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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.

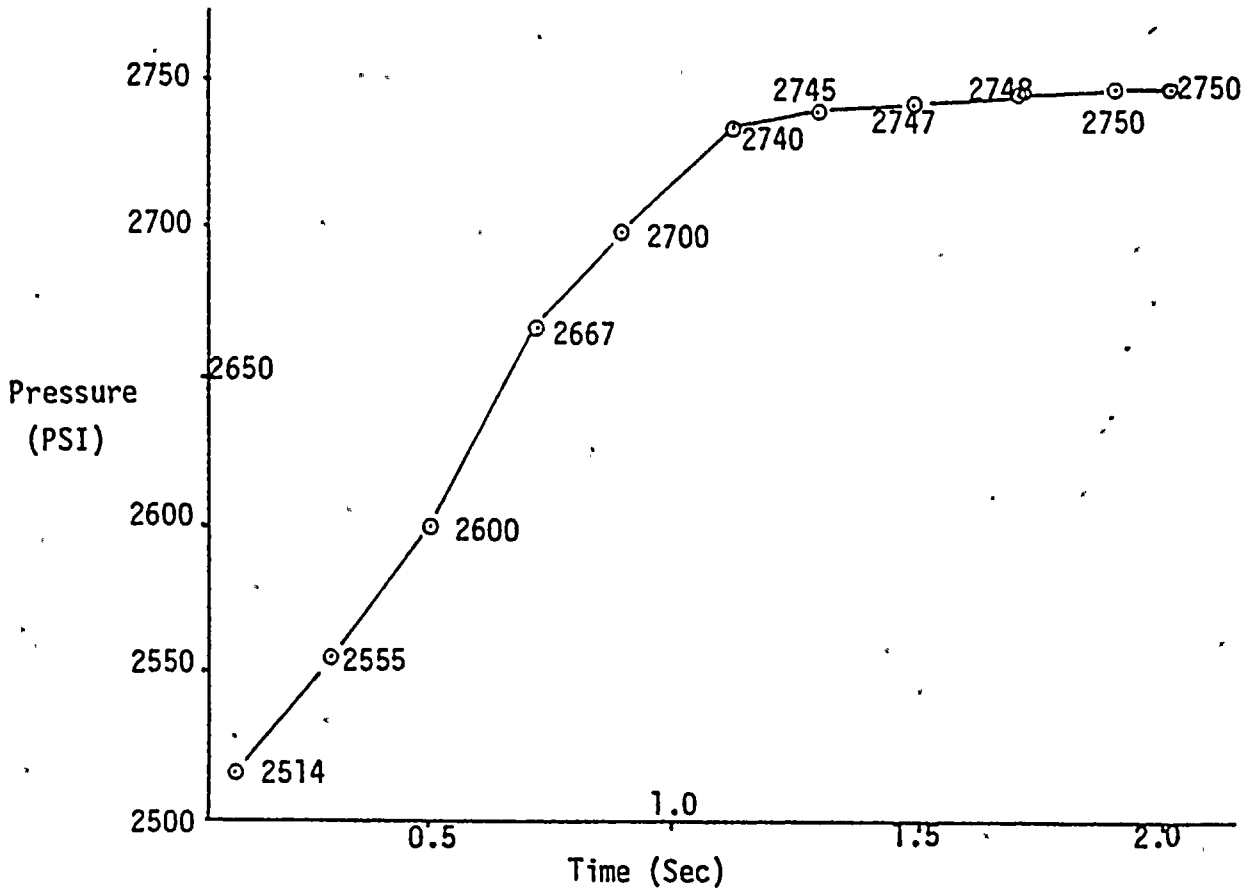
RELAP5 calculates hydrodynamic data for control volumes in each segment of pipe. REPIPE then takes this data and defines two force time histories for each segment, one set for inlet junction forces and the other for outlet junction forces. A TES generated program, SAP2SAP, adds these force time histories.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

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

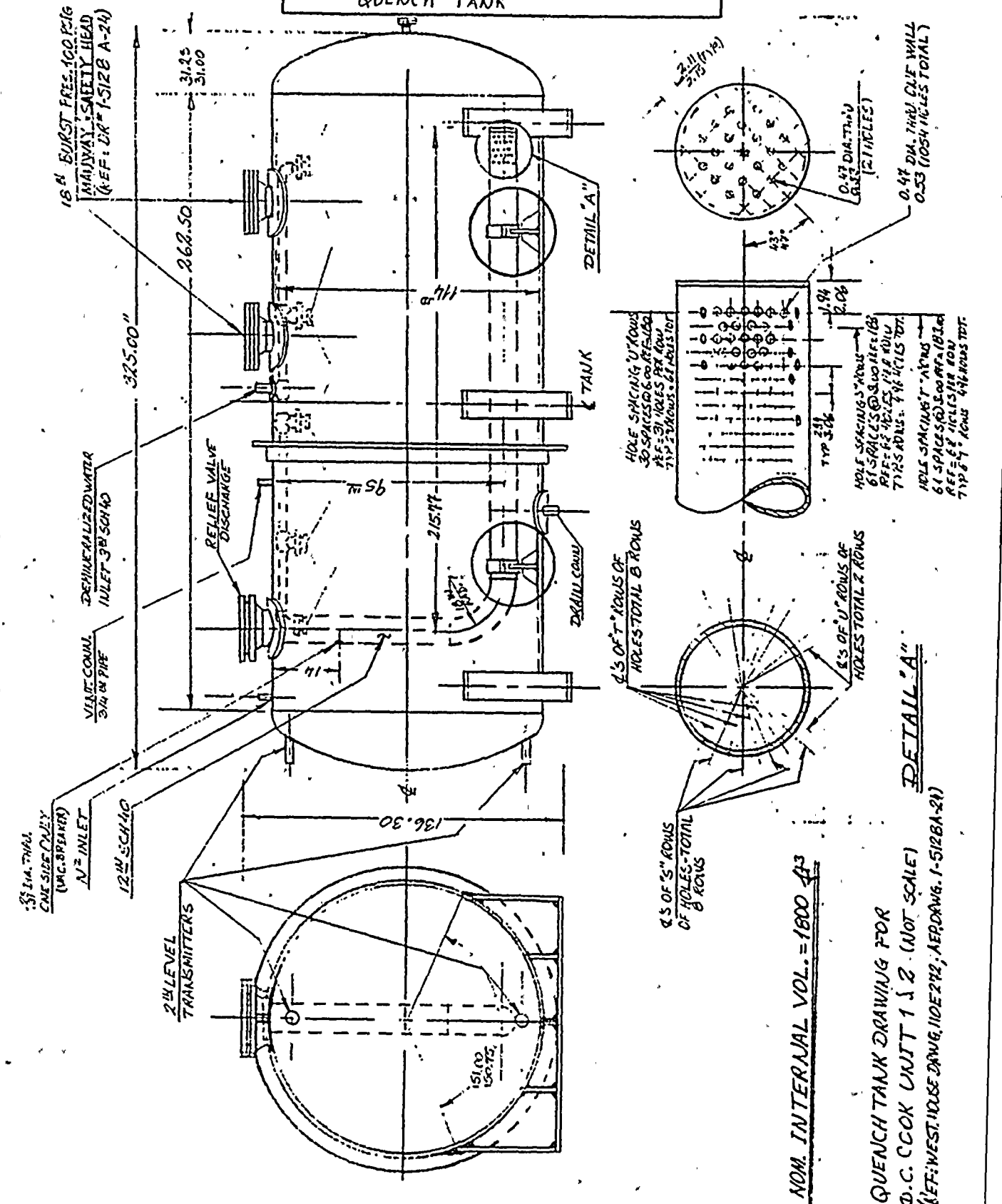


FIGURE 4.2.1-1

BY BAT DATE 1-17-83
CHKD. BY CHM DATE 3-11-83

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. QUENCH TANK 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. #110 E272)

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

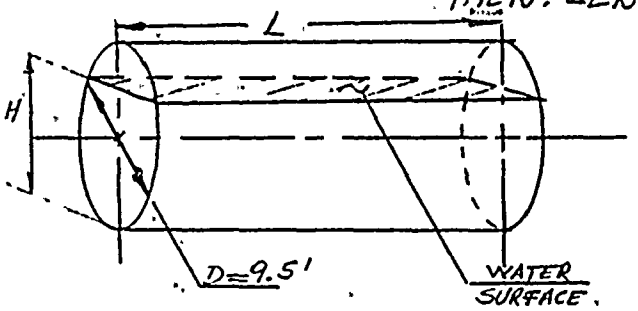
DONALD C. COOK
NUCLEAR GEN. STATION UNITS 1&2
RELAP5 QUENCH TANK MODELING

SHEET NO. 3 OF 6
PROJ. NO. 5364

FIGURE 4.2.1-3

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

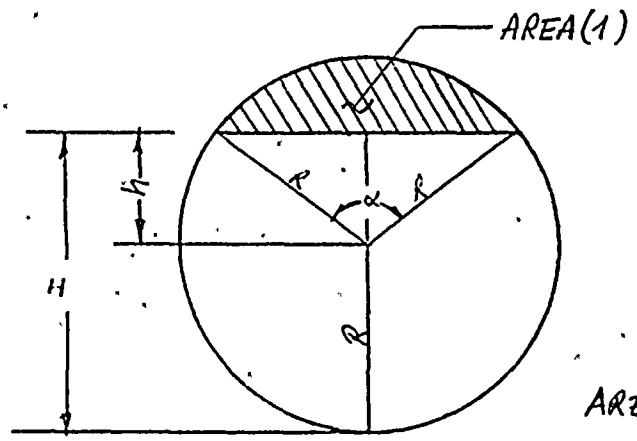
THEN: LENGTH $L = \frac{V}{\left(\frac{D}{2}\right)^2 \pi}$



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

$L = 25.3943$ ft

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



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

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

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

$AREA(1) = 12.7588$ 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:

$\alpha \approx 116.5°$

TELEDYNE ENGINEERING SERVICES

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

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

SHEET NO. 4 OF 6
PROJ. NO. 5364

FIGURE 4.2.1-4

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

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

$$h = 2.4995$$

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

$H \approx 87^{IN} = 7.25$ 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

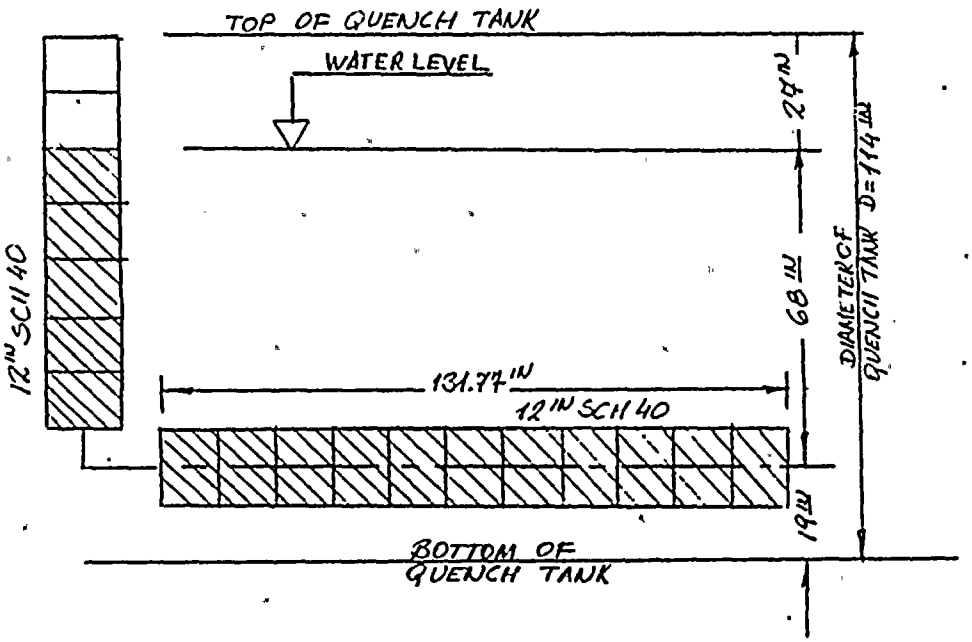
BY BAT DATE 1-17-83
CHKD. BY CMM DATE 3-11-83

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

SHEET NO. 5 OF 6
PROJ. NO. 5364

FIGURE 4.2.1-5

SPARGER MODELING



AREA OF EACH HOLE ON SPARGER SIDE = 0.1963 in^2 = 0.0014 ft^2

TOTAL FLOW AREA OF ALL THE SIDE HOLES = 1054 × 0.0014 = 1.4368 ft^2

FLOW AREA OF 12 IN SCH40 PIPE = 0.7773 ft^2

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 IN SCH40 PIPE.

1 − 0.541 = .459

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

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

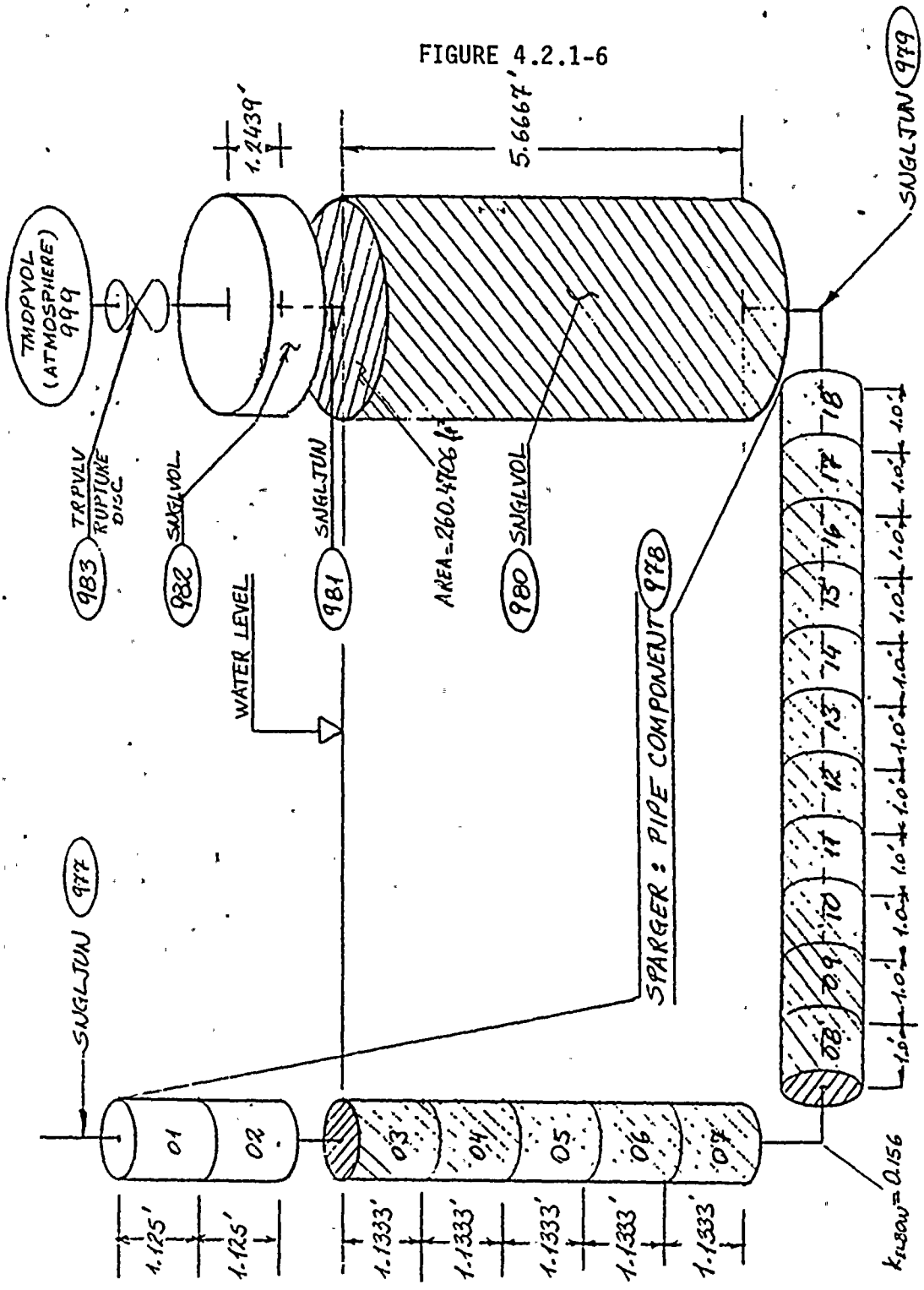
THIS LENGTH IN RELAP MODEL = 215.77 − 84 = 131.77 ≈ 11 ft

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

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

SHEET NO. 6 OF 6
PROJ. NO. 5364

FIGURE 4.2.1-6



RELAP5 QUENCH TANK MODEL

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.

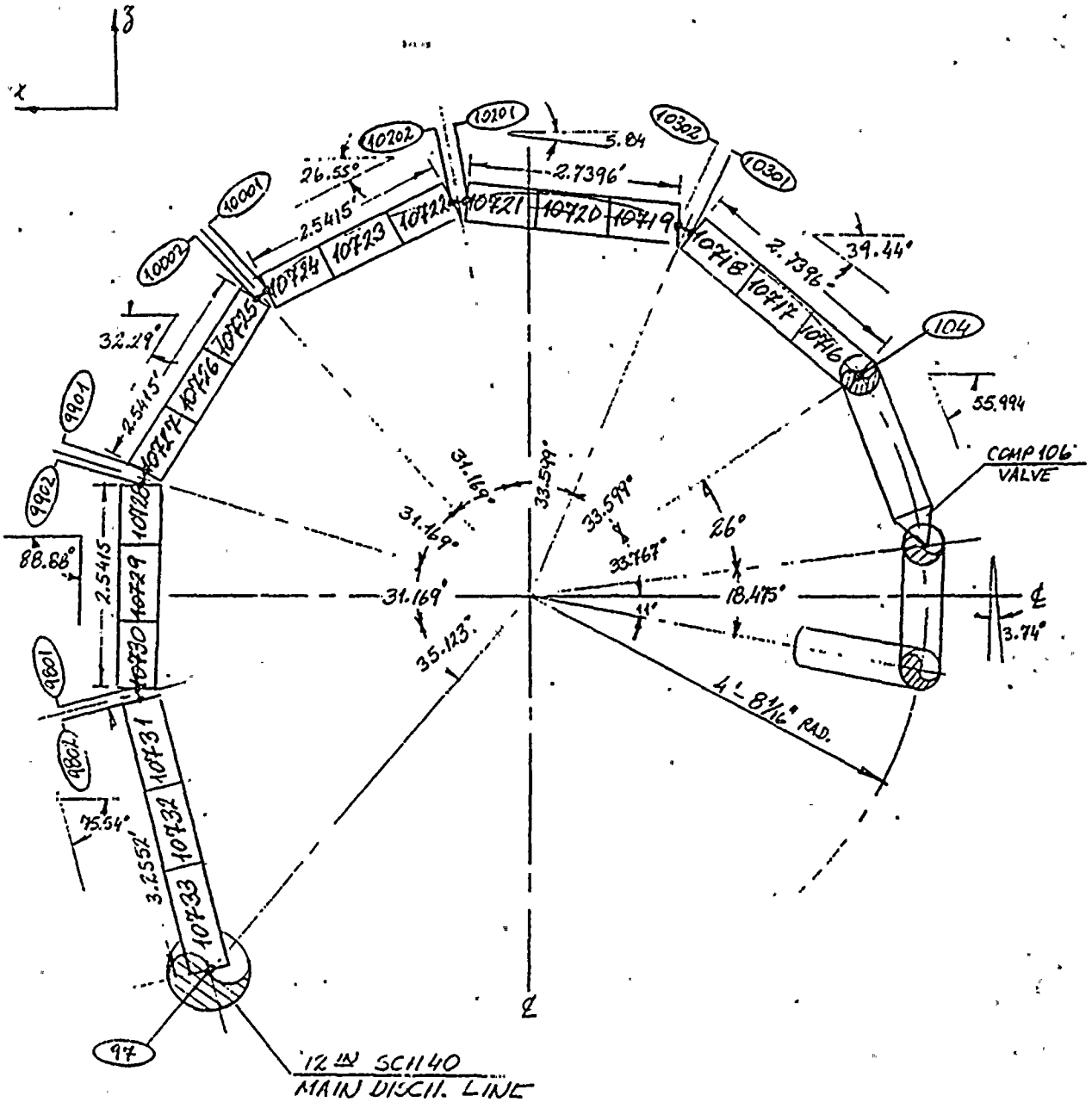
BY BAI DATE 2-8-83
CHKD. BY CJC DATE 2-15-83

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.

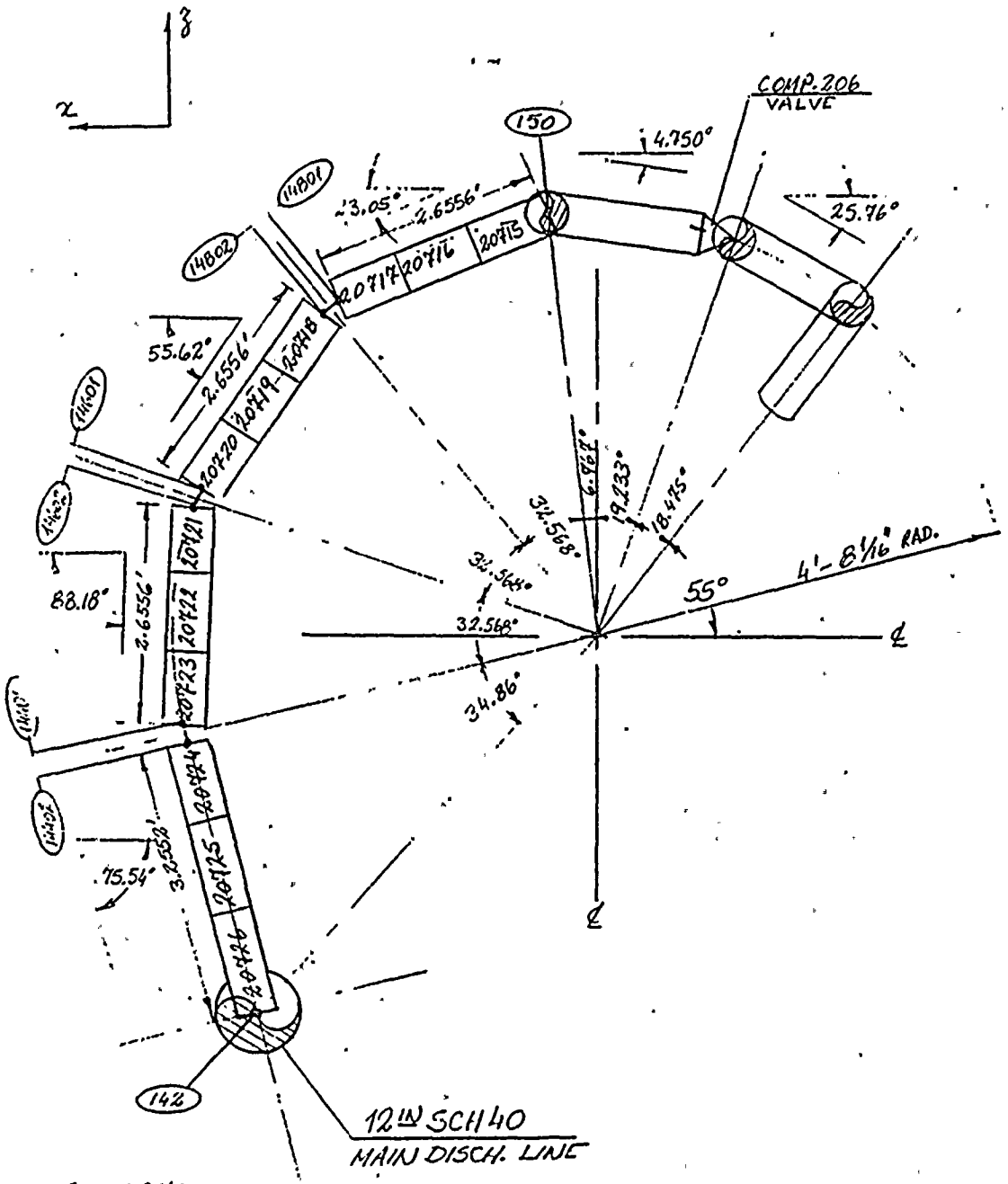
BY BAI DATE 1-6-83
CHKD. BY CJC DATE 2-15-83

D.C. COOK UNIT 1
ARC 2 GEOMETRY @ ELEV. 670'-10"

SHEET NO. 2 OF 5
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.

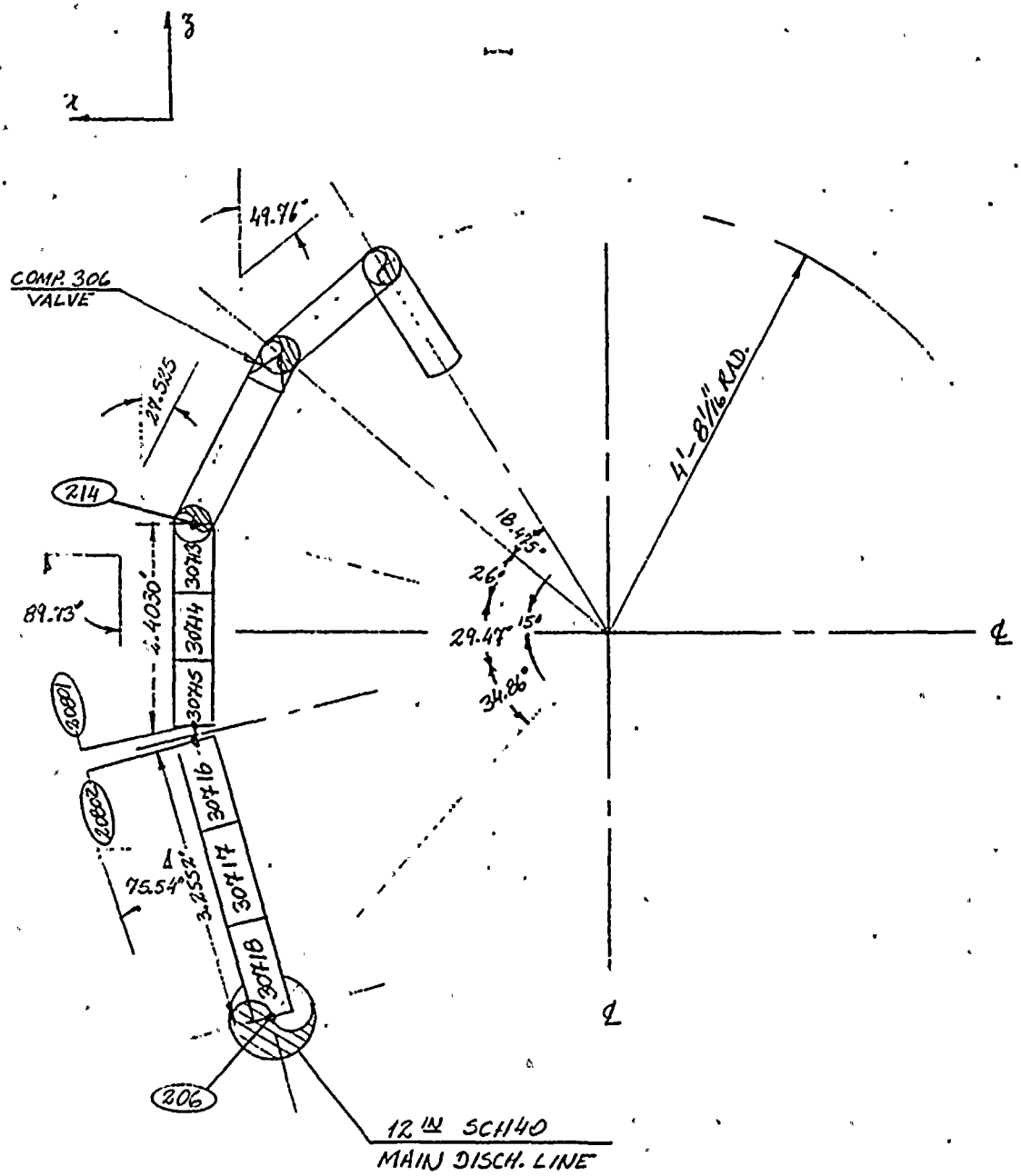
BY BAI DATE 2-15-83
CHKD. BY CJC DATE 2-15-83

D. C. COOK UNIT 1
ARC 3 GEOMETRY @ ELEV. 672'-6"

SHEET NO. 3 OF 5
PROJ. NO. 56.34

FIGURE 4.3.1-3

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



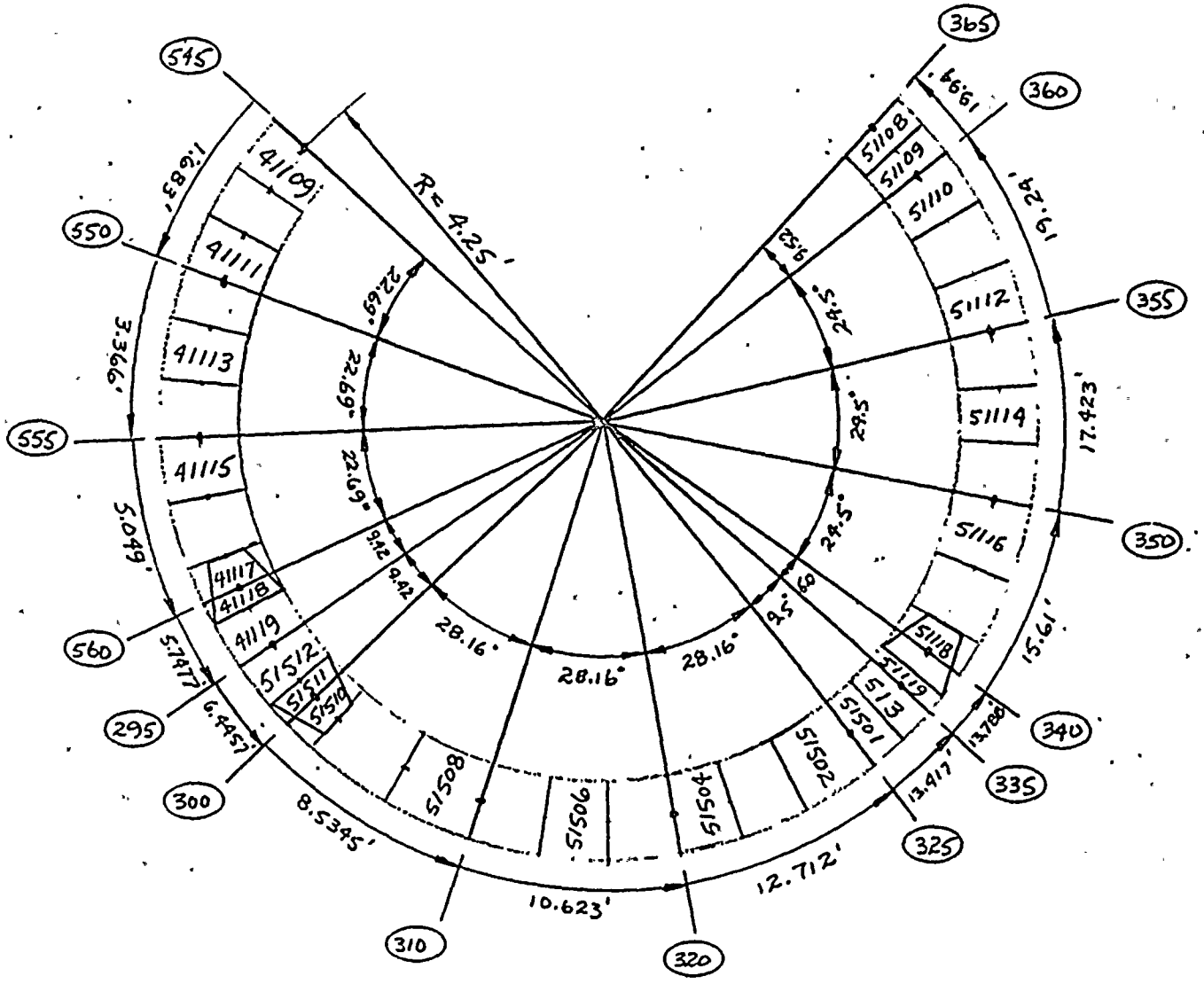
REMARKS:
NUMBER IN ⬭ INDICATE STRUCTURAL NODES
DIMENSIONS BETWEEN NODES REPRESENT CORRESPONDING ARC LENGTHS.

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



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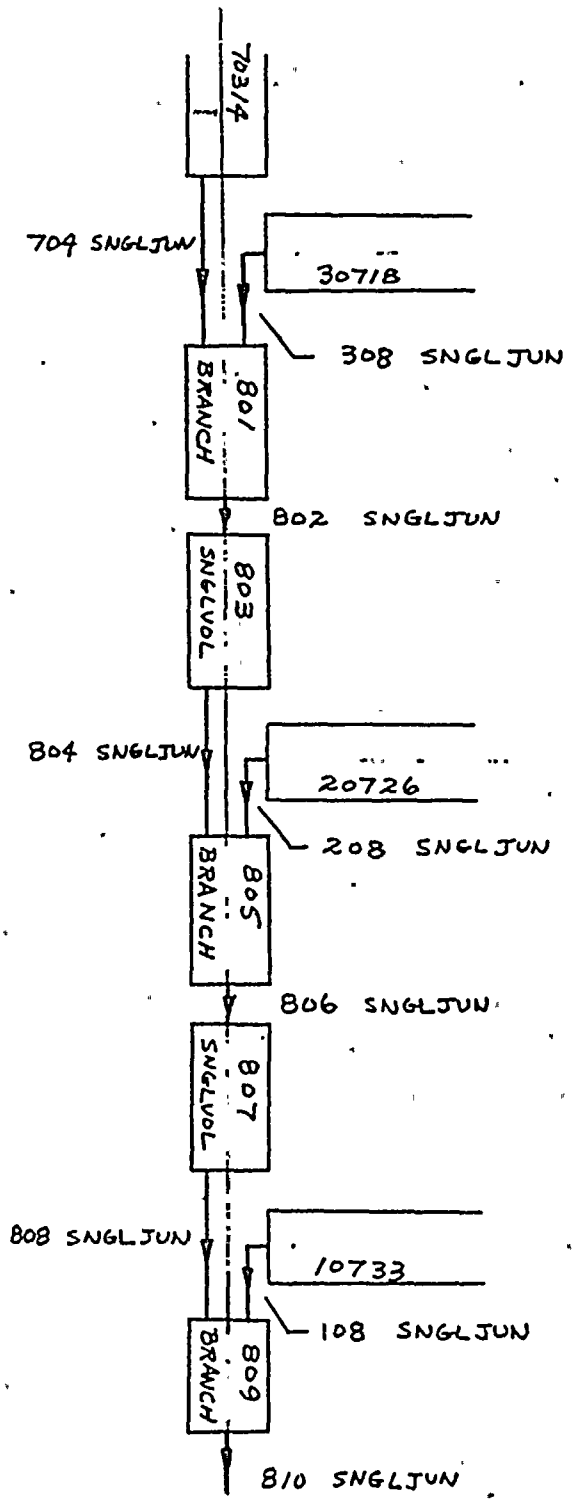
BY CJC DATE 3-25-83
CHKD. BY Carl DATE 3-28-83

UNIT 1 MAIN ARC CONNECTIONS
BRANCHES + TEES

FIGURE 4.3.1-5



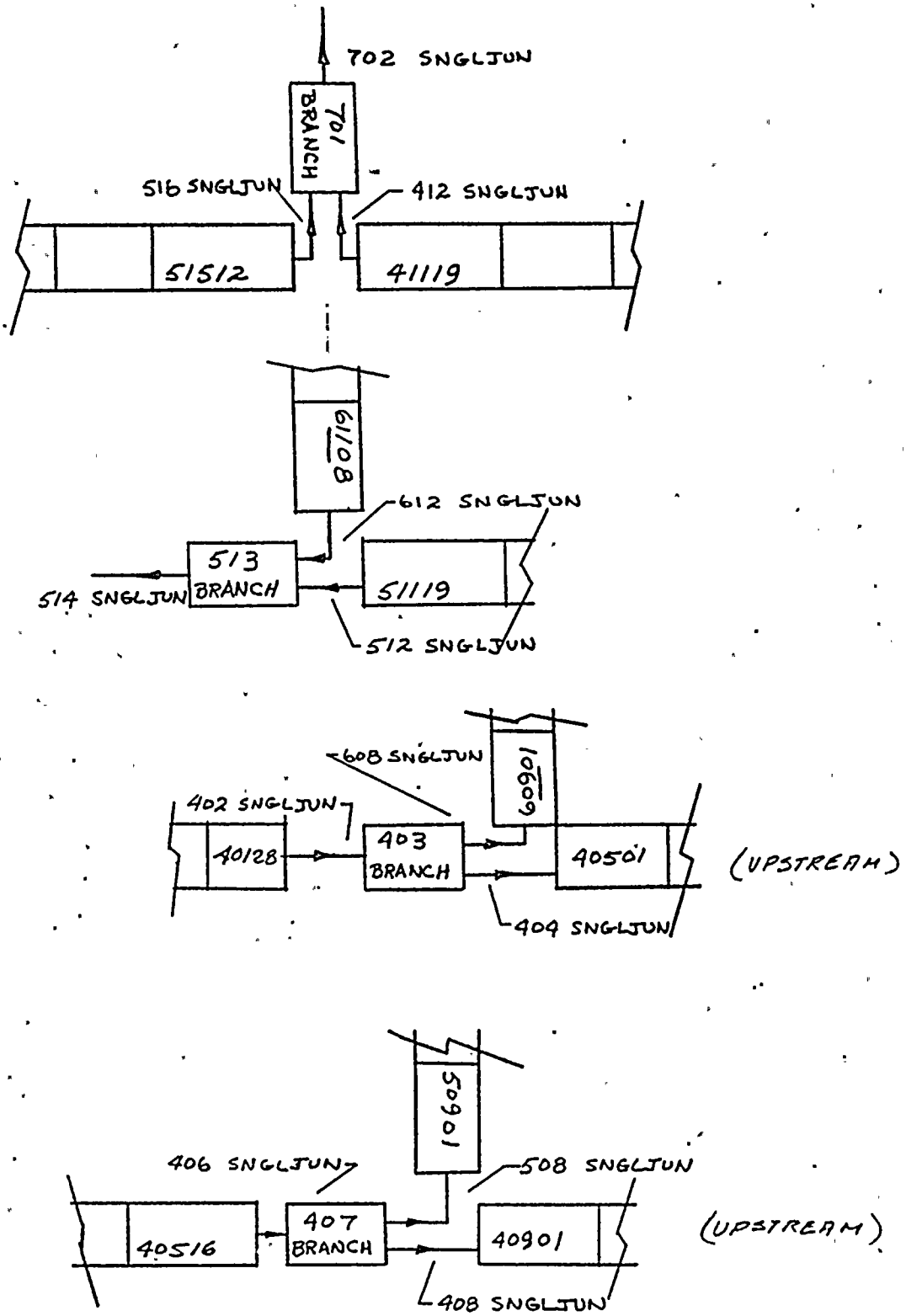
TELEDYNE ENGINEERING SERVICES

CJC DATE 3-25-83
CHK'D. BY CMH 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:

$$W_R = 51.5A\ (1.03P + 14.7)(.9)(.966)C$$ (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.

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CROSBY 6M6 VALVE
RELAP5 MODEL FLOW AREA CALCULATIONS

SHEET NO. 1 OF 3
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.

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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. $\omega_R)_1 = 51.5 \times A_F (1.03 P_{SET} + 14.7) K_D$

WHERE $A_R = 3.644$ in²
$P_{SET} = 2485$ 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) $\omega_R)_2 = 420\,006$ 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) $\omega_R)_3 = 434\,788$ 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)

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

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CROSBY 6M6 VALVE
RELAP5 MODEL FLOW AREA CALCULATIONS

FIGURE 4.4.1=3

IN RELAP5 MODEL FOR THE 6M6 CROSBY VALVE W_R) = 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 ft²
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

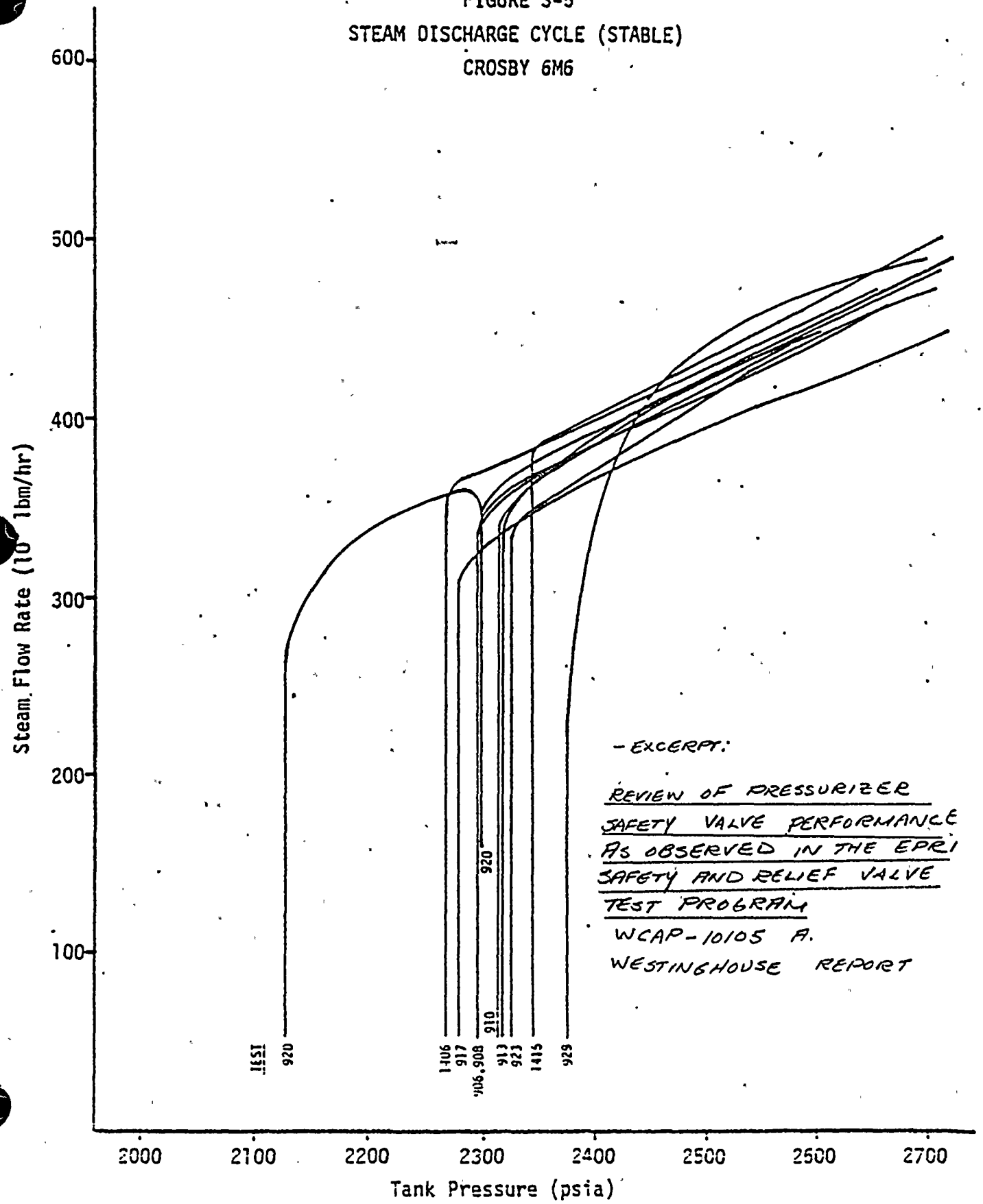
$$A_{FLOW} = \left[0.8 + 0.1 \frac{125.66 - 122.99}{138.01 - 122.99}\right](0.0232)$$

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

∴ CROSBY 6M6 RELAP5 MODEL FLOW AREA = 0.01897 ft²

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.

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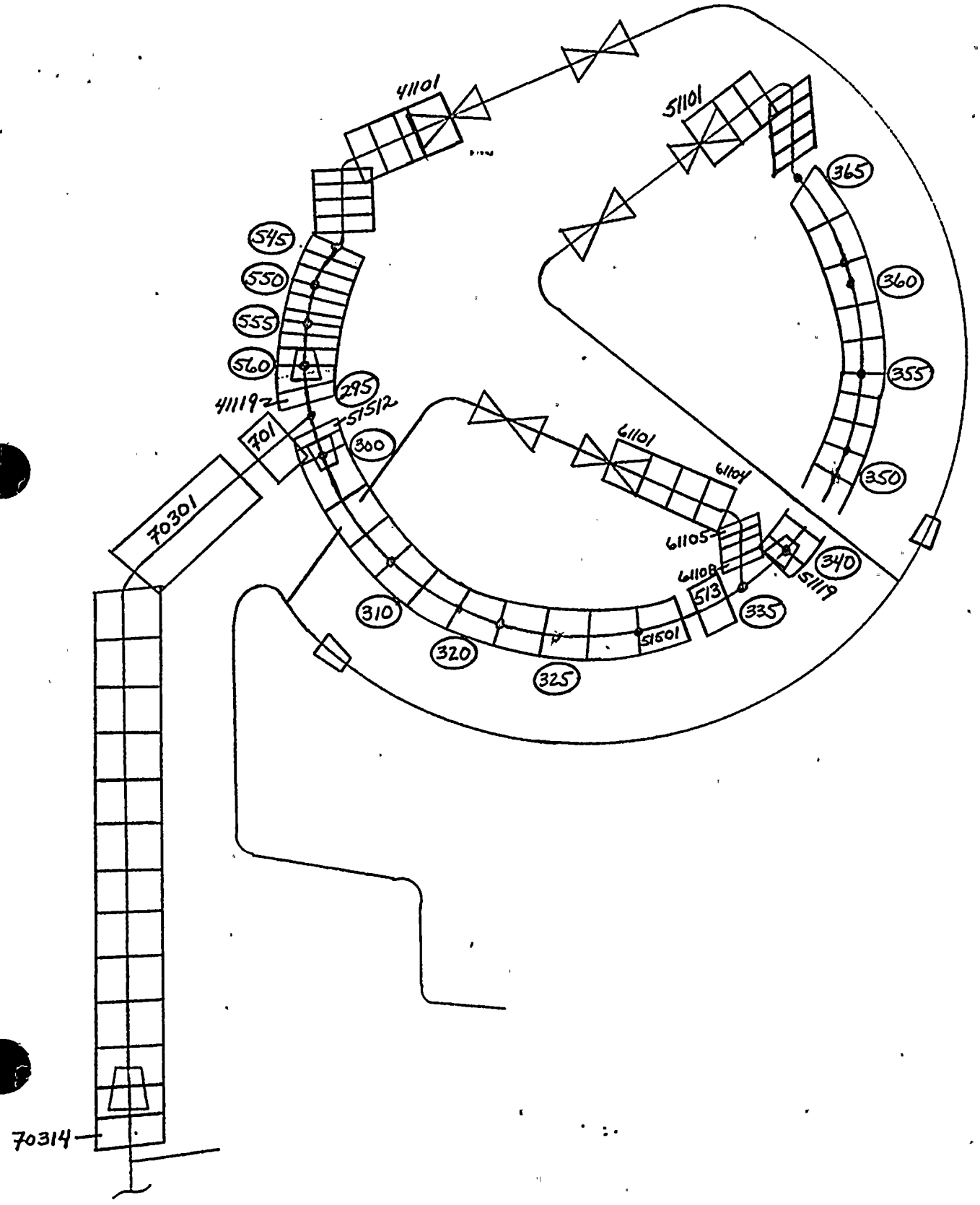
BY CNM DATE 5-25-83

RELAP MODEL SCHEMATIC
UNIT 1 PORV DOWNSTREAM

SHEET NO. 1 OF 3
PROJ. NO. 5364

FIGURE 4.5.1-1

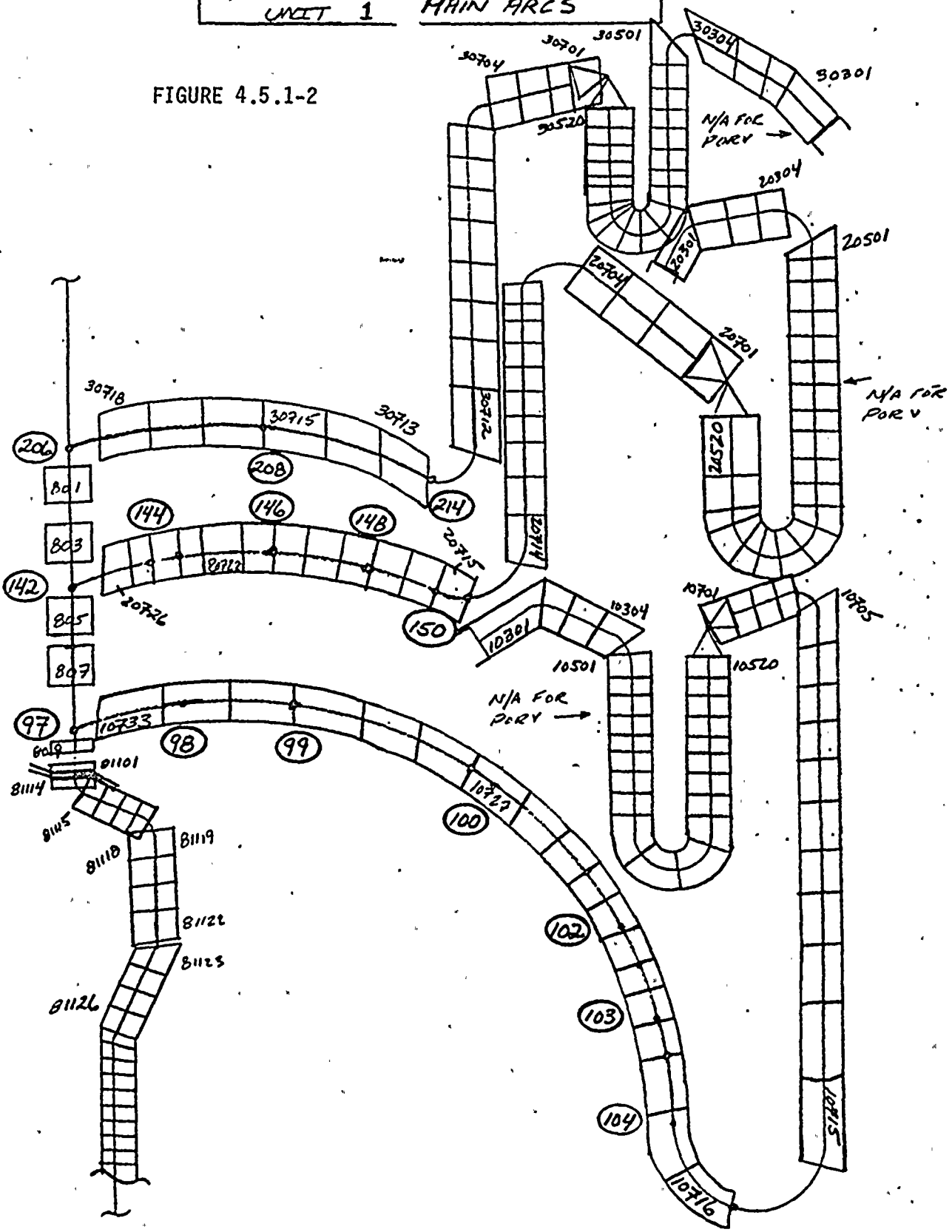


BY ATM DATE 4/14/93
D. BY CHH DATE 5-25-93

RELAP MODEL SCHEMATIC
UNIT 1 MAIN ARCS

SHEET NO. 2 OF 3
PROJ. NO. 5364

FIGURE 4.5.1-2

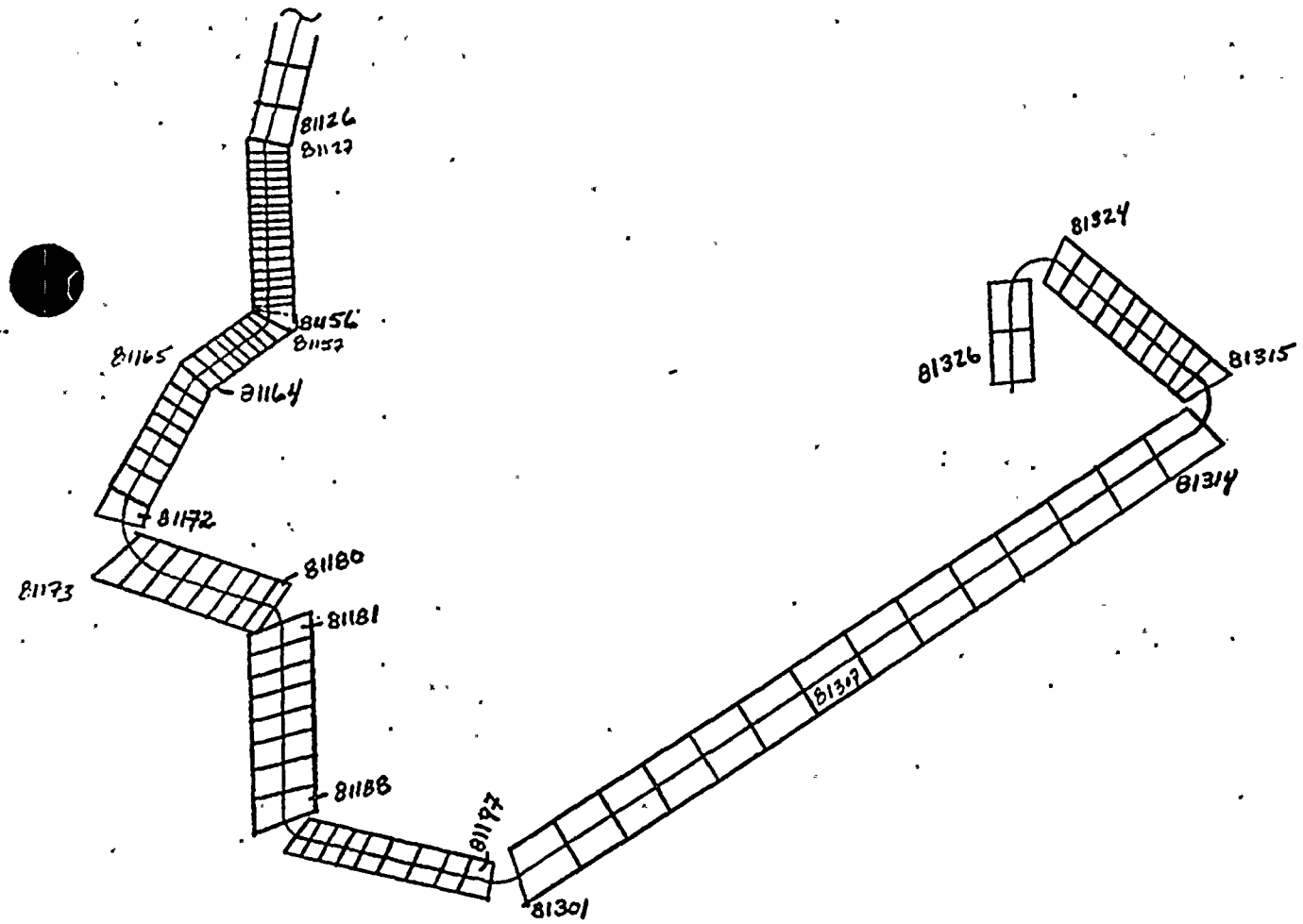


SAM DATE 4-14-85
D. BY CMH DATE 5-25-85

RELAP MODEL SCHEMATIC
UNIT 1 DOWNSTREAM (12IN)

SHEET NO. 3 OF 3
PROJ. NO. 5364

FIGURE 4.5.1-3



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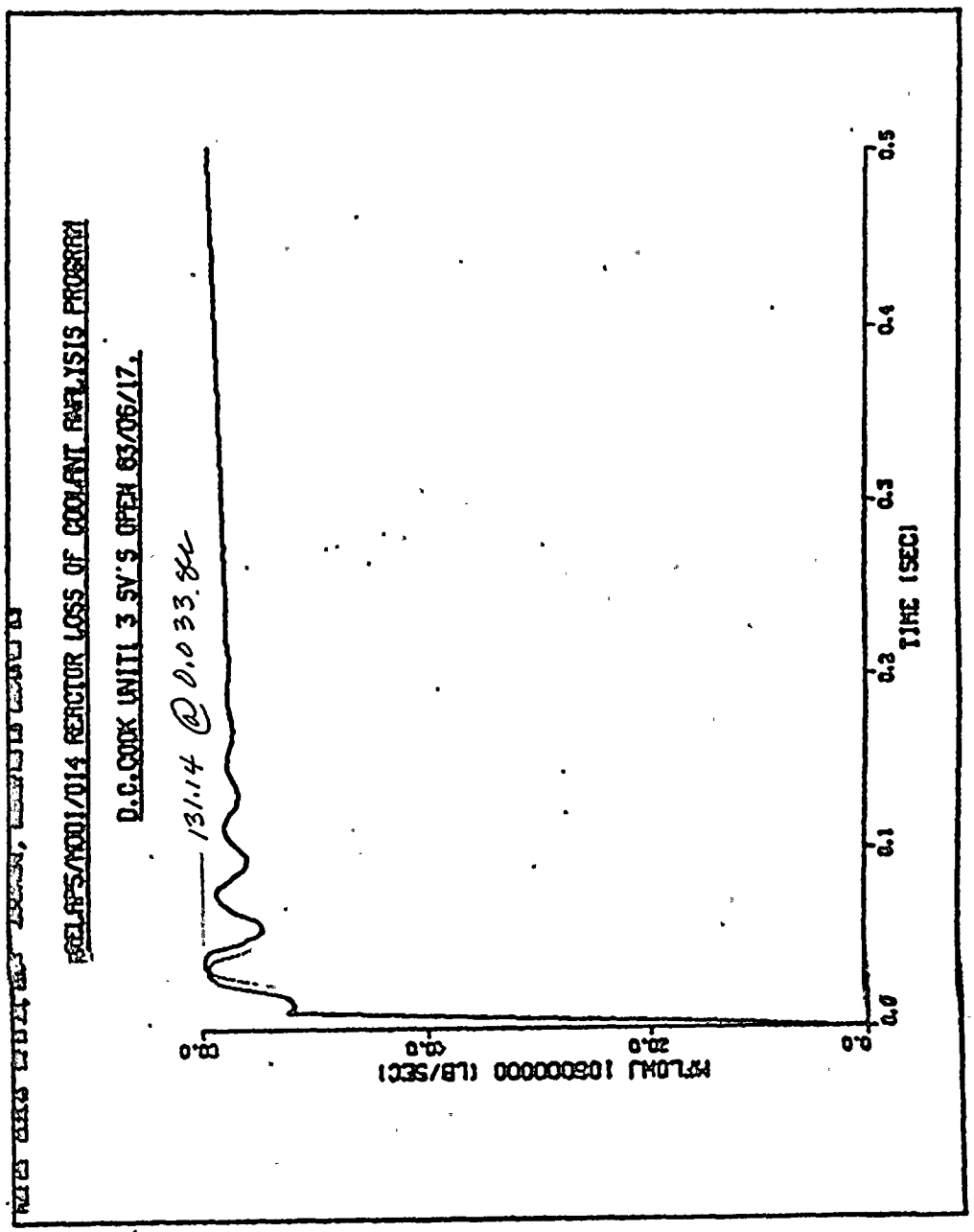

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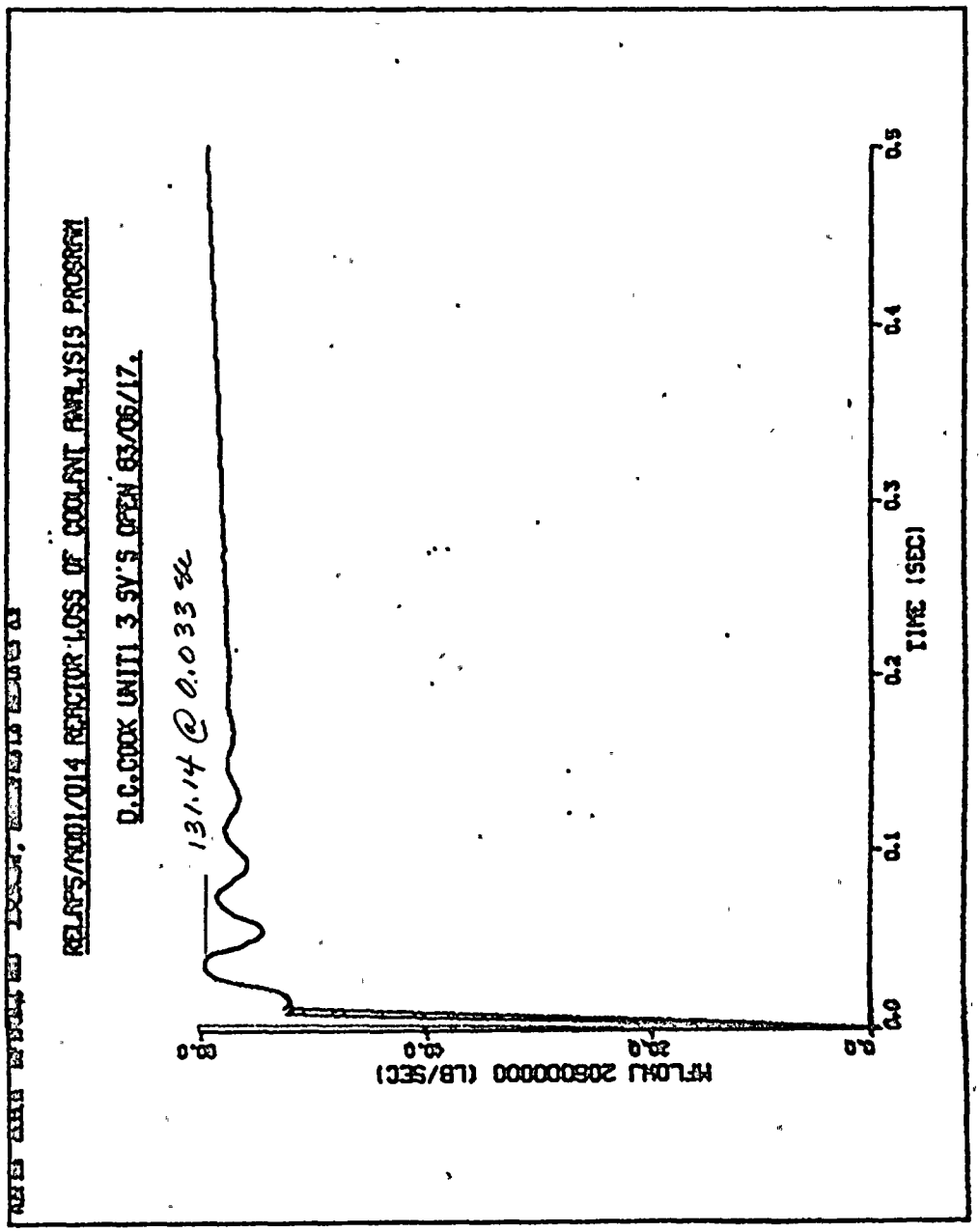

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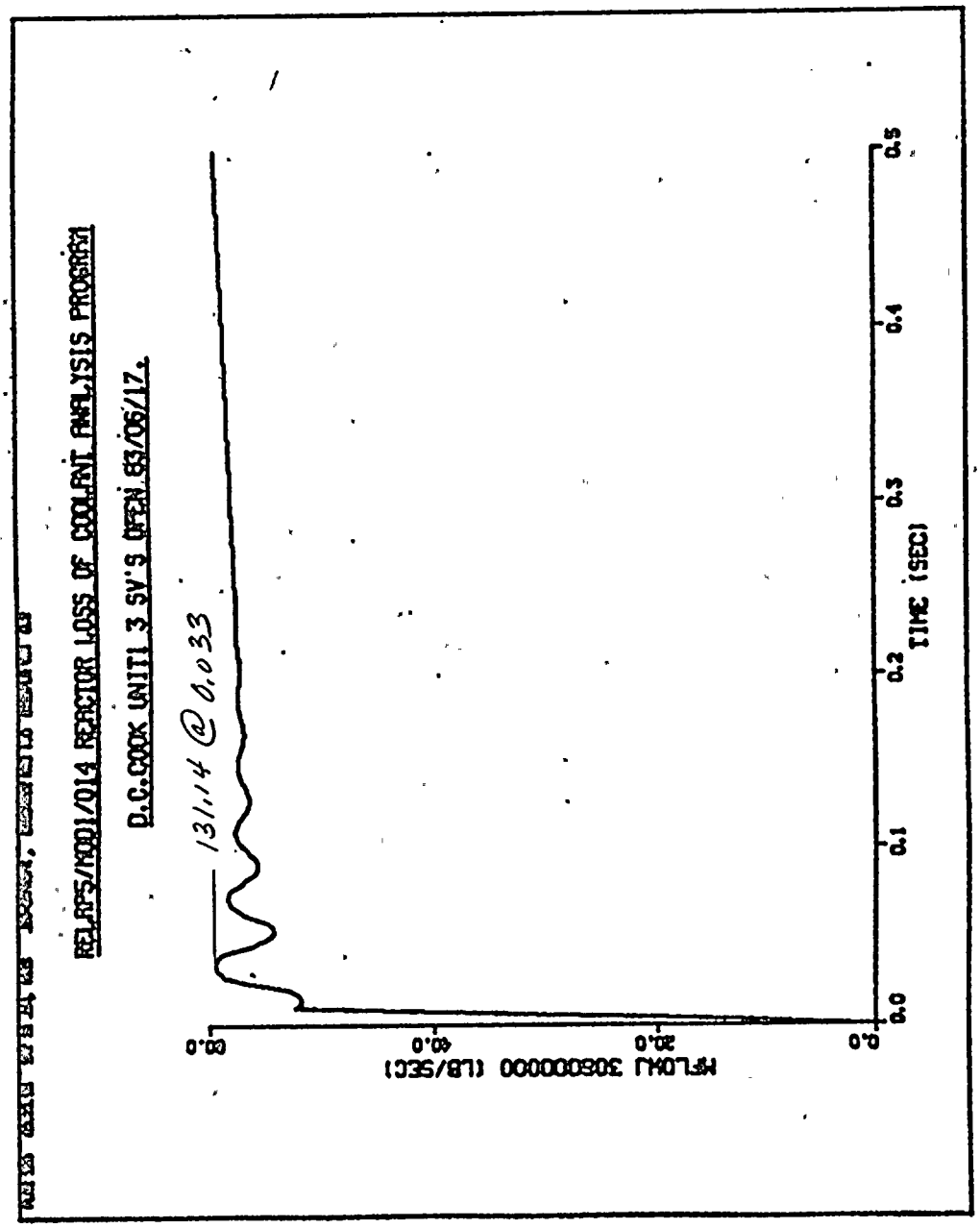

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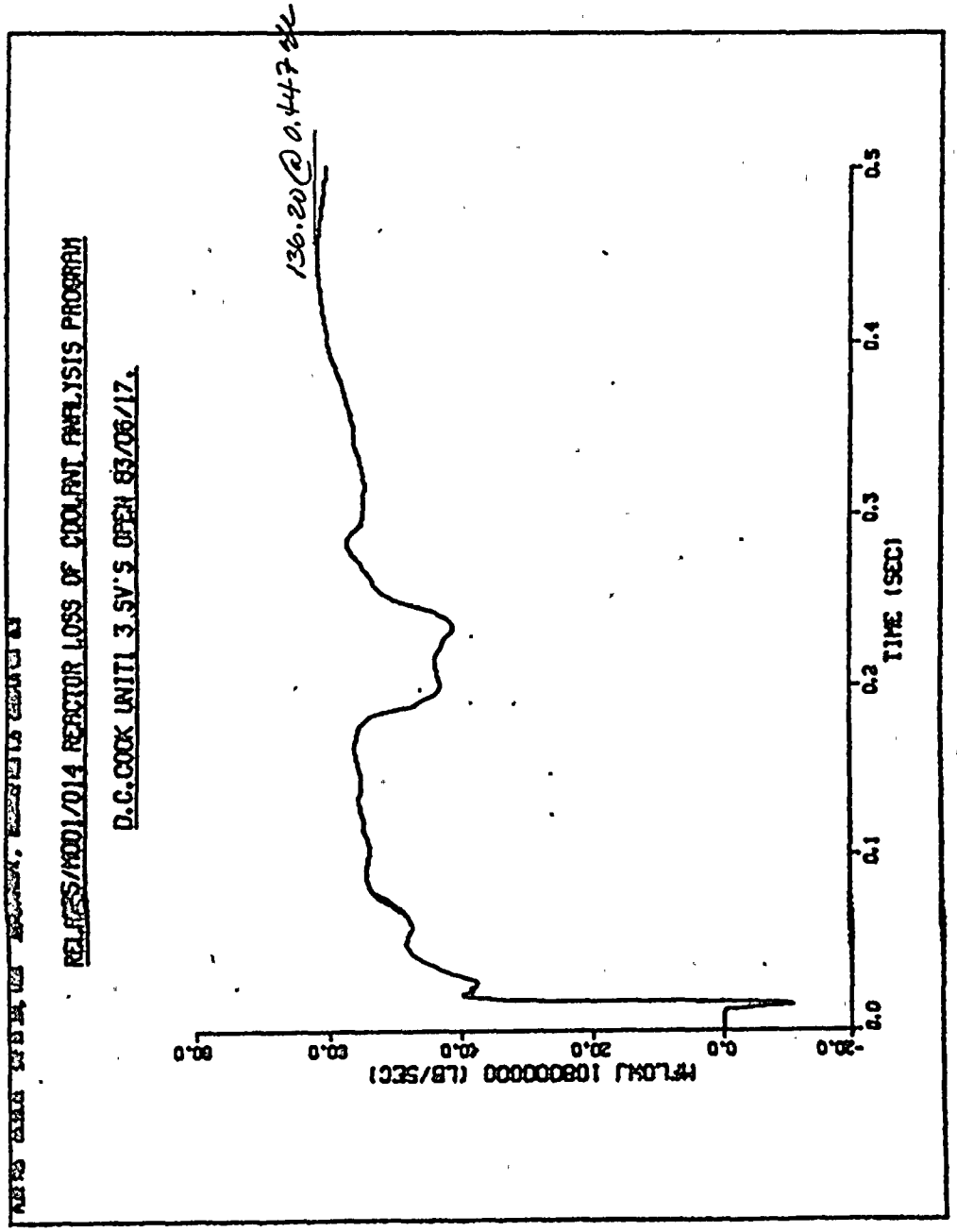

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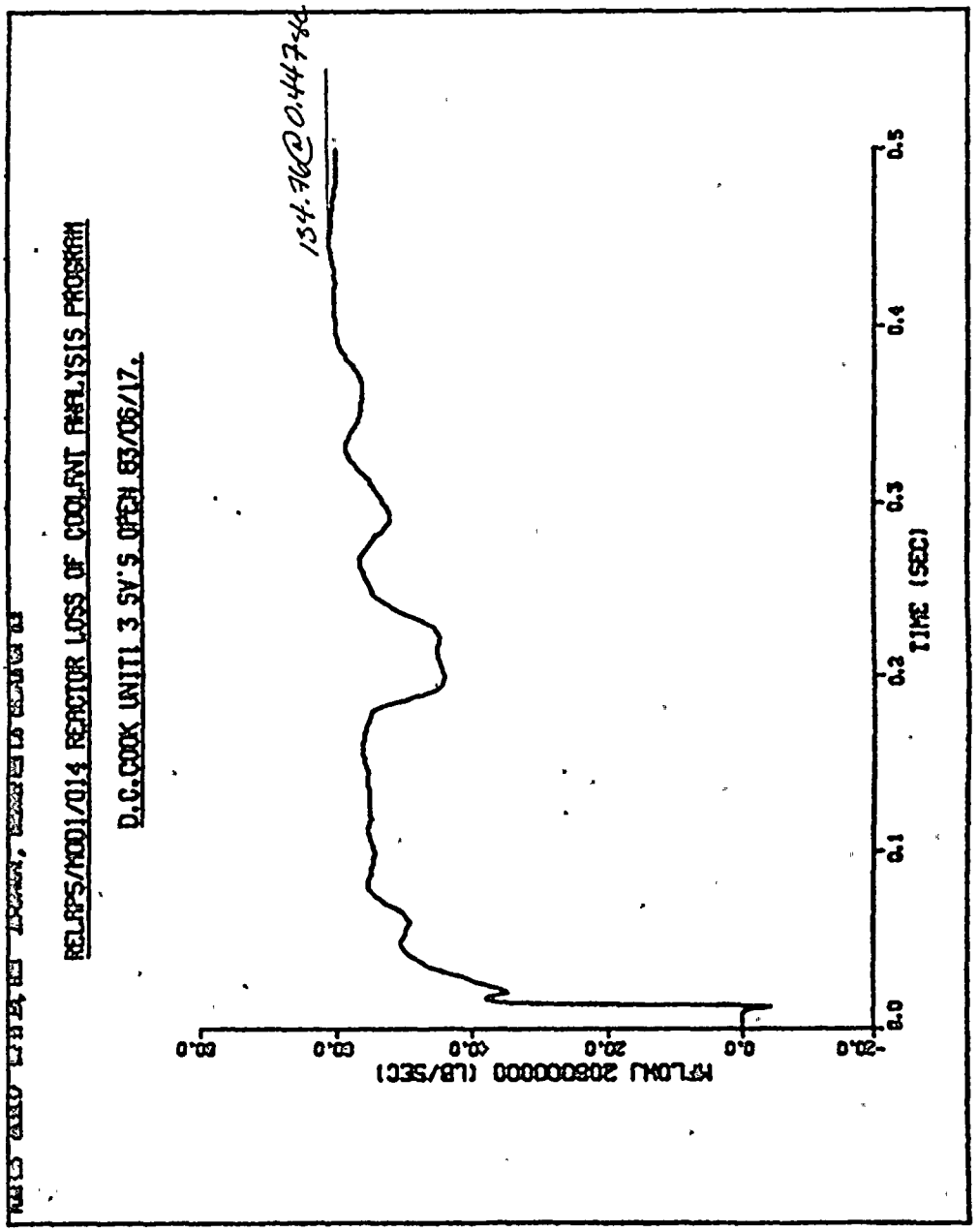

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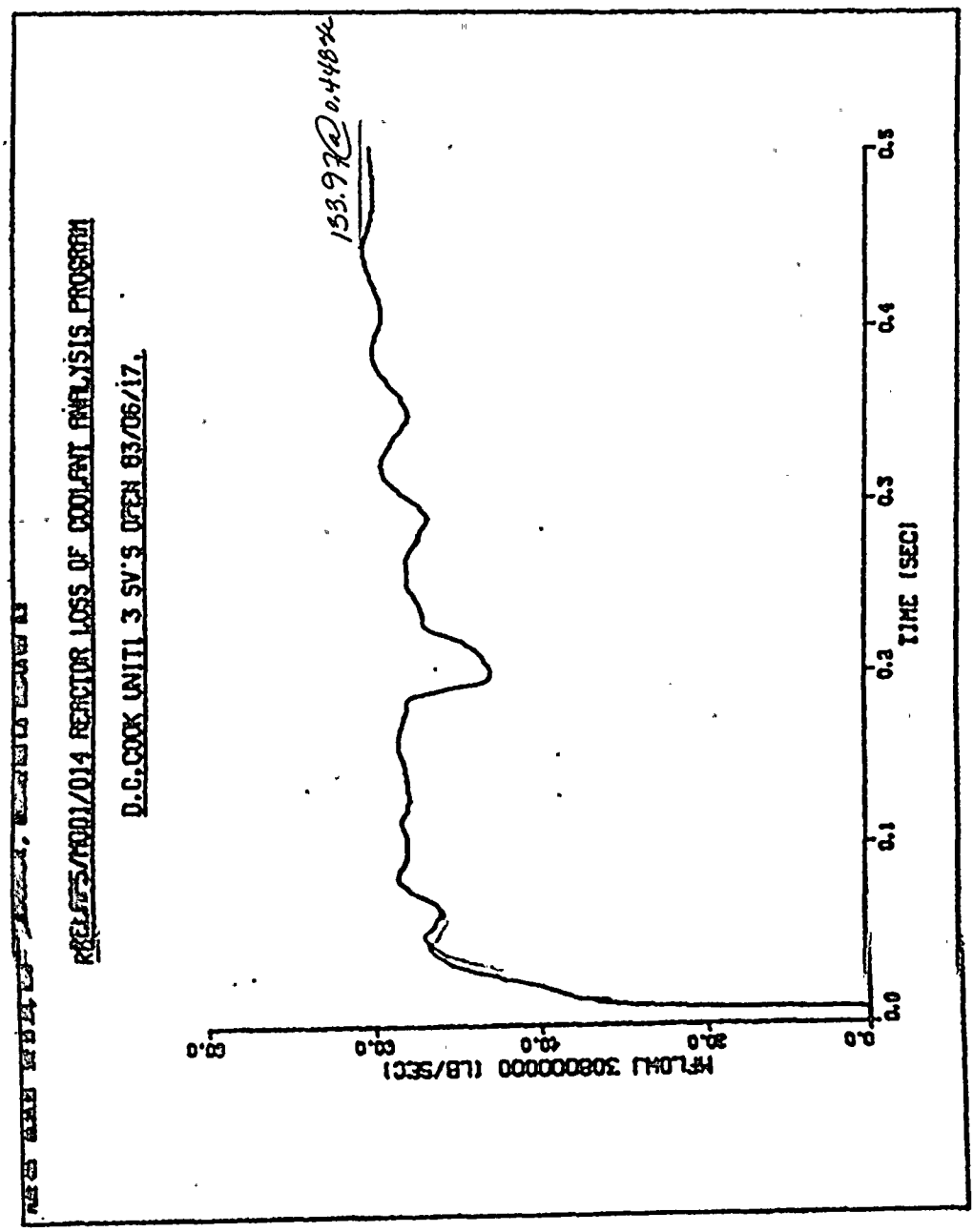

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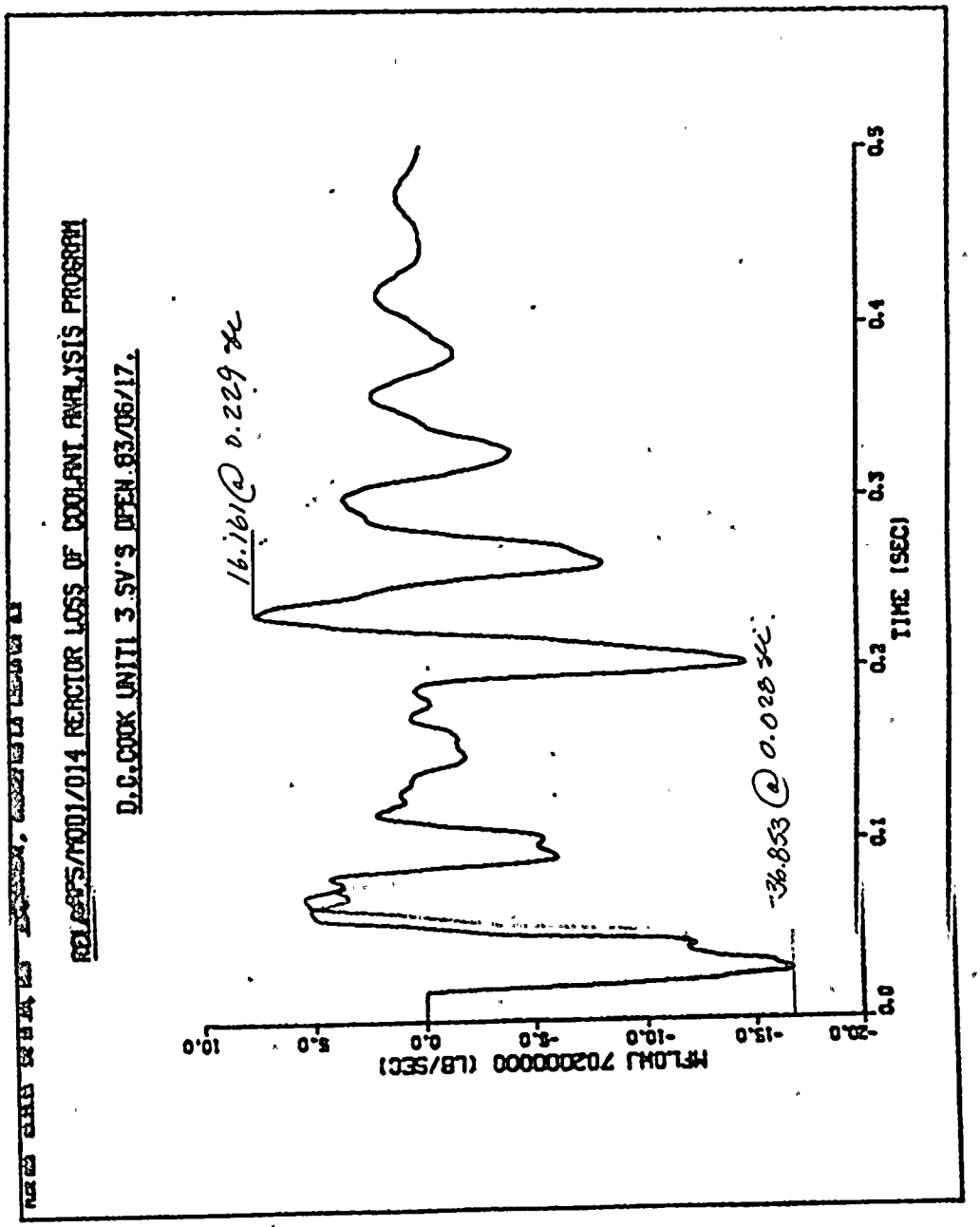

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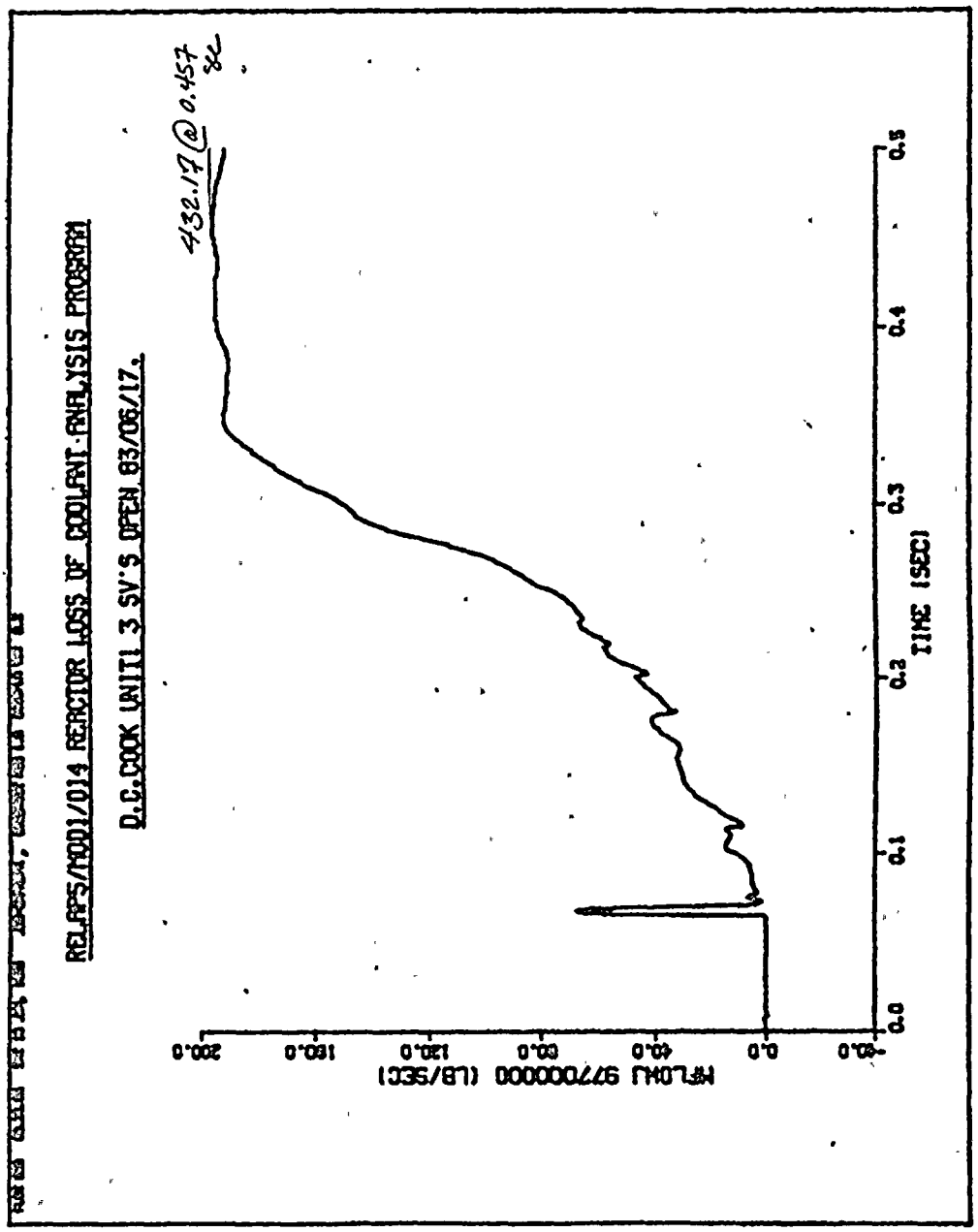

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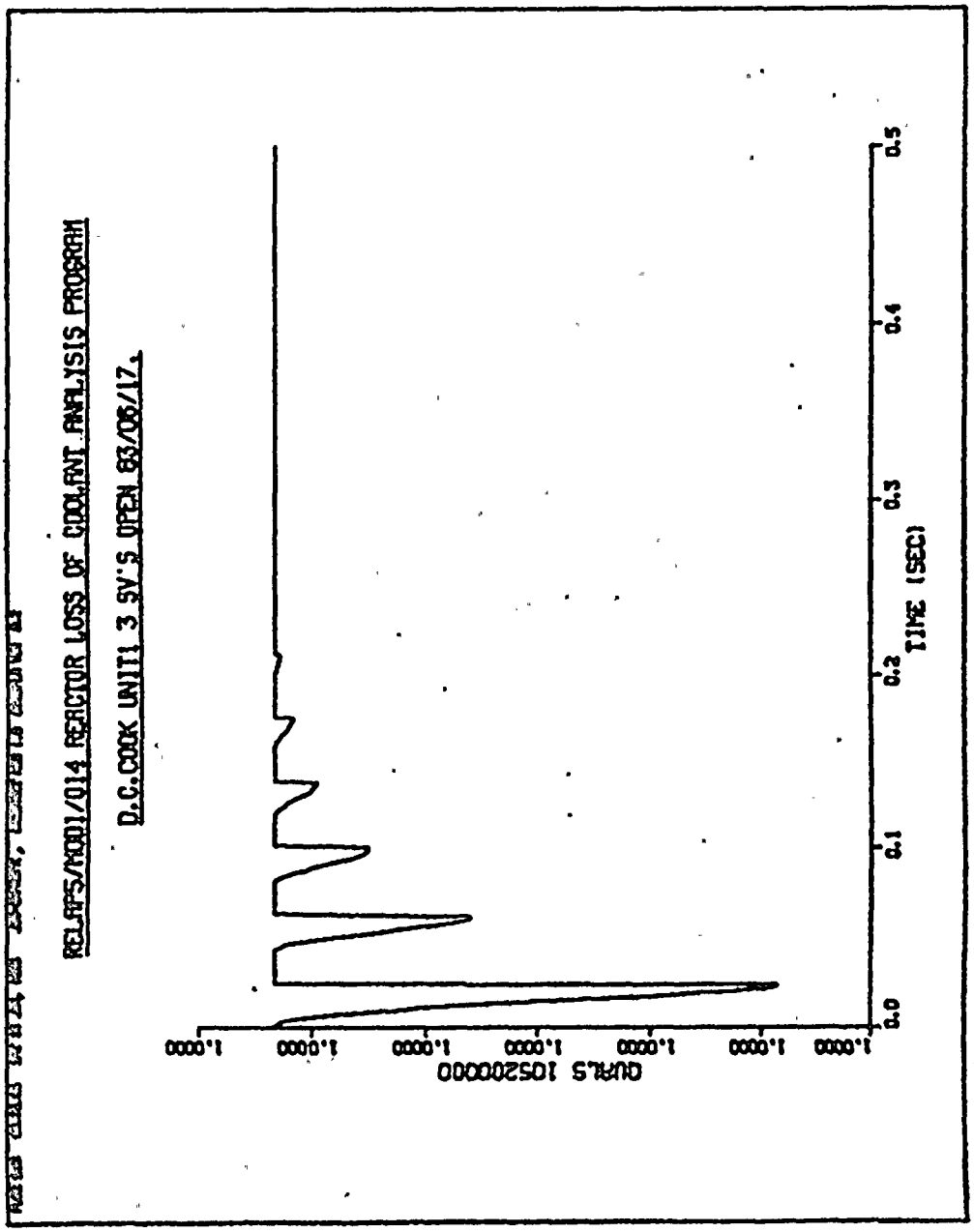
CHKD. BY CMH DATE 6-29-83



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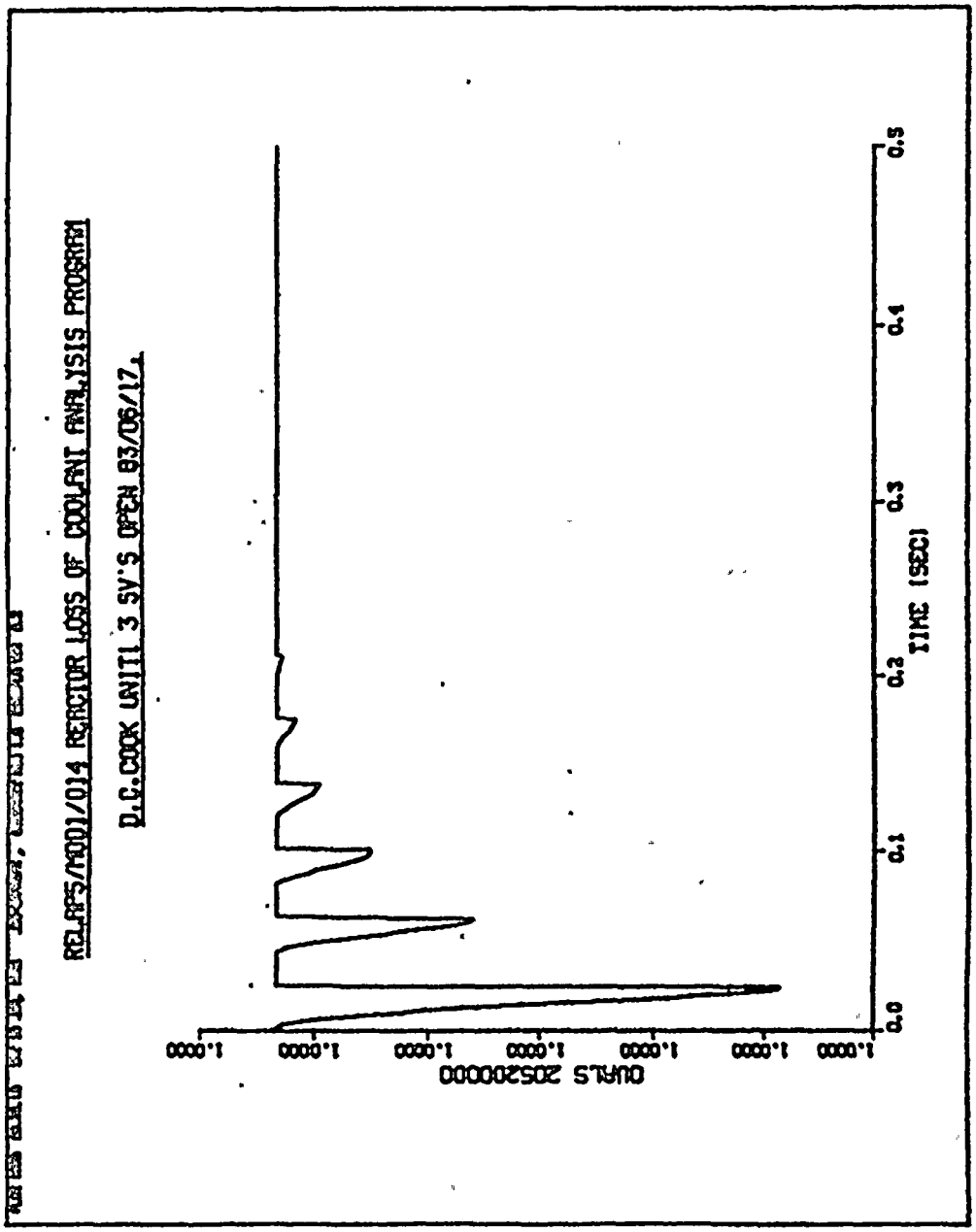

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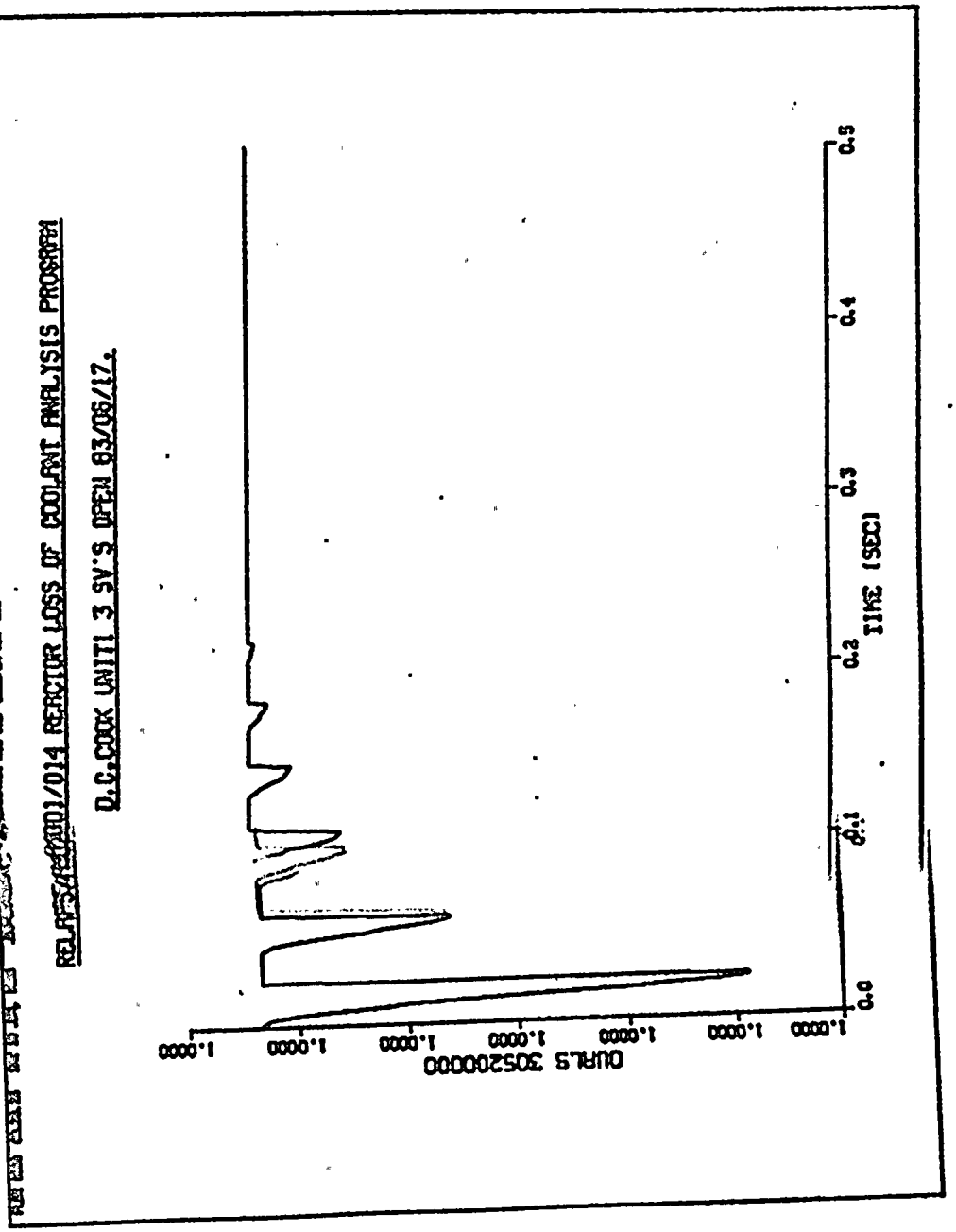

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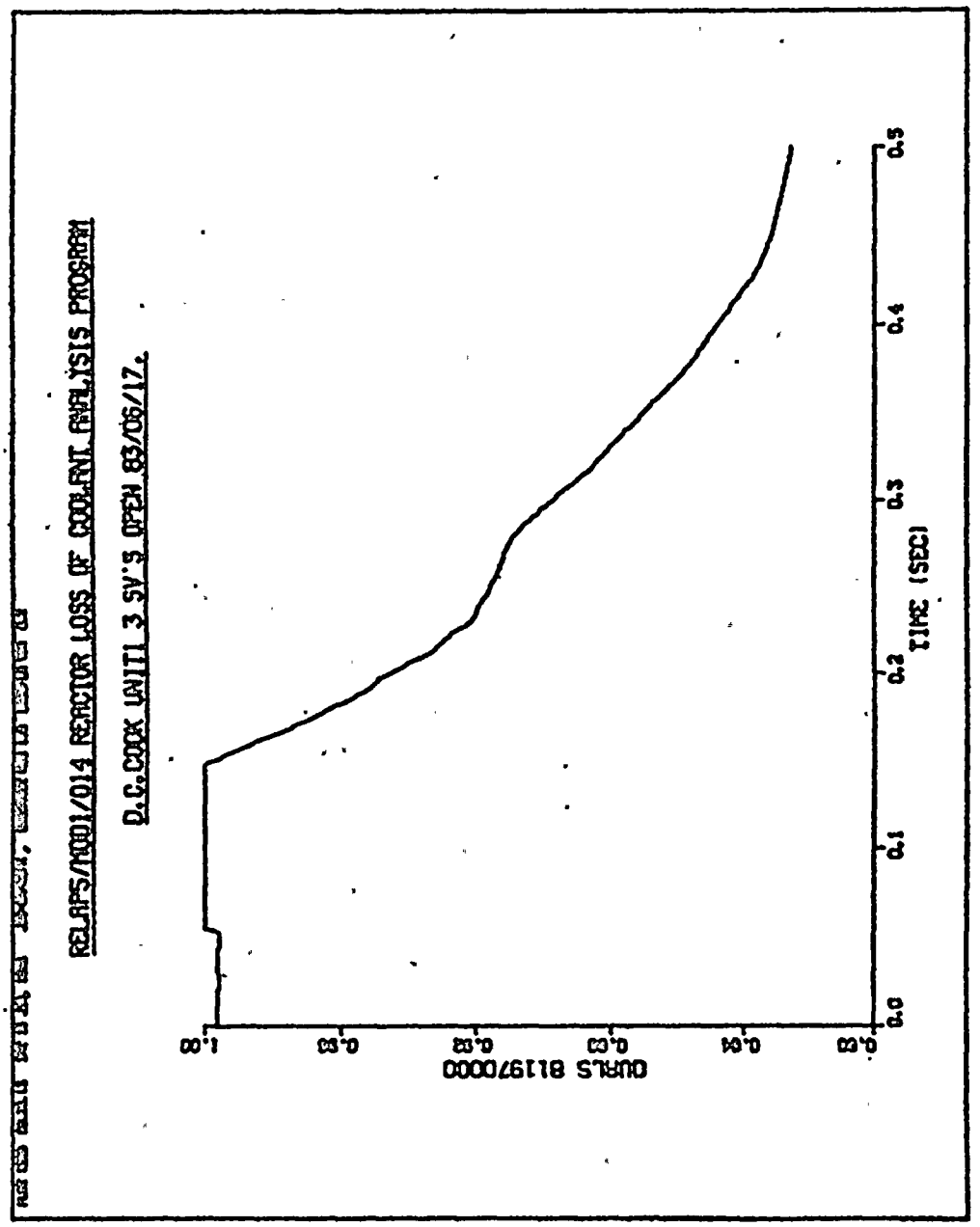

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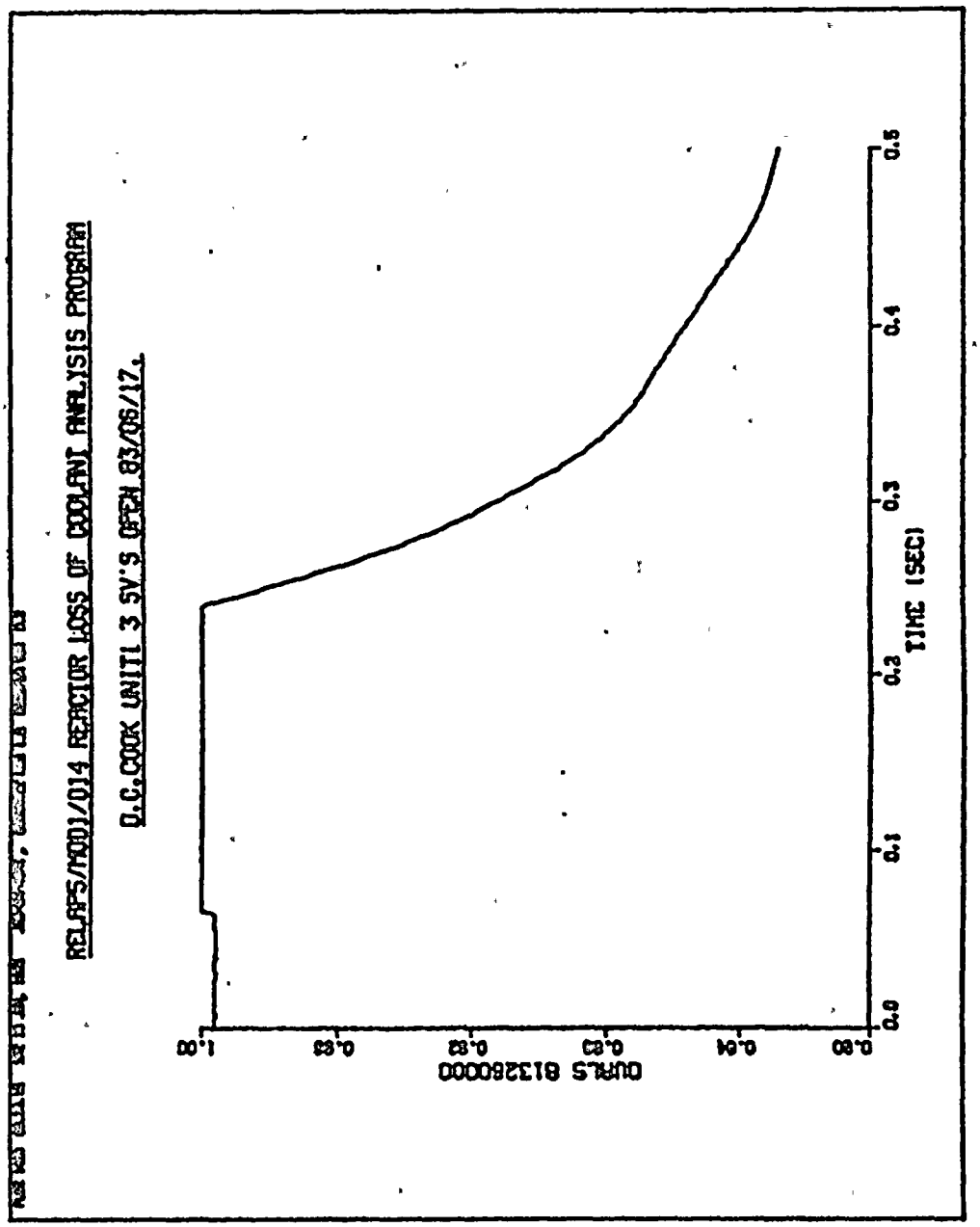

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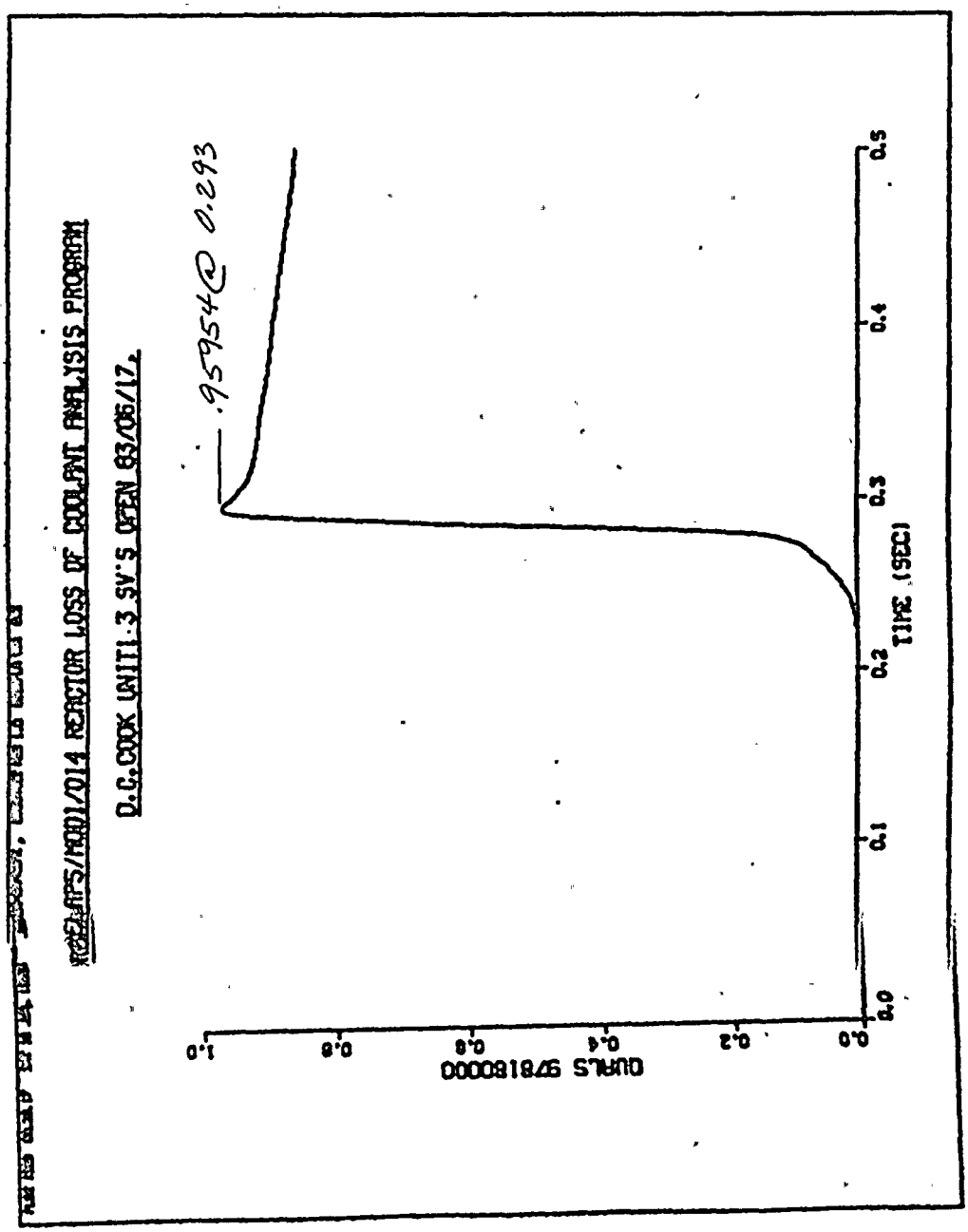

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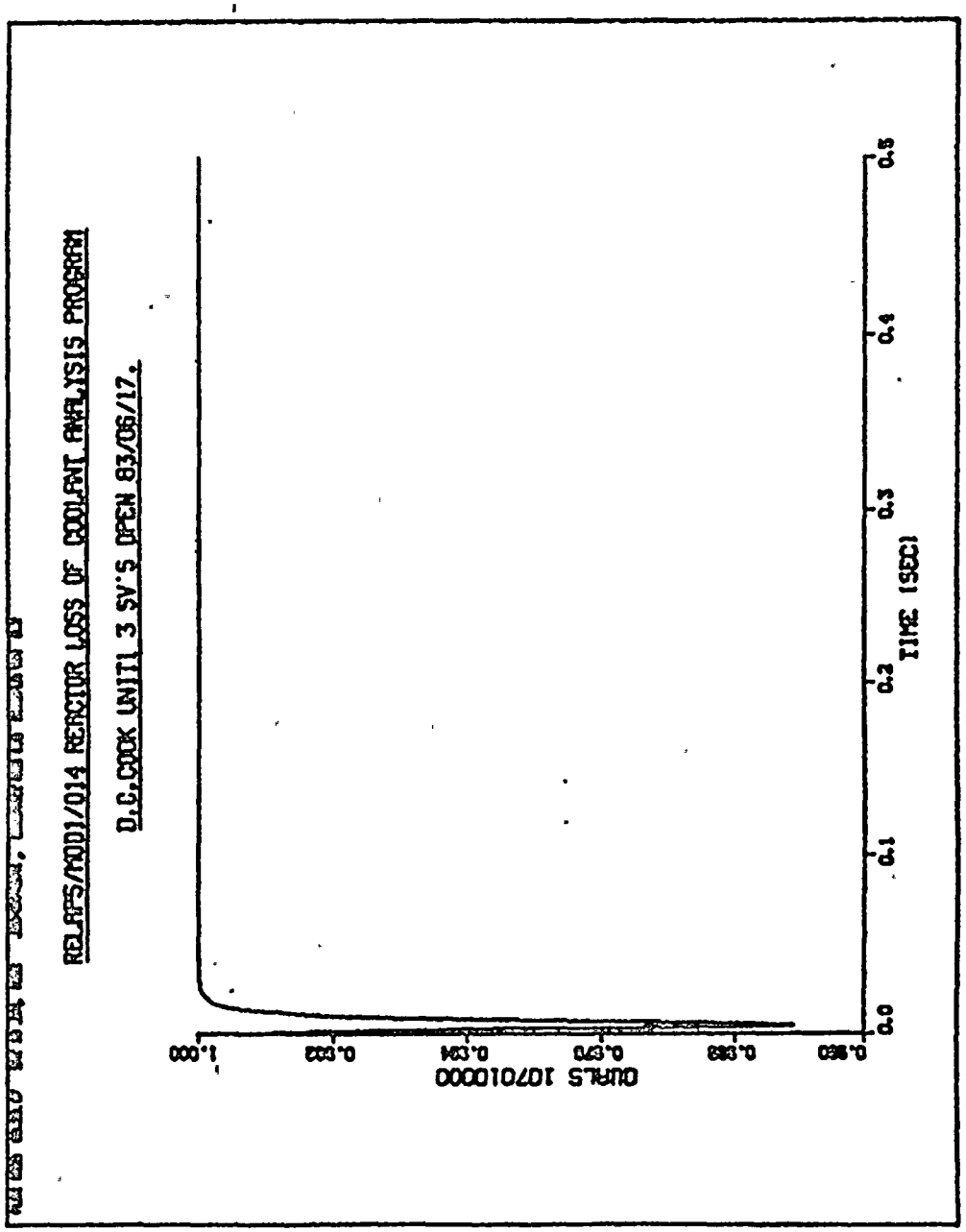

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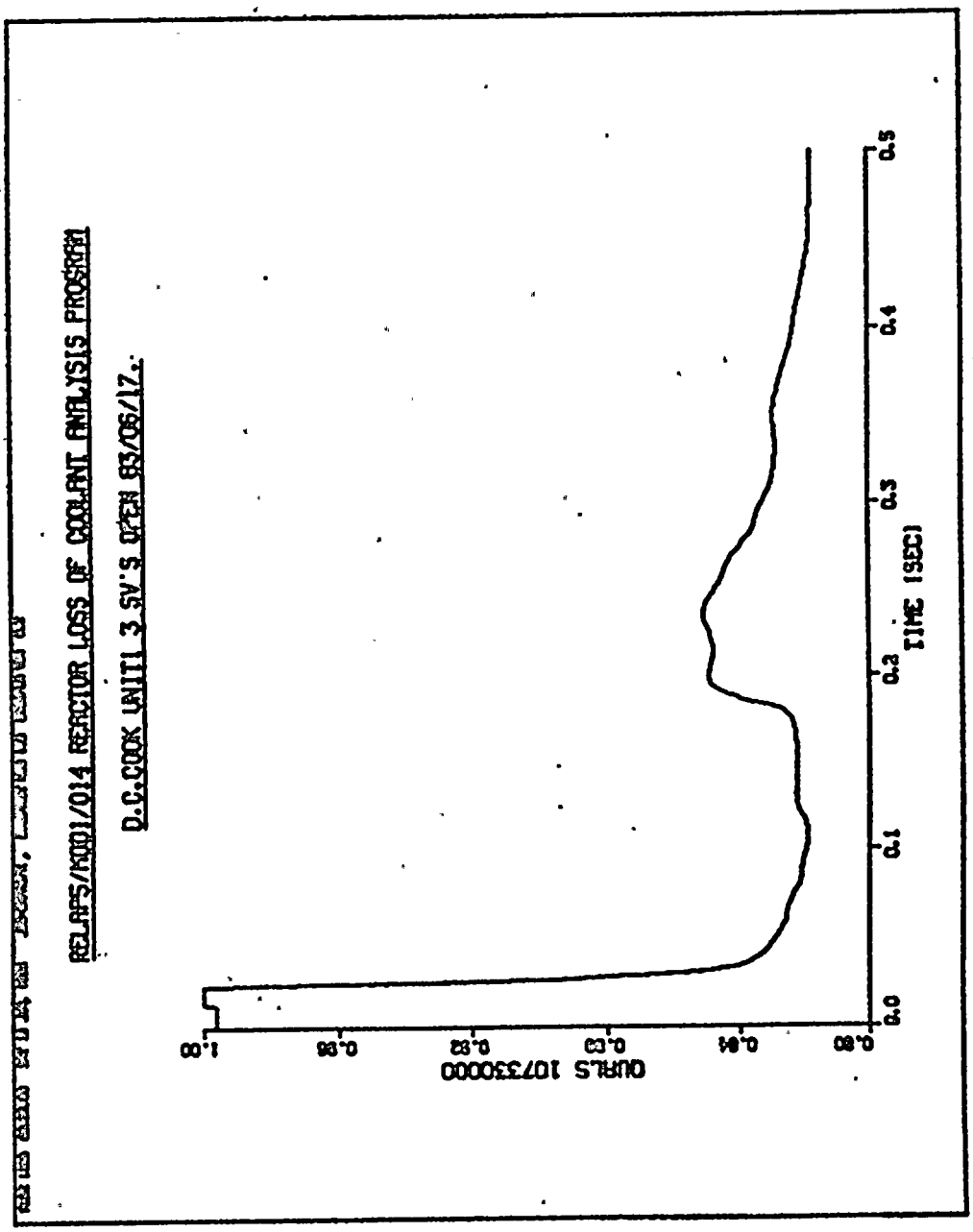

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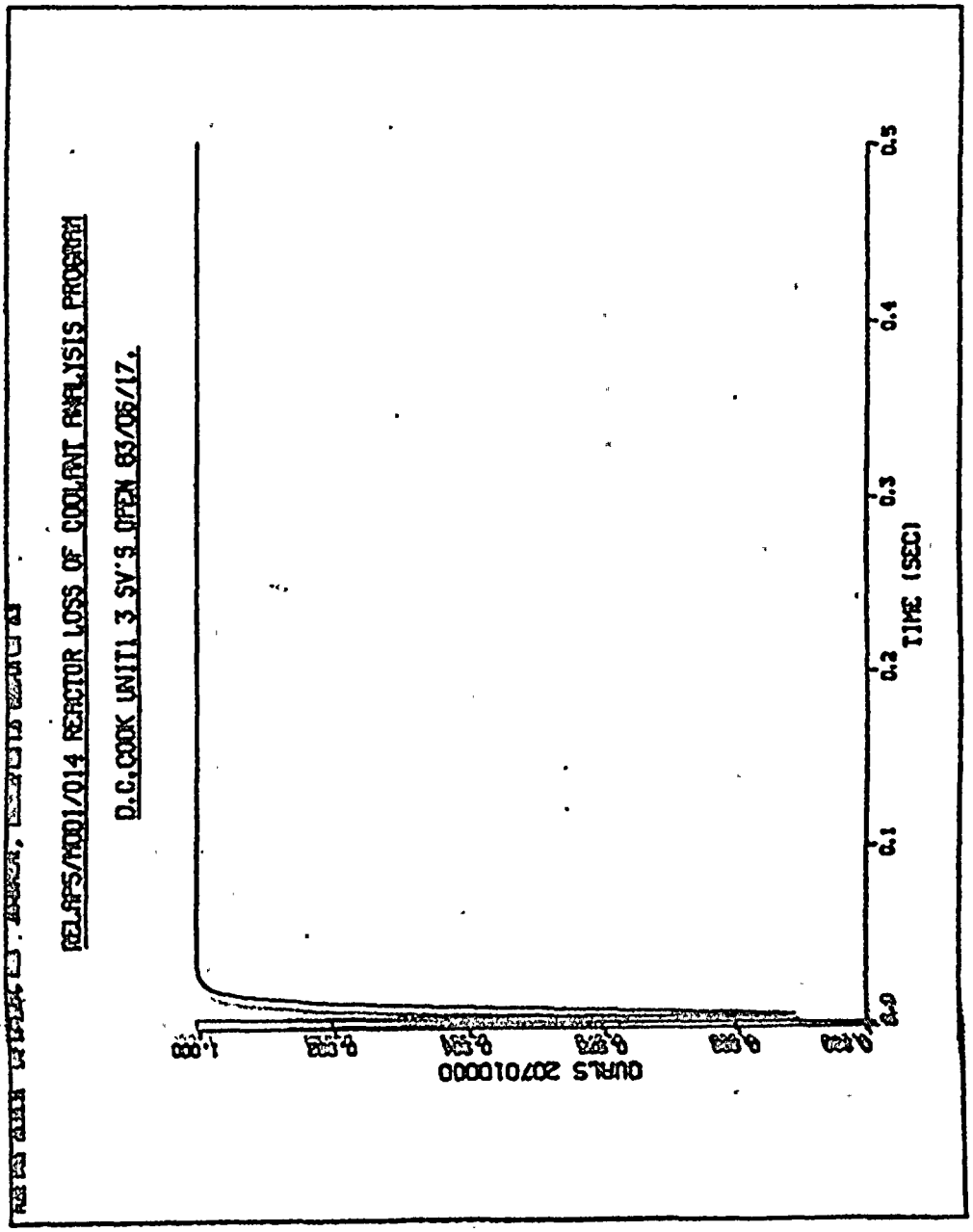

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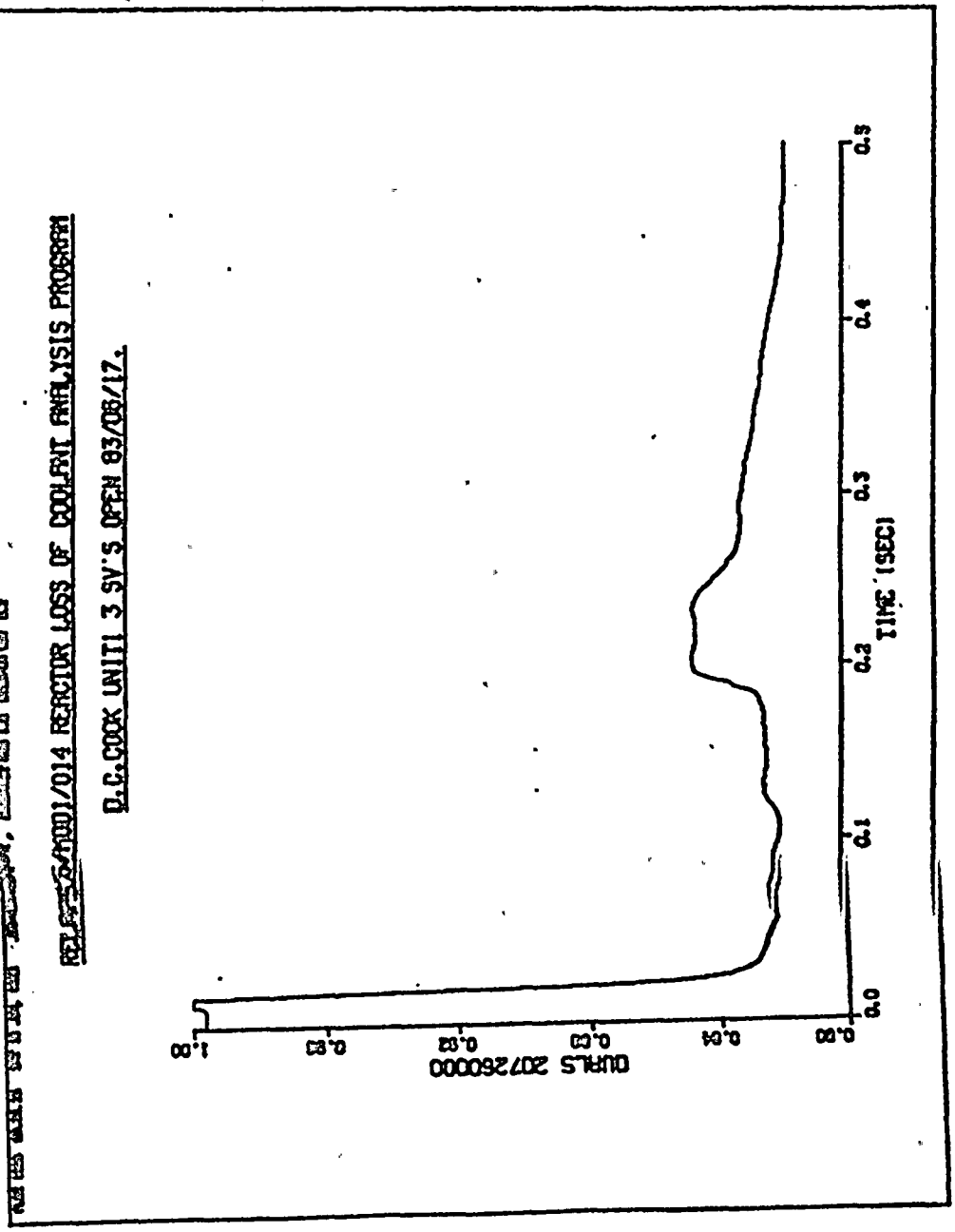

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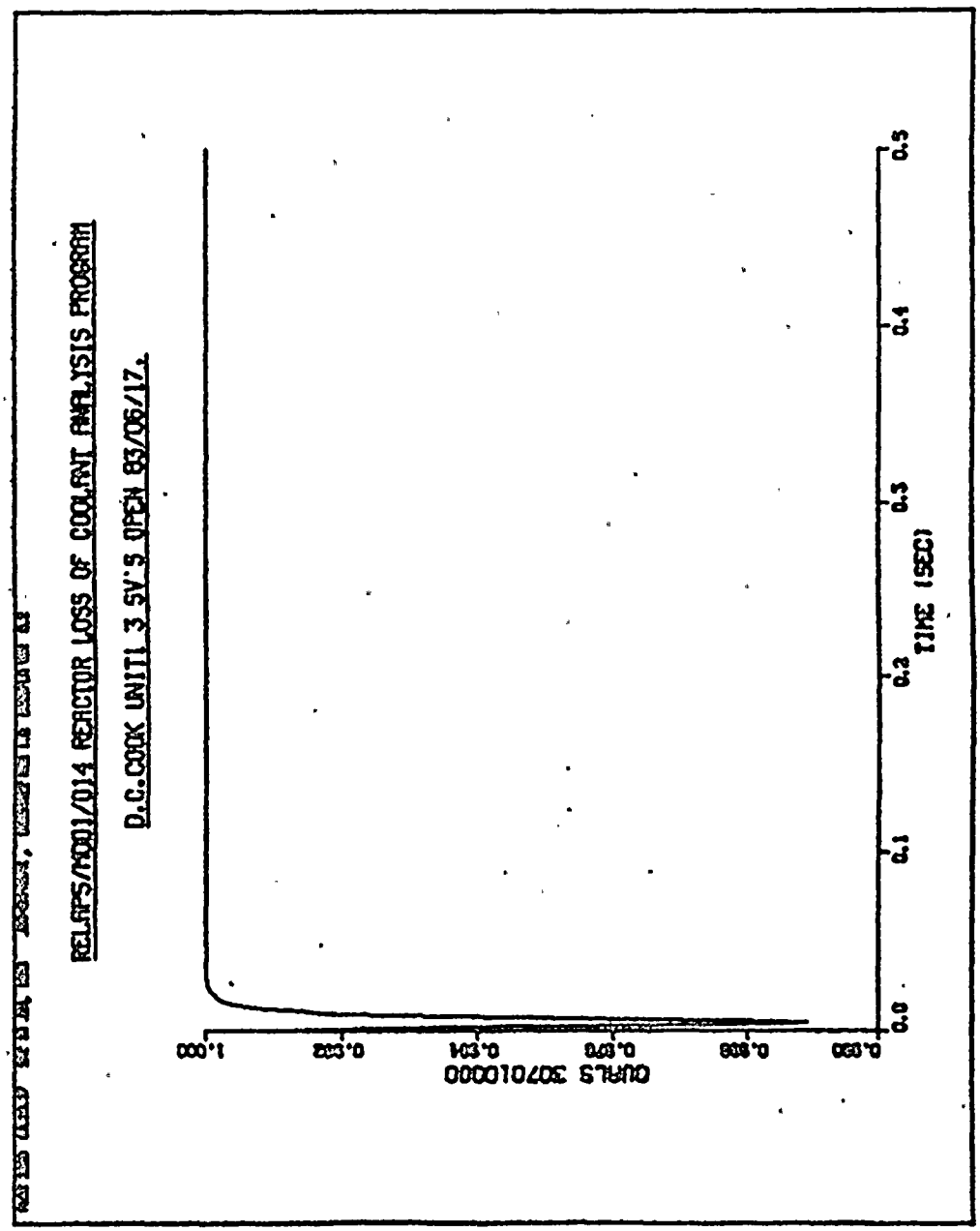

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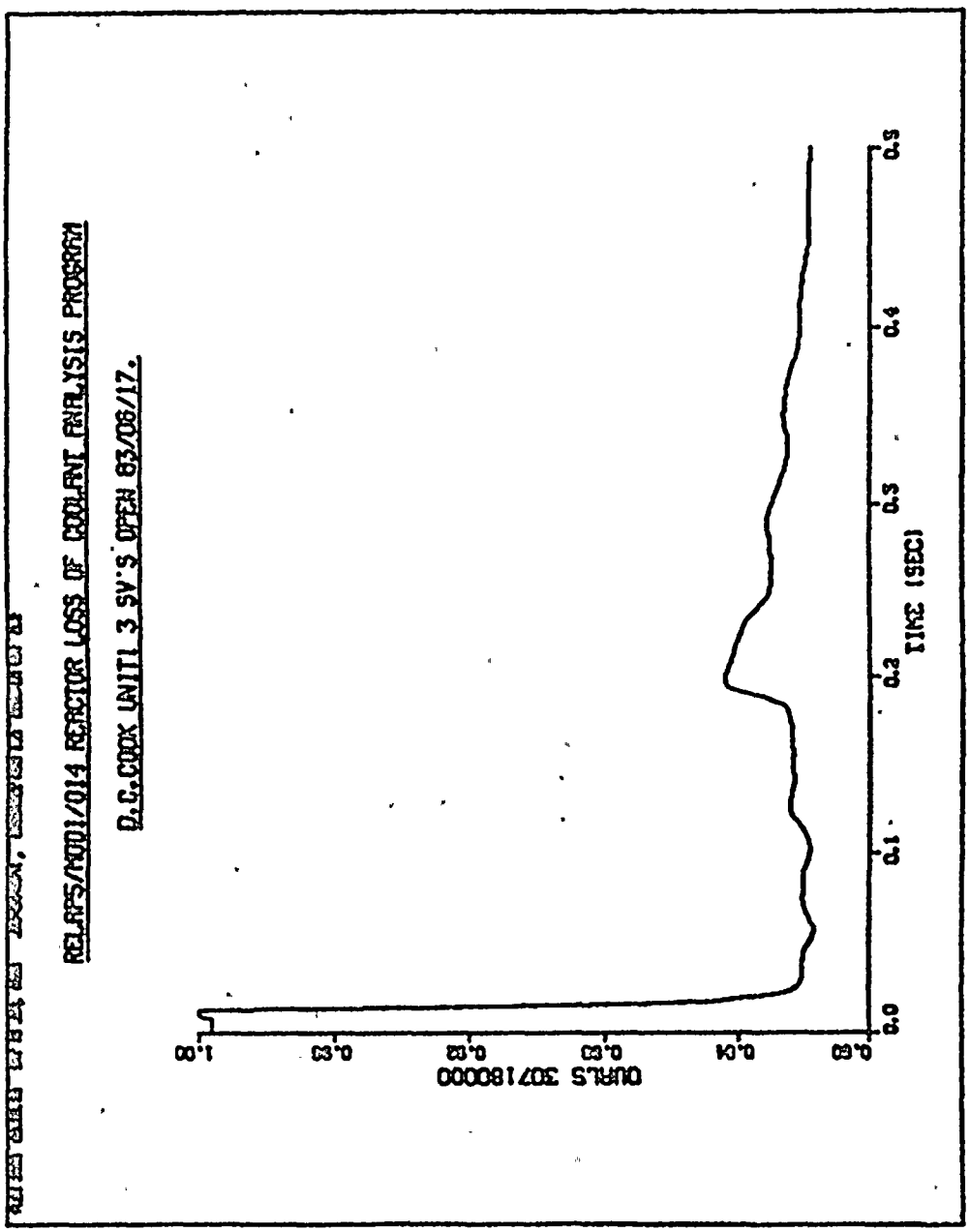

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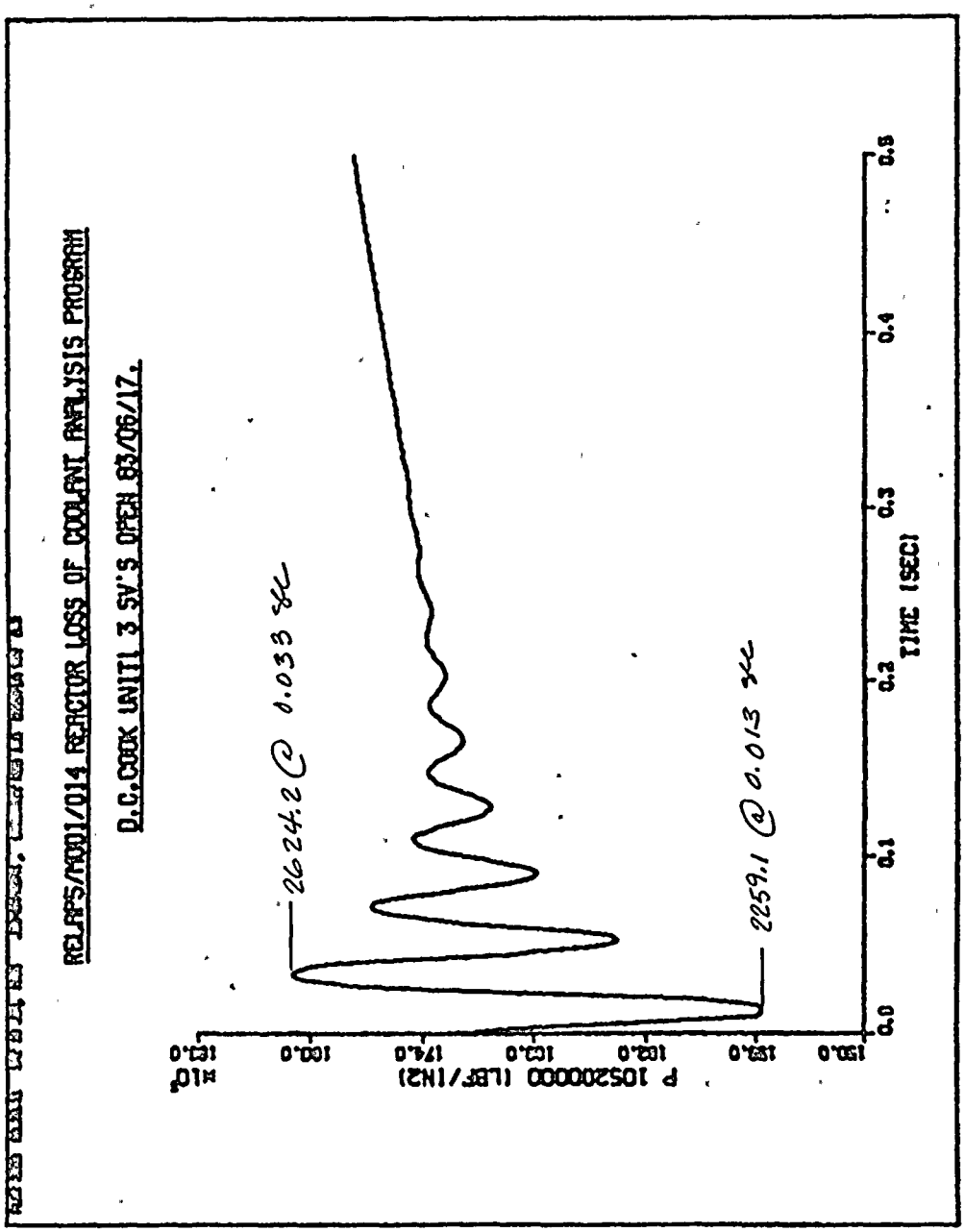

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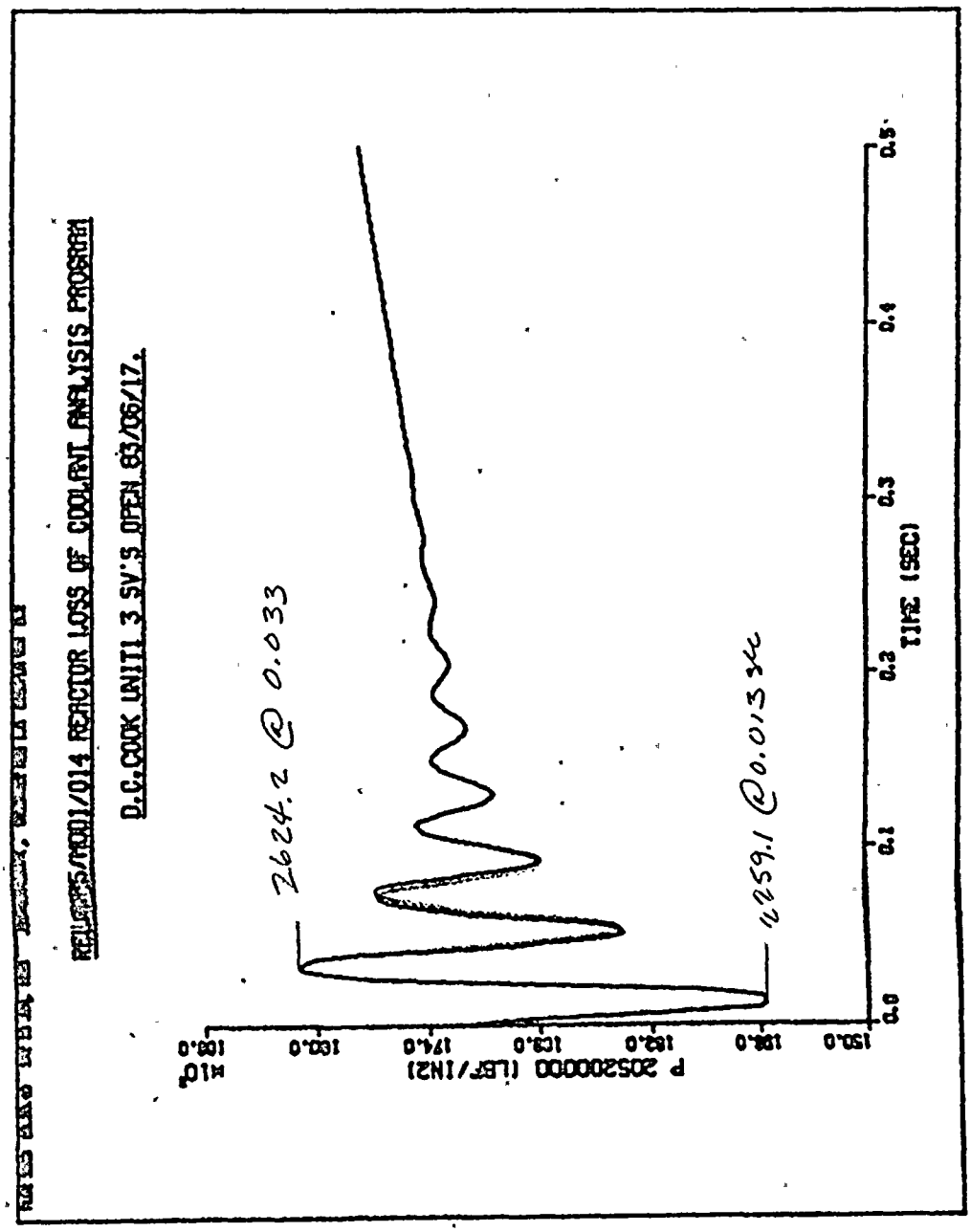

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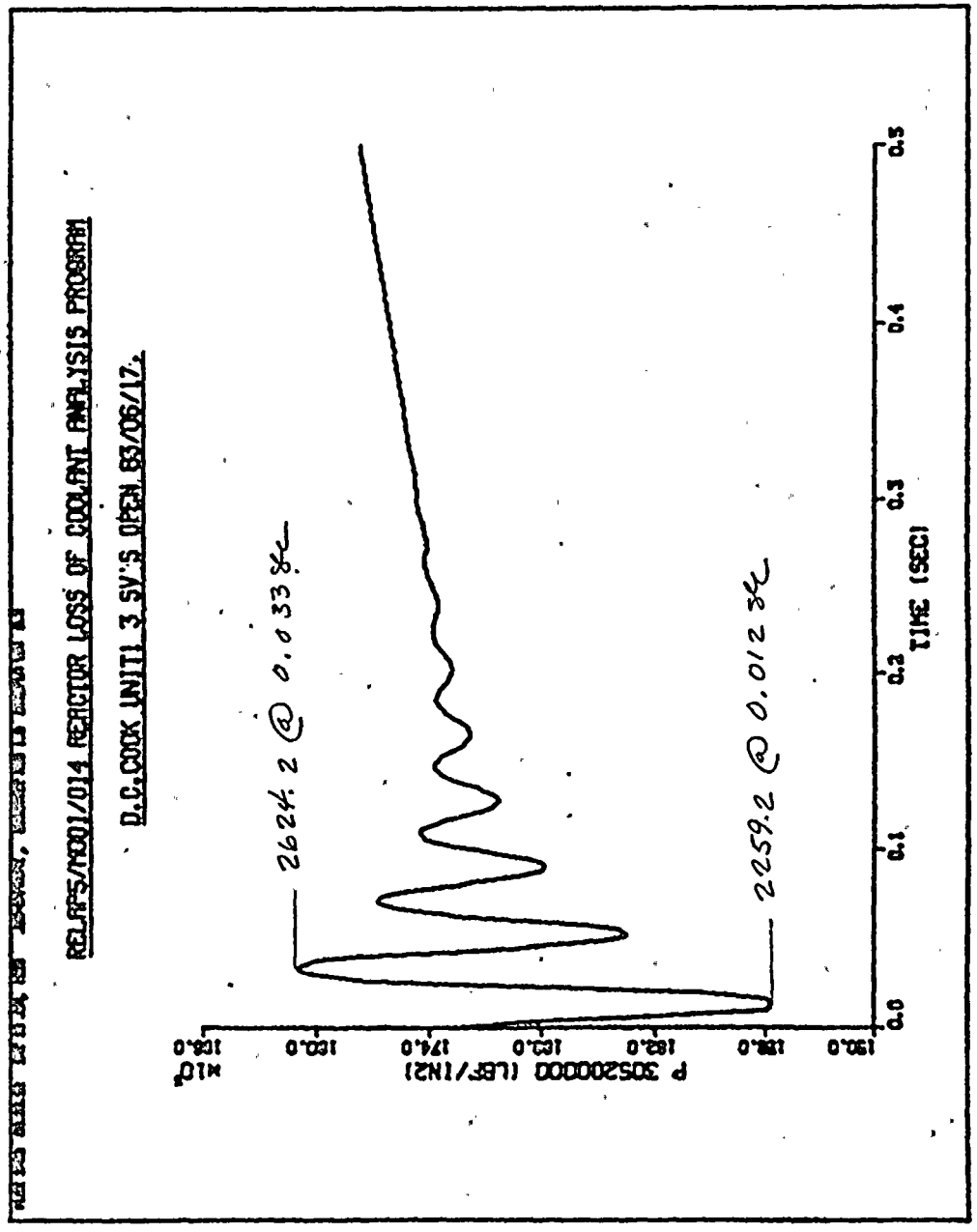

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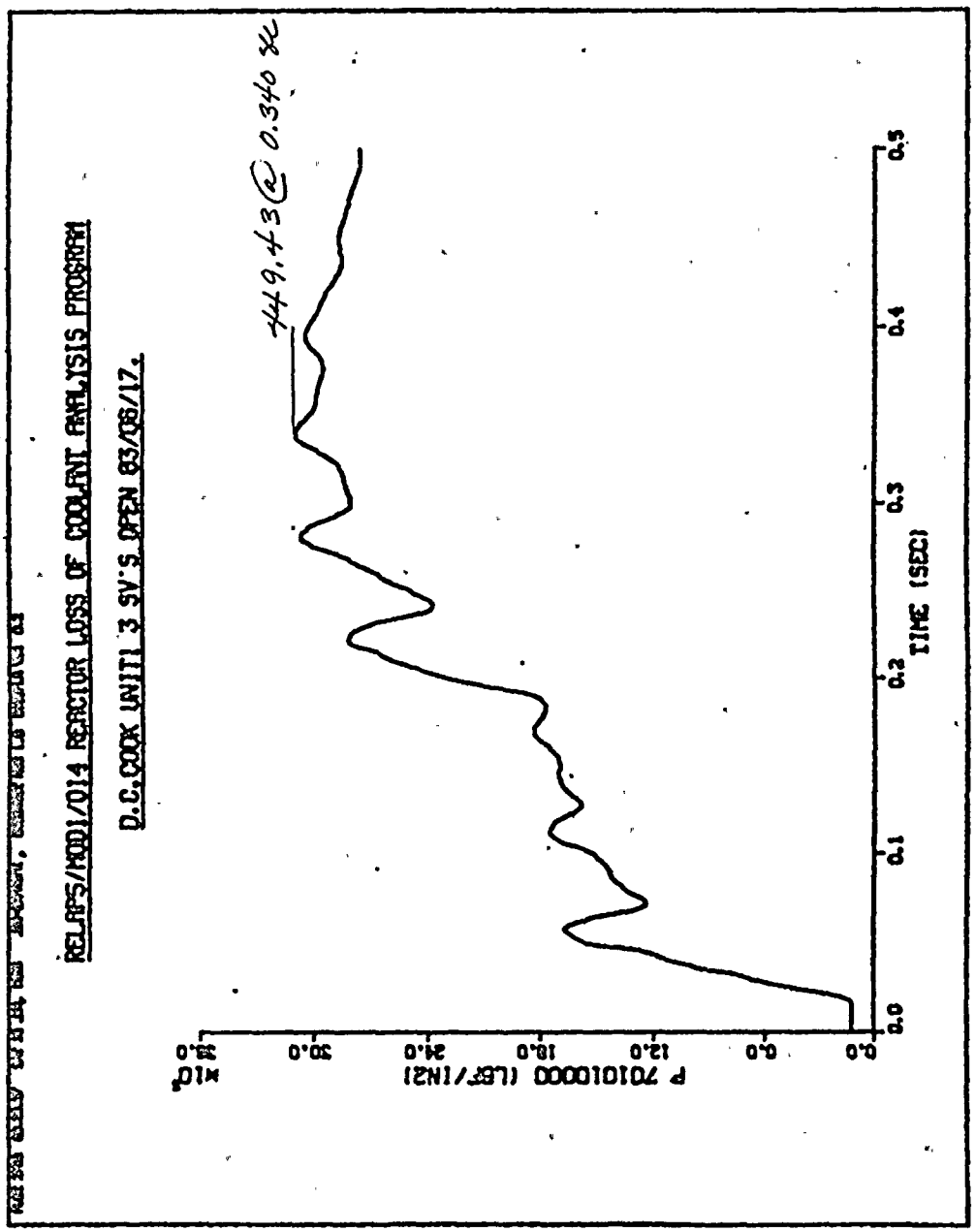
CHKD. BY CHM DATE 6-29-83



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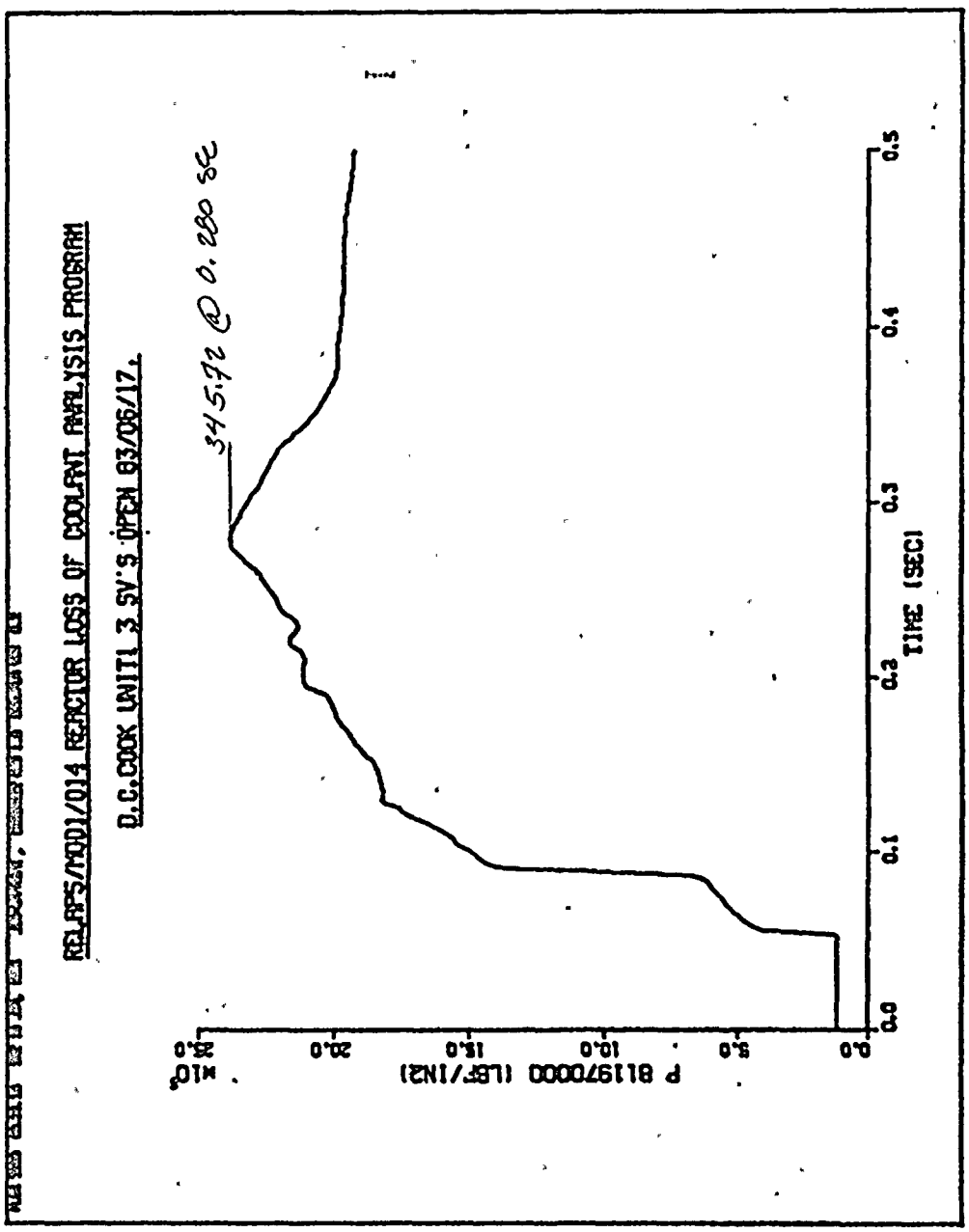

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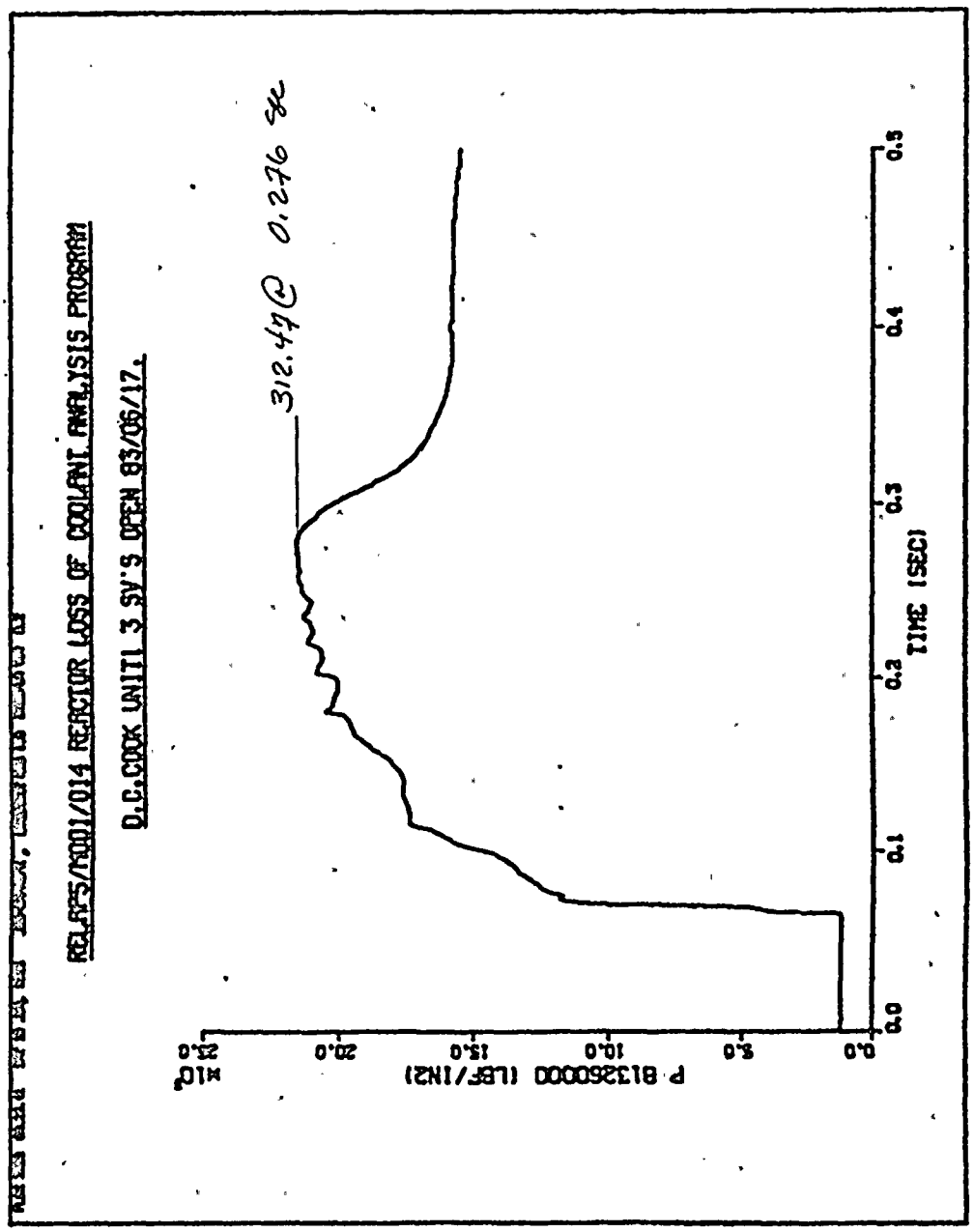

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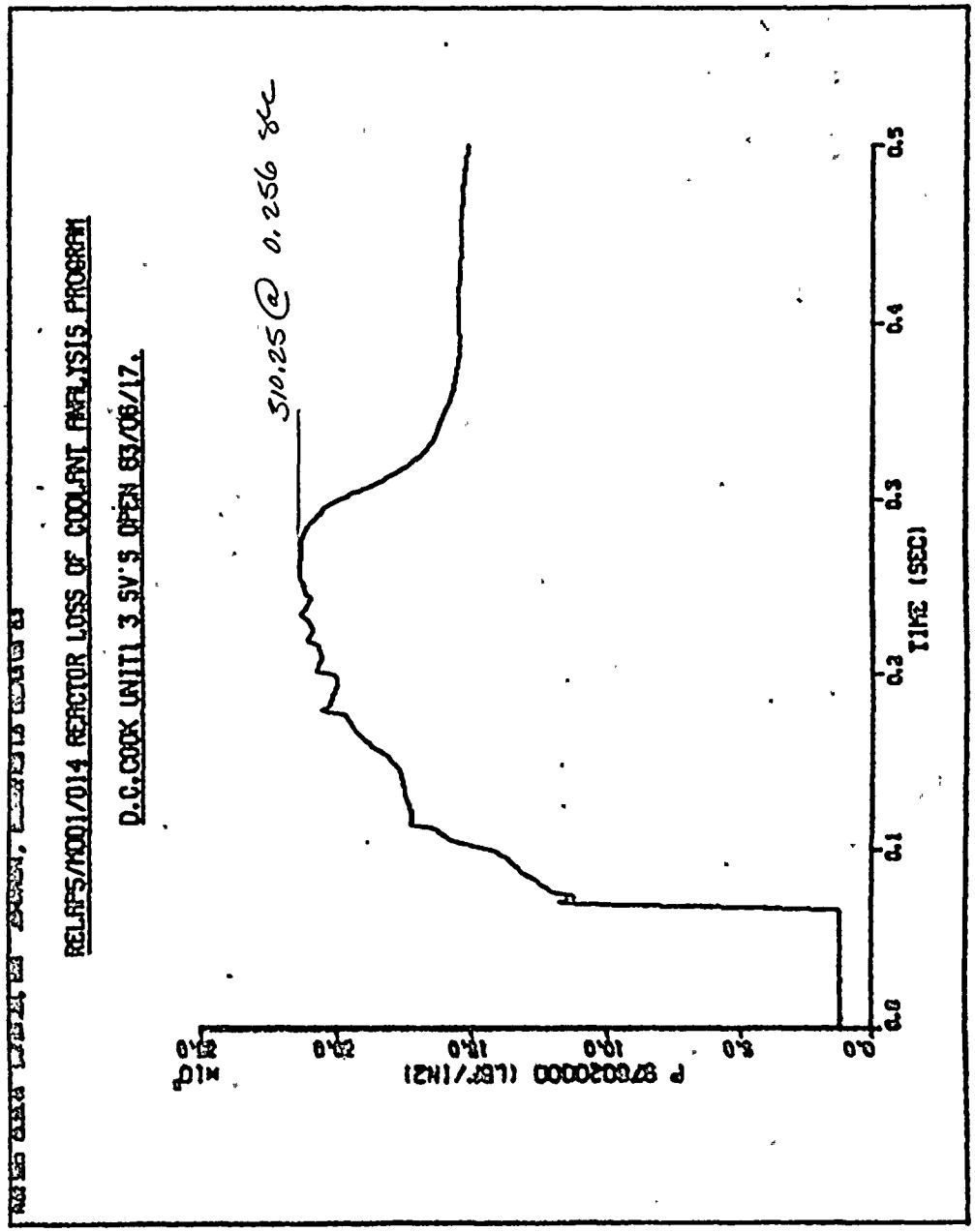
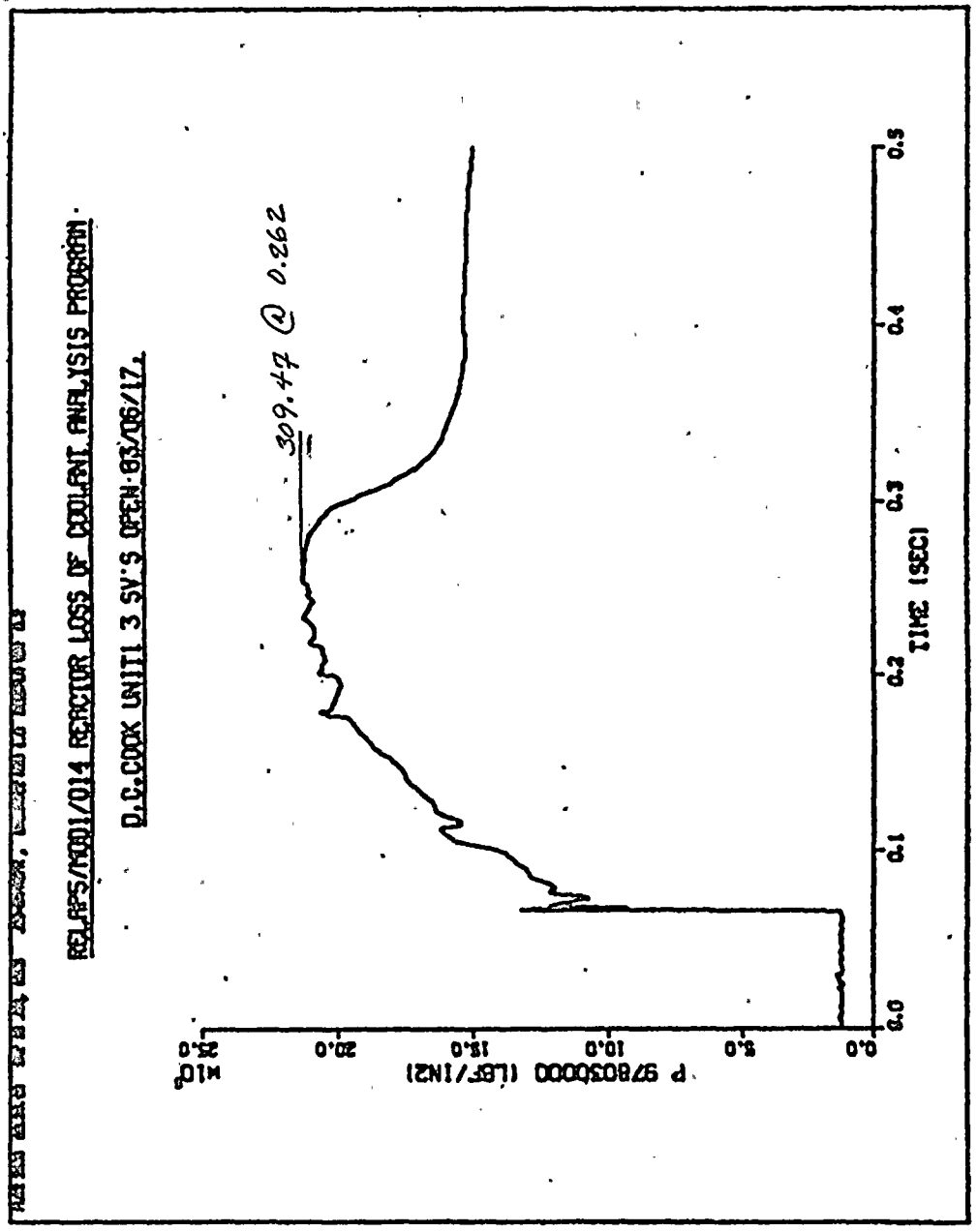
CHKD. BY CHH DATE 6-29-83



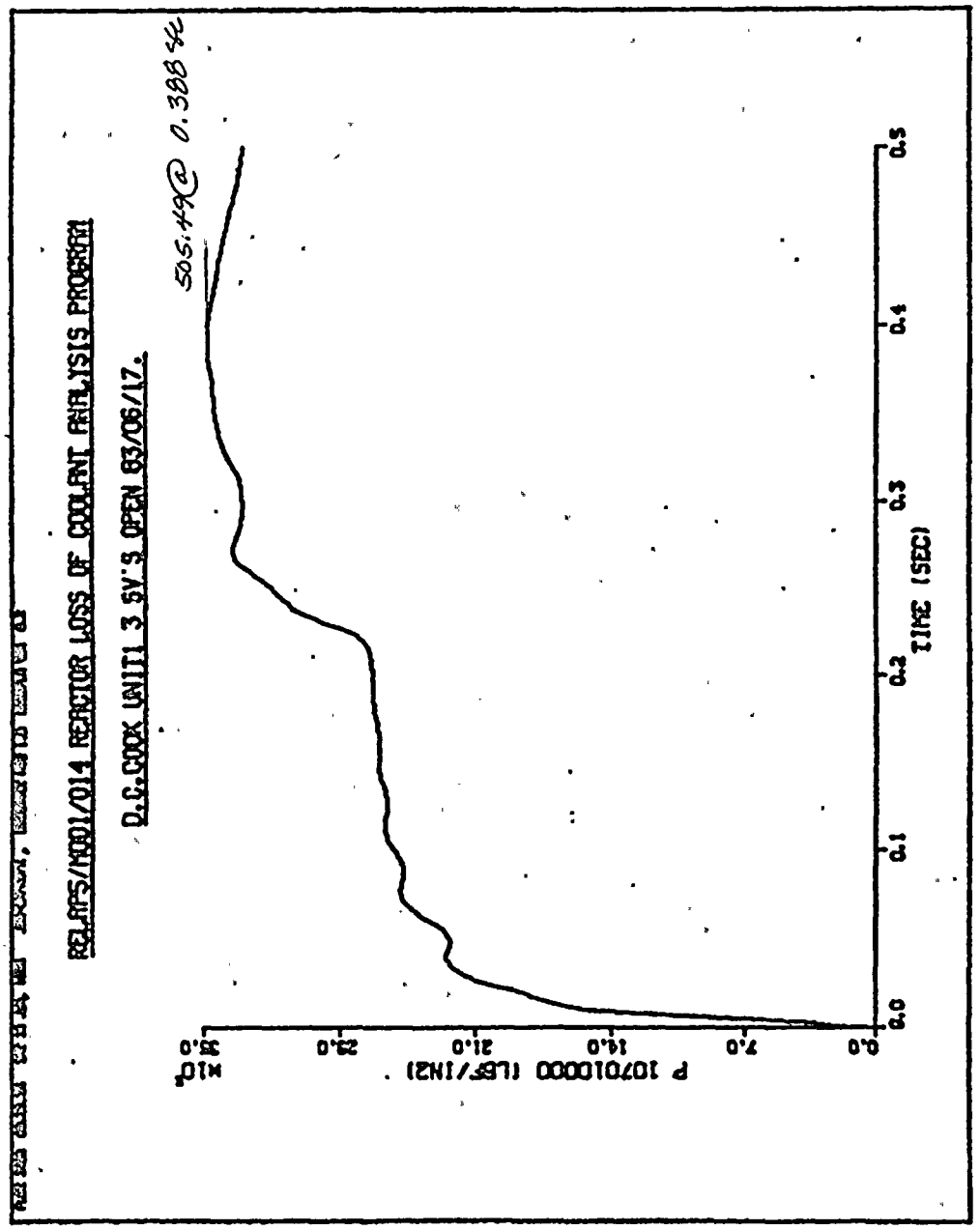
TELEDYNE
ENGINEERING SERVICES

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



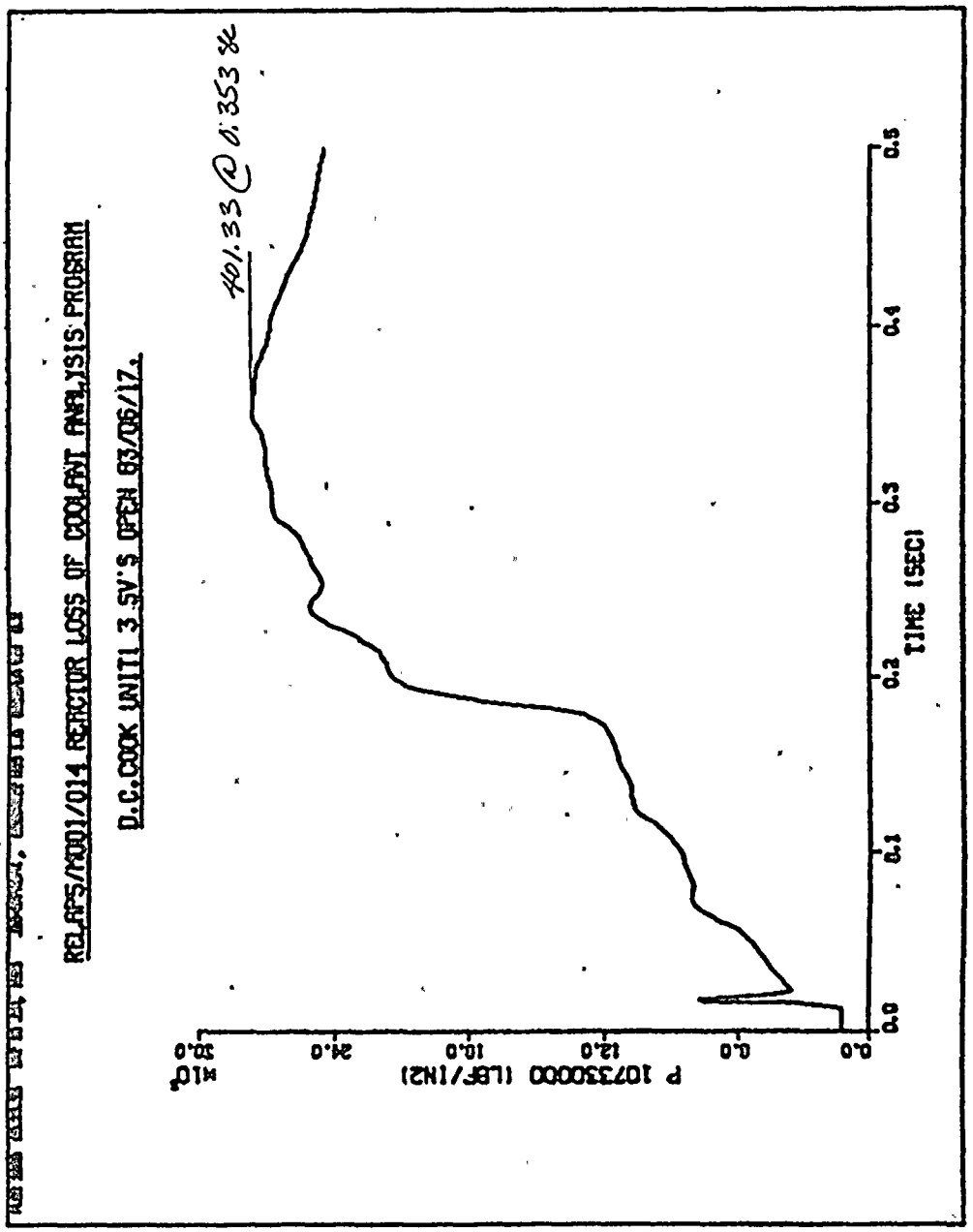
TELEDYNE
ENGINEERING SERVICES

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



TELEDYNE
ENGINEERING SERVICES

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



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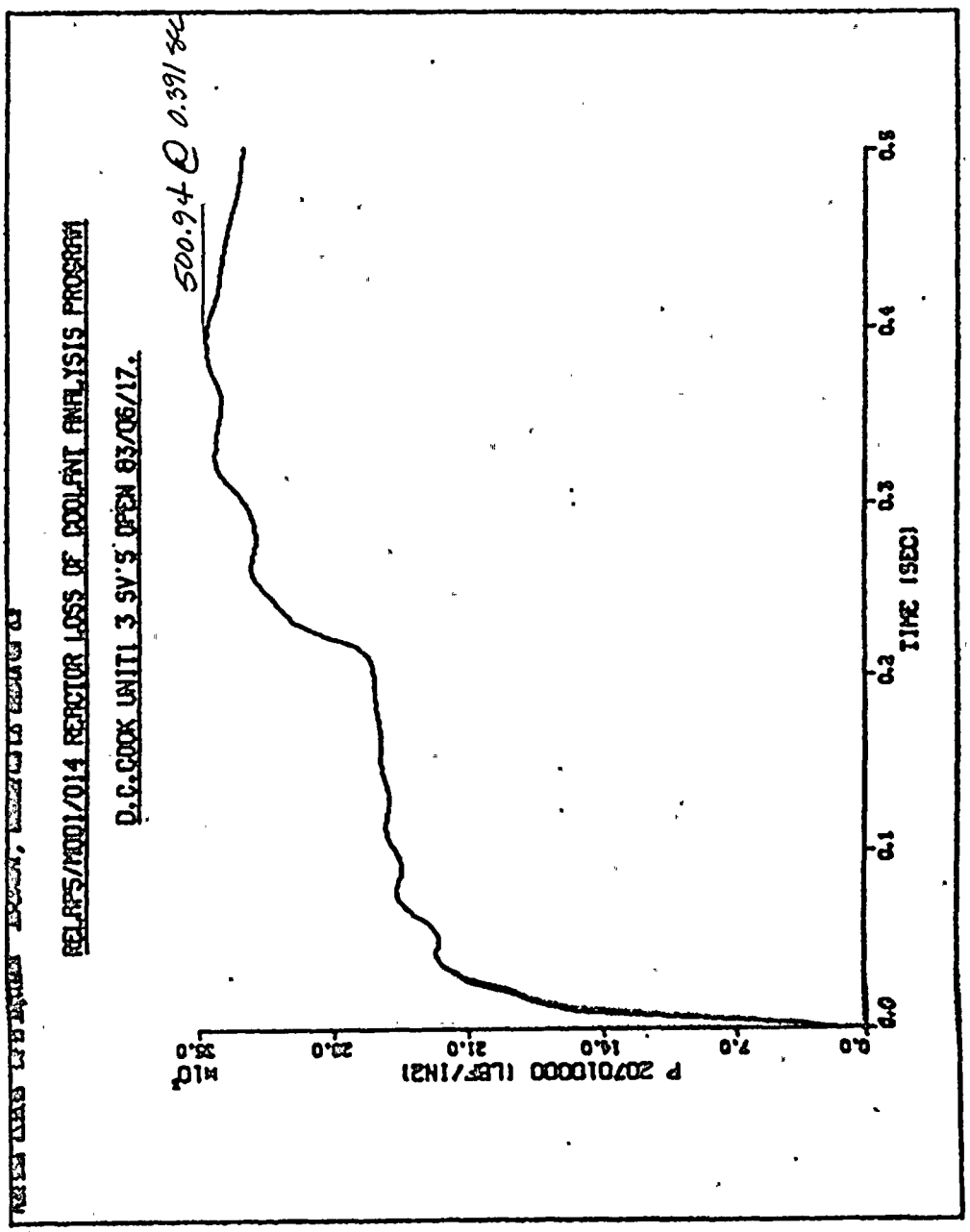
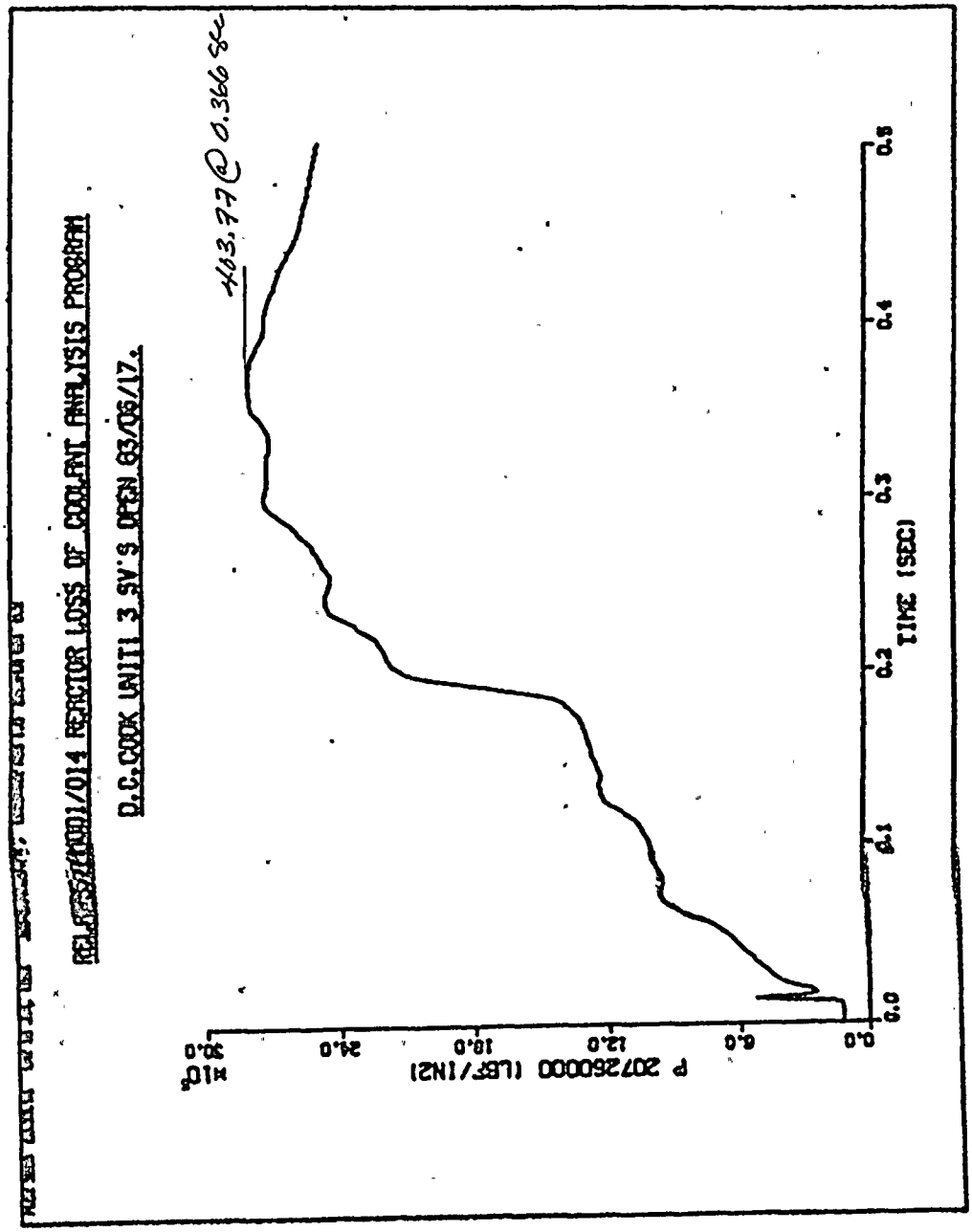
ENGINEERING SERVICES

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



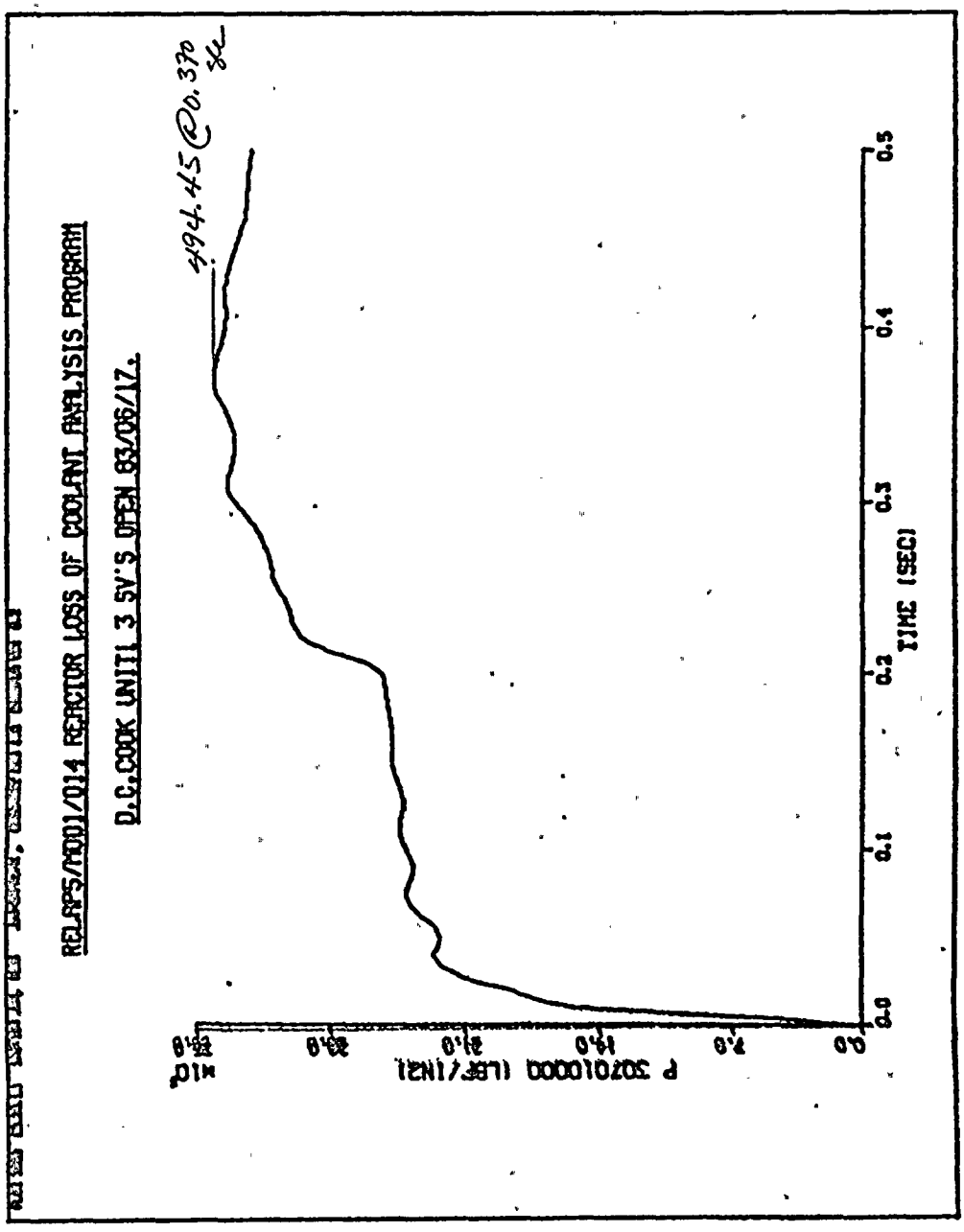
TELEDYNE
ENGINEERING SERVICES

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



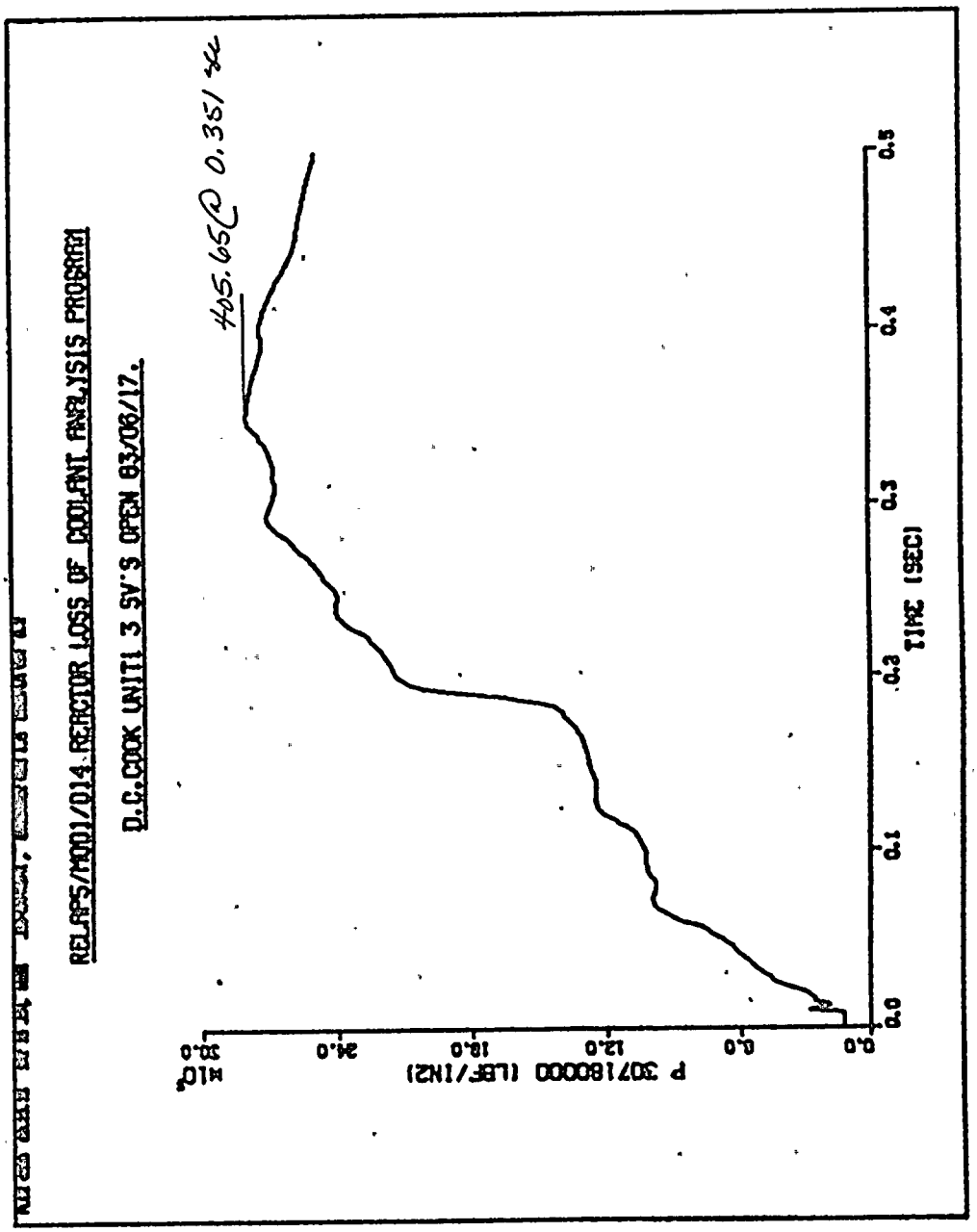
TELEDYNE ENGINEERING SERVICES

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



TELEDYNE
ENGINEERING SERVICES

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



4.6 Force Time History Plots

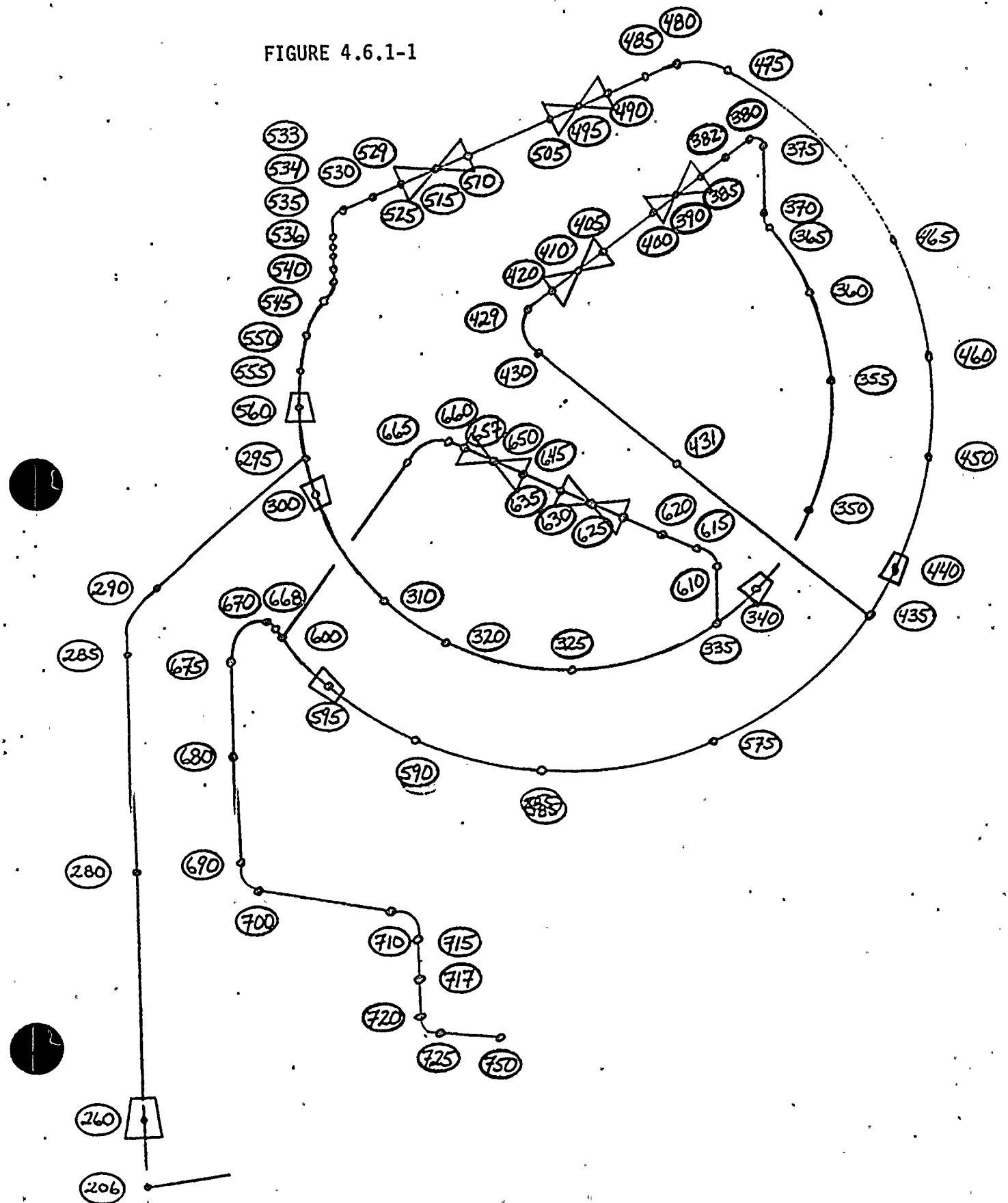
The following are force versus time plots for each pipe segment at a node point described by the structural model. A drawing indicating force placement precedes the set. Since the force time histories were plotted after balancing and merging(i.e. SAP2SAP and MERGE), each plot is unbalanced force versus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

BY [redacted] DATE 4/14/83
CHK'D BY LBS DATE 4-14-83

UNIT 1 STRUCTURAL NODE POINTS
PORV SECTION

SHEET NO. 1 OF 3
PROJ. NO. 5364

FIGURE 4.6.1-1

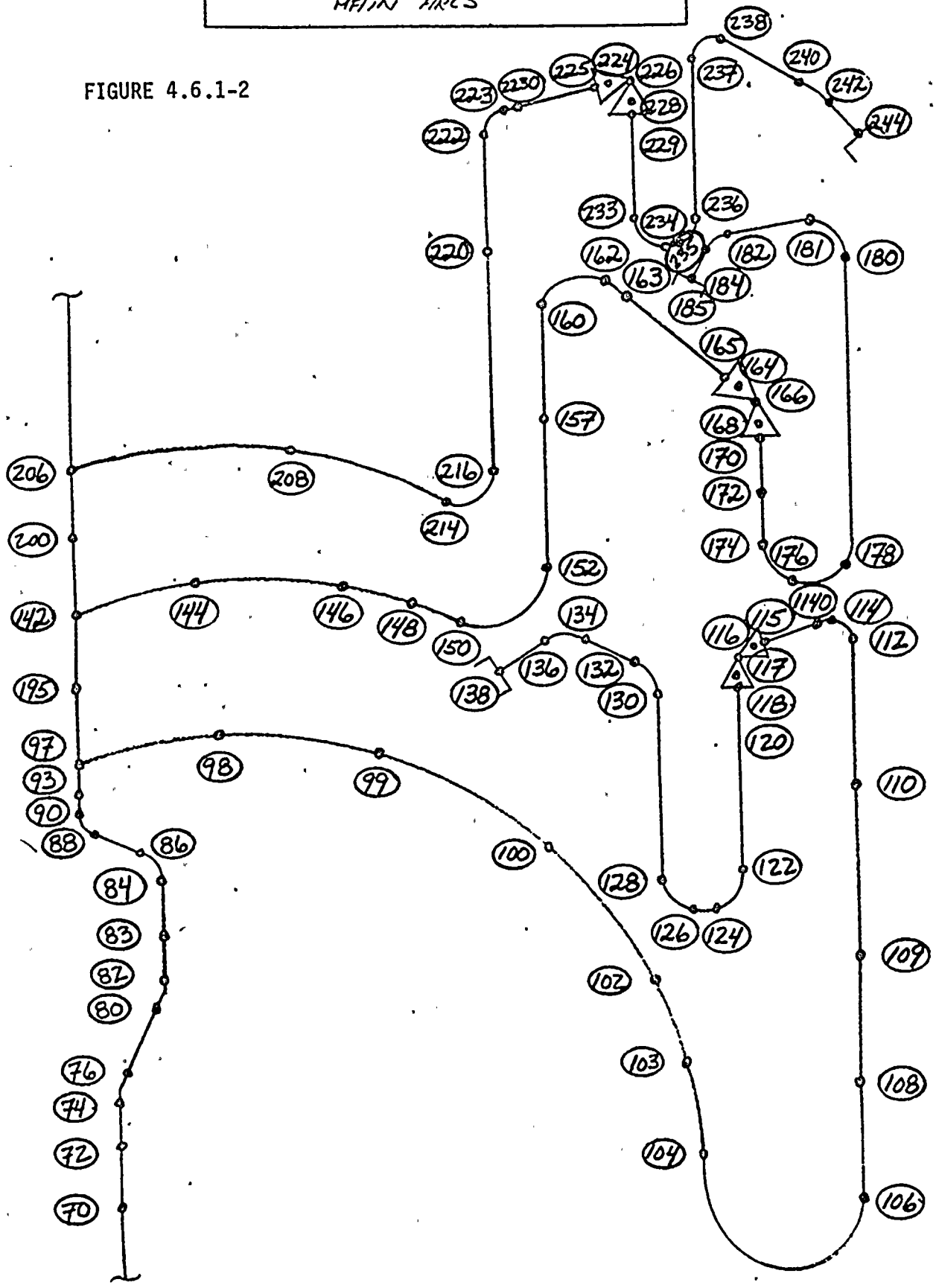


BY M DATE 4-14-83
CHK LBS DATE 4-14-83

UNIT 1 STRUCTURAL NODES POINTS
MAIN ARCS

SHEET NO. 2 OF 3
PROJ. NO. 5364

FIGURE 4.6.1-2

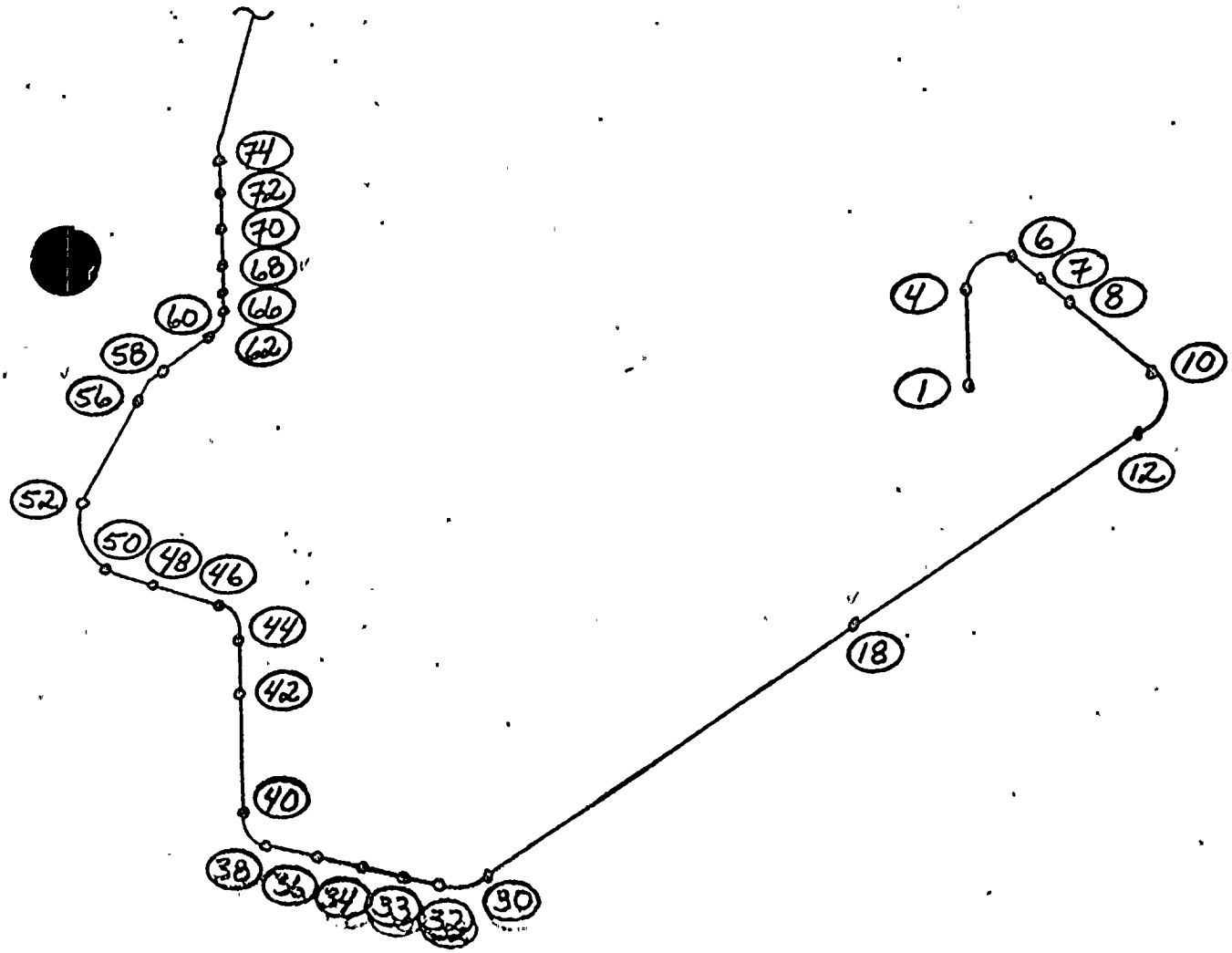


BY [redacted] DATE 4.14.83
CHI LBS DATE 4-14-83

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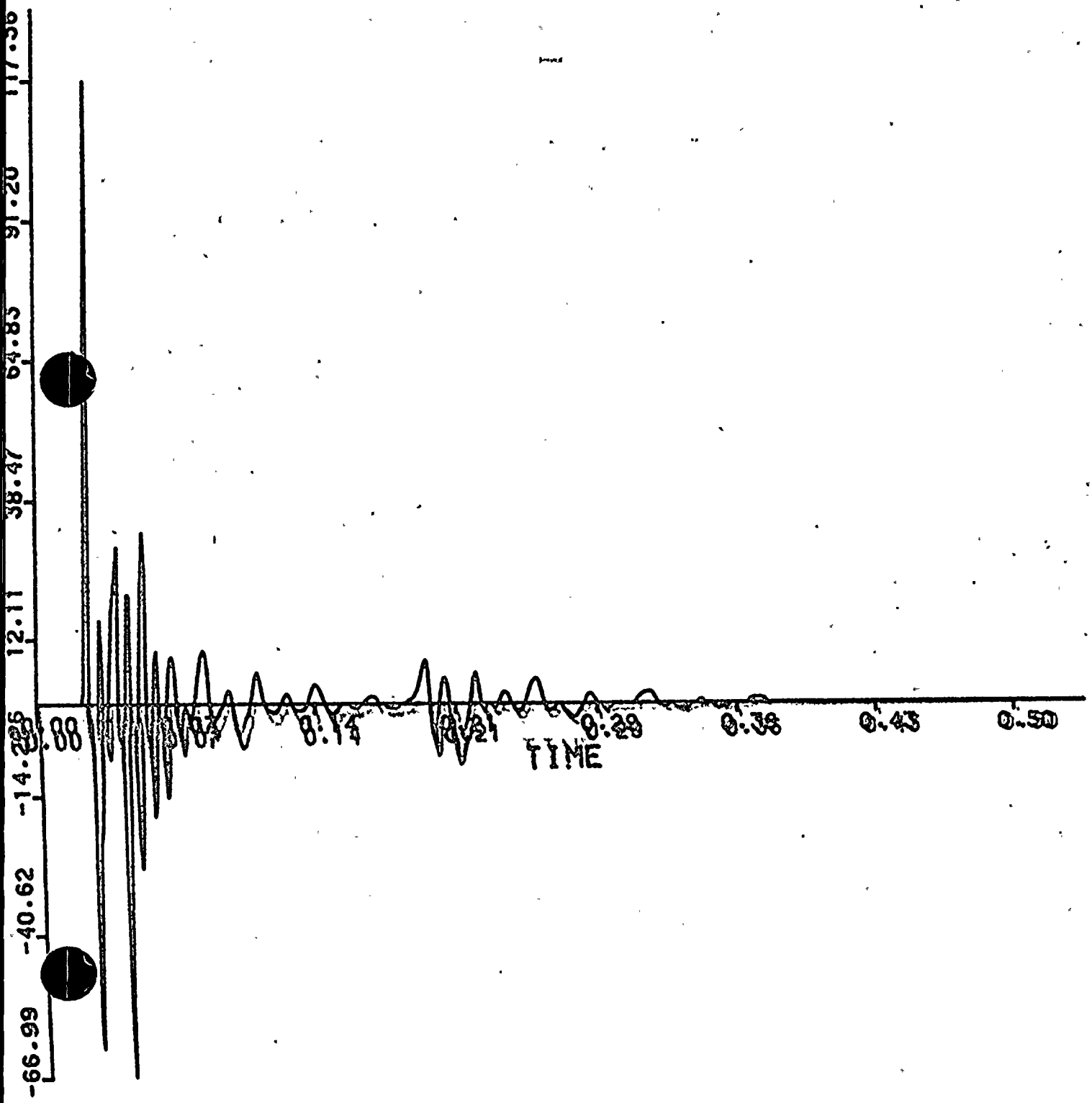
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 1, MAGNITUDE AT NODE POINT 620



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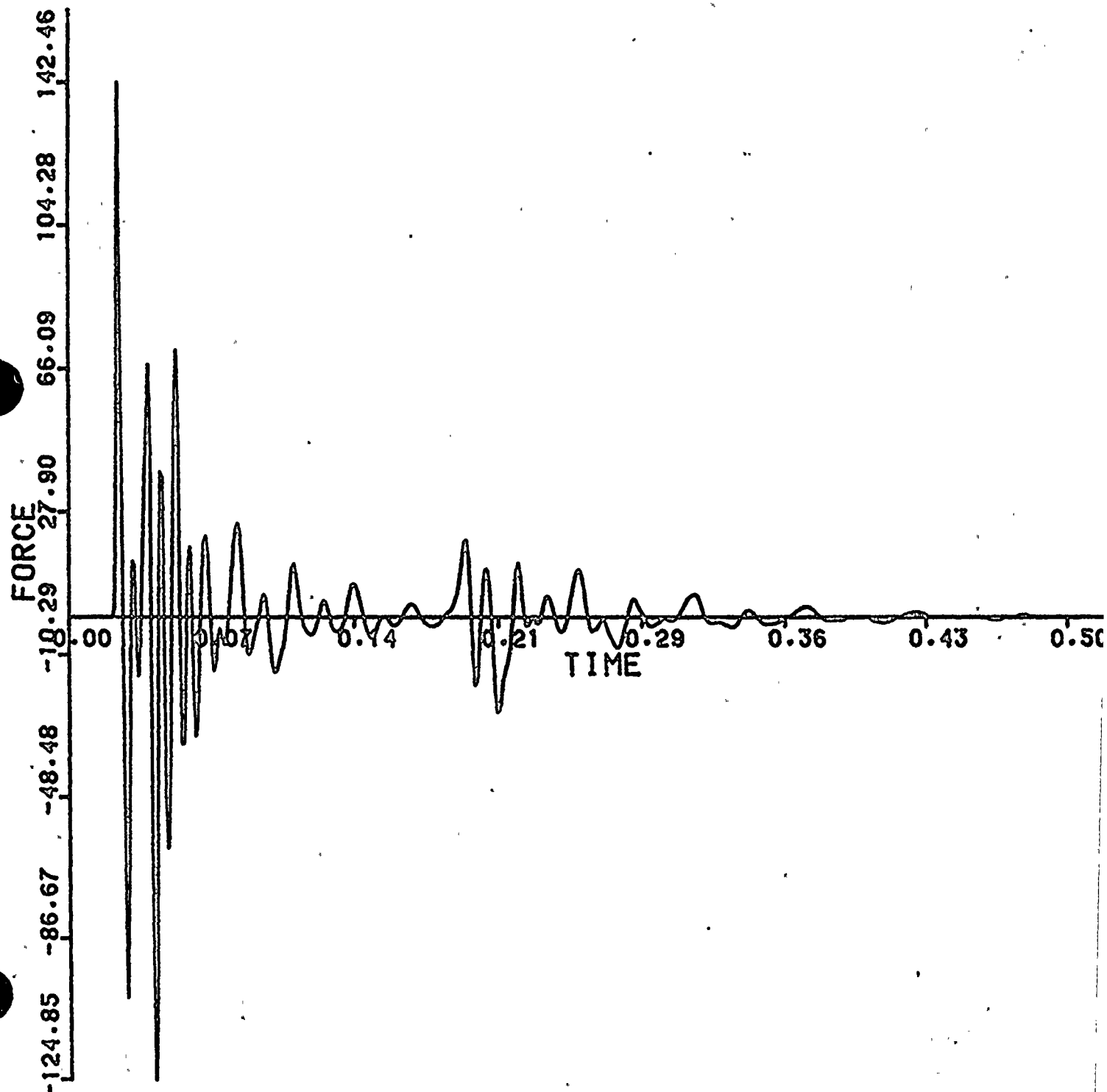
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 2. MAGNITUDE AT NODE POINT 610



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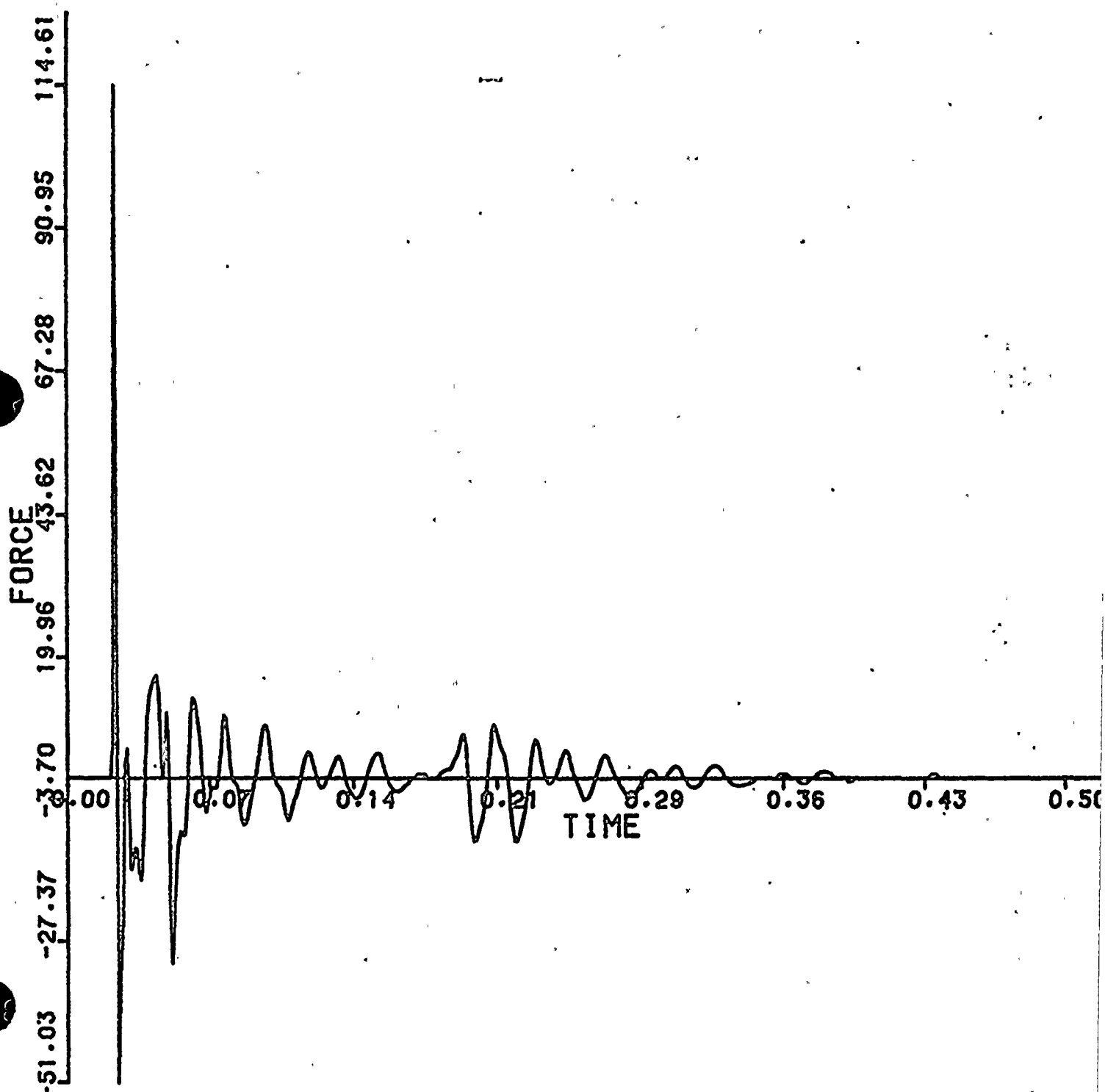
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1. SV MODIFICATION
TIME/FORCE TABLE 3. MAGNITUDE AT NODE POINT 529



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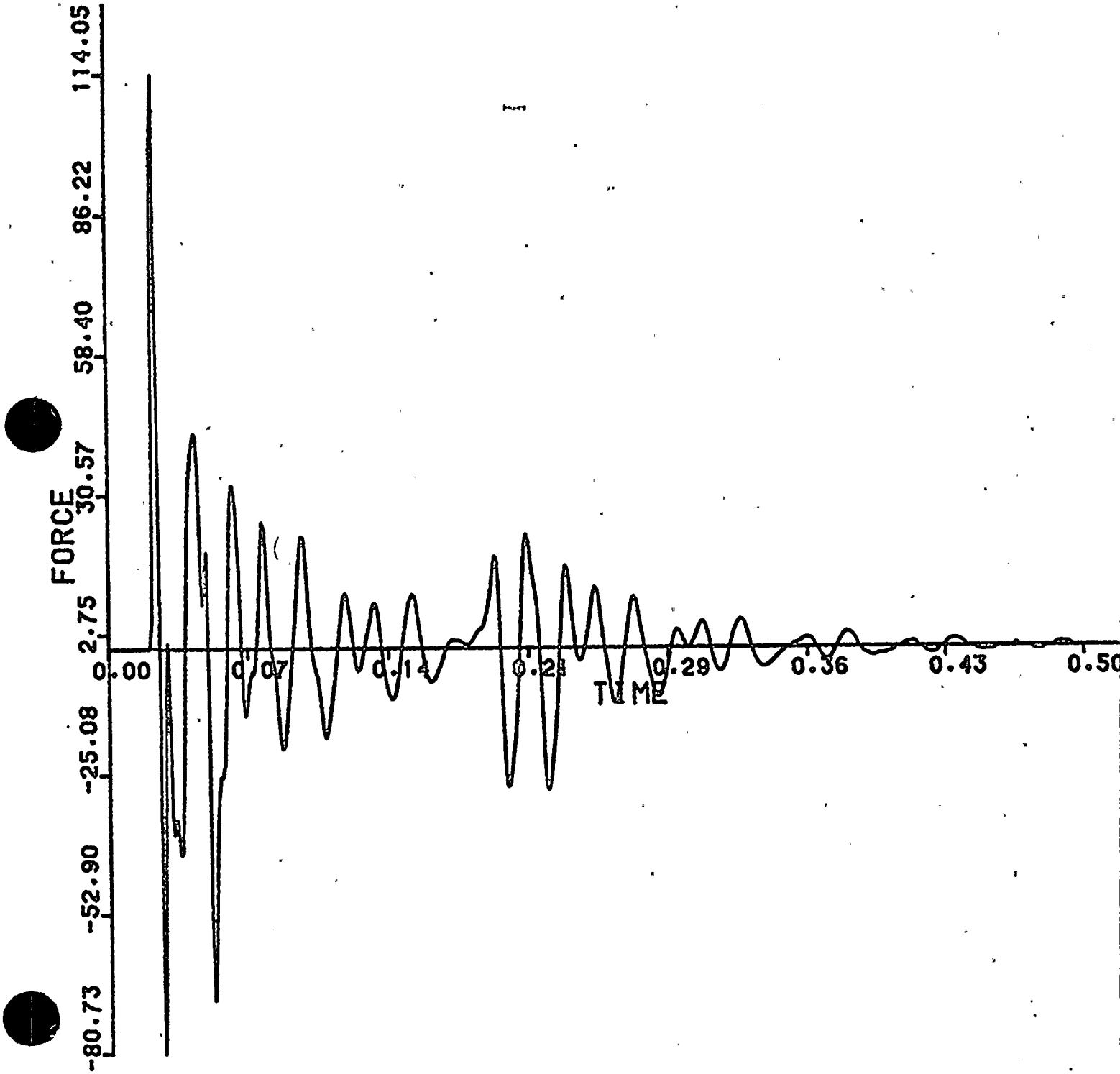
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 4, MAGNITUDE AT NODE POINT 536



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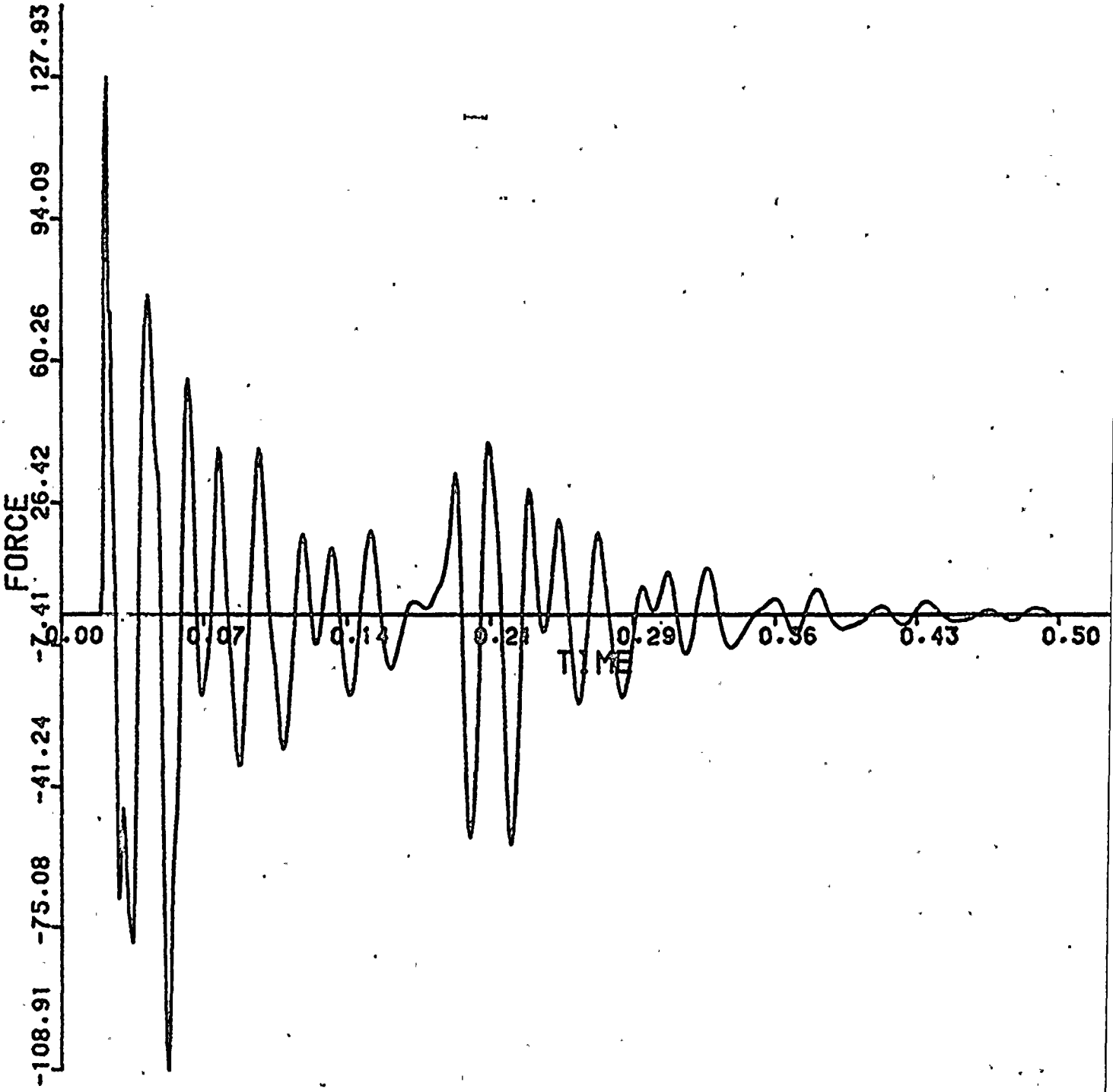
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 5, MAGNITUDE AT NODE POINT 545



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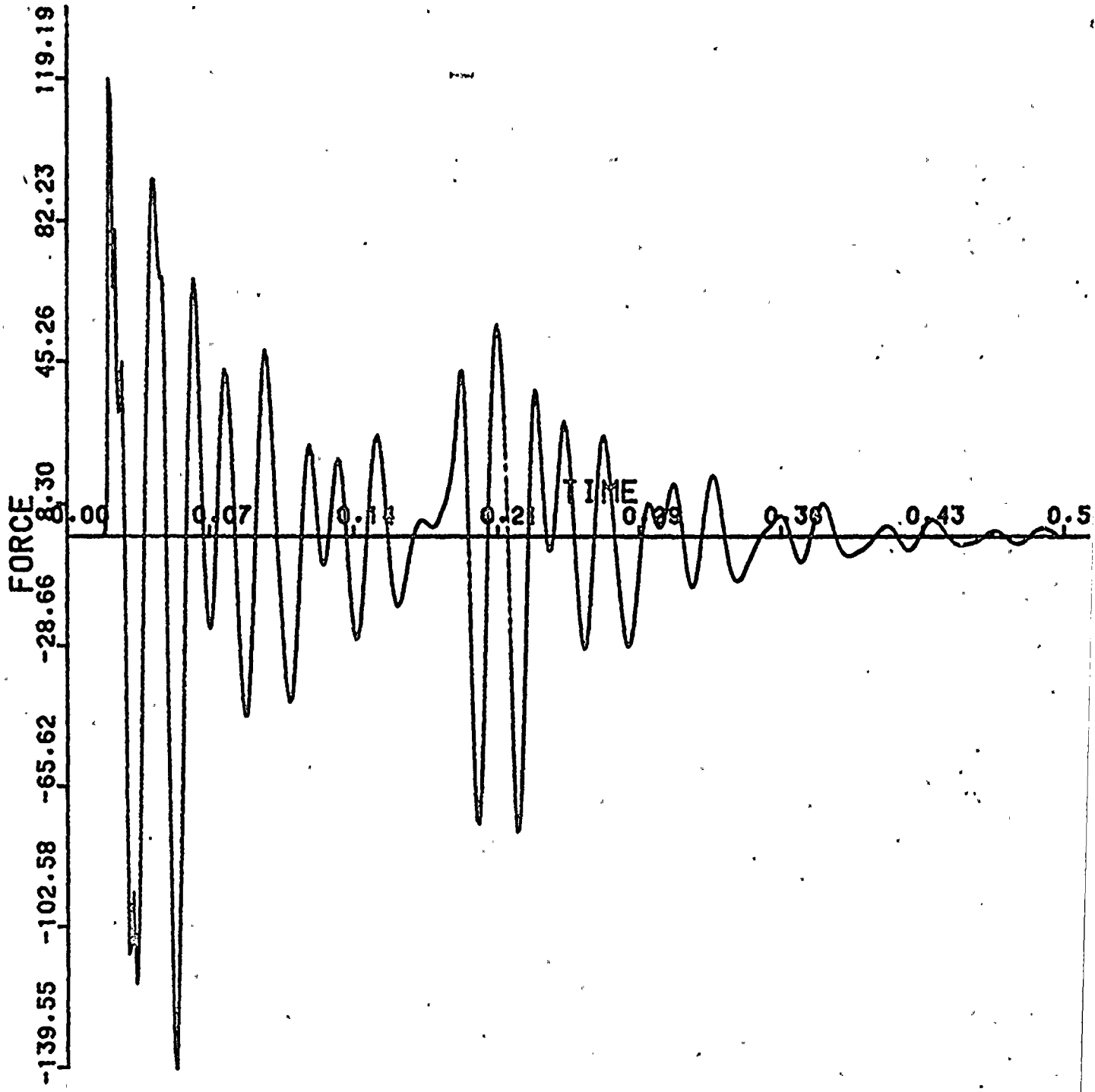
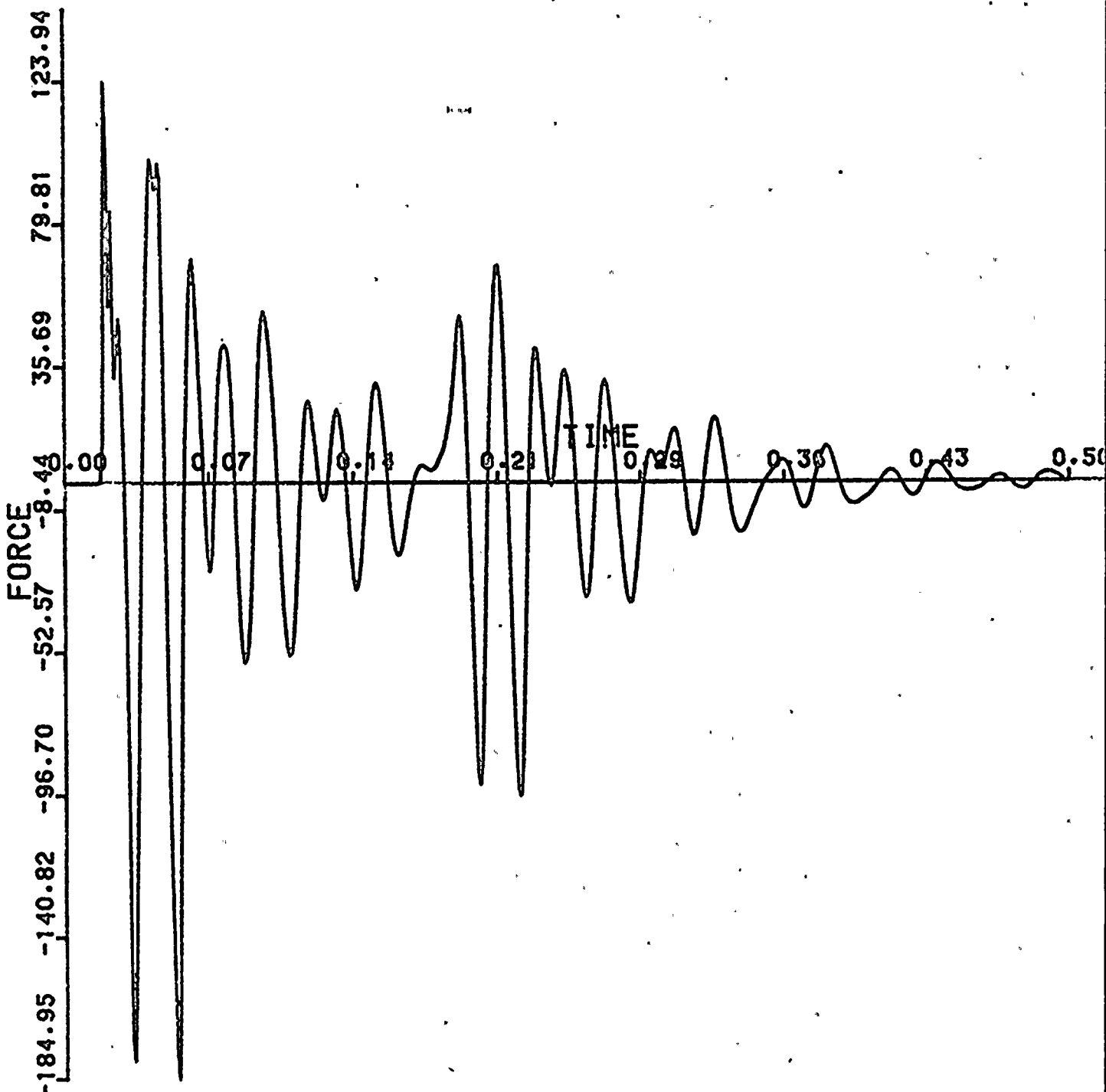
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1. SV MODIFICATION
TIME/FORCE TABLE 6. MAGNITUDE AT NODE POINT 550



SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 7, MAGNITUDE AT NODE POINT 555



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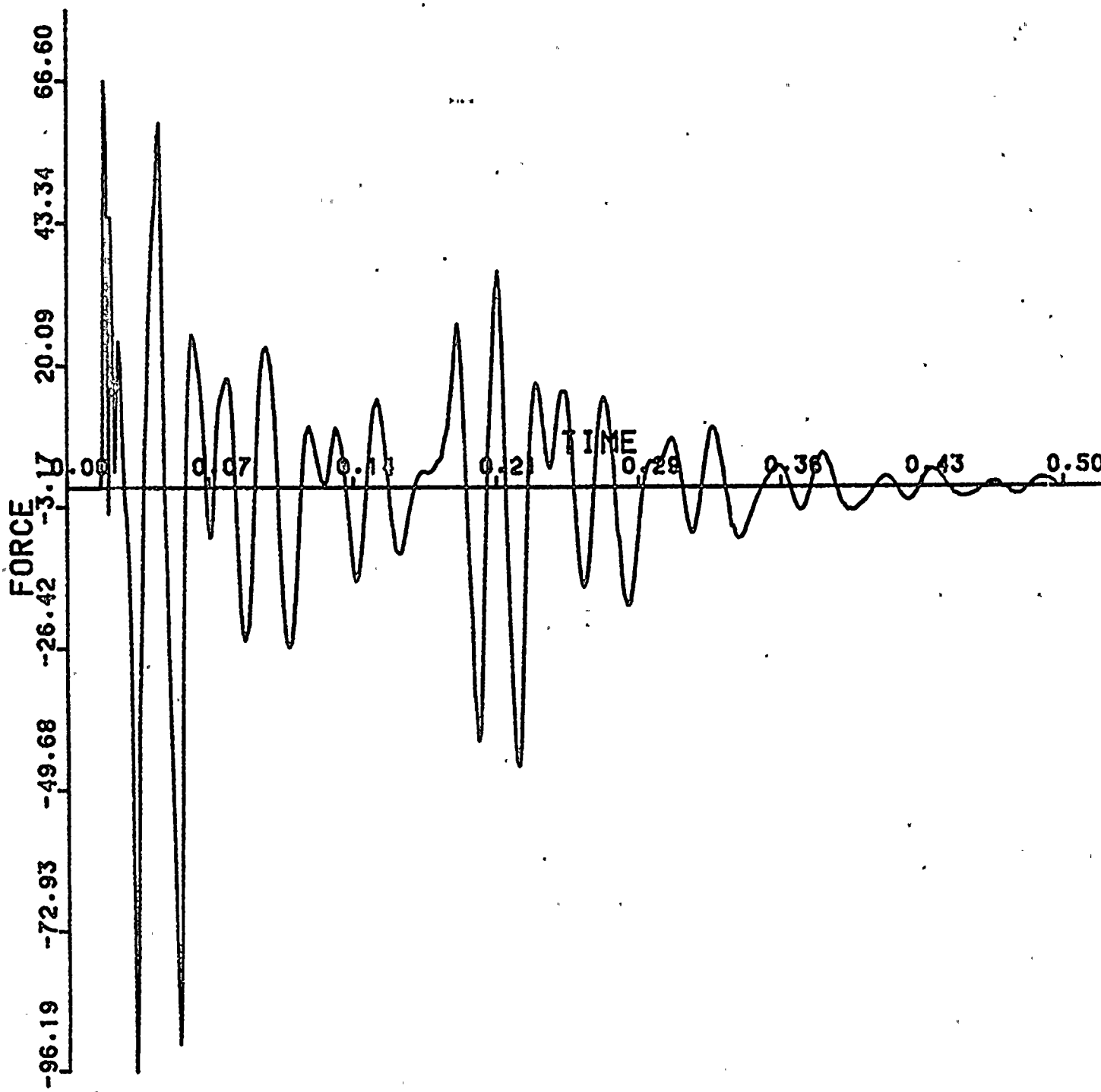
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 8, MAGNITUDE AT NODE POINT 560



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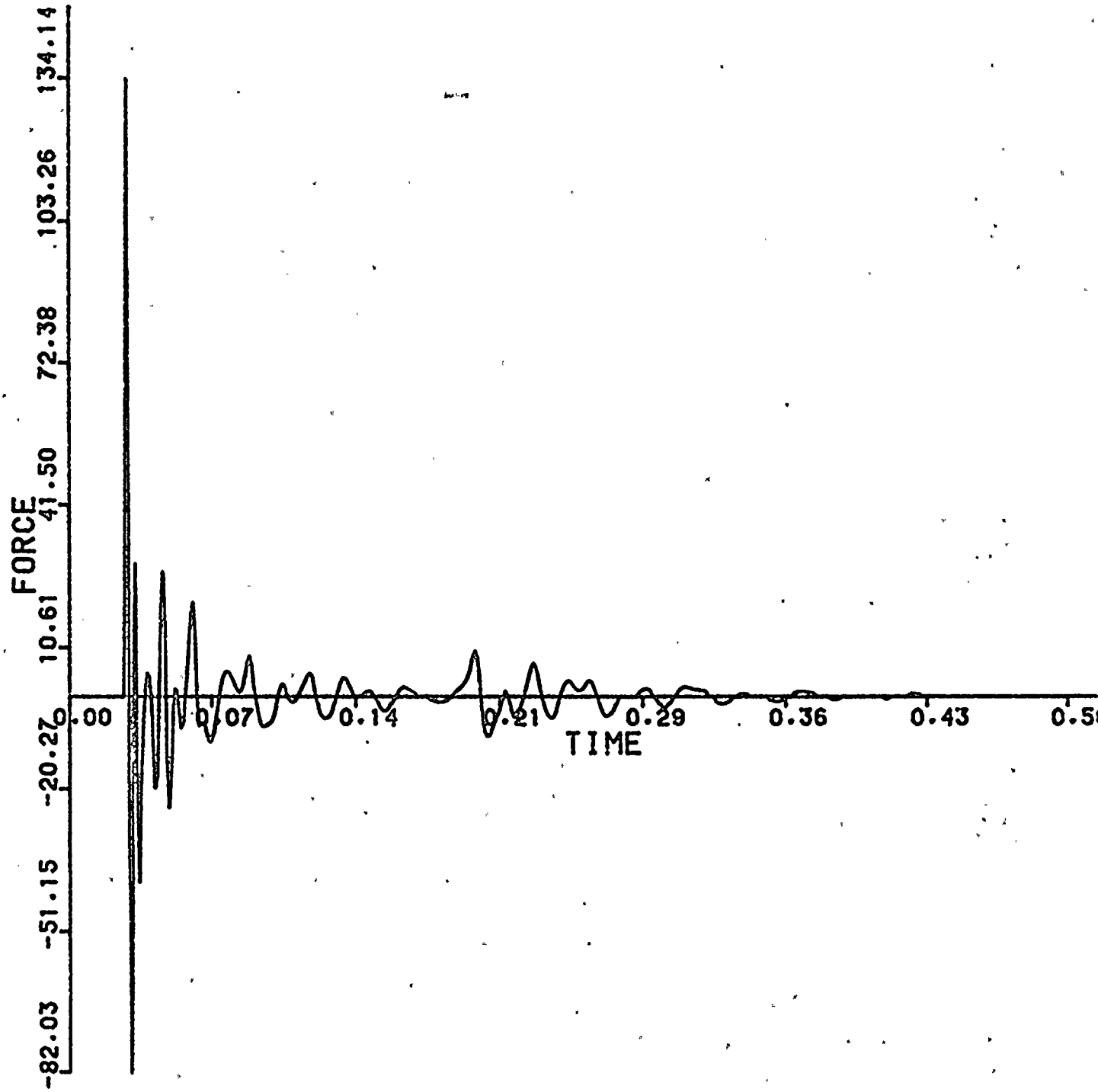
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1. SV MODIFICATION
TIME/FORCE TABLE 9. MAGNITUDE AT NODE POINT 382



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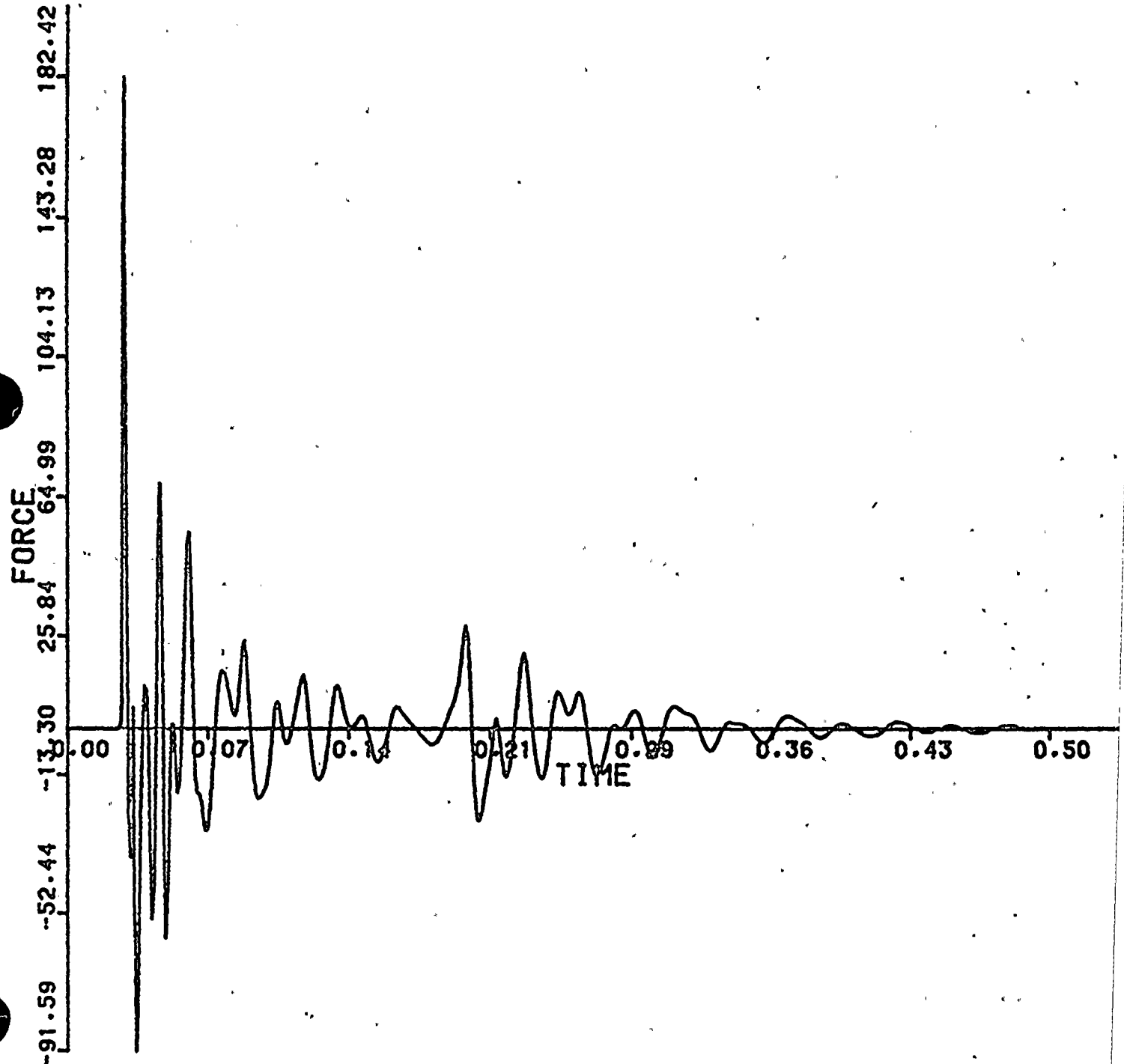
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 10, MAGNITUDE AT NODE POINT 375



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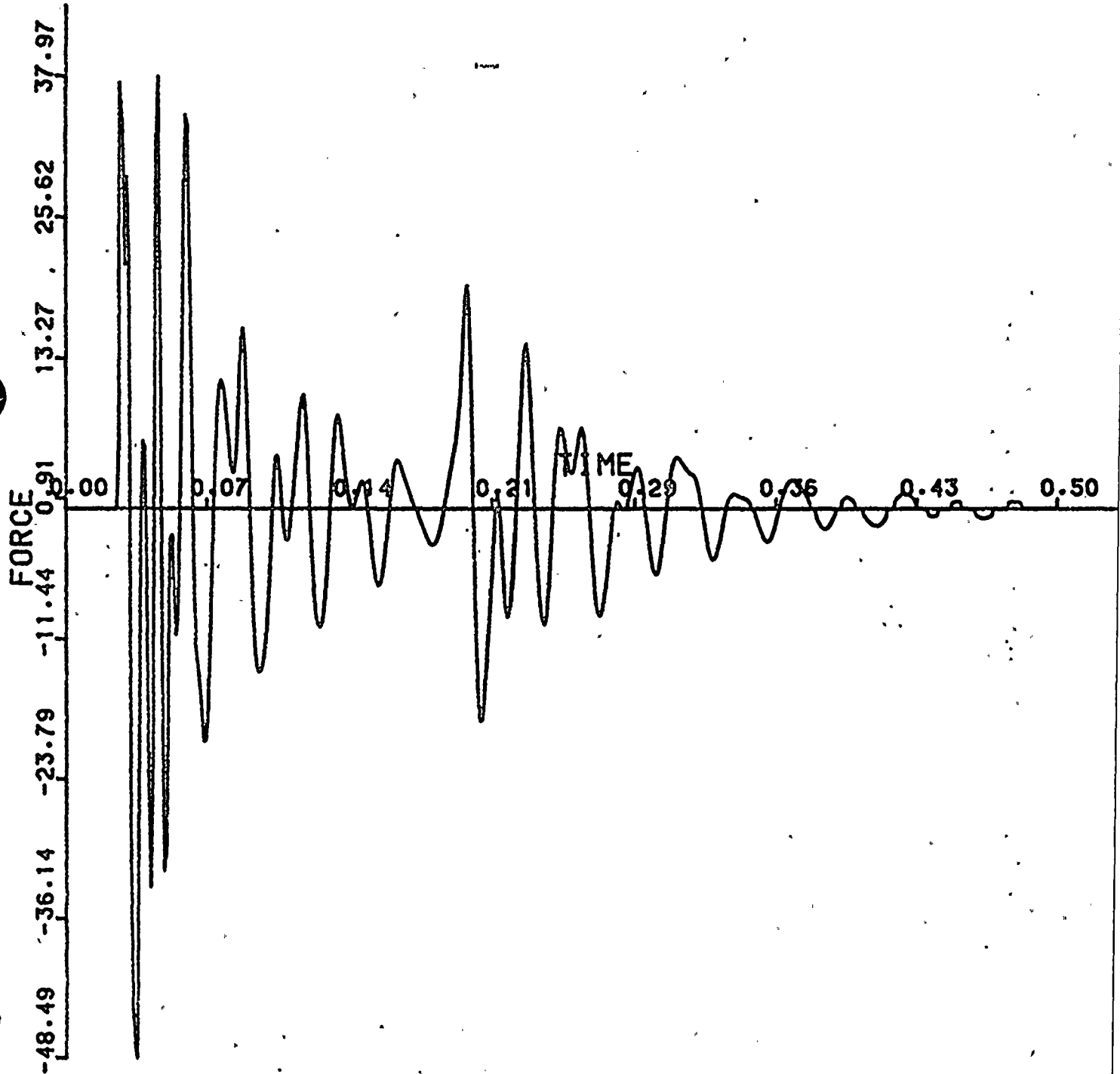
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 11, MAGNITUDE AT NODE POINT 365



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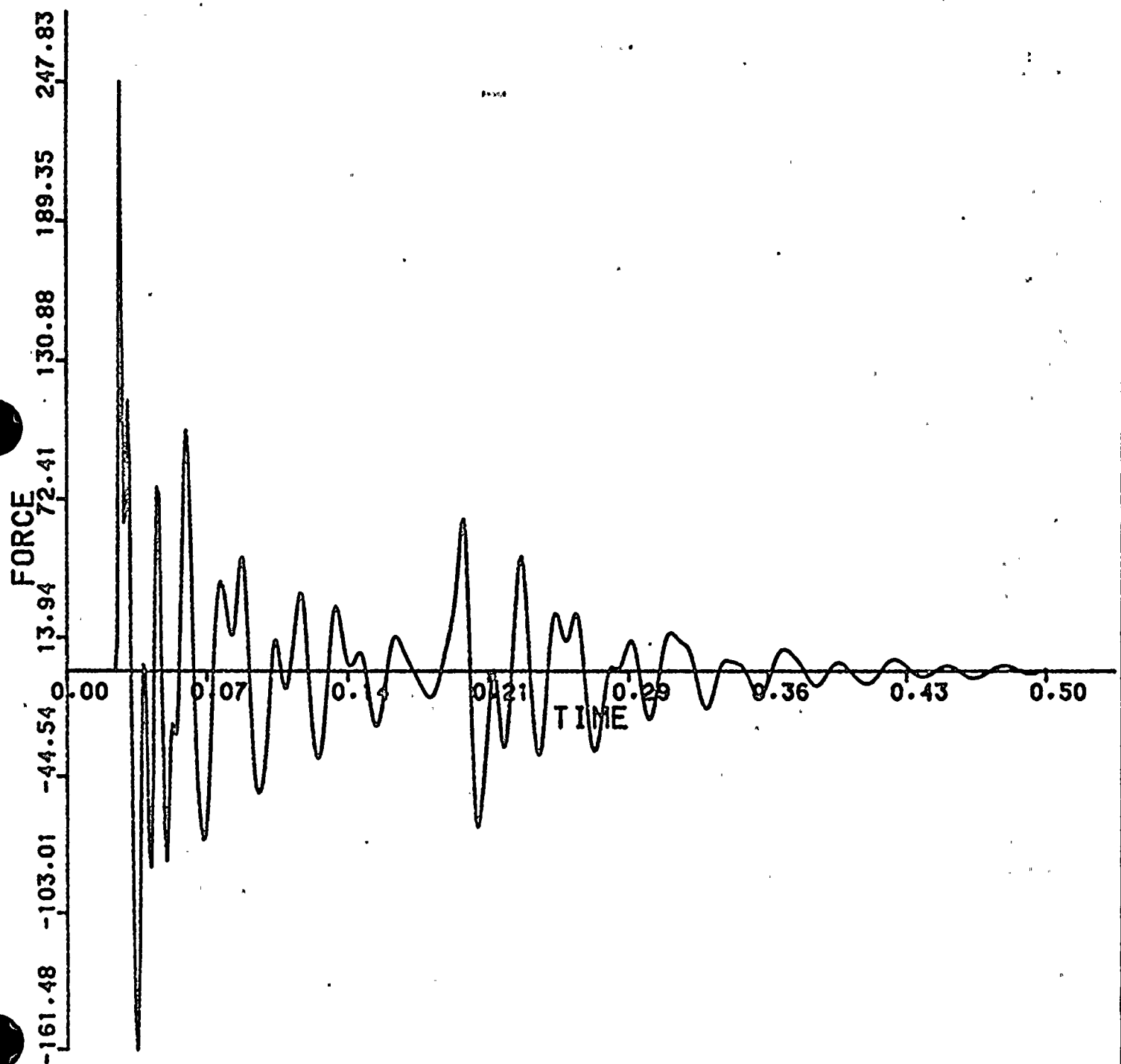
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 12, MAGNITUDE AT NODE POINT 360



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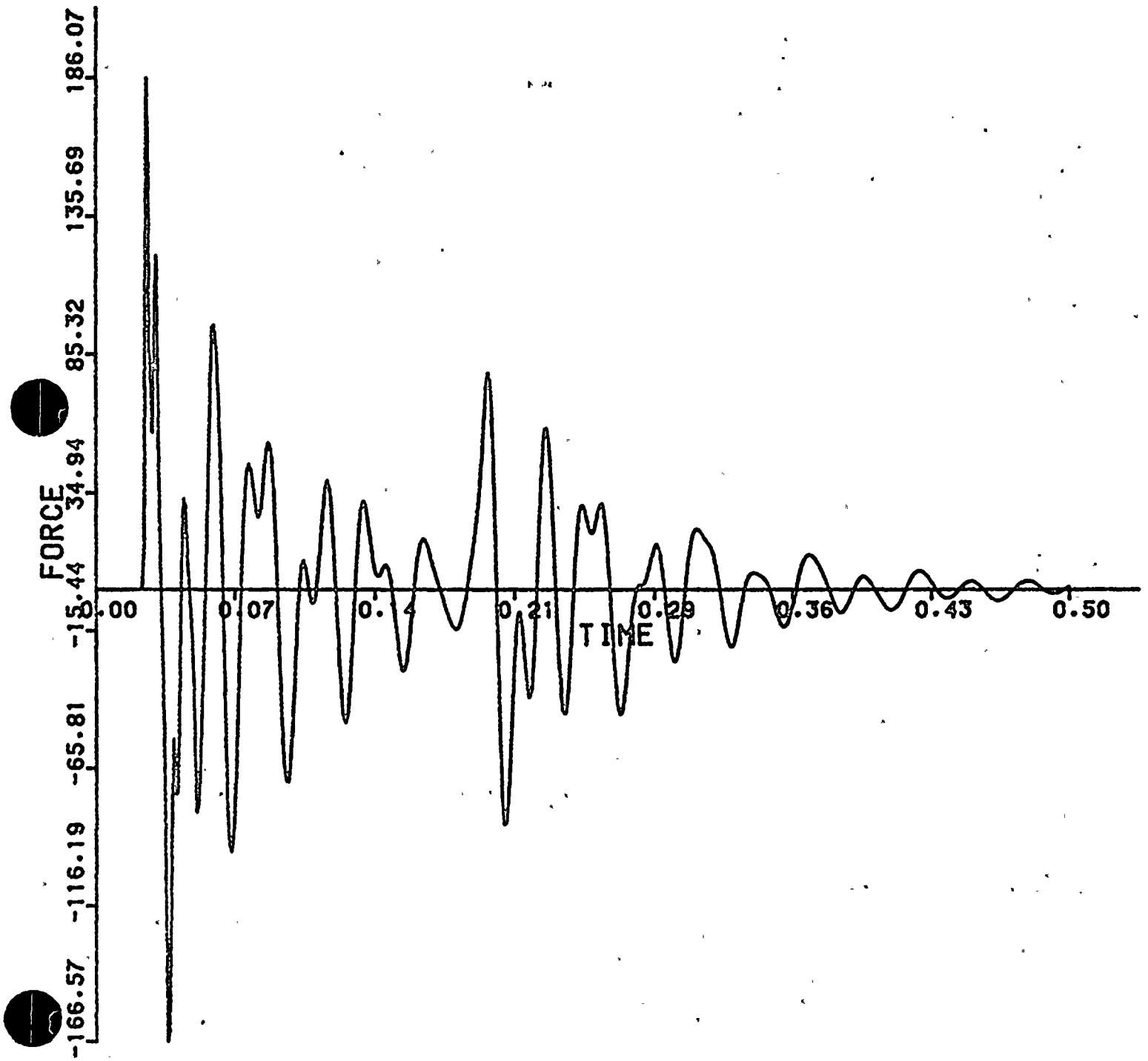
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 13, MAGNITUDE AT NODE POINT 355



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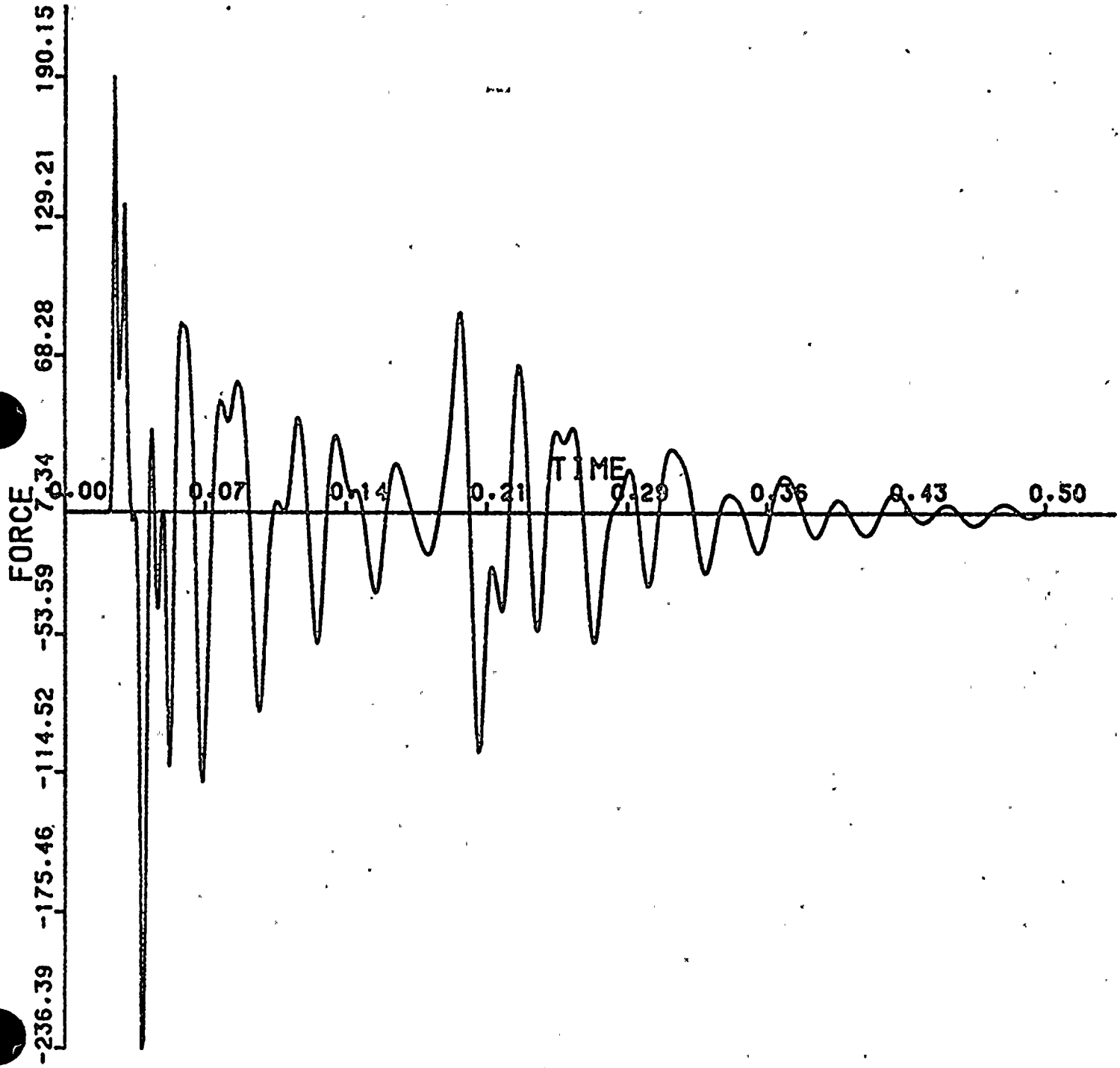
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1. SV MODIFICATION
TIME/FORCE TABLE 14. MAGNITUDE AT NODE POINT 350



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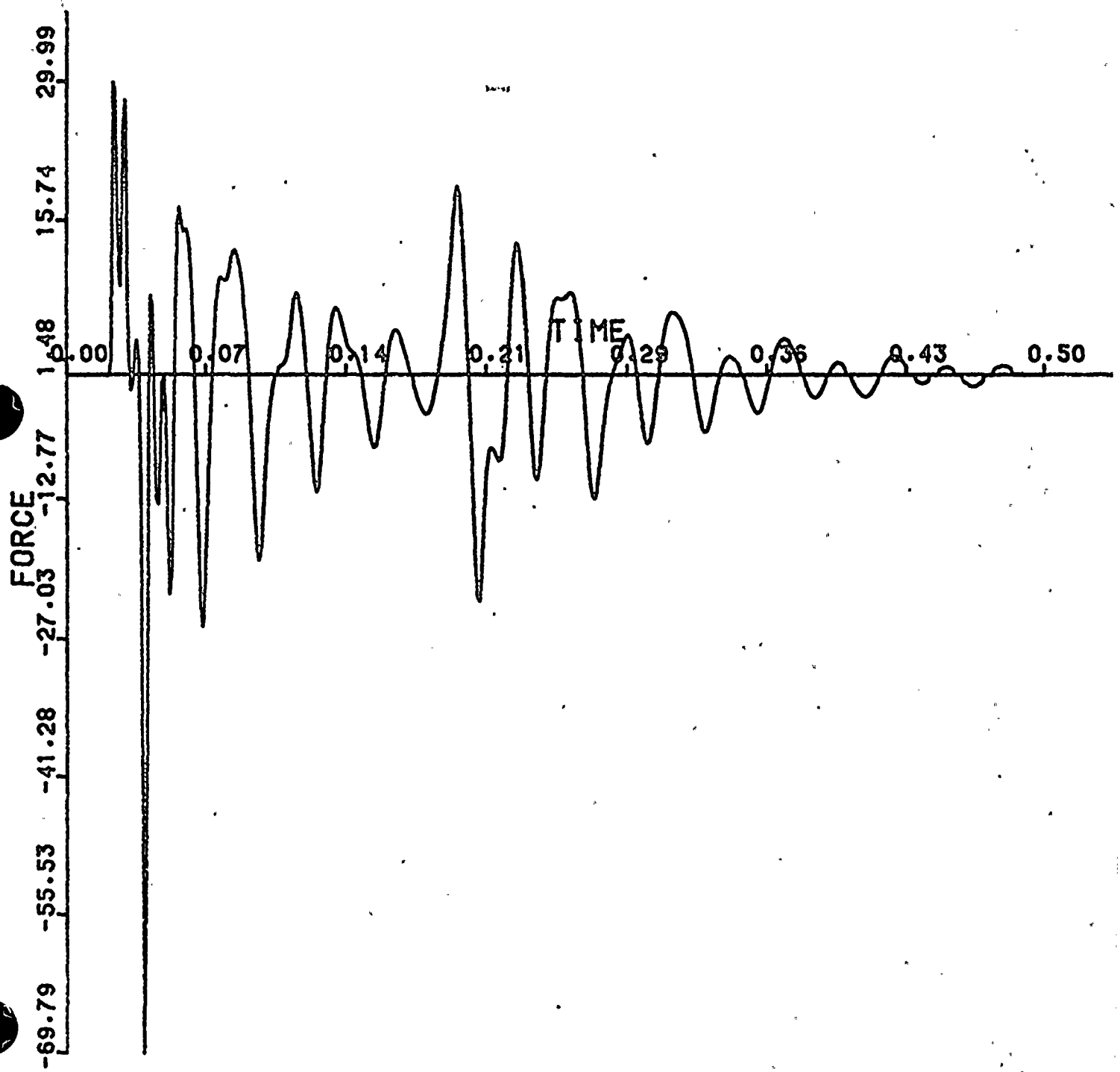
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 15, MAGNITUDE AT NODE POINT 340



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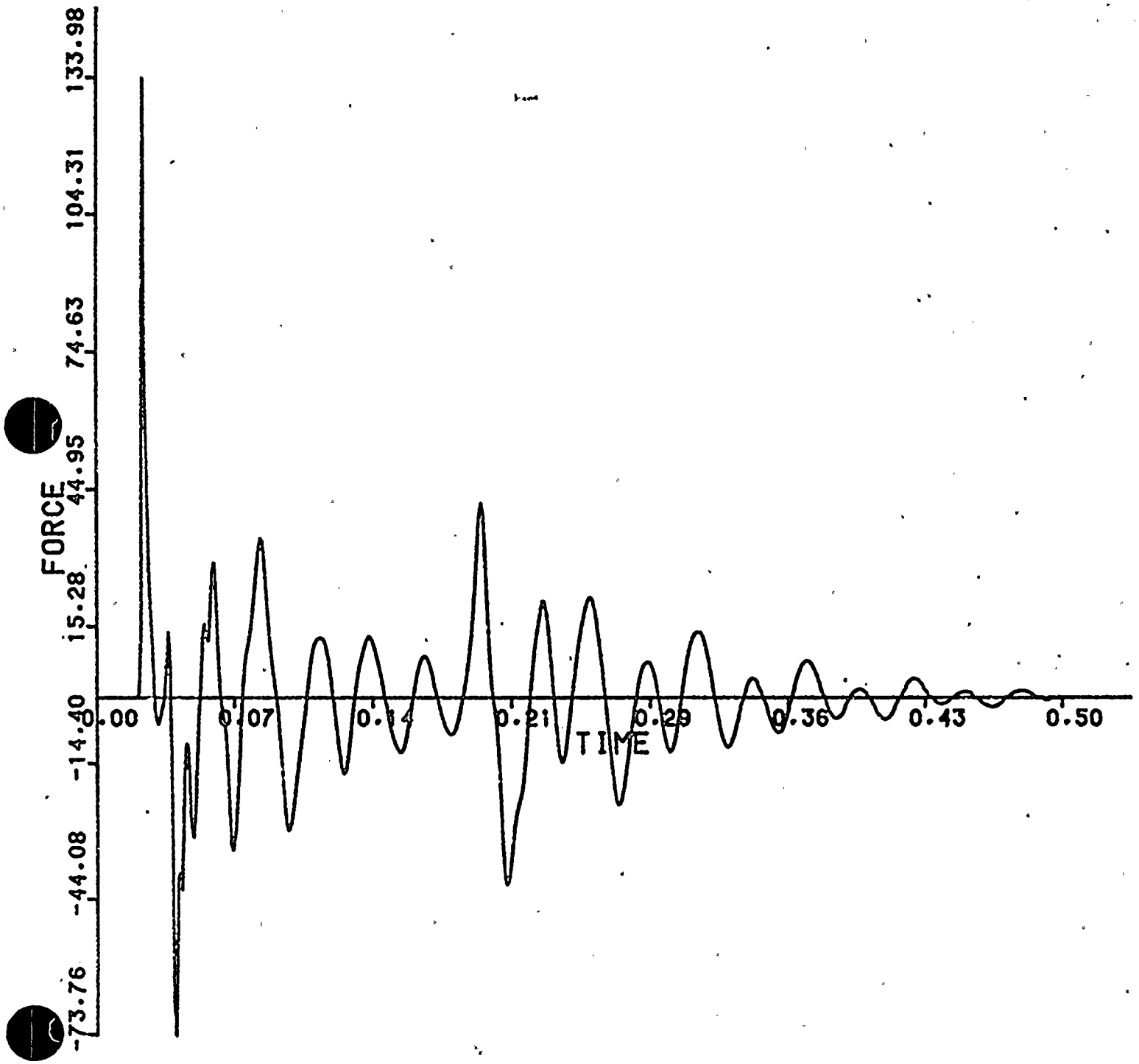
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 16. MAGNITUDE AT NODE POINT 335



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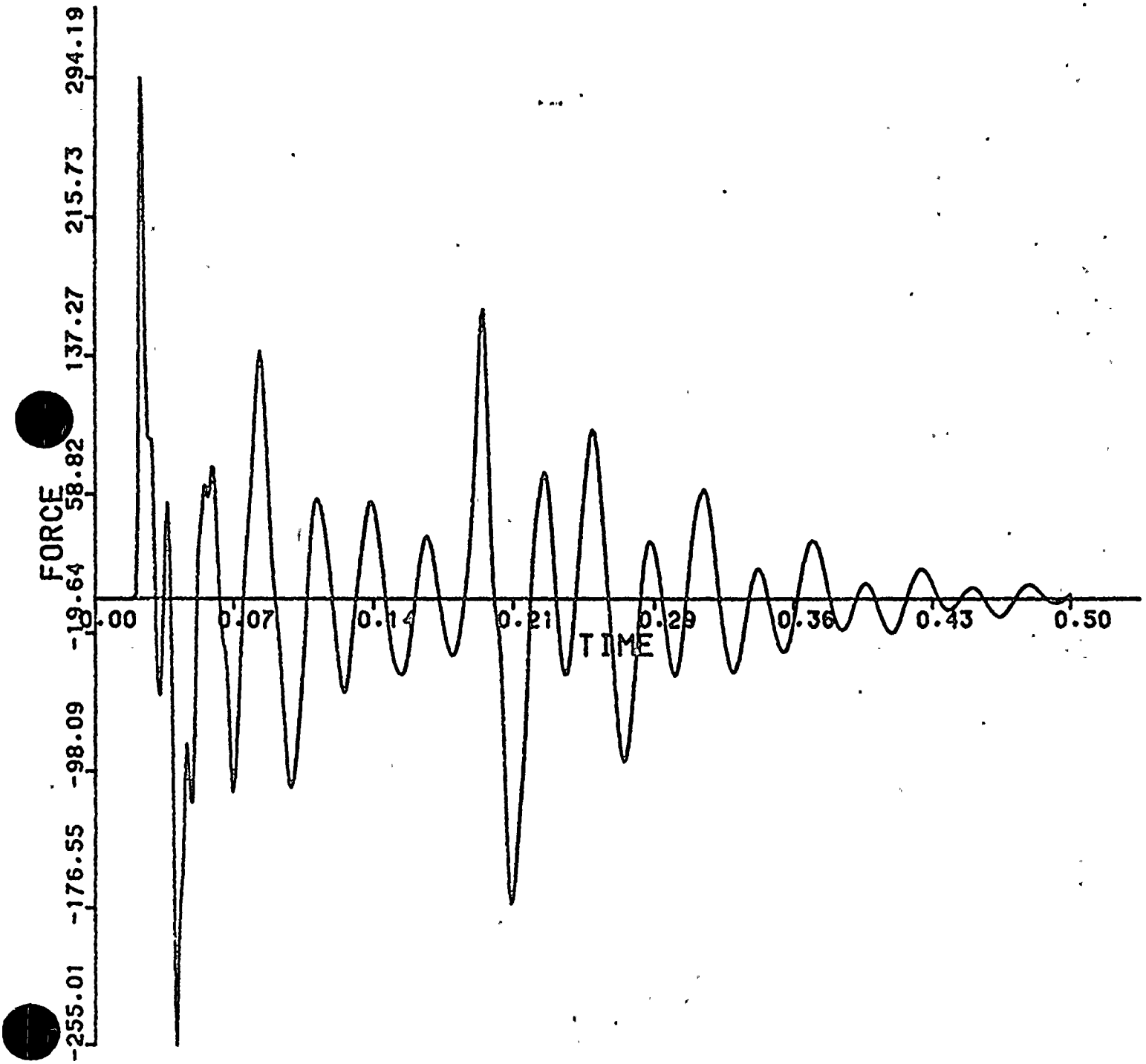
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 17. MAGNITUDE AT NODE POINT 325



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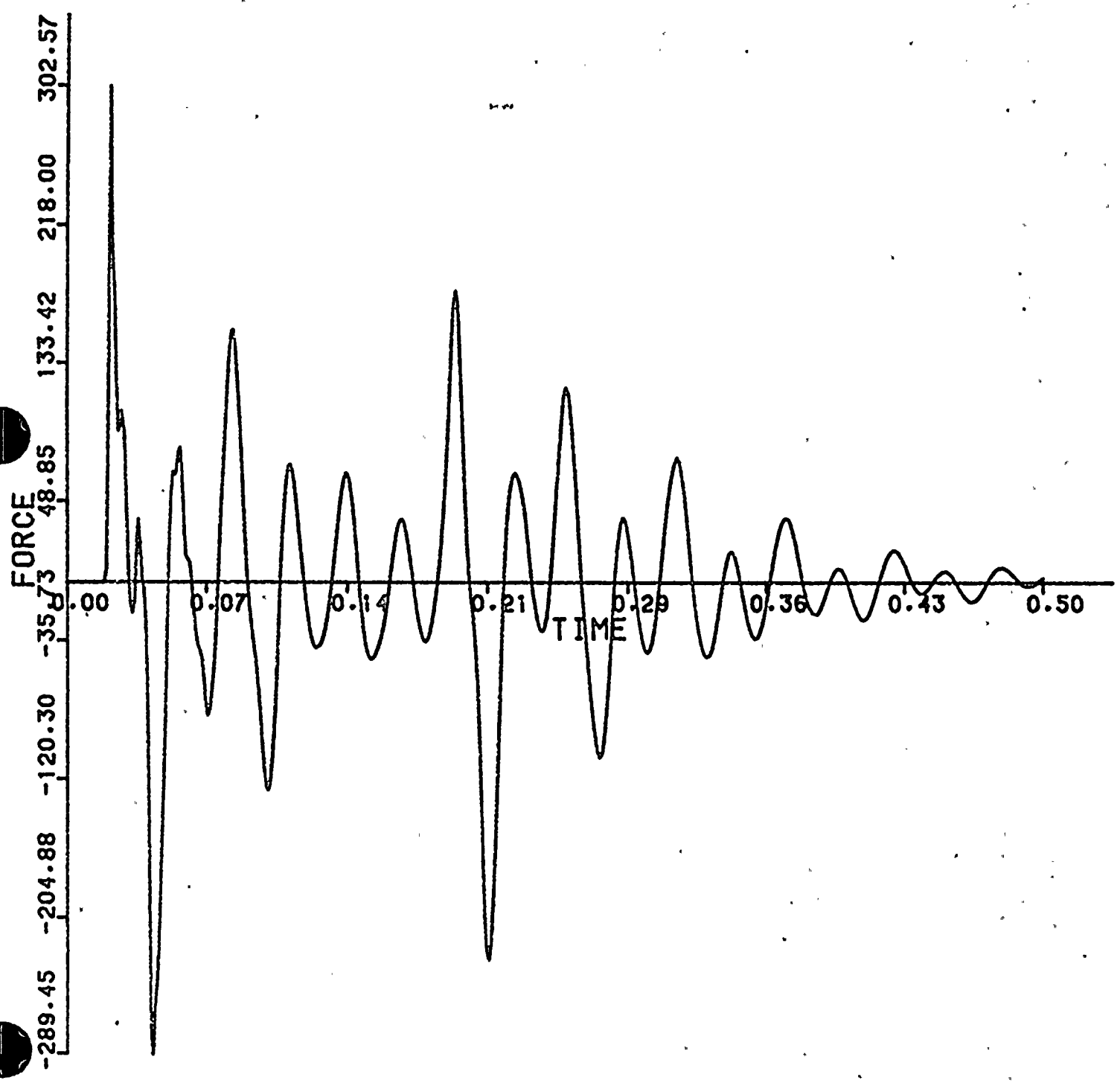
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 18, MAGNITUDE AT NODE POINT 320



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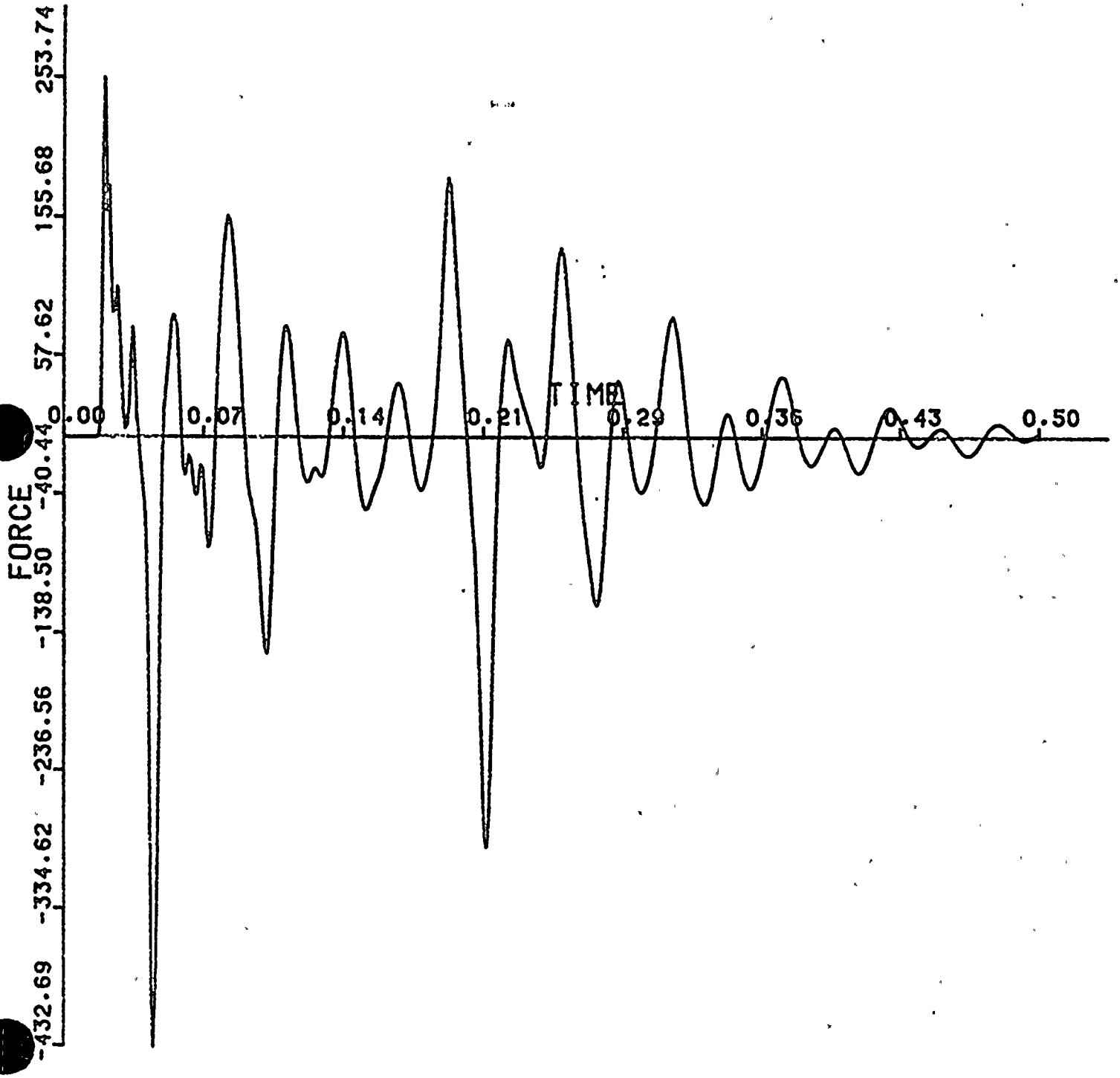
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 19, MAGNITUDE AT NODE POINT 310



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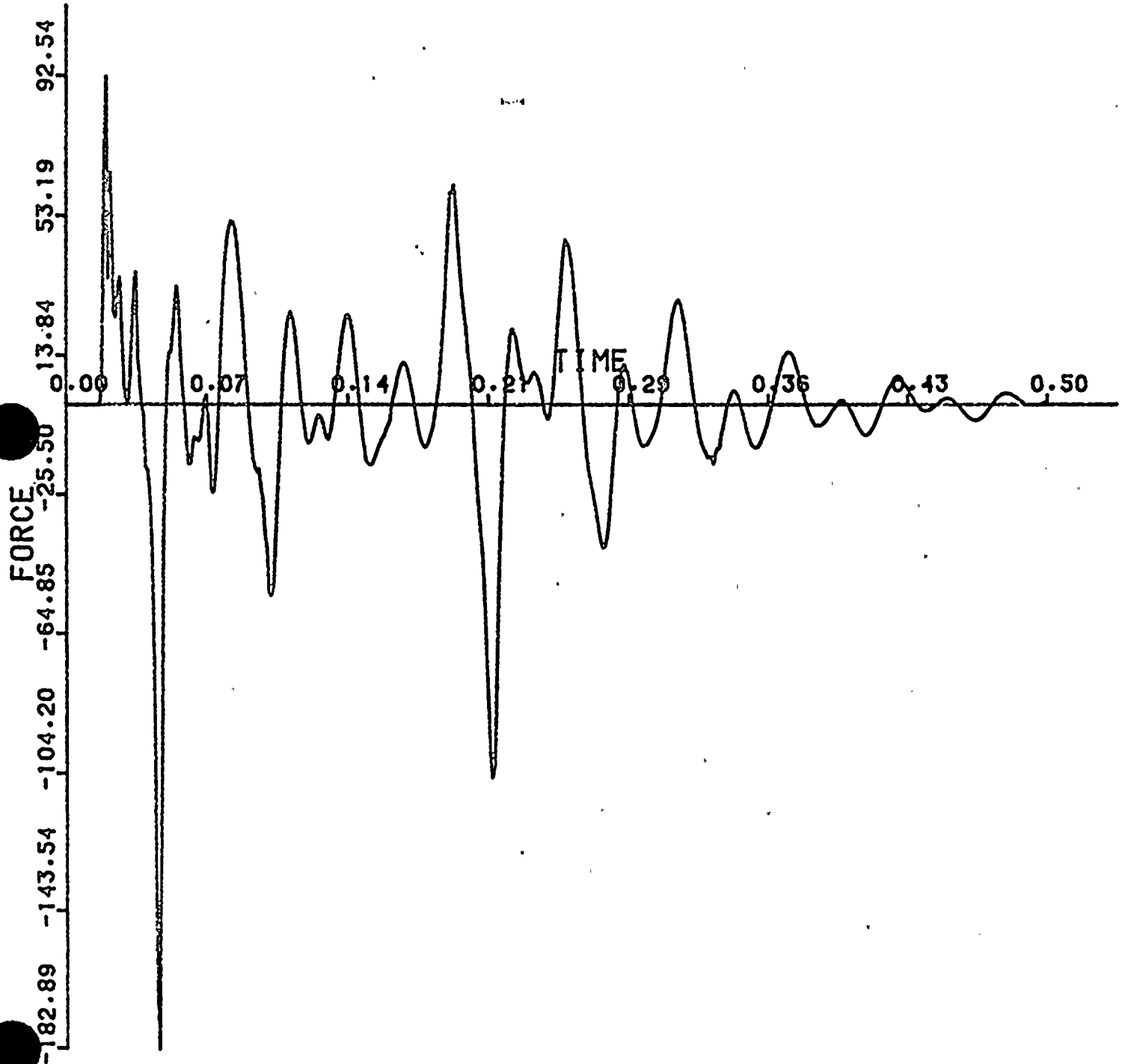
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 20, MAGNITUDE AT NODE POINT 300



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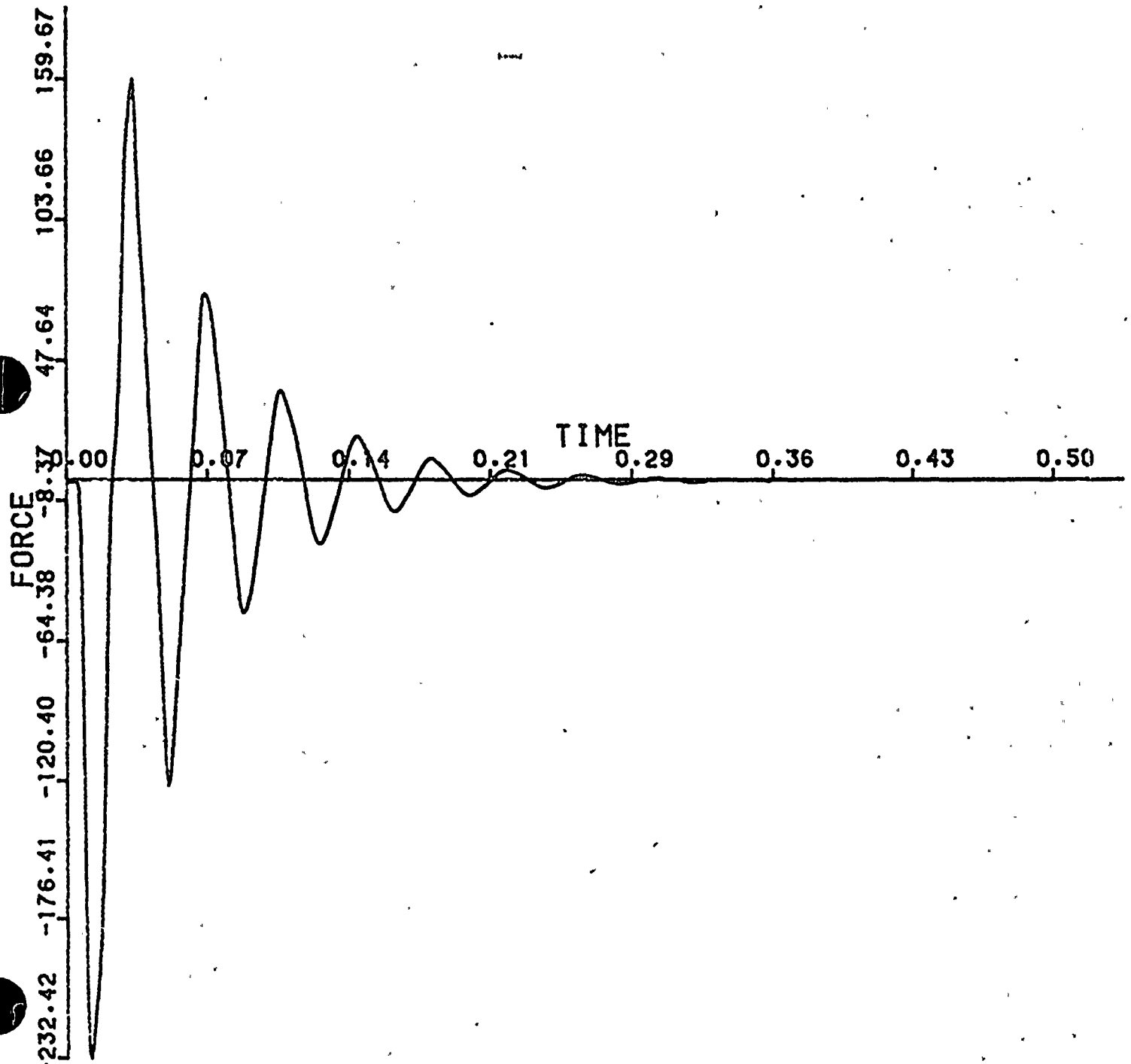
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 21, MAGNITUDE AT NODE POINT 136



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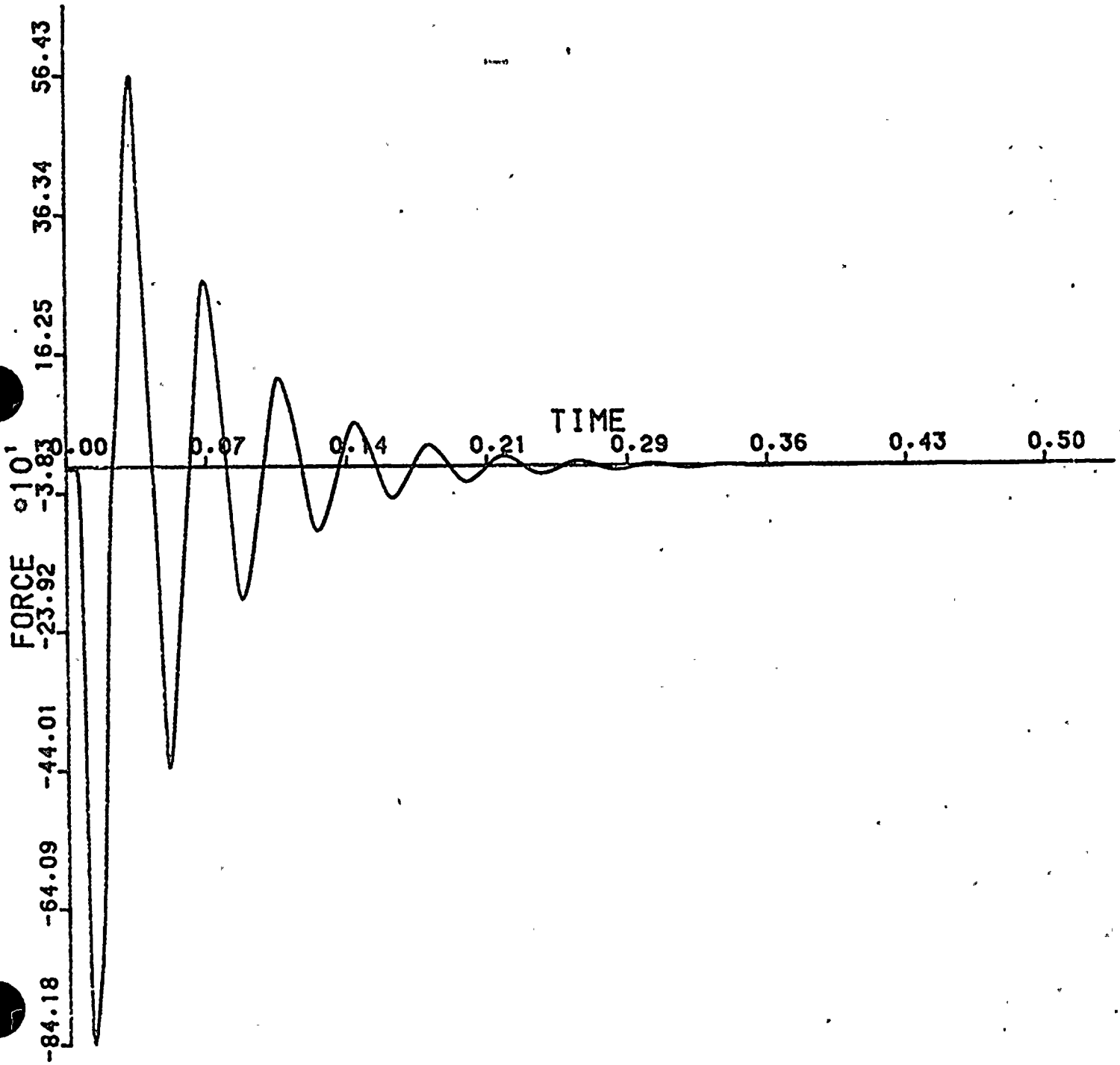
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1. SV MODIFICATION
TIME/FORCE TABLE 22. MAGNITUDE AT NODE POINT 134



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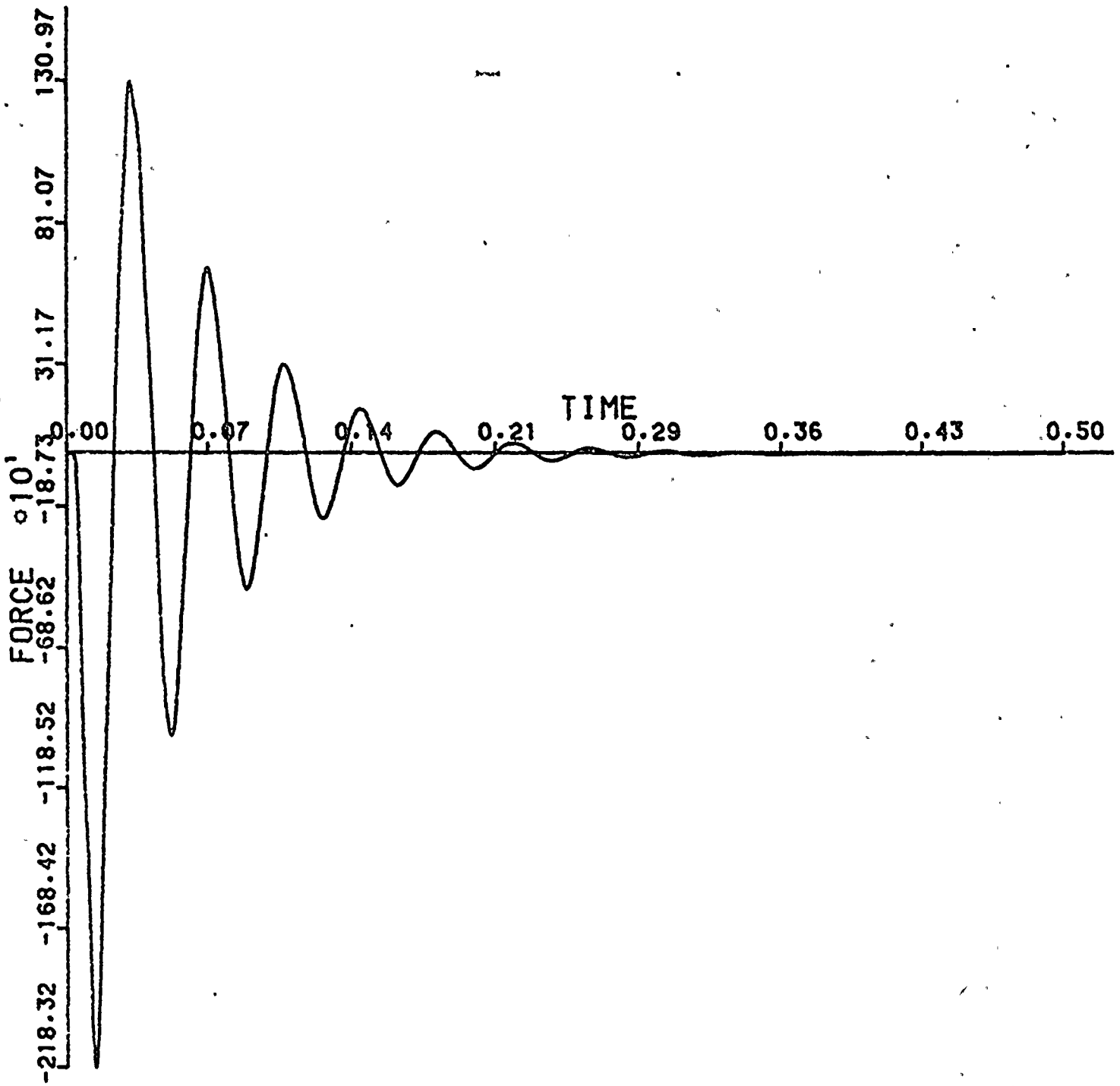
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 23, MAGNITUDE AT NODE POINT 130



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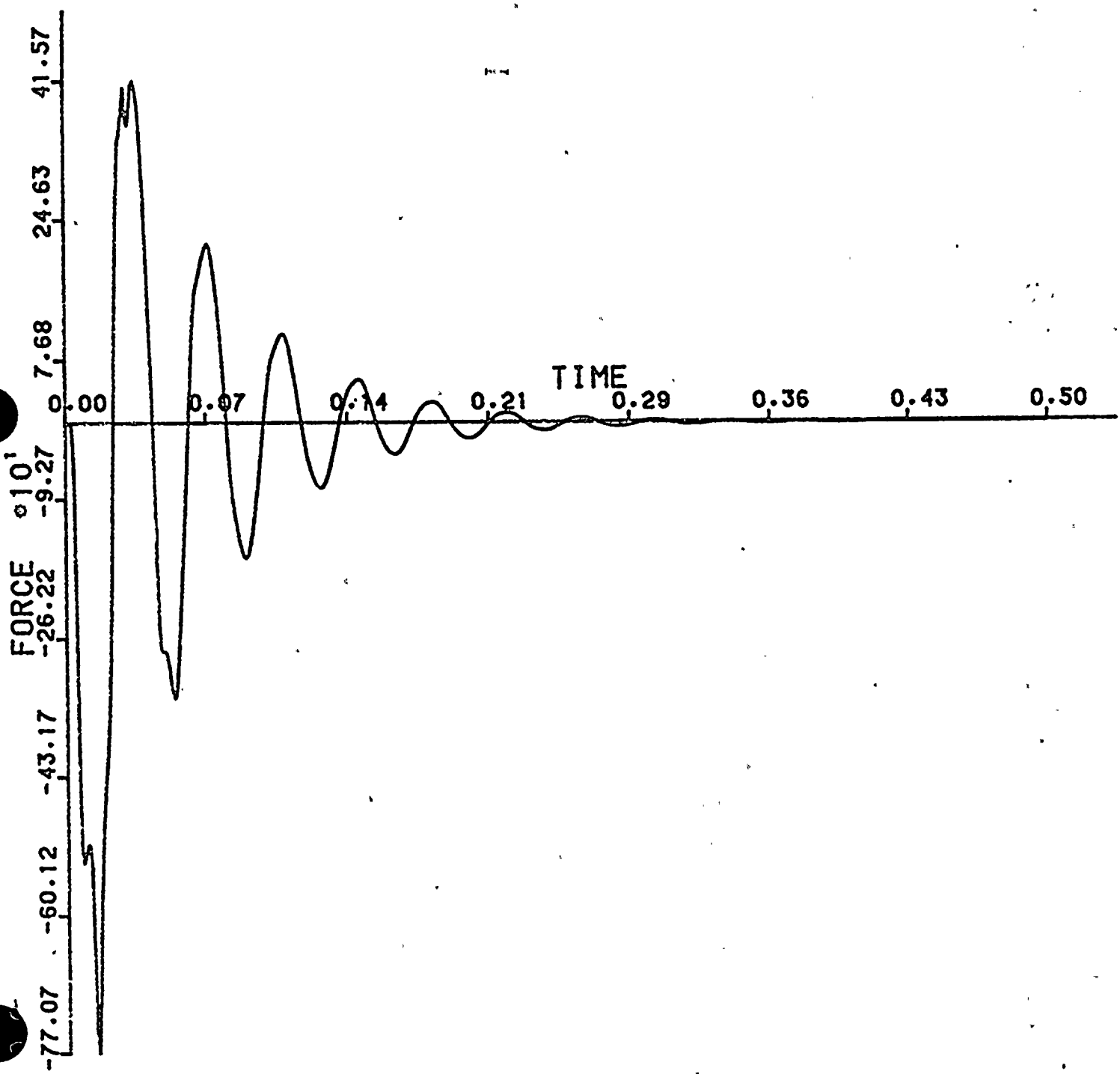
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 24, MAGNITUDE AT NODE POINT 126



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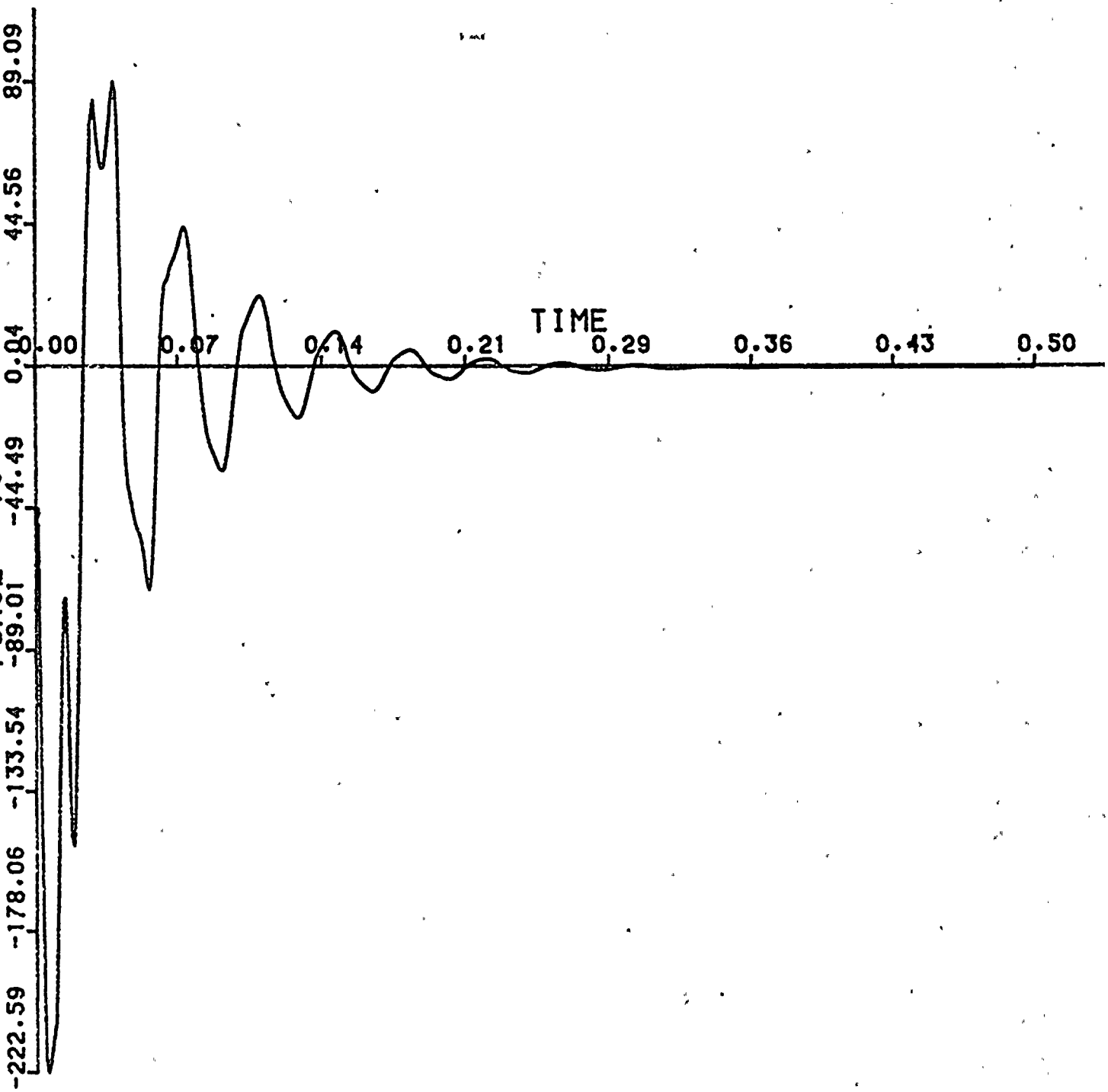
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 25, MAGNITUDE AT NODE POINT 120



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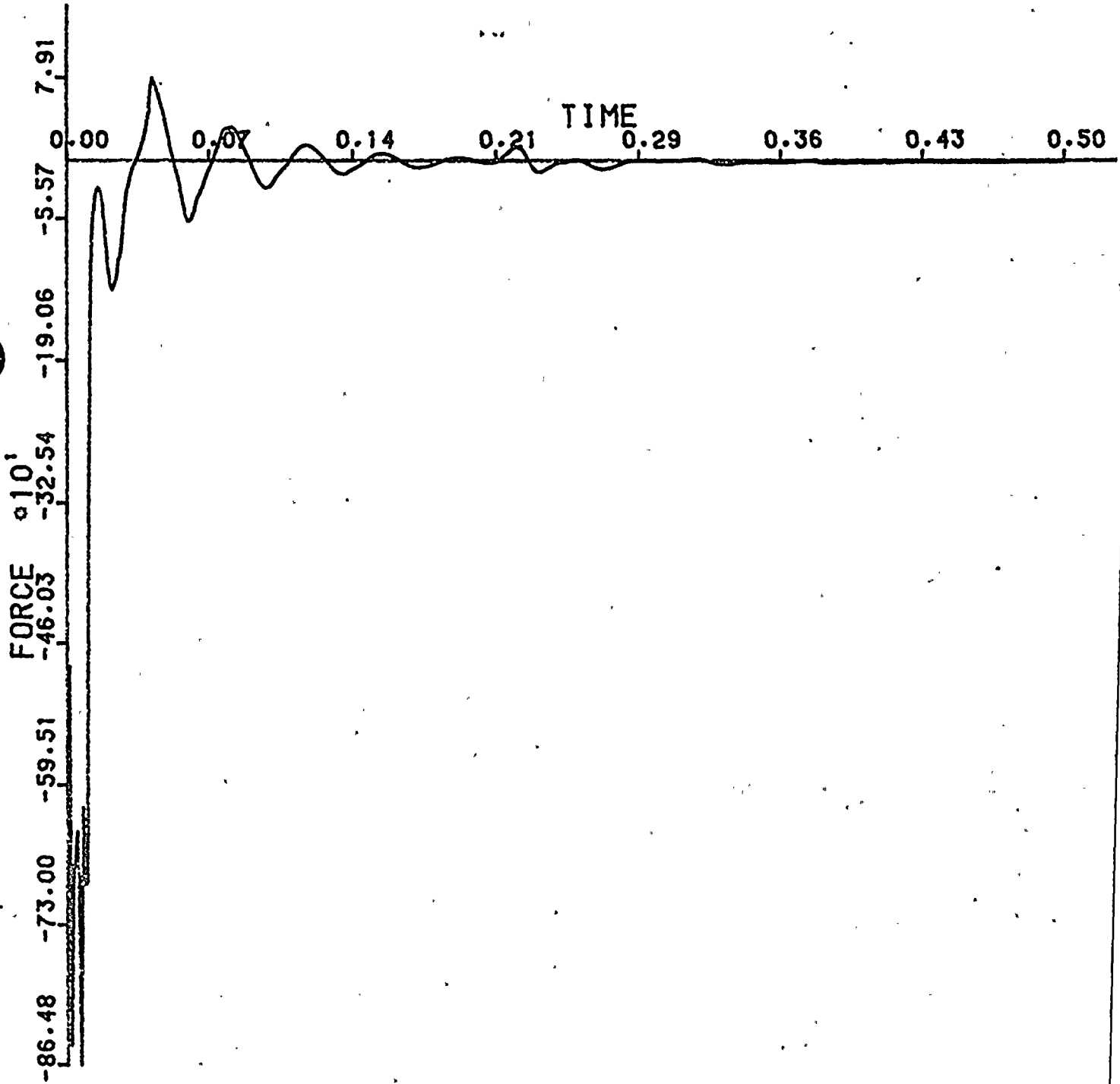
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 26, MAGNITUDE AT NODE POINT 115



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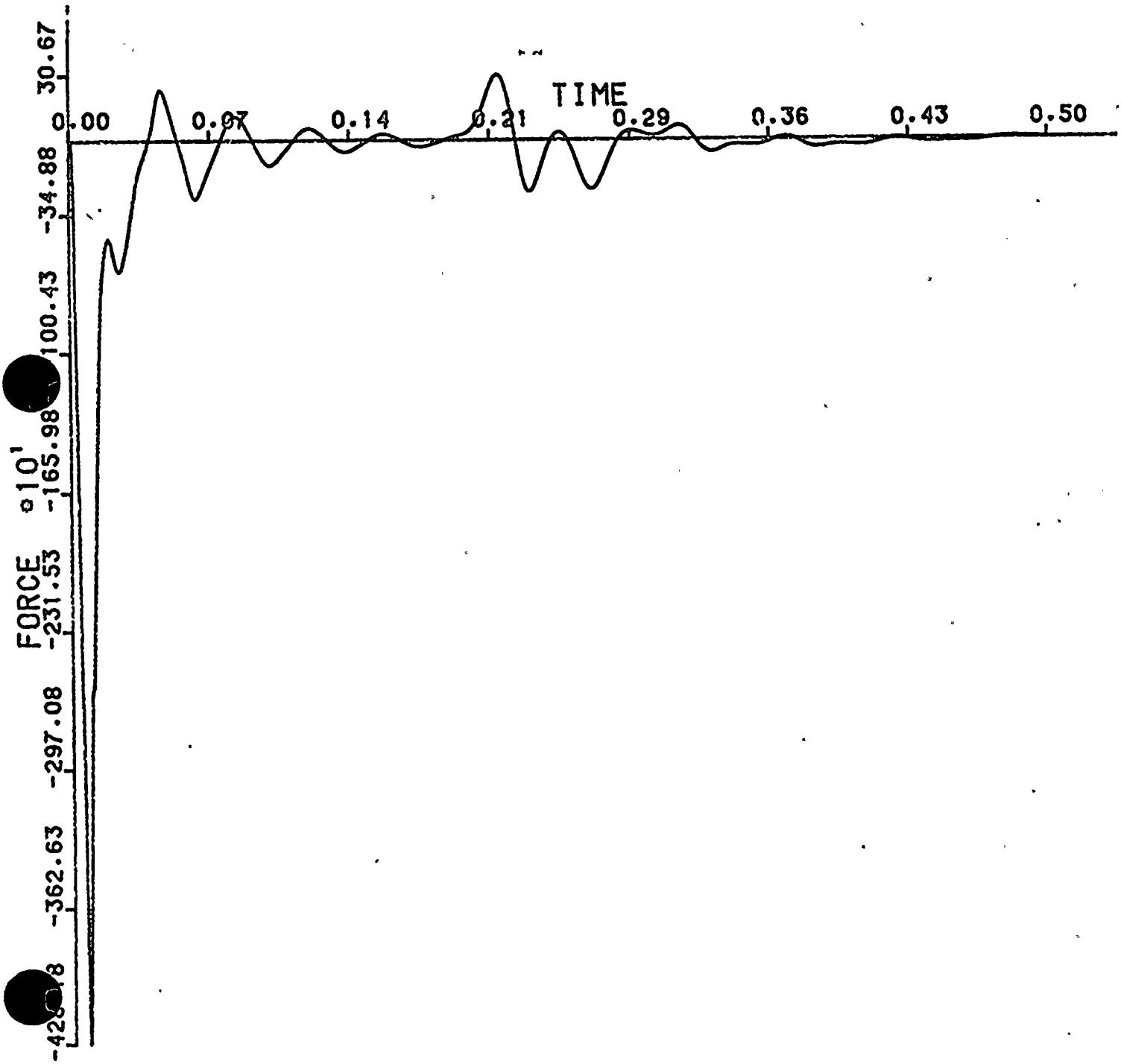
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 27, MAGNITUDE AT NODE POINT 109



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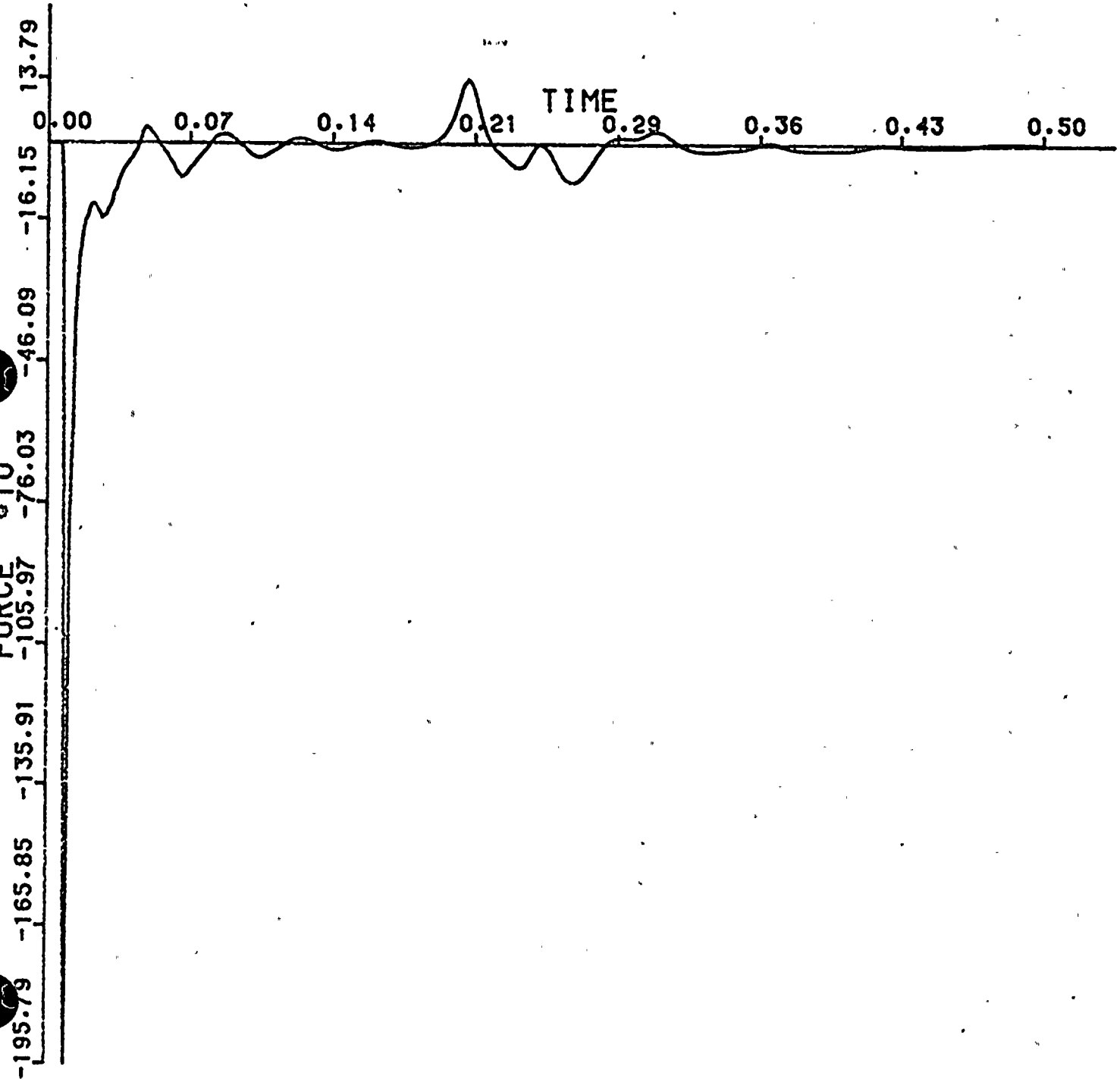
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 28, MAGNITUDE AT NODE POINT 104



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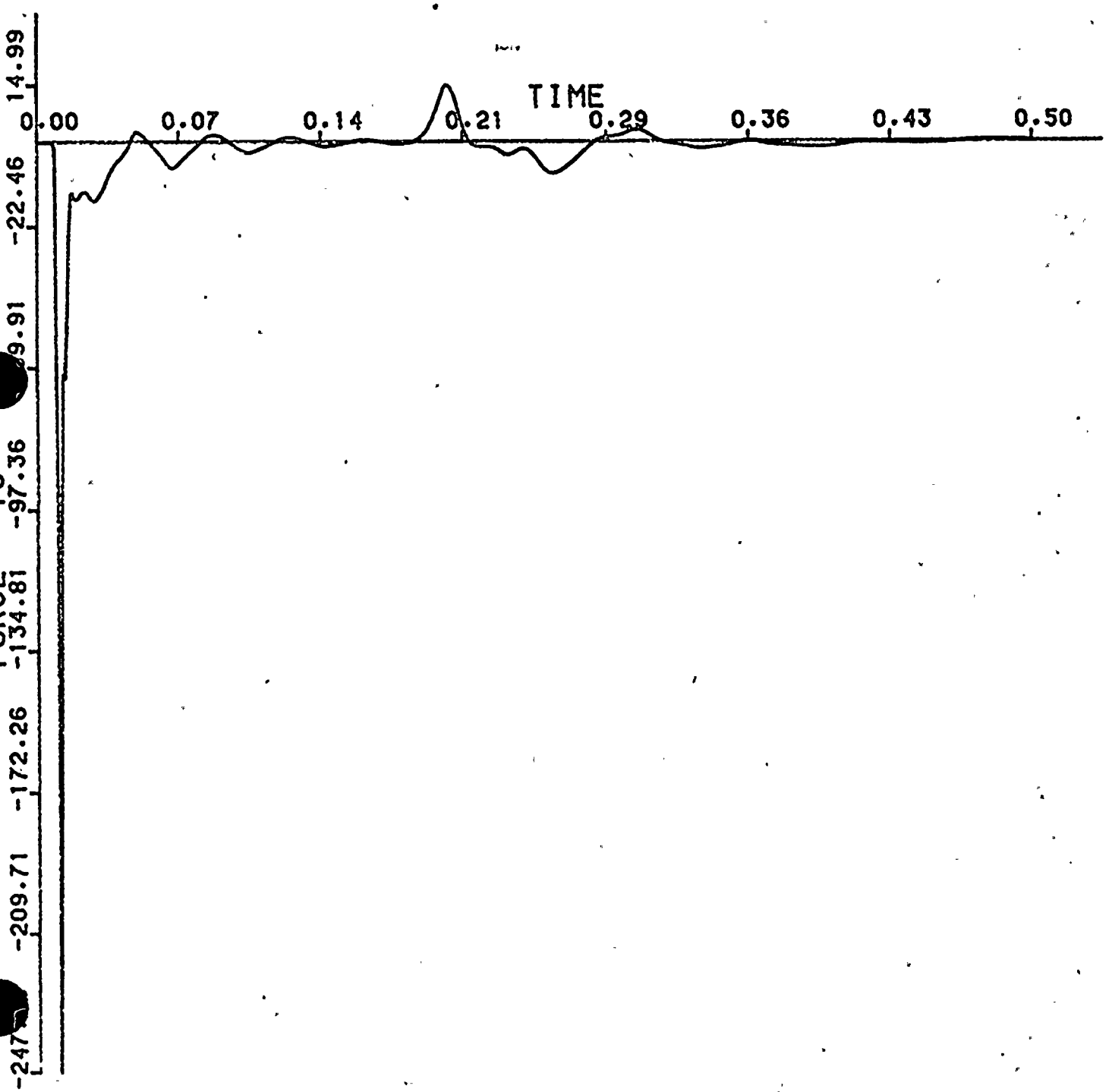
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 29, MAGNITUDE AT NODE POINT 103



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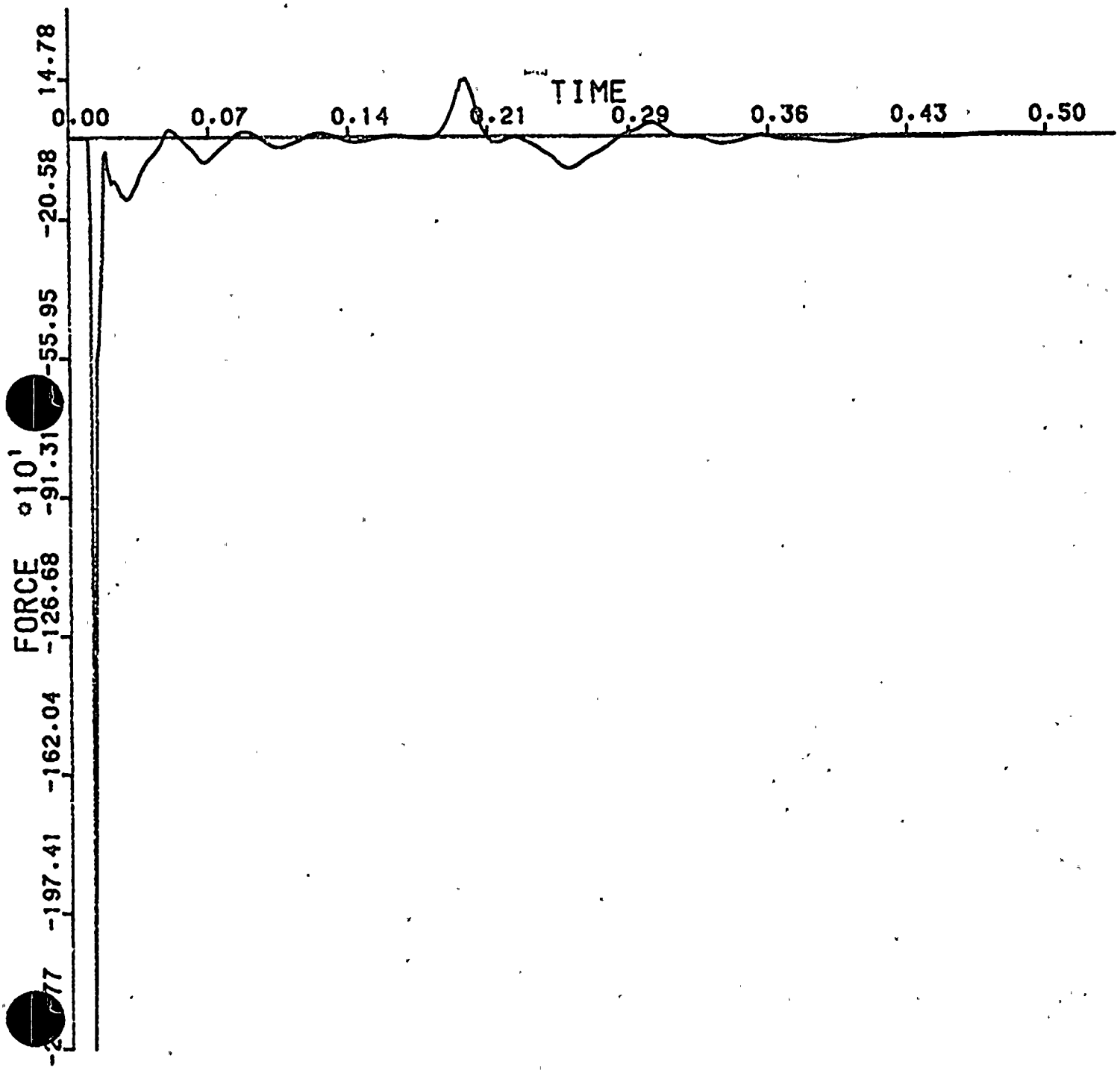
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1. SV MODIFICATION
TIME/FORCE TABLE 30. MAGNITUDE AT NODE POINT 102



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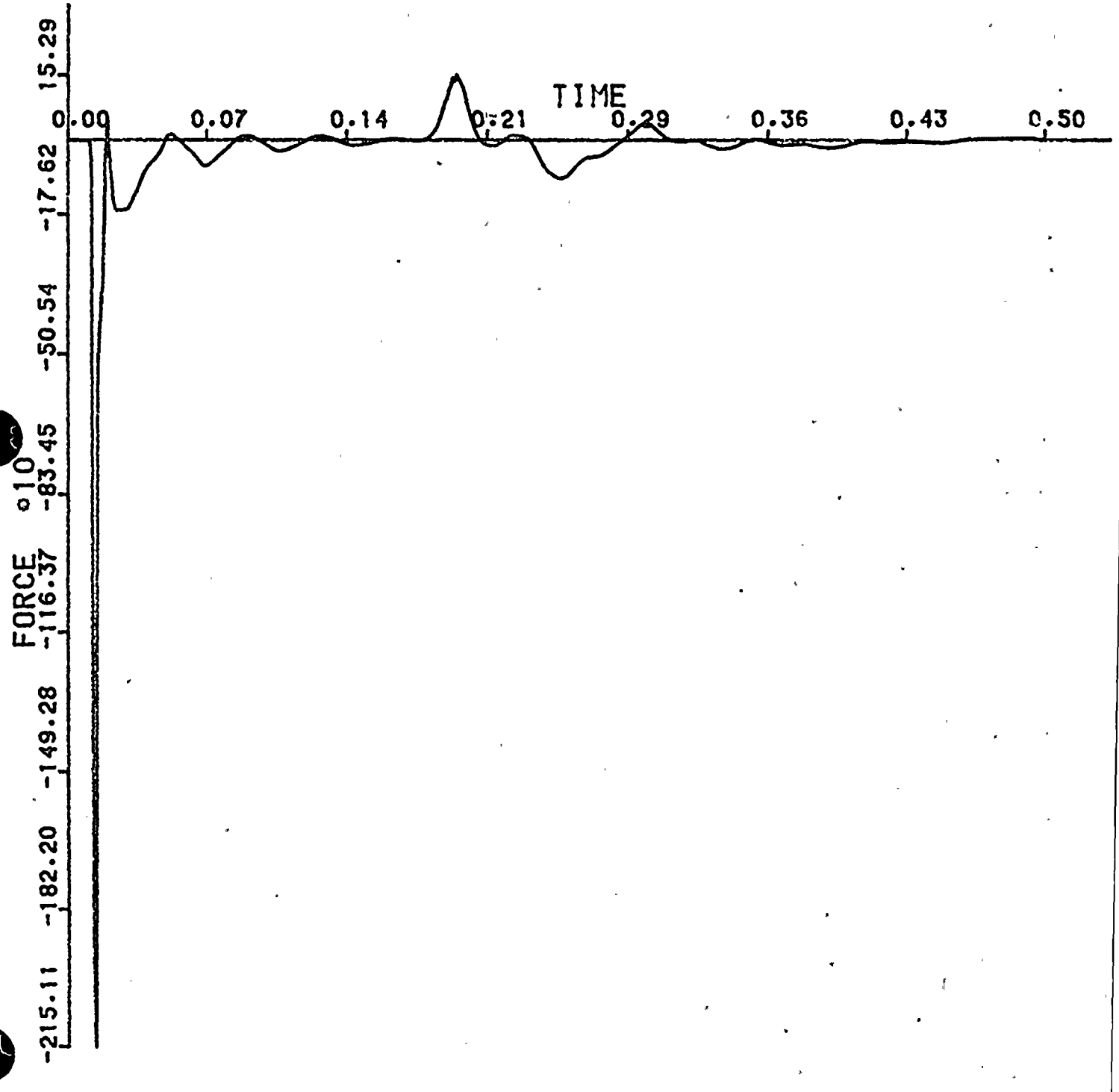
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 31, MAGNITUDE AT NODE POINT 100



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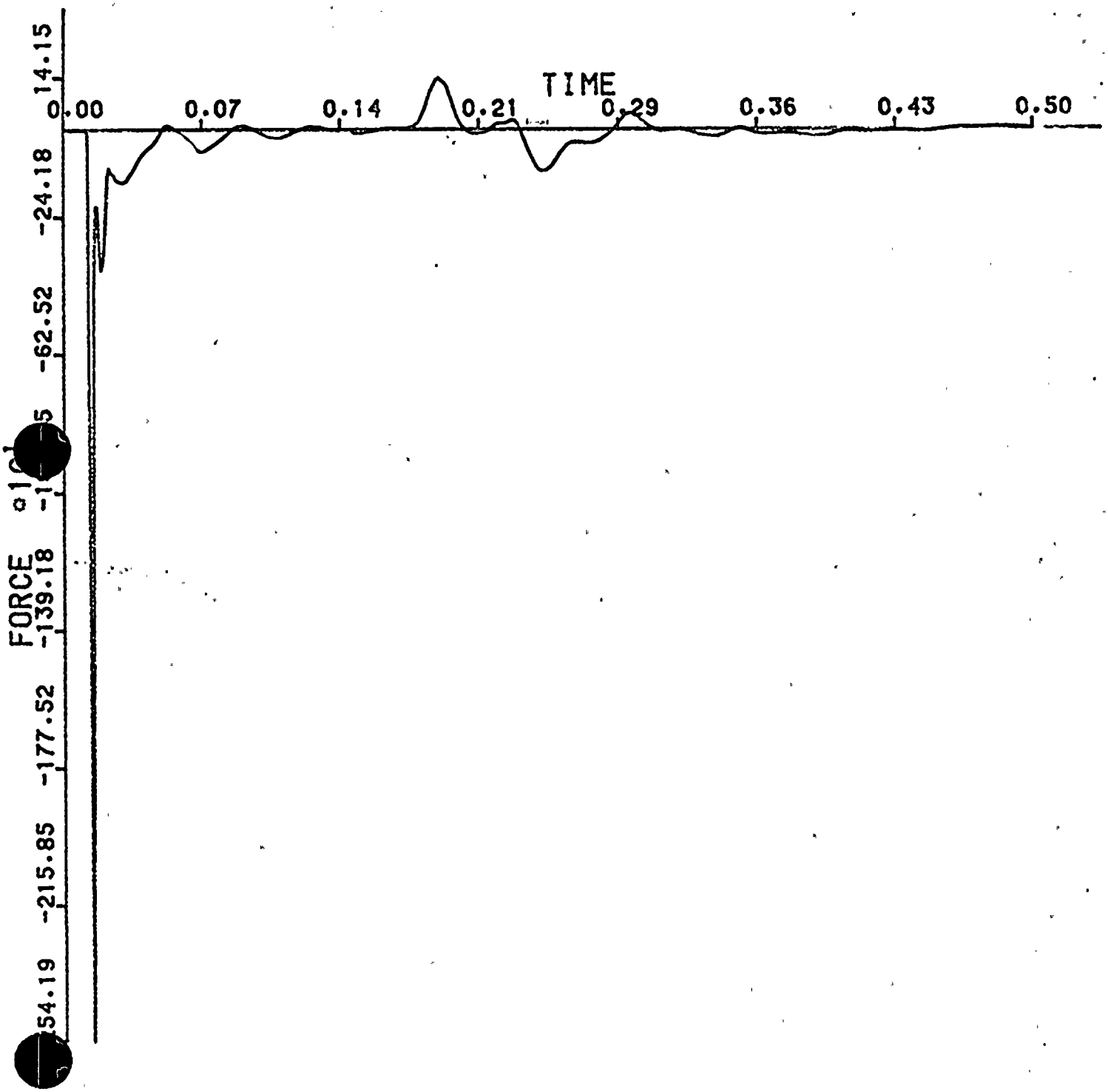
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 32, MAGNITUDE AT NODE POINT 99



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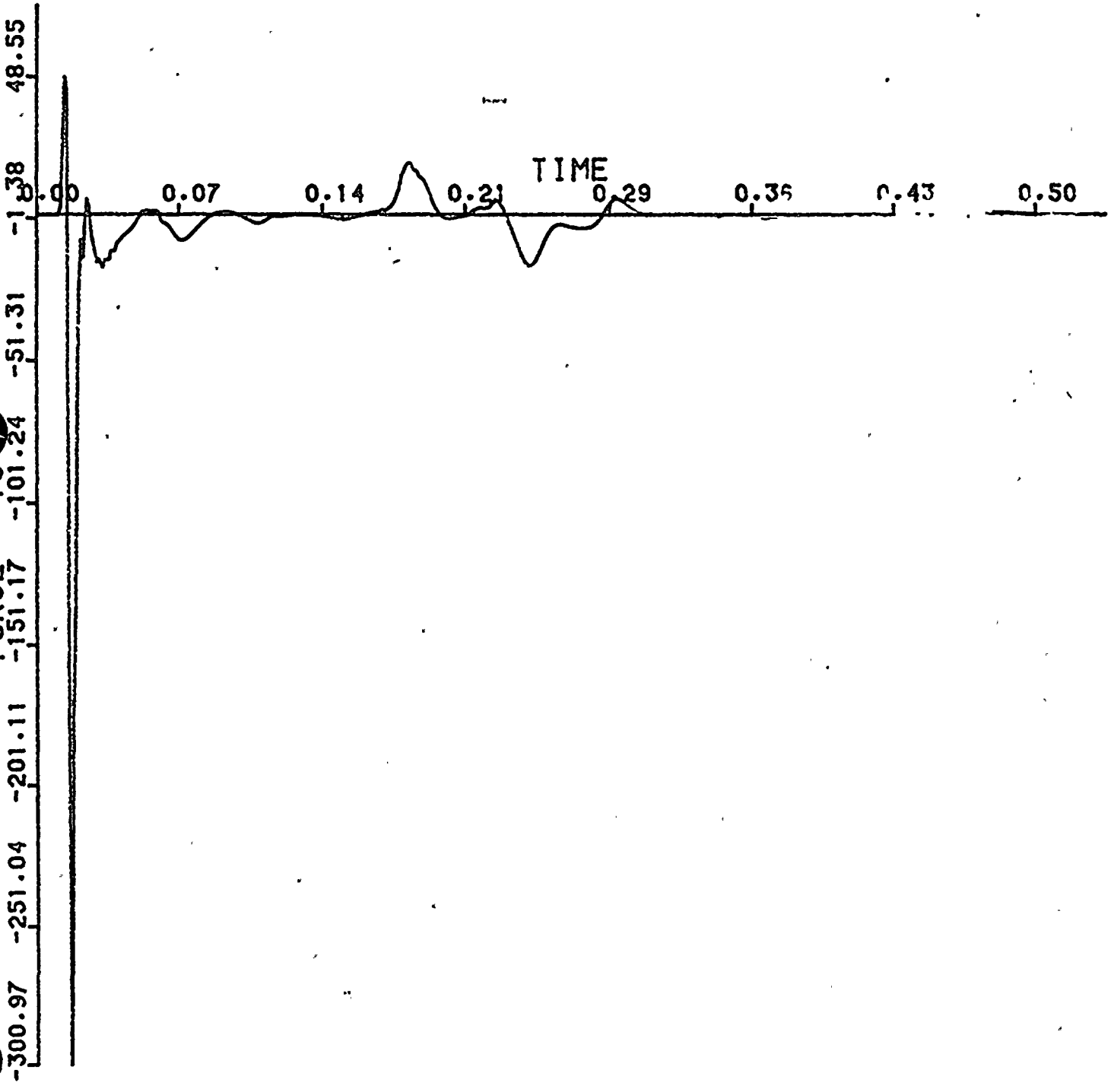
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 33, MAGNITUDE AT NODE POINT 98



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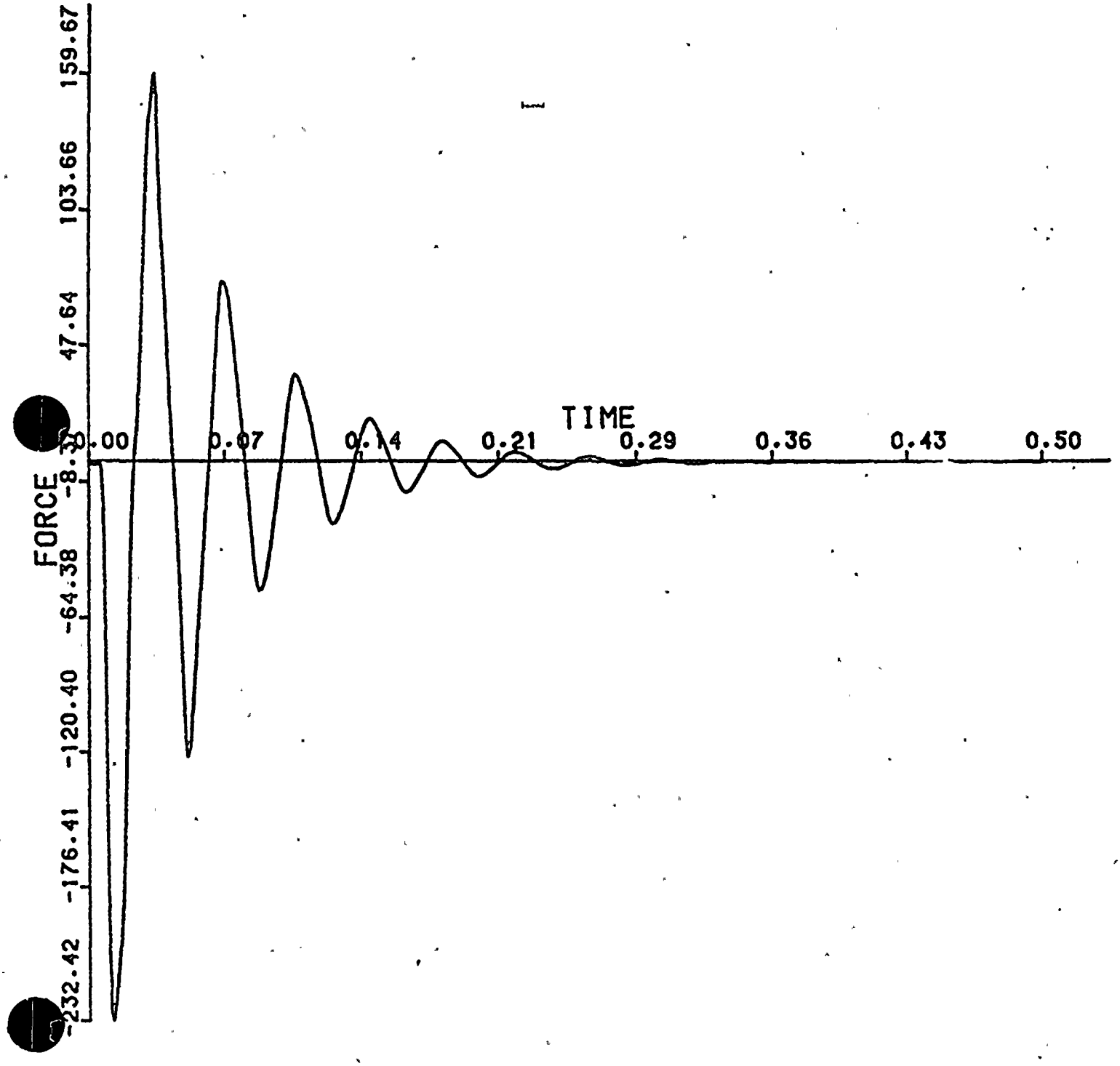
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 34, MAGNITUDE AT NODE POINT 184



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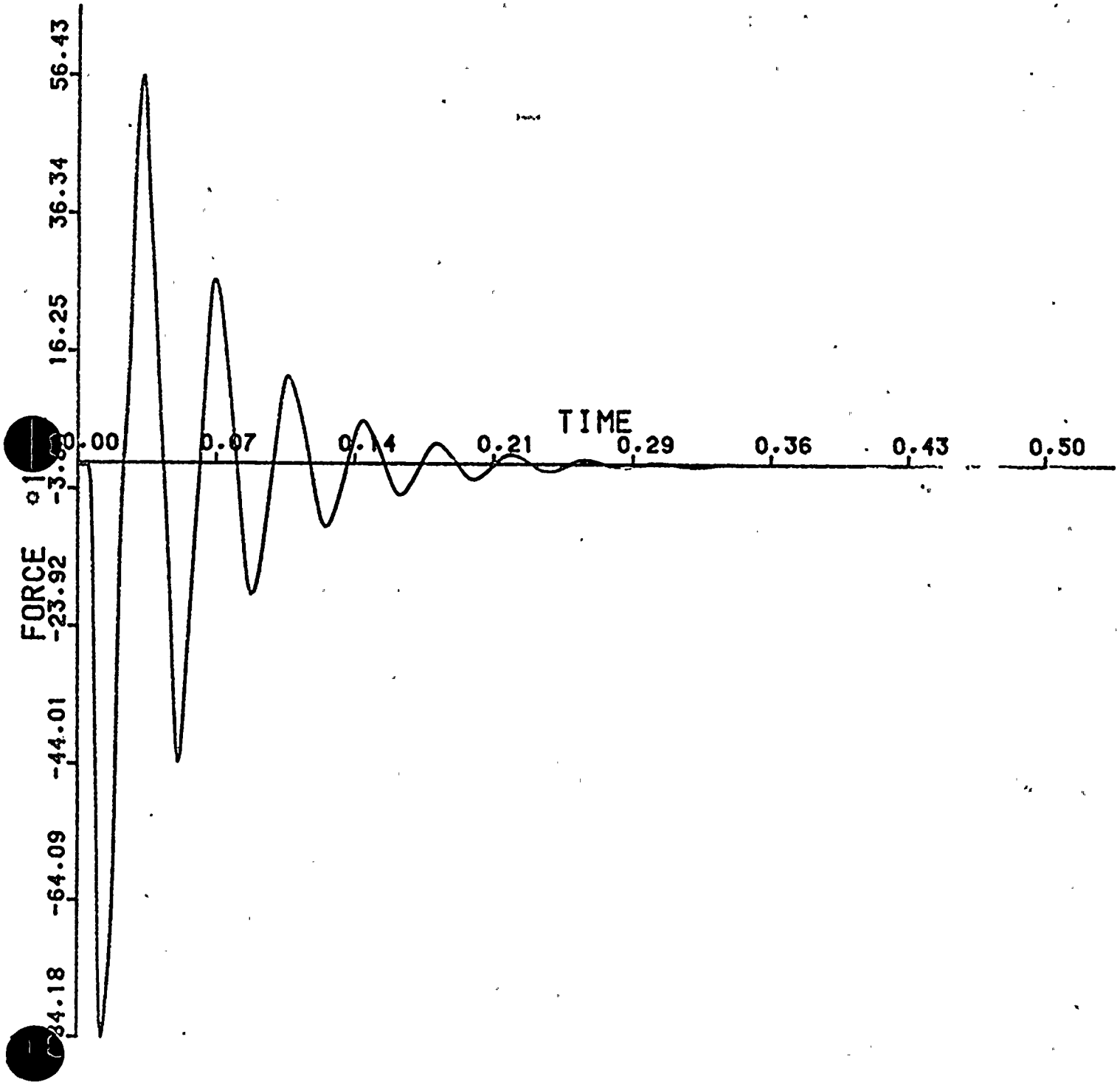
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 35, MAGNITUDE AT NODE POINT 182



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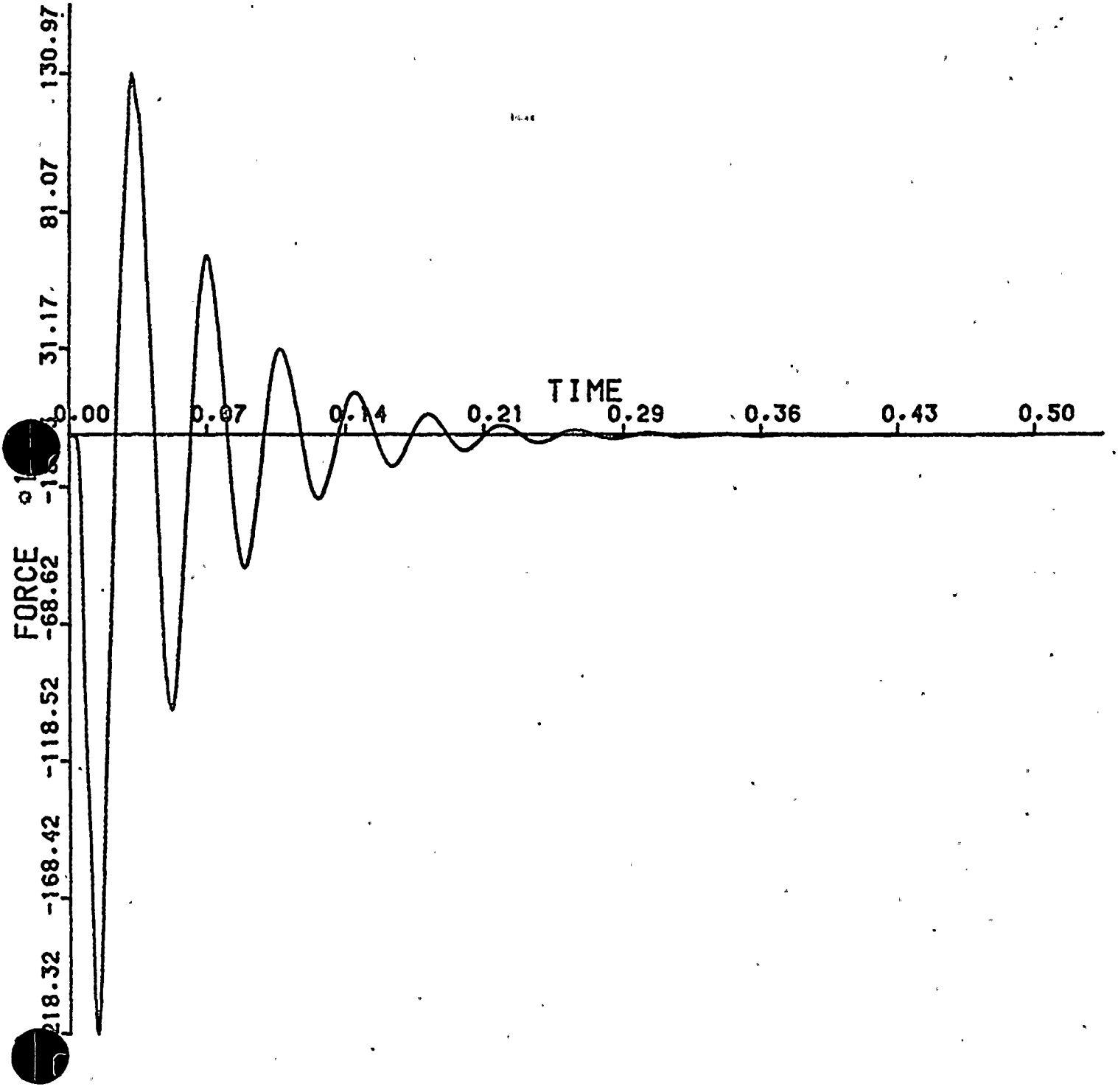
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 36, MAGNITUDE AT NODE POINT 180



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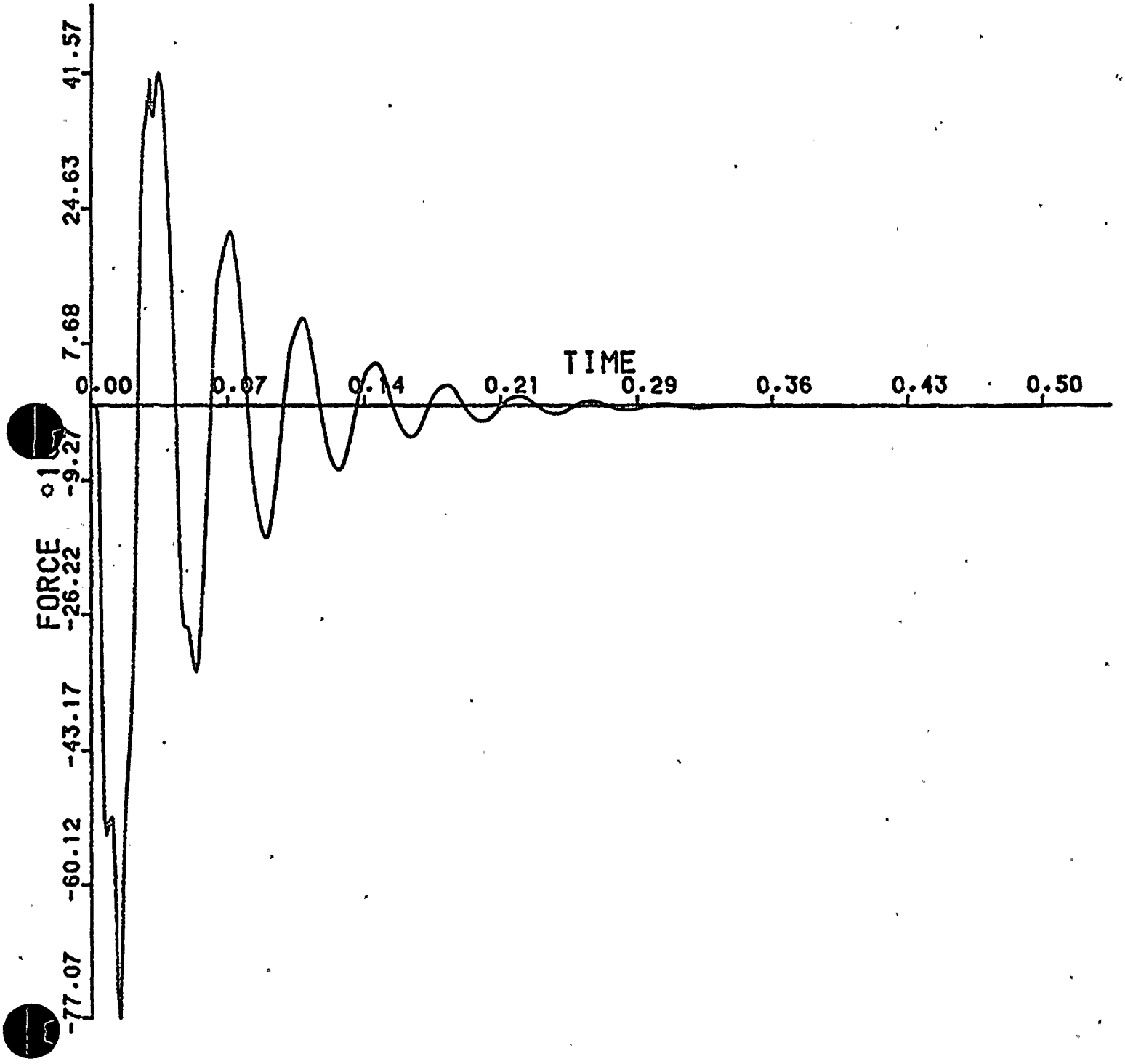
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 37, MAGNITUDE AT NODE POINT 176



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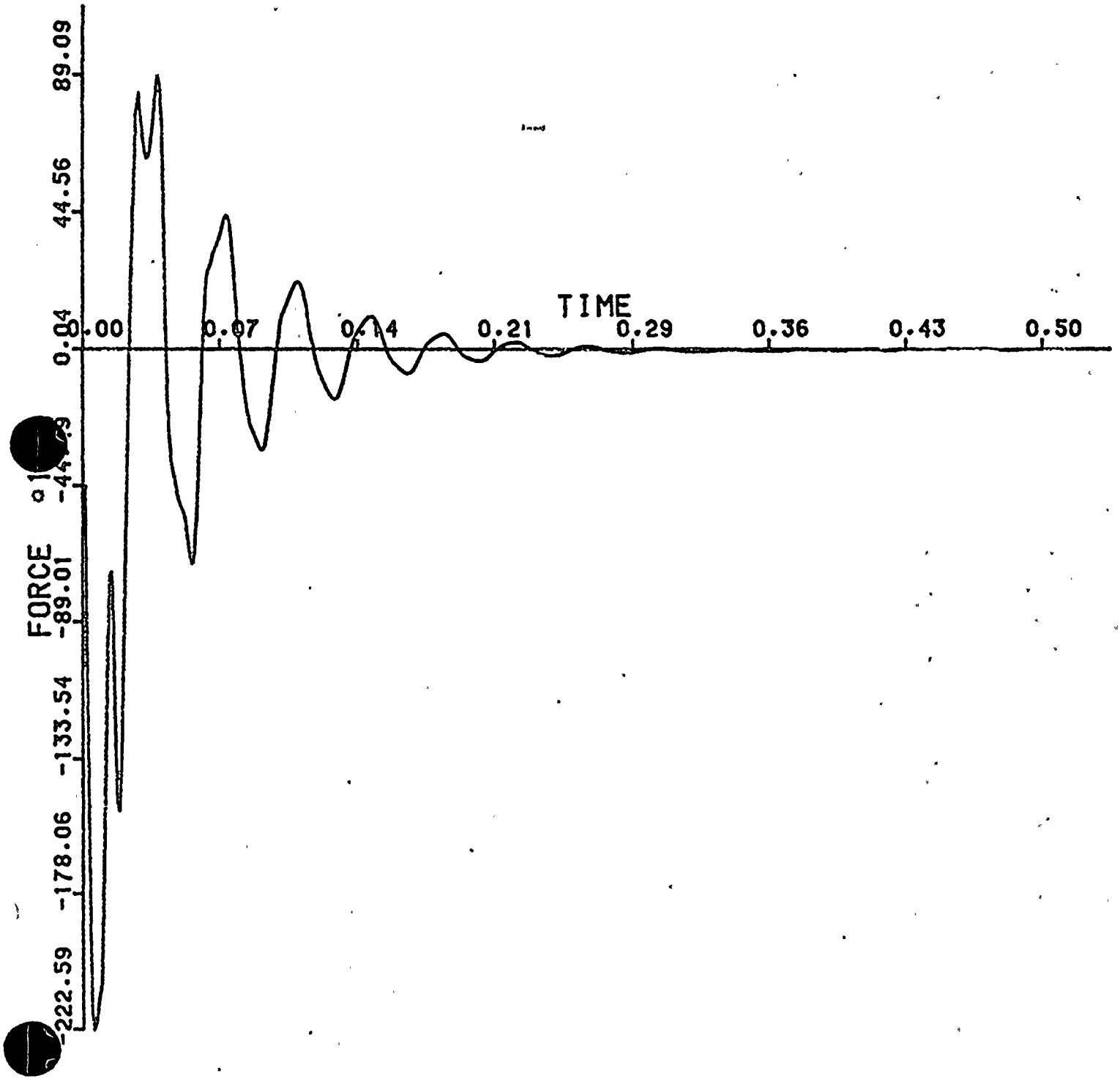
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 38, MAGNITUDE AT NODE POINT 170



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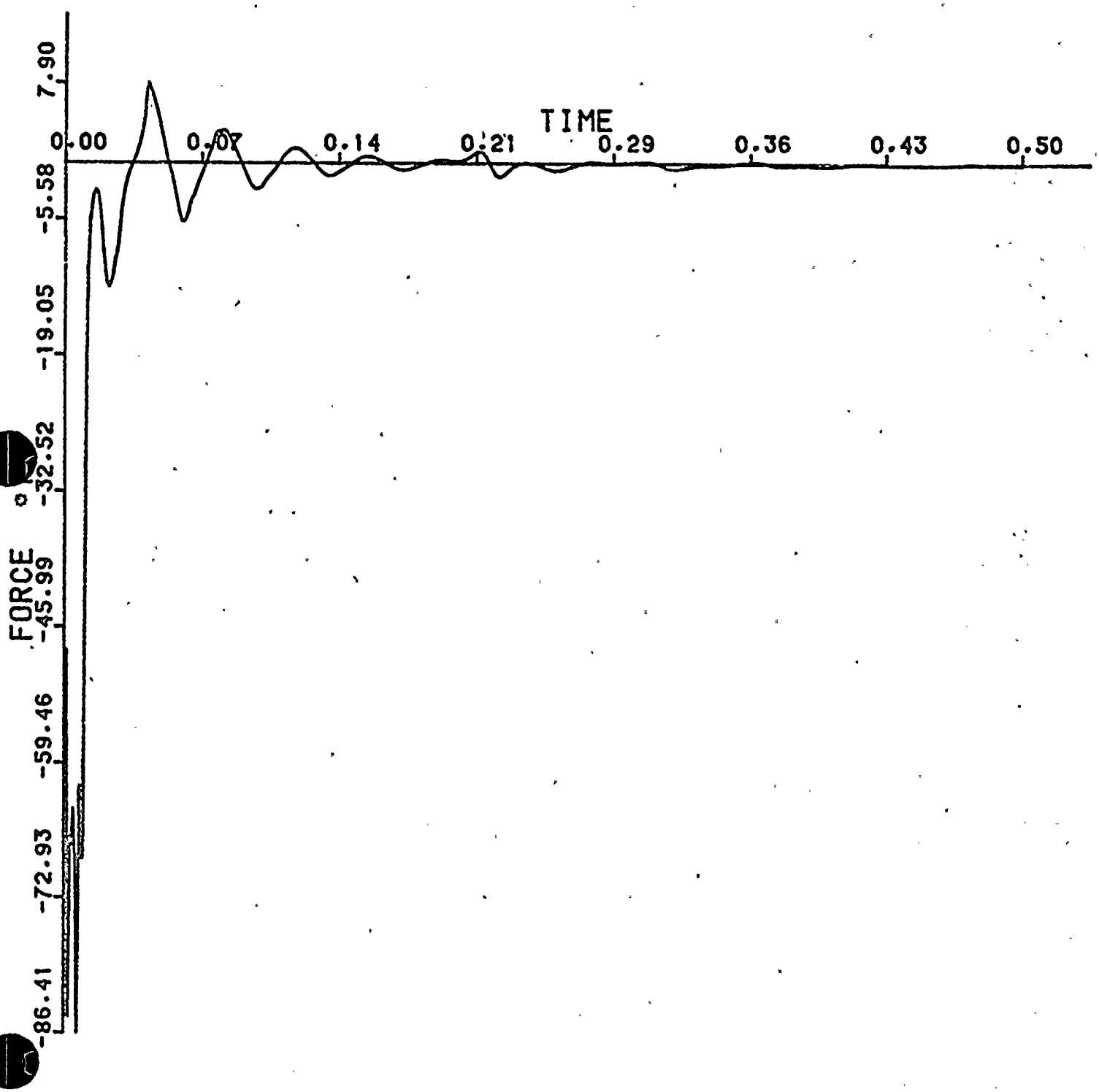
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 39, MAGNITUDE AT NODE POINT 163



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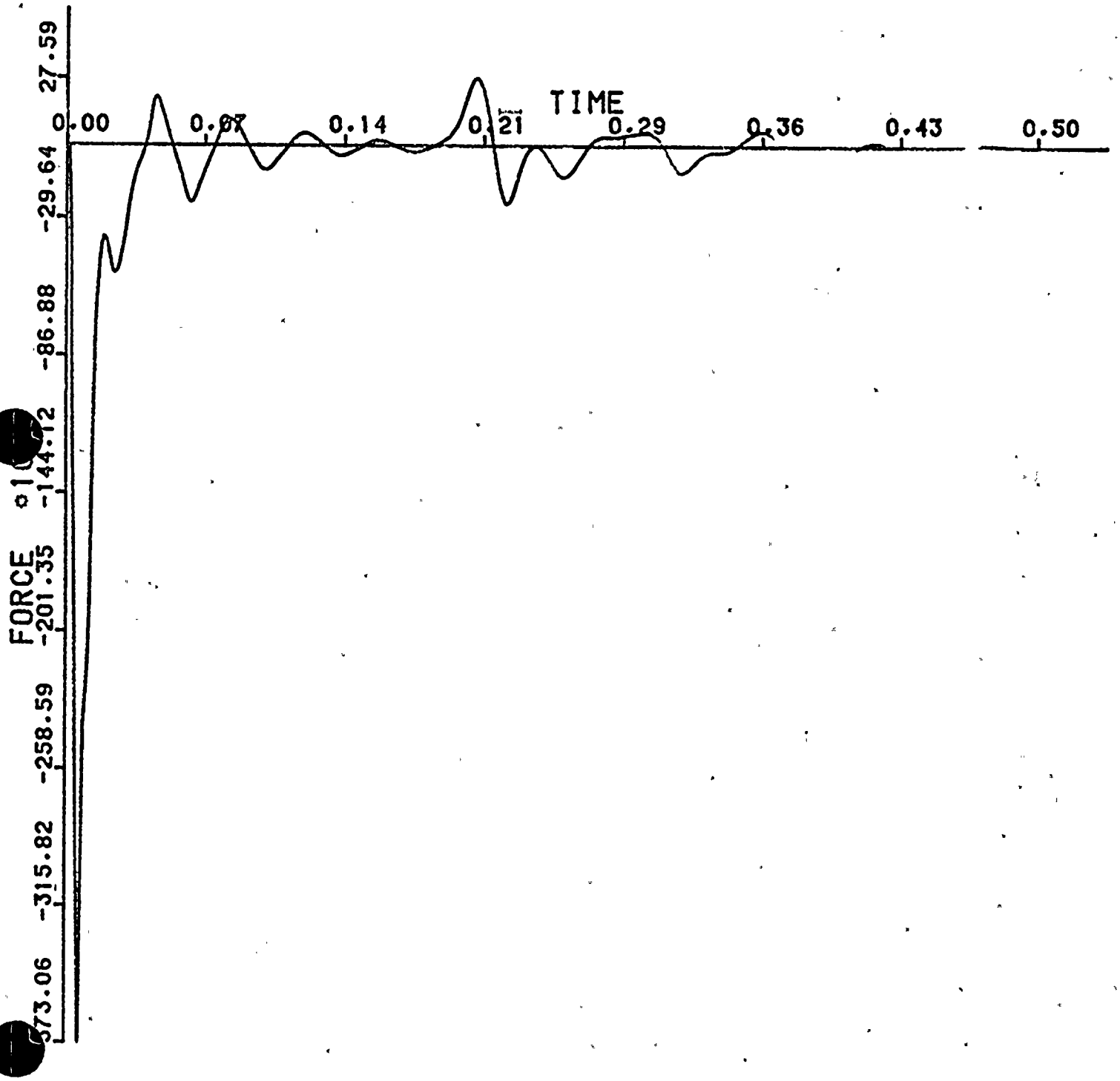
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 40. MAGNITUDE AT NODE POINT 157



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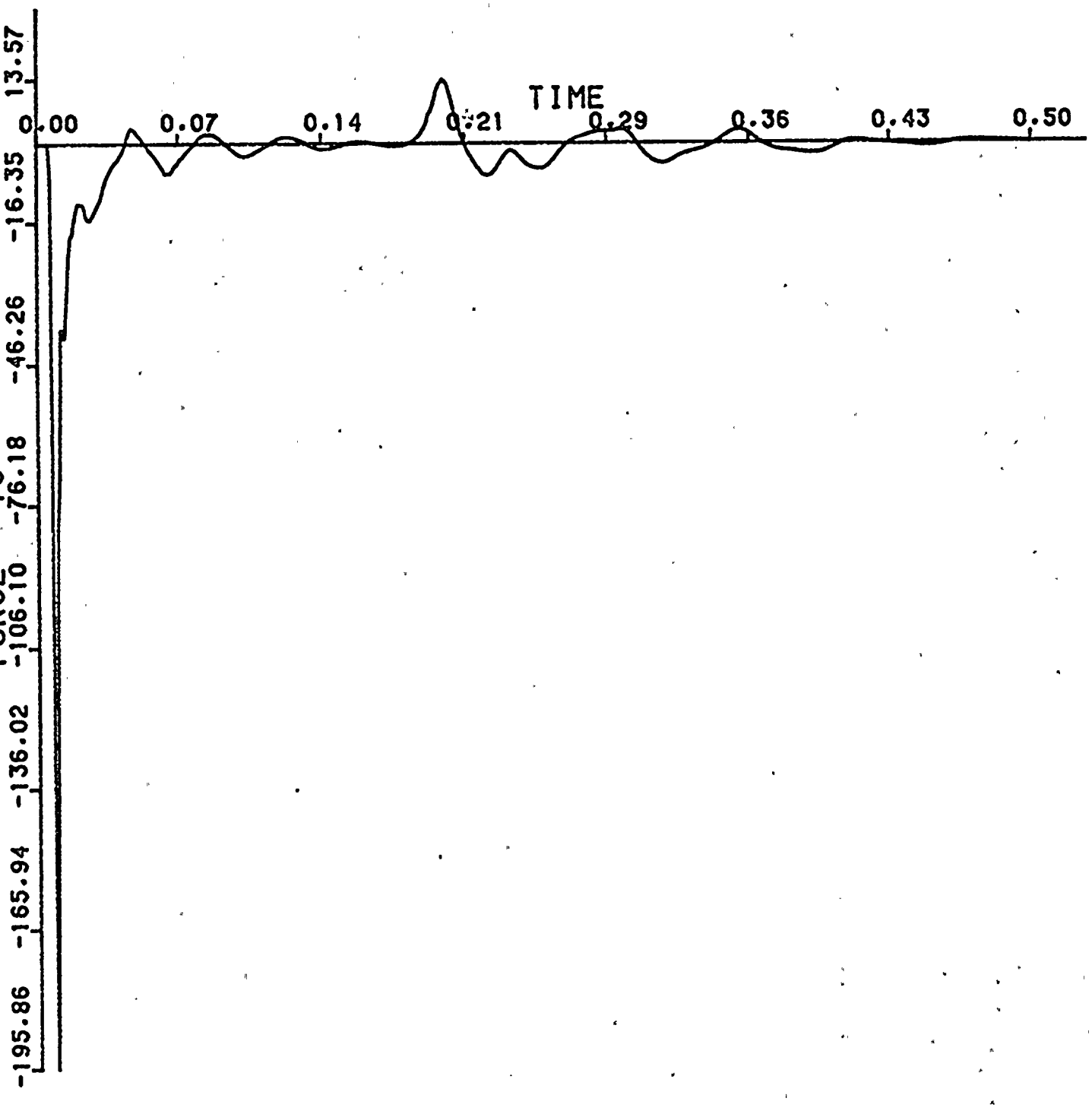
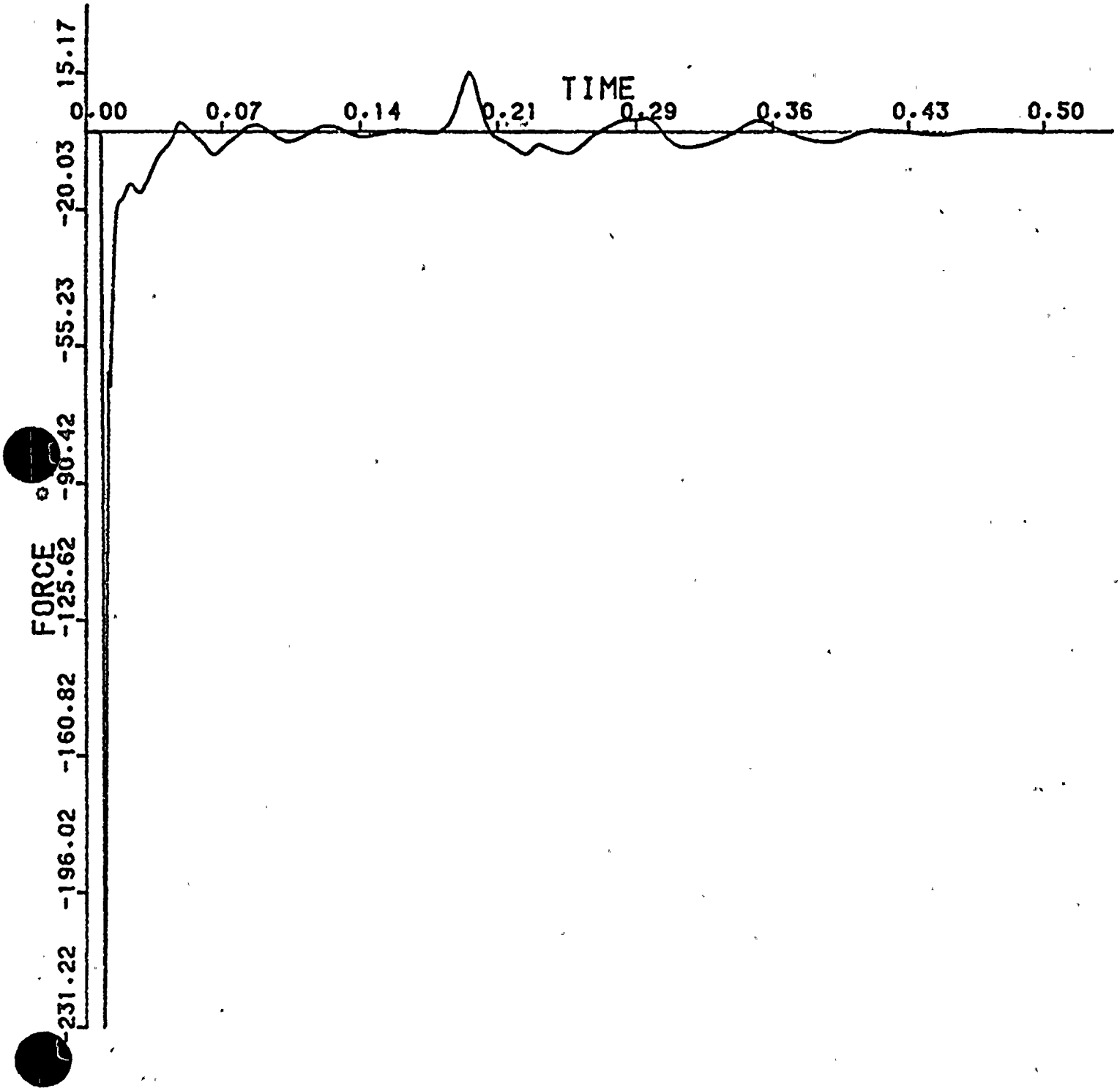
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 41, MAGNITUDE AT NODE POINT 150



SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 42, MAGNITUDE AT NODE POINT 148



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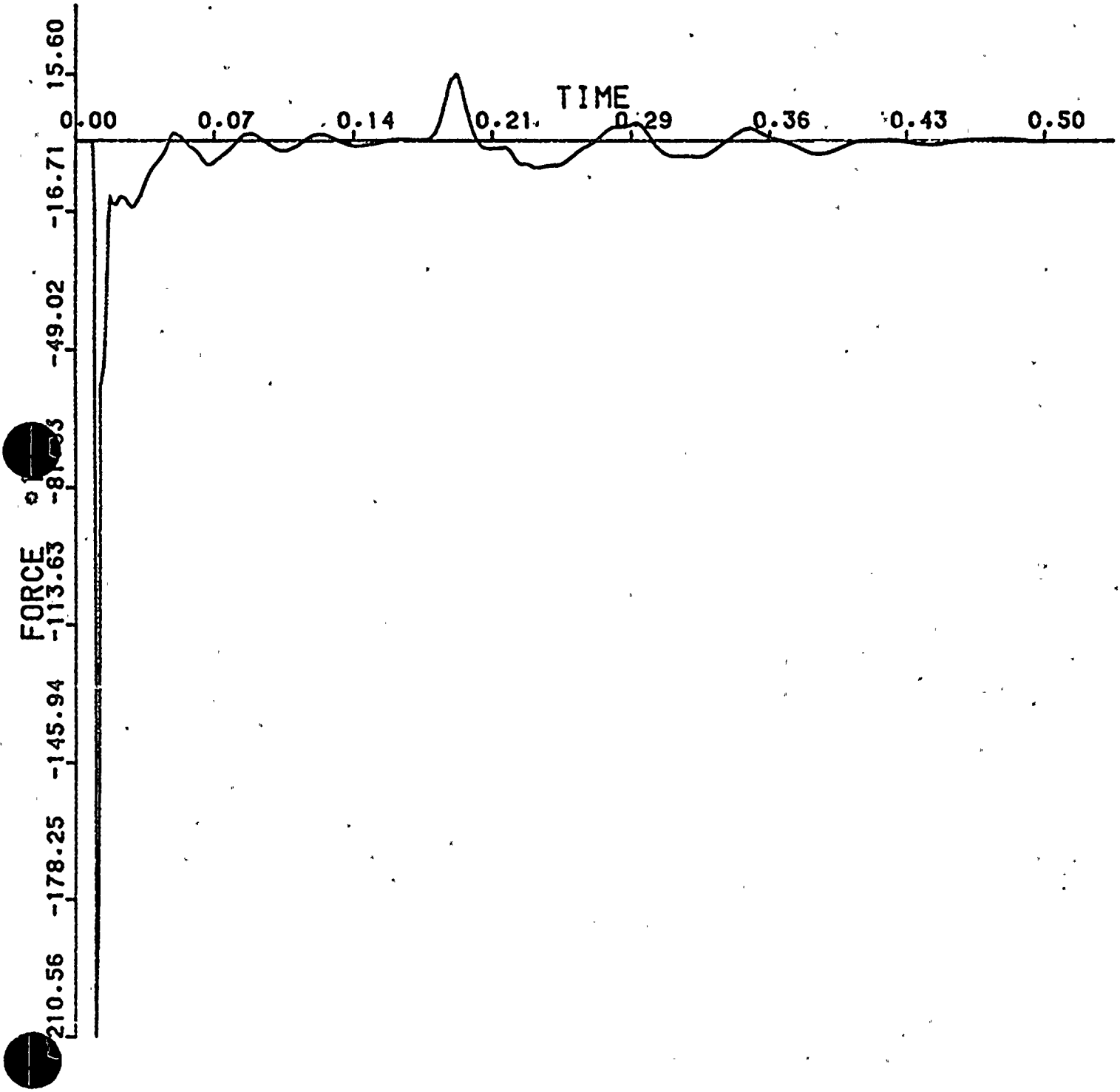
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 43, MAGNITUDE AT NODE POINT 146



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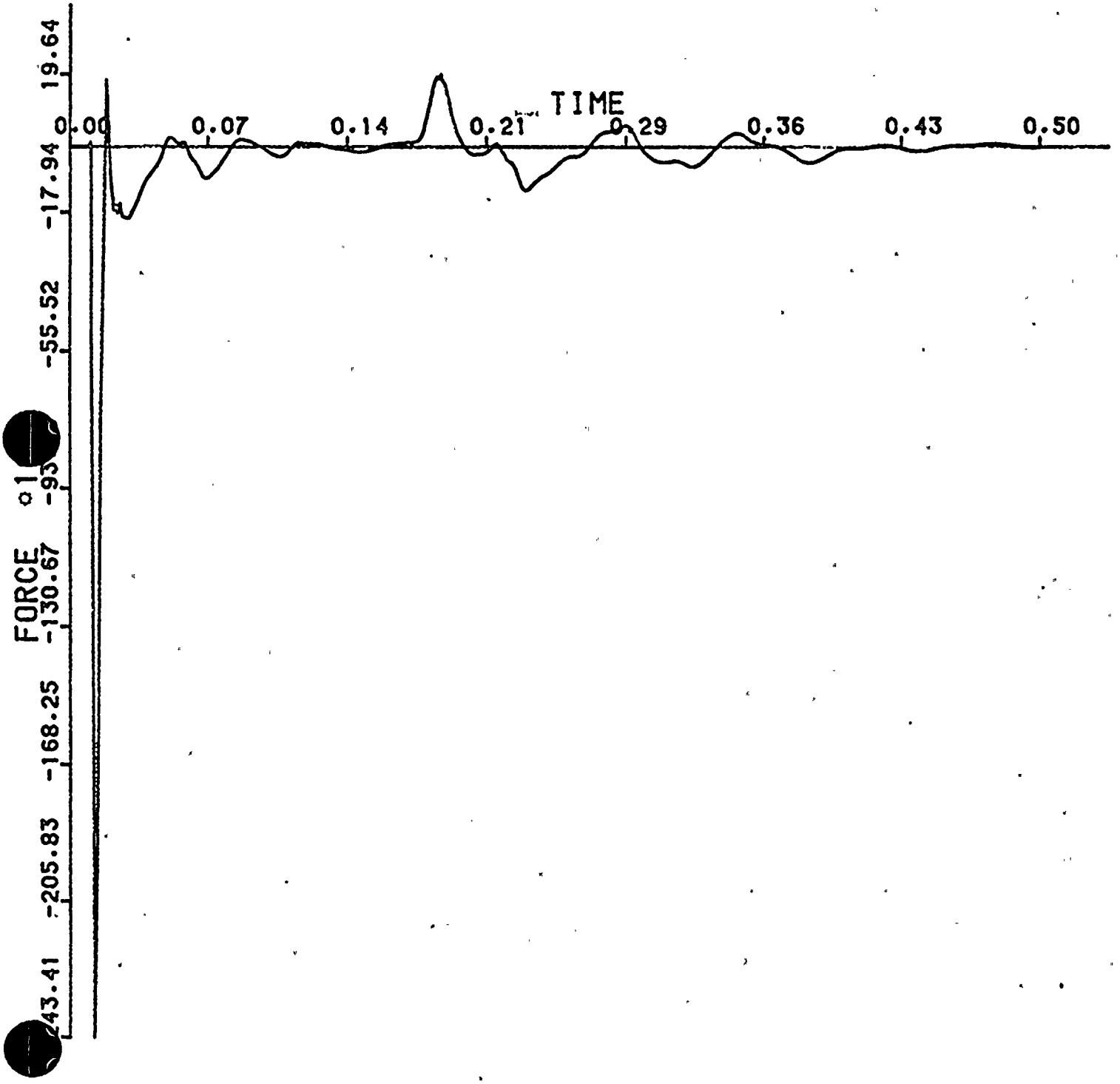
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 44, MAGNITUDE AT NODE POINT 144



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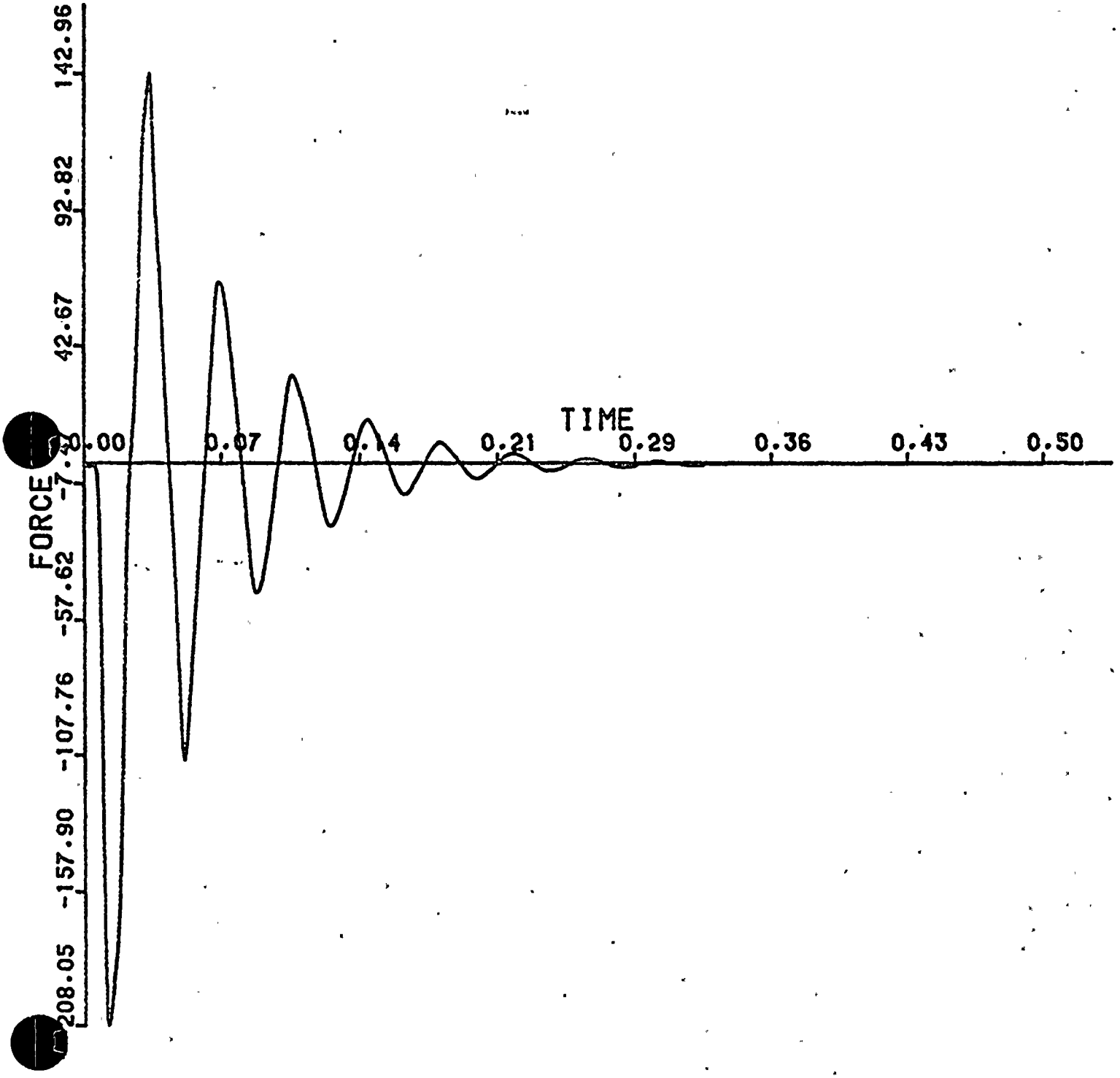
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1. SV MODIFICATION
TIME/FORCE TABLE 45. MAGNITUDE AT NODE POINT 242



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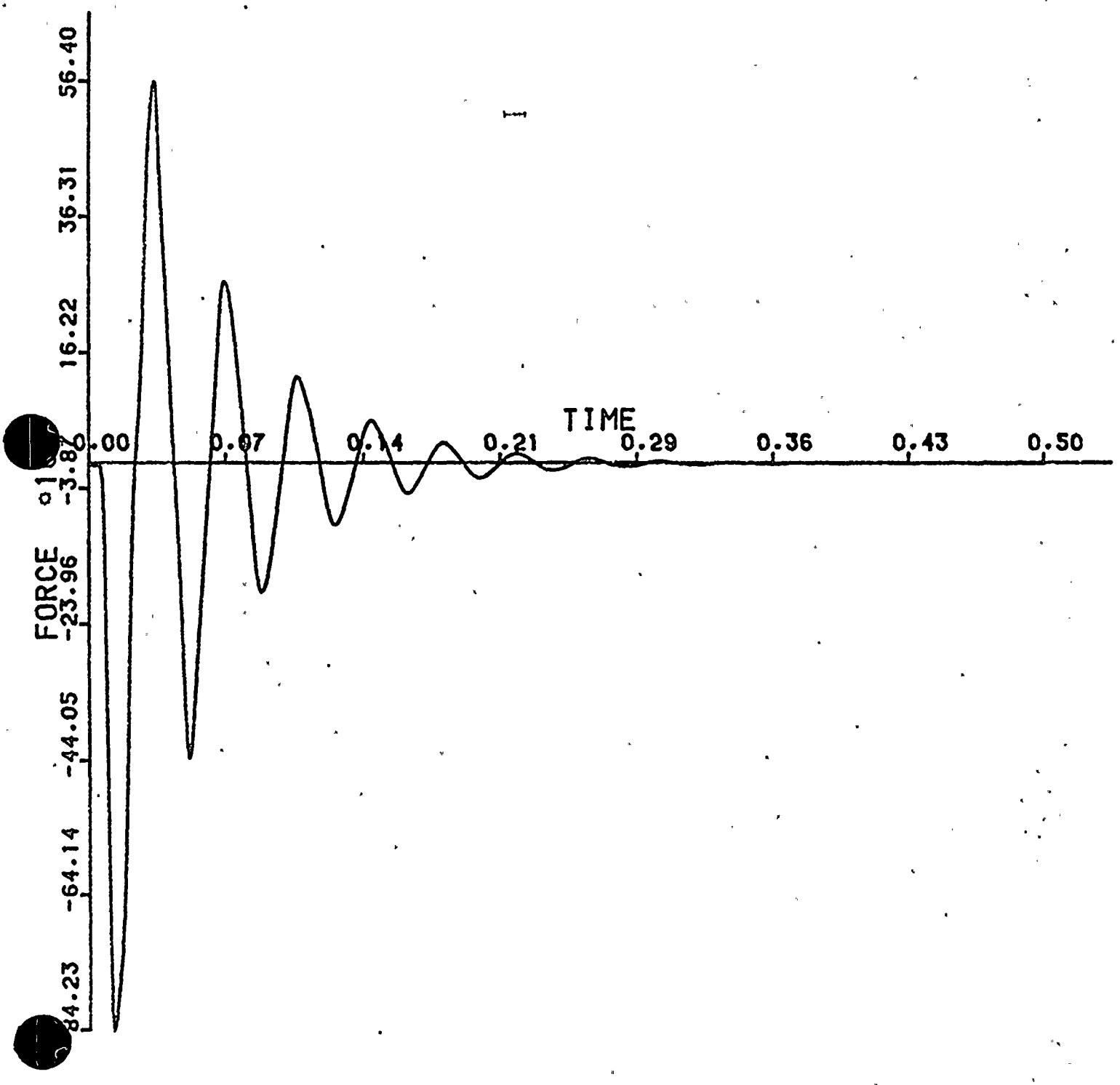
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 46. MAGNITUDE AT NODE POINT 240



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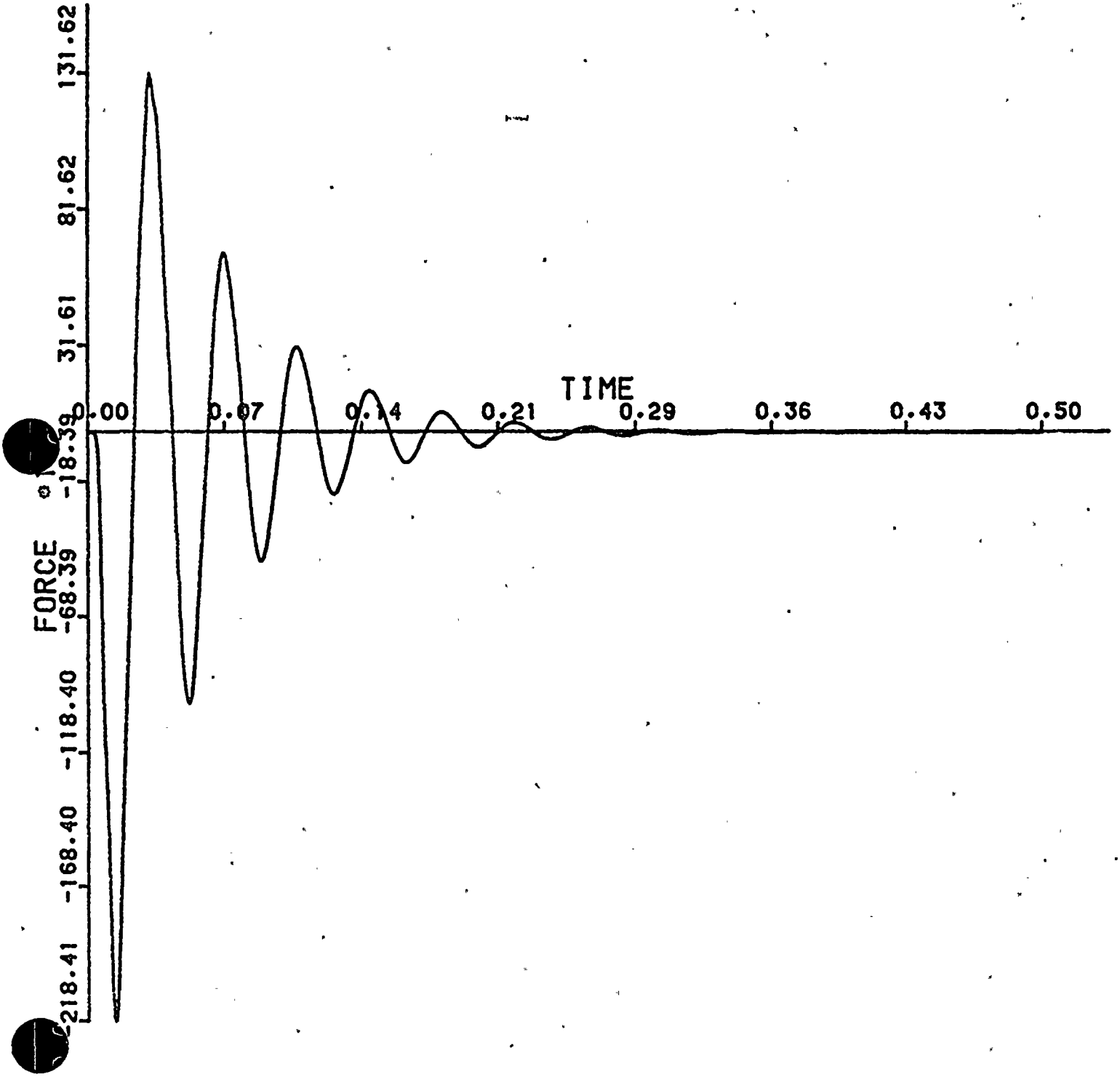
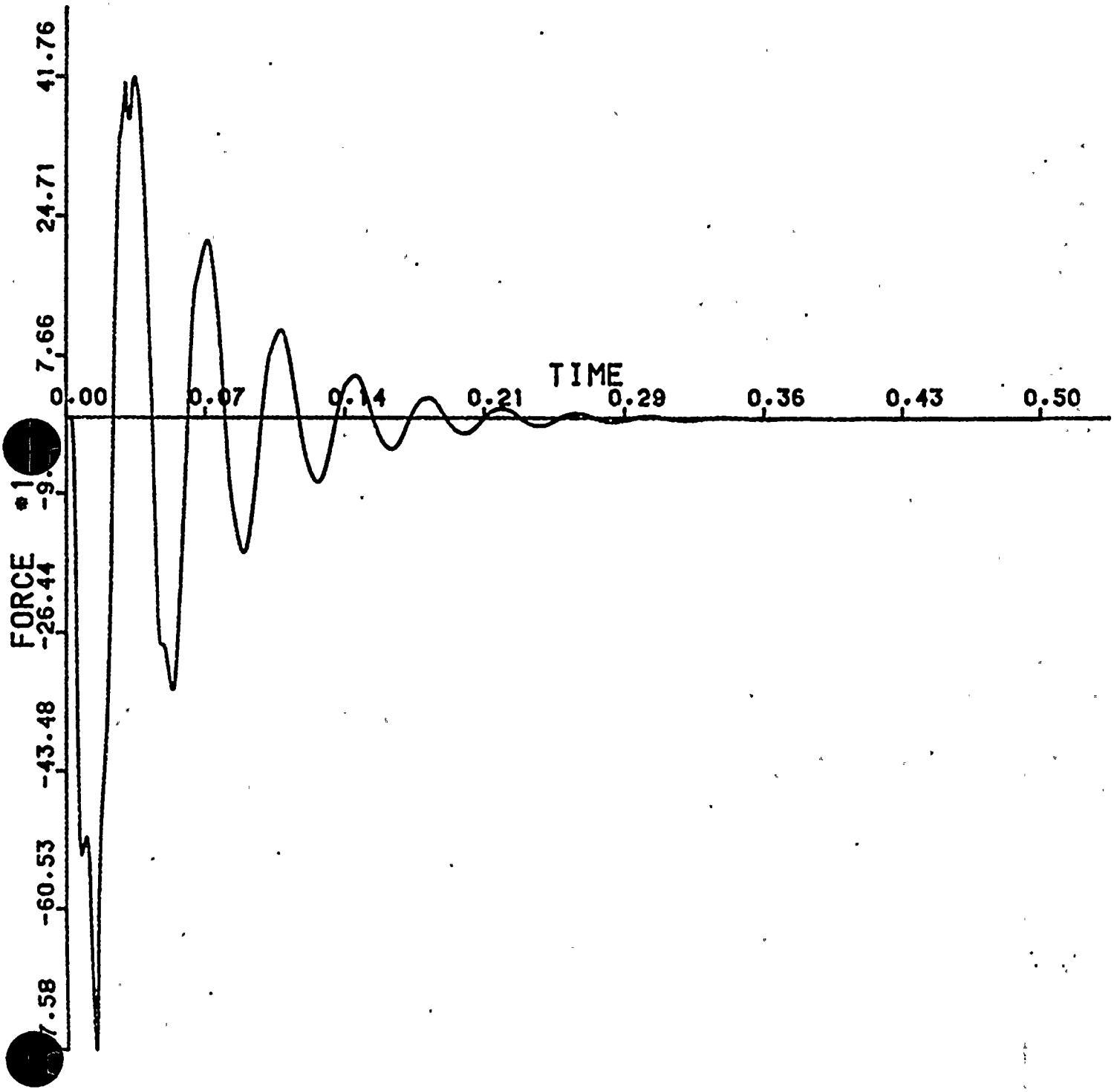
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 47, MAGNITUDE AT NODE POINT 237



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



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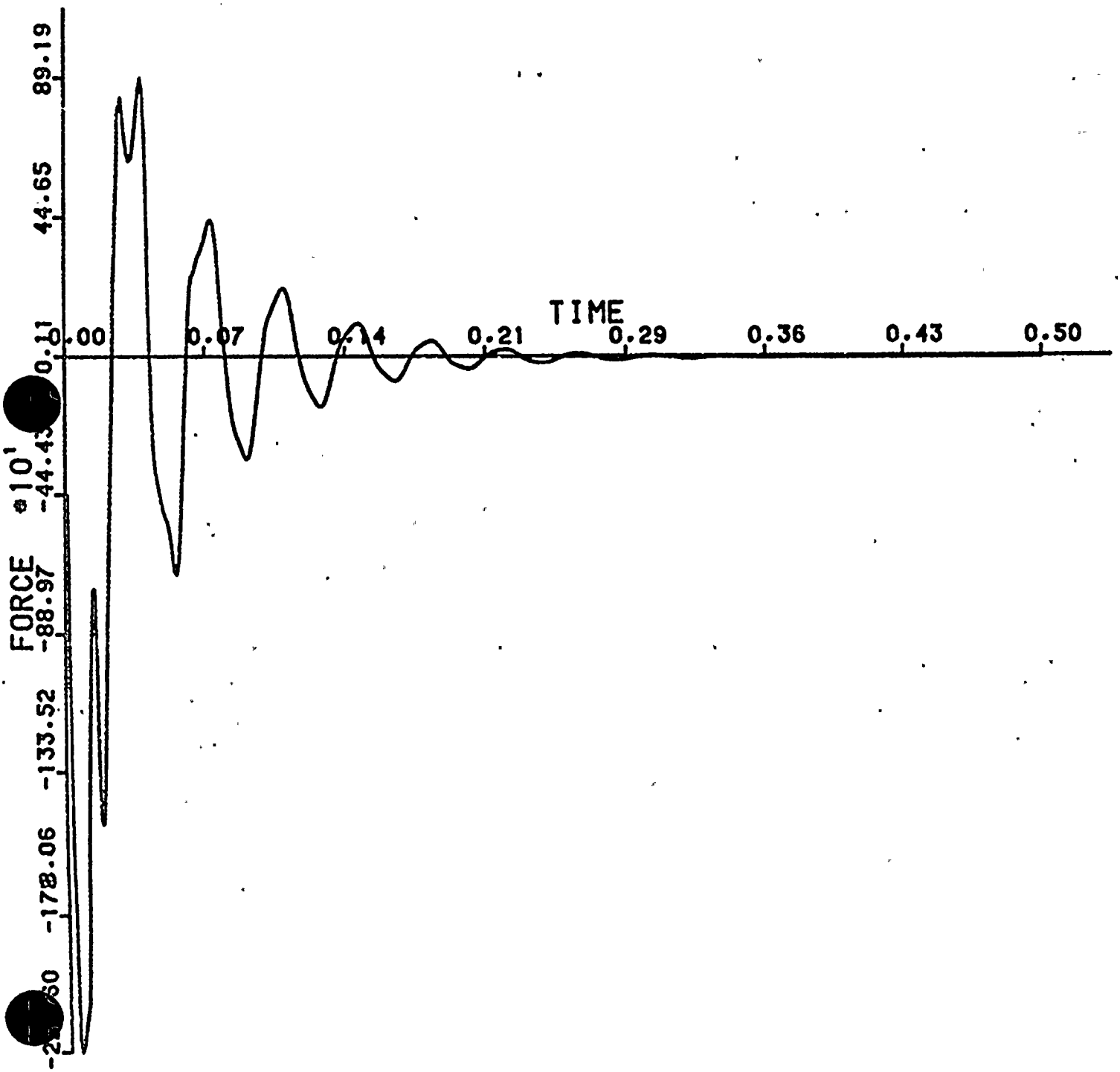
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 49, MAGNITUDE AT NODE POINT 229



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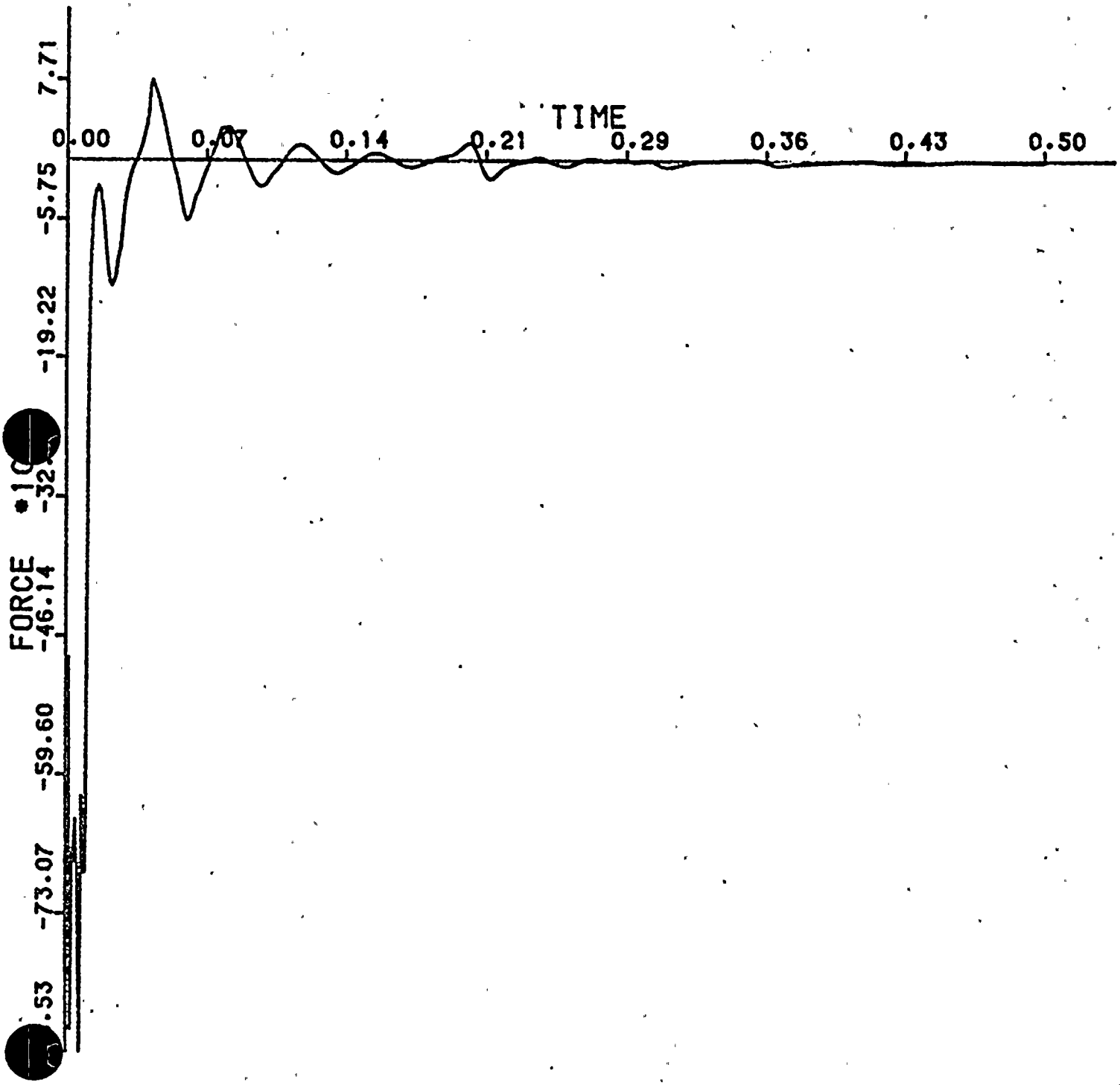
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 50. MAGNITUDE AT NODE POINT 225



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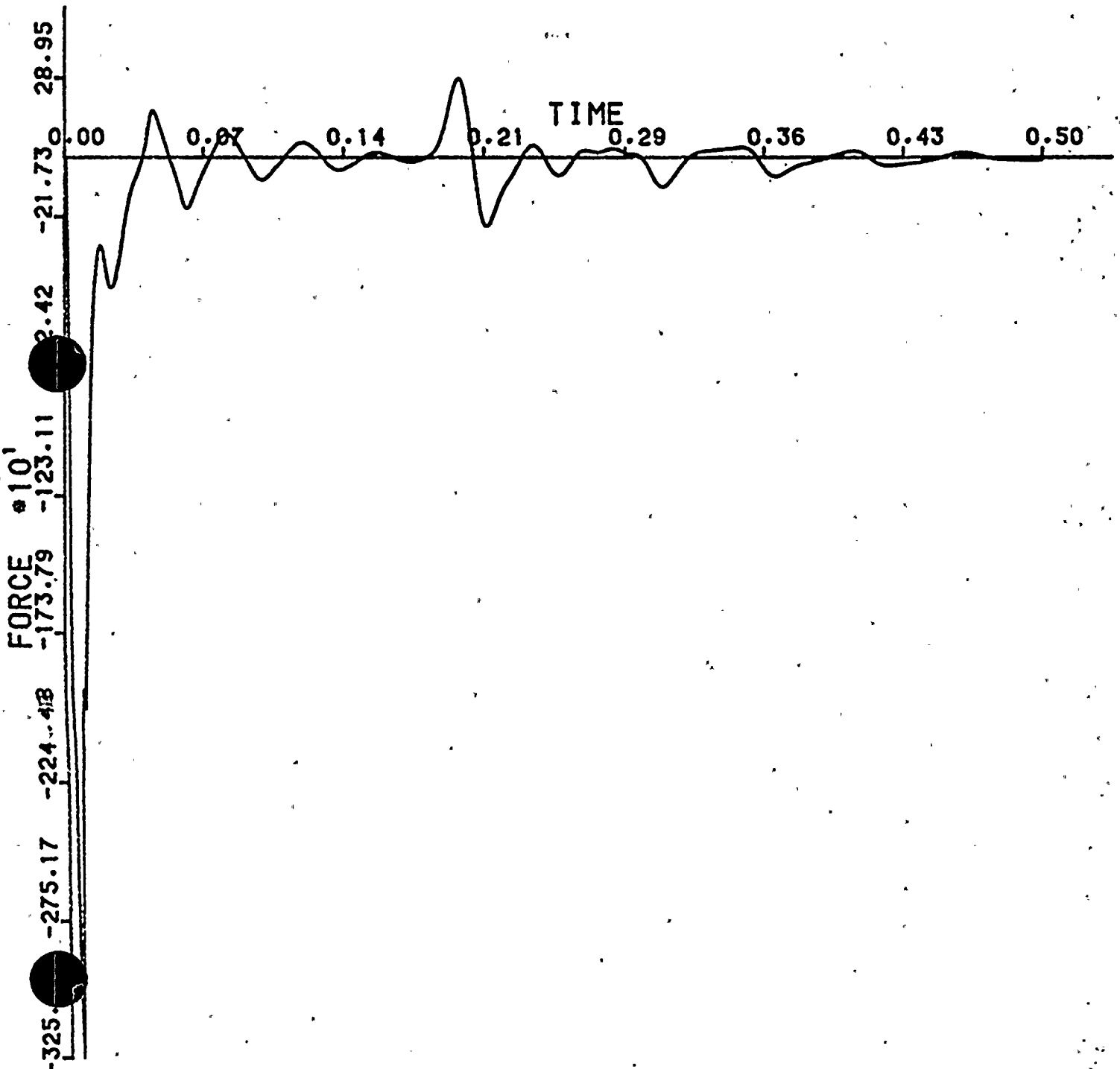
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 51, MAGNITUDE AT NODE POINT 222



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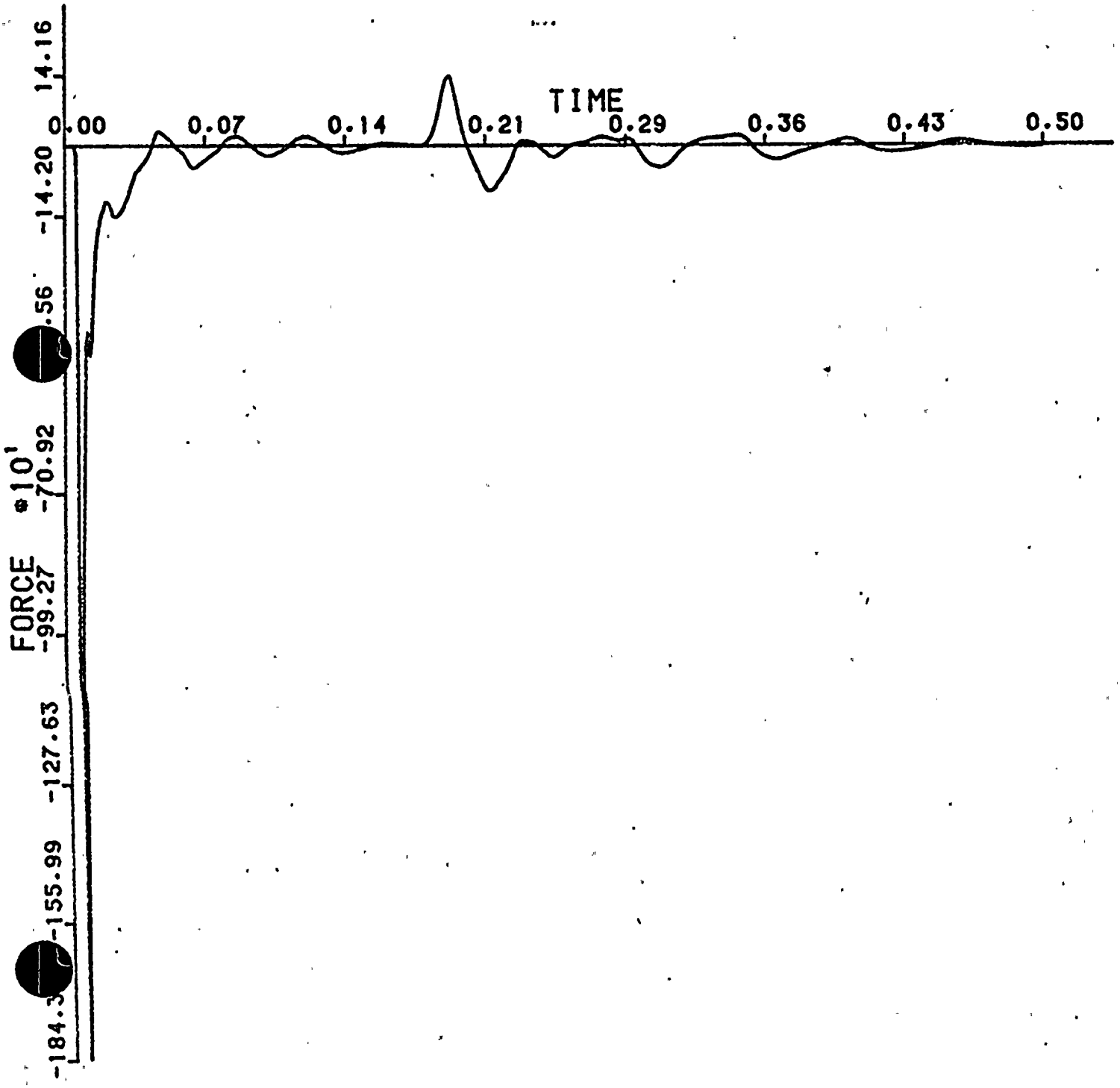
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 52, MAGNITUDE AT NODE POINT 214



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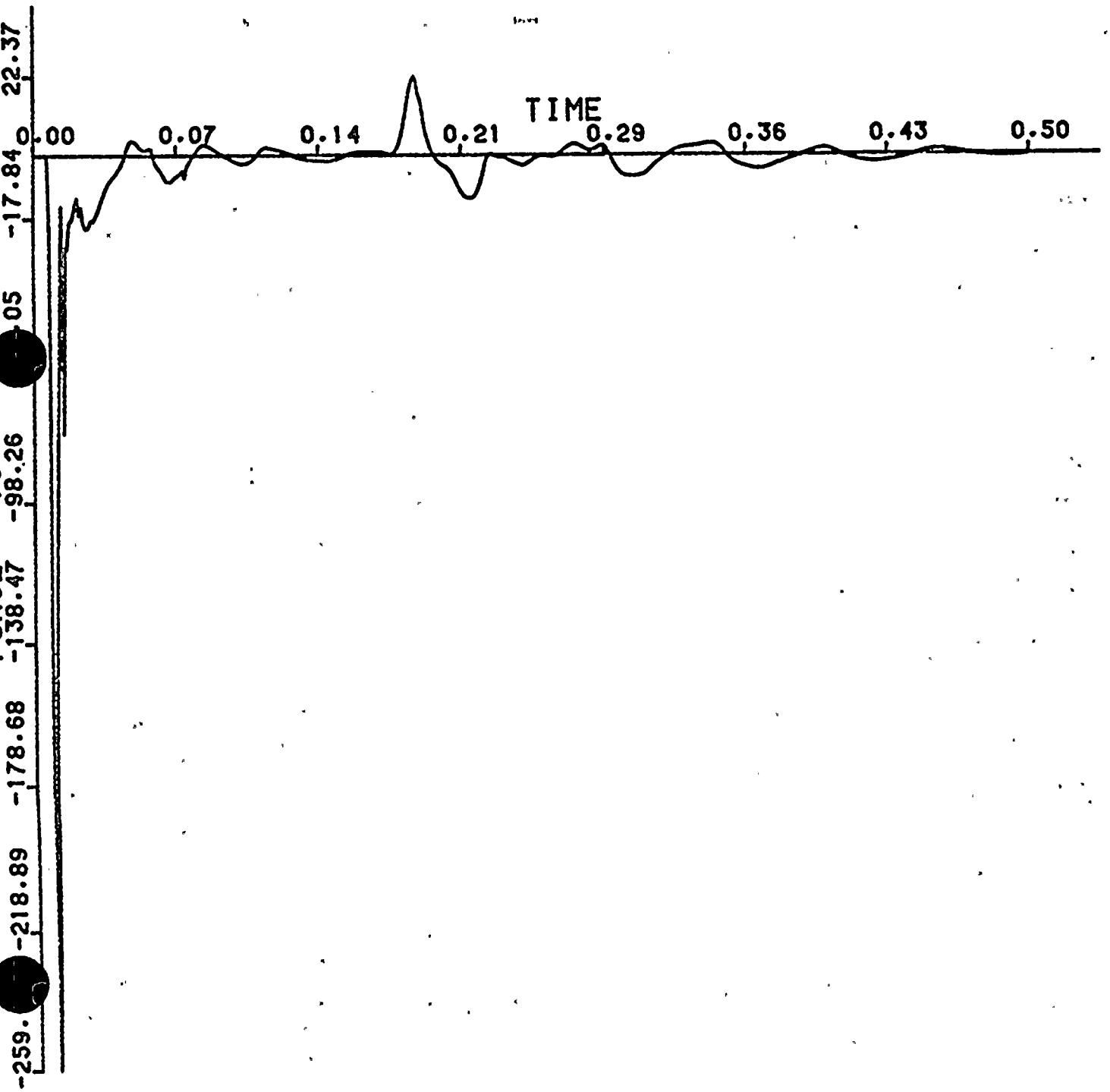
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 53, MAGNITUDE AT NODE POINT 208



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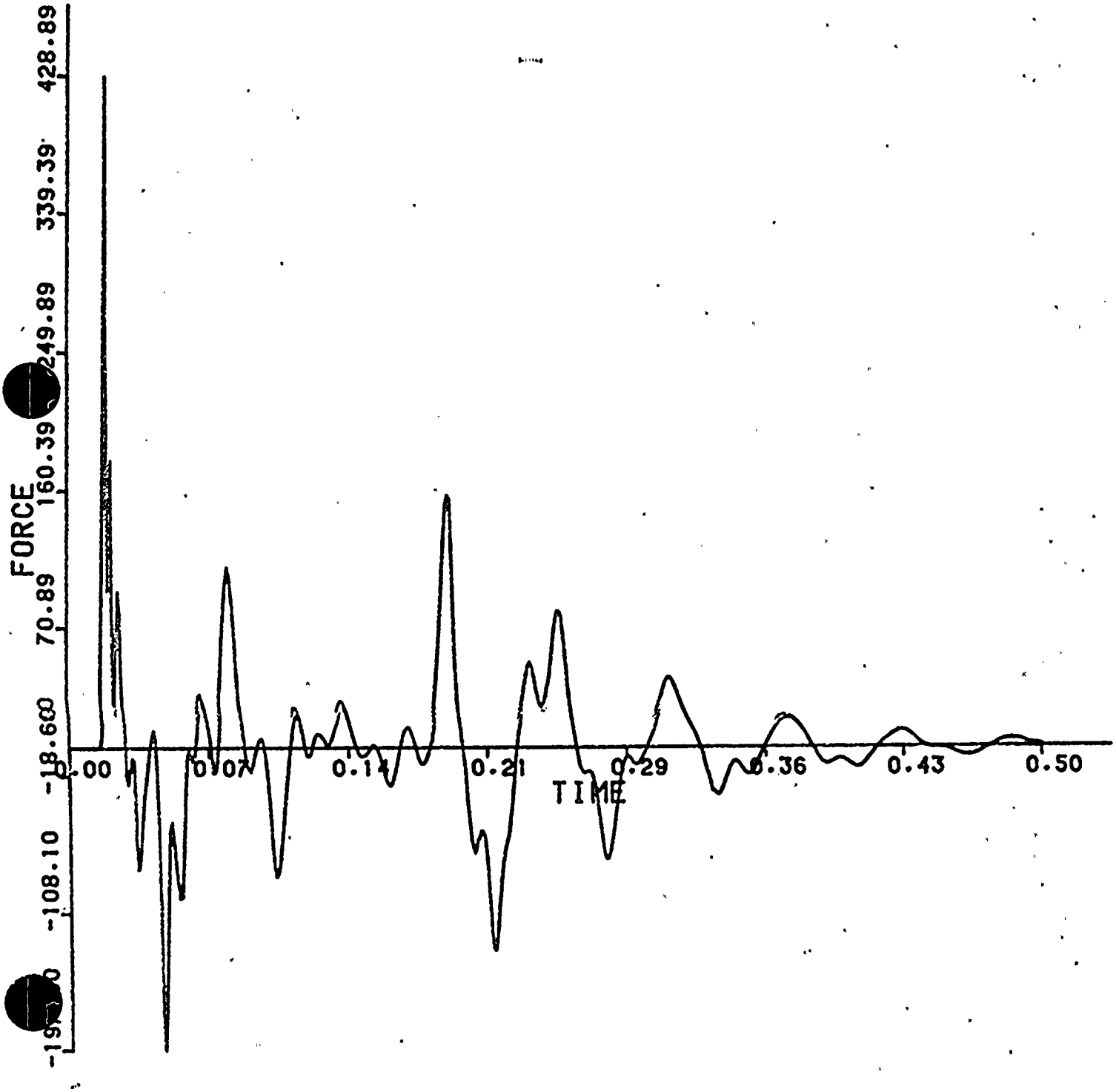
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 54 , MAGNITUDE AT NODE POINT 295



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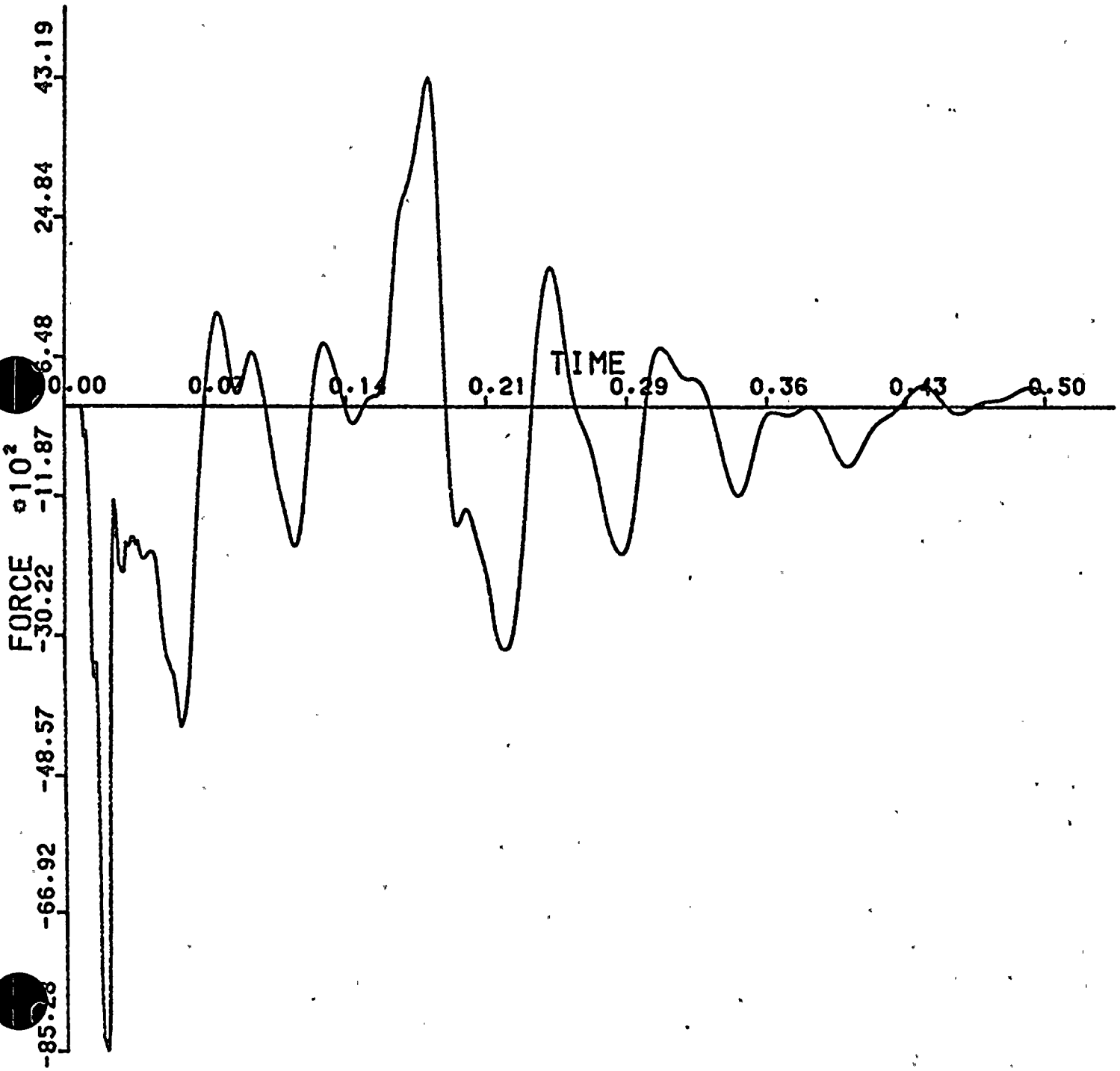
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 55 , MAGNITUDE AT NODE POINT 195



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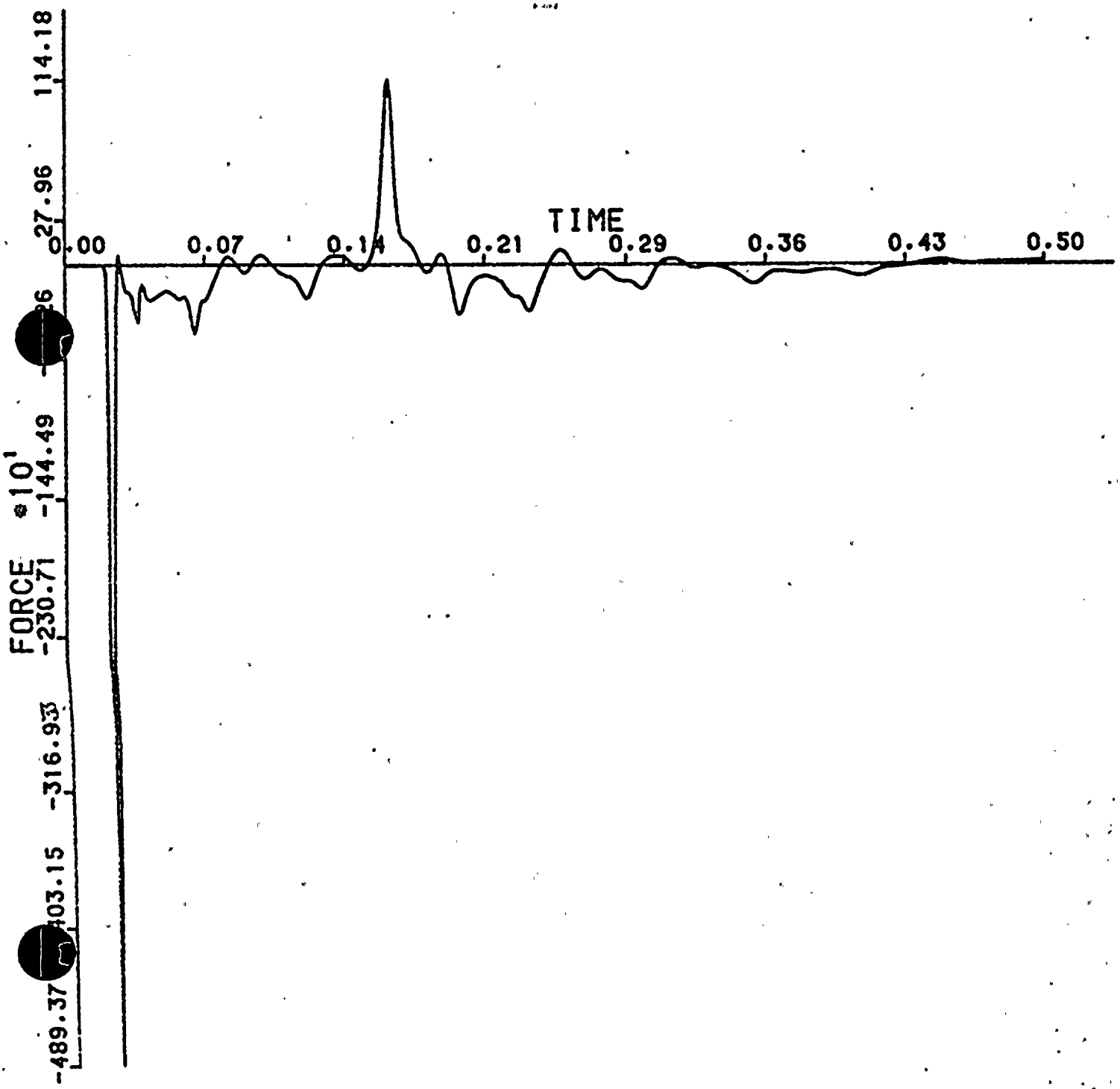
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 56 , MAGNITUDE AT NODE POINT 88



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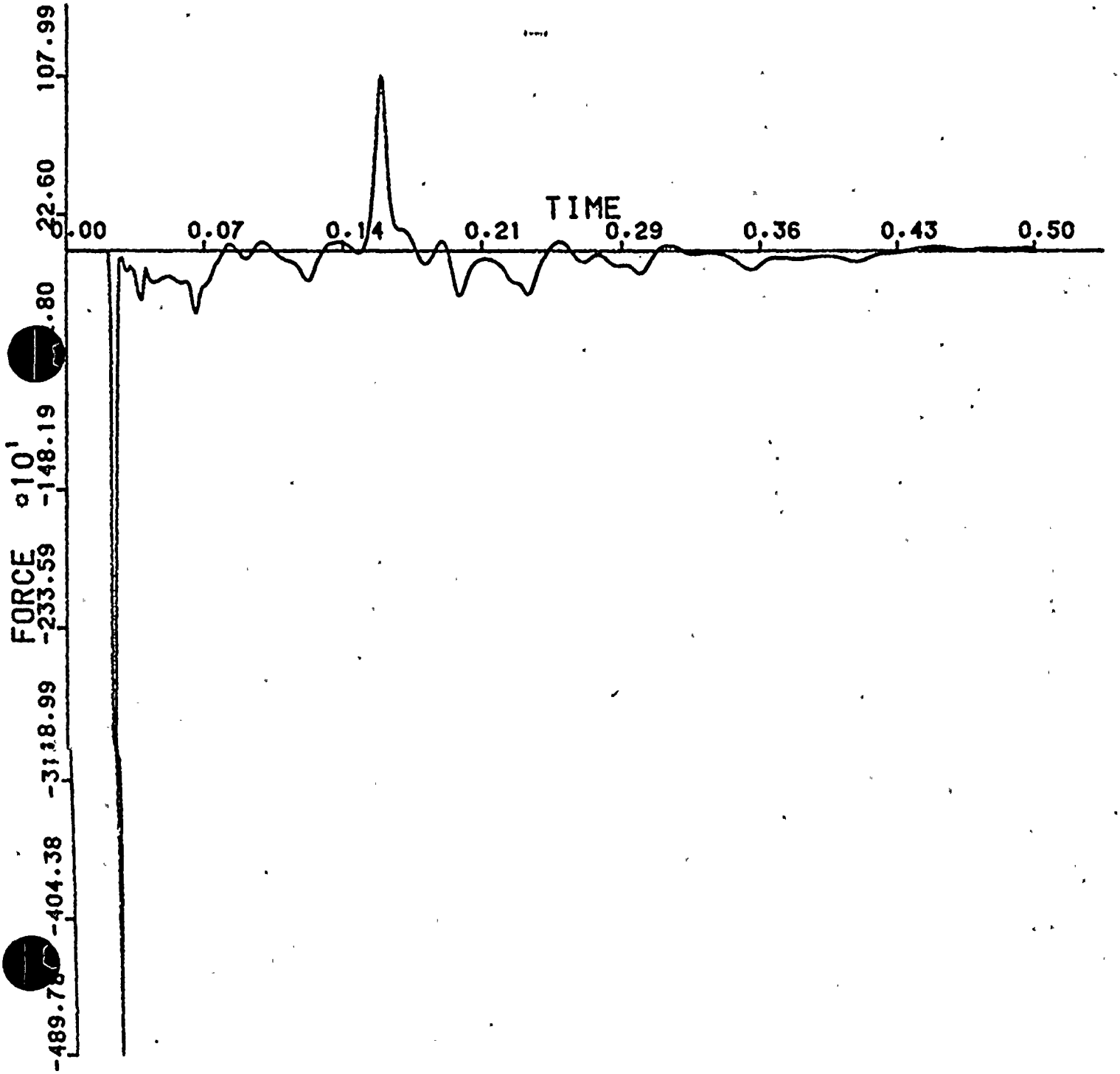
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 57 , MAGNITUDE AT NODE POINT 83



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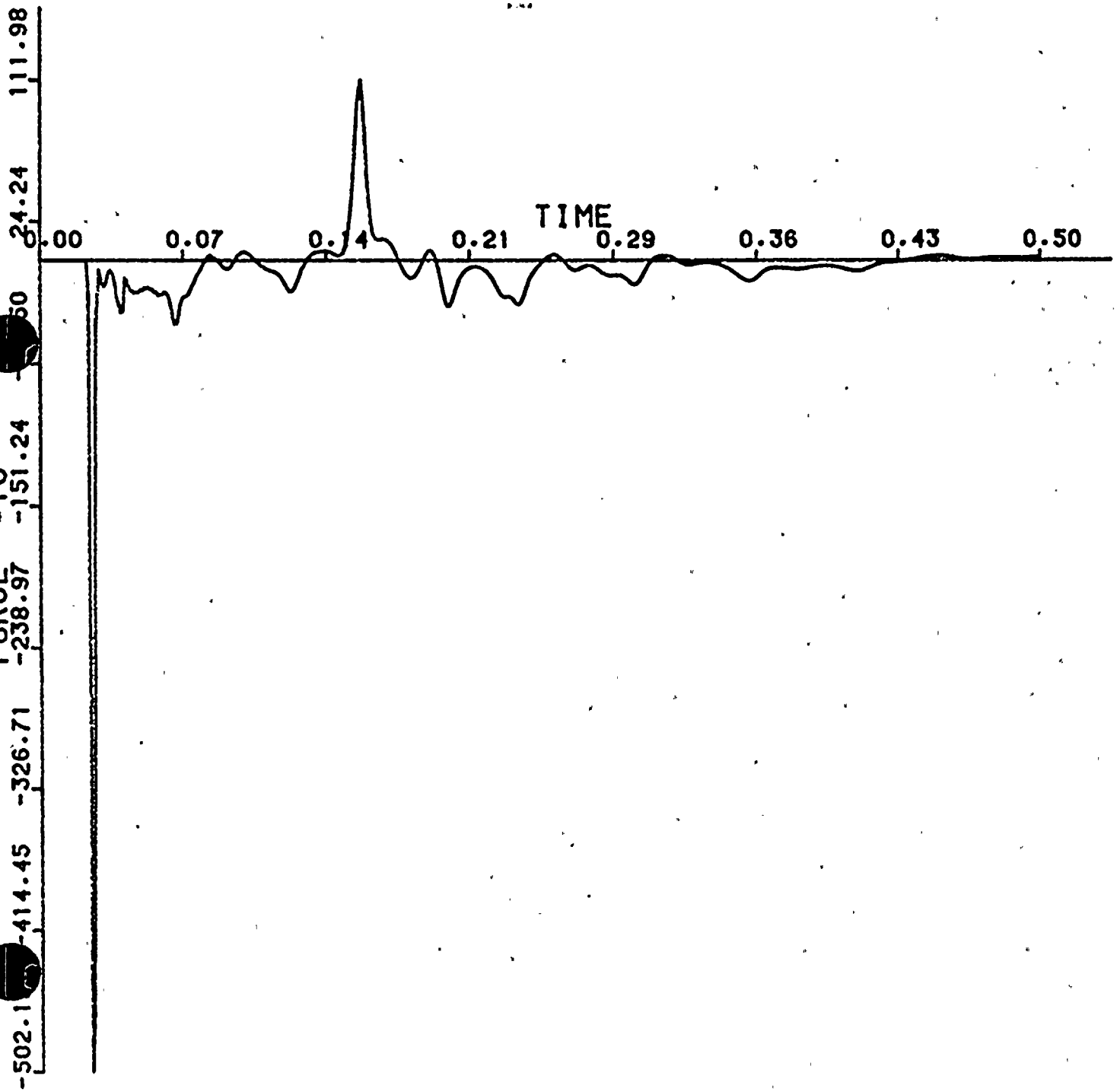
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 58 , MAGNITUDE AT NODE POINT 80



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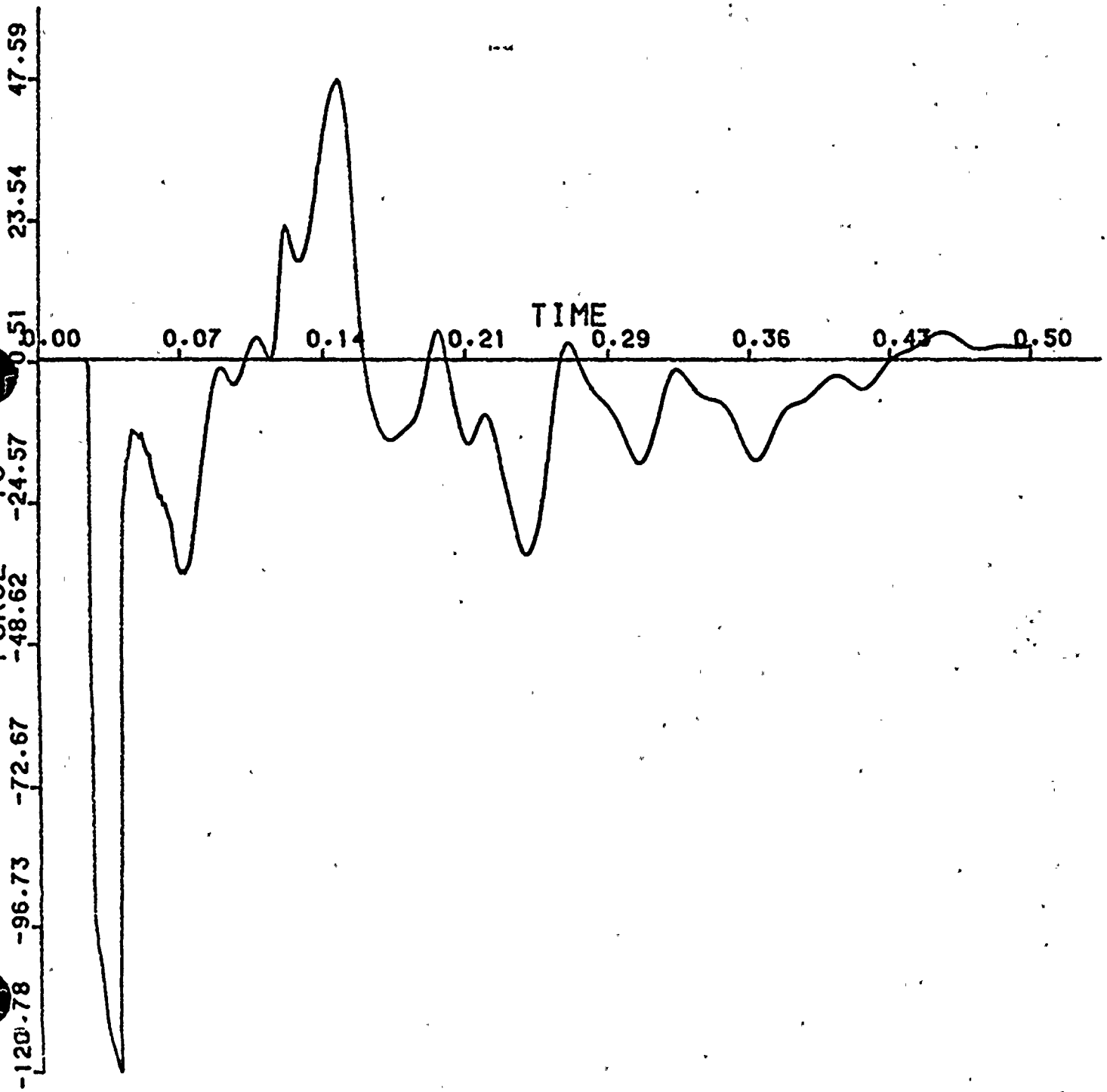
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 59 , MAGNITUDE AT NODE POINT 68



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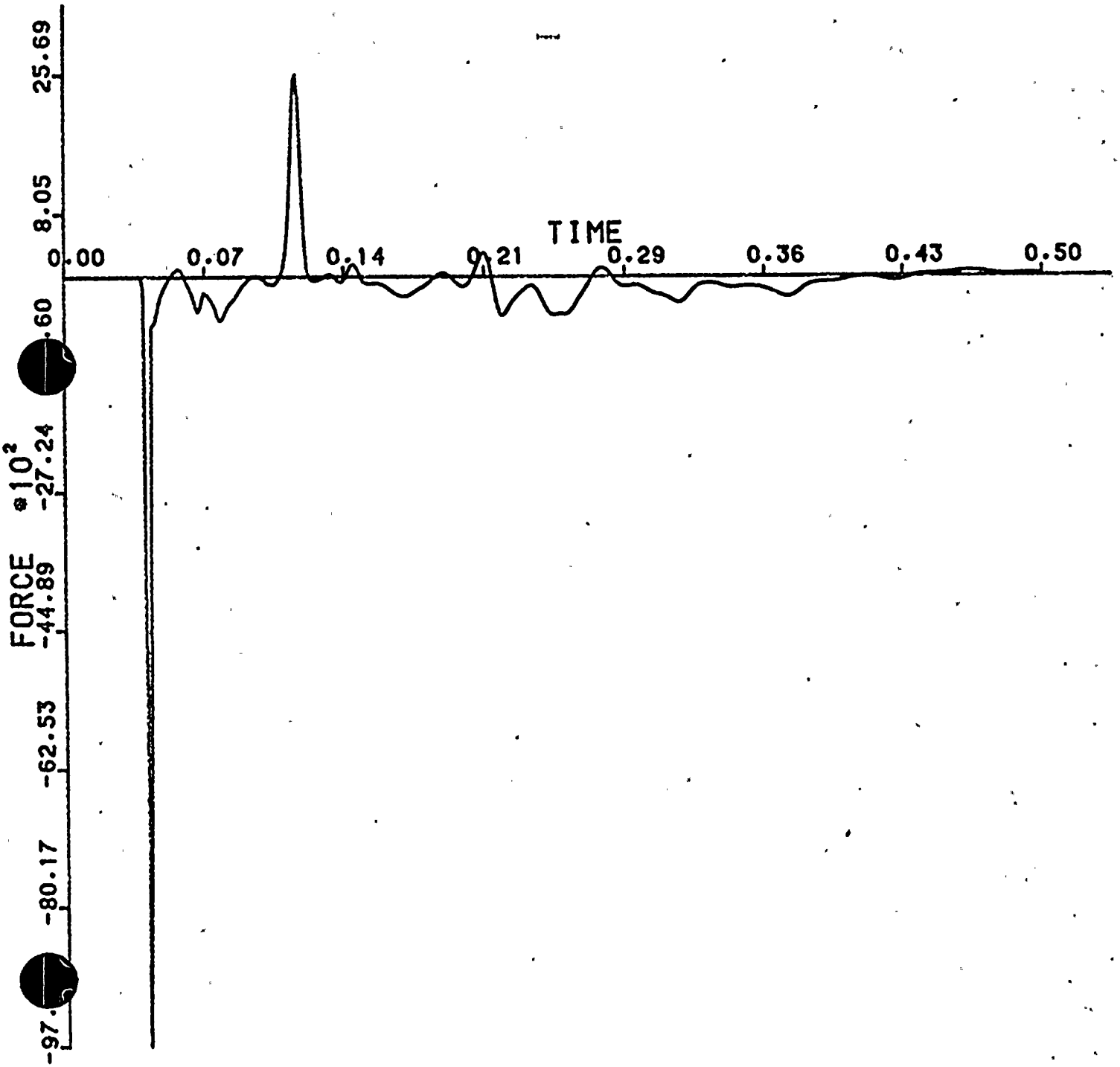
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 60 , MAGNITUDE AT NODE POINT 60



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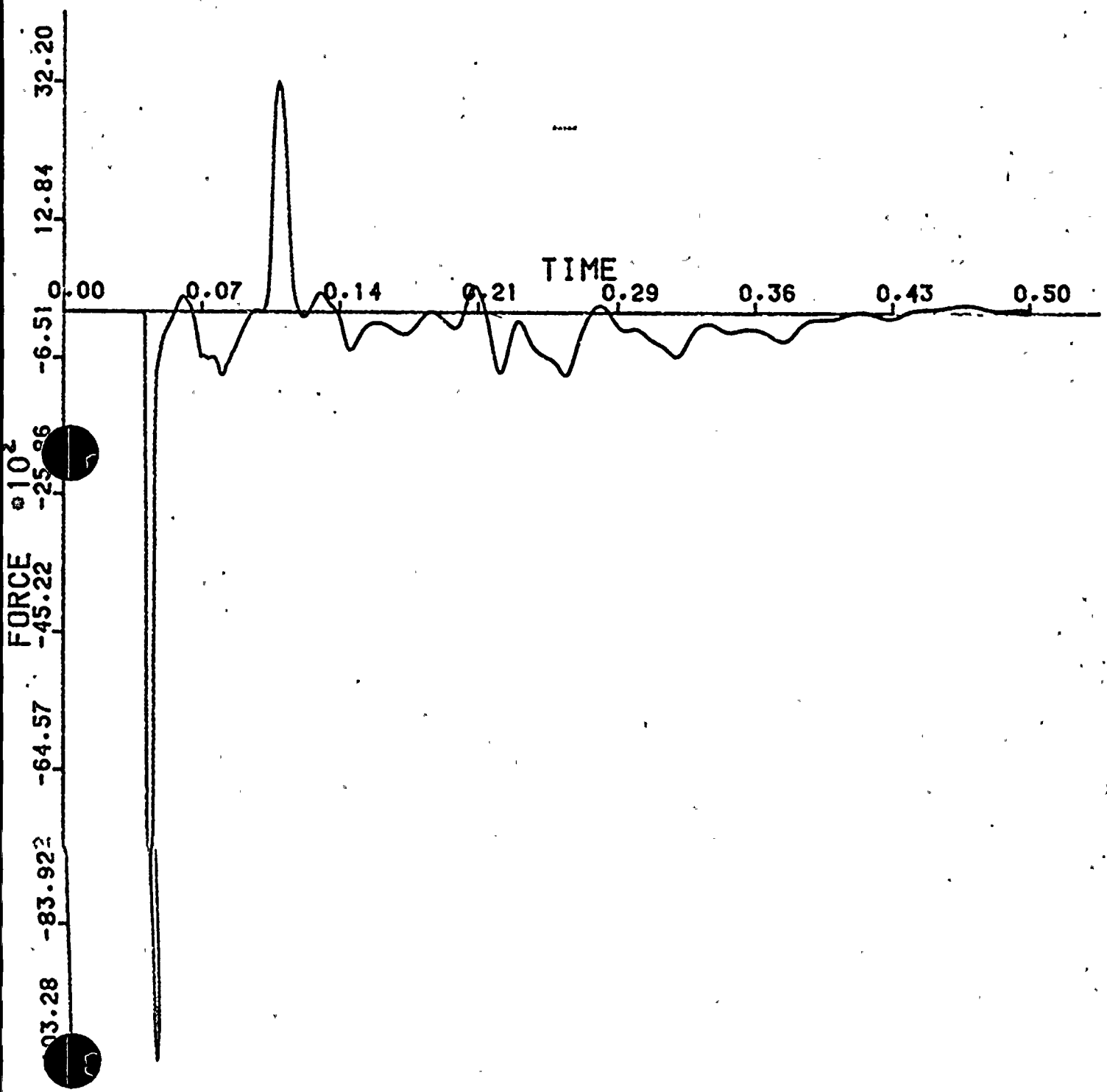
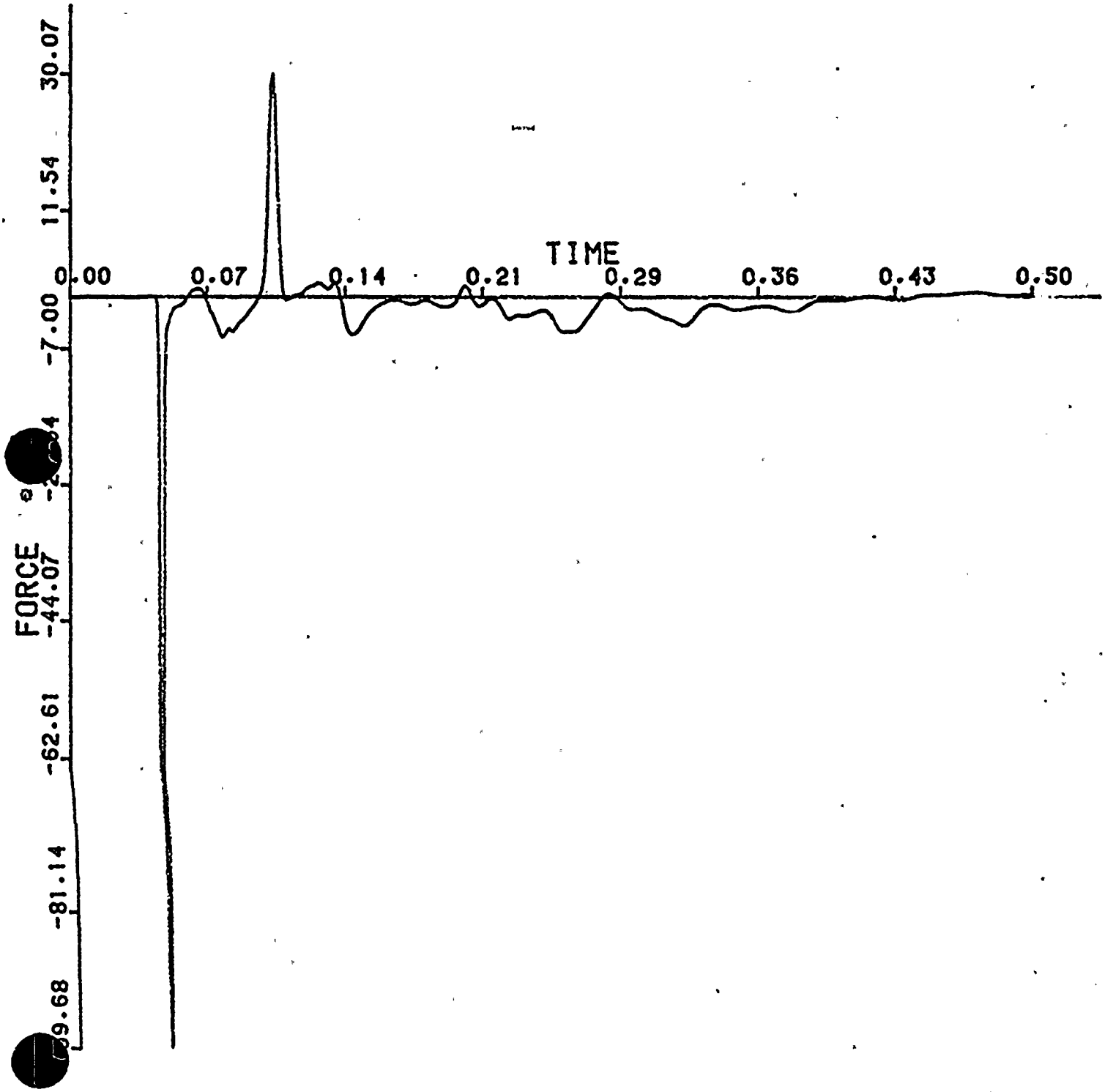
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 61 , MAGNITUDE AT NODE POINT 56



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



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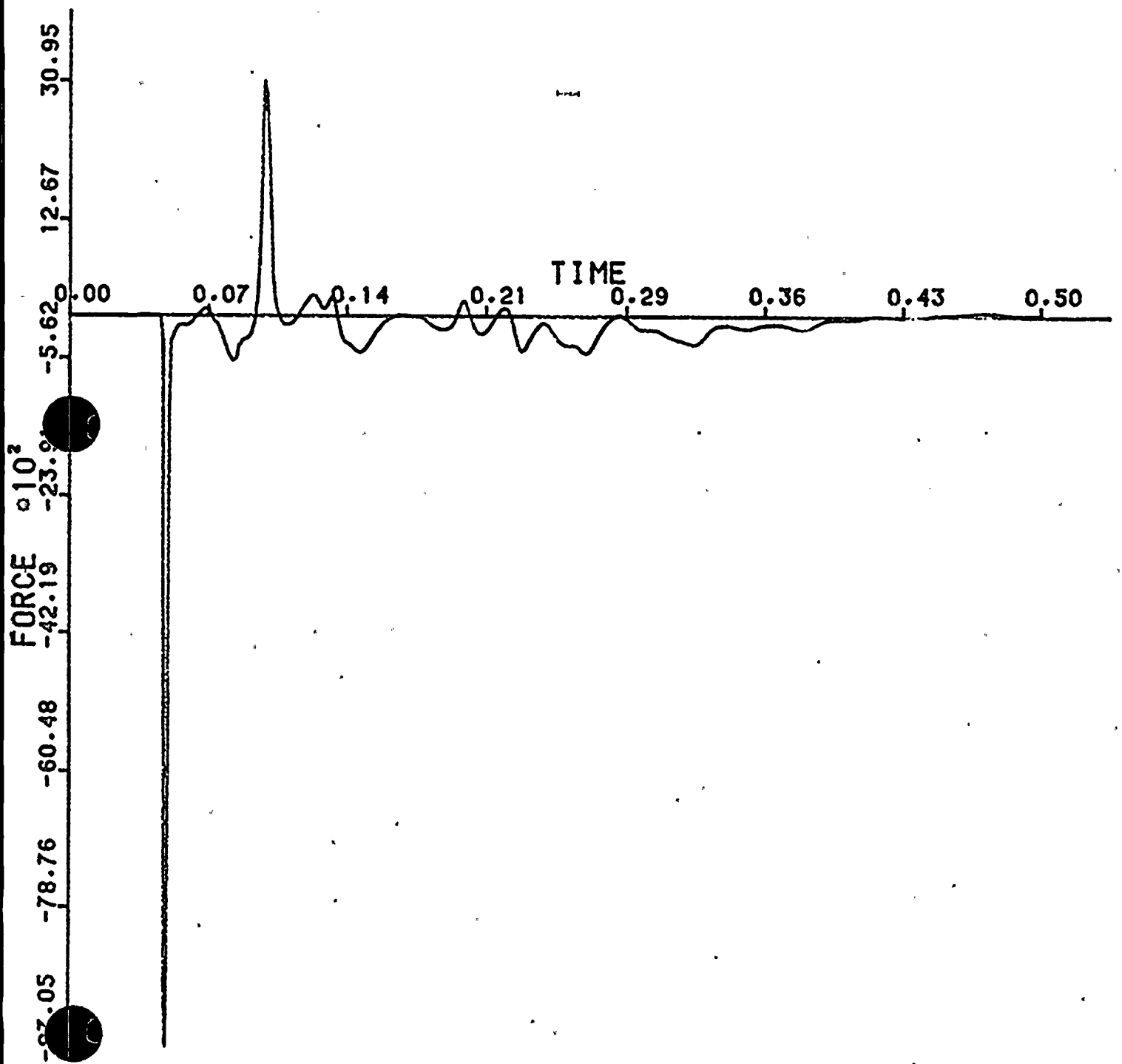
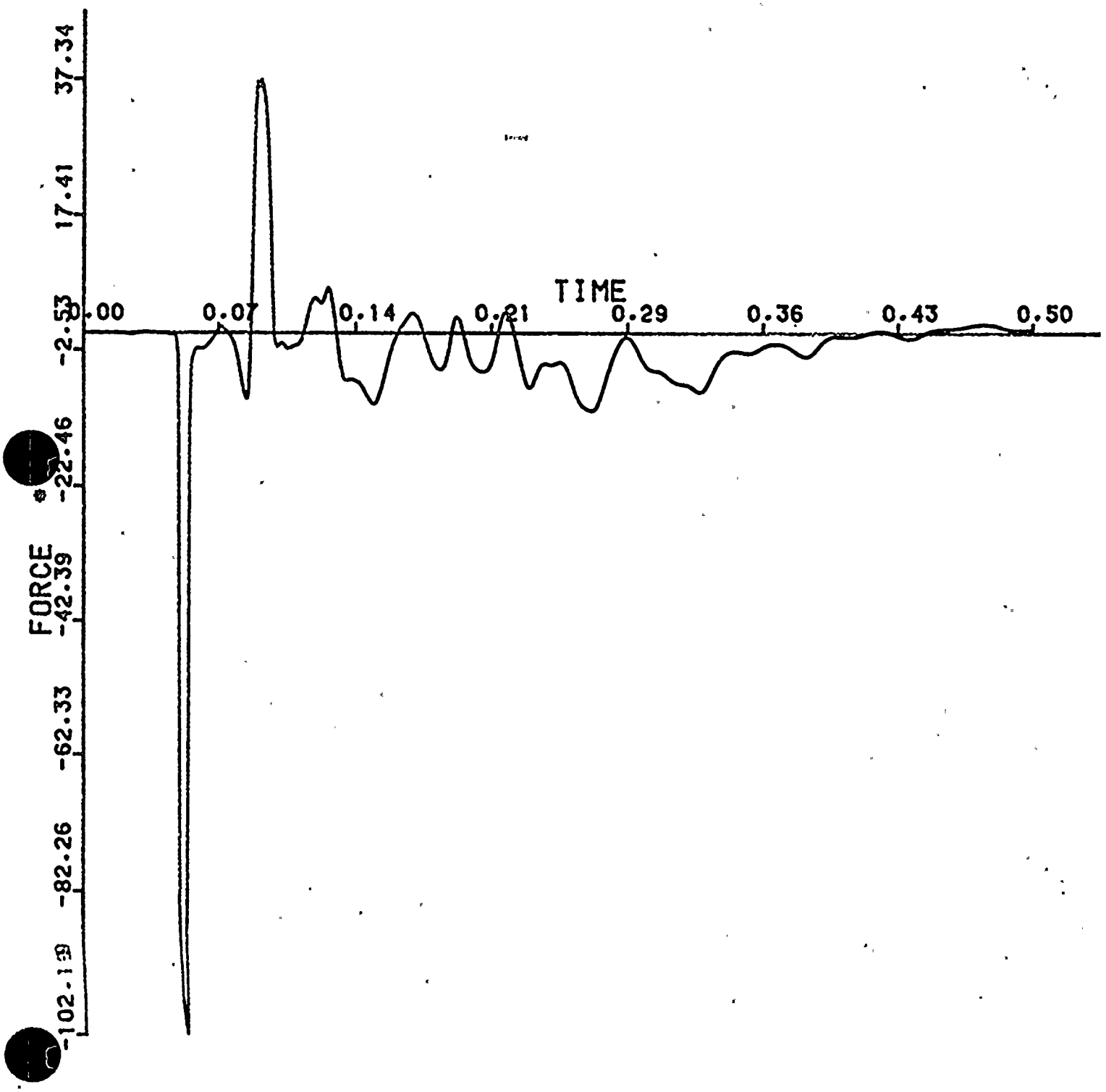
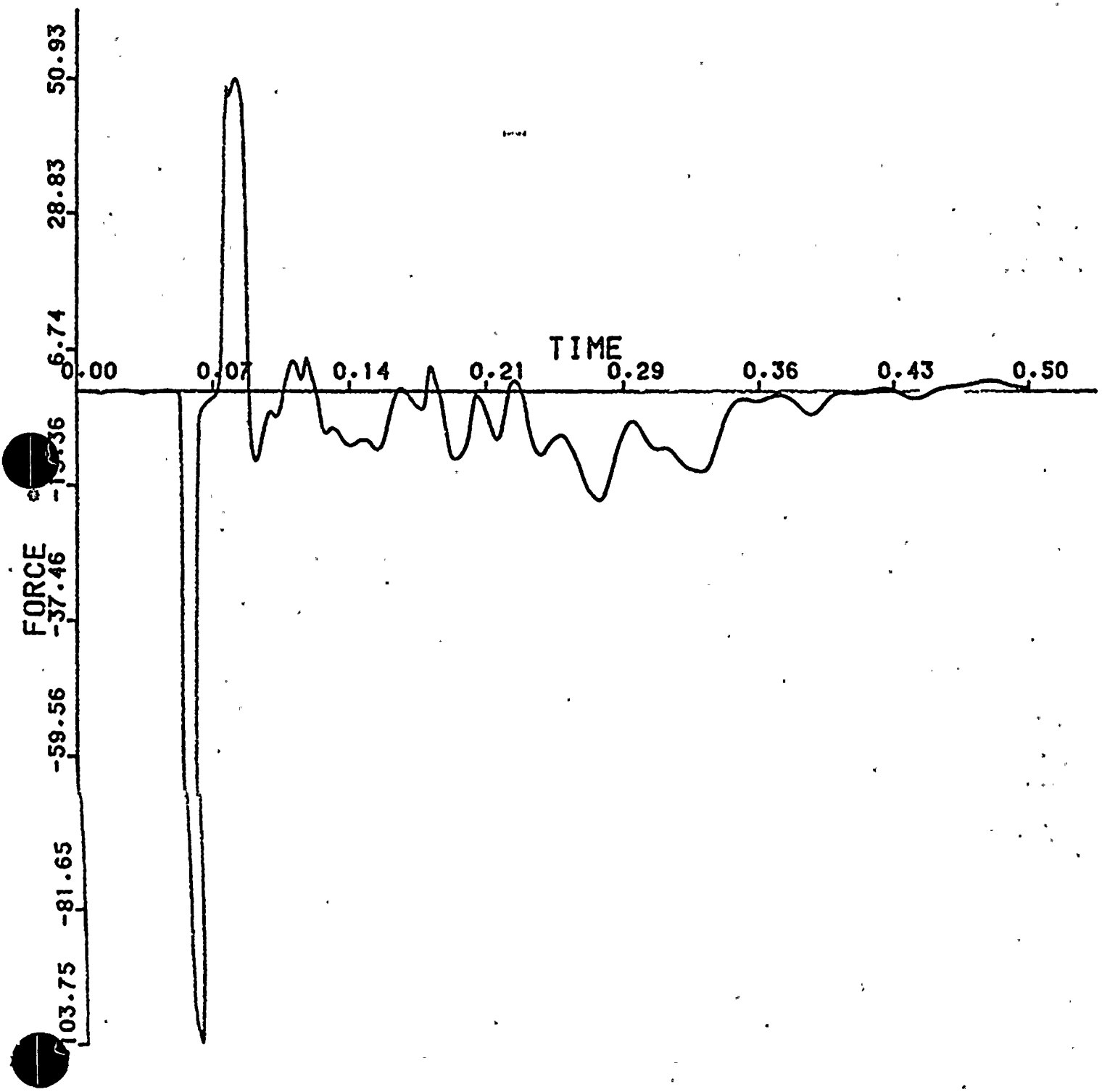
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 63, MAGNITUDE AT NODE POINT 44



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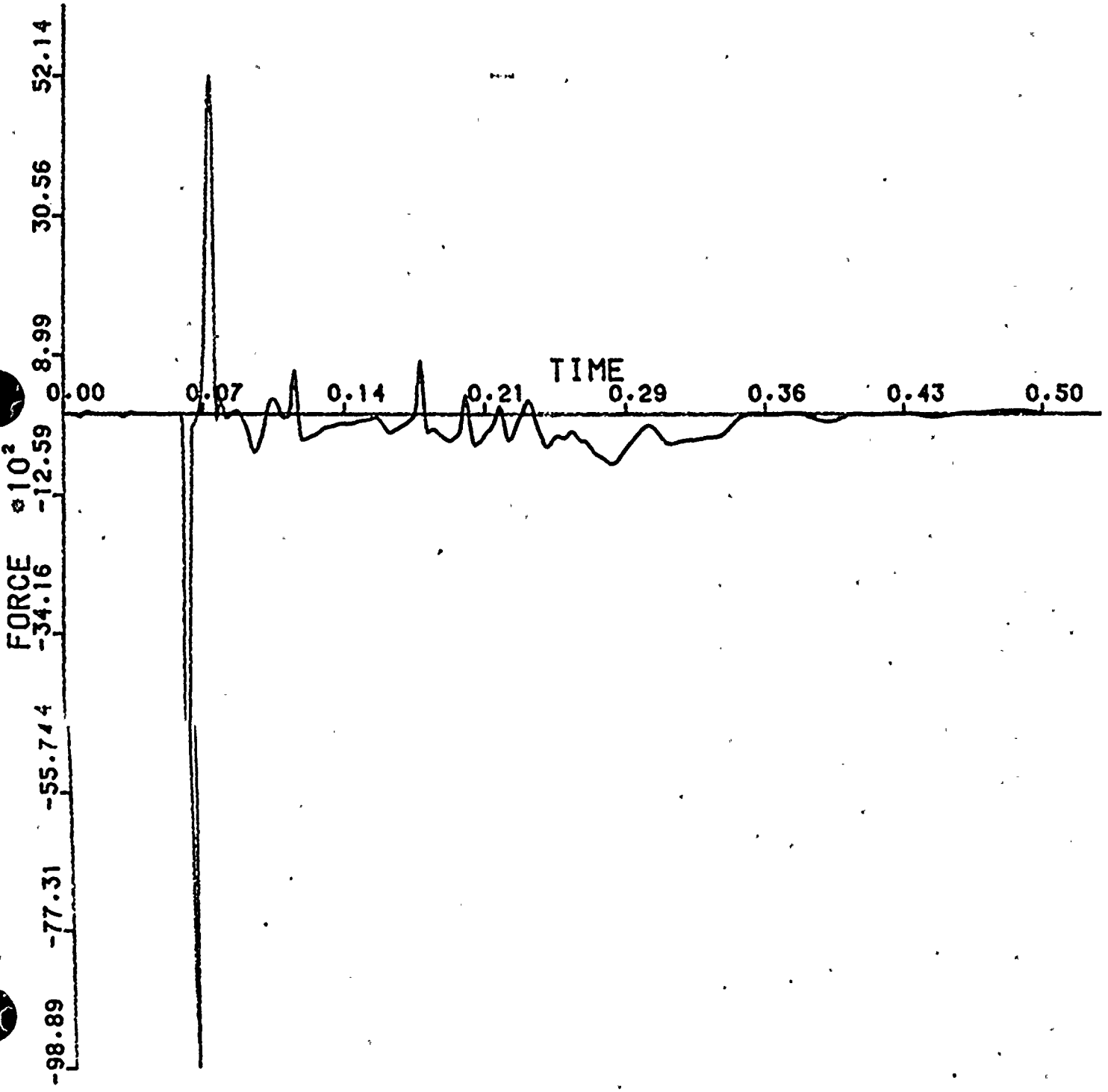
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 66, MAGNITUDE AT NODE POINT 8



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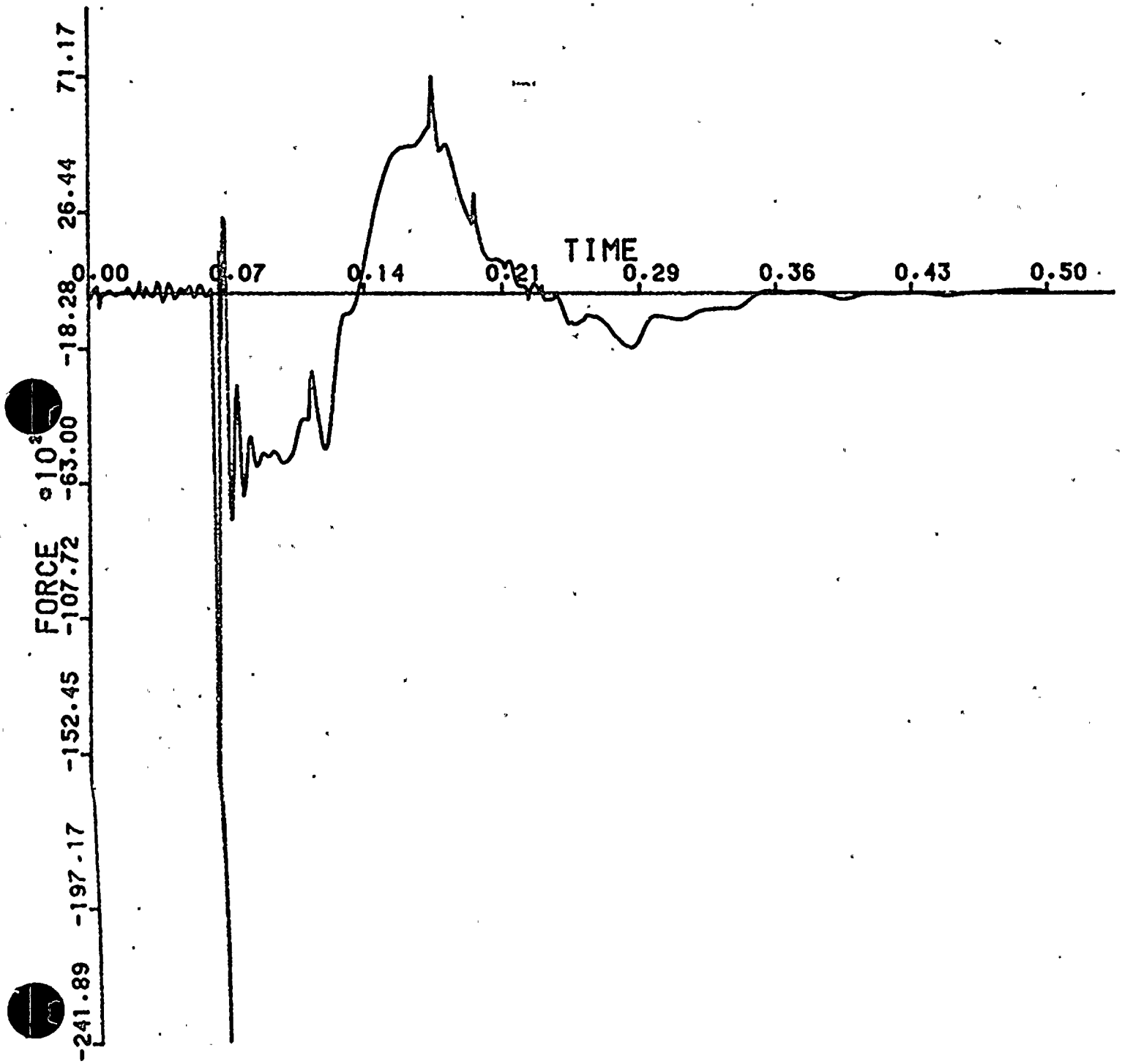
SAP2SAP VERIFICATION 5364 6-JUL-83
DC COOK-UNIT1, SV MODIFICATION
TIME/FORCE TABLE 67, MAGNITUDE AT NODE POINT 4



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

```
    1   =D.C.COOK UNIT1 3  SV'S OPEN
    2   *  DISCHARGE PIPINGS
    3   *  THIS IS THE NUMBERING SYSTEM FOR UNIT1'S RELAP MODEL
    4   *  WHERE COMPONENT'S NUMBERED IN THE;
    5   *          100'S ARE  VALVE SV-45C AND ARC 1 LEVEL  669'-2"
    6   *          200'S ARE  VALVE SV-45B AND ARC 2 LEVEL  670'-10"
    7   *          300'S ARE  VALVE SV-45A ARN ARC 3 LEVEL  672'-8"
    8   *          400'S ARE  PORV NRV-151 AND ARC "A"
    9   *          500'S ARE  PORV NRV-153 AND ARC "B"
   10   *          600'S ARE  PORV NRV-152 AND ARC "C"
   11   *          700'S AND  800'S ARE 6" AND 12" MAIN DISCHARGE PIPING
   12   *          900'S QUENCH TANK PORTION
   13   *          999  ATMOSPHERE
   14   *
   15   *
   16   *
   17   100      NEW  TRANSNT
   18   101       RUN
   19   102       BRITISH    BRITISH
   20   104      NOACTION
   21   *
   22   ************************************************
   23   *      TIME STEP CONTROL                       *
   24   ************************************************
   25   *
   26   201       0.500,1.-7,2.-4,11001,5,50,250
   27   *
   28   *
   29   ************************************************
   30   *          MINOR EDITS                         *
   31   ************************************************
   32   *
   33   301  MFLOWJ  106000000
   34   302  MFLOWJ  206000000
   35   303  MFLOWJ  306000000
   36   304  MFLOWJ  308000000
   37   305  MFLOWJ  208000000
   38   306  MFLOWJ  702000000
   39   307  MFLOWJ  108000000
   40   308  MFLOWJ  977000000
   41   *
   42   309  QUALS   105200000
   43   310  QUALS   107010000
   44   311  QUALS   107330000
   45   312  QUALS   701010000
   46   313  QUALS   811970000
   47   314  QUALS   813250000
   48   315  QUALS   978130000
   49   316  QUALS   205200000
   50   317  QUALS   207010000
   51   318  QUALS   305200000
   52   319  QUALS   207250000
   53   320  QUALS   307010000
   54   321  QUALS   307130000
   55   *
   56   323  P       105200000
```

```
3124  P        107010000
3126  P        107330000
3127  P        701010000
3131  P        811970000
3132  P        813260000
3133  P        978020000
3134  P        978030000
3135  P        205200000
3136  P        207010000
3137  P        305200000
3138  P        207260000
3139  P        307010000
3140  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' 6".
*
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
```

```
  115    2026    307160000,307170000,307180000,801010000
  116    *
  117    *
  118    *
  119    *
  120    *
  121    *    SV ARC FROM VALVE 45B DOWN TO ELEVATION 670' 10"
  122    *
  123    2029    201010000,203010000,203020000,203030000,203040000
  124    2030    205010000,205020000,205030000,205040000,205050000
  125    2031    205060000,205070000,205080000,205090000,205100000
  126    2032    205110000,205120000,205130000,205140000,205150000
  127    2033    205160000,205170000,205180000,205190000,205200000
  128    2034    207010000,207020000,207030000,207040000,207050000
  129    2035    207060000,207070000,207080000,207090000,207100000
  130    2036    207110000,207120000,207130000,207140000,207150000
  131    2037    207160000,207170000,207180000,207190000,207200000
  132    2038    207210000,207220000,207230000,207240000,207250000
  133    2039    207260000,805010000
  134    *
  135    *
  136    *
  137    *
  138    *
  139    *
  140    *    SV ARC FROM VALVE 45C DOWN TO ELEVATION 669' 2"
  141    *
  142    2042    101010000,103010000,103020000,103030000,103040000
  143    2043    105010000,105020000,105030000,105040000,105050000
  144    2044    105060000,105070000,105080000,105090000,105100000
  145    2045    105110000,105120000,105130000,105140000,105150000
  146    2046    105160000,105170000,105180000,105190000,105200000
  147    2047    107010000,107020000,107030000,107040000,107050000
  148    2048    107060000,107070000,107080000,107090000,107100000
  149    2049    107110000,107120000,107130000,107140000,107150000
  150    2050    107160000,107170000,107180000,107190000,107200000
  151    2051    107210000,107220000,107230000,107240000,107250000
  152    2052    107260000,107270000,107280000,107290000,107300000
  153    2053    107310000,107320000,107330000,809010000
  154    *
  155    *
  156    *
  157    *
  158    *
  159    *
  160    ************************************************************************
  161    * THIS RUN OF RELAP INCLUDES SAFETY RELIEF VALVE LINES AND MAIN        *
  162    * DISCHARGE LINE BETWEEN ELEV. 684'-9"  TO  ELEV. 649'- 1/2"           *
  163    ************************************************************************
  164    *
  165    *
  166    *
  167    *
  168    ****************************************
  169    *          TRIPS                       *
  170    ****************************************
  171    *
  172    *
```

```
173    501  TIME  0 GE NULL 0    0.0  L   * VALVE OPENING TRIP
174    502  TIME  0 GE NULL 1    5.0  L   *  JOB TERMINATION TRIP
175    515  P  982010000  GE  NULL 0 114.7   L *  QUENCH TANK RUPTURE PRESS.
176    600       502
177    *
178    ************************************************************
179    *          ***************************************     *
180    *          *  HYDRODYNAMIC COMPONENTS          *     *
181    *          ***************************************     *
182    ************************************************************
183    *
184    ****************************************
185    *  SAFETY VALVES DISCHARGE SECTION     *
186    ****************************************
187    *
188    *
189    *
190    ************************************************************************
191    *    SAFETY VALVE #1   DISCHARGING AT ELEV. 669'-2"   ARC 1
192    ************************************************************************
193    *
194    *    PRESSURIZER COMPONENT
195    1010000   "PRSRZ#1" TMDPVOL
196    1010200   2
197    1010101  0. 20. 500.      0.  0. 0.00005 0. 11
198    1010201  0.,2500.,1      ,2514.,1. .3,2555.,1. .5,2600.,1. .7,2667.,1.
199    1010202  .9,2700.,1      1,2740.,1. 1.3,2745.,1. 1.5,2747.,1. 1.7,2748.,1.
200    1010203  1.9,2750.,1
201    *
202    *    PIPE COMPONENTS
203    1020000   "PRZ1-EXIT"  SNGLJUN
204    1020101   101000000    1000000 0.0 0.0 0.0  1000
205    1020201   1    0.0  0.0  0.0
206    *
207    *    VALVE  UPSTREAM
208    *
209    1030000   "LS1 IN"   PIPE
210    *    NO. OF VOLS.
211    1030001        4
212    *    VOL. FLOW AREA
213    1030101   0.14653      4
214    *    VOL. LENGTHS
215    1030301   0.3490       1
216    1030302   0.4238       4
217    *    VOL. CAL. AUTO
218    1030401   0.0          4
219    *    VERT. ANGLES
220    1030601   45.          1
221    1030602   0.0          4
222    *    PIPE ROUGHNESS
223    1030801   1.513-4      4
224    *    JUN. LOSS COEFF
225    1030901   0.0918       1
226    1030902   0.0          3
227    *
228    1031001   00           4
229    *
230    1031101   1000         3
```

```
*
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  0.0    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        18
*
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
```

```
  289   1070303   0.9132
  290   1070304   0.8472
  291   1070305   1.085
  292   *
  293   1070401   0.0
  294   *
  295   1070601   0.0
  296   1070602   -90.
  297   1070603   0.0
  298   *
  299   1070801   1.52-4   0.
  300   1070901   0.0        0.0
  301   1070902   0.18       0.18
  302   1070903   0.0        0.0
  303   1070904   0.18       0.18
  304   1070905   0.0        0.0
  305   *
  306   1071001   00         33
  307   1071101   1000       32
  308   *
  309   1071201   4   17.7   120   0.93424   0.   33
  310   *
  311   1071300   1
  312   1071301   0.0  0.0  0.0
  313   *
  314   *
  315   *
  316   *
  317   ***************************************************************
  318   *     SAFETY VALVE #2 DISCHARGING AT ELEV.  870'-10"  ARC 2
  319   ***************************************************************
  320   *     PRESSURIZER COMPONENT
  321   2010000   "PRSRZ#2"  TMDPVOL
  322   *
  323   2010101   0.   20.   500.   0.   0.   0.   0.00005   0.   11
  324   2010200   2
  325   2010201   0.,2500.,1.   .2514.,1.  .3,2555.,1.  .5,2600.,1.  .7,2667.,1.
  326   2010202   .9,2700.,1.   .2740.,1.  1.3,2745.,1.  1.5,2747.,1.  1.7,2748.,1.
  327   2010203   1.9,2750.,1.
  328   *
  329   *     PIPE CONPONENTS
  330   2020000   "PRZ2-EXIT"  SNGLJUN
  331   *
  332   2020101   201000000  200000000  0.0  0.0  0.0  1000
  333   *
  334   2020201   1   0.0   0.0   0.0
  335   *
  336   *     VALVE  UPSTREAM
  337   2030000   "LS2  IN"   PIPE
  338   *     NO OF VOL.
  339   2030001        4
  340   *     VOL. FLOW AREA
  341   2030101   0.14653    4
  342   *     VOL LENGTHS
  343   2030301   0.3490     1
  344   2030302   0.4236     4
  345   *     VOL. CAL.  AUTO.
  346   2030401   0.0        4
```

```
*    VERT.  ANGLES
2030601   45.          1
2030602   0.           4
*    PIPE  ROUGHNESS
2030801   1.513-4   0.0
*    JUN.  LOSS  COEFF.
2030901   0.0918    0.0918
2030902   0.0       0.0
*
2031001   00             4
*
2031101   1000           3
*
2031201   2  2500.   1.
*    INITIAL  JUN. FLOWS
2031300   1
2031301   0.0  0.0  0.0
*
*    LOOP  SEAL
*
2040000   "JUN-LS2"   SNGLJUN
2040101   203010000   2050[illegible]000  0.0  0.1838  0.1838  1000
2040201   1    0.0  0.0  1.0
*
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
2050902   0.1836      0.1836
2050903   0.0         0.0
2050904   0.1836      0.1836
2050905   0.0         0.0
*
2051001   00          20
*
2051101   1000        19
*
2051201   2   2500.
*    INITIAL JUN. FLOWS
2051300   1
2051301   0.0  0.0  0.0
*
*    CROSBY  6M6  SAFETY  VALVE #2  SV-45B
*
2060000   "SV N02"   VALVE
```

4
1
3
0. 4
3
6
7
9
10
19
1.0 0.0 0.0 20
19

```
405   2060101   205010000  207000000  0.01897  0.0  0.0  0100  1.0  1.0
406   2060201   1    0.0  0.0  0
407   2060300   MTRVLV
408   2060301   501  502  100.                    0.0   *  VALVE OPEN WITH PROG. START
409   *
410   *     VALVE DOWNSTREAM PIPING
411   2070000   "DWNSTRM#2"   PIPE
412   *
413   2070001                 26
414   2070101   0.20069       26
415   *
416   2070301   0.5261        4
417   2070302   0.9271        14
418   2070303   0.8852        23
419   2070304   1.085         26
420   *
421   2070401   0.0           26
422   *
423   2070601   0.0           4
424   2070602   -90.          14
425   2070603   0.0           26
426   *
427   2070801   1.52-4   0.   26
428   *
429   2070901   0.0           0.0
430   2070902   0.18          0.18
431   2070903   0.0           0.0
432   2070904   0.18          0.18
433   2070905   0.0           0.0
434   *
435   2071001   00            26
436   *
437   2071101   1000          25
438   *
439   2071201   4    17.7     120.    0.93424   0.   26
440   *
441   2071300   1
442   2071301   0.0  0.0  0.0  25
443   *
444   *
445   ********************************************************************
446   *     SAFETY  VALVE  #3 DISCHARGING AT ELEV.  672'-6"   ARC 3
447   ********************************************************************
448   *
449   *     PRESSURIZER  COMPONENT
450   3010000   "PRSRZ#1"  TMDPVOL
451   3010200   2
452   3010101   0.   20.   500.   0.   0.   0.   0.00005  0.   11
453   3010201   0.,2500.,1.  .1,2614.,1.  .3,2555.,1.  .5,2600.,1.  .7,2667.,1.
454   3010202   .9,2700.,1.  1.1,2740.,1.  1.3,2745.,1.  1.5,2747.,1.  1.7,2748.,1.
455   3010203   1.9,2750.,1.
456   *     PIPE  COMPONENTS
457   3020000   "PRZ3-EXIT"  SNGLJUN
458   3020101   301000000  303000000  0.0  0.0  0.0  1000
459   *
460   3020201   1  0.0  0.0  0.0
461   *     VALVE  UPSTREAM
462   *
```

3
4
13
14
25

```
  463    3030000    "LS2 IN"  PIPE
  464    *
  465    3030001          4
  466    *
  467    3030101    0.14653    4
  468    *
  469    3030301    0.3125     1
  470    3030302    0.4236     4
  471    *
  472    3030401    0.0        4
  473    *
  474    3030601    45.        1
  475    3030602    0.0        4
  476    *
  477    3030801    1.513-4    0.0      4
  478    *
  479    3030901    0.0918     0.0918     1
  480    3030902    0.0        0.0        3
  481    *
  482    3031001    00         4
  483    *
  484    3031101    1000       3
  485    *
  486    3031201    2    2500.    1.    0.0  0.0  4
  487    *
  488    3031300    1
  489    3031301    0.0  0.0  0.0        3
  490    *
  491    3040000    "JUN-LS3"  SNGLJUN
  492    3040101    303010000  305000000  0.0  0.1838  0.1836  1000
  493    3040201    1    0.0  0.0  0.0
  494    *
  495    3050000    "LPSL 2"   PIPE
  496    3050001    20
  497    *
  498    3050101    0.14653    20
  499    *
  500    3050301    0.5        10
  501    3050302    0.6203     20
  502    *
  503    3050401    0.0        20
  504    *
  505    3050601    -90.       7
  506    3050602    0.0        10
  507    3050603    90.        20
  508    *
  509    3050801    1.513-4    0.0      20
  510    *
  511    3050901    0.0        0.0        8
  512    3050902    0.1836     0.1836     7
  513    3050903    0.0        0.0        9
  514    3050904    0.1836     0.1836     10
  515    3050905    0.0        0.0        19
  516    *
  517    3051001    00         20
  518    *
  519    3051101    1000       19
  520    *
```

```
  521    3051201    2     2500.    1.0  0.0  0.0  20
  522    *
  523    3051300    1
  524    3051301    0.0  0.0  0.0          19
  525    *
  526    *     CROSSBY  6M6  SAFETY  VALVE #3   SV-45A
  527    *
  528    3060000    "SV N03"  VALVE    * VALVE OPEN WITH PROG. START
  529    3060101    305010000  307000000  0.01897  0.0  0.0   0100  1.  1.
  530    3060201    1   0.0  0.0  0.0
  531    3060300    MTRVLV
  532    3060301    501  502  100.  0.0   *  VALVE  OPENS  WITH  PROG.  START
  533    *
  534    *    VALVE DOWNSTREAM PIPING
  535    3070000    "DWNSTRM#3"   PIPE
  536    3070001    18
  537    *
  538    3070101    0.20089   18
  539    *
  540    3070301    0.5261     4
  541    3070302    1.034     12
  542    3070303    0.801     15
  543    3070304    1.085     18
  544    *
  545    3070401    0.0       18
  546    *
  547    3070601    0.0        4
  548    3070602    -90.      12
  549    3070603    0.0       18
  550    *
  551    3070801    1.52-4   0.    18
  552    *
  553    3070901    0.0       0.0       3
  554    3070902    0.18      0.18      4
  555    3070903    0.0       0.0      11
  556    3070904    0.18      0.18     12
  557    3070905    0.0       0.0      17
  558    *
  559    3071001    00        18
  560    3071101    1000      17
  561    *
  562    3071201    4   17.7   120.   0.93424   0.    18
  563    *
  564    3071300    1
  565    3071301    0.0  0.0  0.0          17
  566    *
  567    *
  568    ********************************************
  569    *     PORV DISCHARGE SECTION               *
  570    ********************************************
  571    *
  572    *
  573    ******************************************************
  574    *   PORV NRV-151 DISCHARGE LINE ARC "A"              *
  575    ******************************************************
  576    *
  577    *
  578    4110000   "PORV1"   PIPE
```

```
579   4110001        19
580   *
581   4110101  0.051132   17
582   4110102  0.200869   19
583   *
584   4110301  0.3724-     4
585   4110302  0.3659      8
586   4110303  0.561      17
587   4110304  0.349      19
588   *
589   4110401  0.0        19
590   *
591   4110601  0.0         4
592   4110602  -90.        8
593   4110603  0.0        19
594   *
595   4110801  1.53-04 .0 17
596   4110802  1.52-04 .0 19
597   *
598   4110901  0.0        0.0      3
599   4110902  0.20838    0.2088   4
600   4110903  0.0        0.0      7
601   4110904  0.20838    0.2088   8
602   4110905  0.0        0.0     16
603   4110906  0.37834    0.1565  17
604   4110907  0.0        0.0     18
605   *
606   4111001  00         19
607   4111101  1000       18
608   *
609   4111201  4    17.7   120.  0.93424  0.0   19
610   *
611   4111300  1
612   4111301  0.0  0.0  0.0  0.0   18
613   *
614   4120000  "ENTERMAIN"  SNGLJUN
615   4120101  411010000  701000000  0.0  0.18  0.18  1000
616   4120201  1    0.0  0.0  0.0
617   *
618   *
619   ***************************************************
620   *   PORV NRV-153 DISCHARGE LINE ARC "B"            *
621   ***************************************************
622   *
623   *
624   *
625   5110000  "PORV2LINE"  PIPE
626   5110001          19
627   *
628   5110101  0.05132    18
629   5110102  0.08840    19
630   *
631   5110301  0.4303      3
632   5110302  0.3620      7
633   5110303  0.35        9
634   5110304  0.6058     18
635   5110305  0.371      19
636   *
```

```
637   5110401   0.0                19
638   *
639   5110601   0.0                3
640   5110602   -90.               7
641   5110603   0.0                19
642   *
643   5110801   1.53-4  .0         18
644   5110802   1.34-4  .0         19
645   *
646   5110901   0.0                0.0       2
647   5110902   0.2088             0.2088    3
648   5110903   0.0                0.0       6
649   5110904   0.2088             0.2088    7
650   5110905   0.0                0.0       17
651   5110906   0.0544             0.0399    18
652   *
653   5111001   00                 19
654   *
655   5111101   1000               18
656   *
657   5111201   4  17.7   120.  0.93424  0.0  19
658   *
659   5111300   1
660   5111301   0.0  0.0   0.0   18
661   *
662   5120000   "JUNC."   SNGLJUN
663   5120101   511010000   513000000  0.0  0.0  0.0  1000
664   5120201   1  0.0  0.0  0.0
665   *
666   *
667   *
668   5130000   "4X4X3TEE"   BRANCH
669   5130001   0
670   5130101   0.08840  0.3524  0.0 0.0 0.0 0.0 0.0  1.34-4  0.0  00
671   5130200   4  17.7   120.  0.93424  0.0  0.0
672   *
673   *
674   5140000   "4IN JUNC"   SNGLJUN
675   5140101   513010000   515000000  0.0  0.0  0.0  1000
676   5140201   1  0.0  0.0  0.0
677   *
678   5150000   "4INSCH40"   PIPE
679   5150001                12
680   *
681   5150101   0.0884         10
682   5150102   0.20069        12
683   *
684   5150301   0.3524         1
685   5150302   0.6963         10
686   5150303   0.349          12
687   *
688   5150401   0.0            12
689   *
690   5150601   0.0            12
691   *
692   5150801   1.34-4  0.0    10
693   5150802   1.52-4  0.0    12
694   *
```

```
695   51509901   0.0        0.0        9
696   51509902   0.1483     0.0815     10
697   51509903   0.0        0.0        11
698   *
699   51510001   00         12
700   *
701   51511101   1000       11
702   *
703   51512201   4  17.7  120.  0.93424  0.0   12
704   *
705   51512300   1
706   51512301   0.0  0.0  0.0   11
707   *
708   51600000   "ENTERMAIN"  SNGLJUN
709   51601101   515010000  701000000  0.0  0.18  0.18   1000
710   51602201   1  0.0  0.0  0.0
711   *
712   *
713   ****************************************************
714   *   PORV NRV-152 DISCHARGE LINE  ARC "C"            *
715   ****************************************************
716   *
717   *
718   *
719   61100000   "PORVDISC3"  PIPE
720   61100001              8
721   *
722   61101101   0.05132    8
723   *
724   61103301   0.3723     4
725   61103302   0.3646     8
726   *
727   61104401   0.0        8
728   *
729   61106601   0.0        4
730   61106602   -90.       8
731   *
732   61106801   1.53-4  .0 8
733   *
734   61109901   0.0        0.0        3
735   61109902   0.2088     0.2088     4
736   61109903   0.0        0.0        7
737   *
738   61110001   00         8
739   61110101   1000       7
740   *
741   61110201   4  17.7  120.  0.93424  0.0   8
742   *
743   61113300   1
744   61113301   0.0  0.0  0.0   7
745   *
746   61200000   "PORVLINE"   SNGLJUN
747   61200101   611010000  513000000  0.0  0.1932  0.1932   1000
748   61200201   1  0.0  0.0  0.0
749   *
750   ****************************************
751   *   MAIN DISCHARGE LINE SECTION        *
752   ****************************************
```

```
*
*
*    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  0.0
*
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"
```

```
811     *
812     *
813     80100000  "12-BRANC1"    BRANCH
814     80100001  0
815     80101001  0.77708  0.8334  0.0  0.0 -90. -0.8334  1.69-4  0.0  00
816     80102000  4   17.7  120.  0.93424  0.0  0.0
817     *
818     80200000  "MAINLINE"  SNGLJUN
819     80201001  801010000  803000000  0.0  0.0  0.0    1000
820     80202001  1   0.0  0.0  0.0
821     *
822     80300000  "MAINLINE"  SNGLVOL
823     80301001  0.77708  0.8334  0.0  0.0 -90.  -0.8334  1.69-4  0.0  00
824     80302000  4  17.7  120.  0.93424  0.0  0.0
825     *
826     *     CONNECTION TO MAIN LINE AT ELEV. 670'-10"
827     *
828     *
829     80400000  "MAINLINE"  SNGLJUN
830     80401001  803010000  805000000  0.0  0.0  0.0    1000
831     80402001  1   0.0  0.0  0.0
832     *
833     20800000  "CON.2"  SNGLJUN
834     20801001  207010000  805000000  0.0  0.156  0.156    1000
835     20802001  1   0.0  0.0  0.0
836     *
837     80500000  "MAINBR.3"  BRANCH
838     80500001  0
839     80501001  0.77708  0.8334 0.0 0.0 -90. -0.8334  1.69-4  0.0  00
840     80502000  4   17.7  120.  0.93424  0.0  0.0
841     *
842     80600000  "MAINLINE"  SNGLJUN
843     80601001  805010000  807000000  0.0  0.0  0.0    1000
844     80602001  1   0.0  0.0  0.0
845     *
846     80700000  "MAINLINE"  SNGLVOL
847     80701001  0.77708  0.8334  0.0  0.0 -90.  -0.8334  1.69-4  0.0  00
848     80702000  4  17.7  120.  0.93424  0.0  0.0
849     *
850     *
851     *     CONNECTION TO MAIN LINE AT ELEV. 669'-2"
852     *
853     *
854     *
855     80800000  "MAINLINE"  SNGLJUN
856     80801001  807010000  809000000  0.0  0.0  0.0    1000
857     80802001  1   0.0  0.0  0.0
858     *
859     10800000  "CON.3"  SNGLJUN
860     10801001  107010000  809000000  0.0  0.156  0.156  1000
861     10802001  1   0.0  0.0  0.0
862     *
863     80900000  "MAINBR4"  BRANCH
864     80900001  0
865     80901001  0.77708  0.8334  0.0 0.0 -90. -0.8334  1.67-4  0.0  00
866     80902000  4  17.7  120.  0.93424 0.0  0.0
867     *
868     81000000  "MAINLINE"  SNGLJUN
```

```
    869   8100101   8609010000  811000000  0.0  0.0  0.0   1000
    870   8100201   1    0.0  0.0  0.0
    871   *
    872   *
    873   8110000   "MAINLINE"   PIPE
    874   *
    875   8110001                97
    876   *
    877   8110101   0.77708      97
    878   *
    879   8110301   1.0149       14
    880   8110302   0.5303       18
    881   8110303   0.5          22
    882   8110304   0.53125      26
    883   8110305   0.9908       56
    884   8110306   0.5          64
    885   8110307   0.8750       72
    886   8110308   0.5104       80
    887   8110309   0.4993       88
    888   8110310   1.0556       97
    889   *
    890   8110401   0.0          97
    891   *
    892   8110601   -90.         14
    893   8110602   -45.         18
    894   8110603   -90.         22
    895   8110604   -45.         26
    896   8110605   -90.         56
    897   8110606   0.0          80
    898   8110607   -90.         88
    899   8110608   0.0          97
    900   *
    901   8110801   1.69-4   0.  97
    902   *
    903   8110901   0.0      0.0      13
    904   8110902   0.078    0.078    14
    905   8110903   0.0      0.0      17
    906   8110904   0.078    0.078    18
    907   8110905   0.0      0.0      21
    908   8110906   0.078    0.078    22
    909   8110907   0.0      0.0      25
    910   8110908   0.078    0.078    26
    911   8110909   0.0      0.0      55
    912   8110910   0.156    0.156    56
    913   8110911   0.0      0.0      63
    914   8110912   0.026    0.026    64
    915   8110913   0.0      0.0      71
    916   8110914   0.13     0.13     72
    917   8110915   0.0      0.0      79
    918   8110916   0.156    0.156    80
    919   8110917   0.0      0.0      87
    920   8110918   0.156    0.156    88
    921   8110919   0.0      0.0      96
    922   *
    923   8111001   00       97
    924   *
    925   8111101   1000     98
    926   *
```

```
927    8111201   4  17.7   120.  0.93424  0.0      97
928    *
929    8111300   1
930    8111301   0.0  0.0   0.0     96
931    *
932    *
933    8120000   "MAINDISC"  SNGLJUN
934    8120101   8110100000  8130000000  0.0  0.156  0.156   1000
935    8120201   1   0.0   0.0  0.0
936    *
937    8130000   "MAINLINE"  PIPE
938    *
939    8130001                26
940    *
941    8130101   0.77708      26
942    *
943    8130301   1.0          14
944    8130302   0.5          24
945    8130303   1.0208       26
946    *
947    8130401   0.0          26
948    *
949    8130601   0.0          24
950    8130602   -90.         26
951    *
952    8130801   1.69-4       0.   26
953    *
954    8130901   0.0          0.0       13
955    8130902   0.156        0.156     14
956    8130903   0.0          0.0       23
957    8130904   0.156        0.156     24
958    8130905   0.0          0.0       25
959    *
960    8131001   00           26
961    *
962    8131101   1000         25
963    *
964    8131201   4  17.7   120.  0.93424  0.0   26
965    *
966    8131300   1
967    8131301   0.0  0.0   0.0       25
968    *
969    *
970    *
971    ****************************************
972    *      QUENCH TANK                     *
973    ****************************************
974    *
975    *
976    *
977    9770000   "QTANK-IN"  SNGLJUN
978    9770101   8130100000  9780000000  0.   0.   0.    1000
979    9770201   1    0.   0.    0.
980    *
981    *    SPARGER 12 IN SCH40 PIPE
982    *
983    9780000   "SPARGER"  PIPE
984    *    NO OF VOLUMES
```

```
  985    9780001   18
  986    *     FLOW AREA
  987    9780101   0.7773      18
  988    *     VOL. LENGTHS
  989    9780301   1.125       2
  990    9780302   1.1333      7
  991    9780303   1.0         18
  992    *     VOL. VOLS.
  993    9780401   0.0         18
  994    *
  995    *     VERTICAL ANGLES
  996    9780601   -90.        7
  997    9780602   0.0         18
  998    *     PIPE  ROUGHNESS
  999    9780801   1.69-4      0.0                                                    18
 1000    *     JUNCTION  LOSS COEFF
 1001    9780901   0.0         0.0                                                    6
 1002    9780902   0.156       0.156                                                  7
 1003    9780903   0.0         0.0                                                    17
 1004    *     VOL. CONTROL FLAG
 1005    9781001   00          18
 1006    *     JUN. CONTROL FLAG
 1007    9781101   1000        17
 1008    *     INITIAL COND.
 1009    9781201   4    17.7   120        0.93424    0.    2
 1010    9781202   3    17.7   120        0.0        0.    18
 1011    *               JUN. INITIAL COND.
 1012    9781300   1
 1013    9781301   0.0  0.0    0.0                                                    17
 1014    *     SPARGER   EXIT
 1015    9790000 "EXIT" SNGLJUN
 1016    9790101   978010000   9990000000    0.0    1.0    1.0    1100
 1017    9790201   1    0.     0.          0.
 1018    *               QUENCH TANK
 1019    *
 1020    *               WATER  VOL.
 1021    9800000 "QT. WATER" SNGL-VOL
 1022    9800101   260.4706    5.6667    0.0    0.0    90.    5.6667  0.003  0.0    01
 1023    9800200   3    17.7          120.
 1024    *               INTERFACE
 1025    9810000 "INTERFACE"  SNGLJUN
 1026    9810101   980010000   9820000000    0.0    0.0    0.0    1000
 1027    9810201   1    0.0    0.0         0.0
 1028    *               AIR  VOLUME
 1029    9820000 "QT.AIR"  SNGL-VOL
 1030    9820101   260.4706    1.2439    0.0    0.0    90.    1.2439  0.003  0.0    01
 1031    9820200   4    17.7   120        0.93424
 1032    *
 1033    *               RUPTURE DISC
 1034    9830000 "RUP.DISC"  VALVE
 1035    9830101   982010000   9990000000    1.77   0.     0.     1100
 1036    9830201   1    0.     0.          0.
 1037    9830300   TRPVLV
 1038    9830301   515         *     VALVE OPENING TRIP
 1039    *
 1040    *
 1041    ****************************************
 1042    *     PIPE OUTSIDE ENVIROMENT          *
```

```
1043    ************************************************
1044    *
1045    *
1046    9990000   "ATMOSPHERE"   TMDPVOL
1047    9990101   10000.    10000.    0.0  0.0  0.0  0.0  .00001  0.0  11
1048    9990200   4
1049    9990201   0.0  14.7  120.    0.9284
1050    *
1051    *
1052    ************************************************
1053    *  PLOT CARDS                                  *
1054    ************************************************
1055    *
1056    *
1057    20300100  MFLOWJ   106000000
1058    20300200  MFLOWJ   206000000
1059    20300300  MFLOWJ   306000000
1060    20300400  MFLOWJ   308000000
1061    20300500  MFLOWJ   208000000
1062    20300600  MFLOWJ   702000000
1063    20300700  MFLOWJ   108000000
1064    20300800  MFLOWJ   977000000
1065    20300900  QUALS    105200000
1066    20301000  QUALS    107010000
1067    20301100  QUALS    107330000
1068    20301200  QUALS    701010000
1069    20301300  QUALS    811970000
1070    20301400  QUALS    813260000
1071    20301500  QUALS    978180000
1072    20301600  QUALS    205200000
1073    20301700  QUALS    207010000
1074    20301800  QUALS    305200000
1075    20301900  QUALS    207260000
1076    20302000  QUALS    307010000
1077    20302100  QUALS    307180000
1078    20302300  P        105200000
1079    20302400  P        107010000
1080    20302600  P        107330000
1081    20302700  P        701010000
1082    20303100  P        811970000
1083    20303200  P        813260000
1084    20303300  P        978020000
1085    20303400  P        978030000
1086    20303500  P        205200000
1087    20303600  P        207010000
1088    20303700  P        305200000
1089    20303800  P        207260000
1090    20303900  P        307010000
1091    20304000  P        307180000
1092    *
1093    *
1094    *
1095    *
1096    .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

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

0./ (repeated)

BY KJG DATE 6-22-83

CHKD. BY CMM DATE 6-27-83

```
90       1020000    0.       -1.0     0./
90       1030000    0.       -1.0     0./
90      -1040000    0.       -1.0     0./
90      -1050000    0.       -1.0     0./
90      -1060000    0.       -1.0     0./
90      -1070000    0.       -1.0     0./
90      -1080000    0.       -1.0     0./
90      -1090000    0.       -1.0     0./
90      -1100000    0.       -1.0     0./
90      -1110000    0.       -1.0     0./
90      -1120000    0.       -1.0     0./
90      -1130000    0.       -1.0     0./
90      -1140000    0.       -1.0     0./
88       1140000    0.2356   -0.7071   0.6667/
88       1150000    0.2356   -0.7071   0.6667/
88       1160000    0.2356   -0.7071   0.6667/
88       1170000    0.2356   -0.7071   0.6667/
86      -1150000    0.2356   -0.7071   0.6667/
86      -1160000    0.2356   -0.7071   0.6667/
86      -1170000    0.2356   -0.7071   0.6667/
86      -1180000    0.2356   -0.7071   0.6667/
84       1180000    0.       -1.0      0./
84       1190000    0.       -1.0      0./
84       1200000    0.       -1.0      0./
84       1210000    0.       -1.0      0./
82      -1190000    0.       -1.0      0./
82      -1200000    0.       -1.0      0./
82      -1210000    0.       -1.0      0./
82      -1220000    0.       -1.0      0./
80       1220000   -0.2356   -0.7071  -0.6667/
80       1230000   -0.2356   -0.7071  -0.6667/
80       1240000   -0.2356   -0.7071  -0.6667/
80       1250000   -0.2356   -0.7071  -0.6667/
76      -1230000   -0.2356   -0.7071  -0.6667/
76      -1240000   -0.2356   -0.7071  -0.6667/
76      -1250000   -0.2356   -0.7071  -0.6667/
76      -1260000   -0.2356   -0.7071  -0.6667/
74  1260000  0.0   -1.0  0.0/
74       1270000    0.0  -1.0   0.0/
74       1280000    0.0  -1.0   0.0/
74       1290000    0.0  -1.0   0.0/
74       1300000    0.0  -1.0   0.0/
74       1310000    0.0  -1.0   0.0/
74       1320000    0.0  -1.0   0.0/
74       1330000    0.0  -1.0   0.0/
74       1340000    0.0  -1.0   0.0/
74       1350000    0.0  -1.0   0.0/
74       1360000    0.0  -1.0   0.0/
74       1370000    0.0  -1.0   0.0/
74       1380000    0.0  -1.0   0.0/
74       1390000    0.0  -1.0   0.0/
74       1400000    0.0  -1.0   0.0/
74       1410000    0.0  -1.0   0.0/
74       1420000    0.0  -1.0   0.0/
74       1430000    0.0  -1.0   0.0/
74       1440000    0.0  -1.0   0.0/
74       1450000    0.0  -1.0   0.0/
74       1460000    0.0  -1.0   0.0/
74       1470000    0.0  -1.0   0.0/
74       1480000    0.0  -1.0   0.0/
74       1490000    0.0  -1.0   0.0/
74       1500000    0.0  -1.0   0.0/
74       1510000    0.0  -1.0   0.0/
CCFI
```

```
74      811520000    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/
COPI
```

```
52      -811700000      -.259     0.0   - 9866/
52      -811710000      -.259     0.0   - 9866/
52      -811720000      -.259     0.0   - 9866/
50       811720000      -1.0      0.0     1 1.0/
50       811730000      -1.0      0.0     1 1.0/
50       811740000      -1.0      0.0     1 1.0/
50       811750000      -1.0      0.0     1 1.0/
50       811760000      -1.0      0.0     1 1.0/
50       811770000      -1.0      0.0     1 1.0/
50       811780000      -1.0      0.0     1 1.0/
50       811790000      -1.0      0.0     1 1.0/
46      -811730000      -1.0      0.0     1 1.0/
46      -811740000      -1.0      0.0     1 1.0/
46      -811750000      -1.0      0.0     1 1.0/
46      -811760000      -1.0      0.0     1 1.0/
46      -811770000      -1.0      0.0     1 1.0/
46      -811780000      -1.0      0.0     1 1.0/
46      -811790000      -1.0      0.0     1 1.0/
46      -811800000      -1.0      0.0     1 1.0/
44       811800000       0.0     -1.0     1 1.0/
44       811810000       0.0     -1.0     1 1.0/
44       811820000       0.0     -1.0     1 1.0/
44       811830000       0.0     -1.0     1 1.0/
44       811840000       0.0     -1.0     1 1.0/
44       811850000       0.0     -1.0     1 1.0/
44       811860000       0.0     -1.0     1 1.0/
44       811870000       0.0     -1.0     1 1.0/
40      -811810000       0.0     -1.0     1 1.0/
40      -811820000       0.0     -1.0     1 1.0/
40      -811830000       0.0     -1.0     1 1.0/
40      -811840000       0.0     -1.0     1 1.0/
40      -811850000       0.0     -1.0     1 1.0/
40      -811860000       0.0     -1.0     1 1.0/
40      -811870000       0.0     -1.0     1 1.0/
40      -811880000       0.0     -1.0     1 1.0/
38       811880000      -1.0      0.0     1 1.0/
38       811890000      -1.0      0.0     1 1.0/
38       811900000      -1.0      0.0     1 1.0/
38       811910000      -1.0      0.0     1 1.0/
38       811920000      -1.0      0.0     1 1.0/
38       811930000      -1.0      0.0     1 1.0/
38       811940000      -1.0      0.0     1 1.0/
38       811950000      -1.0      0.0     1 1.0/
38       811960000      -1.0      0.0     1 1.0/
32      -811890000      -1.0      0.0     1 1.0/
32      -811900000      -1.0      0.0     1 1.0/
32      -811910000      -1.0      0.0     1 1.0/
32      -811920000      -1.0      0.0     1 1.0/
32      -811930000      -1.0      0.0     1 1.0/
32      -811940000      -1.0      0.0     1 1.0/
32      -811950000      -1.0      0.0     1 1.0/
32      -811960000      -1.0      0.0     1 1.0/
32      -812000000      -1.0      0.0     1 1.0/
30       812000000       0.0      0.0     1 1.0/
30       813010000       0.0      0.0     1 1.0/
30       813020000       0.0      0.0     1 1.0/
30       813030000       0.0      0.0     1 1.0/
30       813040000       0.0      0.0     1 1.0/
30       813050000       0.0      0.0     1 1.0/
30       813060000       0.0      0.0     1 1.0/
30       813070000       0.0      0.0     1 1.0/
30       813080000       0.0      0.0     1 1.0/
30       813090000       0.0      0.0     1 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

```
$PIPE
INLINE=2,KBLOCK=300,KPIPE=13,KPLOT(1)=0,KWAVE=1,
KPRINT=-1,KPNV=1,KSTEP=3,
NDROPV=100010000,200010000,300010000,801010000,805010000,
809010000,701010000$
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   0.3705    0.0    0.9272/
385     511010000   0.3705    0.0    0.9272/
385     511020000   0.3705    0.0    0.9272/
380    -511010000   0.3705    0.0    0.9272/
COFI
```


BY KJG DATE 6-22-83

CHKD. BY CHK DATE 6-27-83

```
380      511020000    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/
385      511070000    -.828  0.0  -.563/
385      511080000    -.826  0.0  -.563/
36001   -511080000    -.828  0.0  -.563/
36001   -511090000    -.828  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   812000000  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    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./
cont
```

```
112    107130000   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./
```

COPI

```
180    205060000   0.       -1.0      0./
178    205010000   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/
COPI
```

```
150      -207150000    0.9202     0.      -0.3915/
150      -207160000    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      305130000    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/
 $STEPS TSTEP(1)=0.001,0.500,-1,-1$
```


COFI

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
D.C. 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} 12 f
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

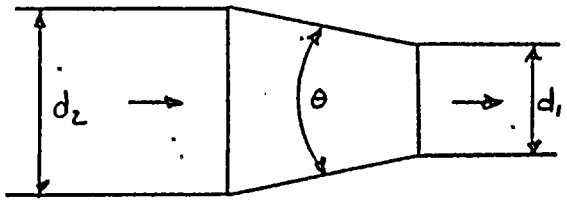
REF: CRANE TECHNICAL PAPER No. 410.

TELEDYNE ENGINEERING SERVICES

JBM DATE 12-8-82
CHKD. BY JEY DATE 12-8-82 6.1.83

AMERICAN ELECTRIC POWER
D.C. COOK UNITS 1 & 2
LOSSES IN REDUCERS

SHEET NO. 1 OF 1
PROJ. NO. 5364



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

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 x 6" SCH 40S	6.065"	11.938"	.5080	40.3°	.2045	.4930
6" SCH 40S x 4" SCH 40S	4.026"	6.065"	.6638	21°	.0815	.1483
4" SCH 40S x 3" SCH 40	3.068"	4.026"	.7620	13.66°	.0399	.0544
3" SCH 160 x 4" SCH 120	2.624"	3.624"	.7241	14.25°	.0472	.0730
4" SCH 120 x 6" SCH 160	3.624"	5.189"	.6984	16.19°	.0577	.0961
6" SCH 40S x 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

CMH DATE 5-24-83
CHKD. BY [illegible] DATE 5-24-83

NON-CONDENSIBLE GAS QUALITY CALCULATION FOR INITIAL COND. UNITS 1 & 2

SHEET NO. 1 OF 1
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 CHM DATE 7-14-83
CHKD. BY LBS DATE 7-14-83

UNIT 1 TEMPERATURE DISTRUBUTION 3V 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:

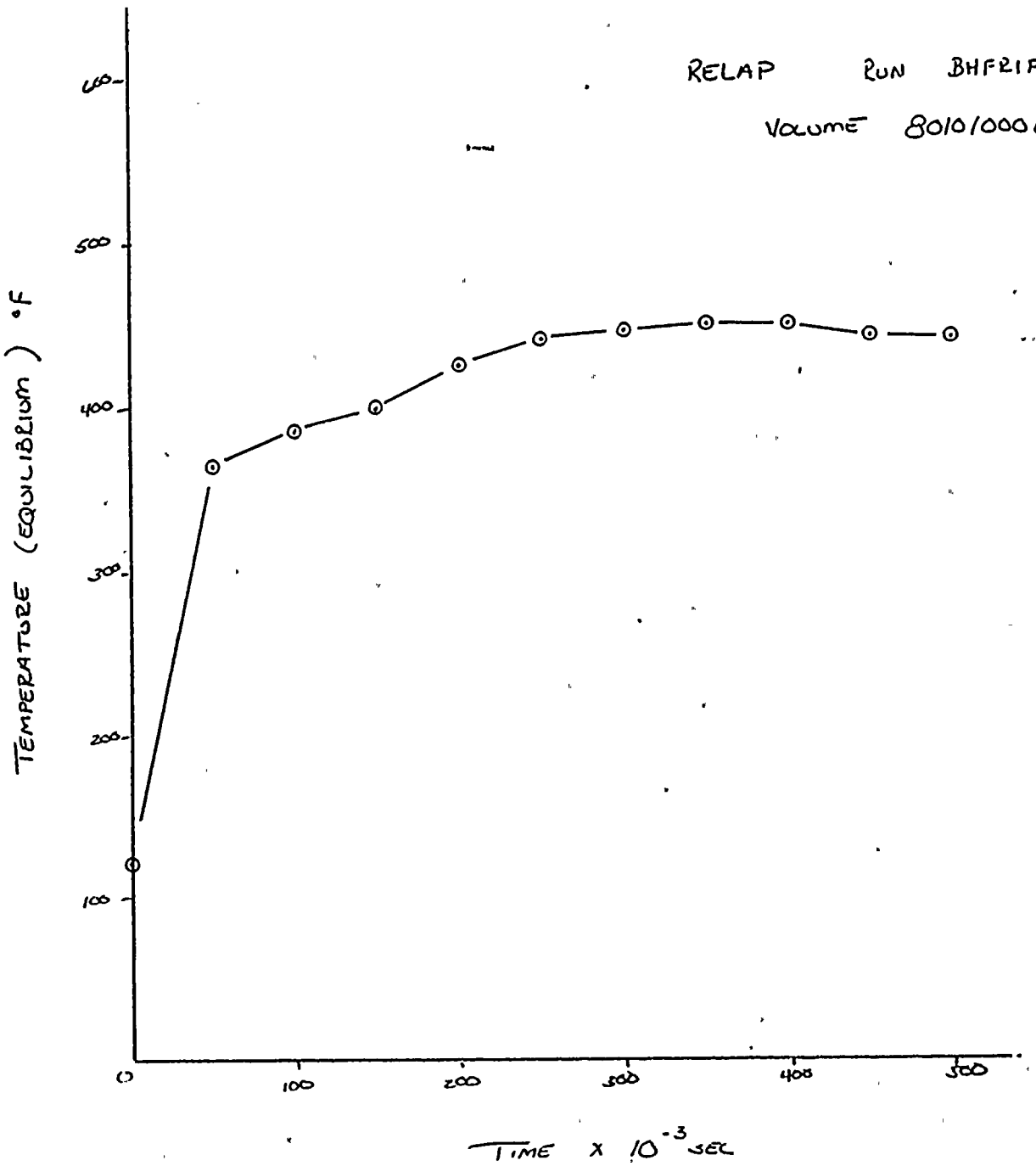
1. THESE ARE STEAM TEMPERATURES NOT PIPE WALL TEMPERATURES
2. THE PIPE WALL TEMPERATURES WILL LAG THESE TEMPS. BY SEVERAL SECONDS.
3. THE PIPE WALL TEMPS MAY EQUAL THE STEAM TEMPS. IN MAGNITUDE BUT WILL NEVER EXCEED THESE TEMPS.
4. THE RELAP ANALYSIS ASSUMED THE PIPE WALL TO BE ADIABATIC THEREFORE THESE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

TELEDYNE ENGINEERING SERVICES

BY KJB DATE 6/30-83
CHKD. BY CHM DATE 7-13-83

UNIT 1 SV MODIFICATION
TEMP DISTRIBUTION

SHEET NO. 2 OF 5
PROJ. NO. 5364

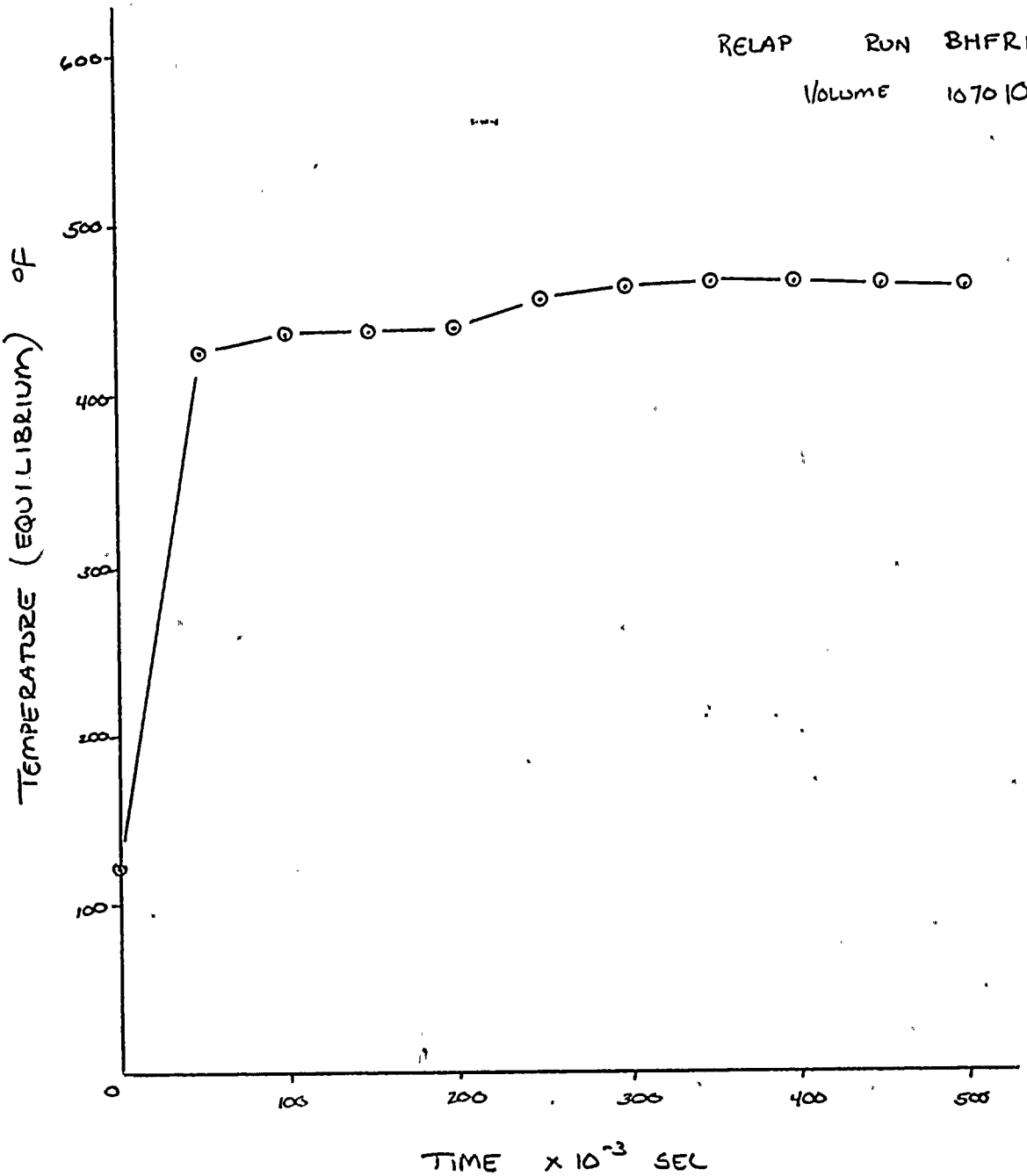


TELEDYNE ENGINEERING SERVICES

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

UNIT 1 SV MODIFICATION
TEMP DISTRIBUTION

SHEET NO. 3 OF 5
PROJ. NO. 5364



TELEDYNE ENGINEERING SERVICES

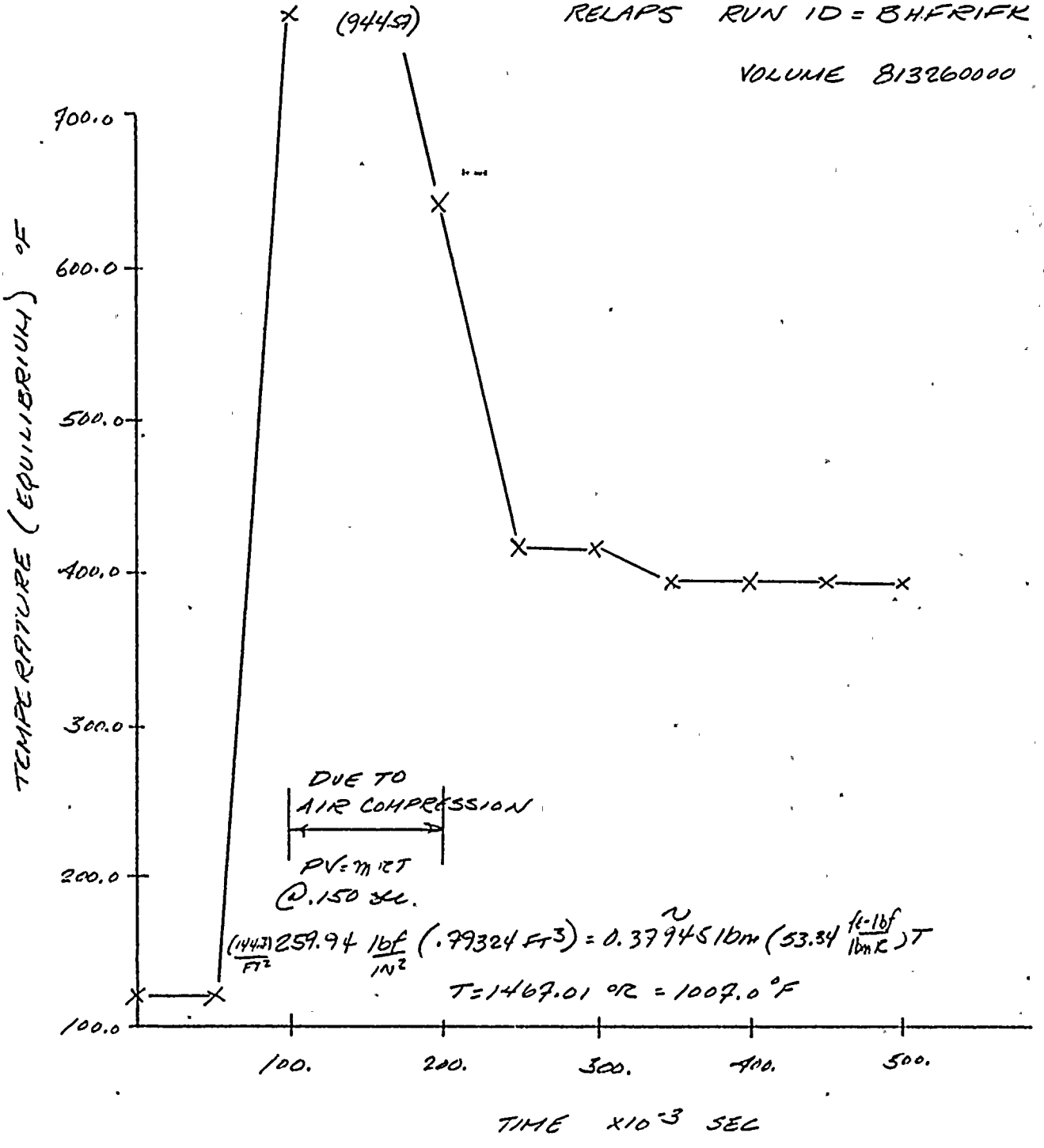
CMM DATE 6-29-83
CHKD. BY KV DATE 6-30-83

UNIT 1 SV MODIFICATION
TEMP. DISTRIBUTION

SHEET NO. 4 OF 5
PROJ. NO. 5364

RELAP5 RUN ID = BHFRIFK

VOLUME 813260000



Technical Report
TR-5364-3
Revision 0

TELEDYNE ENGINEERING SERVICES

BY CNM DATE 6-29-83
CHKD. BY KK DATE 7-6-83

UNIT1 MODIFICATION 5V
TEMP DISTRIBUTION.

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=BHFRIFR	
234	30509	671.60	
225	30901	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

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

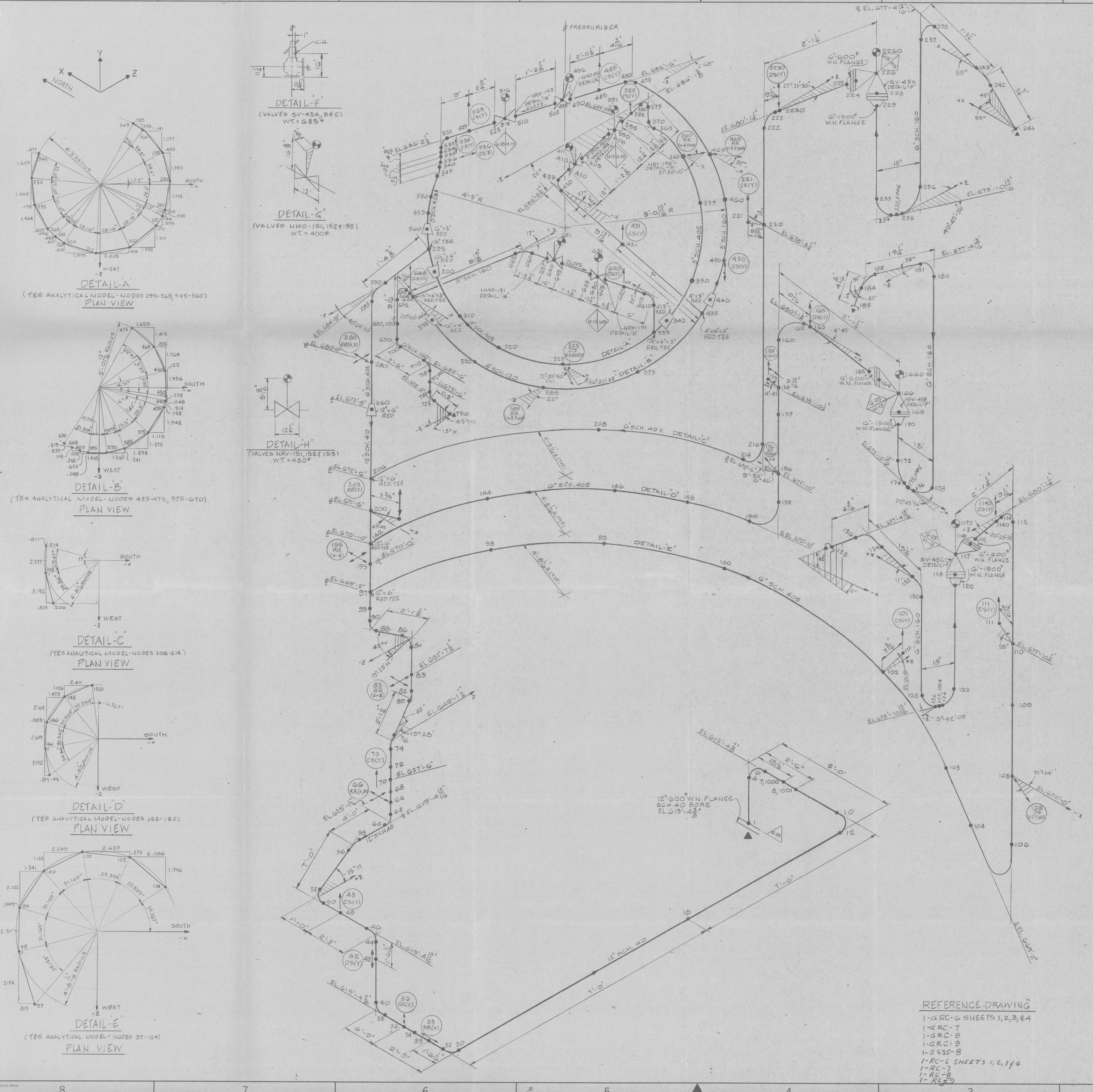
UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
FRACTIONS DECIMALS ANGLES
FINISH
SCALE
USED ON NEXT ASSY

	DESIGNED	DATE
ORIGINATOR	G.K	7.12.83
CHECKED	CHM	7.13.83
APPROVED	KJG	7-13-83
ENGR SPVR	LBS	7-13-83
	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. 5564 | 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
(circle)	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

APERTURE CARD

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

E

8312210225-02

REV	DATE	D.C.O.	ZONE	DESCRIPTION	DRAWN	CHKD	ANAL	ENGR	DWG. CON.
3	7/8/83	5053	C-3 E-3 G-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