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TECHNICAL REPORT

TECHNICAL REPORT TR-5364-3
REVISION 0

BOOK 1 OF 3

DONALD C. COOK NUCLEAR GENERATING PLANT

ANALYSIS OF PRESSURIZER SAFETY VALVE DISCHARGE PIPING SYSTEM, WITH DRAINED LOOP SEALS PER NUREG 0737, II.D.1, UNIT 1

JULY 18, 1983

AMERICAN ELECTRIC POWER SERVICE CORPORATION
2 BROADWAY
NEW YORK, NEW YORK 10004

TECHNICAL REPORT TR-5364-3
REVISION 0

BOOK 1 OF 3

DONALD C. COOK NUCLEAR GENERATING STATION

ANALYSIS OF PRESSURIZER SAFETY VALVE DISCHARGE PIPING SYSTEM, WITH DRAINED LOOP SEALS PER NUREG 0737, II. D.1, UNIT 1

JULY 18, 1983

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1.0 INTRODUCTION

American Electric Power Service Corporation (AEPSC), purchase order number 02676-820-1N, authorized Teledyne Engineering Services (TES) to analyze the Pressurizer Safety/Relief Valve Discharge Piping per NRC NUREG-0737, Item II. D.1 for the Donald C. Cook Nuclear Power Plant, Unit #1..

This activity was performed in accordance with the TES Quality Assurance program which meets the requirements of 10CFR50, Appendix B, and ANSI N45.2.11 as interpreted by Regulatory Guide 1.64, Revision 2.

The scope of work for this effort is described in detail in Teledyne Engineering Services Technical Proposal PR-5653 (Reference 9), dated May 14, 1981 and modified as stated in AEPSC letter dated November 29, 1982, from Mr. Sam Ulan (AEPSC) to Mr. L. B. Semprucci (TES); in AEPSC letter from Mr. Sam Ulan (AEPSC) to Mr. P. D. Harrison (TES) dated March 15, 1983 (References 1 and 11) and in TES letter 5364-44 from Mr. P. D.Harrison (TES) to Mr. S. Ulan (AEPSC) dated May 28, 1983 (Reference 10).

The majority of the analysis was performed after the receipt of AEPSC letters dated November 29, 1982 and March 15, 1983 (References 1 and 11), which were issued after more complete information was available from the EPRI data.

This analysis was performed using large digital computer programs supplemented with any necessary hand calculations. The RELAP5 MOD1 Cycle 14 computer program was used to do the thermal fluid transient analysis. The structural analysis, for all loading conditions, was done utilizing the TMRSAP computer program.

The size of the pressurizer safety/relief valve discharge piping system was so large that the computer models, for both RELAP and TMRSAP, strained the limits of the programs. This condition necessitated multiple RELAP runs in order to execute the thermal fluid transient analysis for the appropriate length of time. For the structural analysis it was necessary to expand the core of the TMRSAP program in order to avoid an overconservative overlap analysis.

2.0 CONCLUSIONS

The analysis performed by TES on the Pressurizer Safety/Relief Valve Discharge Piping System with the Safety Valve loop seal drained, indicates that all criteria of NRC NUREG-0737, Item II.D.1 are met, with the following qualifications:

1) Valve accelerations due to the SV transient shock condition for valves SV-45A, SV-45B and SV-45C exceed the vertical allowable of 2g's (Reference 14). The accelerations exceed the allowable by less than 1g and, therefore, it is TES's opinion that these valve accelerations are acceptable. However, setting the criteria of acceptance of these accelerations is out of the TES work scope and is, therefore, the responsibility of others.

2) The supports listed below exceed the loads given on the As-Built support drawings (see Section 6.2). These support loads, while exceeding the previous loads, do so in most cases by a small percentage. However, acceptance of these loads is out of the TES work scope and is the responsibility of others.

   1-GRC-R-585
   1-GRC-R-589
   1-GRC-R-591
   1-GRC-R-601
   1-GRC-S-608
   1-GRC-R-613
   1-GRC-S-614
   1-GRC-R-616

This report documents that the safety/relief valve discharge piping for Unit 1 is acceptable for emergency conditions assuming drained loop seals. TES Technical Report TR-5364-1, Revision 0 (Reference 2), which is based on the as-built condition, documents the acceptability of the system for normal and upset conditions. Draining the loop seals will not affect the normal and upset conditions.

The purpose of the loop seals was to protect the safety valves from leaking by keeping free hydrogen and high temperatures away from the valve seats. It should be noted that while draining the loop seals relieves the overwhelming stress on the discharge system, see TES Technical Report TR-5364-1, Revision 0 (Reference 2), it also leaves the valve seats unprotected and, therefore, susceptible to leaking. While it is beyond the responsibility of TES, this condition can result in serious consequences and should be investigated.

Support load summary sheets have been included in this report for all supports and supercede the loads reported in TR-5364-1.

3.0 SYSTEM DESCRIPTION/DISCUSSION

The Pressurizer Safety/Relief Valve Discharge Piping System consists of all of the piping from the pressurizer nozzles, down to the sparger in the quench tank. This information is depicted on TES drawing E-5763, Revision 3, generated from AEP drawings 1-GRC-6, sheets 1, 2, 3, and 4; 1-GRC-7; 1-GRC-8; 1-GRC-9; 1-5435-8; 1-RC-6, sheets 1, 2, 3 and 4; 1-RC-7; 1-RC-8; and 1-RC-9.

The "Discharge" piping constitutes a very large system resulting in a large computer model. The size and geometrical complexity, which is due mainly to the sweeping curves around the pressurizer, complicates the modification effort in addition to causing longer run times..

Modification of this complex system, to attempt to secure satisfactory "Safety Valve Discharge" results, is limited to draining the SV loop seals. Heating the loop seals is not a viable "fix" because of the size of the loops. These long loops contain sufficient quantity of water such that on SV Discharge, the water seal does not "flash" completely enough to reduce the very high loads caused by the water slug. Modification to the support system is also a poor option because of the very limited space in the annulus around the pressurizer, which makes construction very difficult.

4.0 THERMAL FLUIDS ANALYSIS

4.1 Introduction

The following thermodynamic fluid analysis determines the fluid forces which act on the pressurizer safety valve discharge piping of the American Electric Power Service Corporation (AEPSC) Donald C. Cook Nuclear Power Plant, Unit 1. These forces are generated by the sudden opening of the pressurizer safety valves during one of the pressurizer transients described in the AEP letter of November 29, 1982 to TES (Reference 1).

These fluid forces and the resulting loads and stresses on the piping system became of increased concern as a result of the incident at Three Mile Island. Following this incident, the NRC issued NUREG 0578 and NUREG 0737, which required that each utility determine the effect of safety/ relief valve operation upon the valve and the discharge piping. An elaborate program involving both testing and analysis was established under the general management of the Electric Power Research Institute (EPRI). The EPRI program included intensive testing of safety and relief valves as well as a full scale safety valve test facility, built at Combustion Engineering in Connecticut.

Simultaneously, an analytical program was initiated to choose and test a computer program which would predict the fluid forces; RELAP5 MOD1 was chosen. RELAP5 MOD1 is the latest in the family of RELAP programs developed at the Idaho National Engineering Laboratory.

The D.C. Cook Units 1 and 2 pressurizer safety valves have "Cold Loop Seals". A "Cold Loop Seal" is a subcooled slug of water trapped between the safety valve seat and the pressurizer nozzle by a loop of piping. The function of this slug of water is to prevent the safety valve from leaking, this is accomplished by keeping free hydrogen away from, and maintaining reduced temperatures at the valve seat. While the loop seal provides a benefit, it also has a serious drawback. When the safety valve opens, the loop seal is shot through the discharge piping with tremendous force. In TES Technical Report TR-5364-1, TES performed a fluid analysis to determine the magnitude of the loads applied

to the discharge piping by the propulsion of the cold loop seal. These loads were calculated to be greater than 100,000 lbf for a single safety valve discharge. The simultaneous discharge of the pressurizer's three safety valves with loop seals could result in loads of over 300,000 lbs.

As explained in TR-5364-1, TES also performed a sensitivity study to determine if raising the loop seal temperature (by electrical trace heating) would reduce the loads. Increasing the loop seal temperature did lower the loads somewhat, however, a significant reduction was not obtained. It was then suggested that the loop seals should be drained so that when the safety valves operated, they would discharge steam only.

This report presents the analysis for the steam discharge that was performed for the Unit 1 pressurizer safety valves. The maximum fluid force calculated in this analysis is 24,000 lbf for simultaneous discharge of all three safety valves. It can be seen that draining the loop seals provides a significant force reduction.

In this analysis, as before, TES has used RELAP5 MOD1 version 2.11 as it is made available through Control Data Corp with a post-processor, REPIPE version 3.10, which calculates the fluid forces. This version of RELAP5 MOD1 is identified by the following computer job control language at Control Data Corporation:

```
BEGIN, RELAP5, R5M2, INPUT=INPUTFILE, SCM=377000B
```

The computer analysis procedure for the thermal analysis portion is included in Appendix A.

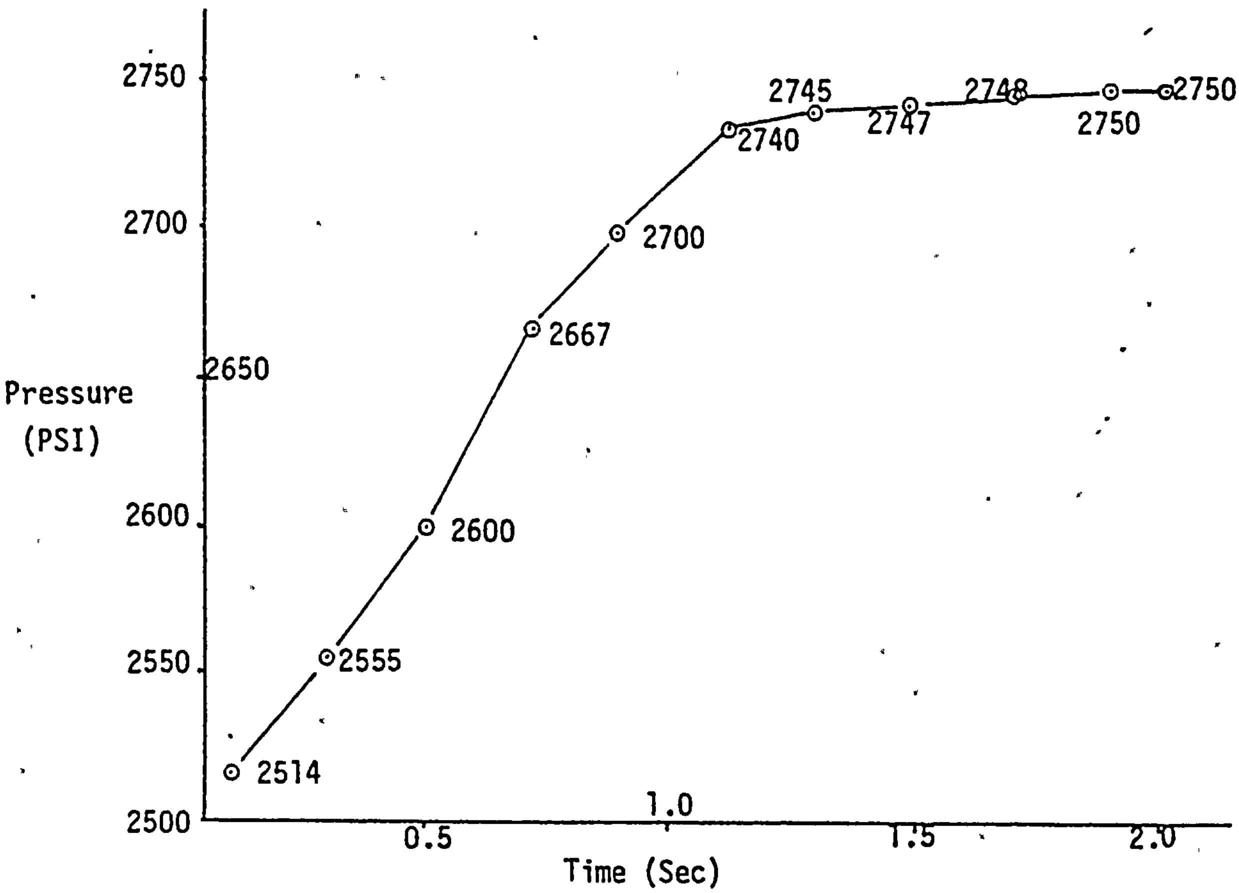
RELAP5 calculates hydrodynamic data for control volumes in each segment of pipe. REPIPE then takes this data and defines two force time histories for each segment, one set for inlet junction forces and the other for outlet junction forces. A TES generated program, SAP2SAP, adds these force time histories. Finally, one force-time history for each segment of axial, unbalanced loads is analyzed structurally.

4.2 RELAP Model

4.2.1 The D.C. Cook pressurizer was modeled as a single time dependent volume with the following transient condition as specified by the AEPSC, November 29, 1982 letter to Mr. L.B. Semprucci, pages 1-7 (Reference 1):

Safety Valves

Pressure Time History (in the pressurizer)



These are the same safety valve pressure boundary conditions that were used in analyzing the quarter model cold loop seal case of TR-5364-1 (Reference 2).

4.2.2 Safety valves were modeled as RELAP junctions emulating Crosby HB-BP-86 valves (Reference 3) with orifice areas of 0.01897 Ft^2 and a valve opening time of 0.010 seconds.

Valve orifice areas were calculated using the Crosby Valve and Gage Company Drawing No. H-51688, Revision A (Reference 3) provided by AEP, and RELAP (Run ID BAICDRO) implementing rated flows. Calculated values are included in Section 4.6 and Figure 4.6.1.

4.2.3 Discharge piping was modeled from all safety and power operated relief valves to the quench tank. This discharge piping included the following pipe sizes:

3 inch, 12 inch	SCH 40
4 inch, 6 inch	SCH 40S
4 inch	SCH 120
3 inch, 6 inch	SCH 160

Friction factors for long and short radius elbows and reducers were taken from technical paper #410 by Crane (Reference 4). Calculations of these frictional losses are included in Appendix A. The discharge piping is defined in segments of straight sections from; elbow to elbow, valve to elbow, etc.

4.2.4 The Quench Tank was modeled in two parts, the sparger and the tank itself, using cylindrical volumes containing water and air. The quench tank volumes were taken from Westinghouse Dwg. No. 110E272 (Reference 5).

The sparger for D.C. Cook is a perforated pipe submerged in water within the quench tank as indicated in Figure 4.2.1. It is represented in RELAP as a pipe similarly submerged and of equal volume.

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BY SAT DATE 1-12-83
CHKD. BY CHM DATE 3-11-83

DONALD C. COOK
NUCLEAR GEN. STATION UNITS 1 & 2
QUENCH TANK

SHEET NO. 1 OF 6
PROJ. NO. 5364

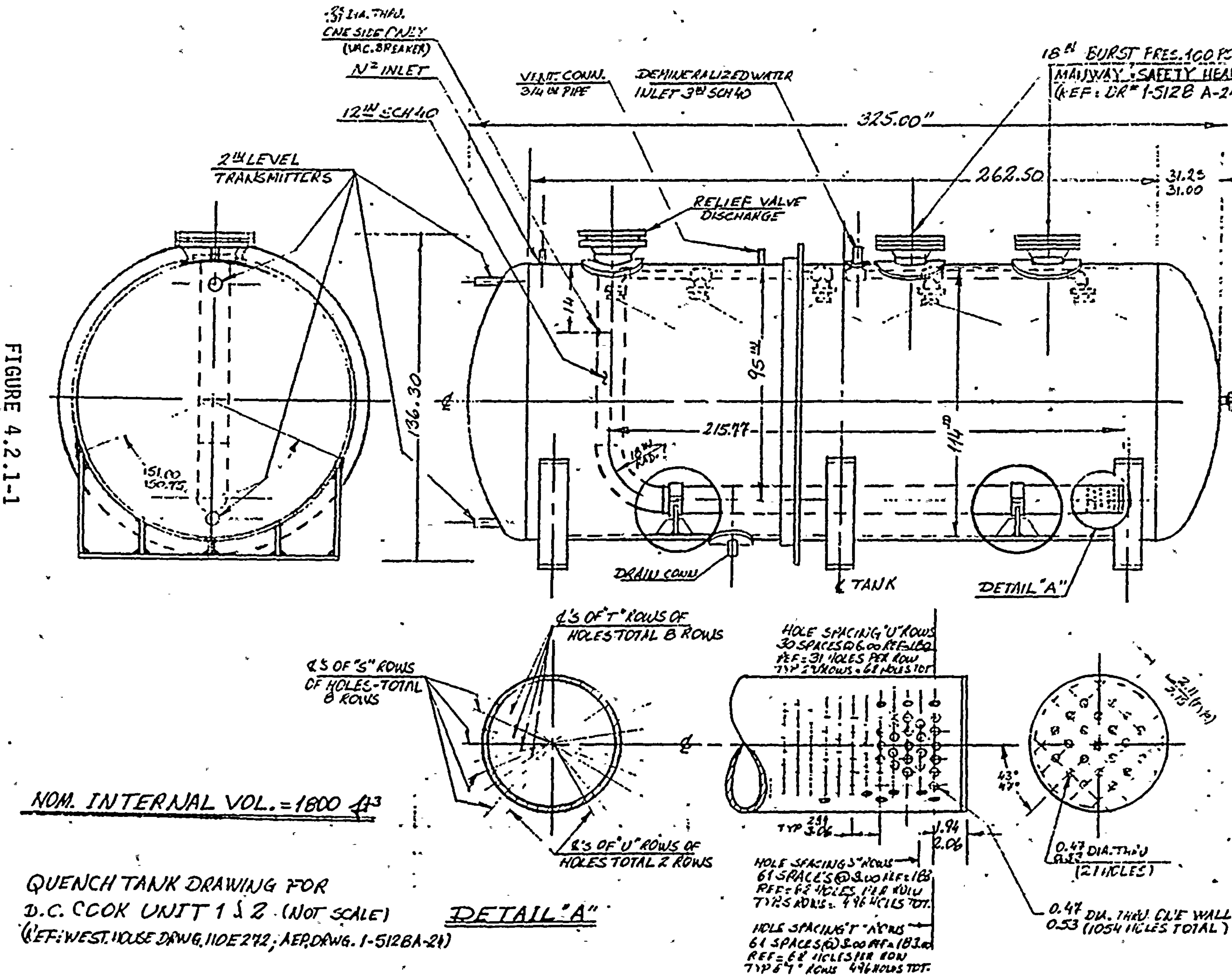

FIGURE 4.2.1-1

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DONALD C. COOK
NUCLEAR GEN. STATION UNITS 1&2
RELAP5 QUENCH TANK MODELING

SHEET NO. 2 OF 6
PROJ. NO. 5364

FIGURE 4.2.1-2

RELAP5 MODEL OF THE QUENCH TANK

REMARKS:

1. QUENCHTANK WAS MODELED AS A SERIES OF "PIPE COMPONENTS" WITH APPROPRIATE FLOW AREAS AND LOSS COEFFICIENTS.

2. WATER LEVEL IN THE QUENCH TANK IS AT THE SAME HEIGHT AS THE WATER LEVEL IN THE SPARGER

3. THE SECTION OF THE SPARGER WITH DISCHARGE HOLES WAS MODELED AS A PIPE WITH ITS LENGTH EQUAL TO THE LENGTH OF THE SPARGER WITH THE TOTAL NUMBER OF HOLE AREAS EQUAL TO FLOW AREA OF THE SPARGER (REF. DETAIL DRW "A")

4. RUPTURE DISCS WERE MODELED AS A TRIP VALVE WHICH OPENS AT THE BURST PRESSURE OF 100 psig.

5. VACUUM BREAKER HOLE WITH DIA. = 0.25 - 0.31 IN AND LOCATED 14 INCHES FROM THE TOP OF THE QUENCH TANK WAS IGNORED IN THE MODELING.

V = NOMINAL INTERNAL VOLUME OF THE TANK = 1800 ft^3 (W.H. Dr.# 110E272)

TANK IS 82% FULL OF WATER. (REF. TELECON LBS WITH SAM ULAN DATED 1-14-83)

V_1 = WATER VOLUME IN THE QUENCH TANK = 1476 ft^3

V_2 = AIR VOLUME IN THE QUENCH TANK = 324 ft^3

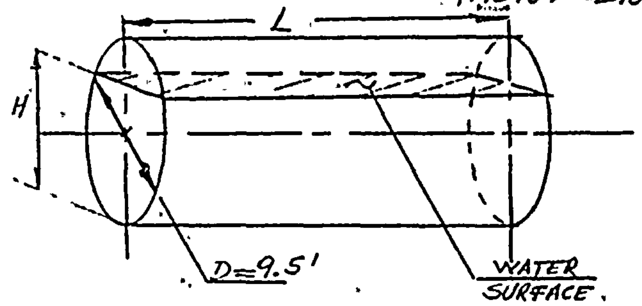
BY BAI DATE 1-17-83
CHKD. BY CMM DATE 3-11-83

DONALD C. COOK
NUCLEAR GEN. STATION UNITS 1 & 2
RELAP5 QUENCH TANK MODELING

FIGURE 4.2.1-3

IF QUENCH TANK IS A CYLINDER WITH D = 114 IN INSIDE DIA.

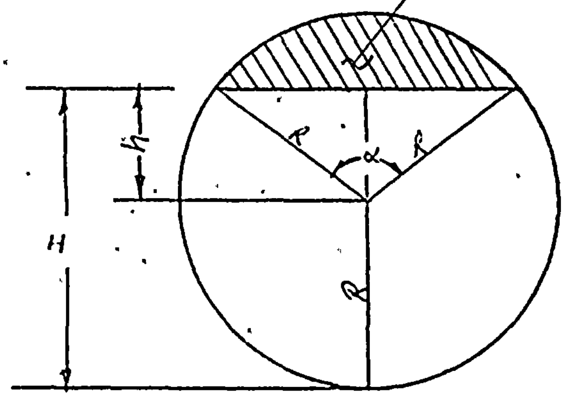
THEN: LENGTH $L = \frac{V}{(\frac{D}{2})^2 \pi}$



$$L = \frac{1800}{(\frac{9.5}{2})^2 \pi}$$

$$L = 25.3943 \text{ ft}$$

H - HEIGHT OF THE WATER LEVEL FROM BOTTOM OF THE TANK



$$AREA(1) = \frac{R^2}{2}(\hat{\alpha} - \sin\alpha) \qquad EQN - (1)$$

WHERE: $\hat{\alpha}$; IN RADIANS

α ; IN DEGREES

$$AREA(1) = \frac{\text{AIR VOLUME}}{\text{HEIGHT OF CYL.}} = \frac{V_2}{L} = \frac{324}{25.3943}$$

$$AREA(1) = 12.7588 \text{ ft}^2$$

SUBSTITUTING INTO EQN (1)

$$12.7588 = \frac{22.5625}{2}(\hat{\alpha} - \sin\alpha)$$

$$13.1310 = \hat{\alpha} - \sin\alpha$$

BY TRIAL AND ERROR:

$\alpha \approx 116.5°$

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DONALD C. COOK
NUCLEAR GEN. STATION UNITS 1 & 2
RELAP5 QUENCH TANK MODELLING

SHEET NO. 4 OF 6
PROJ. NO. 5364

FIGURE 4.2.1-4

$$h = R \cos \frac{\alpha}{2}$$

$$h = 4.75 \cos \frac{116.5}{2}$$

$$h \doteq 2.4995$$

$$H = h + R = 4.75 + 2.4995$$

$H \approx 87^{IN} = 7.25$ ft HEIGHT OF WATER SURFACE FROM THE BOTTOM OF THE QUENCH TANK.

$D - H = 27^{IN} = 2.25$ ft FROM THE TOP OF THE QUENCH TANK TO THE WATER SURFACE.

FROM WATER SURFACE TO THE CENTER OF THE HORIZANTAL SECTION OF THE SPARGER $\approx 68^{IN} = 5.6667$ ft

HEIGHT OF WATER LEVEL IN QUENCH TANK MODEL MUST BE ALSO = 5.6667 ft

VOLUME OF WATER IN QUENCH TANK = 1476 ft^3.

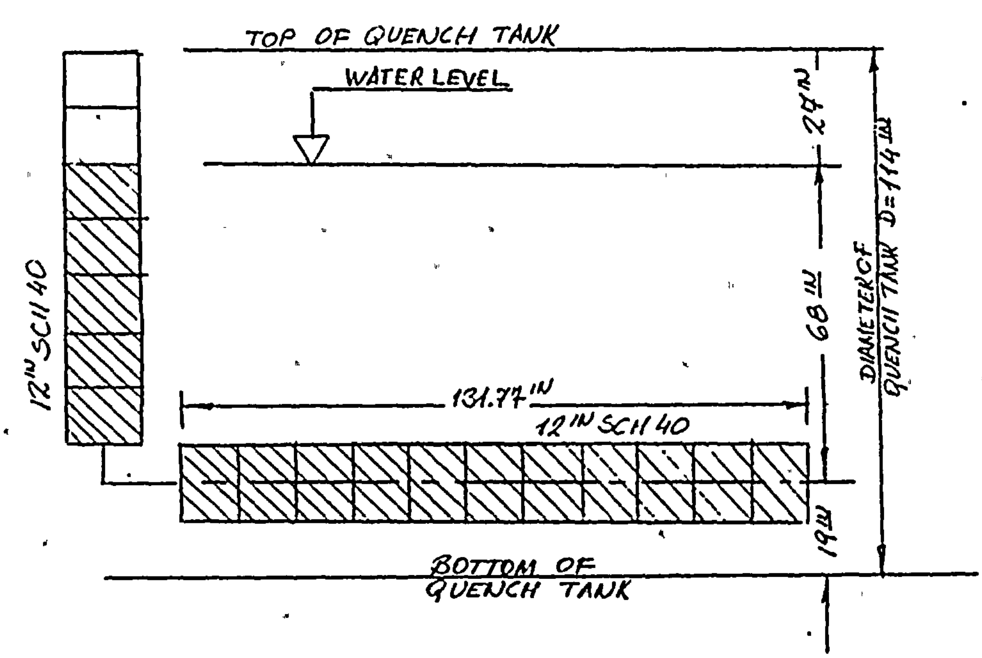
SURFACE AREA BETWEEN WATER AND AIR = $\frac{1476}{5.6667} = 260.4706$ ft^2

VOLUME OF AIR IN QUENCH TANK = 324 ft^3

HEIGHT OF AIR VOLUME IN RELAP MODEL = $\frac{324}{260.4706} = 1.2439$ ft

FIGURE 4.2.1-5

SPARGER MODELING



AREA OF EACH HOLE ON SPARGER SIDE = 0.1963 in² = 0.0014 ft²

TOTAL FLOW AREA OF ALL THE SIDE HOLES = 1054 × 0.0014 = 1.4368 ft²

FLOW AREA OF 12 IN SCH40 PIPE = 0.7773 ft²

ALL THE HOLES ARE DISTRIBUTED EVENLY @ 183 IN LENGTH FROM THE TIP OF THE SPARGER

AREA RATIOS = $\frac{0.7773}{1.4368}$ = 0.541 REPRESENTS THE SECTION OF THE SPARGER WHICH INCLUDES ALL THE HOLES WITH THE TOTAL AREAS EQUAL TO THE FLOW AREA OF THE 12" SCH40 PIPE.

1 − 0.541 = .459

183 × 0.459 = 83.9977 ≈ 84.0" = 7 ft THE LENGTH WHICH MUST BE EXCLUDED FROM THE TIP

TOTAL LENGTH OF HORIZONTAL SECTION = 215.77 IN (REF DWG ON Page 1)

THIS LENGTH IN RELAP MODEL = 215.77 − 84 = 131.77 ≈ 11 ft

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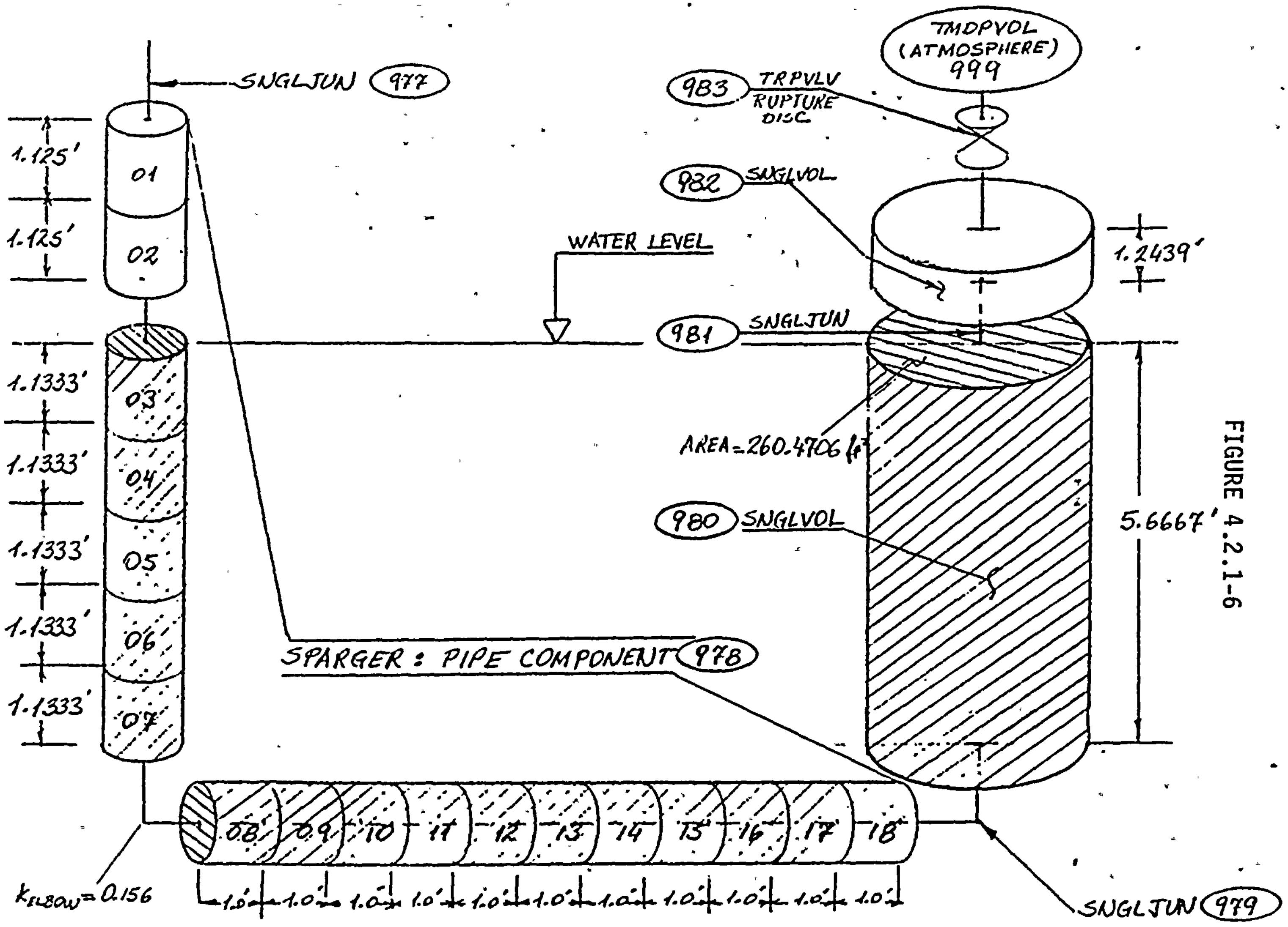
DONALD C. COOK
NUCLEAR GEN. STATION UNITS 1 & 2
RELAP5 QUENCH TANK MODELING



RELAP5 QUENCH TANK MODEL

FIGURE 4.2.1-6

4.3 RELAP Model Control Volumes

The "Evaluation of RELAP5/MOD1 for Calculation of Safety/Relief Valve Discharge Piping Hydrodynamic Loads" report prepared by Intermountain Technologies Inc. (Reference 6) recommends using ten or more control volumes per bounded segment when modeling valve discharge piping for RELAP5, while avoiding significant control volume length differences to preserve pressure wave shapes. The ten control volume criteria recommended by ITI was adhered to by TES in all cases, except in piping arcs and in segments less than three feet in length. The D.C. Cook discharge piping is modeled using as few as one control volume per segment (pipe segments with lengths less than 0.5 feet) and up to thirty-two control volumes per segment.

Arc modeling for Unit 1 is represented in Figure 4.3.1. All arcs for Unit 1 were modeled in RELAP as having no fluid losses. Essentially, RELAP calculates these as straight sections of pipe. REPIPE, however, distributes the calculated forces to pre-assigned node points matching the TES structural models.

Average control volume lengths used for the D.C. Cook RELAP Unit 1 model were:

Pipe Size	Average C.V. Length
3 inch SCH 160	0.4644 feet
6 inch SCH 160	0.5264 feet
4 inch SCH 40S	0.4471 feet
6 inch SCH 40S	0.8614 feet
12 inch SCH 40	0.8064 feet
3 inch SCH 40	0.4744 feet
4 inch SCH 120	0.5056 feet

The schematic of the discharge system modeled in RELAP for the SV Unit 1 model is represented in Figure 4.7.1.

Quench Tank modeling was achieved using twenty control volumes and twenty junctions. Eighteen volumes comprise the sparger model while the remaining two are single volumes modeling the water and air spaces of the quench tank. The water and air volumes as determined from Westinghouse Dwg. No. 110E272 (Reference 5) were input to RELAP to insure proper quenching capacity. Eighteen control volumes forming the sparger are initially 88% full of water representing a submerged pipe. The discharge holes were modeled as a single hole with an area of .7773 ft.^{2} at a point on the sparger where the sum of the small hole areas equal the 12 inch schedule 40 discharge area.

Finally, the tank rupture disk is modeled as a pressure actuated valve placed on the air volume and set to blow out at 100 psig discharging to atmosphere. Figure 4.2.1 represents the D.C. Cook Unit 1 and 2 Quench Tanks. Pressure in the air volume of the quench tank never exceeded 30 psia during the Unit 1 SV transient case of steam and drained loop seals RELAP5 run for 0.5 seconds.

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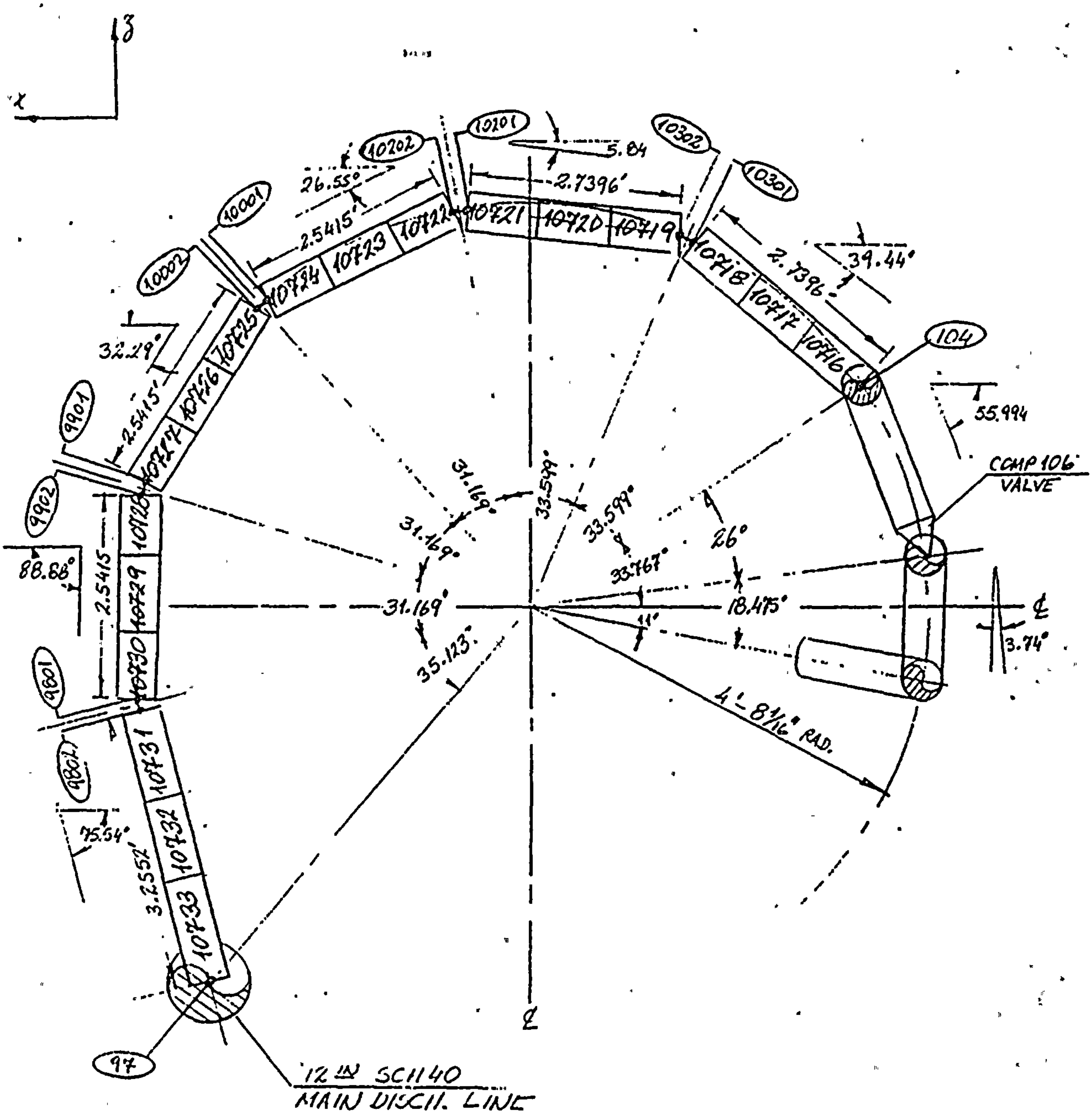
BY BAI DATE 2-8-83
CHKD. BY CJC DATE 2-15-83

D. C. COOK UNIT 1
ARC 1 GEOMETRY @ ELEV. 669'-2"

SHEET NO. 1 OF 5
PROJ. NO. 5364

FIGURE 4.3.1-1

KELAP5 MODEL OF ARC @ ELEVATION 669'-2" (ARC 1)



REMARKS:

NUMBERS IN ⬭ INDICATE STRUCTURAL NODES

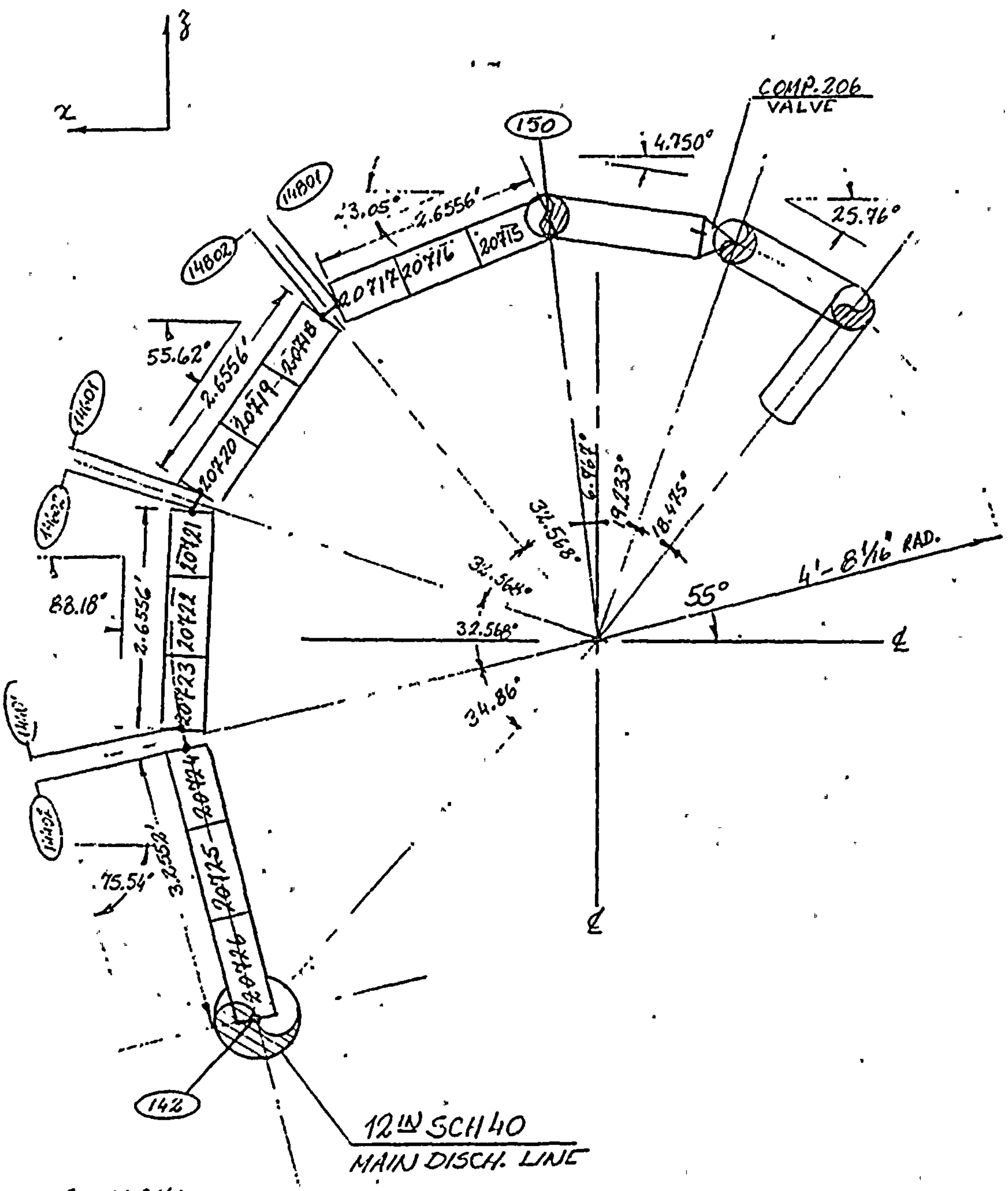
DIMENSIONS BETWEEN NODES REPRESENT CORRESPONDING ARC LENGTHS.

TELEDYNE ENGINEERING SERVICES

BY BAI DATE 2-6-83	D.C. COOK UNIT 1	SHEET NO. 2 OF 5	
CHKD. BY CJC DATE 2-15-83	ARC 2 GEOMETRY @ ELEV. 670'-10"	PROJ. NO. 5364	

FIGURE 4.3.1-2

RELAP5 MODEL OF ARC @ ELEVATION 670'-10" (ARC 2)

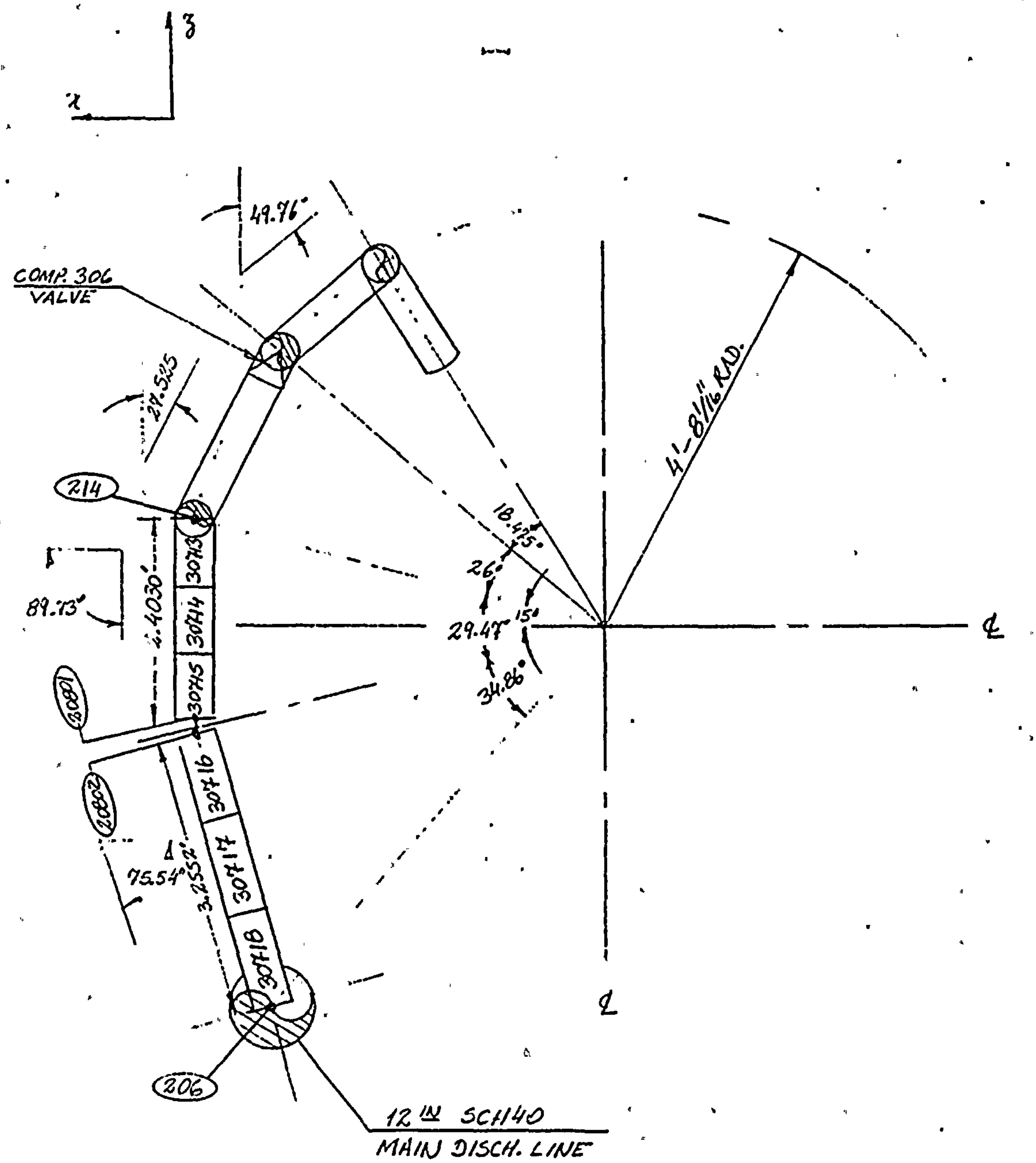


REMARKS:
NUMBERS IN ◯ INDICATE STRUCTURAL NODES
DIMENSIONS BETWEEN NODES REPRESENT CORRESPONDING ARC LENGTHS.

BY BAL DATE 2-6-83 | D. C. COOK UNIT 1 | SHEET NO. 3 OF 5
CHKD. BY CJC DATE 2-15-83 | ARC 3 GEOMETRY @ ELEV. 672'-6" | PROJ. NO. 5634

FIGURE 4.3.1-3

RELAP5 MODEL OF ARC @ ELEVATION 672'-6" (ARC3)



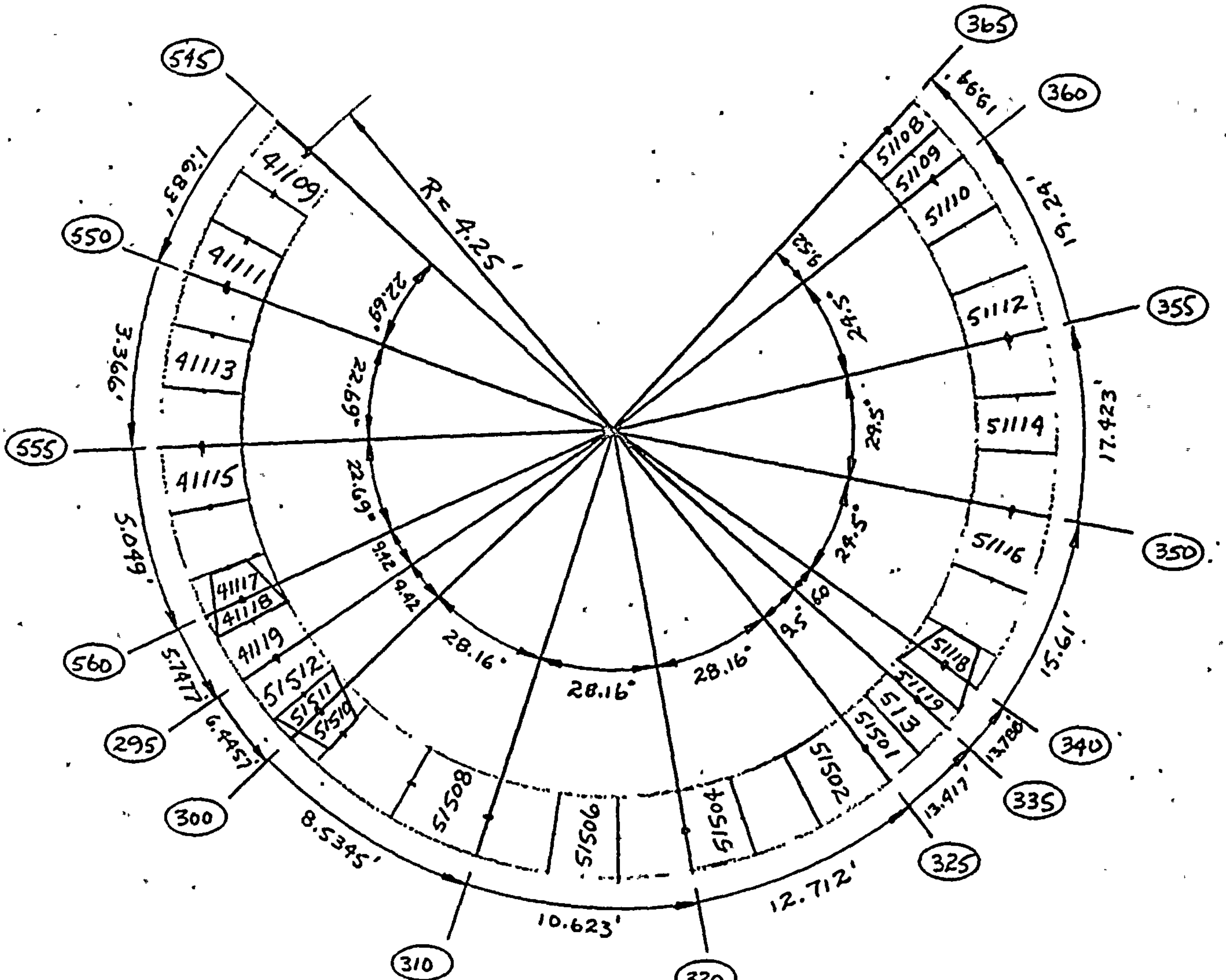
REMARKS:
NUMBER IN ⬭ INDICATE STRUCTURAL NODES
DIMENSIONS BETWEEN NODES REPRESENT CORRESPONDING ARC LENGTHS.

BY CJC DATE 3-25-83
CHKD. BY CHM DATE 3-28-83

UNIT 1 PORV SECTION
RELAP MODEL (DOWNSTREAM)

SHEET NO. 4 OF 5
PROJ. NO. 5364

FIGURE 4.3.1-4

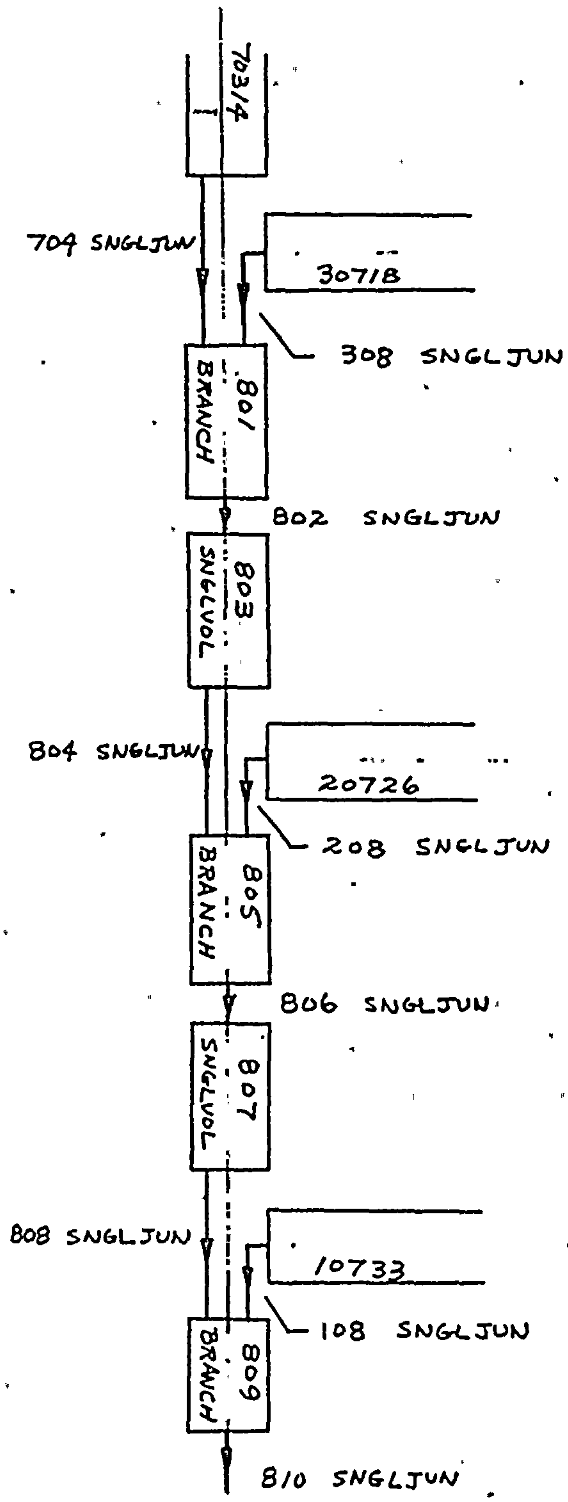


BY CJC DATE 3-25-83
CHKD. BY CWM DATE 3-28-83

UNIT 1 MAIN ARC CONNECTIONS
BRANCHES + TEES

SHEET NO. 1 OF 2
PROJ: NO. 5364

FIGURE 4.3.1-5



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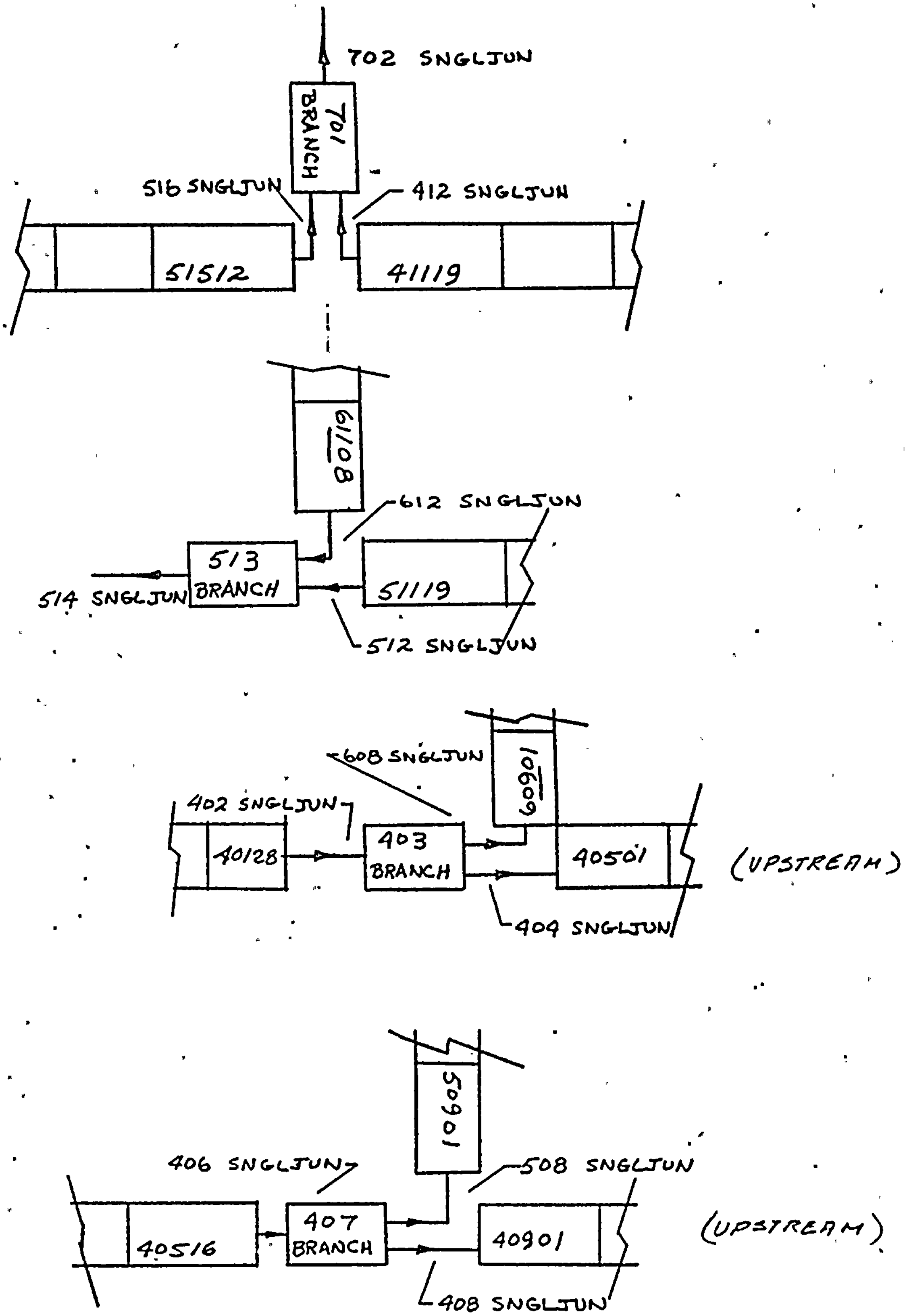
BY CJC DATE 3-25-83 CHKD. BY CMM DATE 3-28-83	UNIT 1 PORV SECTION BRANCHES + TEES	SHEET NO. 2 OF 2 PROJ. NO. 5364

FIGURE 4.3.1-6



4.4 Valve Flow Rate Calculation

The following values were used in valve modeling considerations:

Valve Type	TES Flow[2] Rate Calculated LBM/HR	Max Rating[1] For Steam @ 3% Accum.	Actual Bore Area (IN^2)	Opening Time (Sec)
Crosby Safety Relief Valve	452,393	435,000	3.6 in^2	0.010 (Ref. 15)

1 The maximum rating for steam at 3% accumulation value is from the Crosby Valve and Gage Safety Valve Drawing No. H-51688, Revision A (Reference 3).

2 Flow rate at 2500 psig plus 3% accumulation.

The valve flow rates normally used by TES in the RELAP analysis of the SVs would be a 15% increase in the ASME rated flow: 10% to consider the ASME underating of the theoretical flow and 5% to cover tolerances. However, in this particular case, Westinghouse has provided AEPSC with a summary of the EPRI flow rate tests of the Crosby 6M6 safety valve (Reference 7). Also, see Figure 4.4.1-4. A comparison was made in an effort to achieve a more realistic flow rate. The flow rate chosen which most closely bounds the test data is the following ASME flow rate. All calculations are included as Figure 4.4.1.

$W_T = 51.5\ AP$ Napier's Eq.

ASME rated flow:

$$W_R = 51.5A\ (1.03P + 14.7)(.9)(.966)C \qquad \text{(Ref. 8)}$$

where:

W_T = theoretical flow

W_R = rated flow

coefficients:

1.03 - applies 3% accumulation

0.966 - valve flow coefficient

0.9 - represents theoretical flow rate reduced 10% to equal ASME rating

C = 1.0771 calculated on Figure 4.4.1-2 following.

TELEDYNE ENGINEERING SERVICES

BY BAI DATE 2-4-83	CROSBY 6M6 VALVE	SHEET NO. 1 OF 3
CHKD. BY CMM DATE 2-10-83	RELAP5 MODEL FLOW AREA CALCULATIONS	PROJ. NO. 5364

FIGURE 4.4.1-1

REF: 1. ASME SEC III N.B.-7731.1 & N.B.-7734.2 (1980)

2. CROSBY 6M6 MODEL: HB-BP-86 VALVE DRAWING No: H-51688 REV.A

3. WESTINGHOUSE REPORT WCAP-10105
"REVIEW OF PRESSURIZER SAFETY VALVE PERFORMANCE AS OBSERVED IN THE EPRI SAFETY AND RELIEF VALVE TEST PROGRAM"

4. TES TELECON WITH MR. DAVE TIEBAULT FROM CROSBY DATED 2-4-83

CROSBY 6M6 VALVE PROPERTIES

MANUFACTURER	: CROSBY VALVE & GAGE CO.
TYPE	: SPRING LOADED SAFETY VALVE
MODEL NO	: HB-BP-86 6M6
DRAWING NO.	: H-51688 REV. A
BORE AREA (A_R)	: 3.644 in^2
DESIGN SET PRESS. (P_{SET})	: 2485 psig
DISCHARGE COEF. (K_D)	: 0.966

CALCULATION OF MAX. FLOW RATE (w_R)

THE FOLLOWING ASSUMPTIONS AND CONSIDERATIONS ARE MADE IN DETERMINING w_R FOR RELAP5 MODEL

1. IN THE FOLLOWING CALCULATIONS A CONSTANT SET PRESSURE IS USED TO CALCULATE A FLOW AREA FOR THE RELAP5 MODEL AND DOES NOT NECESSARILY REPRESENT PRESSURIZER INPUT CONDITIONS

2. THERE ARE VARIOUS EQUATIONS AND EXPERIMENTAL RESULTS YIELDING DIFFERENT FLOW RATES. ALL OF THESE ARE PRESENTED IN THE PROCEDING PAGE. A FLOW RATE WAS SELECTED SUCH THAT IT WOULD BE CONSERVATIVE IF COMPARED WITH TEST DATA BUT IT WOULD STILL BE REALISTIC.

BY BAI DATE 2-4-83
CHKD. BY CMM DATE 2-10-83

CROSBY 6M6 VALVE
RELAP5 MODEL FLOW AREA CALCULATIONS

SHEET NO. 2 OF 3
PROJ. NO. 5364

FIGURE 4.4.1-2

VARIOUS FLOW RATES FOR 6M6 CROSBY VALVE FROM DIFFERENT SOURCES

1. FLOW RATE BY USING EQN. $\omega_R)_1 = 51.5 \times A_R (1.03 P_{SET} + 14.7) K_D$

WHERE $A_R = 3.644 \ in^2$
$P_{SET} = 2485$ psig
$K_D = 0.966$

$\therefore \omega_R)_1 = 466\,674$ lb/hr

2. FLOW RATE BY USING EQN. $\omega_R)_2 = 51.5 \times A_R (1.03 P_{SET} + 14.7) K_D (0.9)$

FACTOR: 0.9 TAKES INTO ACCOUNT MANUFACTURING TOLERANCES

(ASME. FLOW RATE FROM OLD EQN) $\therefore \omega_R)_2 = 420\,006$ lb/hr

3. FLOW RATE BY USING EQN. $\omega_R)_3 = 51.5 \times A_R (1.03 P_{SET} + 14.7)(0.9)$

HERE $K_D = 1.0$

(THIS IS THE VALUE PRESENTED ON 6M6 DRWG. (REF.2) AS $\omega_{R_3} \simeq 435\,000$ lb/hr) $\omega_R)_3 = 434788$ lb/hr

4. FLOW RATE BY USING EQN. $\omega_R)_4 = 51.5 \times A_R (1.03 P_{SET} + 14.7) C \times K_D$

(THIS IS THE NEW ASME EQN. WITHOUT MANUFACTURING TOLERANCES)

$$C = \frac{0.1906 \ P_{SET} - 1000}{0.2292 \ P_{SET} - 1061} \qquad C = 1.07711$$

$\omega_R)_4 = 502\,659$ lb/hr

5. FLOW RATE BY USING EQN $\omega_R)_5 = 51.5 A_R (1.03 P_{SET} + 14.7) C \times K_D \times 0.9$
$C = 1.07711$

(FACTOR OF 0.9 INCLUDES MANUFACTURING TOLERANCES) $\omega_R)_5 = 452\,393$ lb/hr

6. MAXIMUM TESTED FLOW RATE (REF.3)

$\omega_R)_6 \cong 444\,000$ lb/hr

TELEDYNE ENGINEERING SERVICES

BY BAI DATE 2-4-83
CHKD. BY CMM DATE 2-10-83

CROSBY 6M6 VALVE
RELAP5 MODEL FLOW AREA CALCULATIONS

SHEET NO. 3 OF 3
PROJ. NO. 5364

FIGURE 4.4.1-3

IN RELAP5 MODEL FOR THE 6M6 CROSBY VALVE $W_R)_3 = 452393$ lb/hr WAS USED BASED ON ASSUMPTION 2 AT PAGE 1.

$$W_R = 452\,393 \text{ lb/hr} = 125.66 \text{ lb/sec}$$

USING THE COMPUTER RUN BAICDRØ

VALVE FULL OPEN AREA IN THE RUN BAICDRØ = 0.0232 ft^2
FLOW RATE @ 80% OPENING = 122.99 lb/sec
FLOW RATE @ 90% OPENING = 138.01 lb/sec

RELAP5 FLOW AREA WHICH DELIVERS $W_R = 125.66$ lb/sec IS CALCULATED BY INTERPOLATION

$$A_{FLOW} = \left[0.8 + 0.1\,\frac{125.66 - 122.99}{138.01 - 122.99}\right](0.0232)$$

$$A_{FLOW} = 0.01897 \text{ ft}^2$$

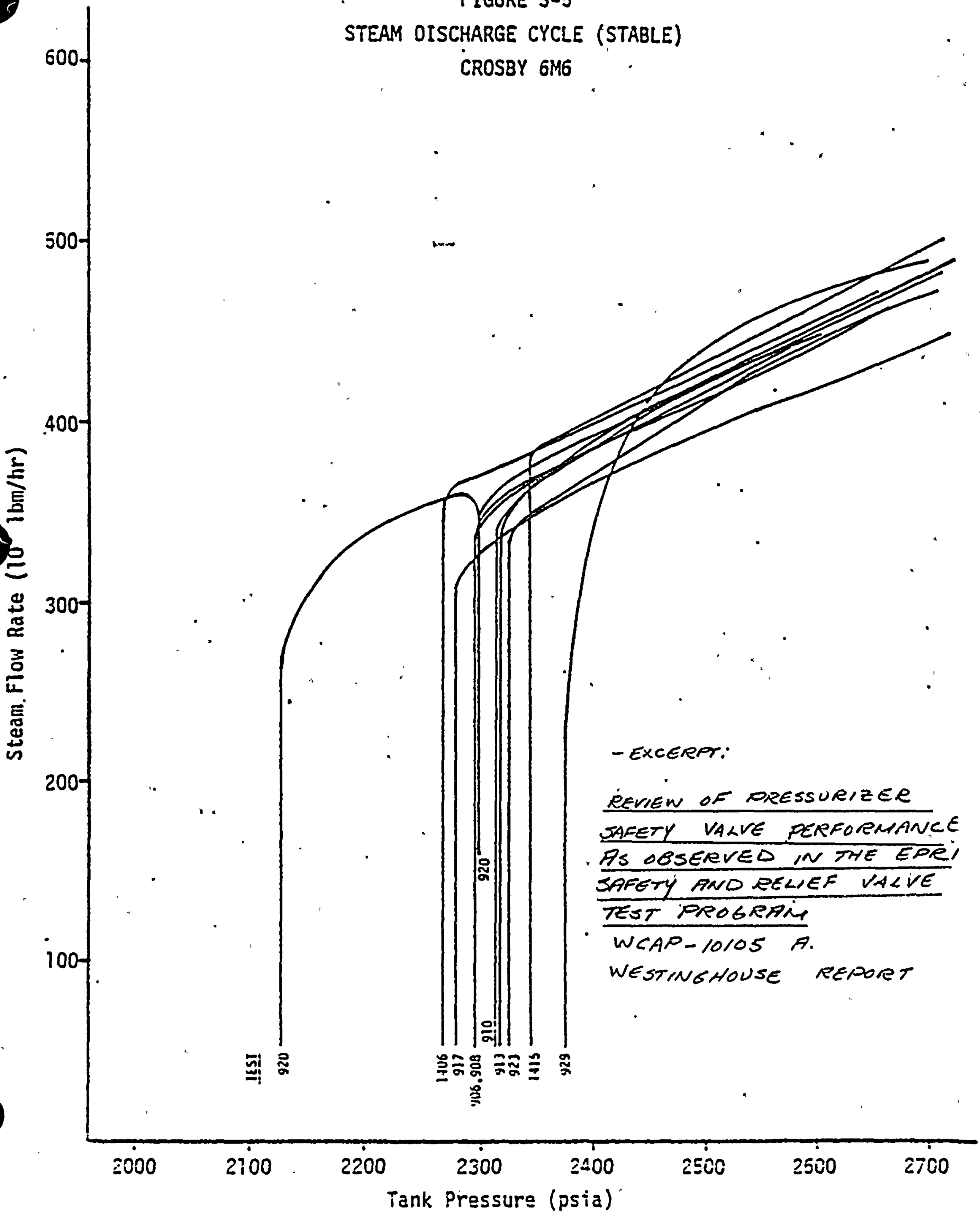
∴ CROSBY 6M6 RELAP5 MODEL FLOW AREA = 0.01897 ft^2

FIGURE 4.4.1-4

FIGURE 3-5

STEAM DISCHARGE CYCLE (STABLE)

CROSBY 6M6



4.5 RELAP Plots

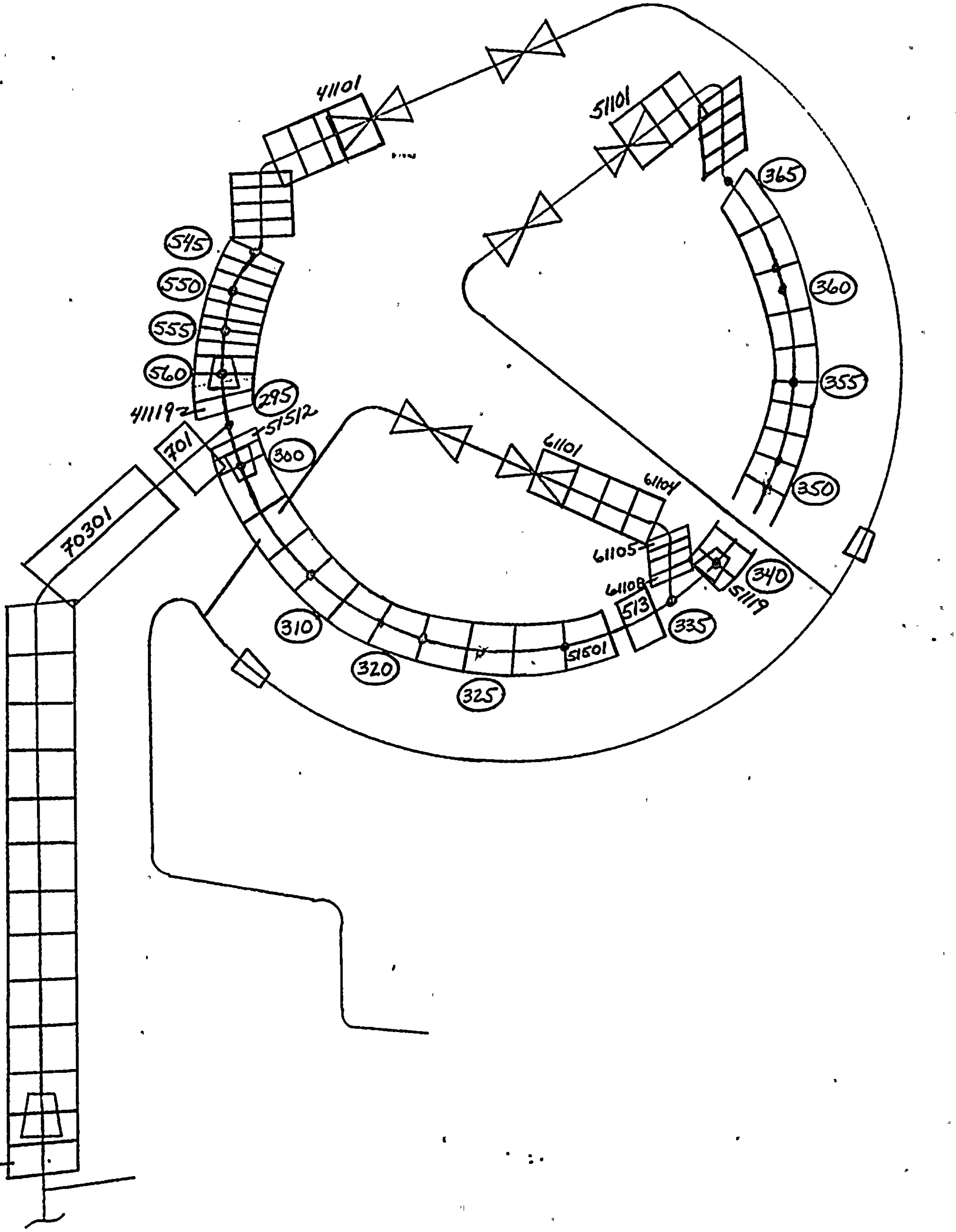
The following plots represent RELAP mass flows, pressures and qualities at various points along the discharge piping. The ordinate axis may not always be correct; many times multipliers will be off (CDC is aware of this problem in RELAP). However, the plots do depict trends accurately and are calculated and reported in RELAP every 0.001 seconds. Correct peaks and times at which they occur are listed with each trace. A RELAP volume schematic precedes the plot set for the transient steam case.

BY PAM DATE 4-14-83
CH. BY CHM DATE 5-25-83

RELAP MODEL SCHEMATIC
UNIT 1 PORV DOWNSTREAM

SHEET NO. 1 OF 3
PROJ. NO. 5364

FIGURE 4.5.1-1

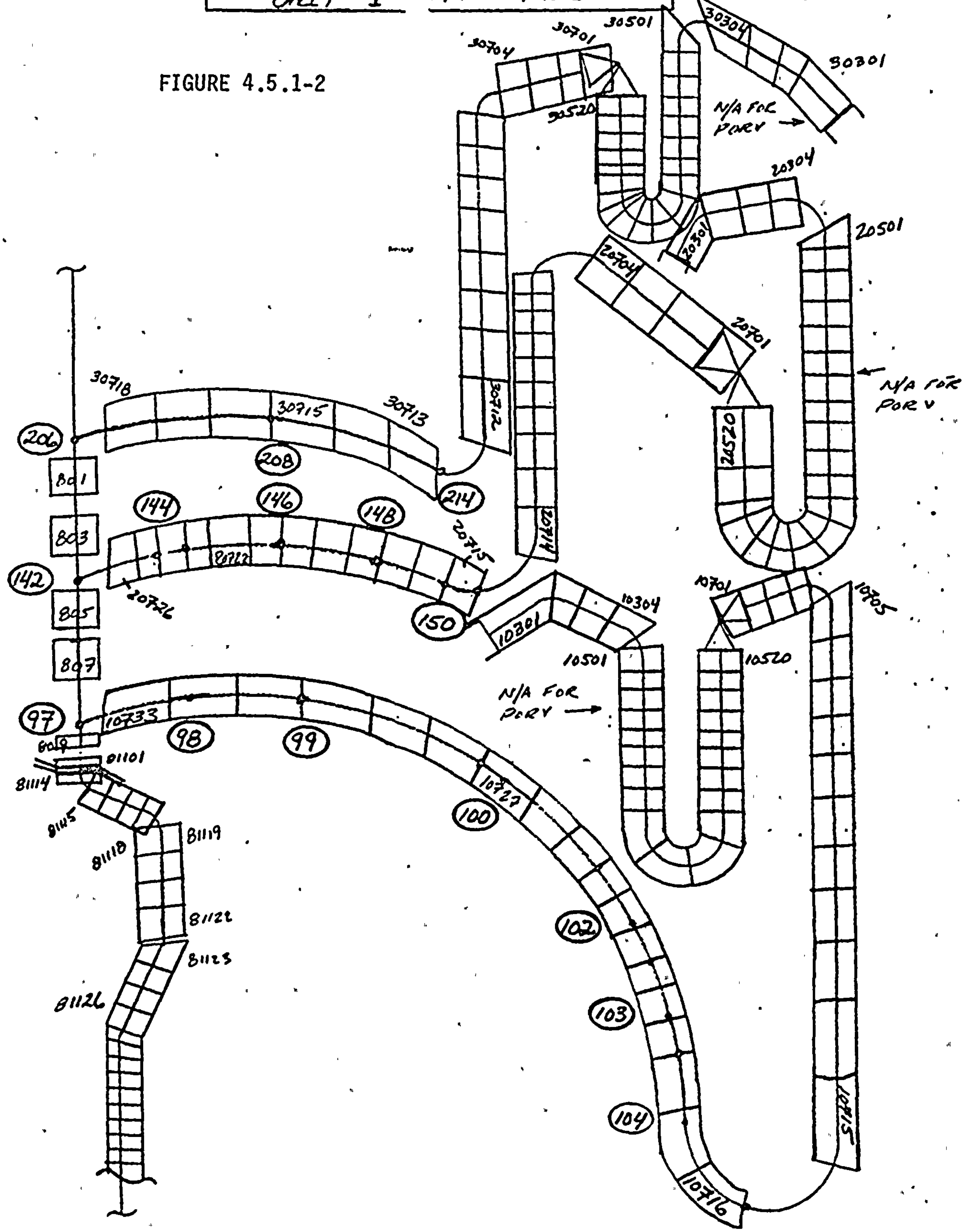


BY KBM DATE 4.14.83
CHKD. BY CHH DATE 5-23-83

RELAP MODEL SCHEMATIC
UNIT 1 MAIN ARCS

SHEET NO. 2 OF 3
PROJ. NO. 5364

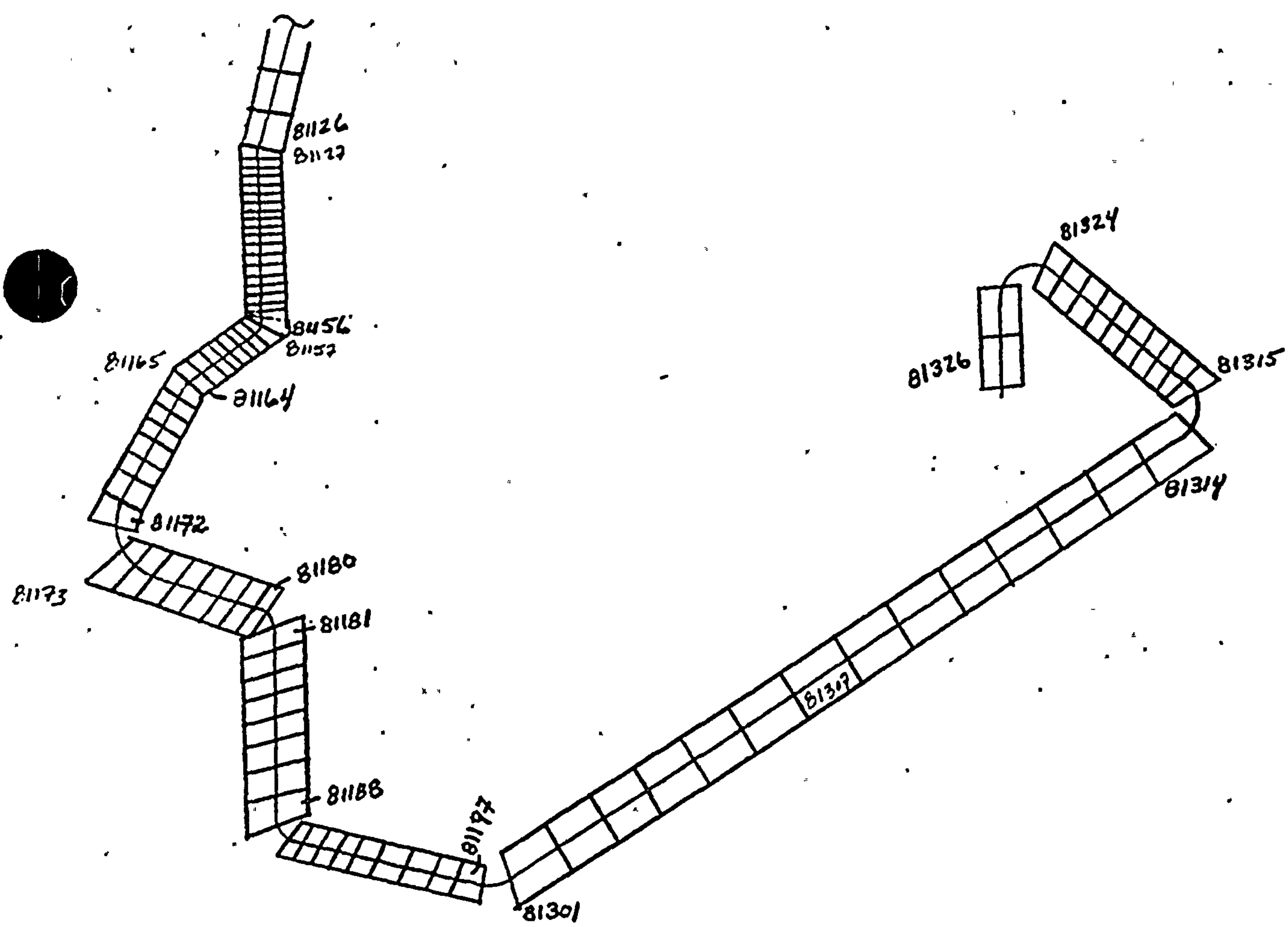
FIGURE 4.5.1-2

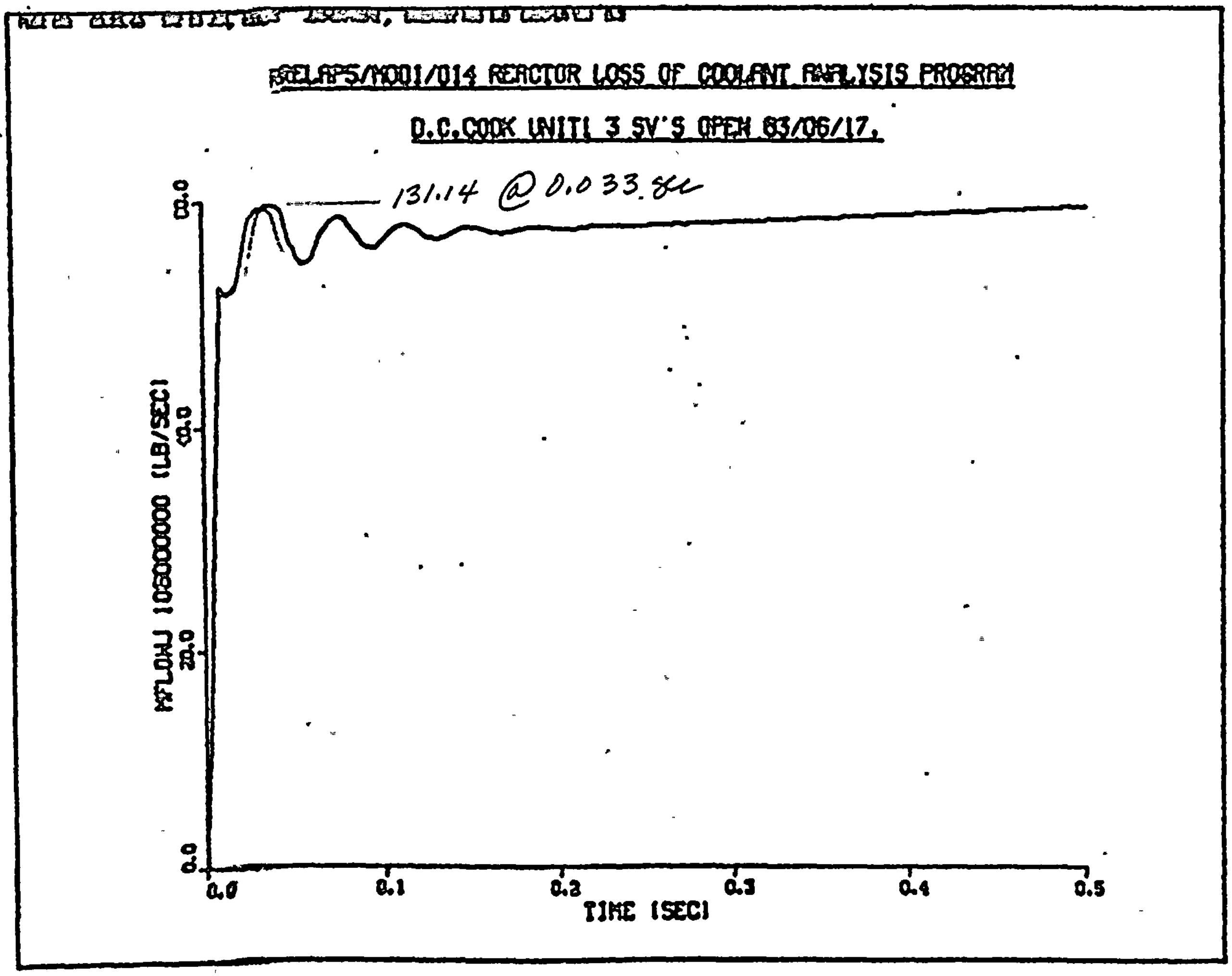


TELEDYNE ENGINEERING SERVICES

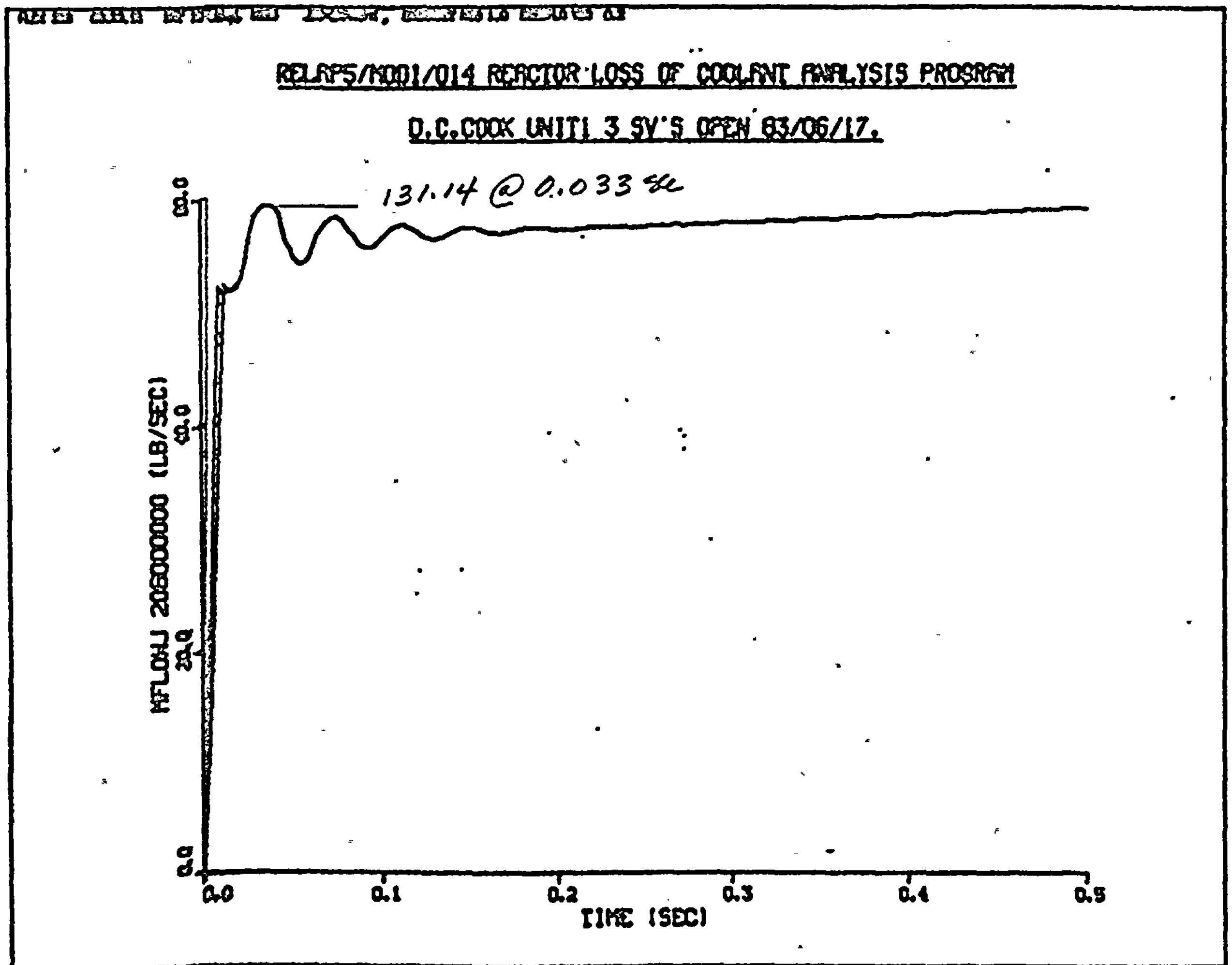
BY CAM DATE 4-14-83	RELAP MODEL SCHEMATIC UNIT 1 DOWNSTREAM (12IN)	SHEET NO. 3 OF 3
CHKD. BY CMH DATE 5-25-83		PROJ. NO. 5364

FIGURE 4.5.1-3





BY KJG DATE 6-21-83
CHKD. BY CWH DATE 6-29-83



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TELEDYNE
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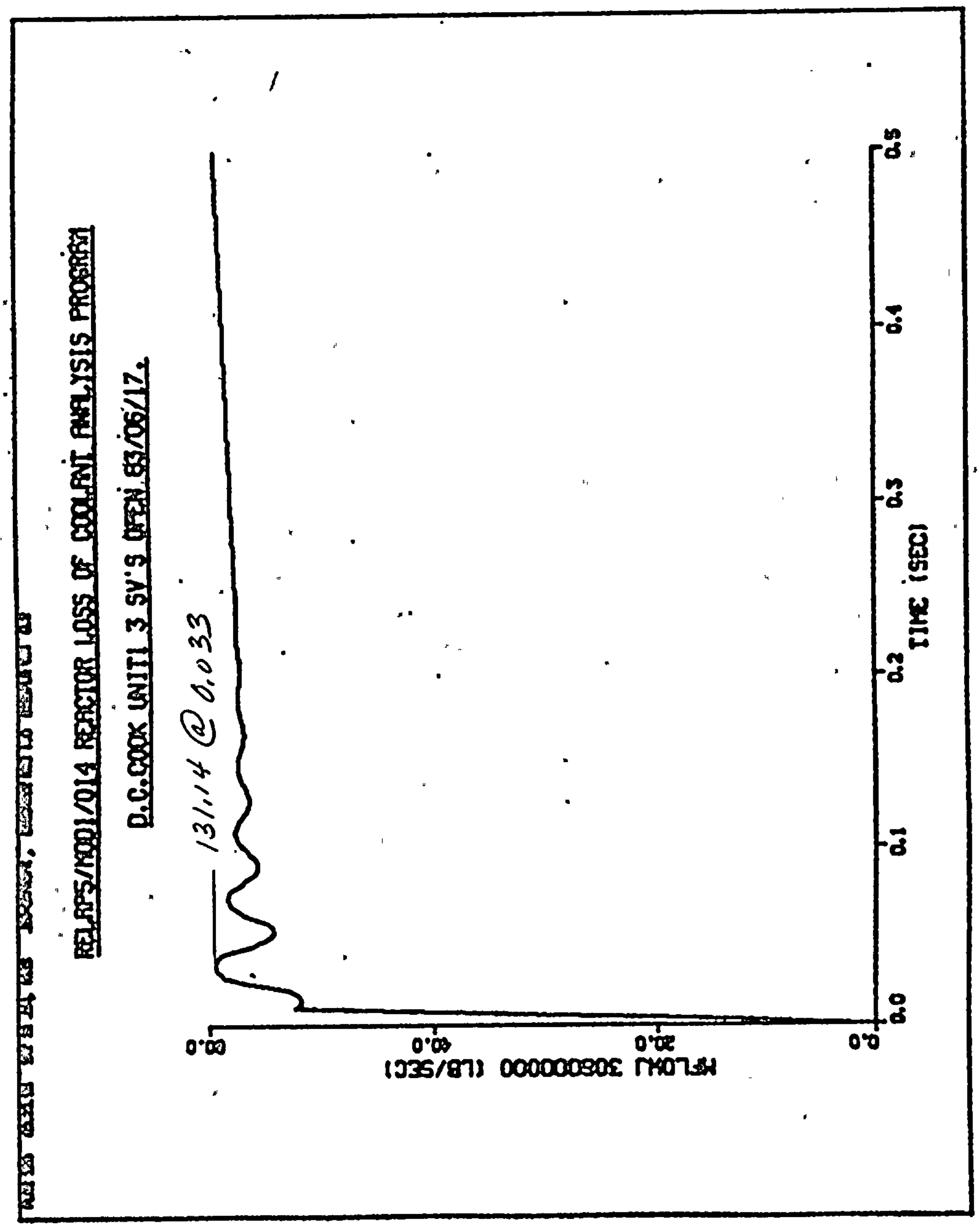
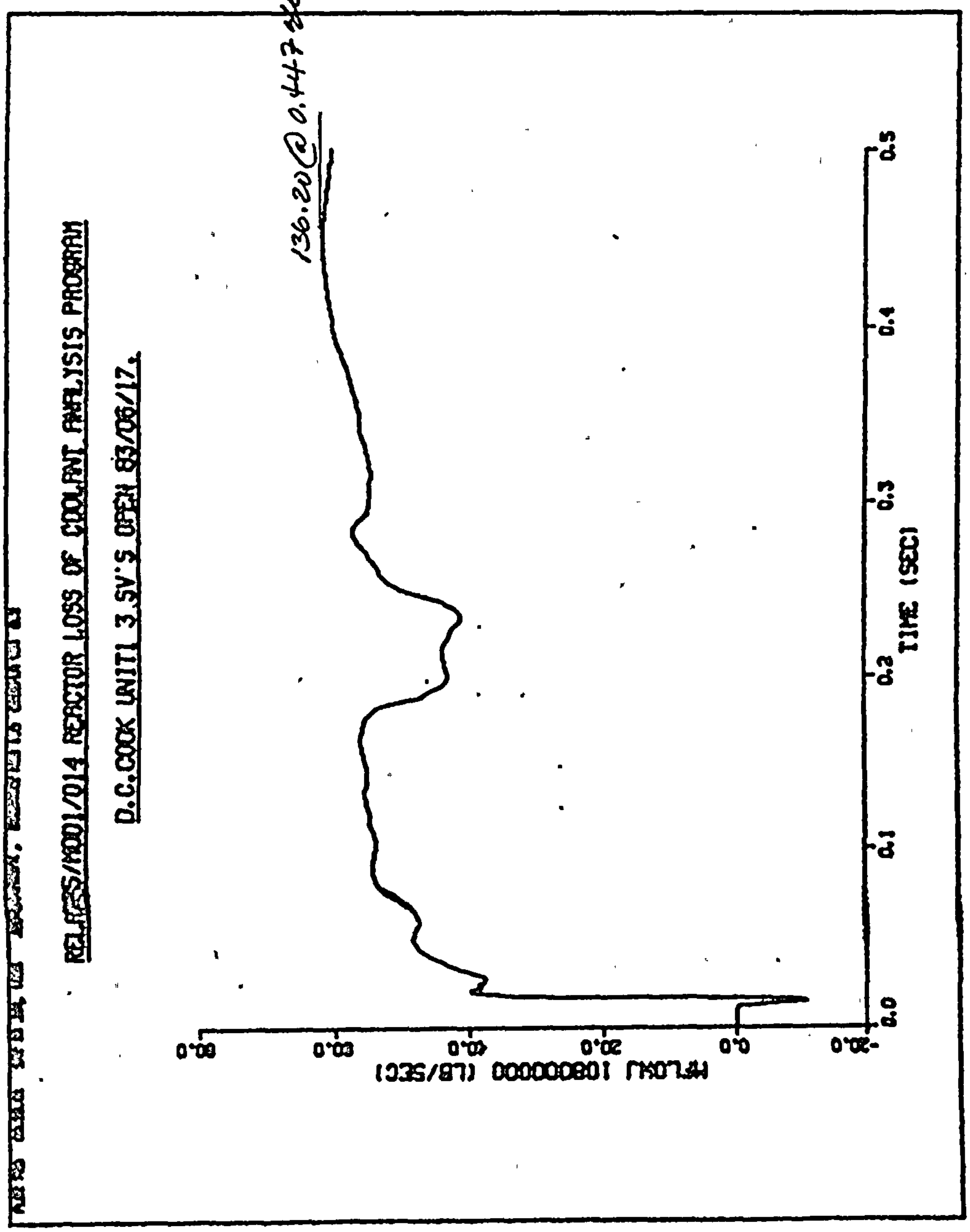
CHKD. BY CWH DATE 6-29-83

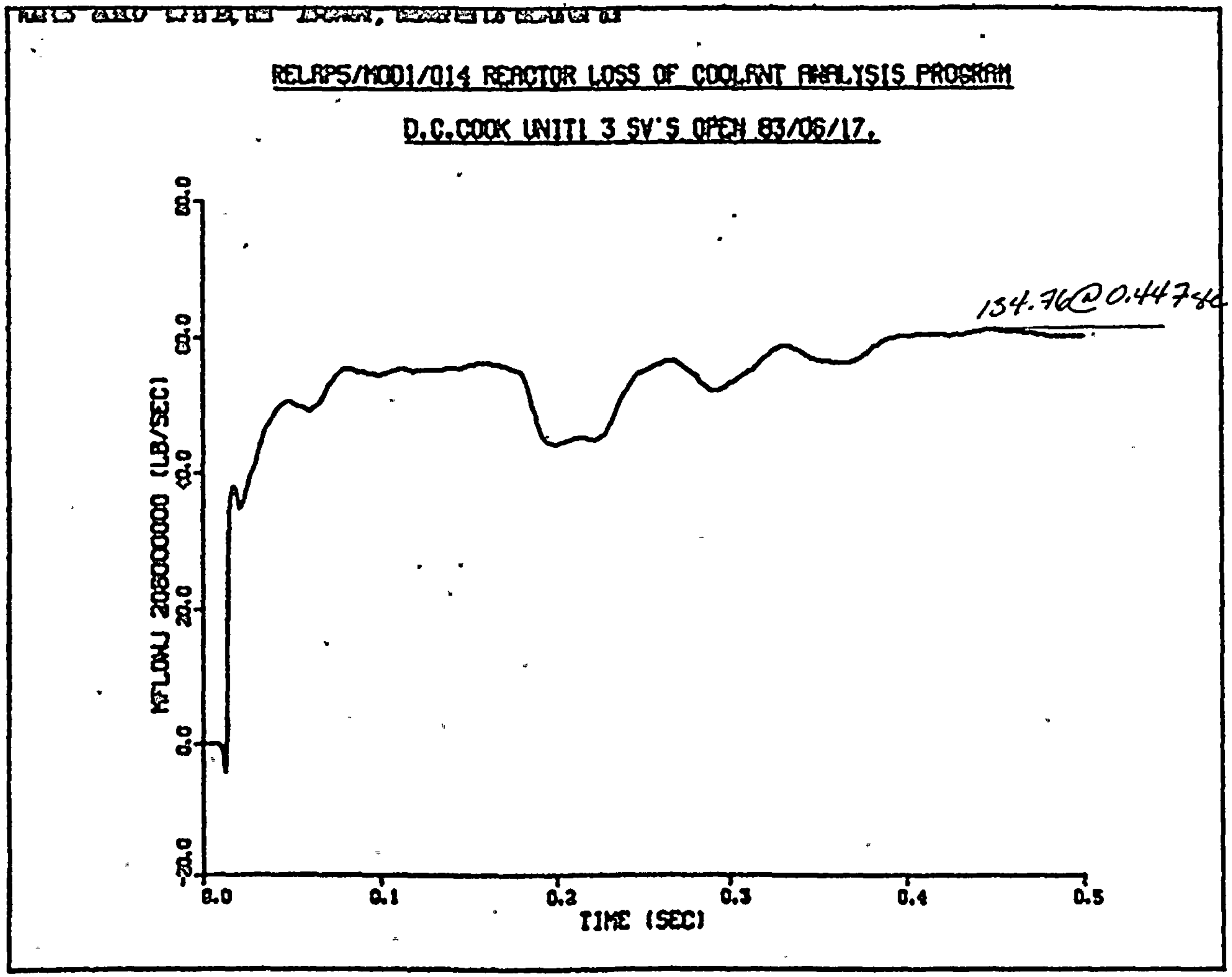
TELEDYNE
ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CMM DATE 6-29-83



BY KJG DATE 6-21-83
CHKD. BY CMM DATE 6-29-83



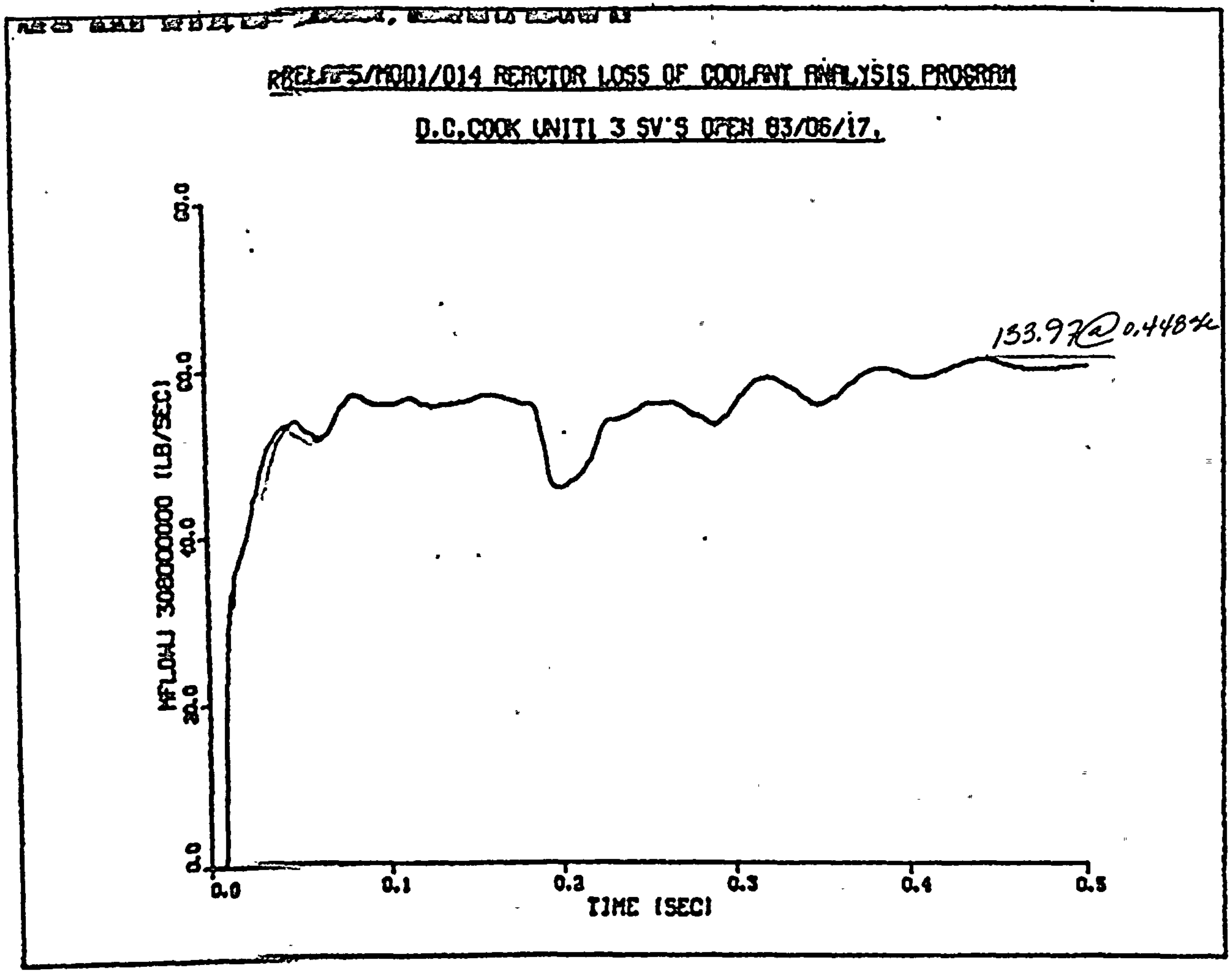


TELEDYNE ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CWH DATE 6-29-83

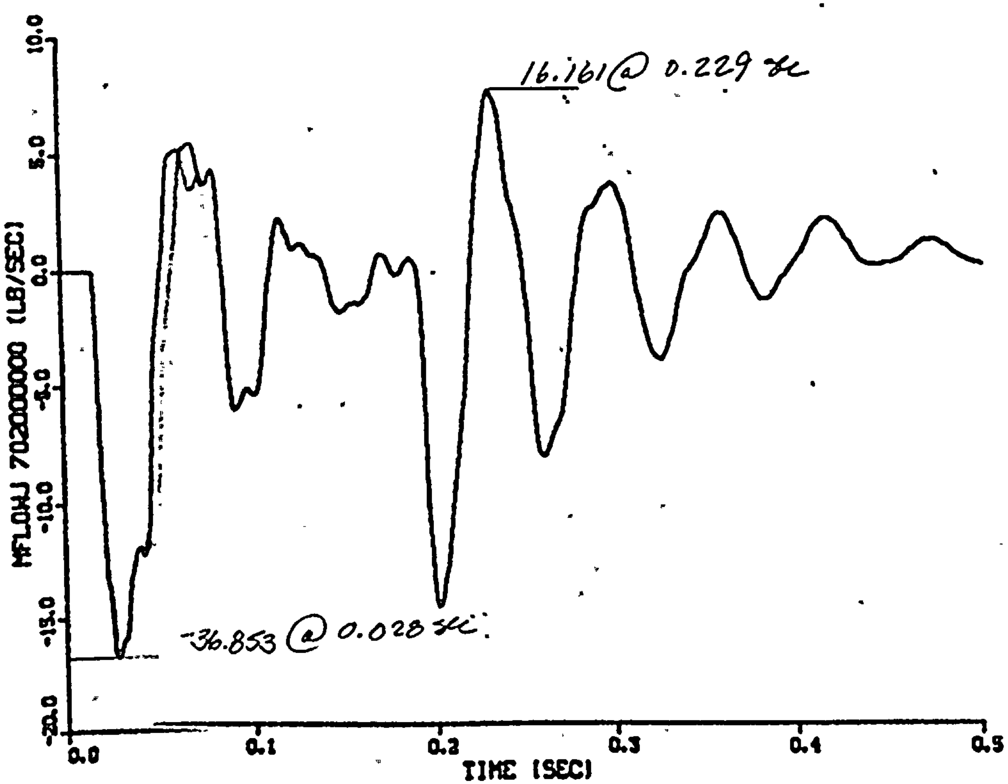
TELEDYNE
ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CWH DATE 6-29-83



RELAP5/MOD1/014 REACTOR LOSS OF COOLANT ANALYSIS PROGRAM

D.C.COOK UNIT1 3 SV'S OPEN.83/06/17.



TELEDYNE ENGINEERING SERVICES

BY KJG DATE 6-21-83
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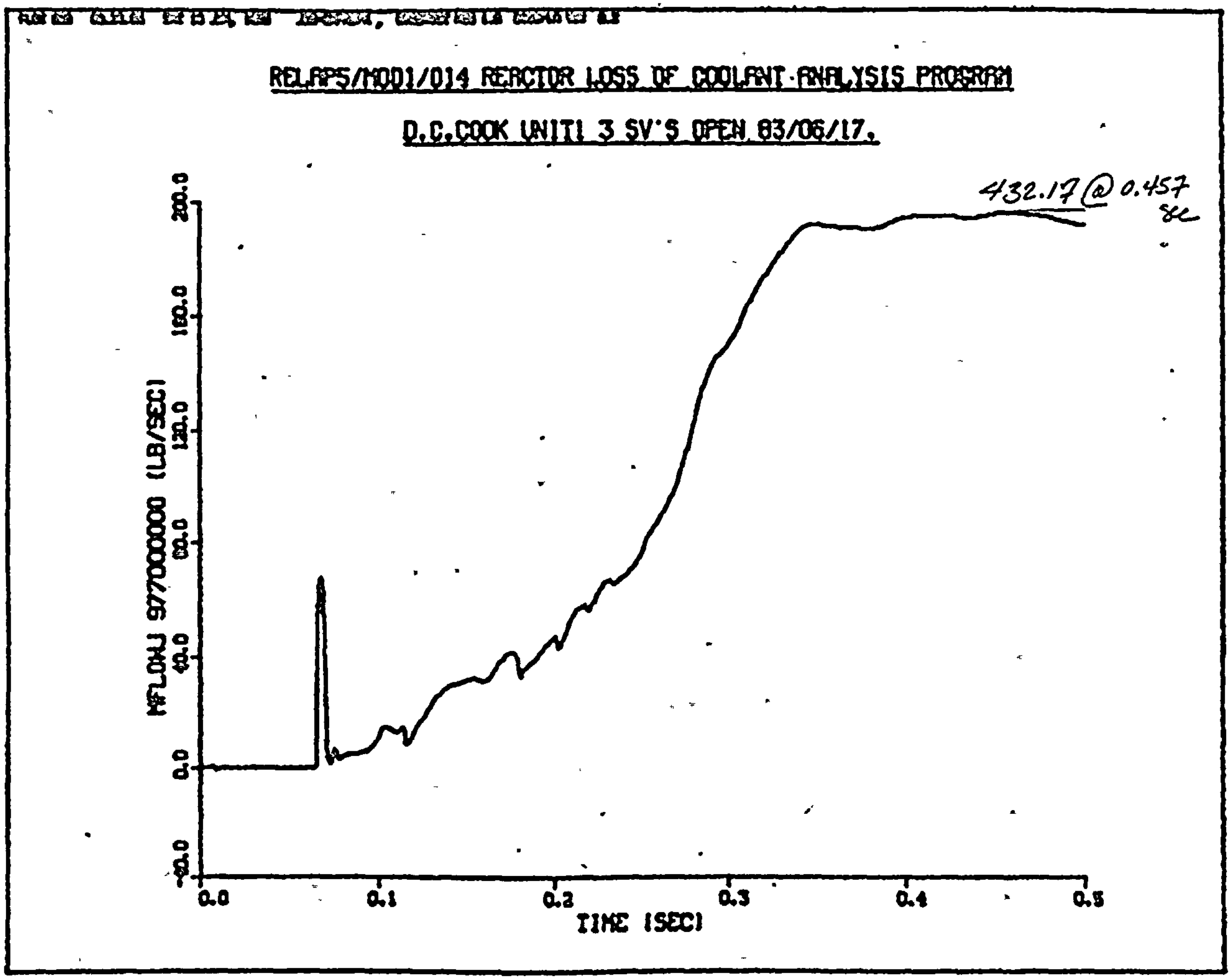
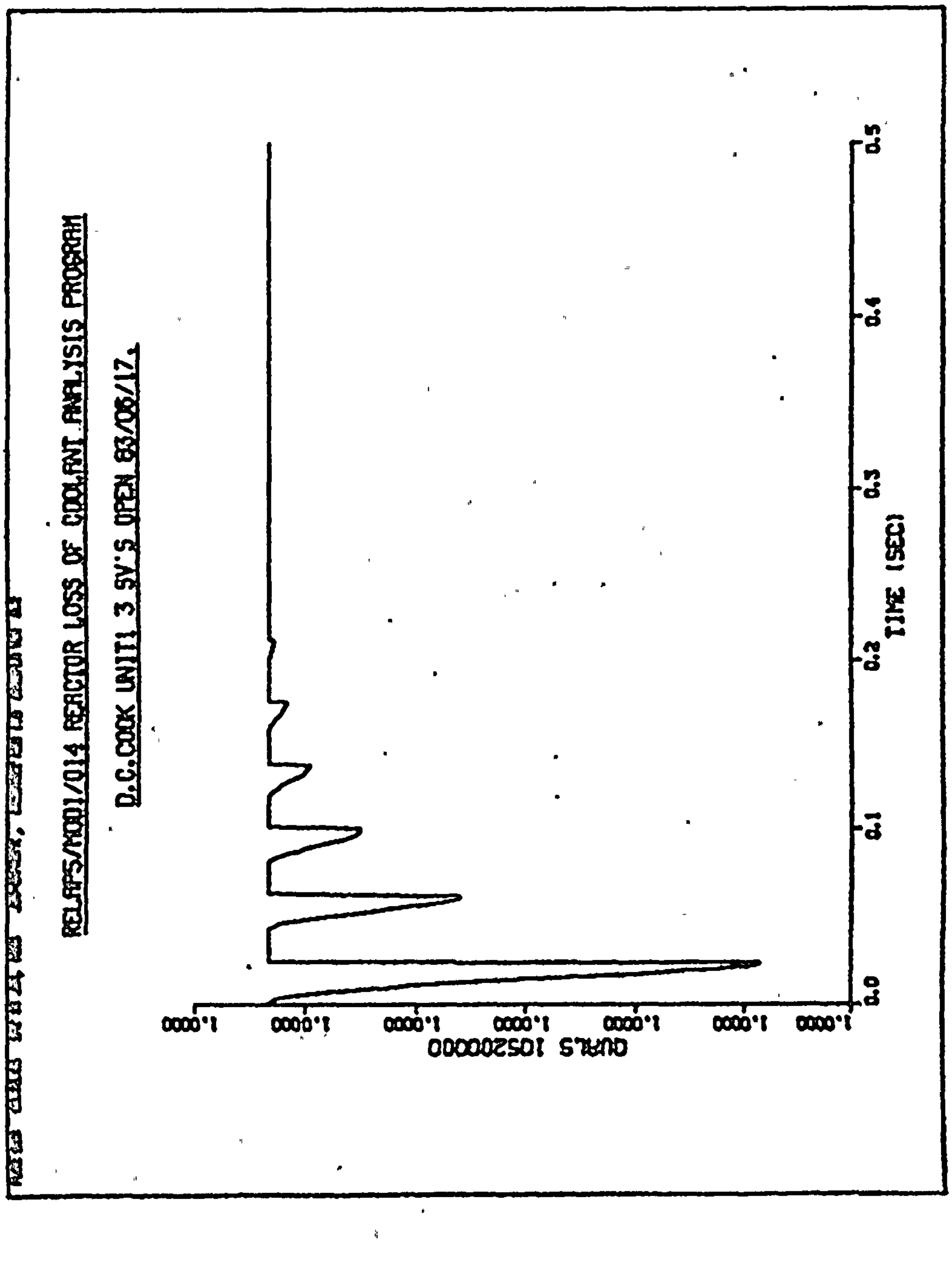


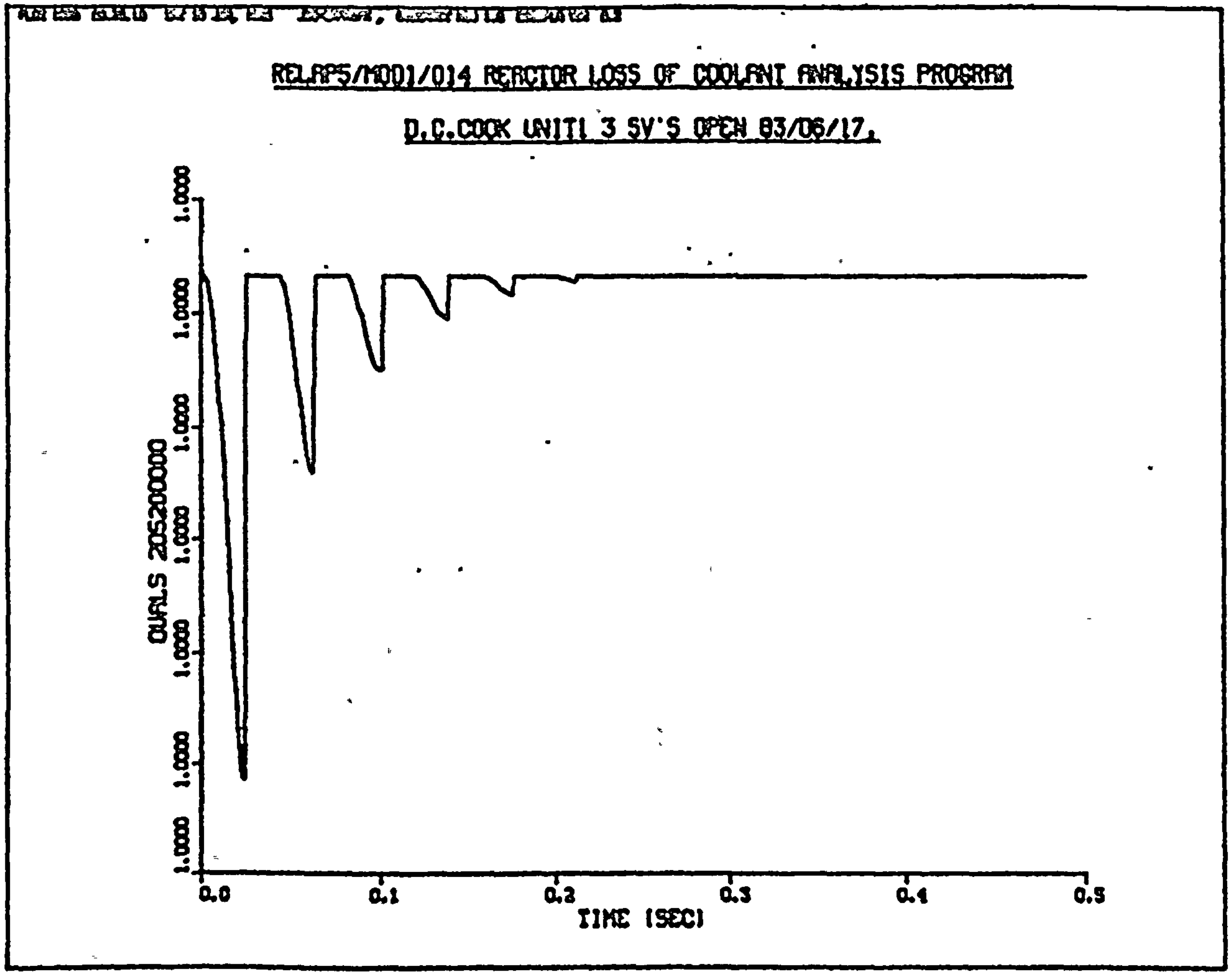
TELEDYNE ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CWH DATE 6-29-83

TELEDYNE ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CMM DATE 6-29-83





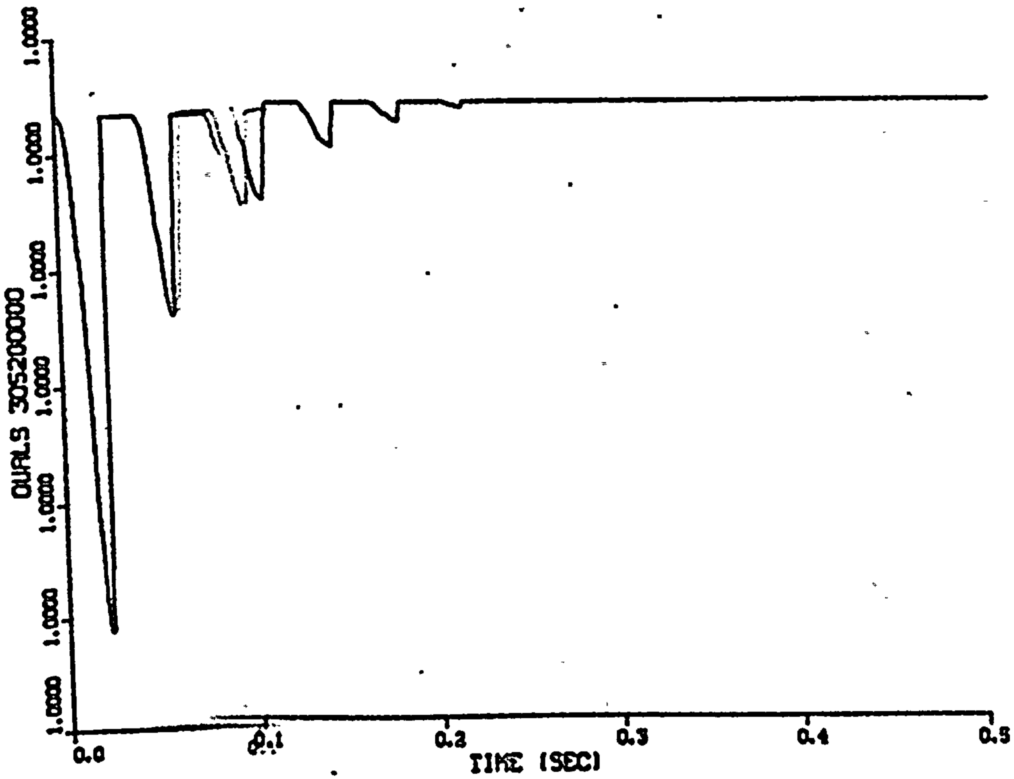
TELEDYNE ENGINEERING SERVICES

BY KJG DATE 6-21-83

CHKD. BY [signature] DATE 6-29-83

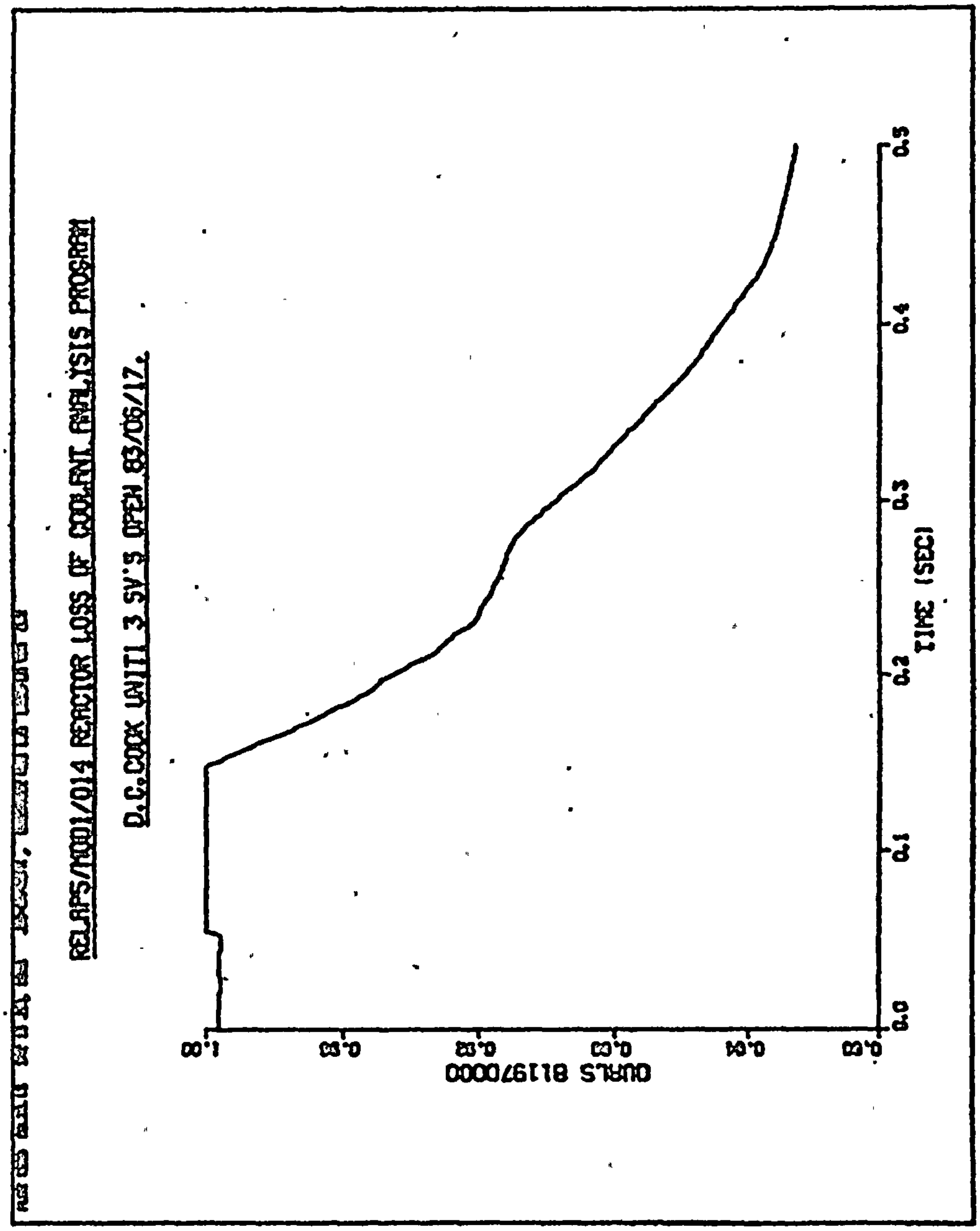
RELAP5/MOD1/014 REACTOR LOSS OF COOLANT ANALYSIS PROGRAM

D.C.COOK UNIT1 3 SV'S OPEN 83/06/17.



TELEDYNE
ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CMM DATE 6-29-83



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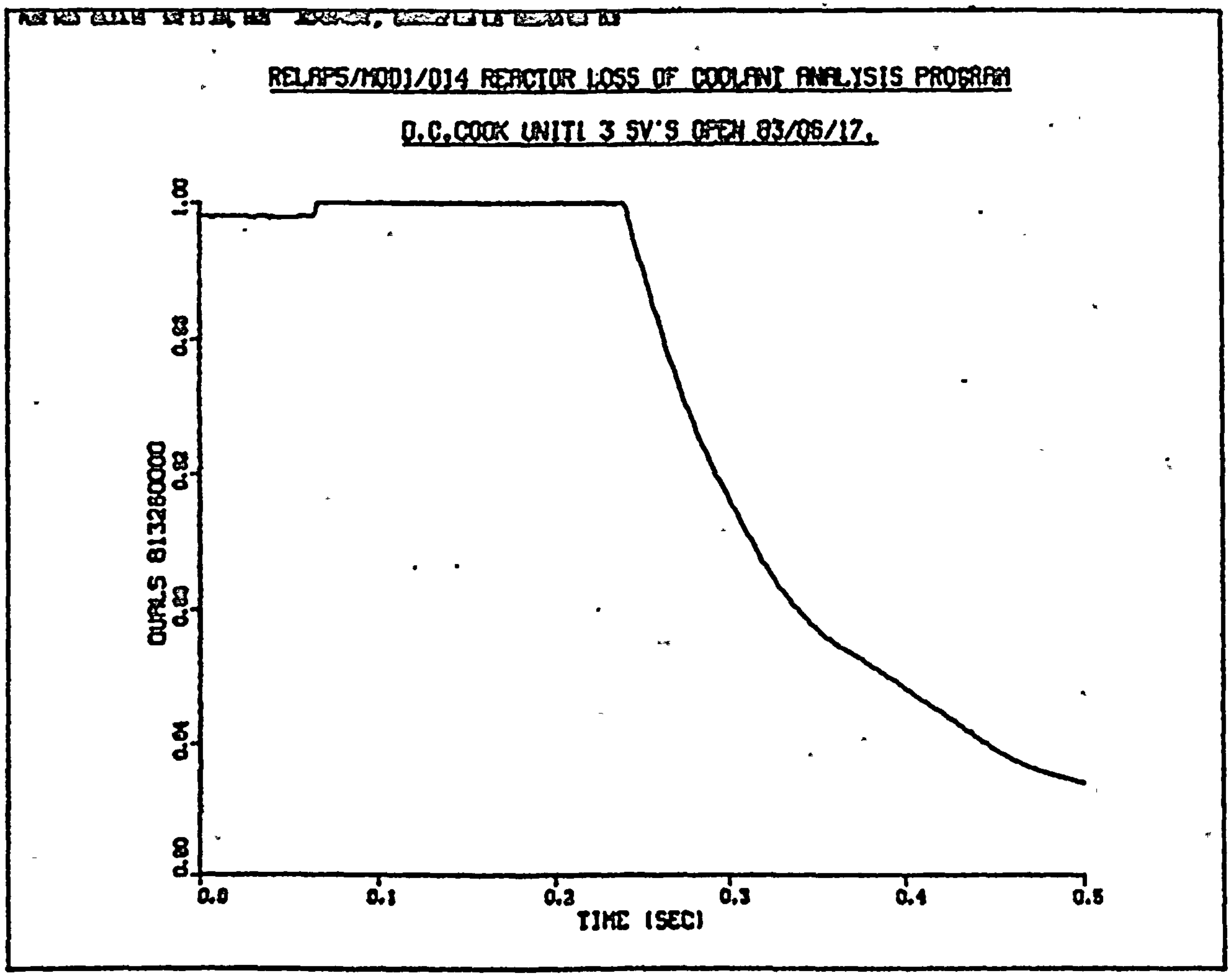

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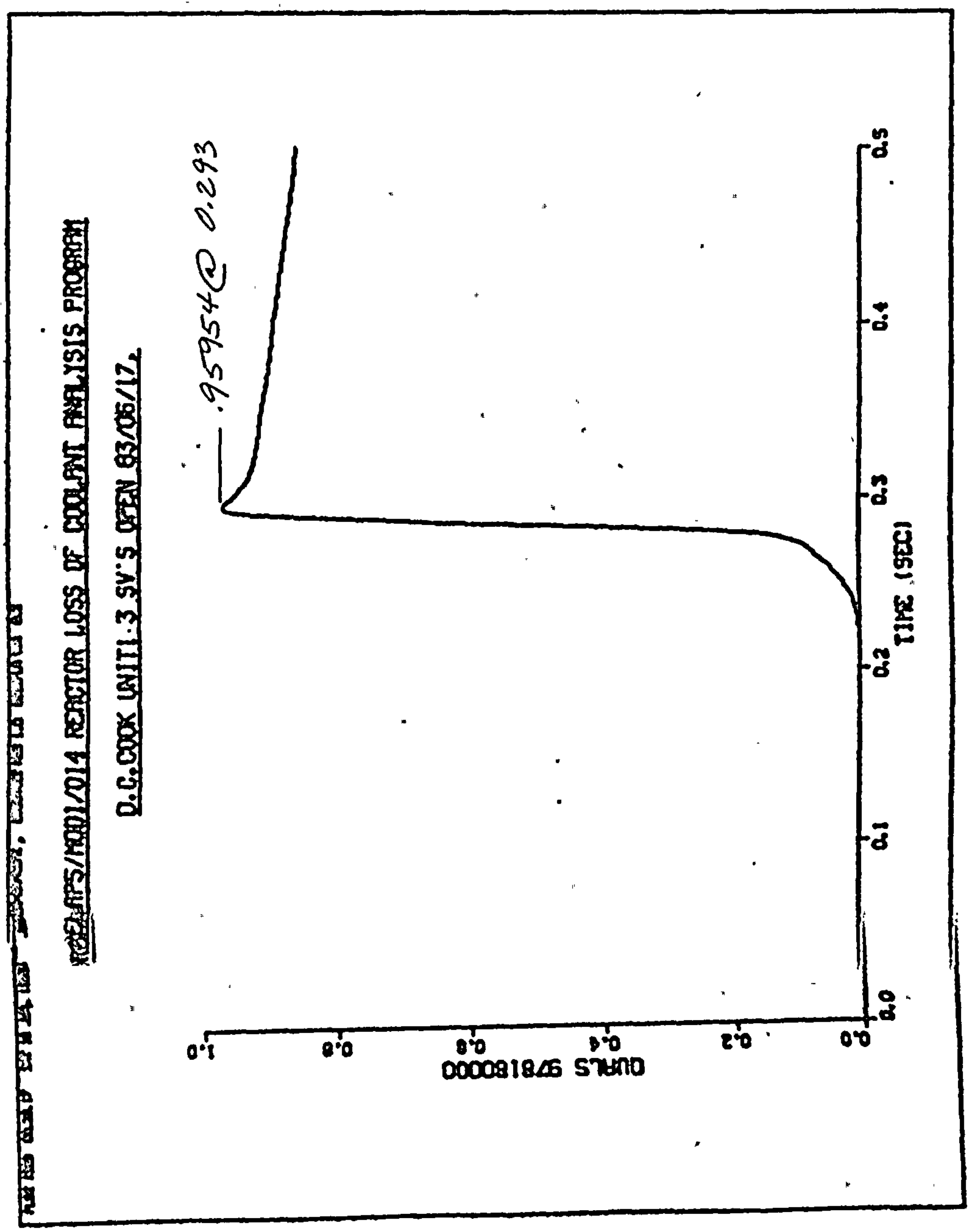

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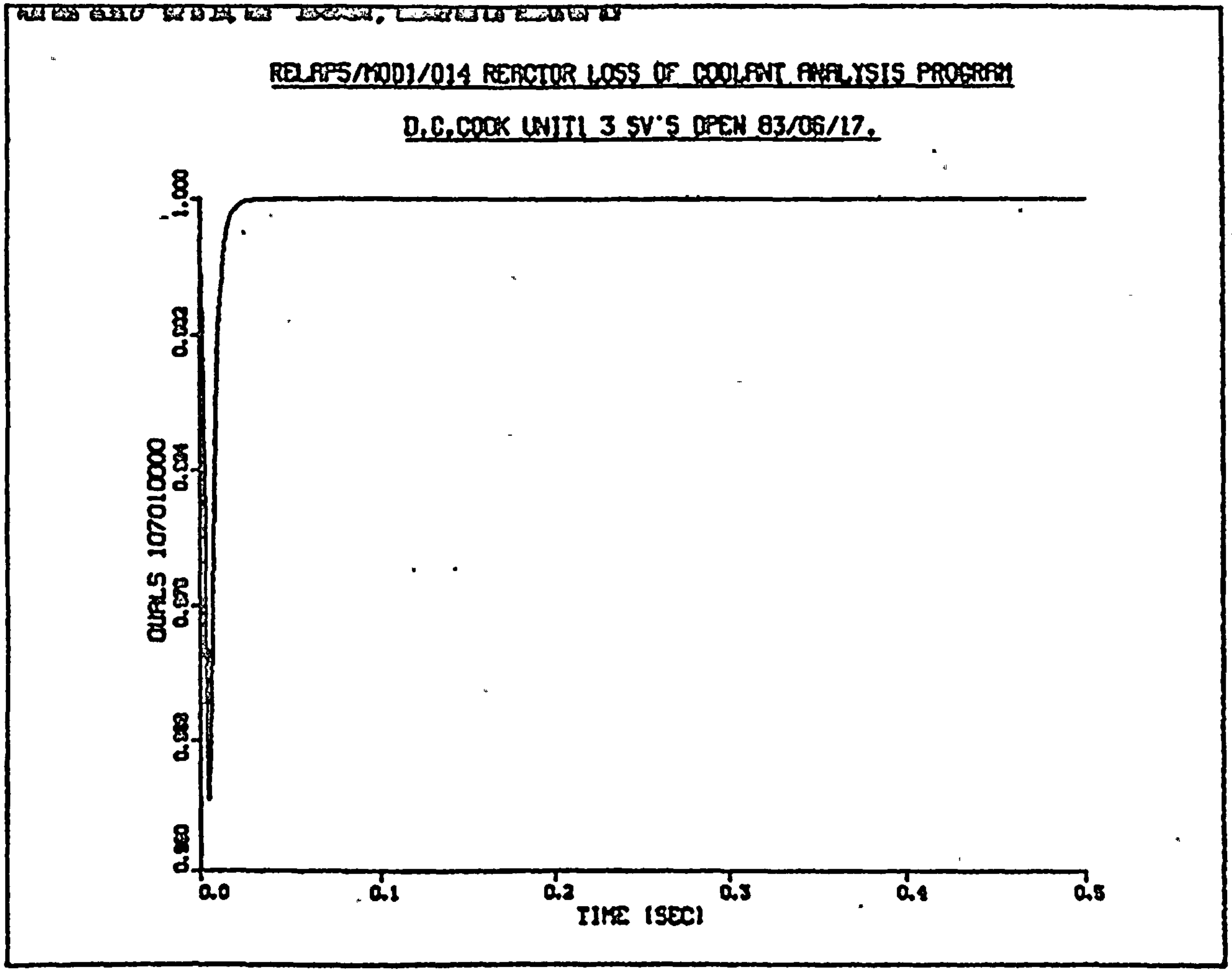

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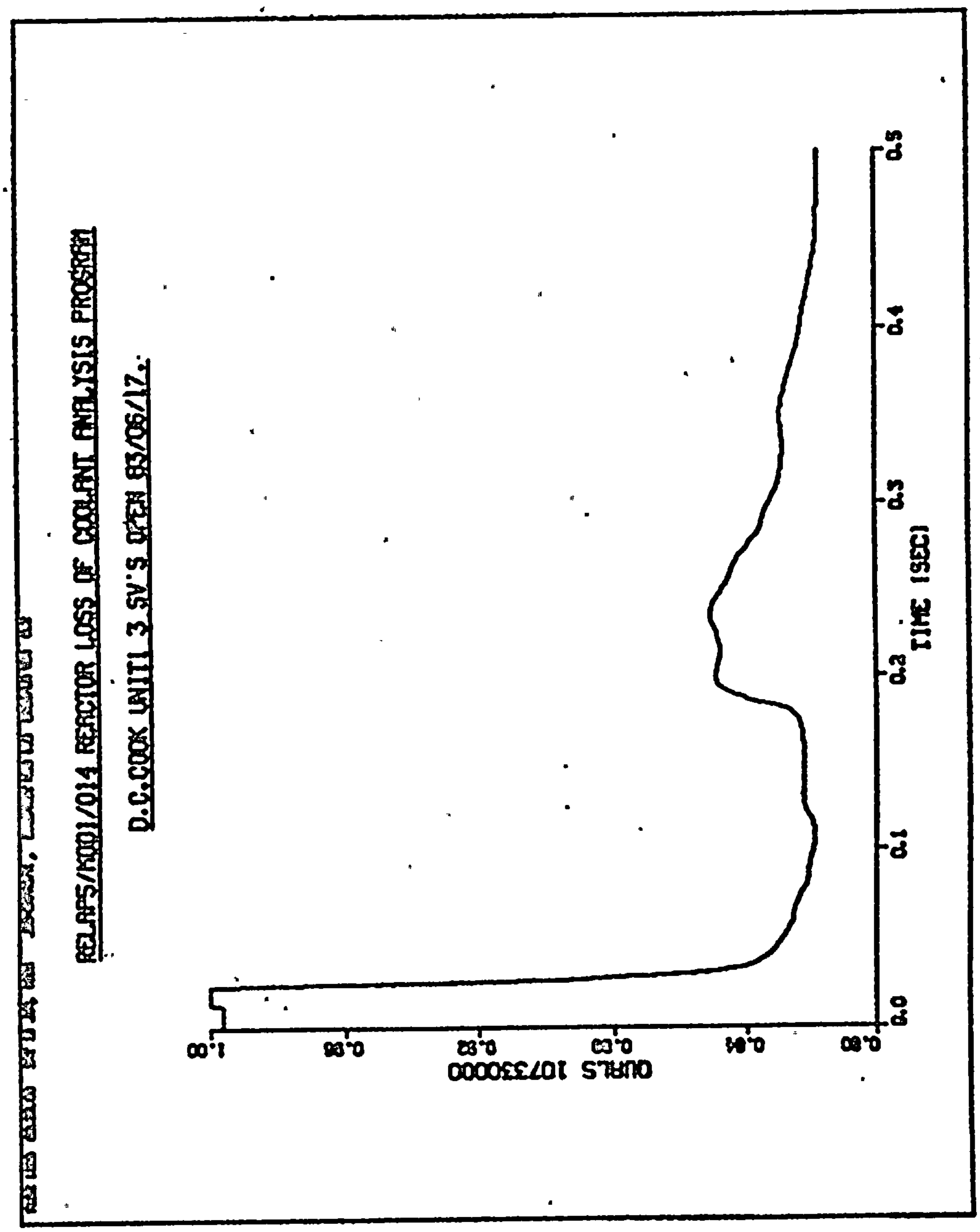
CHKD. BY CMM DATE 6-29-83



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BY KJG DATE 6-21-83
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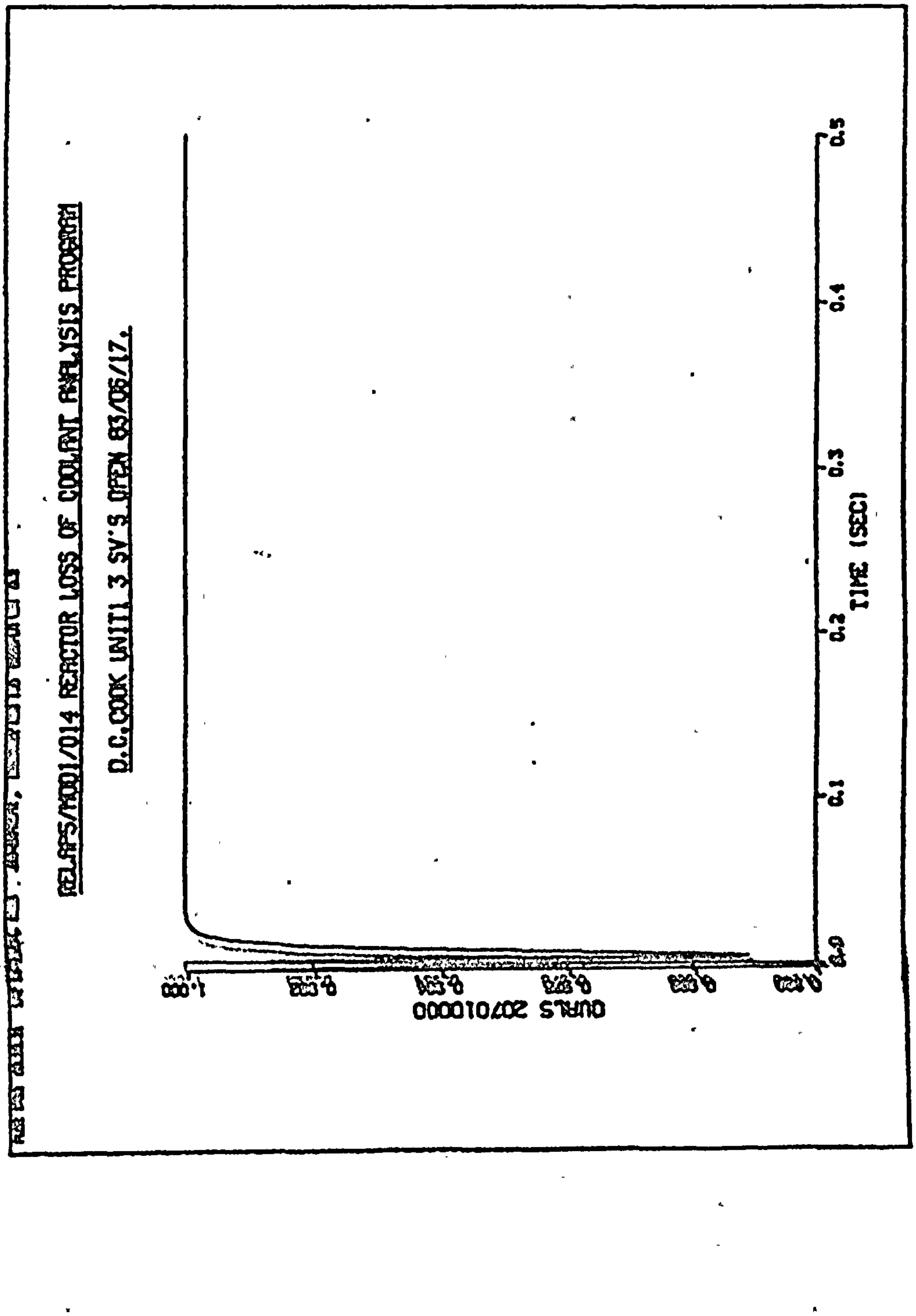
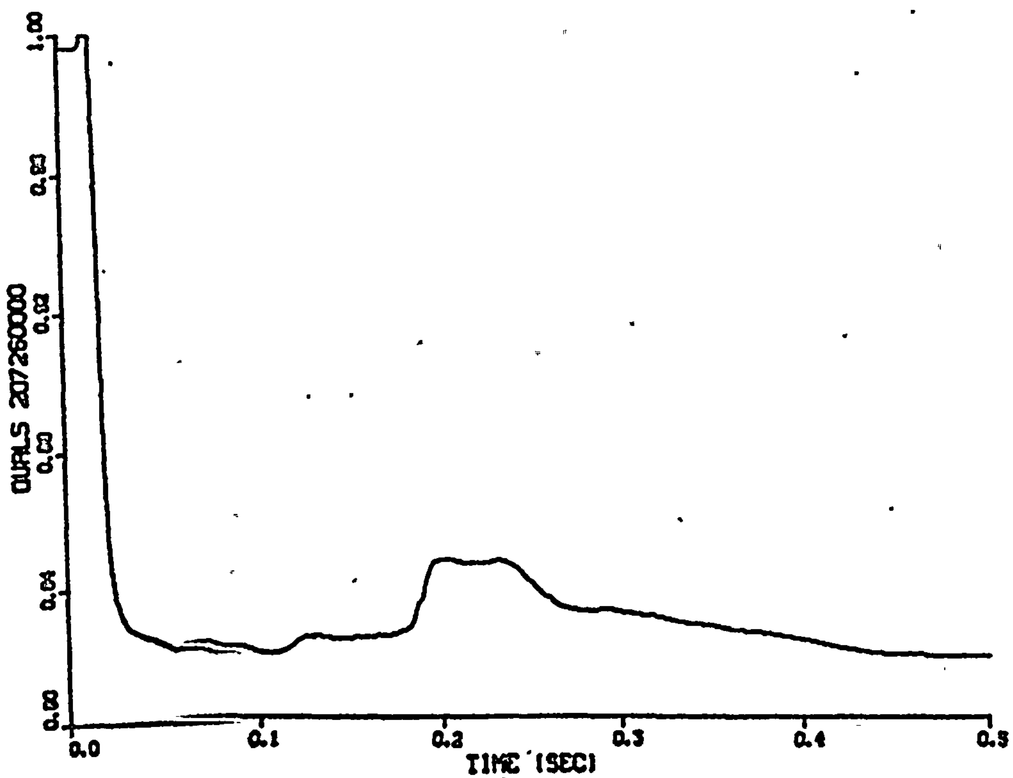


RELAP5/MOD1/014 REACTOR LOSS OF COOLANT ANALYSIS PROGRAM

D.C.COOK UNIT1 3 SV'S OPEN 83/06/17.



TELEDYNE ENGINEERING SERVICES

BY KJG DATE 6-21-83
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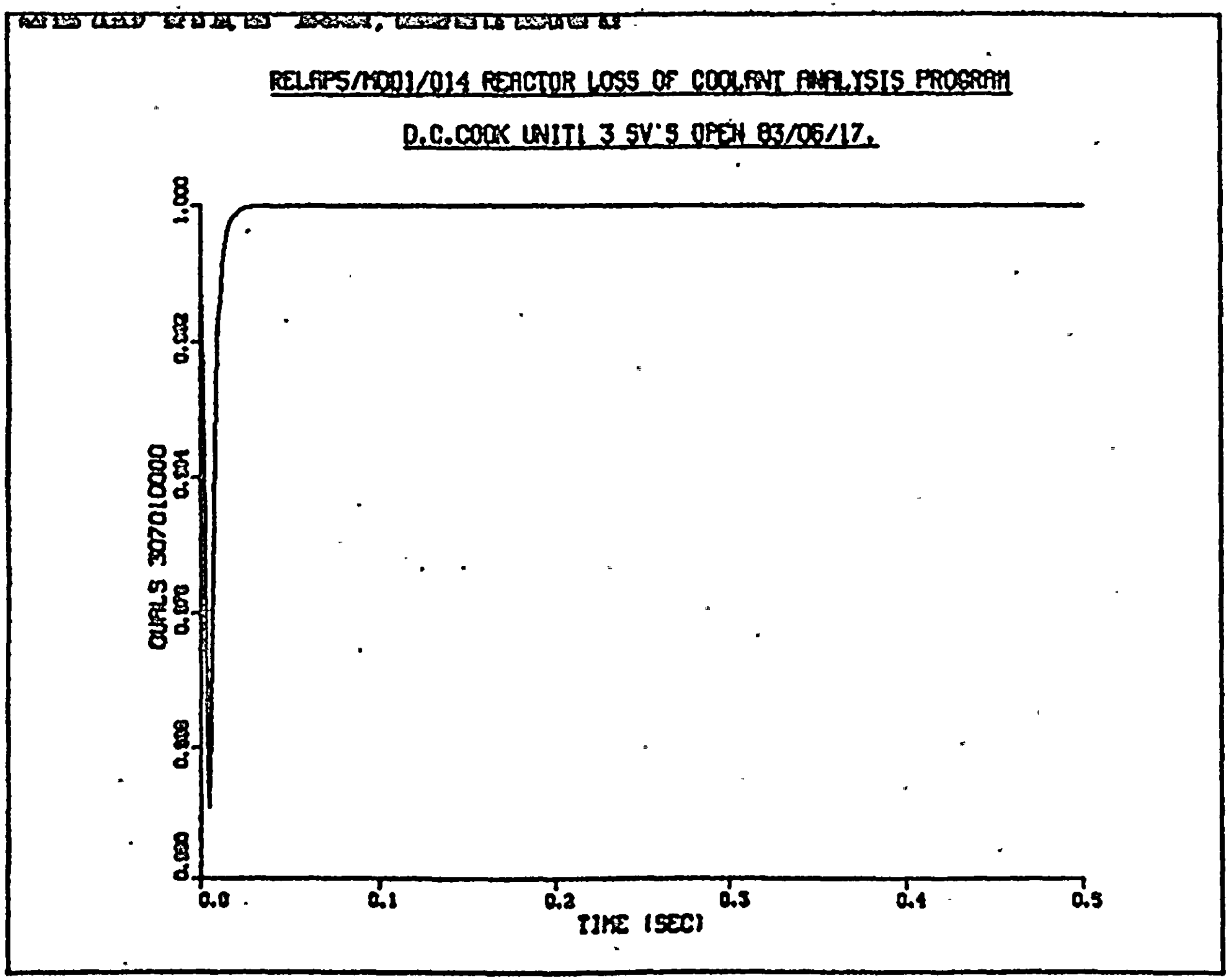


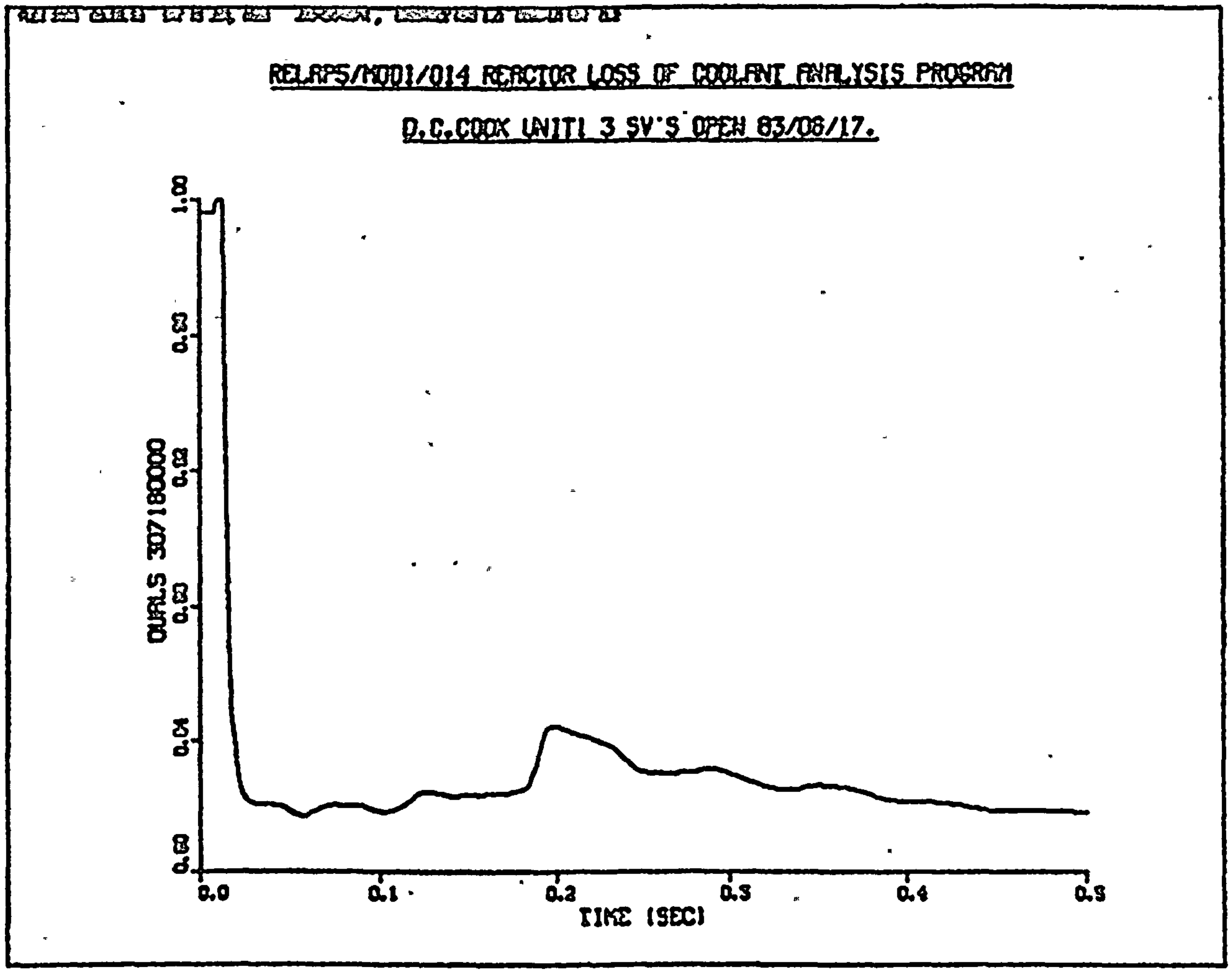
TELEDYNE
ENGINEERING SERVICES

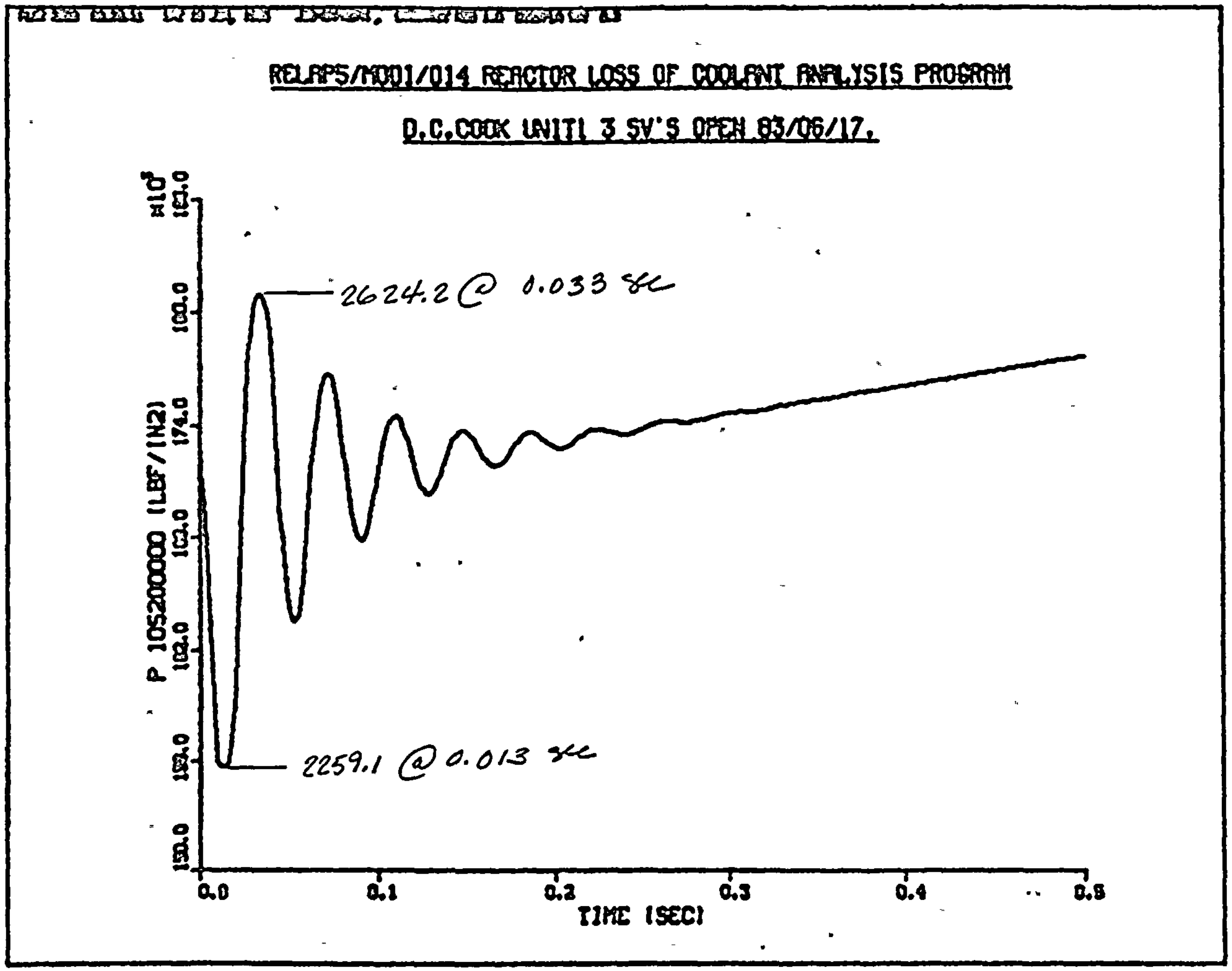
BY KJG DATE 6-21-83

CHKD. BY DATE 6-29-83

TELEDYNE
ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CWH DATE 6-29-83





TELEDYNE ENGINEERING SERVICES

BY KJG DATE 6-21-83

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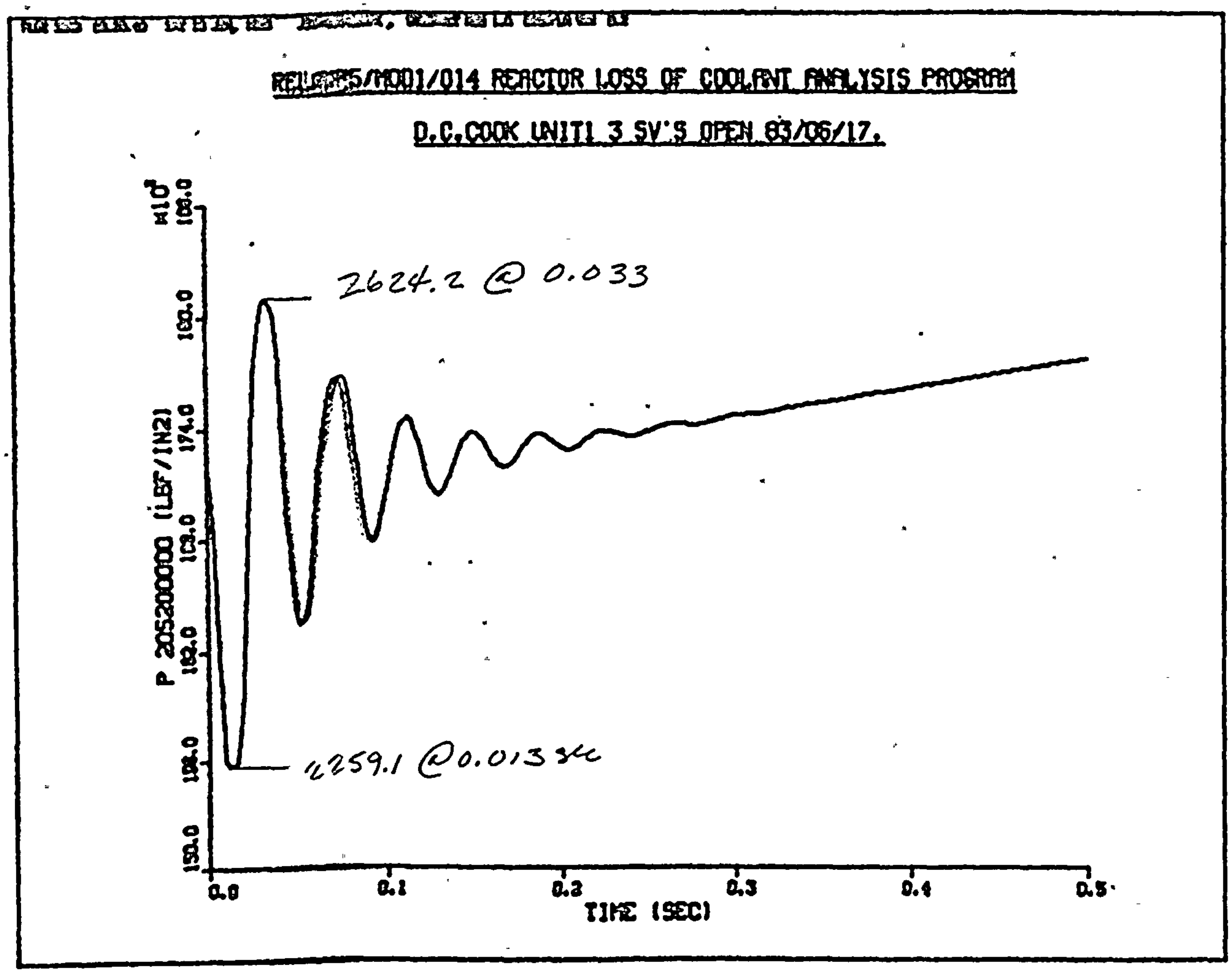

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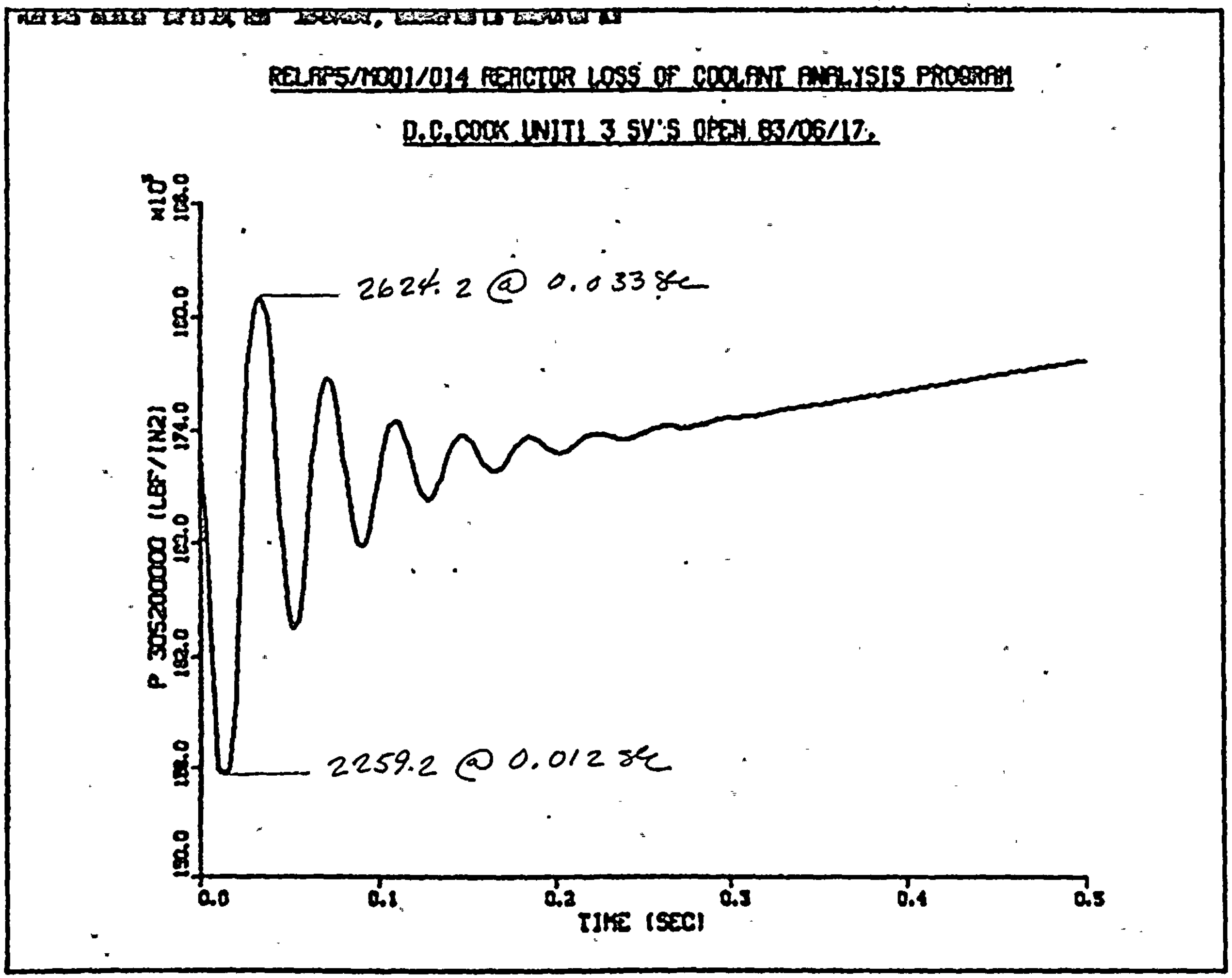
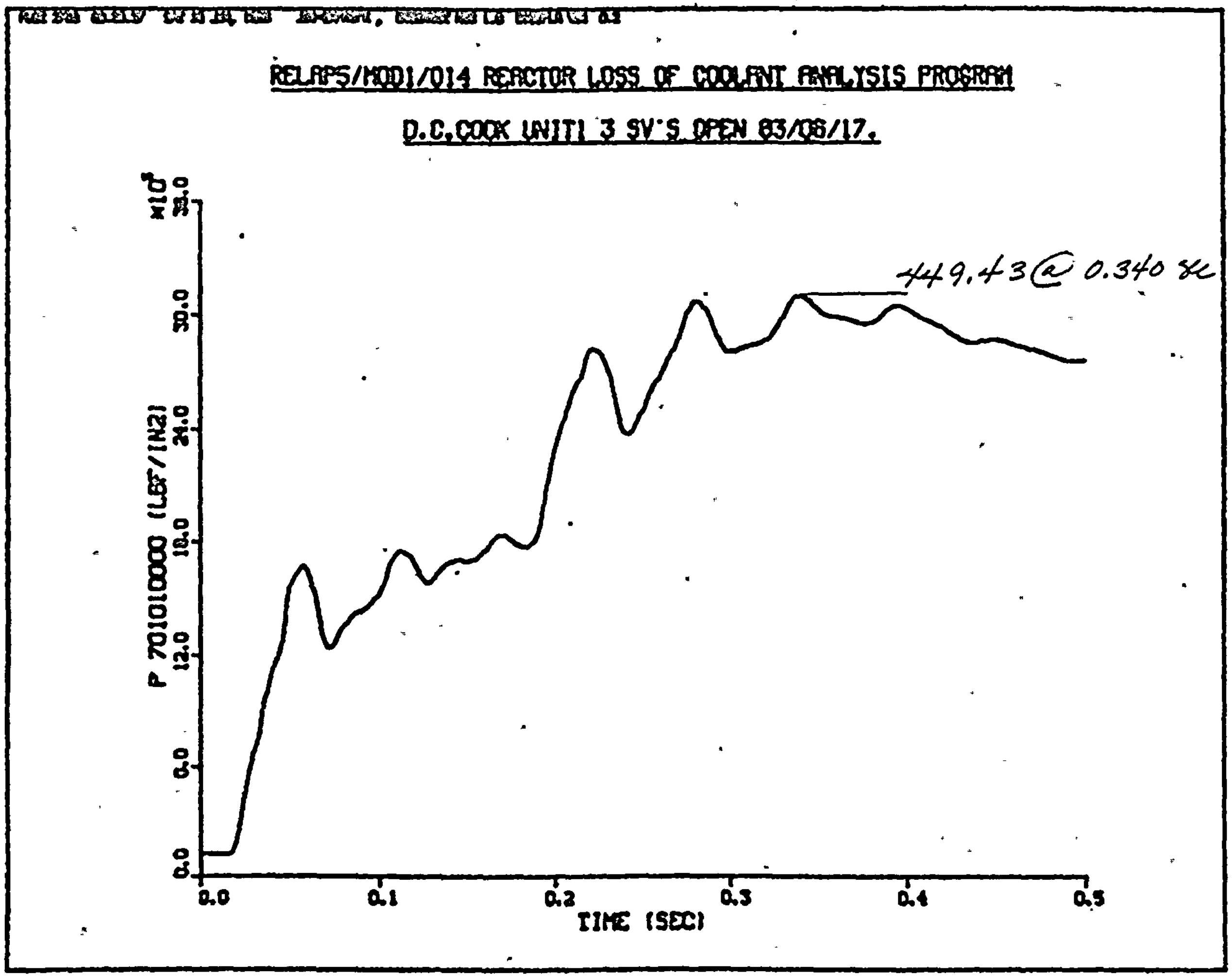


TELEDYNE ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CWY DATE 6-29-83

TELEDYNE ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CWH DATE 6-29-83



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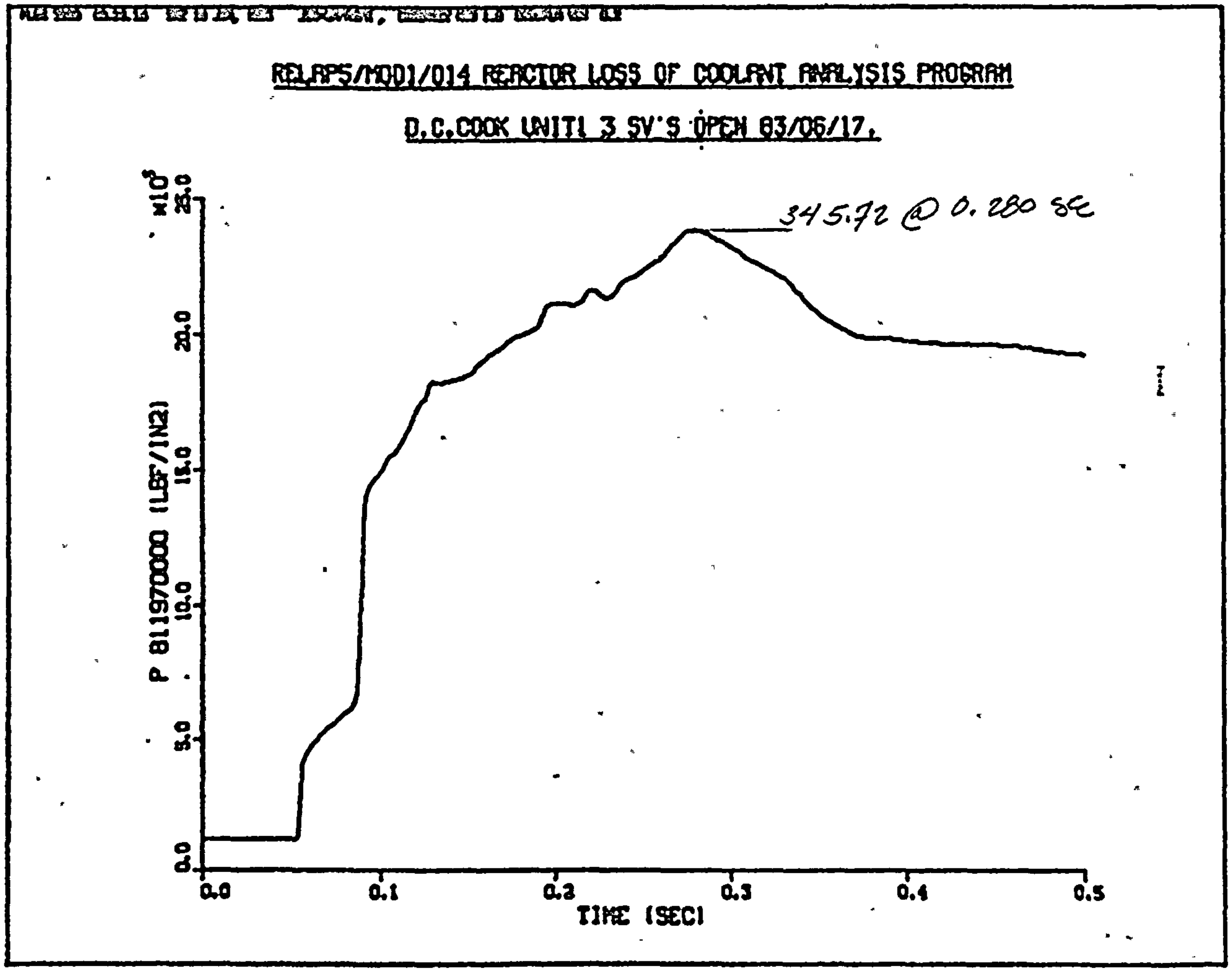
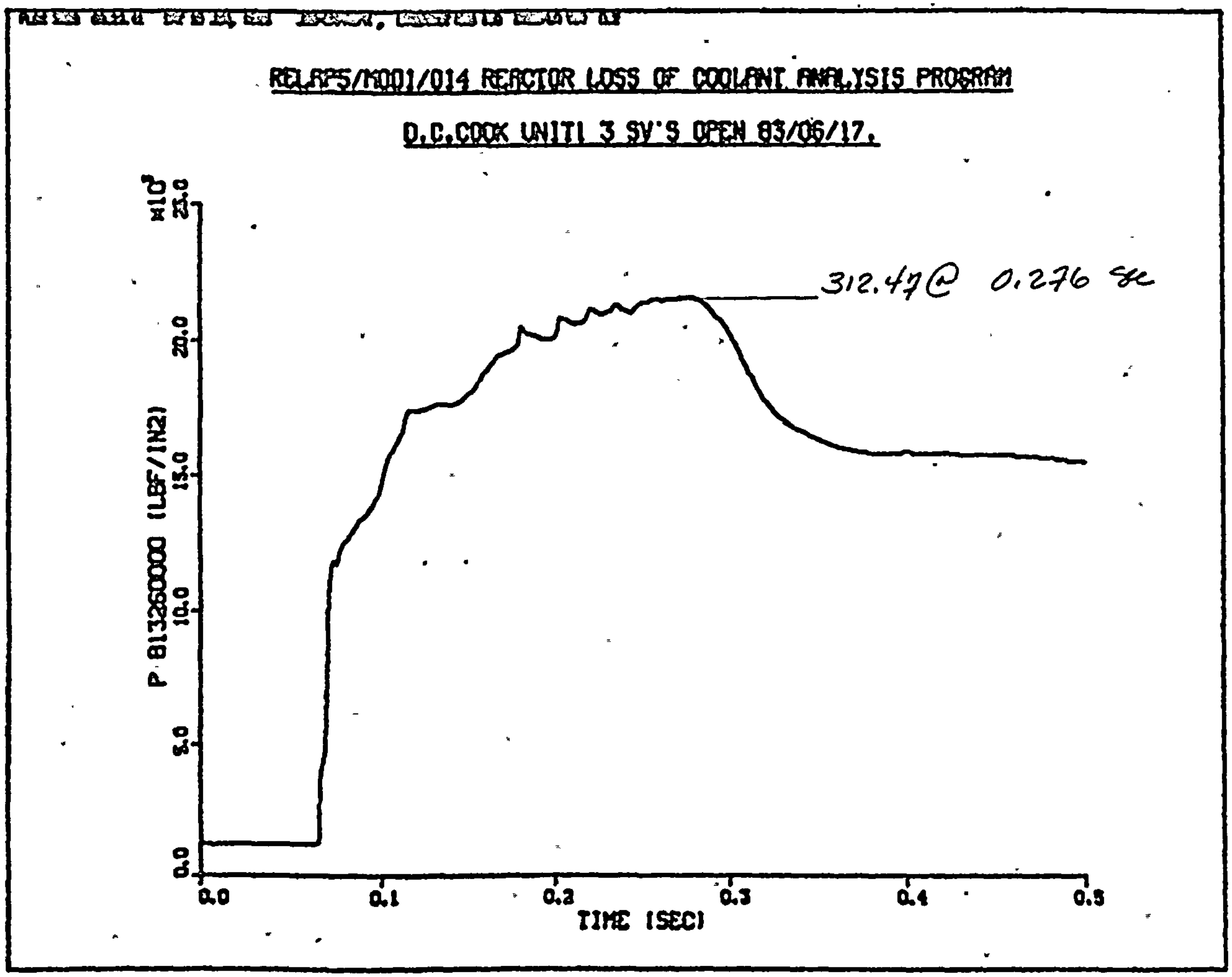
ENGINEERING SERVICES

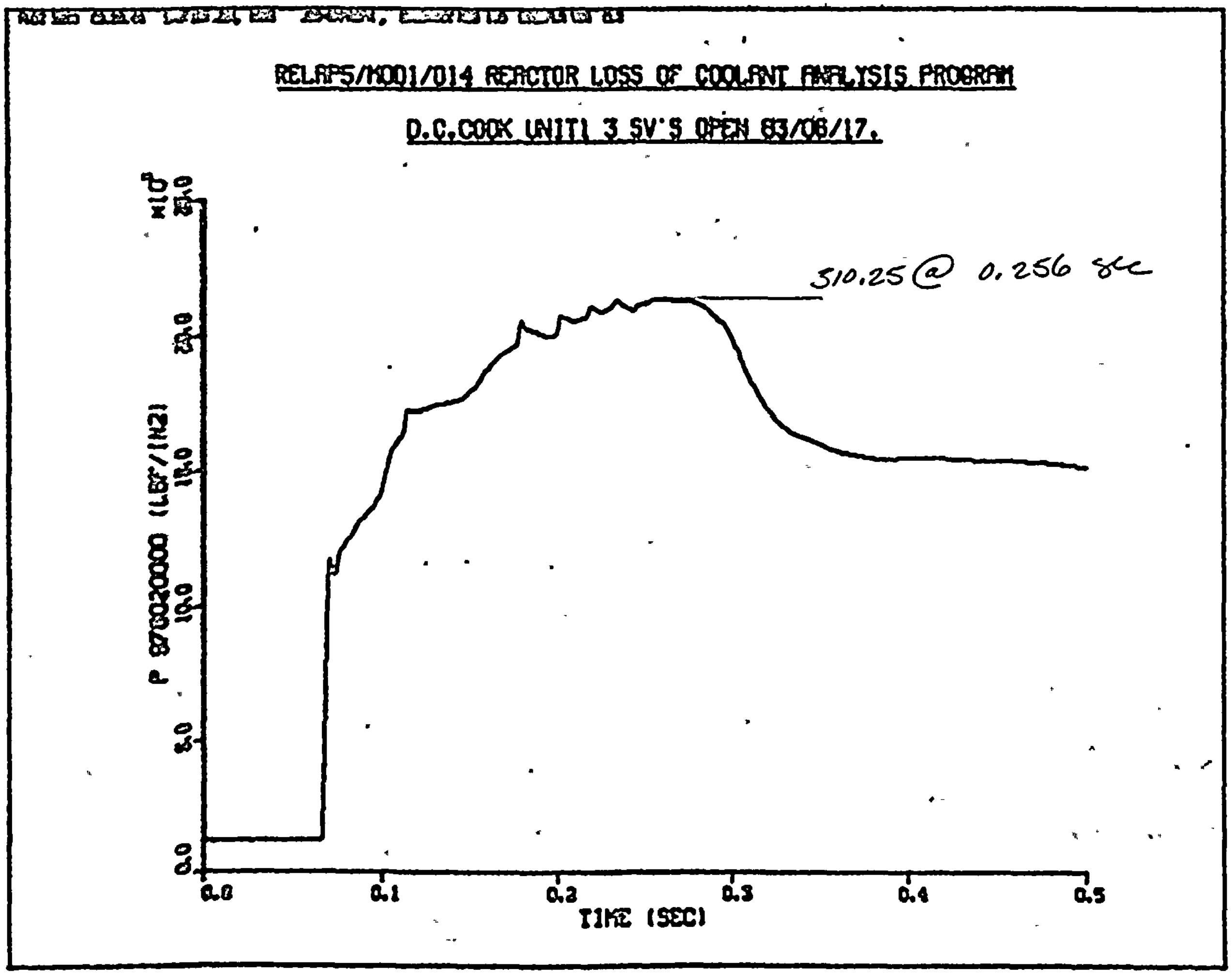
BY KJG DATE 6-21-83
CHKD. BY CWH DATE 6-29-83





TELEDYNE
ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CWH DATE 6-29-83

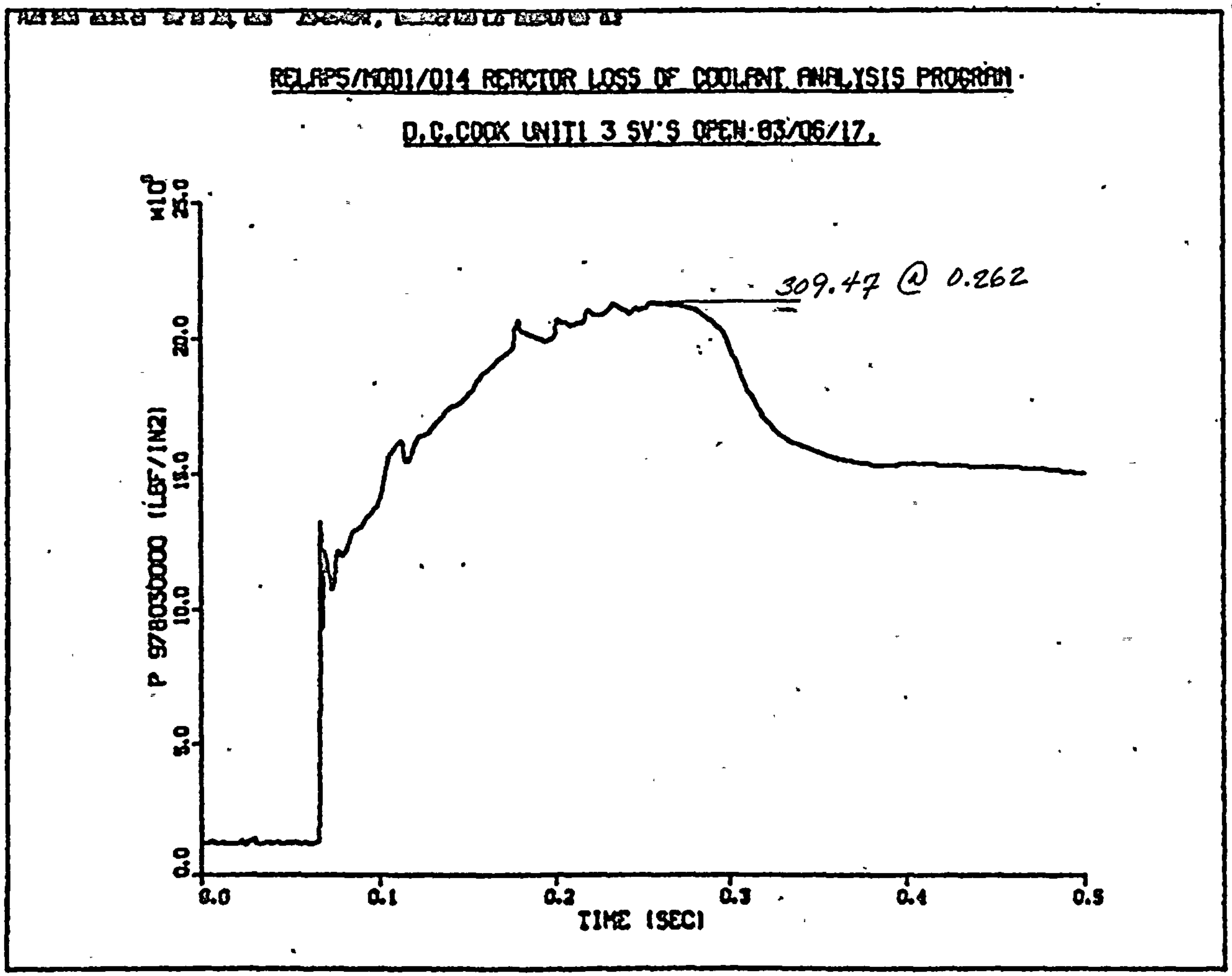


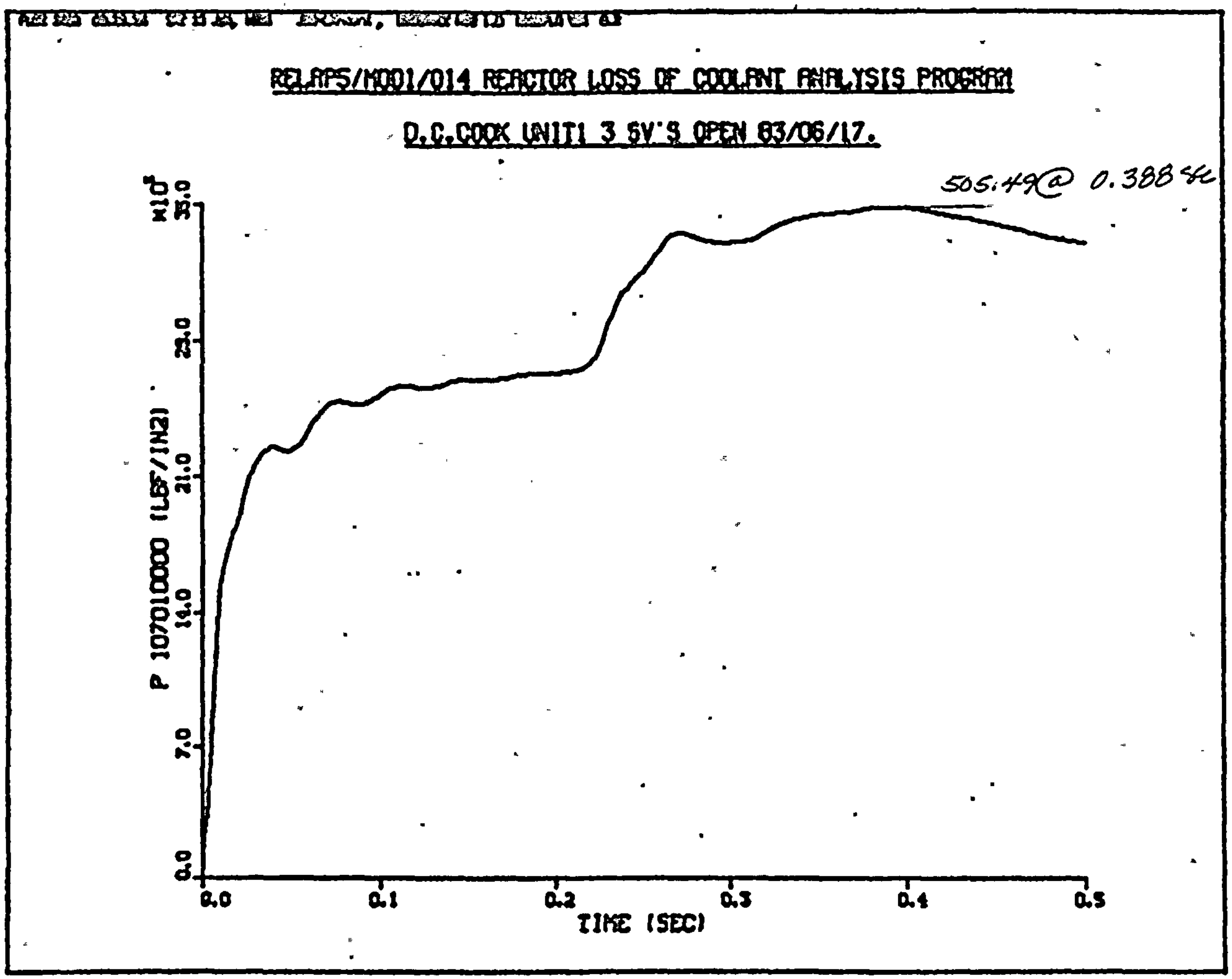
TELEDYNE
ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CWH DATE 6-29-83

TELEDYNE
ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY [illegible] DATE 6-29-83

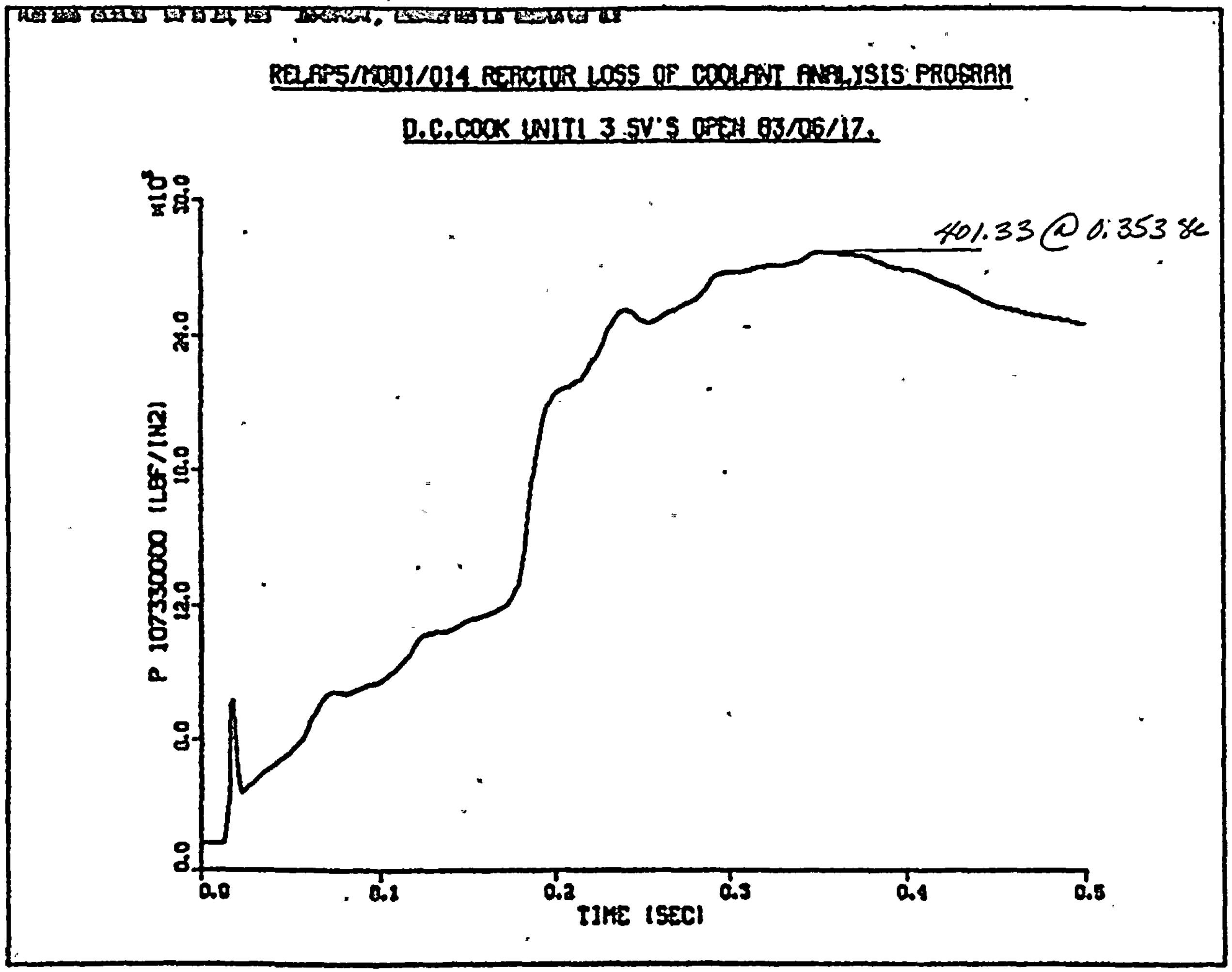




TELEDYNE ENGINEERING SERVICES

BY KJG DATE 6-21-83

CHKD. BY [signature] DATE 6-29-83



TELEDYNE
ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CWH DATE 6-29-83

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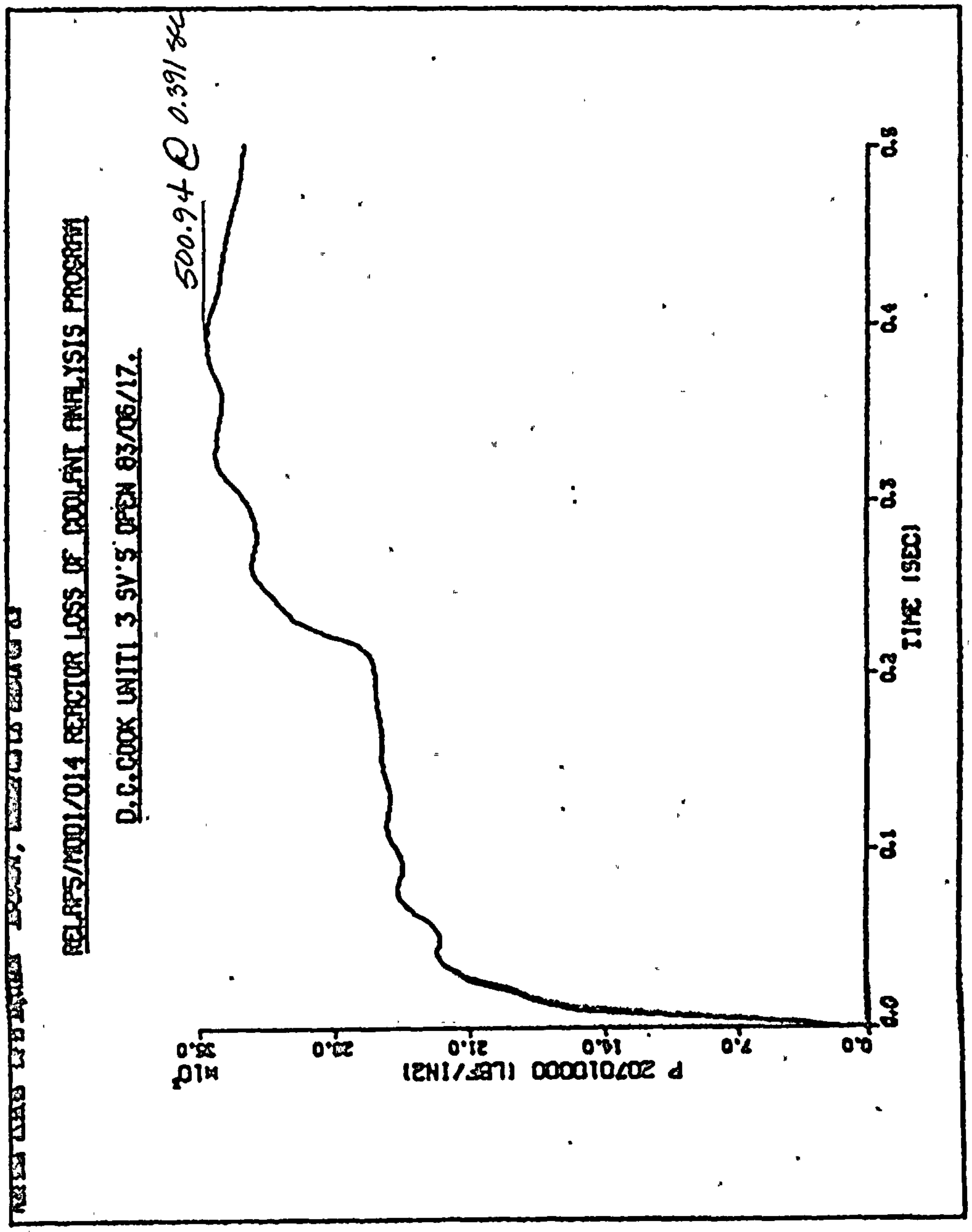
BY KJG DATE 6-21-83
CHKD. BY CMM DATE 6-29-83



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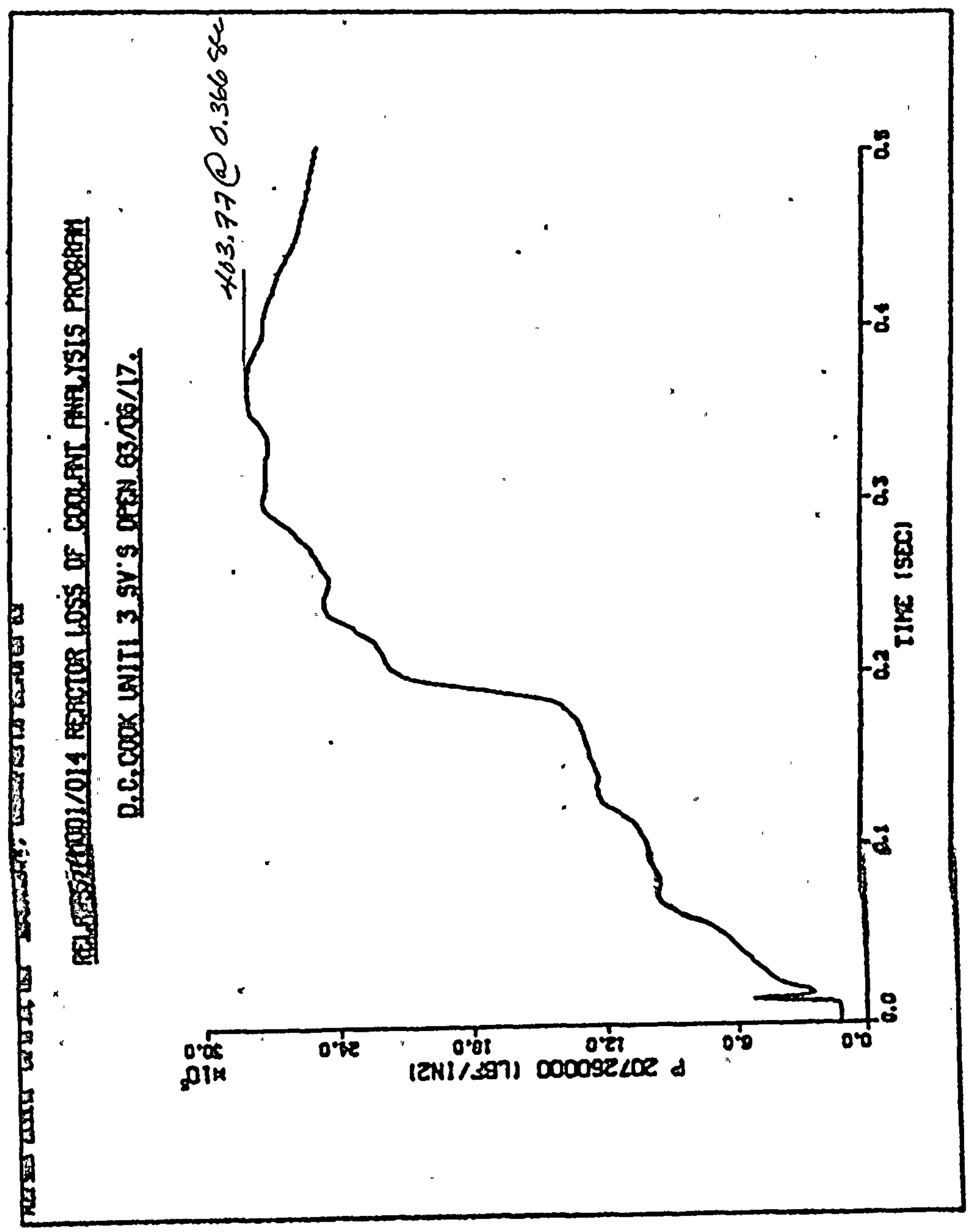
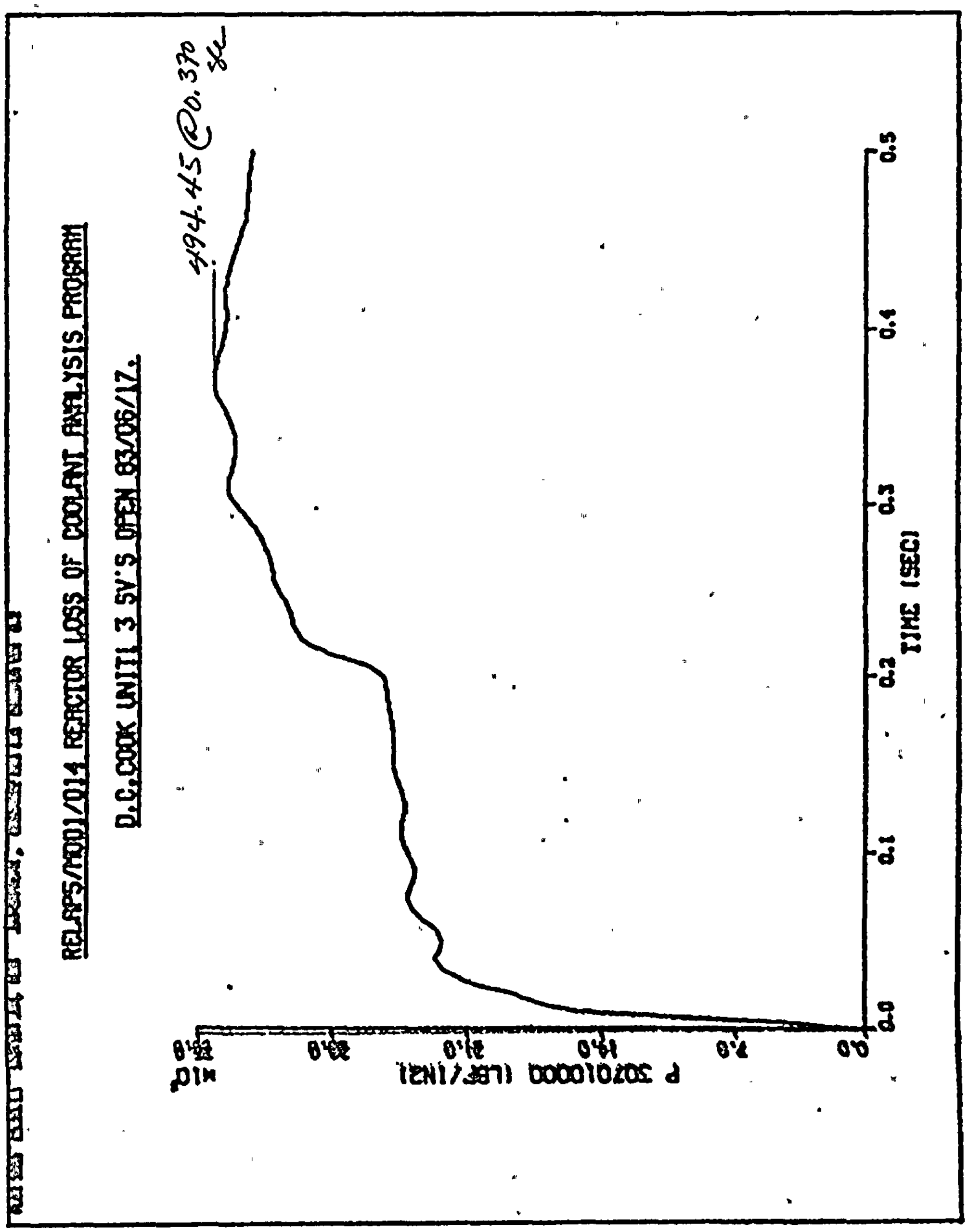
BY KJG DATE 6-21-83
CHKD. BY CMM DATE 6-29-83



TELEDYNE
ENGINEERING SERVICES

BY KJG DATE 6-21-83
CHKD. BY CMM DATE 6-29-83



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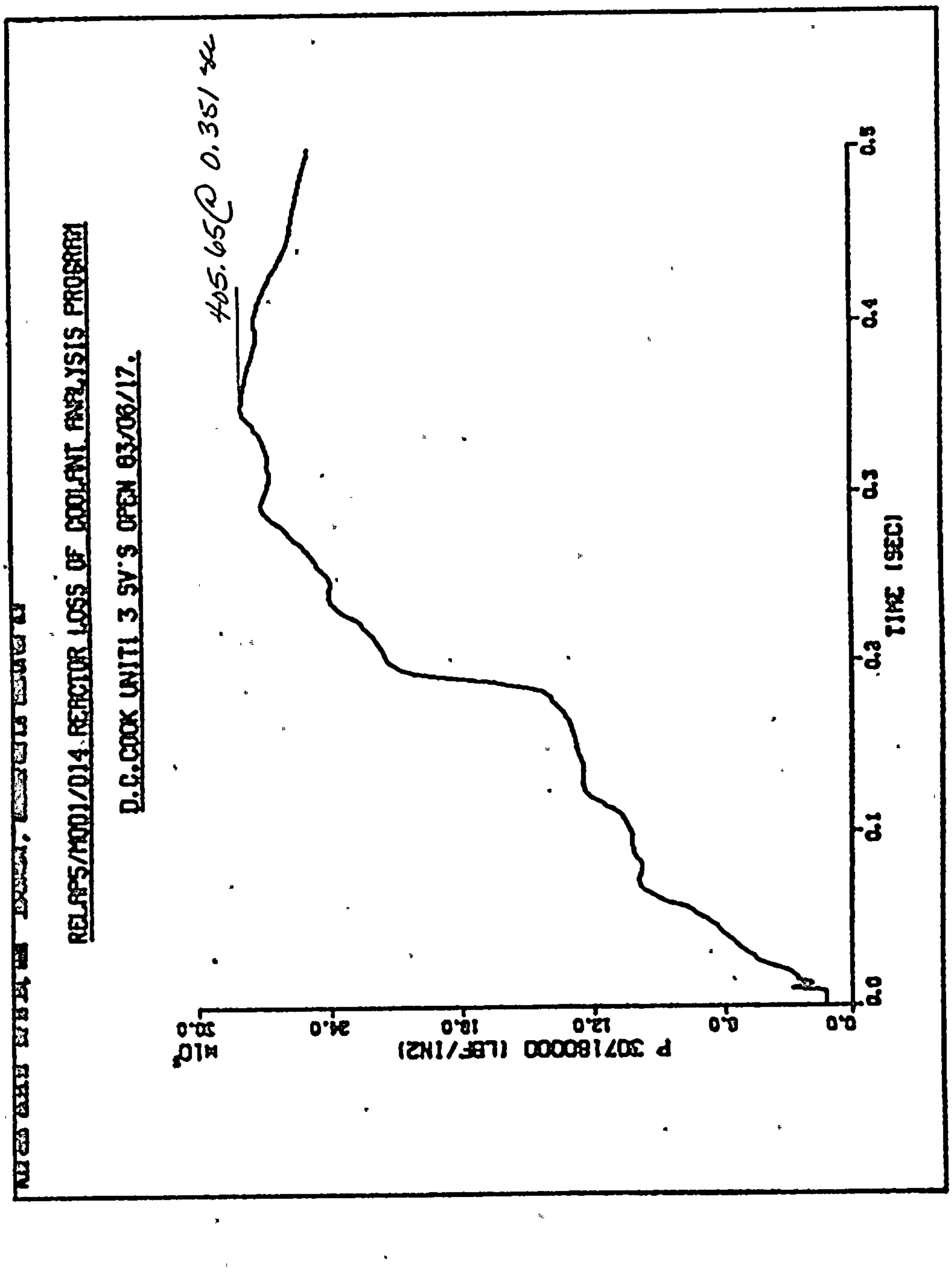
CHKD. BY CMM DATE 6-29-83



4.6 Force Time History Plots

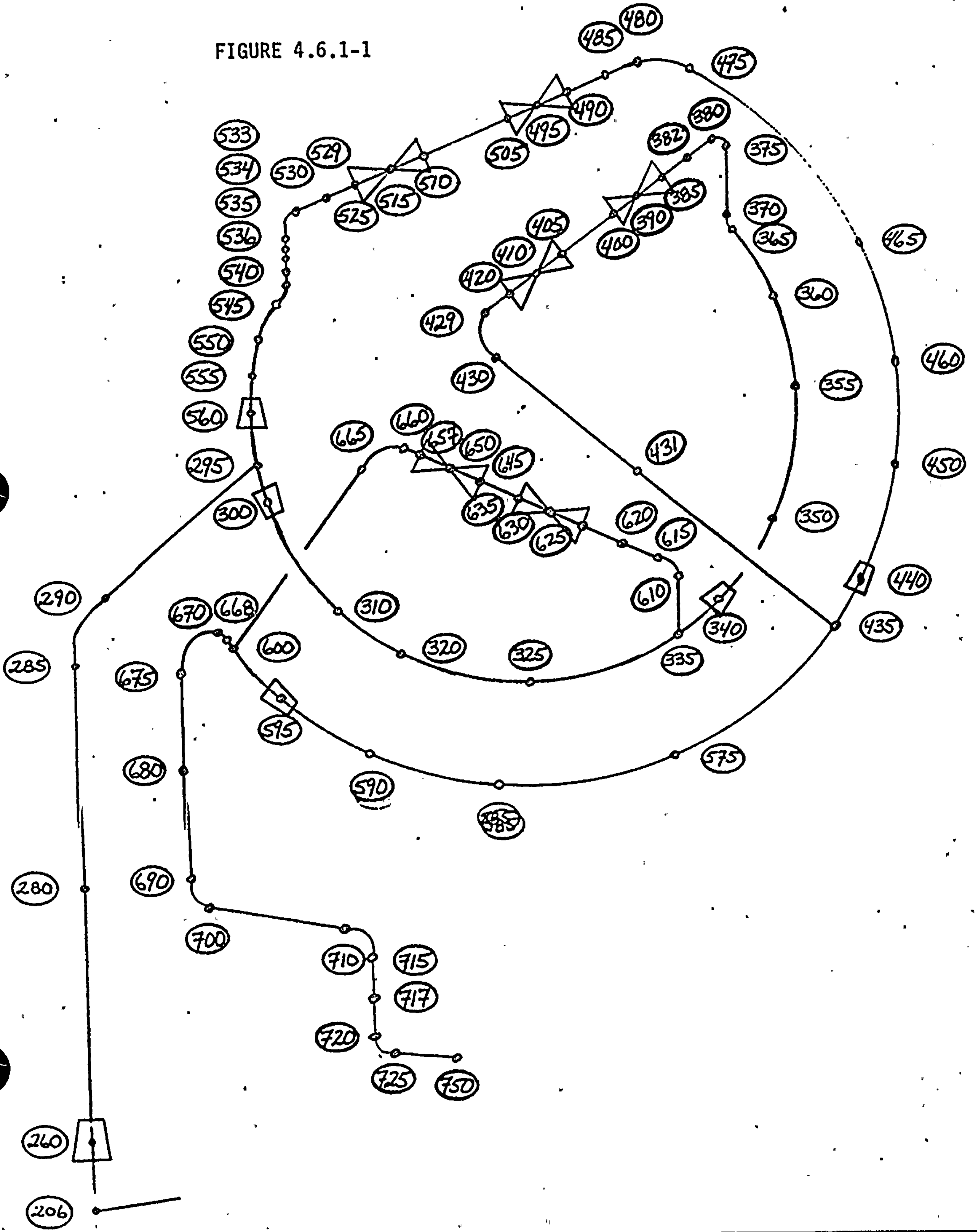
The following are force versus time plots for each pipe segment at a node point described by the structural model. A drawing indicating force placement precedes the set. Since the force time histories were plotted after balancing and merging(i.e. SAP2SAP and MERGE), each plot is unbalanced force versus time from 0.0 to 0.5 seconds. Unit 1 has 67 pipe segments and correspondingly 67 force time histories.

Technical Report
TR-5364-3
Revision 0

TELEDYNE ENGINEERING SERVICES

BY ____ DATE 4-14-83 | UNIT 1 STRUCTURAL NODE POINTS PORV SECTION | SHEET NO. 1 OF 3
CHK'D BY LBS DATE 4-14-83 | | PROJ. NO. 5364

FIGURE 4.6.1-1

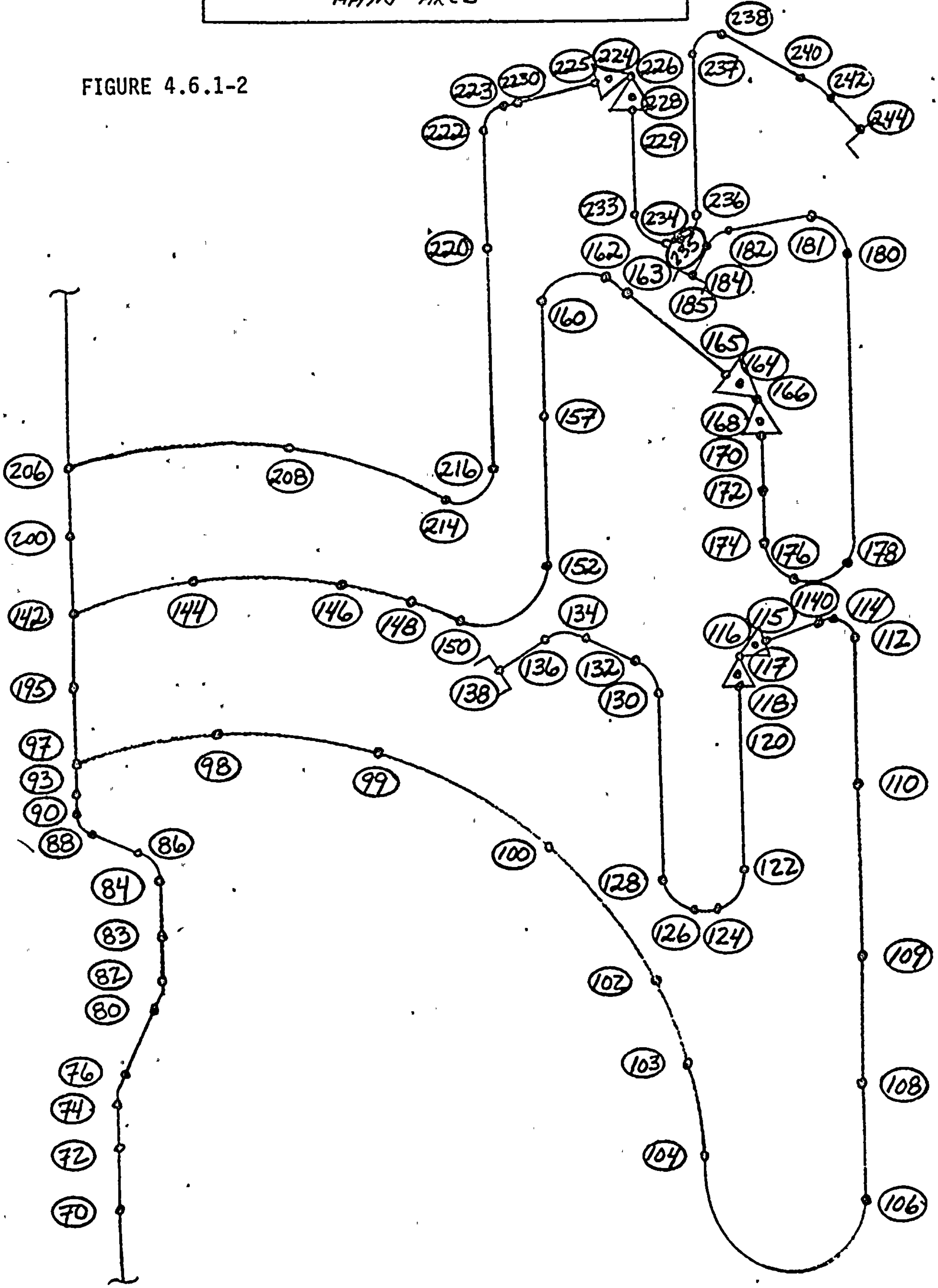


BY ___M___ DATE 4-14-83
CHK'D BY LBS DATE 4-14-83

UNIT 1 STRUCTURAL NODES POINTS
MAIN ARCS

SHEET NO. 2 OF 3
PROJ. NO. 5364

FIGURE 4.6.1-2



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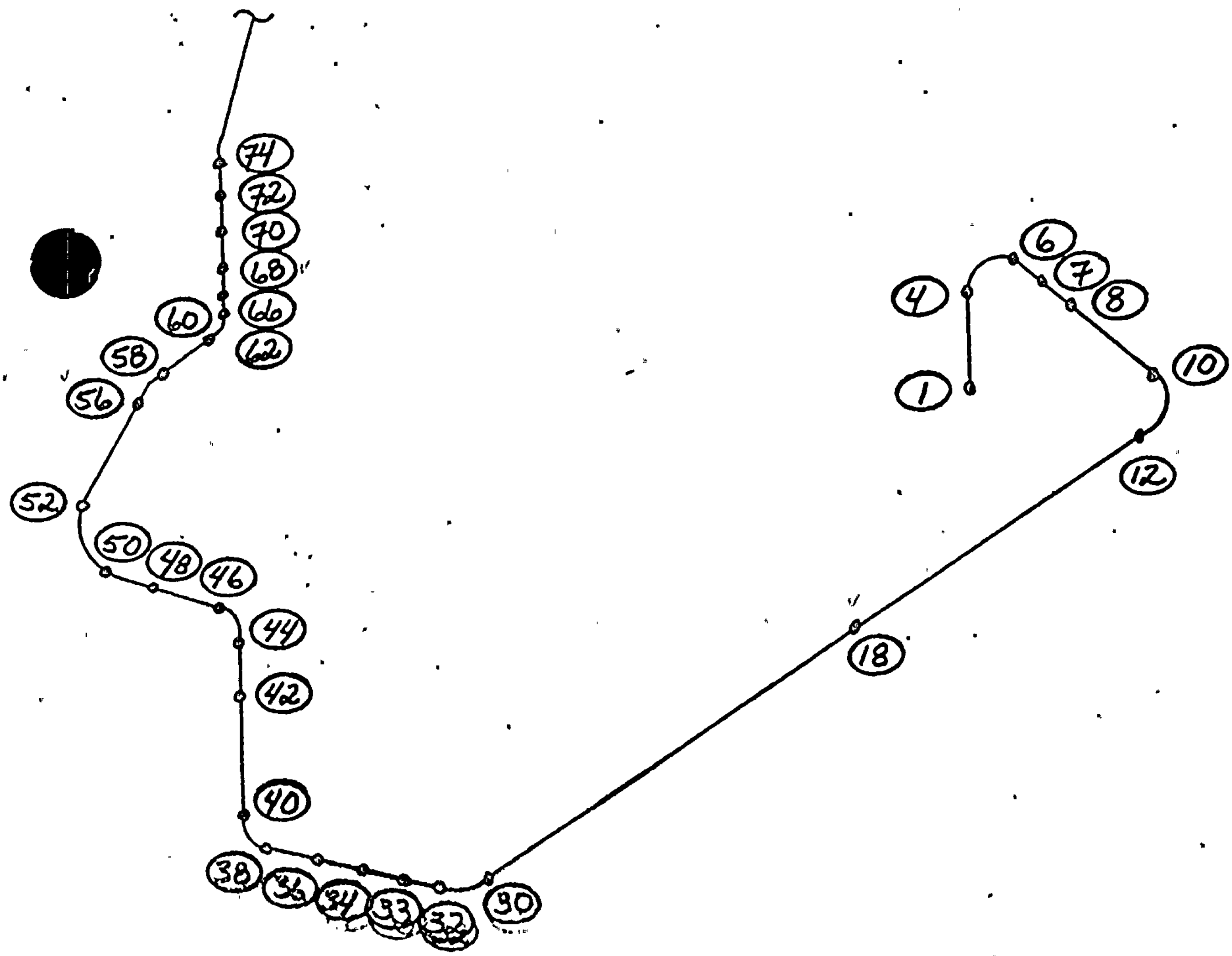
BY ________ DATE 4/14/83
CHK'D LBS DATE 4-14-83

UNIT 1 STRUCTURAL NODE POINTS
DOWNSTREAM (12 IN)

SHEET NO. 3 OF 3
PROJ. NO. 5364

FIGURE 4.6.1-3



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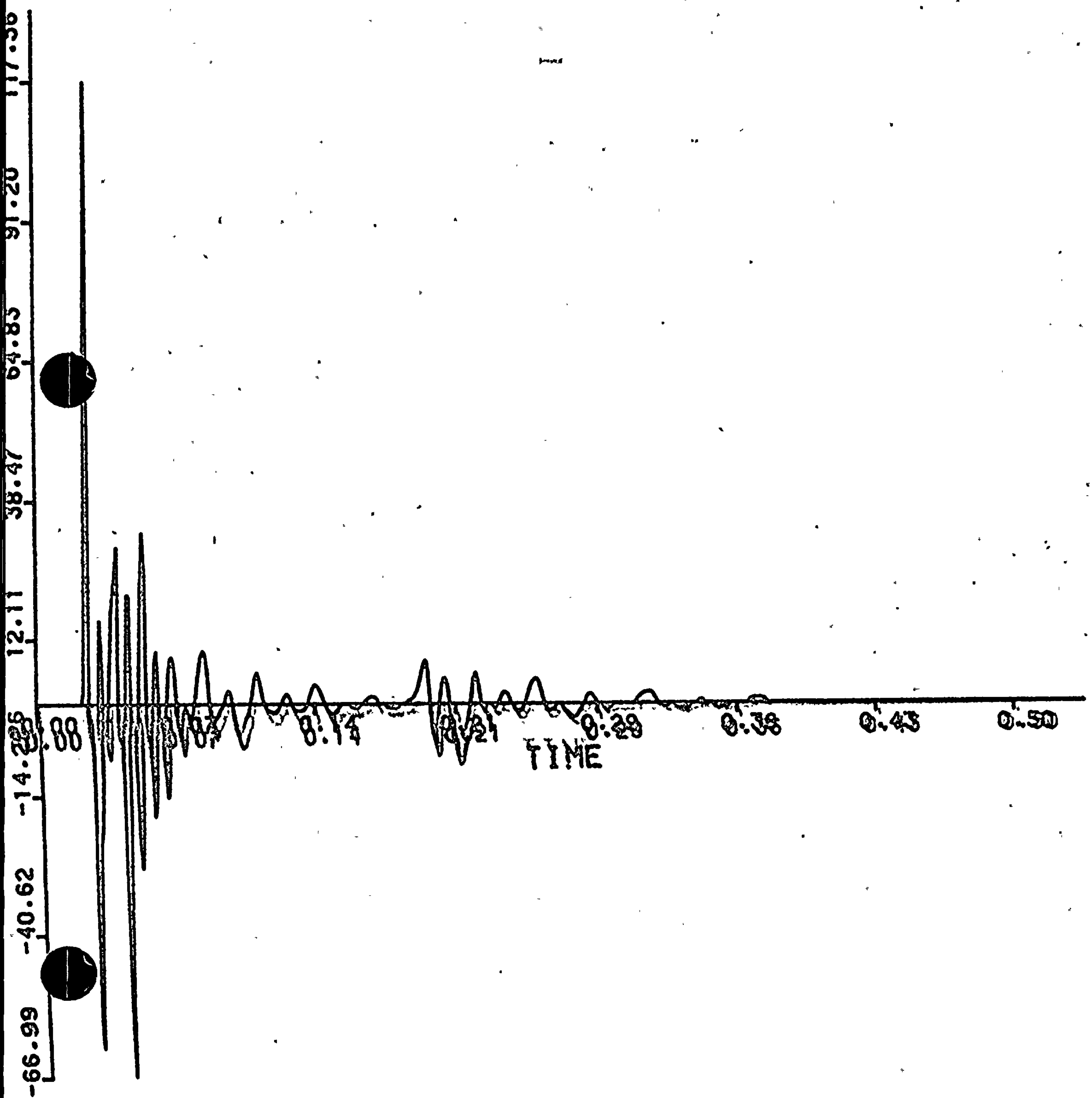
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 1, MAGNITUDE AT NODE POINT 620



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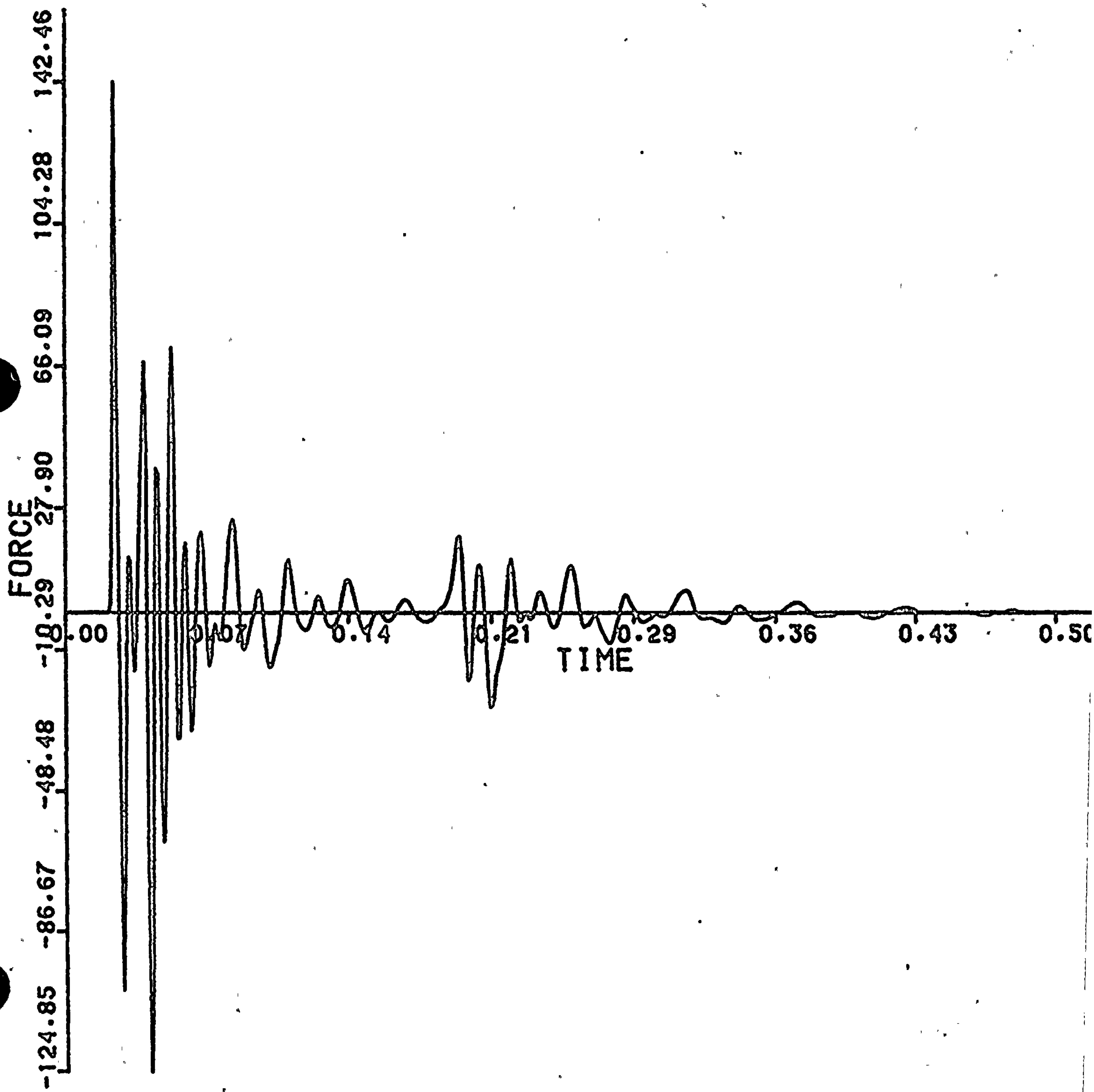
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 2, MAGNITUDE AT NODE POINT 610



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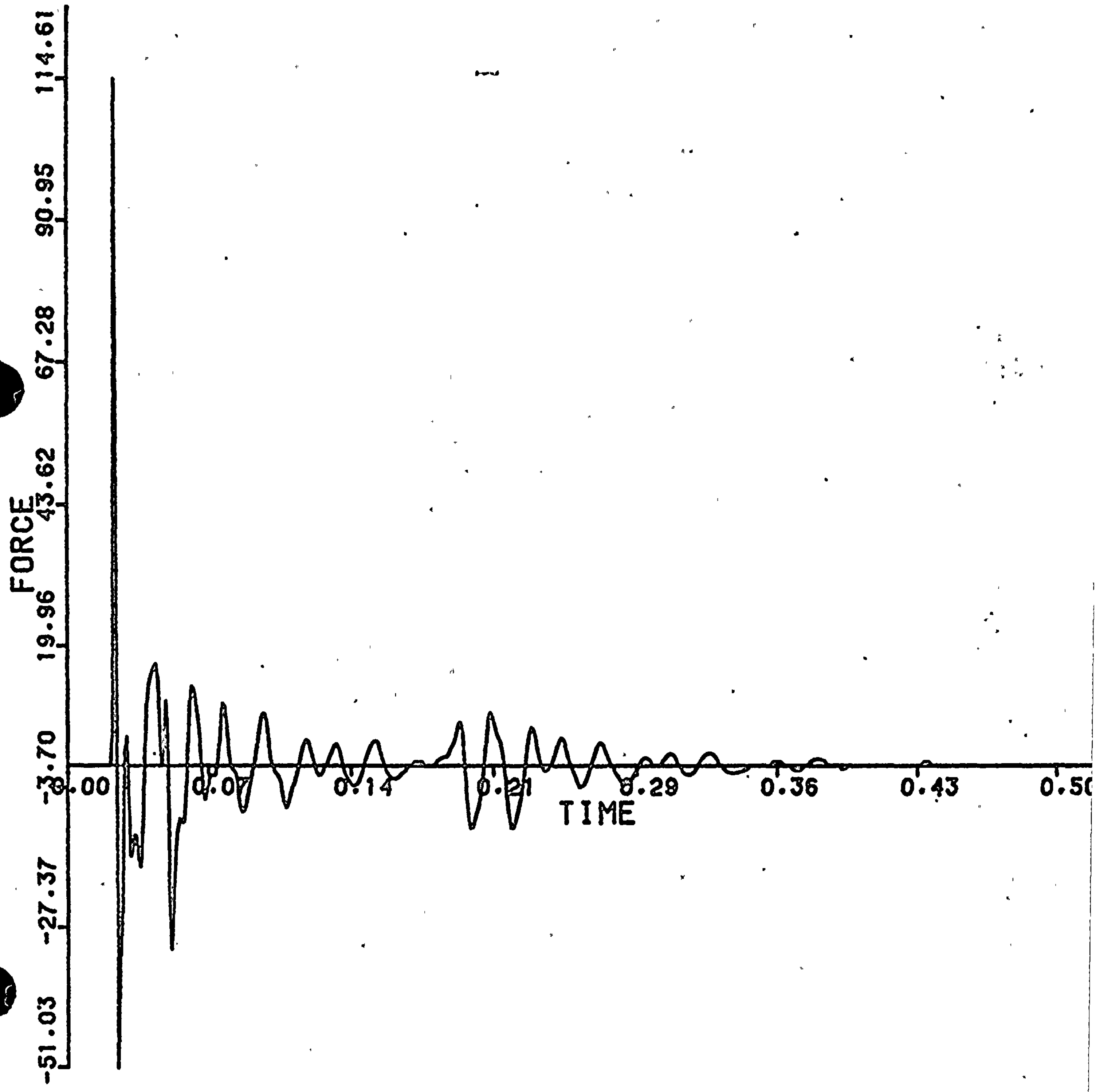
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 3, MAGNITUDE AT NODE POINT 529



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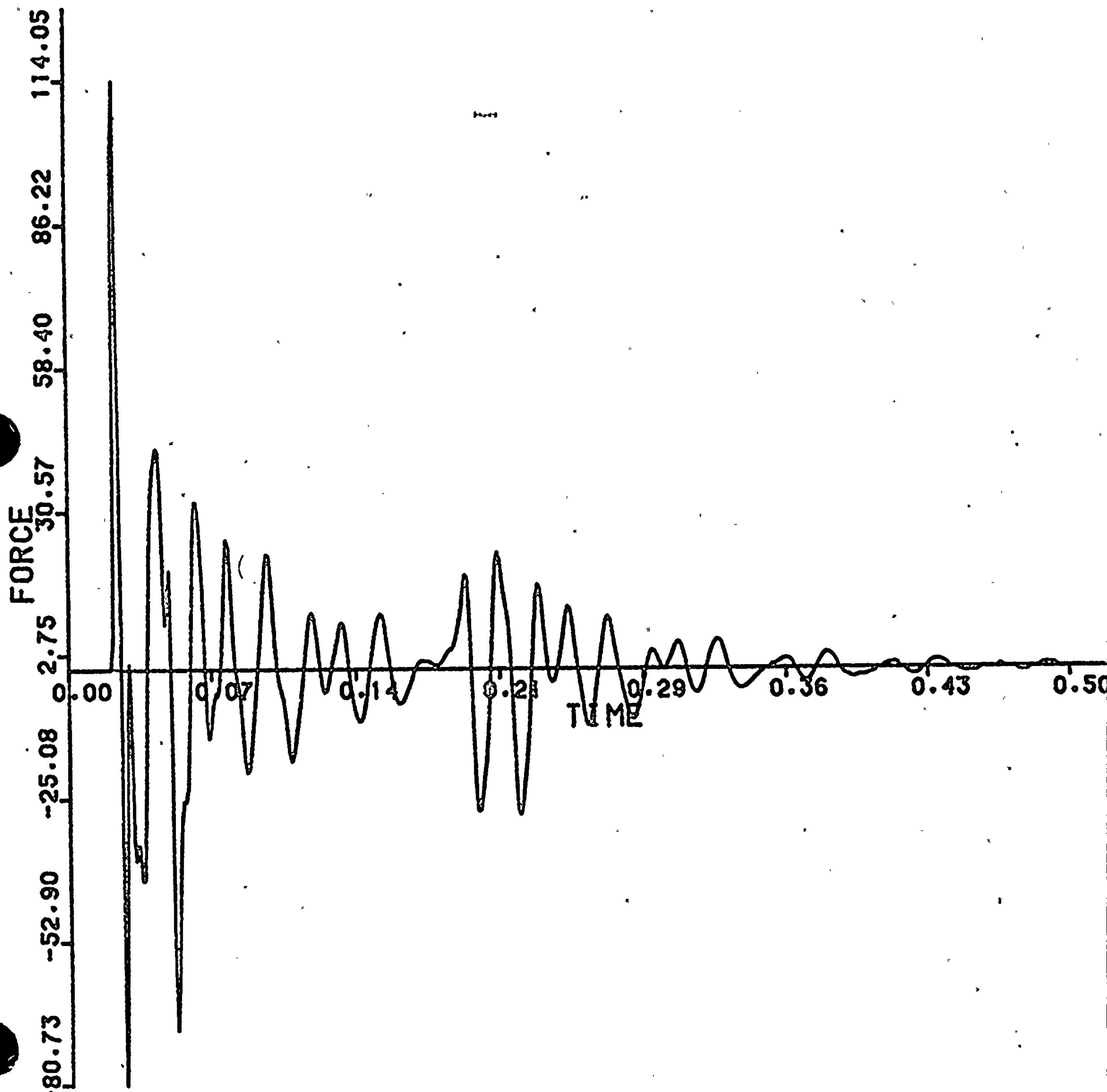
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 4, MAGNITUDE AT NODE POINT 536



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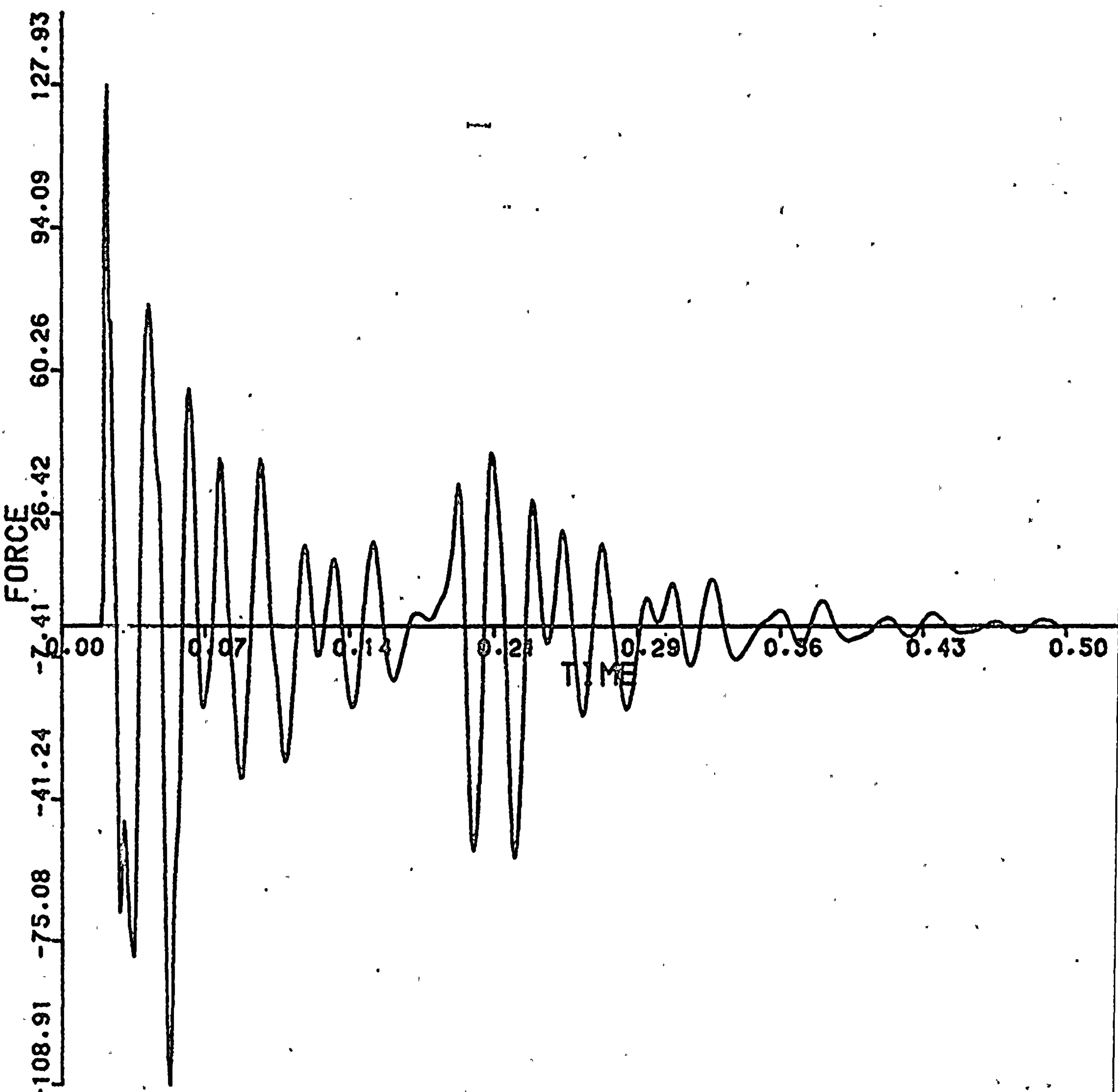
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 5, MAGNITUDE AT NODE POINT 545



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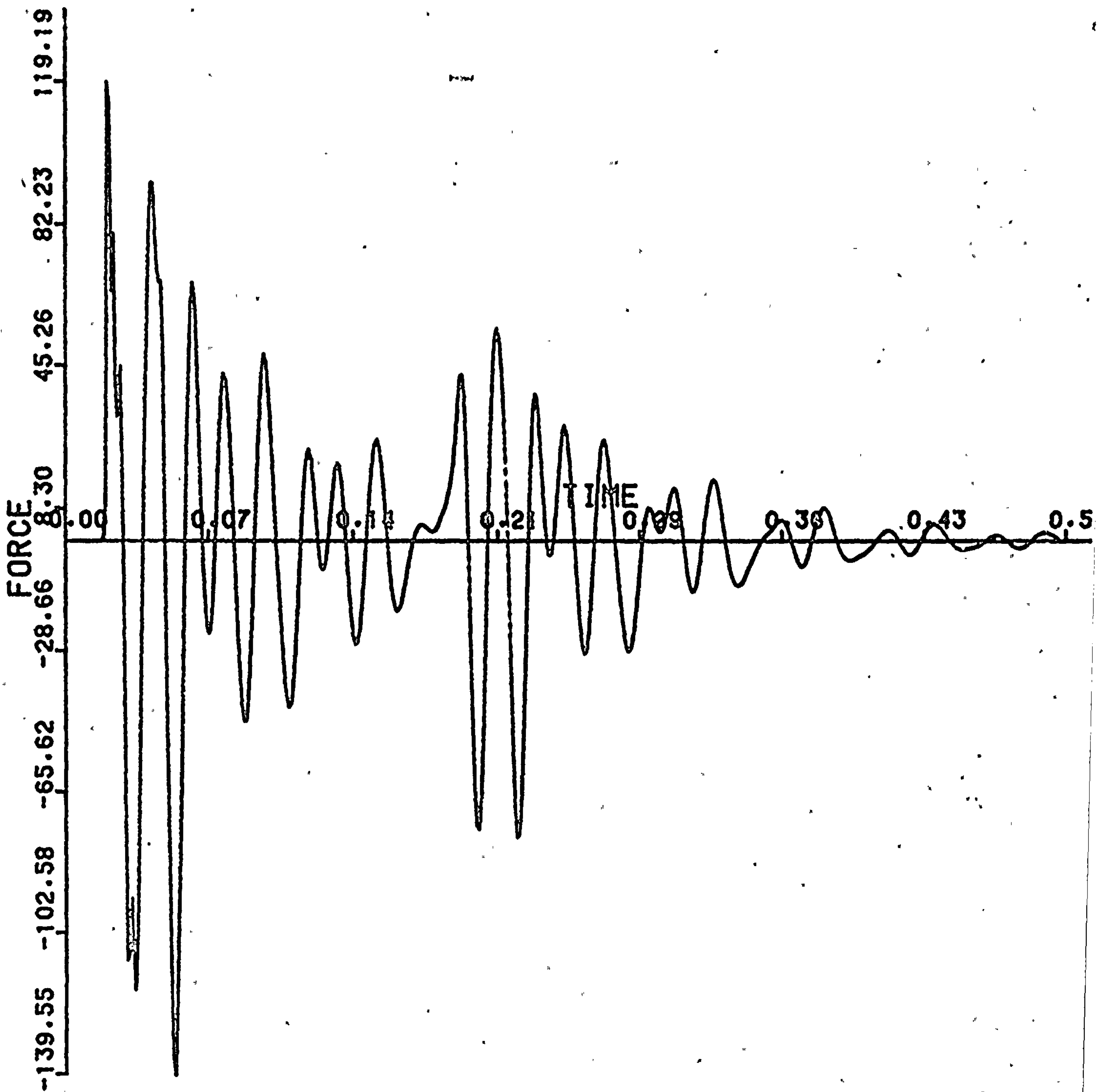
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 6, MAGNITUDE AT NODE POINT 550



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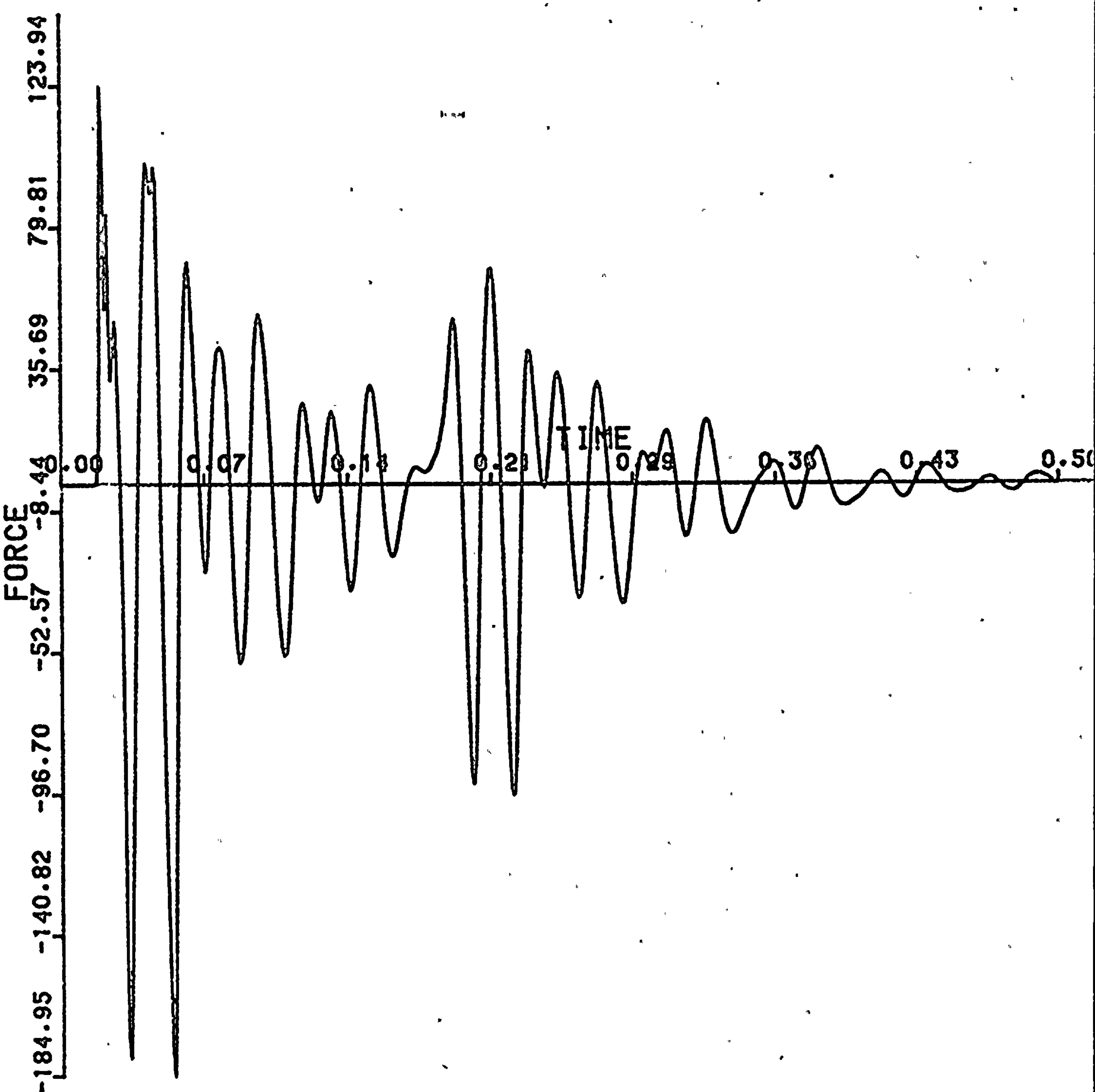
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 7, MAGNITUDE AT NODE POINT 555



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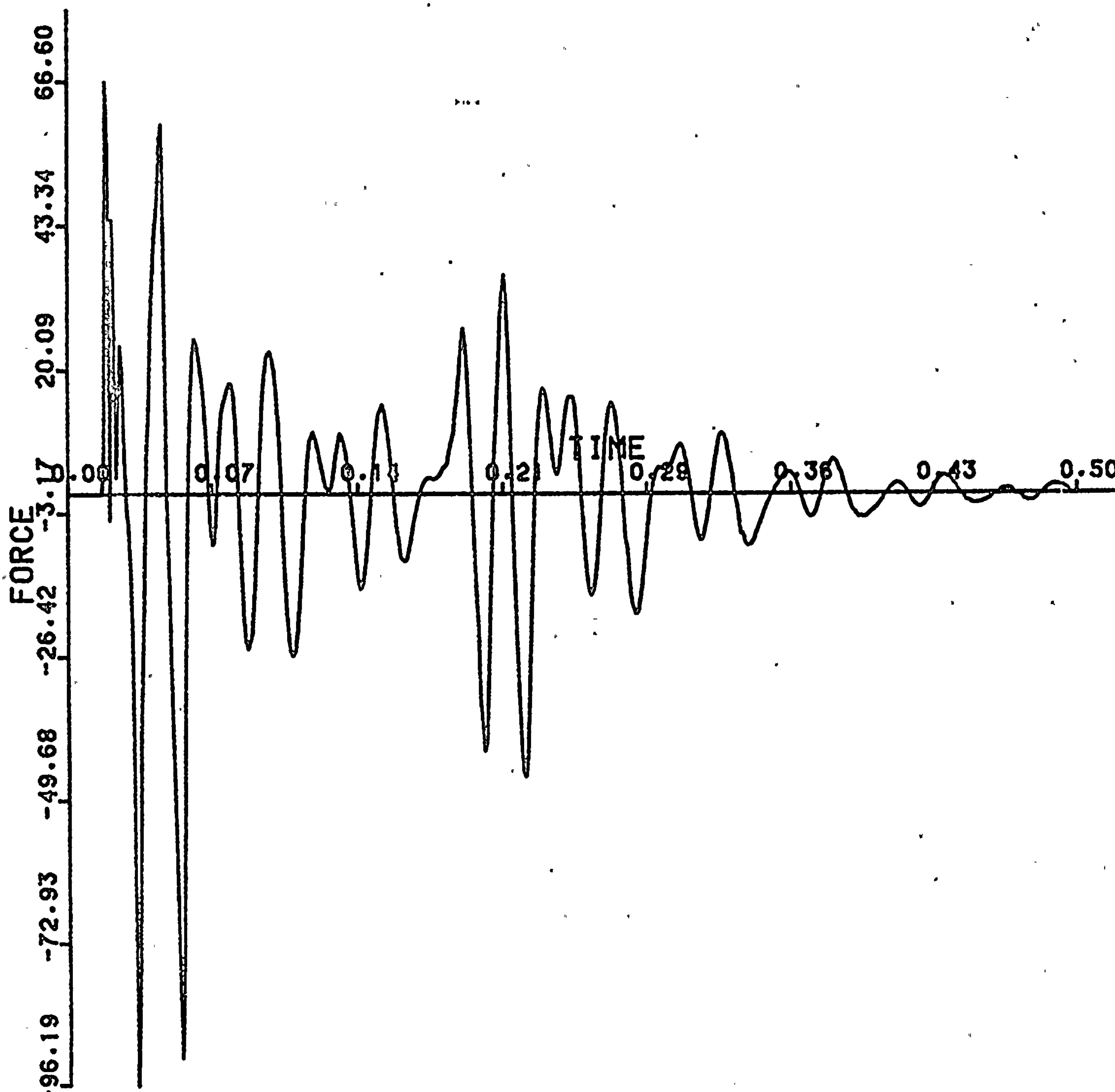
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 8, MAGNITUDE AT NODE POINT 560



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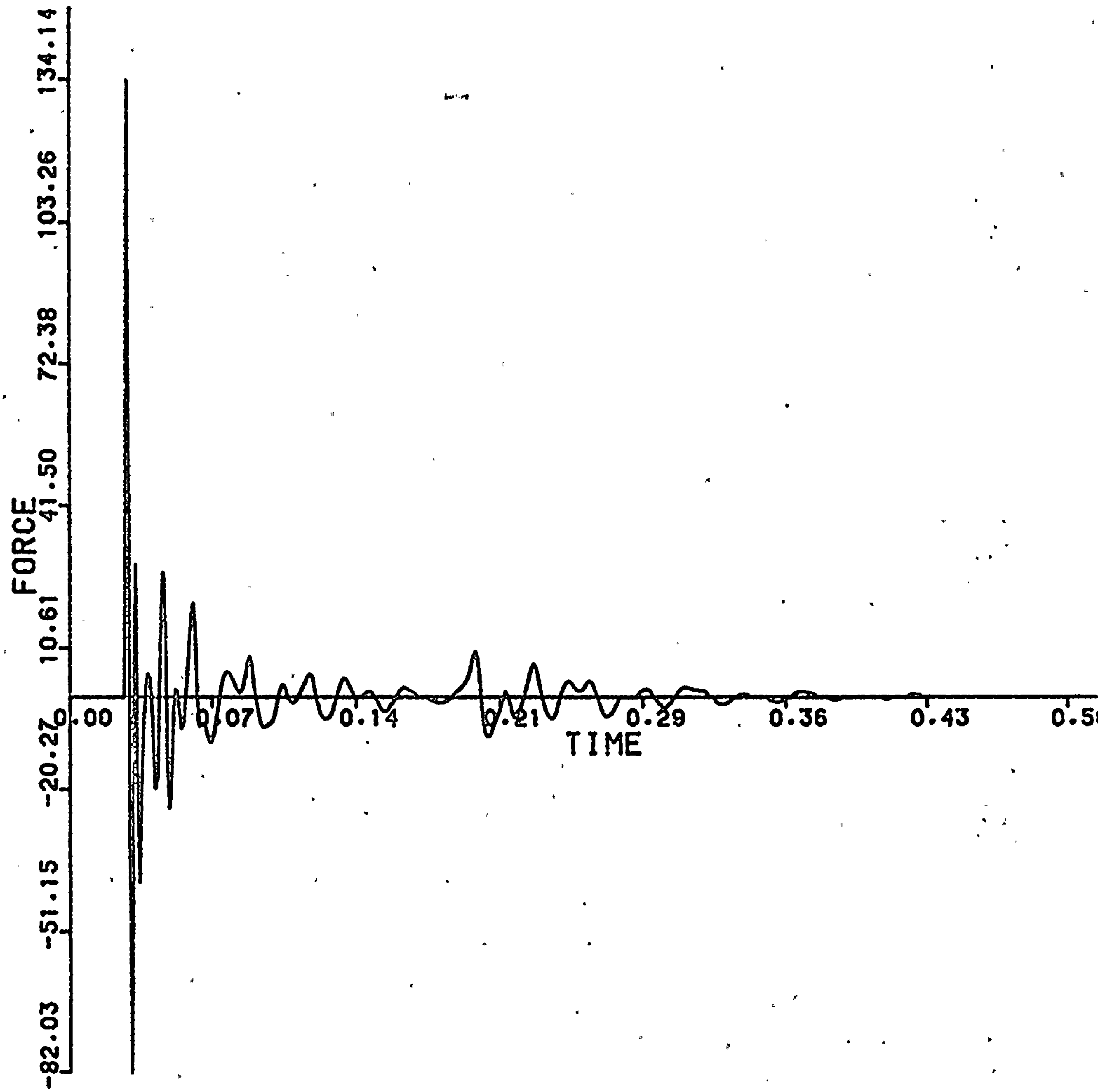
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 9, MAGNITUDE AT NODE POINT 382



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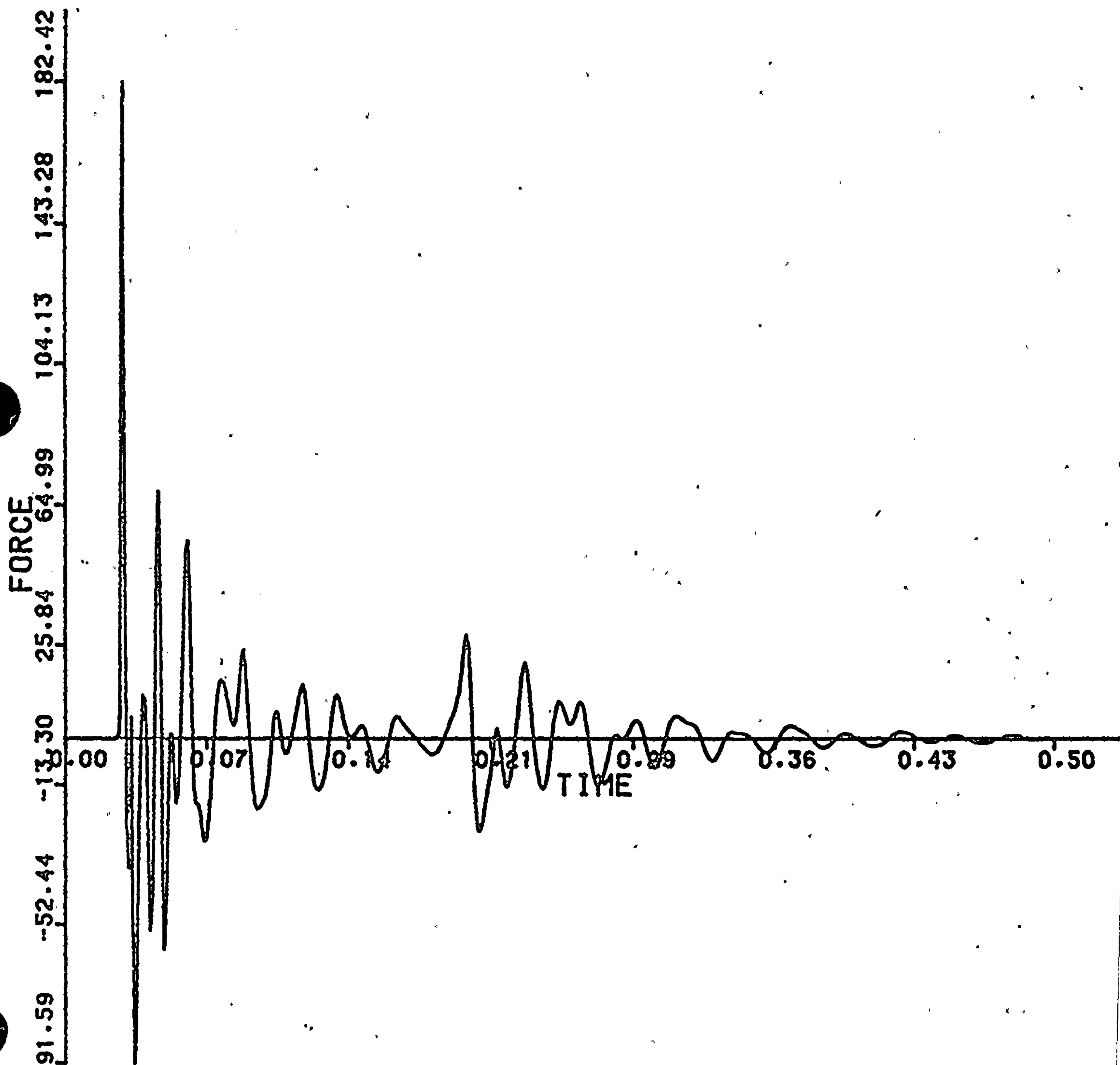
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 10, MAGNITUDE AT NODE POINT 375



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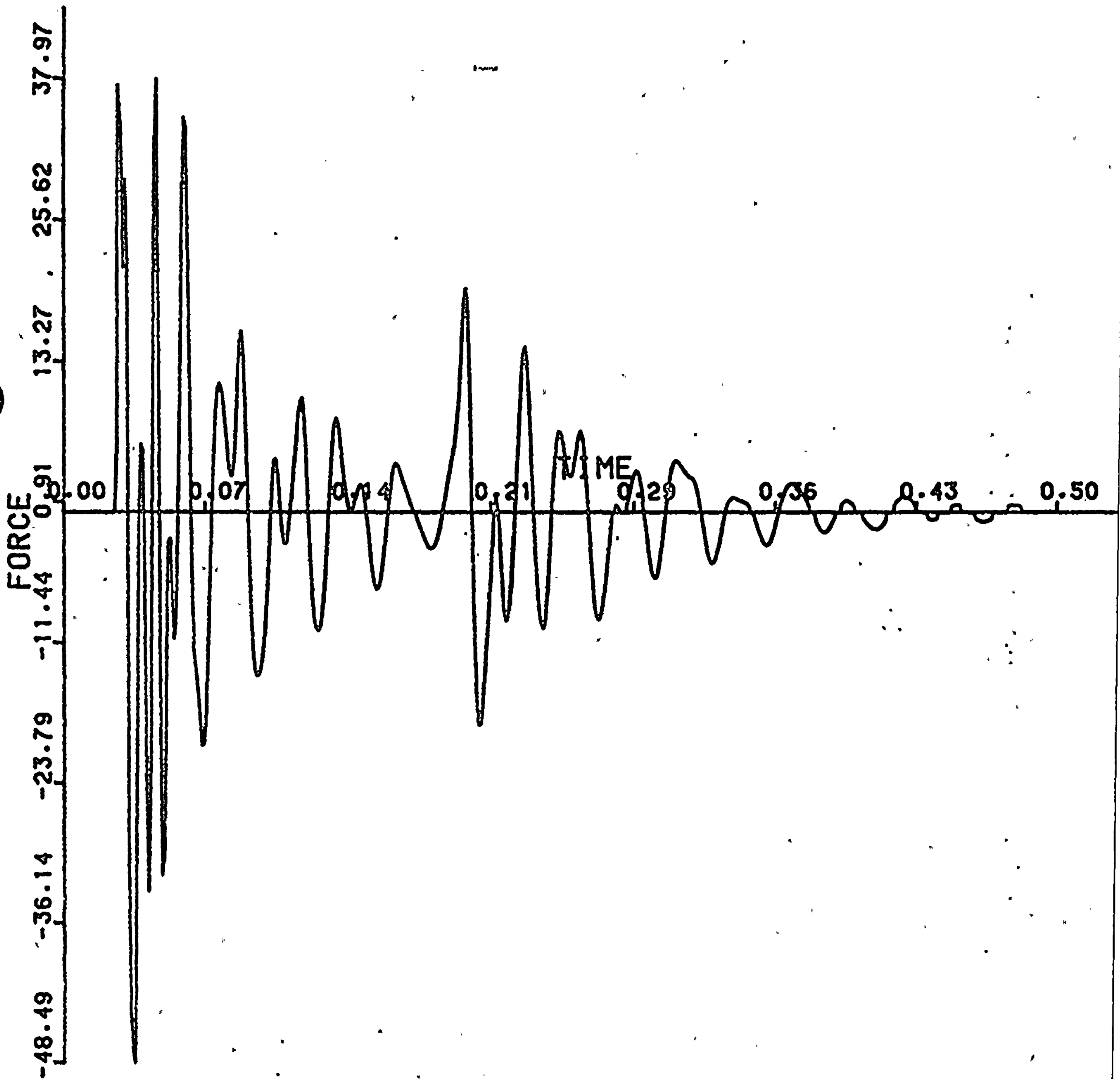
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 11, MAGNITUDE AT NODE POINT 365



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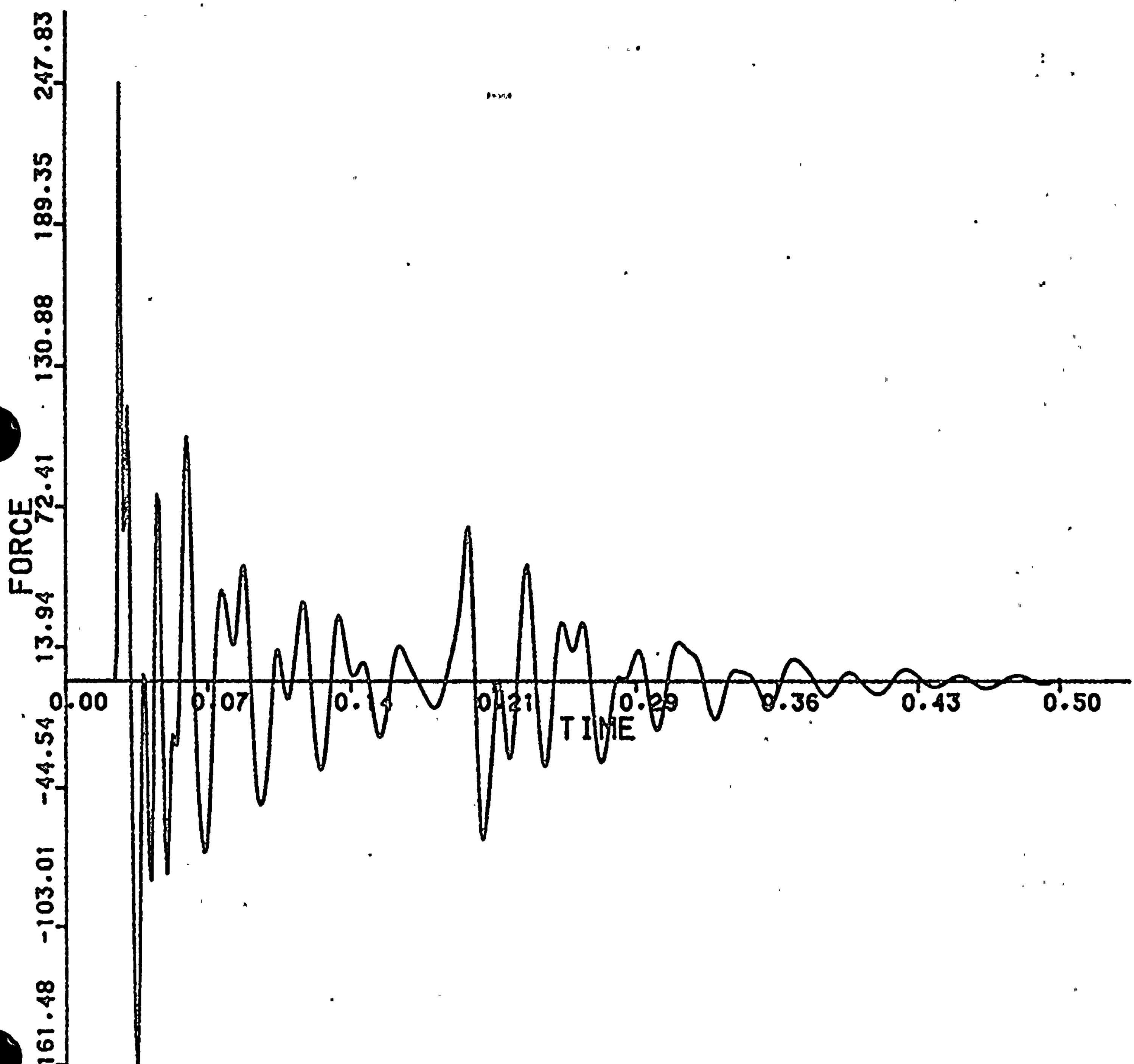
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 12, MAGNITUDE AT NODE POINT 360



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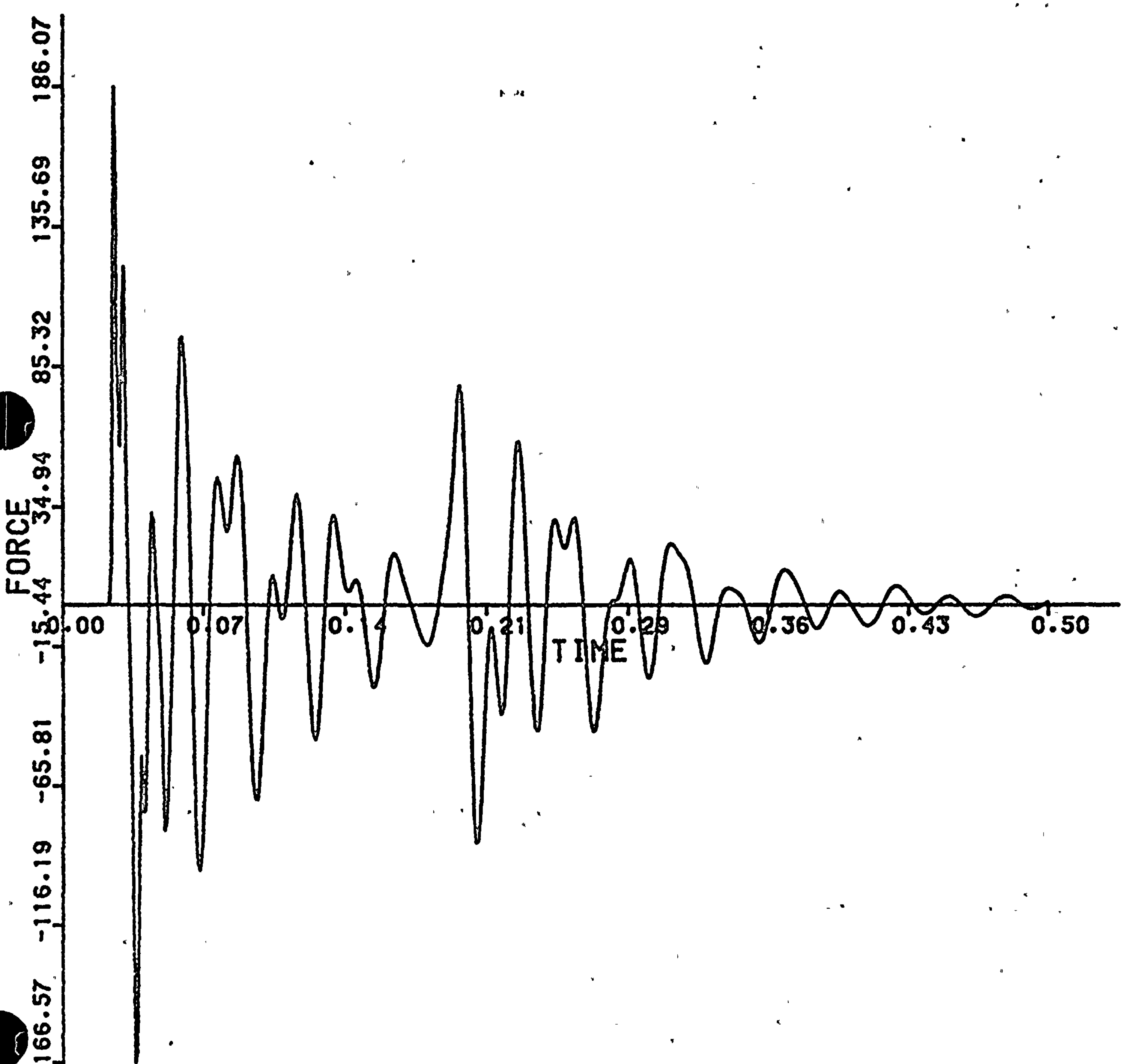
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE   13, MAGNITUDE AT NODE POINT   355



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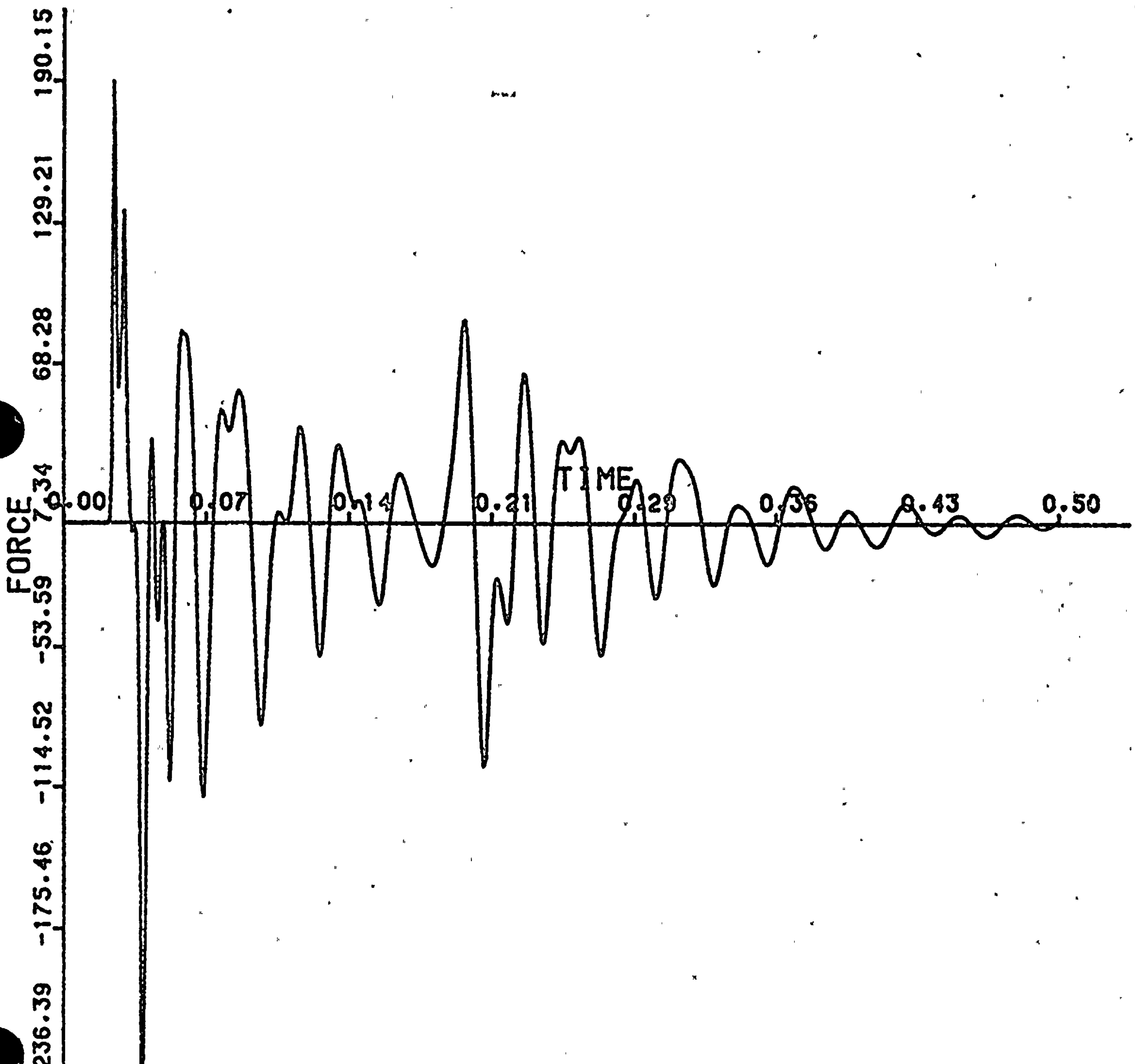
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 14, MAGNITUDE AT NODE POINT 350



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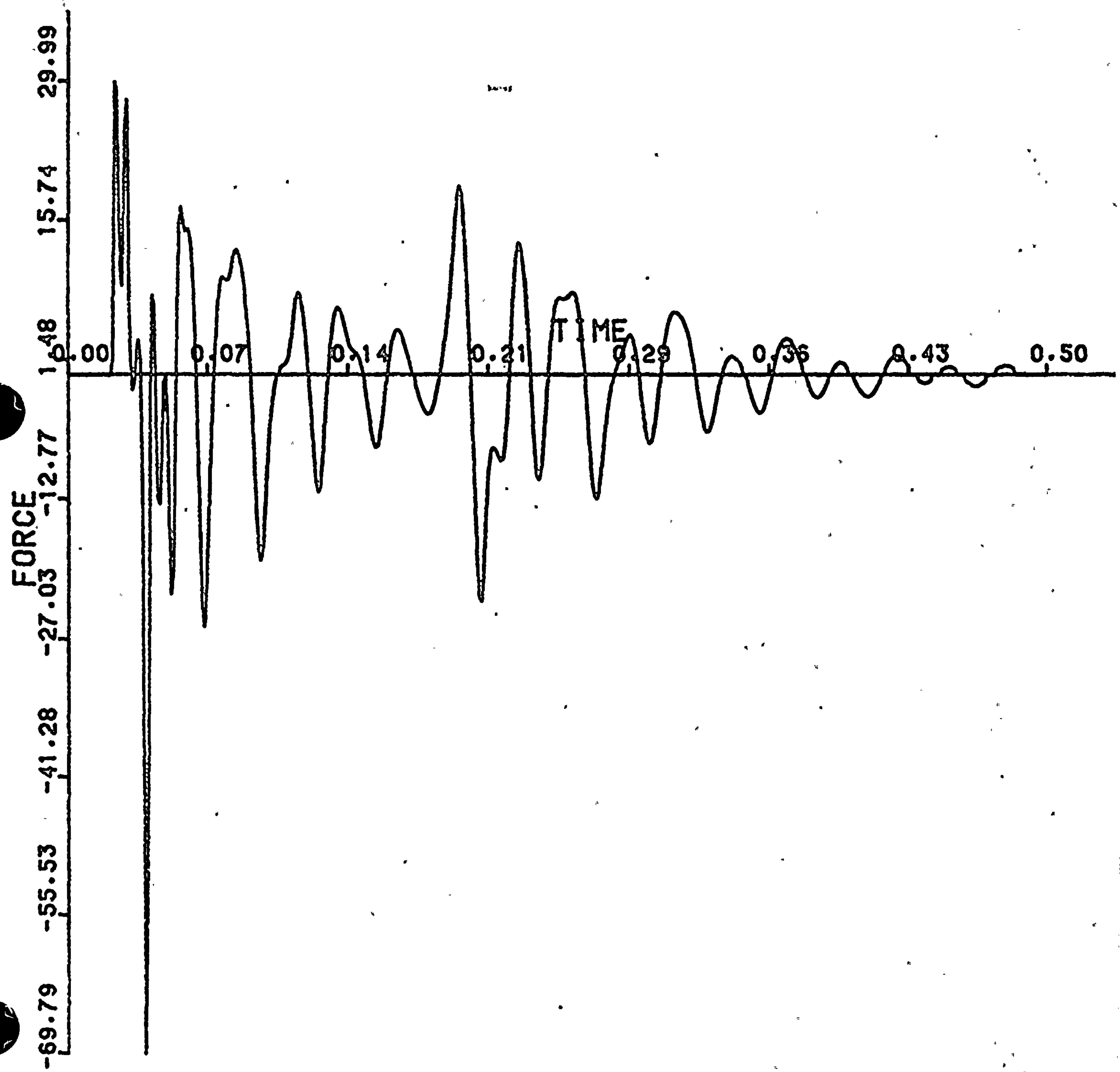
TIME/FORCE TABLE 15, MAGNITUDE AT NODE POINT 340



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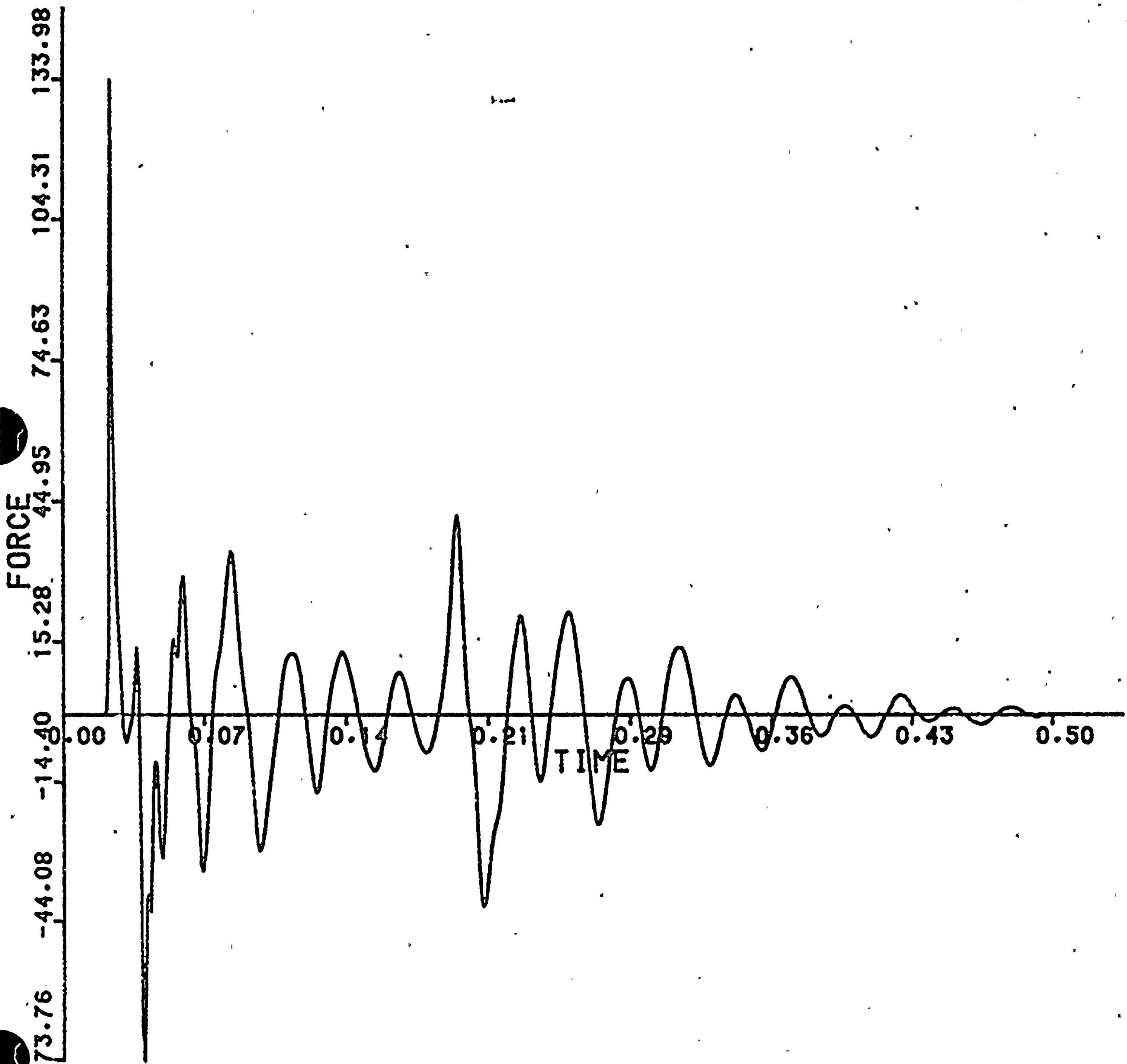
TIME/FORCE TABLE 16, MAGNITUDE AT NODE POINT 335



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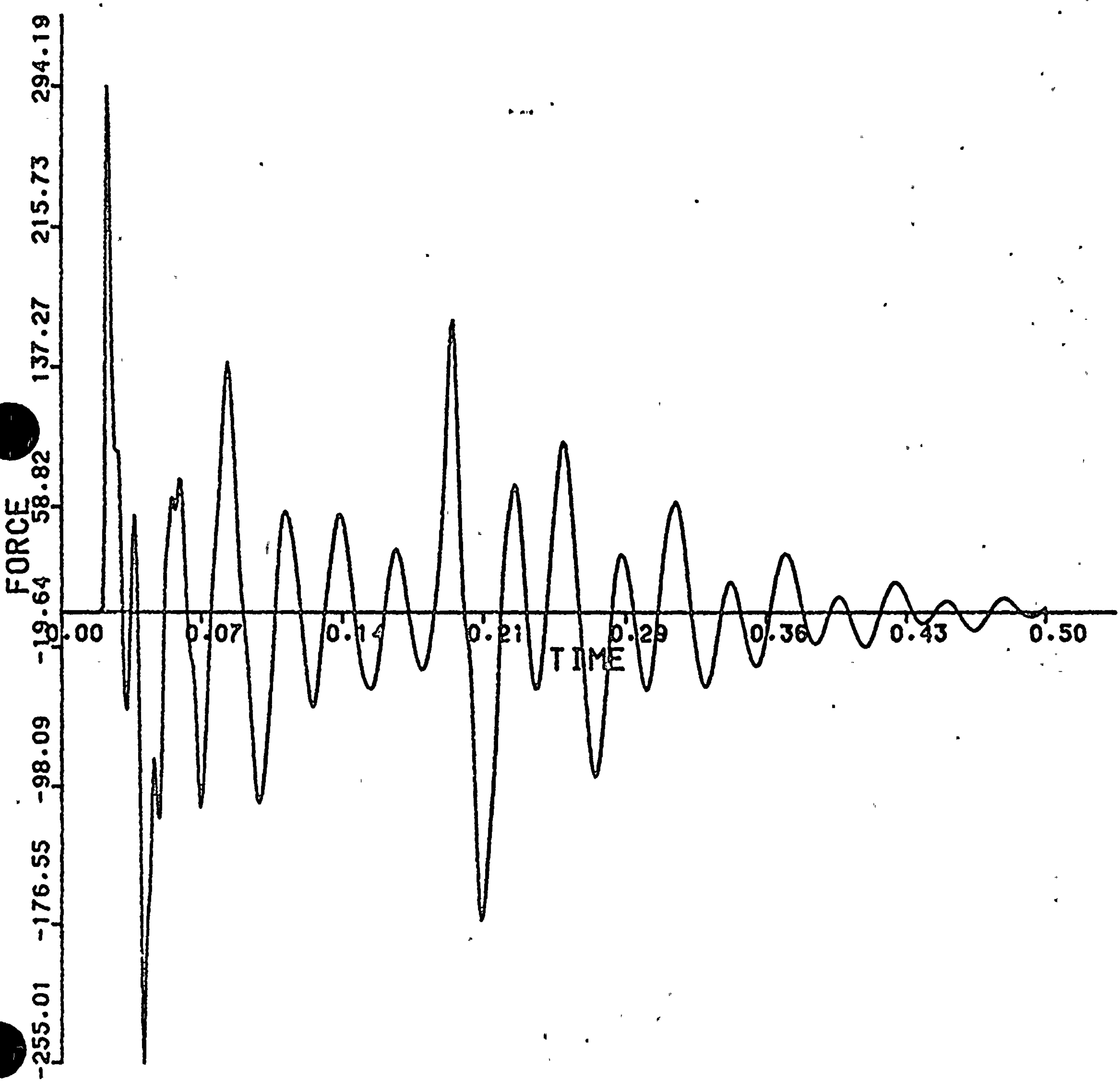
TIME/FORCE TABLE 17, MAGNITUDE AT NODE POINT 325



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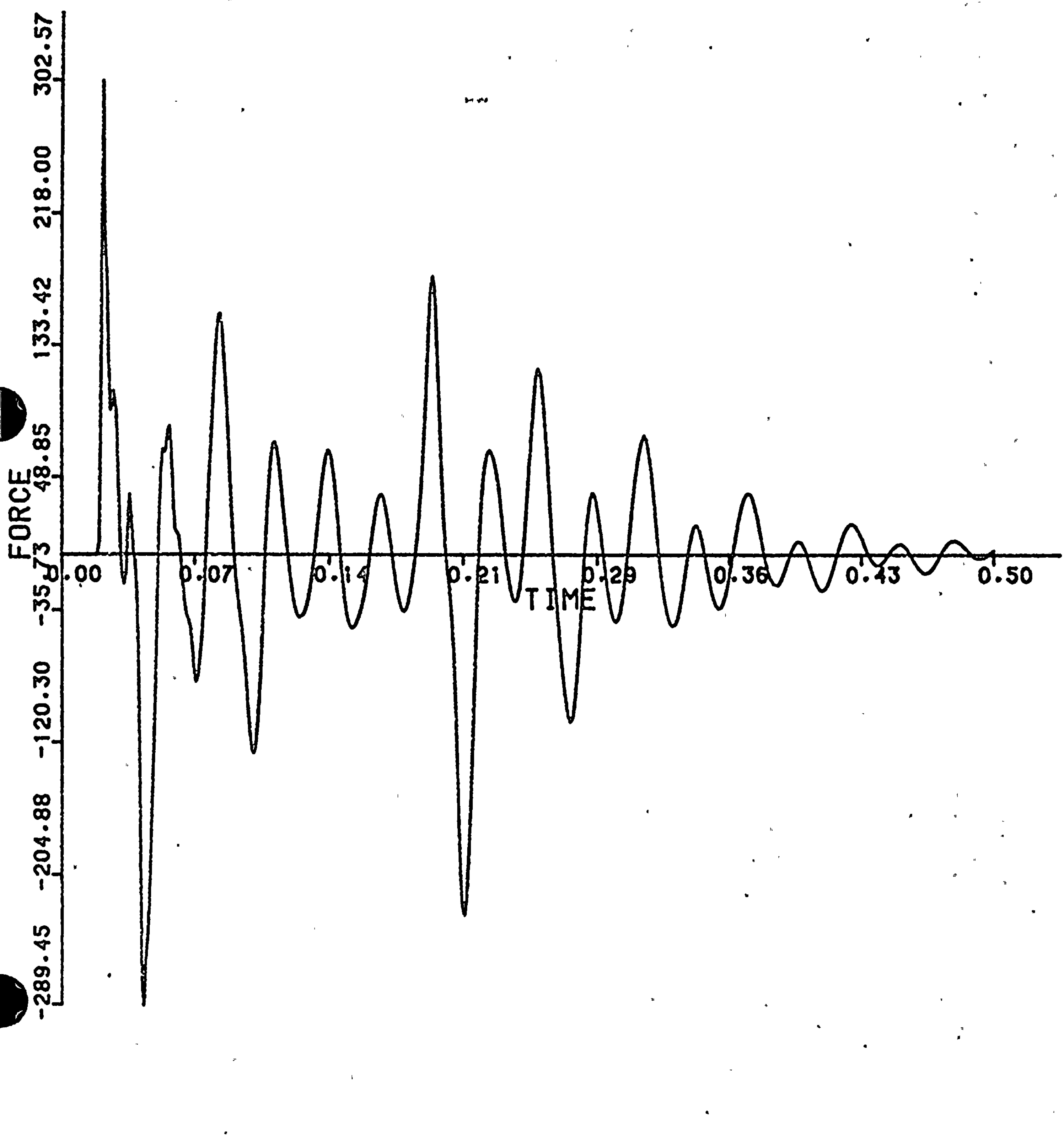
TIME/FORCE TABLE 18, MAGNITUDE AT NODE POINT 320



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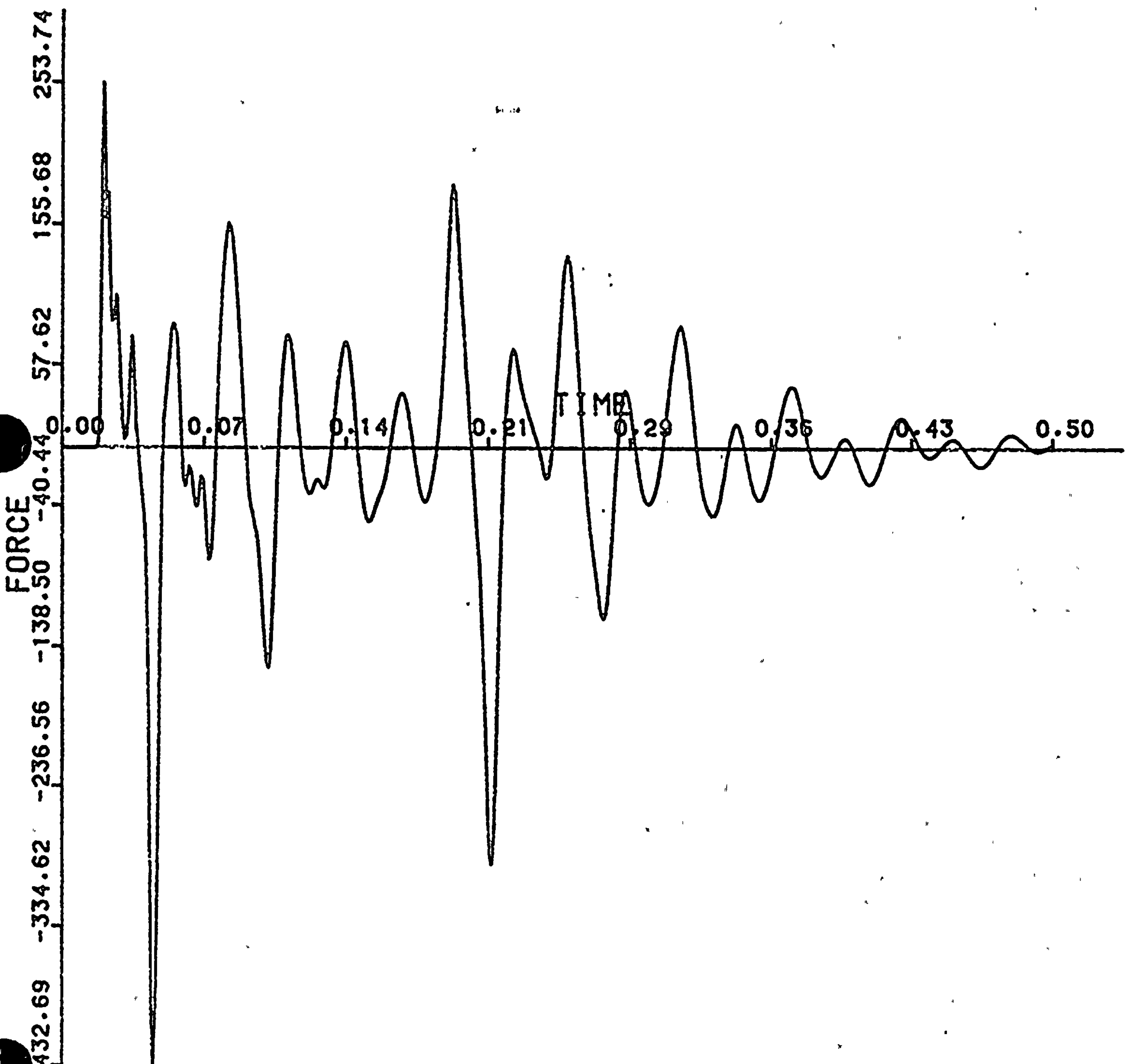
TIME/FORCE TABLE 19, MAGNITUDE AT NODE POINT 310



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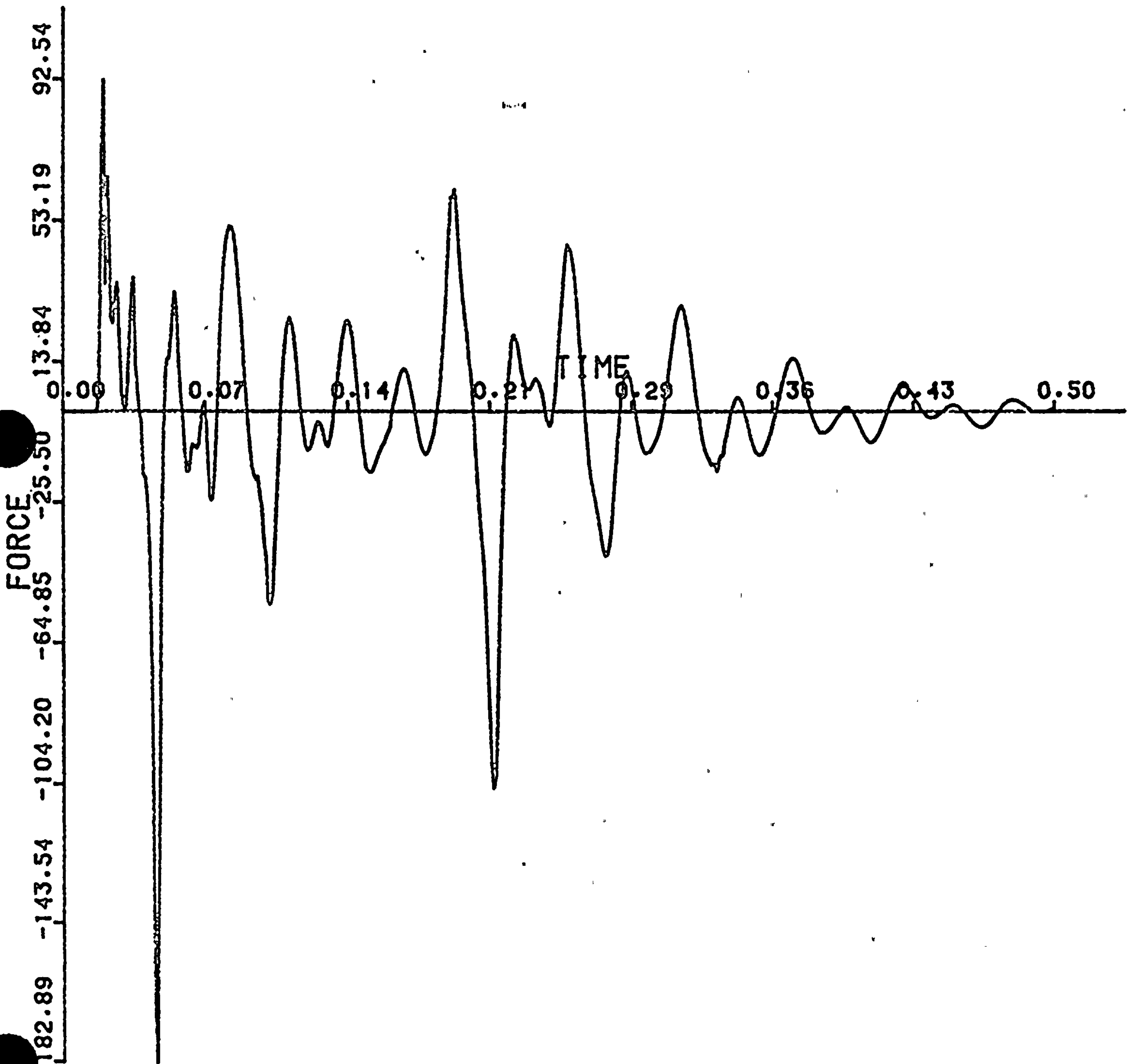
TIME/FORCE TABLE 20, MAGNITUDE AT NODE POINT 300



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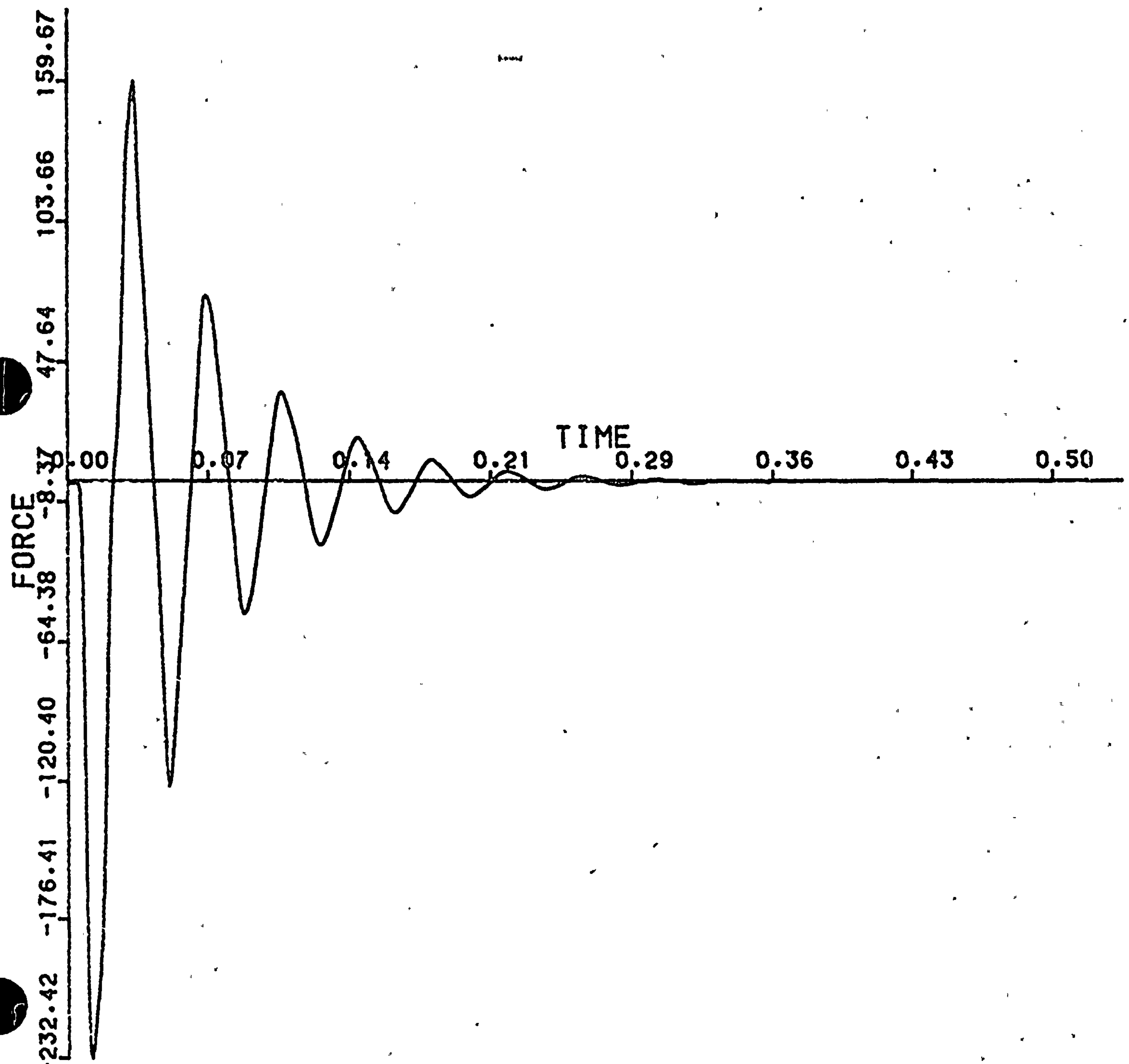

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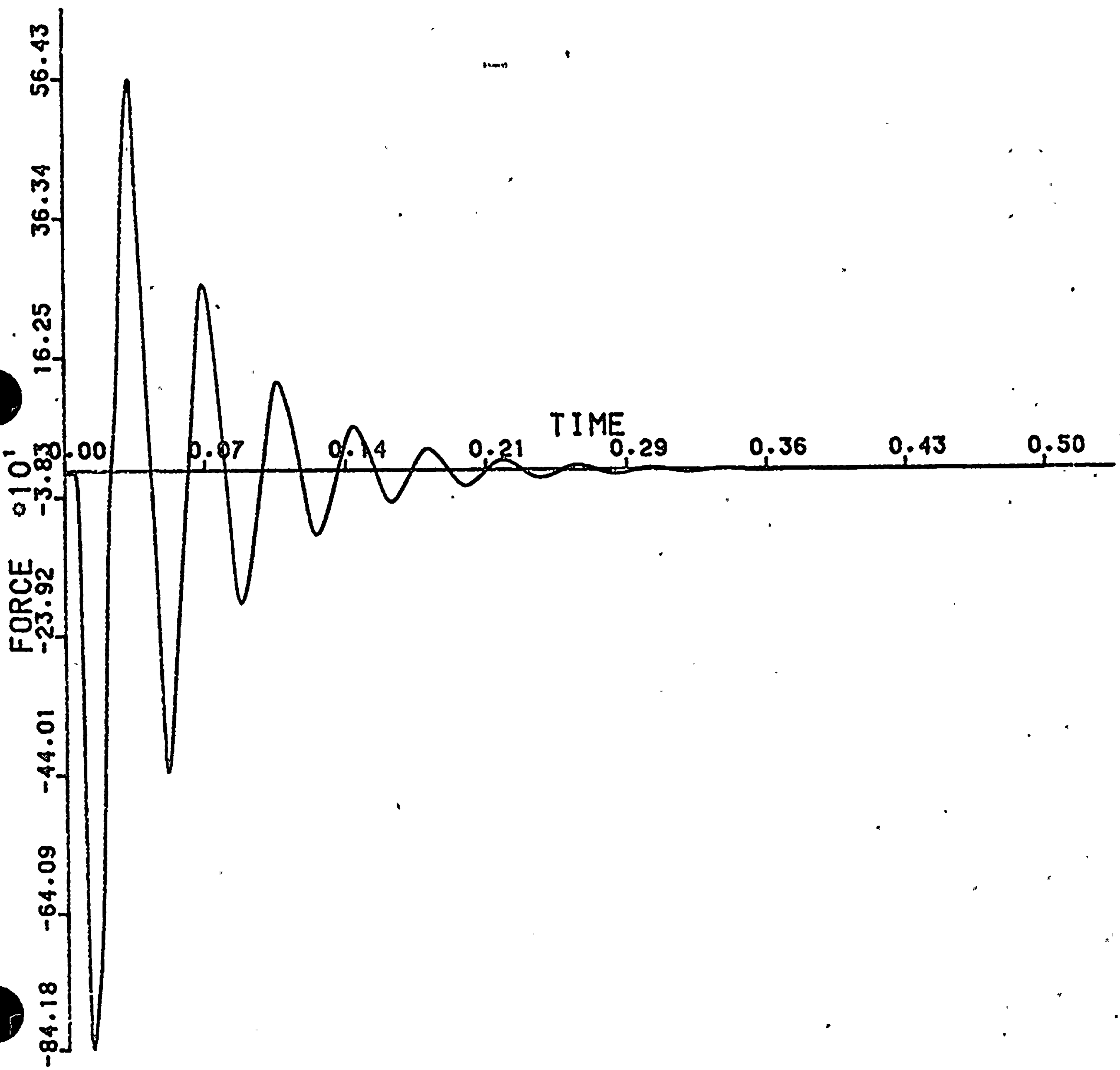
TIME/FORCE TABLE 22, MAGNITUDE AT NODE POINT 134



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ENGINEERING SERVICES

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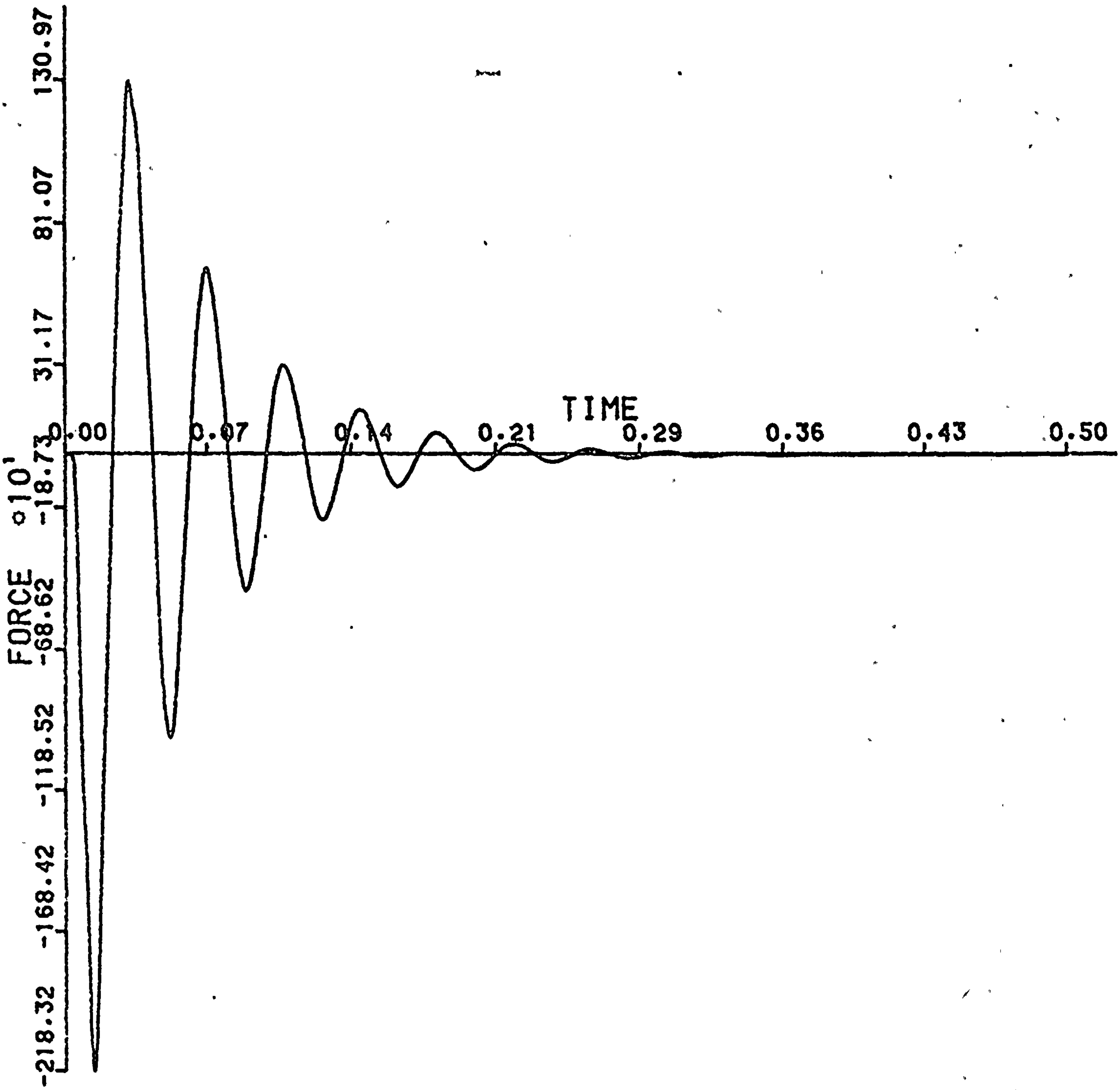
TIME/FORCE TABLE 23, MAGNITUDE AT NODE POINT 130



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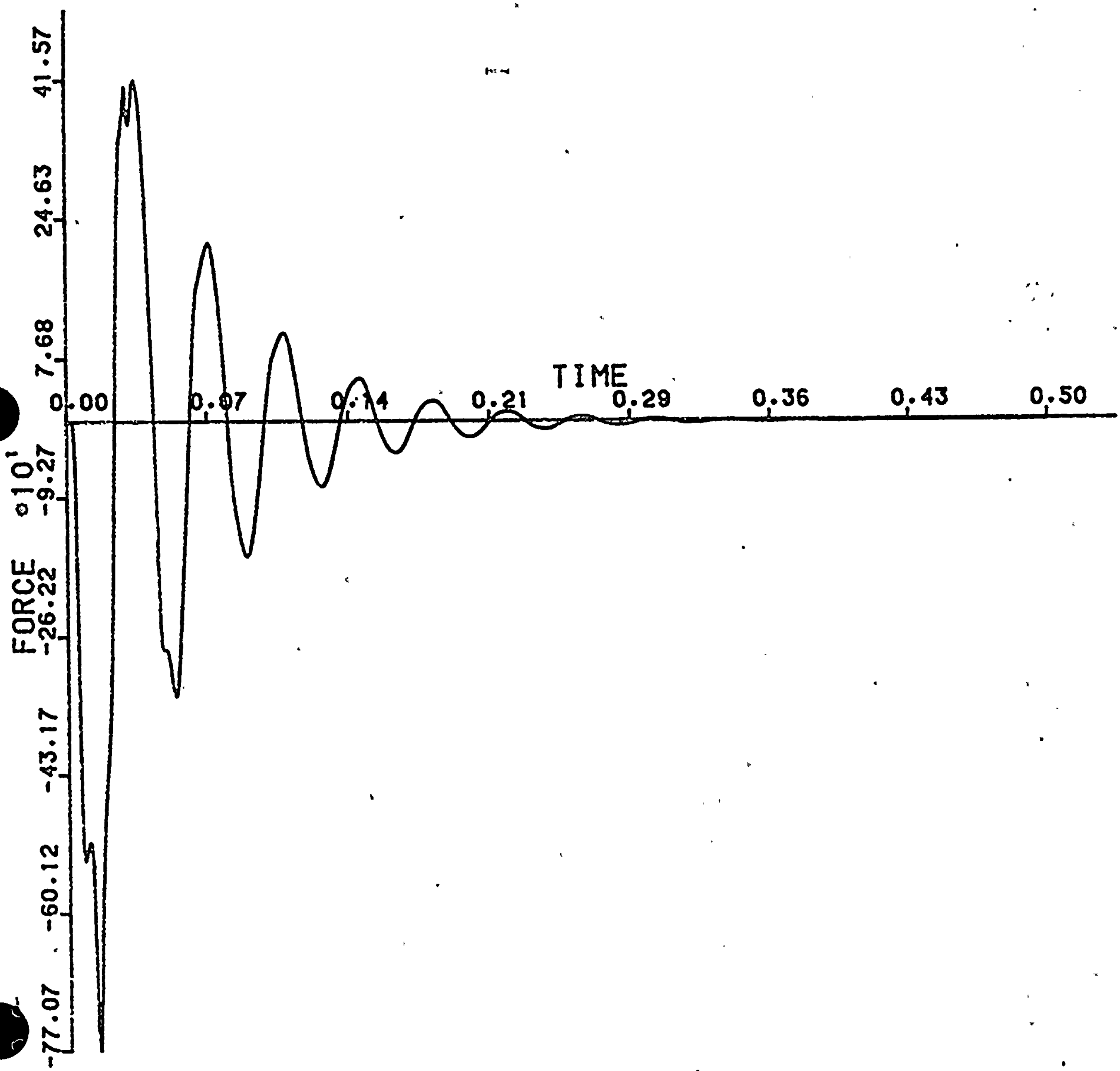

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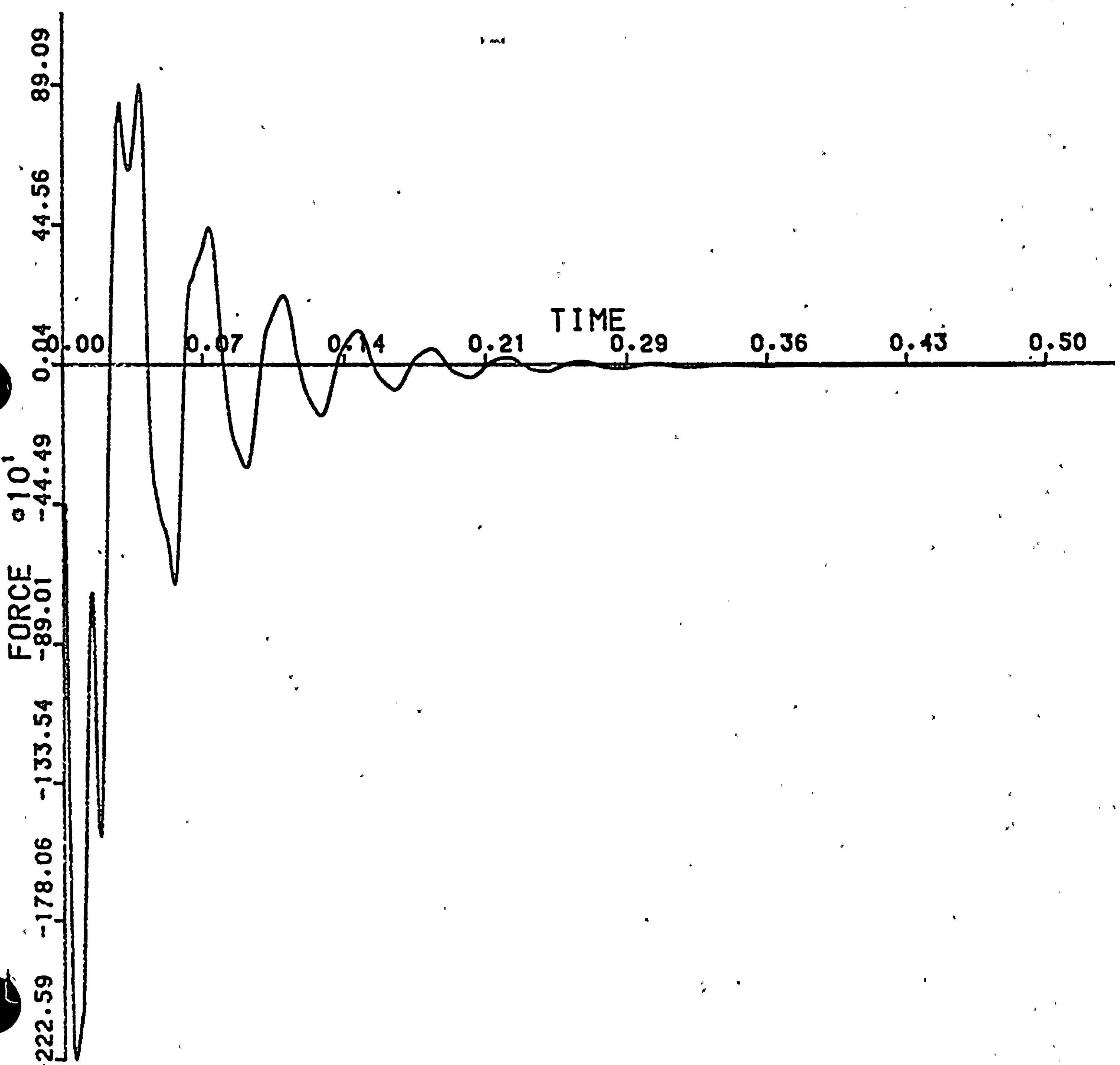
TIME/FORCE TABLE 25, MAGNITUDE AT NODE POINT 120



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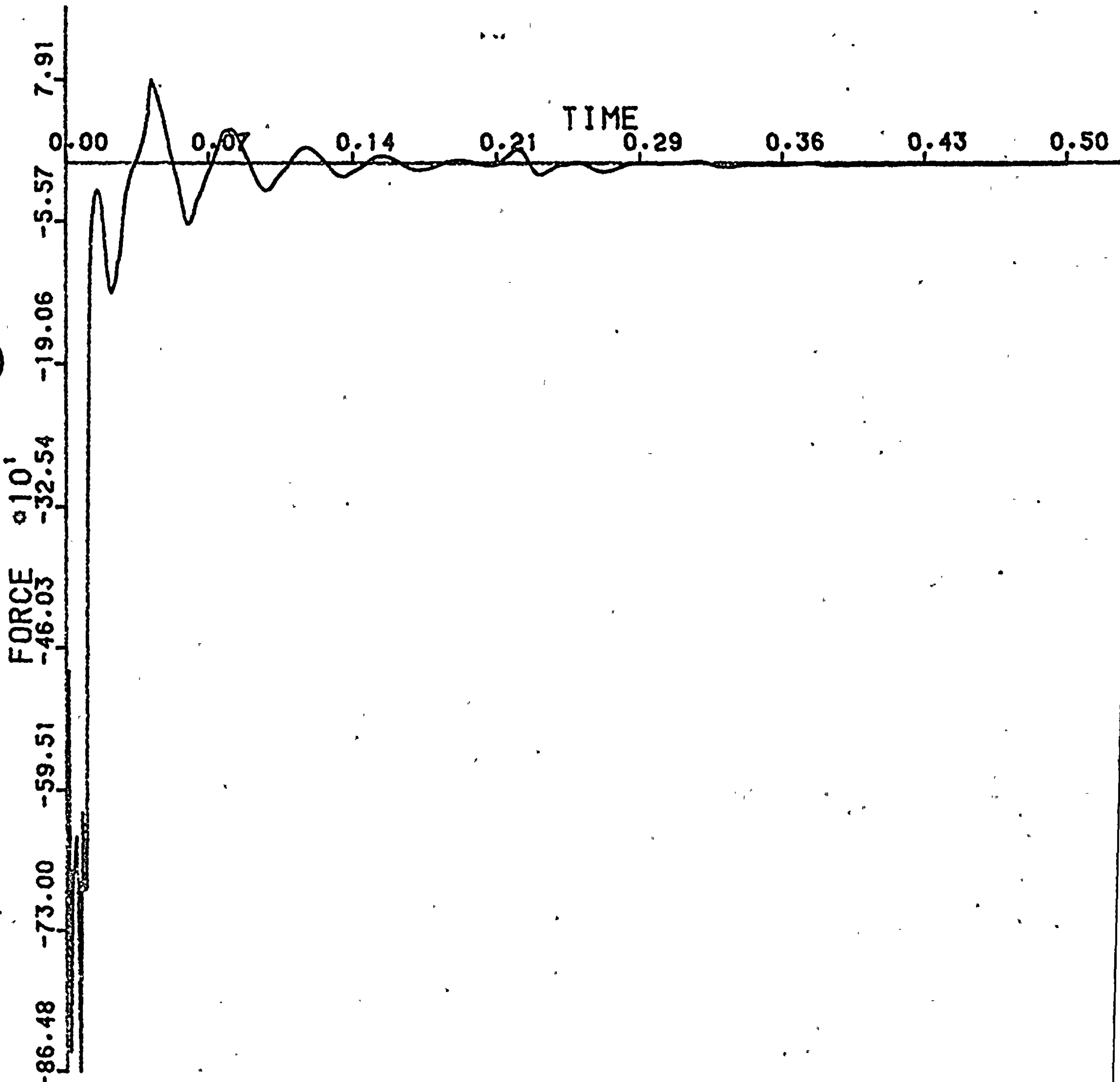

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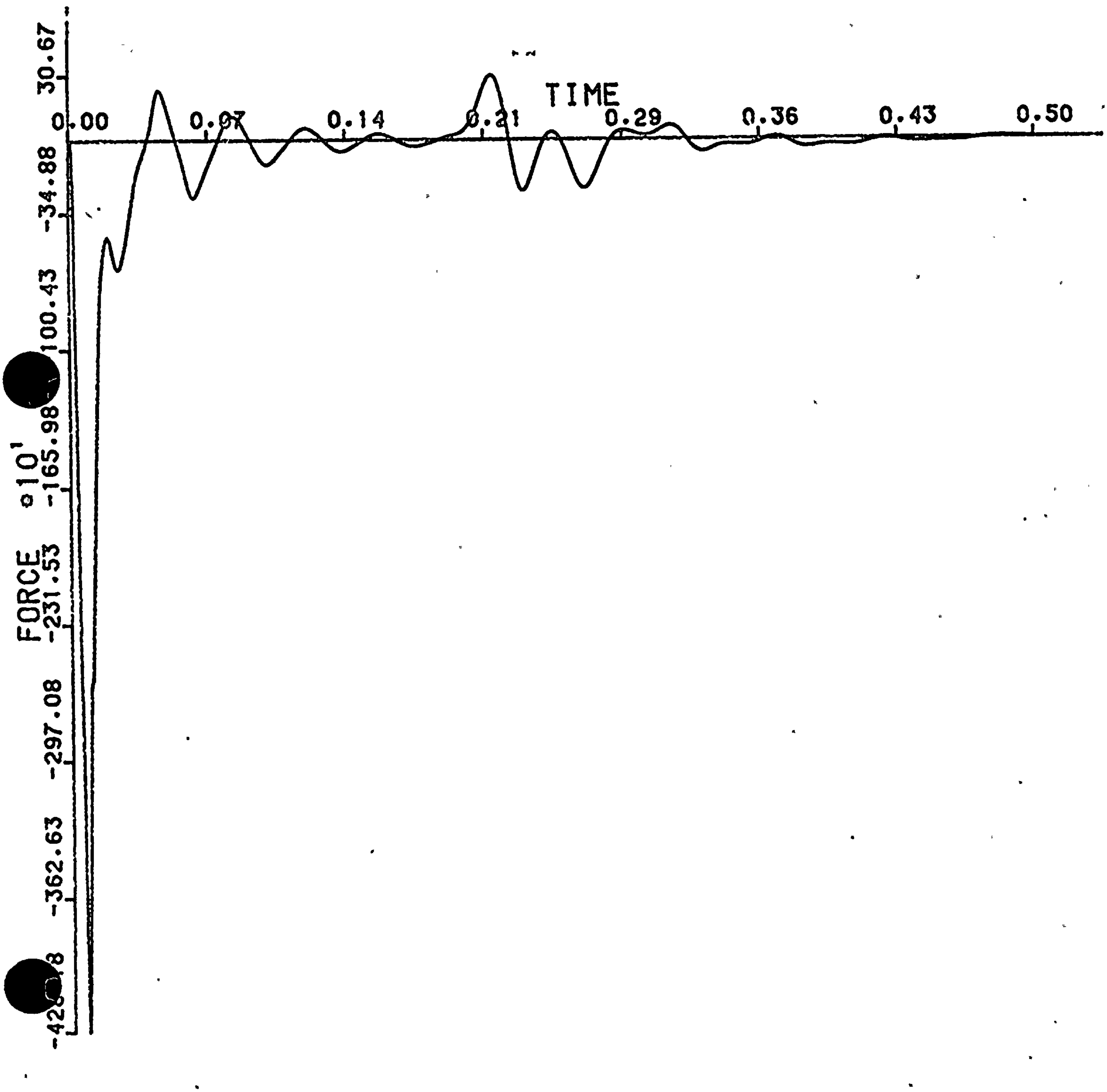
TIME/FORCE TABLE 27, MAGNITUDE AT NODE POINT 109



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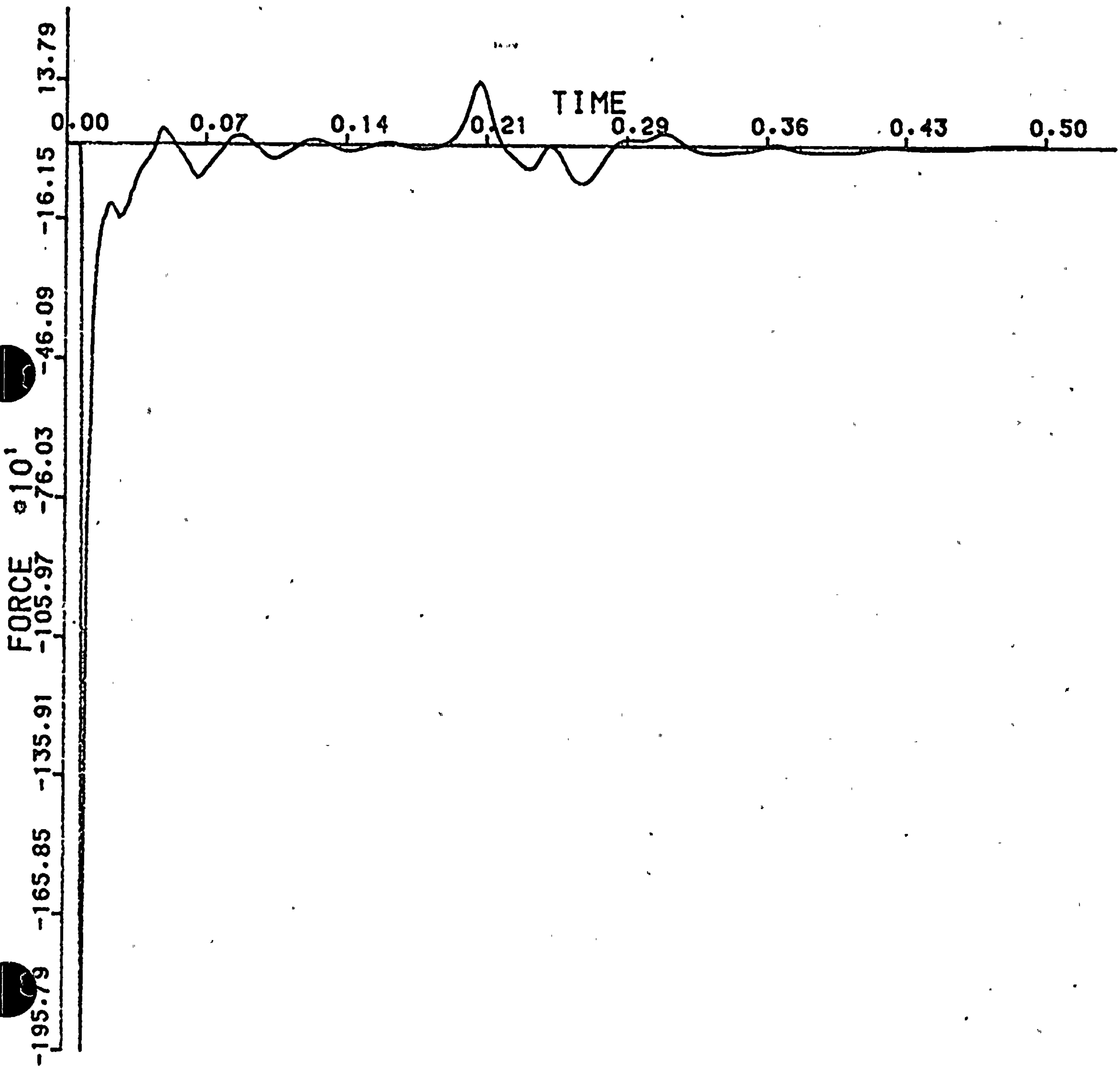

TELEDYNE ENGINEERING SERVICES

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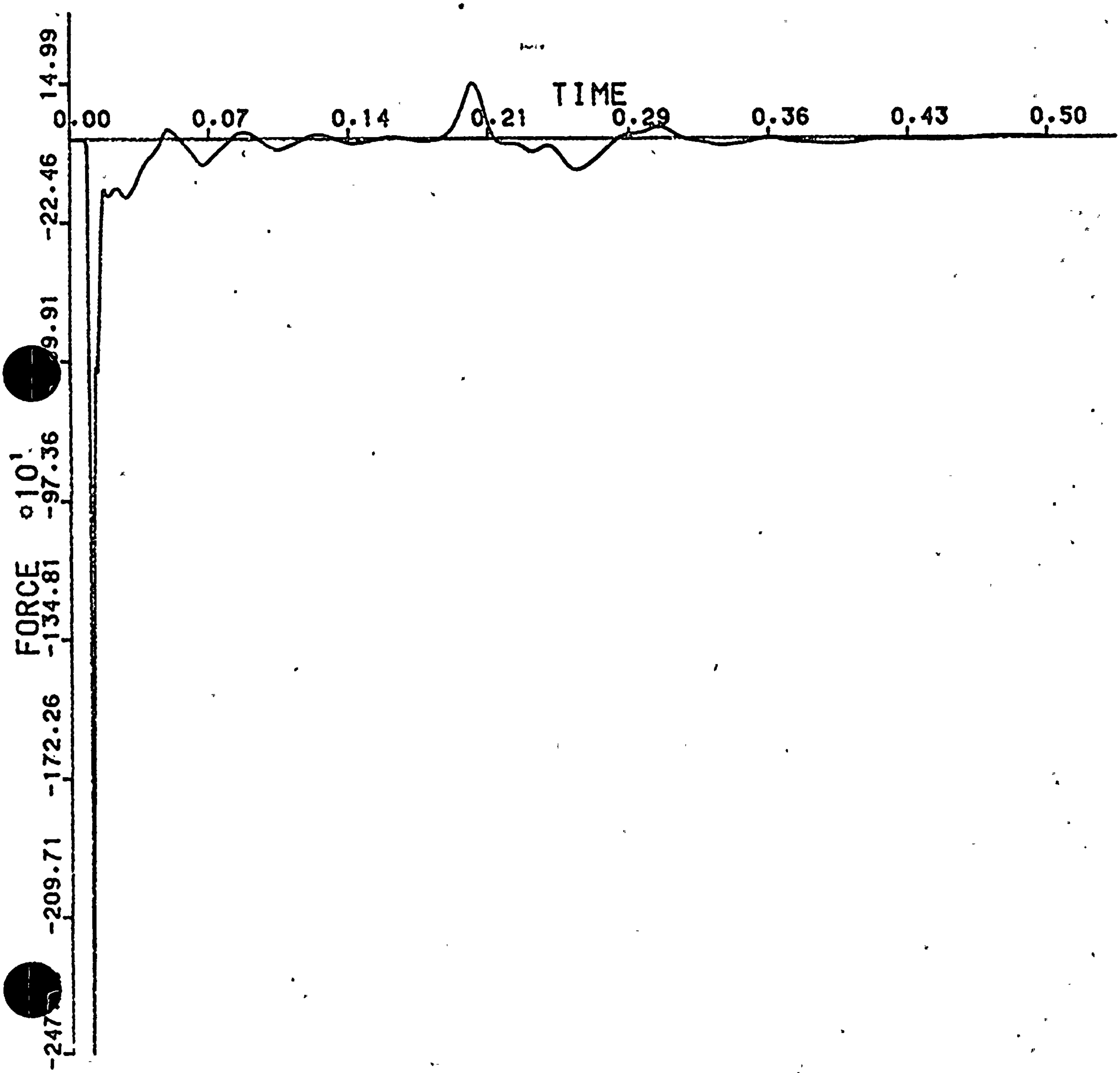
TIME/FORCE TABLE 29, MAGNITUDE AT NODE POINT 103



TELEDYNE ENGINEERING SERVICES

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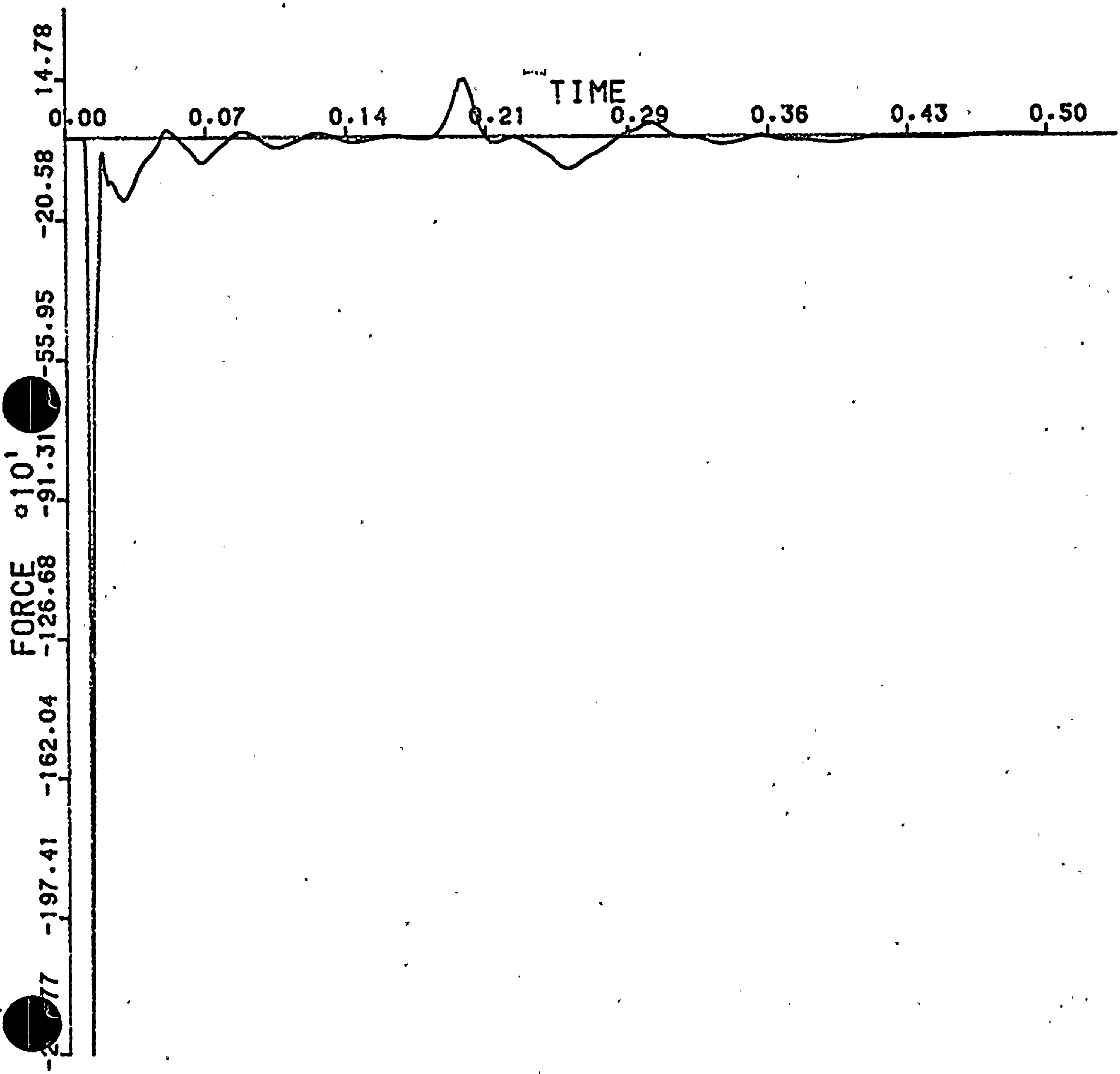
TIME/FORCE TABLE 30, MAGNITUDE AT NODE POINT 102



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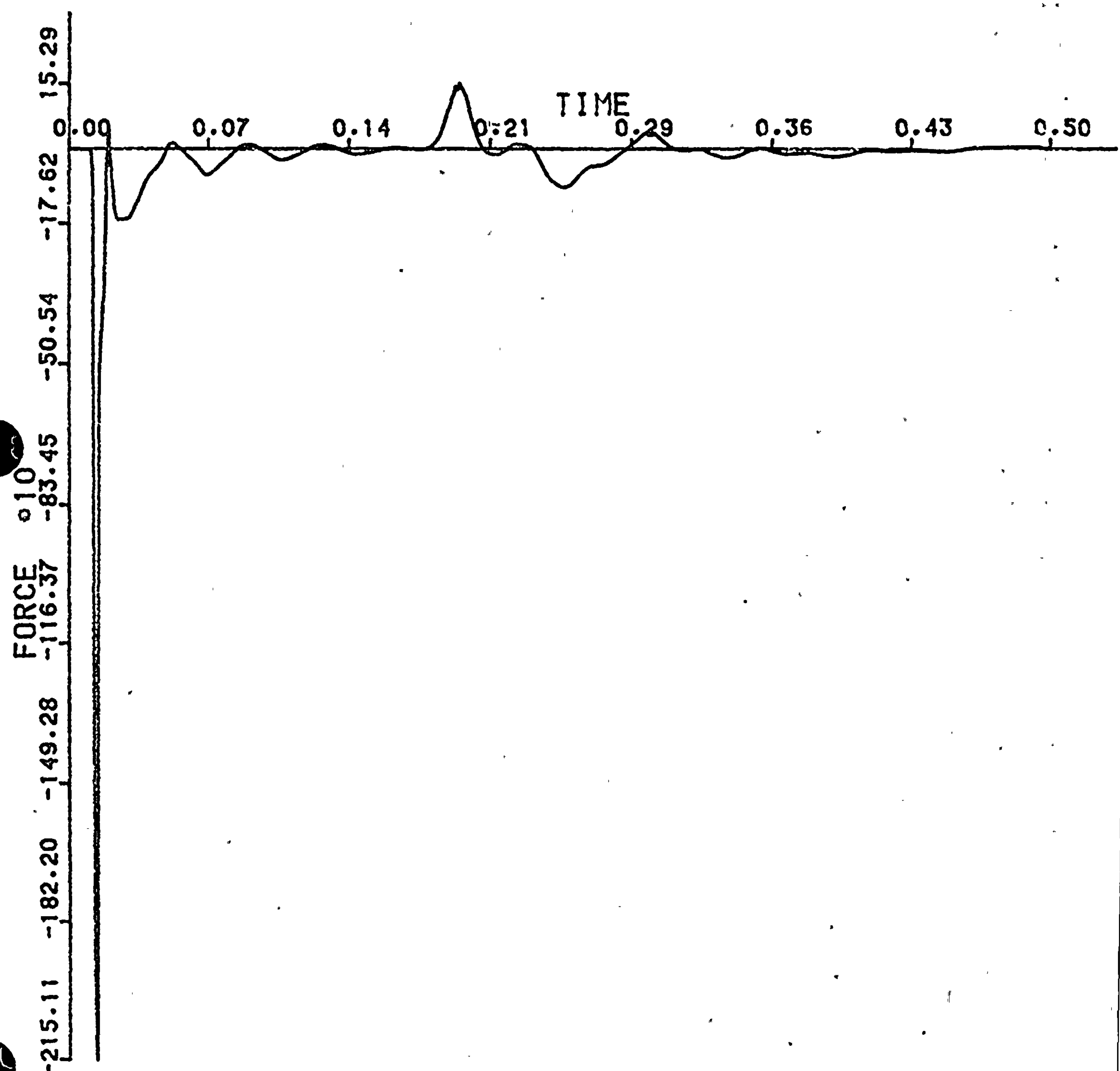
TIME/FORCE TABLE 31, MAGNITUDE AT NODE POINT 100



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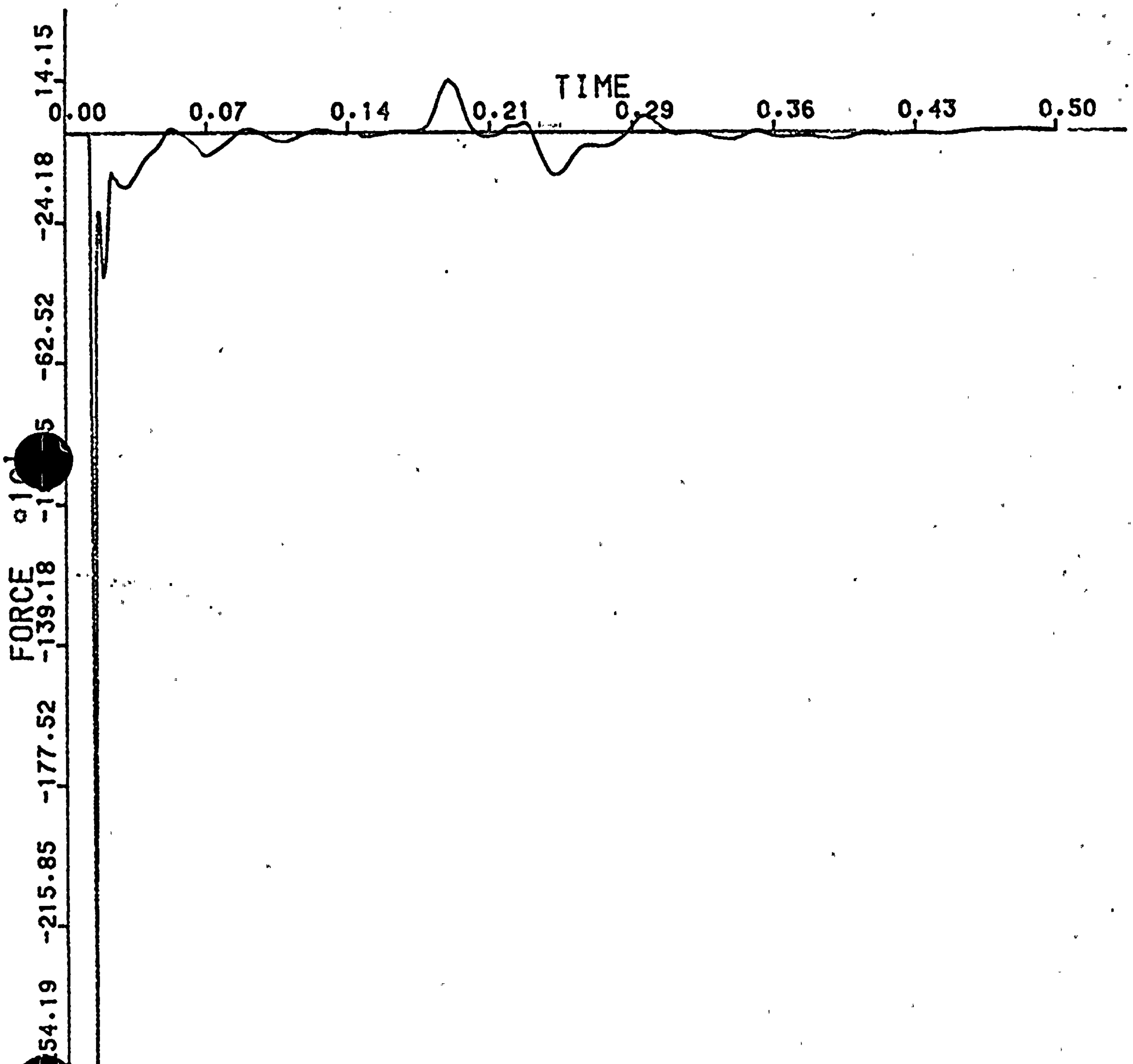
TIME/FORCE TABLE 32, MAGNITUDE AT NODE POINT 99



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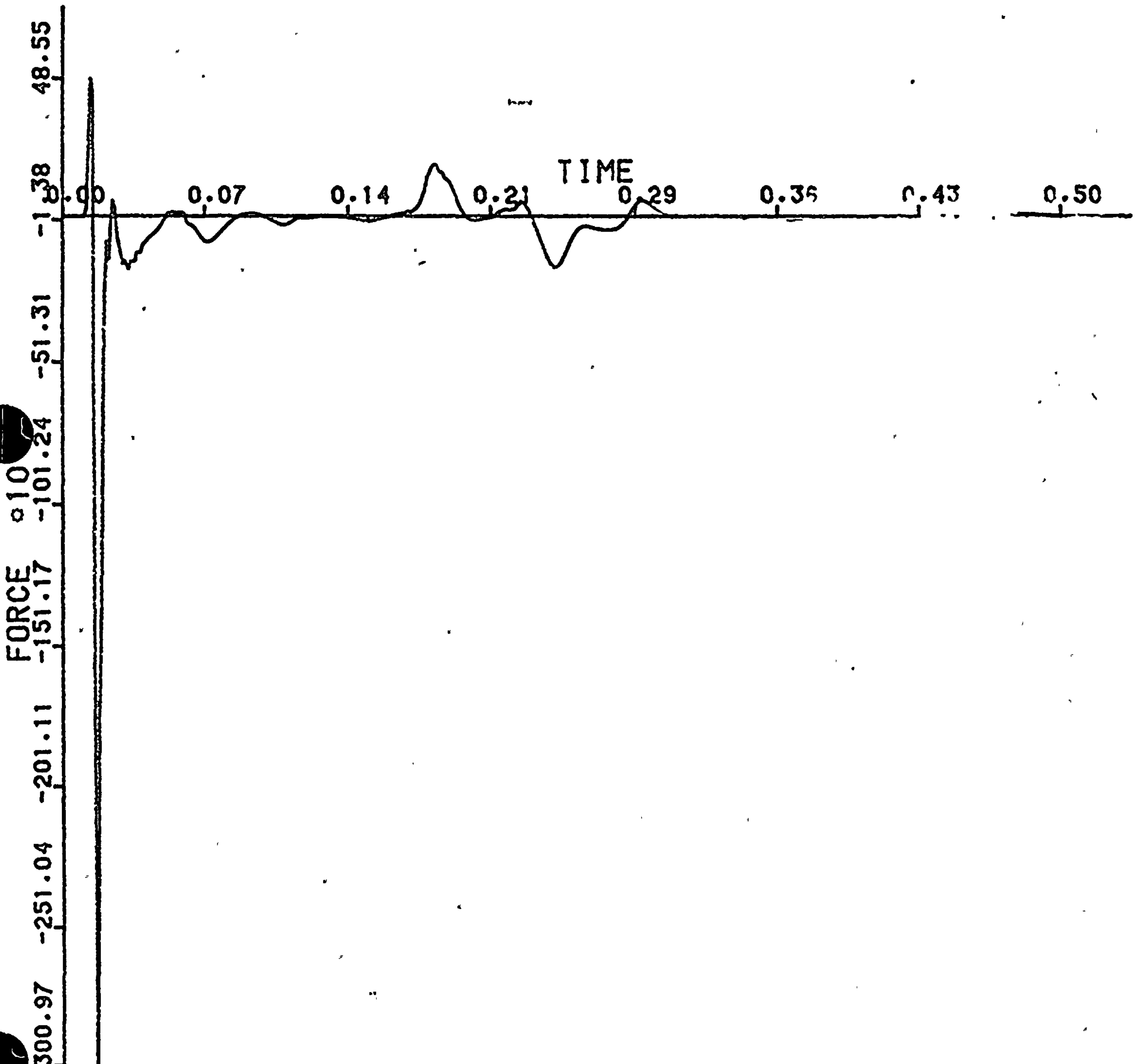
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 33, MAGNITUDE AT NODE POINT 98



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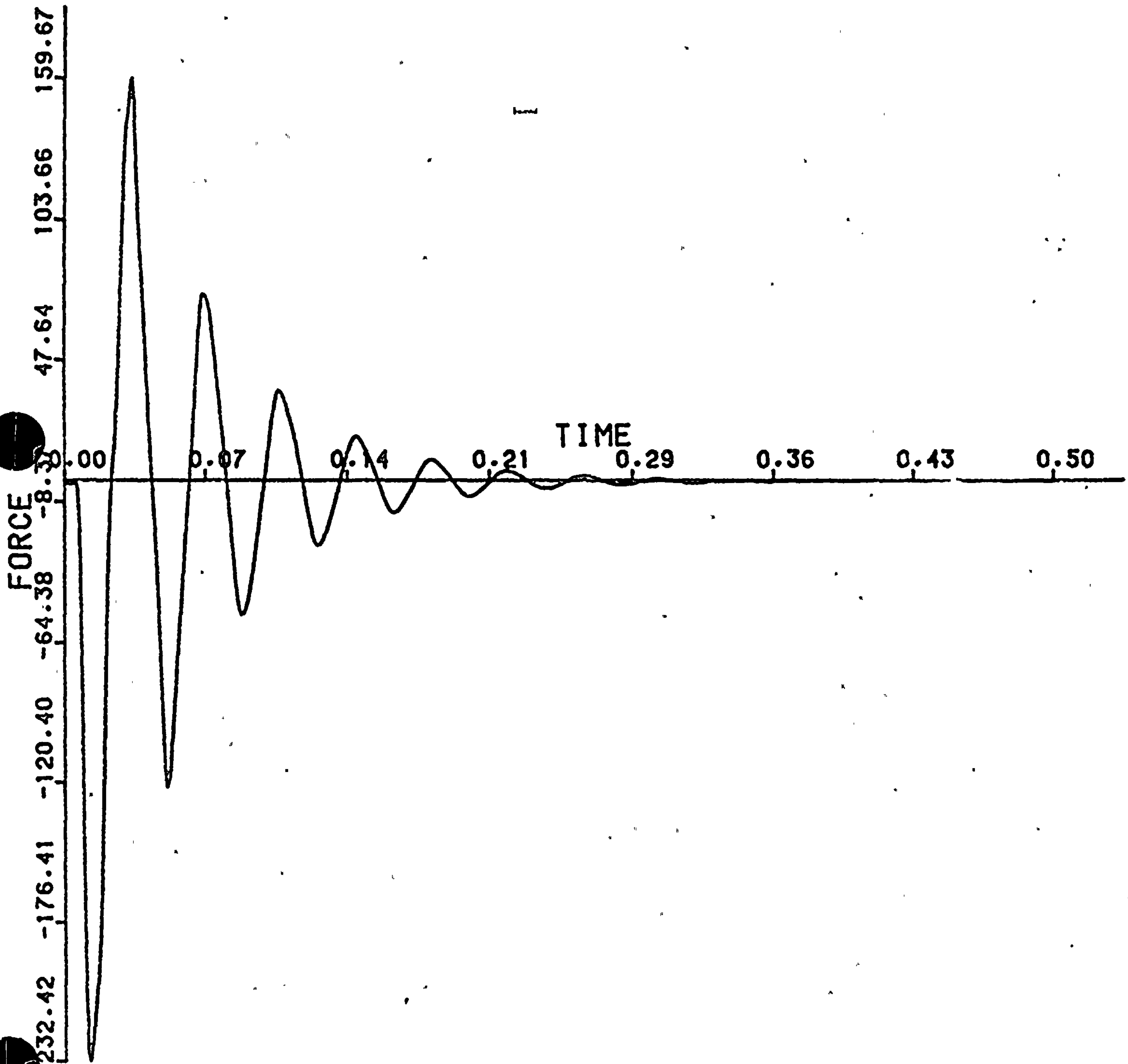
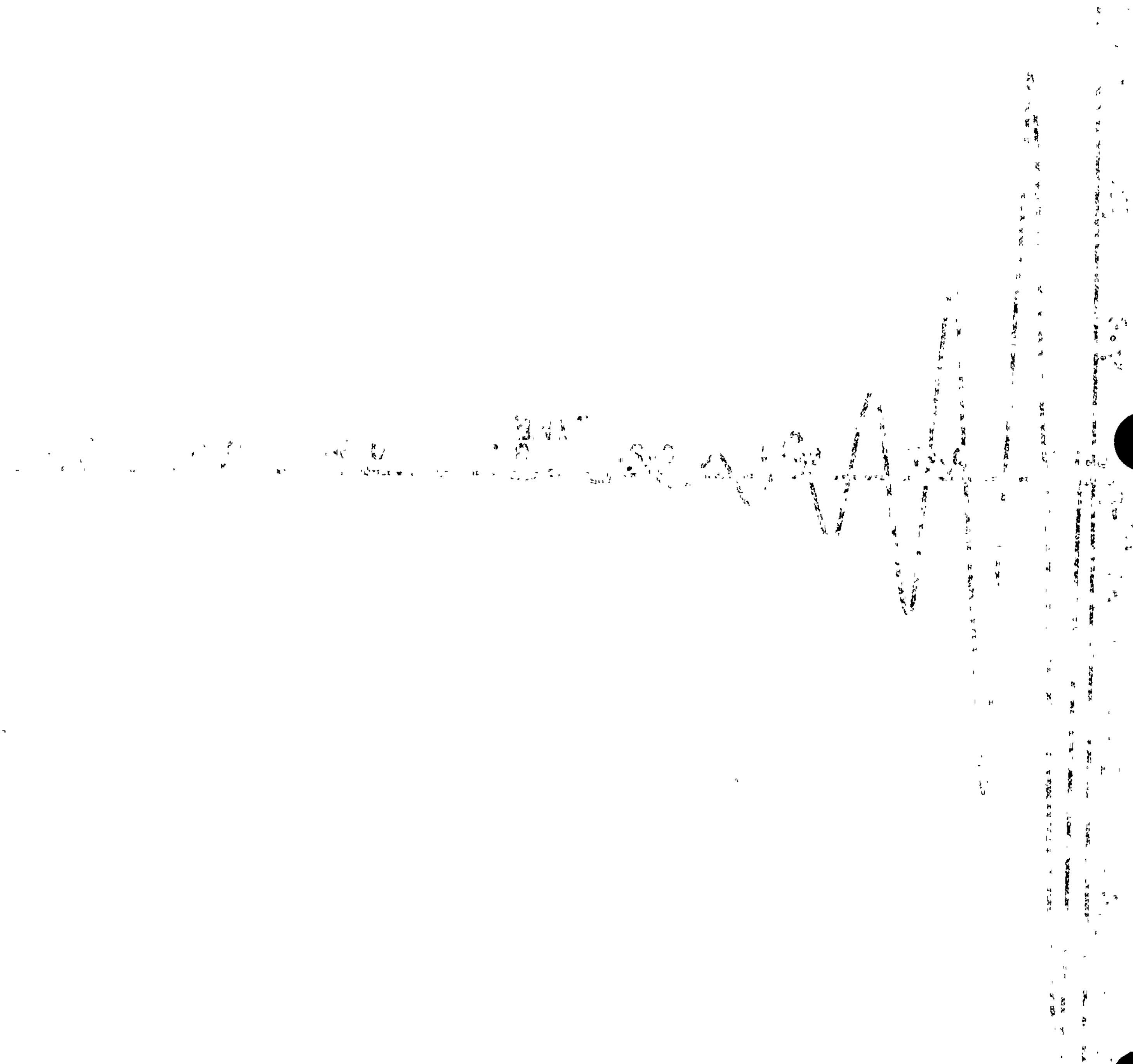
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 34, MAGNITUDE AT NODE POINT 184





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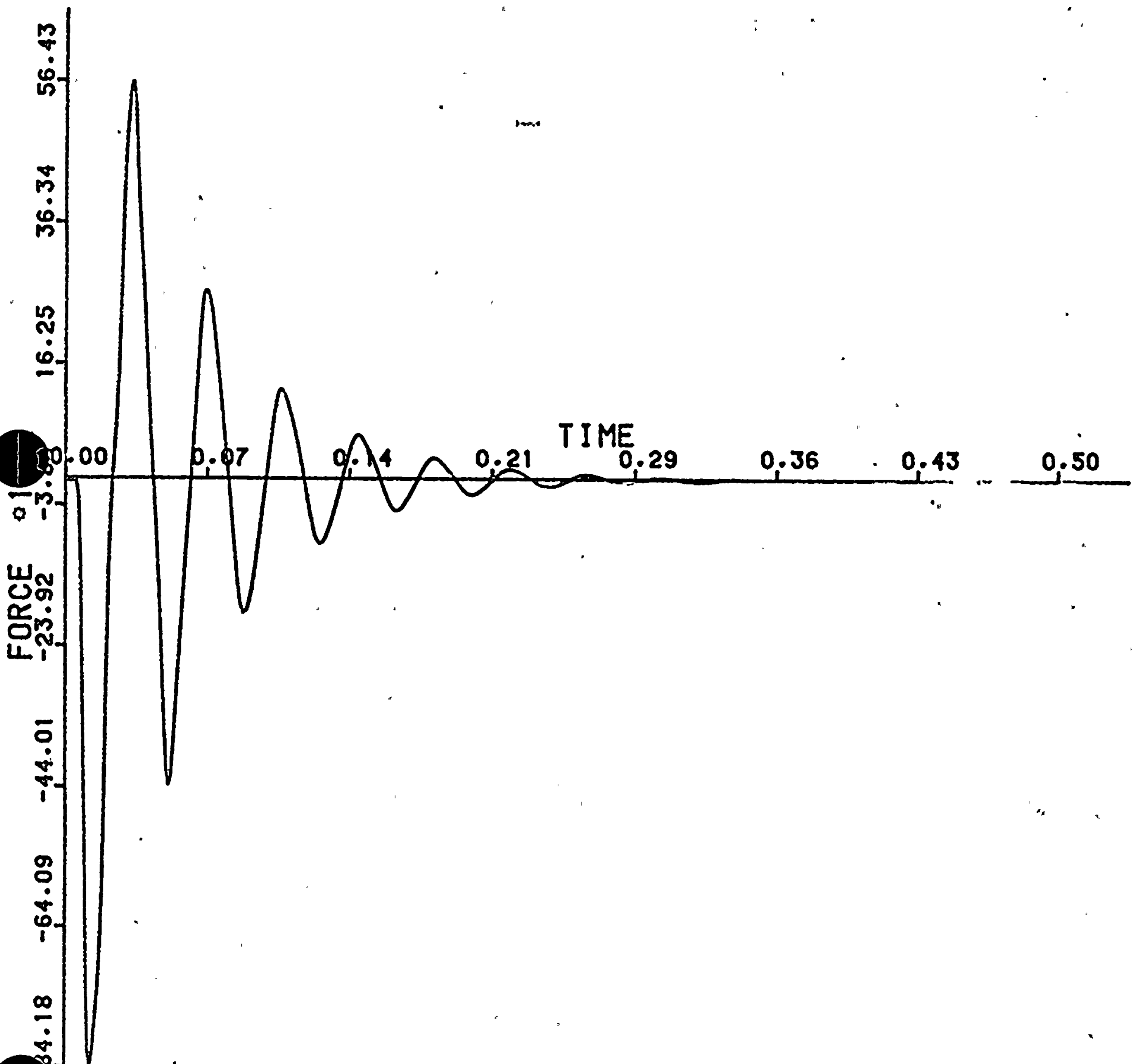
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 35, MAGNITUDE AT NODE POINT 182



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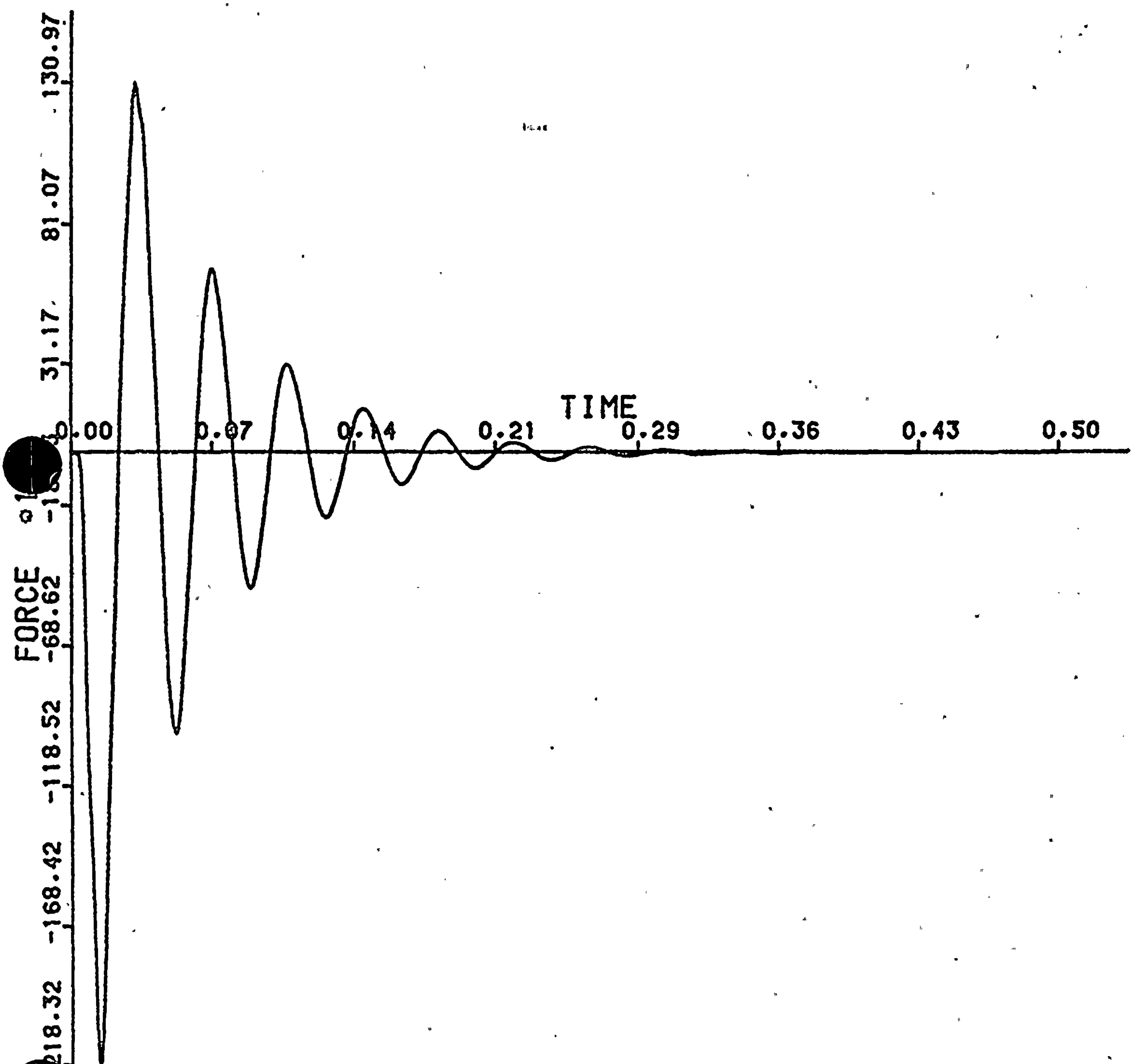
TIME/FORCE TABLE 36, MAGNITUDE AT NODE POINT 180



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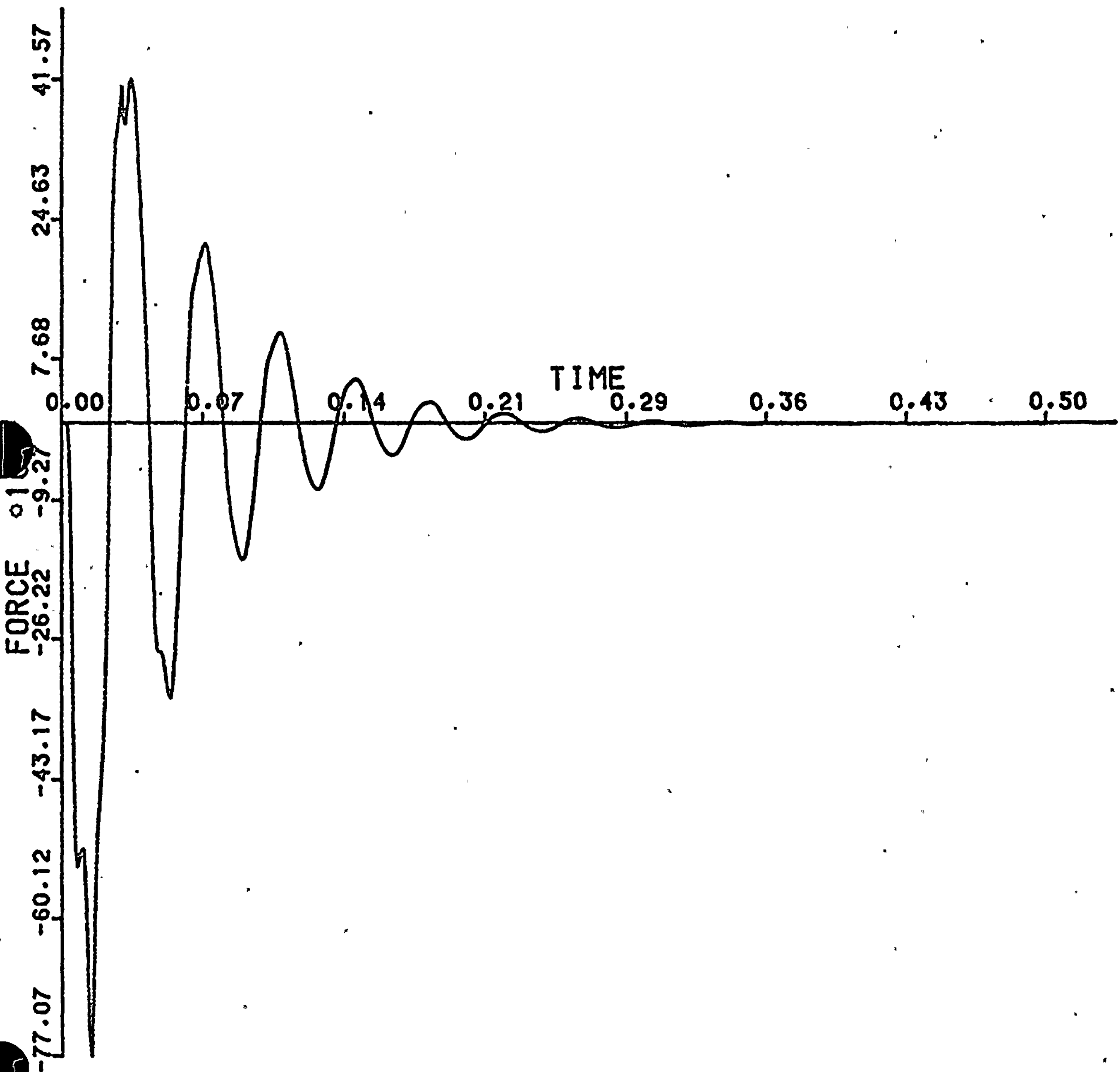
DC COOK-UNIT1, SV MODIFICATION

TIME/FORCE TABLE 37, MAGNITUDE AT NODE POINT 176



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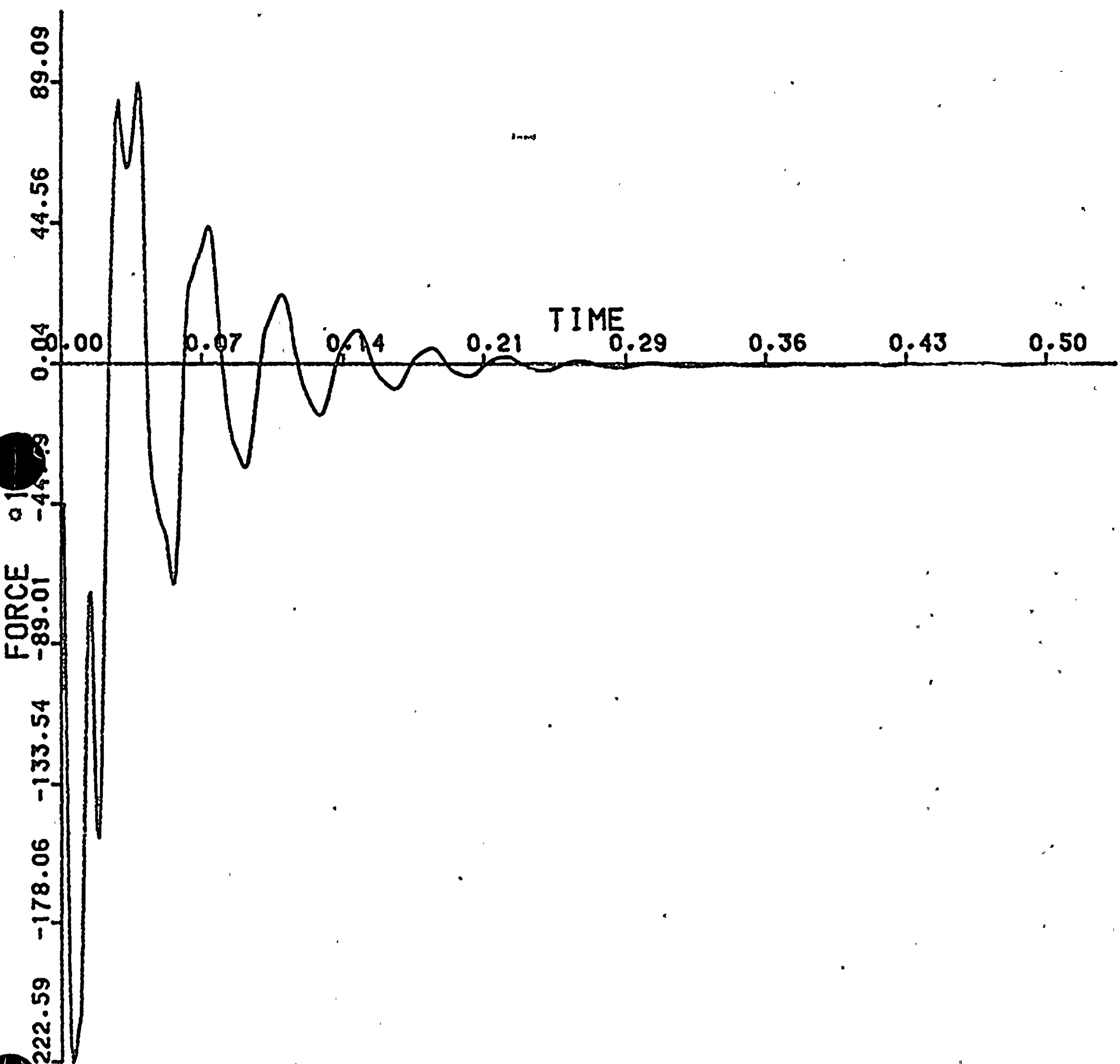
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 38, MAGNITUDE AT NODE POINT 170



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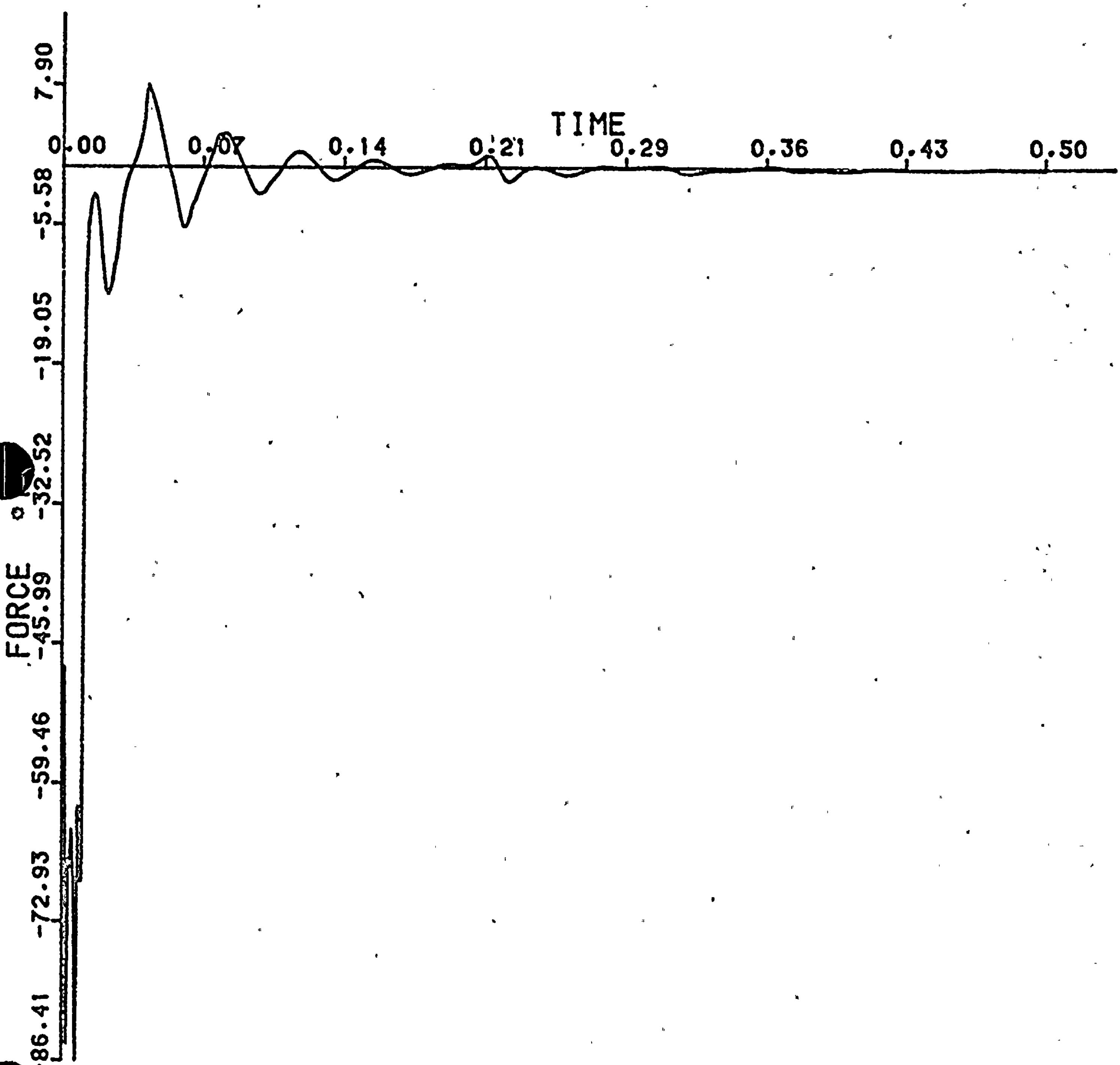
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 39, MAGNITUDE AT NODE POINT 163



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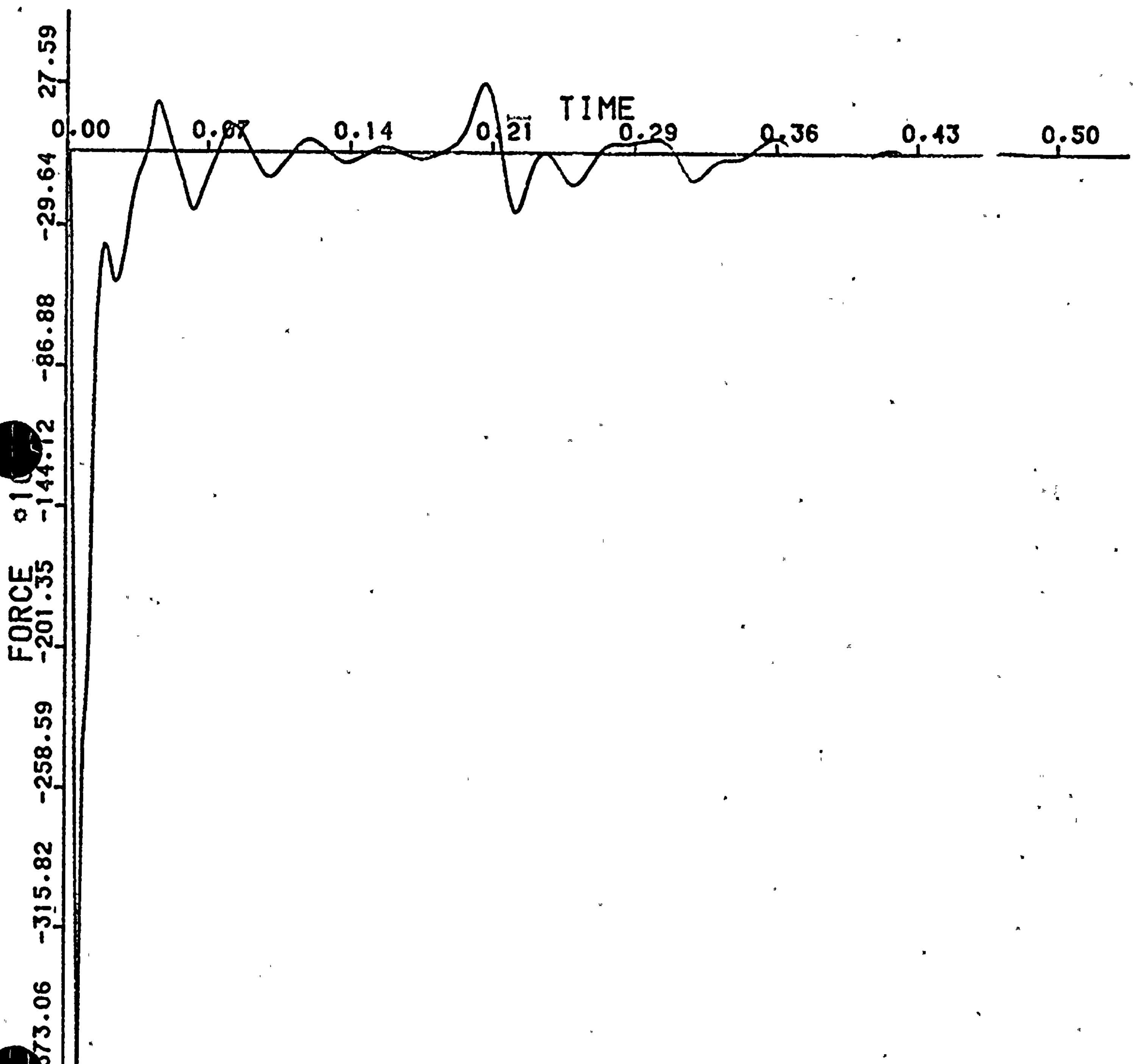
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 40, MAGNITUDE AT NODE POINT 157



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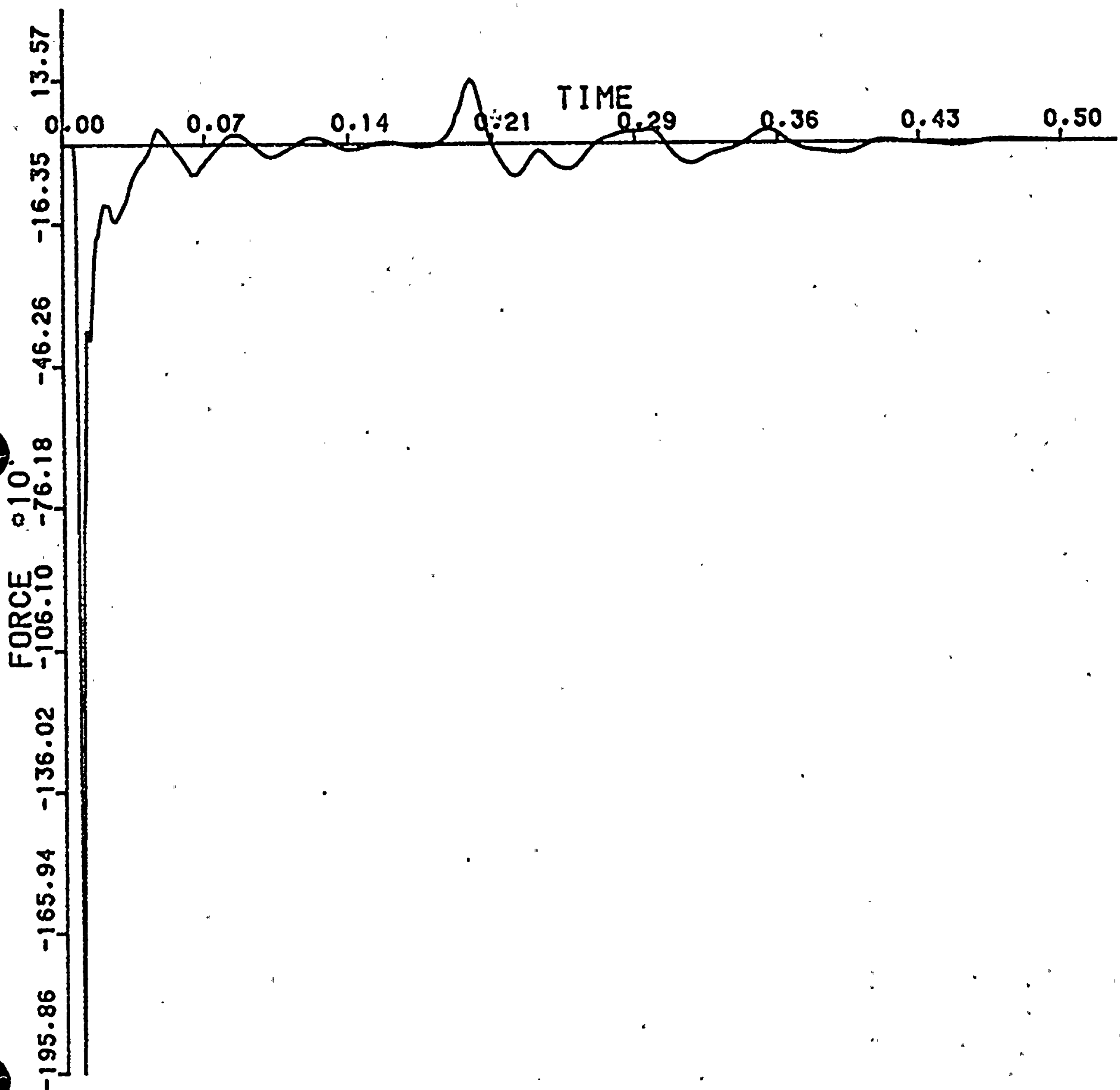
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 41, MAGNITUDE AT NODE POINT 150



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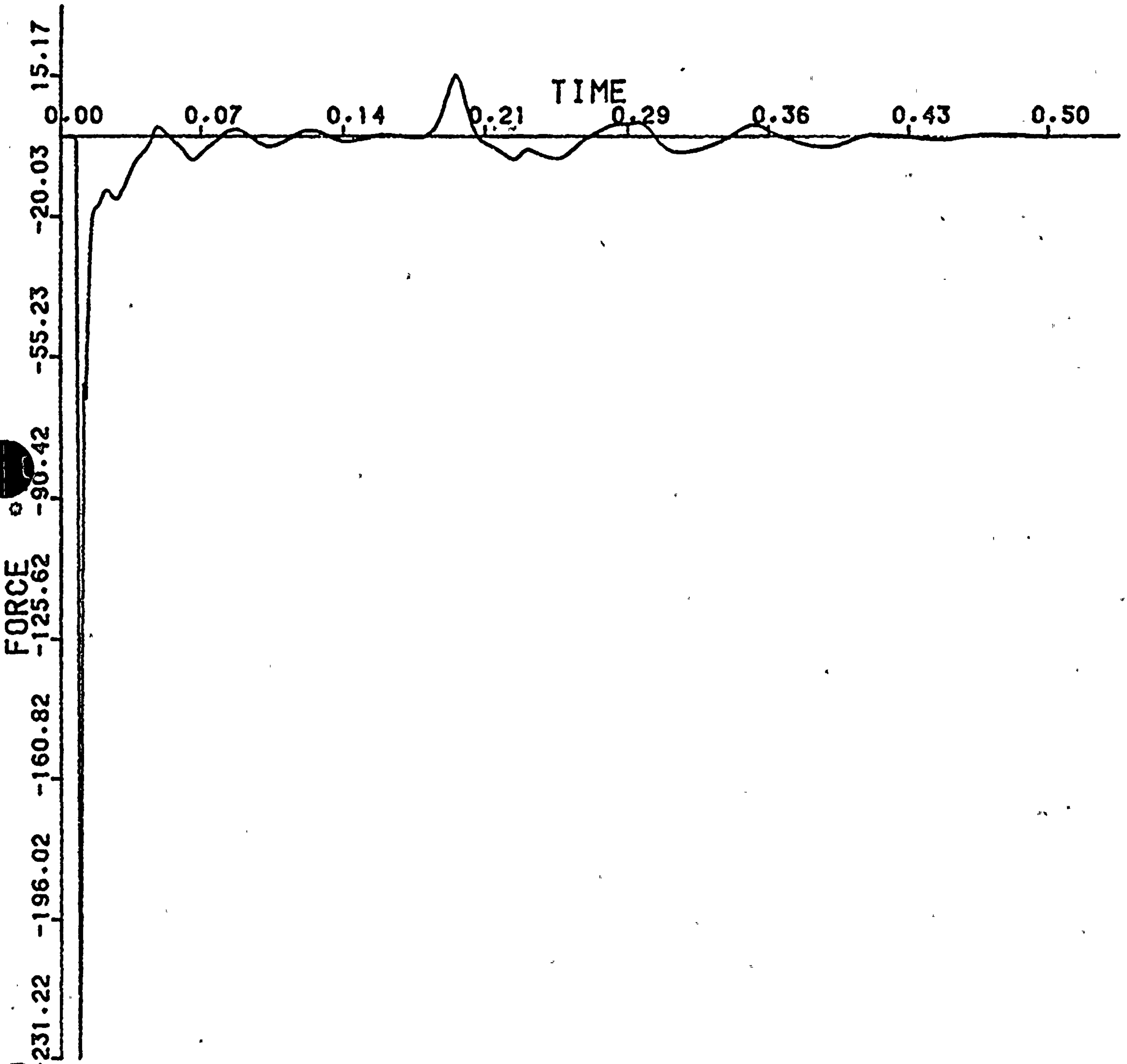
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 42, MAGNITUDE AT NODE POINT 148



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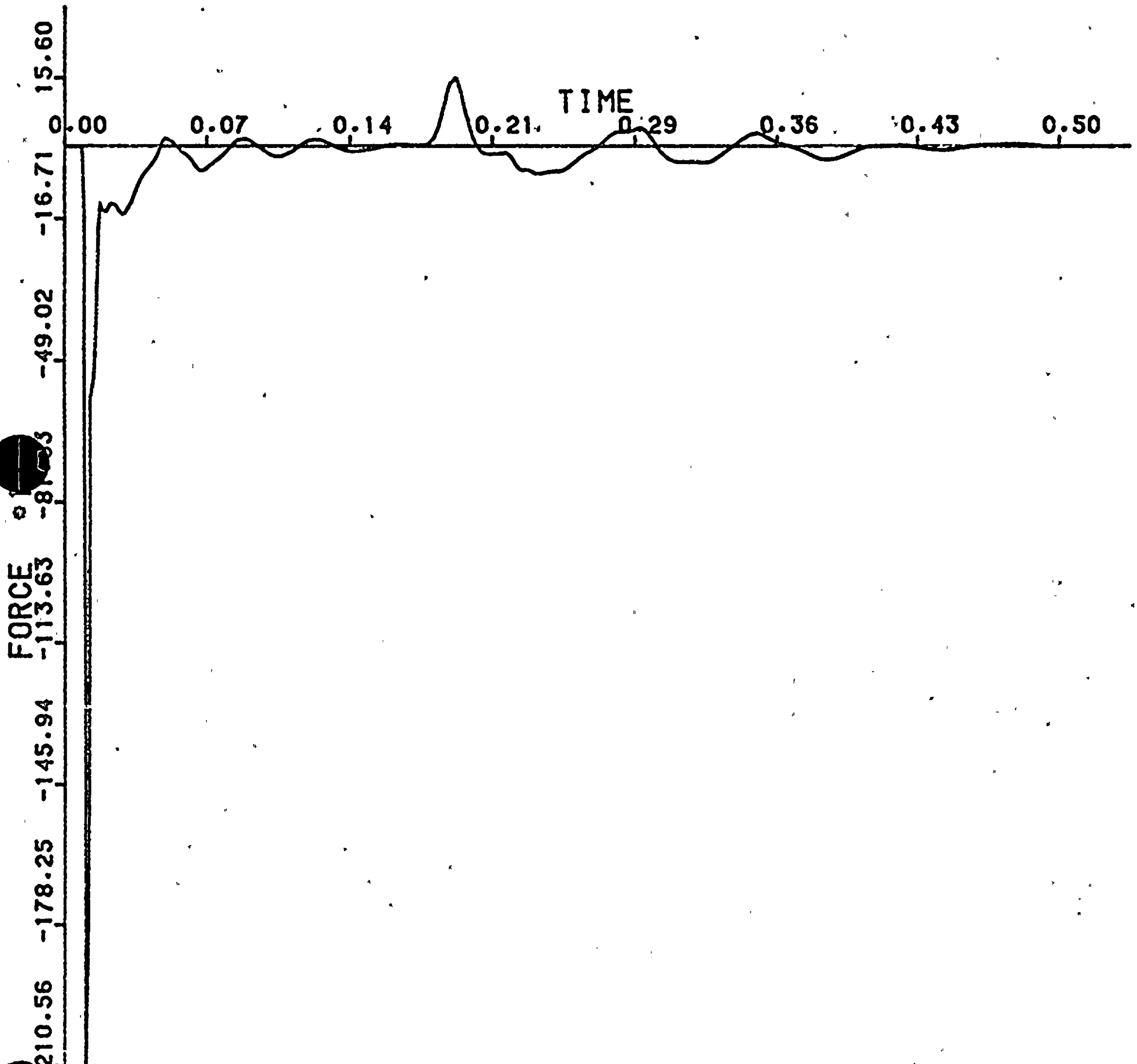
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 43, MAGNITUDE AT NODE POINT 146



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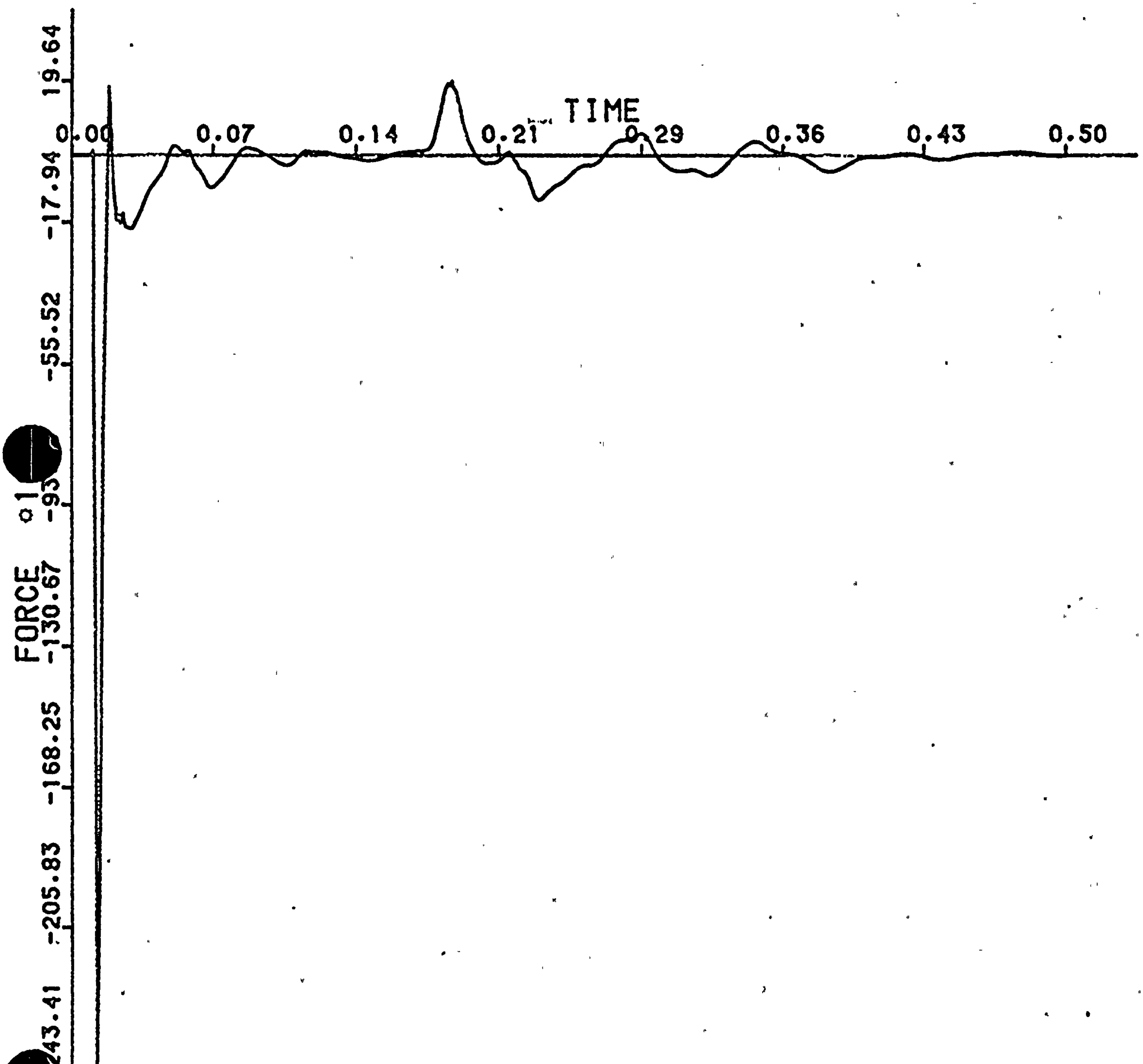
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 44, MAGNITUDE AT NODE POINT 144



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DC COOK-UNIT1, SV MODIFICATION
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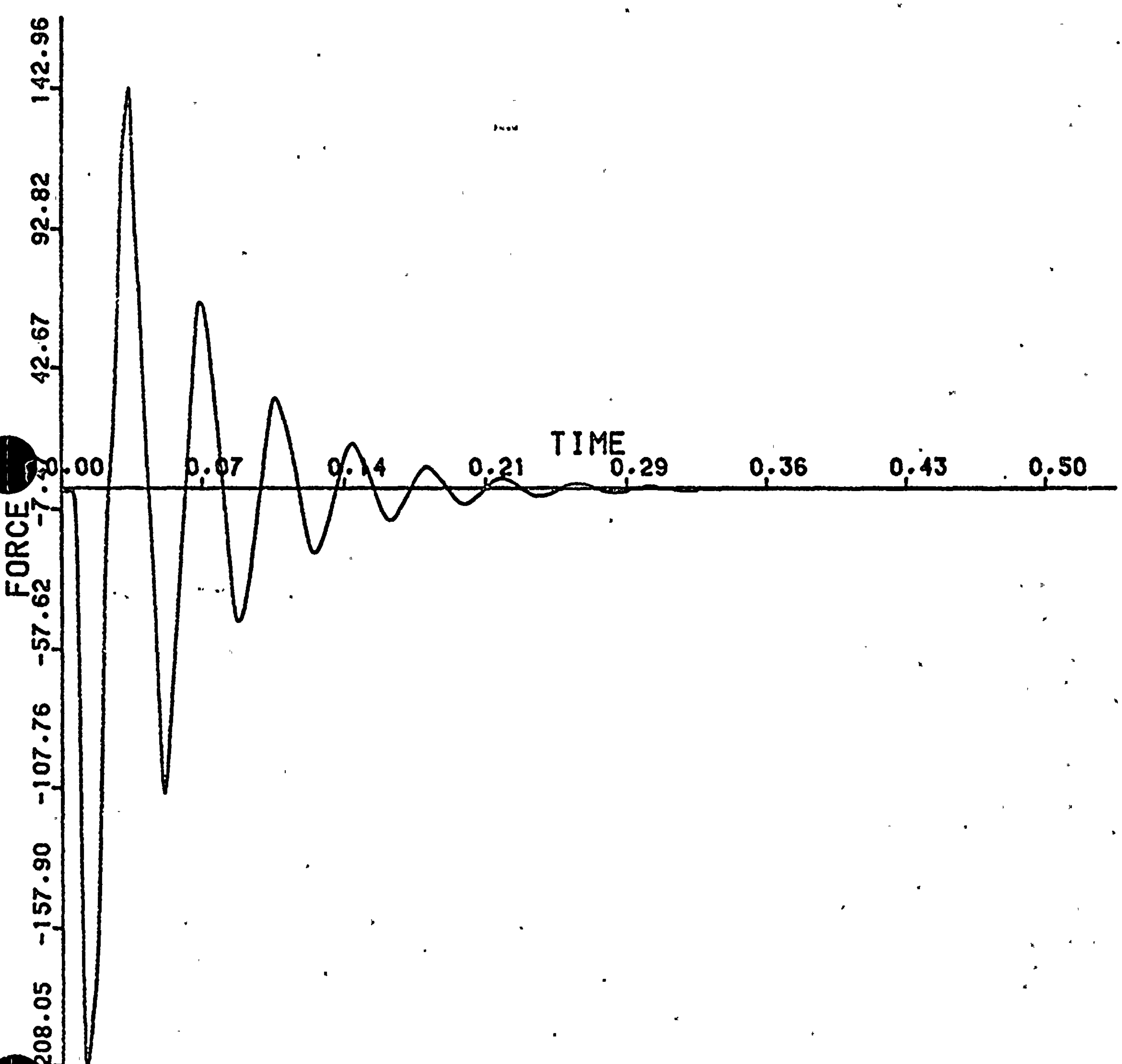

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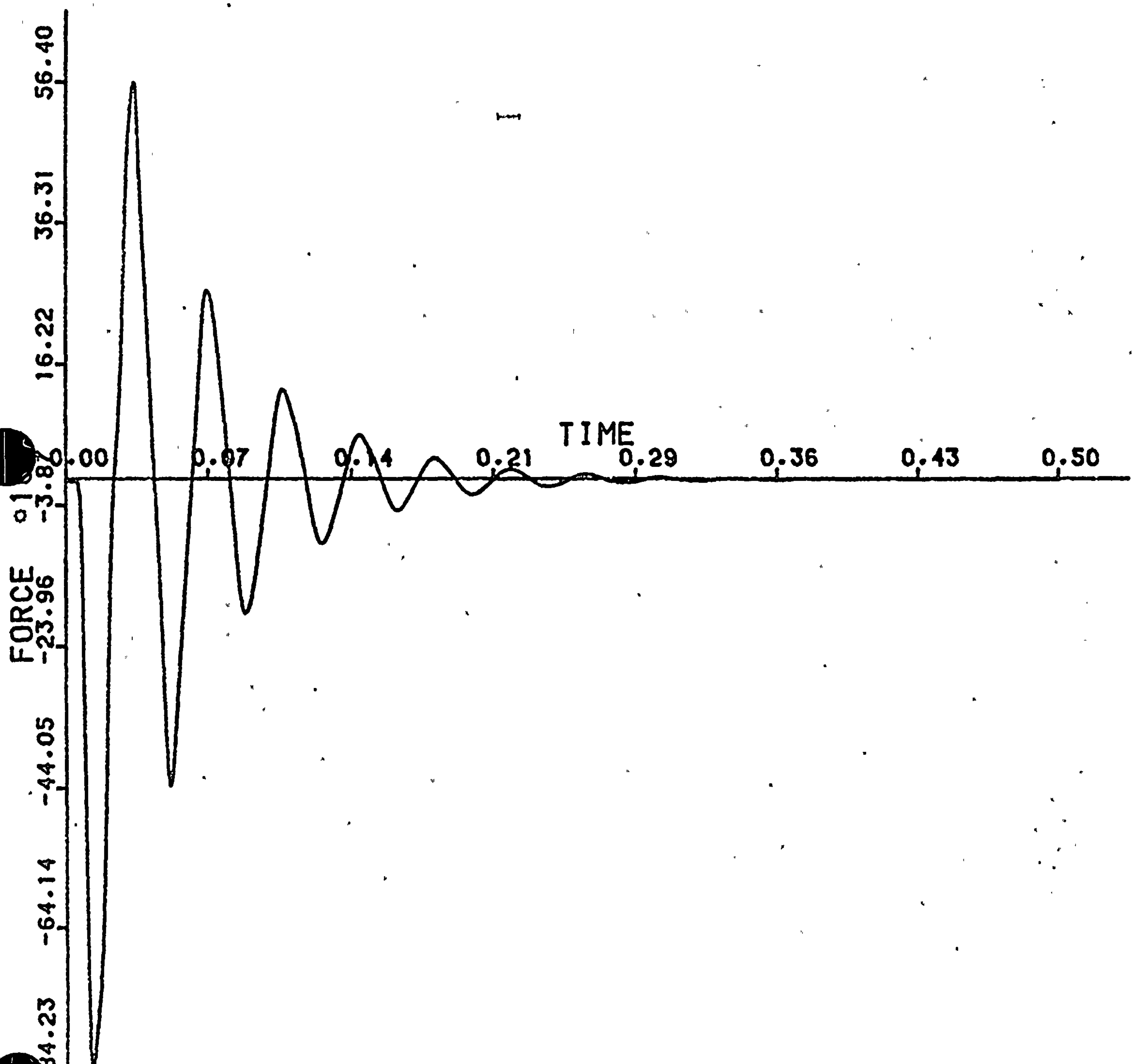
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 46, MAGNITUDE AT NODE POINT 240



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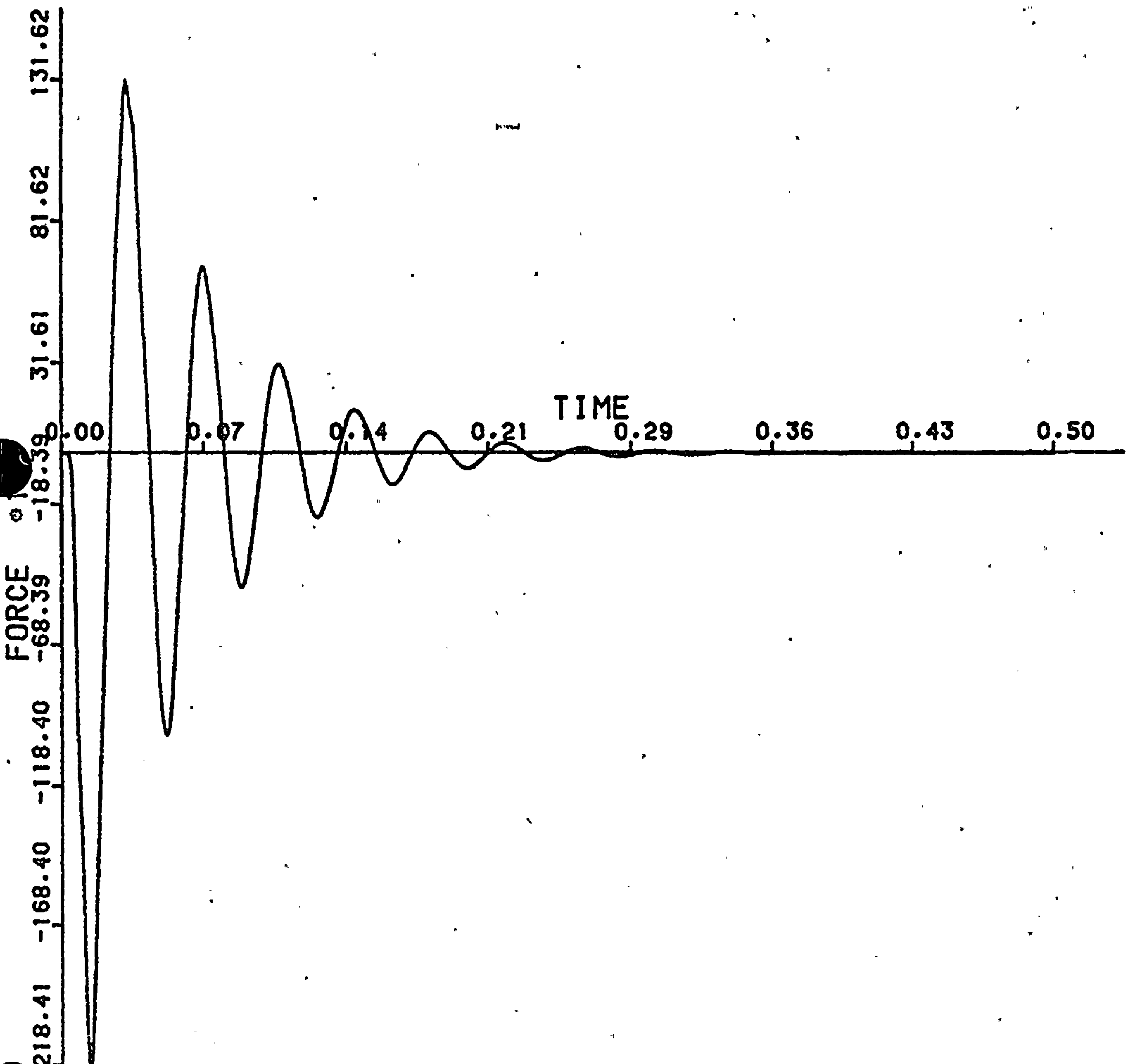
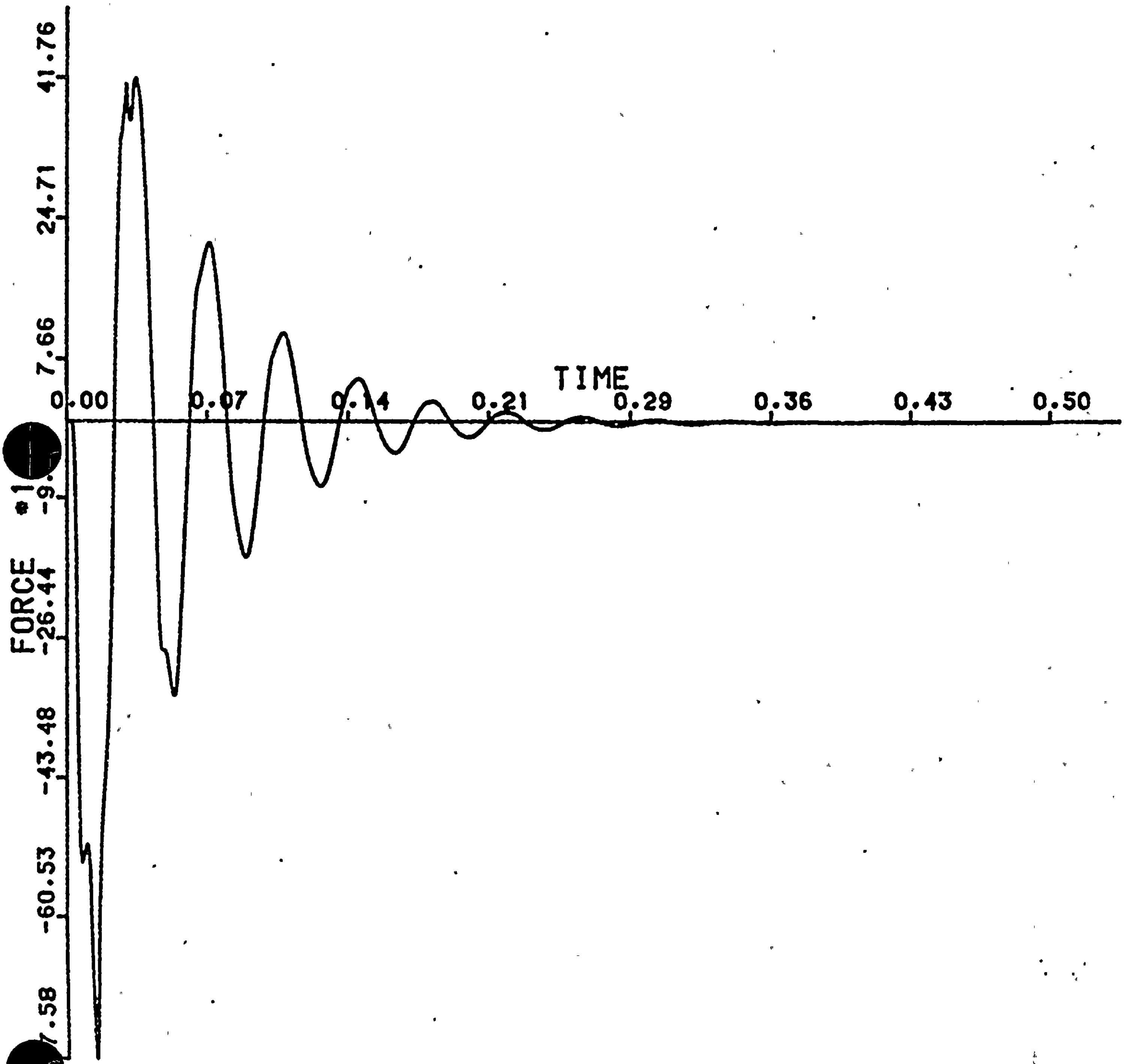
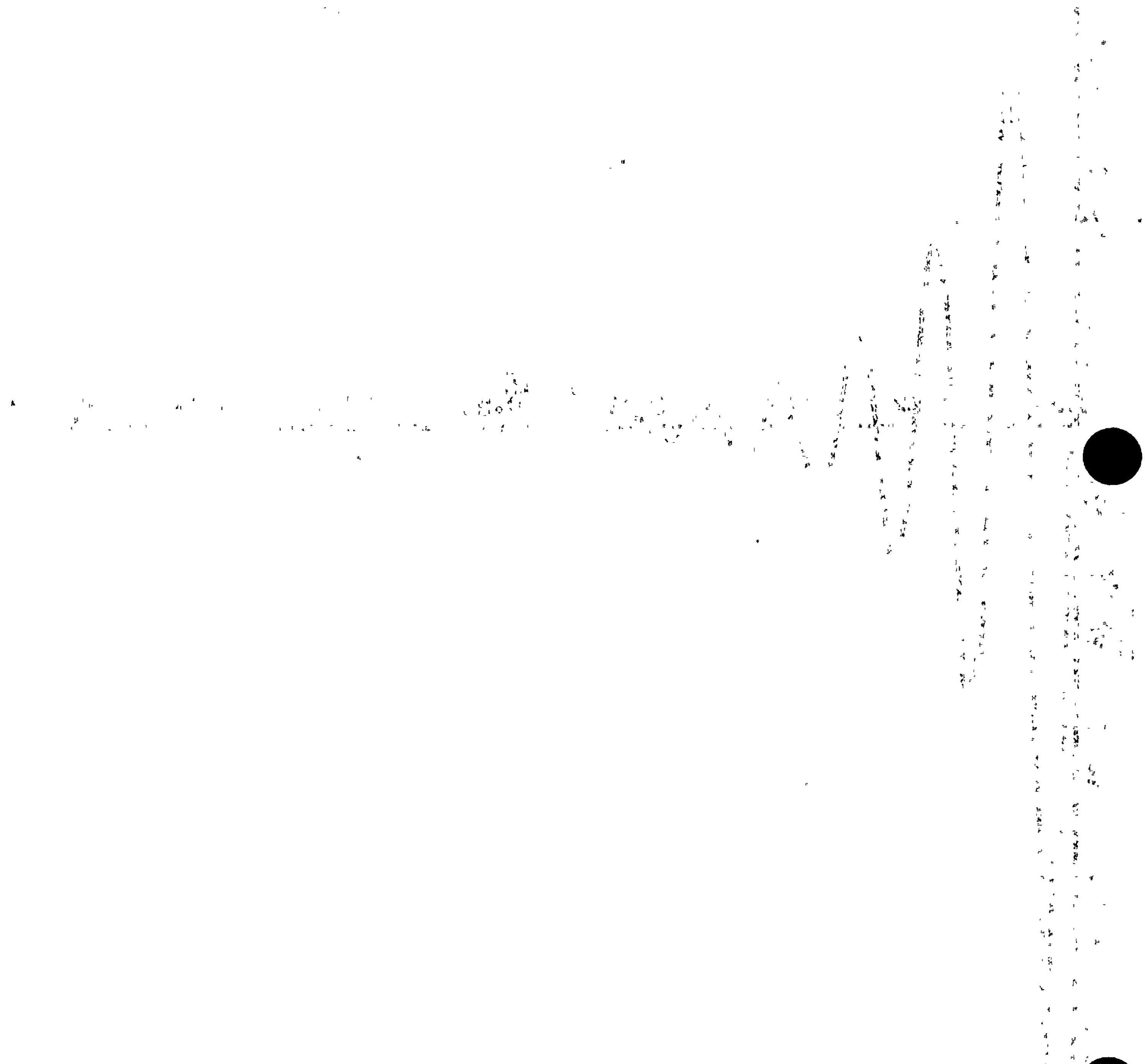
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 47, MAGNITUDE AT NODE POINT 237



SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 48, MAGNITUDE AT NODE POINT .235





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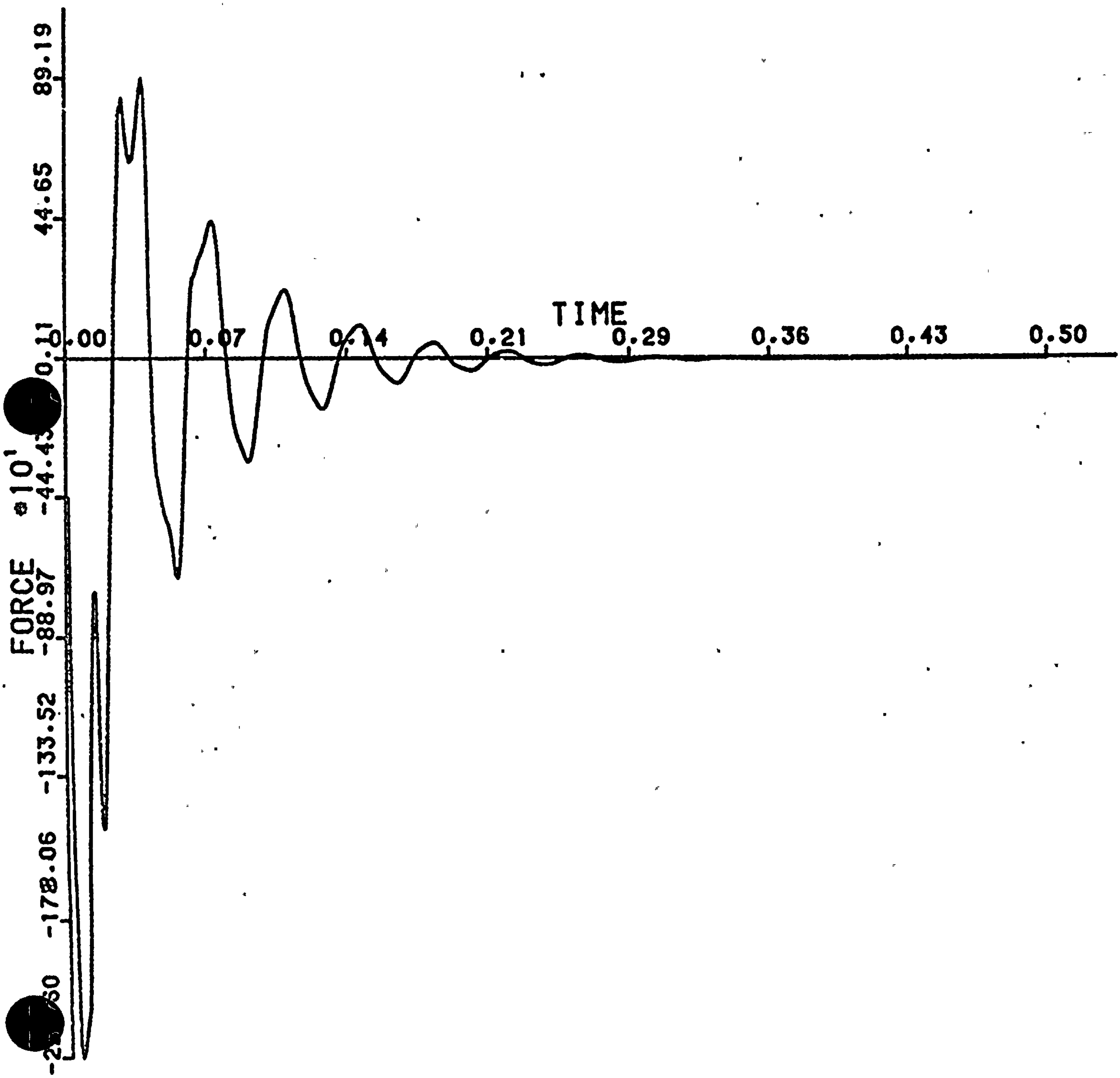
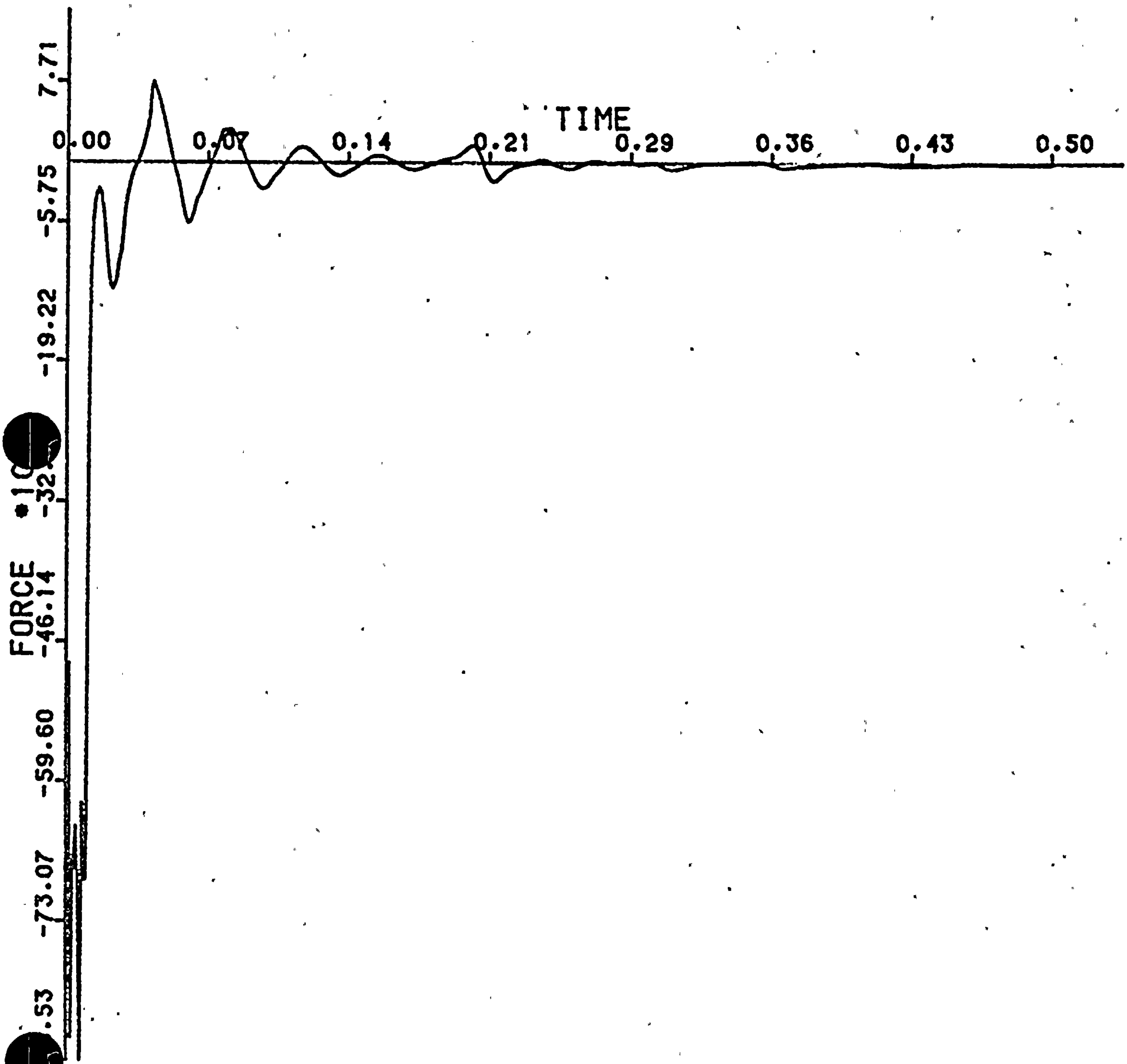
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 49, MAGNITUDE AT NODE POINT 229



SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 50, MAGNITUDE AT NODE POINT 225



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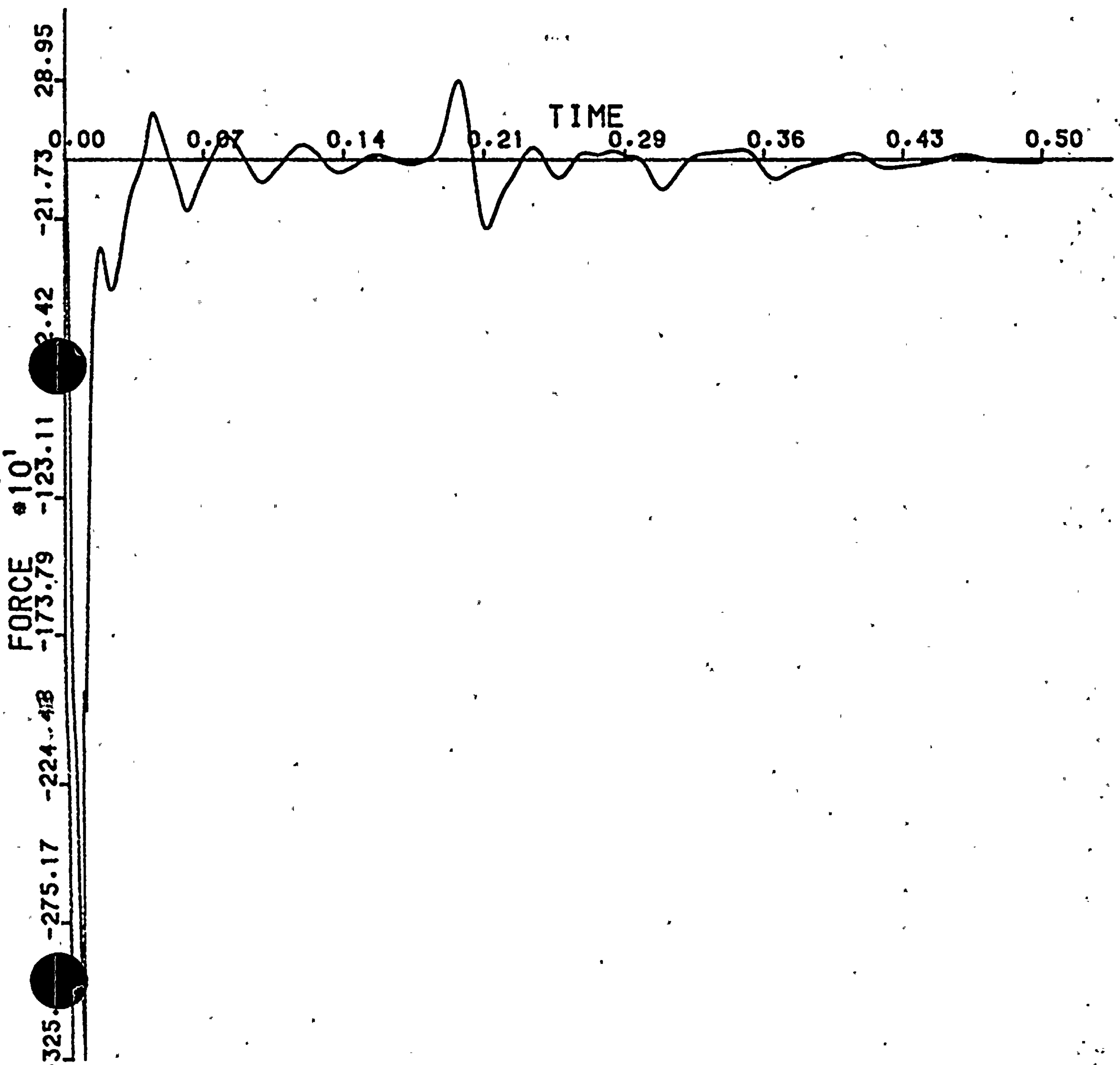
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 51, MAGNITUDE AT NODE POINT 222



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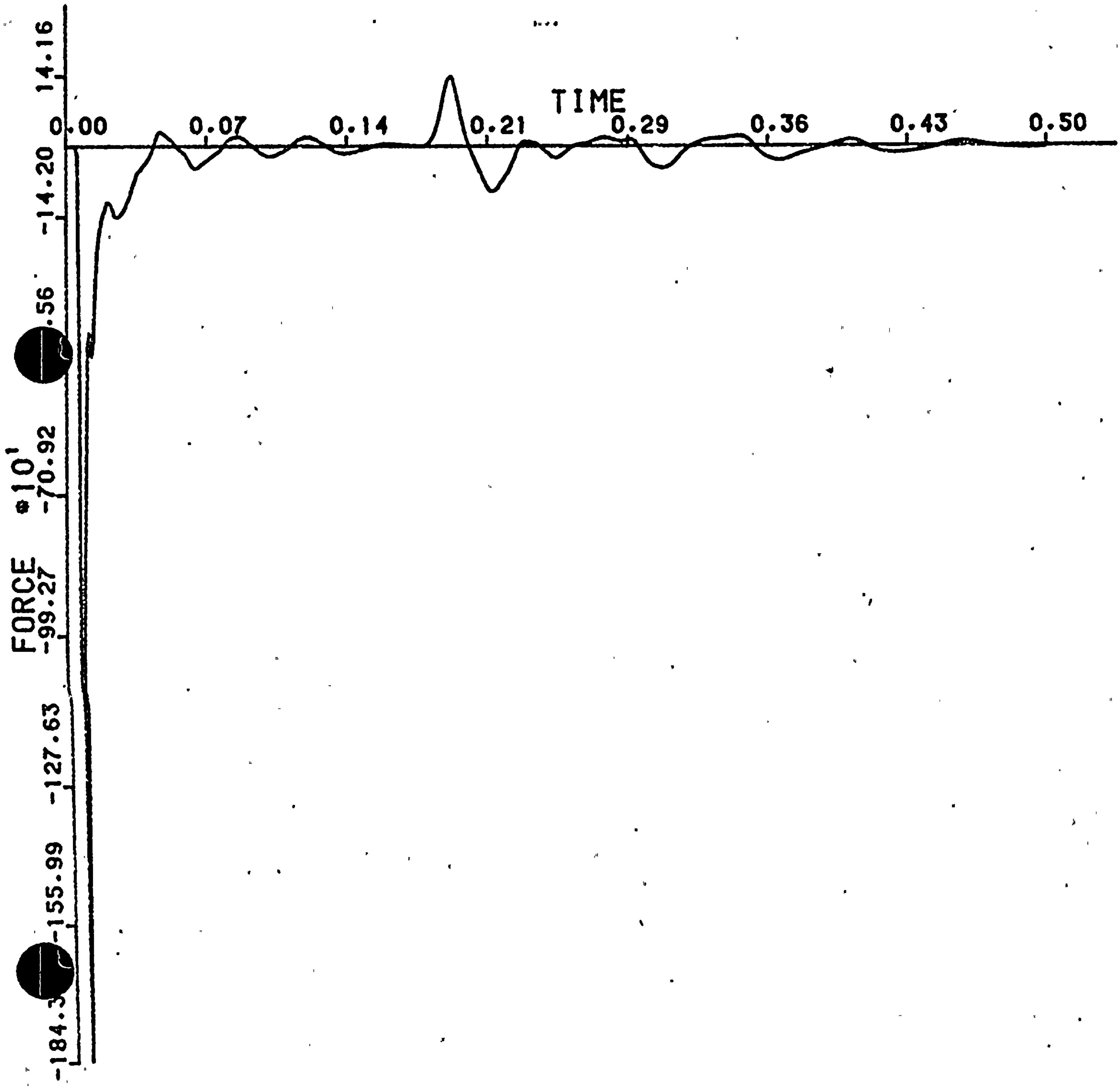
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 52, MAGNITUDE AT NODE POINT 214



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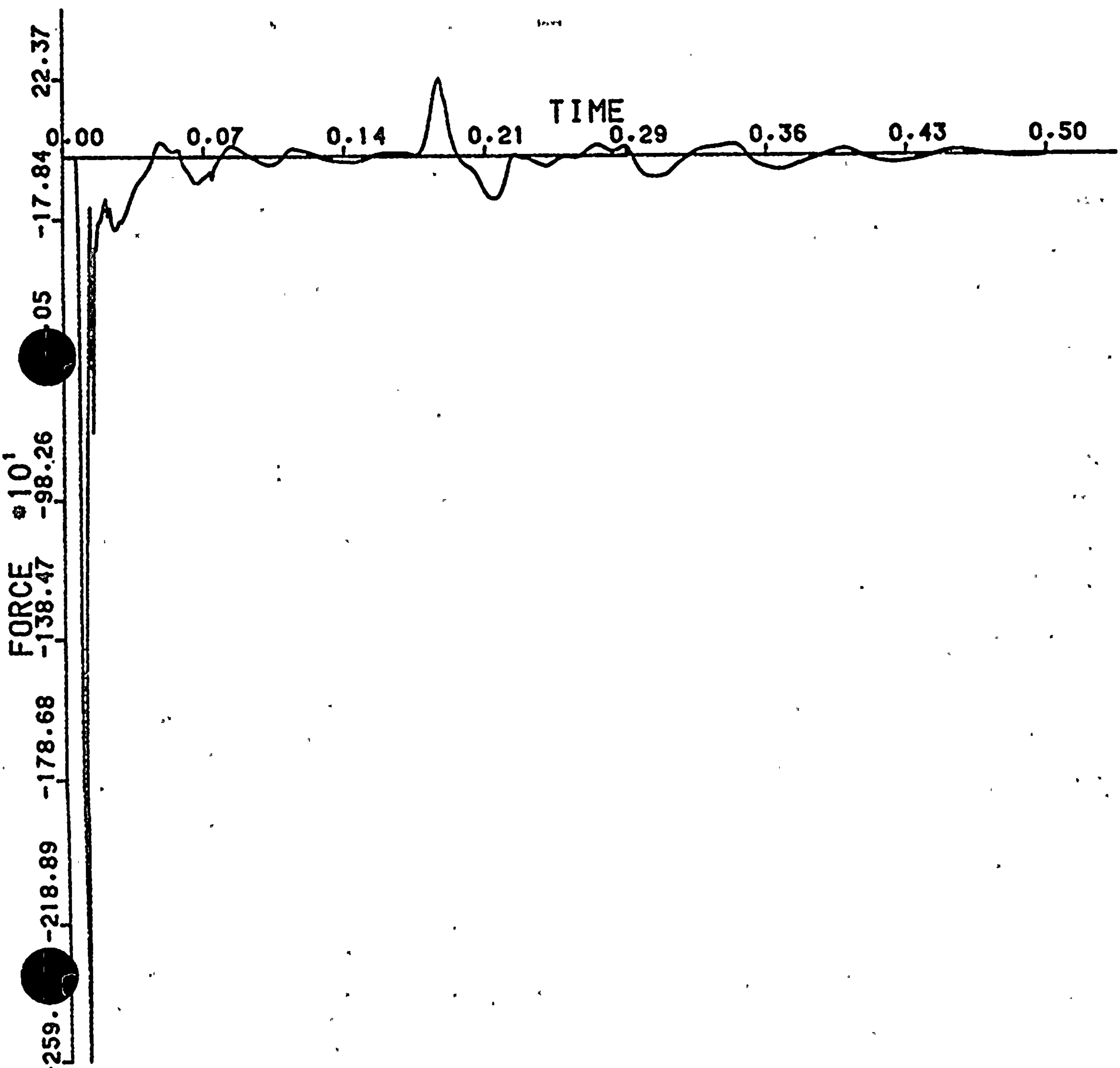
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 53, MAGNITUDE AT NODE POINT 208.



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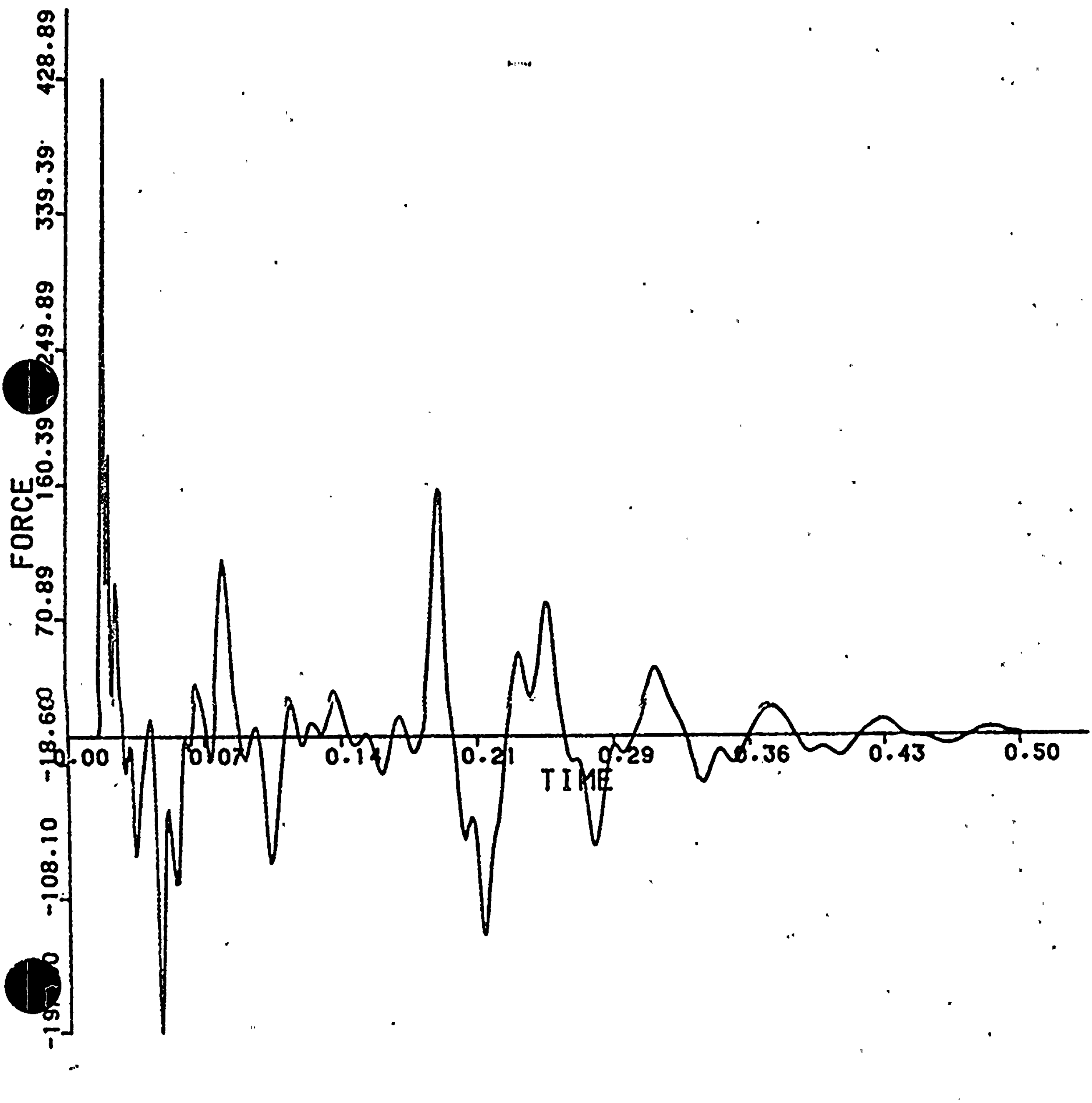
ENGINEERING SERVICES

SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 54 , MAGNITUDE AT NODE POINT 295



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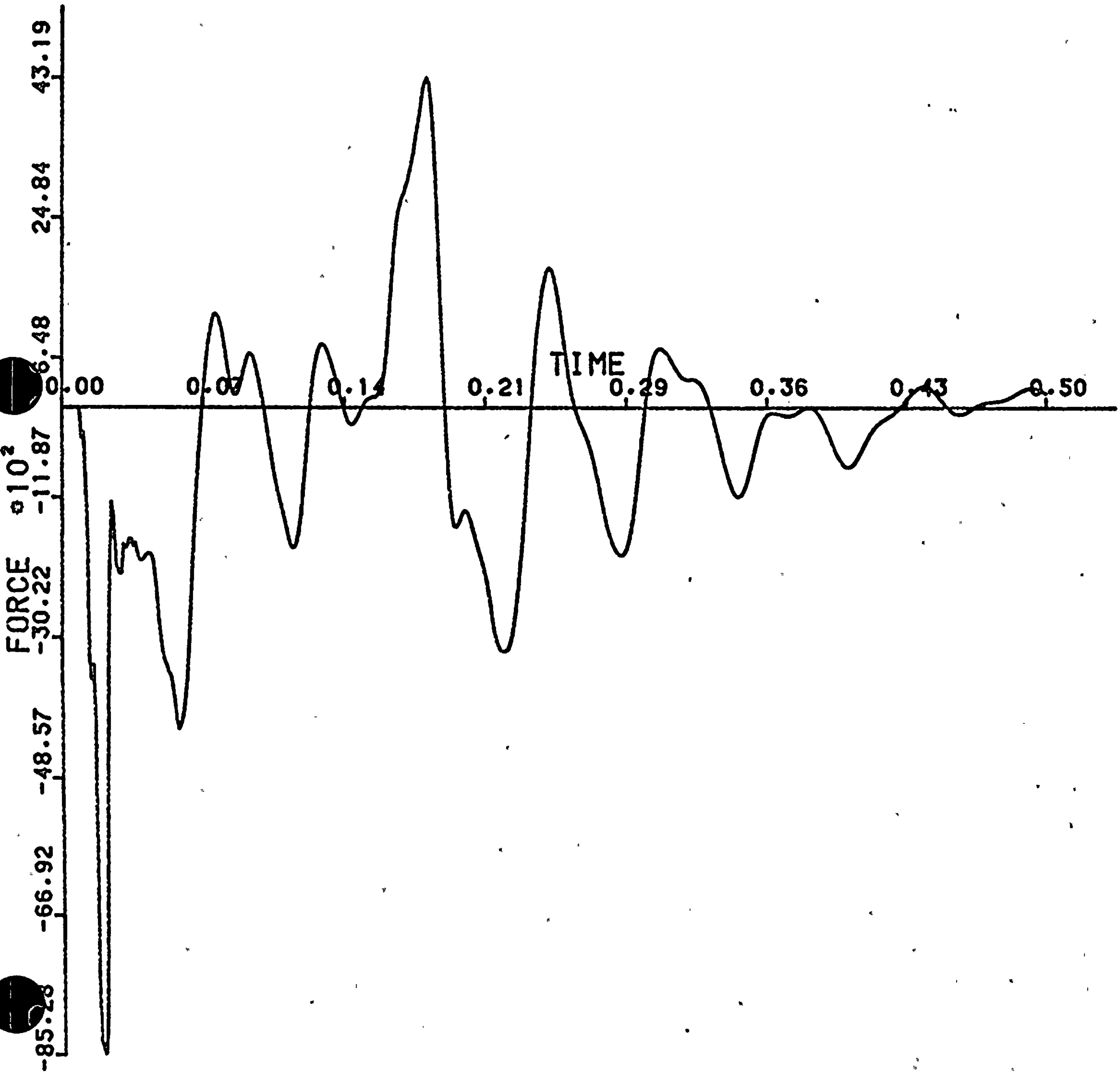
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 55 , MAGNITUDE AT NODE POINT 195



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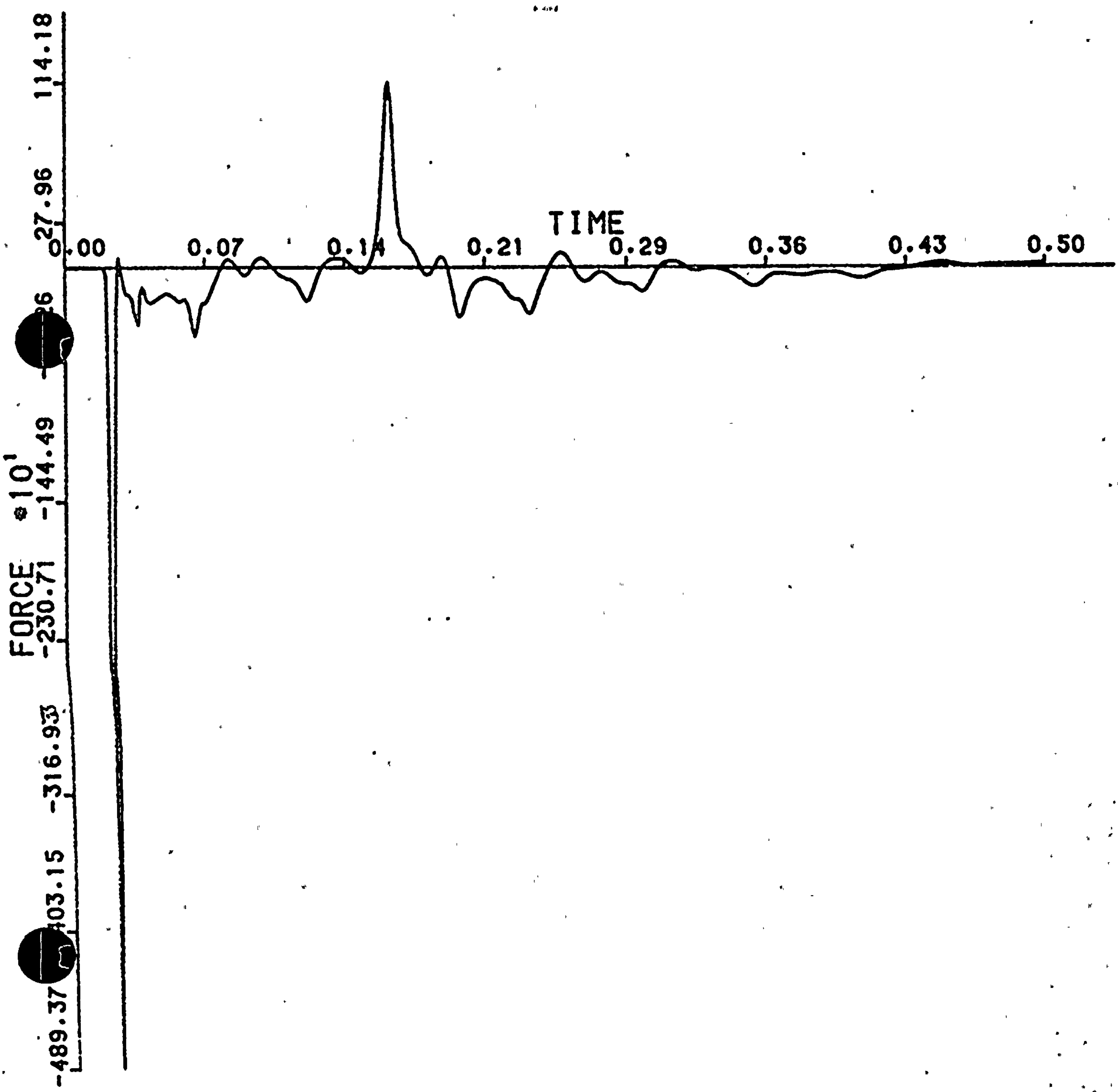
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 56 , MAGNITUDE AT NODE POINT 88



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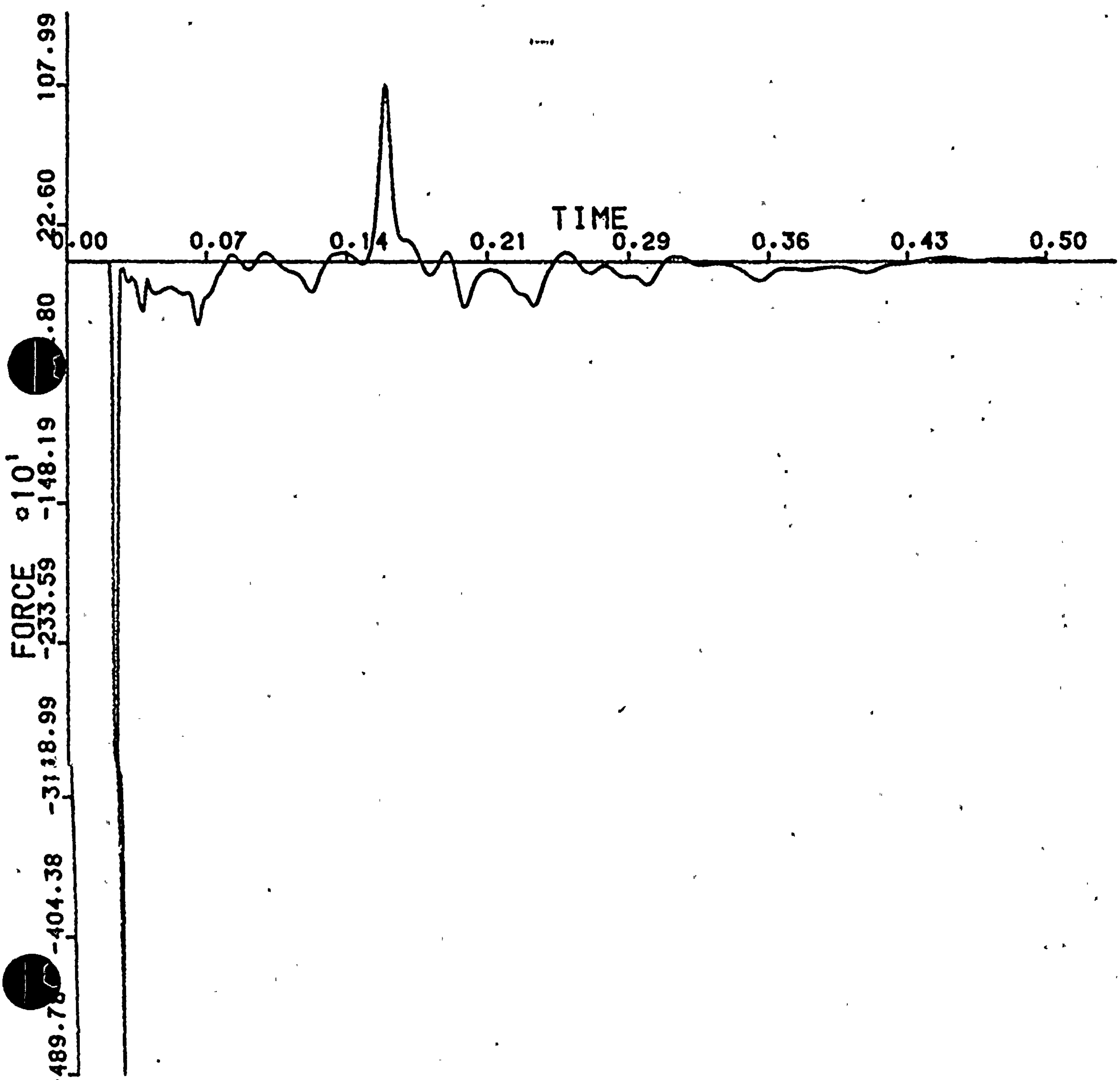
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 57, MAGNITUDE AT NODE POINT 83



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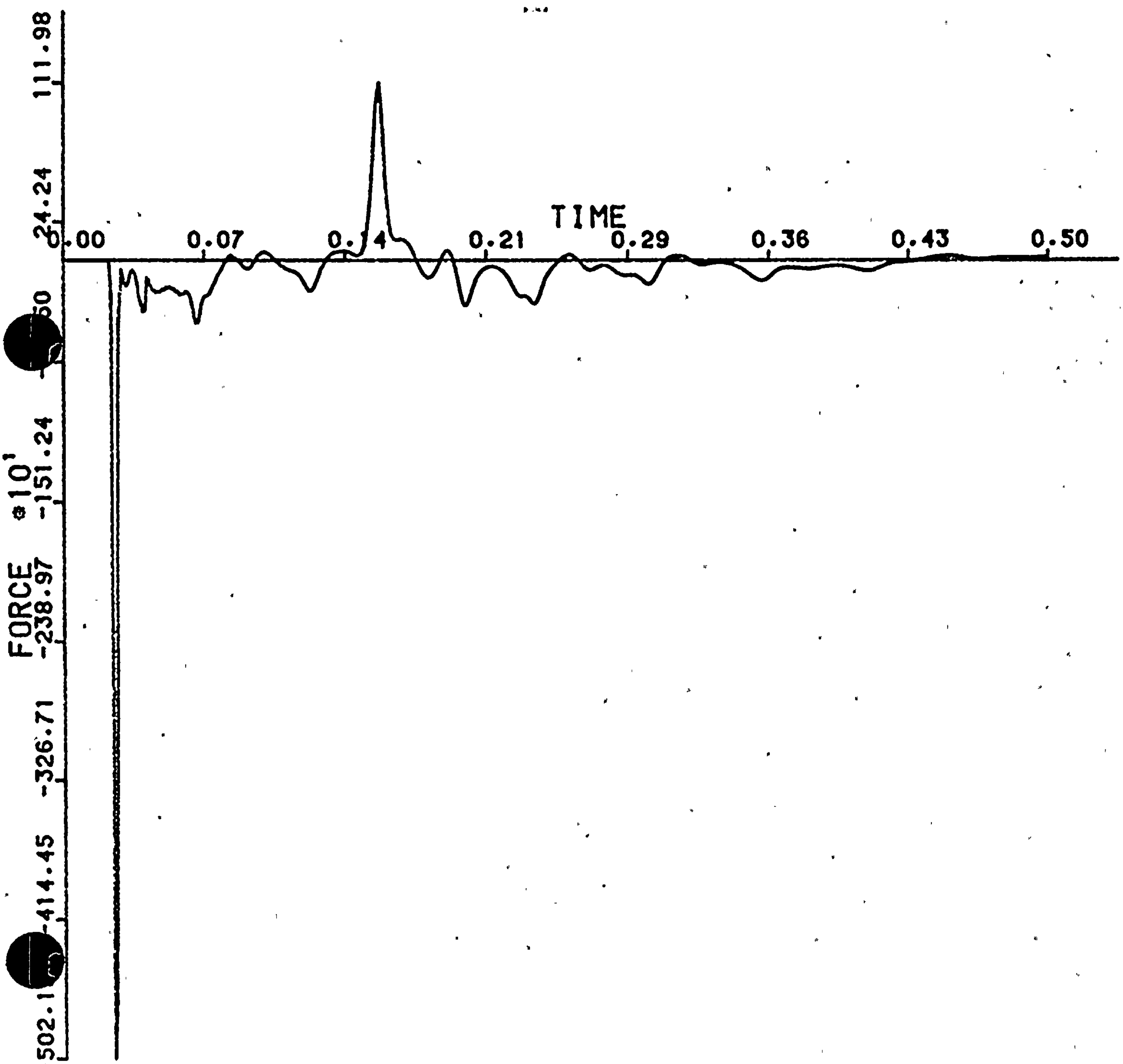
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 58 , MAGNITUDE AT NODE POINT 80



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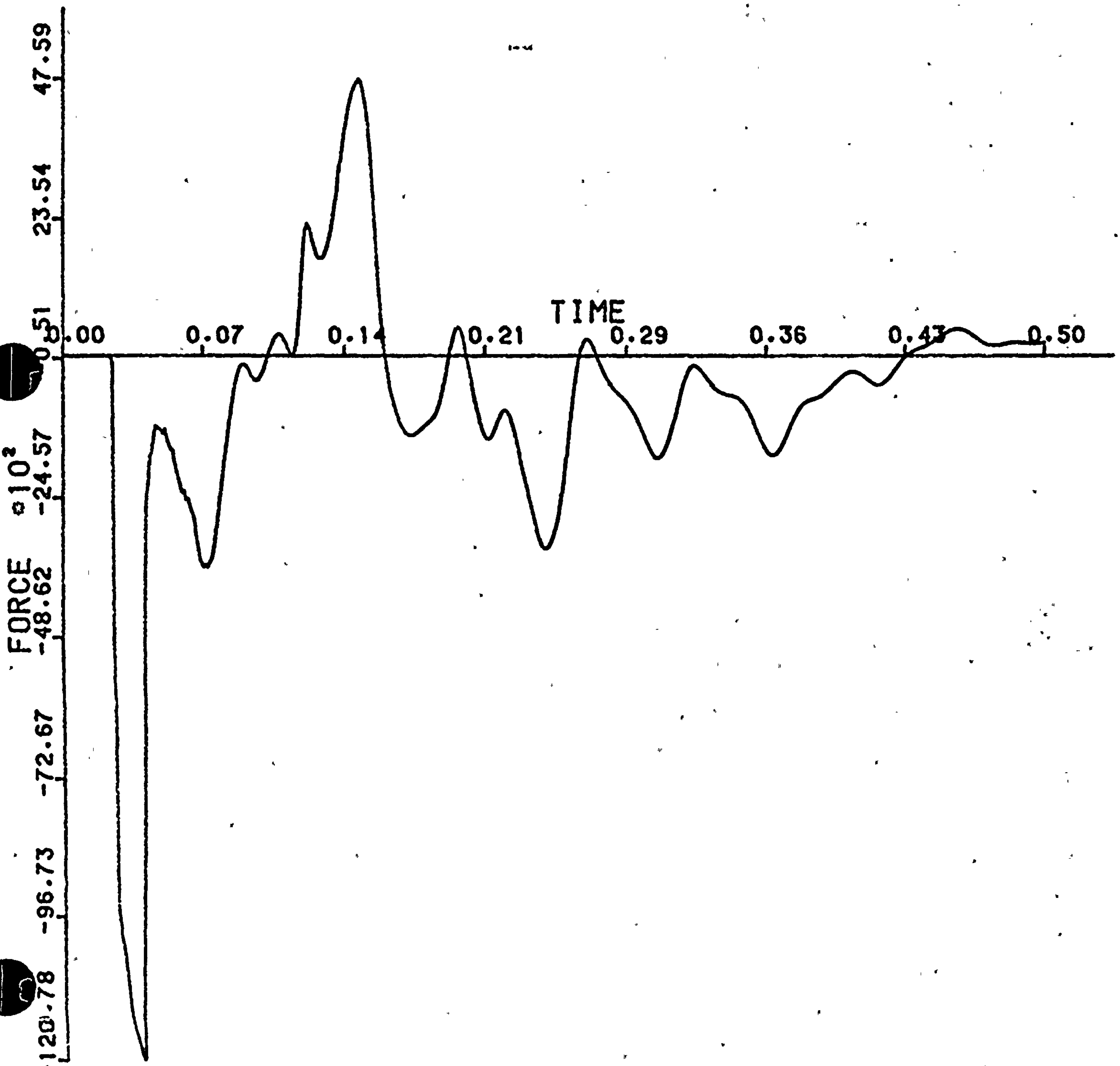
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 59 , MAGNITUDE AT NODE POINT 68



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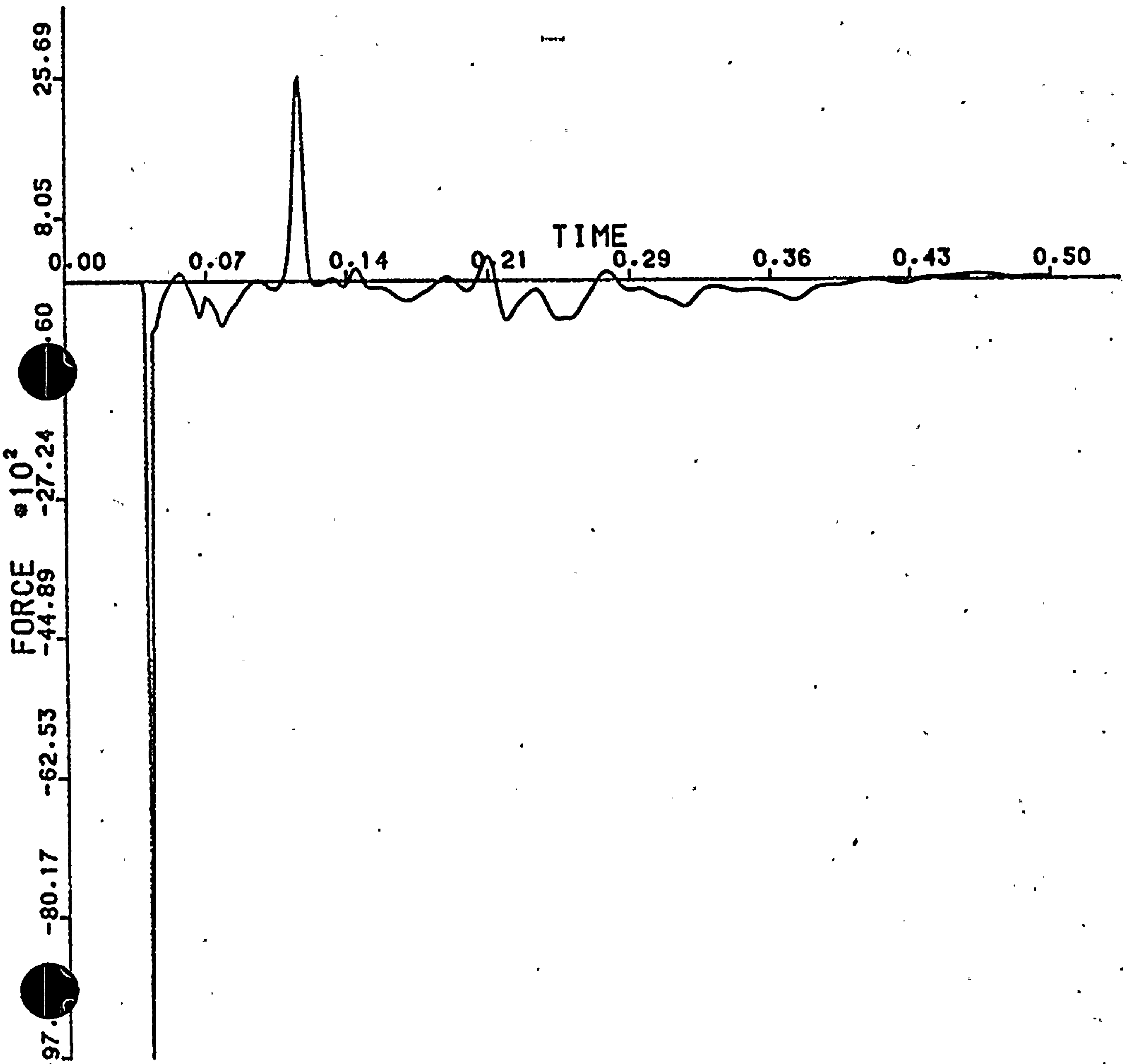
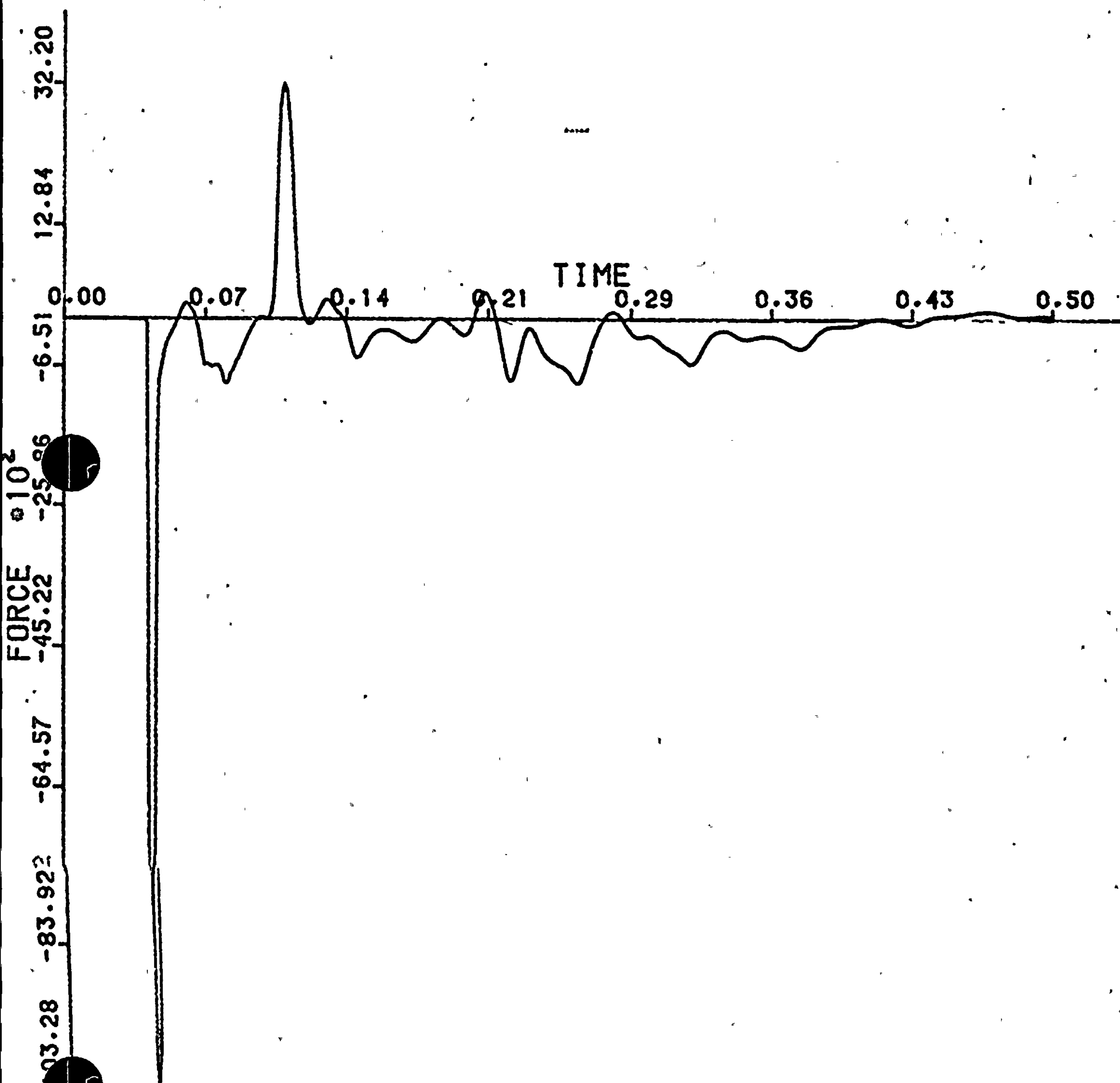
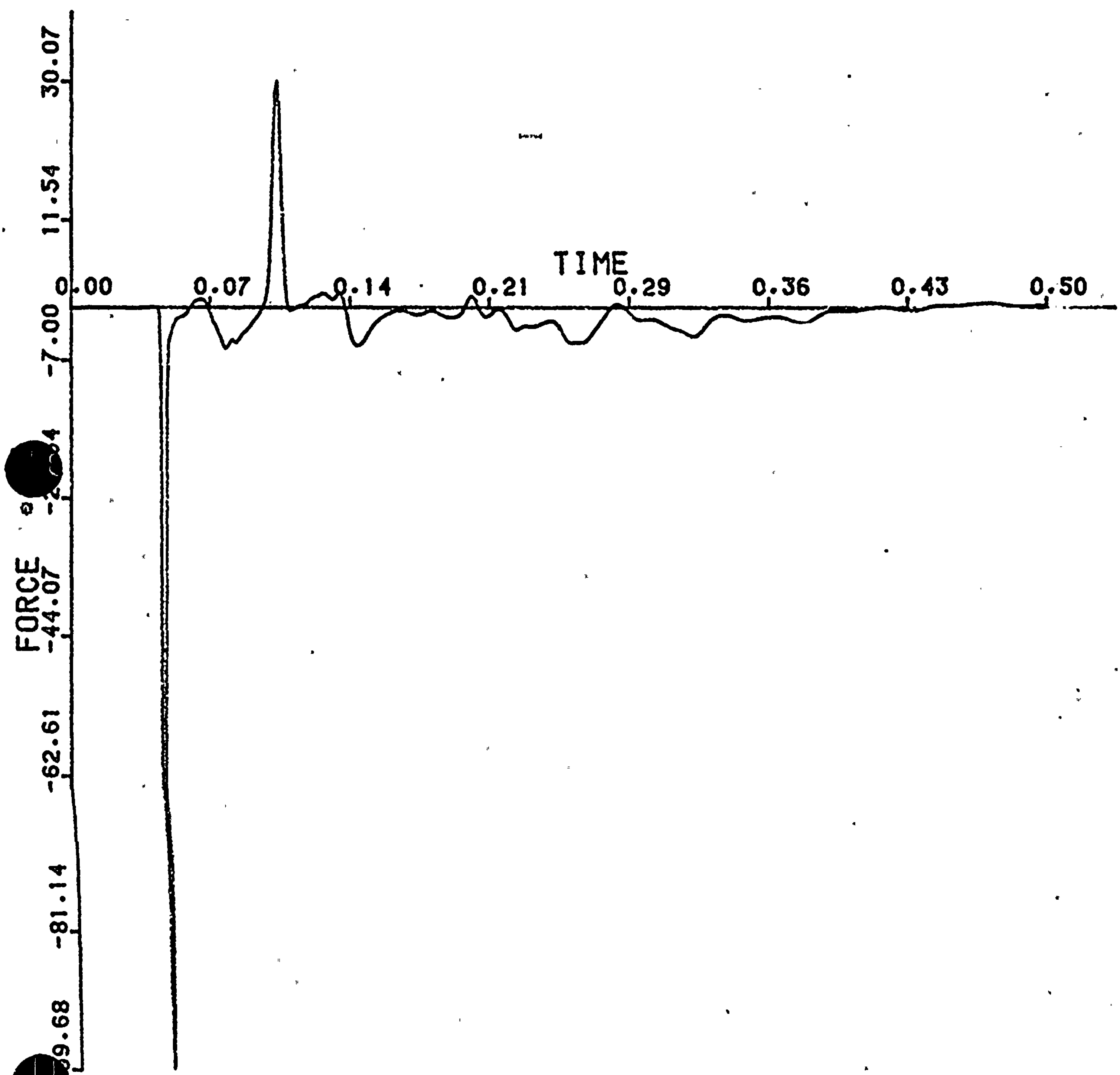
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 60 , MAGNITUDE AT NODE POINT 60



SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 61 , MAGNITUDE AT NODE POINT 56



SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 62., MAGNITUDE AT NODE POINT 48



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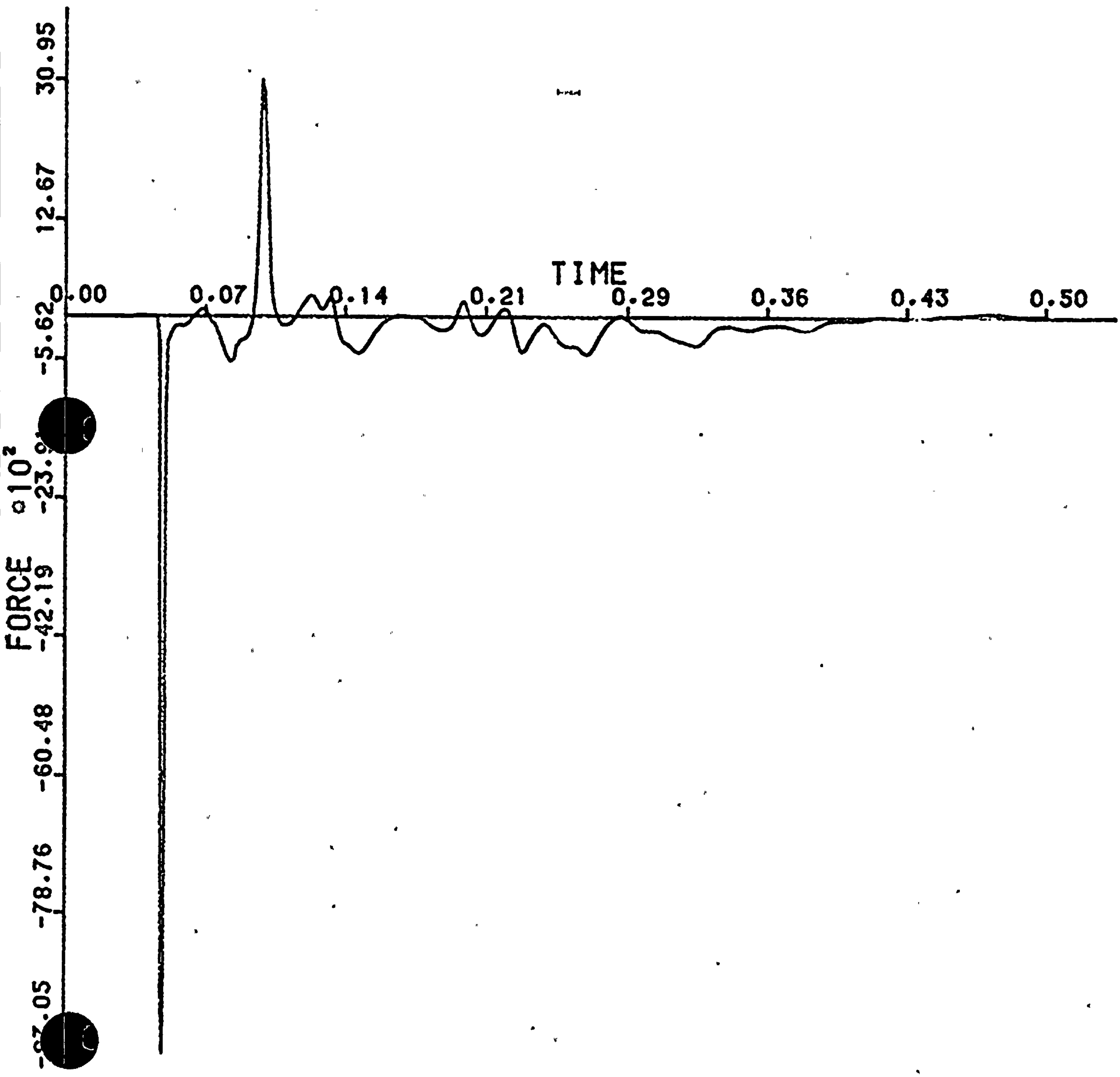
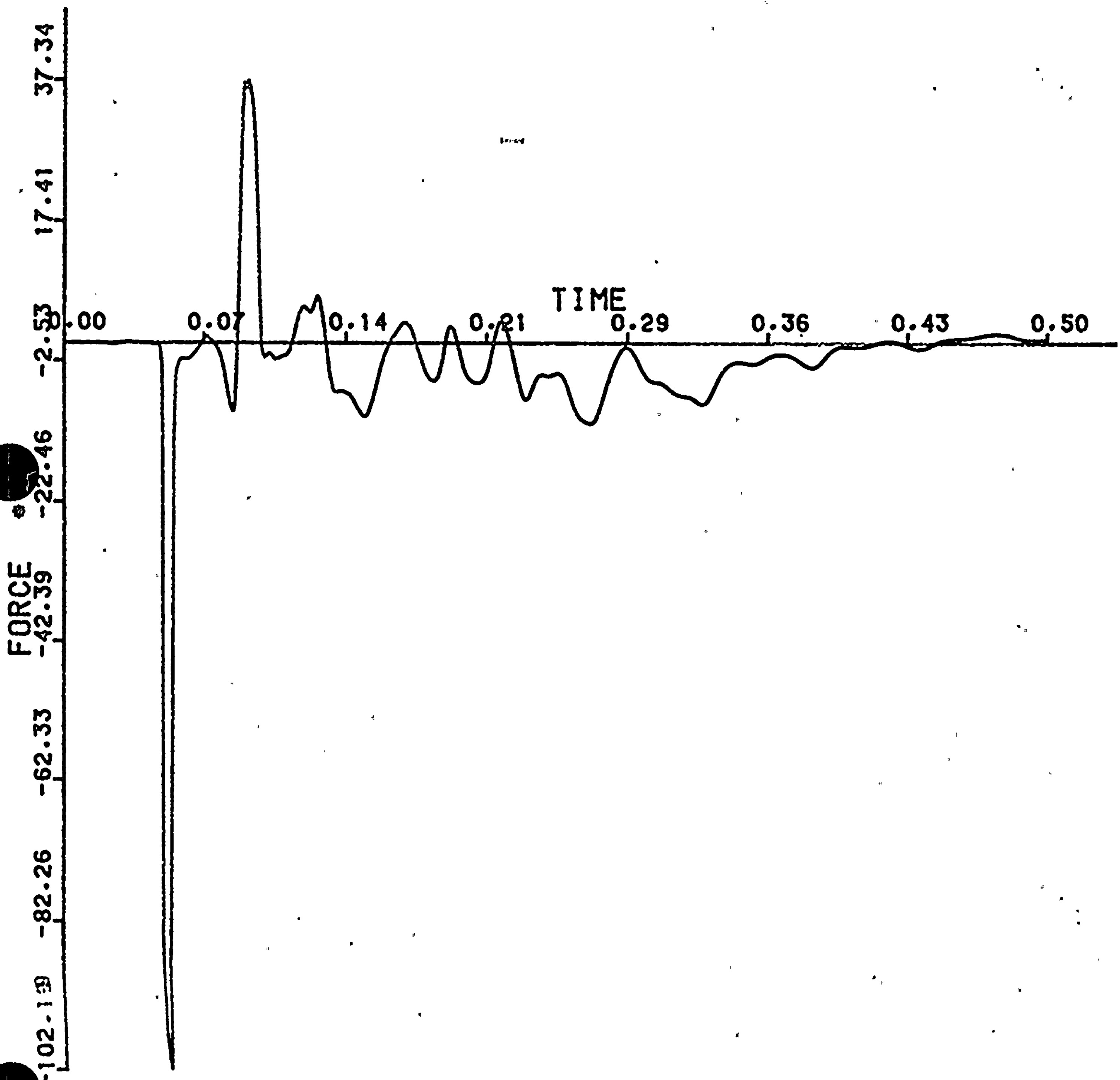
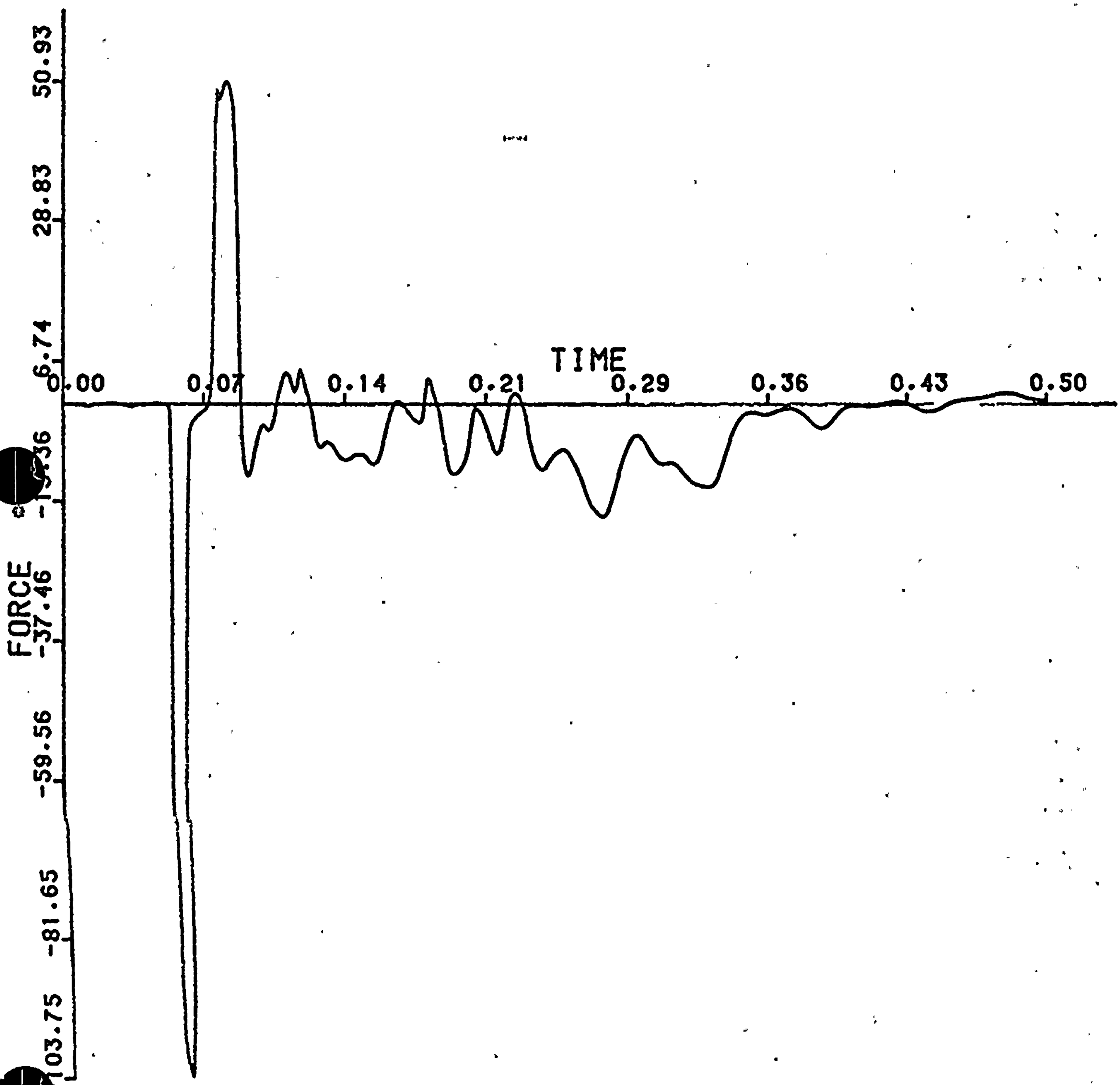
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 63, MAGNITUDE AT NODE POINT 44



SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 64, MAGNITUDE AT NODE POINT 34



SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 65, MAGNITUDE AT NODE POINT 18



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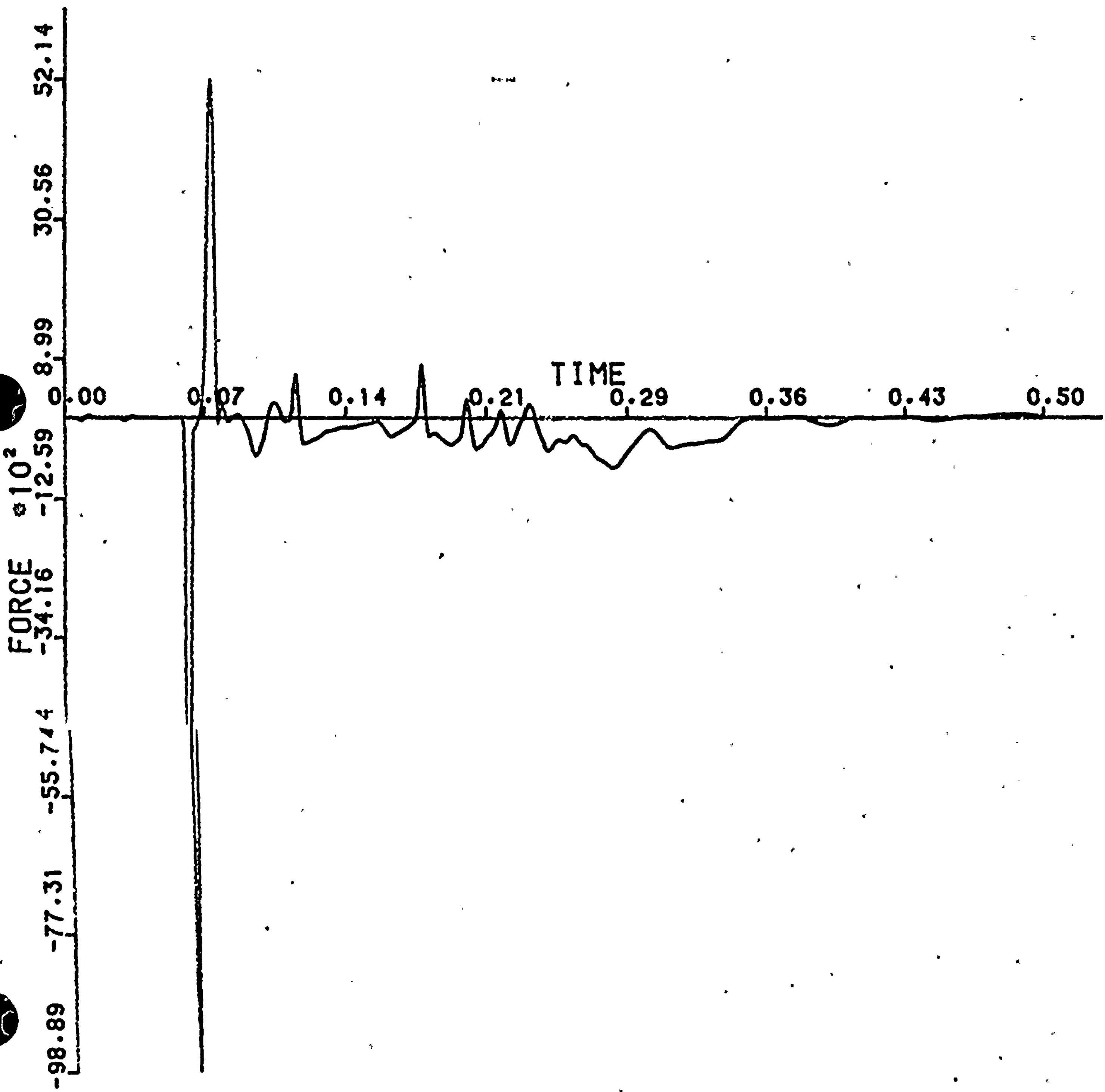
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 66, MAGNITUDE AT NODE POINT 8



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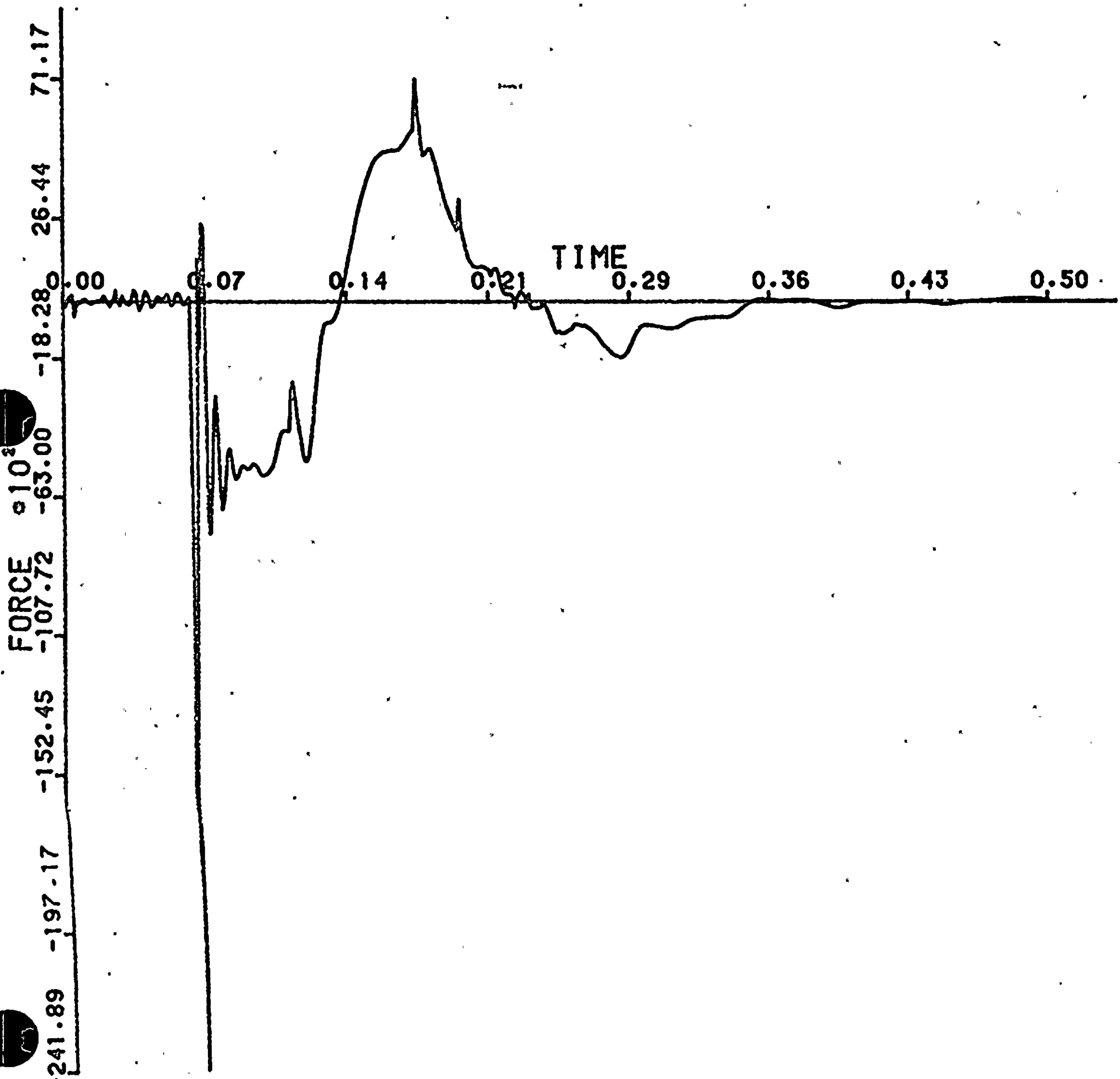
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 67, MAGNITUDE AT NODE POINT 4



4.7 RELAP Input

Included here is the RELAP5 MOD1 input listing for the transient steam case.

The SV model has:

- 375 volumes
- 374 junctions

Heat structures were not included in the RELAP model because of the program capacity. Including heat structures would have further reduced the number of available control volumes. This is a conservative assumption, ITI (Reference 6) showed higher loads were computed without heat structures.

LISTING OF INPUT DATA FOR CASE 1

```
=D.C.COOK UNIT1 3  SV'S OPEN
*  DISCHARGE PIPING
*  THIS IS THE NUMBERING SYSTEM FOR UNIT1'S RELAP MODEL
*  WHERE COMPONENT IS NUMBERED IN THE;
*          100'S ARE  VALVE SV-45C AND ARC 1 LEVEL  669'-2"
*          200'S ARE  VALVE SV-45B AND ARC 2 LEVEL  670'-10"
*          300'S ARE  VALVE SV-45A ARN ARC 3 LEVEL  672'-6"
*          400'S ARE  PORV NRV-151 AND ARC "A"
*          500'S ARE  PORV NRV-153 AND ARC "B"
*          600'S ARE  PORV NRV-152 AND ARC "C"
*          700'S AND  800'S ARE 6" AND 12" MAIN DISCHARGE PIPING
*          900'S QUENCH TANK PORTION
*          999  ATMOSPHERE
*
*
*
100       NEW  TRANSNT
101        RUN
102        BRITISH     BRITISH
104       NOACTION
*
*********************************************
*         TIME STEP CONTROL                 *
*********************************************
*
201        0.500,1.-7,2.-4,11001,5,50,250
*
*
*********************************************
*          MINOR EDITS                      *
*********************************************
*
301  MFLOWJ   106000000
302  MFLOWJ   206000000
303  MFLOWJ   306000000
304  MFLOWJ   308000000
305  MFLOWJ   208000000
306  MFLOWJ   702000000
307  MFLOWJ   108000000
308  MFLOWJ   977000000
*
309  QUALS    105200000
310  QUALS    107010000
311  QUALS    107330000
312  QUALS    701010000
313  QUALS    811970000
314  QUALS    813250000
315  QUALS    978180000
316  QUALS    205200000
317  QUALS    207010000
318  QUALS    305200000
319  QUALS    207260000
320  QUALS    307010000
321  QUALS    307180000
*
323  P        105200000
```

BY KJG DATE 6-21-83

CHKD. BY CMM DATE 6-27-83

```
324   P        107010000
326   P        107330000
327   P        701010000
331   P        811970000
332   P        813260000
333   P        978020000
334   P        978030000
335   P        205200000
336   P        207010000
337   P        305200000
338   P        207260000
339   P        307010000
340   P        307180000
*
*
*****************************************
*  FORCE CARDS  FOR REPIPE              *
*****************************************
*
*
*
*
*
*
*     PIPING DOWNSTREAM OF THE PORV'S
*
2001     5,215
2002     411010000,411020000,411030000,411040000,411050000
2003     411060000,411070000,411080000,411090000,411100000
2004     411110000,411120000,411130000,411140000,411150000
2005     411160000,411170000,411180000,411190000
*
2006     511010000,511020000,511030000,511040000,511050000
2007     511060000,511070000,511080000,511090000,511100000
2008     511110000,511120000,511130000,511140000,511150000
2009     511160000,511170000,511180000,511190000
*
2010     611010000,611020000,611030000,611040000,611050000
2011     611060000,611070000,611080000
*
2012     515010000,515020000,515030000,515040000,515050000
2014     515060000,515070000,515080000,515090000,515100000
2015     515110000,515120000,701010000,513010000
*
*
*
*
*
*    SV ARC FROM VALVE 45A DOWN TO ELEVATION 672' 8".
*
2018     301010000,303010000,303020000,303030000,303040000
2019     305010000,305020000,305030000,305040000,305050000
2020     305060000,305070000,305080000,305090000,305100000
2021     305110000,305120000,305130000,305140000,305150000
2022     305160000,305170000,305180000,305190000,305200000
2023     307010000,307020000,307030000,307040000,307050000
2024     307060000,307070000,307080000,307090000,307100000
2025     307110000,307120000,307130000,307140000,307150000
```


COPY

```
2026      307160000,307170000,307180000,801010000
*
*
*
*
*
*      SV ARC FROM  VALVE 45B DOWN TO ELEVATION 670' 10"
*
2029      201010000,203010000,203020000,203030000,203040000
2030      205010000,205020000,205030000,205040000,205050000
2031      205060000,205070000,205080000,205090000,205100000
2032      205110000,205120000,205130000,205140000,205150000
2033      205160000,205170000,205180000,205190000,205200000
2034      207010000,207020000,207030000,207040000,207050000
2035      207060000,207070000,207080000,207090000,207100000
2036      207110000,207120000,207130000,207140000,207150000
2037      207160000,207170000,207180000,207190000,207200000
2038      207210000,207220000,207230000,207240000,207250000
2039      207280000,805010000
*
*
*
*
*
*
*      SV ARC FROM  VALVE 45C DOWN TO ELEVATION 669' 2"
*
2042      101010000,103010000,103020000,103030000,103040000
2043      105010000,105020000,105030000,105040000,105050000
2044      105060000,105070000,105080000,105090000,105100000
2045      105110000,105120000,105130000,105140000,105150000
2046      105160000,105170000,105180000,105190000,105200000
2047      107010000,107020000,107030000,107040000,107050000
2048      107060000,107070000,107080000,107090000,107100000
2049      107110000,107120000,107130000,107140000,107150000
2050      107160000,107170000,107180000,107190000,107200000
2051      107210000,107220000,107230000,107240000,107250000
2052      107280000,107270000,107280000,107290000,107300000
2053      107310000,107320000,107330000,809010000
*
*
*
*
*
*
*******************************************************************
* THIS RUN OF RELAP INCLUDES SAFETY RELIEF VALVE LINES AND MAIN   *
* DISCHARGE LINE BETWEEN ELEV. 684'-9"  TO  ELEV. 649'- 1/2"      *
*******************************************************************
*
*
*
*
*****************************************
*         TRIPS                         *
*****************************************
*
*
```

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```
501  TIME  0 GE NULL  0   0.0  L   * VALVE OPENING TRIP
502  TIME  0 GE NULL  1   5.0  L   *  JOB TERMINATION TRIP
515  P  982010000  GE  NULL 0 114.7   L *  QUENCH TANK RUPTURE PRESS.
600     502
*
******************************************************************
*              ******************************************        *
*              *  HYDRODYNAMIC COMPONENTS               *        *
*              ******************************************        *
******************************************************************
*
****************************************************
*  SAFETY VALVES DISCHARGE SECTION                 *
****************************************************
*
*
*
****************************************************************************
*   SAFETY VALVE #1   DISCHARGING AT ELEV. 669'-2"  ARC 1
****************************************************************************
*
*    PRESSURIZER COMPONENT
1010000   "PRSRZ#1"  TMDPVOL
1010200   2
1010101  0. 20. 500.  0.   0.  0. 0.00005 0. 11
1010201    0.,2500.,1     .2514.,1.  .3,2555.,1.  .5,2600.,1.  .7,2667.,1.
1010202    .9,2700.,1     1,2740.,1. 1.3,2745.,1. 1.5,2747.,1. 1.7,2748.,1.
1010203    1.9,2750.,1
*
*    PIPE COMPONENTS
1020000   "PRZ1-EXIT"   SNGLJUN
1020101   101000000   103000000 0.0 0.0 0.0  1000
1020201   1    0.0  0.0  0.0
*
*    VALVE  UPSTREAM
*
1030000   "LS1 IN"    PIPE
*     NO. OF VOLS.
1030001        4
*     VOL. FLOW AREA
1030101    0.14653                4
*     VOL. LENGTHS
1030301    0.3490       1
1030302    0.4238       4
*     VOL. CAL. AUTO
1030401    0.0          4
*     VERT. ANGLES
1030601    45.          1
1030602    0.0          4
*     PIPE ROUGHNESS
1030801    1.513-4      0 0       4
*     JUN. LOSS COEFF
1030901    0.0918       0 .0918.   1
1030902    0.0          0 0         3
*
1031001    00           4
*
1031101    1000         3
```


cont

```
*
1031201   2   2500.   1.  0.0  0.0   4
*
*   INITIAL JUN FLOWS
1031300   1
1031301   0.0  0.0  0.0      3
*
*     LOOP SEAL
1040000   "JUN-LS1"   SNGLJUN
1040101   103010000   105000000   0.0    0.1836 0.1836  1000
1040201   1  0.0  0.00   0.0
*
1050000   "LPSL 1"  PIPE
1050001   20
1050101   0.14653    20
*
1050301   0.50       10
1050302   0.6203     20
*
1050401   0.0        20
*
1050601   -90.        7
1050602   0.0        10
1050603   90.        20
*
1050801   1.513-4    0.0  20
*
1050901   0.0        0.0        6
1050902   0.1836     0.1836     7
1050903   0.0        0.0        9
1050904   0.1836     0.1836    10
1050905   0.0        0.0       19
*
1051001   00         20
*
1051101   1000       19
*
1051201   2   2500.   1.0  0.0  0.0  20
*
1051300   1
1051301   0.0  0.0  0.0        19
*
*     CROSBY  6M6  SAFETY  VALVE #1  SV-45C
*
1060000   "SVN01"   VALVE   * VALVE OPEN WITH PROG. START
1060101   105010000   107000000  0.01897    0.0  0.0    0100 1.0   1.0
1060201   1    0.0  0.0  0.0
1060300   MTRVLV
1060301   501  502   100.     0.0   * VALVE OPENS WITH PROG. START
*
*     VALVE  DOWNSTREAM  PIPING
1070000   "DWNSTRM#1"   PIPE
1070001        33
*
1070101   0.20069       33
*
1070301   0.5261         4
1070302   0.9943        15
```

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```
1070303   0.9132
1070304   0.8472
1070305   1.085
*
1070401   0.0
*
1070601   0.0
1070602   -90.
1070603   0.0
*
1070801   1.52-4   0.         3
1070901   0.0       0.0       4
1070902   0.18      0.18      14
1070903   0.0       0.0       15
1070904   0.18      0.18      32
1070905   0.0       0.0
*
1071001   00        33
1071101   1000      32
*
1071201   4   17.7   120      0.93424   0.   33
*
1071300   1
1071301   0.0  0.0  0.0   332
*
*
*
*
*****************************************************************
*     SAFETY VALVE #2 DISCHARGING AT ELEV.  670'-10"  ARC 2
*****************************************************************
*     PRESSURIZER  COMPONENT
2010000   "PRSRZ#2"   TMDPVOL
*
2010101  0.  20.  500.  0  0.  0.  0.00005  0.  11
2010200  2
2010201  0.,2500.,1.  .2514.,1.  .3,2555.,1.  .5,2600.,1.  .7,2667.,1.
2010202  .9,2700.,1.  1.,2740.,1.  1.3,2745.,1.  1.5,2747.,1.  1.7,2748.,1.
2010203  1.9,2750.,1.
*
*    PIPE  COMPONENTS
2020000   "PRZ2-EXIT"   SNGLJUN
*
2020101   201000000   203000000  0.0  0.0  0.0   1000
*
2020201   1   0.0  0.0  0.0
*
*     VALVE  UPSTREAM  PIPE
2030000   "LS2  IN"   PIPE
*     NO OF VOL.
2030001        4
*     VOL. FLOW AREA
2030101   0.14653   4
*     VOL LENGTHS
2030301   0.3490    1
2030302   0.4236    4
*     VOL.  CAL.  AUTO.
2030401   0.0       4
```

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```
*      VERT.   ANGLES
2030601   45.          1
2030602   0.           4
*     PIPE    ROUGHNESS
2030801   1.513-4   0.0          4
*       JUN.    LOSS   COEFF.
2030901   0.0918    0.0918       1
2030902   0.0        0.0         3
*
2031001   00         4
*
2031101   1000       3
*
2031201   2   2500.   1.     0.   4
*       INITIAL   JUN.  FLOWS
2031300   1
2031301   0.0  0.0  0.0          3
*
*     LOOP   SEAL
*
2040000   "JUN-LS2"    SNGLJUN
2040101   203010000   2050[illegible]000   0.0   0.1836   0.1836   1000
2040201   1    0.0   0.0
*
2050000   "LPSL 1"    PIPE
2050001   20
*
2050101   0.14653     20
*
2050301   0.50        10
2050302   0.6203      20
*
2050401   0.0         20
*
2050601   -90.         7
2050602   0.0         10
2050603   90.         20
*
2050801   1.513-4   0.   20
*
2050901   0.0          0.0       6
2050902   0.1836       0.1836    7
2050903   0.0          0.0       9
2050904   0.1836       0.1836    10
2050905   0.0          0.0       19
*
2051001   00          20
*
2051101   1000        19
*
2051201   2    2500.      1.0   0.0   0.0       20
*     INITIAL JUN. FLOWS
2051300   1
2051301   0.0  0.0  0.0        19
*
*     CROSBY  6M6  SAFETY  VALVE #2  SV-45B
*
2060000   "SV N02"    VALVE
```

```
2060101   205010000  207000000  0.01897  0.0  0.0  0100  1.0  1.0
2060201   1   0.0  0.0   0
2060300   MTRVLV
2060301   501  502  100.          0.0   *  VALVE OPEN WITH PROG. START
*
*     VALVE DOWNSTREAM PIPING
2070000   "DWNSTRM#2"   PIPE
*
2070001                  26
2070101   0.20069        26
*
2070301   0.5261         4
2070302   0.9271         14
2070303   0.8852         23
2070304   1.085          26
*
2070401   0.0            26
*
2070601   0.0            4
2070602   -90.           14
2070603   0.0            26
*
2070801   1.52-4     0.     26
*
2070901   0.0        0.0      3
2070902   0.18       0.18     4
2070903   0.0        0.0      13
2070904   0.18       0.18     14
2070905   0.0        0.0      25
*
2071001   00         26
*
2071101   1000       25
*
2071201   4    17.7    120.     0.93424   0.   26
*
2071300   1
2071301   0.0   0.0   0.0   25
*
*
******************************************************************
*     SAFETY  VALVE  #3 DISCHARGING AT ELEV.  672'-6"   ARC 3
******************************************************************
*
*     PRESSURIZER  COMPONENT
3010000   "PRSRZ#1"  TMDPVOL
3010200   2
3010101   0.  20.  500.  0.  0.  0.  0.00005  0.   11
3010201   0.,2500.,1.  .1,2614.,1.  .3,2555.,1.  .5,2600.,1.  .7,2667.,1.
3010202   .9,2700.,1.  1.1,2740.,1.  1.3,2745.,1.  1.5,2747.,1.  1.7,2748.,1.
3010203   1.9,2750.,1.
*     PIPE  COMPONENTS
3020000   "PRZ3-EXIT"   SNGLJUN
3020101   301000000  303000000 0.0  0.0  0.0   1000
*
3020201   1  0.0  0.0  0.0
*     VALVE   UPSTREAM
*
```

```
3030000    "LS2 IN"  PIPE
*
3030001          4
*
3030101   0.14653    4
*
3030301   0.3125     1
3030302   0.4236     4
*
3030401   0.0        4
*
3030601   45.        1
3030602   0.0        4
*
3030801   1.513-4    0.0       4
*
3030901   0.0918     0.0918    1
3030902   0.0        0.0       3
*
3031001   00         4
*
3031101   1000       3
*
3031201   2   2500.   1.   0.0  0.0  4
*
3031300   1
3031301   0.0   0.0   0.0      3
*
3040000   "JUN-LS3"   SNGLJUN
3040101   303010000   305000000  0.0  0.1836  0.1836    1000
3040201   1   0.0   0.0   0.0
*
3050000   "LPSL 2"   PIPE
3050001   20
*
3050101   0.14653    20
*
3050301   0.5        10
3050302   0.6203     20
*
3050401   0.0        20
*
3050601   -90.       7
3050602   0.0        10
3050603   90.        20
*
3050801   1.513-4    0.0       20
*
3050901   0.0        0.0       6
3050902   0.1836     0.1836    7
3050903   0.0        0.0       9
3050904   0.1836     0.1836    10
3050905   0.0        0.0       19
*
3051001   00         20
*
3051101   1000       19
*
```

```
3051201    2    2500.    1.0  0.0  0.0  20
*
3051300    1
3051301    0.0  0.0  0.0          19
*
*    CROSSBY  6M6  SAFETY  VALVE #3   SV-45A
*
3060000    "SV NO3"  VALVE    * VALVE OPEN WITH PROG. START
3060101    305010000  307000000  0.01897  0.0  0.0   0100  1.  1.
3060201    1   0.0  0.0  0.0
3060300    MTRVLV
3060301    501  502  100.  0.0   *  VALVE  OPENS  WITH  PROG.  START
*
*    VALVE DOWNSTREAM PIPING
3070000    "DWNSTRM#3"   PIPE
3070001    18
*
3070101    0.20089    18
*
3070301    0.5261      4
3070302    1.034      12
3070303    0.801      15
3070304    1.085      18
*
3070401    0.0        18
*
3070601    0.0         4
3070602    -90.       12
3070603    0.0        18
*
3070801    1.52-4   0.   18
*
3070901    0.0         0.0        3
3070902    0.18        0.18       4
3070903    0.0         0.0       11
3070904    0.18        0.18      12
3070905    0.0         0.0       17
*
3071001    00         18
3071101    1000       17
*
3071201    4   17.7   120.   0.93424   0.   18
*
3071300    1
3071301    0.0  0.0  0.0          17
*
*
******************************************************
*     PORV DISCHARGE SECTION                         *
******************************************************
*
*
*****************************************************************
*   PORV NRV-151 DISCHARGE LINE ARC "A"                         *
*****************************************************************
*
*
4110000    "PORV1"  PIPE
```

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```
4110001            19
*
4110101   0.051132   17
4110102   0.200869   19
*
4110301   0.3724     4
4110302   0.3659     8
4110303   0.561      17
4110304   0.349      19
*
4110401   0.0        19
*
4110601   0.0        4
4110602   -90.       8
4110603   0.0        19
*
4110801   1.53-4  .0 17
4110802   1.52-4  .0 19
*
4110901   0.0        0.0      3
4110902   0.20888    0.2088   4
4110903   0.0        0.0      7
4110904   0.20888    0.2088   8
4110905   0.0        0.0      16
4110906   0.37834    0.1565   17
4110907   0.0        0.0      18
*
4111001   00         19
4111101   1000       18
*
4111201   4   117.7   120.   0.93424   0.0   19
*
4111300   1
4111301   0.0  0.0  0.0   18
*
4120000   "ENTERMAIN"   SNGLJUN
4120101   411010000   701000000   0.0   0.18   0.18   1000
4120201   1   0.0  0.0  0.0
*
*
****************************************************
*   PORV NRV-153 DISCHARGE LINE ARC "B"            *
****************************************************
*
*
*
5110000   "PORV2LINE"   PIPE
5110001             19
*
5110101   0.05132    18
5110102   0.08840    19
*
5110301   0.4303     3
5110302   0.3620     7
5110303   0.35       9
5110304   0.6058     18
5110305   0.371      19
*
```

```
5110401   0.0          19
*
5110601   0.0          3
5110602   -90.         7
5110603   0.0          19
*
5110801   1.53-4 .0    18
5110802   1.34-4 .0    19
*
5110901   0.0          0.0      2
5110902   0.2088       0.2088   3
5110903   0.0          0.0.     6
5110904   0.2088       0.2088   7
5110905   0.0          0.0      17
5110906   0.0544       0.0399   18
*
5111001   00           19
*
5111101   1000         18
*
5111201   4  17.7      120.  0.93424  0.0  19
*
5111300   1
5111301   0.0  0.0     0.0   18
*
5120000   "JUNC."      SNGLJUN
5120101   511010000  513000000  0.0  0.0  0.0  1000
5120201   1  0.0  0.0  0.0
*
*
*
5130000   "4X4X3TEE"   BRANCH
5130001   0
5130101   0.08840   0.3524  0.0 0.0 0.0 0.0  1.34-4  0.0  00
5130200   4  17.7   120.  0.93424  0.0  0.0
*
*
5140000   "4IN JUNC"   SNGLJUN
5140101   513010000  515000000  0.0  0.0  0.0  1000
5140201   1  0.0  0.0  0.0
*
5150000   "4INSCH40"   PIPE
5150001   12
*
5150101   0.0884       10
5150102   0.20069      12
*
5150301   0.3524       1
5150302   0.6983       10
5150303   0.349        12
*
5150401   0.0          12
*
5150601   0.0          12
*
5150801   1.34-4  0.0  10
5150802   1.52-4  0.0  12
*
```

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```
5150901  0.0         0.0       9
5150902  0.1483      0.0815    10
5150903  0.0         0.0       11
*
5151001  00          12
*
5151101  1000        11
*
5151201  4  17.7   120.  0.93424  0.0   12
*
5151300  1
5151301  0.0  0.0   0.0   11
*
5160000  "ENTERMAIN"   SNGLJUN
5160101  515010000  701000000  0.0  0.18  0.18    1000
5160201  1  0.0  0.0  0.0
*
*
***************************************************
*    PORV NRV-152 DISCHARGE LINE  ARC "C"          *
***************************************************
*
*
*
6110000   "PORVDISC3"  PIPE
6110001              8
*
6110101  0.05132     8
*
6110301  0.3723      4
6110302  0.3646      8
*
6110401  0.0         8
*
6110601  0.0         4
6110602  -90.        8
*
6110801  1.53-4 .0   8
*
6110901  0.0         0.0       3
6110902  0.2088      0.2088    4
6110903  0.0         0.0       7
*
6111001  00          8
6111101  1000        7
*
6111201  4  17.7   120.  0.93424  0.0   8
*
6111300  1
6111301  0.0  0.0   0.0   7
*
6120000  "PORVLINE"   SNGLJUN
6120101  611010000  513000000  0.0  0.1932  0.1932    1000
6120201  1  0.0  0.0  0.0
*
*******************************************
*   MAIN DISCHARGE LINE SECTION           *
*******************************************
```

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```
*
*
*     MAIN  DISCHARGE  LINE
7010000    "ENTERMAIN"     BRANCH
7010001    0
7010101    0.20069   0.7035 0 .0 0.0 0.0 0.0 1.52-4 0.0  00
7010200    4     17.7   120.   0.93424  0.0  0.0
*
7020000    "MAINLINE"   SNGLJUN
7020101    701010000   703000000 0.0  0.0  0.0   1000
7020201    1     0.0  0.0   0.00
*
7030000    "MAINLINE"   PIPE
*
7030001          14
*
7030101    0.20069     12
7030102    0.77708     14    *  12  IN LINE STARTS HERE
*
7030301    0.7035      1
7030302    1.0076      12
7030303    0.5834      14    *  12  IN LINE STARTS HERE
*
7030401    0.0         14
*
7030601    0.0         1
7030602    -90.        14
*
7030801    1.52-4      0.   12
7030802     1.69-4     0.      14
*
7030901    0.180       0.180      1
7030902    0.0         0.0        11
7030903    0.493       0.2045     12
7030904    0.0         0.0        13
*
7031001    00          14
7031101    1000        13
*
7031201    4    17.7    120.    0.93424   0.0   14
*
7031300    1
7031301    0.0  0.0  0.0     13
*
*
7040000    "MAINLINE"   SNGLJUN
7040101    703010000   801000000    0.0   0.0   0.0    1000
7040201    1   0.0  0.0  0.0
*
3080000    "CON.1"   SNGLJUN
3080101    307010000   801000000    0.0   0.156   0.156    1000
3080201    1   0.0  0.0  0.0
*
*
*
*
*
*   CONNECTION  TO MAIN LINE AT ELEV. 672'-6"
```

```
*
*
801000000   "12-BRANC1"   BRANCH
801000001   0
801010101   0.77708   0.8334   0.0   0.0 -90.  -0.8334   1.69-4   0.0   00
801020000   4   17.7   120.   0.93424   0.0   0.0
*
802000000   "MAINLINE"   SNGLJUN
802010101   801010000   803000000   0.0   0.0   0.0   1000
802020101   1   0.0   0.0   0.0
*
803000000   "MAINLINE"   SNGLVOL
803010101   0.77708   0.8334   0.0   0.0 -90.   -0.8334   1.69-4   0.0   00
803020000   4   17.7   120.   0.93424   0.0   0.0
*
*     CONNECTION TO MAIN LINE AT ELEV. 670'-10"
*
*
804000000   "MAINLINE"   SNGLJUN
804010101   803010000   805000000   0.0   0.0   0.0   1000
804020101   1   0.0   0.0   0.0
*
208000000   "CON.2"   SNGLJUN
208010101   207010000   805000000   0.0   0.156   0.156   1000
208020101   1   0.0   0.0   0.0
*
805000000   "MAINBR.3"   BRANCH
805000001   0
805010101   0.77708   0.8334 0.0 0.0 -90. -0.8334   1.69-4   0.0   00
805020000   4   17.7   120.   0.93424   0.0   0.0
*
806000000   "MAINLINE"   SNGLJUN
806010101   805010000   807000000   0.0   0.0   0.0   1000
806020101   1   0.0   0.0   0.0
*
807000000   "MAINLINE"   SNGLVOL
807010101   0.77708   0.8334   0.0   0.0 -90.   -0.8334   1.69-4   0.0   00
807020000   4   17.7   120.   0.93424   0.0   0.0
*
*
*     CONNECTION TO MAIN LINE AT ELEV. 669'-2"
*
*
*
808000000   "MAINLINE"   SNGLJUN
808010101   807010000   809000000   0.0   0.0   0.0   1000
808020101   1   0.0   0.0   0.0
*
108000000   "CON.3"   SNGLJUN
108010101   107010000   809000000   0.0   0.156   0.156   1000
108020101   1   0.0   0.0   0.0
*
809000000   "MAINBR4"   BRANCH
809000001   0
809010101   0.77708   0.8334   0.0 0.0 -90.  -0.8334   1.67-4   0.0   00
809020000   4   17.7   120.   0.93424 0.0   0.0
*
810000000   "MAINLINE"   SNGLJUN
```

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```
8100101  809010000  811000000  0.0  0.0  0.0   1000
8100201  1  0.0  0.0  0.0
*
*
8110000  "MAINLINE"  PIPE
*
8110001            97
*
8110101  0.77708   97
*
8110301  1.0149    14
8110302  0.5303    18
8110303  0.5       22
8110304  0.53125   26
8110305  0.9908    56
8110306  0.5       64
8110307  0.8750    72
8110308  0.5104    80
8110309  0.4993    88
8110310  1.0556    97
*
8110401  0.0       97
*
8110601  -90.      14
8110602  -45.      18
8110603  -90.      22
8110604  -45.      26
8110605  -90.      56
8110606  0.0       80
8110607  -90.      88
8110608  0.0       97
*
8110801  1.69-4    0.   97
*
8110901  0.0       0.0       13
8110902  0.078     0.078     14
8110903  0.0       0.0       17
8110904  0.078     0.078     18
8110905  0.0       0.0       21
8110906  0.078     0.078     22
8110907  0.0       0.0       25
8110908  0.078     0.078     26
8110909  0.0       0.0       55
8110910  0.156     0.156     56
8110911  0.0       0.0       63
8110912  0.026     0.026     64
8110913  0.0       0.0       71
8110914  0.13      0.13      72
8110915  0.0       0.0       79
8110916  0.156     0.156     80
8110917  0.0       0.0       87
8110918  0.156     0.156     88
8110919  0.0       0.0       96
*
8111001  00        97
*
8111101  1000      96
*
```

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```
8111201   4   17.7      120.   0.93424  0.0      97
*
8111300   1
8111301   0.0  0.0      0.0     96
*
*
8120000   "MAINDISC"    SNGLJUN
8120101   811010000  813000000  0.0  0.156  0.156   1000
8120201   1   0.0    0.0   0.0
*
8130000   "MAINLINE"    PIPE
*
8130001                 26
*
8130101   0.77708       26
*
8130301   1.0           14
8130302   0.5           24
8130303   1.0208        26
*
8130401   0.0           26
*
8130601   0.0           24
8130602   -90.          26
*
8130801   1.69-4        0.   26
*
8130901   0.0           0.0         13
8130902   0.156         0.156       14
8130903   0.0           0.0         23
8130904   0.156         0.156       24
8130905   0.0           0.0         25
*
8131001   00            26
*
8131101   1000          25
*
8131201   4   17.7      120.   0.93424 0.0   26
*
8131300   1
8131301   0.0  0.0      0.0         25
*
*
*
*****************************************
*      QUENCH TANK                      *
*****************************************
*
*
*
9770000   "QTANK-IN"   SNGLJUN
9770101   813010000  978000000  0.  0.  0.    1000
9770201   1    0.   0.   0.
*
*    SPARGER  12 IN SCH40  PIPE
*
9780000   "SPARGER"  PIPE
*    NO OF VOLUMES
```

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```
9780001   18
*      FLOW AREA
9780101   0.7773      18
*      VOL. LENGTHS
9780301   1.125       2
9780302   1.1333      7
9780303   1.0         18
*      VOL. VOLS.
9780401   0.0         18
*
*      VERTICAL ANGLES
9780601   -90.        7
9780602   0.0         18
*      PIPE  ROUGHNESS
9780801   1.69-4      0.0        18
*      JUNCTION  LOSS COEFF
9780901   0.0         0.0        6
9780902   0.156       0.158      7
9780903   0.0         0.0        17
*      VOL. CONTROL FLAG
9781001   00          18
*      JUN. CONTROL FLAG
9781101   1000        17
*      INITIAL COND.
9781201   4    17.7   120        0.93424     0.   2
9781202   3    17.7   120        0.0         0.   18
*           JUN. INITIAL COND.
9781300   1
9781301   0.0  0.0  0.0          17
*      SPARGER   EXIT
9790000 "EXIT" SNGLJUN
9790101   978010000   980000000   0.0    1.0    1.0    1100
9790201   1    0.    0.    0.
*           QUENCH TANK
*
*           WATER  VOL.
9800000   "QT. WATER"  SNGLVOL
9800101   260.4706  5.6667   0.0   0.0   90.   5.6667  0.003  0.0   01
9800200   3    17.7   120.
*           INTERFACE
9810000   "INTERFACE"   SNGLJUN
9810101   980010000  982000000   0.0   0.0   0.0   1000
9810201   1    0.0   0.0   0.0
*           AIR  VOLUME
9820000   "QT.AIR"   SNGLVOL
9820101   260.4706  1.2439   0.0   0.0   90.   1.2439  0.003  0.0   01
9820200   4    17.7   120    0.93424
*
*           RUPTURE DISC
9830000   "RUP.DISC"   VALVE
9830101   982010000   999000000   1.77  0.   0.   1100
9830201   1    0.    0.    0.
9830300   TRPVLV
9830301   515      *   VALVE OPENING TRIP
*
*
*********************************************
*   PIPE OUTSIDE ENVIROMENT                 *
```

```
*********************************************
*
*
9990000   "ATMOSPHERE"   TMDPVOL
9990101   10000.   10000.     0.0  0.0  0.0  0.0  .00001  0.0  11
9990200   4
9990201   0.0   14.7   120.    0.9284
*
*
*********************************************
*  PLOT CARDS                               *
*********************************************
*
*
20300100  MFLOWJ   106000000
20300200  MFLOWJ   206000000
20300300  MFLOWJ   306000000
20300400  MFLOWJ   308000000
20300500  MFLOWJ   208000000
20300600  MFLOWJ   702000000
20300700  MFLOWJ   108000000
20300800  MFLOWJ   977000000
20300900  QUALS    105200000
20301000  QUALS    107010000
20301100  QUALS    107330000
20301200  QUALS    701010000
20301300  QUALS    811970000
20301400  QUALS    813260000
20301500  QUALS    978180000
20301600  QUALS    205200000
20301700  QUALS    207010000
20301800  QUALS    305200000
20301900  QUALS    207260000
20302000  QUALS    307010000
20302100  QUALS    307180000
20302300  P        105200000
20302400  P        107010000
20302600  P        107330000
20302700  P        701010000
20303100  P        811970000
20303200  P        813260000
20303300  P        978020000
20303400  P        978030000
20303500  P        205200000
20303600  P        207010000
20303700  P        305200000
20303800  P        207260000
20303900  P        307010000
20304000  P        307180000
*
*
*
*
. END OF CASE
```

4.8 REPIPE Input

These are input listings of Control Data Corporation's RELAP post-processor, REPIPE. Each set represents direction cosines of the RELAP model as well as structural node assignments. On the Unit 1 SV model, it was necessary to break up the model in two sections, of approximately equal size, because of REPIPE's size limitations.

Input Set	Model Section
4.8.1	A
4.8.2	B

4.8.1 REPIPE Input - Section A

```
$PIPES
INLINE=3,KBLOCK=300,KPIPE=13,KPLOT(1,1)=0,KWAVE=1,
KPRINT=-1,KPNV=1,KSTEP=3,
NDROPV=411190000,515120000,307180000,207260000,107330000,978080000$
2951  516000000  -0.648  0.0  -.7611
2951  412000000  -0.648  0.0  -.7611
2951  702000000  -0.648  0.0  -.7611
290  -702000000  -0.648  0.0  -.7611
290  -703010000  -0.648  0.0  -.7611
285        703010000    0.          -1.0     0./
285        703020000    0.          -1.0     0./
285        703030000    0.          -1.0     0./
285        703040000    0.          -1.0     0./
285        703050000    0.          -1.0     0./
285        703060000    0.          -1.0     0./
285        703070000    0.          -1.0     0./
285        703080000    0.          -1.0     0./
285        703090000    0.          -1.0     0./
285        703100000    0.          -1.0     0./
285        703110000    0.          -1.0     0./
285        703120000    0.          -1.0     0./
285        703130000    0.          -1.0     0./
285        704000000    0.          -1.0     0./
285    308000000    0.0    -1.0    0.0/
285        802000000    0.          -1.0     0./
285        804000000    0.          -1.0     0./
285    208000000    0.0    -1.0    0.0/
285        806000000    0.          -1.0     0./
285        808000000    0.          -1.0     0./
285    108000000    0.0    -1.0    0.0/
285        810000000    0.          -1.0     0./
285        811010000    0.          -1.0     0./
285        811020000    0.          -1.0     0./
285        811030000    0.          -1.0     0./
285        811040000    0.          -1.0     0./
285        811050000    0.          -1.0     0./
285        811060000    0.          -1.0     0./
285        811070000    0.          -1.0     0./
285        811080000    0.          -1.0     0./
285        811090000    0.          -1.0     0./
285        811100000    0.          -1.0     0./
285        811110000    0.          -1.0     0./
285        811120000    0.          -1.0     0./
285        811130000    0.          -1.0     0./
90        -703020000    0.          -1.0     0./
90        -703030000    0.          -1.0     0./
90       -703040000    0.          -1.0     0./
90       -703050000    0.          -1.0     0./
90       -703060000    0.          -1.0     0./
90       -703070000    0.          -1.0     0./
90       -703080000    0.          -1.0     0./
90       -703090000    0.          -1.0     0./
90       -703100000    0.          -1.0     0./
90       -703110000    0.          -1.0     0./
90       -703120000    0.          -1.0     0./
90       -703130000    0.          -1.0     0./
90       -704000000    0.          -1.0     0./
90       -802000000    0.          -1.0     0./
90       -804000000    0.          -1.0     0./
90       -806000000    0.          -1.0     0./
90       -808000000    0.          -1.0     0./
90       -810000000    0.          -1.0     0./
90       -811010000    0.          -1.0     0./
```

BY KJG DATE 6-22-83
CHKD. BY CKW DATE 6-27-83

```
90  [illegible]1020000  0.      -1.0     0./
90  [illegible]11030000  0.      -1.0     0./
90  -811040000  0.      -1.0     0./
90  -811050000  0.      -1.0     0./
90  -811060000  0.      -1.0     0./
90  -811070000  0.      -1.0     0./
90  -811080000  0.      -1.0     0./
90  -811090000  0.      -1.0     0./
90  -811100000  0.      -1.0     0./
90  -811110000  0.      -1.0     0./
90  -811120000  0.      -1.0     0./
90  -811130000  0.      -1.0     0./
90  -811140000  0.      -1.0     0./
88   811140000  0.2356  -0.7071  0.6667/
88   811150000  0.2356  -0.7071  0.6667/
88   811160000  0.2356  -0.7071  0.6667/
88   811170000  0.2356  -0.7071  0.6667/
86  -811150000  0.2356  -0.7071  0.6667/
86  -811160000  0.2356  -0.7071  0.6667/
86  -811170000  0.2356  -0.7071  0.6667/
86  -811180000  0.2356  -0.7071  0.6667/
84   811180000  0.      -1.0     0./
84   811190000  0.      -1.0     0./
84   811200000  0.      -1.0     0./
84   811210000  0.      -1.0     0./
82  -811190000  0.      -1.0     0./
82  -811200000  0.      -1.0     0./
82  -811210000  0.      -1.0     0./
82  -811220000  0.      -1.0     0./
80   811220000  -0.2356  -0.7071  -0.6667/
80   811230000  -0.2356  -0.7071  -0.6667/
80   811240000  -0.2356  -0.7071  -0.6667/
80   811250000  -0.2356  -0.7071  -0.6667/
76  -811230000  -0.2356  -0.7071  -0.6667/
76  -811240000  -0.2356  -0.7071  -0.6667/
76  -811250000  -0.2356  -0.7071  -0.6667/
76  -811260000  -0.2356  -0.7071  -0.6667/
74  811260000  0.0  -1.0  0.0/
74  811270000  0.0  -1.0  0.0/
74  811280000  0.0  -1.0  0.0/
74  811290000  0.0  -1.0  0.0/
74  811300000  0.0  -1.0  0.0/
74  811310000  0.0  -1.0  0.0/
74  811320000  0.0  -1.0  0.0/
74  811330000  0.0  -1.0  0.0/
74  811340000  0.0  -1.0  0.0/
74  811350000  0.0  -1.0  0.0/
74  811360000  0.0  -1.0  0.0/
74  811370000  0.0  -1.0  0.0/
74  811380000  0.0  -1.0  0.0/
74  811390000  0.0  -1.0  0.0/
74  811400000  0.0  -1.0  0.0/
74  811410000  0.0  -1.0  0.0/
74  811420000  0.0  -1.0  0.0/
74  811430000  0.0  -1.0  0.0/
74  811440000  0.0  -1.0  0.0/
74  811450000  0.0  -1.0  0.0/
74  811460000  0.0  -1.0  0.0/
74  811470000  0.0  -1.0  0.0/
74  811480000  0.0  -1.0  0.0/
74  811490000  0.0  -1.0  0.0/
74  811500000  0.0  -1.0  0.0/
74  811510000  0.0  -1.0  0.0/
```

74	[illegible]520000	0.0	-1.0	0.0/
74	811530000	0.0	-1.0	0.0/
74	811540000	0.0	-1.0	0.0/
74	811550000	0.0	-1.0	0.0/
62	-811270000	0.0	-1.0	0.0/
62	-811280000	0.0	-1.0	0.0/
62	-811290000	0.0	-1.0	0.0/
62	-811300000	0.0	-1.0	0.0/
62	-811310000	0.0	-1.0	0.0/
62	-811320000	0.0	-1.0	0.0/
62	-811330000	0.0	-1.0	0.0/
62	-811340000	0.0	-1.0	0.0/
62	-811350000	0.0	-1.0	0.0/
62	-811360000	0.0	-1.0	0.0/
62	-811370000	0.0	-1.0	0.0/
62	-811380000	0.0	-1.0	0.0/
62	-811390000	0.0	-1.0	0.0/
62	-811400000	0.0	-1.0	0.0/
62	-811410000	0.0	-1.0	0.0/
62	-811420000	0.0	-1.0	0.0/
62	-811430000	0.0	-1.0	0.0/
62	-811440000	0.0	-1.0	0.0/
62	-811450000	0.0	-1.0	0.0/
62	-811460000	0.0	-1.0	0.0/
62	-811470000	0.0	-1.0	0.0/
62	-811480000	0.0	-1.0	0.0/
62	-811490000	0.0	-1.0	0.0/
62	-811500000	0.0	-1.0	0.0/
62	-811510000	0.0	-1.0	0.0/
62	-811520000	0.0	-1.0	0.0/
62	-811530000	0.0	-1.0	0.0/
62	-811540000	0.0	-1.0	0.0/
62	-811550000	0.0	-1.0	0.0/
62	-811560000	0.0	-1.0	0.0/
60	811560000	0.0	0.0	-1.0/
60	811570000	0.0	0.0	-1.0/
60	811580000	0.0	0.0	-1.0/
60	811590000	0.0	0.0	-1.0/
60	811600000	0.0	0.0	-1.0/
60	811610000	0.0	0.0	-1.0/
60	811620000	0.0	0.0	-1.0/
60	811630000	0.0	0.0	-1.0/
58	-811570000	0.0	0.0	-1.0/
58	-811580000	0.0	0.0	-1.0/
58	-811590000	0.0	0.0	-1.0/
58	-811600000	0.0	0.0	-1.0/
58	-811610000	0.0	0.0	-1.0/
58	-811620000	0.0	0.0	-1.0/
58	-811630000	0.0	0.0	-1.0/
58	-811640000	0.0	0.0	-1.0/
56	811640000	-.259	0.0	-.966/
56	811650000	-.259	0.0	-.966/
56	811660000	-.259	0.0	-.966/
56	811670000	-.259	0.0	-.966/
56	811680000	-.259	0.0	-.966/
56	811690000	-.259	0.0	-.966/
56	811700000	-.259	0.0	-.966/
56	811710000	-.259	0.0	-.966/
52	-811650000	-.259	0.0	-.966/
52	-811660000	-.259	0.0	-.966/
52	-811670000	-.259	0.0	-.966/
52	-811680000	-.259	0.0	-.966/
52	-811690000	-.259	0.0	-.966/

52	[illegible]700000	-.259	0.0	[illegible]/
52	-811710000	-.259	0.0	[illegible]/
52	-811720000	-.259	0.0	[illegible]/
50	811720000	-1.0	0.0	1.0/
50	811730000	-1.0	0.0	1.0/
50	811740000	-1.0	0.0	1.0/
50	811750000	-1.0	0.0	1.0/
50	811760000	-1.0	0.0	1.0/
50	811770000	-1.0	0.0	1.0/
50	811780000	-1.0	0.0	1.0/
50	811790000	-1.0	0.0	1.0/
46	-811730000	-1.0	0.0	1.0/
46	-811740000	-1.0	0.0	1.0/
46	-811750000	-1.0	0.0	1.0/
46	-811760000	-1.0	0.0	1.0/
46	-811770000	-1.0	0.0	1.0/
46	-811780000	-1.0	0.0	1.0/
46	-811790000	-1.0	0.0	1.0/
46	-811800000	-1.0	0.0	1.0/
44	811800000	0.0	-1.0	0.0/
44	811810000	0.0	-1.0	0.0/
44	811820000	0.0	-1.0	0.0/
44	811830000	0.0	-1.0	0.0/
44	811840000	0.0	-1.0	0.0/
44	811850000	0.0	-1.0	0.0/
44	811860000	0.0	-1.0	0.0/
44	811870000	0.0	-1.0	0.0/
40	-811810000	0.0	-1.0	0.0/
40	-811820000	0.0	-1.0	0.0/
40	-811830000	0.0	-1.0	0.0/
40	-811840000	0.0	-1.0	0.0/
40	-811850000	0.0	-1.0	0.0/
40	-811860000	0.0	-1.0	0.0/
40	-811870000	0.0	-1.0	0.0/
40	-811880000	0.0	-1.0	0.0/
38	811880000	-1.0	0.0	0.0/
38	811890000	-1.0	0.0	0.0/
38	811900000	-1.0	0.0	0.0/
38	811910000	-1.0	0.0	0.0/
38	811920000	-1.0	0.0	0.0/
38	811930000	-1.0	0.0	0.0/
38	811940000	-1.0	0.0	0.0/
38	811950000	-1.0	0.0	0.0/
38	811960000	-1.0	0.0	0.0/
32	-811890000	-1.0	0.0	0.0/
32	-811900000	-1.0	0.0	0.0/
32	-811910000	-1.0	0.0	0.0/
32	-811920000	-1.0	0.0	0.0/
32	-811930000	-1.0	0.0	0.0/
32	-811940000	-1.0	0.0	0.0/
32	-811950000	-1.0	0.0	0.0/
32	-811960000	-1.0	0.0	0.0/
32	-812000000	-1.0	0.0	0.0/
30	812000000	0.0	0.0	1.0/
30	813010000	0.0	0.0	1.0/
30	813020000	0.0	0.0	1.0/
30	813030000	0.0	0.0	1.0/
30	813040000	0.0	0.0	1.0/
30	813050000	0.0	0.0	1.0/
30	813060000	0.0	0.0	1.0/
30	813070000	0.0	0.0	1.0/
30	813080000	0.0	0.0	1.0/
30	813090000	0.0	0.0	1.0/

COPI

```
30        813100000     0.0    0.0    1.0/
30        813110000     0.0    0.0    1.0/
30        813120000     0.0    0.0    1.0/
30        813130000     0.0    0.0    1.0/
12       -813010000     0.0    0.0    1.0/
12       -813020000     0.0    0.0    1.0/
12       -813030000     0.0    0.0    1.0/
12       -813040000     0.0    0.0    1.0/
12       -813050000     0.0    0.0    1.0/
12       -813060000     0.0    0.0    1.0/
12       -813070000     0.0    0.0    1.0/
12       -813080000     0.0    0.0    1.0/
12       -813090000     0.0    0.0    1.0/
12       -813100000     0.0    0.0    1.0/
12       -813110000     0.0    0.0    1.0/
12       -813120000     0.0    0.0    1.0/
12       -813130000     0.0    0.0    1.0/
12       -813140000     0.0    0.0    1.0/
10        813140000     1.0    0.0    0.0/
10        813150000     1.0    0.0    0.0/
10        813160000     1.0    0.0    0.0/
10        813170000     1.0    0.0    0.0/
10        813180000     1.0    0.0    0.0/
10        813190000     1.0    0.0    0.0/
10        813200000     1.0    0.0    0.0/
10        813210000     1.0    0.0    0.0/
10        813220000     1.0    0.0    0.0/
10        813230000     1.0    0.0    0.0/
6        -813150000     1.0    0.0    0.0/
6        -813160000     1.0    0.0    0.0/
6        -813170000     1.0    0.0    0.0/
6        -813180000     1.0    0.0    0.0/
6        -813190000     1.0    0.0    0.0/
6        -813200000     1.0    0.0    0.0/
6        -813210000     1.0    0.0    0.0/
6        -813220000     1.0    0.0    0.0/
6        -813230000     1.0    0.0    0.0/
6        -813240000     1.0    0.0    0.0/
4         813240000     0.0   -1.0    0.0/
4         813250000     0.0   -1.0    0.0/
4         977000000  0.0   -1.0  0.0/
4         978010000  0.0   -1.0  0.0/
4         978020000  0.0   -1.0  0.0/
4         978030000  0.0   -1.0  0.0/
4         978040000  0.0   -1.0  0.0/
4         978050000  0.0   -1.0  0.0/
4         978060000  0.0   -1.0  0.0/
1        -813250000     0.0   -1.0    0.0/
1        -977000000     0.0   -1.0    0.0/
1         -978010000  0.0   -1.0  0.0/
1        -978020000  0.0   -1.0  0.0/
1        -978030000  0.0   -1.0  0.0/
1        -978040000  0.0   -1.0  0.0/
1        -978050000  0.0   -1.0  0.0/
1        -978060000  0.0   -1.0  0.0/
1        -978070000  0.0   -1.0  0.0/
99999/
 $STEPS TSTEP(1)=0.001,0.500,-1,-1$
```

4.8.2 REPIPE Input - Section B

```
$PIP
INLIN  ,KBLOCK=300,KPIPE=13,KPLOT(1)=0,KWAVE=1,
KPRINT=-1,KPNV=1,KSTEP=3,
NDROPV=100010000,200010000,300010000,801010000,805010000,
809010000,701010000$
625    610000000    -0.9272    0.0    0.375/
625    611010000    -0.9272    0.0    0.375/
625    611020000    -0.9272    0.0    0.375/
625    611030000    -0.9272    0.0    0.375/
615   -611010000    -0.9272    0.0    0.375/
615   -611020000    -0.9272    0.0    0.375/
615   -611030000    -0.9272    0.0    0.375/
615   -611040000    -0.9272    0.0    0.375/
610     611040000    0.0 -1.0   0.0/
610     611050000    0.0 -1.0   0.0/
610     611060000    0.0 -1.0   0.0/
610     611070000    0.0 -1.0   0.0/
335    -611050000    0.0 -1.0   0.0/
335    -611060000    0.0 -1.0   0.0/
335    -611070000    0.0 -1.0   0.0/
335    -612000000    0.0 -1.0   0.0/
525    410000000    0.9272     0.0    -0.3746/
525    411010000    0.9272     0.0    -0.3746/
525    411020000    0.9272     0.0    -0.3746/
525    411030000    0.9272     0.0    -0.3746/
530   -411010000    0.9272     0.0    -0.3746/
530   -411020000    0.9272     0.0    -0.3746/
530   -411030000    0.9272     0.0    -0.3746/
530   -411040000    0.9272     0.0    -0.3746/
533     411040000    0.0 -1.0   0.0/
533     411050000    0.0 -1.0   0.0/
533     411060000    0.0 -1.0   0.0/
533     411070000    0.0 -1.0   0.0/
540    -411050000    0.0 -1.0   0.0/
540    -411060000    0.0 -1.0   0.0/
540    -411070000    0.0 -1.0   0.0/
540    -411080000    0.0 -1.0   0.0/
545     411080000   .285   0.0 -.9585/
545     411090000   .285   0.0 -.9585/
545     411100000   .285   0.0 -.9585/
55001  -411090000   .285   0.0 -.9585/
55001  -411100000   .285   0.0 -.9585/
55001  -411110000   .285   0.0 -.9585/
55002   411110000   -.107   0.0 -.9943/
55002   411120000   -.107   0.0 -.9943/
55002   411130000   -.107   0.0 -.9943/
55501  -411120000   -.107   0.0 -.9943/
55501  -411130000   -.107   0.0 -.9943/
55501  -411140000   -.107   0.0 -.9943/
55502   411140000   -.483   0.0 -.876/
55502   411150000   -.483   0.0 -.876/
55502   411160000   -.483   0.0 -.876/
56001  -411150000   -.483   0.0 -.876/
56001  -411160000   -.483   0.0 -.876/
56001  -411170000   -.483   0.0 -.876/
56002   411170000   -.7064   0.0 -.7078/
56002   411180000   -.7064   0.0 -.7078/
295    -411180000   -.7064   0.0 -.7078/
295    -412000000   -.7064   0.0 -.7078/
385    510000000   0.3706    0.0    0.9272/
385    511010000   0.3706    0.0    0.9272/
385    511020000   0.3706    0.0    0.9272/
380   -511010000   0.3706    0.0    0.9272/
COPY
```

BY KJG DATE 6-22-83
CHKD. BY CHH DATE 6-27-83

```
380   [illegible]1020000    0.3708    0.0     0.9272/
380   511030000    0.3706    0.0     0.9272/
375    511030000    0.0 -1.0  0.0/
375    511040000    0.0 -1.0  0.0/
375    511050000    0.0 -1.0  0.0/
375    511060000    0.0 -1.0  0.0/
370   -511040000    0.0 -1.0  0.0/
370   -511050000    0.0 -1.0  0.0/
370   -511060000    0.0 -1.0  0.0/
370   -511070000    0.0 -1.0  0.0/
365    511070000   -.826  0.0 -.563/
365    511080000   -.826  0.0 -.583/
36001 -511080000   -.826  0.0 -.563/
36001 -511090000   -.826  0.0 -.563/
36002  511090000   -.633  0.0 -.7745/
36002  511100000   -.633  0.0 -.7745/
36002  511110000   -.633  0.0 -.7745/
35501 -511100000   -.633  0.0 -.7745/
35501 -511110000   -.633  0.0 -.7745/
35501 -511120000   -.633  0.0 -.7745/
35502  511120000  -.254  0.0 -.967/
35502  511130000  -.254  0.0 -.967/
35502  511140000  -.254  0.0 -.967/
35001 -511130000  -.254  0.0 -.967/
35001 -511140000  -.254  0.0 -.967/
35001 -511150000  -.254  0.0 -.967/
35002  511150000   .169  0.0 -.9856/
35002  511160000   .169  0.0 -.9856/
35002  511170000   .169  0.0 -.9856/
34001 -511160000   .169  0.0 -.9856/
34001 -511170000   .169  0.0 -.9856/
34001 -511180000   .169  0.0 -.9856/
34002  511180000   .415  0.0 -.9099/
33501 -512000000   .415  0.0 -.9099/
33502  512000000   .525  0.0 -.851/
33502 612000000  0.525  0.0  -0.851/
33502  514000000   .525  0.0 -.851/
32501 -514000000   .525  0.0 -.851/
32501 -515010000   .525  0.0 -.851/
32502  515010000   .773  0.0 -.635/
32502  515020000   .773  0.0 -.635/
32502  515030000   .773  0.0 -.635/
32001 -515020000   .773  0.0 -.635/
32001 -515030000   .773  0.0 -.635/
32001 -515040000   .773  0.0 -.635/
32002  515040000   .981  0.0 -.195/
32002  515050000   .981  0.0 -.195/
32002  515060000   .981  0.0 -.195/
31001 -515050000   .981  0.0 -.195/
31001 -515060000   .981  0.0 -.195/
31001 -515070000   .981  0.0 -.195/
31002  515070000   .957  0.0  .290/
31002  515080000   .957  0.0  .290/
31002  515090000   .957  0.0  .290/
30001 -515080000   .957  0.0  .290/
30001 -515090000   .957  0.0  .290/
30001 -515100000   .957  0.0  .290/
30002  515100000   .812  0.0  .583/
30002  515110000   .812  0.0  .583/
2952    -515110000    .812  0.0  .583/
2952    -516000000    .812  0.0  .583/
138  102000000  -0.694  0.707 -0.135/
138 -103010000  -0.694  0.707  -0.135/
```

COPI

134	[illegible]10000	-0.9816	0.0	-0.1908/
134	103020000	-0.9816	0.0	-0.1908/
134	103030000	-0.9816	0.0	-0.1908/
132	-103020000	-0.9816	0.0	-0.1908/
132	-103030000	-0.9816	0.0	-0.1908/
132	-104000000	-0.9816	0.0	-0.1908/
130	104000000	0.0	-1.0	0.0/
130	105010000	0.0	-1.0	0.0/
130	105020000	0.0	-1.0	0.0/
130	105030000	0.0	-1.0	0.0/
130	105040000	0.0	-1.0	0.0/
130	105050000	0.0	-1.0	0.0/
130	105060000	0.0	-1.0	0.0/
128	-105010000	0.0	-1.0	0.0/
128	-105020000	0.0	-1.0	0.0/
128	-105030000	0.0	-1.0	0.0/
128	-105040000	0.0	-1.0	0.0/
128	-105050000	0.0	-1.0	0.0/
128	-105060000	0.0	-1.0	0.0/
128	-105070000	0.0	-1.0	0.0/
126	105070000	-0.0652	0.0	0.9979/
126	105080000	-0.0652	0.0	0.9979/
126	105090000	-0.0652	0.0	0.9979/
124	-105080000	-0.0652	0.0	0.9979/
124	-105090000	-0.0652	0.0	0.9979/
124	-105100000	-0.0652	0.0	0.9979/
122	105100000	0.	1.0	0./
122	105110000	0.	1.0	0./
122	105120000	0.	1.0	0./
122	105130000	0.	1.0	0./
122	105140000	0.	1.0	0./
122	105150000	0.	1.0	0./
122	105160000	0.	1.0	0./
122	105170000	0.	1.0	0./
122	105180000	0.	1.0	0./
122	105190000	0.	1.0	0./
118	-105110000	0.	1.0	0./
118	-105120000	0.	1.0	0./
118	-105130000	0.	1.0	0./
118	-105140000	0.	1.0	0./
118	-105150000	0.	1.0	0./
118	-105160000	0.	1.0	0./
118	-105170000	0.	1.0	0./
118	-105180000	0.	1.0	0./
118	-105190000	0.	1.0	0./
118	-106000000	0.	1.0	0./
115	106000000	0.3498	0.	0.9368/
115	107010000	0.3498	0.	0.9368/
115	107020000	0.3498	0.	0.9368/
115	107030000	0.3498	0.	0.9368/
114	-107010000	0.3498	0.	0.9368/
114	-107020000	0.3498	0.	0.9368/
114	-107030000	0.3498	0.	0.9368/
114	-107040000	0.3498	0.	0.9368/
112	107040000	0.	-1.0	0./
112	107050000	0.	-1.0	0./
112	107060000	0.	-1.0	0./
112	107070000	0.	-1.0	0./
112	107080000	0.	-1.0	0./
112	107090000	0.	-1.0	0./
112	107100000	0.	-1.0	0./
112	107110000	0.	-1.0	0./
112	107120000	0.	-1.0	0./

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112	[illegible]07130000	0.	-1.0	0./
112	107140000	0.	-1.0	0./
106	-107050000	0.	-1.0	0./
106	-107060000	0.	-1.0	0./
106	-107070000	0.	-1.0	0./
106	-107080000	0.	-1.0	0./
106	-107090000	0.	-1.0	0./
106	-107100000	0.	-1.0	0./
106	-107110000	0.	-1.0	0./
106	-107120000	0.	-1.0	0./
106	-107130000	0.	-1.0	0./
106	-107140000	0.	-1.0	0./
106	-107150000	0.	-1.0	0./
104	107150000	0.7723	0.	0.6353/
104	107160000	0.7723	0.	0.6353/
104	107170000	0.7723	0.	0.6353/
10301	-107160000	0.7723	0.	0.6353/
10301	-107170000	0.7723	0.	0.6353/
10301	-107180000	0.7723	0.	0.6353/
10302	107180000	0.9948	0.	0.1018/
10302	107190000	0.9948	0.	0.1018/
10302	107200000	0.9948	0.	0.1018/
10201	-107190000	0.9948	0.	0.1018/
10201	-107200000	0.9948	0.	0.1018/
10201	-107210000	0.9948	0.	0.1018/
10202	107210000	0.8945	0.	-0.4470/
10202	107220000	0.8945	0.	-0.4470/
10202	107230000	0.8945	0.	-0.4470/
10001	-107220000	0.8945	0.	-0.4470/
10001	-107230000	0.8945	0.	-0.4470/
10001	-107240000	0.8945	0.	-0.4470/
10002	107240000	0.534	0.	-0.8453/
10002	107250000	0.534	0.	-0.8453/
10002	107260000	0.534	0.	-0.8453/
9901	-107250000	0.534	0.	-0.8453/
9901	-107260000	0.534	0.	-0.8453/
9901	-107270000	0.534	0.	-0.8453/
9902	107270000	0.0195	0.	-0.9998/
9902	107280000	0.0195	0.	-0.998/
9902	107290000	0.0195	0.	-0.998/
9801	-107280000	0.0195	0.	-0.998/
9801	-107290000	0.0195	0.	-0.998/
9801	-107300000	0.0195	0.	-0.998/
9802	107300000	-0.2497	0.	-0.9683/
9802	107310000	-0.2497	0.	-0.9683/
9802	107320000	-0.2497	0.	-0.9683/
97	-107310000	-0.2497	0.	-0.9683/
97	-107320000	-0.2497	0.	-0.9683/
97	-108000000	-0.2497	0.	-0.9683/
185	202000000	0.4056	0.7071	0.5792/
184	-203010000	0.4056	0.7071	0.5792/
182	203010000	-0.5736	0.0	0.8192/
182	203020000	-0.5736	0.0	0.8192/
182	203030000	-0.5736	0.	0.8192/
181	-203020000	-0.5736	0.	0.8192/
181	-203030000	-0.5736	0.	0.8192/
181	-204000000	-0.5736	0.	0.8192/
180	204000000	0.	-1.0	0./
180	205010000	0.	-1.0	0./
180	205020000	0.	-1.0	0./
180	205030000	0.	-1.0	0./
180	205040000	0.	-1.0	0./
180	205050000	0.	-1.0	0./

180	[illegible]5060000	0.	-1.0	0./
178	[illegible]05010000	0.	-1.0	0./
178	-205020000	0.	-1.0	0./
178	-205030000	0.	-1.0	0./
178	-205040000	0.	-1.0	0./
178	-205050000	0.	-1.0	0./
178	-205060000	0.	-1.0	0./
178	-205070000	0.	-1.0	0./
176	205070000	0.9006	0.	0.4346/
176	205080000	0.9006	0.	0.4346/
176	205090000	0.9006	0.	0.4346/
174	-205080000	0.9006	0.	0.4346/
174	-205090000	0.9006	0.	0.4346/
174	-205100000	0.9006	0.	0.4346/
172	205100000	0.	1.0	0./
172	205110000	0.	1.0	0./
172	205120000	0.	1.0	0./
172	205130000	0.	1.0	0./
172	205140000	0.	1.0	0./
172	205150000	0.	1.0	0./
172	205160000	0.	1.0	0./
172	205170000	0.	1.0	0./
172	205180000	0.	1.0	0./
172	205190000	0.	1.0	0./
168	-205110000	0.	1.0	0./
168	-205120000	0.	1.0	0./
168	-205130000	0.	1.0	0./
168	-205140000	0.	1.0	0./
168	-205150000	0.	1.0	0./
168	-205160000	0.	1.0	0./
168	-205170000	0.	1.0	0./
168	-205180000	0.	1.0	0./
168	-205190000	0.	1.0	0./
168	-206000000	0.	1.0	0./
164	206000000	0.9966	0.	0.0828/
164	207010000	0.9966	0.	0.0828/
164	207020000	0.9966	0.	0.0828/
164	207030000	0.9966	0.	0.0828/
162	-207010000	0.9966	0.	0.0828/
162	-207020000	0.9966	0.	0.0828/
162	-207030000	0.9966	0.	0.0828/
162	-207040000	0.9966	0.	0.0828/
160	207040000	0.	-1.0	0./
160	207050000	0.	-1.0	0./
160	207060000	0.	-1.0	0./
160	207070000	0.	-1.0	0./
160	207080000	0.	-1.0	0./
160	207090000	0.	-1.0	0./
160	207100000	0.	-1.0	0./
160	207110000	0.	-1.0	0./
160	207120000	0.	-1.0	0./
160	207130000	0.	-1.0	0./
152	-207050000	0.	-1.0	0./
152	-207060000	0.	-1.0	0./
152	-207070000	0.	-1.0	0./
152	-207080000	0.	-1.0	0./
152	-207090000	0.	-1.0	0./
152	-207100000	0.	-1.0	0./
152	-207110000	0.	-1.0	0./
152	-207120000	0.	-1.0	0./
152	-207130000	0.	-1.0	0./
152	-207140000	0.	-1.0	0./
150	207140000	0.9202	0.	-0.3915/

COPY

150	[illegible]150000	0.9202	0.	-0.3915/
150	[illegible]7160000	0.9202	0.	-0.3915/
14801	-207150000	0.9202	0.	-0.3915/
14801	-207160000	0.9202	0.	-0.3915/
14801	-207170000	0.9202	0.	-0.3915/
14802	207170000	0.5647	0.	-0.8253/
14802	207180000	0.5647	0.	-0.8253/
14802	207190000	0.5647	0.	-0.8253/
14601	-207180000	0.5647	0.	-0.8253/
14601	-207190000	0.5647	0.	-0.8253/
14601	-207200000	0.5647	0.	-0.8253/
14602	207200000	0.0318	0.	-0.9995/
14602	207210000	0.0318	0.	-0.9995/
14602	207220000	0.0318	0.	-0.9995/
14401	-207210000	0.0318	0.	-0.9995/
14401	-207220000	0.0318	0.	-0.9995/
14401	-207230000	0.0318	0.	-0.9995/
14402	207230000	-0.2497	0.	-0.9683/
14402	207240000	-0.2497	0.	-0.9683/
14402	207250000	-0.2497	0.	-0.9683/
142	-207240000	-0.2497	0.	-0.9683/
142	-207250000	-0.2497	0.	-0.9683/
142	-208000000	-0.2497	0.	-0.9683/
244	302000000	0.3641	0.7071	0.606/
242	-303010000	0.3641	0.7071	0.606/
240	303010000	0.5150	0.0	0.8524/
240	303020000	0.5150	0.	0.8524/
240	303030000	0.5150	0.	0.8524/
238	-303020000	0.5150	0.	0.8572/
238	-303030000	0.5150	0.	0.8572/
238	-304000000	0.5150	0.	0.8572/
237	304000000	0.	-1.0	0./
237	305010000	0.	-1.0	0./
237	305020000	0.	-1.0	0./
237	305030000	0.	-1.0	0./
237	305040000	0.	-1.0	0./
237	305050000	0.	-1.0	0./
237	305060000	0.	-1.0	0./
236	-305010000	0.	-1.0	0./
236	-305020000	0.	-1.0	0./
236	-305030000	0.	-1.0	0./
236	-305040000	0.	-1.0	0./
236	-305050000	0.	-1.0	0./
236	-305060000	0.	-1.0	0./
236	-305070000	0.	-1.0	0./
235	305070000	0.7633	0.	-0.6460/
235	305080000	0.7633	0.	-0.6460/
235	305090000	0.7633	0.	-0.6460/
234	-305080000	0.7633	0.	-0.6460/
234	-305090000	0.7633	0.	-0.6460/
234	-305100000	0.7633	0.	-0.6460/
233	305100000	0.	1.0	0./
233	305110000	0.	1.0	0./
233	305120000	0.	1.0	0./
233	305130000	0.	1.0	0./
233	305140000	0.	1.0	0./
233	305150000	0.	1.0	0./
233	305160000	0.	1.0	0./
233	305170000	0.	1.0	0./
233	305180000	0.	1.0	0./
233	305190000	0.	1.0	0./
228	-305110000	0.	1.0	0./
228	-305120000	0.	1.0	0./

cont

```
228   [illegible]5130000   0.        1.0     0./
228   -305140000   0.        1.0     0./
228   -305150000   0.        1.0     0./
228   -305160000   0.        1.0     0./
228   -305170000   0.        1.0     0./
228   -305180000   0.        1.0     0./
228   -305190000   0.        1.0      0./
228   -306000000   0.        1.0      0./
224    306000000   0.4621    0.      -0.8868/
224    307010000   0.4621    0.      -0.8868/
224    307020000   0.4621    0.      -0.8868/
224    307030000   0.4621    0.      -0.8868/
223   -307010000   0.4621    0.      -0.8868/
223   -307020000   0.4621    0.      -0.8868/
223   -307030000   0.4621    0.      -0.8868/
223   -307040000   0.4621    0.      -0.8868/
222    307040000   0.       -1.0     0./
222    307050000   0.       -1.0     0./
222    307060000   0.       -1.0     0./
222    307070000   0.       -1.0     0./
222    307080000   0.       -1.0     0./
222    307090000   0.       -1.0     0./
222    307100000   0.       -1.0     0./
222    307110000   0.       -1.0     0./
216   -307050000   0.       -1.0     0./
216   -307060000   0.       -1.0     0./
216   -307070000   0.       -1.0     0./
216   -307080000   0.       -1.0     0./
216   -307090000    0.     -1.0    0./
216   -307100000    0.     -1.0    0./
216   -307110000    0.     -1.0    0./
216   -307120000    0.     -1.0    0./
214    307120000    0.0047  0.     -0.99999/
214    307130000    0.0047  0.     -0.99999/
214    307140000    0.0047  0.     -0.99999/
20801     -307130000   0.0047    0.     -0.99999/
20801     -307140000   0.0047    0.     -0.99999/
20801     -307150000   0.0047    0.     -0.99999/
20802      307150000   -0.2497   0.     -0.9683/
20802      307160000   -0.2497   0.      -0.9683/
20802      307170000   -0.2497   0.      -0.9683/
206       -307160000   -0.2497   0.      -0.9683/
206       -307170000   -0.2497   0.      -0.9683/
206       -308000000   -0.2497   0.      -0.9683/
99999/
 $STEPS TSTEP(1)=0.001,0.500,-1,-1$
```


COPY

4.9 APPENDIX A

TELEDYNE ENGINEERING SERVICES

BY JBM DATE 8-24-82
CHKD. BY SGC DATE 8-25-82
6-1-83

AMERICAN ELECTRIC POWER
DC. COOK UNITS 1 & 2
PIPE PROPERTIES

SHEET NO. 1 OF 1
PROJ. NO. 5364

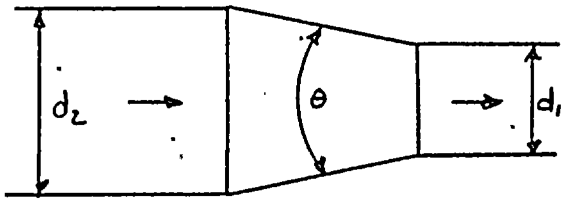
PIPE PROPERTIES

SIZE	SCHEDULE	I.D. (in.)	FLOW AREA (ft^2)	FRICTION FACTOR f	ϵ/d	ROUGHNESS ϵ (ft)	* K_{ELBOW} $12f$
3"	40	3.068	.05132	.0174	.0006	1.53×10^{-4}	.2088
3"	160	2.624	.03757	.0181	.0007	1.53×10^{-4}	.2172
4"	40	4.026	.08840	.0161	.0004	1.34×10^{-4}	.1932
4"	120	3.624	.07160	.0162	.00044	1.33×10^{-4}	.1944
6"	40	6.065	.20069	.015	.0003	1.52×10^{-4}	.1800
6"	160	5.189	.14653	.0153	.00035	1.51×10^{-4}	.1836
12"	40	11.938	.77708	.013	.00017	1.69×10^{-4}	.1560

* RESISTANCE DUE TO BEND ONLY FOR 1.5d BENDS

REF: CRANE TECHNICAL PAPER No. 410.

BY JBM DATE 12-8-82	AMERICAN ELECTRIC POWER	SHEET NO. 1 OF 1
CHKD. BY JEY DATE 12-8-82	D.C. COOK UNITS 1 & 2	PROJ. NO. 5364
[initials] 6-1-83	LOSSES IN REDUCERS	



$$\beta = \frac{d_1}{d_2}$$

IF : $\theta \leq 45°$

FORWARD LOSS COEFFICIENTS

$$K = 0.8\left(\sin\frac{\theta}{2}\right)(1-\beta^2)$$

REVERSE LOSS COEFFICIENTS

$$K = 2.6\left(\sin\frac{\theta}{2}\right)(1-\beta^2)^2$$

SIZE	d_1	d_2	β	θ	K, FORWARD	K, REVERSE
12" SCH 40 × 6" SCH 40S	6.065"	11.938"	.5080	40.3°	.2045	.4930
6" SCH 40S × 4" SCH 40S	4.026"	6.065	.6638	21°	.0815	.1483
4" SCH 40S × 3" SCH 40	3.068"	4.026"	.7620	13.66°	.0399	.0544
3" SCH 160 × 4" SCH 120	2.624"	3.624"	.7241	14.25°	.0472	.0730
4" SCH 120 × 6" SCH 160	3.624"	5.189"	.6984	16.19°	.0577	.0961
6" SCH 40S × 3" SCH 40	3.068"	6.065"	.5059	30.48°	.1565	.3784

REFERENCE: CRANE TECHNICAL PAPER 410 p. A-26

K IS TAKEN WITH RESPECT TO THE SMALLER DIAMETER PIPE.

TELEDYNE ENGINEERING SERVICES

BY CMM	DATE 5-24-83	NON-CONDENSIBLE GAS QUALITY CALCULATION FOR INITIAL COND. UNITS 1 & 2	SHEET NO. 1 OF 1
CHKD. BY [illegible]	DATE 5-26-83		PROJ. NO. 5364

FOR INITIAL CONDITIONS OF:

$P_T = 17.7$ psia

$T = 120°$ F $\quad P_v = 1.6924$ psia

SPECIFIC HUMIDITY $\gamma = \frac{M_w}{M_a} = \frac{\text{MASS OF WATER VAPOR}}{\text{MASS OF AIR}} = \frac{v_a}{v_w}$

$$\gamma = \frac{R_a T/P_a}{R_w T/P_w} = 0.622 \frac{P_w}{P_a}$$

$$\gamma = 0.622 \frac{1.6924 \text{ psia}}{16.008 \text{ psia}}$$

$$\gamma = 0.06576$$

NONCONDENSIBLE GAS (AIR) QUALITY $= 1 - \gamma = 0.93424$

TELEDYNE ENGINEERING SERVICES

BY CMM DATE 7-14-83
CHKD. BY LBS DATE 7-14-83

UNIT 1 TEMPERATURE DISTRIBUTION SV MOD

SHEET NO. 1 OF 5
PROJ. NO. 5364

THE FOLLOWING TEMPERATURE DISTRIBUTION (PAGE 5 OF 5) IS EXTRACTED FROM THE RELAP RUN FOR STRUCTURAL PURPOSES. THE PRECEDING PLOTS (1-3) SHOW TEMPERATURE VERSUS TIME AT SOME POINTS ON THE DISCHARGE TO CONFER THE TIME AT WHICH MAXIMUM TEMPERATURE VALUES OCCURED. THAT TIME WAS USED TO ESTIMATE MAXIMUMS FOR ALL OTHER POINTS ON THE DISCHARGE PIPING YIELDING THE VALUES ON PAGE 4.

THE FOLLOWING CONDITIONS APPLY TO THESES TEMPERATURES:

1. THESE ARE STEAM TEMPERATURES NOT PIPE WALL TEMPERATURES
2. THE PIPE WALL TEMPERATURES WILL LAG THESE TEMPS. BY SEVERAL SECONDS.
3. THE PIPE WALL TEMPS MAY EQUAL THE STEAM TEMPS. IN MAGNITUDE BUT WILL NEVER EXCEED THESE TEMPS.
4. THE RELAP ANALYSIS ASSUMED THE PIPE WALL TO BE ADIABATIC THEREFORE THESE STEAM TEMPS [illegible] CONSERVATIVE UPPER BOUND.

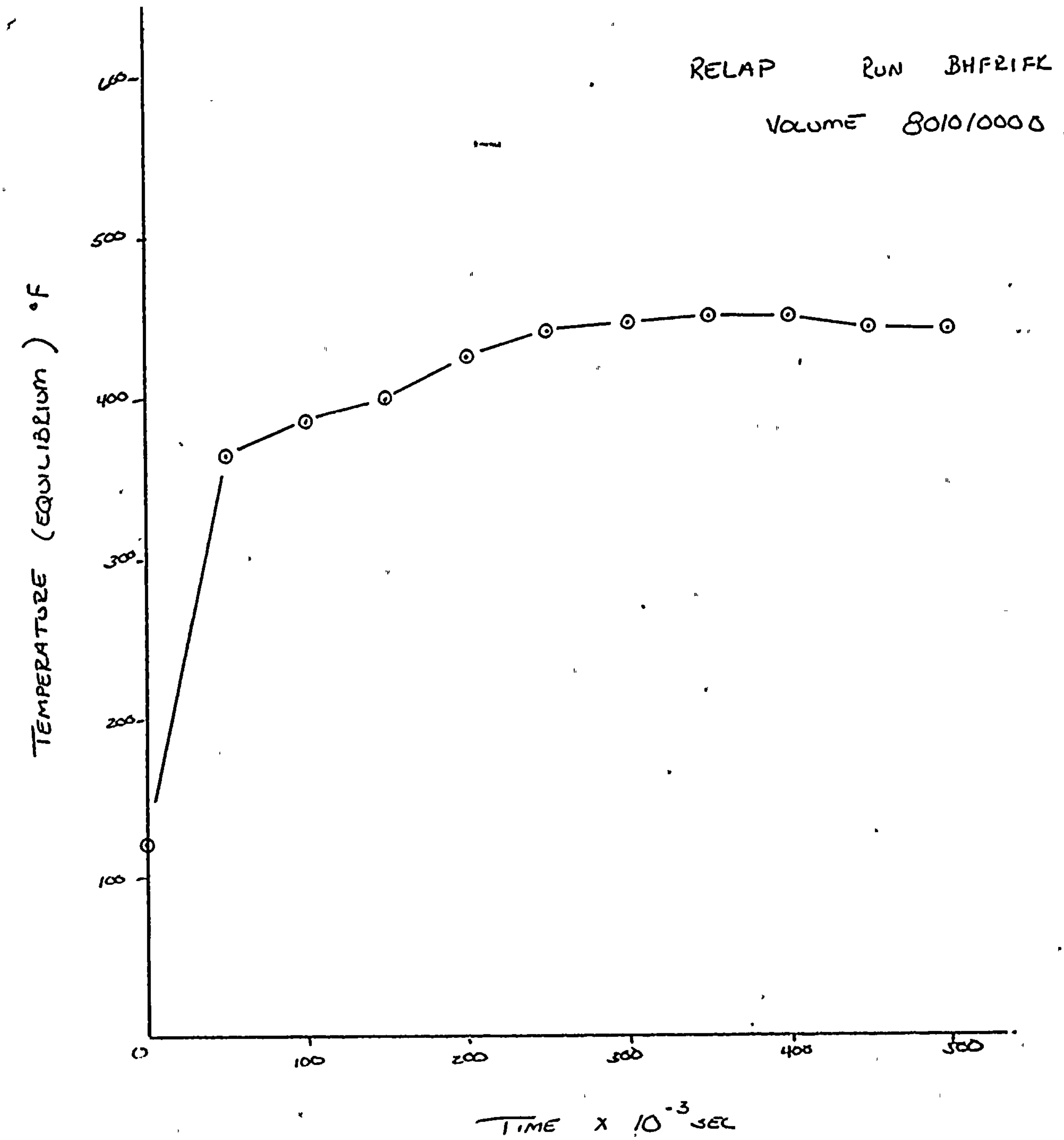
Technical Report
TR-5364-3
Revision 0

TELEDYNE ENGINEERING SERVICES

BY KJB DATE 6-30-83
CHKD. BY CMM DATE 7-13-83

UNIT 1 SV MODIFICATION
TEMP DISTRIBUTION

SHEET NO. 2 OF 5
PROJ. NO. 5364



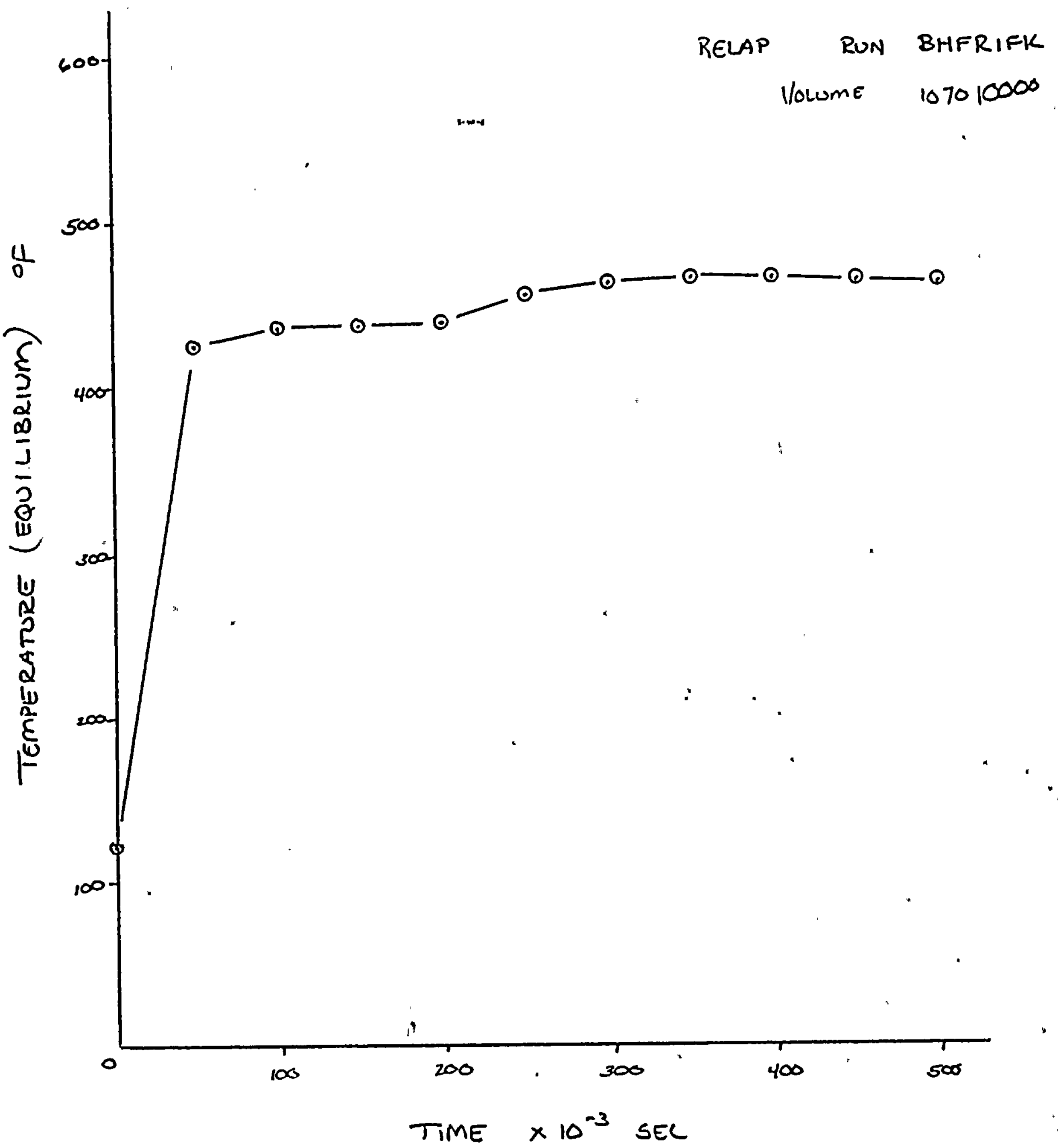
Technical Report
TR-5364-3
Revision 0

TELEDYNE ENGINEERING SERVICES

BY KJG DATE 6-30-83
CHKD. BY CMM DATE 7-13-83

UNIT I SV MODIFICATION
TEMP DISTRIBUTION

SHEET NO. 3 OF 5
PROJ. NO. 5364



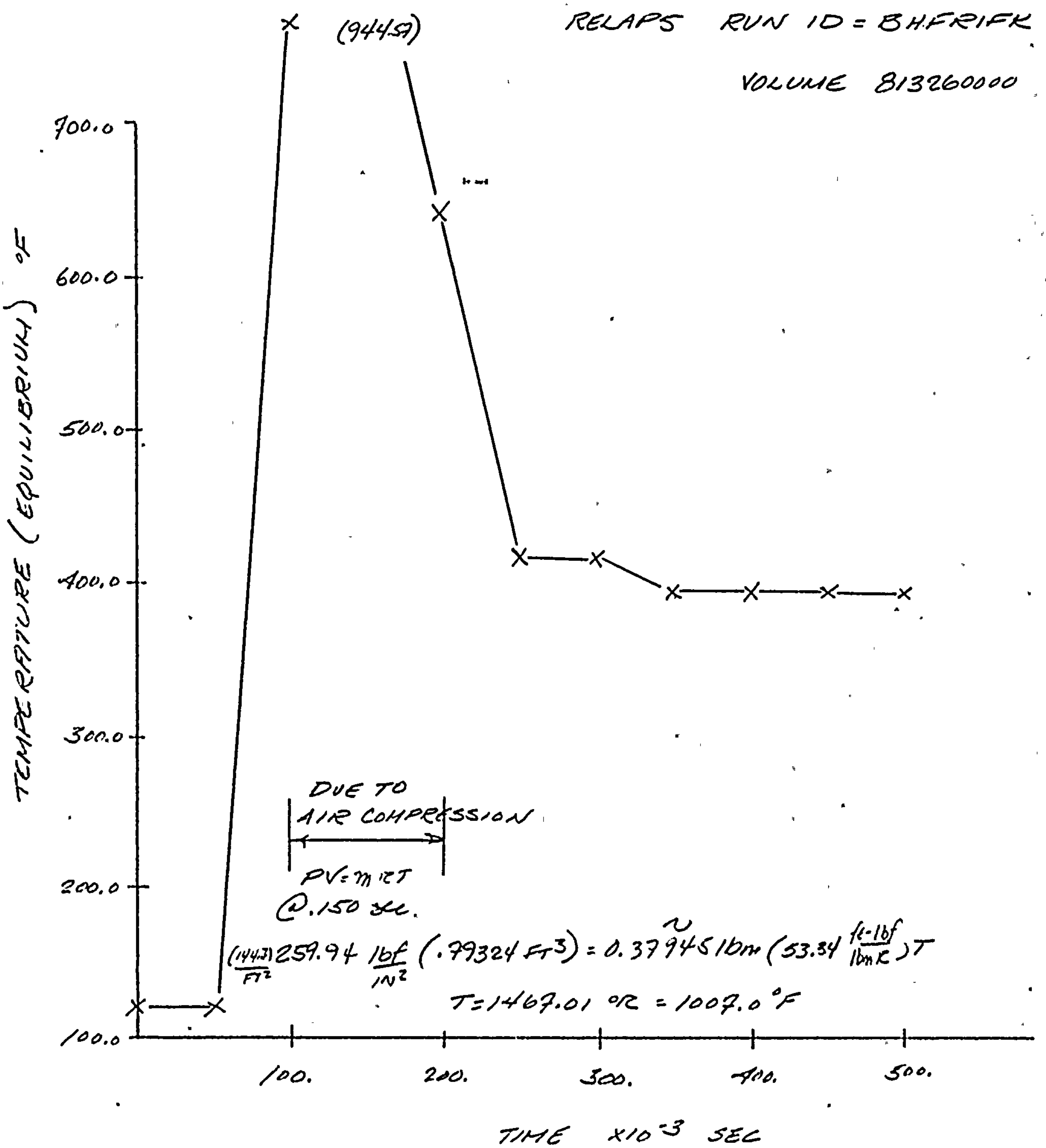
Technical Report
TR-5364-3
Revision 0

TELEDYNE ENGINEERING SERVICES

BY CMM DATE 6-29-83
CHKD. BY KG DATE 6-30-83

UNIT 1 SV MODIFICATION
TEMP. DISTRIBUTION

SHEET NO. 4 OF 5
PROJ. NO. 5364



Technical Report
TR-5364-3
Revision 0

TELEDYNE ENGINEERING SERVICES

BY CMM DATE 6-29-83
CHKD. BY KG DATE 7-6-83

UNIT 1 MODIFICATION SV
TEMP DISTRIBUTION.

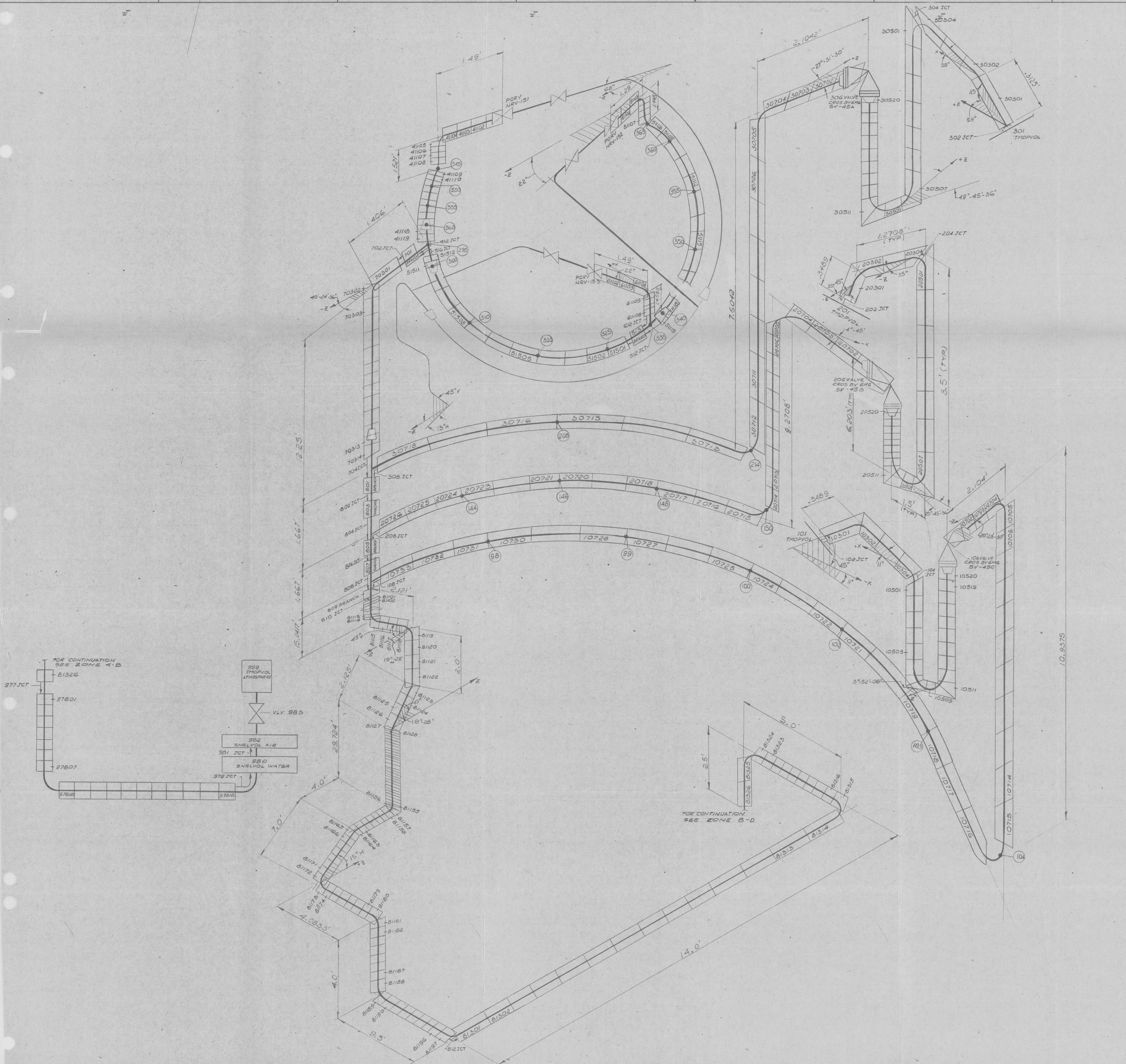
SHEET NO. 5 OF 5.
PROJ. NO. 5364

THE PRECEEDING PLOT SETS DETERMINED THE 400 MSEC DATA POINT AS THE OCCURANCE OF PEAK TEMPERATURES

NODE POINT	RELAP5 CONTROL VOLUME	EQUILIBRIUM TEMP (°F) EXTRACTED FROM RUN @ 400 MSEC ID= BHFRIFK
234	30509	671.60
225	30701	464.08
208	30715	444.72
174	20510	671.59
165	20701	466.90
146	20719	445.98
126	10509	671.60
115	10701	467.99
102	10721	447.27
525	41101	923.21 *
550	41112	566.63
625	61101	923.45 *
385	51101	959.93 *
355	51112	815.89 *
320	51505	495.24
285	70302	453.60
200	80101	451.63
84	81119	440.23
60	81158	428.34
46	81180	422.39
33	81195	413.89
18	81311	406.31
1	81326	393.78

* THESE TEMPS REPRESENT THE EFFECT OF ADIABATIC COMPRESSION OF THE N_2 IN THE DISCHARGE LINE WHICH IS TRAPPED AGAINST THE CLOSED PORV'S. THE RELAP PROGRAM DOES NOT ADEQUATELY REPRESENT THE MIXING BETWEEN THE STEAM AND N_2 AT THESE POINTS THEREFORE THIS IS AN UPPER BOUND OF THE ACTUAL TEMPERATURE. IN THE PHYSICAL SYSTEM MORE MIXING WOULD OCCUR AND THESE TEMPERATURES WOULD BE QUICKLY DISSAPATED.

LIST OF MATERIAL				
ITEM	IDENT NUMBER	DRAWING NUMBER	DESCRIPTION / MATERIAL	QTY



PIPE SIZE	PIPE SCHEDULE	FLOW AREA (FT²)
3"	40	.0513
3"	160	.0376
4"	40	.0884
4"	120	.0716
6"	40	.2007
6"	160	.1465
12"	40	.7771

PRC APERTURE CARD

8312210225-01

E

REV	DATE	D.C.O.	ZONE	DESCRIPTION	DRAWN	CHKD	ANAL	ENGR	DWG. CON.

REVISIONS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± DECIMALS ± ANGLES ±

FINISH √

SCALE

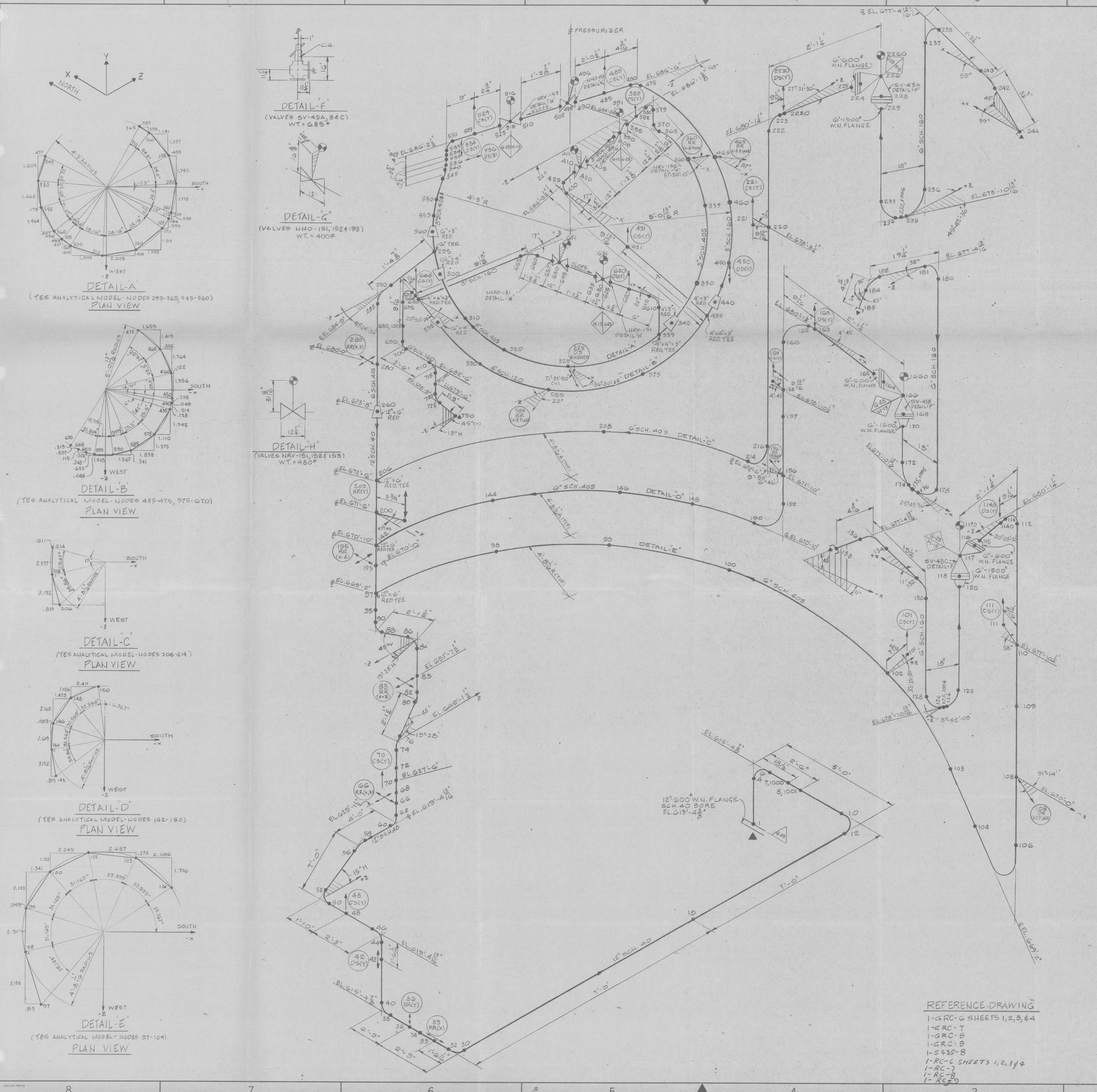
USED ON/NEXT ASSY

DESIGNED		
DRAWN	G.K	7.12.83
CHECKED	CMM	7.13.83
ANALYZED	KJG	7-13-83
ENGR. APPR.	LBS	7-13-83
DWG. CON.	SDL	7-14-83

TELEDYNE ENGINEERING SERVICES
WALTHAM, MASS.

TITLE RELAP MODEL-SV DISCHARGE-DRAINED LOOPSEAL MOD. D.C. COOK NUC. POWER PLANT UNIT 1

PROJECT NO. 5364 DRAWING NO. E -8596 REV. 0



	LINE SIZE	PIPE SCHEDULE	MATERIAL	TYPE
G-23	3	40S	SA-312	304 SEAMLESS
	4	40S	SA-312	304 SEAMLESS
	6	40S	SA-312	304 SEAMLESS
	12	40	SA-358 CLASS 1	316 WELDED
M-15	3	160	SA-376	304 SEAMLESS
	4	120	SA-376	316 SEAMLESS
	6	160	SA-376	316 SEAMLESS

LEGEND

SYMBOL	DEFINITION
	RESTRAINT DESIGNATION
RR(XYZ)	RIGID RESTRAINT
US(XYZ)	UNIDIRECTIONAL SUPPORT
DS(XYZ)	DYNAMIC SNUBBER
VS(XYZ)	VARIABLE SPRING SUPPORT
CS(XYZ)	CONSTANT FORCE SUPPORT
▲	ANCHOR
△	MODE NUMBER-SEE TABLE
	NOTE NUMBER
	COLUMN LINE
	TANGENT INTERSECT POINT
	JOINT IDENTIFICATION NUMBER

SUPPORT NODE NUMBER	SUPPORT MARK NUMBER
33	1-GRC-R-585
36	1-GRC-R-586
42	1-GRC-S-587
48	1-GRC-C-588
66	1-GRC-R-589
70	1-GRC-C-590
83	1-GRC-R-591
101	1-GRC-C-615
108	1-GRC-S-598
111	1-GRC-C-593
1140	1-GRC-S-592
195	1-GRC-R-600
156	1-GRC-S-599
159	1-GRC-C-595
163	1-GRC-S-594
203	1-GRC-R-616
221	1-GRC-C-597
2230	1-GRC-S-596
280	1-GRC-R-601
325	1-GRC-S-614
360	1-GRC-R-613
382	1-GRC-C-612
431	1-GRC-C-611
450	1-GRC-S-604
465	1-GRC-R-605
485	1-GRC-C-606
529	1-GRC-C-607
534	1-GRC-S-608
536	1-GRC-R-609
585	1-GRC-R-603
668	1-GRC-C-602
620	1-GRC-C-610

NOTES

1. ALL ELBOWS ARE LONG RADIUS (1.5D)
2. FOR DETAILS "A" THROUGH "E" ALL DIMENSIONS ARE IN FEET UNLESS OTHERWISE SPECIFIED.

REFERENCE DRAWING

1-GRC-6 SHEETS 1, 2, 3, & 4
1-GRC-7
1-GRC-8
1-GRC-9
1-5435-8
1-RC-6 SHEETS 1, 2, 3 & 4
1-RC-7
1-RC-8
1-RC-9

8312210225-02

REV	DATE	D.C.O.	ZONE	DESCRIPTION	DRAWN	CHKD	ANAL	ENGR	DWG. CON.
3	7/8/83	5053	C-3 E-3 B-3	ADDED NODE NUMBERS	GK	DDL	DmD	PDH	SDC 7-7-83
2	6-6-83	4927	3A	ADDED REFERENCE DRAWINGS	GK	DDL	DmD	PDH	CGS 6/6/83
1	5/25/83	4843	—	GENERAL REVISIONS	TFW	DDL	DmD	PDH	SDC 5-26-83

REVISIONS

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS ± — DECIMALS ± — ANGLES ± —
FINISH √
SCALE
USED ON/NEXT ASSY

		DATE
DESIGNED		
DRAWN	RS	2/8/83
CHECKED	DmD	2/28/83
ANALYZED	KFB	2/28/83
ENGR. APPR.	PDH	2/28/83
DWG. CON.	SDC	2/28/83

TELEDYNE ENGINEERING SERVICES
WALTHAM, MASS.

TITLE: STRESS ISOMETRIC
PRESSURIZER SAFETY & RELIEF
VALVE DISCHARGE PIPING
D.C. COOK NUCLEAR POWER STATION UNIT-1

PROJECT NO. 5364 — DRAWING NO. E-5763 — REV. 3