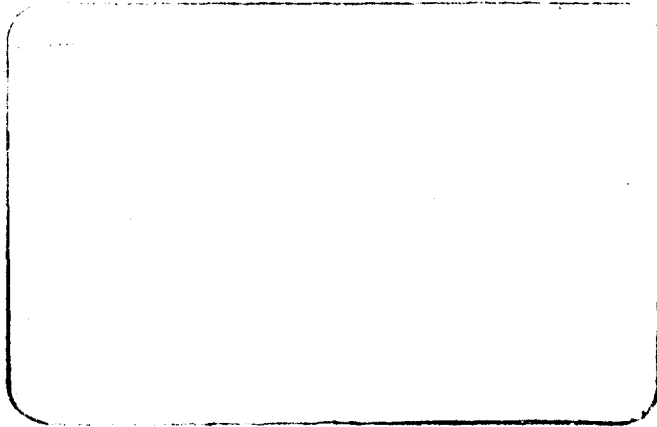


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**Corporation**  
COCKEYSVILLE, MARYLAND  
formerly Aircraft Armaments, Inc.



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**AIRCRAFT ARMAMENTS, Inc.**

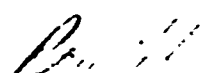
PHASE I REPORT  
GROUND SLIDE AIRDROP STUDY  
ADDENDUM

*TECHNICAL REPORT*  
*69-15-AD*  
*(ER-3841)*

**REPORT NO.**

August 1966

**DATE**

  
\_\_\_\_\_  
R. C. Wible, Project Engineer

\_\_\_\_\_  
J. E. Foster, Project Manager

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## I. INTRODUCTION

This writing is **continuation** of the Phase I Report of the Ground Slide Airdrop Study, ER-3841. AAI has performed this study under Contract No. DA-19-129-AMC-337(N) from the U. S. Army Natick Laboratories. The specific object of this report is to present the findings of the Exploratory Test Phase, Phase II, and compare these actual findings to those predicted by the analysis presented in the Study Phase, Phase I. Also included in this report are all changes, deletions, and revisions to be incorporated in the preliminary design specifications of the Phase I report.

The actual findings were acquired from tests performed at Fort Bragg, North Carolina. These tests were conducted by AAI in conjunction with the U. S. Army Field Test Team. The test description and test program is explained in the Report of Exploratory Test Program, ER-4356. Figures 1, 2, 3, 4, and 5 show a typical drop sequence from an actual test. **Table 1 lists tests with the associated test conditions.**



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PAGE NO. D-2

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FIGURE 1



FIGURE 2

INC 1981





FIGURE 3

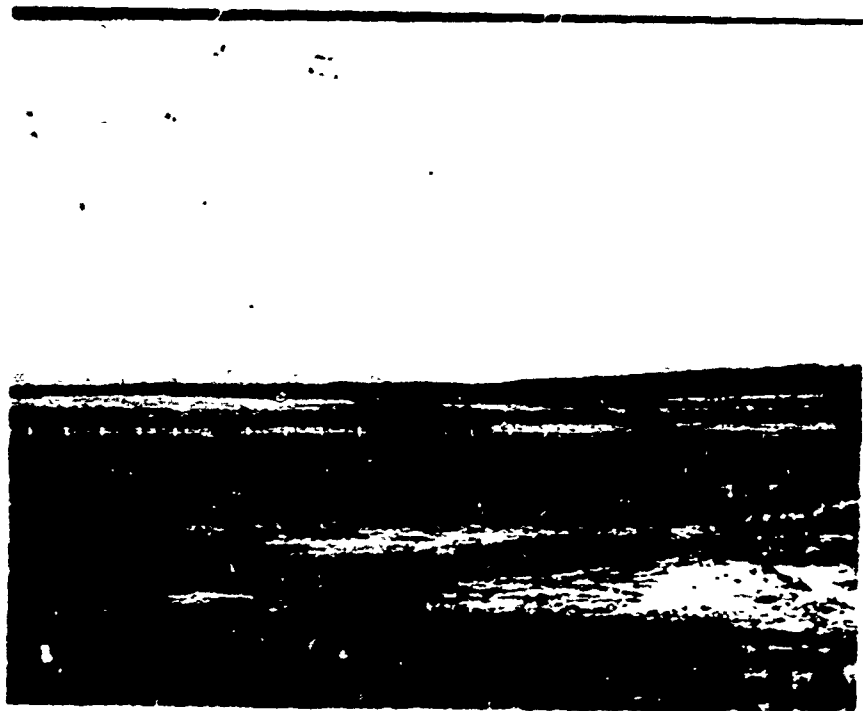
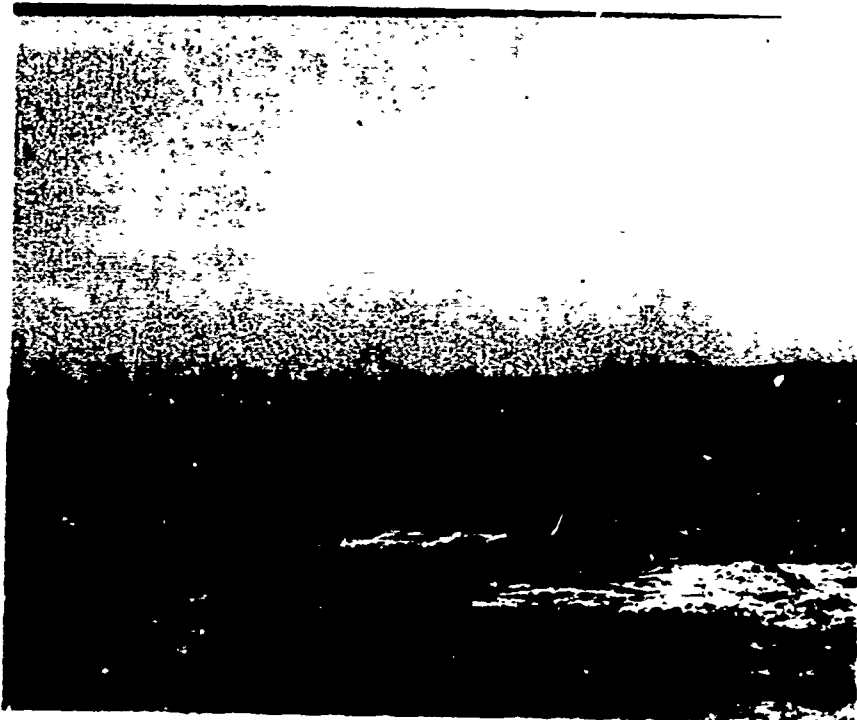


FIGURE 4

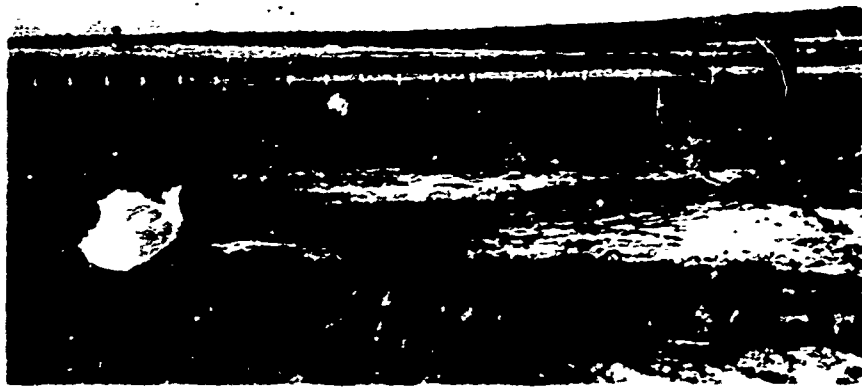


FIGURE 5



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TAB  
TEST SC

Type of Test	Test no.	Ground (hard-smooth) (s) Surface (soft-uneven)(u)	Aircraft Speed (knot) (IAS)	Aircraft Heading (Deg.) Nominal	Platform Length (ft)	Aft Restraint Force (lbs)	Cargo Weight (lbs)	Ring Slot Extraction Chute Size (ft)	Riser Extension Length (ft)
Smooth, hard surface	1	S	90	030	9	4500	3950	22	60
	2	S	90	030	9	4500	3950	22	60
Uneven, soft surface	3	U	85	005	9	4500	3950	22	60
	4	U	85	005	9	4500	3950	22	60
Maximum Extraction Acceleration	5	U	80	005	9	2000	1850	15	60
Minimum Extraction Acceleration	6	U	90	005	9	2000	3000	15	60
Extraction Point Misaligned	7	U	90	005	9	4500	3780	22	60
Extreme C.G. Location	8	U	85	005	9	4500	3780	22	60
Combination of #7 & #8	9	U	90	005	9	4500	3780	22	60
Extraction Point Misaligned	10	U	85	005	9	4500	3780	22	60
Less Severe #10	11	U	80	005	9	4500	3780	22	60
Repeat of #1	12	S	90	005	9	4500	3780	22	60
Extreme Forward End Down Condition	13	U	90	005	9	4500	3780	22	60
Extreme Aft End Down Condition	14	U	100	005	9	4500	3780	22	60
Repeat of #7	15	U	90	005	9	4500	3780	22	60

A

TABLE 1  
TEST SCHEDULE

Chute Size (ft)	Riser Extension Length (ft)	Extraction Point Distance (ft)	Extraction Point a Distance (in.)	Extraction Point b Distance (in.)	Extraction Point c Distance (in.)	C.G. d Distance (in.)	C.G. e Distance (in.)	C.G. f Distance (in.)	Cargo Length (ft)	Cargo Height (ft)	Cargo Width (ft)	Wind Velocity (knots)	Wind Heading (Deg.)	Drop Zone Heading (deg.)	Platform(all alum)(A) Type(wood & alum) (W)
60	22	54	0	1.4	0	0	24.3	7.5	3	5	8	300	030	005	A
60	22	54	0	1.4	0	0	24.3	7.5	3	5	0	0	030	005	A
60	22	54	0	1.4	0	0	24.3	7.5	3	5	0	180	005	005	A
60	22	54	0	1.4	0	0	24.3	7.5	3	5	5	290	005	005	A
60	22	54	0	-1.3	0	0	23.5	7.5	3.1	5	8-10	230	005	005	A
60	22	54	0	0	0	0	25.0	7.5	2.8	5	4-6	80	005	005	A
60	22	54	0	5.0	0	0	24.0	7.5	2.3	5	11-14	90	005	005	W
60	22	54	0	1.0	5.0	0	24.0	7.5	2.3	5	10	130	005	005	W
60	22	54	0	7.0	5.0	0	24.0	7.5	2.3	5	10	190	005	005	W
60	22	54	10.25	0	0	0	24.0	7.5	2.3	5	2	265	005	005	W
60	22	54	5.00	0	0	0	24.0	7.5	2.3	5	8-10	40	005	005	W
60	22	54	0	0	0	0	24.0	7.5	2.3	5	3-6	90	005	005	W
60	22	64	0	3.0	10	0	24.0	7.5	2.3	5	6-9	330	005	005	W
60	22	44	0	9.0	-10	0	24.0	7.5	2.3	5	7-11	310	005	005	W
60	22	54	0	5.0	0	0	24	7.5	2.3	5	3-5	190	005	005	W

B



## II. PRESENTATION OF RESULTS

### A. General

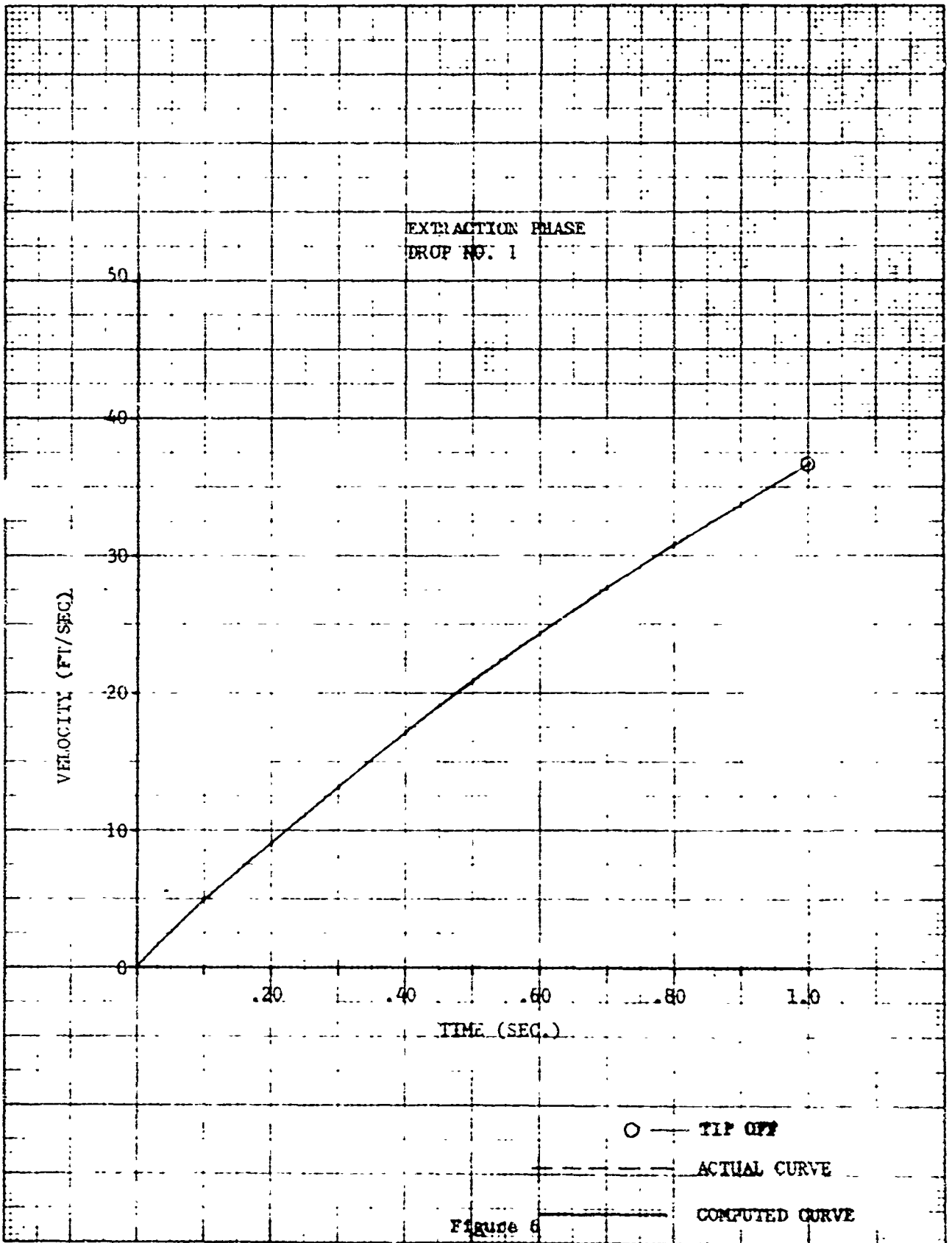
The results of the test program and the corresponding computer analysis for each test are presented in this section. These results are presented, for ease of handling, in three phases, i.e., Extraction and Tip-off, Descent, and Ground Impact.

In each case the actual test conditions were used as inputs to the computer program and the computed values of velocity, time, distance, etc. are compared with the actual values. In general, the tests values and the computed values are in close agreement. The discrepancies that do occur can be attributed to (1) the inability of the equations of motion to account for all actual happenings such as initial cargo jerk due to restraint strap break and cargo angular acceleration after tip-off induced by aircraft pitching and (2) the inability to select the inputs for the computer with a high degree of accuracy.

Drop No. 2 will not be presented because of camera failure.

### B. Extraction Phase

The time-displacement recorder was used to monitor the relative velocity of the cargo with respect to the aircraft, during the extraction phase. The data obtained was reduced to velocity-versus-time curves. Figures 6 through 19 show plots comparing these actual curves to the curves predicted by the computer analysis. Drop Nos. 1, 4 and 7 are incomplete due to lack of test data.



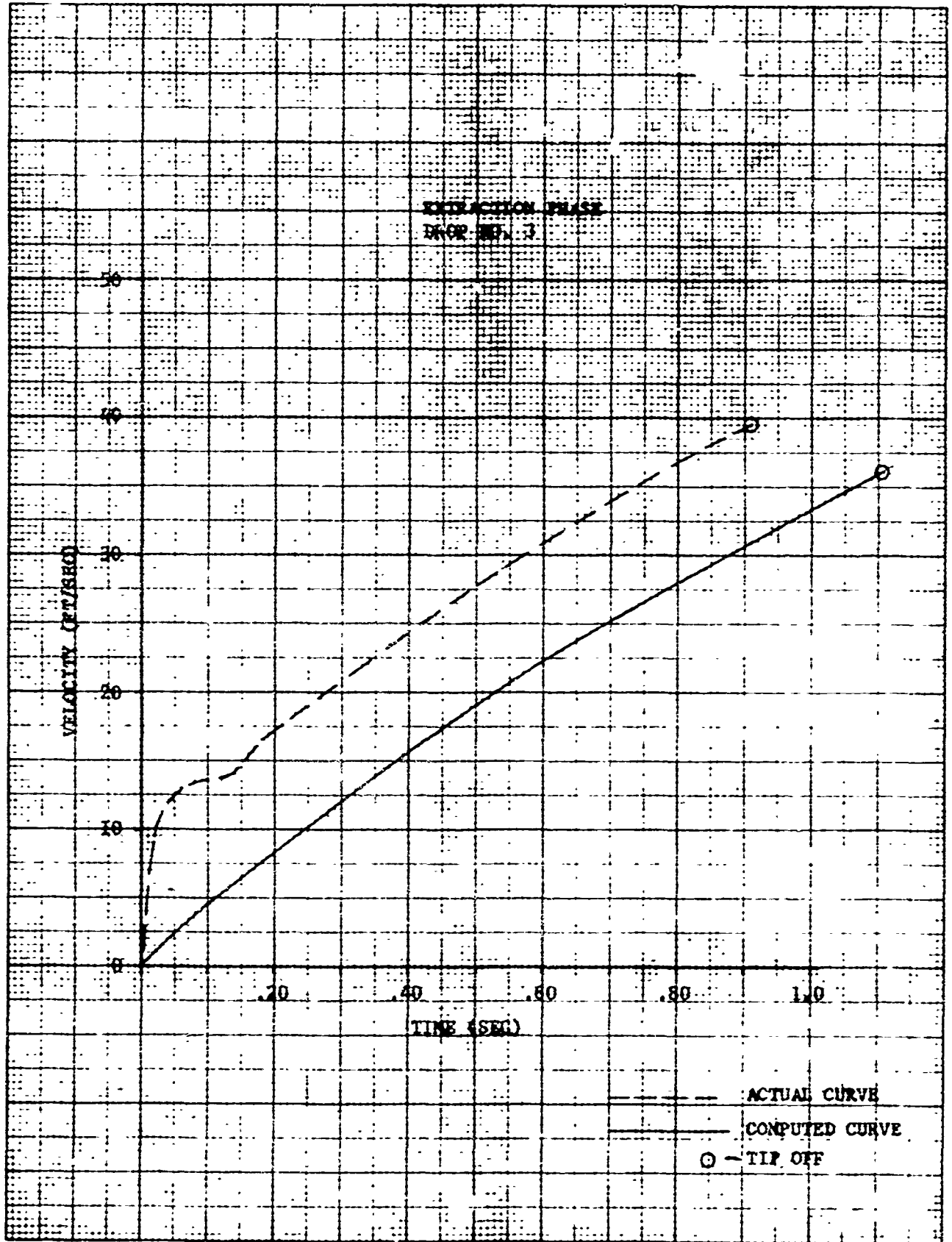


Figure 7



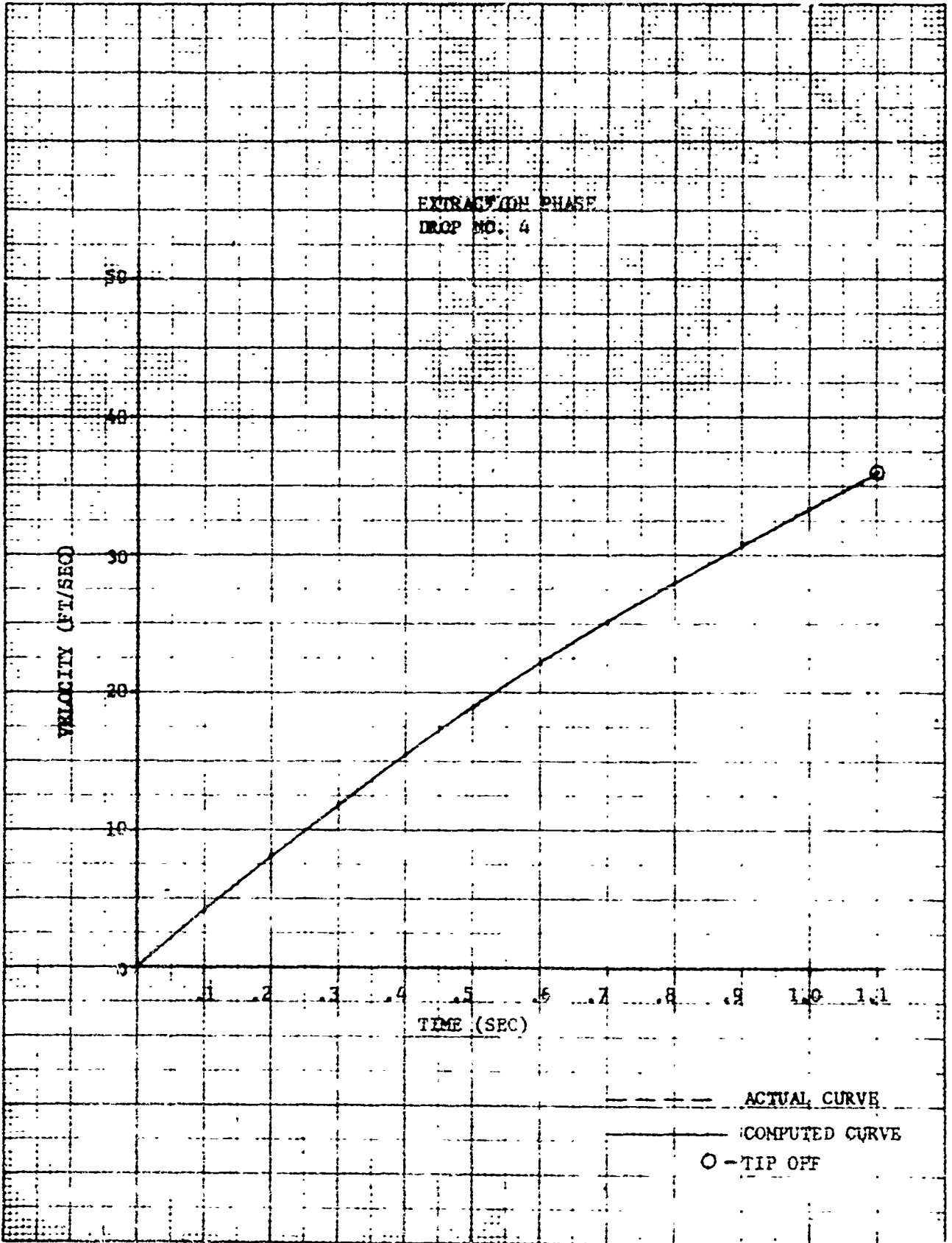


Figure 8

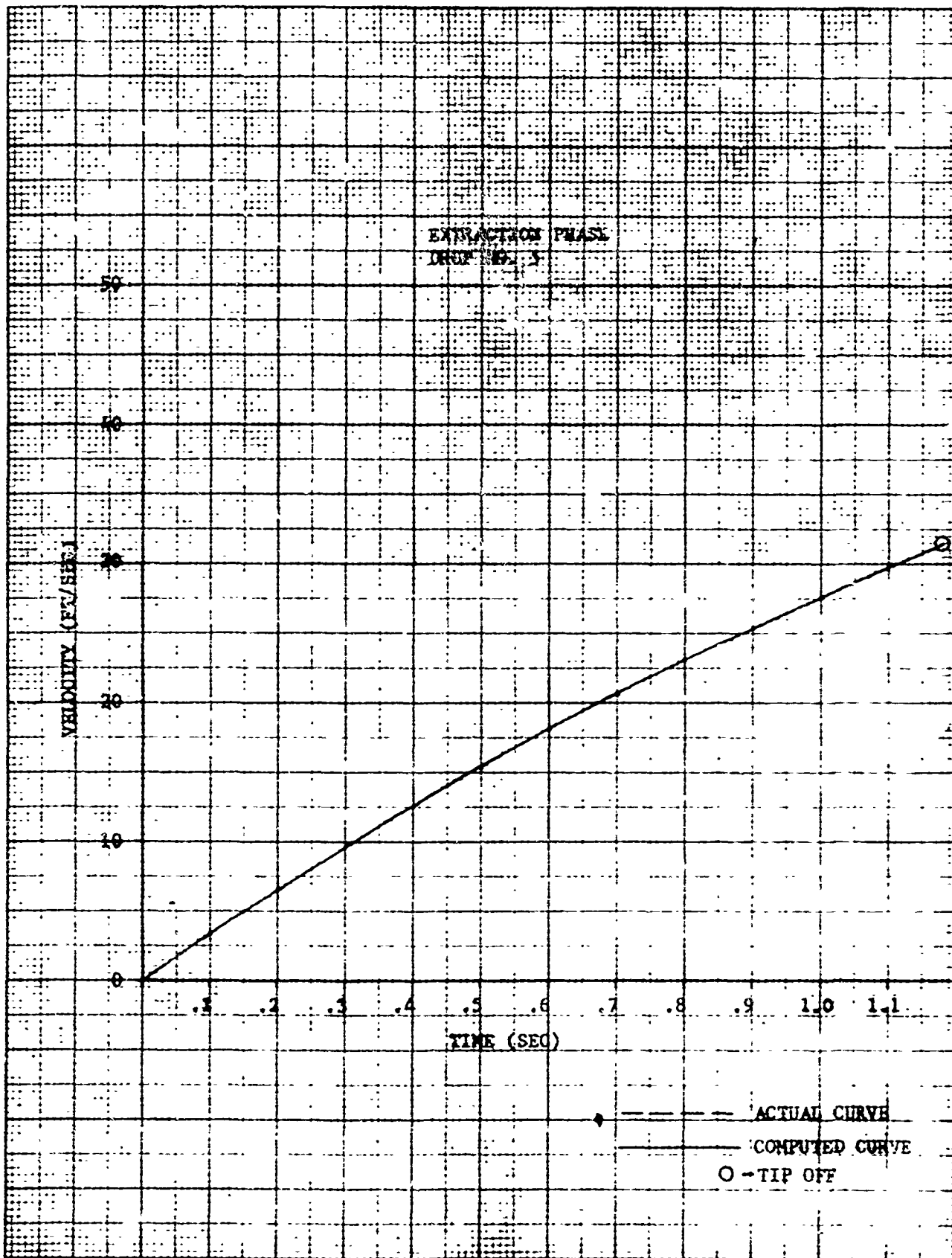


Figure 9

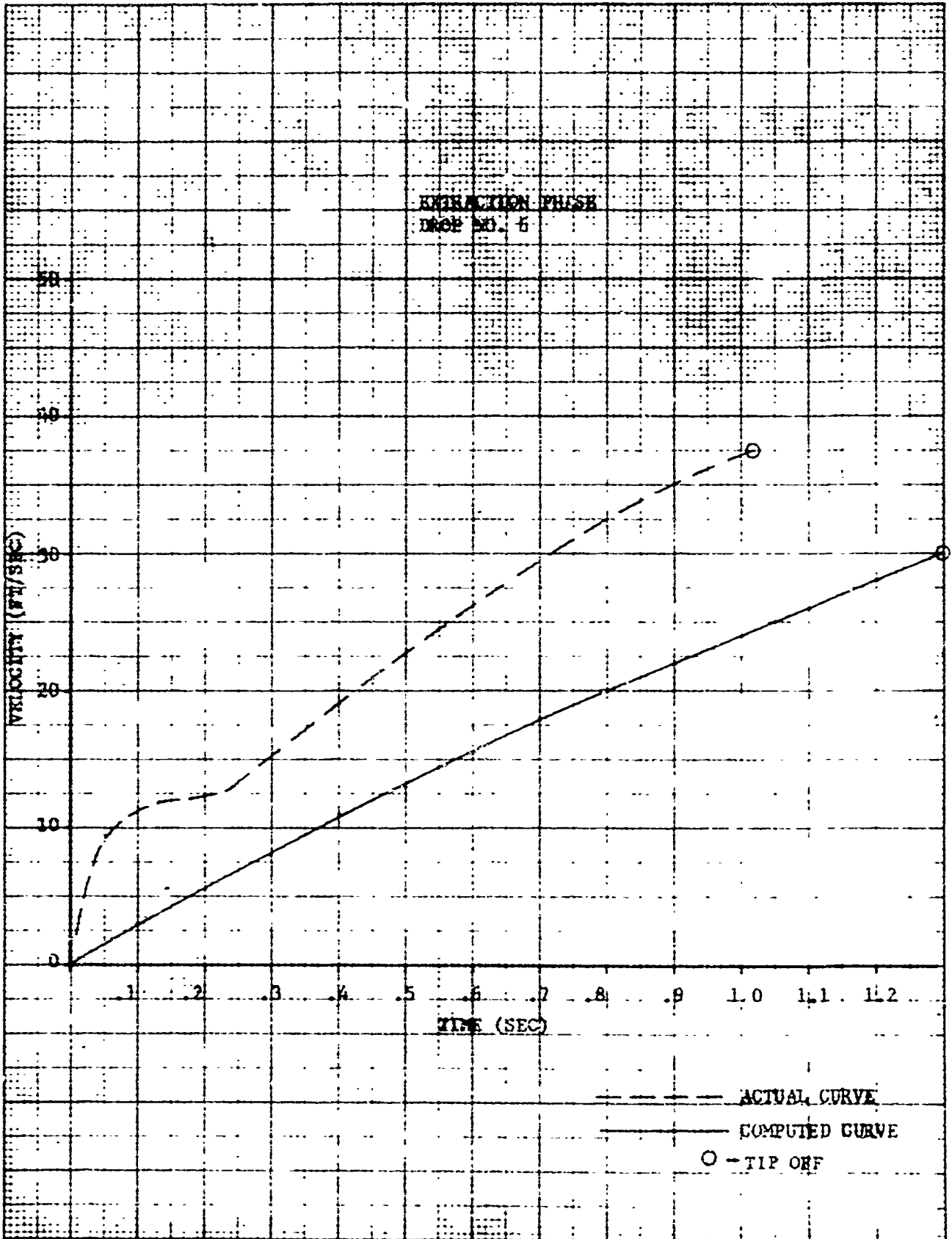


Figure 10

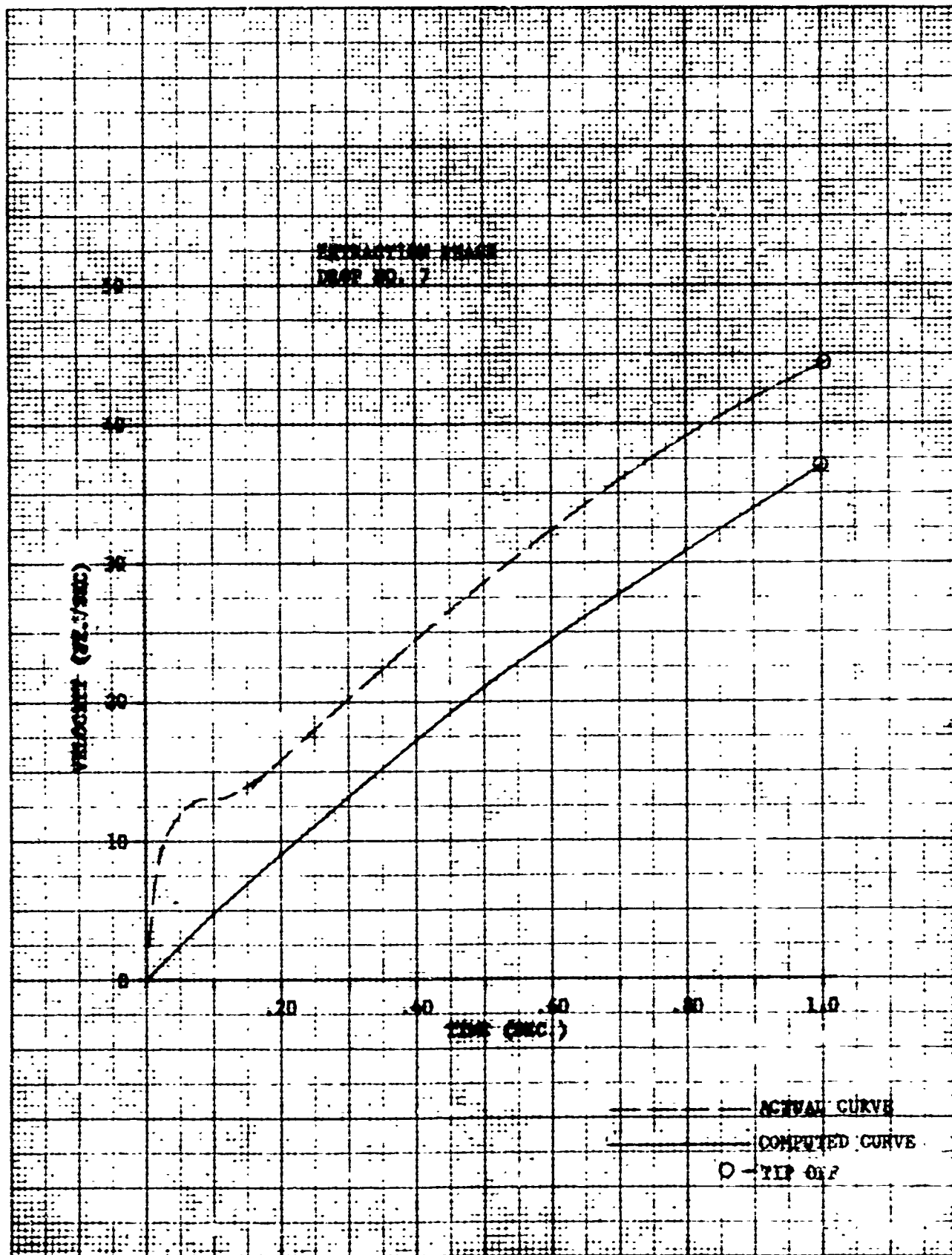


Figure 11

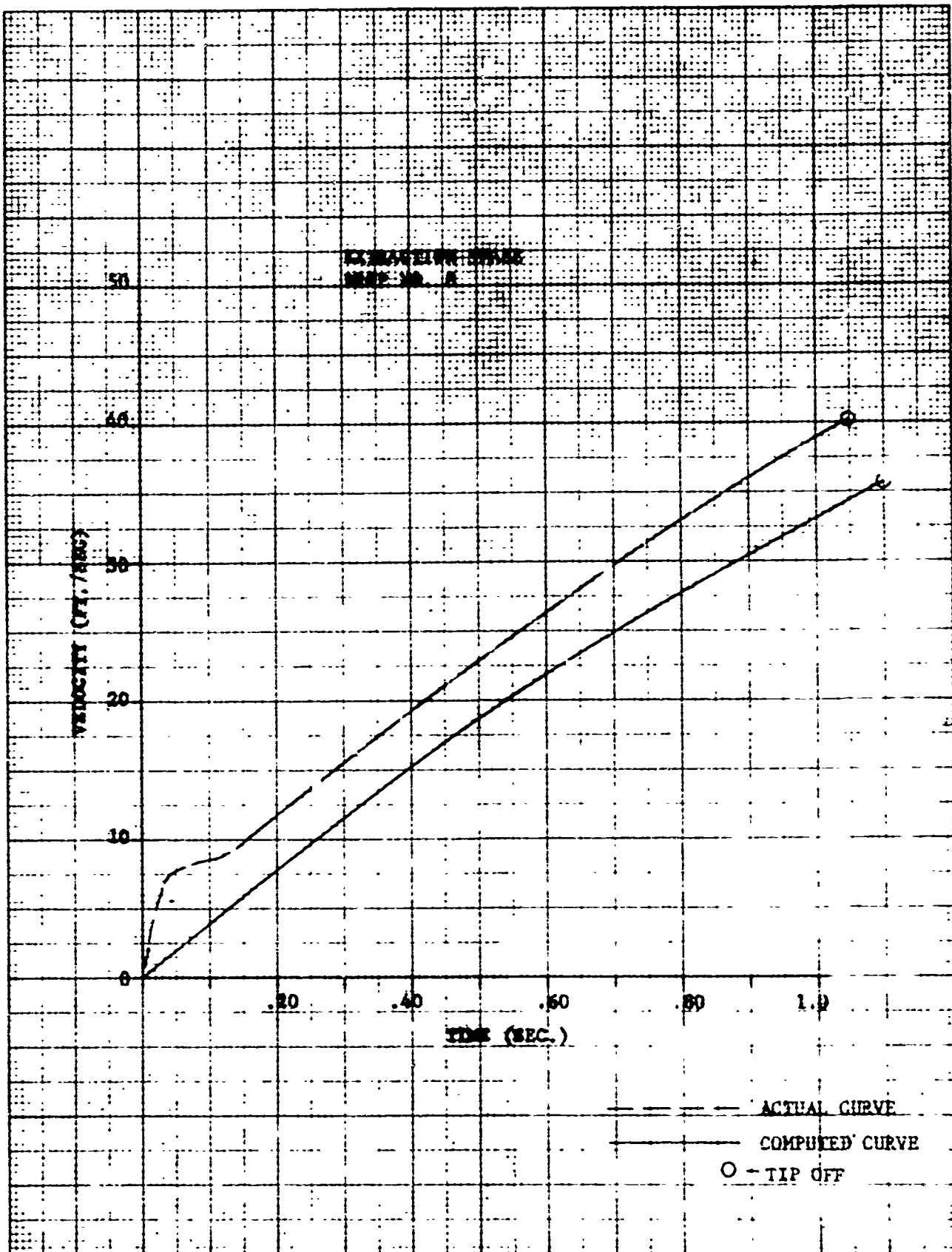


Figure 12

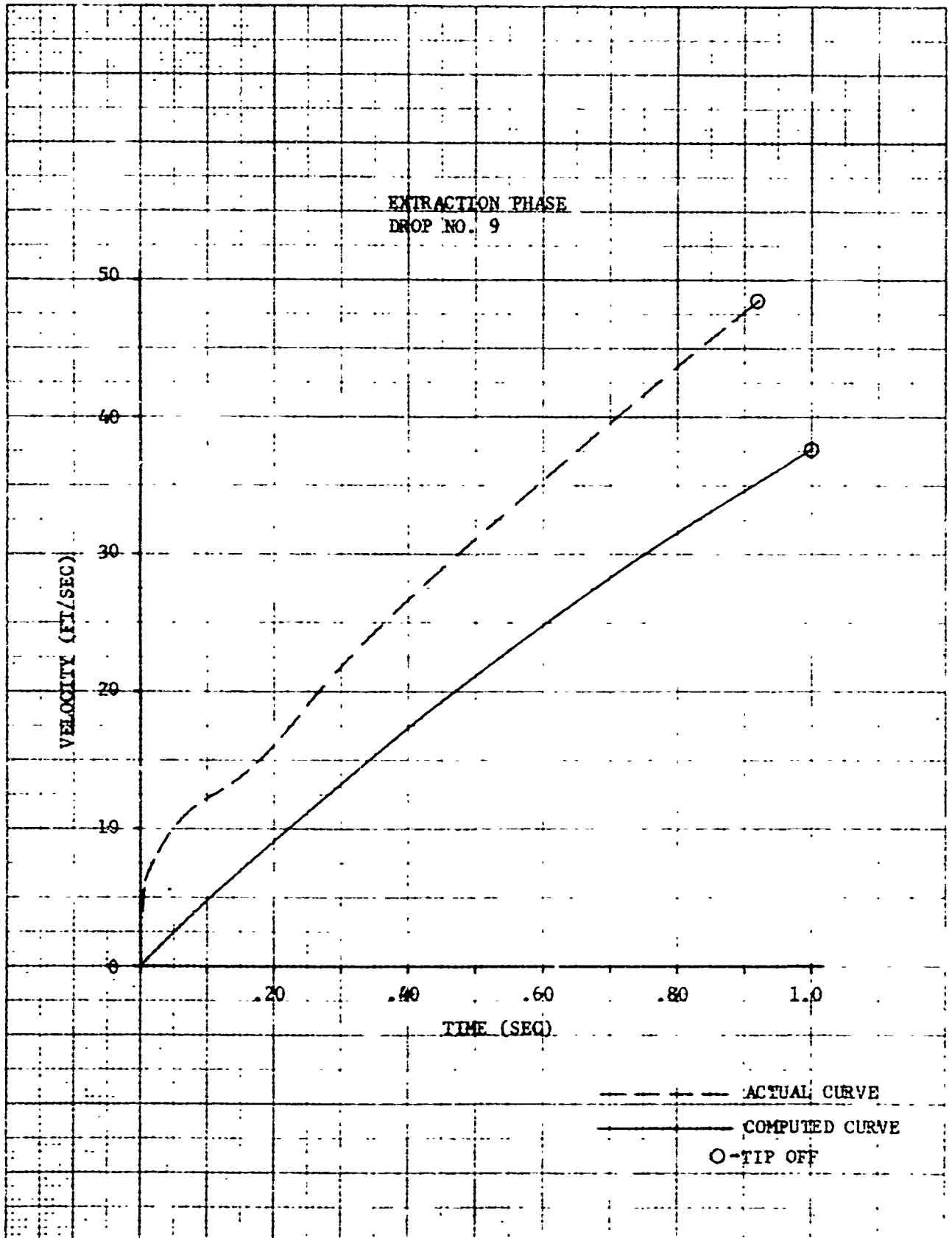


Figure 13

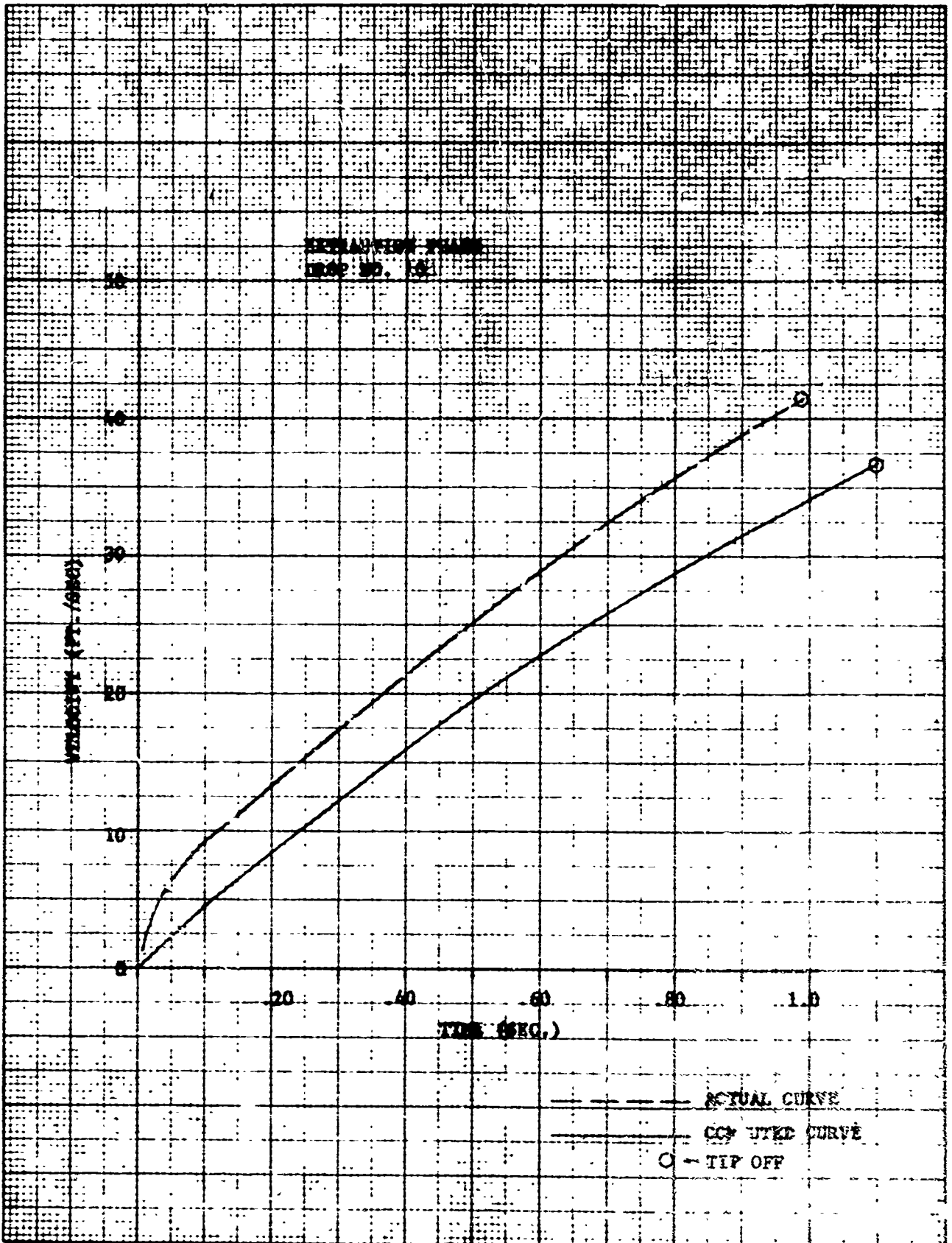


Figure 14

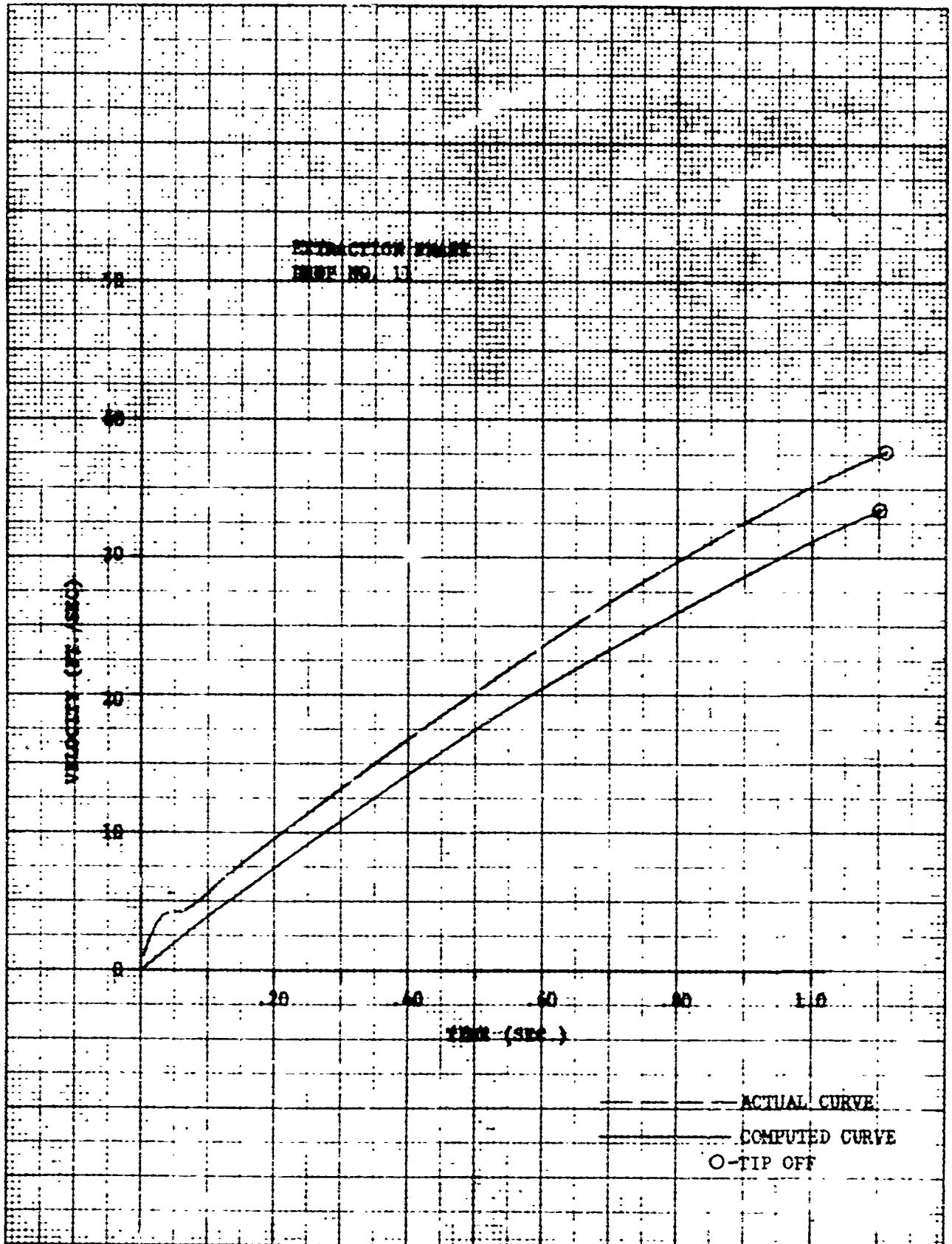


Figure 15



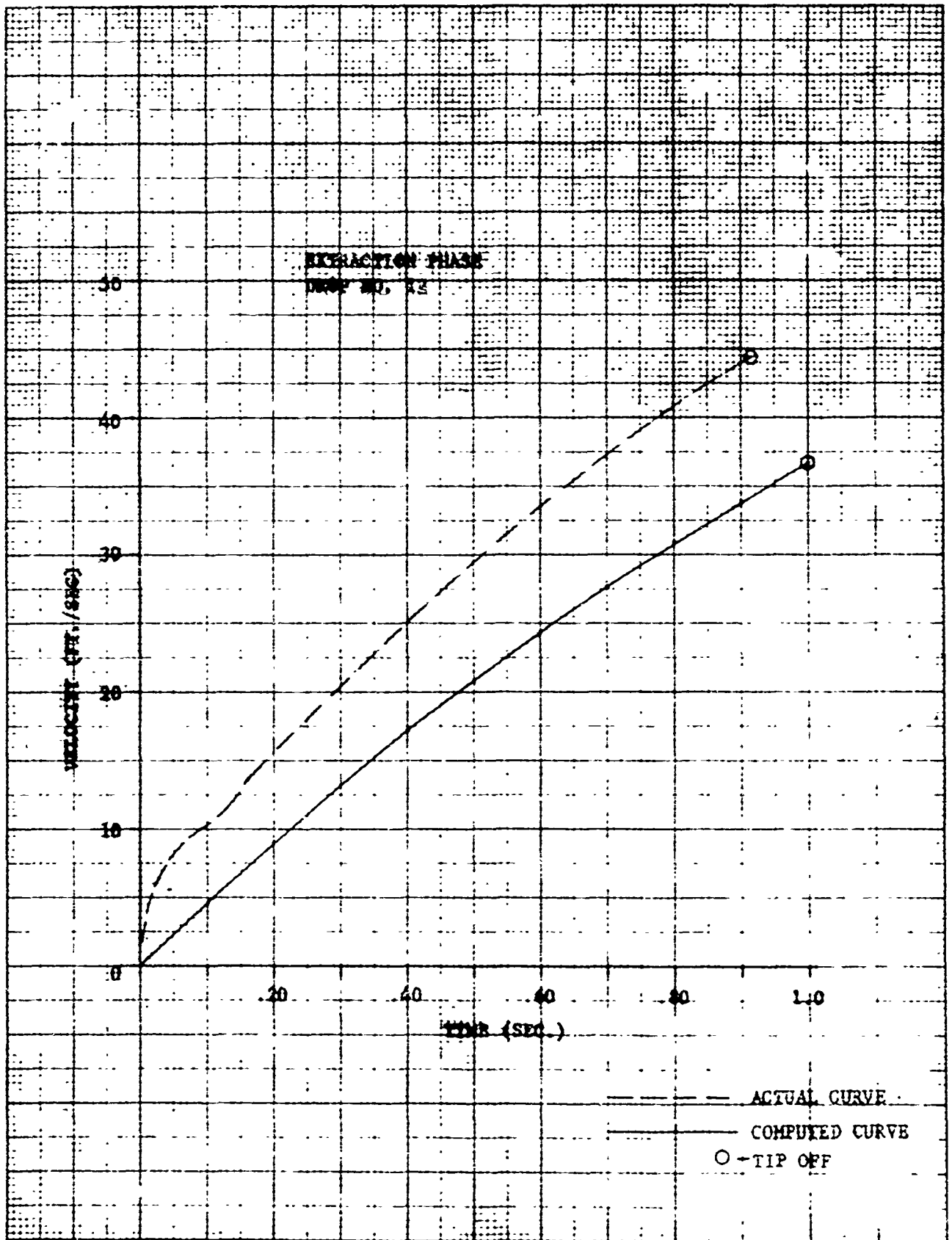


Figure 16

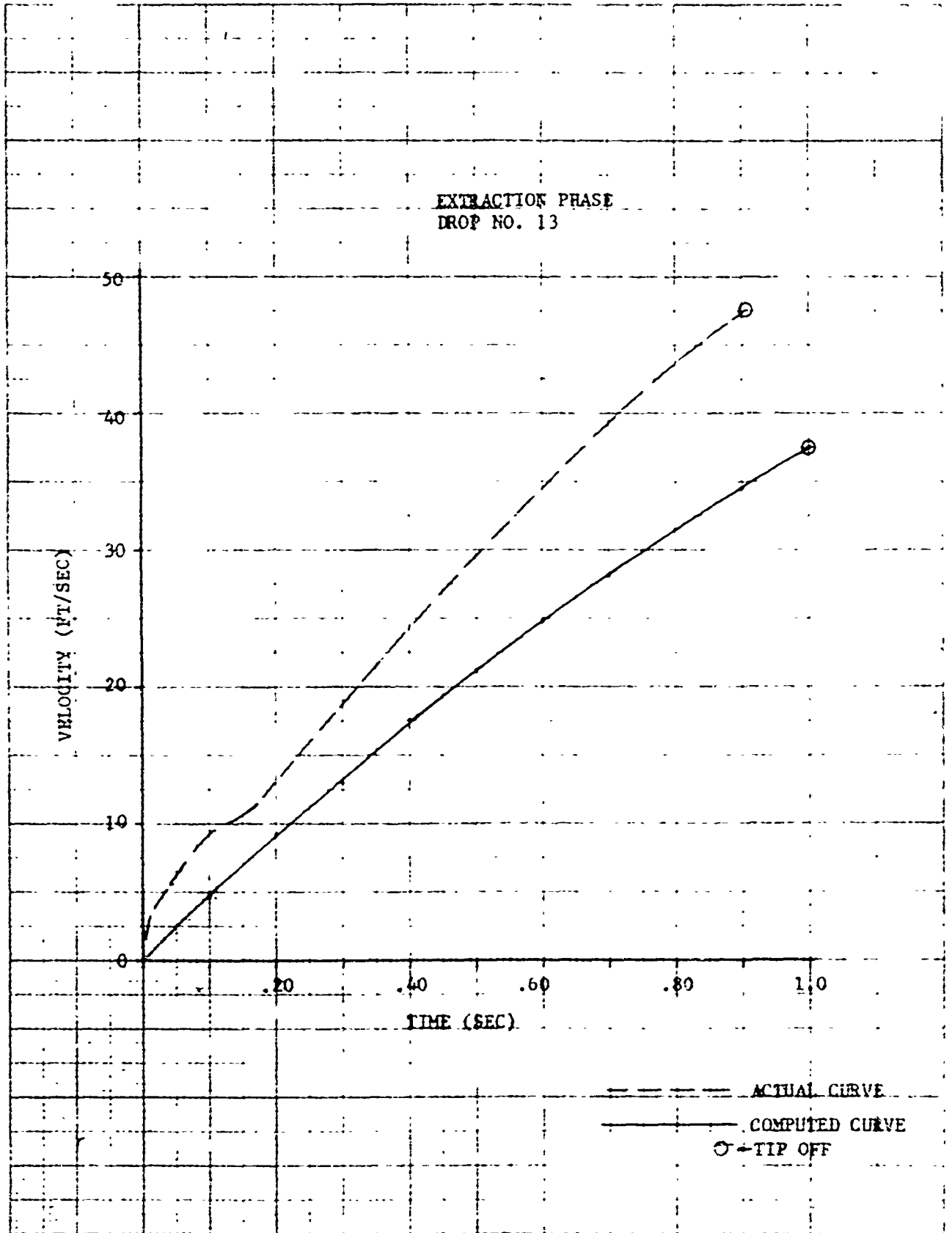


Figure 17

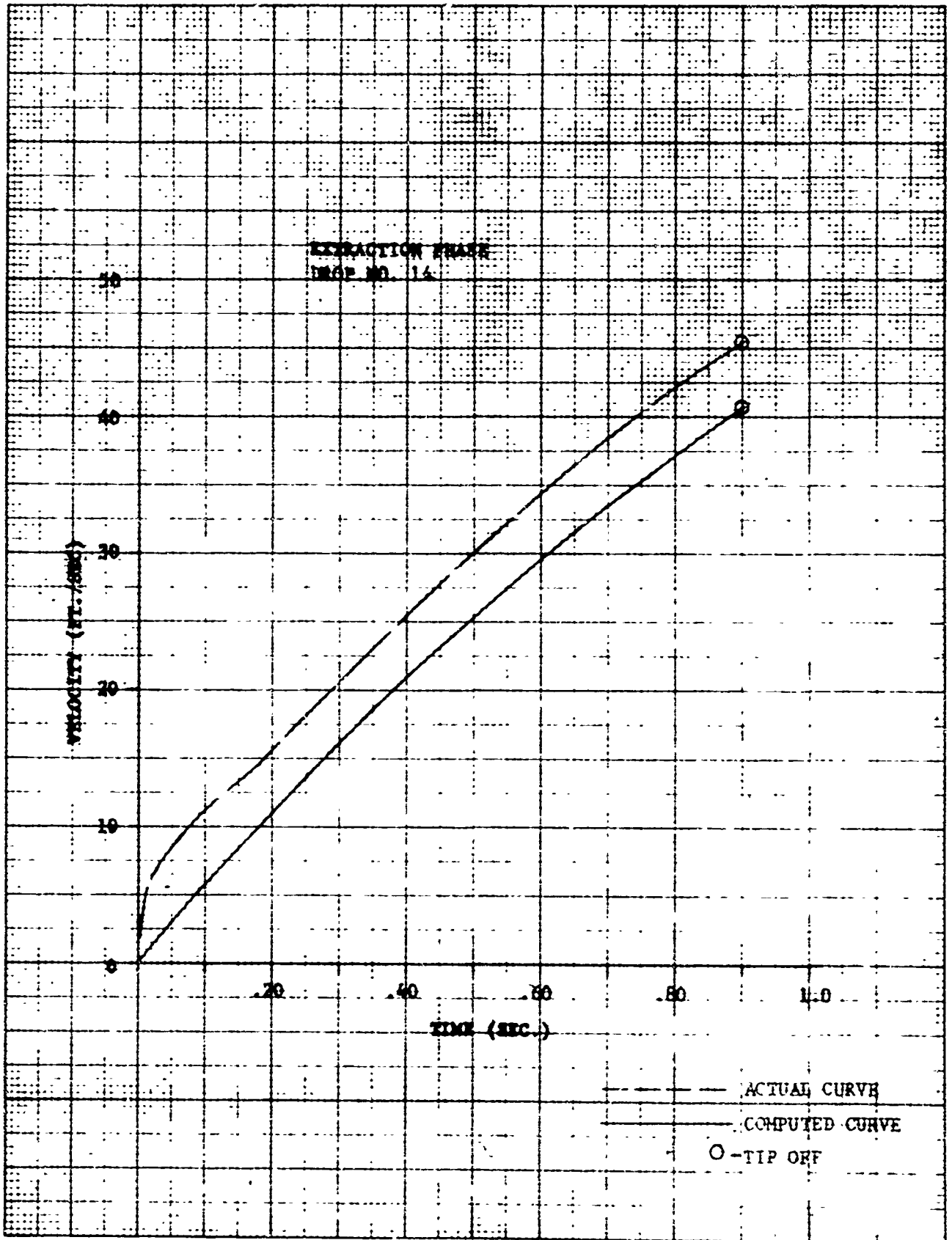


Figure 18

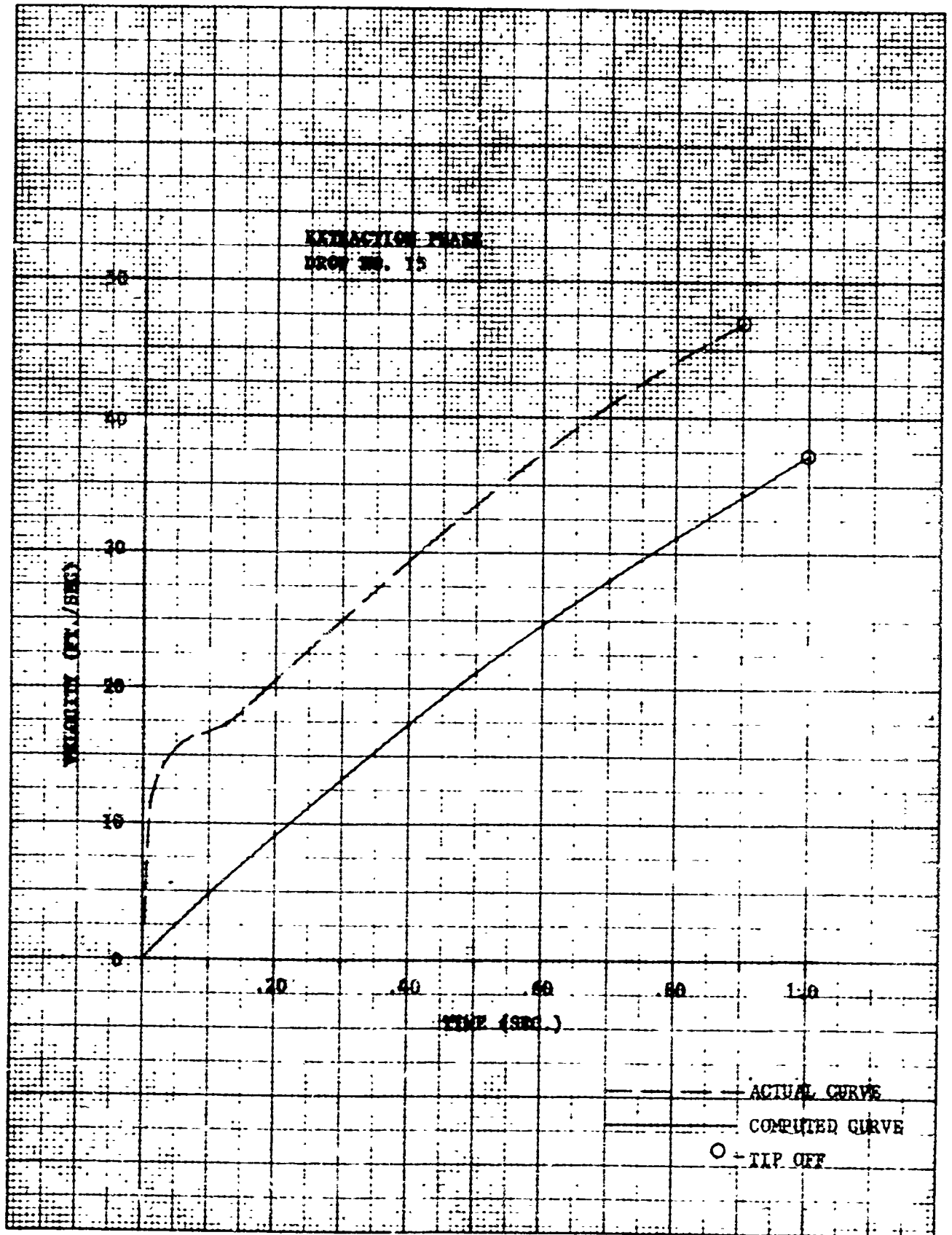


Figure 19



As can be seen, the slopes of these curves are quite similar which indicates the actual "g" loads are close to the predicted, however, the amplitudes for a given time are noticeably different. This is one of the cases indicated earlier when the equations of motion are not capable of predicting actual occurrences. The computer equations assume a rigid non-flexible member between the load and the parachute; thus, theoretically, the load is subjected to the exact force-time output of the parachute which decays proportionally to the decay of the  $V^2$  term. This results in a velocity-time curve which is relatively smooth as shown in the figures. However, in the real case the connecting member, being nylon webbing, is quite flexible and can store some energy prior to load movement. Therefore, at load movement, which is some predetermined time during the inflation period, the load is subjected to force levels for a short time that are higher than predicted. This gives a cargo jerk which results in an initial steep slope on the velocity-time curve with a larger amplitude than would be obtained for the theoretical case.

### C. Descent Phase

Cargo motion during the descent phase was recorded by high-speed motion picture cameras. The film was then reduced using a motion analyzer to various useful curves. Plots were made of each individual test showing the actual curve and the curve predicted by the computer. All curves start at the beginning of the descent phase and run to ground impact. Figures 20 through 33 present the plots of cargo altitude versus horizontal travel. Plots of Drops No. 1, 3, 8 and 11 are incomplete due to the inability to acquire sufficient film data.

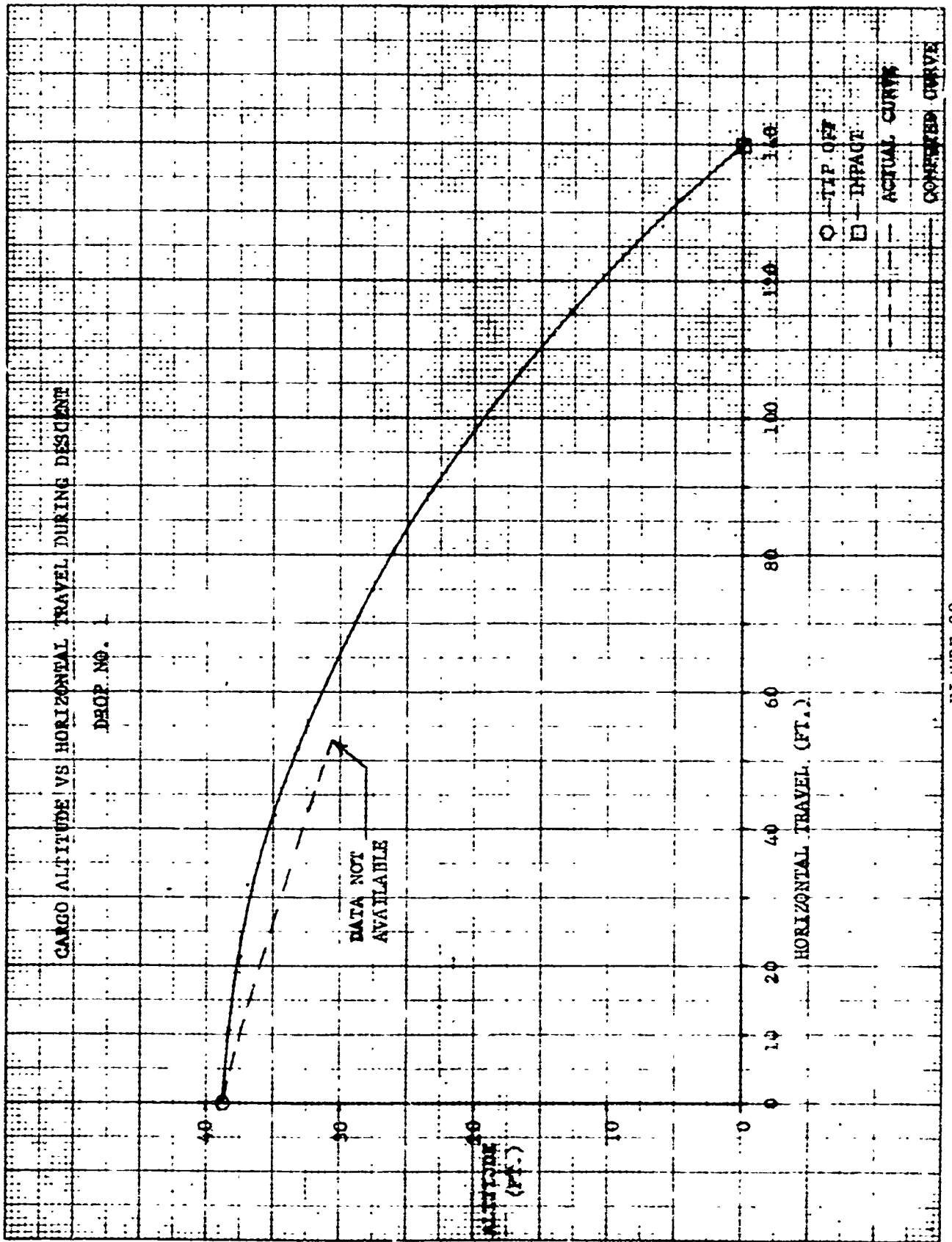


FIGURE 20

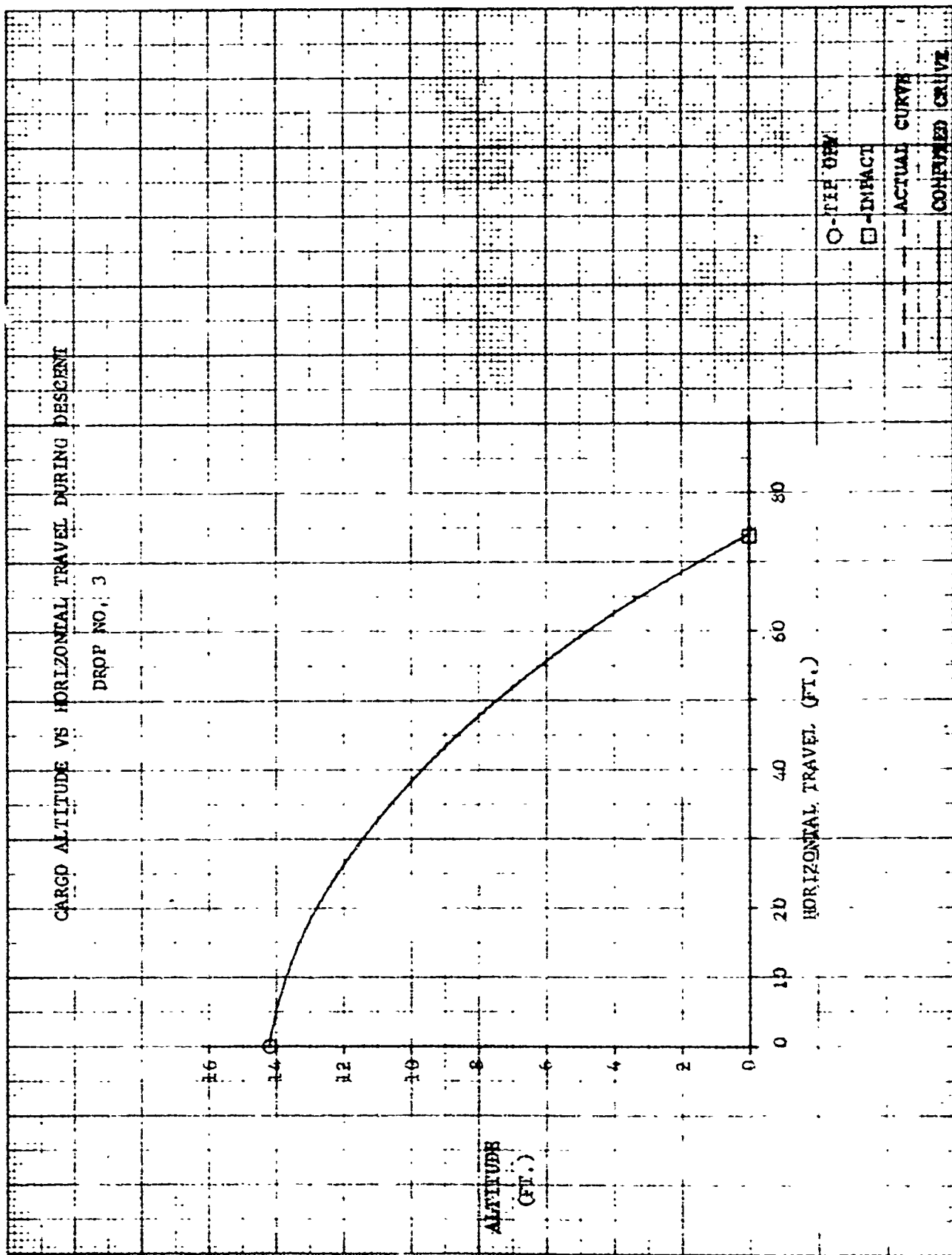


FIGURE 21

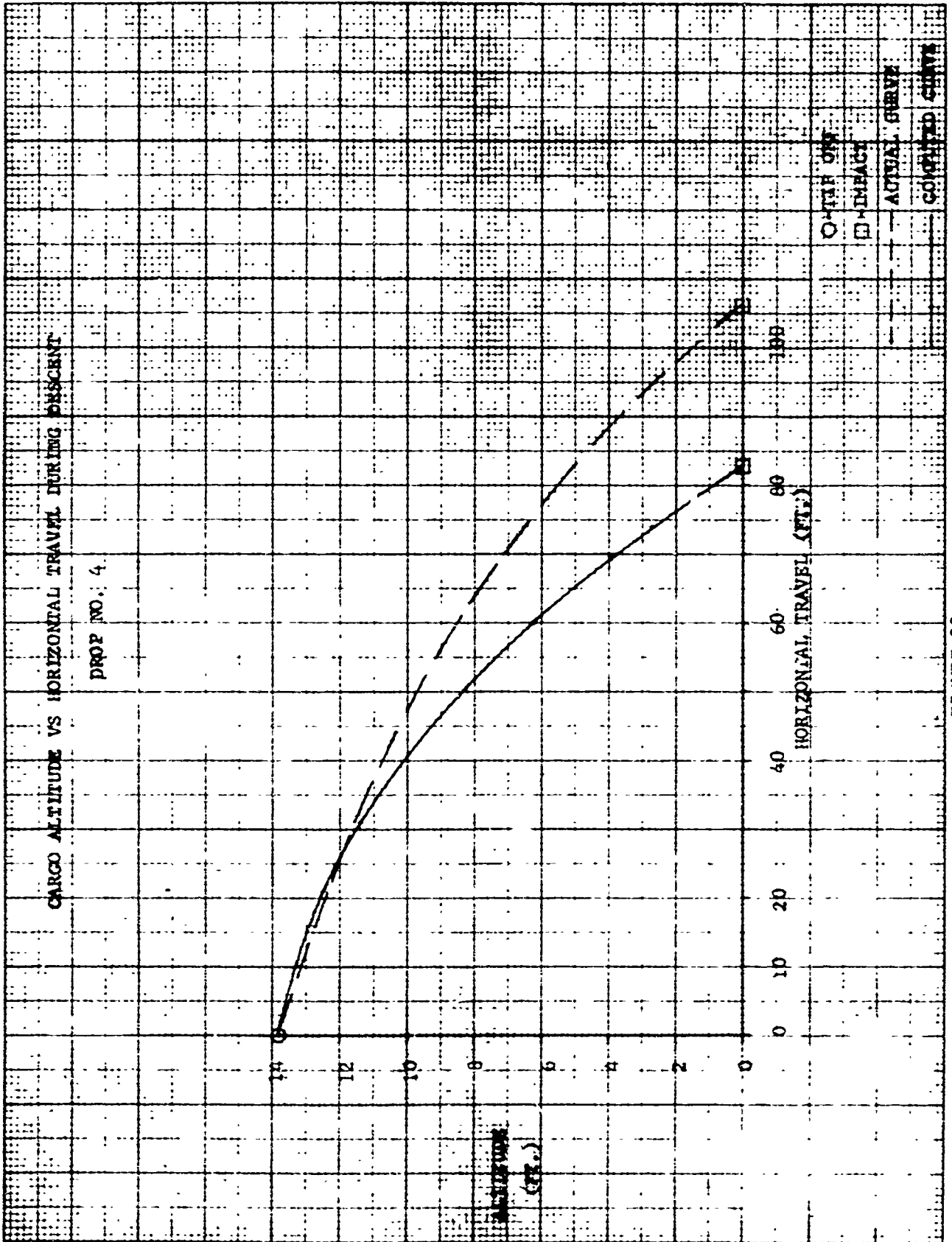


FIGURE 22



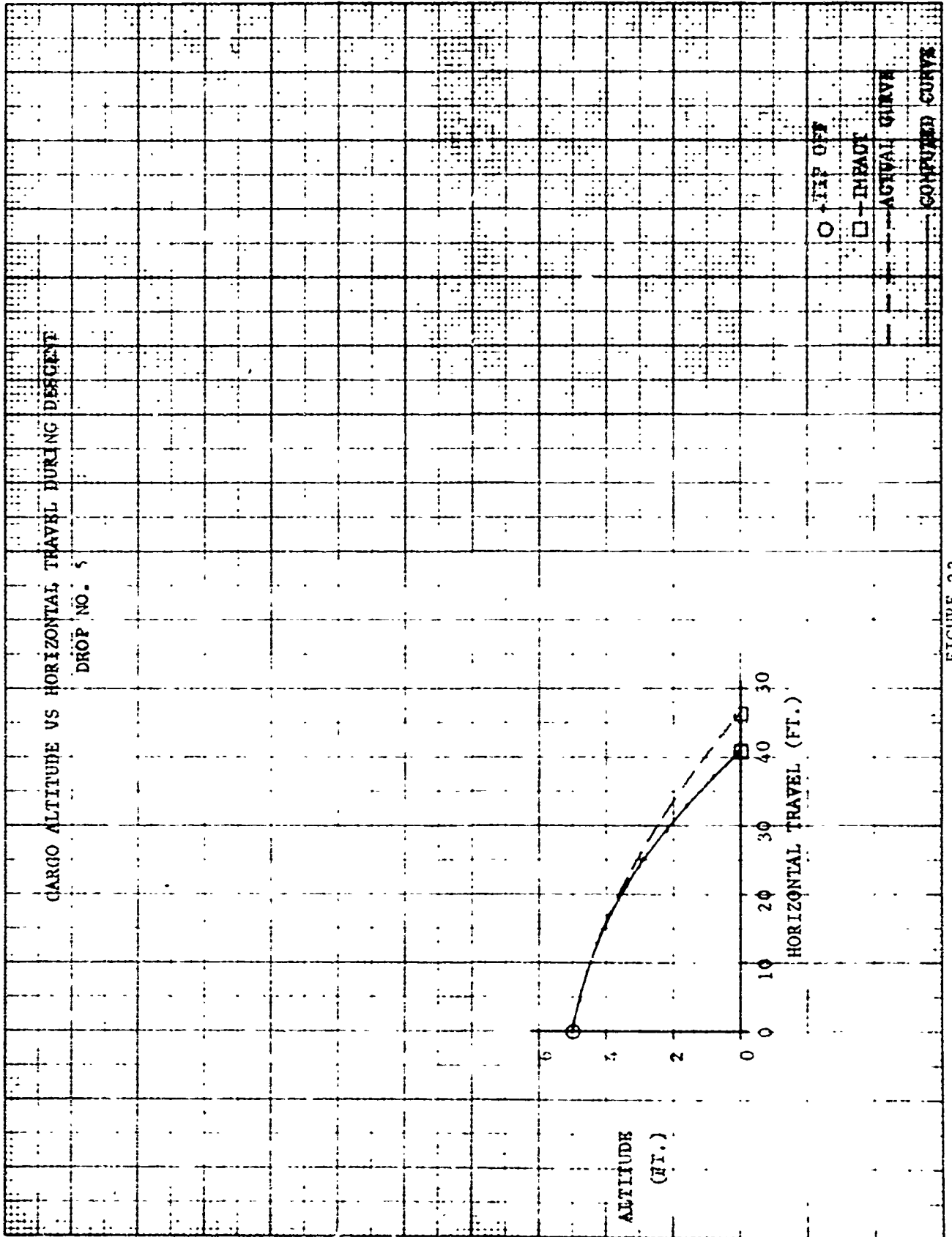


FIGURE 23

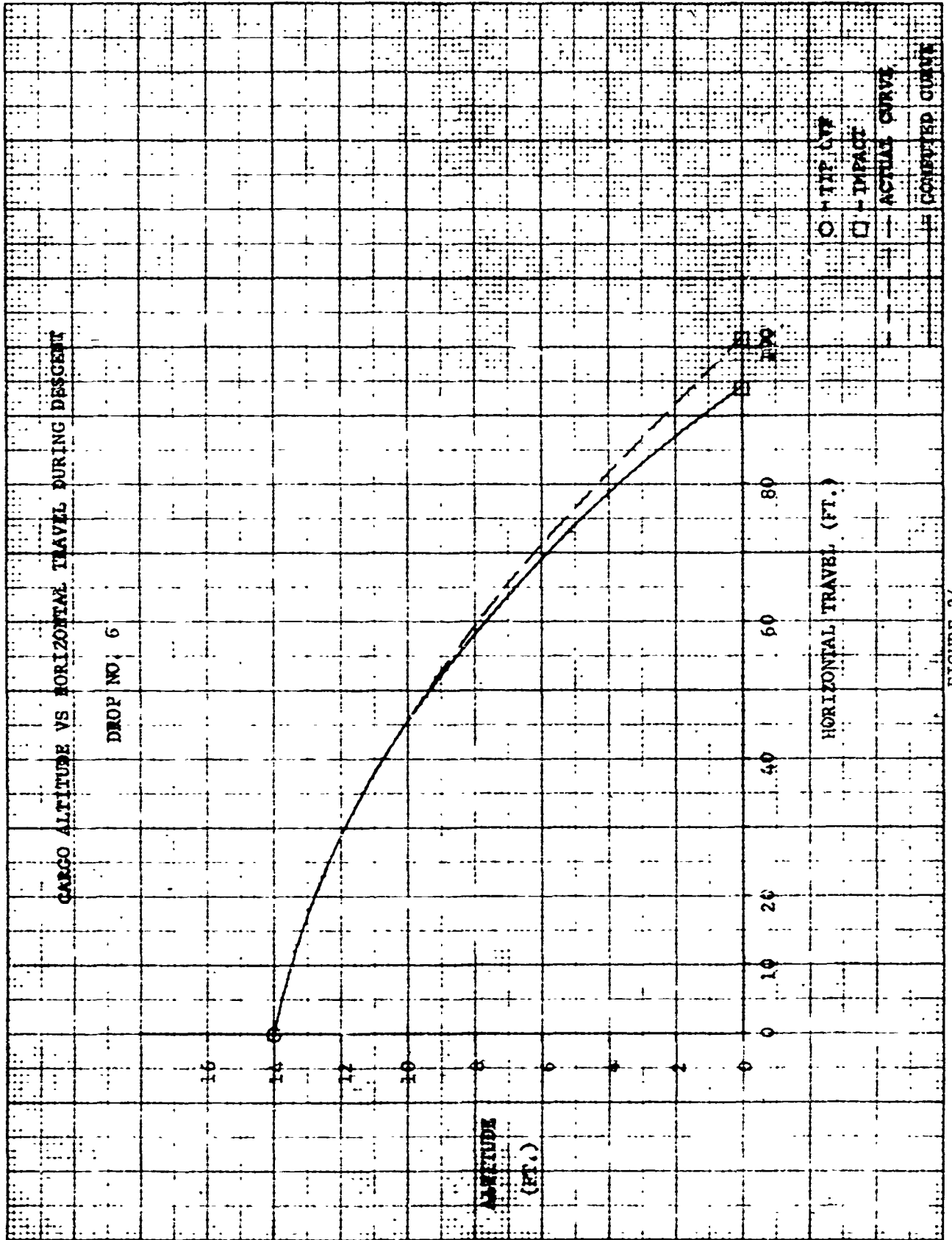


FIGURE 24

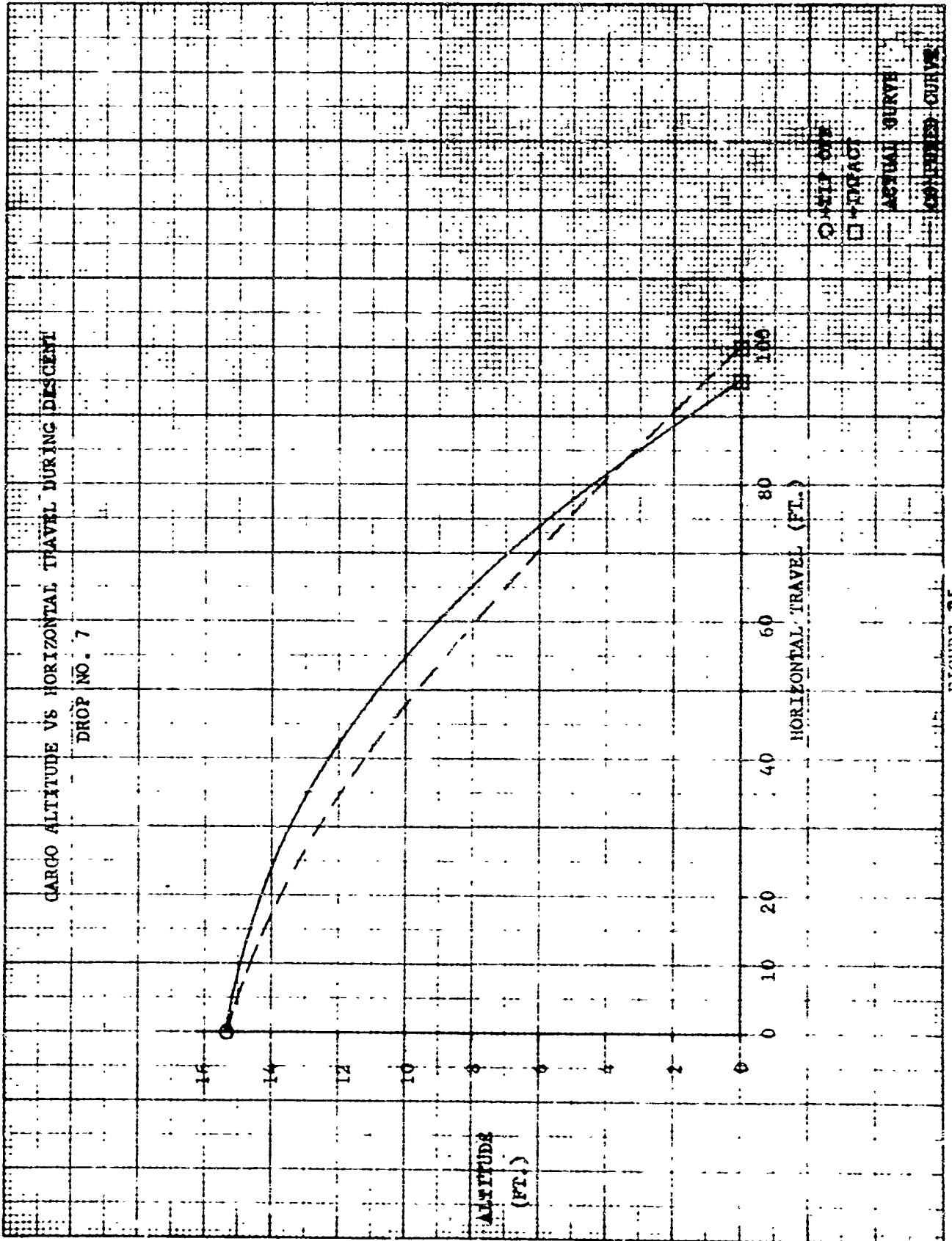


FIGURE 25

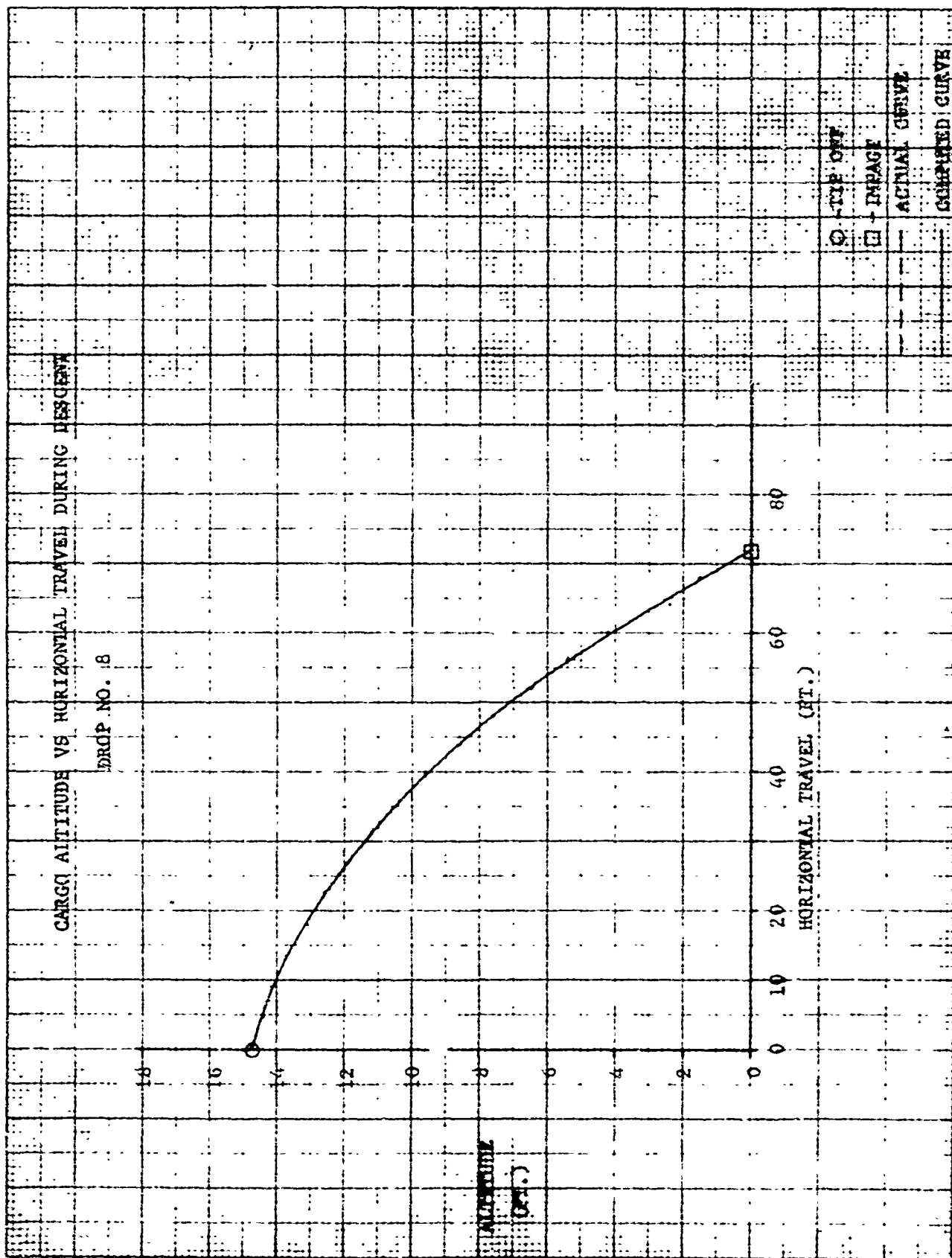


FIGURE 26

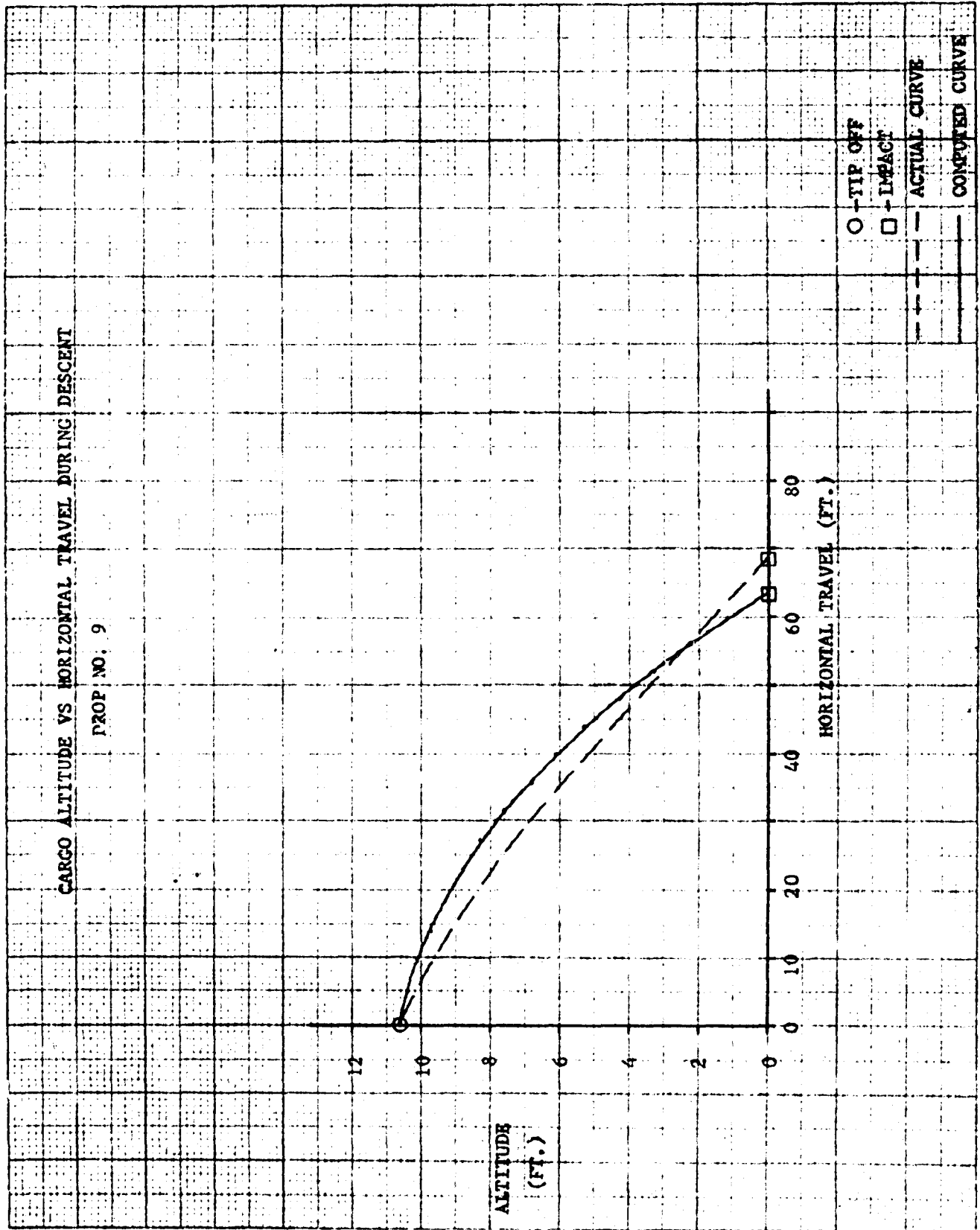


FIGURE 27

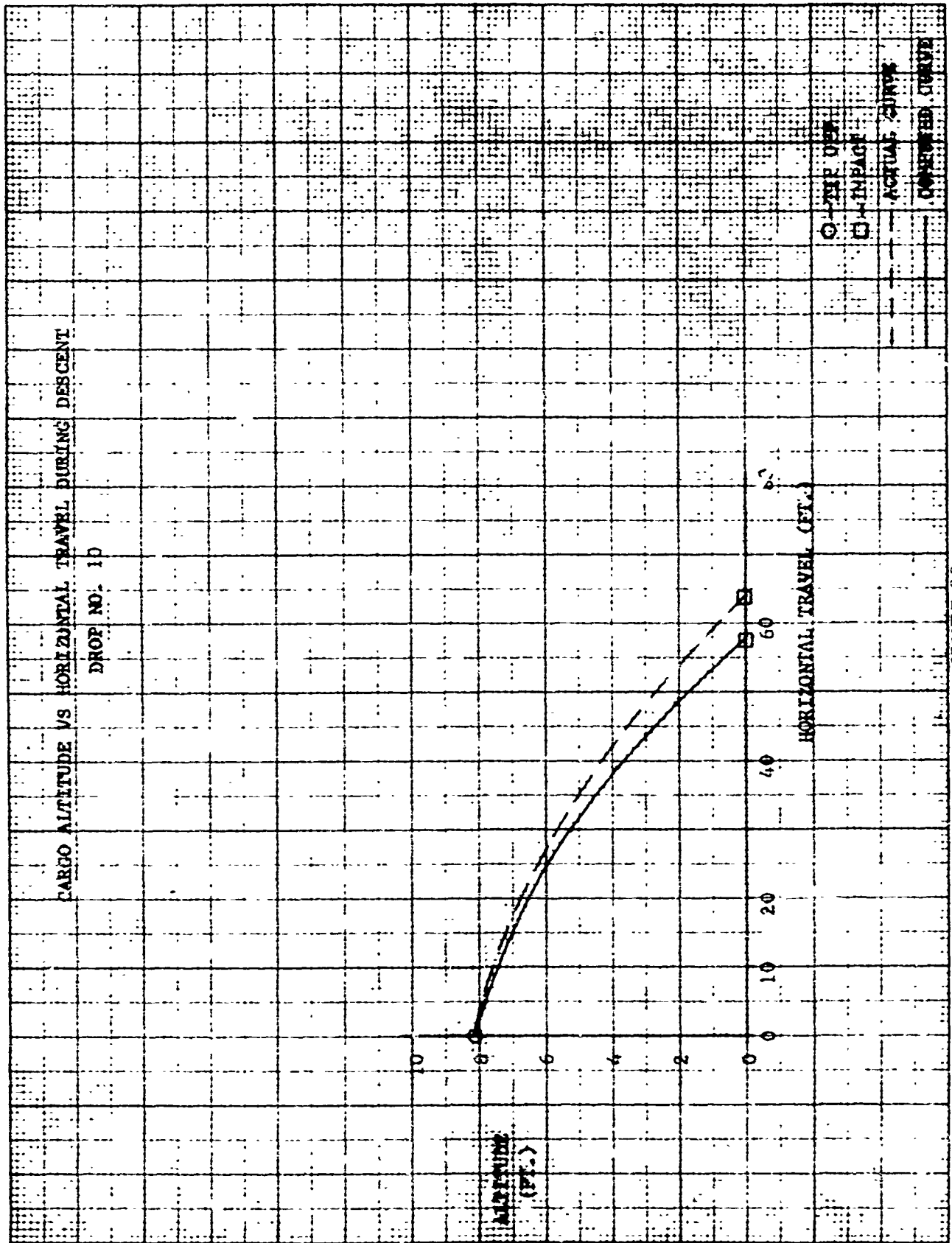


FIGURE 28

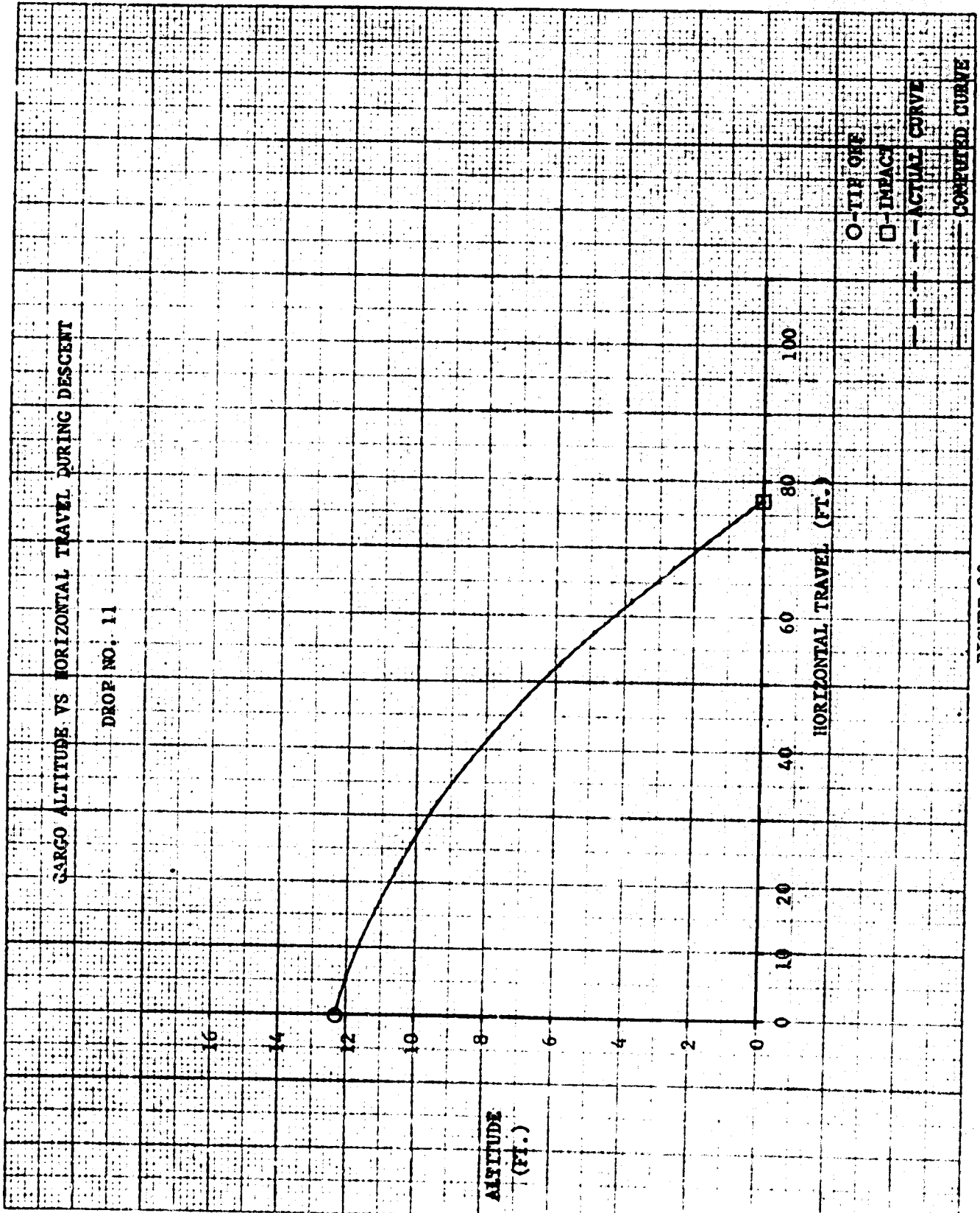


FIGURE 29

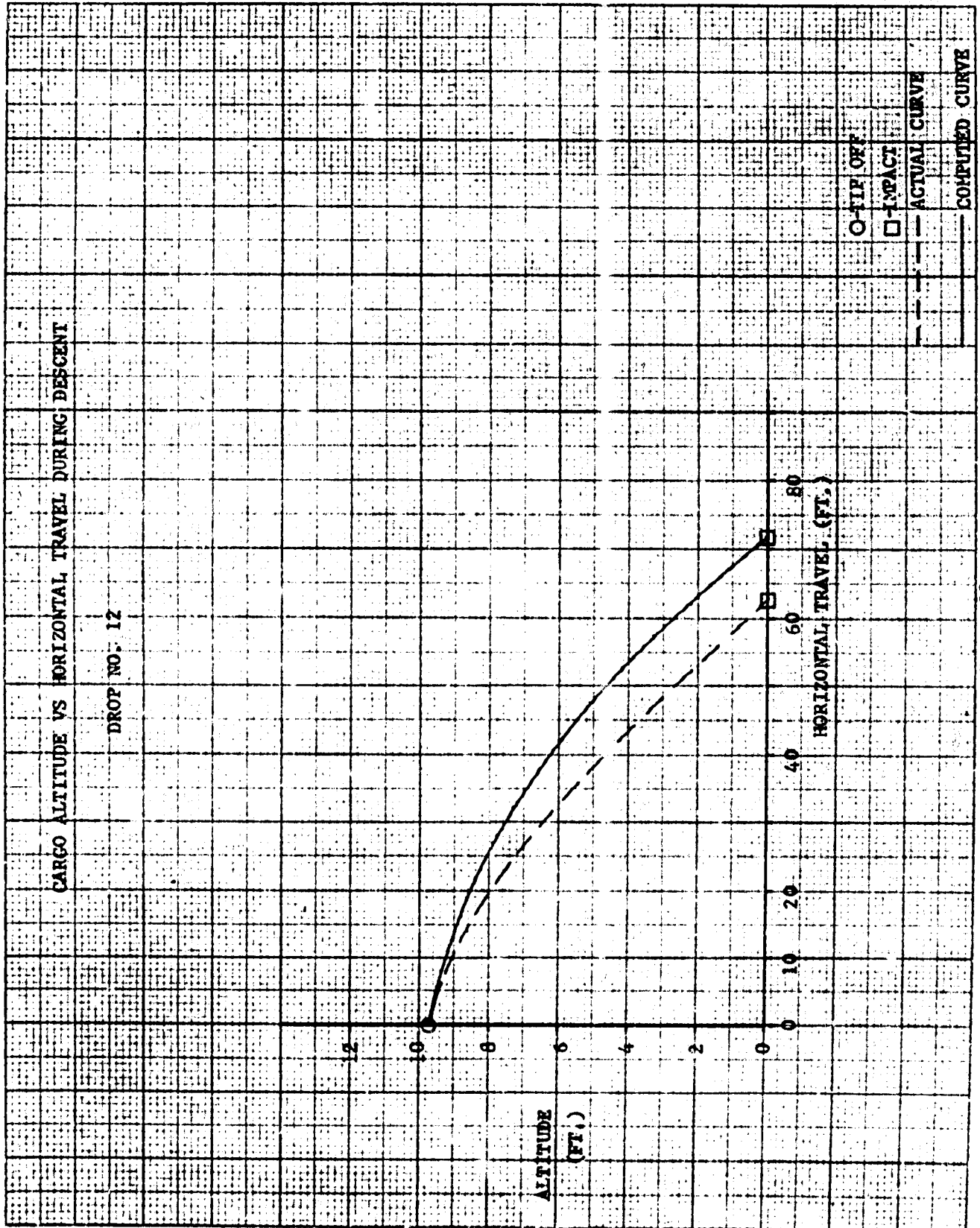


FIGURE 30



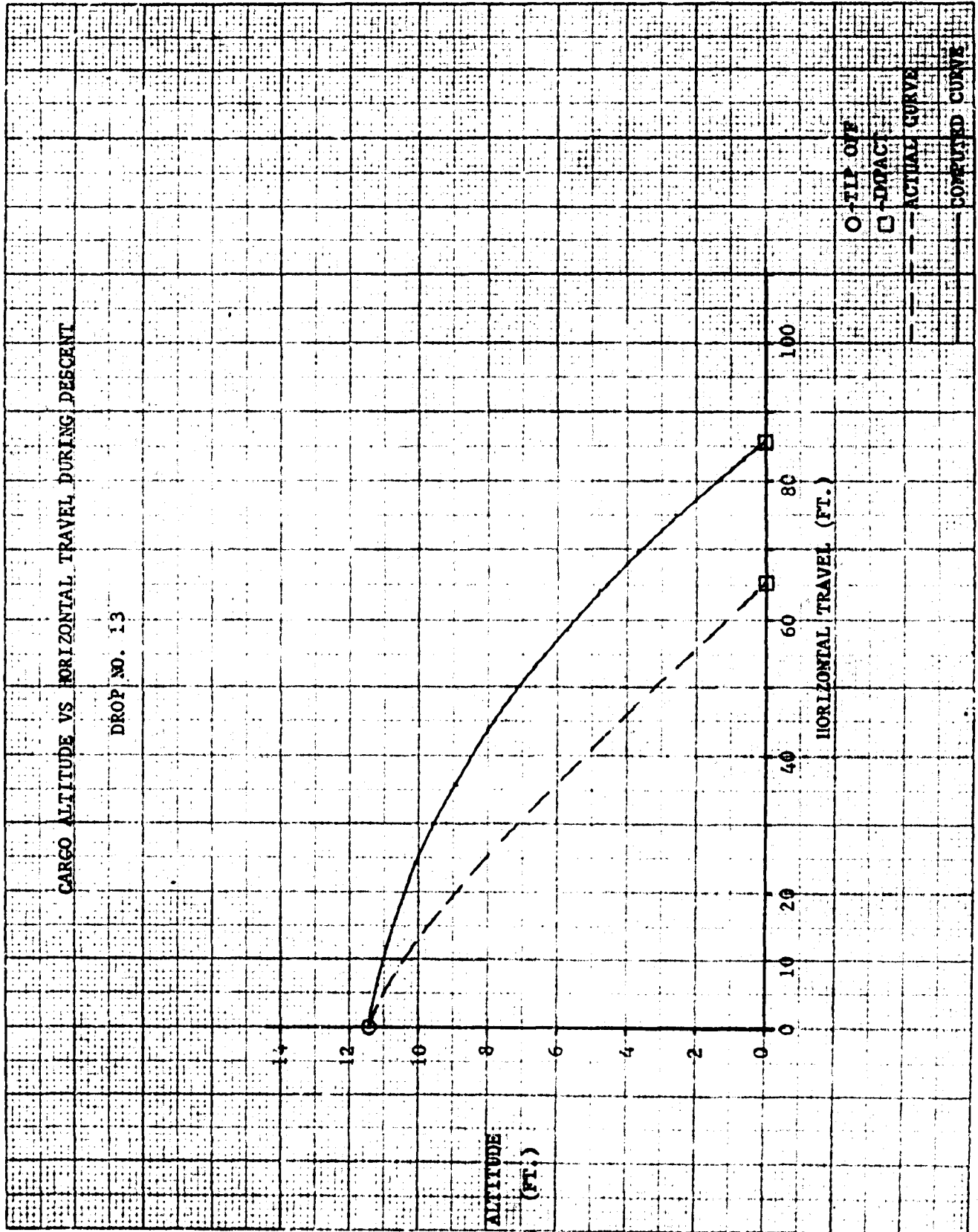


FIGURE 31

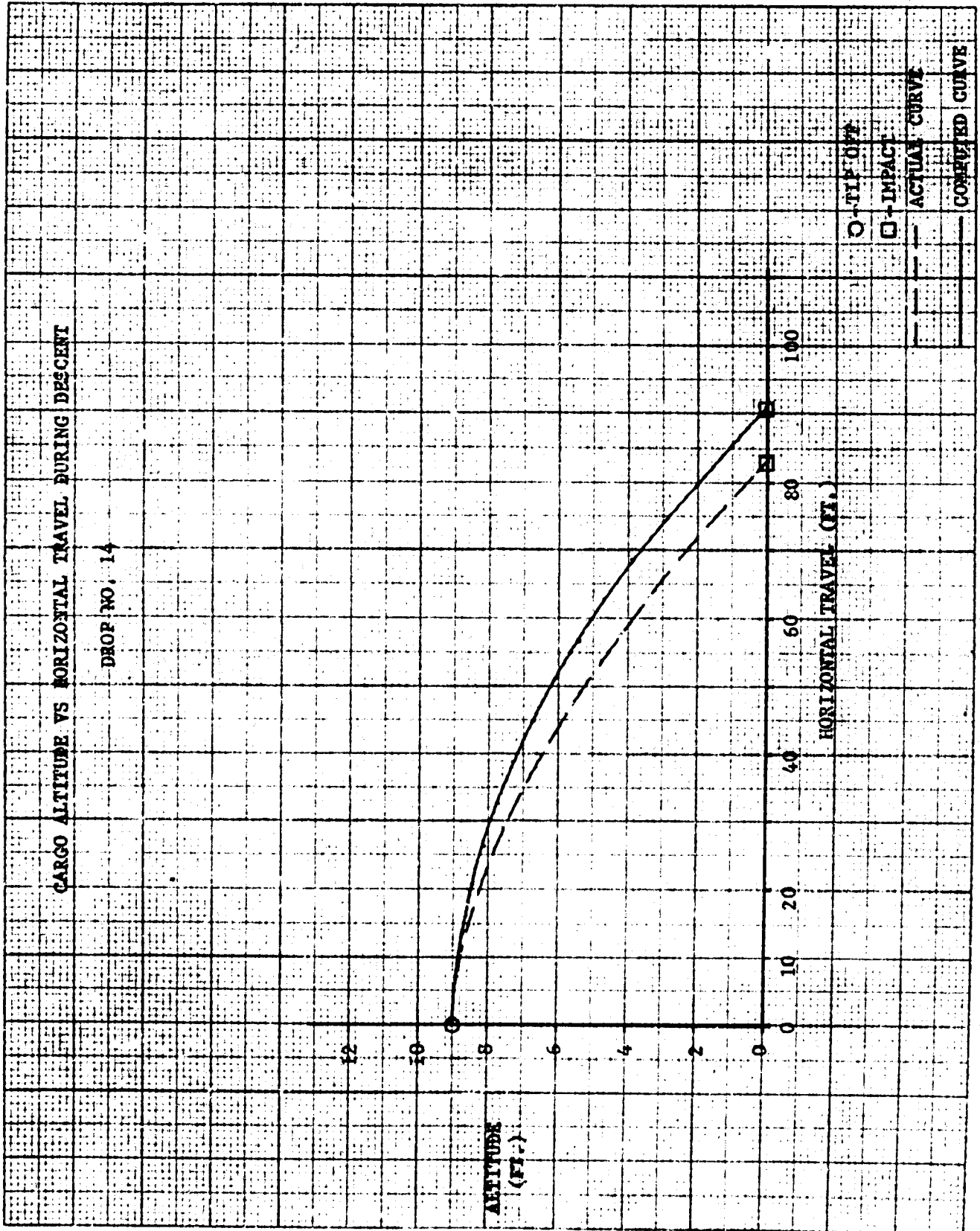


FIGURE 32

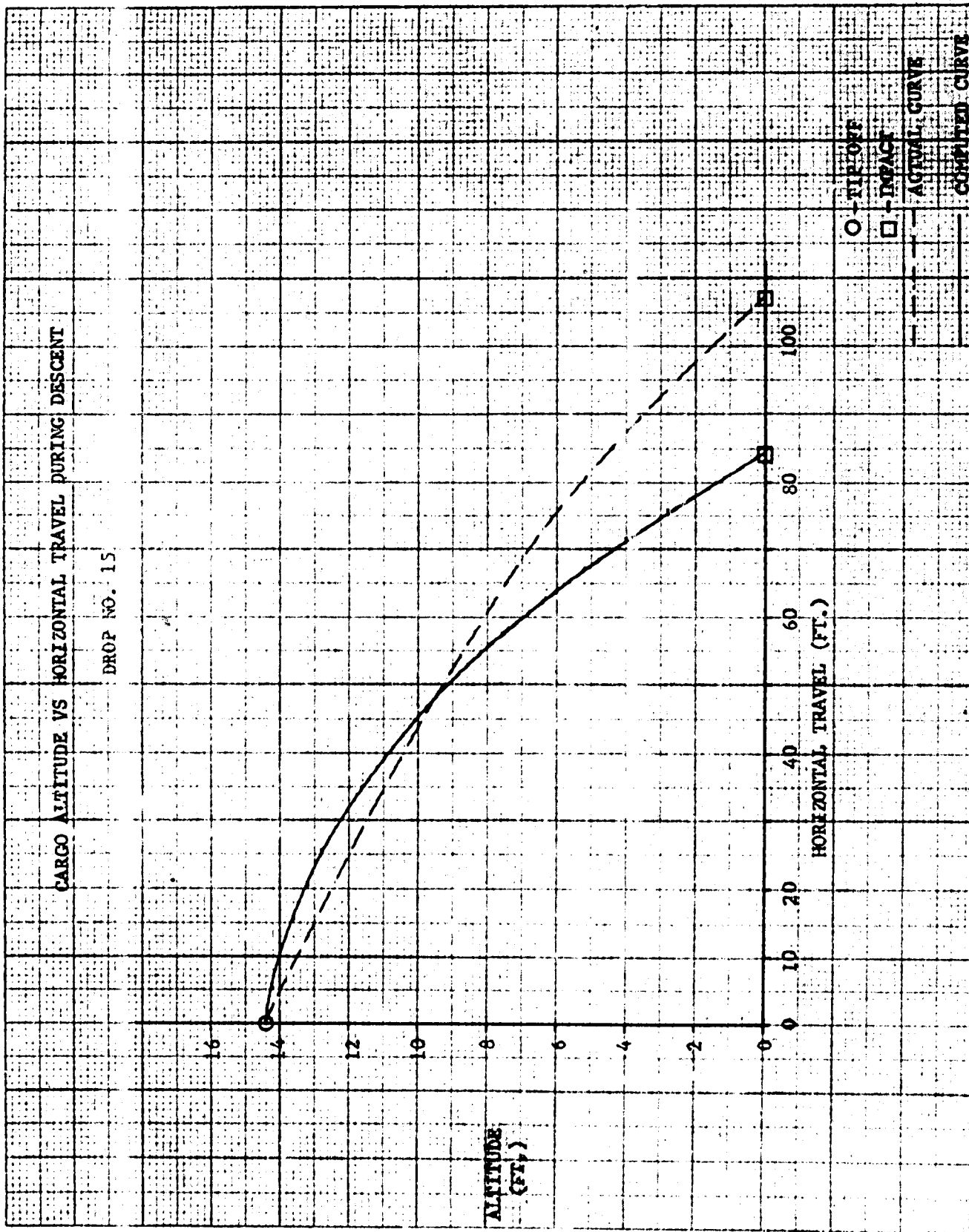


FIGURE 33



A second curve was generated from the data obtained on each test. This curve was a plot of horizontal travel versus descent time. Comparative curves were obtained from the computer analysis and are shown in Figures 34-47. Again Drop No. 1, 3, 8 and 11 are incomplete due to lack of data.

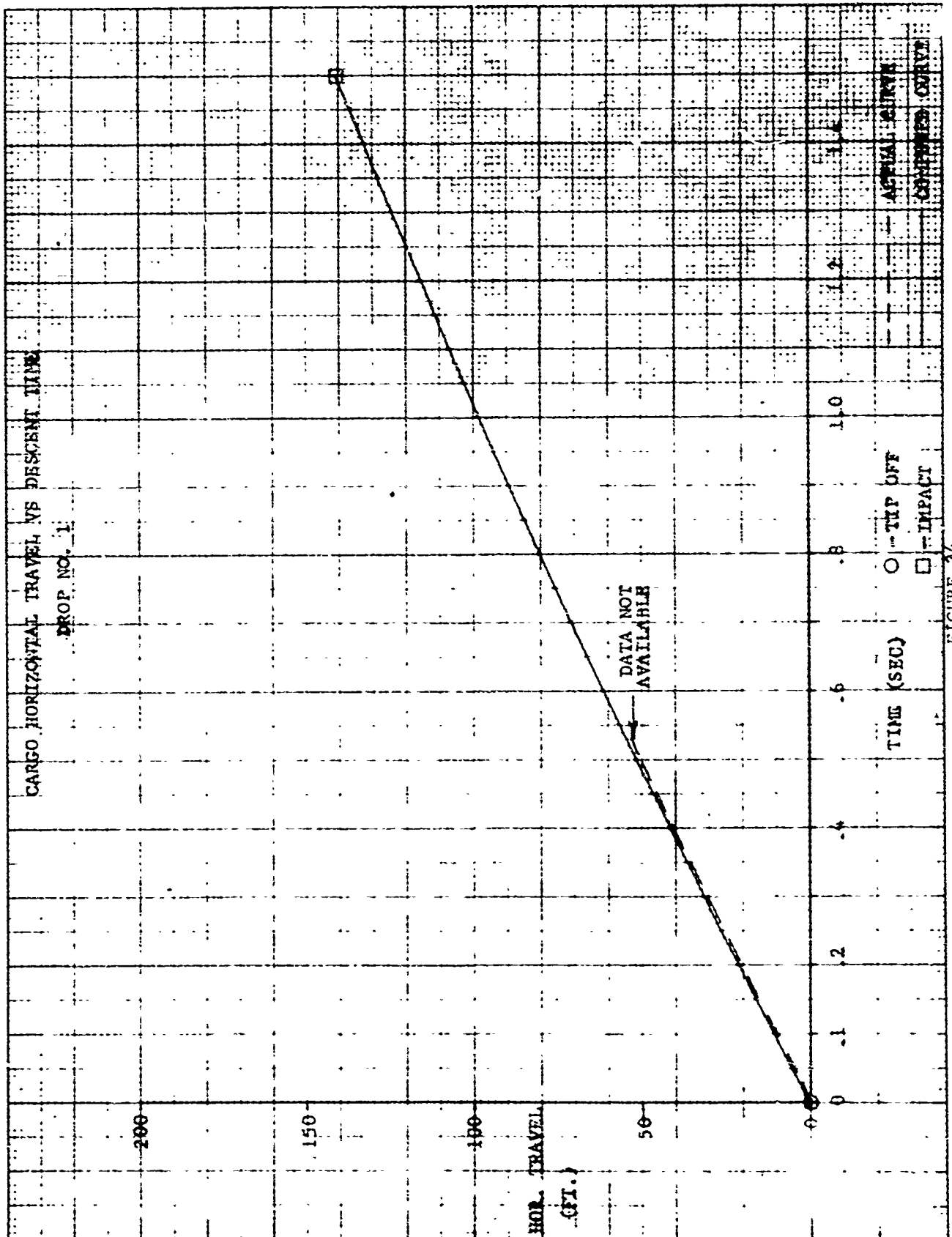


FIGURE 3A

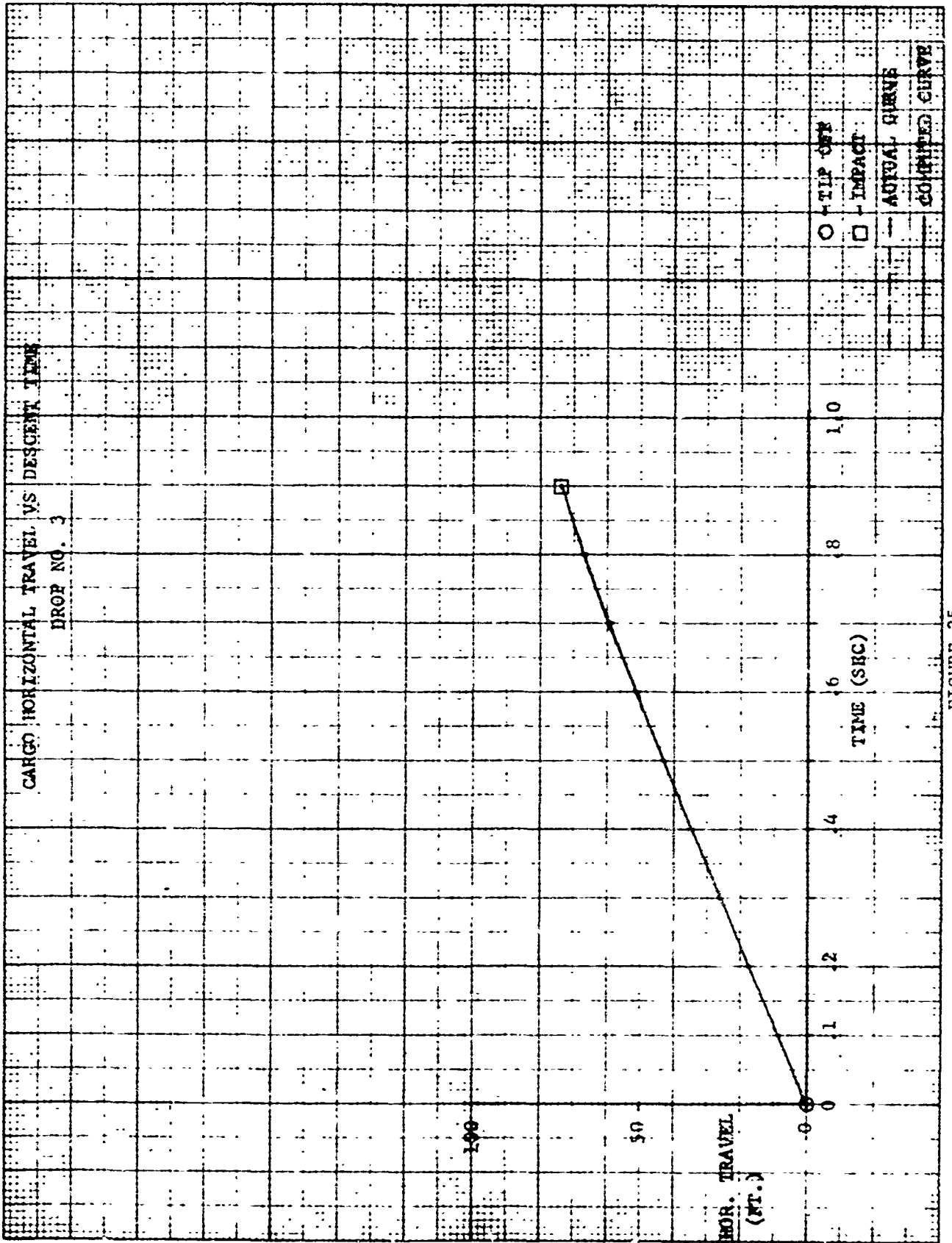


FIGURE 35

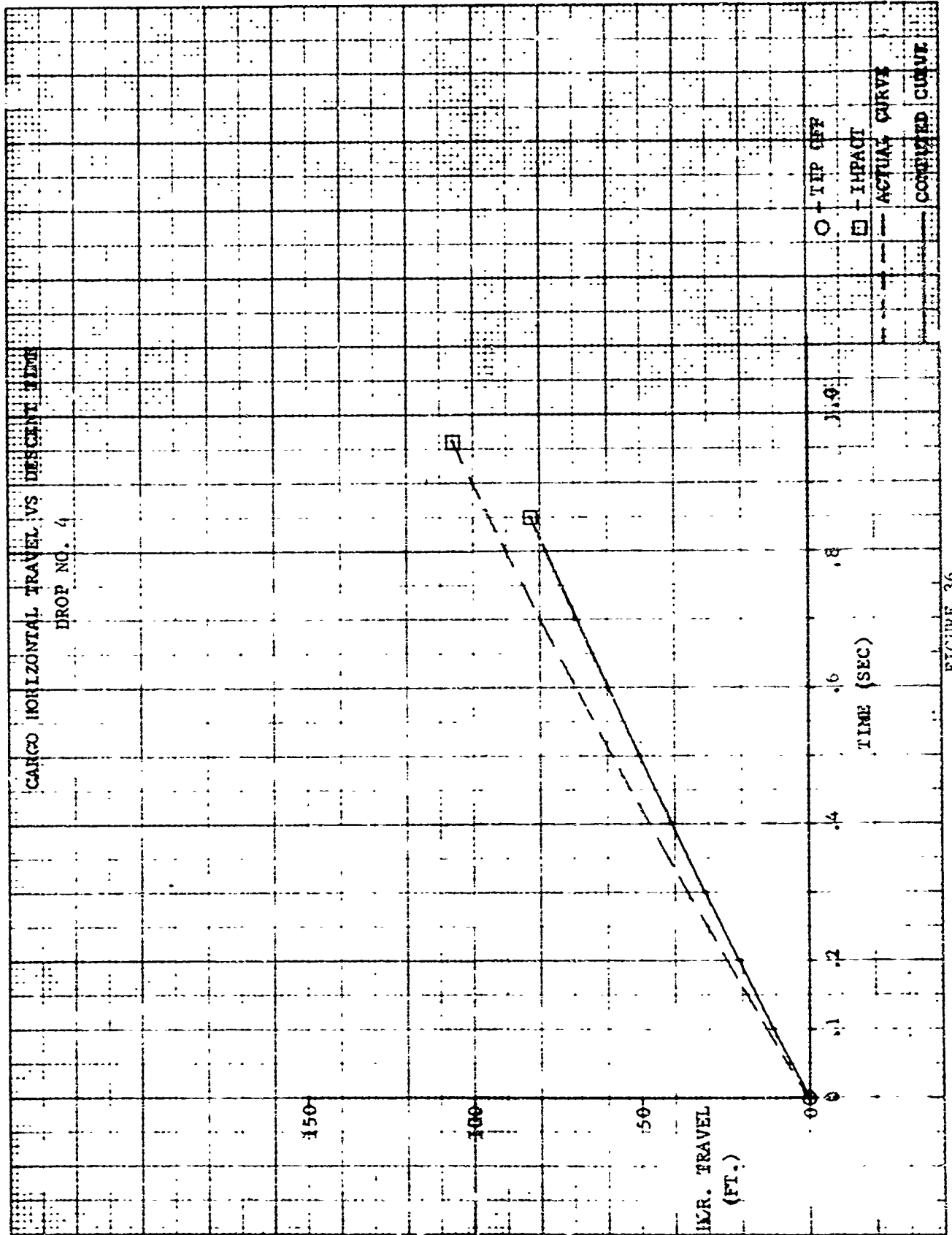


FIGURE 36

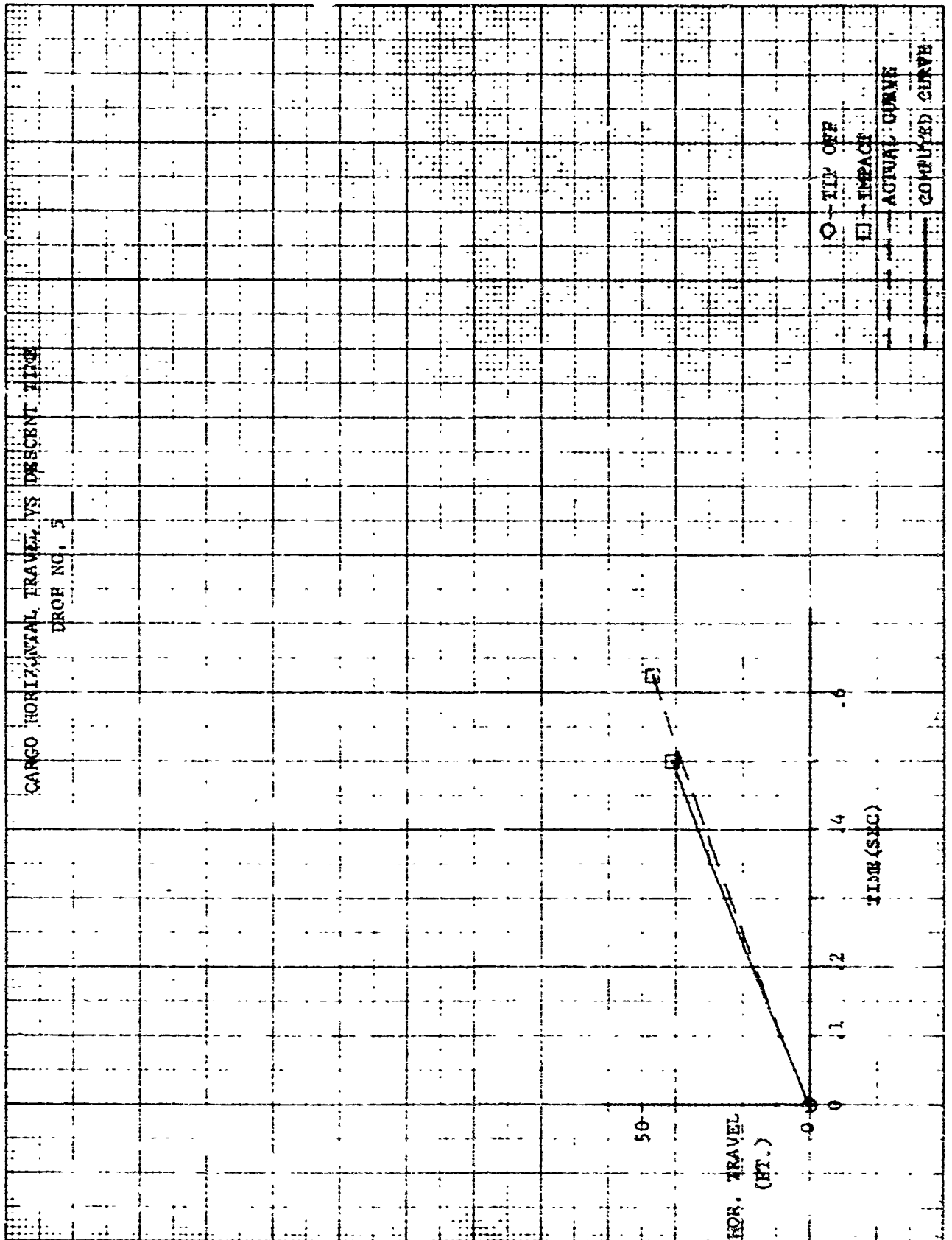


FIGURE 37



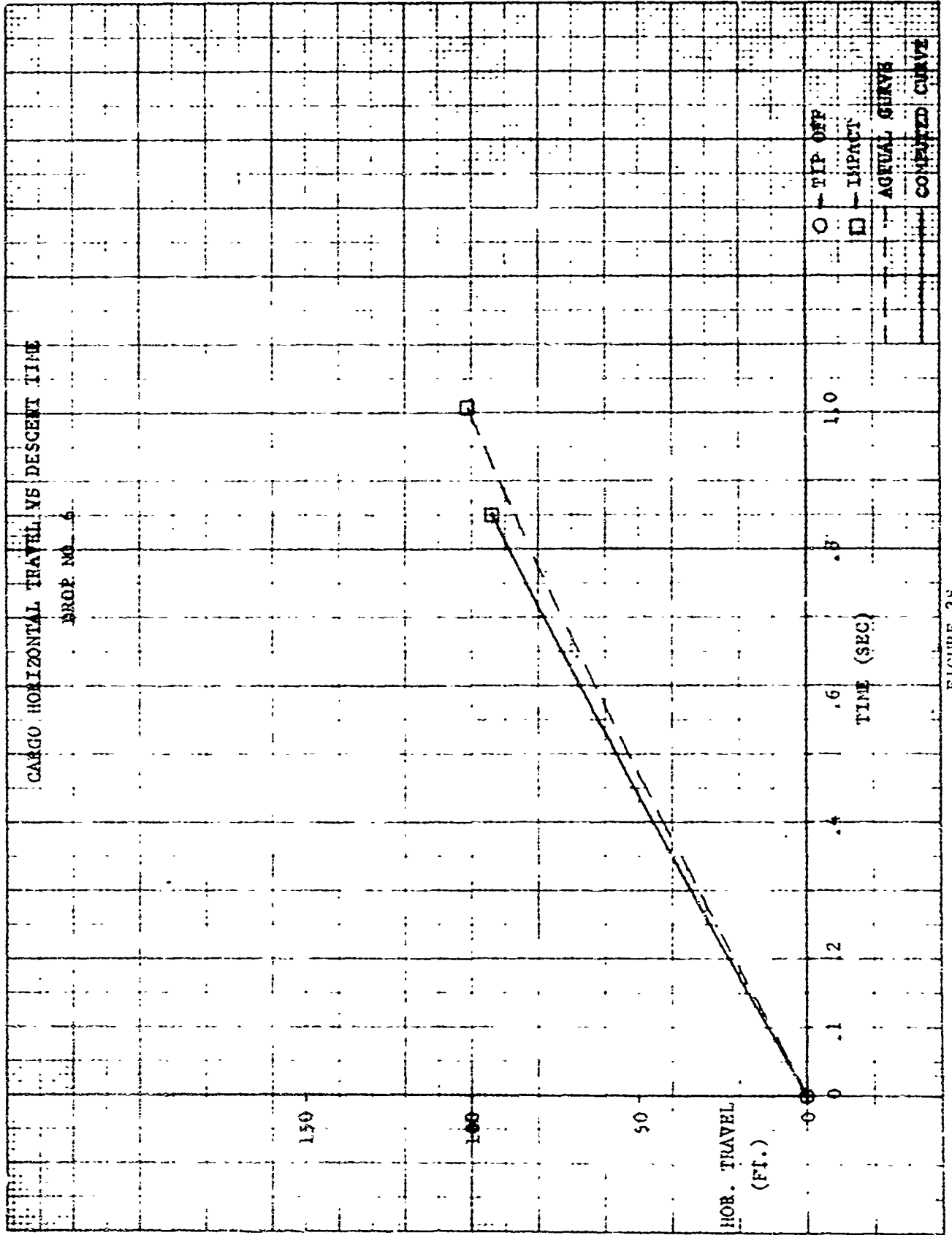


FIGURE 38

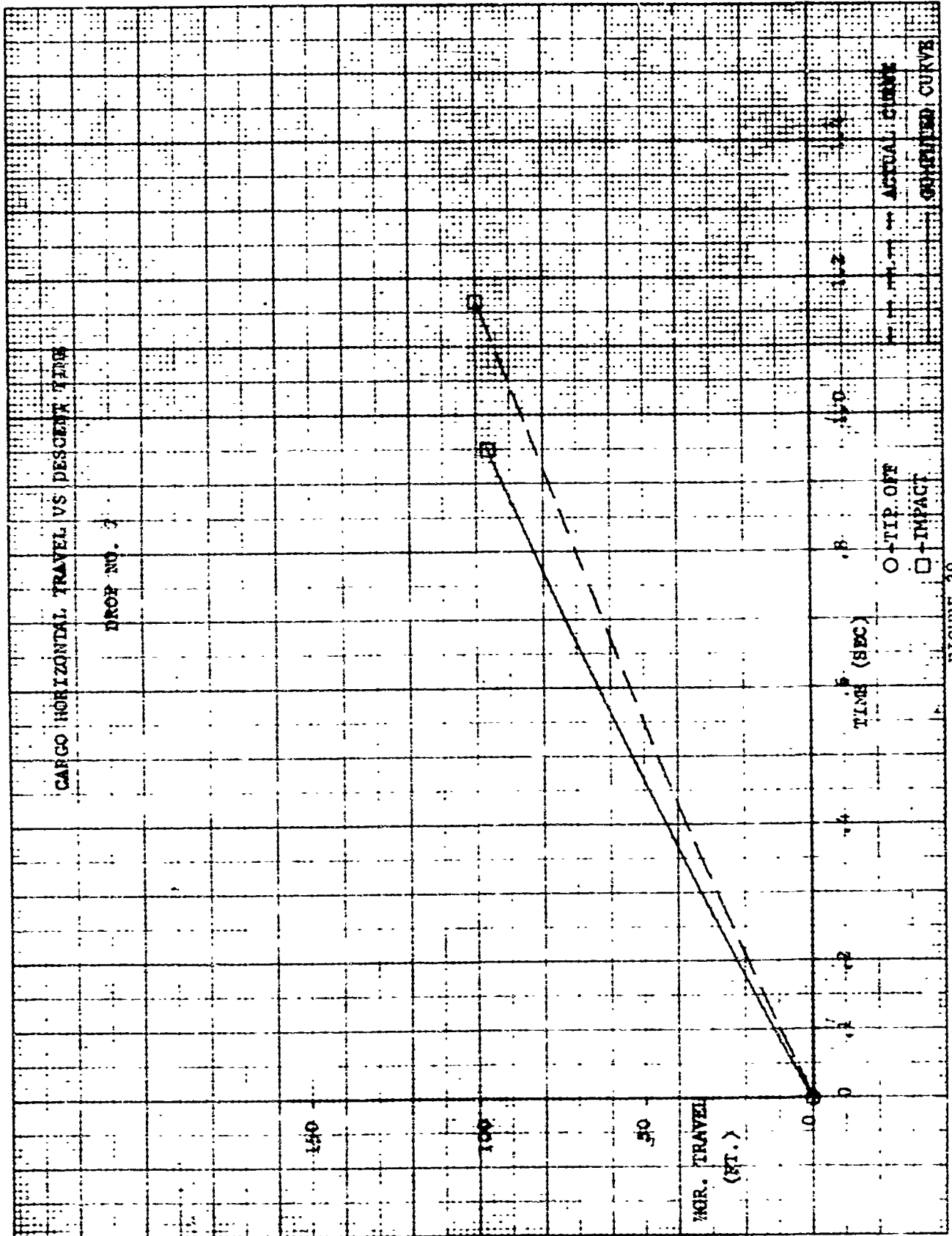


FIGURE 39

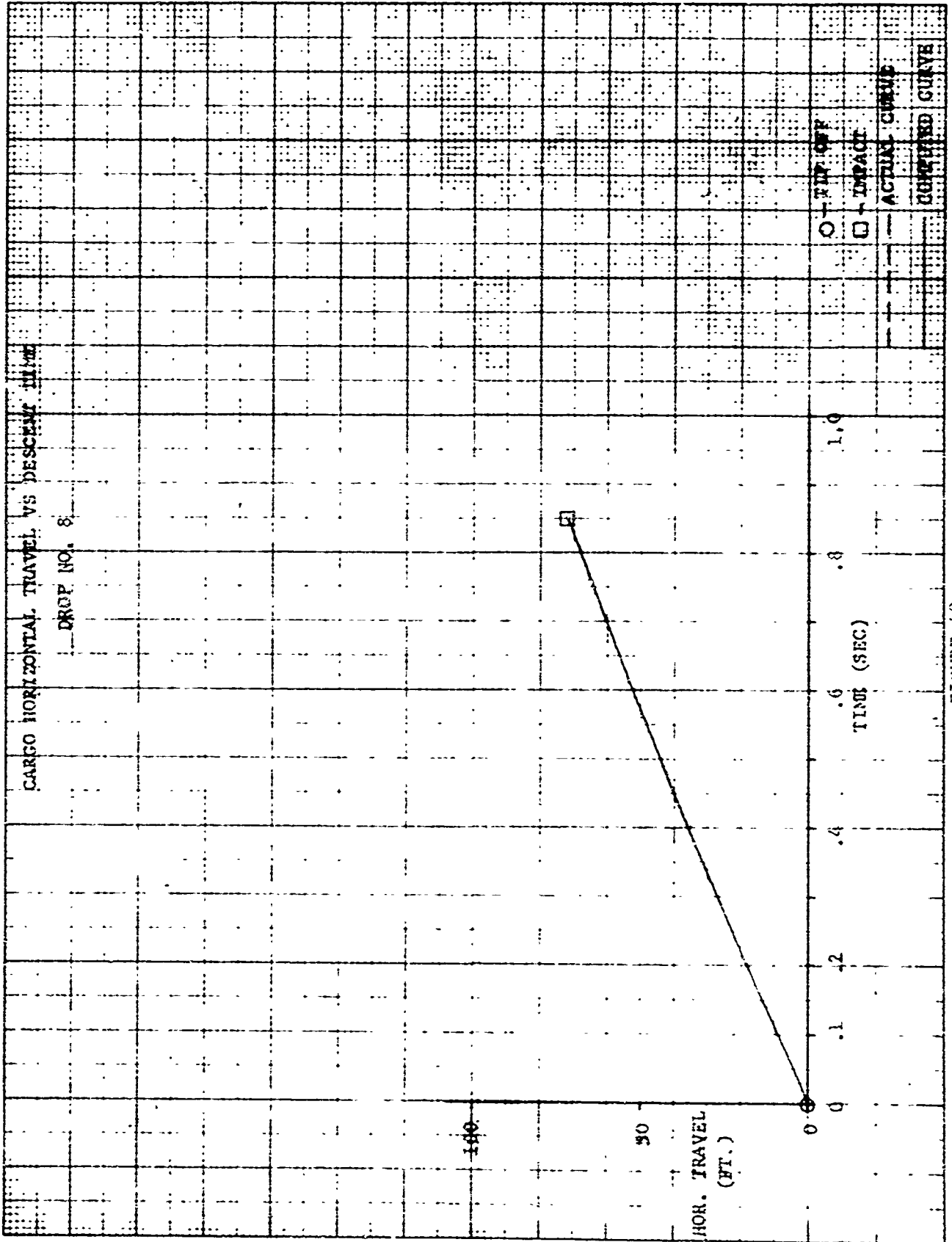


FIGURE 40

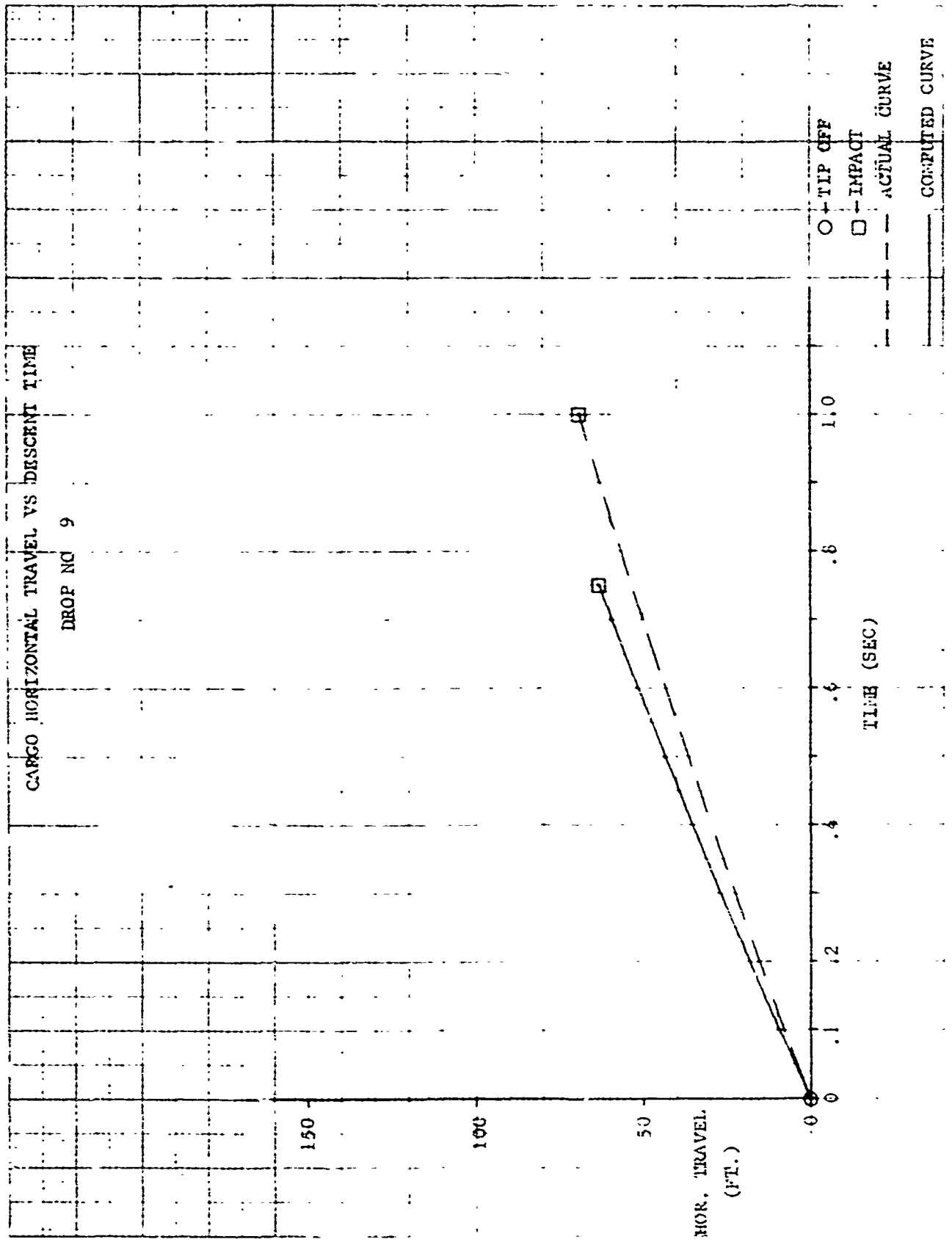


FIGURE 41

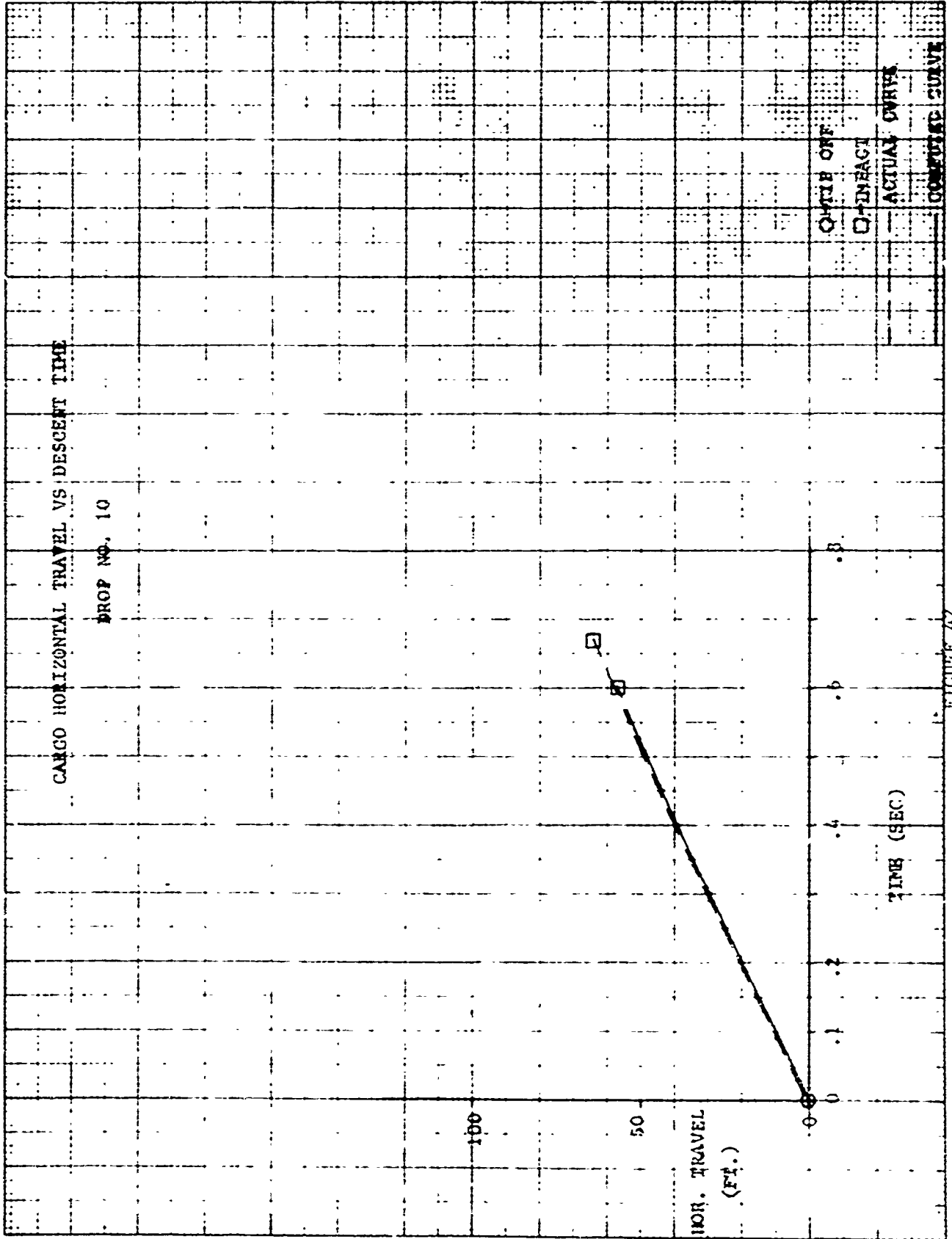


FIGURE 42

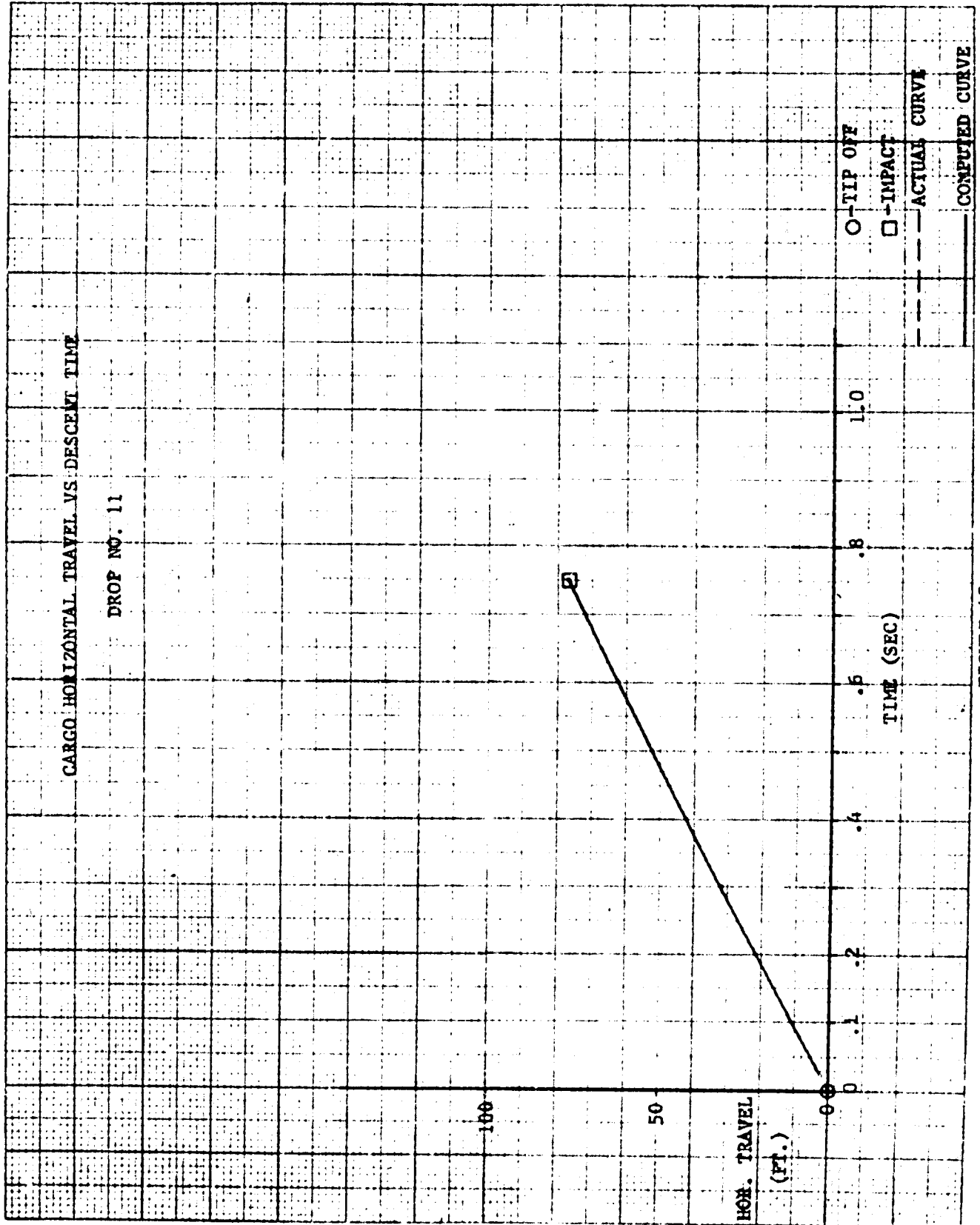


FIGURE 43

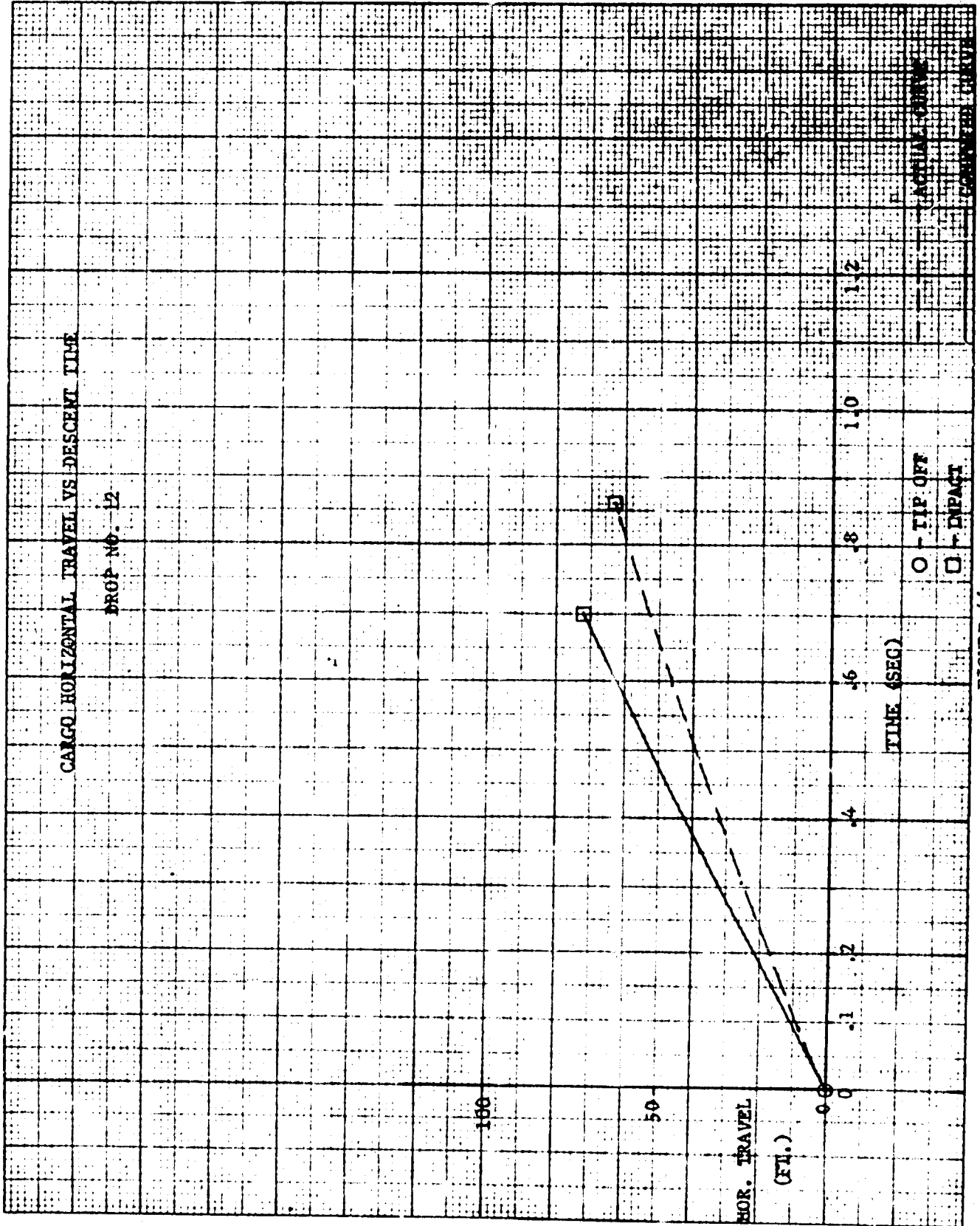


FIGURE 44

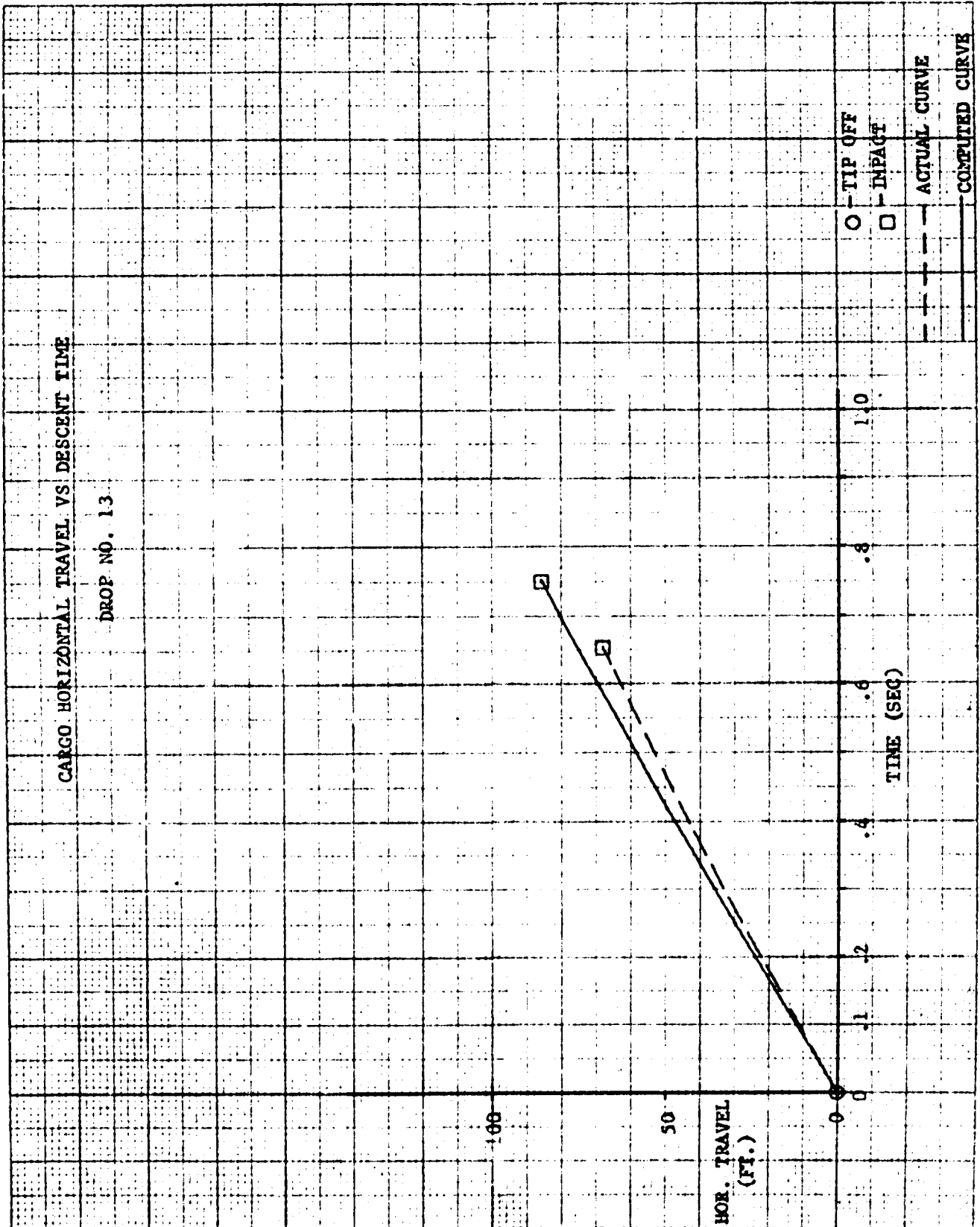


FIGURE 45



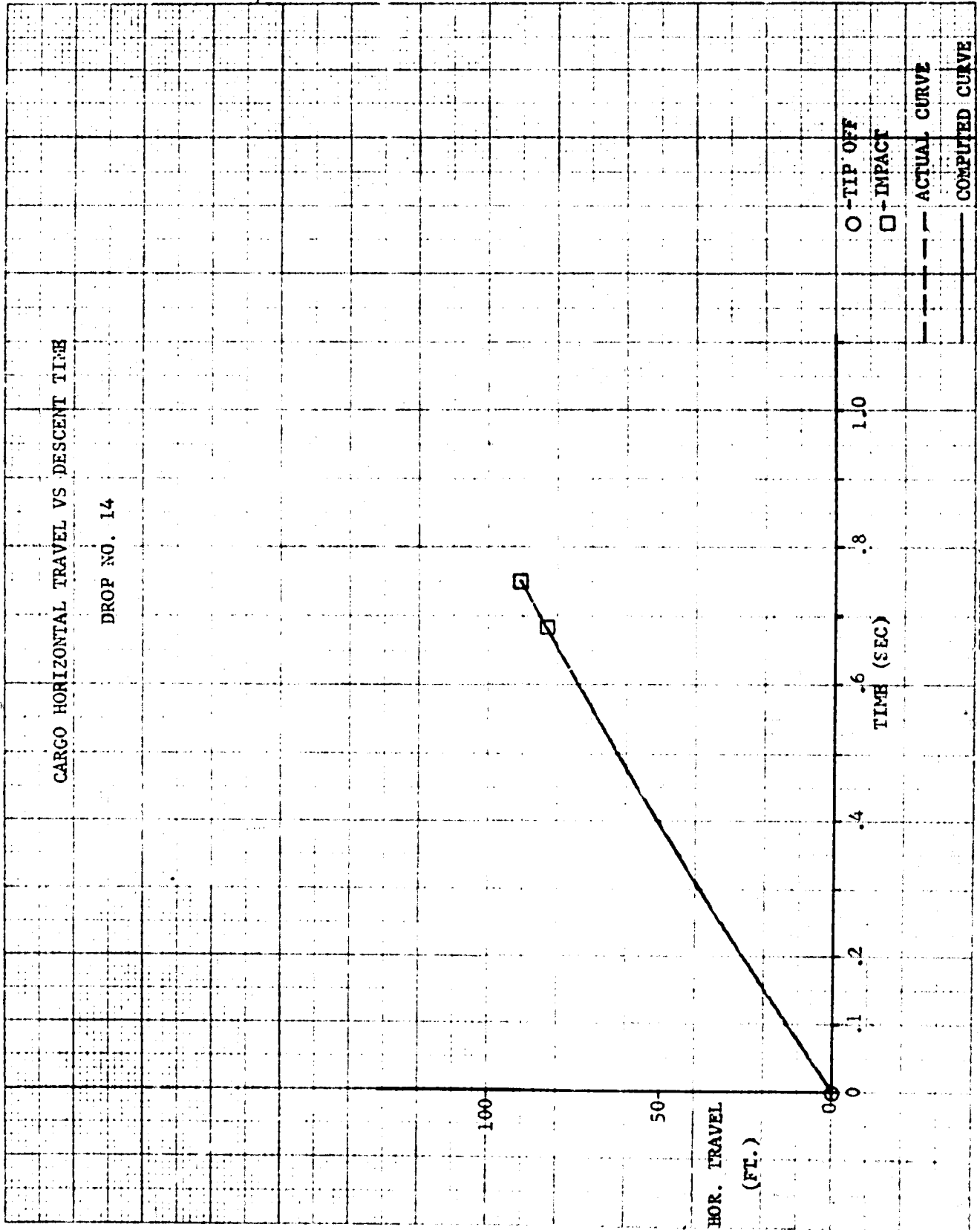


FIGURE 46

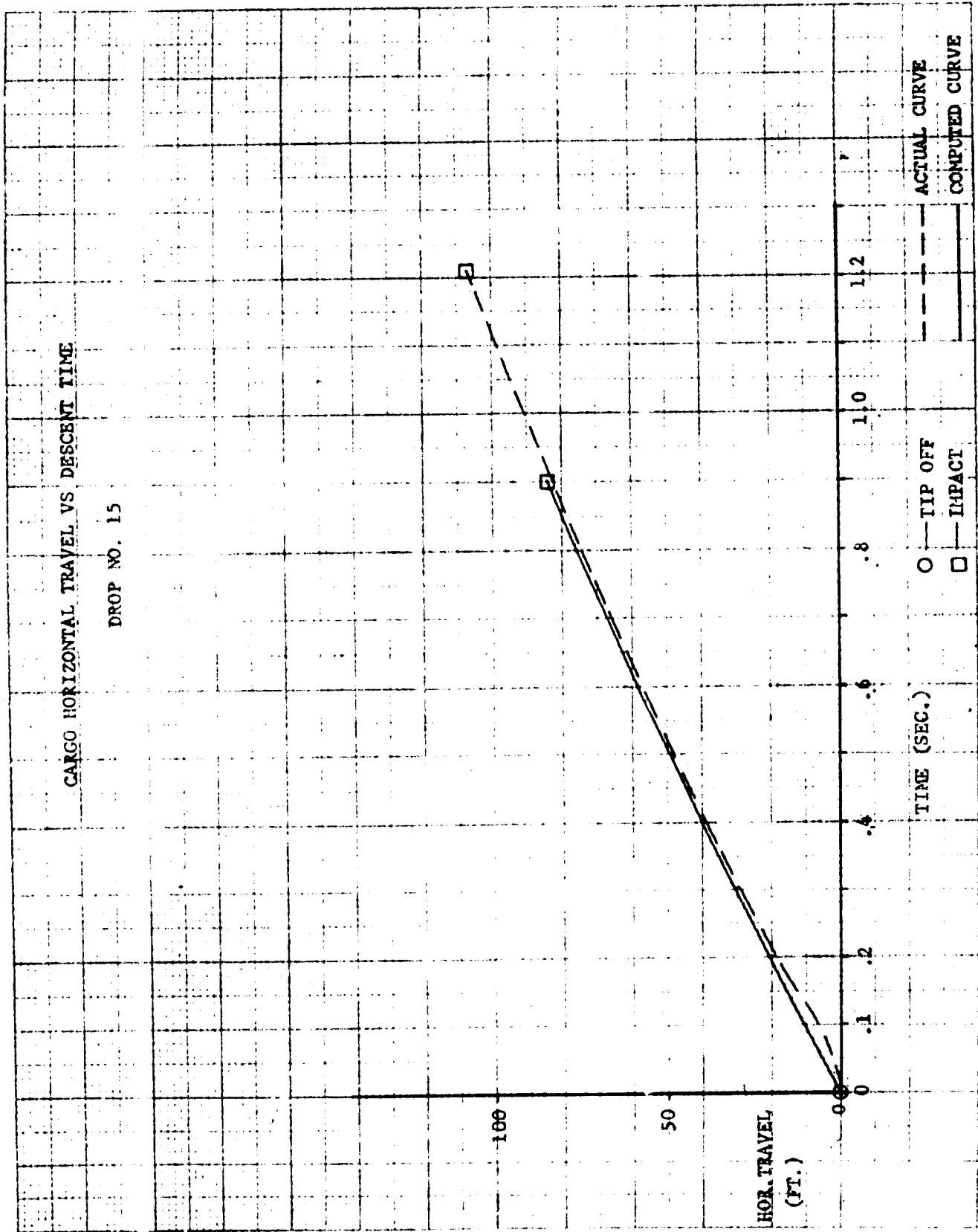


FIGURE 47



The third plot used in comparing the computer analysis against actual tests is shown below in Figures 48 through 61. These are plots of cargo pitch angle versus descent time. Drops Nos. 1, 3, 8 and 11 are not complete because sufficient data was not acquired from these tests.

In several of the tests, as shown by the curves, the actual cargo pitch angle is quite different from the predicted angle. In the tests the aircraft is pitching, due to turbulence and aircraft instability and this induces some angular acceleration to the cargo. One assumption in the computer equations is that the aircraft does not change pitch angle during extraction.

In figures 76 through 89 cargo pitch angle was plotted versus drop altitude. In these curves the effect of aircraft induced angular acceleration can also be observed.

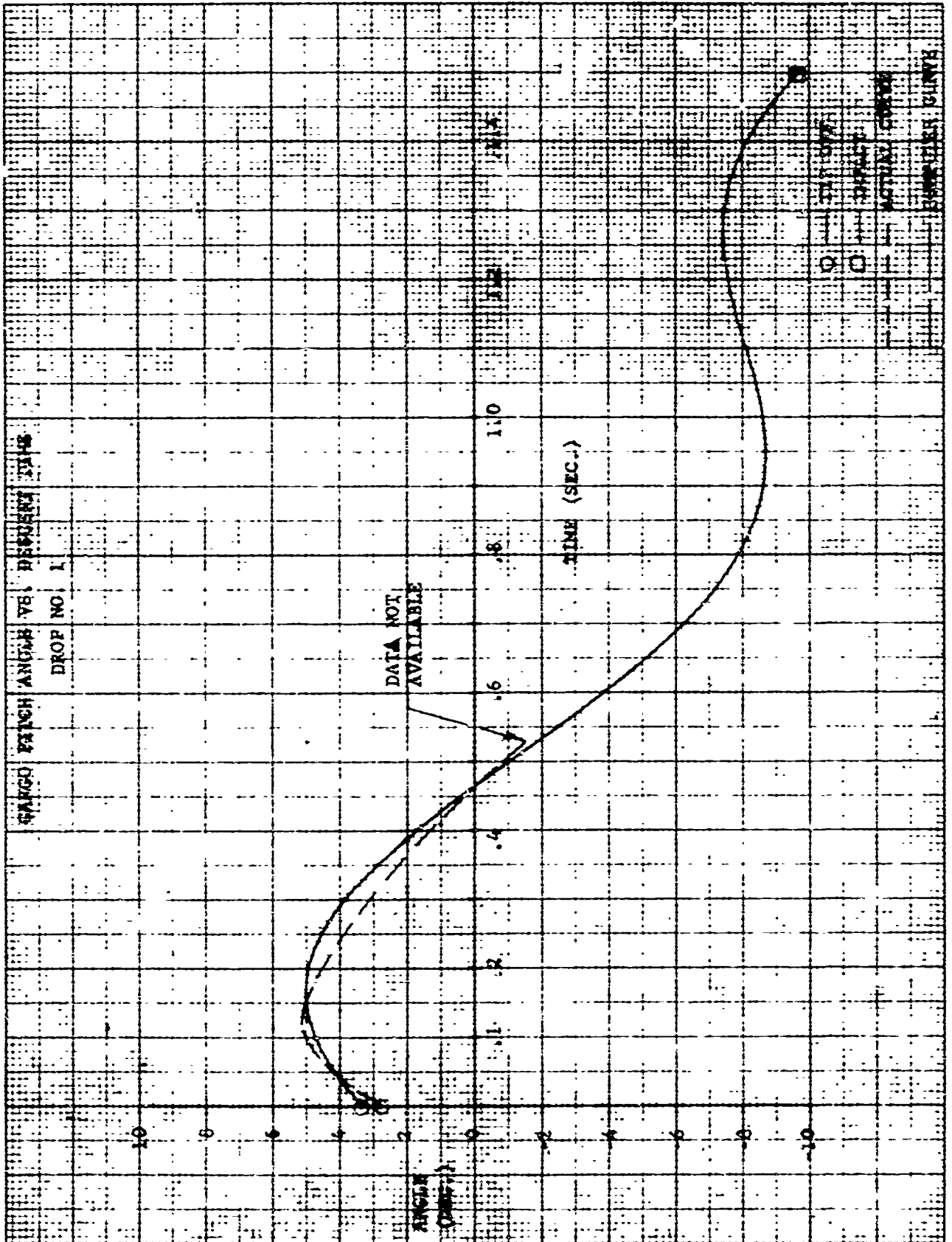


Figure 48

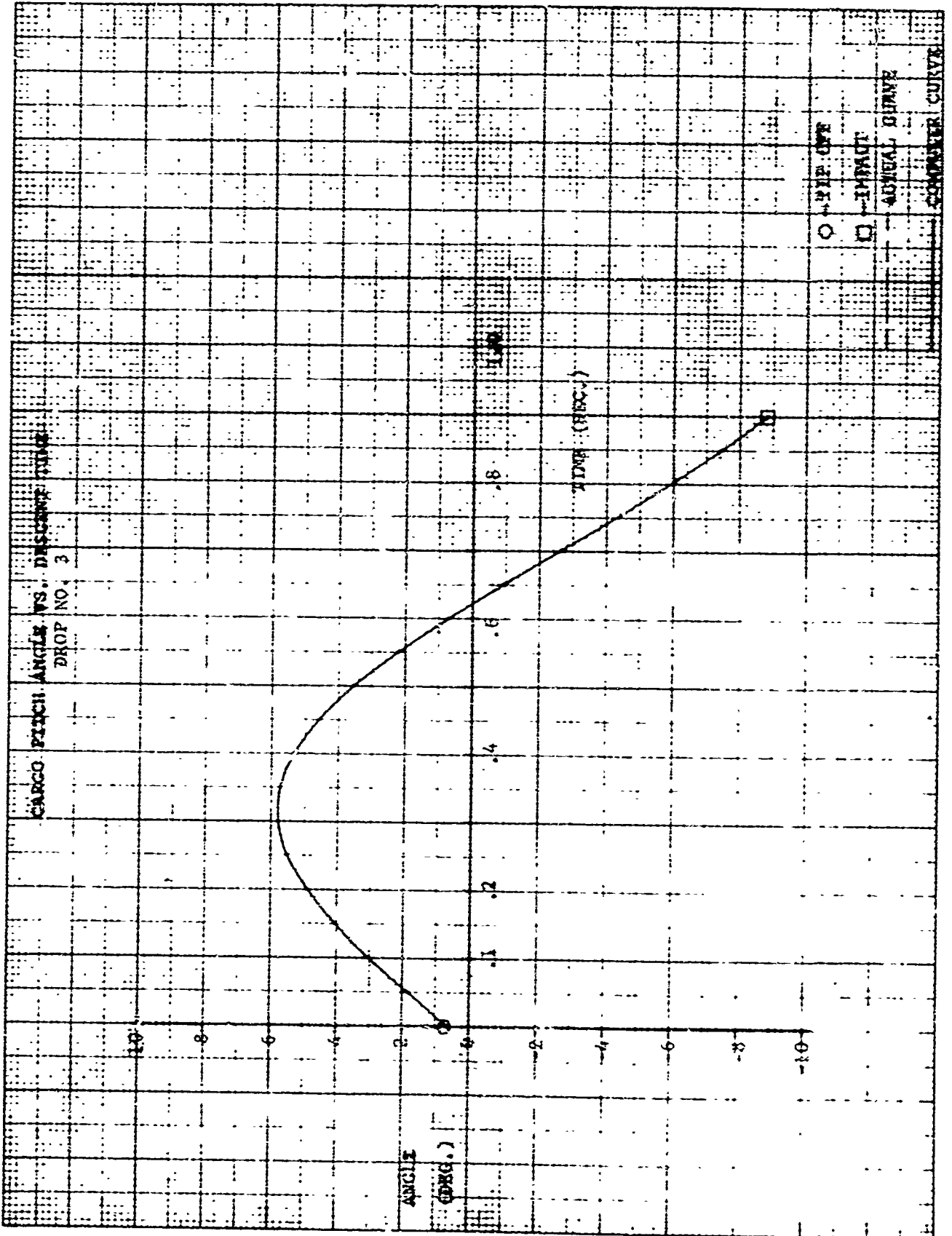


Figure 49

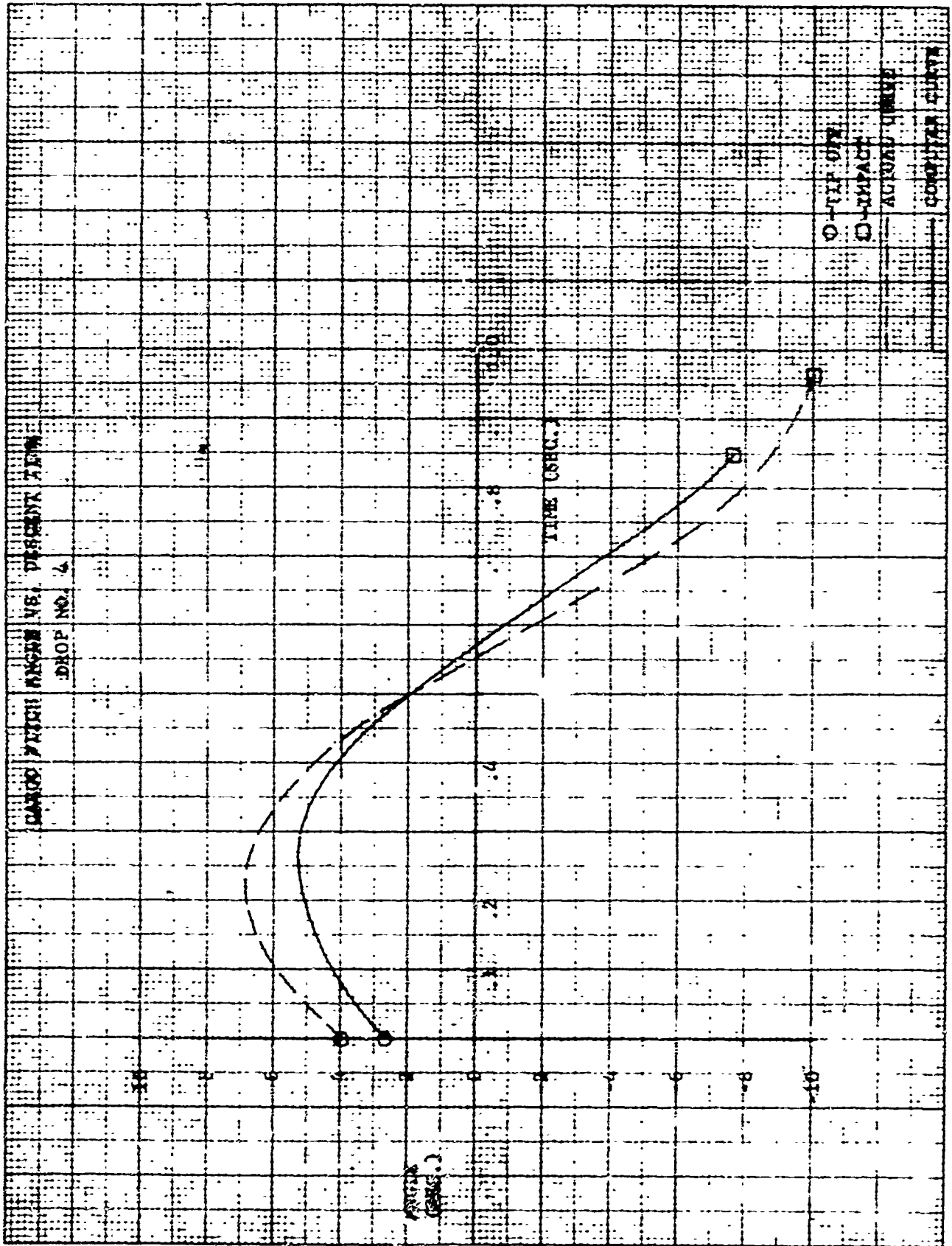


Figure 50



Figure 51

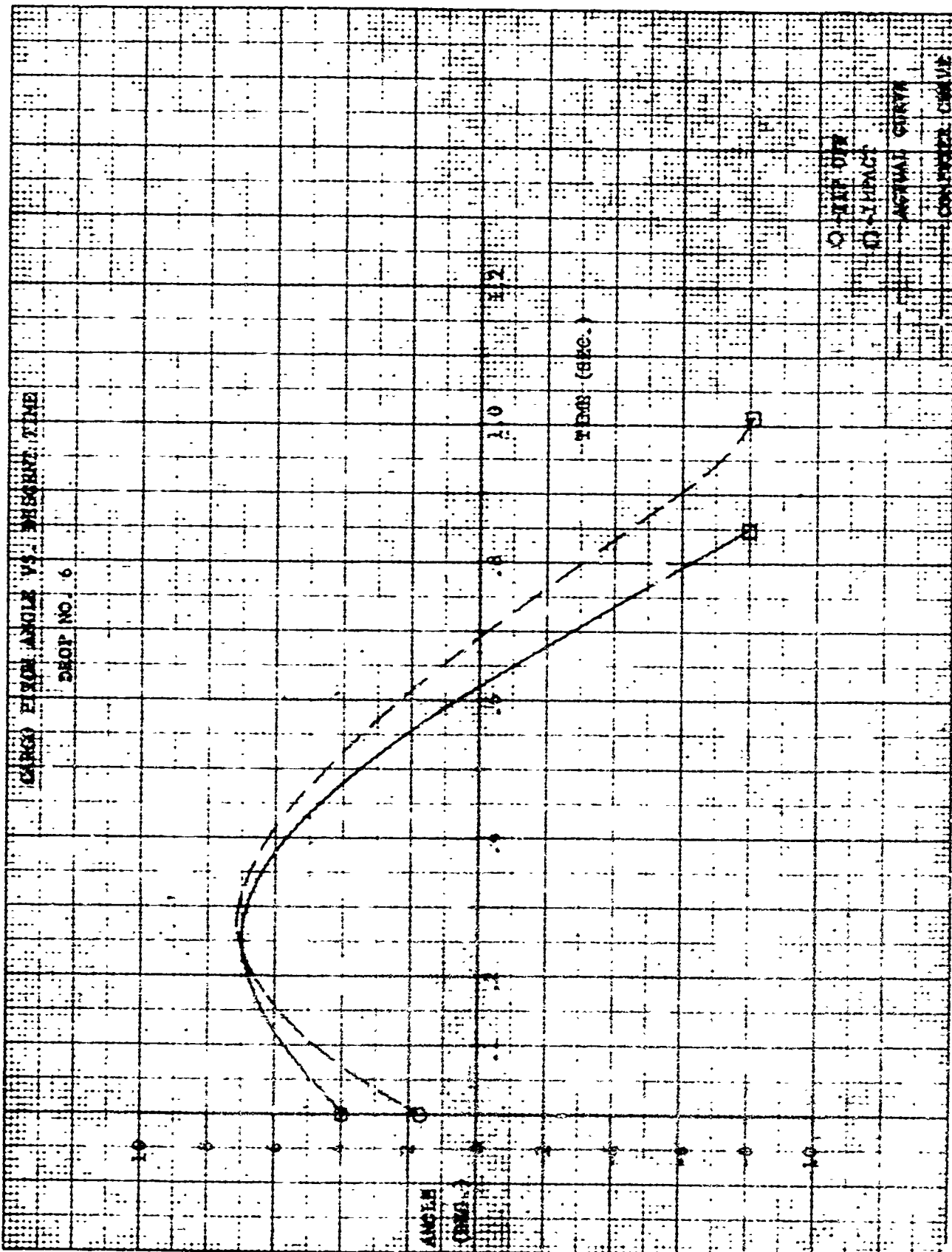


Figure 52



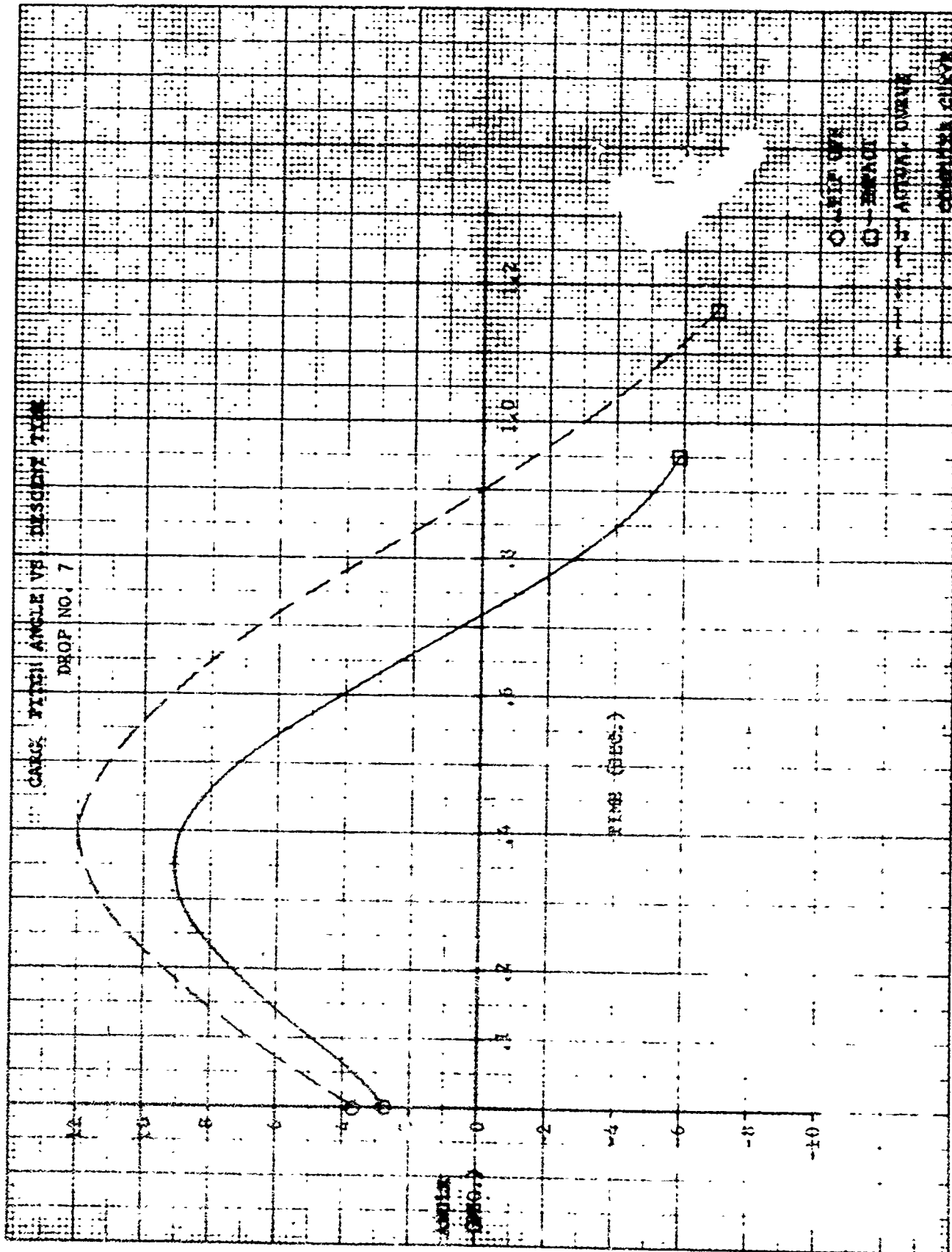


Figure 53

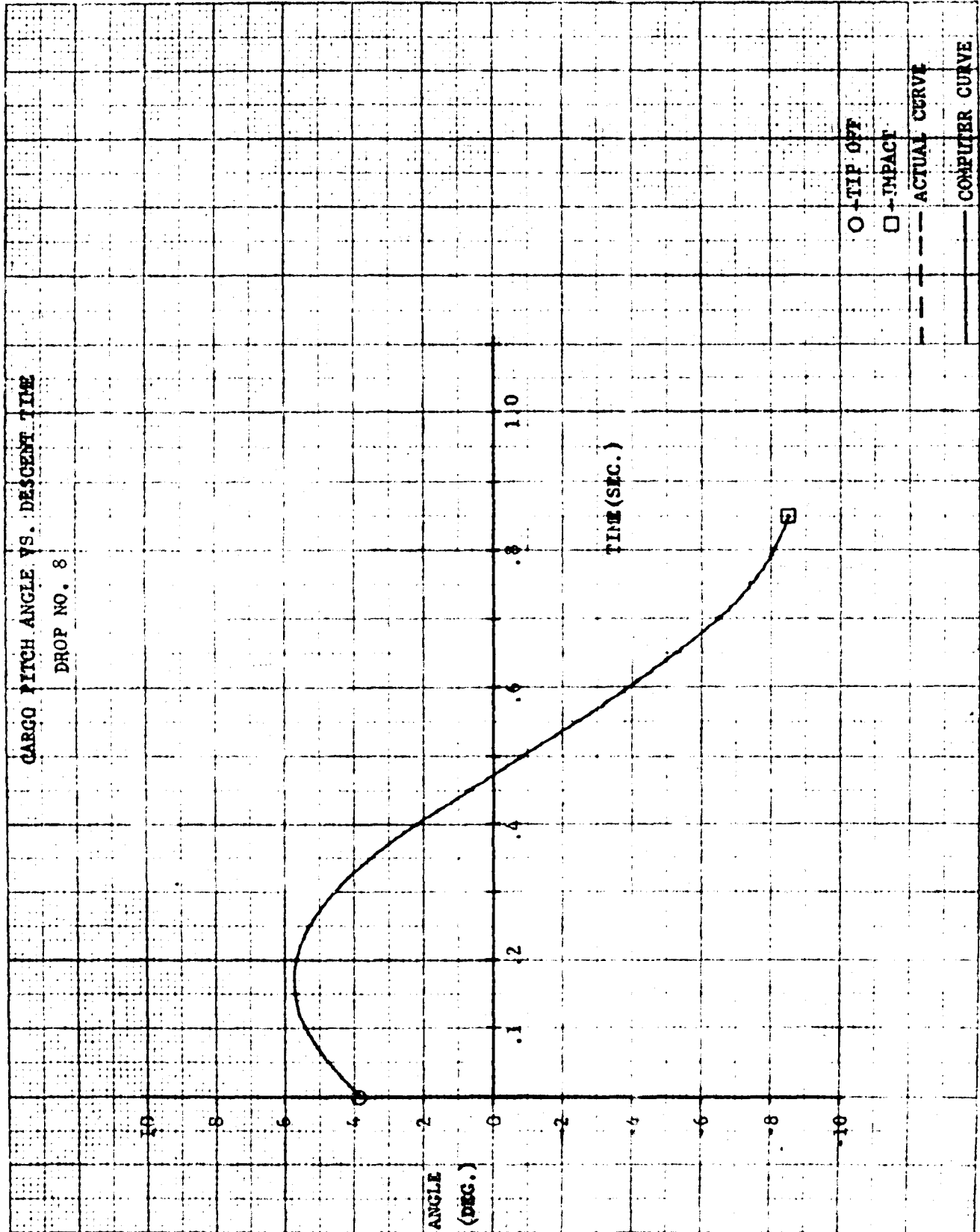


Figure 54

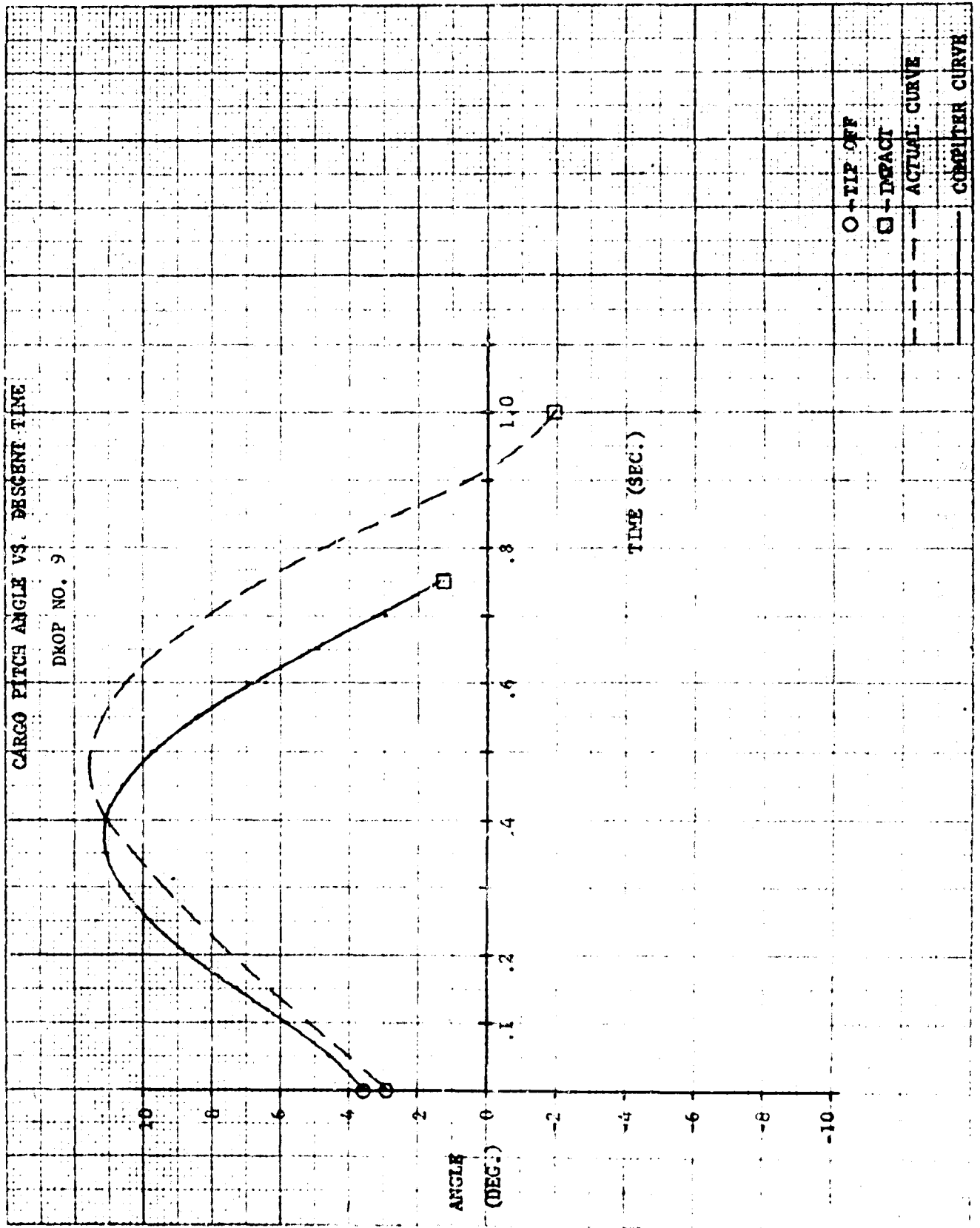


Figure 55

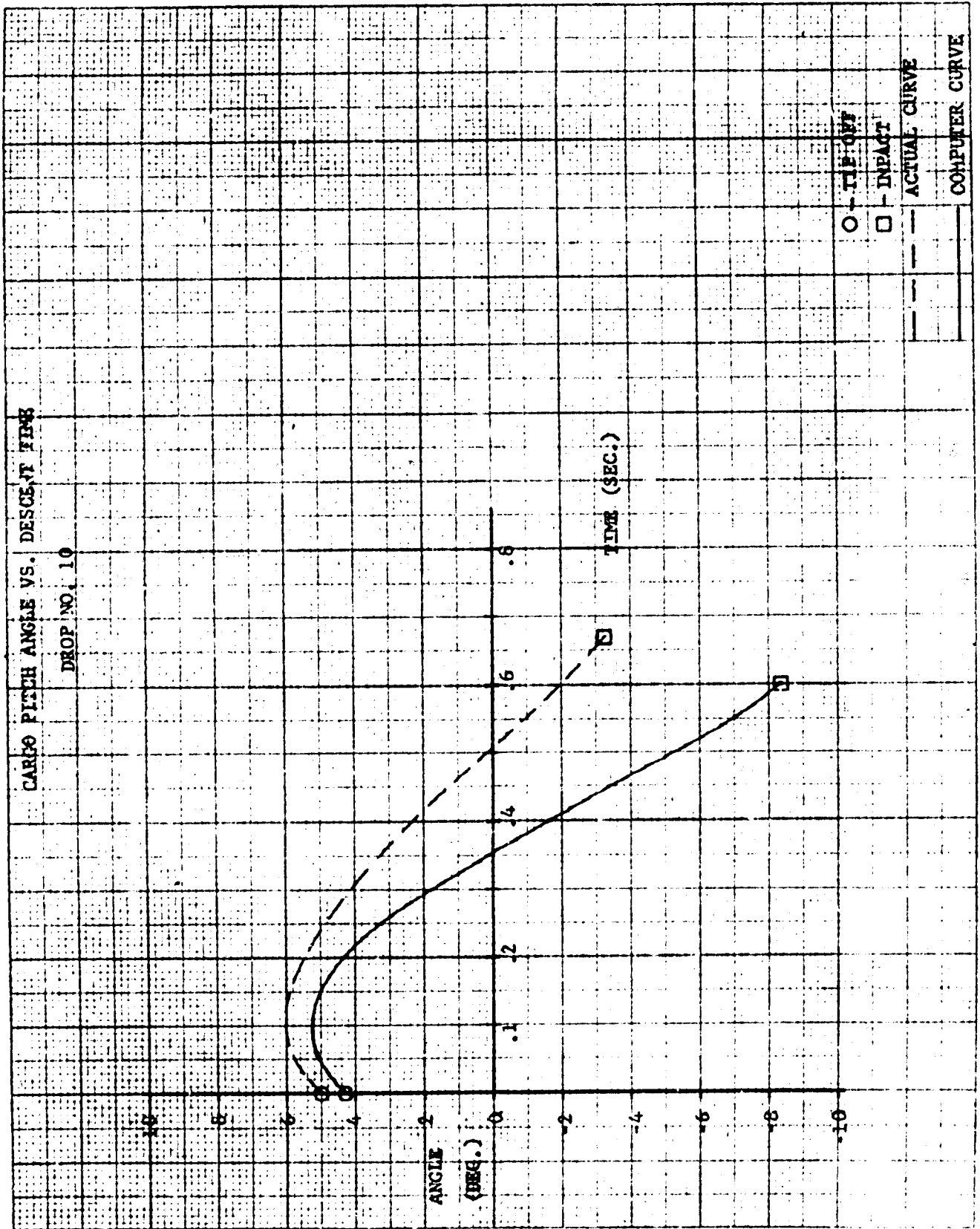


Figure 56

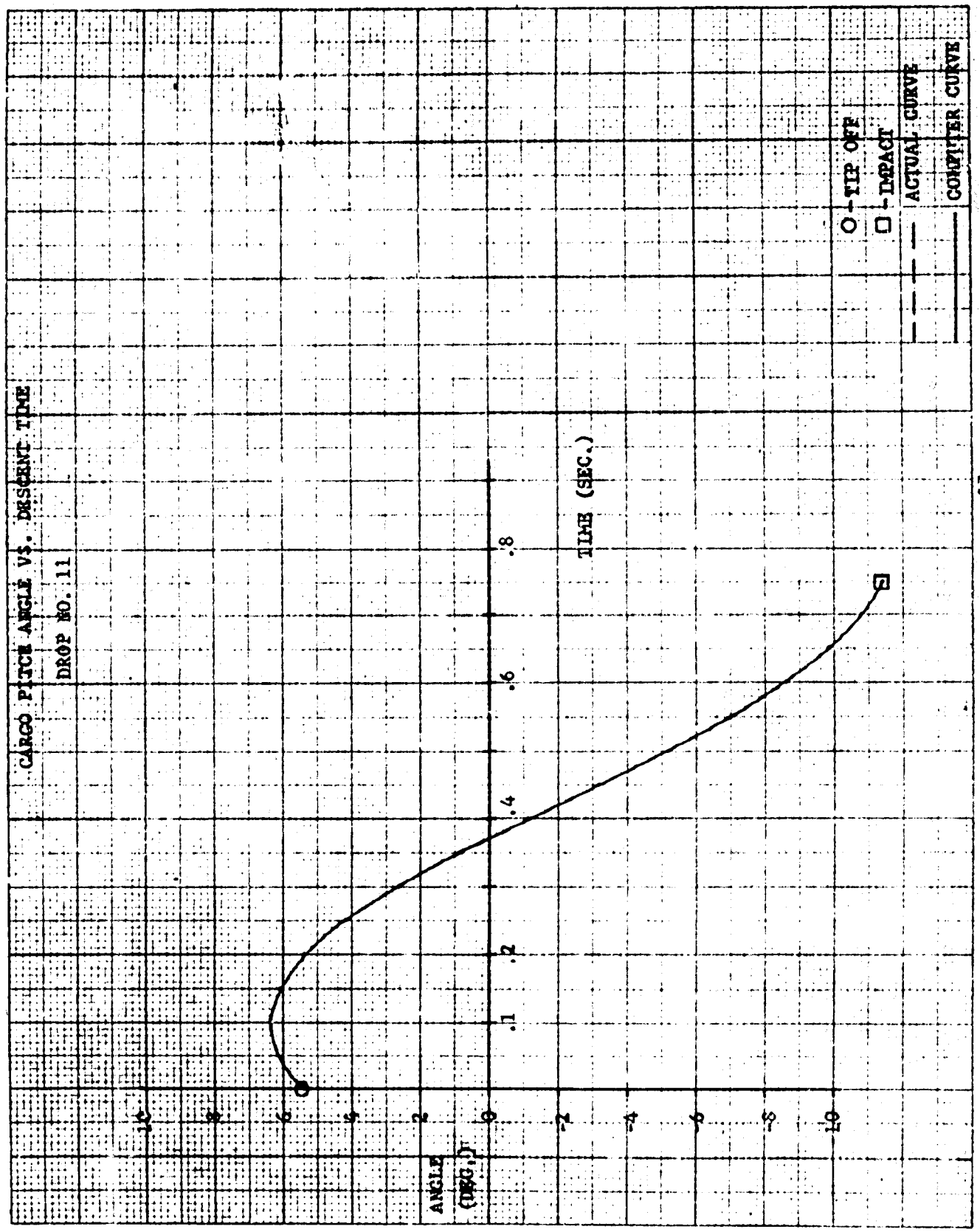


Figure 57

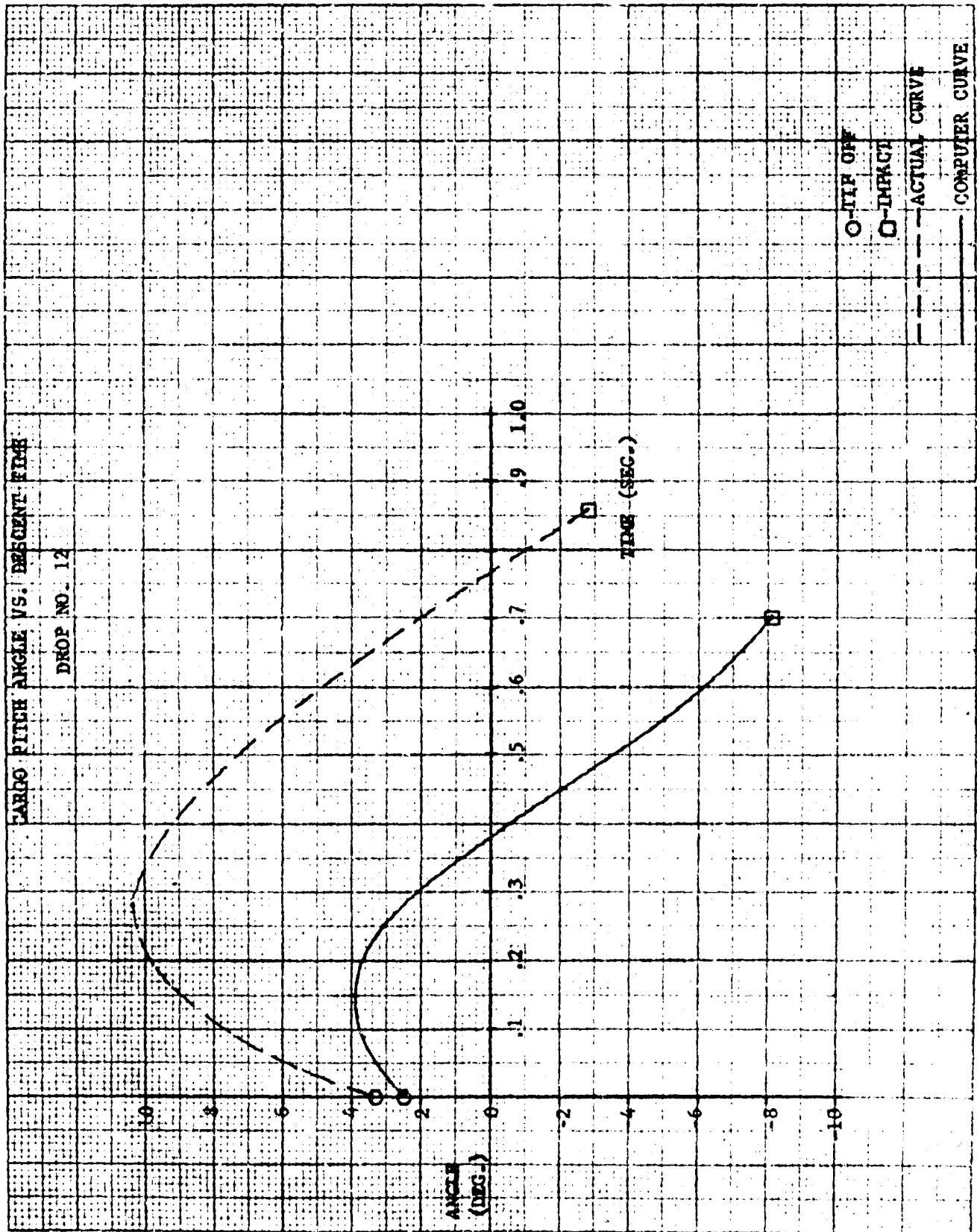


Figure 58

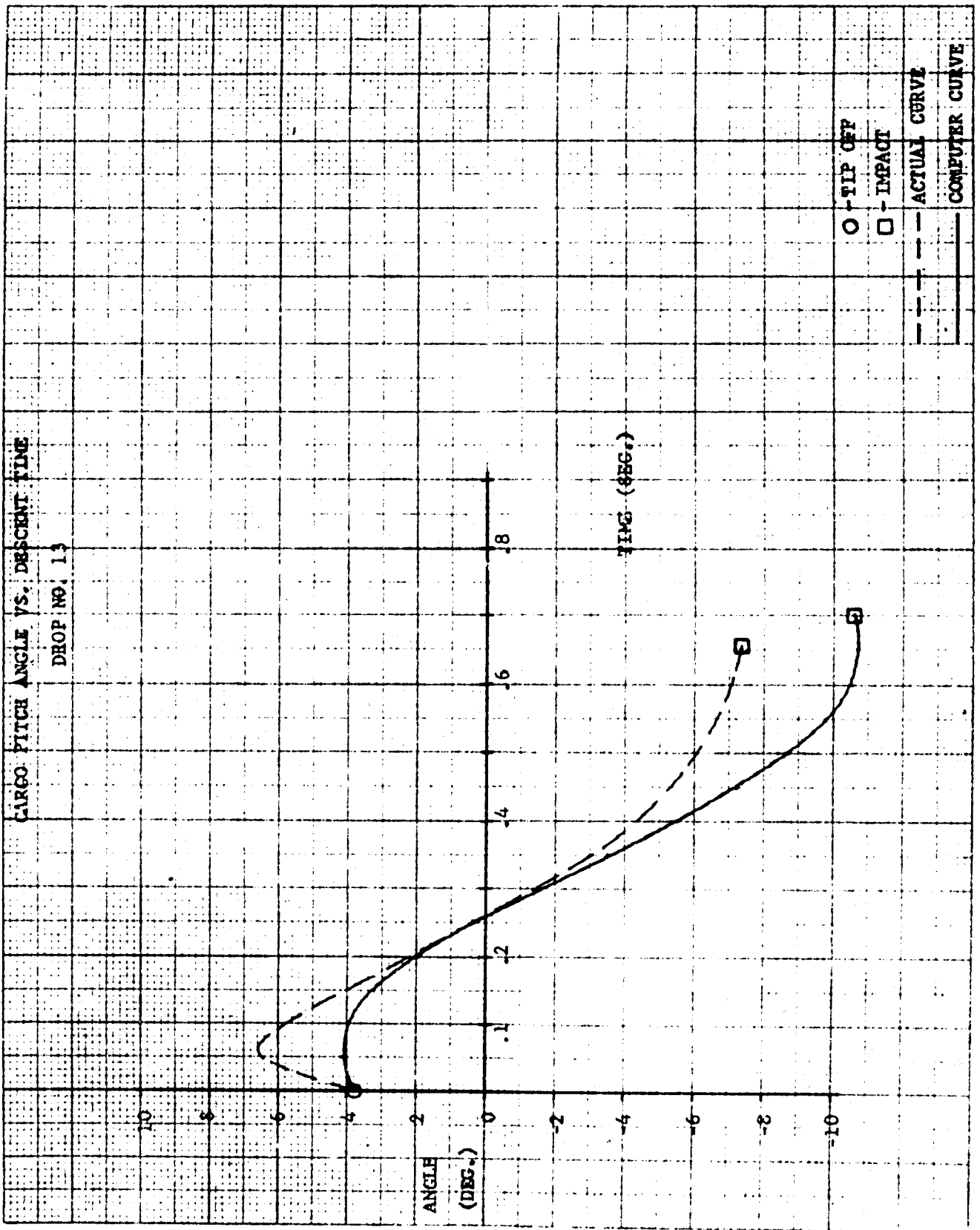


Figure 59

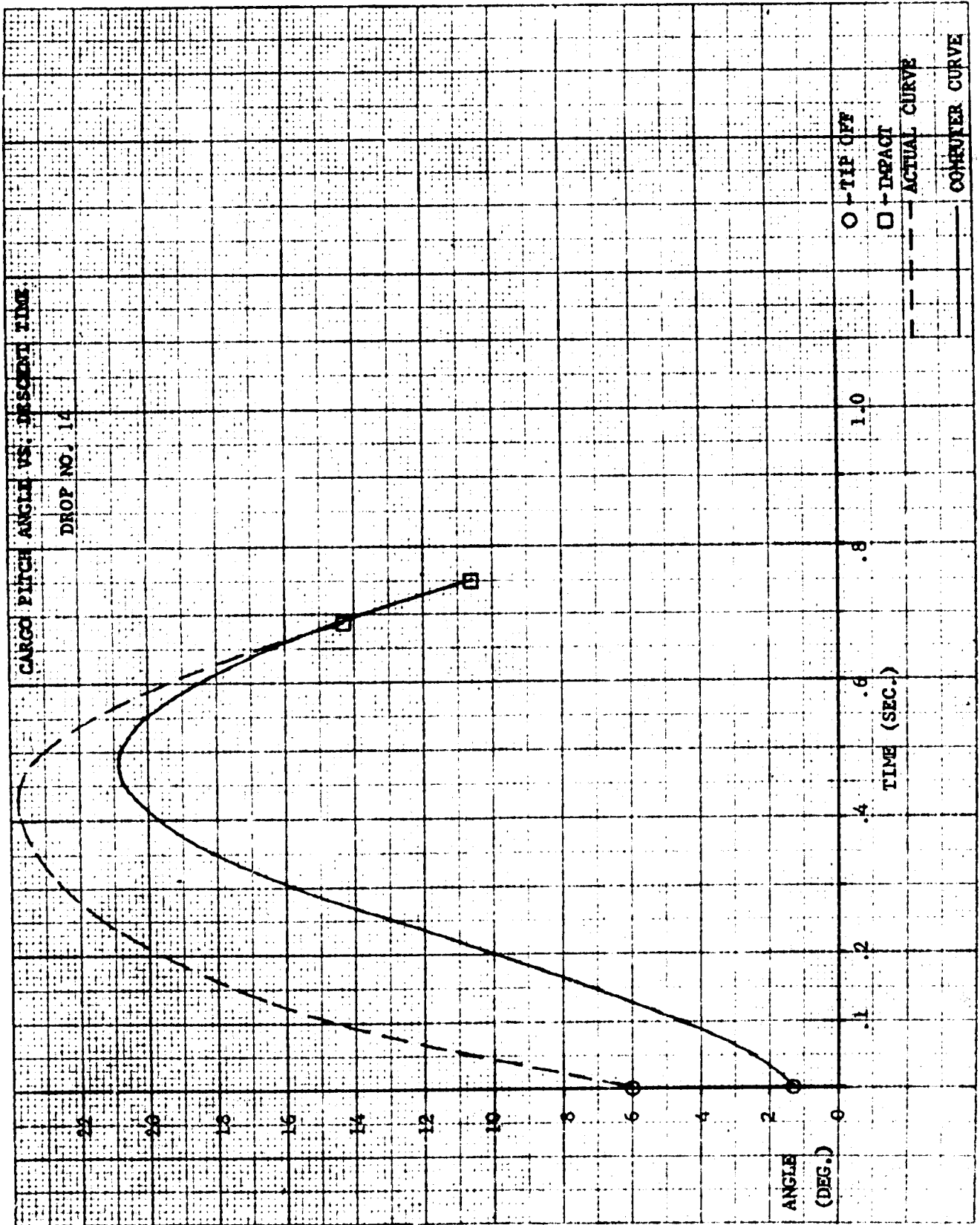


Figure 60



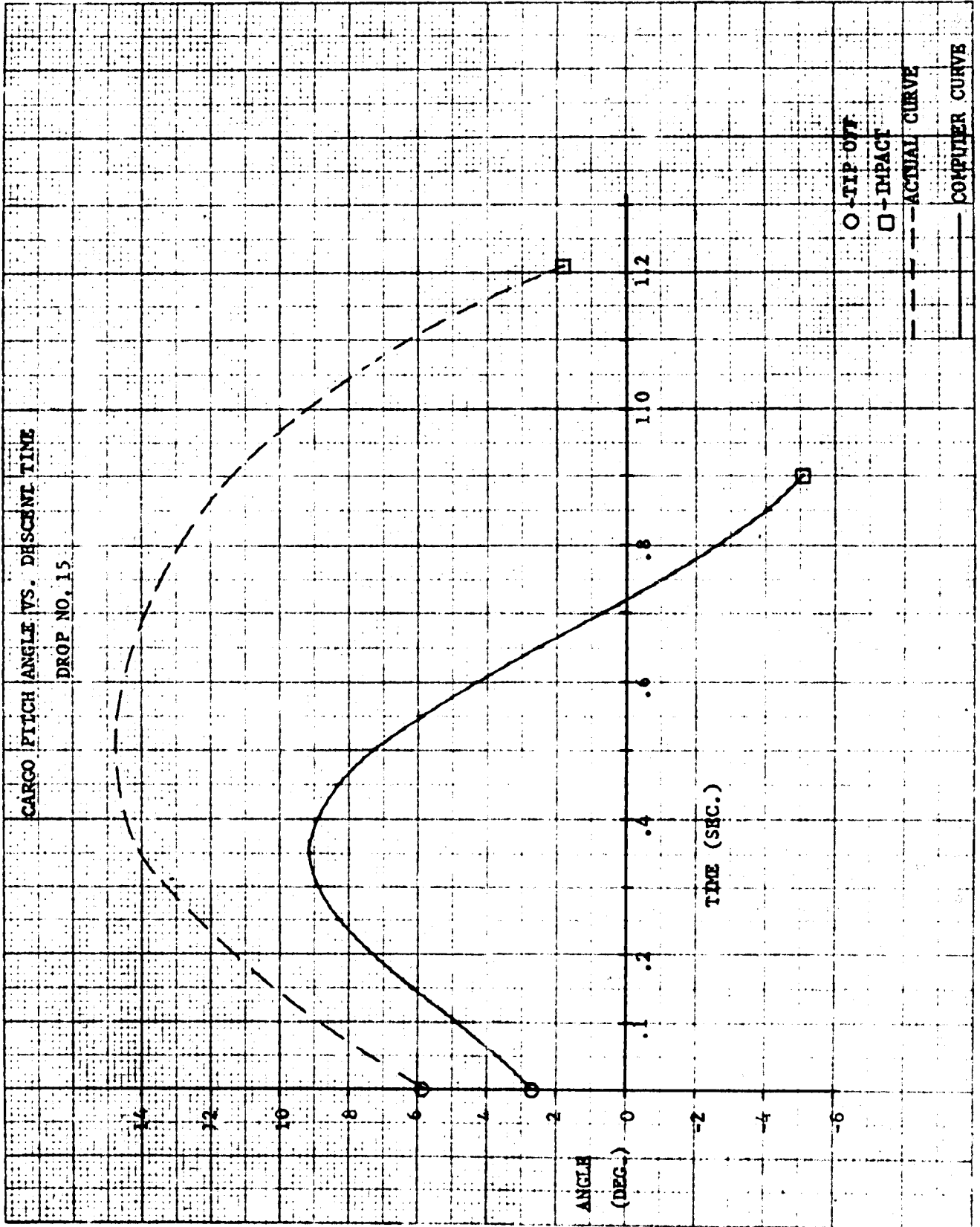


Figure 61

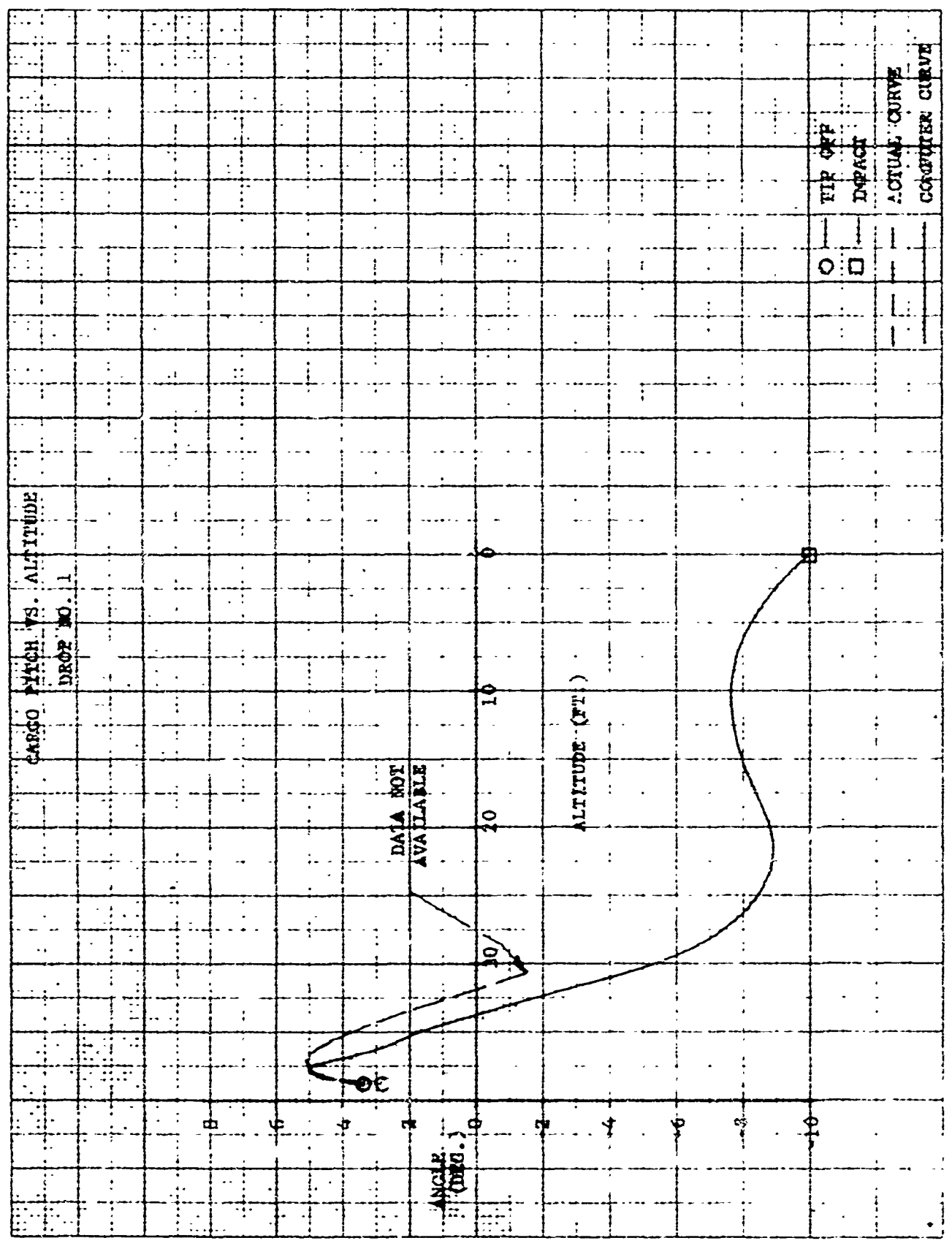


FIGURE 62

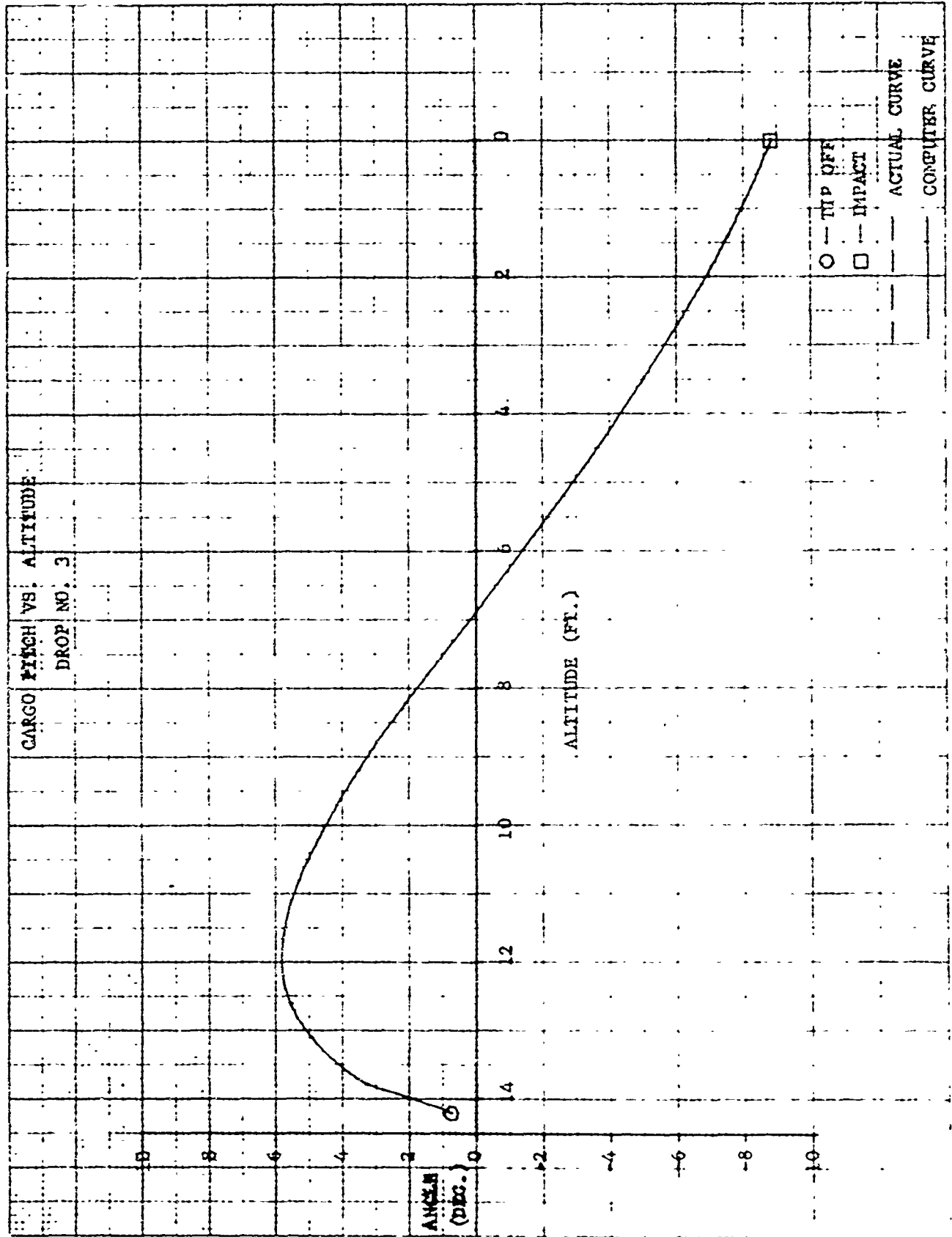


FIGURE 63

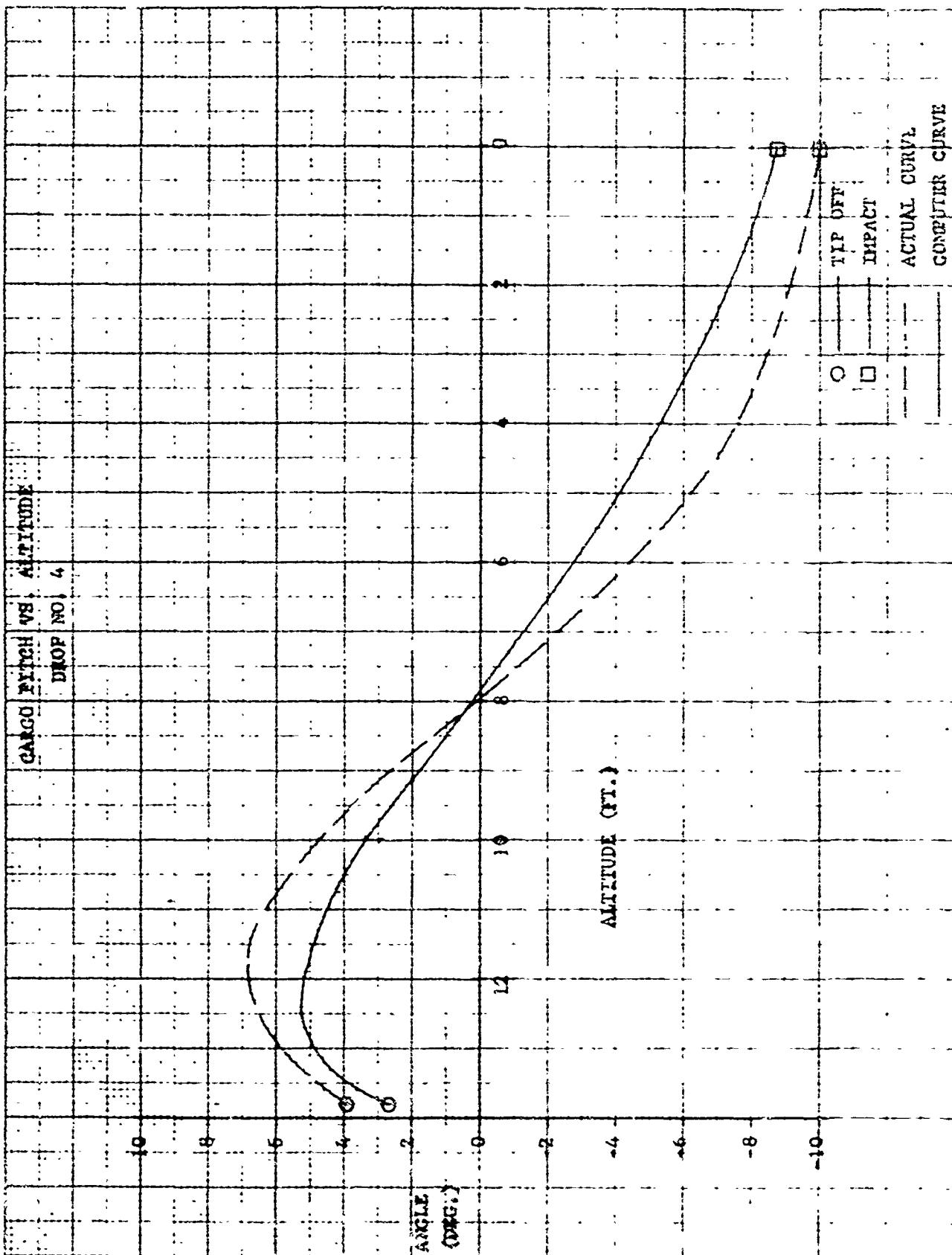


FIGURE 64

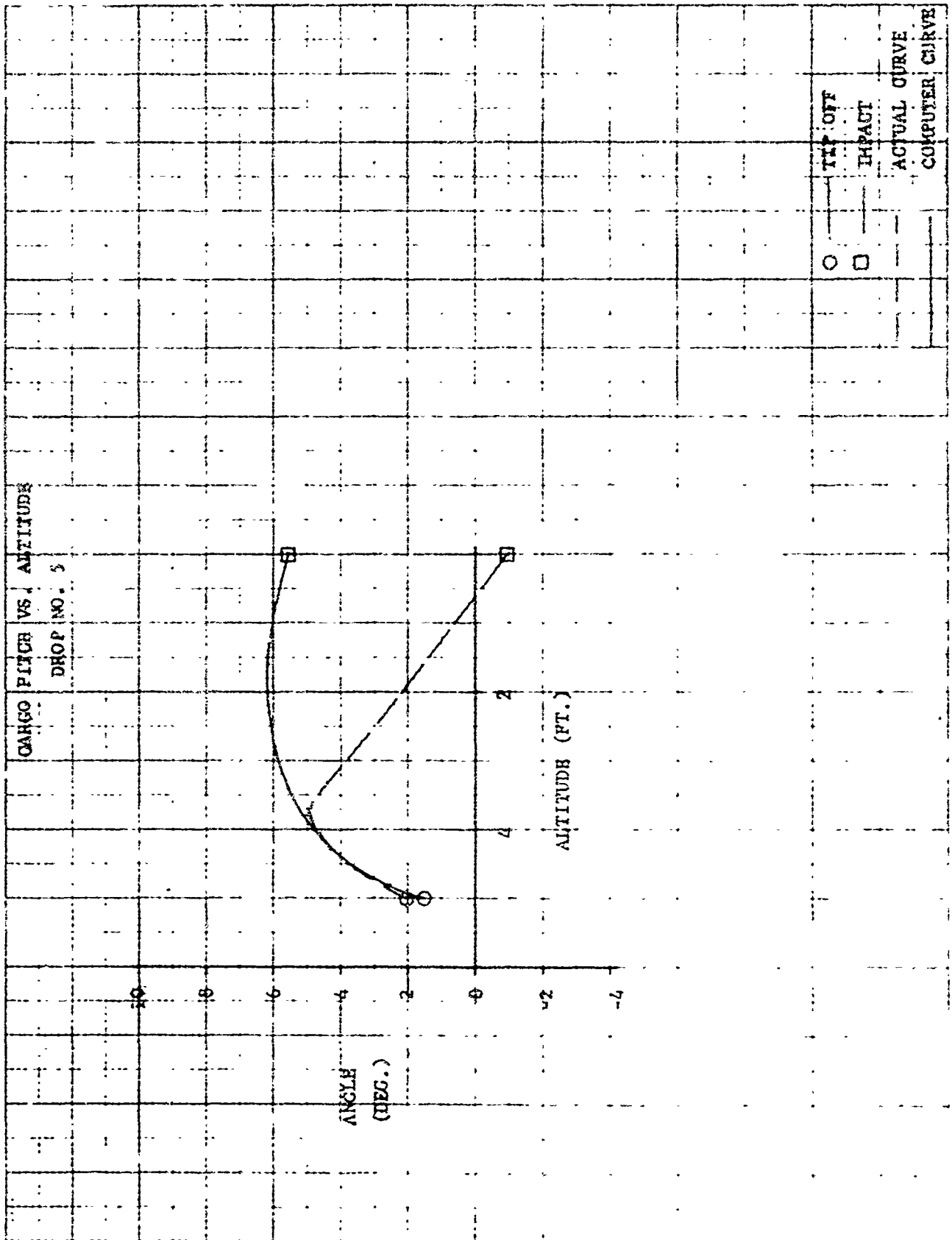


FIGURE 65

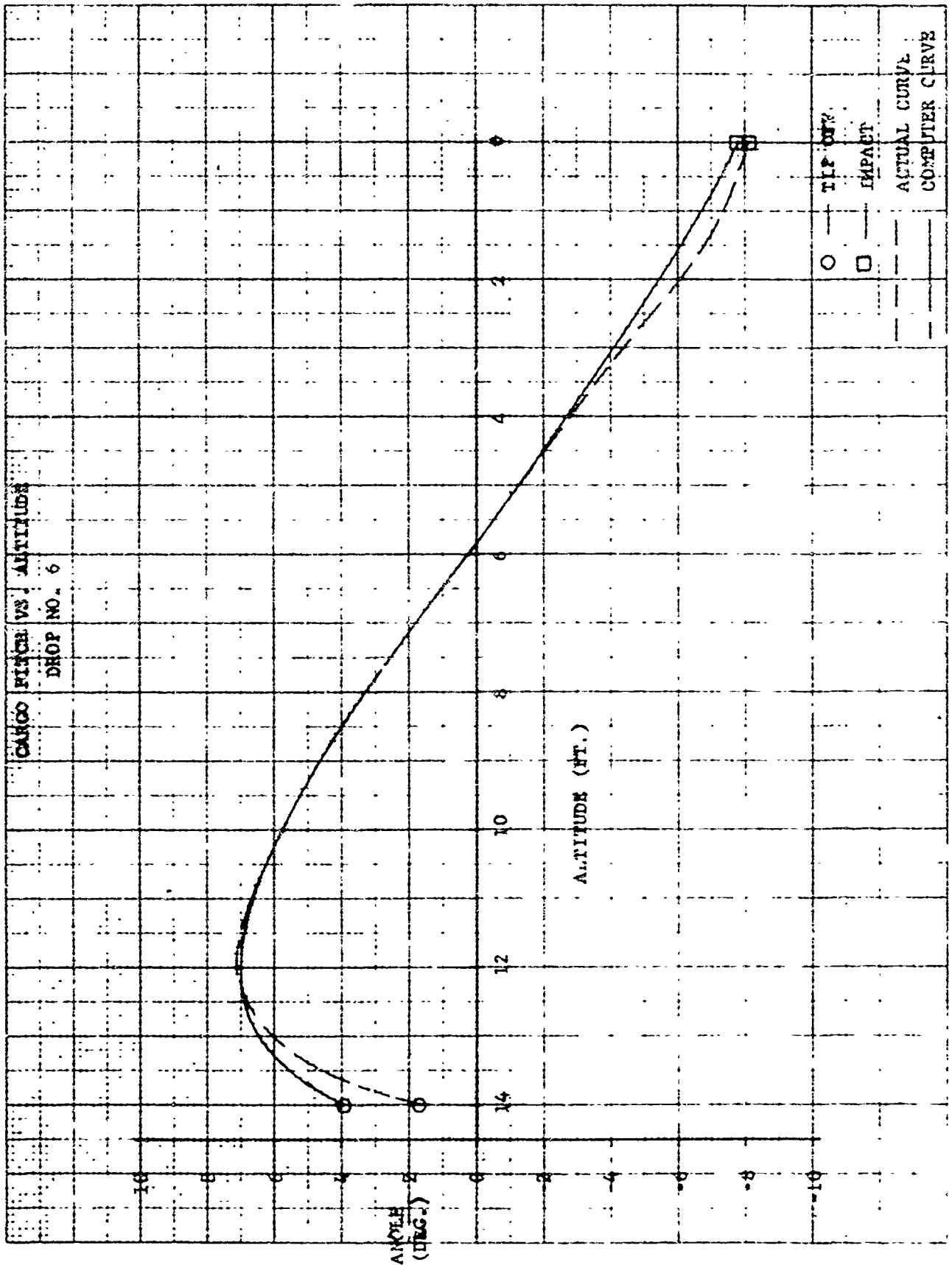


FIGURE 66

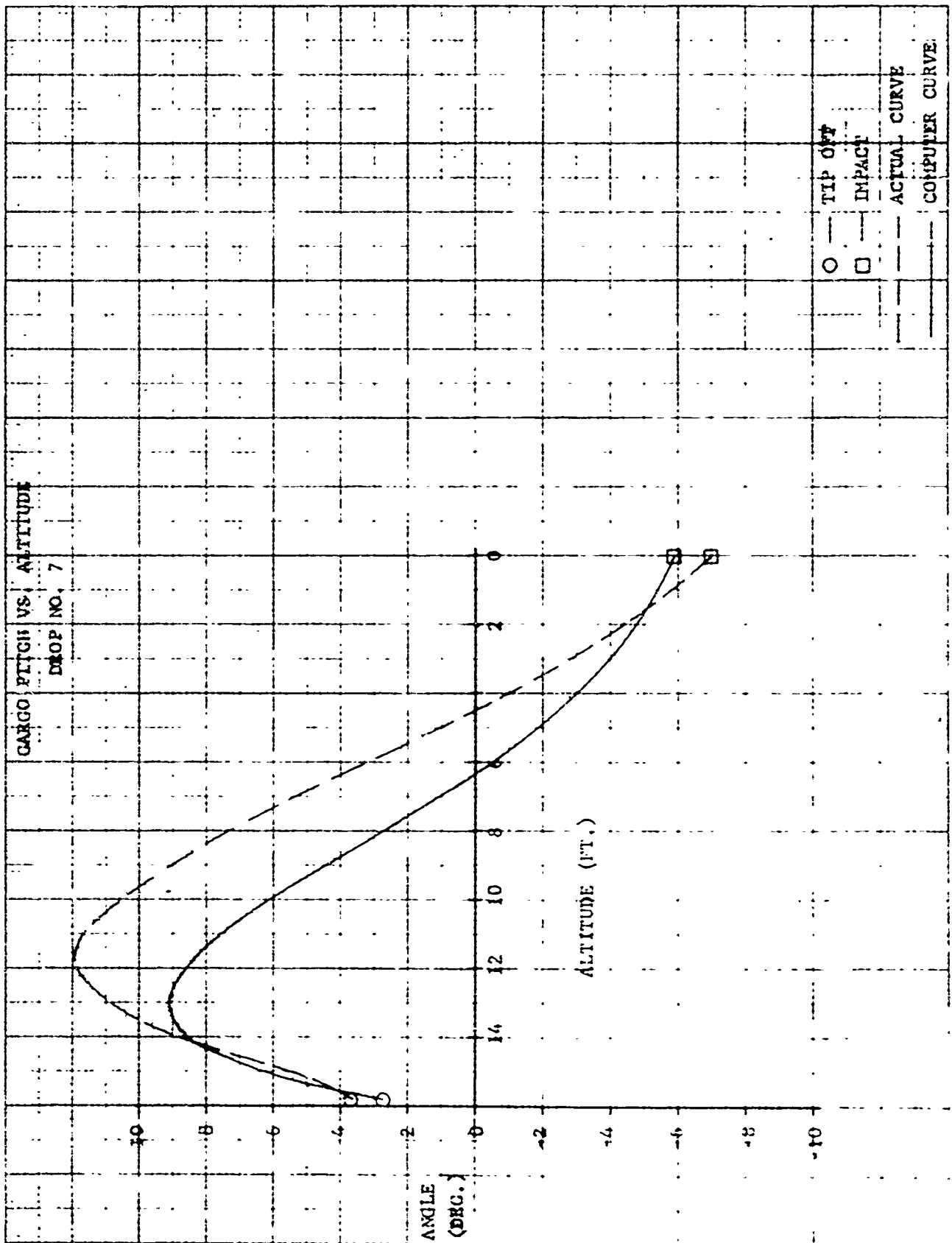


FIGURE 67

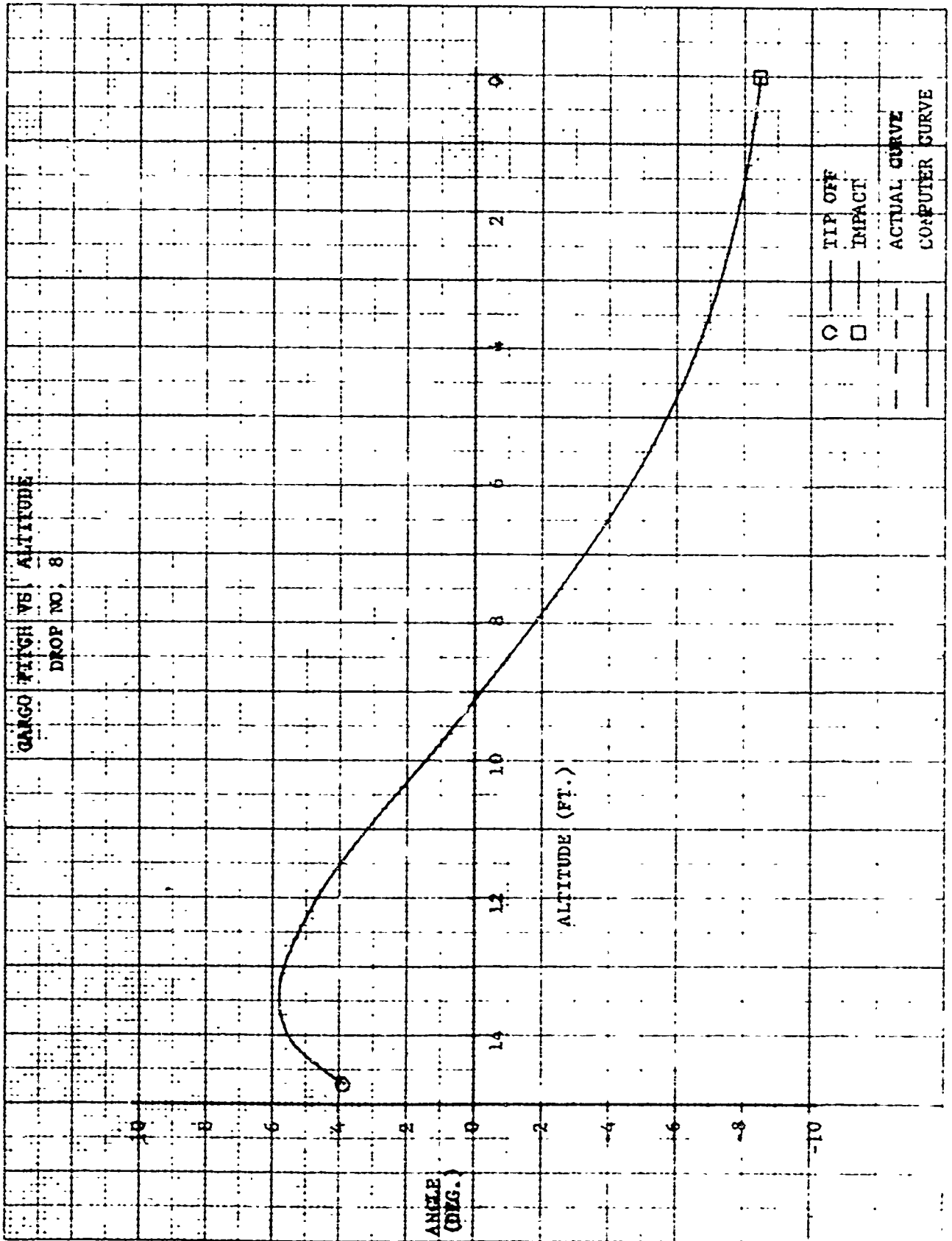


FIGURE 68



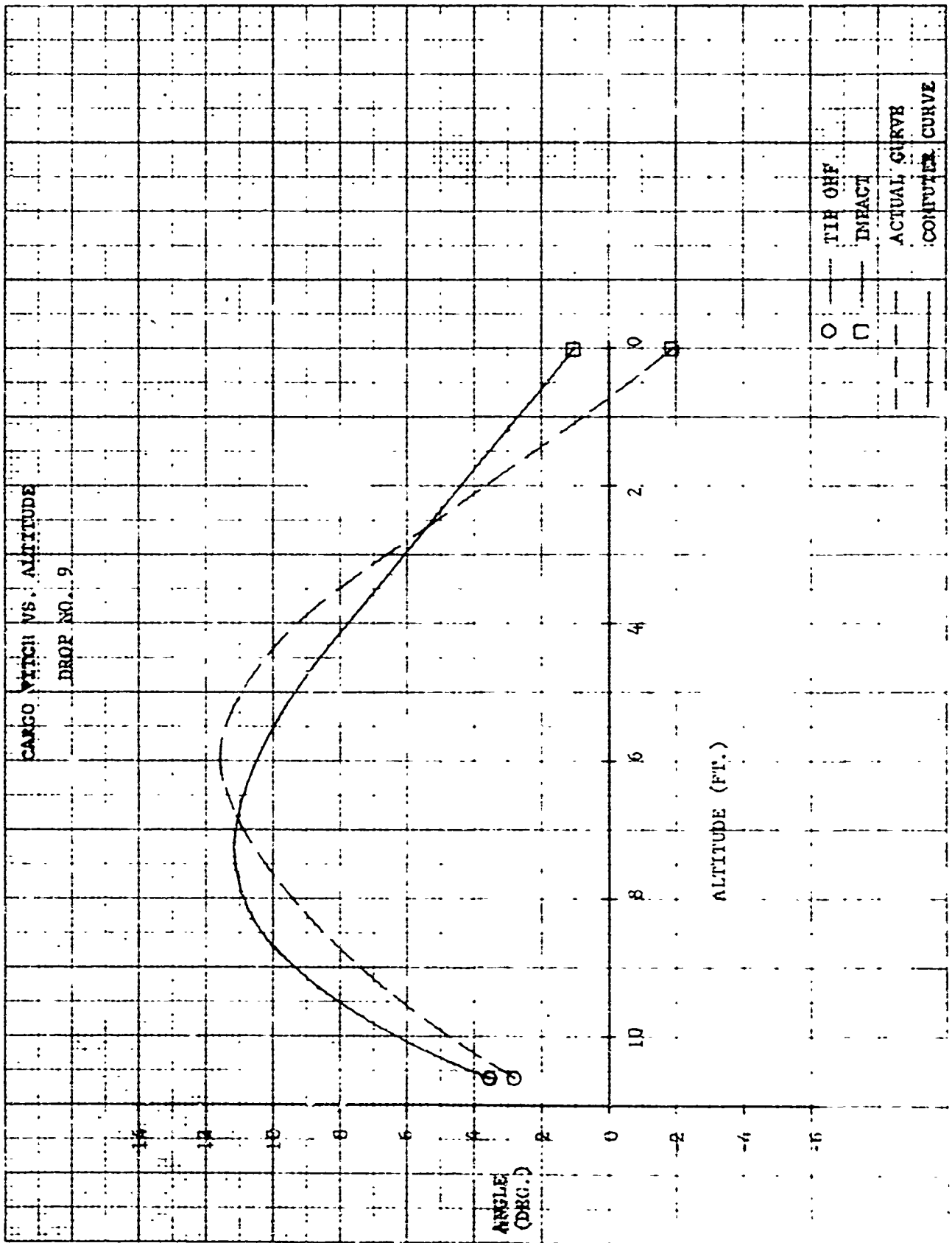


FIGURE 69

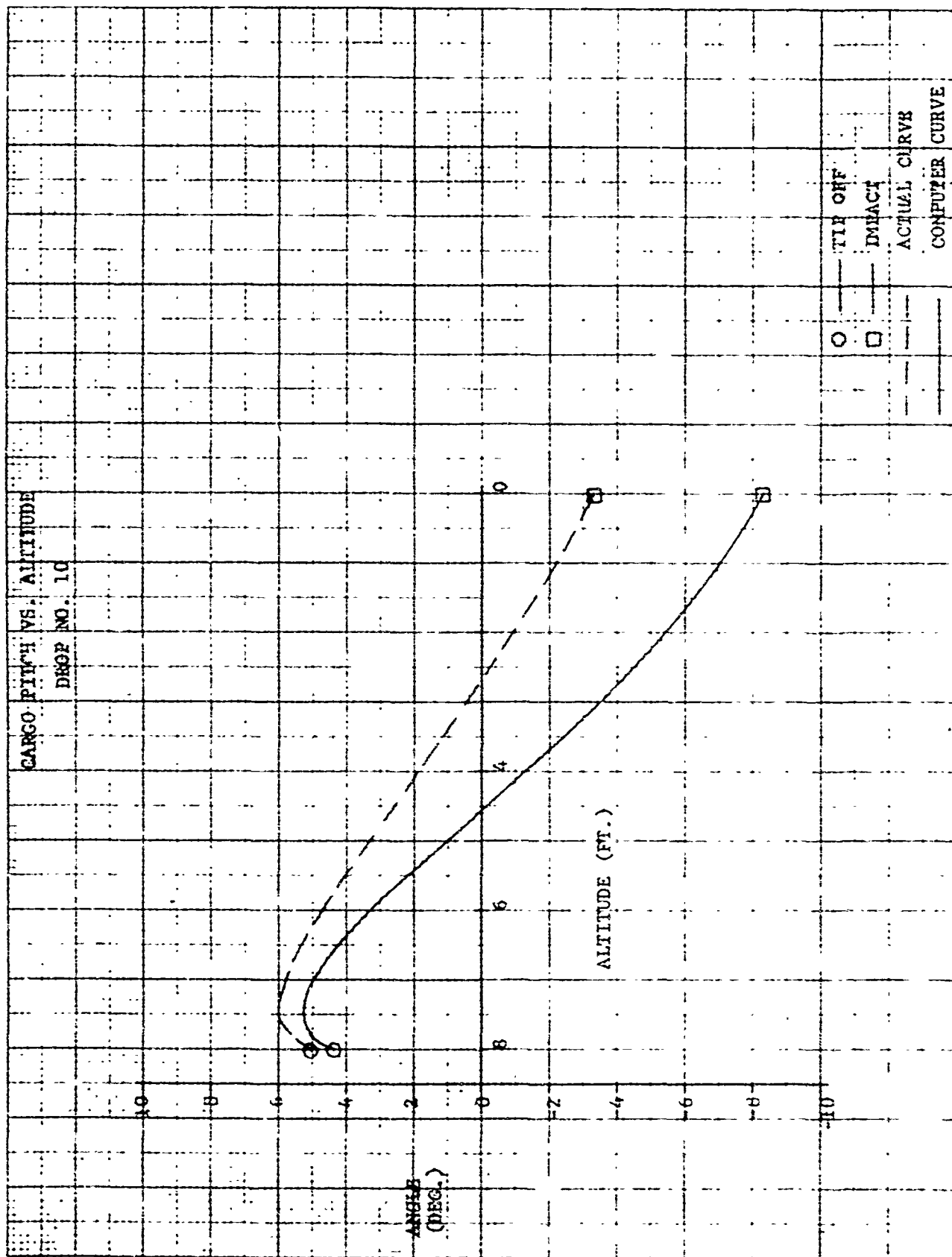


FIGURE 70

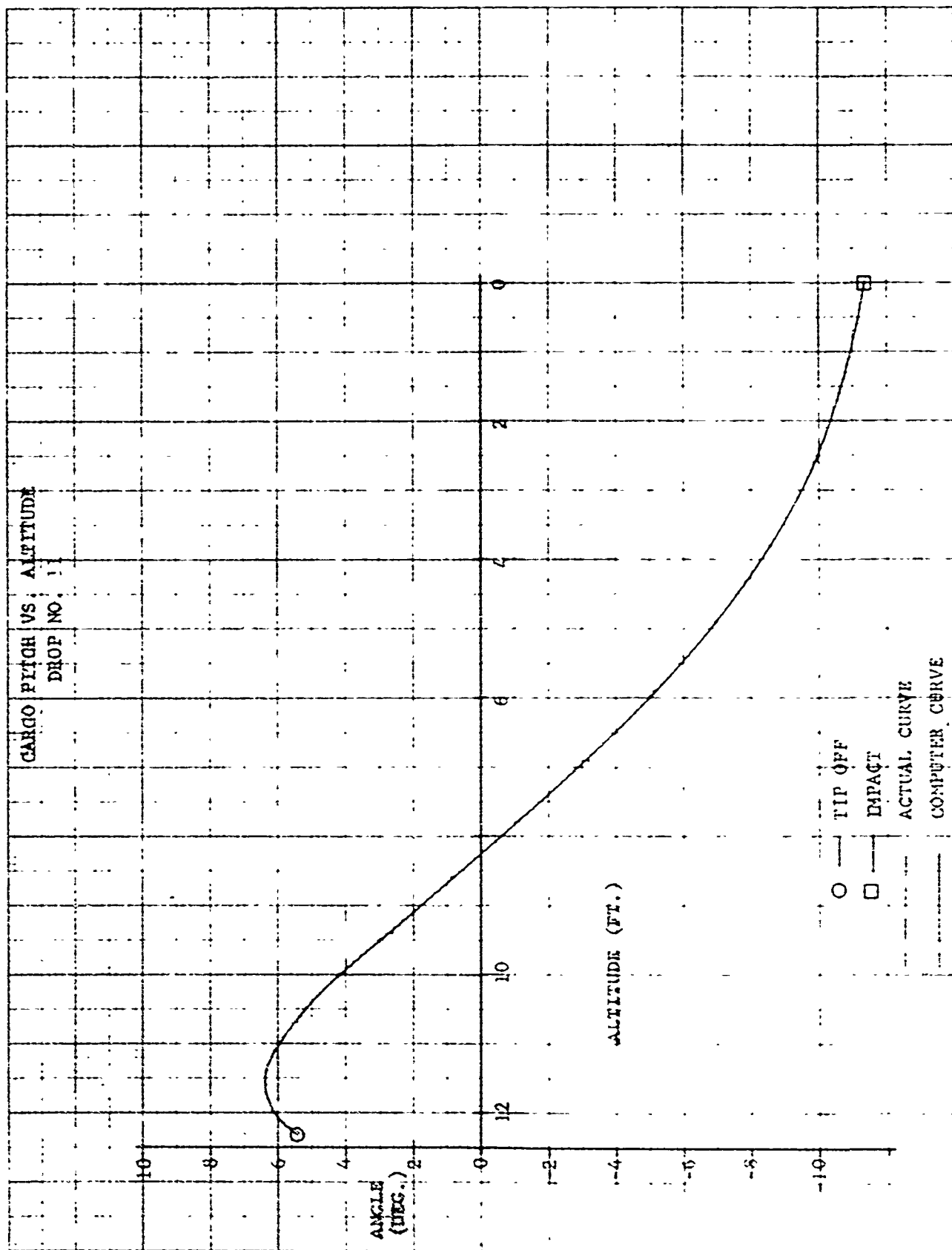


FIGURE 71

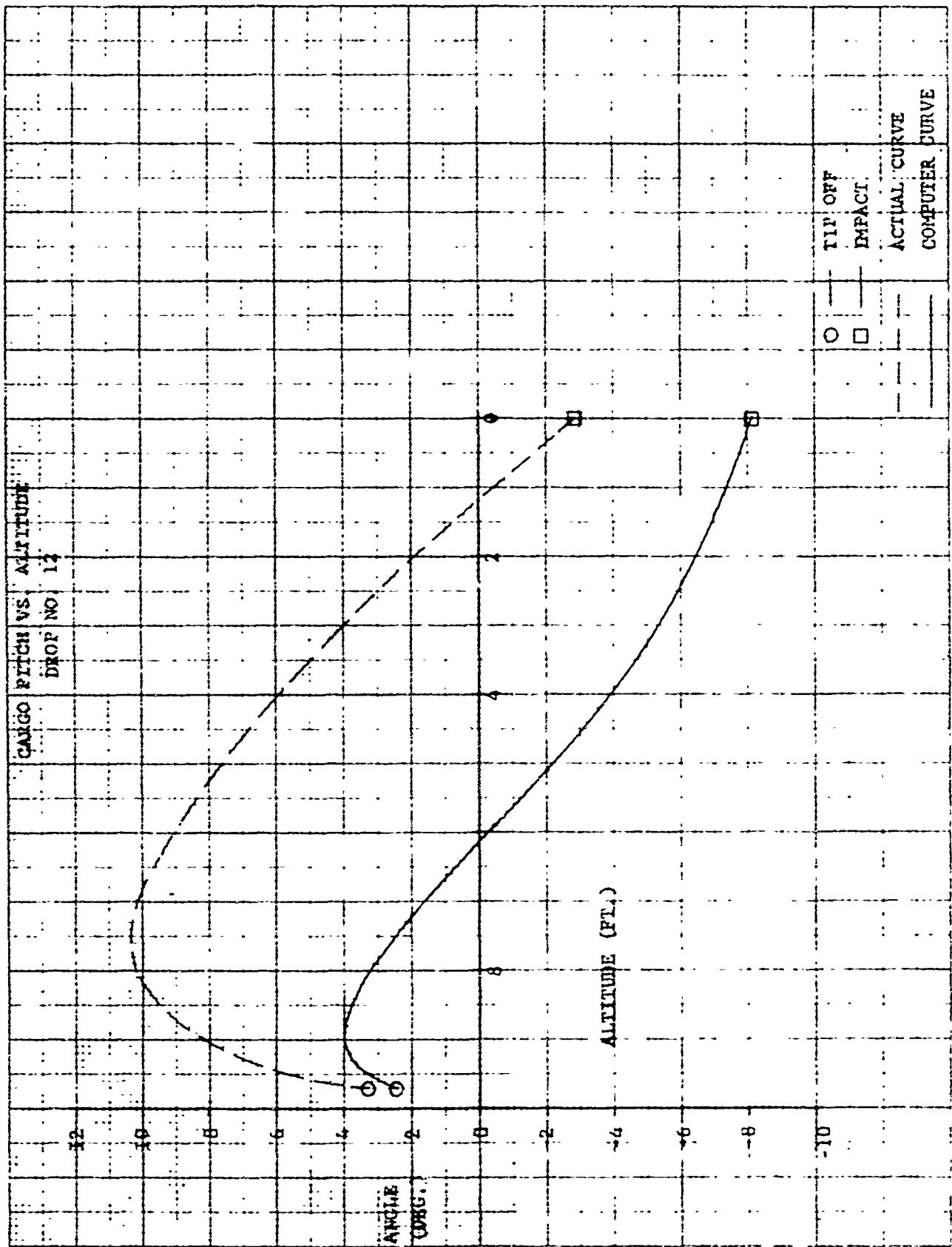


FIGURE 72

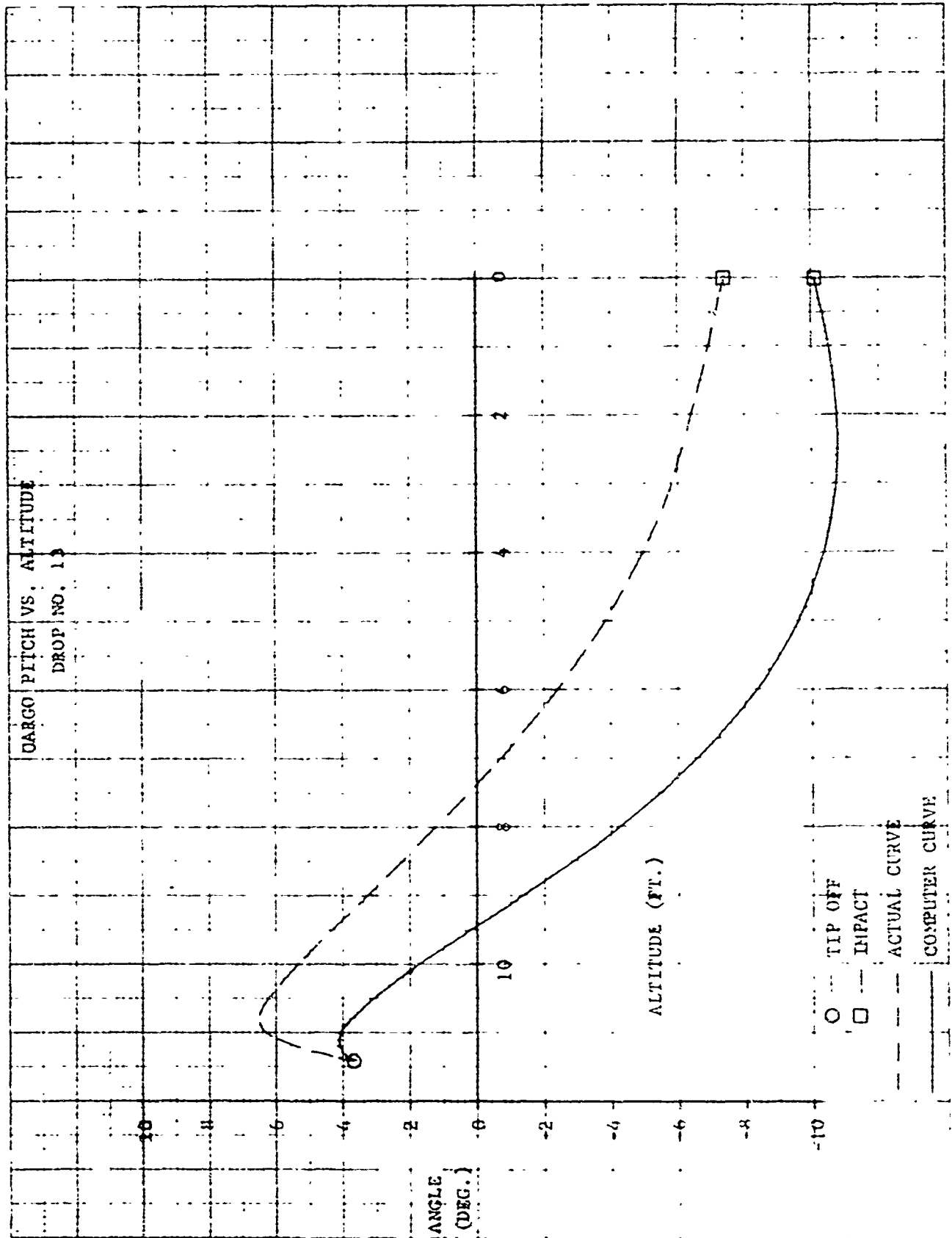


FIGURE 73

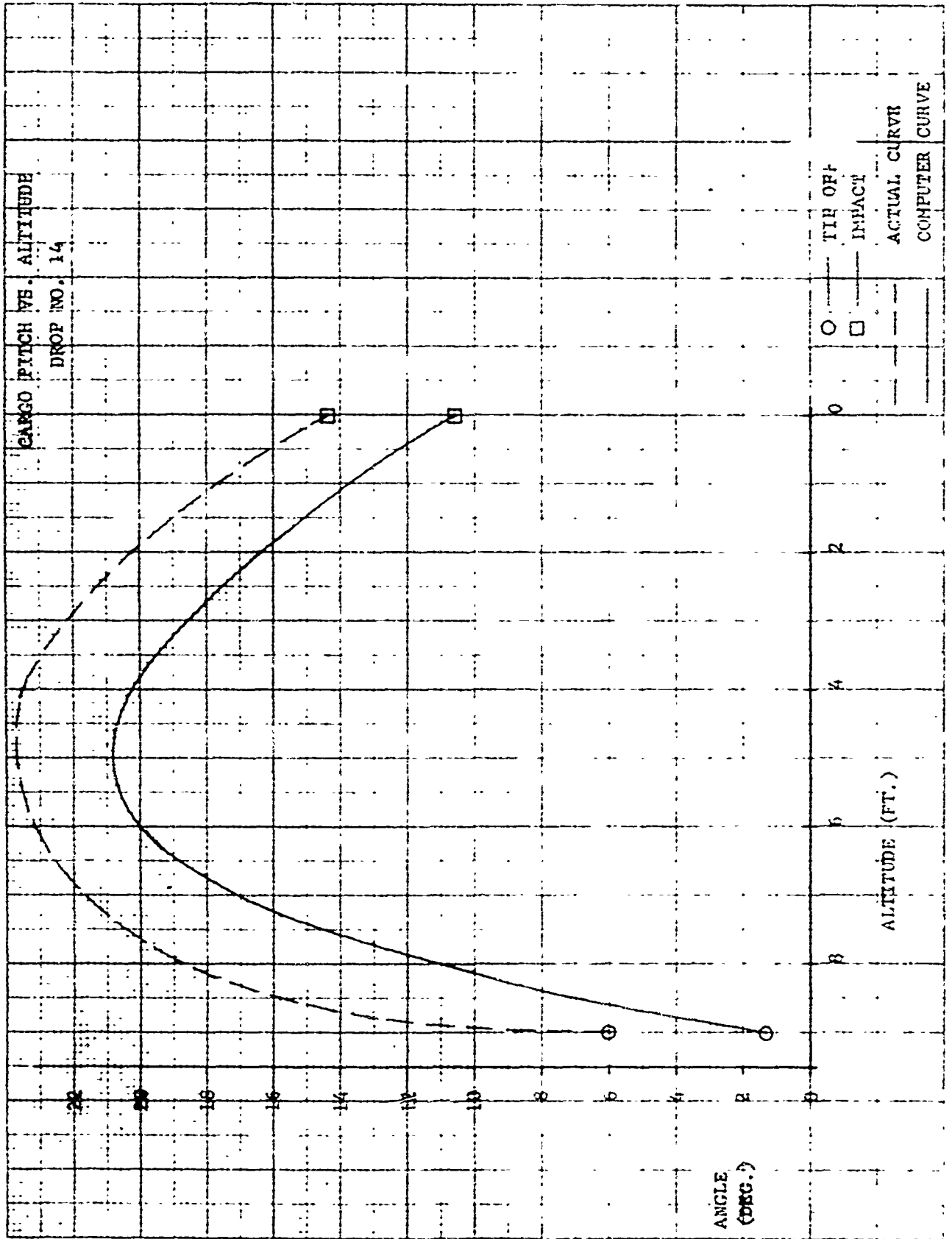


FIGURE 14

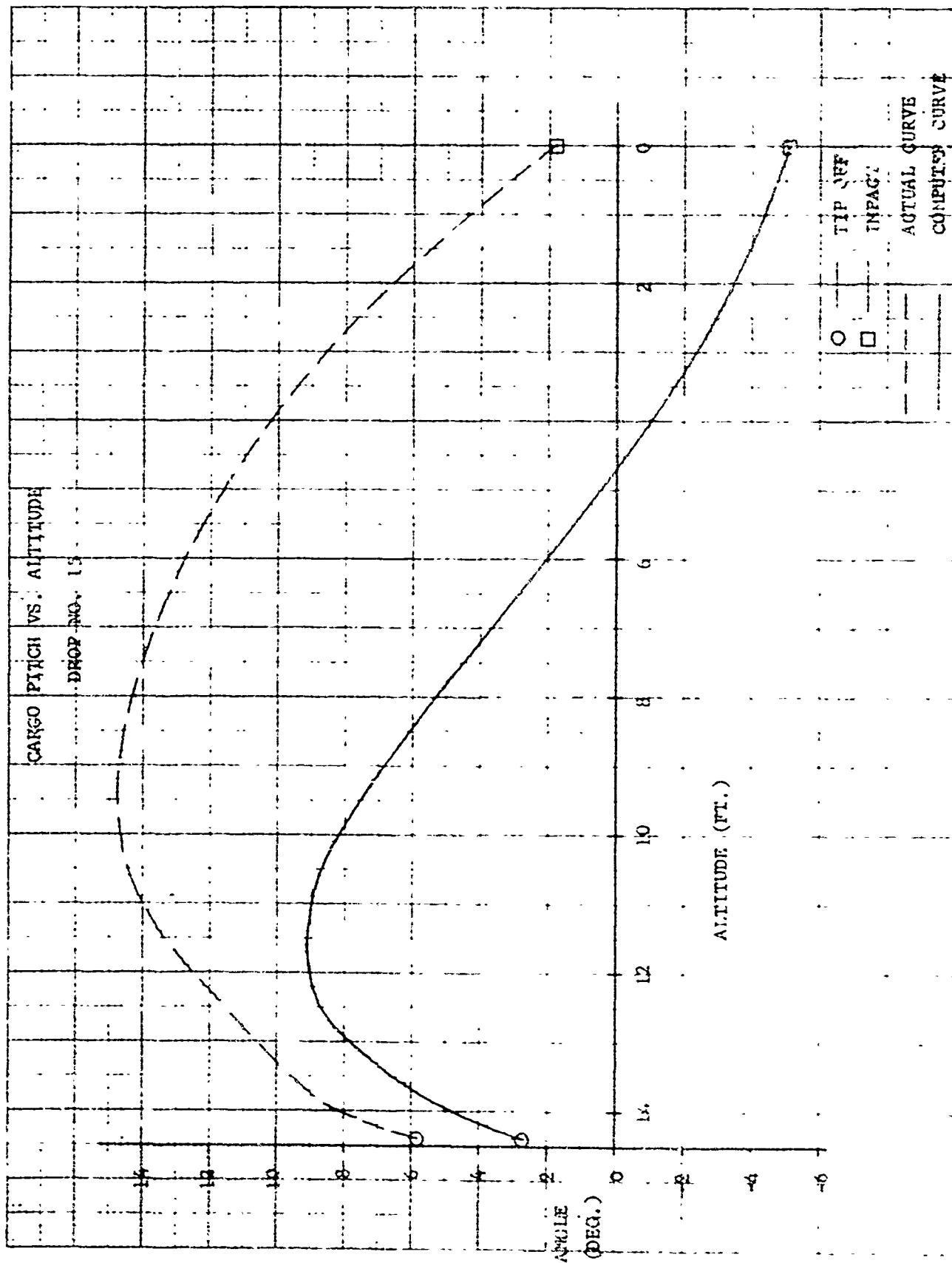


FIGURE 75



In Figures 76 through 89 plots of predicted cargo horizontal velocity versus descent time are given. Due to the inaccuracies of graphically integrating distance-versus-time data, the actual velocity-versus-time plots are not given since the comparison would be misleading. However, since such close agreement was witnessed between the actual and predicted curves of horizontal travel versus descent time, it can be stated that the actual curves of horizontal velocity versus descent time will be in close agreement with the predicted curves.



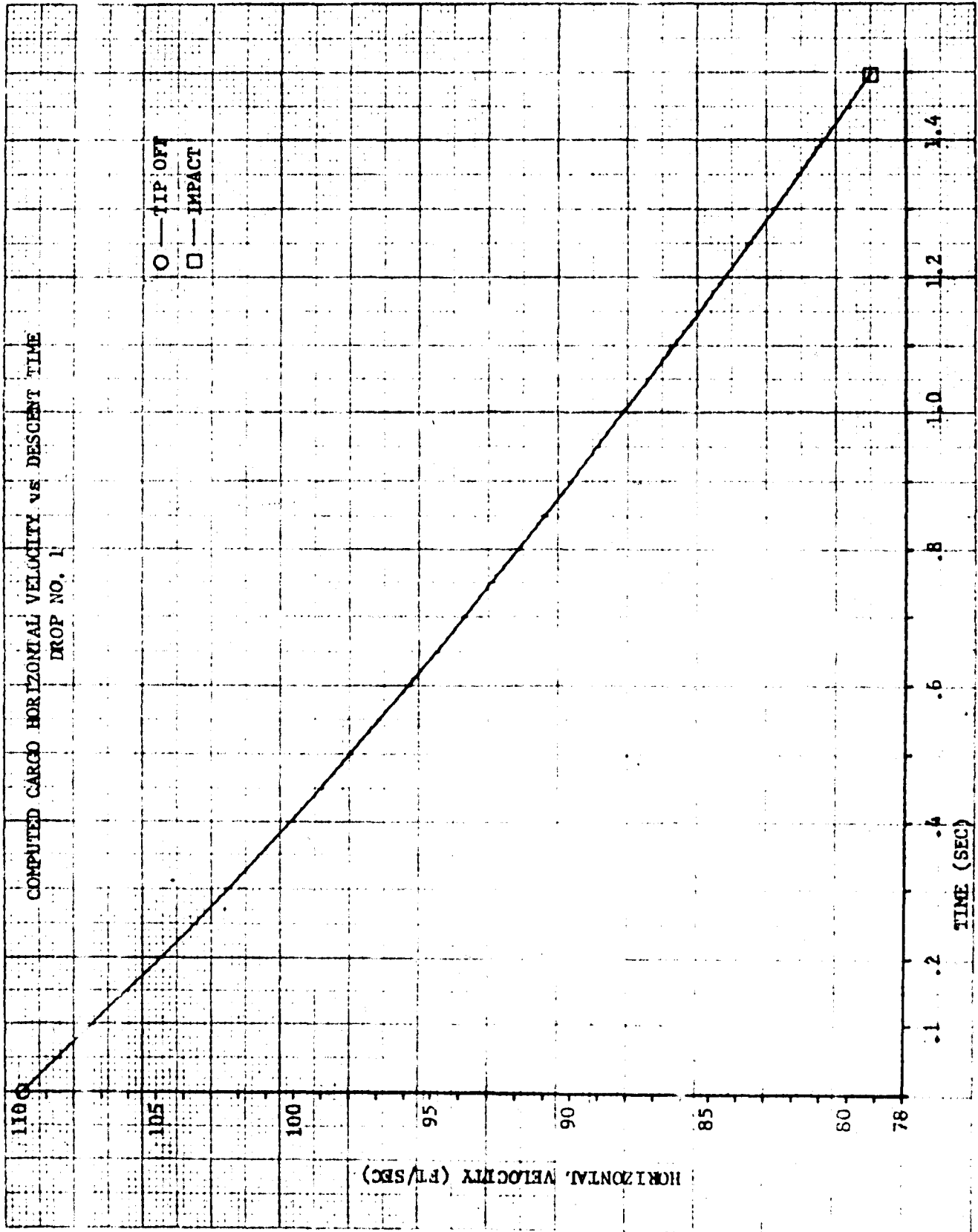


Figure 76

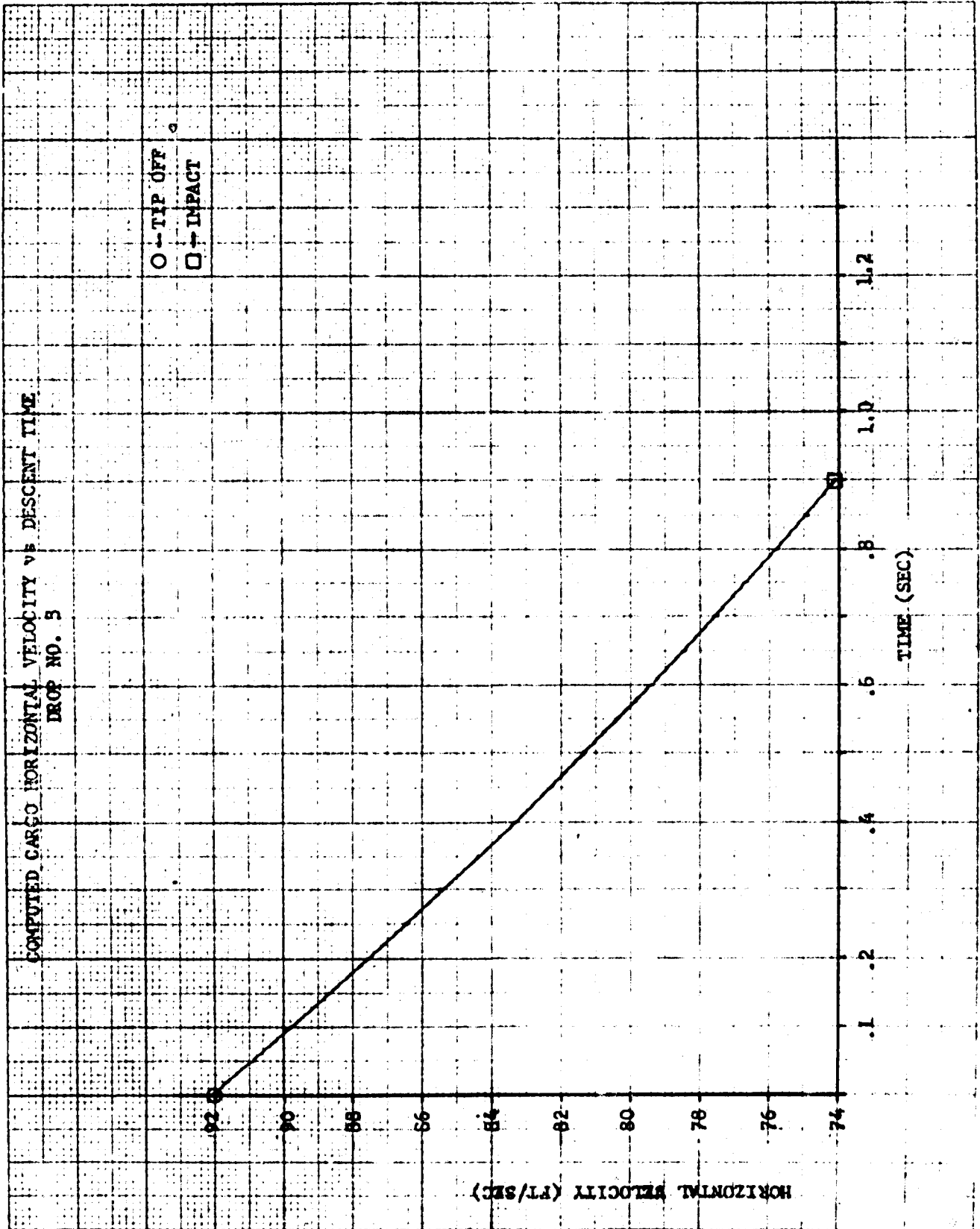


Figure 77

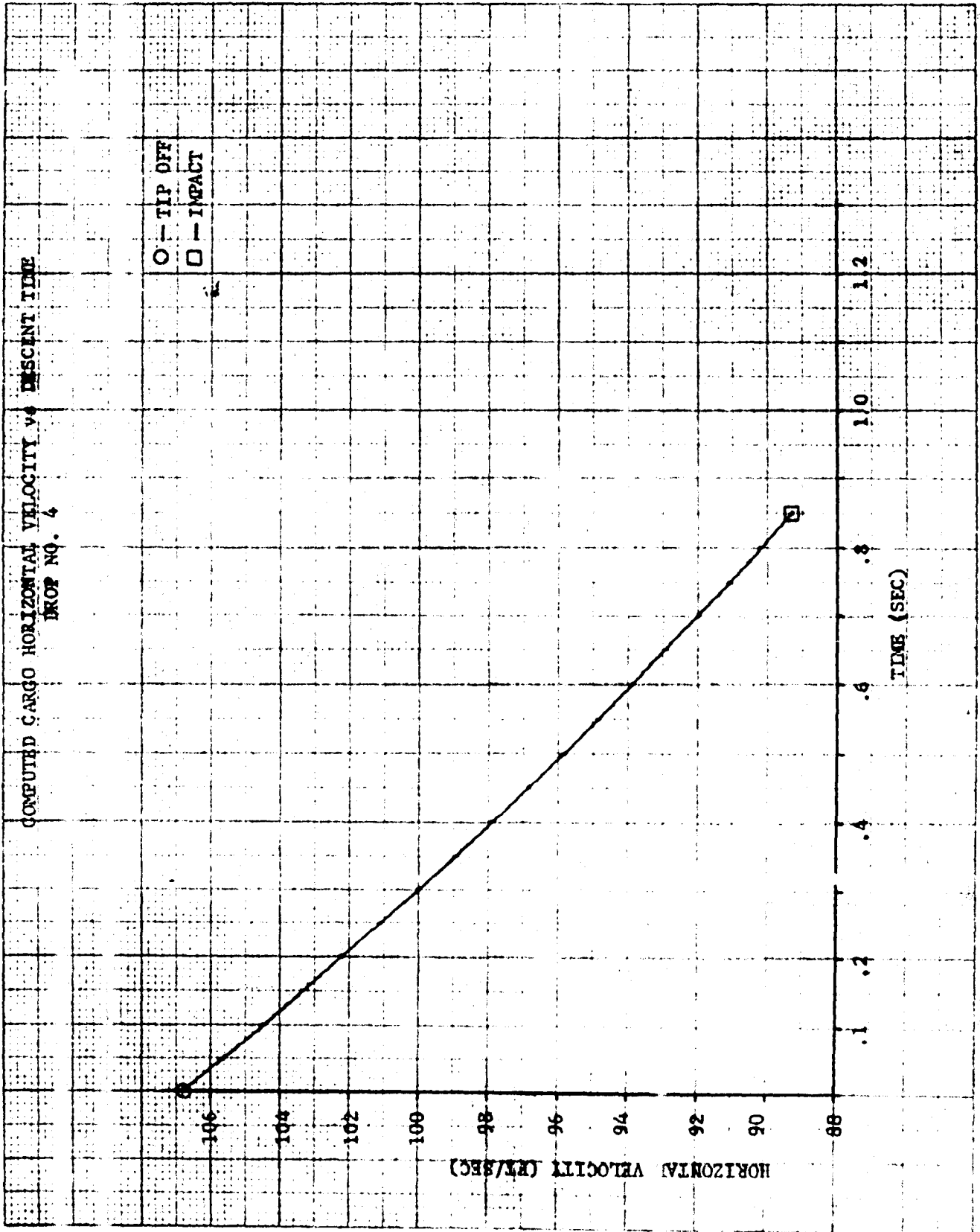


Figure 78

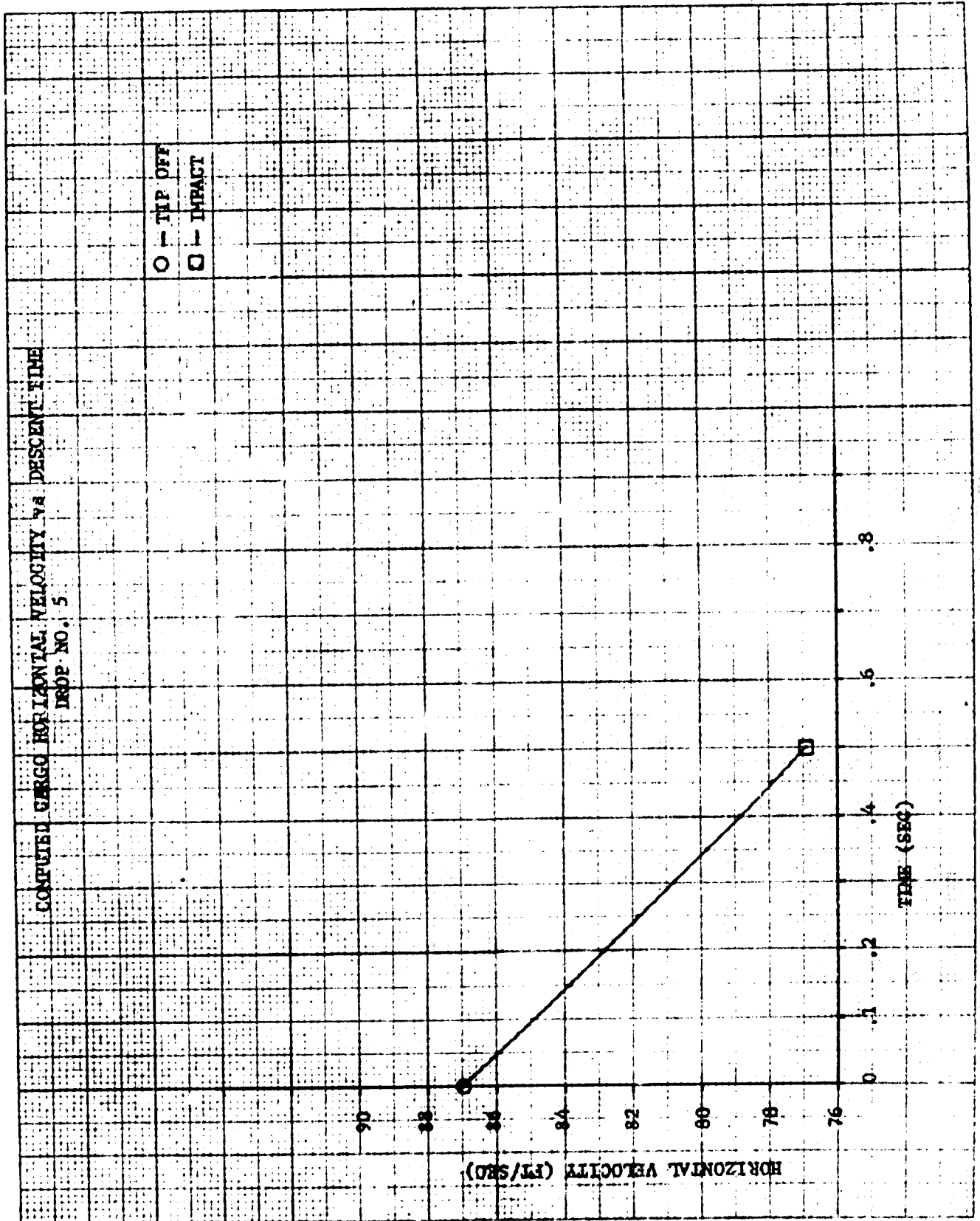


Figure 79

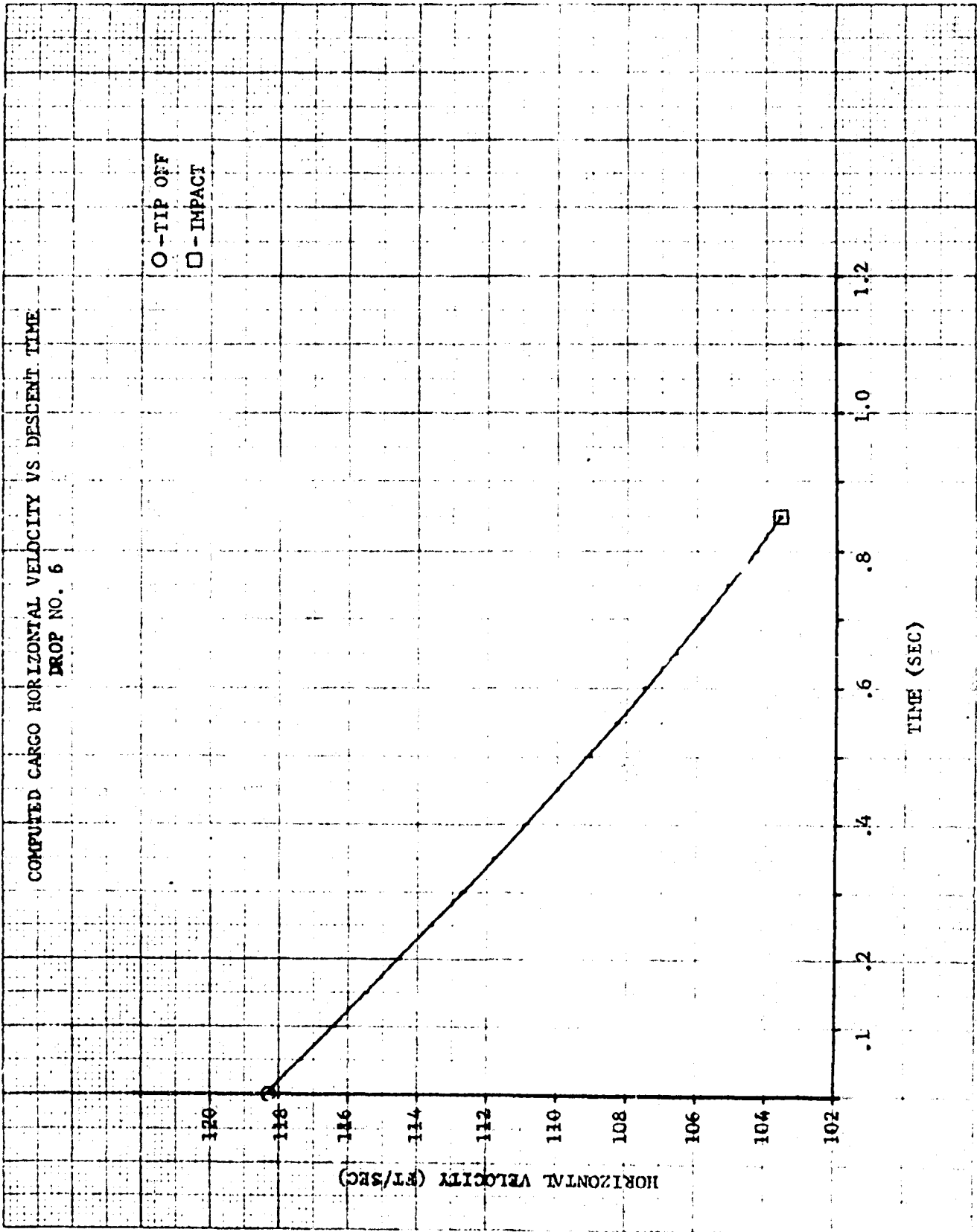


Figure 80

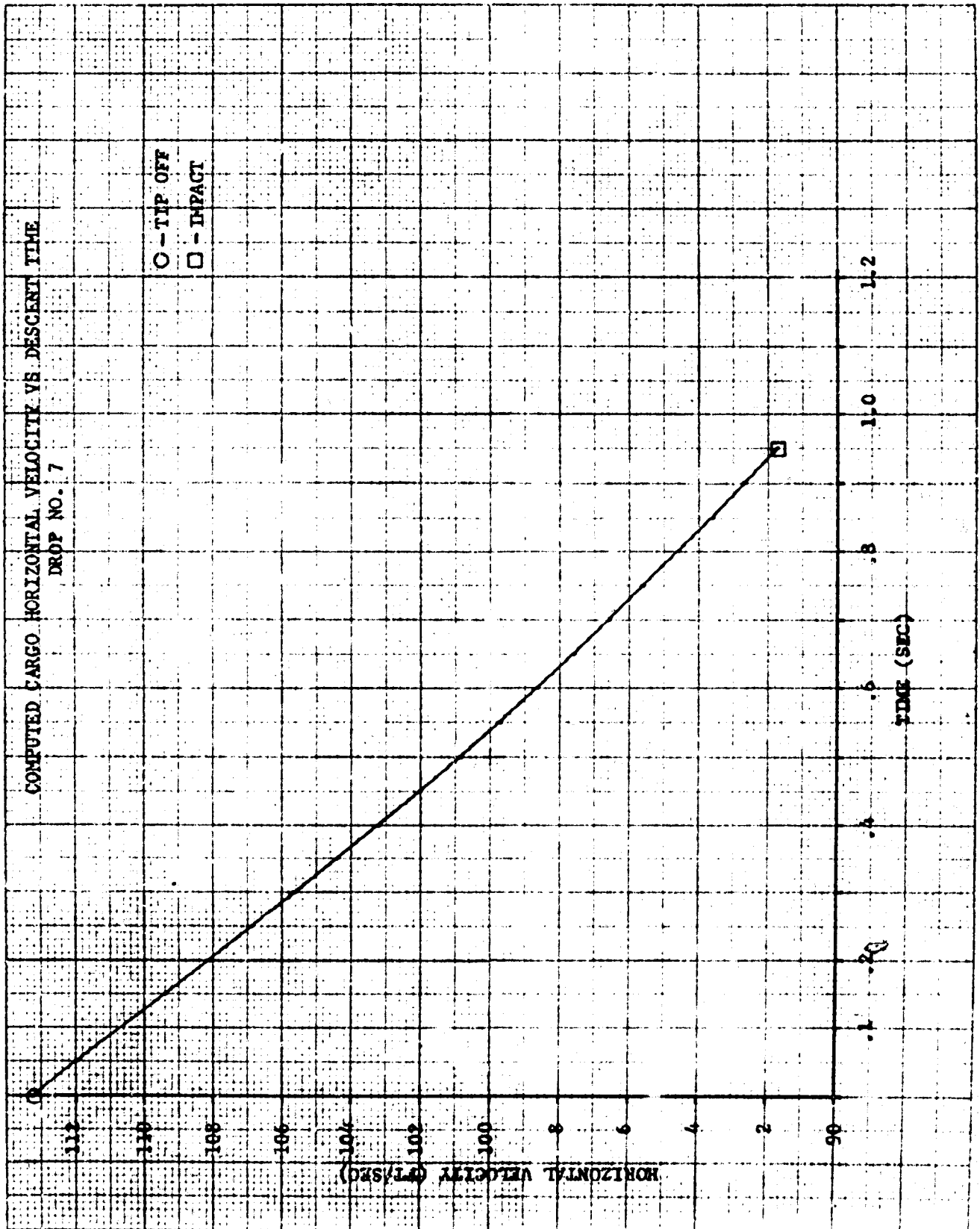


Figure 81

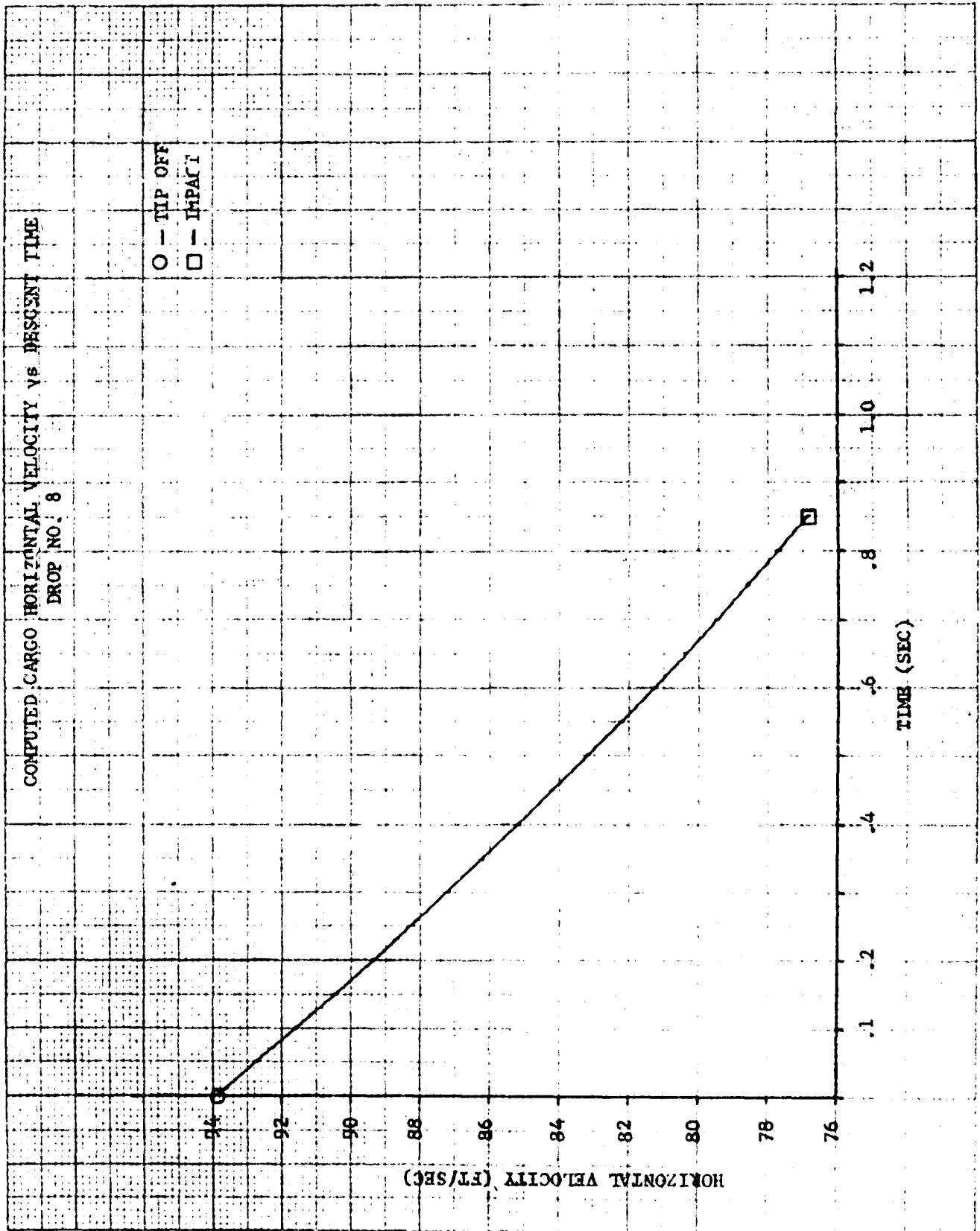


Figure 82

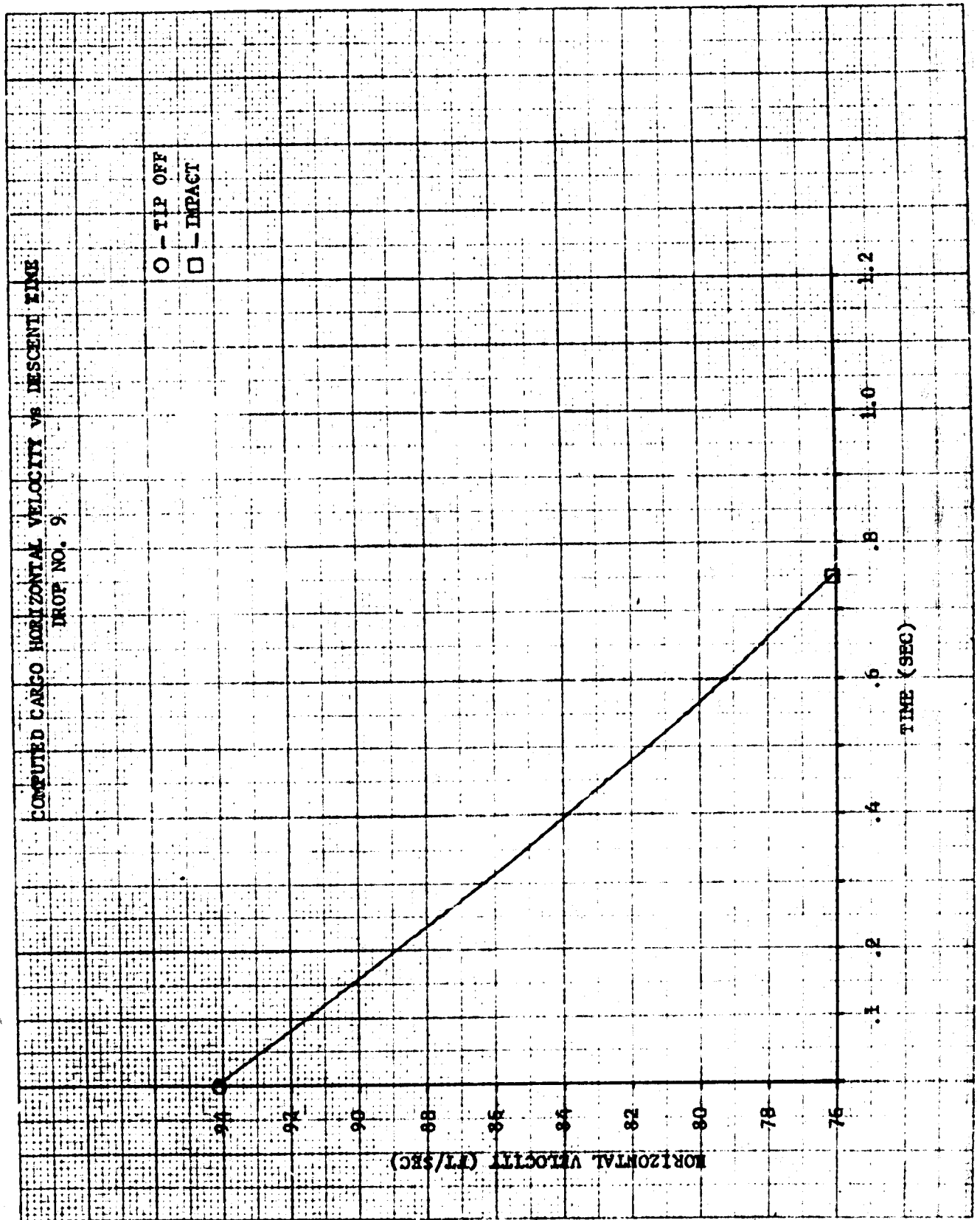


Figure 83



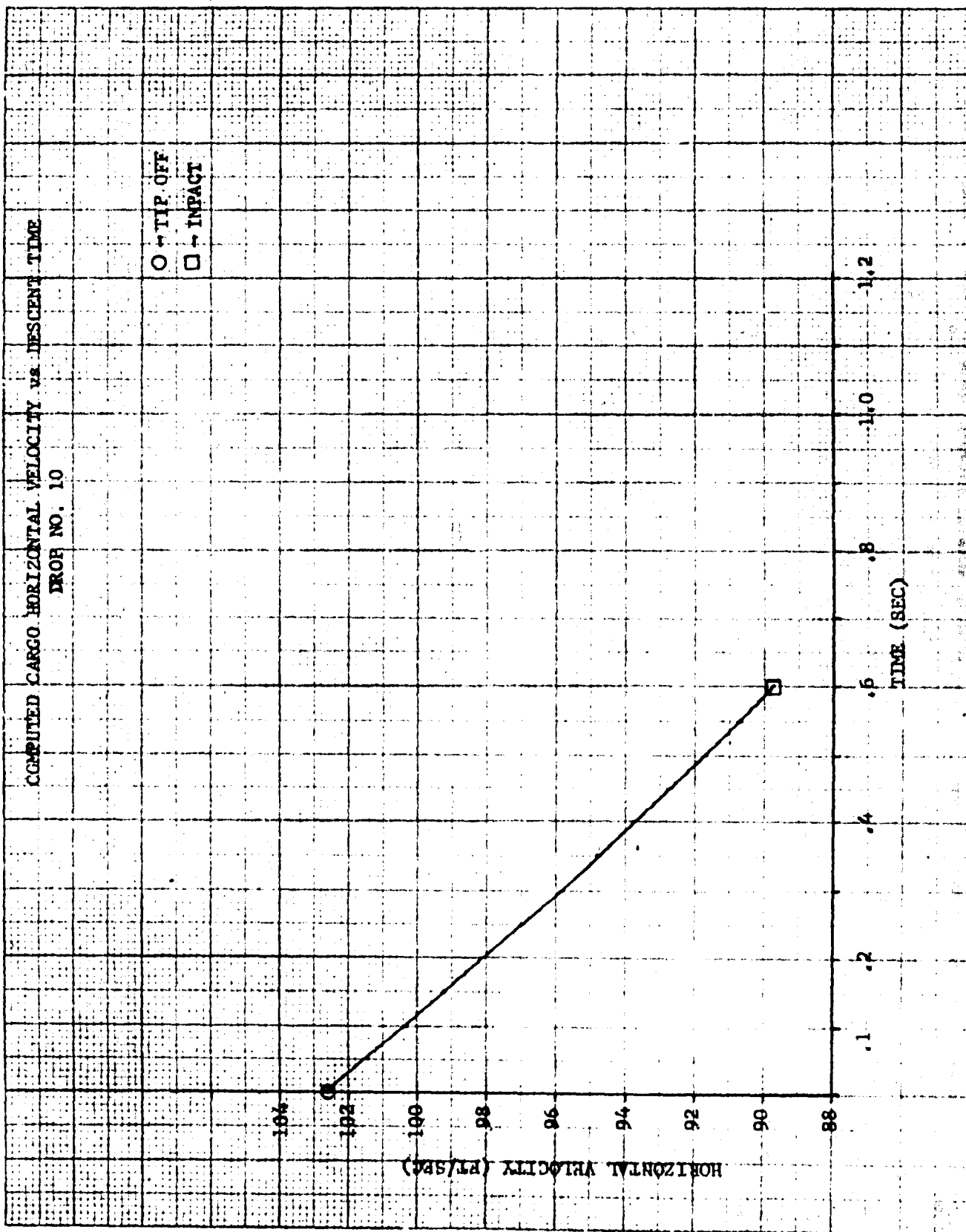


Figure 84

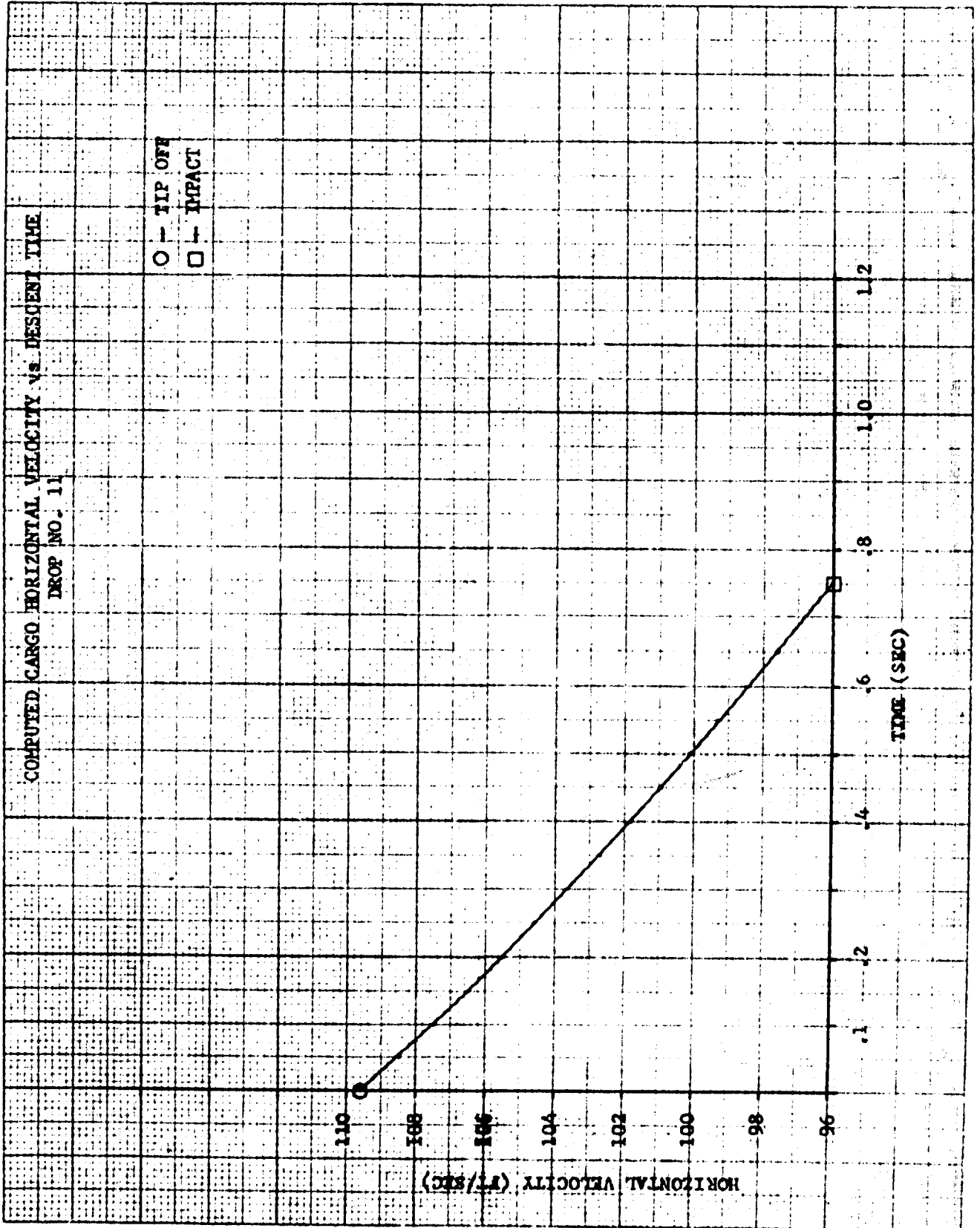


Figure 85

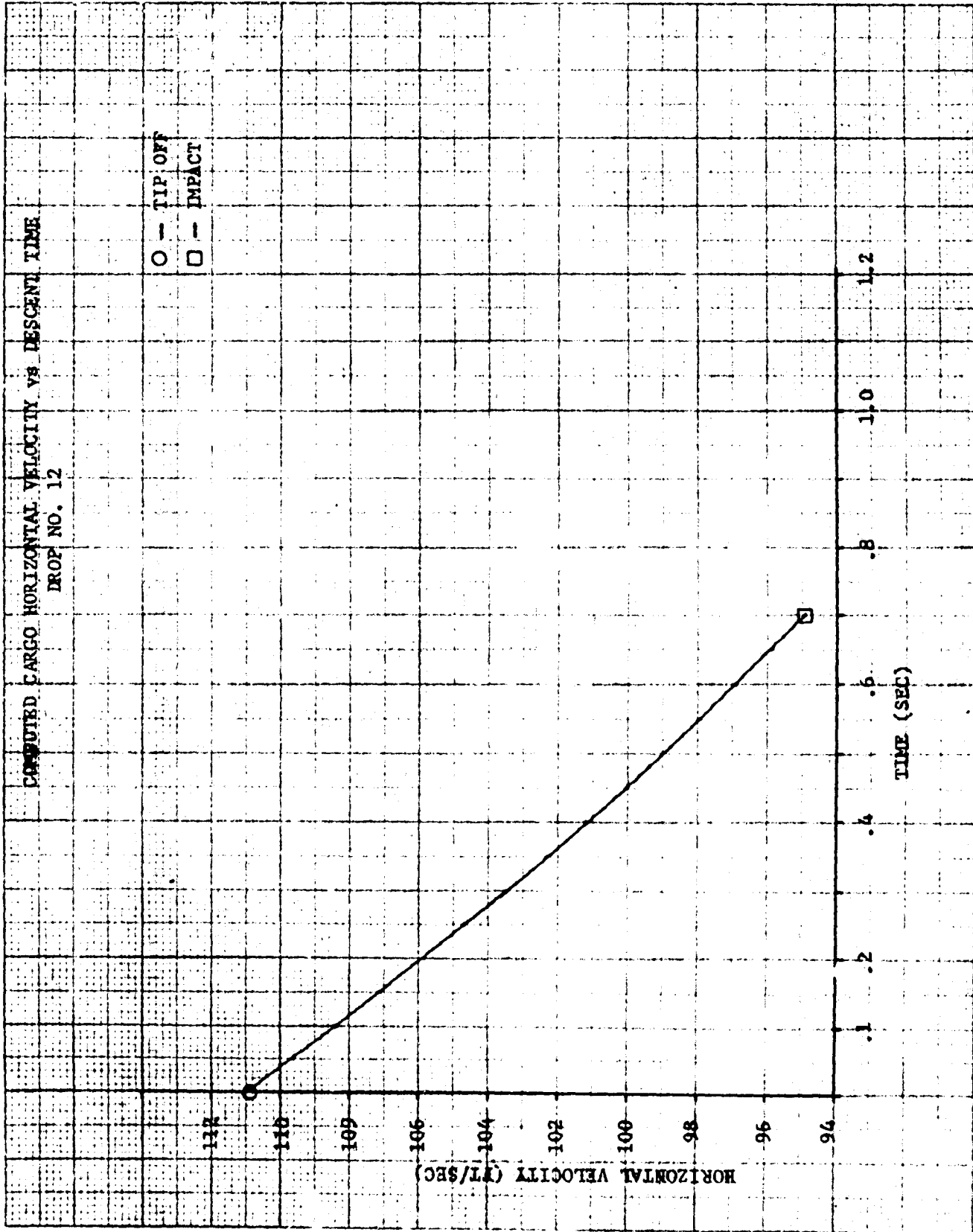


Figure 86

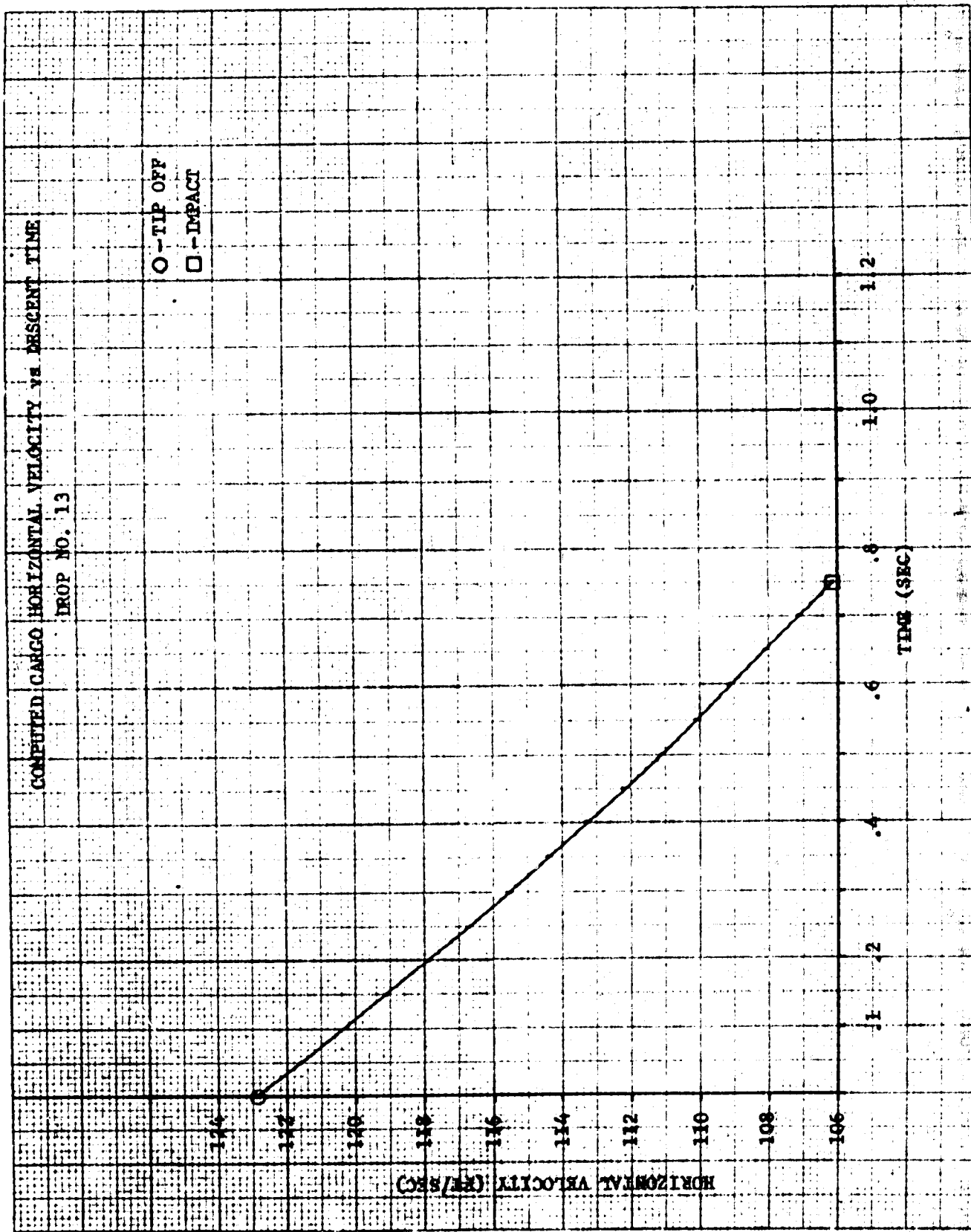


Figure 87

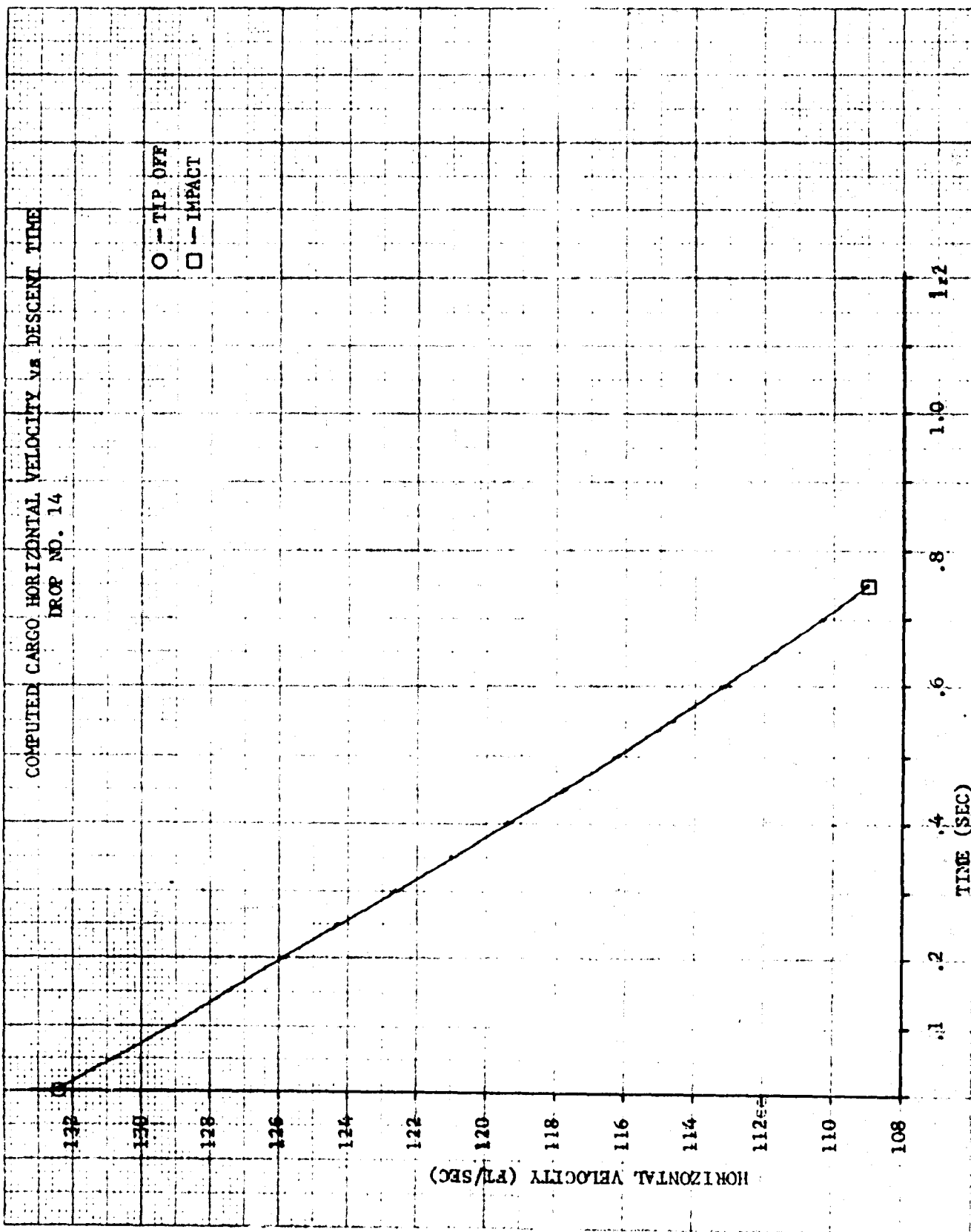


Figure 88

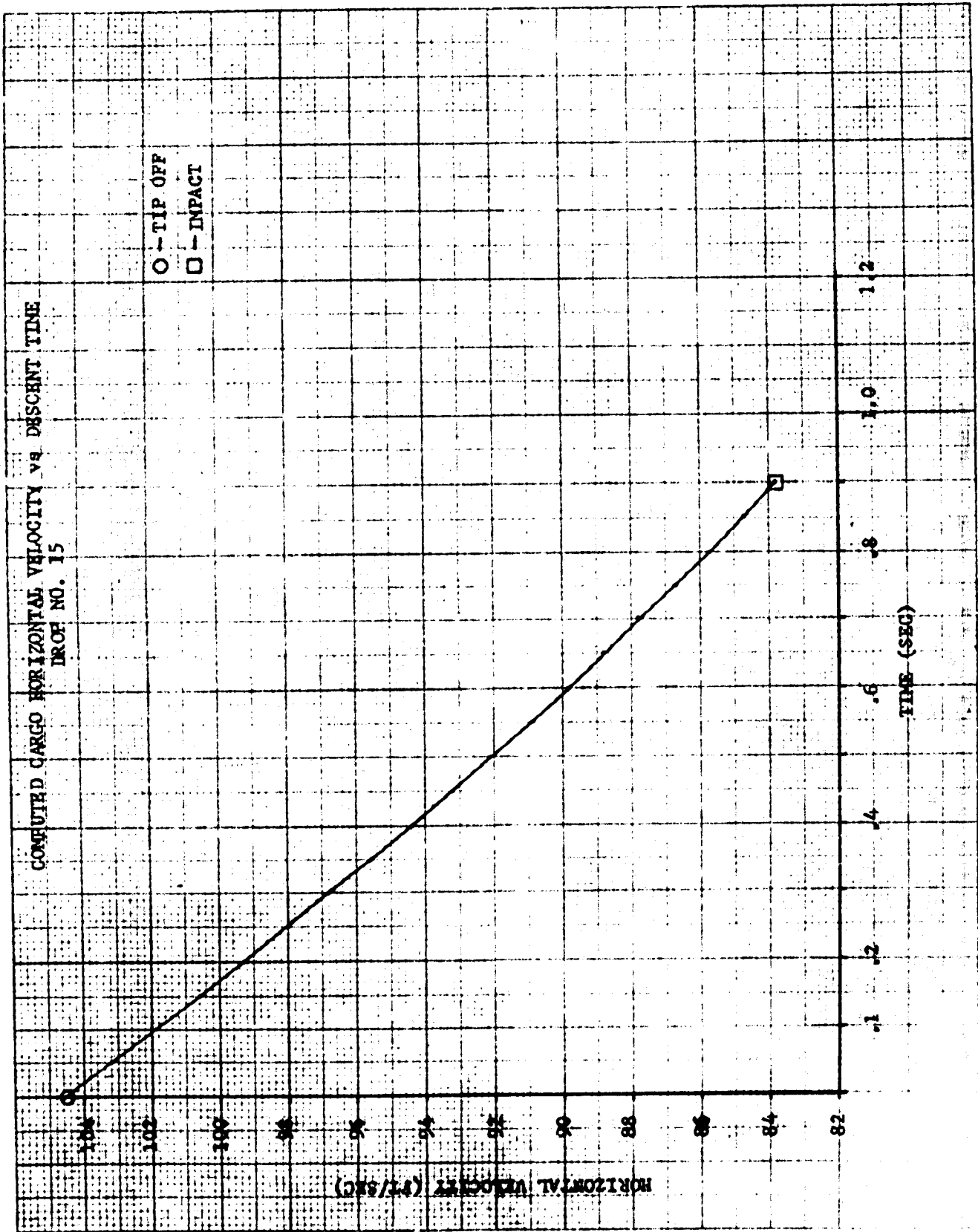


Figure 89



#### D. Impact Phase

The equations for this phase are much less descriptive of the actual motion than are the equations for the drop phase. Too many variables are not and cannot be considered in the computer program. The slide length seems to be the only method of comparing the computer analysis against the actual occurrence for the impact phase. Below is a tabulation of slide lengths.

Test No.	Slide Length	
	Actual	Computer
1.	Load Overturn	116.8
3.	65	73.32
4.	60	102.08
5.	80	90.67
6.	90	138.85
7.	Load Overturn	105.23
8.	72	77.07
9.	60	76.46
10.	Load Overturn	104.39
11.	90	117.65
12.	90	154.28
13.	110	131.29
14.	110	100.61
15.	160	88.76

A value for the coefficient of friction was extremely difficult to select. Below is a list of variables that effect the coefficient of friction.

1. Impact Zone Terrain
2. Impact Zone Vegetation
3. Impact Zone Moisture Content



4. Impact Zone Hardness
5. Impact Zone Material
6. Load Platform Material
7. Load Impact Angle.

The instantaneous value of the coefficient of friction changes all along the slide path in the actual situation. Whereas, the computer assumes the instantaneous coefficient value is equal to the average value. With this though that the exact coefficient of friction value is nearly impossible to obtain, one can say that the two comparative slide lengths are in close agreement.





III. COMPUTER PROGRAM

A. General

When the computer program was set up for use on AAI's computer it was necessary to rewrite the program in three distinct separate phases due to the size of AAI's computer. The new program along with its inputs is presented in this section. Also included is a listing of the numerical values of the input as obtained from the test program.

B. Nomenclature

Presented below is the program input nomenclature. It was felt that clarification was needed as far as defining the coordinate system of each individual computer input.

<u>Nomenclature</u>	<u>Units</u>	<u>Definition</u>
$t_0$	sec	Extraction start time
$\psi_0$	degrees	Initial yaw angle of cargo in ground fixed frame of reference
$r_{x_0}$	feet	x component of distance from wind fixed frame of reference to cargo c.g.
$r_{y_0}$	feet	y component of distance from wind fixed frame of reference to cargo c.g.
$\dot{r}_{x_0}$	ft/sec	$\frac{d r_{x_0}}{dt}$
$\dot{r}_{y_0}$	ft/sec	$\frac{d r_{y_0}}{dt}$



<u>Nomenclature</u>	<u>Units</u>	<u>Definition</u>
$L_{y_0}$	feet	y component from parachute C.G. to extraction point in ground fixed frame of reference.
$L_{z_0}$	feet	z component from parachute C.G. to extraction point in ground fixed frame of reference.
$\dot{L}_{y_0}$	ft/sec	$\frac{d L_{y_0}}{dt}$
$\dot{L}_{z_0}$	ft/sec	$\frac{d L_{z_0}}{dt}$
$\theta_a$	degree	Pitch angle of aircraft in ground fixed frame of reference
$\phi_a$	degree	Roll angle of aircraft in ground fixed frame of reference
$\psi_a$	degree	Yaw angle of aircraft in ground fixed frame of reference
$r_{ax_0}$	feet	x distance from ground fixed frame of reference to aircraft C.G.
$r_{ay_0}$	feet	y distance from ground fixed frame of reference to aircraft C.G.
$r_{az_0}$	feet	z distance from ground fixed frame of reference to aircraft C.G.
$\Delta t_1$	second	Time increment for extraction phase
$\Delta t_2$	second	Time increment for tip-off phase
$\Delta t_3$	second	Time increment for descent phase
a	feet	x distance from cargo c.g. to extraction point in cargo frame of reference
b	feet	y distance from cargo c.g. to extraction point in cargo frame of reference



<u>Nomenclature</u>	<u>Units</u>	<u>Definition</u>
$c$	feet	z distance from cargo c.g. to extraction point in cargo frame of reference.
$d$	feet	x distance from cargo c.g. to center of the platform floor in cargo frame of reference
$e$	feet	y distance from cargo c.g. to center of the platform floor in cargo frame of reference
$f$	feet	z distance from cargo c.g. to center of the platform floor in cargo frame of reference
$n$	feet	z distance from aircraft c.g. to reaction point in aircraft frame of reference
$m$	slugs	Mass of cargo
$M$	slugs	Mass of parachute
$I_{xx}$	slugs-ft <sup>2</sup>	Moment of inertia of the cargo about its x axis
$I_{yy}$	slug-ft <sup>2</sup>	Moment of inertia of the cargo about its y axis
$I_{zz}$	slug-ft <sup>2</sup>	Moment of inertia of the cargo about its z axis
$V_x$	ft/sec	x component of wind velocity in the ground fixed frame of reference
$V_y$	ft/sec	y component of wind velocity in the ground fixed frame of reference
$V_z$	ft/sec	z component of wind velocity in the ground fixed frame of reference
$V_{ax}$	ft/sec	x component of aircraft velocity in the wind fixed frame of reference
$V_{ay}$	ft/sec	y component of aircraft velocity in the wind fixed frame of reference



<u>Nomenclature</u>	<u>Units</u>	<u>Definition</u>
$V_{az}$	ft/sec	z component of aircraft velocity in the wind fixed frame of reference
$d_e$	feet	x component from cargo c.g. position, before extraction, to the tip of the aircraft ramp in the aircraft frame of reference.
$l_c$	feet	Half length of platform
$K_{L\alpha}$	slug/ft. rad.	Slope of the $K_L$ versus $\alpha$ (angle of attack) curve
$K_{D_0}$	slug/ft.	Cargo drag factor with $\alpha = 0$
$K_{D_2}$	slug/ft. rad.	Slope of $K_D$ versus $\alpha^2$ curve
$Z_{test}$	feet	Altitude test for descent phase
$(C_D A)_0$	ft <sup>2</sup>	Product of drag coefficient and inflated parachute drag area
Diam.	ft.	Skirt diameter of inflated parachute
$G_N$	--	Number of parachutes used
$G_F$	--	Cluster factor
$\rho_0$	slug/ft <sup>3</sup>	Air density at the extraction altitude



## IMPACT PHASE INPUT NOMENCLATURE

<u>Nomenclature</u>	<u>Units</u>	<u>Definition</u>
$t_o$	second	starting time
$\Delta t$	second	time increment for numerical integration
$X_o$	feet	x component of cargo position in ground fixed frame of reference
$\dot{X}_o$	ft/sec	$(\frac{dX}{dt})_o$
$e_o$	radians	Pitch angle of cargo in ground fixed frame of reference
$\dot{e}_o$	rad/sec	$(\frac{de}{dt})_o$
$L_{X_o}$	feet	X component of parachute line length in ground fixed frame of reference
$\dot{L}_{X_o}$	ft/sec	$(\frac{dL_X}{dt})_o$
$V_x$	ft/sec	X component of wind velocity in ground fixed frame of reference
$V_z$	ft/sec	Z component of wind velocity in ground fixed frame of reference
ALT	feet	Z component from aircraft C.G. to ground fixed frame of reference
$K_{11}$	feet	X component from cargo C.G. to attachment point of external decelerator in cargo frame of reference
$K_{13}$	feet	Z component from cargo C.G. to attachment point of external decelerator in cargo frame of reference
a	feet	X component from cargo C.G. to extraction point on cargo frame of reference
c.	feet	Z component from cargo C.G. to extraction point in cargo frame of reference



<u>Nomenclature</u>	<u>Units</u>	<u>Definition</u>
d	feet	X component from cargo C.G. to platform centerline in cargo frame of reference
f	feet	Z component from cargo C.G. to platform floor in cargo frame of reference
$l_c$	feet	half length of the platform
$I_{yy}$	slug-ft <sup>2</sup>	Moment of inertia of the cargo about its y axis
$K_c$	slug/ft	Parachute drag factor
m	slugs	mass of cargo
M	slugs	mass of parachute
CN		Case number
$\theta_{max}$	radians	critical pitch angle for which pitch will occur
Dia. Chute	feet	inflated parachute diameter
..		coefficient of friction
.	feet	line length
$\dot{z}_o$	ft/sec	vertical impact velocity
$\ddot{x}_o$	ft/sec <sup>2</sup>	$(\frac{d^2x}{dt^2})_o$
f	pounds	magnitude of external force



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C. Computer Program and Inputs

Several changes were made in the original computer program.

Below is a listing of all four phases of the revised program.



```

00000 *
00000 C   GROUND SLIDE AIR DROP - EXTRACTION PHASE
00000 C
00000 C   PAGE NO. 1
00000 C
00000 COMMON      CN,DELTO,PSO,PSDO,RXO,RYC,RXDO,RYDO,XLYDO,XLZDO,XLZO,
00000 1XLYO,THDO,THO,C15,TC,T,RAXO,VAX,RAYO,VAY,RAZO,VAZ,C13,P20,C20,C3,C
00000 24,C8,C5,C37,C38,XH2,P23,P22,XN,P24,P25,P27,F,XA,C,XB,XJ,NTBLE,DIA
00000 3MO,NDRDO,CKF,XLM,XJYY,C49,XJJ,XJXX,C50,XJ2,XJZZ,C51,XSM,C39,C12,K,
00000 4ISTEP,IP,IP1,VX,VY,VZ,XLC,D,DELTO3,XIP13,DELTO ,ZDTEST
00000 EQUIVALENCE (DATA(1),CN)
00000 DIMENSION DATA(73)
00000 DIMENSION A(12,12),YA(12),B(12),TCHUTE(12),DRI(12),XLI(12),XLDI(12
00000 1),XLDI(12),DRDO(15),CORATI(15)
00000 READ 10,TO,PSO,PSDO,RXO,RYO,RXDO,RYDO,XLYDO,XLZDO,XLZO,XLYO,THA,PH
00000 1A,PSA,RAXO,RAYO,RAZO,DELTO,XIP1,XA,XB,C,D,E,F,XN,XSM,XLM,XIXX,XIYY
00000 2,XIZZ,VX,VY,VZ,VAX,VAY,VAZ,DE,DELTO2,DELTO3,XLC,XKLA,XKDO,XKDA,ZDT
00000 3EST,XIP12,XIP13,CDAO,DIAMO,GN,GF,CN,RMO
00000 10 FORMAT(8F10.4)
00000 PRINT 4,CN
00000 4 FORMAT(12H1CASE NUMBER,F7.4/17H EXTRACTION PHASE)
00000 PRINT 1,TO,PSO,PSDO,RXO,RYO,RXDO,RYDO,XLYDO,XLZDO,XLZO,XLYO,THA,PH
00000 1A,PSA,RAXO,RAYO,RAZO,DELTO,XIP1,XA,XB,C,D,E,F,XN,XSM,XLM,XIXX,XIYY
00000 2,XIZZ,VX,VY,VZ,VAX,VAY,VAZ,DE,DELTO2,DELTO3,XLC,XKLA,XKDO,XKDA,ZDT
00000 3EST,XIP12,XIP13,CDAO,DIAMO,GN,GF,RMO
00000 READ 3000,NTBLE,(TCHUTE(ITBLE),DRI(ITBLE),XLI(ITBLE),XLDI(ITBLE),X
00000 1LDDI(ITBLE),ITBLE=1,NTBLE)
00000 3000 FORMAT(110/(5F10.5))
00000 PRINT 3001,(TCHUTE(ITBLE),DRI(ITBLE),XLI(ITBLE),XLOI(ITBLE),XLDI(
00000 1ITBLE),ITBLE=1,NTBLE)
00000 C
00000 C   PAGE NO. 2
00000 C
00000 C 3001 FORMAT(//41H CHUTE DIAMETER AND LINE LENGTH VARIATION//(10X,5F10.5
00000 1))
00000 READ 4000,NDRDO,(DRDO(I),CORATI(I),I=1,NDRDO)
00000 4000 FORMAT(110/(8F10.4))
00000 PRINT 4001,(DRDO(I),CORATI(I),I=1,NDRDO)
00000 4001 FORMAT(//21H (CDA) RATIO VS DR/DO//(10X,2F20.8))
00000 1 FORMAT(//5H INPUT/(4F20.8))
00000 K=12
00000 CKF=RMO *GN*GF*CDA6/2.
00000 XJXX=XIXX/XLM
00000 XJYY=XIYY/XLM
00000 XJZZ=XIZZ/XLM
00000 C49=XJXX-XJZZ
00000 C50=XJYY-XJZZ
00000 C
00000 C   PAGE NO. 3
00000 C
00000 C  C51=XJXX-XJYY
00000 C  XJ1=C49+XJYY
00000 C  XJ2=C51+XJZZ
00000 C  XJ3=C51-XJZZ

```





```

00000 C1=COSF(THA/57.29578)
00000 C2=SINF(THA/57.29578)
00000 C3=COSF(PHA/57.29578)
00000 C4=SINF(PHA/57.29578)
00000 C5=COSF(PSA/57.29578)
00000 C6=SINF(PSA/57.29578)
00000 C7=C6*C1
00000 C8=C5*C4
00000 C9=C6*C4
00000 C10=DE*DE
00000 C12=XSM*32.16
00000 C13=1.+XSM/XLM
00000 C14=XM-F
00000 C25=PSA/57.29578
00000 C36=C4*C1
00000 C37=C6*C3
00000 C38=C5*C3
00000 C39=C13*32.16
00000 P22=C7-C8*C2
00000 P23=C5*C1+C9*C2
00000 P24=C5*C2-C9*01
00000 C
00000 C PAGE NO. 4
00000 C
00000 P25=C6*C2+C8*C1
00000 P26=C3*C2
00000 P27=C3*C1
00000 P50=PS0/57.29578
00000 T=T0
00000 DELT2=DELT0/2.
00000 IPI=X|PI
00000 IP=|PI
00000 ISTEP=1
00000 IK=1
00000 200 DET2=DELT2
00000 PS1=PS0
00000 PSD1=PSD0
00000 RX1=RX0
00000 RY1=RY0
00000 RXD1=RXD0
00000 RYD1=RYD0
00000 XLYD1=XLYD0
00000 XLZD1=XLZD0
00000 XLZ1=XLZ0
00000 XLY1=XLY0
00000 300 TT=T0-T
00000 RAX1=RAX0+VAX*TT
00000 RAY1=RAY0+VAY*TT
00000 C
00000 C PAGE NO. 5
00000 C
00000 RAZ1=RAZ0+VAZ*TT
00000 DO 450 I=1,12
00000 YA(I)=0.
00000 B(I)=0.

```



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```

00000 DO 410 J=1,12
00000 410 A(I,J)=0.
00000 A(4,1)=C13
00000 A(4,4)=1.
00000 A(5,2)=C13
00000 A(5,5)=1.
00000 A(6,3)=C13
00000 A(6,6)=1.
00000 A(8,7)=C4
00000 A(9,1)=P24
00000 A(9,2)=P25
00000 A(9,3)=-P27
00000 A(7,7)=P26
00000 C16=C26-PS9
00000 C17=SINF(C16)
00000 C18=COSF(C16)
00000 C19=C2+C18-C36+C17
00000 C20=SQRTF(1.-C19+C19)
00000 C21=C19/C20
00000 C22=P27/C20
00000 C23=(C2+C17+C36+C18)/C20
00000 RZ0=RAZ1+((RX0-RAX1)*P24+(RY0-RAY1)*P25+C14)/P27
00000 C
00000 C PAGE NO. 6
00000 C
00000 RZD0=VAZ+((RXD0-YAX)*P24+(RYD0-VAY)*P25)/P27
00000 PH0=ACOSF(C22/SQRTF(C22+C22+C23+C23))
00000 IF(C23)9000,9001,9001
00000 9000 PH0=-PH0
00000 9001 PHD0=-C22+C21+PSB6
00000 TH0=ACOSF(C20/SQRTF(C20+C20+C19+C19))
00000 IF(C19)9002,9003,9003
00000 9002 TH0=-TH0
00000 9003 THD0=C23+PSD0
00000 C24=SINF(PS0)
00000 C25=COSF(PS0)
00000 C27=C25+C23
00000 C28=C24+C23
00000 P1=X1+C19+C+C20
00000 P2=X1+C20-C+C19
00000 P3=P1+C23
00000 P4=P1+C22+XB+C23
00000 P5=P3-XB+C22
00000 C29=P2+C24
00000 C36=P5+C25
00000 C31=P2+C25
00000 C32=P5+C24
00000 C33=2.*P4
00000 C40=C24+C22
00000 C41=C25+C22
00000 C42=P2+P2
00000 C43=PSD0+PSD0
00000 C44=PHD0+PHD0
00000 C
00000 C PAGE NO. 7

```



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```

00000 C
00000 C45=THD0+THD0
00000 C46=PHD0+PSD0
00000 C47=PSD0+THD0
00000 C48=PHD0+THD0
00000 C52=2.*P2+C48
00000 C53=C33+C46
00000 C54=2.*C47
00000 P7=C24+C19+C27+C20
00000 P8=C25+C19+C28+C20
00000 P11=P1+C25+P2+C28
00000 P12=P1+C24+P2+C27
00000 P13=C29+C30
00000 P14=C31+C32
00000 P15=C29+P3+C25
00000 P16=C31+P3+C24
00000 P18=P1+P1+X8+X8
00000 P19=(XA+XA+C+C)*C22
00000 P20=P19+P3+X8
00000 P21=C33+P4+XJ1
00000 C
00000 C PAGE NO. 8
00000 C
00000 DO J010 I= 2,NTBLE
00000 IF(TCHUTE(I)-T0) J010,J011,J011
00000 J010 CONTINUE
00000 J011 TFRAC= (T0-TCHUTE(I-1))/(TCHUTE(I)-TCHUTE(I-1))
00000 DR= DR(I-1)+(DR(I)-DR(I-1))*TFRAC
00000 DRD0=DR/DIANG
00000 XL= XLI(I-1)+(XLI(I)-XLI(I-1))*TFRAC
00000 XLD= XLDI(I-1)+(XLDI(I)-XLDI(I-1))*TFRAC
00000 XLDD=XLDDI(I-1)+(XLDDI(I)-XLDDI(I-1))*TFRAC
00000 XLX0= -SORTF(XL+XL-XLY0+XLY0-XLZ0+XLZ0)
00000 XLXD0=(XL+XLD-XLY0+XLY0-XLZ0+XLZ0)/XLX0
00000 P37= RXD0+XLXD0-P13+PSD0+P4+C24+PHD0-P11+THD0
00000 P38= RYD0+XLYD0+P14+PSD0+P4+C25+PHD0-P12+THD0
00000 P39= RZD0+XLZD0-P5+PHD0+P2+C22+THD0
00000 DO 4010 I= 2,NDRD0
00000 IF(DRD0I(I)-DRD0) 4010,4011,4011
00000 4010 CONTINUE
00000 4011 CDRAT= CDRATI(I-1)+(CDRATI(I)-CDRATI(I-1))*(DRD0-DRD0I(I-1))/(DRD0
00000 I(I)-DRD0I(I-1))
00000 XKF= CKF+CDRAT
00000 P40= XKF/XLM*SORTF(P37+P37+P38+P38+P39+P39)
00000 C
00000 C PAGE NO. 9
00000 C
00000 A(1,1)= -P4
00000 A(1,3)= P14
00000 A(1,4)= -P4
00000 A(1,6)= P14
00000 A(1,7)= P4+P13
00000 A(1,8)= -C31+P5-C24+(XJYY+P18)
00000 A(1,9)= C25+(P20+C22+XJYY)-C24+P2+X8
00000 YA(1)= -P14+J2.16+P40*(P4+P37-P14+P39)-P4+P14+C43+C31+P4+C44-(P12+

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00000 1XB+C26+C22+C49)+C45+C25+P21+C46+(C49+XJ1+C33+P12)+C47+C52+P12-C27+
00000 2XJ3+C48
00000 A(2,2)= P4
00000 A(2,3)= -P13
00000 A(2,5)= P4
00000 A(2,6)= -P13
00000 A(2,7)= P4+P14
00000 A(2,8)= P2+C32-C25+(P18+XJXX)
00000 A(2,9)= -C31+X8-P20+C24-C40+XJXX
00000 YA(2)=P13+J2.16+P40+(P13+P39-P4+P38)+P4+P13+C43-C29+P4+C44-(P11+XB
00000 1+C27+C22+C50)+C45-C24+P21+C46+(C33+P11+C41+XJ1)+C47+C52+P11-C28+XJ
00000 22+C48
00000 C
00000 C PAGE NO. 10
00000 C
00000 A(3,1)= P13
00000 A(3,2)= -P14
00000 A(3,4)= P13
00000 A(3,5)= -P14
00000 A(3,7)= -C42+P5+P5-XJZZ
00000 A(3,8)= P2+P4
00000 A(3,9)= P1+P5+C23+(XJZZ+C42)
00000 YA(3)=P40+(P14+P38-P13+P37)+(P2+P5-C24+C25+C51)+C44+C22+(P2+XB+C40
00000 1+C25+C51)+C45+C53+P5-C54+P2+P4+C22+C22+C48+(COSF(2.+P80)+C51-XJZZ-
00000 22.C42)
00000 A(4,7)= -P13
00000 A(4,8)= P4+C24
00000 A(4,9)= -P11
00000 A(5,7)= P14
00000 A(5,8)= -P4+025
00000 A(5,9)= -P12
00000 A(6,8)= -P5
00000 A(6,9)= P2+C22
00000 C
00000 C PAGE NO. 11
00000 C
00000 A(10,4)= XLX0
00000 A(10,5)= XLY0
00000 A(10,6)= XLZ0
00000 YA(10)= XL+XLDD-XLY06+XLXD0-XLYD0+XLYD0-XLZ06+XLZD0+XLD+XLD
00000 A(11,1)= -XSM+XLY0
00000 A(11,2)= XSM+XLX0
00000 A(12,1)= XSM+XLZ0
00000 A(12,3)= -XSM+XLX0
00000 C34= C22+C3
00000 C35= C18+C3
00000 P6= C22+C20
00000 P98= P22+C24+P23+C25
00000 P29= P22+C25-P23+C24
00000 P31= C34+C18+C23+C4
00000 P32=C23+C35-C22+C4
00000 P33= RAX1-RX0-P24+XN
00000 P34= RAY1-RY0-P25+XN
00000 P35= RAZ1-RZ0+P27+XN
00000 C
```



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00000 C PAGE NO. 12
00000 C
00000 P41= P6/XLM
00000 P42= P7/XLM
00000 P43= P8/XLM
00000 A(1,10)= -P33*P41-P35*P43
00000 A(1,11)= -P23*P41-P26*P43
00000 A(1,12)= C37*P41-C4*P43
00000 A(2,10)= P34*P41+P35*P42
00000 A(2,11)= P22*P41+P26*P42
00000 A(2,12)= C38*P41+C4*P42
00000 A(3,10)= P34*P43-P33*P42
00000 A(3,11)= P22*P43-P23*P42
00000 A(3,12)= C38*P43+C37*P42
00000 A(4,10)= P43
00000 YA(4)= -P37*P40+P14*C43+C32*C44+P16*C45-C53*C25-P12*C54-C52*C48
00000 A(5,10)= P42
00000 YA(5)= -P38*P40+P13*C43-C39*C44+P15*C45-C24*C53+P11*C54+C52*C41
00000 C
00000 C PAGE NO. 13
00000 C
00000 A(6,10)= -P41
00000 YA(6)= -C39*P40+P4*C44+C22*P1*C45+C52*C23
00000 A(7,8)= P28
00000 A(7,9)= -C22*P29-C23*P26
00000 YA(7)= -P29*C46-P28*C22*C47+(P26*C22-P29*C23)*C48
00000 A(11,10)= P7*XLX8-P8*XLX9
00000 YA(11)= 0,0
00000 A(12,10)= P8*XLX9+P8*XLX9
00000 YA(12)= C12*XLX8
00000 A(8,8)= -C3*C17
00000 A(8,9)= -P31
00000 YA(8)= -C35*C46+C34*C17*C47-P32*C48
00000 CALL SIMEQ(A,YA,B,R)
00000 C
00000 C PAGE NO. 14
00000 C
00000 ISTEP= -1STEP
00000 IF(ISTEP)GOTO 10,000,350
00000 3,10 IP= IP+8
00000 IF(IP-IP1)GOTO 210,220,220
00000 220 X= RXD+YX*II
00000 Y= RYD+VY*II
00000 Z= RZD+VZ*II
00000 XP= X*XLX8+P14
00000 YP= Y*XLX8+P13
00000 ZP= Z*XLX8+P4
00000 XD= RXDQ+YX
00000 YD= RYDQ+VY
00000 ZD= RZDQ+VZ
00000 IC= SORTF(XSM+XSM*(B(1)*B(1)+B(2)*B(2)+(B(3)-J2,16)*(B(3)-J2,16))+B
00000 1(10)*B(10)+2.*XSM*B(10)*(B(1)*P8+B(2)*P7-(B(3)-J2,16)*P6))
00000 PRINT 2 ,TO,X,Y,Z,XD,YD,ZD,XP,YP,ZP,PSQ,PH0,TH0,(B(1),:1,12)
00000 20 FORMAT(///4F20.0/ (20X,3F20.6 ))
00000 PRINT 41,IC

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00000      41 FORMAT(20X,F20.8)
00000      IP=0
00000      C
00000      C      PAGE NO. 15
00000      C
00000      210 C55= B(11)/B(10)
00000      IF(IK)3,3,2
00000      2 C61= C55
00000      C10= (RX0-RAX0*DE)*(RX0-RAX0*DE)
00000      IK= -IK
00000      3 IF(C55-C55-C10)350,212,212
00000      212 PRINT 30,T0
00000      30 FORMAT(///F20.6,24H END OF EXTRACTION PHASE )
00000      XH2=C55
00000      DELT0=DELT02
00000      DELT2=DELT0/2.
00000      ISTEP=1
00000      IPI=XIPI2
00000      IP=IPI
00000      C
00000      C      PREPARE TAPES FOR INPUT TO PHASE, II.
00000      C
00000      WRITE TAPE 1,DATA
00000      WRITE TAPE 1,XKLA,XK00,XK0A
00000      WRITE TAPE 1,(TCHUTE(I),DRI(I),XLI(I),XLDI(I),XLDDI(I),I=1,NTBLE)
00000      WRITE TAPE 1,(DRD0(I),CDRATI(I),I=1,NDRD0)
00000      STOP
00000      350 RXD0= RXD1+B(1)*DELT2
00000      RYD0= RYD1+B(2)*DELT2
00000      XLYD0= XL)D1+B(5)*DELT2
00000      XLZD0= XLZD1+B(3)*DELT2
00000      PSD0= PSD1+B(7)*DELT2
00000      RX0= RX1+(RXD2+RXD0)*DELT2/2.
00000      RY0= RY1+(RYD1+RYD0)*DELT2/2.
00000      XLY0= XLY1+(XLYD1+XLYD0)*DELT2/2.
00000      XLZ0= XLZ1+(XLZD1+XLZD0)*DELT2/2.
00000      PS0= PS1+(PSD1+PSD0)*DELT2/2.
00000      T0= T0+DELT2
00000      DELT2= DELT0
00000      IF(ISTEP)300,900,200
00000      900 STOP
00000      END
```



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00000 C GROUND SLIDE AIR DROP SYSTEM TIPOFF PHASE
00000 VELOCF(DA,DB)=DA+DB*DET2
00000 DISPLF(DA,DB,DC)=DA+(DB+DC)*DET2/2.
00000 COMMON CN,DELTA2,PS0,PS00,RX0,RY0,RX00,RY00,XLY0,XLZ0,
00000 1XLY0,TH0,TH00,T0,T00,T,RAX0,YAX,RAY0,VAX,RAZ0,VAZ,C13,P20,C20,C3,C
00000 24,C6,C5,C37,C36,XH2,P23,P22,XH,P24,P25,P27,F,XA,C,X0,XJ1,NTBLE,DIA
00000 J00,NDR00,CKF,XLM,XJYY,C49,XJ3,XJXX,C50,XJ2,XJZZ,C51,X3M,C39,C12,K,
00000 4ISTEP,IP,IPI,VX,VY,VZ,XLC,D,DELTA03,XIPI3,DELTA ,ZOTEST
00000 EQUIVALENCE (DATA(1),CN)
00000 DIMENSION DATA(73)
00000 DIMENSION A(12,12),YA(12),B(12)
00000 DIMENSION TCHUTE(12),DRI(12),XLI(12),XLD(12),XLDD(12)
00000 DIMENSION DRD0(15),CDRATI(15)
00000 C IF SJ1 IS ON, CASE NUMBER IS READ FROM CARD AND DATA ON PAPER
00000 C TAPE IS SEARCHED UNTIL THIS CASE NUMBER IS FOUND
00000 C IF SJ1 IS OFF, THE FIRST SET OF DATA ON THE TAPE IS USED
00000 IF(SENSE SWITCH 1)7000,7100
00000 7000 READ 8000,CCN
00000 8000 FORMAT(F10.0)
00000 7100 READ TAPE 1,DATA
00000 READ TAPE 1,XKLA,XKD0,XKDA
00000 READ TAPE 1,(TCHUTE(I),DRI(I),XLI(I),XLD(I),XLDD(I),I=1,NTBLE)
00000 READ TAPE 1,(DRD0(I),CDRATI(I),I=1,NDRD0)
00000 IF(SENSE SWITCH 1)7200,8002
00000 7200 IF(CCN-CN)7100,8002,7100
00000 8002 PRINT4,CN
00000 4 FORMAT(12H1CASE NUMBER,F7.4/13H TIPOFF PHASE)
00000 200 DELTA2=DELTA
00000 PS1=PS0
00000 PSD1=PS00
00000 RX1=RX0
00000 RY1=RY0
00000 RXD1=RXD0
00000 RYD1=RYD0
00000 XLYD1=XLYD0
00000 XLZD1=XLZD0
00000 XLZ1=XLZ0
00000 XLY1=XLY0
00000 THD1=THD0
00000 TH1=TH0
00000 300 TT=T0-T
00000 RAX1=RAX0+YAX*TT
00000 RAY1=RAY0+VAX*TT
00000 RAZ1=RAZ0+VAZ*TT
00000 DO 410 I=1,12
00000 YA(I)=0.
00000 B(I)=0.
00000 DO 410 J=1,12
00000 410 A(I,J)=0.
00000 A(4,1)=C13
00000 A(4,4)=1.
00000 A(5,2)=C13
00000 A(5,5)=1.
00000 A(6,3)=C13

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00000      A(6,6)=1.
00000      440 A(7,7)=P26
00000      450 C16=C26-P80
00000          C17=SINF(C16)
00000          C18=COSF(C16)
00000          C19=SINF(TH0)
00000          C20=COSF(TH0)
00000          C23=(C3+C3+C17+C18+C19+C4*SORTF(C20+C26-C3+C3+C17+C17))/(C20+C3+C
00000          13=C18+C18+C4+C4))
00000          C22=SORTF(1.-C23+C23)
00000          PH0=ACOSF(C22)
00000          IF(C23)9000,9001,9001
00000      9000 PH0=-PH0
00000      9001 C24=SINF(PS0)
00000          C25=COSF(PS0)
00000          C27=C25+C23
00000          C28=C24+C23
00000          P6=C22+C20
00000          P7=C24+C19+C27+C20
00000          P8=C25+C19+C28+C20
00000          P9=C24+C20-C27+C19
00000          P10=C25+C20+C28+C19
00000          P17=C22+C19
00000          P31=C22+C3+C18+C23+C4
00000          PH00=((C3+(P10+C6-P9/C5)-P17+C6)*TH00-C3*(P7+C6+P8+C5)*PSD0)/(P31+
00000          1C20)
00000          RZ0=RAZ1-(P8*(RAX1-RX0)+P7*(RAY1-RY0)+XH2*(P8+P23+P7+P22-P6+P26)-X
00000          IN*(P8+P24+P7+P25+P6+P27)+F)/P6
00000          P55=RAX1-RX0-P24+XN+XH2*P23
00000          P56=RAY1-RY0-P25+XN+XH2*P22
00000          P57=RAZ1-RZ0+P27+IN+XH2*P26
00000          P60=P55+U24-P56+C25
00000          P61=P7+P55-P6+P56
00000          P62=C23+C20+P57-P6+P60
00000          P63=P10+P55+P9+P56+P17+P57
00000          RZD0=VAZ-(P8*(VAX-RXD0)+P7*(VAY-RYD0)-PSD0*P61+PHD0*P52+THD0*P63)/
00000          1P6
00000      450 P1=XA+C19+C+C20
00000          P2=XA+C20-C+C19
00000          P3=P1+C23
00000          P4=P1+C22+XB+C23
00000          P5=P3-XB+C22
00000          C29=P2+C24
00000          C30=P5+C25
00000          C31=C2+C25
00000          C32=P5+C24
00000          C33=2.*P4
00000          C40=C24+C22
00000          C41=C25+C22
00000          C42=P2*P2
00000          C43=PSD0*PSD0
00000          C44=PHD0*PHD0
00000          C45=THD0*THD0
00000          C46=PHD0*PSD0
00000          C47=PSD0*THD0

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00000 C48=PHD0*THD0
00000 C52=2.*P2*C48
00000 C53=C33*C46
00000 C54=2.*C47
00000 P7=C24*C19+C27*C20
00000 P8=C25*C19-C28*C20
00000 P11=P1*C25-P2*C28
00000 P12=P1*C24+P2*C27
00000 P13=C29-C30
00000 P14=C31+C32
00000 P15=C29-P3*C25
00000 P16=C31+P3*C24
00000 P18=P1*P1*XB*XB
00000 P19=(XA*XA+C*C)*C22
00000 P20=P19+P3*XB
00000 P21=C33+P4*XJ1
00000 DO 3010 ITBLE=2,NTBLE
00000 IF(TCHUTE(ITBLE)-T0)3010,3011,3011
00000 3010 CONTINUE
00000 3011 TFRAC=(T0-TCHUTE(ITBLE-1))/(TCHUTE(ITBLE)-TCHUTE(ITBLE-1))
00000 DR=DR1(ITBLE-1)+(DR1(ITBLE)-DR1(ITBLE-1))*TFRAC
00000 DRD0=DR/DIAM0
00000 XL=XLI(ITBLE-1)+(XLI(ITBLE)-XLI(ITBLE-1))*TFRAC
00000 XLD=XLDI(ITBLE-1)+(XLDI(ITBLE)-XLDI(ITBLE-1))*TFRAC
00000 XLDD=XLDDI(ITBLE-1)+(XLDDI(ITBLE)-XLDDI(ITBLE-1))*TFRAC
00000 XLX0=-SORTF(XL*XL-XLY0*XLY0-XLZ0*XLZ0)
00000 XLXD0=(XL*XLD-XLY0*XLYD0-XLZ0*XLZD0)/XLX0
00000 P37=RXD0+XLXD0-P13*PSD0+P4*C24*PHD0-P11*THD0
00000 P38=RYD0+XLYD0+P14*PSD0-P4*C25*PHD0-P12*THD0
00000 P39=RZD0+XLZD0-P5*PHD0+P2*C22*THD0
00000 DO 4010 IDRD0=2,MDRD0
00000 IF(DRD01(IDRD0)-DRD0)4010,4011,4011
00000 4010 CONTINUE
00000 4011 CDRAT=CDRAT1(IDRD0-1)+(CDRAT1(IDRD0)-CDRAT1(IDRD0-1))*(DRD0-DRD01(
00000 IDRD0-1))/(DRD01(IDRD0)-DRD01(IDRD0-1))
00000 XKF=CKF*CDRAT
00000 P40=XKF/XLM*SORTF(P37*P37+P38*P38+P39*P39)
00000 A(1,1)=-P4
00000 A(1,3)=P14
00000 A(1,4)=-P4
00000 A(1,6)=P14
00000 A(1,7)=P4*P13
00000 A(1,8)=-C31*P5-C24*(XJYY+P18)
00000 A(1,9)=C25*(P20+C23*XJYY)-C24*P2*XB
00000 YA(1)=-P14*32.16+P40*(P4*P37-P14*P39)-P4*P14*C43+C31*P4*C44-(P12*X
00000 B+C28*C22*C40)*C45+C25*P21*C46+(C40*XJ1+C33*P12)*C47+C52*P12-C27*X
00000 2J3*C48
00000 A(2,2)=P4
00000 A(2,3)=-P13
00000 A(2,5)=P4
00000 A(2,6)=-P13
00000 A(2,7)=P4*P14
00000 A(2,8)=P2*C32-C25*(P18+XJXX)
00000 A(2,9)=-C31*XB-P20*C24-C40*XJXX
00000 YA(2)=P13*32.16+P40*(P13*P39-P4*P38)+P4*P13*C43-C29*P4*C44-(P11*XB

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AIN INT



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00000 1+C27+C22+C50)+C45-C24+P21+C46+(C33+P11+C41+XJ1)+C47+C52+P11-C28+XJ
00000 22+C48
00000 A(3,1)=-P13
00000 A(3,2)=-P14
00000 A(3,4)=P13
00000 A(3,5)=-P14
00000 A(3,7)=-C42-P5+P5-XJZZ
00000 A(3,8)=P2+P4
00000 A(3,9)=P1+P5+C23+(XJZZ+C42)
00000 YA(3)=P40+(P14+P38-P13+P37)+(P2+P5-C24+C25+C51)+C44+C22+(P2+XB+C40
00000 1+C25+C51)+C45+C53+P5-C54+P2+P4+C22+C22+C48+(COSF(2,+PS0)+C51-XJZZ-
00000 22+C42)
00000 A(4,7)=-P13
00000 A(4,8)=P4+C24
00000 A(4,9)=-P11
00000 A(5,7)=P14
00000 A(5,8)=-P4+C25
00000 A(5,9)=-P12
00000 A(6,8)=-P5
00000 A(6,9)=P2+C22
00000 A(10,4)=XLX0
00000 A(10,5)=XLY0
00000 A(10,6)=XLZ0
00000 YA(10)=XL+XL00-XLXD0+XLXD0-XLYD0+XL/D0-XLZD0+XLZD0+XLD+XLD
00000 A(11,1)=-XSM+XLY0
00000 A(11,2)=XSM+XLX0
00000 A(12,1)=XSM+XLZ0
00000 A(12,3)=-XSM+XLX0
00000 460 C34+C22+C3
00000 C35=C3+C18
00000 P6=C22+C20
00000 P28=P22+C24+P23+C25
00000 P29=P22+C25+P23+C24
00000 P31=C34+C18+C23+C4
00000 P32=C23+C35-C22+C4
00000 P33=RAX1-RX0-P24+XN
00000 P34=RAY1-RY0-P25+XN
00000 P35=RAZ1-RZ0+P27+XN
00000 P41=P6/XLM
00000 P42=P7/XLM
00000 P43=P8/XLM
00000 A(1,10)=-P33+P41-P35+P43
00000 A(1,11)=-P23+P41-P26+P43
00000 A(1,12)=C37+P41-C4+P43
00000 A(2,10)=P34+P41+P35+P42
00000 A(2,11)=P22+P41+P26+P42
00000 A(2,12)=C38+P41+C4+P42
00000 A(3,10)=P34+P43-P33+P42
00000 A(3,11)=P22+P43-P23+P42
00000 A(3,12)=C37+P42+C38+P43
00000 A(4,10)=P43
00000 YA(4)=-P37+P40+P14+C43+C32+C44+P16+C45-C53+C25-P12+C54-C52+C40
00000 A(5,10)=P42
00000 YA(5)=-P38+P40+P13+C33-C30+C44+P15+C45-C24+C53+P11+C54+C52+C41
00000 A(6,10)=-P41

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00000 YA(6)=-C39-P39+P40+P4+C44+C22+P1+C45+C52+C23
00000 A(7,8)=P28
00000 A(7,9)=-C22+P29-C23+P26
00000 YA(7)=-P29+C46-P28+C22+C47+(P26+C22-P29+C23)*C46
00000 A(11,10)=P7*XLX0-P8*XLY0
00000 YA(11)=0.0
00000 A(12,10)=P6*XLX0+P8*XLZ0
00000 YA(12)=C12*XLX0
00000 470 P9=C24+C20-C27+C19
00000 P10=C25+C20+C28+C19
00000 P17=C22+C19
00000 480 P30=P24+C25+P25+C24
00000 P44=P25+C25-P24+C24
00000 P45=C23+C20
00000 P46=C23+C19
00000 P47=RAX1-RX0
00000 P48=RAY1-RY0
00000 P49=RAZ1-RZ0
00000 P53=C3+(P7+C6+P8+C5)
00000 P54=C4+P17+C3+(P9+C5-P10+C6)
00000 A(7,7)=-P53
00000 A(7,8)=-P31+C20
00000 A(7,9)=-P54
00000 YA(7)=C43+C3+(P6+C6-P7+C5)-C44+P32+C20+C45+((P6+C6-P7+C5)*C3+P6+C4
00000 1)+2*(C46+P6+C3+C17+C47+C3+(P9+C6+P10+C5)-C48+P31+C19)
00000 A(8,1)=P8
00000 A(8,2)=P7
00000 A(8,3)=-P6
00000 A(8,7)=P61
00000 A(8,8)=-P62
00000 A(8,9)=-P63
00000 YA(8)=-C43*(P6+P55+P7+P56)+C44*(P45+P60+P6+P57)-C45*(P8+P55+P7+P5
00000 16-P6+P57)-2*((VAX-RXD0)*(PSD0+P7+PHD0+P6+C24-THD0+P10)-(VAY-RYD0)
00000 2*(PSD0+P6+PHD0+P6+C25+THD0+P9)-(VAZ-RZD0)*(PHD0+P45+THD0+P17)+C46=
00000 3P6*(P55+C25+P56+C24)+C47*(P9+P55-P10+P56)-C48*(P17+P60-P46+P57)
00000 670 A(9,10)=XM2
00000 A(9,11)=-1.
00000 GO TO 500
00000 500 CALL SIMEQ(A,YA,B,K)
00000 ISTEP=-ISTEP
00000 IF(ISTEP)310,900,350
00000 310 IP=IP+1
00000 IF(.P-IP)210,220,220
00000 220 X=RX0+VX*IT
00000 Y=RY0+VY*IT
00000 Z=RZ0+VZ*IT
00000 XP=X+XLX0+P14
00000 YP=Y+XLY0+P13
00000 ZP=Z+XLZ0+P4
00000 XD=RXD0+VX
00000 YD=RYD0+VY
00000 ZD=RZD0+VZ
00000 TC=SQRT((XSM+XSM*(B(X)*B(1)+B(2)+B(2)+B(3)-32.16)*(B(3)-32.16))+B
00000 1(10)+B(10)+2.*XSM*B(10)*(B(1)*P8+B(2)*P7-(B(3)-32.16)*P6))
00000 PRINT 20,TD,X,Y,Z,XD,YD,ZD,XP,YP,ZP,PSG,PHO,THO,(B(1),I=1,9)

```

11  
INC



```

00000 20 FORMAT(///4F20.8/ (20X,3F20.8 ))
00000 PRINT 41,TC
00000 41 FORMAT(20X,F20.8)
00000 IP=0
00000 21 PRINT22,(B(I),I=10,12)
00000 22 FORMAT(20X,3F20.8/)
00000 210 GO TO 213
00000 213 IF(B(10))215,215,214
00000 214 C59=B(12)/B(10)
00000 C60=P10*P47*P9*P48*P17*P49*(P10*P23+P9*P22+P17*P26)*XN2*(P17*P27-P
00000 110*P24-P9*P25)*XN+P54*C59
00000 IF(C60-XLC-D)350,215,215
00000 215 PRINT40,T0
00000 40 FORMAT(///F20.8,20H END OF TIPOFF PHASE)
00000 K=K-3
00000 DELT0=DELTO3
00000 DELT2=DELTO/2.
00000 DET2=DELTO
00000 ISTEP=1
00000 IPI=XIPI3
00000 IP=IPI
00000 C PHASE III INPUT TAPE
00000 WRITE TAPE 1, DATA
00000 WRITE TAPE 1, XKLA, XKD0, XKDA, PH0, PHD0, R200, R20
00000 WRITE TAPE 1, (TCHUTE(I), DRI(I), XLI(I), XLDI(I), XLODI(I), I=1, NTBLE)
00000 WRITE TAPE 1, (DRDOI(I), CDRAI(I), I=1, NDRD0)
00000 GO TO 900
00000 350 RXD0=VELOCF(RXD1,B(1))
00000 RYD0=VELOCF(RYD1,B(2))
00000 XLZD0=VELOCF(XLZD1,B(6))
00000 XLYD0=VELOCF(XLYD1,B(5))
00000 PSD0=VELOCF(PSD1,B(7))
00000 RX0=DISPLF(RX1,RXD1,RXD0)
00000 RY0=DISPLF(RY1,RYD1,RYD0)
00000 XLZ0=DISPLF(XLZ1,XLZD1,XLZD0)
00000 XLY0=DISPLF(XLY1,XLYD1,XLYD0)
00000 PSD0=DISPLF(PS1,PSD1,PSD0)
00000 THD0=VELOCF(THD1,B(9))
00000 TH0=DISPLF(TH1,THD1,THD0)
00000 360 T0=T0+DELT2
00000 DET2=DELTO
00000 IF(ISTEP)300,900,200
00000 900 STOP
00000 END

```



```

00000 C GROUND SLIDE AIR DROP SYSTEM DESCENT PHASE
00000 VELOCF(DA,DB)=DA*DB*DET2
00000 COMMON CN,DELT2,PSQ,PSDQ,RXQ,RYQ,RXDQ,RYDQ,XLYDQ,XLZDQ,XLZO,
00000 1XLYQ,THDQ,THQ,C16,TQ,T,RAXQ,VAX,RATQ,VAY,RAZQ,VAZ,C13,P24,C24,C3,C
00000 24,C6,C5,C37,C38,XHQ,P23,P22,XM,P24,P25,P27,F,X2-C,XQ,XJ1,NTBLE,DIA
00000 3MO,MORDQ,CKF,XLM,XJYY,C49,XJ3,XJXX,C50,XJ2,XJZZ,C51,X8M,C39,C12,K,
00000 4ISTEP,IP,[PI,VX,VY,YZ,XLC,D,DELTO3,XIP!3,DELTO ,ZDTEST
00000 EQUIVALENCE (DATA(1),CN)
00000 DIMENSION DATA(73)
00000 DISPLF(DA,DB,DC)=DA+(DB+DC)*DET2/2.
00000 DIMENSION A(12,12),YA(12),B(12)
00000 DIMENSION TCHUTE(12),DRI(12),XLI(12),XLDI(12),XLDDI(12)
00000 DIMENSION DRDDI(15),CORATI(15)
00000 C IF SJ1 IS ON, CASE NUMBER IS READ FROM CARD AND DATA ON PAPER
00000 C TAPE IS SEARCHED UNTIL THIS CASE NUMBER IS FOUND
00000 C IF SJ1 IS OFF, THE FIRST SET OF DATA ON THE TAPE IS USED
00000 IF(SENSE SWITCH 1)7000,7100
00000 7000 READ 8000,CCM
00000 8000 FORMAT(F10.0)
00000 7100 READ TAPE 1,DATA
00000 READ TAPE 1 ,XKLA,XKDB,XKDA,PHQ,PHDQ,RZDQ,RZQ
00000 READ TAPE 1,(TCHUTE(I),DRI(I),XLI(I),XLDI(I),XLDDI(I),I=1,NTBLE)
00000 READ TAPE 1,(DRDDI(I),CORATI(I),I=1,MORDQ)
00000 IF(SENSE SWITCH 1)7200,8002
00000 7200 IF(CCM-CN)7100,8002,7100
00000 8002 PRINT4,CN
00000 4 FORMAT(12H1CASE NUMBER,F7.4/14H DESCENT PHASE)
00000 C
00000 NZ= 1
00000 DO 80 ITBLE= 2,NTBLE
00000 IF(TCHUTE(ITBLE)-TQ) 80,81,81
00000 80 CONTINUE
00000 81 TFRAC=(TQ-TCHUTE(ITBLE-1))/(TCHUTE(ITBLE)-TCHUTE(ITBLE-1))
00000 XL=XLI(ITBLE-1)+(XLI(ITBLE)-XLI(ITBLE-1))*TFRAC
00000 XLD=XLDI(ITBLE-1)+(XLDI(ITBLE)-XLDI(ITBLE-1))*TFRAC
00000 XLXQ=-SORTF(XL*XL-XLYQ*XLYQ-XLZQ*XLZQ)
00000 XLXDQ=(XL*XLD-XLYQ*XLYDQ-XLZQ*XLZDQ)/XLXQ
00000 C
00000 200 DET2=DELT2
00000 PS1=PSQ
00000 PSD1=PSDQ
00000 RX1=RXQ
00000 RY1=RYQ
00000 RXD1=RXDQ
00000 RYD1=RYDQ
00000 XLYD1=XLYDQ
00000 XLZD1=XLZDQ
00000 C
00000 XLXD1= XLXDQ
00000 C
00000 XLZ1=XLZQ
00000 XLY1=XLYQ
00000 C
00000 XLX1=XLXQ

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```
00000 C
00000 280 TH1=TH0
00000 THD1=THD0
00000 RZD1=RZD0
00000 RZ1=RZ0
00000 290 PHD1=PHD0
00000 PH1=PH0
00000 300 TT=TG-T
00000 RAX1=RAX0+VAX*TT
00000 RAY1=RAY0+VAY*TT
00000 RAZ1=RAZ0+VAZ*TT
00000 DO 410 I=1,12
00000 YA(I)=0.
00000 B(I)=0.
00000 DO 410 J=1,12
00000 410 A(I,J)=0.
00000 A(4,1)=C13
00000 A(4,4)=1.
00000 A(5,2)=C13
00000 A(5,5)=1.
00000 A(6,3)=C13
00000 A(6,6)=1.
00000 450 C16=C20-PS0
00000 C17=SINF(C16)
00000 C18=COSF(C16)
00000 457 C19=SINF(TH0)
00000 C20=COSF(TH0)
00000 C21=C19/C20
00000 C22=COSF(PH0)
00000 C23=SINF(PH0)
00000 C24=SINF(PS0)
00000 C25=COSF(PS0)
00000 C27=C25*C23
00000 C28=C24+C23
00000 458 P1=XA*C19+C*C20
00000 P2=XA*C20-C*C19
00000 P3=P1*C23
00000 P4=P1*C22+XB*C23
00000 P5=P3-XB*C22
00000 C29=P2*C24
00000 C30=P5*C25
00000 C31=P2*C25
00000 C32=P5*C24
00000 C33=2.*P4
00000 C40=C24*C22
00000 C41=C25*C22
00000 C42=P2*P2
00000 C43=PSD0*PSD0
00000 C44=PHD0*PHD0
00000 C45=THD0*THD0
00000 C46=PHD0*PSD0
00000 C47=PSD0*THD0
00000 C48=PHD0*THD0
00000 C52=2.*P2*C48
00000 C53=C33*C46
```



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00000 C54=2.*C47
00000 P7=C24*C19+C27*C20
00000 P8=C25*C19-C28*C20
00000 P11=P1*C25-P2*C28
00000 P12=P1*C24+P2*C27
00000 P13=C29-C30
00000 P14=C31+C32
00000 P15=C29-P3*C25
00000 P16=C31+P3*C24
00000 P18=P1*P1*X8*X8
00000 P19=(XA*XA+C*C)*C22
00000 P20=P19+P3*X8
00000 P21=C33*P4*XJ1
00000 DO 3010 I:BLE=2,NTBLE
00000 IF(TCHUTE(ITBLE)-T0)3010,3011,3011
00000 3010 CONTINUE
00000 3011 TFRAC=(T0-TCHUTE(ITBLE-1))/(TCHUTE(ITBLE)-TCHUTE(ITBLE-1))
00000 DR=DRI(ITBLE-1)+(DRI(ITBLE)-DRI(ITBLE-1))*TFRAC
00000 DRD0=DR/DIAM0
00000 XL=XL1(ITBLE-1)+(XL1(ITBLE)-XL1(ITBLE-1))*TFRAC
00000 XLD=XLD1(ITBLE-1)+(XLD1(ITBLE)-XLD1(ITBLE-1))*TFRAC
00000 XLDD=XLDD1(ITBLE-1)+(XLDD1(ITBLE)-XLDD1(ITBLE-1))*TFRAC
00000 C
00000 GO TO (1,2) NZ
00000 1 XLX2= -SORTF(XL*XL-XLY0*XLY0-XLZ0*XLZ0)
00000 IF(XLX2*1.)11,12,12
00000 11 XLX0= XLX2
00000 XLXD0= (XL*XLD-XLY0*XLYD0-XLZ0*XLZD0)/XLX0
00000 GO TO 3
00000 12 NZ= 2
00000 XLXD0= VELOCF(XLXD1,B(4))
00000 XLX0= DISPLF(XLX1,XLXD1,XLXD0)
00000 2 XLZ0= SORTF(XL*XL-XLY0*XLY0-XLZ0*XLZ0)
00000 XLZD0= (XL*XLD-XLY0*XLYD0-XLZ0*XLZD0)/XLX0
00000 3 P37= RXD0+XLYD0-P13*PSD0+P4*C24*PHD0-P11*THD0
00000 C
00000 P38=RYD0+XLYD0+P14*PSD0+P4*C25*PHD0-P12*THD0
00000 P39=RZD0+XLZD0+P5*PHD0+P2*C22*THD0
00000 DO 4010 IDR0=2,NDR0
00000 IF(DRD01(IDR0)-DRD0)4010,4011,4011
00000 4010 CONTINUE
00000 4011 CDRAT=CDRAT1(IDR0-1)+(CDRAT1(IDR0)-CDRAT1(IDR0-1))*(DRD0-DRD01(
00000 1>IDR0-1))/(DRD01(IDR0)-DRD01(IDR0-1))
00000 XKF=CKF*CDRAT
00000 P40=XKF/SLM*SORTF(P37*P37+P38*P38+P39*P39)
00000 A(1,1)=-P4
00000 A(1,3)=P14
00000 A(1,4)=-P4
00000 A(1,6)=P14
00000 A(1,7)=P4*P1
00000 A(1,8)=-C31*P5-C24*(XJYY+P18)
00000 A(1,9)=C25*(P20+C22*(XJYY))-C24*P2*X8
00000 YA(1)=-P14*32.16*P40*(P4*P37-P14*P39)-P4*P14*C43*C31*P4*C44-(P12*X
00000 18+C28*C22*C49)*C45+C25*P21*C46*(C40*XJ1+C33*P12)*C47*C52*P12-C27*X
00000 2J39C48

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000000 A(2,2)=P4
000000 A(2,3)=-P13
000000 A(2,5)=P4
000000 A(2,6)=-P13
000000 A(2,7)=P4+P14
000000 A(2,8)=P2+C32-C25+(P18+XJXX)
000000 A(2,9)=-C31+XB-P20+C24-C40+XJXX
000000 YA(2)=P13+32.16+P40+(P13+P39-P4+P38)+P4+P13+C43-C29+P4+C44-(P11+XB
000000 1+C27+C22+C50)+C45-C24+P21+C46+(C33+P11+C41+XJ1)+C47+C52+P11-C28+XJ
000000 22+C48
000000 A(3,1)=P13
000000 A(3,2)=-P14
000000 A(3,4)=P13
000000 A(3,5)=-P14
000000 A(3,7)=-C42-P5+P5-XJZZ
000000 A(3,8)=P2+P4
000000 A(3,9)=P1+P5+C23+(XJZZ+C42)
000000 YA(3)=P40+(P14+P38-P13+P37)+(P2+P5-C24+C25+C51)+C44+C22+(P2+XB+C40
000000 1+C25+C51)+C45+C53+P5-C54+P2+P4+C22+C22+C48+(COSF(2.+P80)+C51-XJZZ-
000000 22.C42)
000000 A(4,7)=-P13
000000 A(4,8)=P4+C24
000000 A(4,9)=-P11
000000 A(5,7)=P14
000000 A(5,8)=-P4+C25
000000 A(5,9)=-P12
000000 A(6,8)=-P5
000000 A(6,9)=P2+C22
000000 A( 7,4)=XLX0
000000 A( 7,5)=XLY0
000000 A( 7,6)=XLZ0
000000 YA( 7)=XL+XLDD- XLXD0+XLXD0-XLYD0+XLYD0-XLZD0+XLZD0+XLD+XLD
000000 A( 8,2)=XSM+XLZ0
000000 A( 8,3)=-XSM+XLY0
000000 A( 9,1)=A( 8,2)
000000 A( 9,3)=-XSM+XLX0
000000 470 P9=C24+C20-C27+C19
000000 P10=C25+C20+C28+C19
000000 P17=C22+C19
000000 P36=RXD0+RXD0+RYD0+RYD0+RZD0+RZD0
000000 C56=SQRTF(P36)
000000 C57=(P10+RXD0+P9+RYD0+P17+RZD0)/C56
000000 C58=SQRTF(1.-C57+C57)
000000 ALPHA=ACOSF(C57/SQRTF(C57+C57+C58+C58))
000000 IF(C58)9000,9001,9001
000000 9000 ALPHA=-ALPHA
000000 9001 XKL=XKLA+ALPHA
000000 XKD=XKD0+XKDA+ALPHA+ALPHA
000000 YA(4)=-((XKD+P10+XKL+P8)+P36/XLM-P37+P40+P14+C43+C32+C44+P16+C45-C5
000000 13+C25-P12+C54-C52+C40
000000 YA(5)=-((XKD+P9+XKL+P7)+P36/XLM-P38+P40+P13+C43-C30+C44+P15+C45-C24
000000 1+C53+P11+C54+C52+C41
000000 YA(6)=-((XKD+C19+XKL+C20)+P36+C22/XLM-C39-P39+P40 P4+C44+C22+P1+C45
000000 1+C52+C23
000000 YA(8)=P36+(XLY0+C22+(XKD+C19+XKL+C20)-XLZ0+(XKD+P9+XKL+P7))+C12+XL

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00000      1Y0
00000      YA(9)=P36*(XLX0*C22*(XKD*C19-XKL*C20)-XLZ0*(XKQ*P10+XKL*P8))+C12*X
00000      1LX0
00000      500 CALL SIMEO(A,YA,B,K)
00000      ISTEP=-ISTEP
00000      IF(ISTEP)310,900,350
00000      310 IP=IP+1
00000      IF(IP-IP1)210,220,220
00000      210 GO TO 216
00000      220 X=RX0+VX*IT
00000      Y=RY0+VY*IT
00000      Z=RZ0+VZ*IT
00000      XP=X+XLXG*P14
00000      YP=Y+XLY0*P13
00000      ZP=Z+XLZ0*P4
00000      XD=RX00+VX
00000      YD=RY00+VY
00000      ZD=RZ00+VZ
00000      TC=SQRT((XSM*XSM*(B(1)*B(1)+B(2)*B(2)+(B(3)-32.16)*(B(3)-32.16)))+(
00000      1XKL*XKL+XKD*XKD)*P36*P36+2.*XSM*P36*(B(1)*(XKL*P8-XKD*P10)+B(2)*(X
00000      2KL*P7-XKD*P9)-(B(3)-32.16)*(XKL*P8+XKD*P17)))
00000      PRINT 20,T0,X,Y,Z,XD,YD,ZD,XP,YP,ZP,PS0,PH0,TH0,(B(1),I=1,9)
00000      PRINT 21,TC
00000      20 FORMAT(///4F20.8/ (20X,3F20.8 ))
00000      21 FORMAT(20X,F20.8)
00000      IP=0
00000      IF(Z-ZDTEST)901,901,350
00000      901 PRINT 50,T0
00000      GO TO 900
00000      216 ZD=RZ00+VZ
00000      IF(Z-ZDTEST)217,217,350
00000      217 PRINT 50,T0
00000      50 FORMAT(///F20.8,21H END OF DESCENT PHASE)
00000      GO TO 220
00000      350 RXD0=VELOCF(RXD1,B(1))
00000      RYD0=VELOCF(RYD1,B(2))
00000      XLYD0=VELOCF(XLYD1,B(5))
00000      PSD0=VELOCF(PSD1,B(7))
00000      RX0=DISPLF(RX1,RXD1,RXD0)
00000      RY0=DISPLF(RY1,RYD1,RYD0)
00000      XLY0=DISPLF(XLY1,XLYD1,XLYD0)
00000      PS0=DISPLF(PS1,PSD1,PSD0)
00000      360 PHD0=VELOCF(PHD1,B(8))
00000      PH0=DISPLF(PH1,PHD1,PHD0)
00000      370 THD0=VELOCF(THD1,B(9))
00000      TH0=DISPLF(TH1,THD1,THD0)
00000      RZD0=VELOCF(RZD1,B(3))
00000      RZ0=DISPLF(RZ1,RZD1,RZD0)
00000      C
00000      GO TO (13,14) NZ
00000      13 XLZD0=VELOCF(XLZD1,B(6))
00000      XLZ0=DISPLF(XLZ1,XLZD1,XLZD0)
00000      GO TO 380
00000      14 XLXD0=VELOCF(XLXD1,B(4))
00000      XLX0=DISPLF(XLX1,XLXD1,XLXD0)

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```
00000 C
00000 300 T0=T0+DELTA
00000      DELTA=DELTA
00000      IF(ISTEP)300,900,200
00000 900 STOP
00000      END
```



```

00000 *
00000 C   GROUND SLIDE AIRDROP SYSTEM  IMPACT PHASE
00000      VELOCF(DA,DE)=DA+DB*DET2
00000      DISPLF(DA,DE,DC)=DA+(DB*DC)*DET2/2.
00000      COMMON      TO,DELTO,XS,XSD,TH0,THD0,XLX0,XLXD0,VX,VZ,ALT,XK1,XK3,
00000      IXA,XC,D,F,XLC,XIYY,XKF,XSM,XLM,CN,THMAX,DCHUTE,XMU,XL,F1,XIPI,ZD0
00000      2,XDD
00000      EQUIVALENCE (DATA(1),T0)
00000      DIMENSION A(8,8),YA(1),R(8)
00000      DIMENSION DATA(31)
00000      READ 10,DATA
00000      10 FORMAT(8F10,3)
00000      PRINT20,CN
00000      20 FORMAT(12H1CASE NUMBER: F7.4/7H IMPACT)
00000      PRINT 30,DATA
00000      30 FORMAT(/6H INPUT/(8F10.3/))
00000      IS(TH0)50,260,40
00000      40 DX=-XLC*D
00000      GO TO 44
00000      50 DX=XLC*D
00000      44 IK=1
00000      45 DELT2=DELTO/2.
00000      IP1=XIPI
00000      IP=IP1
00000      ISTEP=1
00000      55 ASSIGN 63 TO ICHECK
00000      ASSIGN 65 TO ISKIP
00000      ASSIGN 71 TO IOO
00000      60 C1= SINF(TH0)
00000      C2= COSF(TH0)
00000      P1= XA*C1+XC*C2
00000      P2= XA*C2-XC*C1
00000      P3= XK1*C1+XK3*C2
00000      P4= XK1*C2-XK3*C1
00000      P5= DX*C1-F*C2
00000      P6= DX*C2-F*C1
00000      GO TO ICHECK
00000      63 XLZ0= SORTF(XI,XL-XLX0*XLX0)
00000      XLZ00= -XLX0*XLXD0/XLZ0
00000      Z0= ALT-P5
00000      Z00= -P6*THD0
00000      GO TO ISKIP
00000      64 XD= XEA+P6EA-P6
00000      XD0= P5*THD0
00000      65 P7= XD0+XLXD0-F1*THD0-VX
00000      P8= Z00+XLZ00+P2*THD0-VZ
00000      P9= XKF*SORTF(P7*P7+P8*P8)/XLM
00000      P10= P7*P9-P2*THD0*THD0
00000      P11= P8*P9-P1*THD0*THD0*17.10
00000      DO 70 I=1,8
00000      YA(I)= 0.0
00000      DO 70 J=1,8
00000      70 A(I,J)= 0.0
00000      A(1,1)=XSM * XLM

```



```
00000 A(1,2)= XLM
00000 GO TO 100
00000 71 A(1,5)=-XLM * P1
00000 A(1,6)= XHU
00000 YA(1)= -F1-XLM*P10
00000 A(2,3)= XSM * XLM
00000 A(2,4)= XLM
00000 A(2,5)= XLM * P2
00000 A(2,6)= -1.0
00000 YA(2)= -XSM*J2.16-XLM*P11
00000 A(3,1)=P1
00000 A(3,2)= P1
00000 A(3,3)= -P2
00000 A(3,4)= -P2
00000 A(3,5)= -(X1Y1/XLM+P1*P1+P2*P2)
00000 A(3,6)= (P3+XHU*P5)/XLM
00000 YA(3)= P2*P11-P1*P10-F1*P3/XLM
00000 A(4,1)= XLZ0
00000 A(4,2)= XLZ0
00000 A(4,3)=-XLX0
00000 A(4,4)= -XLX0
00000 A(4,5)= -P1*XLZ0-P2*XLX0
00000 YA(4)= P11*XLX0- X*XLZ0
00000 A(5,2)= XLX0
00000 A(5,4)= XLZ0
00000 YA(5)= -(XLX00*XLX00+XLZ00*XLZ00)
00000 A(6,3)= 1.0
00000 A(6,5)= P6
00000 YA(6)= P5*THD0+THD0
00000 IF(ISTEP)320,900,310
00000 310 DET2=DELT2
00000 X1=X0
00000 XD1=XD0
00000 XLX1=XLX0
00000 XLXD1=XLXD0
00000 TH1=TH0
00000 THD1=THD0
00000 K=6
00000 J=K+1
00000 320 CALL SIMEQ(A,YA,B,K)
00000 ISTEP=-ISTEP
00000 IF(ISTEP)100,900,170
00000 80 IP=IP+1
00000 IF(IP-IP1)120,100,100
00000 100 PRINT110,10,X0,Z0,TH0,XD0,ZD,J,THD0,XLX0,XLZ0,(B(I),I=1,6)
00000 110 FORMAT(//4F20.8/(20X,3F20.8))
00000 IP=0
00000 120 IF(XD0-P3*THD0)220,220,130
00000 130 IF(TH0MAX+TH0MAX-TH0*TH0)140,100,140
00000 140 IF(IK-2)141,150,141
00000 141 IF((ALT-F)*(ALT-F)-Z0*Z0)240,240,150
00000 150 IF((ALT-Z0-XLZ0-P1)*(ALT-Z0-XLZ0-P1)-DCHUTE*DCHUTE/9.)200,200,170
00000 170 TH00=VELOCF(THD1,8(5))
00000 TH0=DISPLF(TH1,THD1,THD0)
00000 9170 XD0=VELOCF(XD1,8(1))
```



```
00000      XLX09=VELOC(XLXD1,8(2))
00000      X0=DISPLF(X1,XD1,XD0)
00000      XLXC=DISPLF(XLX1,XLD1,XLD0)
00000      T0=T0-DELT2
00000      DET2=DELT0
00000      IK=0
00000      GO TO 55
00000      180 PRINT190,T0
00000      190 FORMAT(/F20.8,25H CARGO LIKELY TO TURN OVER)
00000      200 STOP
00000      260 PRINT210,T0
00000      210 FORMAT(/F20.8,48H CHUTE IN CONTACT WITH GROUND,IMPACT EDGE MOVING)
00000      GO TO 260
00000      220 PRINT230,T0
00000      230 FORMAT(/F20.8,31H IMPACT EDGE HAS STOPPED MOVING)
00000      GO TO 290
00000      240 IF(DX)250,909,260
00000      250 TH0=0.
00000      IK=2
00000      DX=XLC*D
00000      THD0=-(.3*ZD0/DX)
00000      GO TO 9170
00000      260 PRINT270,T0
00000      270 FORMAT(/F20.8,23H STABLE SURFACE CONTACT)
00000      GO TO 300
00000      260 IP=IP1
00000      ISTEP=1
00000      330 DET2=DELT2
00000      X1=X0
00000      XD1=XD0
00000      XLX1=XLX0
00000      XLXD1=XLXD0
00000      TH1=TH0
00000      THD1=THD0
00000      335 ASSIGN 63 TO ICHECK
00000      ASSIGN 65 TO ISKIP
00000      ASSIGN 72 TO IQ0
00000      GO TO 60
00000      72  A(1,5)= -P1 * XLM
00000      A(1,6)= XMU
00000      YA(1)= -F1-P10*XLM
00000      A(2,3)= XSM + XLM
00000      A(2,4)= XLM
00000      A(2,5)= P2 * XLM
00000      A(2,6)= -1.0
00000      A(2,7)= -1.0
00000      YA(2)= -J2.16*XSM-P11*XLM
00000      A(3,1)= P1
00000      A(3,2)= P1
00000      A(3,3)= -P2
00000      A(3,4)= -P2
00000      A(3,5)= -(X1YY/XLM+P1*P1+P2*P2)
00000      A(3,6)= (P6+P5*XMU)/XLM
00000      A(3,7)= P2/XLM
00000      YA(3)= P2*P11-P1*P10-F1*P3/XLM
```



```

00000      A(4,1)= XLZ0
00000      A(4,2)= XLZ0
00000      A(4,3)= -XLX0
00000      A(4,4)= - XLX0
00000      A(4,5)= -(P1*XLZ0+P2*XLX0)
00000      A(4,7)= XLX0/XLM
00000      YA(4)= P11*XLX0-P10*XLZ0
00000      A(5,2)= XLX0
00000      A(5,4)= XLZ0
00000      YA(5)= -(XLXD0*XLXD0+XLZD0*XLZD0)
00000      A(6,3)= 1.0
00000      A(6,5)= P6
00000      YA(6)= P5*THD0*THD0
00000      A(7,3)= 1.0
00000      A(7,4)= 1.0
00000      A(7,5)= P2
00000      YA(7)= P1*THD0*THD0
00000      K=7
00000      J=K+1
00000      CALL SIMEQ(A,YA,B,K)
00000      ISTEP=-ISTEP
00000      IF(ISTEP)360,900,435
00000      360 IP=IP+1
00000      IF(IP-IP1)390,370,370
00000      376 PRINT110,T0,X0,Z0,TH0,XD0,ZD0,THD0,XLX0,XLZ0,(B(I),I=1,7)
00000      IP=0
00000      390 IF(XD0-P5*THD0)420,400,410
00000      410 IF((K-2)411,430,411
00000      411 IF((ALT-F)*(ALT-F)-Z0*Z0)420,420,430
00000      430 IF(THD0MAX*THD0MAX-THD0*THD0)160,160,435
00000      435 THD0=VELOC(F(THD1,B(5)))
00000      TH0=DISPL(F(TH1,THD1,THD0))
00000      9435 XD0=VELOC(F(XD1,B(1)))
00000      XLXD0=VELOC(F(XLXD1,B(2)))
00000      X0=DISPL(F(X1,XD1,XD0))
00000      XLX0=DISPL(F(XLX1,XLXD1,XLXD0))
00000      T0=T3+DEL12
00000      DET2=DEL10
00000      IK=0
00000      IF(ISTEP)335,900,330
00000      420 IF(DX)350,900,570
00000      560 TH0=0.
00000      IK=2
00000      DX=XLC+D
00000      THD0=-(.3*Z00/DX)
00000      GO TO 9435
00000      290 XEA=X0
00000      P6EA=P6
00000      450 IP=IP1
00000      ISTEP=1
00000      460 DET2=DEL12
00000      XLX1=XLX0
00000      XLXD1=XLXD0
00000      TH1=TH0
00000      THD1=THD0

```



```
00000 465 ASSIGN 63 TO ICHECK
00000 ASSIGN 64 TO ISKIP
00000 ASSIGN 73 TO IGO
00000 GO TO 60
00000 73 A(1,5) = -P1 * XLM
00000 A(1,7) = 1.0
00000 YA(1) = -F1-P10*XLM
00000 A(2,3) = XSM + XLM
00000 A(2,4) = XLM
00000 A(2,5) = P2 * XLM
00000 A(2,6) = -1.0
00000 YA(2) = -XSM*32.16-P11*XLM
00000 A(3,1) = P1
00000 A(3,2) = P1
00000 A(3,3) = -P2
00000 A(3,4) = -P2
00000 A(3,5) = -(P1*P1+P2*P2*X1YY/XLM)
00000 A(3,6) = P6/XLM
00000 A(3,7) = P5/XLM
00000 YA(3) = P2*P11-P1*P10-F1*P3/XLM
00000 A(4,1) = XLZ0
00000 A(4,2) = XLZ0
00000 A(4,3) = -XLX0
00000 A(4,4) = -XLX0
00000 A(4,5) = -(P1*XLZ0+P2*XLX0)
00000 YA(4) = P11*XLX0-P10*XLZ0
00000 A(5,2) = XLX0
00000 A(5,4) = XLZ0
00000 YA(5) = -(XLX00*XLX00+XLZ00*XLZ00)
00000 A(6,3) = 1.0
00000 A(6,5) = P6
00000 YA(6) = P5*THD0+THD0
00000 A(7,1) = 1.0
00000 A(7,5) = -P5
00000 YA(7) = P6*THD0+THD0
00000 K=7
00000 J=K+1
00000 CALL SIMEQ(A,YA,B,K)
00000 ISTEP=ISTEP
00000 IF(ISTEP) < 90,900,535
00000 490 IP=IP+1
00000 IF(IP-IP1) 520,500,500
00000 500 PRINT I10, I0, X0, Z0, TH0, X00, Z00, TH00, XLX0, XLZ0, (B(I), I=1,7)
00000 IP=0
00000 IF(IK-2) 520,530,520
00000 520 IF((ALT-F)*(ALT-F)-Z0*Z0,540,540,525
00000 525 I ((ALT-Z0-XLZ0-P1)*(ALT-Z0-XLZ0-P1)-DCHUTE*DCHUTE/9, ) 400,400,530
00000 530 IF(TH0MAX+TH0MAX-TH0*TH0) 100,100,535
00000 535 TH00=VELDCF(TH01,815)
00000 TH0=DISPLF(TH1,TH01,TH00)
00000 9535 XLX00=VELDCF(XLX01,812)
00000 XLX0=DISPLF(XLX1,XLX01,XLX00)
00000 I0=I0+DELT2
00000 DCF2=DELTO
00000 IK=0
```



```
00000 IF(!STEP)465,900,460
00000 540 IF(DX)550,400,260
00000 550 XEA=X0+XLC*2.
00000 *P6EA=DX*C2-F*C1
00000 TH0=0.
00000 IK=2
00000 DX=XLC*D
00000 THD0= (.3*ZD0/DX)
00000 GO TO 0535
00000 400 PRI' 580,TD
00000 580 FORMAT1/F20.8,484 CHUTE IN CONTACT WITH GROUND,(IMPACT PT. STOPPED)
00000 XEA=X0
00000 P6EA=P6
00000 590 IP=IPI
00000 ISTEP=1
00000 600 DET2=DELTA2
00000 XLX1=XLX0
00000 XLX01=XLX00
00000 TH1=TH0
00000 THD1=THD0
00000 605 ASSIGN 63 TO ICHECK
00000 ASSIGN 61 TO ISKIP
00000 ASSIGN 74 TO IGG
00000 GO TO 60
00000 74 A(1,5)= -P1 * XLM
00000 A(1,7)= 1.0
00000 YA(1)= -F1-P10*XLM
00000 A(2,3)= XSM * XLM
00000 A(2,4)= XLM
00000 A(2,5)= P2 * XLM
00000 A(2,6)= -1.0
00000 A(2,8)= -1.0
00000 YA(2)= -32.16*XSM-P11*XLM
00000 A(3,1)= P1
00000 A(3,2)= P1
00000 A(3,3)= -P2
00000 A(3,4)= -P2
00000 A(3,5)= -(P2*P2+P1*P1+X1Y1/XLM)
00000 A(3,6)= P6/XLM
00000 A(3,7)= P5/XLM
00000 A(3,8)= P2/XLM
00000 YA(3)= P2*P11-F1*P10*F1*P3/XLM
00000 A(4,1)= XLZ0
00000 A(4,2)= XLZ0
00000 A(4,3)= -XLX0
00000 A(4,4)= -XLX0
00000 A(4,5)= -(P1*XLZ0+P2*XLX0)
00000 A(4,6)= XLX0/XLM
00000 YA(4)= P11*XLX0-P10*XLZ0
00000 A(5,2)= XLX0
00000 A(5,4)= XLZ0
00000 YA(5)= -(XLX00+XLX00+XLZ00+XLZ00)
00000 A(6,3)= 1.0
00000 A(6,5)= P6
00000 YA(6)= P5*THD0+THD0
```





```
00000 A(7,3)= 1.0
00000 A(7,4)= 1.0
00000 A(7,5)= P2
00000 YA(7)= P1*THD0*THD0
00000 I(8,1)= 1.0
00000 A(8,5)= -P5
00000 YA(8)= P6*THD0*THD0
00000 K=8
00000 J=K+1
00000 CALL SIMEQ(A,YA,B,')
00000 ISTEP=-ISTEP
00000 IF(ISTEP)630,900,700
00000 630 IP=IP+1
00000 IF(IP-IP1)660,640,640
00000 640 PRINT110,T0,X0,Z0,TH0,XD0,ZD0,THD0,XLX0,XLZ0,(B(I),I=1,8)
00000 IP=J
00000 660 IF(T-OMAX*THOMAX-THD*TH0)180,180,670
00000 670 IF((K-2)671,700,671
00000 671 IF((ALT-F)*(ALT-F)-Z0*Z0)680,680,780
00000 680 IF(DX)690,900,570
00000 690 THD=0.
00000 IK=2
00000 DX=XLC+D
00000 THD3=-(.3*ZD0/DX)
00000 IK=J
00000 GO TO 9700
00000 700 THD0=VELOC(F(THD1,B(5)))
00000 TH0=DISPL(F(TH1,THD1,THD0))
00000 9700 XLXD0=VELOC(F(XLXD1,B(2)))
00000 XLX0=DISPL(F(XLX1,XLXD1,XLXD0))
00000 T0=T0+DEL T2
00000 DET2=DEL T0
00000 IF(ISTEP)605,900,600
00000 300 IP=IP+1
00000 ISTEP=1
00000 710 DET2=DEL T2
00000 X1=X0
00000 XLX1=XLX0
00000 XD1=XD0
00000 XLXD1=XLXD0
00000 715 P12=XD0+XLXD0-VX
00000 P13=XLZD0-VZ
00000 P14=XKF*SQRTF(P12*P12+P13*P13)/XLM
00000 XLZ0=SQRTF(XL*XL-XLX0*XLX0)
00000 XLZD0=-XLX0*XLXD0/XLZ0
00000 DO 720 I=1,8
00000 YA(I)= 0.0
00000 DO 720 J=1,8
00000 720 A(I,J)= 0.0
00000 A(1,1)= XSA * XLM
00000 A(1,2)= XLM
00000 A(1,4)= XMU
00000 YA(1)= -F1-P12*P14*XLM
00000 A(2,3)= XLM
00000 A(2,4)= -1.0
```



```

00000 YA(2) = -(XSM+XLM)*J2.15-P13*P14*XLM
00000 A(3,1) = XC
00000 A(3,2) = XC
00000 A(3,3) = -XA
00000 A(3,4) = XMU*F/XLM
00000 A(3,5) = 1.0/XLM
00000 YA(3) = XA*(J2.16+P13*P14)-XC*P12*P14-F*XK3/XLM
00000 A(4,1) = XLZ0
00000 A(4,2) = XLZ0
00000 A(4,3) = -XLX0
00000 YA(4) = XLX0*(J2.16+P13*P14)-XLZ0*P12*P14
00000 A(5,2) = XLX0
00000 A(5,3) = XLZ0
00000 YA(5) = -(XLXD0+XLXD0+XLZD0+XLZD0)
00000 K=5
00000 J=K+1
00000 CALL SIMEO(A,YA,B,K)
00000 ISTEP=-ISTEP
00000 IF(ISTEP)740,900,810
00000 740 IP=IP+1
00000 IF(IP-IP1)770,750,750
00000 750 PRINT110,T0,X0,XLX0,XLZ0,XD0,(B(I),I=1,5)
00000 IP=0
00000 770 IF((ALT-Z0-XLZ0-P1)*(ALT-Z0-XLZ0-P1)-DCHUTE*DCHUTE/9.)570,570,780
00000 780 IF(XD0)790,790,810
00000 790 PRINT800,T0
00000 800 FORMAT(/F20.8,30H IMPACT PHASE SUCCESSFULLY COMPLETED)
00000 STOP
00000 810 XD0=VELOCF(XD1,B(2))
00000 XLXD0=VELOCF(XLXD1,B(2))
00000 X0=DISPLF(X1,XD1,XD0)
00000 XLX0=DISPLF(XLX1,XLXD1,XLXD0)
00000 T0=T0+DELT2
00000 DET2=DELT9
00000 IF(ISTEP)715,900,710
00000 715 PRINT820,T0
00000 820 FORMAT(/F20.8,40H CHUTE IN CONTACT,STABLE SURFACE CONTACT)
00000 830 IP=IP1
00000 ISTEP=1
00000 840 DET2=DELT2
00000 X1=X0
00000 XD1=XD0
00000 845 P12=XD0-VX
00000 P13=-VZ
00000 P14=XKF*SQRTF(P12*P12+P13*P13)/XLM
00000 DO 846 I=1,8
00000 YA(I)=0.0
00000 DO 846 J=1,6
00000 846 A(I,J)=0.0
00000 A(1,1)=XSM+XLM
00000 A(1,2)=XMU
00000 A(1,4)=-1.0
00000 YA(1)=-F1-P12*P14*XLM
00000 A(2,2)=-1.0
00000 A(2,4)=-1.0

```



```
000000 YA(2) = -(XSM+XLM)*32.10-P13*P14+XLM
000000 A(3,1) = XC*XLM
000000 A(3,2) = XHU*F
000000 A(3,3) = 1.0
000000 A(3,4) = XA
000000 YA(3) = XLM*XA*(32.10+P13*P14)-XLM*XC*(12*P14-F*XKJ
000000 A(4,1) = XLZ0
000000 A(4,4) = XLX0/XLM
000000 YA(4) = XLX0*(32.10+P13*P14)-XLZ0*P12*P14
000000 K=4
000000 J=K+1
000000 CALL TIME0(A,YA,B,X)
000000 ISTEP=-ISTEP
000000 IF(ISTEP)850,900,890
000000 850 IP=IP+1
000000 IF(IP-IP1)880,860,860
000000 860 PRINT110,T0,X0,XD0,(B(I),I=1,4)
000000 IP=0
000000 880 IF(XD0)790,790,890
000000 890 XD0=VELOC(XD1,B(1))
000000 X0=DISPLF(X1,XD1,XD0)
000000 T0=T0+DELT0
000000 DET2=DELT0
000000 IF(ISTEP)845,920,840
000000 END
```



AIRCRAFT ARMAMENTS, Inc.

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Table I is a listing of the appropriate input values for the drop phase computer program. Table II is a listing of the input values for the impact phase computer program, some of which are obtained from the results of the drop phase computer run.



AIRCRAFT ARMAMENTS, Inc.

DROP PHASE INPUTS

CASE No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
$x_0$	0															
$\psi_0$	0		-7.	-12.	-7.				-7.		-7.	-7.	-7.			
$\Psi_0$	0															
$\pi_{x0}$	0															
$\pi_{y0}$	0															
$\dot{x}_{20}$	151.6		142.	145.05	134.6	151.7	150.4	142.8	152.	143.5	134.8	151.7	151.7	168.5	152.	
$\dot{y}_{20}$	-11.8		1.64	-8.25	10.17	8.45	23.4	14.0		-3.295	8.05	8.31	-10.4	-11.43		
$L_x$	0															
$L_y$	0															
$L_{z0}$	0															
$L_{x0}$	6.45		-9.53	4.78	5.85	-4.31	-12.78	-8.1		1.80	-4.95	-4.54	5.675	5.62		
$\theta_a$	2.		-1.	1.		2.	2.	2.	3.	3.	4.	1.	3.	1.	2.	
$\phi_a$	0															
$\psi_a$	0		-7.	-12.	-7.				-7.		-7.	-7.	-7.			
$\pi_{ax0}$	0															
$\pi_{ay0}$	0															
$\pi_{az0}$	0															
$\Delta t$	.01		.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	
NO. CYCLES / PRINT	10.		10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	
$z$	-5.		-5.	-5.	-5.	-5.	-5.	-5.	-5.	-5.	-5.	-5.	-5.75	-4.125	-5.	
$t$	0									.355	-.916					
$r$	.117		.117	.117		.08	5.	.167	.66					-.127	.335	.5
$d$	0							.42	.42					-.75	.975	
$h$	0															
$f$	-2.01		-2.01	-2.01	-1.85	-2.	-1.92	-1.92	-1.92	-1.92	-2.	-1.91	-1.92	-1.72	-1.92	
$N$	-2.		-2.	-2.	-2.	-2.	-2.	-2.	-2.	-2.	-2.	-2.	-2.	-2.	-2.	
$m$	119		119	119.5	57.5	93.1	117.5	117.5	117.5	117.5	117.5	117.5	117.5	117.5	117.5	
$M_i$	1.09		1.09	1.09	.684	.682	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	1.09	
$I_{xx}$	344.4		344.4	344.4	229.6	300.9	305.2	307.	307.6	307.6	307.6	307.6	307.6	307.6	307.6	
$I_{yy}$	452.8		452.8	452.8	434.	461.4	382.5	386.5	386.5	386.5	386.5	386.5	386.5	423.	444.3	389.5
$I_{zz}$	643.		643.	643.	508.9	595.1	571.8	593.8	593.8	593.8	593.8	593.8	593.8	634.	662.4	571.8
$V_x$	0		-11.7	1.75	-11.8	.3	3.28	-9.	-16.9	-.7	12.9	1.2	13.3	7.15	-7.75	
$V_y$	11.8		-1.64	8.25	10.17	-8.45	-23.4	-14.0		3.29	-8.05	-8.31	10.4	11.4		
$V_z$	0															
$V_{ax}$	151.6		142.	145.05	134.6	151.7	150.4	142.8	152.	143.5	134.8	151.7	151.7	168.5	152.	
$V_{ay}$	-11.8		1.64	-8.25	-10.17	8.45	23.4	14.0		-3.295	8.05	8.31	-10.4	-11.43		
$V_{az}$	0															
$d_L$	-22.6		-22.6	-22.6	-22.	-22.3	-22.6	-22.2	-22.6	-22.6	-22.6	-22.6	-22.6	-22.6	-22.6	
$\Delta t_2$	.001		.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	.001	
$\Delta t_3$	.01		.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	.01	
$k_c$	4.83		4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83	4.83	
$K_{Loc}$	.1175		.1175	.1175	.1175	.1175	.1175	.1175	.1175	.1175	.1175	.1175	.1175	.1175	.1175	
$K_{D0}$	.0121		.0121	.0121	.0121	.0121	.0121	.0121	.0121	.0121	.0121	.0121	.0121	.0121	.0121	
$K_{D00}$	.153		.153	.153	.153	.153	.153	.153	.153	.153	.153	.153	.153	.153	.153	
Z TEST	-50.		-25.	-25.	-25.	-25.	-25.	-25.	-25.	-25.	-25.	-25.	-25.	-25.	-25.	
NO. CYCLES	10.		10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	10.	
PH. CYCLES	5.		5.	5.	5.	5.	5.	5.	5.	5.	5.	5.	5.	5.	5.	
$C_{DA0}$	204.		204.	204.	92.8	92.8	204.	204.	204.	204.	204.	204.	204.	204.	204.	
DIAM.	15.4		15.4	15.4	10.5	10.5	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	15.4	
$G_N$	1.		1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	
$G_F$	1.		1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	1.	
$P_0$	.0024		.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	.0024	

TABLE I

RAINBOW 1388A



AIRCRAFT ARMAMENTS, Inc.

IMPACT PHASE INPUTS

CASE No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
$t_0$	0.0		0.0												0.0
$\Delta t$	.005		.005												.005
$X_0$	2943		215.08	241.34	185.54	295.99	245.76	213.88	190.27	208.52	243.59	227.67	251.57	238.72	223.24
$\dot{X}_0$	79481		74.084	57.373	76.936	103.504	91.749	76.851	76.096	89.771	96.054	94.935	106.159	109.63	83.803
$\theta_0$	-.154		-.115	-.113	.096	-.139	-.103	-.148	.018	-.145	-.178	-.142	-.176	.184	-.089
$\dot{\theta}_0$	-.342		-.424	-.25	-.179	-.572	-.192	-.1	-.378	-.438	-.135	-.233	.216	-.1123	-.325
$Lx_0$	-82981		-82.64	-82.74	-77.369	-77.193	-81.245	-81.951	-82.694	-82.444	-82.338	-82.556	-82.43	-82.441	-82.454
$\dot{L}x_0$	6.05		2.267	1.9	.36	1.9	2.39	1.18	1.25	.8	1.8	.95	1.49	2.75	2.09
$V_x$	0.0		11.7		-11.3	.3	3.28	-9.	-16.9	-.7	12.9	1.2	13.3	7.15	-6.75
$V_z$	0.0		-1.64												0.0
ALT	-41		-15.91	-11.78	-7.6	17.744	-19.172	-18.499	-14.06	-12.31	-17301	-13.02	-14.	-12.35	-17.72
$K_{11}$	0.0		0.0												0.0
$K_{13}$	0.0		0.0												0.0
$a$	-5.		-5.									-5.	-5.75	-4.125	-5.
$c$	.117		.117	.117	0.0	.68	.5	.167	.666	0.0	0.0	0.0	-.167	.935	.5
$d$	0.0		0.0				0.0	.42	.42	0.0	0.0	0.0	-.75	.875	0.0
$f$	-2.01		-2.01	-2.01	-1.85	-2.	-1.92			-1.92	-2.	-1.91	-1.92		-1.92
$l_c$	483		483												4.83
$I_{yy}$	4528		452.8	452.8	434.	461.4	383.5	386.5				386.5	428.	444.3	383.5
$K_f$	.123		.123	.123	.057	.057	.123								.123
$m$	119.5		119.5	119.5	57.5	93.1	117.5	119.5	119.5	117.5					117.5
$M$	1.09		1.09	1.09	.684	.684	1.09								1.09
CN	1.0		3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0	13.0	14.0	15.0
$\theta_{max}$	.873		.873												.873
Dia. CH/Te	15.4		15.4	15.4	10.5	10.5	15.4								15.4
$U$	.9		1.35								1.35	.9	1.35		1.35
$L$	86.5		83.	83.	77.7	77.7	83.								83.
$f_z$	0.0		0.0												0.0
No. CYCLES / PRINT	20		20												20
$Z_0$	-46422		-28.996	-28.63	-17.034	-28.499	-30.063	-29.652	-24.724	-24.851	-27.657	-24.169	-26.565	-22.271	-28.845
$\dot{X}_0$	-17.25		-16.814	-17.38	-19.192	-14.828	-16.61	-17.123	-20.285	-18.809	-15.573	-19.545	-19.34	-25.768	-19.005

TABLE II

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## D. Lateral Restraint

It was originally thought that the pilot would fly the aircraft in a crabbed position during a crosswind situation. In this position he would have lined the aircraft up with its velocity vector in the wind fixed frame of reference. The extraction parachute in this case would be directly behind the aircraft, because the parachute always lines up with the aircraft velocity vector in the wind fixed frame of reference. Taking this into consideration, the computer program was written excluding a lateral movement restraint requirement in the extraction phase. Such a restraint, of course, is unnecessary when the extraction parachute is directly behind the load.

Due to the difficulty encountered in trying to maintain a stable attitude while flying the aircraft in a crosswind situation, the actual cases proved to be different. When only a few feet above the ground the pilot was concerned primarily with motion in the direction that would result in ground contact, i.e., pitch angle change and vertical motion; therefore, the aircraft was usually not lined up with the resultant velocity vector. The parachute in this case would not be directly behind the aircraft, but would be off to one side. How extreme the parachute is off to one side depends on the magnitude of the angular difference between the actual aircraft heading vector and the velocity vector of the aircraft in the wind fixed frame of reference. Lack of a lateral restraint in the extraction phase of the computer program will allow the load to exceed the lateral boundaries of the aircraft when acted upon by some side force. The side force in this case is the lateral component of the extraction force produced by the misaligned parachute. In actuality the load cannot exceed the aircraft lateral boundaries; thus an error could be produced in the



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computer results without this restraint. To add this restraint requirement to the computer program would mean a major change to the program. It was found that the error this caused could be minimized by forcing certain inputs to be particular values in the tip-off phase. The two inputs that were changed were the yaw angle ( $\psi$ ) and the lateral position vector ( $r_y$ ). These two quantities were given values they would have at tip-off if the load were laterally restrained by the aircraft.





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## IV. CONCLUSIONS AND RECOMMENDATIONS

Included in this section are the changes, deletions, and revisions to the Phase I report. Major changes, deletions, and revisions are not necessary due to the close agreement of the results from the computer analysis when compared to the actual occurrence. There are a few minor changes that will further refine the analysis if incorporated. The following changes and revisions should be incorporated in the Phase I Report.

The limits of the extraction point locations with respect to the cargo C.G. in both the vertical and lateral direction should be changed. These changes are as follows: Vertical distance from G.C. to be within + 10 inches and -5 inches. Lateral distance from C.G. to be within  $\pm 5$  inches. The lateral limitation was decreased because the cargo could become jammed in the cargo compartment and cause aircraft damage, when the lateral offset distance was too large.

The longitudinal limitation in the location of the C.G. from the center of a 9 foot platform can be changed from  $\pm 6$  inches to  $\pm 10$  inches. The maximum offset was not found during the testing program but the load did survive with a  $\pm 10$  inch offset.

The limitation of the 12 knot crosswind is not a product caused by system operation as originally thought. Instead, this limit is influenced mainly by the ability of the pilot to manipulate the aircraft in excessive crosswind. Since the aircraft flies very close to the ground, it is affected by the ground turbulence. This turbulence causes the aircraft to move quite erratically and almost impossible to control. Aircraft dipping and lifting



10 feet is common with ground turbulence caused by a 12 knot wind. Thus, in most cases the pilot will fly the aircraft 20 feet or higher above the ground with a crosswind of 12 knots or more. This drop altitude will cause cargo damage for excessive impact forces.

Sufficient **data** was not **acquired** to state whether the limits on the impact angle are maximum. However in test no. 14 the load impacted at a  $14^{\circ}$  tail down angle with load survival.

As the load descends, it oscillates. For loads that are alike, the oscillations will be identical. Therefore, the impact angle is dependent on the altitude for any load. Further investigation is needed in this area to more closely identify specific load properties with oscillatory motion. This in turn will also increase load survivability.

At this time there have been no tests of multiple load delivery using the ground slide system. It is recommended that efforts be directed in this area to gain this much needed knowledge.

On all except one of these tests, the cargo was restrained to the platform by use of chains. These were used so that the load would not shift at all during the testing. Of course, in an actual air delivery situation regular restraint straps are used. The information acquired from the tests can be applied to an air delivery situation, in that the shifting limitations are described.



A special platform is needed that will resist overturn, withstand the forces exerted upon it at ground impact, and prohibit bending in the longitudinal direction. This platform will basically have a rounded front edge and heavy rails that run longitudinally. The platform used in the test phase had these physical qualities, but it was over designed. During the testing the only part of the platform that seemed to show any failure was the bottom surface. This failure only appears on the platforms that have wooden panels. The design of the new platform should have as its goals: low cost, light weight, bending resistance in rails, and overturn resistance.

Unclassified

Security Classification

DOCUMENT CONTROL DATA - I & D

(Security classification of title, body of abstract and indexing annotation must be entered when the overall report is classified)

1. ORIGINATING ACTIVITY (Corporate author) AAI Corporation Cockeysville, Maryland		2a. REPORT SECURITY CLASSIFICATION Unclassified	
2b. GROUP			
3. REPORT TITLE Ground Slide Airdrop Study: Phase I (Addendum)			
4. DESCRIPTIVE NOTES (Type of report and inclusive dates) Exploratory test			
5. AUTHOR(S) (First name, middle initial, last name) R.C. Wible J.E. Foster			
6. REPORT DATE August 1966	7a. TOTAL NO. OF PAGES 140	7b. NO. OF REFS	
8a. CONTRACT OR GRANT NO. DA19-129-AMC-337(N)	8b. ORIGINATOR'S REPORT NUMBER(S) ER-3841		
8c. PROJECT NO. 1F121401D195	8d. OTHER REPORT NO(S) (Do not include numbers that may be assigned this report) 69-15-AD		
10. DISTRIBUTION STATEMENT This document has been approved for public release and sale; its distribution is unlimited.			
11. SUPPLEMENTARY NOTES Addendum to technical report, 69- AD, (ER-3841), January 1965, contract No. DA19-129-AMC-337(N), U. S. Army Natick Labs.		12. SPONSORING MILITARY ACTIVITY US Army Natick Laboratories Natick, Massachusetts 01760	

13. ABSTRACT

This report is a continuation of the Phase I Report of the Ground Slide Airdrop Study conducted under Contract No. DA19-129-AMC-337(N). The object of the report is to present the findings of the Exploratory Test Phase, Phase II, and to compare the actual findings to those predicted by the Phase I study.

Results of limited flight tests conducted at Ft. Bragg, North Carolina are presented and compared to analytical results which were generated using test conditions as input values. In general, the test values and the computed values are in close agreement.

Also included are all changes, deletions and revisions to be incorporated in the preliminary design specifications of the Phase I report.

Unclassified

Unclassified

Security Classification

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Testing	8					
Systems	9					
Delivery	9					
Air-drop operations	9					
Ground slide	10					