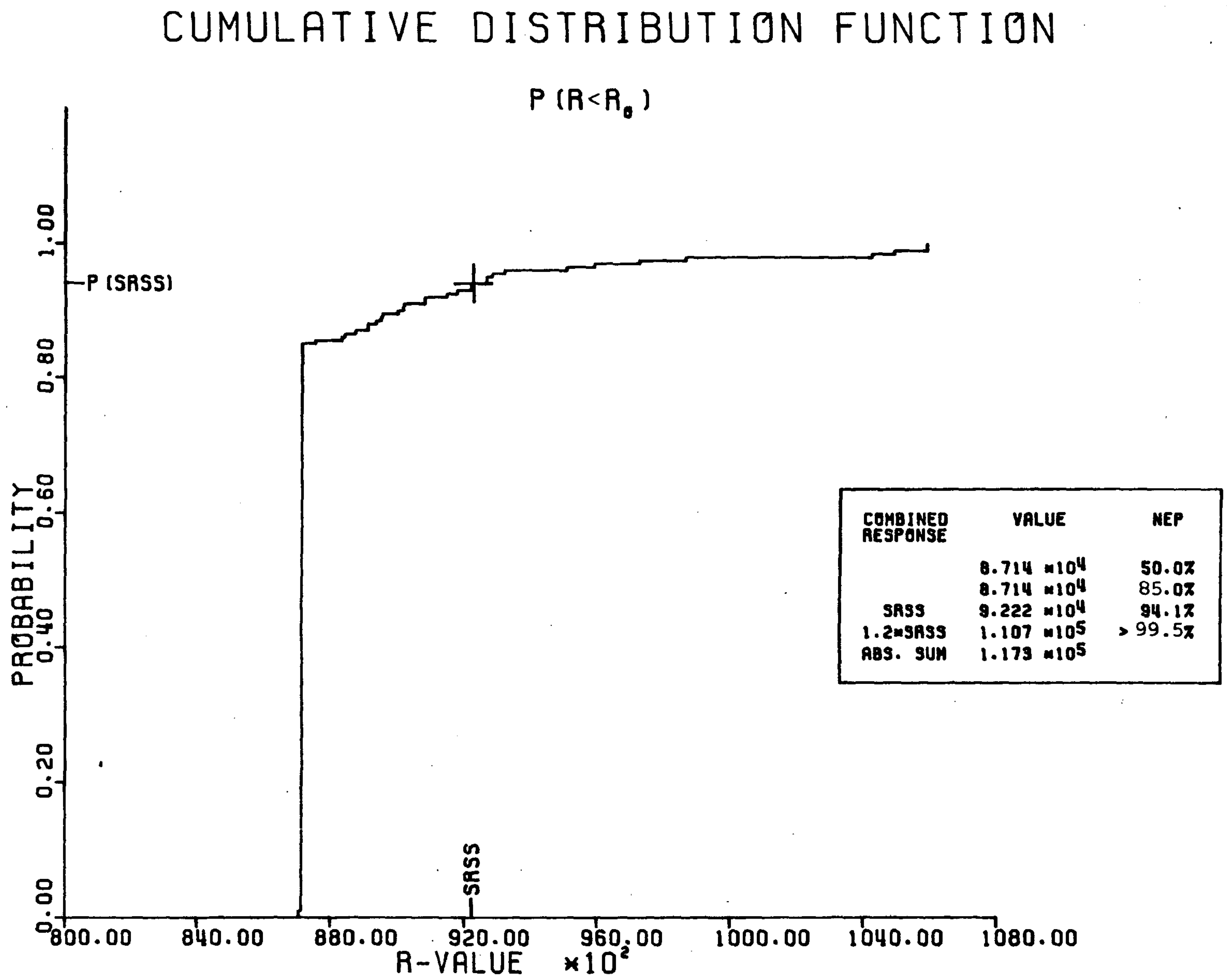


FIGURE B-21. NSSS RECIRCULATION PIPING PUMP INLET , LOCATION 4-8
OBE + SRV-1 LOAD COMBINATION, MOMENT (FT-LBS)

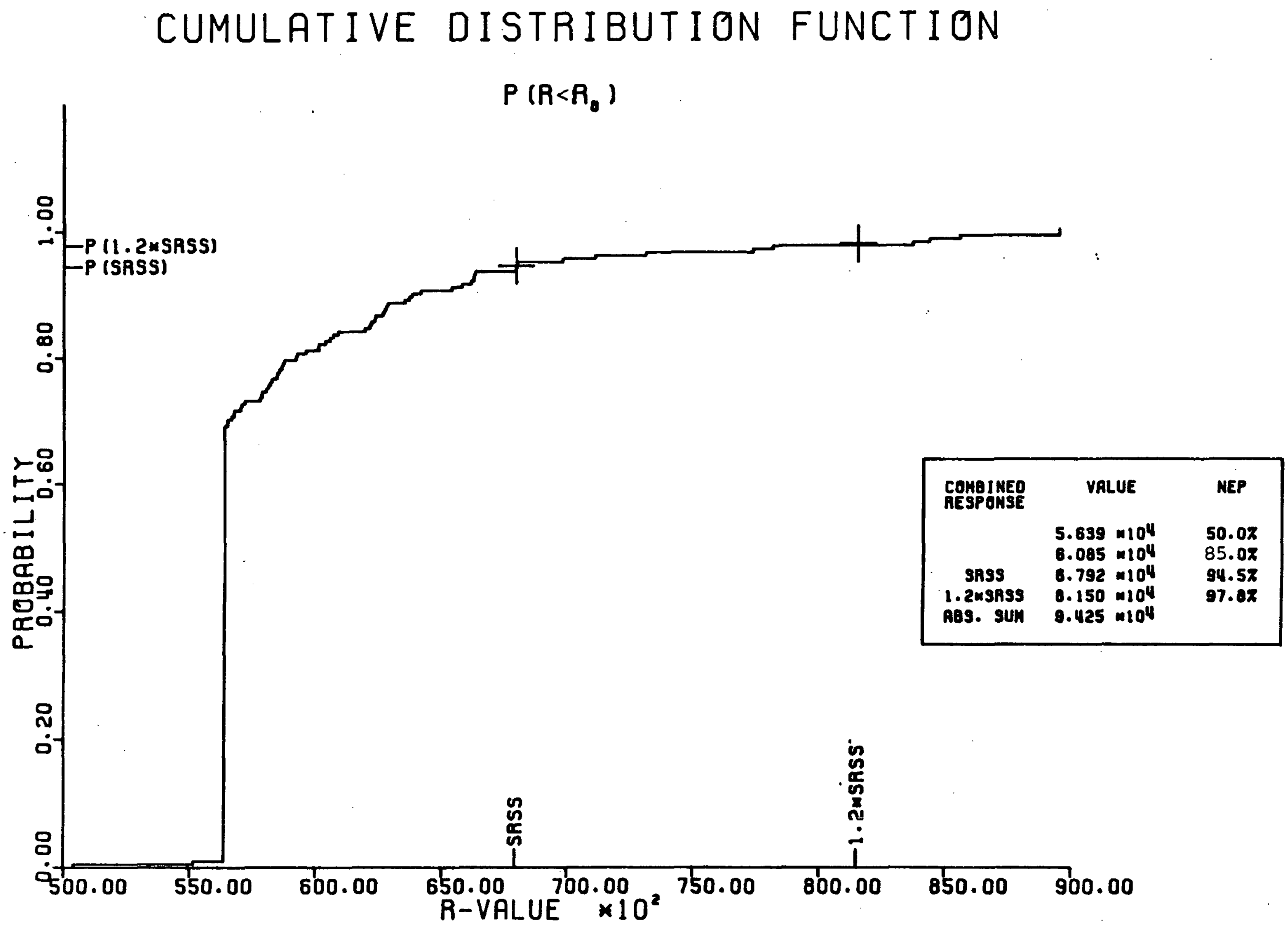


FIGURE B-22. NSSS RECIRCULATION PIPING TEE , LOCATION 4-10
OBE + SRV-1 LOAD COMBINATION, MOMENT (FT-LBS)

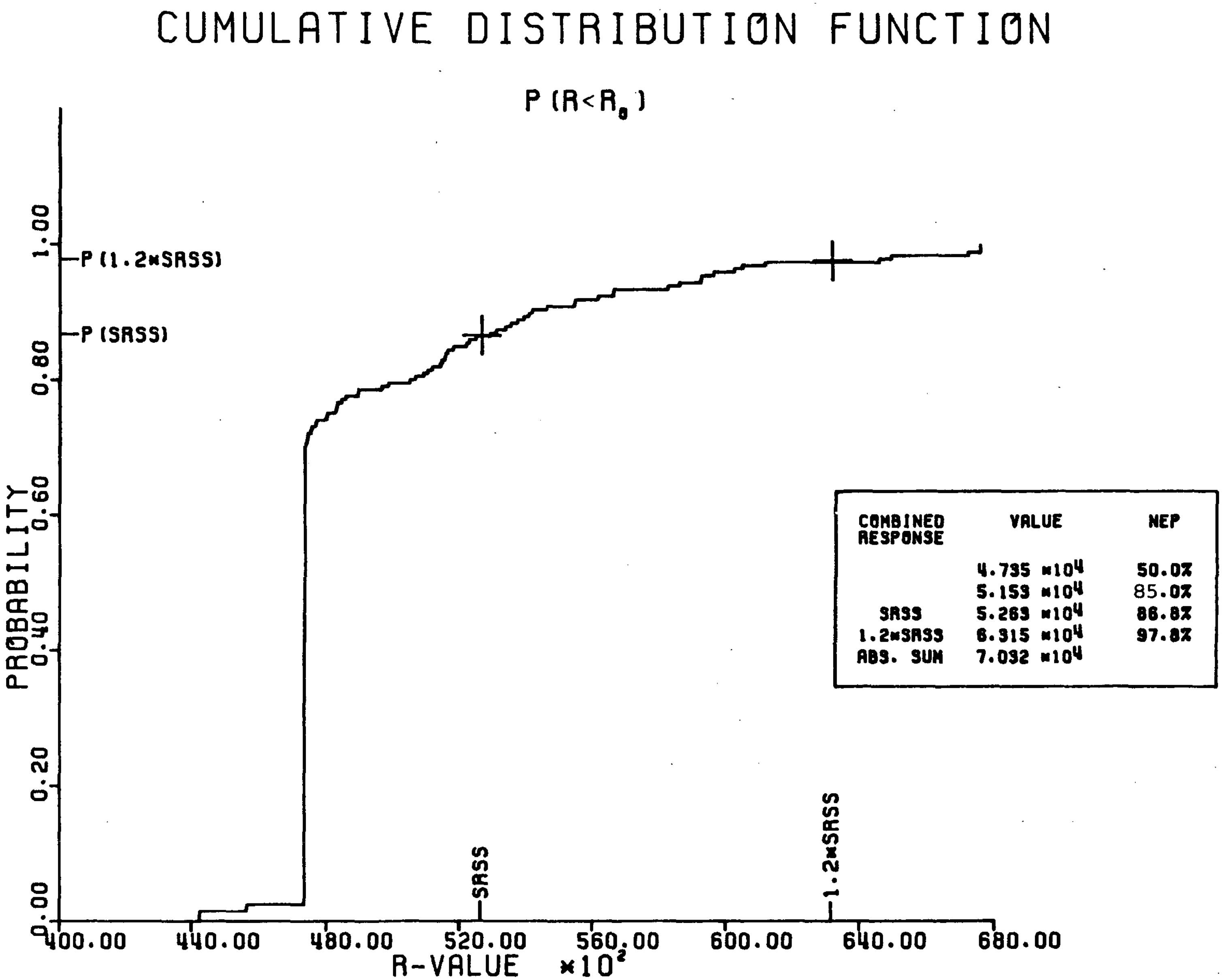


FIGURE B-23. NSSS RECIRCULATION PIPING ELBOW , LOCATION 4-11
OBE + SRV-1 LOAD COMBINATION, MOMENT (FT-LBS)

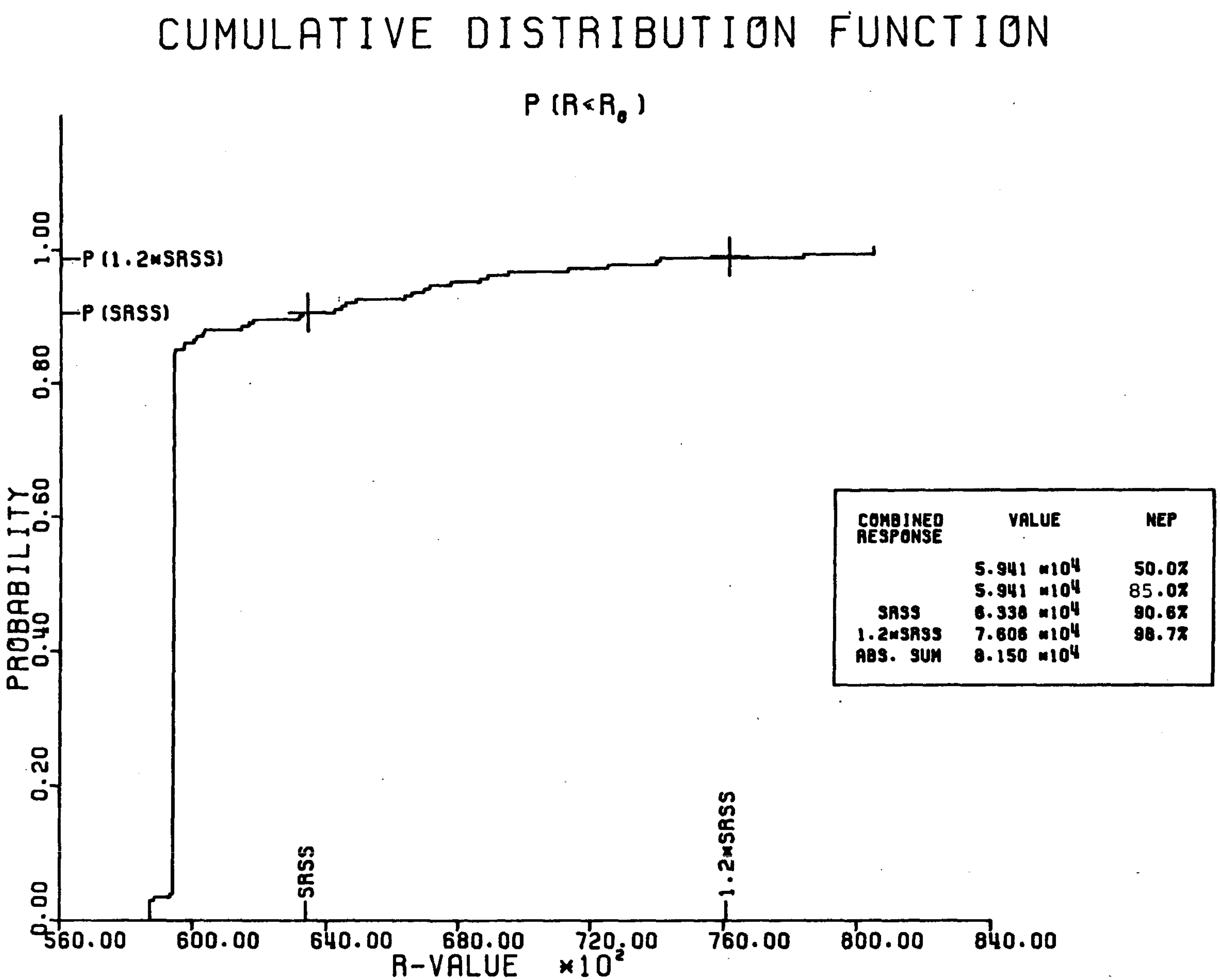


FIGURE B-24. NSSS RECIRCULATION PIPING PIPE ELEMENT, LOCATION 4-12
OBE + SRV-1 LOAD COMBINATION, MOMENT (FT-LBS)

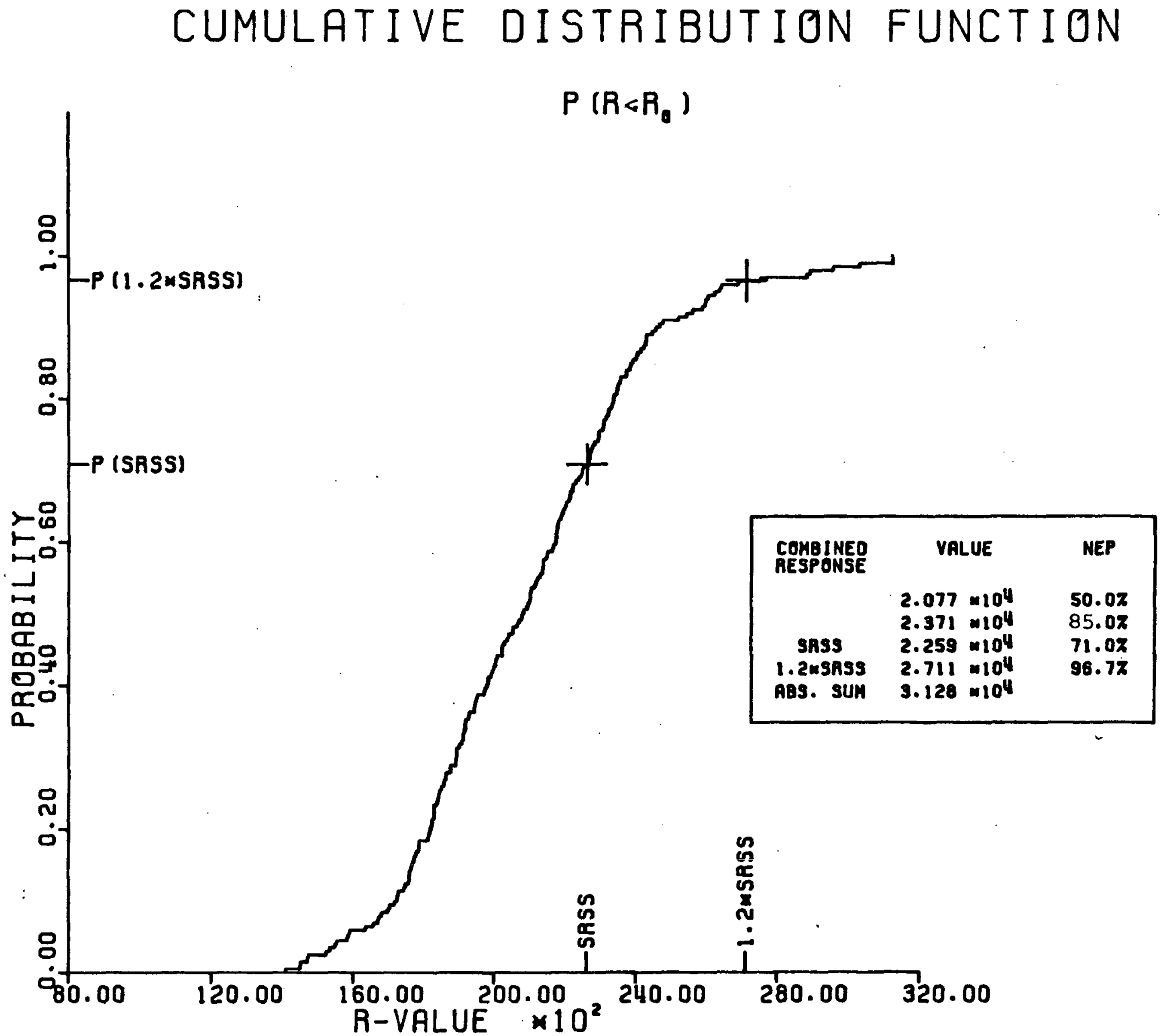


FIGURE B-25. NSSS RECIRCULATION PIPING ELBOW , LOCATION 4-9
OBE + SRV-ALL LOAD COMBINATION, MOMENT (FT-LBS)

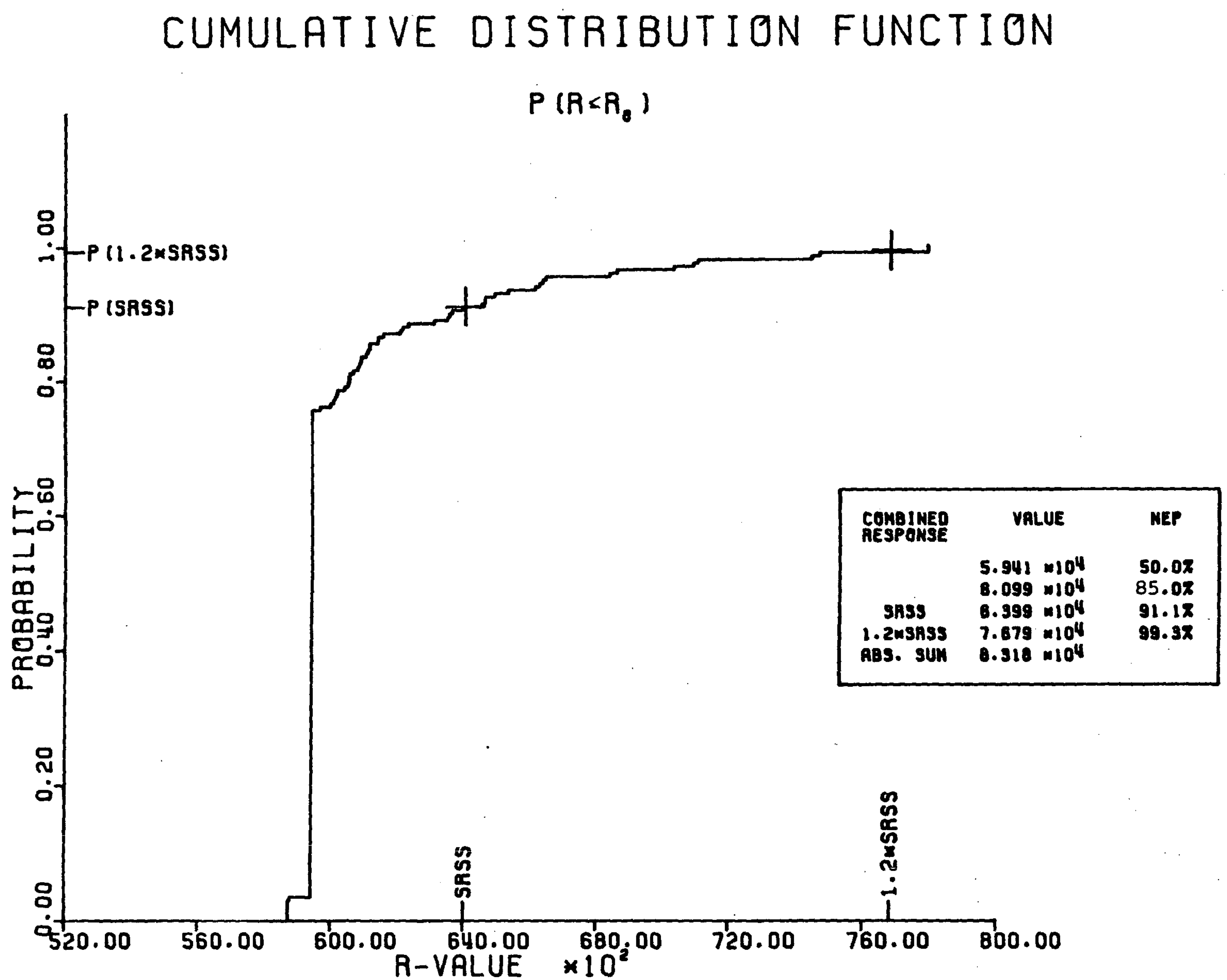
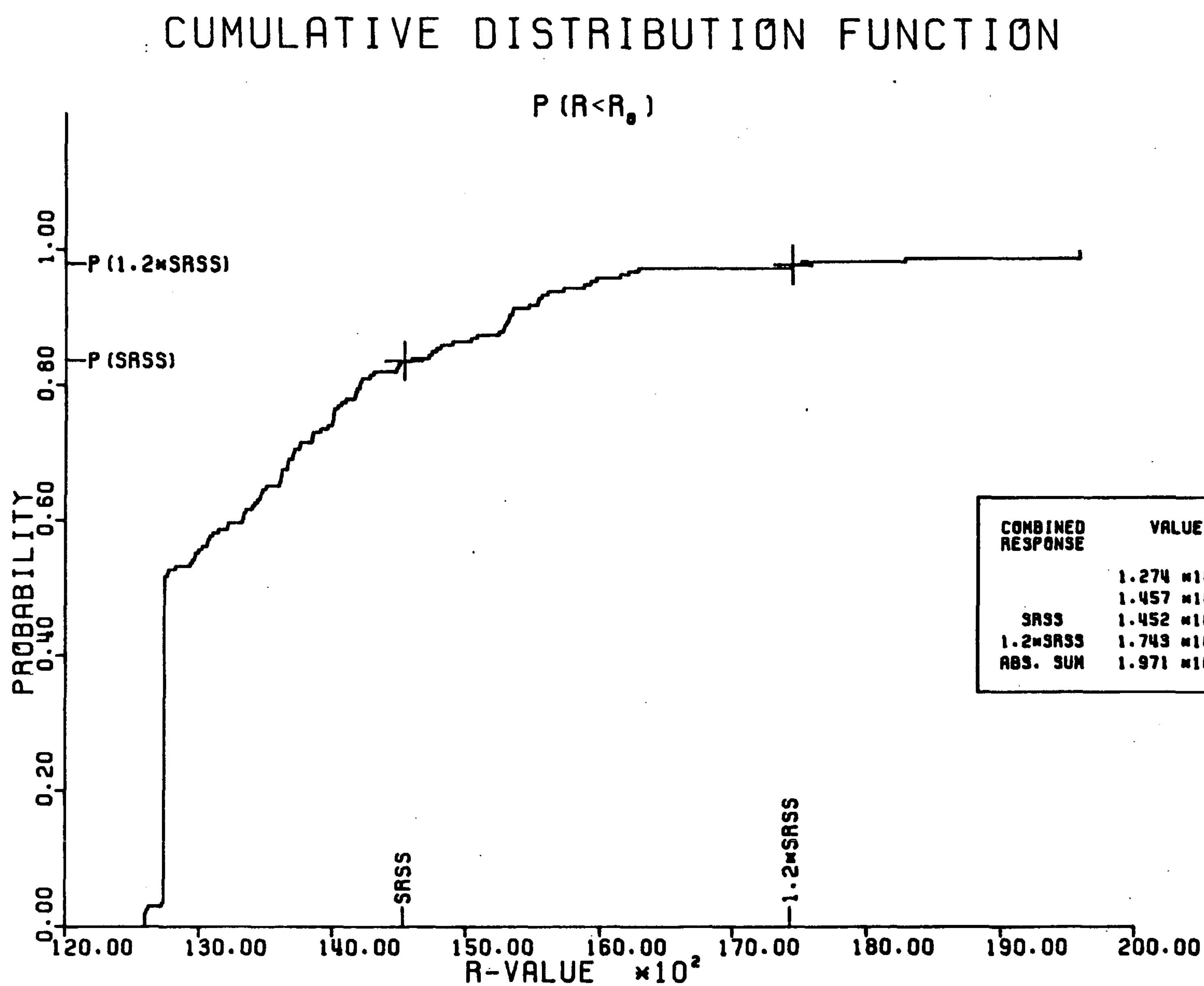


FIGURE B-26. NSSS RECIRCULATION PIPING PIPE ELEMENT, LOCATION 4-12
OBE + SRV-ALL LOAD COMBINATION, MOMENT (FT-LBS)



COMBINED RESPONSE	VALUE	NEP
	1.274×10^4	50.0%
	1.457×10^4	85.0%
SRSS	1.452×10^4	83.7%
1.2*SRSS	1.743×10^4	98.0%
ABS. SUM	1.971×10^4	

FIGURE B-27. NSSS RECIRCULATION PIPING SWEEPOLET , LOCATION 4-13
OBE + SRV-ALL LOAD COMBINATION, MOMENT (FT-LBS)

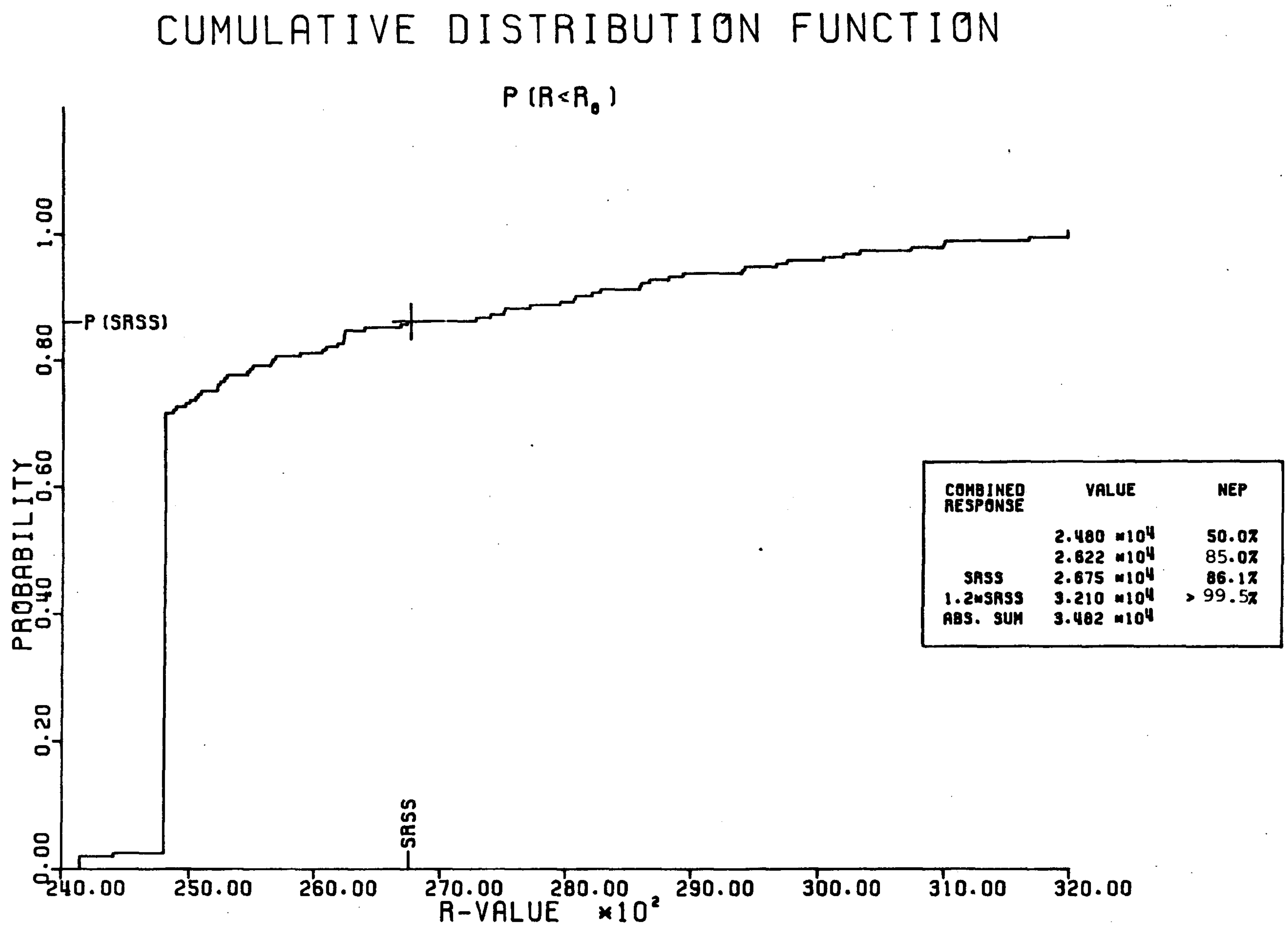


FIGURE B-28. NSSS RECIRCULATION PIPING ELBOW , LOCATION 4-9
SSE + SRV-1 LOAD COMBINATION, MOMENT (FT-LBS)

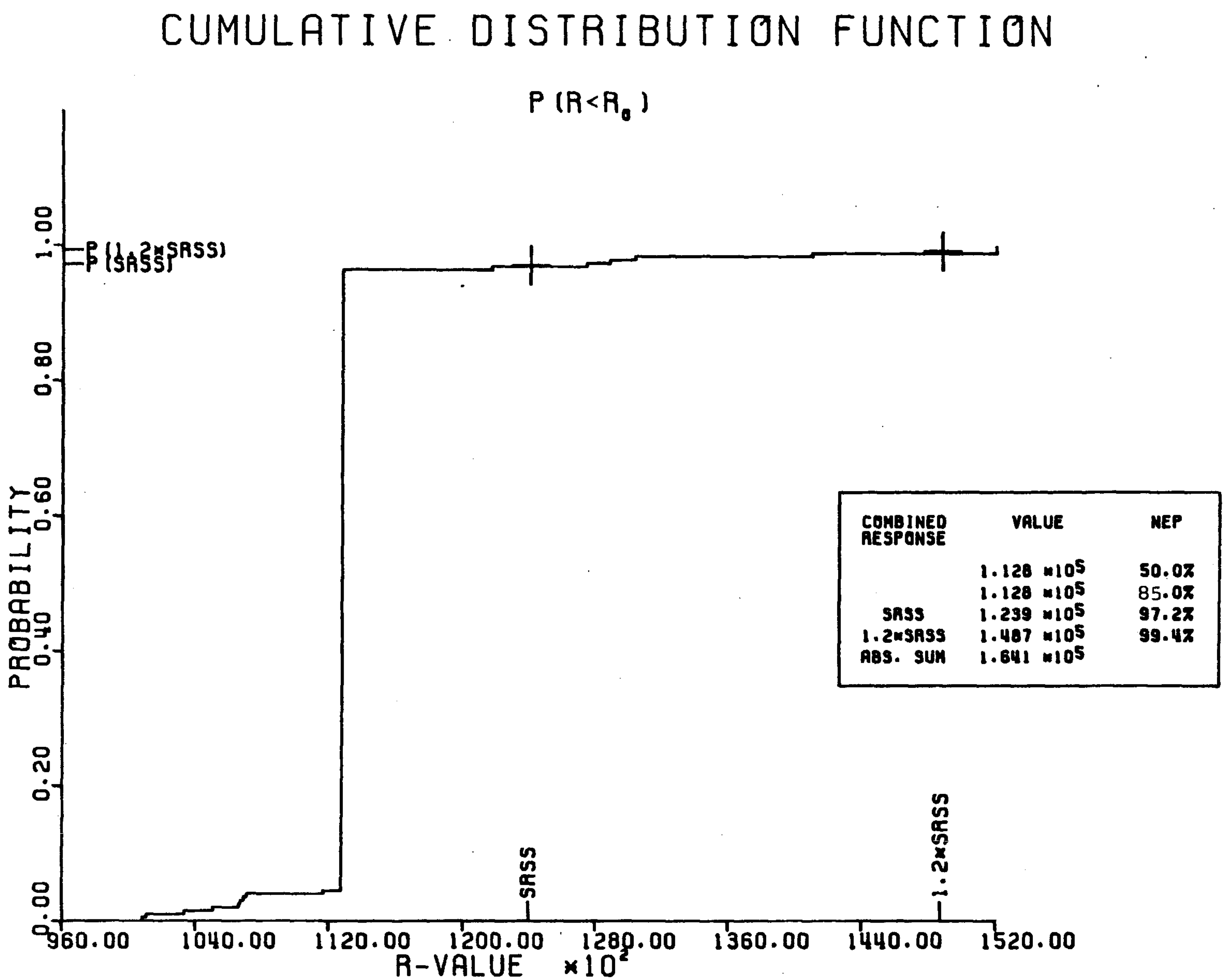


FIGURE B-29. NSSS RECIRCULATION PIPING TEE , LOCATION 4-10
SSE + SRV-ALL LOAD COMBINATION, MOMENT (FT-LBS)

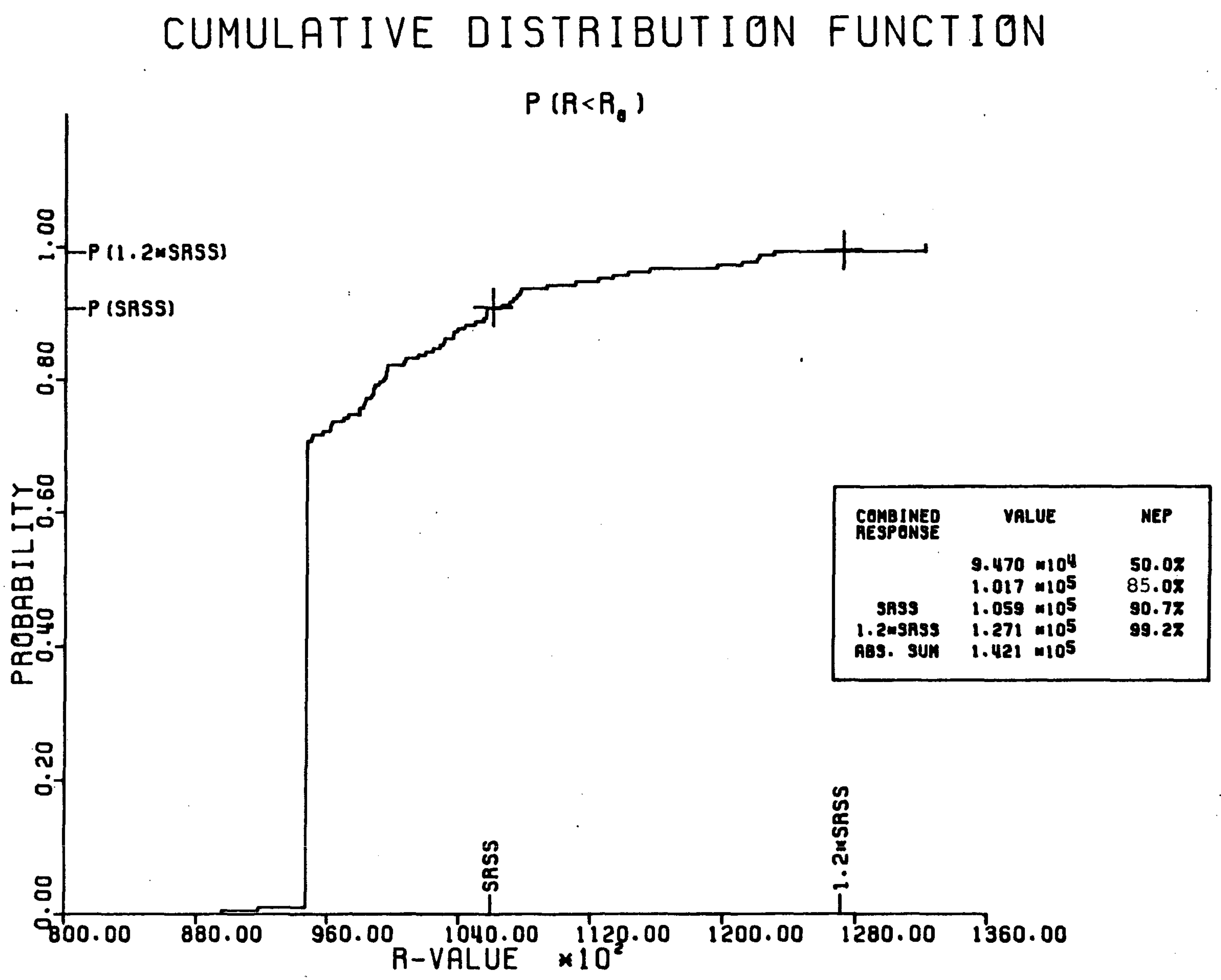


FIGURE B-30. NSSS RECIRCULATION PIPING ELBOW , LOCATION 4-11
SSE + SRV-ALL LOAD COMBINATION, MOMENT (FT-LBS)

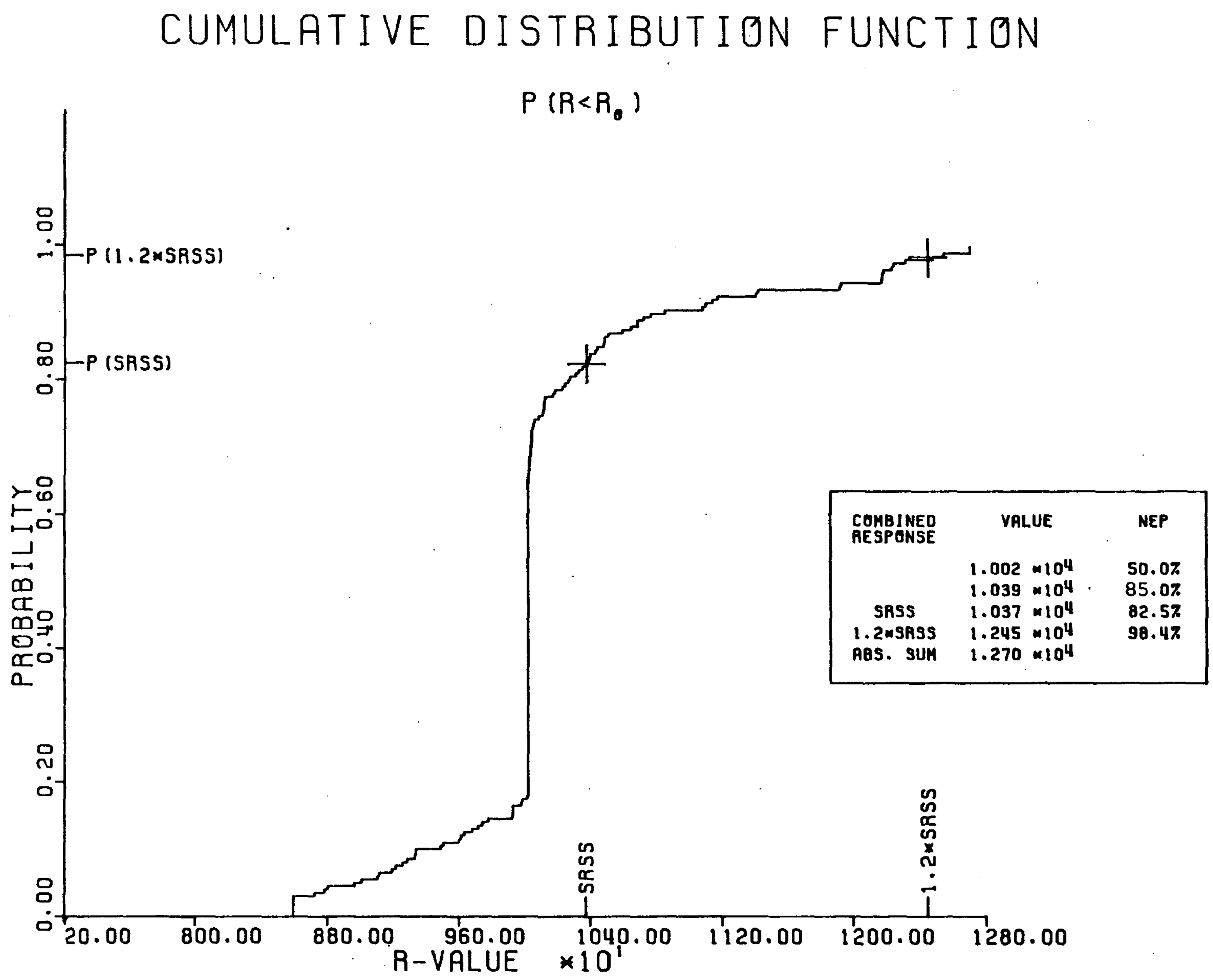
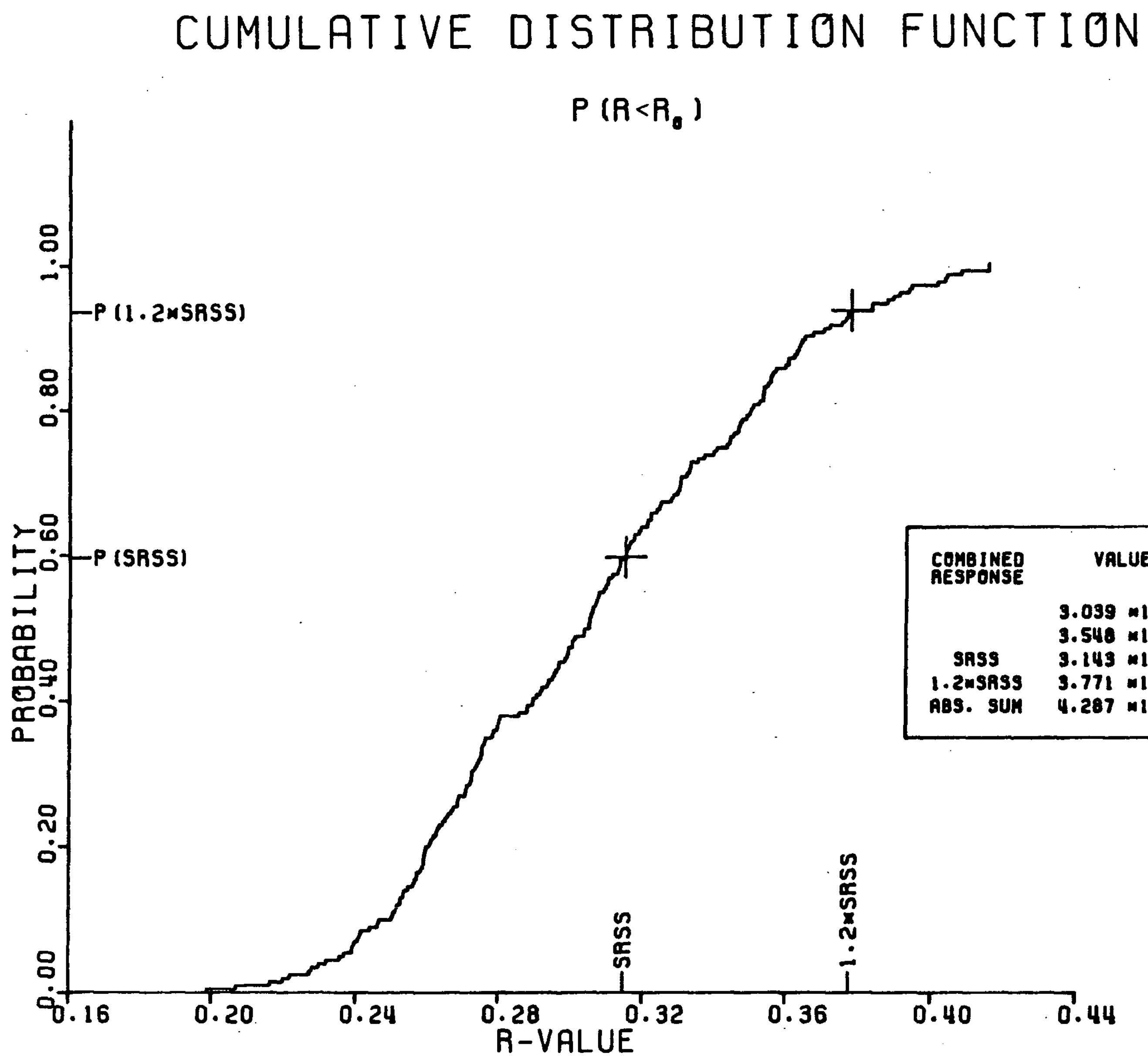


FIGURE B-31. NSSS RECIRCULATION PIPING ELBOW , LOCATION 4-9
SRV-1 + CHUG LOAD COMBINATION, MOMENT (FT-LBS)



COMBINED RESPONSE	VALUE	NEP
	3.039×10^{-1}	50.0%
	3.548×10^{-1}	85.0%
SRSS	3.143×10^{-1}	59.6%
1.2*SRSS	3.771×10^{-1}	93.6%
ABS. SUM	4.287×10^{-1}	

FIGURE B-32. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-2
OBE + SRV-1 LOAD COMBINATION, ACCELERATION (G)

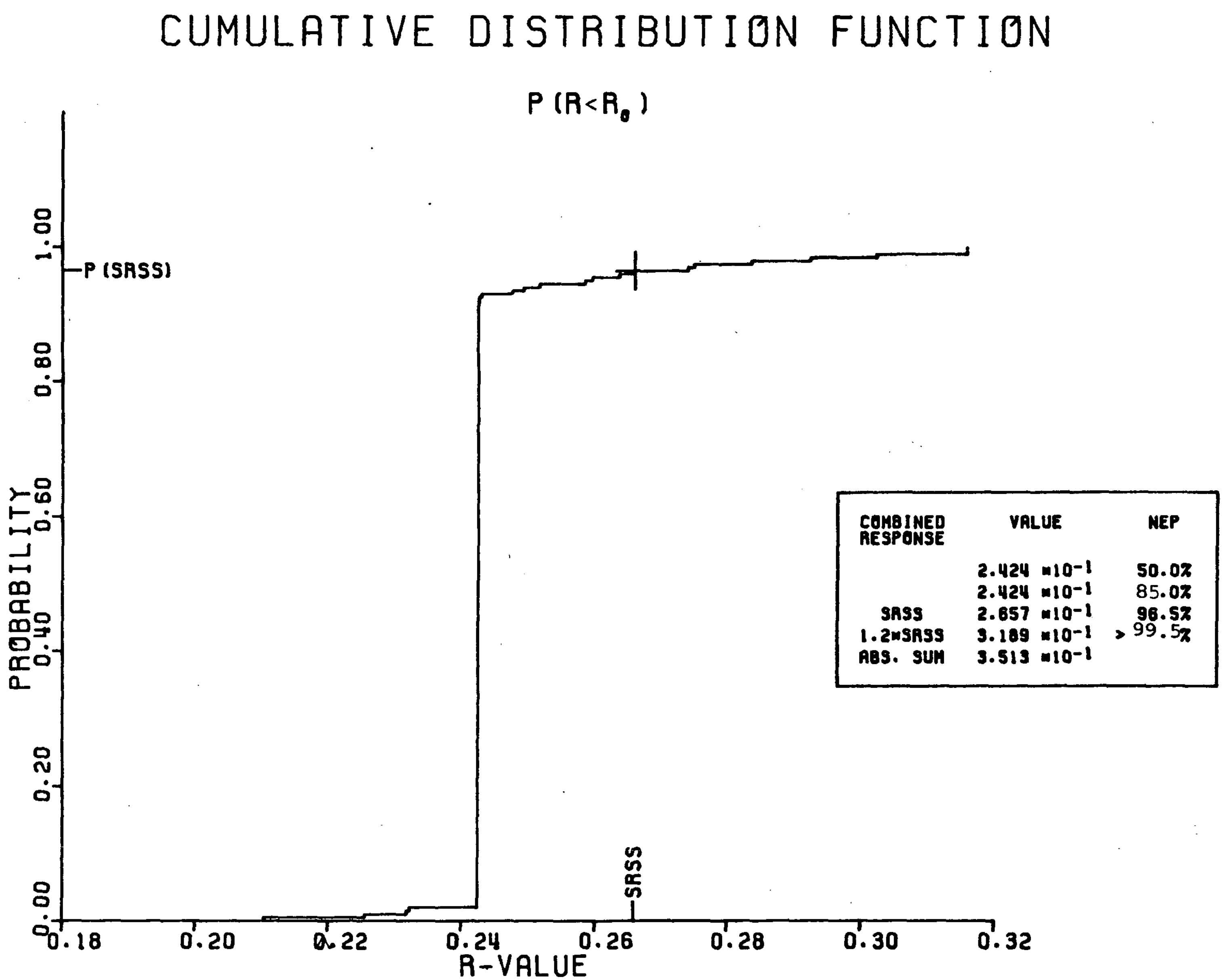


FIGURE B-33. NSSS RECIRCULATION PIPING FLOW CONTROL VALVE, LOCATION 4-6
OBE + SRV-1 LOAD COMBINATION, ACCELERATION (G)

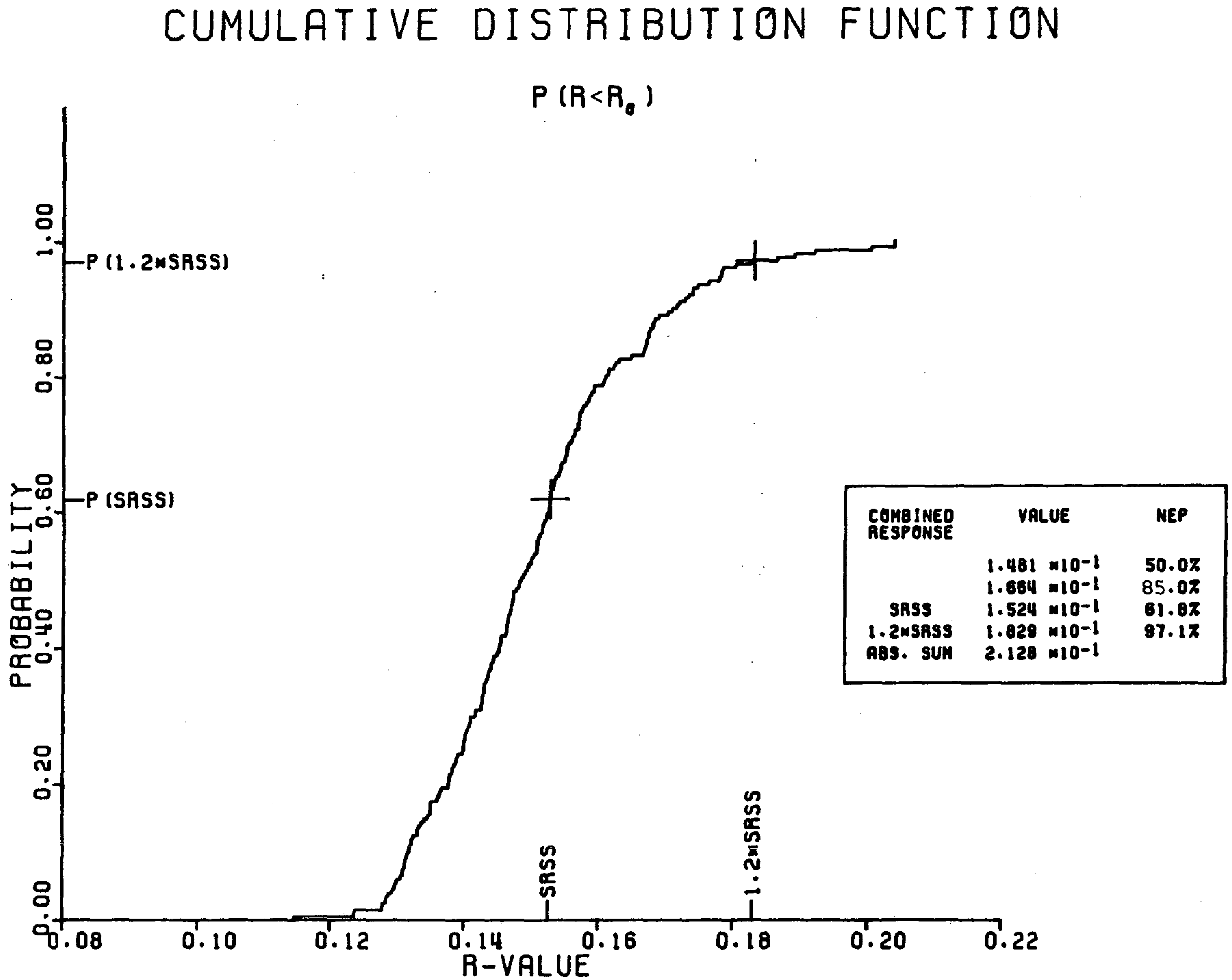


FIGURE B-34. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-3
OBE + SRV-ALL LOAD COMBINATION, ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION

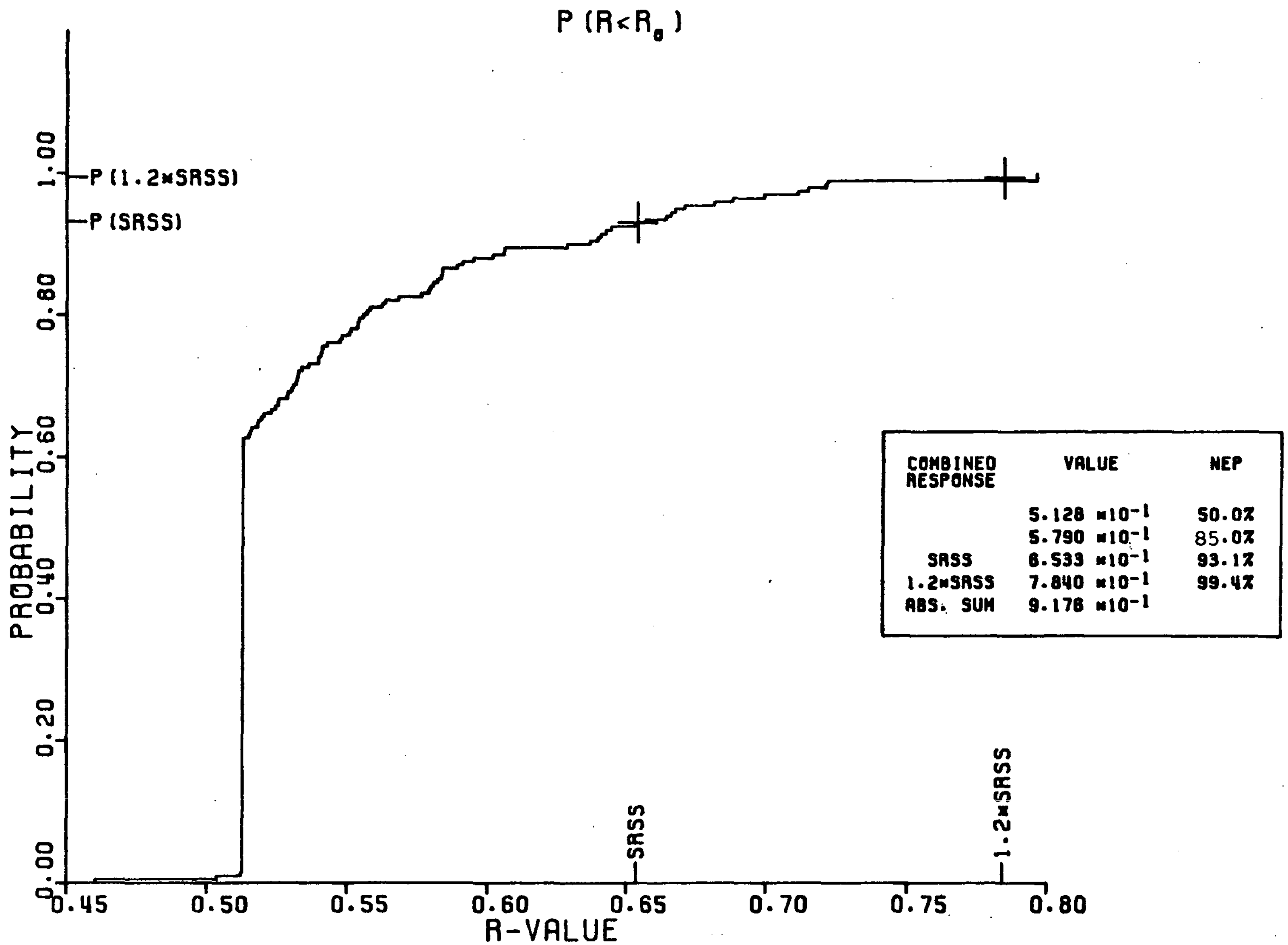


FIGURE B-35. NSSS RECIRCULATION PIPING DISCHARGE VALVE LOCATION 4-7
OBE + SRV-ALL LOAD COMBINATION, ACCELERATION (G)

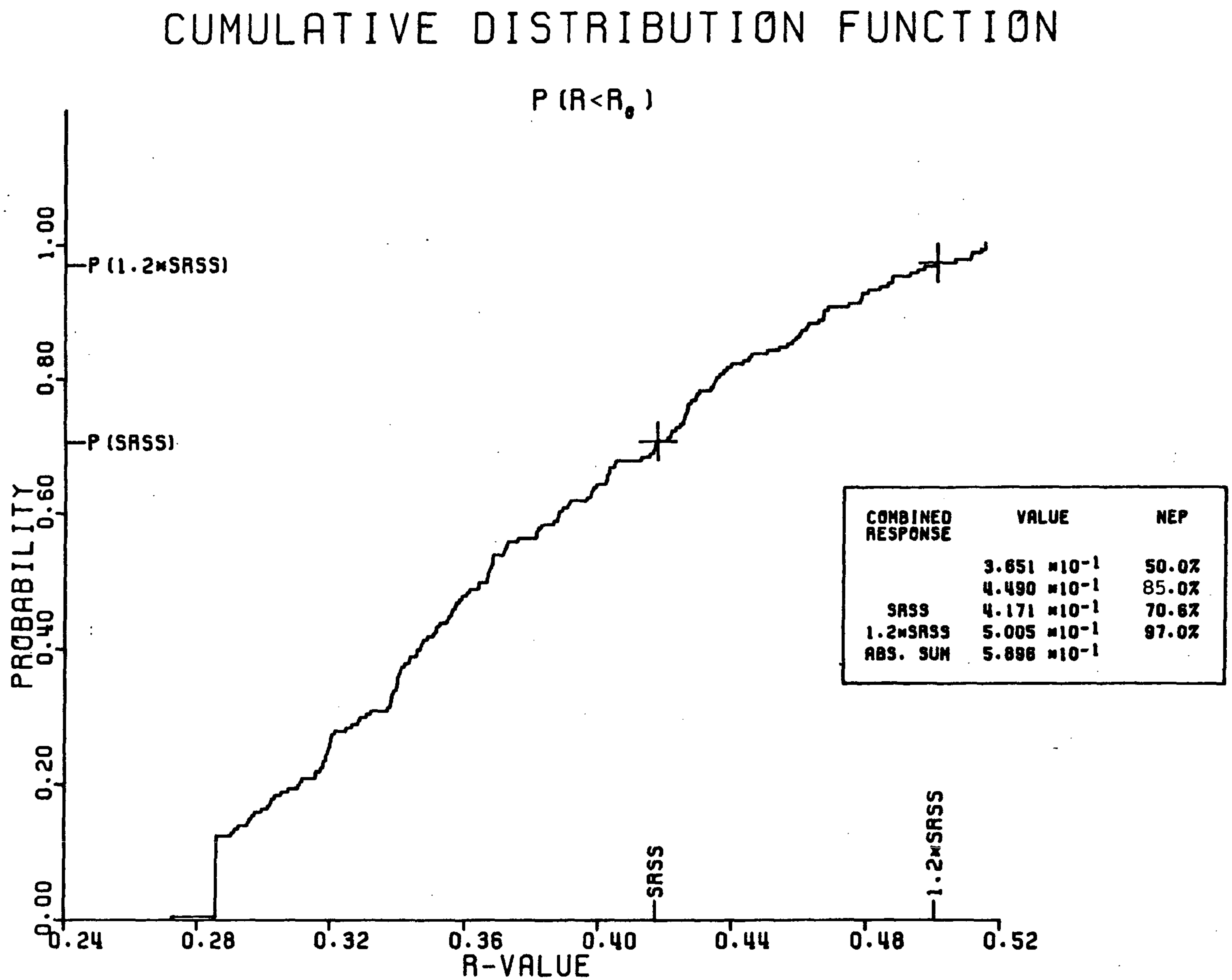


FIGURE B-36. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-1
SSE + SRV-1 LOAD COMBINATION, ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION

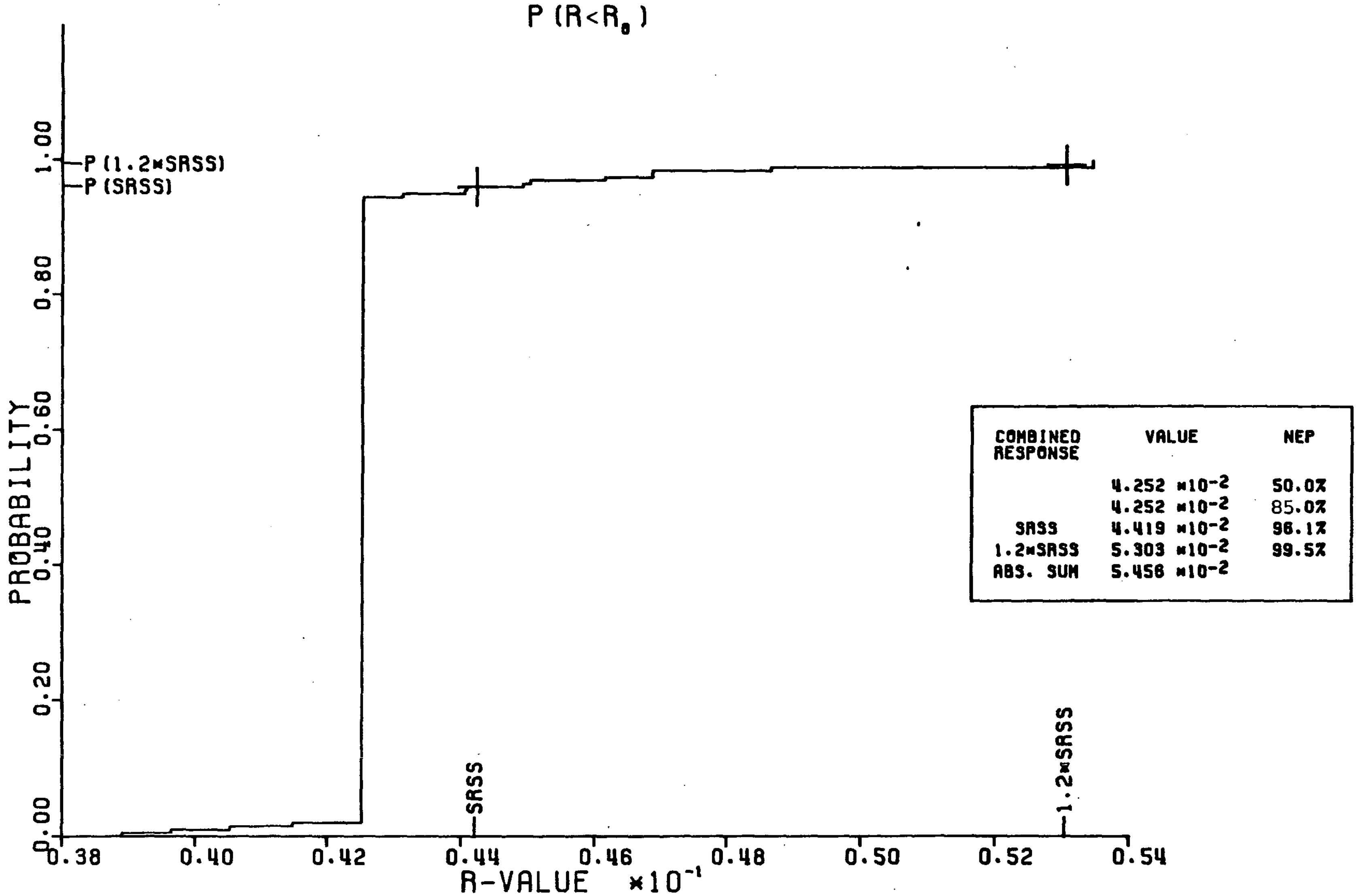


FIGURE B-37. NSSS RECIRCULATION PIPING PUMP C. G. LOCATION 4-5
SSE + SRV-1 LOAD COMBINATION, ACCELERATION (G)

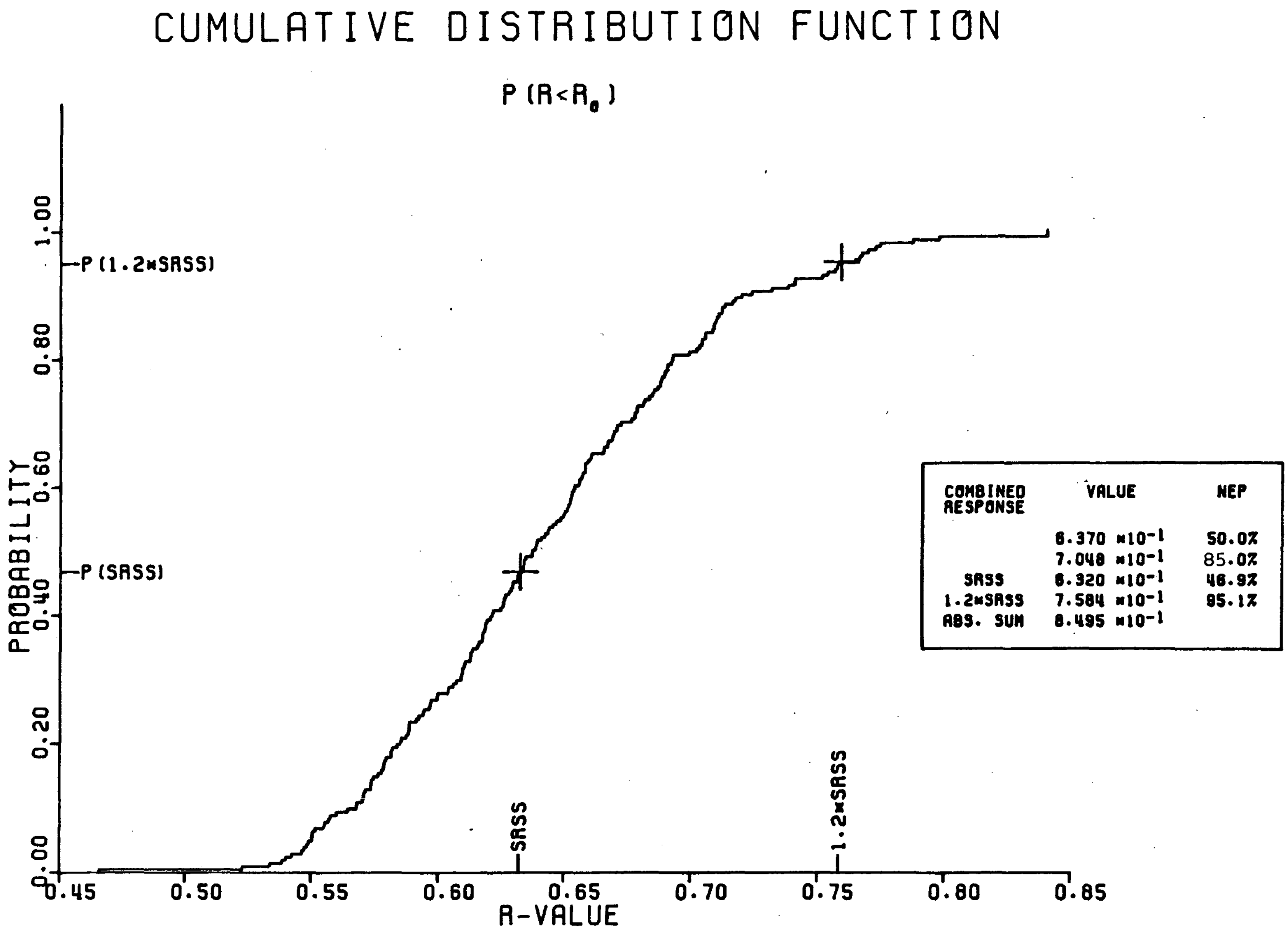
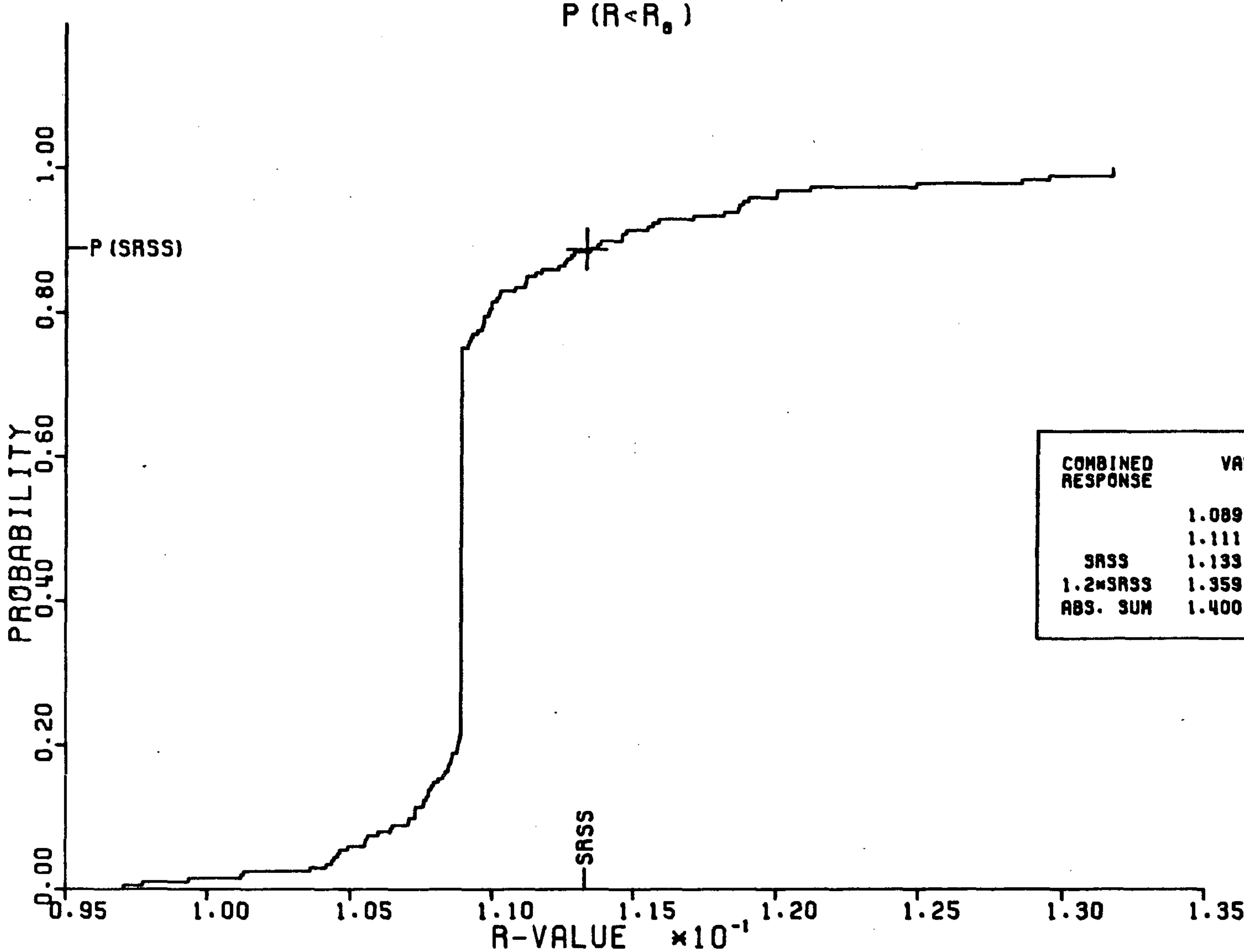


FIGURE B-38. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-1
SSE + SRV-ALL LOAD COMBINATION, ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	1.089 ×10^{-1}	50.0%
	1.111 ×10^{-1}	85.0%
SRSS	1.133 ×10^{-1}	88.9%
1.2×SRSS	1.359 ×10^{-1}	> 99.5%
ABS. SUM	1.400 ×10^{-1}	

FIGURE B-39. NSSS RECIRCULATION PIPING FLOW CONTROL VALVE LOCATION 4-6
SRV-1 + CHUG LOAD COMBINATION, ACCELERATION (G)

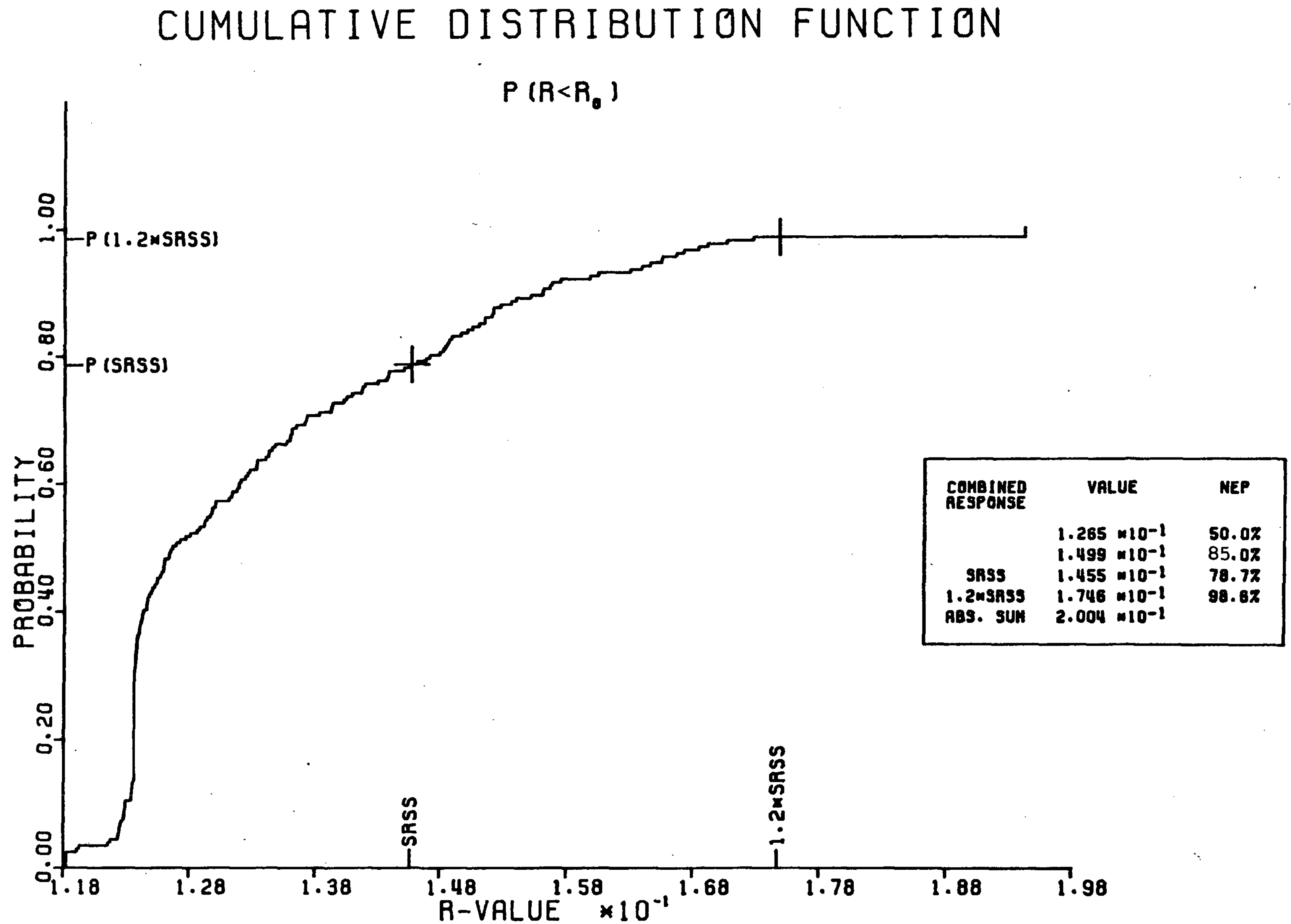


FIGURE B-40. NSSS MAIN STEAM PIPING CDF CURVE, LOCATION 6-3
CHUG + SRV-ALL LOAD COMBINATION, ACCELERATION (G)

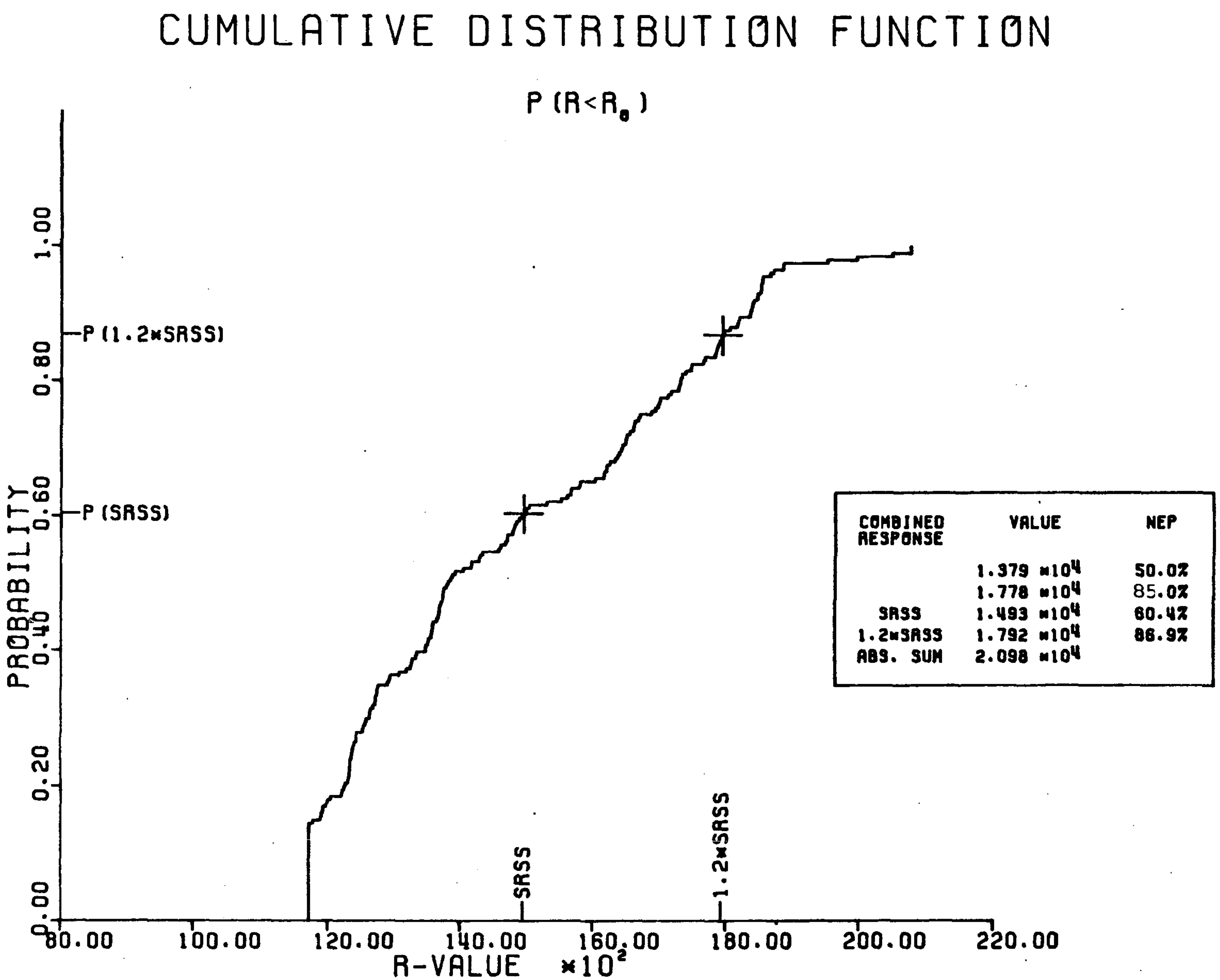


FIGURE B-41. BOP PIPING CDF CURVE, FEEDWATER LINE, LOCATION 1-2
OBE + SRV-1 LOAD COMBINATION, SUPPORT FORCE (LBS)

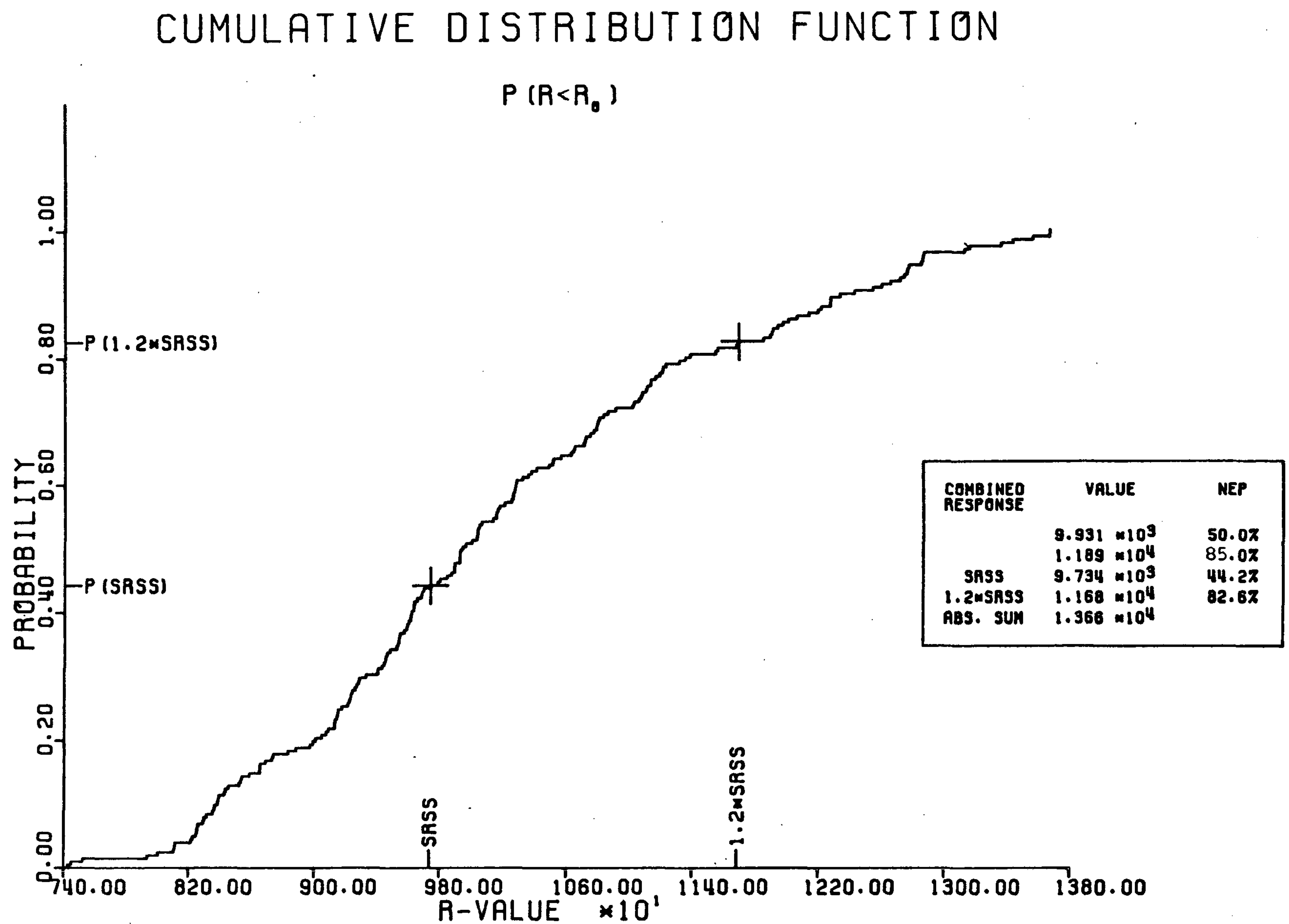
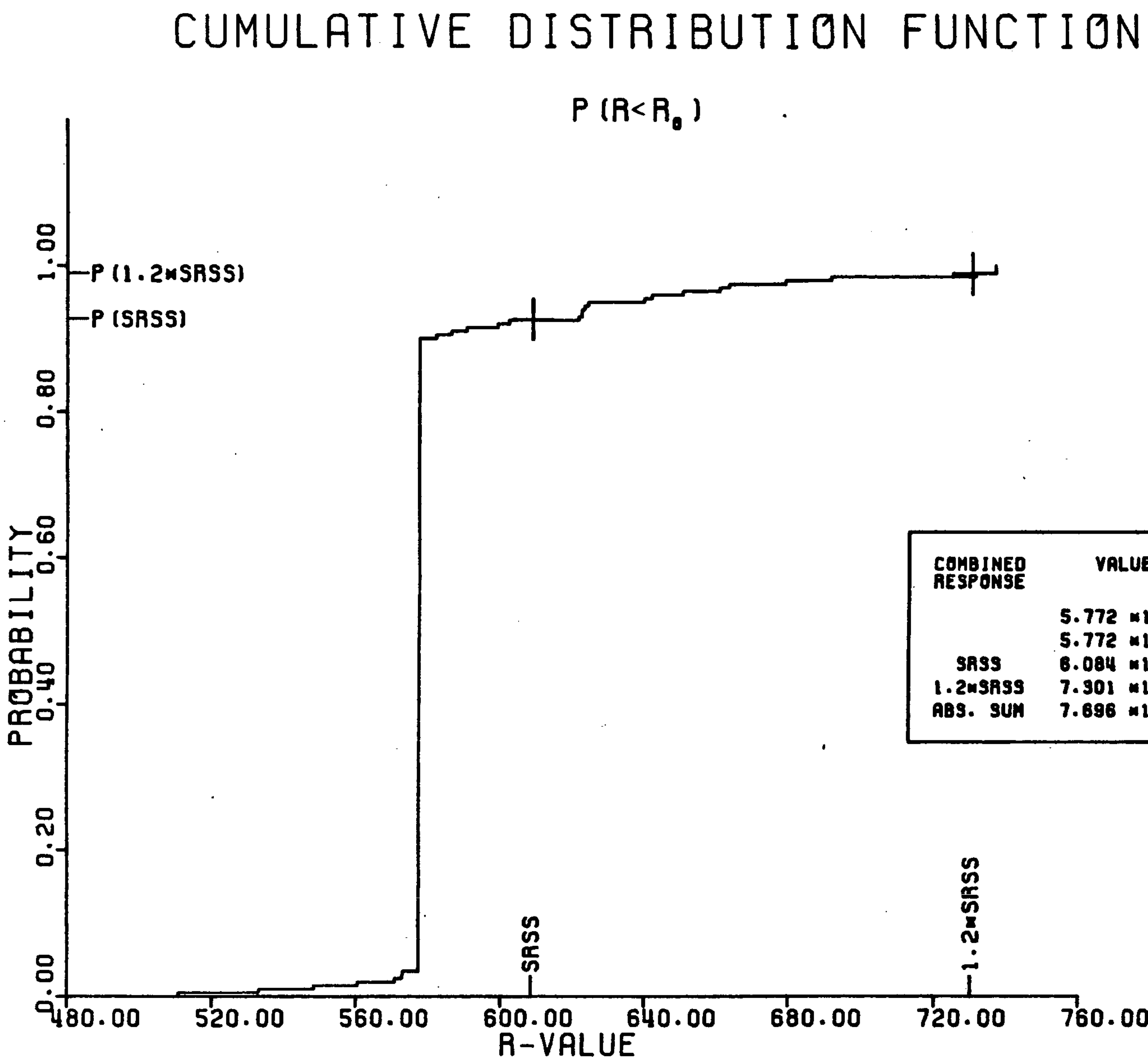


FIGURE B-42. BOP PIPING CDF CURVE, FEEDWATER LINE, LOCATION 1-3
OBE + SRV-1 LOAD COMBINATION, PIPE MOMENT MB3 (FT-LBS)



COMBINED RESPONSE	VALUE	NEP
	5.772 *10^2	50.0%
	5.772 *10^2	85.0%
SRSS	6.084 *10^2	92.7%
1.2*SRSS	7.301 *10^2	99.0%
ABS. SUM	7.696 *10^2	

FIGURE B-43. BOP PIPING CDF CURVE, FPC + CU REFUELING WATER LINE, LOCATION 2-5
OBE + SRV-1 LOAD COMBINATION, PIPE MOMENT Y (FT-LBS)

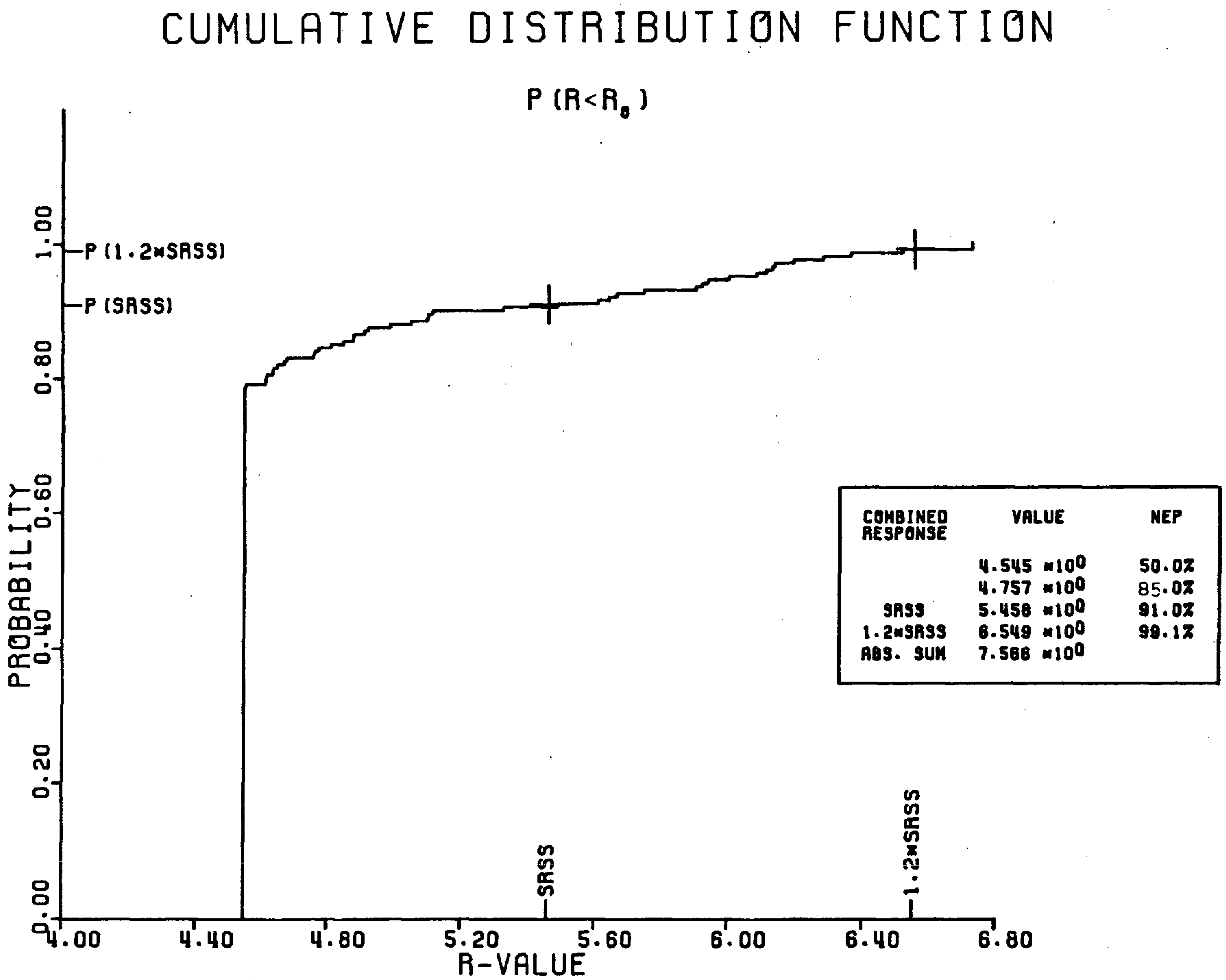


FIGURE B-44. BOP PIPING CDF CURVE, FPC + CU REFUELING WATER LINE, LOCATION 2-8
OBE + SRV-1 LOAD COMBINATION, AXIAL SUPPORT (LBS)

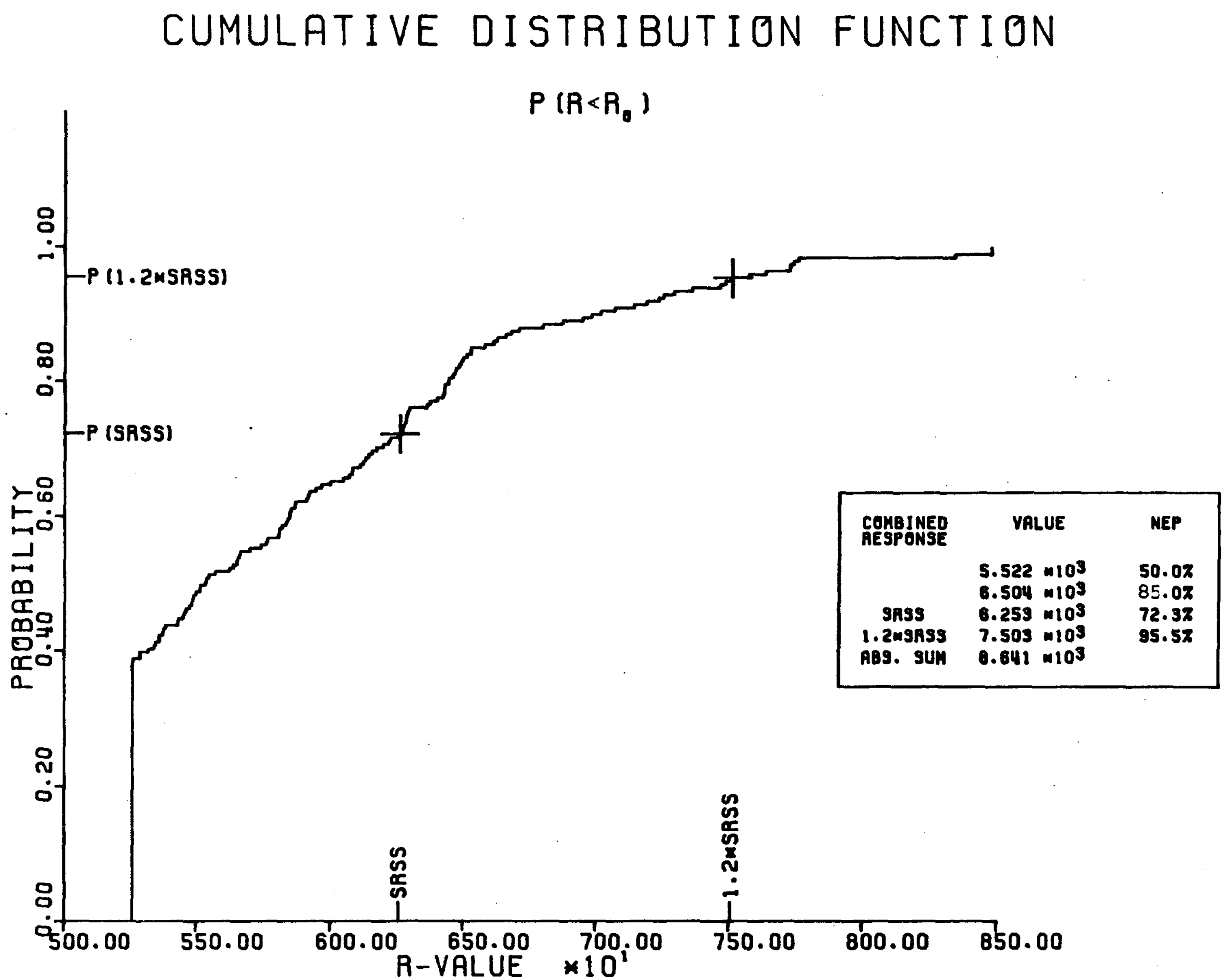


FIGURE B-45. BOP PIPING CDF CURVE, FEEDWATER LINE, LOCATION 1-1
OBE + SRV-ALL LOAD COMBINATION, PIPE MOMENT MB3 (FT-LBS)

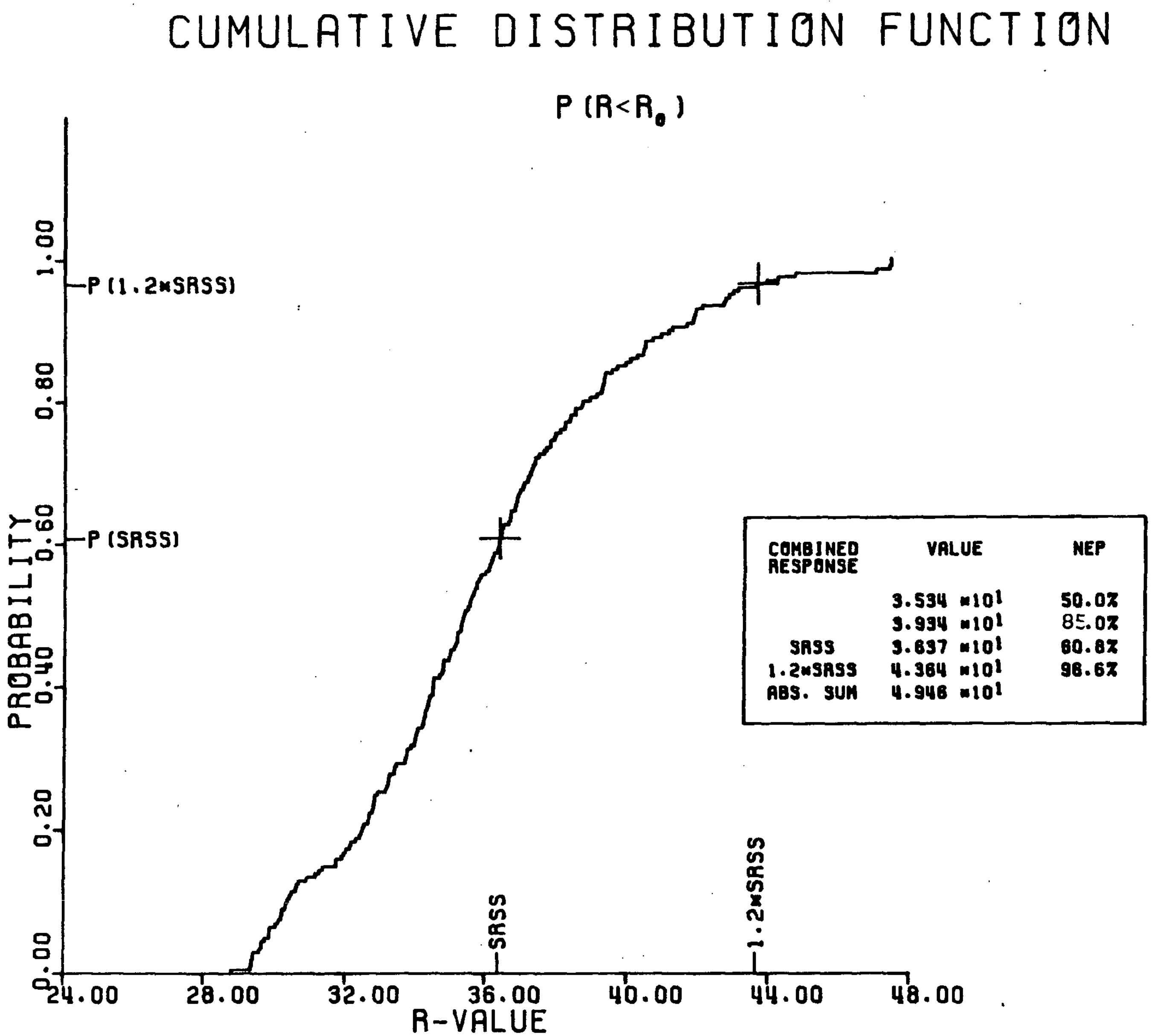


FIGURE B-46. BOP PIPING CDF CURVE, RWCU PIPING, LOCATION 1-4
OBE + SRV-ALL LOAD COMBINATION, PIPE MOMENT MB3 (FT-LBS)

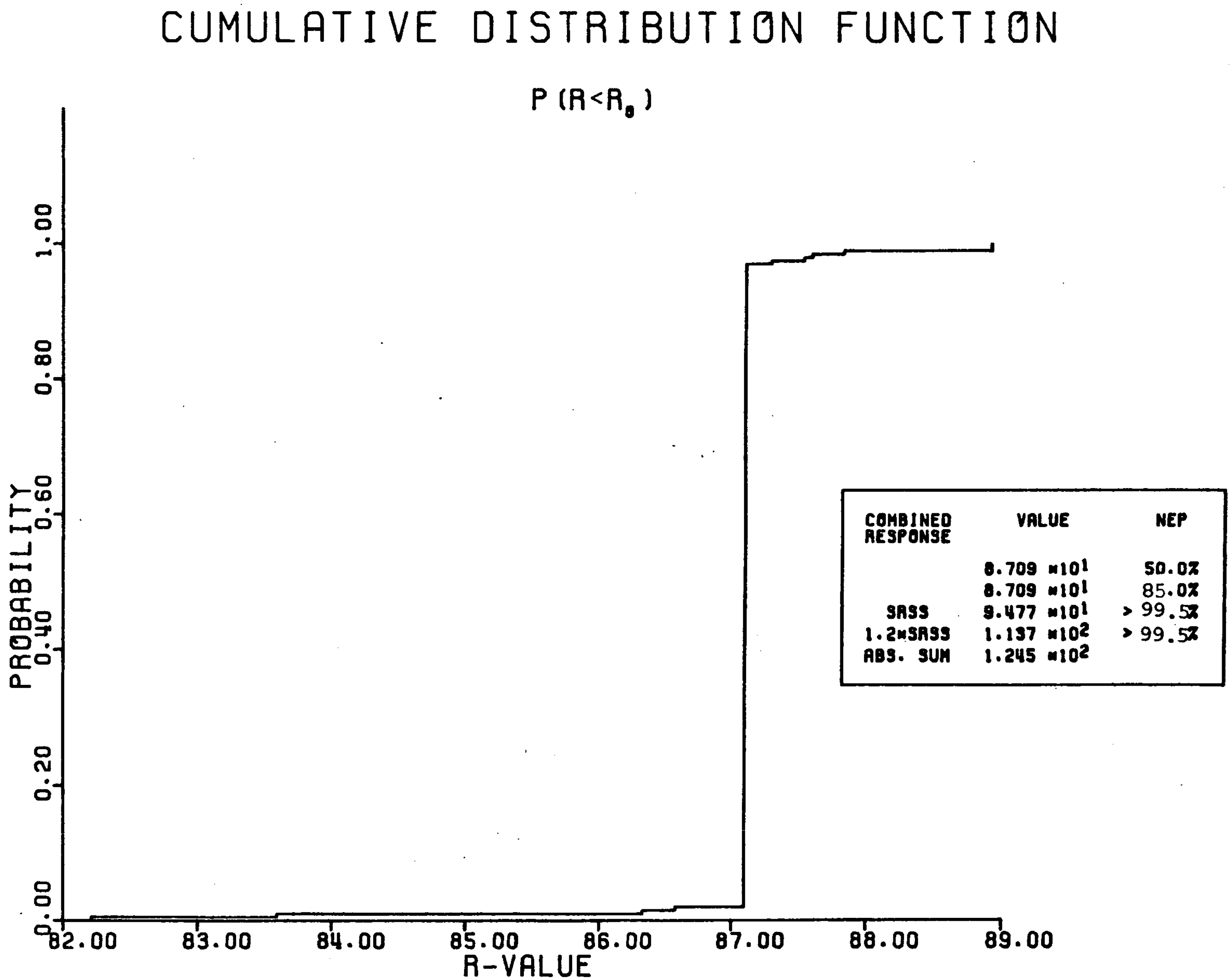
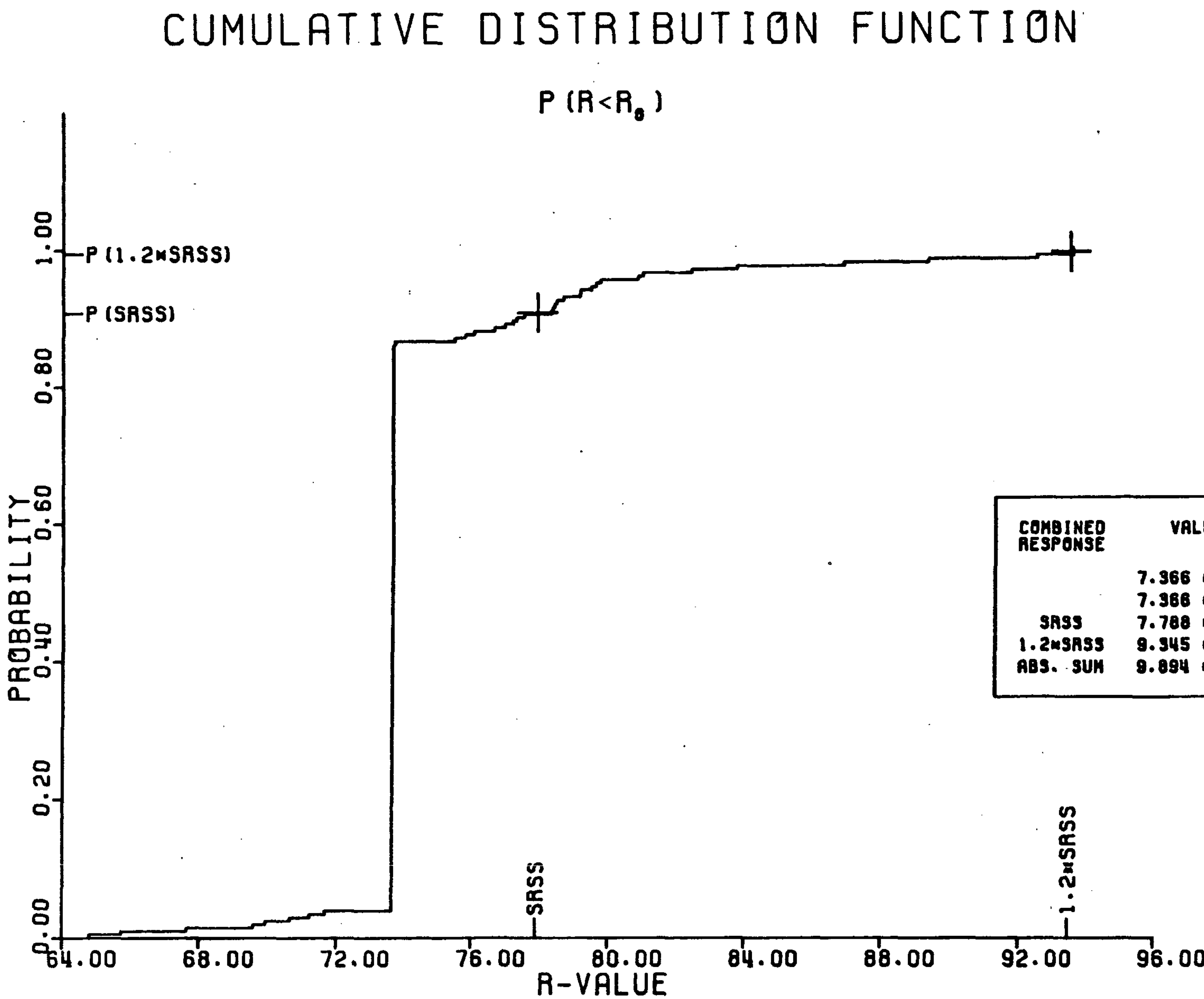


FIGURE B-47. BOP PIPING CDF CURVE, FPC + CU REFUELING WATER LINE, LOCATION 2-6
OBE + SRV-ALL LOAD COMBINATION, PIPE MOMENT Y (FT-LBS)



COMBINED RESPONSE	VALUE	NEP
	7.366 *10^{1}	50.0%
	7.366 *10^{1}	85.0%
SRSS	7.788 *10^{1}	90.8%
1.2*SRSS	9.345 *10^{1}	99.5%
ABS. SUM	9.894 *10^{1}	

FIGURE B-48. BOP PIPING CDF CURVE, FPC + CU REFUELING WATER LINE, LOCATION 2-7 OBE + SRV-ALL LOAD COMBINATION, PIPE MOMENT Y (FT-LBS)

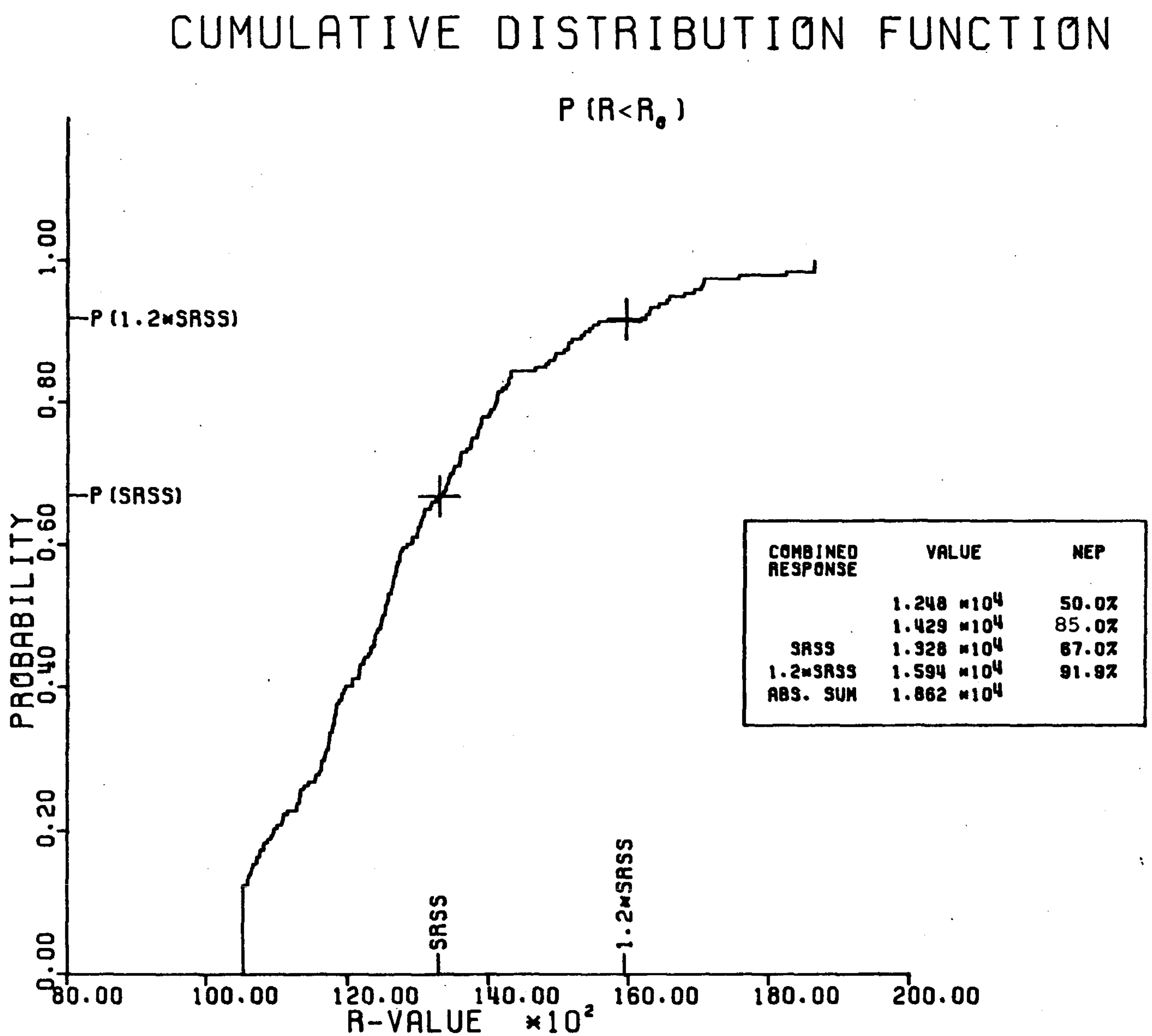


FIGURE B-49. BOP PIPING CDF CURVE, FEEDWATER LINE, LOCATION 1-1
SSE + SRV-1 LOAD COMBINATION, PIPE MOMENT MB3 (FT-LBS)

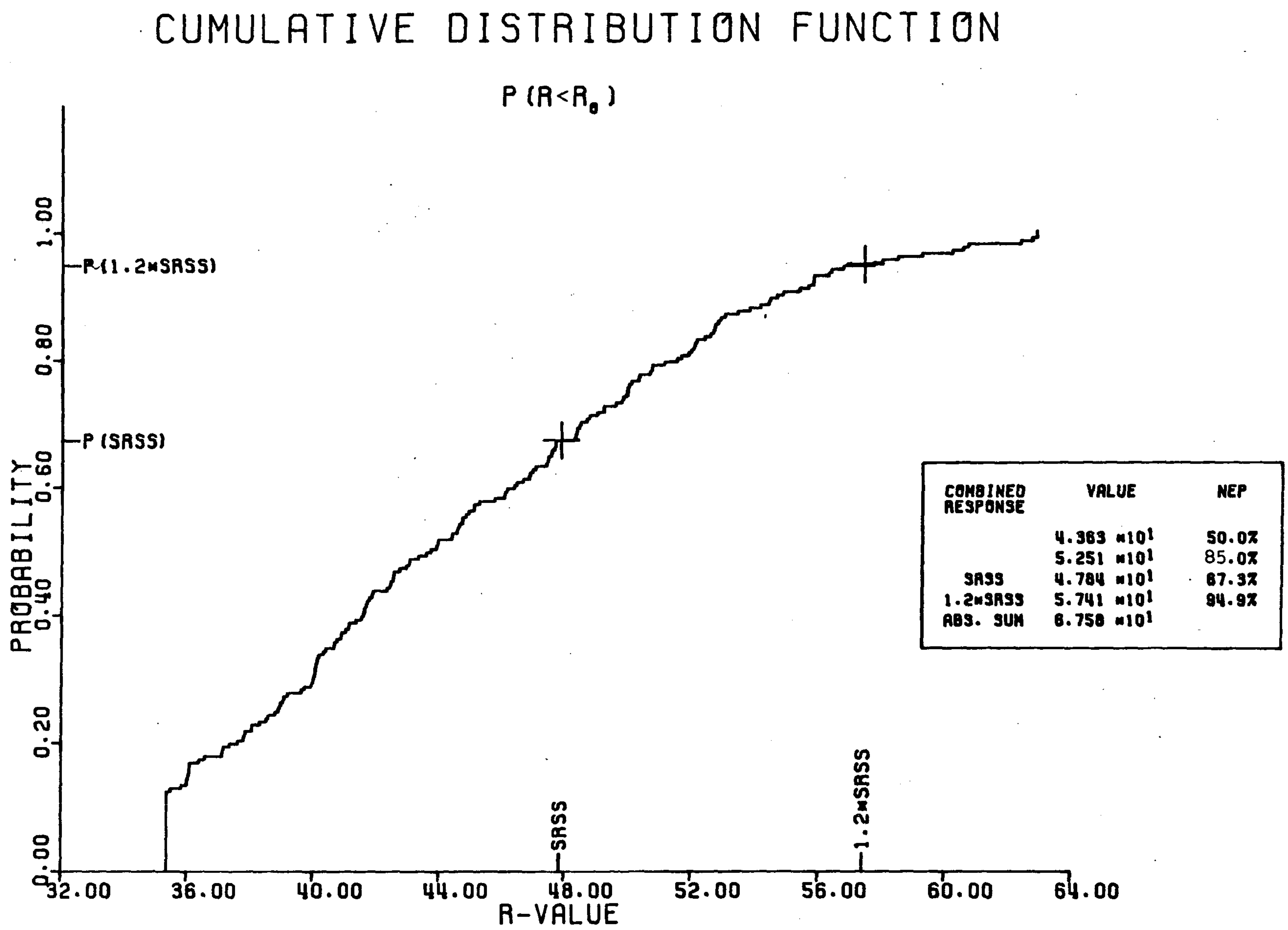


FIGURE B-50. BOP PIPING CDF CURVE, RWCU PIPING, LOCATION 1-4
SSE + SRV-1 LOAD COMBINATION, PIPE MOMENT MB3 (FT-LBS)

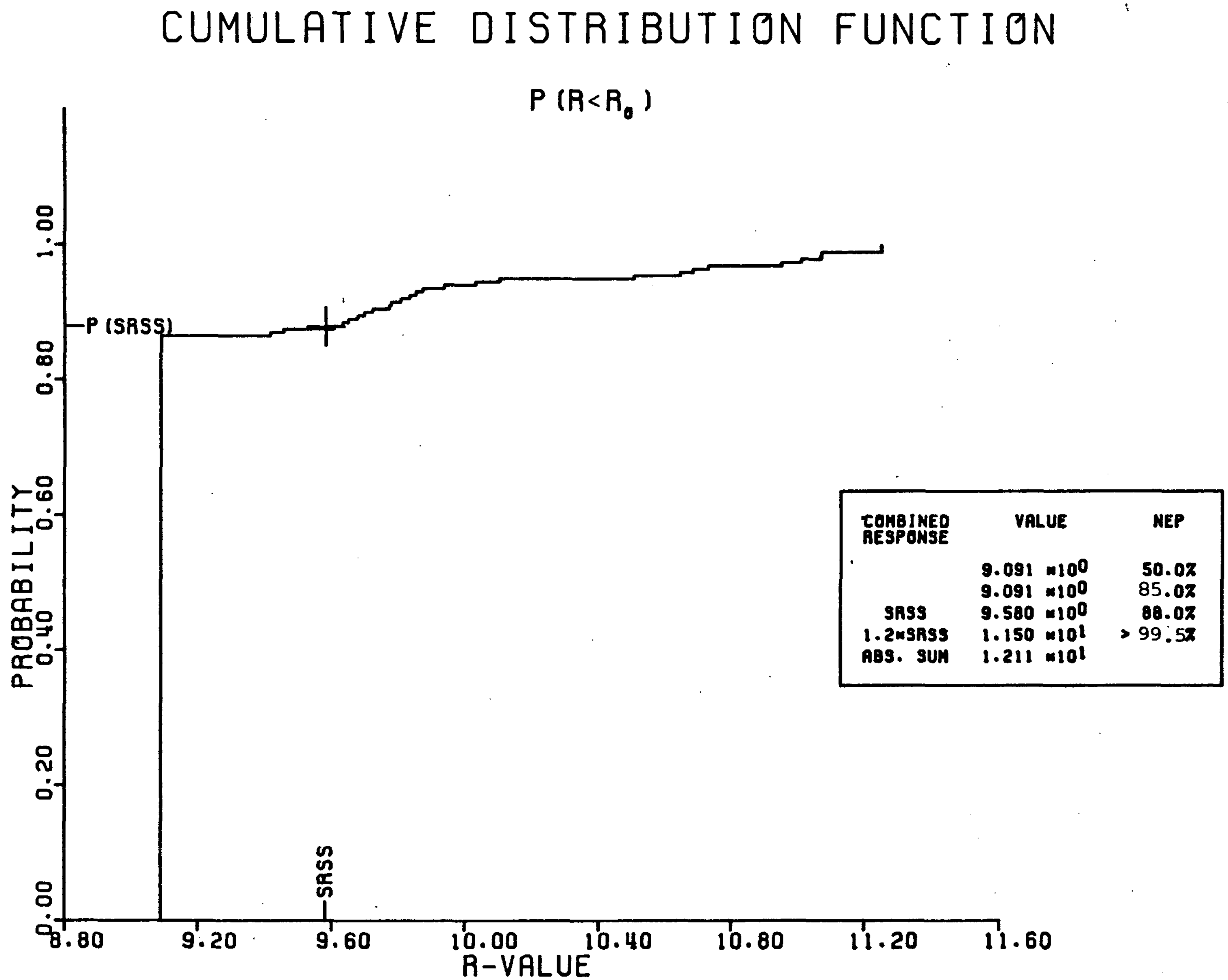


FIGURE B-51. BOP PIPING CDF CURVE, FPC & CU REFUELING WATER LINE, LOCATION 2-8
SSE + SRV-1 LOAD COMBINATION, AXIAL SUPPORT (LBS)

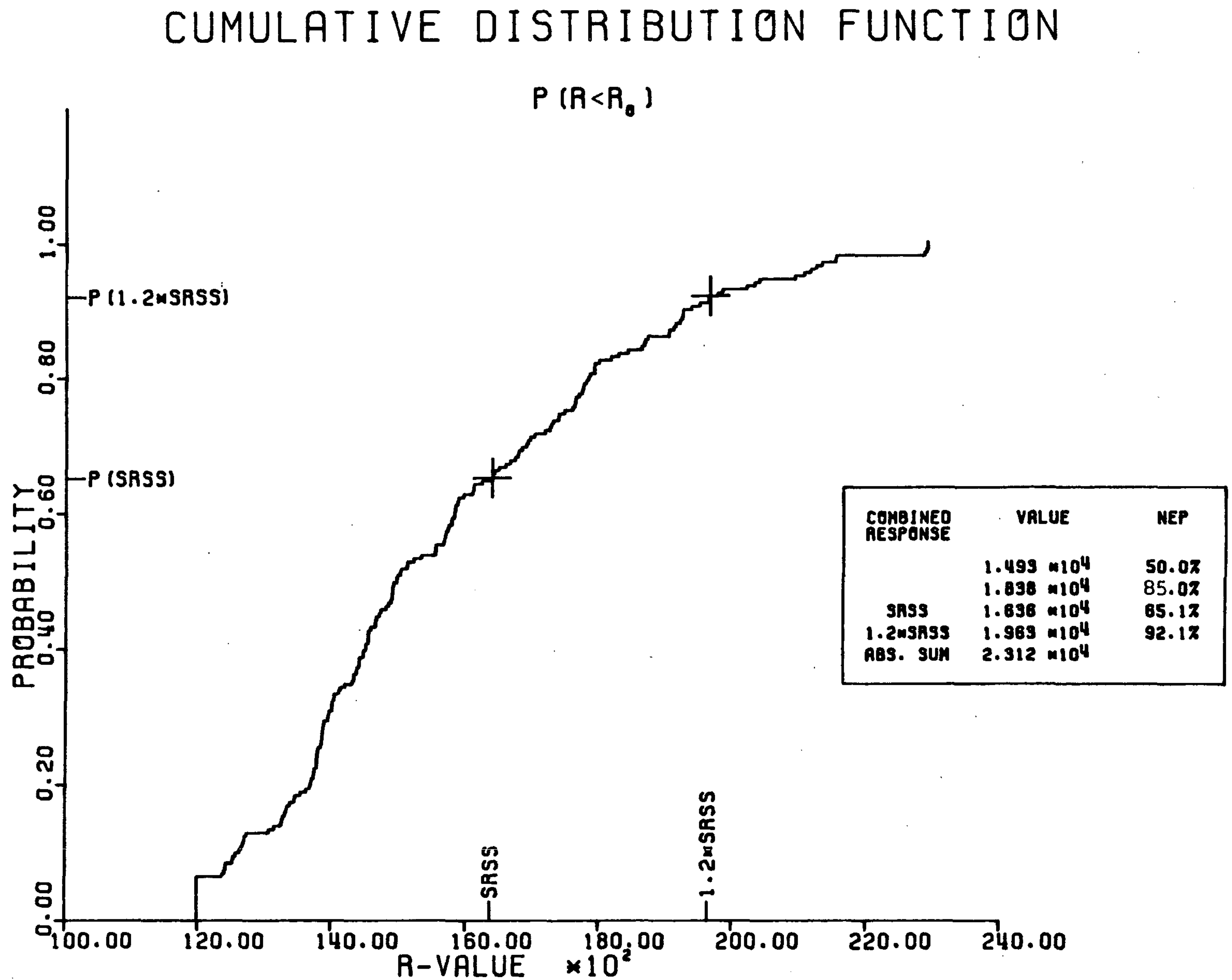


FIGURE B-52. BOP PIPING CDF CURVE, FEEDWATER LINE, LOCATION 1-3
SSE + SRV-ALL LOAD COMBINATION, PIPE MOMENT MB3 (FT-LBS)

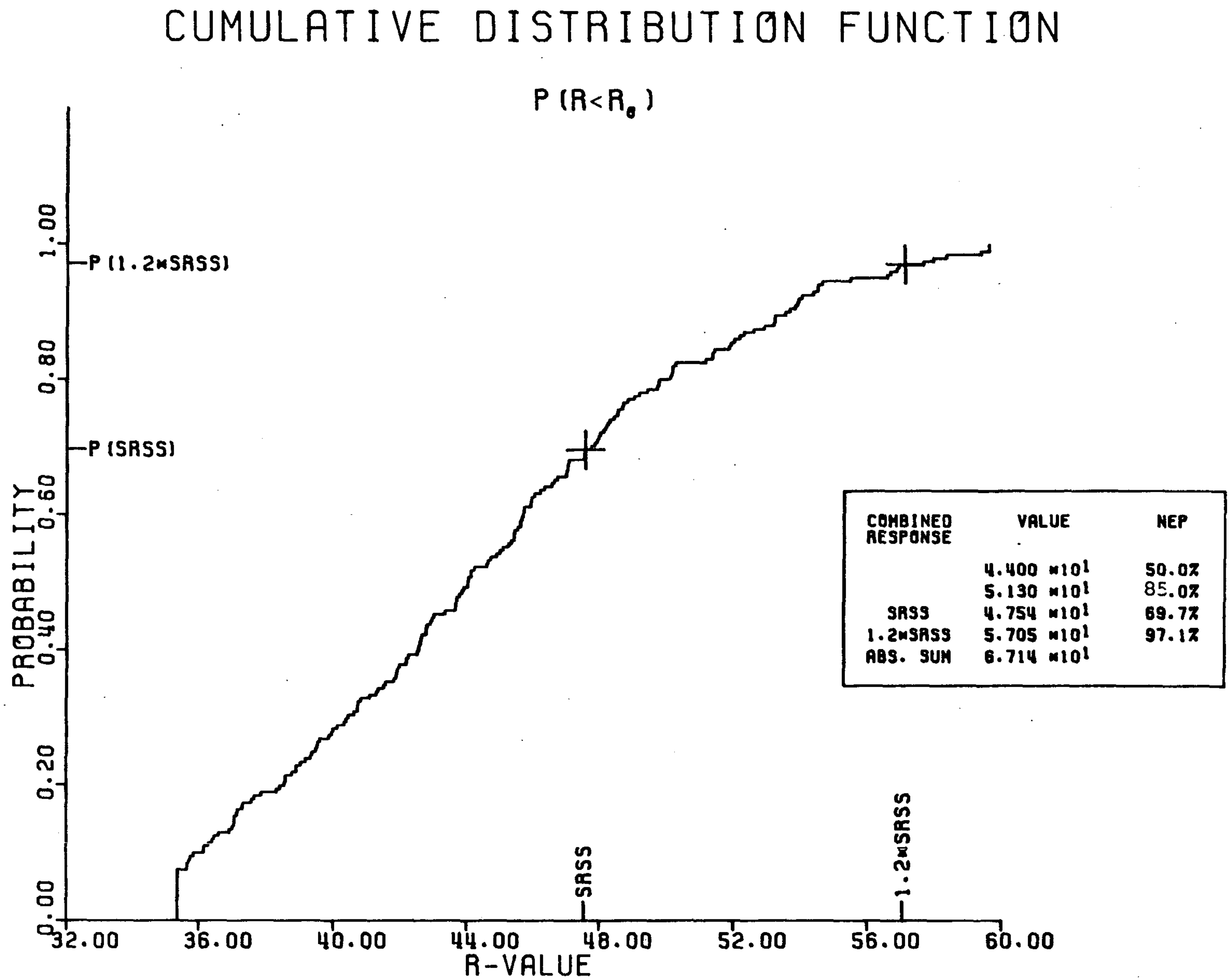


FIGURE B-53. BOP PIPING CDF CURVE, RWCU PIPING, LOCATION 1-4
SSE + SRV-ALL LOAD COMBINATION, PIPE MOMENT MB3 (FT-LBS)

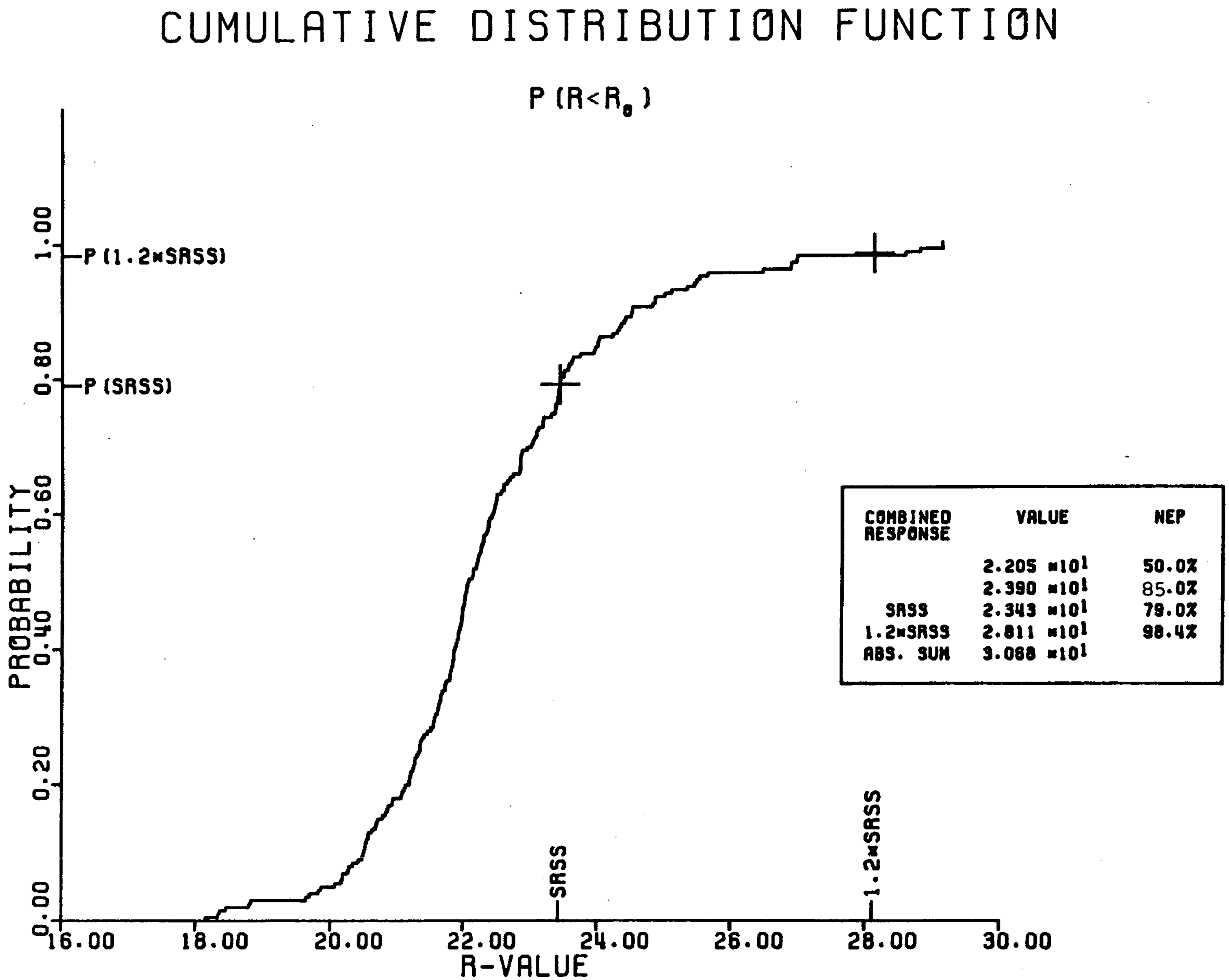


FIGURE B-54. BOP PIPING CDF CURVE, FPC & CU REFUELING WATER LINE, LOCATION 2-8
SSE + SRV-ALL LOAD COMBINATION, AXIAL SUPPORT (LBS)

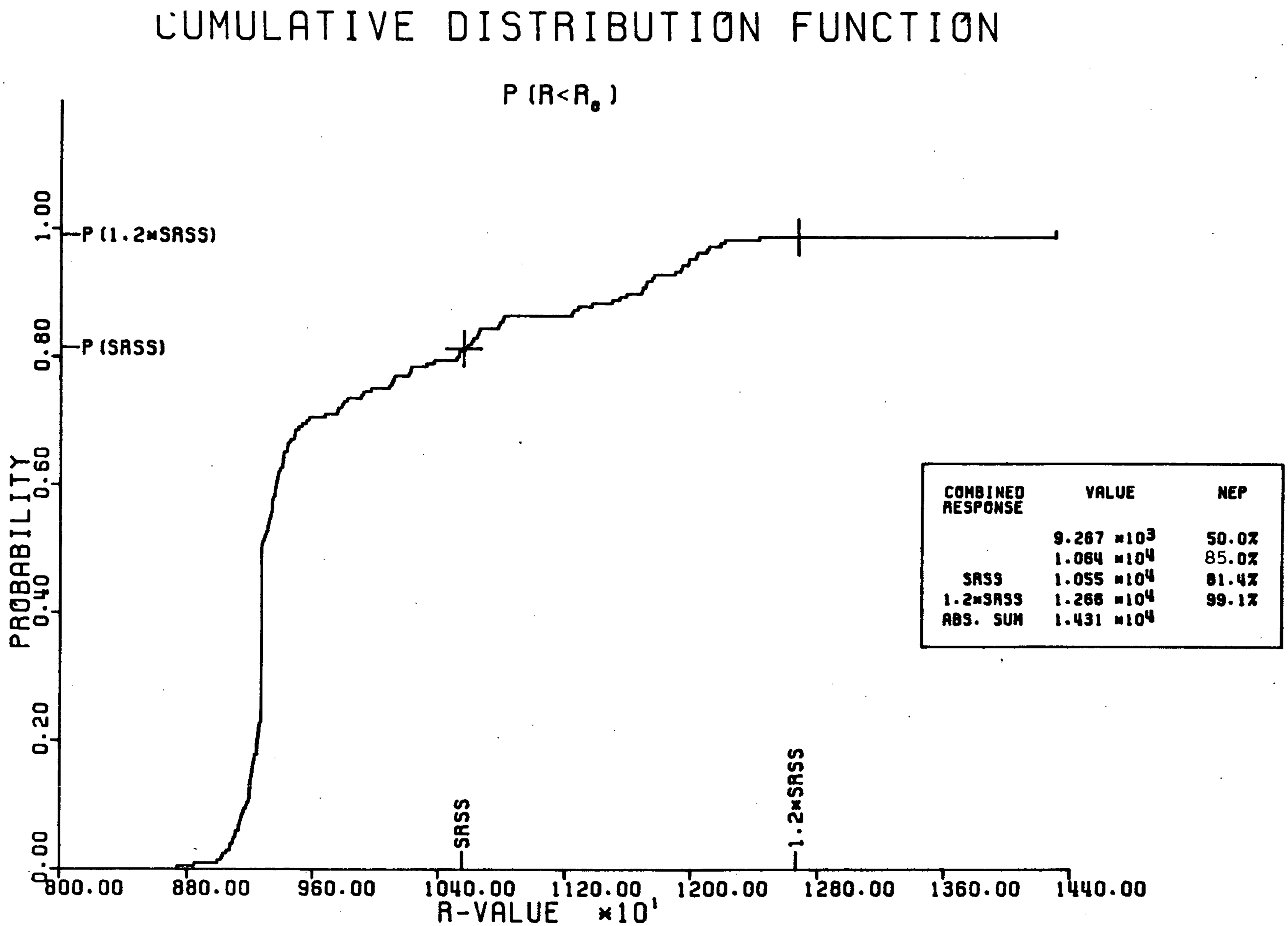


FIGURE B-55. BOP PIPING CDF CURVE, FEEDWATER LINE, LOCATION 1-2
SRV-1 + CHUG LOAD COMBINATION, SUPPORT FORCE (LBS)

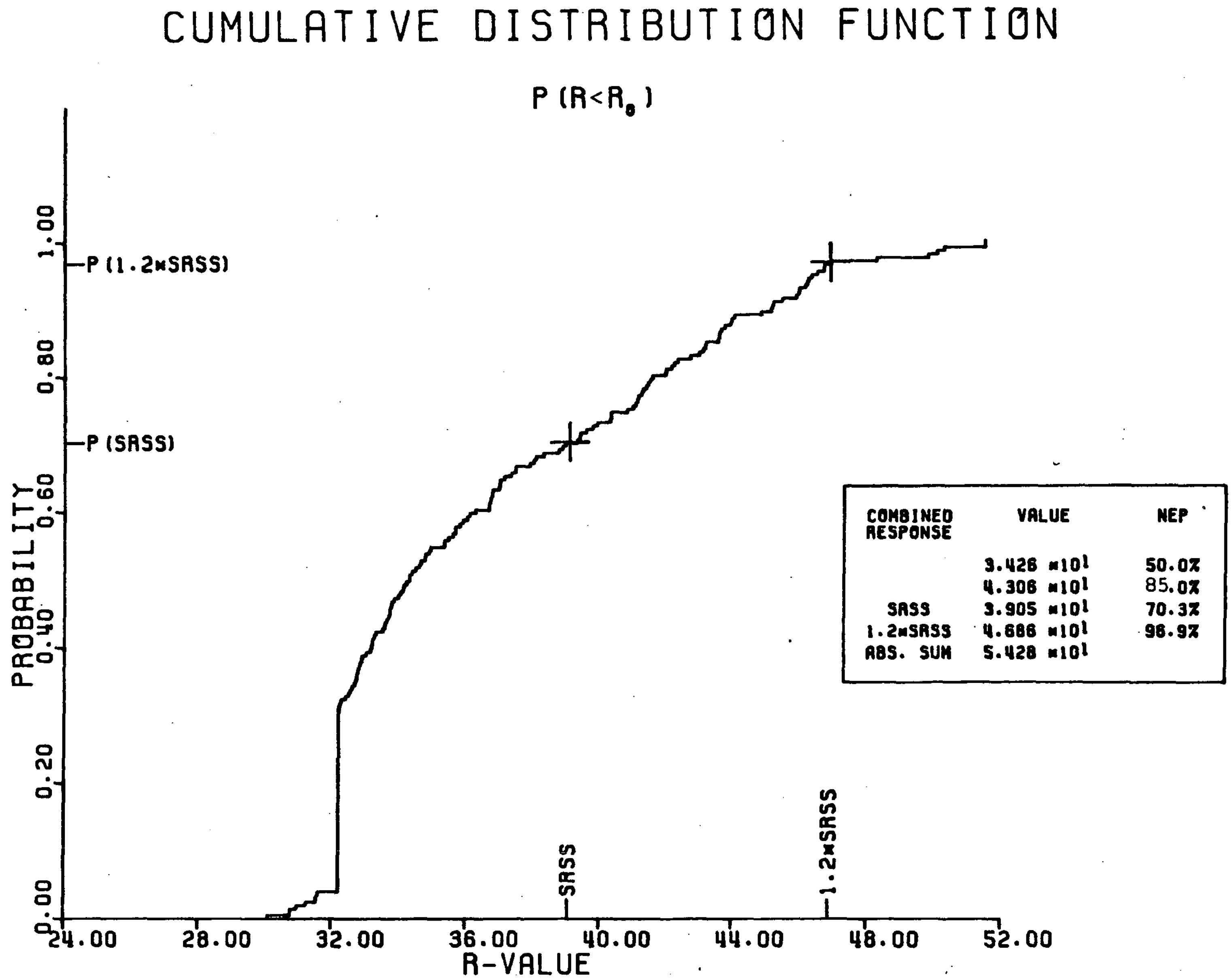


FIGURE B-56. BOP PIPING CDF CURVE, RWCU PIPING, LOCATION 1-4
SRV-1 + CHUG LOAD COMBINATION, PIPE MOMENT MB3 (FT-LBS)

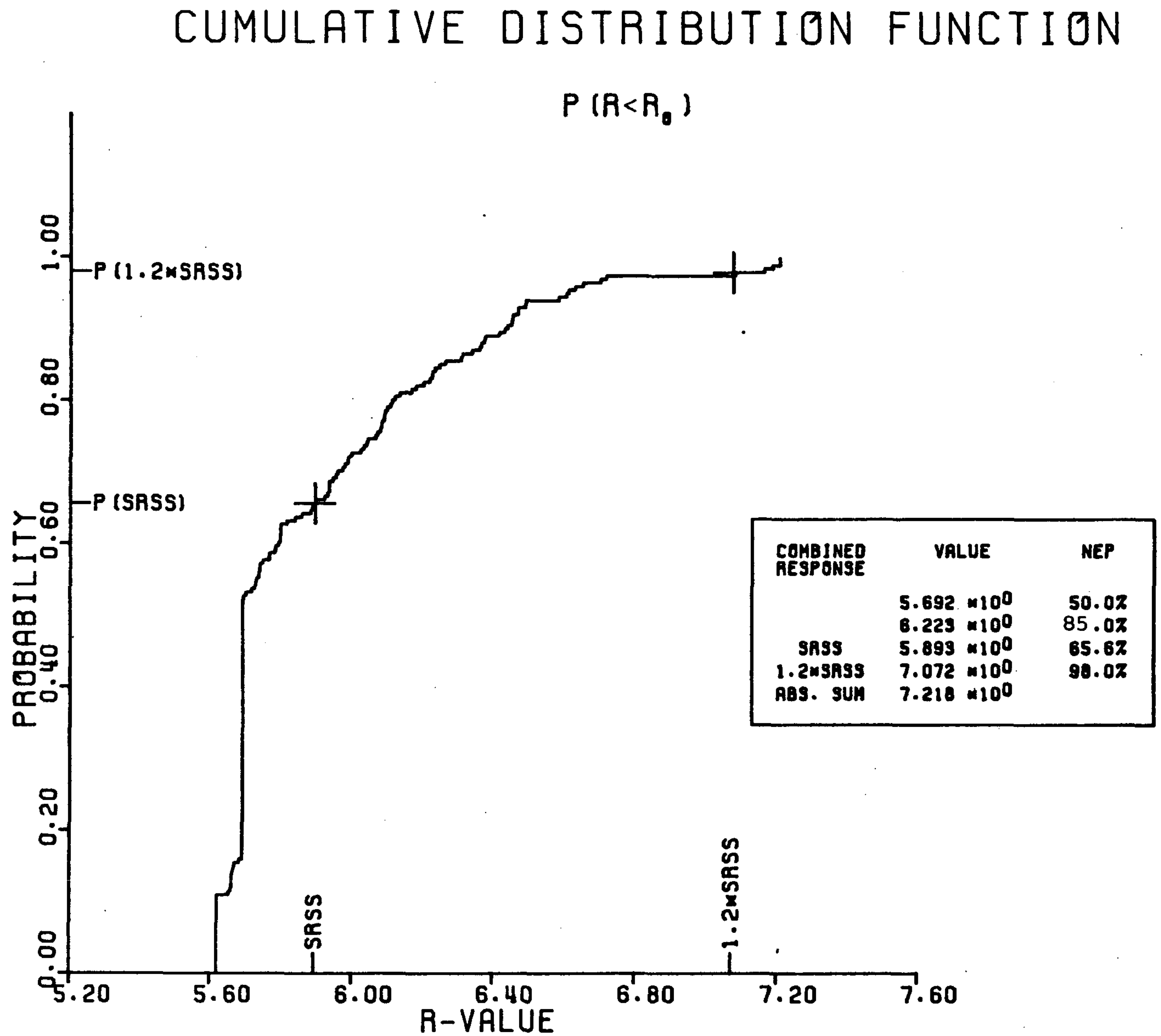
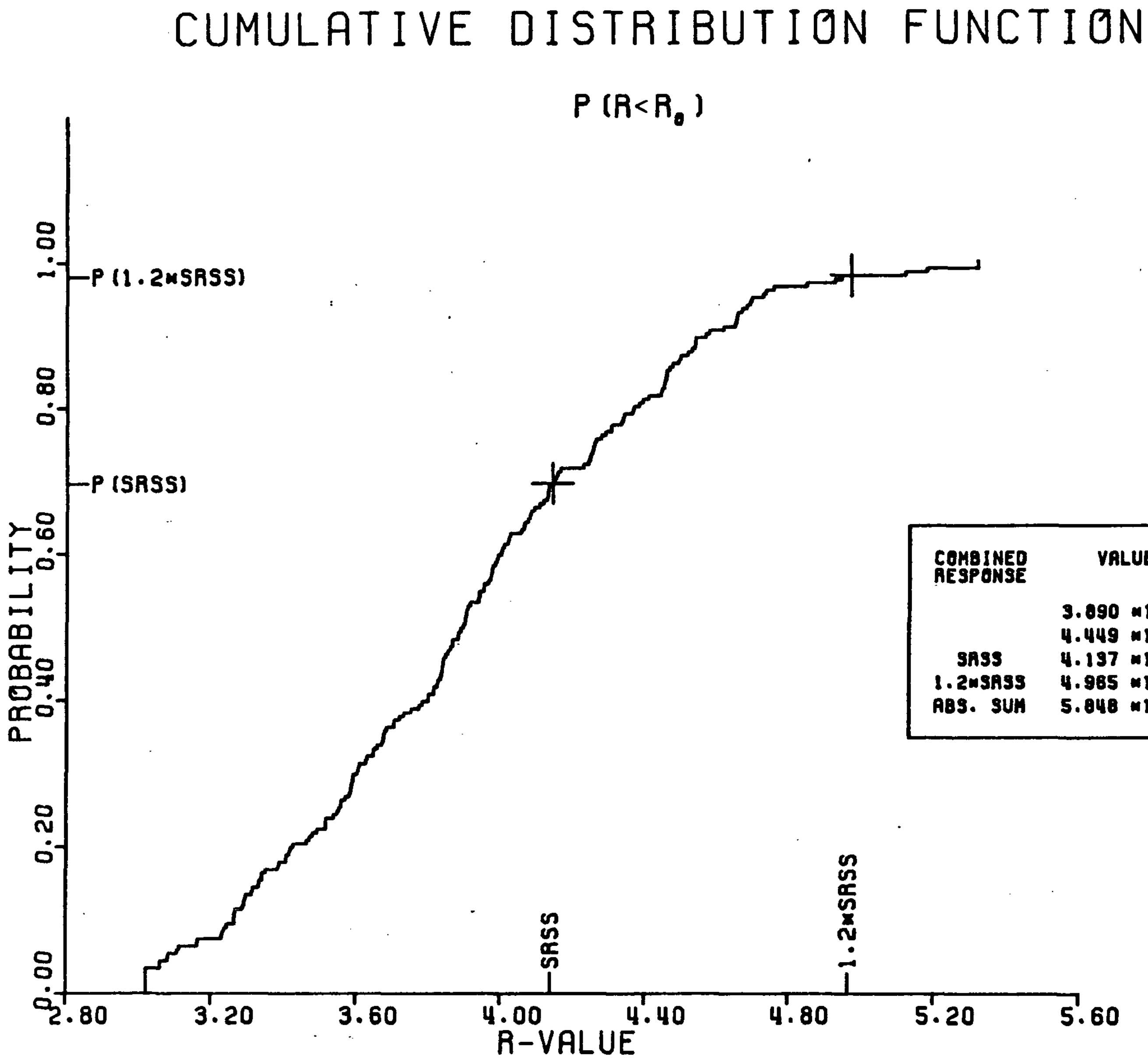


FIGURE B-57. BOP PIPING CDF CURVE, FPC + CU REFUELING WATER LINE, LOCATION 2-7
SRV-1 + CHUG LOAD COMBINATION, PIPE MOMENT Y (FT-LBS)



COMBINED RESPONSE	VALUE	NEP
	3.890 *10^0	50.0%
	4.449 *10^0	85.0%
SRSS	4.137 *10^0	69.6%
1.2*SRSS	4.965 *10^0	98.1%
ABS. SUM	5.848 *10^0	

FIGURE B-58. BOP PIPING CDF CURVE, FPC + CU REFUELING WATER LINE, LOCATION 2-8
SRV-1 + CHUG LOAD COMBINATION, AXIAL SUPPORT (LBS)

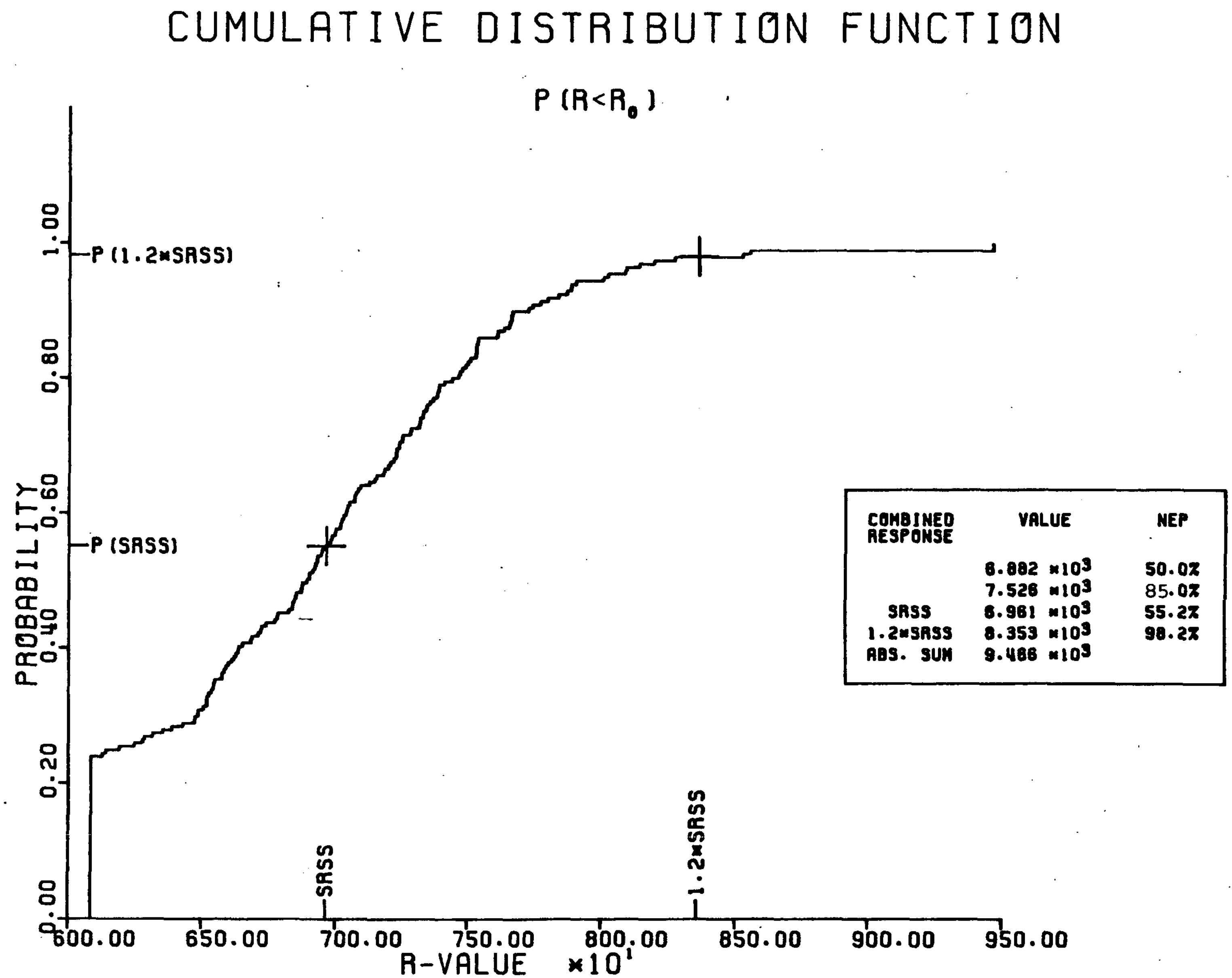


FIGURE B-59. BOP PIPING CDF CURVE, FEEDWATER LINE, LOCATION 1-1
SRV-ALL + CHUG LOAD COMBINATION, PIPE MOMENT MB3 (FT-LBS)

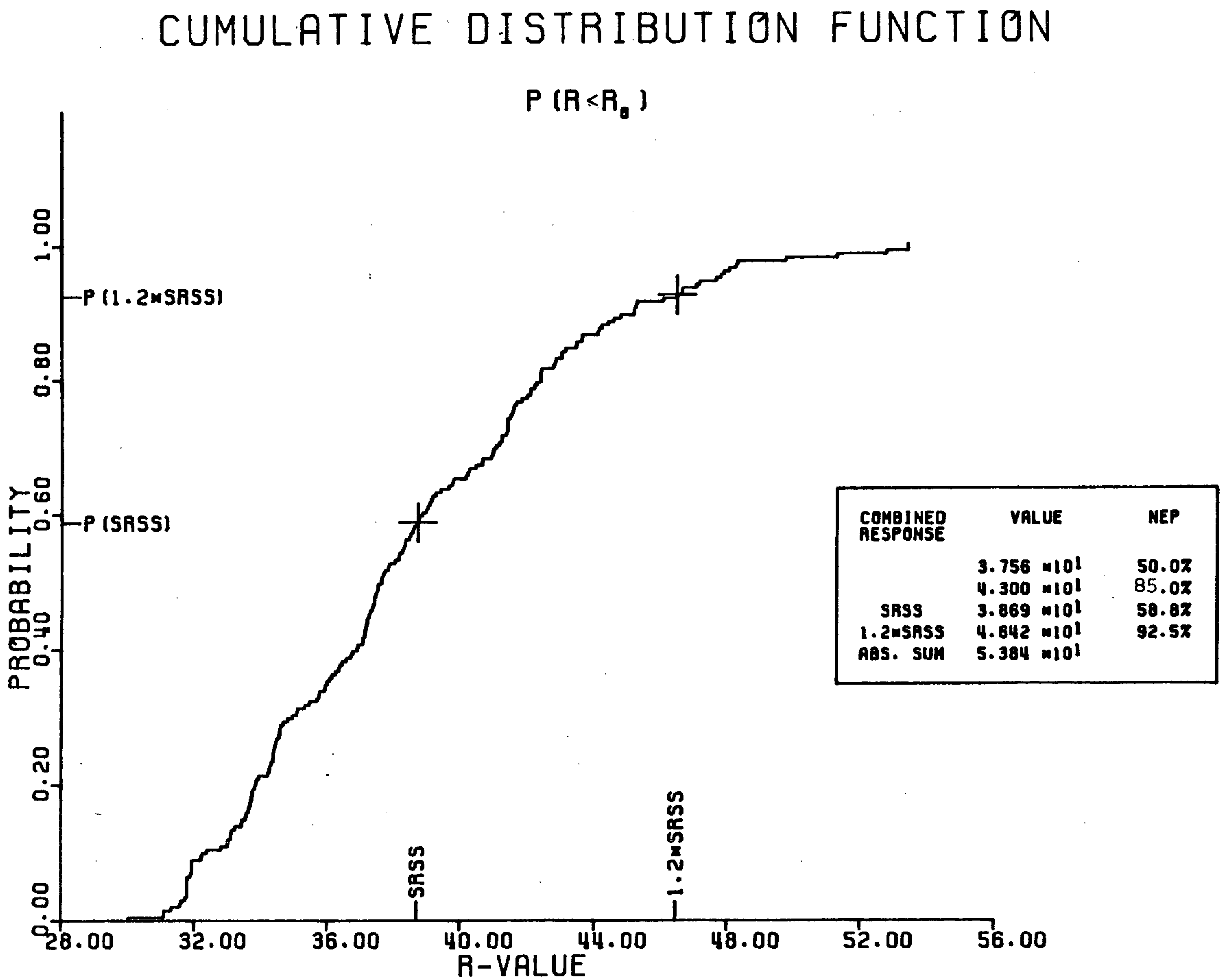


FIGURE B-60. BOP PIPING CDF CURVE, RWCU PIPING, LOCATION 1-4
SRV-ALL + CHUG LOAD COMBINATION, PIPE MOMENT MB3 (FT-LBS)

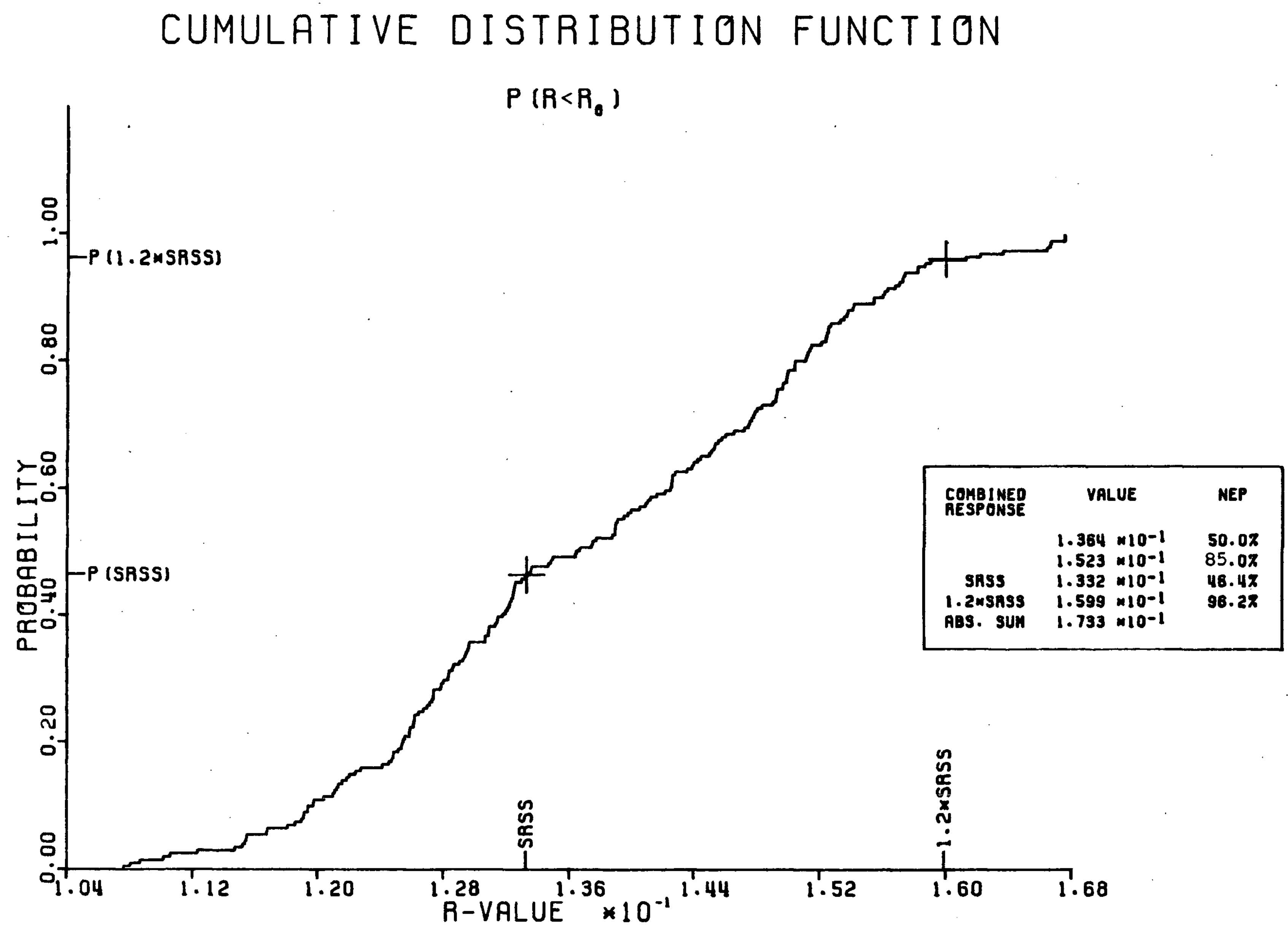


FIGURE B-61. BOP PIPING CDF CURVE, HPCS TEST LINE, LOCATION 3-1
OBE + SRV-ALL LOAD COMBINATION, ACCELERATION (G)

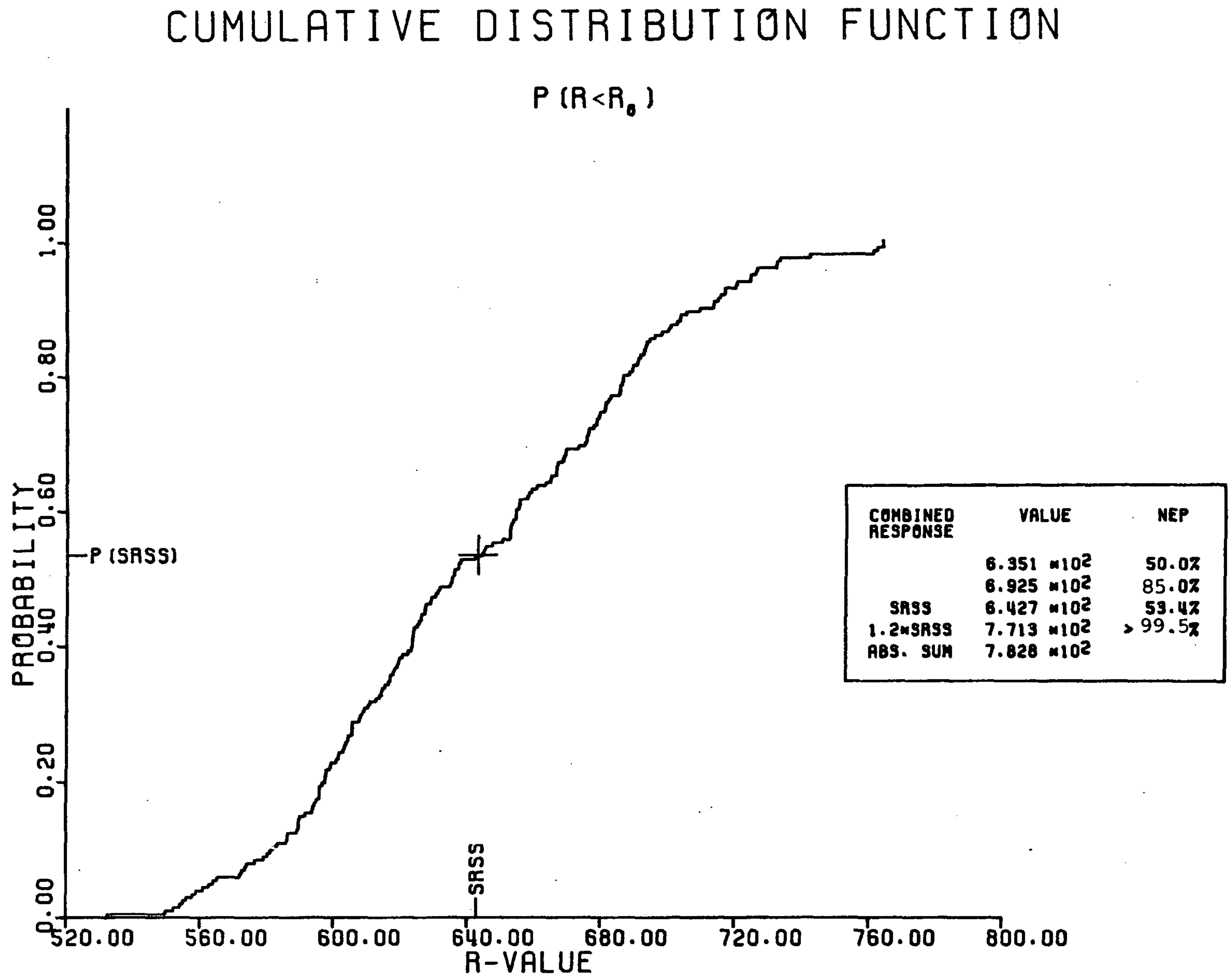


FIGURE B-62. BOP PIPING CDF CURVE, HPCS TEST LINE, LOCATION 3-3
OBE + SRV-ALL LOAD COMBINATION, SUPPORT FORCE (LBS)

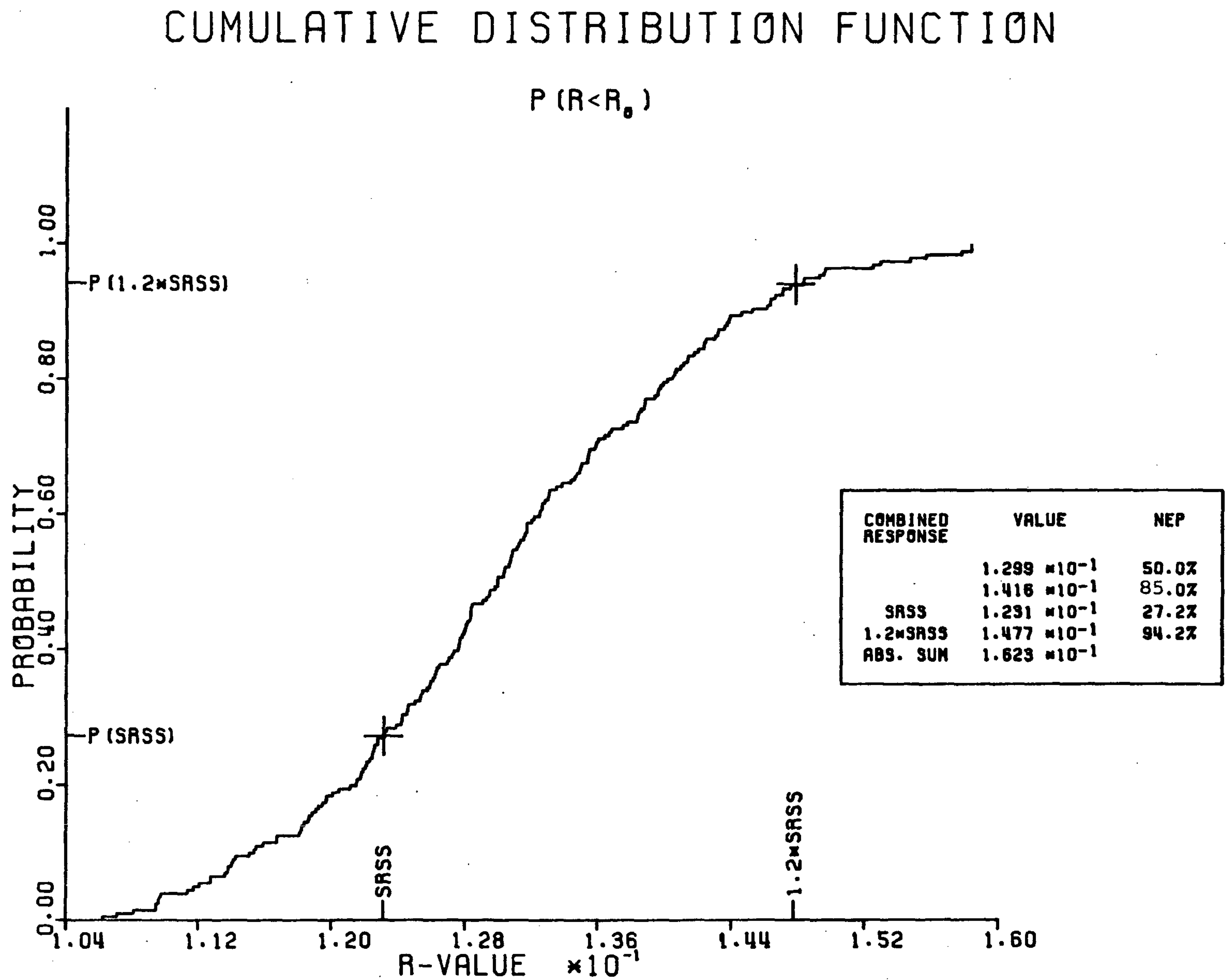
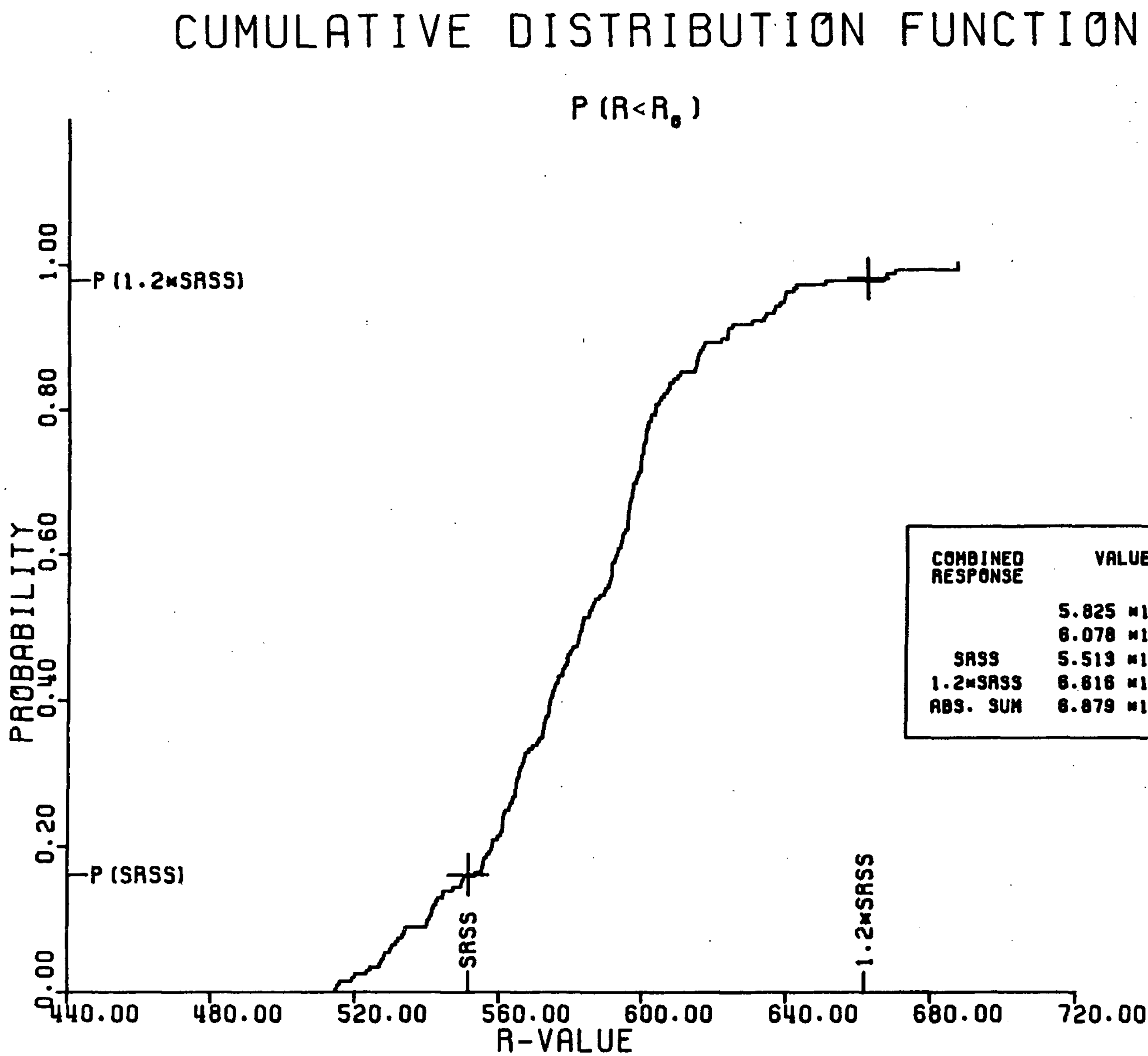


FIGURE B-63. BOP PIPING CDF CURVE, HPCS TEST LINE, LOCATION 3-1
OBE + SRV-ADS LOAD COMBINATION, ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	5.825 *10²	50.0%
	6.078 *10²	85.0%
SRSS	5.513 *10²	16.1%
1.2*SRSS	6.616 *10²	97.9%
ABS. SUM	6.879 *10²	

FIGURE B-64. BOP PIPING CDF CURVE, HPCS TEST LINE, LOCATION 3-3
OBE + SRV-ADS LOAD COMBINATION, SUPPORT FORCE (LBS)

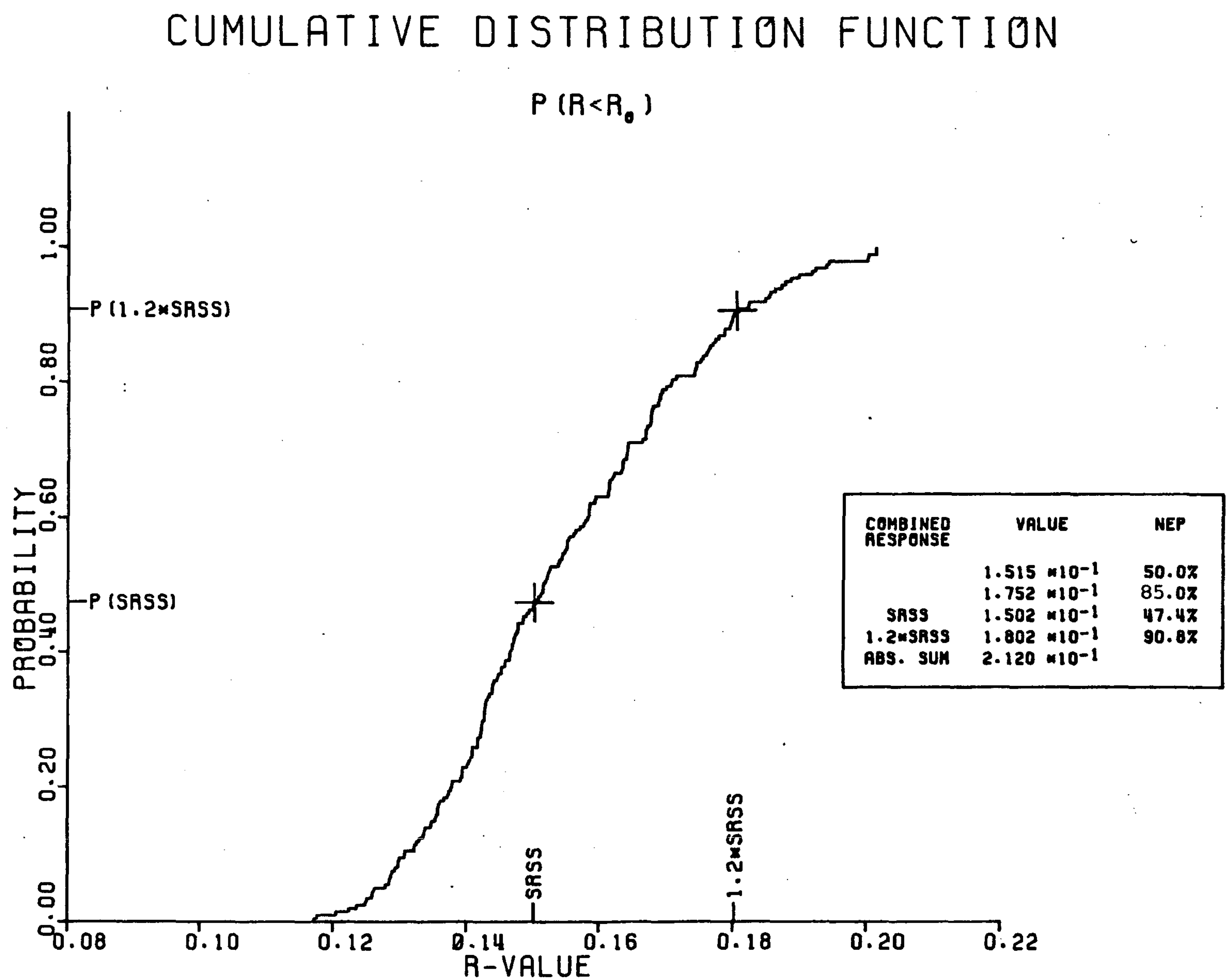
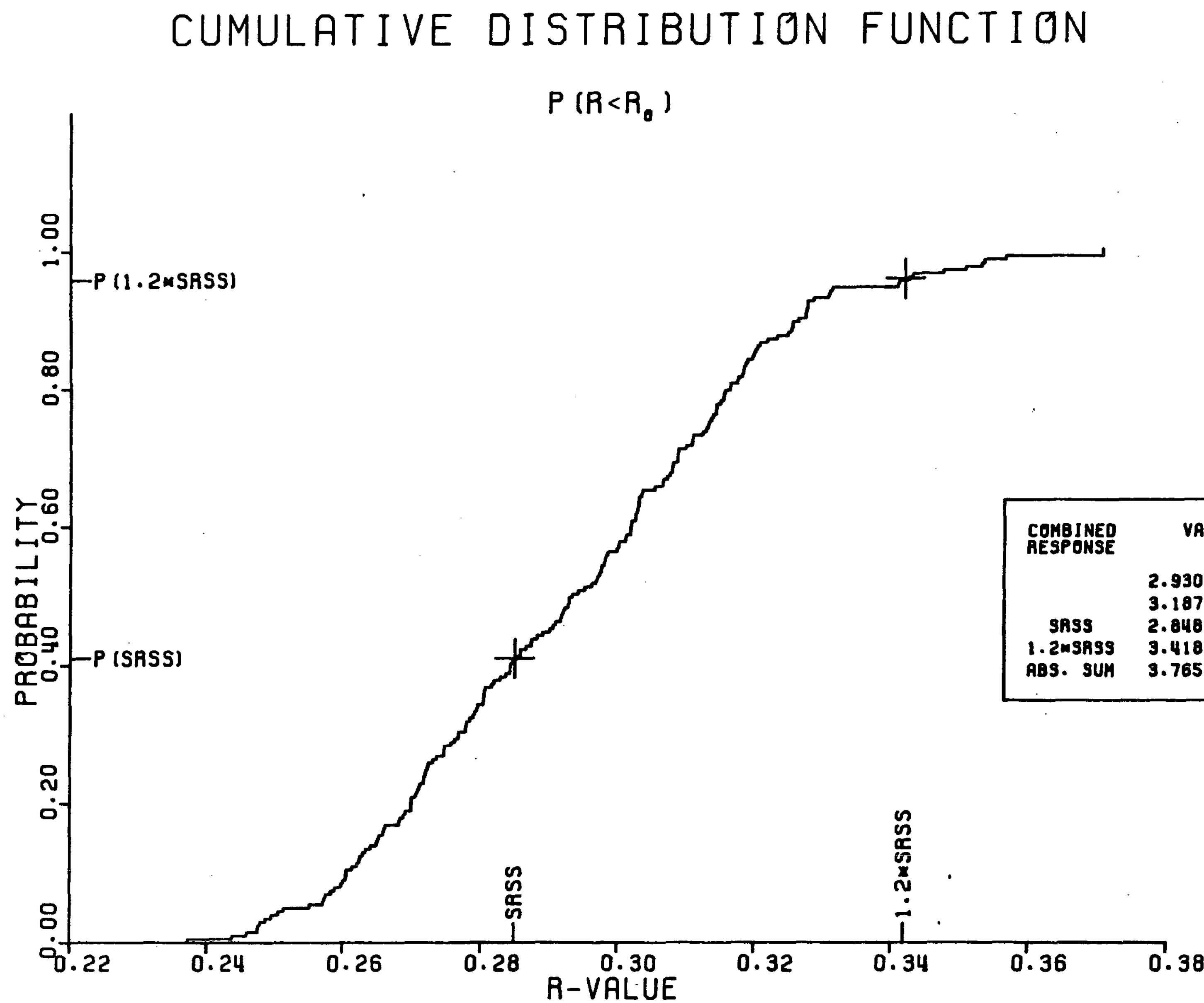


FIGURE B-65. BOP PIPING CDF CURVE, HPCS TEST LINE, LOCATION 3-1
SSE + SRV-ADS LOAD COMBINATION, ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	2.930×10^{-1}	50.0%
	3.187×10^{-1}	85.0%
SRSS	2.848×10^{-1}	41.0%
1.2*SRSS	3.418×10^{-1}	95.8%
ABS. SUM	3.765×10^{-1}	

FIGURE B-66. BOP PIPING CDF CURVE, HPCS TEST LINE, LOCATION 3-2
SSE + SRV-ADS LOAD COMBINATION, ACCELERATION (G)

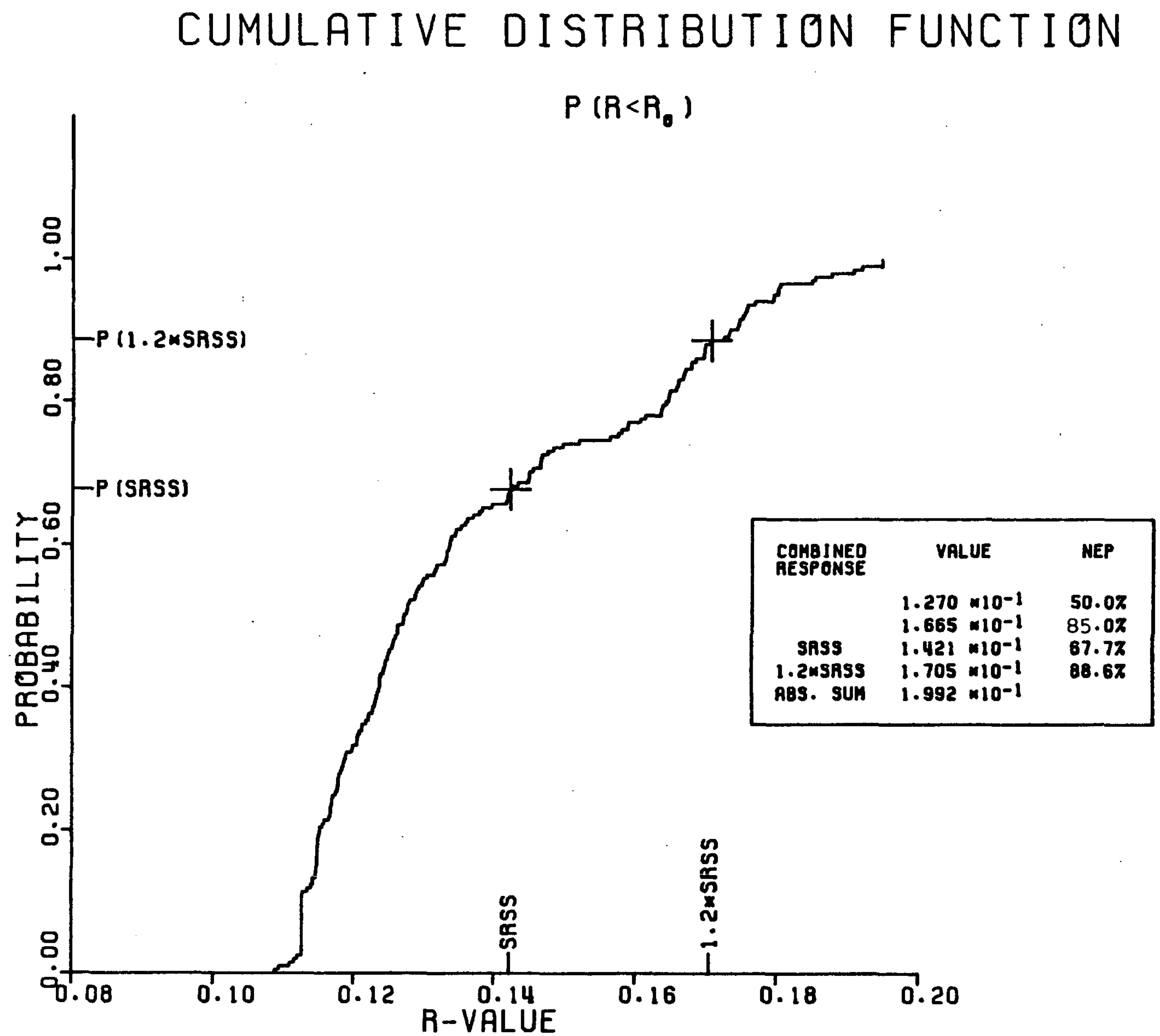


FIGURE B-67. BOP PIPING CDF CURVE, HPCS TEST LINE, LOCATION 3-1
SRV-ADS + CHUG LOAD COMBINATION, ACCELERATION (G)

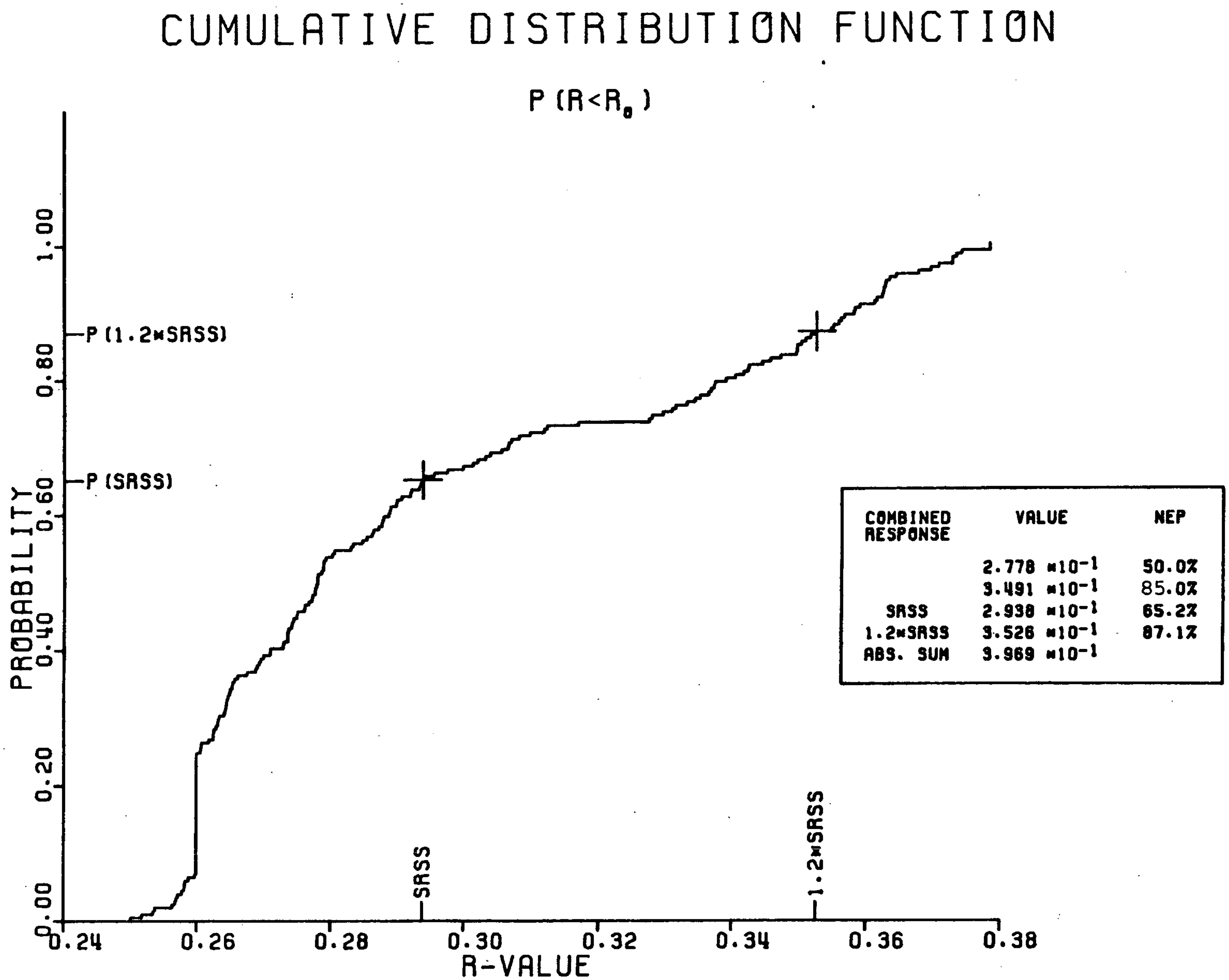


FIGURE B-68. BOP PIPING CDF CURVE, HPCS TEST LINE, LOCATION 3-2
SRV-ADS + CHUG LOAD COMBINATION, ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION

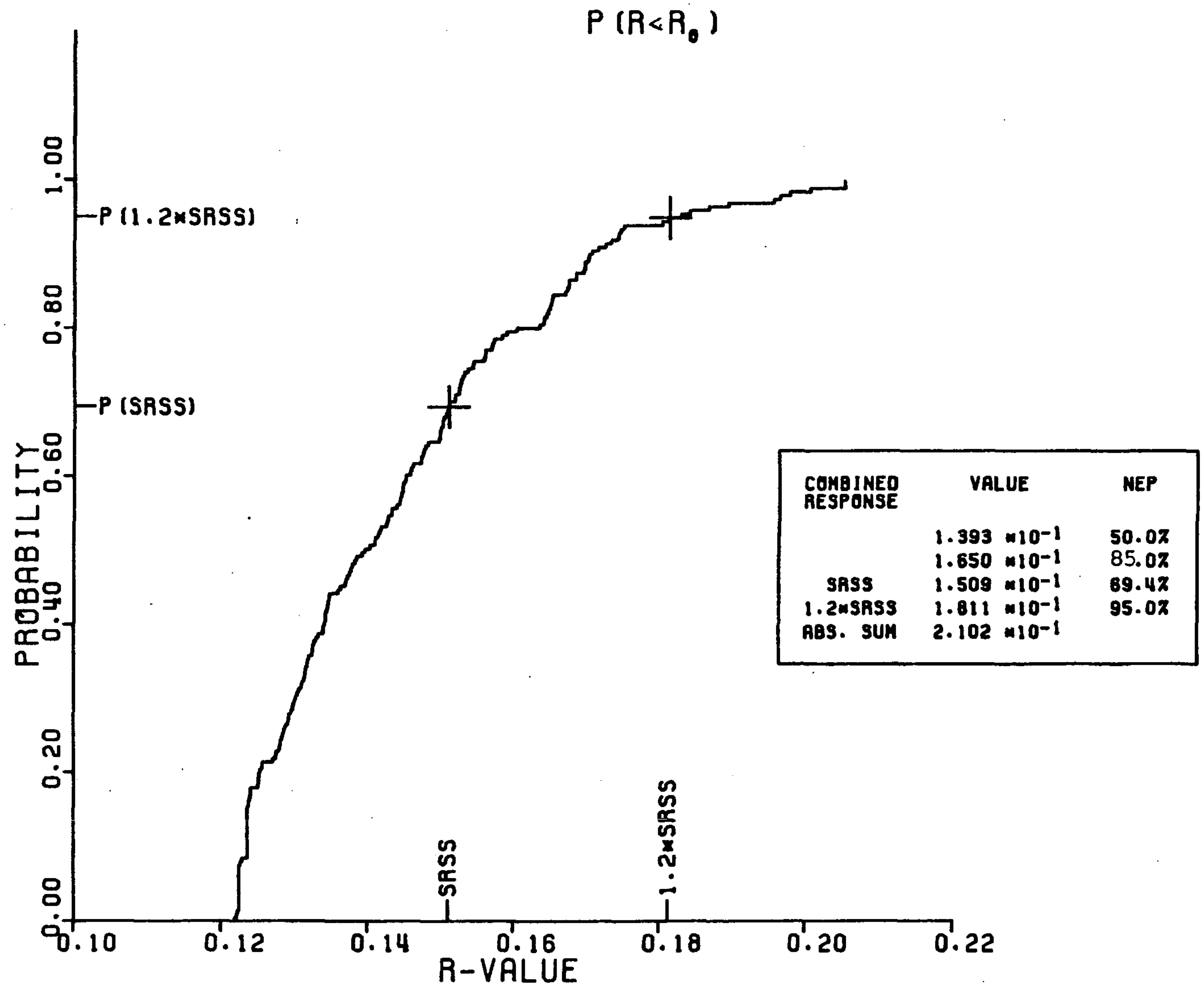


FIGURE B-69. BOP PIPING CDF CURVE, HPCS TEST LINE, LOCATION 3-1
SRV-ALL + CHUG LOAD COMBINATION, ACCELERATION (G)

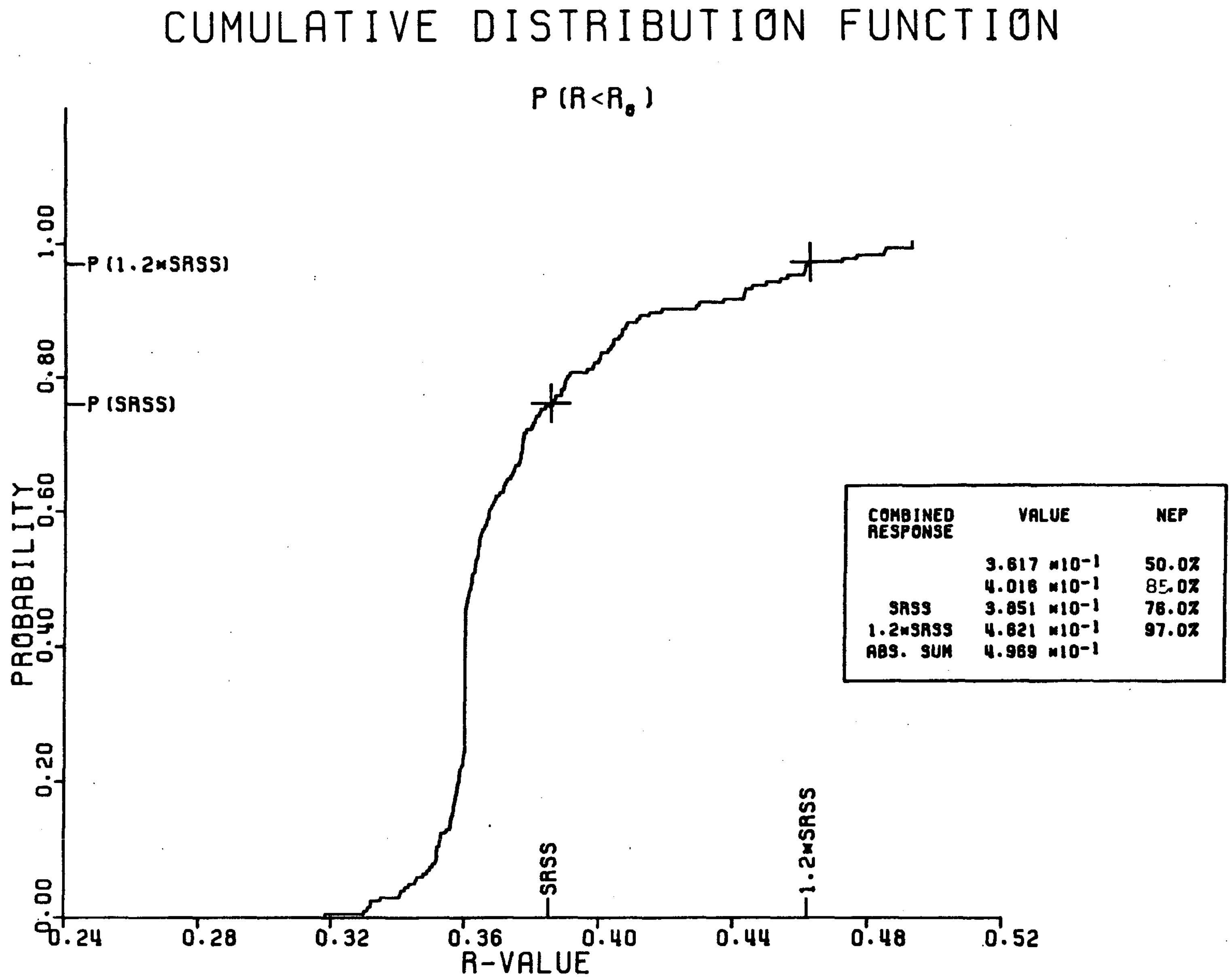
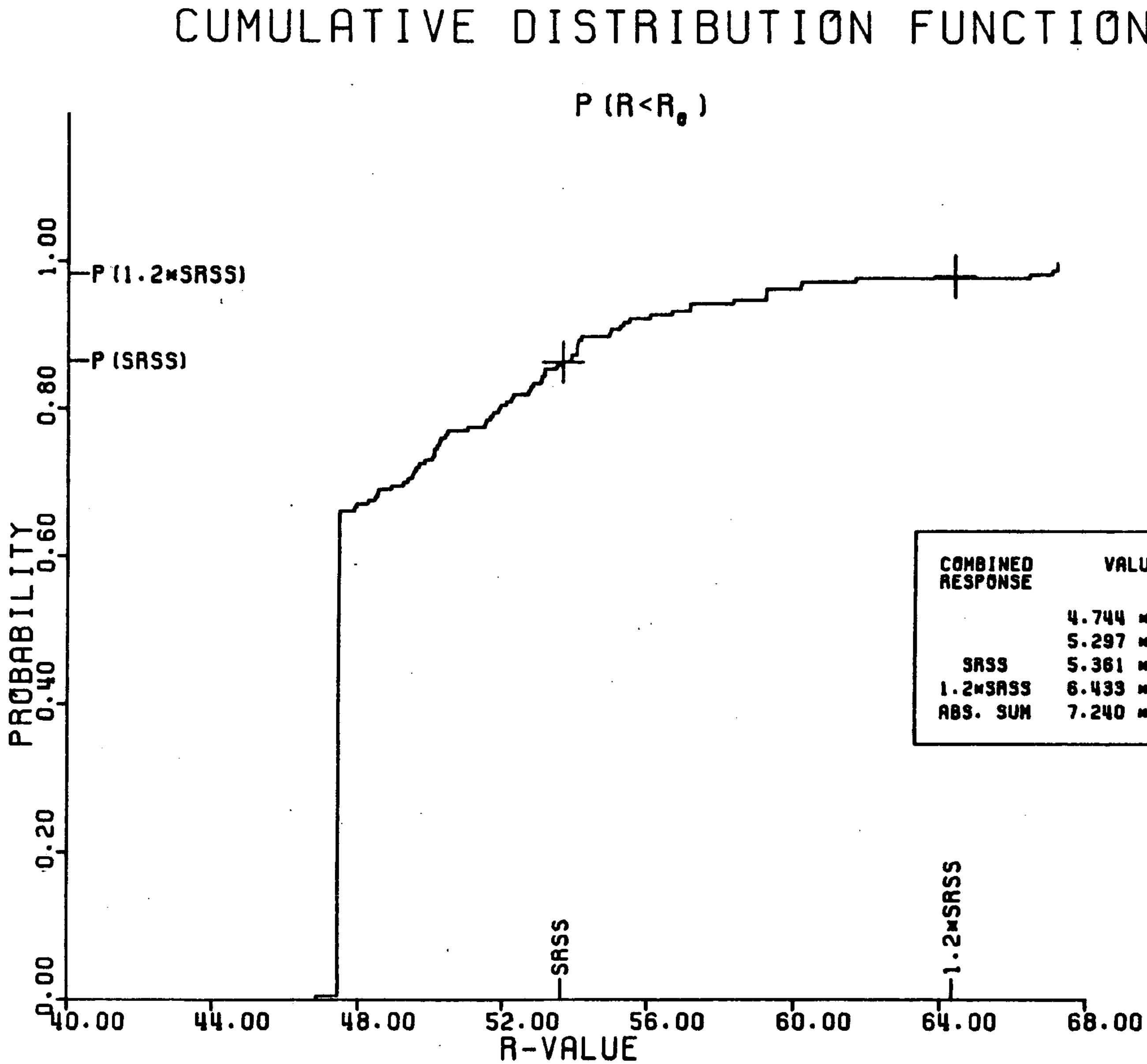


FIGURE B-70. BOP PIPING CDF CURVE, HPCS TEST LINE, LOCATION 3-2
SRV-ALL + CHUG LOAD COMBINATION, ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	4.744×10^1	50.0%
	5.297×10^1	85.0%
SRSS	5.361×10^1	86.5%
1.2*SRSS	6.433×10^1	98.3%
ABS. SUM	7.240×10^1	

FIGURE B-71. BOP PIPING CDF CURVE, COMBUSTION GAS SUPPLY LINE, LOCATION 4-18
OBE + SRV-1 LOAD COMBINATION, SUPPORT REACTION (LBS)

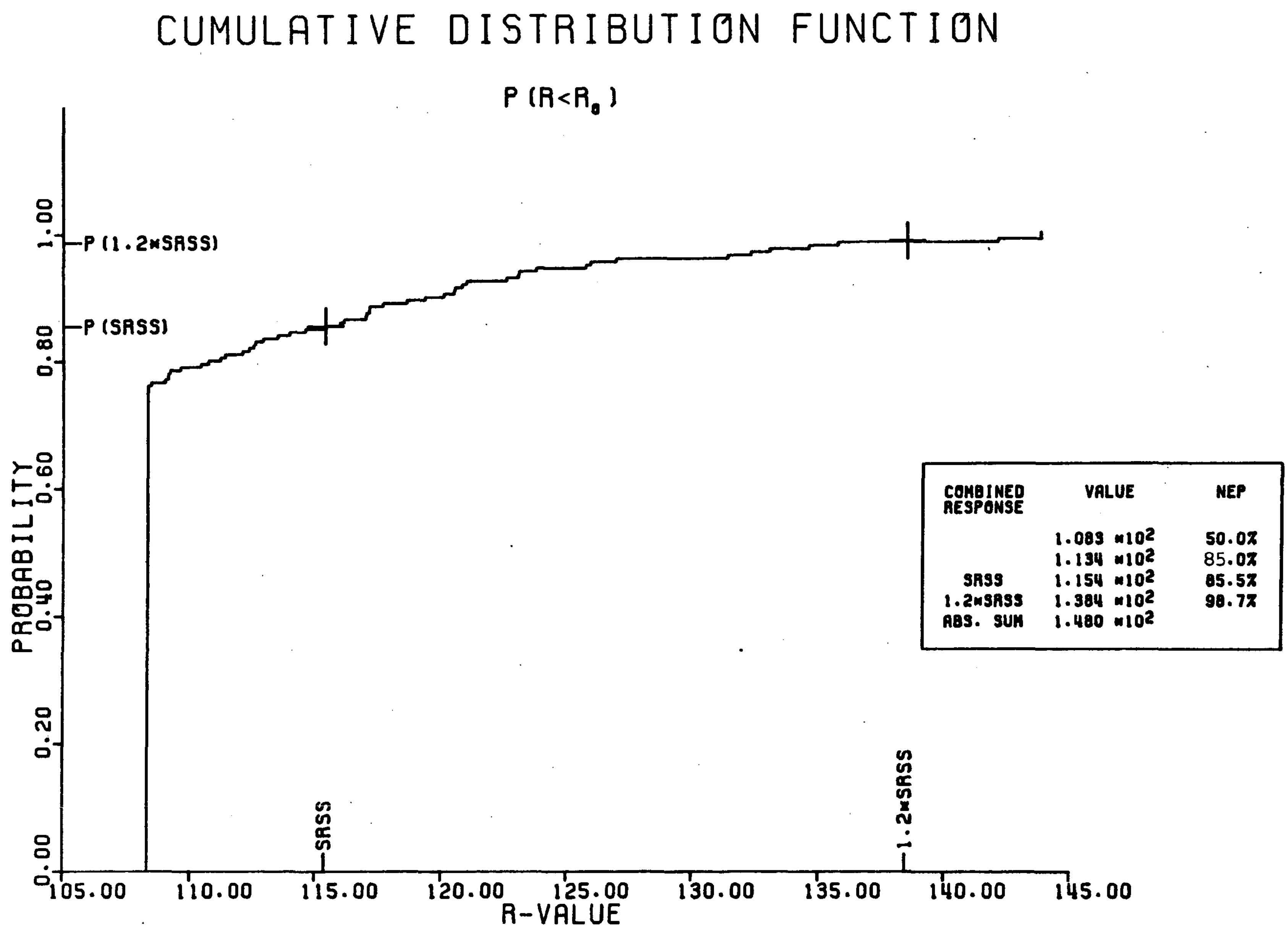


FIGURE B-72. BOP PIPING CDF CURVE, COMBUSTION GAS SUPPLY LINE, LOCATION 1-21
OBE + SRV-1 LOAD COMBINATION, AXIAL FORCE (LBS)

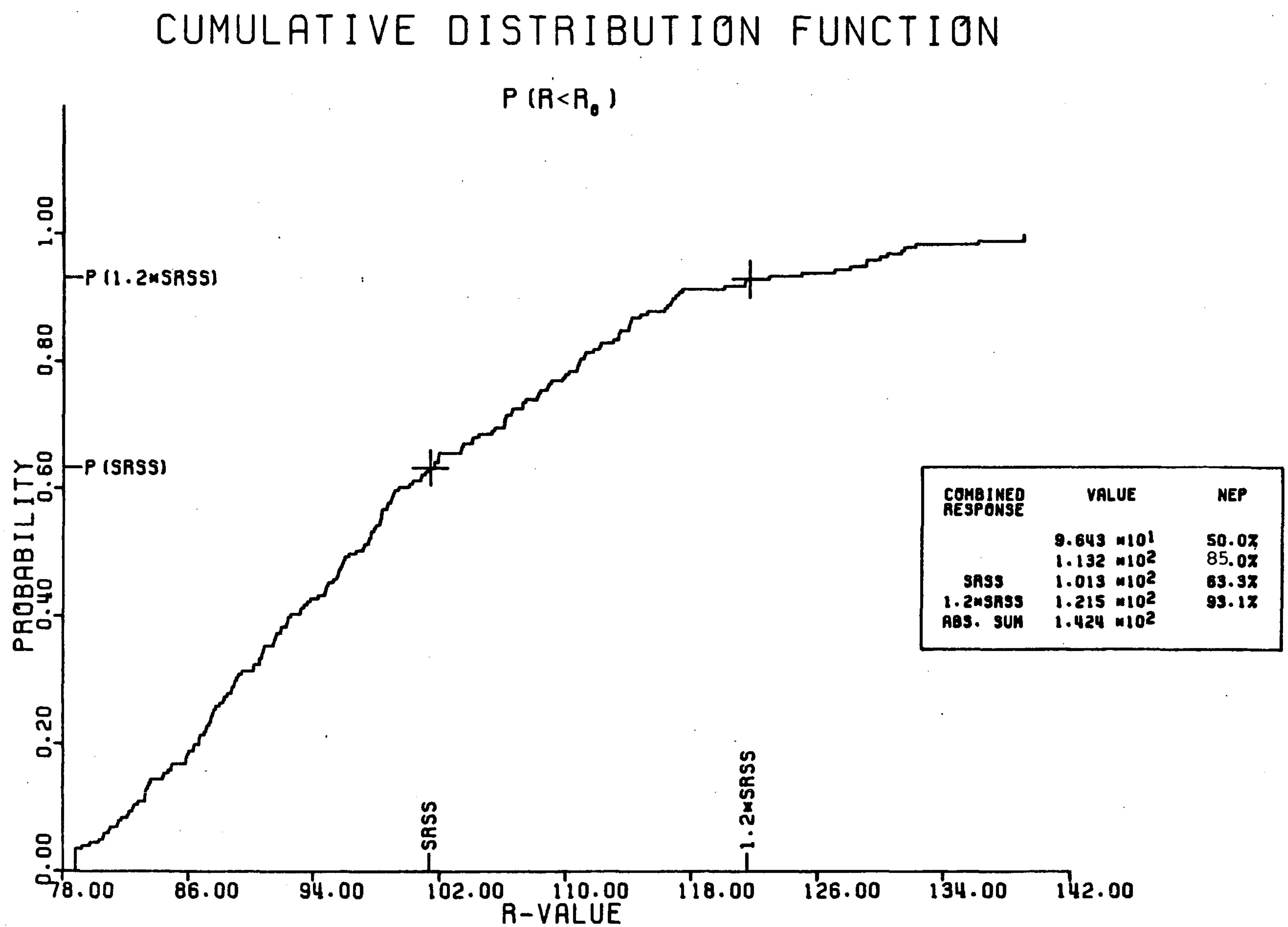


FIGURE B-73. BOP PIPING CDF CURVE, COMBUSTION GAS SUPPLY LINE, LOCATION 4-20
OBE + SRV-ALL LOAD COMBINATION, MOMENT Y (FT-LBS)

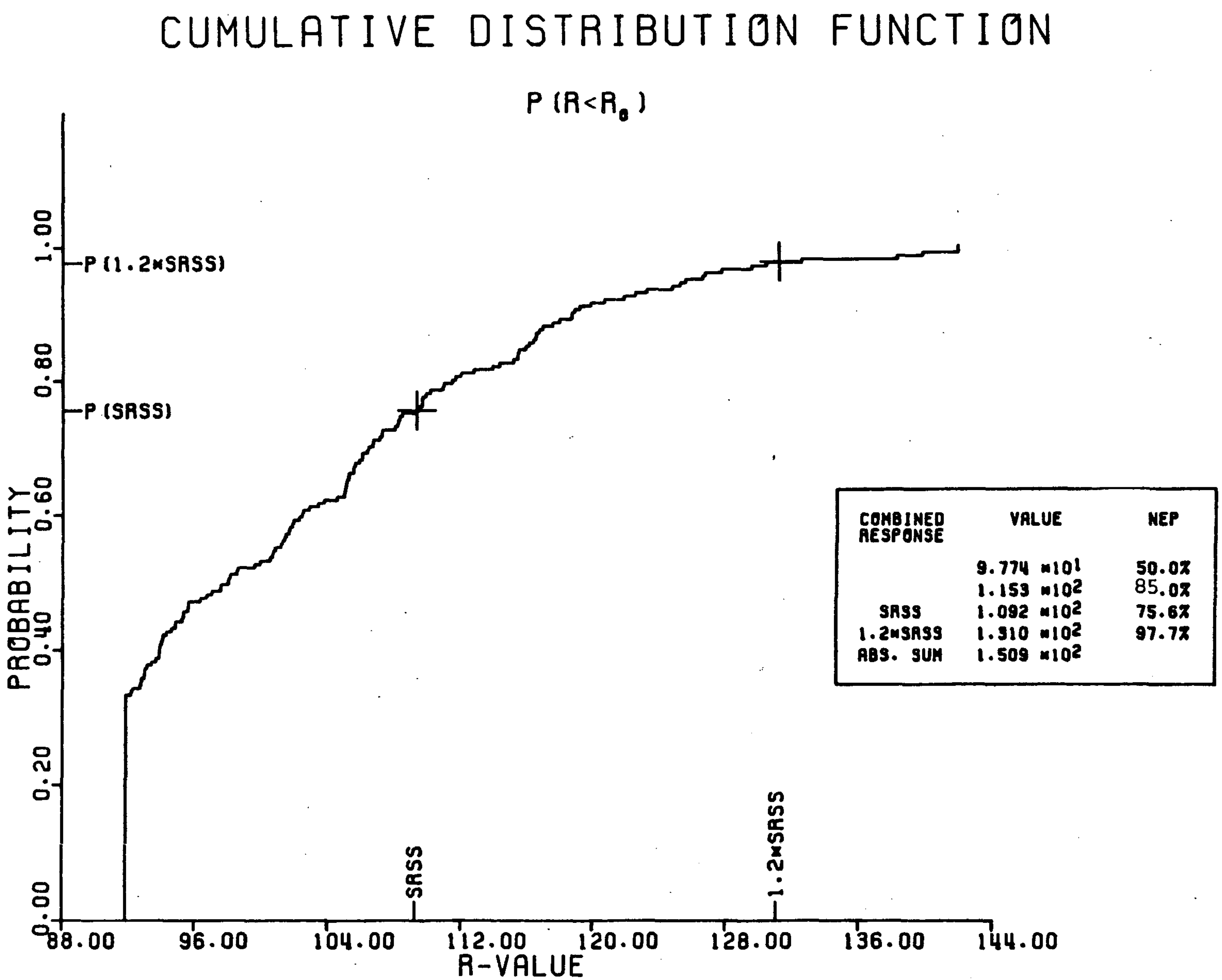


FIGURE B-74. BOP PIPING CDF CURVE, COMBUSTION GAS SUPPLY LINE, LOCATION 4-19
OBE + SRV-ALL LOAD COMBINATION, SHEAR Y (LBS)

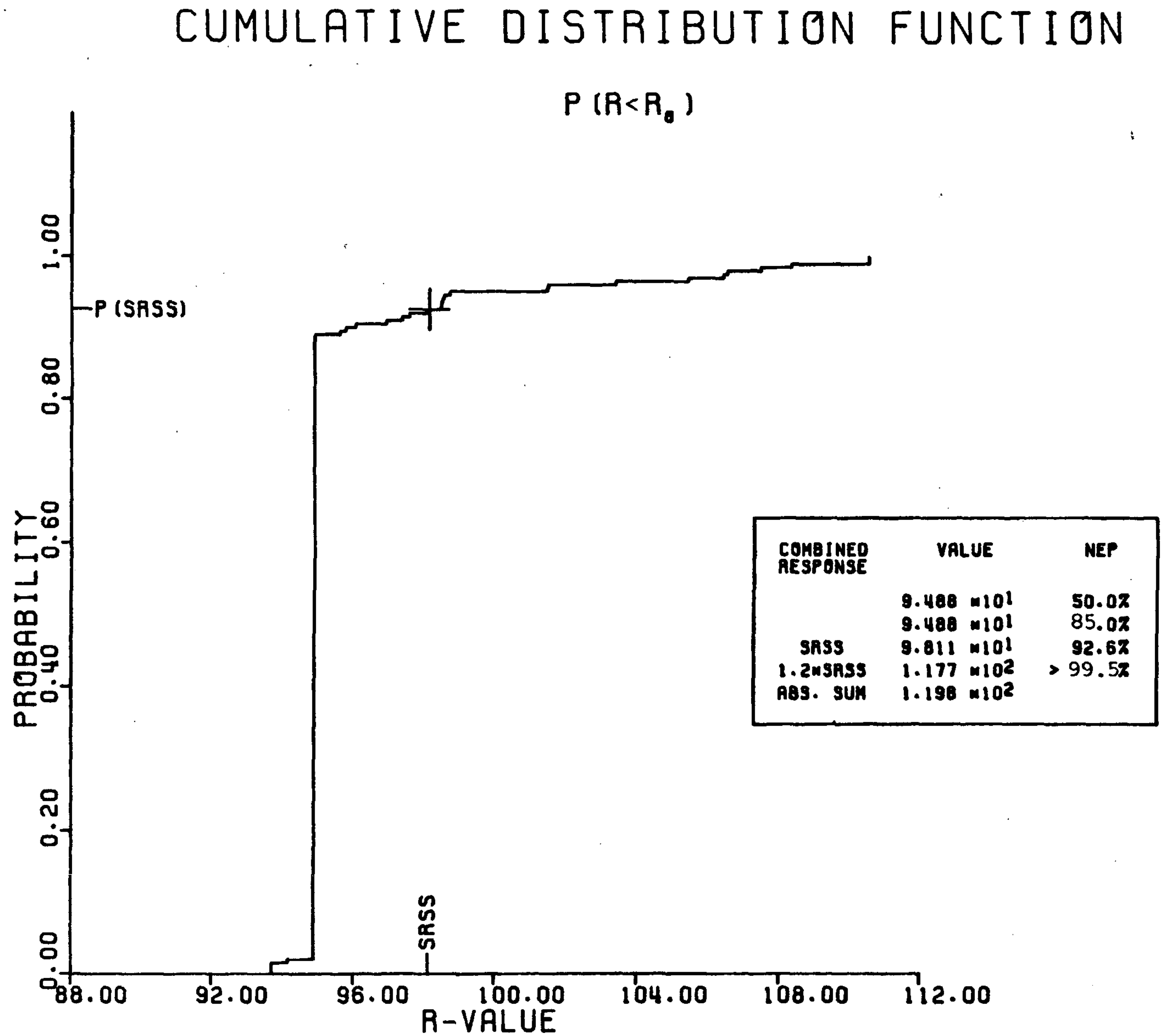


FIGURE B-75. BOP PIPING CDF CURVE, COMBUSTION GAS SUPPLY LINE, LOCATION 4-18
SSE + SRV-1 LOAD COMBINATION, SUPPORT REACTION (LBS)

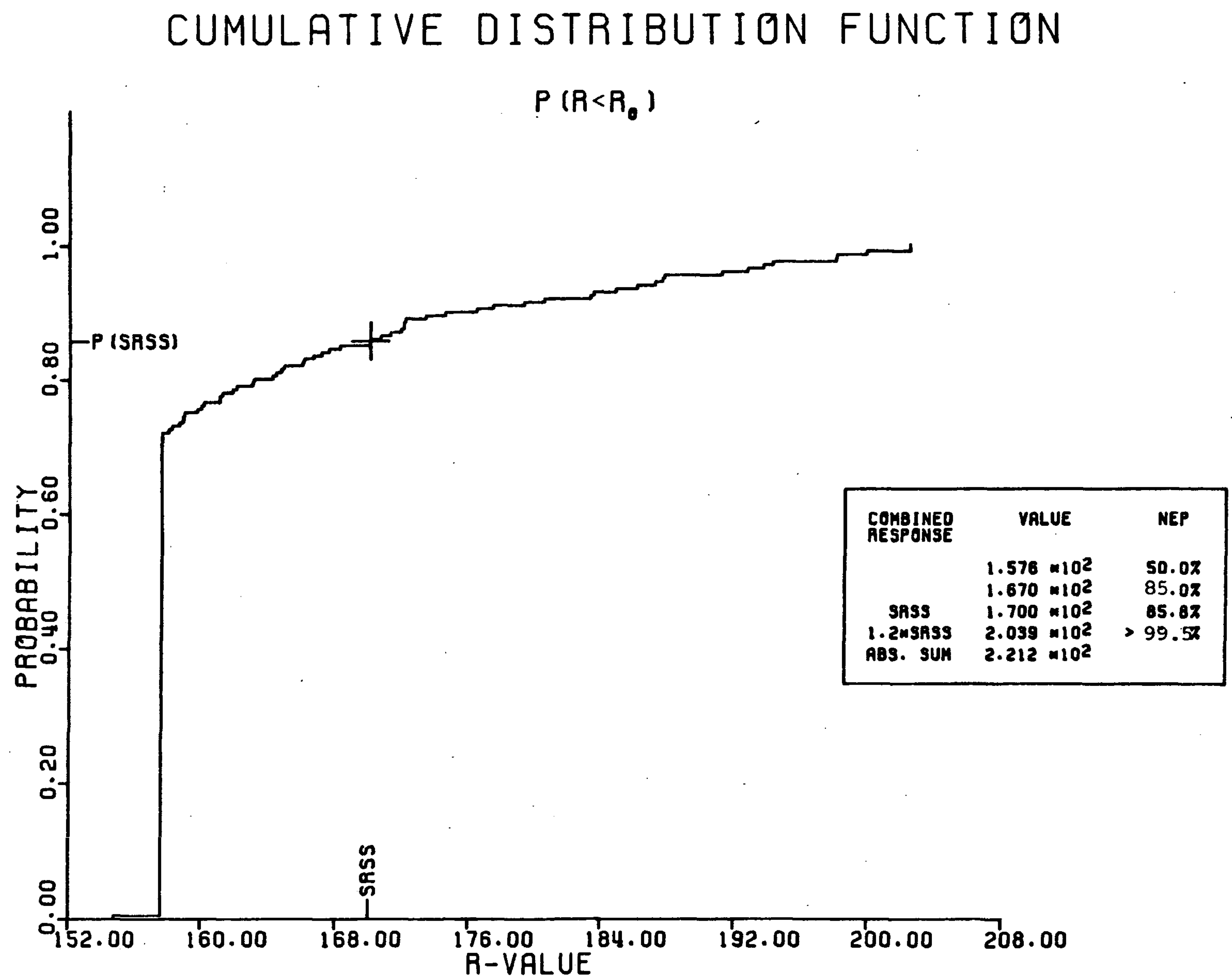
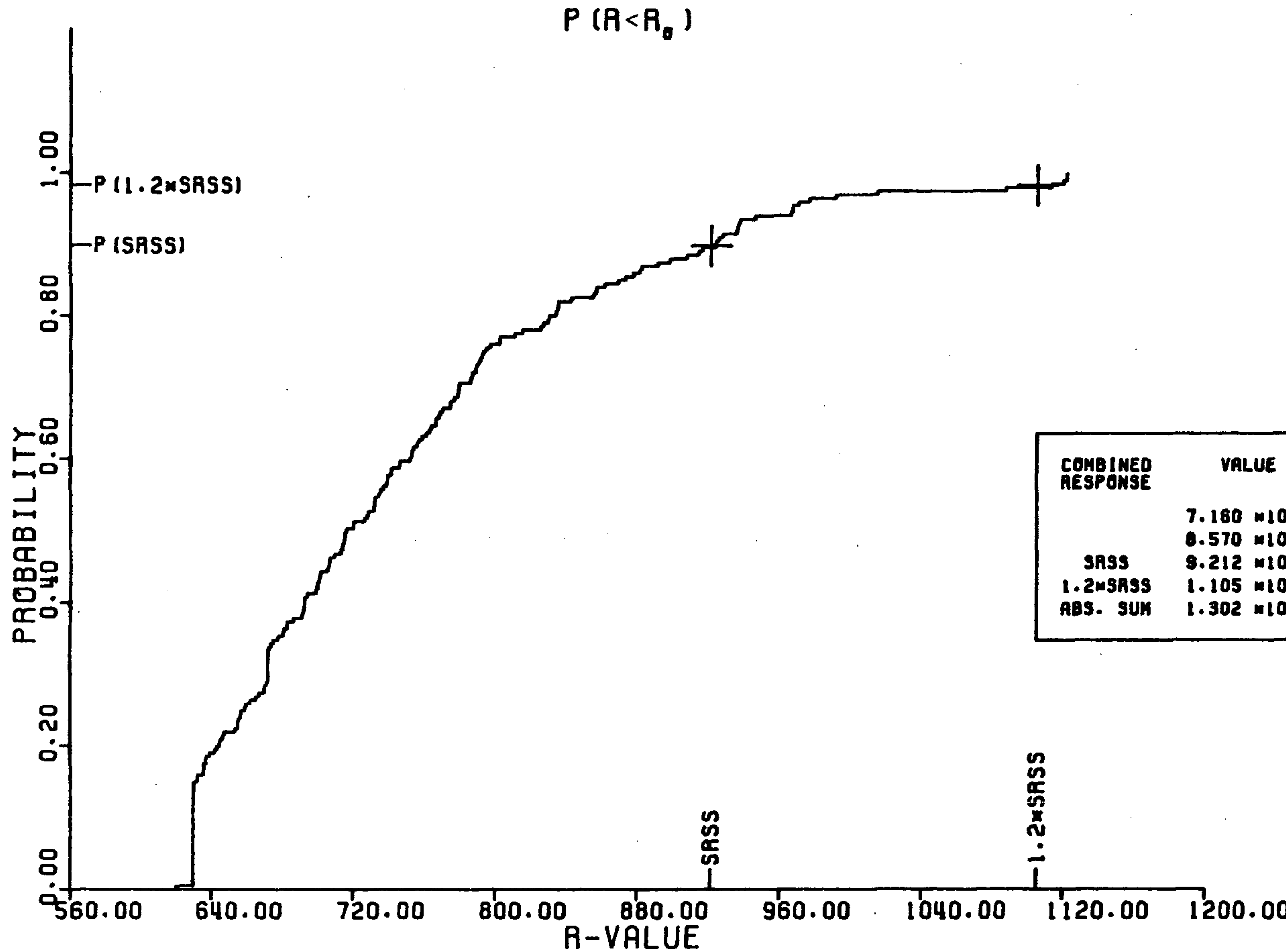


FIGURE B-76. BOP PIPING CDF CURVE, COMBUSTION GAS SUPPLY LINE, LOCATION 4-20
SSE + SRV-ALL LOAD COMBINATION, MOMENT Y (FT-LBS)

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	7.160 *10^2	50.0%
	8.570 *10^2	85.0%
SASS	9.212 *10^2	89.9%
1.2*SASS	1.105 *10^3	98.4%
ABS. SUM	1.302 *10^3	

FIGURE B-77. BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-17
OBE + SAV-1 LOAD COMBINATION, MOMENT Y-AXIS (IN-LBS)

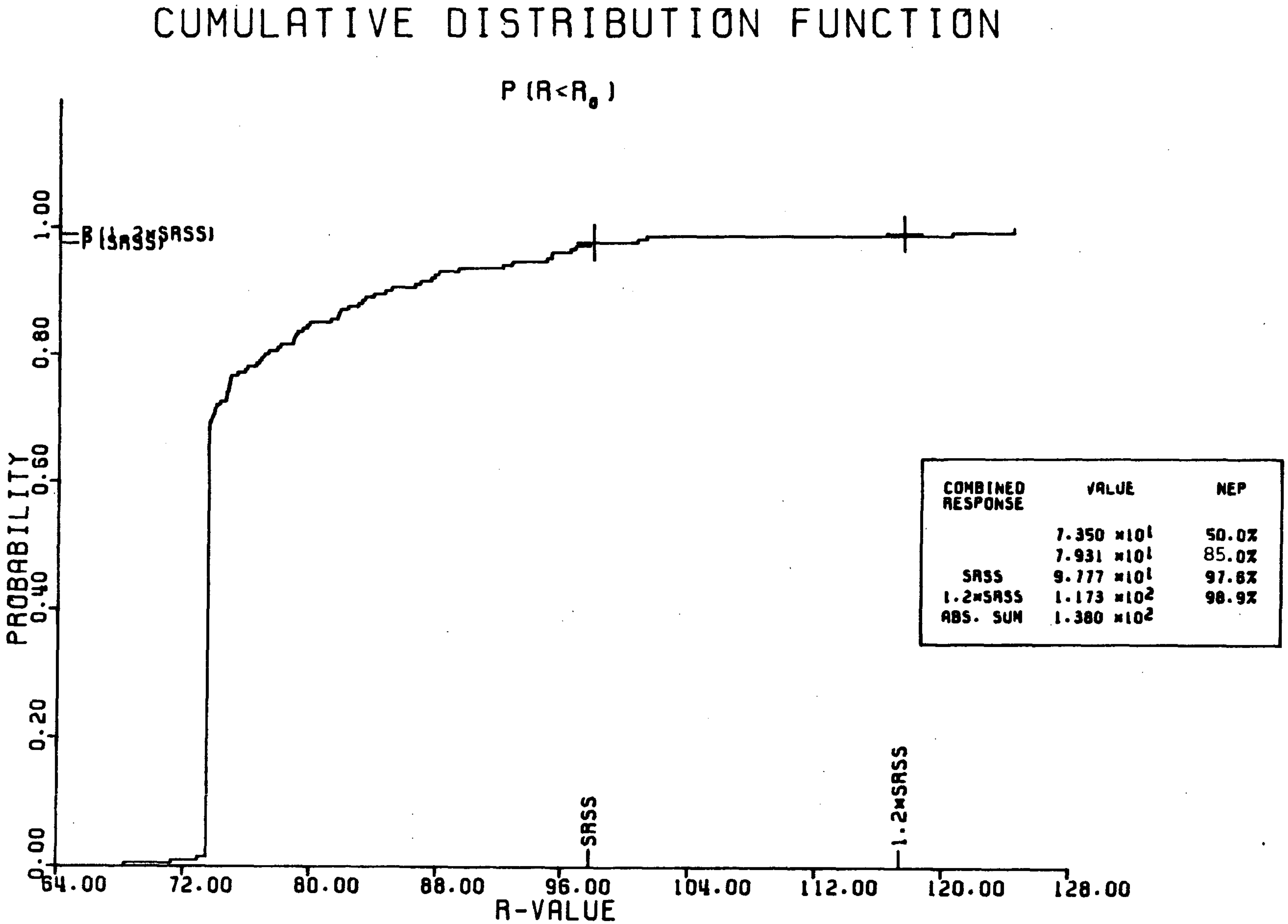
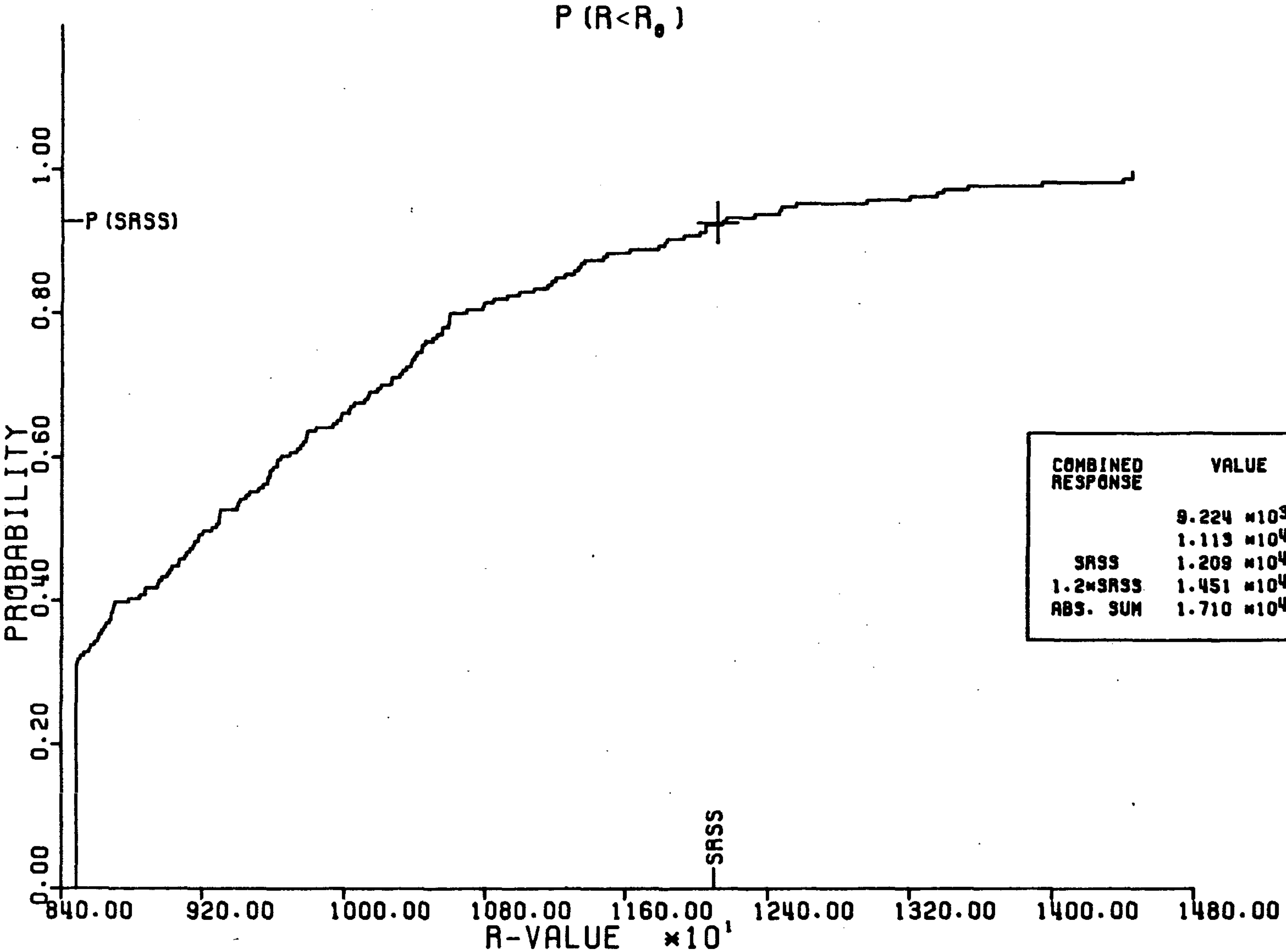


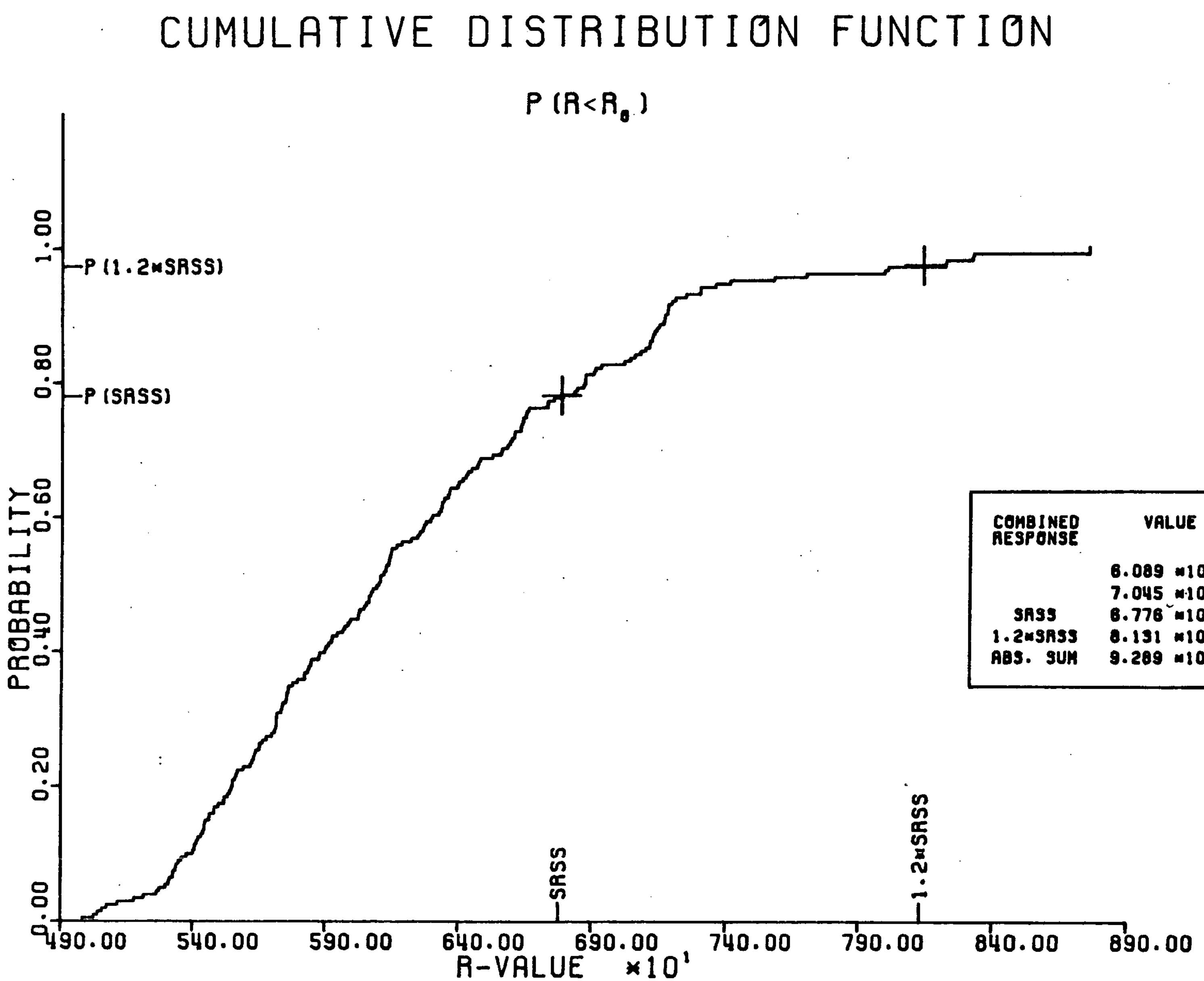
FIGURE B-78. BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-14
OBE + SRV-1 LOAD COMBINATION, FORCE Y-AXIS (LBS)

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	9.224×10^3	50.0%
	1.113×10^4	85.0%
SASS	1.209×10^4	92.9%
1.2×SASS	1.451×10^4	> 99.5%
ABS. SUM	1.710×10^4	

FIGURE B-79. BOP PIPING CDF CURVE, LOW PRESSURE COOLANT SUPPLY LINE, LOCATION 2-2 OBE + SRV-ALL LOAD COMBINATION, PIPE MOMENT Y (FT-LBS)



COMBINED RESPONSE	VALUE	NEP
	6.089 ×10³	50.0%
	7.045 ×10³	85.0%
SASS	6.776 ×10³	78.0%
1.2×SASS	8.131 ×10³	97.3%
ABS. SUM	9.289 ×10³	

FIGURE B-80. BOP PIPING CDF CURVE, LOW PRESSURE COOLANT SUPPLY LINE, LOCATION 2-3 OBE + SRV-ALL LOAD COMBINATION, PIPE MOMENT Y (FT-LBS)

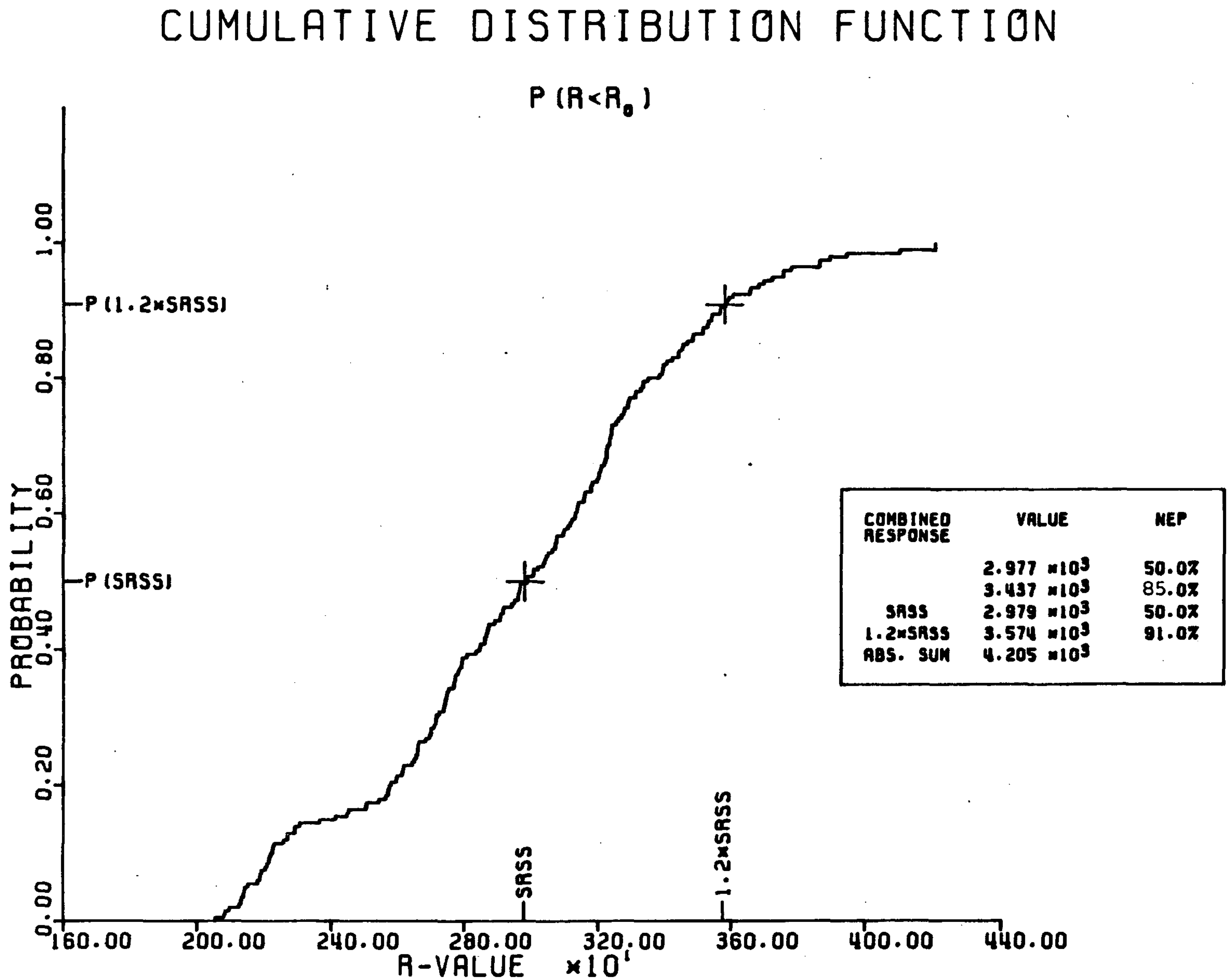
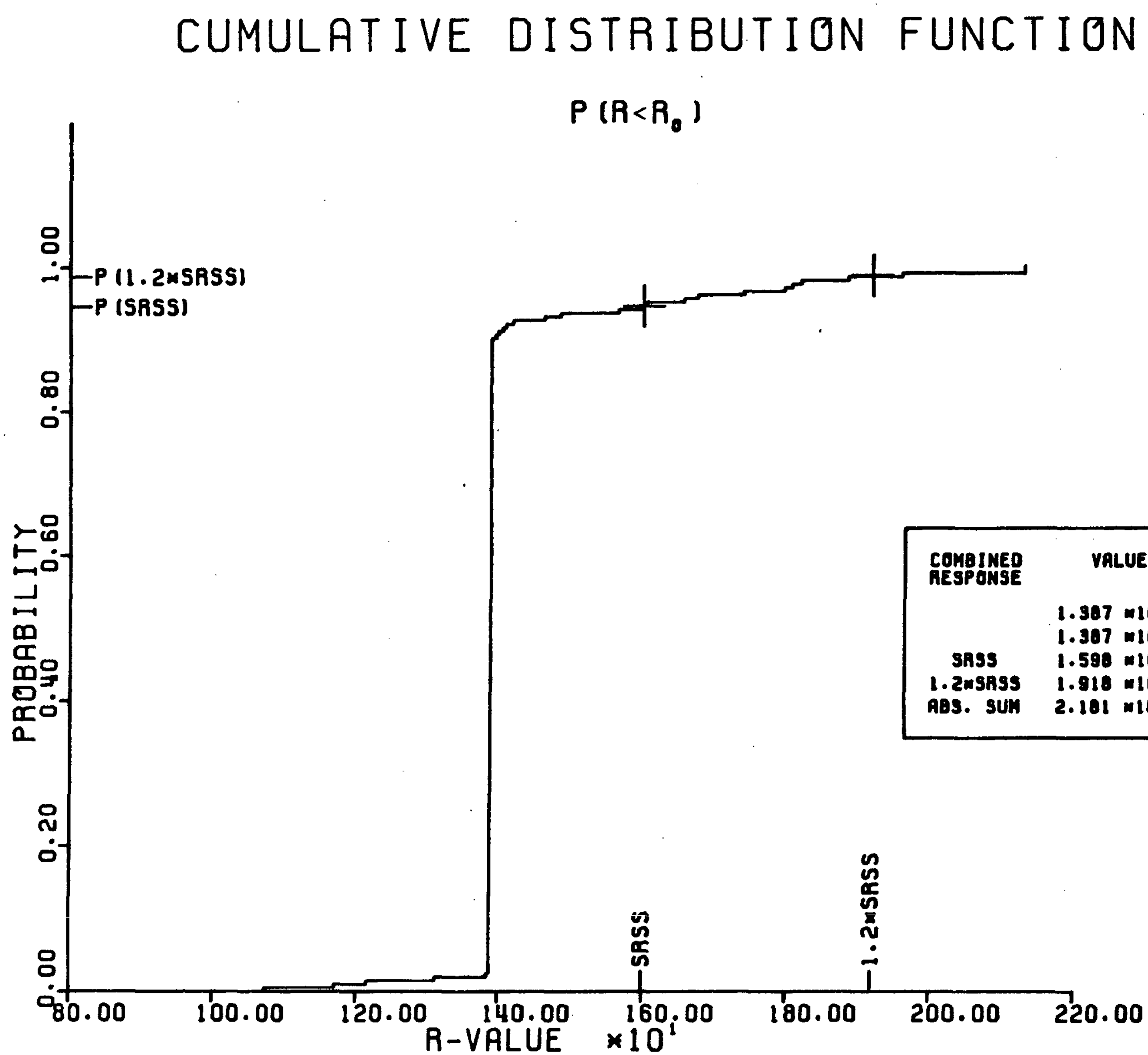


FIGURE B-81. BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-16
OBE + SRV-ADS LOAD COMBINATION, MOMENT Y-AXIS (IN-LBS)



COMBINED RESPONSE	VALUE	NEP
	1.387×10^3	50.0%
	1.387×10^3	85.0%
SRSS	1.598×10^3	94.5%
1.2×SRSS	1.918×10^3	98.7%
ABS. SUM	2.181×10^3	

FIGURE B-82. BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-18
OBE + SRV-ADS LOAD COMBINATION, MOMENT Y-AXIS (IN-LBS)

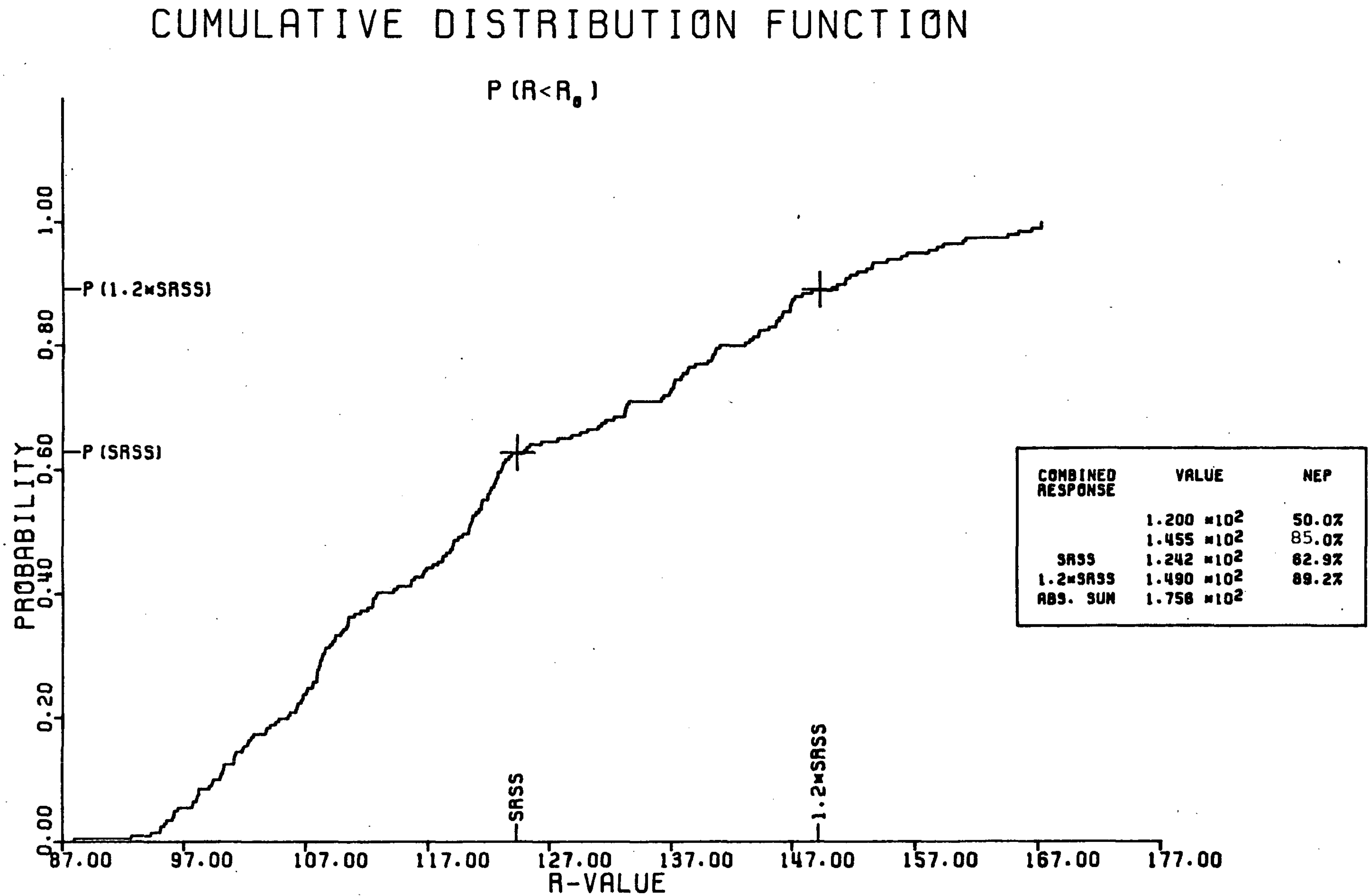
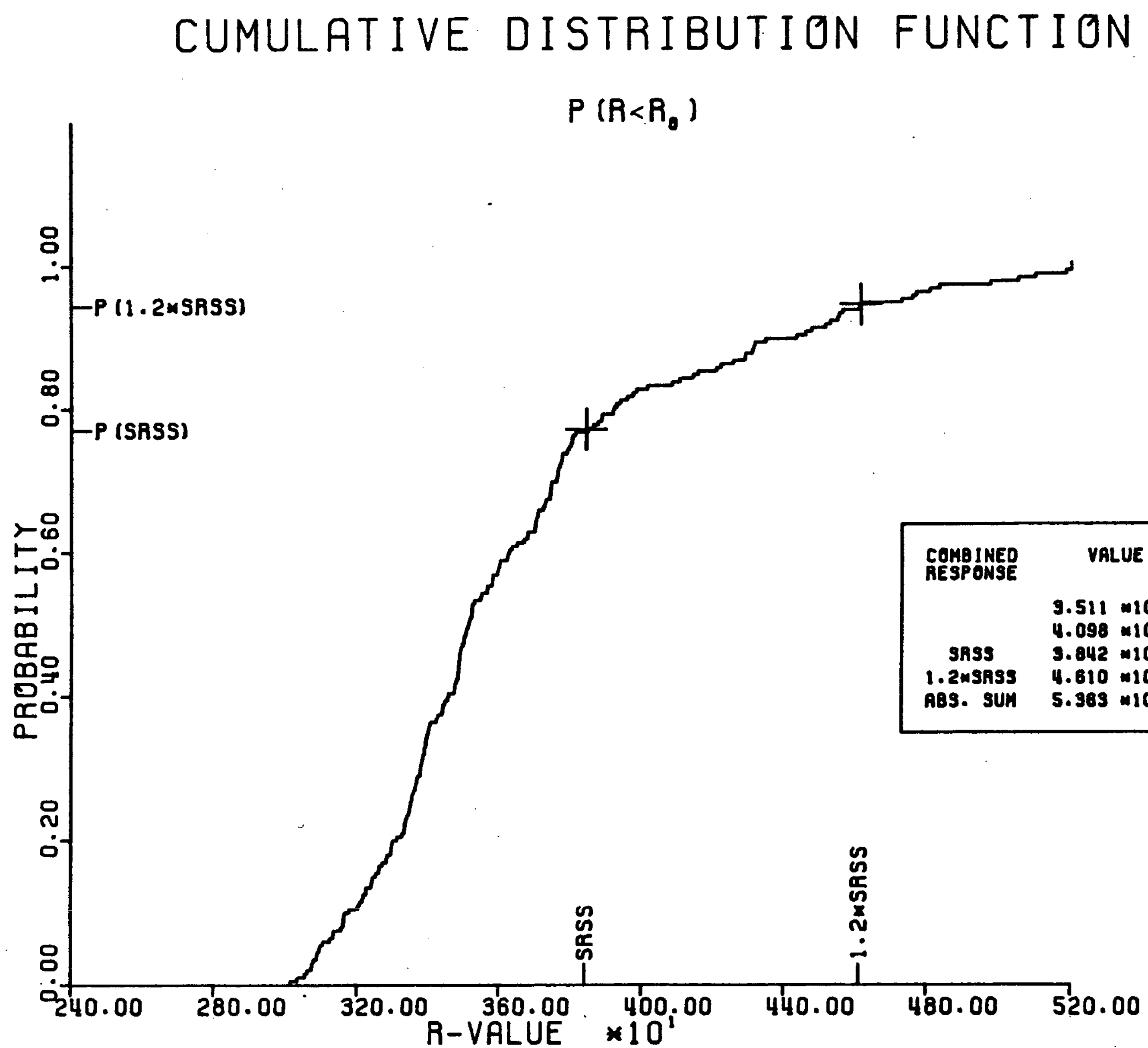


FIGURE B-83. BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-15
SSE + SRV-1 LOAD COMBINATION, FORCE Y-AXIS (LBS)



COMBINED RESPONSE	VALUE	NEP
	3.511 ×10³	50.0%
	4.098 ×10³	85.0%
SRSS	3.842 ×10³	77.0%
1.2×SRSS	4.610 ×10³	94.4%
ABS. SUM	5.363 ×10³	

FIGURE B-84. BOP PIPING CDF CURVE, LOW PRESSURE COOLANT SUPPLY LINE, LOCATION 2-1 SSE + SRV-1 LOAD COMBINATION, PIPE MOMENT Y (FT-LBS)

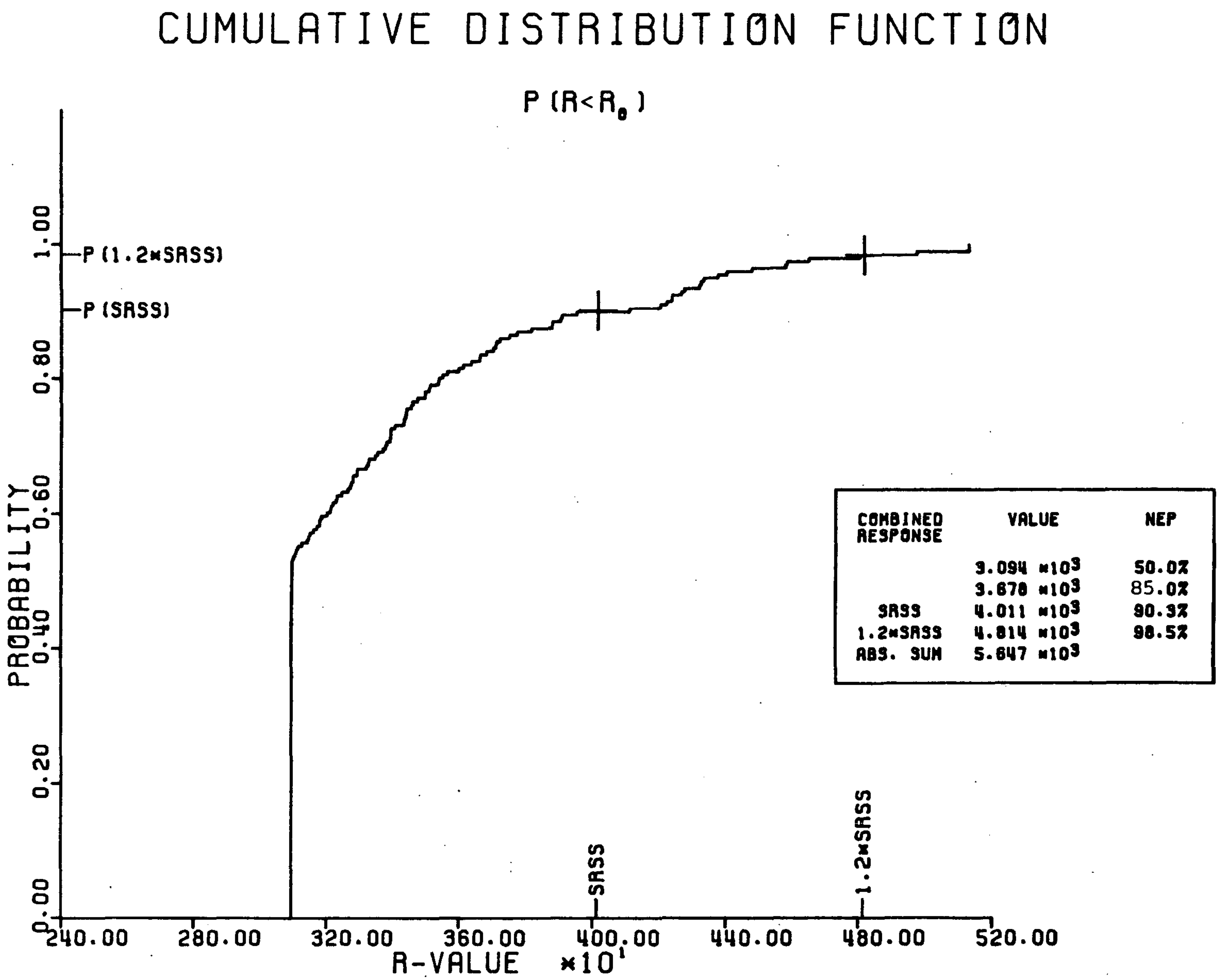


FIGURE B-85. BOP PIPING CDF CURVE, LOW PRESSURE COOLANT SUPPLY LINE, LOCATION 2-4 SSE + SRV-1 LOAD COMBINATION, AXIAL SUPPORT (LBS)

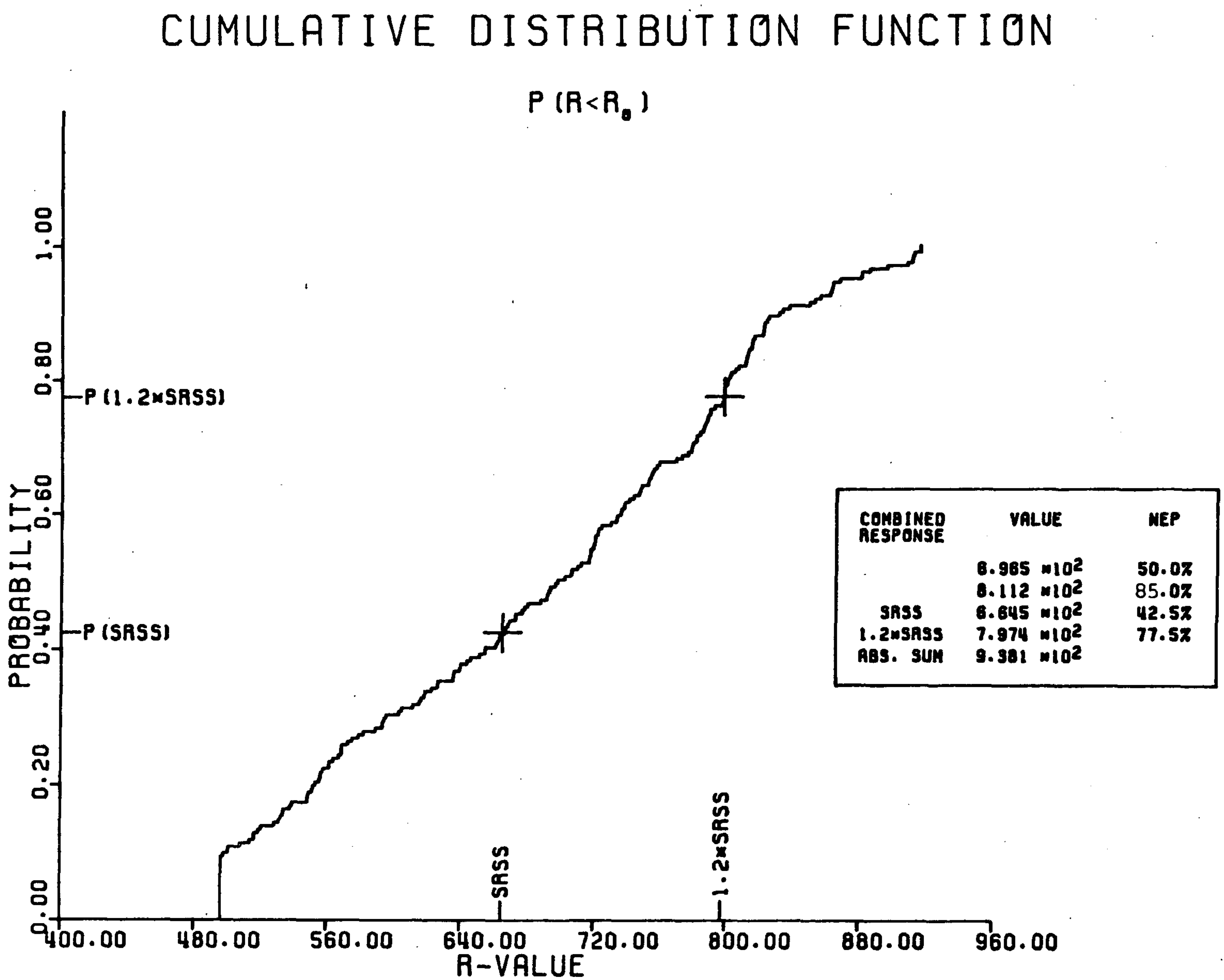


FIGURE B-86. BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-19
SSE + SRV-ALL LOAD COMBINATION, FORCE X-AXIS (LBS)

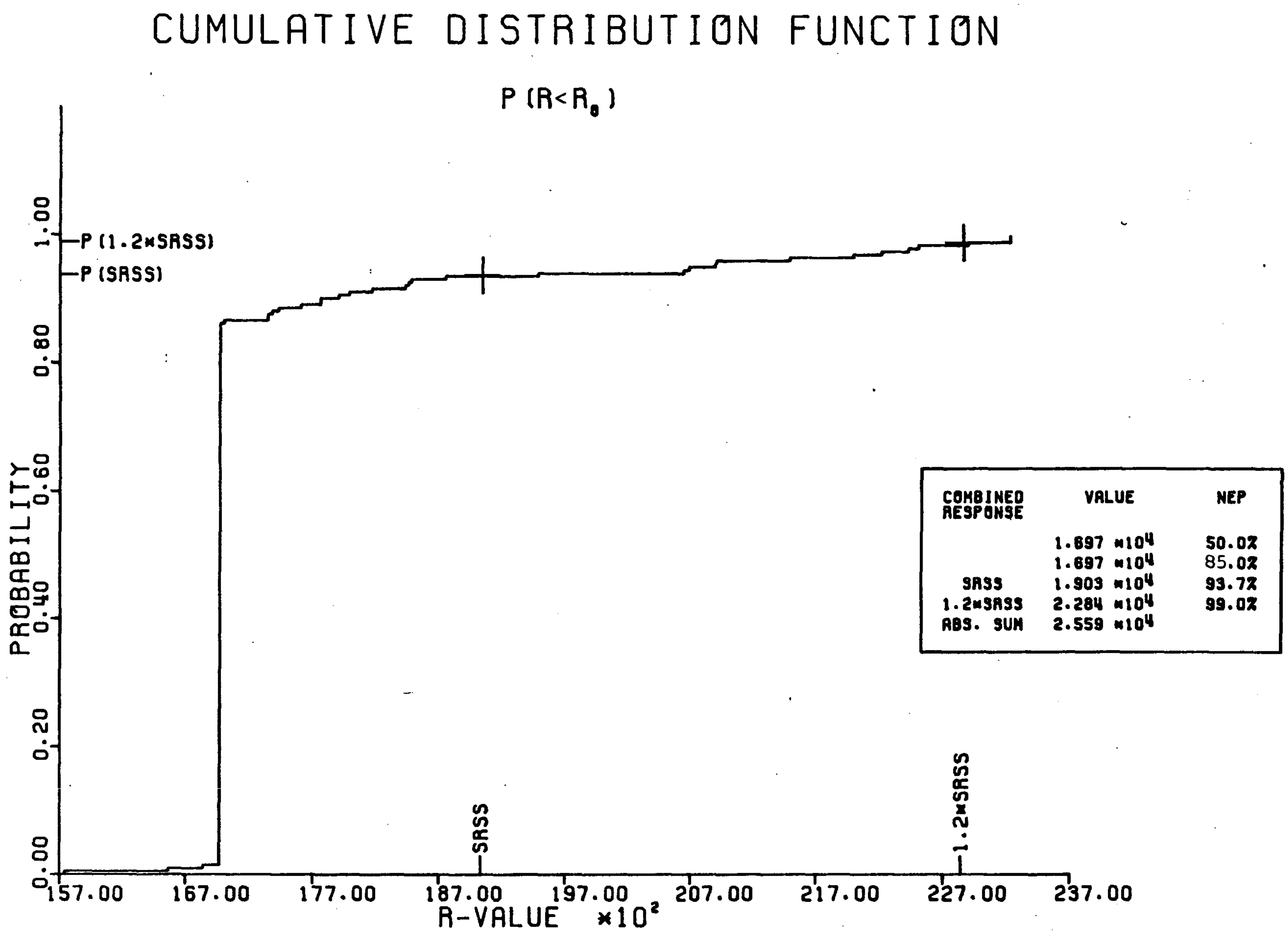


FIGURE B-87. BOP PIPING CDF CURVE, LOW PRESSURE COOLANT SUPPLY LINE, LOCATION 2-2
SSE + SRV-ALL LOAD COMBINATION, PIPE MOMENT Y (FT-LBS)

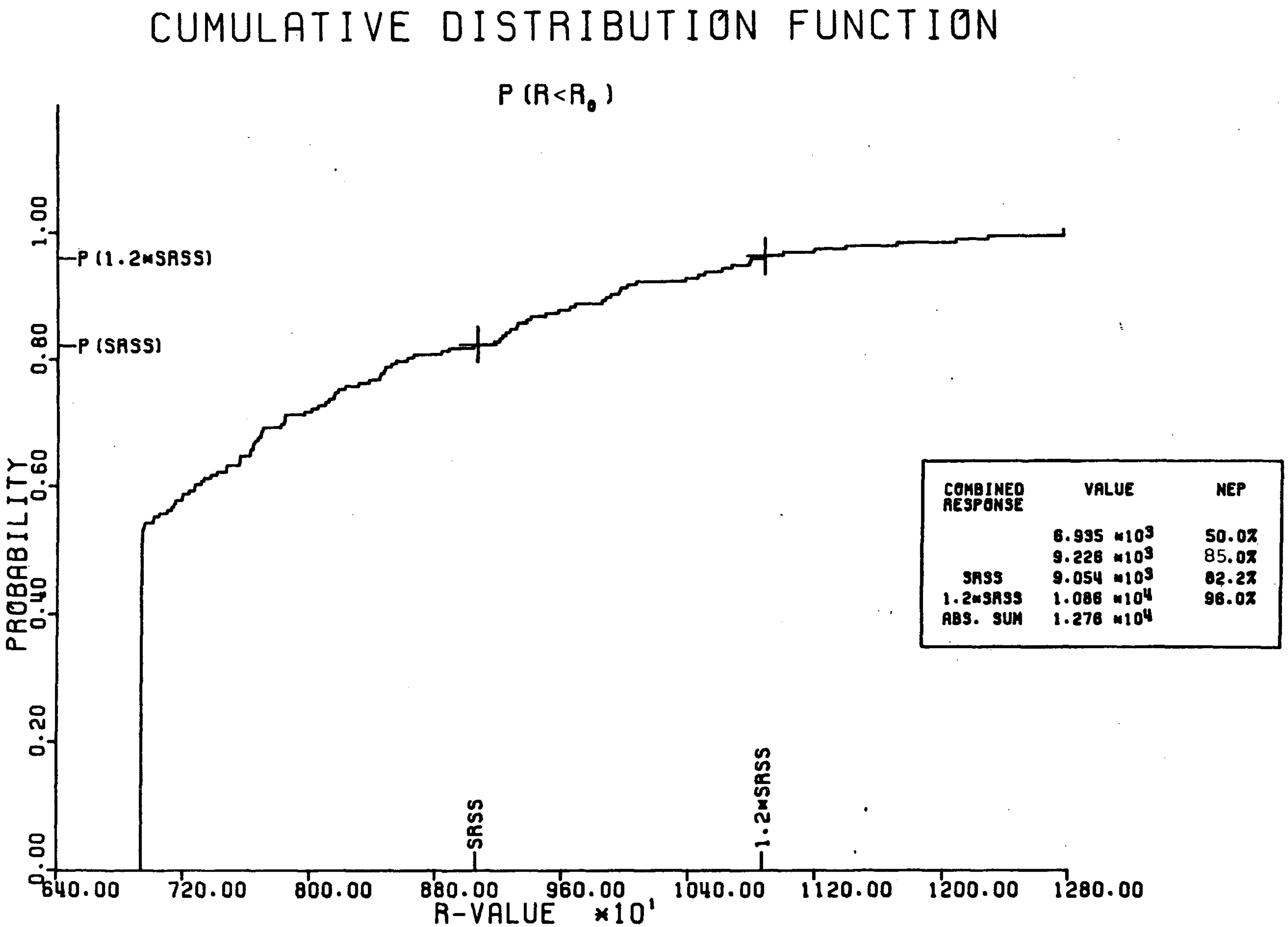
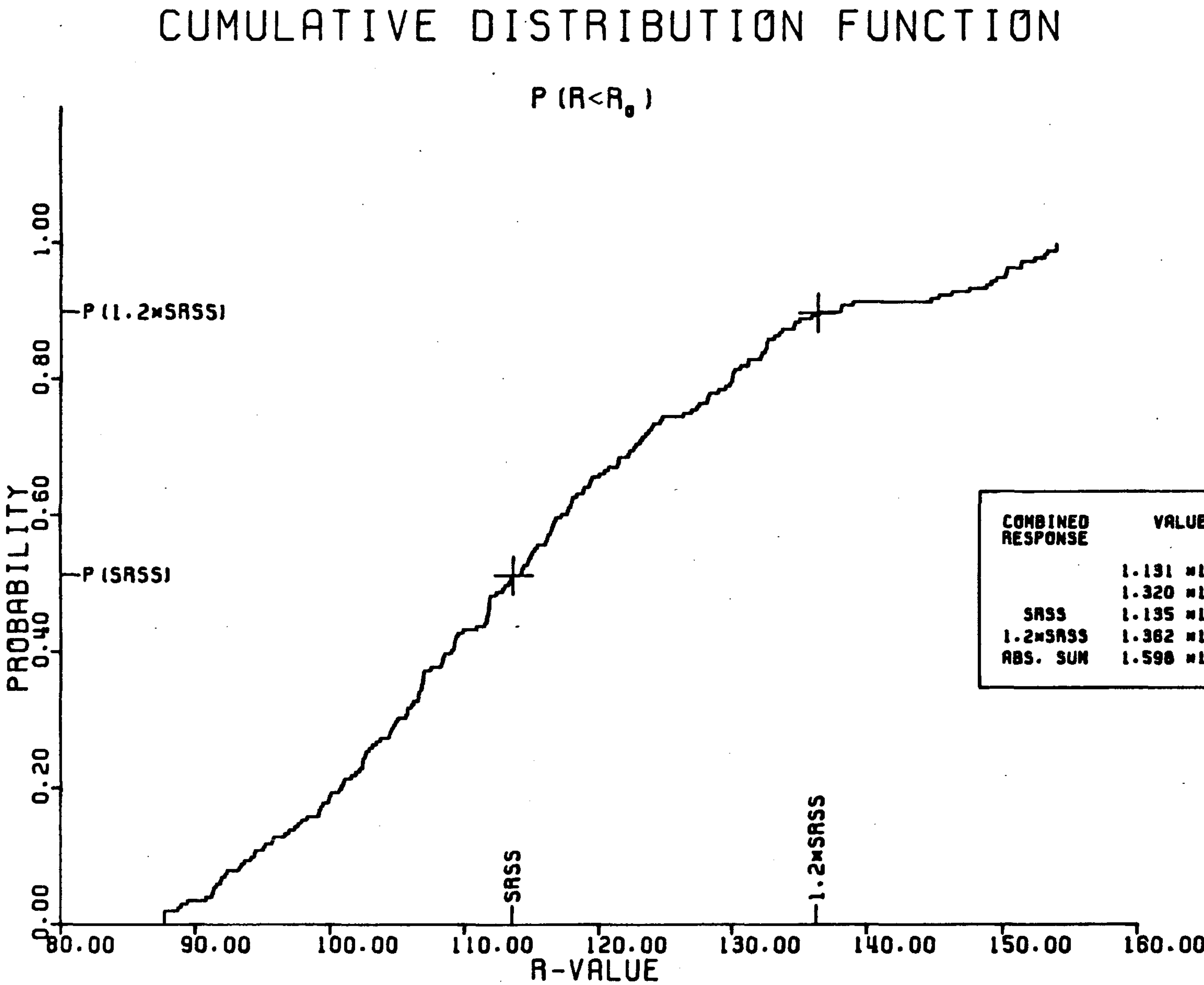


FIGURE B-88. BOP PIPING CDF CURVE, LOW PRESSURE COOLANT SUPPLY LINE, LOCATION 2-3
SSE + SRV-ALL LOAD COMBINATION, PIPE MOMENT Y (FT-LBS)



COMBINED RESPONSE	VALUE	NEP
	1.131 $\times 10^2$	50.0%
	1.320 $\times 10^2$	85.0%
SRSS	1.135 $\times 10^2$	51.3%
1.2*SRSS	1.362 $\times 10^2$	89.9%
ABS. SUM	1.598 $\times 10^2$	

FIGURE B-89. BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-15
SRV-1 + CHUG LOAD COMBINATION, FORCE Y-AXIS (LBS)

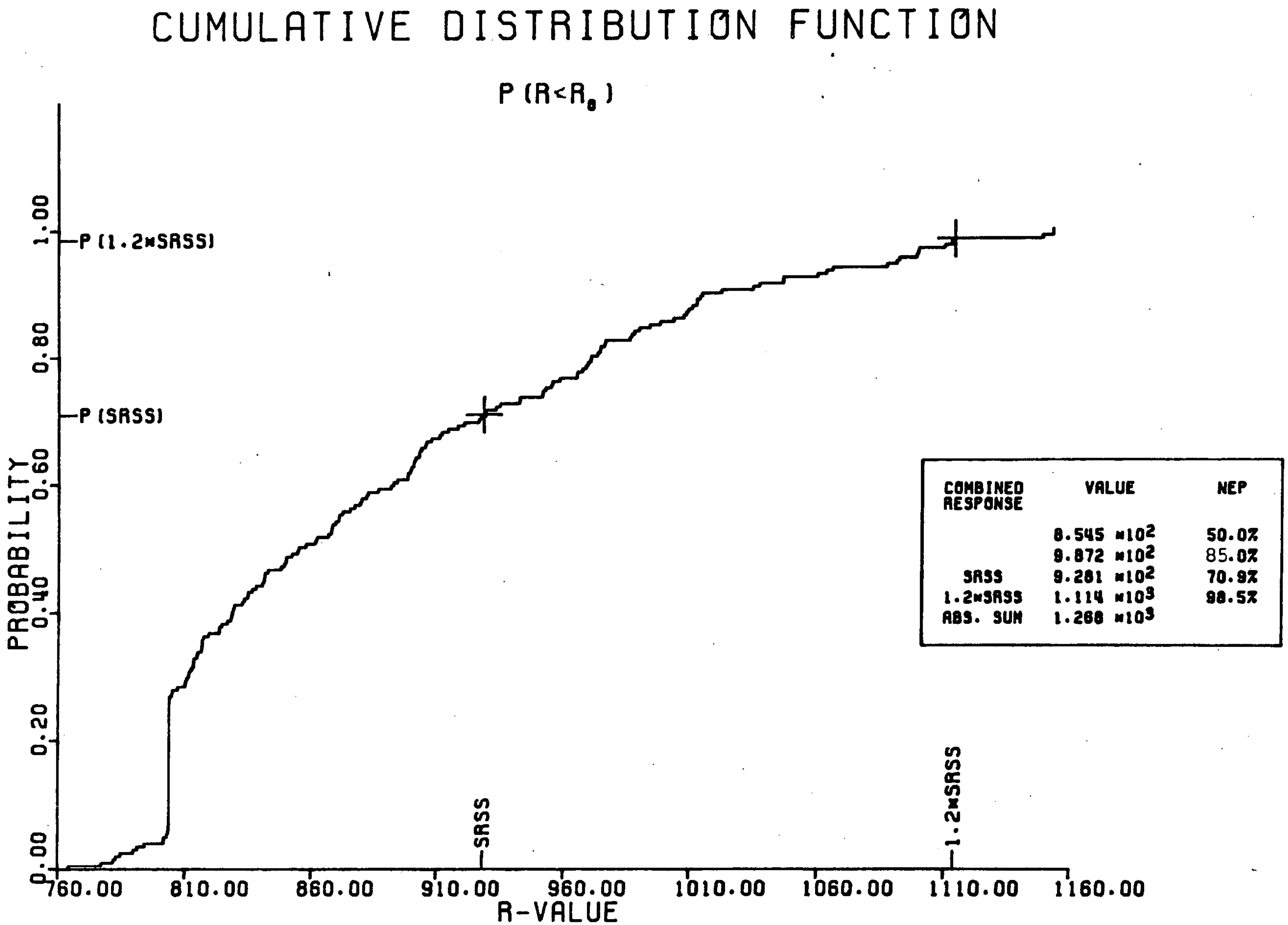


FIGURE B-90. BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-16
SRV-1 + CHUG LOAD COMBINATION, MOMENT Y-AXIS (IN-LBS)

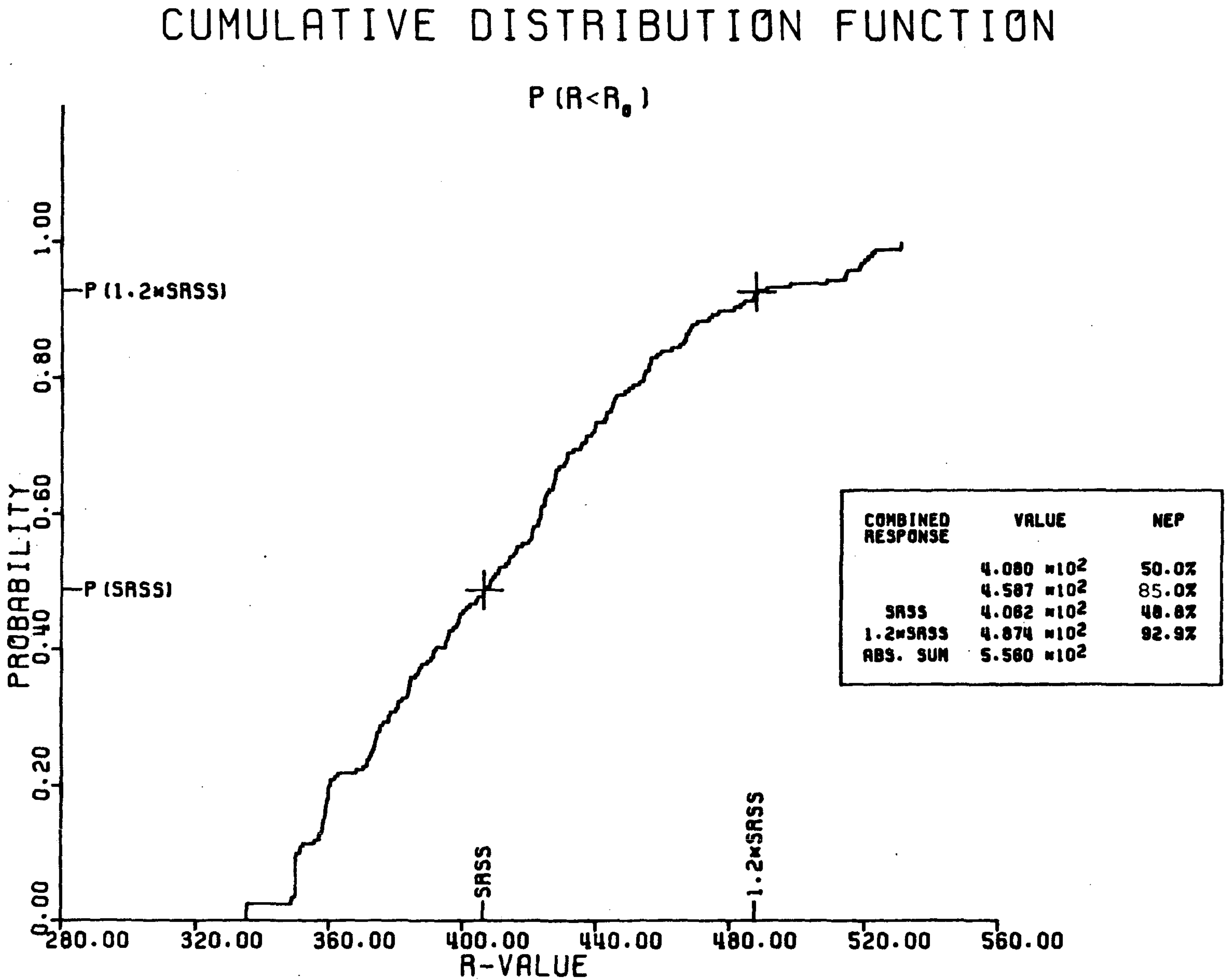
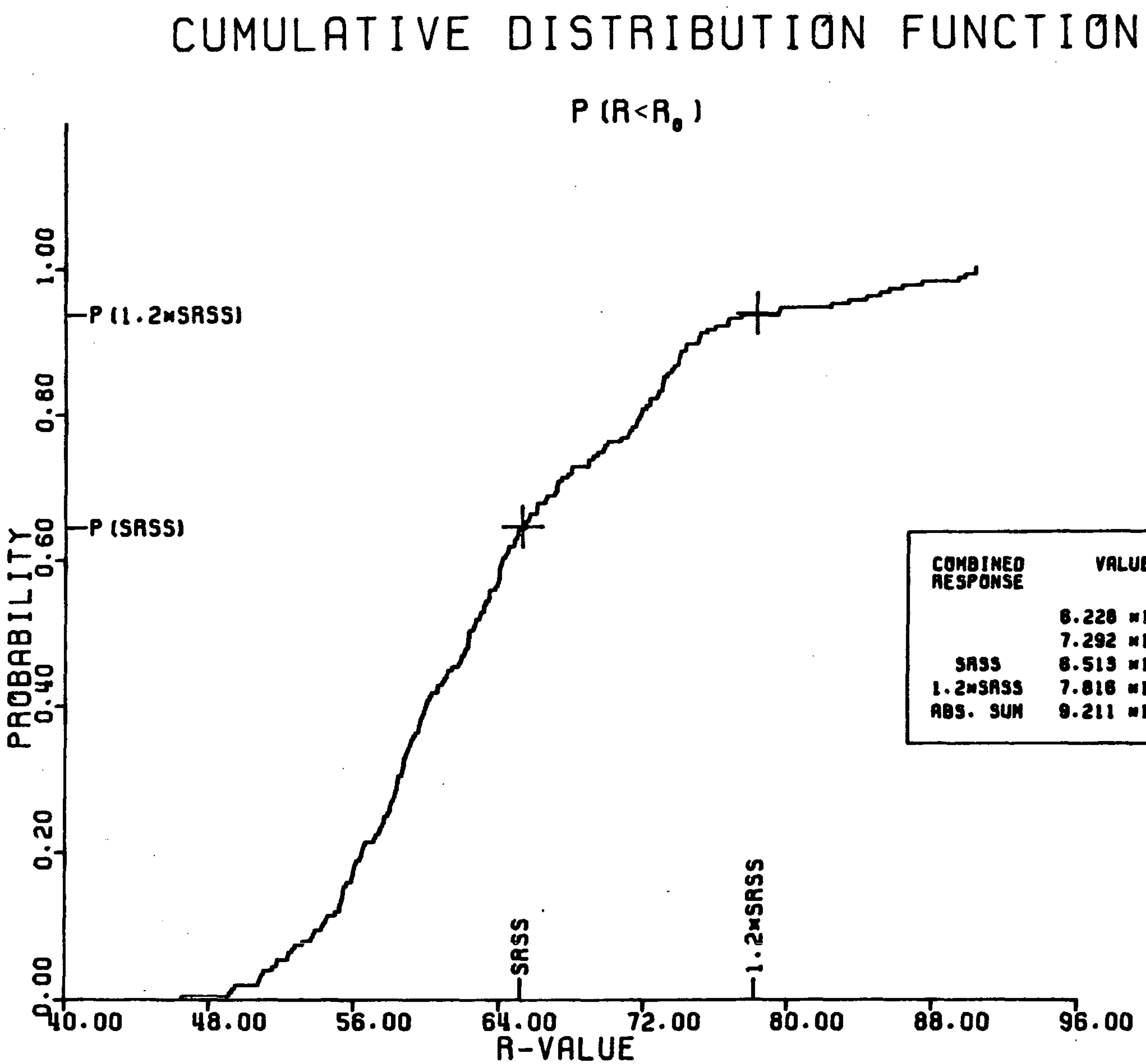


FIGURE B-91. BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-17
SRV-ADS + CHUG LOAD COMBINATION, MOMENT Y-AXIS (IN-LBS)



COMBINED RESPONSE	VALUE	NEP
	6.228 ×10[1]	50.0%
	7.292 ×10[1]	85.0%
SRSS	6.513 ×10[1]	64.4%
1.2×SRSS	7.816 ×10[1]	93.7%
ABS. SUM	9.211 ×10[1]	

FIGURE B-92. BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-14
SRV-ADS + CHUG LOAD COMBINATION, FORCE Y-AXIS (LBS)

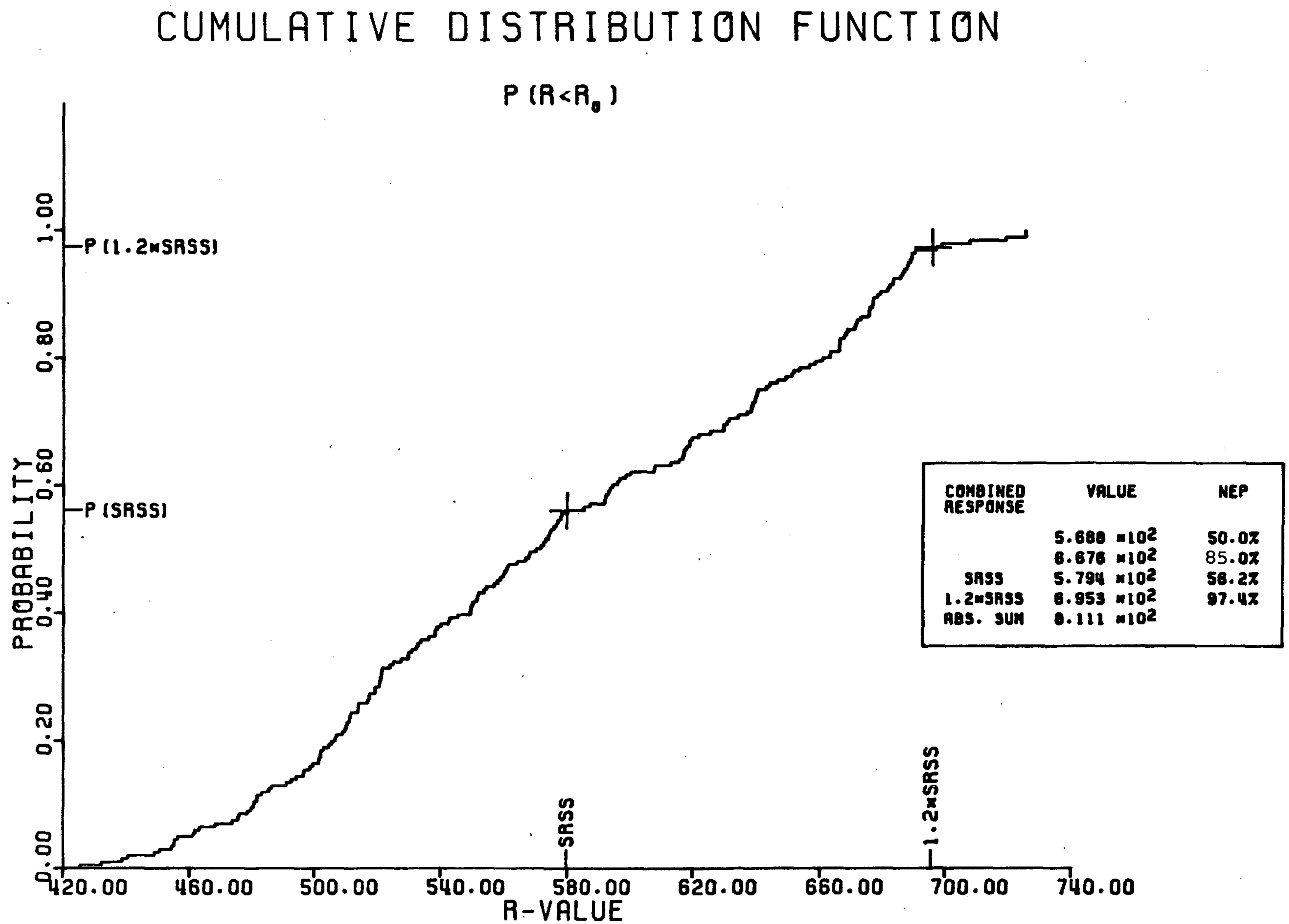


FIGURE B-93 BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-16
SRV-ALL + CHUG LOAD COMBINATION, MOMENT Y-AXIS (IN-LBS)

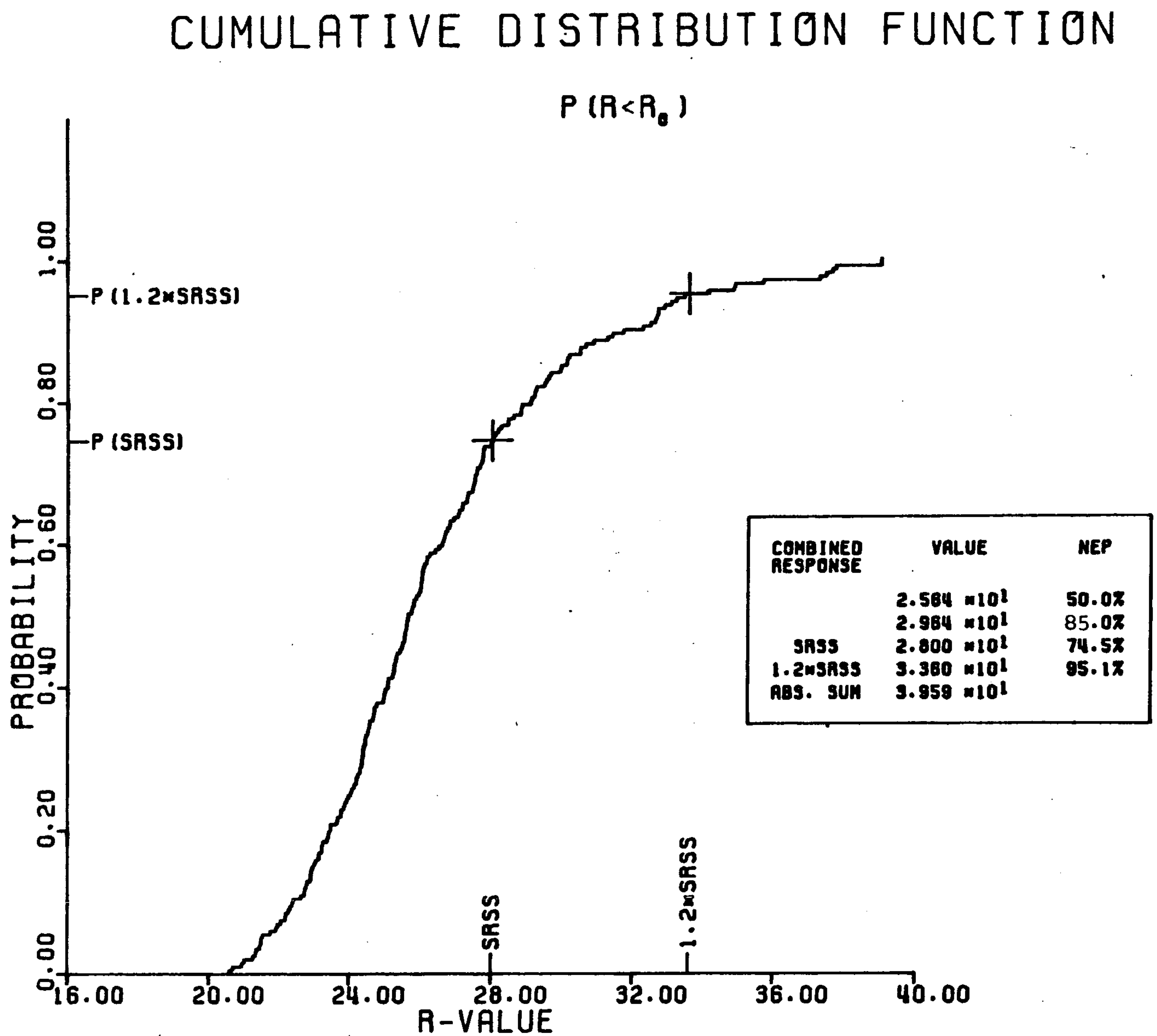
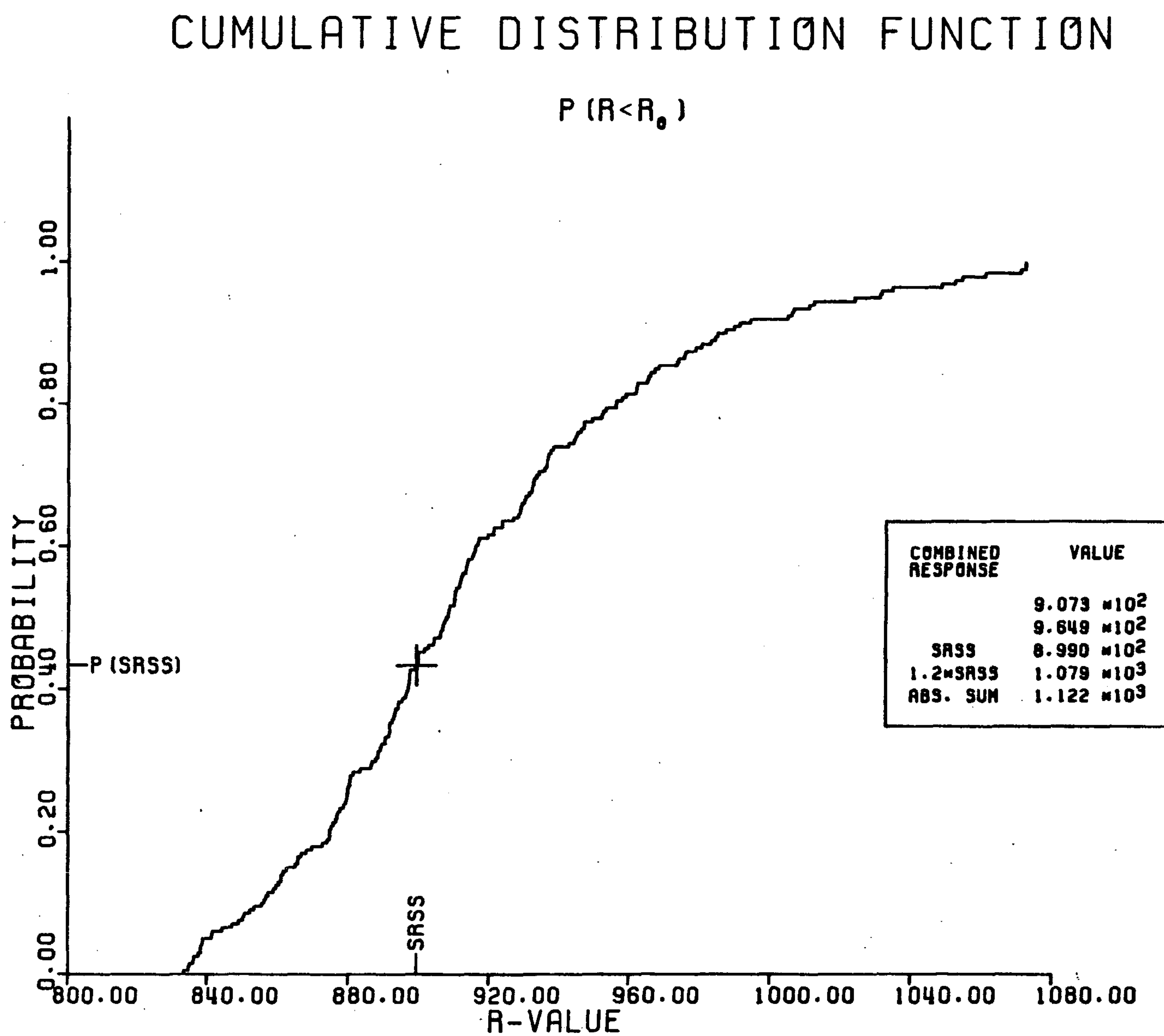


FIGURE B-94. BOP PIPING CDF CURVE, FP-18 LINE, LOCATION 5-20
SRV-ALL + CHUG LOAD COMBINATION, FORCE Y-AXIS (LBS)



COMBINED RESPONSE	VALUE	NEP
	9.073×10^2	50.0%
	9.649×10^2	85.0%
SRSS	8.990×10^2	43.4%
1.2*SRSS	1.079×10^3	> 99.5%
ABS. SUM	1.122×10^3	

FIGURE B-95. BOP PIPING CDF CURVE, HPCS PUMP DISCHARGE LINE LOCATION 3-8 OBE + SRV-ALL LOAD COMBINATION, FORCE (LBS)

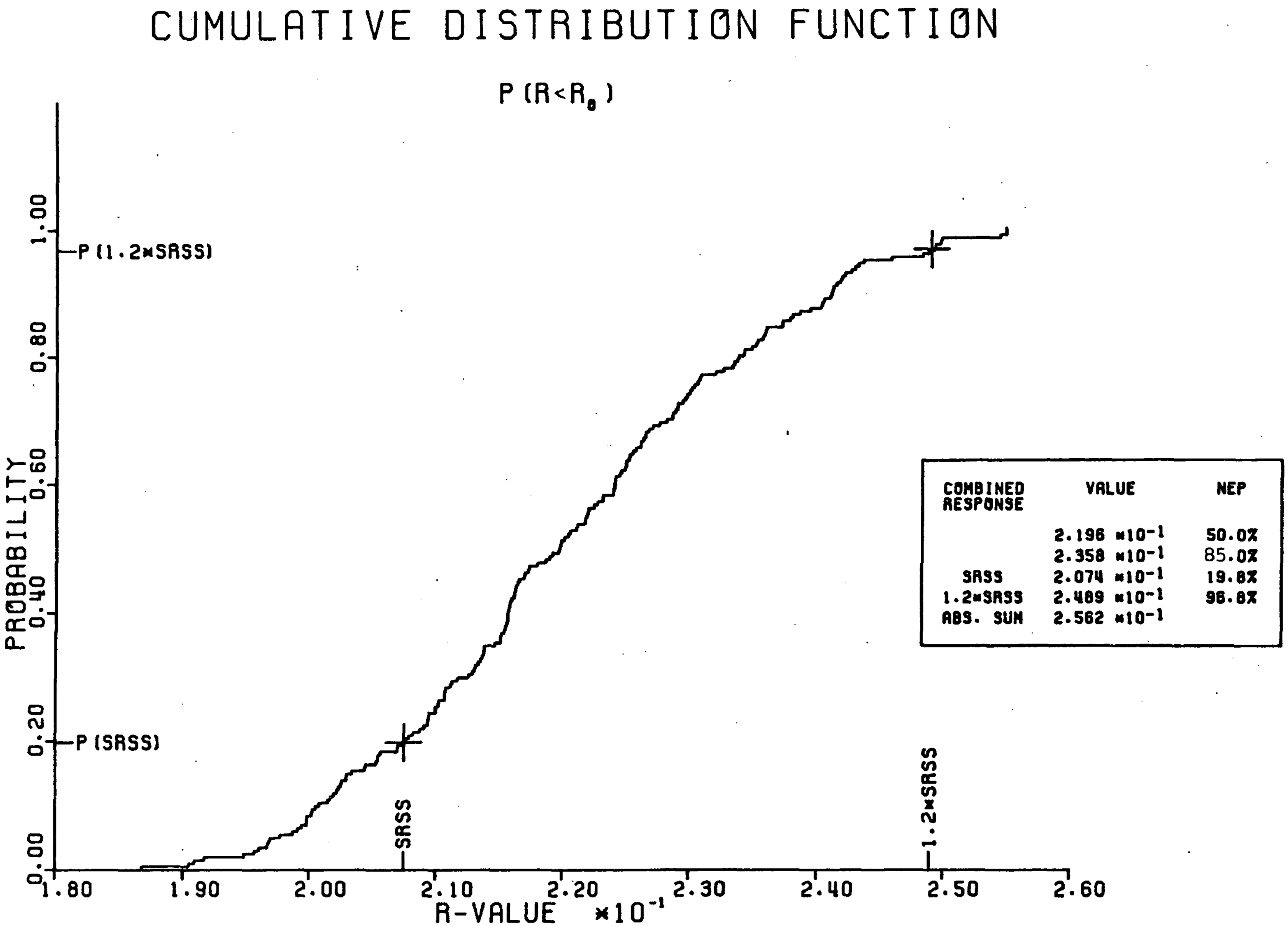


FIGURE B-96. BOP PIPING CDF CURVE, HPCS PUMP DISCHARGE LINE LOCATION 3-6
OBE + SRV-ALL LOAD COMBINATION, ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION

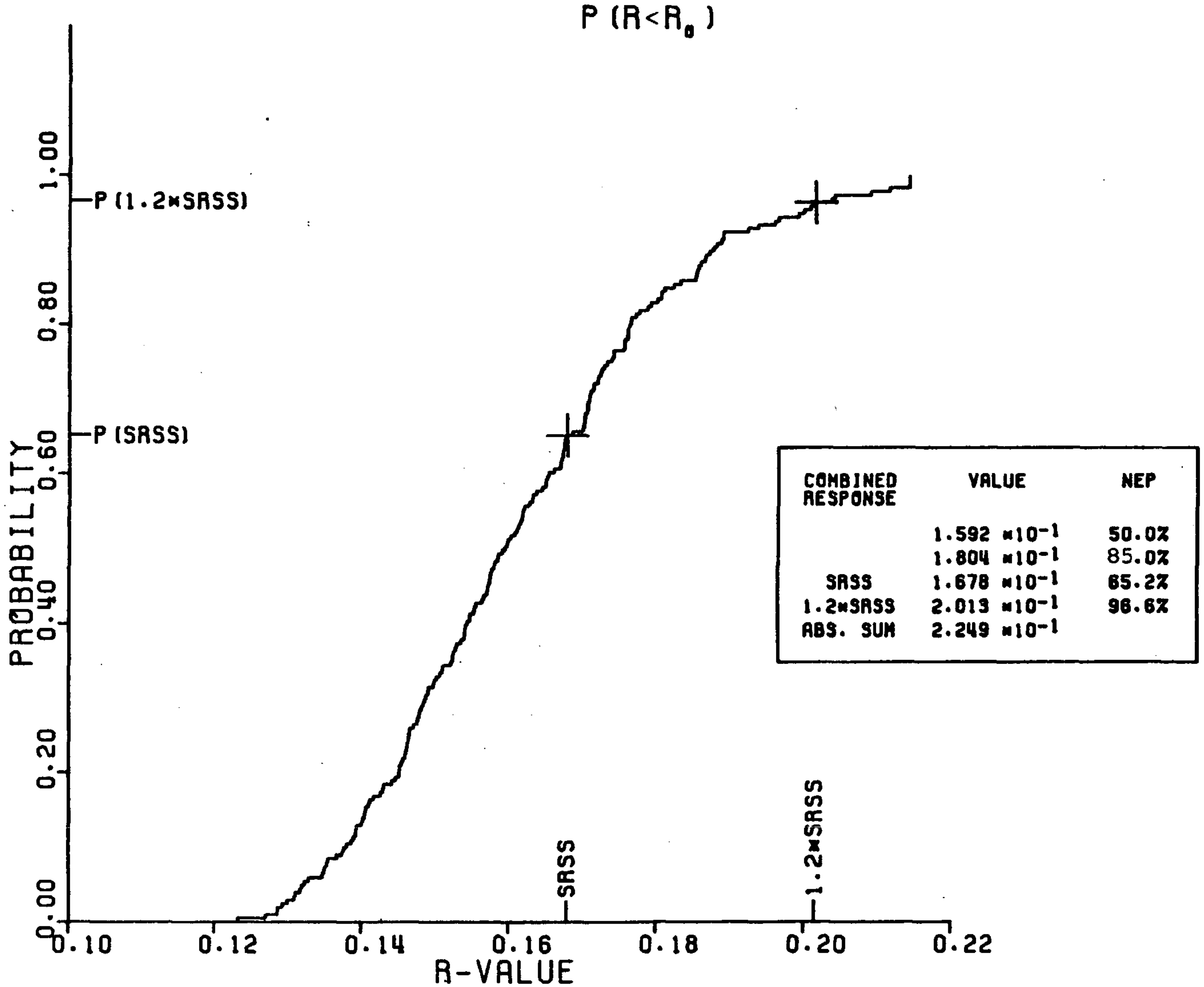


FIGURE B-97. BOP PIPING CDF CURVE, HPCS PUMP DISCHARGE LINE LOCATION 3-4 OBE + SRV-ADS LOAD COMBINATION, ACCELERATION (G)

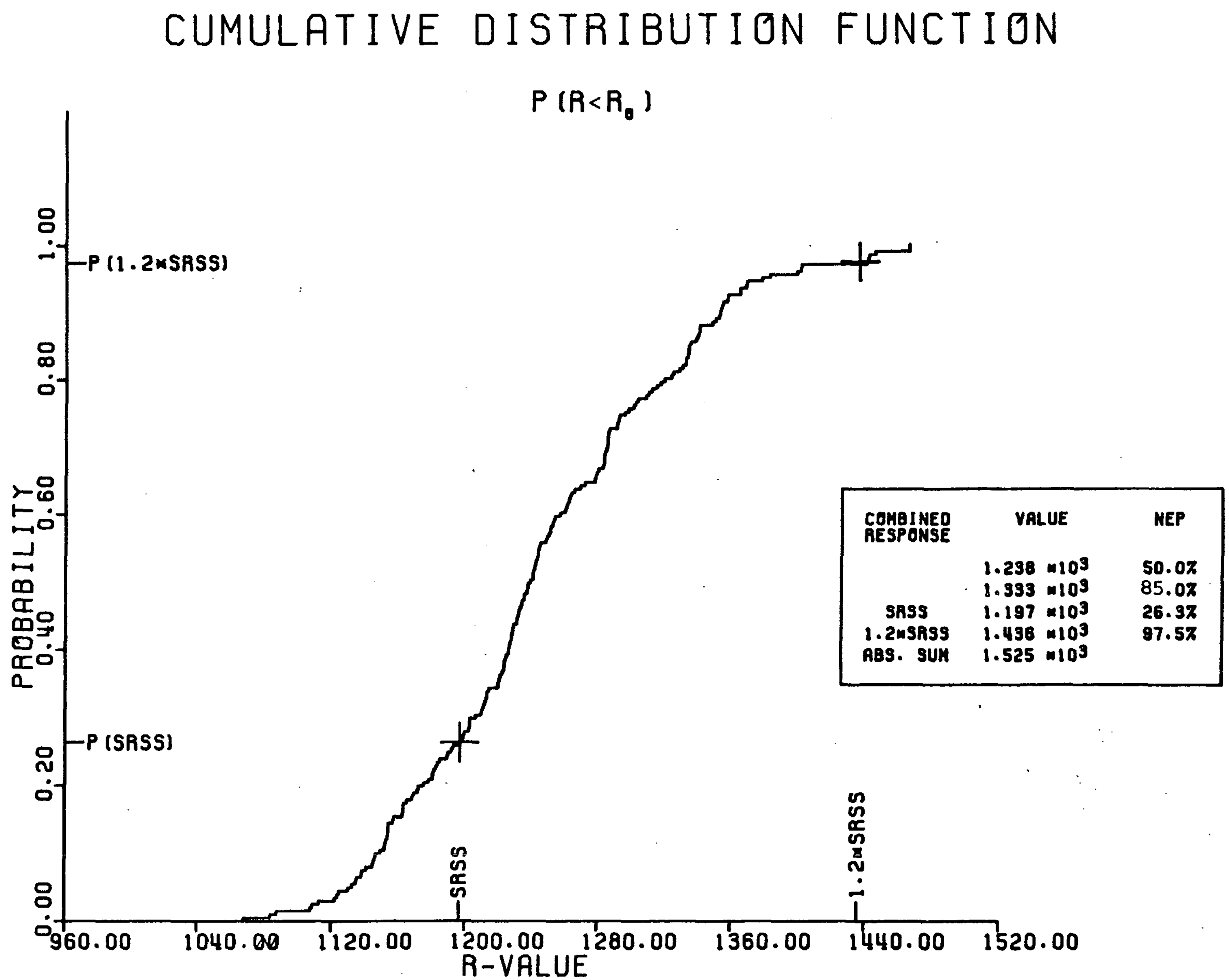


FIGURE B-98. BOP PIPING CDF CURVE, HPCS PUMP DISCHARGE LINE LOCATION 3-7
OBE + SRV-ADS LOAD COMBINATION, MOMENT (FT-LBS)

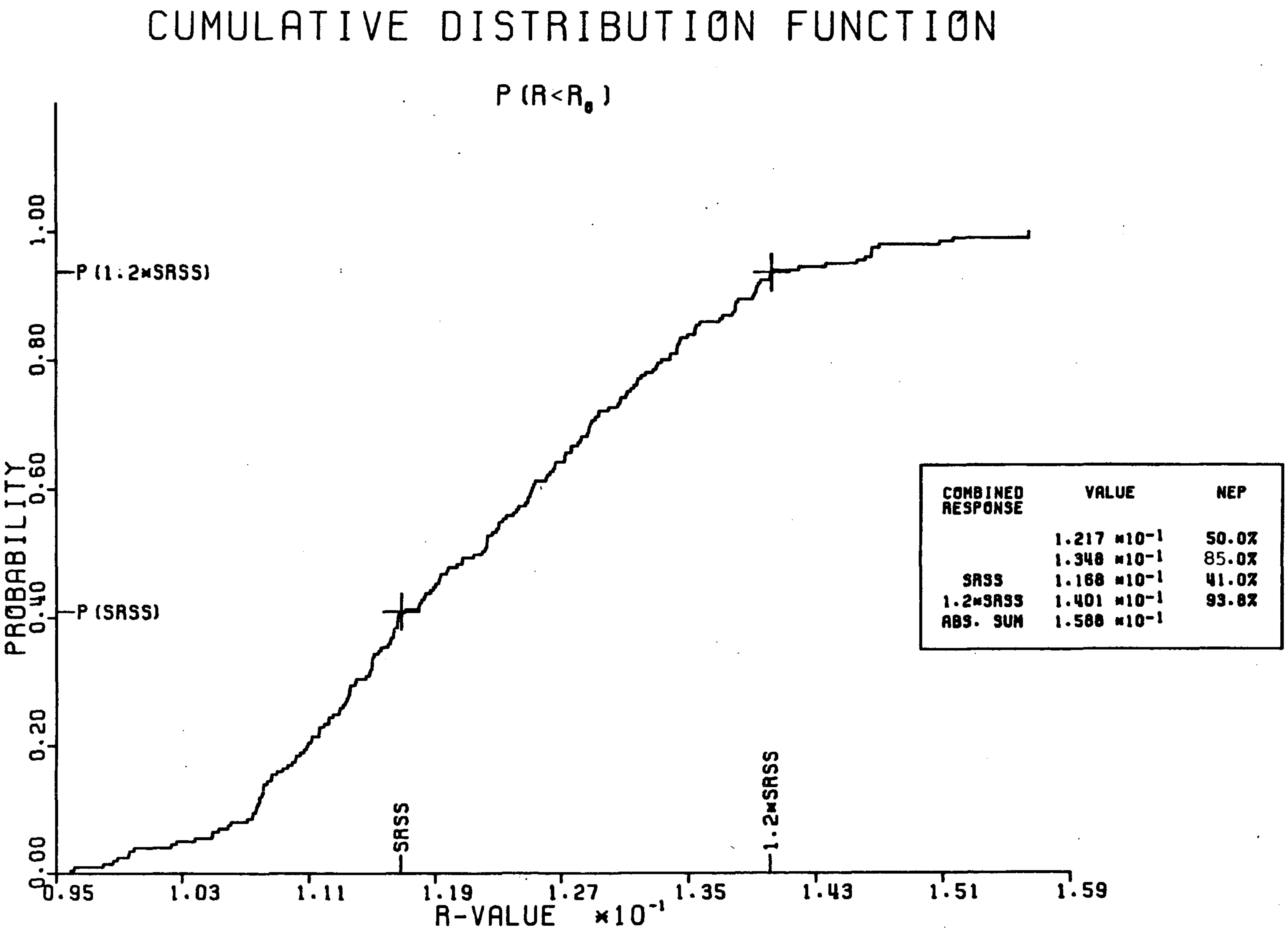


FIGURE B-99. BOP PIPING CDF CURVE, HPCS PUMP DISCHARGE LINE LOCATION 3-6
OBE + SRV-ADS LOAD COMBINATION, ACCELERATION (G)

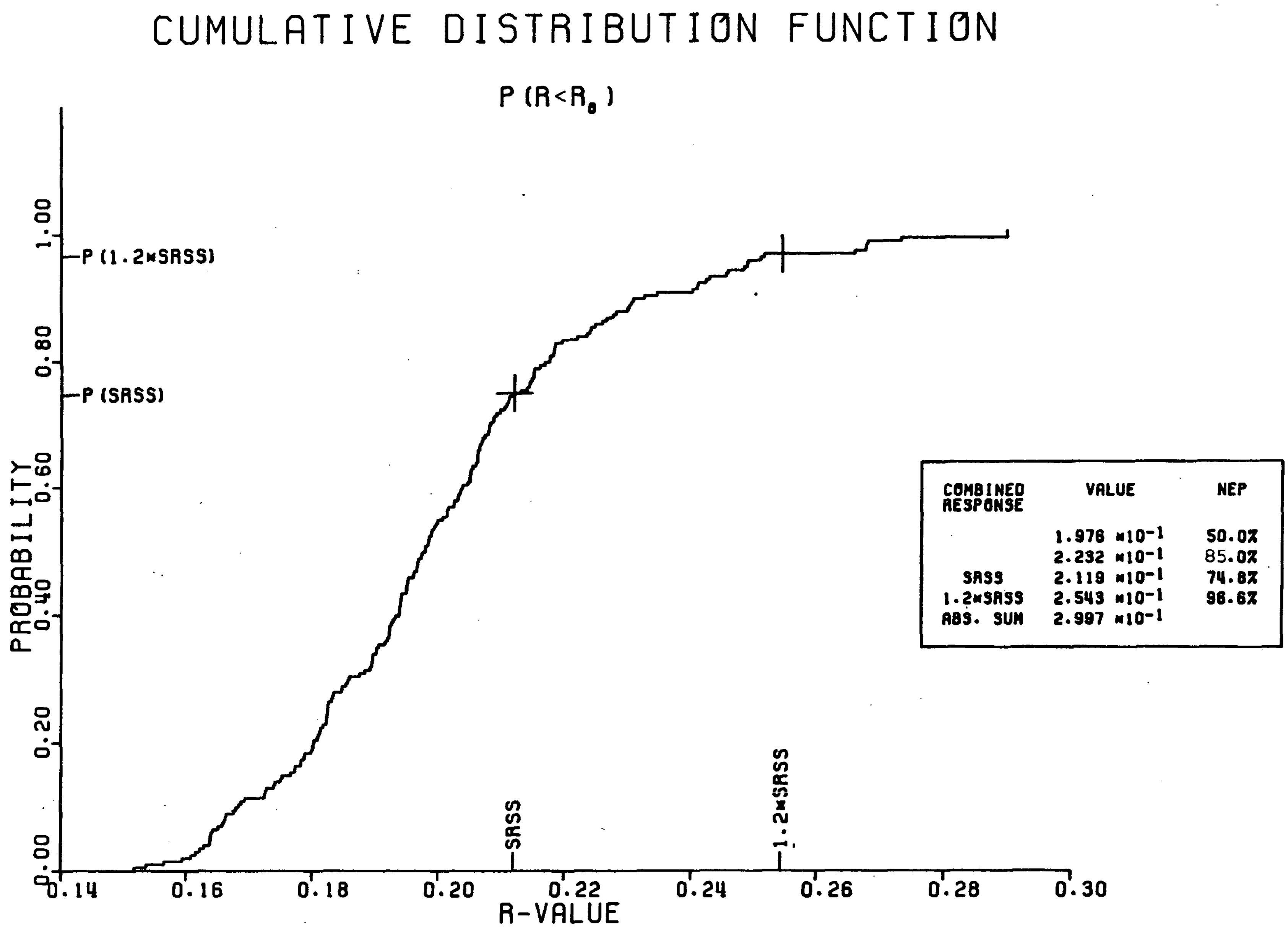


FIGURE B-100. BOP PIPING CDF CURVE, HPCS PUMP DISCHARGE LINE LOCATION 3-4
SSE + SRV-ADS LOAD COMBINATION, ACCELERATION (G)

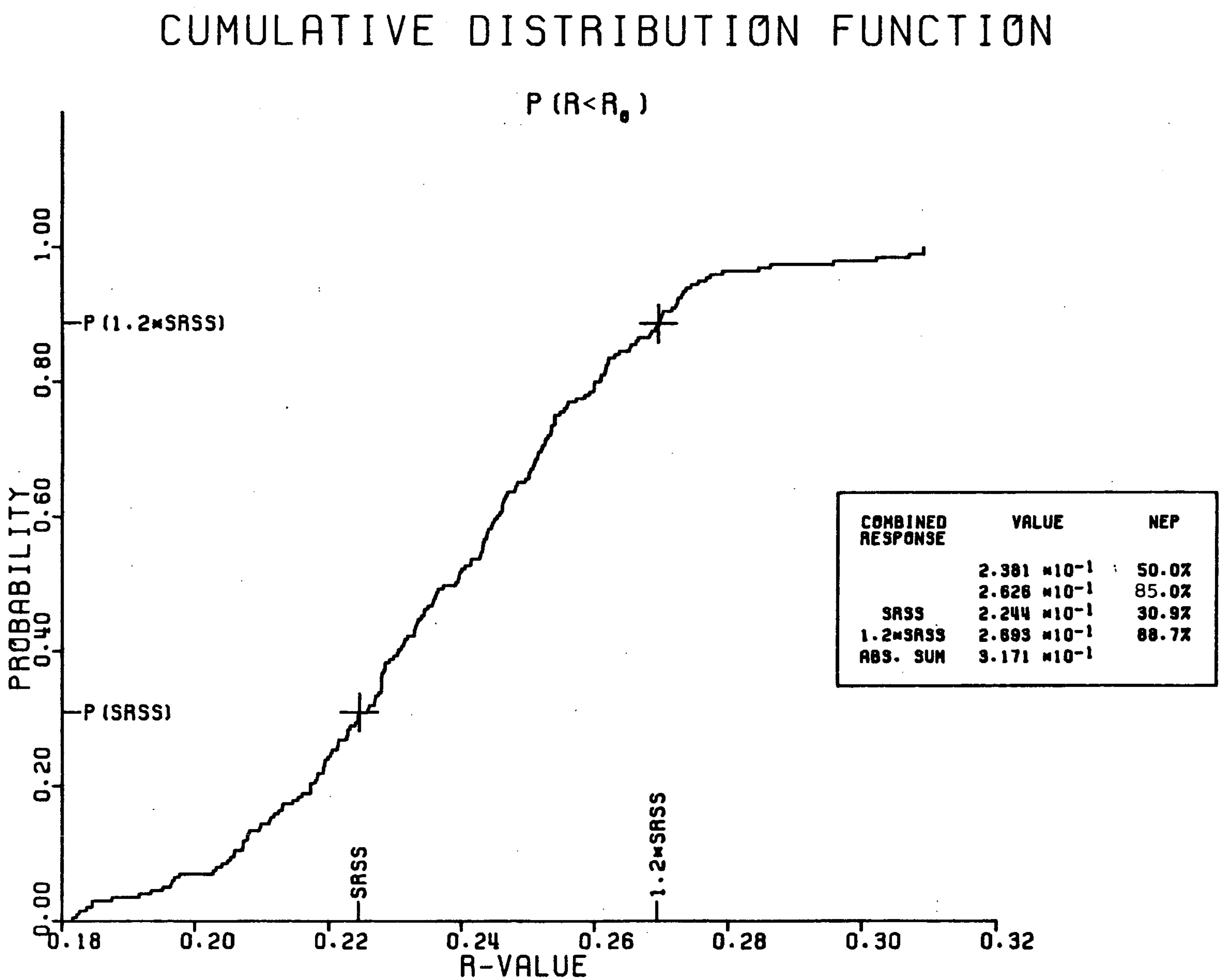
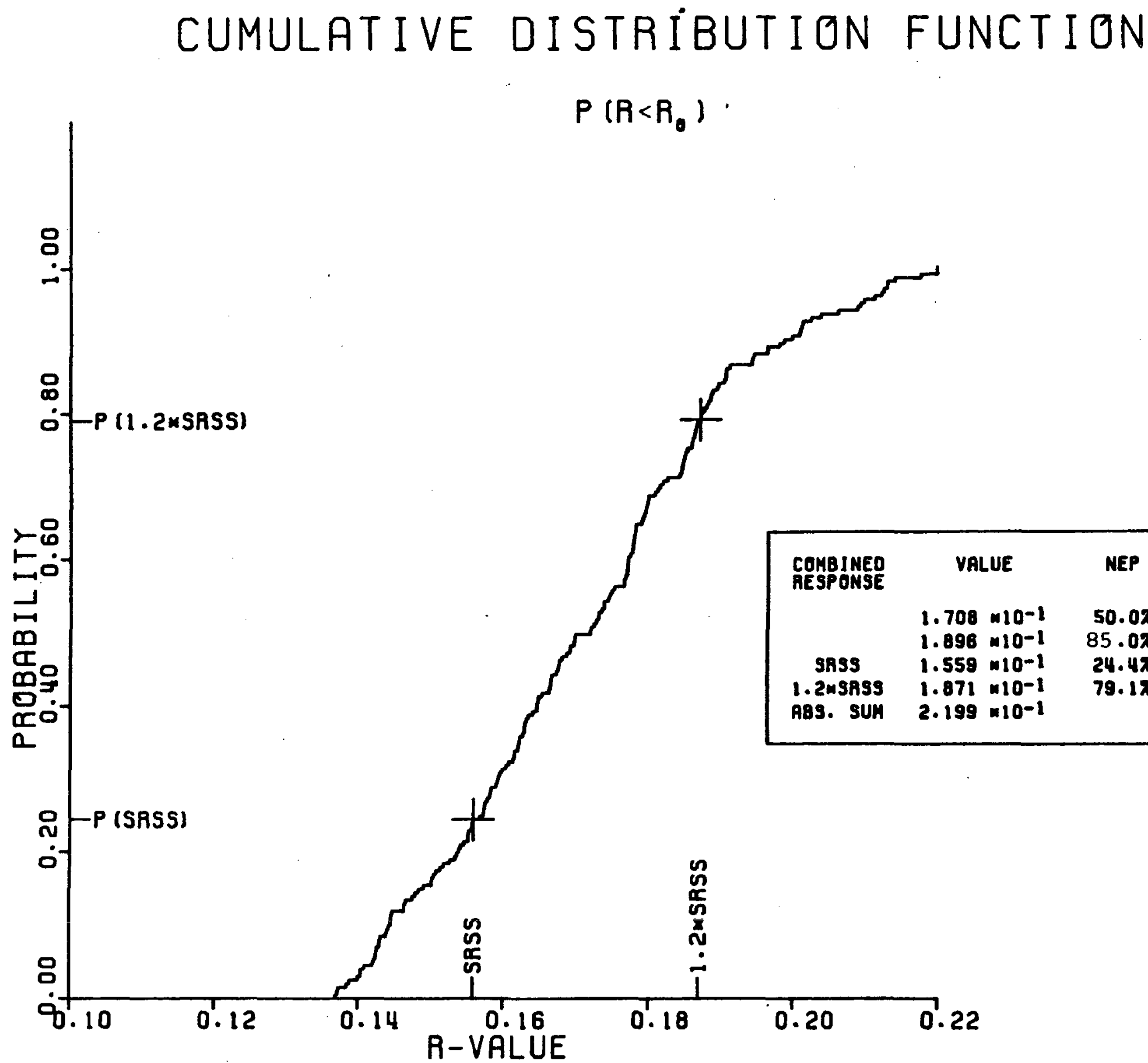


FIGURE B-101. BOP PIPING CDF CURVE. HPCS PUMP DISCHARGE LINE LOCATION 3-5
SRV-ADS + CHUG LOAD COMBINATION. ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	1.708 $\times 10^{-1}$	50.0%
	1.896 $\times 10^{-1}$	85.0%
SRSS	1.559 $\times 10^{-1}$	24.4%
1.2*SRSS	1.871 $\times 10^{-1}$	79.1%
ABS. SUM	2.199 $\times 10^{-1}$	

FIGURE B-102. BOP PIPING CDF CURVE, HPCS PUMP DISCHARGE LINE LOCATION 3-6 SRV-ADS + CHUG LOAD COMBINATION, ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION

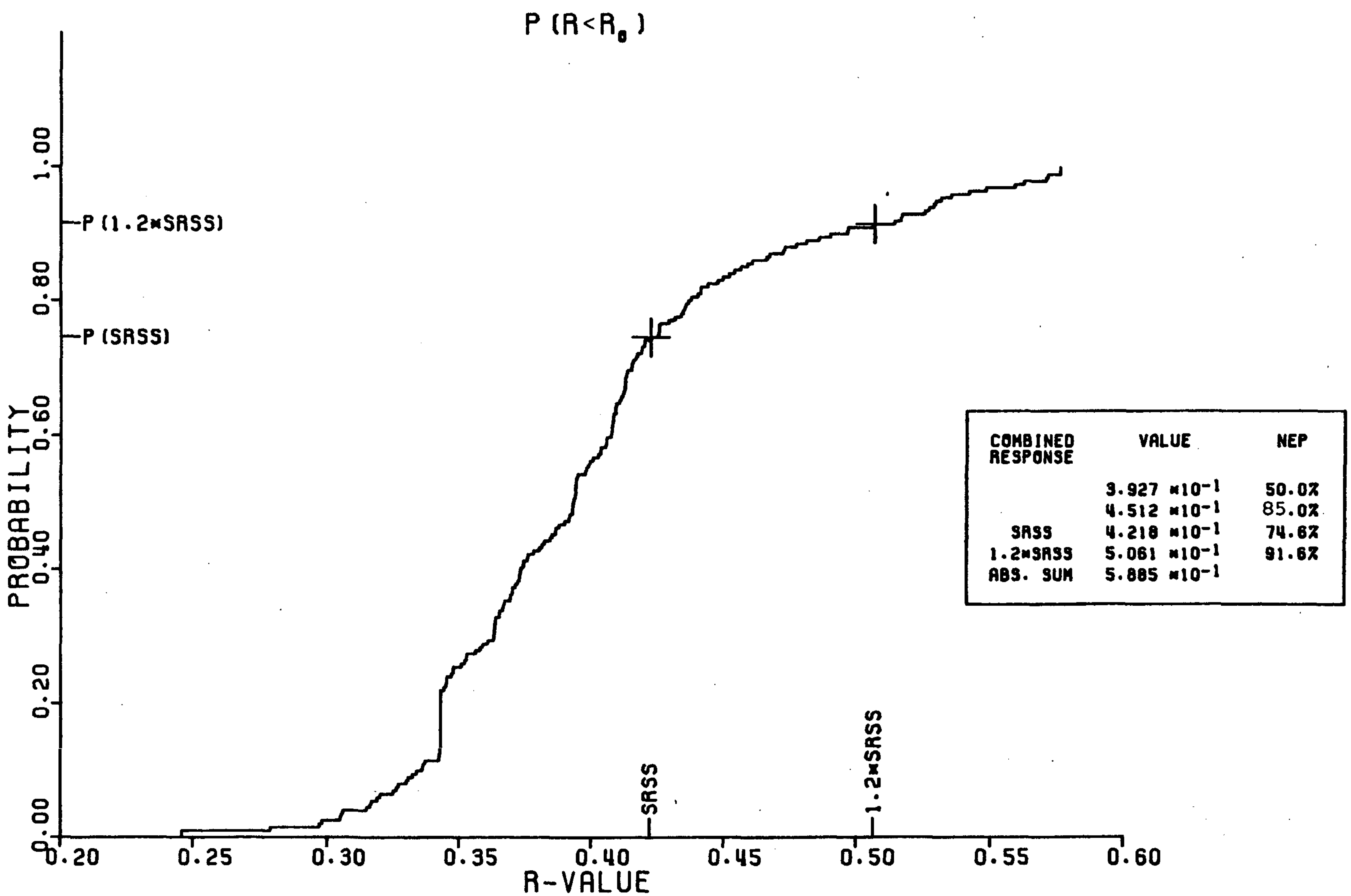


FIGURE B-103. BOP PIPING CDF CURVE, HPCS PUMP DISCHARGE LINE LOCATION 3-4
SRV-ALL + CHUG LOAD COMBINATION, ACCELERATION (G)

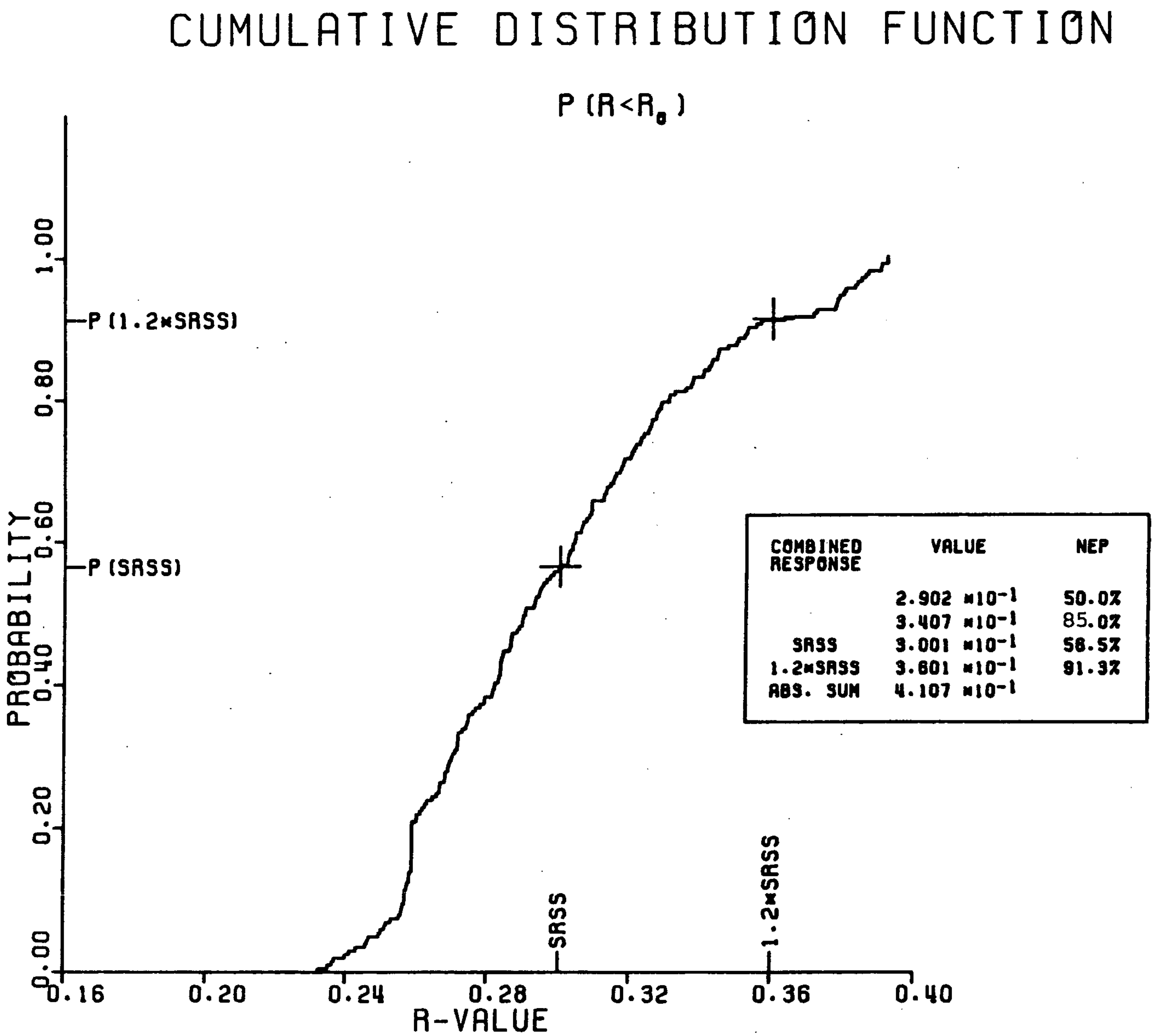
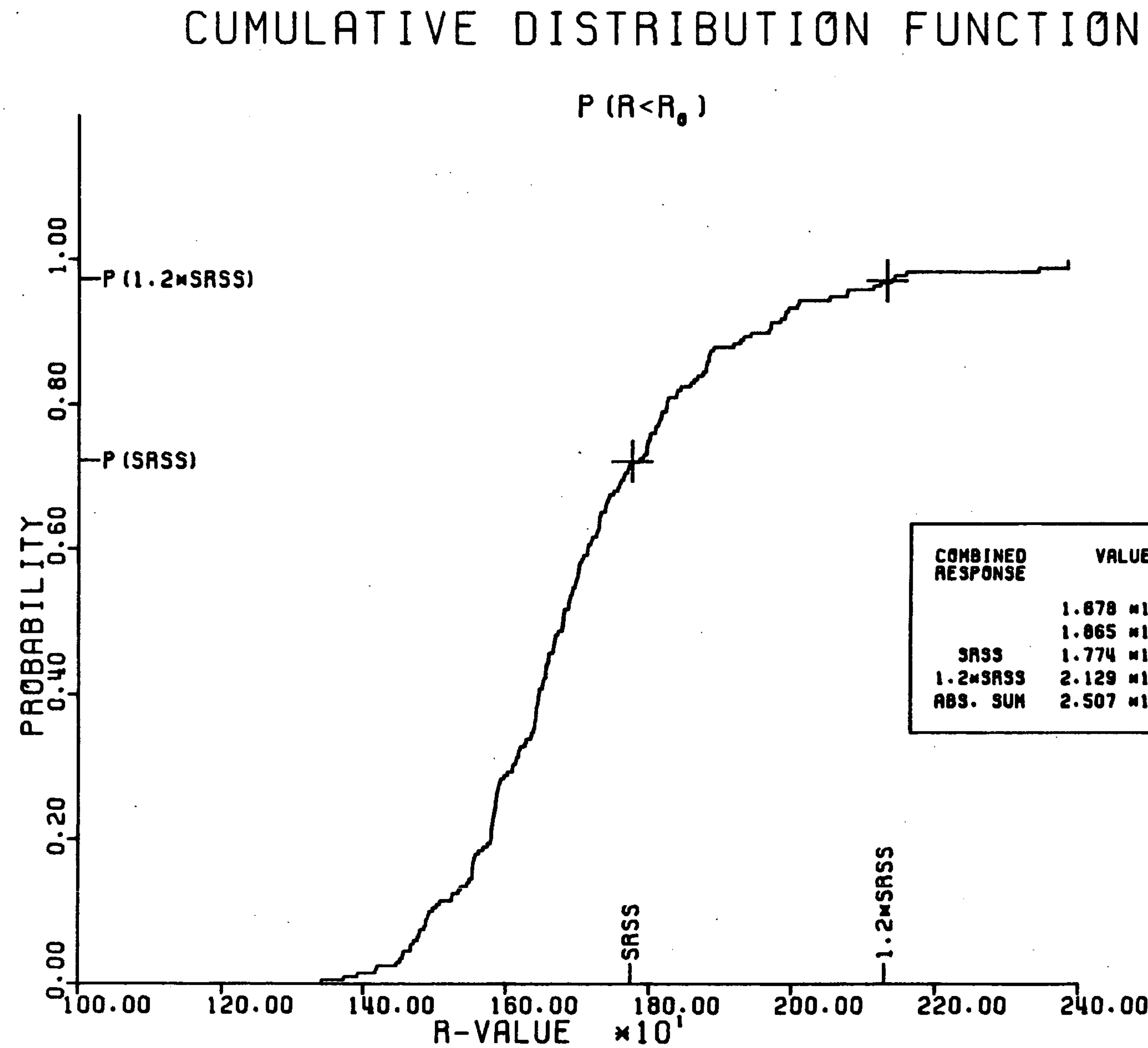


FIGURE B-104. BOP PIPING CDF CURVE, HPCS PUMP DISCHARGE LINE LOCATION 3-5 SRV-ALL + CHUG LOAD COMBINATION, ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	1.678×10^3	50.0%
	1.865×10^3	85.0%
SRSS	1.774×10^3	72.3%
1.2*SRSS	2.129×10^3	97.3%
ABS. SUM	2.507×10^3	

FIGURE B-105. BOP PIPING CDF CURVE, RESIDUAL HEAT REMOVAL LINE LOCATION 4-17
OBE + SRV-1 LOAD COMBINATION, MOMENT Y (FT-LBS)

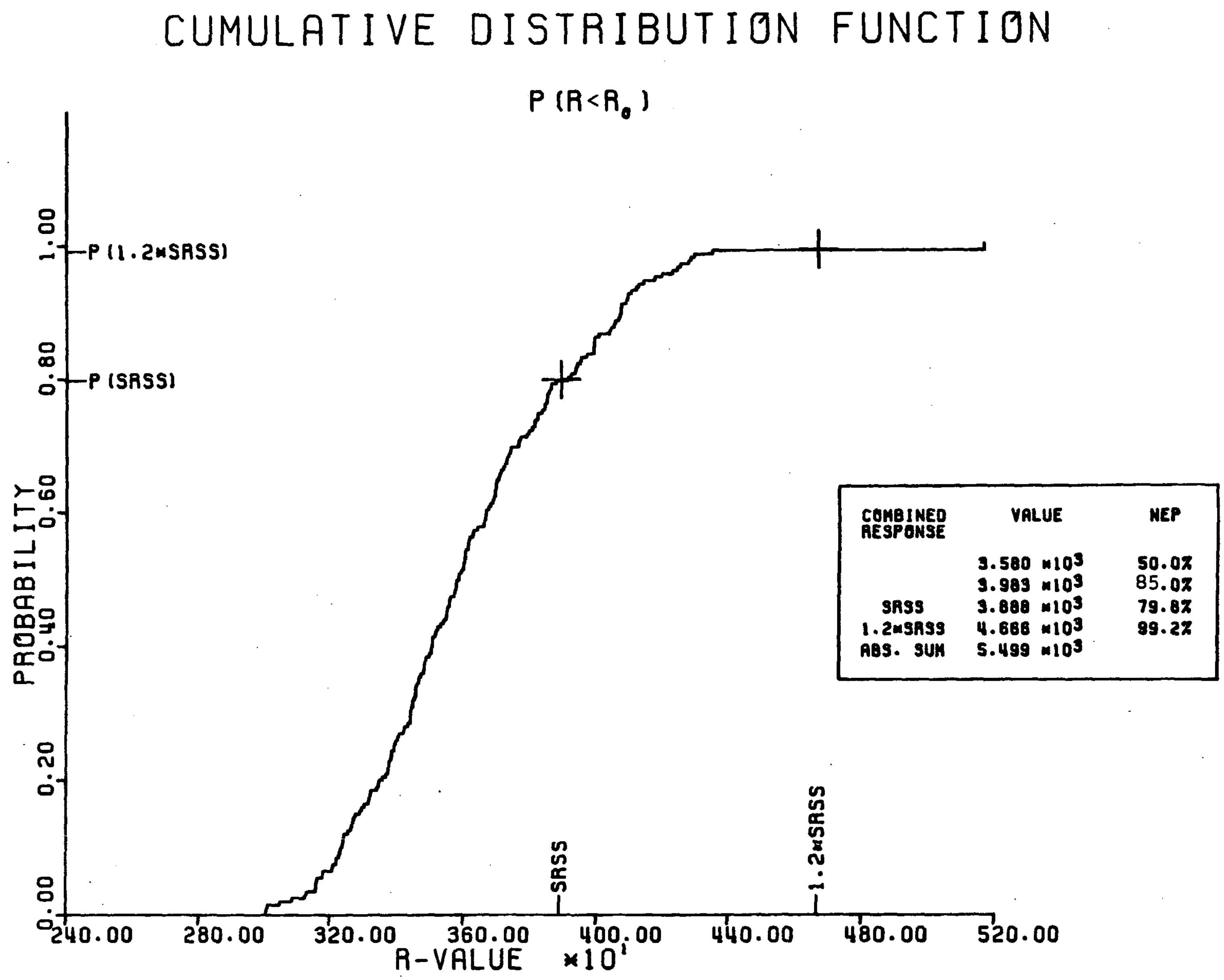


FIGURE B-106. BOP PIPING CDF CURVE, RESIDUAL HEAT REMOVAL LINE LOCATION 4-15
OBE + SRV-1 LOAD COMBINATION, MOMENT Y (FT-LBS)

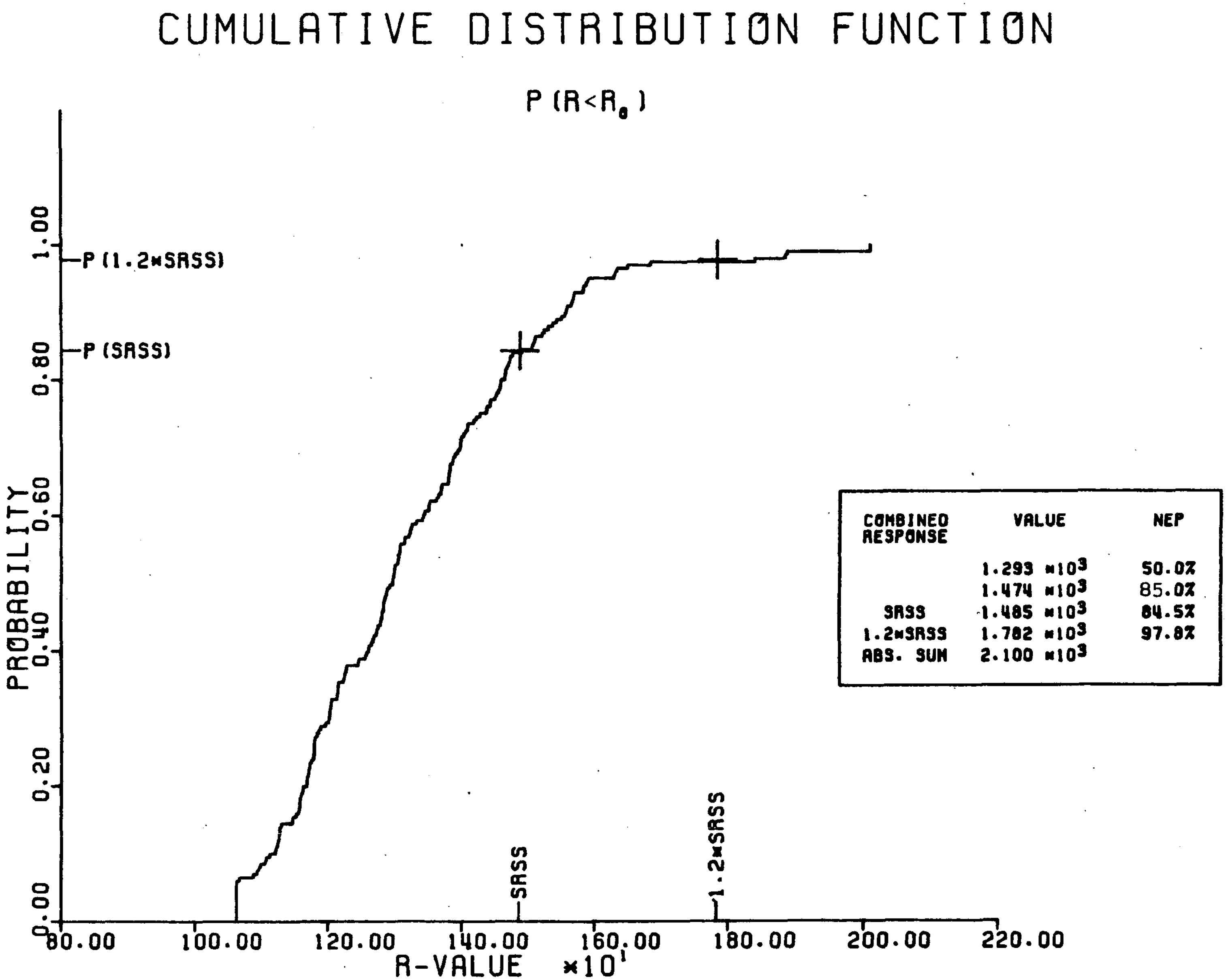
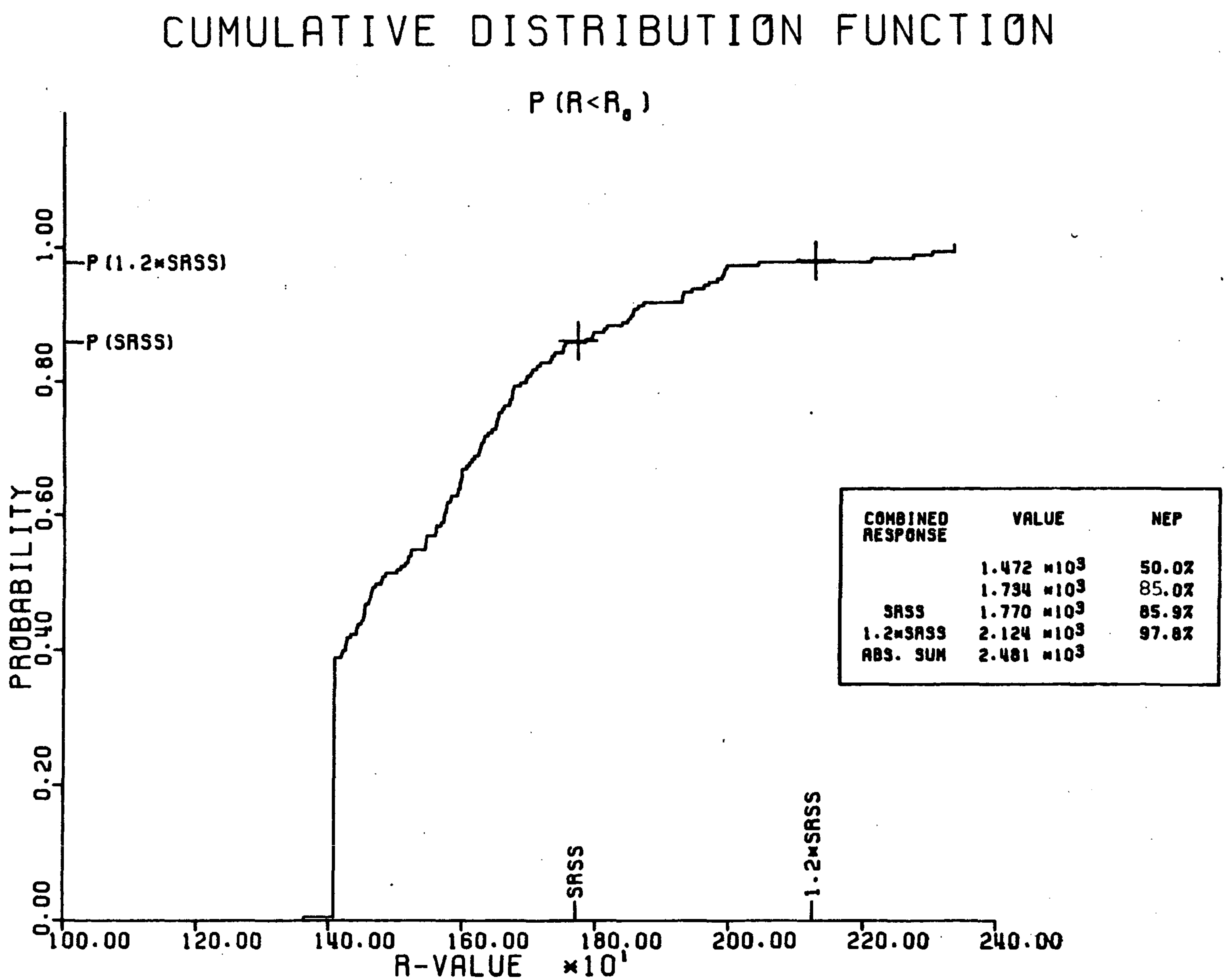


FIGURE B-107. BOP PIPING CDF CURVE, RESIDUAL HEAT REMOVAL LINE LOCATION 4-14
OBE + SRV-ALL LOAD COMBINATION, SUPPORT REACTION (LBS)



COMBINED RESPONSE	VALUE	NEP
	1.472×10^3	50.0%
	1.734×10^3	85.0%
SRSS	1.770×10^3	85.9%
1.2*SRSS	2.124×10^3	97.8%
ABS. SUM	2.481×10^3	

FIGURE B-108. BOP PIPING CDF CURVE, RESIDUAL HEAT REMOVAL LINE LOCATION 4-16
OBE + SRV-ALL LOAD COMBINATION, SHEAR Y (LBS)

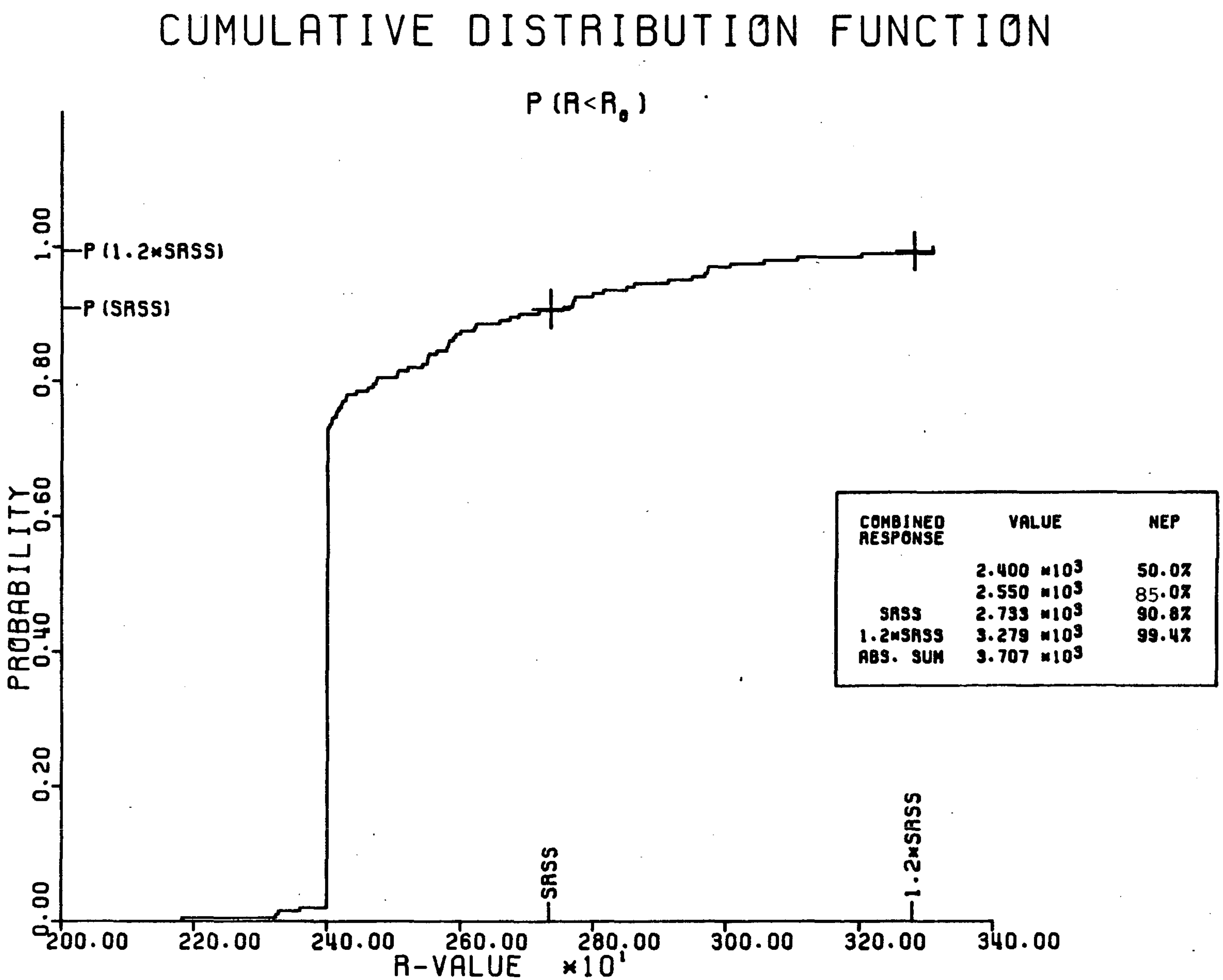


FIGURE B-109. BOP PIPING CDF CURVE, RESIDUAL HEAT REMOVAL LINE LOCATION 4-17
SSE + SRV-1 LOAD COMBINATION, MOMENT Y (FT-LBS)

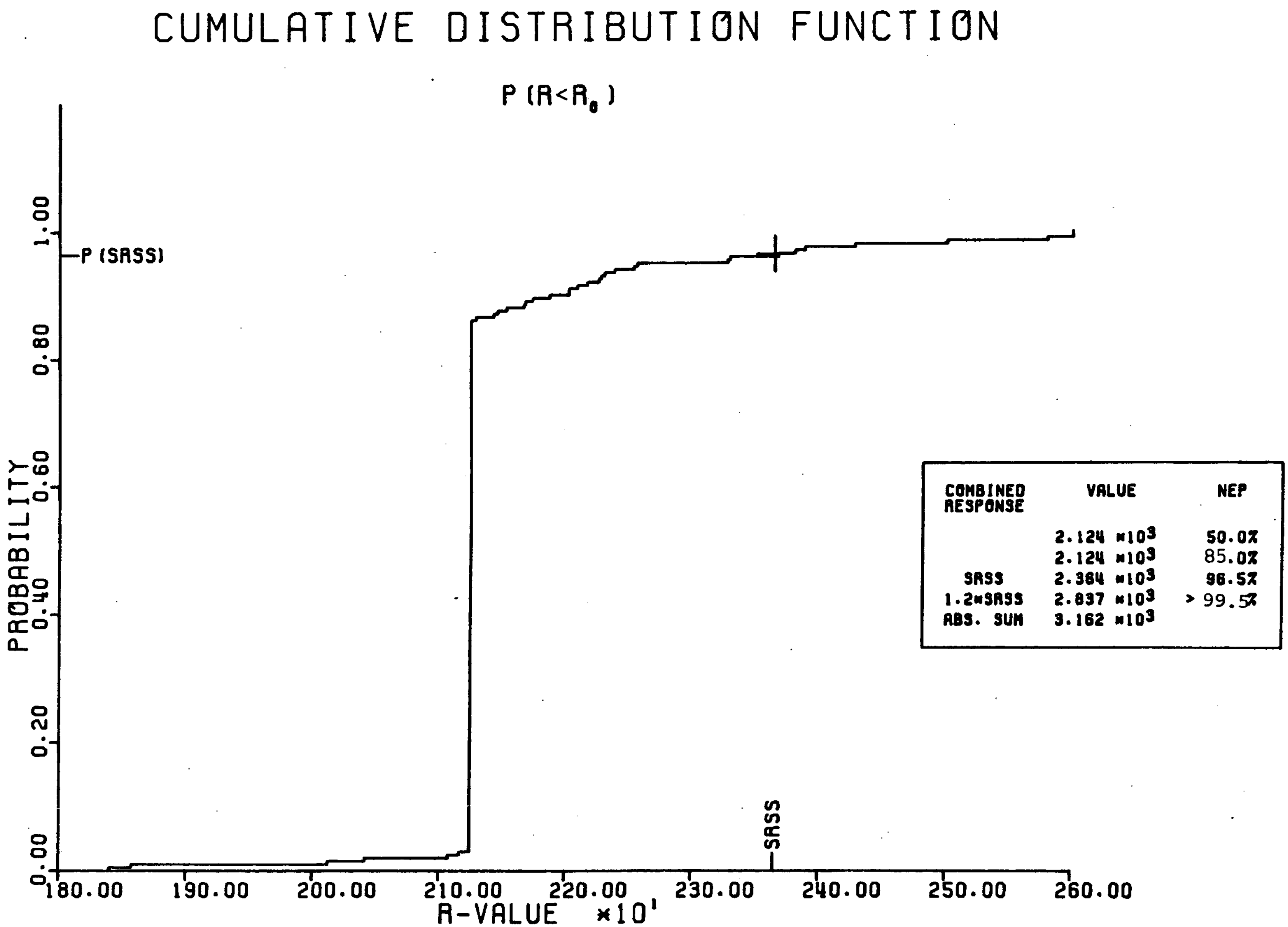


FIGURE B-110. BOP PIPING CDF CURVE, RESIDUAL HEAT REMOVAL LINE LOCATION 4-14
SSE + SRV-ALL LOAD COMBINATION, SUPPORT REACTION (LBS)

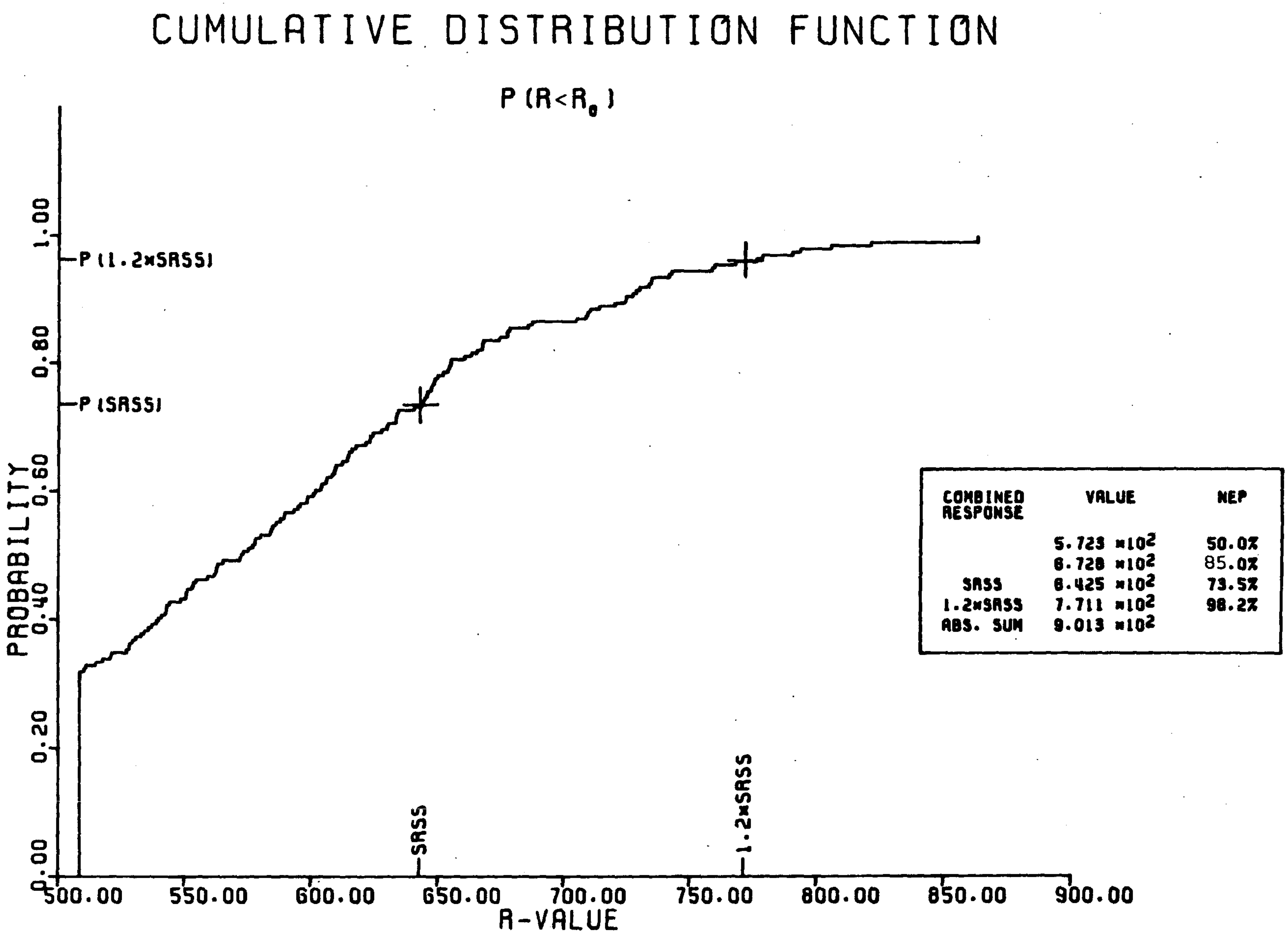


FIGURE B-111. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-7
OBE + SRV-1 LOAD COMBINATION, FORCE Z-AXIS (LBS)

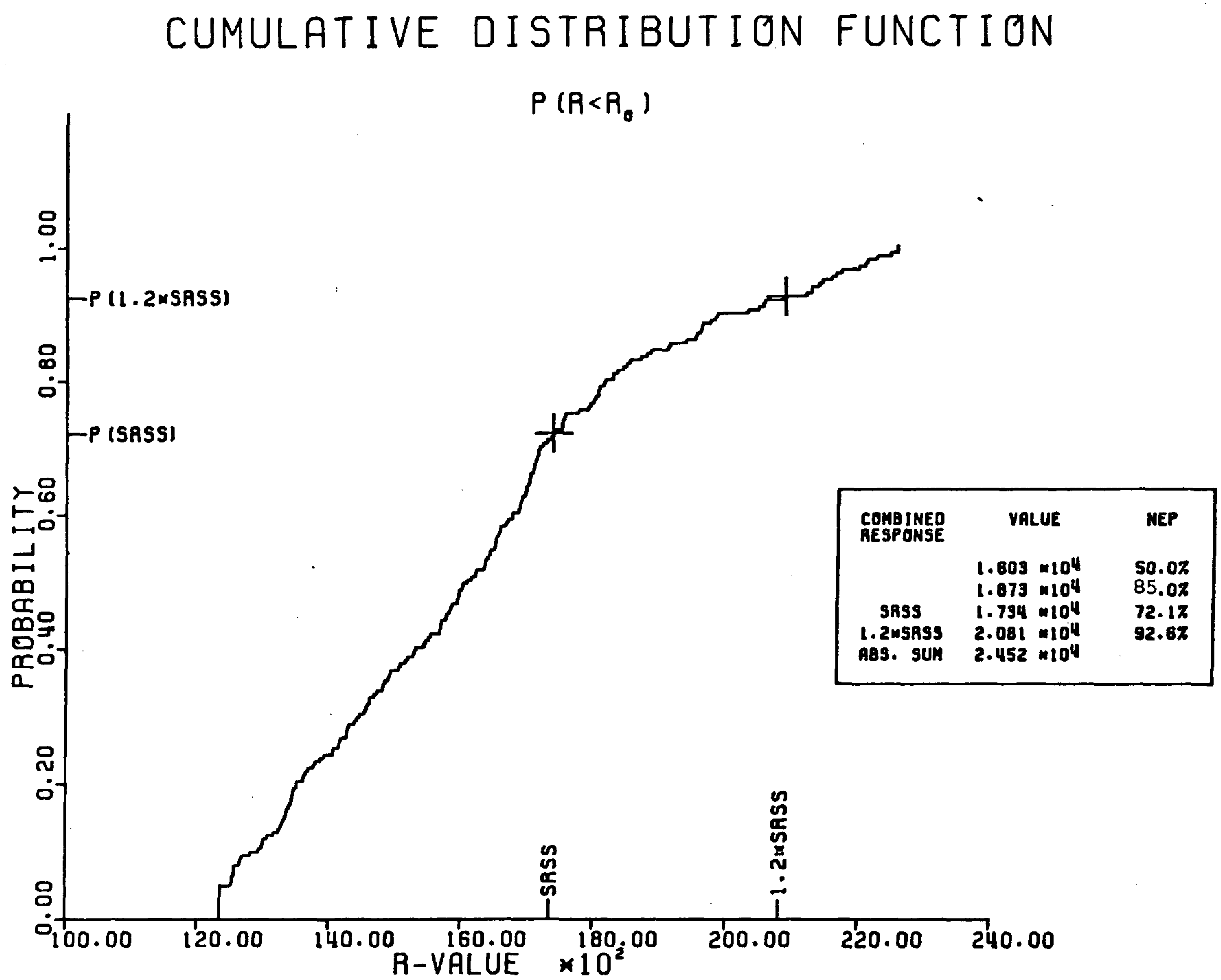


FIGURE B-112. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-10
OBE + SRV-1 LOAD COMBINATION, MOMENT Y-AXIS (IN-LBS)

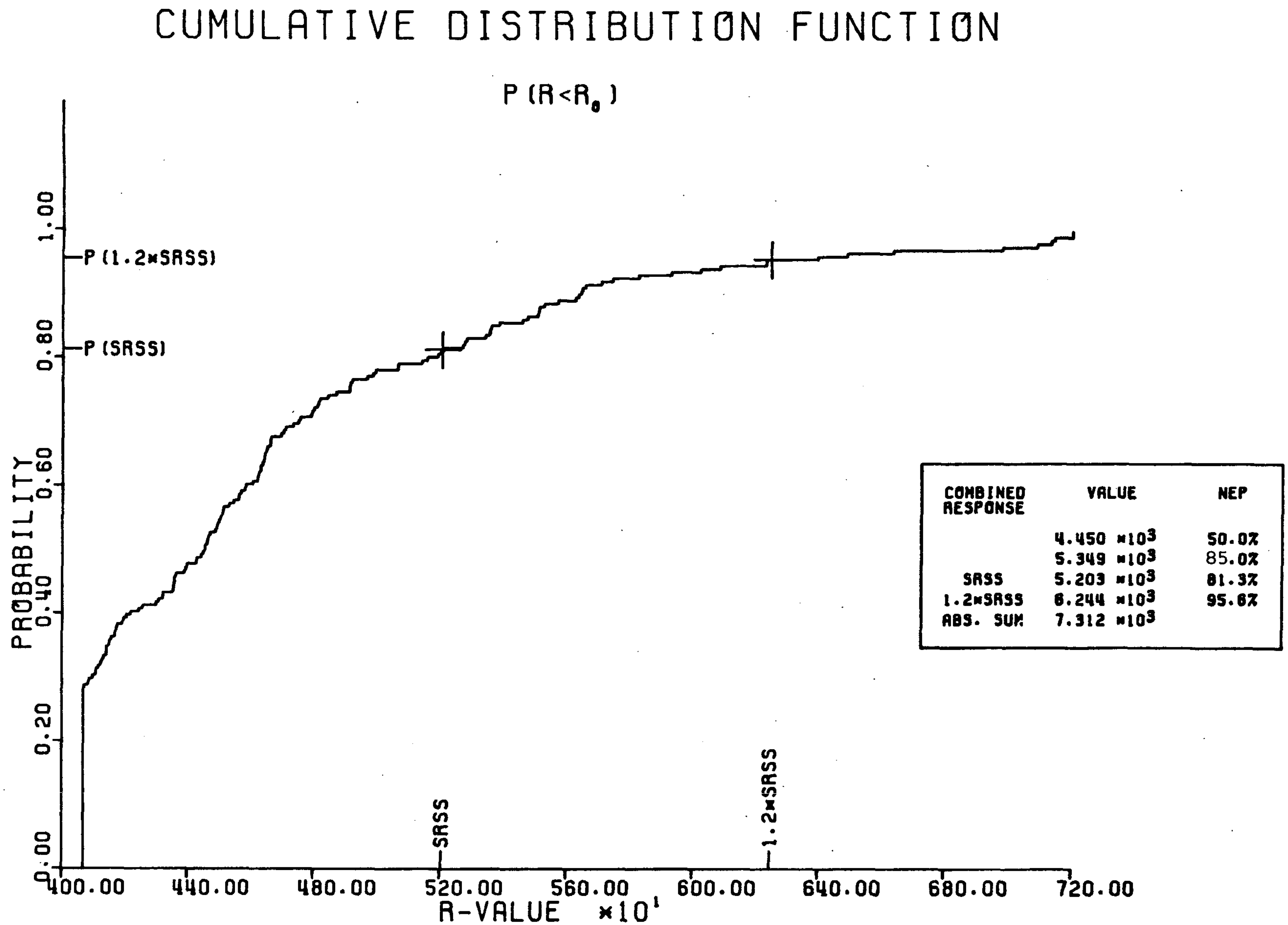
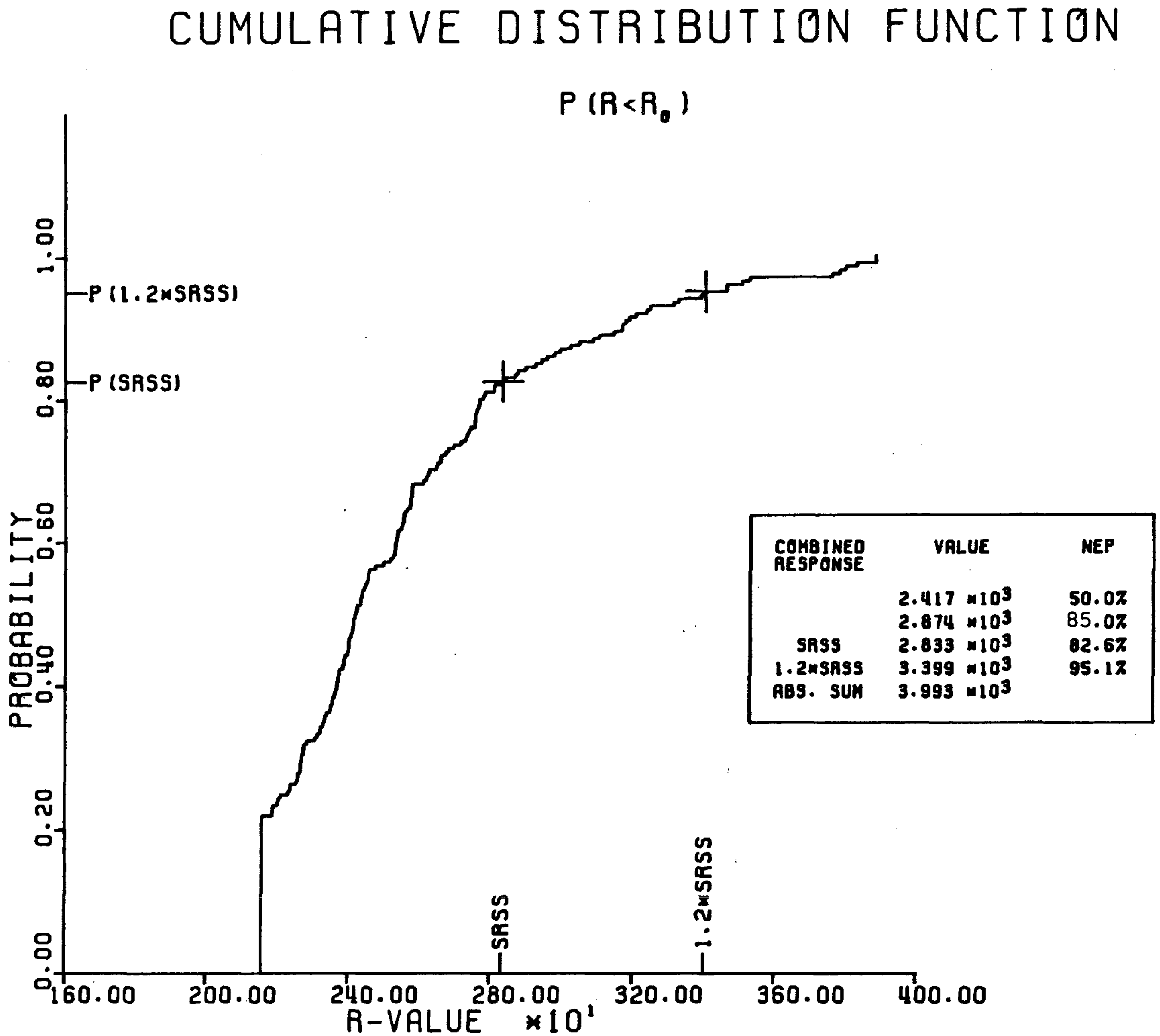


FIGURE B-113. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-11
OBE + SRV-ADS LOAD COMBINATION, MOMENT Z-AXIS (IN-LBS)



COMBINED RESPONSE	VALUE	NEP
	2.417 *10^3	50.0%
	2.874 *10^3	85.0%
SRSS	2.833 *10^3	82.6%
1.2*SRSS	3.399 *10^3	95.1%
ABS. SUM	3.993 *10^3	

FIGURE B-114. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-12
OBE + SRV-ADS LOAD COMBINATION, FORCE Y-AXIS (LBS)

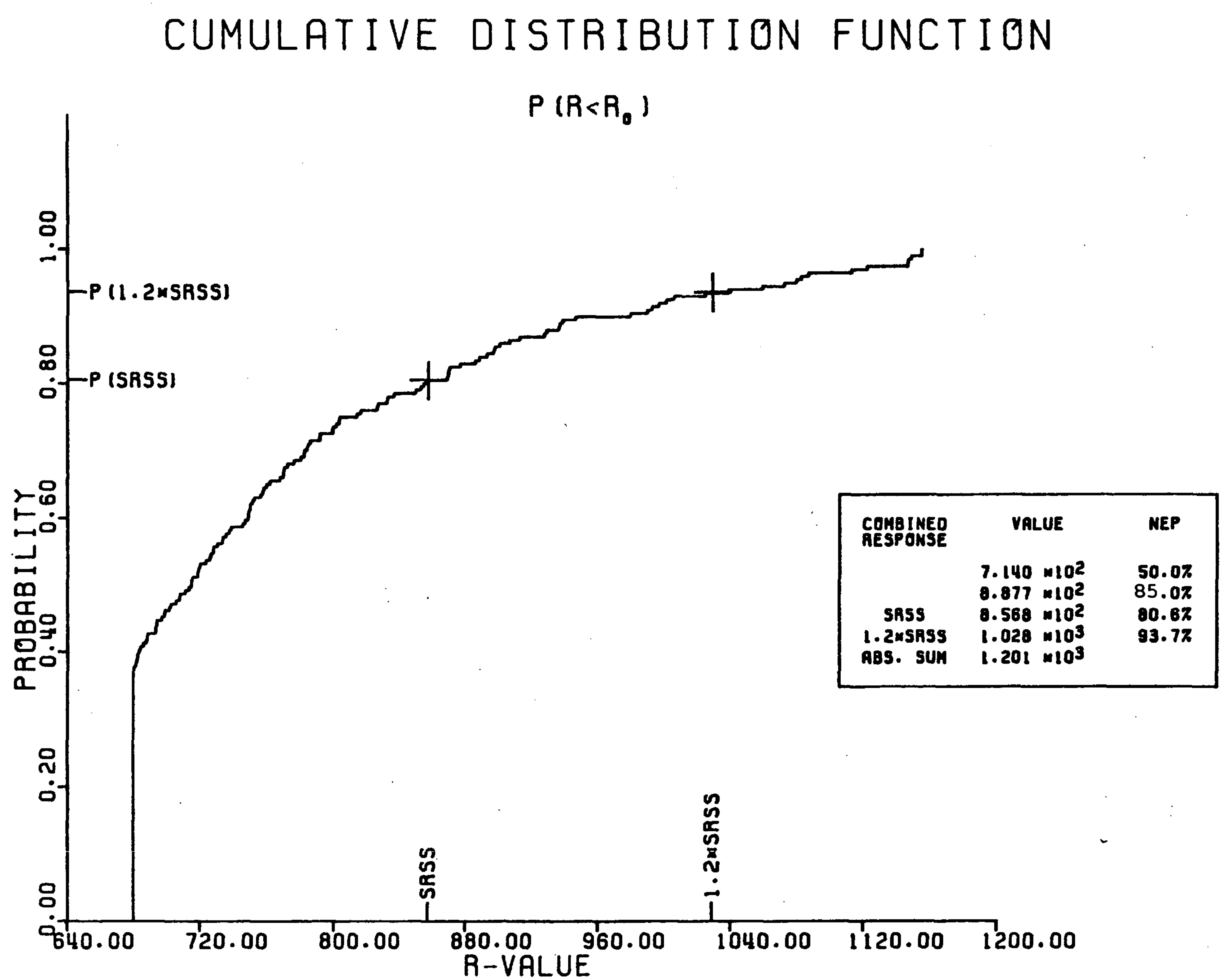


FIGURE B-115. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-13
SSE + SRV-1 LOAD COMBINATION, FORCE Y-AXIS (LBS)

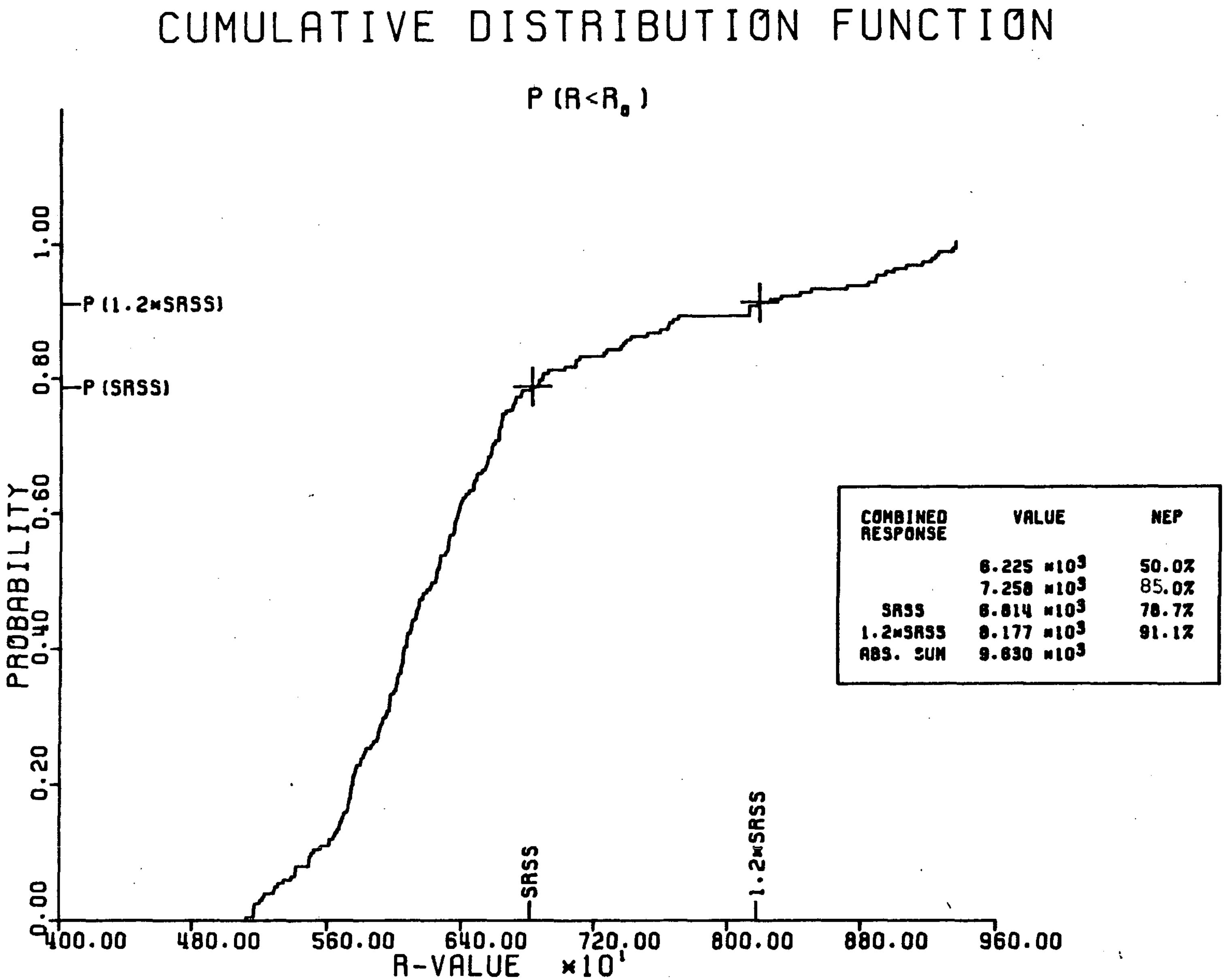


FIGURE B-116. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-8
SSE + SRV-ALL LOAD COMBINATION, MOMENT Y-AXIS (IN-LBS)

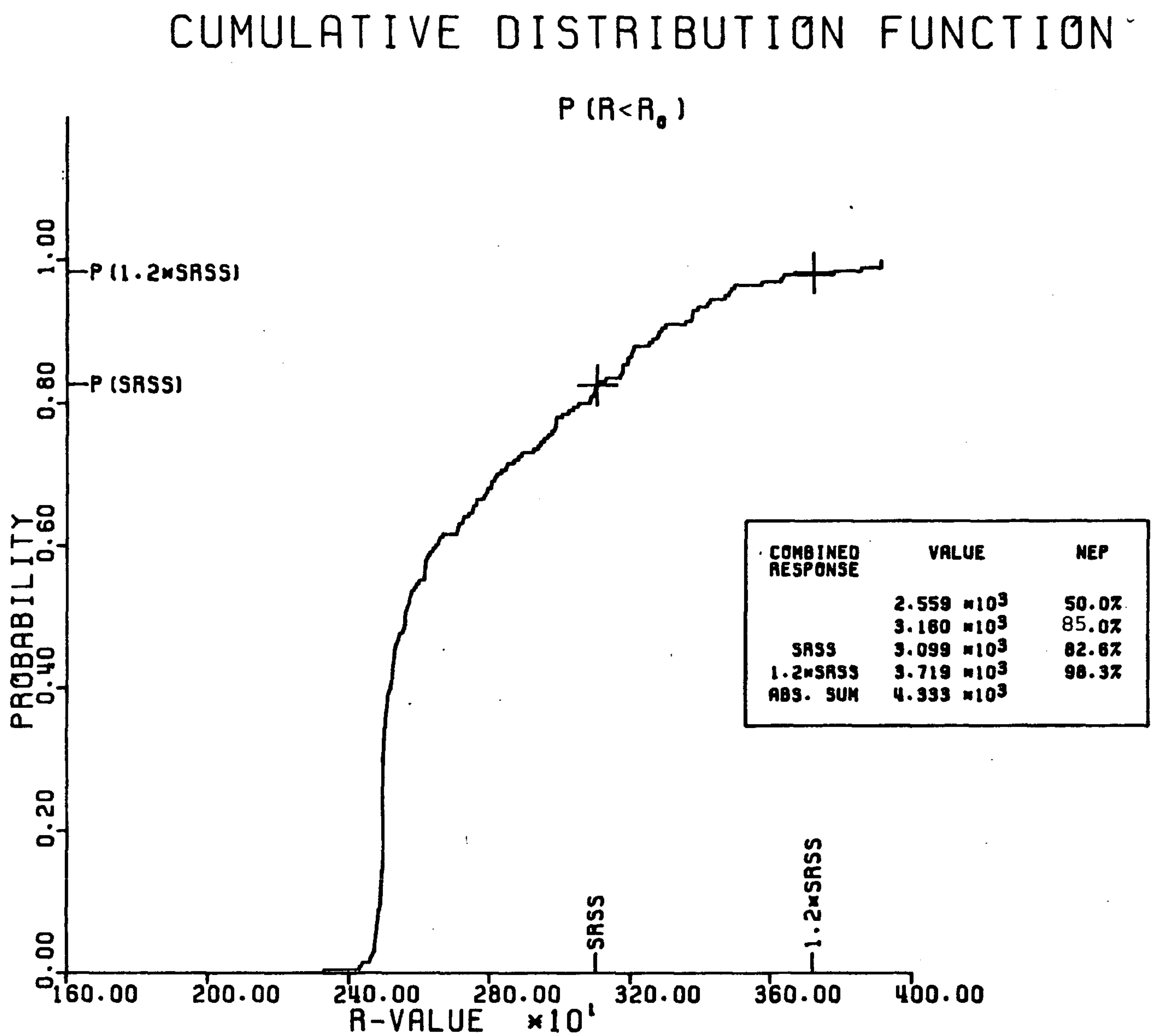
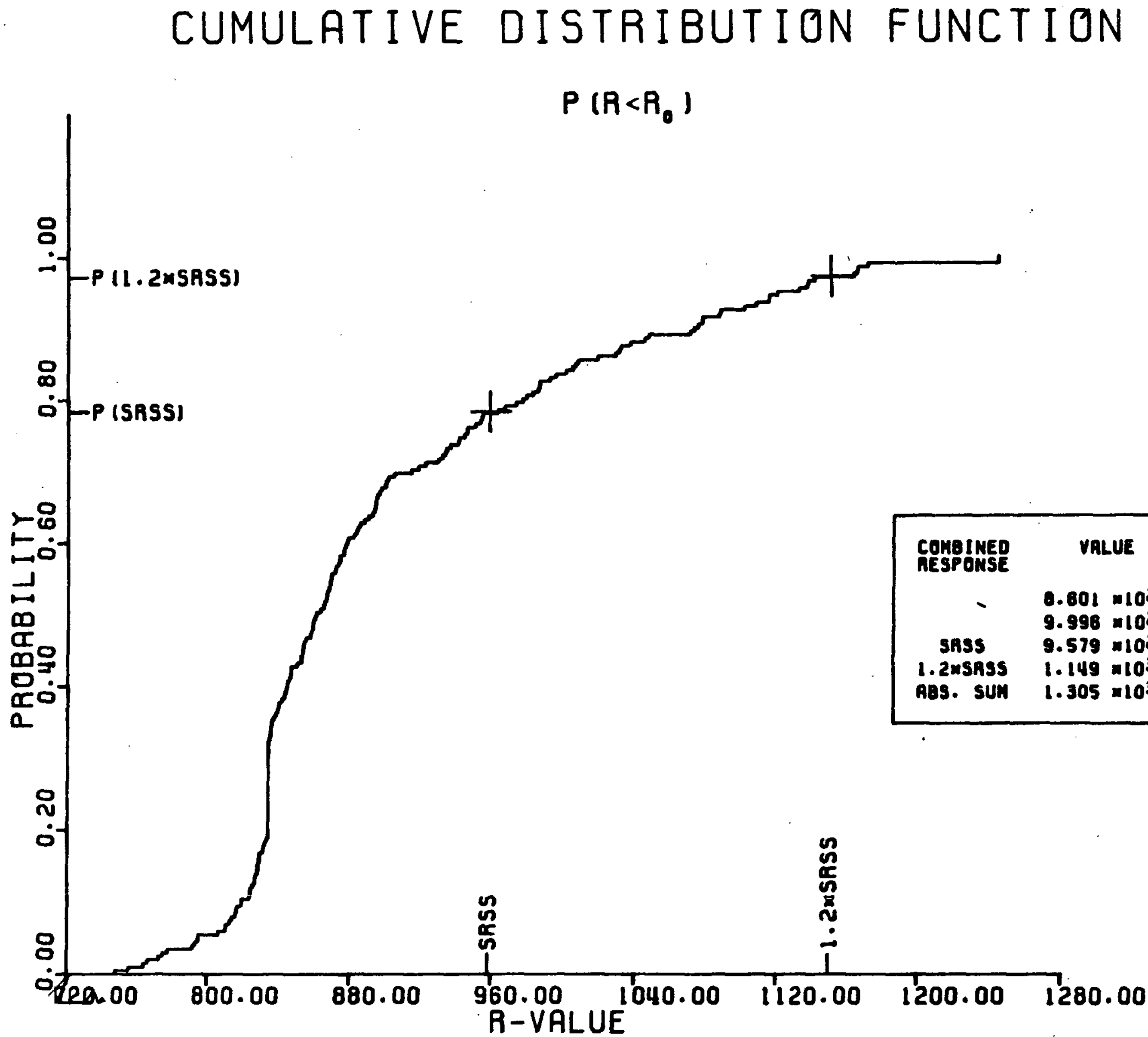


FIGURE B-117. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-8
SRV-1 + CHUG LOAD COMBINATION, MOMENT Y-AXIS (IN-LBS)



COMBINED RESPONSE	VALUE	NEP
	8.601 ×10²	50.0%
	9.998 ×10²	85.0%
SRSS	9.579 ×10²	78.3%
1.2×SRSS	1.149 ×10³	97.2%
ABS. SUM	1.305 ×10³	

FIGURE B-118. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-12
SRV-1 + CHUG LOAD COMBINATION, FORCE Y-AXIS (LBS)

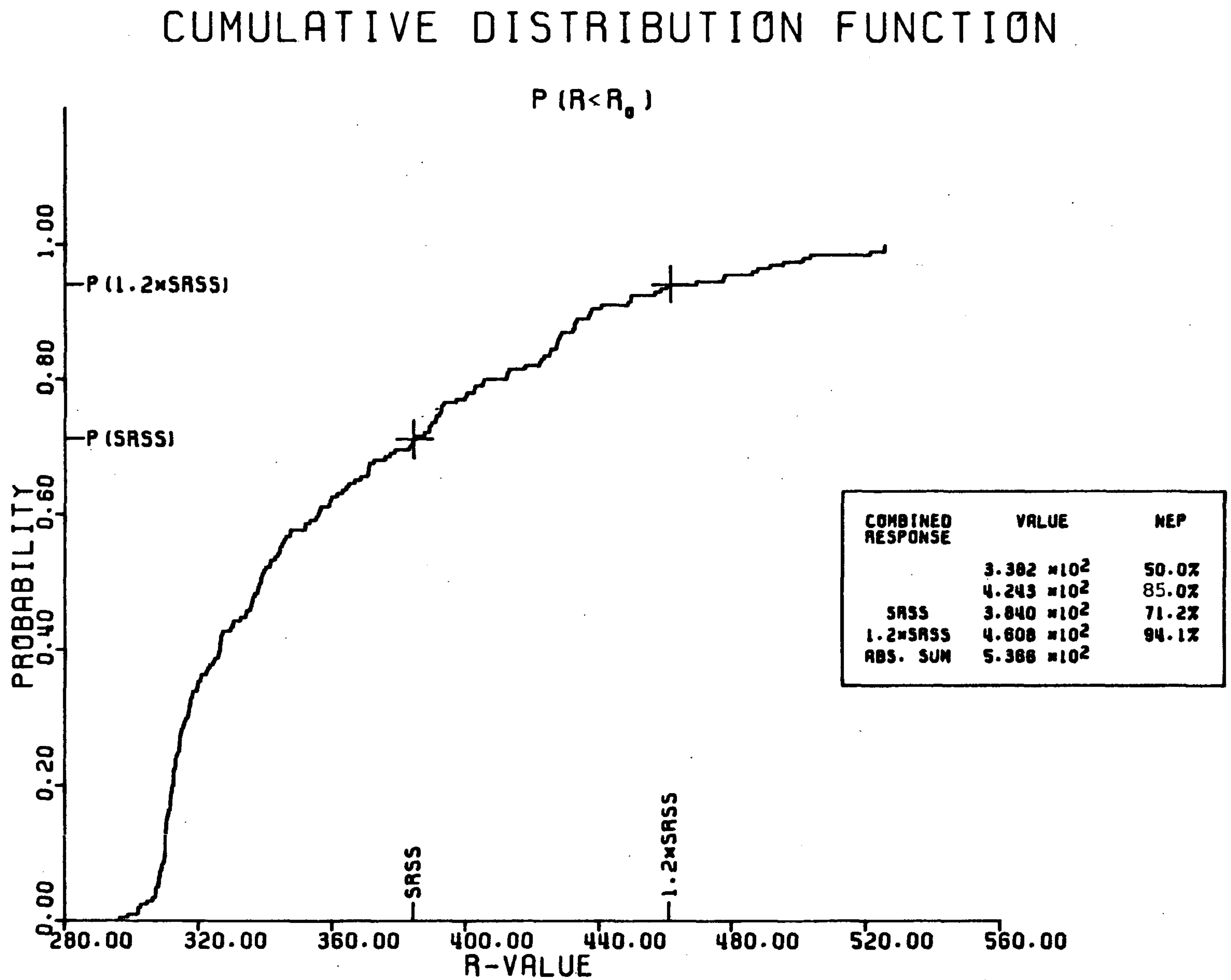


FIGURE B-119. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-13
SRV-ADS + CHUG LOAD COMBINATION, FORCE Y-AXIS (LBS)

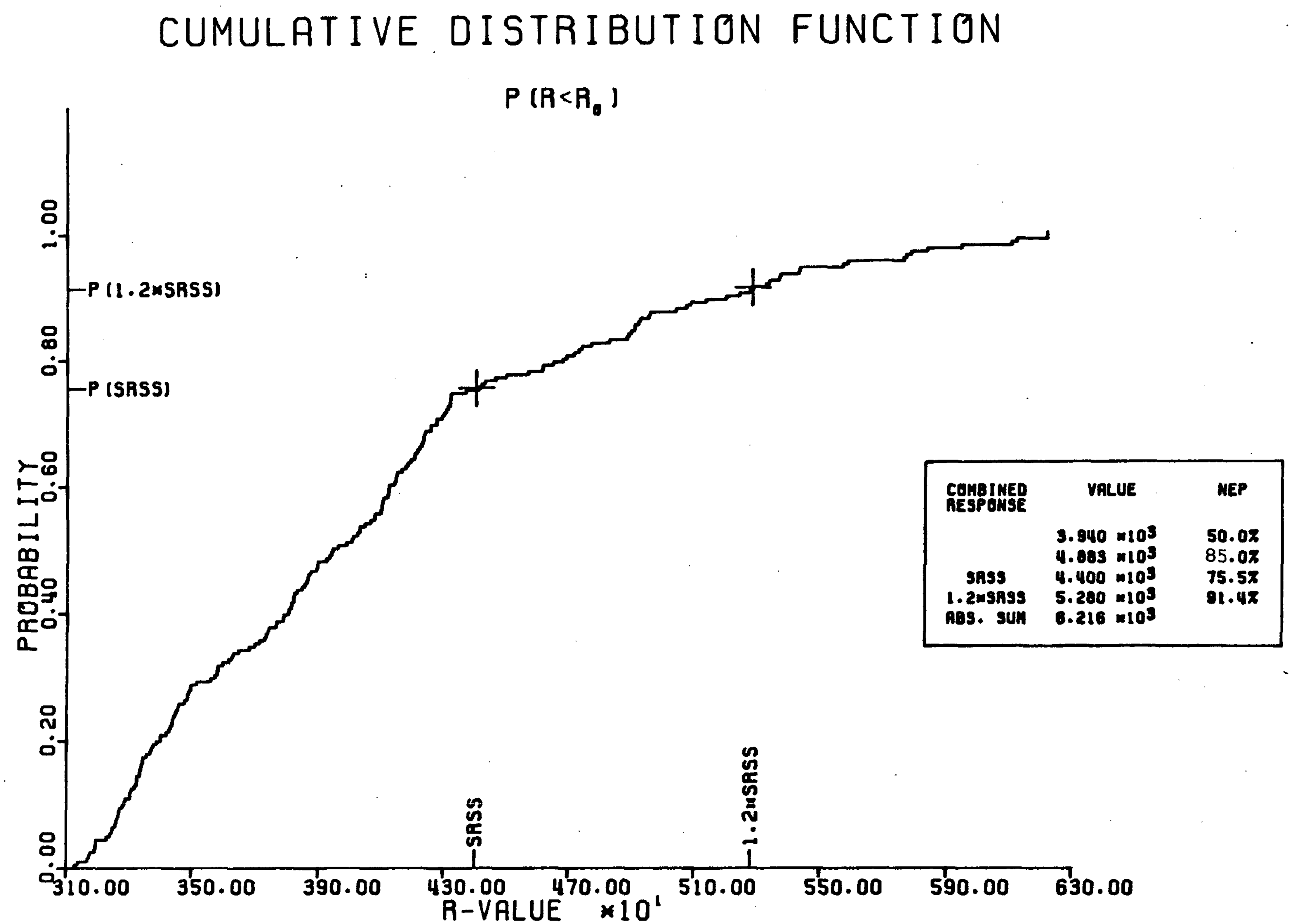


FIGURE B-120. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-11
SRV-ADS + CHUG LOAD COMBINATION, MOMENT Z-AXIS (IN-LBS)

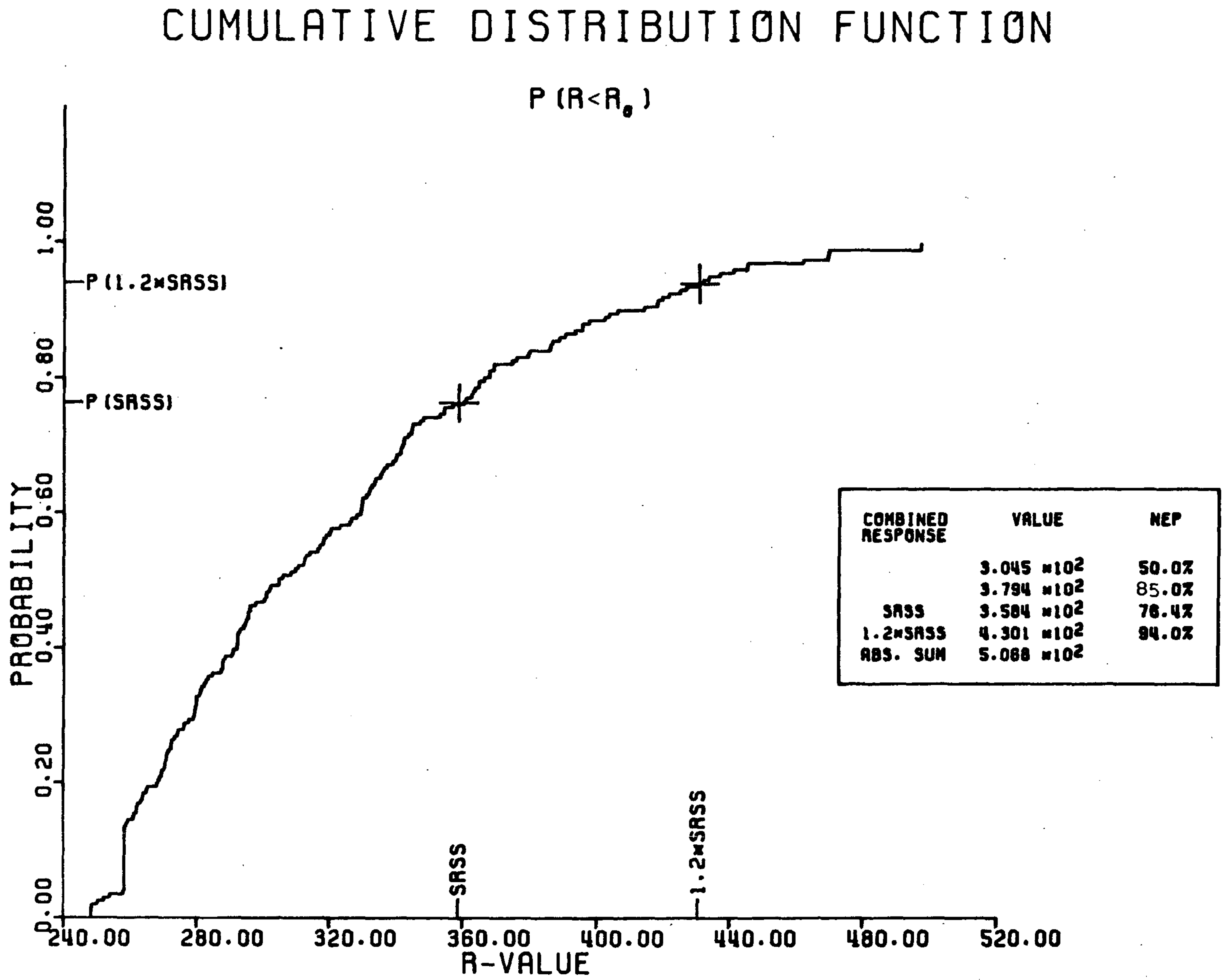
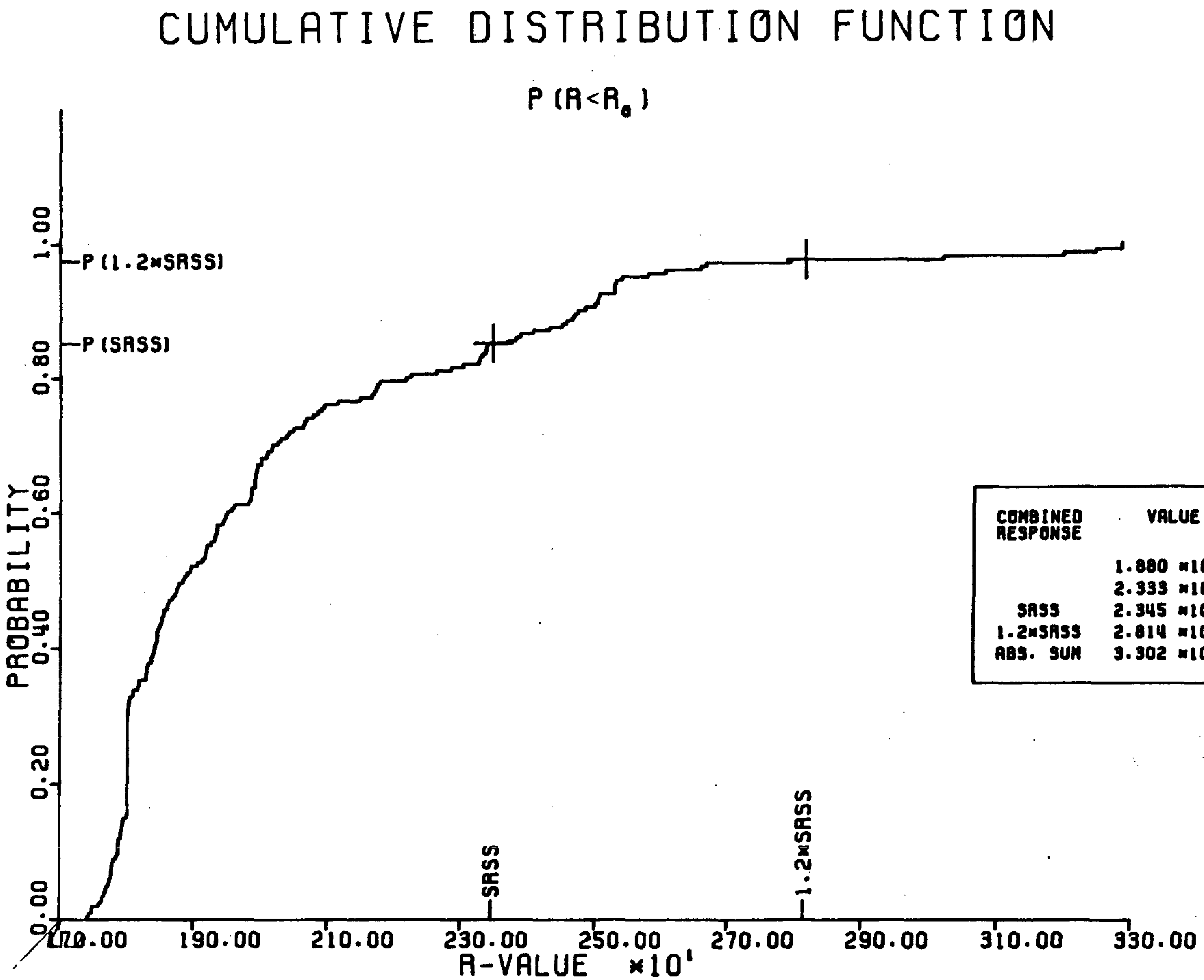


FIGURE B-121. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-7
SRV-ALL + CHUG LOAD COMBINATION, FORCE Z-AXIS (LBS)



COMBINED RESPONSE	VALUE	NEP
	1.880 $\times 10^3$	50.0%
	2.333 $\times 10^3$	85.0%
SRSS	2.345 $\times 10^3$	85.2%
1.2*SRSS	2.814 $\times 10^3$	97.6%
ABS. SUM	3.302 $\times 10^3$	

FIGURE B-122. BOP PIPING CDF CURVE, RH-10 LINE, LOCATION 5-9
SRV-ALL + CHUG LOAD COMBINATION, MOMENT Z-AXIS (IN-LBS)

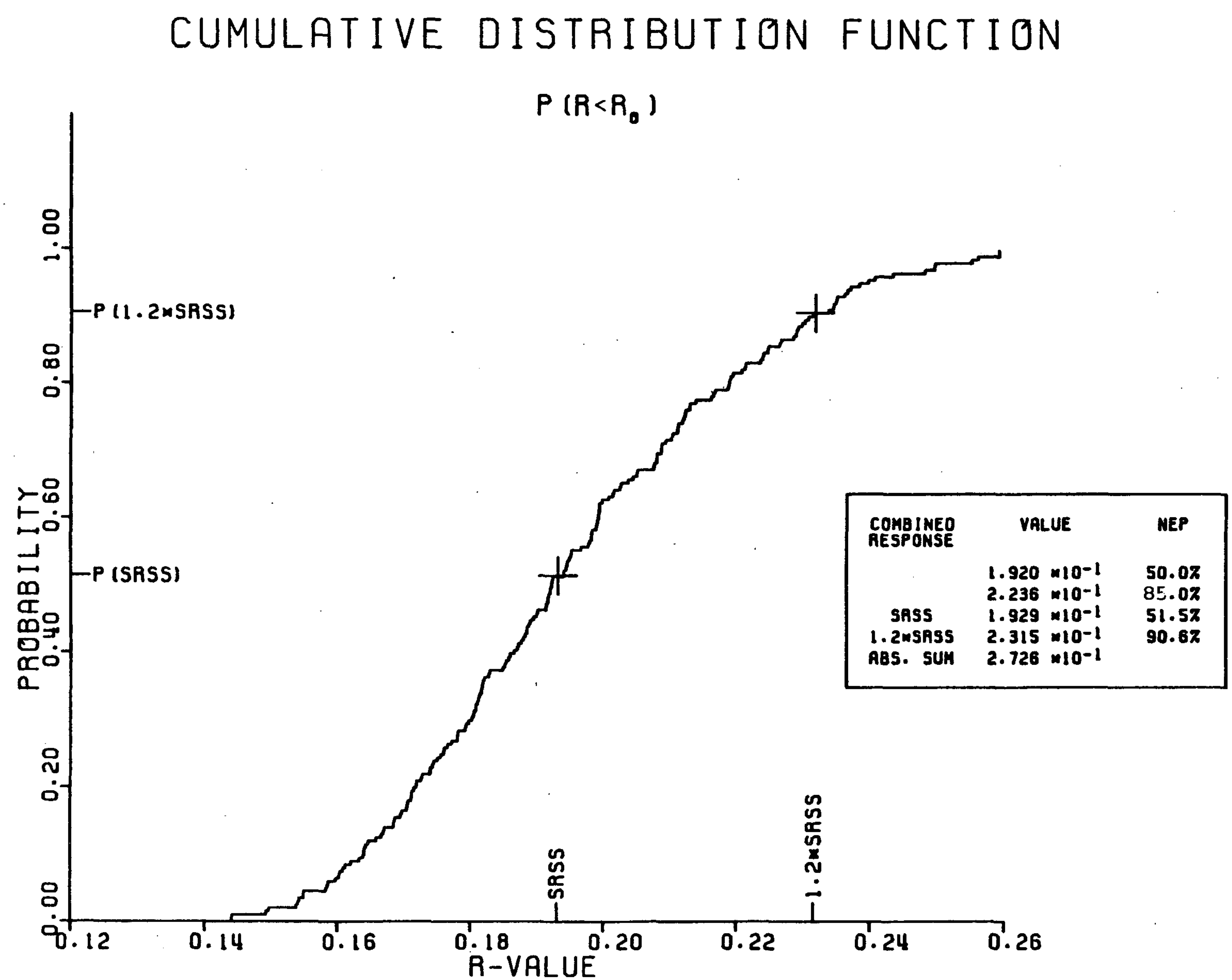
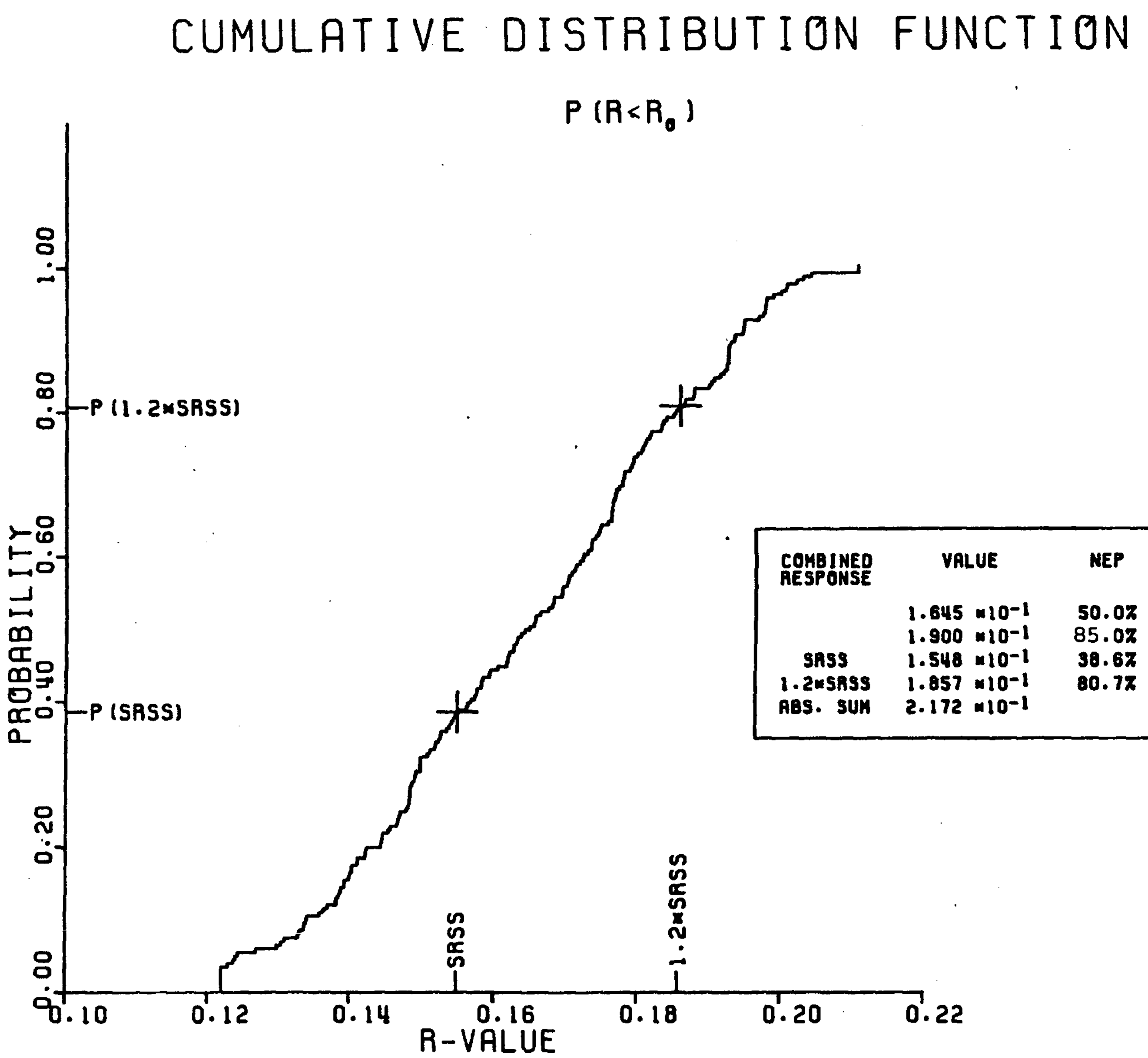


FIGURE B-123. BOP EQUIPMENT CDF CURVE, DRYWELL LOCATION 1-9
OBE + SRV-1 LOAD COMBINATION, VERTICAL ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	1.645 *10^{-1}	50.0%
	1.900 *10^{-1}	85.0%
SRSS	1.548 *10^{-1}	38.6%
1.2*SRSS	1.857 *10^{-1}	80.7%
ABS. SUM	2.172 *10^{-1}	

FIGURE B-124. BOP EQUIPMENT CDF CURVE, DRYWELL LOCATION 1-13
OBE + SRV-1 LOAD COMBINATION, TANGENTIAL ACCELERATION (G)

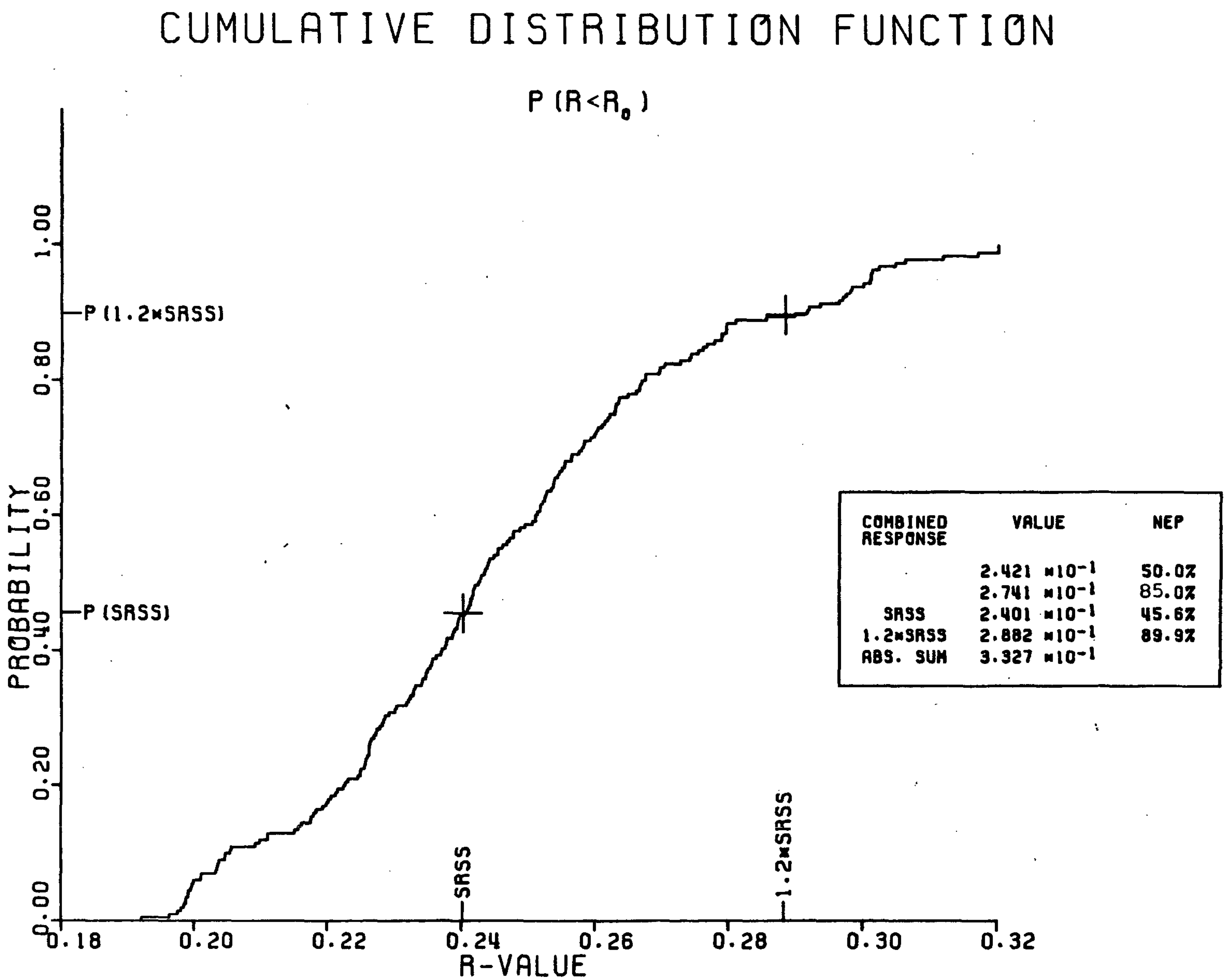


FIGURE B-125. BOP EQUIPMENT CDF CURVE, DRYWELL LOCATION 1-6
OBE + SRV-ALL LOAD COMBINATION, VERTICAL ACCELERATION (G)

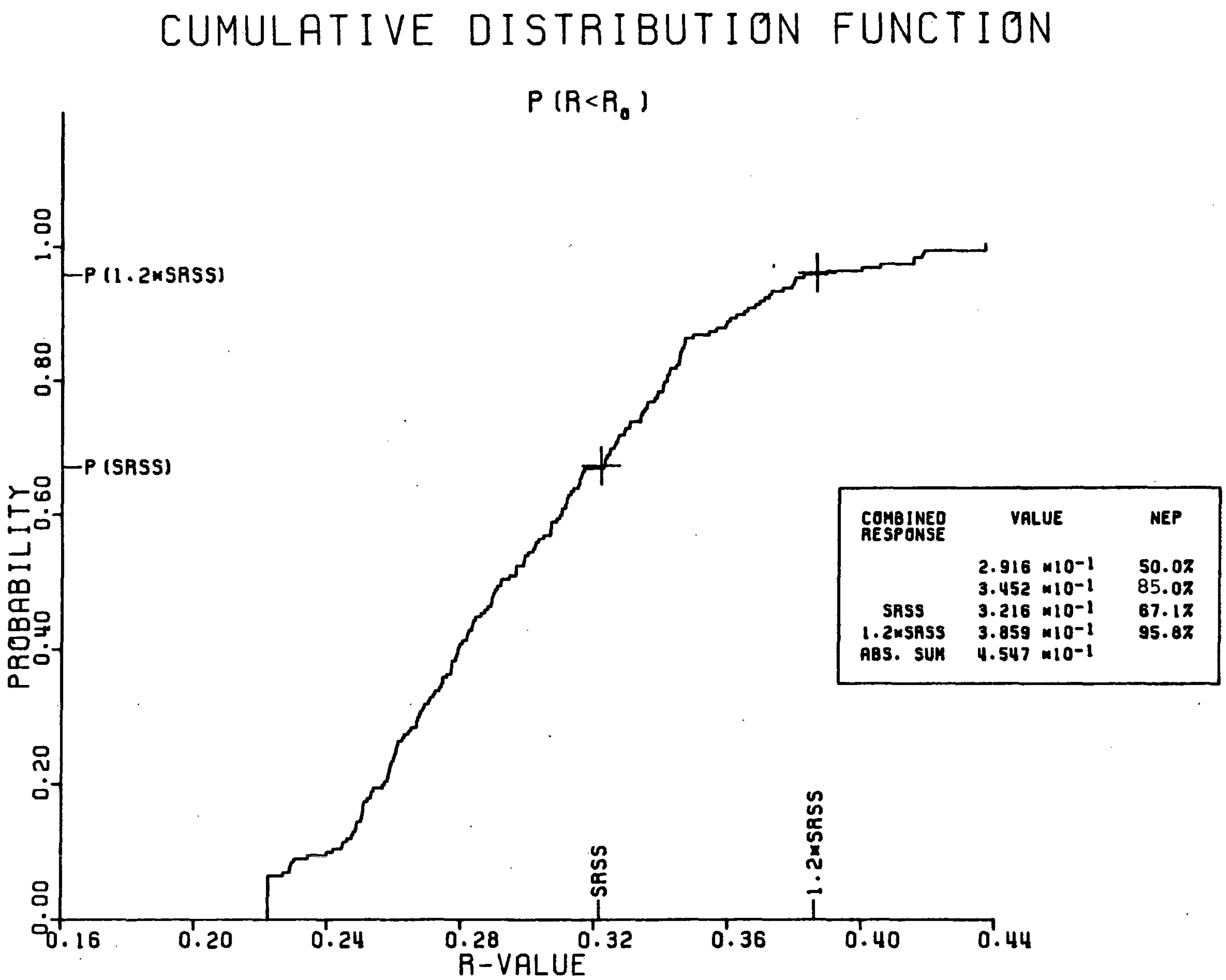


FIGURE B-126. BOP EQUIPMENT CDF CURVE, DRYWELL LOCATION 1-11
SSE + SRV-ALL LOAD COMBINATION, RADIAL ACCELERATION (G)

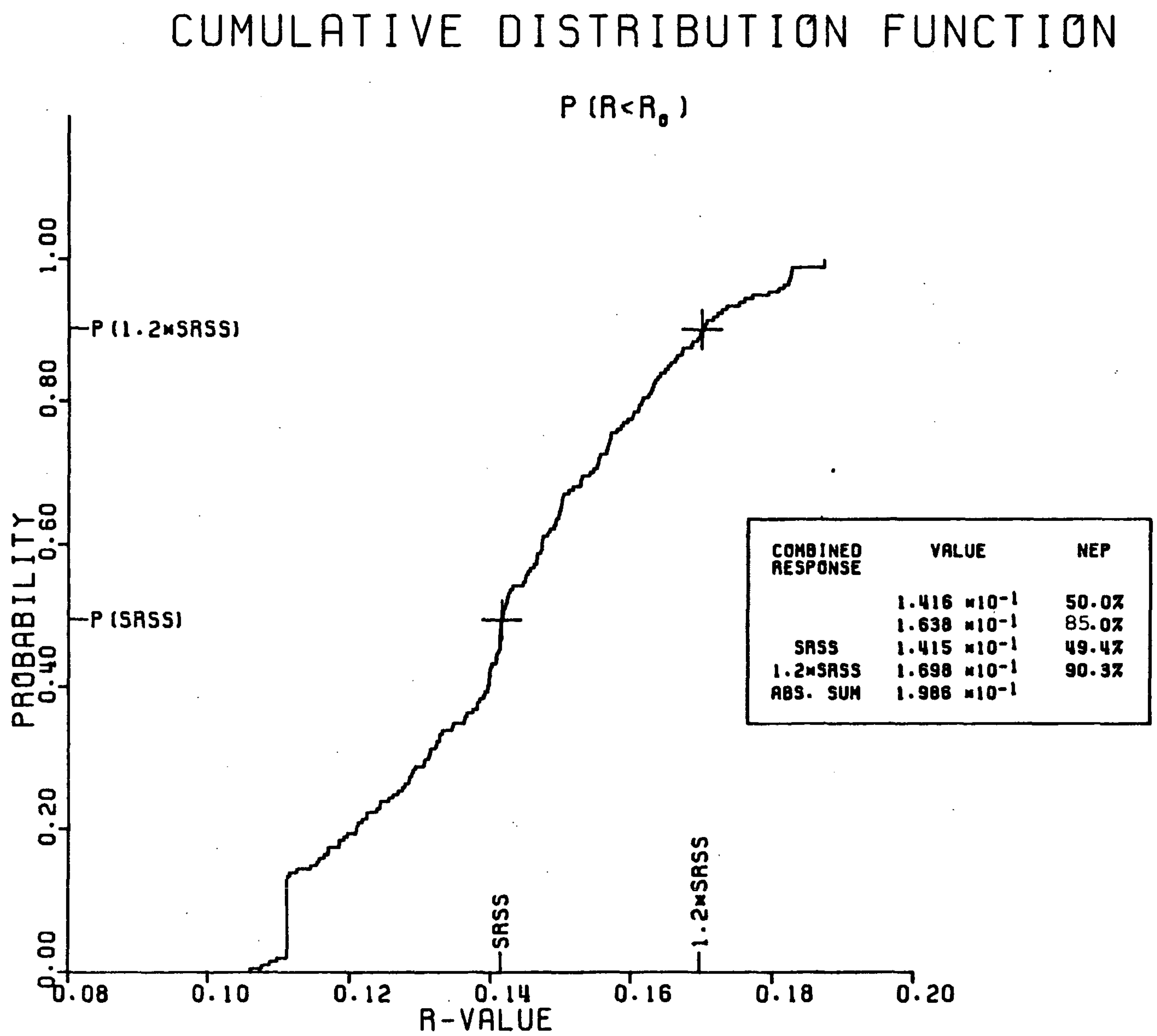


FIGURE B-127. BOP EQUIPMENT CDF CURVE, DRYWELL LOCATION 1-5
SRV-1 + CHUG LOAD COMBINATION, RADIAL ACCELERATION (G)

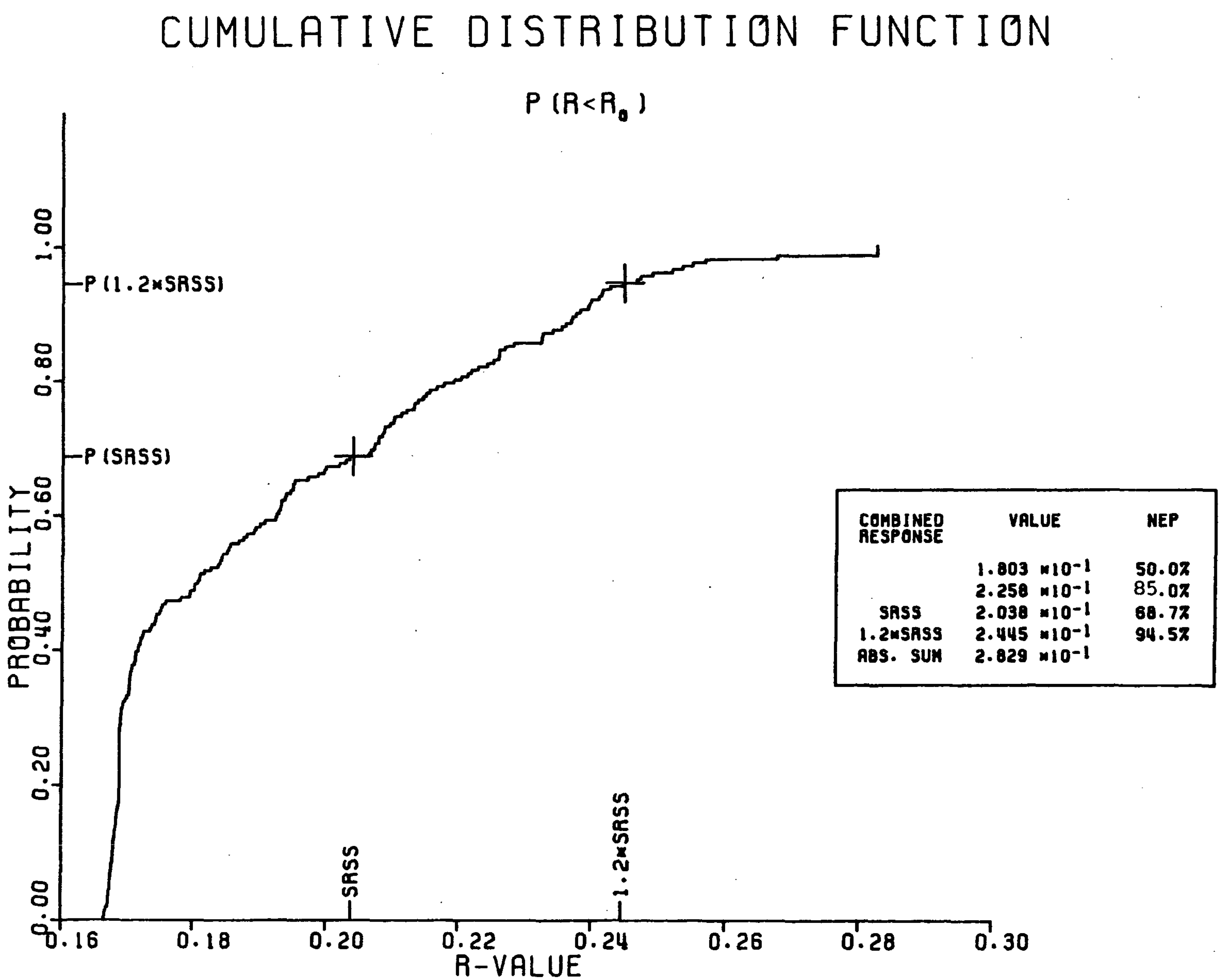


FIGURE B-128. BOP EQUIPMENT CDF CURVE, DRYWELL LOCATION 1-9
SRV-ALL + CHUG LOAD COMBINATION, VERTICAL ACCELERATION (G)

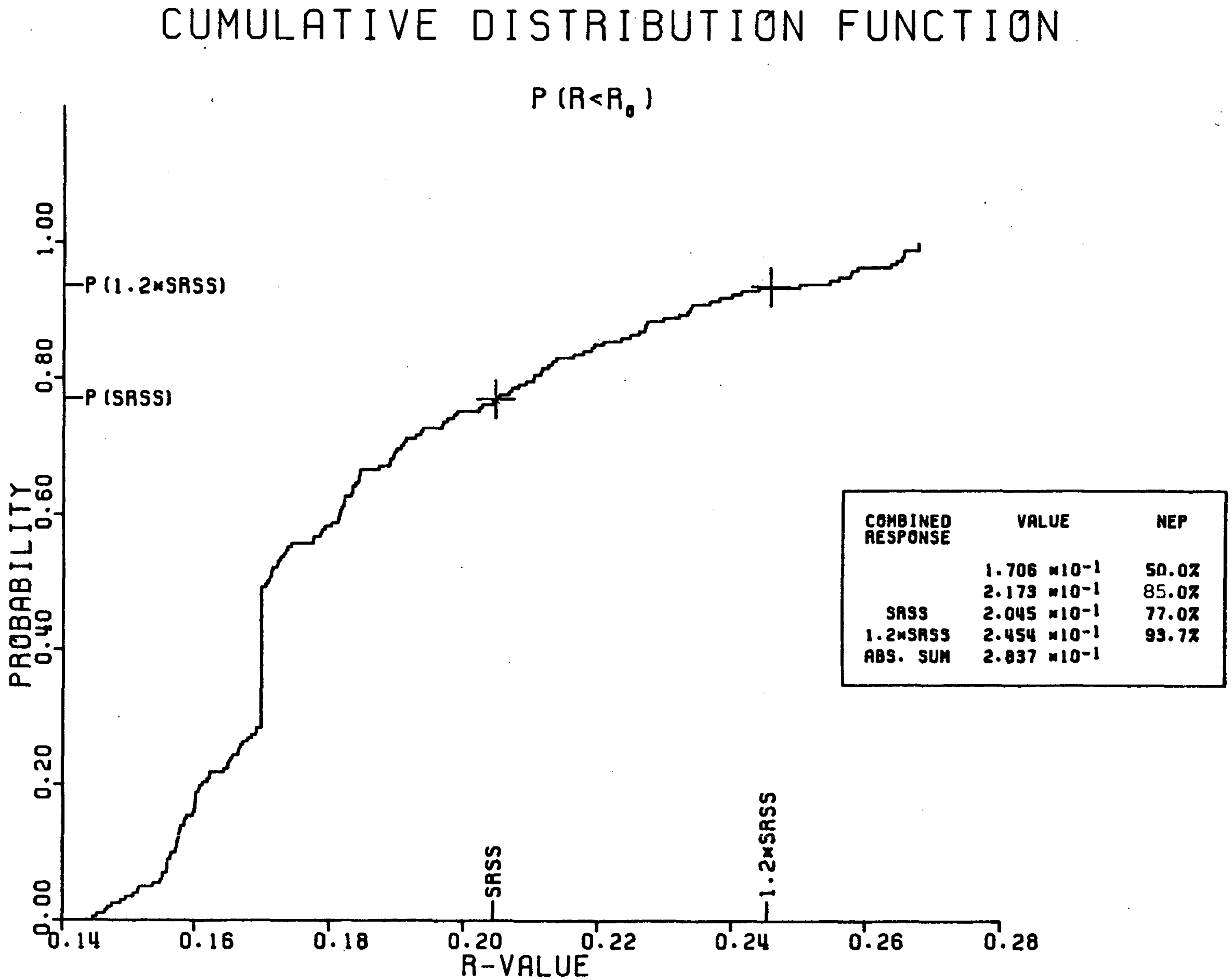


FIGURE B-129. BOP EQUIPMENT CDF CURVE, DRYWELL LOCATION 1-12
SRV-ALL + CHUG LOAD COMBINATION, VERTICAL ACCELERATION (G)

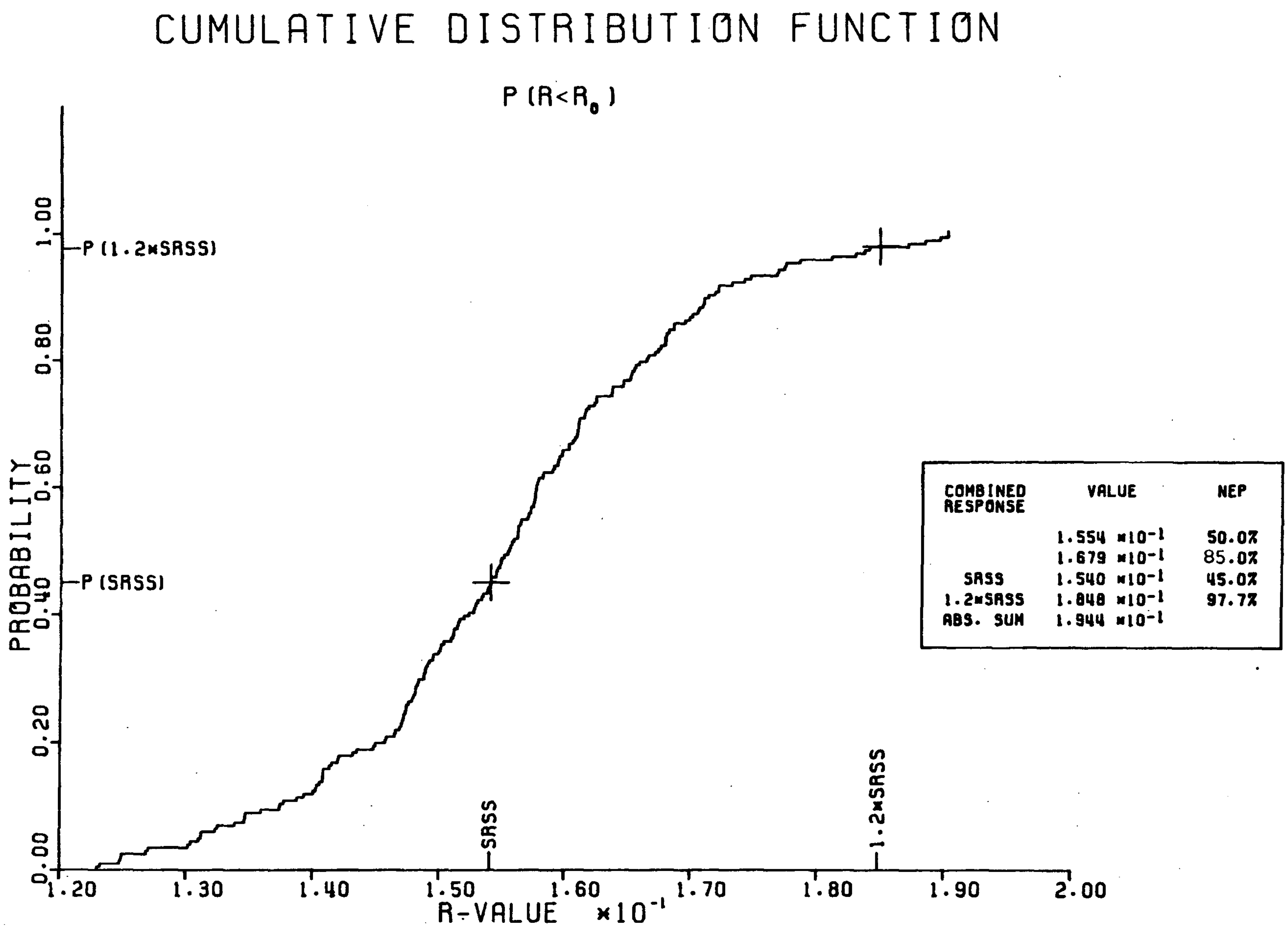


FIGURE B-130. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 3-12
OBE + SRV-ALL LOAD COMBINATION, VERTICAL ACCELERATION (G)

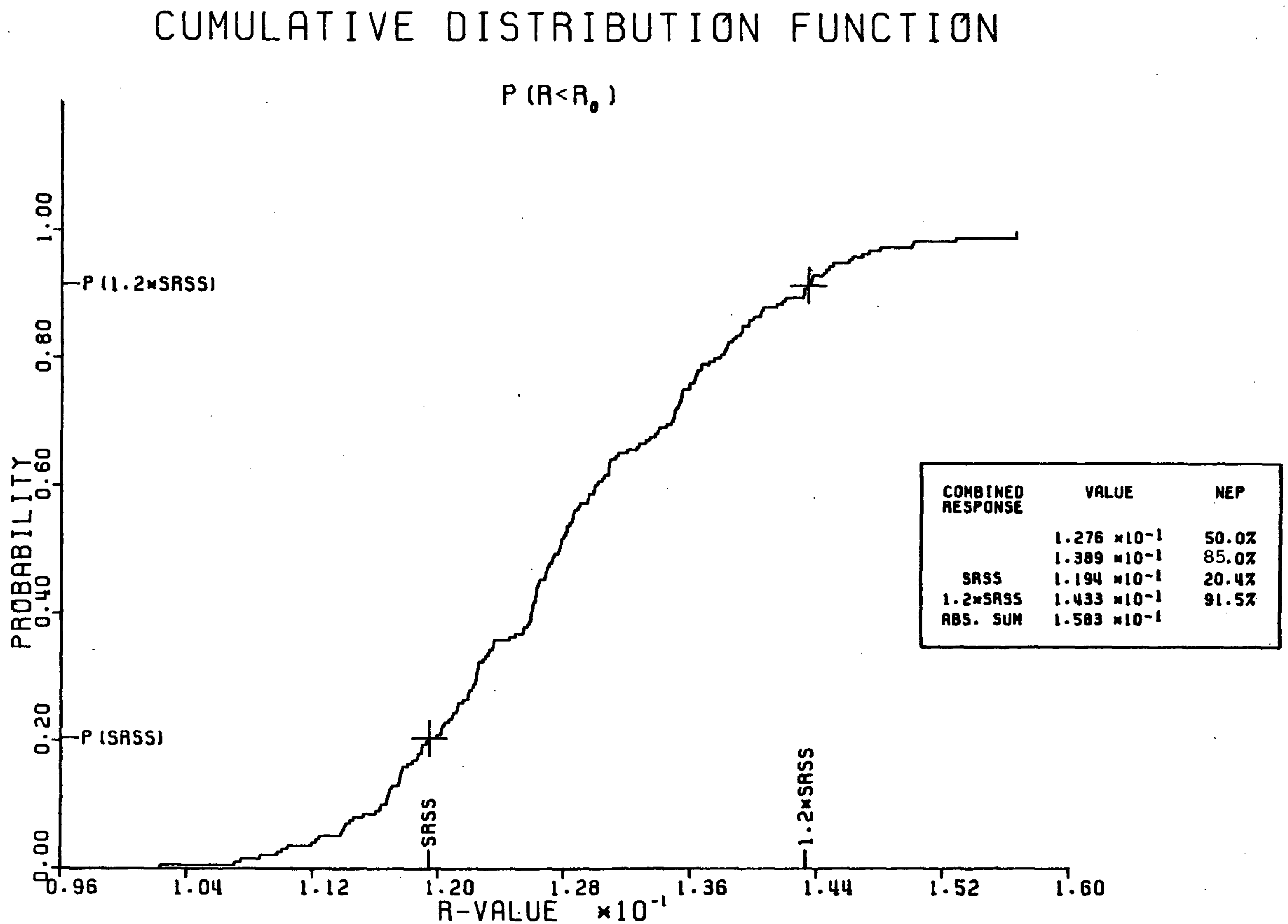
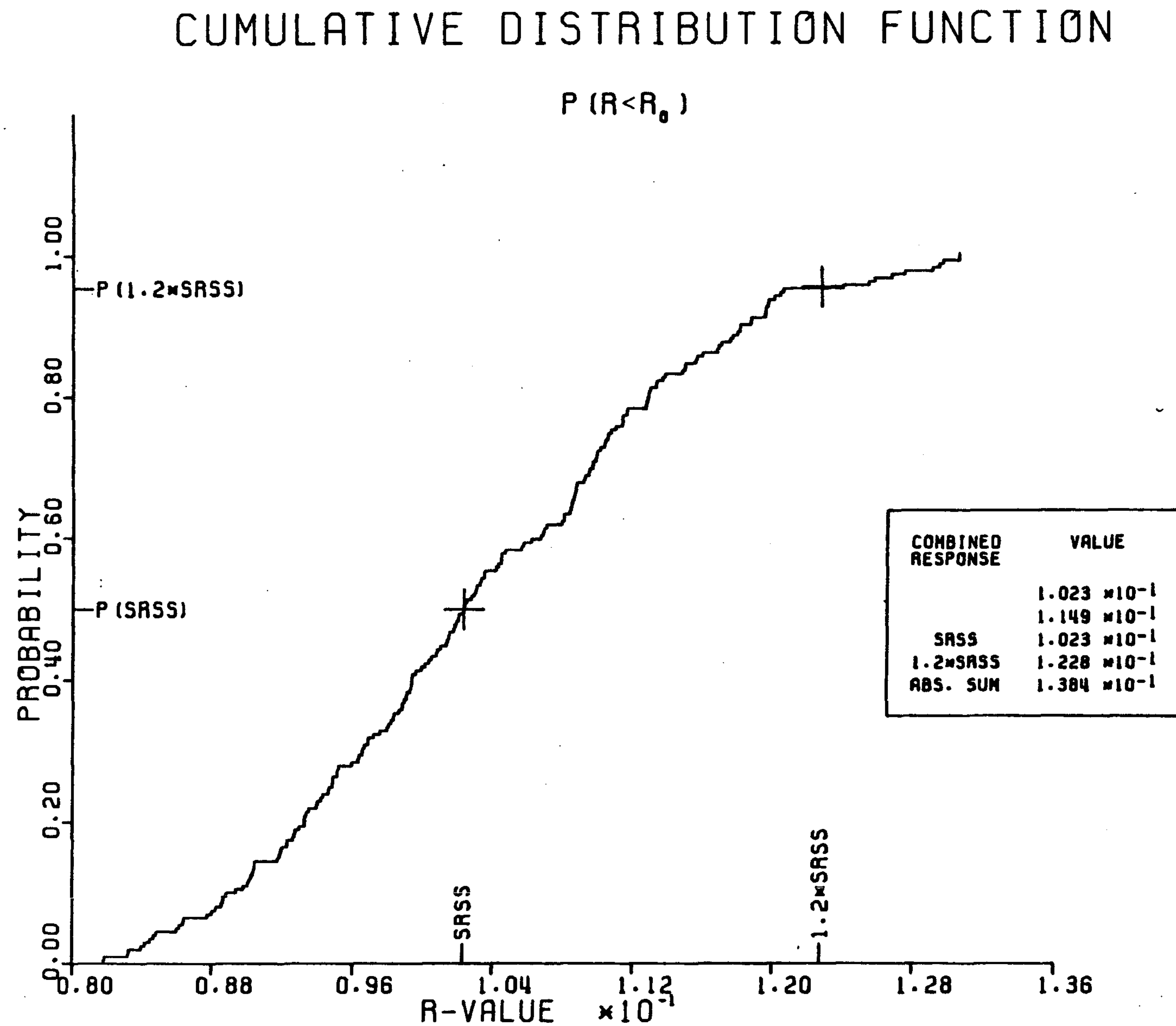


FIGURE B-131. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 3-11
OBE + SRV-ADS LOAD COMBINATION, VERTICAL ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	1.023 ×10⁻¹	50.0%
	1.149 ×10⁻¹	85.0%
SRSS	1.023 ×10⁻¹	50.0%
1.2*SRSS	1.228 ×10⁻¹	95.3%
ABS. SUM	1.384 ×10⁻¹	

FIGURE B-132. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 3-12
OBE + SRV-ADS LOAD COMBINATION, VERTICAL ACCELERATION (G)

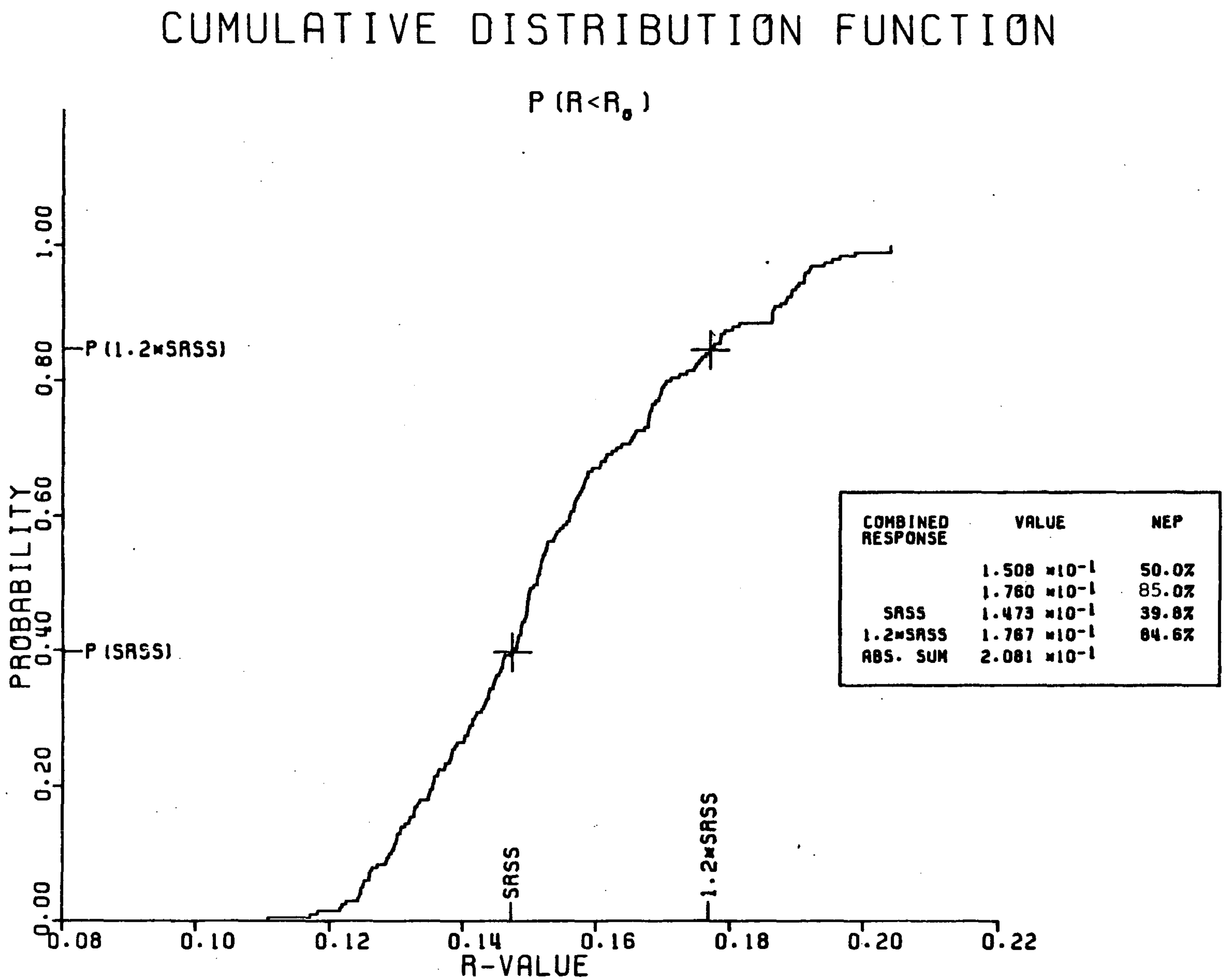


FIGURE B-133. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 3-11
SSE + SRV-ADS LOAD COMBINATION, VERTICAL ACCELERATION (G)

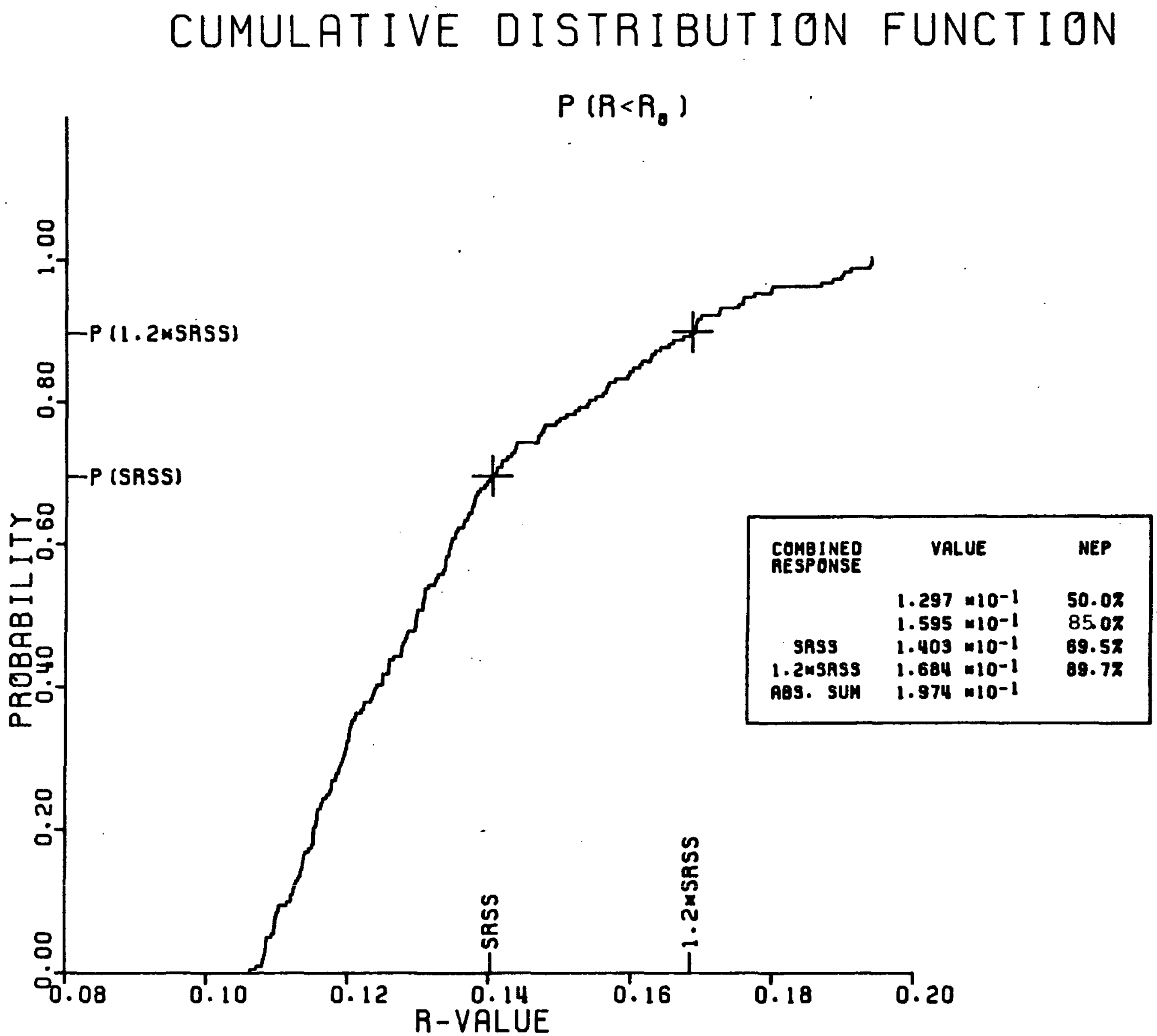


FIGURE B-134. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 3-11 SRV-ADS + CHUG LOAD COMBINATION, VERTICAL ACCELERATION (G)

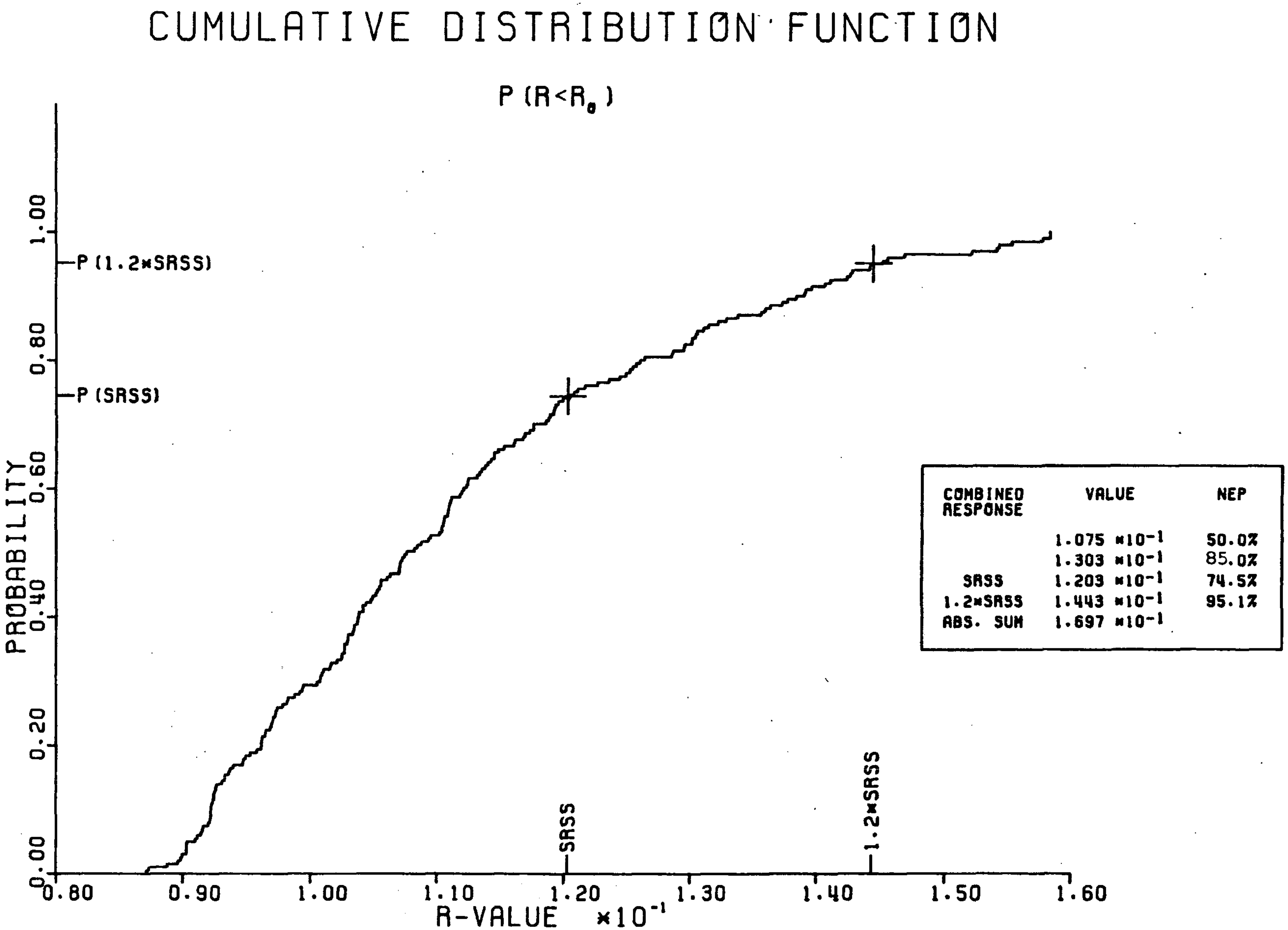


FIGURE B-135. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 3-12
SRV-ADS + CHUG LOAD COMBINATION, VERTICAL ACCELERATION (G)

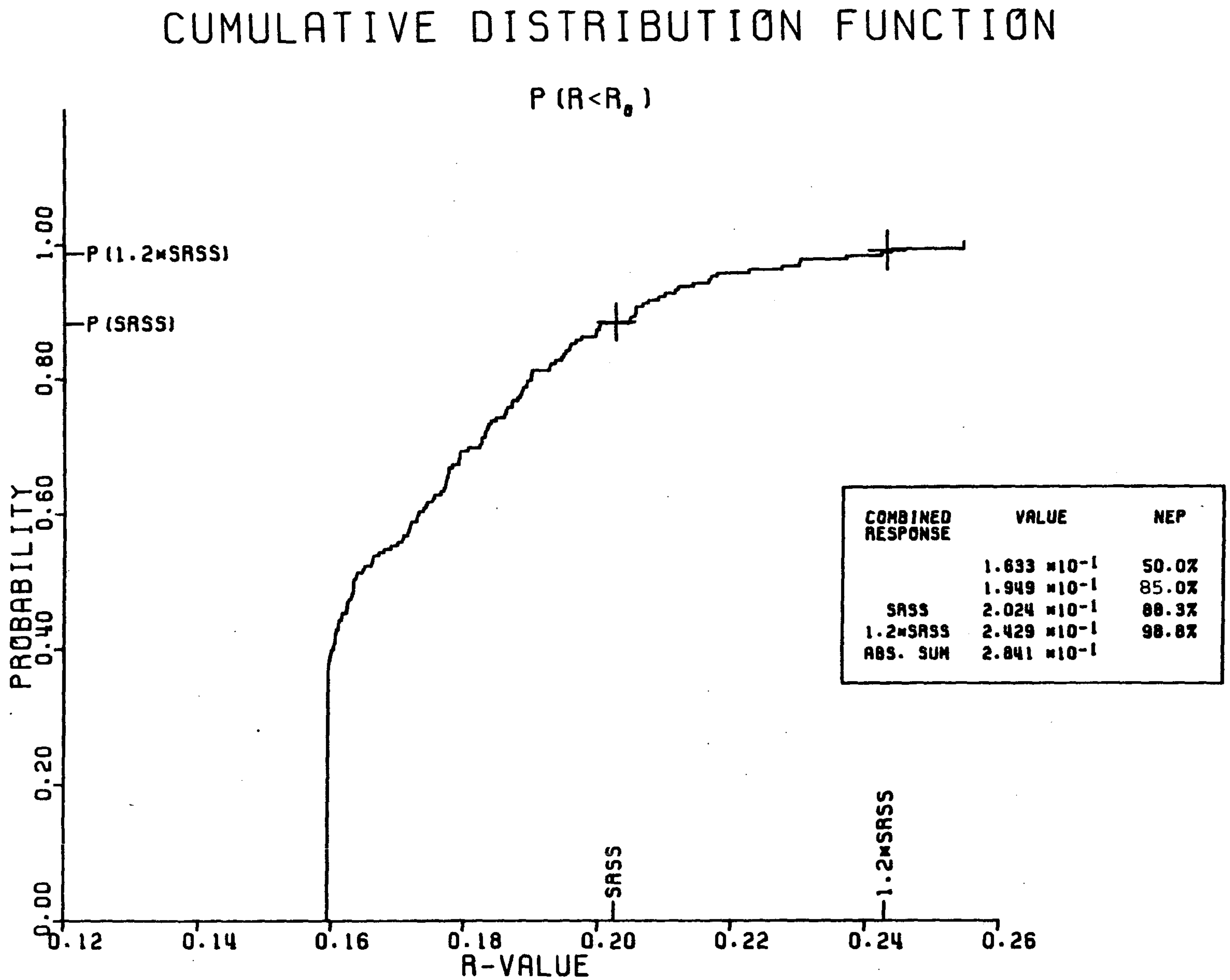
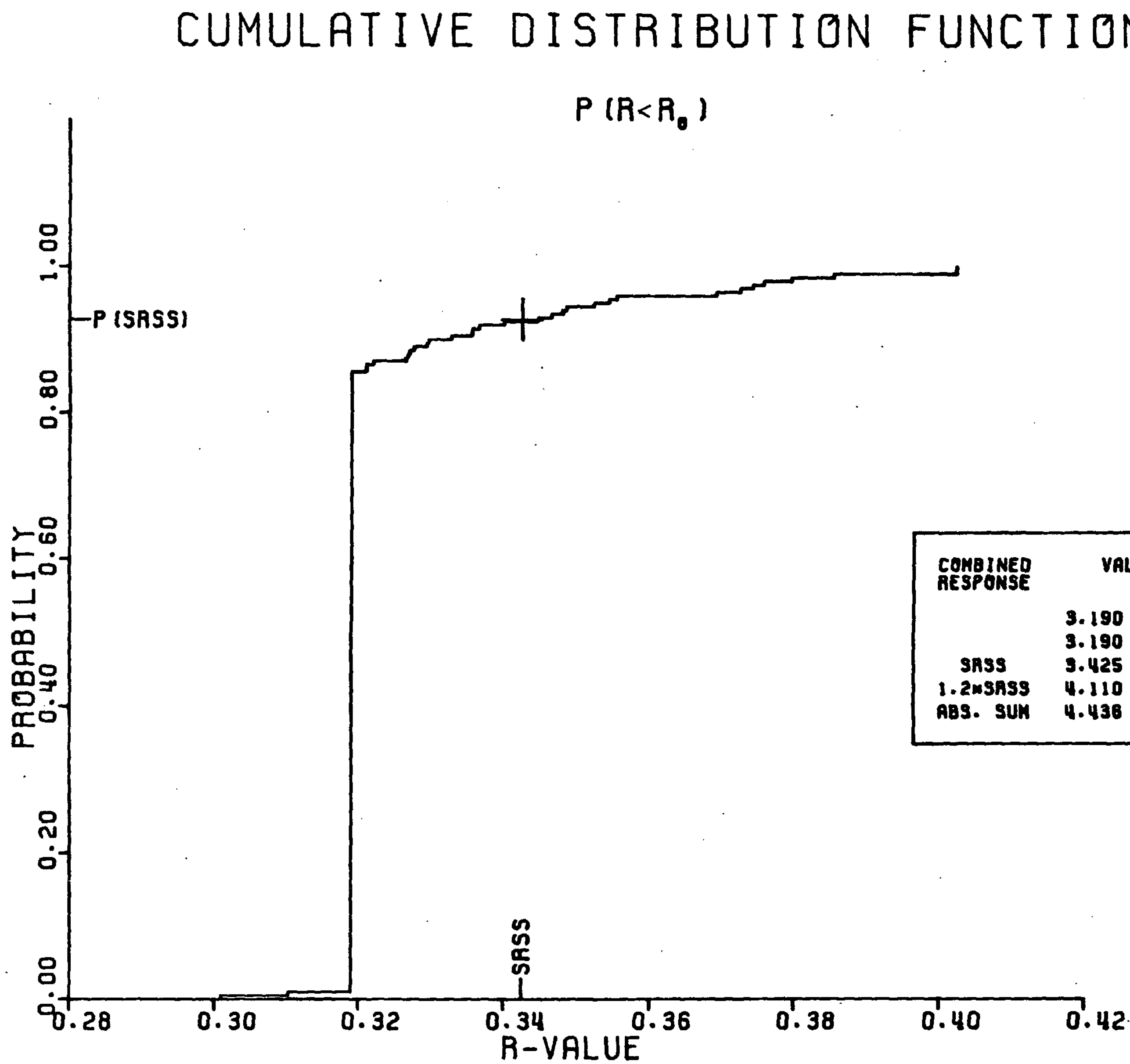


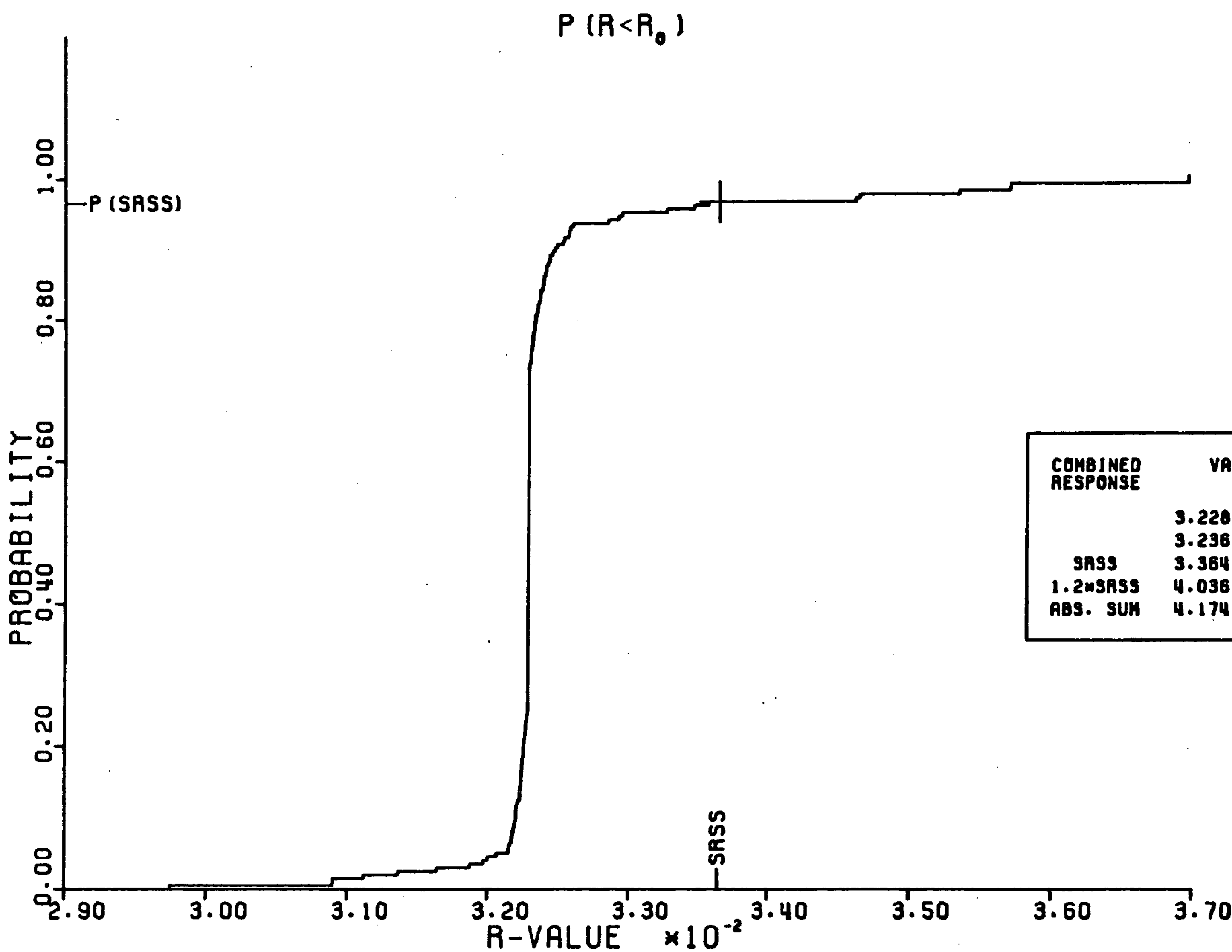
FIGURE B-136. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 4-23
OBE + SRV-ALL LOAD COMBINATION, RADIAL ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	3.190×10^{-1}	50.0%
	3.190×10^{-1}	85.0%
SASS	3.425×10^{-1}	92.8%
1.2*SASS	4.110×10^{-1}	> 99.5%
ABS. SUM	4.438×10^{-1}	

FIGURE B-137. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 4-23
SSE + SRV-ALL LOAD COMBINATION, RADIAL ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	3.228×10^{-2}	50.0%
	3.236×10^{-2}	85.0%
SASS	3.364×10^{-2}	96.6%
1.2×SASS	4.036×10^{-2}	> 99.5%
ABS. SUM	4.174×10^{-2}	

FIGURE B-138. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 4-22
SRV-1 + CHUG LOAD COMBINATION, VERTICAL ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION

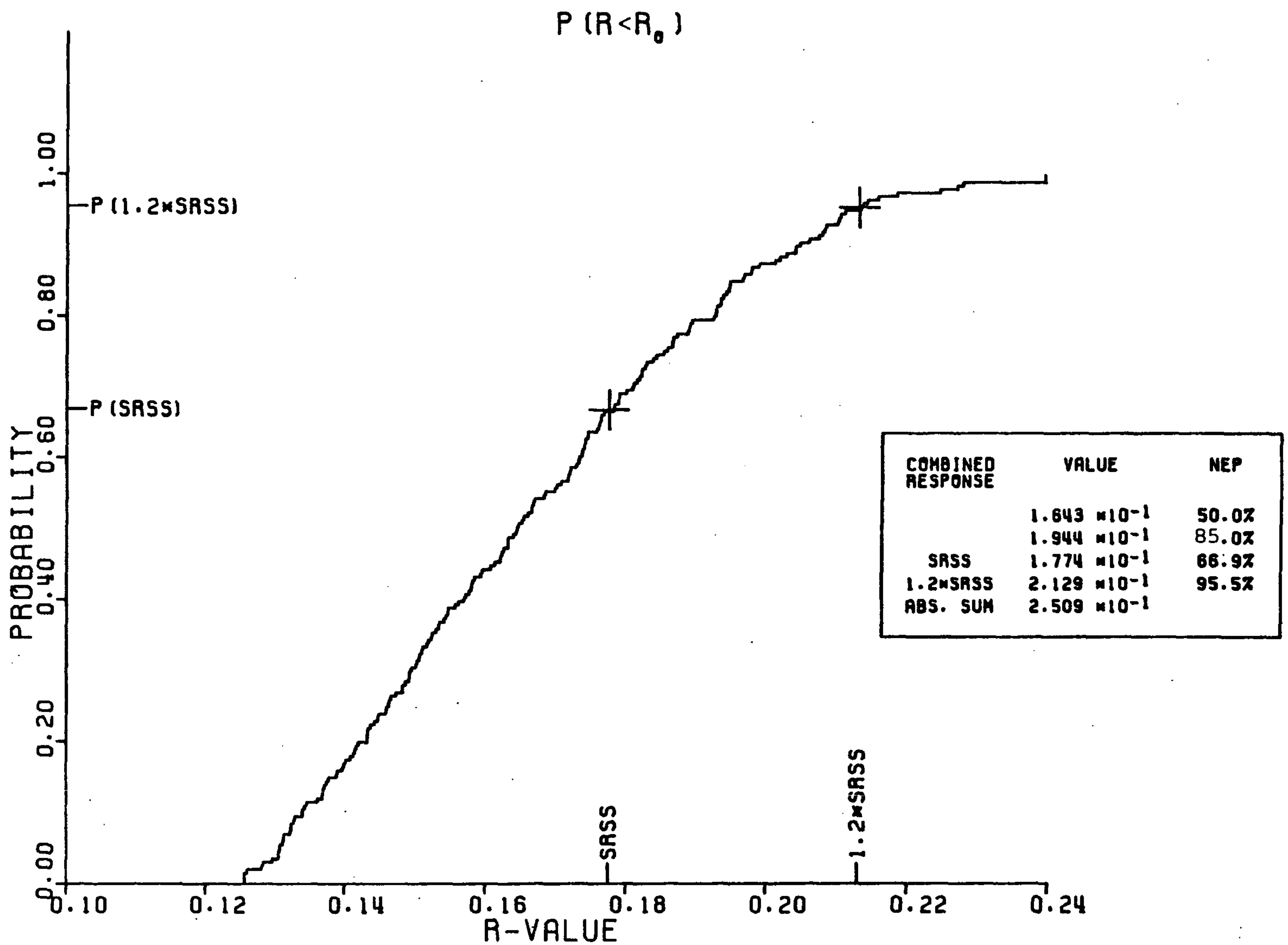


FIGURE B-139. BOP EQUIPMENT CDF CURVE, CONTAINMENT BUILDING LOCATION 5-23
OBE + SRV-1 LOAD COMBINATION, HORIZONTAL ACCELERATION (G)

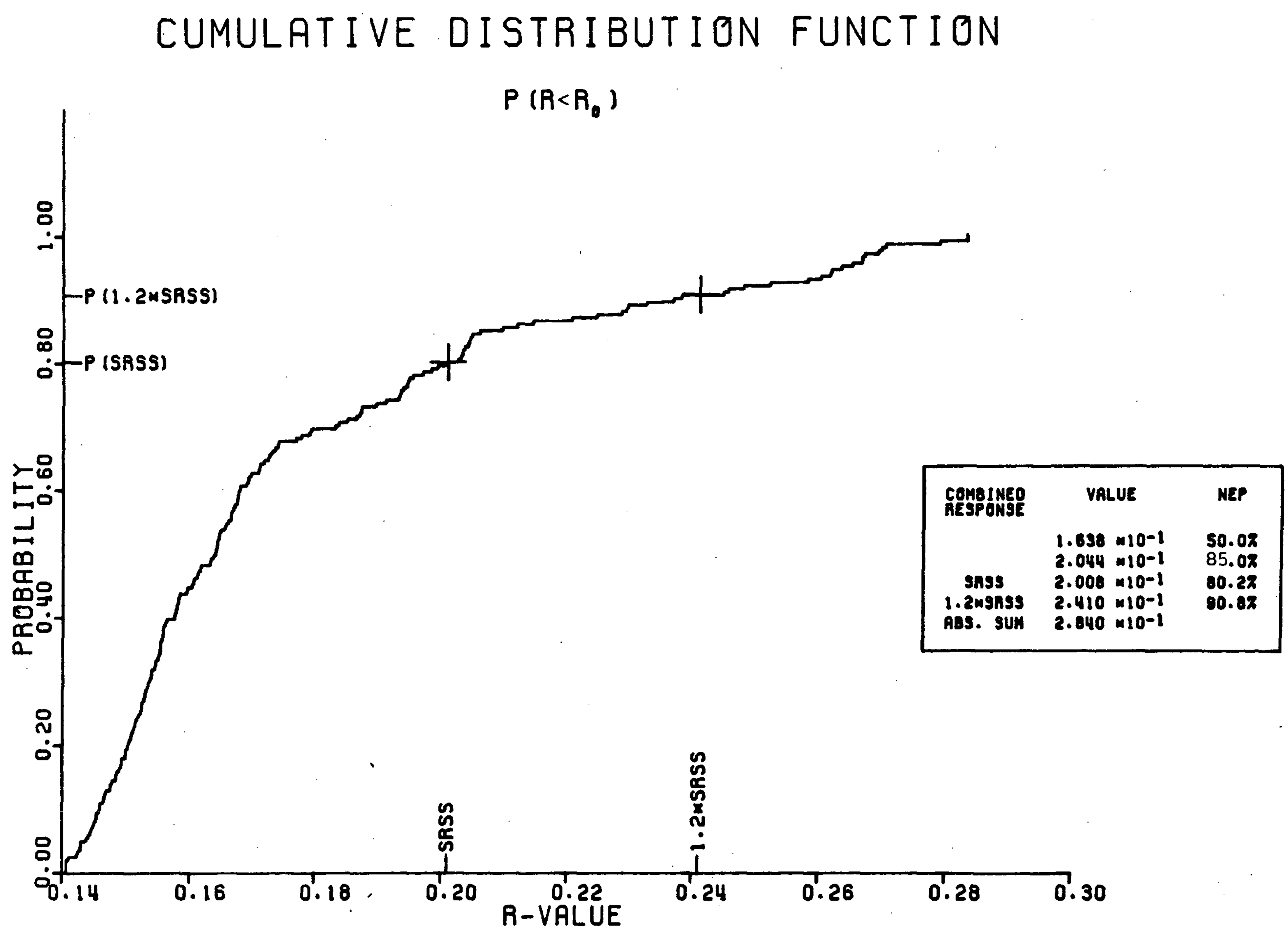
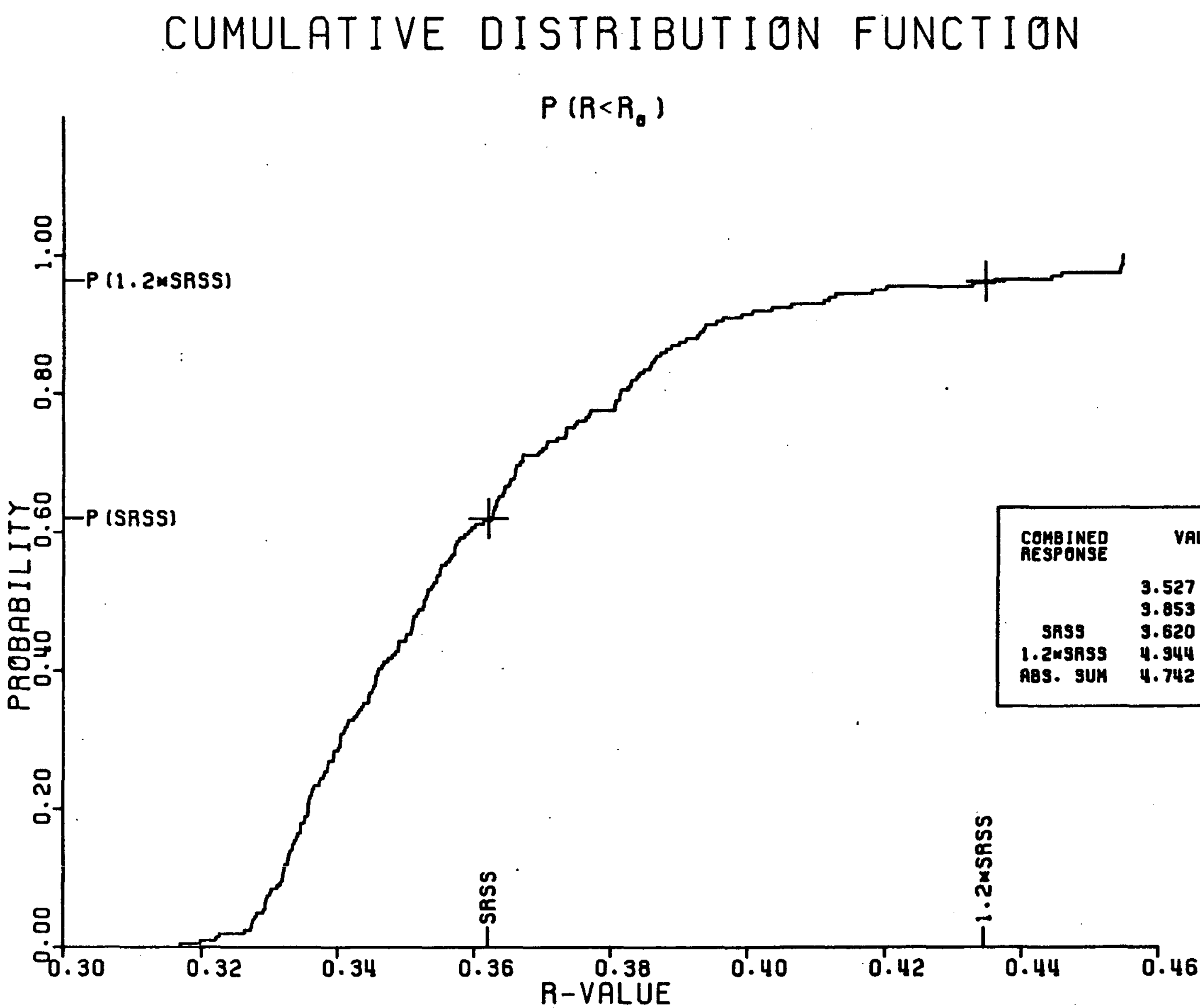
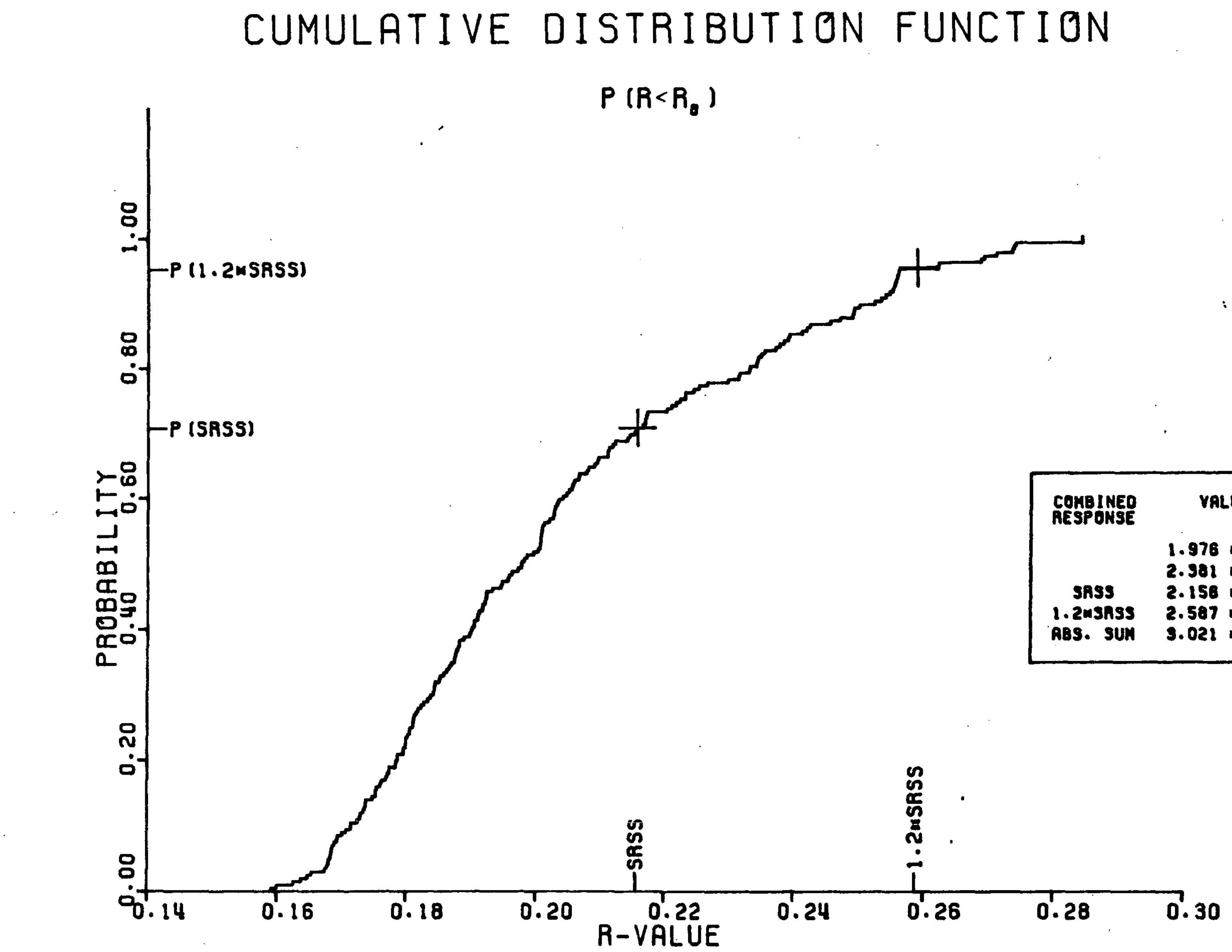


FIGURE B-140. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 2-9
OBE + SRV-1 LOAD COMBINATION, RADIAL ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	3.527×10^{-1}	50.0%
	3.853×10^{-1}	85.0%
SRSS	3.620×10^{-1}	62.0%
1.2*SRSS	4.344×10^{-1}	96.3%
ABS. SUM	4.742×10^{-1}	

FIGURE B-141. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 2-9
OBE + SRV-ALL LOAD COMBINATION, RADIAL ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	1.976×10^{-1}	50.0%
	2.381×10^{-1}	85.0%
SRSS	2.158×10^{-1}	70.7%
1.2*SRSS	2.587×10^{-1}	95.3%
ABS. SUM	3.021×10^{-1}	

FIGURE B-142. BOP EQUIPMENT CDF CURVE, CONTAINMENT BUILDING LOCATION 5-23
OBE + SRV-ADS LOAD COMBINATION, HORIZONTAL ACCELERATION (G)

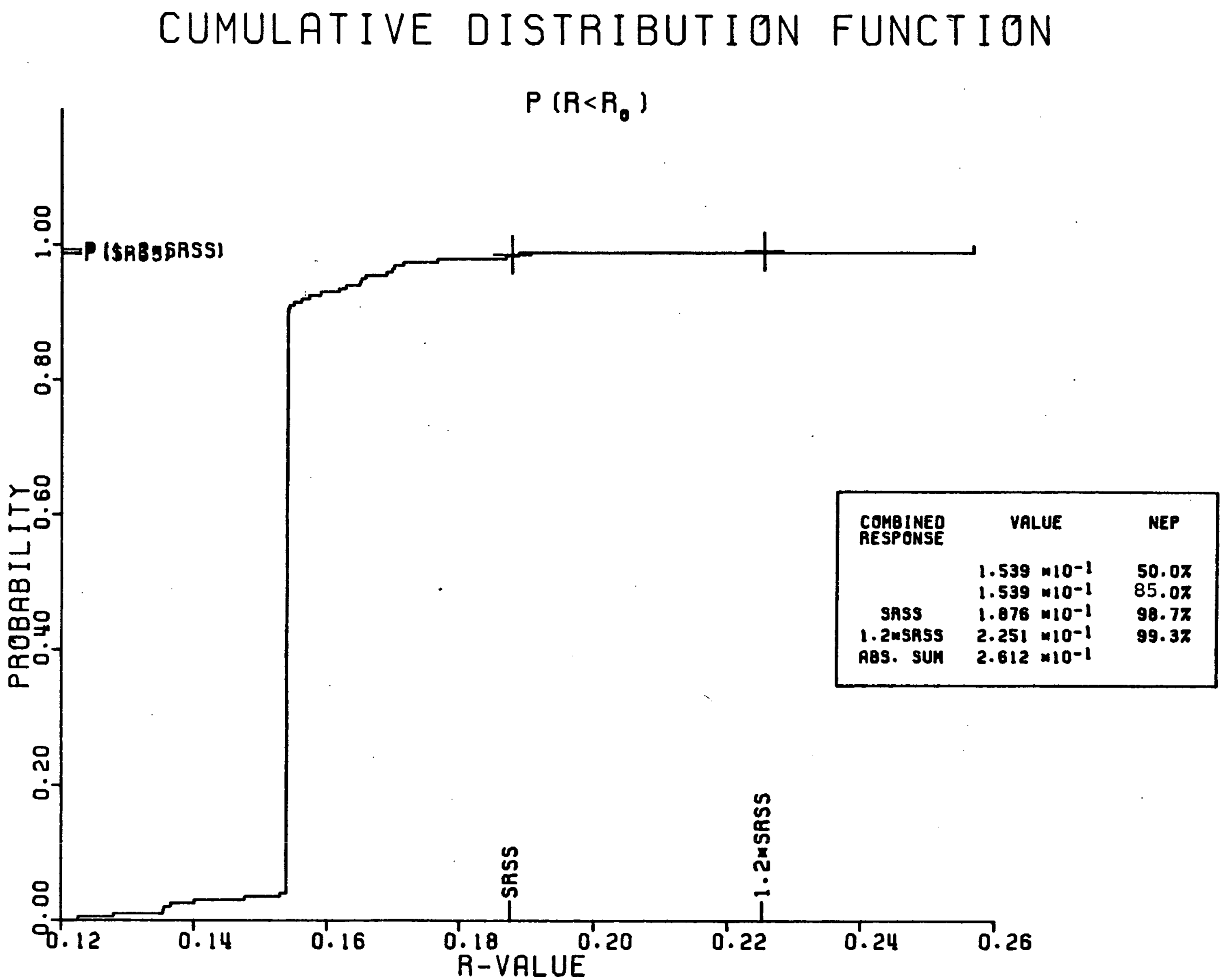


FIGURE B-143. BOP EQUIPMENT CDF CURVE, CONTAINMENT BUILDING LOCATION 5-26
OBE + SRV-ADS LOAD COMBINATION, VERTICAL WALL ACCELERATION (G)

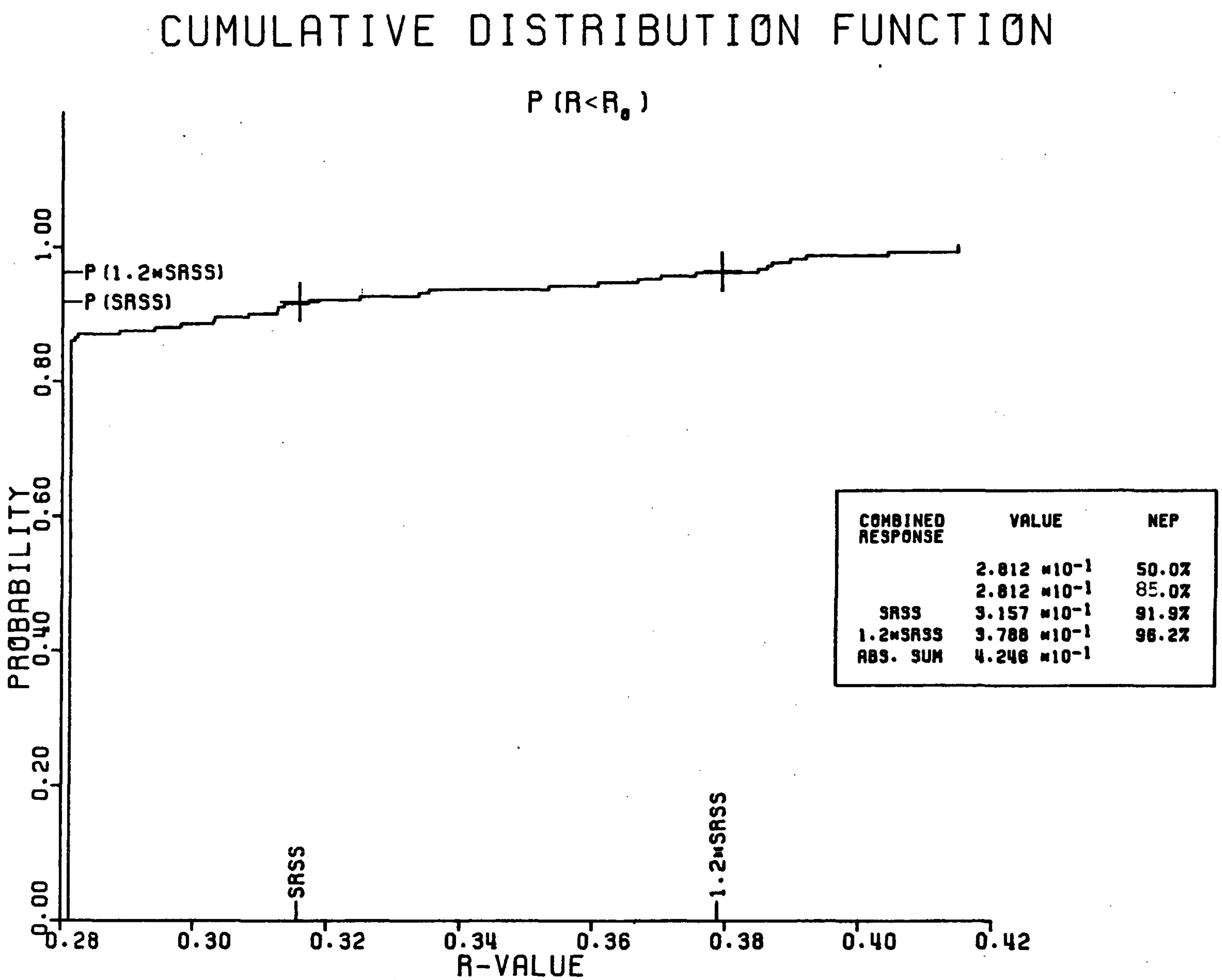


FIGURE B-144. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 2-9
SSE + SRV-1 LOAD COMBINATION, RADIAL ACCELERATION (G)

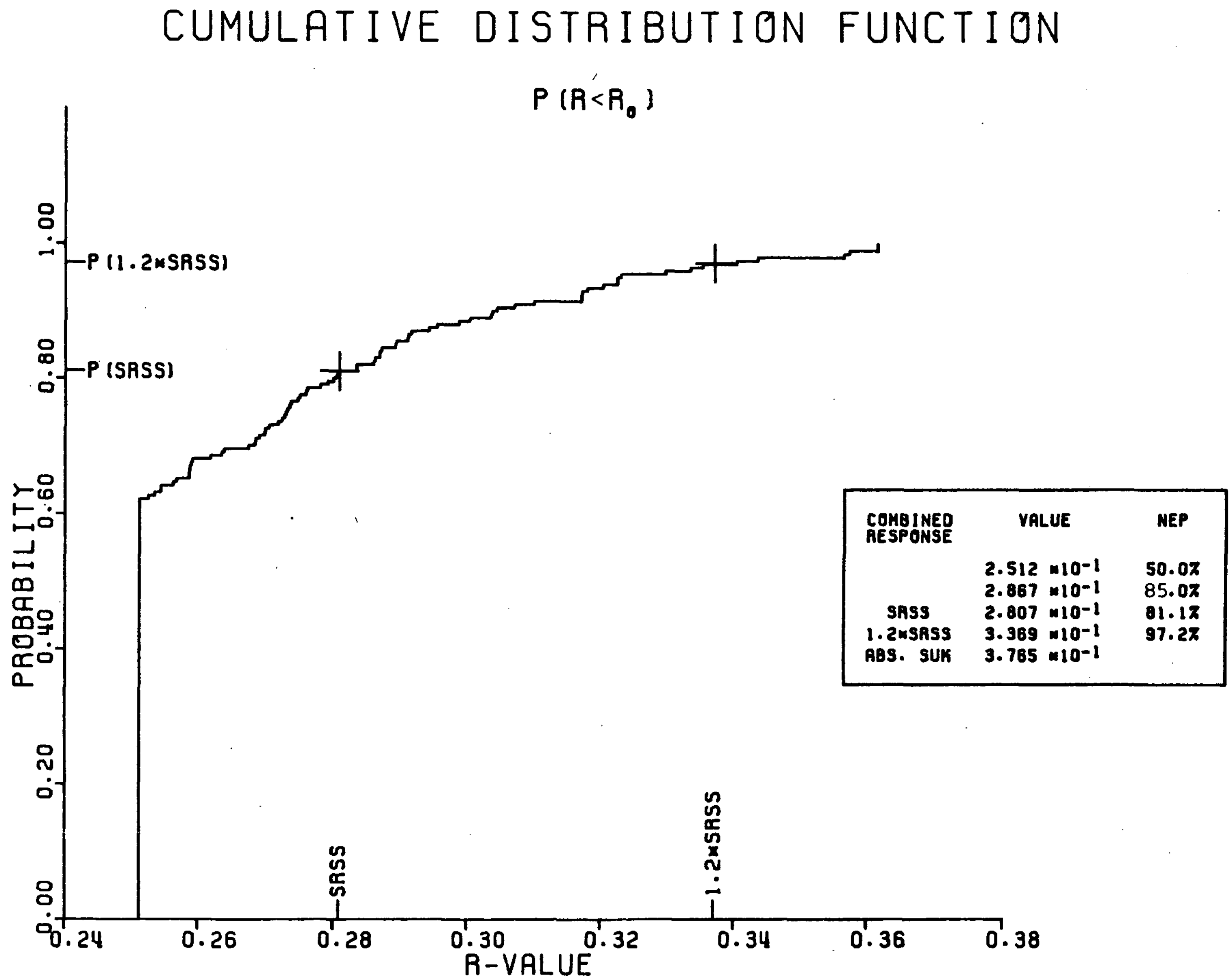
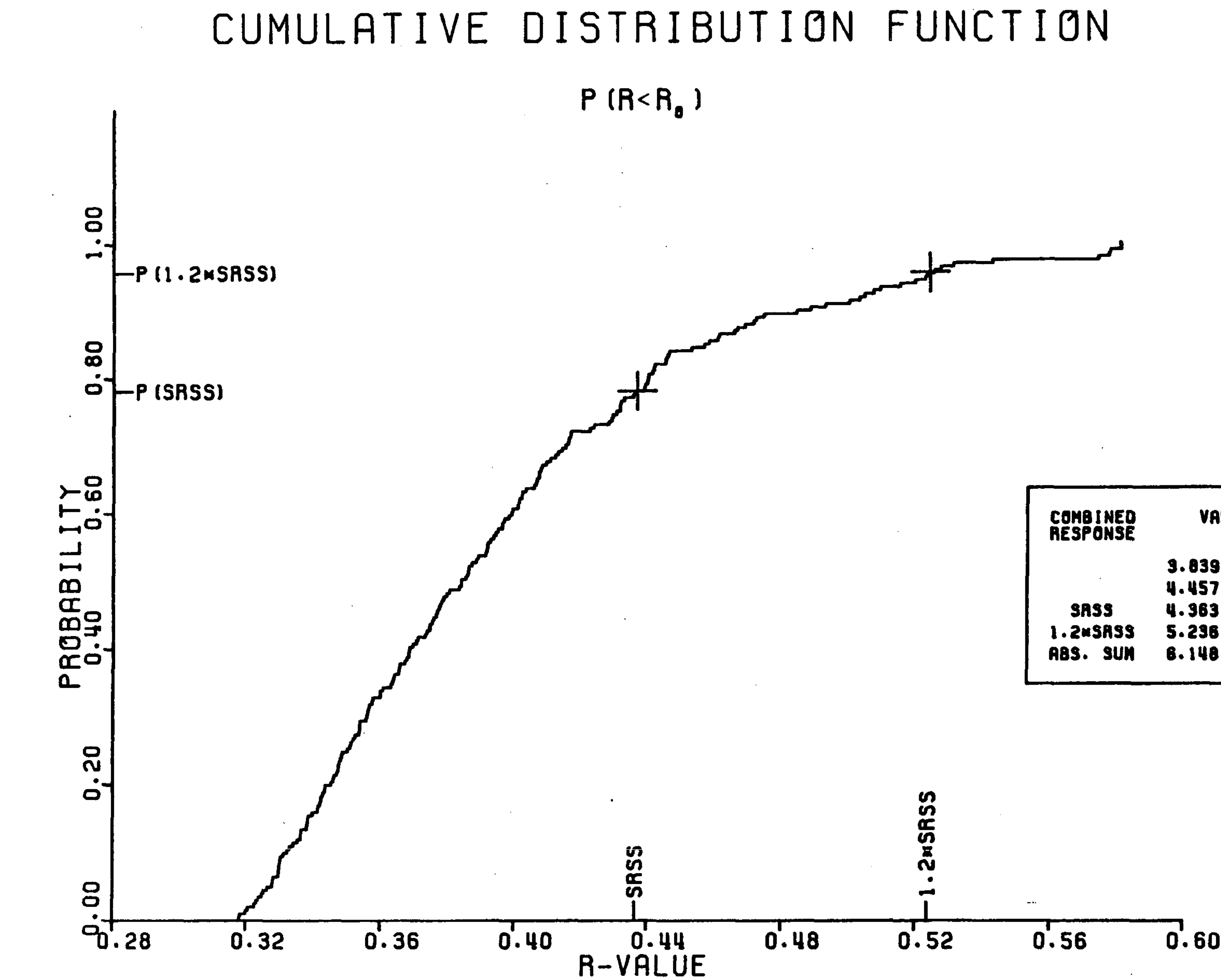


FIGURE B-145. BOP EQUIPMENT CDF CURVE, CONTAINMENT BUILDING LOCATION 5-23
SSE + SRV-1 LOAD COMBINATION, HORIZONTAL ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	3.839×10^{-1}	50.0%
	4.457×10^{-1}	85.0%
SRSS	4.363×10^{-1}	78.1%
1.2*SRSS	5.236×10^{-1}	95.7%
ABS. SUM	6.148×10^{-1}	

FIGURE B-146. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 2-9
SSE + SRV-ALL LOAD COMBINATION, RADIAL ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION

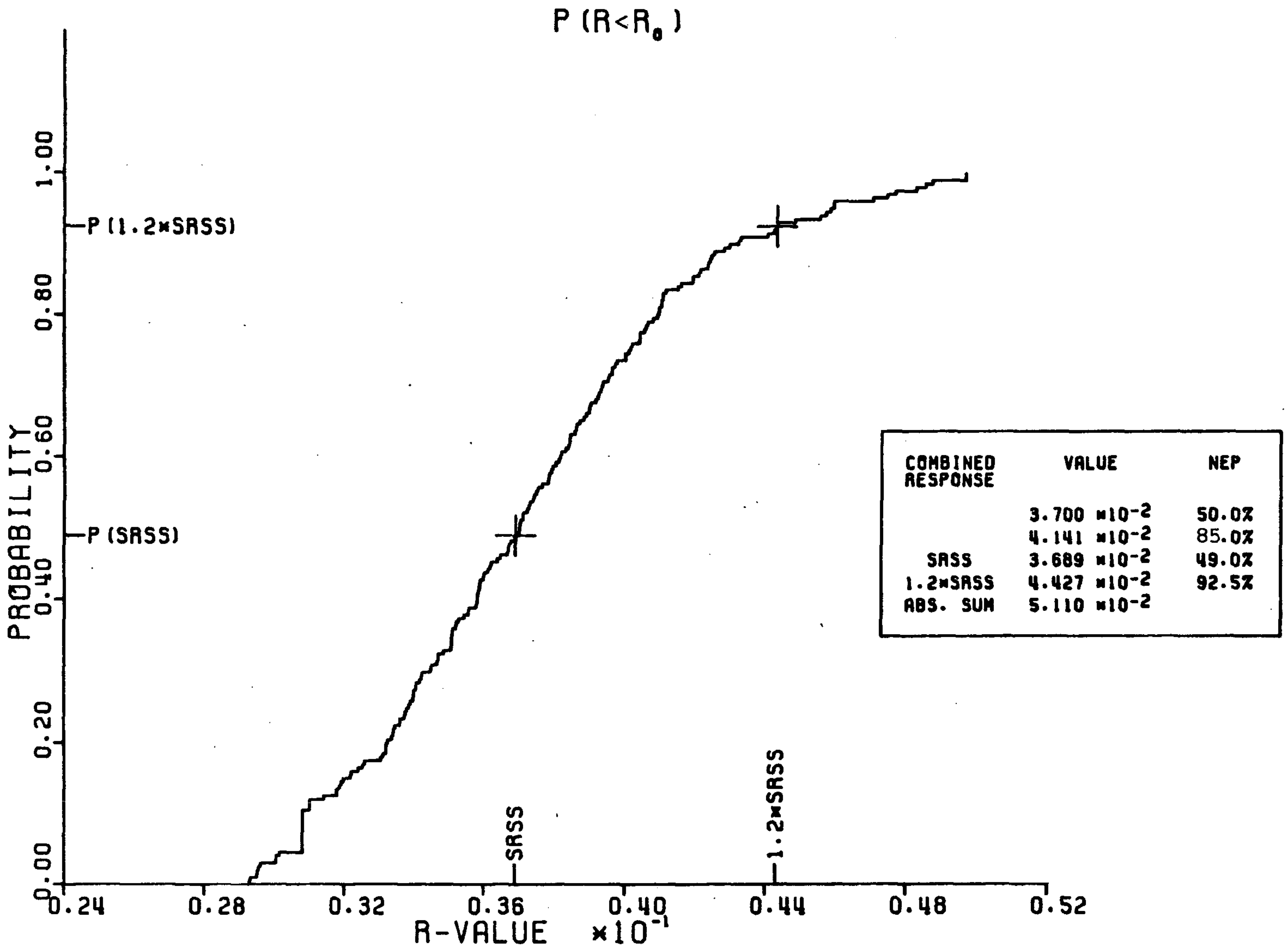
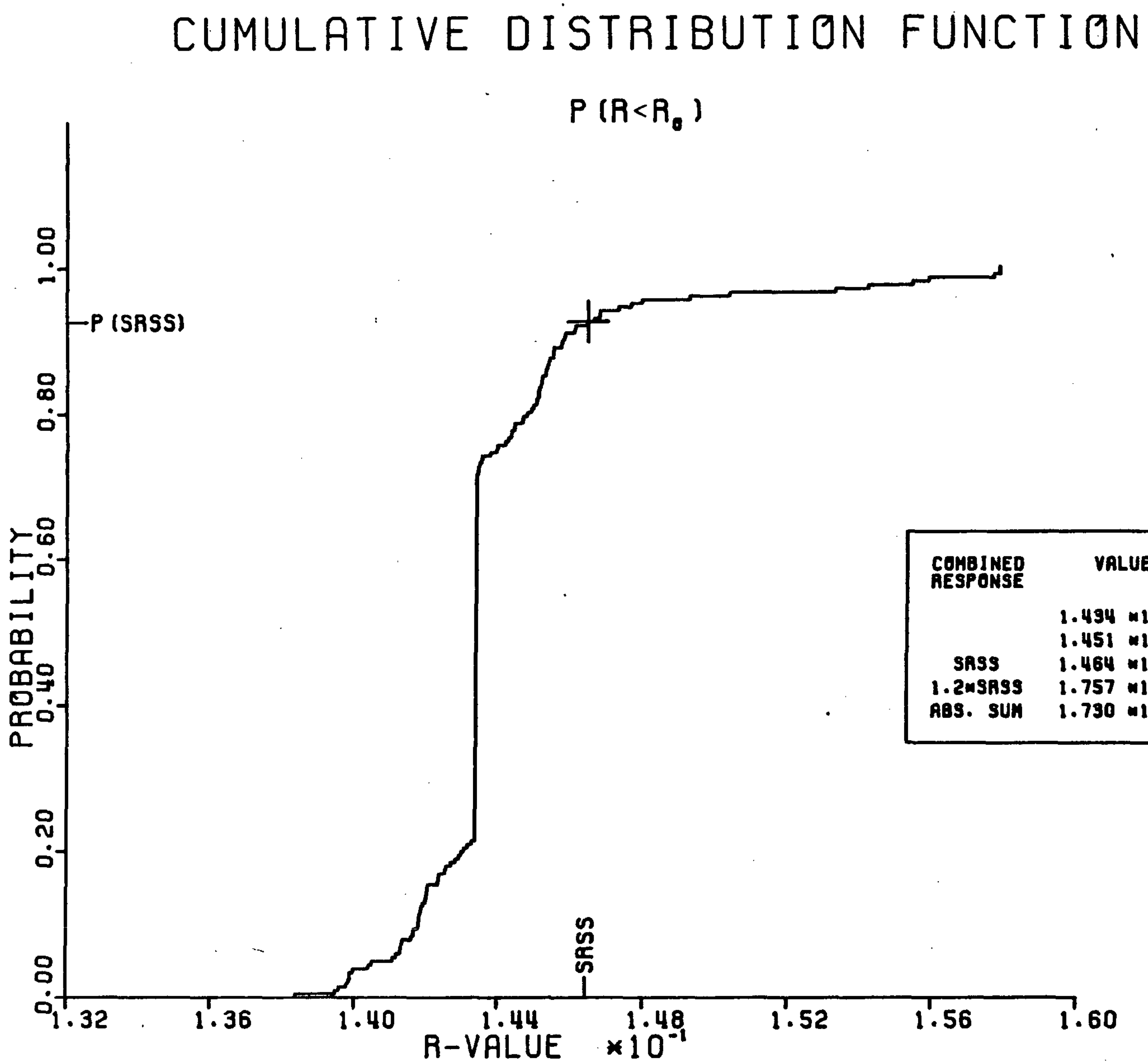


FIGURE B-147. BOP EQUIPMENT CDF CURVE, CONTAINMENT BUILDING LOCATION 5-26
SRV-1 + CHUG LOAD COMBINATION, VERTICAL WALL ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	1.434 ×10^{-1}	50.0%
	1.451 ×10^{-1}	85.0%
SASS	1.464 ×10^{-1}	92.6%
1.2×SASS	1.757 ×10^{-1}	100.0%
ABS. SUM	1.730 ×10^{-1}	

FIGURE B-148. BOP EQUIPMENT CDF CURVE, CONTAINMENT VESSEL LOCATION 2-9
SRV-1 + CHUG LOAD COMBINATION, RADIAL ACCELERATION (G)

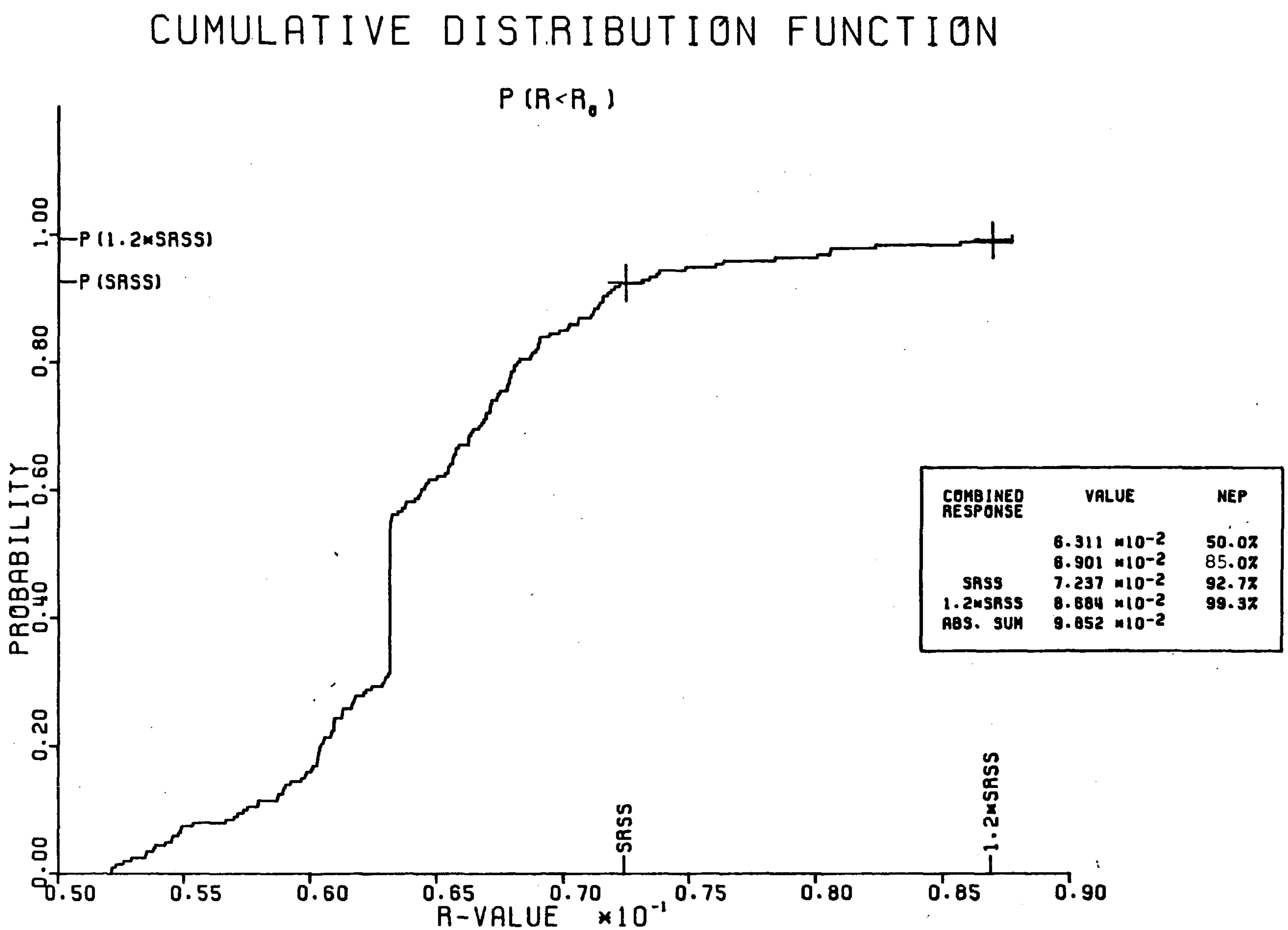


FIGURE B-149. BOP EQUIPMENT CDF CURVE, CONTAINMENT BUILDING LOCATION 5-24
SRV-ADS + CHUG LOAD COMBINATION, VERTICAL WALL ACCELERATION (G)

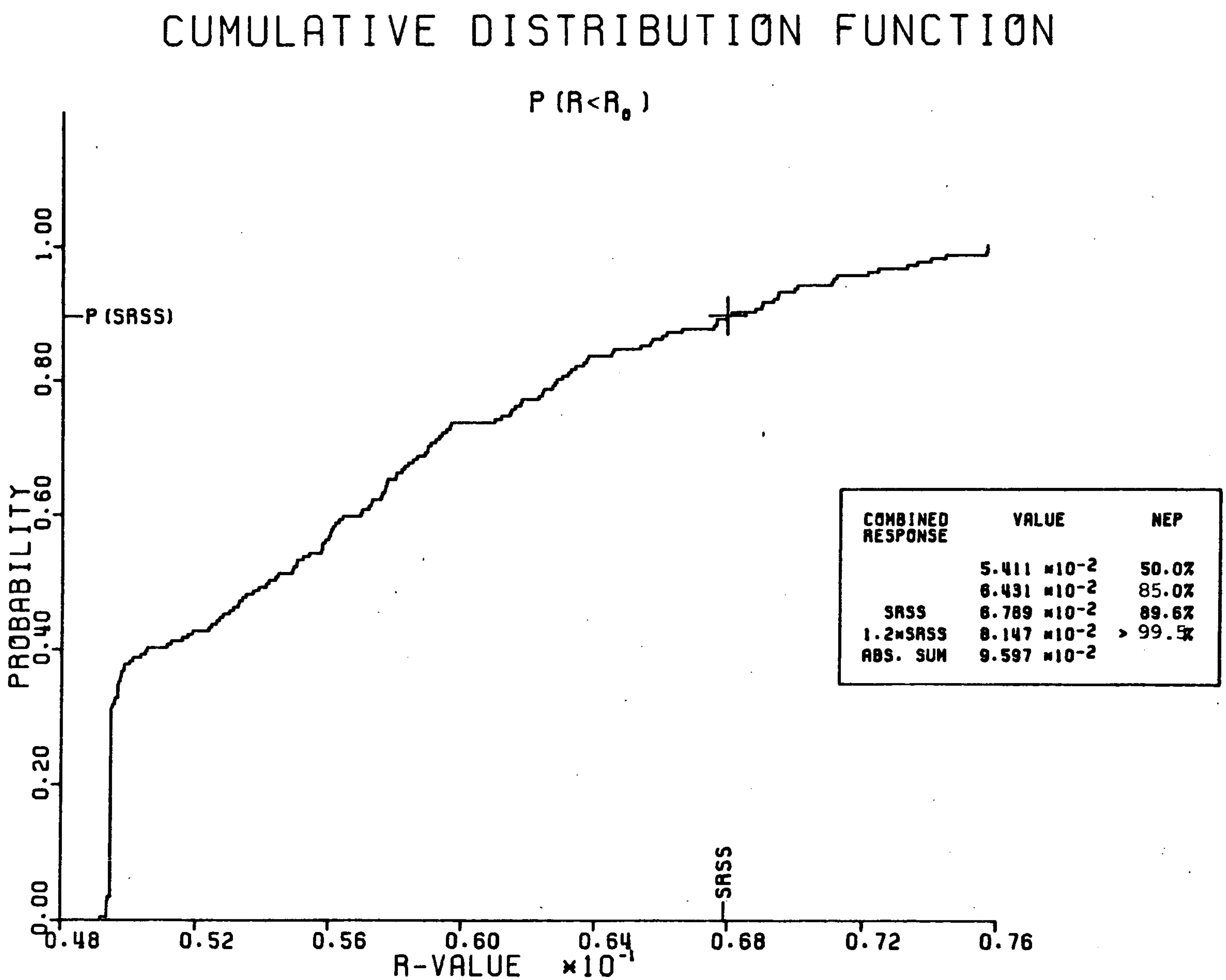


FIGURE B-150. BOP EQUIPMENT CDF CURVE, CONTAINMENT BUILDING LOCATION 5-27
SRV-ADS + CHUG LOAD COMBINATION, HORIZONTAL ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION

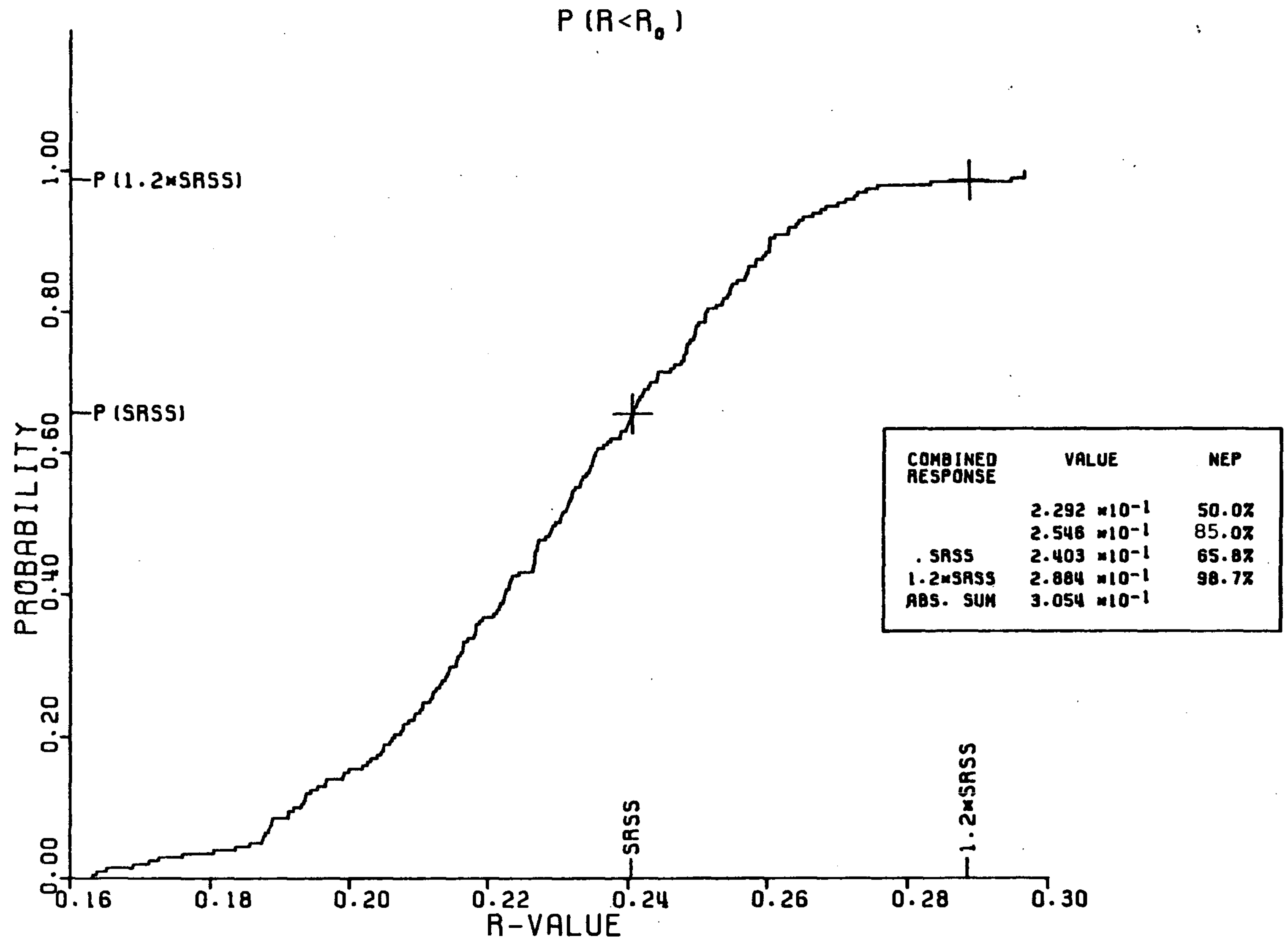
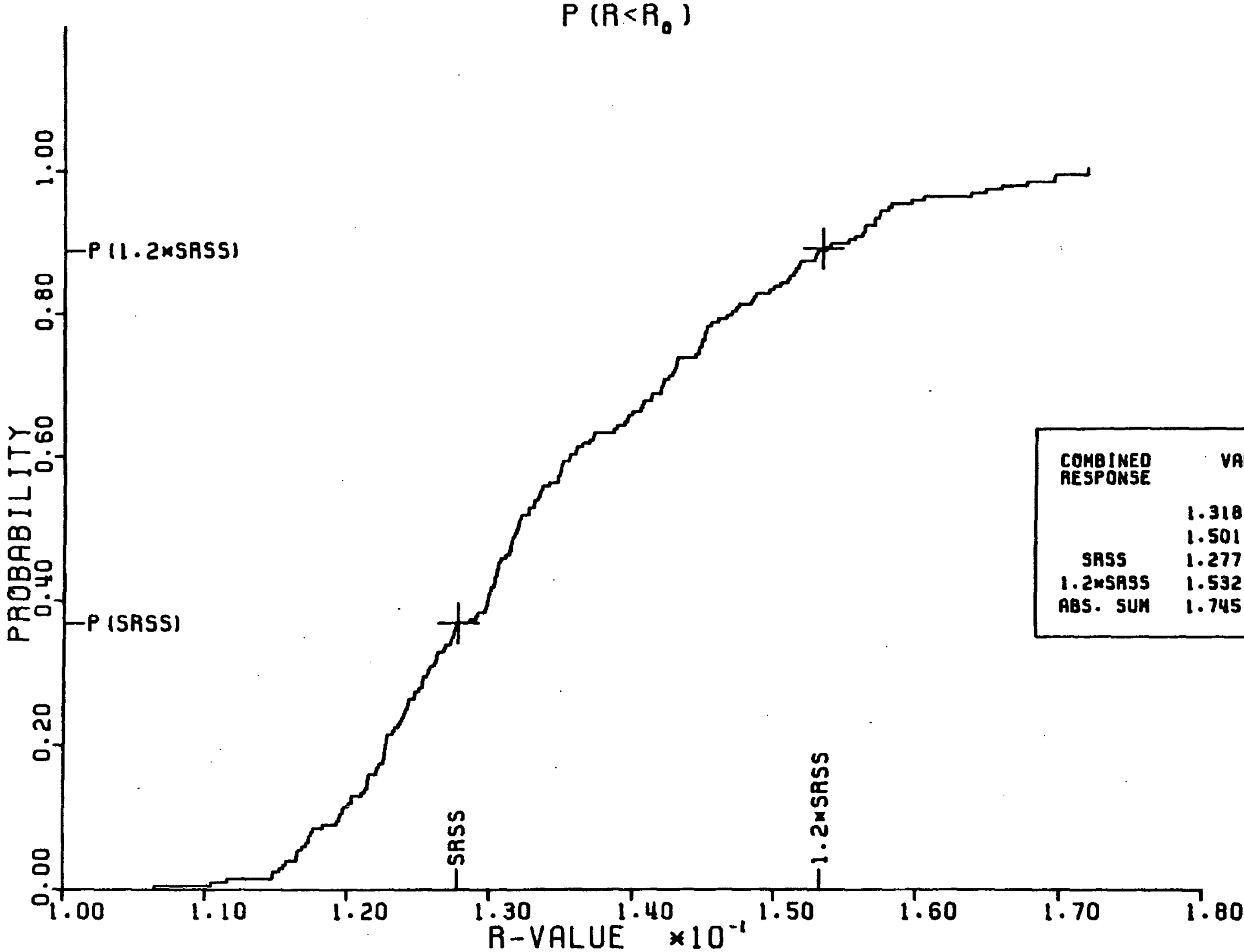


FIGURE B-151. BOP EQUIPMENT CDF CURVE, SHIELD BUILDING LOCATION 3-10
OBE + SRV-ALL LOAD COMBINATION, VERTICAL ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	1.318 $\times 10^{-1}$	50.0%
	1.501 $\times 10^{-1}$	85.0%
SRSS	1.277 $\times 10^{-1}$	36.9%
1.2×SRSS	1.532 $\times 10^{-1}$	88.9%
ABS. SUM	1.745 $\times 10^{-1}$	

FIGURE B-152. BOP EQUIPMENT CDF CURVE, SHIELD BUILDING LOCATION 3-9
OBE + SRV-ADS LOAD COMBINATION, VERTICAL ACCELERATION (G)

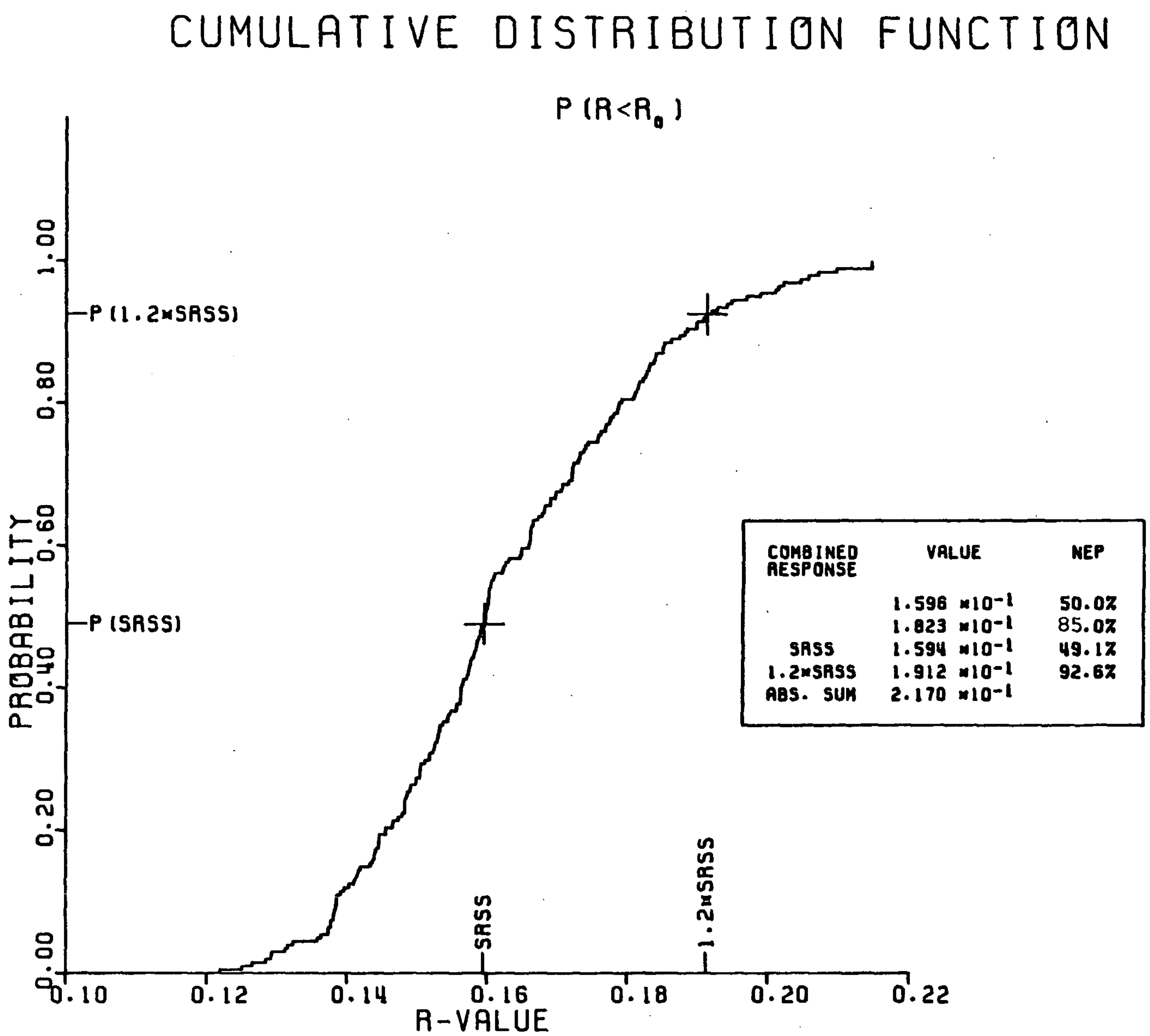
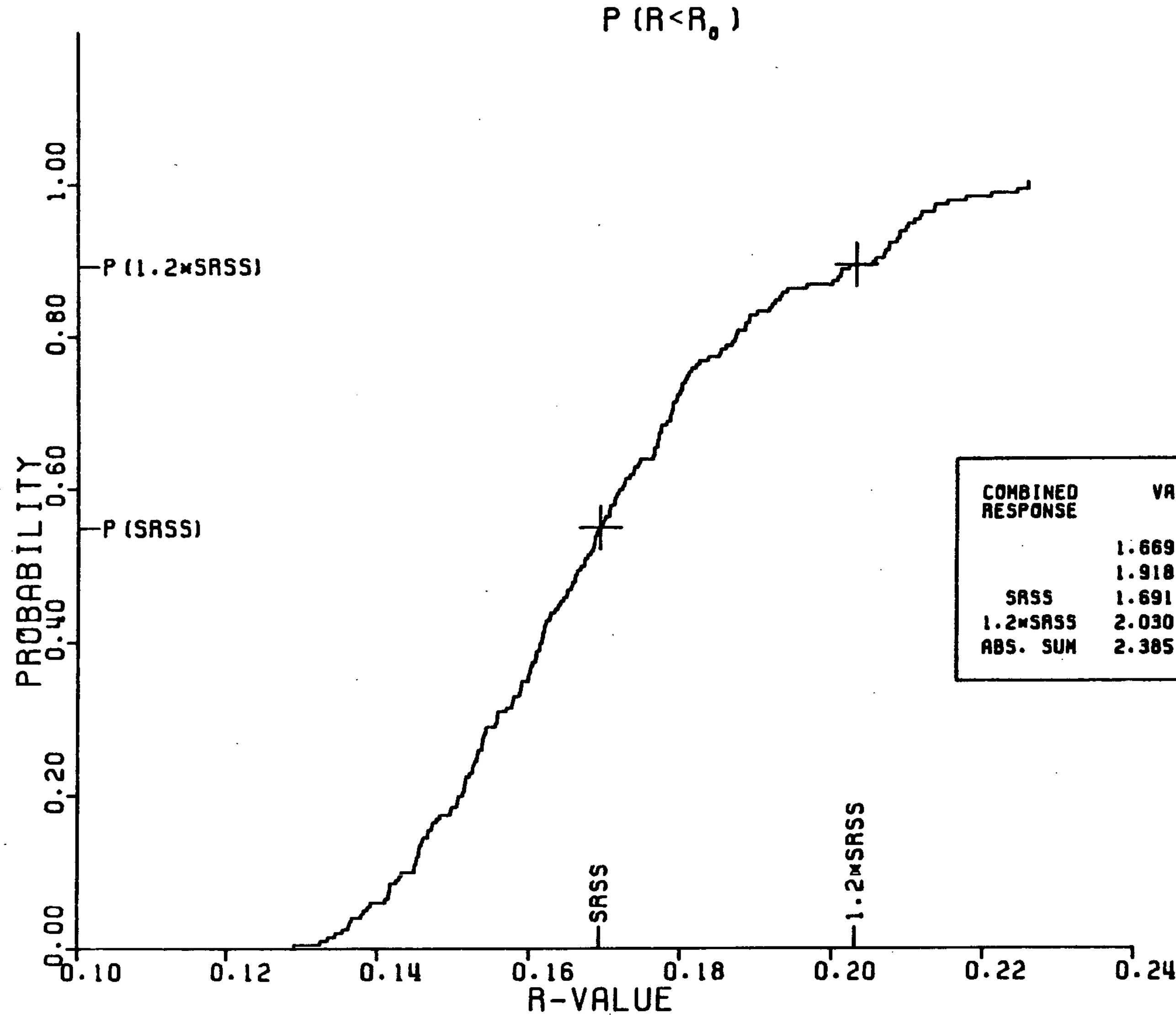


FIGURE B-153. BOP EQUIPMENT CDF CURVE, SHIELD BUILDING LOCATION 3-10
OBE + SRV-ADS LOAD COMBINATION, VERTICAL ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	1.669 ×10⁻¹	50.0%
	1.918 ×10⁻¹	85.0%
SRSS	1.691 ×10⁻¹	54.8%
1.2×SRSS	2.030 ×10⁻¹	89.2%
ABS. SUM	2.385 ×10⁻¹	

FIGURE B-154. BOP EQUIPMENT CDF CURVE, SHIELD BUILDING LOCATION 3-9
SSE + SRV-ADS LOAD COMBINATION, VERTICAL ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION

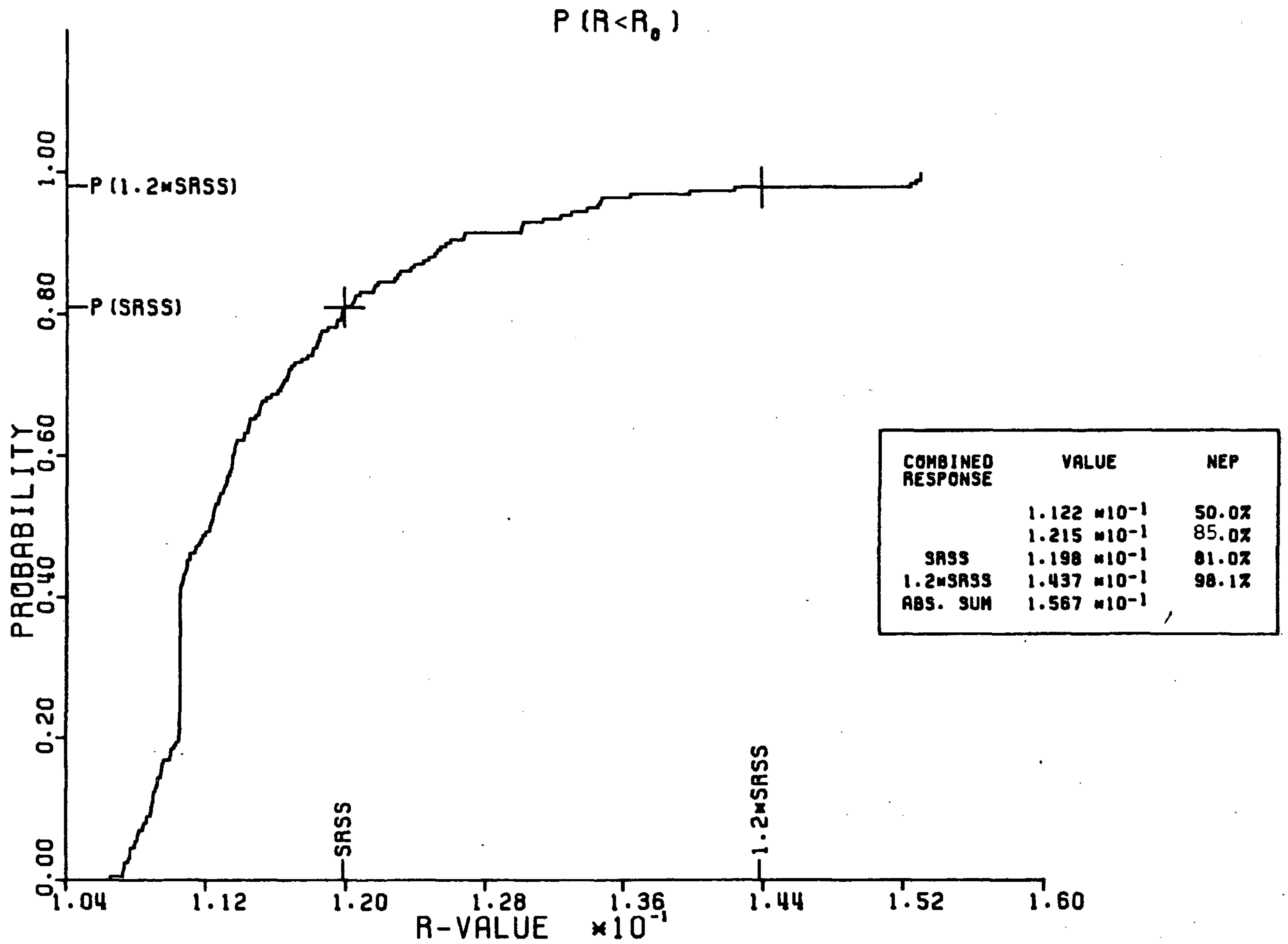


FIGURE B-155. BOP EQUIPMENT CDF CURVE, SHIELD BUILDING LOCATION 3-9
SRV-ADS + CHUG LOAD COMBINATION, VERTICAL ACCELERATION (G)

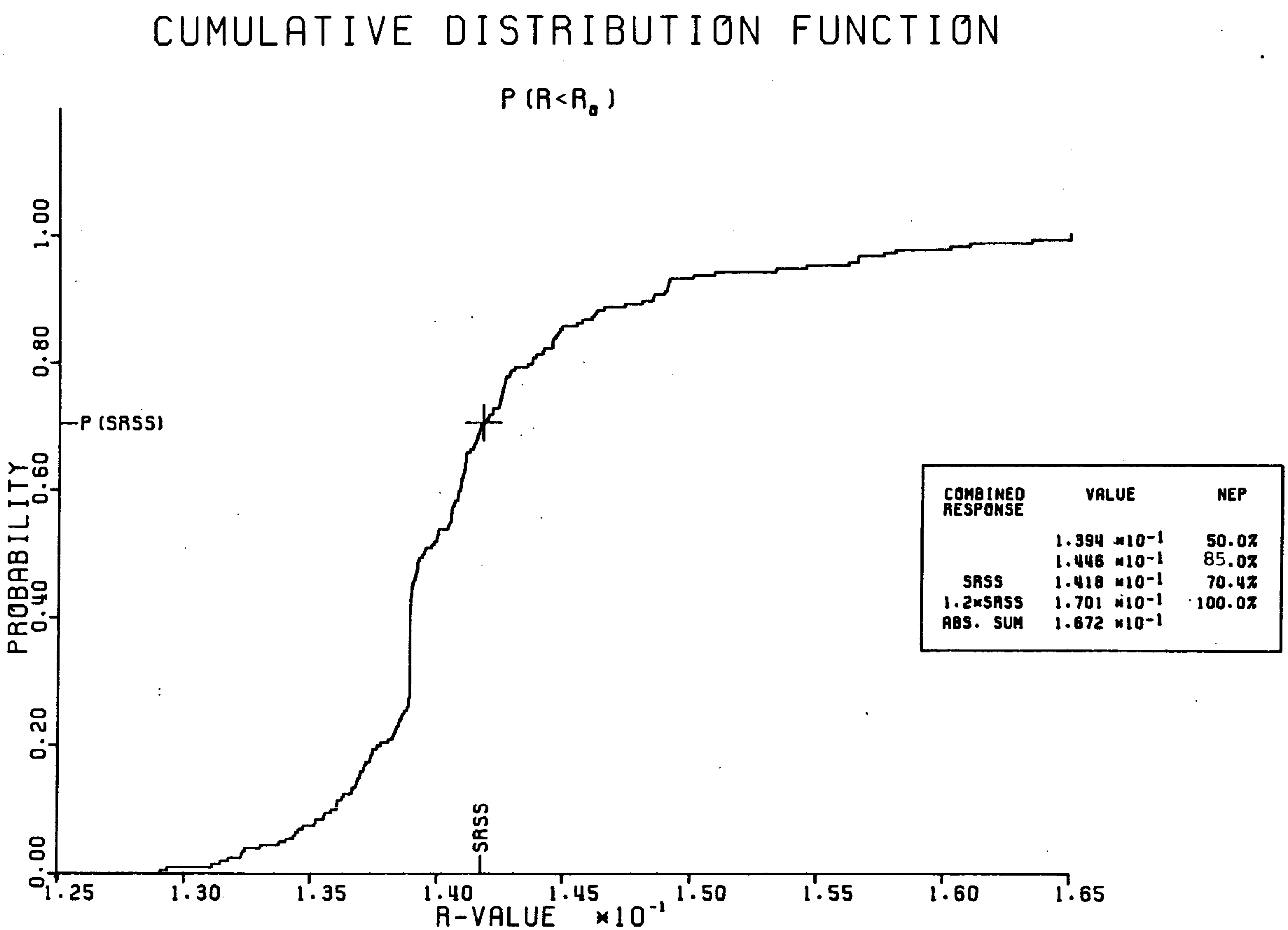


FIGURE B-156. BOP EQUIPMENT CDF CURVE, SHIELD BUILDING LOCATION 3-10
SRV-ADS + CHUG LOAD COMBINATION, VERTICAL ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION

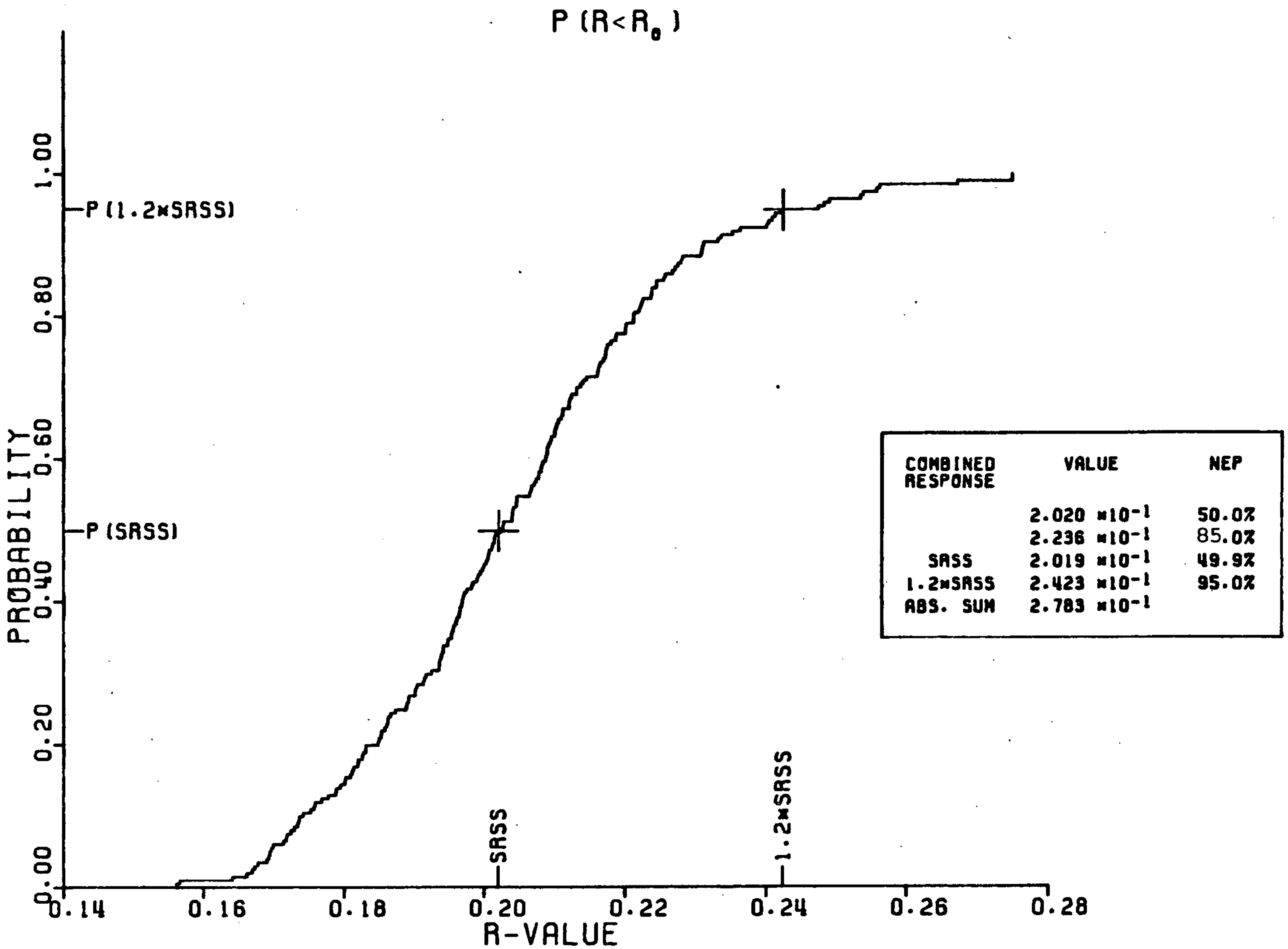
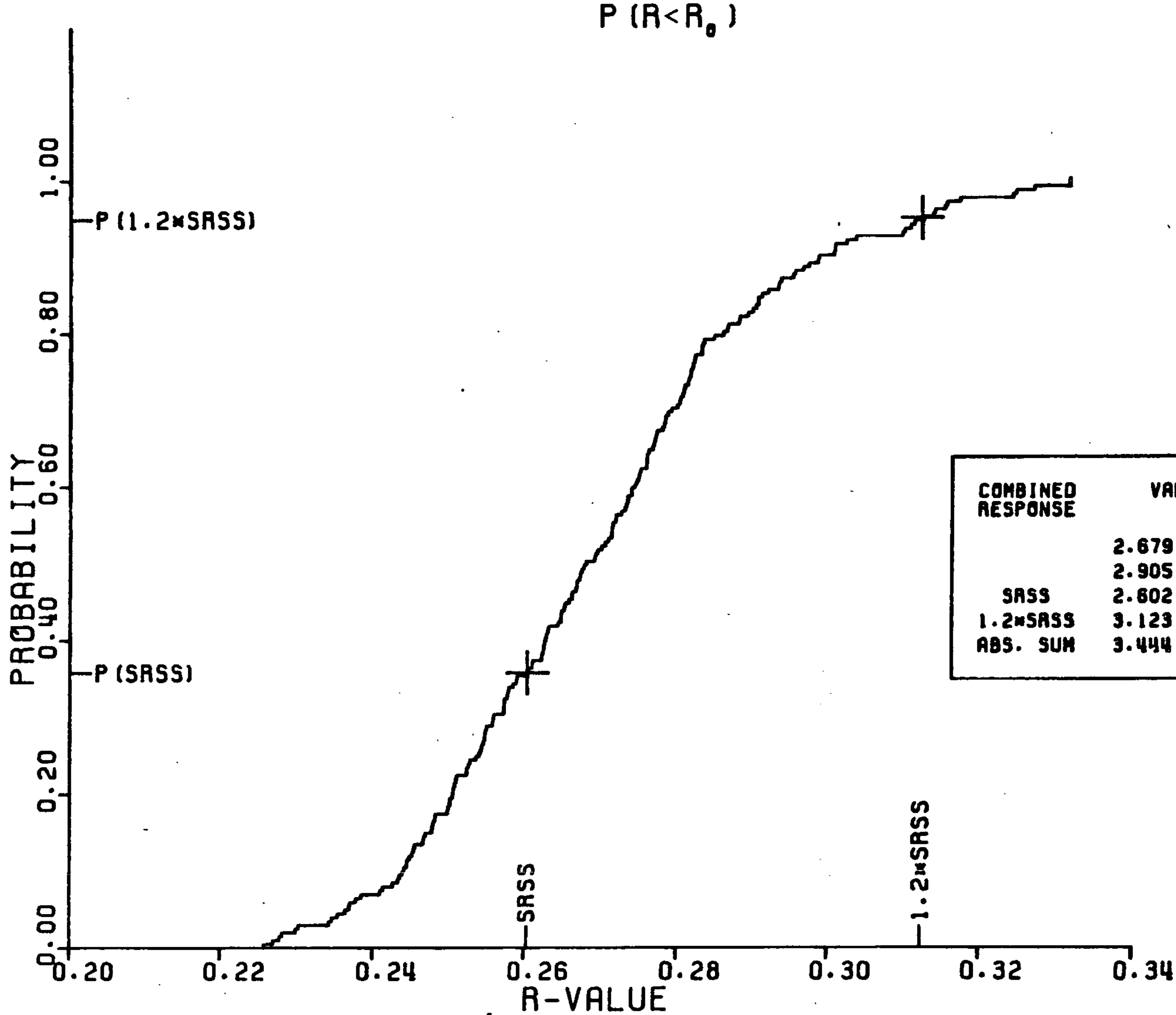


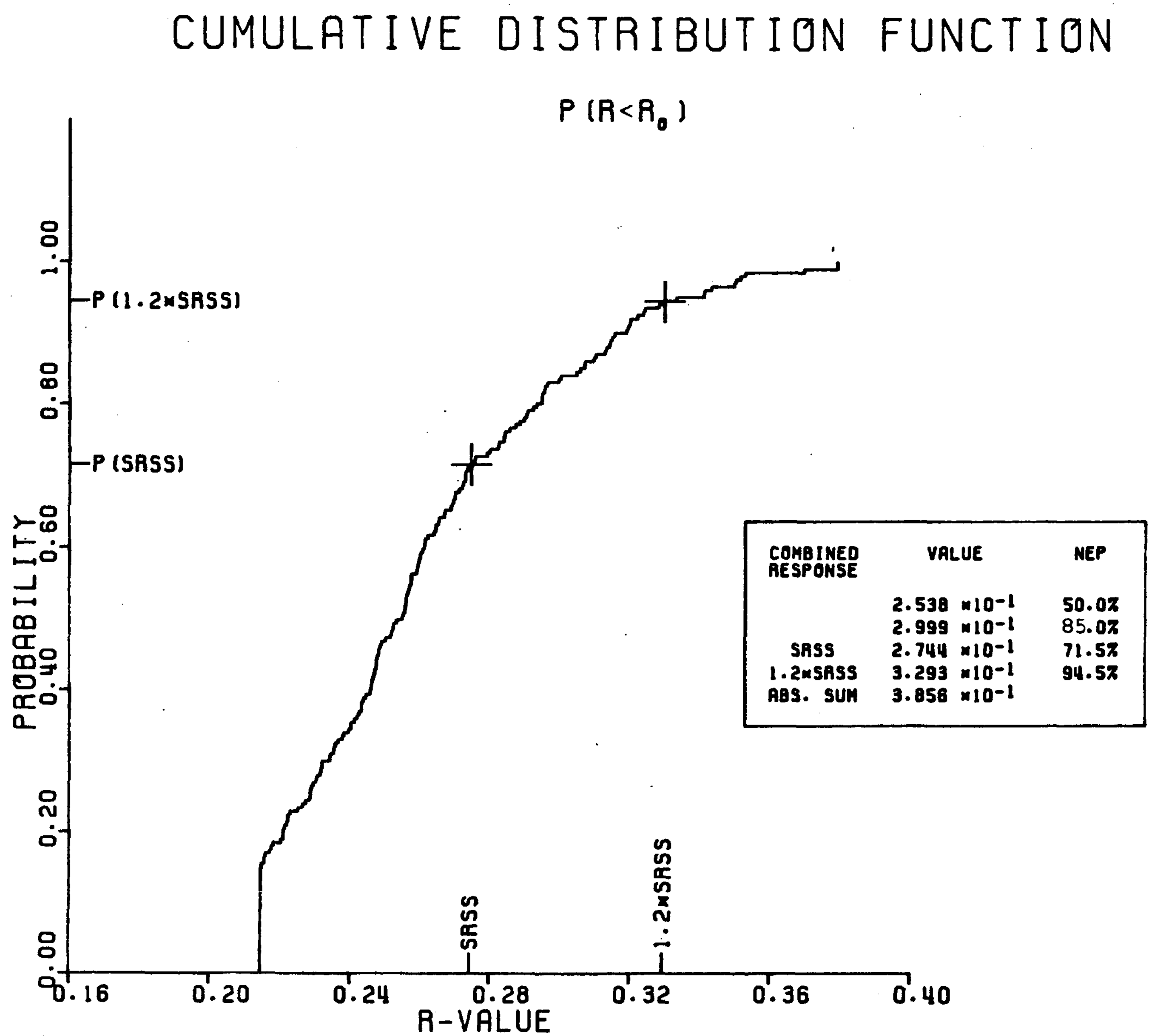
FIGURE B-157. BOP EQUIPMENT CDF CURVE, SHIELD BUILDING LOCATION 4-25
OBE + SRV-1 LOAD COMBINATION, RADIAL ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	2.679 $\times10^{-1}$	50.0%
	2.905 $\times10^{-1}$	85.0%
SRSS	2.602 $\times10^{-1}$	35.8%
1.2*SRSS	3.123 $\times10^{-1}$	94.9%
ABS. SUM	3.444 $\times10^{-1}$	

FIGURE B-158. BOP EQUIPMENT CDF CURVE, SHIELD BUILDING LOCATION 4-25
OBE + SRV-ALL LOAD COMBINATION, RADIAL ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	2.538×10^{-1}	50.0%
	2.999×10^{-1}	85.0%
SRSS	2.744×10^{-1}	71.5%
1.2*SRSS	3.293×10^{-1}	94.5%
ABS. SUM	3.856×10^{-1}	

FIGURE B-159. BOP EQUIPMENT CDF CURVE, SHIELD BUILDING LOCATION 4-25
SSE + SRV-1 LOAD COMBINATION, RADIAL ACCELERATION (G)

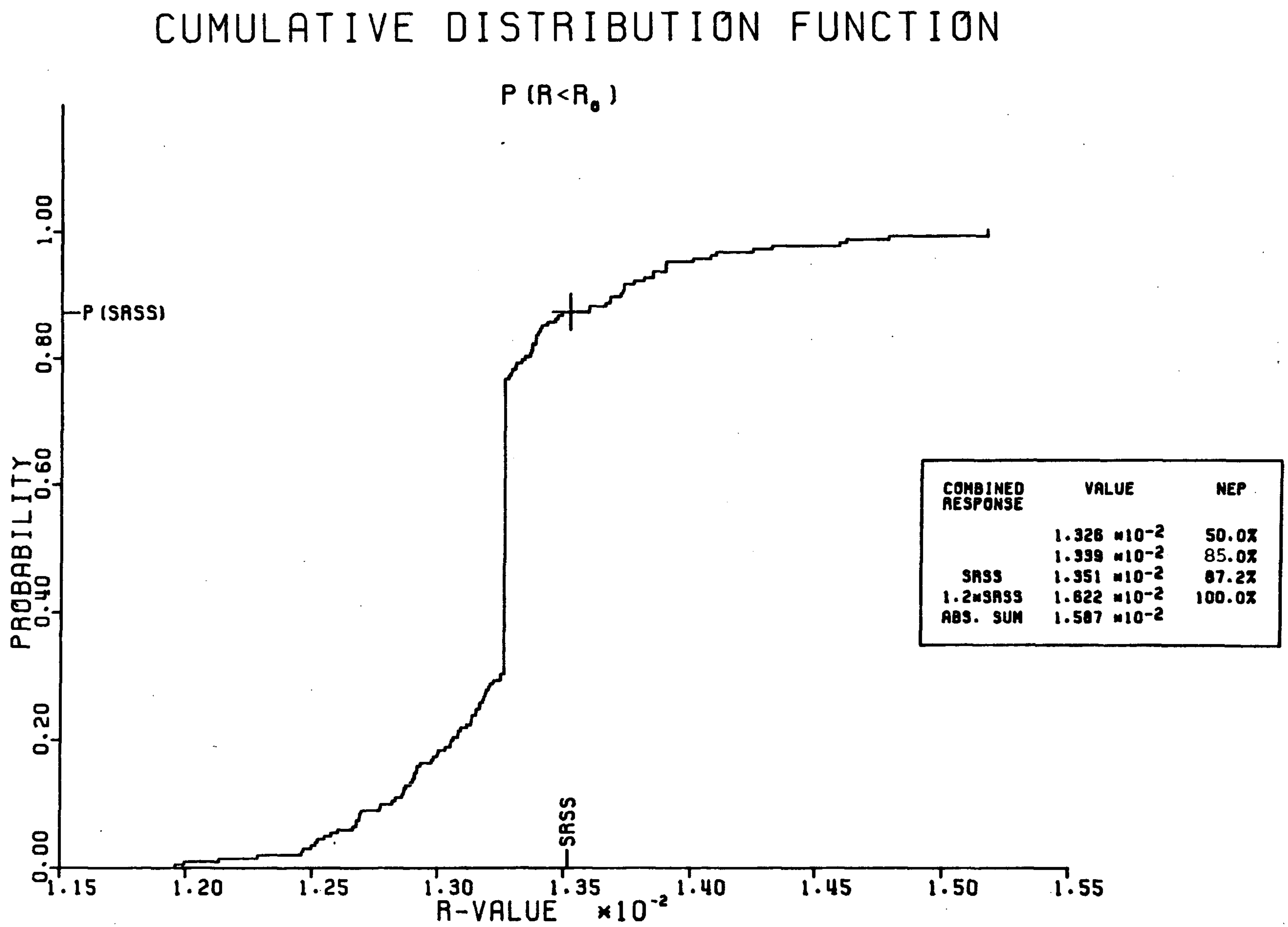
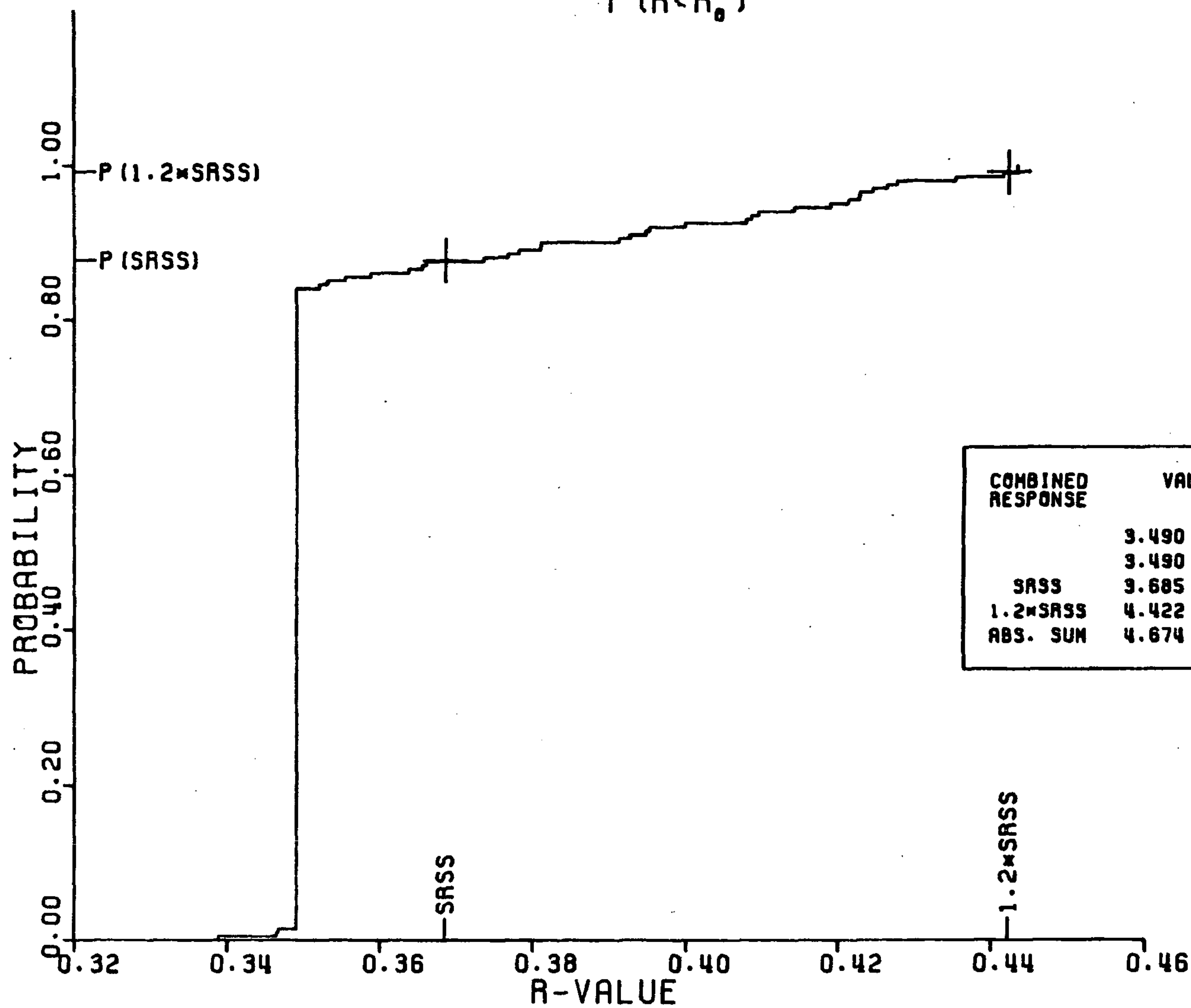


FIGURE B-160. BOP EQUIPMENT CDF CURVE, SHIELD BUILDING LOCATION 4-26
SRV-1 + CHUG LOAD COMBINATION, VERTICAL ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	3.490×10^{-1}	50.0%
	3.490×10^{-1}	85.0%
SARSS	3.685×10^{-1}	87.7%
1.2*SARSS	4.422×10^{-1}	99.2%
ABS. SUM	4.674×10^{-1}	

FIGURE B-161. BOP EQUIPMENT CDF CURVE, AUXILIARY BUILDING LOCATION 5-29
OBE + SRV-1 LOAD COMBINATION, VERTICAL SLAB ACCELERATION (G)

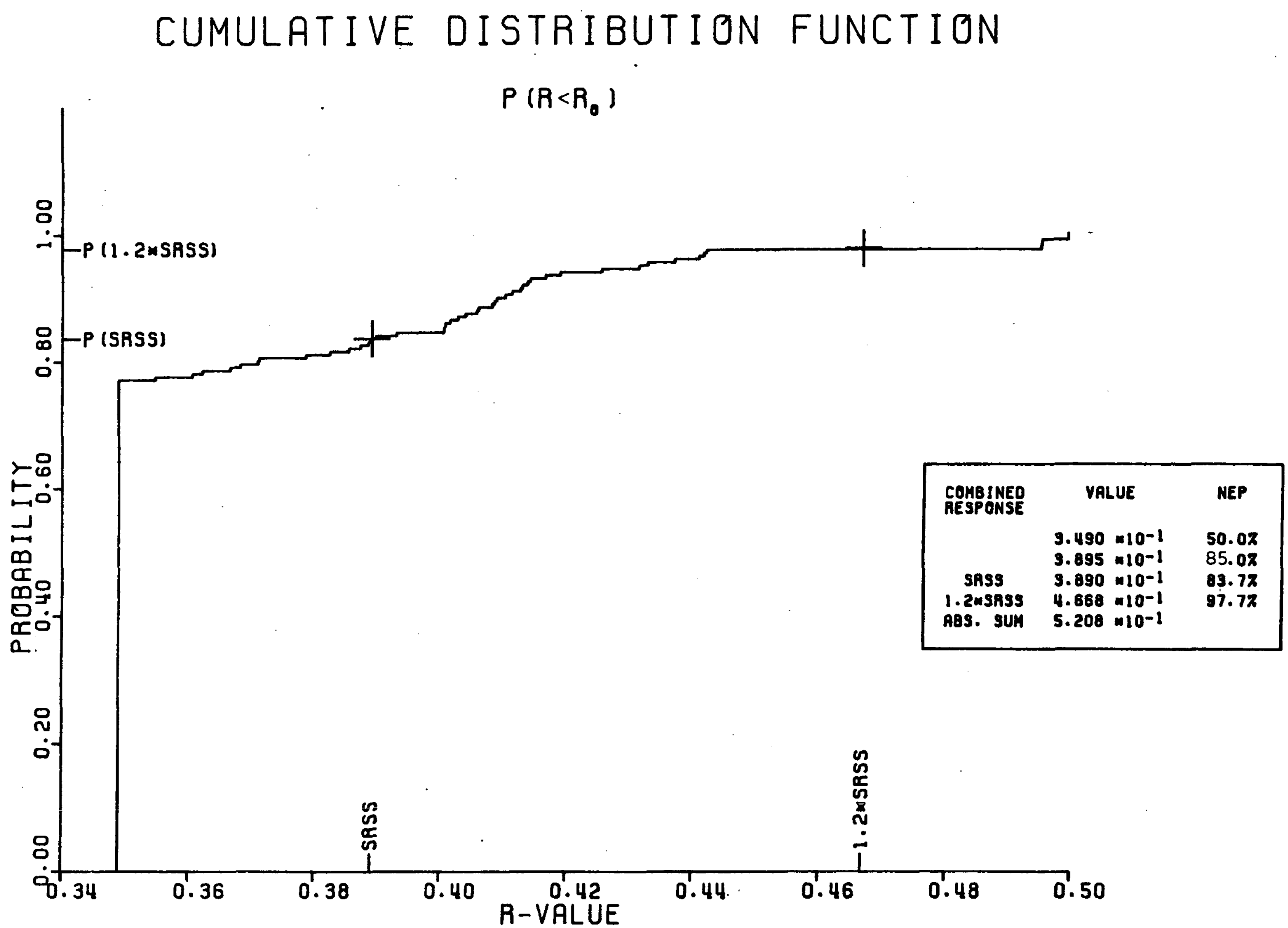
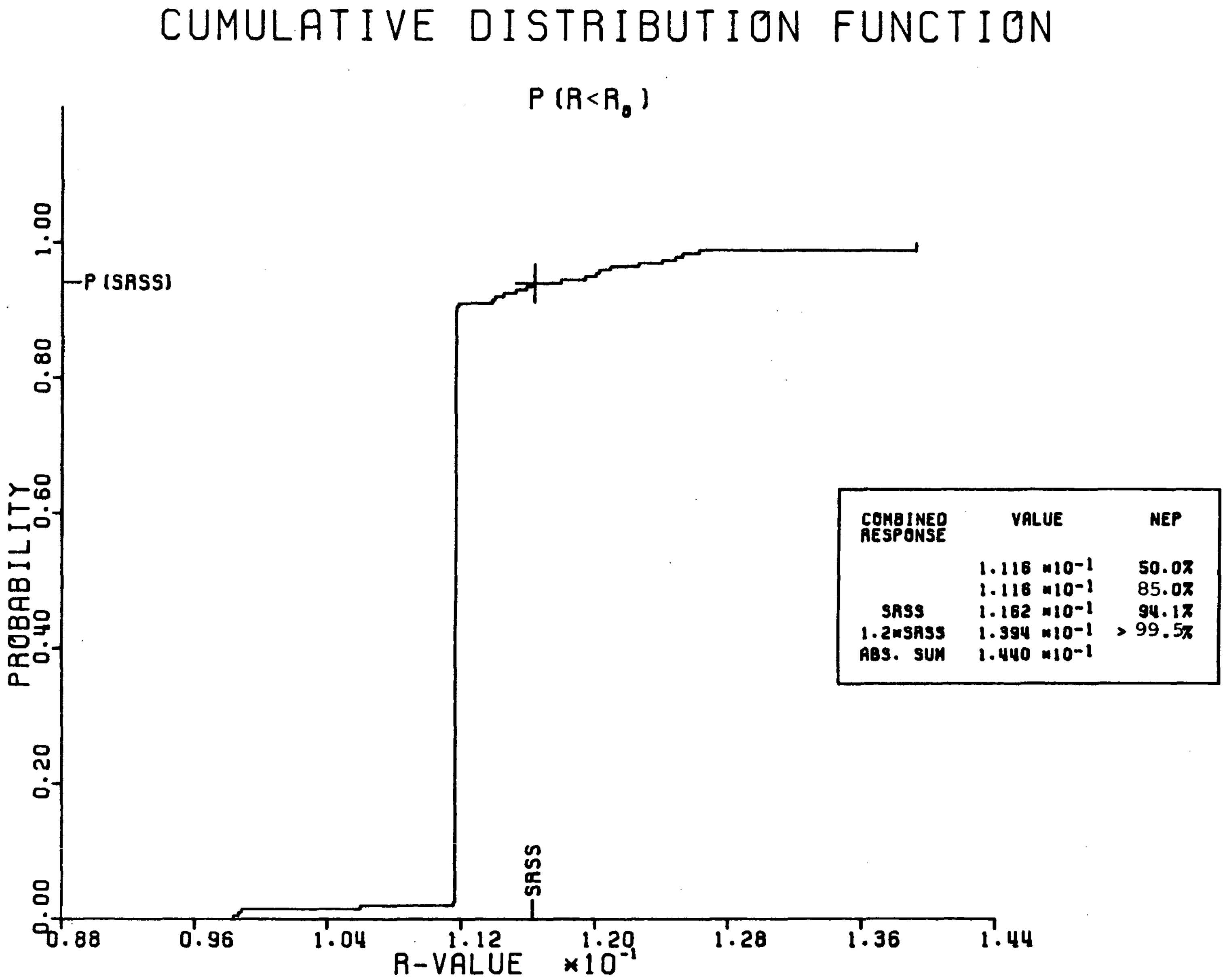


FIGURE B-162. BOP EQUIPMENT CDF CURVE, AUXILIARY BUILDING LOCATION 5-29
OBE + SRV-ADS LOAD COMBINATION, VERTICAL SLAB ACCELERATION (G)



COMBINED RESPONSE	VALUE	NEP
	1.116×10^{-1}	50.0%
	1.116×10^{-1}	85.0%
SRSS	1.162×10^{-1}	94.1%
1.2*SRSS	1.394×10^{-1}	> 99.5%
ABS. SUM	1.440×10^{-1}	

FIGURE B-163. BOP EQUIPMENT CDF CURVE, AUXILIARY BUILDING LOCATION 5-22
OBE + SRV-ADS LOAD COMBINATION, VERTICAL WALL ACCELERATION (G)

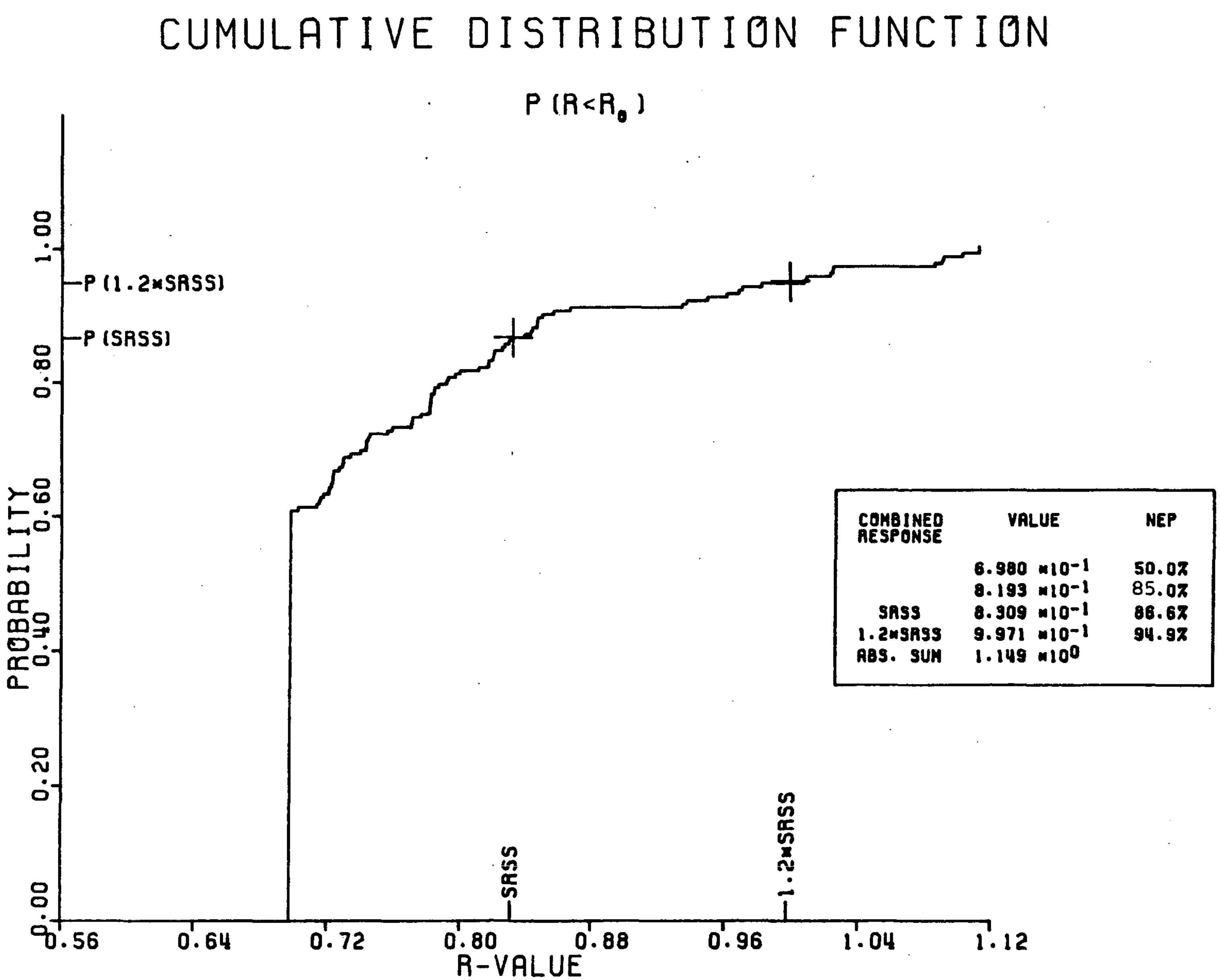


FIGURE B-164. BOP EQUIPMENT CDF CURVE, AUXILIARY BUILDING LOCATION 5-29
SSE + SRV-ALL LOAD COMBINATION, VERTICAL SLAB ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION

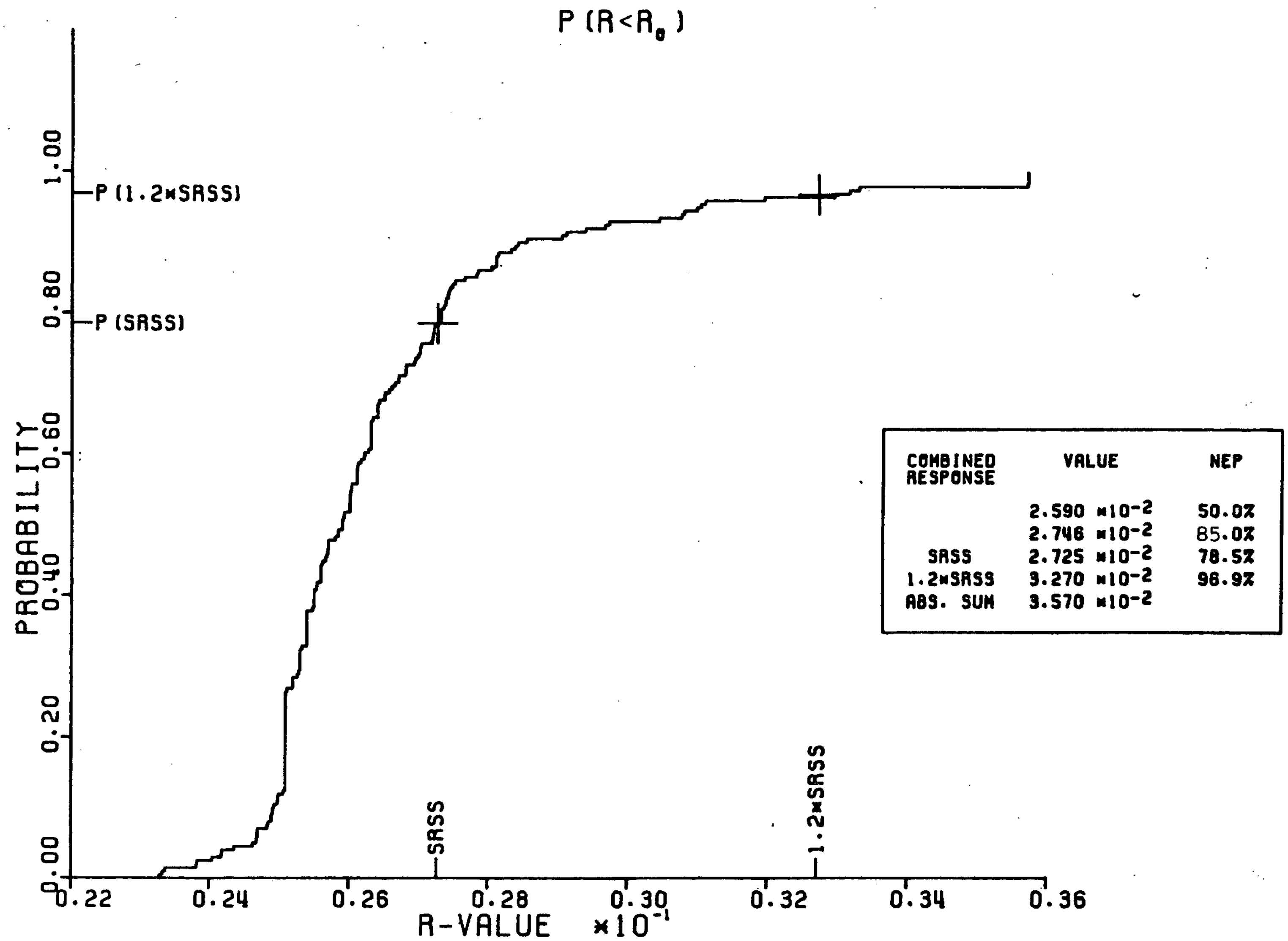
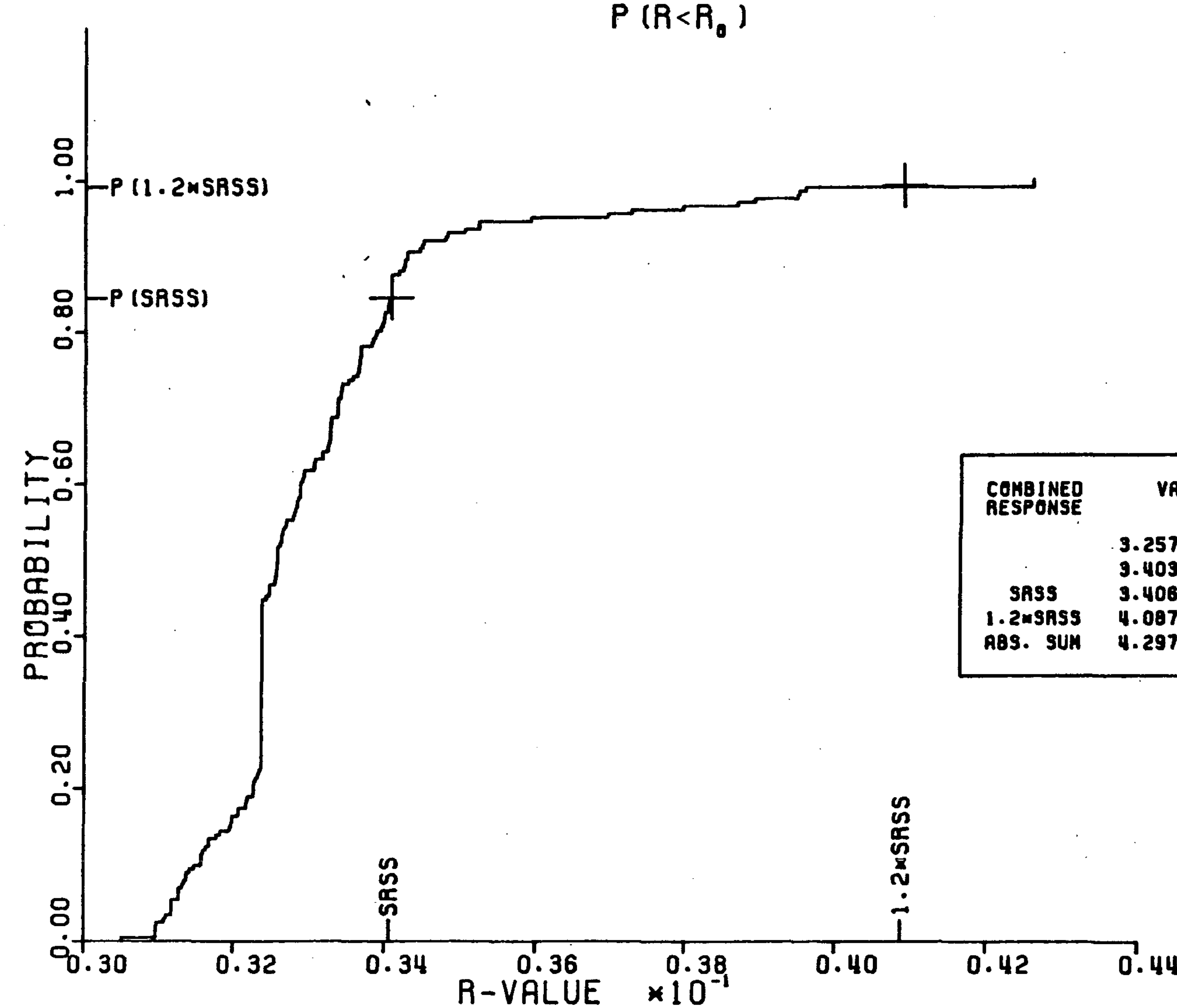


FIGURE B-165. BOP EQUIPMENT CDF CURVE, AUXILIARY BUILDING LOCATION 5-22
SRV-1 + CHUG LOAD COMBINATION, VERTICAL WALL ACCELERATION (G)

CUMULATIVE DISTRIBUTION FUNCTION



COMBINED RESPONSE	VALUE	NEP
	3.257×10^{-2}	50.0%
	3.403×10^{-2}	85.0%
SASS	3.406×10^{-2}	84.5%
1.2*SASS	4.087×10^{-2}	99.2%
ABS. SUM	4.297×10^{-2}	

FIGURE B-166. BOP EQUIPMENT CDF CURVE, AUXILIARY BUILDING LOCATION 5-22
SRV-ADS + CHUG LOAD COMBINATION, VERTICAL WALL ACCELERATION (G)

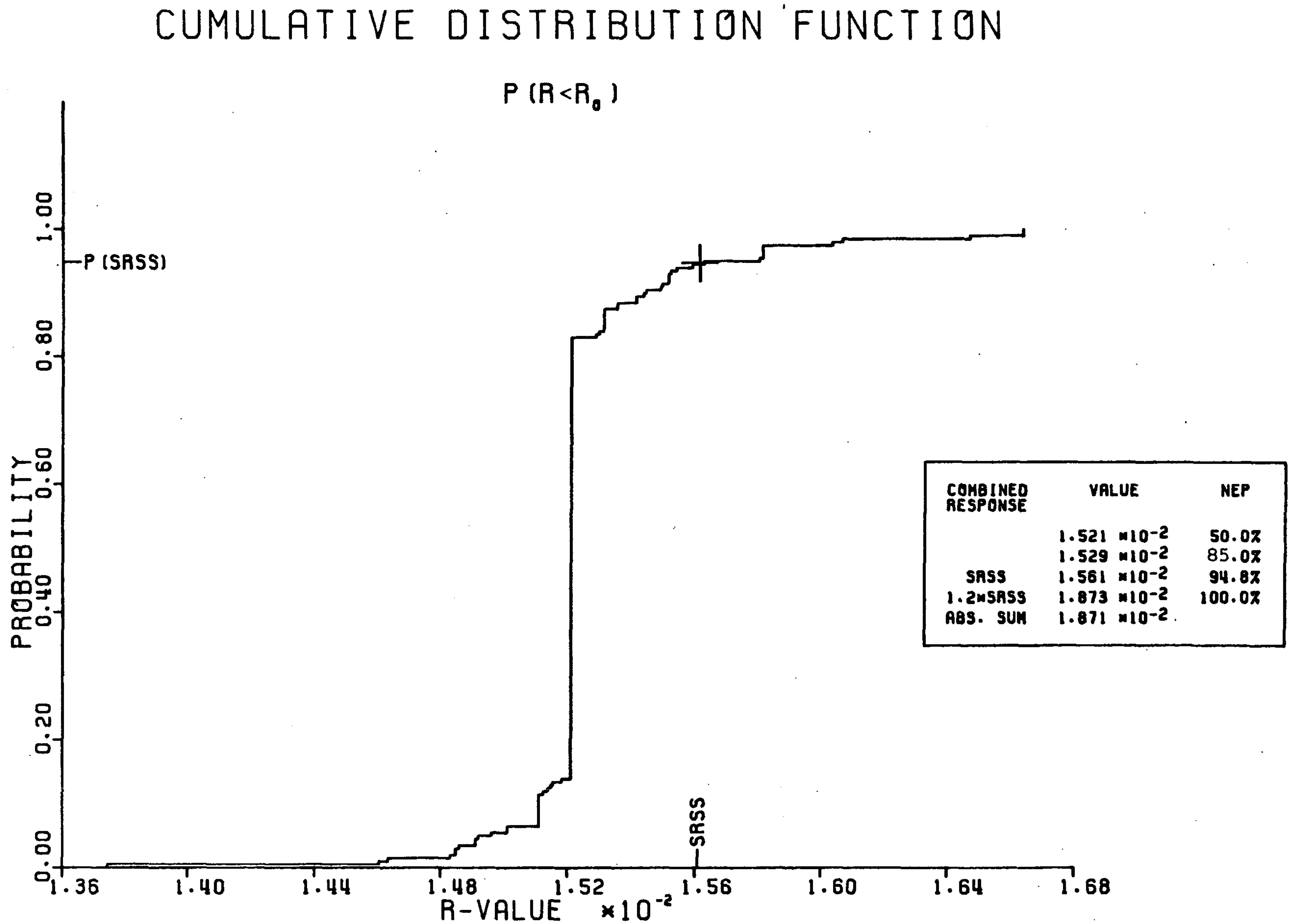


FIGURE B-167. BOP EQUIPMENT CDF CURVE, AUXILIARY BUILDING LOCATION 5-21
SRV-ALL + CHUG LOAD COMBINATION, HORIZONTAL ACCELERATION (G)

APPENDIX C

RESPONSE TIME HISTORY PAIRS USED TO GENERATE CDF CURVES

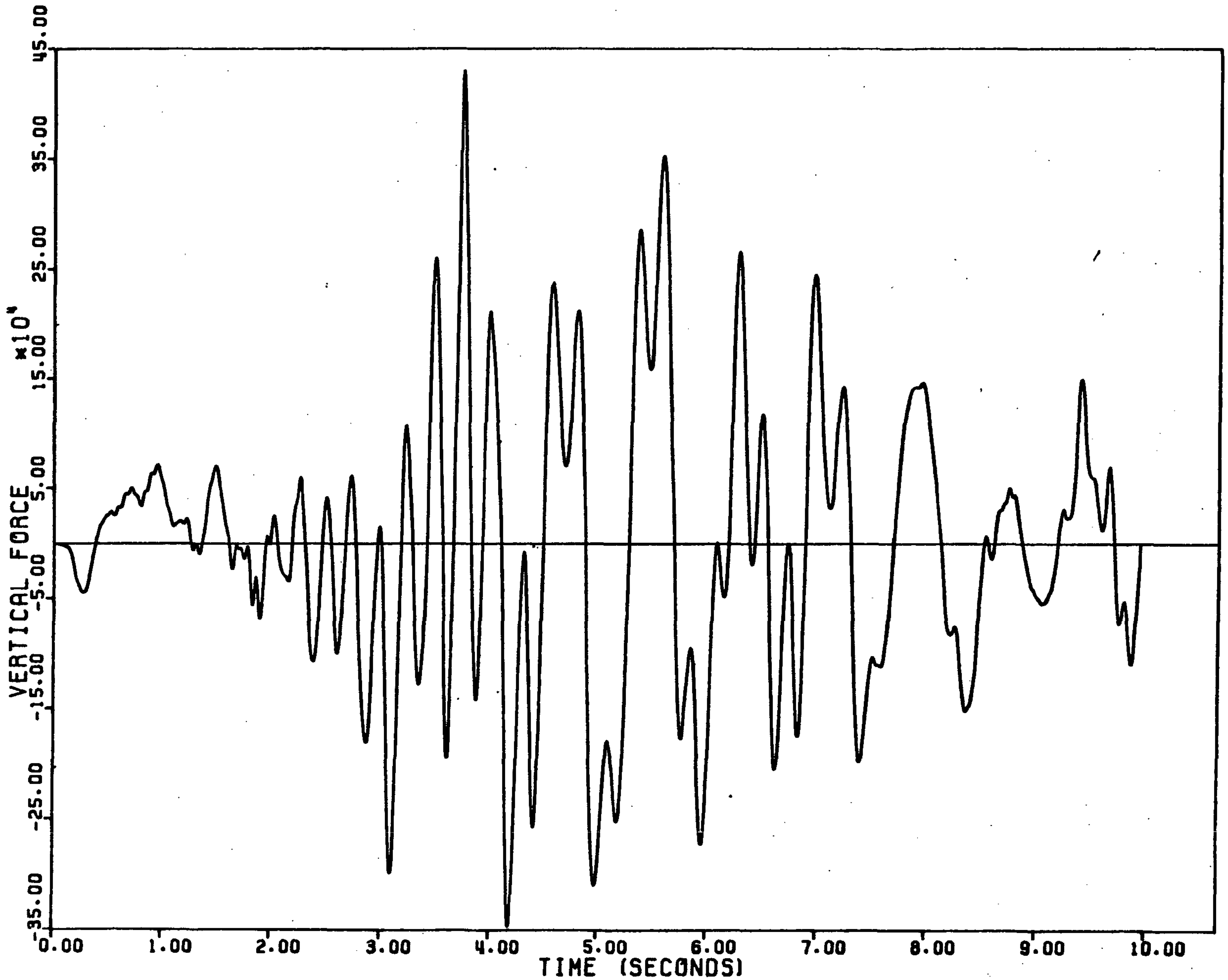


FIGURE C-1A. NUCLEAR STEAM SUPPLY SYSTEM, RPV SKIRT , LOCATION 5-5
OBE LOADING - RECORD 505 - VERT. FORCE (LBS) ,NPTS = 1995, DT = .005

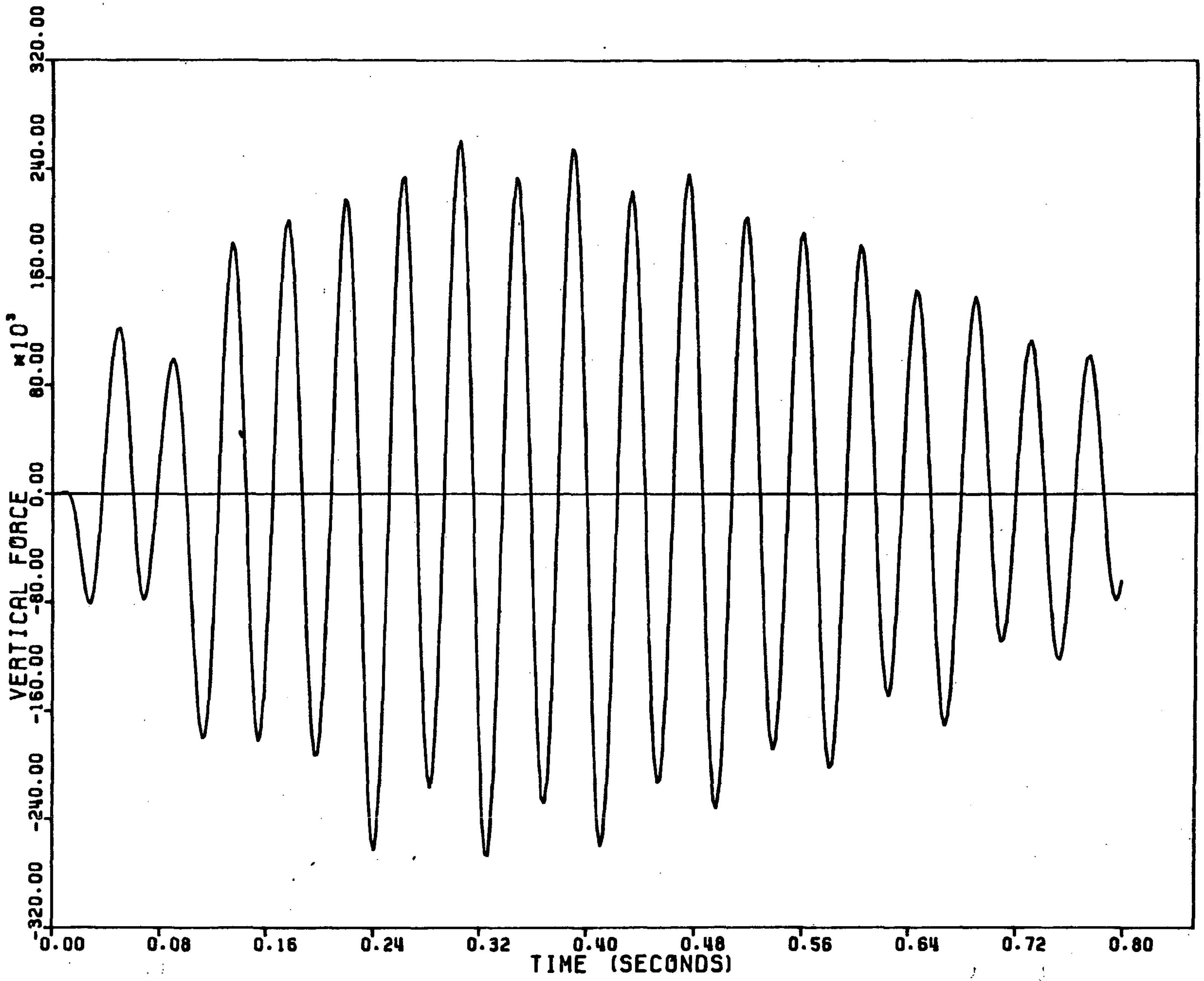


FIGURE C-1B. NUCLEAR STEAM SUPPLY SYSTEM. RPV SKIRT , LOCATION 5-5
SRV-1 LOADING - RECORD 515 - VERT. FORCE (LBS) .NPTS = 400. DT = .002

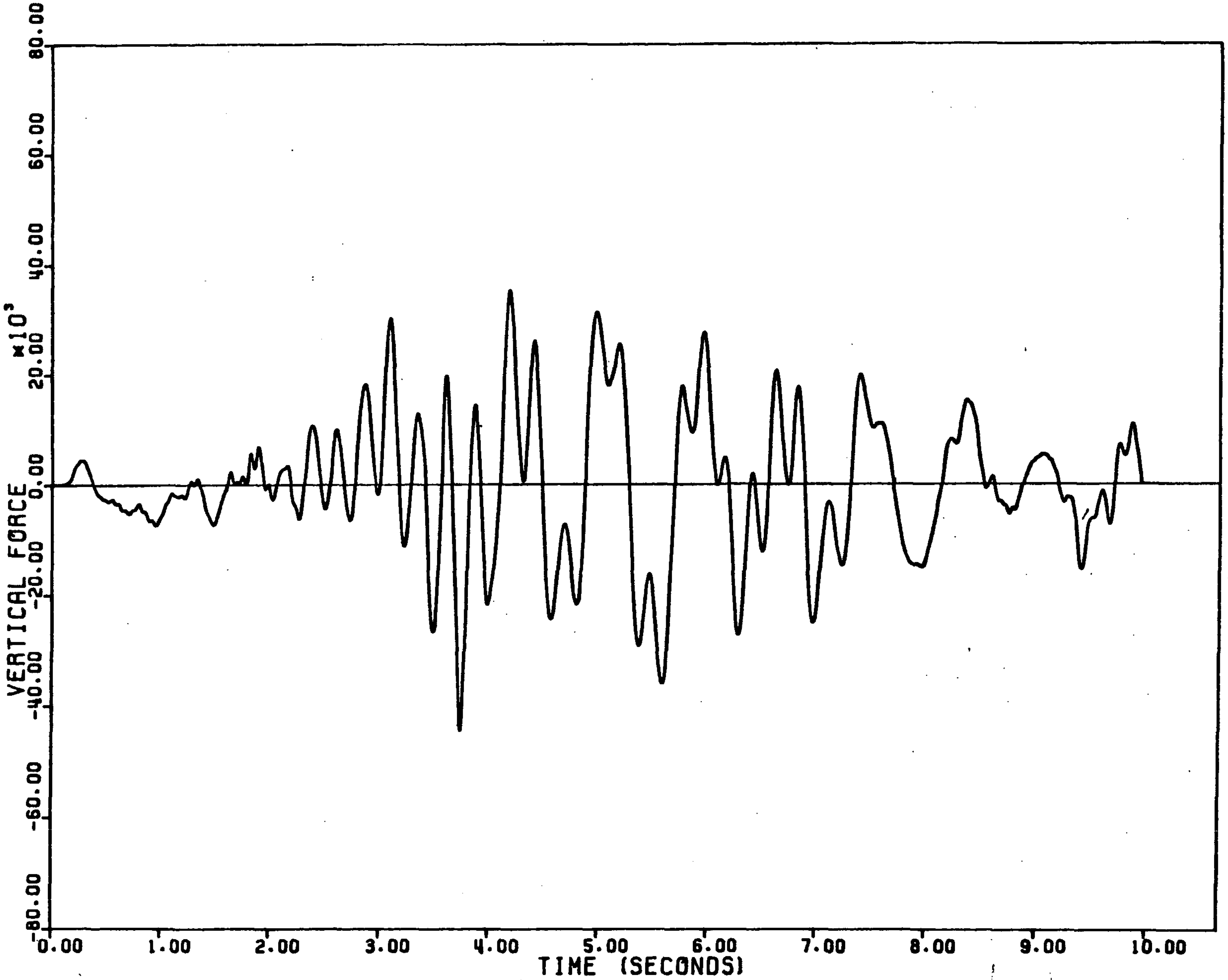


FIGURE C-2A. NUCLEAR STEAM SUPPLY SYSTEM, SHROUD SUPPORT, LOCATION 5-4
OBE LOADING - RECORD 504 - VERT. FORCE (LBS) .NPTS = 1995, DT = .005

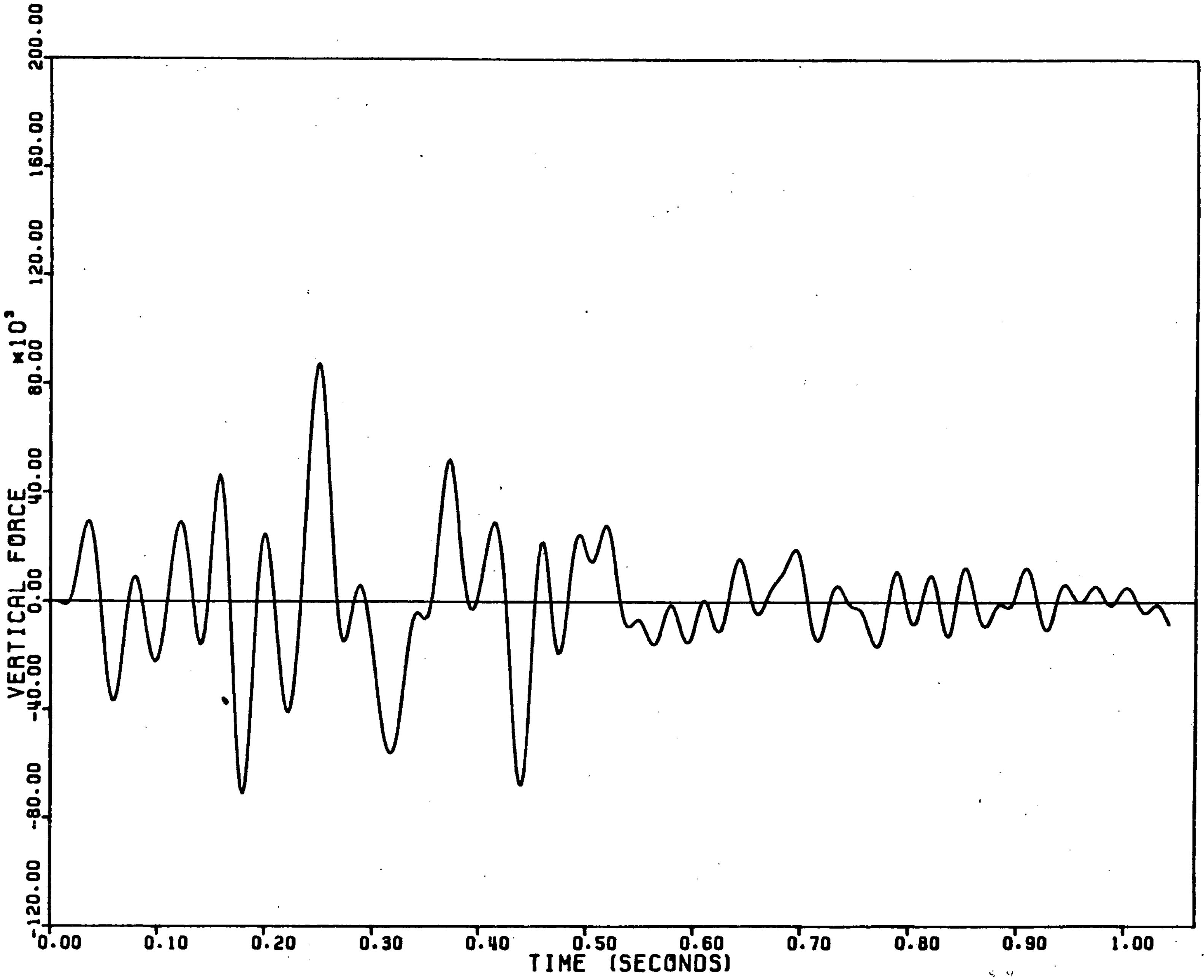


FIGURE C-2B. NUCLEAR STEAM SUPPLY SYSTEM, SHROUD SUPPORT, LOCATION 5-4
SRV-ALL LOADING - RECORD 534 - VERT. FORCE (LBS) ,NPTS = 522, DT = .002

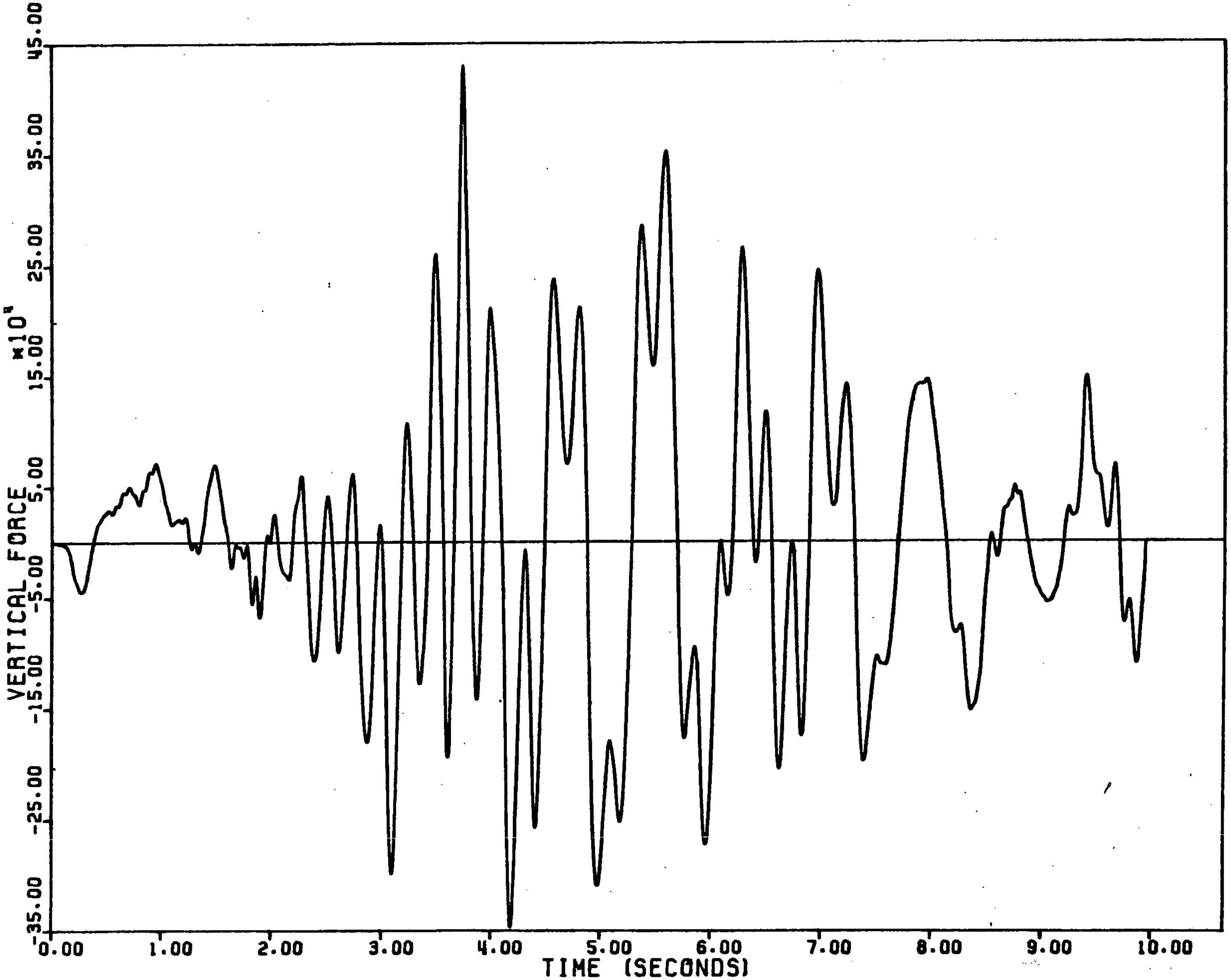


FIGURE C-3A. NUCLEAR STEAM SUPPLY SYSTEM, RPV SKIRT , LOCATION 5-5
OBE LOADING - RECORD 505 - VERT. FORCE (LBS) .NPTS = 1995, DT = .005

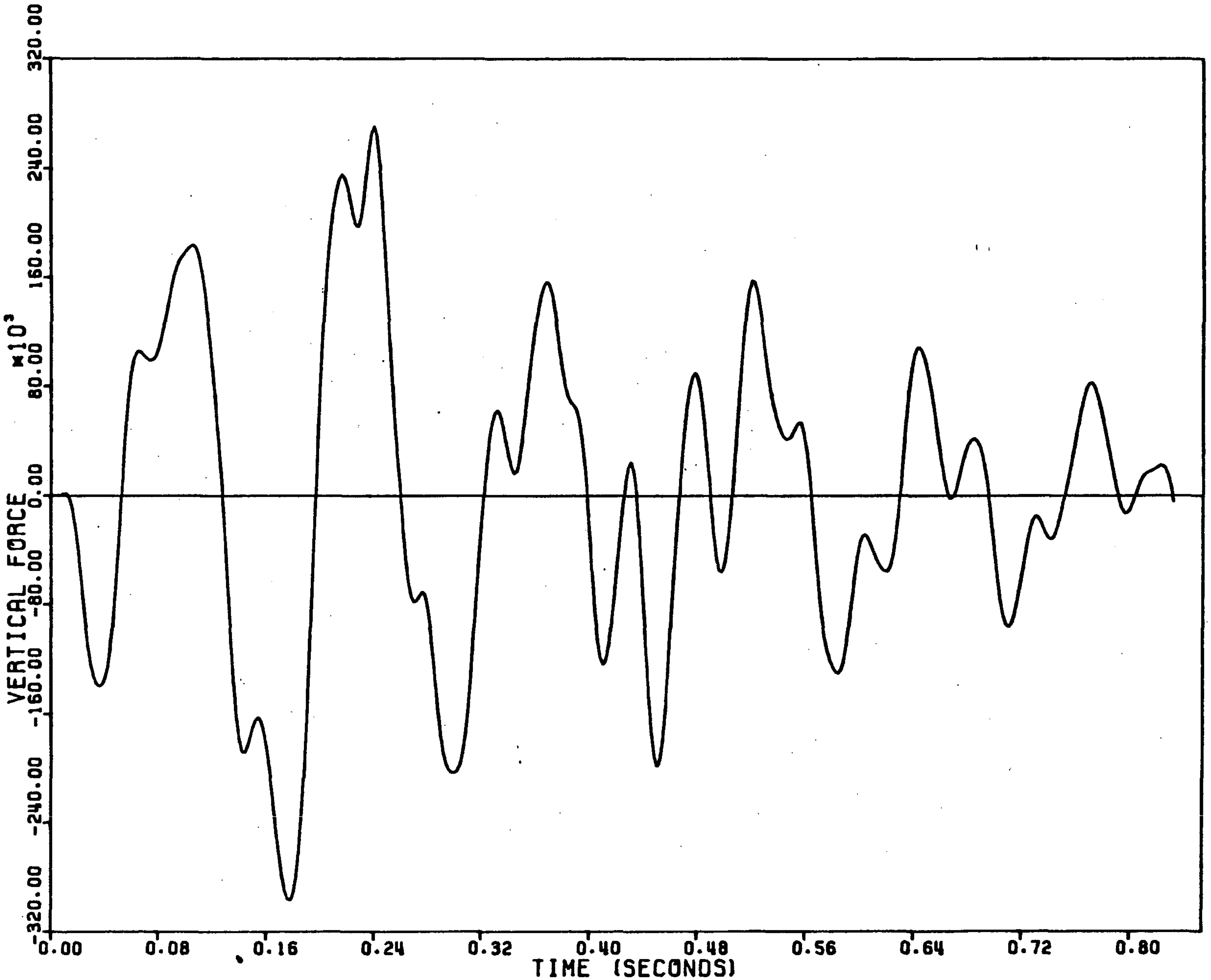


FIGURE C-3B. NUCLEAR STEAM SUPPLY SYSTEM, RPV SKIRT . LOCATION 5-5
SRV-ADS LOADING - RECORD 525 - VERT. FORCE (LBS) .NPTS = 417. DT = .002

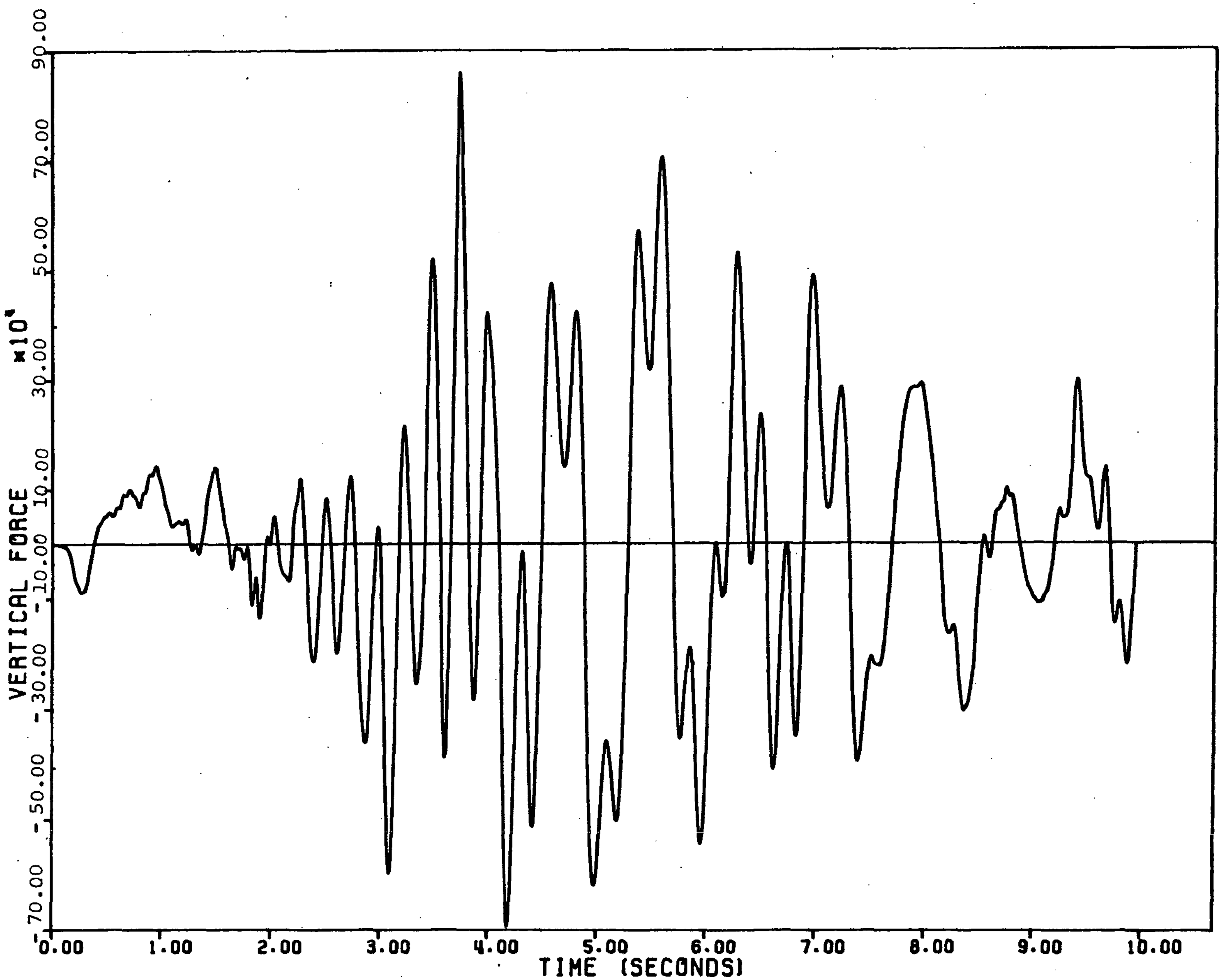


FIGURE C-4A. NUCLEAR STEAM SUPPLY SYSTEM, RPV SKIRT , LOCATION 5-5
SSE LOADING - RECORD 505 - VERT. FORCE (LBS) ,NPTS = 1995, DT = .005

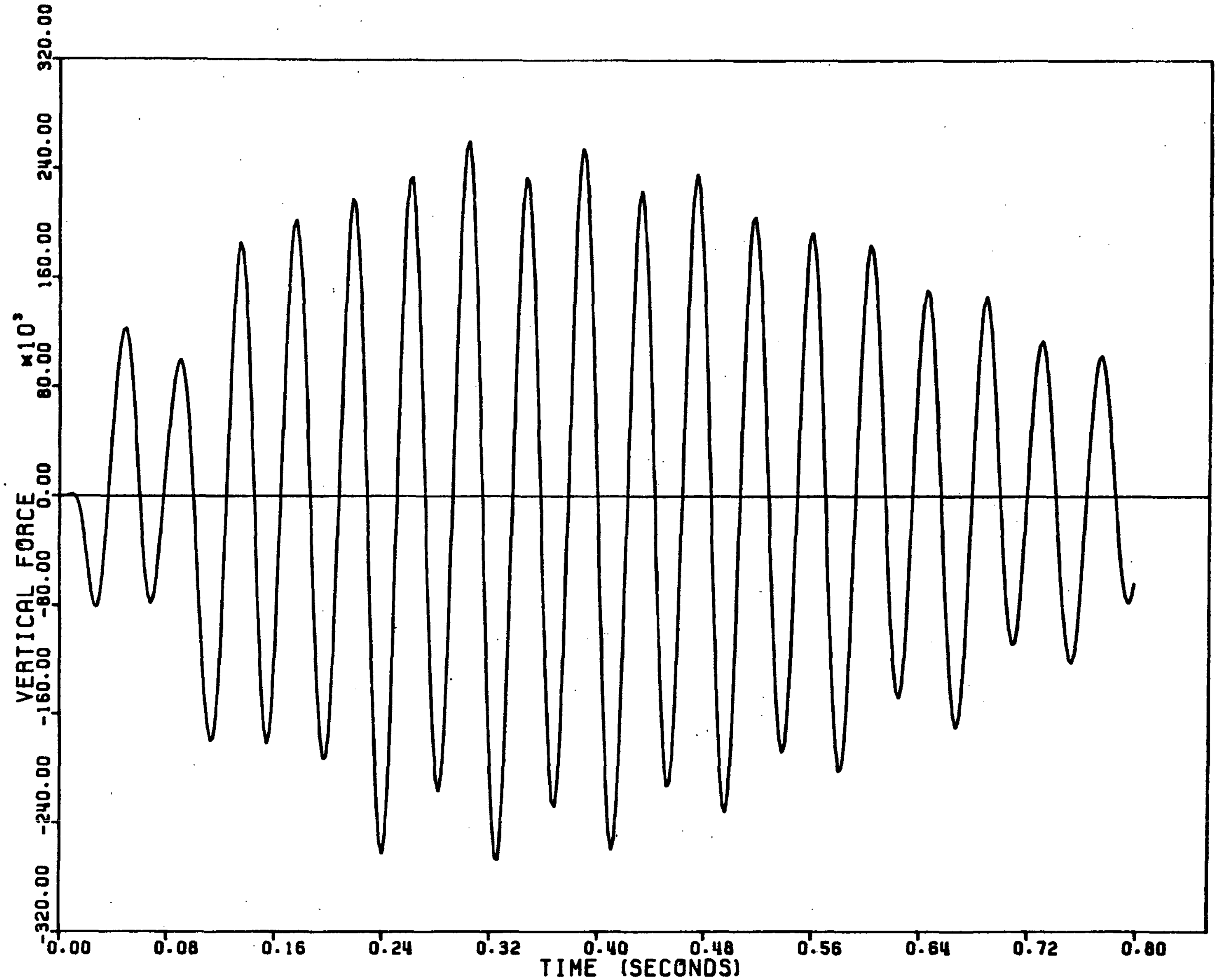


FIGURE C-4B. NUCLEAR STEAM SUPPLY SYSTEM, RPV SKIRT , LOCATION 5-5
SRV-1 LOADING - RECORD 515 - VERT. FORCE (LBS) .NPTS = 400, DT = .002

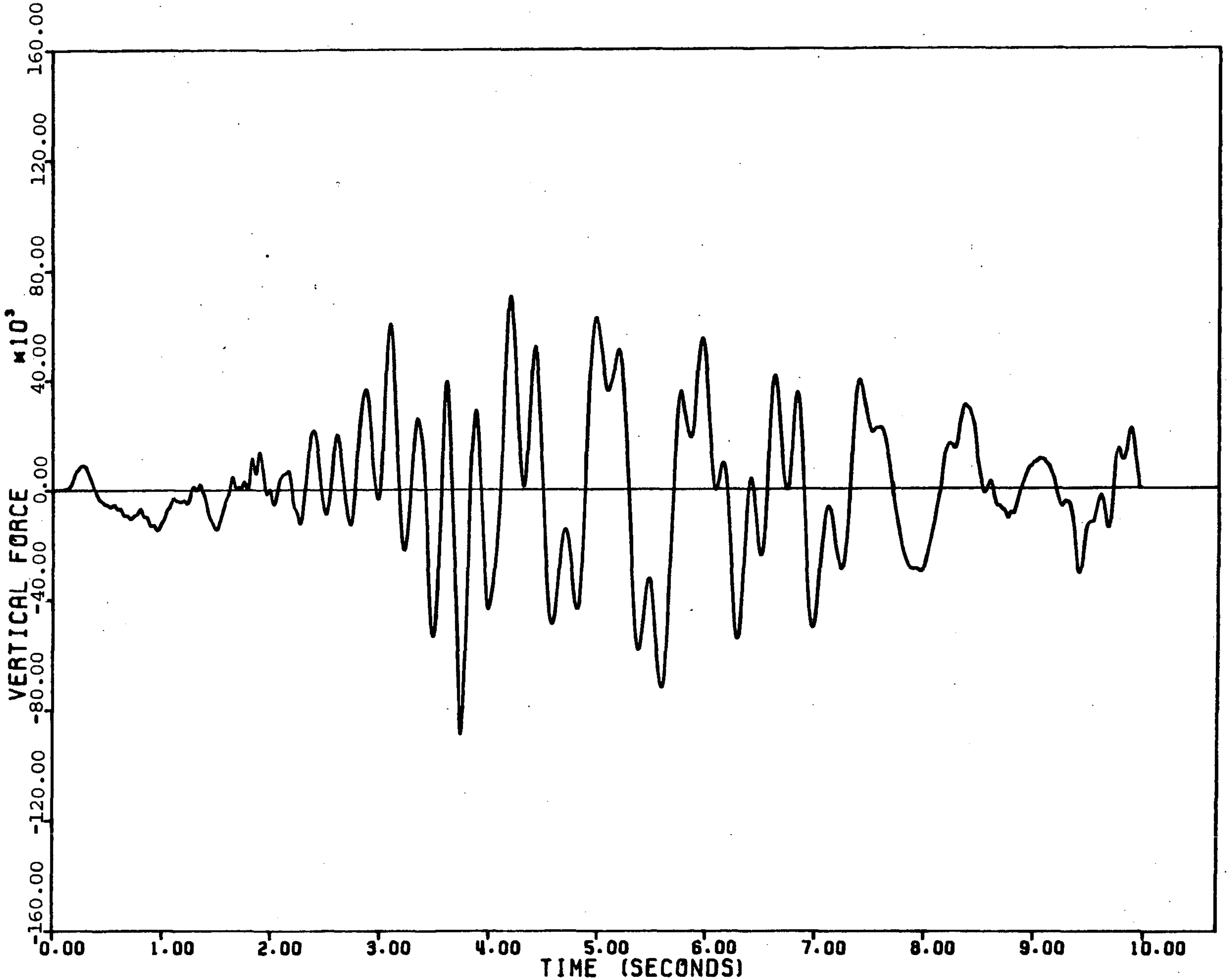


FIGURE C-5A. NUCLEAR STEAM SUPPLY SYSTEM, SHROUD SUPPORT, LOCATION 5-4
SSE LOADING - RECORD 504 - VERT. FORCE (LBS) .NPTS = 1995, DT = .005

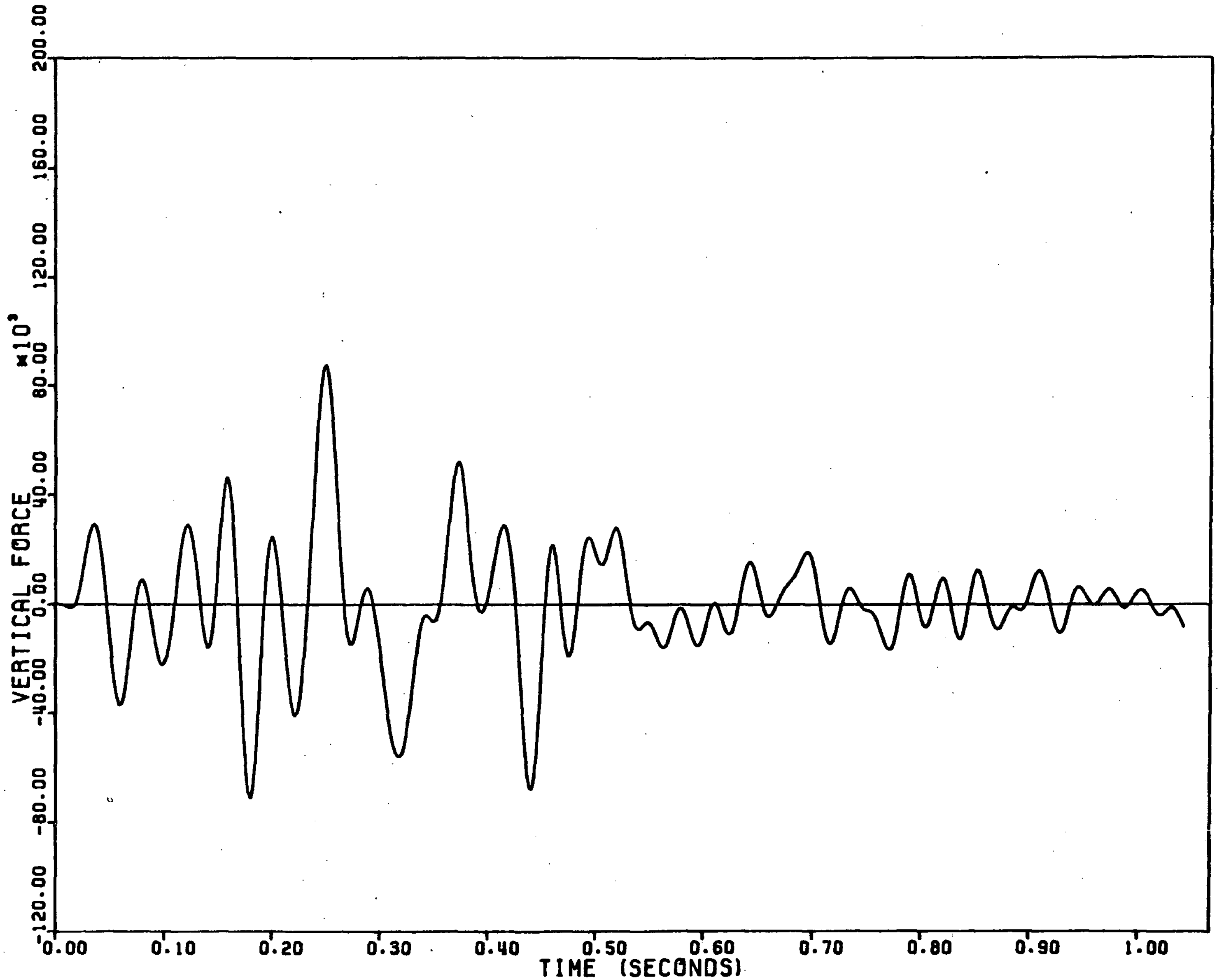


FIGURE C-5B. NUCLEAR STEAM SUPPLY SYSTEM, SHROUD SUPPORT, LOCATION 5-4
SRV-ALL LOADING - RECORD 534 - VERT. FORCE (LBS) ,NPTS = 522, DT = .002

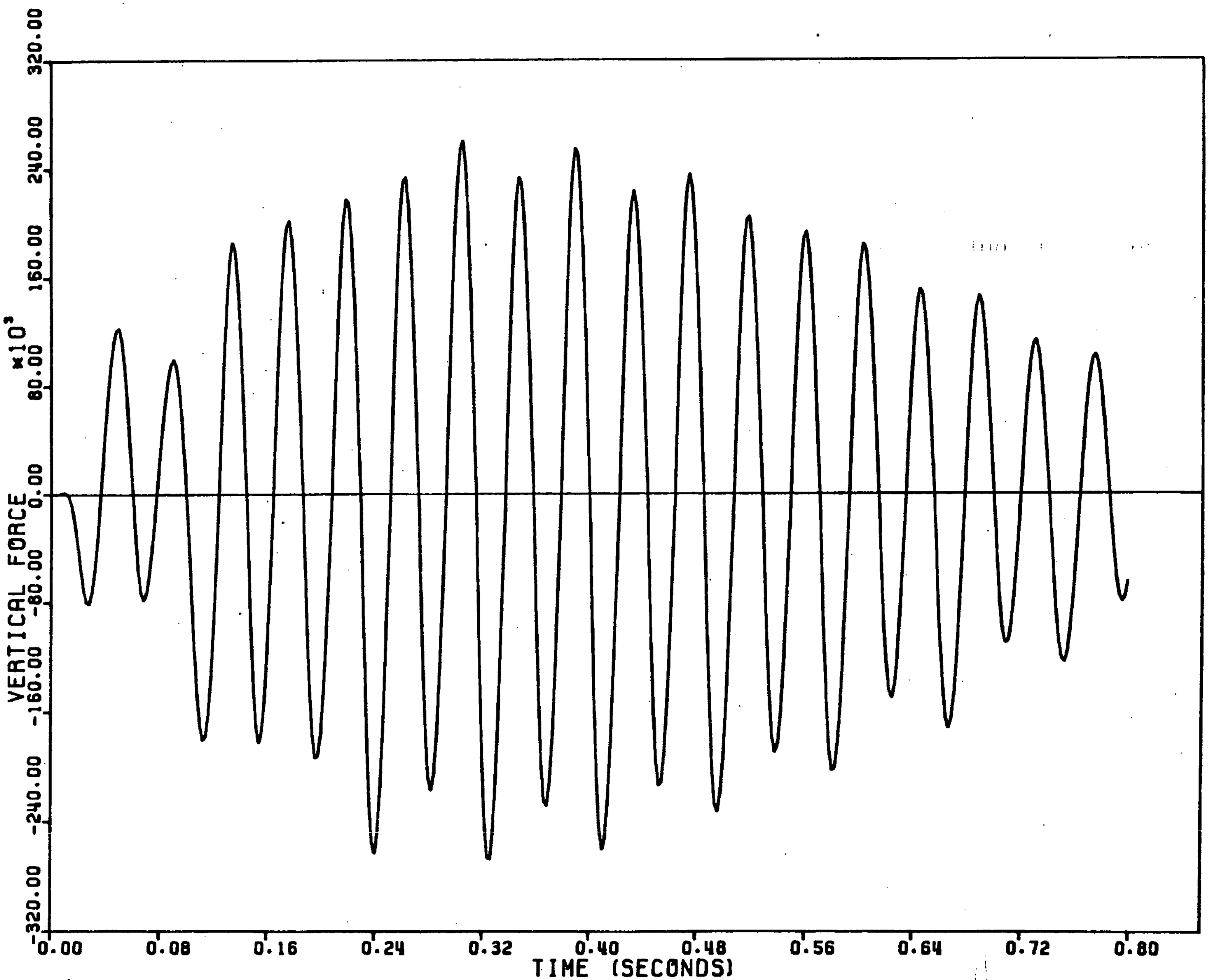


FIGURE C-6A. NUCLEAR STEAM SUPPLY SYSTEM, RPV SKIRT , LOCATION 5-5
SRV-1 LOADING - RECORD 515 -OOERT. FORCE (LBS) .NPTS = 400, DT = .002

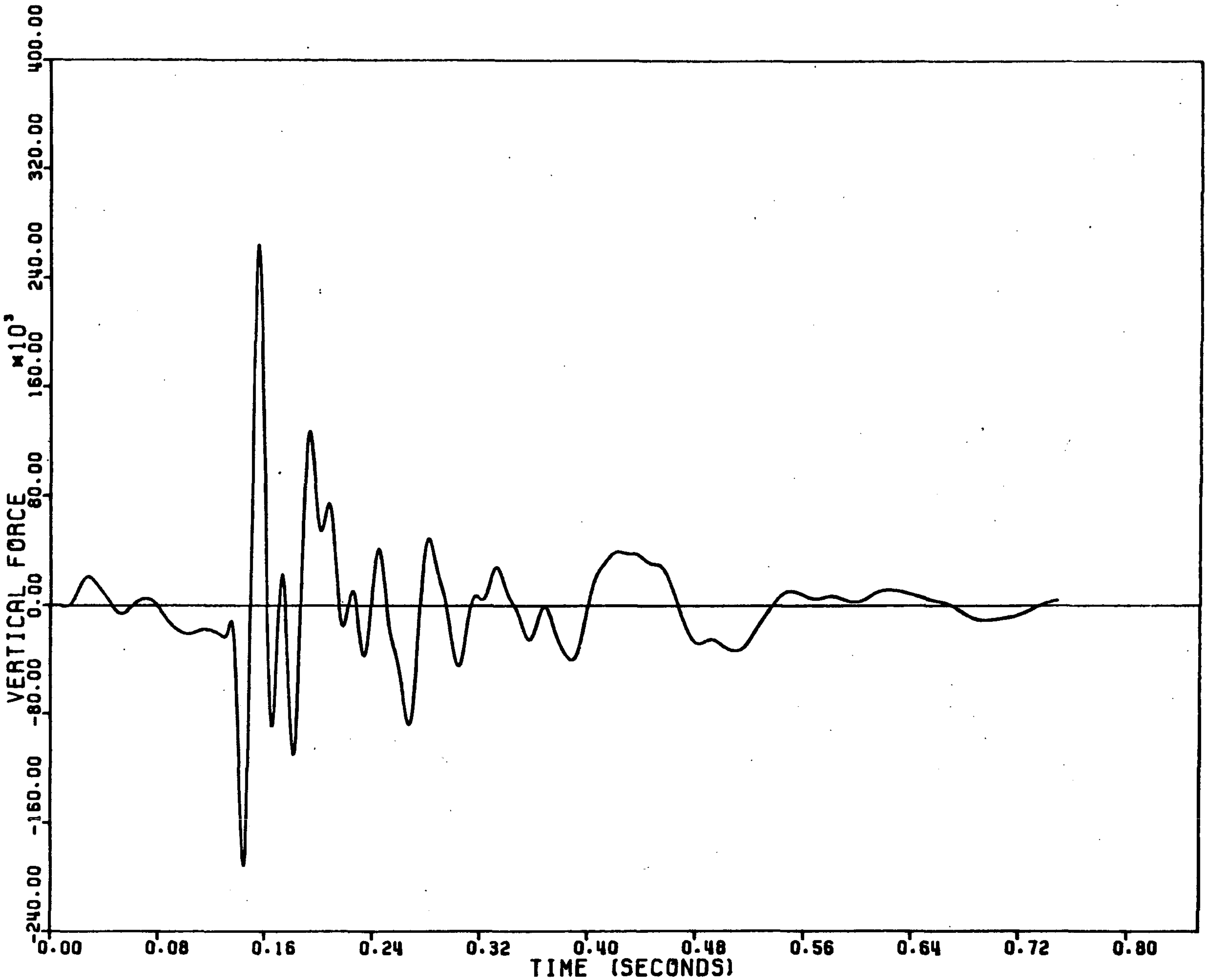


FIGURE C-6B. NUCLEAR STEAM SUPPLY SYSTEM, RPV SKIRT , LOCATION 5-5
CHUG LOADING - RECORD 545 - VERT. FORCE (LBS) ,NPTS = 749, DT = .001

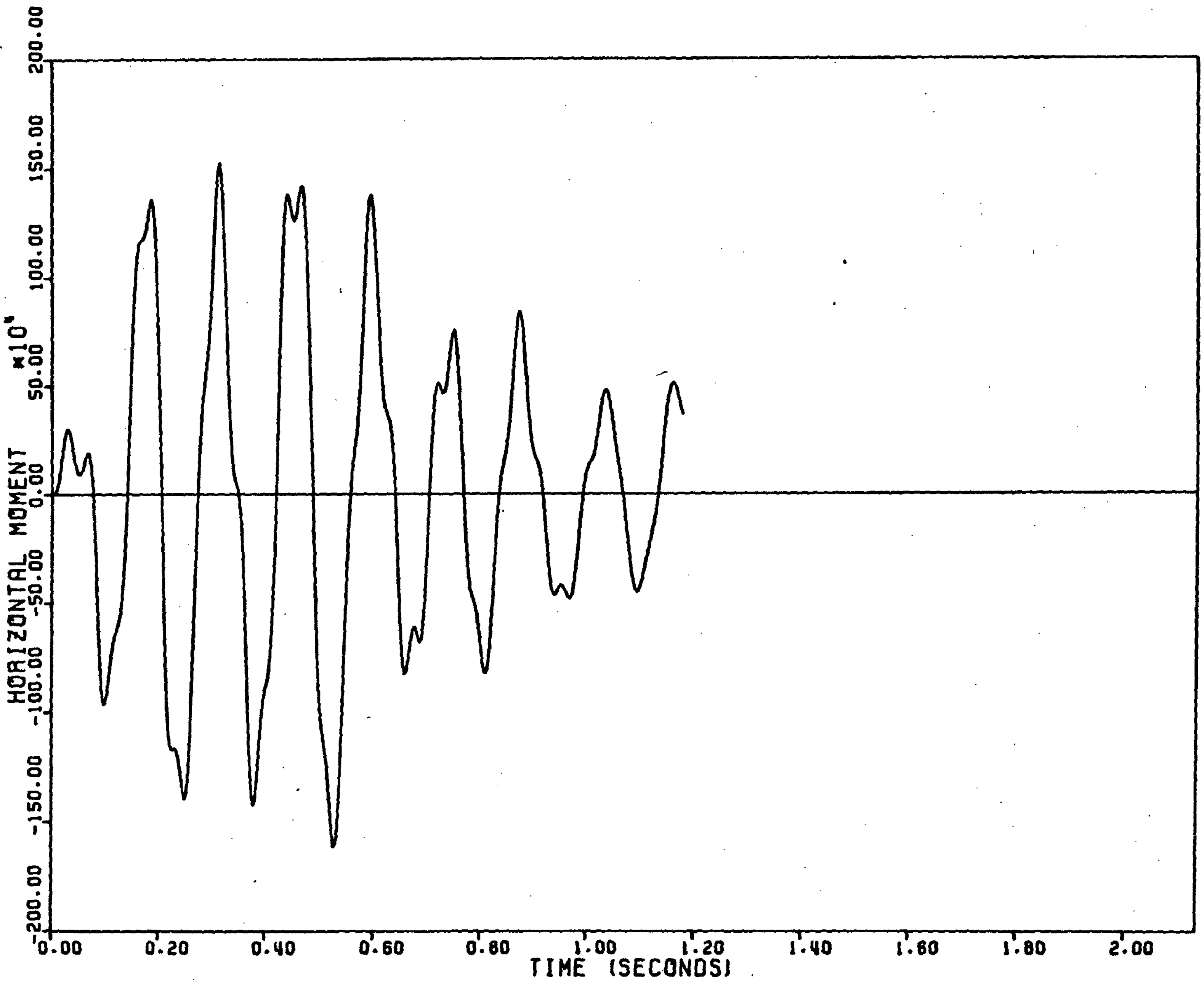


FIGURE C-7A. NUCLEAR STEAM SUPPLY SYSTEM, SHROUD SUPPORT LOCATION 4-4
SRV-1 LOADING - RECORD 613 - HORIZ.MOMENT (IN-LBS) ,NPTS = 393, DT = .003

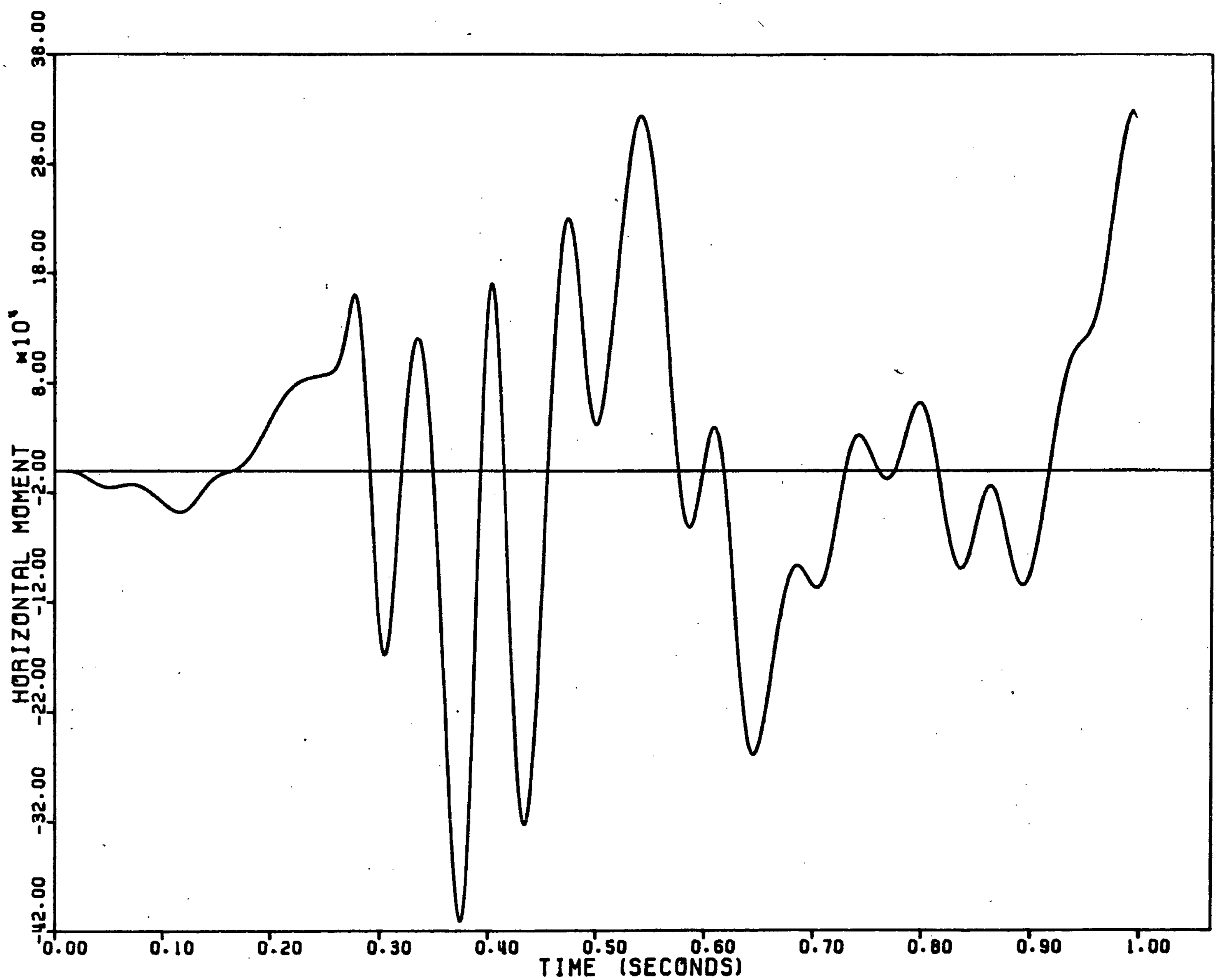


FIGURE C-7B. NUCLEAR STEAM SUPPLY SYSTEM, SHROUD SUPPORT LOCATION 4-4
CHUG12 LOADING - RECORD 643 - HORIZ.MOMENT (IN-LBS) .NPTS = 995. DT = .001

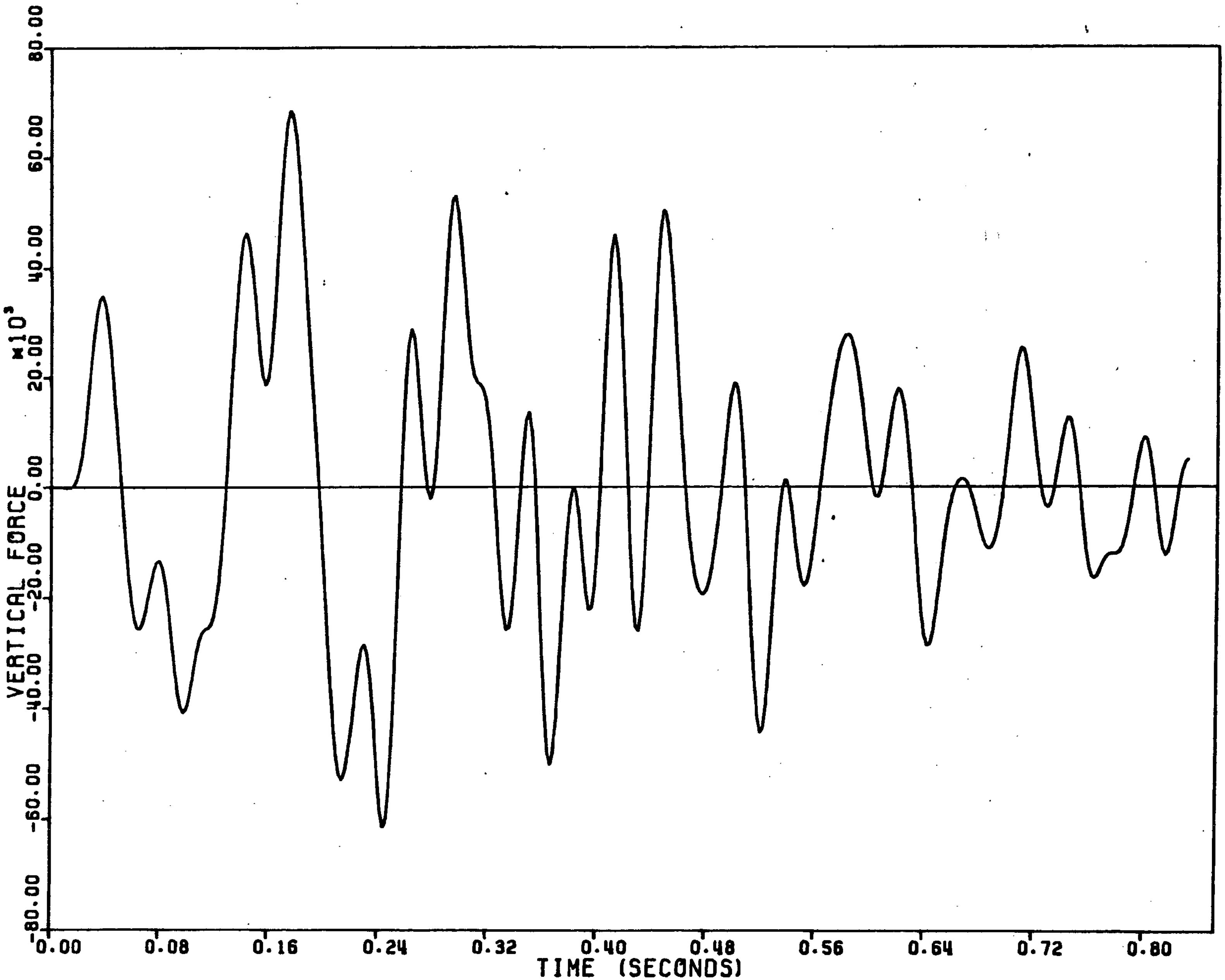


FIGURE C-8A. NUCLEAR STEAM SUPPLY SYSTEM, CORE PLATE , LOCATION 5-6
SRV-ADS LOADING - RECORD 526 - VERT. FORCE (LBS) ,NPTS = 417, DT = .002

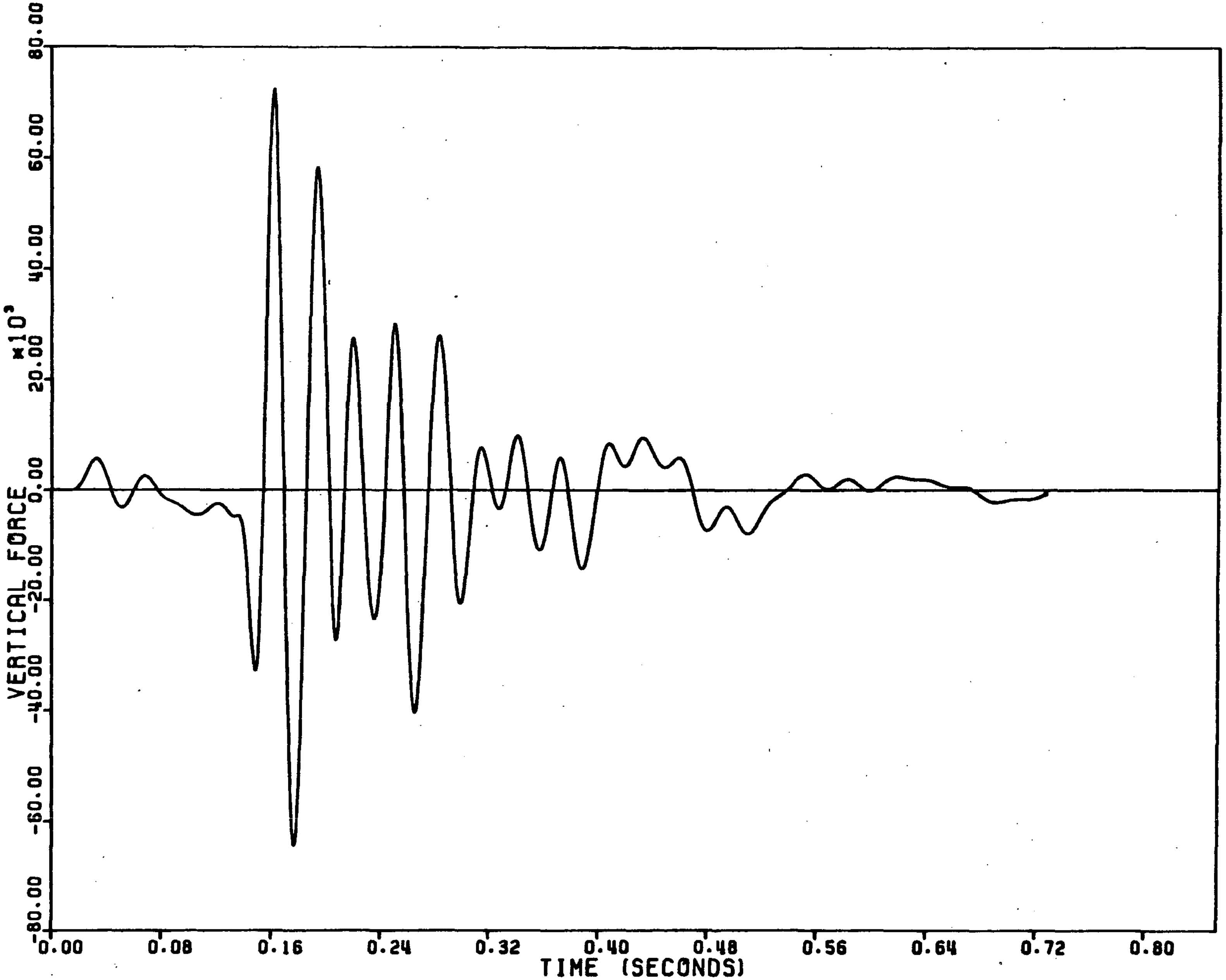


FIGURE C-8B. NUCLEAR STEAM SUPPLY SYSTEM, CORE PLATE , LOCATION 5-6
CHUG LOADING - RECORD 546 - VERT. FORCE (LBS) .NPTS = 749, DT = .001

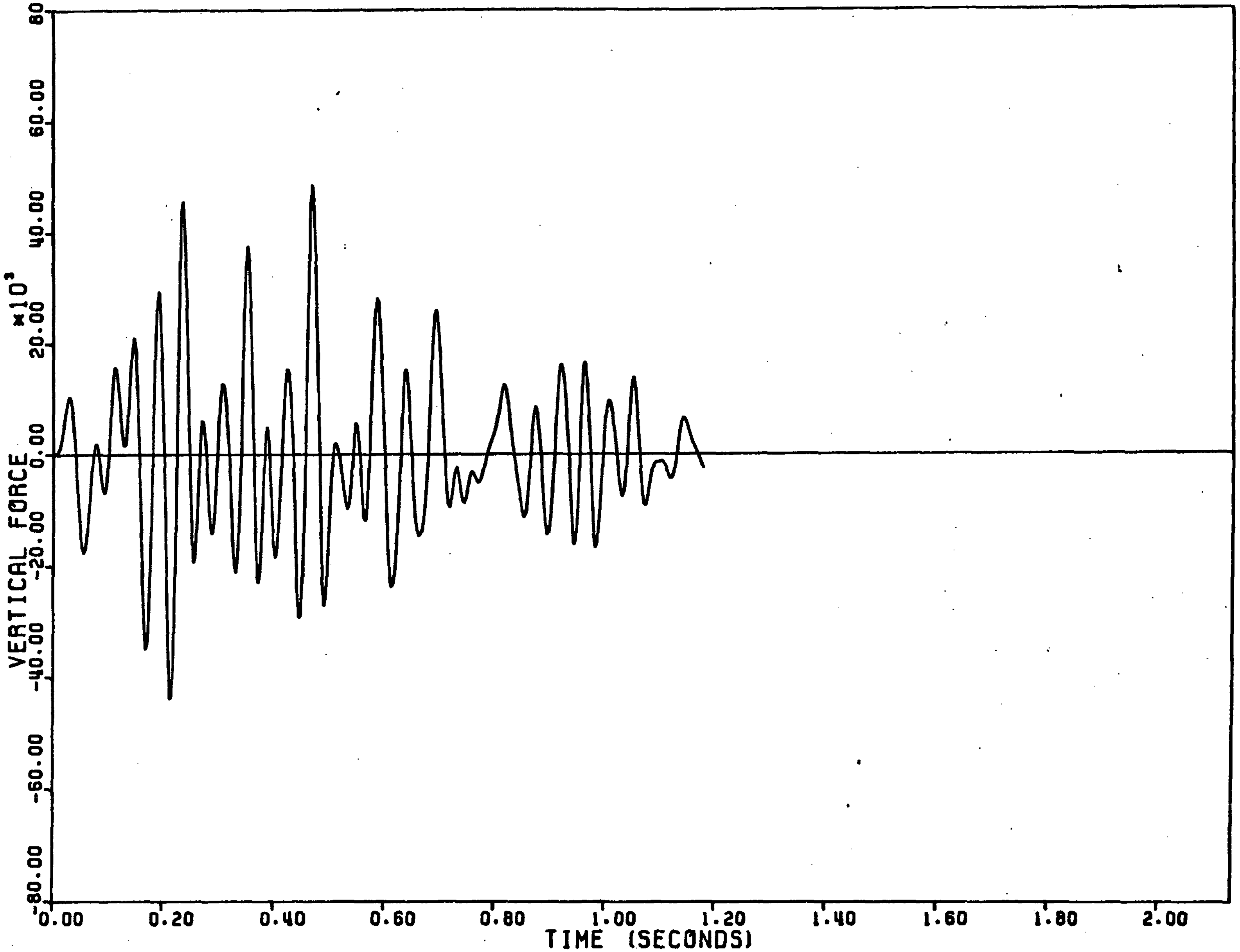


FIGURE C-9A. NUCLEAR STEAM SUPPLY SYSTEM, CORE PLATE LOCATION 4-3
SRV-ADS LOADING - RECORD 621 - VERT. FORCE (LBS) .NPTS = 393, DT = .003

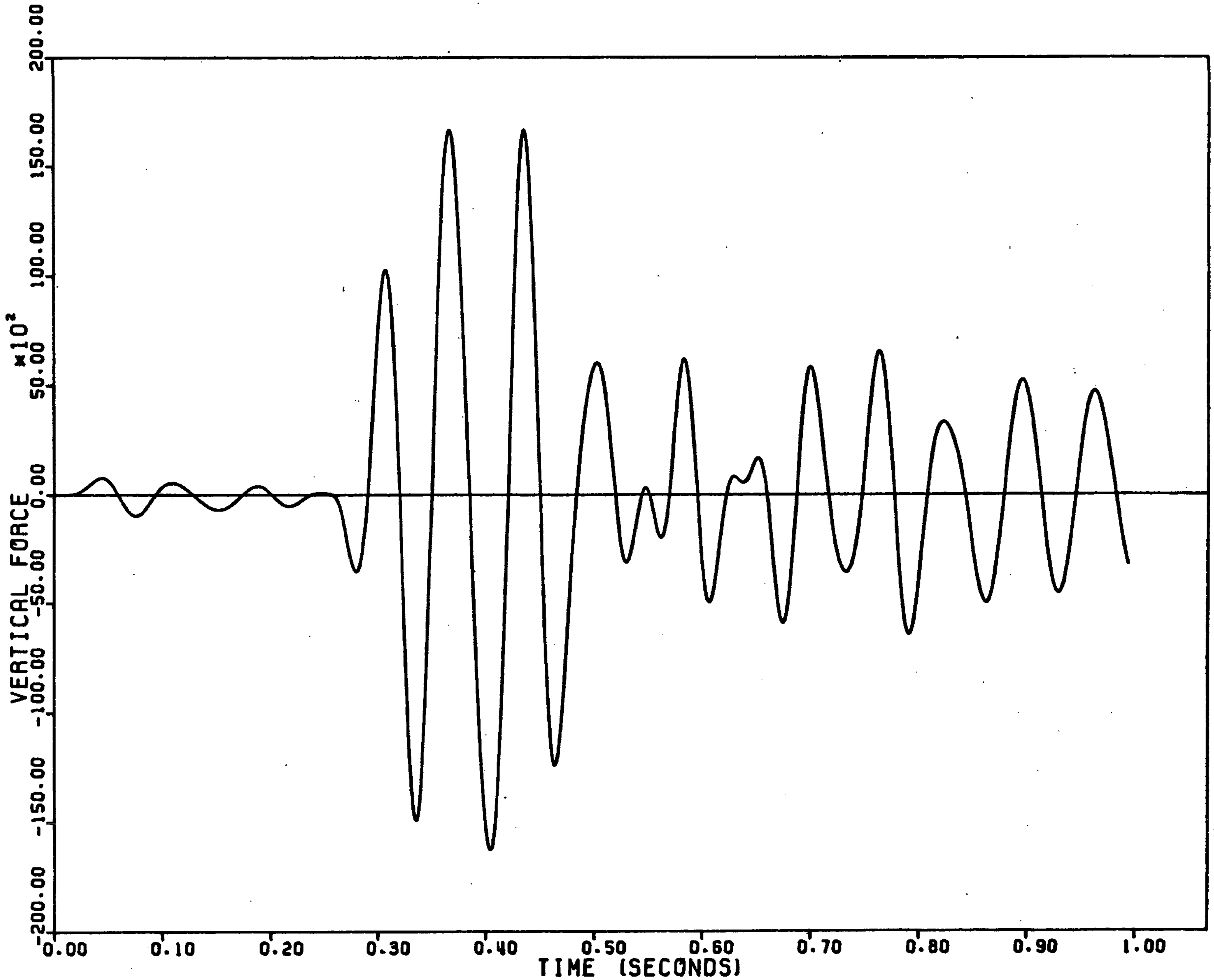


FIGURE C-9B. NUCLEAR STEAM SUPPLY SYSTEM, CORE PLATE LOCATION 4-3
CHUG10 LOADING - RECORD 641 - VERT. FORCE (LBS) ,NPTS = 995, DT = .001

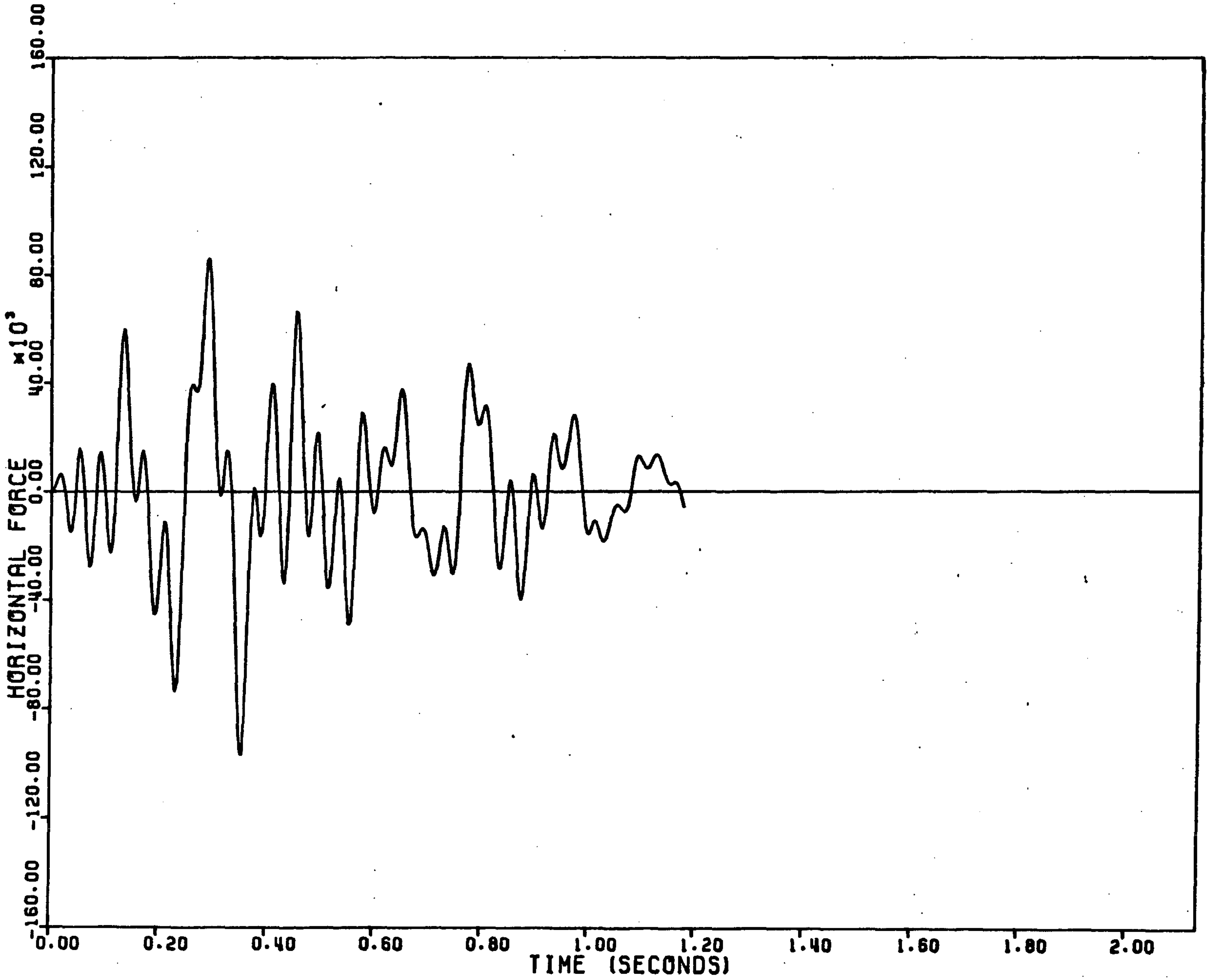


FIGURE C-10A. NUCLEAR STEAM SUPPLY SYSTEM, RPV SKIRT LOCATION 4-2
SRV-ADS LOADING - RECORD 622 - HORIZ. FORCE (LBS) .NPTS = 393, DT = .003

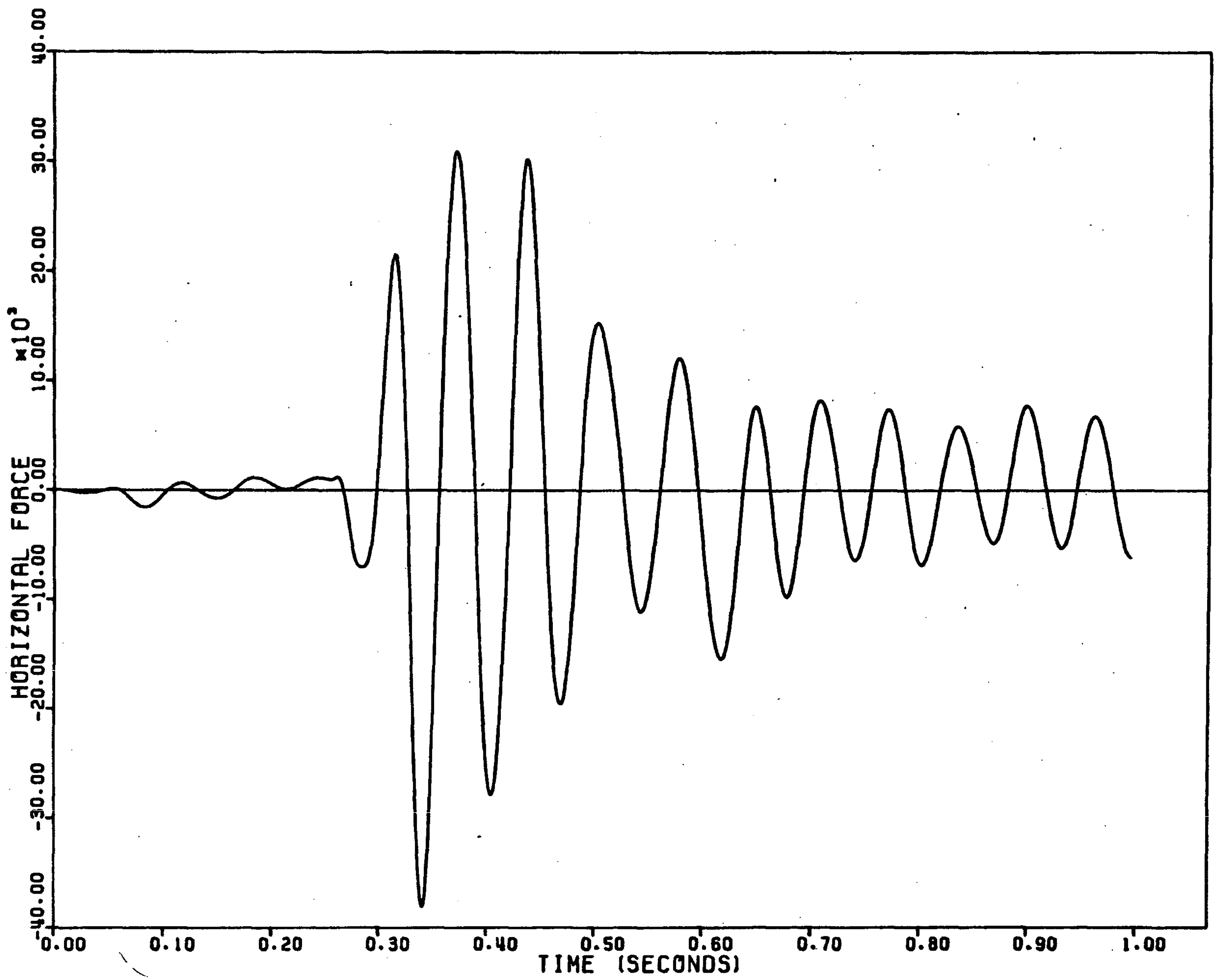


FIGURE C-10B. NUCLEAR STEAM SUPPLY SYSTEM, RPV SKIRT LOCATION 4-2
CHUG10 LOADING - RECORD 642 - HORIZ. FORCE (LBS) ,NPTS = 995, DT = .001

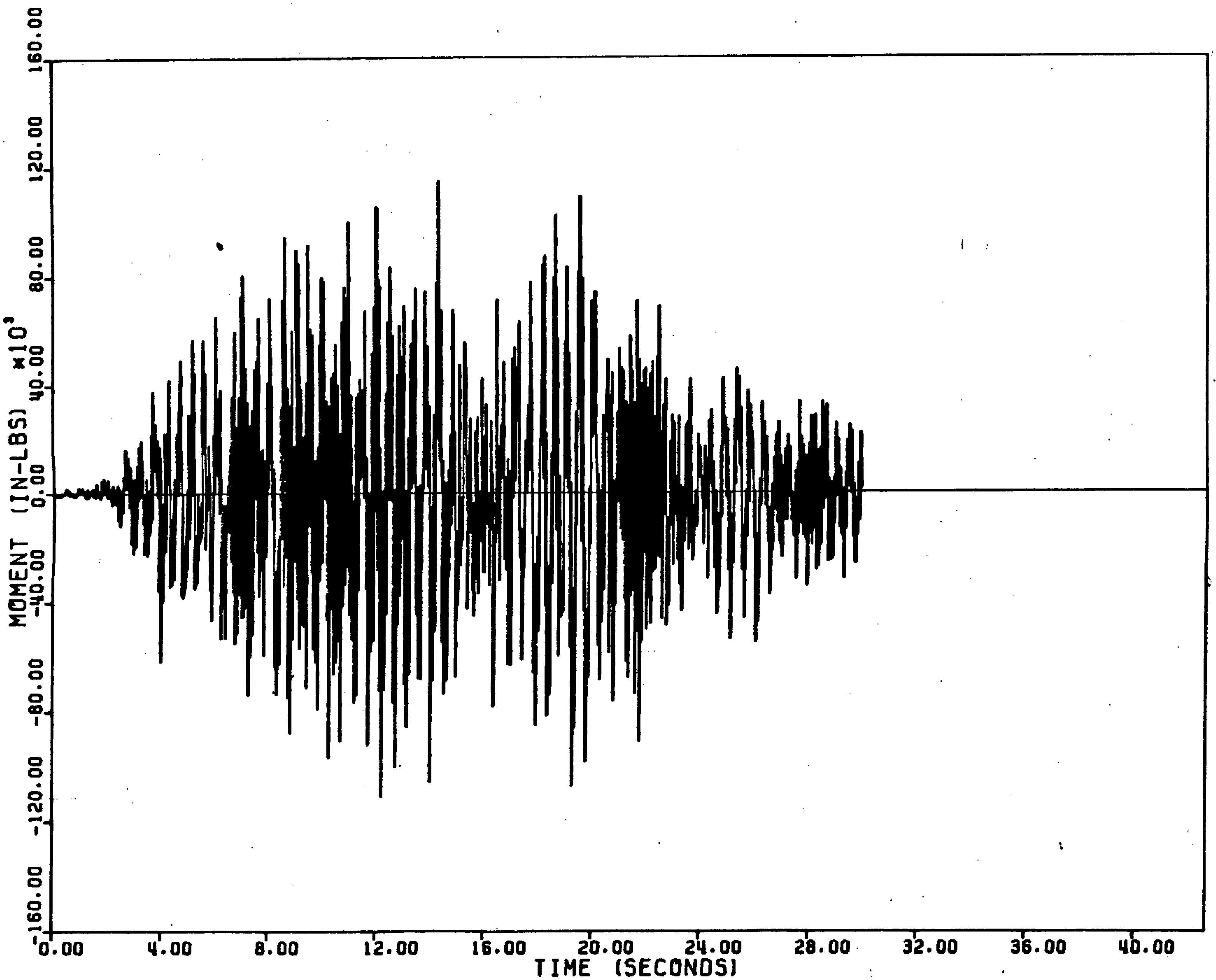


FIGURE C-11A. NSSS MAIN STEAM PIPING MSIV INLET , LOCATION 6-4
OBE LOADING - RECORD 804 - MOMENT (IN-LBS) .NPTS = 4989. DT = .006

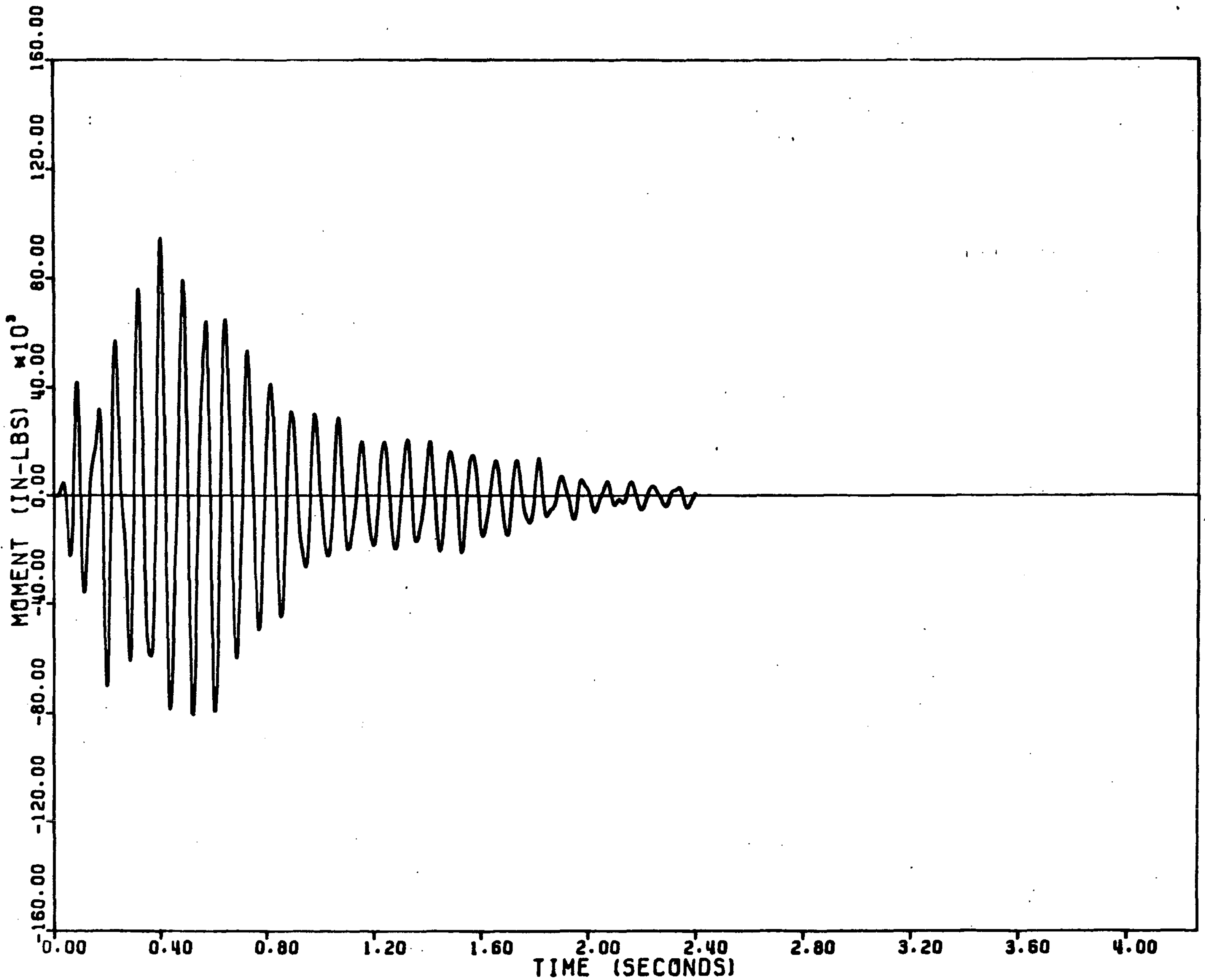


FIGURE C-11B. NSSS MAIN STEAM PIPING MSIV INLET , LOCATION 6-4
SRV-1 LOADING - RECORD 814 - MOMENT (IN-LBS) ,NPTS = 2393, DT = .001

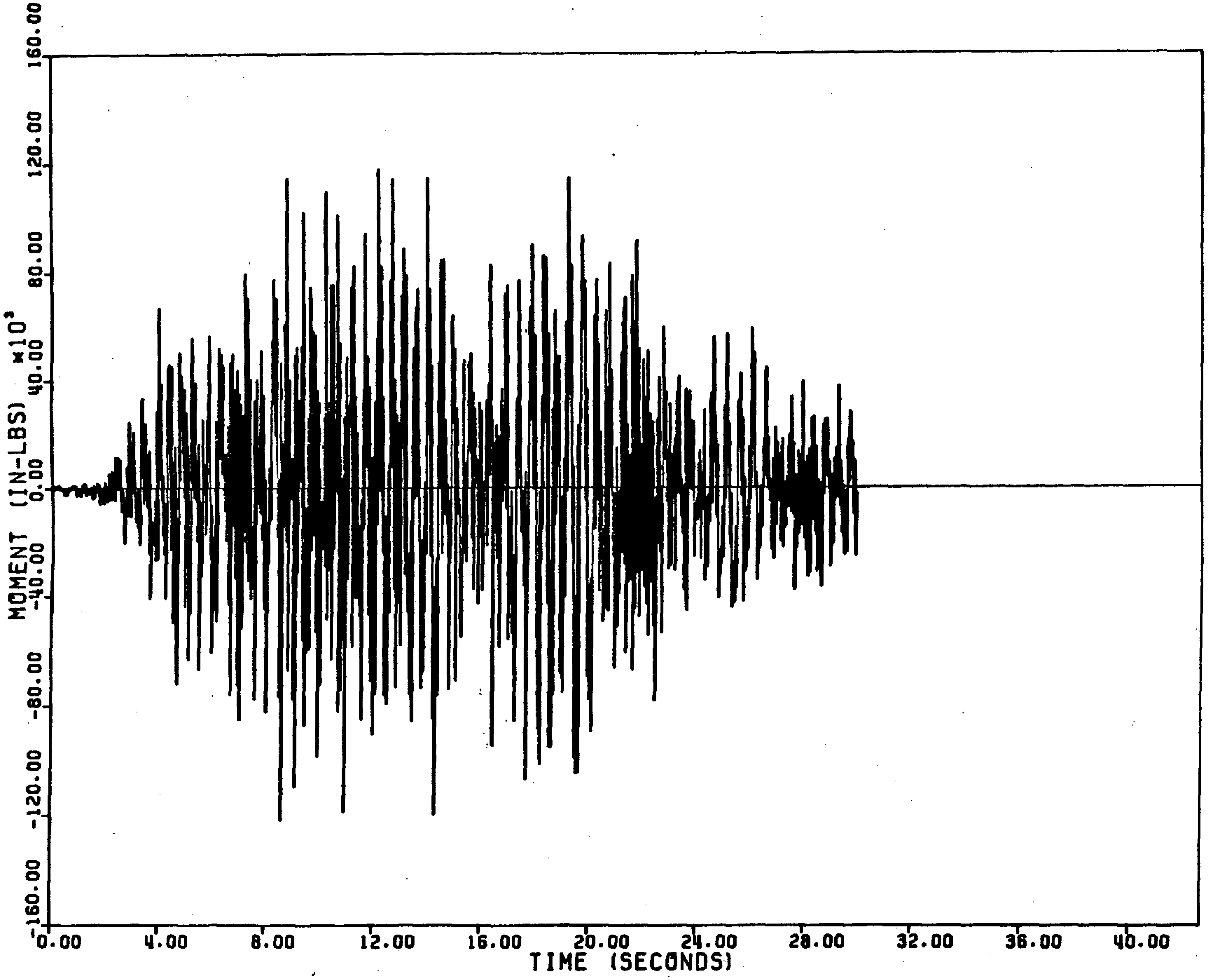


FIGURE C-12A. NSSS MAIN STEAM PIPING ELBOW ,LOCATION 6-5
OBE LOADING - RECORD 805 - MOMENT (IN-LBS) ,NPTS = 4989, DT = .006

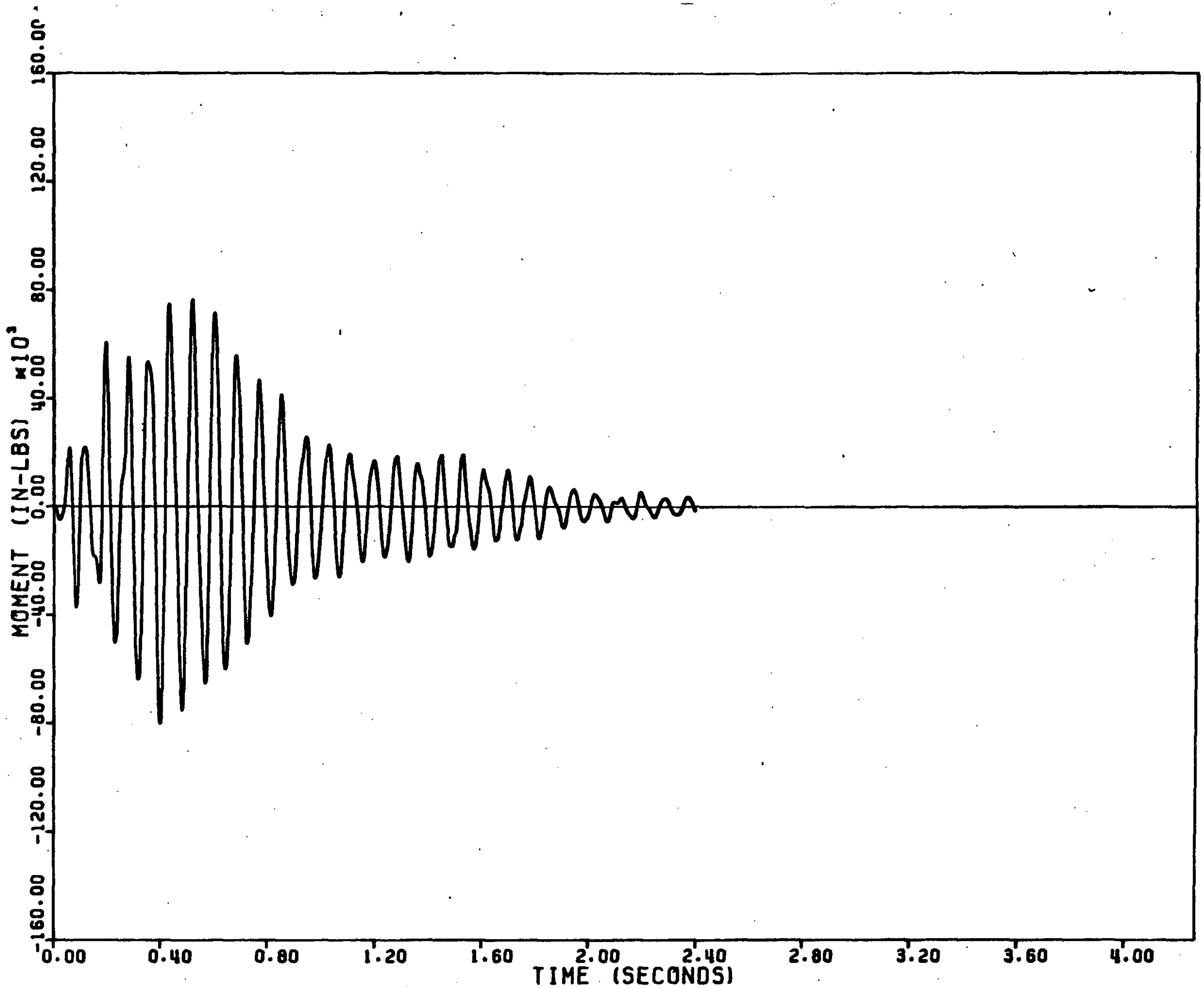


FIGURE C-12B. NSSS MAIN STEAM PIPING ELBOW ,LOCATION 6-5
SRV-1 LOADING - RECORD 815 - MOMENT (IN-LBS) ,NPTS = 2393, DT = .001

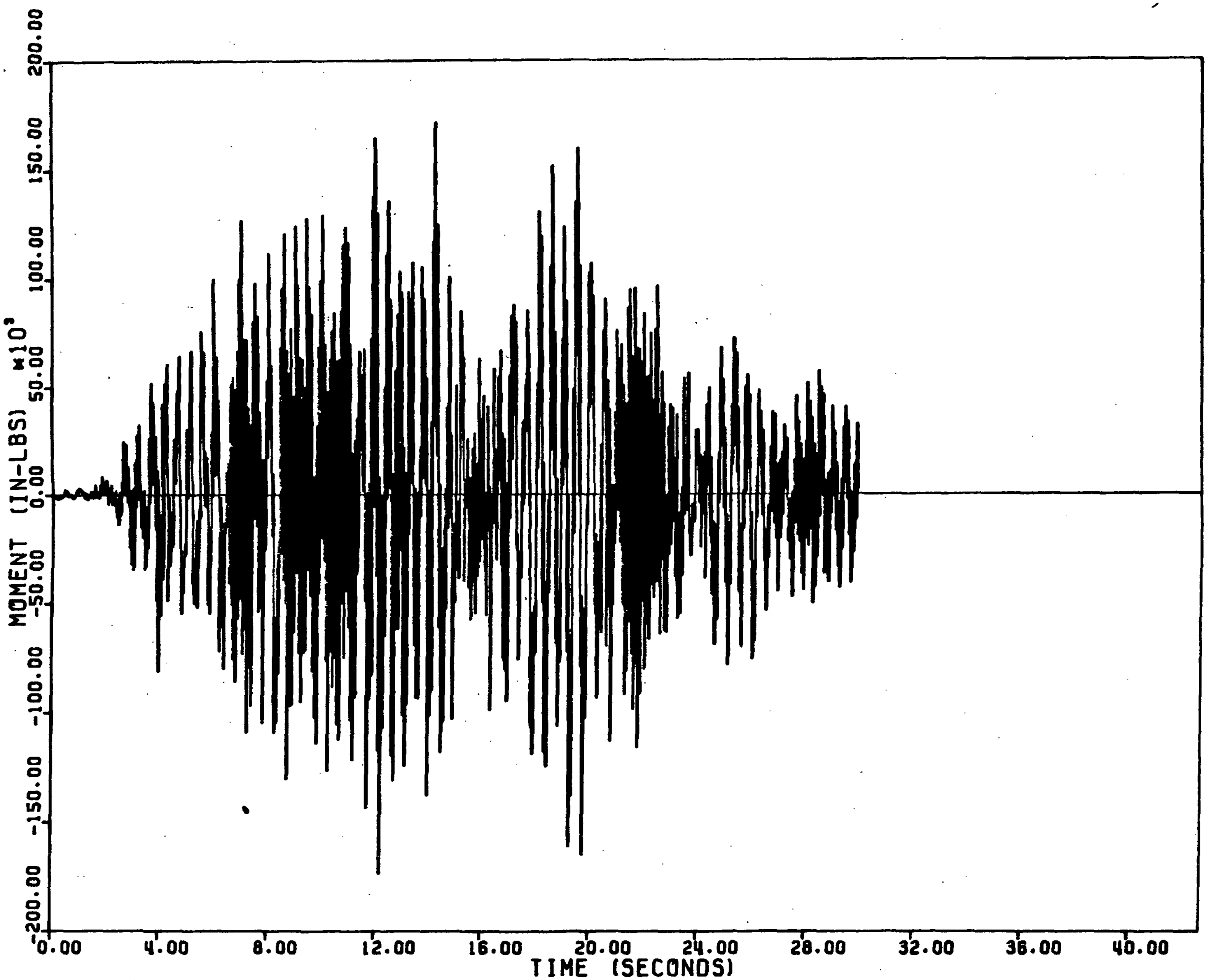


FIGURE C-13A. NSSS MAIN STEAM PIPING ELBOW ,LOCATION 6-7
OBE LOADING - RECORD 807 - MOMENT (IN-LBS) ,NPTS = 4989, DT = .006

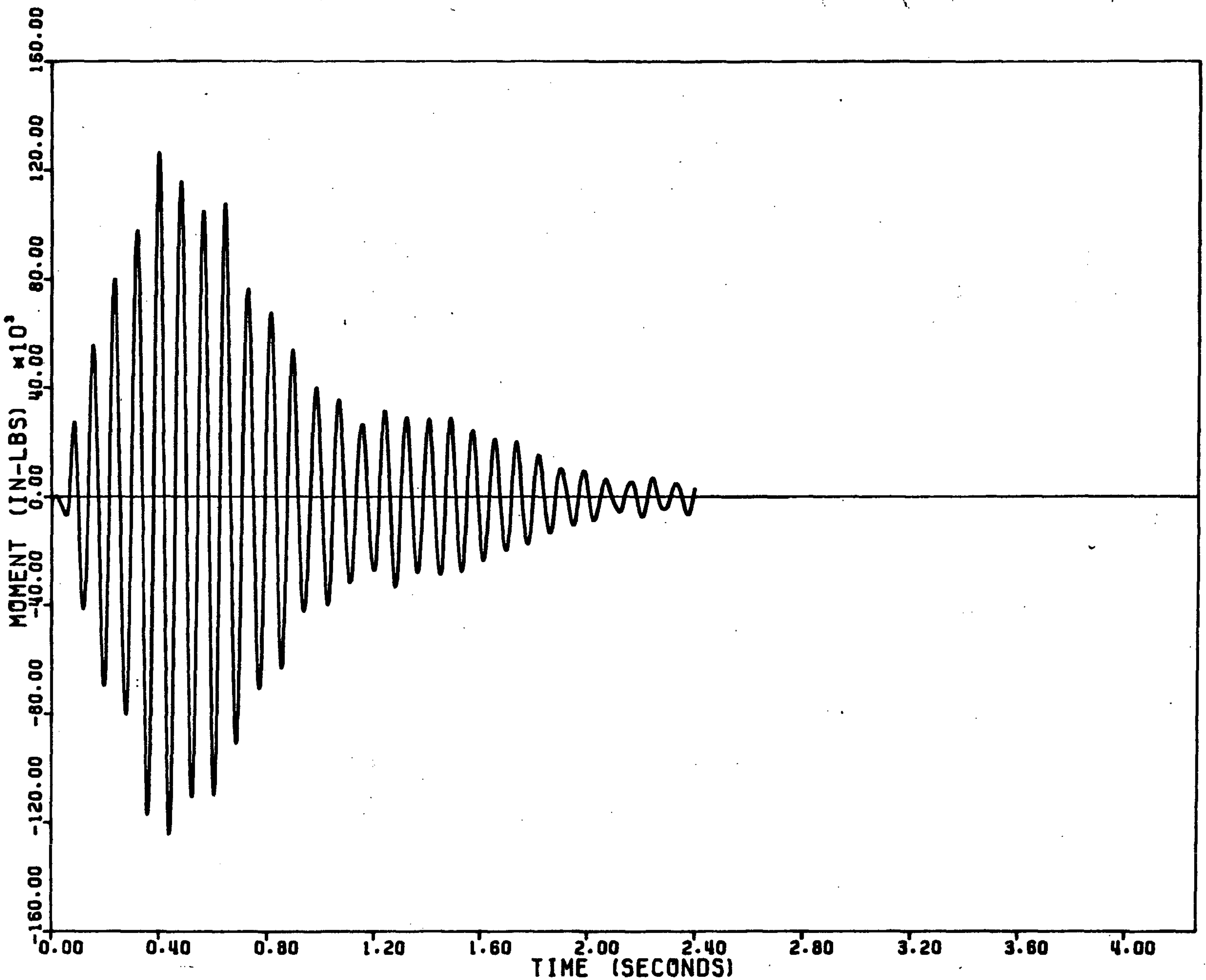


FIGURE C-13B. NSSS MAIN STEAM PIPING ELBOW ,LOCATION 6-7
SRV-1 LOADING - RECORD 817 - MOMENT (IN-LBS) ,NPTS = 2393, DT = .001

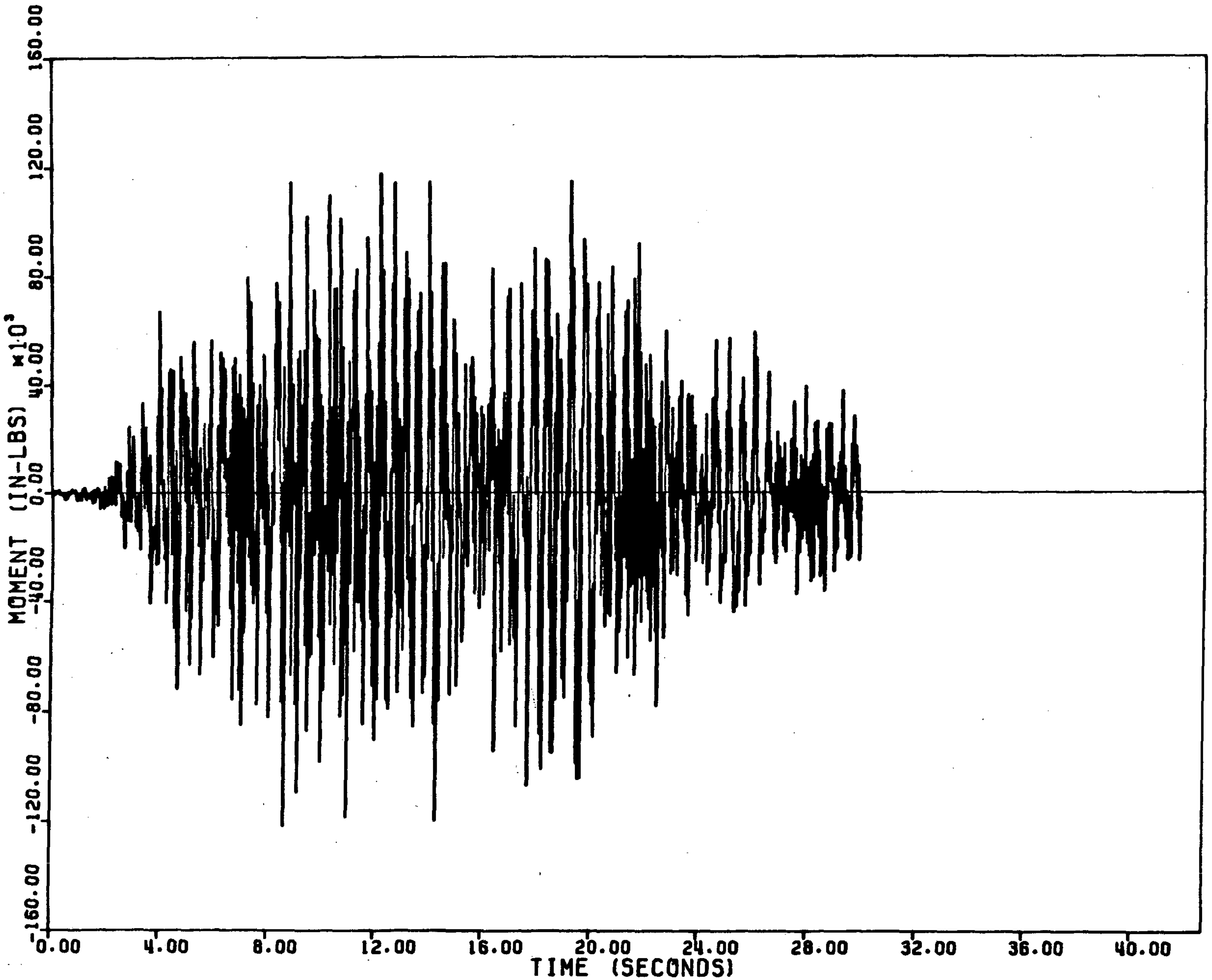


FIGURE C-14A. NSSS MAIN STEAM PIPING ELBOW ,LOCATION 6-5
OBE LOADING - RECORD 805 - MOMENT (IN-LBS) ,NPTS = 4989, DT = .006

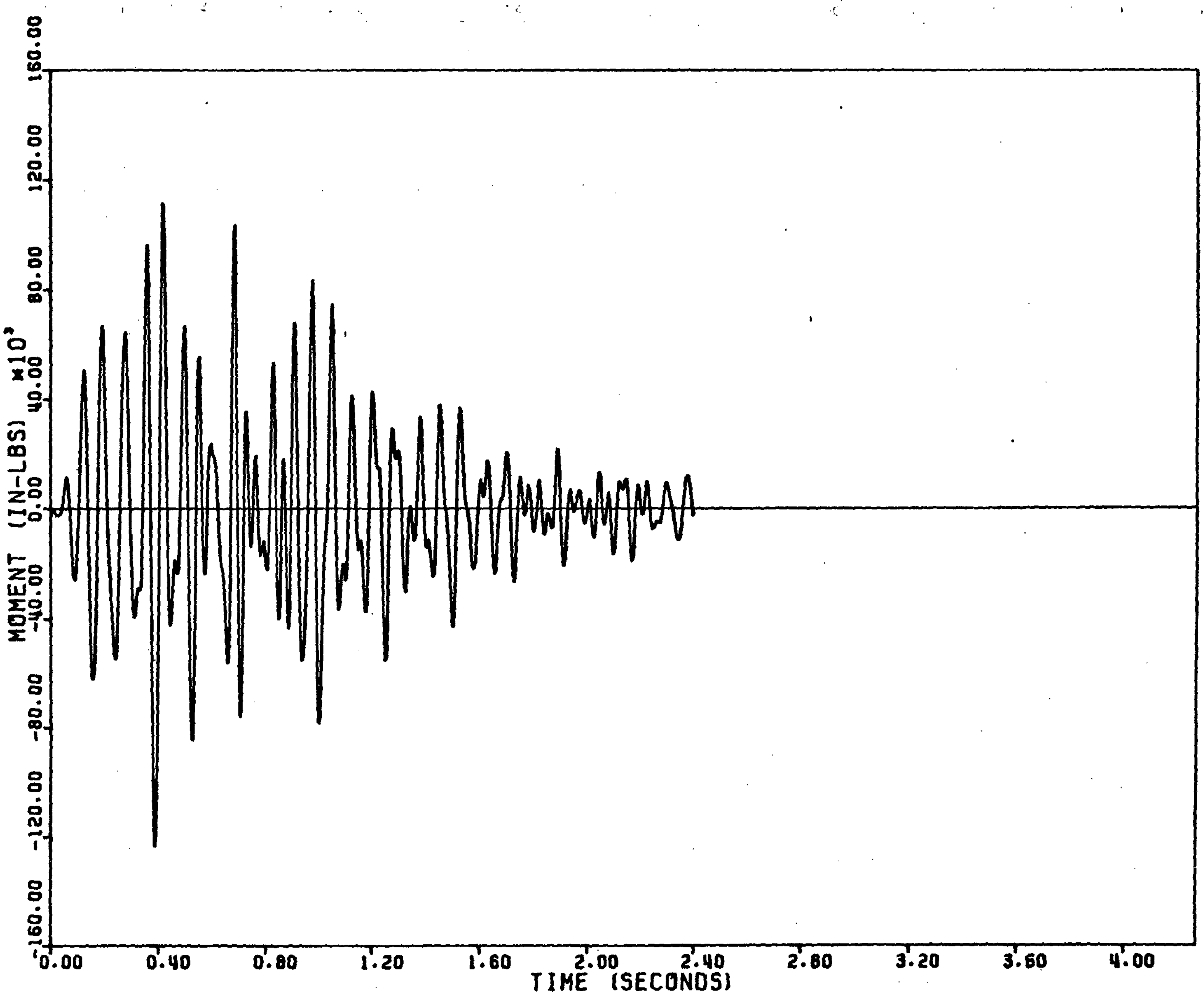


FIGURE C-14B. NSSS MAIN STEAM PIPING ELBOW ,LOCATION 6-5
SAV-ALL LOADING - RECORD 835 - MOMENT (IN-LBS) ,NPTS = 799, DT = .003

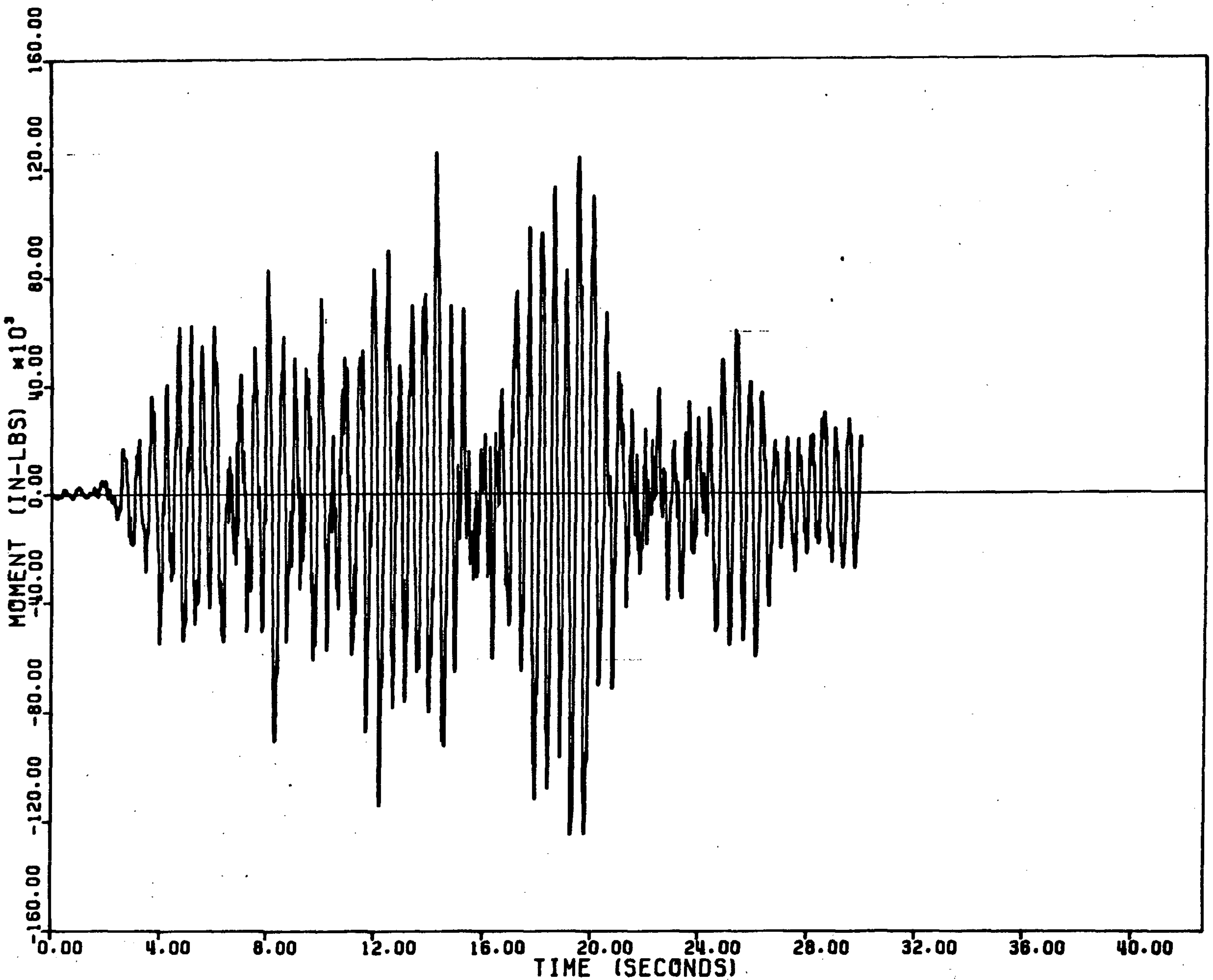


FIGURE C-15A. NSSS MAIN STEAM PIPING PIPE ELEMENT ,LOCATION 6-6
OBE LOADING - RECORD 806 - MOMENT (IN-LBS) ,NPTS = 4989. DT = .006

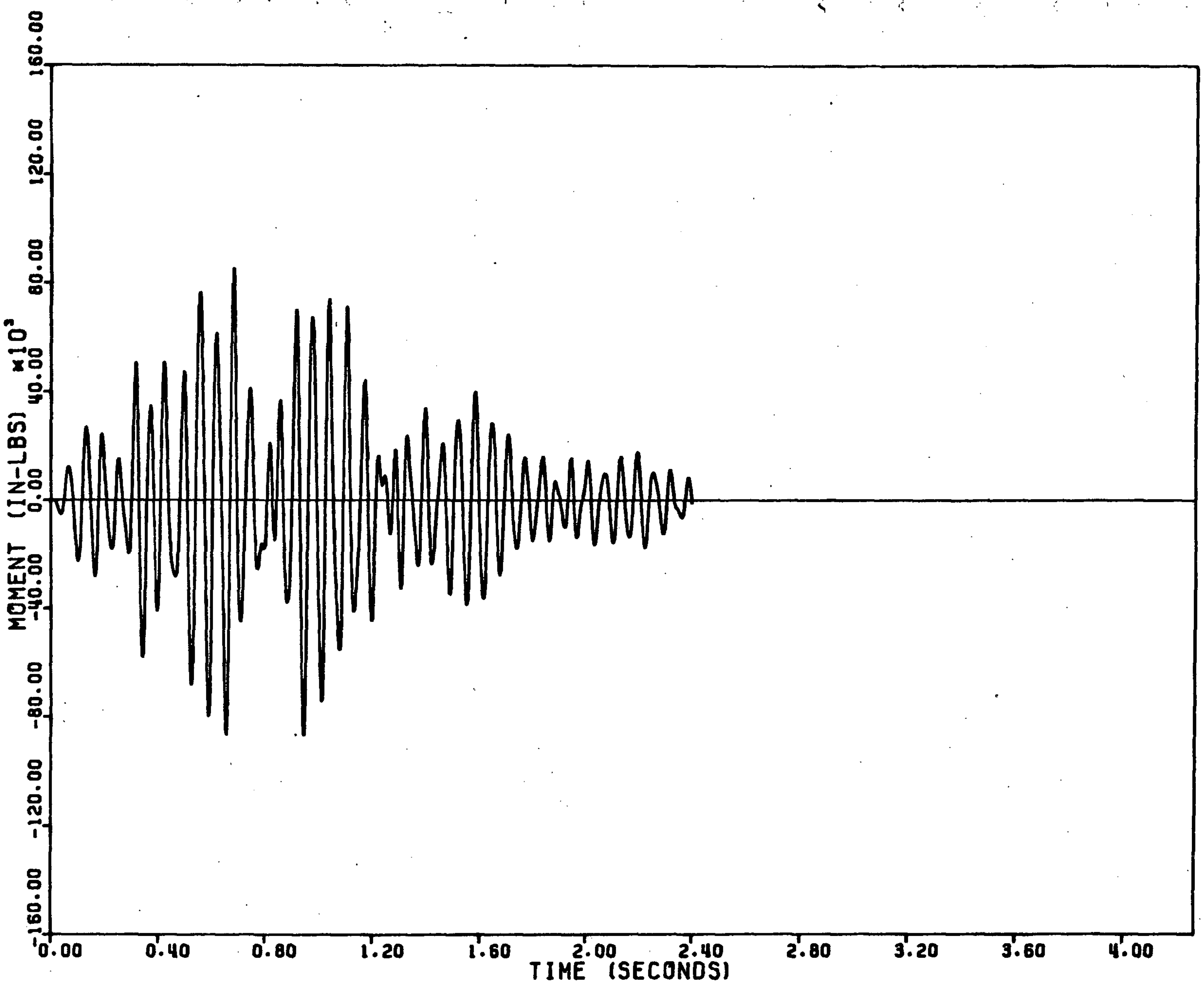


FIGURE C-15B. NSSS MAIN STEAM PIPING PIPE ELEMENT ,LOCATION 6-6
SRV-ALL LOADING - RECORD 836 - MOMENT (IN-LBS) ,NPTS = 799, DT = .003

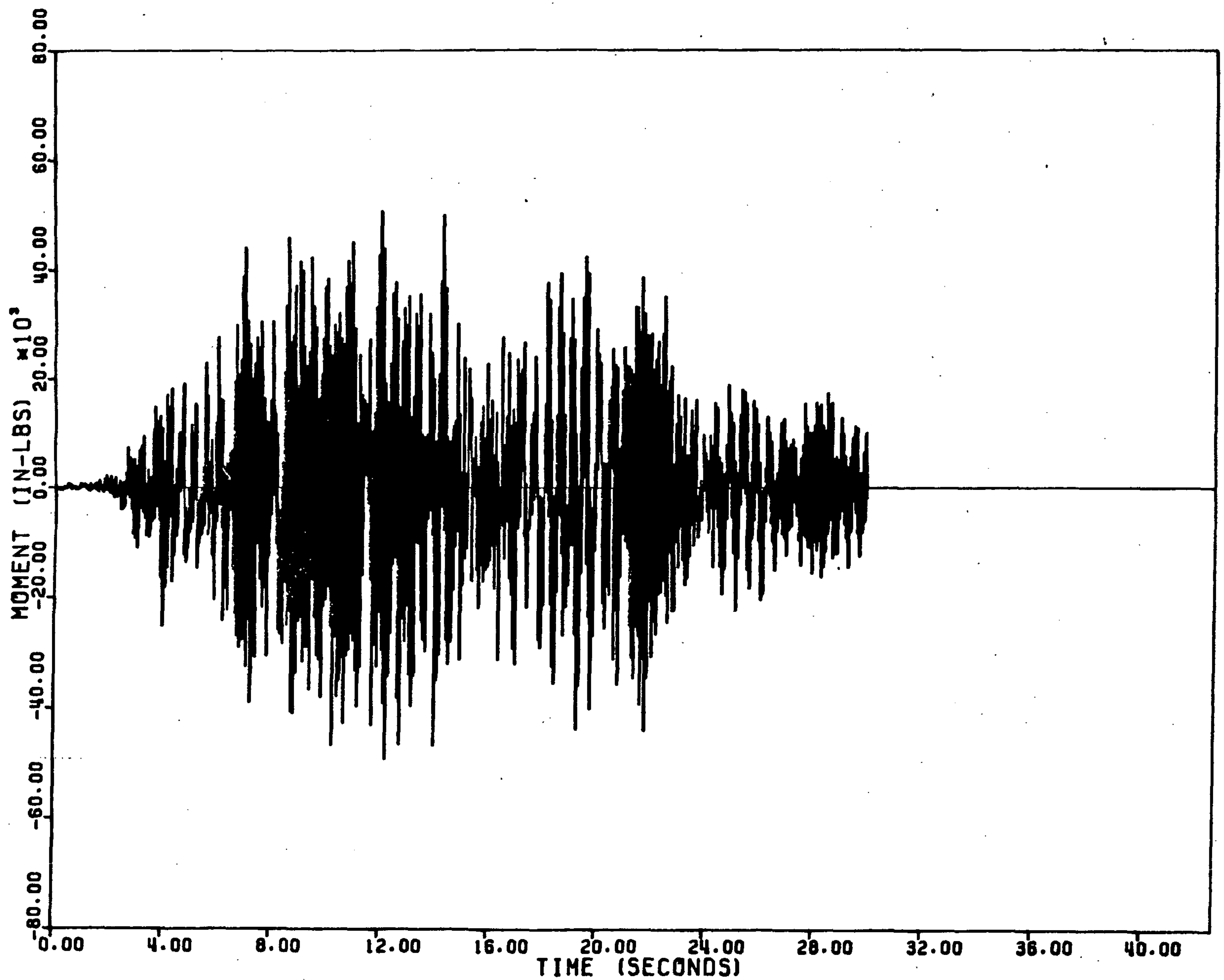


FIGURE C-16A. NSSS MAIN STEAM PIPING SWEEPOLET, LOCATION 6-9
OBE LOADING - RECORD 809 - MOMENT (IN-LBS) ,NPTS = 4989, DT = .006

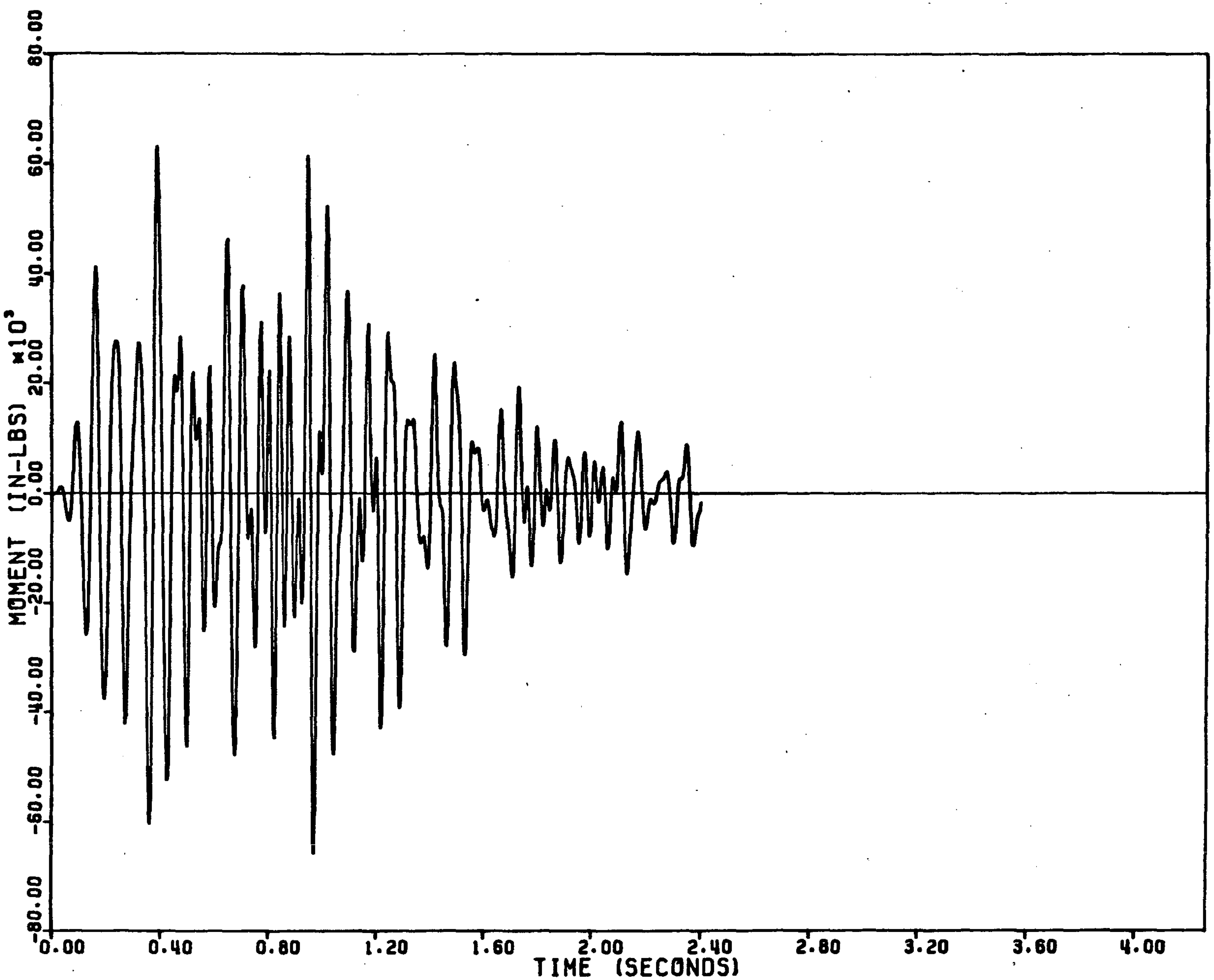


FIGURE C-16B. NSSS MAIN STEAM PIPING SWEEPOLET, LOCATION 6-9
SRV-ALL LOADING - RECORD 839 - MOMENT (IN-LBS) ,NPTS = 799, DT = .003

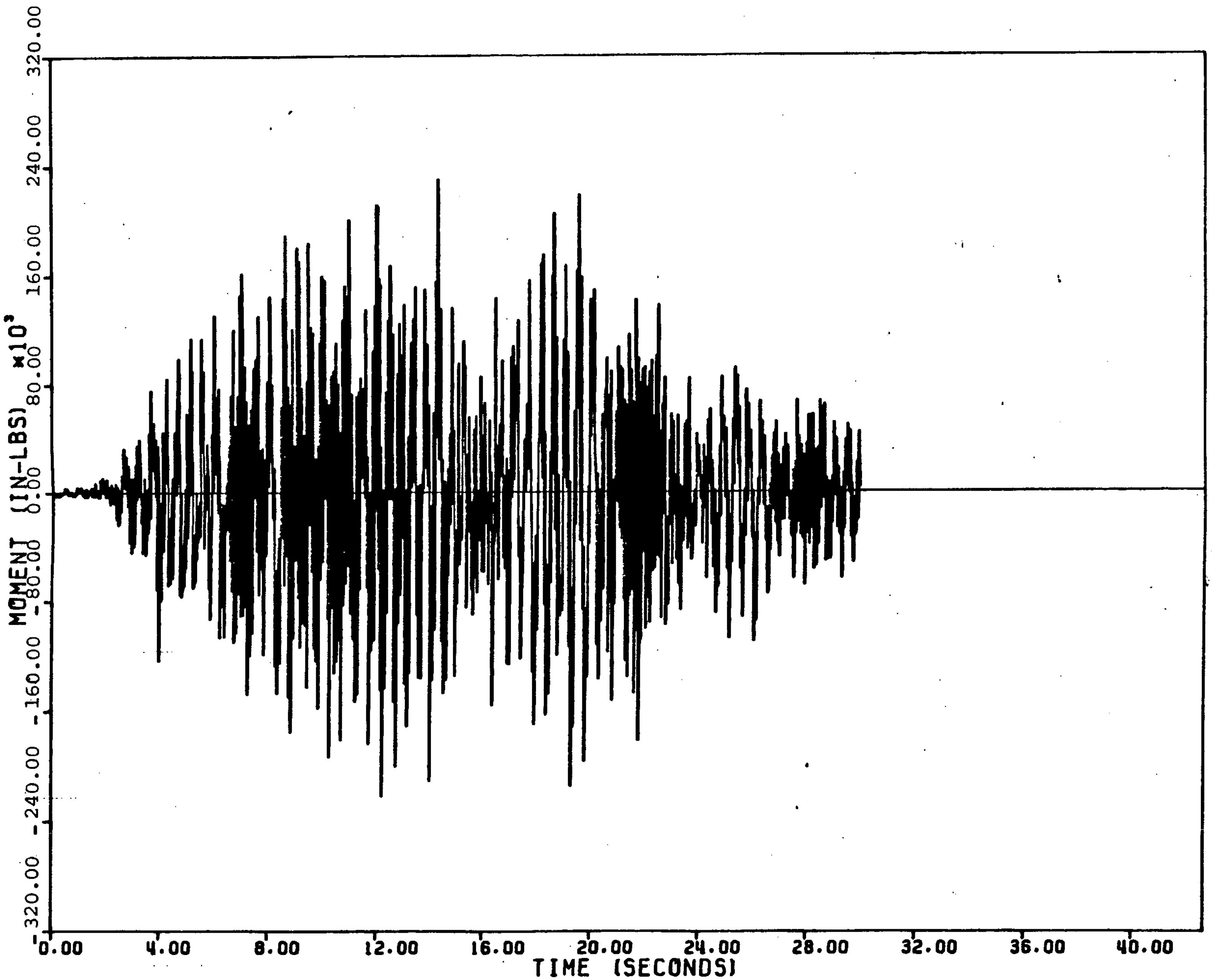


FIGURE C-17A. NSSS MAIN STEAM PIPING MSIV INLET , LOCATION 6-4
SSE LOADING - RECORD 804 - MOMENT (IN-LBS) .NPTS = 4989. DT = .006

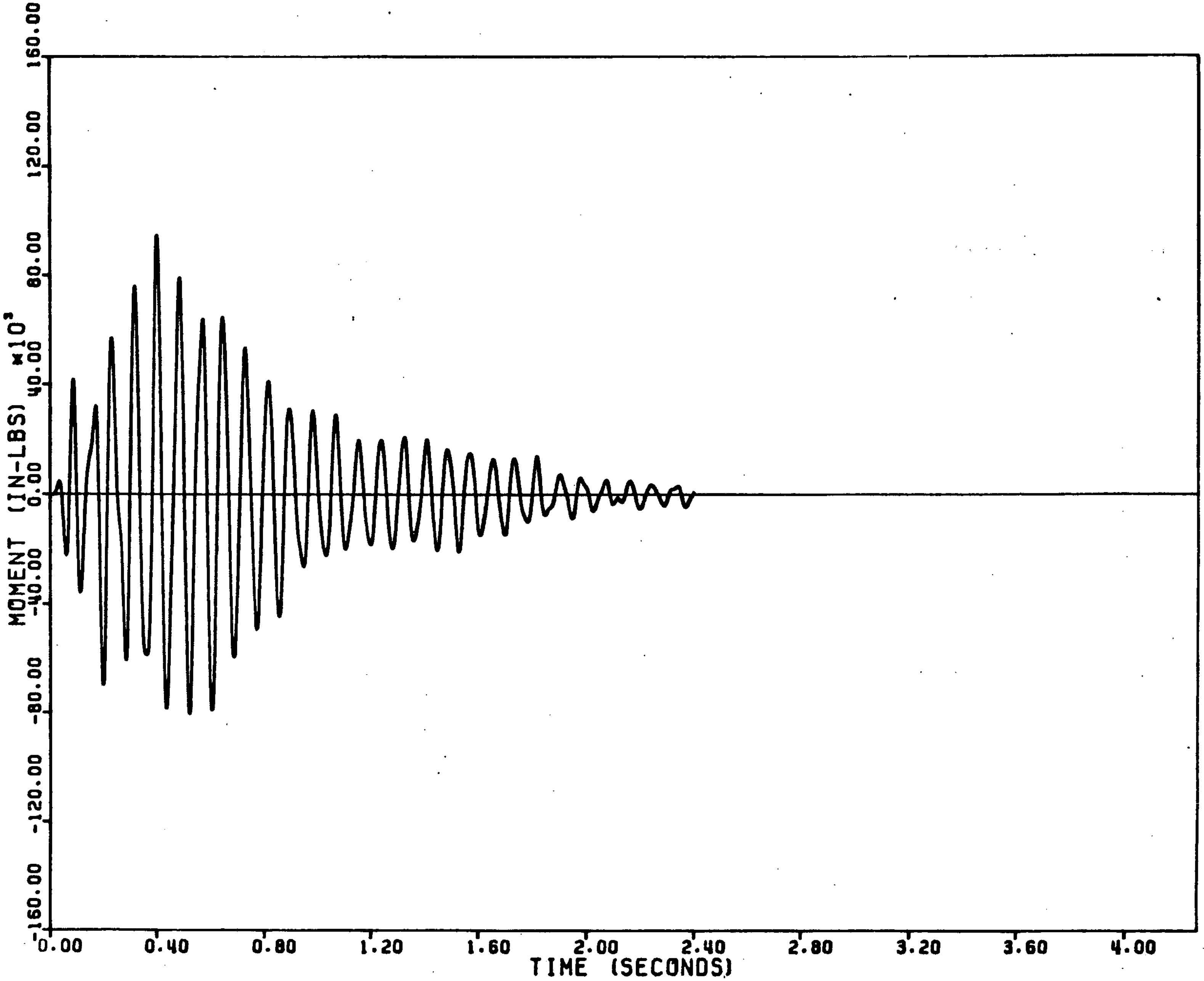


FIGURE C-17B. NSSS MAIN STEAM PIPING MSIV INLET , LOCATION 6-4
SRV-1 LOADING - RECORD 814 - MOMENT (IN-LBS) .NPTS = 2393, DT = .001

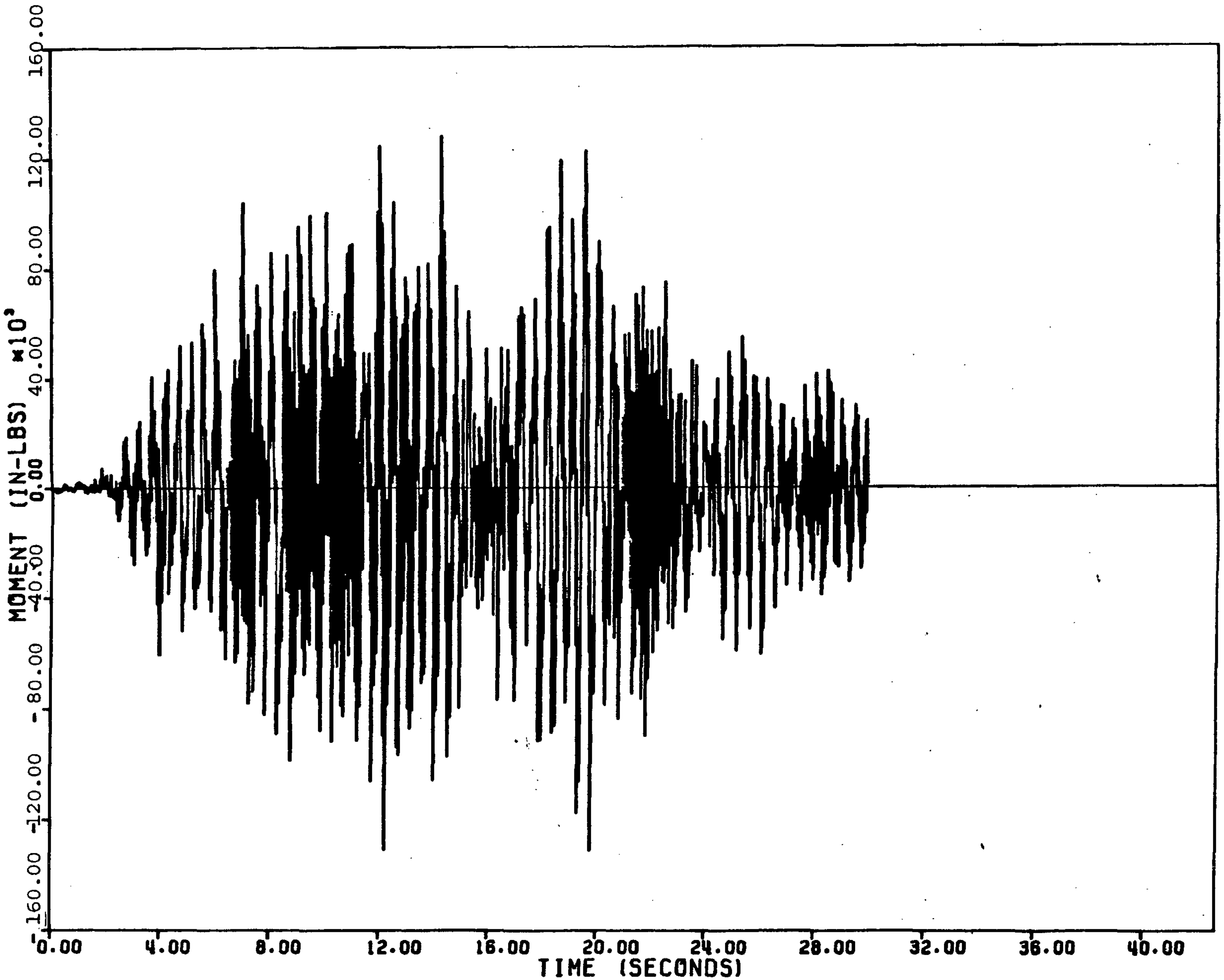


FIGURE C-18A. NSSS MAIN STEAM PIPING SWEEPOLET, LOCATION 6-8
SSE LOADING - RECORD 808 - MOMENT (IN-LBS) .NPTS = 4989, DT = .006

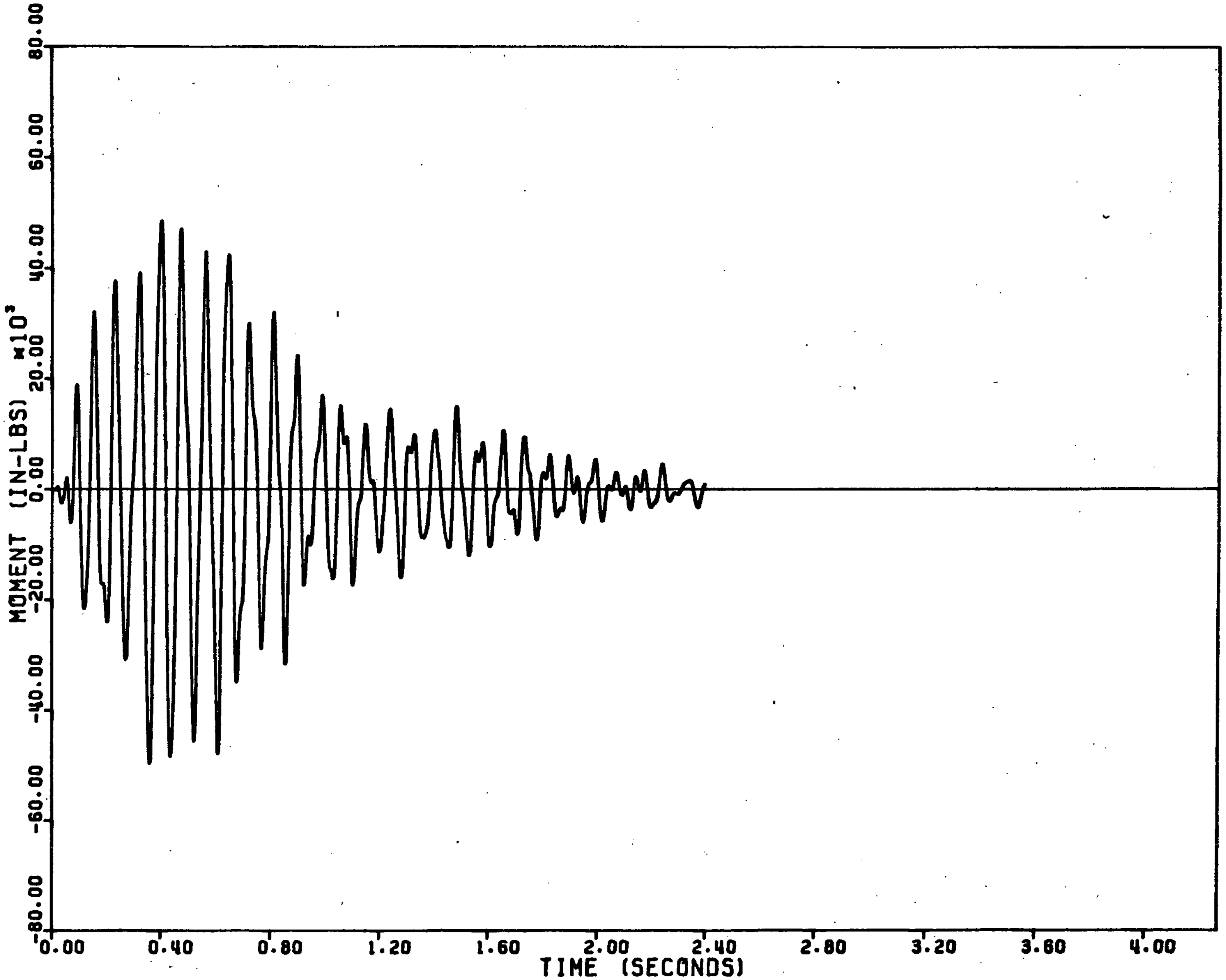
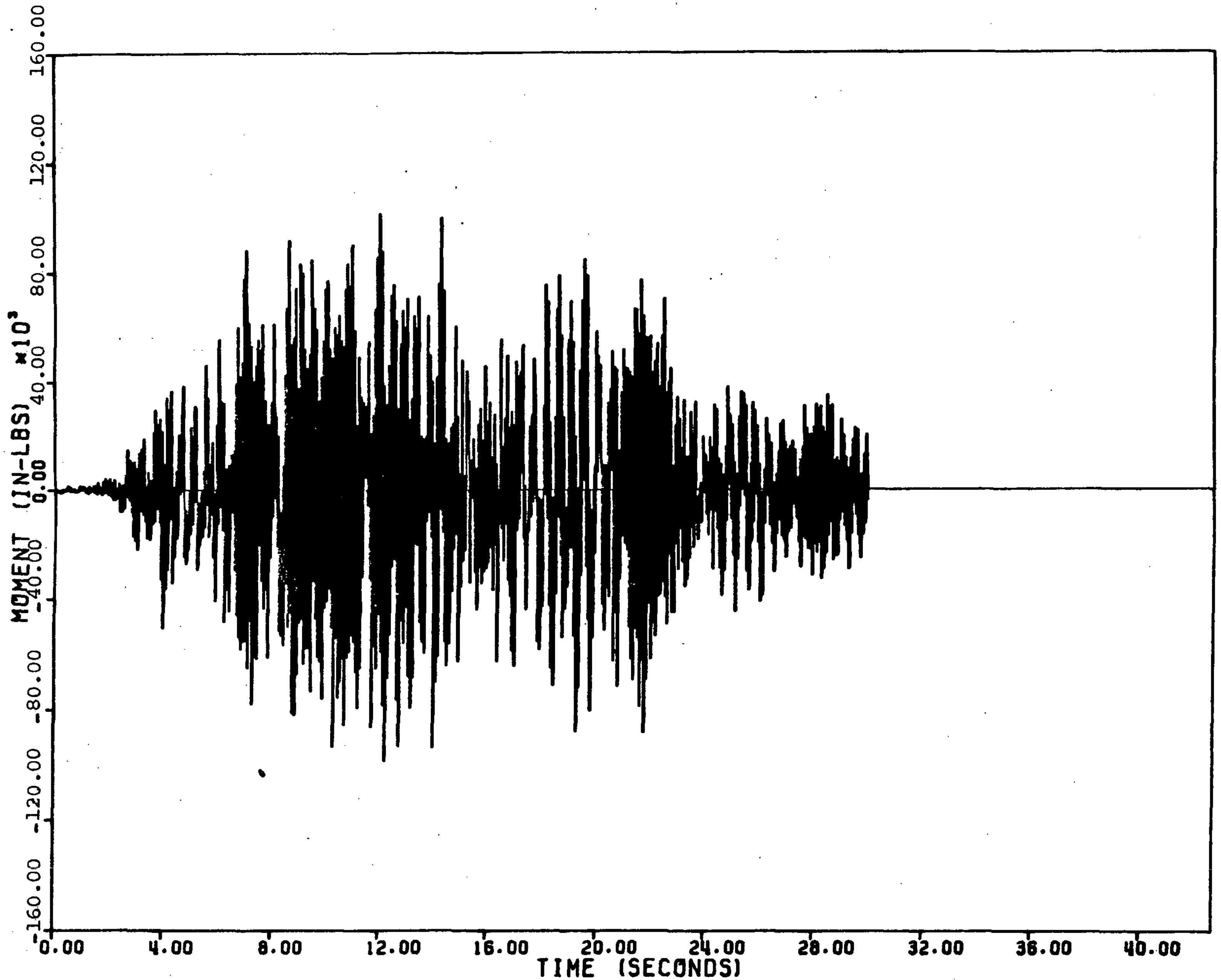


FIGURE C-18B. NSSS MAIN STEAM PIPING SWEEPOLET, LOCATION 6-8
SRV-1 LOADING - RECORD 818 - MOMENT (IN-LBS) ,NPTS = 2393, DT = .001



FIGURF C-19A. NSSS MAIN STEAM PIPING SWEEPOLET, LOCATION 6-9
SSE LOADING - RECORD 809 - MOMENT (IN-LBS) ,NPTS = 4989, DT = .006

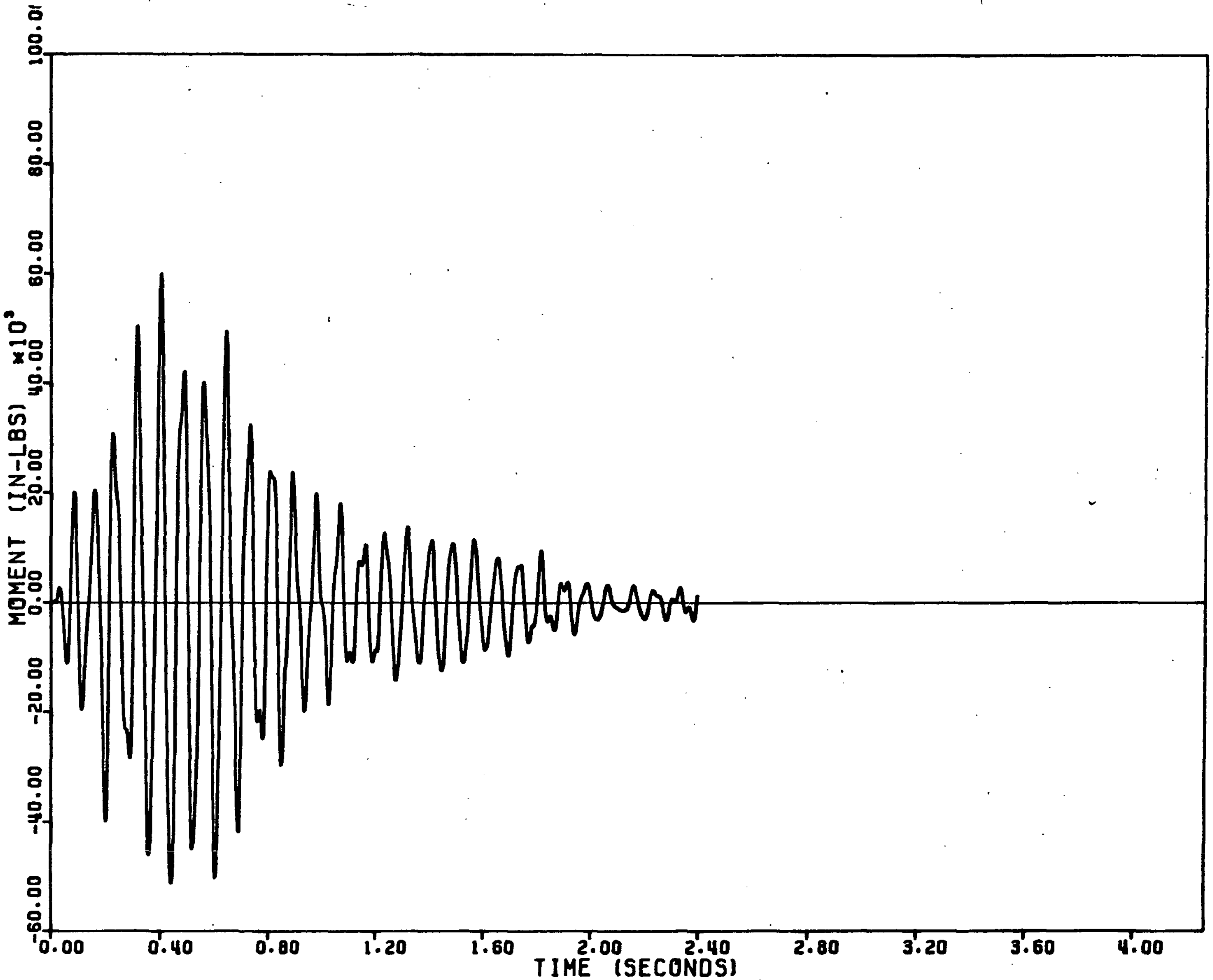


FIGURE C-19B. NSSS MAIN STEAM PIPING SWEEPOLET, LOCATION 6-9
SRV-1 LOADING - RECORD 819 - MOMENT (IN-LBS) .NPTS = 2393, DT = .001

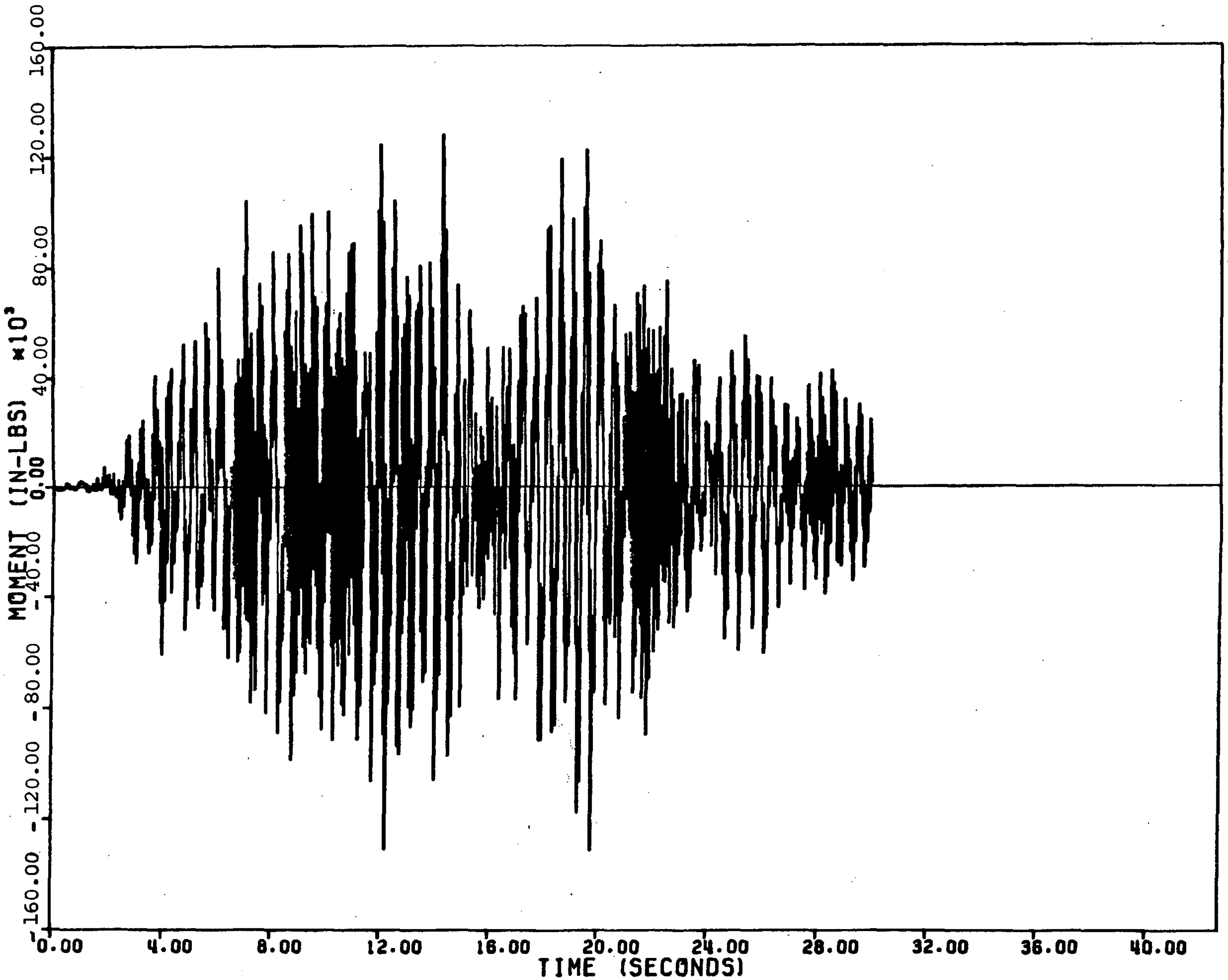


FIGURE C-20A. NSSS MAIN STEAM PIPING SWEEPOLET, LOCATION 6-8
SSE LOADING - RECORD 808 - MOMENT (IN-LBS) .NPTS = 4989, DT = .006

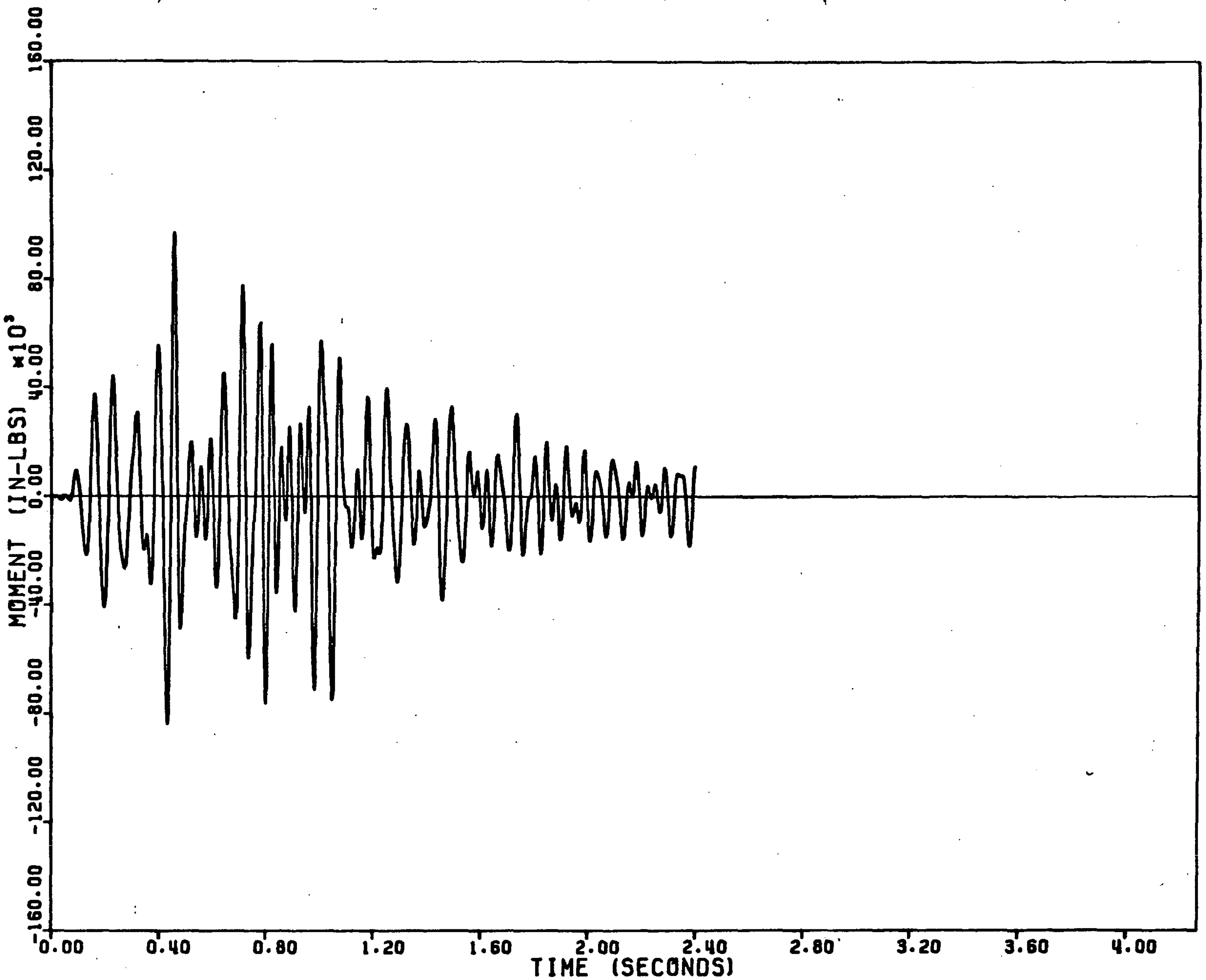


FIGURE C-20B. NSSS MAIN STEAM PIPING SWEEPOLET, LOCATION 6-8
SRV-ALL LOADING - RECORD 838 - MOMENT (IN-LBS) ,NPTS = 799, DT = .003

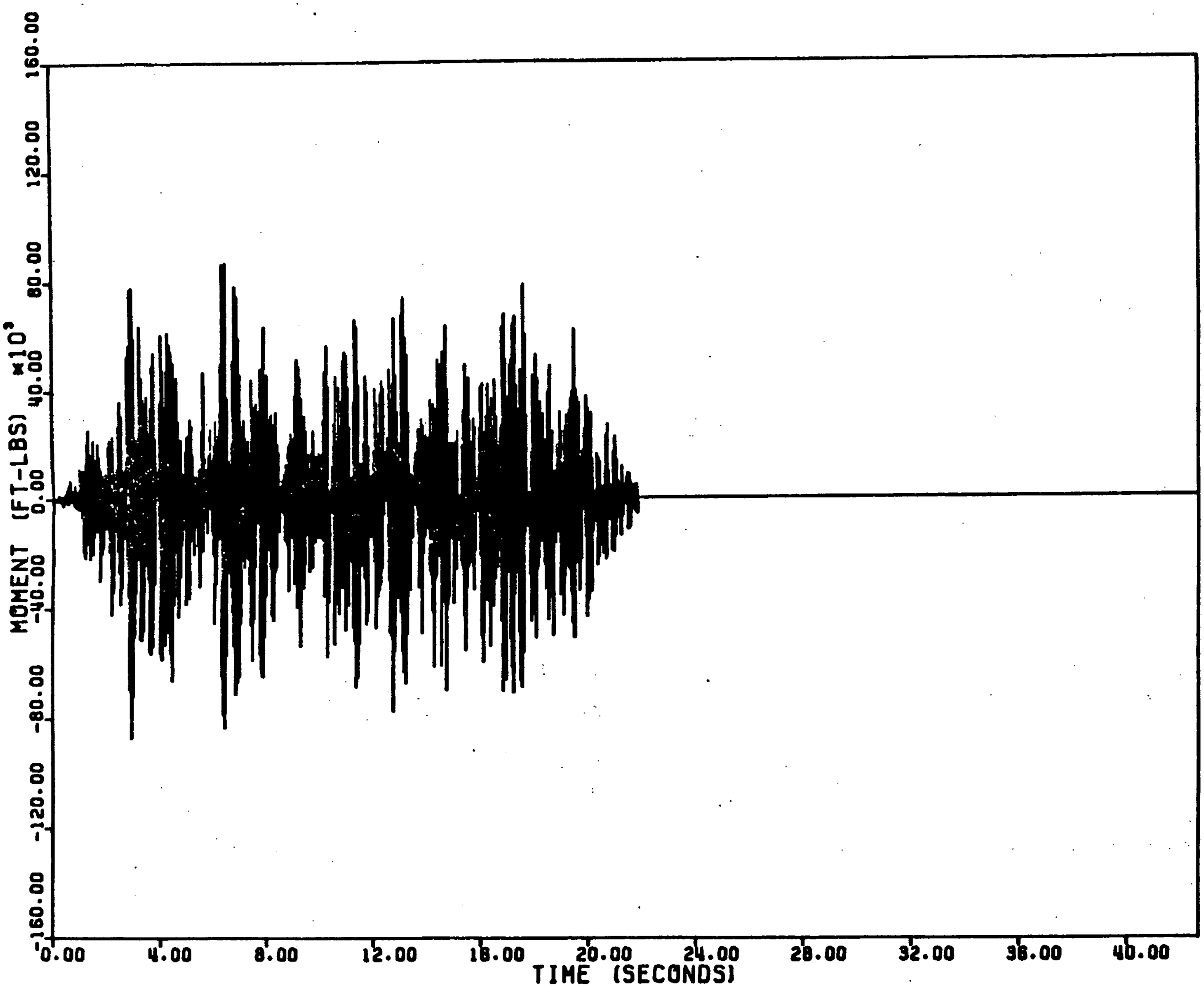


FIGURE C-21A. NSSS RECIRCULATION PIPING PUMP INLET, NODE 22, LOCATION 4-8
OBE LOADING - RECORD 704 - MOMENT (FT-LBS)) .NPTS = 2183, DT = .0100

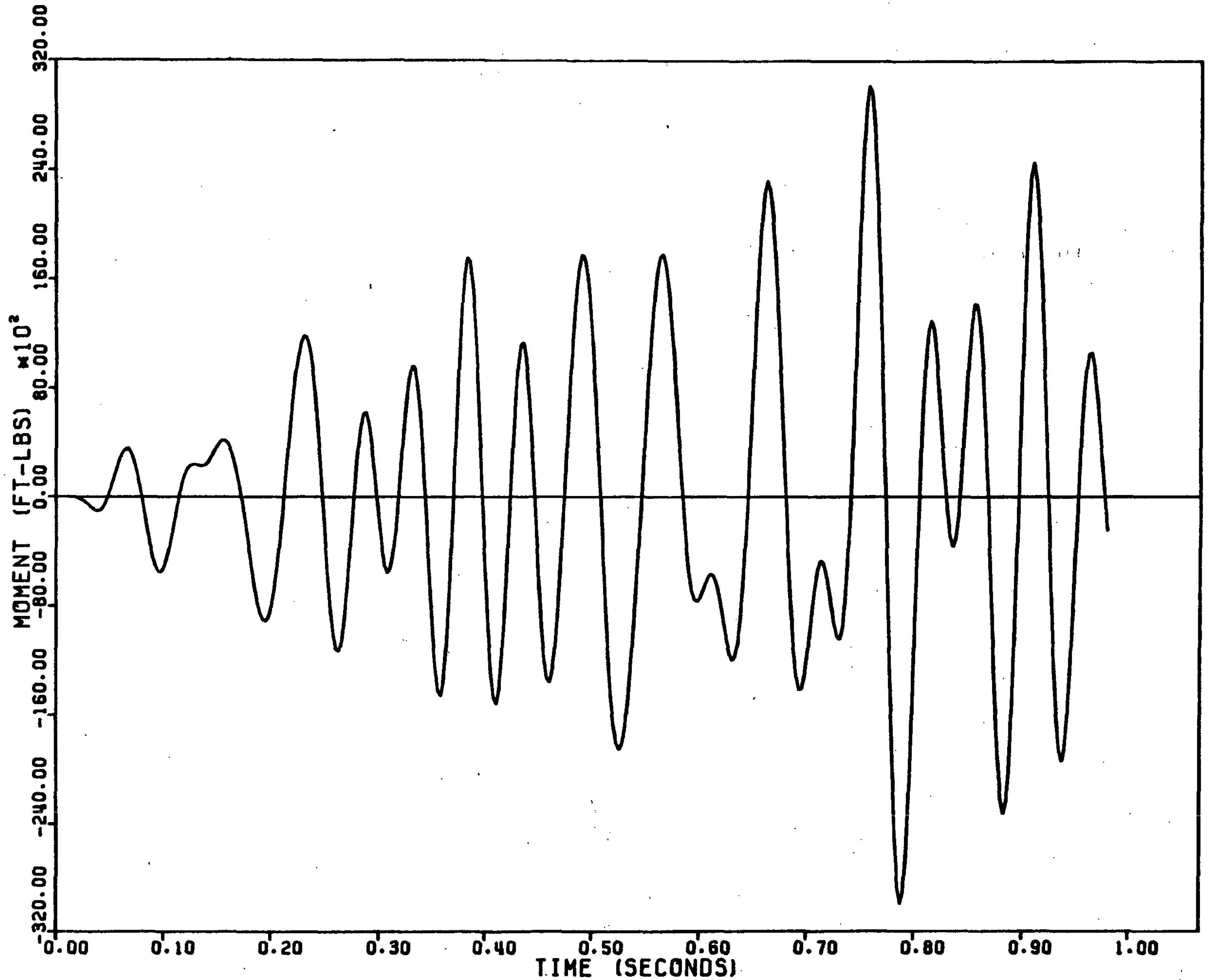


FIGURE C-21B. NSSS RECIRCULATION PIPING PUMP INLET, NODE 22, LOCATION 4-8
SRV-1 LOADING - RECORD 714 - MOMENT (FT-LBS) .NPTS = 393, DT = .0025

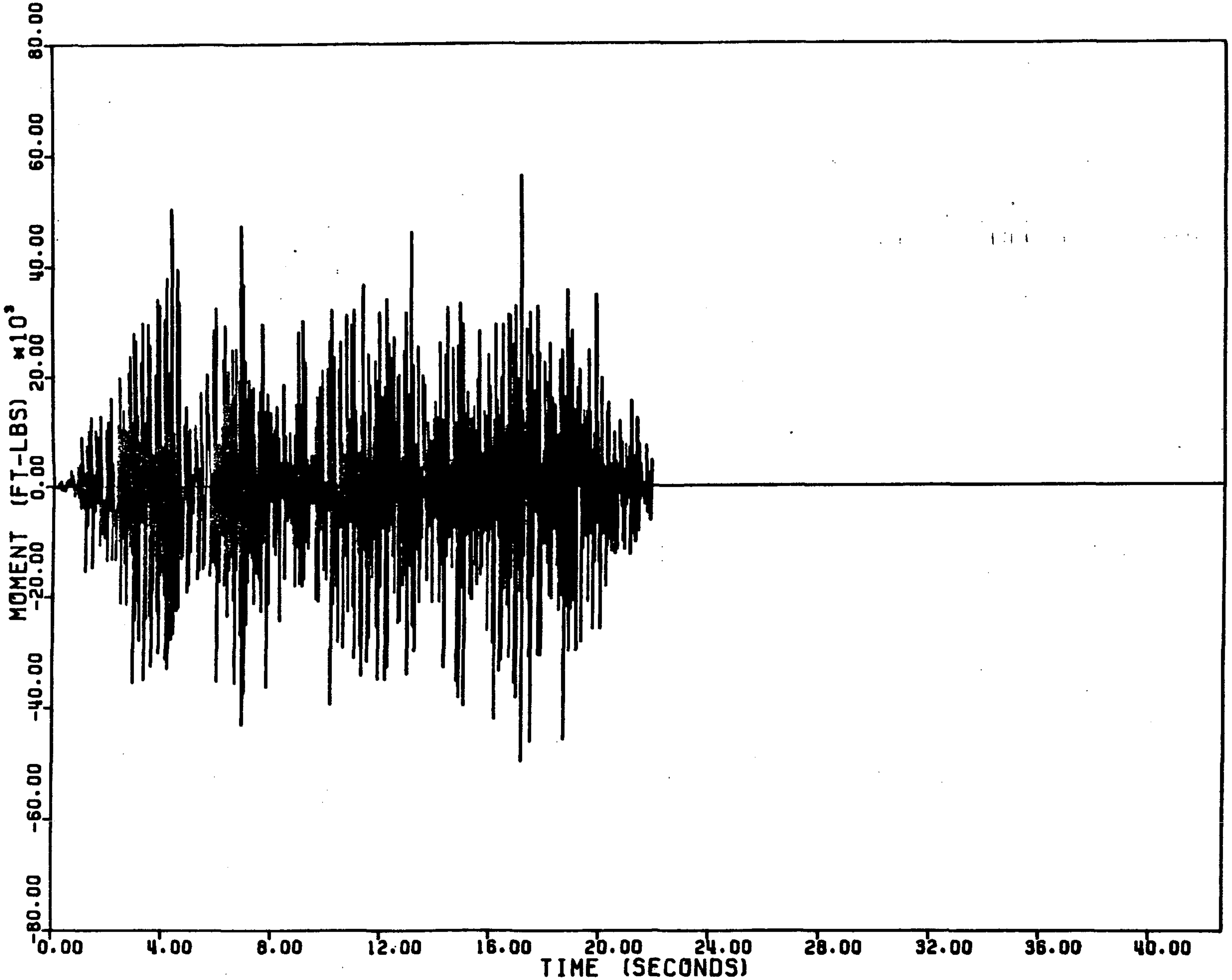


FIGURE C-22A. NSSS RECIRCULATION PIPING TEE , NODE 64, LOCATION 4-10
OBE LOADING - RECORD 706 - MOMENT (FT-LBS)) .NPTS = 2183, DT = .0100

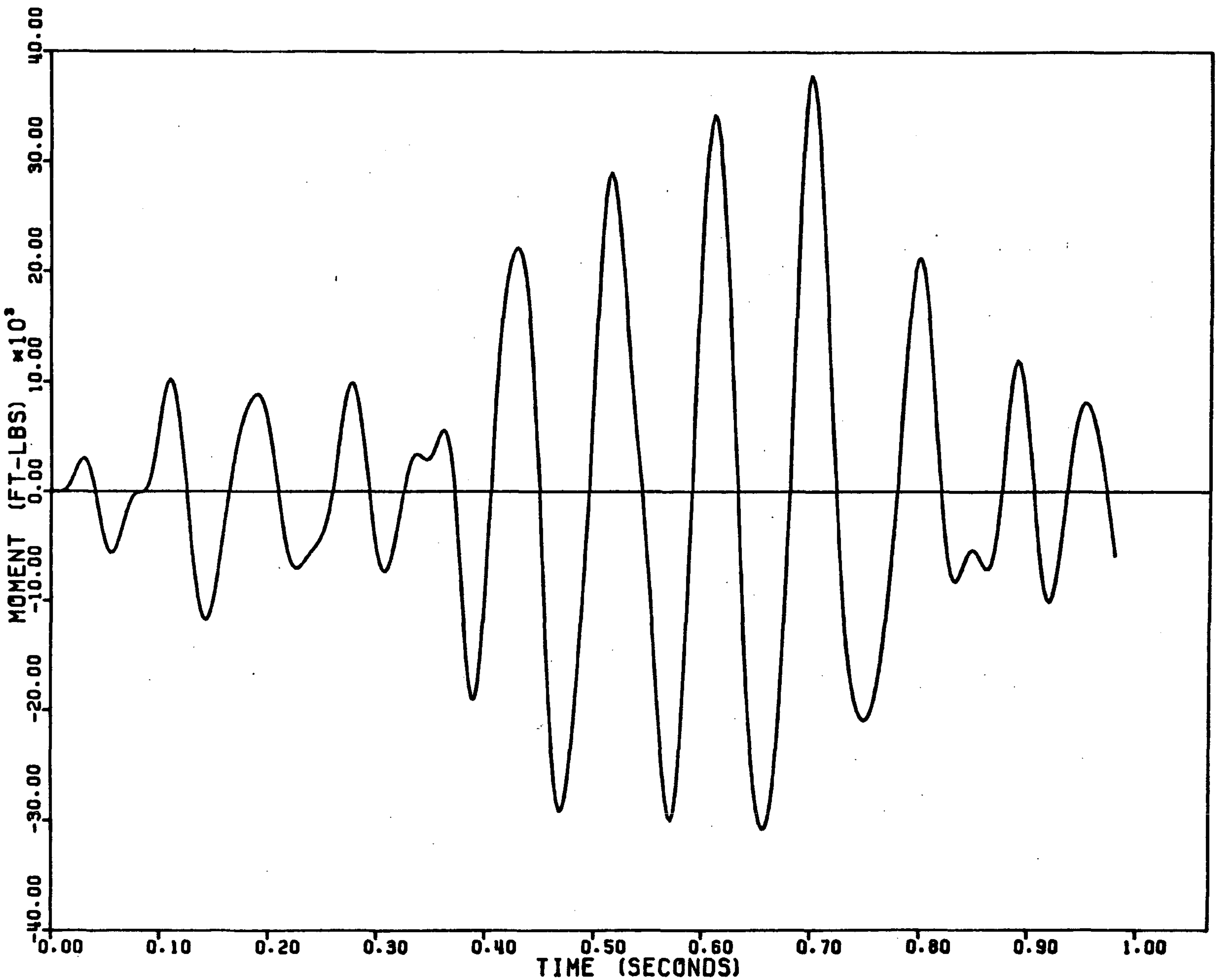


FIGURE C-22B. NSSS RECIRCULATION PIPING TEE , NODE 64, LOCATION 4-10
SRV-1 LOADING - RECORD 716 - MOMENT (FT-LBS) .NPTS = 393. DT = .0025

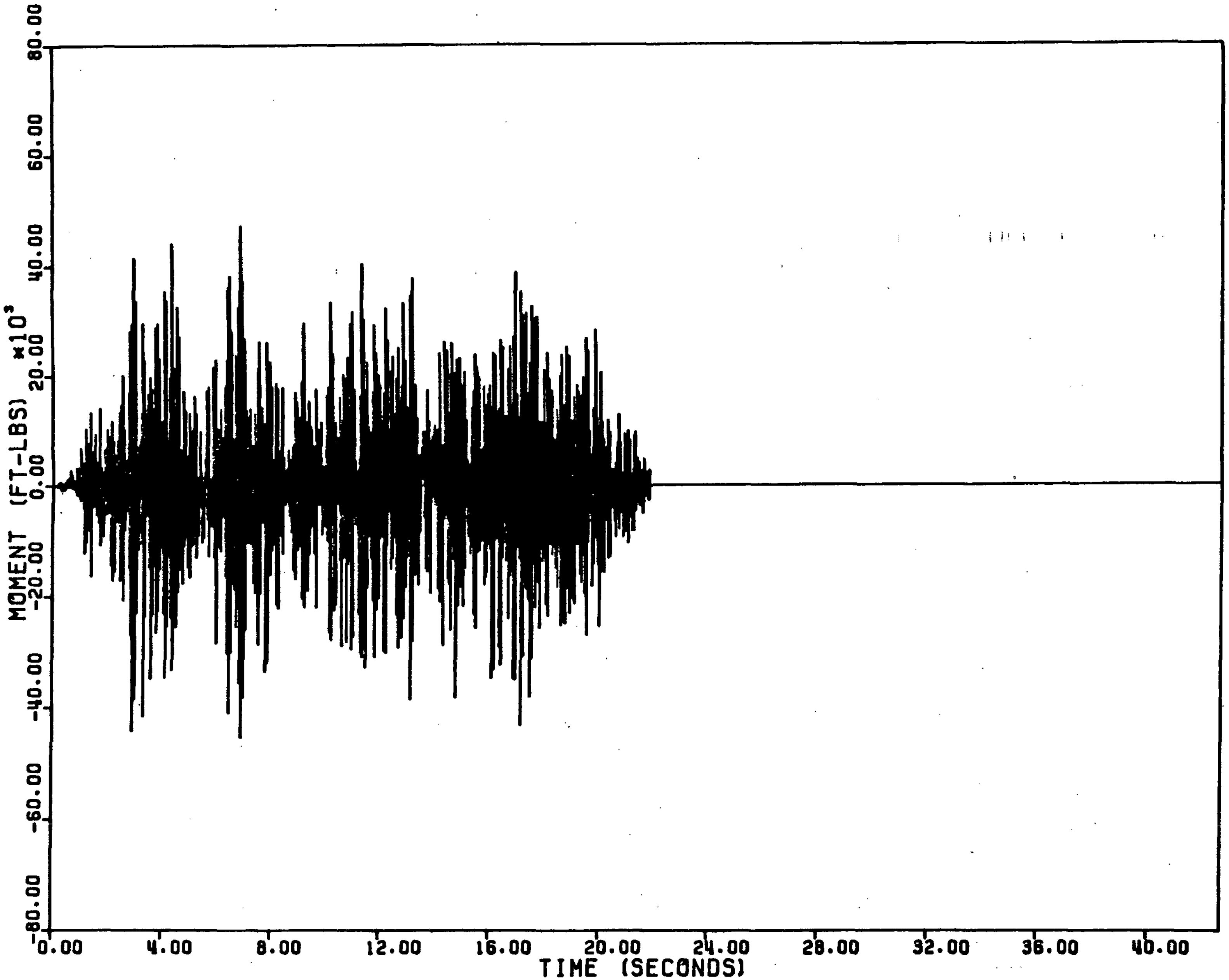


FIGURE C-23A. NSSS RECIRCULATION PIPING ELBOW , NODE 90, LOCATION 4-11
OBE LOADING - RECORD 707 - MOMENT (FT-LBS)) .NPTS = 2183, DT = .0100

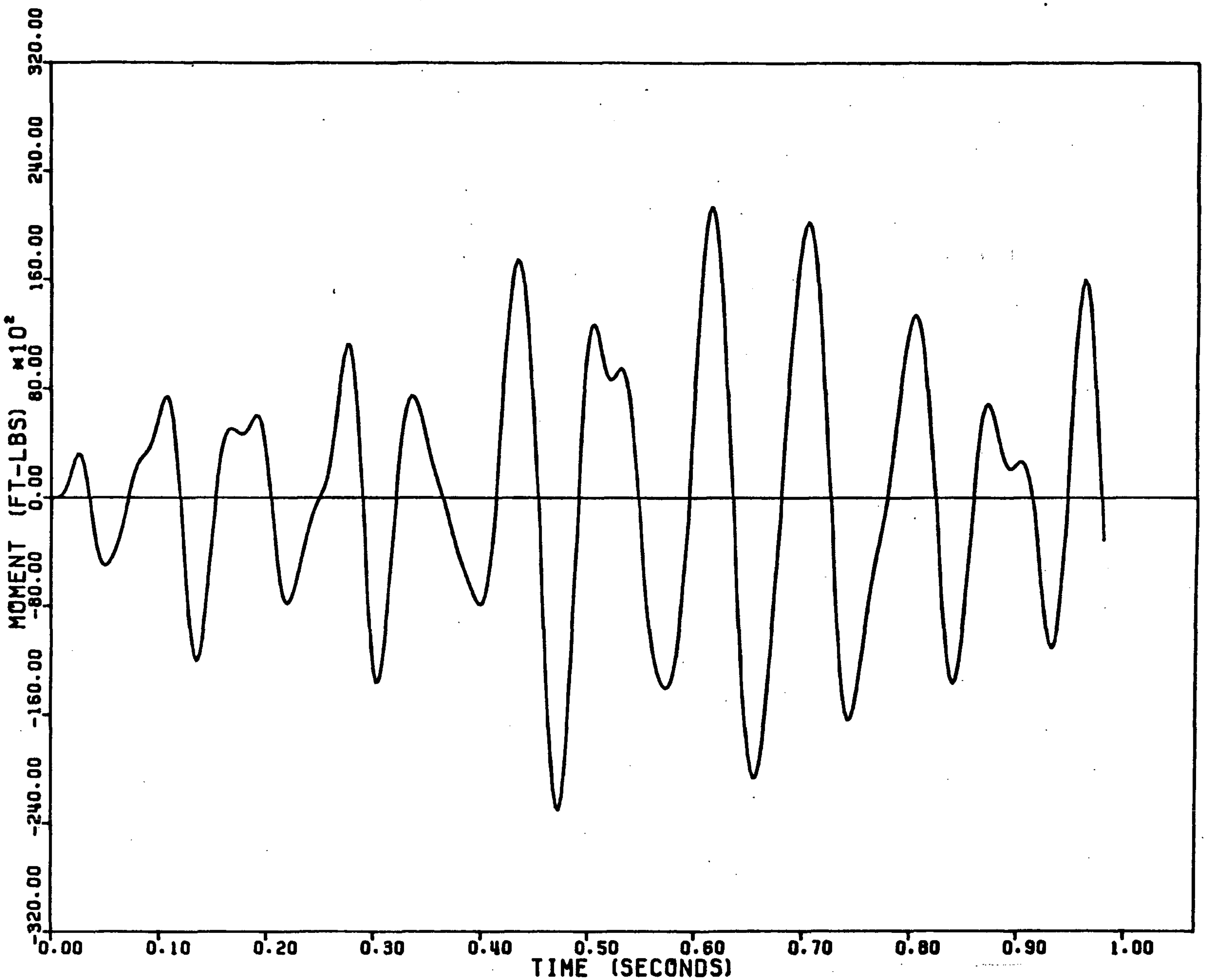


FIGURE C-23B. NSSS RECIRCULATION PIPING ELBOW , NODE 90, LOCATION 4-11
SRV-1 LOADING - RECORD 717 - MOMENT (FT-LBS) ,NPTS = 393, DT = .0025

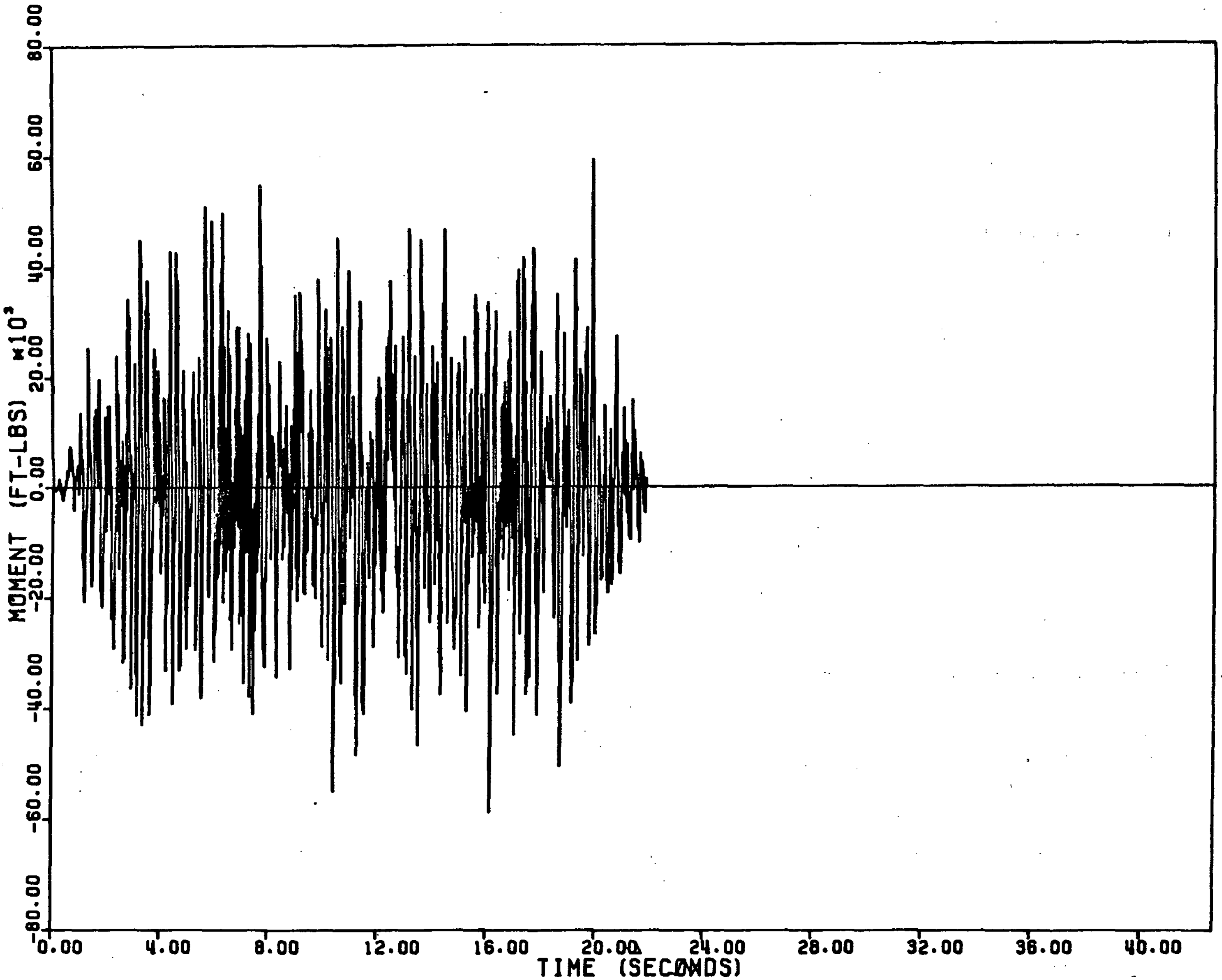


FIGURE C-24A. NSSS RECIRCULATION PIPING PIPE ELEMENT , NODE 93, LOCATION 4-12
OBE LOADING - RECORD 708 - MOMENT (FT-LBS)) .NPTS = 2183, DT = .0100

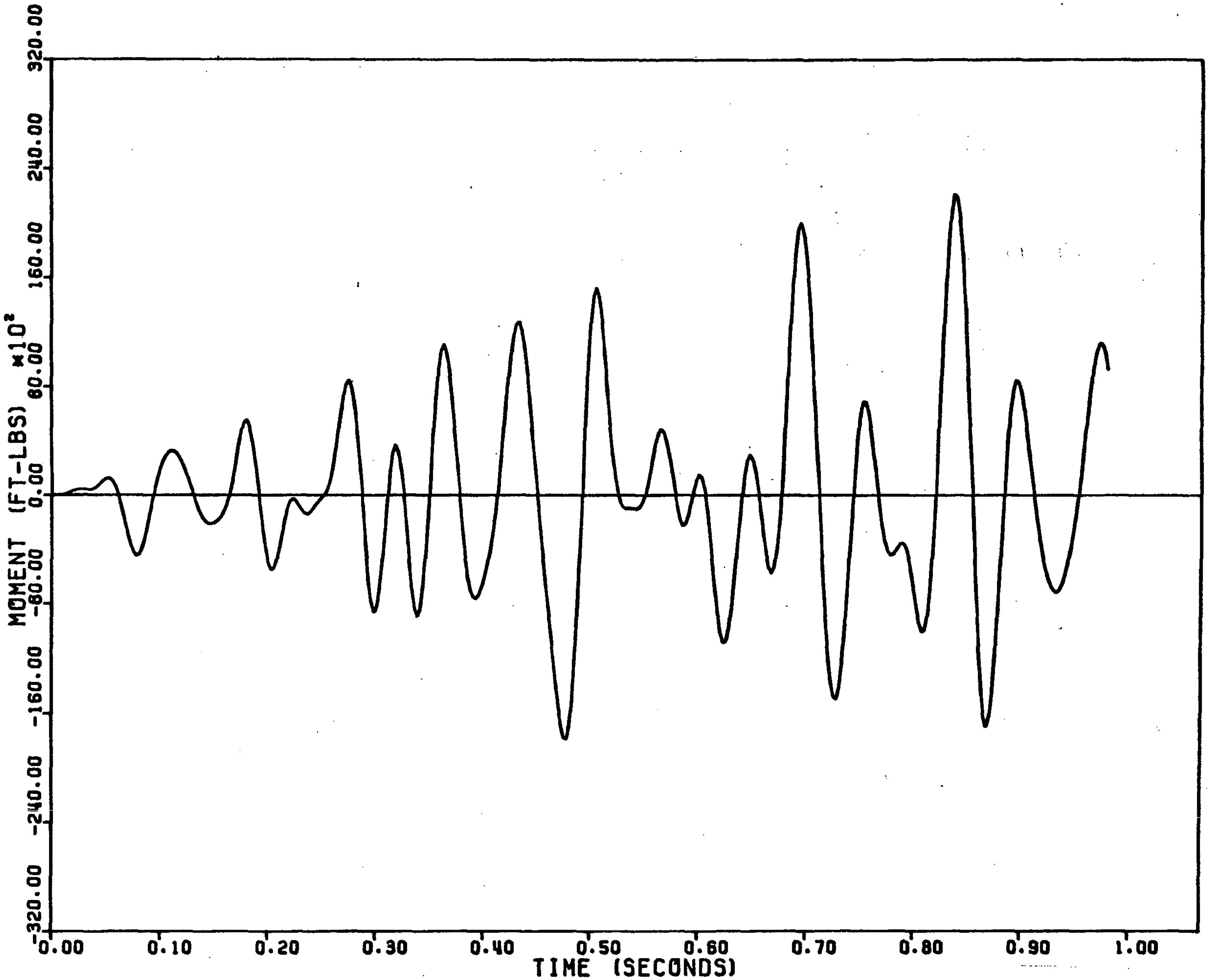


FIGURE C-24B. NSSS RECIRCULATION PIPING PIPE ELEMENT , NODE 93, LOCATION 4-12
SRV-1 LOADING - RECORD 718 - MOMENT (FT-LBS) ,NPTS = 393, DT = .0025

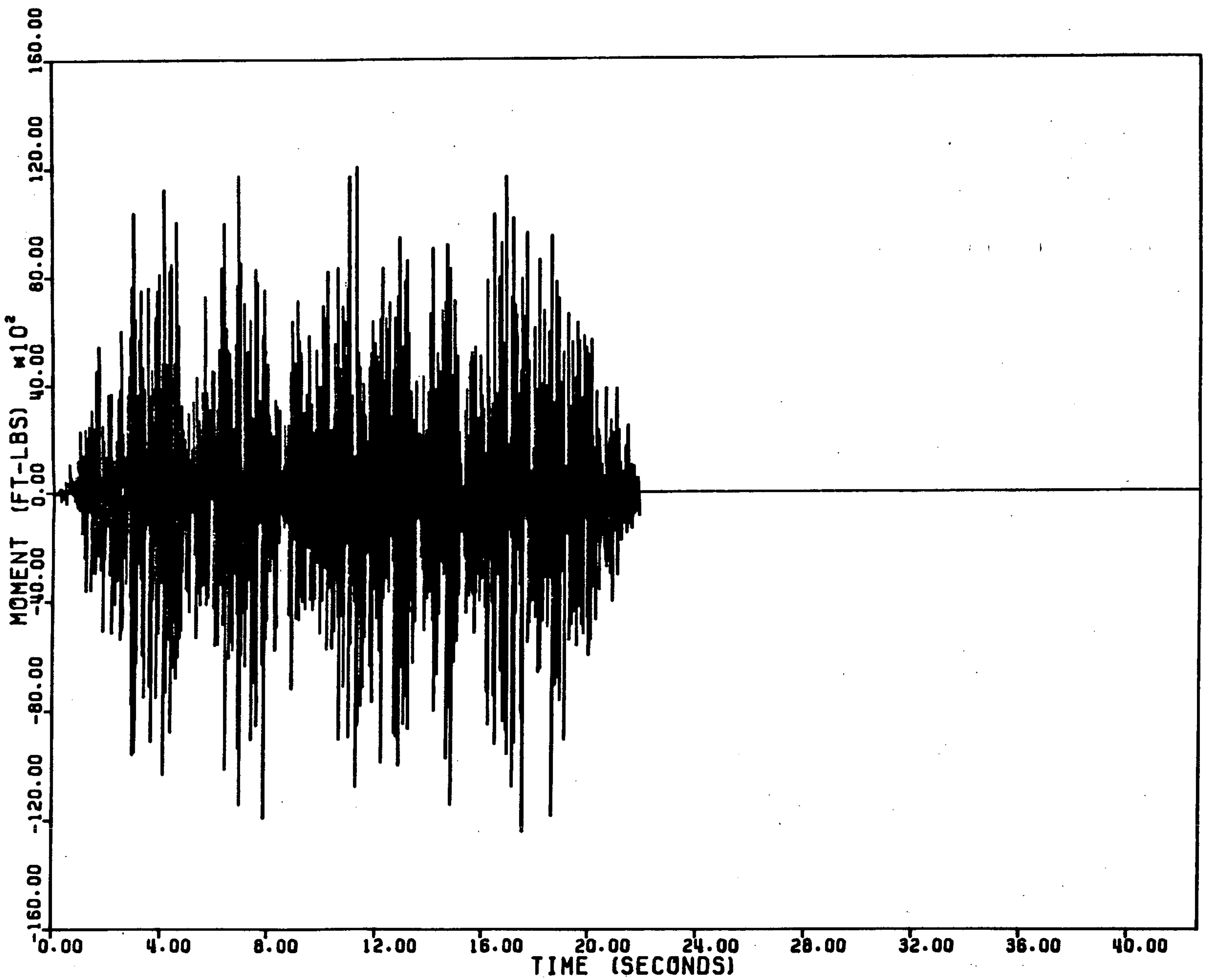


FIGURE C-25A. NSSS RECIRCULATION PIPING ELBOW , NODE 46, LOCATION 4-9
OBE LOADING - RECORD 705 - MOMENT (FT-LBS)) ,NPTS = 2183, DT = .0100

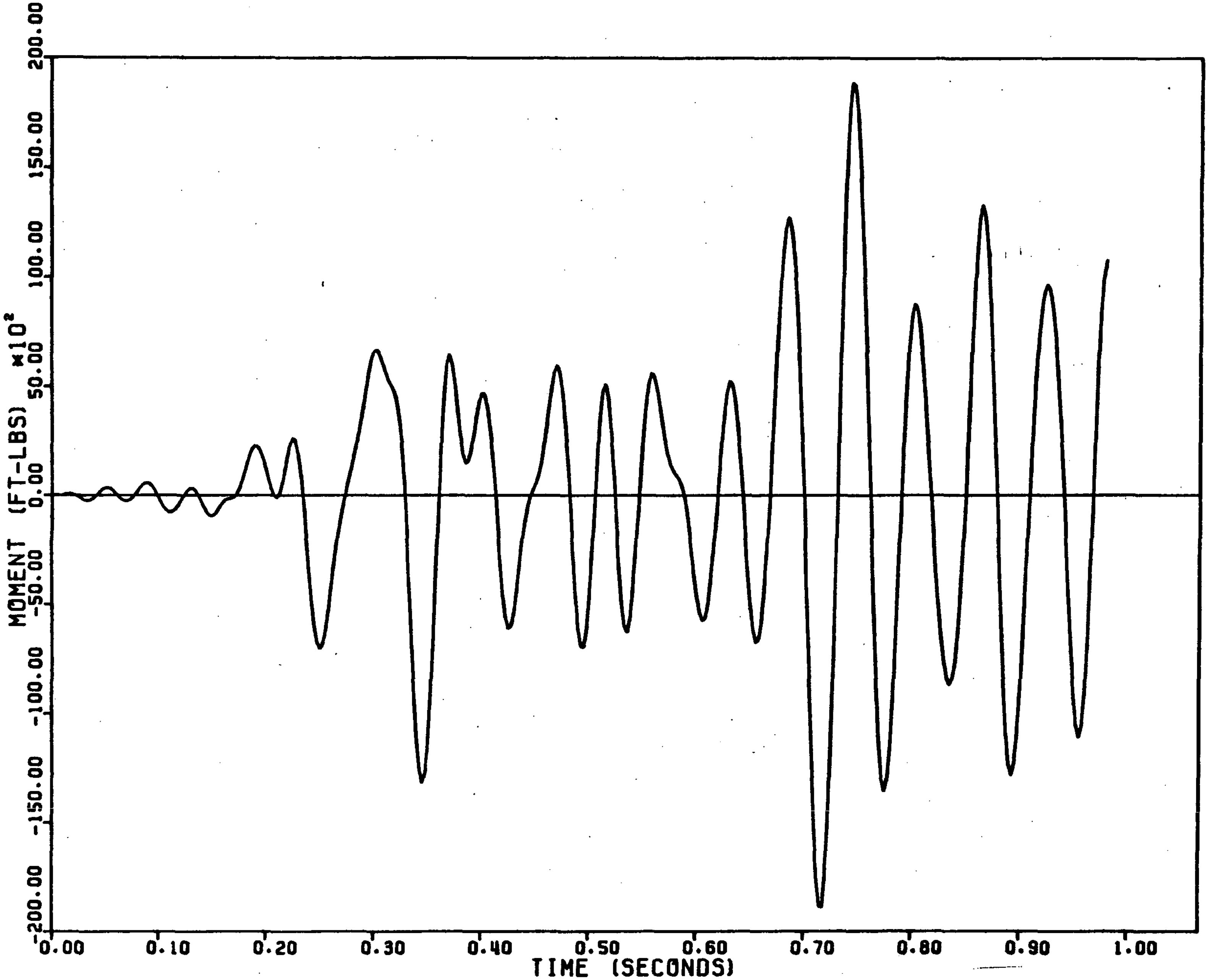


FIGURE C-25B. NSSS RECIRCULATION PIPING ELBOW , NODE 46, LOCATION 4-9
SRV-ALL LOADING - RECORD 735 - MOMENT (FT-LBS) ,NPTS = 393, DT = .0025

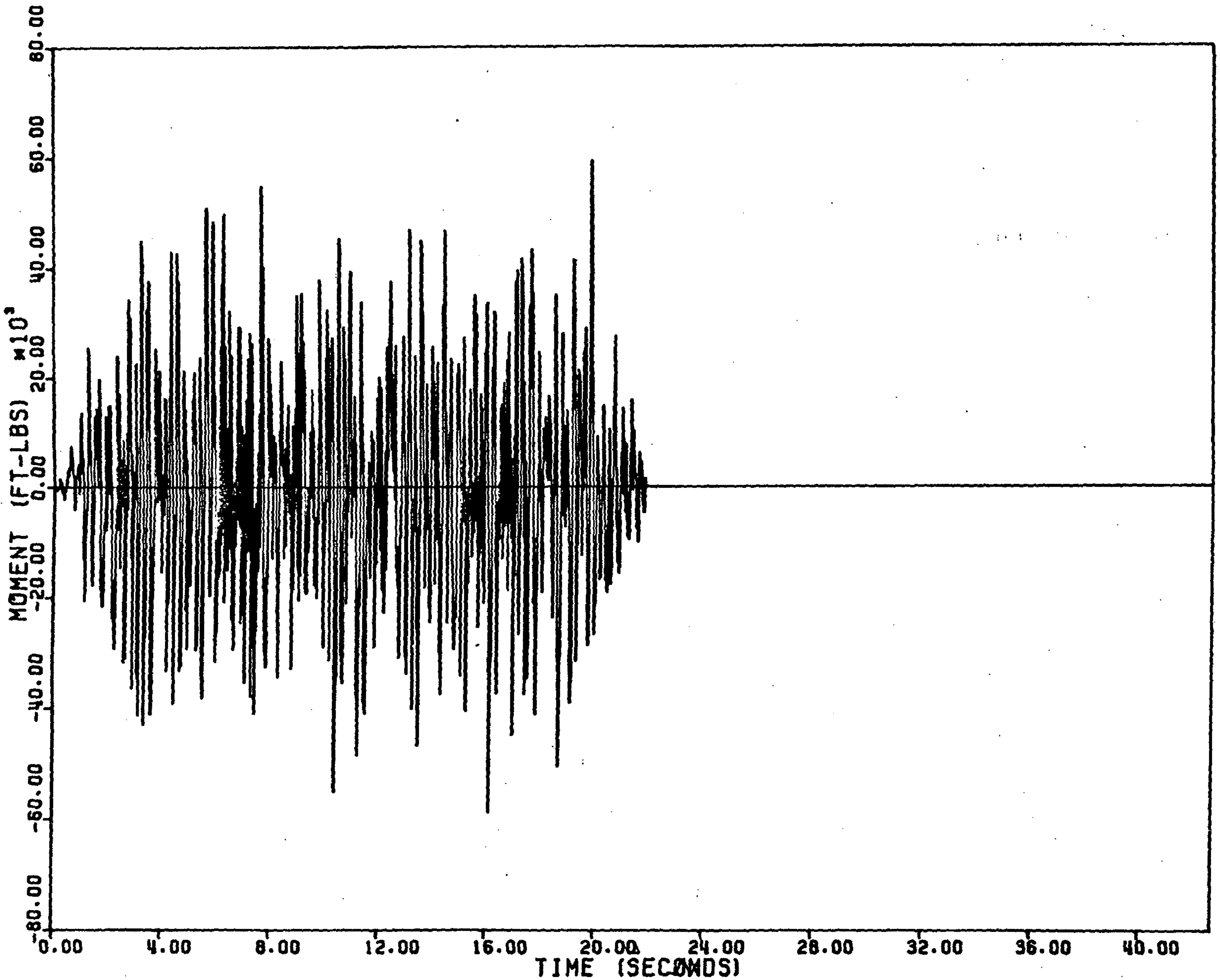


FIGURE C-26A. NSSS RECIRCULATION PIPING PIPE ELEMENT , NODE 93, LOCATION 4-12
OBE LOADING - RECORD 708 - MOMENT (FT-LBS)) ,NPTS = 2183, DT = .0100

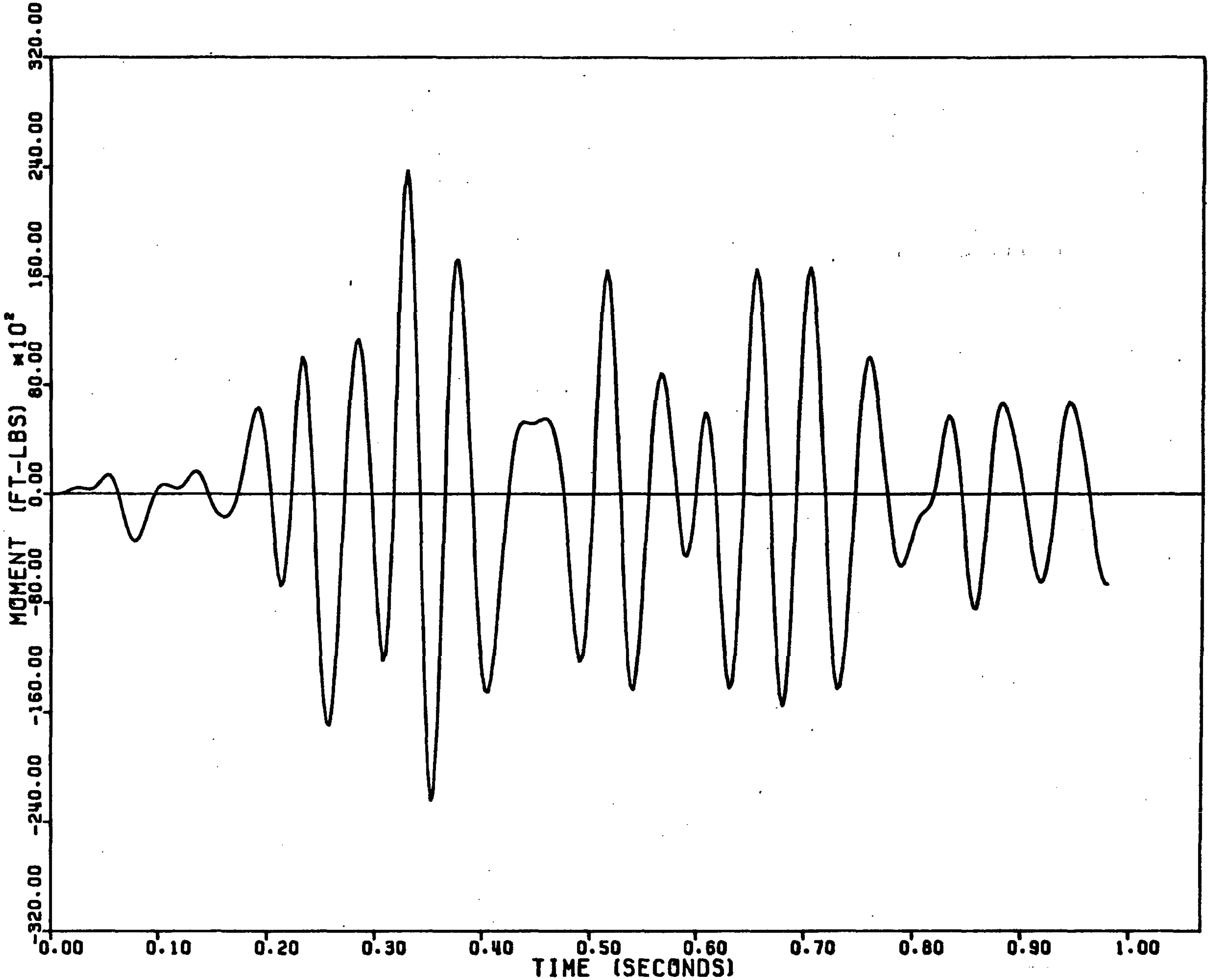


FIGURE C-26B. NSSS RECIRCULATION PIPING PIPE ELEMENT , NODE 93, LOCATION 4-12
SRV-ALL LOADING - RECORD 738 - MOMENT (FT-LBS) .NPTS = 393, DT = .0025

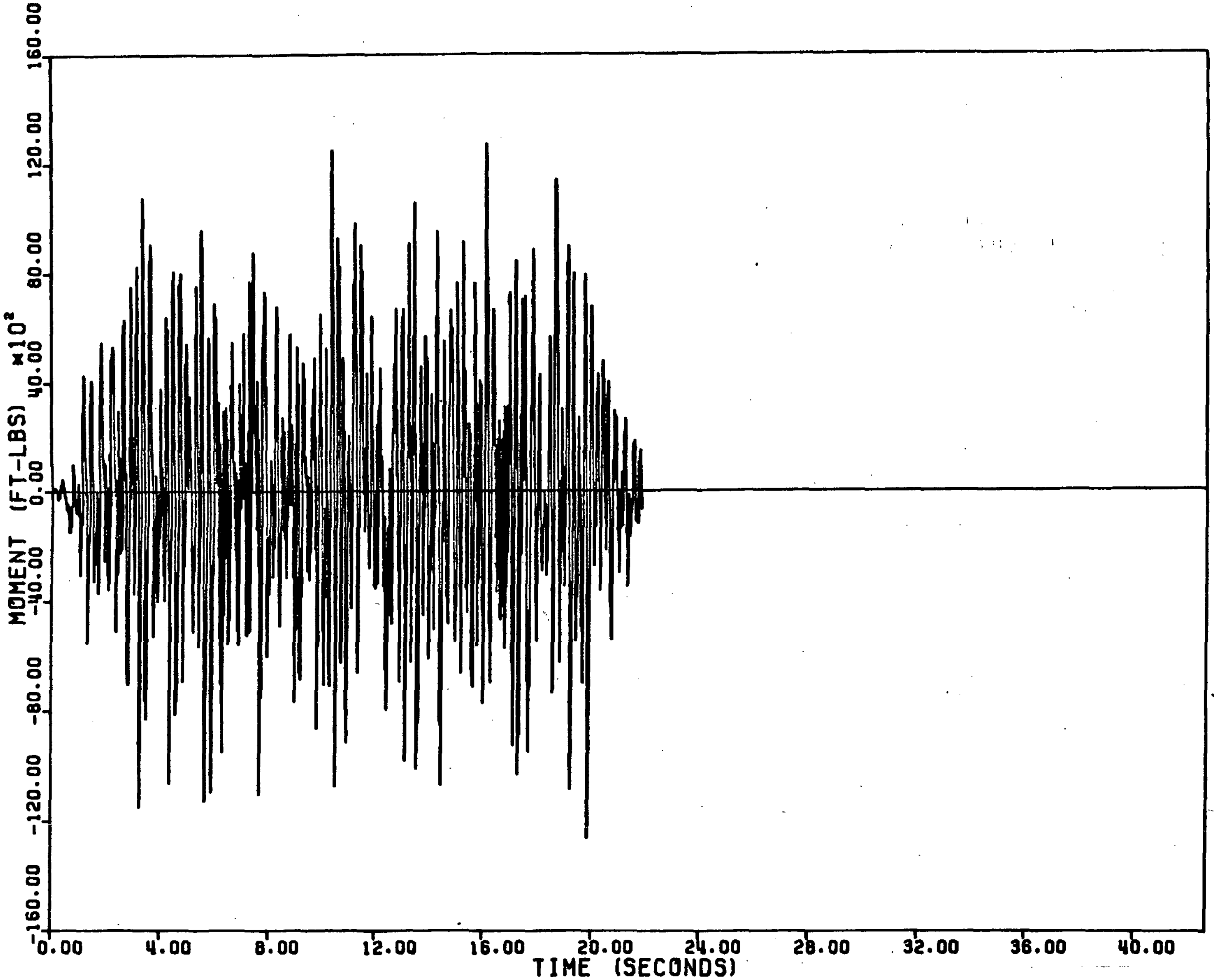


FIGURE C-27A. NSSS RECIRCULATION PIPING SWEEPOLET , NODE 144 LOCATION 4-13
OBE LOADING - RECORD 709 - MOMENT (FT-LBS)) ,NPTS = 2183, DT = .0100

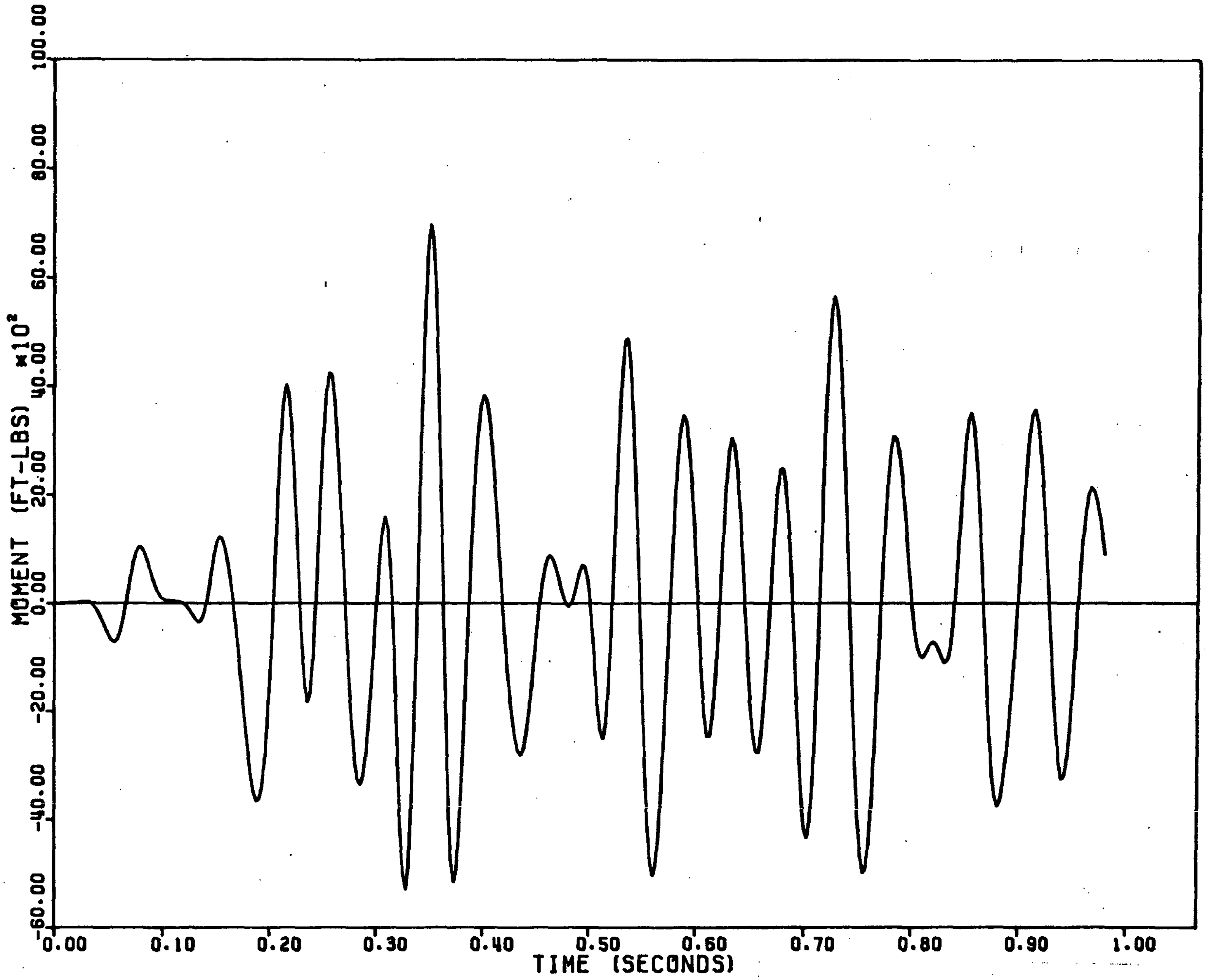


FIGURE C-27B. NSSS RECIRCULATION PIPING SWEEPOLET , NODE 144 LOCATION 4-13
SRV-ALL LOADING - RECORD 739 - MOMENT (FT-LBS) .NPTS = 393. DT = .0025

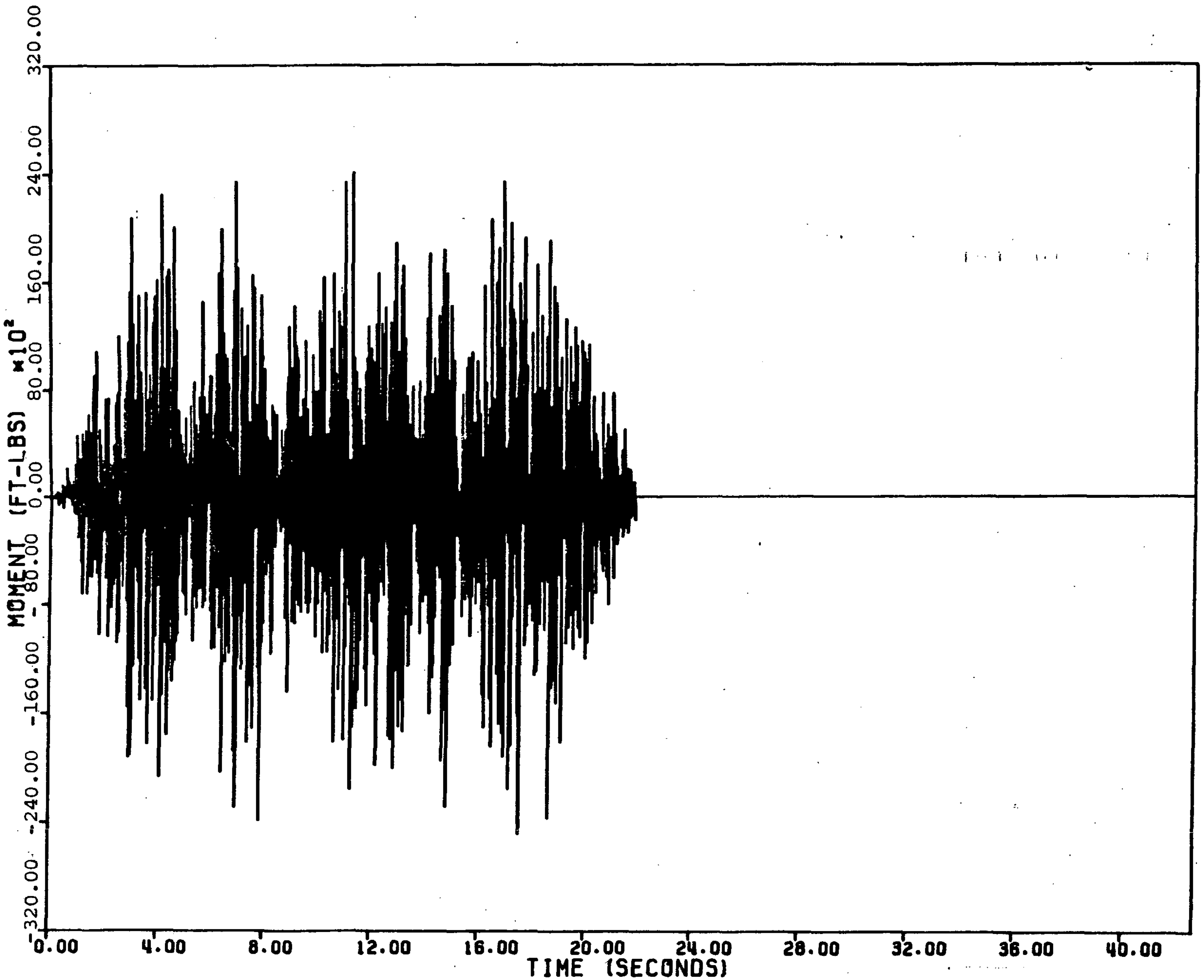


FIGURE C-28A. NSSS RECIRCULATION PIPING ELBOW , NODE 46, LOCATION 4-9
SSE LOADING - RECORD 705 - MOMENT (FT-LBS)) ,NPTS = 2183, DT = .0100

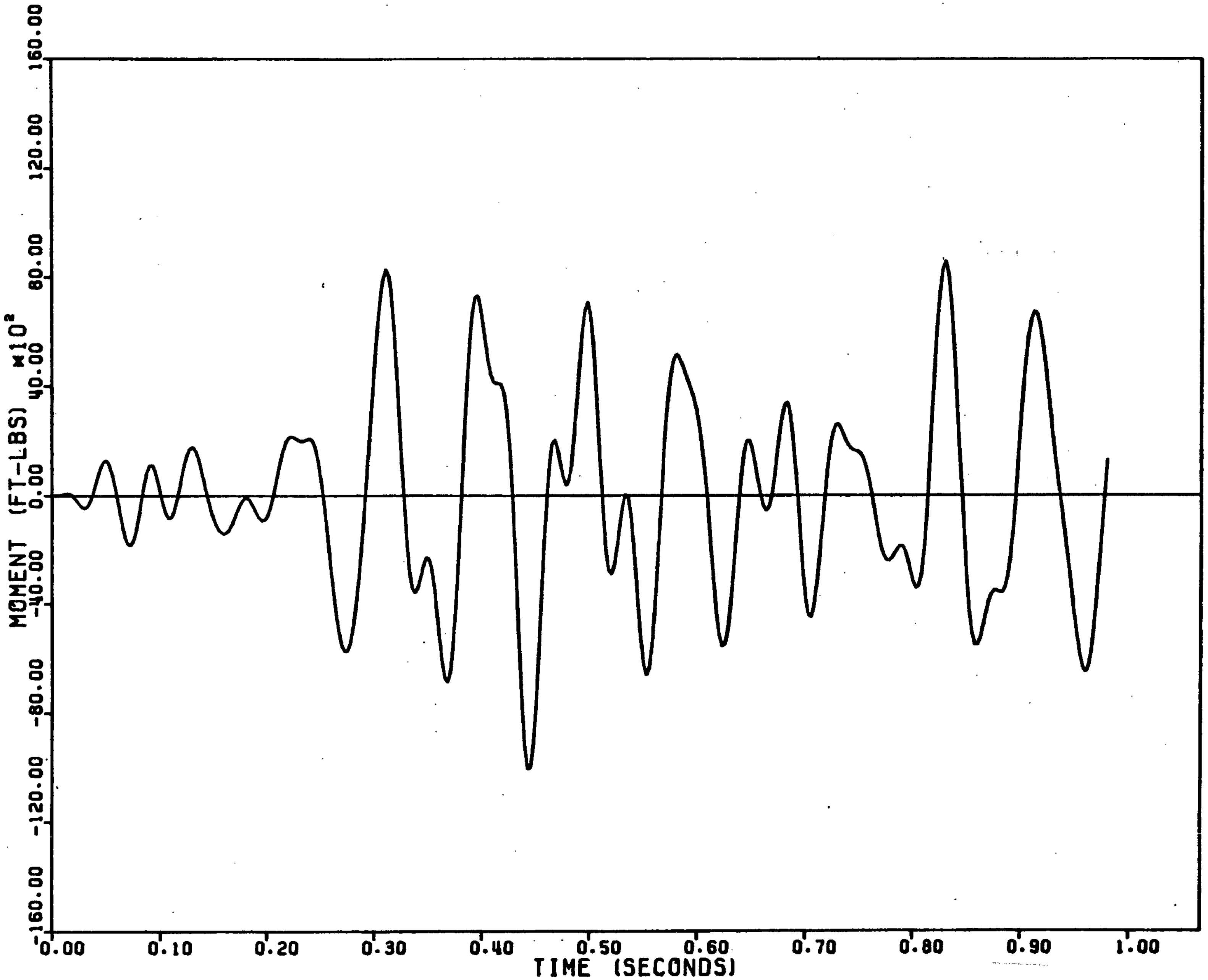


FIGURE C-28B. NSSS RECIRCULATION PIPING ELBOW , NODE 46, LOCATION 4-9
SRV-1 LOADING - RECORD 715 - MOMENT (FT-LBS) ,NPTS = 393, DT = .0025

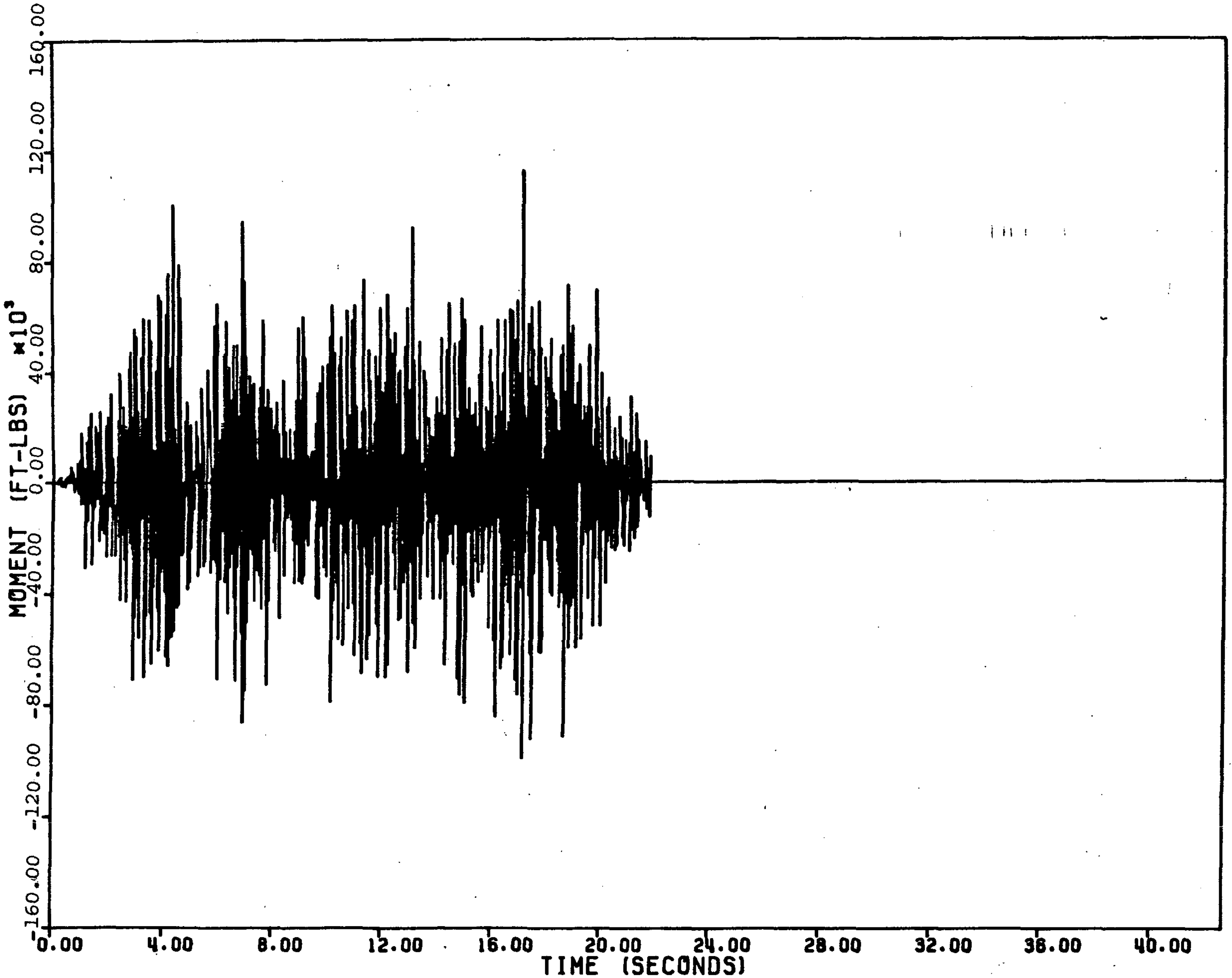


FIGURE 29A. NSSS RECIRCULATION PIPING TEE , NODE 64, LOCATION 4-10
SSE LOADING - RECORD 706 - MOMENT (FT-LBS)) ,NPTS = 2183, DT = .0100

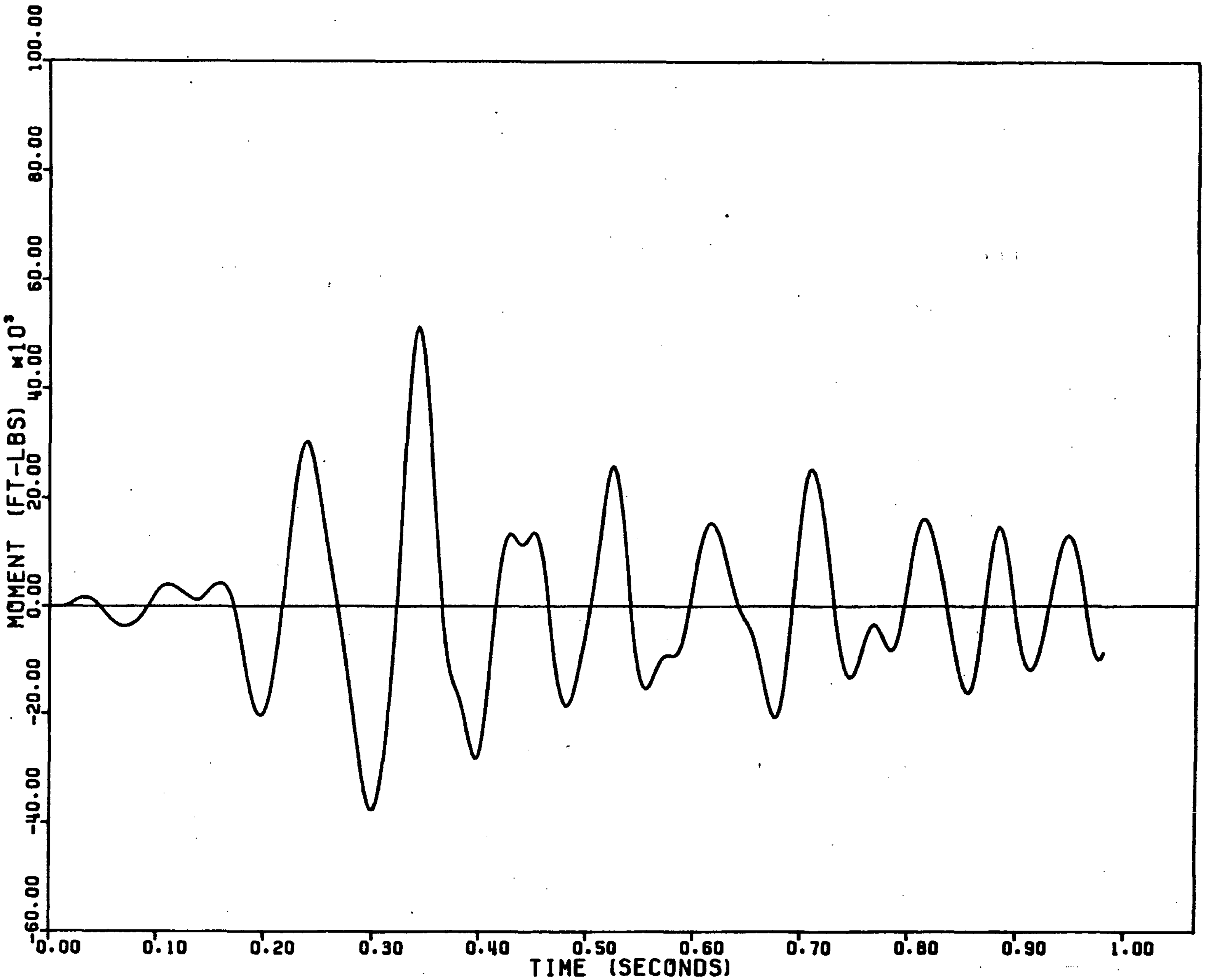


FIGURE 29B. NSSS RECIRCULATION PIPING TEE , NODE 64, LOCATION 4-10
SRV-ALL LOADING - RECORD 736 - MOMENT (FT-LBS) ,NPTS = 393, DT = .0025

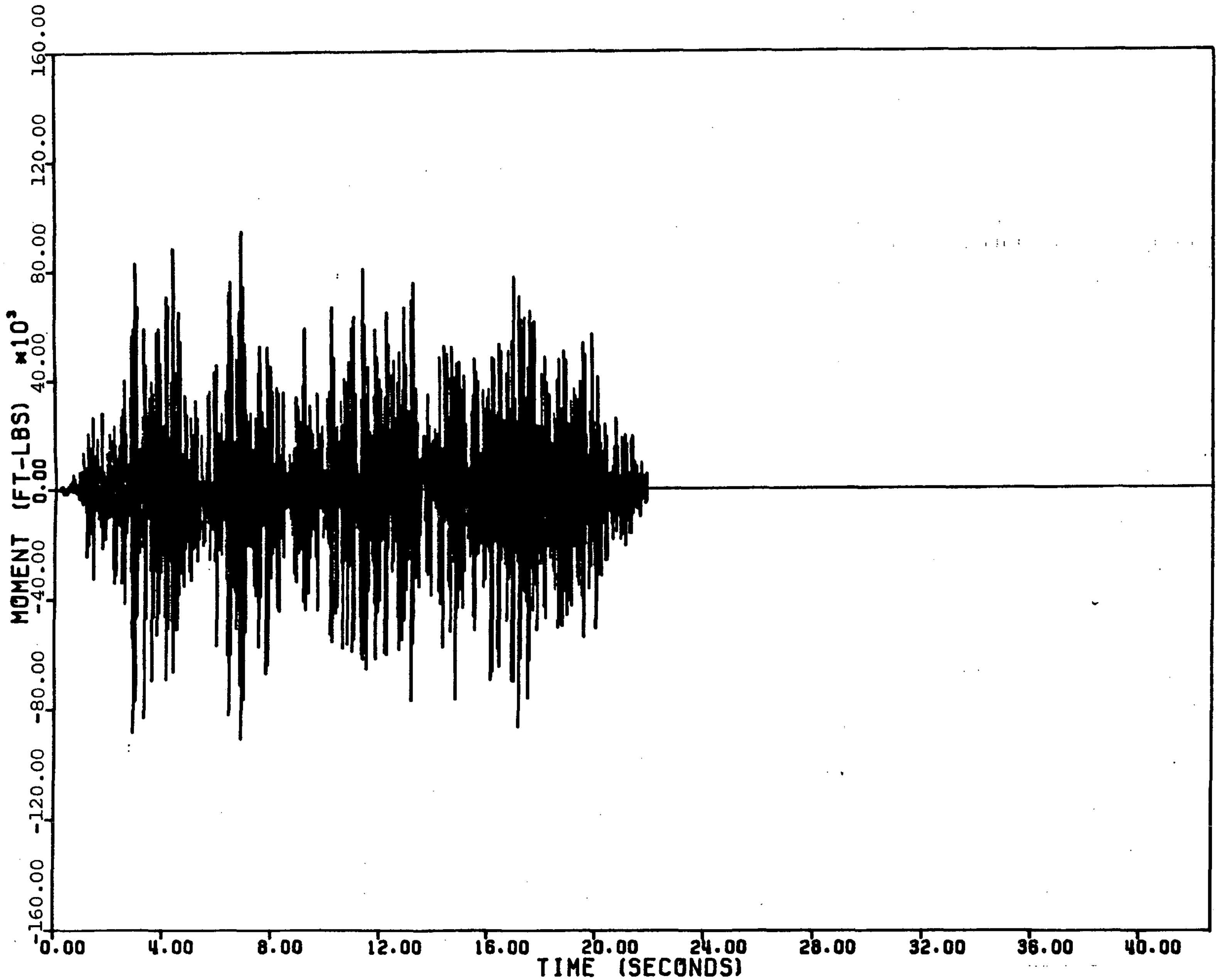


FIGURE C-30A. NSSS RECIRCULATION PIPING ELBOW , NODE 90, LOCATION 4-11
SSE LOADING - RECORD 707 - MOMENT (FT-LBS)) ,NPTS = 2183, DT = .0100

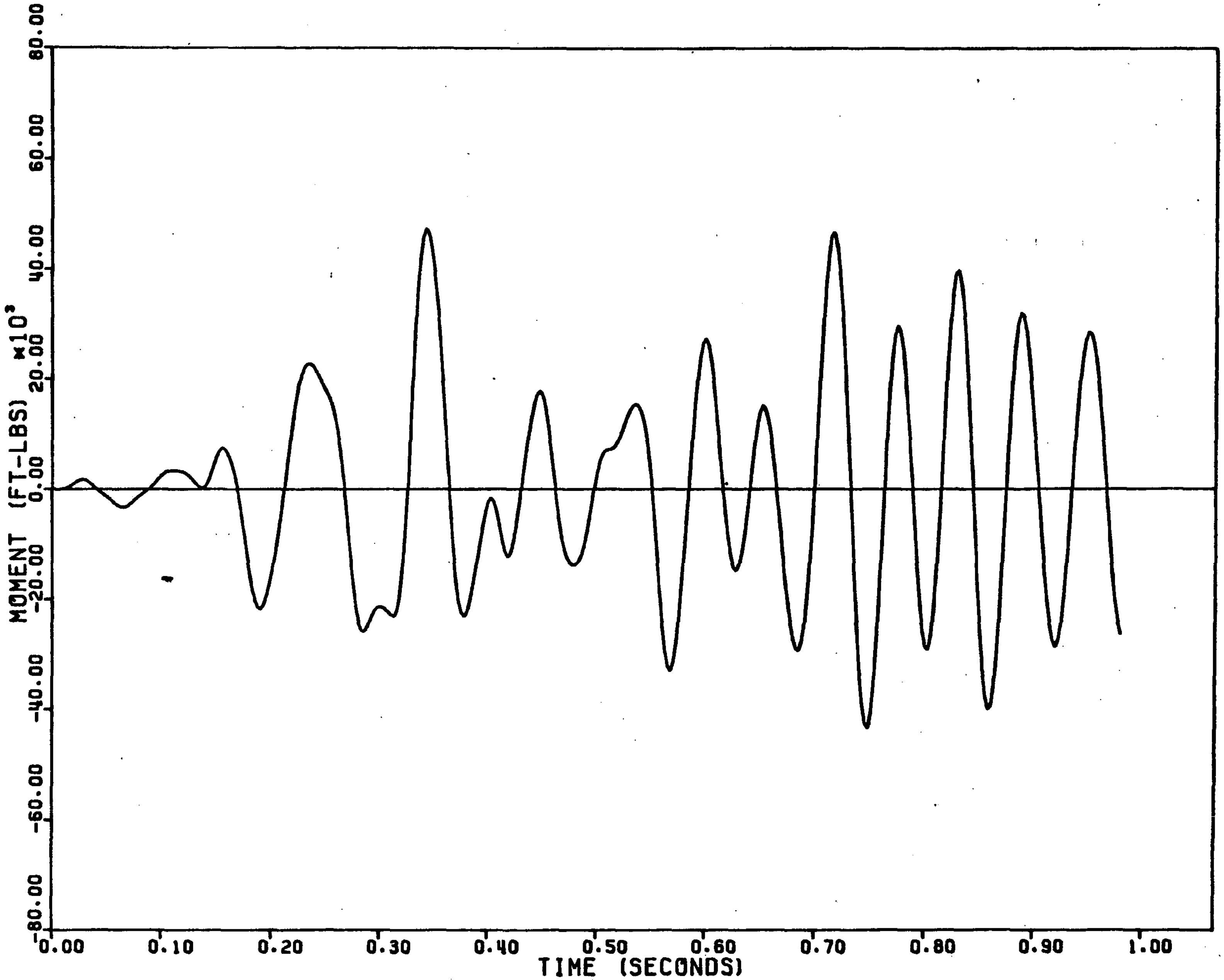


FIGURE C-30B. NSSS RECIRCULATION PIPING ELBOW . NODE 90. LOCATION 4-11
SRV-ALL LOADING - RECORD 737 - MOMENT (FT-LBS) .NPTS = 393. DT = .0025

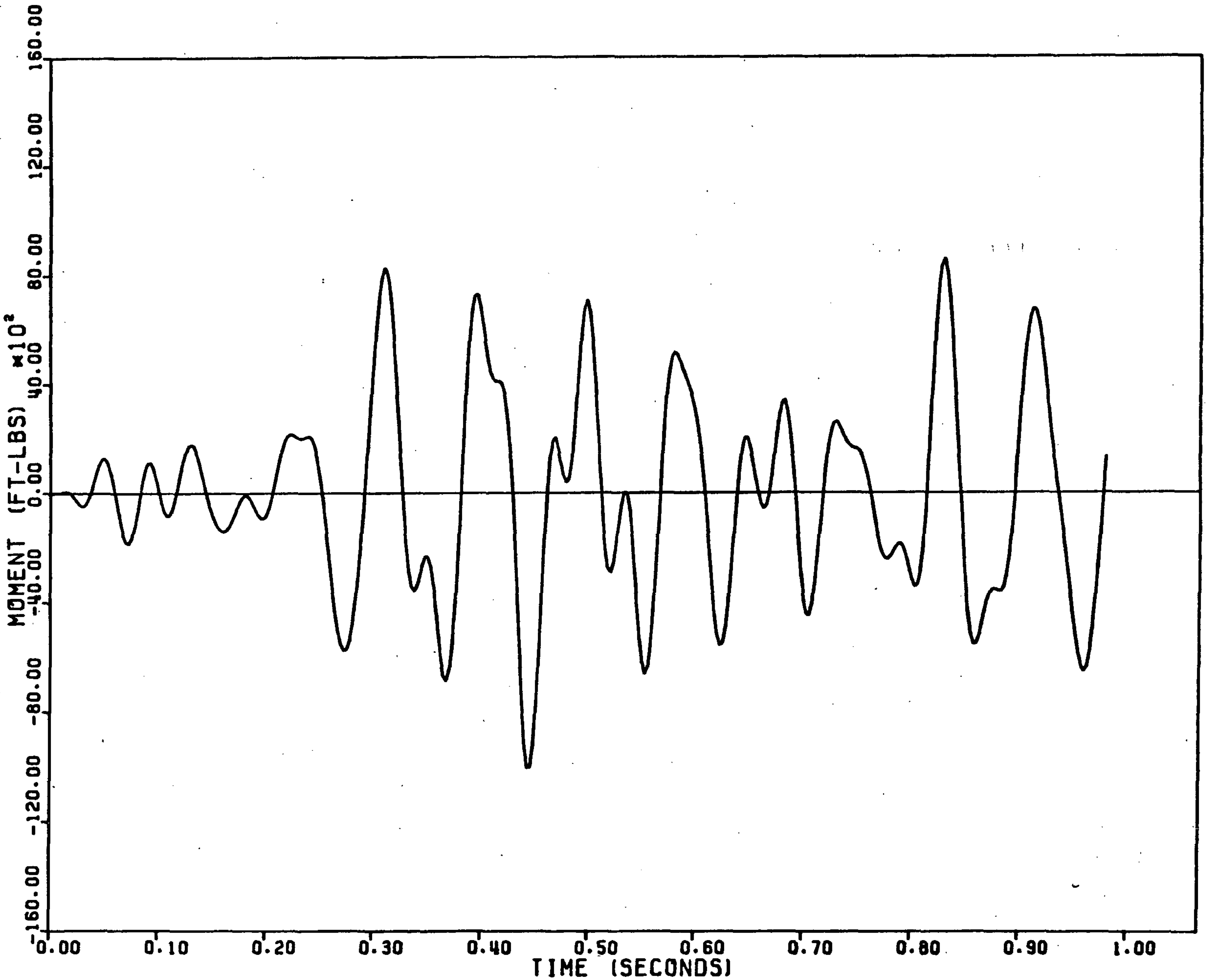


FIGURE C-31A. NSSS RECIRCULATION PIPING ELBOW , NODE 46, LOCATION 4-9
SRV-1 LOADING - RECORD 715 - MOMENT (FT-LBS) ,NPTS = 393, DT = .0025

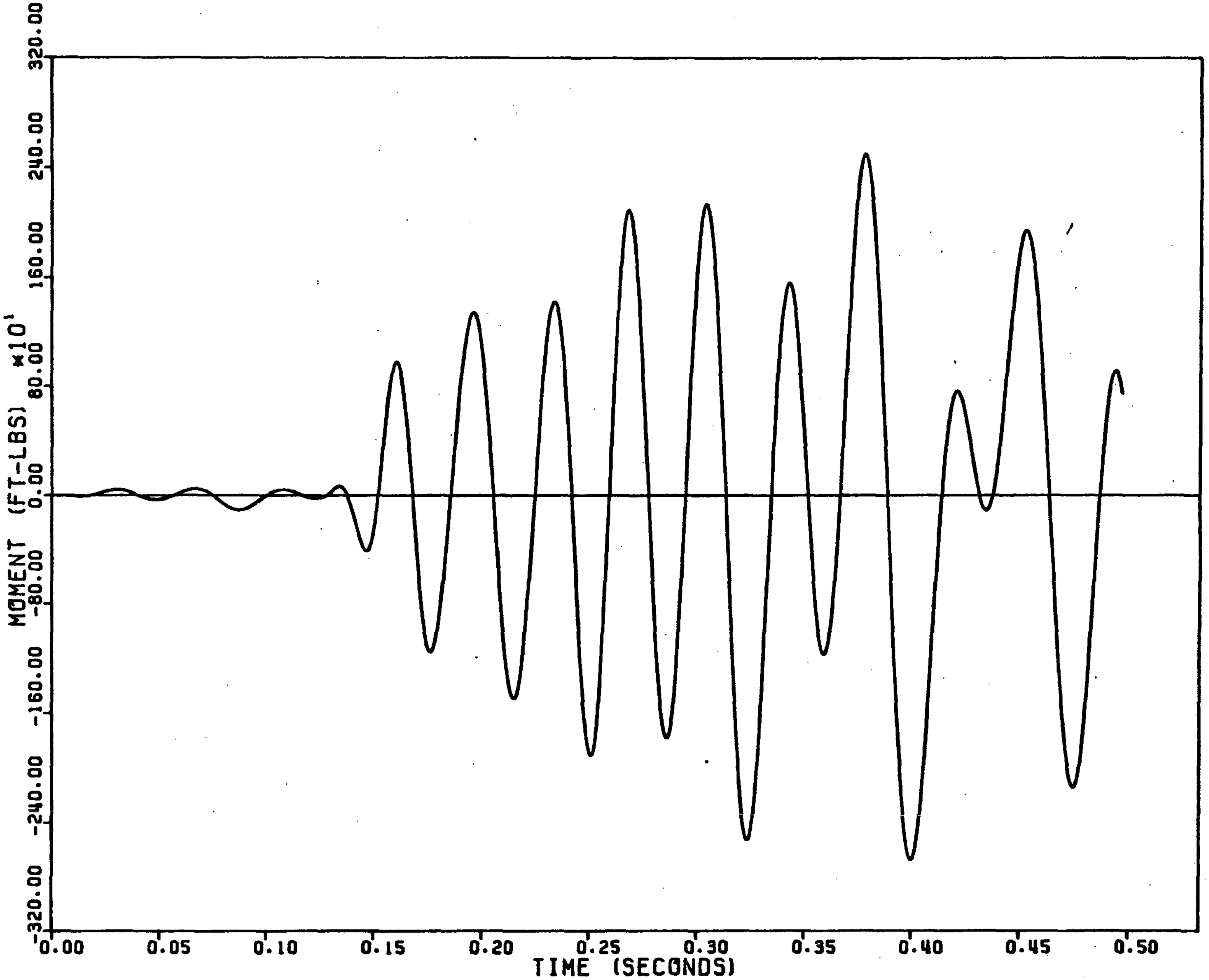


FIGURE C-31B. NSSS RECIRCULATION PIPING ELBOW , NODE 46, LOCATION 4-9
CHUG LOADING - RECORD 745 - MOMENT (FT-LBS) ,NPTS = 995, DT = .0005

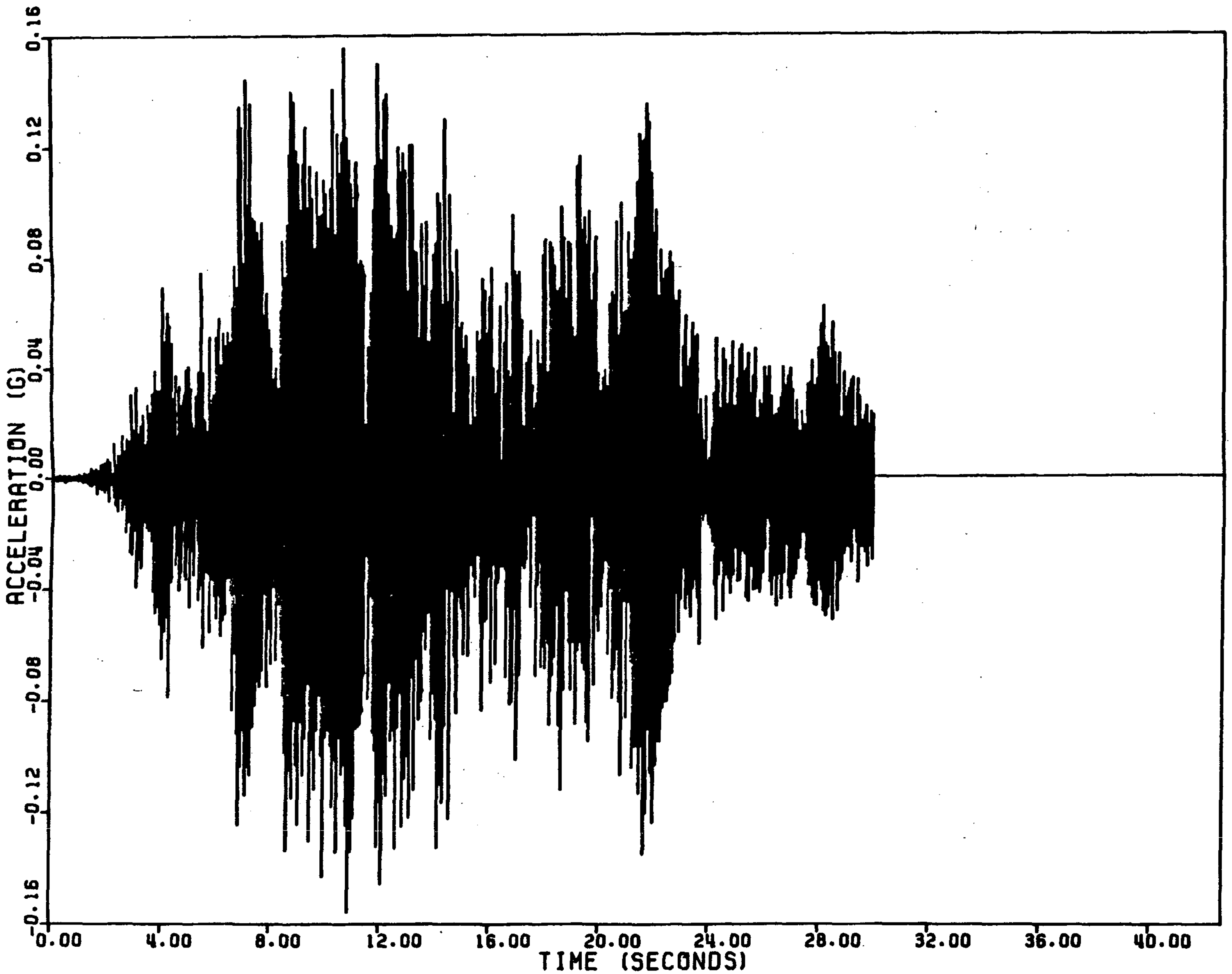


FIGURE C-32A. NSSS MAIN STEAM PIPING SRV C. G. , LOCATION 6-2
OBE LOADING - RECORD 802 - ACCELERATION (G) ,NPTS = 4989, DT = .006

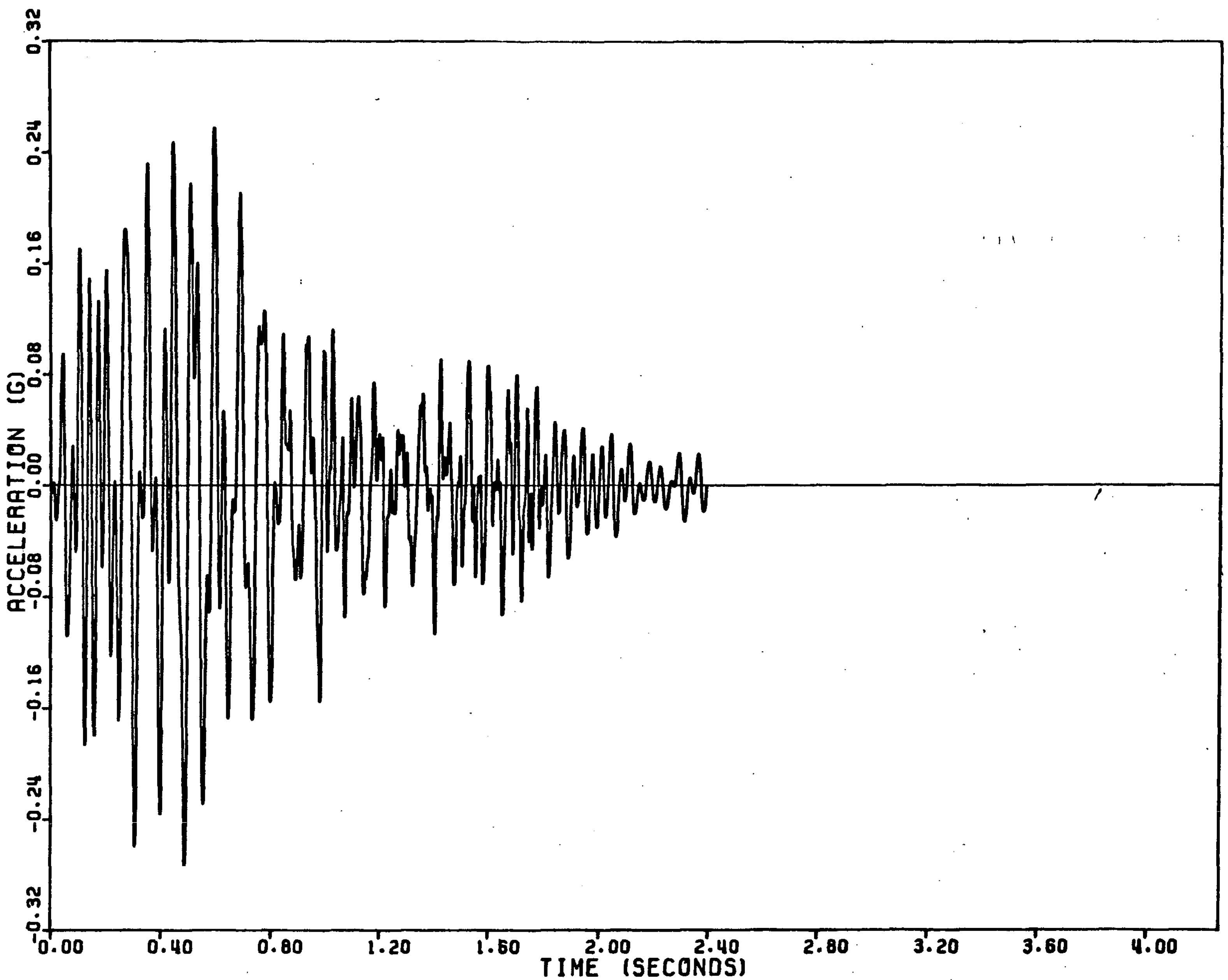


FIGURE C-32B. NSSS MAIN STEAM PIPING SRV C. G. , LOCATION 6-2
SRV-1 LOADING - RECORD 812 - ACCELERATION (G) .NPTS = 2393. DT = .001

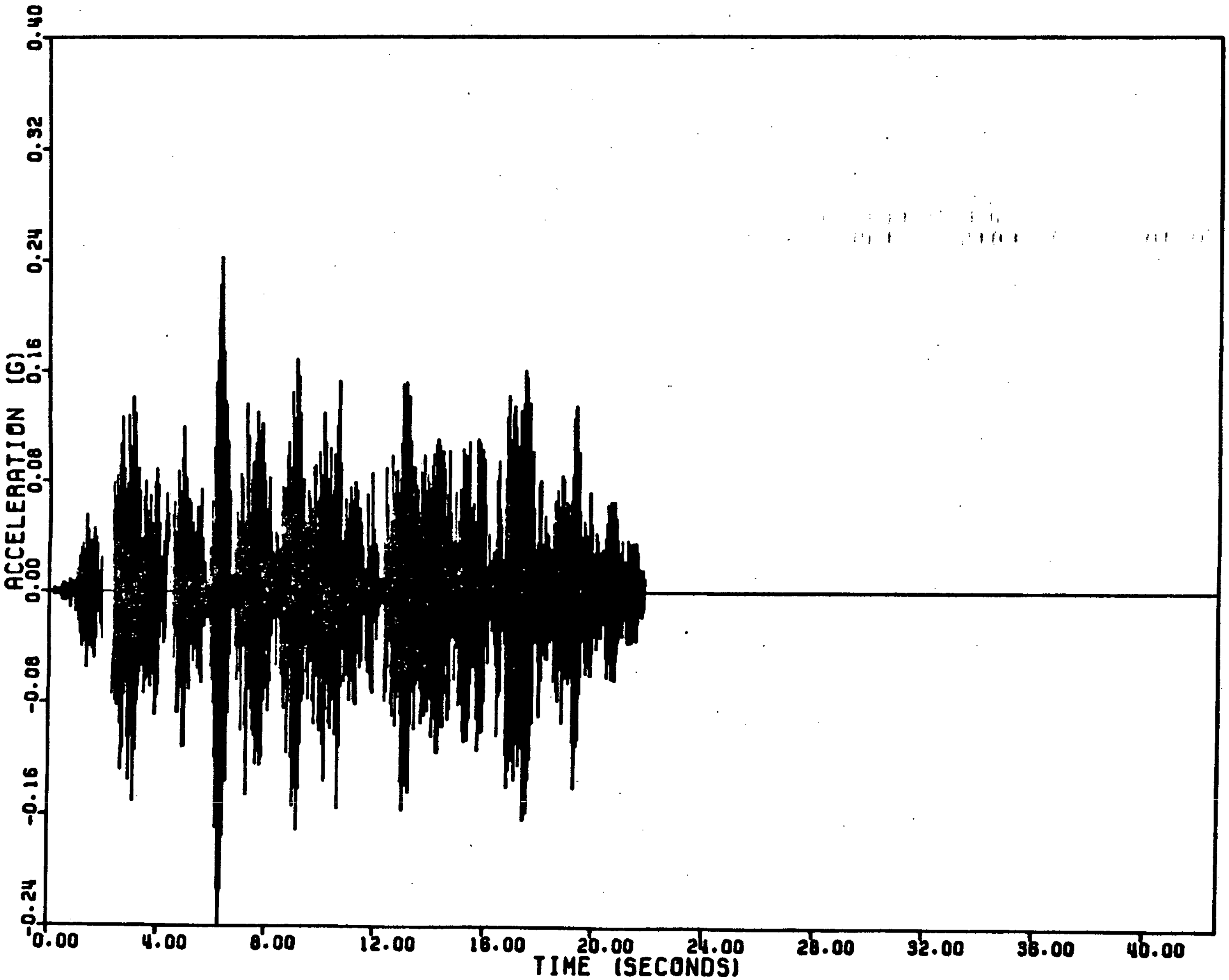


FIGURE C-33A. NSSS RECIRCULATION PIPING FLOW CONTROL VALVE.LOCATION 4-6
OBE LOADING - RECORD 702 - ACCELERATION (G) .NPTS = 2183, DT = .0100

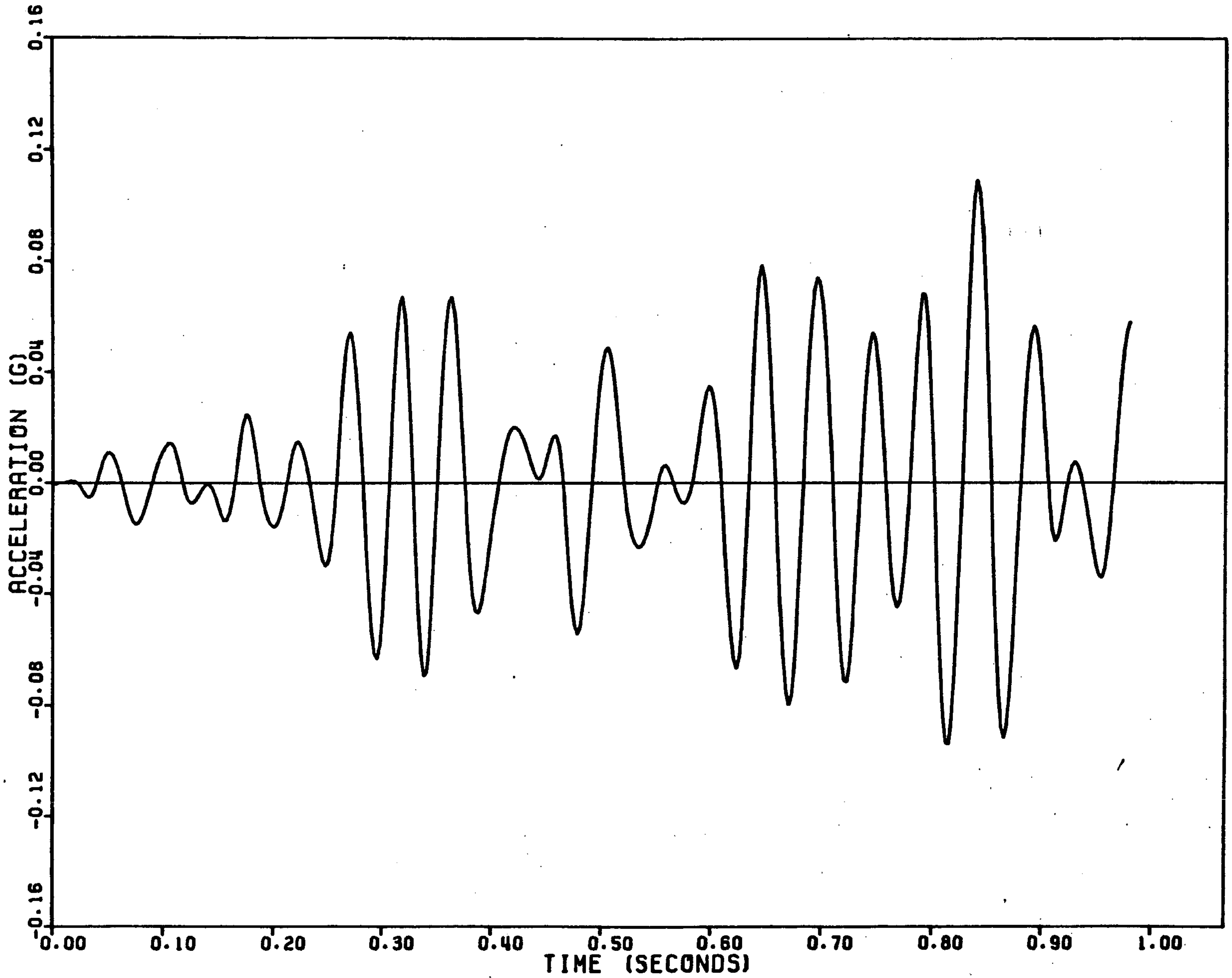


FIGURE C-33B. NSSS RECIRCULATION PIPING FLOW CONTROL VALVE,LOCATION 4-6
SRV-1 LOADING - RECORD 712 - ACCELERATION (G) ,NPTS = 393, DT = .0025

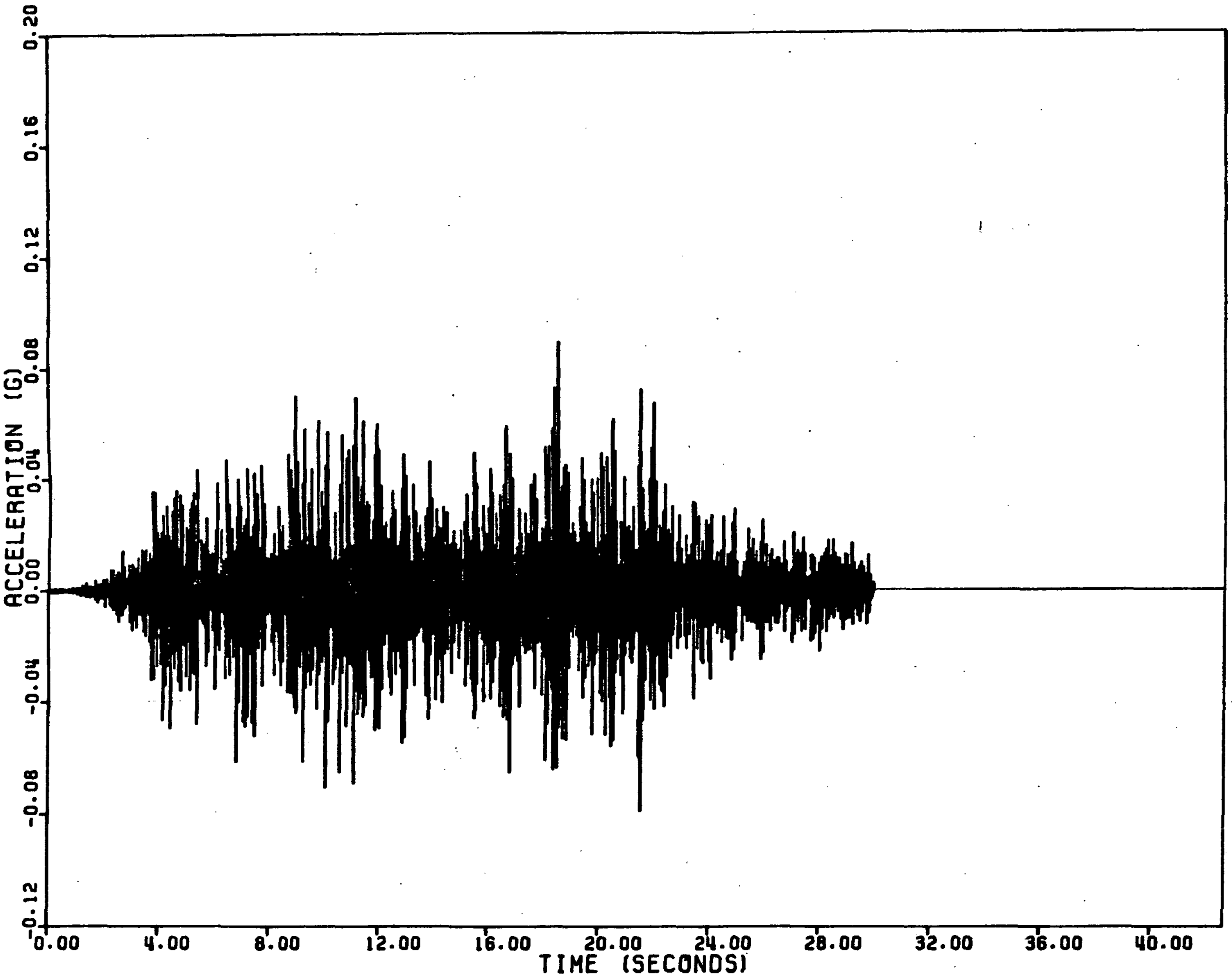


FIGURE C-34A. NSSS MAIN STEAM PIPING MSIV C. G. , LOCATION 6-3
OBE LOADING - RECORD 803 - ACCELERATION (G) ,NPTS = 4989, DT = .006

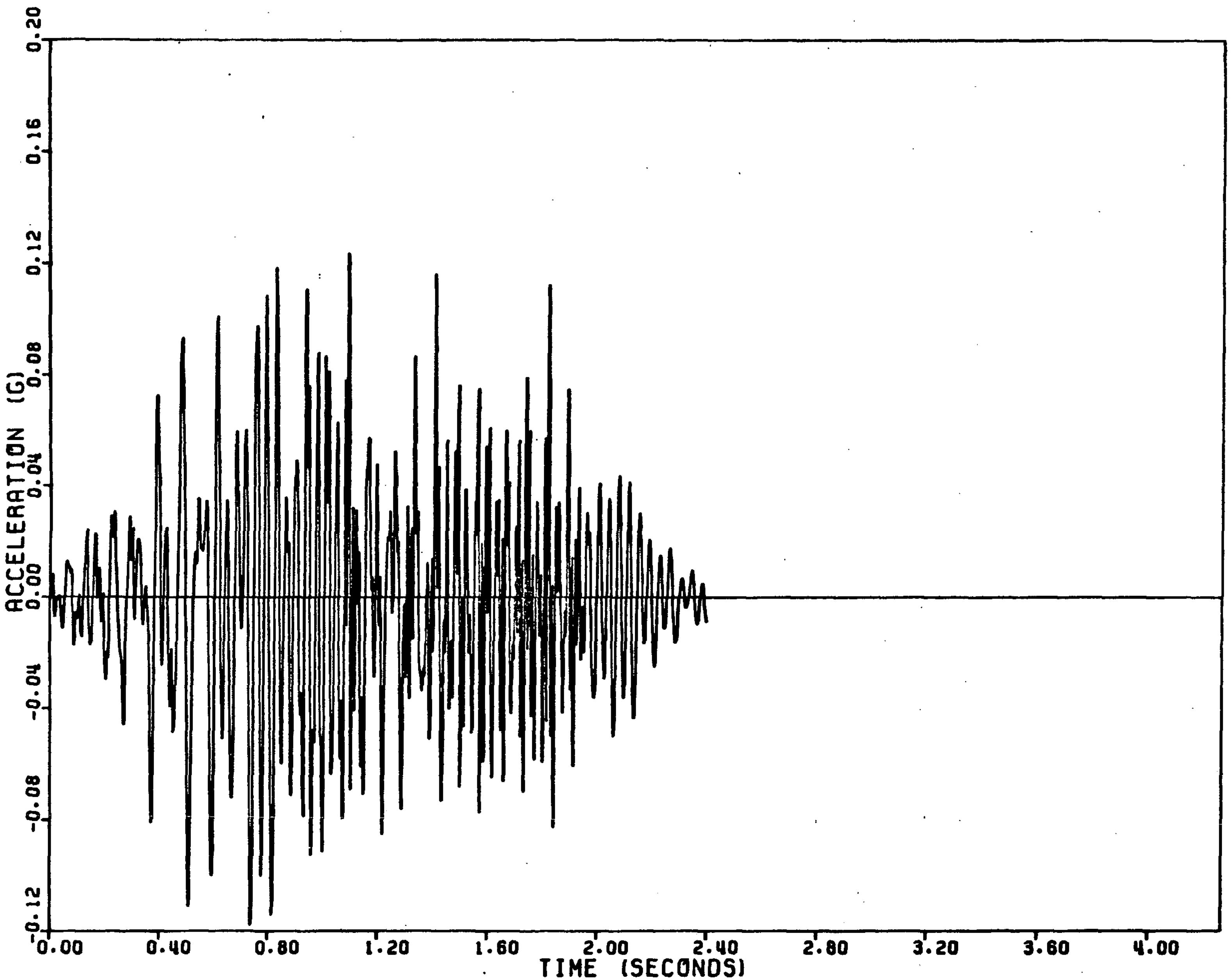


FIGURE C-34B. NSSS MAIN STEAM PIPING MSIV C. G. , LOCATION 6-3
SRV-ALL LOADING - RECORD 833 - ACCELERATION (G) ,NPTS = 799, DT = .003

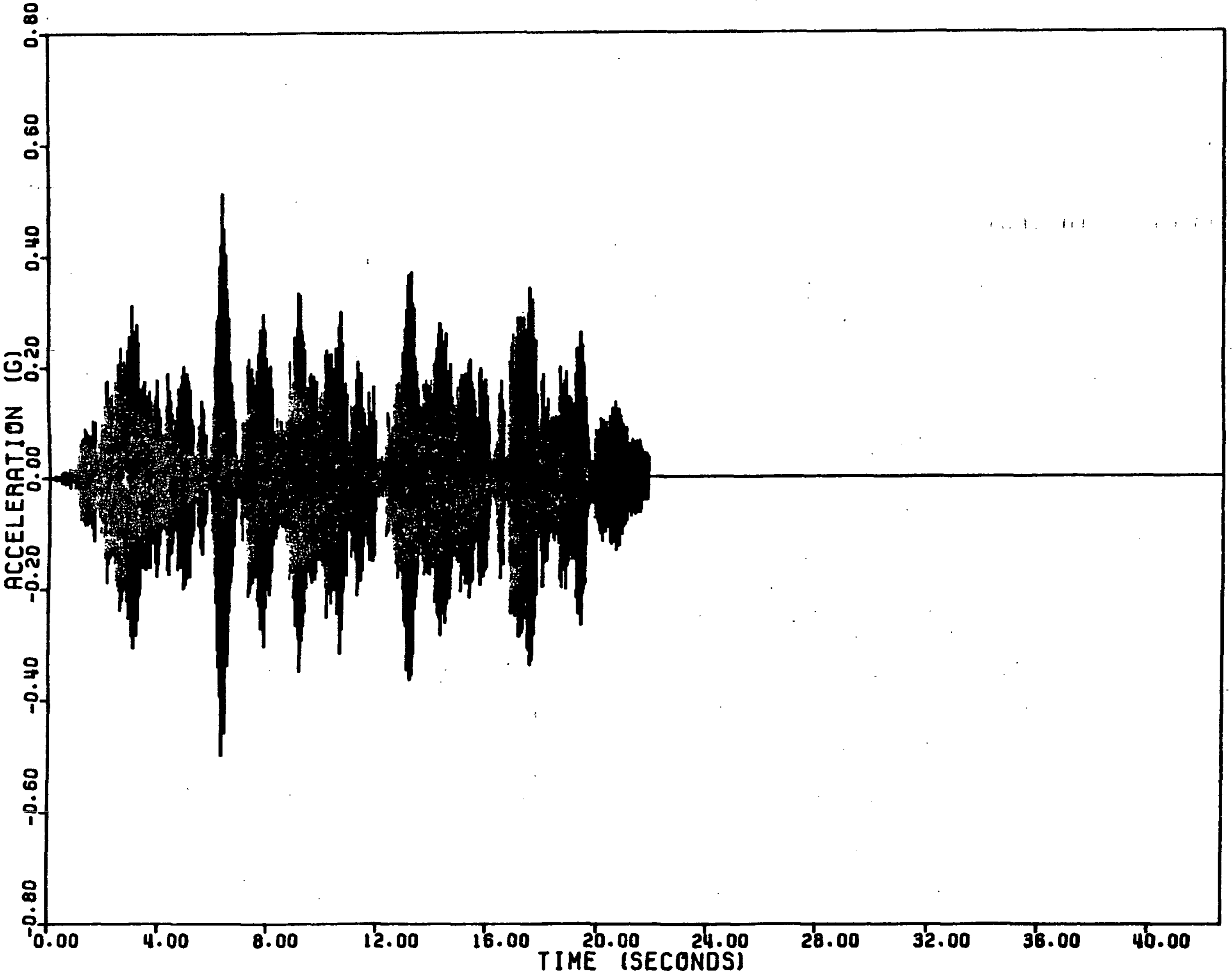


FIGURE C-35A. NSSS RECIRCULATION PIPING DISCHARGE VALVE, LOCATION 4-7
OBE LOADING - RECORD 703 - ACCELERATION (G) .NPTS = 2183, DT = .0100

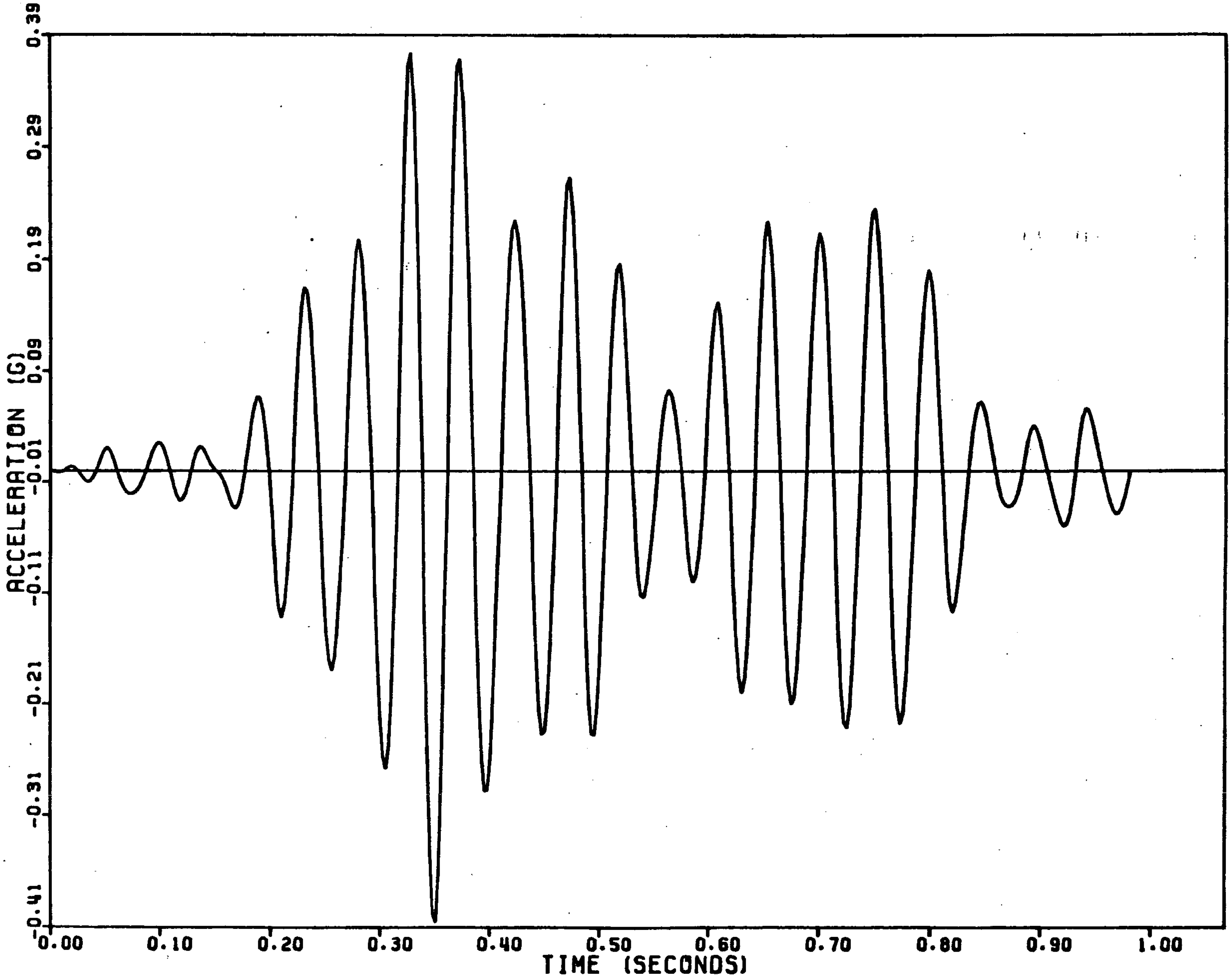


FIGURE C-35B. NSSS RECIRCULATION PIPING DISCHARGE VALVE, LOCATION 4-7
SRV-ALL LOADING - RECORD 733 - ACCELERATION (G) .NPTS = 393, DT = .0025

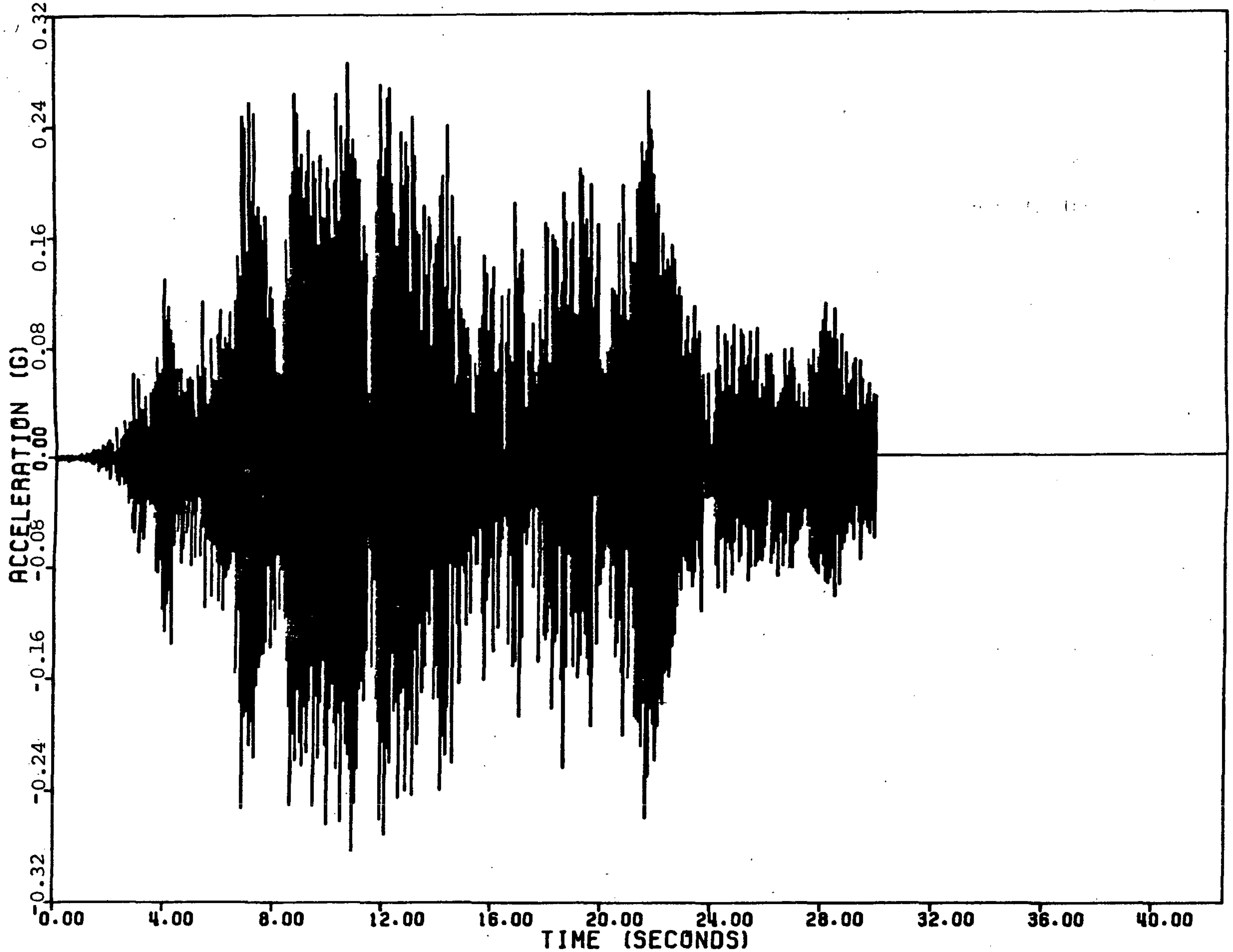


FIGURE C-36A, NSSS MAIN STEAM PIPING SRV C. G. . LOCATION 6-1
SSE LOADING - RECORD 801 - ACCELERATION (G) .NPTS = 4989, DT = .006

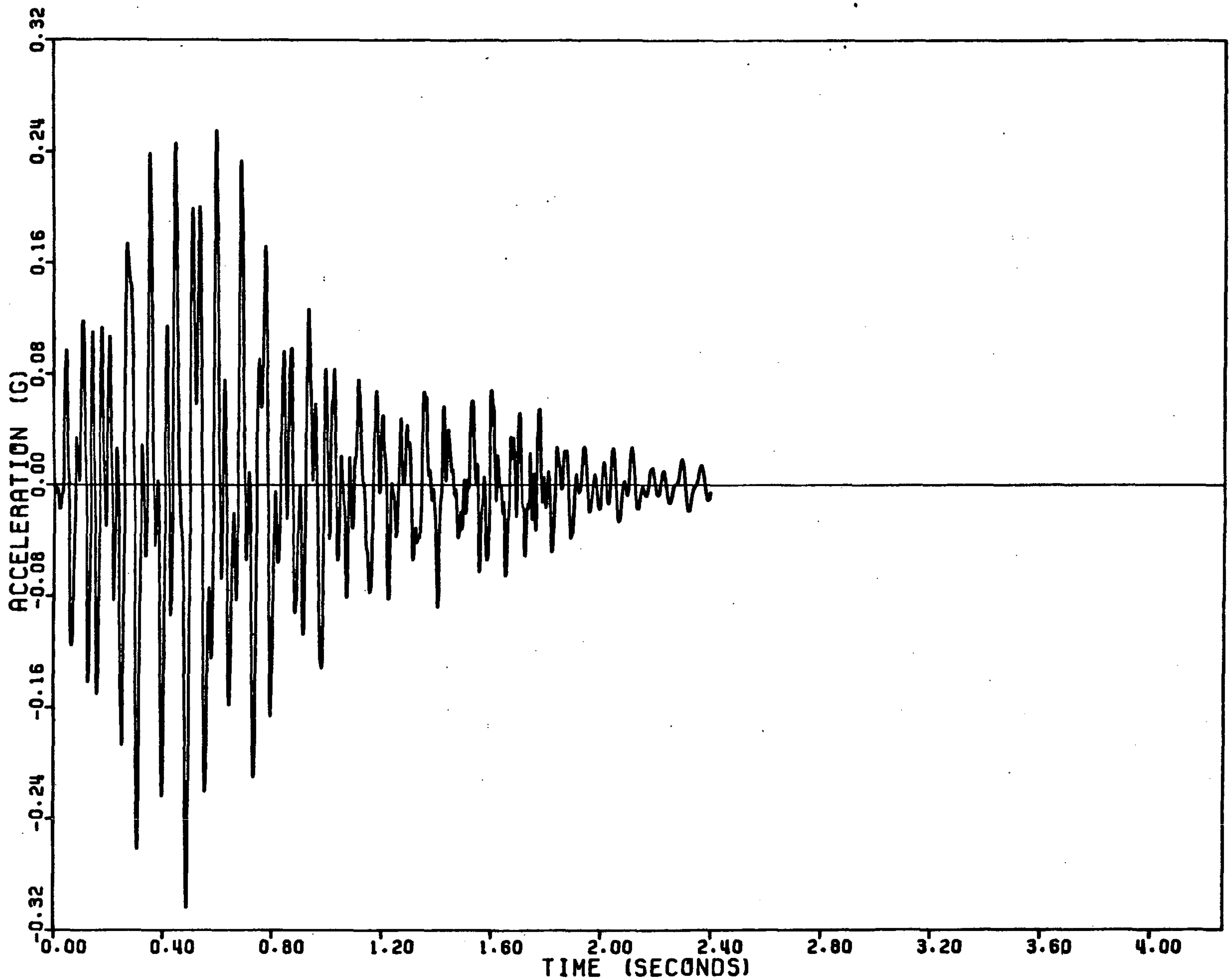


FIGURE C-36B. NSSS MAIN STEAM PIPING SRV C. G. , LOCATION 6-1
SRV-1 LOADING - RECORD 811 - ACCELERATION (G) ,NPTS = 2393, DT = .001

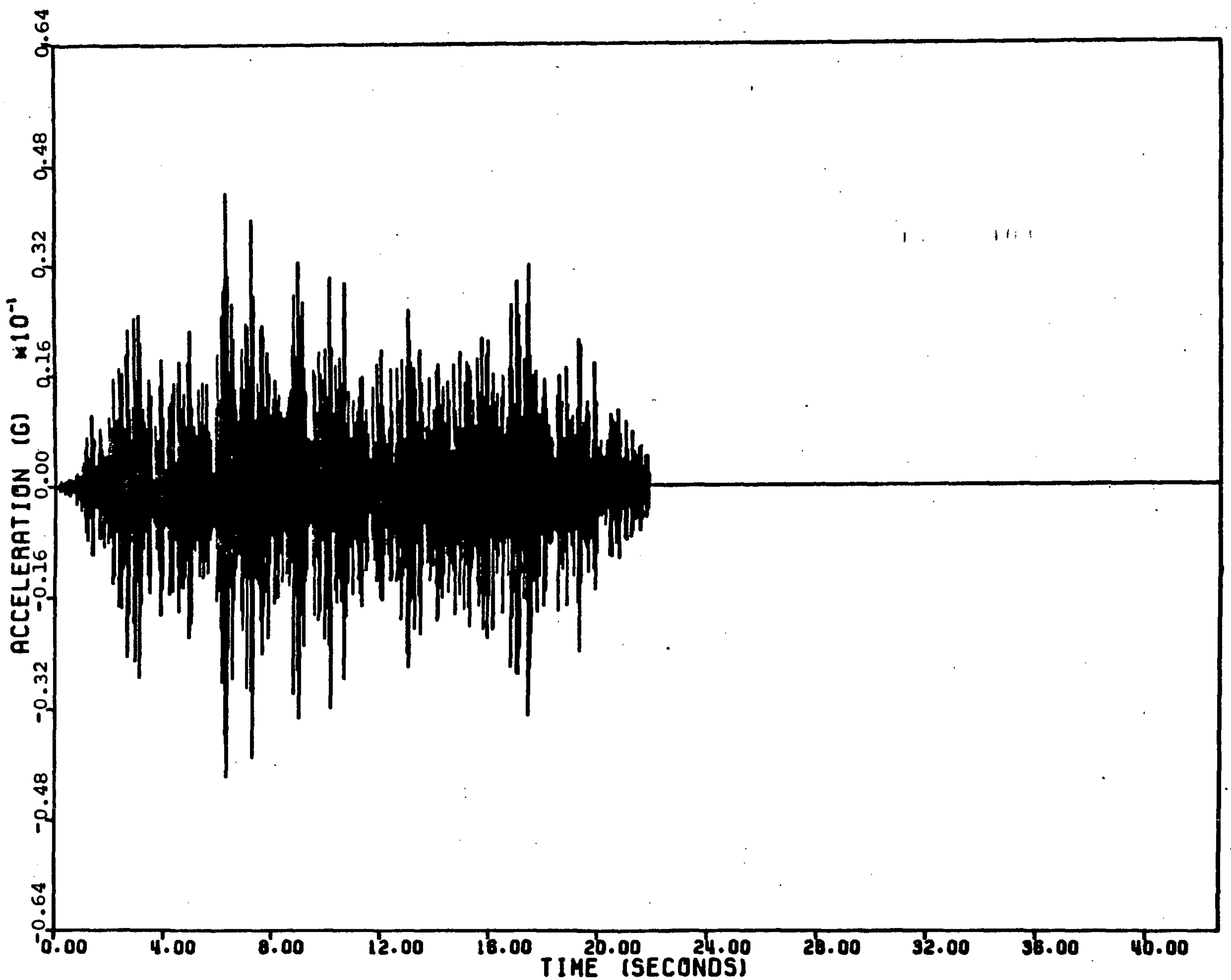


FIGURE C-37A. NSSS RECIRCULATION PIPING PUMP C. G. ,LOCATION 4-5
SSE LOADING - RECORD 701 - ACCELERATION (G) ,NPTS = 2183, DT = .0100

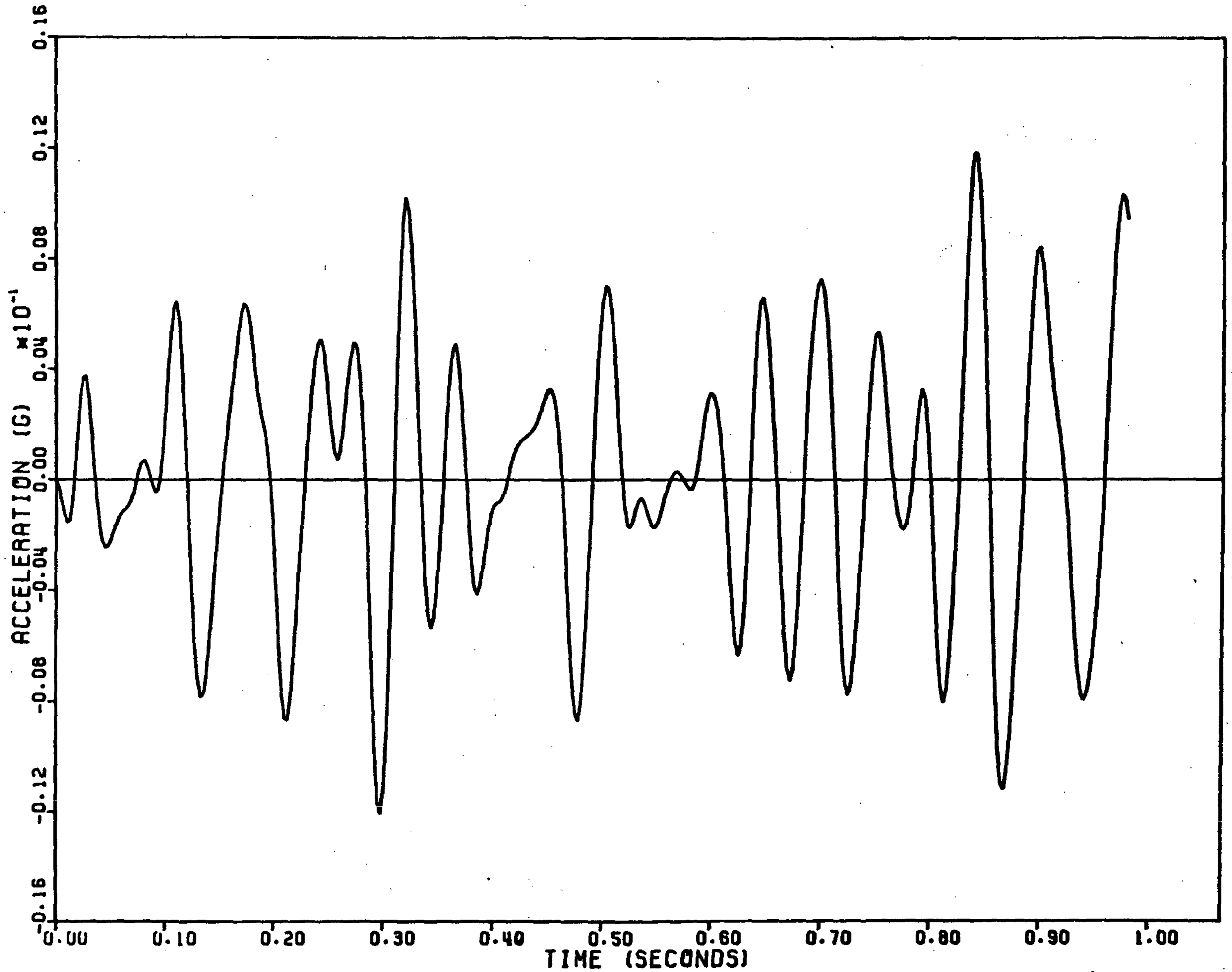


FIGURE C-37B. NSSS RECIRCULATION PIPING PUMP C. G. ,LOCATION 4-5
SRV-1 LOADING - RECORD 711 - ACCELERATION (G) ,NPTS = 393. DT = .0025

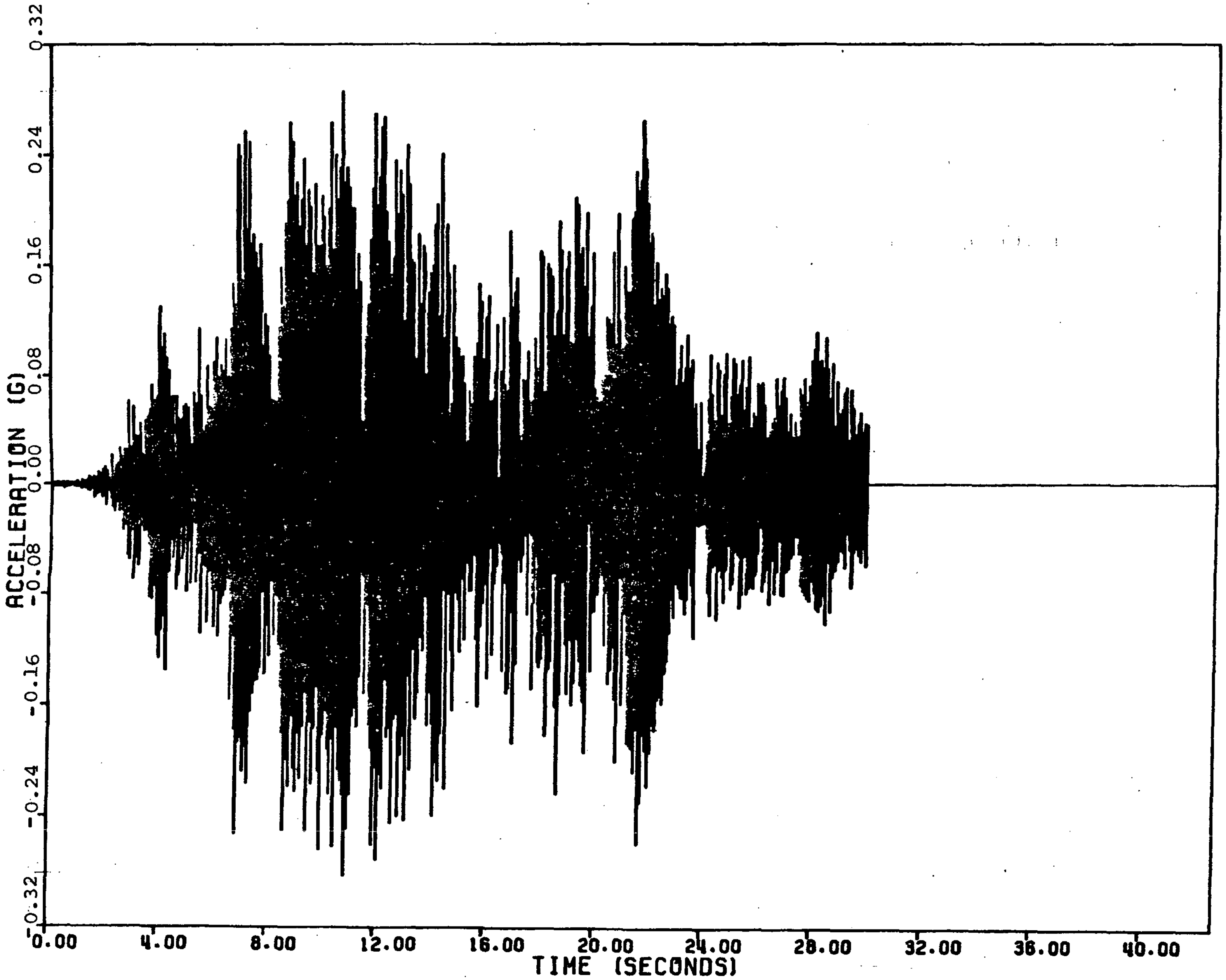


FIGURE C-38A. NSSS MAIN STEAM PIPING SRV C. G. , LOCATION 6-1
SSE LOADING - RECORD 801 - ACCELERATION (G) ,NPTS = 4989, DT = .006

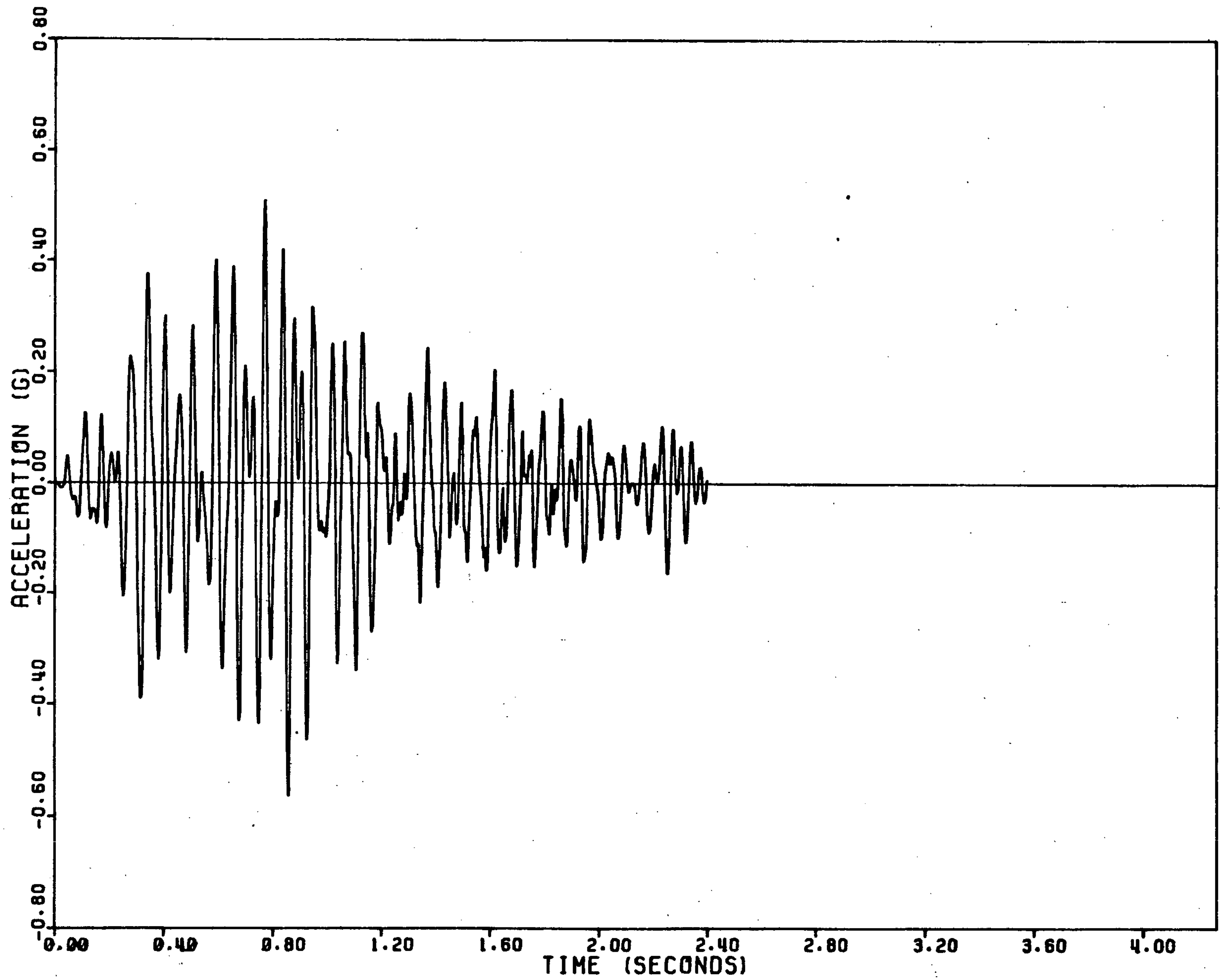


FIGURE C-38B. NSSS MAIN STEAM PIPING SRV C. G. , LOCATION 6-1
SRV-ALL LOADING - RECORD 831 - ACCELERATION (G) ,NPTS = 799, DT = .003

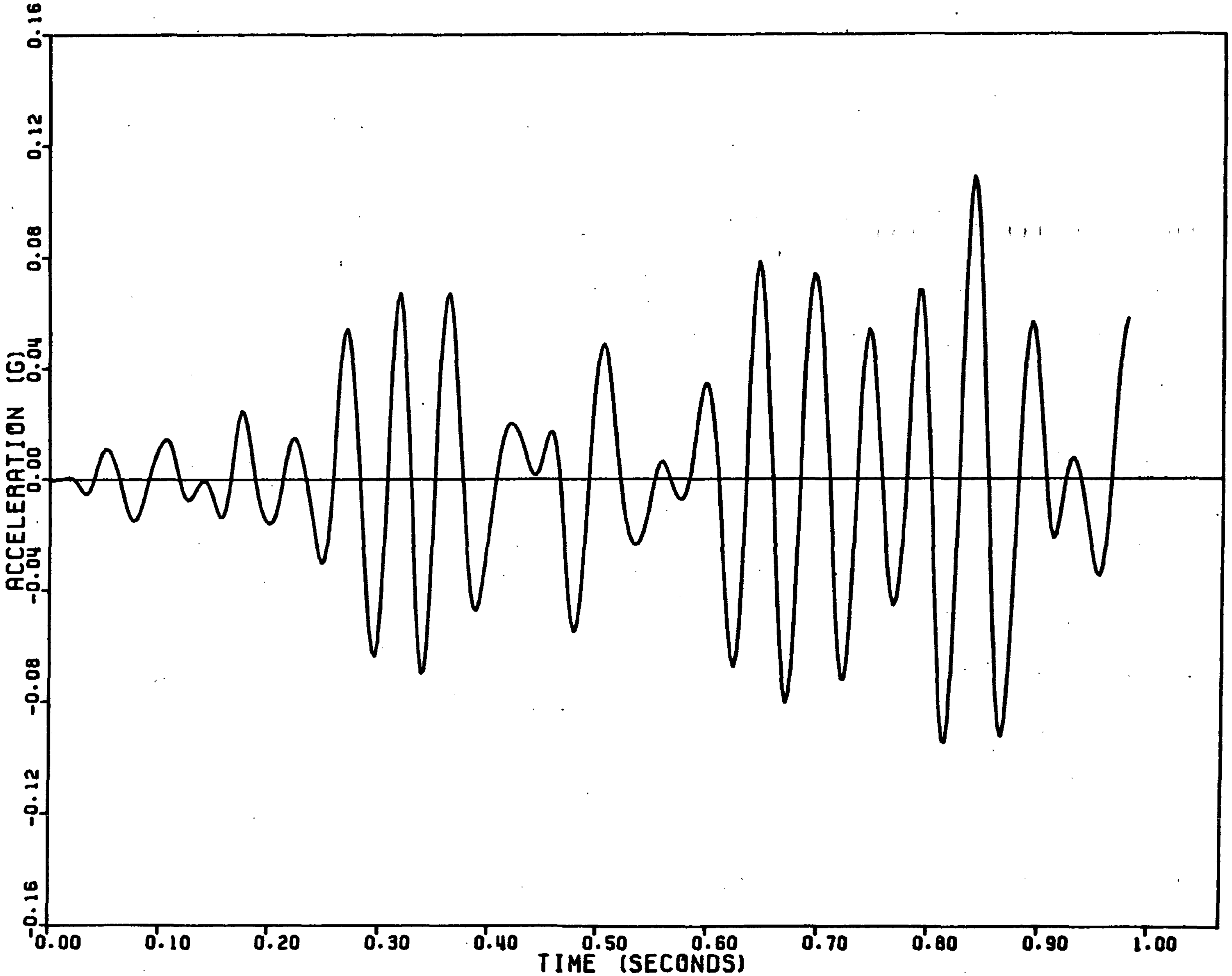


FIGURE C-39A. NSSS RECIRCULATION PIPING FLOW CONTROL VALVE, LOCATION 4-6
SRV-1 LOADING - RECORD 712 - ACCELERATION (G) .NPTS = 393, DT = .0025

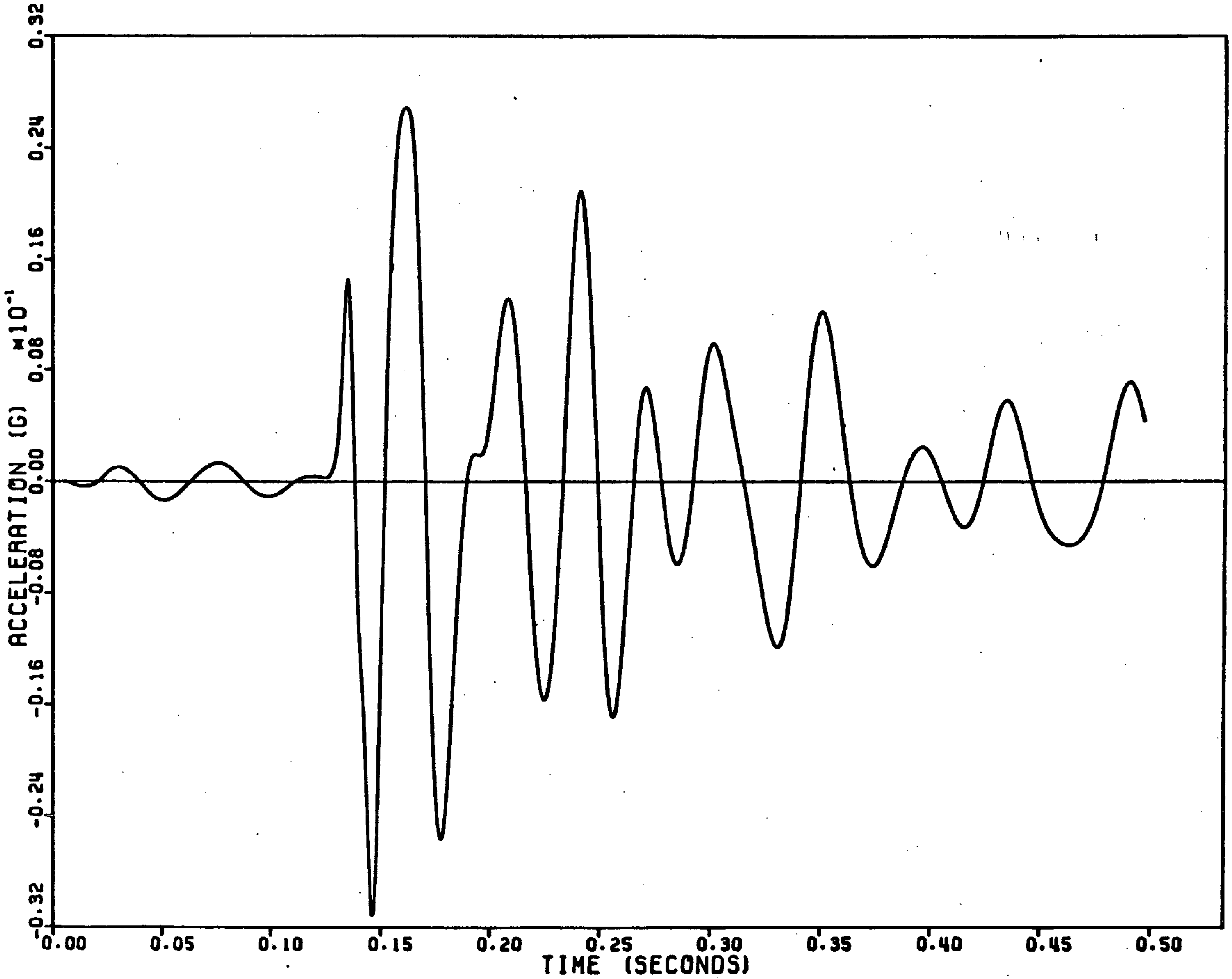


FIGURE C-39B. NSSS RECIRCULATION PIPING FLOW CONTROL VALVE, LOCATION 4-6
CHUG LOADING - RECORD 742 - ACCELERATION (G) , NPTS = 995, DT = .0005

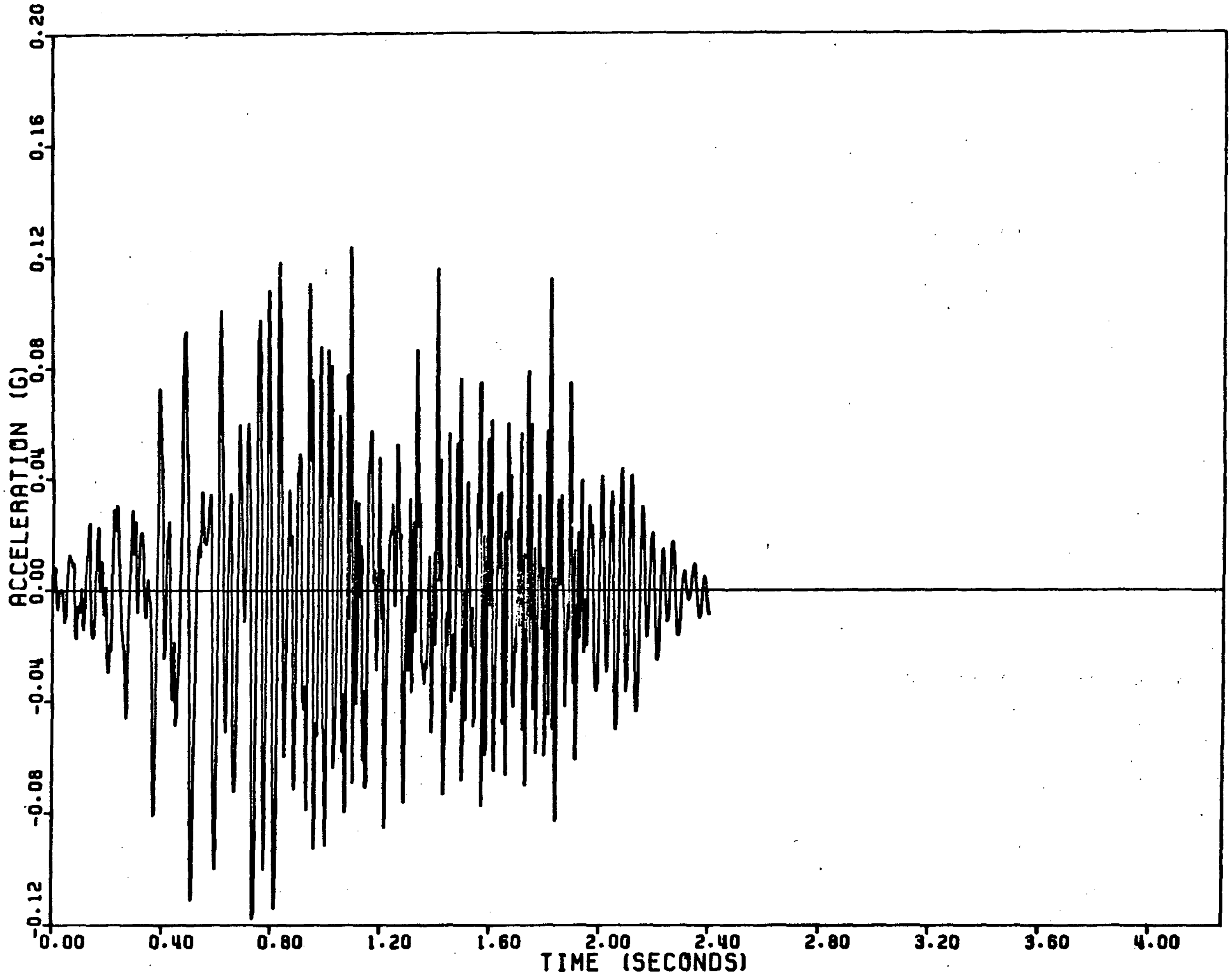


FIGURE C-40A. NSSS MAIN STEAM PIPING MSIV C. G. , LOCATION 6-3
SRV-ALL LOADING - RECORD 833 - ACCELERATION (G) ,NPTS = 799, DT = .003

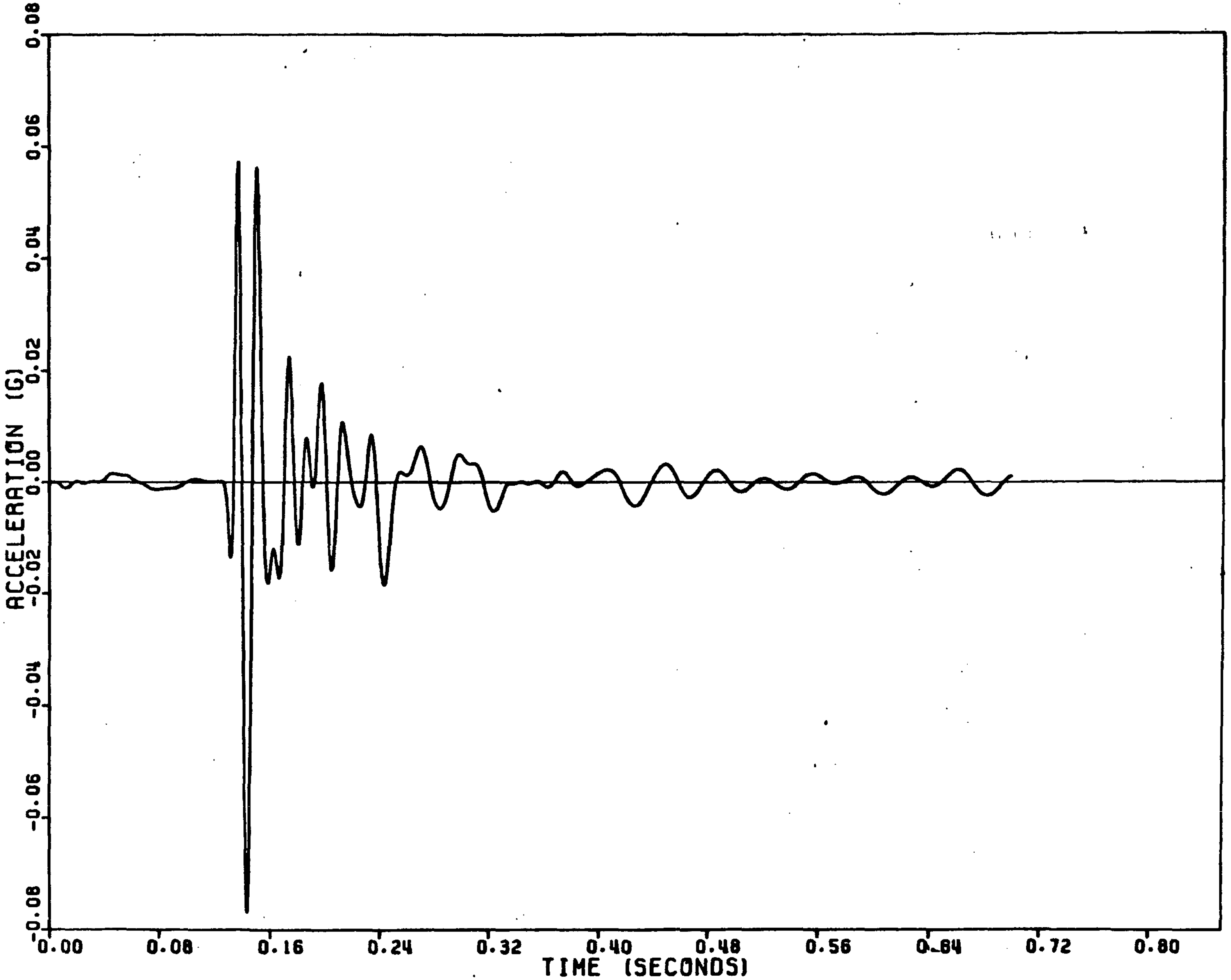


FIGURE C-40B. NSSS MAIN STEAM PIPING MSIV C. G. , LOCATION 6-3
CHUG LOADING - RECORD 843 - ACCELERATION (G) .NPTS = 699. DT = .001

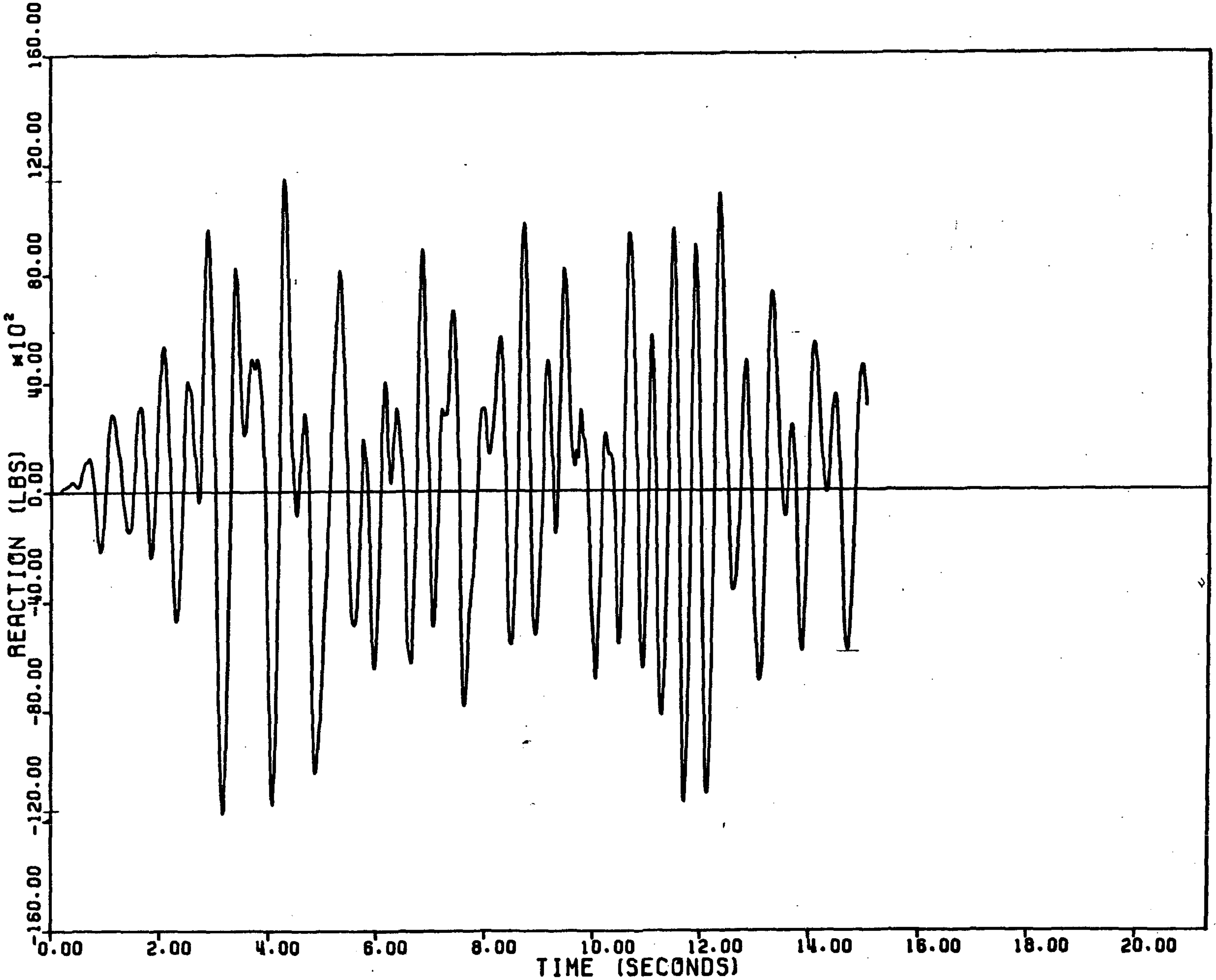


FIGURE C-41A. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-2
OBE LOADING - RECORD 102 - SUPPORT FORCE (LBS) - NPTS = 1504, DT = .01

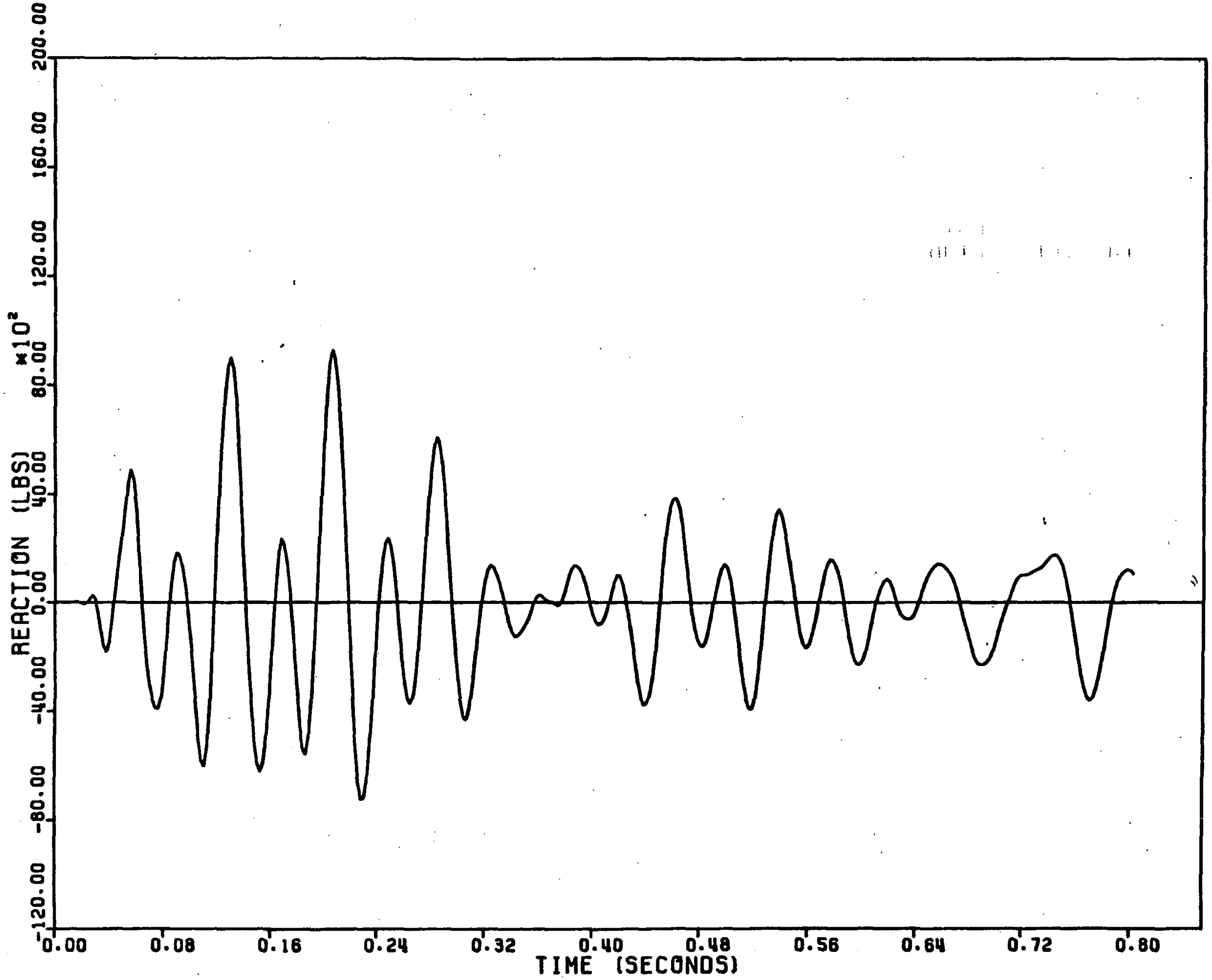


FIGURE C-41B. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-2
SRV-1 LOADING - RECORD 109 - SUPPORT FORCE (LBS) - NPTS = 401, DT = .002

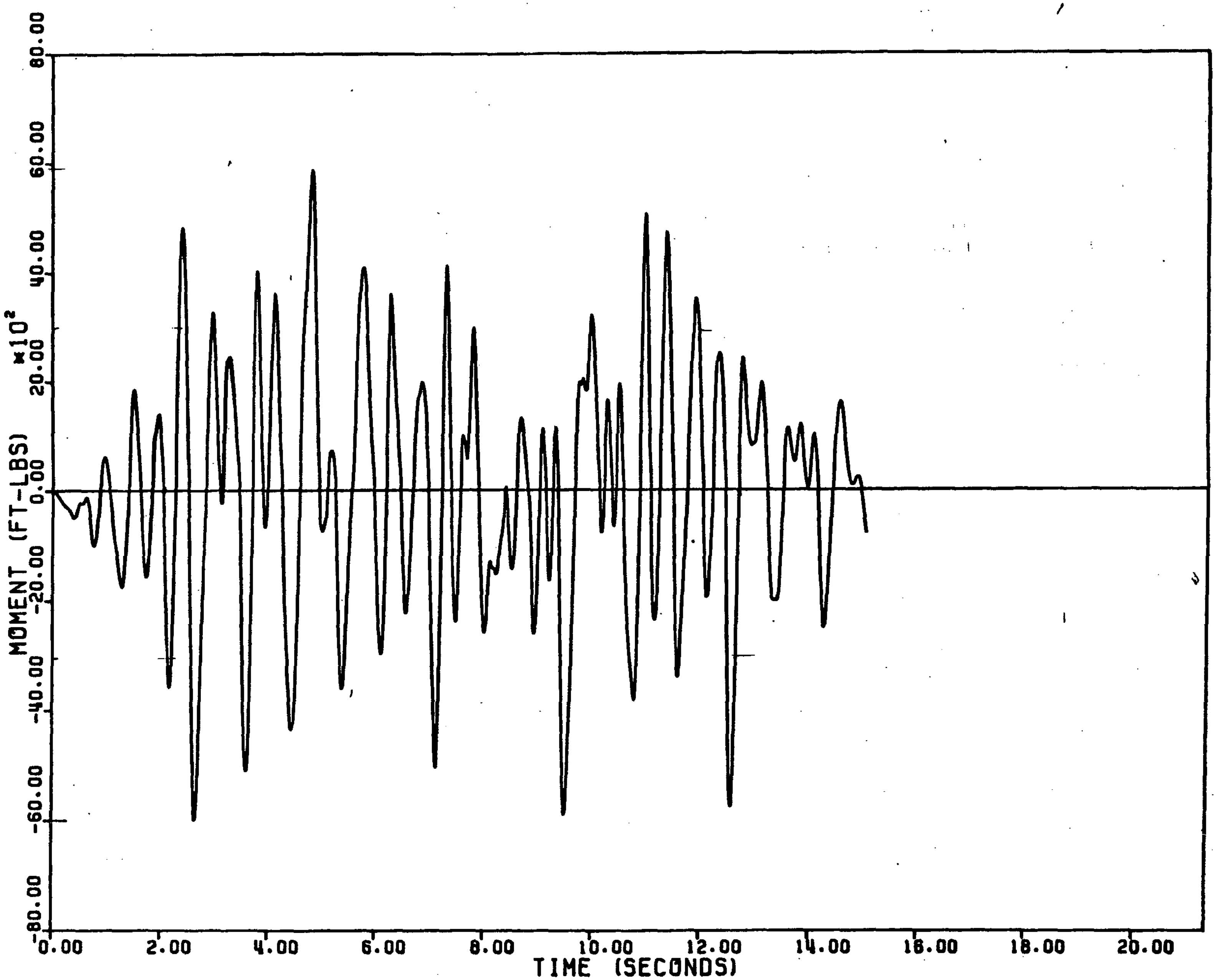


FIGURE C-42A. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-3
OBE LOADING - RECORD 103 - PIPE MOMENT MB3 (FT-LBS), NPTS = 1504, DT = .01

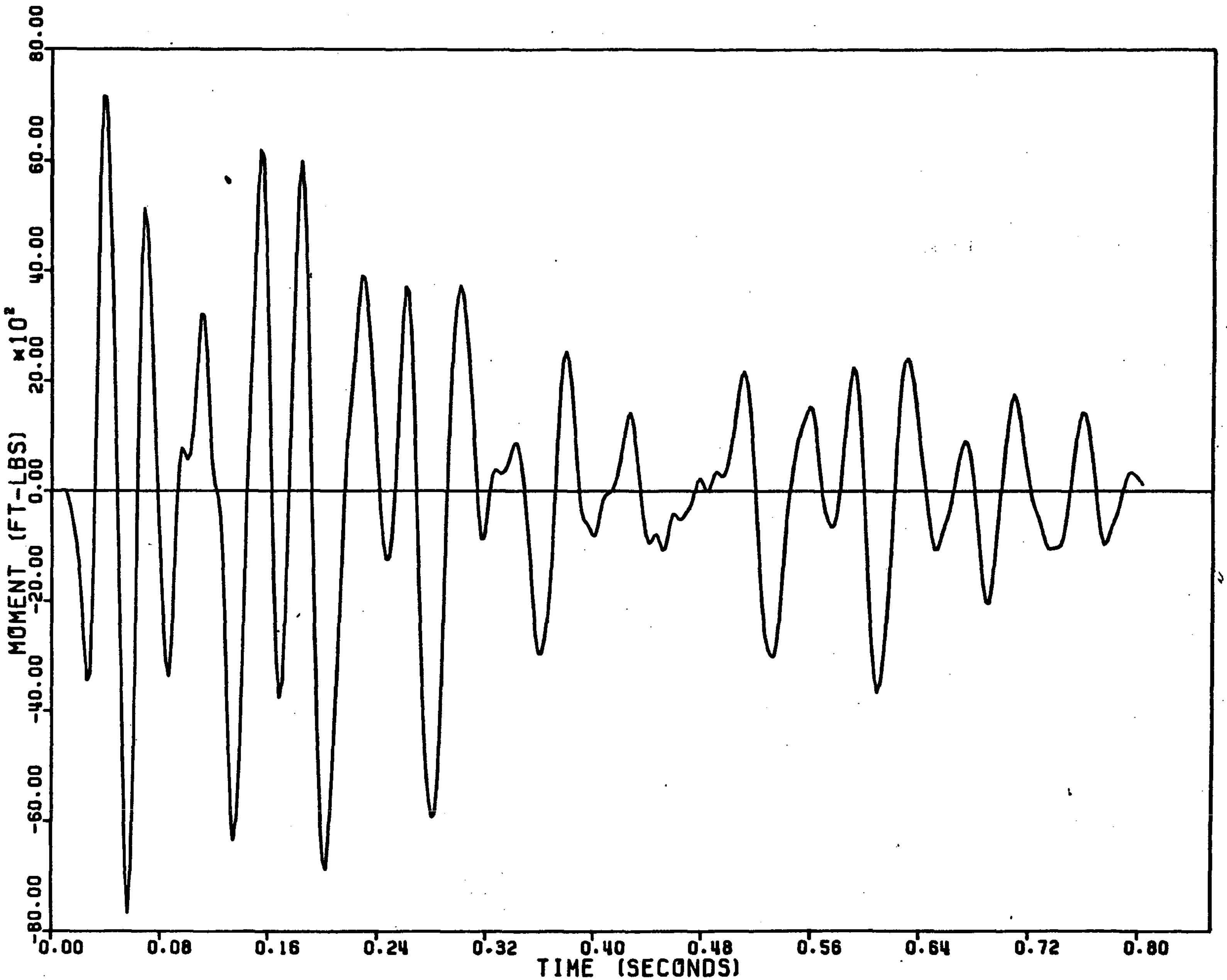


FIGURE C-42B. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-3
SRV-1 LOADING - RECORD 110 - PIPE MOMENT MB3 (FT-LBS), NPTS = 401, DT = .002

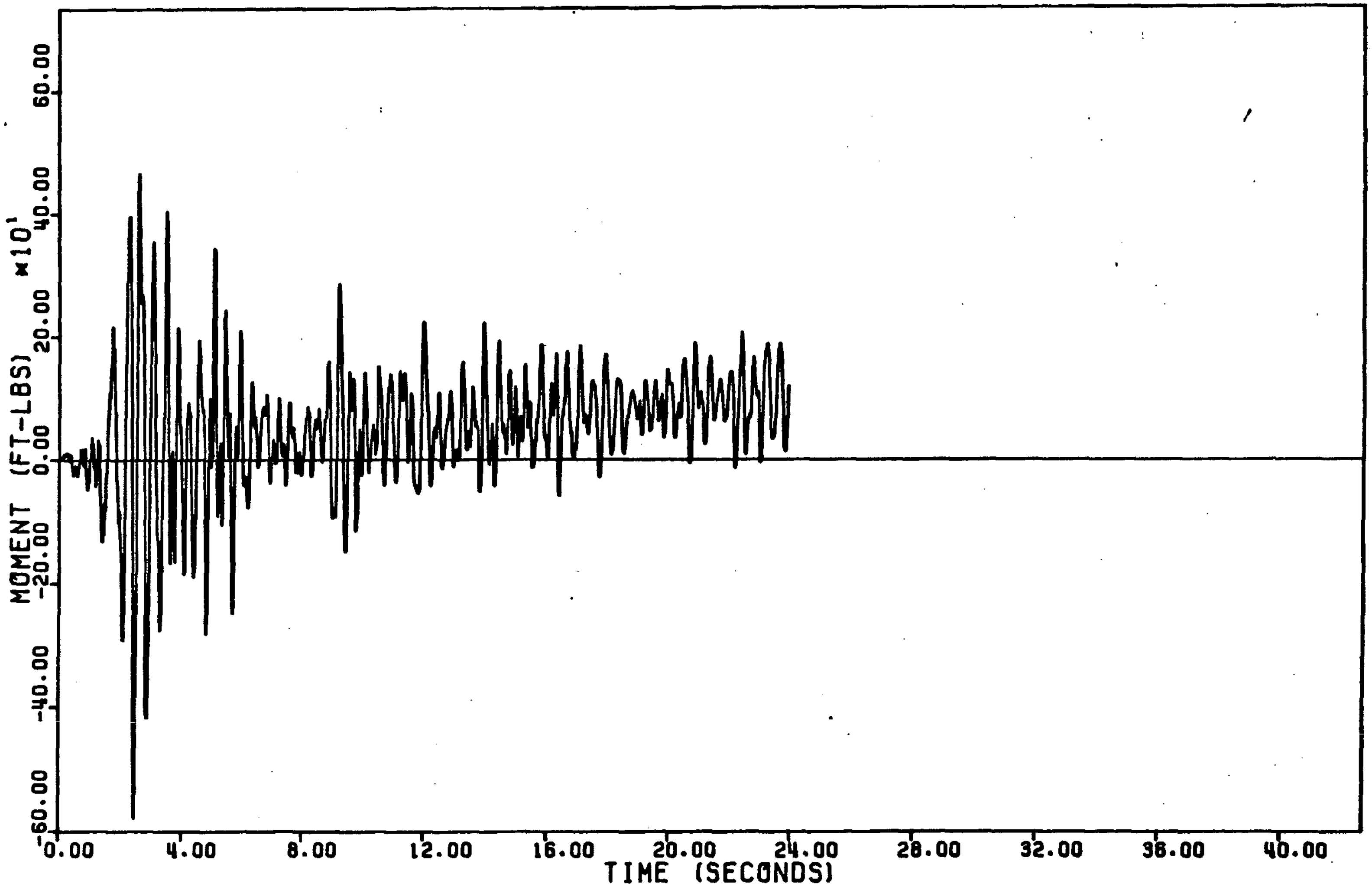


FIGURE C-43A. BOP PIPING TIME HISTORIES, FPC & CU REFUELING WATER LINE,LOCATION 2-5
OBE LOADING - RECORD 705 - PIPE MOMENT Y (FT-LBS) , NPTS = 2388, DT = .01

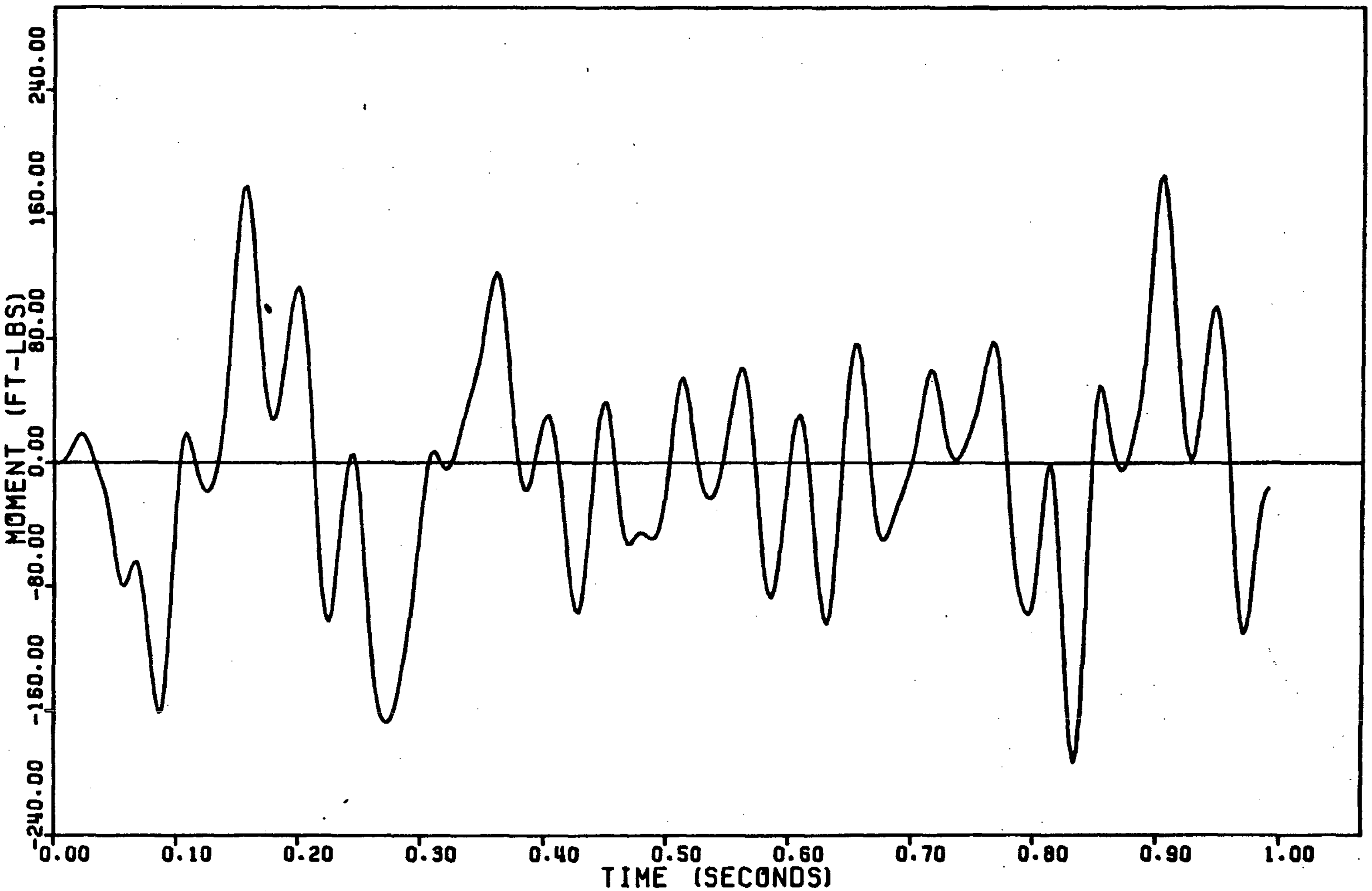


FIGURE C-43B. BOP PIPING TIME HISTORIES, FPC & CU REFUELING WATER LINE, LOCATION 2-5
SRV-1 LOADING - RECORD 715 - PIPE MOMENT Y (FT-LBS) , NPTS = 397, DT = .0025

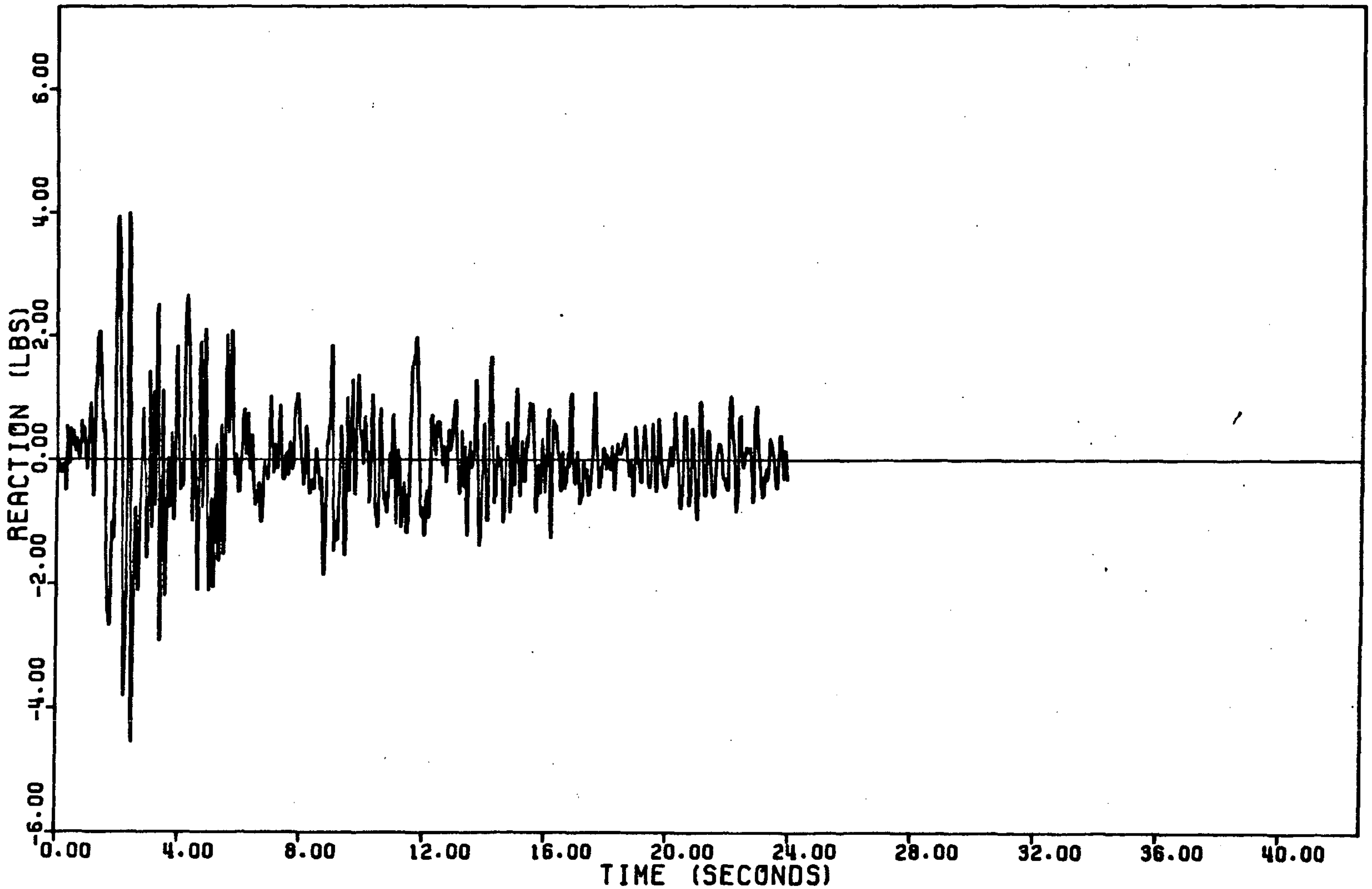


FIGURE C-44A. BOP PIPING TIME HISTORIES. FPC & CU REFUELING WATER LINE, LOCATION 2-8
OBE LOADING - RECORD 708 - AXIAL SUPPORT (LBS) , NPTS = 2388, DT = .01

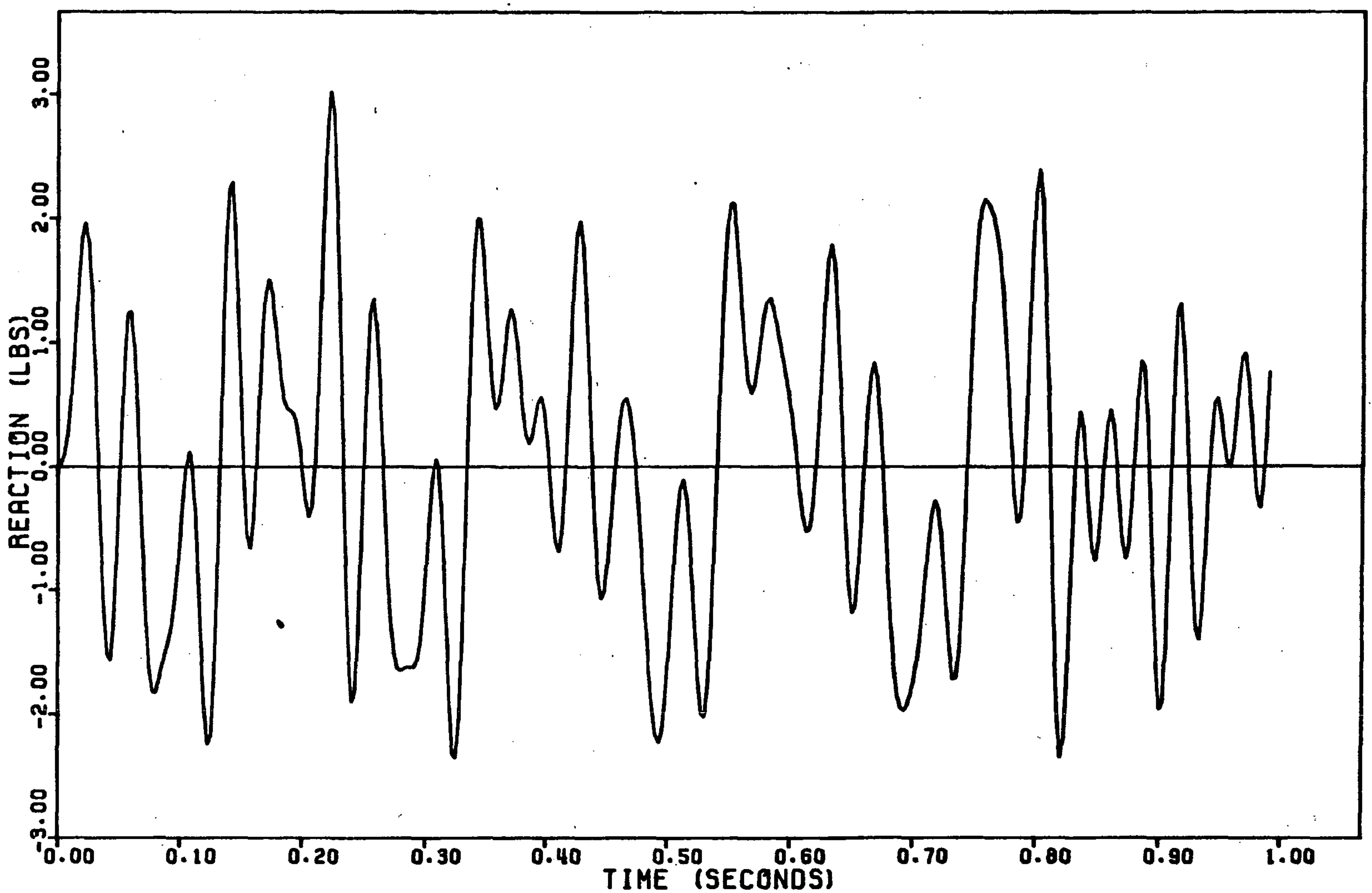


FIGURE C-44B. BOP PIPING TIME HISTORIES, FPC & CU REFUELING WATER LINE, LOCATION 2-8
SRV-1 LOADING - RECORD 718 - AXIAL SUPPORT (LBS) NPTS = 397, DT = .0025

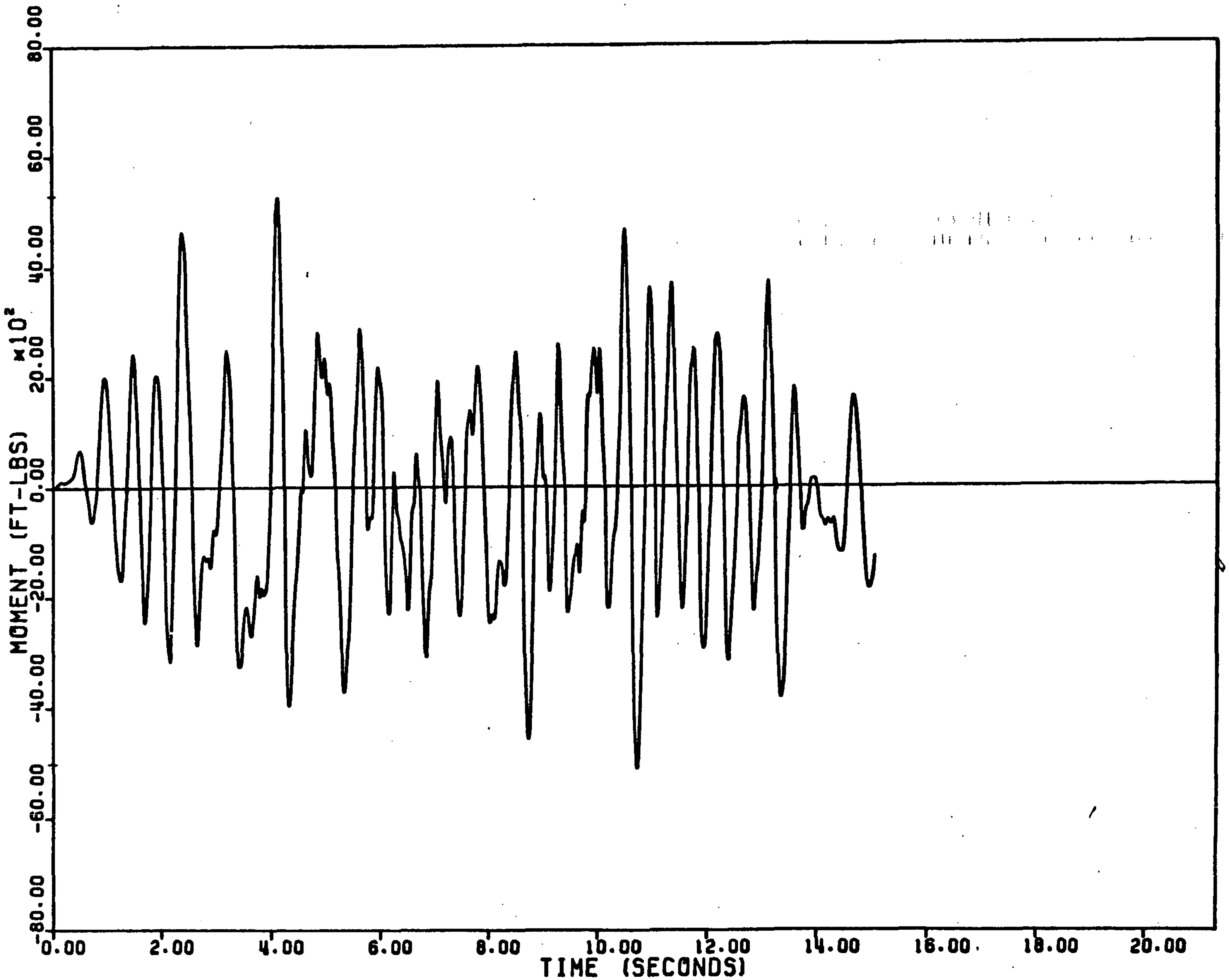


FIGURE C-45A. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-1
OBE LOADING - RECORD 101 - PIPE MOMENT MB3 (FT-LBS), NPTS = 1504, DT = .01

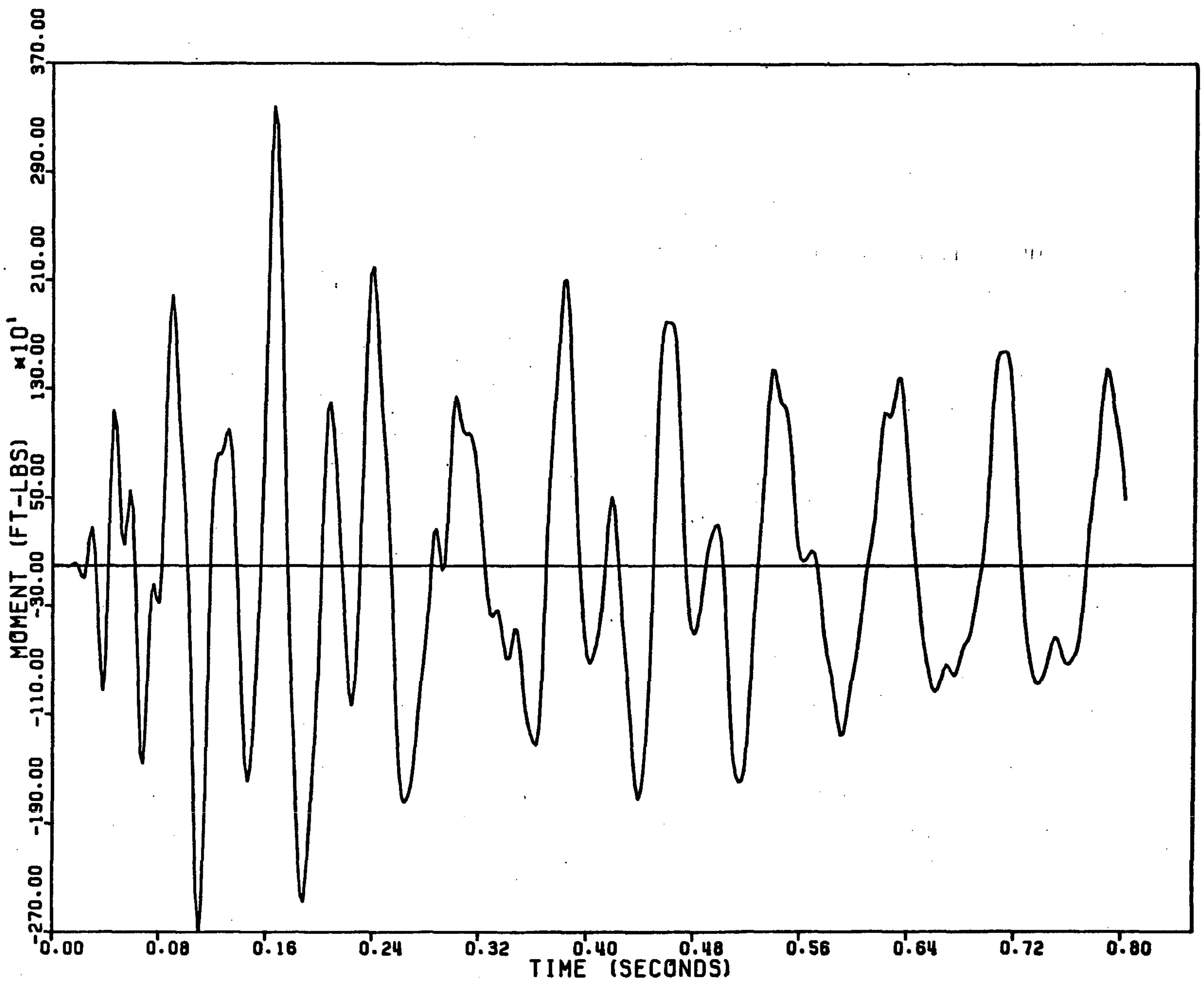


FIGURE C-45B. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-1
SRV-ALL LOADING- RECORD 122 - PIPE MOMENT MB3 (FT-LBS), NPTS = 401, DT = .002

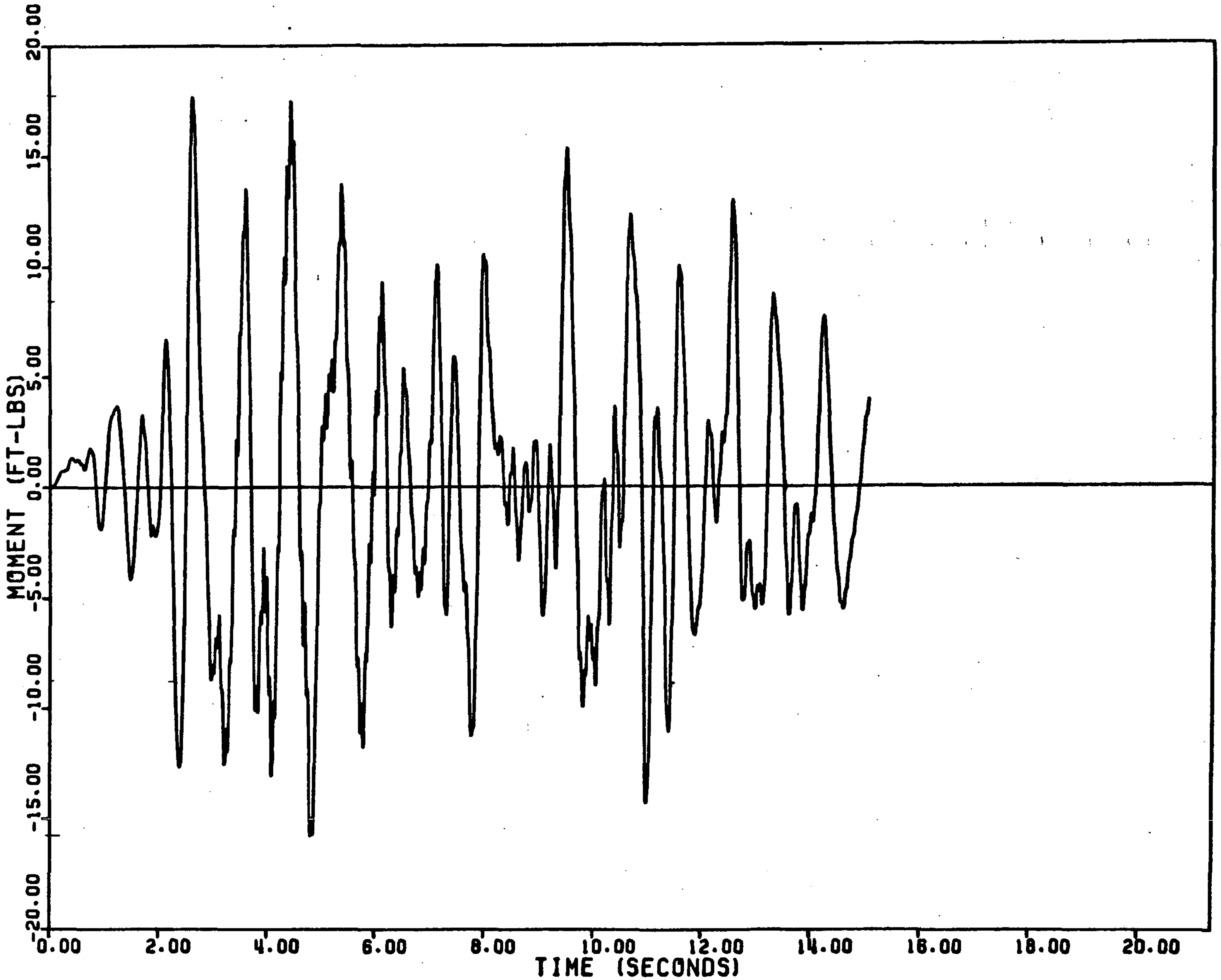


FIGURE C-46A. BOP PIPING TIME HISTORIES, RWCU PIPING, LOCATION 1-4
OBE LOADING - RECORD 104 - PIPE MOMENT MB3 (FT-LBS), NPTS = 1504, DT = .01

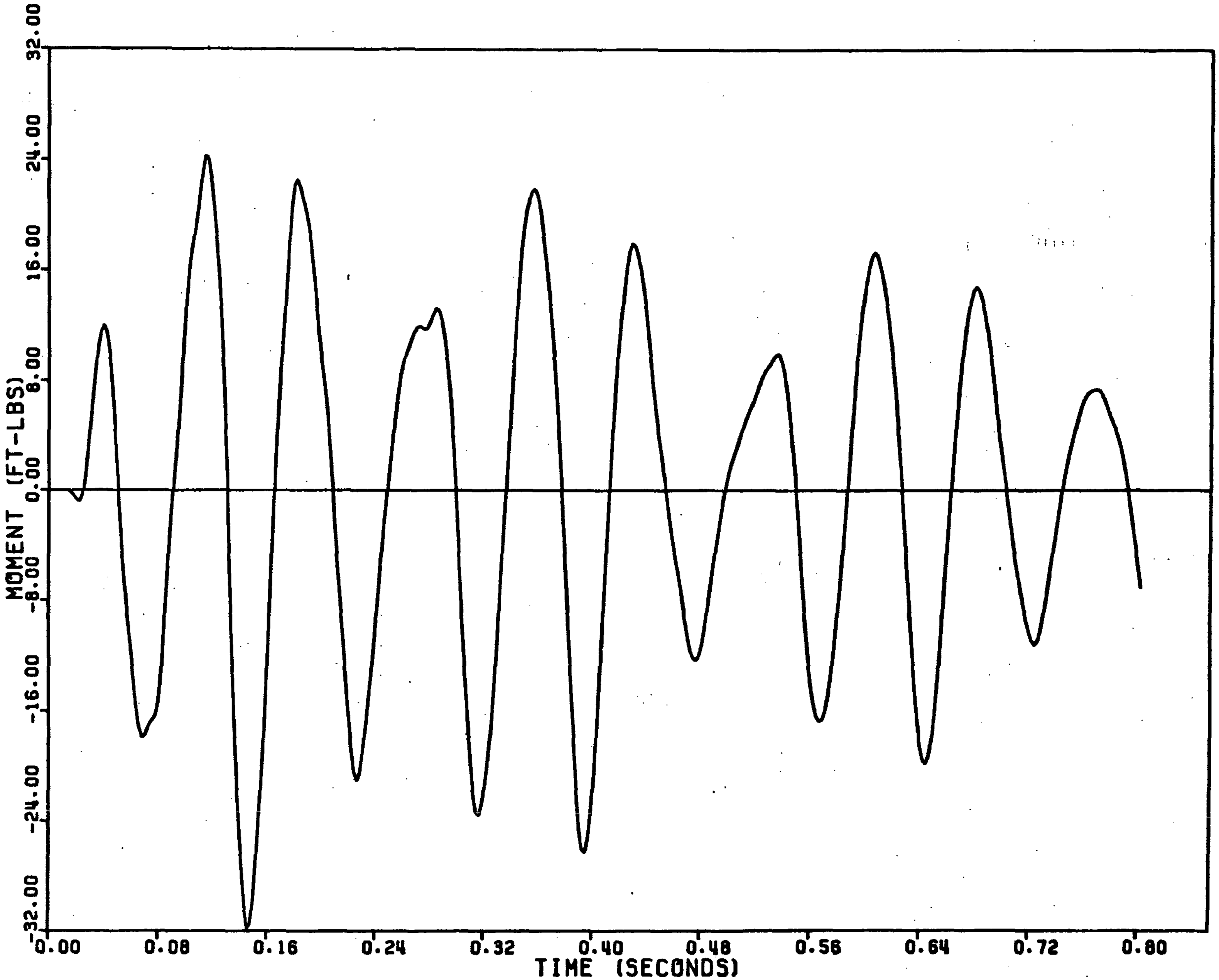


FIGURE C-46B. BOP PIPING TIME HISTORIES, RWCU PIPING, LOCATION 1-4
SRV-ALL LOADING- RECORD 125 - PIPE MOMENT MB3 (FT-LBS), NPTS = 401, DT = .002

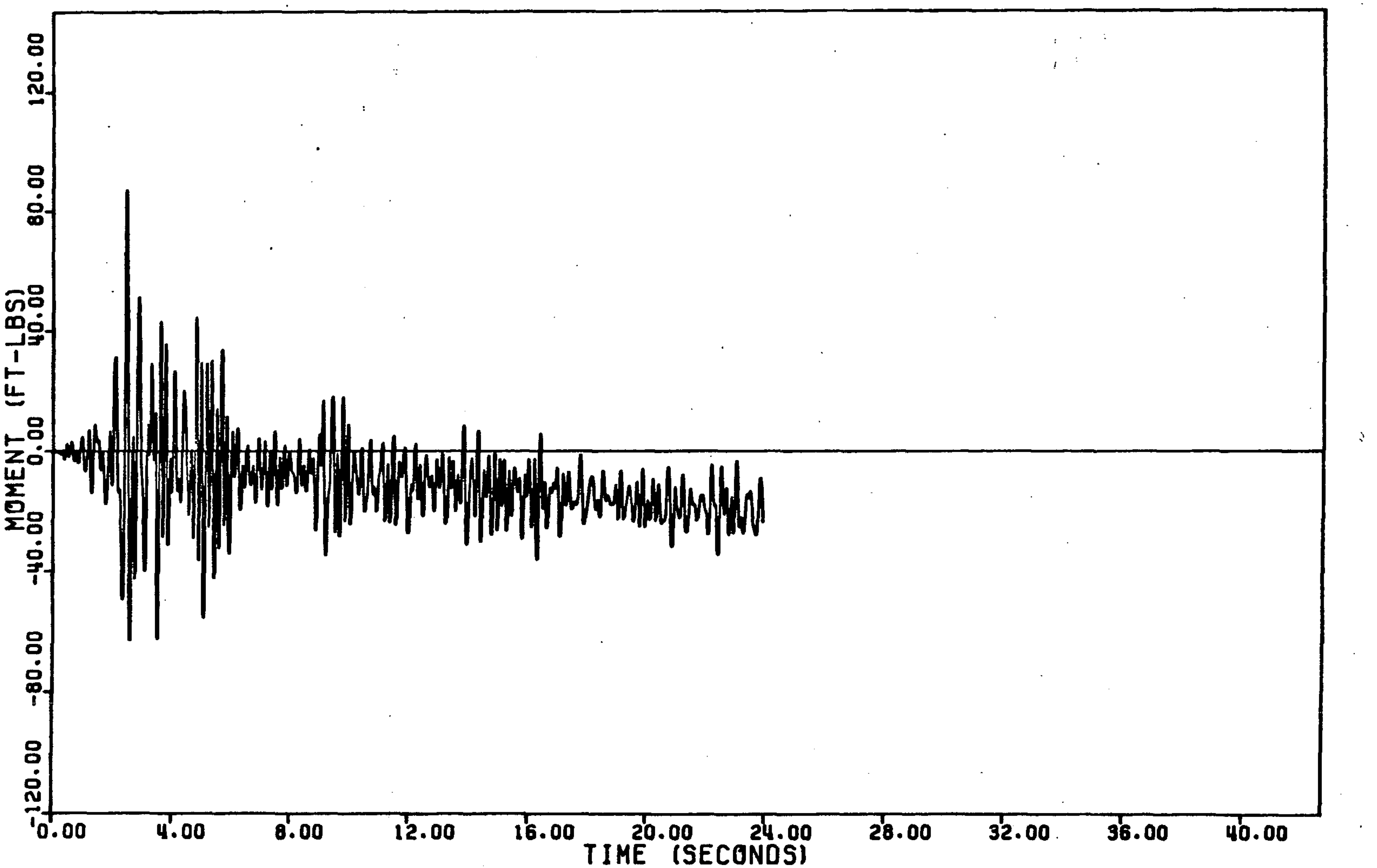


FIGURE C-47A. BOP PIPING TIME HISTORIES. FPC & CU REFUELING WATER LINE, LOCATION 2-6
OBE LOADING - RECORD 706 - PIPE MOMENT Y (FT-LBS) , NPTS = 2388, DT = .01

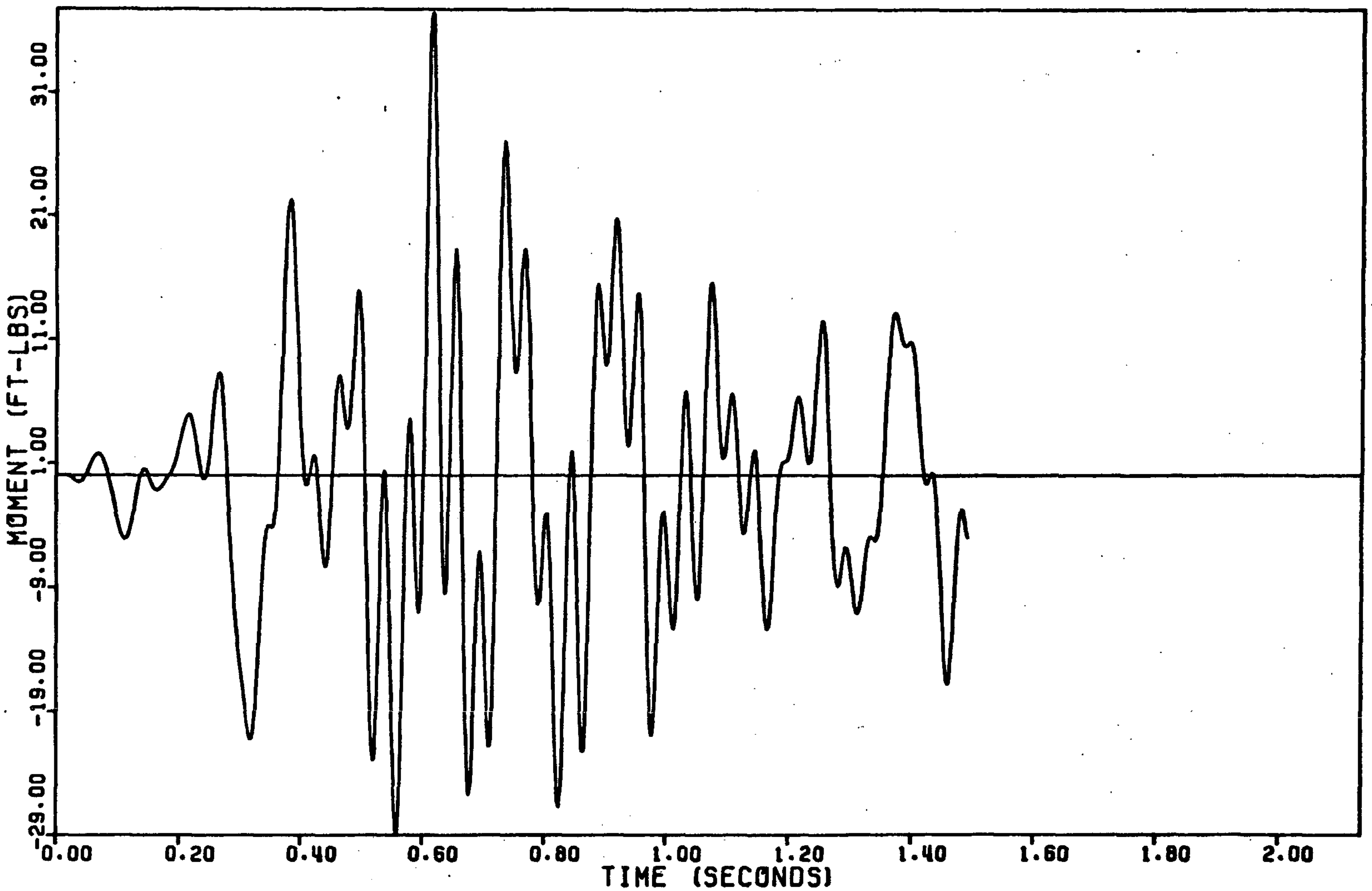


FIGURE C-47B. BOP PIPING TIME HISTORIES, FPC & CU REFUELING WATER LINE, LOCATION 2-6
SRV-ALL LOADING- RECORD 736 - PIPE MOMENT Y (FT-LBS) , NPTS = 597, DT = .0025

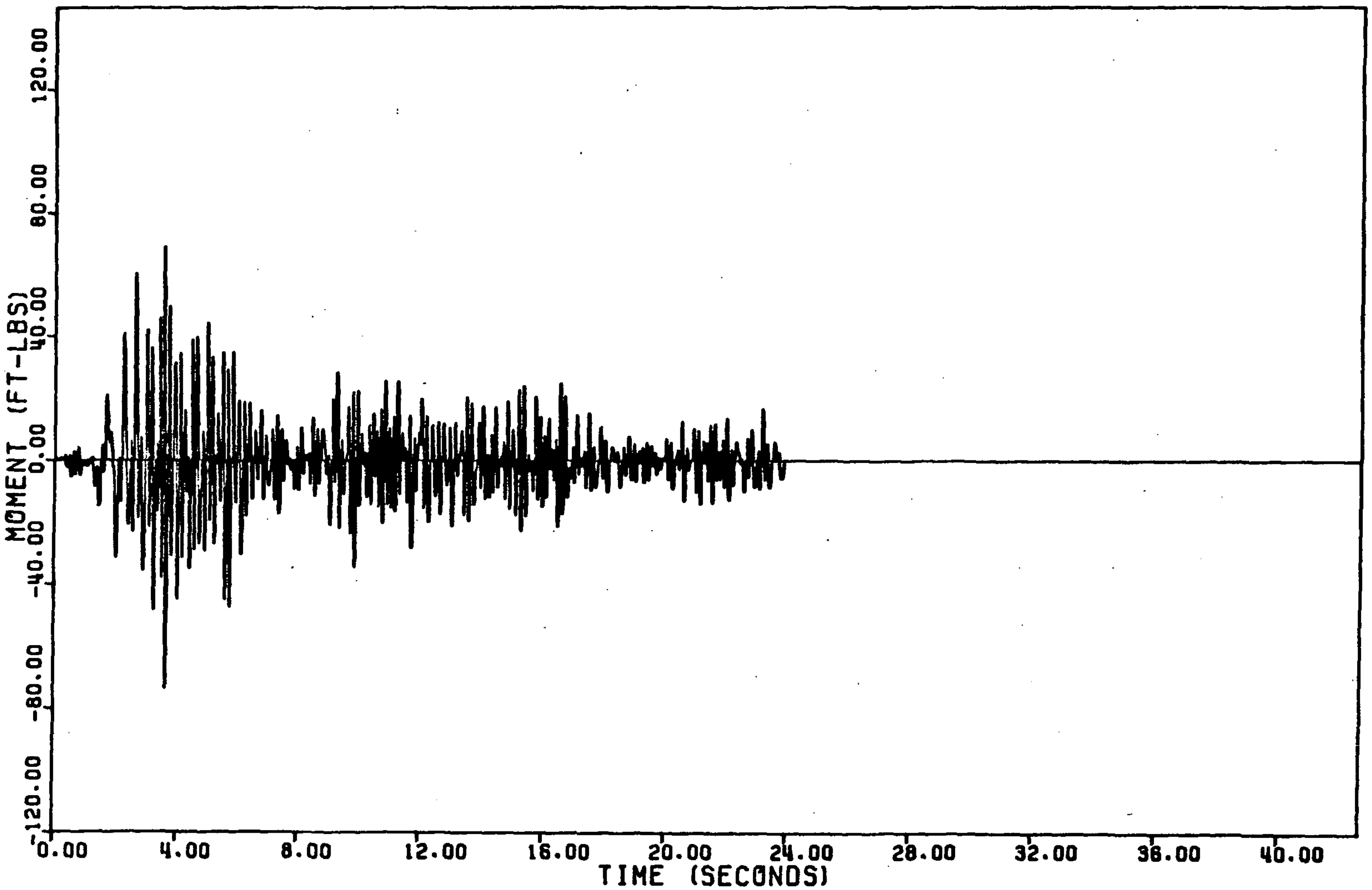


FIGURE C-48A. BOP PIPING TIME HISTORIES. FPC & CU REFUELING WATER LINE.LOCATION 2-7
OBE LOADING - RECORD 707 - PIPE MOMENT Y (FT-LBS) , NPTS = 2388, DT = .01

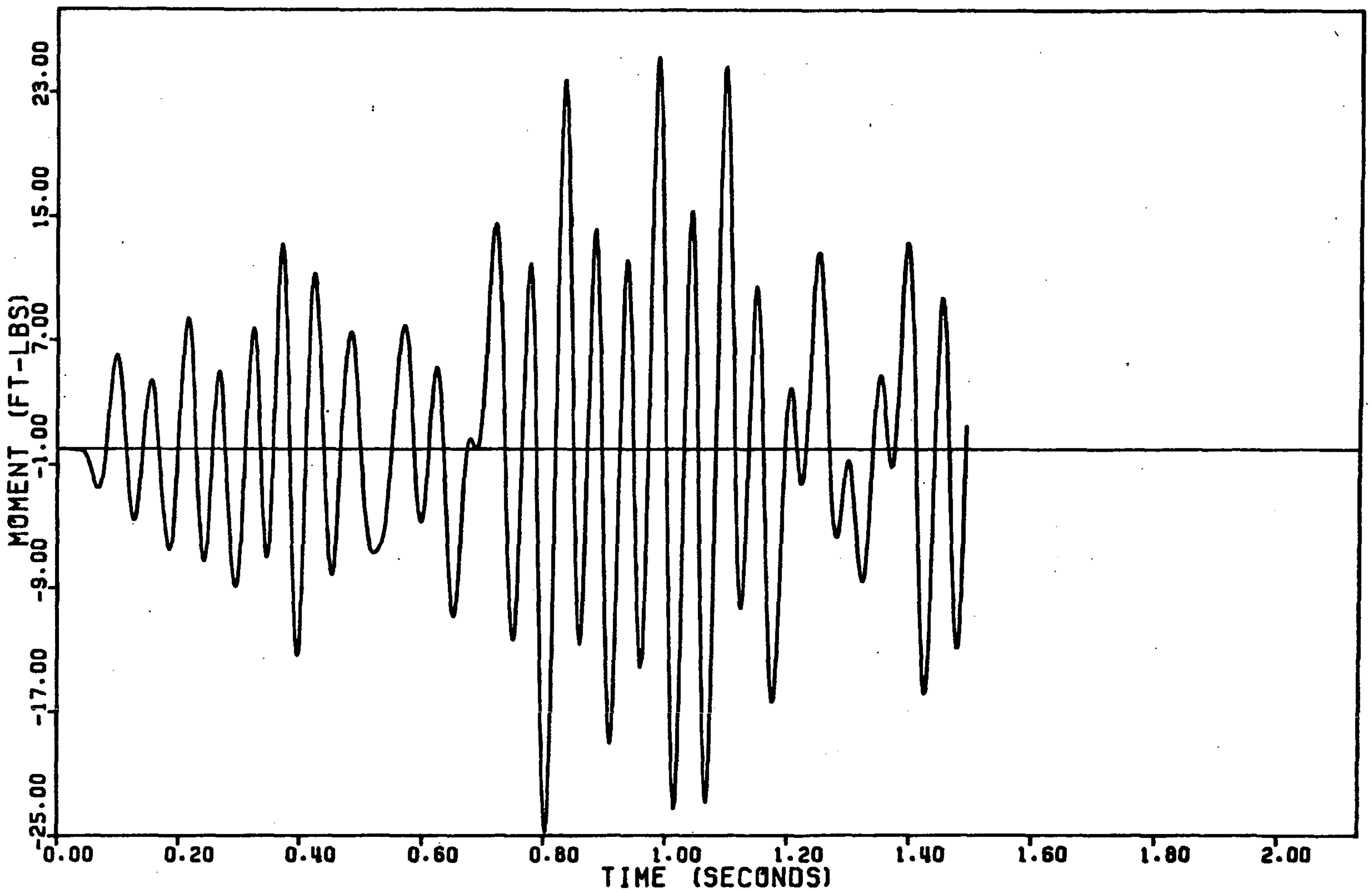


FIGURE C-48B. BOP PIPING TIME HISTORIES, FPC & CU REFUELING WATER LINE, LOCATION 2-7
SRV-ALL LOADING- RECORD 737 - PIPE MOMENT Y (FT-LBS) , NPTS = 597, DT = .0025

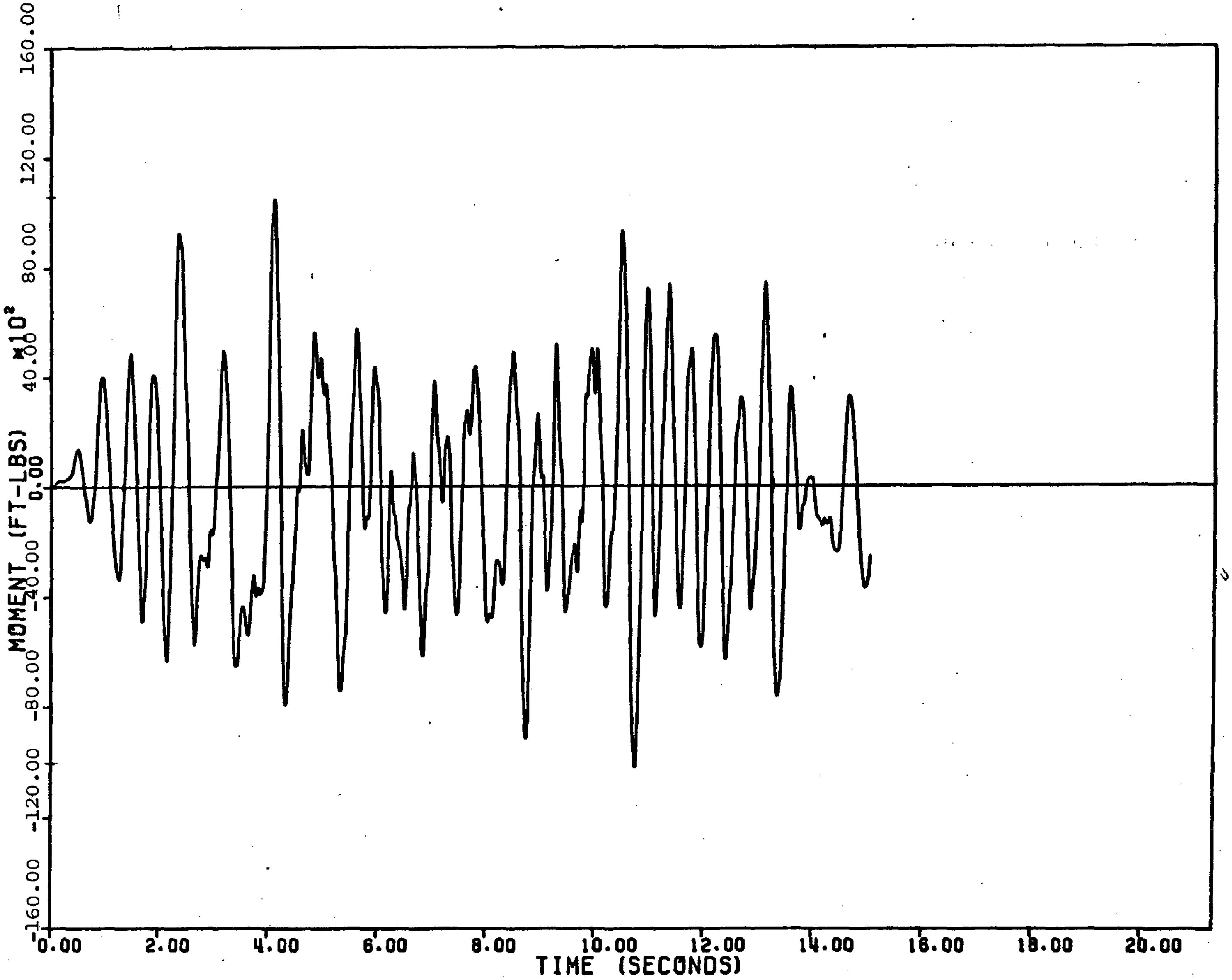


FIGURE C-49A. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-1
SSE LOADING - RECORD 101 - PIPE MOMENT MB3 (FT-LBS), NPTS = 1504, DT = .01

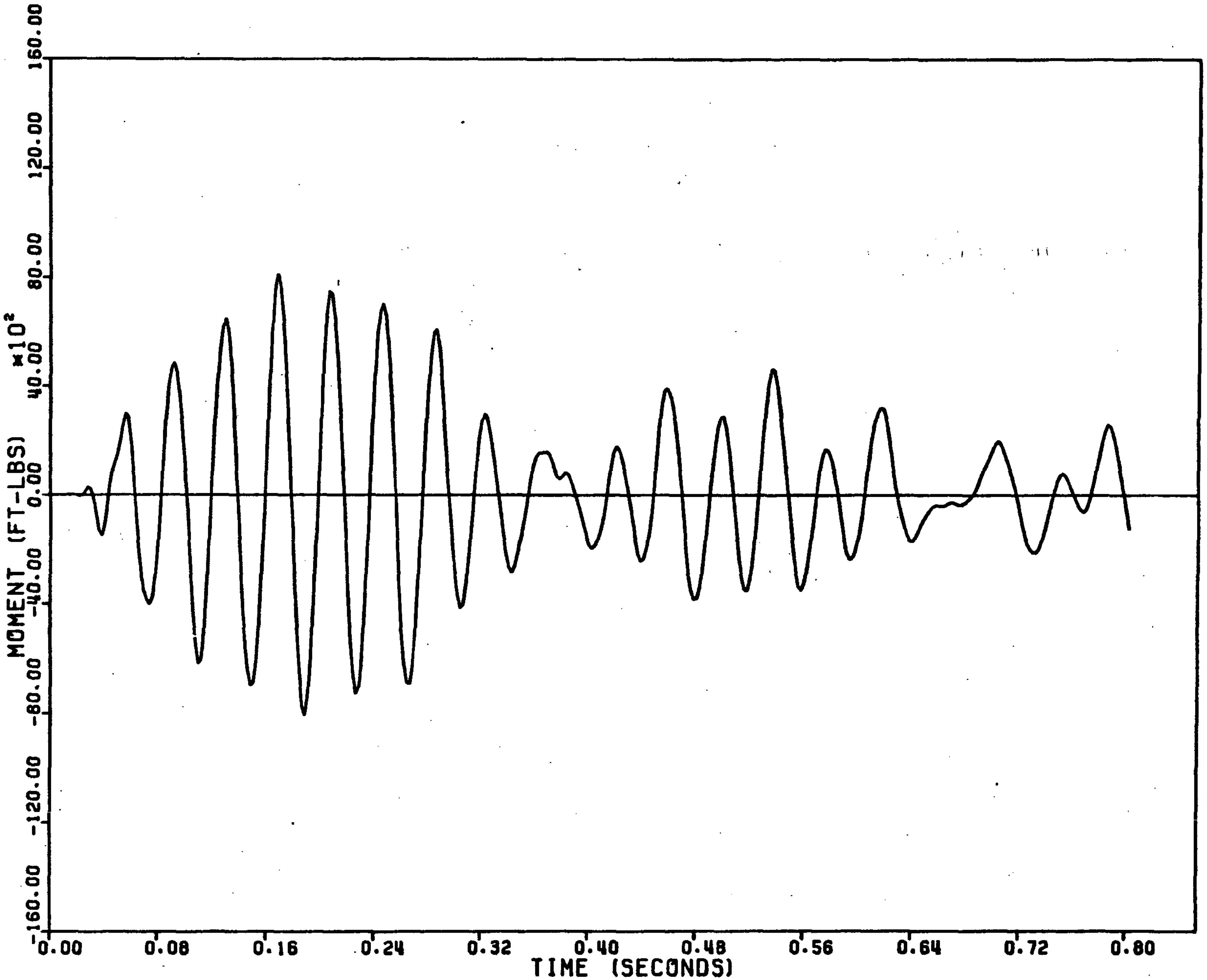


FIGURE C-49B. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-1
SRV-1 LOADING - RECORD 108 - PIPE MOMENT MB3 (FT-LBS), NPTS = 401, DT = .002

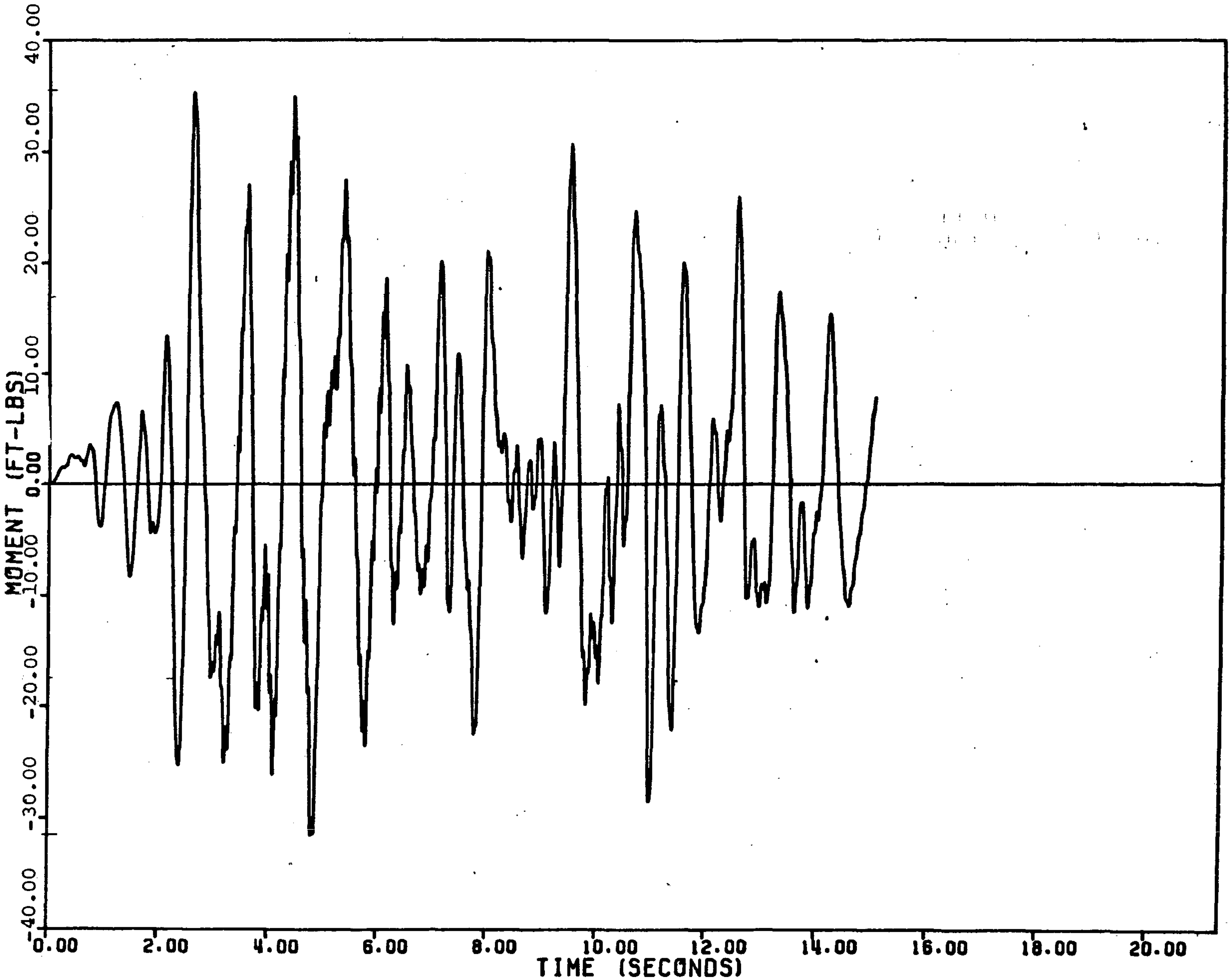


FIGURE C-50A. BOP PIPING TIME HISTORIES, RWCU PIPING, LOCATION 1-4
SSE LOADING - RECORD 104 - PIPE MOMENT MB3 (FT-LBS), NPTS = 1504, DT = .01

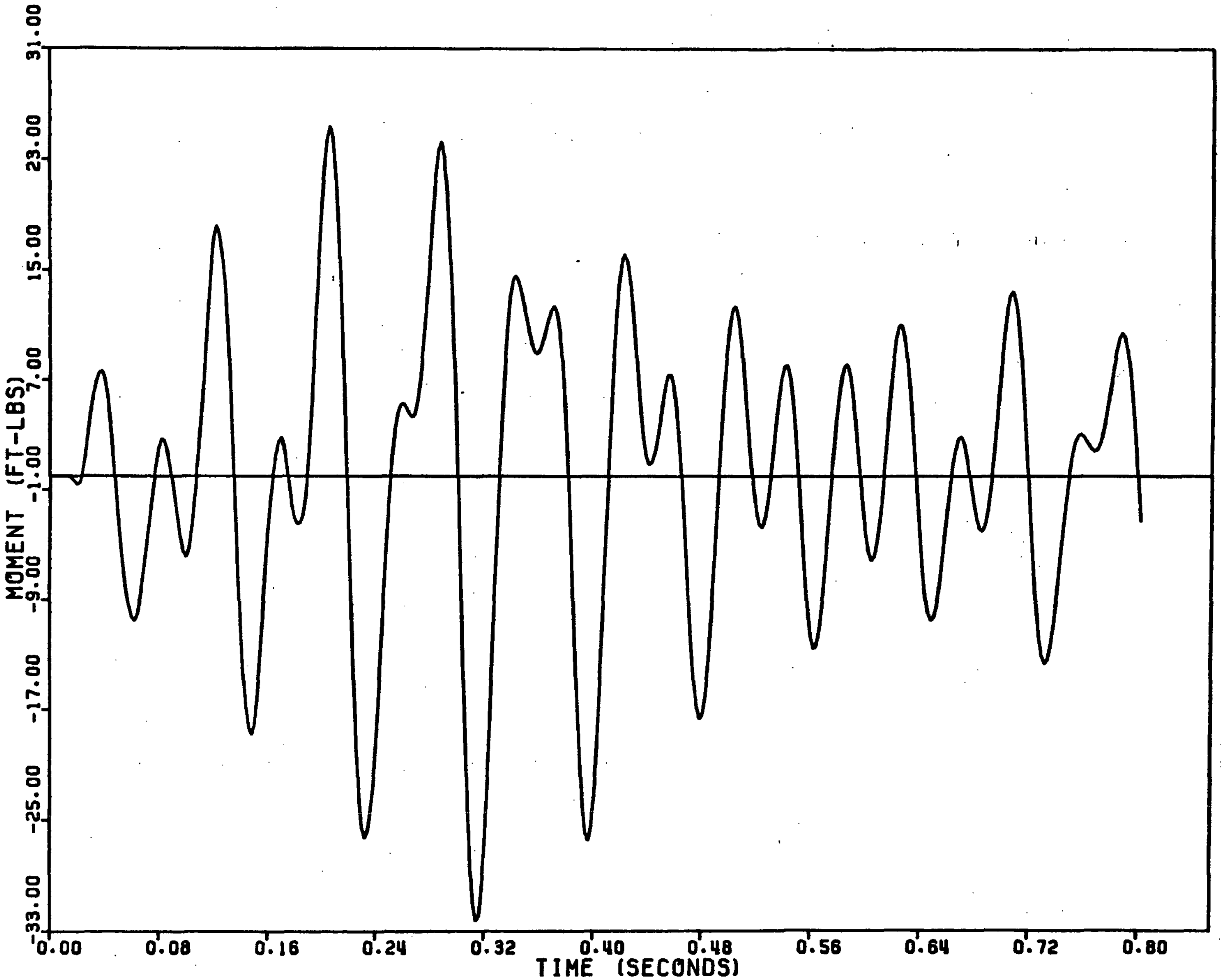


FIGURE C-50B. BOP PIPING TIME HISTORIES, RWCU PIPING, LOCATION 1-4
SRV-1 LOADING - RECORD 111 - PIPE MOMENT MB3 (FT-LBS), NPTS = 401, DT = .002

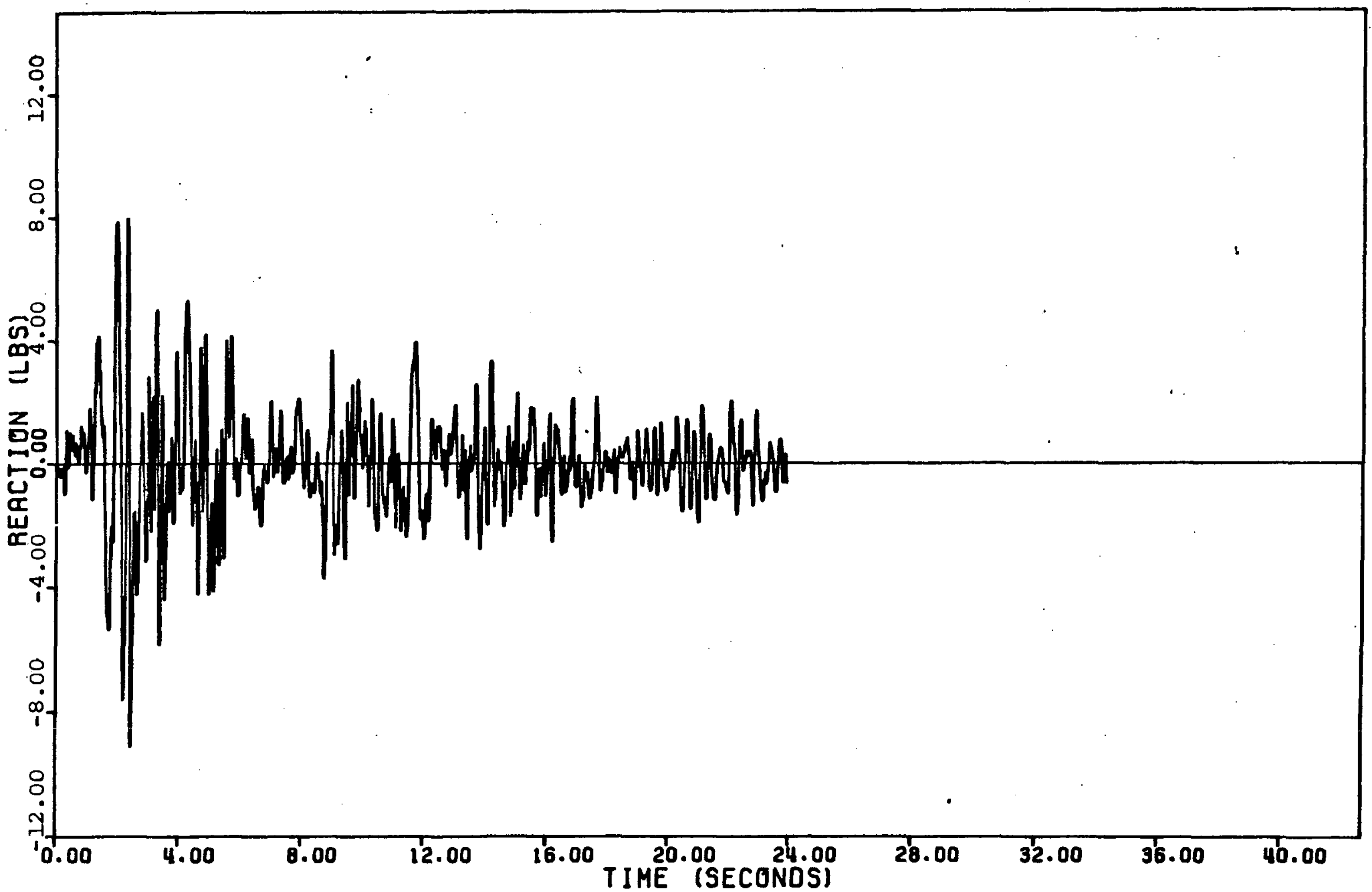


FIGURE C-51A. BOP PIPING TIME HISTORIES, FPC & CU REFUELING WATER LINE, LOCATION 2-8
SSE LOADING - RECORD 708 - AXIAL SUPPORT (LBS) , NPTS = 2388, DT = .01

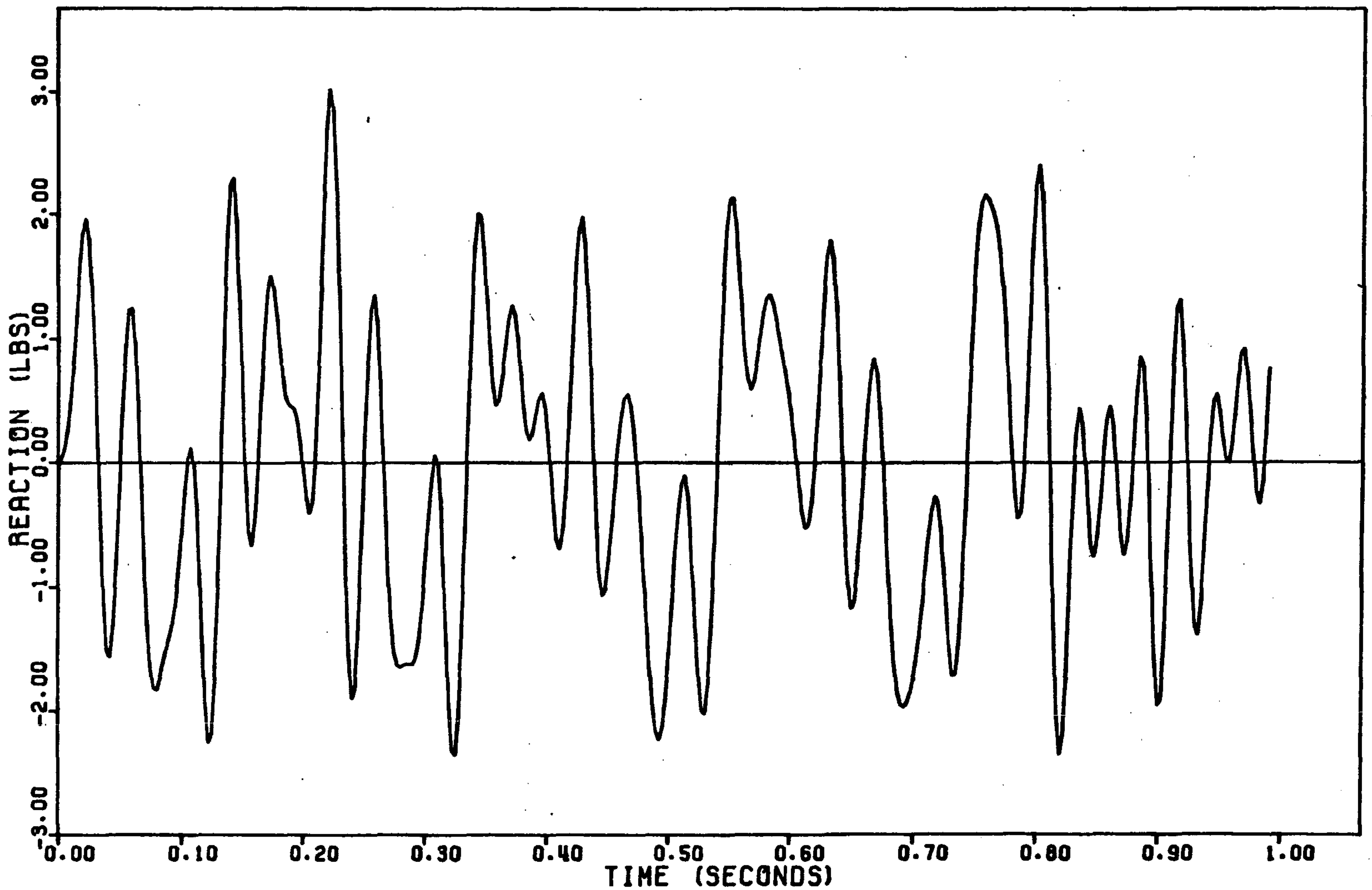


FIGURE C-51B. BOP PIPING TIME HISTORIES, FPC & CU REFUELING WATER LINE, LOCATION 2-8
SRV-1 LOADING - RECORD 718 - AXIAL SUPPORT (LBS) NPTS = 397, DT = .0025

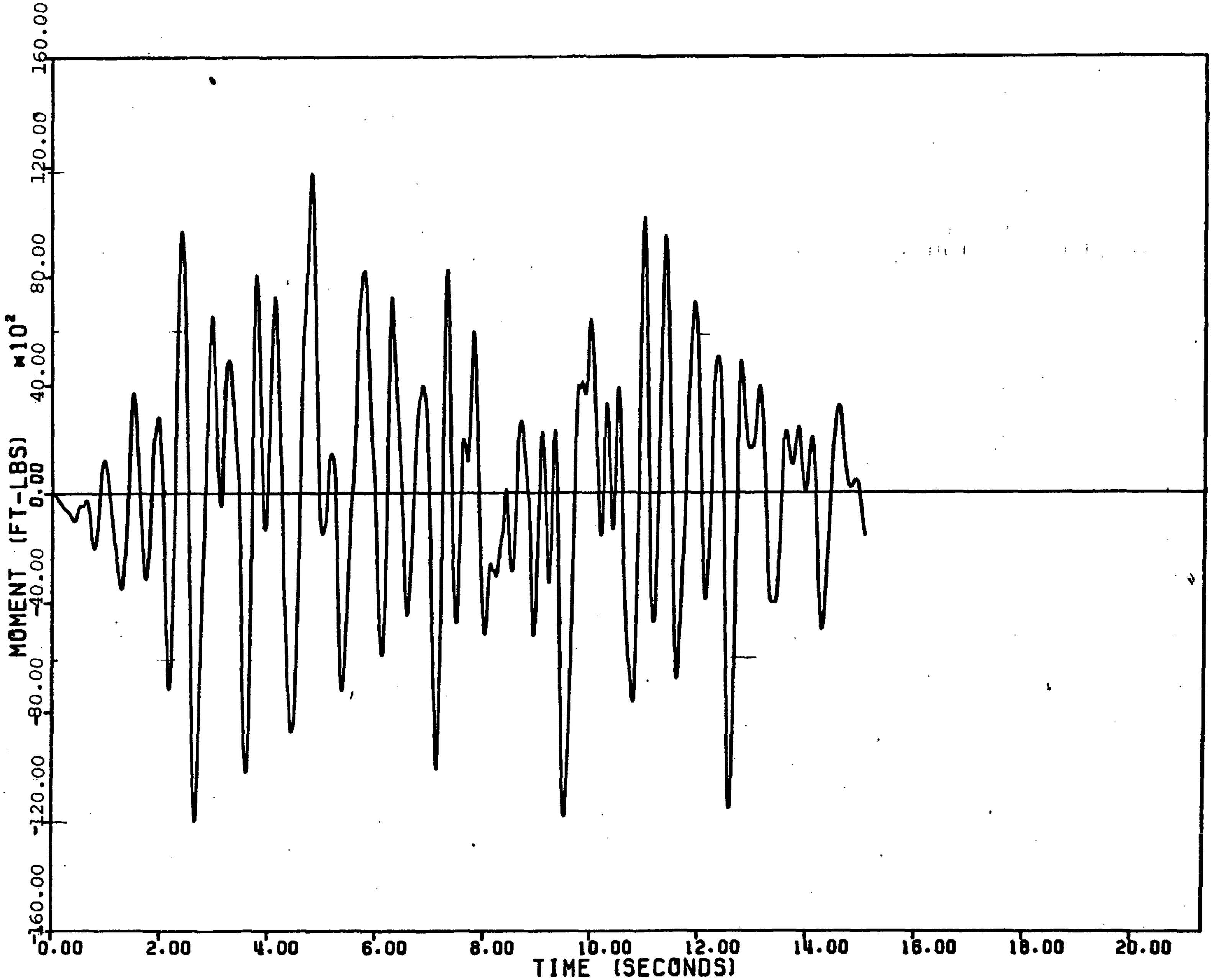


FIGURE C-52A. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-3
SSE LOADING - RECORD 103 - PIPE MOMENT MB3 (FT-LBS), NPTS = 1504, DT = .01

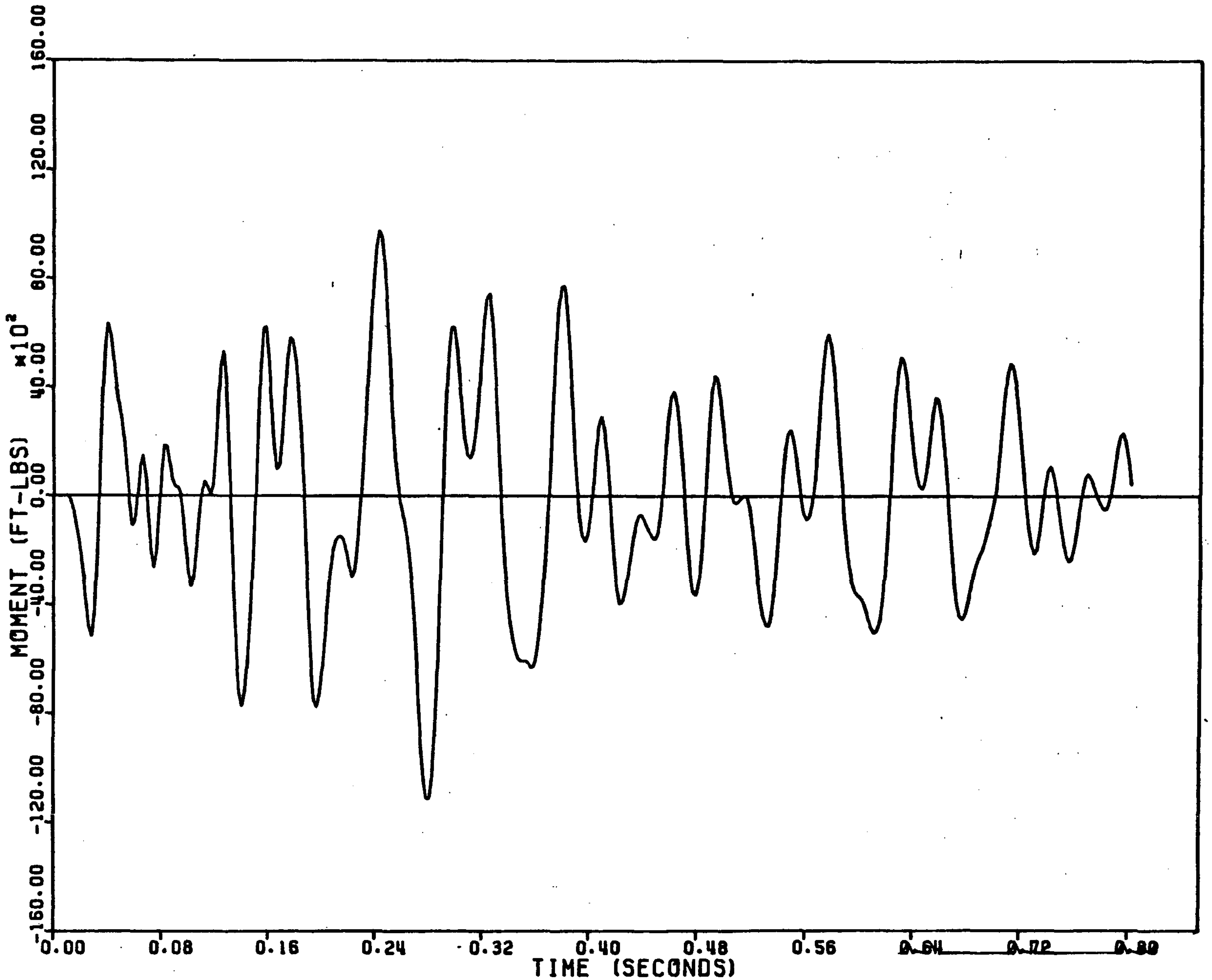


FIGURE C-52B. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-3
SRV-ALL LOADING- RECORD 124 - PIPE MOMENT MB3 (FT-LBS), NPTS = 401, DT = .002

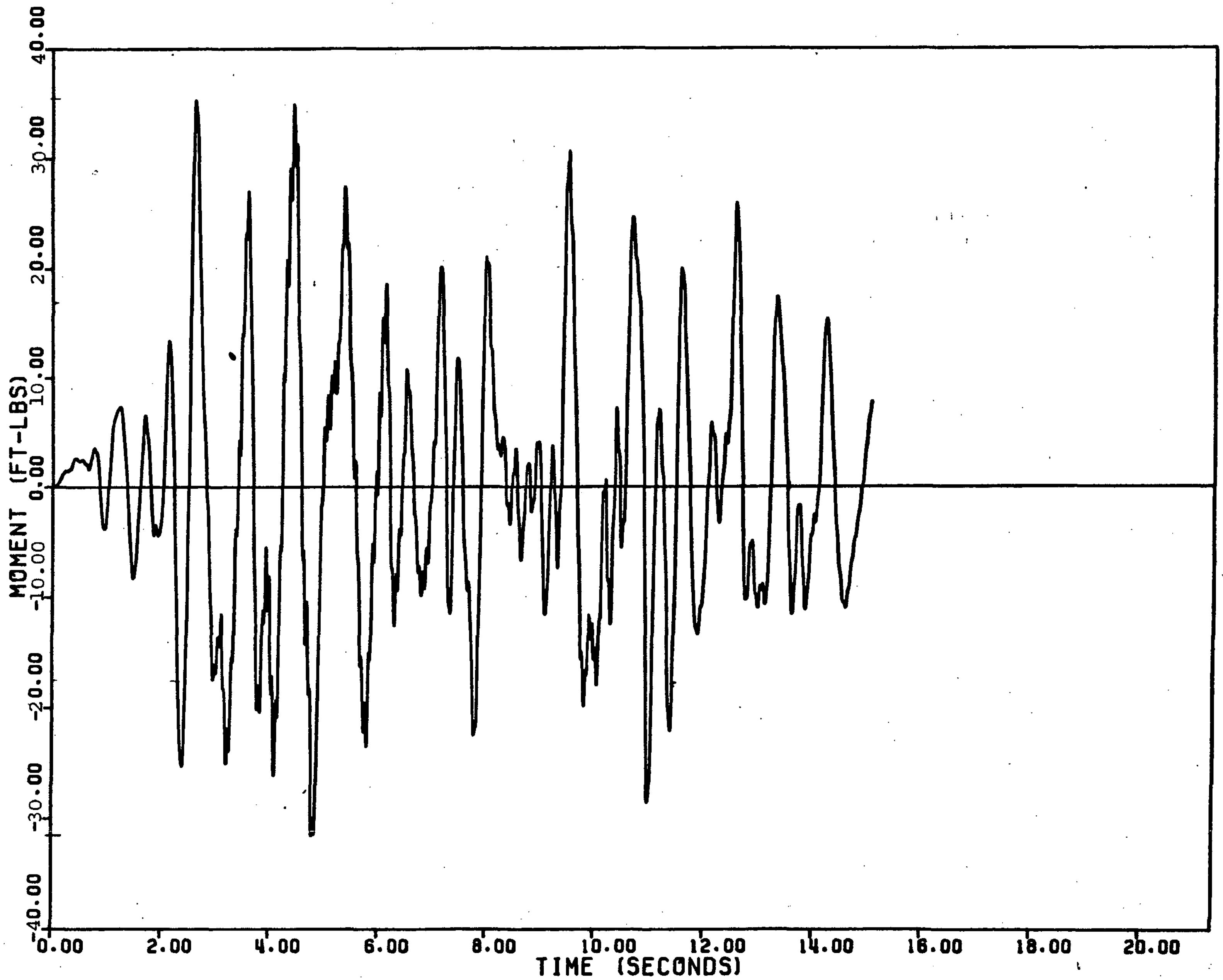


FIGURE C-53A. BOP PIPING TIME HISTORIES, RWCU PIPING, LOCATION 1-4
SSE LOADING - RECORD 104 - PIPE MOMENT MB3 (FT-LBS), NPTS = 1504, DT = .01

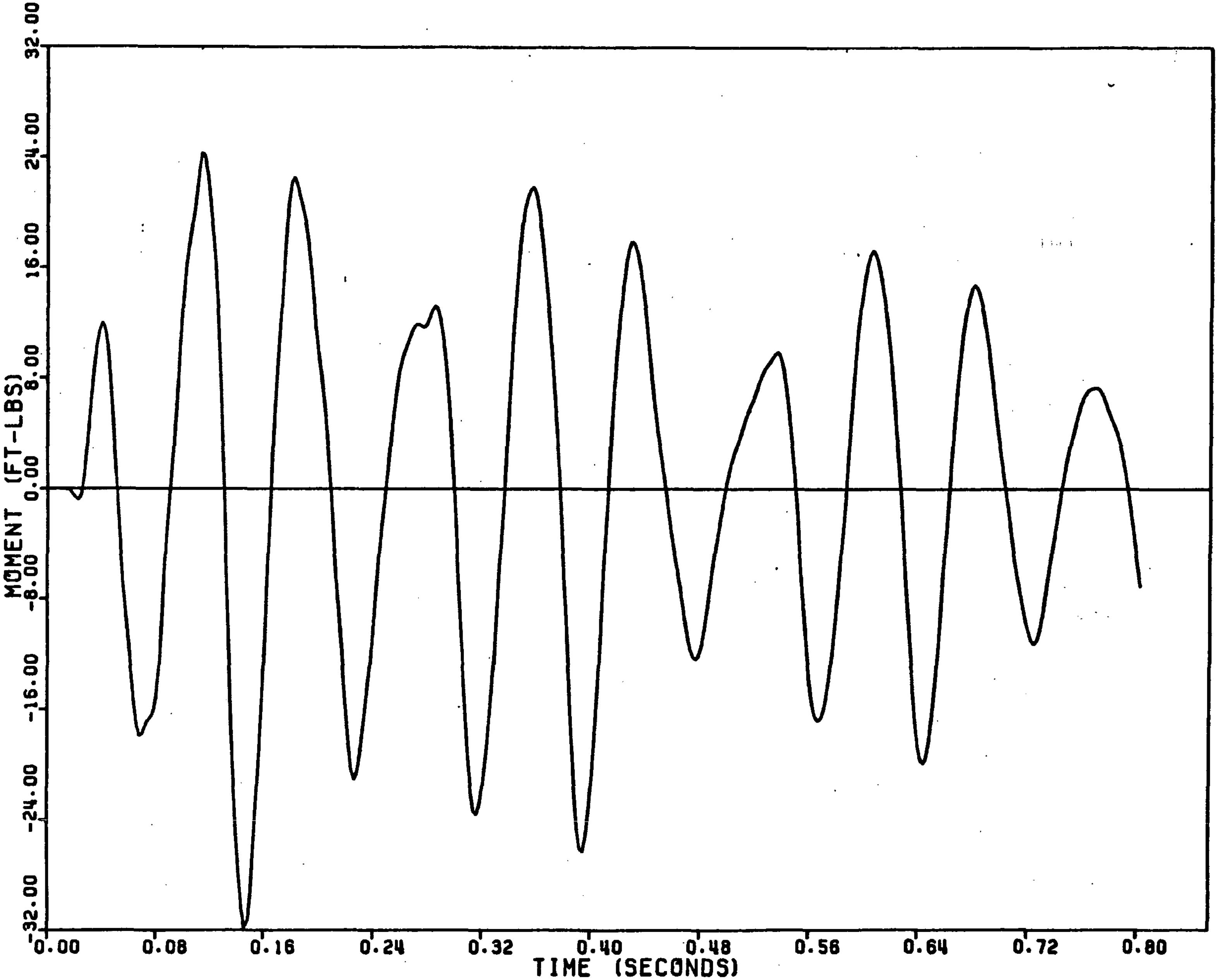


FIGURE C-53B. BOP PIPING TIME HISTORIES, RWCU PIPING, LOCATION 1-4
SRV-ALL LOADING- RECORD 125 - PIPE MOMENT MB3 (FT-LBS), NPTS = 401, DT = .002

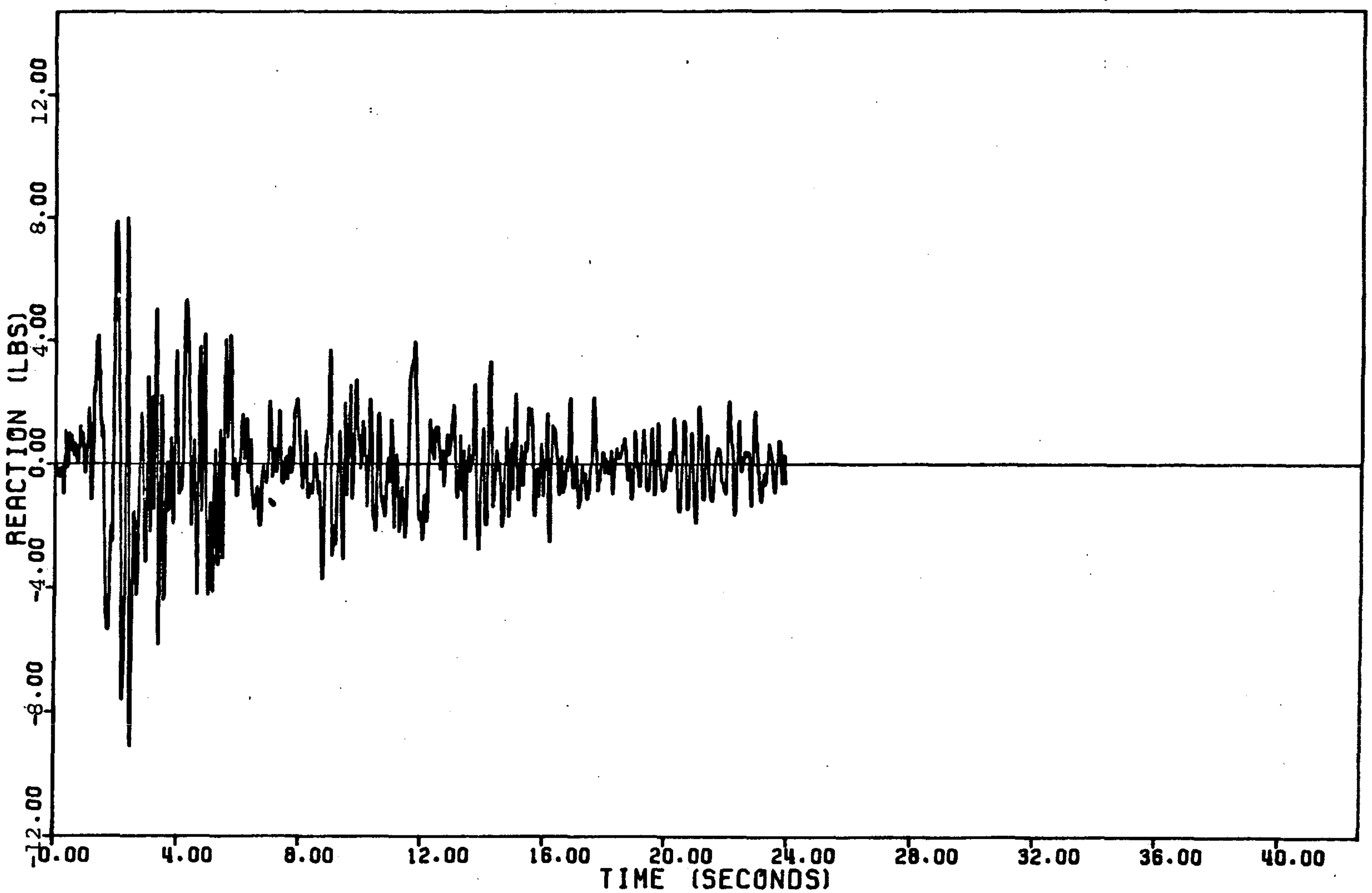


FIGURE C-54A. BOP PIPING TIME HISTORIES, FPC & CU REFUELING WATER LINE, LOCATION 2-8
SSE LOADING - RECORD 708 - AXIAL SUPPORT (LBS) , NPTS = 2388, DT = .01

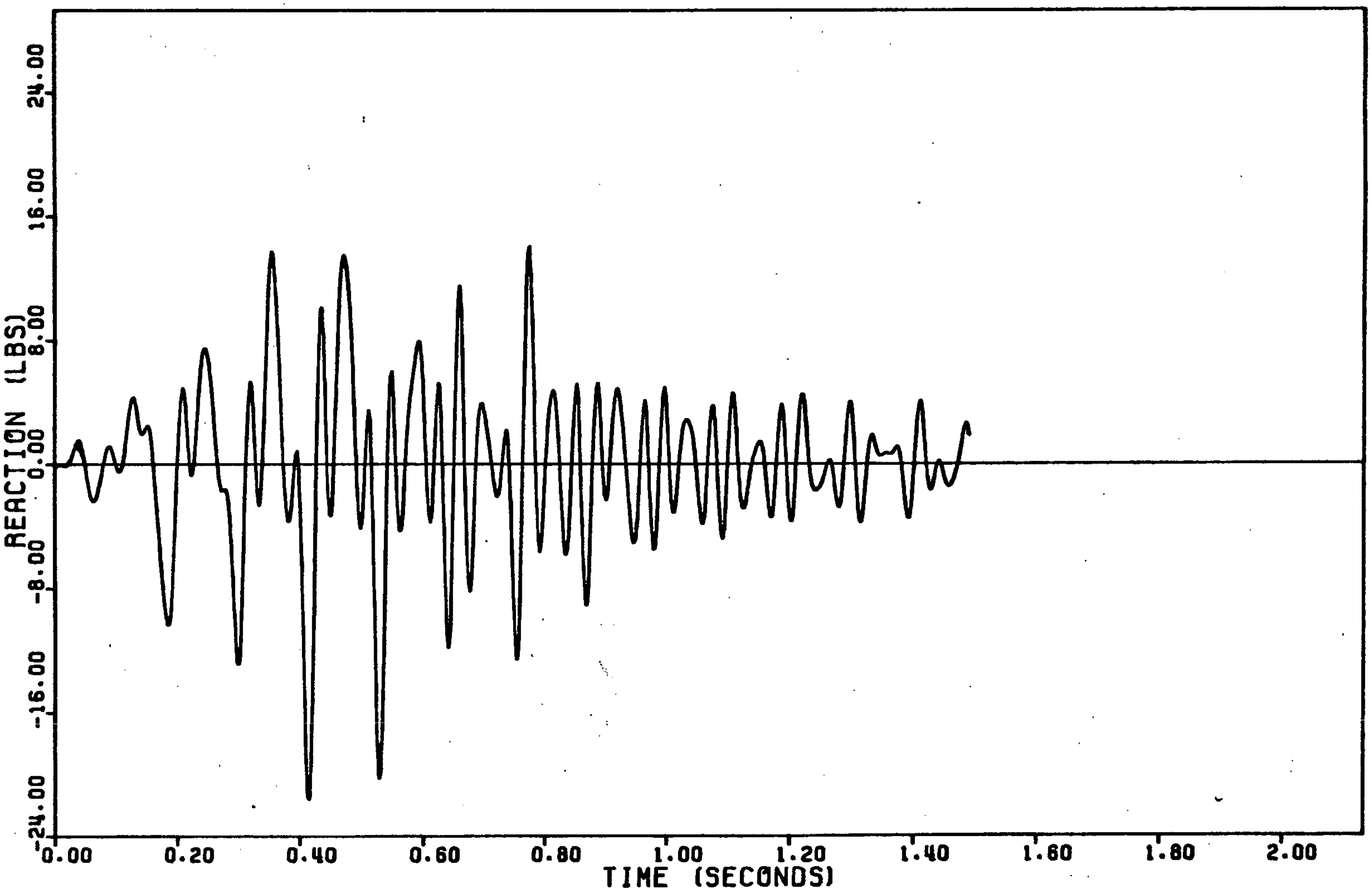


FIGURE C-54B. BOP PIPING TIME HISTORIES. FPC & CU REFUELING WATER LINE.LOCATION 2-8
SRV-ALL LOADING- RECORD 738 - AXIAL SUPPORT (LBS) NPTS = 597. DT = .0025

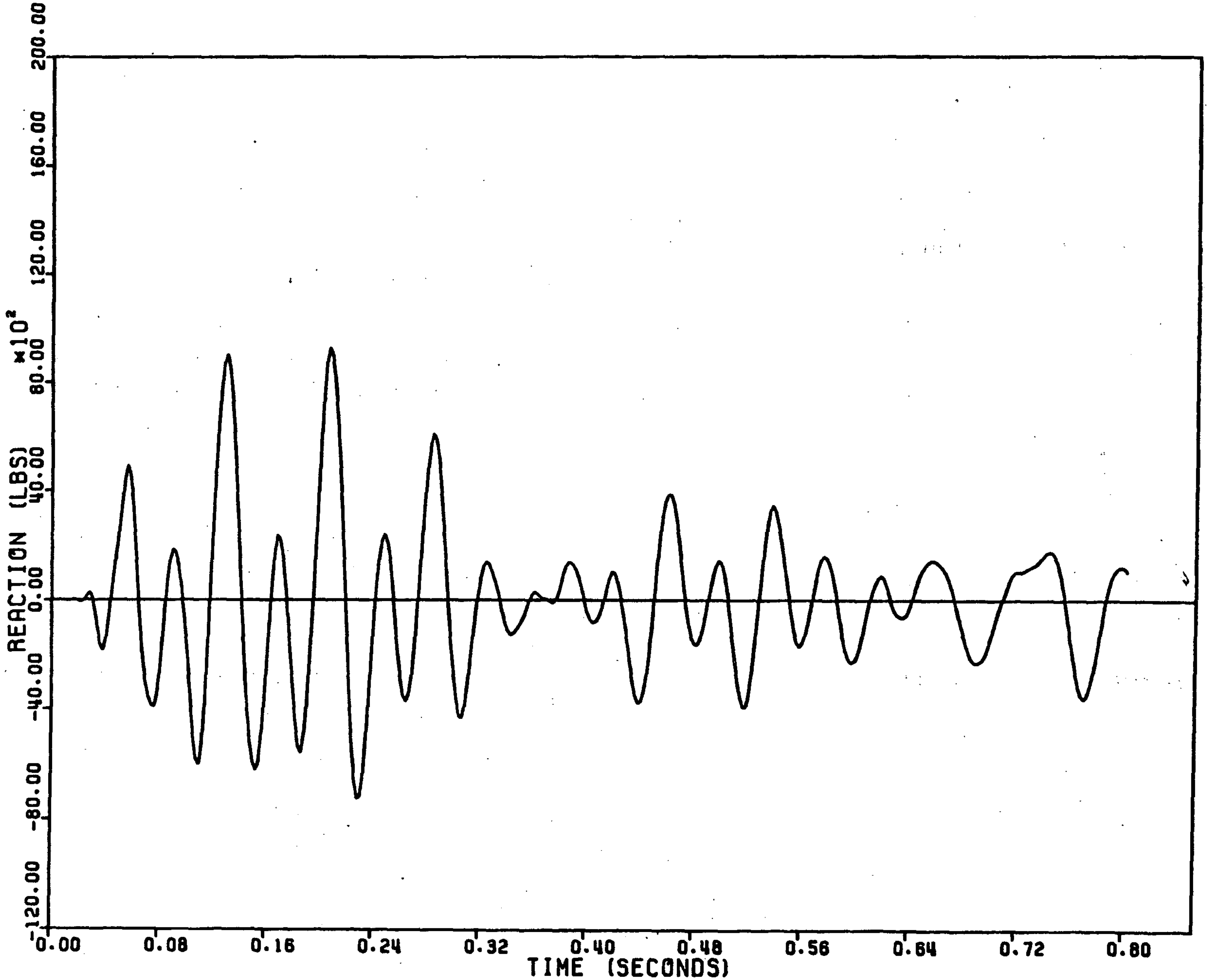


FIGURE C-55A. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-2
SRV-1 LOADING - RECORD 109 - SUPPORT FORCE (LBS) - NPTS = 401, DT = .002

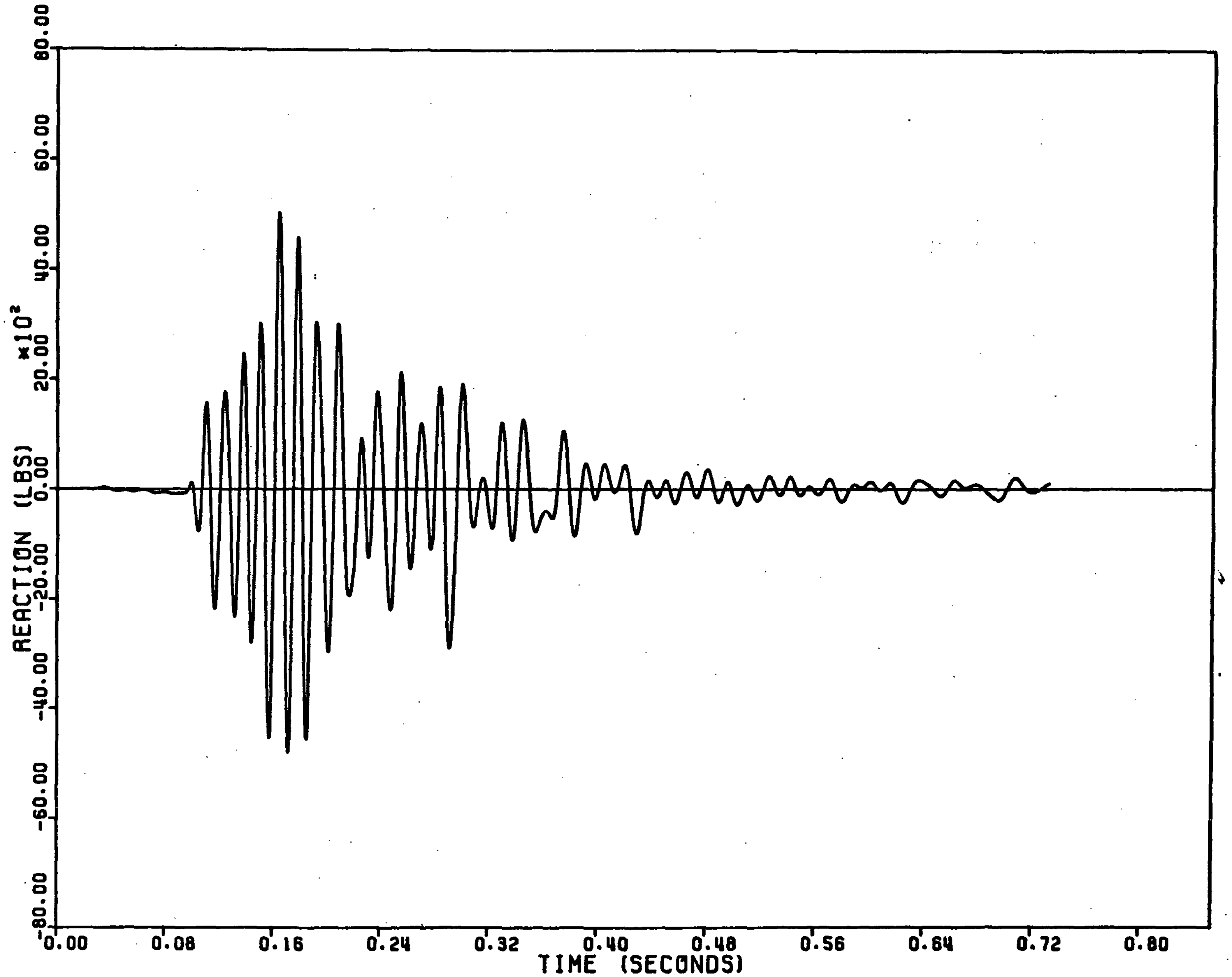


FIGURE C-55B. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-2
CHUG LOADING - RECORD 130 - SUPPORT FORCE (LBS) - NPTS = 1465, DT = .0005

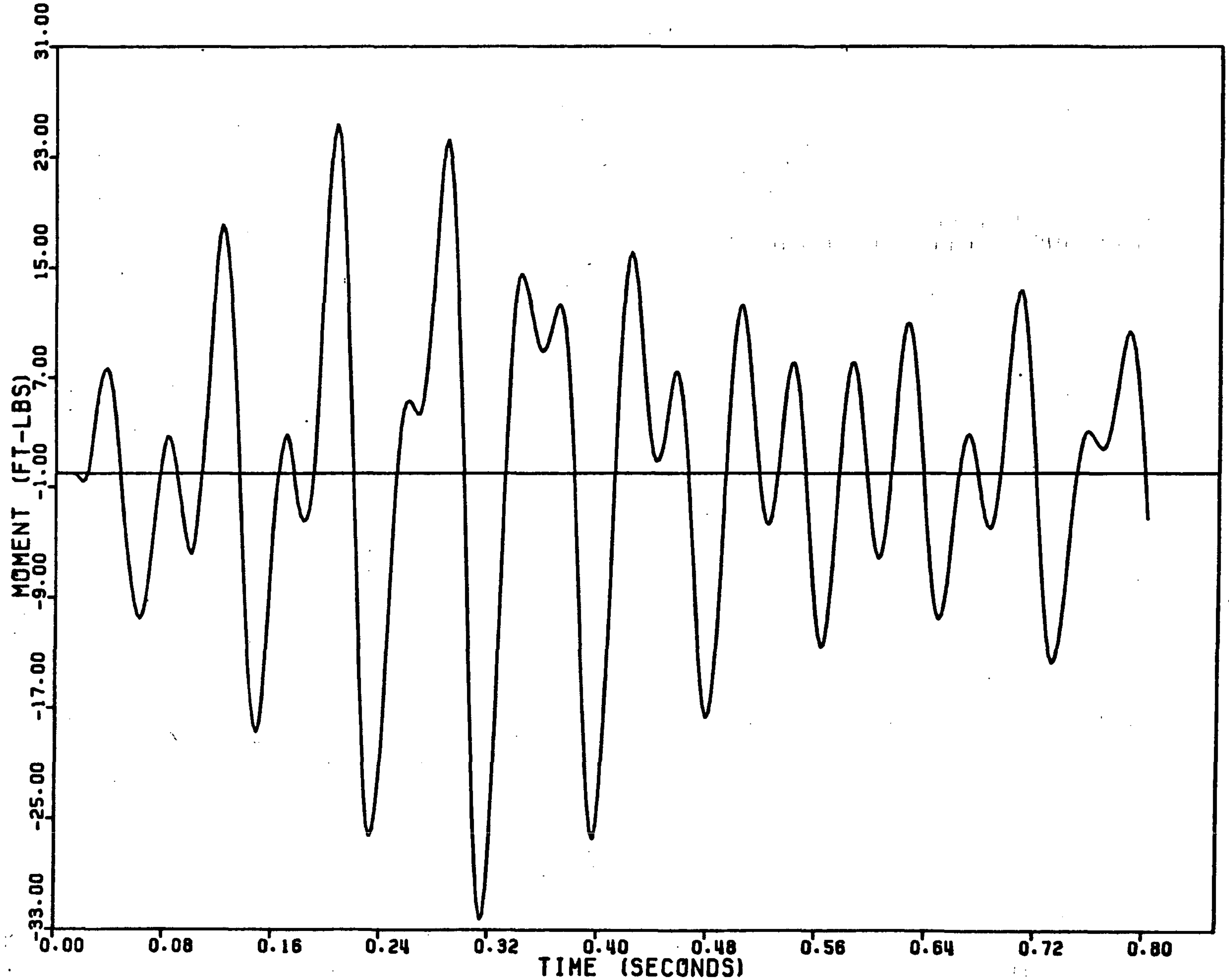


FIGURE C-56A. BOP PIPING TIME HISTORIES, RWCU PIPING, LOCATION 1-4
SRV-1 LOADING - RECORD 111 - PIPE MOMENT MB3 (FT-LBS), NPTS = 401, DT = .002

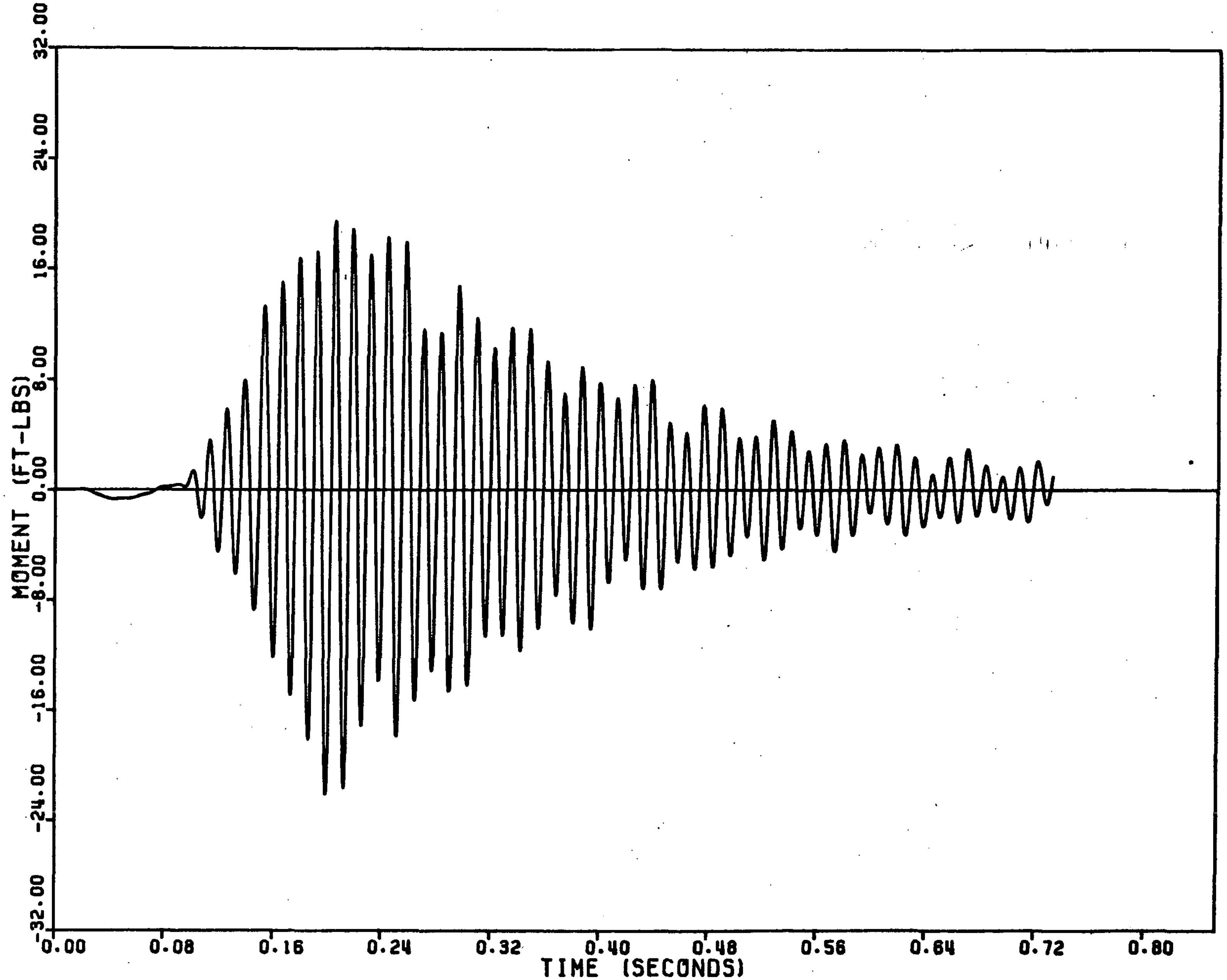


FIGURE C-56B. BOP PIPING TIME HISTORIES, RWCU PIPING, LOCATION 1-4
CHUG LOADING - RECORD 132 - PIPE MOMENT MB3 (FT-LBS), NPTS = 1465, DT = .0005

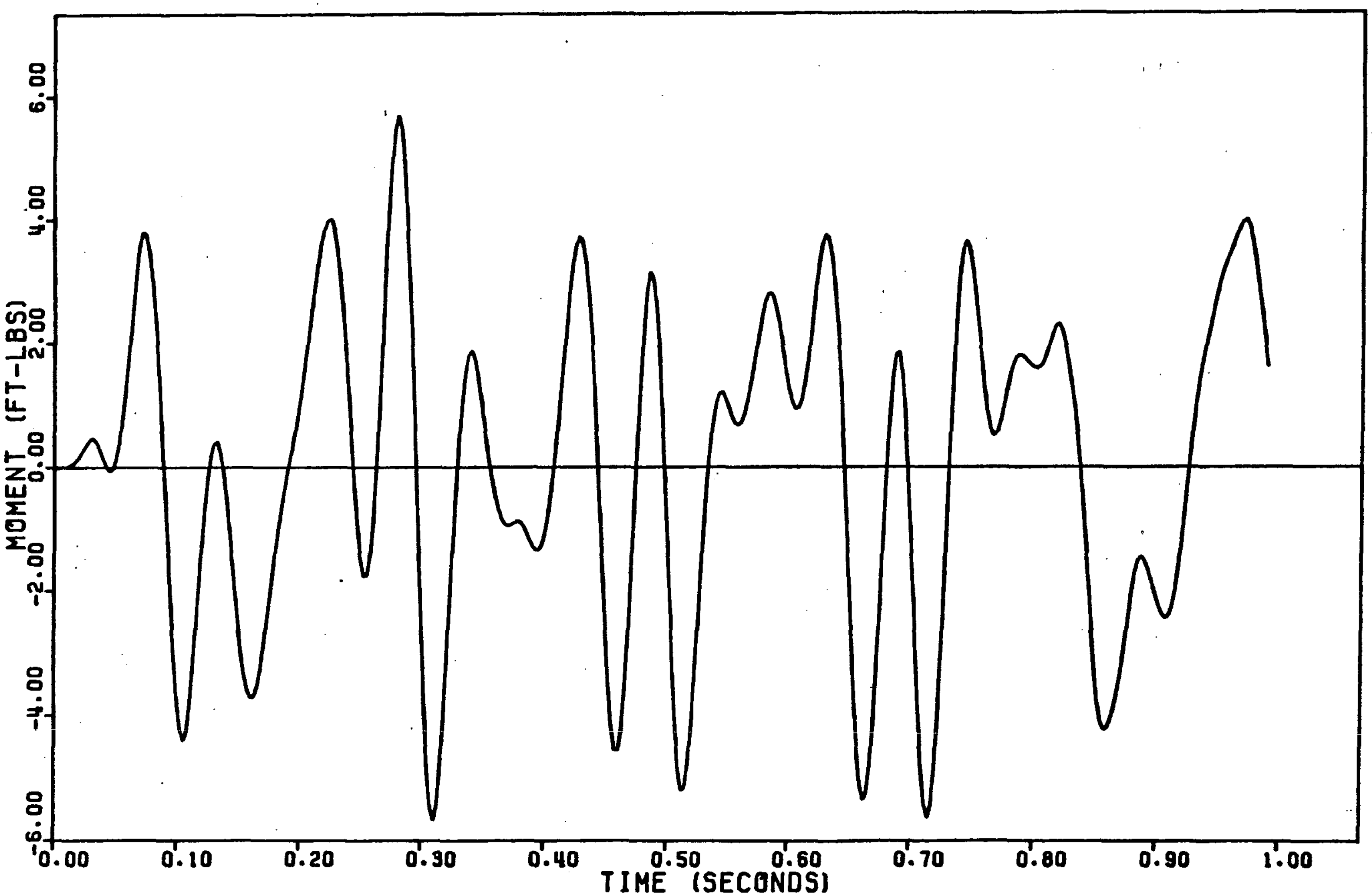


FIGURE C-57A. BOP PIPING TIME HISTORIES, FPC & CU REFUELING WATER LINE, LOCATION 2-7
SRV-1 LOADING - RECORD 717 - PIPE MOMENT Y (FT-LBS) , NPTS = 397, DT = .0025

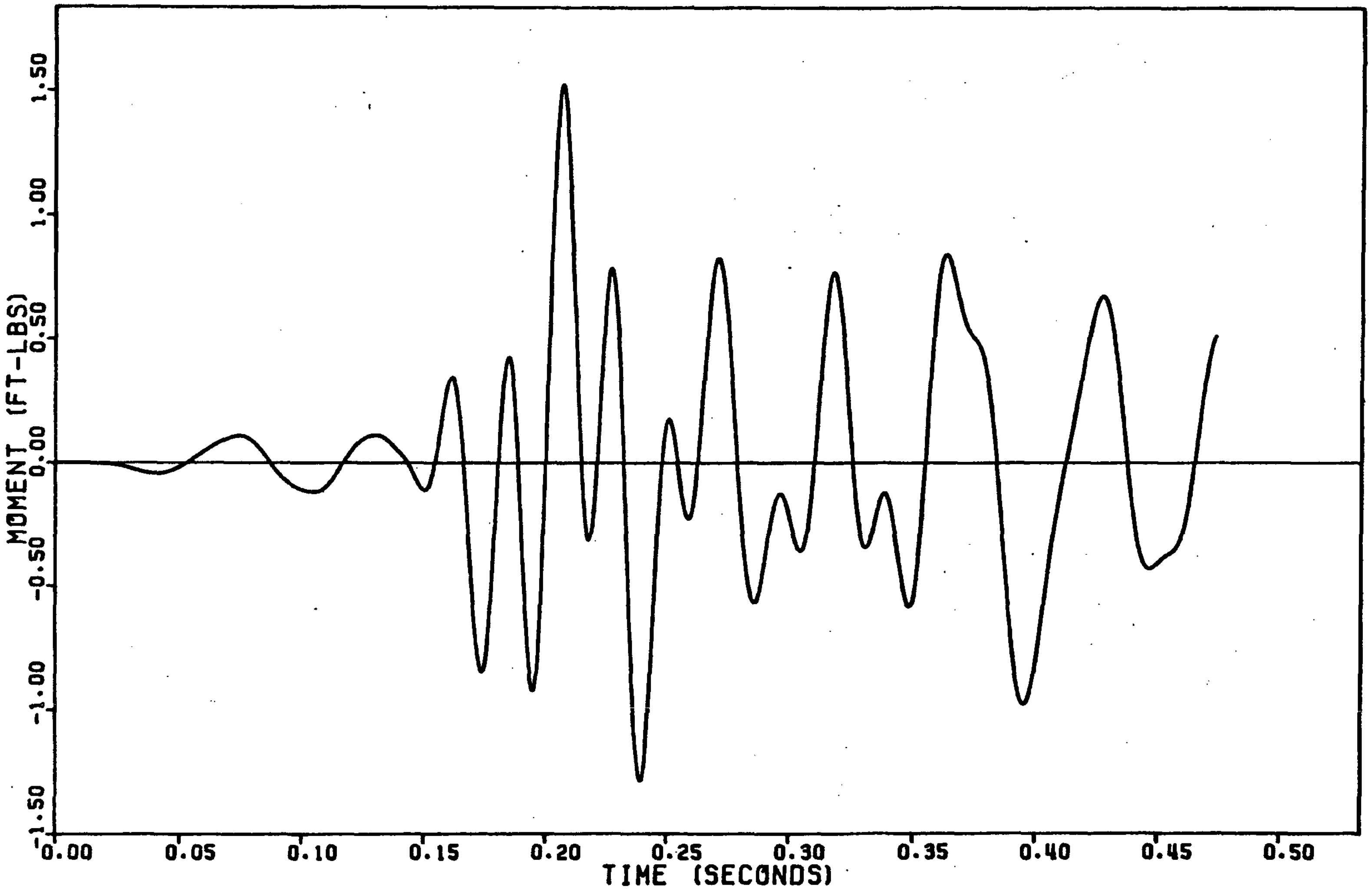


FIGURE C-57B. BOP PIPING TIME HISTORIES. FPC & CU REFUELING WATER LINE.LOCATION 2-7
CHUG LOADING - RECORD 747 - PIPE MOMENT Y (FT-LBS) . NPTS = 948 . DT = .0005

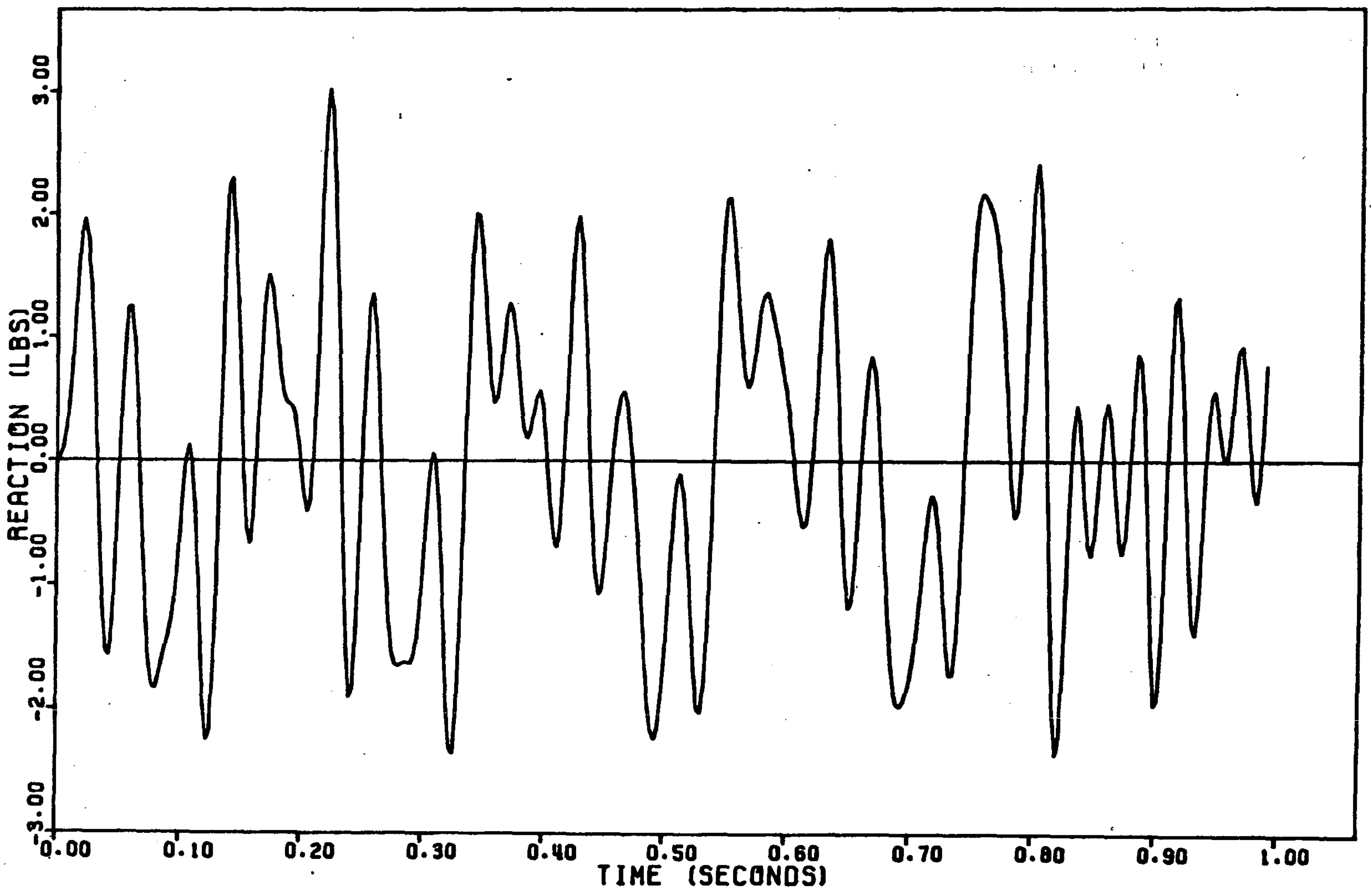


FIGURE C-58A. BOP PIPING TIME HISTORIES, FPC & CU REFUELING WATER LINE, LOCATION 2-8
SRV-1 LOADING - RECORD 718 - AXIAL SUPPORT (LBS) NPTS = 397, DT = .0025

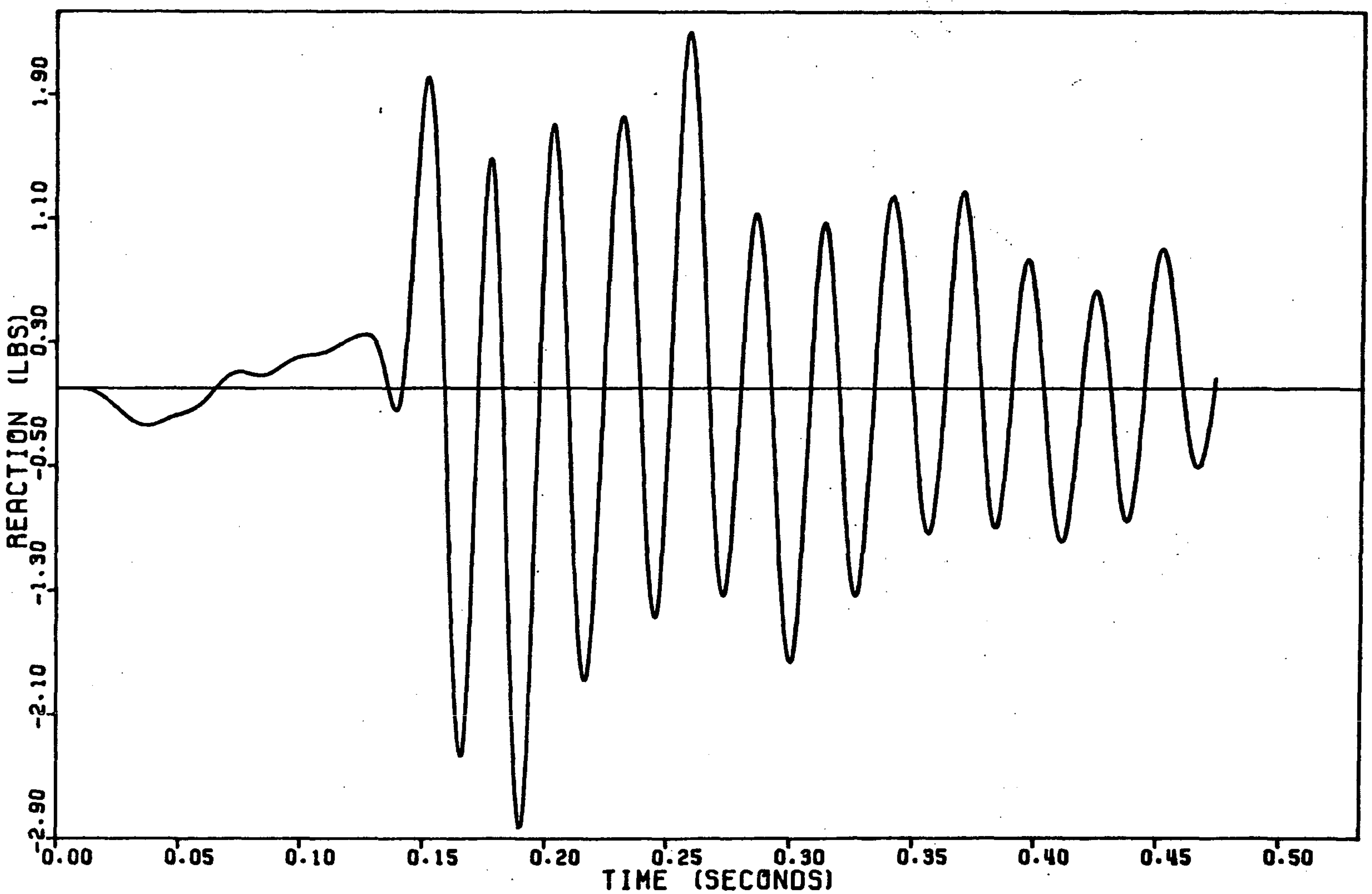


FIGURE C-58B. BOP PIPING TIME HISTORIES, FPC & CU REFUELING WATER LINE, LOCATION 2-8
CHUG LOADING - RECORD 748 - AXIAL SUPPORT (LBS) NPTS = 948 , DT = .0005

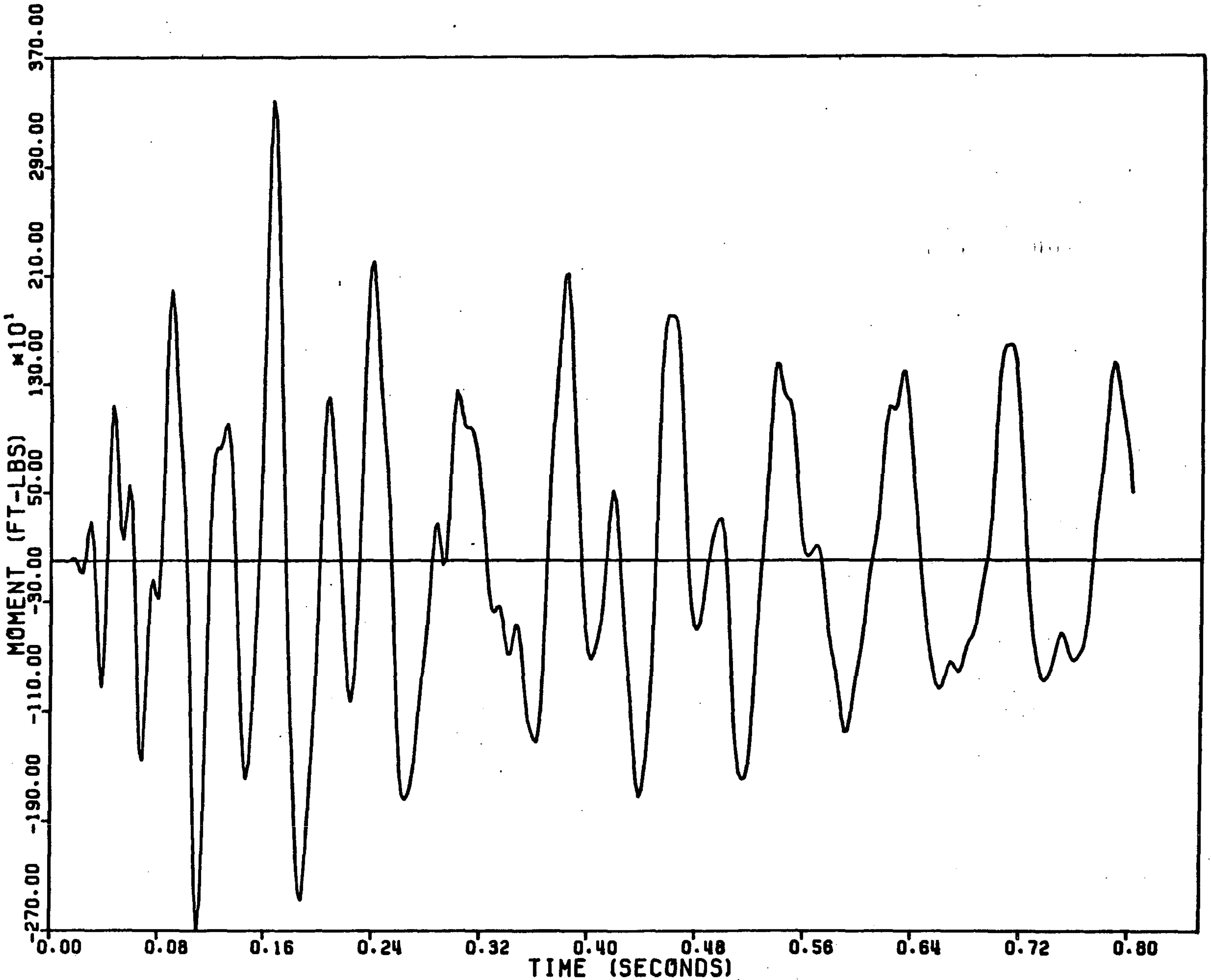


FIGURE C-59A. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-1
SRV-ALL LOADING- RECORD 122 - PIPE MOMENT MB3 (FT-LBS), NPTS = 401, DT = .002

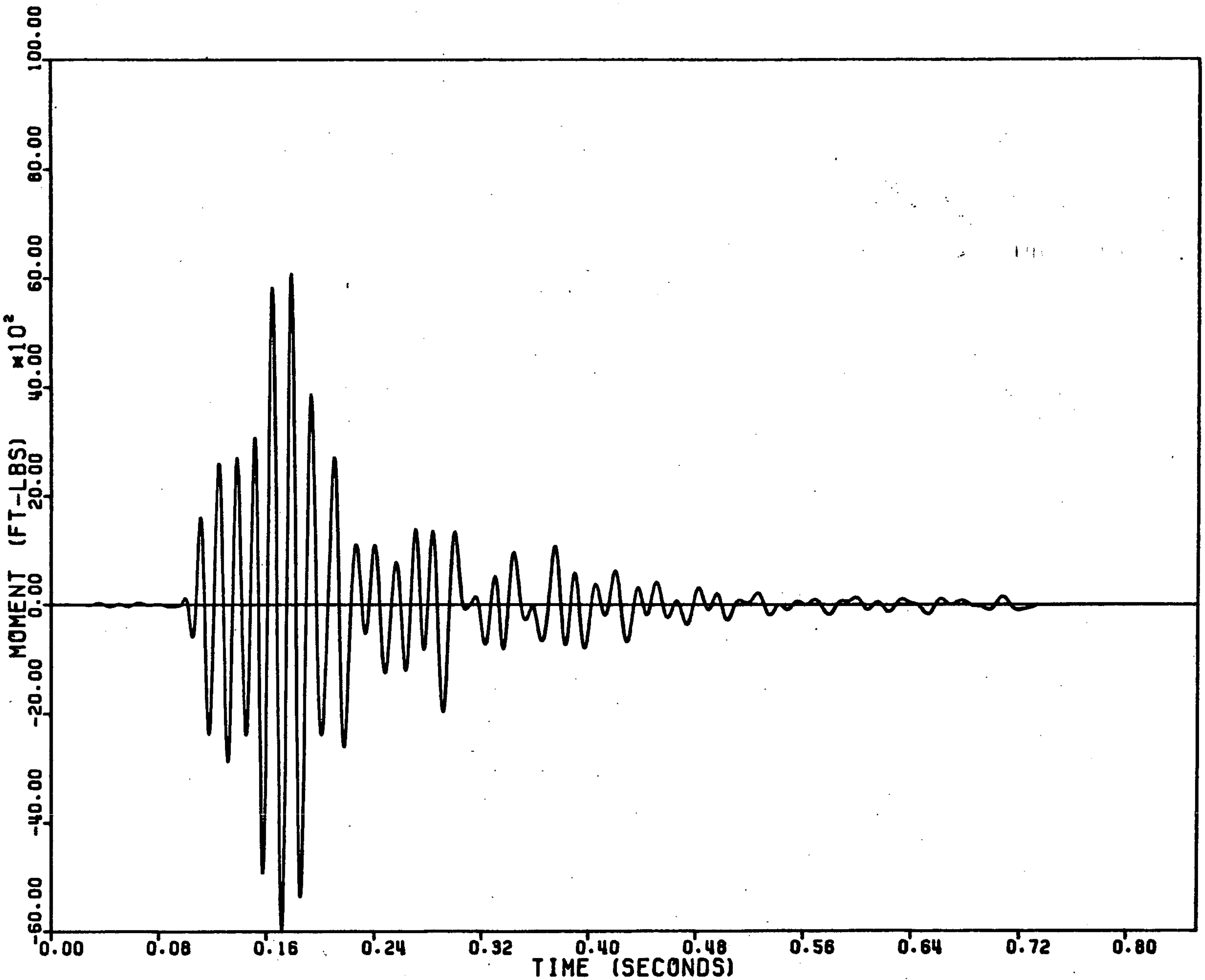


FIGURE C-59B. BOP PIPING TIME HISTORIES, FEEDWATER LINE, LOCATION 1-1
CHUG LOADING - RECORD 129 - PIPE MOMENT MB3 (FT-LBS), NPTS = 1465, DT = .0005

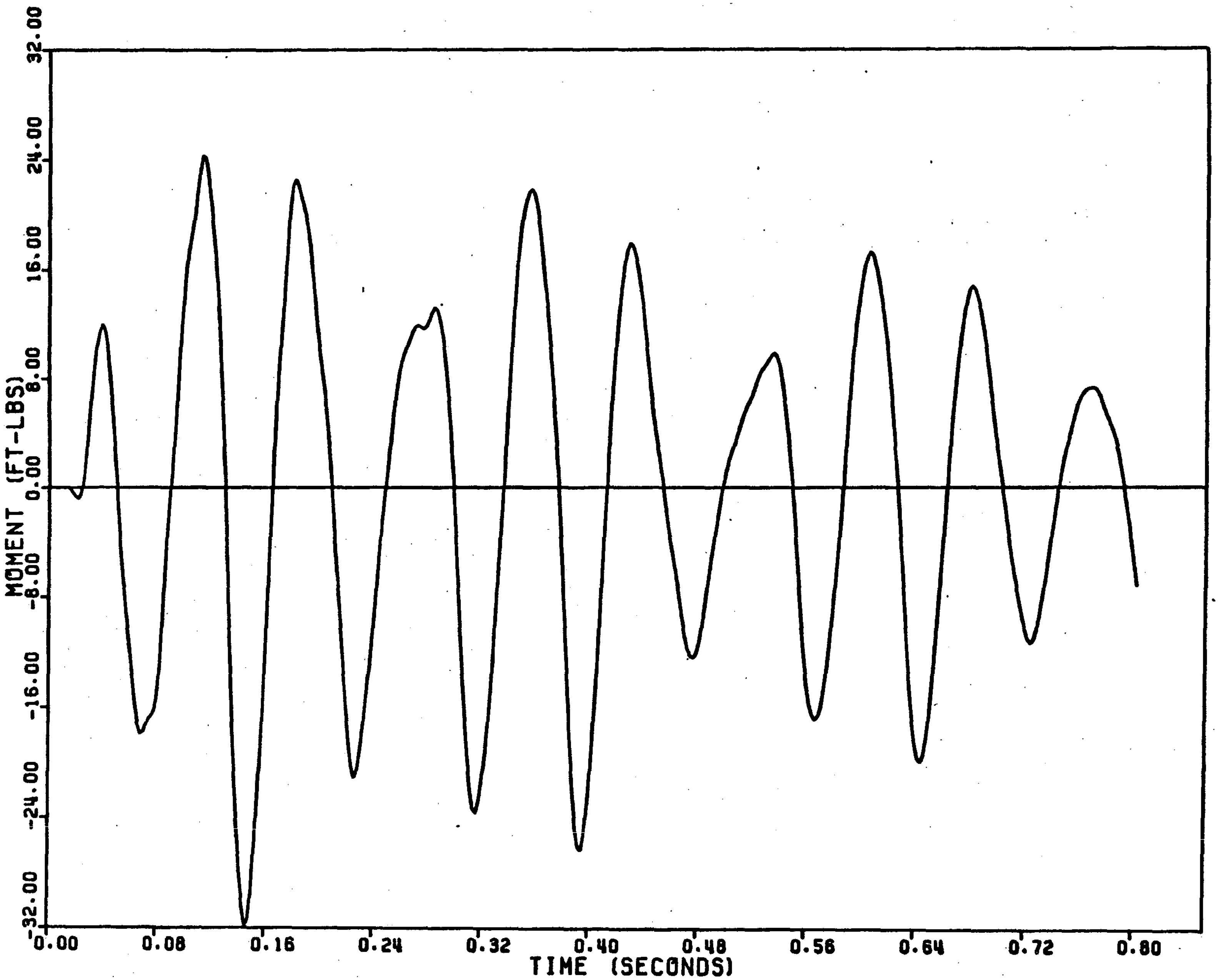


FIGURE C-60A. BOP PIPING TIME HISTORIES, RWCU PIPING, LOCATION 1-4
SRV-ALL LOADING- RECORD 125 - PIPE MOMENT MB3 (FT-LBS), NPTS = 401, DT = .002

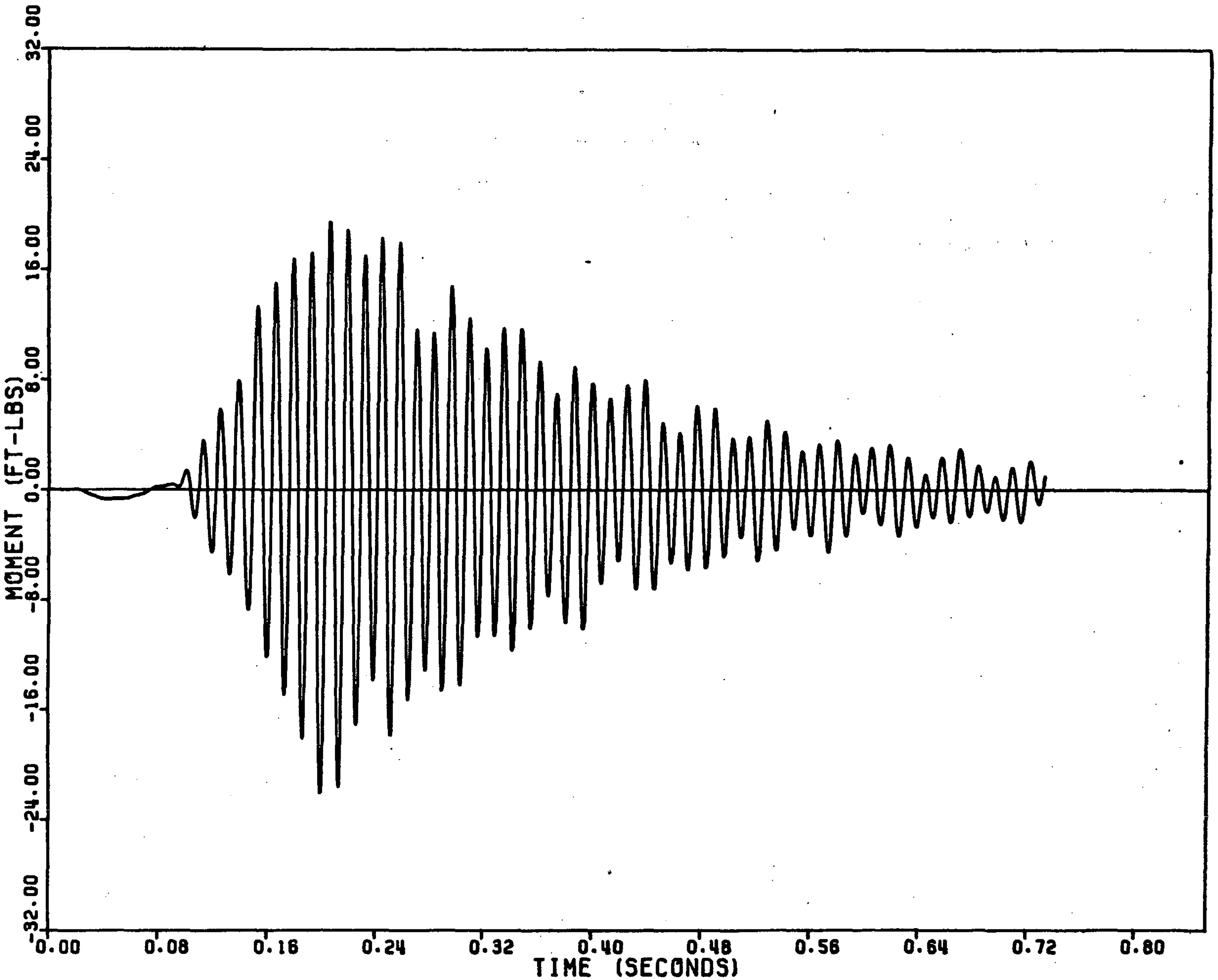


FIGURE C-60B. BOP PIPING TIME HISTORIES, RWCU PIPING, LOCATION 1-4
CHUG LOADING - RECORD 132 - PIPE MOMENT MB3 (FT-LBS), NPTS = 1465, DT = .0005

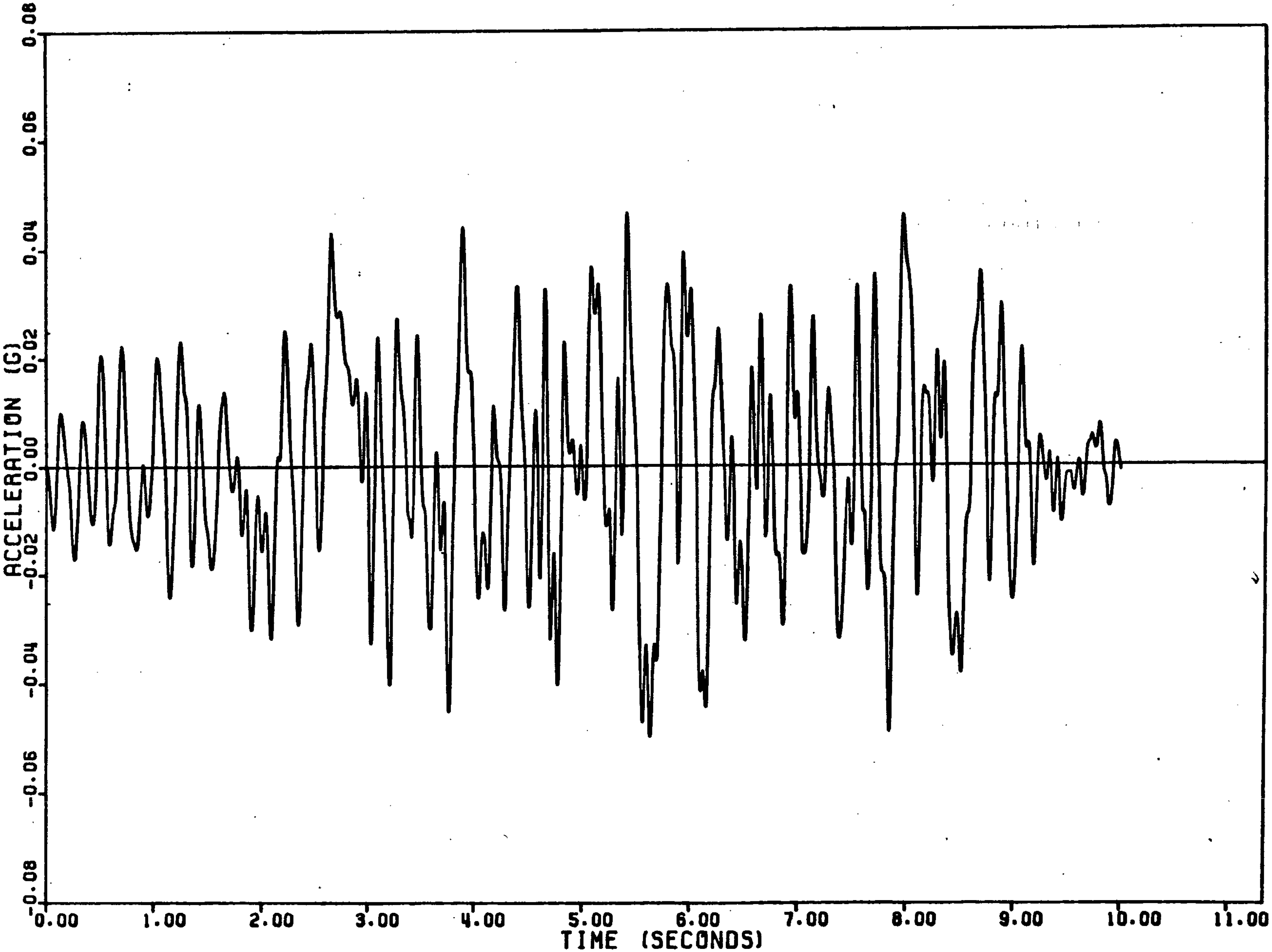


FIGURE C-61A. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-1
OBE LOADING - RECORD 311 - ACCELERATION (G), NPTS = 2001, DT = .005

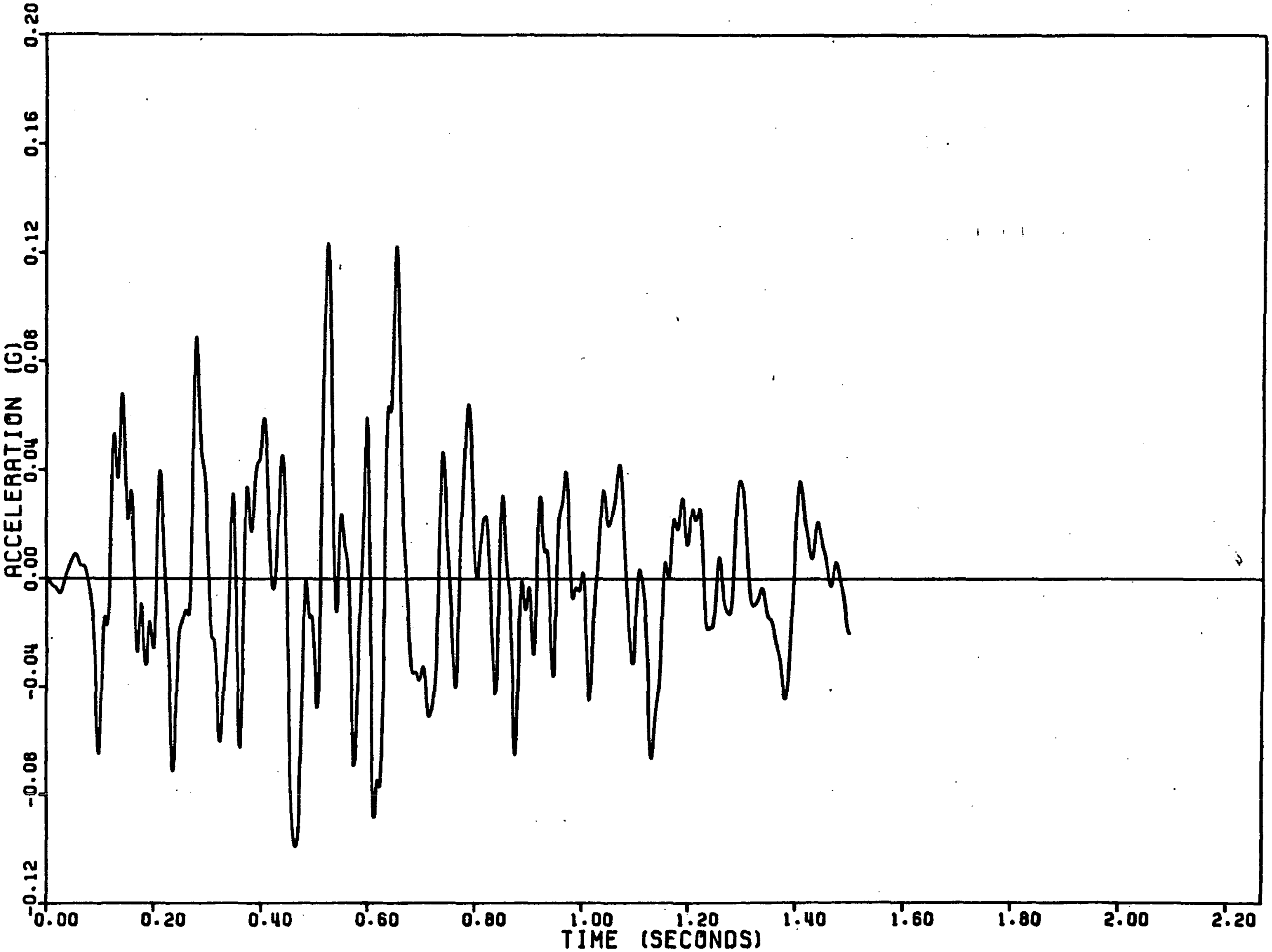


FIGURE C-61B. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-1
SRV-ALL LOADING- RECORD 344 - ACCELERATION (G), NPTS =1501, DT = .0010

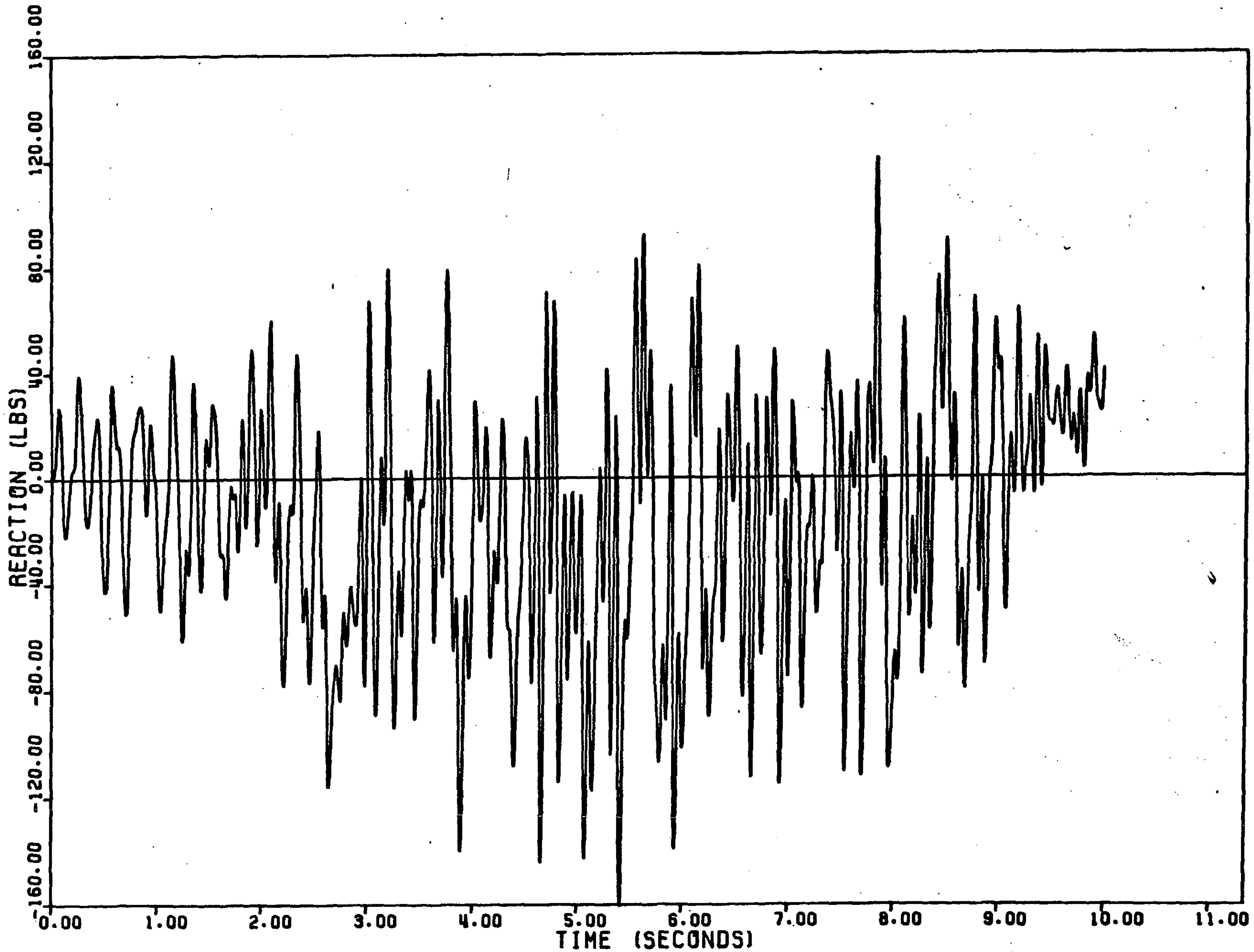


FIGURE C-62A. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-3
OBE LOADING - RECORD 313 - SUPPORT FORCE (LBS) , NPTS = 2001, DT = .005

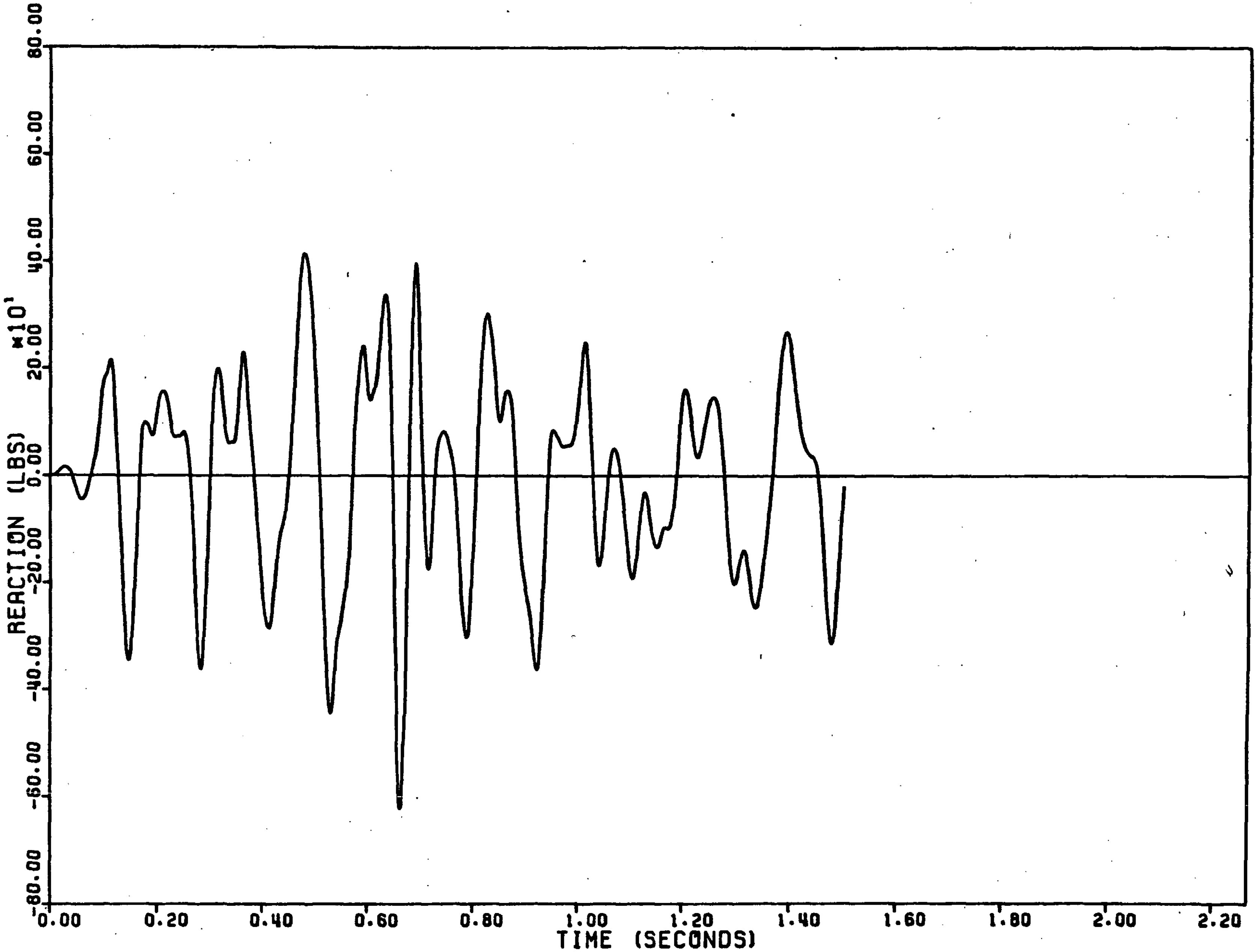


FIGURE C-62B. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-3
SRV-ALL LOADING- RECORD 346 - SUPPORT FORCE (LBS) . NPTS =1501, DT = .0010

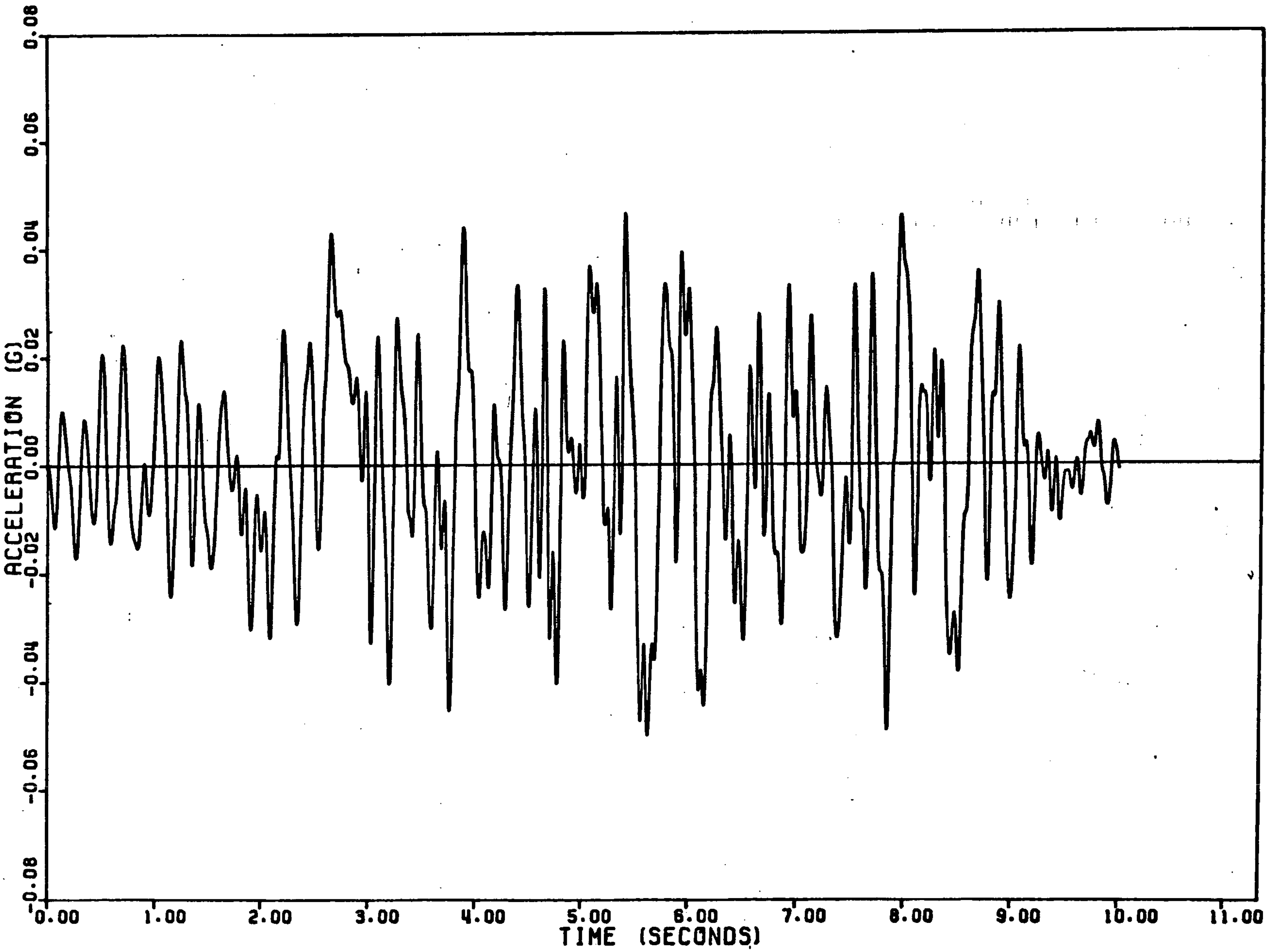


FIGURE C-63A. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-1
OBE LOADING - RECORD 311 - ACCELERATION (G), NPTS = 2001, DT = .005

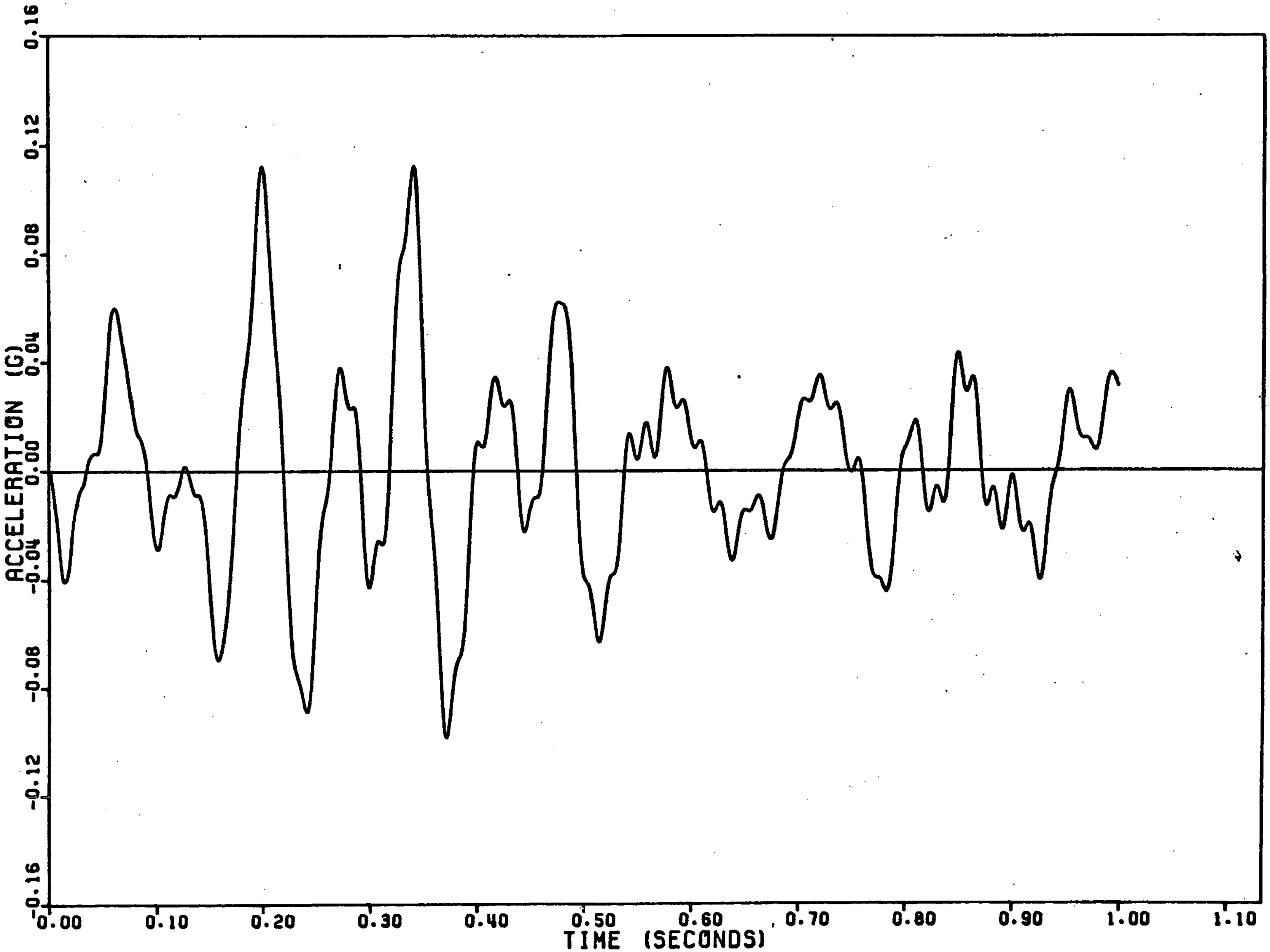


FIGURE C-63B. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-1
SRV-ADS LOADING- RECORD 341 - ACCELERATION (G), NPTS =1000, DT = .0010

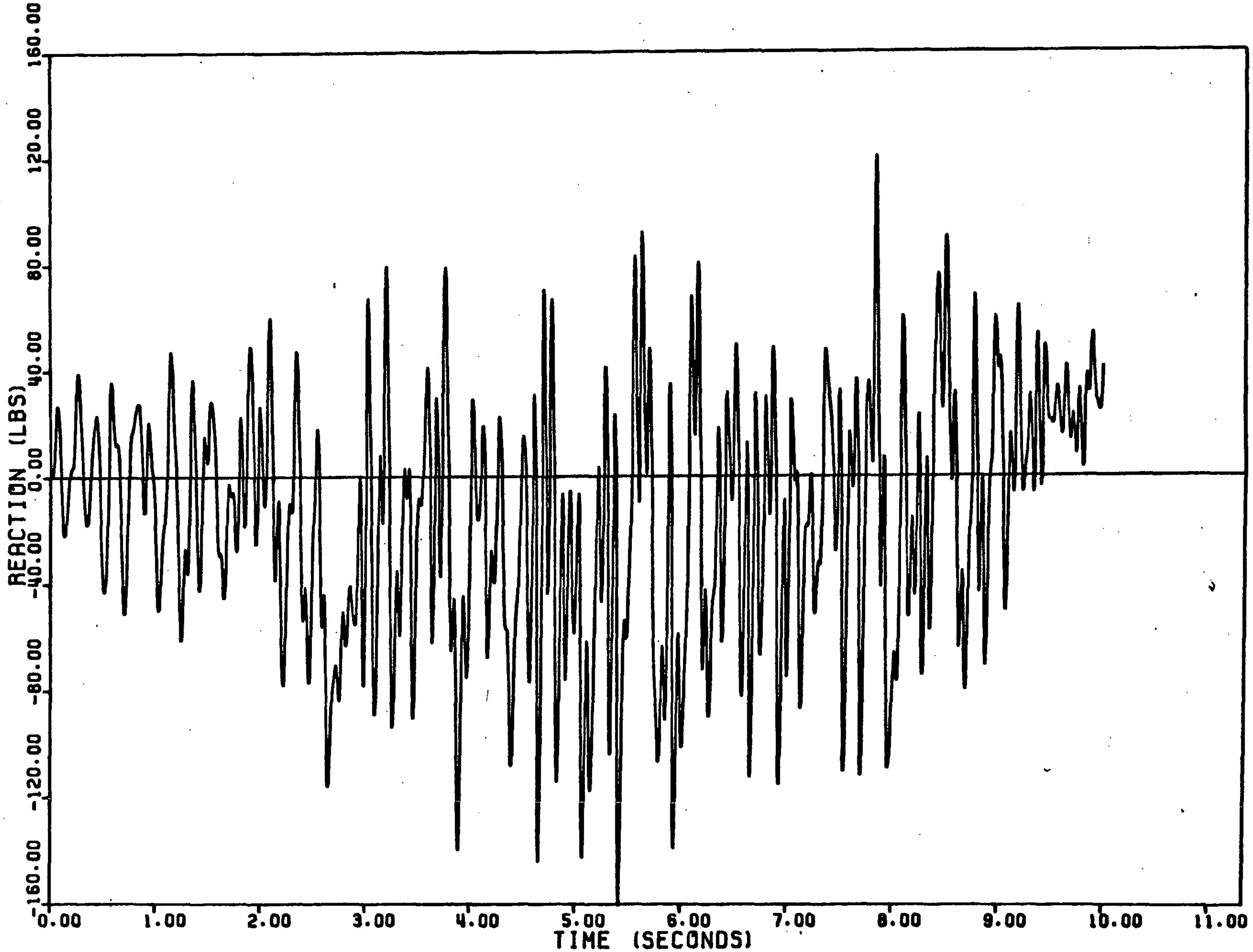


FIGURE C-64A. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-3
OBE LOADING - RECORD 313 - SUPPORT FORCE (LBS) , NPTS = 2001, DT = .005

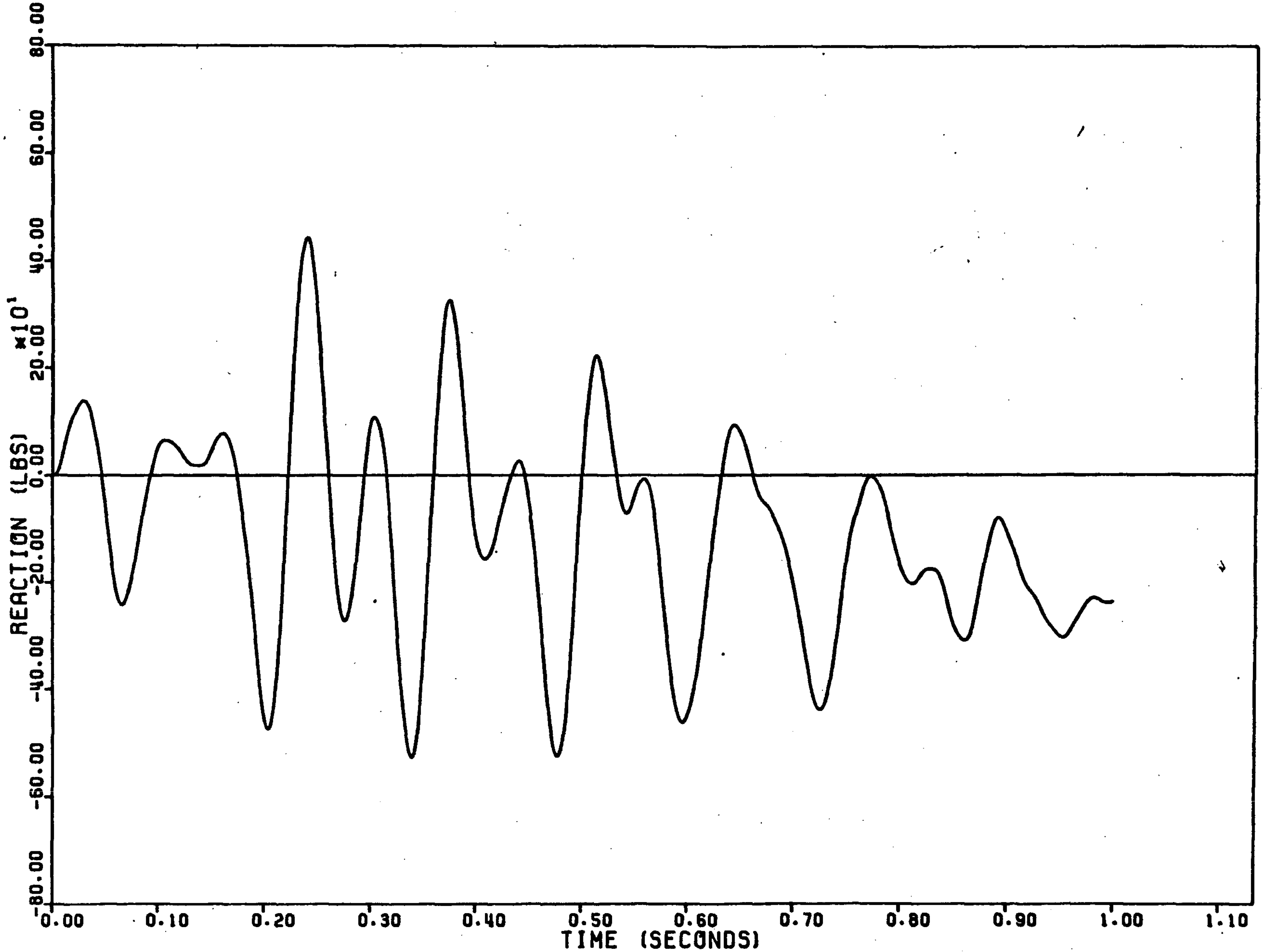


FIGURE C-64B. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-3
SRV-ADS LOADING- RECORD 343 - SUPPORT FORCE (LBS) , NPTS =1000, DT = .0010

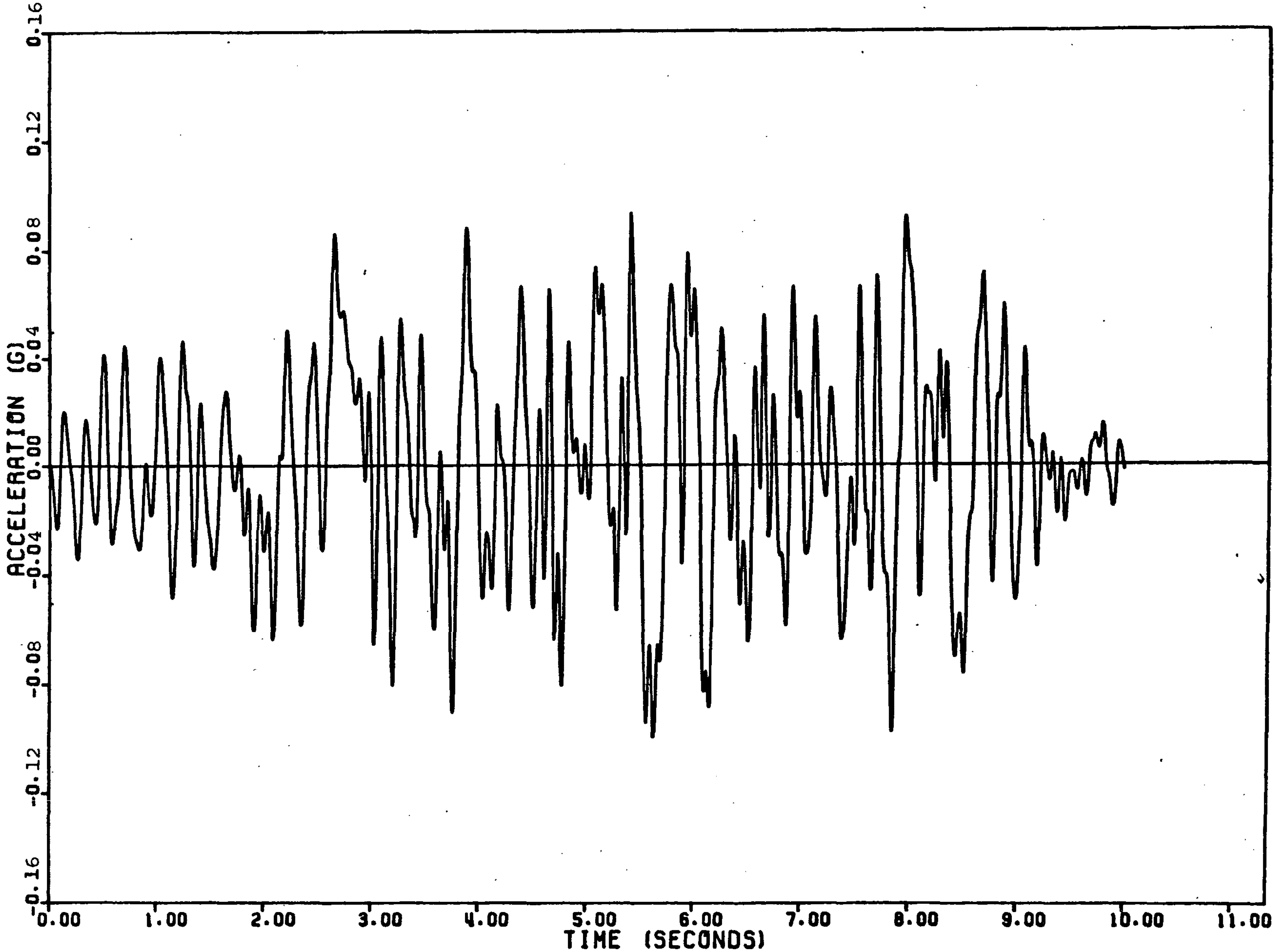


FIGURE C-65A. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-1
SSE LOADING - RECORD 311 - ACCELERATION (G), NPTS = 2001, DT = .005

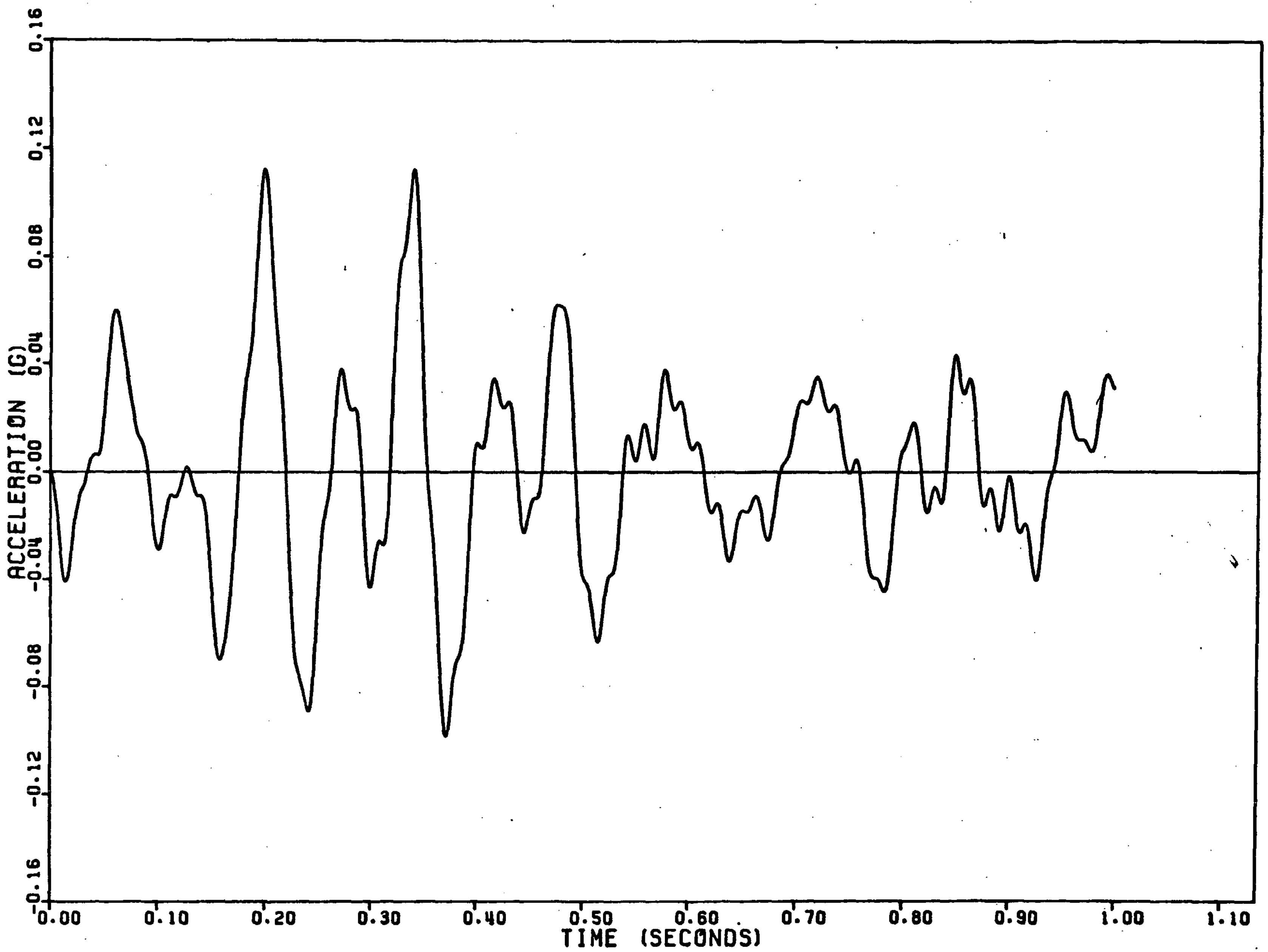


FIGURE C-65B. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-1
SRV-ADS LOADING- RECORD 341 - ACCELERATION (G). NPTS =1000. DT = .0010

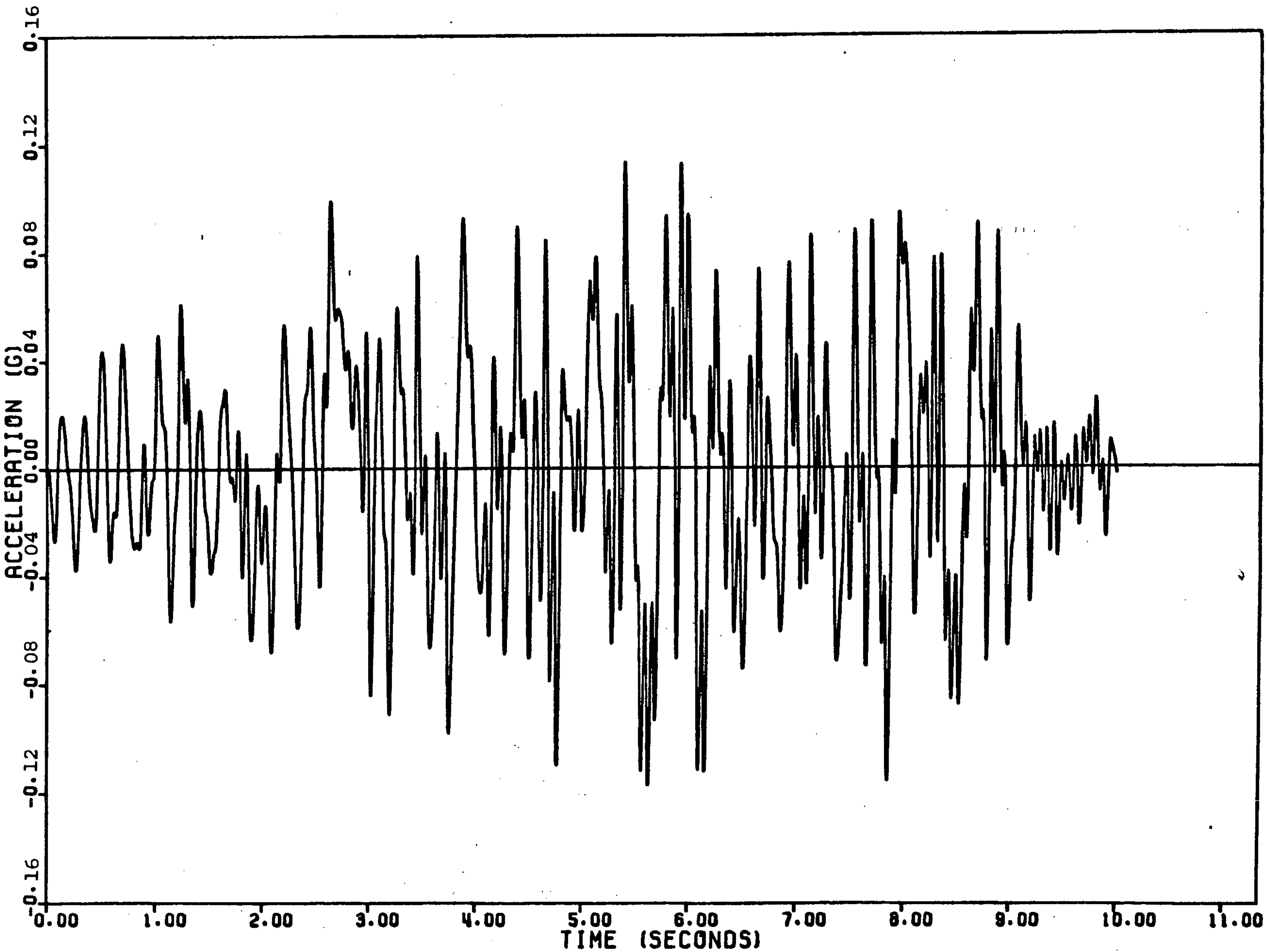


FIGURE C-66A. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-2
SSE LOADING - RECORD 312 - ACCELERATION (G), NPTS = 2001, DT = .005

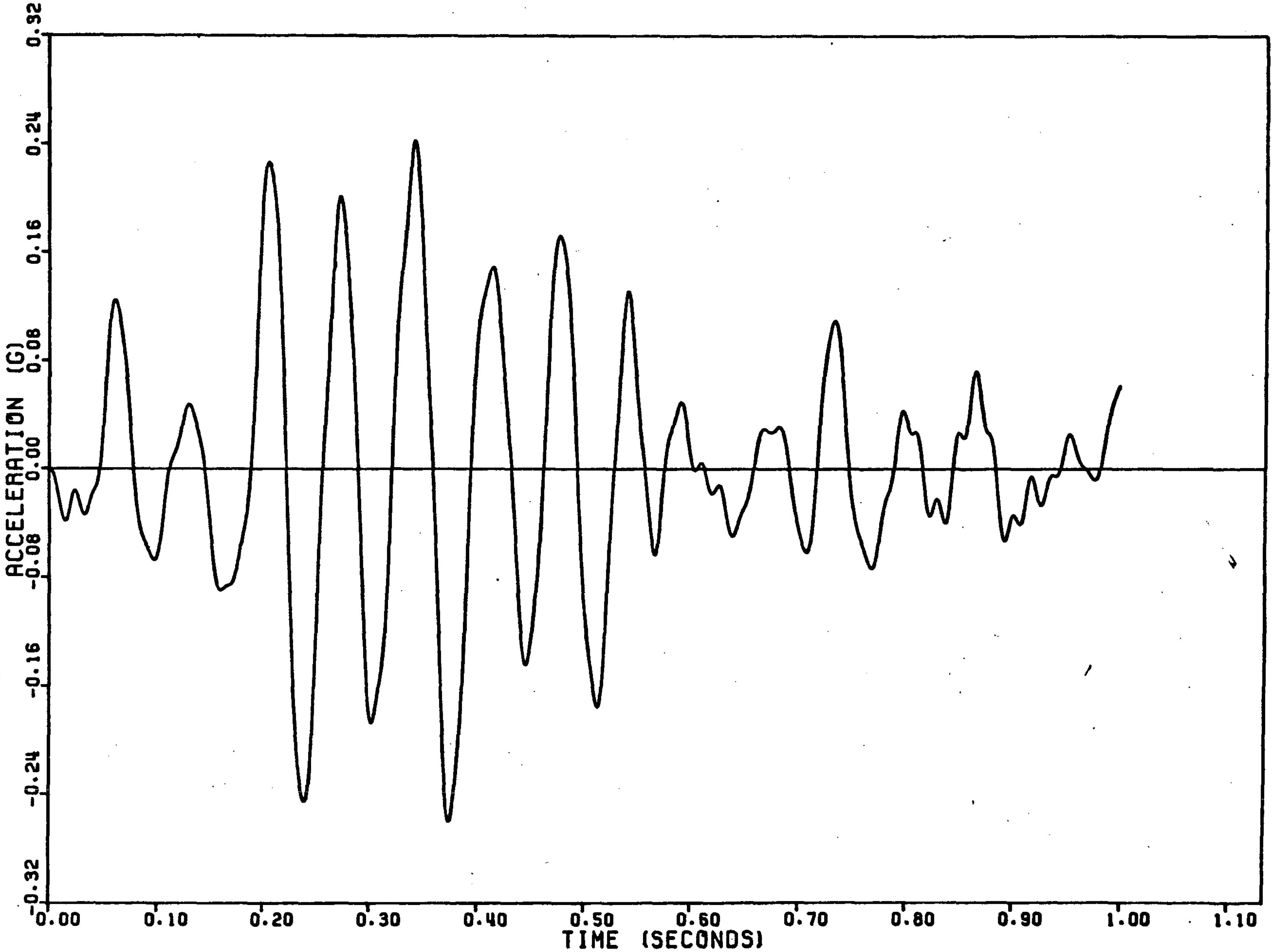


FIGURE C-66B. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-2
SRV-ADS LOADING- RECORD 342 - ACCELERATION (G), NPTS =1000, DT = .0010

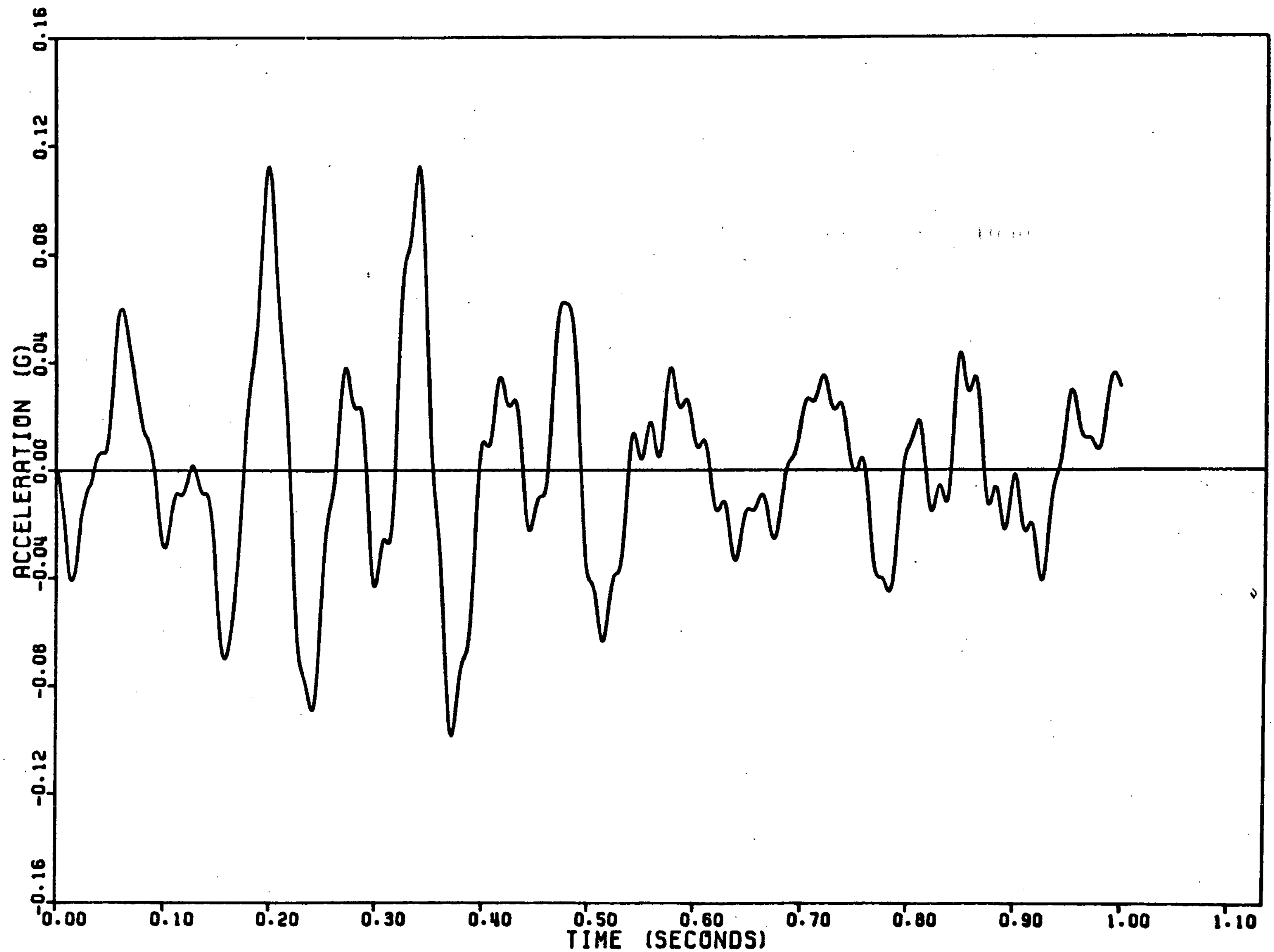


FIGURE C-67A. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-1
SRV-ADS LOADING- RECORD 341 - ACCELERATION (G), NPTS =1000, DT = .0010

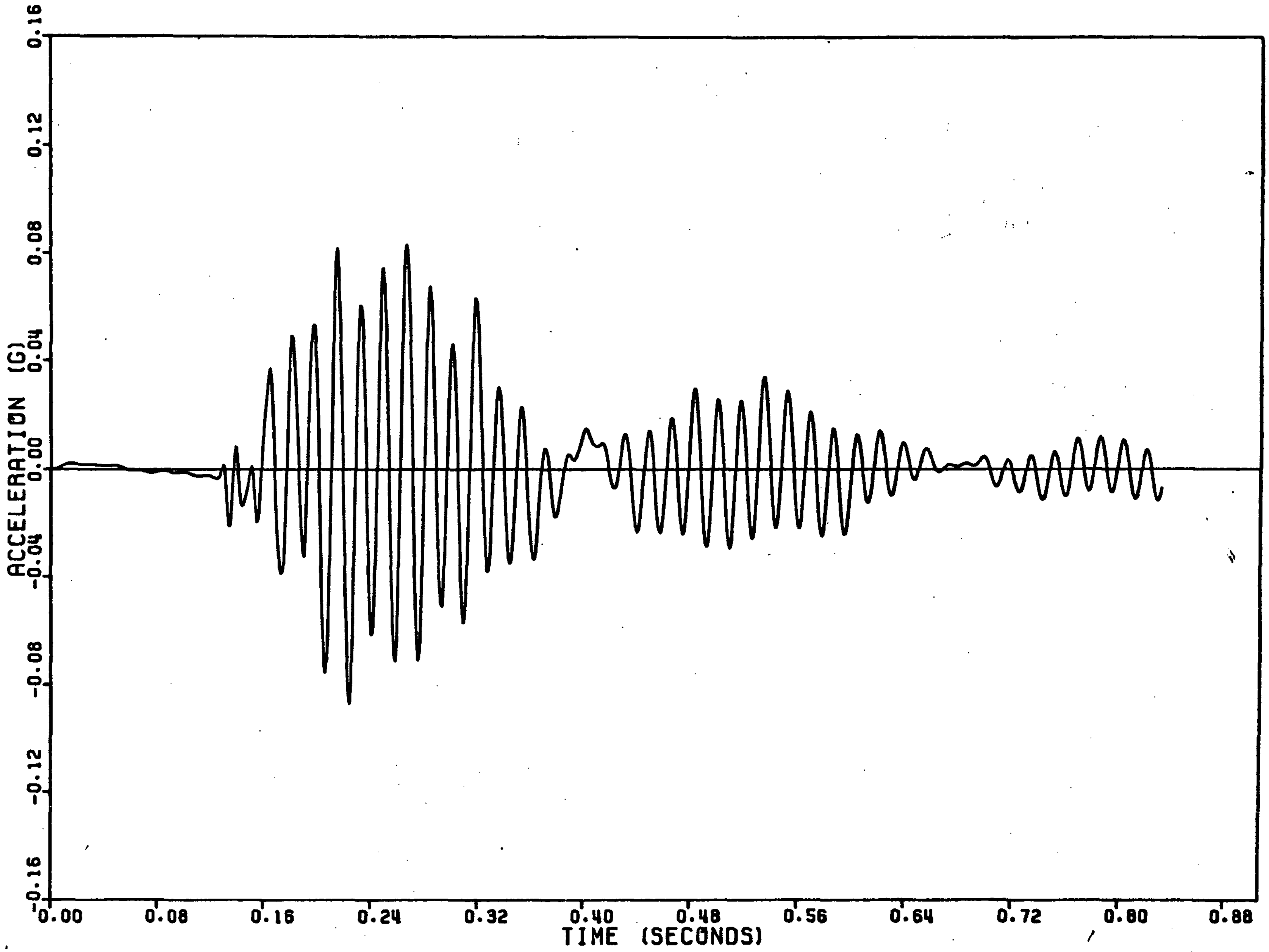


FIGURE C-67B. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-1
CHUG LOADING - RECORD 371 - ACCELERATION (G), NPTS = 833, DT = .001

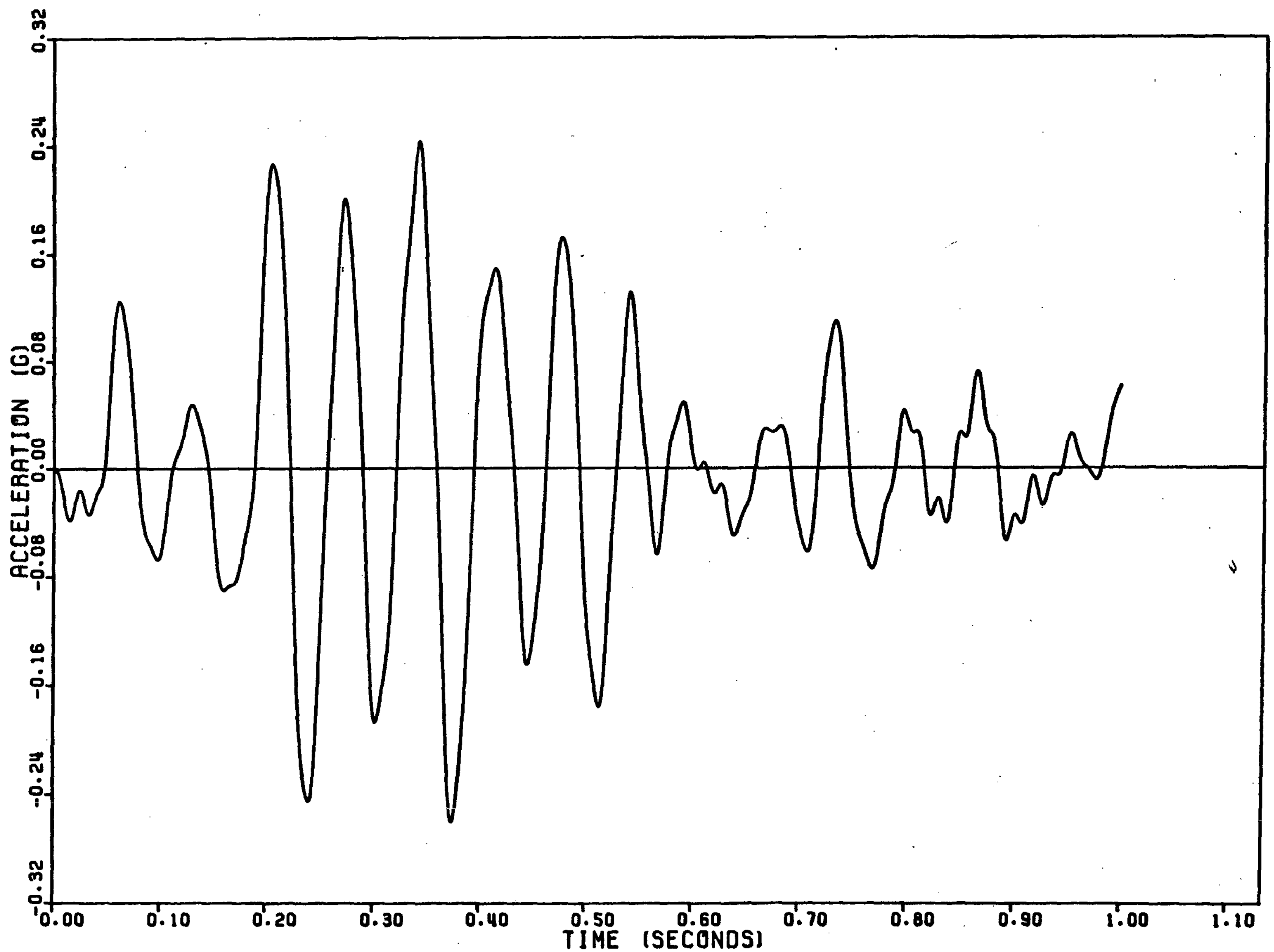


FIGURE C-68A. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-2
SRV-ADS LOADING- RECORD 342 - ACCELERATION (G), NPTS =1000, DT = .0010

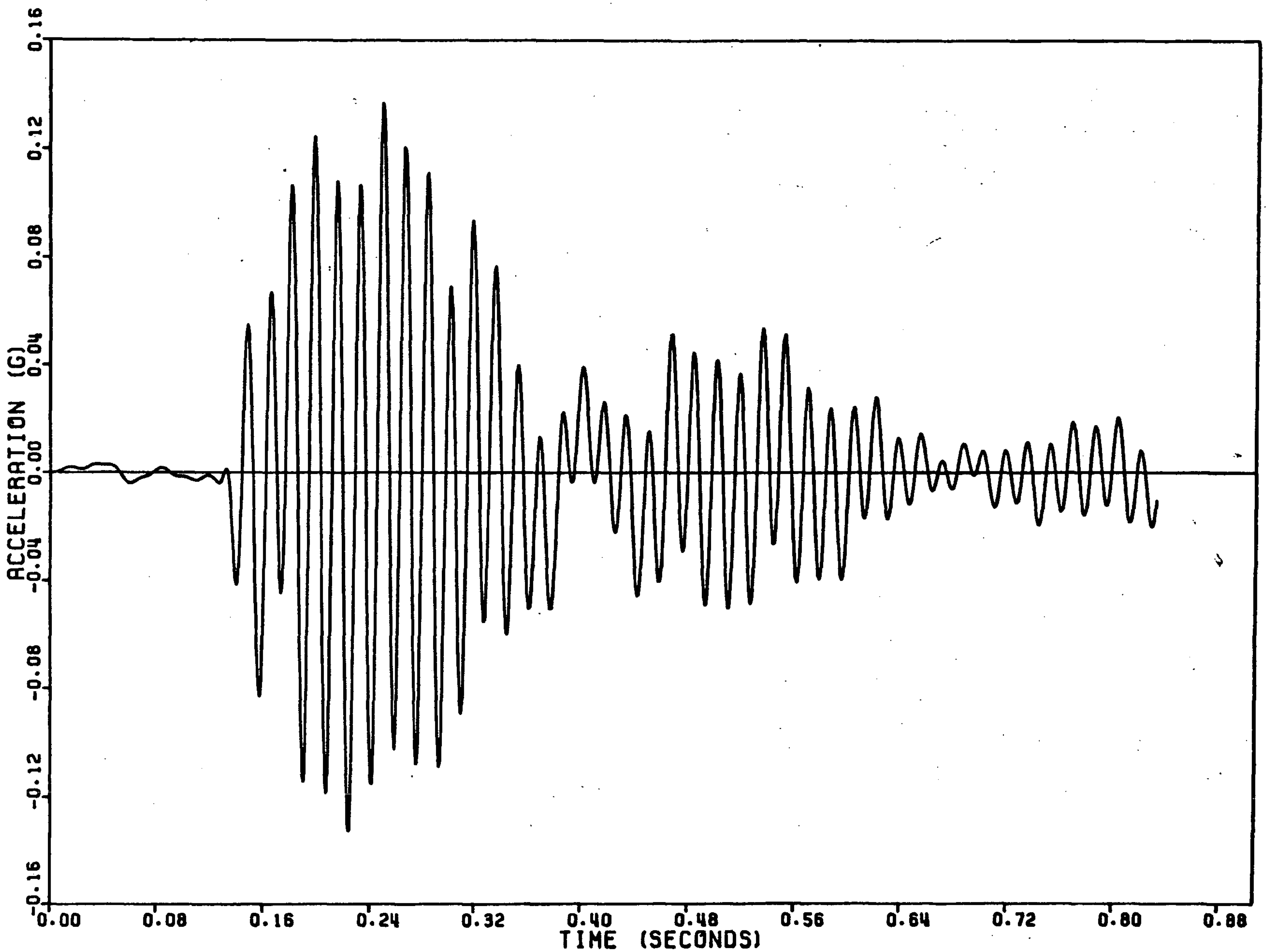


FIGURE C-68B. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-2
CHUG LOADING - RECORD 372 - ACCELERATION (G), NPTS = 833, DT = .001

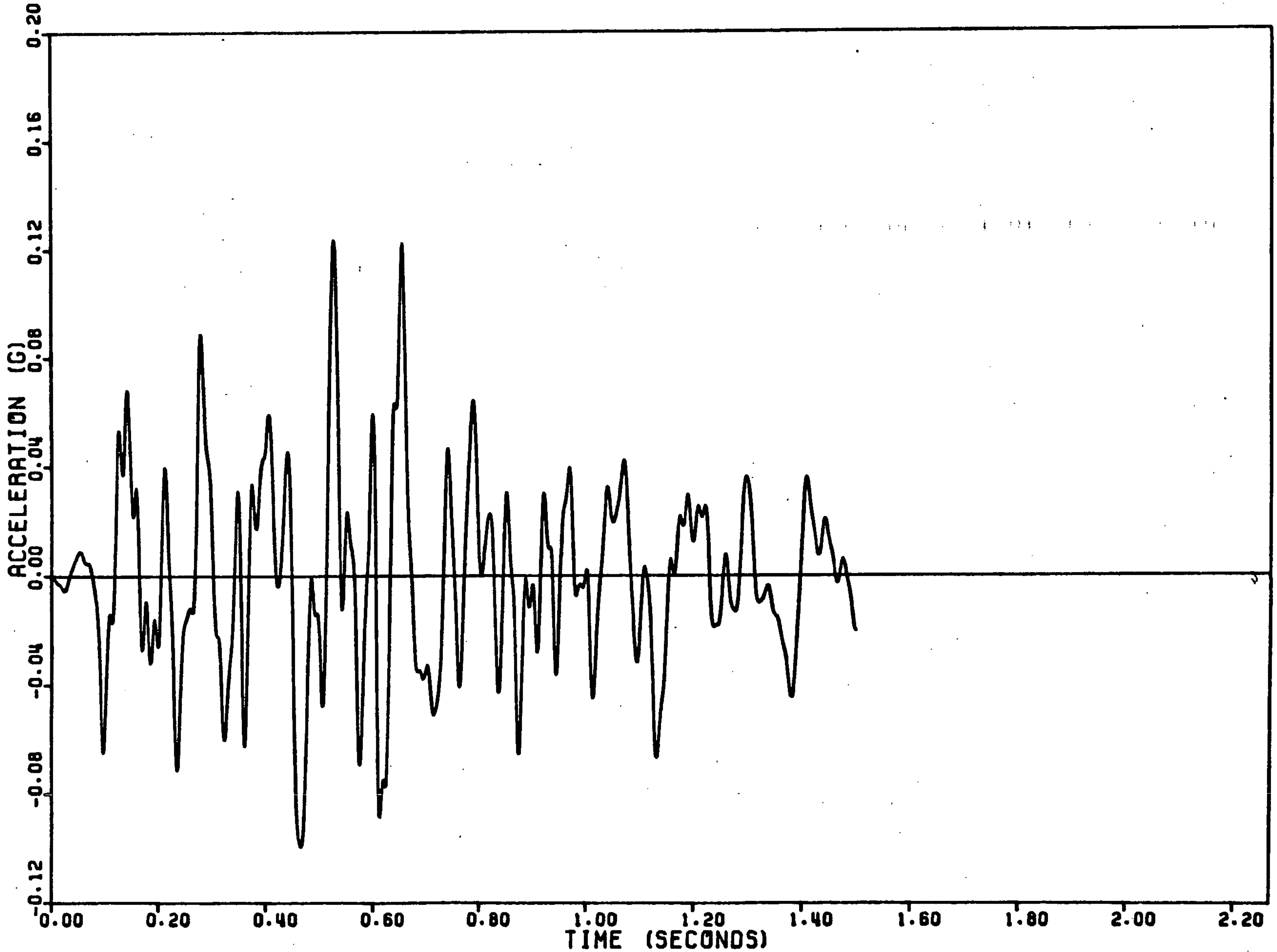


FIGURE C-69A. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-1
SRV-ALL LOADING- RECORD 344 - ACCELERATION (G), NPTS =1501, DT = .0010

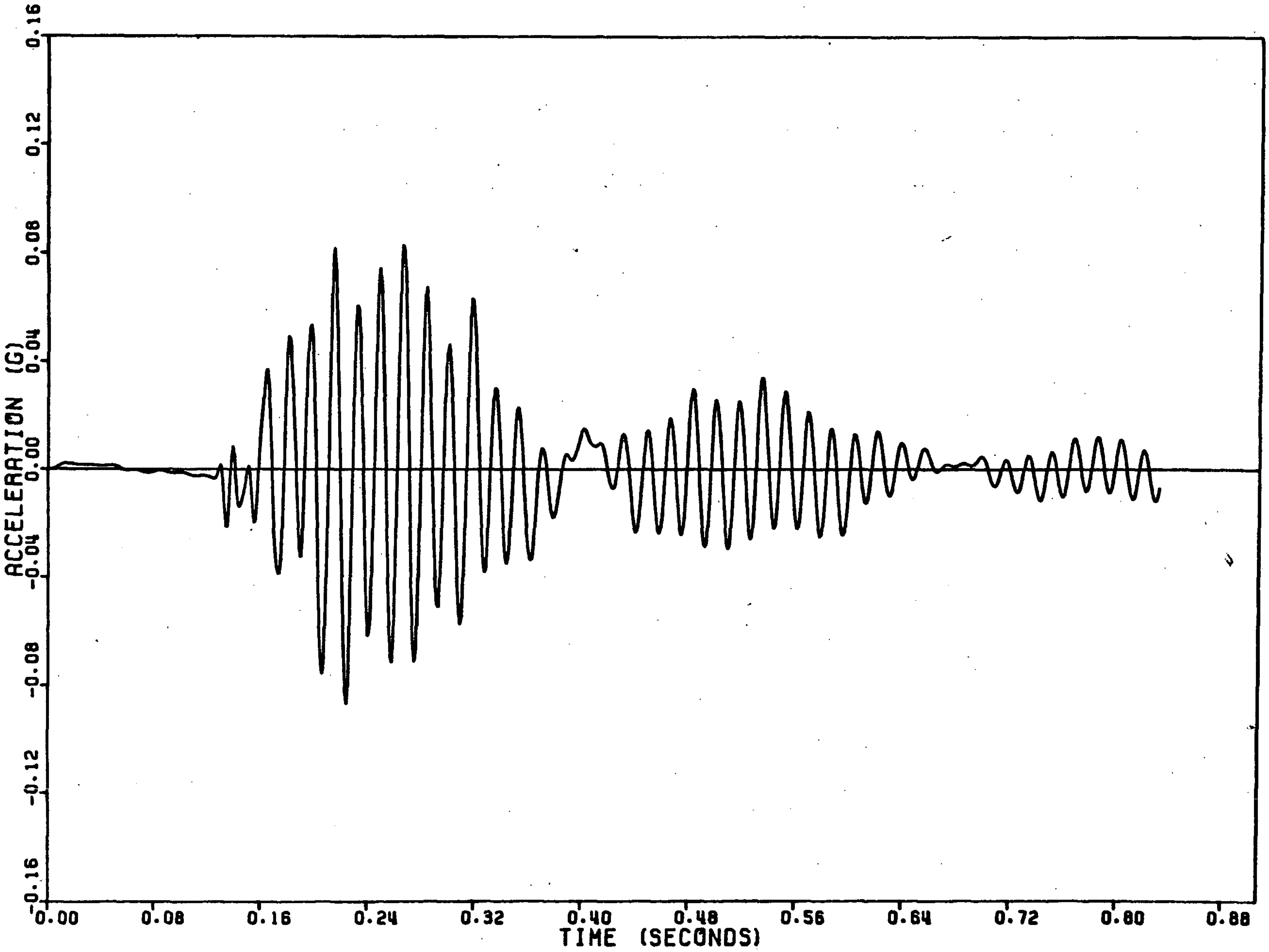


FIGURE C-69B. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-1
CHUG LOADING - RECORD 371 - ACCELERATION (G), NPTS = 833, DT = .001

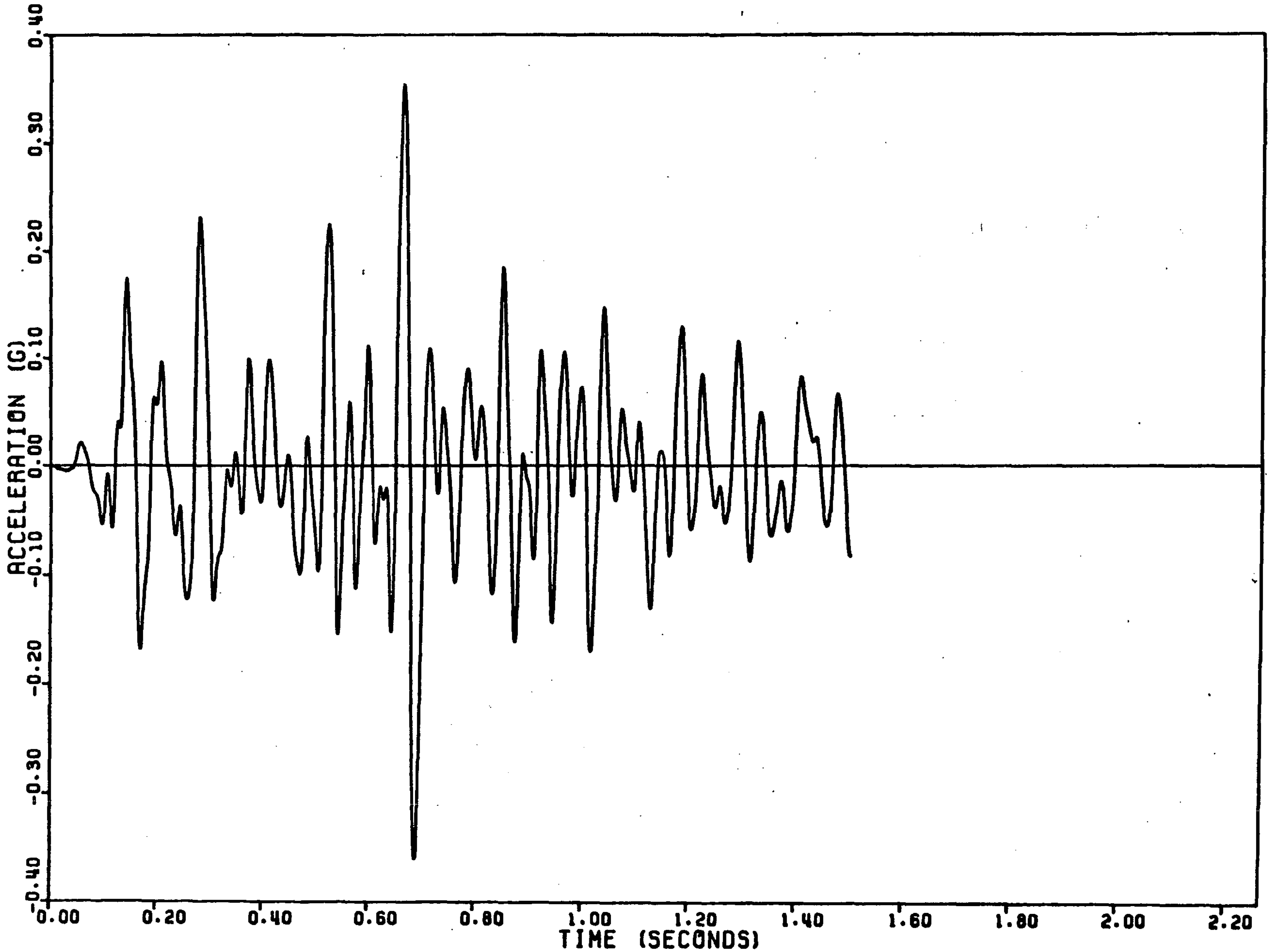


FIGURE C-70A. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-2
SRV-ALL LOADING- RECORD 345 - ACCELERATION (G), NPTS =1501, DT = .0010

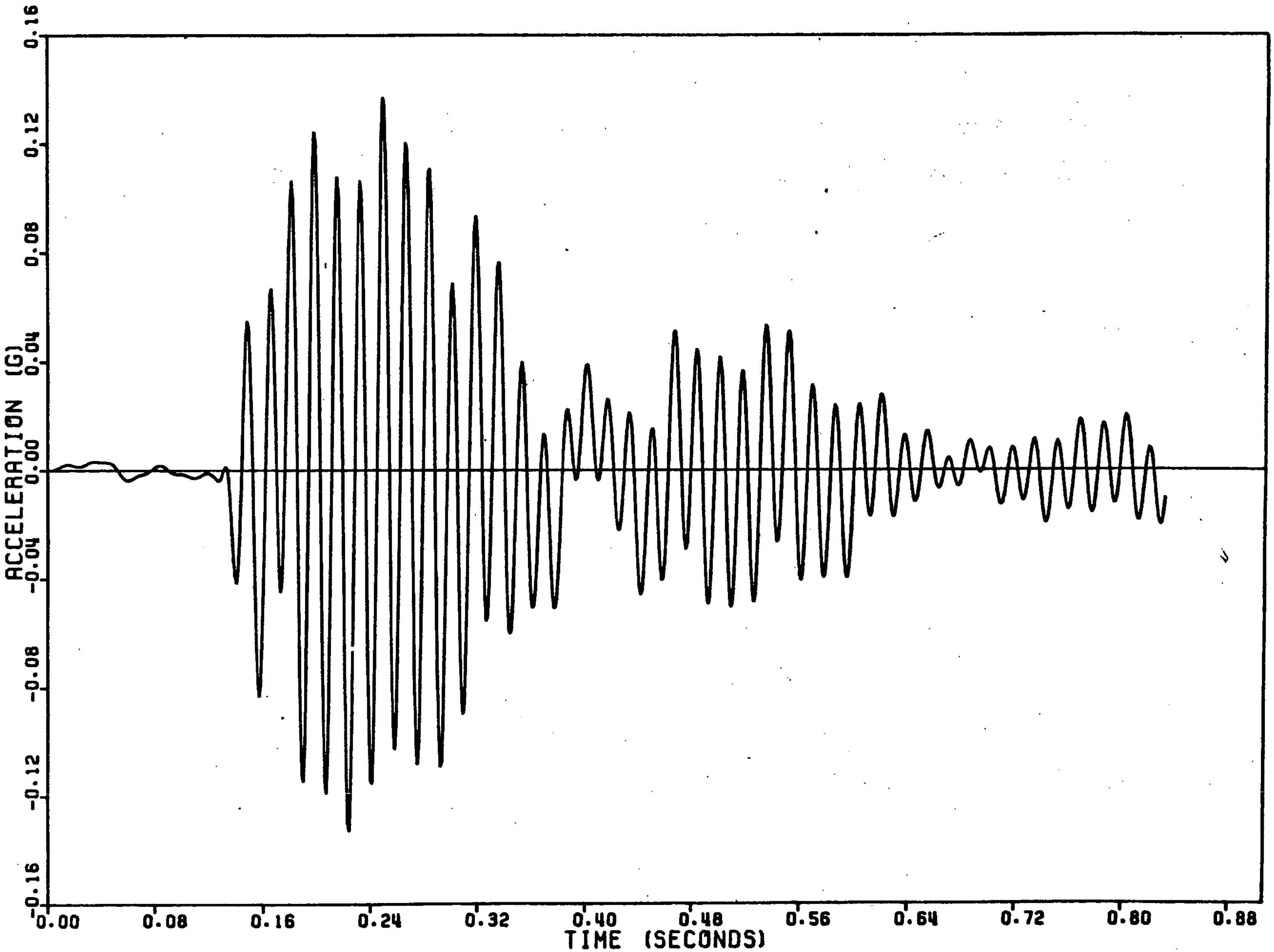


FIGURE C-70B. BOP PIPING TIME HISTORIES, HPCS TEST LINE LOCATION 3-2
CHUG LOADING - RECORD 372 - ACCELERATION (G), NPTS = 833, DT = .001

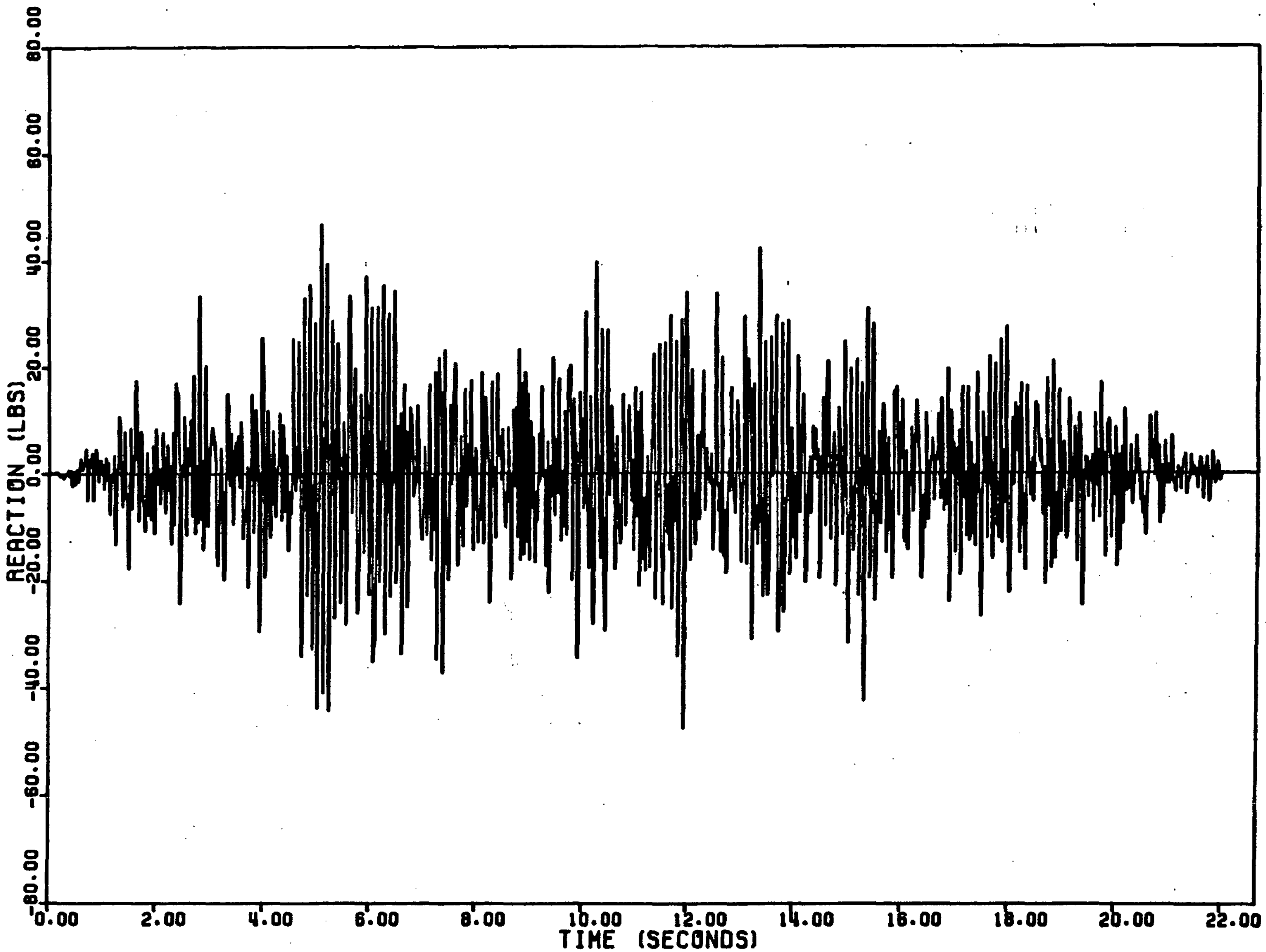


FIGURE C-71A. BOP PIPING TIME HISTORIES, COMBUSTIBLE GAS SUPPLY LINE, LOCATION 4-18
OBE LOADING -RECORD 1 - SUPPORT REACTION (LBS), NPTS = 2200, DT = .0100

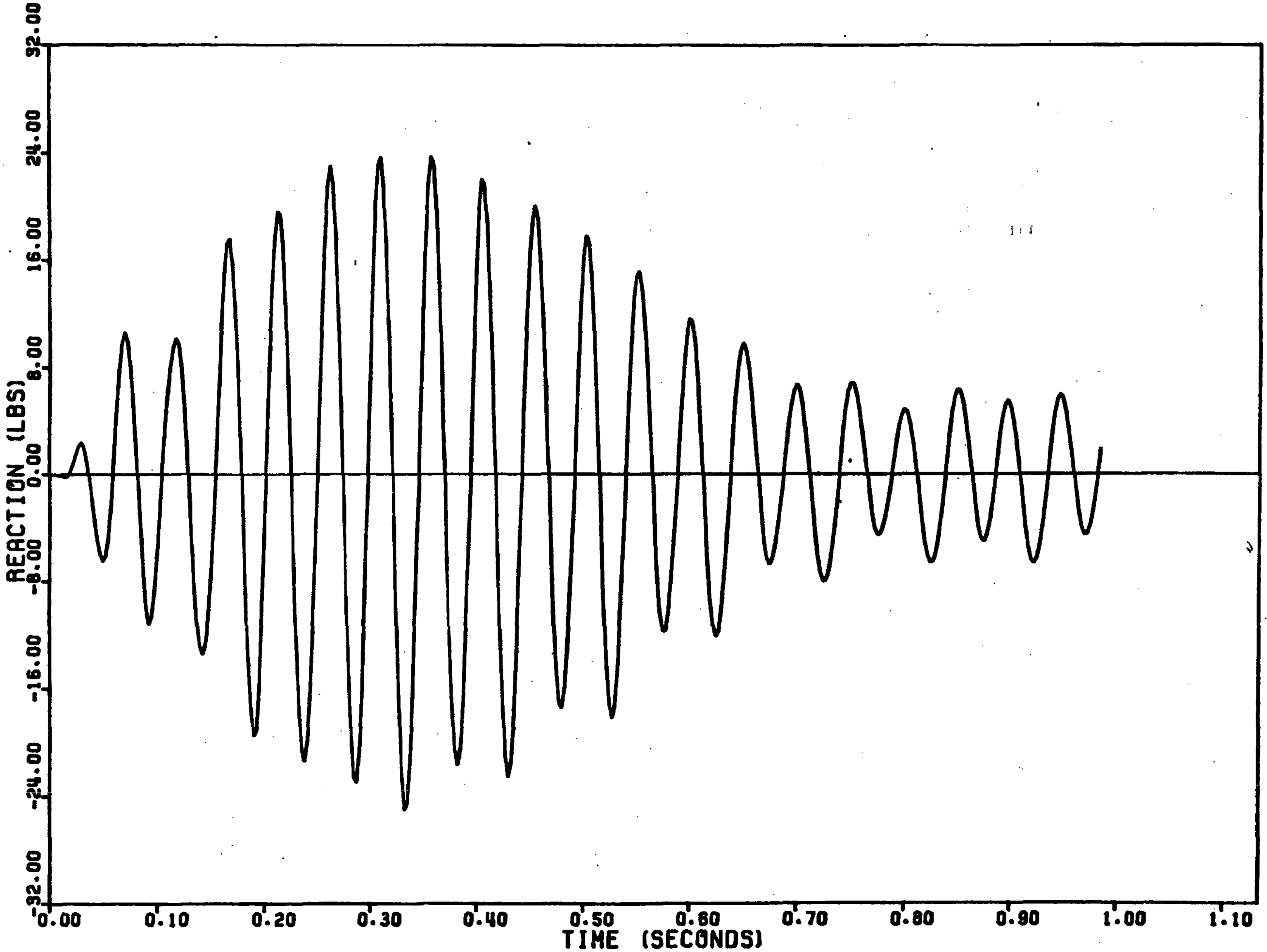


FIGURE C-71B. BOP PIPING TIME HISTORIES, COMBUSTIBLE GAS SUPPLY LINE, LOCATION 4-18
SRV-1 LOADING -RECORD 11 - SUPPORT REACTION (LBS), NPTS = 395 ,DT = .0025

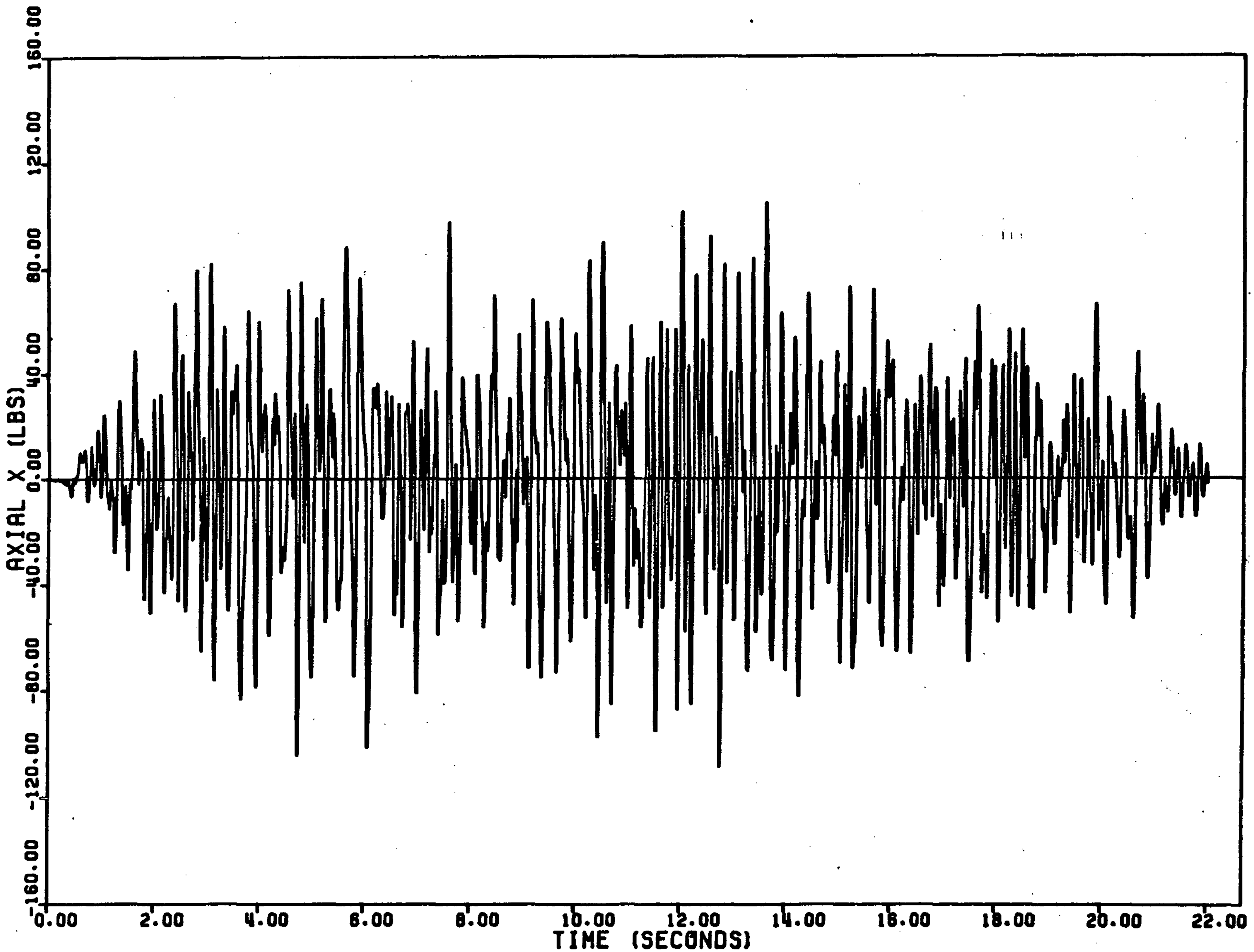


FIGURE C-72A. BOP PIPING TIME HISTORIES, COMBUSTIBLE GAS SUPPLY LINE, LOCATION 4-21
OBE LOADING -RECORD 1 - AXIAL X (LBS) , NPTS = 2200,DT = .0100

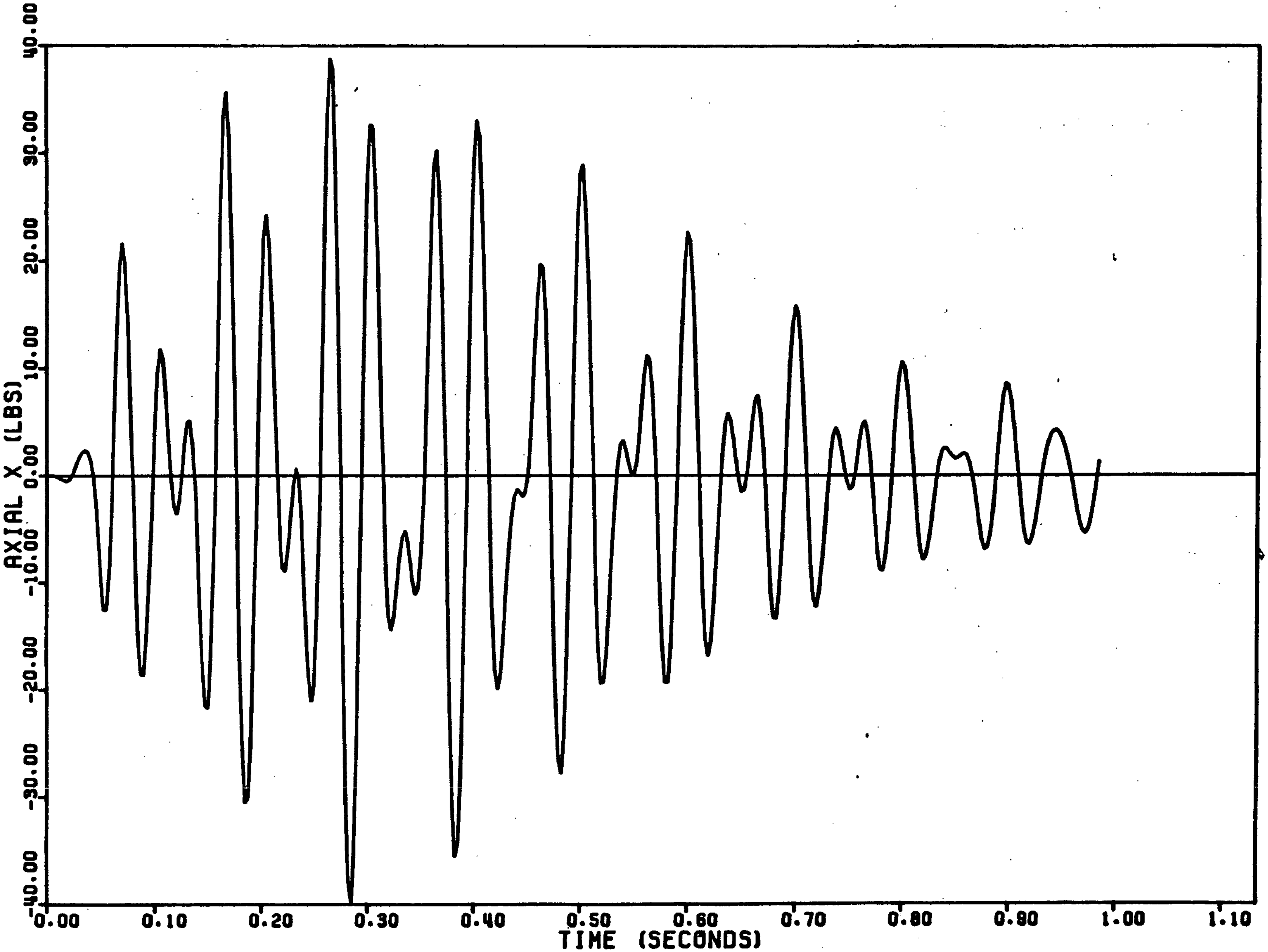


FIGURE C-72B. BOP PIPING TIME HISTORIES, COMBUSTIBLE GAS SUPPLY LINE, LOCATION 4-21
SRV-1 LOADING -RECORD 11 - AXIAL X (LBS) , NPTS = 395 ,DT = .0025

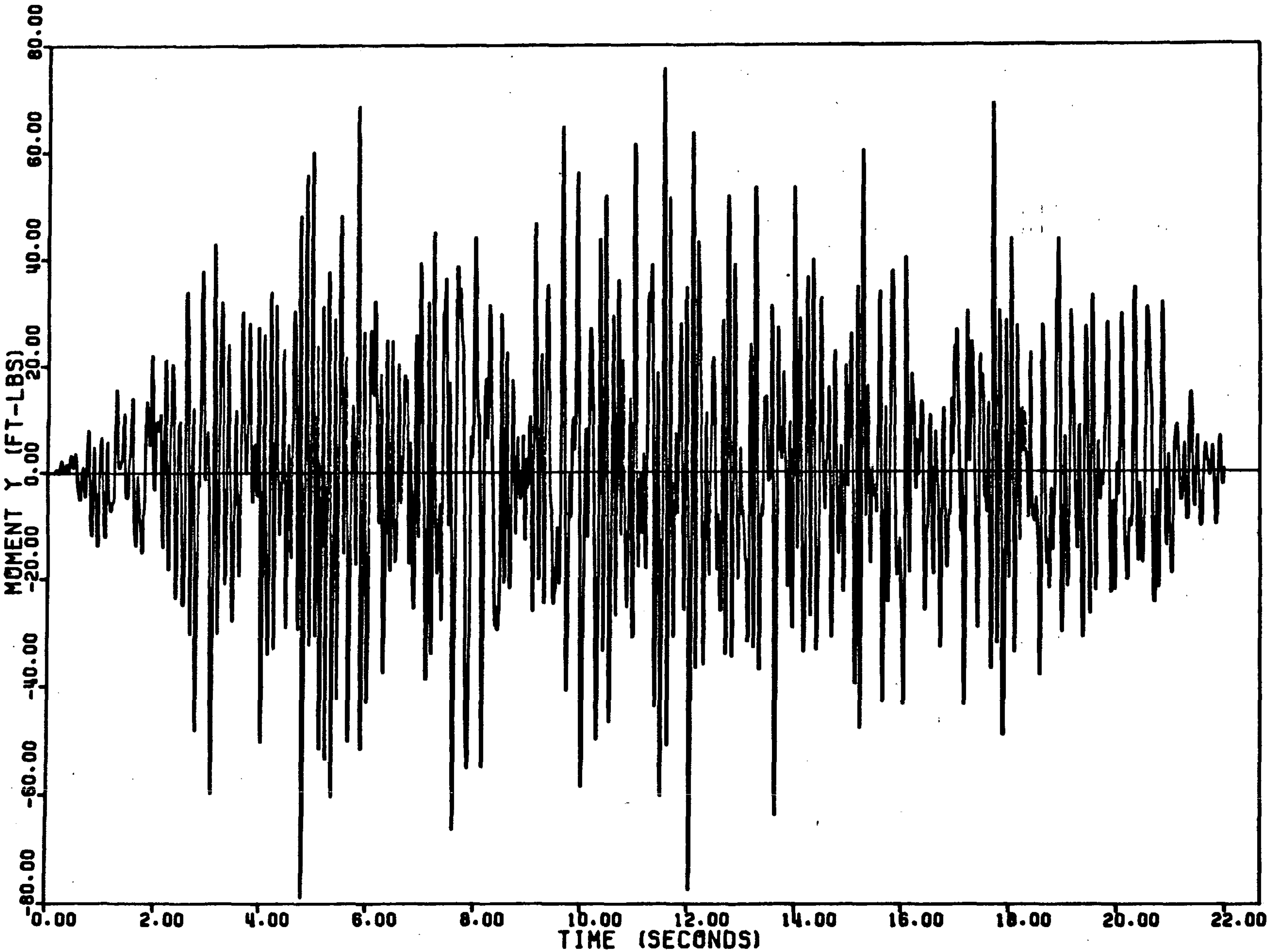


FIGURE C-73A. BOP PIPING TIME HISTORIES, COMBUSTIBLE GAS SUPPLY LINE, LOCATION 4-20
OBE LOADING -RECORD 2 - MOMENT Y (FT-LBS) , NPTS = 2200, DT = .0100

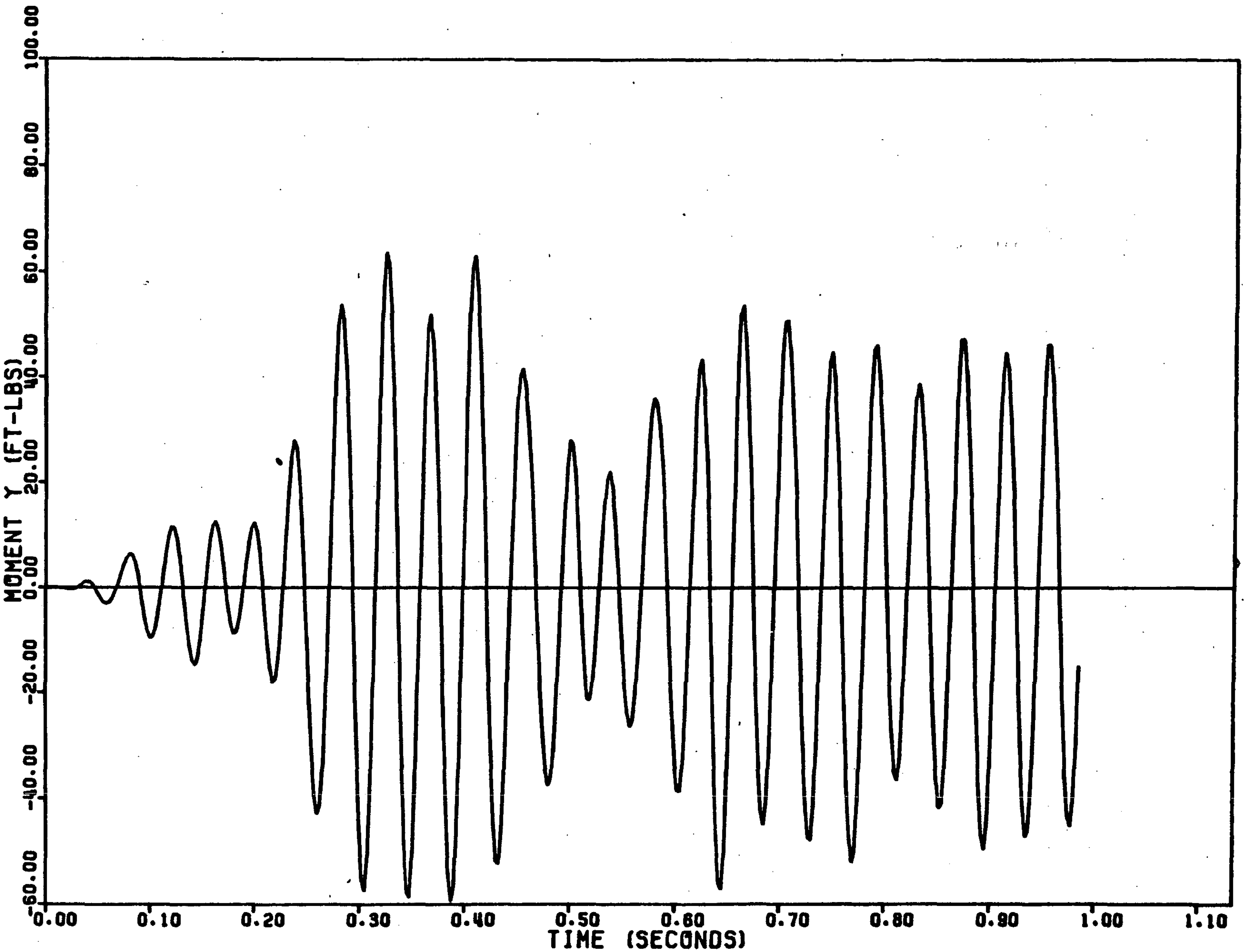


FIGURE C-73B. BOP PIPING TIME HISTORIES, COMBUSTIBLE GAS SUPPLY LINE, LOCATION 4-20
SRV-ALL LOADING -RECORD 22 - MOMENT Y (FT-LBS) , NPTS = 395 ,DT = .0025

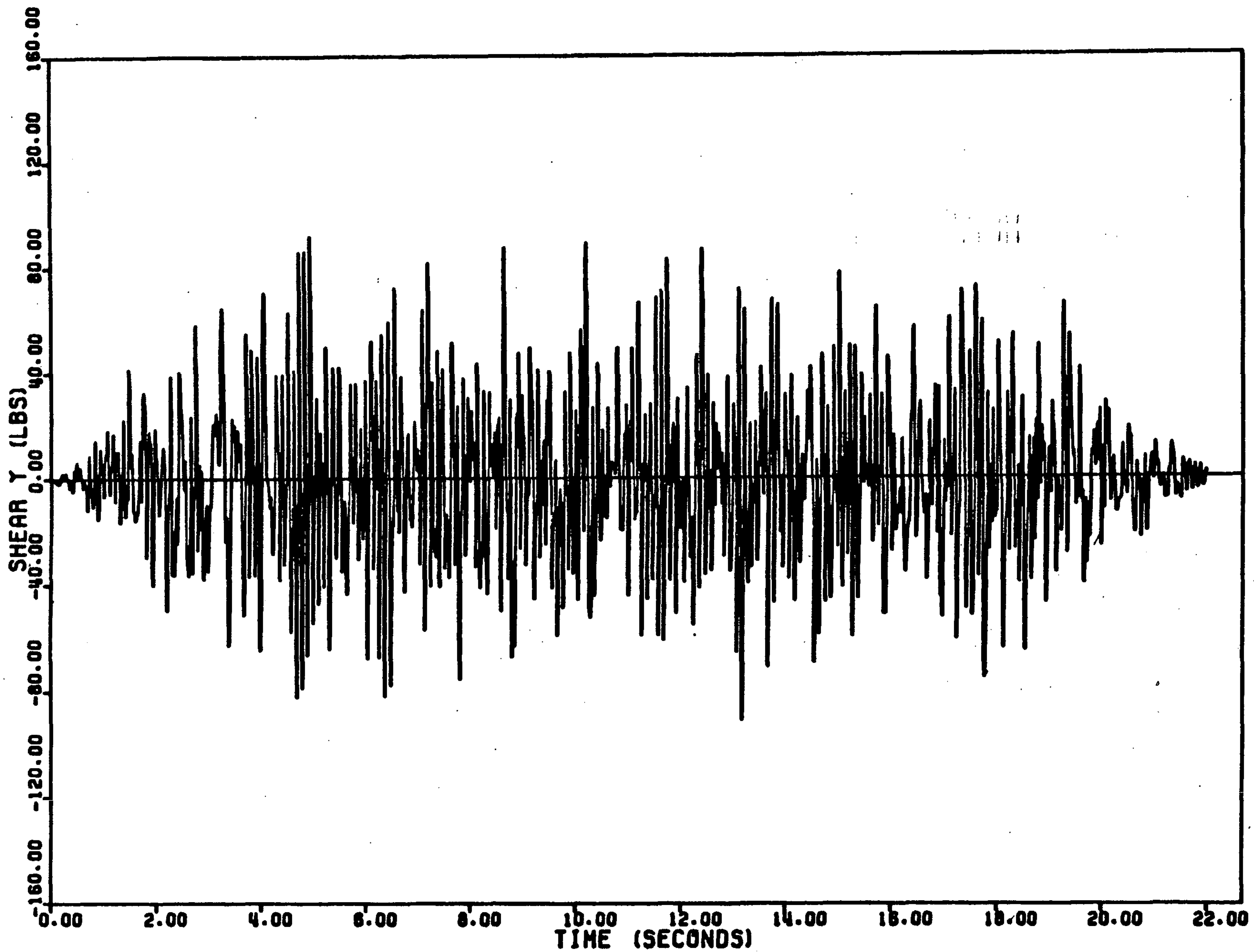


FIGURE C-74A. BOP PIPING TIME HISTORIES, COMBUSTIBLE GAS SUPPLY LINE, LOCATION 4-19
OBE LOADING -RECORD 3 - SHEAR Y (LBS) , NPTS = 2200, DT = .0100

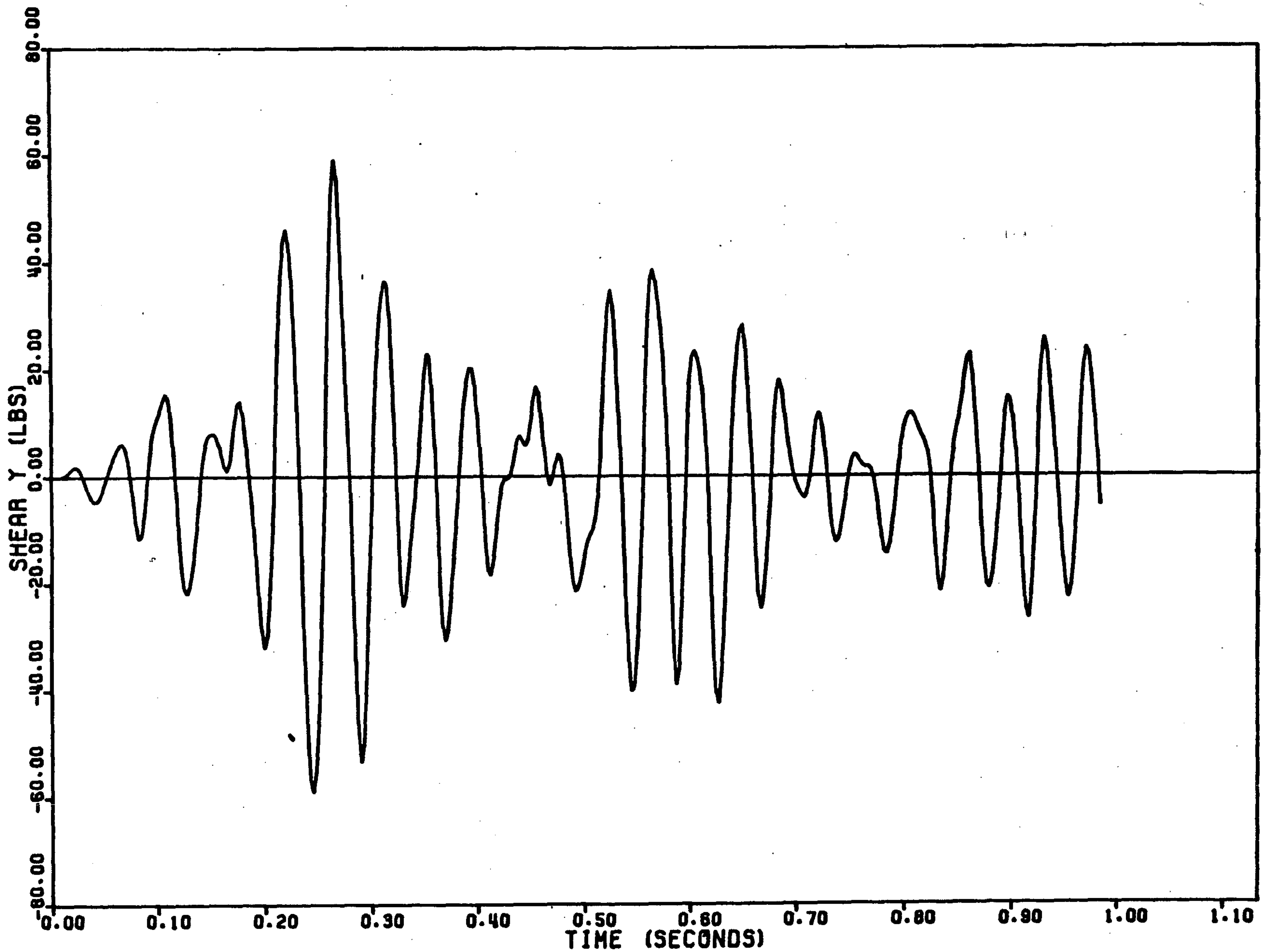


FIGURE C-74B. BOP PIPING TIME HISTORIES, COMBUSTIBLE GAS SUPPLY LINE, LOCATION 4-19
SRV-ALL LOADING -RECORD 23 - SHEAR Y (LBS) , NPTS = 395 , DT = .0025

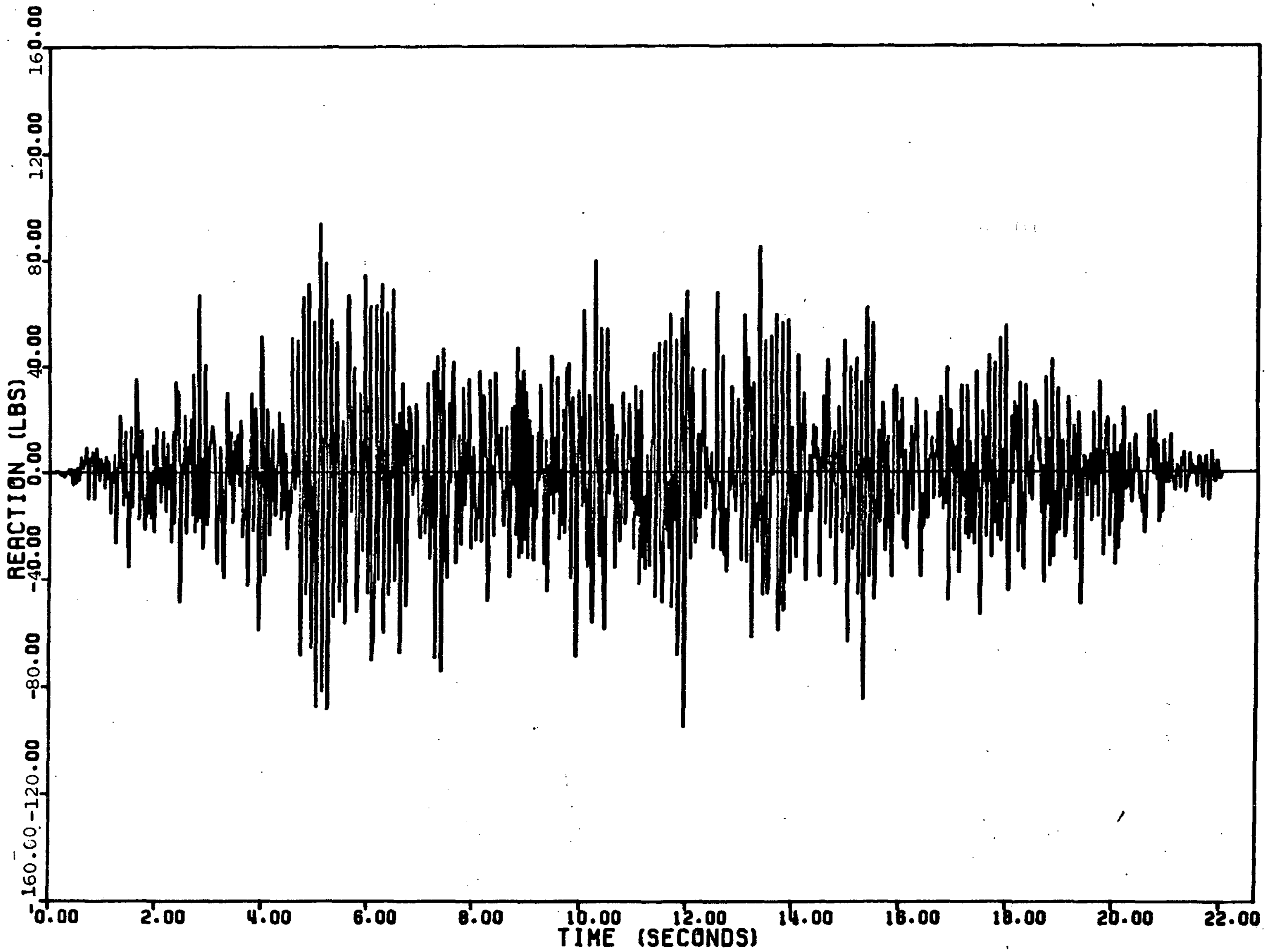


FIGURE C-75A. BOP PIPING TIME HISTORIES, COMBUSTIBLE GAS SUPPLY LINE, LOCATION 4-18
SSE LOADING -RECORD 1 - SUPPORT REACTION (LBS), NPTS = 2200,DT = .0100

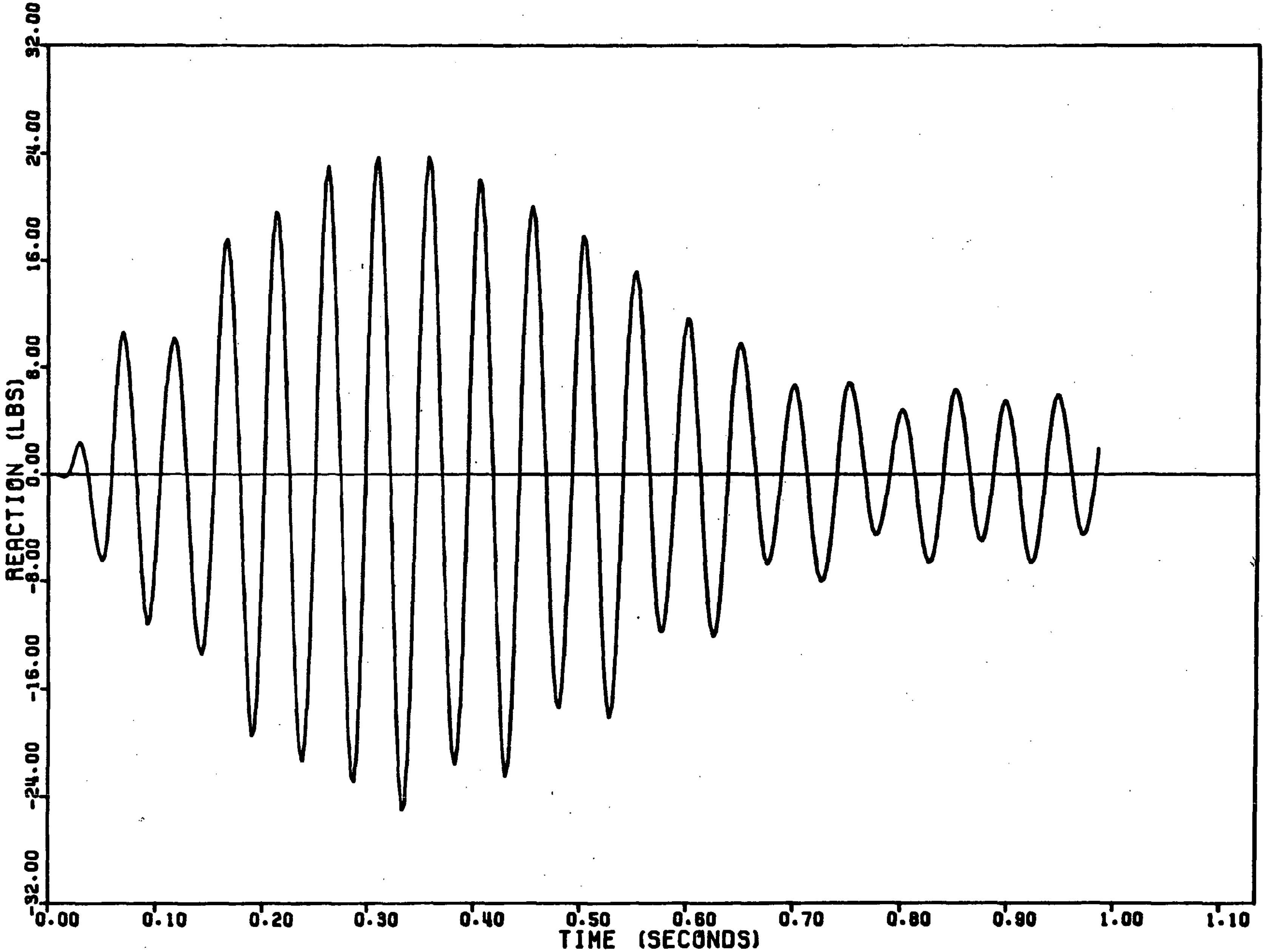


FIGURE C-75B. BOP PIPING TIME HISTORIES. COMBUSTIBLE GAS SUPPLY LINE. LOCATION 4-18
SRV-1 LOADING -RECORD 11 - SUPPORT REACTION (LBS). NPTS = 395 .DT = .0025

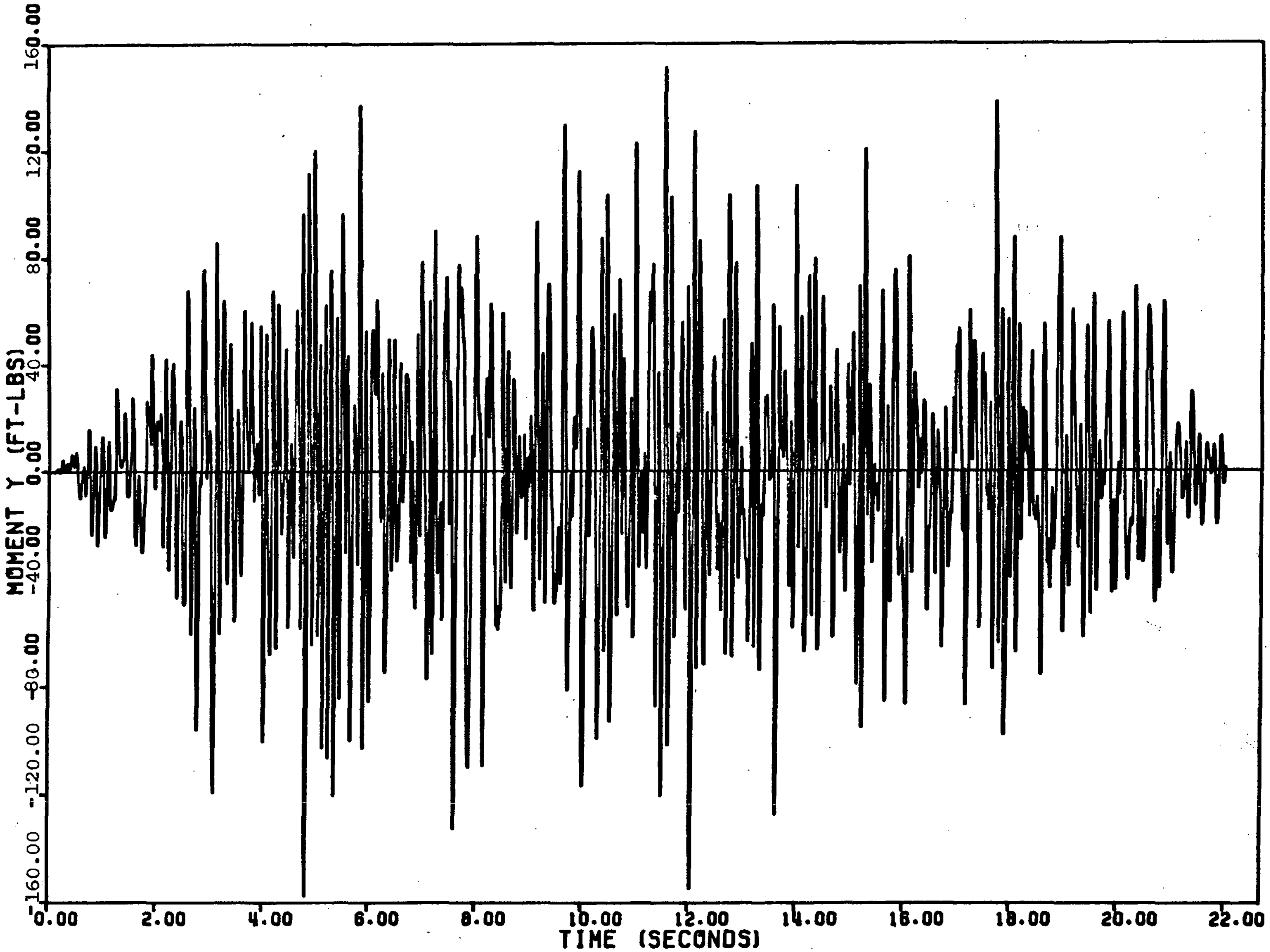


FIGURE C-76A. BOP PIPING TIME HISTORIES, COMBUSTIBLE GAS SUPPLY LINE, LOCATION 4-20
SSE LOADING -RECORD 2 - MOMENT Y (FT-LBS) , NPTS = 2200, DT = .0100

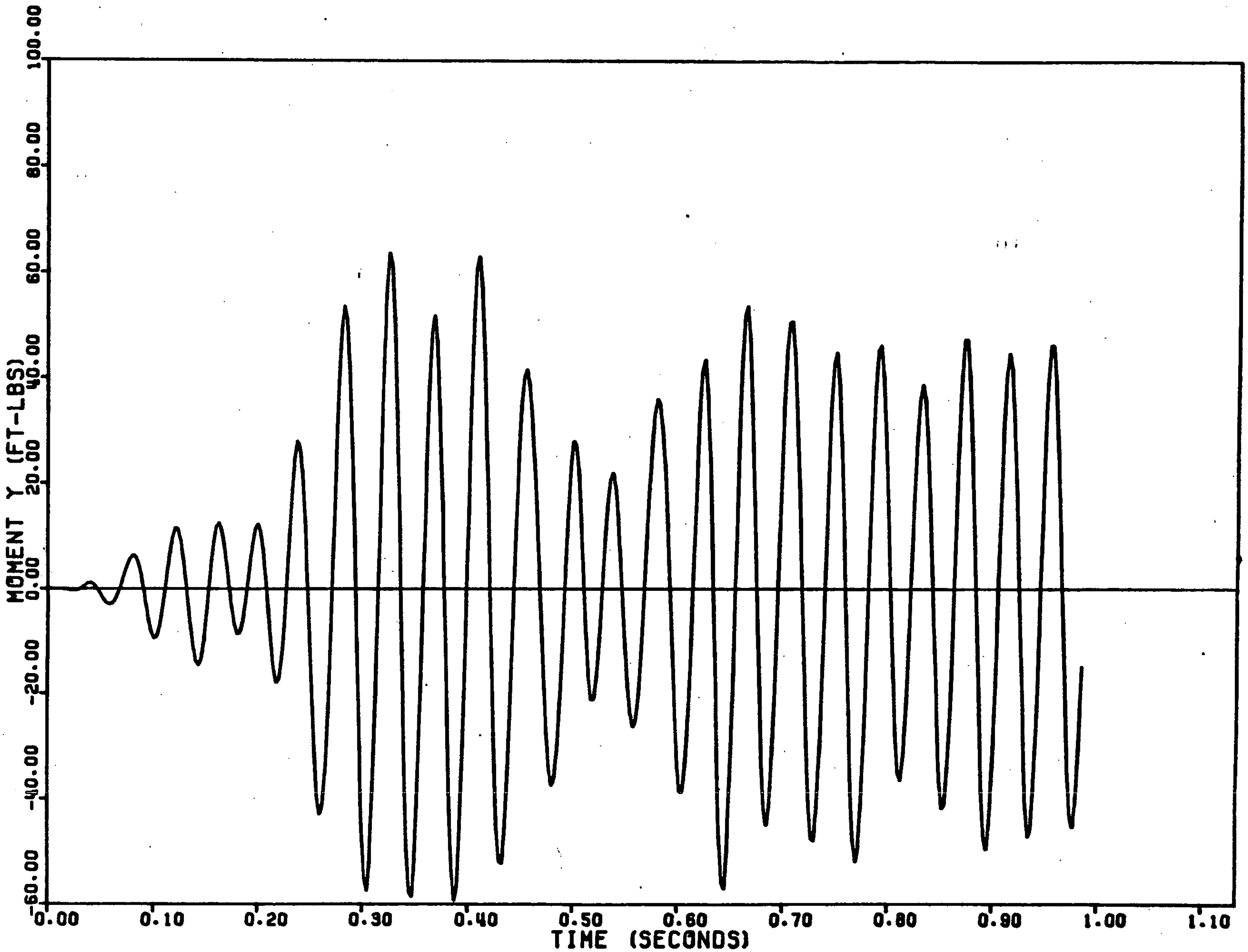


FIGURE C-76B. BOP PIPING TIME HISTORIES, COMBUSTIBLE GAS SUPPLY LINE, LOCATION 4-20
SRV-ALL LOADING -RECORD 22 - MOMENT Y (FT-LBS) , NPTS = 395 ,DT = .0025

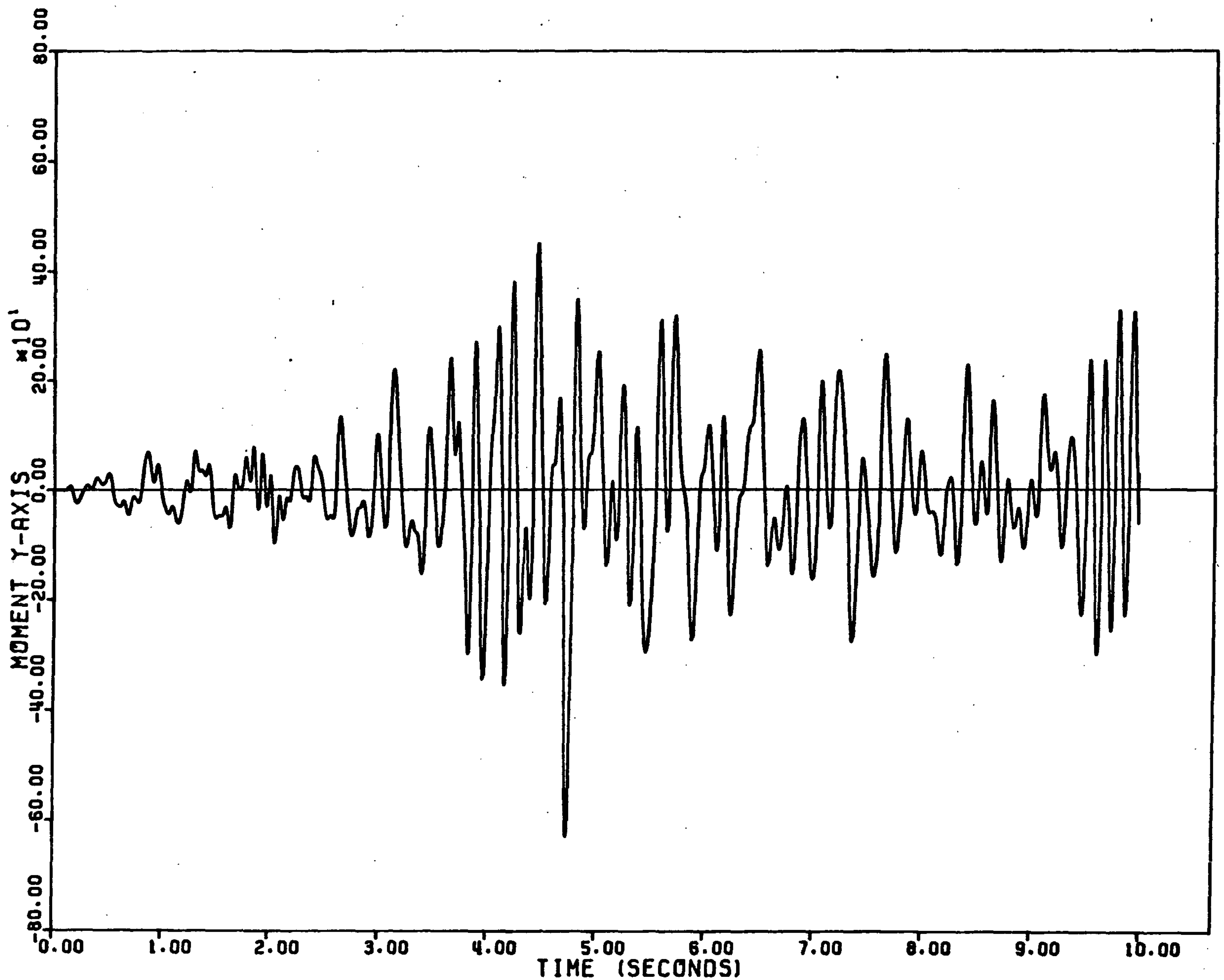


FIGURE C-77A. BOP PIPING, FP-18 LINE, NODE MJ-52, LOCATION 5-17
OBE LOADING - RECORD 1011 - MOMENT Y-AXIS (IN-LBS) , NPTS =3324, DT = .003

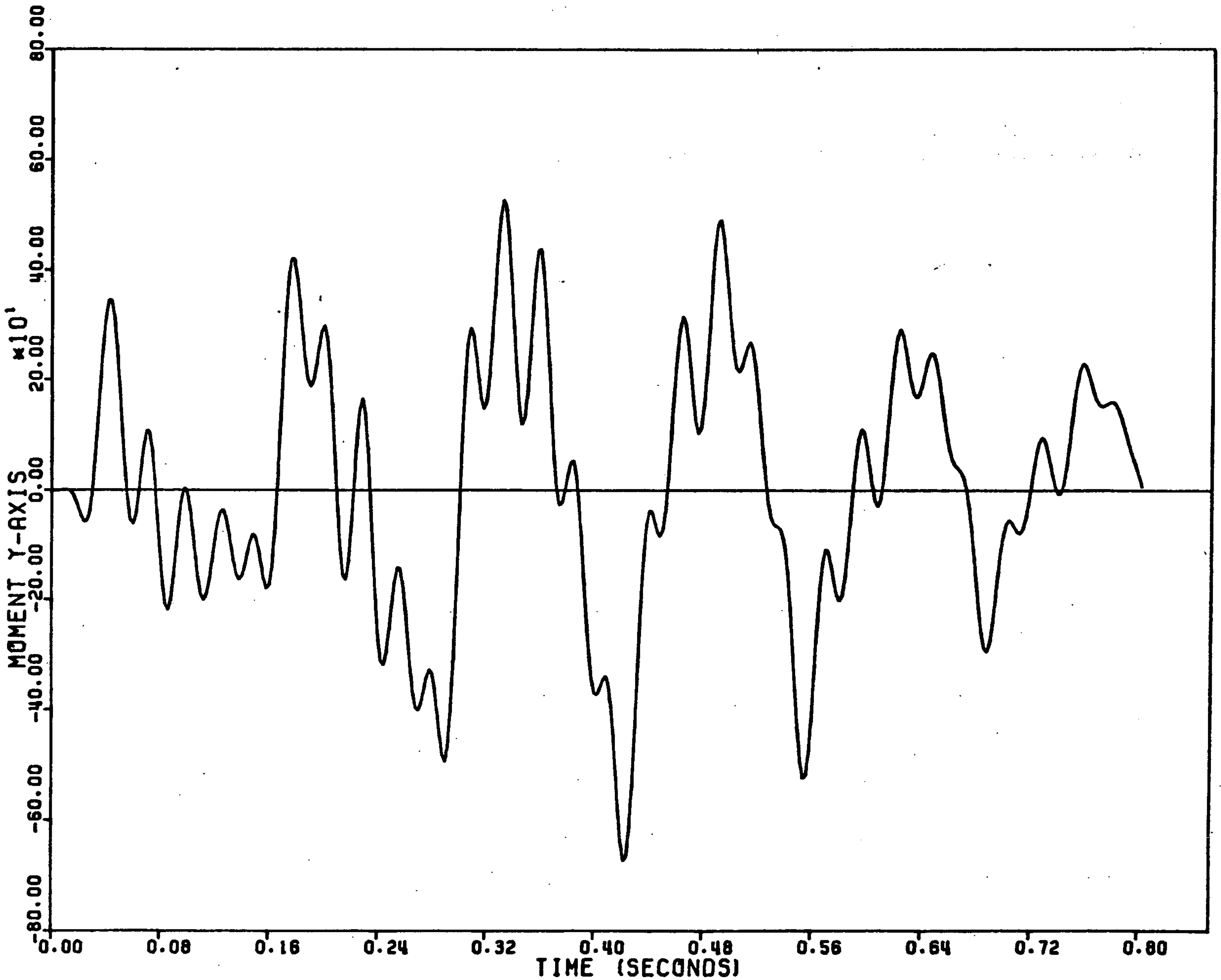


FIGURE C-77B. BOP PIPING, FP-18 LINE, NODE MJ-52, LOCATION 5-17
SRV-1 LOADING - RECORD 1031 - MOMENT Y-AXIS (IN-LBS), NPTS = 402, DT = .002

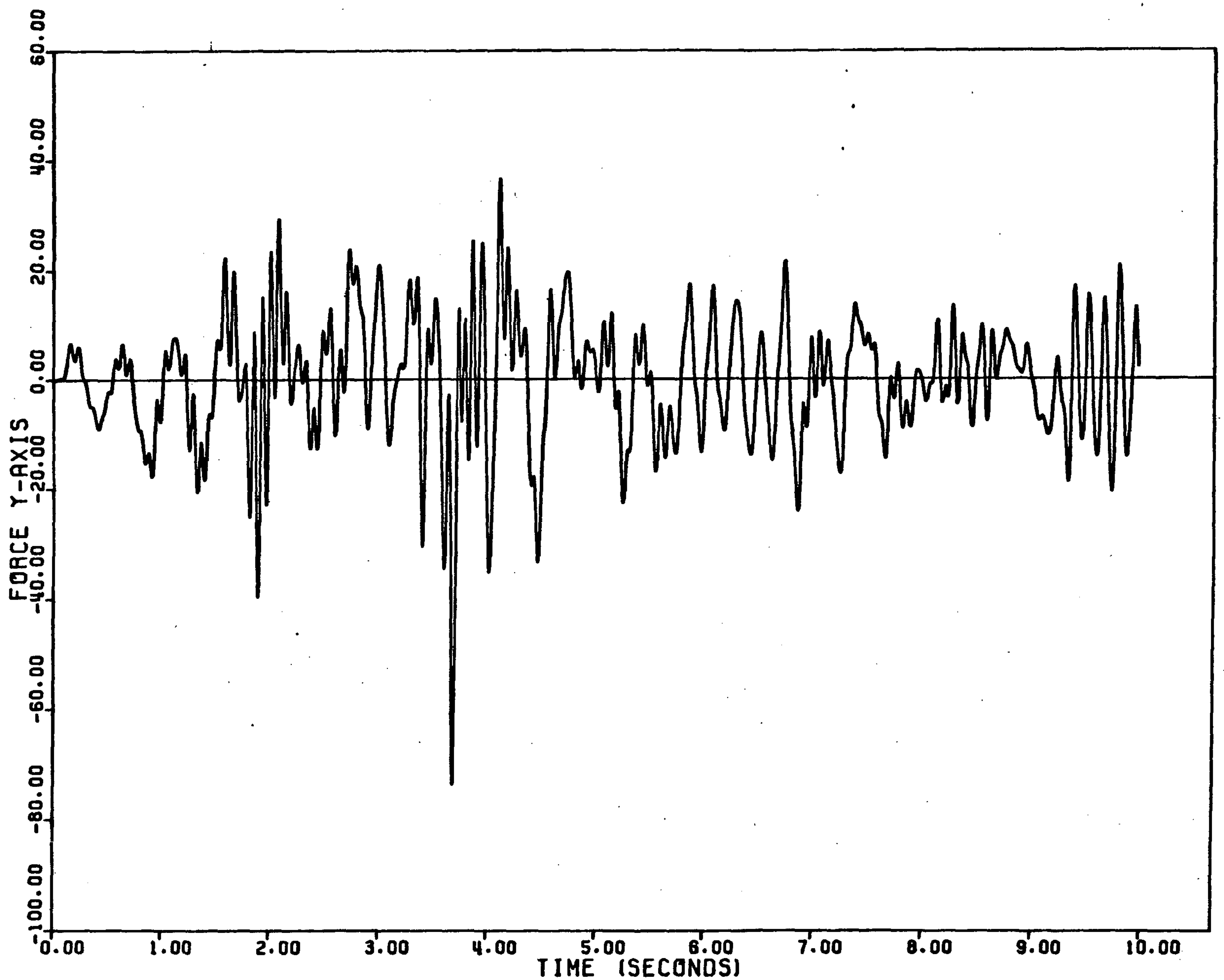


FIGURE C-78A. BOP PIPING, FP-18 LINE, NODE JT-42, LOCATION 5-14
OBE LOADING - RECORD 1008 - FORCE Y-AXIS (LBS) . NPTS =3324, DT = .003

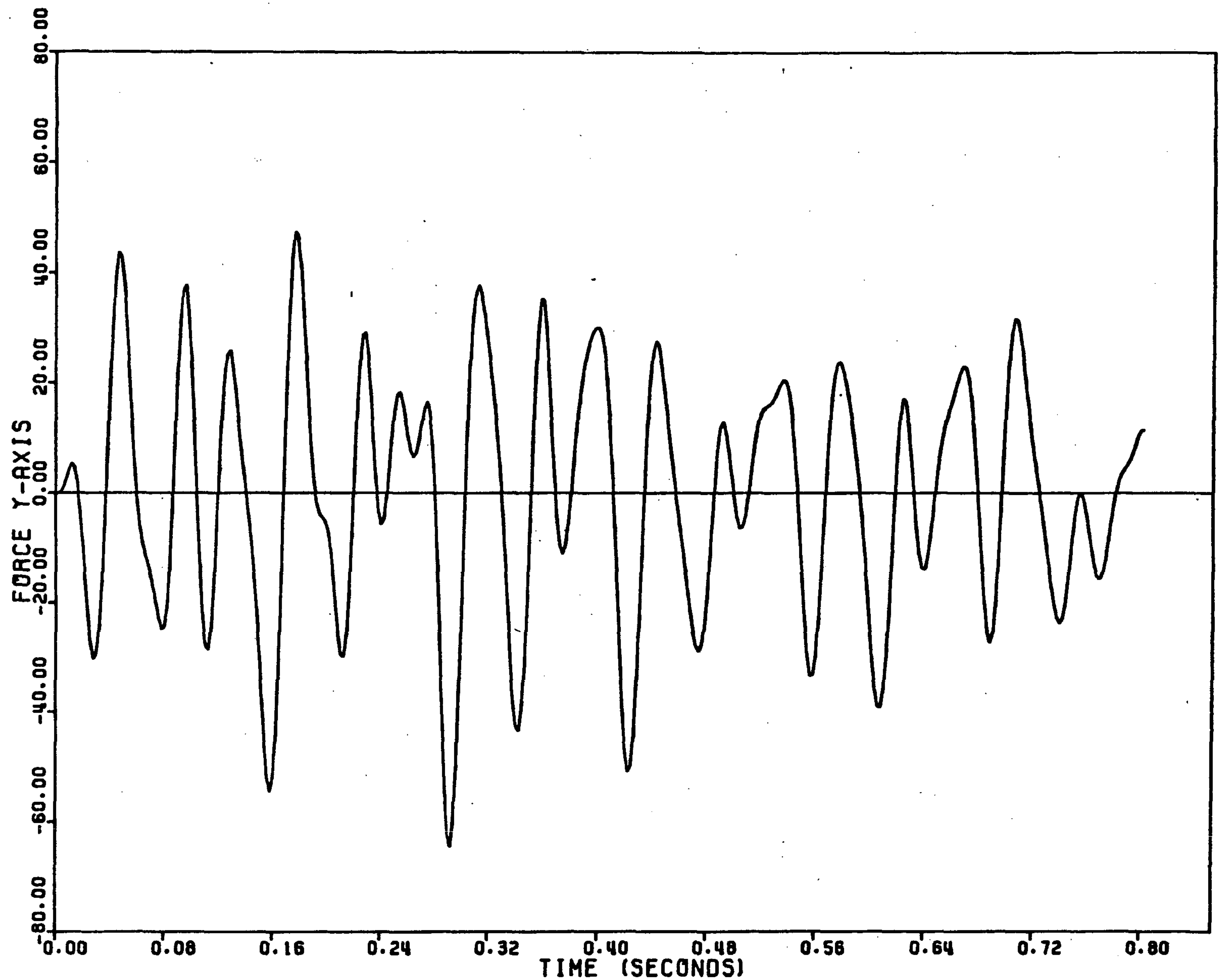


FIGURE C-78B. BOP PIPING, FP-18 LINE, NODE JT-42, LOCATION 5-14
SRV-1 LOADING - RECORD 1028 - FORCE Y-AXIS (LBS) , NPTS = 402, DT = .002

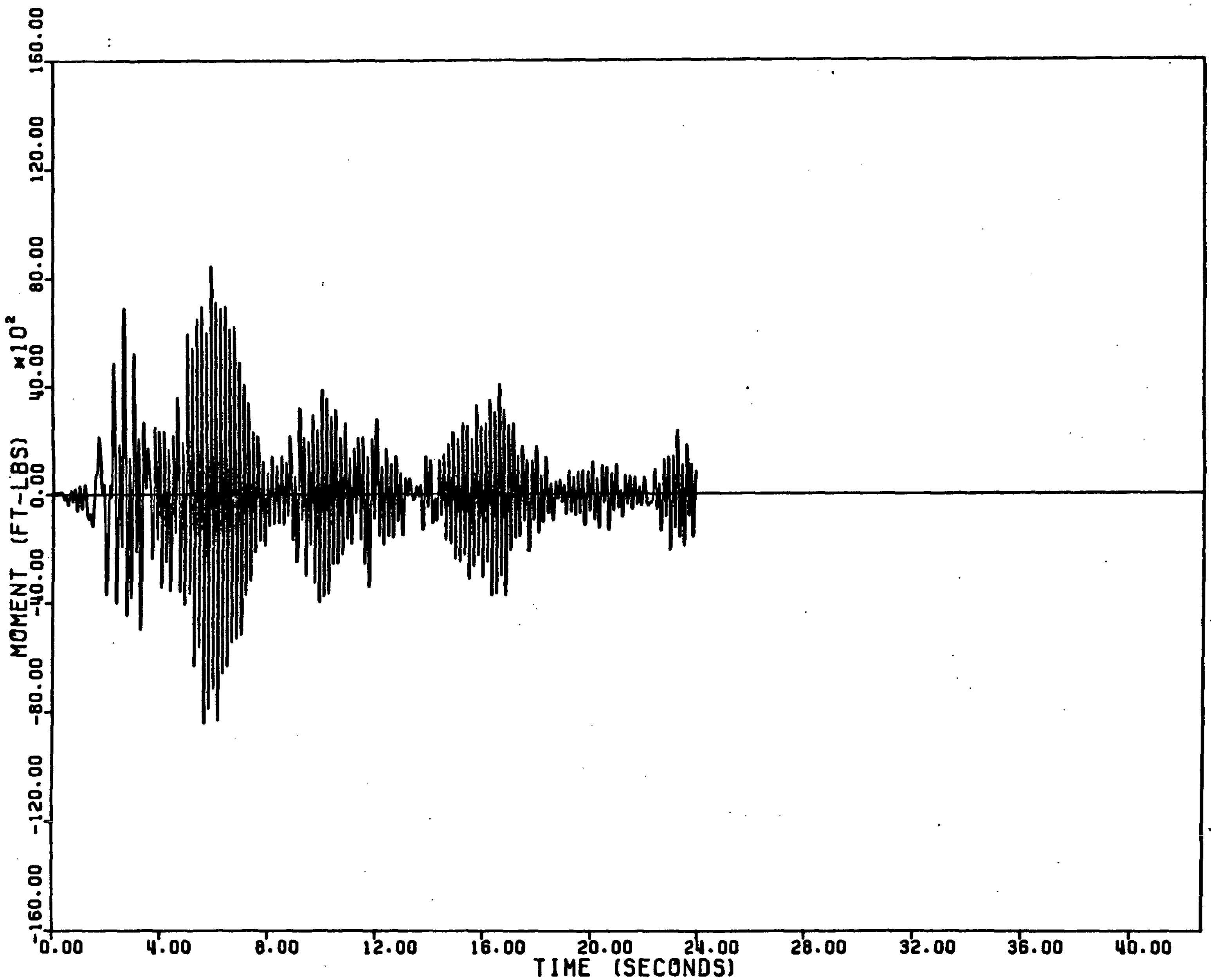


FIGURE C-79A. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-2
OBE LOADING - RECORD 702 - PIPE MOMENT Y (FT-LBS), NPTS = 2388, DT = .01

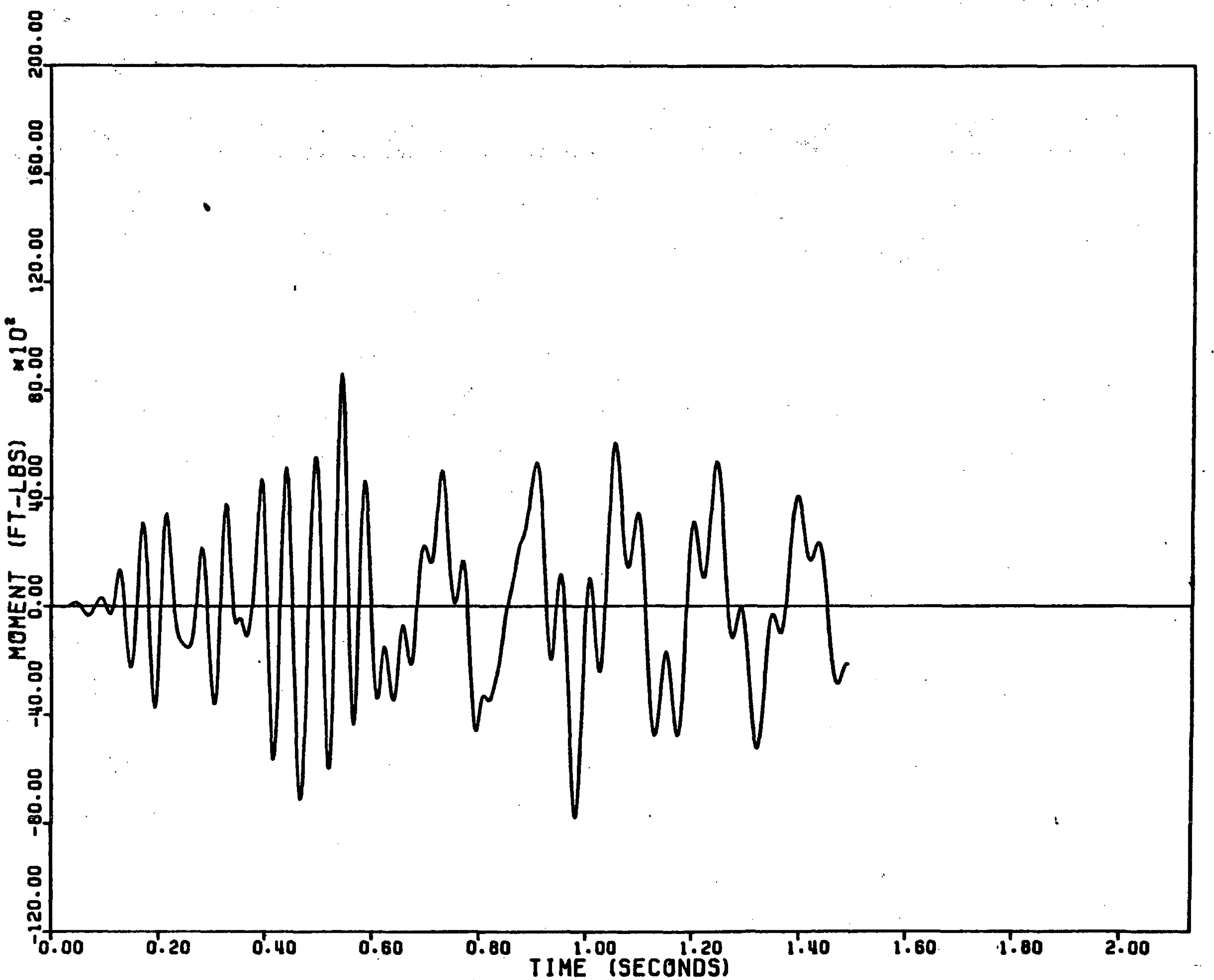


FIGURE C-79B. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-2
SRV-ALL LOADING- RECORD 732 - PIPE MOMENT Y (FT-LBS) , NPTS = 597, DT = .0025

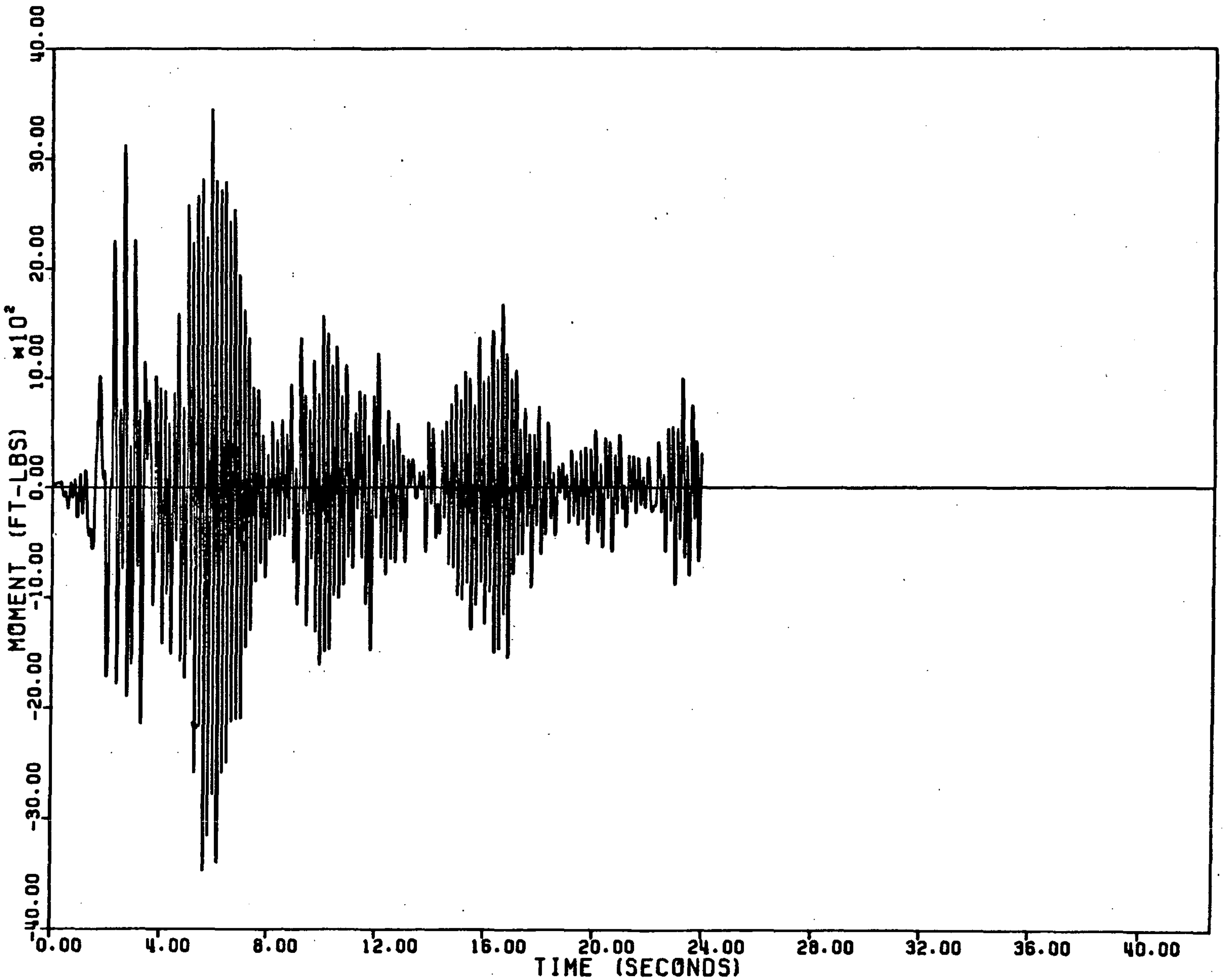


FIGURE C-80A. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-3
OBE LOADING - RECORD 703 - PIPE MOMENT Y (FT-LBS) , NPTS = 2388, DT = .01

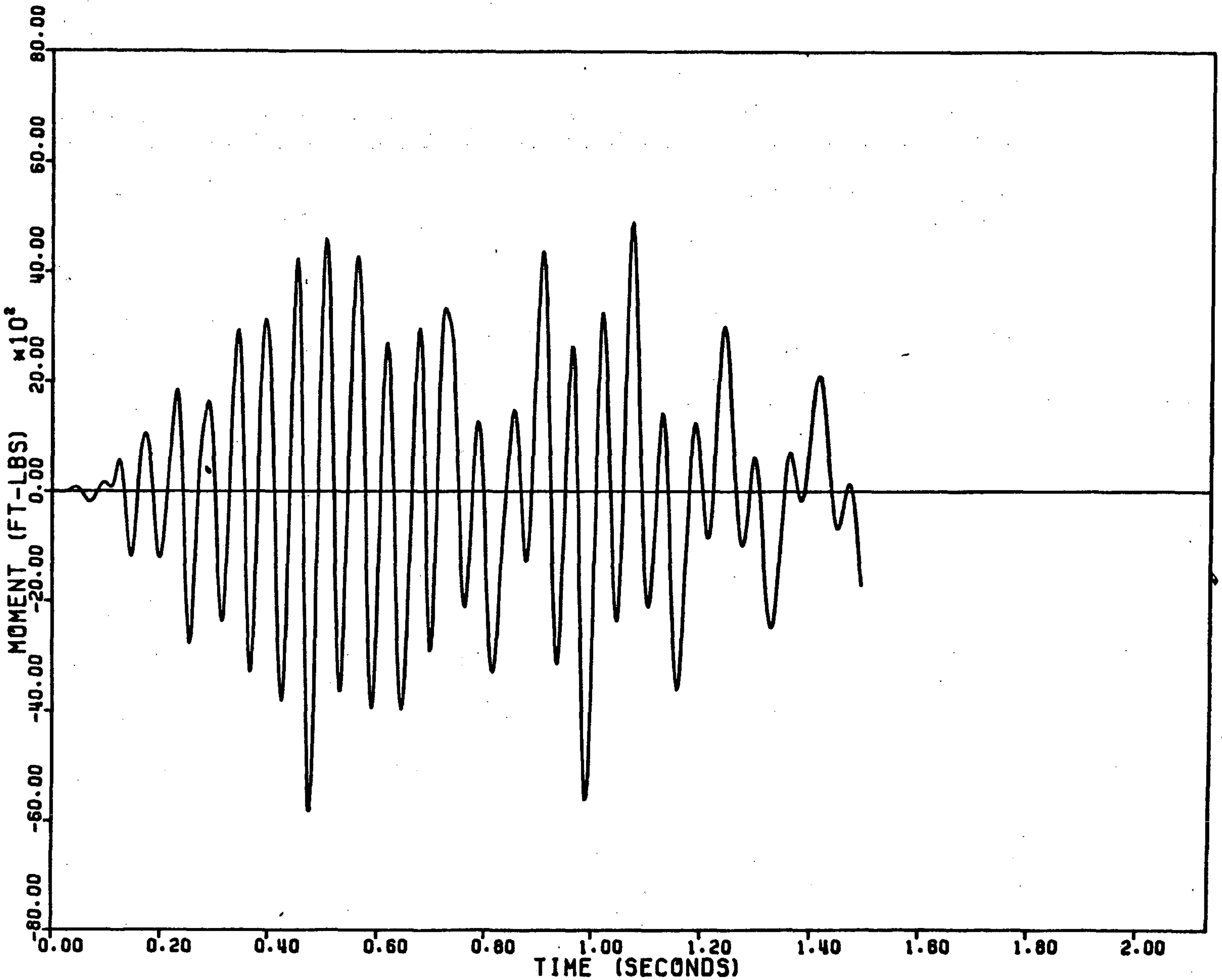


FIGURE C-80B. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-3
SRV-ALL LOADING- RECORD 733 - PIPE MOMENT Y (FT-LBS) , NPTS = 597, DT = .0025

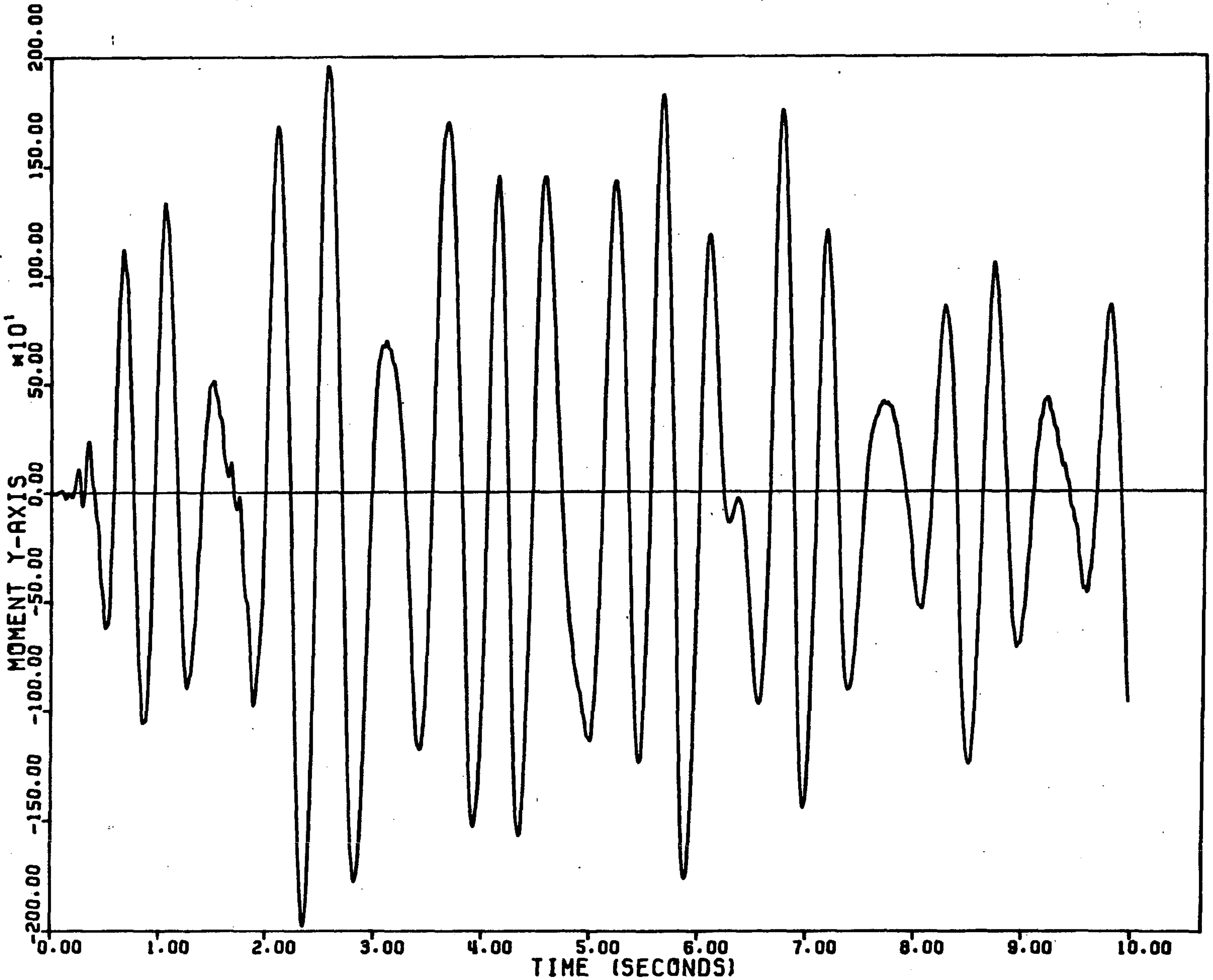


FIGURE C-81A. BOP PIPING, FP-18 LINE, NODE MI-24, LOCATION 5-16
OBE LOADING - RECORD 1010 - MOMENT Y-AXIS (IN-LBS) , NPTS =3324, DT = .003

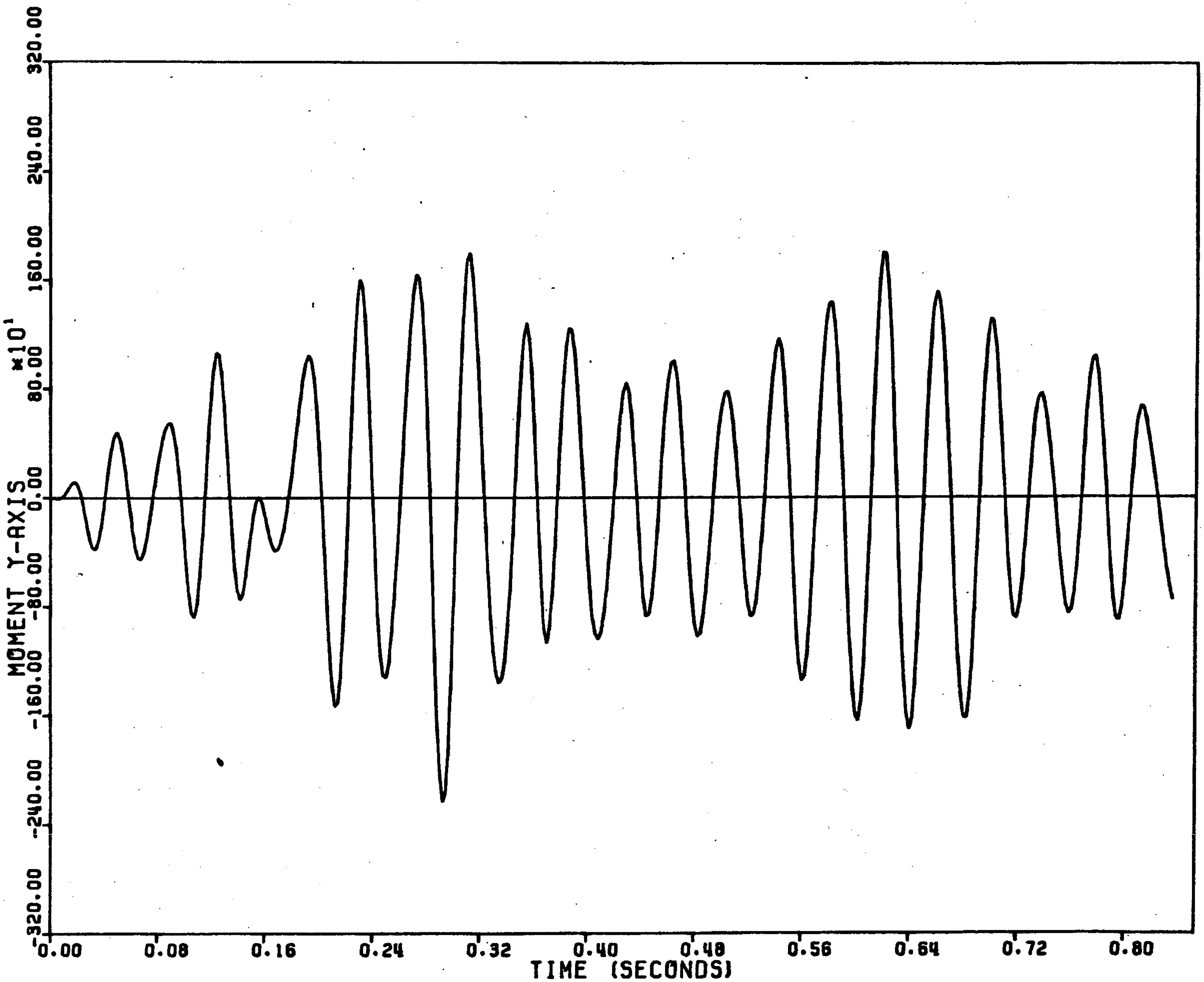


FIGURE C-81B. BOP PIPING, FP-18 LINE, NODE MI-24, LOCATION 5-16
SRV-ADS LOADING - RECORD 1050 - MOMENT Y-AXIS (IN-LBS), NPTS = 419, DT = .002

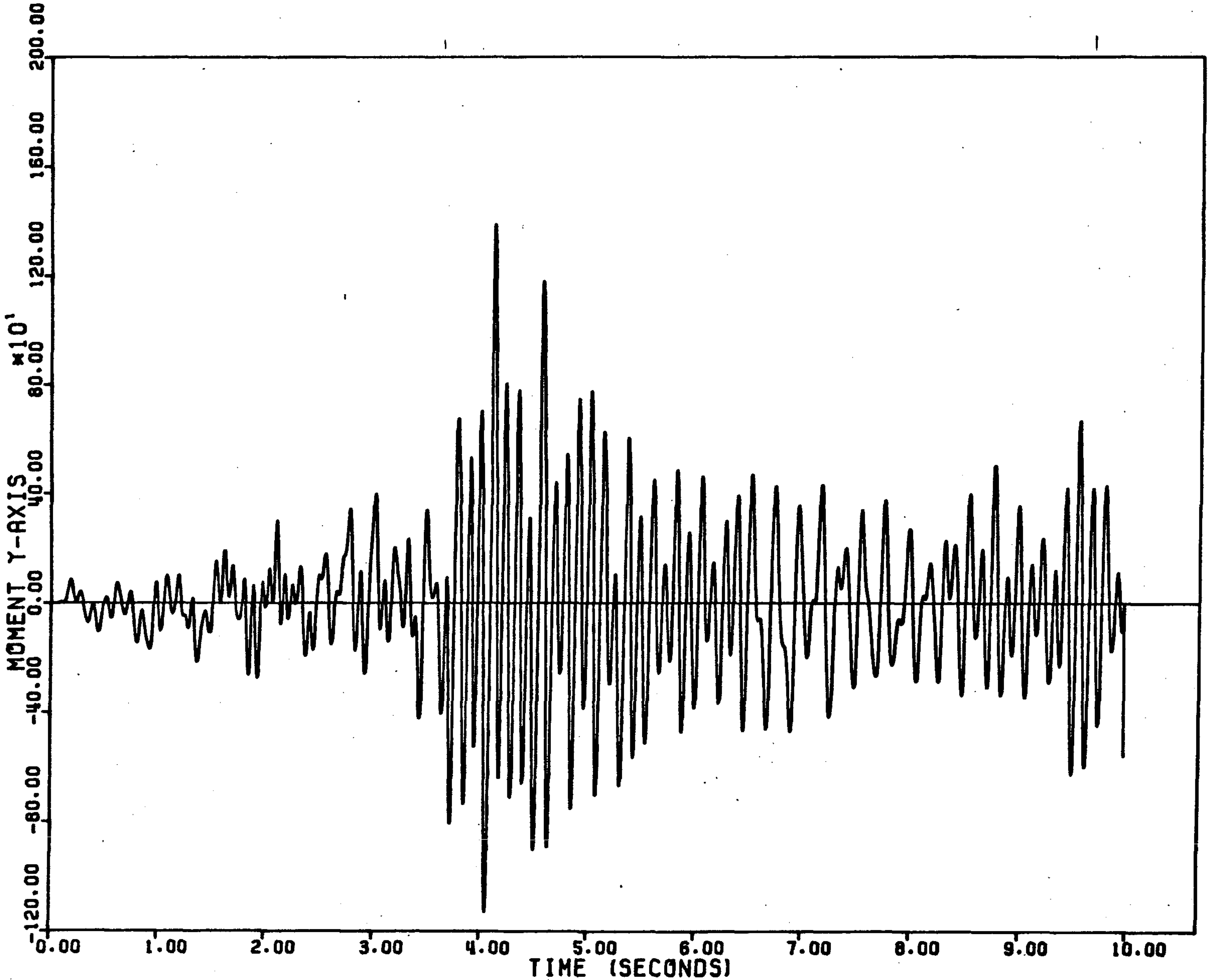


FIGURE C-82A. BOP PIPING, FP-18 LINE, NODE MJ-76, LOCATION 5-18
OBE LOADING - RECORD 1012 - MOMENT Y-AXIS (IN-LBS) , NPTS =3324, DT = .003

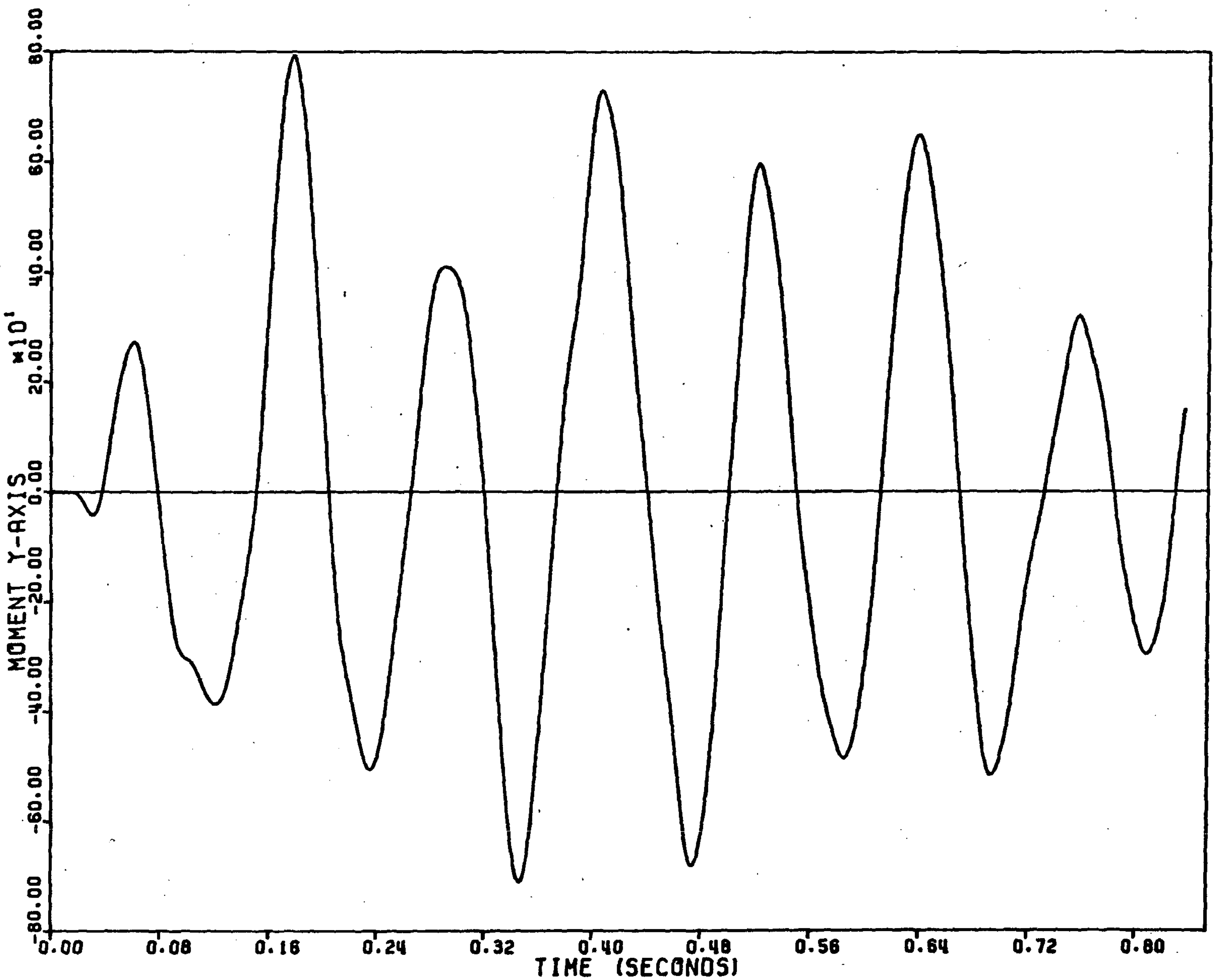


FIGURE C-82B. BOP PIPING, FP-18 LINE, NODE MJ-76, LOCATION 5-18
SRV-ADS LOADING - RECORD 1052 - MOMENT Y-AXIS (IN-LBS), NPTS = 419, DT = .002

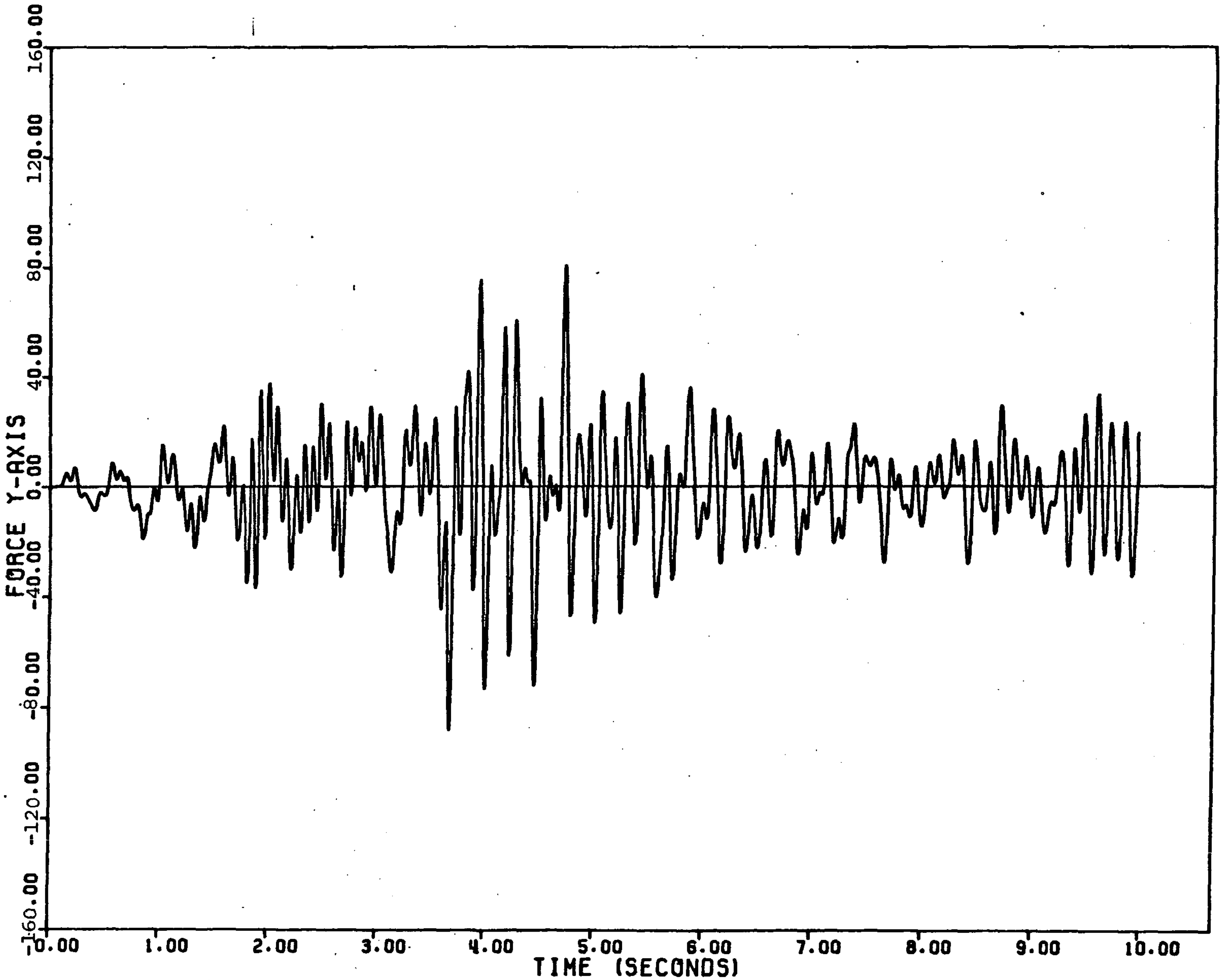


FIGURE C-83A. BOP PIPING, FP-18 LINE, NODE JT-95, LOCATION 5-15
SSE LOADING - RECORD 1009 - FORCE Y-AXIS (LBS) , NPTS =3324, DT = .003

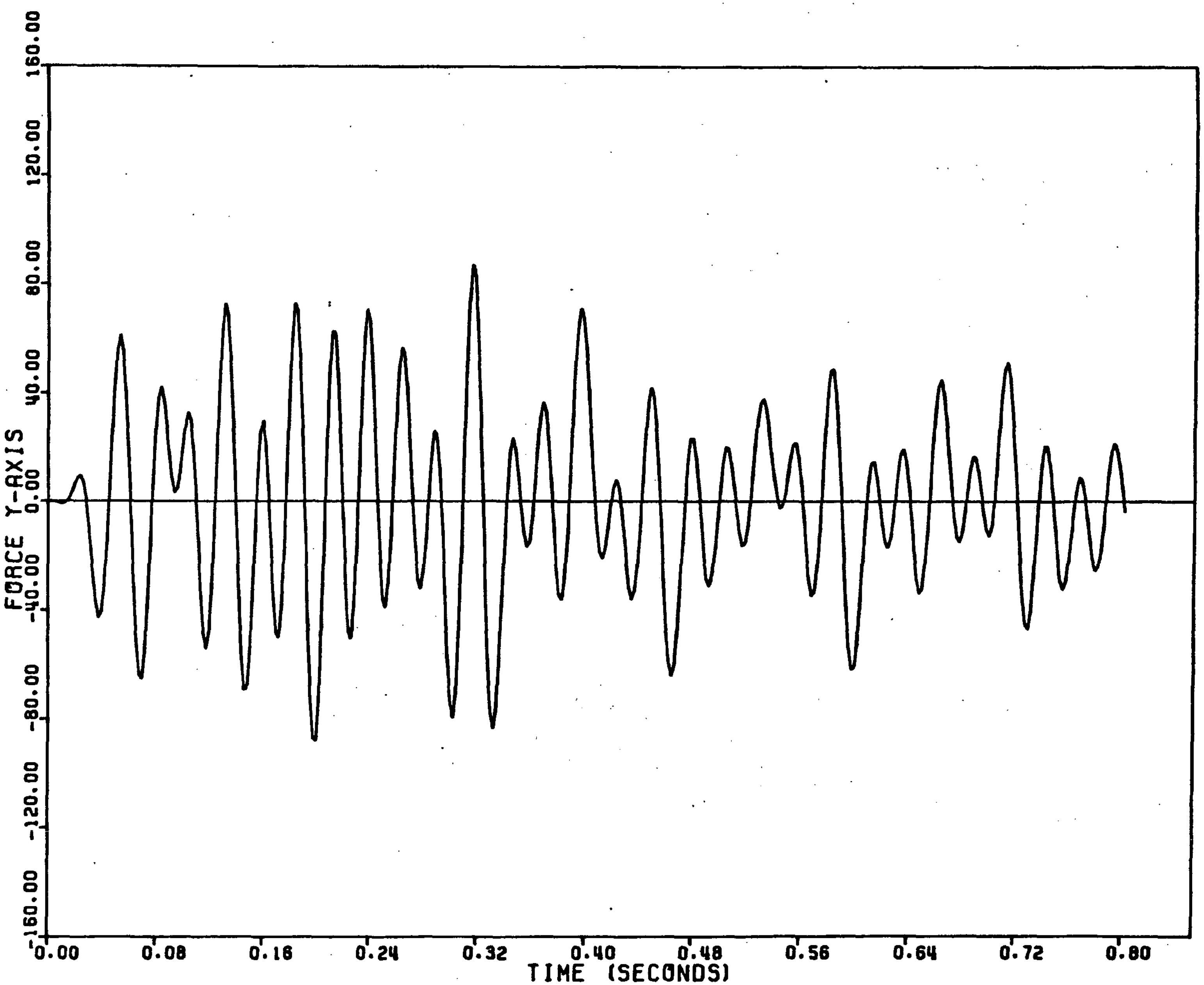


FIGURE C-83B. BOP PIPING, FP-18 LINE, NODE JT-95, LOCATION 5-15
SRV-1 LOADING - RECORD 1029 - FORCE Y-AXIS (LBS) , NPTS = 402, DT = .002

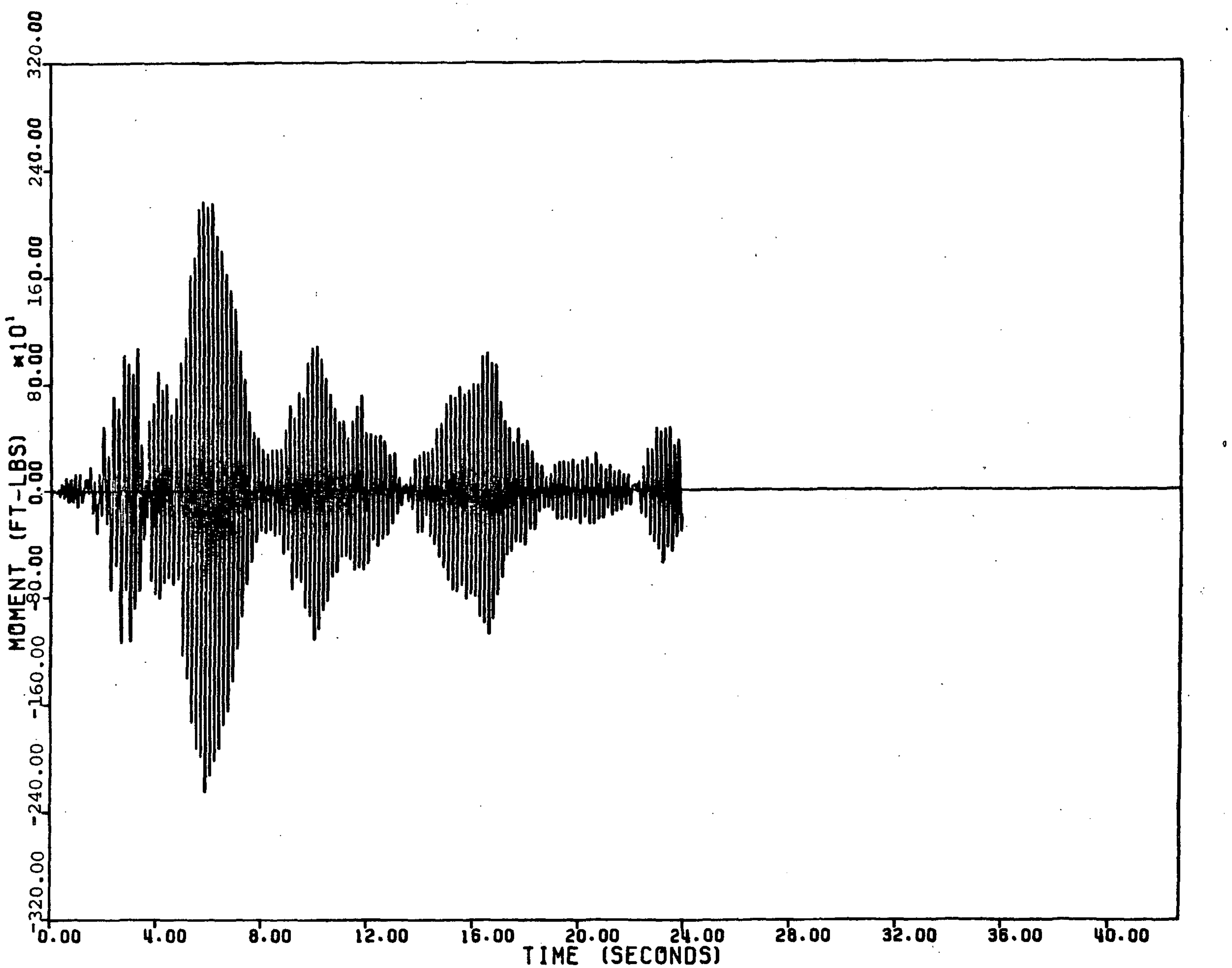


FIGURE C-84A. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-1
SSE LOADING - RECORD 701 - PIPE MOMENT Y (FT-LBS) , NPTS = 2388, DT = .01

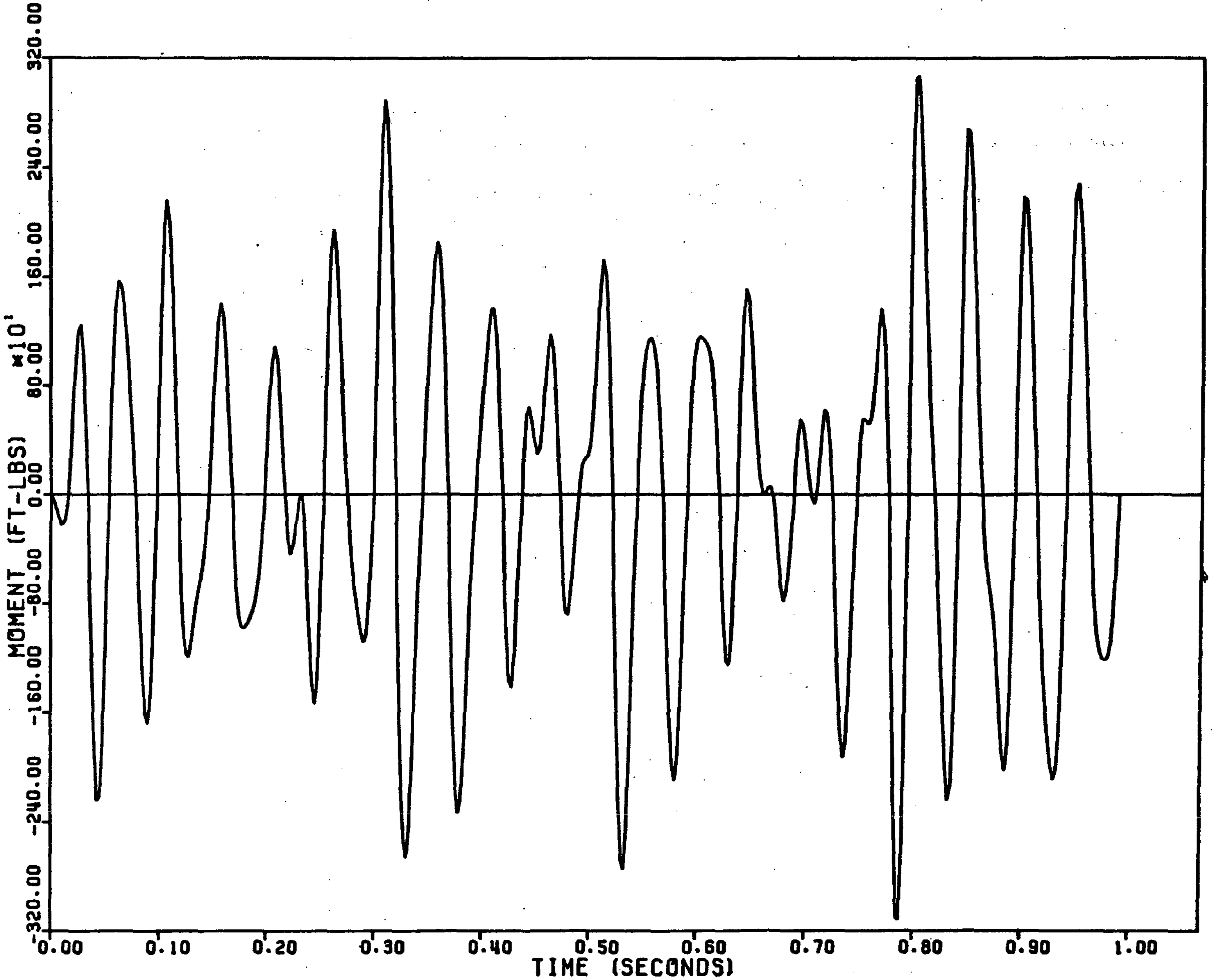


FIGURE C-84B. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-1
SRV-1 LOADING - RECORD 711 - PIPE MOMENT Y (FT-LBS) , NPTS = 397, DT = .0025

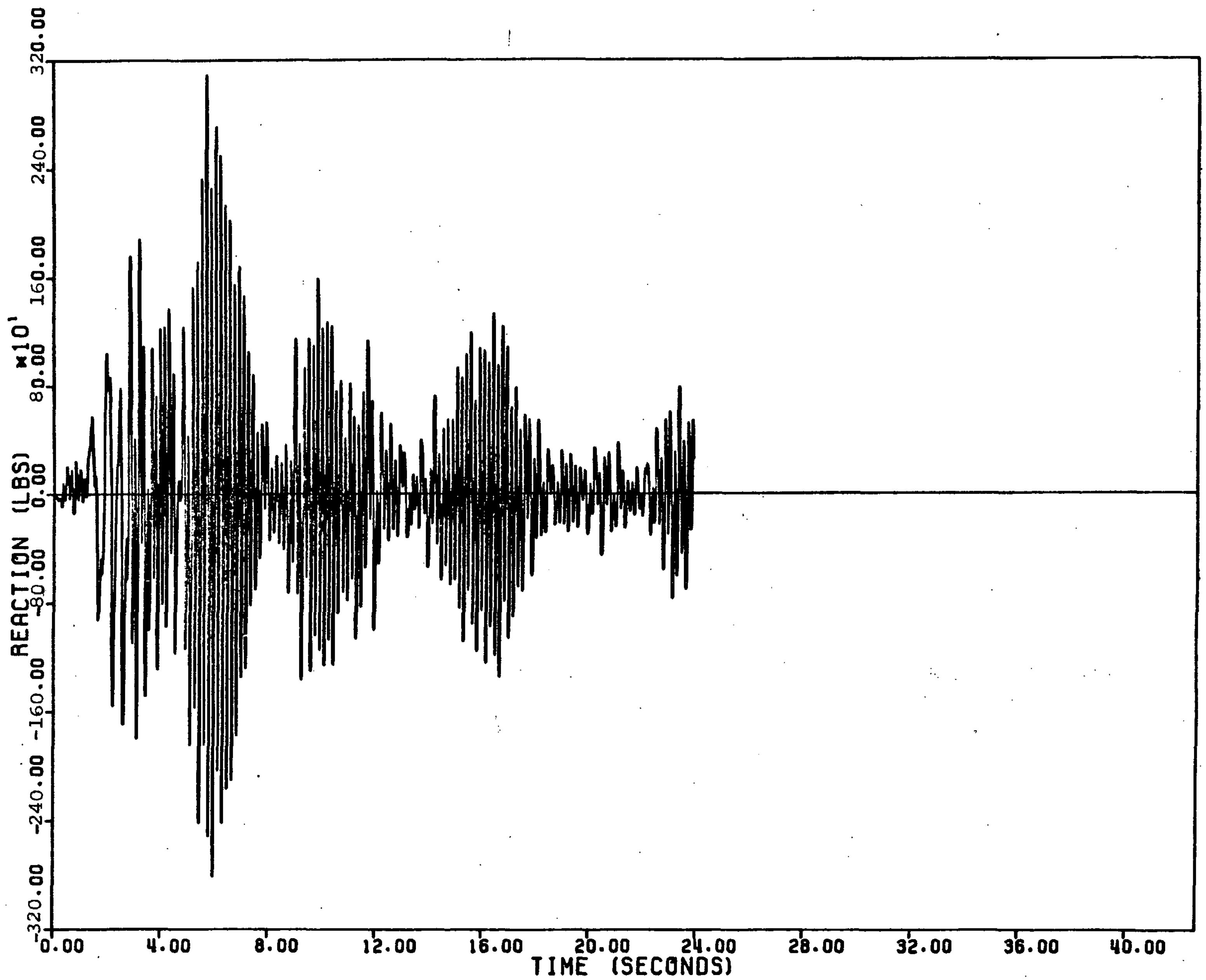


FIGURE C-85A. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-4
SSE LOADING - RECORD 704 - AXIAL SUPPORT (LBS) , NPTS = 2388, DT = .01

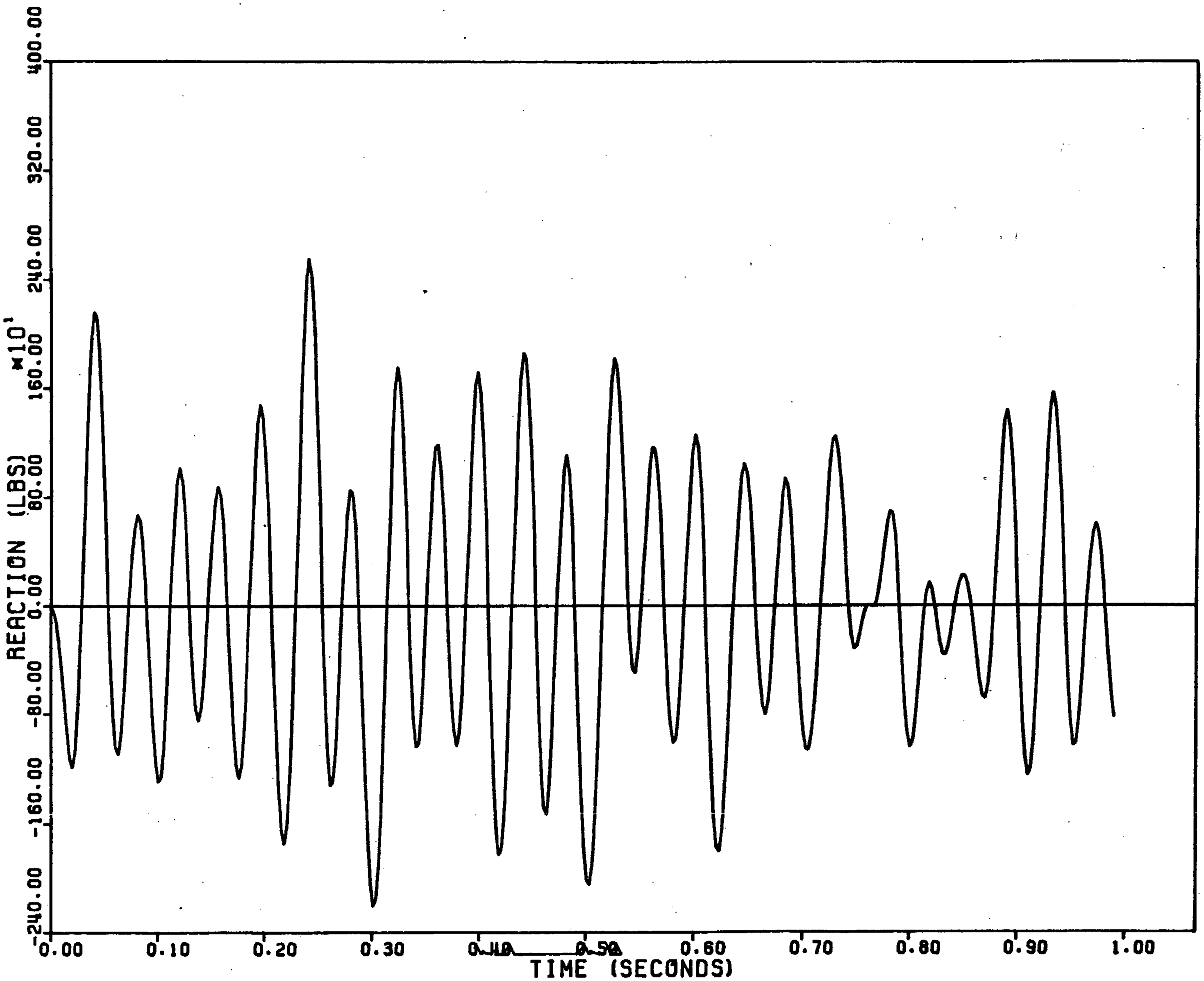


FIGURE C-85B. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-4
SRV-1 LOADING - RECORD 714 - AXIAL SUPPORT (LBS) , NPTS = 397, DT = .0025

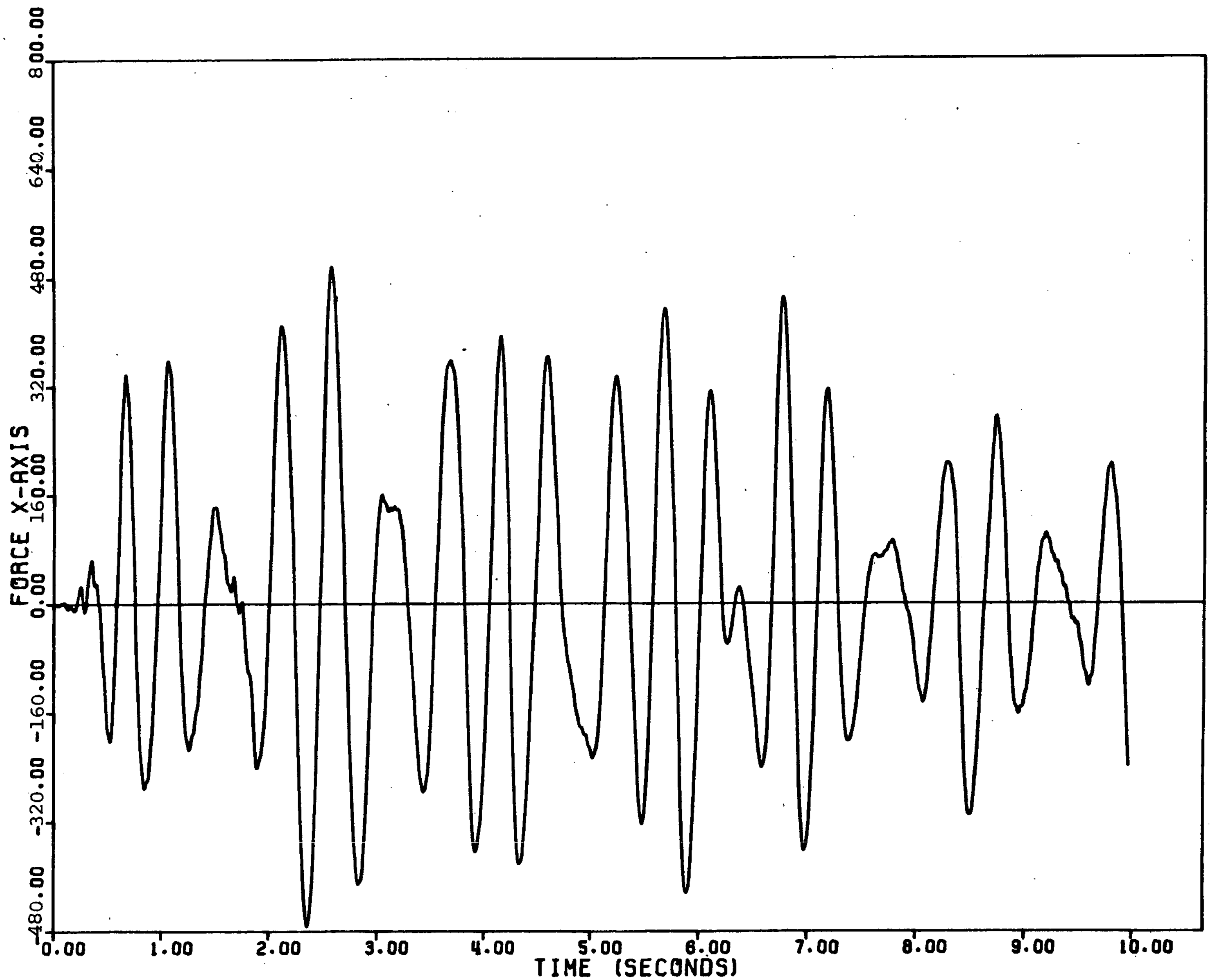


FIGURE C-86A. BOP PIPING, FP-18 LINE, NODE JT-105B, LOCATION 5-19
SSE LOADING - RECORD 1013 - FORCE X-AXIS (LBS) , NPTS =3324, DT = .003

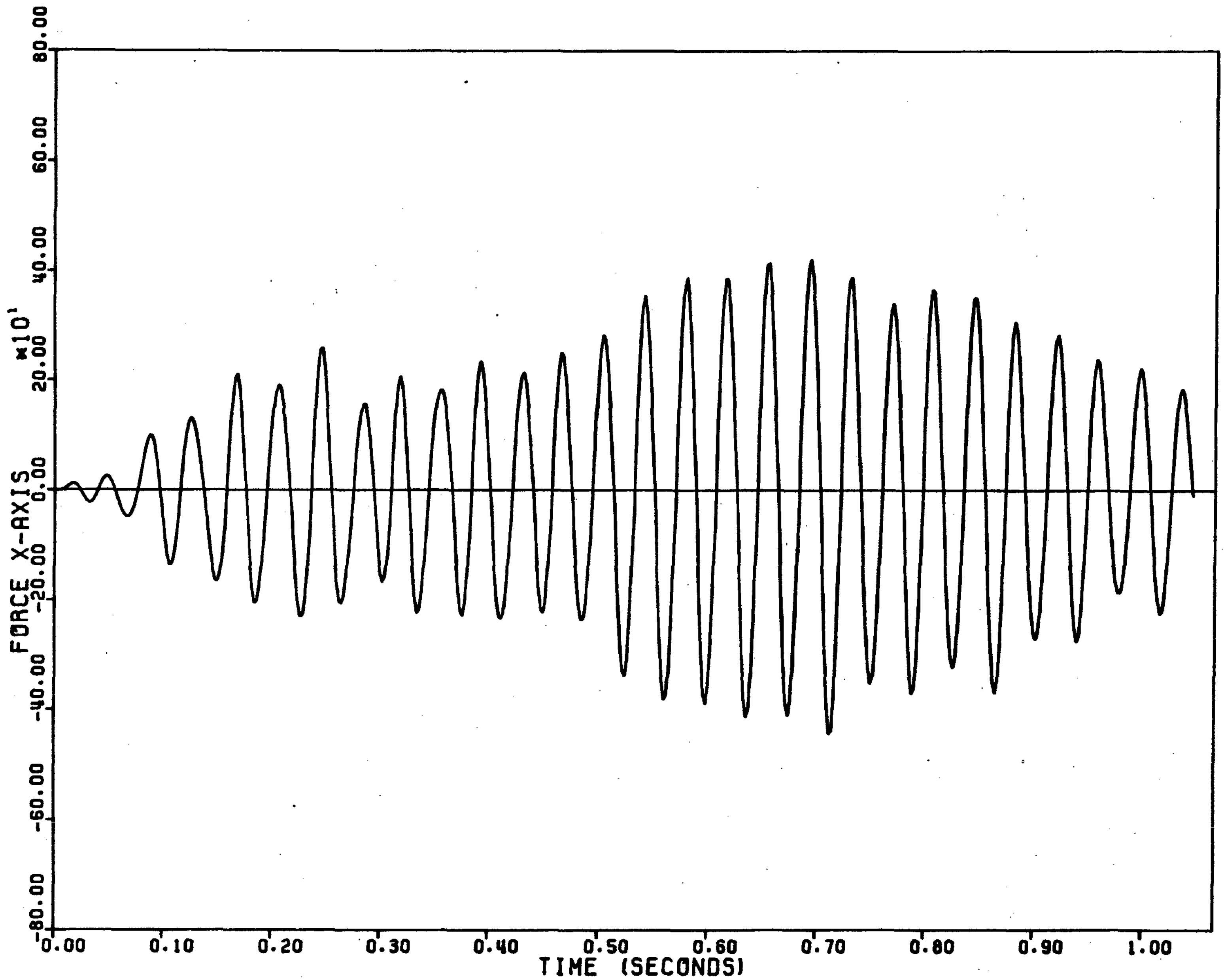


FIGURE C-86B. BOP PIPING, FP-18 LINE, NODE JT-105B, LOCATION 5-19
SRV-ALL LOADING - RECORD 1073 - FORCE X-AXIS (LBS) , NPTS = 524, DT = .002

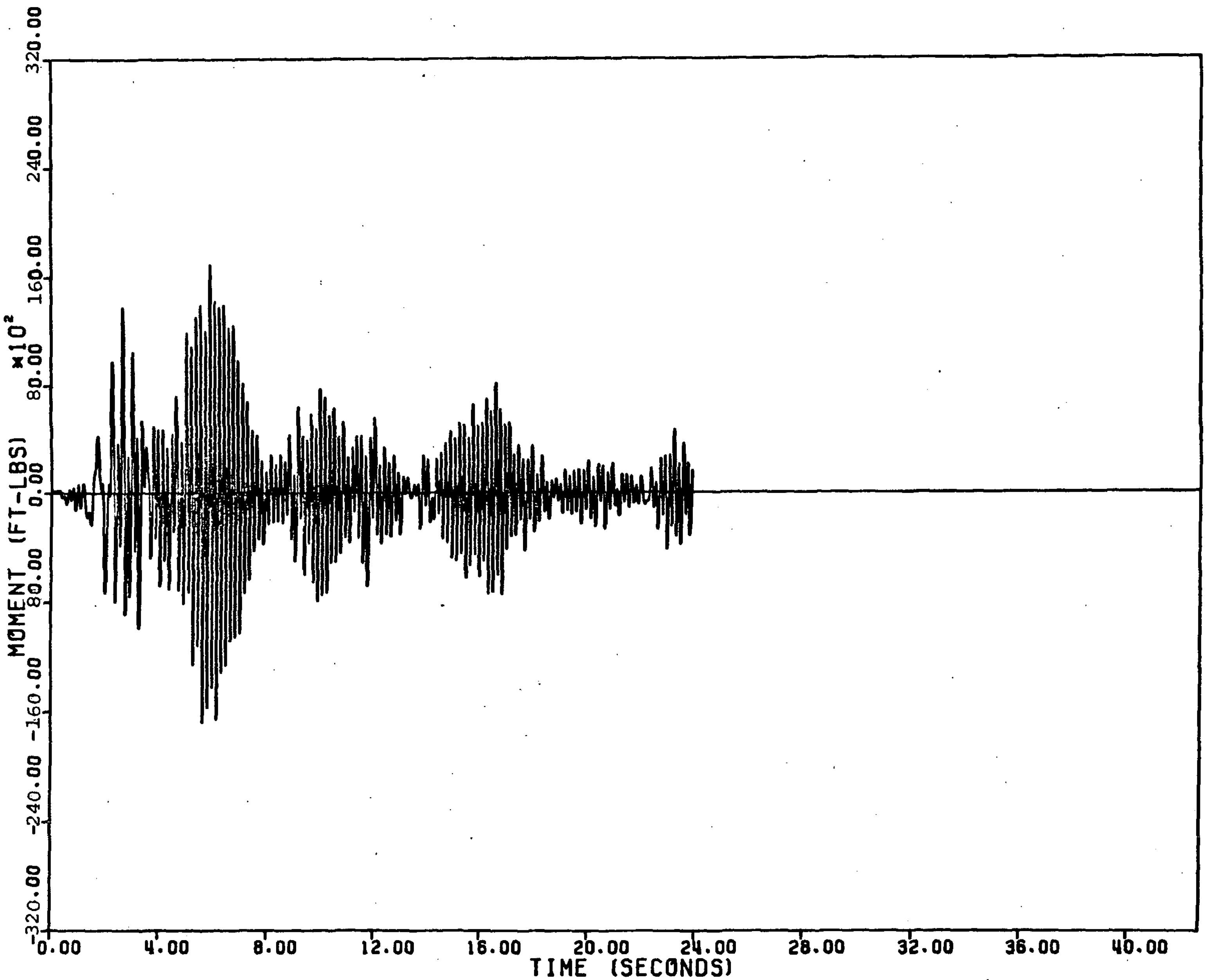


FIGURE C-87A. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-2
SSE LOADING - RECORD 702 - PIPE MOMENT Y (FT-LBS) , NPTS = 2388, DT = .01

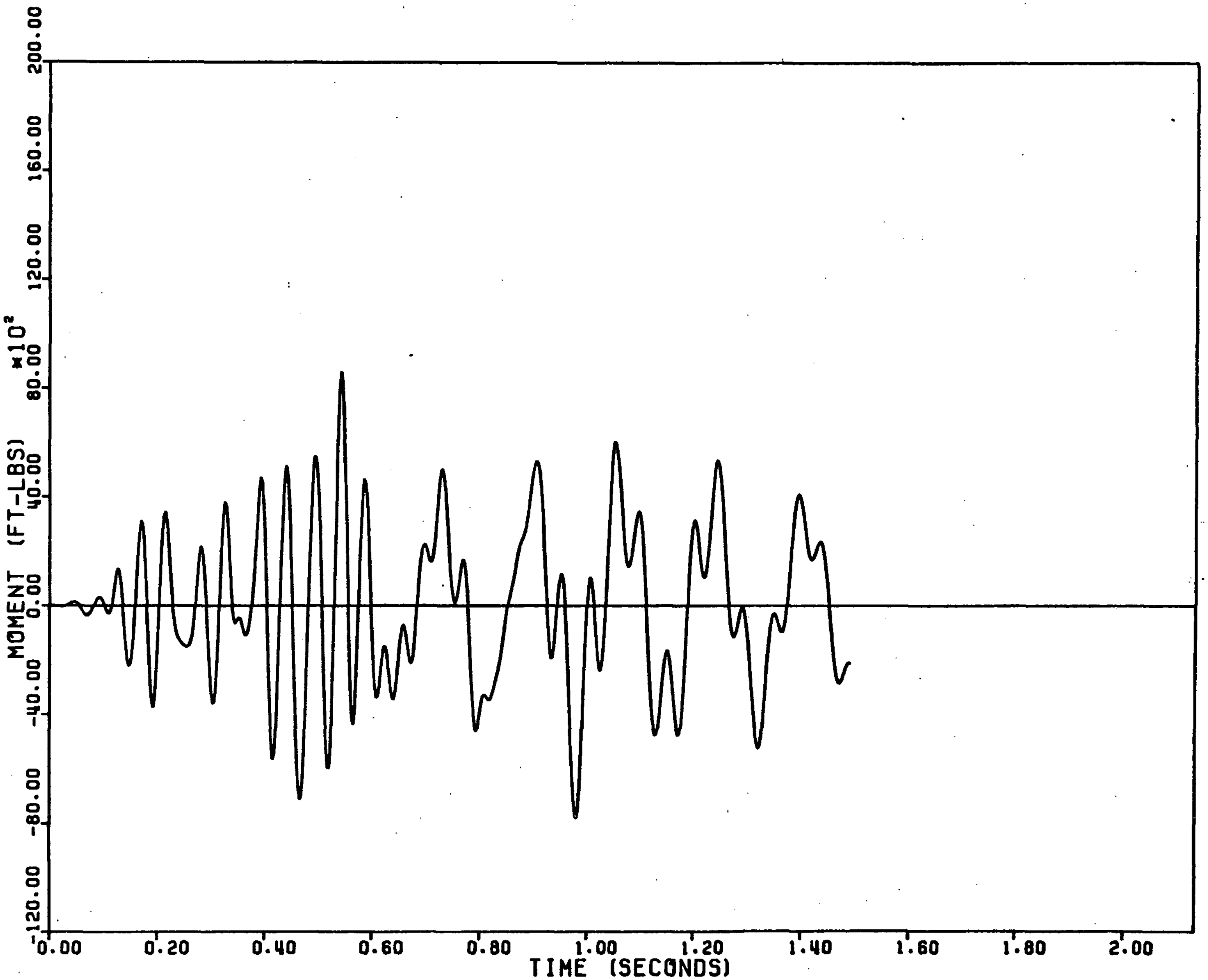


FIGURE C-87B. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-2
SRV-ALL LOADING- RECORD 732 - PIPE MOMENT Y (FT-LBS) , NPTS = 597, DT = .0025

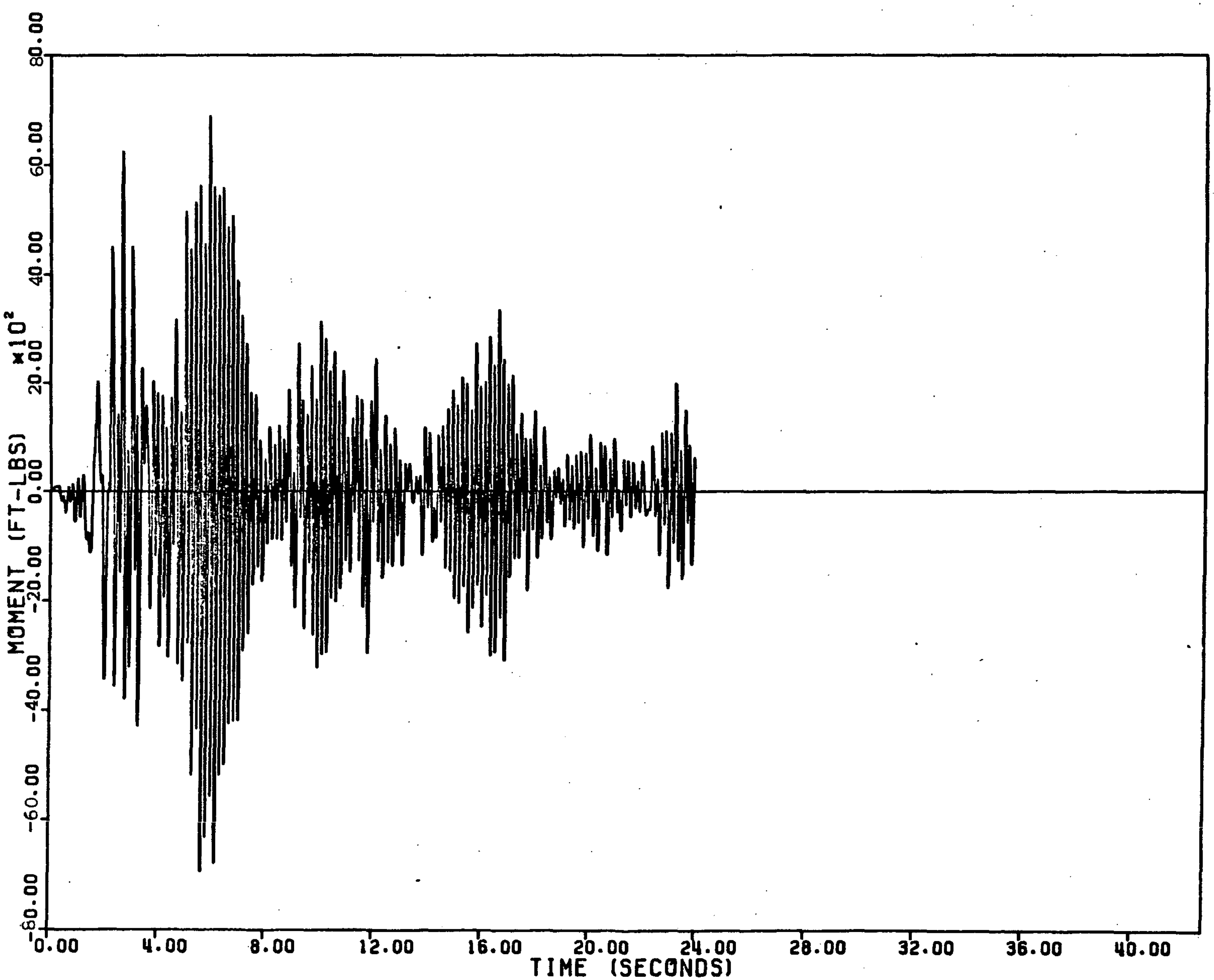


FIGURE C-88A. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-3
SSE LOADING - RECORD 703 - PIPE MOMENT Y (FT-LBS) , NPTS = 2388, DT = .01

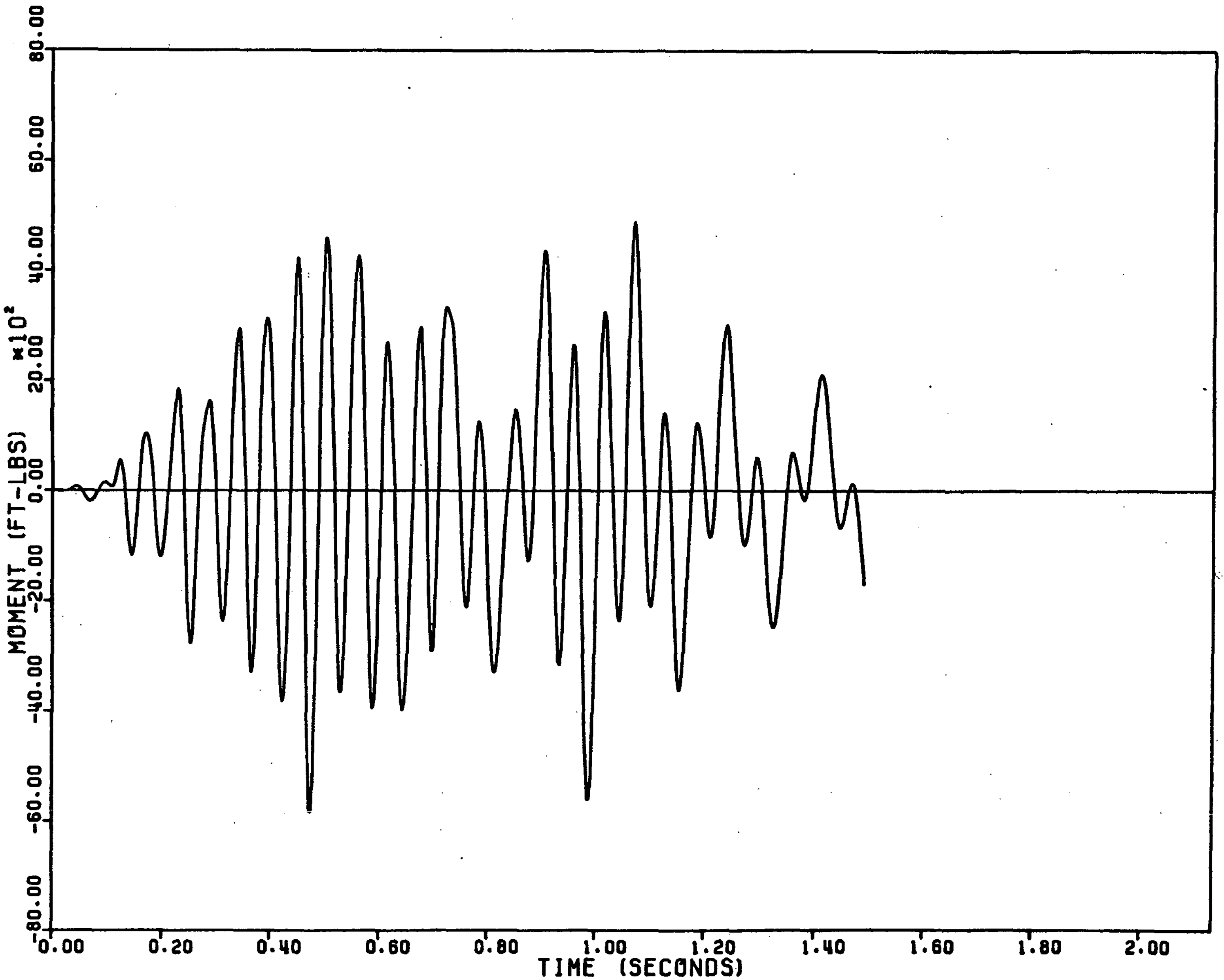


FIGURE C-88B. BOP PIPING TIME HISTORIES, LOW PRESSURE COOLANT SUPPLY, LOCATION 2-3
SRV-ALL LOADING- RECORD 733 - PIPE MOMENT Y (FT-LBS) , NPTS = 597, DT = .0025

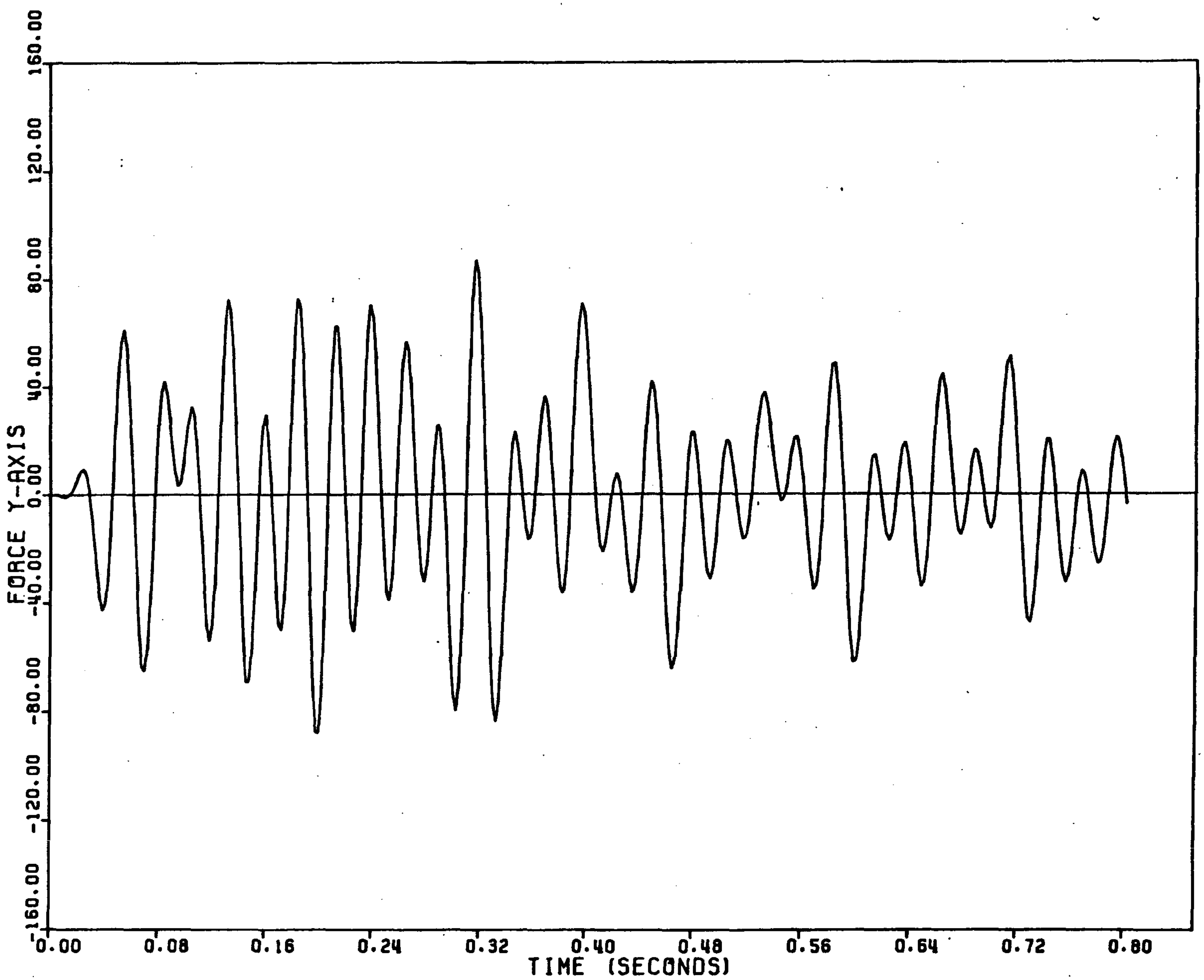


FIGURE C-89A. BOP PIPING, FP-18 LINE, NODE JT-95, LOCATION 5-15
SRV-1 LOADING - RECORD 1029 - FORCE Y-AXIS (LBS) , NPTS = 402, DT = .002

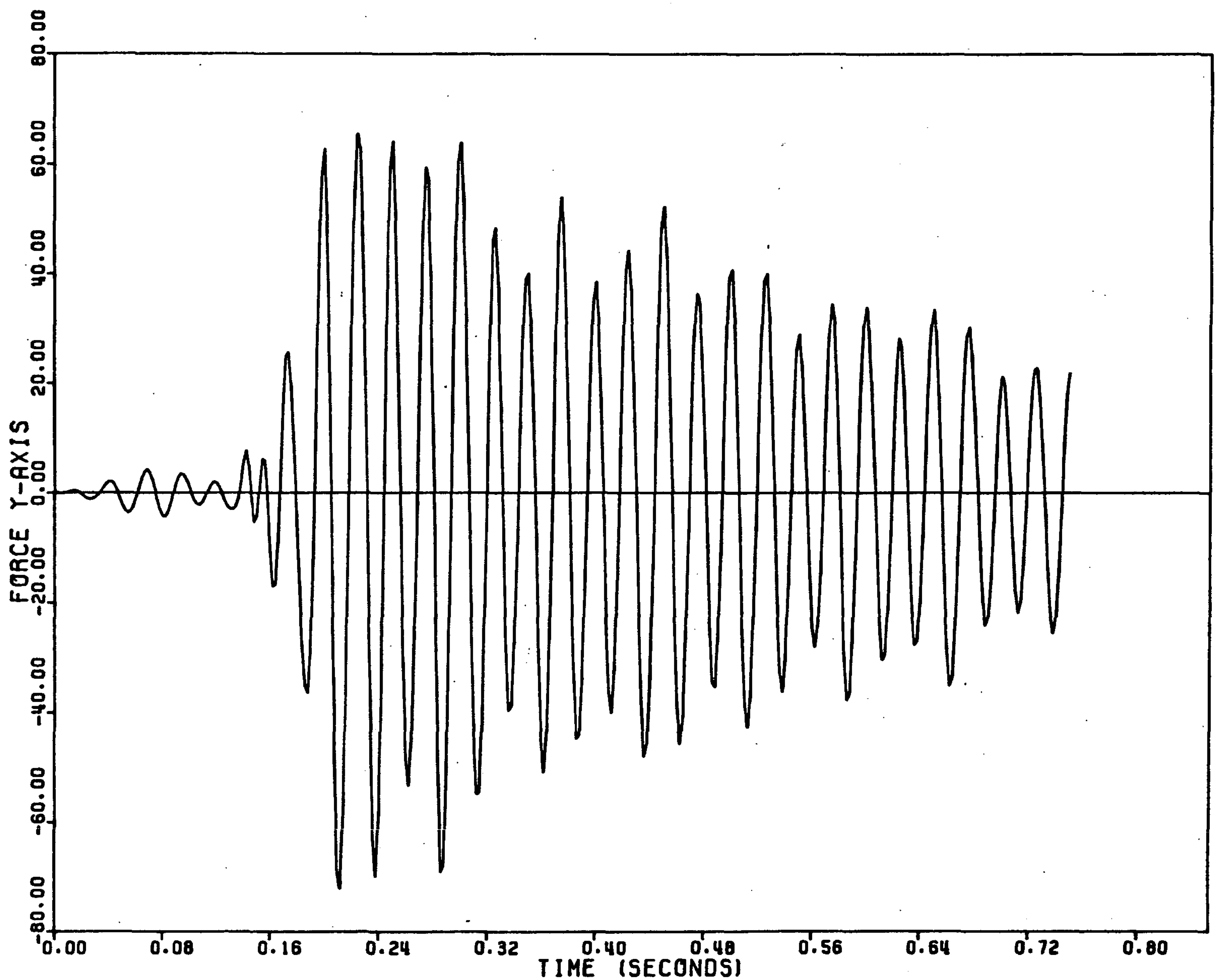


FIGURE C-89B. BOP PIPING, FP-18 LINE, NODE JT-95, LOCATION 5-15
CHUG LOADING - RECORD 1089 - FORCE Y-AXIS (LBS) , NPTS =376, DT = .002

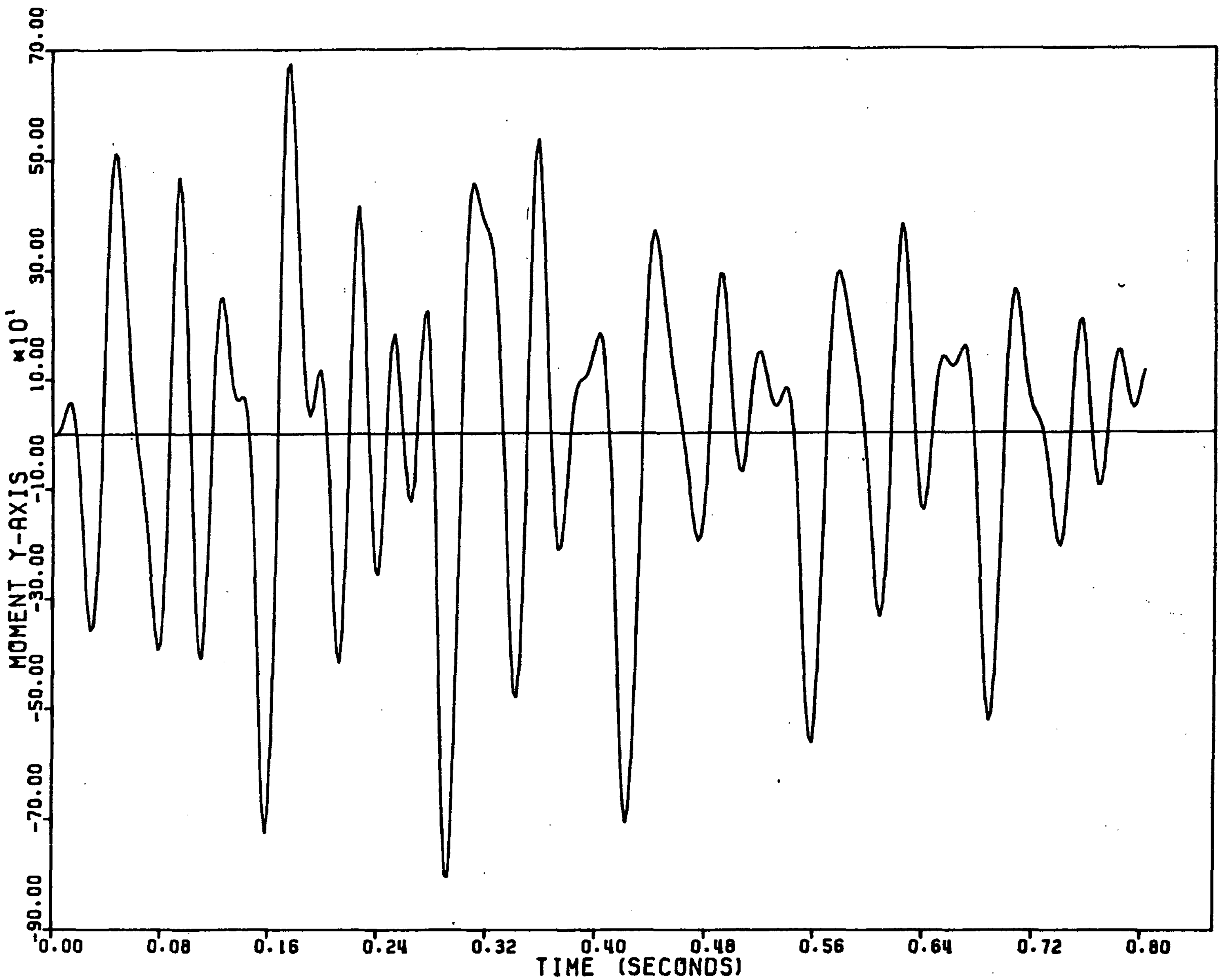


FIGURE C-90A. BOP PIPING, FP-18 LINE, NODE MI-24, LOCATION 5-16
SRV-1 LOADING - RECORD 1030 - MOMENT Y-AXIS (IN-LBS), NPTS = 402, DT = .002

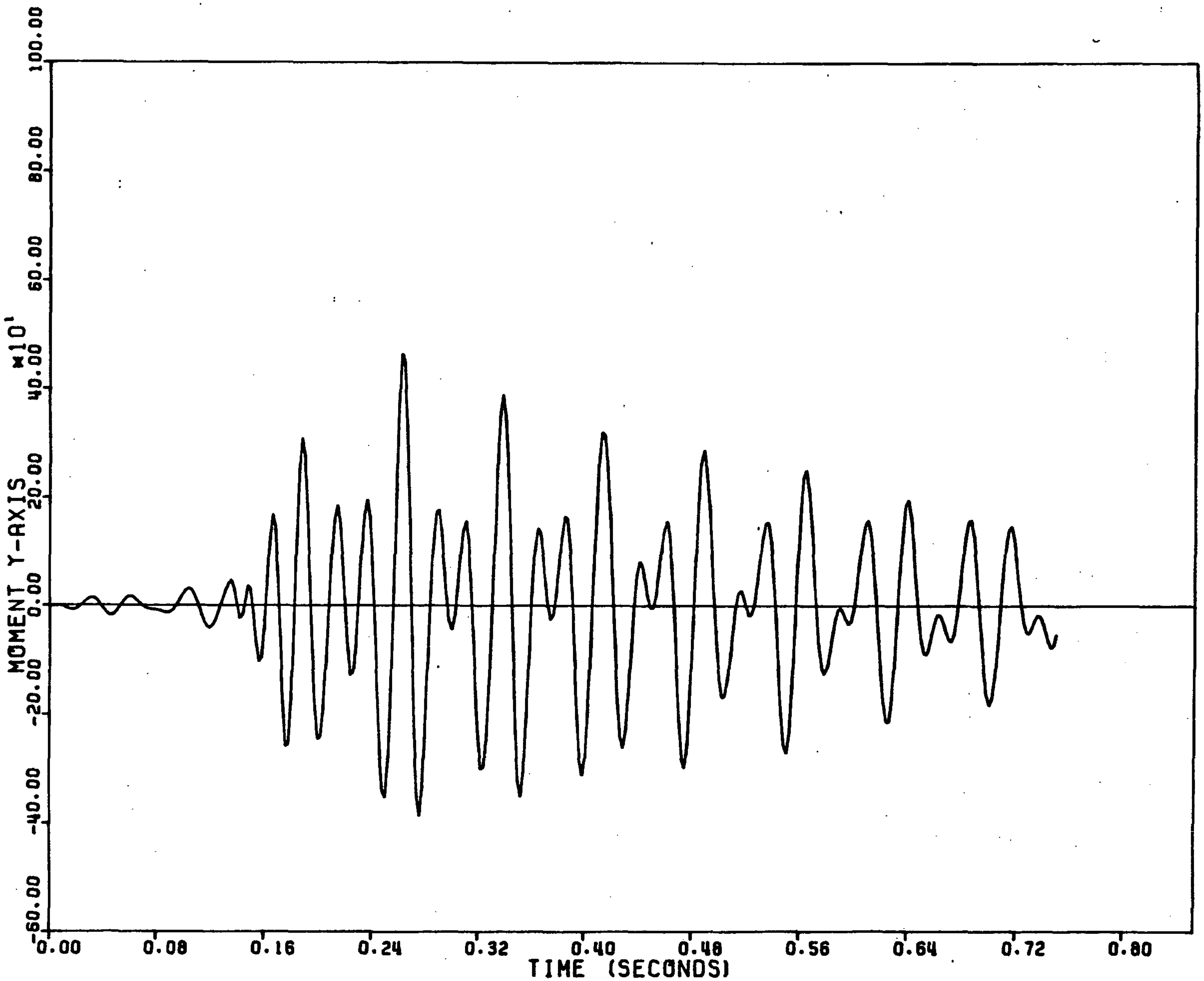


FIGURE C-90B. BOP PIPING, FP-18 LINE, NODE MI-24, LOCATION 5-16
CHUG LOADING - RECORD 1090A- MOMENT Y-AXIS (IN-LBS) , NPTS =376, DT = .002

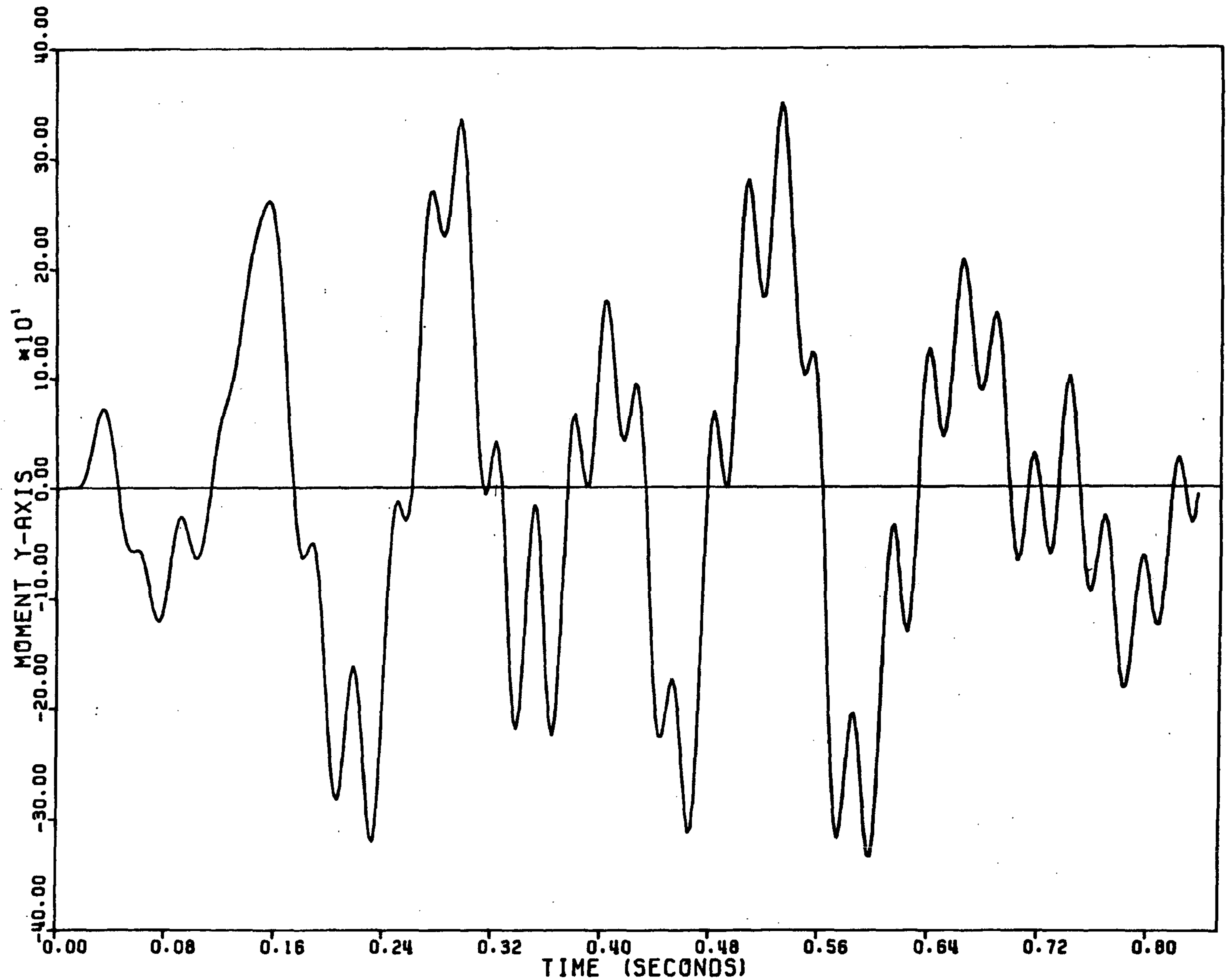


FIGURE C-91A. BOP PIPING, FP-18 LINE, NODE MJ-52, LOCATION 5-17
SRV-ADS LOADING - RECORD 1051 - MOMENT Y-AXIS (IN-LBS), NPTS = 419, DT = .002

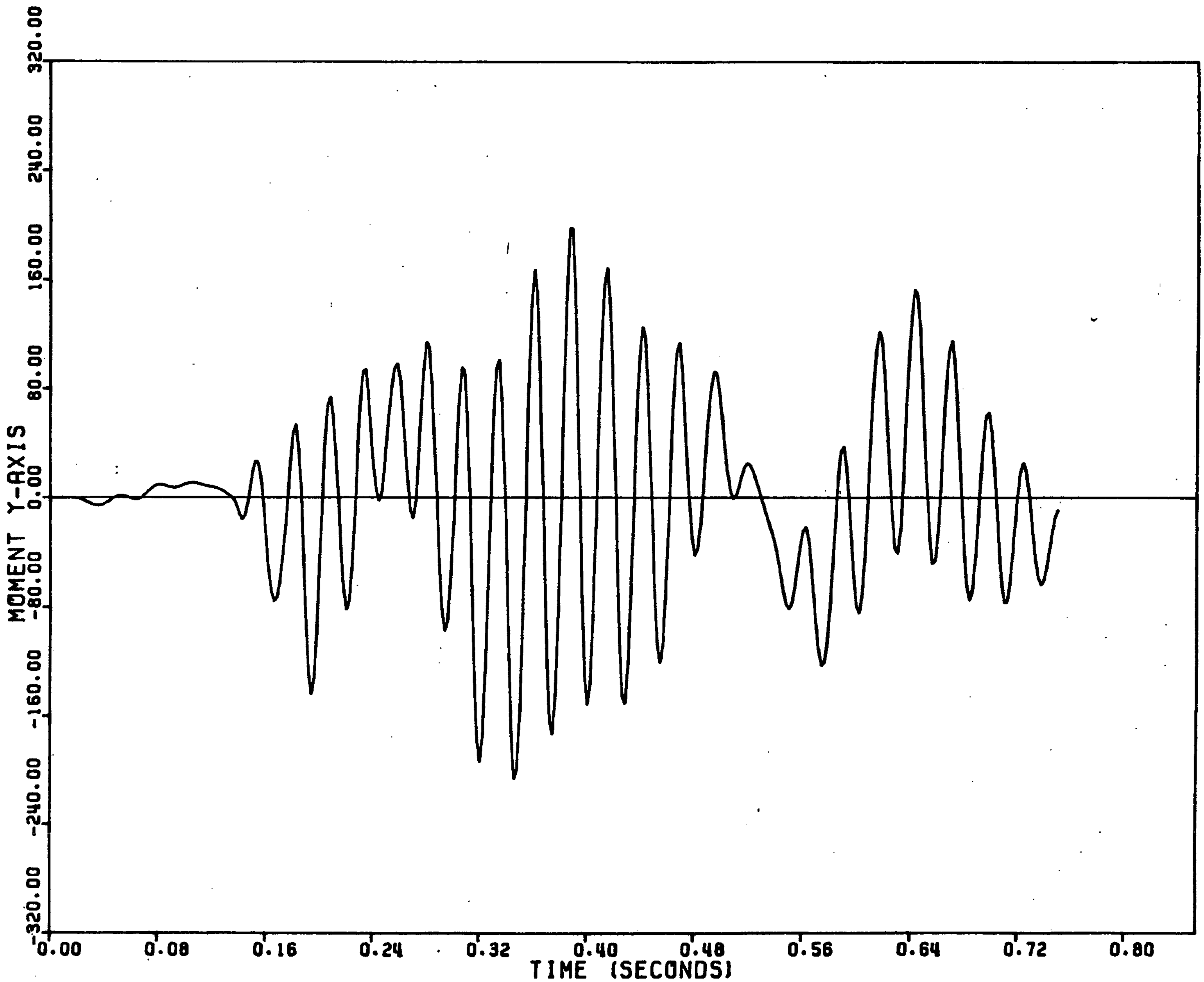


FIGURE C-91B. BOP PIPING, FP-18 LINE, NODE MJ-52, LOCATION 5-17
CHUG LOADING - RECORD 1091 - MOMENT Y-AXIS (IN-LBS) , NPTS =376, DT = .002

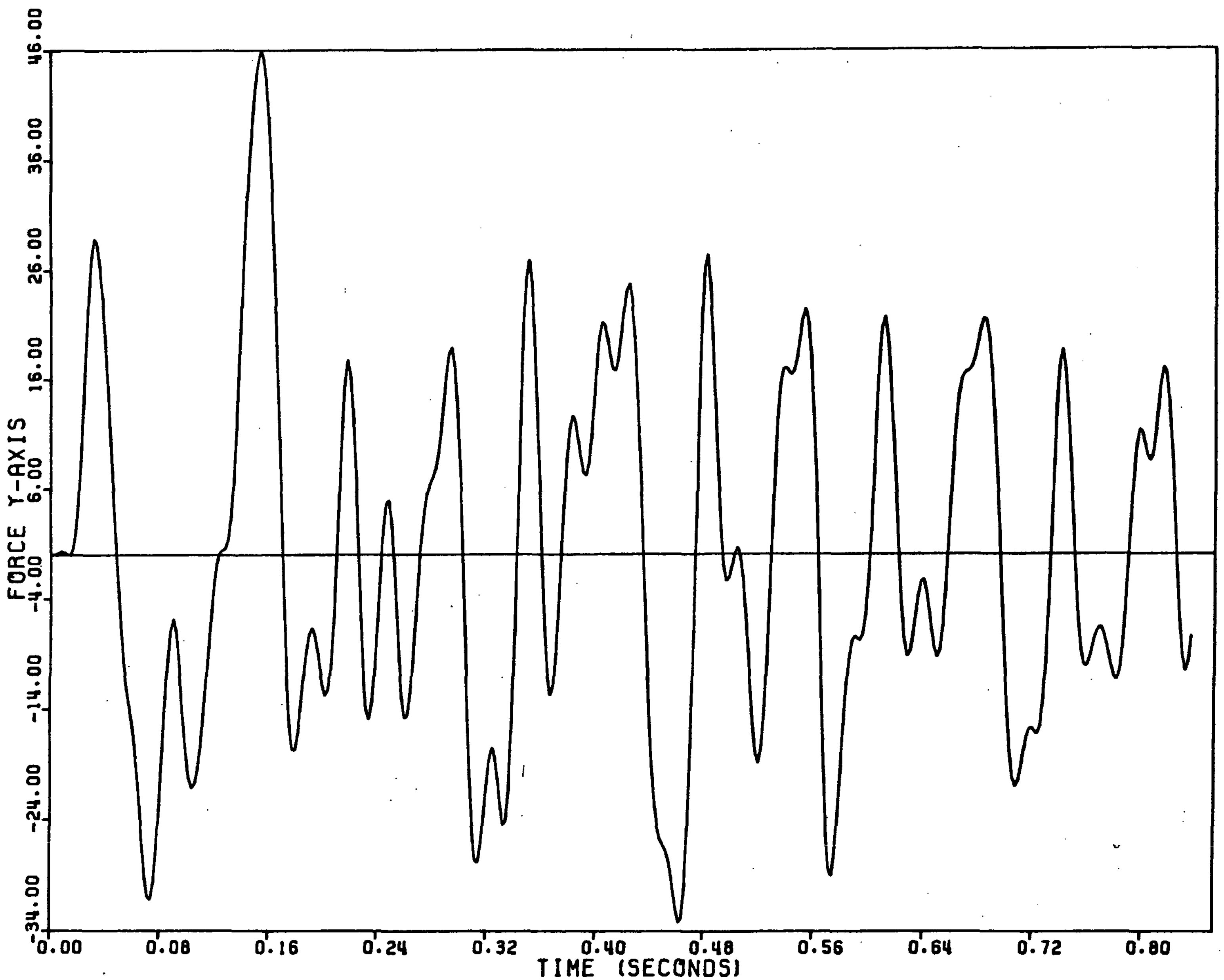


FIGURE C-92A. BOP PIPING, FP-18 LINE, NODE JT-42, LOCATION 5-14
SRV-ADS LOADING - RECORD 1048 - FORCE Y-AXIS (LBS)LBS), NPTS = 419, DT = .002

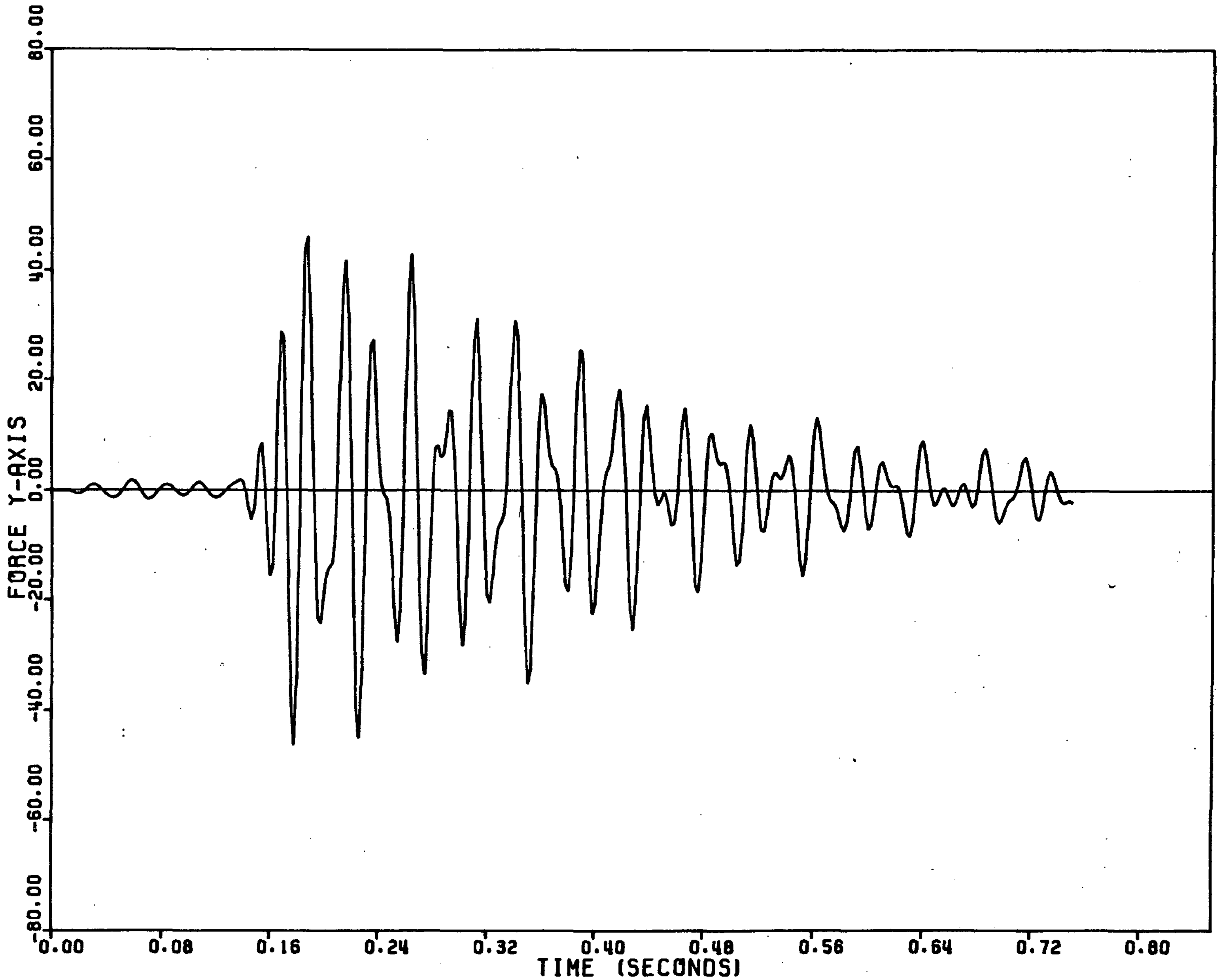


FIGURE C-92B. BOP PIPING, FP-18 LINE, NODE JT-42, LOCATION 5-14
CHUG LOADING - RECORD 1088 - FORCE Y-AXIS (LBS) , NPTS =376, DT = .002

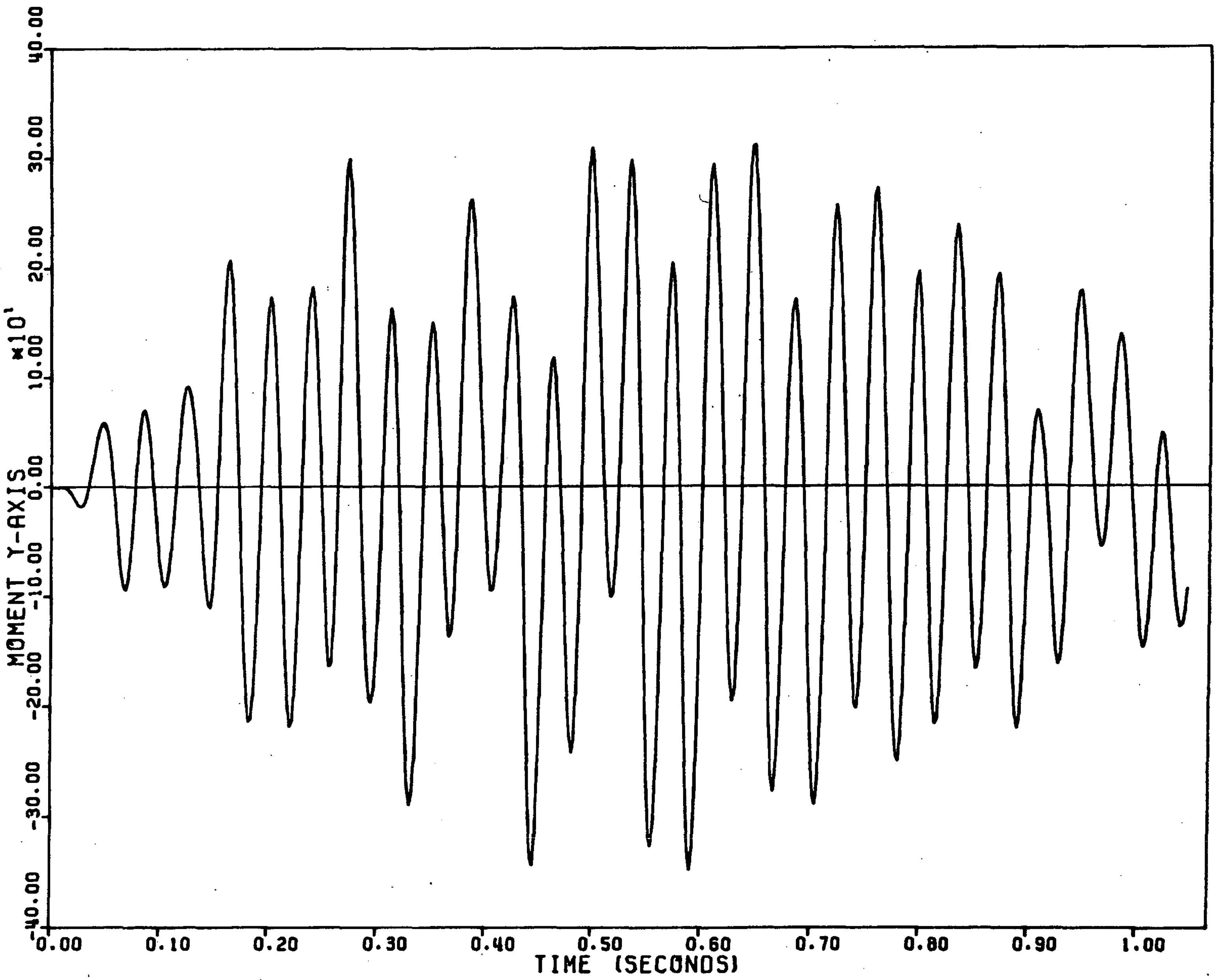


FIGURE C-93A. BOP PIPING, FP-18 LINE, NODE MI-24, LOCATION 5-16
SRV-ALL LOADING - RECORD 1070 - MOMENT Y-AXIS (IN-LBS) , NPTS = 524 DT = .002

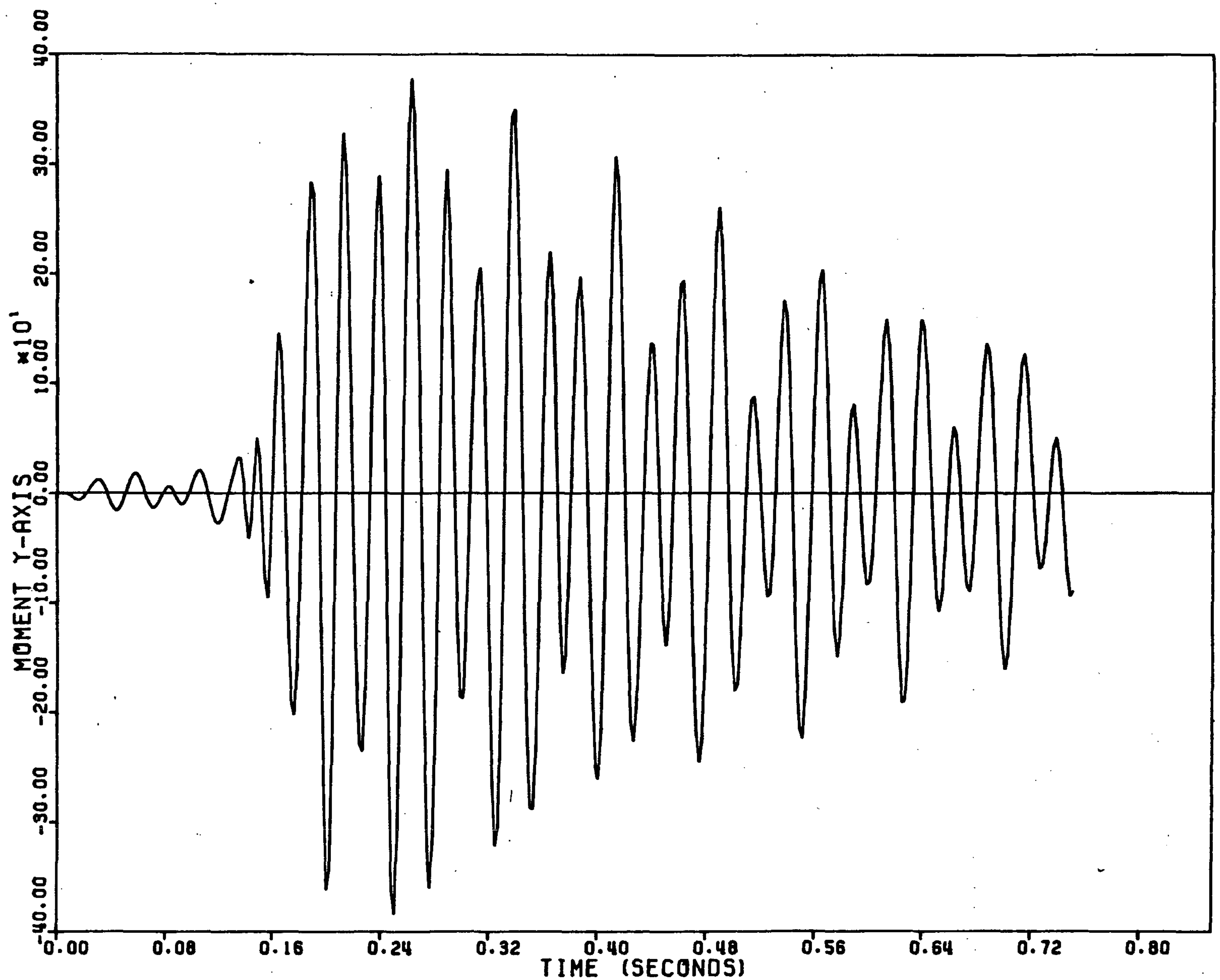


FIGURE C-93B. BOP PIPING, FP-18 LINE, NODE MI-24, LOCATION 5-16
CHUG LOADING - RECORD 1090B- MOMENT Y-AXIS (IN-LBS) , NPTS =376, DT = .002

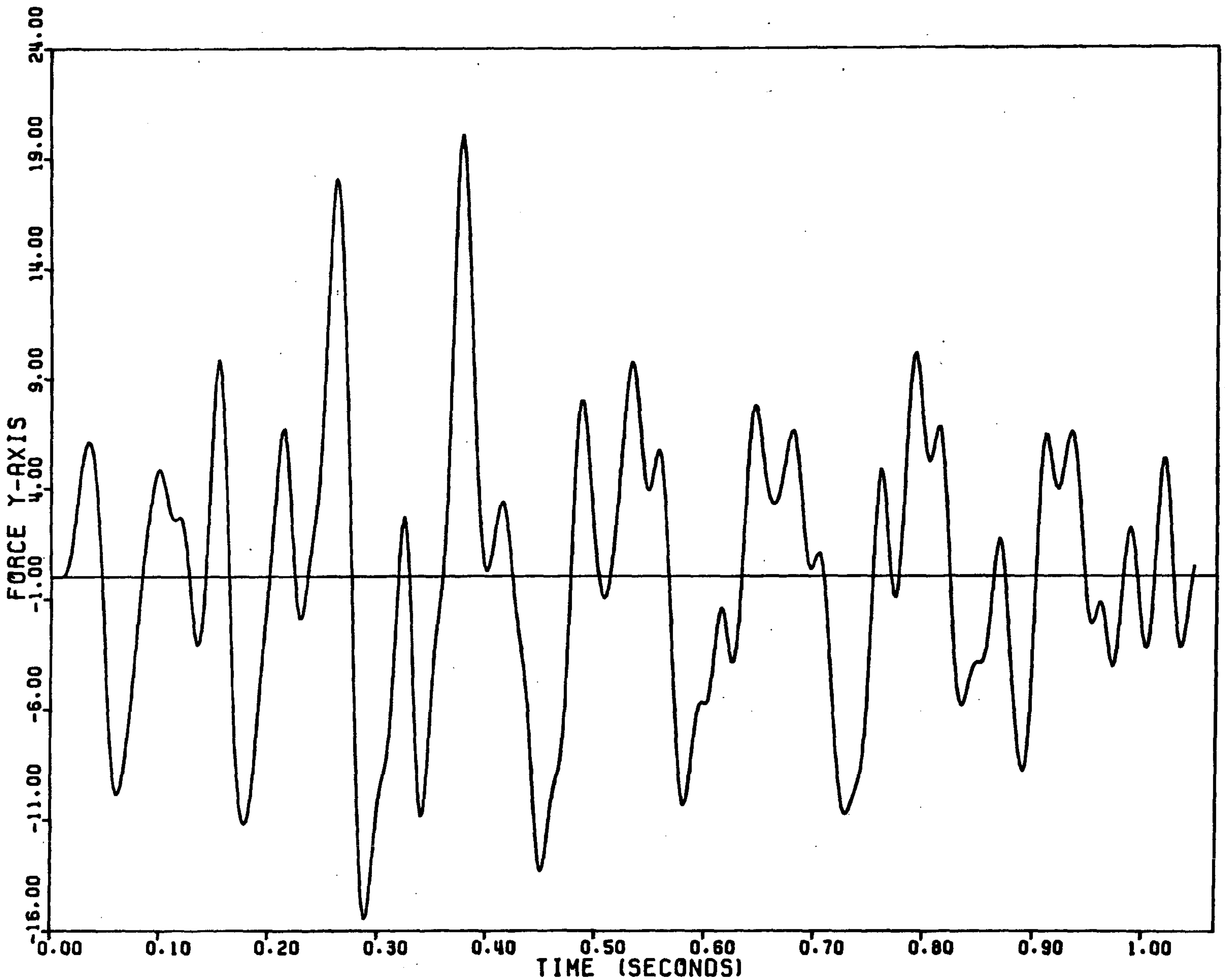


FIGURE C-94A. BOP PIPING, FP-18 LINE, NODE JT-608 , LOCATION 5-20
SRV-ALL LOADING - RECORD 1074 - FORCE Y-AXIS (LBS) , NPTS = 524, DT = .002

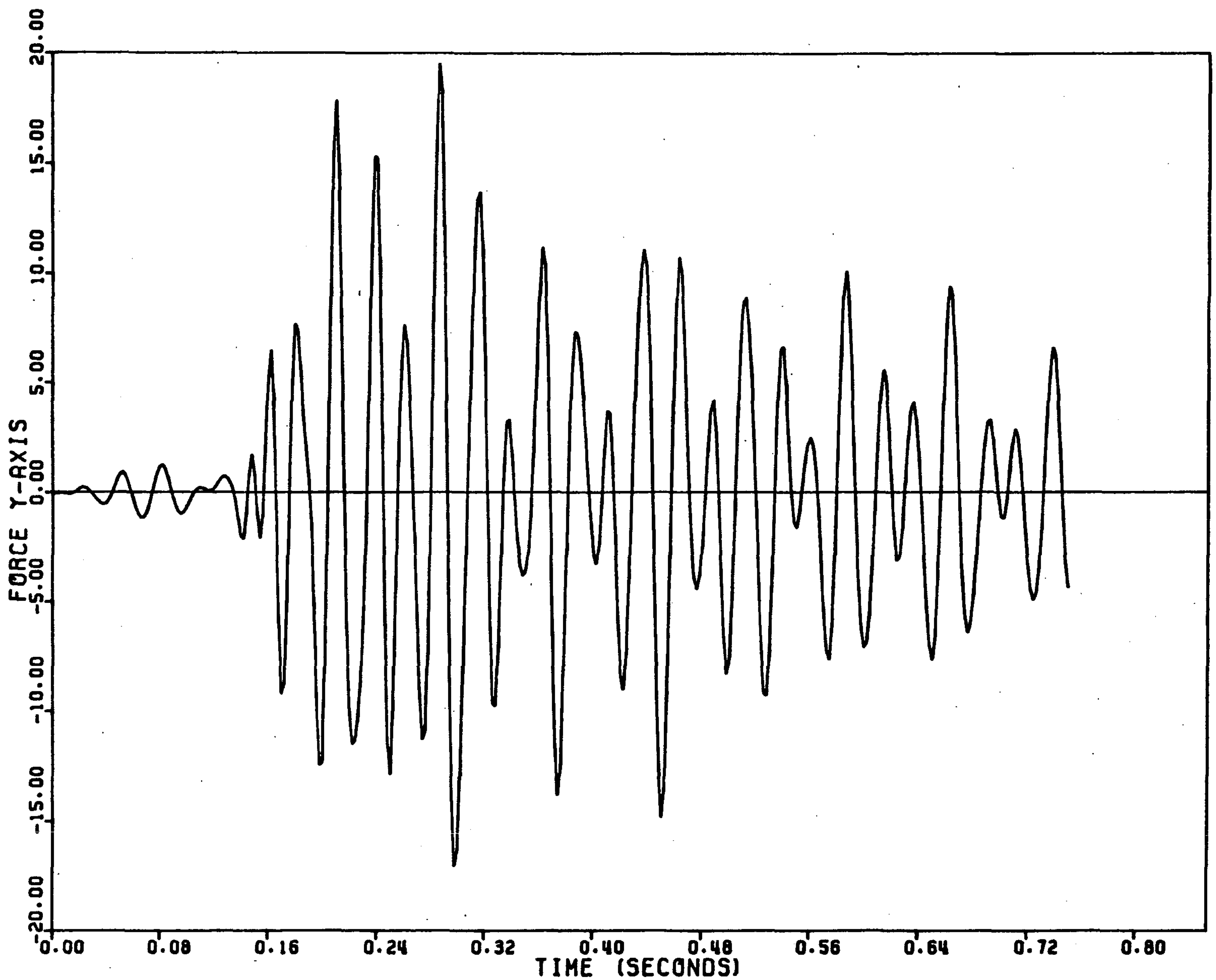


FIGURE C-94B. BOP PIPING, FP-18 LINE, NODE JT-60B , LOCATION 5-20
CHUG LOADING - RECORD 1094 - FORCE Y-AXIS (LBS) , NPTS =376, DT = .002

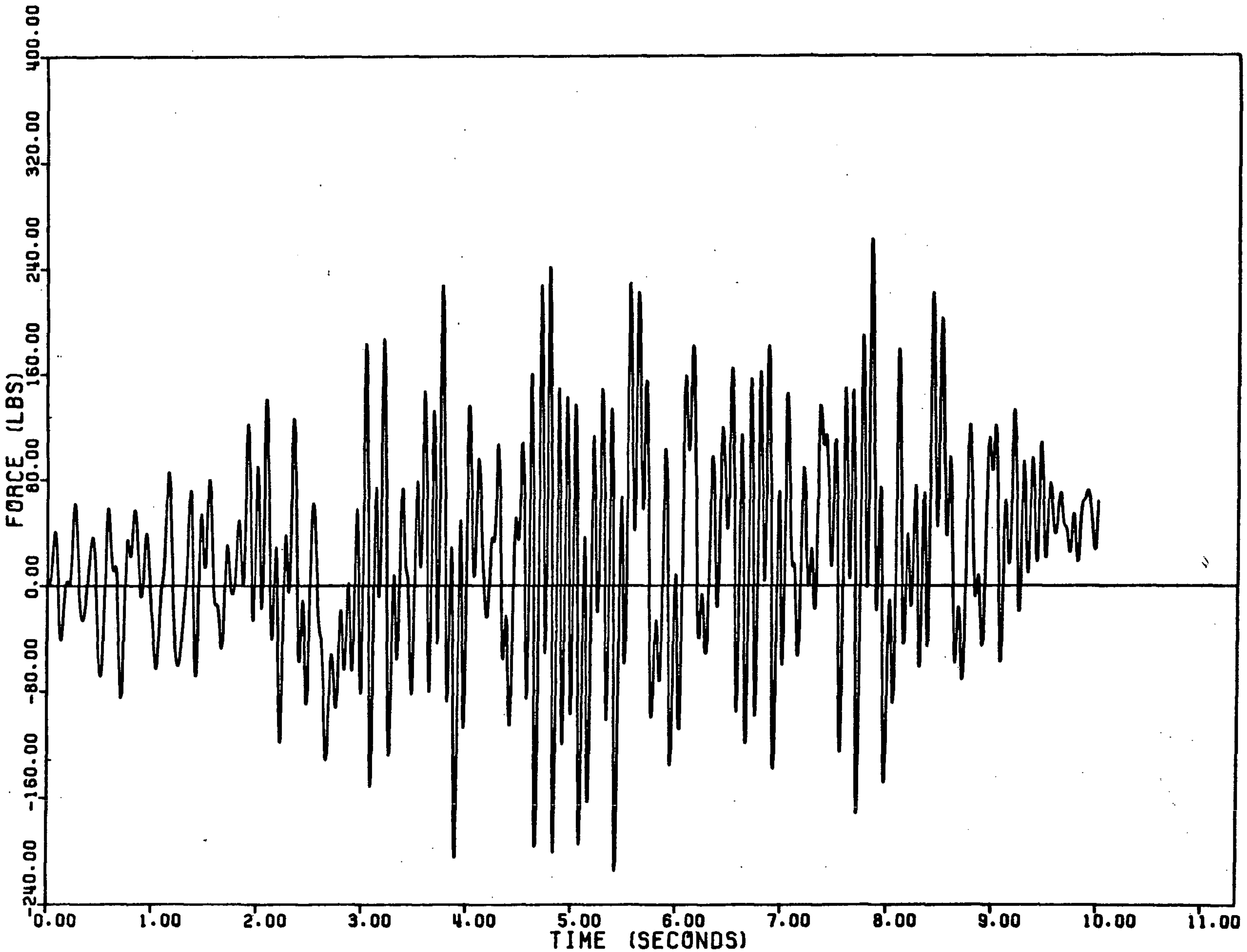


FIGURE C-95A. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-8
OBE LOADING - RECORD 305 - FORCE (LBS) , NPTS = 2001, DT = .005

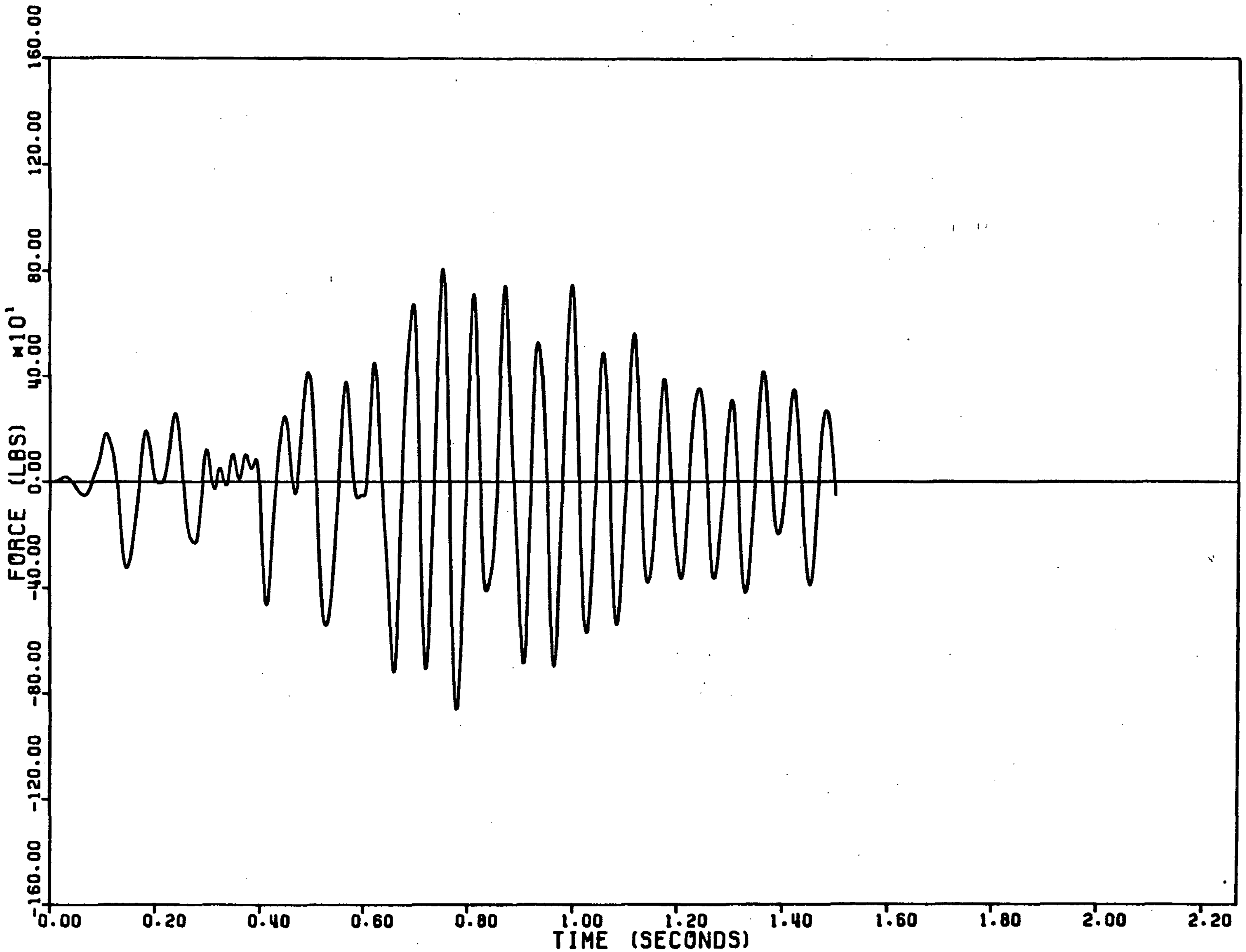


FIGURE C-95B. BOP PIPING TIME HISTORIES. HPCS PUMP DISCHARGE LINE LOCATION 3-8
SRV-ALL LOADING- RECORD 355 - FORCE (LBS) , NPTS =1501, DT = .0010

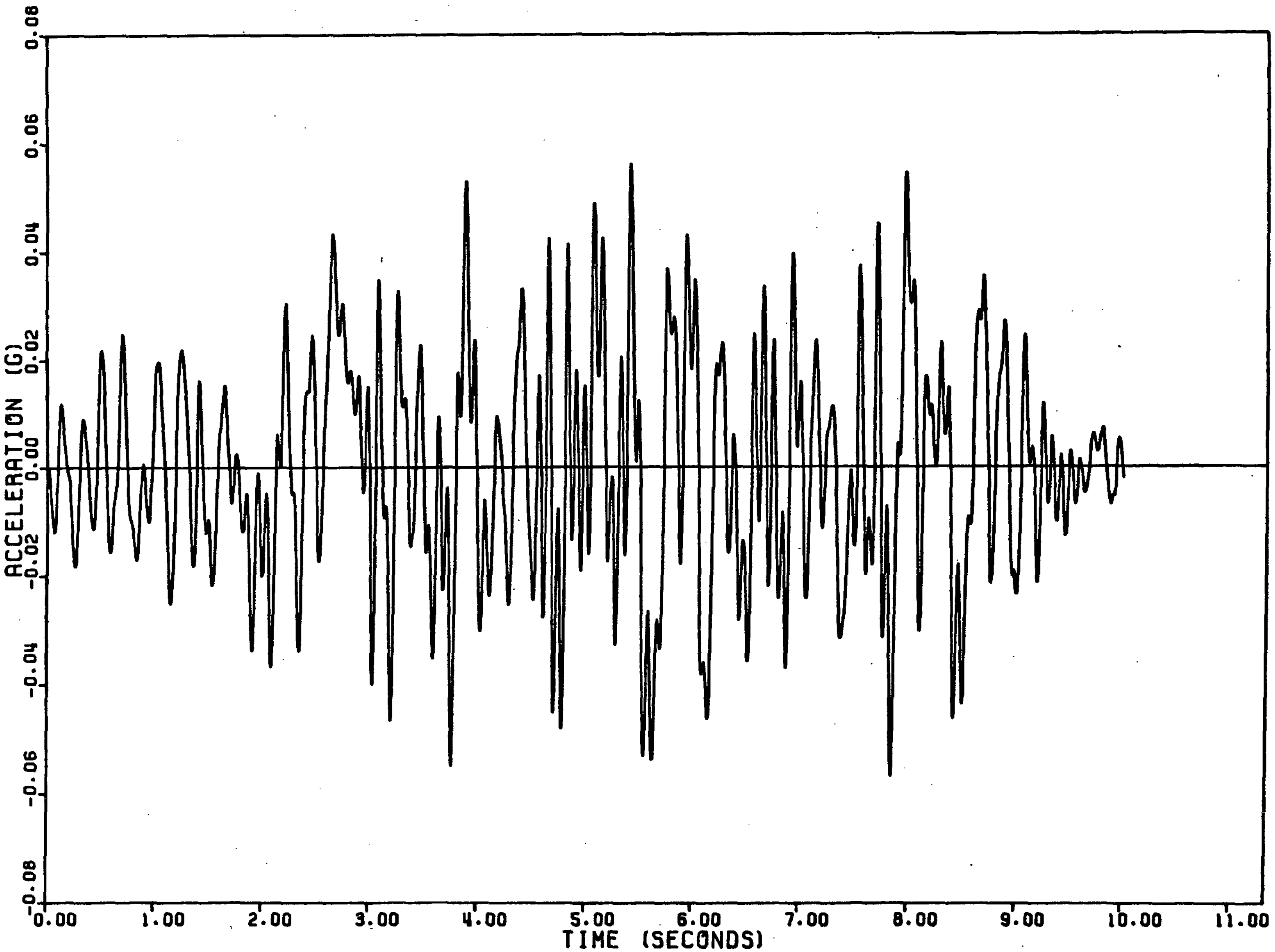


FIGURE C-96A. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-6
OBE LOADING - RECORD 303 - ACCELERATION (G), NPTS = 2001, DT = .005

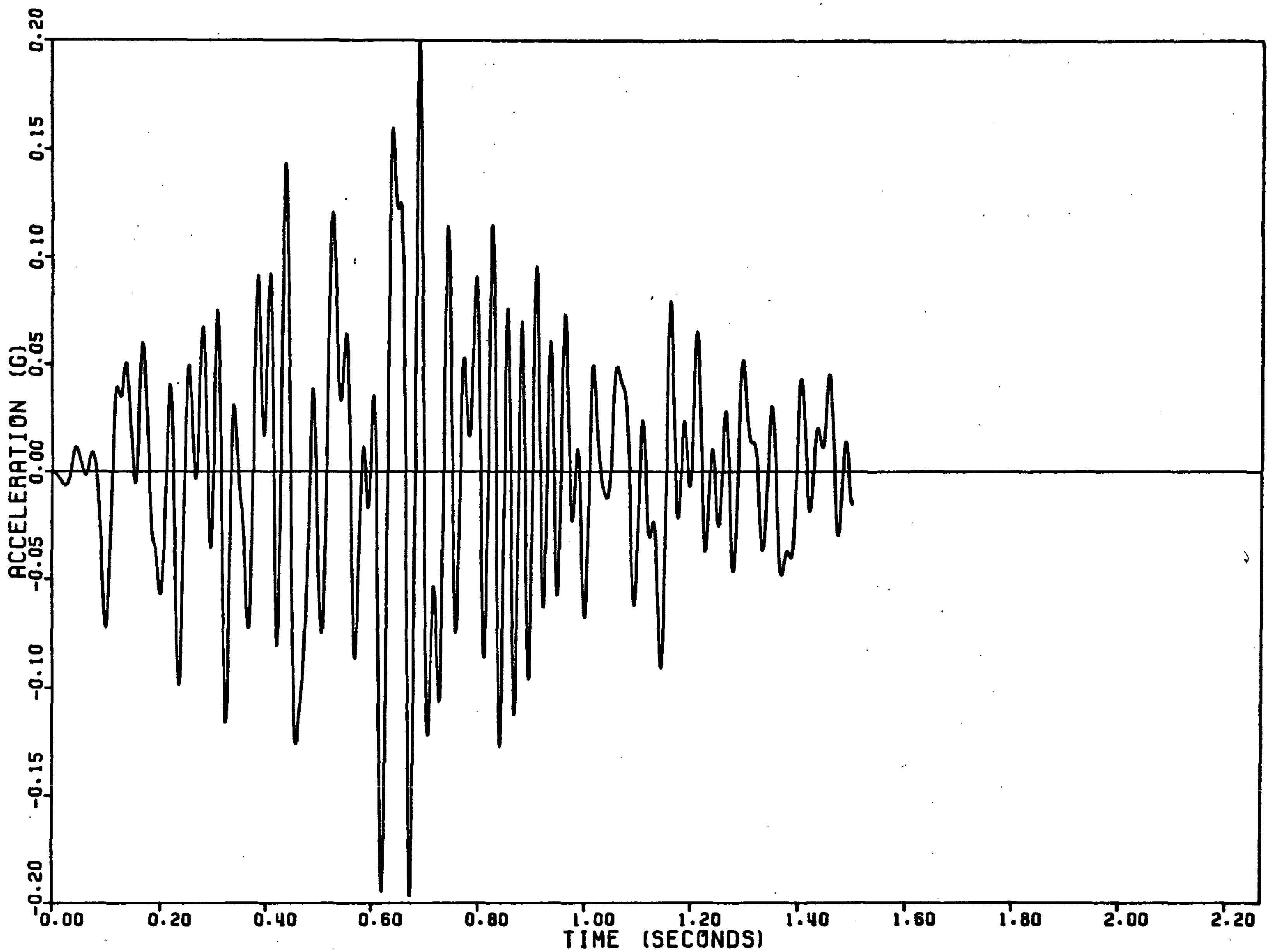


FIGURE C-96B. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-6
SRV-ALL LOADING- RECORD 353 - ACCELERATION (G), NPTS =1501, DT = .0010

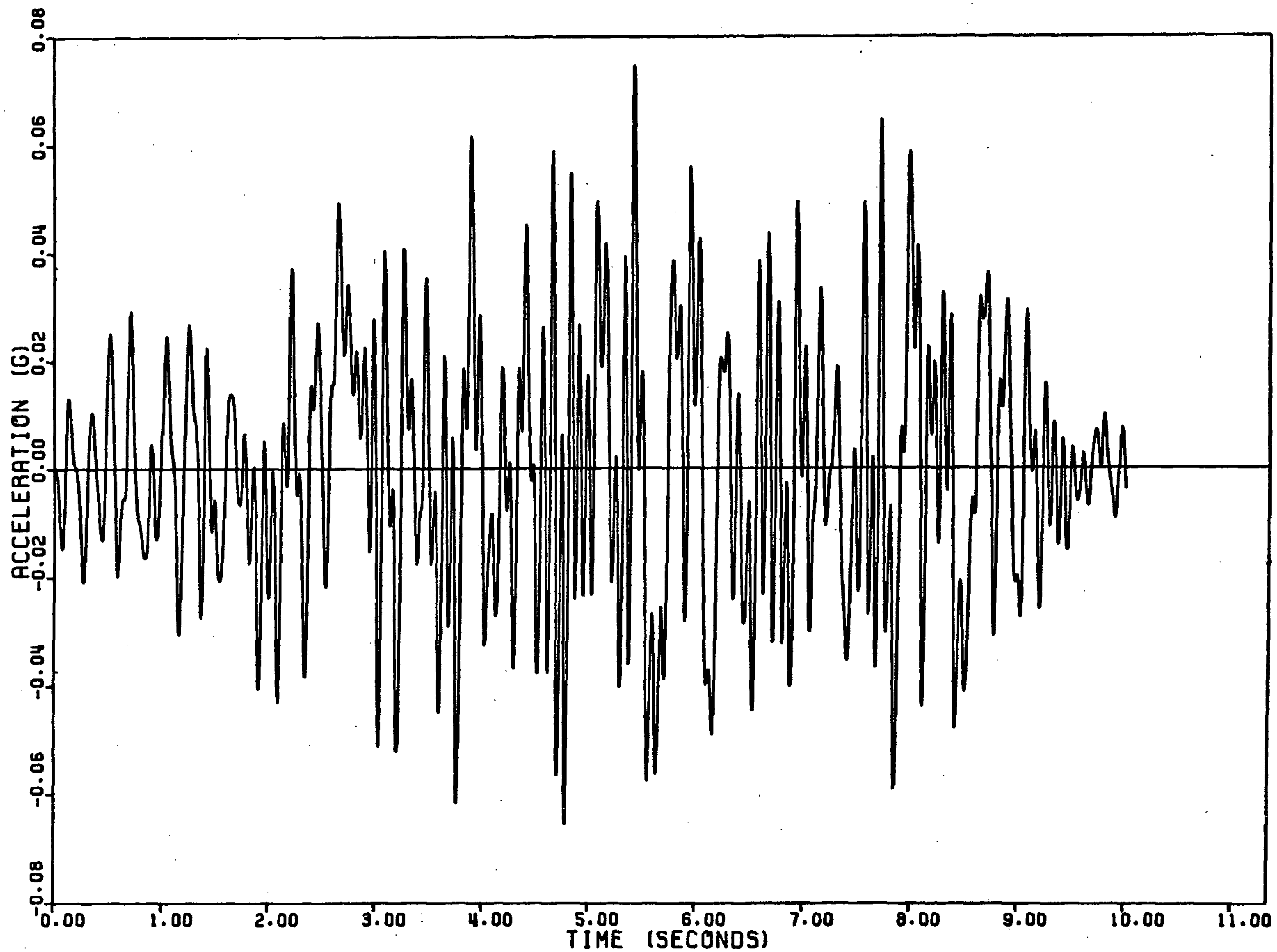


FIGURE C-97A. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-4
OBE LOADING - RECORD 301 - ACCELERATION (G), NPTS = 2001, DT = .005

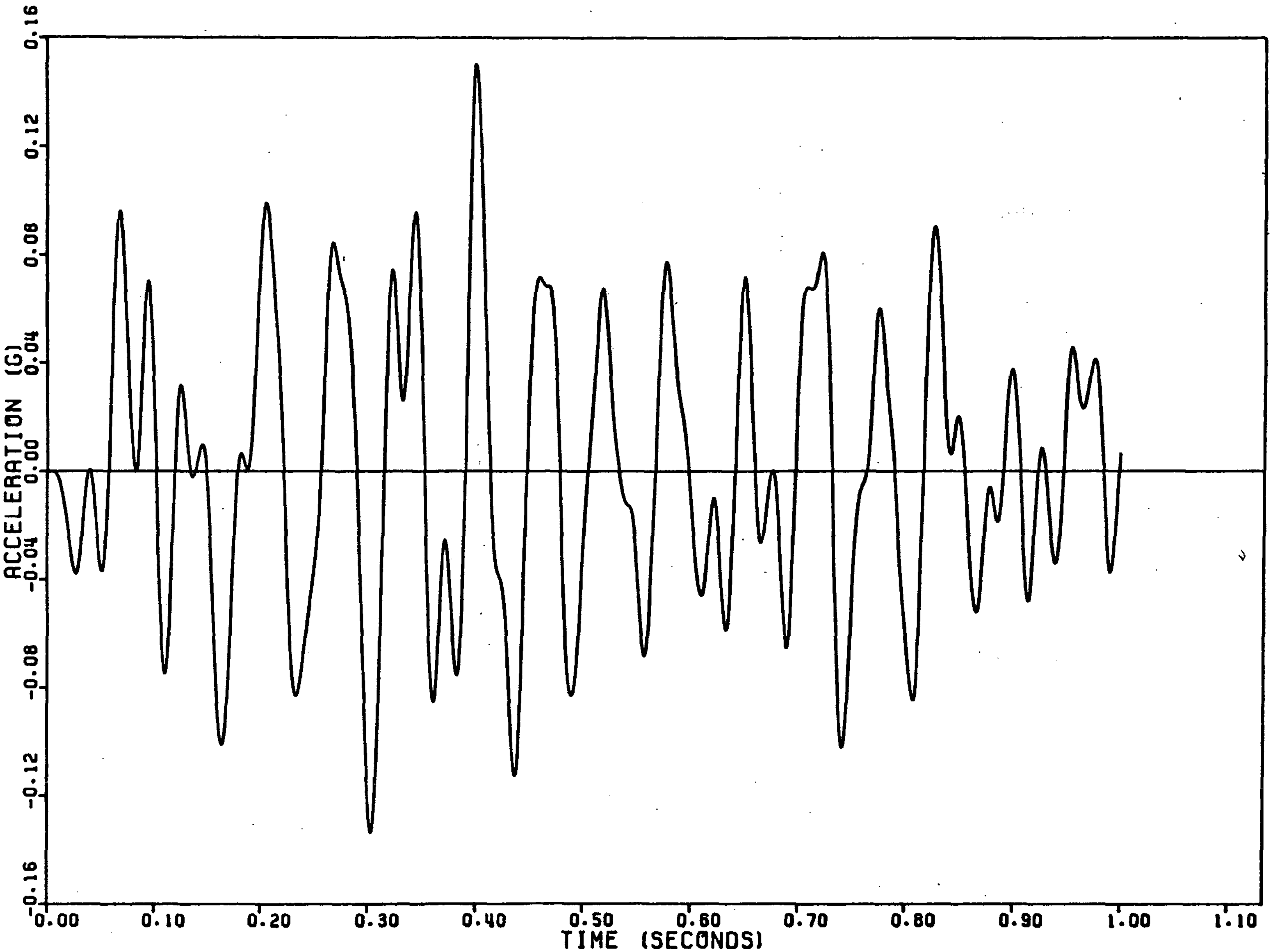


FIGURE C-97B. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-4
SRV-ADS LOADING- RECORD 331 - ACCELERATION (G), NPTS =1000, DT = .0010

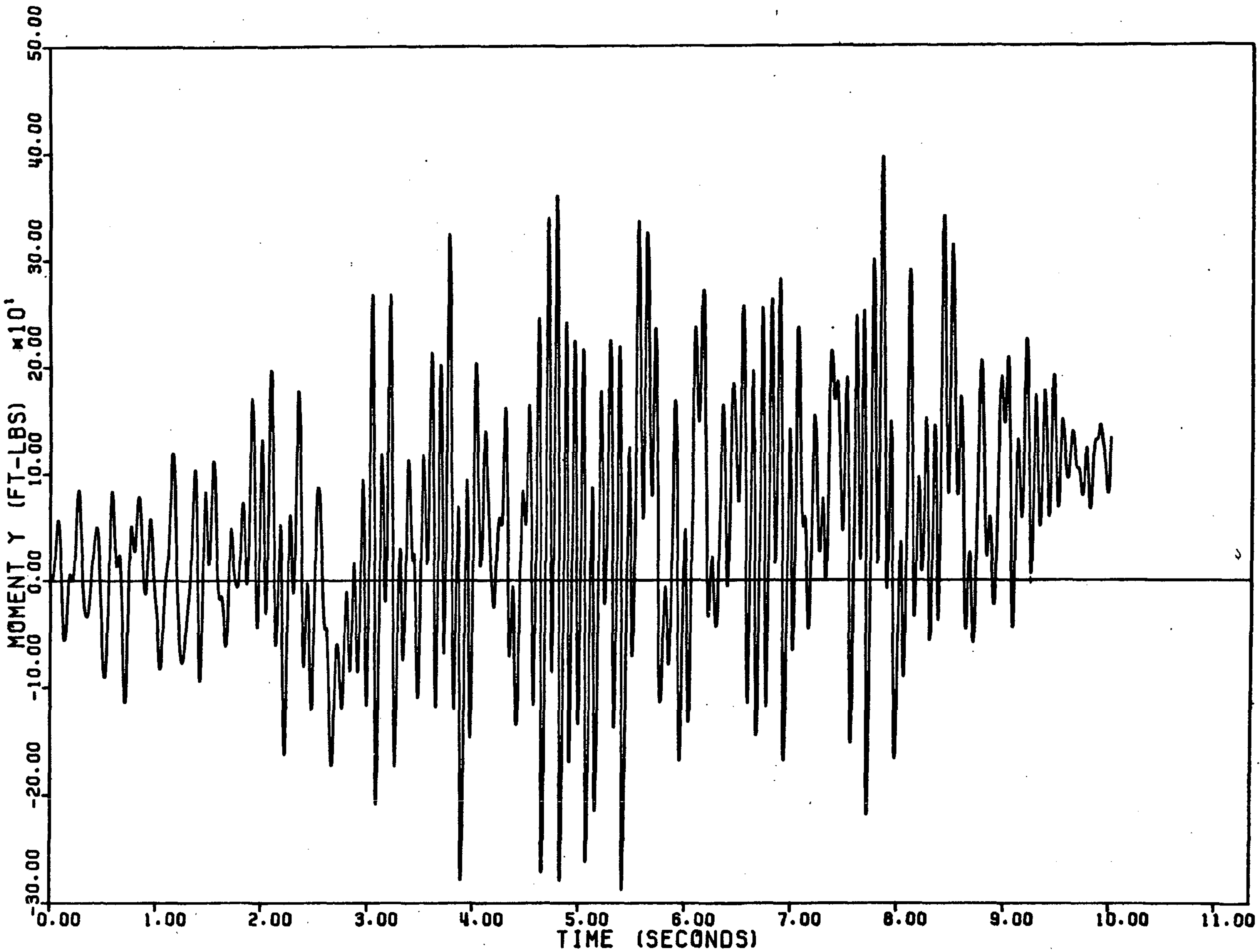


FIGURE C-98A. BOP PIPING TIME HISTORIES. HPCS PUMP DISCHARGE LINE LOCATION 3-7
OBE LOADING - RECORD 304 - MOMENT (FT-LBS) . NPTS = 2001. DT = .005

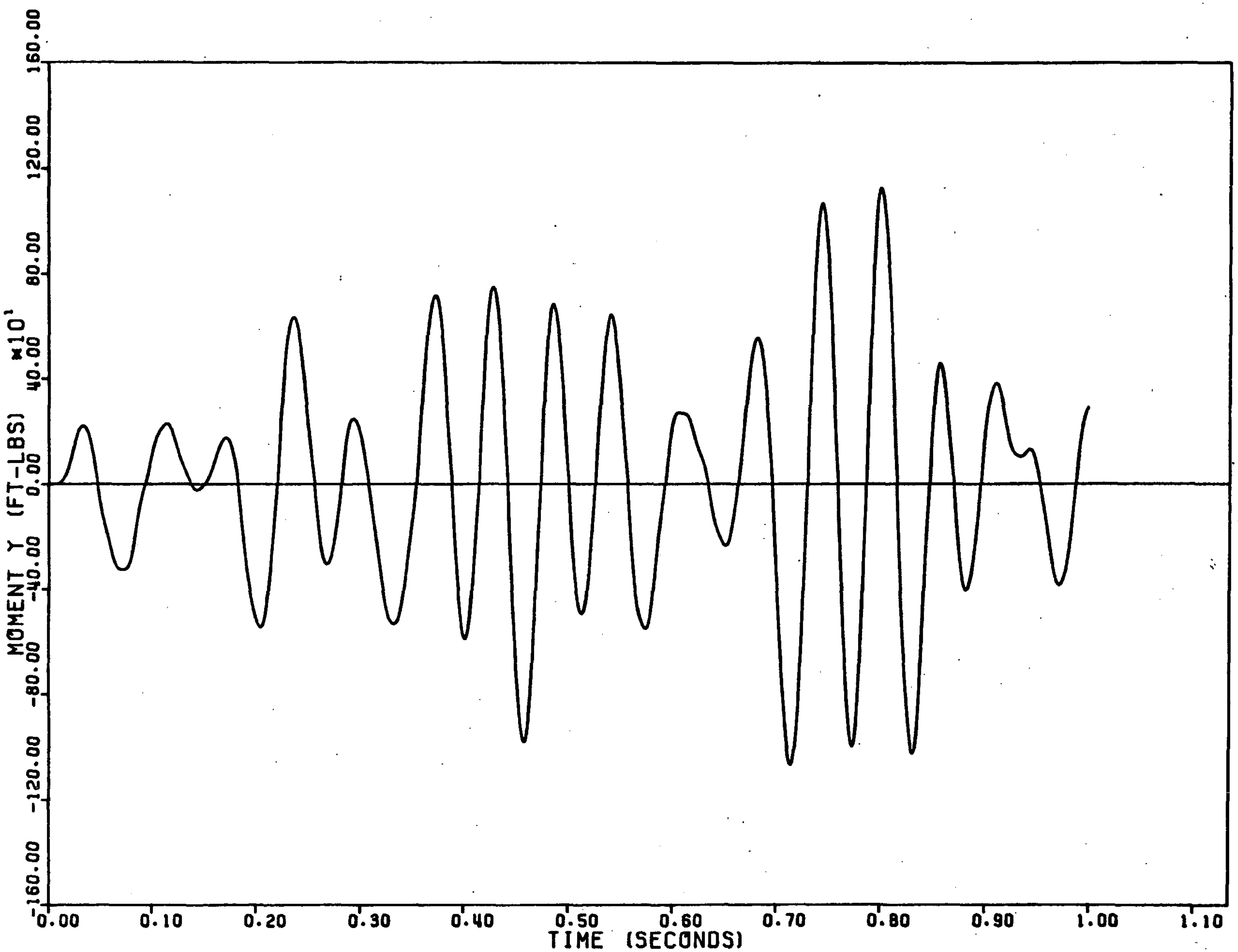


FIGURE C-98B. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-7
SRV-ADS LOADING- RECORD 334 - MOMENT (FT-LBS) , NPTS =1000, DT = .0010

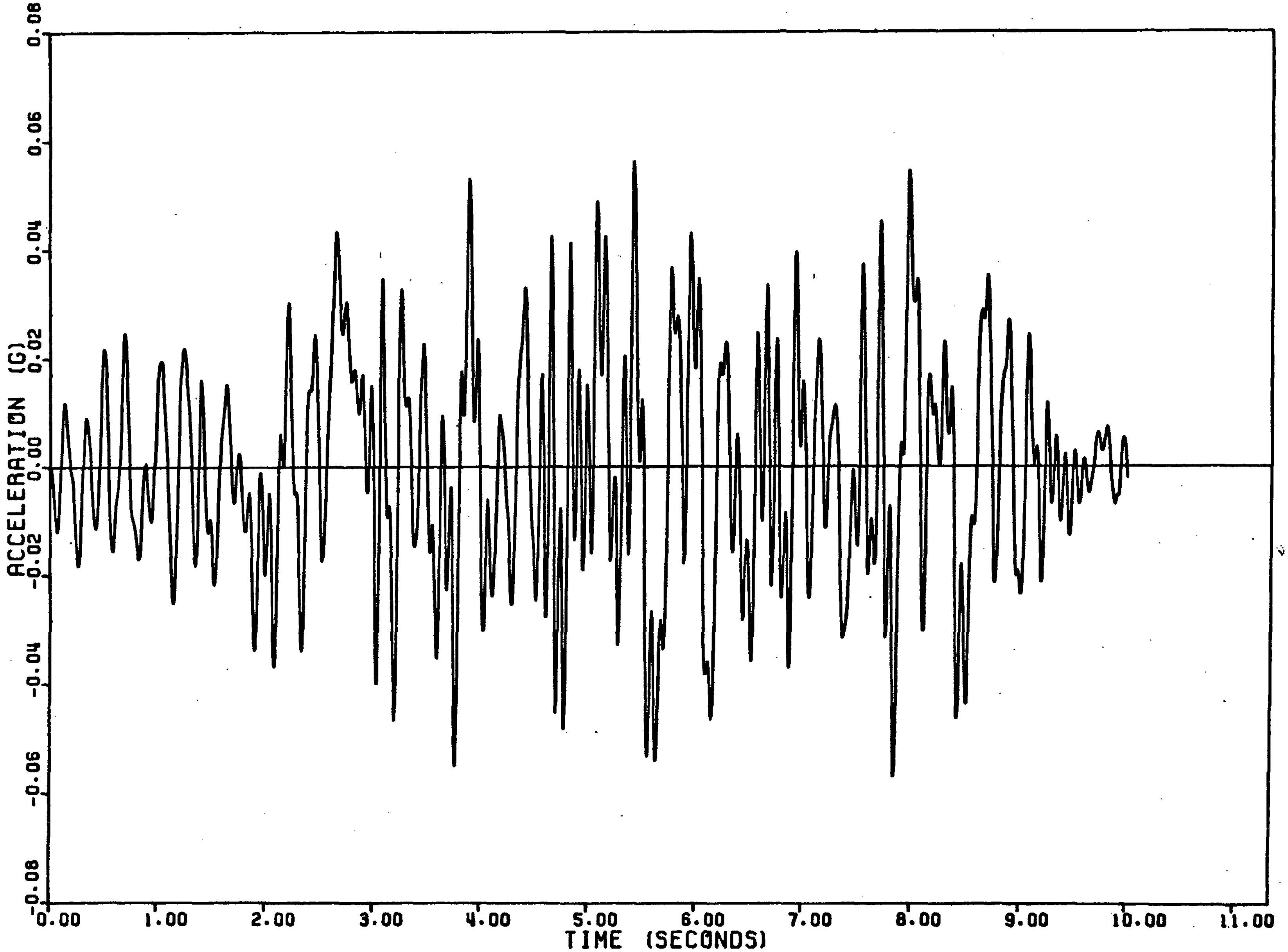


FIGURE C-99A. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-6
OBE LOADING - RECORD 303 - ACCELERATION (G), NPTS = 2001, DT = .005

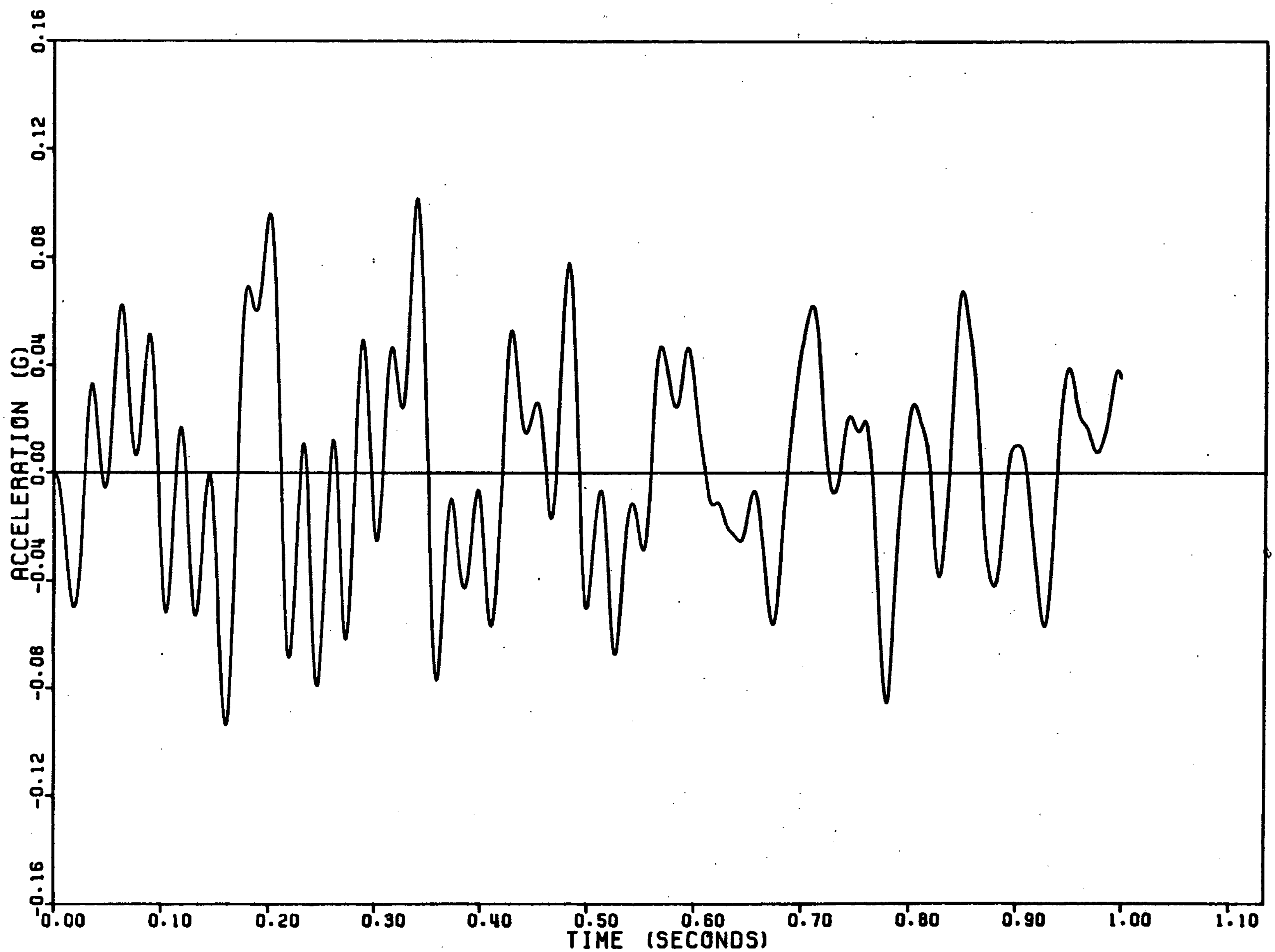


FIGURE C-99B. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-6
SRV-ADS LOADING- RECORD 333 - ACCELERATION (G), NPTS =1000, DT = .0010

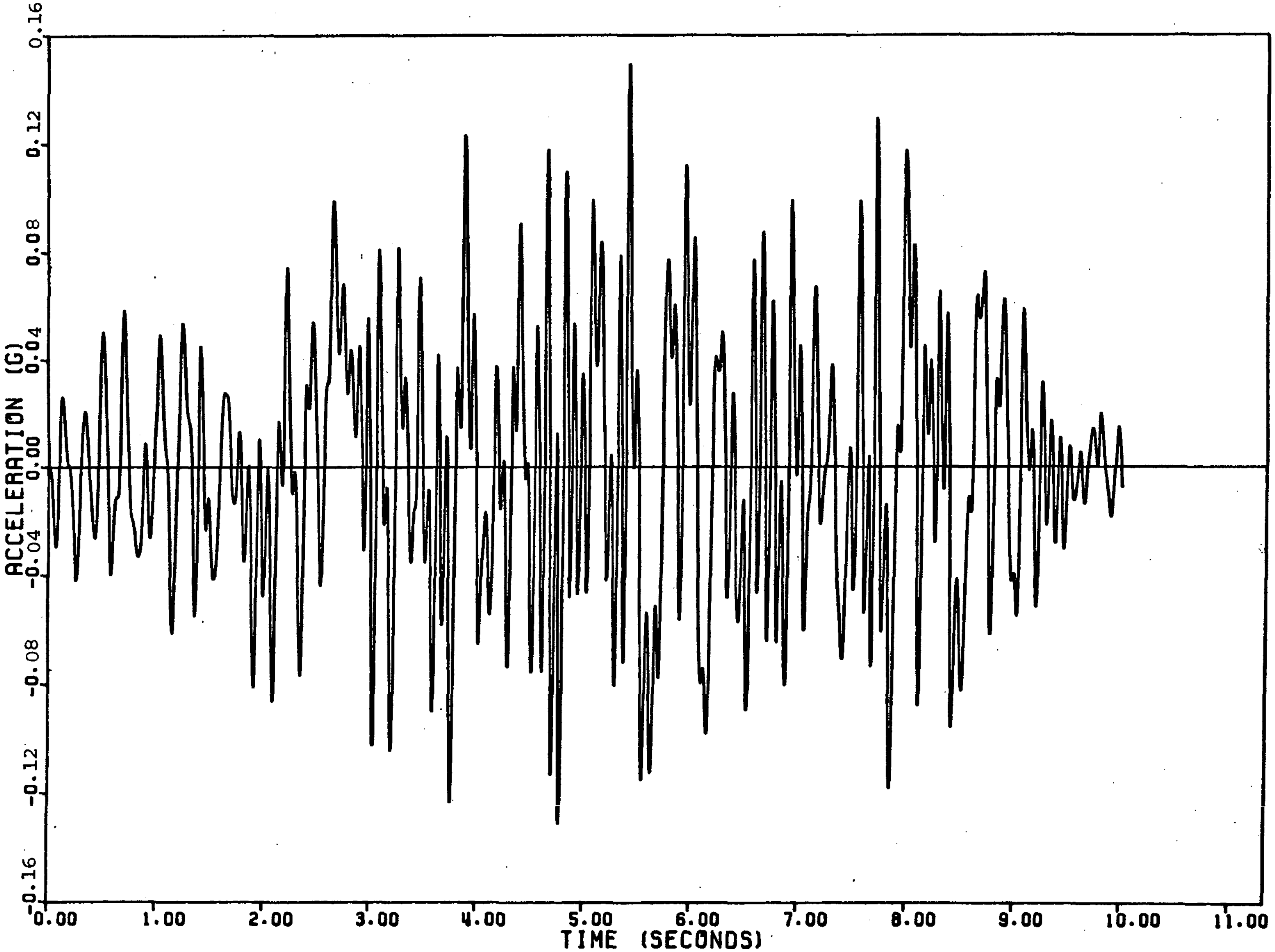


FIGURE C-100A. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-4
SSE LOADING - RECORD 301 - ACCELERATION (G), NPTS = 2001, DT = .005

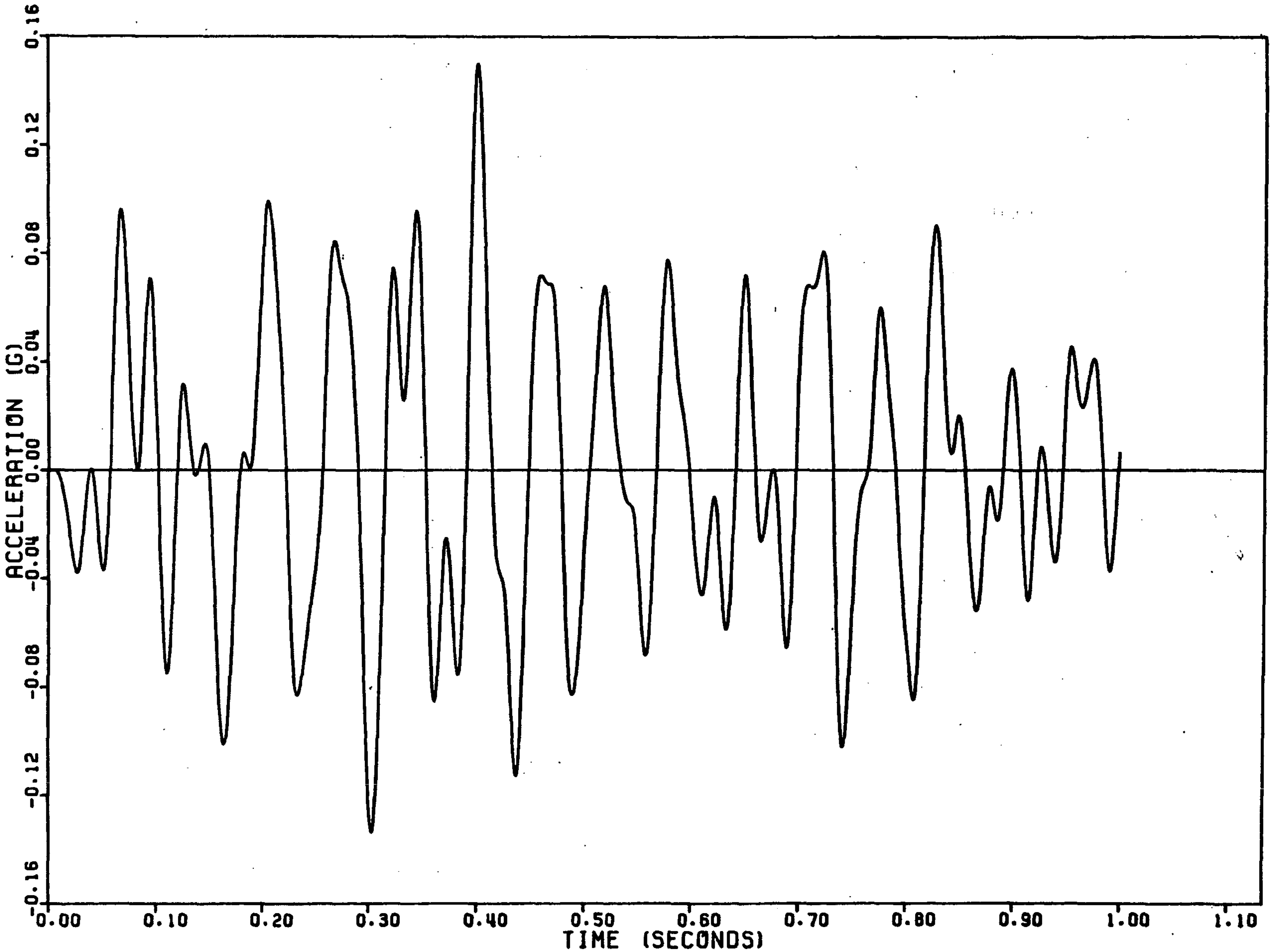


FIGURE C-100B. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-4
SRV-ADS LOADING- RECORD 331 - ACCELERATION (G), NPTS =1000, DT = .0010

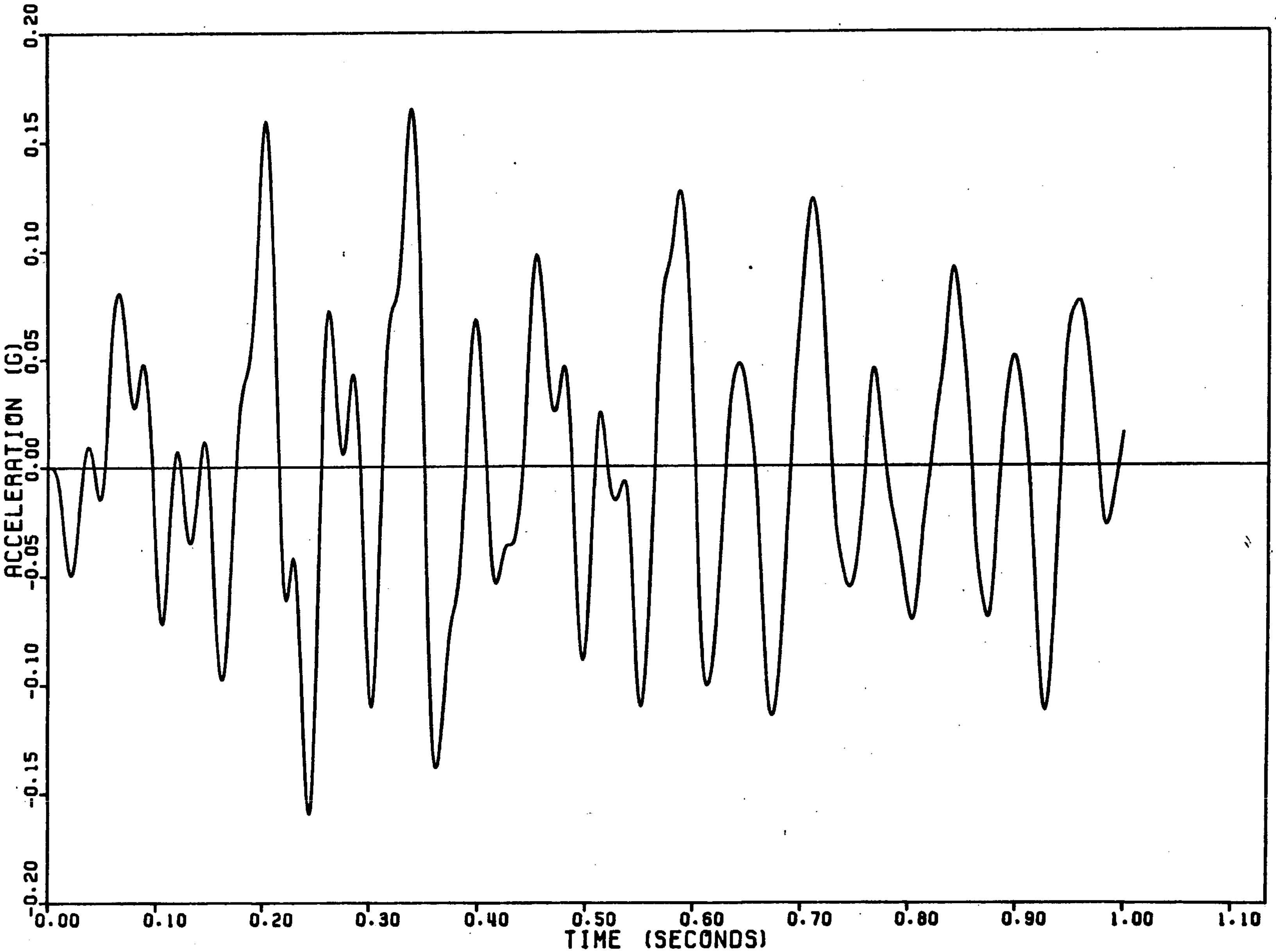


FIGURE C-101A. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-5
SRV-ADS LOADING- RECORD 332 - ACCELERATION (G), NPTS =1000, DT = .0010

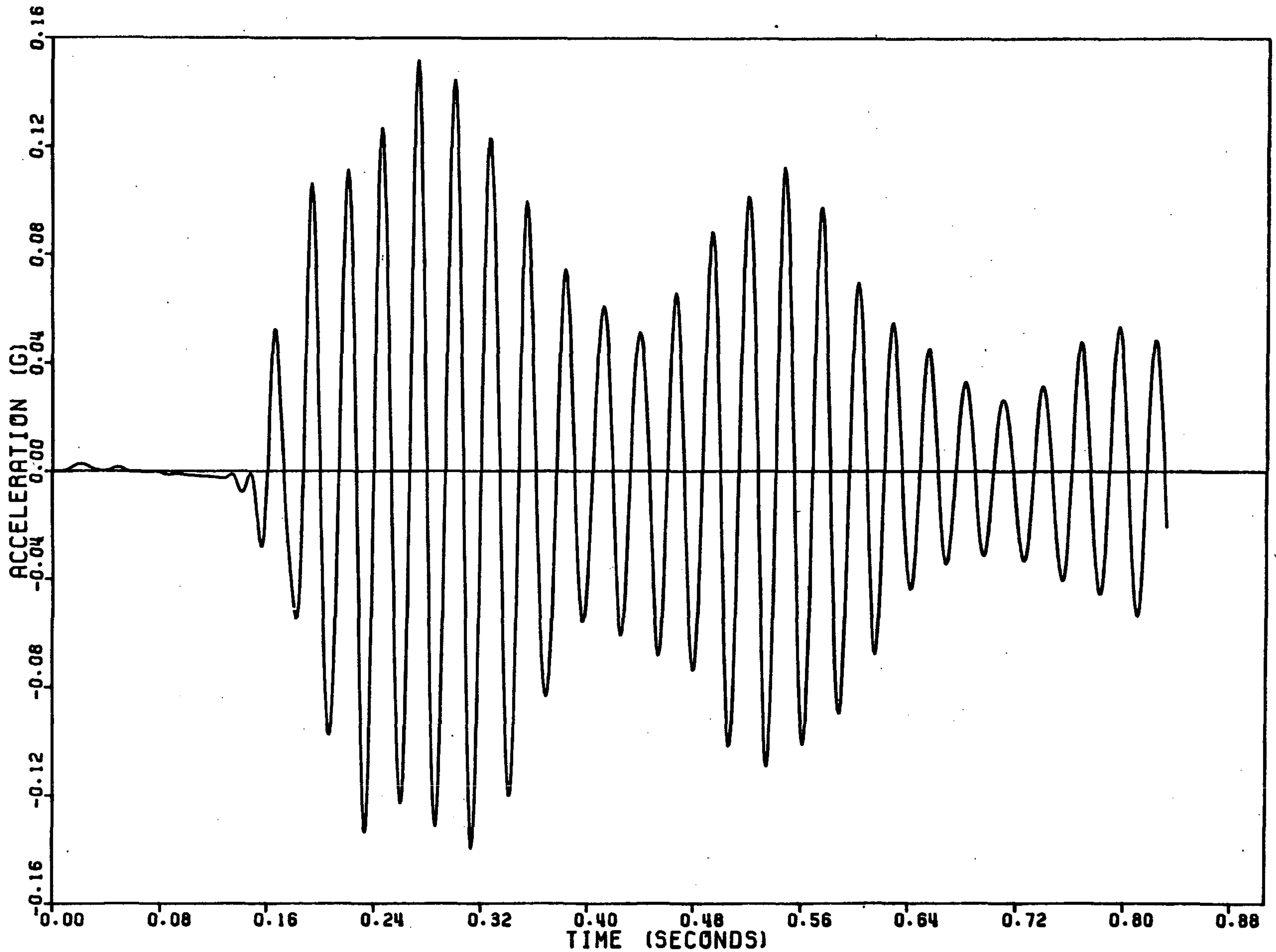


FIGURE C-101B. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-5
CHUG LOADING - RECORD 362 - ACCELERATION (G), NPTS = 833, DT = .001

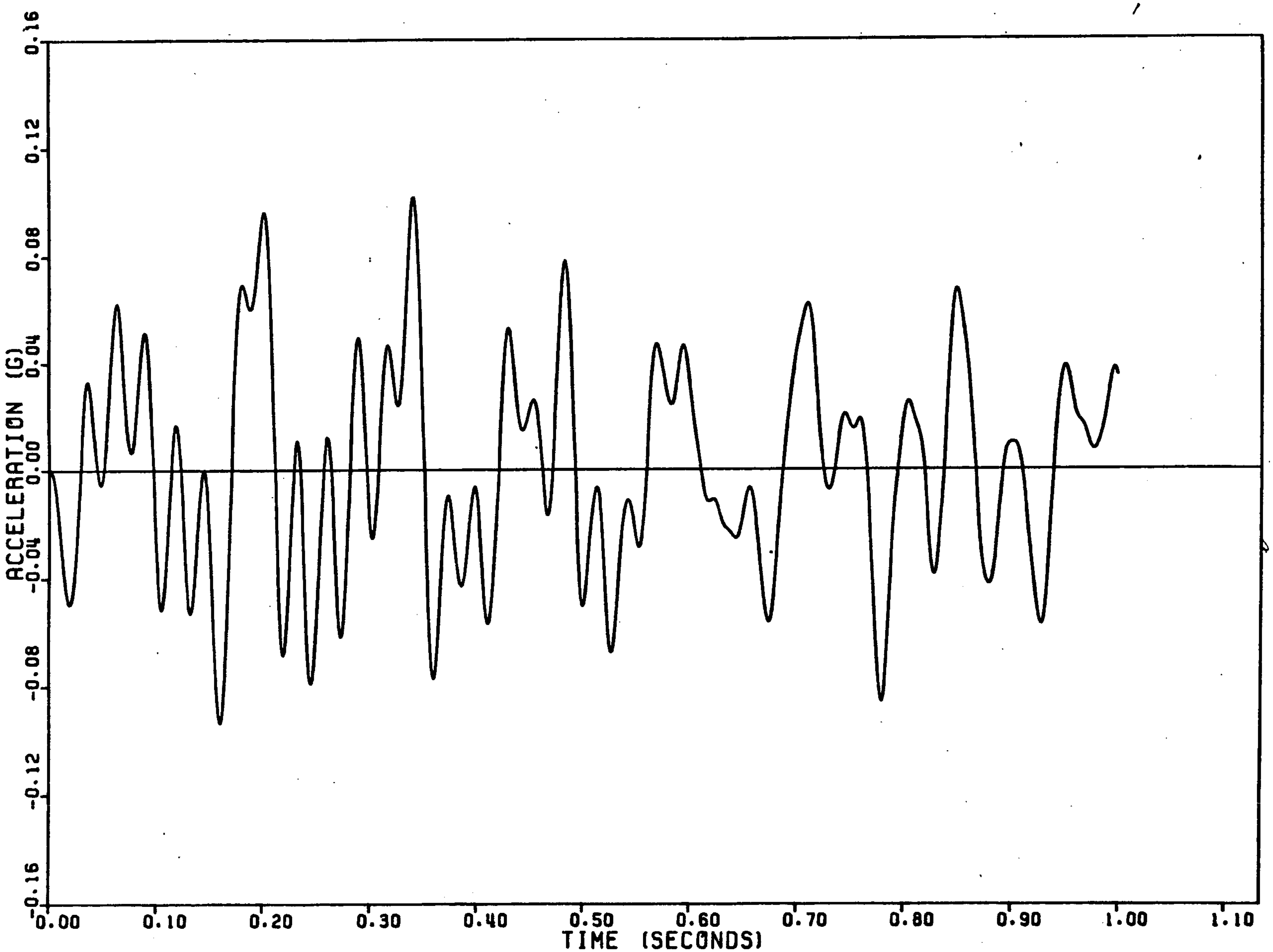


FIGURE C-102A. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-6
SRV-ADS LOADING- RECORD 333 - ACCELERATION (G), NPTS =1000, DT = .0010

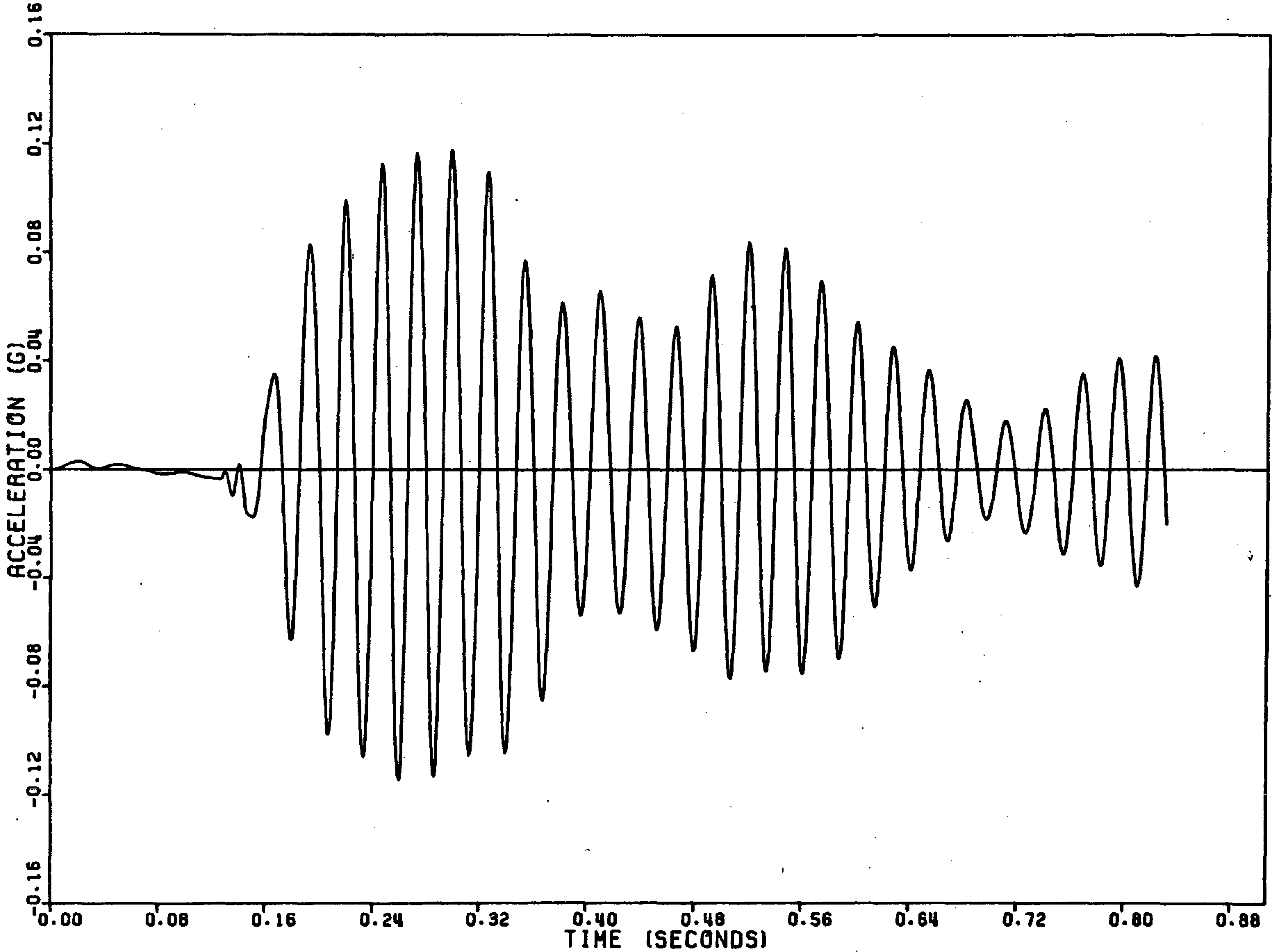


FIGURE C-102B. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-6
CHUG LOADING - RECORD 363 - ACCELERATION (G), NPTS = 833, DT = .001

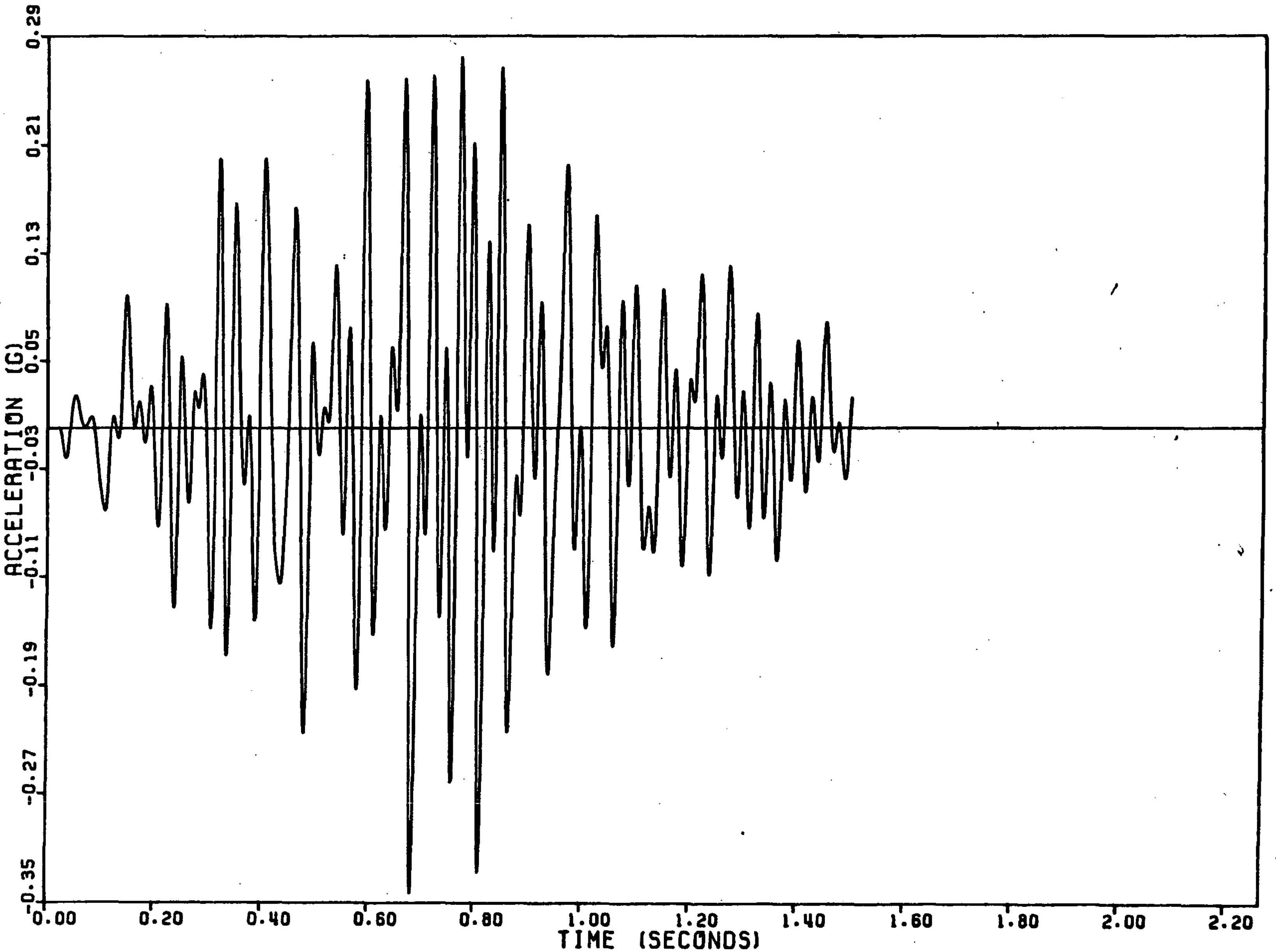


FIGURE C-103A. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-4
SRV-ALL LOADING- RECORD 351 - ACCELERATION (G), NPTS =1501, DT = .0010

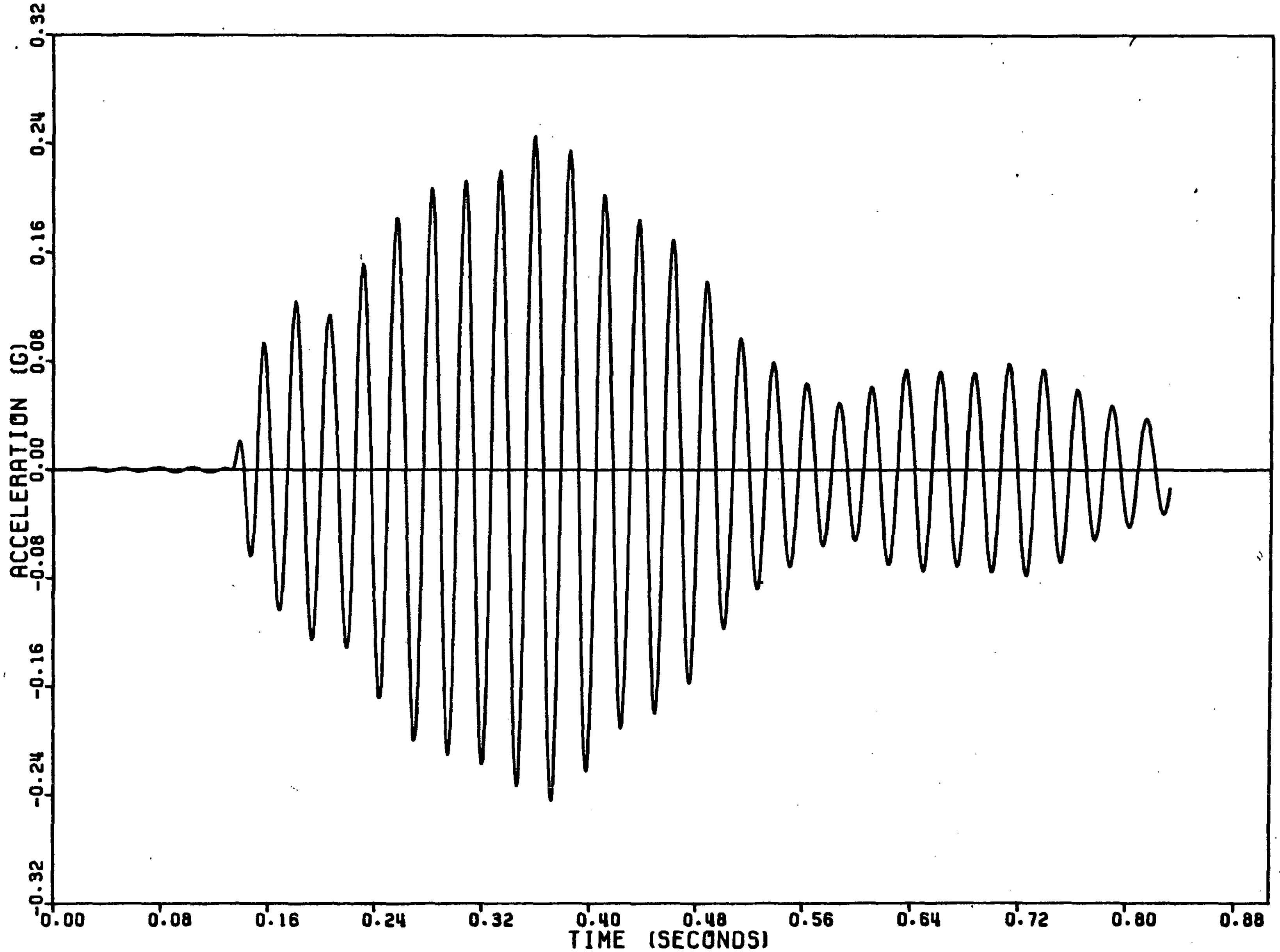


FIGURE C-103B. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-4
CHUG LOADING - RECORD 361 - ACCELERATION (G), NPTS = 833, DT = .001

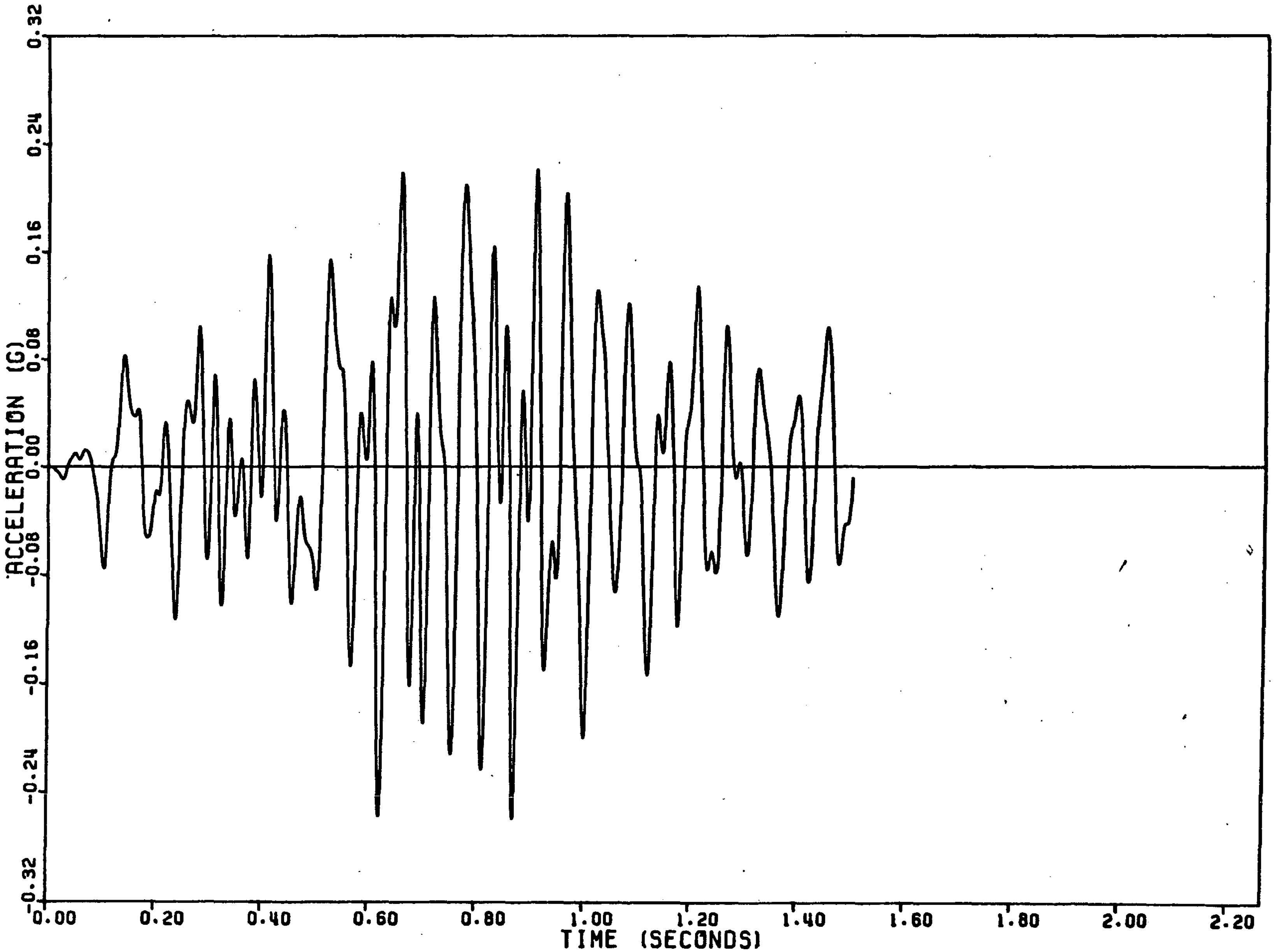


FIGURE C-104A. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-5
SRV-ALL LOADING- RECORD 352 - ACCELERATION (G), NPTS =1501, DT = .0010

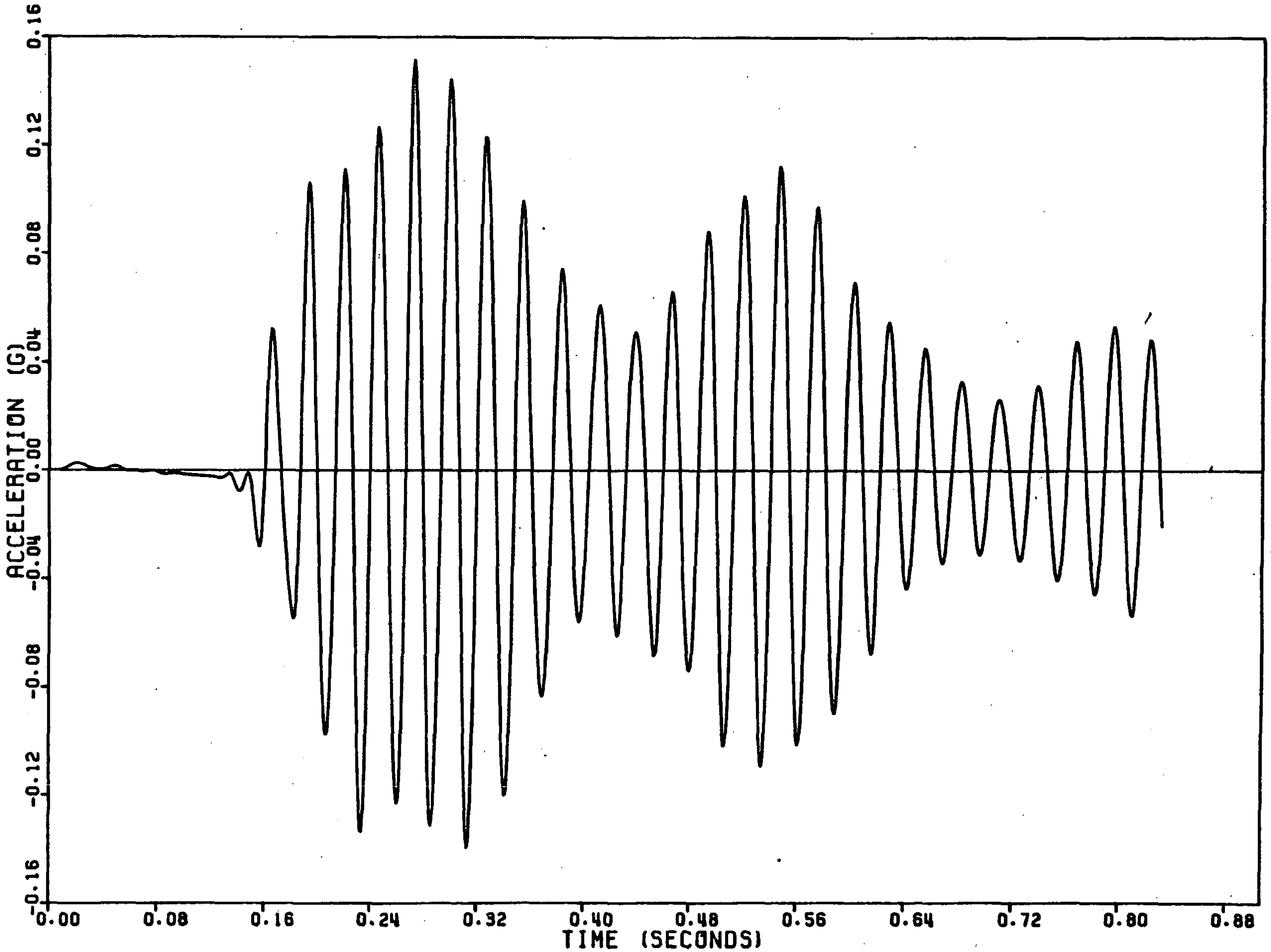


FIGURE C-104B. BOP PIPING TIME HISTORIES, HPCS PUMP DISCHARGE LINE LOCATION 3-5
CHUG LOADING - RECORD 362 - ACCELERATION (G), NPTS = 833, DT = .001

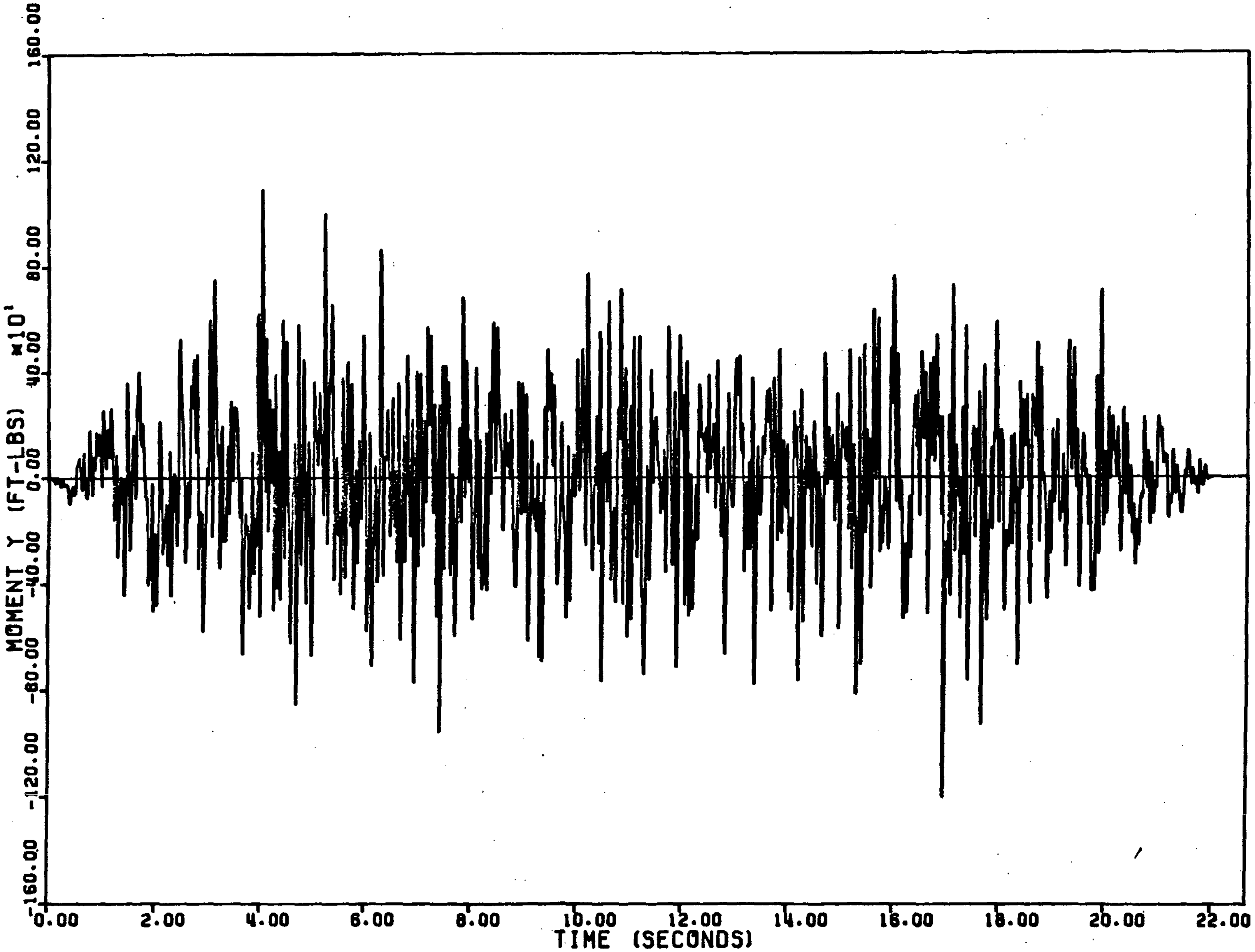


FIGURE C-105A. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-17
OBE LOADING -RECORD 4 - MOMENT Y (FT-LBS) , NPTS = 2200, DT = .0100

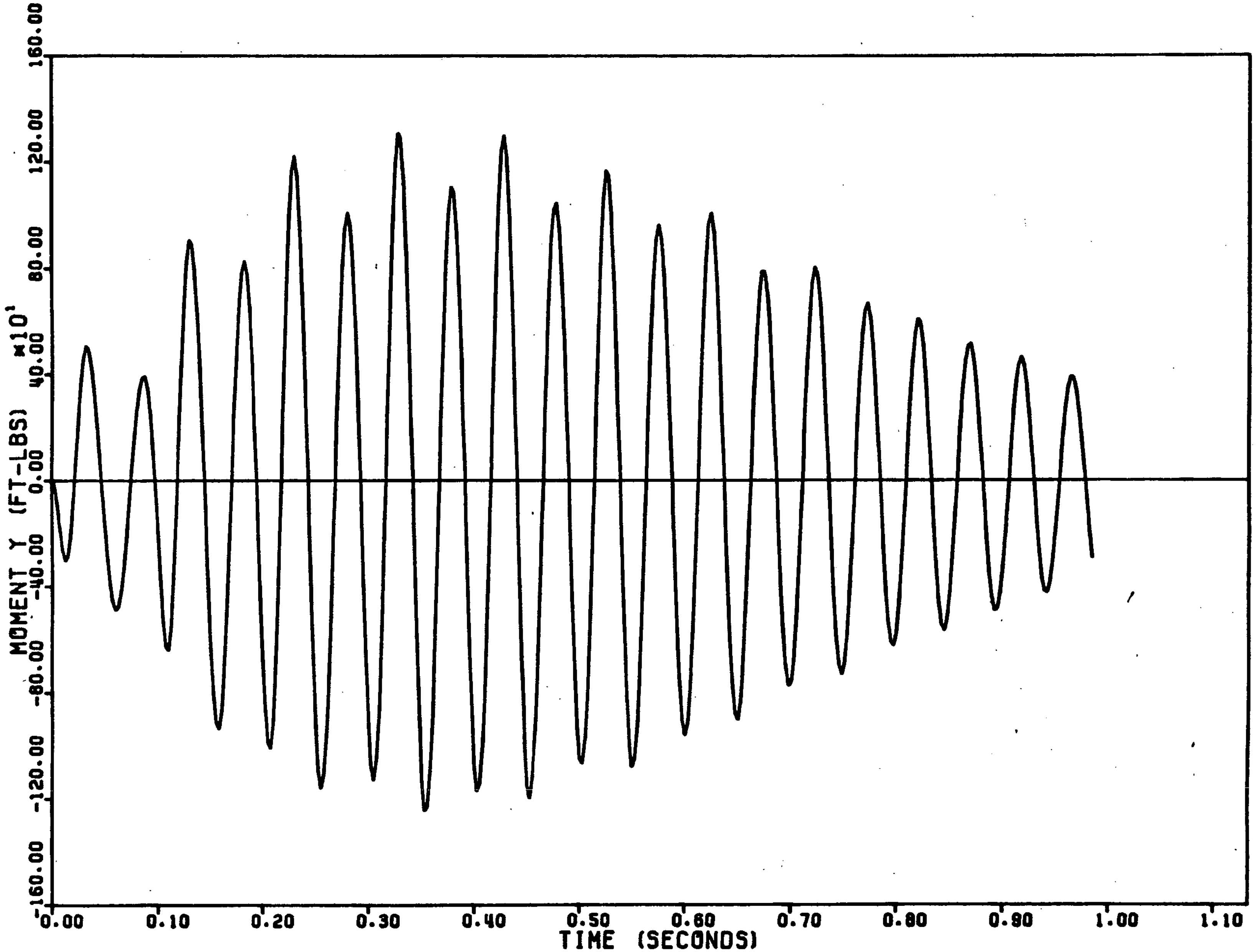


FIGURE C-105B. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-17
SRV-1 LOADING -RECORD 14 - MOMENT Y (FT-LBS) , NPTS = 395 ,DT = .0025

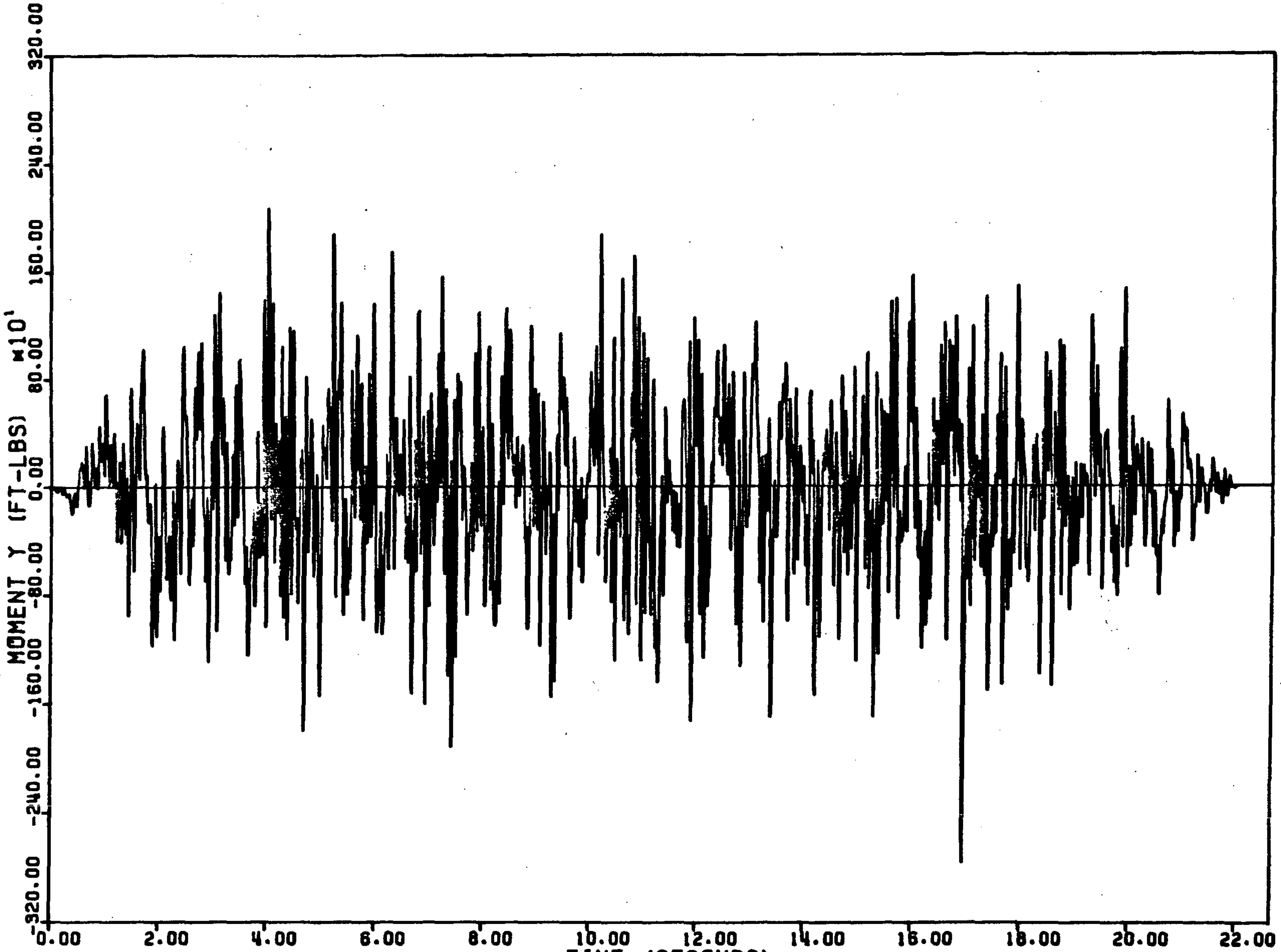


FIGURE C-106A. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-15
OBE LOADING -RECORD 108- MOMENT Y (FT-LBS) , NPTS = 2200.DT = .0100

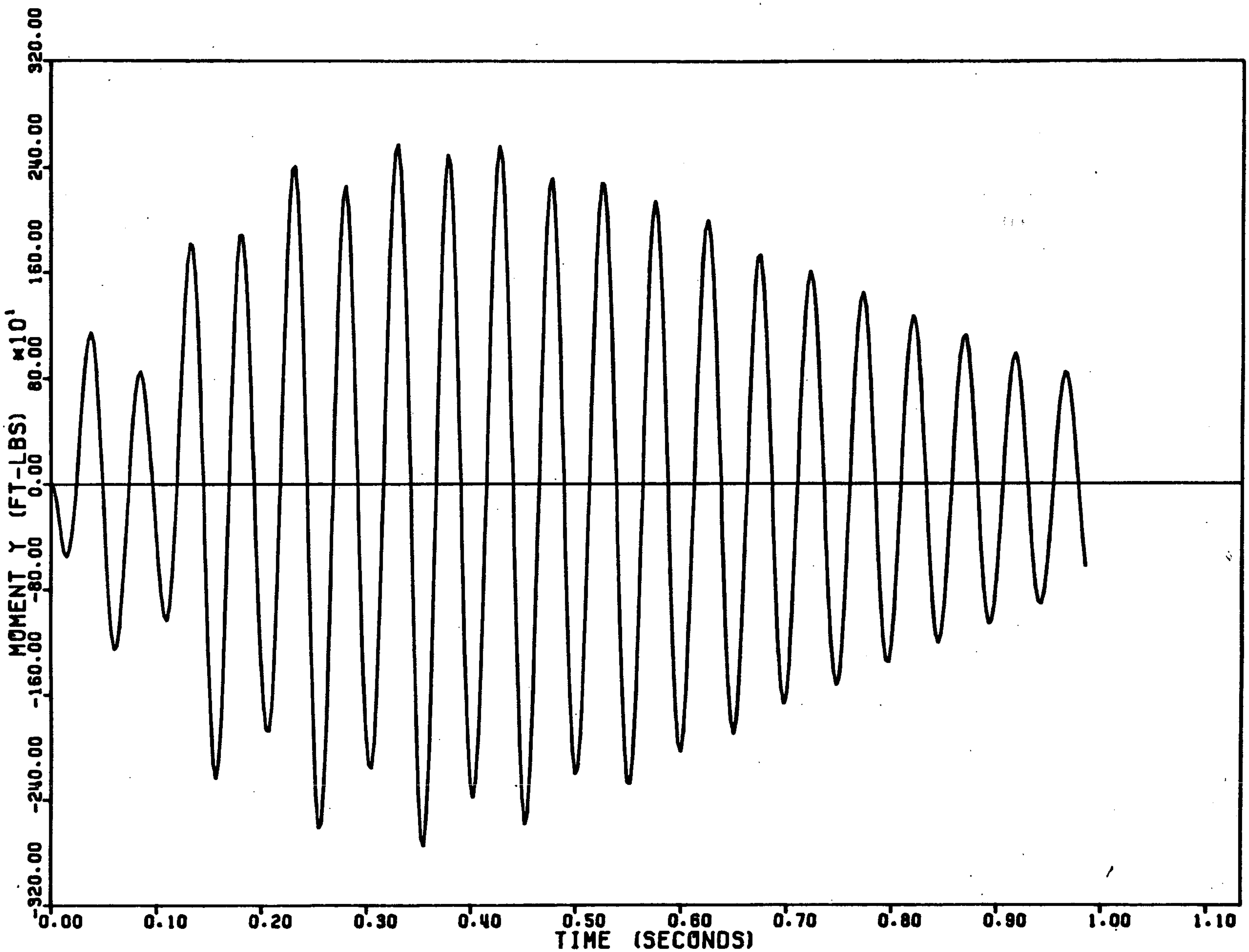


FIGURE C-106B. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-16
SRV-1 LOADING -RECORD 208- MOMENT Y (FT-LBS) , NPTS = 395 ,DT = .0025

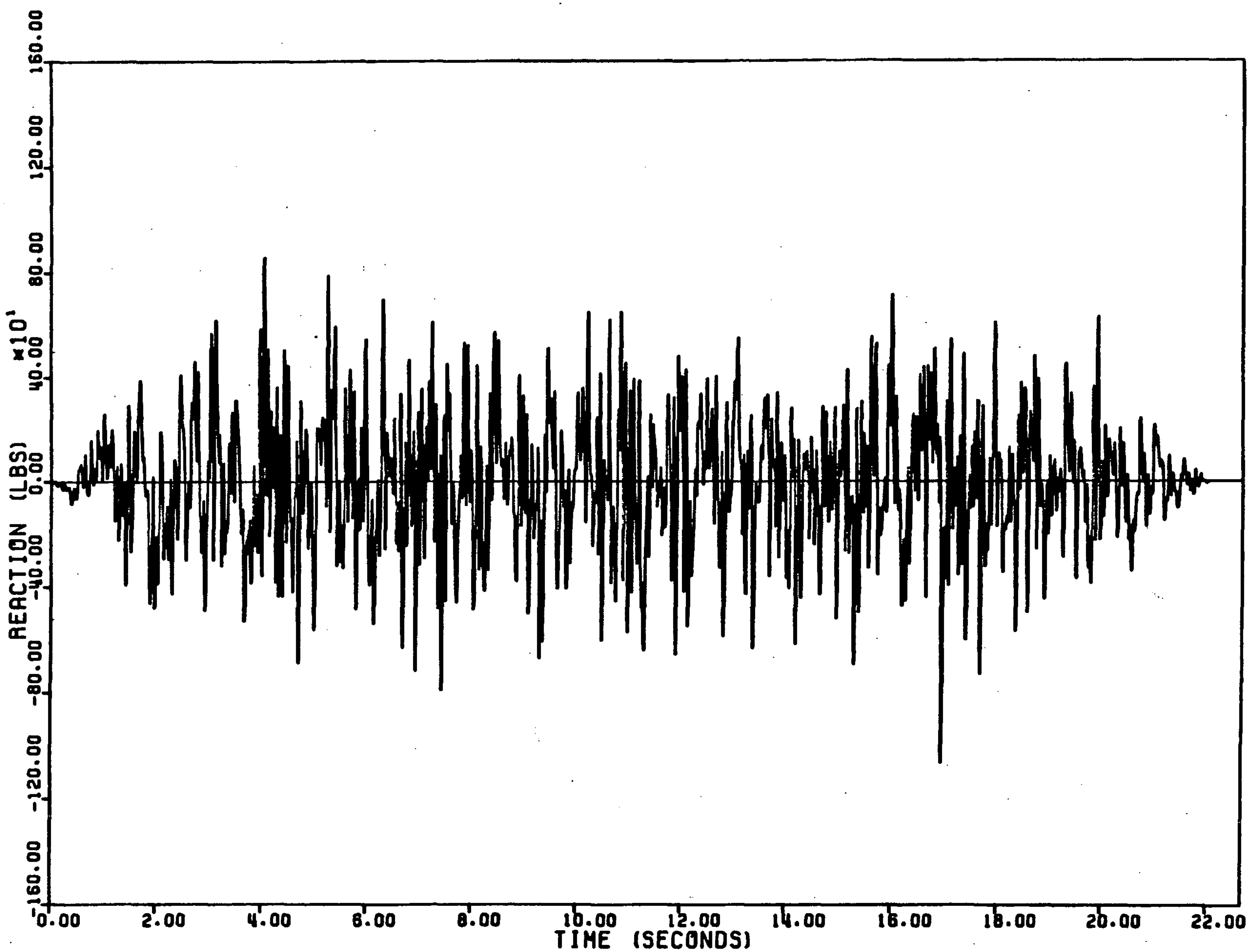


FIGURE C-107A. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-14
OBE LOADING -RECORD 5 - SUPPORT REACTION (LBS), NPTS = 2200,DT = .0100

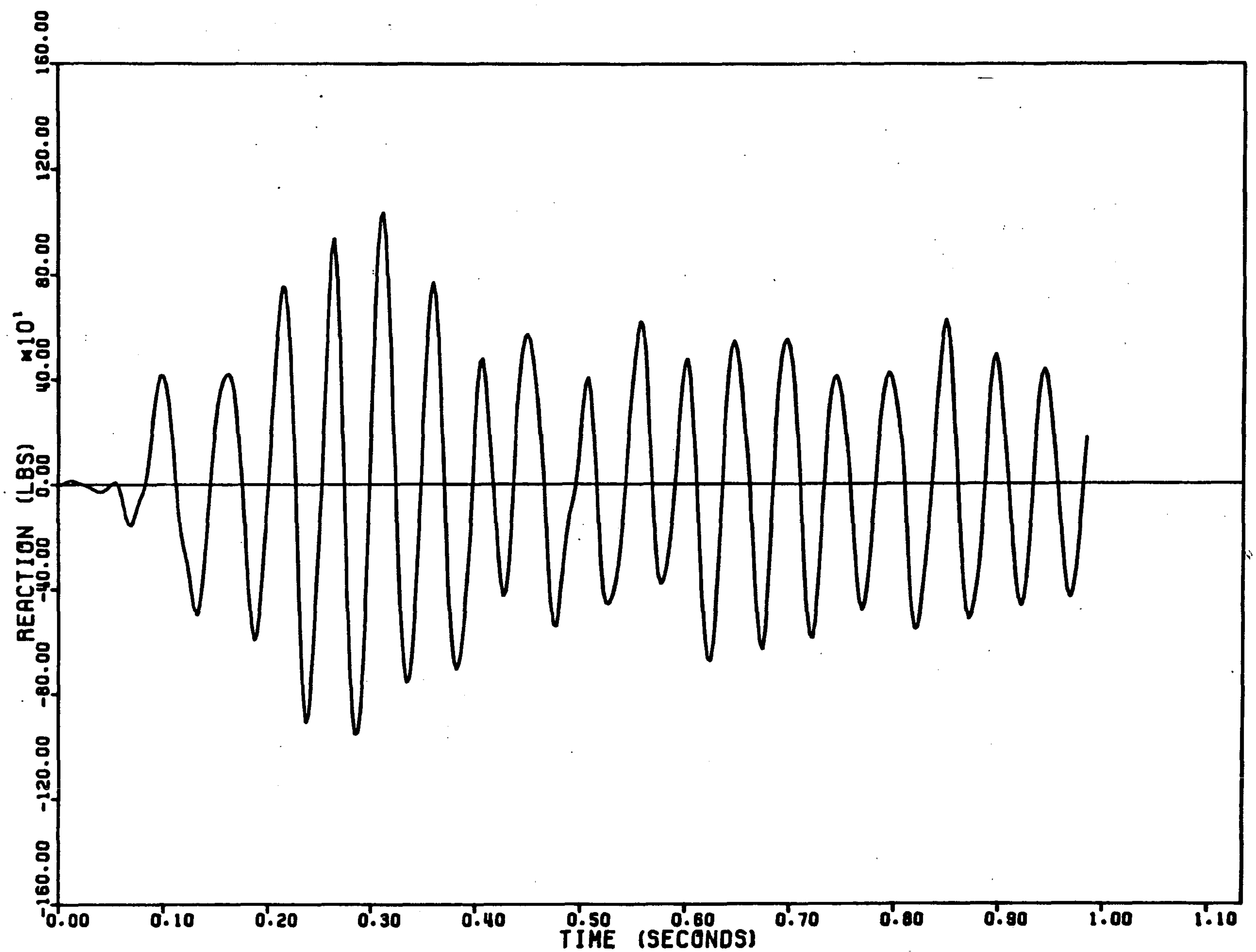


FIGURE C-107B. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-14
SRV-ALL LOADING -RECORD 25 - SUPPORT REACTION (LBS), NPTS = 395 ,DT = .0025

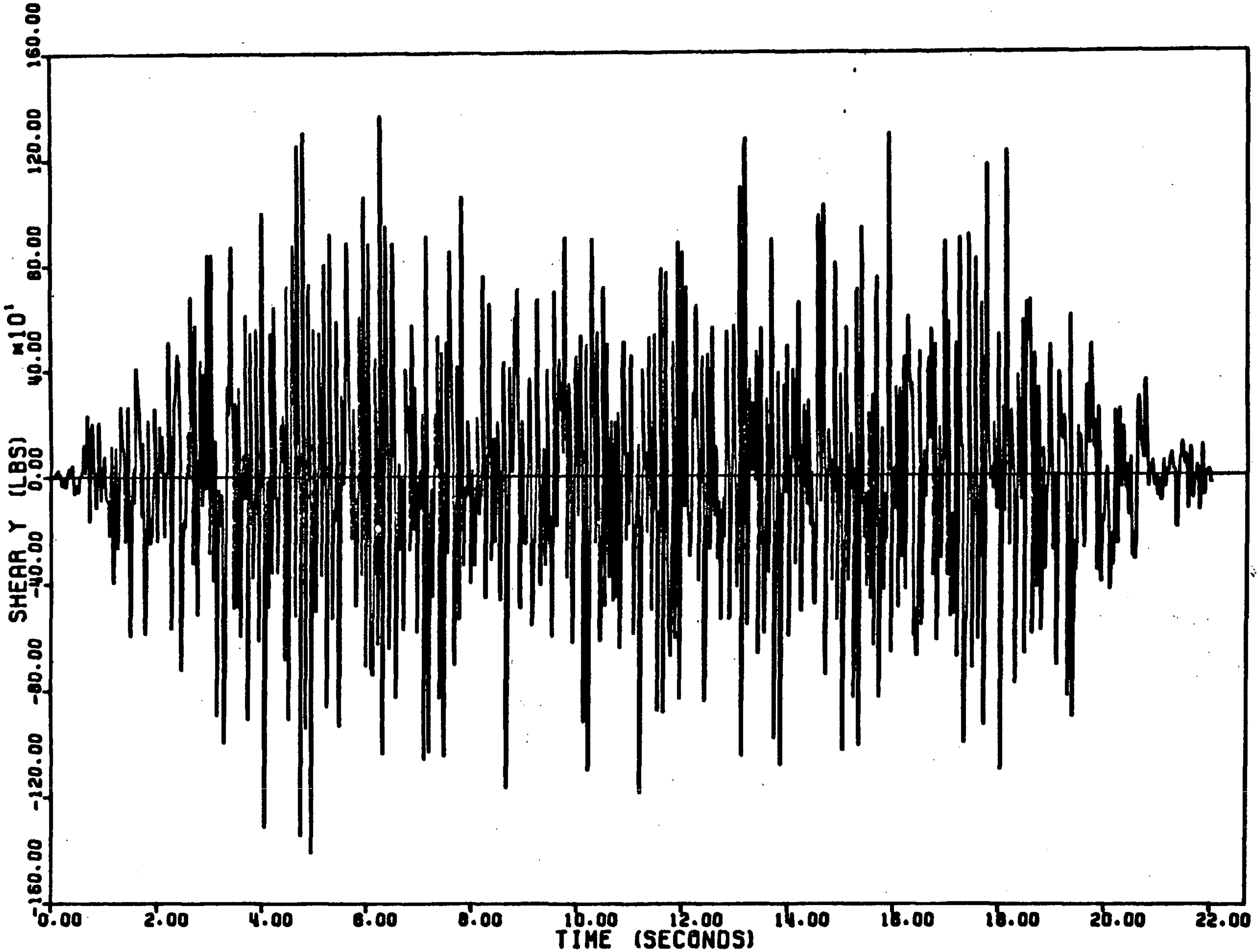


FIGURE C-108A. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-16
OBE LOADING -RECORD 108- SHEAR Y (LBS) , NPTS = 2200, DT = .0100

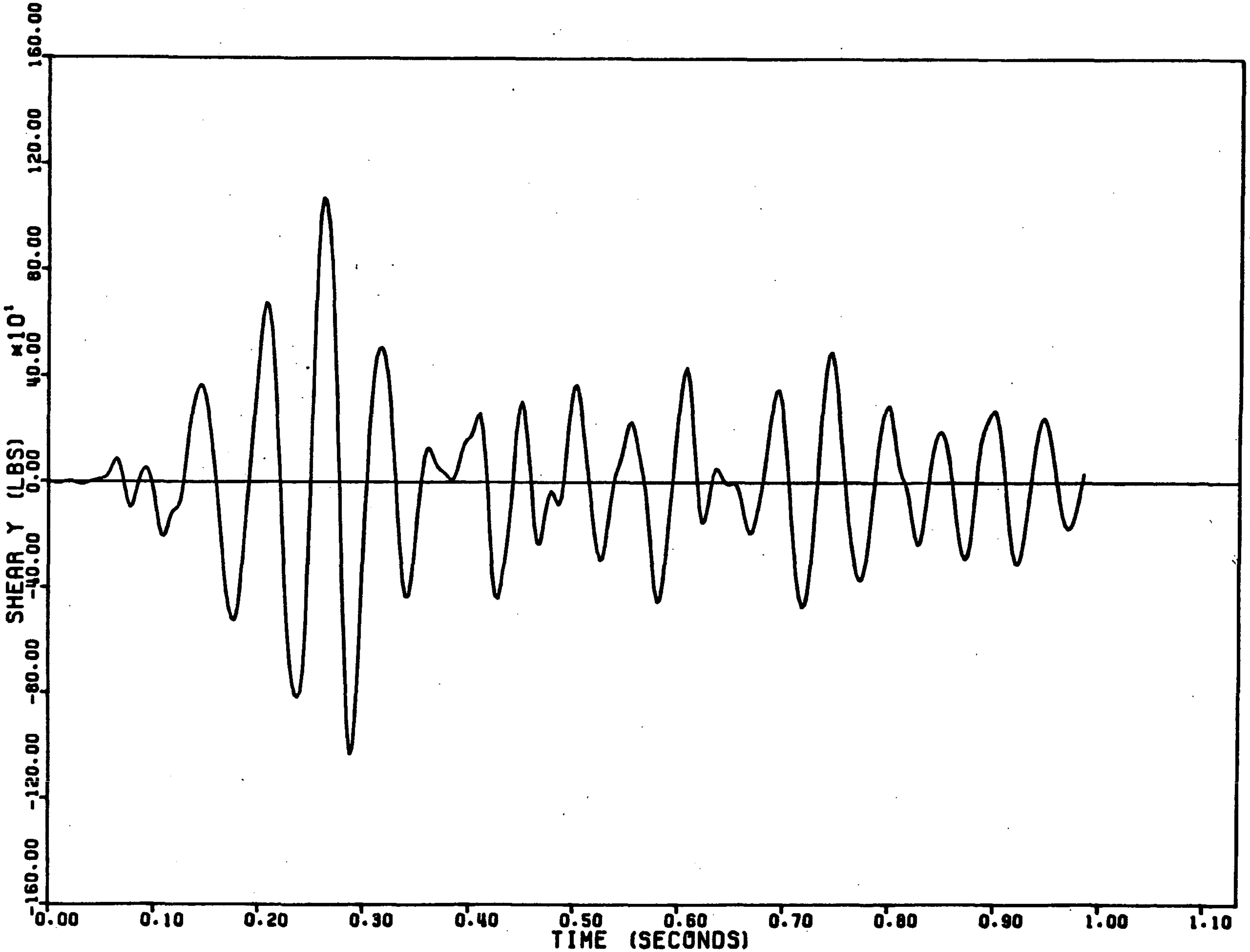


FIGURE C-108B. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-16
SRV-ALL LOADING -RECORD 308- SHEAR Y (LBS) , NPTS = 395 ,DT = .0025

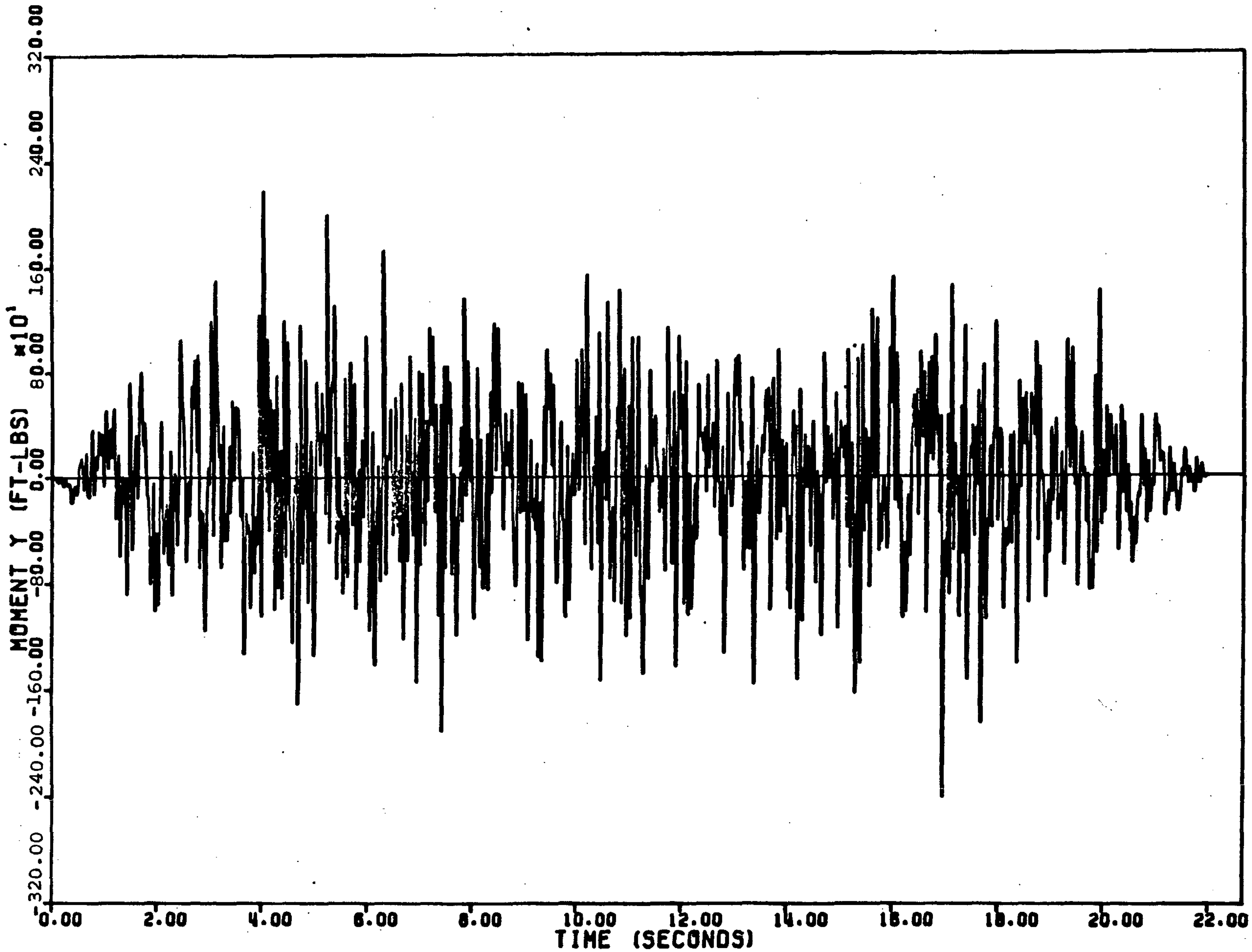


FIGURE C-109A. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-17
SSE LOADING -RECORD 4 - MOMENT Y (FT-LBS) , NPTS = 2200,DT = .0100

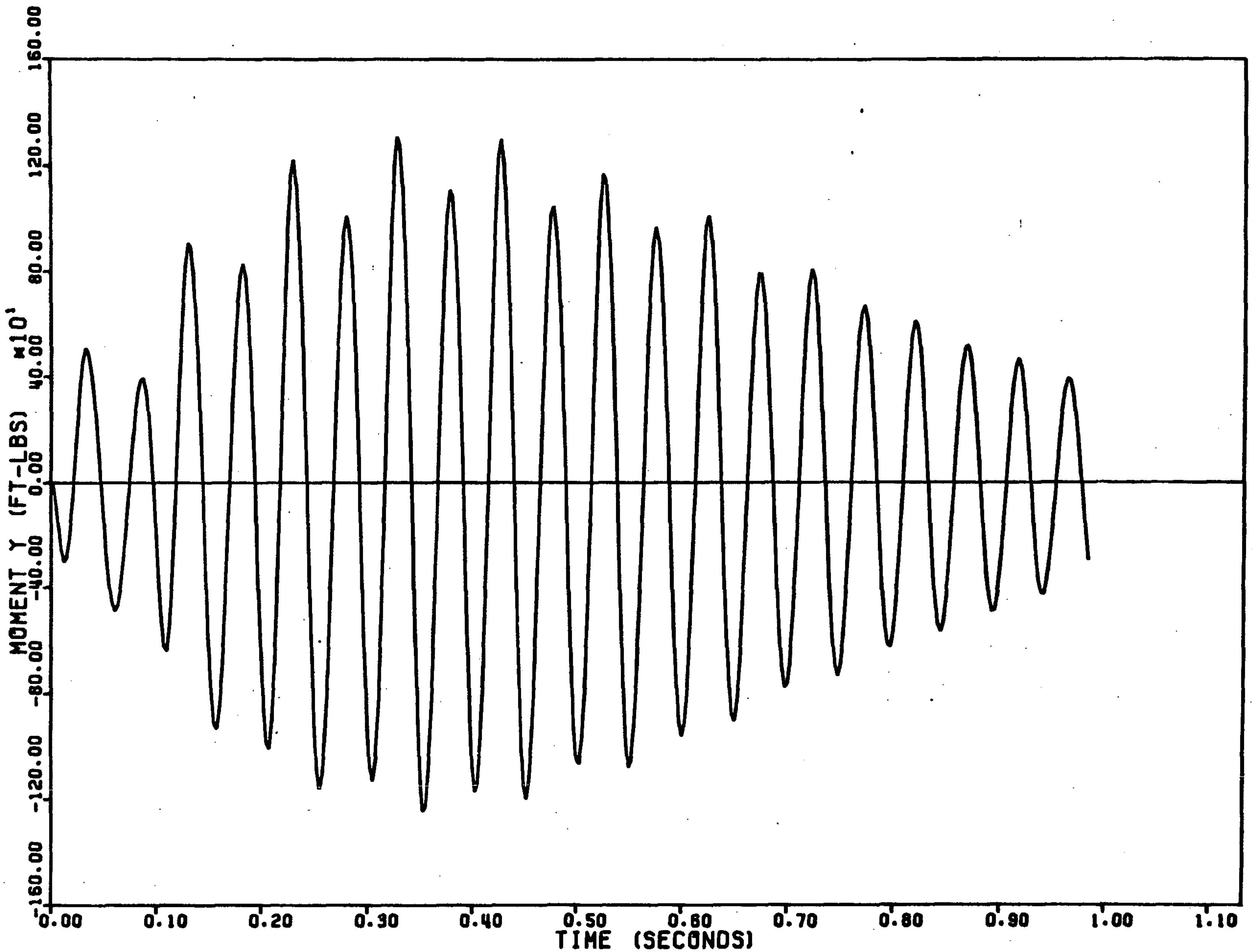


FIGURE C-109B. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-17
SRV-1 LOADING -RECORD 14 - MOMENT Y (FT-LBS) , NPTS = 395 ,DT = .0025

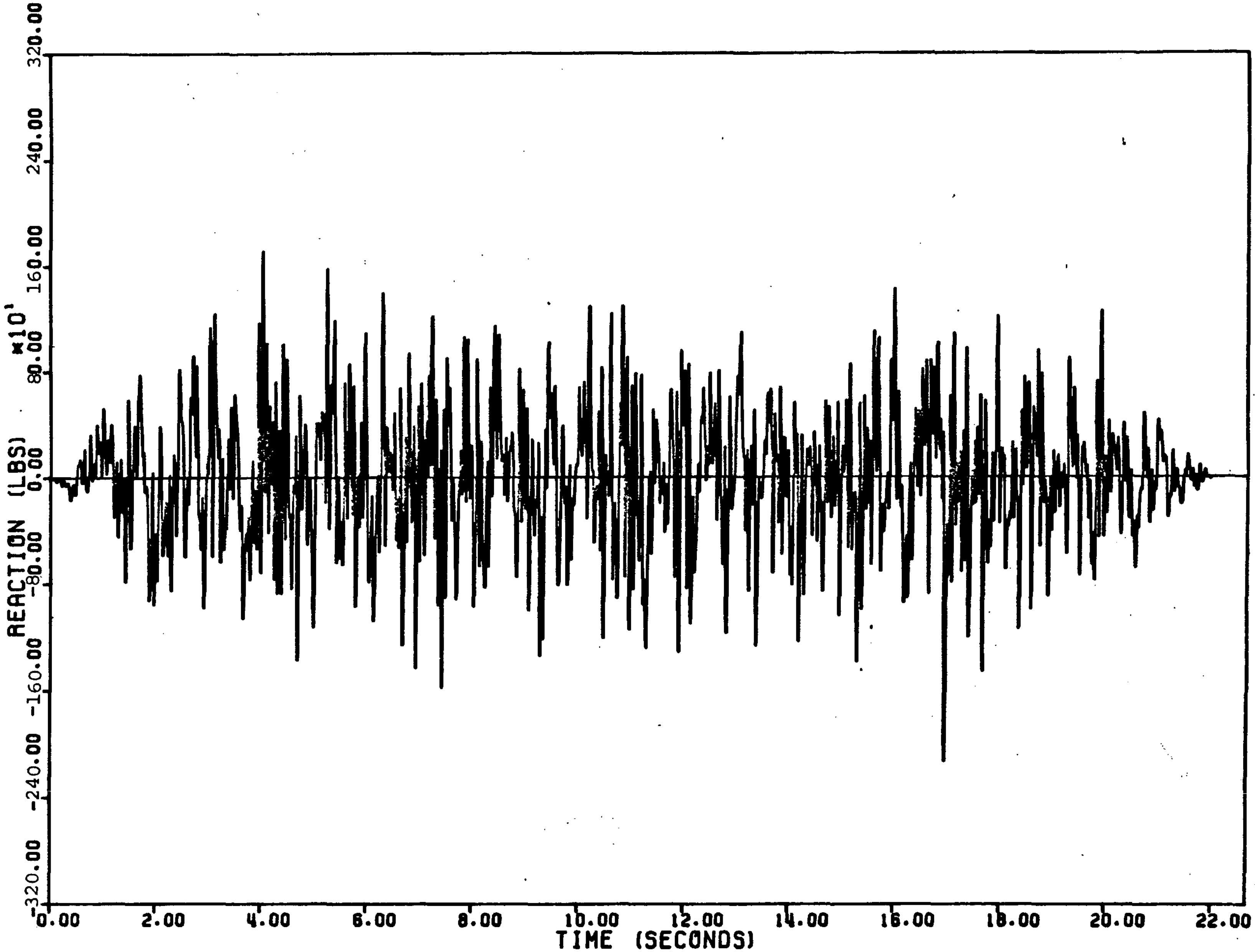


FIGURE C-110A. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-14
SSE LOADING -RECORD 5 - SUPPORT REACTION (LBS), NPTS = 2200, DT = .0100

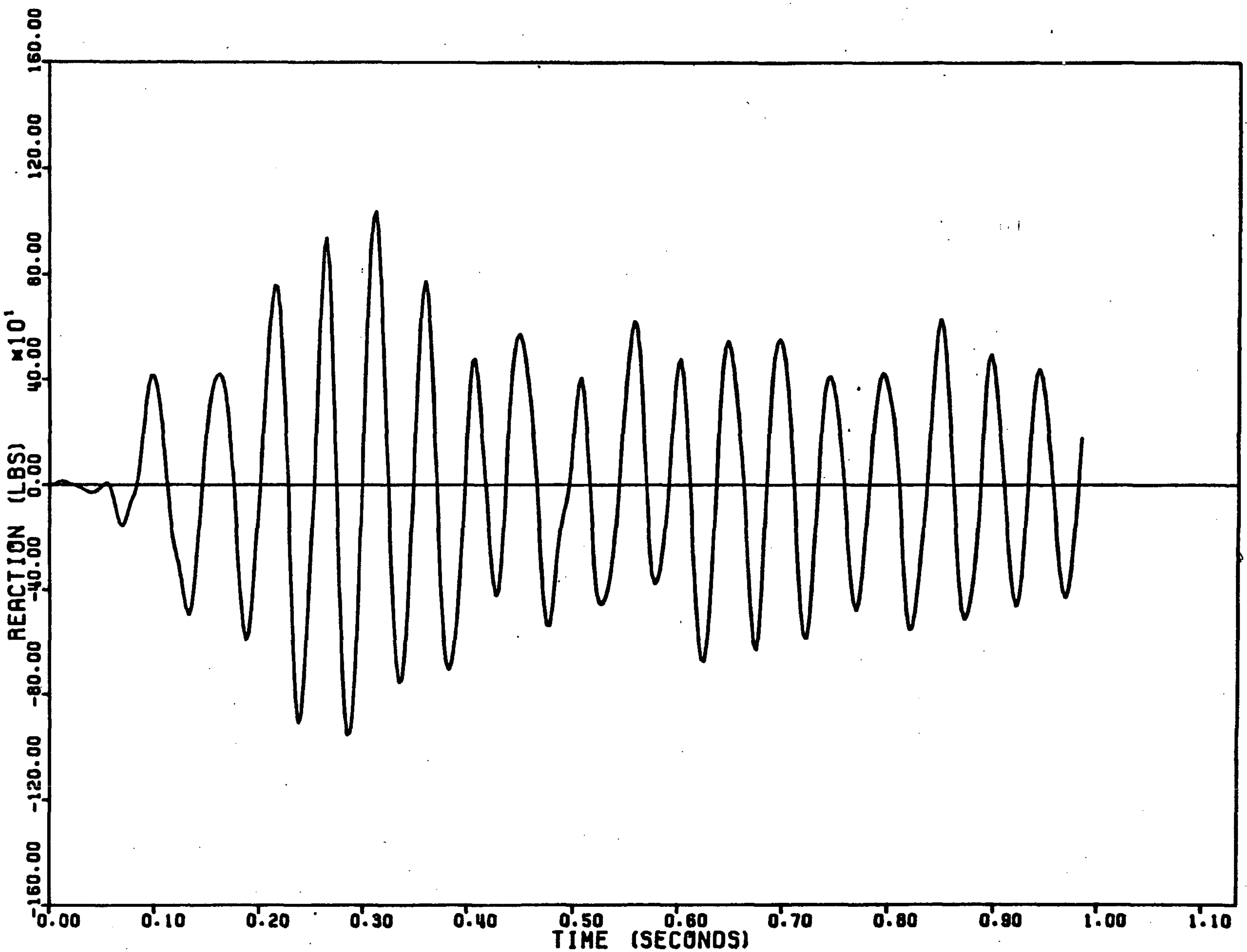


FIGURE C-110B. BOP PIPING TIME HISTORIES, RESIDUAL HEAT REMOVAL LINE, LOCATION 4-14
SRV-ALL LOADING -RECORD 25 - SUPPORT REACTION (LBS), NPTS = 395 ,DT = .0025

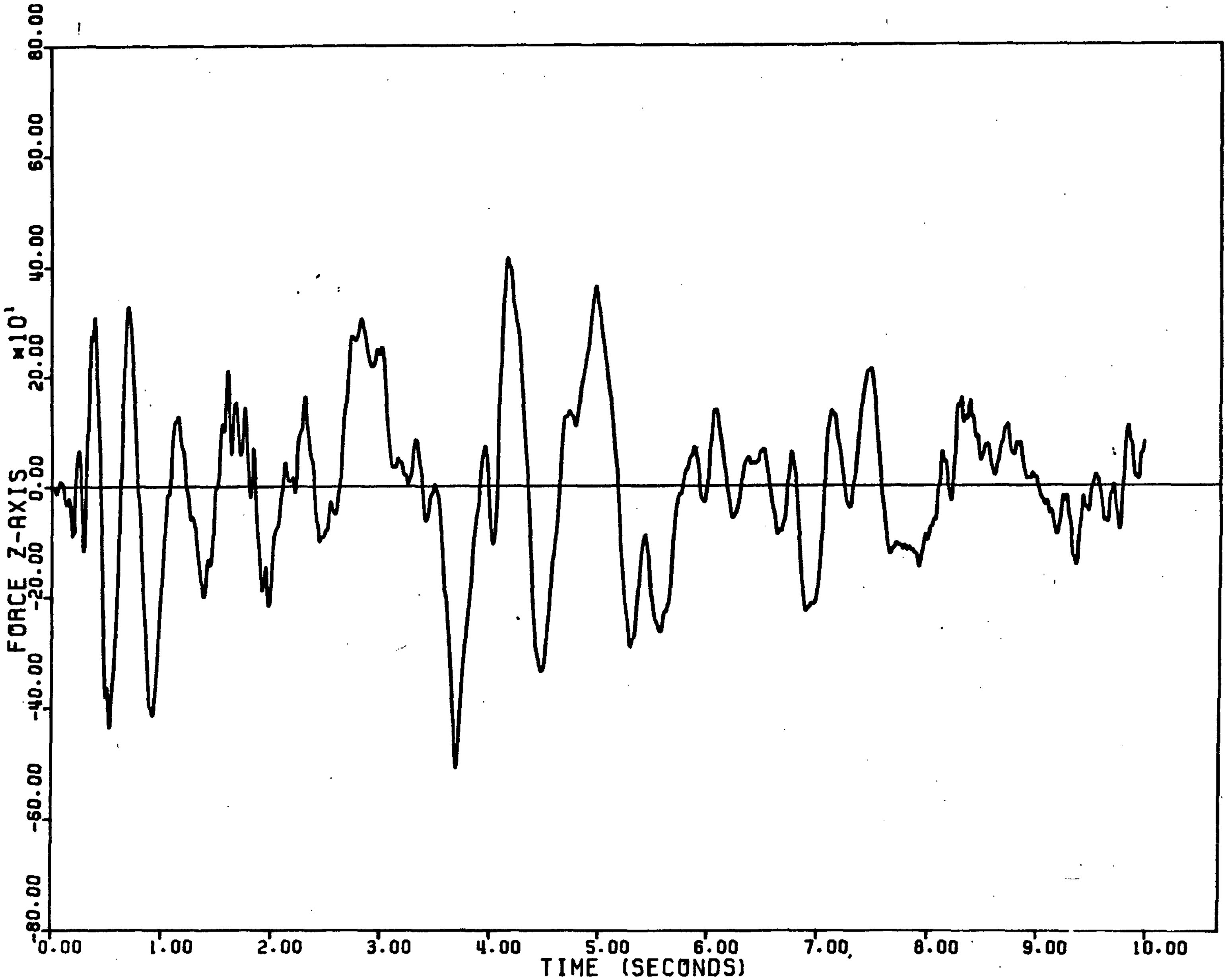


FIGURE C-111A. BOP PIPING, RH-10 LINE, NODE JT-66, LOCATION 5-7
OBE LOADING - RECORD 1001 - FORCE Z-AXIS (LBS) ,NPTS = 3324, DT = .003

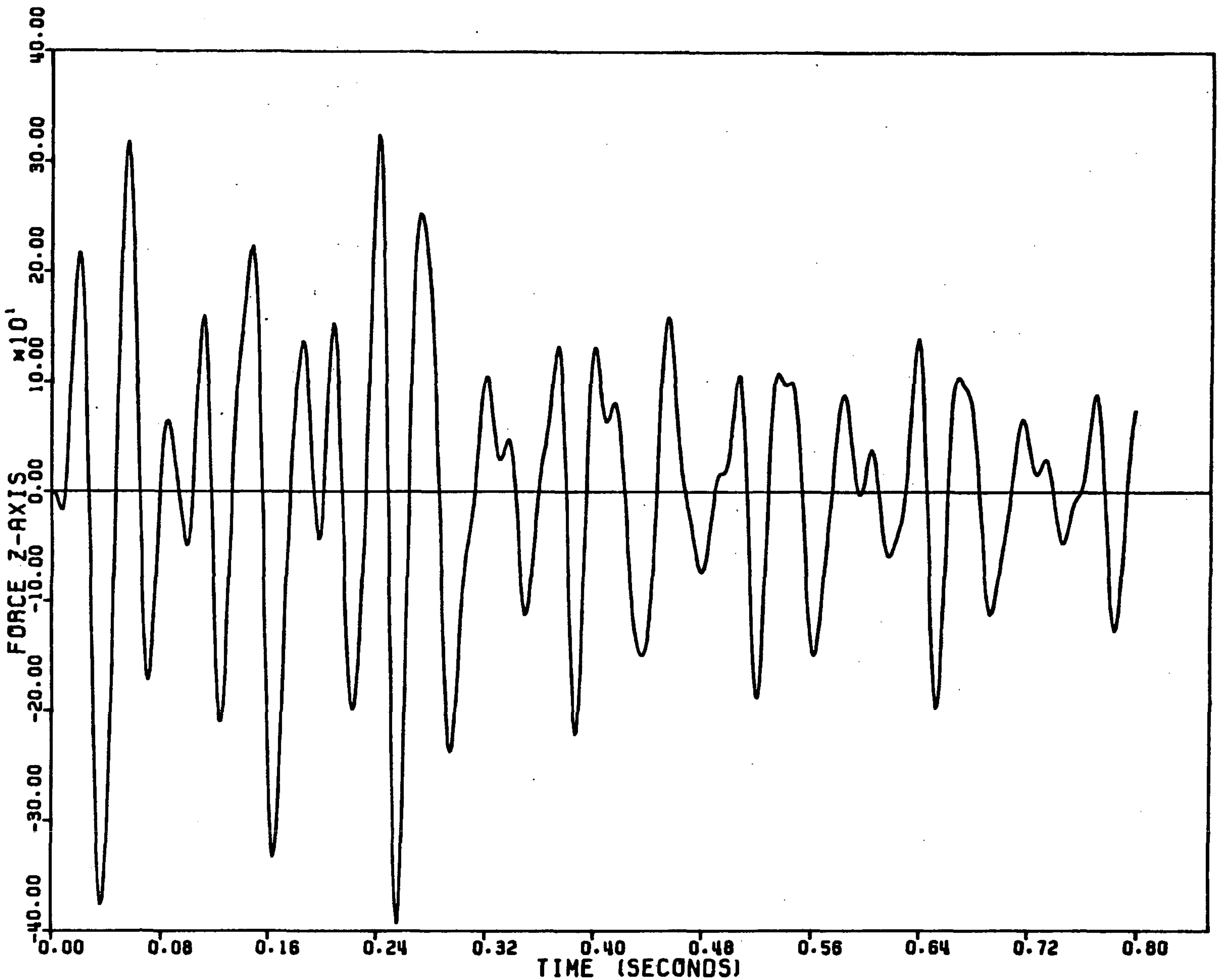


FIGURE C-111B. BOP PIPING, RH-10 LINE, NODE JT-66, LOCATION 5-7
SRV-1 LOADING - RECORD 1021 - FORCE Z-AXIS (LBS) , NPTS = 601, DT = .00133

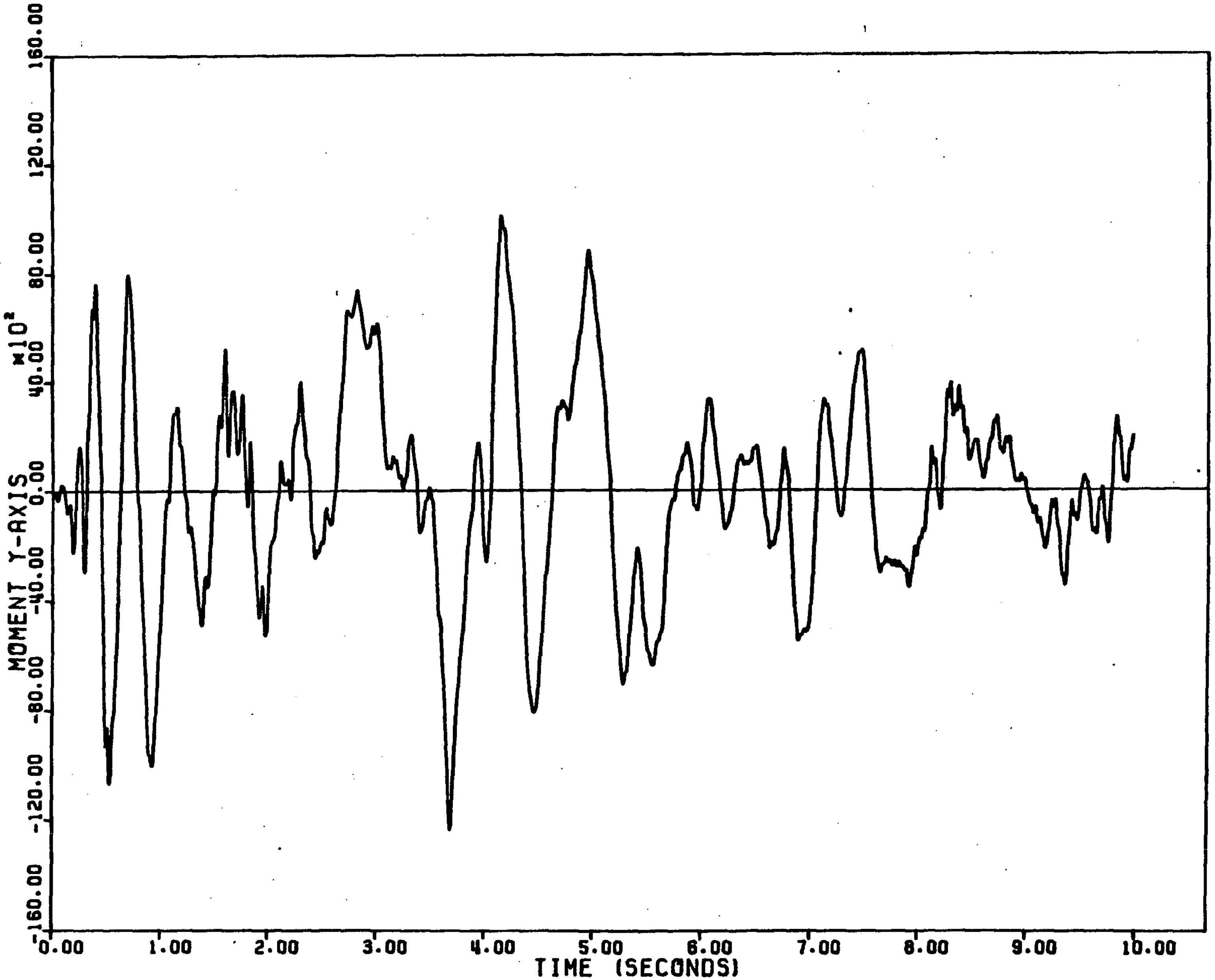


FIGURE C-112A. BOP PIPING, RH-10 LINE, NODE MJ-28, LOCATION 5-10
OBE LOADING - RECORD 1004 - MOMENT Y-AXIS (IN-LBS), NPTS = 3324, DT = .003

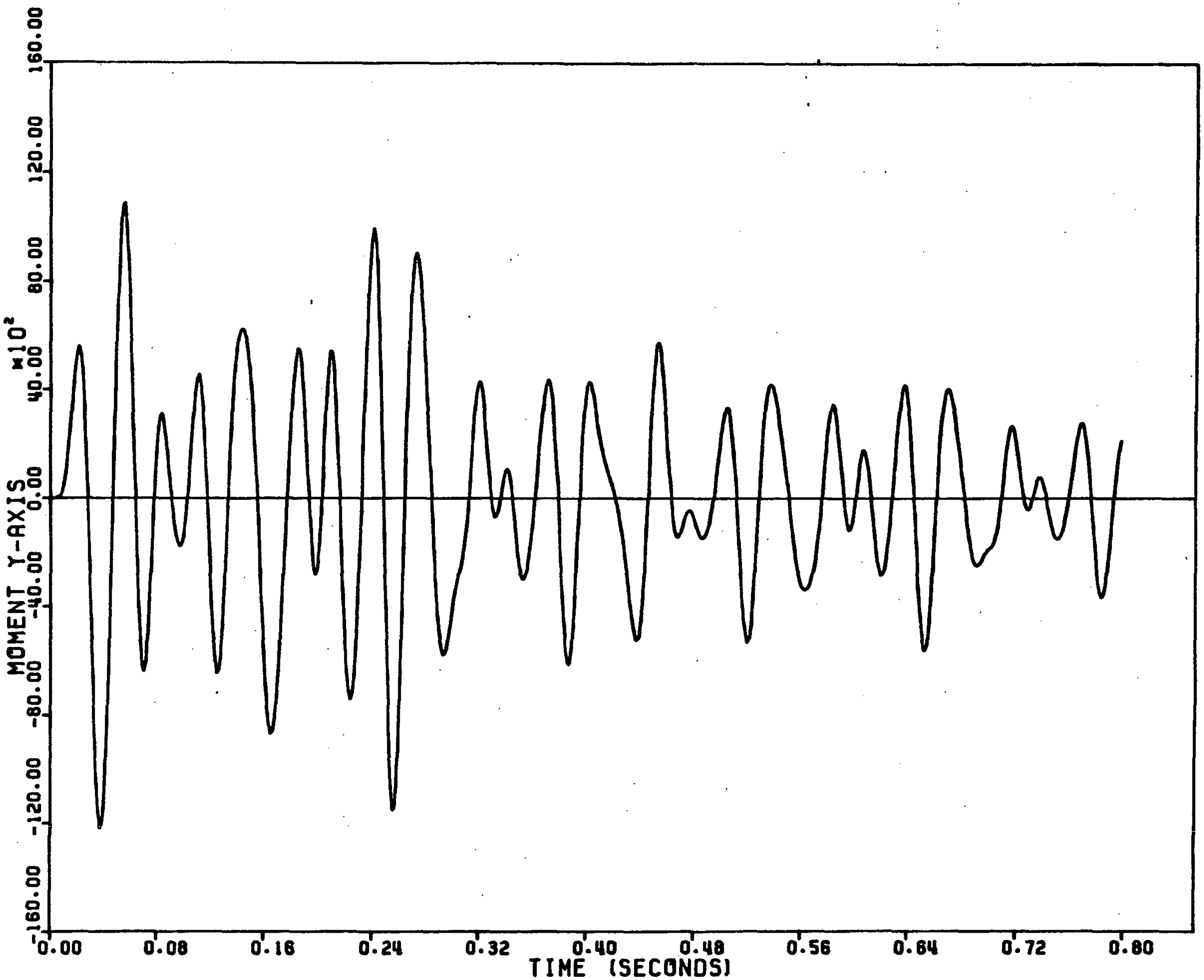


FIGURE C-112B. BOP PIPING, RH-10 LINE, NODE MJ-28, LOCATION 5-10
SRV-1 LOADING - RECORD 1024 - MOMENT Y-AXIS (IN-LBS), NPTS = 601, DT = .00133

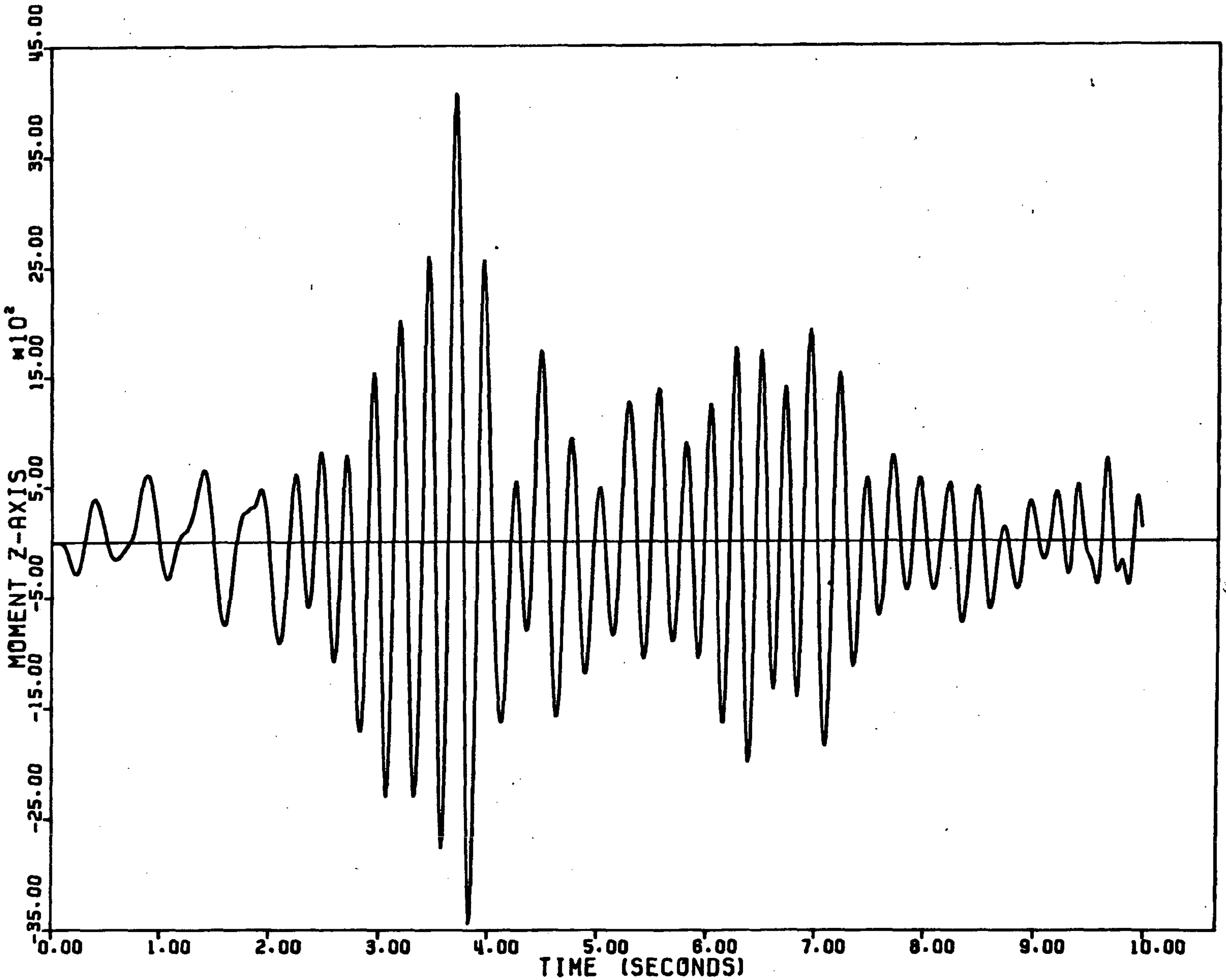


FIGURE C-113A. BOP PIPING, RH-10 LINE, NODE MJ-28, LOCATION 5-11
OBE LOADING - RECORD 1005 - MOMENT Z-AXIS (IN-LBS), NPTS = 3324, DT = .003

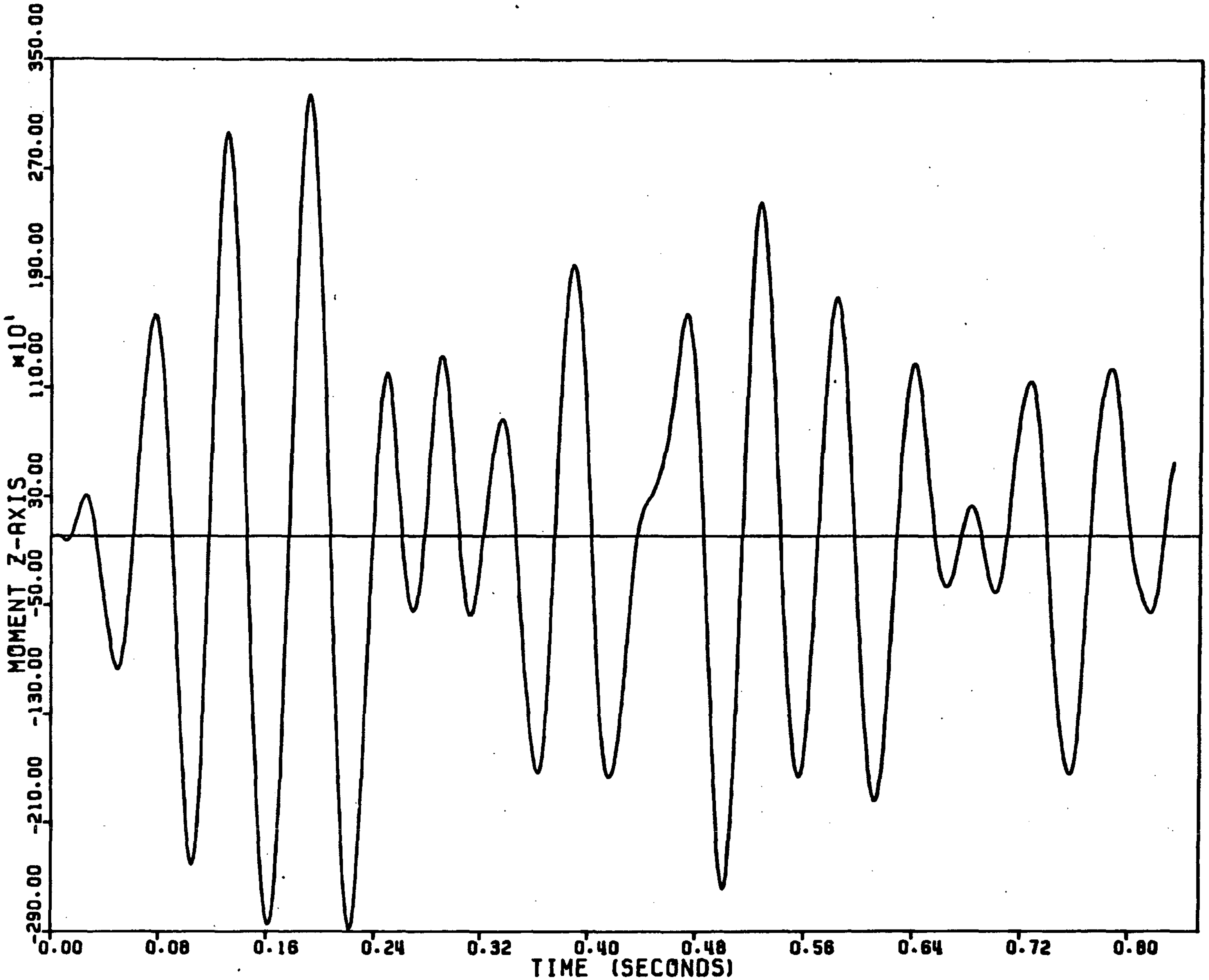


FIGURE C-113B. BOP PIPING, RH-10 LINE, NODE MJ-28, LOCATION 5-11
SRV-ADS LOADING - RECORD 1045 - MOMENT Z-AXIS (IN-LBS), NPTS = 628, DT = .00133

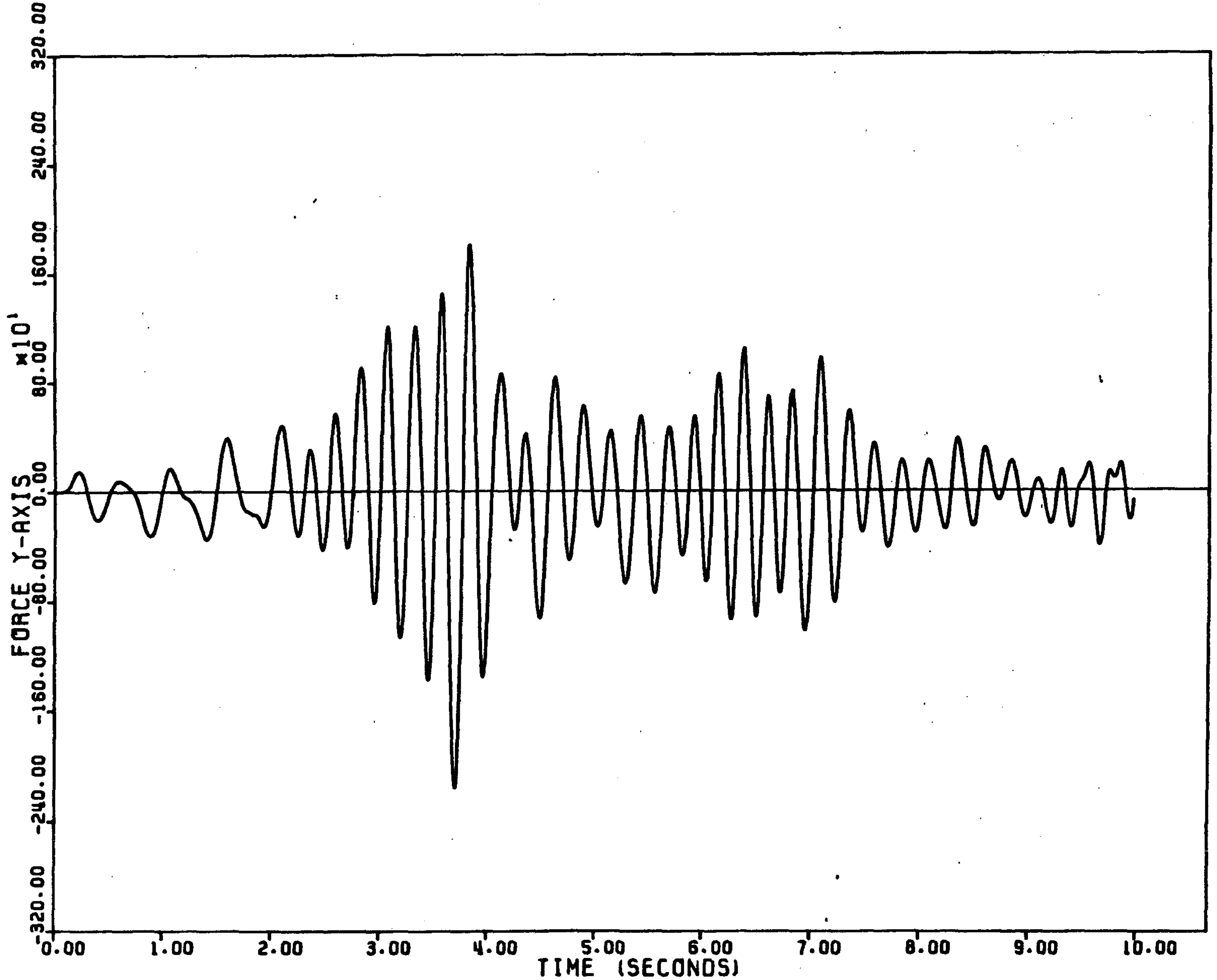


FIGURE C-114A. BOP PIPING, RH-10 LINE, NODE JT-7 , LOCATION 5-12
OBE LOADING - RECORD 1006 - FORCE Y-AXIS (LBS) ,NPTS = 3324, DT = .003

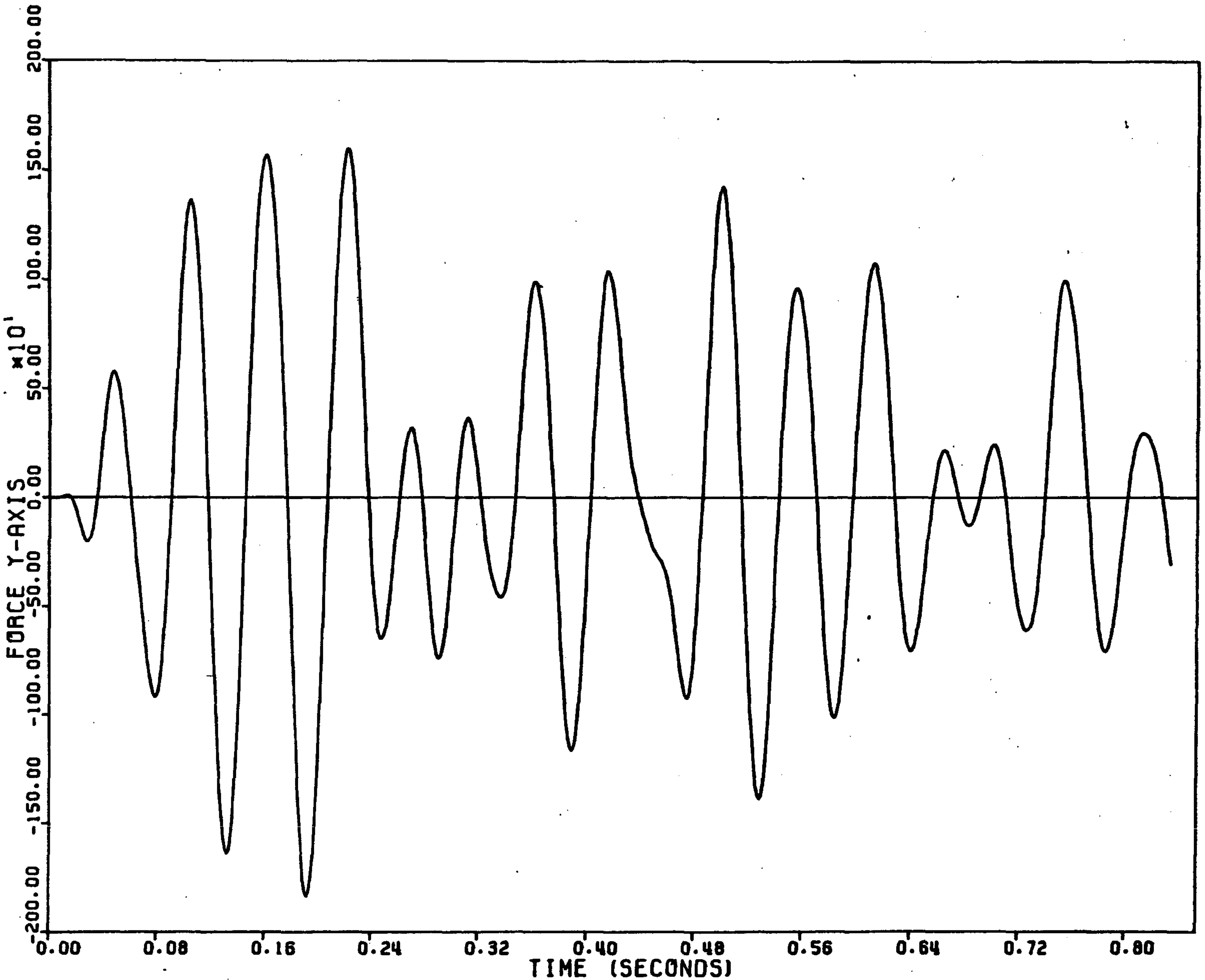


FIGURE C-114B. BOP PIPING, RH-10 LINE, NODE JT-7 , LOCATION 5-12
SRV-ADS LOADING - RECORD 1046 - FORCE Y-AXIS (LBS) , NPTS = 628, DT = .00133

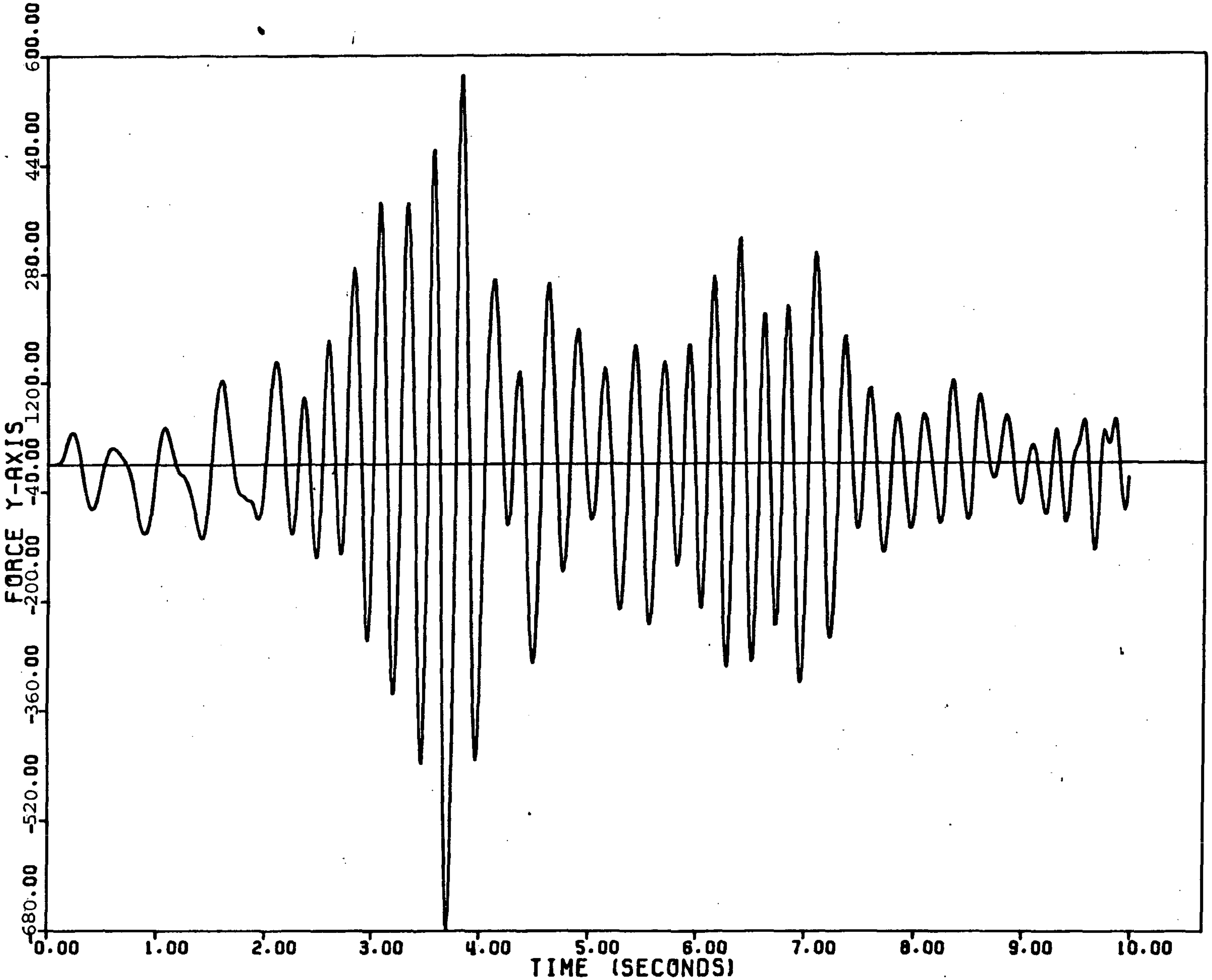


FIGURE C-115A. BOP PIPING, RH-10 LINE, NODE JT-42, LOCATION 5-13
SSE LOADING - RECORD 1007 - FORCE Y-AXIS (LBS) .NPTS = 3324, DT = .003

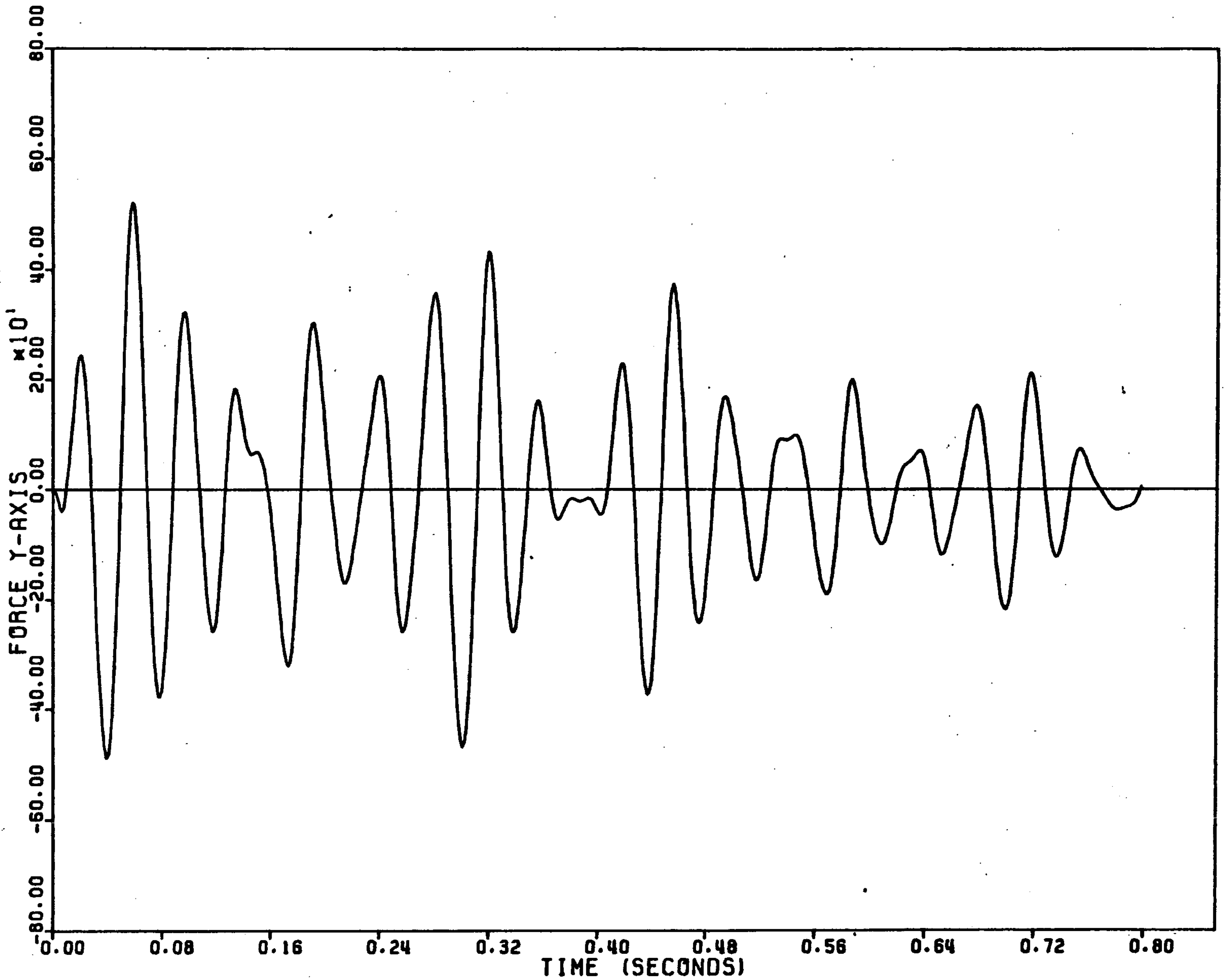


FIGURE C-115B. BOP PIPING, RH-10 LINE, NODE JT-42, LOCATION 5-13
SRV-1 LOADING - RECORD 1027 - FORCE Y-AXIS (LBS) , NPTS = 601, DT = .00133

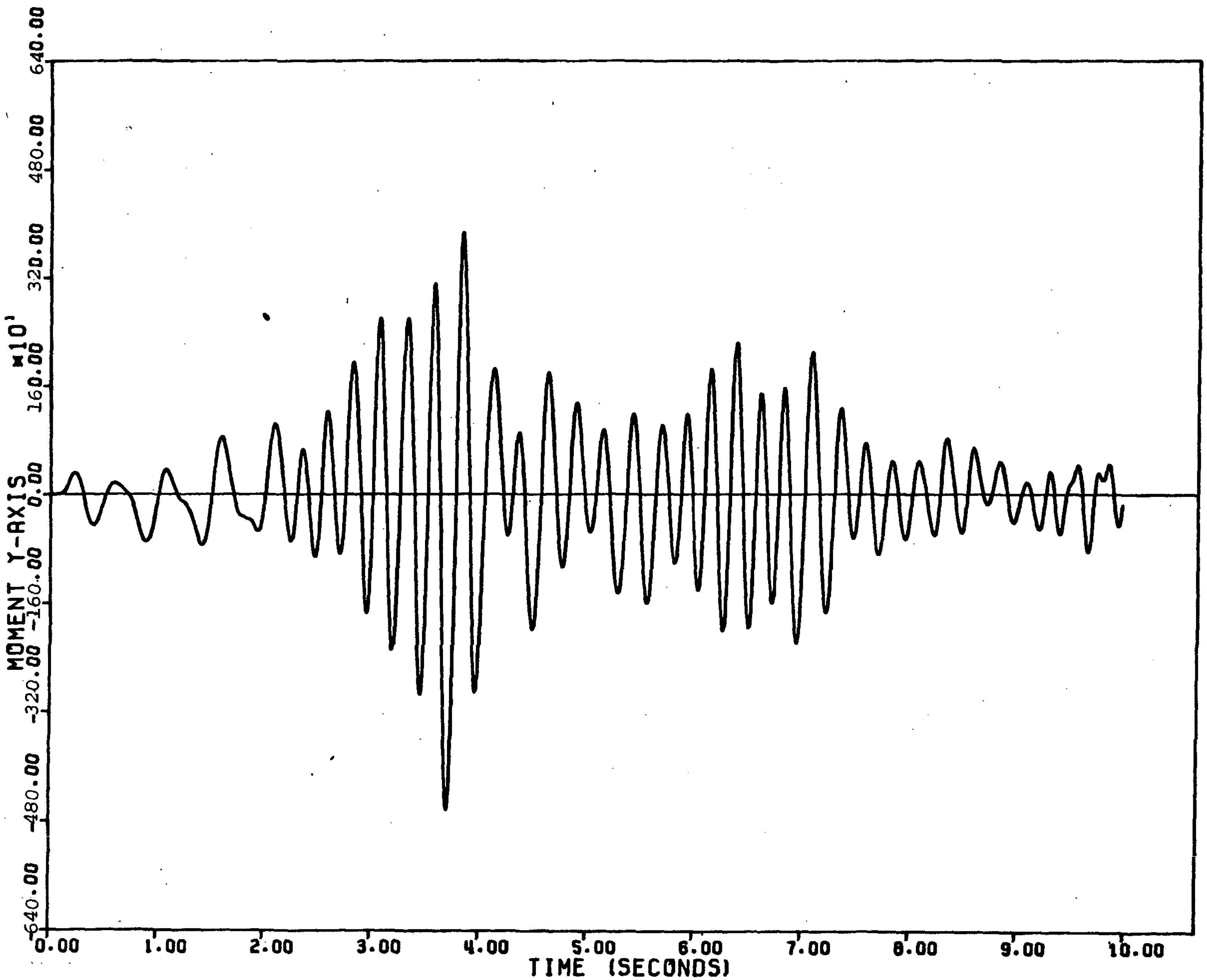


FIGURE C-116A. BOP PIPING, RH-10 LINE, NODE MI-20, LOCATION 5-8
SSE LOADING - RECORD 1002 - MOMENT Y-AXIS (IN-LBS), NPTS = 3324, DT = .003

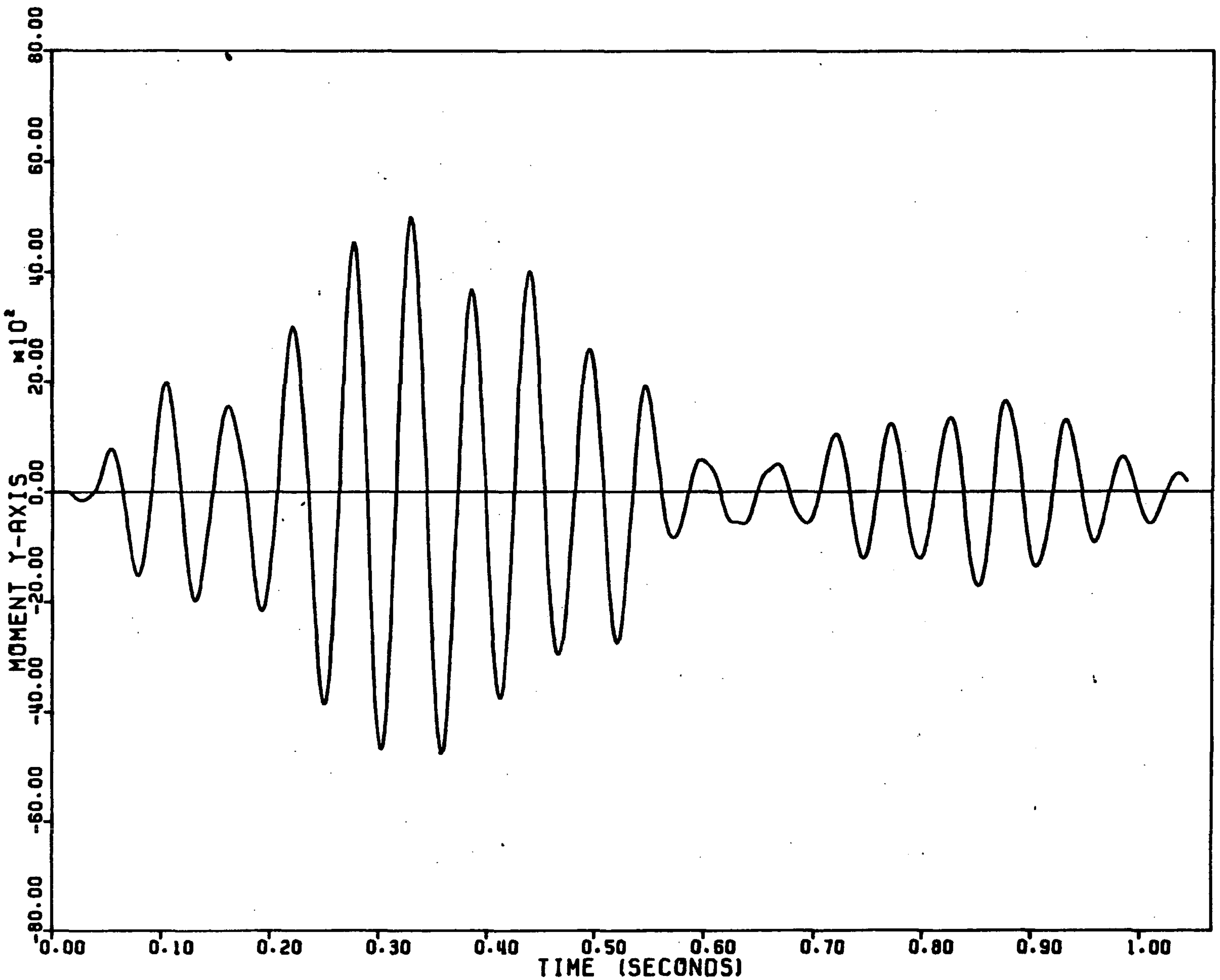


FIGURE C-116B. BOP PIPING, RH-10 LINE, NODE MI-20, LOCATION 5-8
SRV-ALL LOADING - RECORD 1062 - MOMENT Y-AXIS (IN-LBS), NPTS = 785, DT = .00133

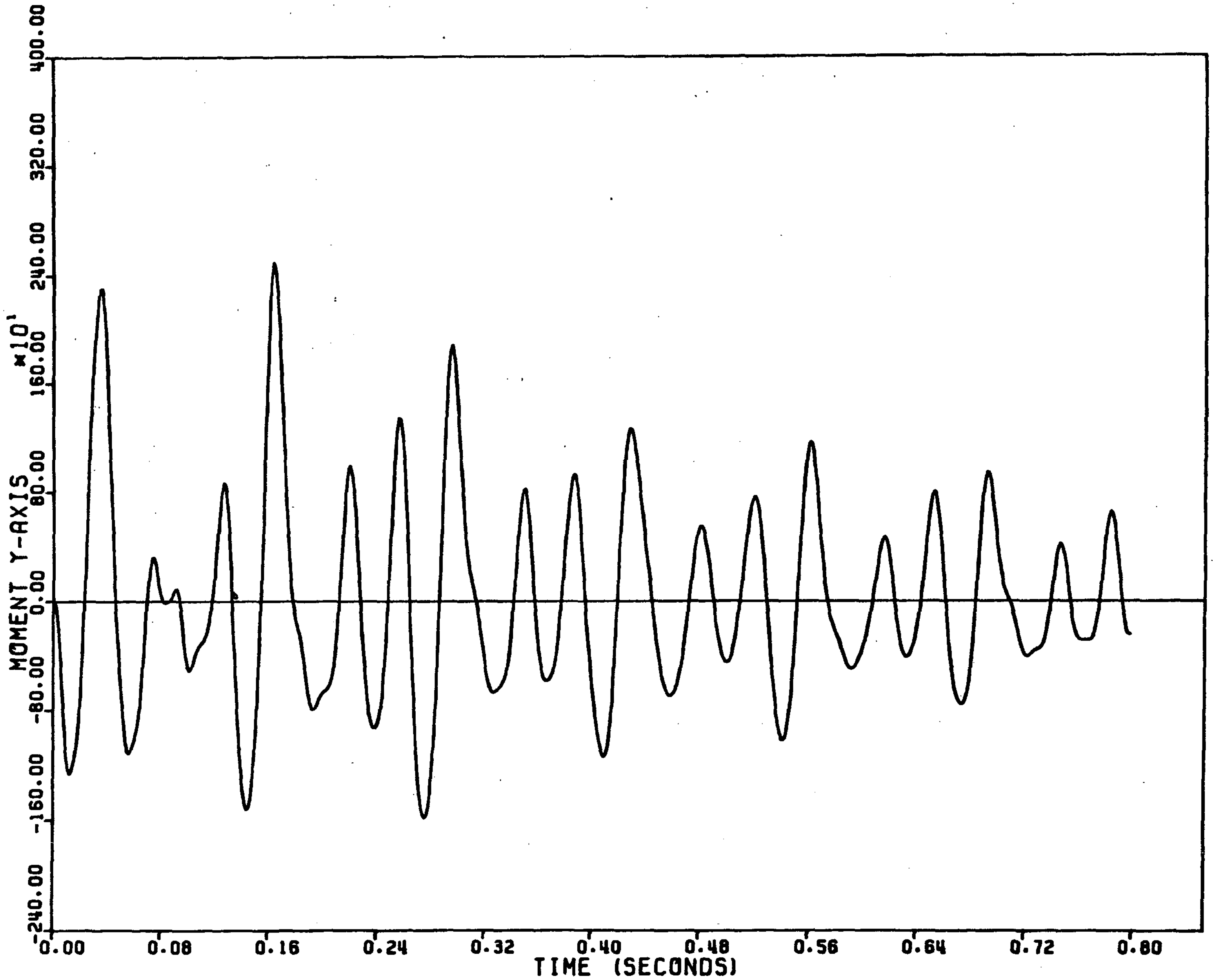


FIGURE C-117A. BOP PIPING, RH-10 LINE, NODE MI-20, LOCATION 5-8
SRV-1 LOADING - RECORD 1022 - MOMENT Y-AXIS (IN-LBS), NPTS = 601, DT = .00133

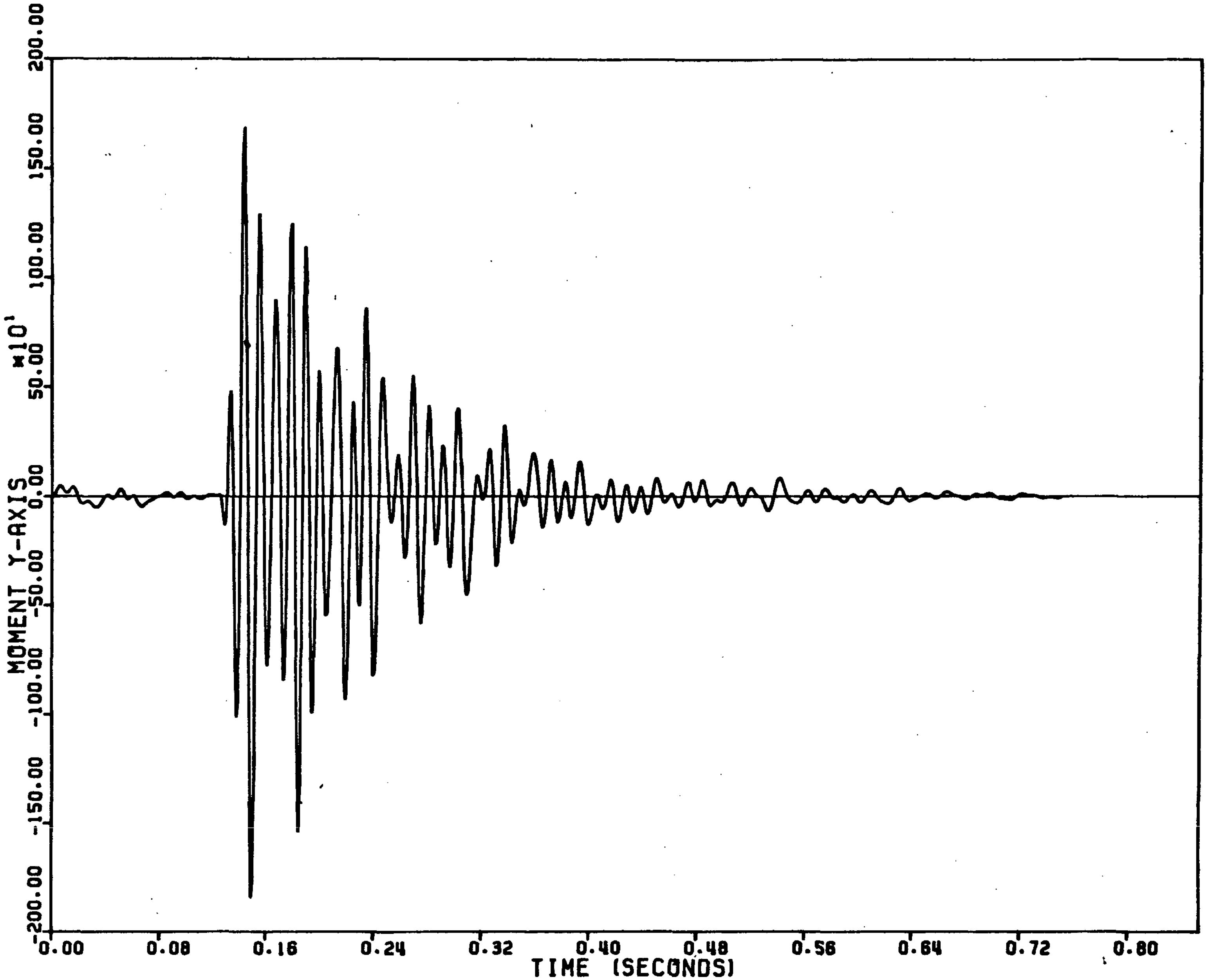


FIGURE C-117B. BOP PIPING, RH-10 LINE, NODE MI-20, LOCATION 5-8
CHUG LOADING - RECORD 1082 - MOMENT Y-AXIS (IN-LBS), NPTS = 751, DT = .001

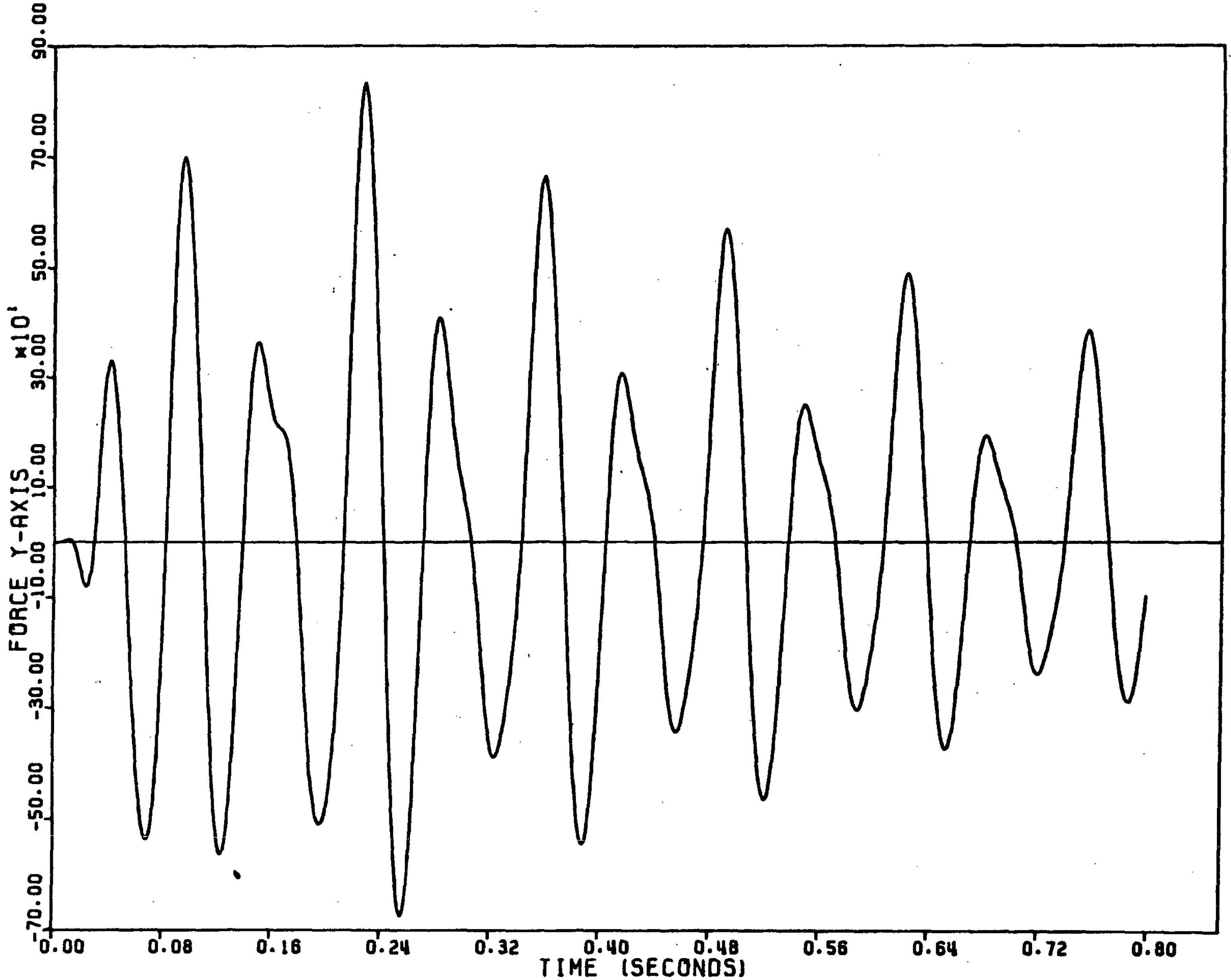


FIGURE C-118A. BOP PIPING, RH-10 LINE, NODE JT-7 , LOCATION 5-12
SRV-1 LOADING - RECORD 1026 - FORCE Y-AXIS (LBS) , NPTS = 601, DT = .00133

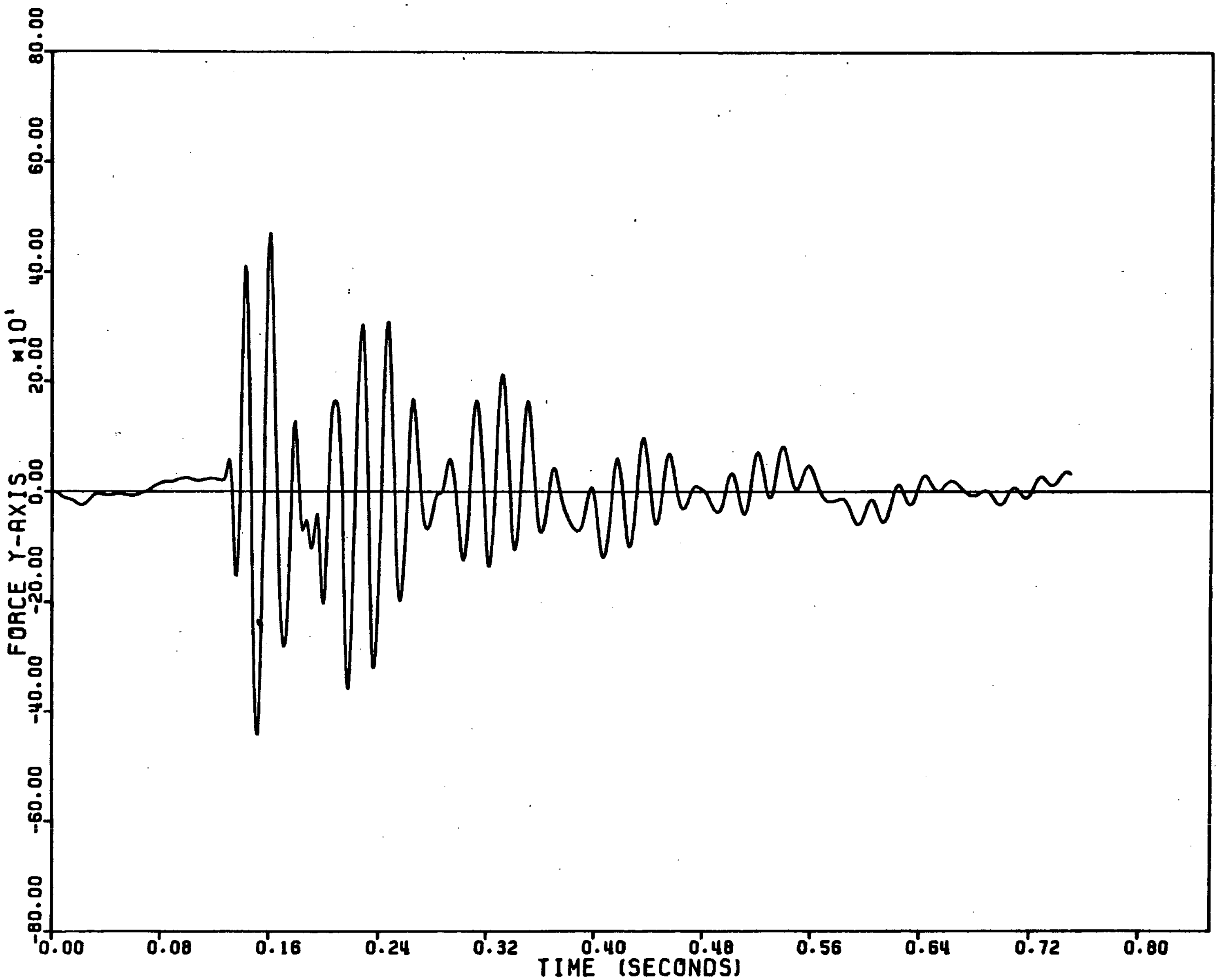


FIGURE C-118B. BOP PIPING, RH-10 LINE, NODE JT-7 , LOCATION 5-12
CHUG LOADING - RECORD 1086 - FORCE Y-AXIS (LBS) , NPTS = 751, DT = .001

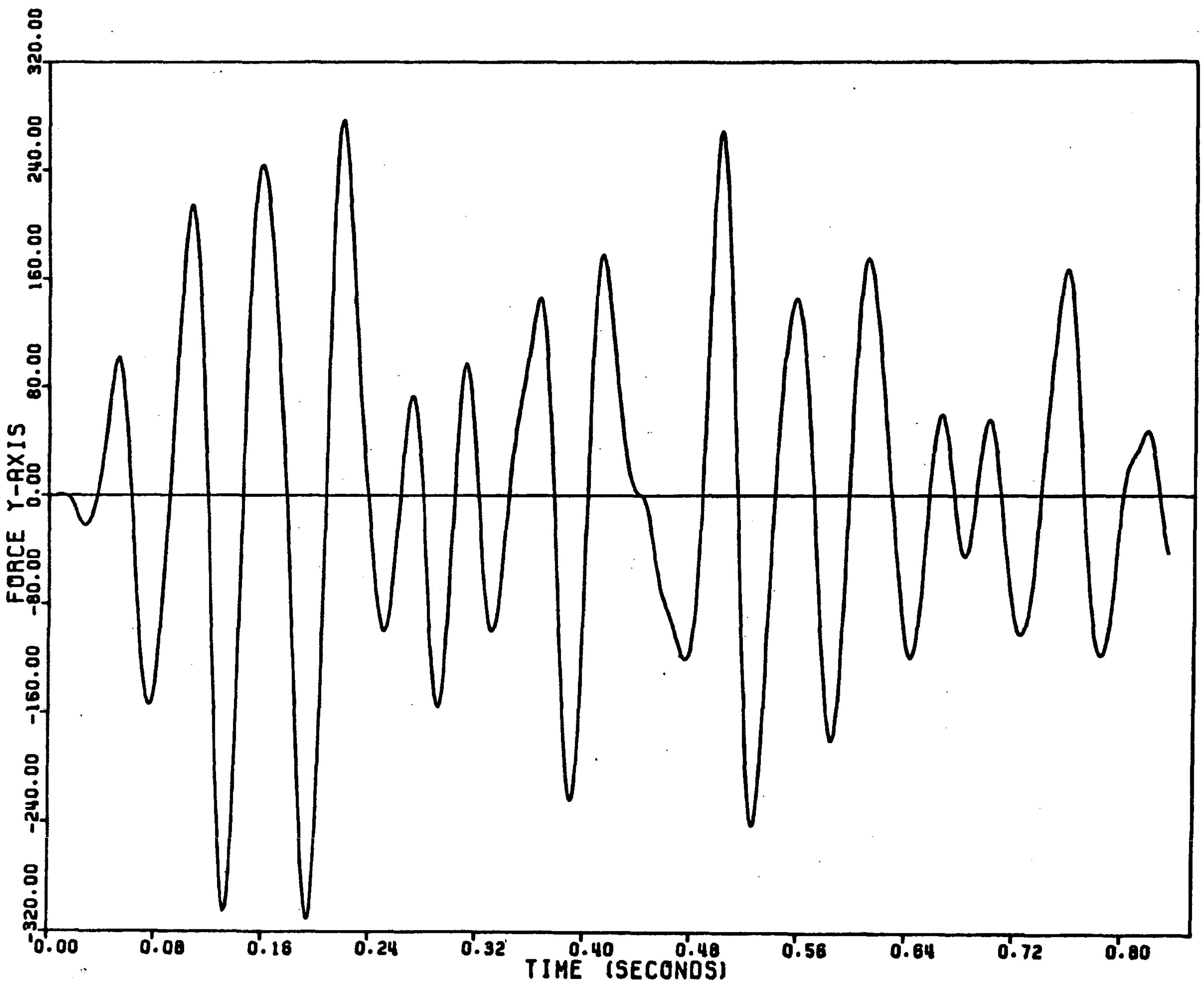


FIGURE C-119A. BOP PIPING, RH-10 LINE, NODE JT-42, LOCATION 5-13
SRV-ADS LOADING - RECORD 1047 - FORCE Y-AXIS (LBS) , NPTS = 628, DT = .00133

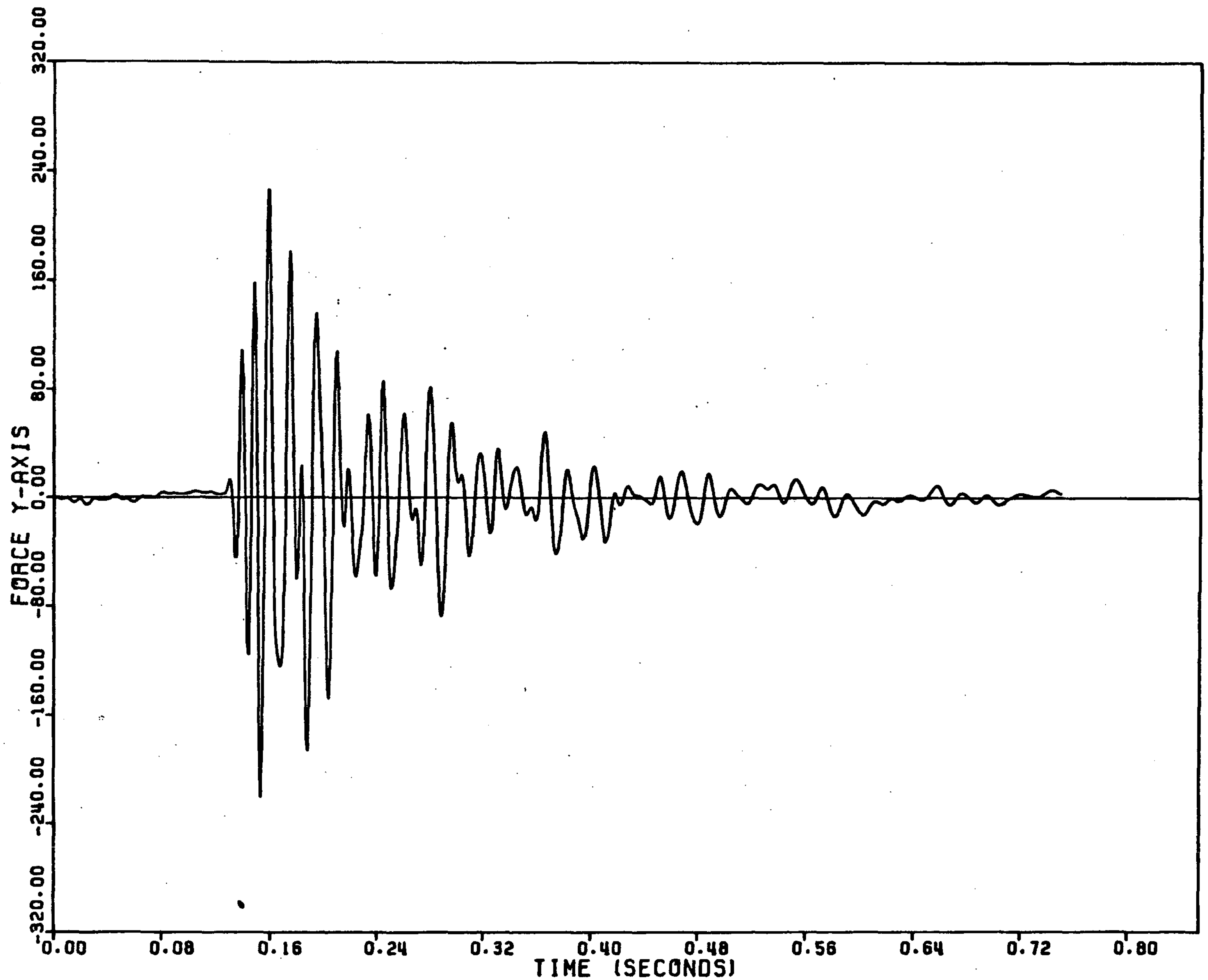


FIGURE C-119B. BOP PIPING, RH-10 LINE, NODE JT-42, LOCATION 5-13
CHUG LOADING - RECORD 1087 - FORCE Y-AXIS (LBS) , NPTS = 751, DT = .001

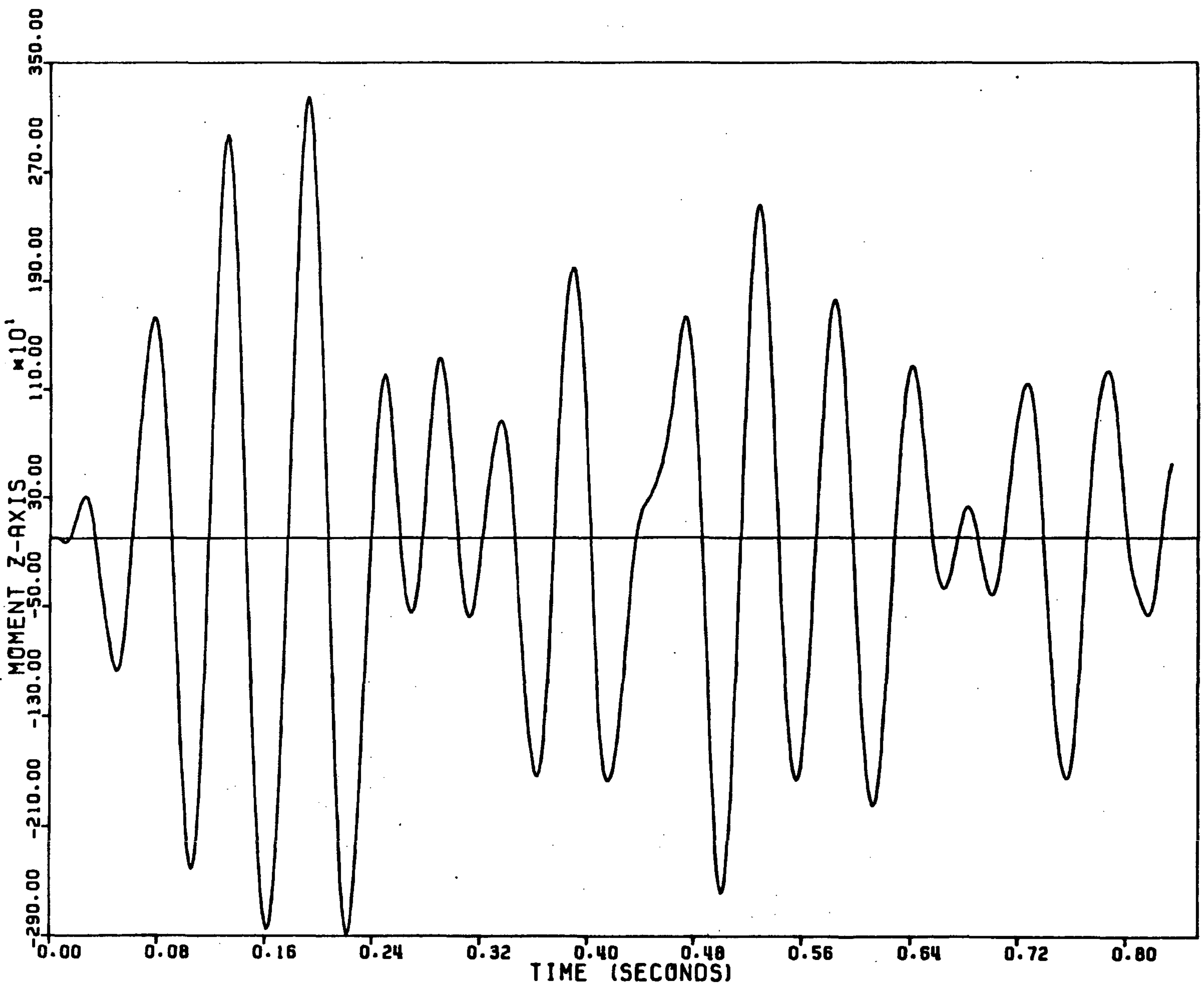


FIGURE C-120A. BOP PIPING, RH-10 LINE, NODE MJ-28, LOCATION 5-11
SRV-ADS LOADING - RECORD 1045 - MOMENT Z-AXIS (IN-LBS), NPTS = 628, DT = .00133

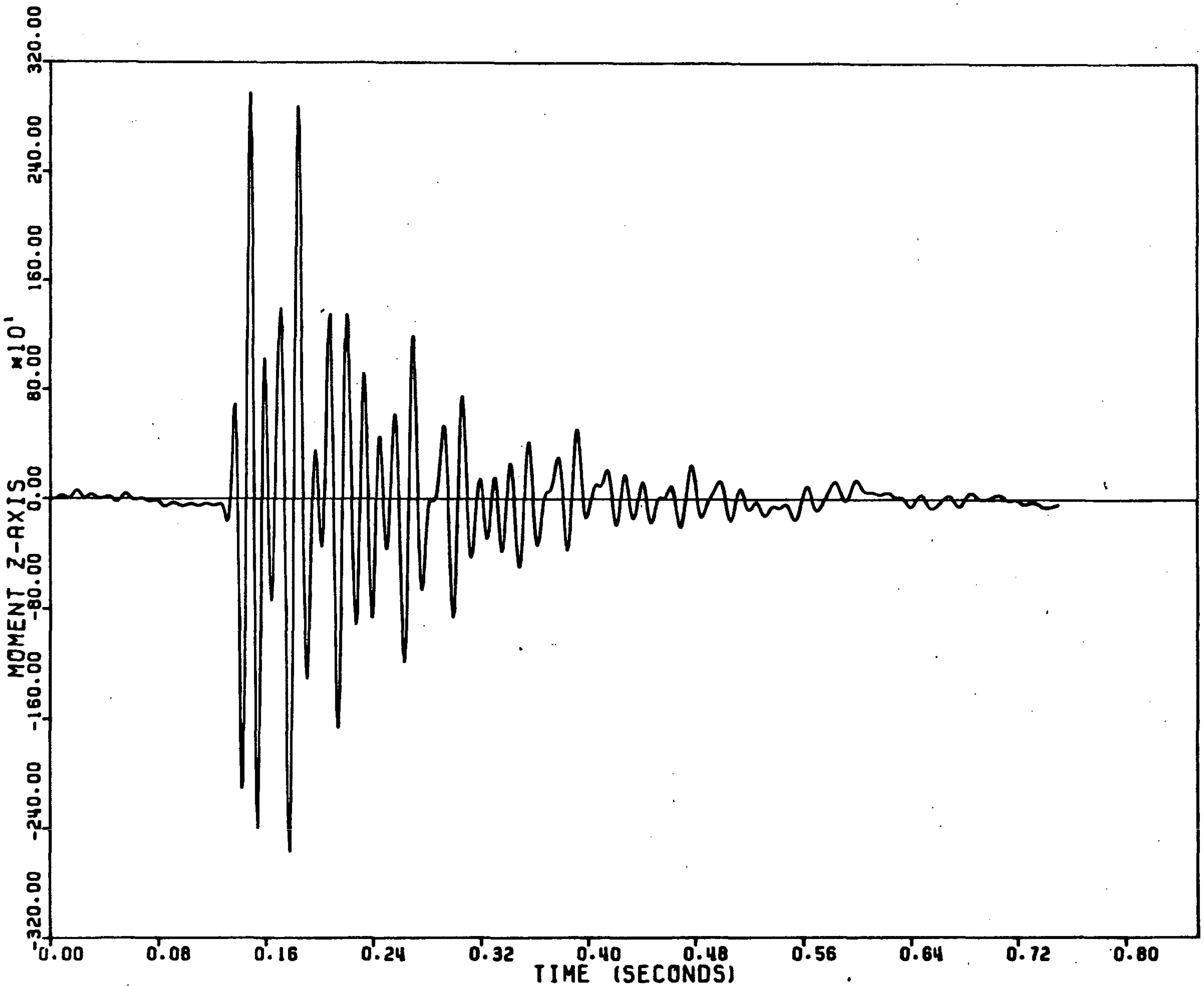


FIGURE C-120B. BOP PIPING, RH-10 LINE, NODE MJ-28, LOCATION 5-11
CHUG LOADING - RECORD 1085 - MOMENT Z-AXIS (IN-LBS), NPTS = 751, DT = .001

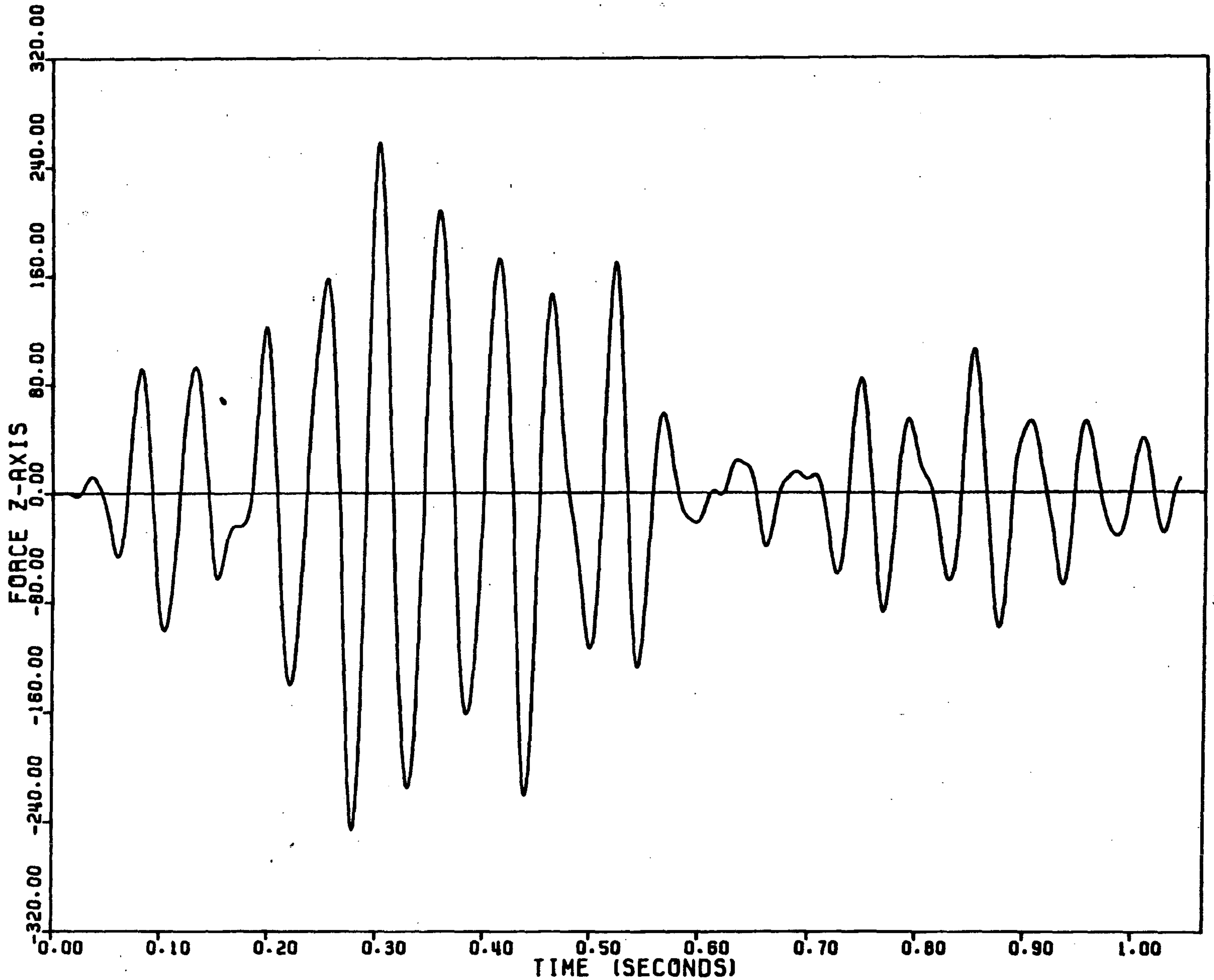


FIGURE C-121A. BOP PIPING, RH-10 LINE, NODE JT-66, LOCATION 5-7
SRV-ALL LOADING - RECORD 1061 - FORCE Z-AXIS (LBS) , NPTS = 785, DT = .00133

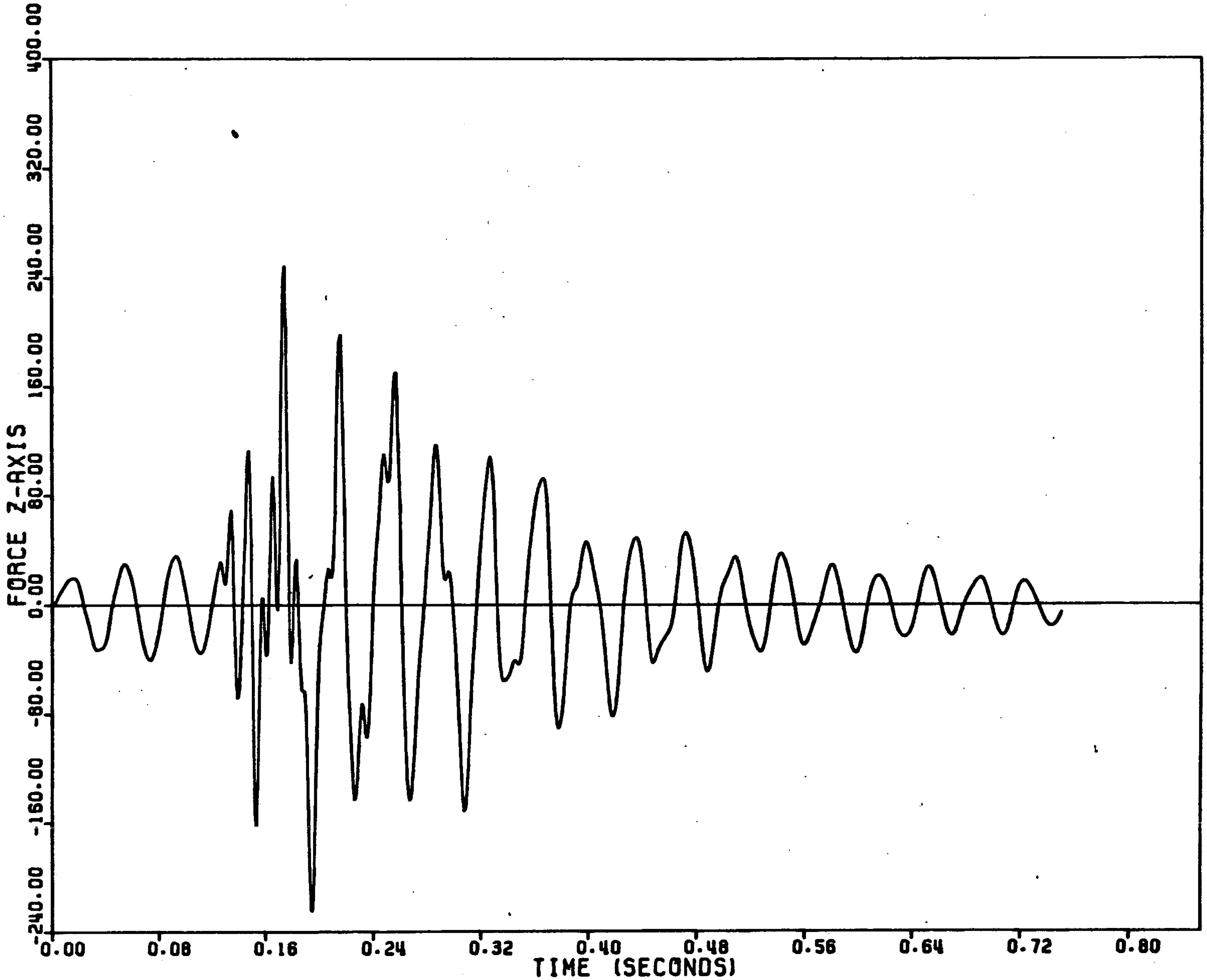


FIGURE C-121B. BOP PIPING, RH-10 LINE, NODE JT-66, LOCATION 5-7
CHUG LOADING - RECORD 1081 - FORCE Z-AXIS (LBS) , NPTS = 751, DT = .001

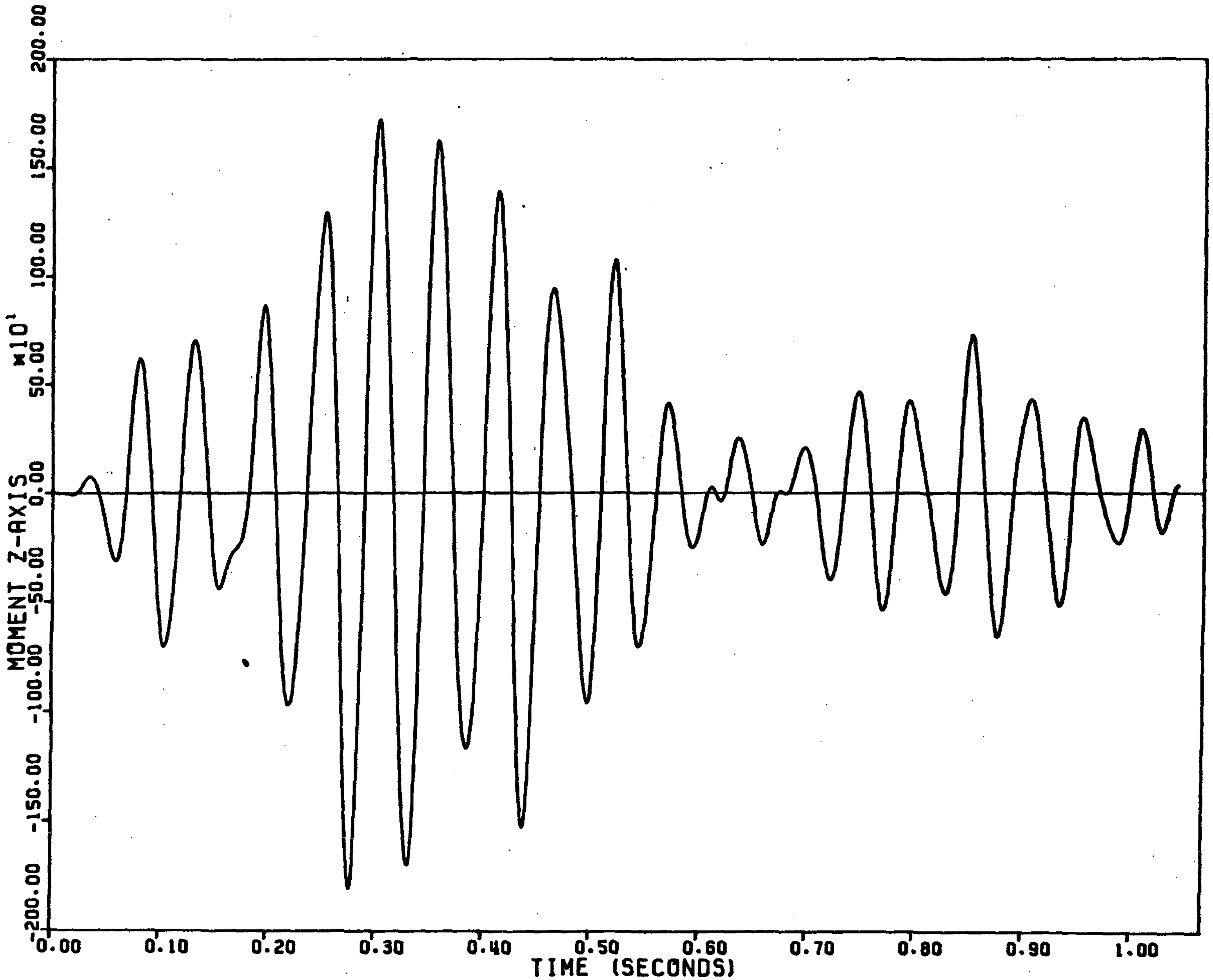


FIGURE C-122A. BOP PIPING, RH-10 LINE, NODE MI-20, LOCATION 5-9
SRV-ALL LOADING - RECORD 1063 - MOMENT Z-AXIS (IN-LBS), NPTS = 785, DT = .00133

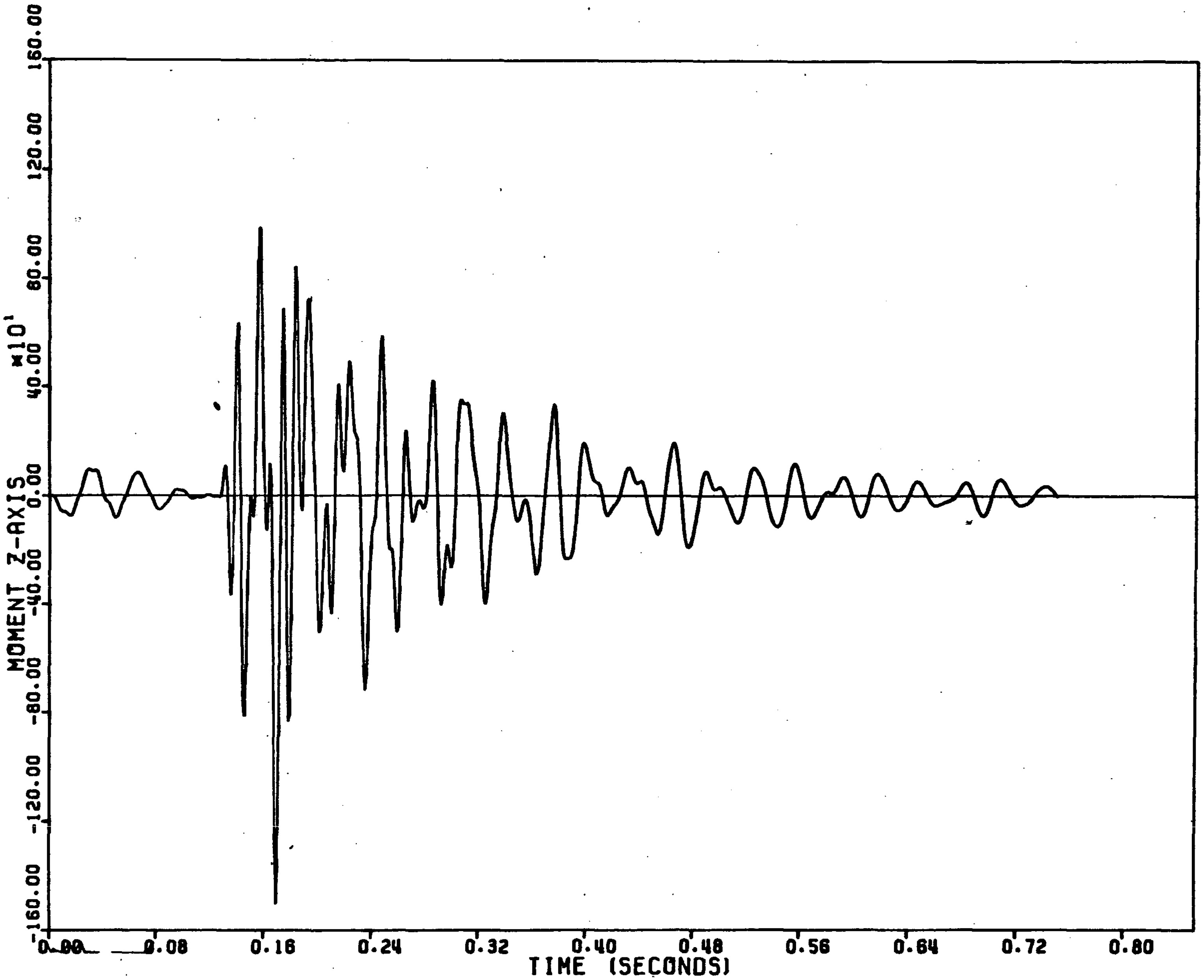


FIGURE C-122B. BOP PIPING, RH-10 LINE, NODE MI-20, LOCATION 5-9
CHUG LOADING - RECORD 1083 - MOMENT Z-AXIS (IN-LBS), NPTS = 751, DT = .001

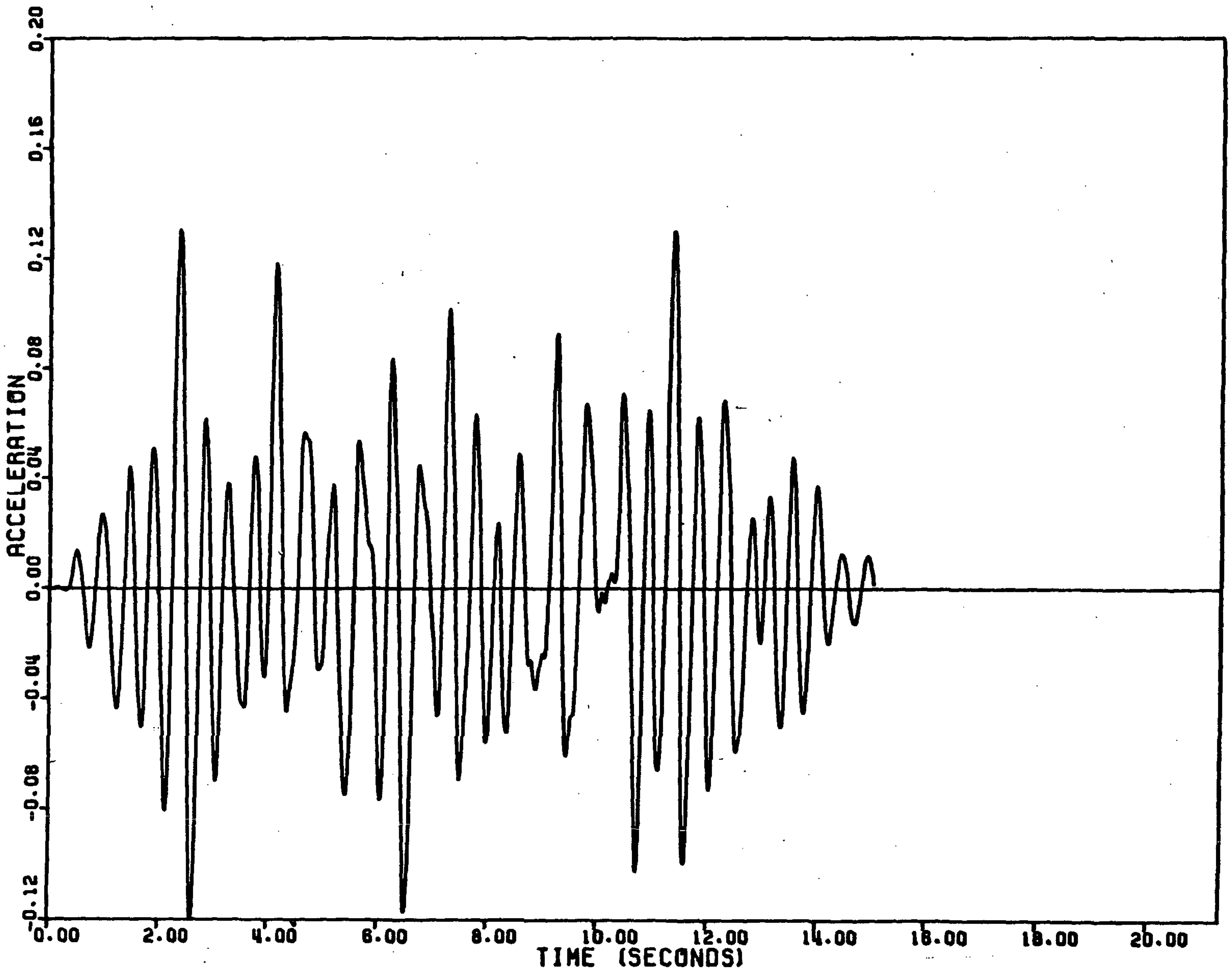


FIGURE C-123A. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-9
OBE LOADING - RECORD 106 - VERT. ACCELERATION (G), NPTS = 1504, DT = .0100

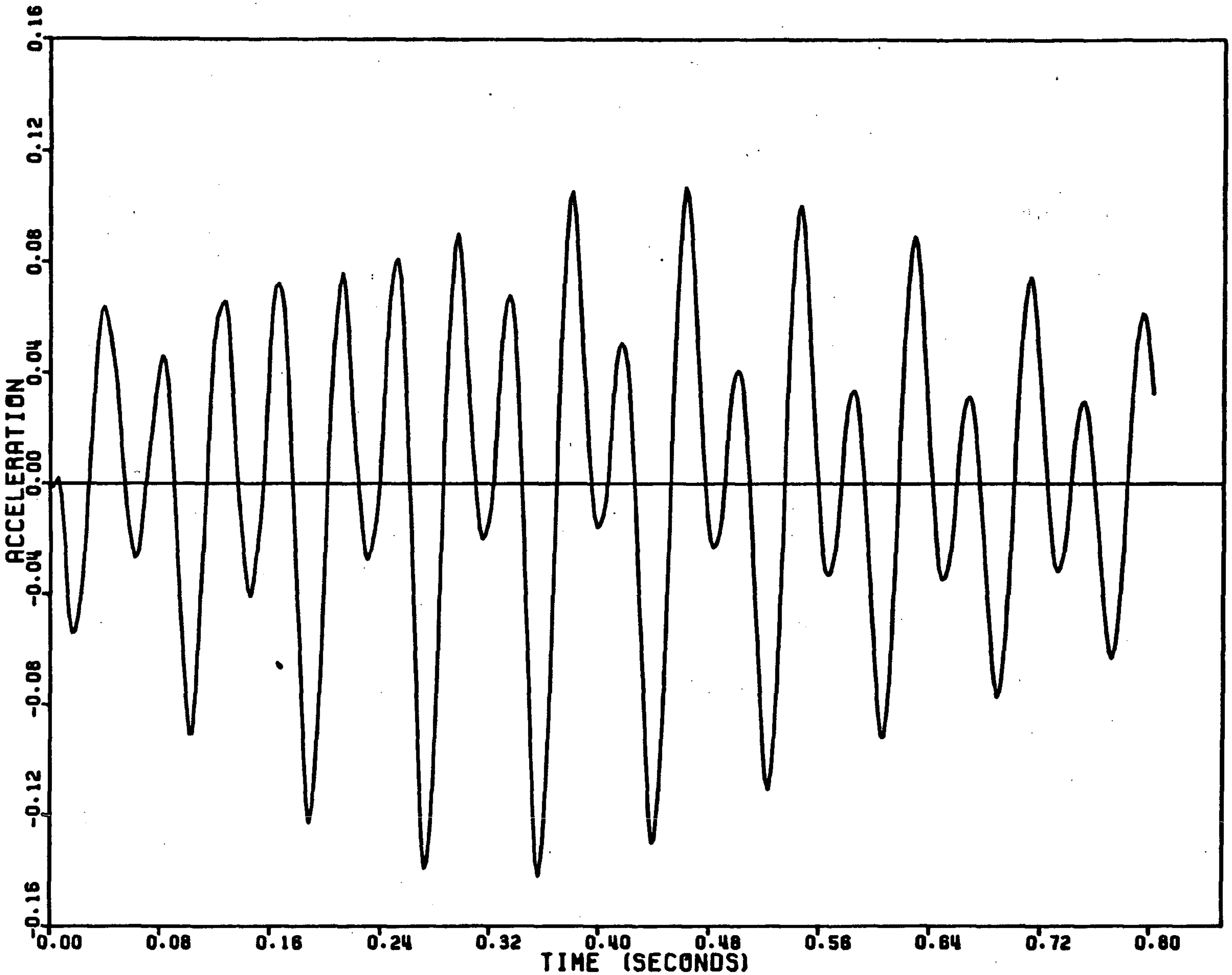


FIGURE C-123B. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-9
SRV-1 LOADING - RECORD 113 - VERT. ACCELERATION (G), NPTS = 402, DT = .0020

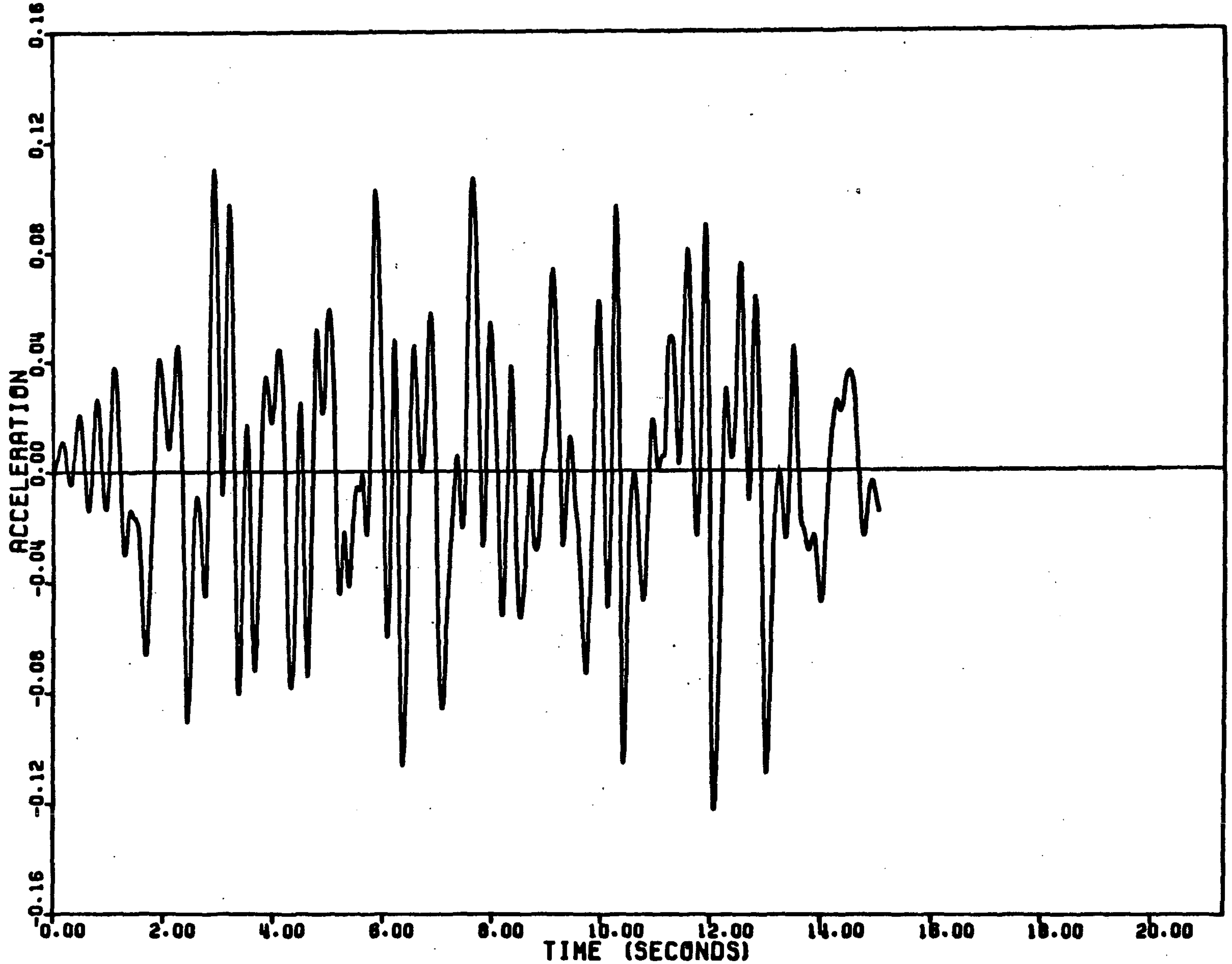


FIGURE C-124A. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-13
OBE LOADING - RECORD 107 - E - W ACCELERATION (G), NPTS = 1504, DT = .0100

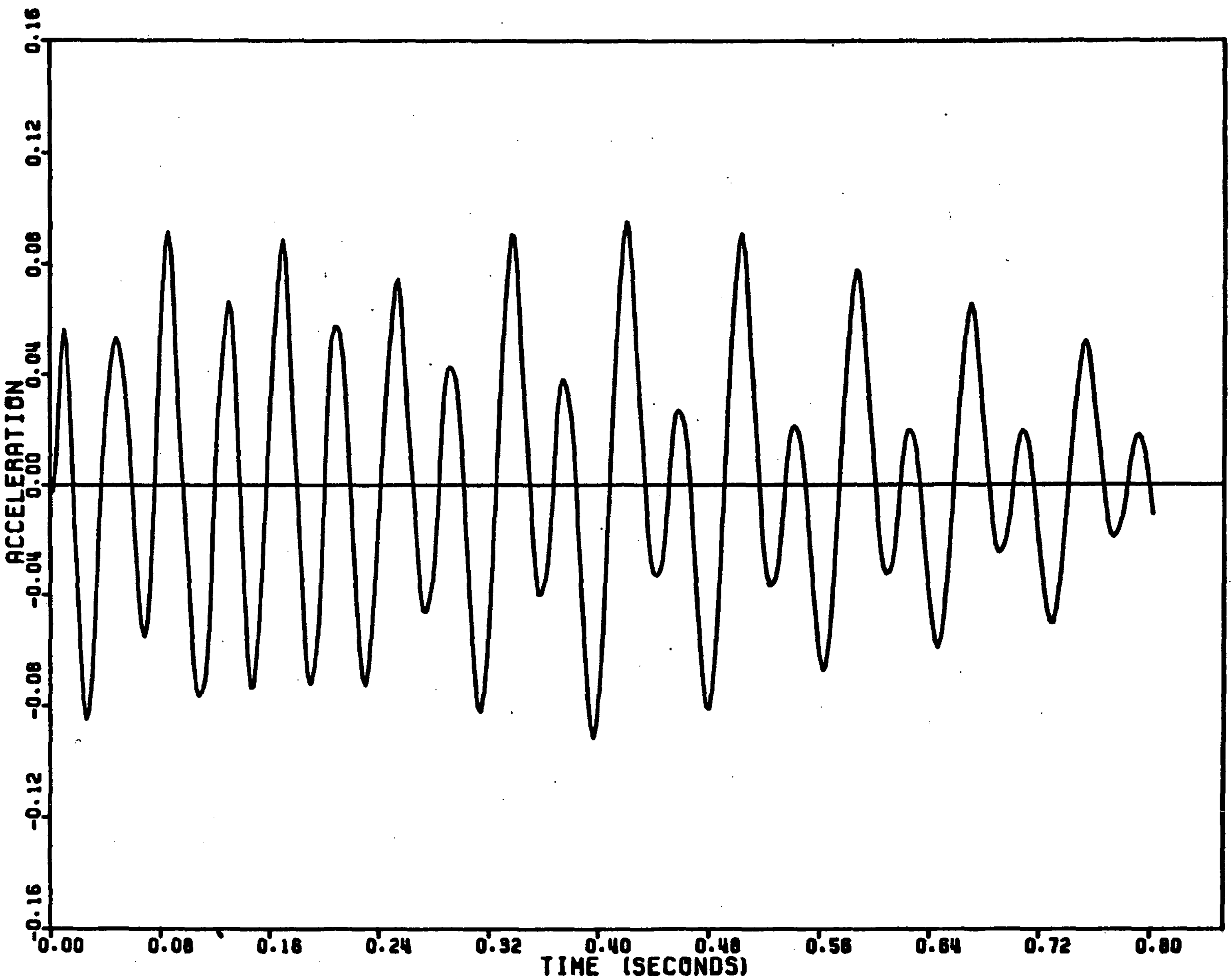


FIGURE C-124B. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-13
SRV-1 LOADING - RECORD 114 - TANG. ACCELERATION (G), NPTS = 402, DT = .0020

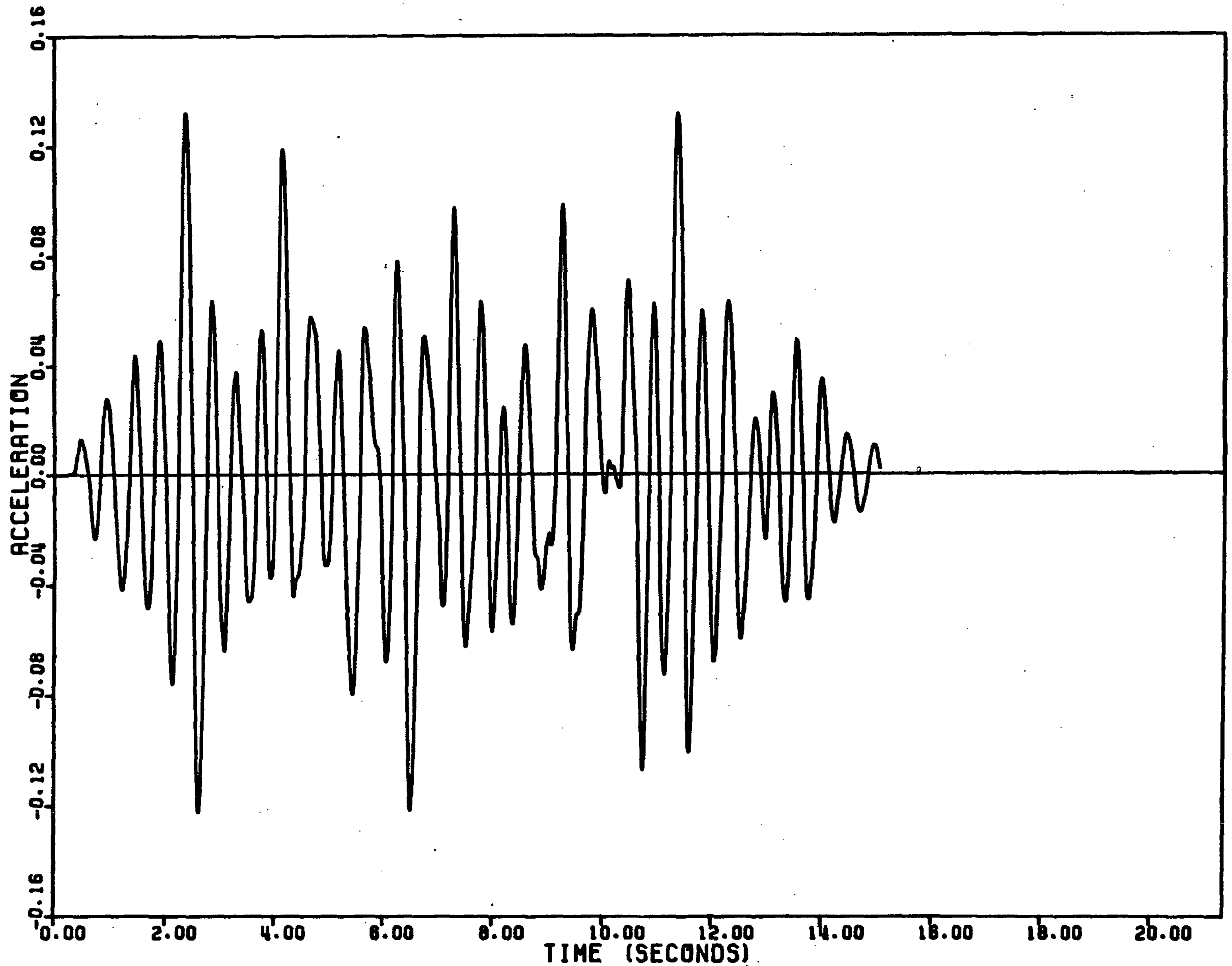


FIGURE C-125A. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-6
OBE LOADING - RECORD 105 - VERT. ACCELERATION (G), NPTS = 1504, DT = .0100

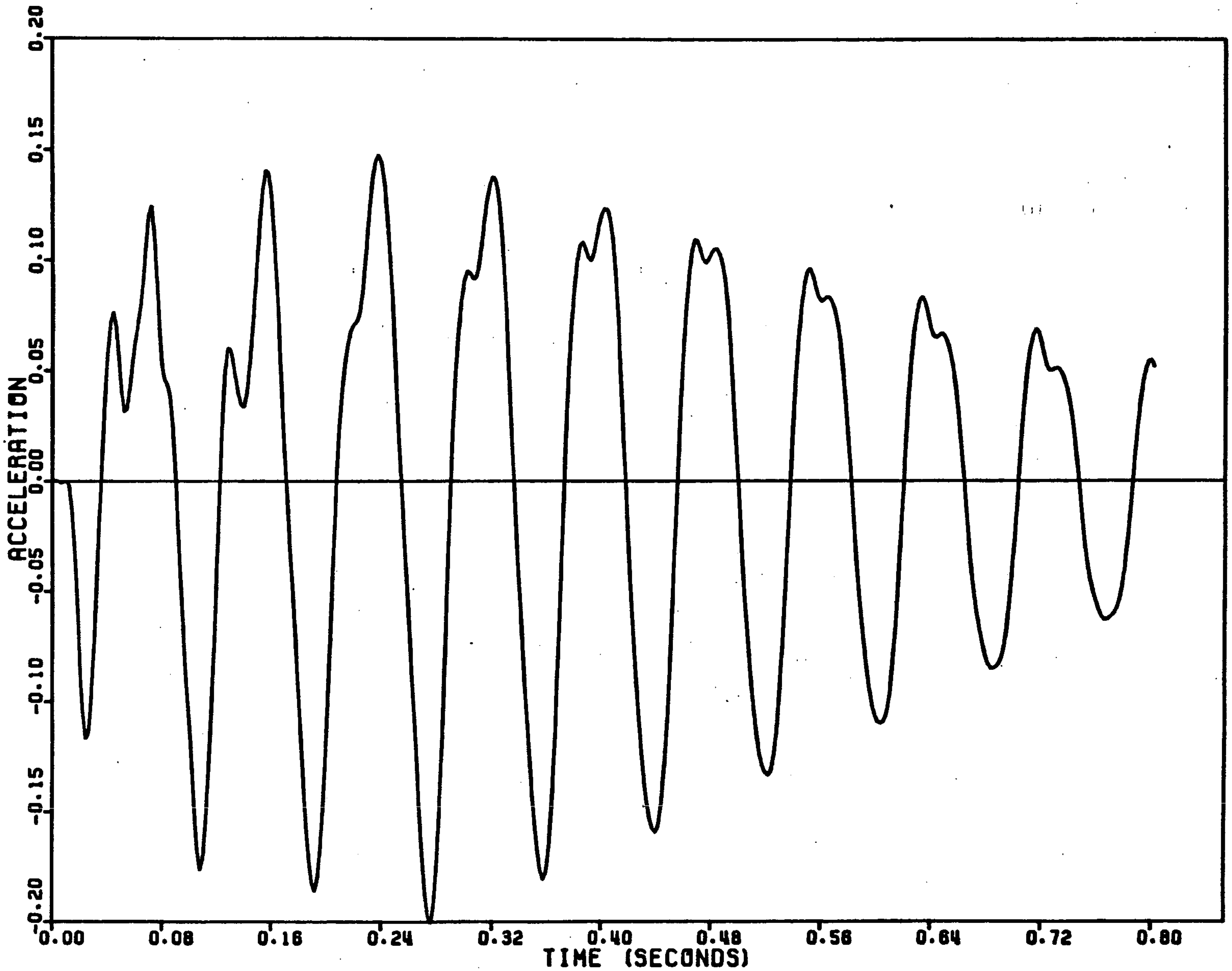


FIGURE C-125B. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-6
SRV-ALL LOADING- RECORD 126 - VERT. ACCELERATION (G), NPTS = 402, DT = .0020

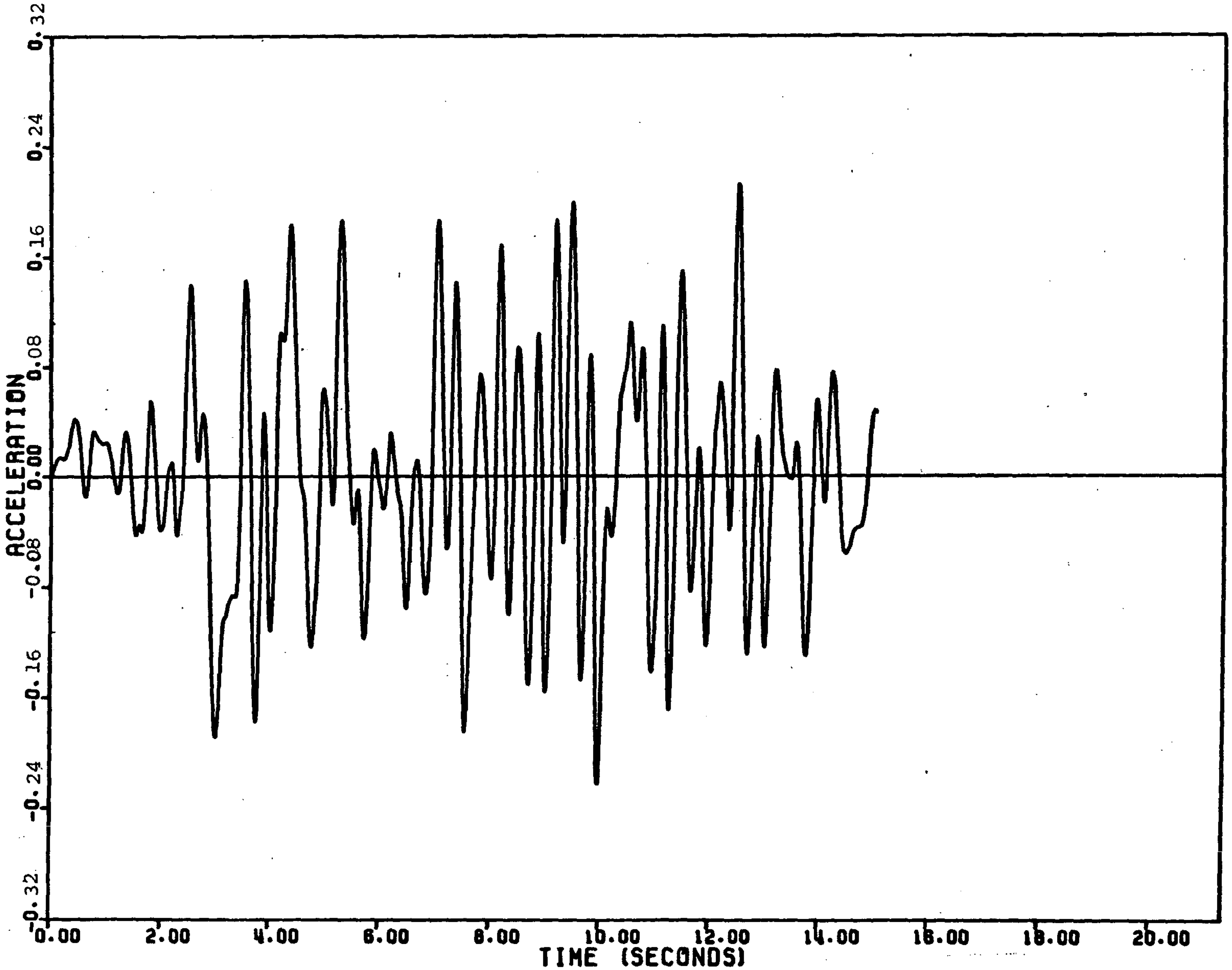


FIGURE C-126A. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-11
SSE LOADING - RECORD 107 - N - S ACCELERATION (G), NPTS = 1504, DT = .0100

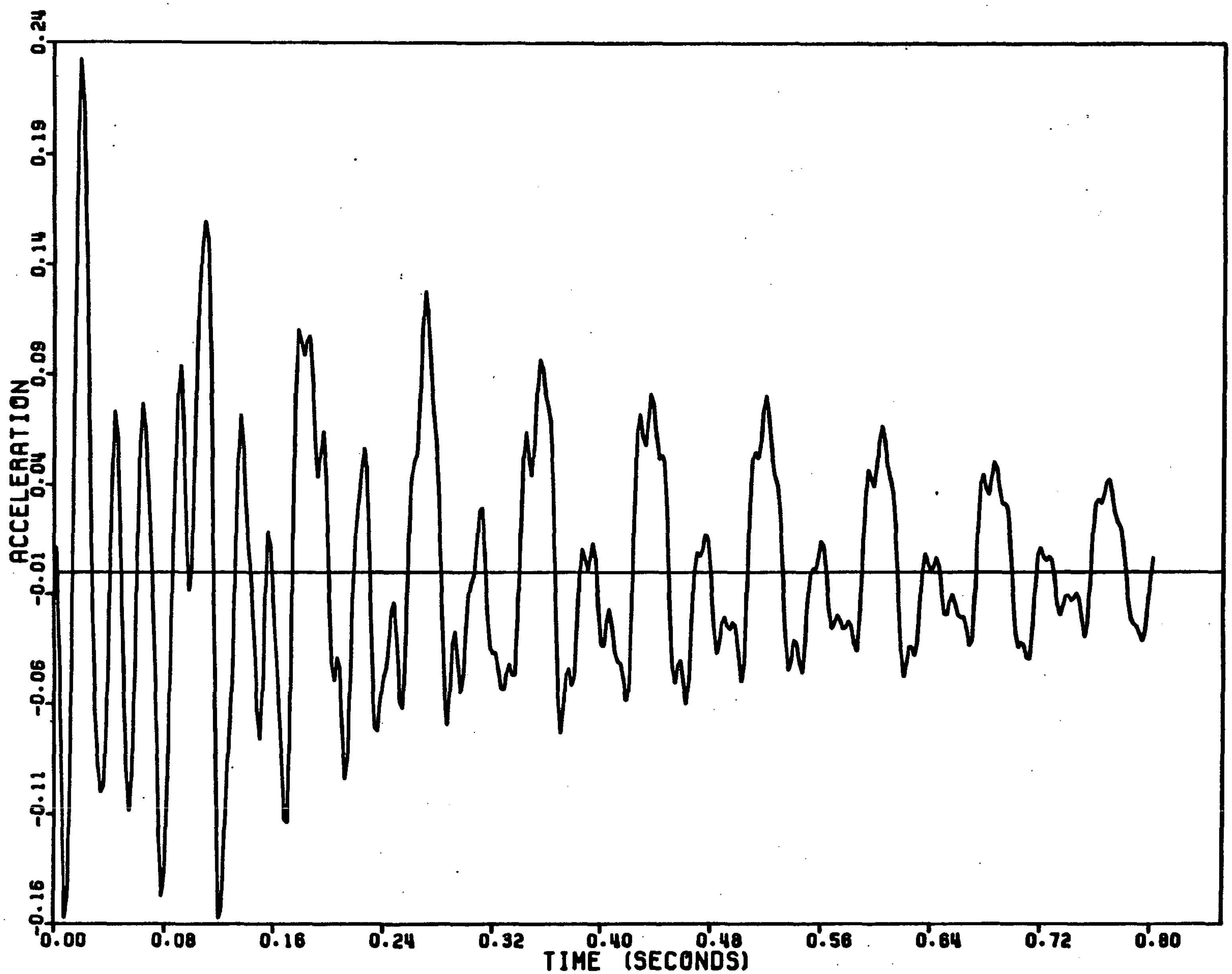


FIGURE C-126B. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-11
SRV-ALL LOADING- RECORD 128 - RADIAL ACCELERATION (G), NPTS = 402, DT = .0020

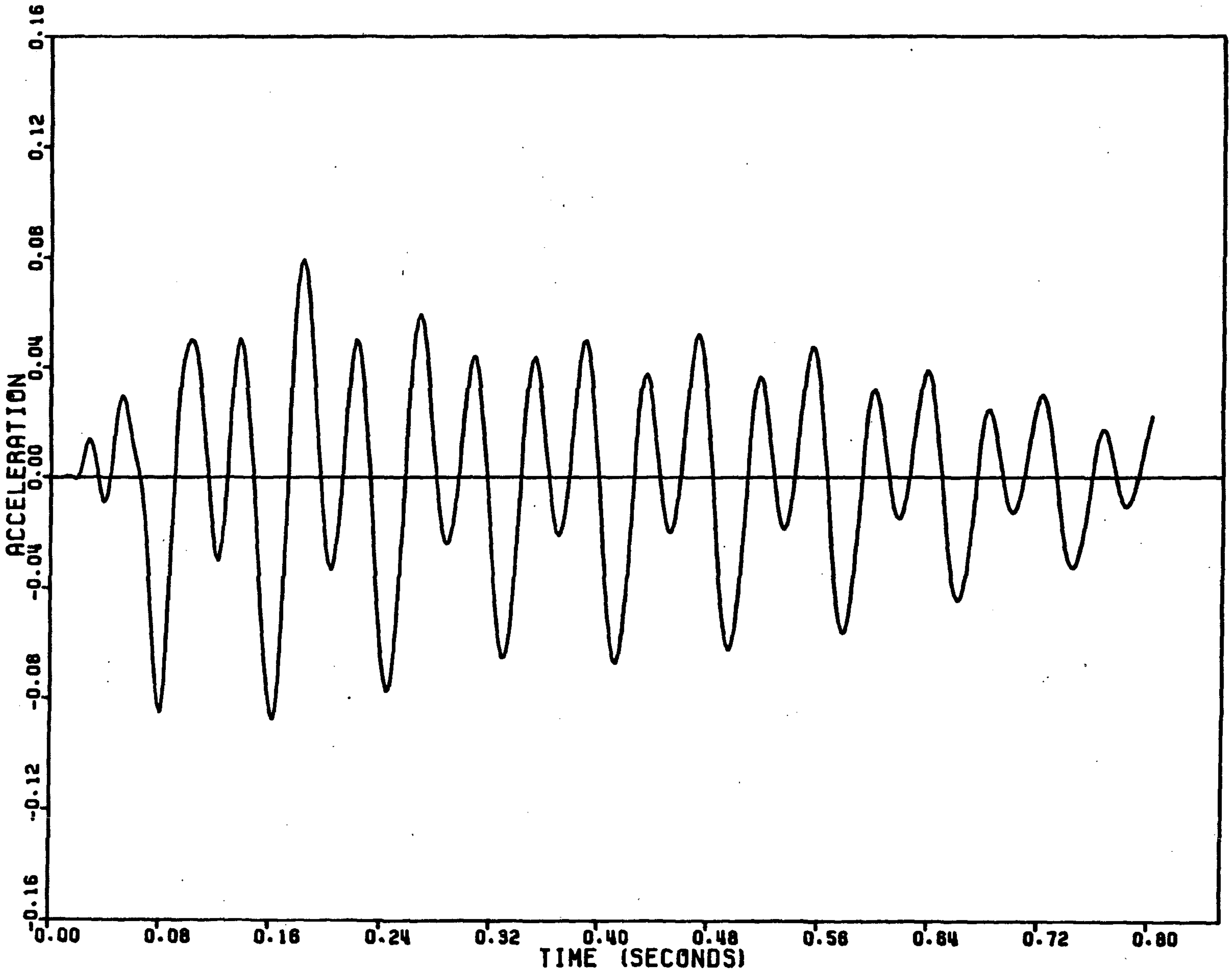


FIGURE C-127A. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-5
SRV-1 LOADING - RECORD 112 - RADIAL ACCELERATION (G), NPTS = 402, DT = .0020

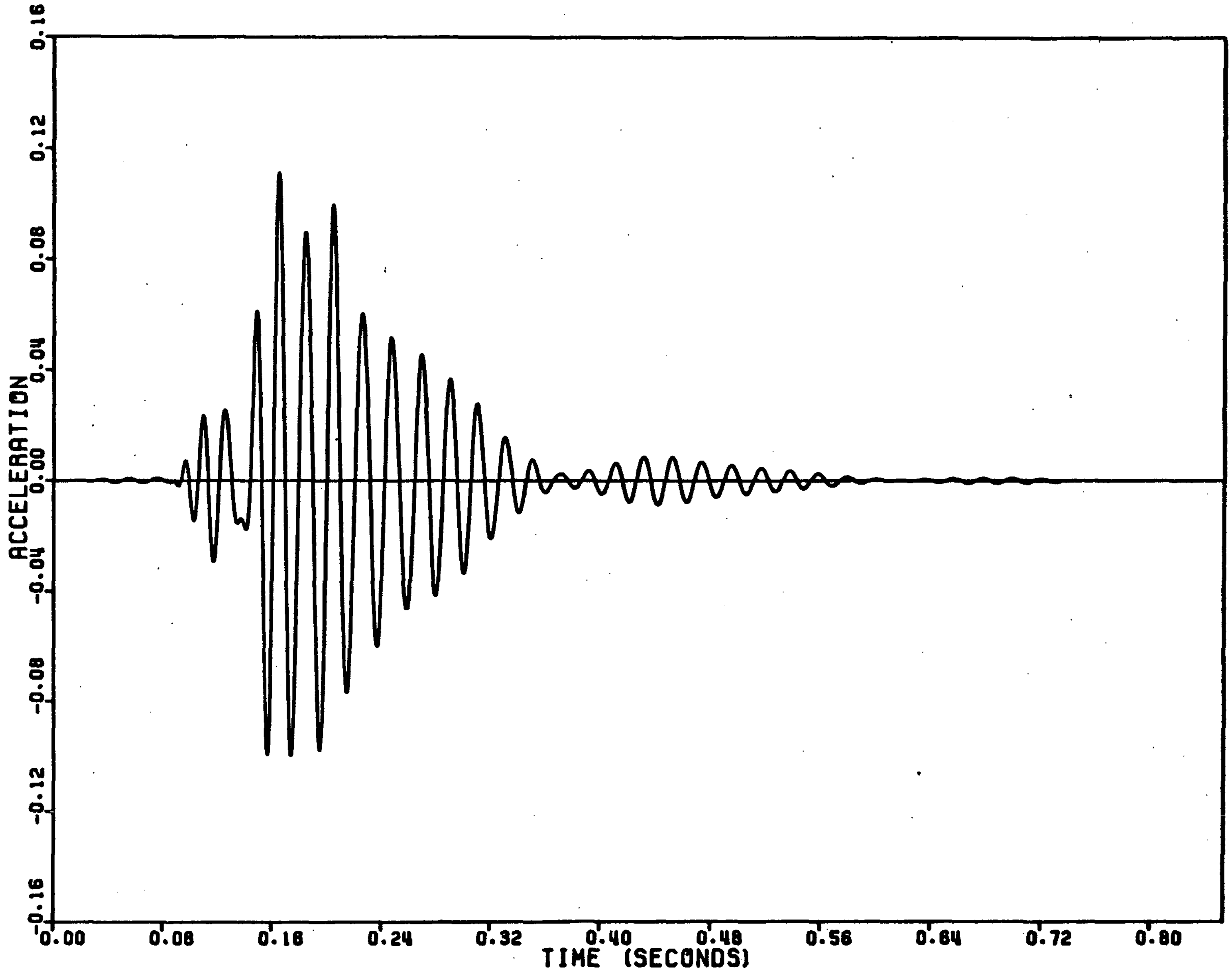


FIGURE C-127B. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-5
CHUG LOADING - RECORD 133 - RADIAL ACCELERATION (G), NPTS = 1466, DT = .0005

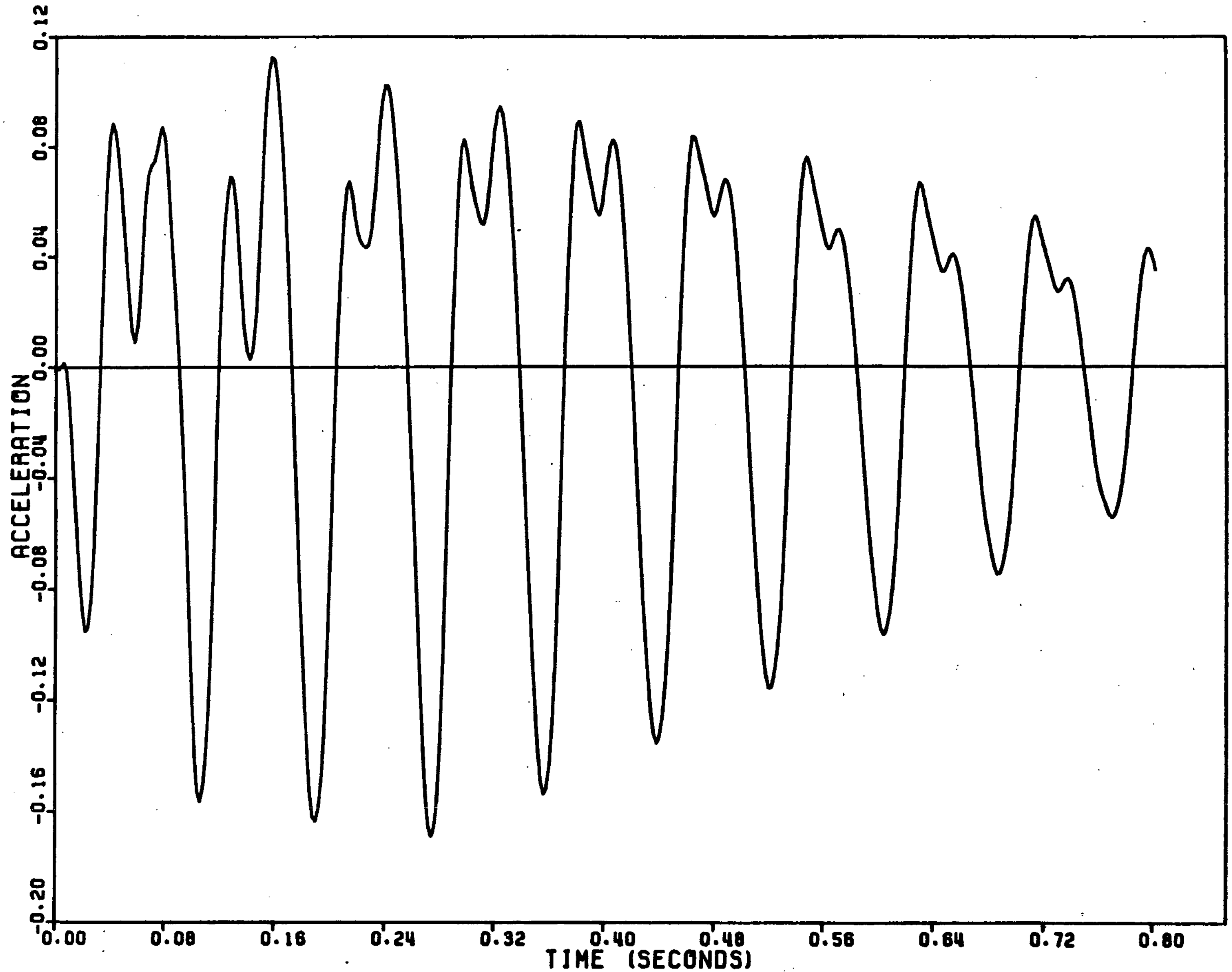


FIGURE C-128A. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-9
SRV-ALL LOADING- RECORD 127 - VERT. ACCELERATION (G), NPTS = 402, DT = .0020

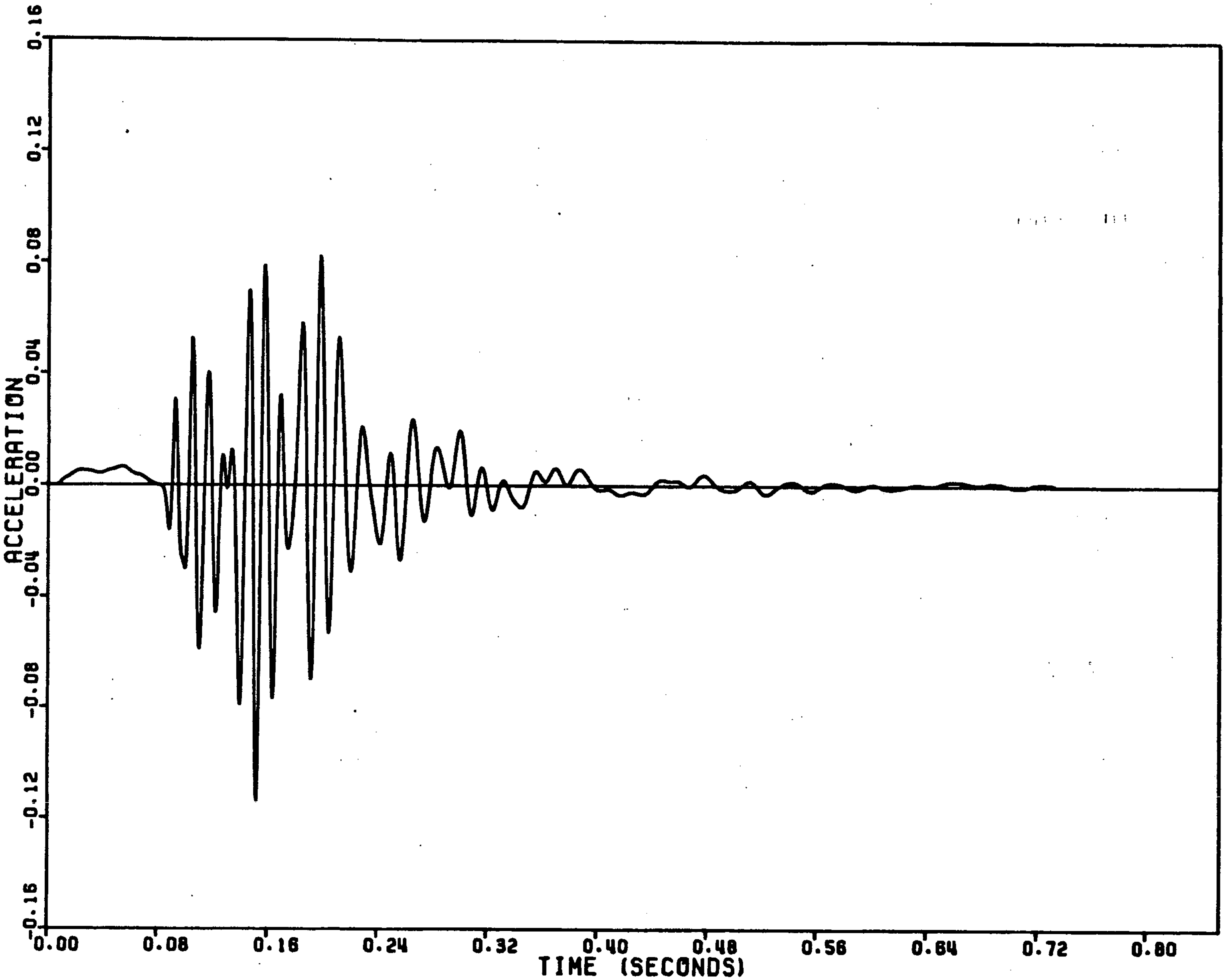


FIGURE C-128B. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-9
CHUG LOADING - RECORD 134 - VERT. ACCELERATION (G), NPTS = 1466, DT = .0005

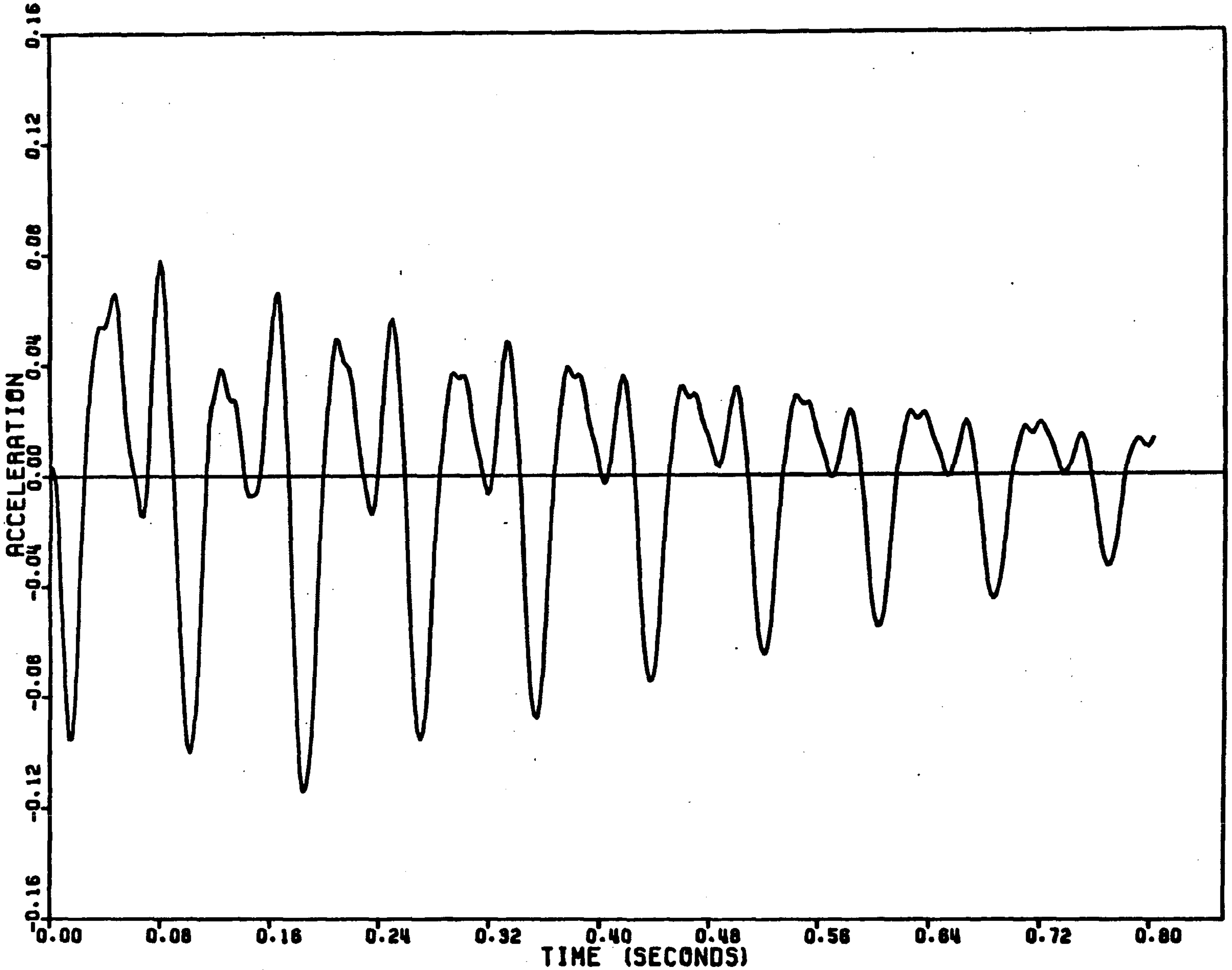


FIGURE C-129A. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-12
SRV-ALL LOADING- RECORD 128 - VERT. ACCELERATION (G), NPTS = 402, DT = .0020

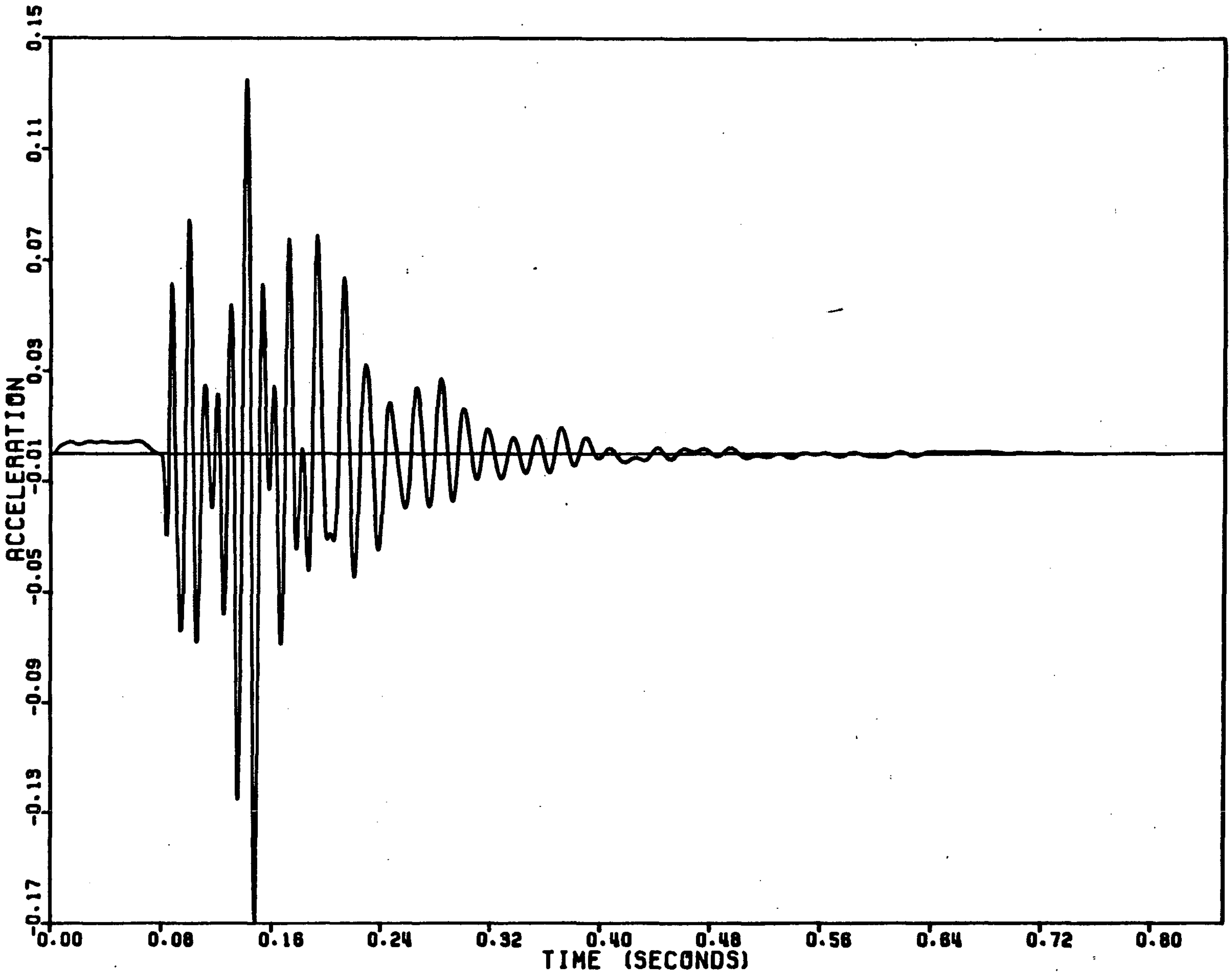


FIGURE C-129B. BOP EQUIPMENT TIME HISTORIES, DRYWELL LOCATION 1-12
CHUG LOADING - RECORD 135 - VERT. ACCELERATION (G), NPTS = 1466, DT = .0005

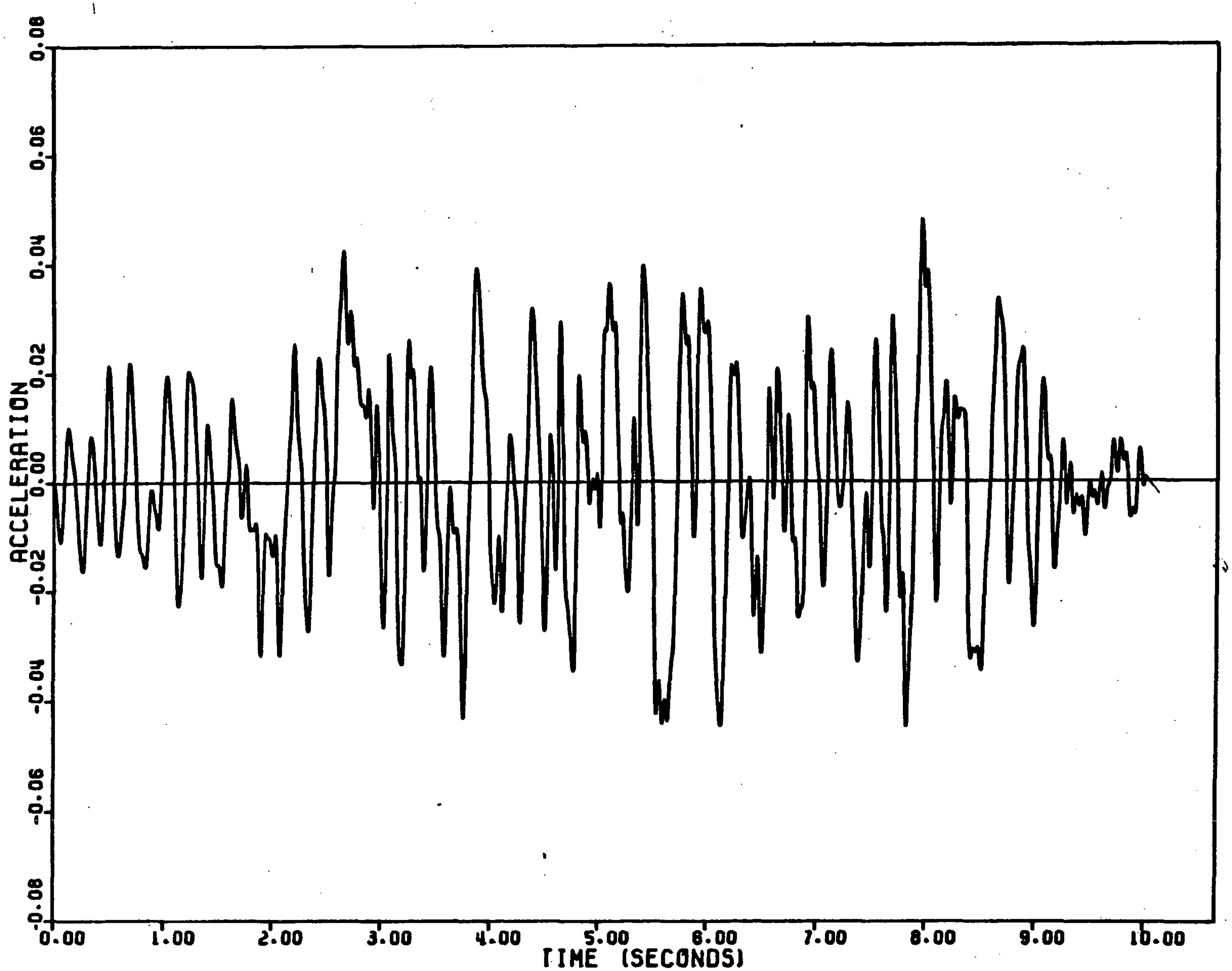


FIGURE C-130A. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-12
OBE LOADING RECORD 310 - VERT. ACCELERATION (G), NPTS = 2001, DT = .005

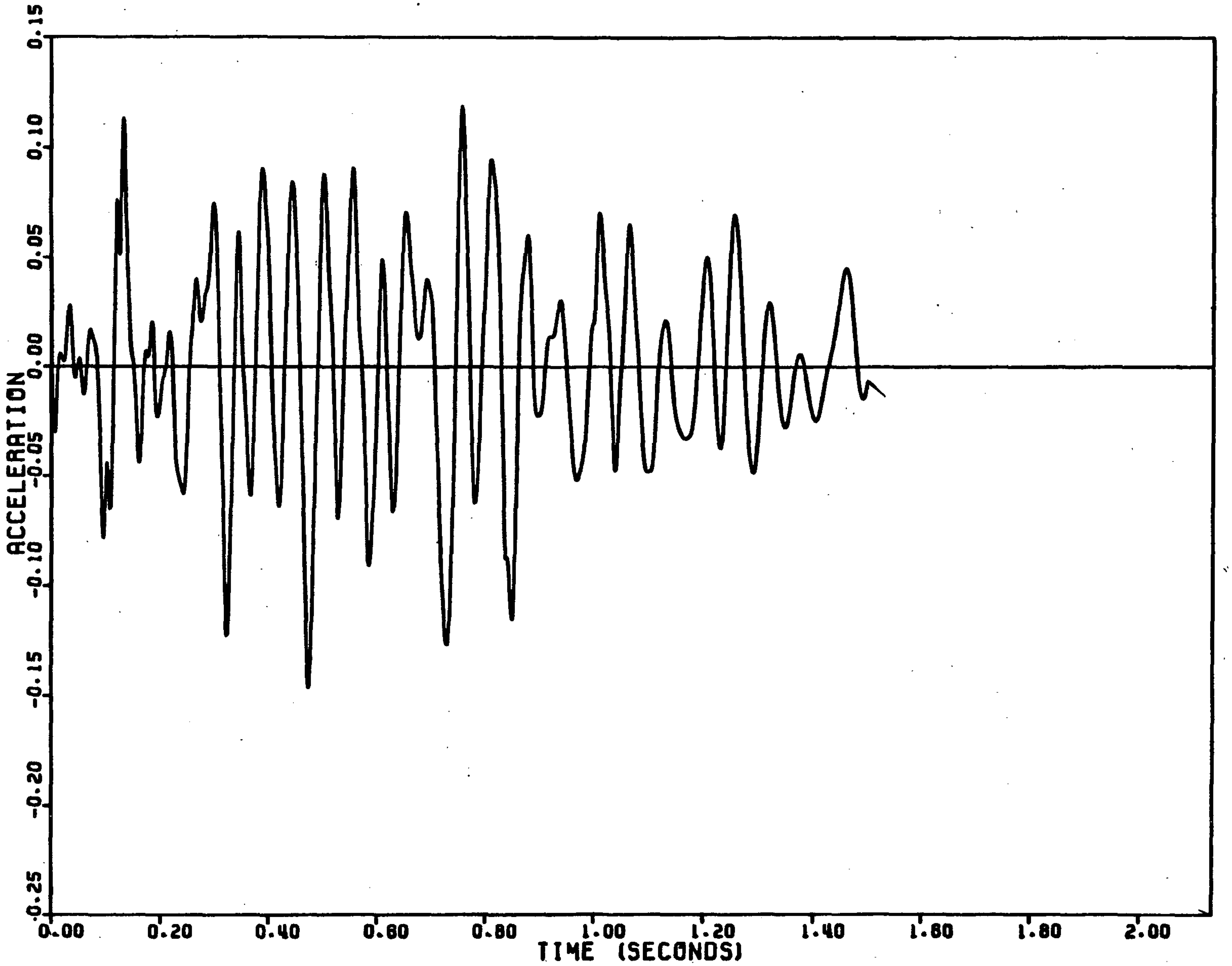


FIGURE C-130B. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-12
SRV-ALL LOADING - RECORD 360 - VERT. ACCELERATION (G), NPTS = 1500, DT = .0010

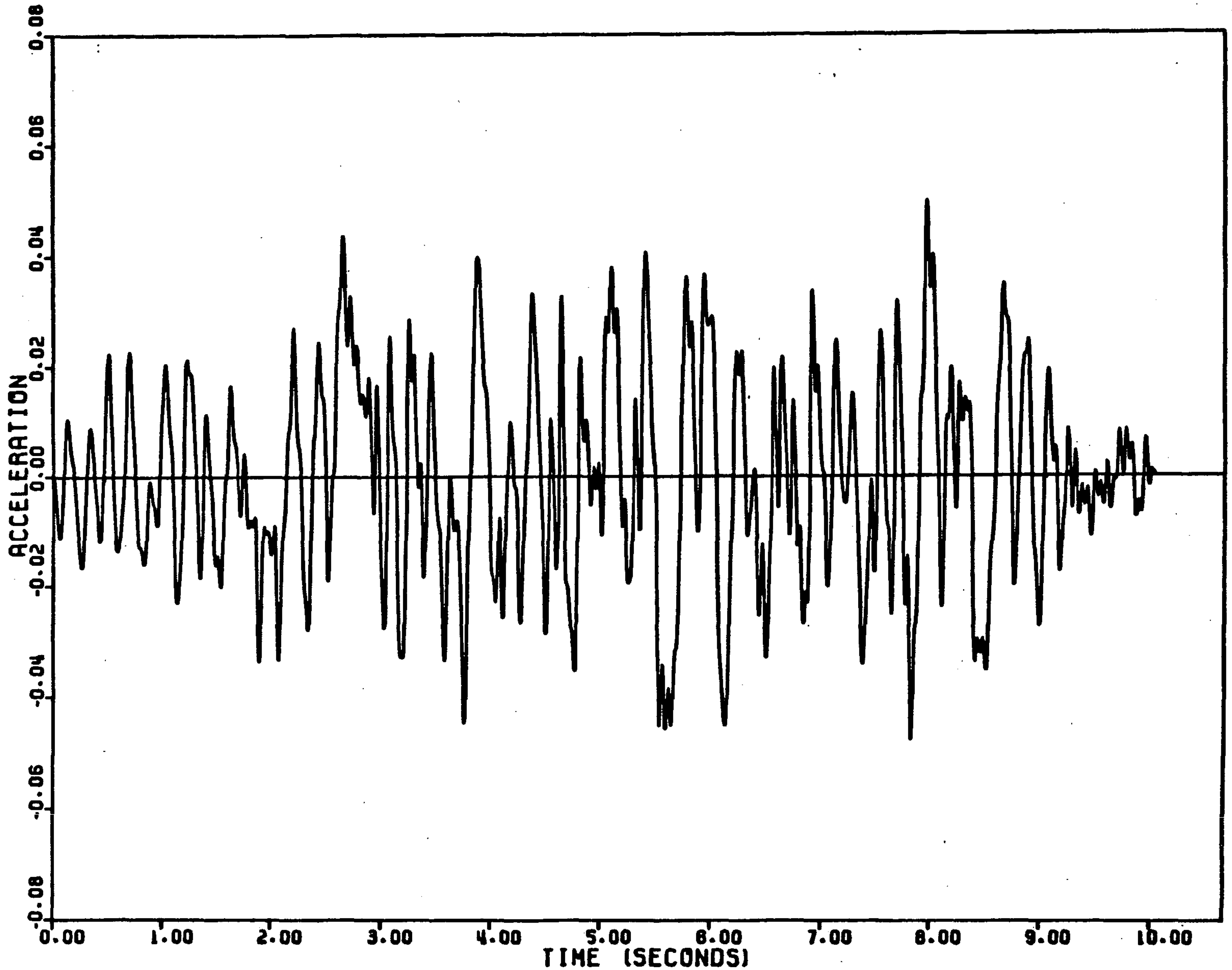


FIGURE C-131A. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-11
OBE LOADING RECORD 309 - VERT. ACCELERATION (G), NPTS = 2001, DT = .005

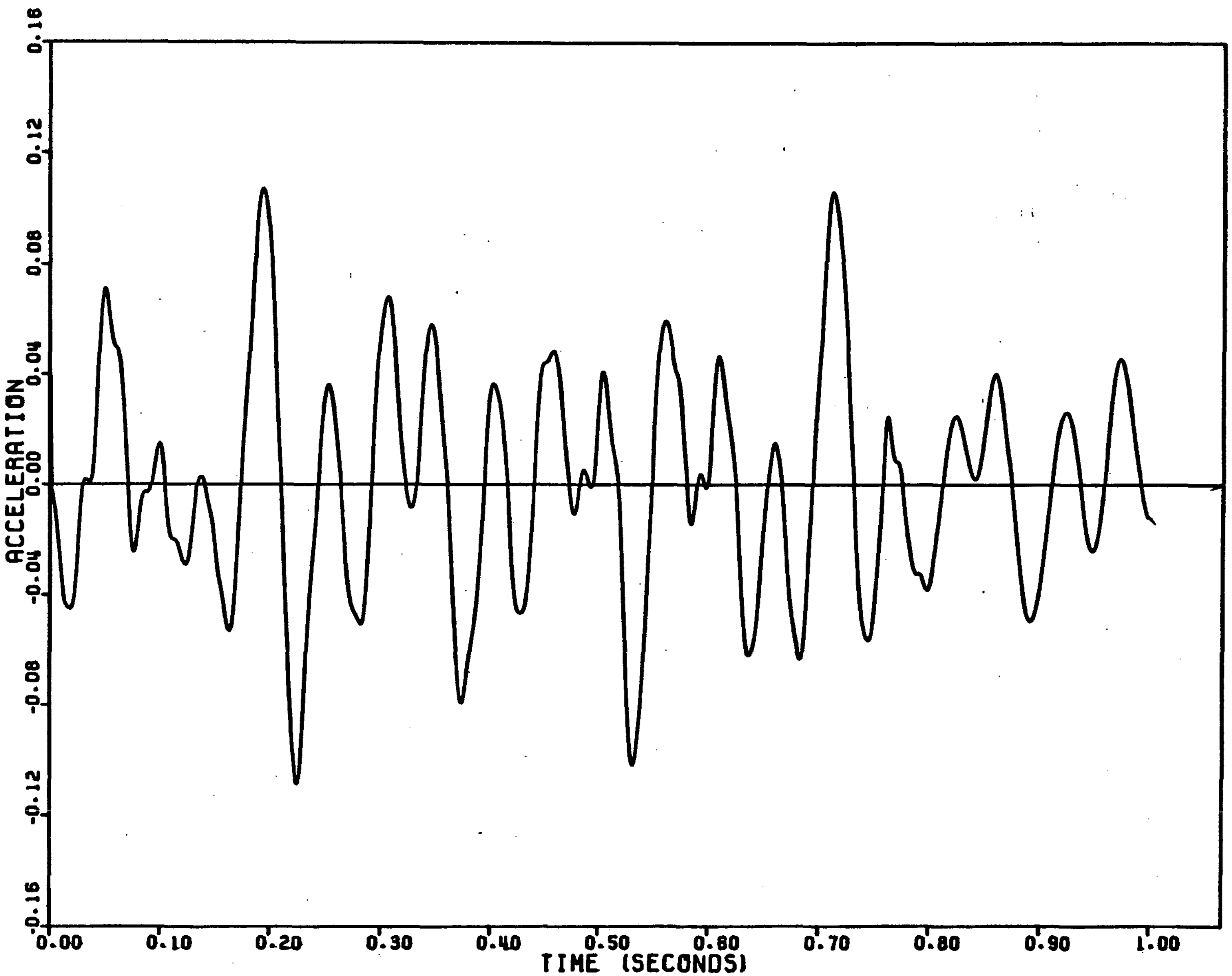


FIGURE C-131B. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-11
SRV-ADS LOADING - RECORD 339 - VERT. ACCELERATION (G), NPTS = 1000, DT = .0010

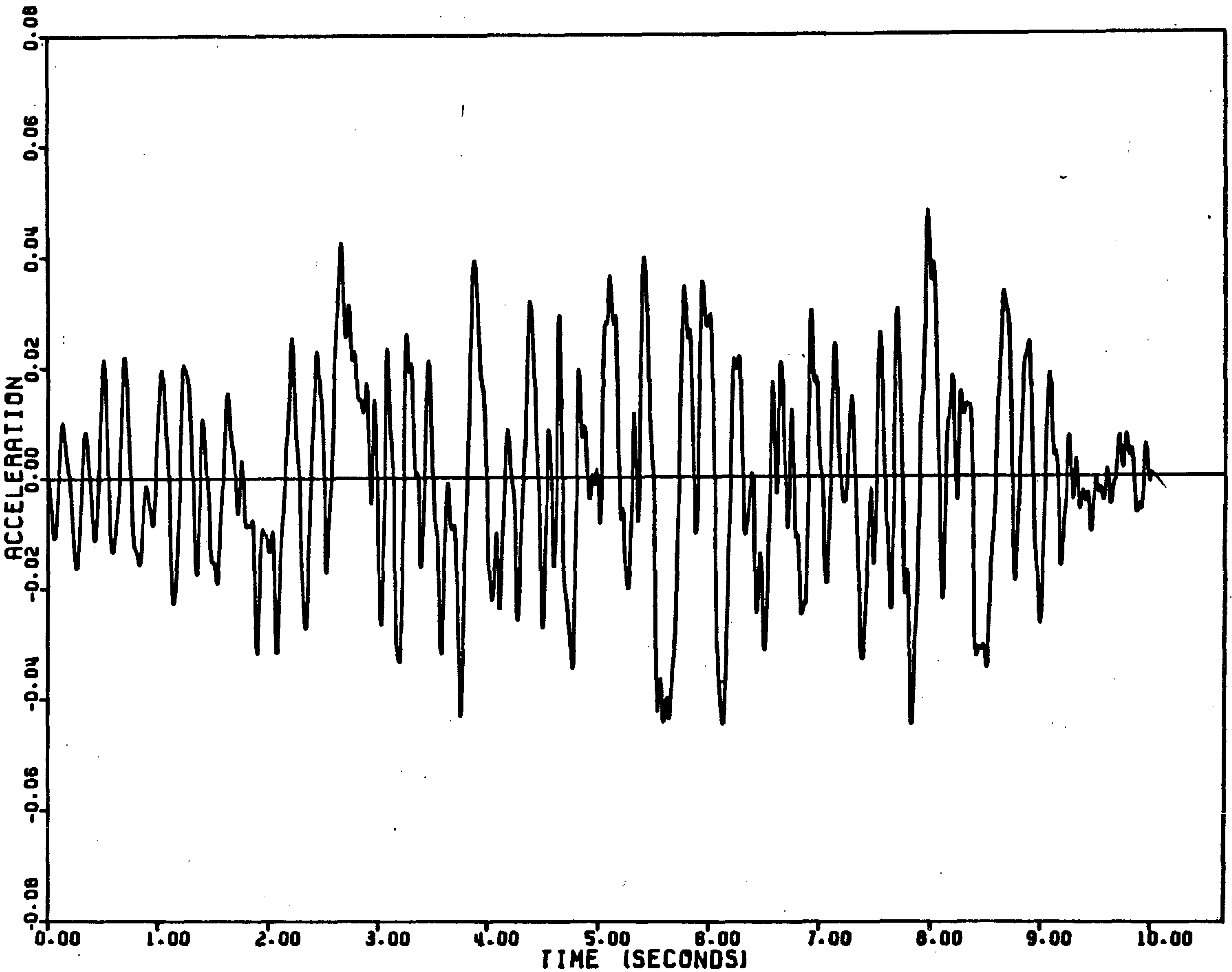


FIGURE C-132A. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-12
OBE LOADING RECORD 310 - VERT. ACCELERATION (G), NPTS = 2001, DT = .005

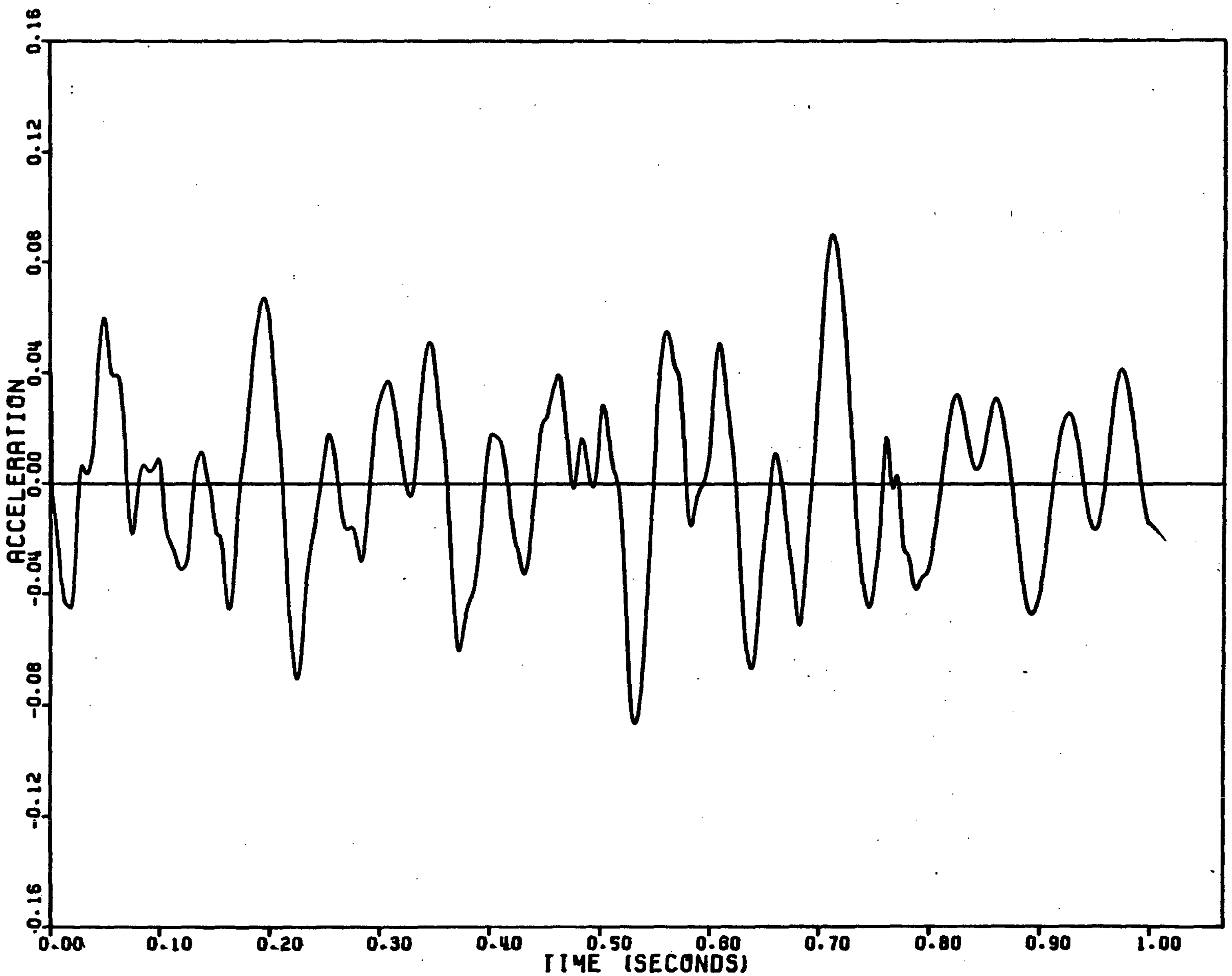


FIGURE C-132B. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-12
SRV-ADS LOADING - RECORD 340 - VERT. ACCELERATION (G), NPTS = 1000, DT = .0010

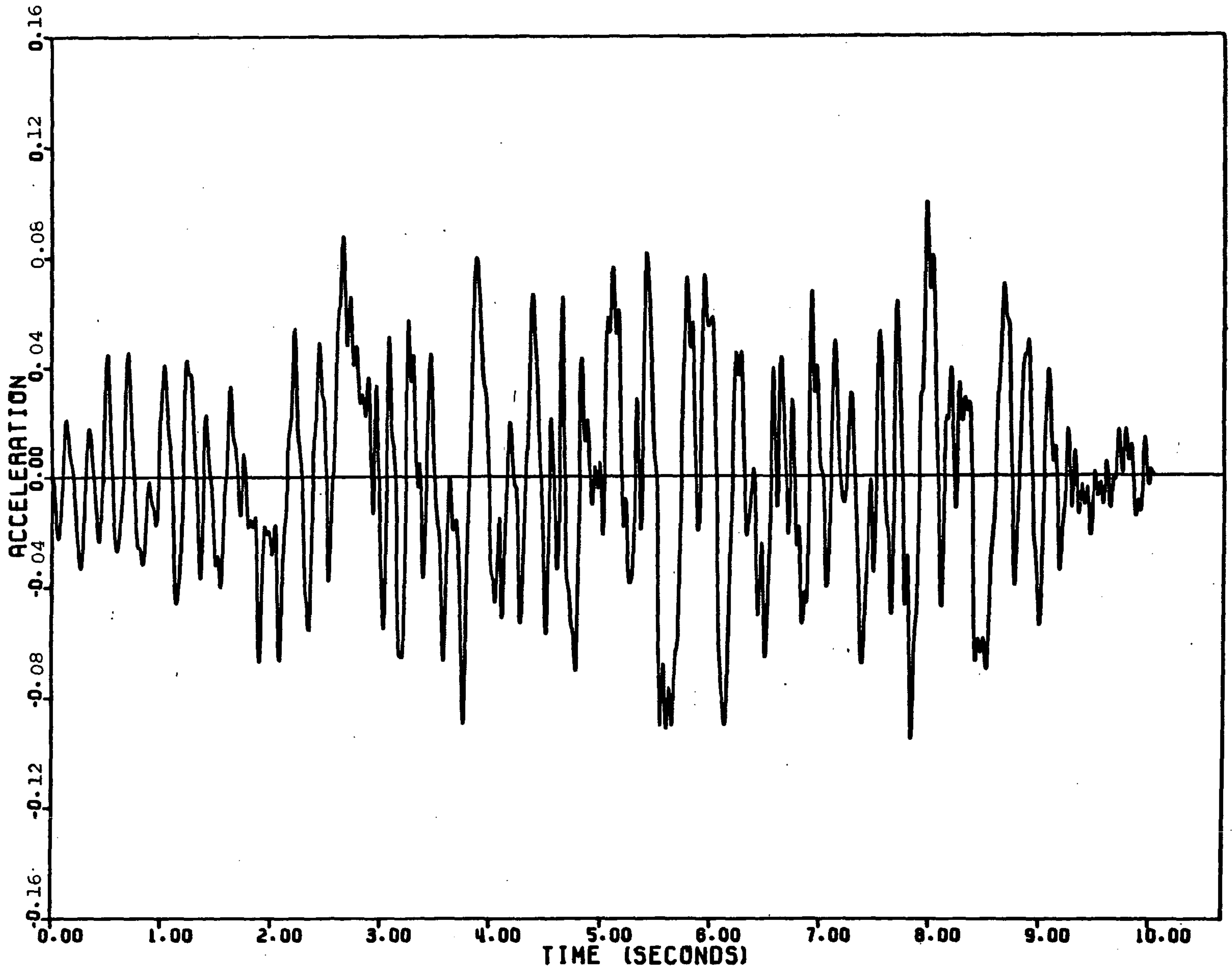


FIGURE C-133A. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-11
SSE LOADING RECORD 309 - VERT. ACCELERATION (G), NPTS = 2001, DT = .005

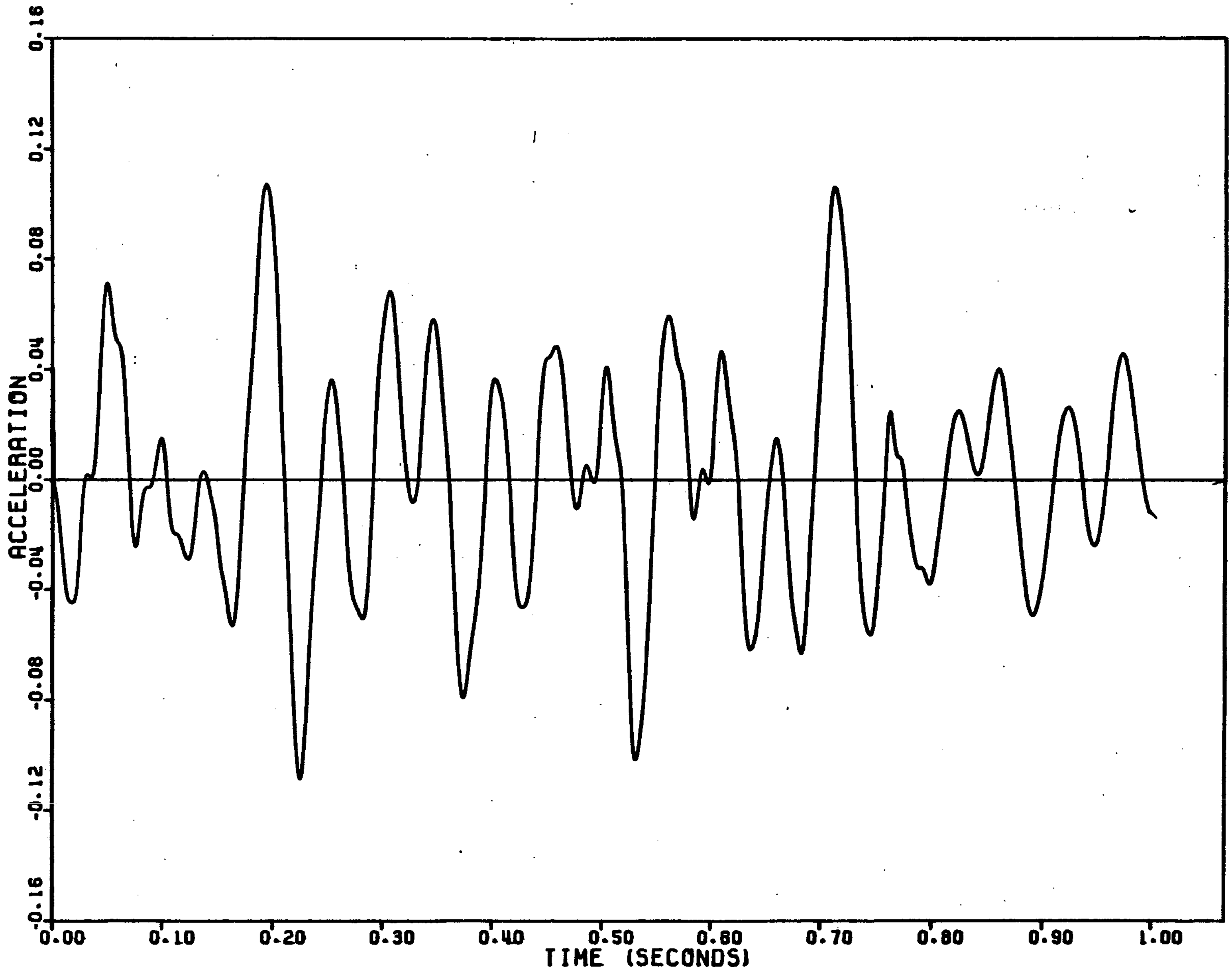


FIGURE C-133B. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-11
SRV-ADS LOADING - RECORD 339 - VERT. ACCELERATION (G), NPTS = 1000, DT = .0010

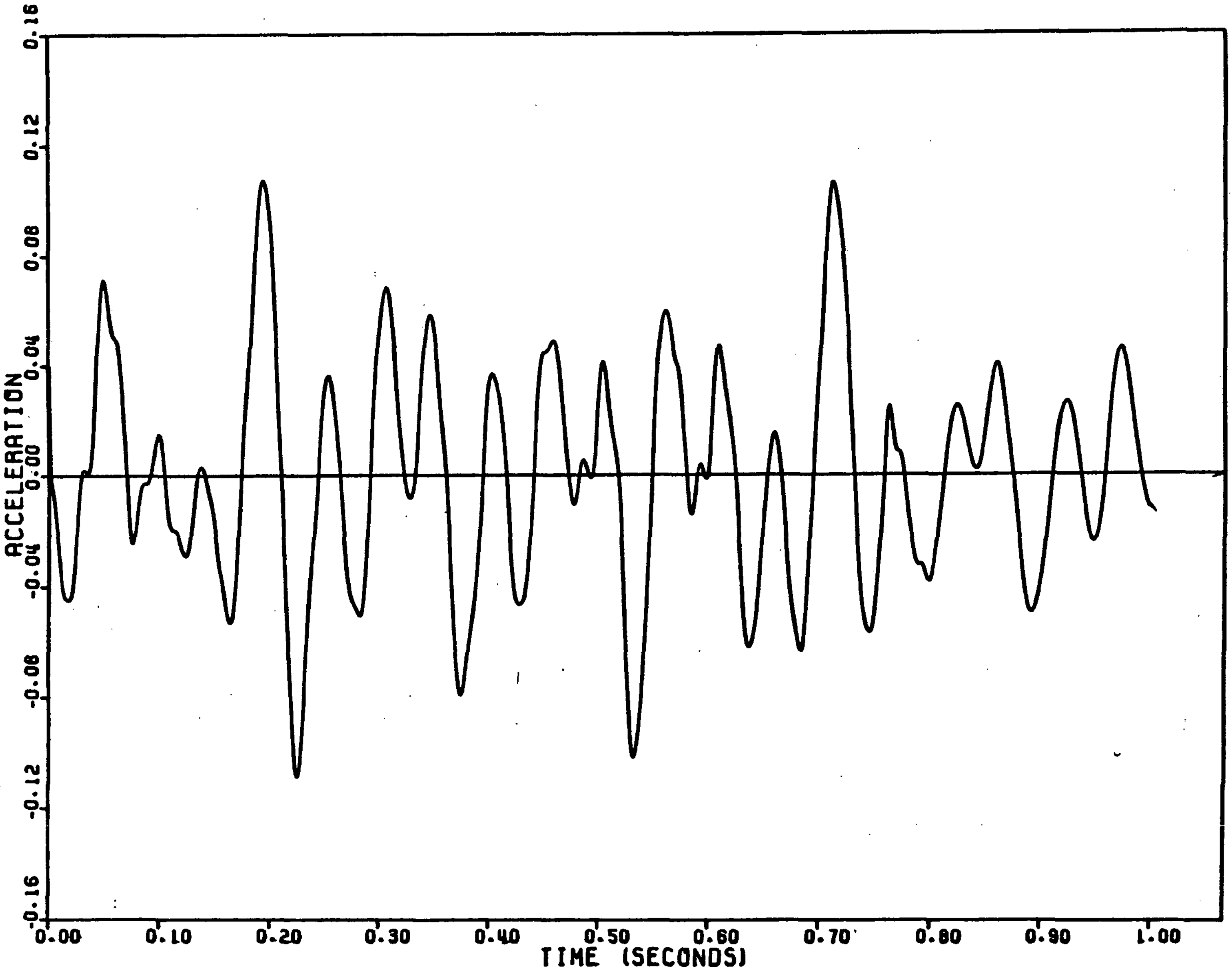


FIGURE C-134A. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-11
SRV-ADS LOADING - RECORD 339 - VERT. ACCELERATION (G), NPTS = 1000, DT = .0010

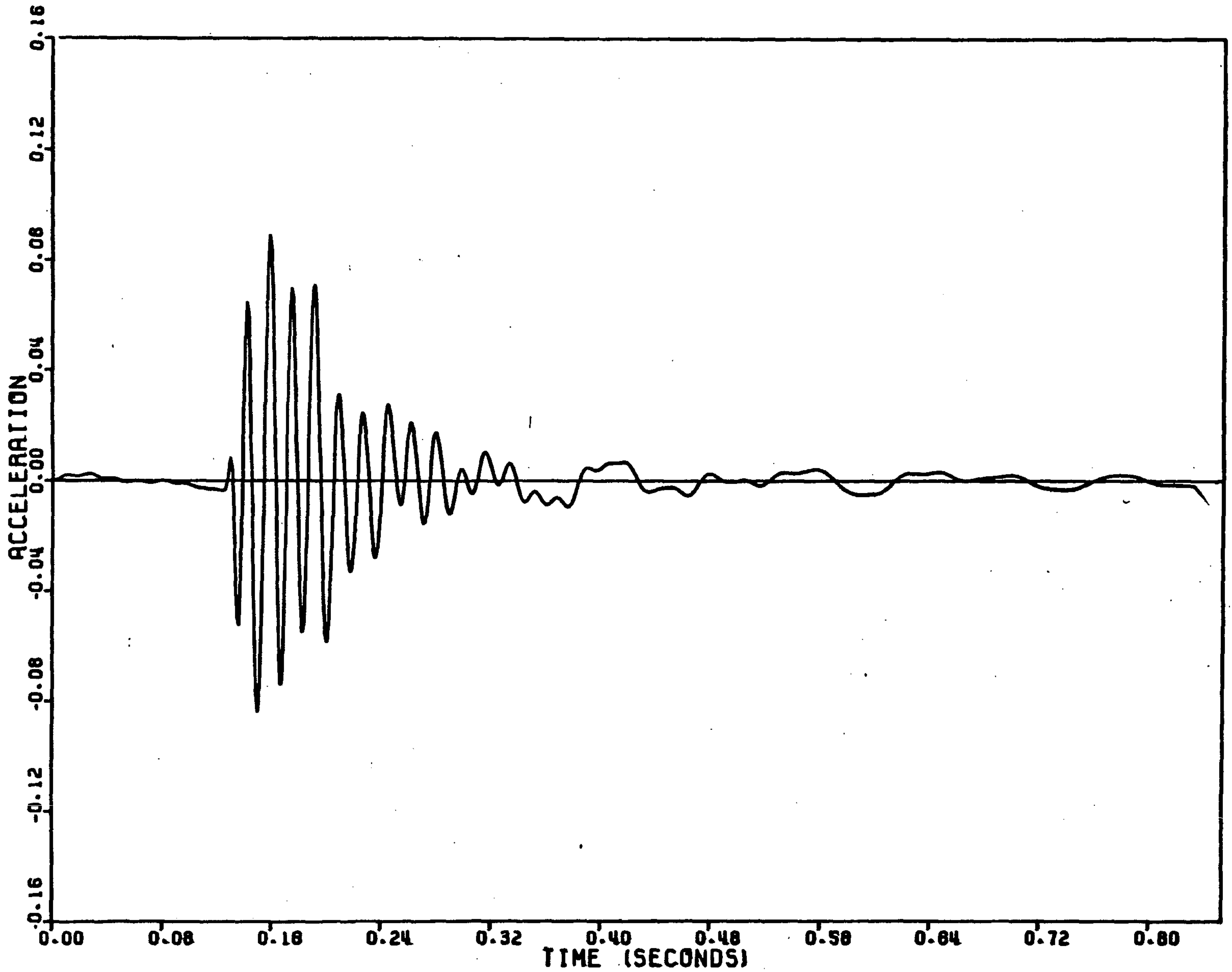


FIGURE C-134B. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-11
CHUG LOADING - RECORD 369 - VERT. ACCELERATION (G), NPTS = 833, DT = .0010

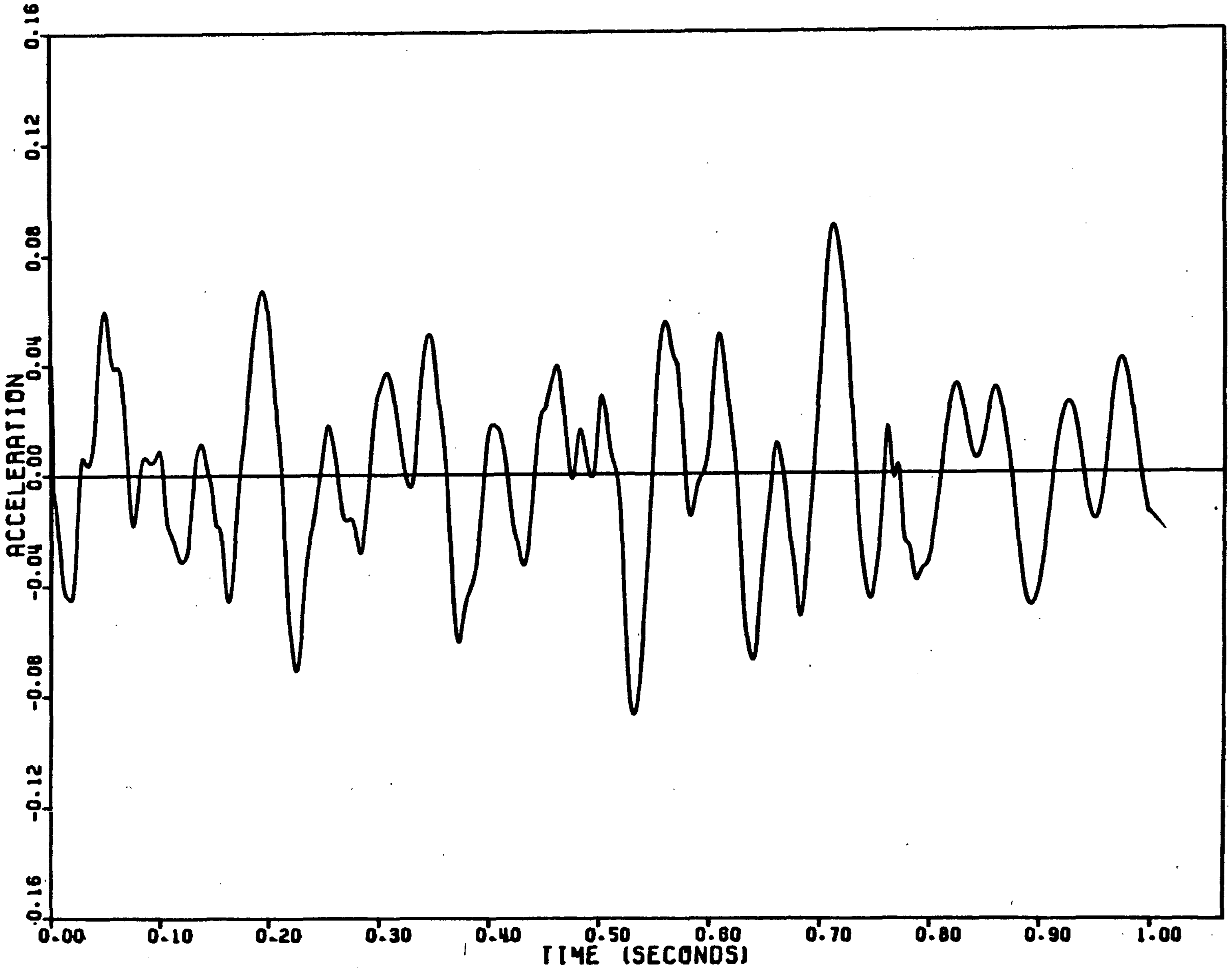


FIGURE C-135A. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-12
SRV-ADS LOADING - RECORD 340 - VERT. ACCELERATION (G), NPTS = 1000, DT = .0010

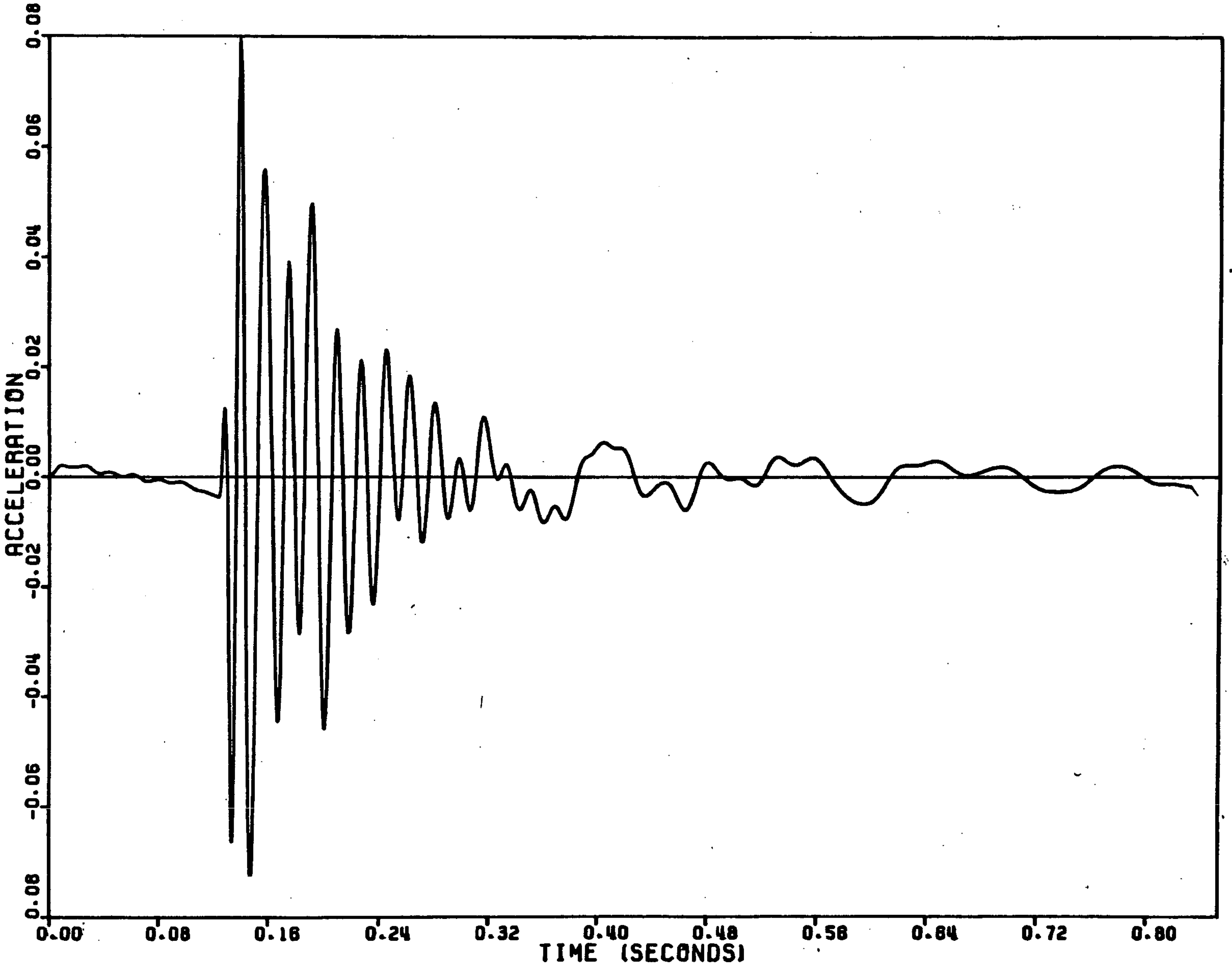


FIGURE C-135B. EQUIPMENT T.H., CONTAINMENT VESSEL LOCATION 3-12
CHUG LOADING - RECORD 370 - VERT. ACCELERATION (G), NPTS = 833, DT = .0010

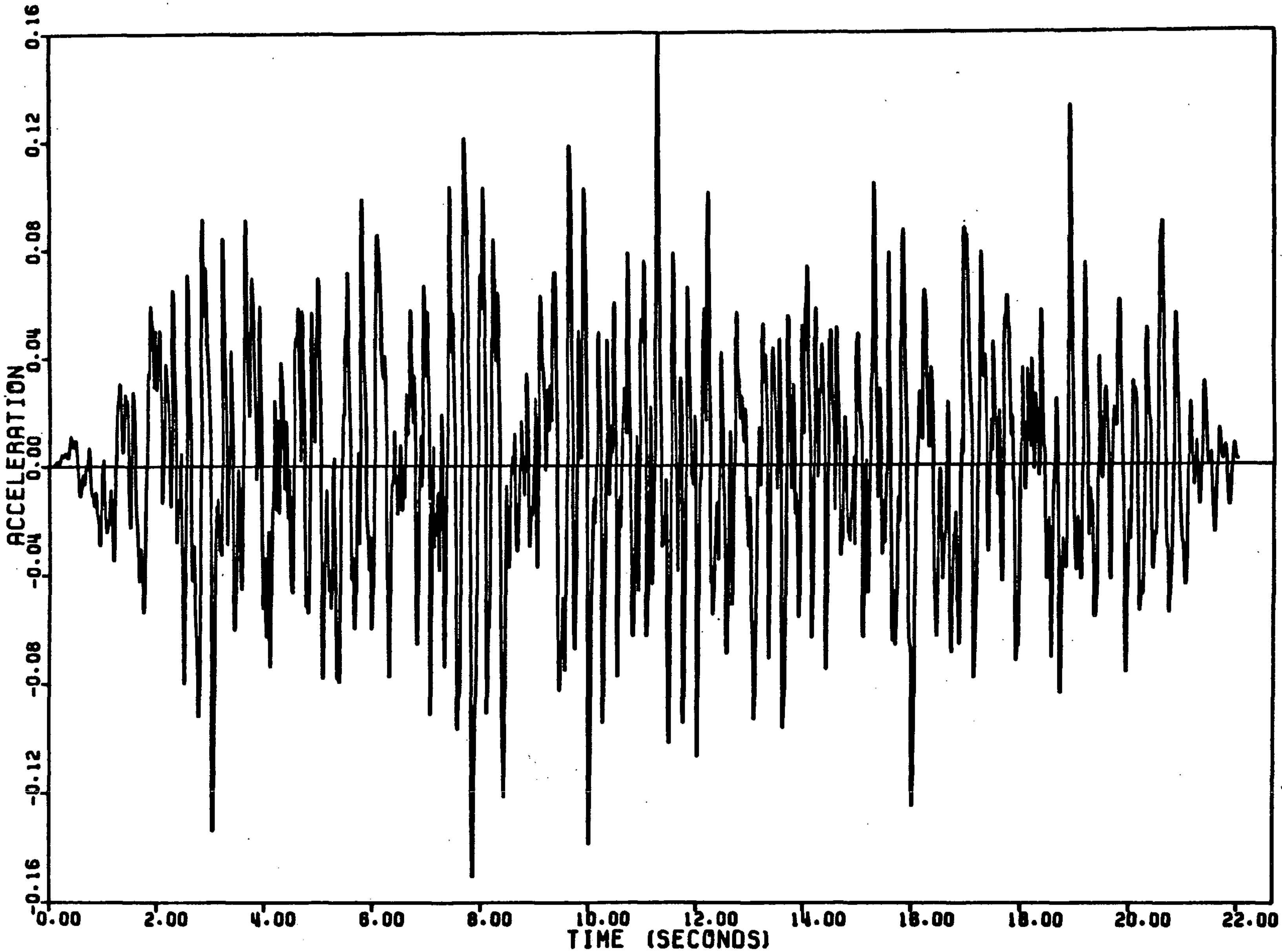


FIGURE C-136A. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 4-23
OBE LOADING - RECORD 10 - RADIAL ACCELERATION (G), NPTS = 2200, DT = .0100

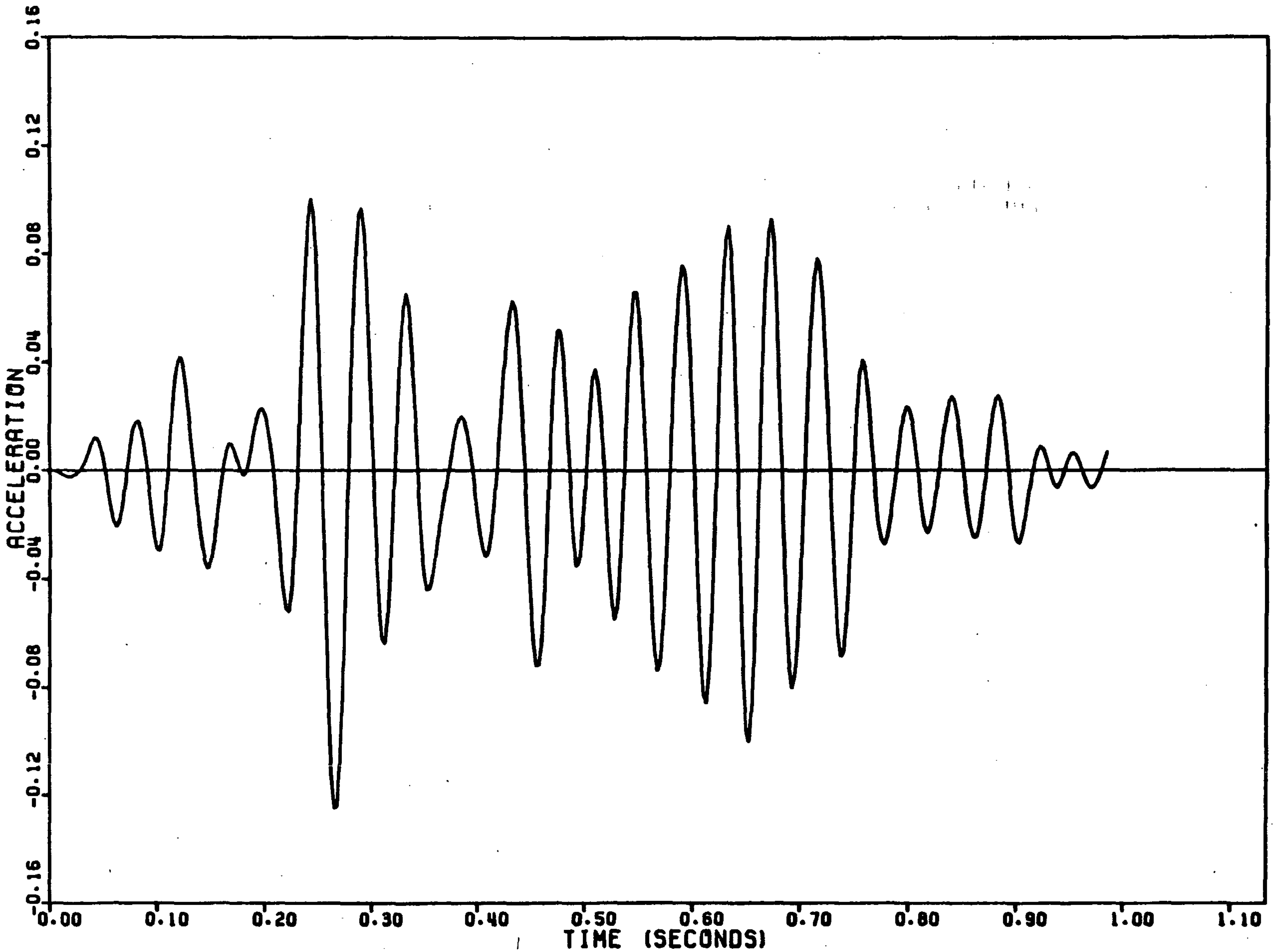


FIGURE C-136B. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 4-23
SRV-ALL LOADING- RECORD 30 - RADIAL ACCELERATION (G), NPTS = 395, DT = .0025

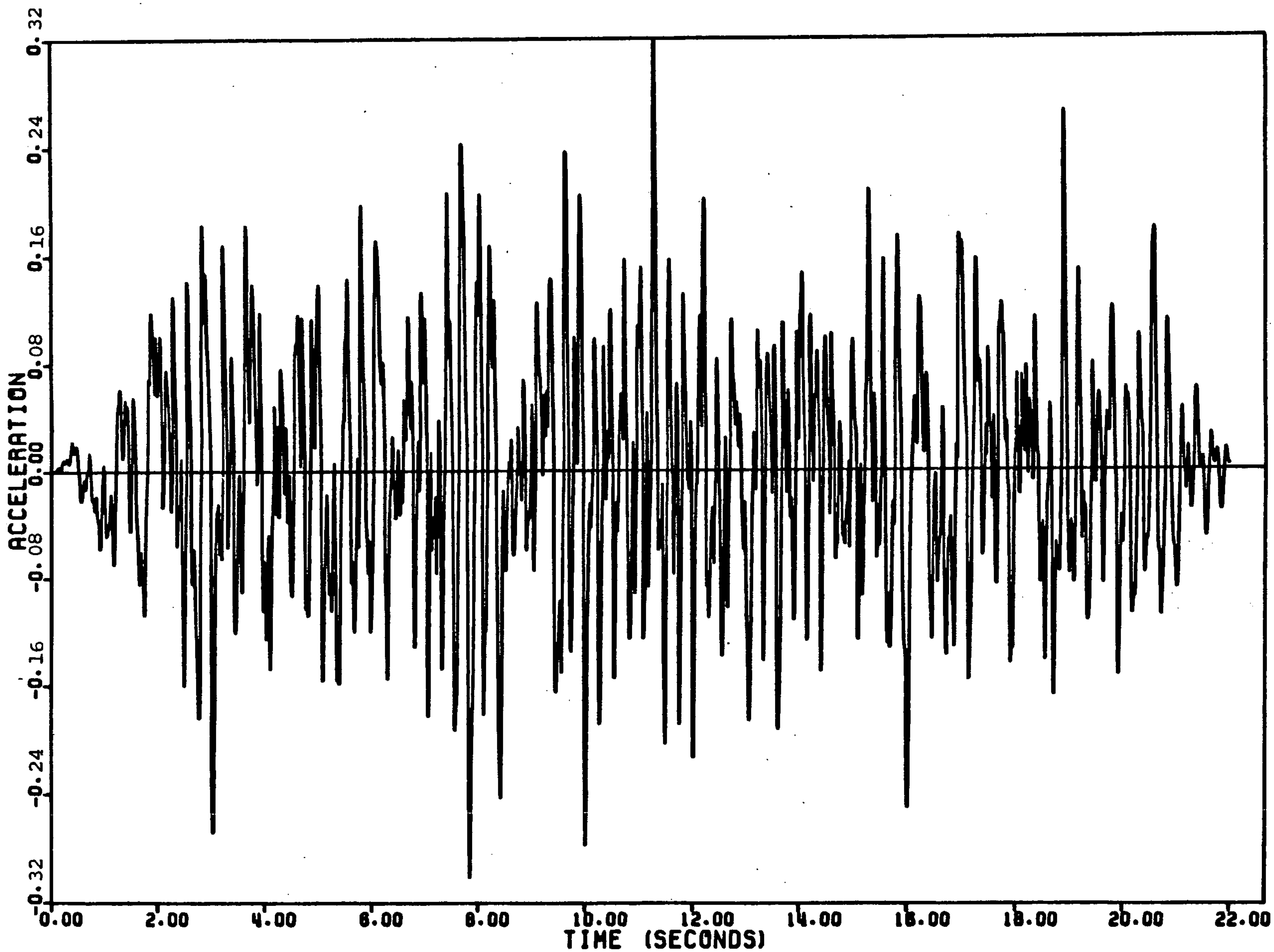


FIGURE C-137A. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 4-23
SSE LOADING - RECORD 10 - RADIAL ACCELERATION (G), NPTS = 2200, DT = .0100

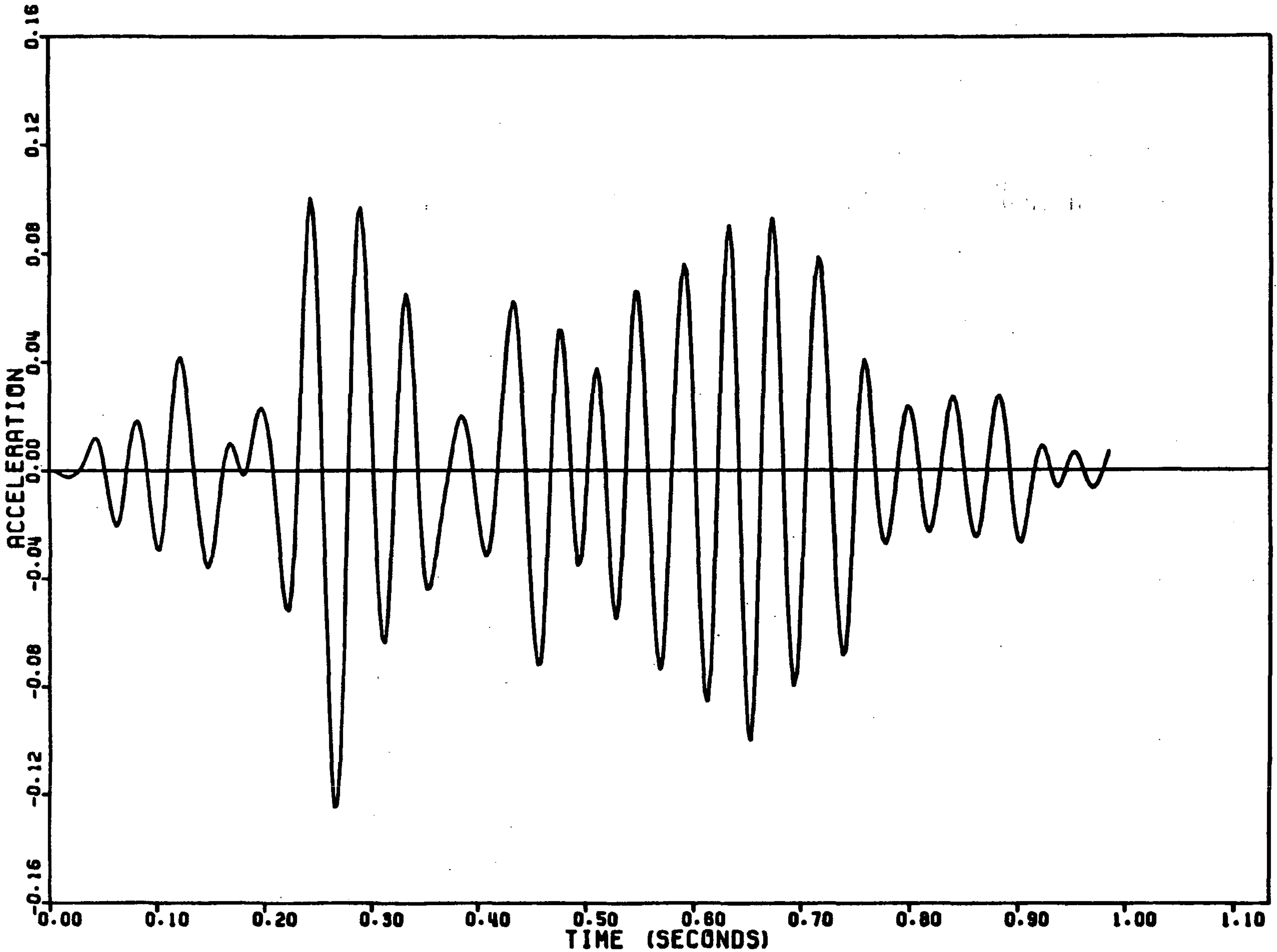


FIGURE C-137B. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 4-23
SRV-ALL LOADING- RECORD 30 - RADIAL ACCELERATION (G), NPTS = 395, DT = .0025

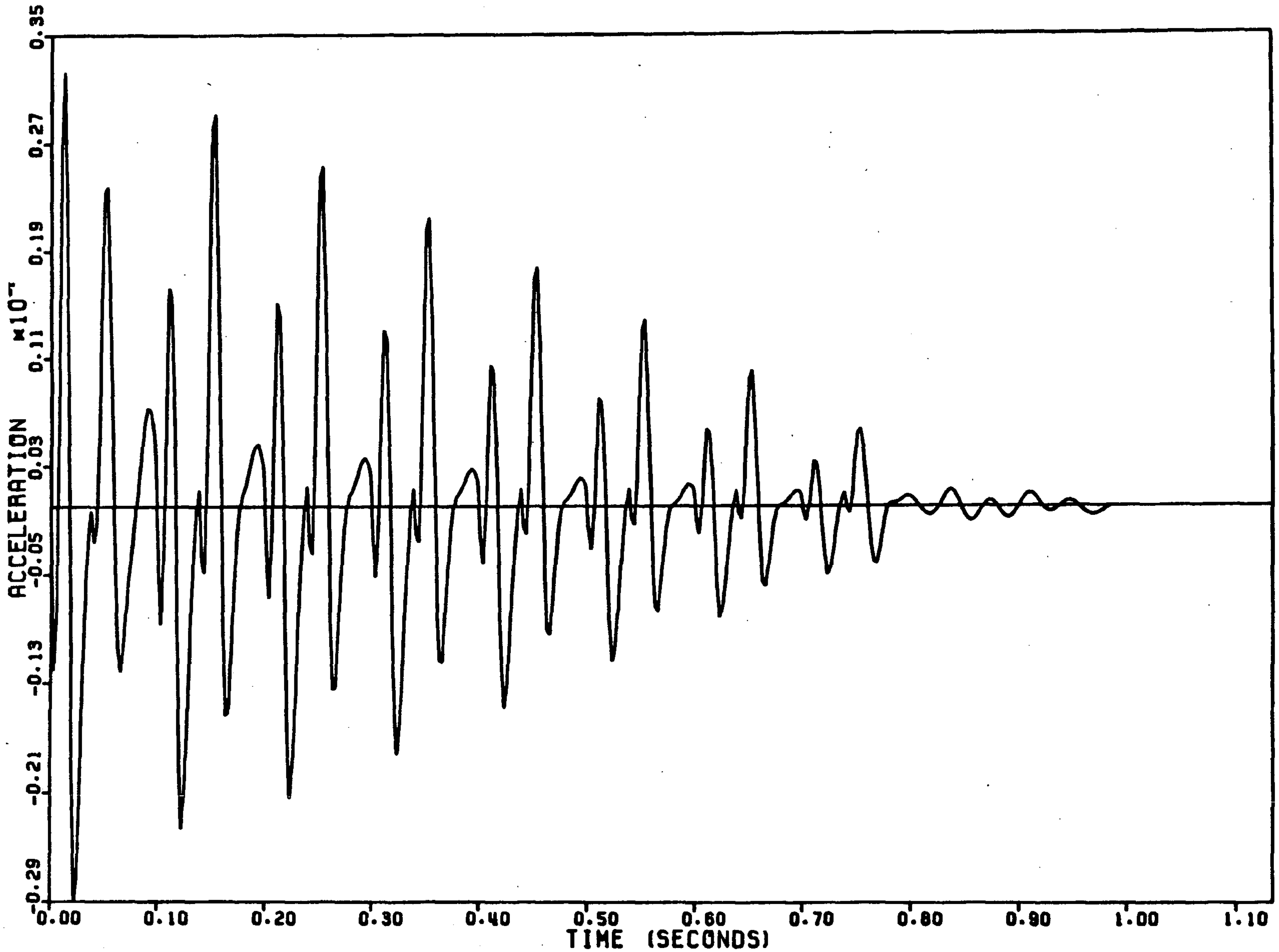


FIGURE C-138A. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 4-22
SRV-1 LOADING - RECORD 20A - VERT. ACCELERATION (G), NPTS = 395, DT = .0025

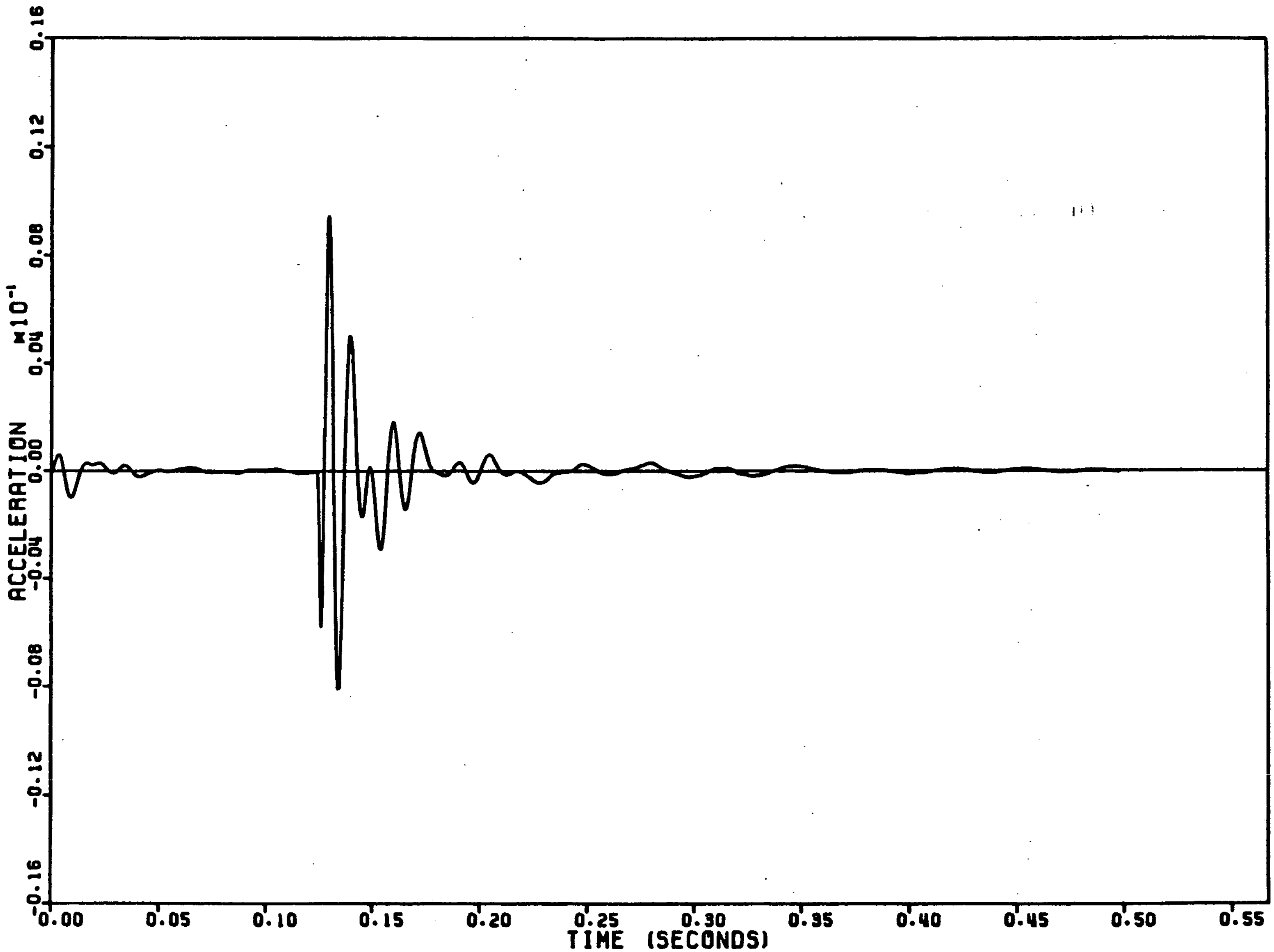


FIGURE C-138B. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 4-22
CHUG LOADING - RECORD 40A - VERT. ACCELERATION (G), NPTS = 997, DT = .0005

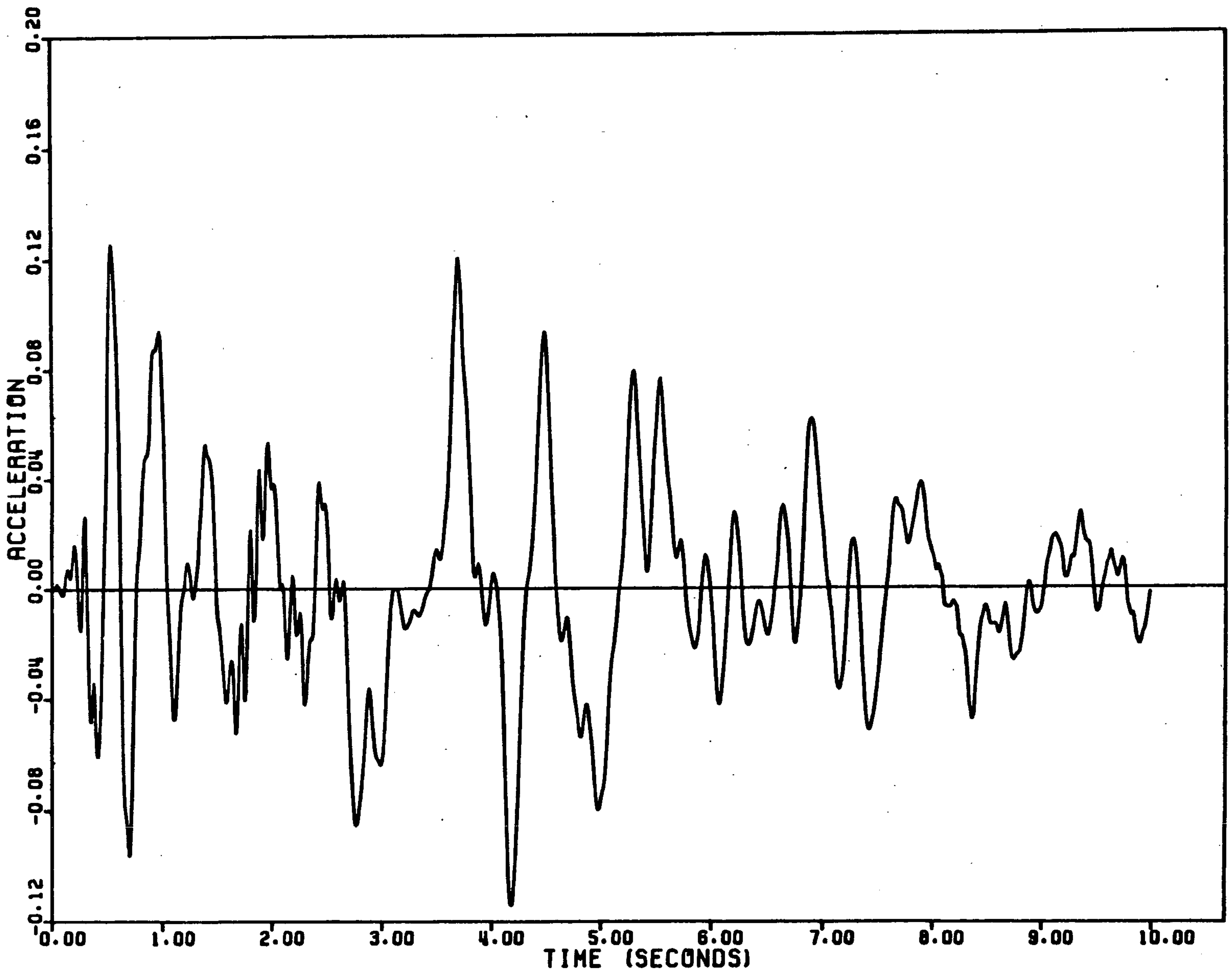


FIGURE C-139A. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-23
OBE LOADING RECORD 403 N - S ACCELERATION (G), NPTS = 999, DT = .0100

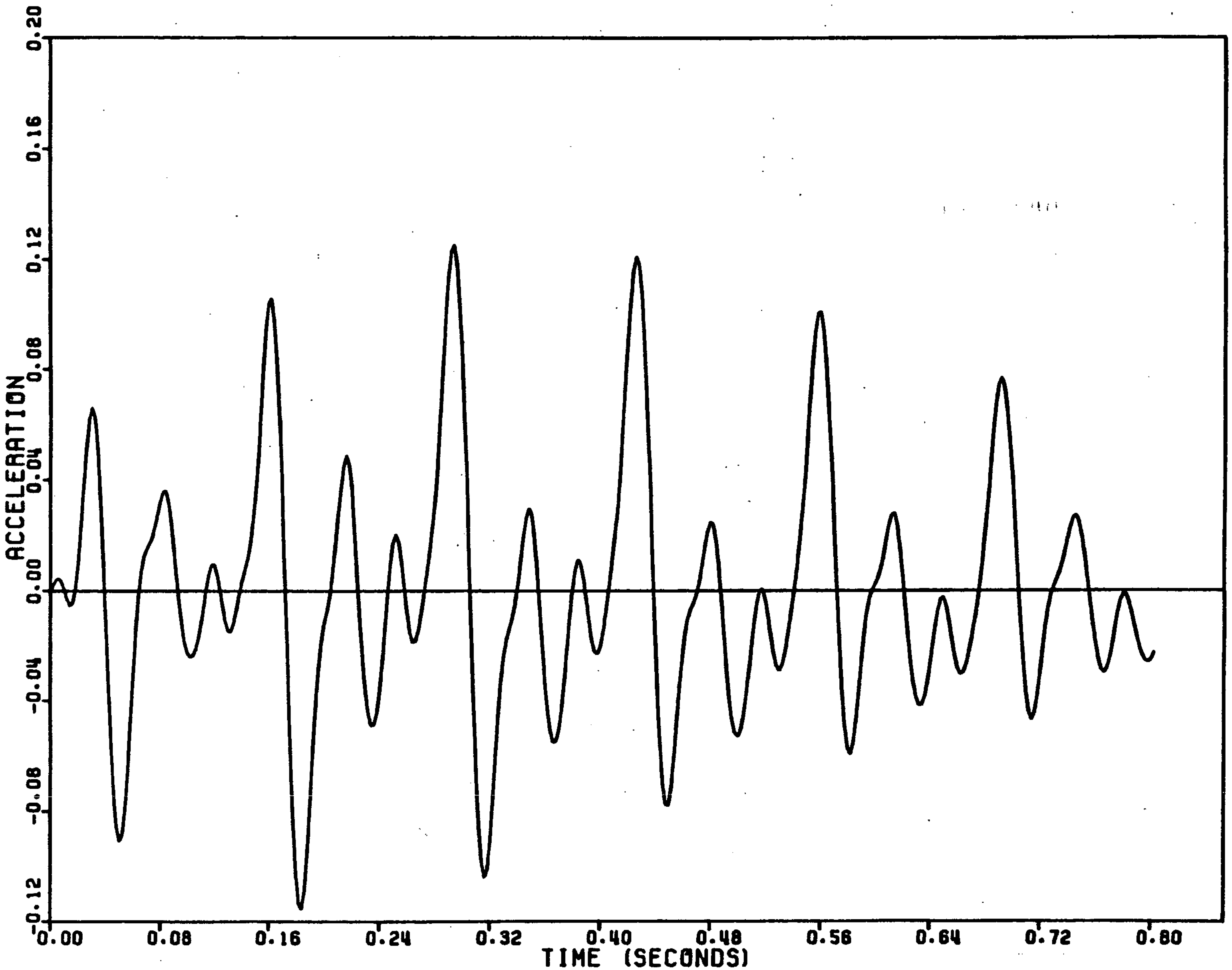


FIGURE C-139B. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-23
SRV-1 LOADING RECORD 413 - HORIZ. ACCELERATION (G), NPTS = 402, DT = .002

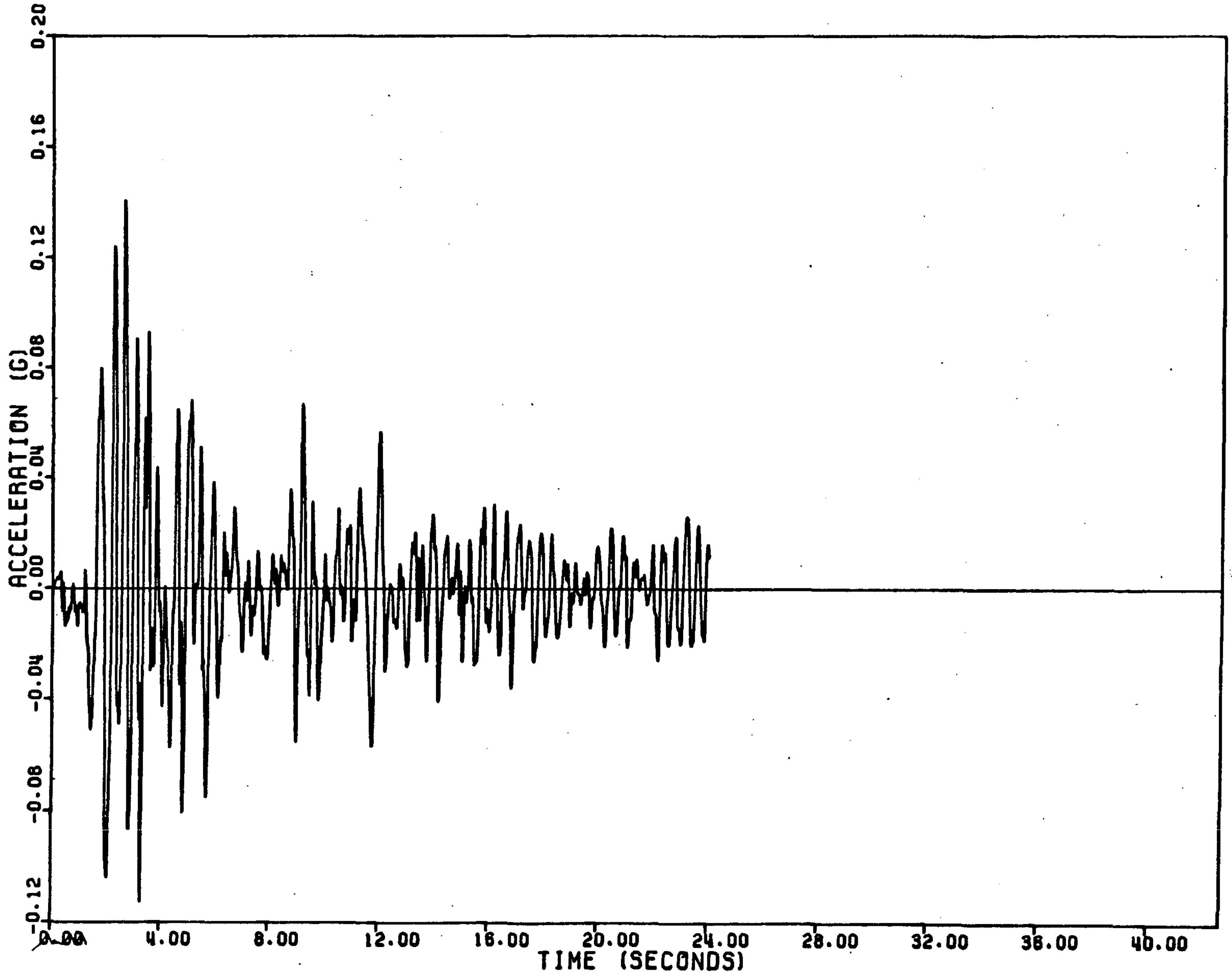


FIGURE C-140A. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 2-9
OBE LOADING - RECORD 709 - RADIAL ACCELERATION (G) , NPTS = 2399, DT = .01

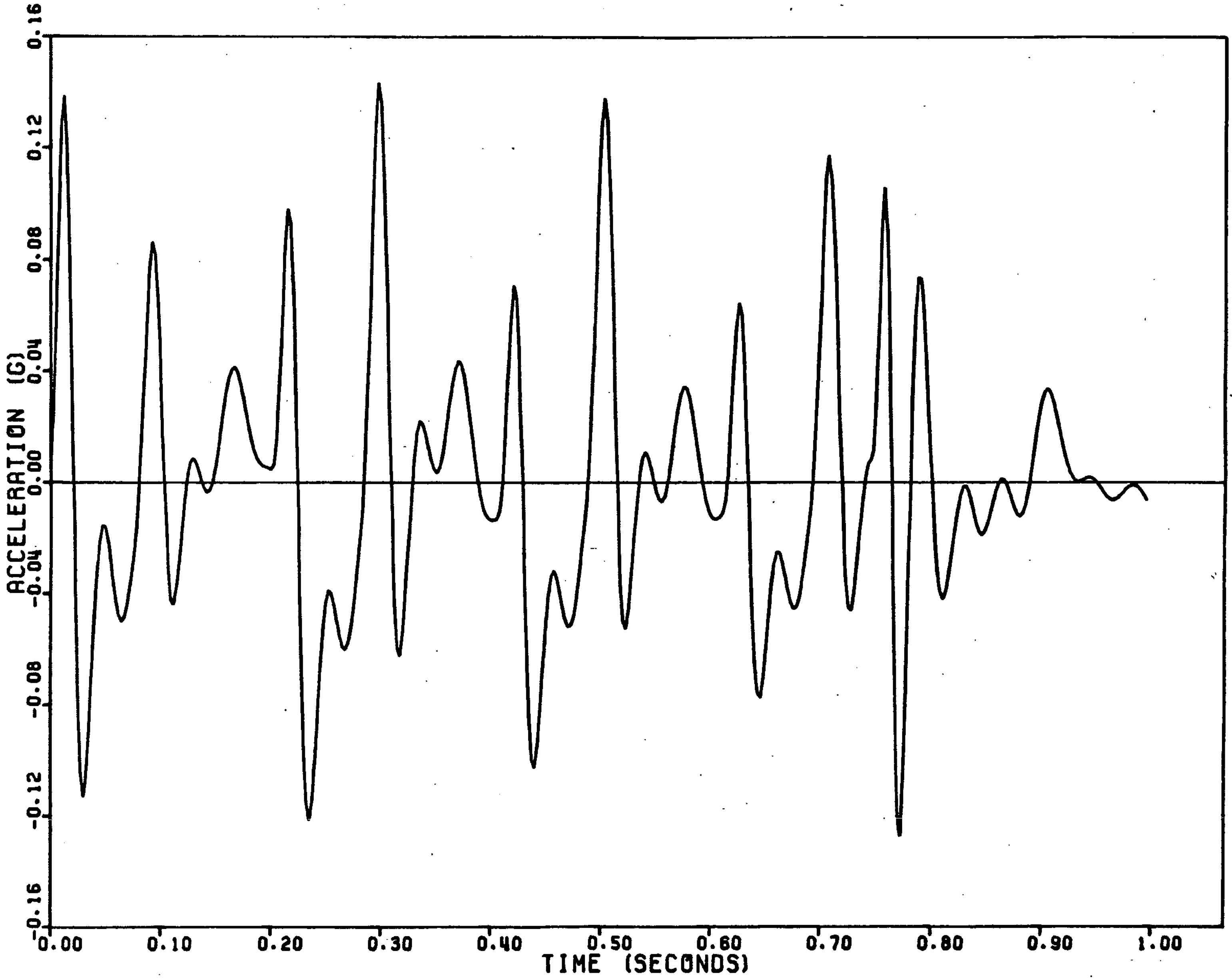


FIGURE C-140B. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 2-9
SRV-1 LOADING - RECORD 719 - RADIAL ACCELERATION (G) NPTS = 399, DT = .0025

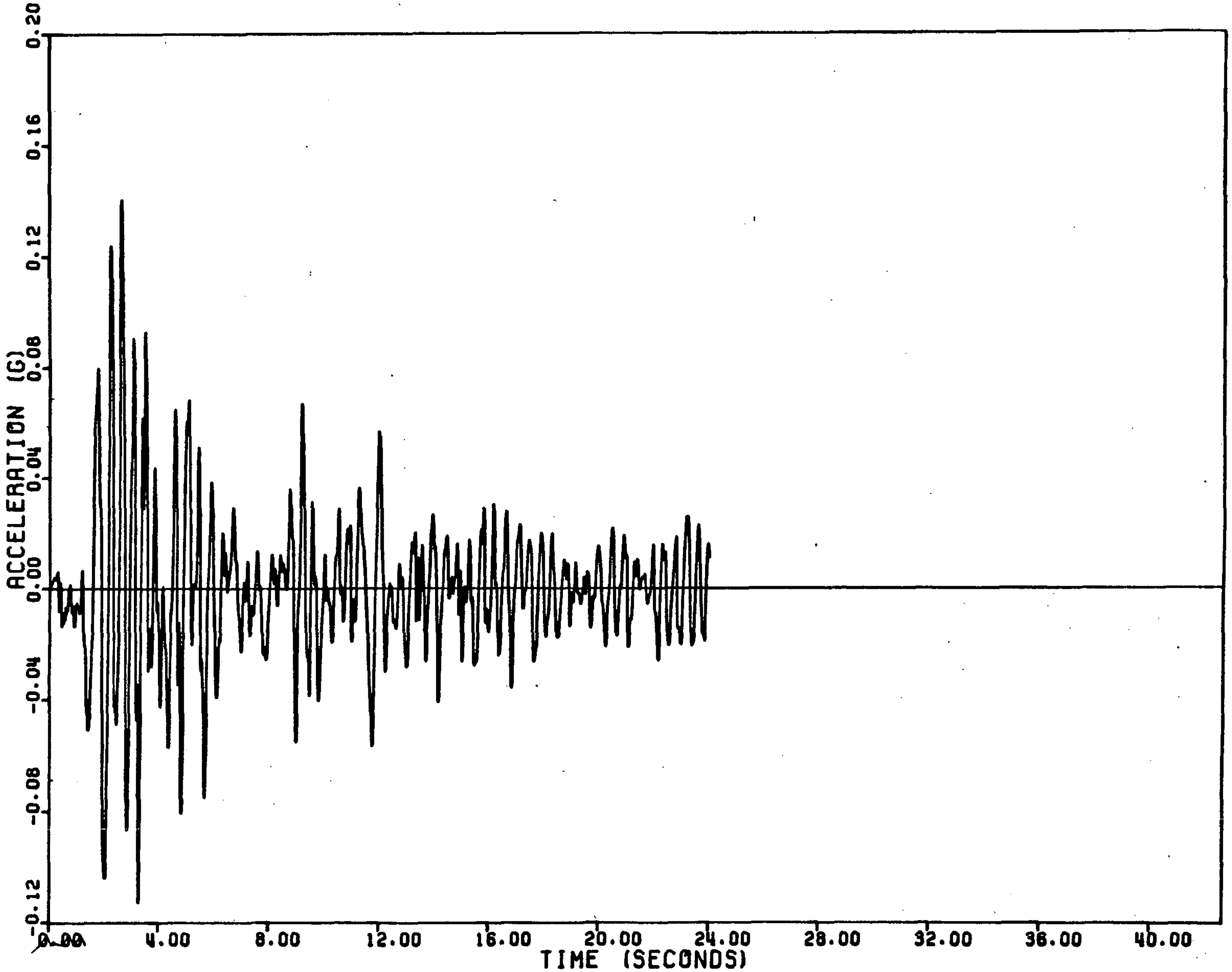


FIGURE C-141A. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 2-9
OBE LOADING - RECORD 709 - RADIAL ACCELERATION (G) , NPTS = 2399, DT = .01

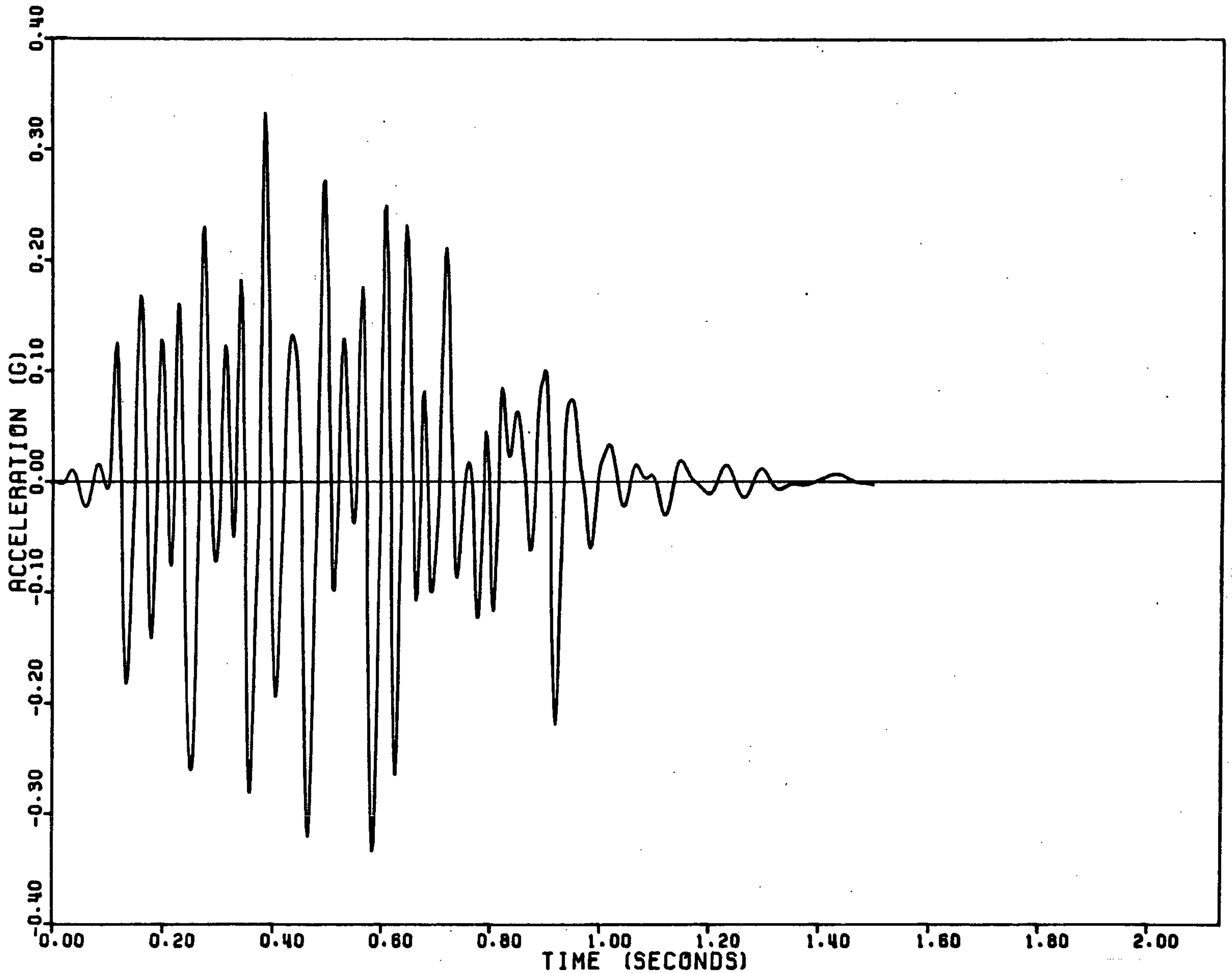


FIGURE C-141B. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 2-9
SRV-ALL LOADING- RECORD 739 - RADIAL ACCELERATION (G) NPTS = 599, DT = .0025

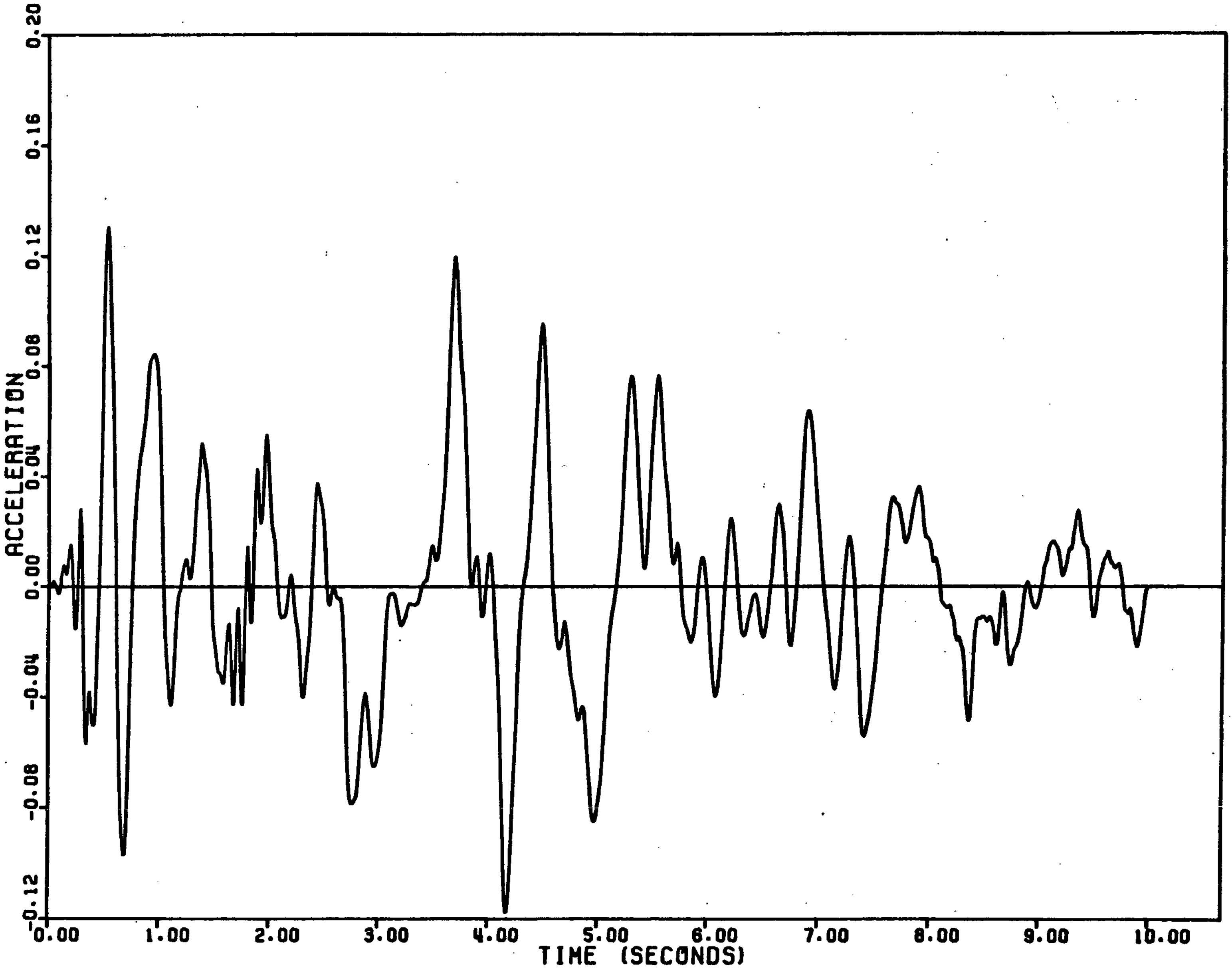


FIGURE C-142A. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-23
OBE LOADING RECORD 403 E - W ACCELERATION (G), NPTS = 999, DT = .0100

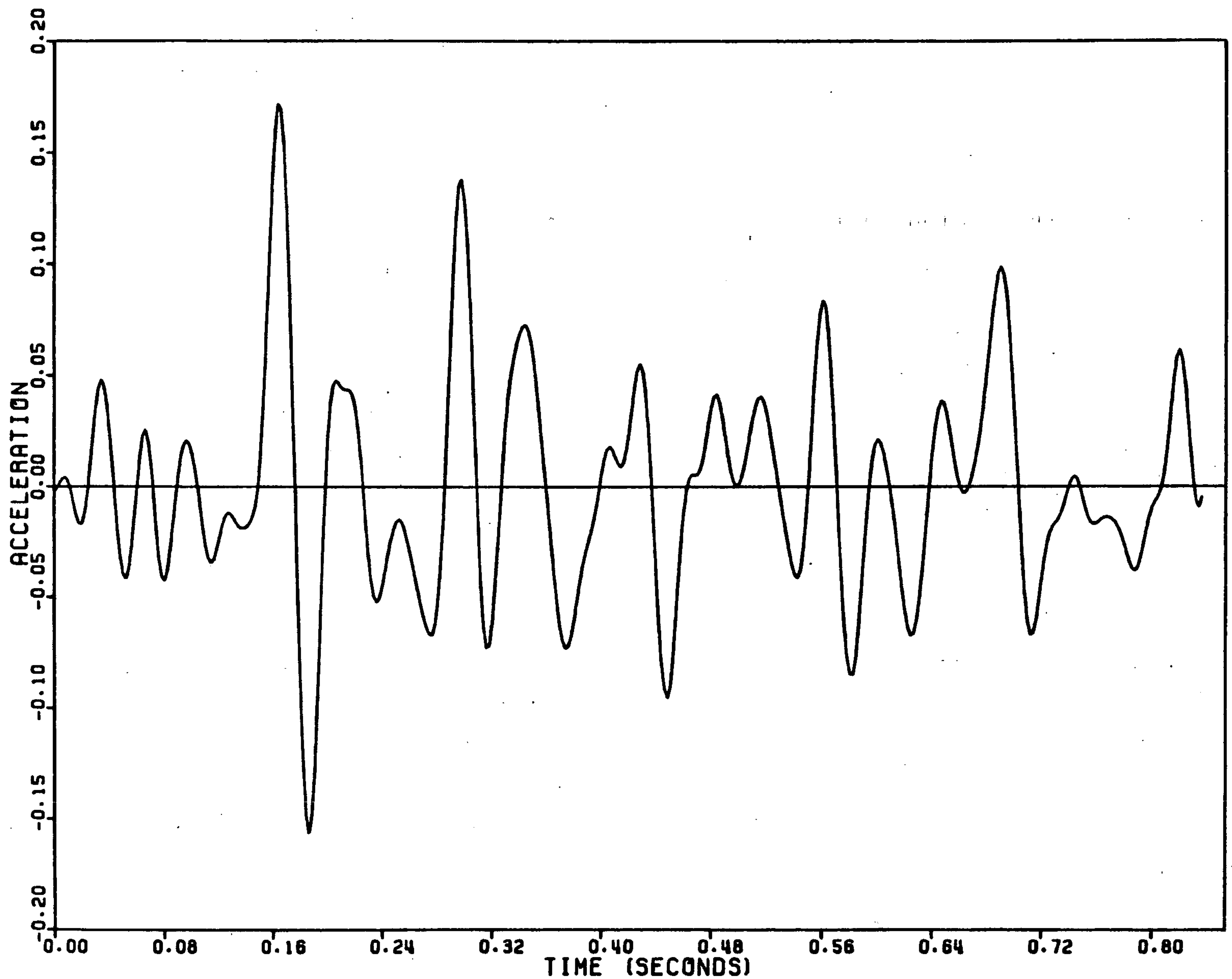


FIGURE C-142B. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-23
SRV-ADS LOADING RECORD 423 - HORIZ. ACCELERATION (G), NPTS = 419, DT = .002

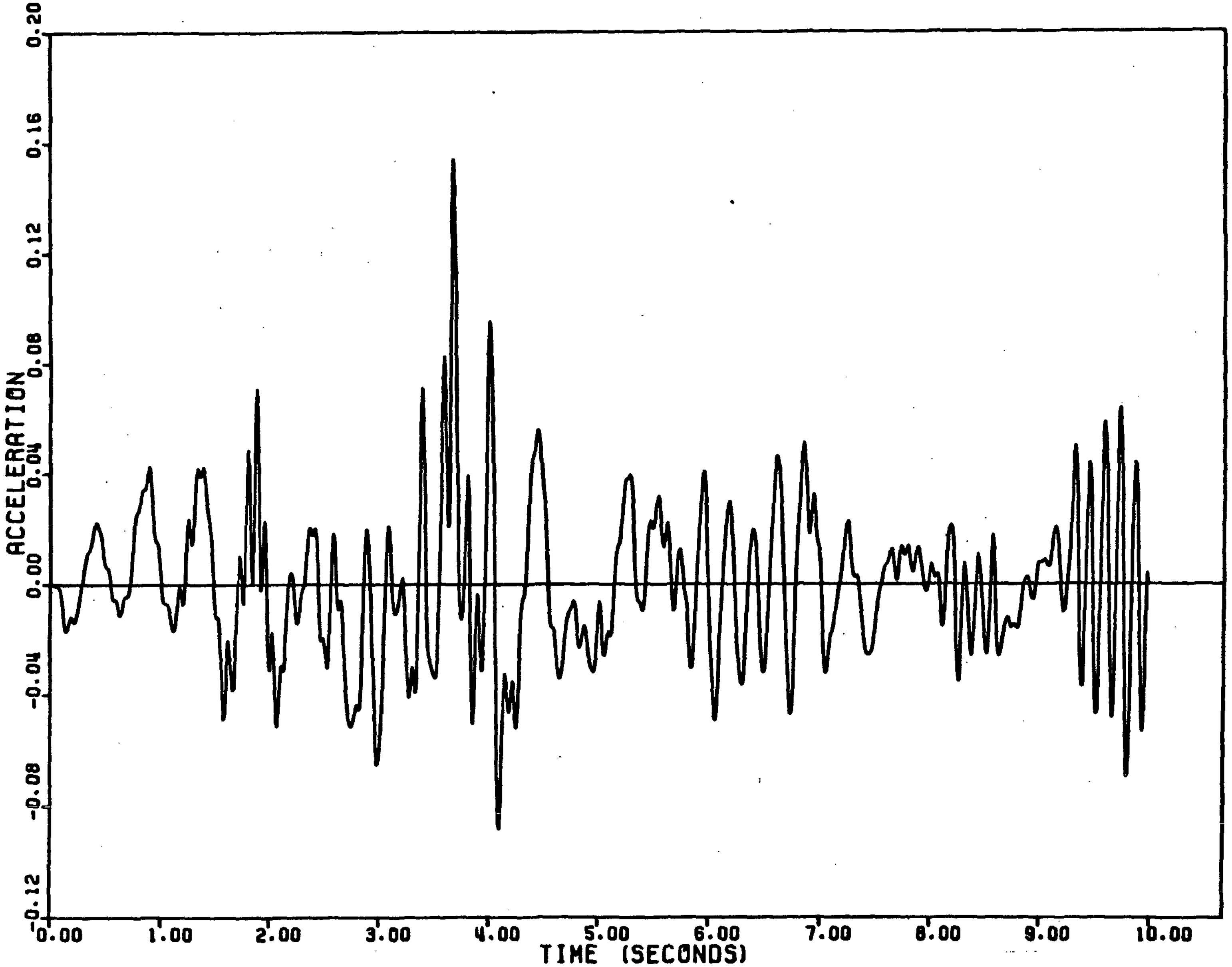


FIGURE C-143A. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-26
OBE LOADING RECORD 404 - VERT. WALL ACCEL. (G), NPTS = 999, DT = .01

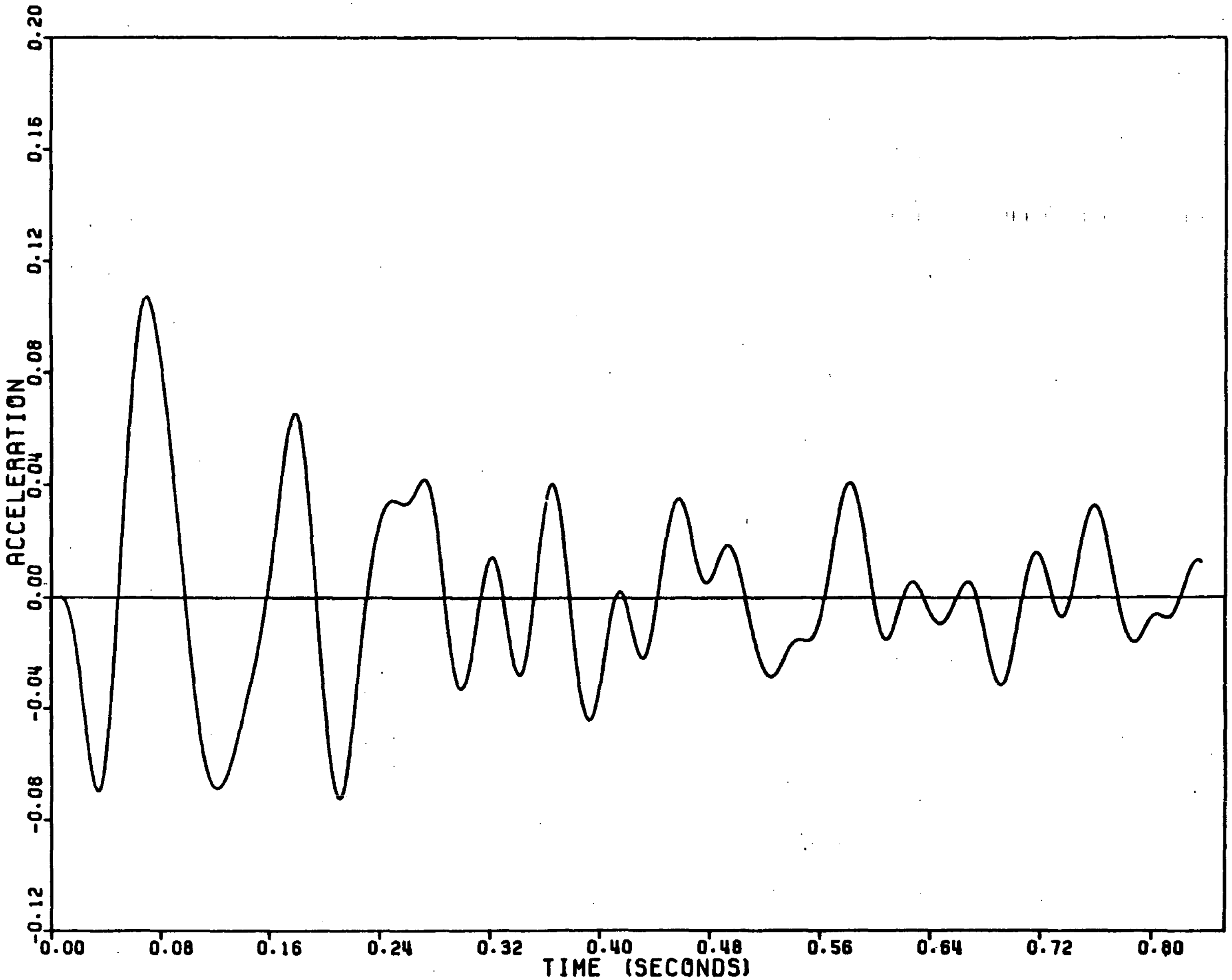


FIGURE C-143B. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-26
SRV-ADS LOADING RECORD 424 - VERT. WALL ACCEL. (G), NPTS = 419, DT = .0020

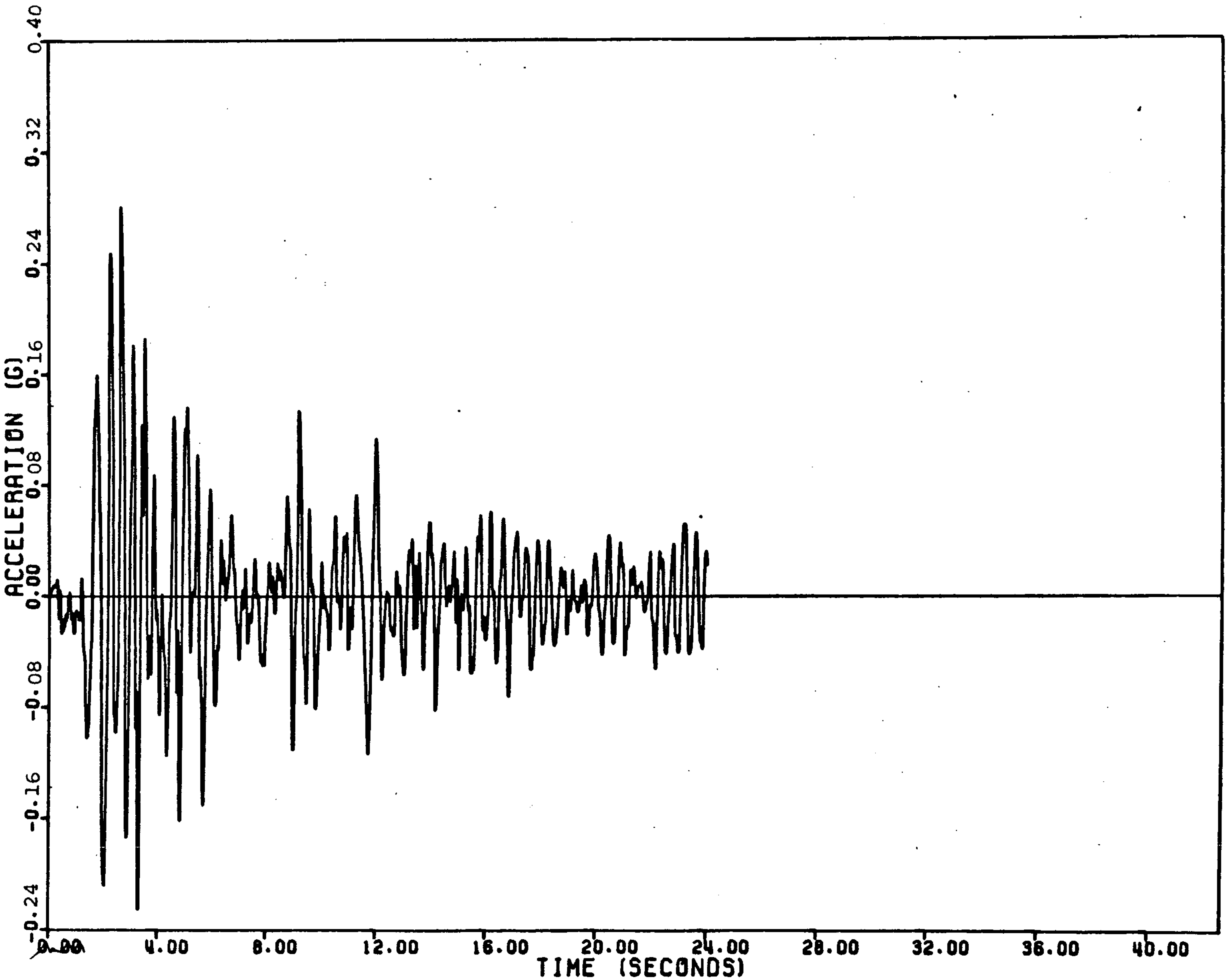


FIGURE C-144A. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 2-9
SSE LOADING - RECORD 709 - RADIAL ACCELERATION (G) , NPTS = 2399, DT = .01

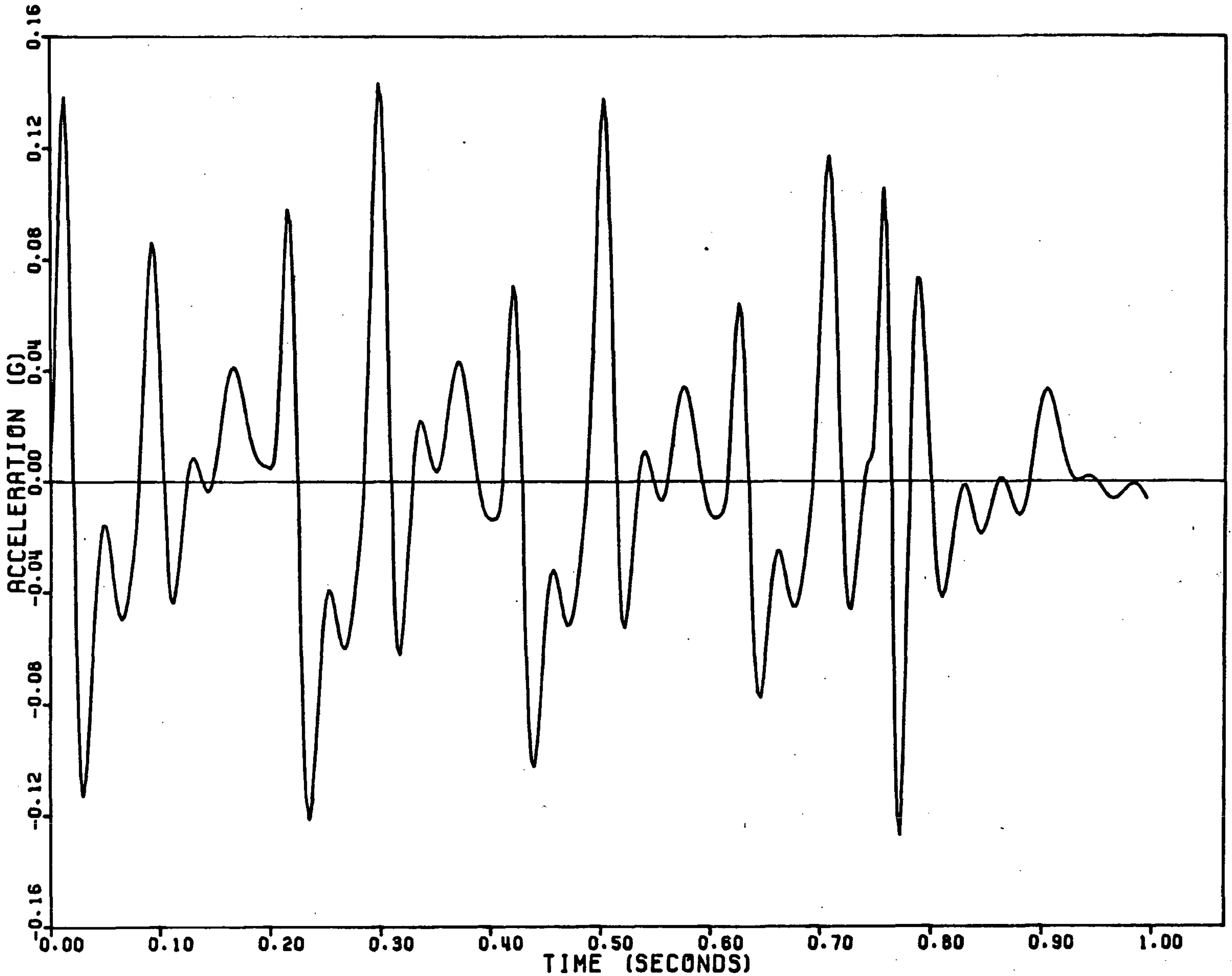


FIGURE C-144B. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 2-9
SRV-1 LOADING - RECORD 719 - RADIAL ACCELERATION (G) NPTS = 399, DT = .0025

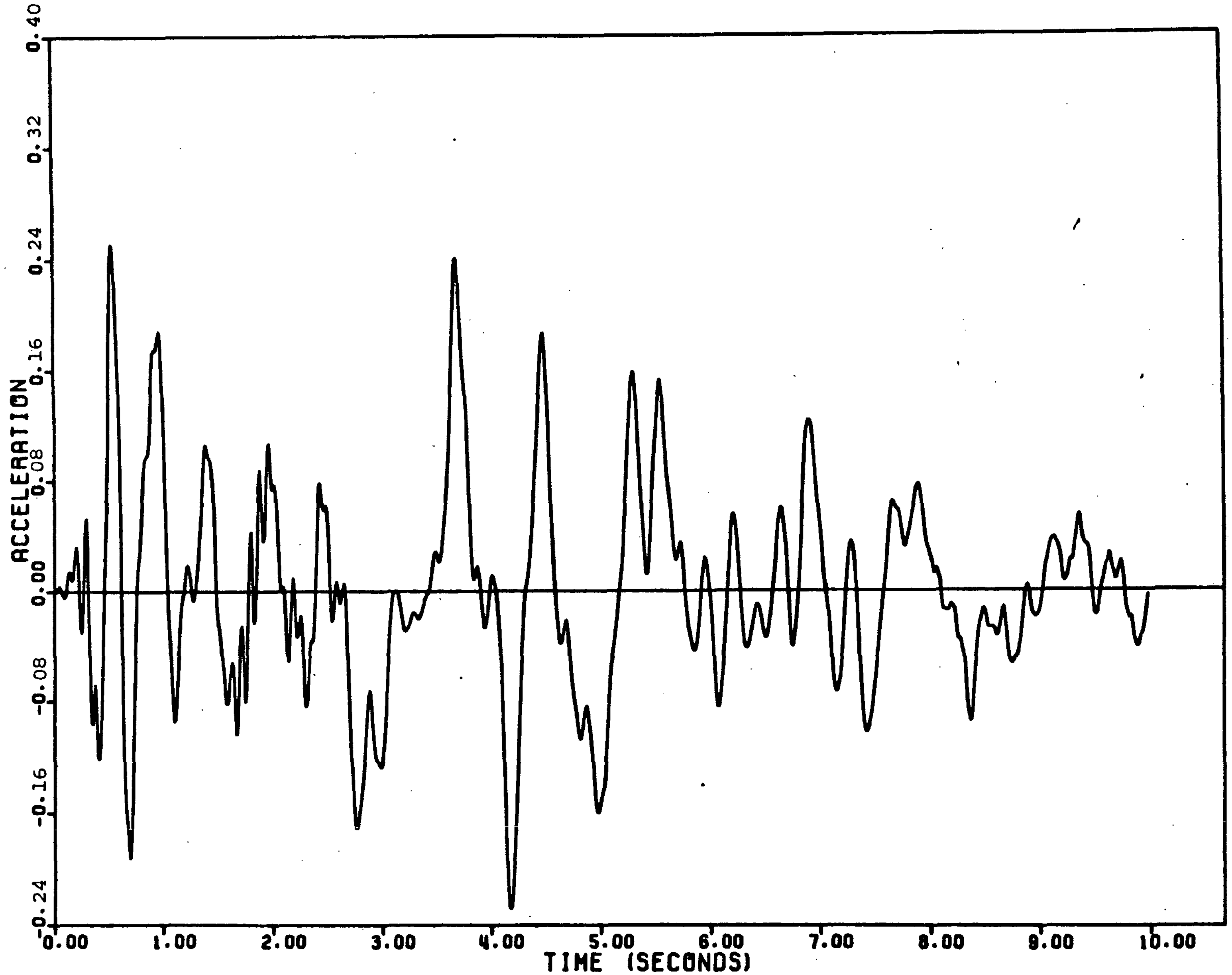


FIGURE C-145A. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-23
SSE LOADING RECORD 403 N - S ACCELERATION (G), NPTS = 999, DT = .0100

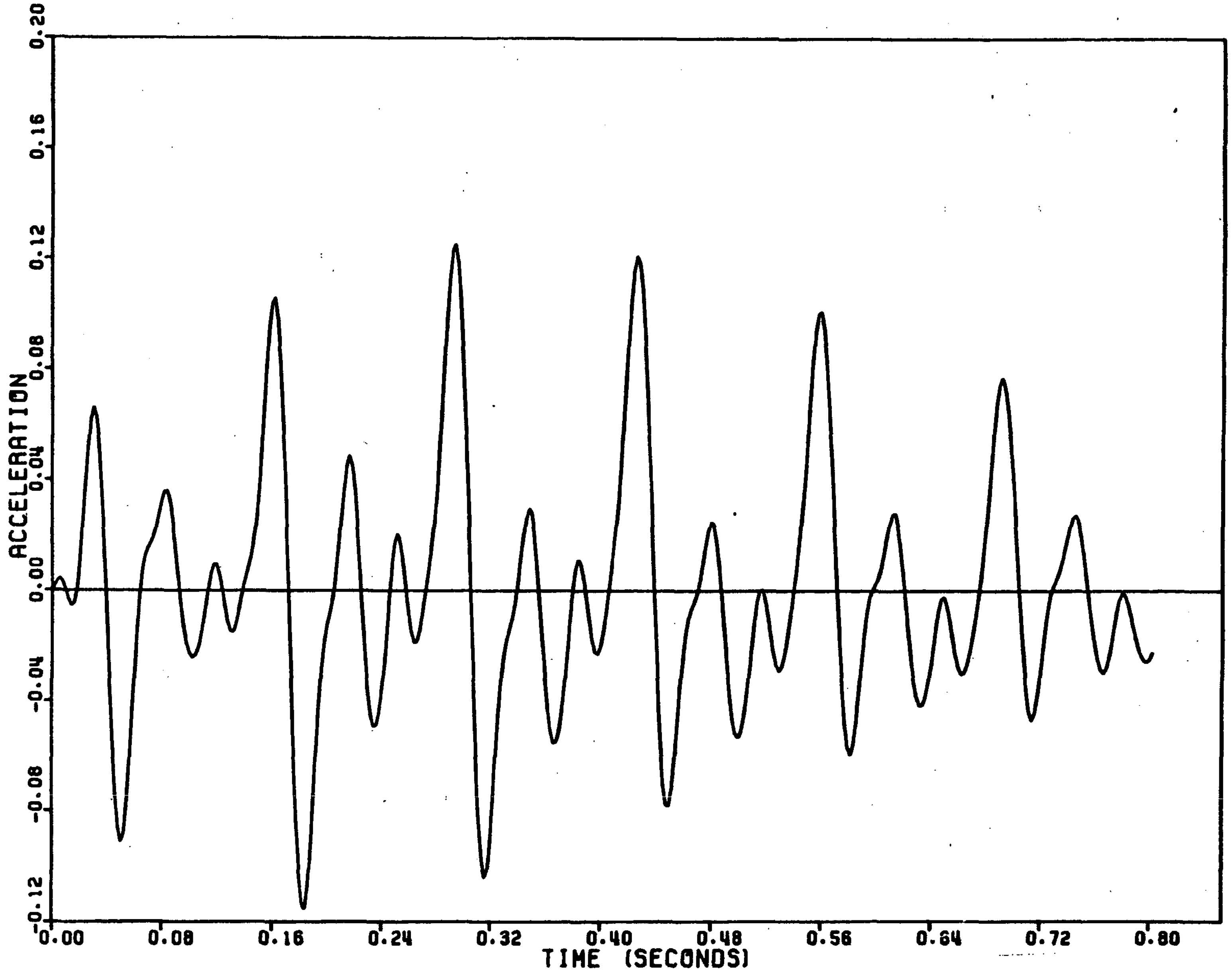


FIGURE C-145B. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-23
SRV-1 LOADING RECORD 413 - HORIZ. ACCELERATION (G), NPTS = 402, DT = .002

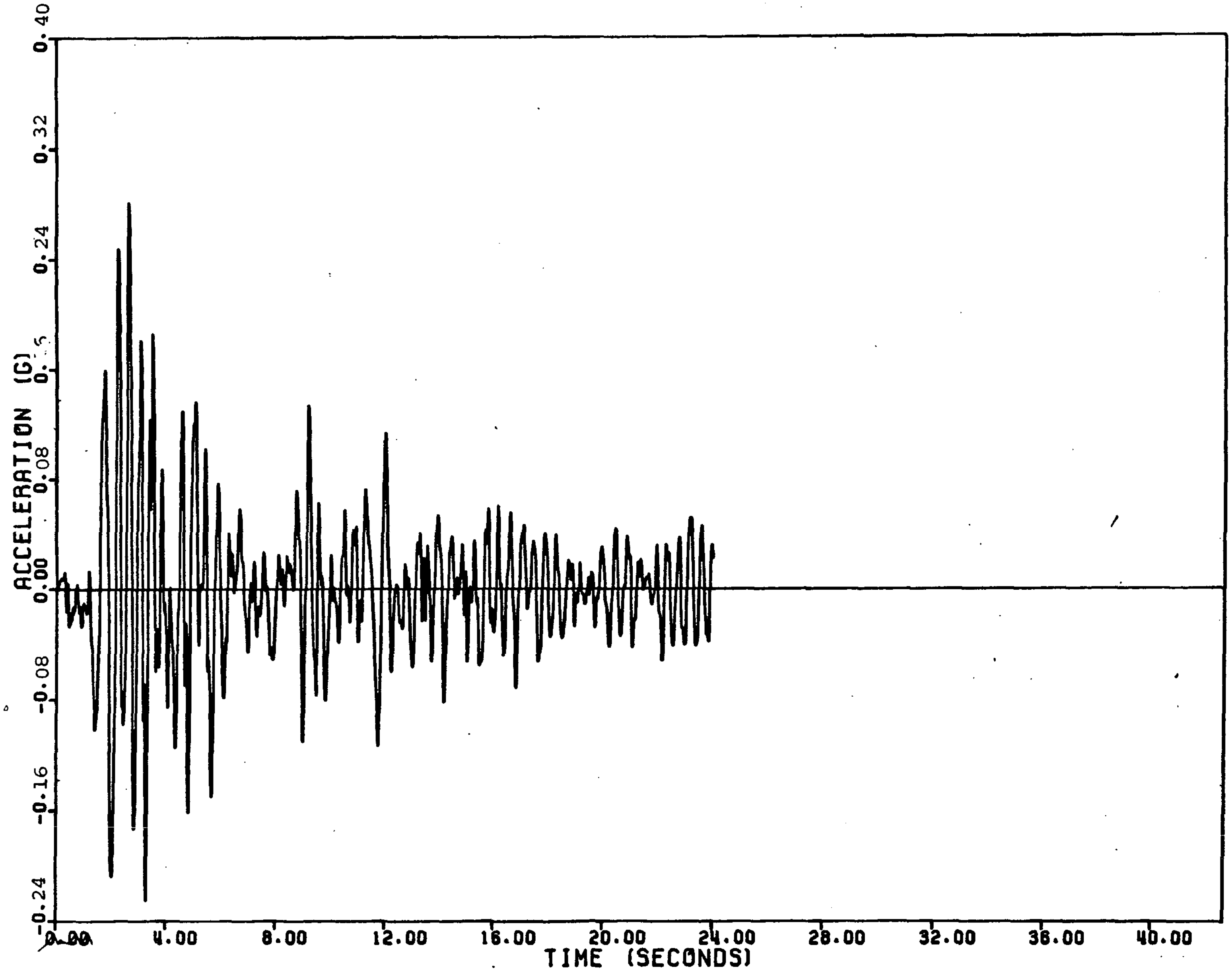


FIGURE C-146A. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 2-9
SSE LOADING - RECORD 709 - RADIAL ACCELERATION (G) , NPTS = 2399, DT = .01

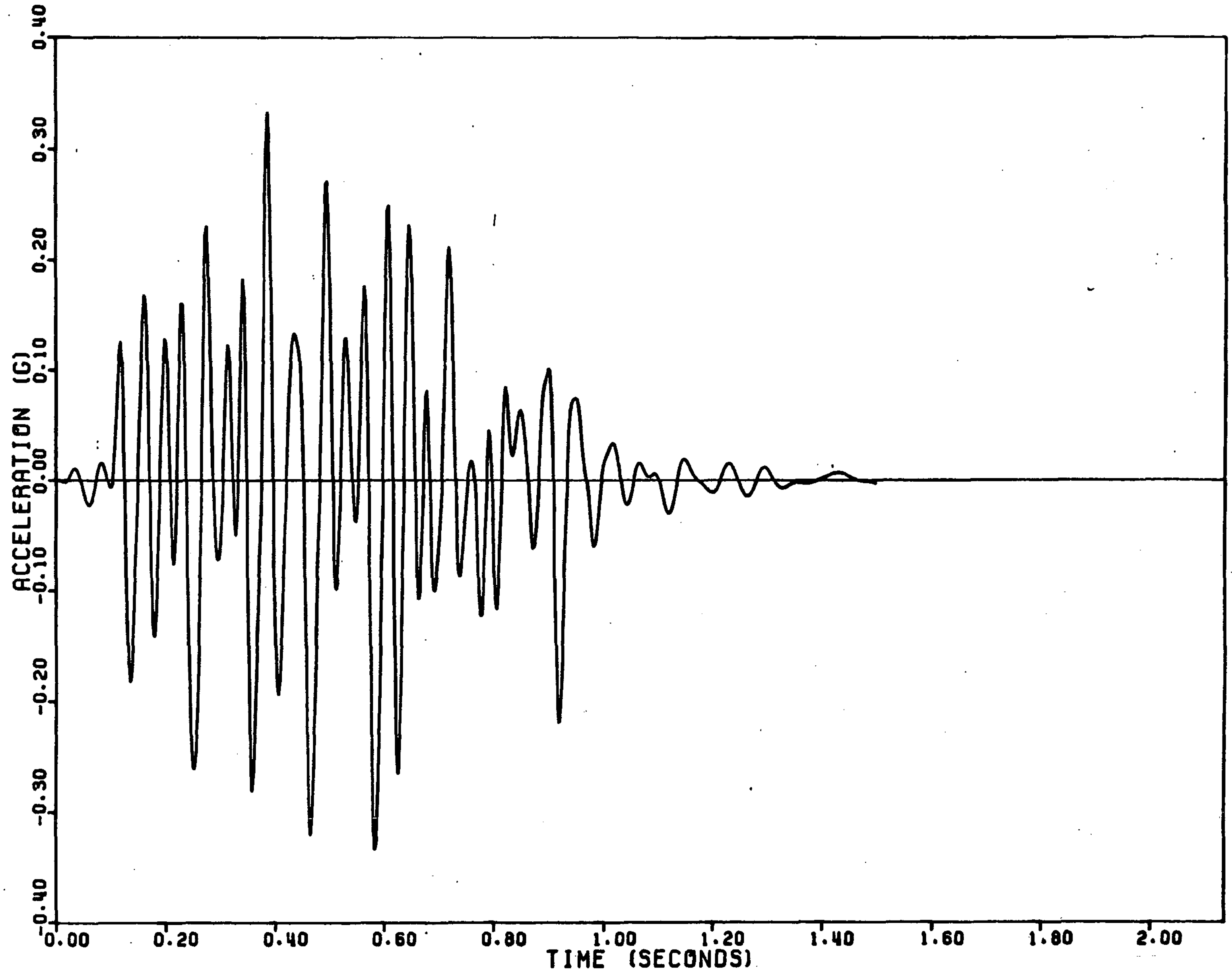


FIGURE C-146B. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 2-9
SRV-ALL LOADING- RECORD 739 - RADIAL ACCELERATION (G) NPTS = 599, DT = .0025

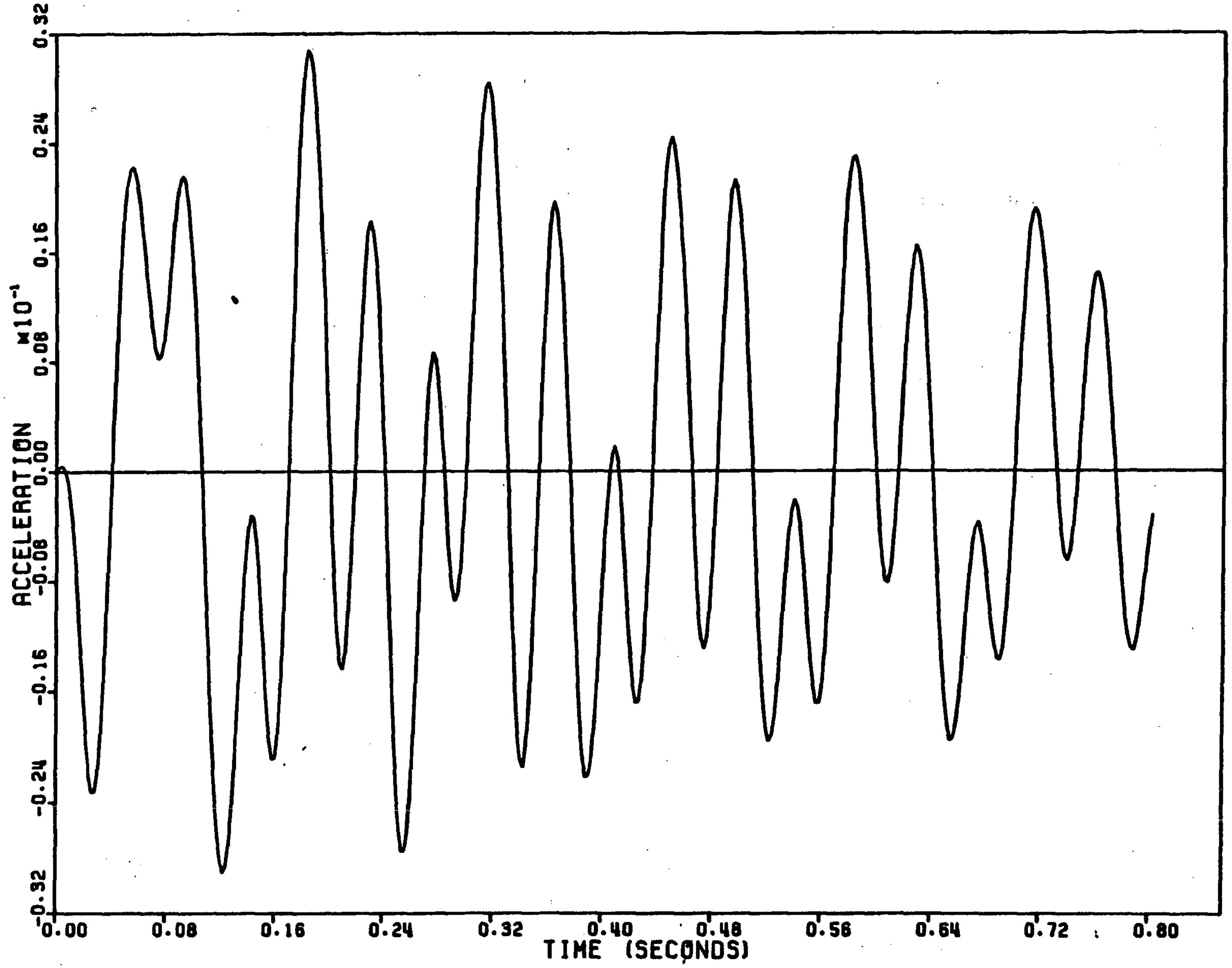


FIGURE C-147A. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-26
SRV-1 LOADING RECORD 414 - VERT. WALL ACCEL. (G), NPTS = 402, DT = .0020

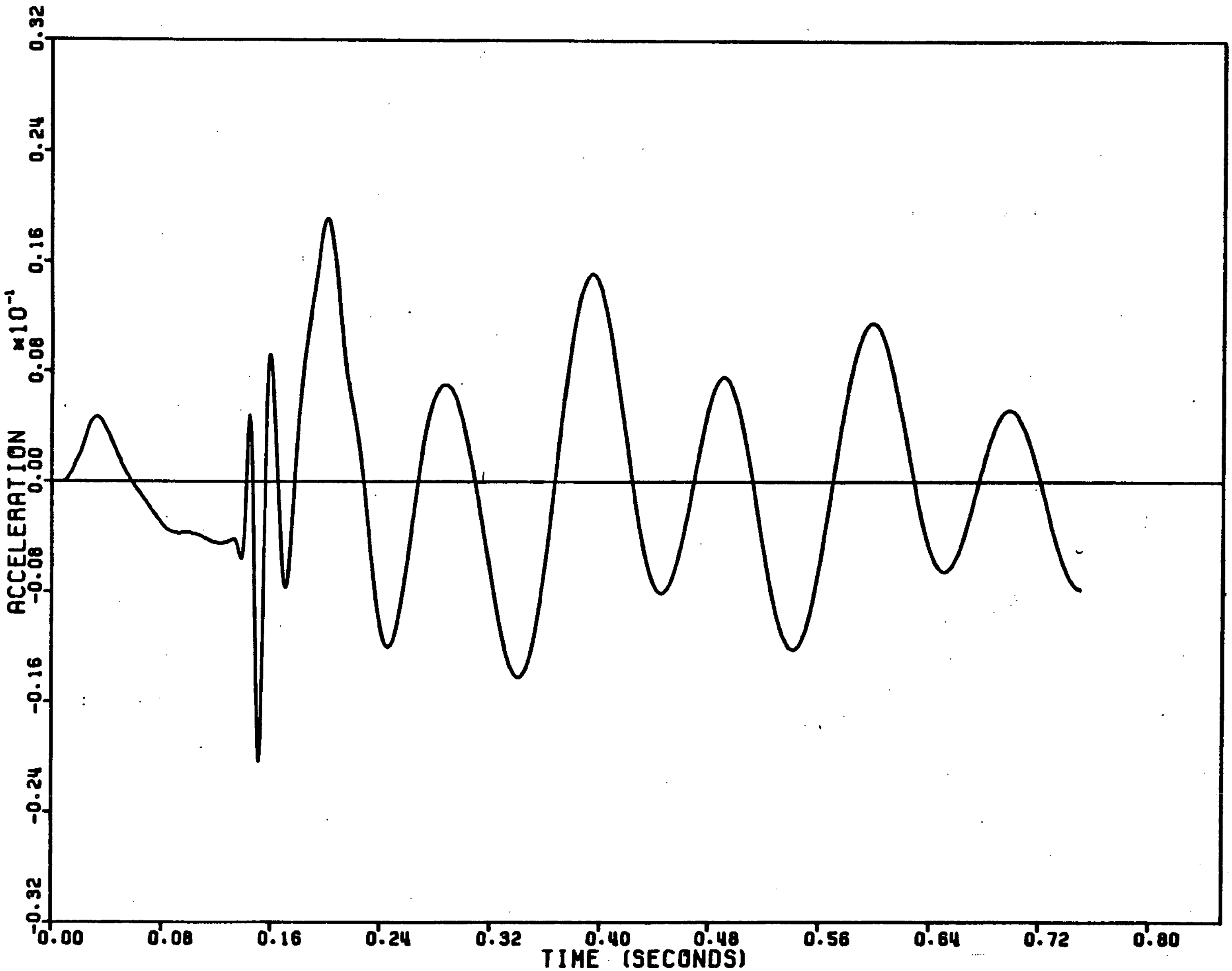


FIGURE C-147B. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-26
CHUG LOADING RECORD 444 - VERT. WALL ACCEL. (G), NPTS = 751, DT = .0010

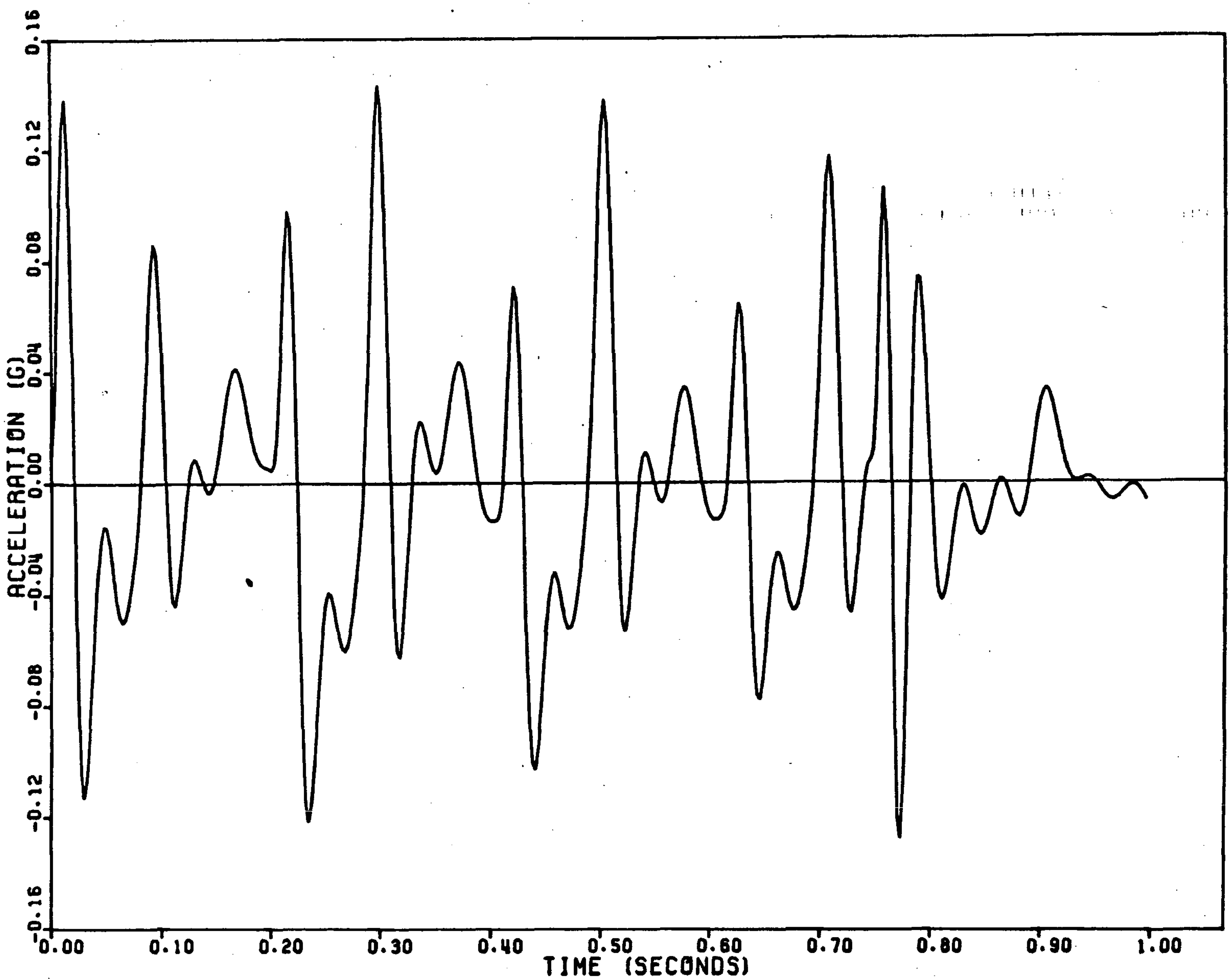


FIGURE C-148A. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 2-9
SRV-1 LOADING - RECORD 719 - RADIAL ACCELERATION (G) NPTS = 399, DT = .0025

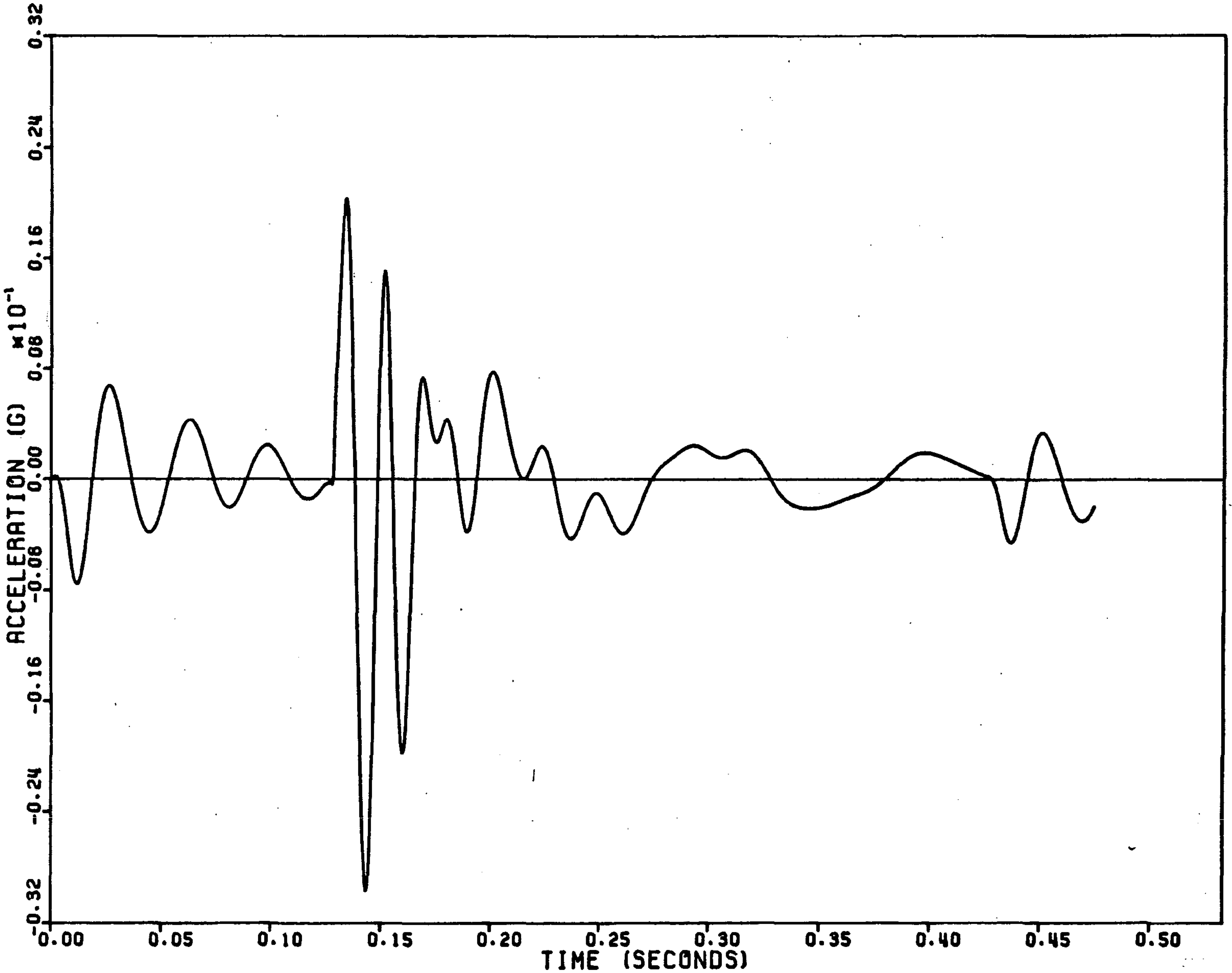


FIGURE C-148B. BOP EQUIPMENT TIME HISTORIES, CONTAINMENT VESSEL LOCATION 2-9
CHUG LOADING - RECORD 749 - RADIAL ACCELERATION (G) ,NPTS = 950 , DT = .0005

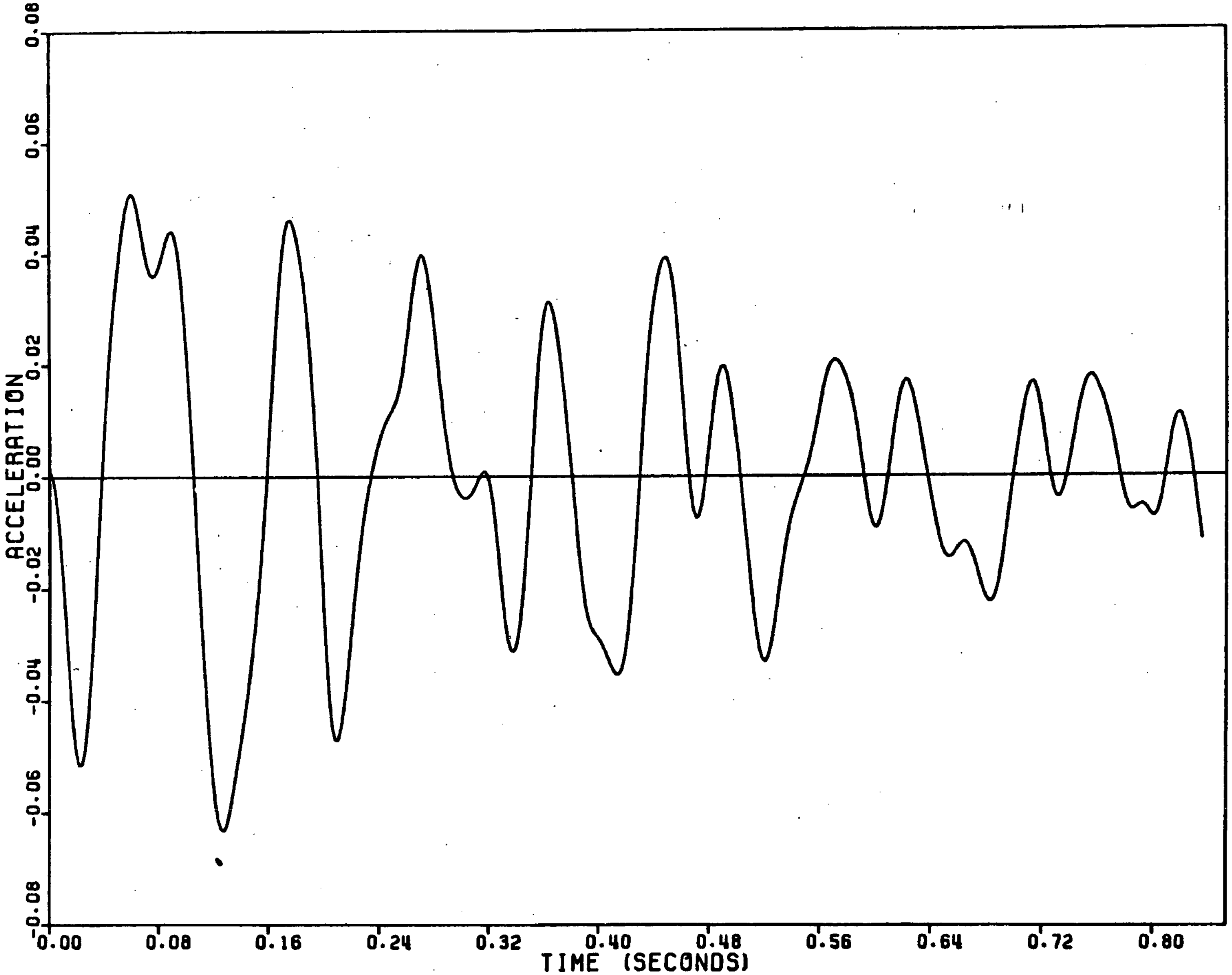


FIGURE C-149A. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-24
SRV-ADS LOADING RECORD 423 - VERT. WALL ACCEL. (G), NPTS = 419, DT = .0020

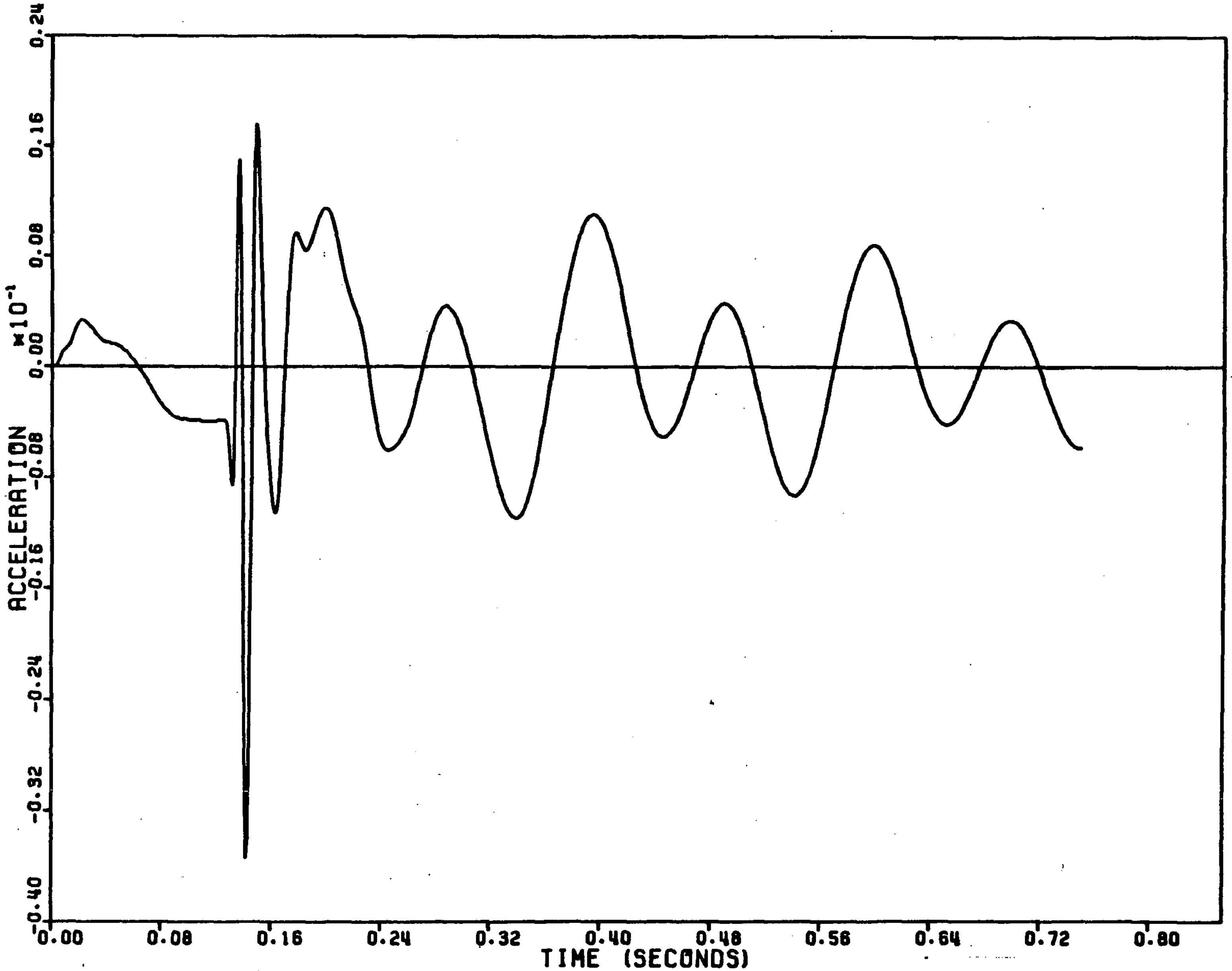


FIGURE C-149B. BOP EQUIPMENT T.H., CONTAINMENT BUILDING LOCATION 5-24
CHUG LOADING RECORD 443 - VERT. WALL ACCEL. (G), NPTS = 751, DT = .0010

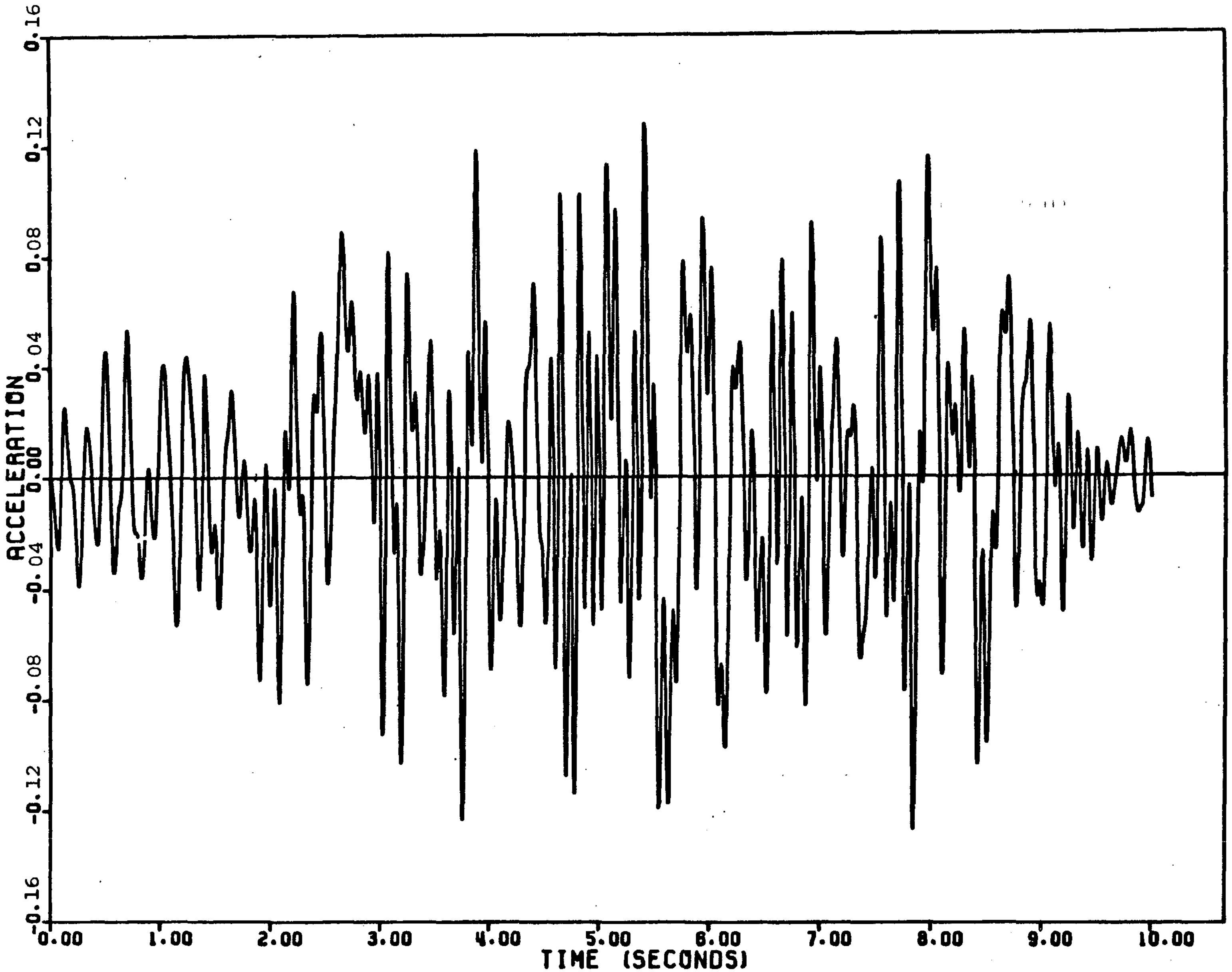


FIGURE C-154A. EQUIPMENT T.H., SHIELD BUILDING LOCATION 3-9
SSE LOADING RECORD 306 - VERT. ACCELERATION (G), NPTS = 2001, DT = .005

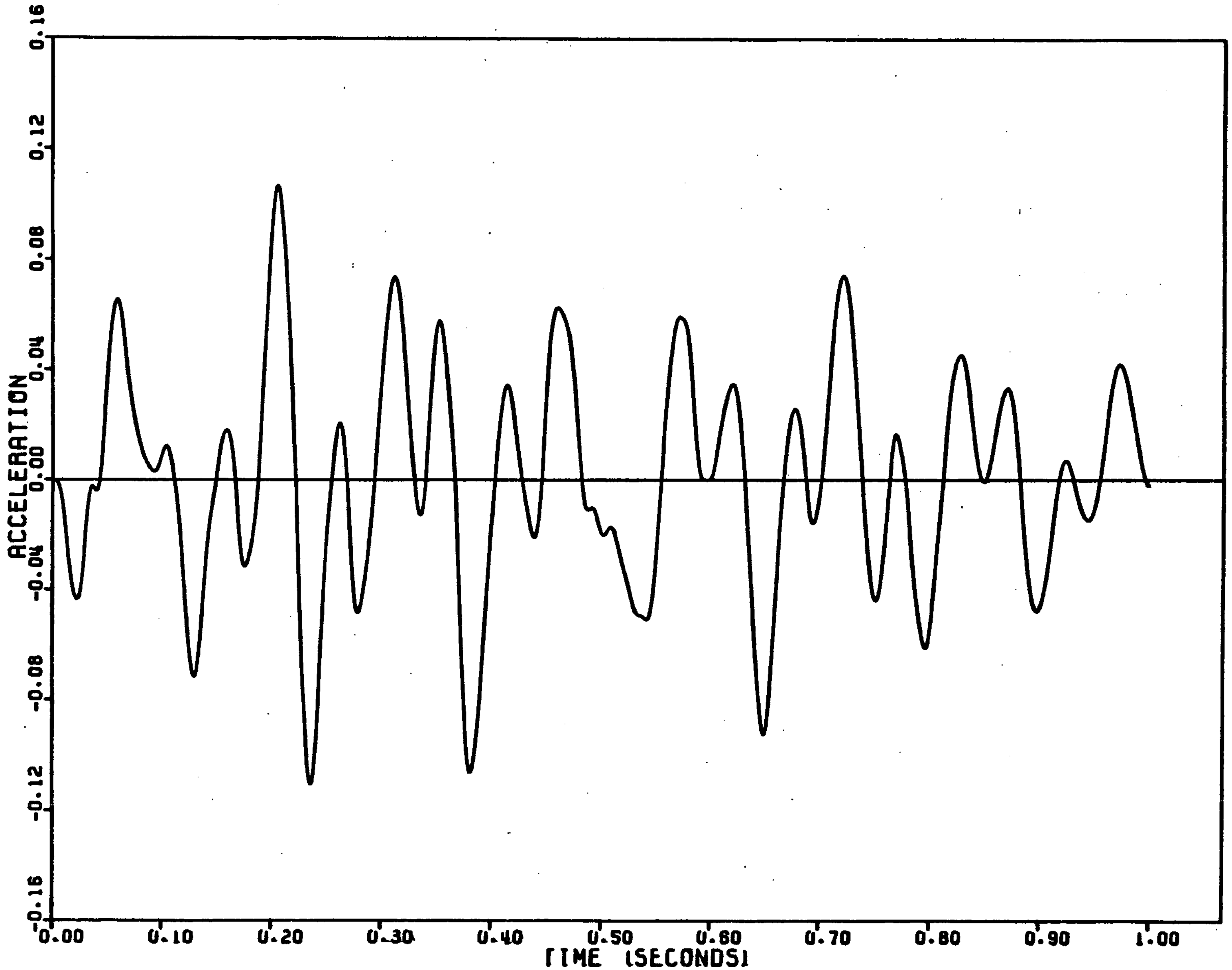


FIGURE C-154B. EQUIPMENT T.H., SHIELD BUILDING LOCATION 3-9
SRV-ADS LOADING - RECORD 336 - VERT. ACCELERATION (G), NPTS = 1000, DT = .0010

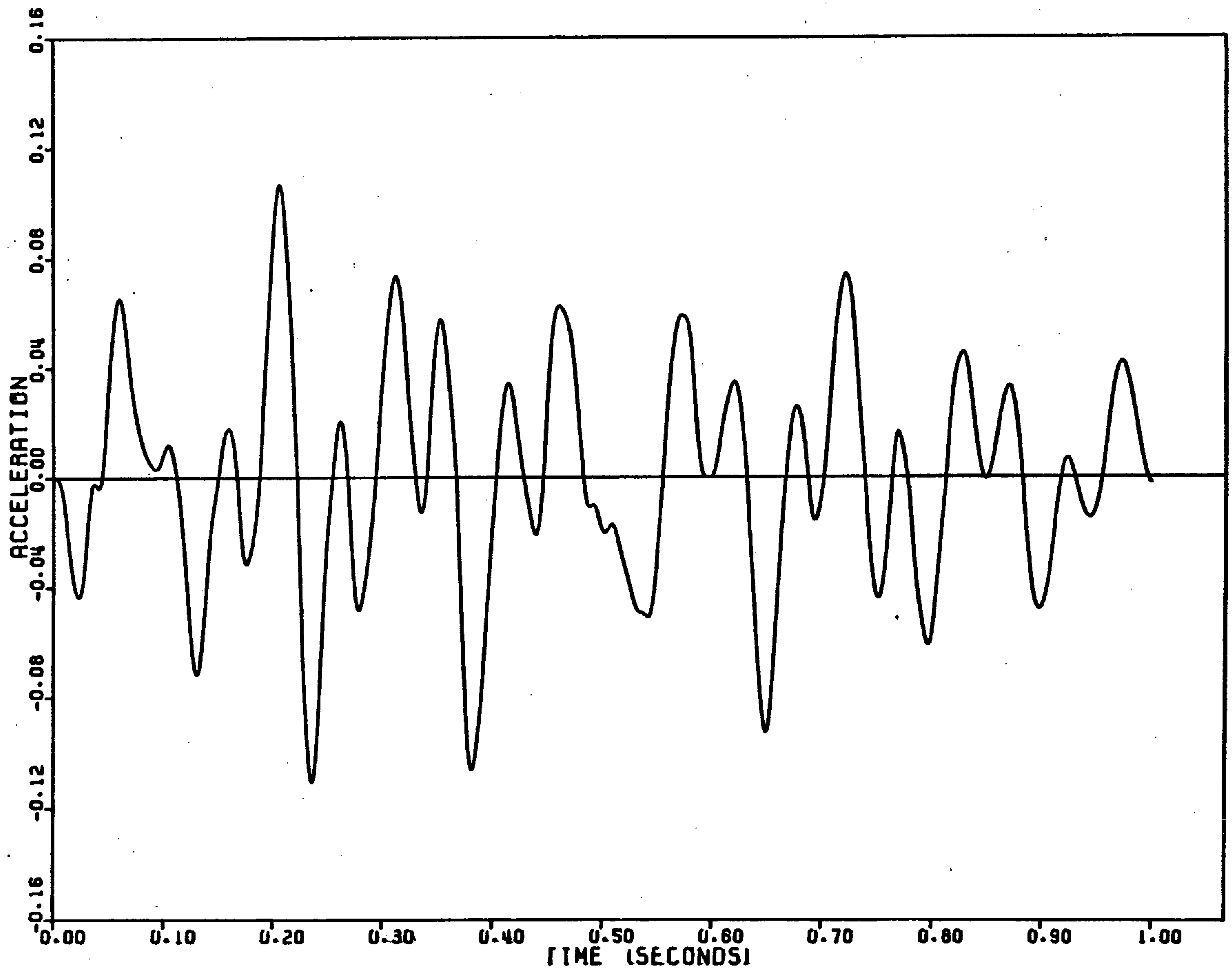


FIGURE C-155A. EQUIPMENT T.H., SHIELD BUILDING LOCATION 3-9
SRV-ADS LOADING - RECORD 336 - VERT. ACCELERATION (G), NPTS = 1000, DT = .0010

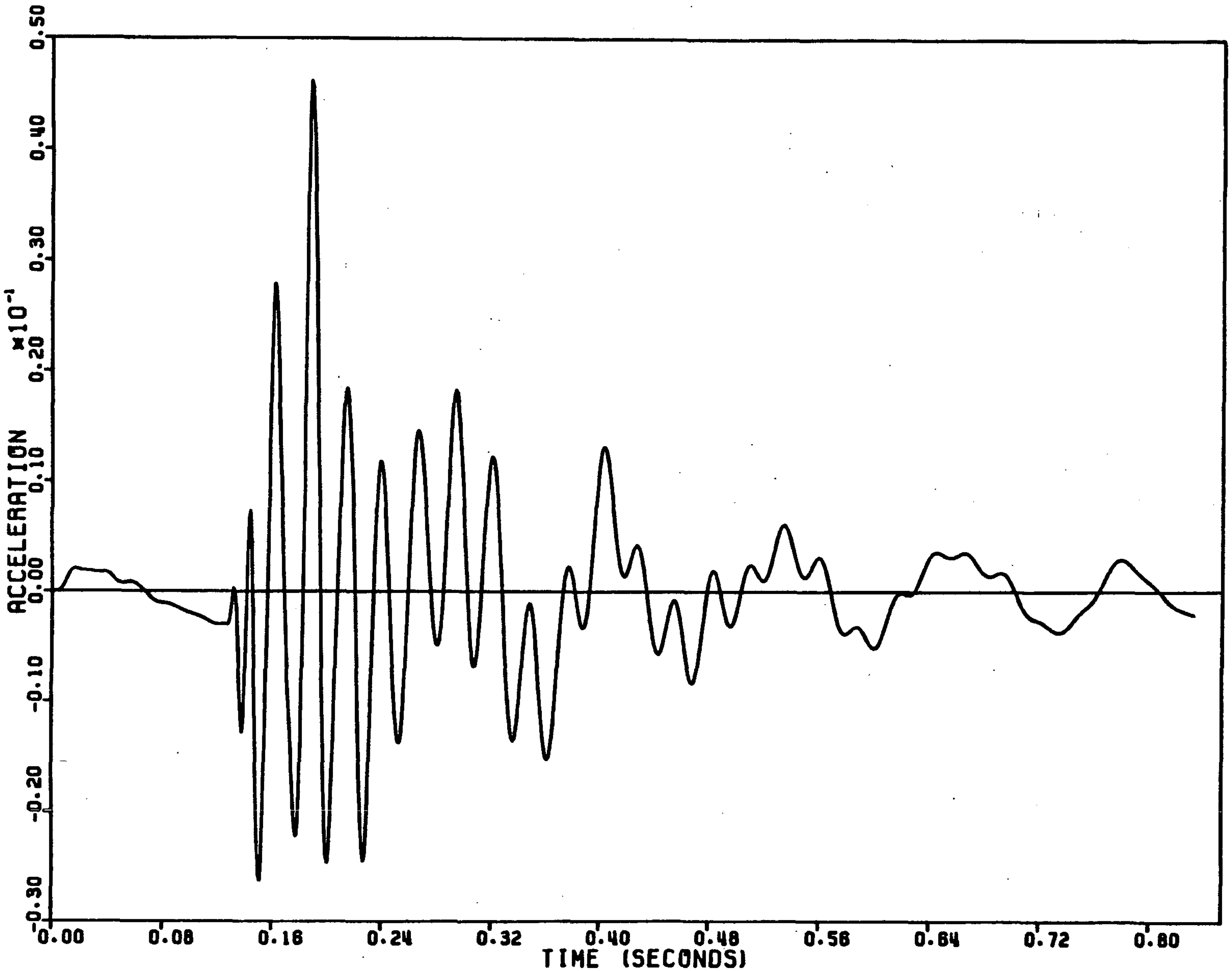


FIGURE C-155B. EQUIPMENT T.H., SHIELD BUILDING LOCATION 3-9
CHUG LOADING - RECORD 366 - VERT. ACCELERATION (G), NPTS = 833, DT = .0010

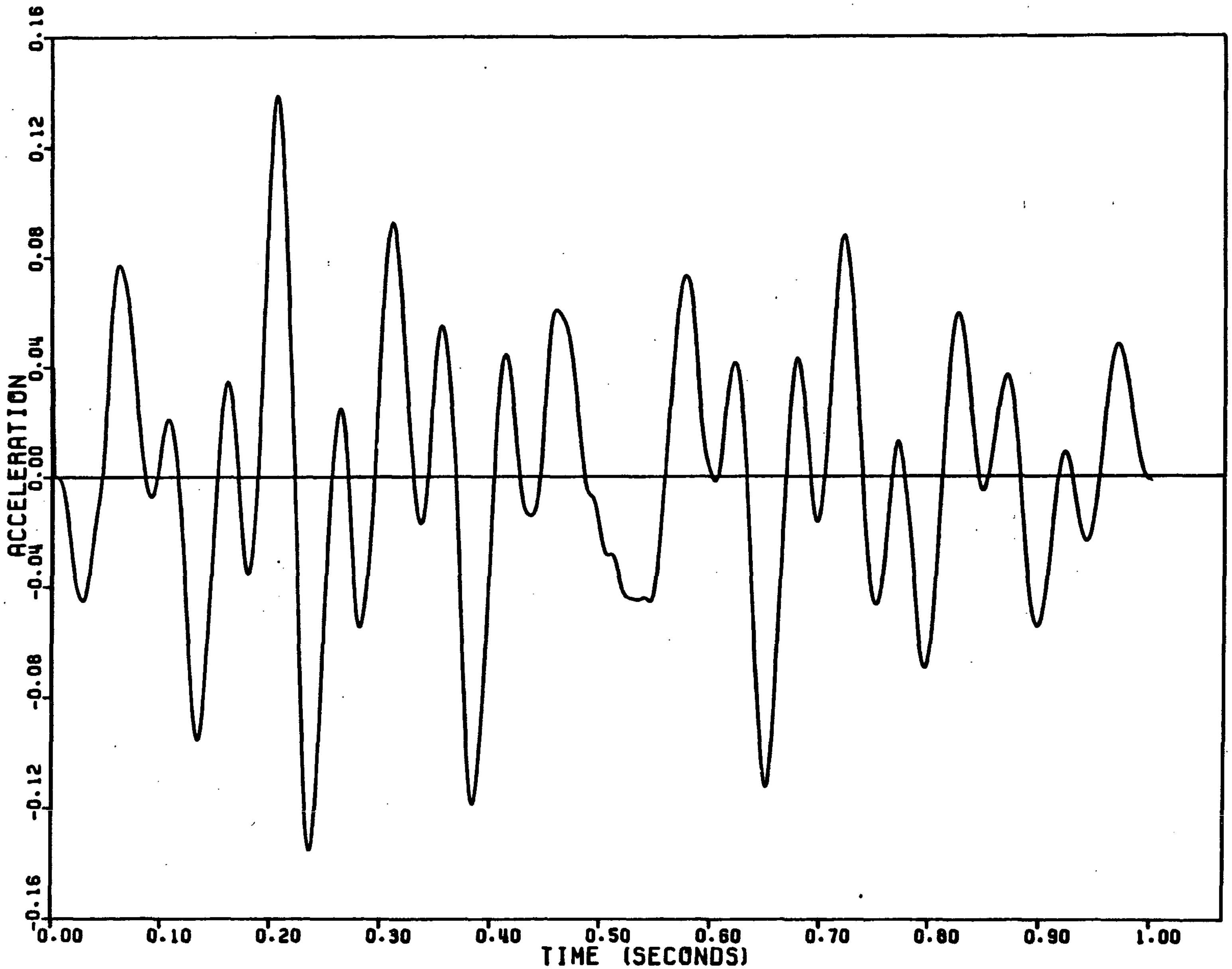


FIGURE C-156A. EQUIPMENT T.H., SHIELD BUILDING LOCATION 3-10
SRV-ADS LOADING - RECORD 337 - VERT. ACCELERATION (G), NPTS = 1000, DT = .0010

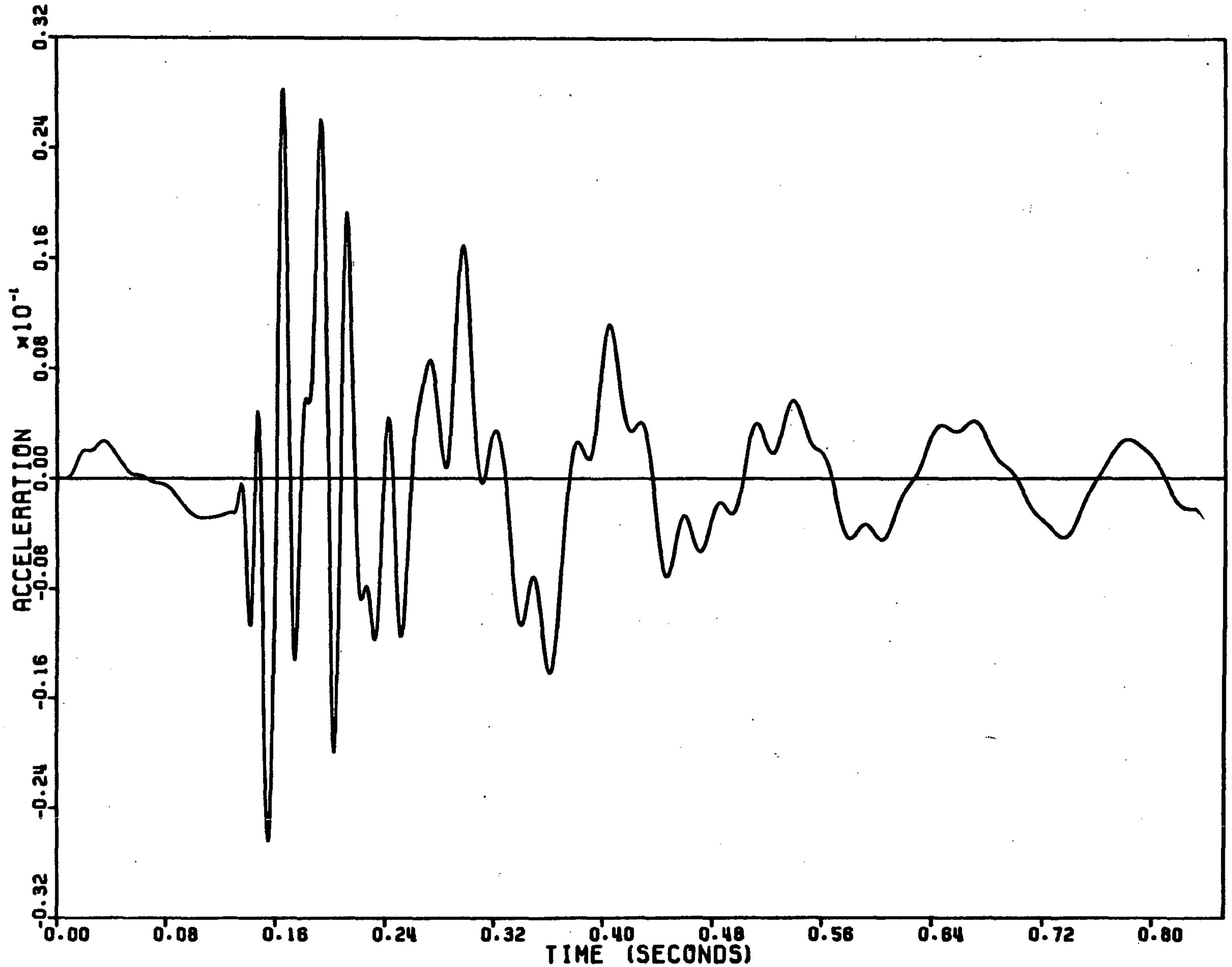


FIGURE C-156B. EQUIPMENT T.H., SHIELD BUILDING LOCATION 3-10
CHUG LOADING - RECORD 367 - VERT. ACCELERATION (G), NPTS = 833, DT = .0010

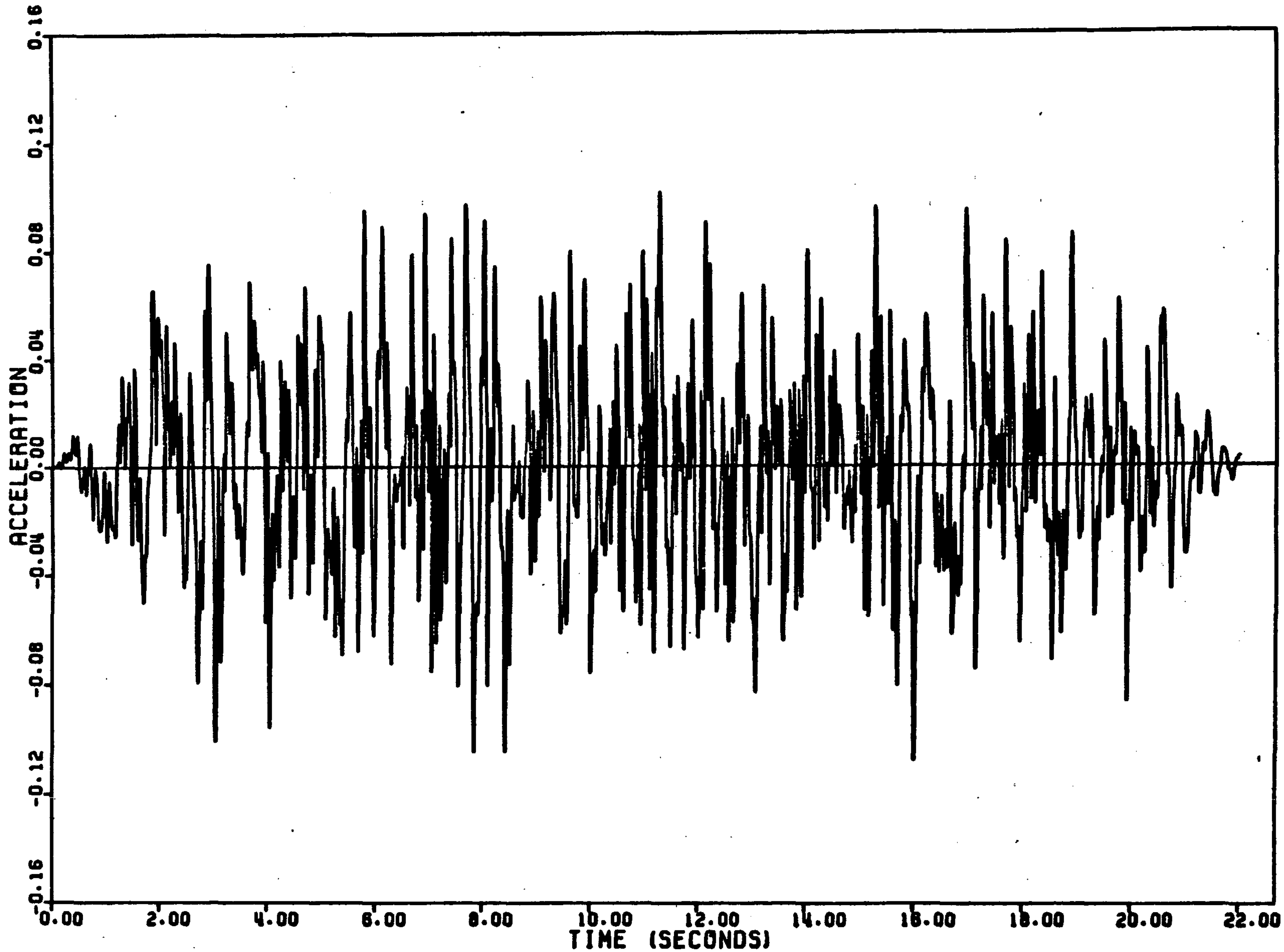


FIGURE C-157A. BOP EQUIPMENT TIME HISTORIES, SHIELD BUILDING LOCATION 4-25
OBE LOADING - RECORD 6 - RADIAL ACCELERATION (G), NPTS = 2200, DT = .0100

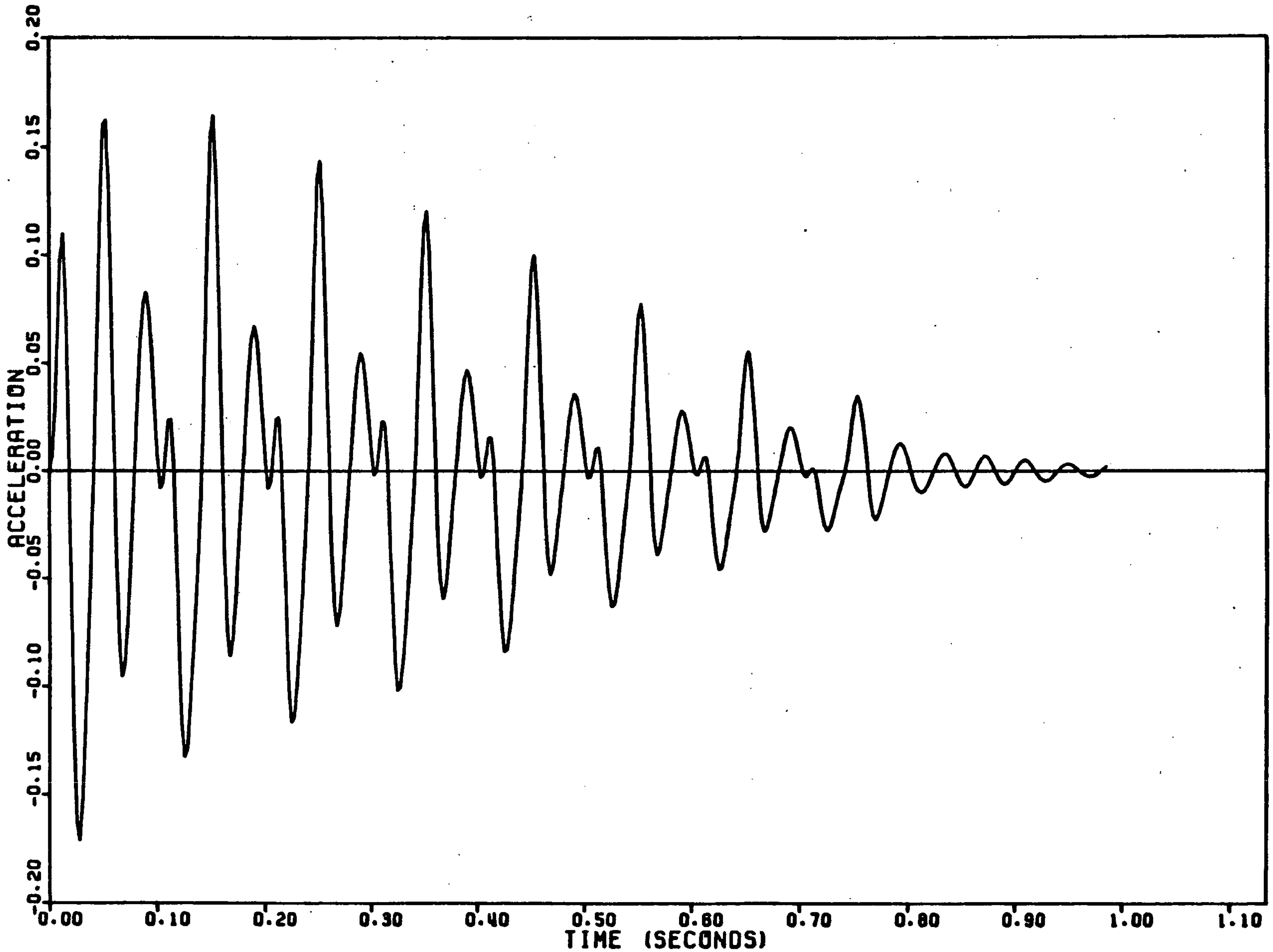


FIGURE C-157B. BOP EQUIPMENT TIME HISTORIES, SHIELD BUILDING LOCATION 4-25
SRV-1 LOADING - RECORD 16 - RADIAL ACCELERATION (G), NPTS = 395, DT = .0025

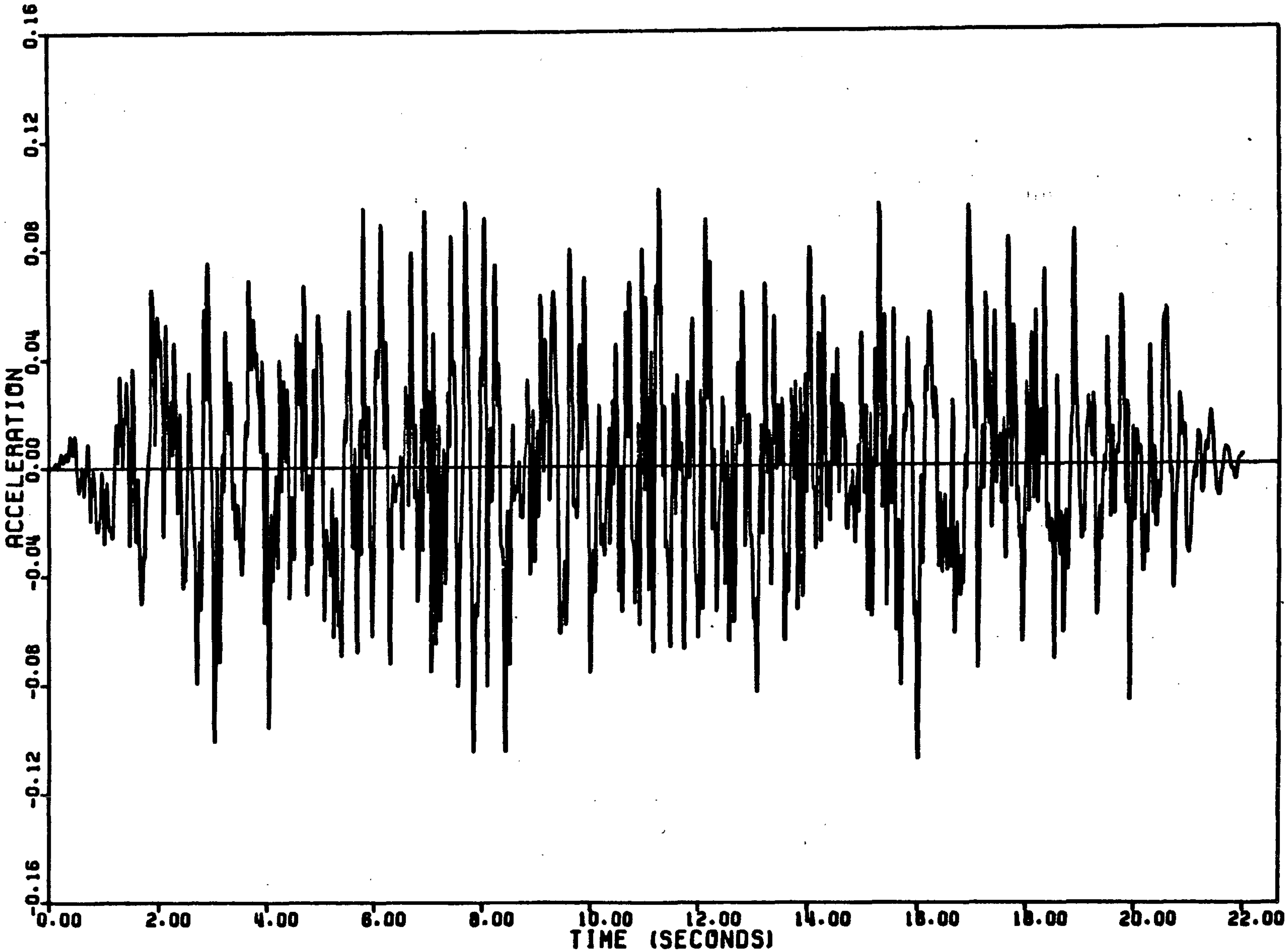


FIGURE C-158A. BOP EQUIPMENT TIME HISTORIES, SHIELD BUILDING LOCATION 4-25
OBE LOADING - RECORD 6 - RADIAL ACCELERATION (G), NPTS = 2200, DT = .0100

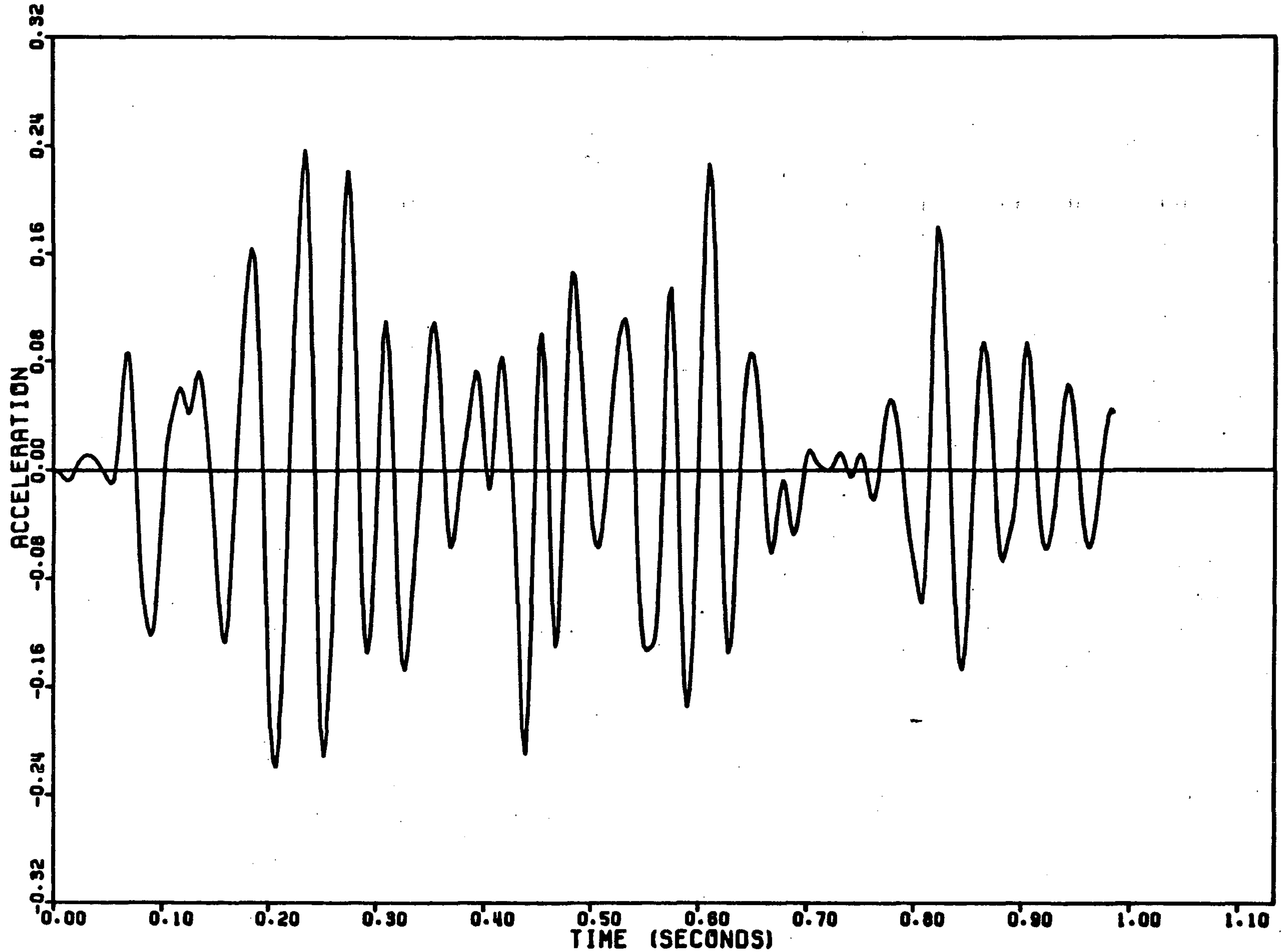


FIGURE C-158B. BOP EQUIPMENT TIME HISTORIES, SHIELD BUILDING LOCATION 4-25
SRV-ALL LOADING- RECORD 26 - RADIAL ACCELERATION (G), NPTS = 395, DT = .0025

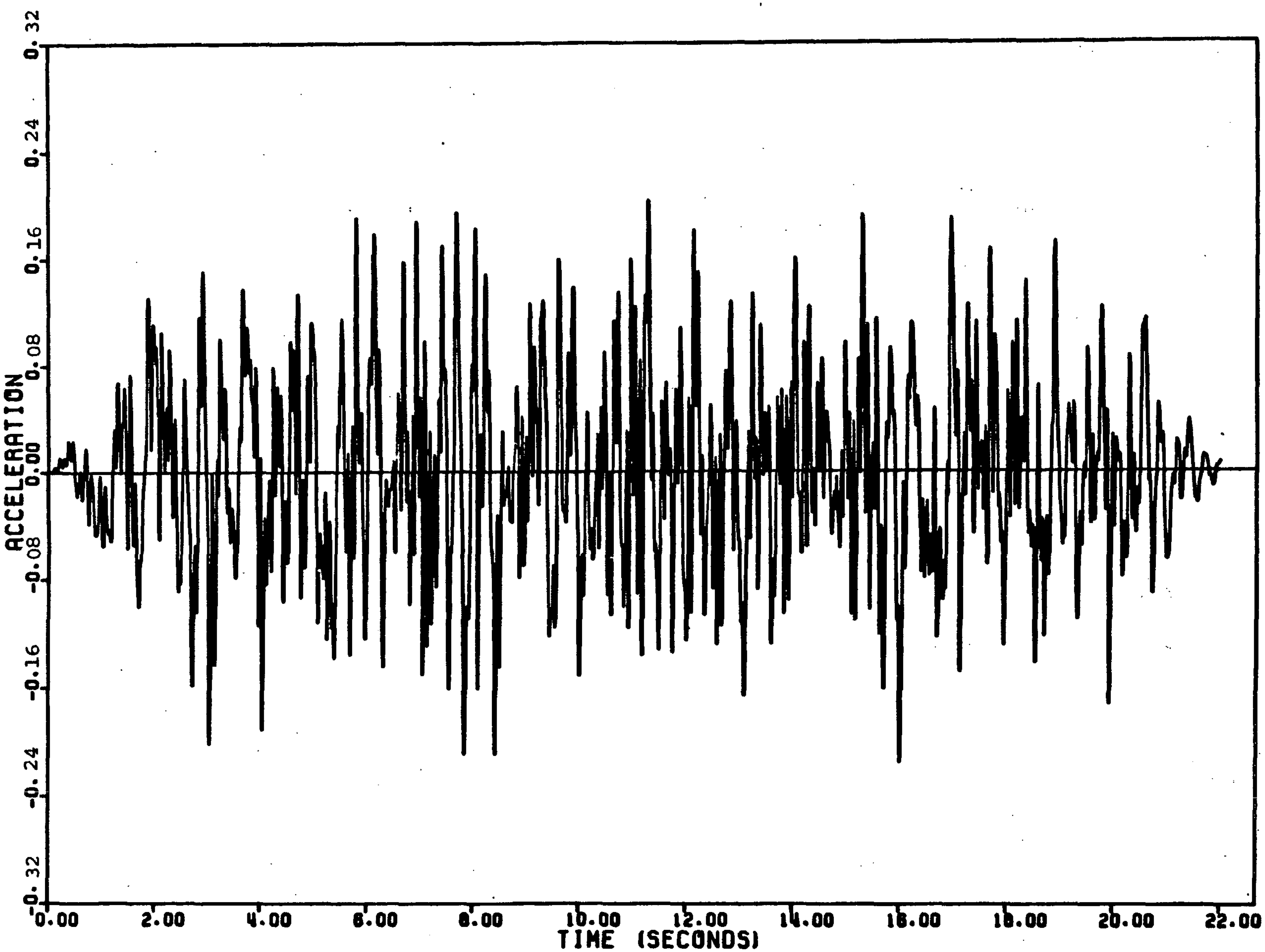


FIGURE C-159A. BOP EQUIPMENT TIME HISTORIES, SHIELD BUILDING LOCATION 4-25
SSE LOADING - RECORD 6 - RADIAL ACCELERATION (G), NPTS = 2200, DT = .0100

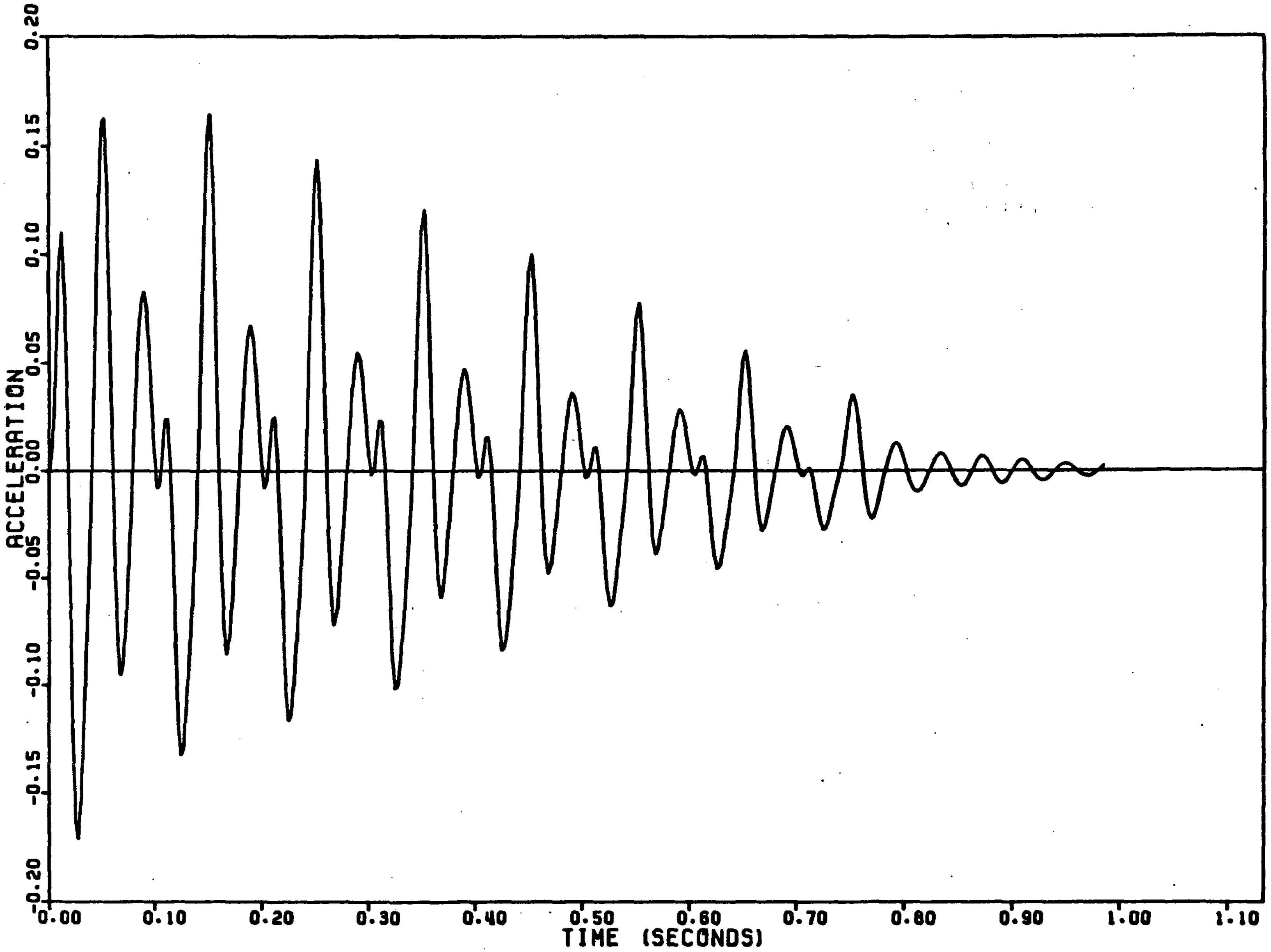


FIGURE C-159B. BOP EQUIPMENT TIME HISTORIES, SHIELD BUILDING LOCATION 4-25
SRV-1 LOADING - RECORD 16 - RADIAL ACCELERATION (G), NPTS = 395, DT = .0025

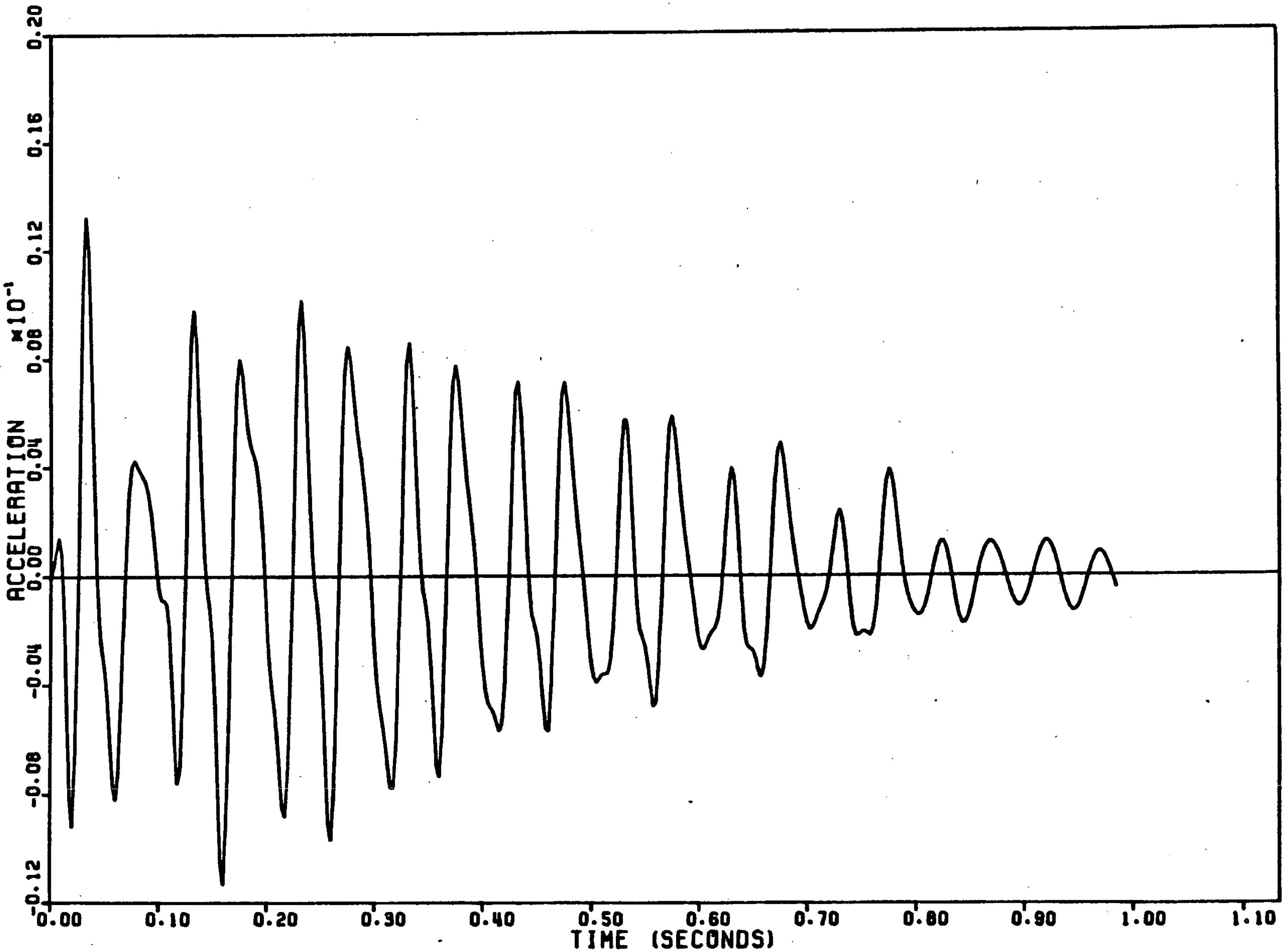


FIGURE C-160A. BOP EQUIPMENT TIME HISTORIES, SHIELD BUILDING LOCATION 4-26
SRV-1 LOADING - RECORD 17 - VERT. ACCELERATION (G), NPTS = 395, DT = .0025

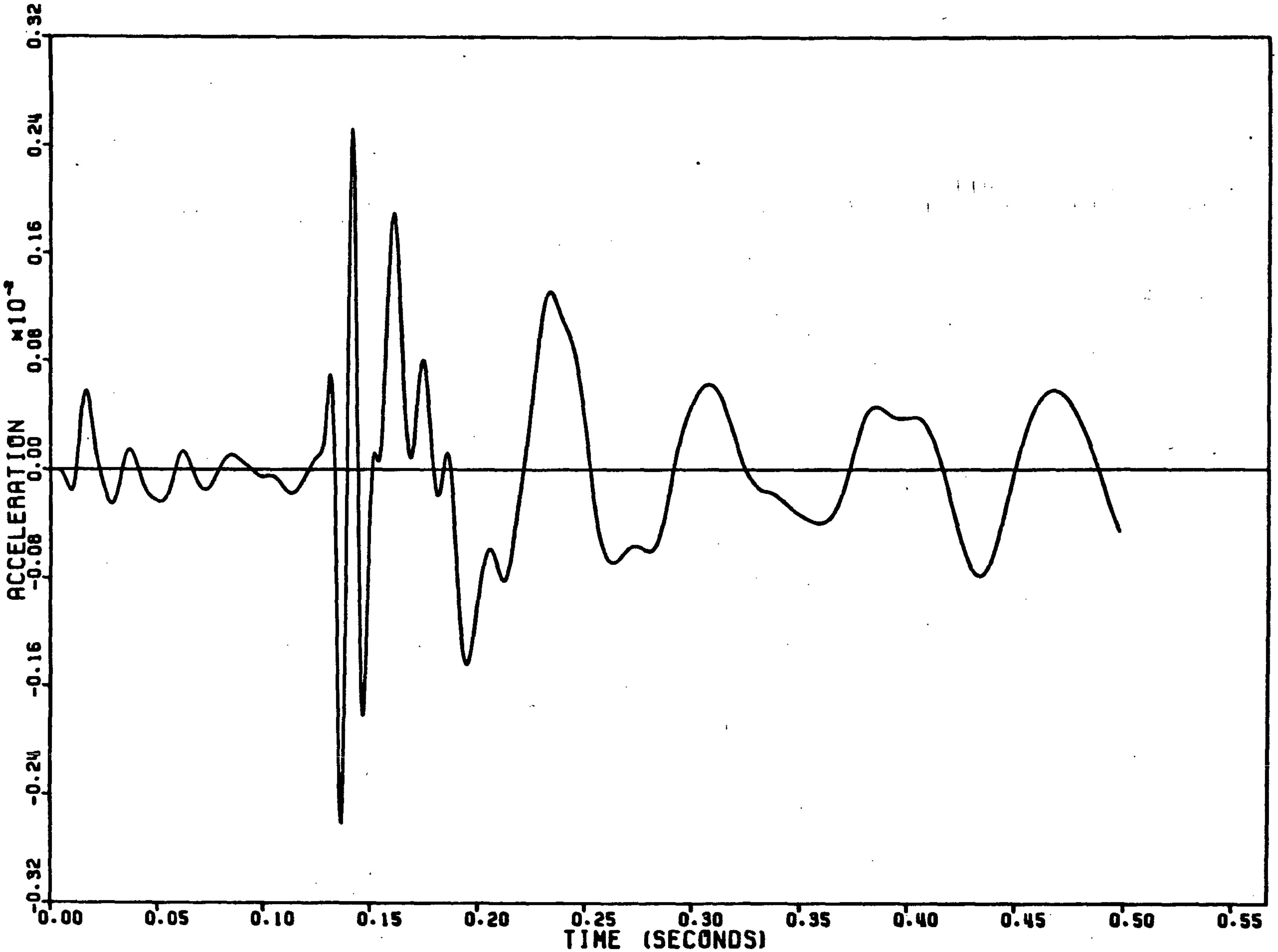


FIGURE C-160B. BOP EQUIPMENT TIME HISTORIES, SHIELD BUILDING LOCATION 4-26
CHUG LOADING - RECORD 37 - VERT. ACCELERATION (G), NPTS = 997, DT = .0005

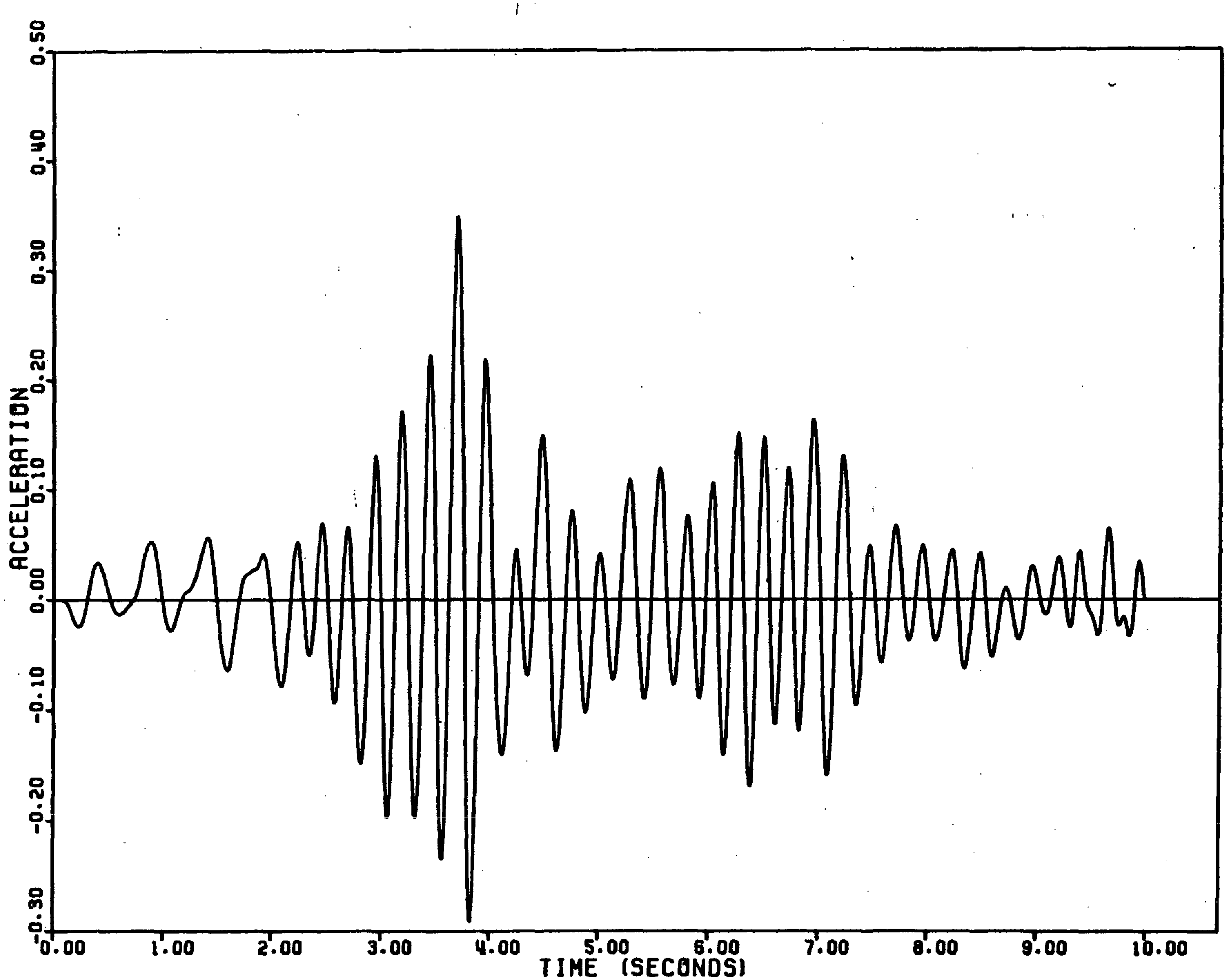


FIGURE C-161A. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-29
OBE LOADING RECORD 401 - VERT. SLAB ACCEL. (G), NPTS = 999, DT = .0100

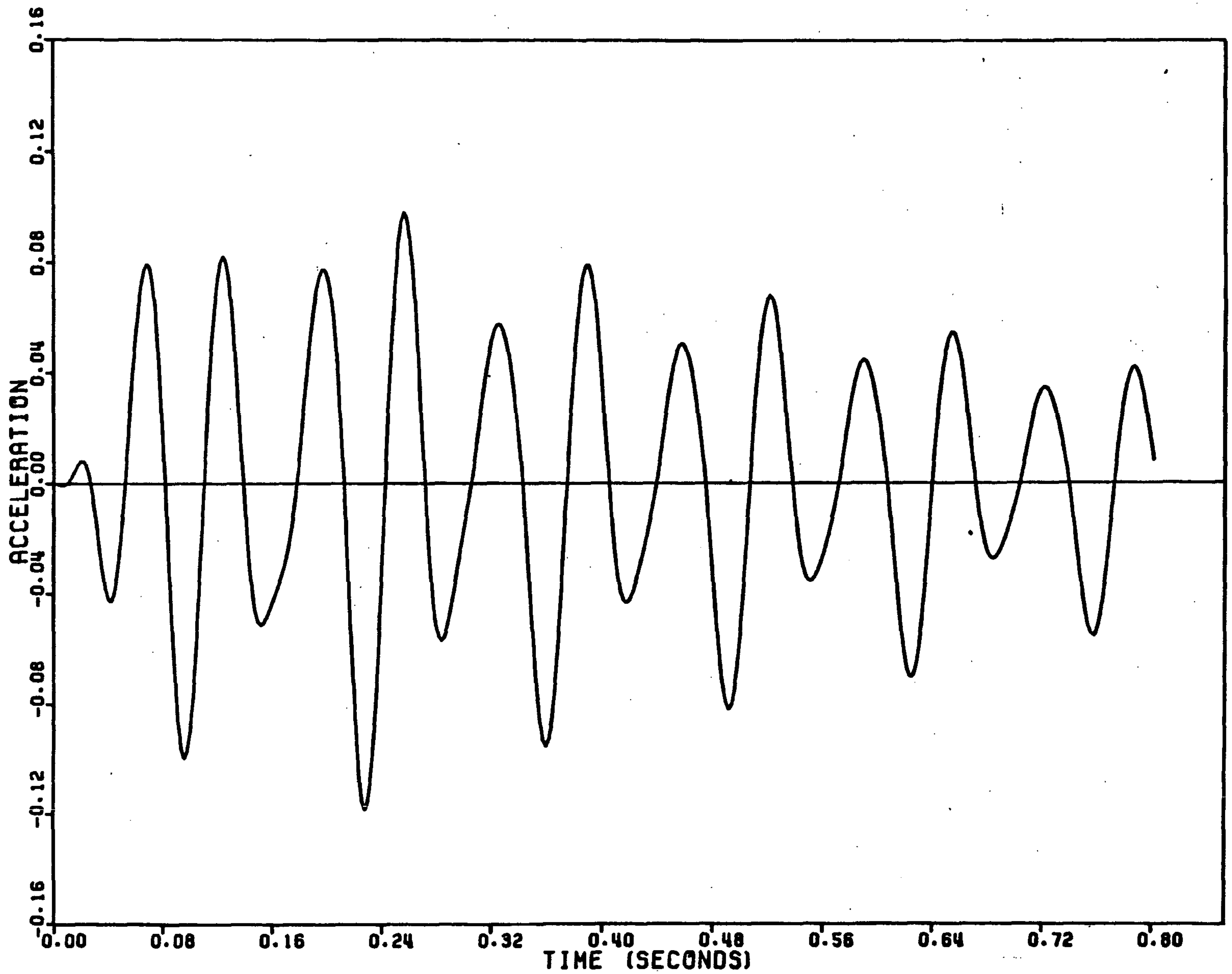


FIGURE C-161B. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-29
SRV-1 LOADING RECORD 411 - VERT. SLAB ACCEL. (G), NPTS = 402, DT = .002

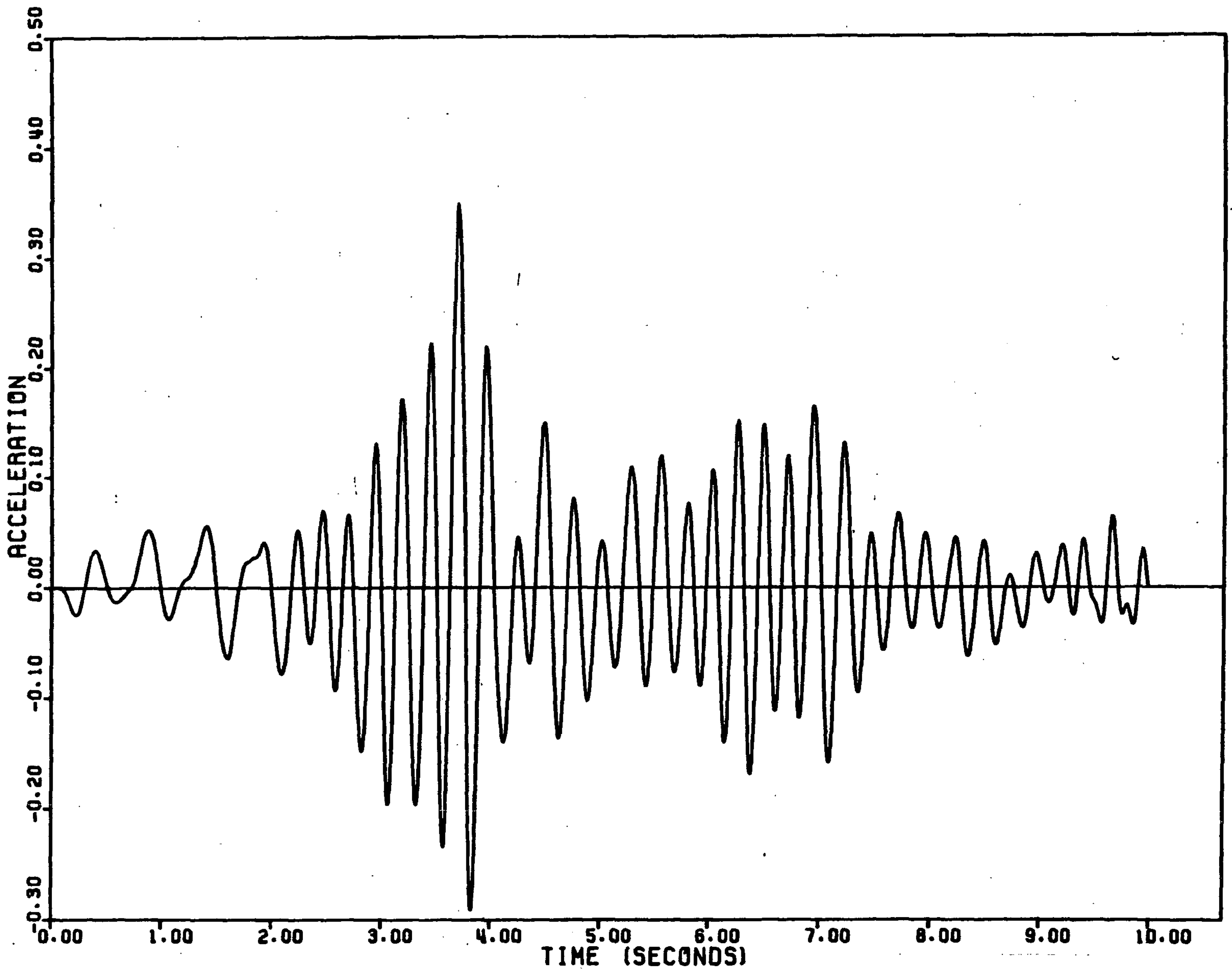


FIGURE C-162A. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-29
OBE LOADING RECORD 401 - VERT. SLAB ACCEL. (G), NPTS = 999, DT = .0100

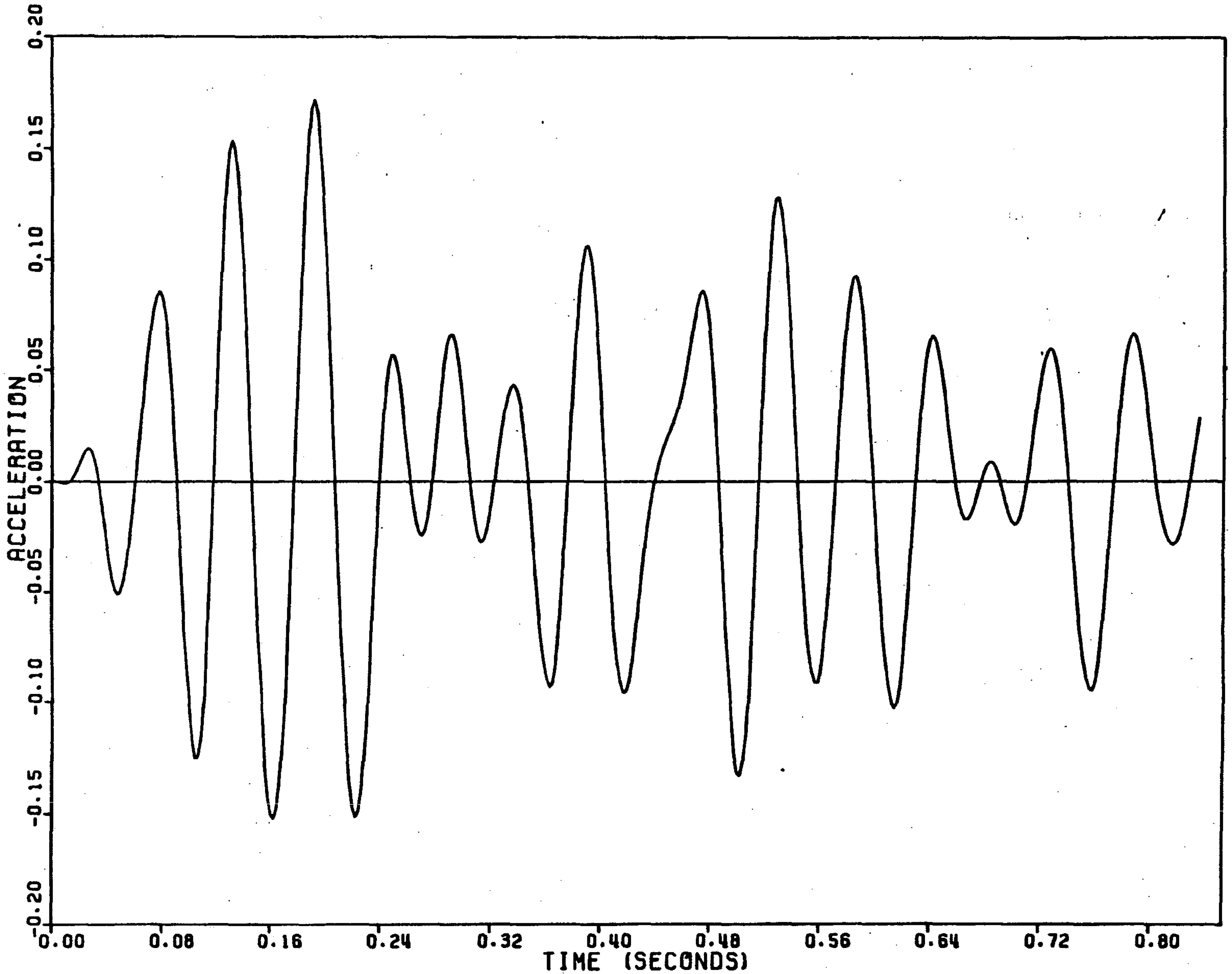


FIGURE C-162B. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-29
SRV-ADS LOADING RECORD 421 - VERT. SLAB ACCEL. (G), NPTS = 419, DT = .002

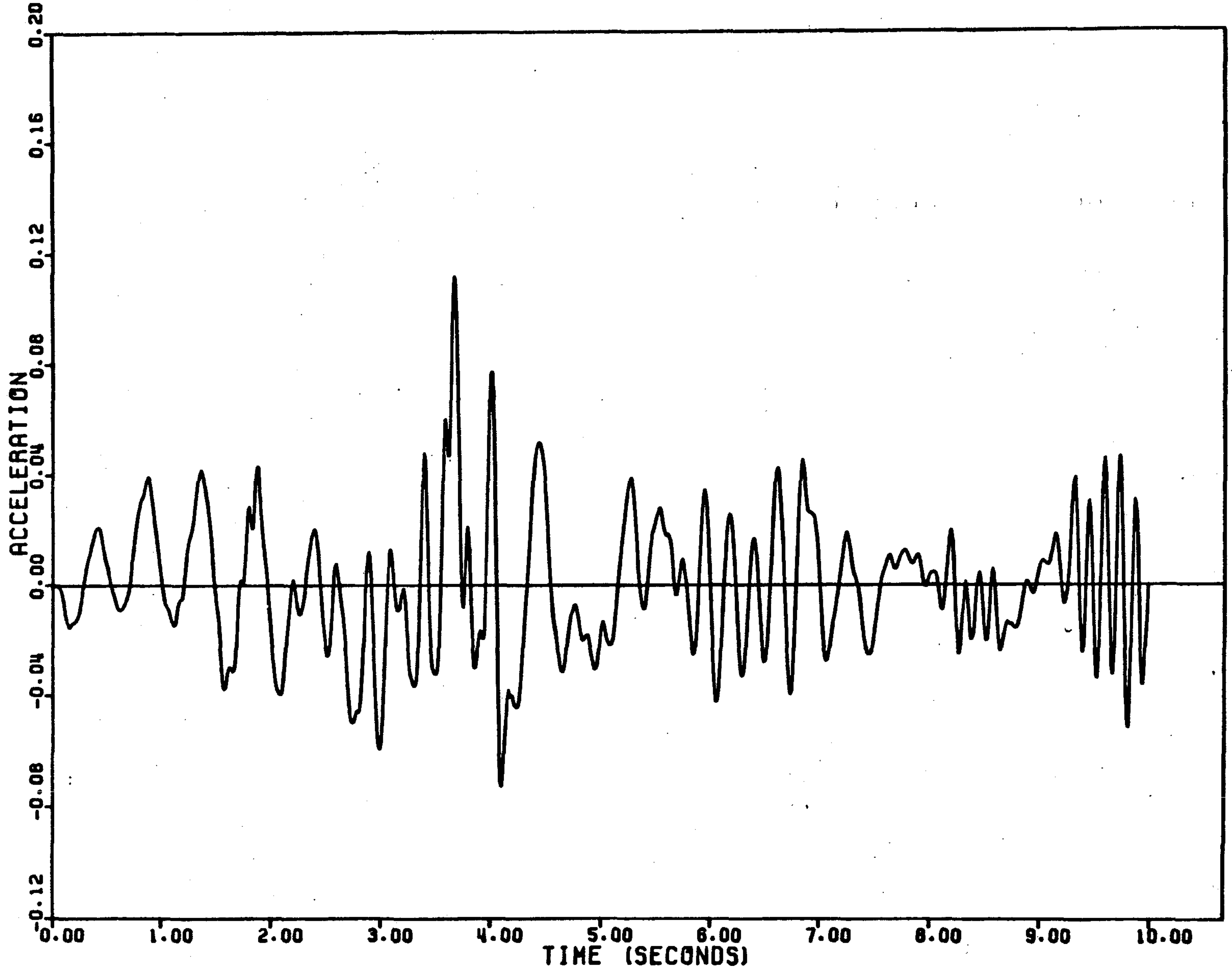


FIGURE C-163A. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-22
OBE LOADING RECORD 401 - VERT. WALL ACCEL. (G), NPTS = 999, DT = .0100

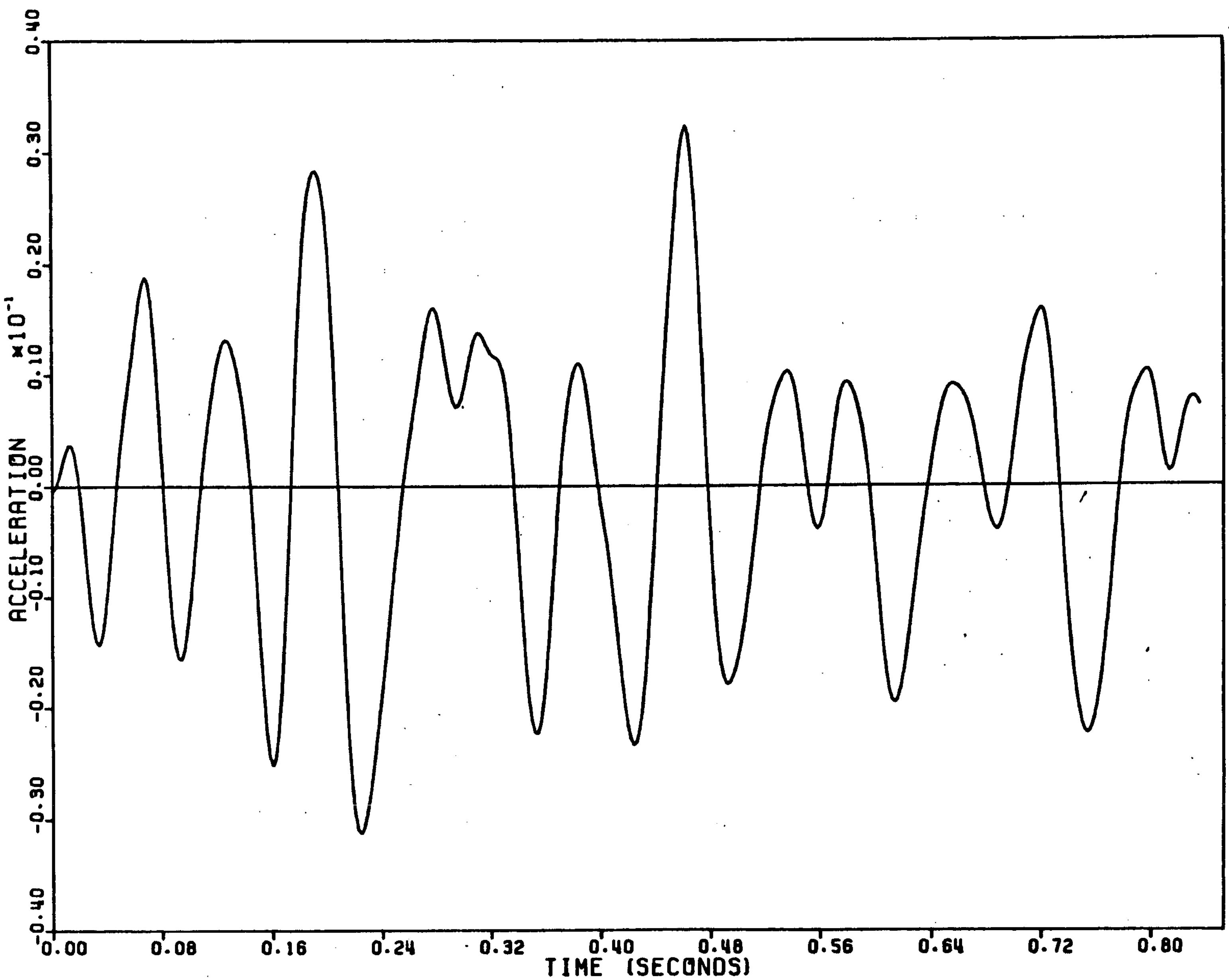


FIGURE C-163B. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-22
SRV-ADS LOADING RECORD 421 - VERT. WALL ACCEL. (G), NPTS = 419, DT = .0020

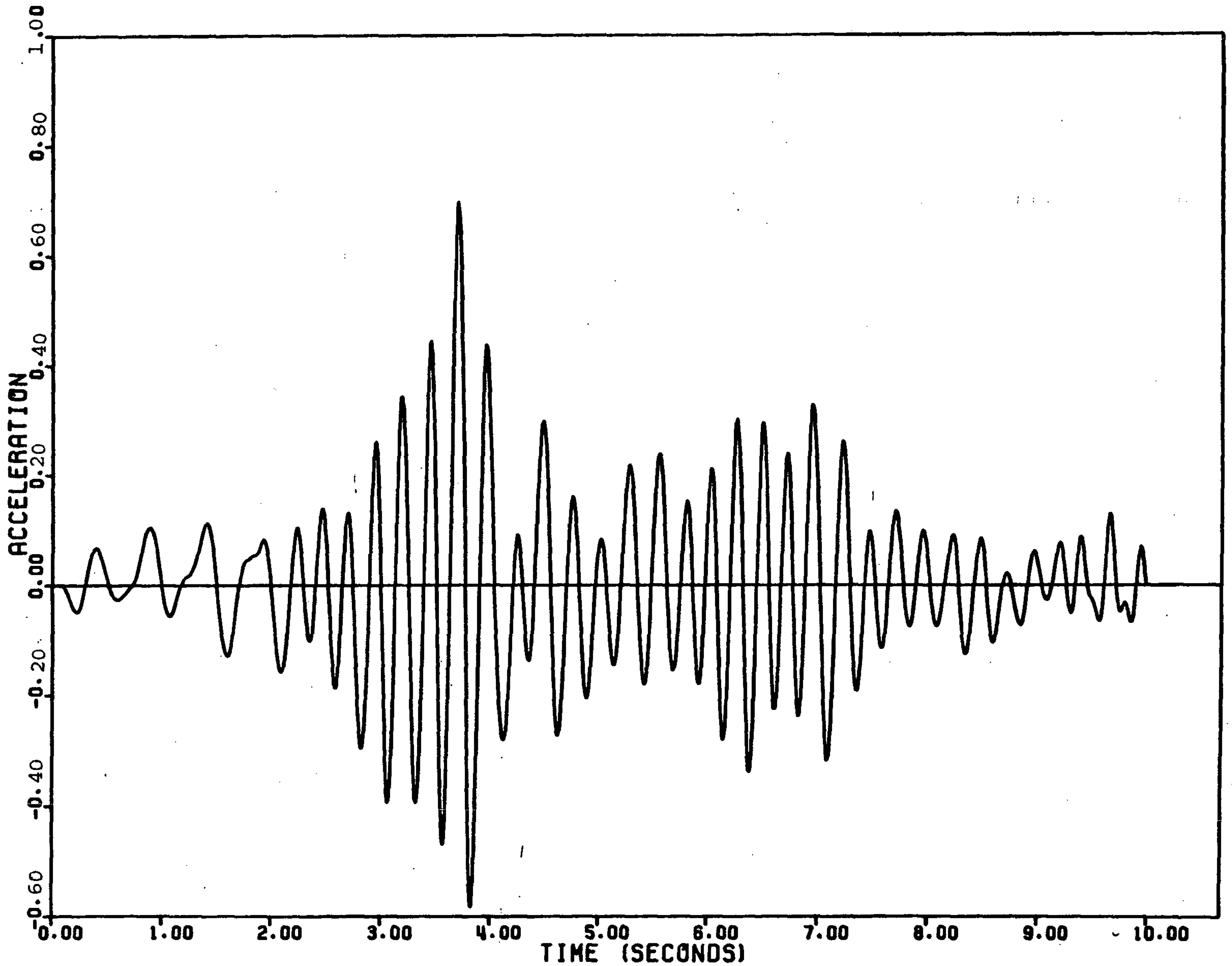


FIGURE C-164A. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-29
SSE LOADING RECORD 401 - VERT. SLAB ACCEL. (G), NPTS = 999, DT = .0100

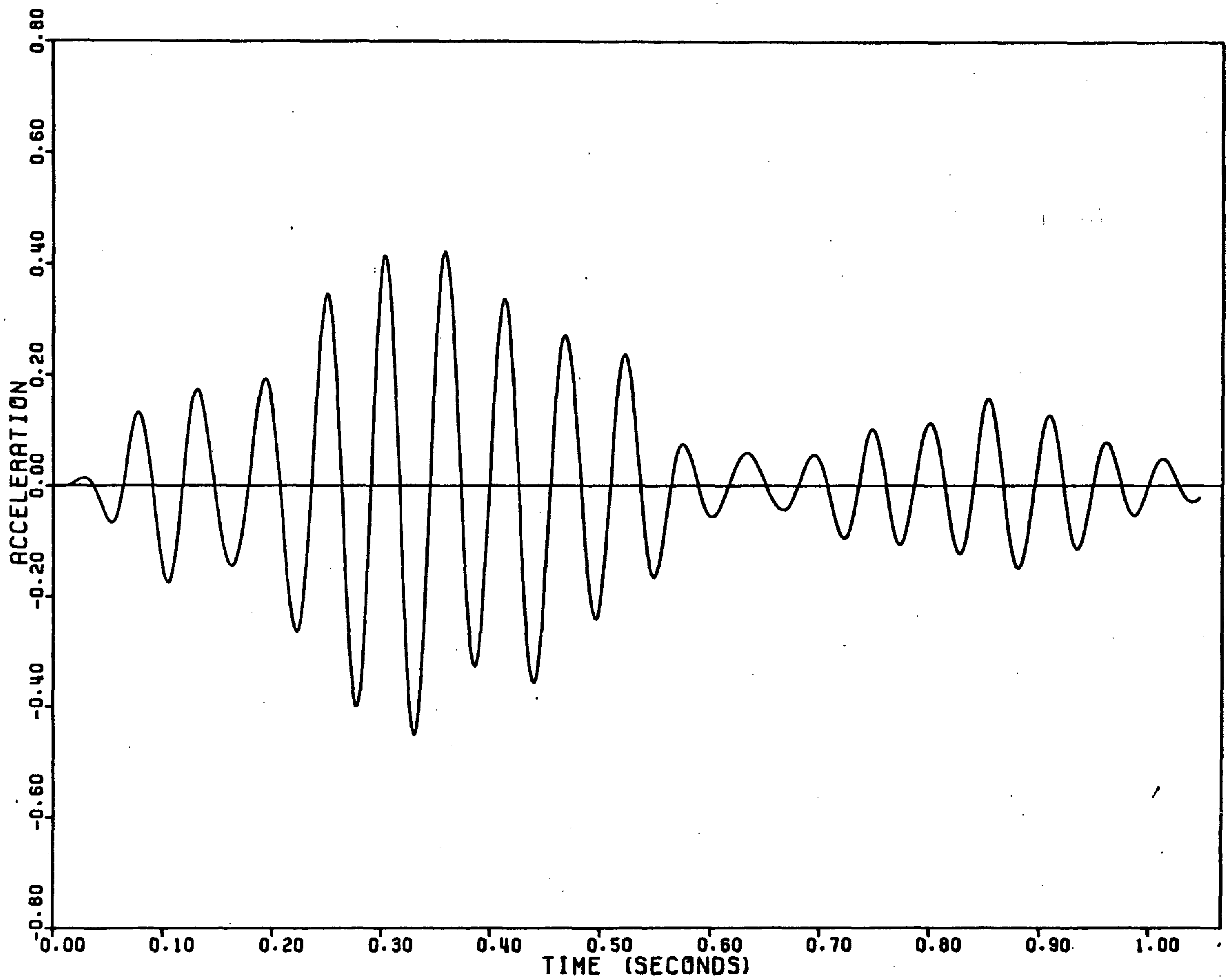


FIGURE C-164B. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-29
SRV-ALL LOADING RECORD 431 - VERT. SLAB ACCEL. (G), NPTS = 524. DT = .002

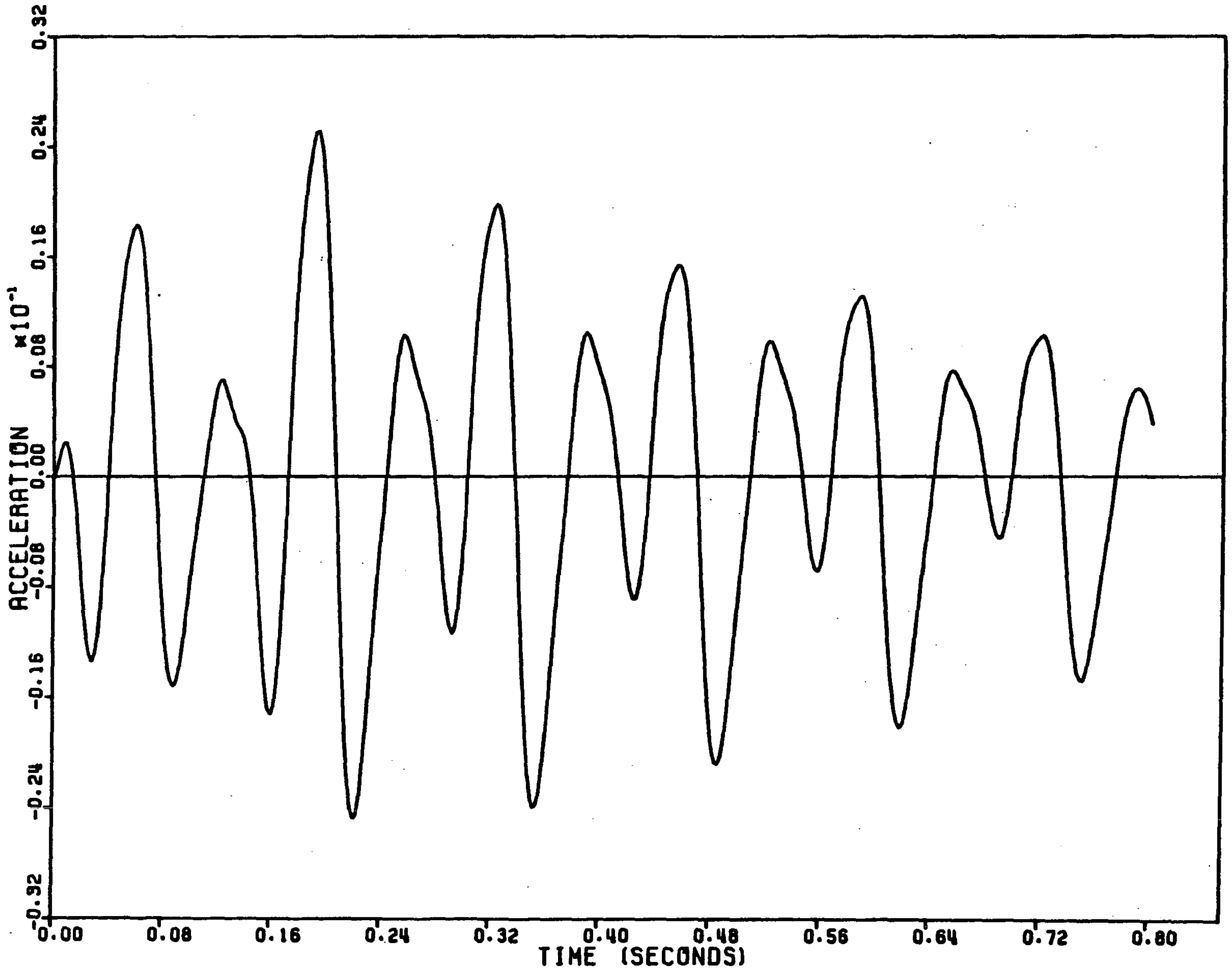


FIGURE C-165A. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-22
SRV-1 LOADING RECORD 411 - VERT. WALL ACCEL. (G), NPTS = 402, DT = .0020

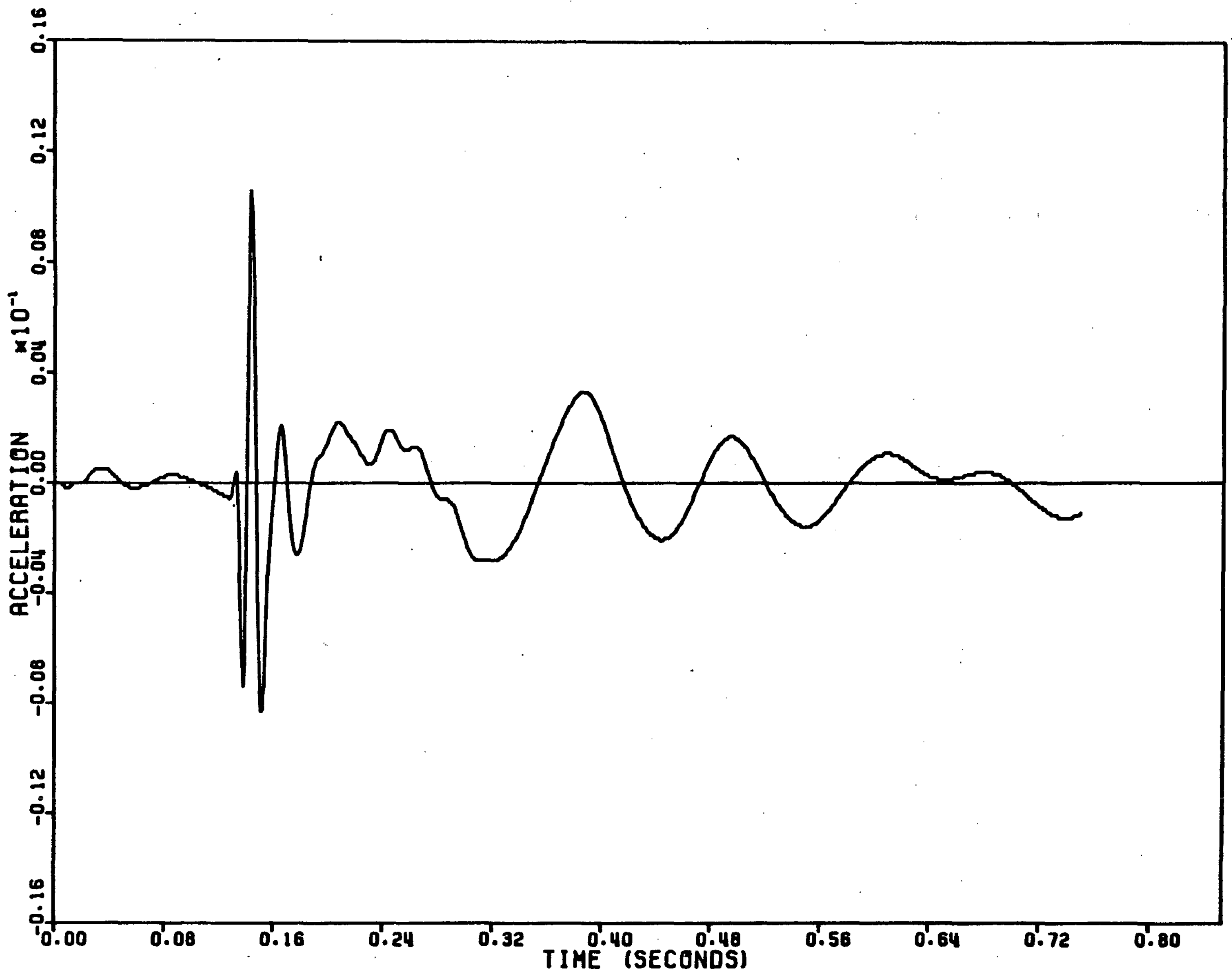


FIGURE C-165B. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-22
CHUG LOADING RECORD 441 - VERT. WALL ACCEL. (G), NPTS = 751, DT = .0010

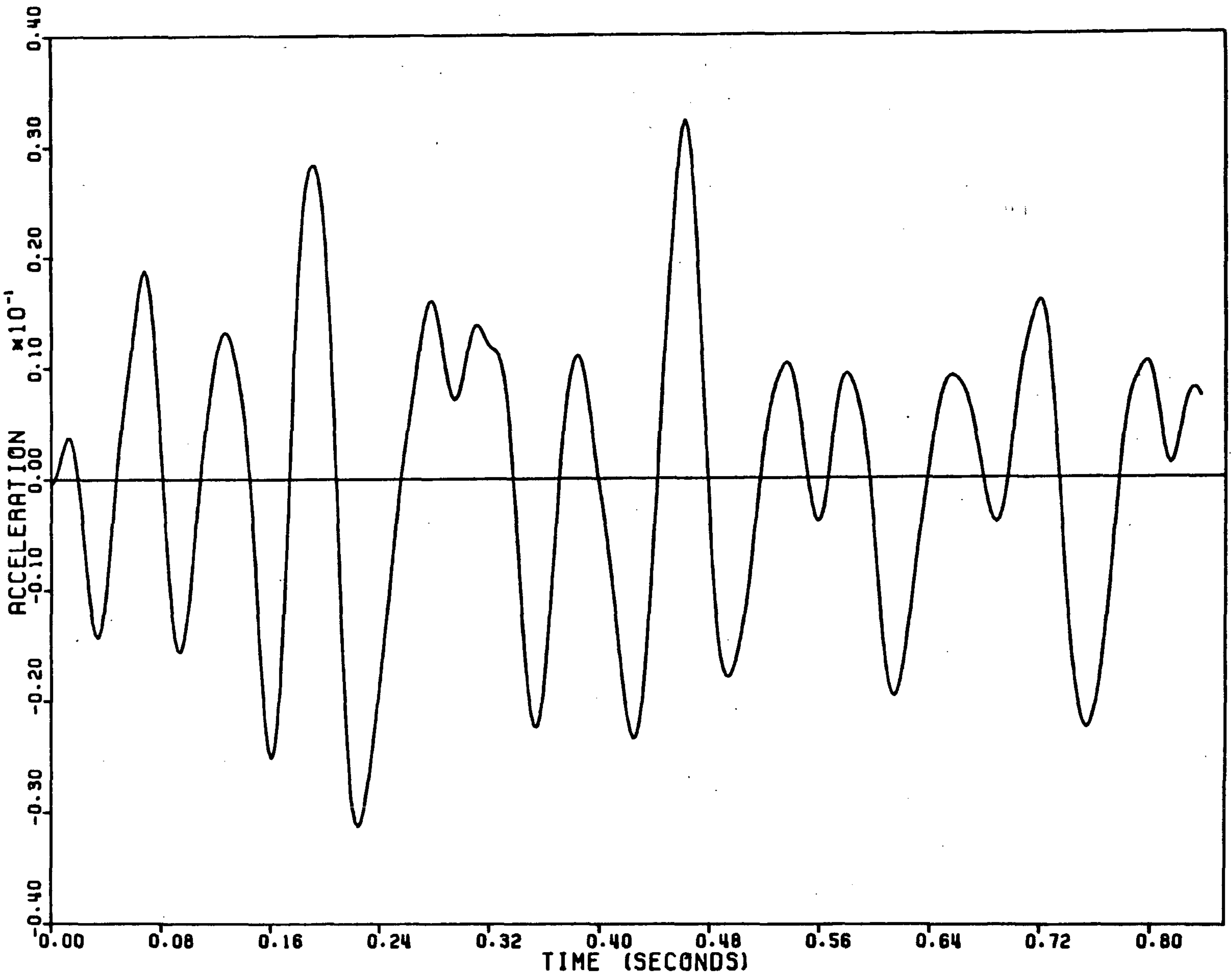


FIGURE C-166A. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-22
SRV-ADS LOADING RECORD 421 - VERT. WALL ACCEL. (G), NPTS = 419, DT = .0020

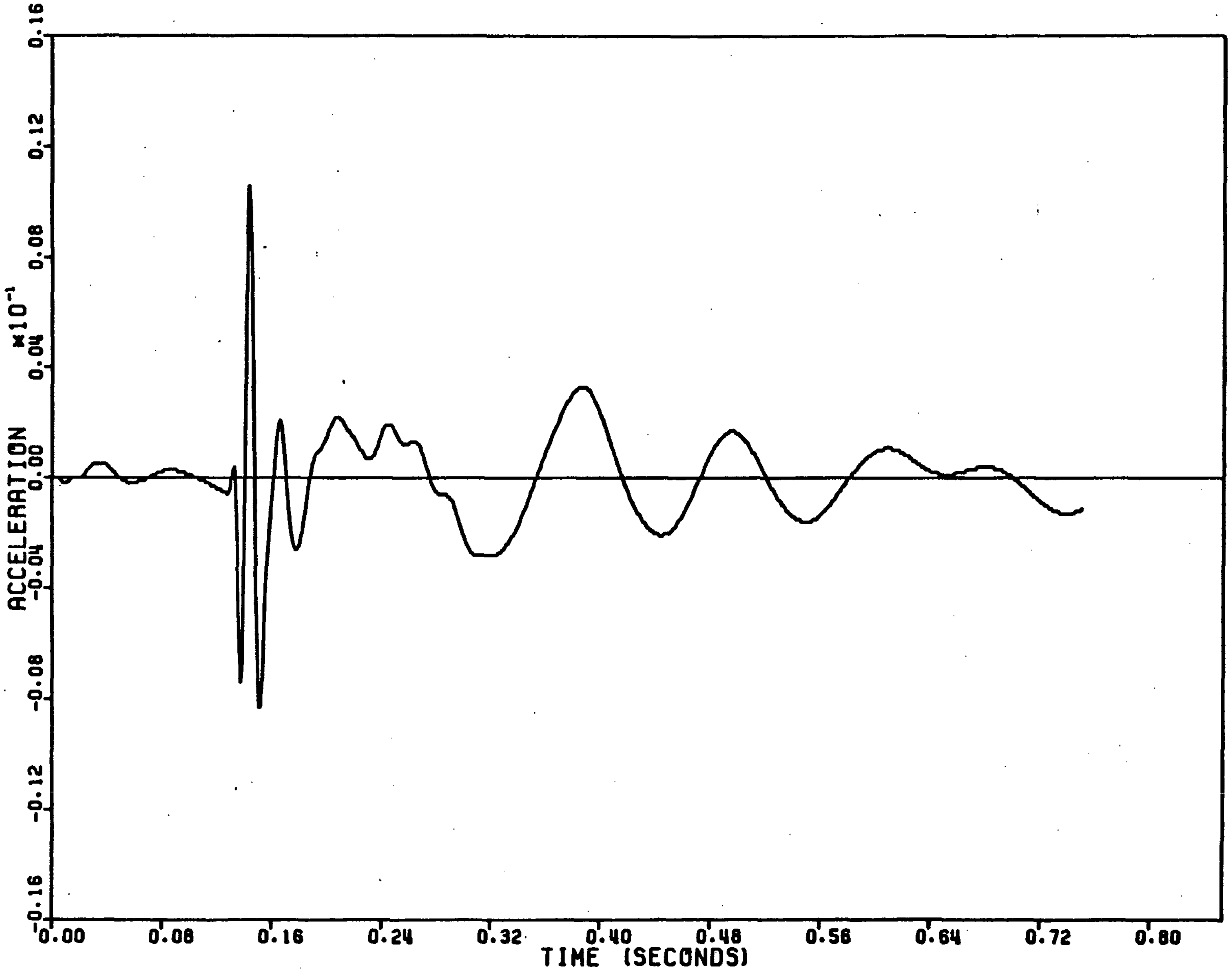


FIGURE C-166B. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-22
CHUG LOADING RECORD 441 - VERT. WALL ACCEL. (G), NPTS = 751, DT = .0010

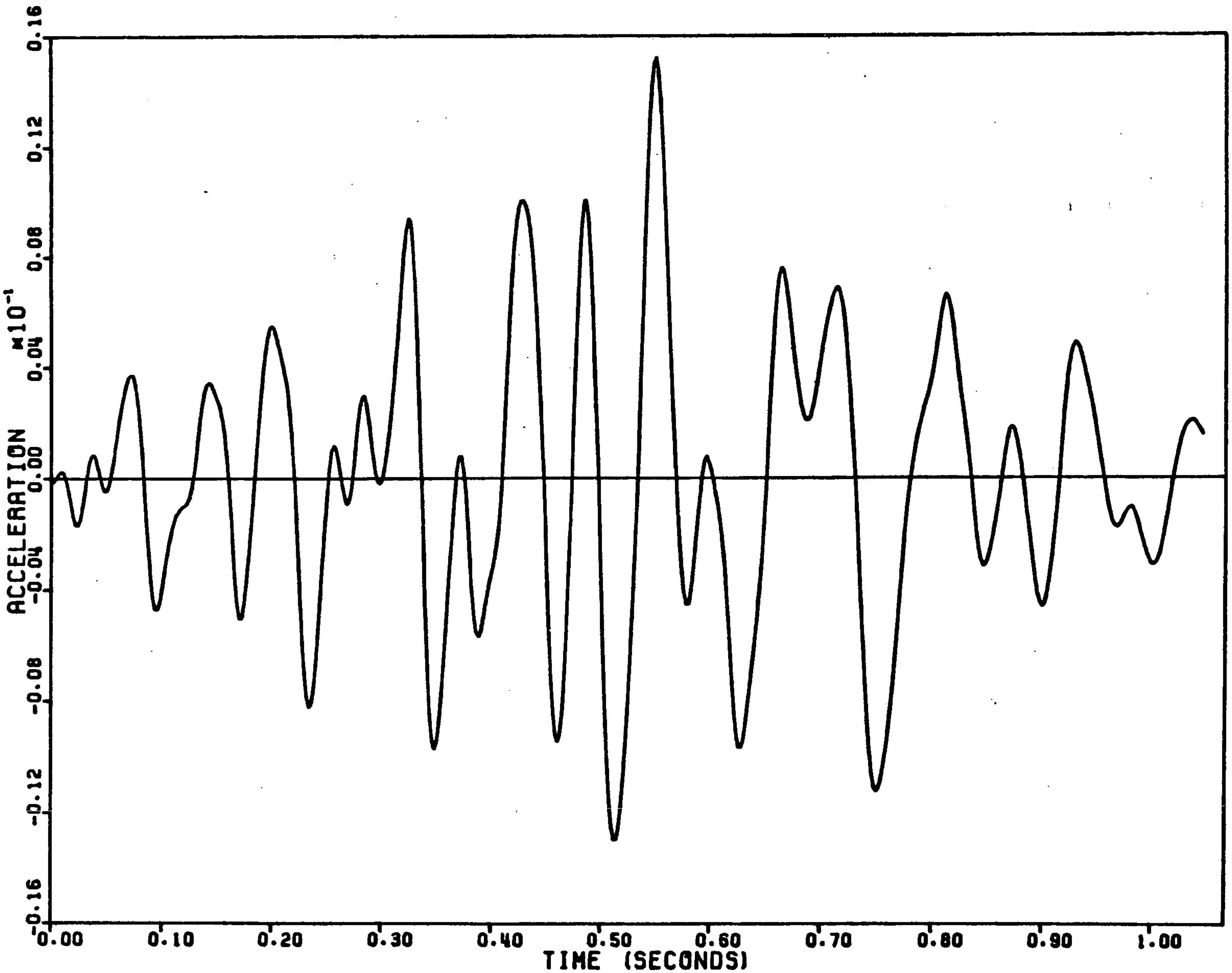


FIGURE C-167A. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-21
SRV-ALL LOADING RECORD 431 - HORIZ. ACCELERATION (G), NPTS = 524, DT = .002

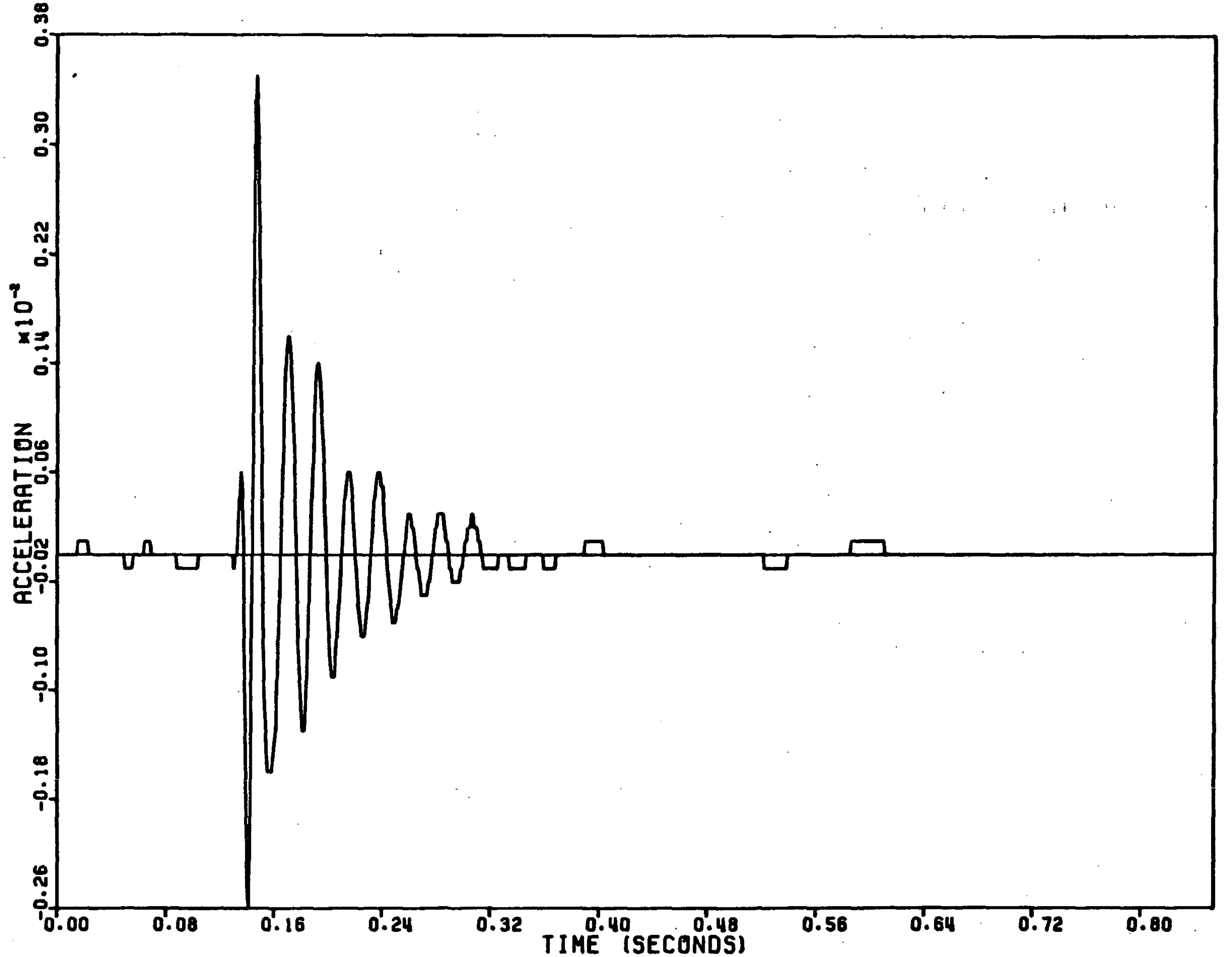


FIGURE C-167B. BOP EQUIPMENT T.H., AUXILIARY BUILDING LOCATION 5-21
CHUG LOADING RECORD 441 - HORIZ. ACCELERATION (G), NPTS = 751, DT = .001

APPENDIX D

ANALYSIS OF TRENDS IN THE DATA SET

APPENDIX D

As noted in Section 3.2, the 167 sample data set was broken down into several smaller subsets in order to determine if any trends were to be noted and to be sure that each response combination case could properly be considered as part of a single uniform data set. The entire set of data was broken down by:

1. Load Combination
2. Response Quantity
3. Equipment Category
4. Ratio A_2/A_1

where A_2 represents the peak amplitude of the short duration, higher frequency response and A_1 the peak amplitude of the long duration, lower frequency response. This appendix presents a detailed analysis of these data subsets.

D.1 Breakdown by Load Combination

Figure D-1 presents histograms of the R_{50}/SRSS response ratio for the three loadings considered in this study. Of the 167 total response combination cases investigated, only 17 resulted in an actual 50% NEP response value which exceeded the SRSS calculated response by more than 1% (the maximum variance being 9.5%). Of these, 12 were associated with an OBE + SRV case (75 total cases), 3 were associated with an SSE + SRV case (42 total cases), and 2 were associated with an SRV + CHUG case (50 total cases). The mean and standard deviations of the ratio R_{50}/SRSS for each of the three load combinations are all similar and one can easily accept the hypothesis that the results for the three load cases are all part of a single uniform data set.

D.2 Breakdown by Response Quantity

The response data supplied by the Architect/Engineer firms covered a variety of response parameters including acceleration, axial forces, shear forces, bending moments and support reactions. Figure D-2 presents histograms of the R_{50}/SRSS response ratio comparing the distributions for the 70 cases involving acceleration response and the 97 cases involving force or moment response. It can be seen that there is a slight trend toward higher values of R_{50}/SRSS from the acceleration response data. The mean value of the R_{50}/SRSS response parameter from the 70 acceleration response samples is 0.952 while the standard deviation is 0.070. These are in comparison with mean and standard deviation values of 0.913 and 0.063, respectively, for the 97 sample force and moment response distribution. It can also be seen that of the 17 cases for which R_{50} exceeded the SRSS calculated response value by more than one percent, 12 were evaluations of acceleration response data. It should be noted that acceleration is a less important design quantity and that high frequency acceleration response is not generally important to stress.

It will be subsequently shown that the ratio A_2/A_1 (where A_2 is the high frequency, short duration peak amplitude, and A_1 is the lower frequency, longer duration peak amplitude) does influence the ratio R_{50}/SRSS to a reasonable extent. This ratio A_2/A_1 was often greater for the acceleration cases than for the force and moment cases as shown below:

	Number of Cases				
	Total	$A_2/A_1 < 0.5$	$0.5 < A_2/A_1 < 1.0$	$1.0 \leq A_2/A_1 \leq 2.0$	$A_2/A_1 > 2.0$
Acceleration	70	17	22	21	10
Force & Moment	97	22	53	17	5

The ratio A_2/A_1 was less than 1.0 in 77% of the force and moment cases but was less than 1.0 for only 56% of the acceleration cases. In contrast, this ratio was greater than 2.0 in only 5% of the force and moment cases but was greater than 2.0 for 14% of the acceleration cases. This trend is expected since acceleration response frequently exhibits higher frequency content while force, moment, or stress response may not. The trend that shows a slightly greater ratio of R_{50}/SRSS for acceleration responses is judged to be totally due to the difference in the ratio A_2/A_1. Even with this slight trend, statistical hypothesis testing demonstrates the acceptability of the hypothesis that the ratio R_{50}/SRSS for acceleration data and for force or moment data are all part of a single uniform data set.

D.3 Breakdown by Equipment Categories

Figure D-3 presents a comparison of the R_{50}/SRSS response ratio histograms broken down into the categories of NSSS, BOP piping, and BOP equipment. One notes 2 out of 40 cases exceeding 1.01 for the NSSS, 11 out of 82 cases exceeding 1.01 for the BOP piping, and 5 out of 45 cases for BOP equipment. The BOP piping and equipment cases also have higher mean response ratios than for the NSSS cases. Again, this trend appears to be due to ratios of A_2/A_1 contained in each of the cases as shown below:

		Number of Cases			
	Total	$A_2/A_1 < 0.5$	$0.5 < A_2/A_1 < 1.0$	$1.0 \leq A_2/A_1 \leq 2.0$	$A_2/A_1 > 2.0$
NSSS	40	16	15	9	0
BOP Piping	82	10	46	16	10
BOP Equipment	45	13	14	13	5

The ratio A_2/A_1 is less than 1.0 for 78%, 68% and 60% of the NSSS, BOP piping, and BOP equipment cases, respectively. Also, A_2/A_1 exceeds 2.0 for none of the NSSS cases and for 12% and 11% of the BOP piping and BOP equipment cases, respectively. The higher number of cases in which A_2/A_1 exceeds 1.0 results in the higher mean ratios of R_{50}/SRSS and the higher number of cases in which this ratio exceeds 1.01.

The ratio of R_{50}/SRSS for the NSSS cases, BOP piping cases, and BOP equipment cases are all part of a single uniform data set as demonstrated by statistical hypothesis testing.

D.4 Breakdown by Ratio A_2/A_1

Table D-1 tabulates the number of cases in which R_{50}/SRSS exceeds 1.01, and 1.05 versus A_2/A_1 ratios. Figure D-4 presents a comparison of the R_{50}/SRSS response ratio histograms for four different ranges of the ratio A_2/A_1 (less than 0.5, 0.5 to 1.0, 1.0 to 2.0, and greater than 2.0). The mean value, $\bar{x}$, of R_{50}/SRSS for the 39 cases where $A_2/A_1 < 0.5$ is 0.944 and the standard deviation, σ, is 0.026. The SRSS method of response combination is always conservative for these cases. The comparatively small standard deviation of the distribution is a result of the small variation between the most likely response for these cases (peak of low frequency response alone) and the SRSS calculated value; the variation being small due to the peak amplitude ratio of the two responses being combined. For the three ranges where the high frequency response is of more importance, the mean value of R_{50}/SRSS definitely increases with increasing ratios of A_2/A_1 ranging from 0.895 to 1.012. For cases where A_2/A_1 is less than 2.0, the SRSS response combination method provides a conservative bias which decreases with increasing values of A_2/A_1 while for cases where A_2/A_1 exceeds 2.0, the SRSS method provides a negligibly unconservative bias but even so, on the average, constitutes a very accurate means of computing combined dynamic response. As expected, the standard deviations of these distributions are higher as the peak amplitudes of the responses being combined are more nearly equal and lower as the amplitude of either response history becomes more predominant.

When A_2/A_1 is less than 0.5 so that the low-frequency response amplitude (A_1) is predominant over the high-frequency response amplitude (A_2), the CDF curve takes the form of a step function with the 50% NEP value and often the 85% NEP value being equal to the peak amplitude of the low frequency response. The non-exceedance probability associated with the SRSS value, P(SRSS), is generally much greater than 50% and the non-exceedance probability associated with 1.2 times the SRSS calculated response, P(1.2 SRSS), is always much greater than 85%. This characteristic can be seen in Figure B-137 in Appendix B which was generated by the time phased response combination of the response histories shown in Figures C-137A and C-137B from Appendix C. When $A_2/A_1 \leq 0.5$, the SRSS response combination method is very conservative. The most probable response combination would be obtained by using A_1 only (i.e., ignoring A_2 because the short duration record is not likely to combine with a significant peak of the long duration record when the long duration record predominates).

When the low-frequency and high-frequency response amplitudes are approximately equal ($A_1 \approx A_2$), the CDF curve is characterized by a normal "S" shape. For such cases, the non-exceedance probability P(SRSS) is nearly always greater than 50% and P(1.2 SRSS) is high generally being much greater than 85%. Figure B-14 represents the combination of two nearly equal peak OBE and SRV_1 responses. Since the magnitude of the high frequency SRV response is significant, the peak combined response will nearly always occur during the time when the SRV is active and thus the peak combined response will occur when a significant peak of the earthquake response combines with one of the peaks (positive or negative) of the SRV response. Hence, $A_1 \approx A_2$, the SRSS response combination method is generally conservative.

For cases where the high-frequency amplitude is somewhat greater than the low-frequency amplitude ($1.0 < A_2/A_1 < 2.0$), the value of P(SRSS) is approximately equal to 50% and the value of P(1.2 SRSS) remains high, being generally much greater than 85%. An example of a case of this type is shown in Figure B-157 which is a combination of OBE and SRV_1 responses. Again, the peak combined response will certainly occur during the active portion of the SRV. Hence, when $1.0 \leq A_2/A_1 \leq 2.0$, the SRSS method generally leads to a combined response very close to the R_{50} response.

When A_2/A_1 exceeds 2.0, the ratio of R_{50}/SRSS marginally exceeds 1.0 in many of the cases. This ratio has a 90% probability of being between about 0.94 and 1.08 for these cases. The probability P(1.2 SRSS) remains high being generally much greater than 85%. An example of a case of this type is shown in Figure B-131. For this case, the peak combined response again clearly occurs during the time that the SRV is active. When A_2/A_1 exceeds 2.0, the SRSS method of response combination is slightly unconservative on the average when compared to the R_{50} combined response but remains a perfectly adequate response combination method even in these cases.

The data set did not include any cases where the amplitude of the high-frequency response exceeded three times the amplitude of the lower frequency response. For such cases, the SRSS calculated response approaches that computed by absolute summation.

In no case, was the conservatively computed ratio R_{50}/SRSS greater than 1.095. Thus, all 167 cases meet Newmark-Kennedy Criterion 2 and responses can be combined by SRSS.

TABLE D-1

EFFECT OF A_2/A_1 RATIO ON $R_{50}/SRSS$

A_2/A_1	Number of Cases		
	TOTAL	$R_{50}/SRSS > 1.01$	$R_{50}/SRSS > 1.05$
< 0.5	39	0	0
0.5 - 1.0	75	3	2
1.0 - 2.0	38	6	1
> 2.0	15	8	4
TOTAL	167	17	7

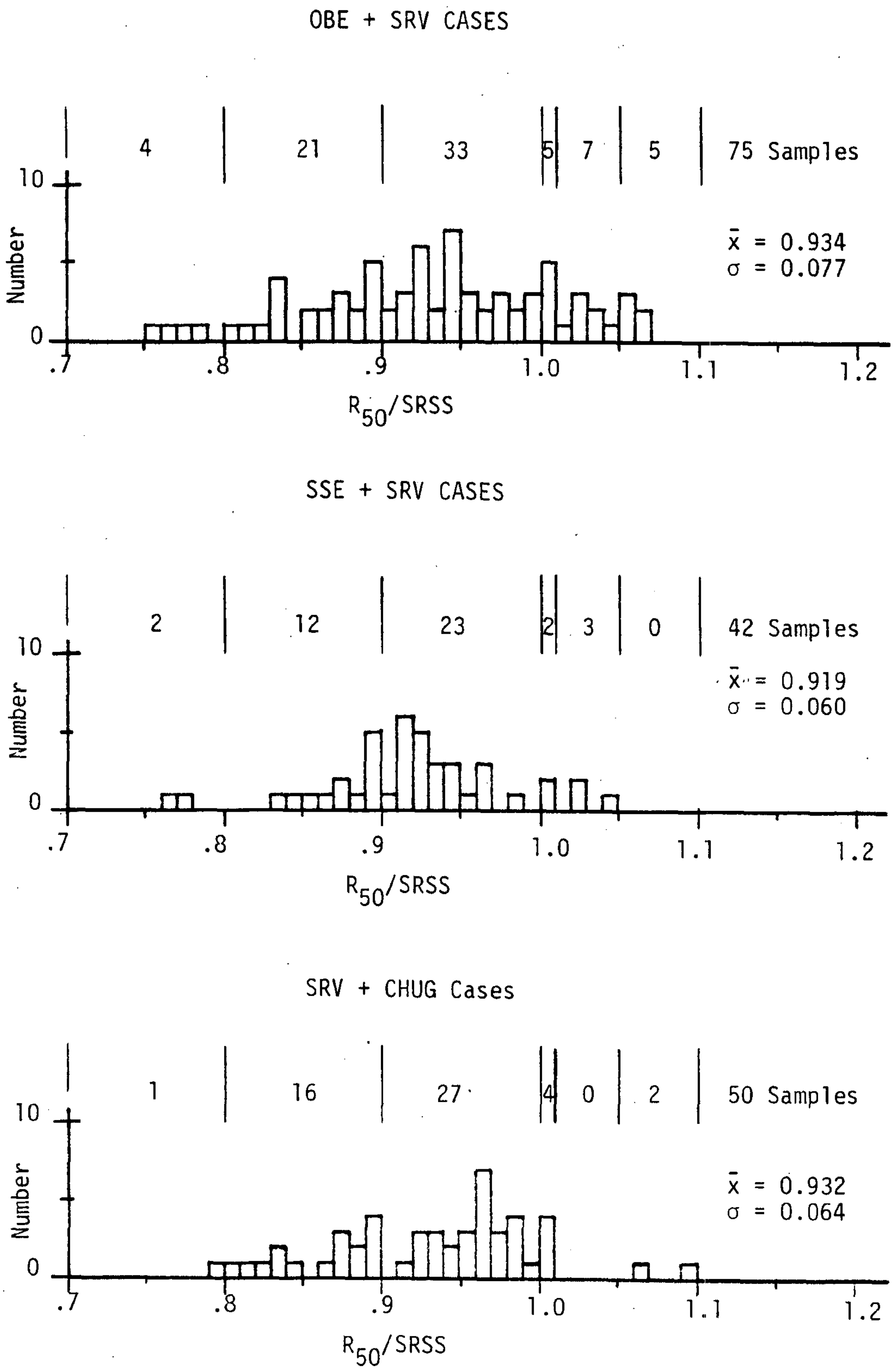
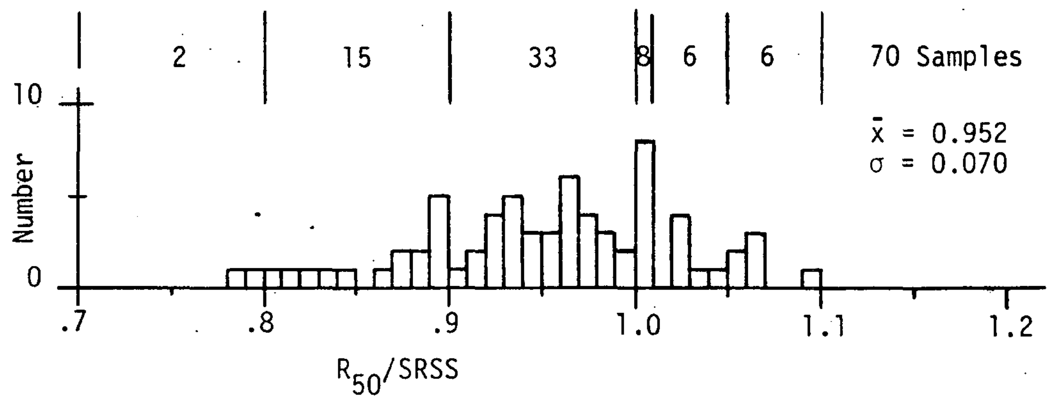


FIGURE D-1. COMPARISON OF R_{50}/SRSS FOR OBE + SRV CASES, SSE + SRV CASES AND SRV + CHUG CASES

Acceleration Response



Force and Moment Response

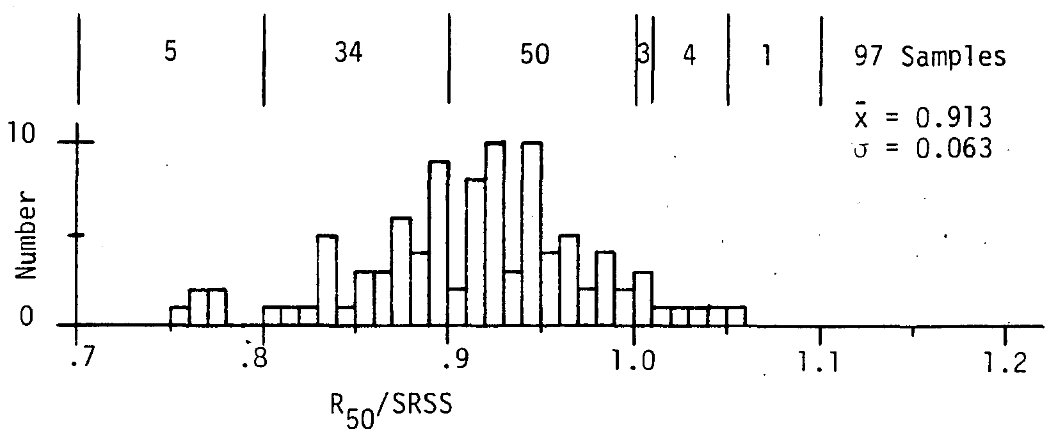


FIGURE D-2. COMPARISON OF R_{50}/SRSS FOR ACCELERATION RESPONSE AND FOR FORCE AND MOMENT RESPONSE

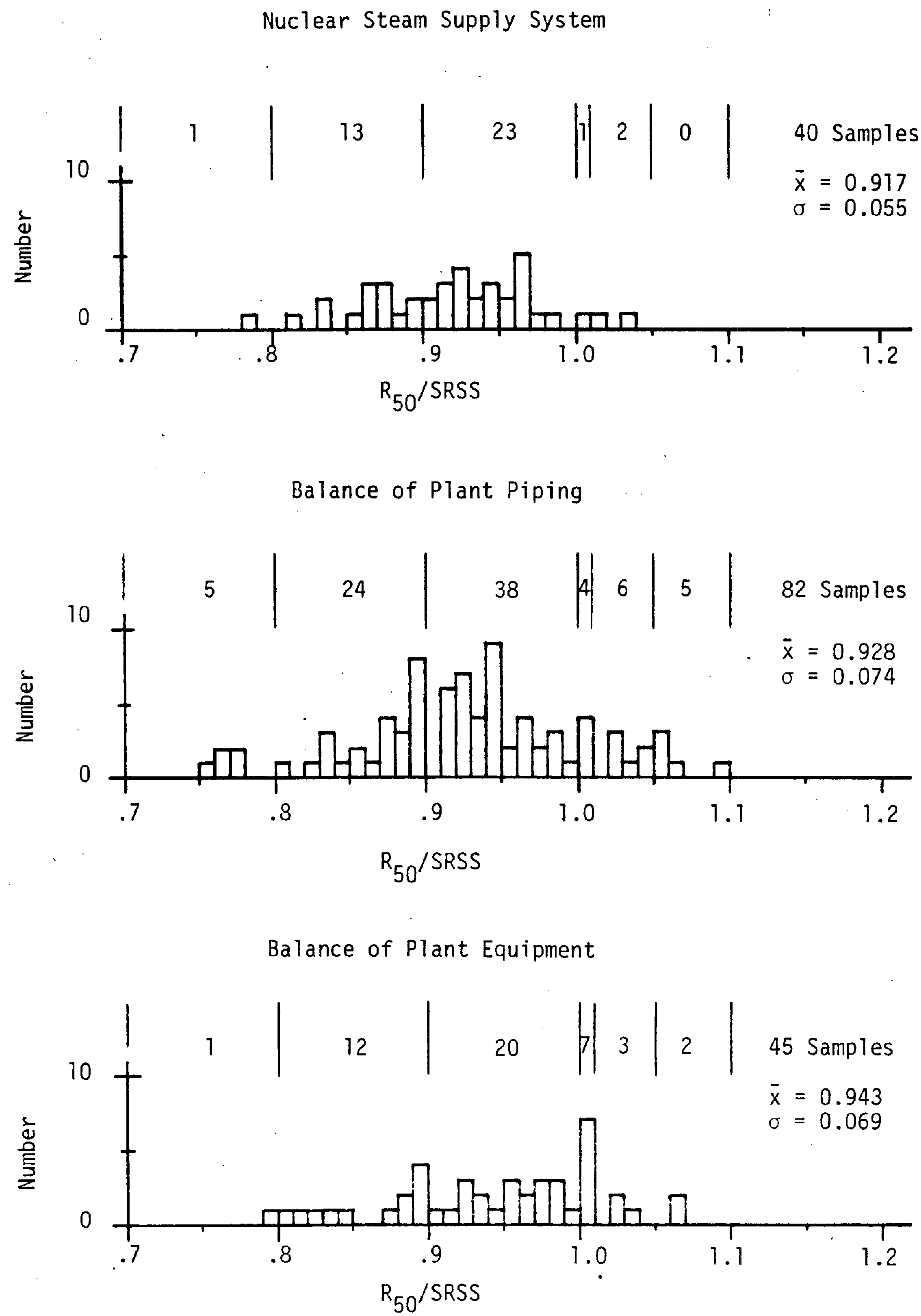


FIGURE D-3. COMPARISON OF R_{50}/SRSS FOR MAJOR COMPONENT CATEGORIES

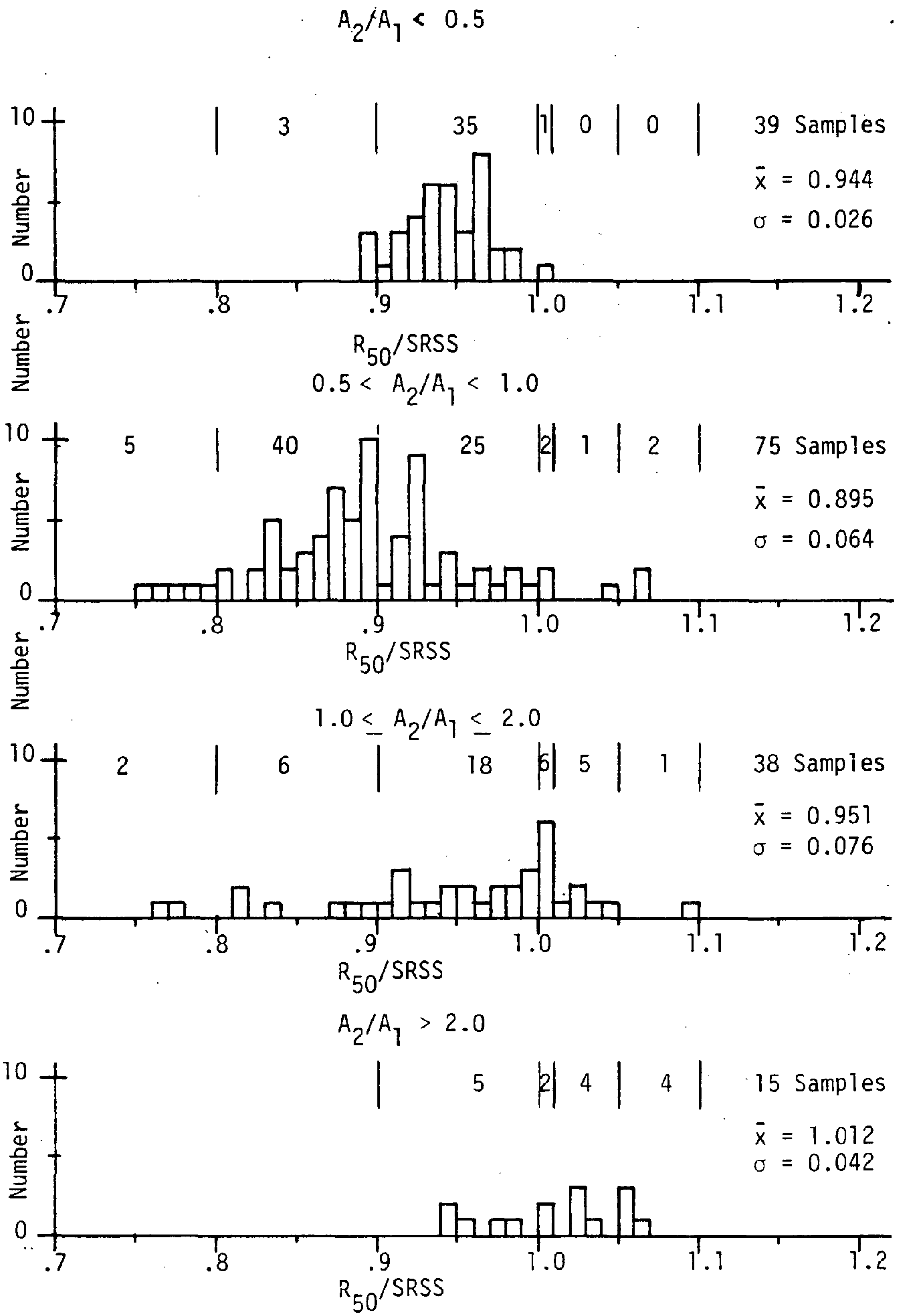


FIGURE D-4. COMPARISON OF R_{50}/SRSS FOR FOUR RANGES OF A_2/A_1