John D. O'Toole
Vice President

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September 15, 1982

Re: Indian Point Unit No. 2
Docket No. 50-247

Director of Nuclear Reactor Regulation
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

ATTN: Mr. Steven A. Varga, Chief
Operating Reactors Branch No. 1
Division of Licensing

Dear Mr. Varga:

In response to NUREG-0737, Section II.D.1, "Performance Testing of BWR and PWR Relief and Safety Valves", we provided by letter dated July 1, 1982 a partial submittal to meet the requirements of this task item and indicated that additional information would be submitted by September 15, 1982. Accordingly, this letter and attachments provide the plant-specific response and evaluation of the Block Valve Test program for Indian Point Unit No. 2, (Attachment A), and a thermal hydraulic analysis of the associated piping and support system (Attachment B).

Should you or your staff have any questions, please contact us.

Very truly yours,

John D. O'Toole

attach.

A046

ATTACHMENT A

PWR SAFETY AND RELIEF VALVE TEST PROGRAM, PORV BLOCK VALVE ADEQUACY REPORT

CONSOLIDATED EDISON COMPANY OF NEW YORK, INC.
INDIAN POINT UNIT 2

SEPTEMBER 1982

1.0 INTRODUCTION

NUREG-0737, Item II.D.1.B requests PWR utilities demonstrate block valves function properly over expected operating and accident conditions. This demonstration is to be supported by test data.

In response to NUREG-0737, Item II.D.1.B, Reference 1 transmitted to the NRC "EPRI PWR Safety and Relief Valve Test Program, PORV Block Valve Information Package", May 1982 (Reference 2). Included in this submittal were:

- A description of block valves used in or planned for use in PWR plants.
- An EPRI report entitled "EPRI/Marshall Electric Motor Operated Valve (Block Valve) Interim Test Data Report," May 31, 1982.
- A Westinghouse report entitled "EPRI Summary Report: Westinghouse Gate Valve Closure Testing Program," March 31, 1982.

Reference 1 also states that PWR utilities believe sufficient evidence (supported by test data) is available to demonstrate block valve "operability". Response to the NUREG guidance was to be fulfilled by submittal of the above mentioned document package and a separate plant-specific evaluation of safety and relief valve operability.

This document provides the plant-specific response and evaluation of the Block Valve Test program for Indian Point Unit 2.

2.0 BLOCK VALVE DESIGN INFORMATION

The block valves installed at Indian Point Unit 2 are Westinghouse Model 3GM88 motor operated gate valves (described in Table 2-1).

During the EPRI Test program tests were conducted on a Westinghouse Model 3GM88 block valve at the Marshall test facility. Results of those tests are detailed in Reference 2.

For comparison a description of the Westinghouse test valves is provided in Table 2-2. As can be seen, the valves tested by EPRI are similar to the block valves installed at Indian Point.

3.0 SUMMARY OF BLOCK VALVE TEST RESULTS

3.1 Westinghouse Block Valve Model 3GM88

Results of the Westinghouse 3GM88 Block Valve Tests are contained in Section 3.2 of Reference 2.

TABLE 2-1

INDIAN POINT PORV BLOCK VALVE DESCRIPTION

Valve Information

Manufacturer.	Westinghouse Electric Corporation
Description	Motor Operated Gate Valve
Quantity.	2
Model	3GM88
Drawing No.	8372D25

Valve Operator Information

Manufacturer.	Limitorque
Description	Motorized Valve Operator
Model	SB-00-15
Voltage, Volts.	460
Speed	10 sec.
RPM	3600

TABLE 2-2

WESTINGHOUSE TEST VALVE DESCRIPTION, TEST SERIES

M-WS1**

General Valve Information

Manufacturer	Westinghouse Electric Corporation
Description	Motor Operated Gate Valve
Model	MOD03000GM88FNB0D0 (88 Series)
Serial No.	*
Drawing No	8374D34

General Valve Operator Information

Manufacturer	Limitorque
Description	Motorized Valve Operator
Model	SB-00-15
Serial No.	*
Torque Switch Setting	*
Voltage	575
RPM	3600

* Not Supplied by the Manufacturer

** Source: Reference 2

The evaluation tests were conducted at Marshall Steam Station test facility with the Control Components International PORV mounted downstream of the Westinghouse test valve. The valve was cycled 21 times and the results of these tests are summarized in Table 3.2-3 of Reference 2.

Prior to initiation of the evaluation tests, several attempts were made to outfit the valve with a motor operator with 575 volt capability as required by the Marshall test facility electric power supply. Initially no 575 volt Limitorque operator was available so several Rotork operators, available at that time, were tried. During these preliminary checkouts, difficulty was encountered with closing the valve completely. Finally a 575 volt Limitorque SB-00-15 operator was made available and installed on the test valve.

On the initial evaluation test, considerable valve packing leakage was observed. The packing was tightened to stop the leakage. When the valve was cycled it remained 4% open. The torque switch setting was increased and the valve closed fully on the second attempt and throughout the remainder of the evaluation tests.

The valve was cycled against full flow at 2280-2420 psi nominal line pressures. Stroke times were reported between 6.2 and 12.9 seconds. No appreciable seat leakage was measured. The valve fully opened and closed for 20 of the 21 evaluation cycles. As stated above, the valve closed to within 4% of closure for the first cycle.

Supplemental test results are summarized in table 3.2-4 of Reference 2 and detail the calibration and checkout activities that were carried out during the period of June 27, 1980, to August 11, 1980, as well as two additional cycles which occurred after the evaluation tests.

The test valve was inspected after the evaluation tests and all internal parts were in good condition.

A subsequent examination made after all testing showed the wedge guides evidenced some galling but all other parts were in good condition.

During the testing at Marshall, the stem thrust required to close the valve was measured using axial-type strain gages. The resulting forces were considerably higher than expected. When subsequent closure problems occurred in Spain a series of tests and analyses were conducted by Westinghouse to determine the cause of the higher than expected closing loads. A report of this testing and analysis is contained in Reference 2.

Reference 2 concludes the closure problems encountered were the result of under-predicting the stem thrust required to close the valve against high differential pressures. The standard closing load equation used by Westinghouse has been appropriately modified based on test results.

4.0 CONCLUSIONS

The Westinghouse valve tested at the Marshall Steam Station as part of the EPRI Safety and Relief Valve test program is similar in design to the block valves installed at Indian Point Unit 2 and this valve successfully completed the evaluation and supplementary test program, fully opening and closing on demand.

Furthermore, the Westinghouse model 3GM88 block valve installed at Indian Point has been modified by Westinghouse to provide sufficient closing thrust as determined in the Westinghouse test program. (Reference 3)

5.0 REFERENCES

1. Letter from R. C. Youngdahl, Consumers Power, to H. Denton, NRC, dated June 1, 1982.

2. "EPRI PWR Safety and Relief Valve Test Program PORV Block Valve Information Package" dated May, 1982.

3. Letter from J. D. O'Toole (Con Edison) to B. H. Grier (NRC) dated May 8, 1981.

ATTACHMENT B

PRESSURIZER SAFETY AND RELIEF LINE EVALUATION SUMMARY REPORT

CONSOLIDATED EDISON COMPANY OF NEW YORK

INDIAN POINT UNIT #2

SEPTEMBER 1982

TABLE OF CONTENTS

1.0 INTRODUCTION

The pressurizer safety and relief valve (PSARV) discharge piping system for pressurized water reactors, located on the top of the pressurizer, provides over-pressure protection for the reactor coolant system. A water seal is often maintained upstream of each pressurizer safety and relief valve. However, for the Indian Point Unit #2 plant,a water seal does not exist. The piping between the pressurizer nozzle and the valve inlets are steam-filled. Upon actuation of the valves, the steam driven by high system pressure generates hydraulic shock loads on the piping and supports.

Under NUREG-0737, Section II.D.1, "Performance Testing of BWR and PWR Relief and Safety Valves", all operating plant licensees and applicants are required to conduct testing to qualify the reactor coolant system relief and safety valves under expected operating conditions for design-basis transients and accidents. In addition to the qualification of valves, the functionability and structural integrity of the as-built discharge piping and supports must also be demonstrated on a plant specific basis.

In response to these requirements, a program for the performance testing of PWR safety and relief valves was formulated by EPRI. The primary objective of the Test Program was to provide full scale test data confirming the functionability of the reactor coolant system power operated relief valves and safety valves for expected operating and accident conditions. The second objective of the program was to obtain sufficient piping thermal hydraulic load data to permit confirmation of models which may be utilized for plant unique analysis of safety and relief discharge piping systems. Based on the results of the aforementioned EPRI Safety and Relief Valve Test Program, additional thermal hydraulic analyses are required to adequately define the loads on the piping system due to valve actuation.

This report is the response of the Consolidated Edison Company of New York to the U.S. NRC plant specific request for piping and support evaluation and is applicable to Indian Point Unit #2.

2.0 PIPE STRESS CRITERIA

2.1 Pipe Stress Calculation

The piping between the valves and the pressurizer relief tank was initially analyzed,prior to the EPRI Test Program, in accordance with the requirements of USAS B31.1.0-1967 Code and the Indian Point Unit #2 Design Criteria. These requirements establish limits for stresses from sustained loads and occasional loads (including earthquake), thermal expansion loads, and sustained plus thermal expansion loads, respectively. The appropriate allowable stresses for use were determined in accordance with the requirements of the Code.

2.2 Load Combinations

In order to evaluate the pressurizer safety and relief valve piping, appropriate load combinations were developed. The load combinations and the associated allowable stress limits used for the piping and piping components in the initial analysis were:

$$P + D \leq S_h$$

$$P + D + OBE + TR \leq 1.2\ S_h$$

$$T \leq S_A = f(1.25\ S_c + .25\ S_h)$$

Where:

P - Stress due to internal design pressure

D - Stress due to deadweight

OBE - Stress due to operational basis earthquake

T - Stress due to thermal expansion & anchor movement

TR - Stress due to transient valve operation

S_h - Allowable stress at hot temperature, as defined in the Code

S_c - Allowable stress at ambient temperature, as defined in the Co
S_A - Allowable stress range, as defined in the Code
f - Stress range reduction factor, as defined in the Code

These load combinations are more restrictive than the criteria recommended by the piping subcommittee of the PWR Test Program.

To account for fatigue effects of the transient loads, it was assumed that the transient produce secondary stresses. The number of equivalent full temperature cycles used to determine 'f' was calculated as follows for selected points of higher thermal stress:

$$N = N_T + T_1^5 N_{TR}$$

$$T_1 = \frac{TR}{T}$$

Where:

N = Equivalent full temperature cycles
N_T = Number of full temperature cycles
N_{TR} = Number of transient cycles
T_1 = Ratio of transient stress to expansion stress

Total pressurizer nozzle loads were calculated using the following load combinations:

$$\overline{D} + \overline{T} + \overline{OBE} + \overline{TR}$$

Where:

$\overline{D}$ = Nozzle load (forces & moments) due to deadweight
$\overline{T}$ = Nozzle load (forces & moments) due to thermal expansion anchor movement and associated operating temperatures
$\overline{OBE}$ = Nozzle load (forces & moments) due to operational basis earthquake
$\overline{TR}$ = Nozzle load (forces & moments) due to transient

Total valve nozzle loads were calculated using the following load combinations:

$$P + \overline{D} + \overline{T} + \overline{OBE} \text{ and } P_o + \overline{D} + \overline{T_o} + \overline{TR}$$

Where: (P, $\overline{D}$, $\overline{T}$, $\overline{OBE}$ and $\overline{TR}$ as previously defined)

P_o = Stress due to internal pressure during plant heat-up mode of operation

$\overline{T_o}$ = Nozzle load (forces & moments) due to thermal expansion and anchor movement during plant heat-up mode of operation

The pipe internal pressure and temperature considered in the above P_o and $\overline{T_o}$ load cases were respectively 400 PSIA and 445°F

3.0 LOADING

The following loading conditions were considered in the initial piping stress analyses:

A. Internal pressure
B. Deadweight
C. Normal operating thermal moment loadings
D. Additional thermal moment loadings due to the different possible combinations of safety or relief valve operations
E. Loadings due to postulated seismic events
F. Thrust loadings due to steam and/or water discharge during safety or relief valve operations

4.0 ANALYTICAL METHODS

The three-dimensional piping system model which includes the effect of supports, valves and equipment was represented by an ordered set of data which numerically describes the physical system. All piping and piping components are assumed to behave in a linear elastic manner.

The thrust evaluation conducted prior to the EPRI Test Program was performed in two distinct steps:

A. Generation of thermal hydraulic time-history loads upon actuation of the safety and relief valves, utilizing the W proprietary computer program, FLASH-IV.

B. Application of the forces generated from (A) with appropriate dynamic load factors to the static structural model to determine component stresses and loads.

The static model from the deadweight and thermal analysis was utilized for the thrust analysis. The overall approach employed to evaluate the effects,due to the discharge of either safety or relief valves,was:

- A general approach to determine the forcing functions acting on the piping system which are induced by transients of the type investigated, was developed.

- An investigation was conducted to determine which valve and which cycling operating mode would result in significant effects on the piping system.

- For these selected transients, a detailed analysis was performed to determine time-histories of the forces acting on the piping system.

- These force time-histories were evaluated to identify the times and the associated forces which induced significant effects on the piping system.

- Finally after determining the Dynamic Load Factor (DLF) to be applied to these selected force sets, a static pipe stress analysis was performed.

The seismic analysis was performed using the response spectral method with a lumped multi-mass piping model. The stiffness representation of the system in the mathematical model included piping, pressurizer, supports, and restraints. The results generated from the seismic analysis were combined in accordance with Section 2.2.

5.0 THERMAL HYDRAULIC MODELING - POST EPRI TESTS

The thermal hydraulic Analysis for the Indian Point Unit #2 piping and support system was carried out in three steps: plant hydraulic modelling, comparison of EPRI test data and plant specific analysis.

5.1 Plant Hydraulic Model/Computer Program

When the pressurizer pressure reaches the set pressure (approximately 2,500 psia for a safety valve and 2,350 psia for a relief valve) and the valve opens, the high pressure steam in the pressurizer forces the steam through the valve and down the piping system to the pressurizer relief tank. The arrangement for Indian Point Unit #2 does not include loop seals. For the pressurizer safety and relief piping system, analytical hydraulic models, as shown in Figures 5-1 and 5-2, were developed to represent the conditions described above.

The Computer Code ITCHVALVE was used to perform the transient hydraulic analysis for the system. This program uses the Method of Characteristics approach to generate fluid parameters as a function of time. One-dimensional fluid flow calculations applying both the implicit and explicit characteristic methods are performed. Using this approach, the piping network is input as a series of single pipes. The network is generally joined together at one or more places by two or three-way junctions. Each of the single pipes has associated with it friction factors, angles of elevation and flow areas.

Conservation equations can be converted to the following characteristic equations:

$$\frac{dz}{dt} = V + c$$

$$\frac{dP}{dt} + \rho c \frac{dV}{dt} = c(F + \rho g \cos\theta) - \frac{q'''c^2}{\rho \frac{\partial h}{\partial \rho}}$$

$$\frac{dz}{dt} = V - c$$

$$\frac{dP}{dt} - \rho c \frac{dV}{dt} = -c(F + \rho g \cos\theta) - \frac{q'''c^2}{\rho \frac{\partial h}{\partial \rho}}$$

$$c^2 = \frac{-\partial h/\partial \rho}{\frac{\partial h}{\partial \rho} - \frac{1}{\rho J}}$$

Z = variable of length measurement

t = time

V = fluid velocity

c = sonic velocity

P = pressure

ρ = fluid density

F = flow resistance

g = gravity

θ = angle off vertical

q'''=rate of heat generation per unit pipe length

J = conversion factor for converting pressure units to equivalent heat units

The computer program possesses special provisions to allow analysis of valve opening and closing situations.

Fluid acceleration inside the pipe generates reaction forces on all segments of the line that are bounded at either end by an elbow or bend. Reaction forces resulting from fluid pressure and momentum variations are calculated. These forces can be expressed in terms of the fluid properties available from the transient hydraulic analysis, performed using program ITCHVALVE. The momentum equation can be expressed in vector form as:

$$\sum \vec{F}_{cv} = \frac{1}{g_c}\frac{\partial}{\partial t}\int_v \rho \vec{V} dv + \frac{1}{gc}\int \rho \vec{V}(\vec{V} \cdot \vec{n} dA)$$

From this equation, the total force on the pipe can be derived:

$$\sum F_{pipe} = \frac{r_1}{g_c}\frac{(1 - \cos \alpha_1)}{\sin \alpha_1}\frac{\partial W}{\partial t}\Bigg|_{\text{Bend 1}} + \frac{r_2}{g_c}\frac{(1 - \cos \alpha_2)}{\sin \alpha_2}\frac{\partial W}{\partial t}\Bigg|_{\text{Bend 2}}$$

$$+ \frac{1}{g_c}\int_{\substack{\text{straight}\\ \text{pipe}}} \frac{\partial W}{\partial t} dl$$

A = piping flow area

v = volume

F = force

r = radius of curvature of appropriate elbow

α = angle of appropriate elbow

W = mass acceleration

All other terms are previously defined.

Unbalanced forces are calculated for each straight segment of pipe from the pressurizer to the relief tank using program FORFUN. The time-histories of these forces are stored on tape for potential subsequent structural analysis of the pressurizer safety and relief lines.

5.8 Comparison of EPRI Test Results

Piping load data has been generated from the tests conducted by EPRI at the Combustion Engineering Test Facility. Pertinent tests simulating dynamic opening of the safety valves for representative commercial upstream environments were carried out. The resulting downstream piping loadings and responses were measured. Upstream environments for particular valve opening cases of importance, which envelope the commercial scenarios, are:

A. Cold Water Discharge Followed by Steam - steam between the pressure source and the loop seal - cold loop seal between the steam and the valve.

B. Hot Water Discharge Followed by Steam -steam between the pressure source and the loop seal - hot loop seal between the steam and the valve.

C. Steam Discharge -steam between the pressure source and the valve.

Specific thermal hydraulic and structural analyses have been completed for the Combustion Engineering Test Configuration. Figure 5-3 illustrates the placement of force measurement sensors at the test site. Figures 5-4, 5-5 and 5-6 illustrate a comparison of the calculated versus experimental results for Test 908, the cold water discharge followed by steam case. Figure 5-4 shows the pressure time-histories for PT9, which is located just downstream of the valve. Figure 5-5 and 5-6 illustrate, respectively, the force time-histories of the horizontal run (WE28/WE29) and the long vertical run (WE32/WE33) immediately downstream of the safety valve. Significant structural damping in the third segment after the valve was noticed at the test and was verified by structural analyses. Consequently, a comparison of force WE30/WE31 was not presented here. No useable test data for sensor WE34/WE35 was available for Test 908.

Figures 5-7 through 5-11 illustrate a comparison of calculated versus experimental results for Test 917, the hot water discharge followed by steam case. Figure 5-7 shows the pressure time-histories for PT9. Figures 5-8, 5-9, 5-10 and 5-11 illustrate, respectively, the thermal hydraulically calculated and the experimentally determined force time-histories for (WE28/WE29), (WE32/WE33), (WE30/WE31) and (WE34/WE35). Blowdown forces were included in the total analytically calculated force for WE34/WE35 as this section of piping vents to the atmosphere. Comparisons were also made to the test data available for safety valve discharge without a loop seal (steam discharge).

The application of the ITCHVALVE and FORFUN computer programs for calculating the fluid-induced loads on the piping downstream of the safety and relief valves has been demonstrated. Although not presented here, the capability has also been shown by direct comparison to the solutions of classifical problems.

5.3 Plant Specific Thermal Hydraulic Cases

The cases analyzed are based upon the consideration of all pertinent Indian Point Unit #2 FSAR events and the cold-overpressurization event.

Table 5-1 presents the results of loss-of-load and locked-rotor analyses for Westinghouse 4-loop plants, including Indian Point Unit #2. The inlet fluid conditions expected at the safety valve and power operated relief valve inlet are identified. In general, safety valves open on steam and no liquid discharge is observed. Consequently, the design specification for safety valves at Indian Point Unit #2 is for steam service only. Cold overpressurization is not a design basis for the safety valves, but is for the power-operated relief valves (PORV's).

At Indian Point Unit #2, an overpressurization protection system (OPS) is presently implemented to protect the reactor coolant system (RCS) from exceeding the Appendix G limits, when the RCS temperature is below 310°F. Two overpressurization bounding scenarios were considered to determine the proper set points for the OPS. One scenario is the inadvertent actuation of one safety injection pump at low RCS pressure (mass addition). The other scenario is the startup of one RCS pump with a hotter steam generator resulting in heat addition to the RCS. For RCS temperatures greater than 250°F, a very large steam bubble will be presented in the pressurizer and no water solid condition will occur. As a result, only steam will be discharged when the PORV's are opened. For RCS temperatures less than 250°F, the pressurizer would be either water solid or contain a small nitrogen bubble. As a result, either solid water discharge or nitrogen followed by water will occur. Further, for the initial evaluation of the piping and supports, it was conservatively assumed that the insurge rate to the pressurizer was a constant value of 350 lbs/sec, a maximum upper bound associated with the evaluation of the heat addition transient is caused by the startup of an RCS pump with the steam generator 100°F hotter than the RCS. This insurge is (a factor of four) greater than the insurge caused by the inadvertent actuation of a safety injection pump.

Based on the previous discussion, the following time-history cases were investigated.

A. Steam Discharge for Both the Safety and Relief Valves

Prior to valve opening, steam exists from the pressurizer to the safety/relief valves. Once the set pressure is reached, the valve opens discharging steam to the downstream piping. The pertinent initial condition data used was:

Safety valve discharge	- Pressure = 2575 psia
	- h_{steam} = 1070 btu/lb
	- Valve opening time = 0.02 sec.
Relief valve discharge	- Pressure = 2600 psia
	- h_{steam} = 1065 btu/lb
	- Valve opening time = 0.40 sec.

The downstream sections for both the safety and relief valve discharge cases were presumed to be at 18 psia.

B. Water Discharge Through the Relief Valves Without a Nitrogen Bubble

Prior to relief valve opening, water at 1600 psia and 123.7 btu/lb was presumed from the pressurizer to the upstream side of the valves. The downstream pressure was set at 18 psia. The valve was opened in 0.40 seconds.

C. Water Discharge Through the Relief Valves with a Nitrogen Bubble

Prior to valve opening, steam exists from the pressurizer nozzles to the relief valves. The pressurizer is assumed full of water. At time = 0+, the valve opens and water is injected into the pressurizer at the effective heat addition rate of 350 lbs/sec. The valve is allowed to open fully in 0.40 seconds. The initial upstream and downstream pressures are 1000 psia and 18 psia, respectively.

Cases A, B and C bound all pertinent valve actuatton transients during normal plant operation and during the heatup and cold overpressurization stage of operation. Conservative set pressures were used in all analyses. Normal design criteria for valve opening is 1.0 seconds. Using an opening time of 0.4 seconds is, therefore, conservative.

6.0 RESULTS AND CONCLUSIONS

Because there is no loop seal and the length of inlet piping is short, the Indian Point Unit #2 pressurizer safety and relief line piping has a favorable configuration. A significant amount of design analysis effort was expended prior to the EPRI tests.

The original design basis analysis performed prior to the EPRI tests for the pressurizer safety and relief valve discharge piping system was reviewed. The hydraulic analysis was conducted using appropriate analysis methods. The hydraulic loads derived were amplified by a dynamic load factor of 2.0 and a quasi-static structural analysis was performed on that conservative basis. Subsequently, a static analysis was performed for water solid discharge to protect against over-pressurization. Again, conservative factors were applied to the loads.

Thermal hydraulic reanalysis of the system for the applicable operating and cold overpressurization transient conditions was initiated subsequent to the availability of EPRI test data generated at the Combustion Engineering Test Facility. Results, listed in Table 6-1, indicate that the original thermal hydraulic design loads subsequent to discharge of the safety valves are conservative after dynamic amplification. The original design basis loads and the revised loads are in good agreement with those observed from the full scale

EPRI test data. Figures 6-1, 6-2 and 6-3 illustrate the calculated force time-history plots for the three segments of piping immediately downstream of the safety valve on line #342 for steam discharge of the safety valve. Table 6-2 shows that the original design thermal hydraulic loads are either conservative or are of the same order of magnitude as the loads determined from Case A - steam discharge of the relief valves and Case B - water discharge of the relief valves without a nitrogen bubble. Figures 6-4 through 6-12 illustrate the calculated force time-history plots for Case B - the water solid - cold overpressurization condition. The results for Case C are significantly higher. It is believed that these applied loads would not cause an overstress problem since they are of extremely short duration. Also, this case is very unlikely and the assumptions made are very conservative. The more likely event for cold overpressurization is the actuation of one safety injection pump which generates a pressurizer surge rate of 80 lbs/sec, rather than 350 lbs/sec, as in the heat addition case. Verification of the support adequacy for this particular case (Case C), however, is being evaluated. The results of this evaluation will be submitted to the U.S. NRC when available.

Based on analytical work and tests to date, all acoustic pressures in the upstream piping calculated or observed prior to and during safety valve loop seal discharge are below the maximum permissible pressure. An evaluation of this inlet piping phenomenum was conducted and the results are documented in a report entitled "Review of Pressurizer Safety Valve Performance As Observed in the EPRI Safety and Relief Valve Test Program", WCAP-10105, dated June, 1982. There is approximately one foot of 4-inch schedule 160 piping between the Indian Point Unit #2 pressurizer nozzle and the inlet of the safety valves. There is no loop seal. No significant pressure perturbations were observed in tests or analytically calculated for configurations without loop seals. The calculated maximum upstream pressure is, therefore, significantly below the maximum permissible pressure.

In summary, a significant amount of design analyses was performed prior to the EPRI tests. Thermal hydraulic reanalyses of the system for all pertinent transients were performed and a comparison of the new applied loadings to the design basis loadings was made. Revised loadings for steam discharge through the relief valves, steam discharge through the safety valves and water solid discharge through the relief valves were seen to be either conservative or of the same order of magnitude as the design loads. The results for relief valve discharge of water with a nitrogen bubble showed higher loads than the applied design basis loads, however, the loads should not cause an overstress problem. The support adequacy for this particular case is being evaluated.

Table 5-1 VALVE INLET CONDITIONS FOR FSAR EVENTS RESULTING IN STEAM DISCHARGE

Reference Plant	Valve Opening Pressure (psia)	Maximum Pressurizer Pressure(psia)/ Limiting Event
Safety Valves Only		
4-Loop	2500	2555/Loss of Load
Safety and Relief Valves		
4-Loop	2350	2532/Loss of Load

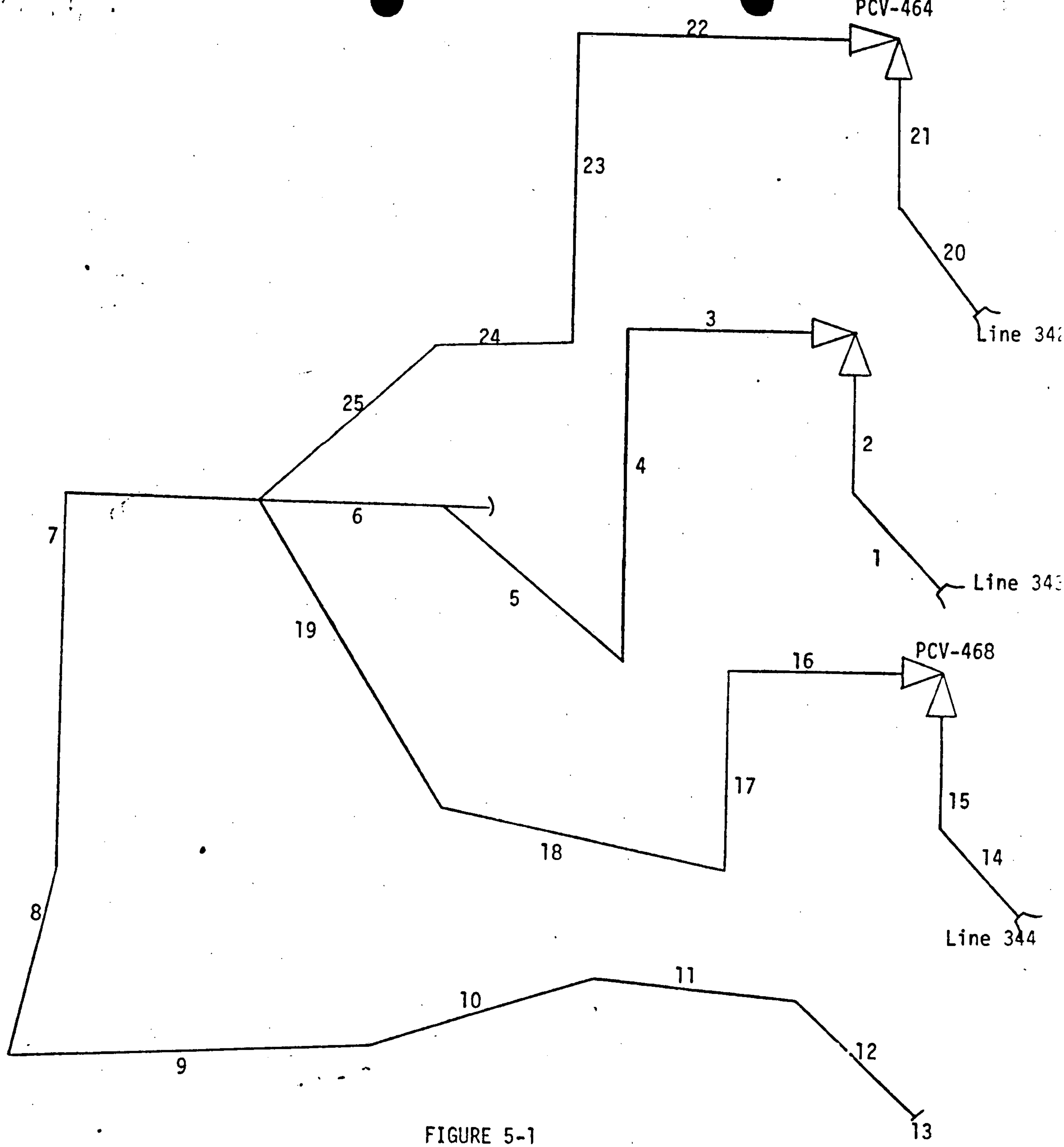
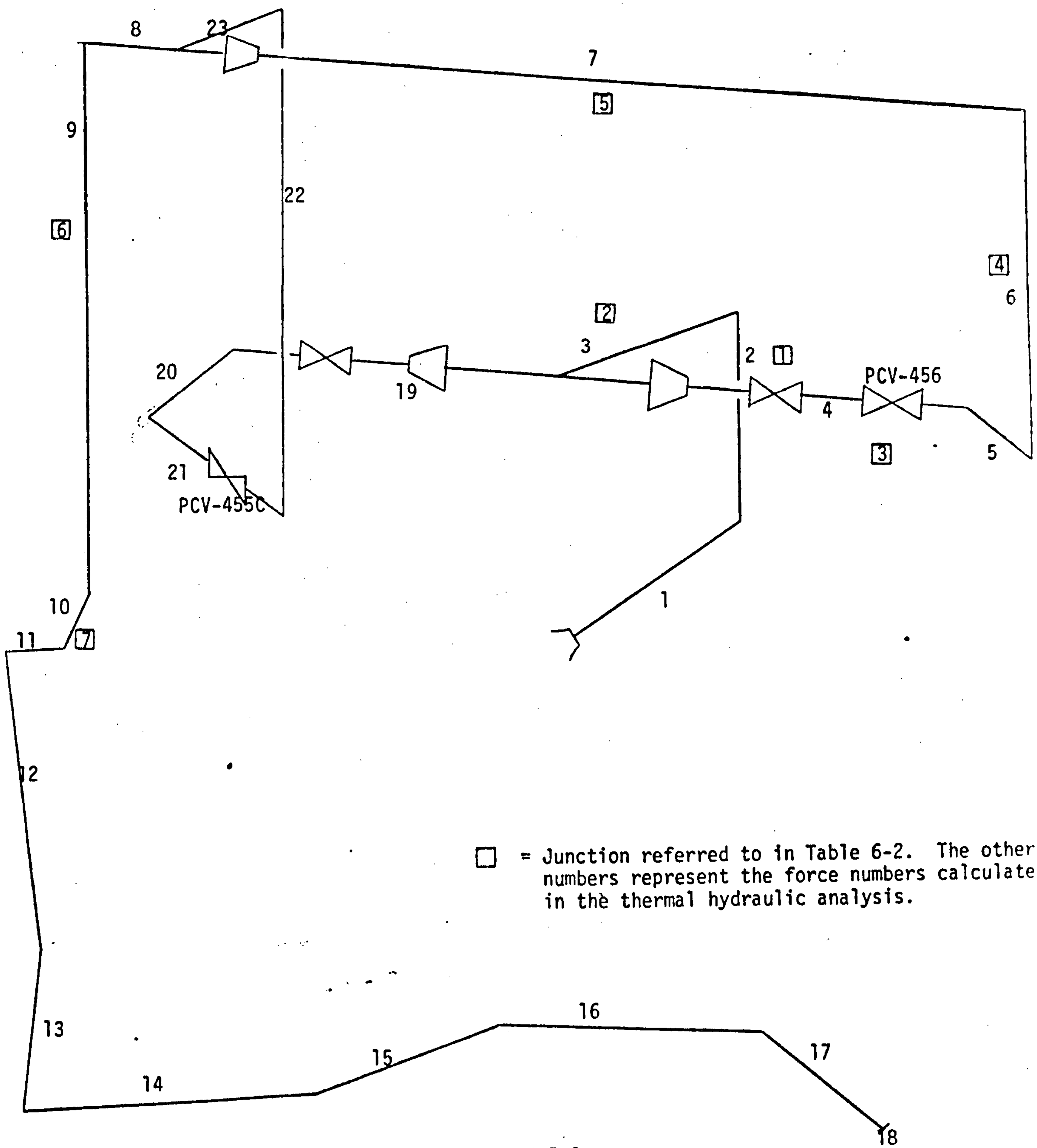


FIGURE 5-1

THERMAL HYDRAULIC MODEL FOR INDIAN POINT
UNIT #2 SAFETY LINES



□ = Junction referred to in Table 6-2. The other numbers represent the force numbers calculated in the thermal hydraulic analysis.

FIGURE 5-2

THERMAL HYDRAULIC MODEL FOR INDIAN POINT UNIT #2 RELIEF LINE

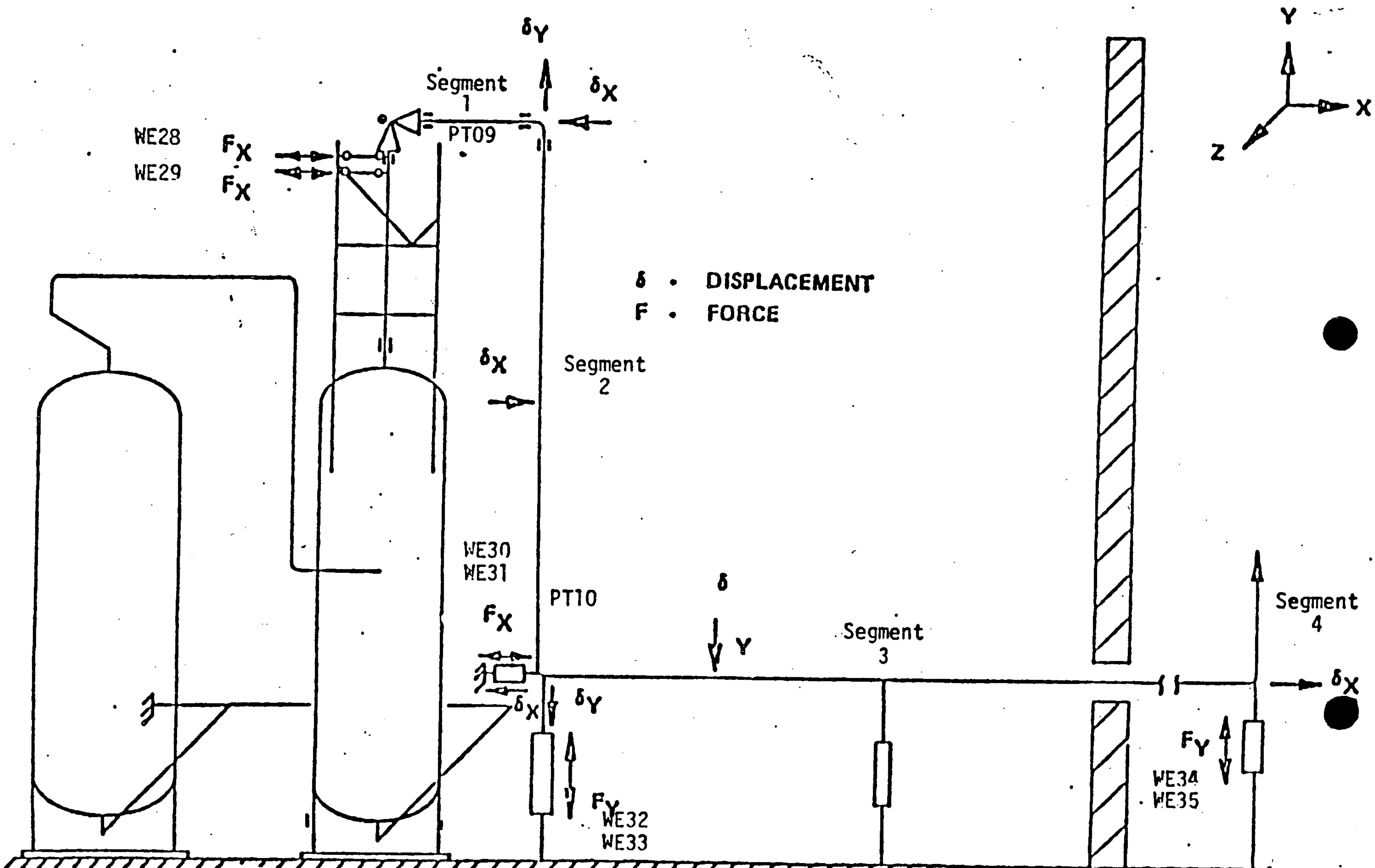


FIGURE 5-3: STRUCTURAL RESPONSE - FORCE MEASUREMENT LOCATIONS - EPRI TESTS

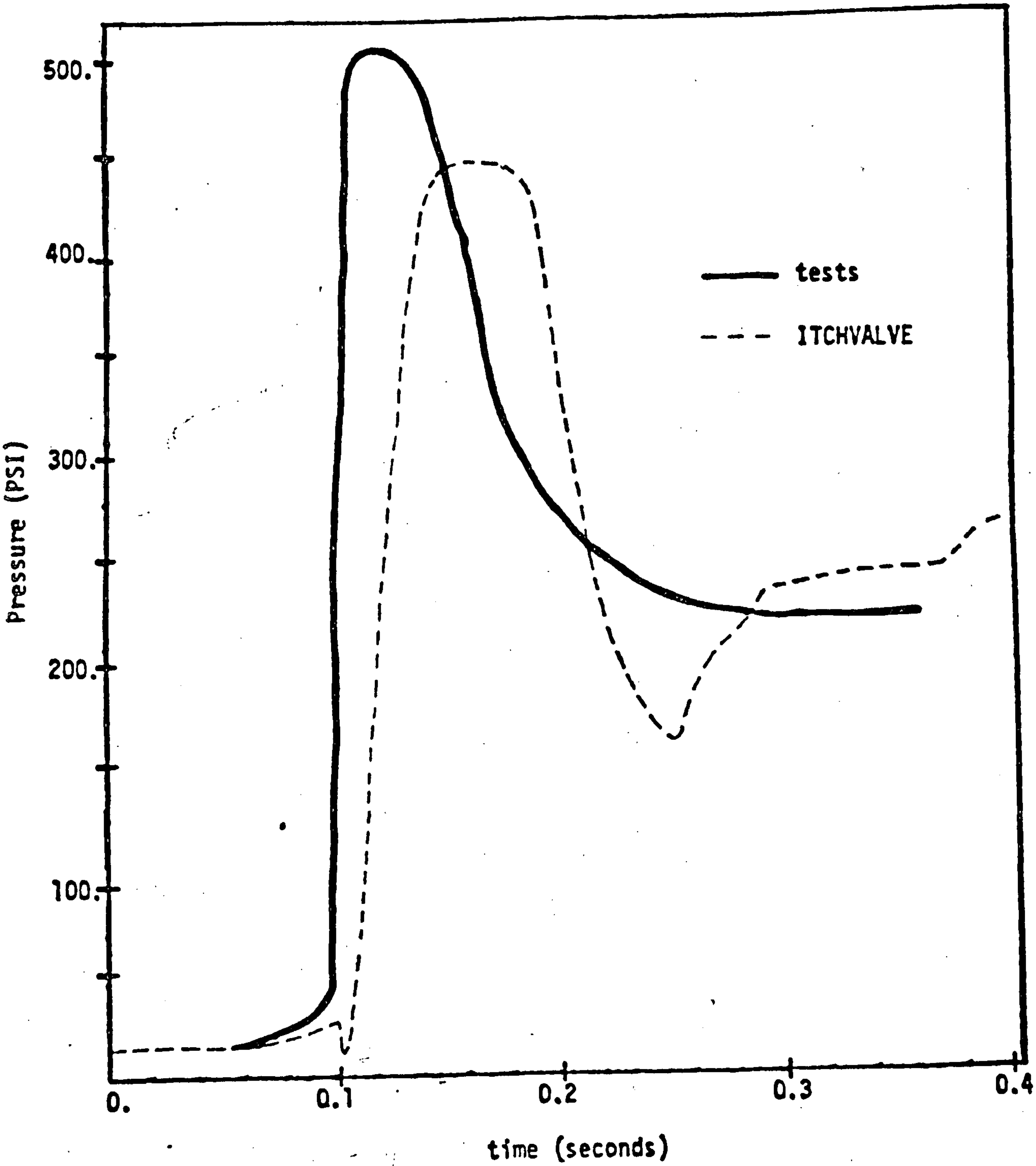


FIGURE 5-4 : Comparison of the EPRI Pressure Time-History for PT09 from Test 908 with the ITCHVALVE Predicted Pressure Time-History

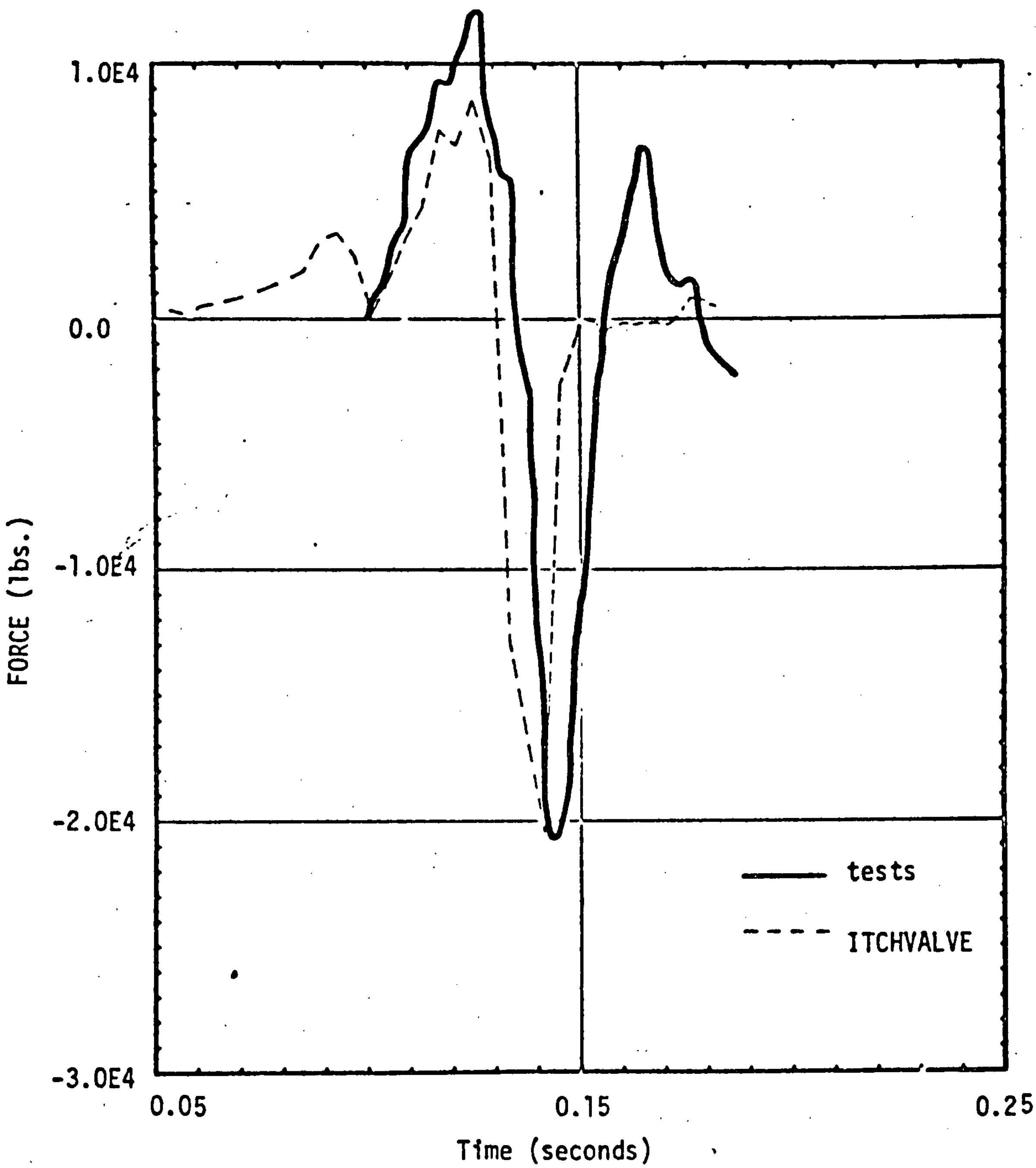


FIGURE 5-5: COMPARISON OF THE EPRI FORCE TIME-HISTORY FOR WE28 and WE29 FROM TEST 908 WITH THE ITCHVALVE PREDICTED FORCE TIME-HISTORY

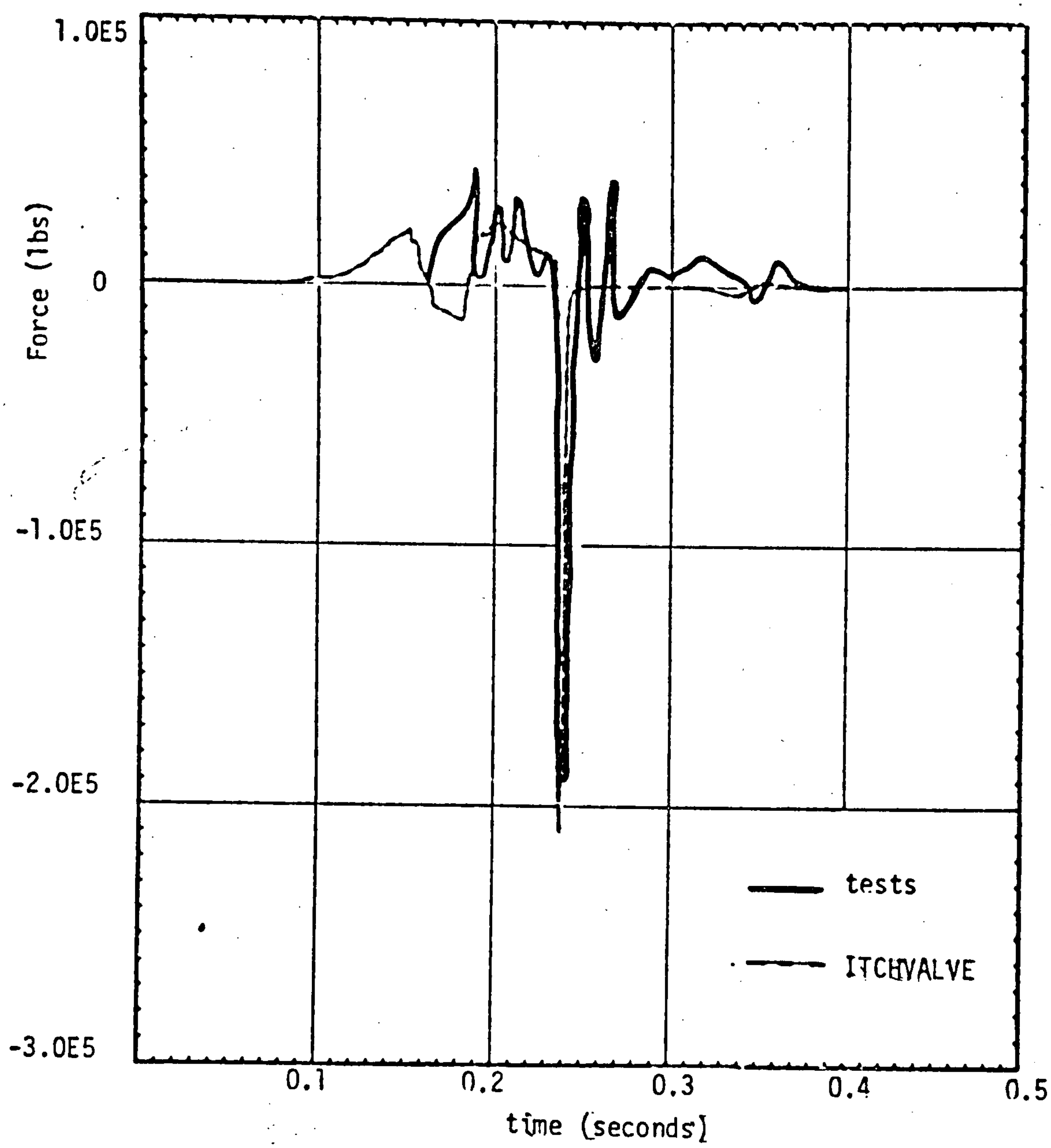


FIGURE 5-6: COMPARISON OF THE EPRI FORCE TIME-HISTORY FOR WE32 AND WE33 FROM TEST 908 WITH THE ITCHVALVE PREDICTED FORCE TIME-HISTORY

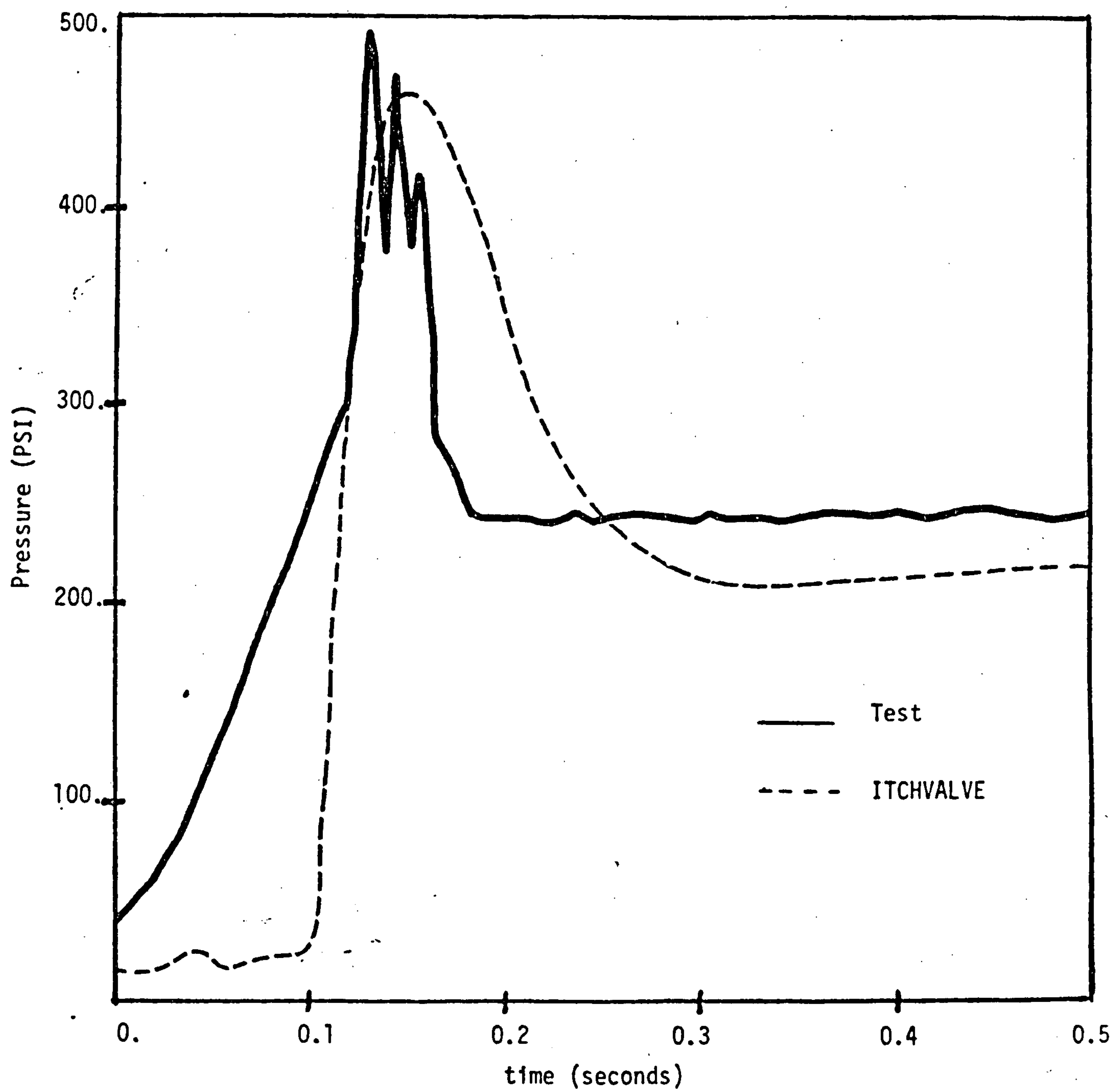


FIGURE 5-7: Comparison of the EPRI Pressure Time-History from PT09 from Test 917 with the ITCHVALVE Predicted Pressure Time-History

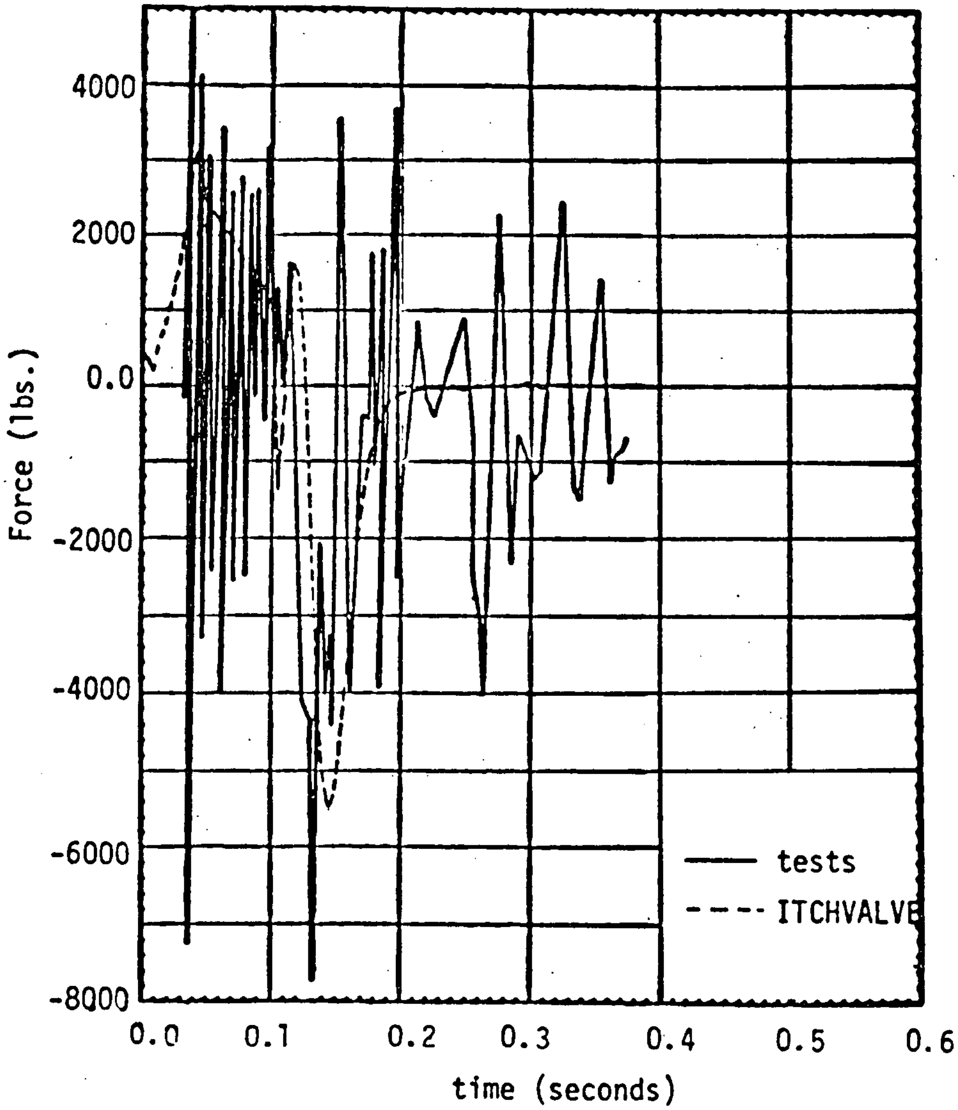


FIGURE 5-8: Comparison of the EPRI Force Time-History for WE28 and WE29 from Test 917 with the ITCHVALVE Predicted Force Time-History

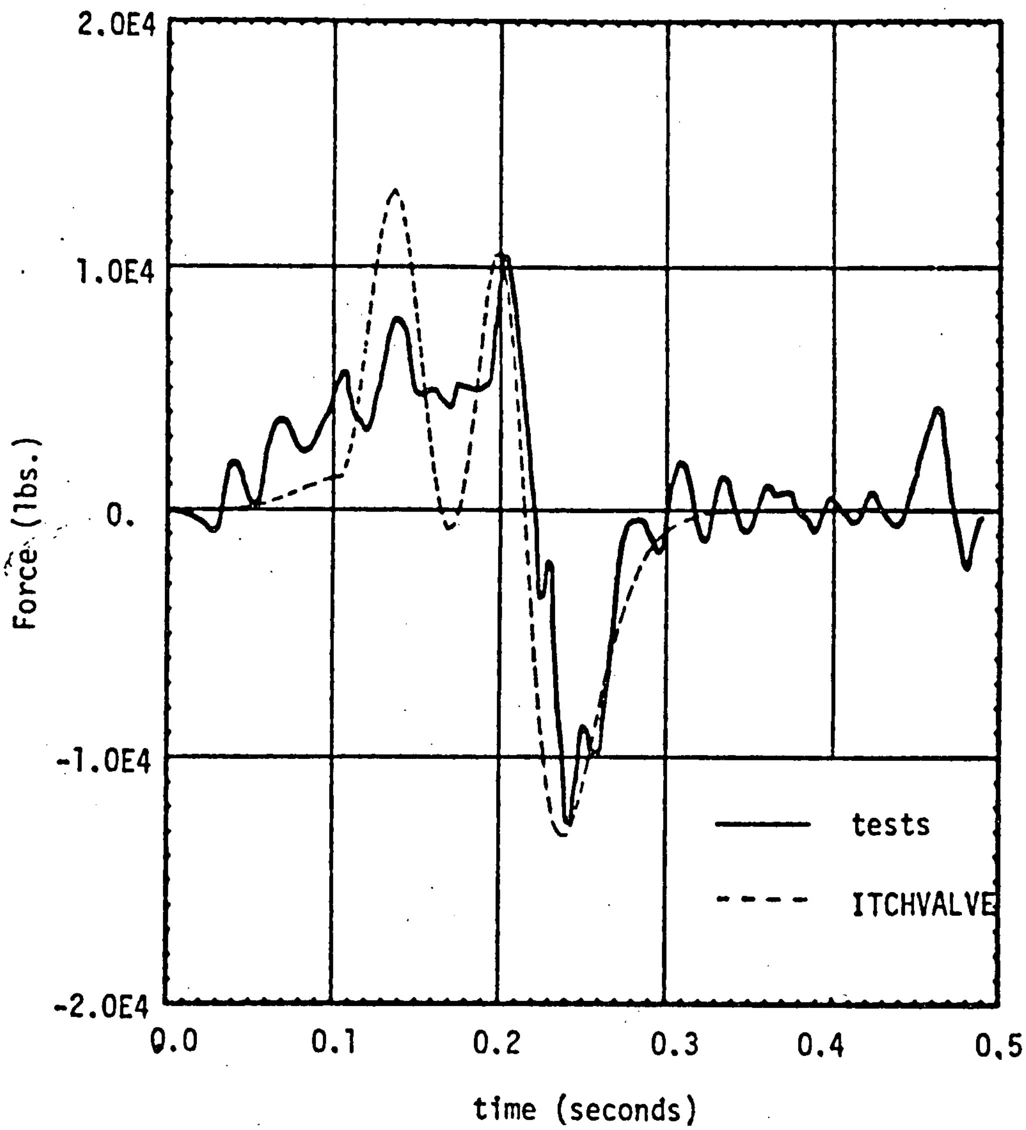


FIGURE 5-9: Comparison of the EPRI Force Time-History for WE32 and WE33 from Test 917 with the ITCHVALVE Predicted Force Time-History

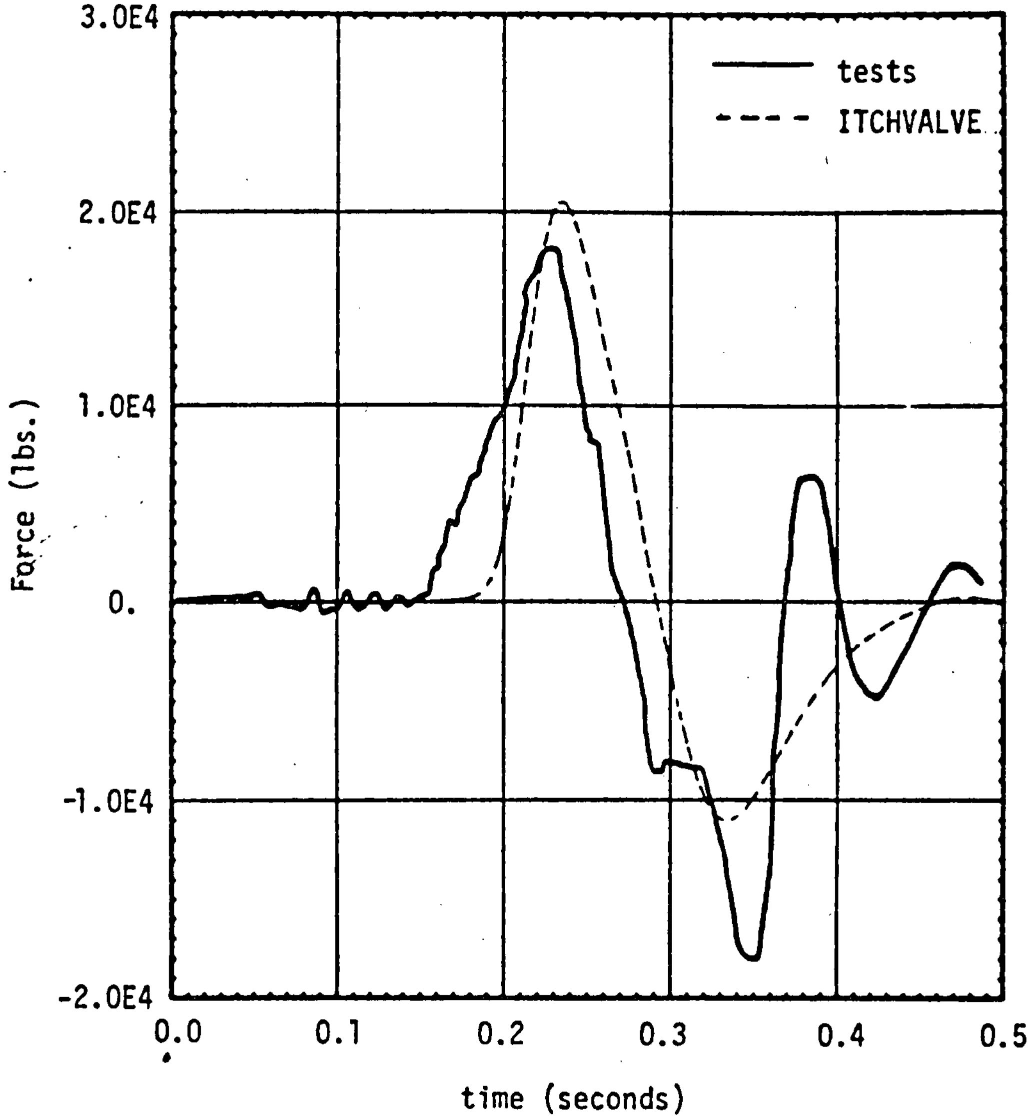


FIGURE 5-10: Comparison of the EPRI Force Time-History For WE30 and WE31 From Test 917 with the ITCHVALVE Predicted Force Time-History

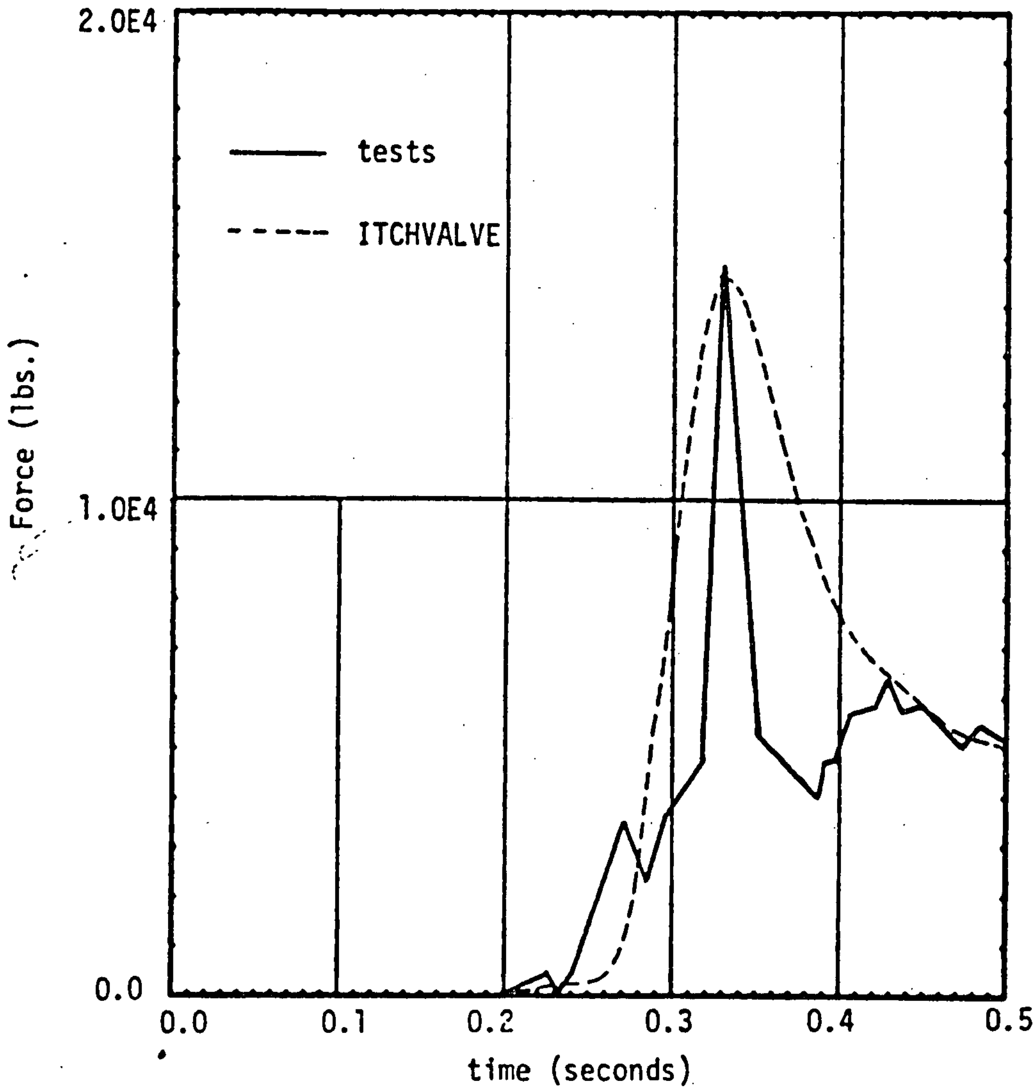


FIGURE 5-11: Comparison of the EPRI Force Time-History For WE34 and WE35 from Test 917 with the ITCHVALVE Predicted Force Time-History

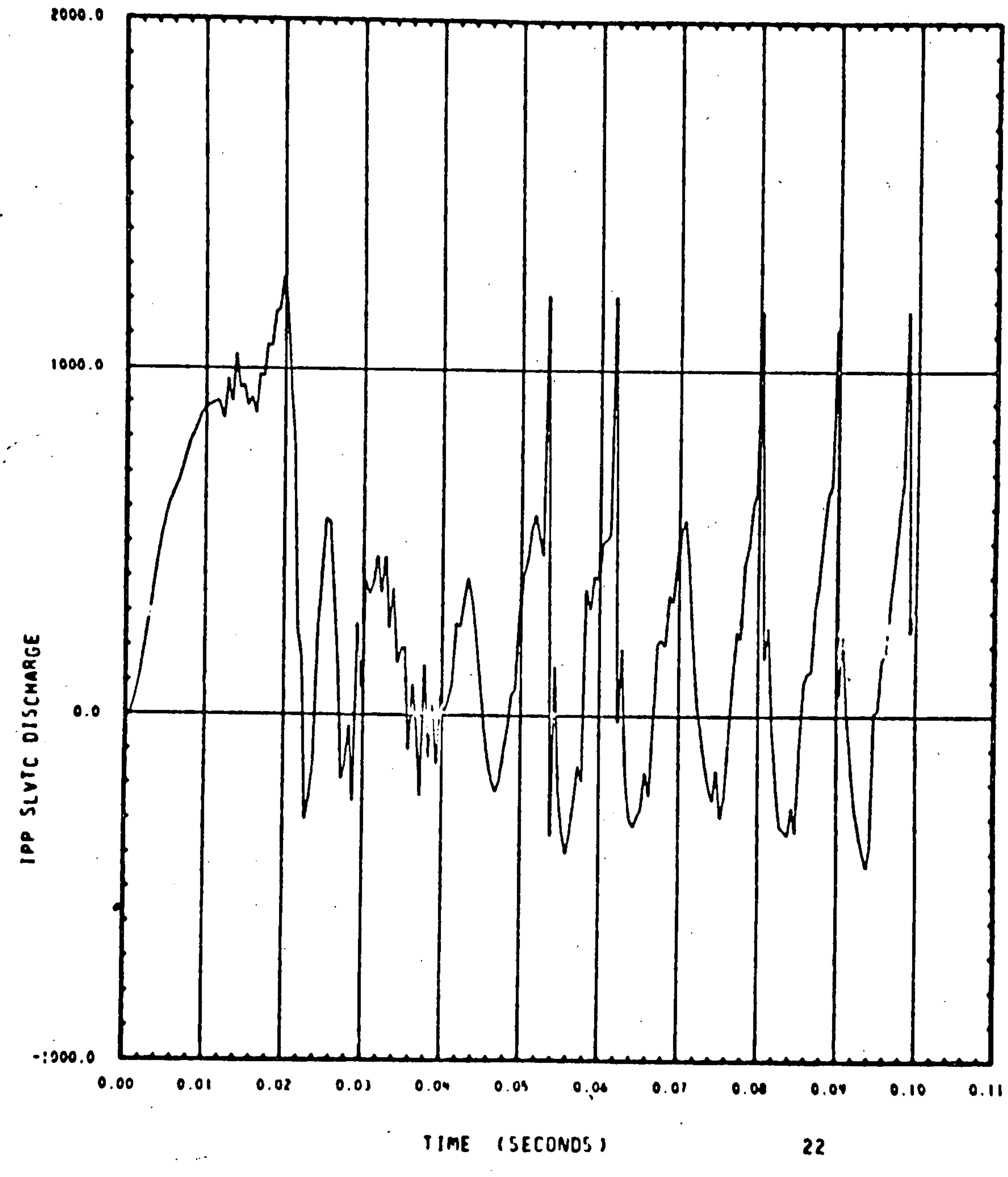


FIGURE 6-1

FORCE TIME-HISTORY FOR FORCE #22 AS DEFINED IN FIGURE 5-1
FOR STEAM DISCHARGE THROUGH THE IPP #2 SAFETY VALVES

(Line 342-Horizontal Force on PCV-464)

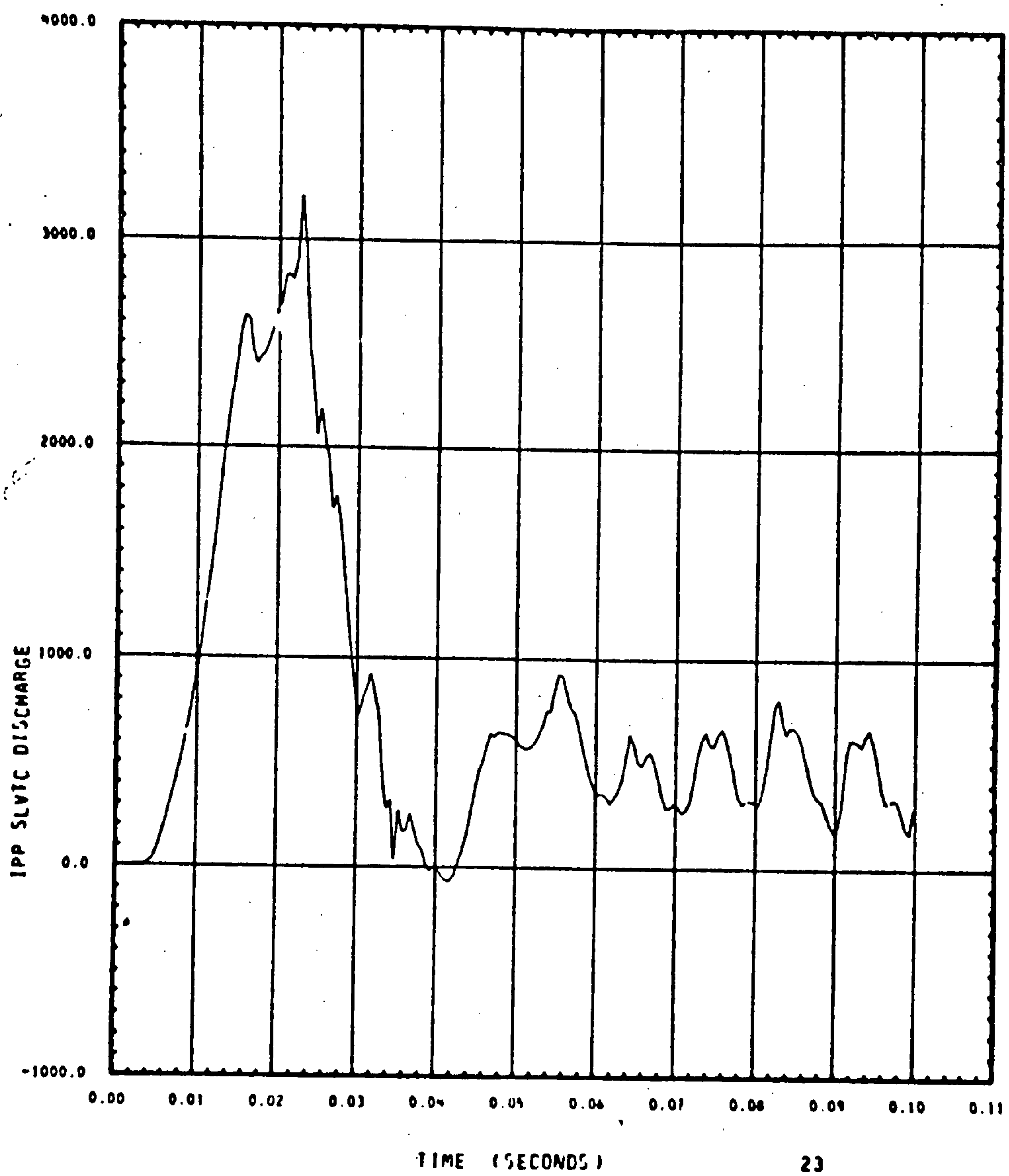


FIGURE 6-2

FORCE TIME-HISTORY FOR FORCE #23 AS DEFINED IN FIGURE 5-1
FOR STEAM DISCHARGE THROUGH THE IPP #2 SAFETY VALVES

(Line 342-Vertical Force Between 1st & 2nd Elbows Downstream of PCV-464)

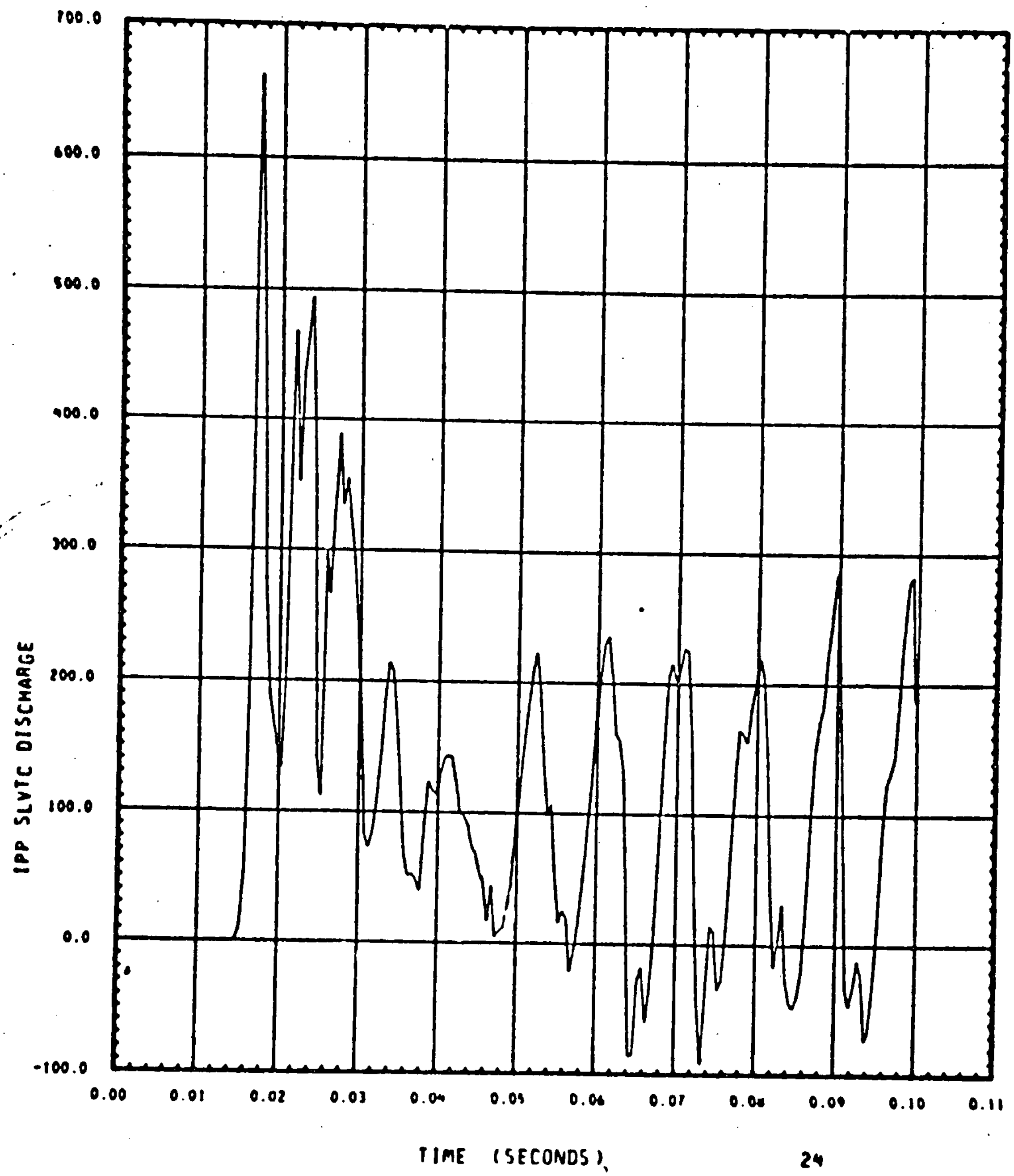


FIGURE 6-3

FORCE TIME-HISTORY FOR FORCE #24 AS DEFINED IN FIGURE 5-1
FOR STEAM DISCHARGE THROUGH THE IPP #2 SAFETY VALVES

(Line 342-Horizontal Force on 2nd Elbow Downstream of PCV-464)

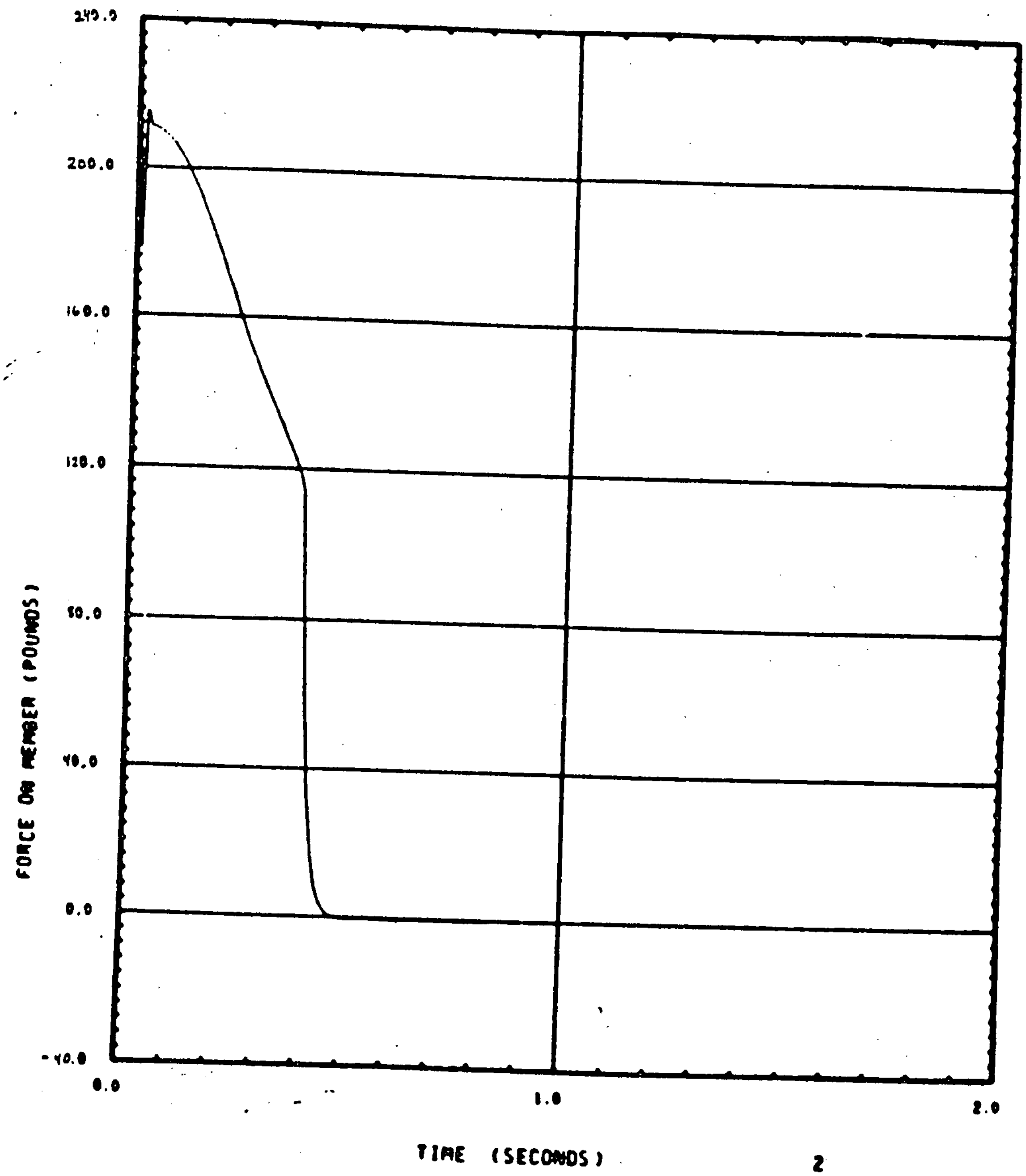


FIGURE 6-4

FORCE TIME-HISTORY FOR FORCE #2 AS DEFINED IN FIGURE 5-2
FOR WATER SOLID DISCHARGE THROUGH THE IPP #2 RELIEF VALVES

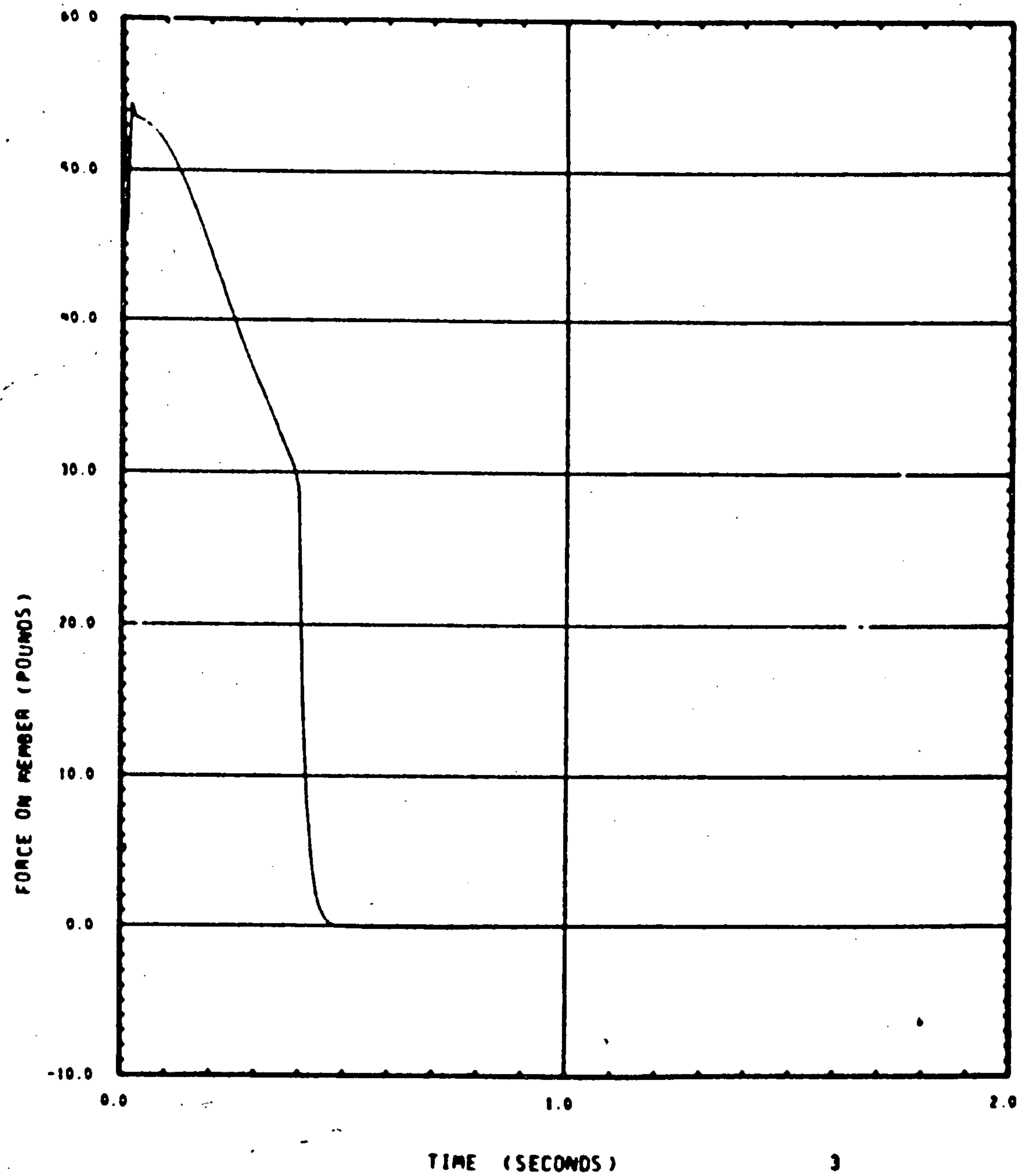


FIGURE 6-5

FORCE TIME-HISTORY FOR FORCE #3 AS DEFINED IN FIGURE 5-2 FOR WATER SOLID DISCHARGE THROUGH THE IPP #2 RELIEF VALVES

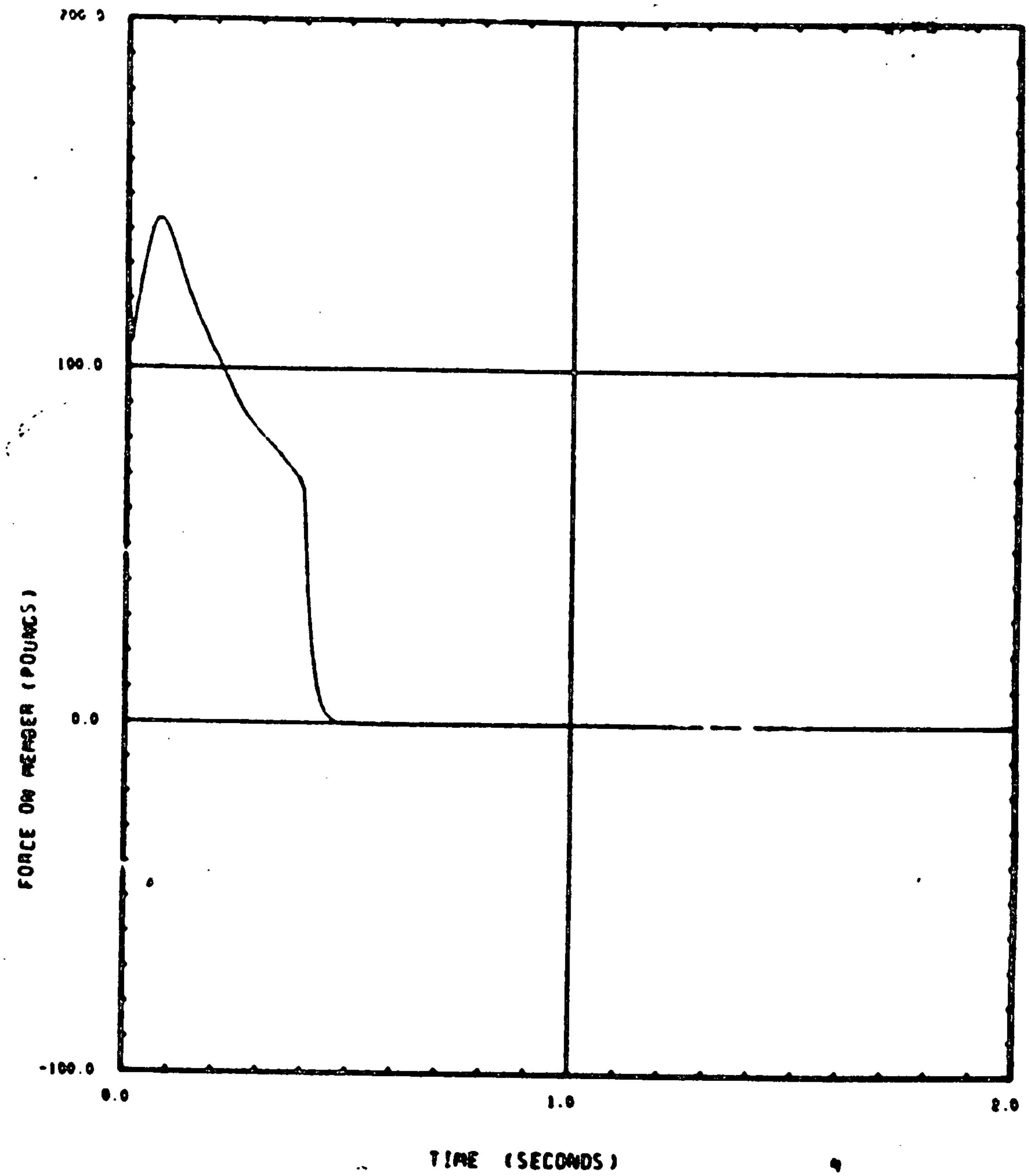


FIGURE 6-6

FORCE TIME-HISTORY FOR FORCE #4 AS DEFINED IN FIGURE 5-2
FOR WATER SOLID DISCHARGE THROUGH THE BPP #2 RELIEF VALVES

NOTE: Peak force on Junction 3 in Table 6-2 is this Force 4 + Force 5.

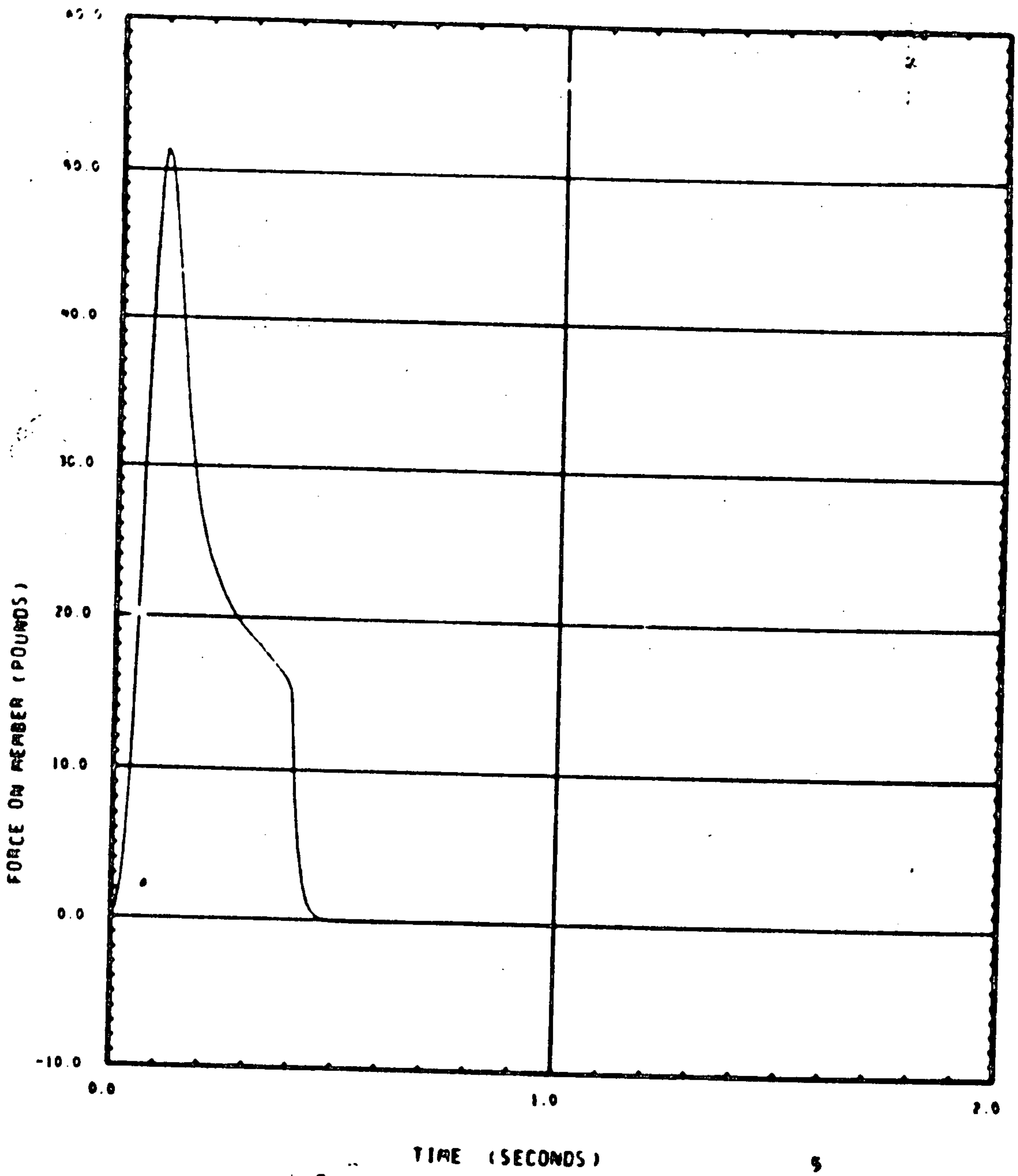


FIGURE 6-7

FORCE TIME-HISTORY FOF FORCE #5 AS DEFINED IN FIGURE 5-2
FOR WATER SOLID DISCHARGE THROUGH THE IPP #2 RELIEF VALVES

Note: Peak force on Junction 3 in Table 6-2 is this Force 5 + Force 4.

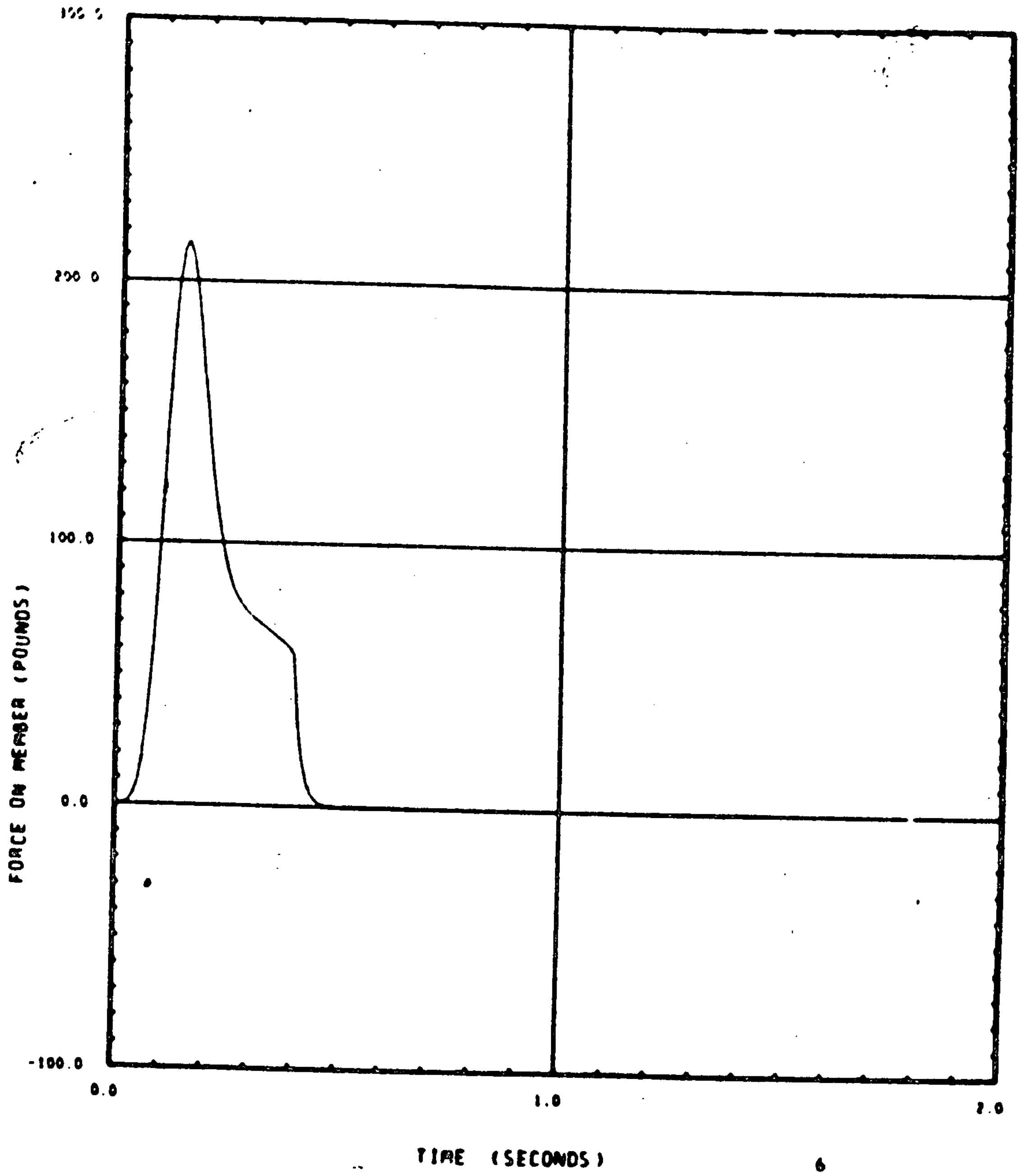


FIGURE 6-8

FORCE TIME-HISTORY FOR FORCE #6 AS DEFINED IN FIGURE 5-2
FOR WATER SOLID DISCHARGE THROUGH THE IPP #2 RELIEF VALVES

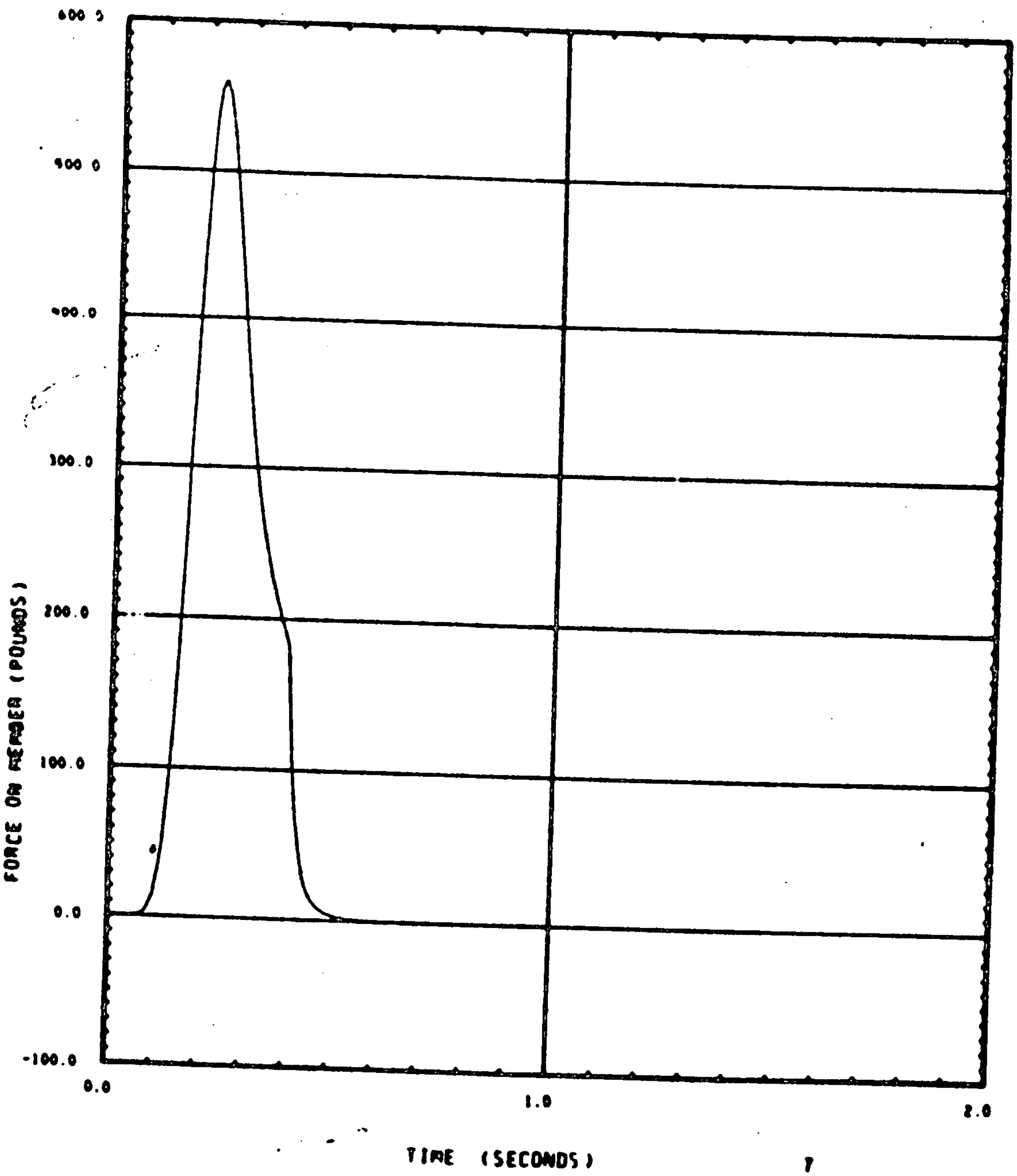


FIGURE 6-9

FORCE TIME-HISTORY FOR FORCE #7 AS DEFINED IN FIGURE 5-2
FOR WATER SOLID DISCHARGE THROUGH THE IPP #2 RELIEF VALVES

Note: Peak force of Junction 5 in Table 6-2 is this Force 7 + Force 8.

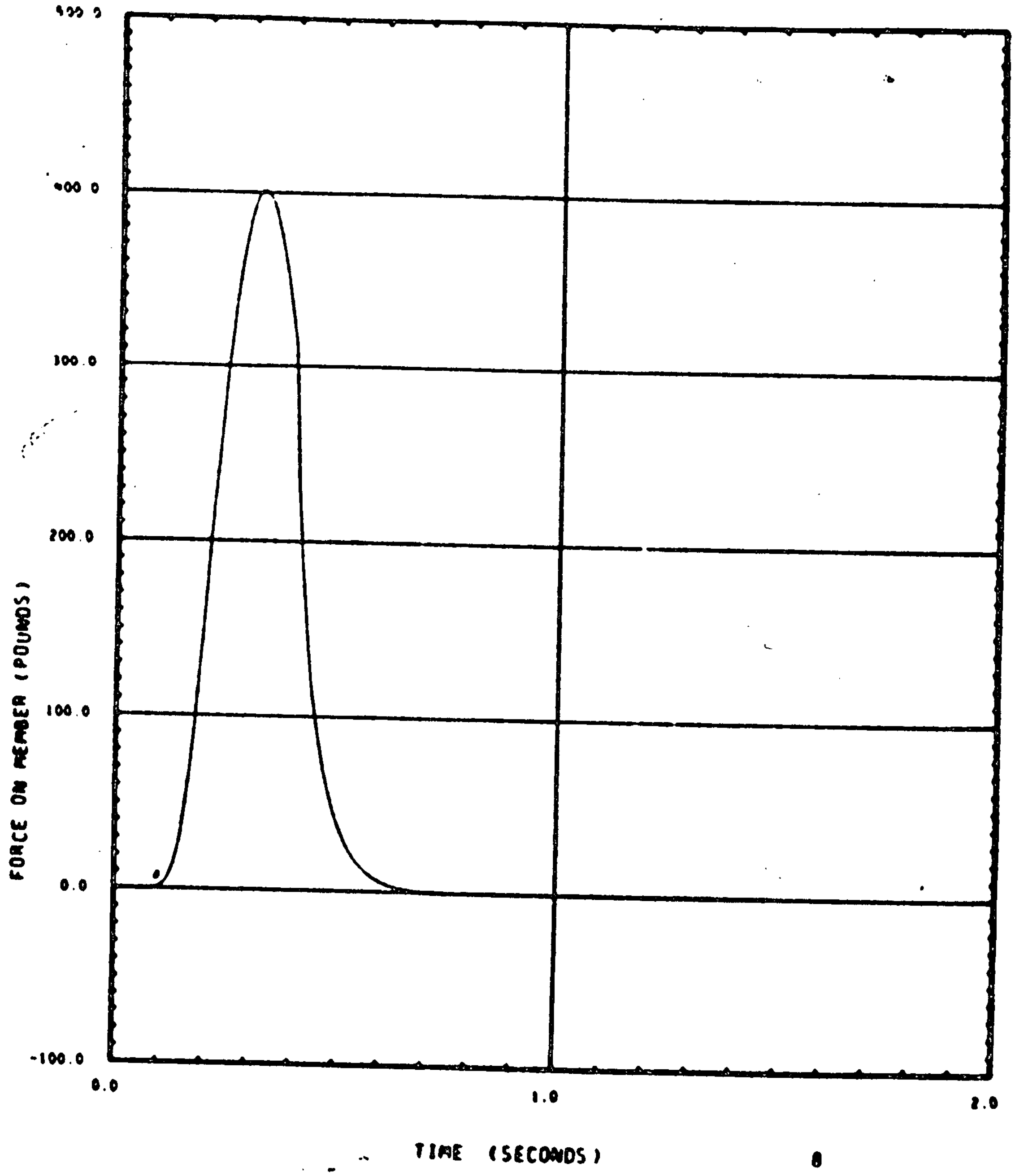


FIGURE 6-10

FORCE TIME-HISTORY FOR FORCE #8 AS DEFINED IN FIGURE 5-2
FOR WATER SOLID DISCHARGE THROUGH THE IPP #2 RELIEF VALVES

Note: Peak force of Junction 5 in Table 6-2 is this Force 8 + Force 7.

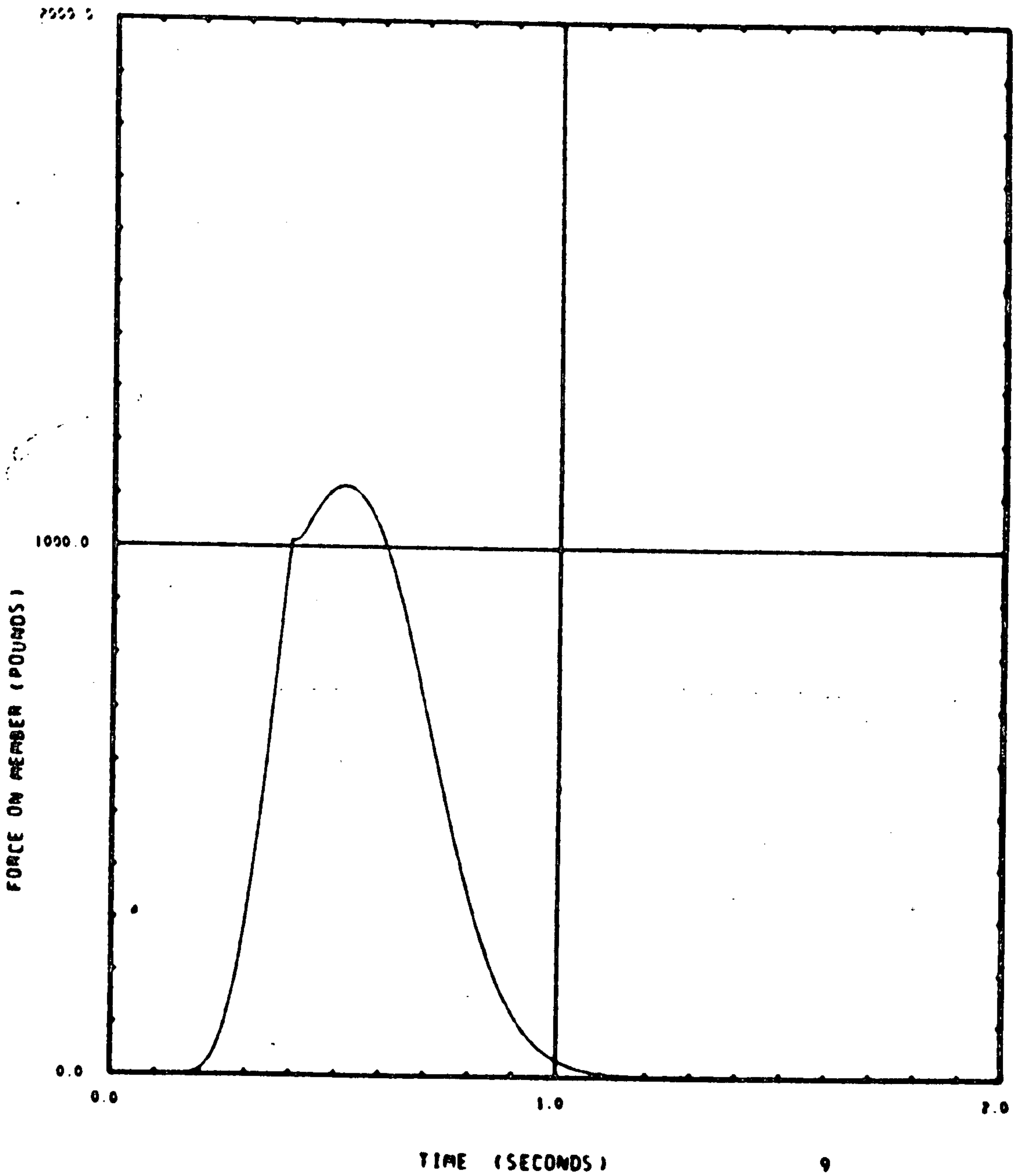


FIGURE 6-11

FORCE TIME-HISTORY FOR FORCE #9 AS DEFINED IN FIGURE 5-2
FOR WATER SOLID DISCHARGE THROUGH THE IPP #2 RELIEF VALVES

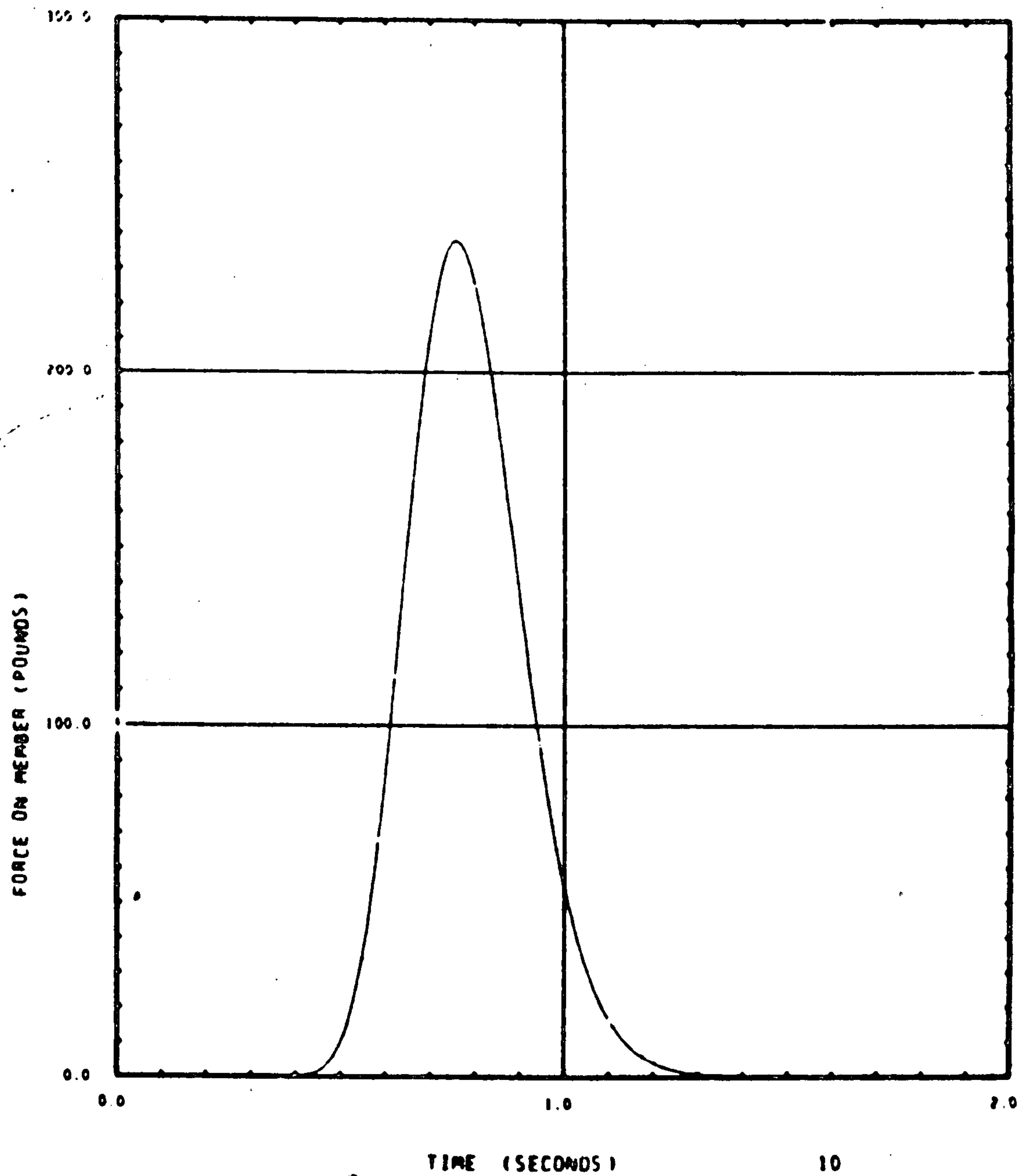


FIGURE 6-12

FORCE TIME-HISTORY FOR FORCE #10 AS DEFINED IN FIGURE 5-2 FOR WATER SOLID DISCHARGE THROUGH THE IPP #2 RELIEF VALVES

TABLE 6-1

IPP #2 SAFETY VALVE DISCHARGE CASES - PEAK FORCES

Force Location	Peak Force(lbs) Design Basis	Peak Force(lbs) Case A Steam Discharge
A. Line 342-Horizontal force on PCV-464	1200.	1261.
B. Line 342-Vertical force between 1st and 2nd elbows	4100.	3203.
C. Line 342-Horizontal force on second elbow	2700.	662.
D. Line 343-Horizontal force on PCV-466	910.	1257.
E. Line 343-Vertical force between 1st and 2nd elbows	4000.	3075.
F. Line 343-Horizontal force on second elbow	2300.	633.
G. Line 344-Horizontal force on PCV-468	1650.	1643.
H. Line 344-Vertical force between 1st and 2nd elbows	4400.	3312.
I. Line 344-Horizontal force on second elbow	2900.	561.

Refer to Figure 5-1 for location of above forces.

TABLE 6-2

IPP #2 RELIEF VALVE DISCHARGE CASES - PEAK FORCES

Junction	Peak Force(1bs) Design Basis Water Solid	Peak Force(1bs) Case A Steam Discharge	Peak Force(1bs) Case B Water Solid	Peak Force(1b Case C N2 Bubble
1	89.	55.	215.	6718.
2	23.	14.	56.	1779.
3	199.	69.	194.	7571.
4	344.	114.	215.	478.
5	793.	499.	962.	520.
6	595.	698.	1115.	111.
7	272.	135.	238.	54.

Refer to Figure 5-2 for location of above forces.

* Extremely short duration peaks.