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TNT EQUIVALENCY OF EAK EXPLOSIVE

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U.S. ARMY ARMAMENT RESEARCH AND DEVELOPMENT CENTER

LARGE CALIBER WEAPON SYSTEMS LABORATORY

DOVER, NEW JERSEY

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This project was accomplished as part of the U.S. Army's Manufacturing Methods and Technology Program. The primary objective of this program is to develop, on a timely basis, manufacturing processes, techniques, and equipment for use in the production of Army materiel.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

TNT equivalency	Time of arrival
EAK explosive	MMT-Safety
Scaled positive impulse	
Scaled distance	
Peak pressure	

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Peak side-on blast overpressure and scaled positive impulse have been measured for EAK explosive. The equivalency testing addressed the cylindrical shipping container. High explosive equivalency values for each test series were obtained as a function of scaled distance by comparison to known pressure and impulse characteristics for TNT hemispherical surface bursts.

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SUMMARY

The insensitive high explosive EAK was detonated in a configuration that simulated its storage/shipping container. Blast output parameters were measured, and the TNT equivalency was computed based on the comparison with TNT hemispherical surface bursts. The results are shown below:

	TNT Equivalency (%) at Scaled Distance										
	$1.19 \text{ m/kg}^{1/3}$ $(3.0 \text{ ft/lb}^{1/3})$		$1.59 \text{ m/kg}^{1/3}$ $(4.0 \text{ ft/lb}^{1/3})$		$2.14 \text{ m/kg}^{1/3}$ $(5.4 \text{ ft/lb}^{1/3})$		$3.57 \text{ m/kg}^{1/3}$ $(9.0 \text{ ft/lb}^{1/3})$		$7.14 \text{ m/kg}^{1/3}$ $(18.0 \text{ ft/lb}^{1/3})$		$15.87 \text{ m/kg}^{1/3}$ $(40.0 \text{ ft/lb}^{1/3})$	
Configuration	P	I	P	I	P	I	P	I	P	I	P	I
Simulated shipping drum 11.34 kg (25 lb)	109	81	82	70	70	64	99	51	116	78	72	70
Simulated shipping drum 22.68 kg (50 lb)	98	99	92	56	81	68	130	67	116	68	100	83

Due to the insensitive characteristics of EAK, a 15% conically shaped composition C-4 booster had to be used to ensure a high order detonation. The pressure equivalencies ranged from a high of 130% to a low of 70%. The impulse equivalencies were less than 100%, ranging from a high of 99% to a low of 51%.

CONTENTS

INTRODUCTION

Background

The EAK intermolecular explosive is not a military standard explosive and no existing facilities are available for its production, therefore, explosive classification has not been specifically designated, either in its in-process or final form. The formulation has been designated as an insensitive high explosive (IHE) by the Air Force. It is presently a proposed filler for the standard MK82, GP (500 lb) bomb, and a modified formulation is proposed for large caliber projectile fills. Because the explosive is insensitive to shock, this may reduce the quantity-distance storage requirements. Also, EAK is easier to produce than TNT, and the raw materials used to make it are lower in cost, nonpetroleum based, and commercially available in large quantities, making it economically more attractive than TNT.

The chemical constituents of EAK by percent weight are:

Component	%
Ethylenediamine dinitrate	45.7
Ammonium nitrate	46.2
Potassium nitrate	8.1

The tests were conducted in accordance with the requirements of MMT Project 5860108 as an engineering effort to provide TNT equivalency data.

Objective

The objective of this test program was to determine the maximum output from the detonation of EAK in terms of the peak overpressure and positive impulse. The measured pressure and impulse data were compared with known TNT test data to determine the equivalency of EAK in relation to TNT.

EXPERIMENTAL METHODS

Materials

Test material was EAK high explosive. EAK was received from the Naval Weapons Station, Yorktown, Virginia, in metal

shipping drums. Each drum contained 90.7 kg (200 lbs) of EAK. The physical characteristics were chips of various thicknesses and dimensions.

Test Plan

EAK output was evaluated for weights and configurations simulating its shipping/storage container. The proposed shipping/storage container is a fiber drum 17 inches in diameter by 10 inches in height:

a. A cylindrical container (figure 1) with a charge weight of 11.34 kg (25 lb) of EAK was used to simulate the shipping/storage container with a dimensional scaling factor of 0.79. The container was constructed from fiberboard with a height of 20.1 cm (7.9 inches) and a diameter of 34.3 cm (13.5 inches).

b. A cylindrical container (figure 2) with a charge weight of 22.68 kg (50 lb) of EAK was used to simulate the shipping/storage container with a dimensional scaling factor of 1.0. The container was constructed from fiberboard with a height of 25.4 cm (10 inches) and a diameter of 43.2 cm (17.0 inches).

Each test charge was initiated with a J-2 blasting cap and a conically shaped booster of composition C-4 high explosive. It was necessary to use a 15% C-4 booster to achieve a complete detonation. The C-4 was shaped conically with an aspect ratio of 1:4 (H/W). The C-4 was centered on top of the EAK in the simulated shipping/storage container with the blasting cap inserted at the apex and embedded to the cone's center.

The test charge for each configuration was placed on a 1010 carbon-steel witness plate, 1.27 cm (0.5 inches) thick, with the outside dimension 15.2 cm (6 inches) larger than the base of the test configuration dimensions. Figure 3 shows the test area. The area was refurbished after each test subsequent to measurement of crater diameter and depth.

Instrumentation

Twelve side-on pressure transducers were mounted and placed at ground level in two 90-degree arrays within the test area shown in figure 3. Distances between the transducers and charge were calculated to correspond to scaled distances of 1.19, 1.59, 2.14, 3.57, 7.14 and 15.87 m/kg$^{1/3}$ (3.0, 4.0, 5.4, 9.0, 18.0 and 40.0 ft/lb$^{1/3}$). The transducers were individually calibrated prior to each test series with quasistatic pressure pulses, using a

20.1 cm
(7.9 in)

34.3 cm
(13.5 in)
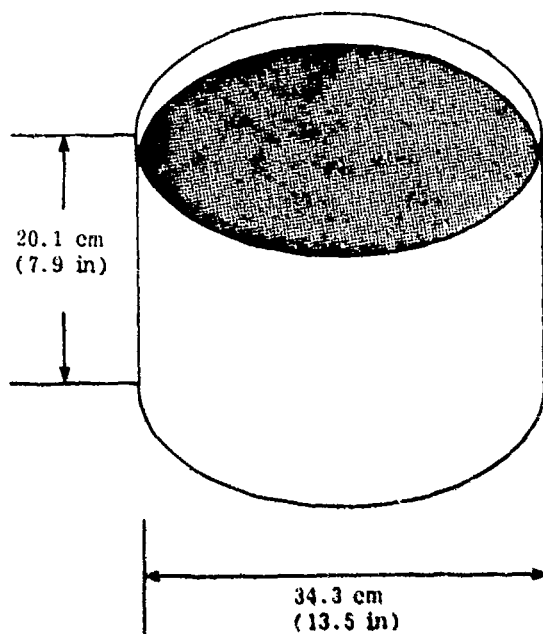
Figure 1.   Simulated scaled shipping/storage container
11.34 kg (25 lb)

25.4 cm
(10.0 in)

43.2 cm
(17.0 in)
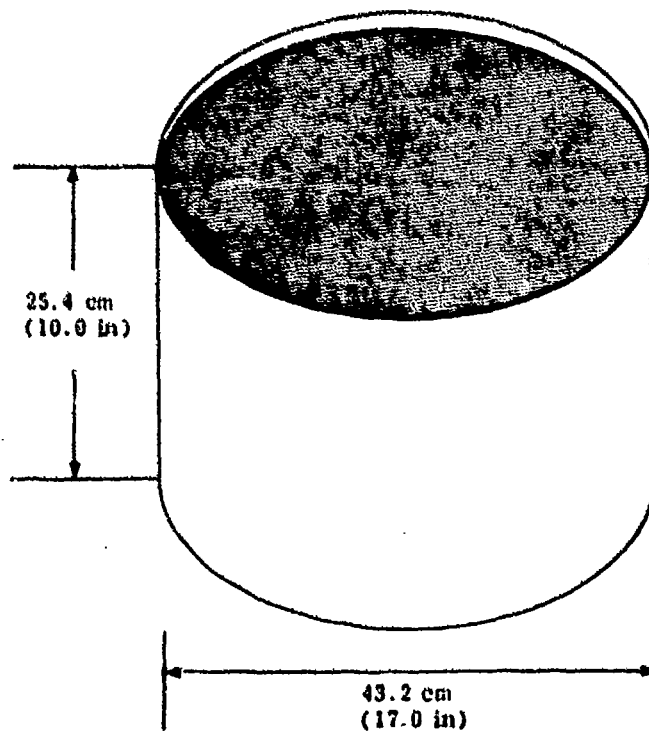
Figure 2.   Simulated full scale shipping/storage container
22.68 kg (50 lb)

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standard solenoid-actuated air-pressure calibration fixture
adjusted to correspond to expected overpressure based on an assumed
TNT equivalency of 100%. Signal-line continuity and channelization
were checked prior to each test. Details of distances between
charge and transducers, calibration pressures, and expected peak
overpressures at each distance are shown in table 1.
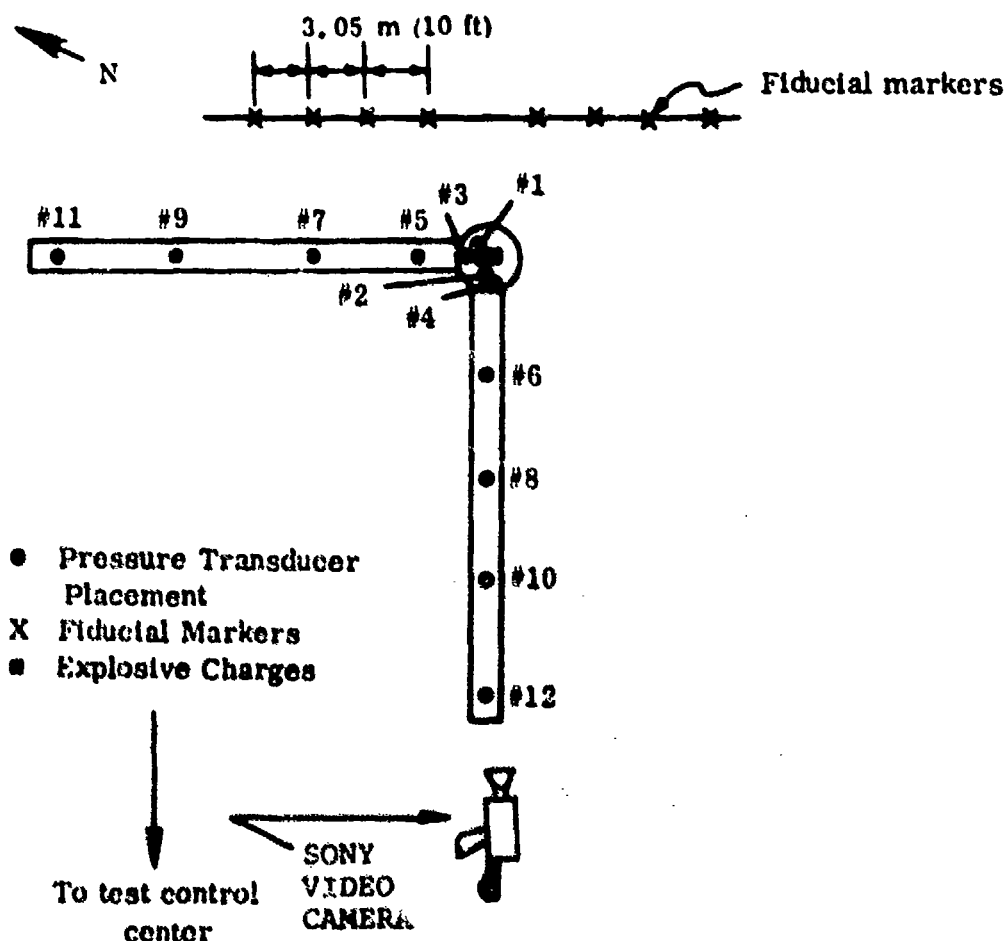
Figure 3. Test area showing charge placement, transducer
placement, and camera placement

Signals were recorded using six two-channel and two four-
channel Nicolet Explorer digital oscilloscopes. A complete
description of the recording system is given in Appendix A. These
digital oscilloscopes offer the ability to capture, store, and
display one-shot transient signals with both pre- and post-trigger
information. Ionization probes were used to trigger the Nicolets
and get T_0. for time of arrival data.

Before and after color still photographs were taken of
each test, showing typical setup and results. Standard
meteorological data were recorded for each test. Video coverage of
each test was also recorded.

Table 1. Transducer calibration and placement of EAK

Channel number	Scaled distance $m/kg^{1/3}$ $(ft/lb^{1/3})$	Expected pressure kPa (psi)	Calibration pressure kPa (psi)	100% Over calibration pressure kPa (psi)	Radial distance m (ft)	
					Charge weight 11.34 kg (25 lb)	Charge weight 22.68 kg (50 lb)
1,2	1.19 (3)	922 (133.71)	2068.5 (300)	4137.4 (600)	2.67 (8.77)	3.37 (11.05)
3,4	1.59 (4)	479.8 (69.58)	1034.3 (150)	2068.5 (300)	3.57 (11.70)	4.49 (14.74)
5,6	2.14 (5.4)	242.5 (35.17)	517.2 (75)	1034.3 (150)	4.81 (15.79)	6.06 (19.89)
7,8	3.57 (9)	81.5 (11.82)	103.4 (15)	206.9 (30)	8.02 (26.32)	10.11 (33.16)
9,10	7.14 (18)	24.07 (3.49)	34.5 (5)	69.0 (10)	16.04 (52.63)	20.21 (66.31)
11,12	15.9 (40)	8.14 (1.18)	13.8 (2)	27.6 (4)	35.65 (116.96)	44.92 (147.36)

RESULTS

Data Analysis

Peak overpressure and positive impulse information were acquired in digital form. Data that could be attributed to instrumentation or explosive malfunction were excluded. The mean and standard deviation were then obtained and all data which fell outside two standard deviations were excluded from the TNT equivalency calculations. The data were then compared to data from TNT hemispheres.[1] A computer program was employed which utilized an iterative process that factors out the contribution of the booster charge weight and calculates the pressure and impulse equivalencies.[2] The calculated TNT equivalencies were arranged in tabular form and plotted as functions of sample scaled distance. The standard curve for TNT hemisphere reference data is shown in figure 4.
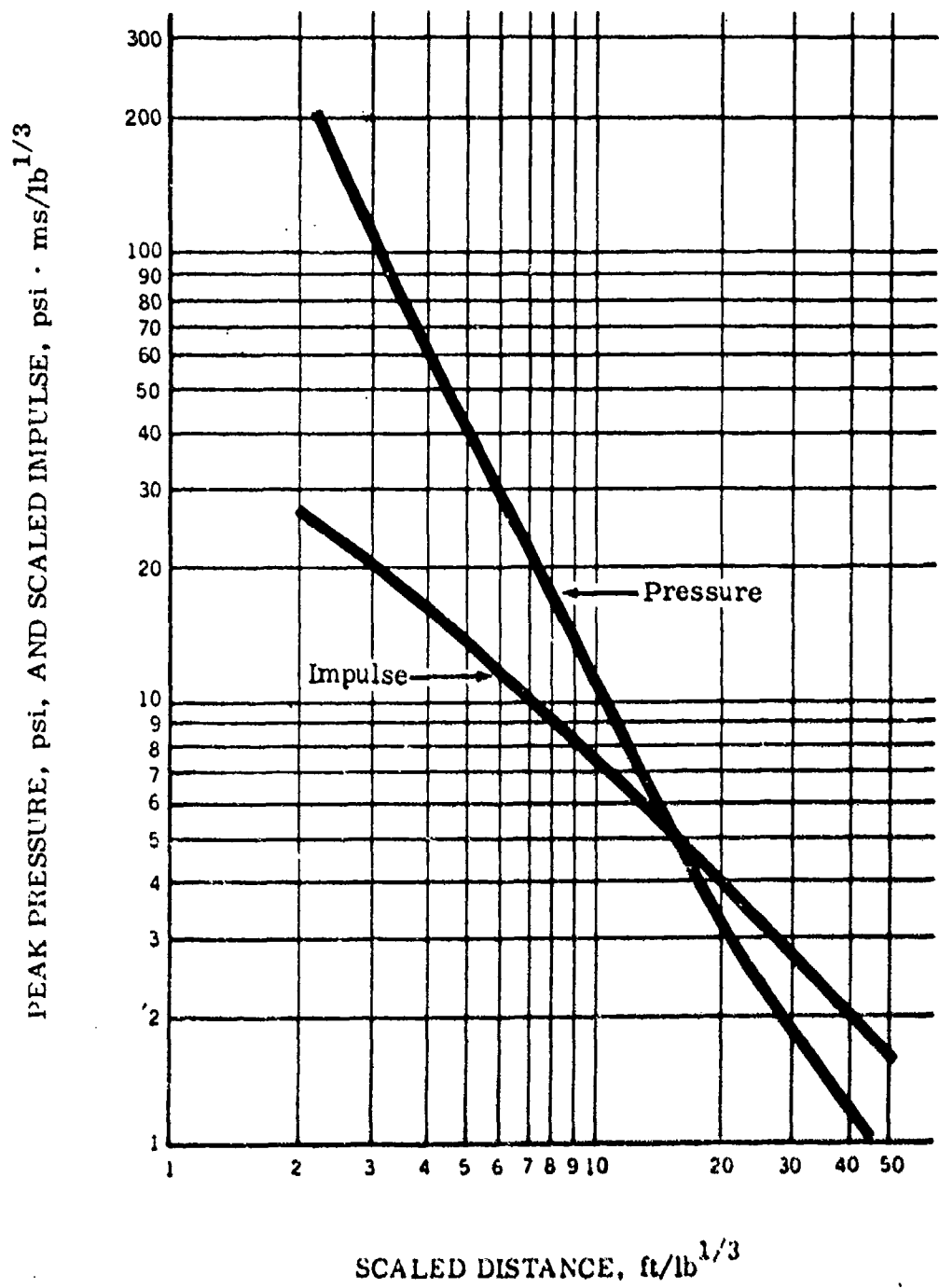
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Figure 4. TNT hemisphere reference data

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Test Results

A description of the instrumentation system is given in
Appendix A. Data sheets for all tests with pertinent measured
parameters are given in Appendix B. Selected pretest and posttest
still photographs are shown in Appendix C. Test numbers are shown
for local reference only and provide access to original range data
files.

Mean pressure scaled positive impulse, and TNT equivalency
data are summarized by test configuration in tables 2 and 3.
Figures 5 and 7 show the plots of peak pressure, and scaled
positive impulse versus scaled distance. Figures 6 and 8 show the
plots of TNT equivalency versus scaled distance for peak pressure
and scaled positive impulse by test configuration. The deviation
from cube root scaling is shown in figure 9.

Discussion

Plots of peak pressure and scaled positive impulse for the
simulated shipping/storage container with a charge weight of
11.34 kg (25 lb) are shown in figure 5. The plots of TNT
equivalencies for pressure and scaled positive impulse are shown in
figure 6. Pressure values were less than expected. Only at scaled
distances of 1.19 $m/kg^{1/3}$ (30 $ft/lb^{1/3}$) and 7.14 $m/kg^{1/3}$
(18.0 $ft/lb^{1/3}$) were the pressure equivalency values greater than
100%. Scaled positive impulse values were lower than expected at
all scaled distances. The impulse TNT equivalency values were all
less tan 100%, ranging from a high of 81% at a scaled distance ot
1.19 $m/kg^{1/3}$ (3.0 $ft/lb^{1/3}$) to a low of 51% at a scaled distance
ot 3.57 $m/kg^{1/3}$ (9.0 $ft/lb^{1/3}$).

Plots of peak pressure and scaled positive impulse for the
simulated shipping/storage container with a charge weight of
22.68 kg (50 lb) are shown in figure 7. The plots of TNT equiva-
lencies for pressure and scaled positive impulse are shown in
figure 8. Pressure values were less than expected at the
near-field scaled distances, $\leq$ 2.14 $m/kg^{1/3}$ (5.4 $ft/lb^{1/3}$), and
greater at the far-field scaled distances, $\geq$ 3.57 $m/kg^{1/3}$
(9.0 $ft/lb^{1/3}$). Therefore, pressure equivalencies were less
than 100% at the near-field scaled distances, $\leq$ 2.14 $m/kg^{1/3}$
(5.4 $ft/lb^{1/3}$), and greater than 100% at the far-field scaled
distances, $\geq$ 3.57 $m/kg^{1/3}$ (9.0 $ft/lb^{1/3}$). Scaled positive
impulse values were less than expected at all scaled distances.
Therefore, the impulse TNT equivalency values were all less
than 100%.

Table 2. Summary of test results, 11.34 kg (25 lb) charge in a cylindrical shipping container

Radius meters (ft)	Scaled distance m/kg$^{1/3}$ (ft/lb$^{1/3}$)	Peak pressure kPa (psi)	Scaled positive impulse kPa ms/kg$^{1/3}$ (psi ms/lb$^{1/3}$)	Pressure TNT equivalency (%)	Impulse TNT equivalency (%)
2.67 (8.77)	1.19 (3)	1072 (155.47)	155.7 (17.35)	109	81
3.57 (11.70)	1.59 (4)	475.2 (68.92)	114 (12.70)	82	70
4.81 (15.79)	2.14 (5.4)	221.7 (32.15)	85.7 (9.55)	70	64
8.02 (26.32)	3.57 (9)	88.6 (12.85)	48.5 (5.40)	99	51
16.04 (52.63)	7.14 (18)	27.7 (4.02)	32.8 (3.65)	116	78
35.65 (116.96)	15.87 (40)	7.8 (1.13)	14.6 (1.63)	72	70

Table 3. Summary of test results, 22.68 kg (50 lb) charge in a cylindrical shipping container

Radius meters (ft)	Scaled distance m/kg$^{1/3}$ (ft/lb$^{1/3}$)	Peak pressure kPa (psi)	Scaled positive impulse kPa ms/kg$^{1/3}$ (psi ms/lb$^{1/3}$)	Pressure TNT equivalency (%)	Impulse TNT equivalency (%)
3.37 (11.05)	1.19 (3)	1012.3 (146.81)	177.2 (19.75)	98	99
4.49 (14.74)	1.59 (4)	517.3 (75.02)	102.9 (11.47)	92	56
6.06 (19.89)	2.14 (5.4)	245.3 (35.58)	89.3 (9.95)	81	68
10.11 (33.16)	3.57 (9)	105.7 (15.33)	57.3 (6.39)	130	67
20.21 (66.31)	7.14 (18)	27.7 (4.02)	28.5 (3.18)	116	68
44.92 (147.36)	15.87 (40)	8.8 (1.28)	16.1 (1.79)	100	83

Figure 5. Pressure and impulse versus scaled distance for 11.34 kg (25 lb) charge of EAK in cylindrical shipping container

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PRESSURE SCALED DISTANCE, ft/lb$^{1/3}$

IMPULSE SCALED DISTANCE, ft/lb$^{1/3}$

Figure 6.   Pressure and impulse TNT equivalency for
11.34 kg (25 lb) charge of EAK in a cylindrical
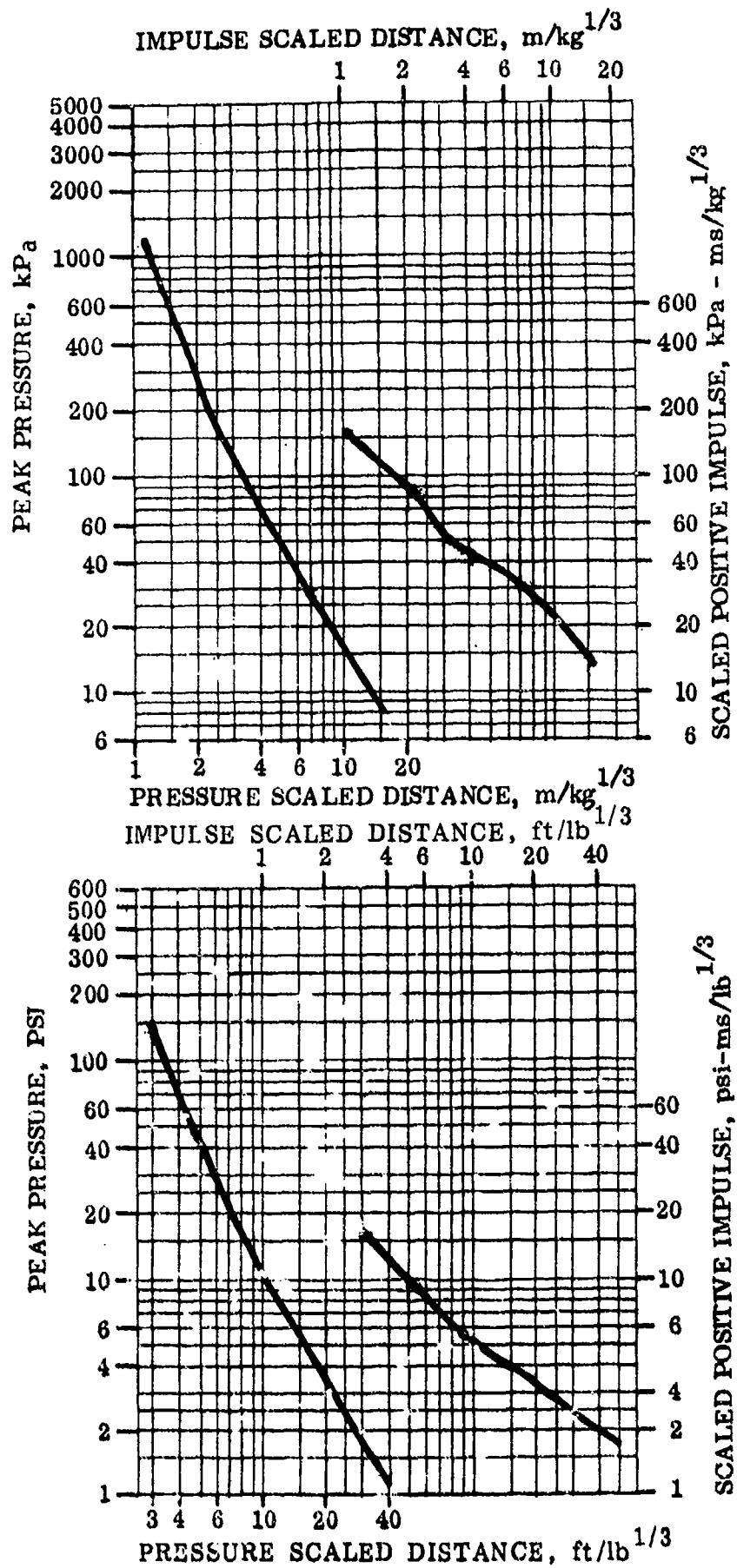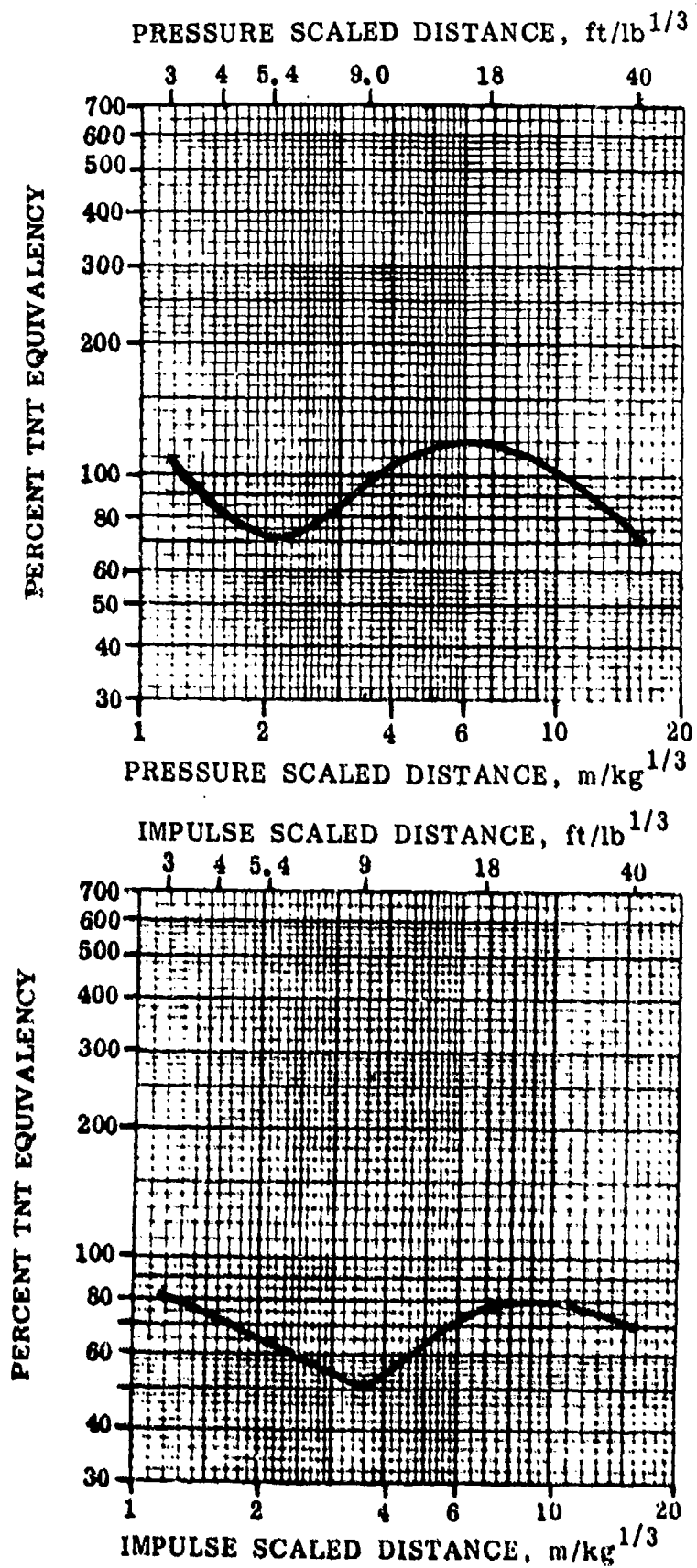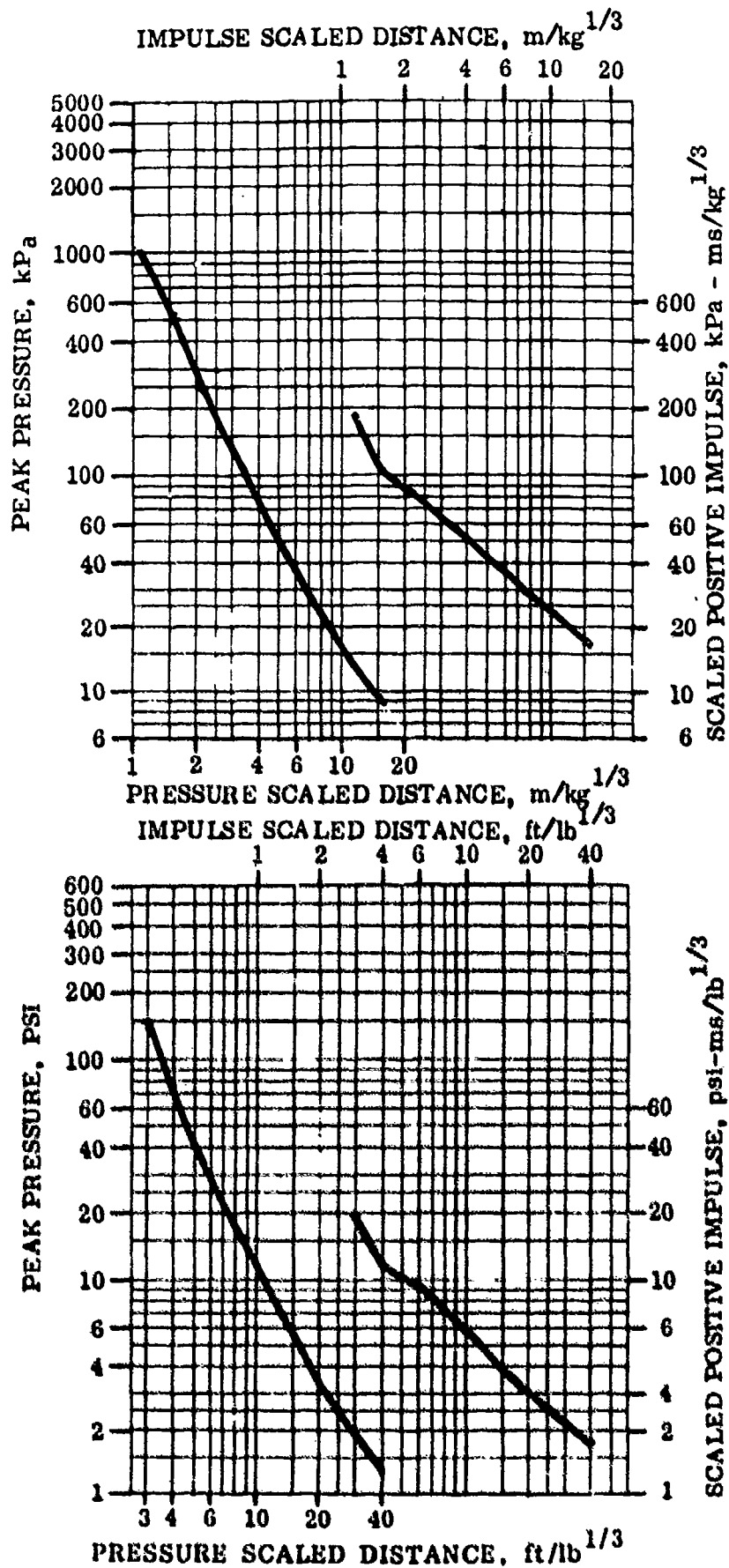shipping container

Figure 7. Pressure and impulse versus scaled distance for
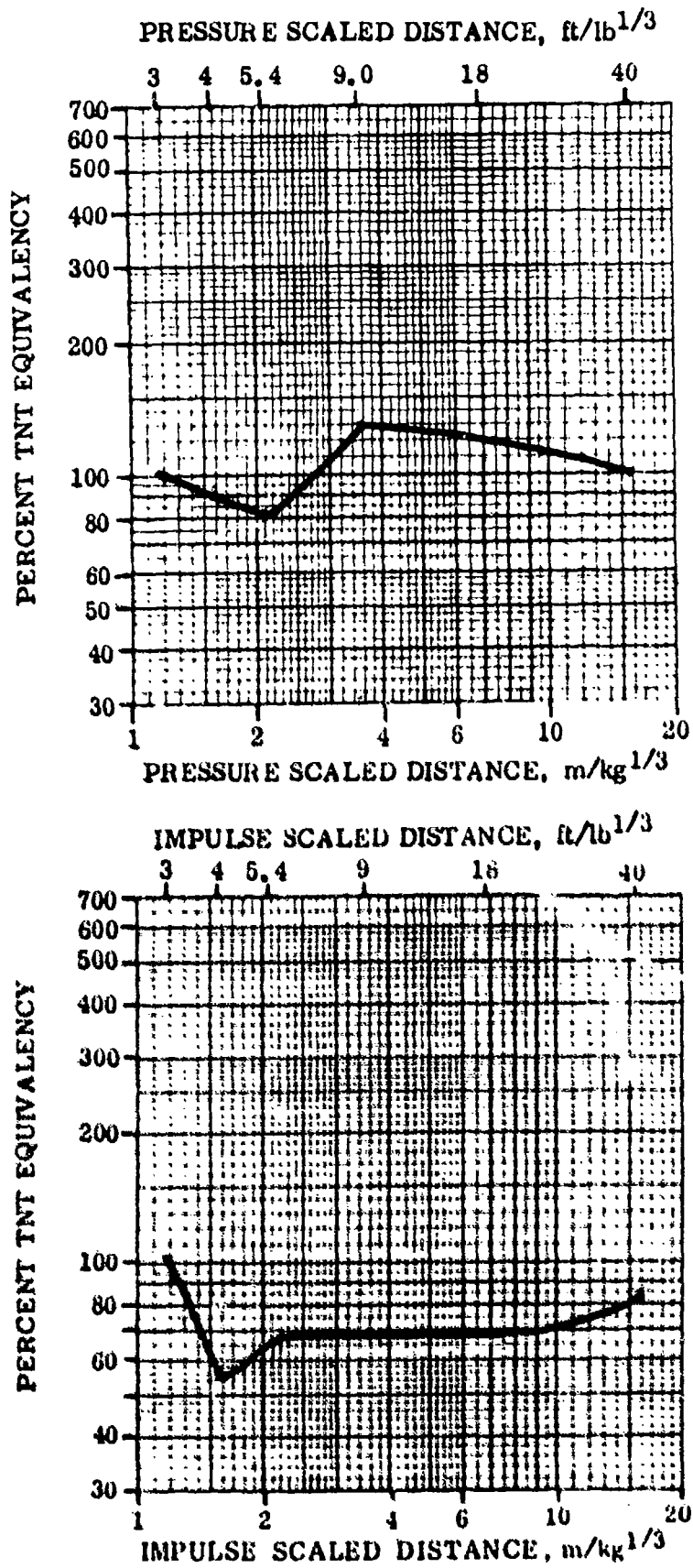22.68 kg (50 lb) charge of EAK in a cylindrical
shipping container

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Figure 8. Pressure and impulse TNT equivalency for 22.68 kg (50 lb) charge of EAK in a cylindrical shipping container
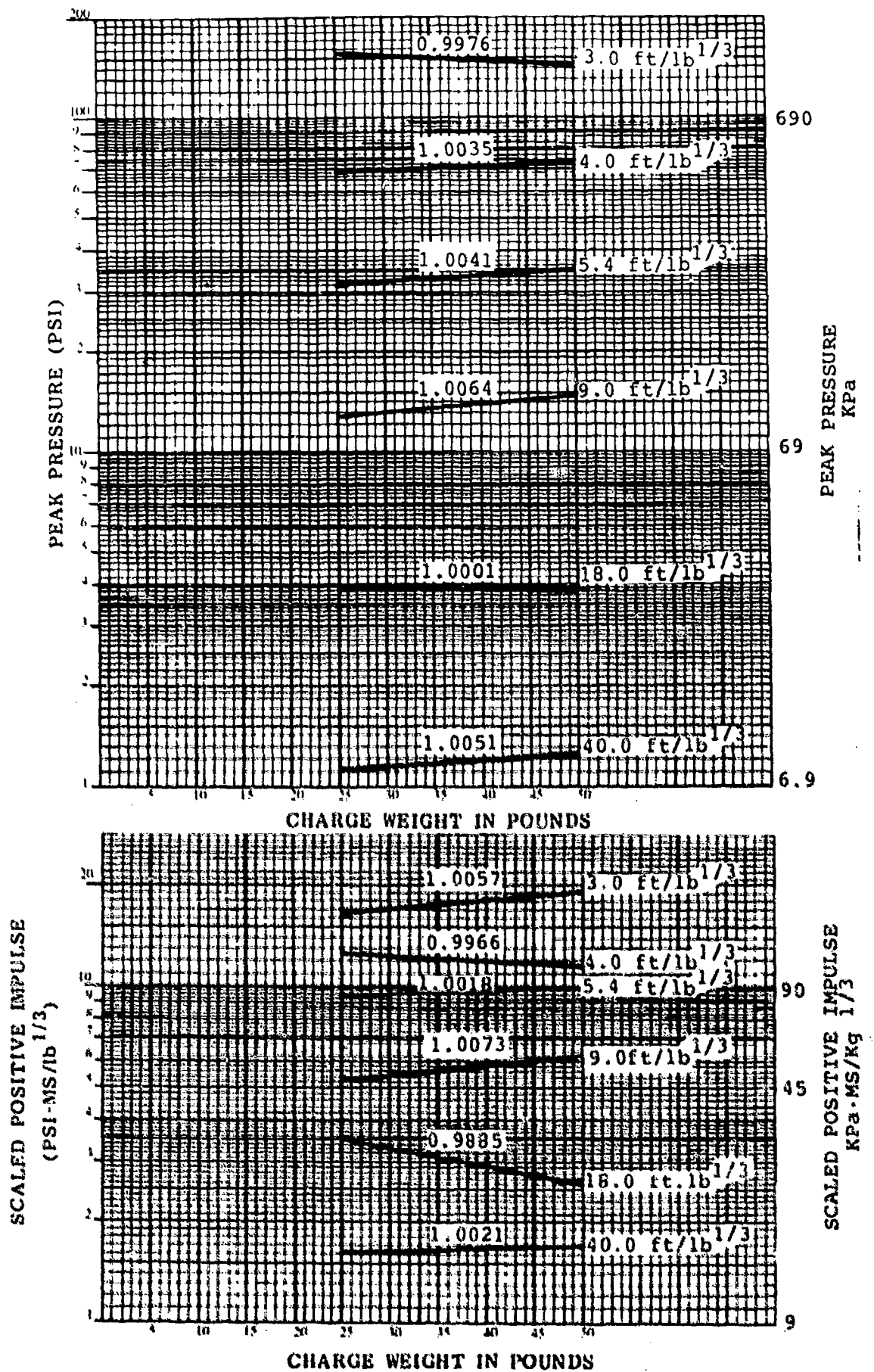
Figure 9. Deviation from cube root scaling

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Plots of peak pressure and scaled positive impulse for the 11.34 kg (25 lb) charge and the 22.68 kg (50 lb) charge in a simulated shipping/storage container show the same general trend. The plots of TNT equivalency values for pressure and scaled positive impulse show the same general trend. The EAK formulation was designated to be an insensitive high explosive, and the test results confirm this in that a booster of 15% was required to achieve a complete detonation.

Figure 9 shows the deviation from cube root scaling as a function of the charge weight. Theoretically, a given output will occur at a distance from an explosion that is proportional to the cube root of the energy yield (known as cube root scaling or Hopkinson's scaling).[3] With the aid of such a law, it is possible to present data for a large range of weights in a simple form, and by the use of scaled distances, one is able to calculate properties of an explosion of any given energy, if those for another energy are known. By the use of cube root scaling, one can determine if output is increasing or decreasing with charge weight. To what degree the output is increasing or decreasing can be determined by performing a least squares linear regression analysis, which is designed to minimize the sum of the squares of the deviations of the actual data points from the straight line of best fit. A slope of one (1) for this line would indicate, by definition, that the data scales. An increase in output with increasing charge weight would be indicated by a positive slope. A decrease in output with increasing charge weight would be indicated by a negative slope. Equal rise and fall in the slope of the line indicates equal percentage changes. For EAK in a cylindrical shipping container, the slopes of the line for deviation from "cube root scaling" for peak pressure at each scaled distance, as a function of charge weight, ranged from a negative slope of 0.9976 to a positive slope of 1.0064. The slopes of the line for deviation from "cube root scaling" for scaled positive impulse at each scaled distance, as a function of charge weight, ranged from a negative slope of 0.9885 to a positive slope of 1.0073.

All of the information presented in this report is based on experimental data. As with any result based on experimental data, there is an inherent scatter involved; that is, the curves and tables presented represent the "best fit" or average values of the data, with some associated error band.

CONCLUSIONS

1. The blast output from EAK is dependent upon the configuration from which it detonates.

2. TNT equivalency values were determined for EAK in configurations that simulate the cylindrical shipping container.

3. To within experimental limits, blast pressure and
    impulse scale as a cube root function of the charge
    weight.

4. The pressure equivalency of EAK explosive as
    determined in this test series ranged from a high of
    130% to a low of 70%. The impulse equivalency is
    less than 100% for all scaled distances.

RECOMMENDATIONS

1. In order to design meaningful experiments and for the
    resulting data to be intelligently applied, it is
    important that the many factors and parameters that
    affect the airblast be recognized and the data be
    used in the context in which they were derived.

2. The TNT equivalency of pressure and impulse values
    determined by the test series should be used in the
    structural design of protective facilities.

3. EAK should be tested in the configurations that are
    typical for a manufacturing facility.

4. For close-in structural design (scaled distances
    generally less than 3 $ft/lb^{1/3}$), values generated by
    this test program should not be used. A method for
    determining the TNT spherical equivalent weight is to
    multiply the charge weight by an equivalency from the
    ratios of the heats of detonation. Then a factor
    must be determined for the effect of charge shape.
    Some sources for this data are in references 4-5.

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REFERENCES

1. Kingery, C. N. Airblast Parameters Versus Distance for Hemispherical TNT Surface Bursts, BRL Report No. 1344, September 1966.

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3. Hopkinson, B. 1915 British Ordnance Board Minutes 13565.

4. Wisotski, John, and Snyer, W. H. "Characteristics of Blast Wave Obtained from Cylindrical High Explosive Charge," Denver Research Institute, November 1965.

5. Plooster, M. N. "Blast Front Pressure from Cylindrical Charges of High Explosives," Naval Weapons Center Technical Memorandum No. 3631, Navy Contract No. N00123-76-C-0166, Denver Research Institute, September 1978.

APPENDIX A

INSTRUMENTATION

Twelve PCB Piezotronics side-on pressure transducers were mounted flush to the surface in each of two sand-filled arrays within the test area. Each transducer was connected by an underground coaxial cable system into the instrumentation building approximately 800 feet from the test area. All signals were amplified by a model 494A06 PCB amplifier and recorded simultaneously on dual channel Nicolet Explorer oscilloscopes and a Honeywell 1858 visicorder. The Nicolet Explorer oscilloscopes were chosen because of their performance; they also provide a wide choice of options and measurement capabilities. It is basically a two-channel, 500 kHz oscilloscope having a writing rate of 5 cm/μsec, rise time of 500 ns and high resolution. It is useful in transducer measurements in providing direct electrical signal measurements, and with the built-in magnetic disk recorder, has the capability of storing signal waveforms for quick and easy recall. The Nicolet Explorer oscilloscopes were interfaced to a Tektronix 4052 graphic system and the peak blast overpressure and positive impulse information were obtained in digital form. The Honeywell 1858 visicorder was operated at 160 inches per second along with a 1 kHz timing pulse.
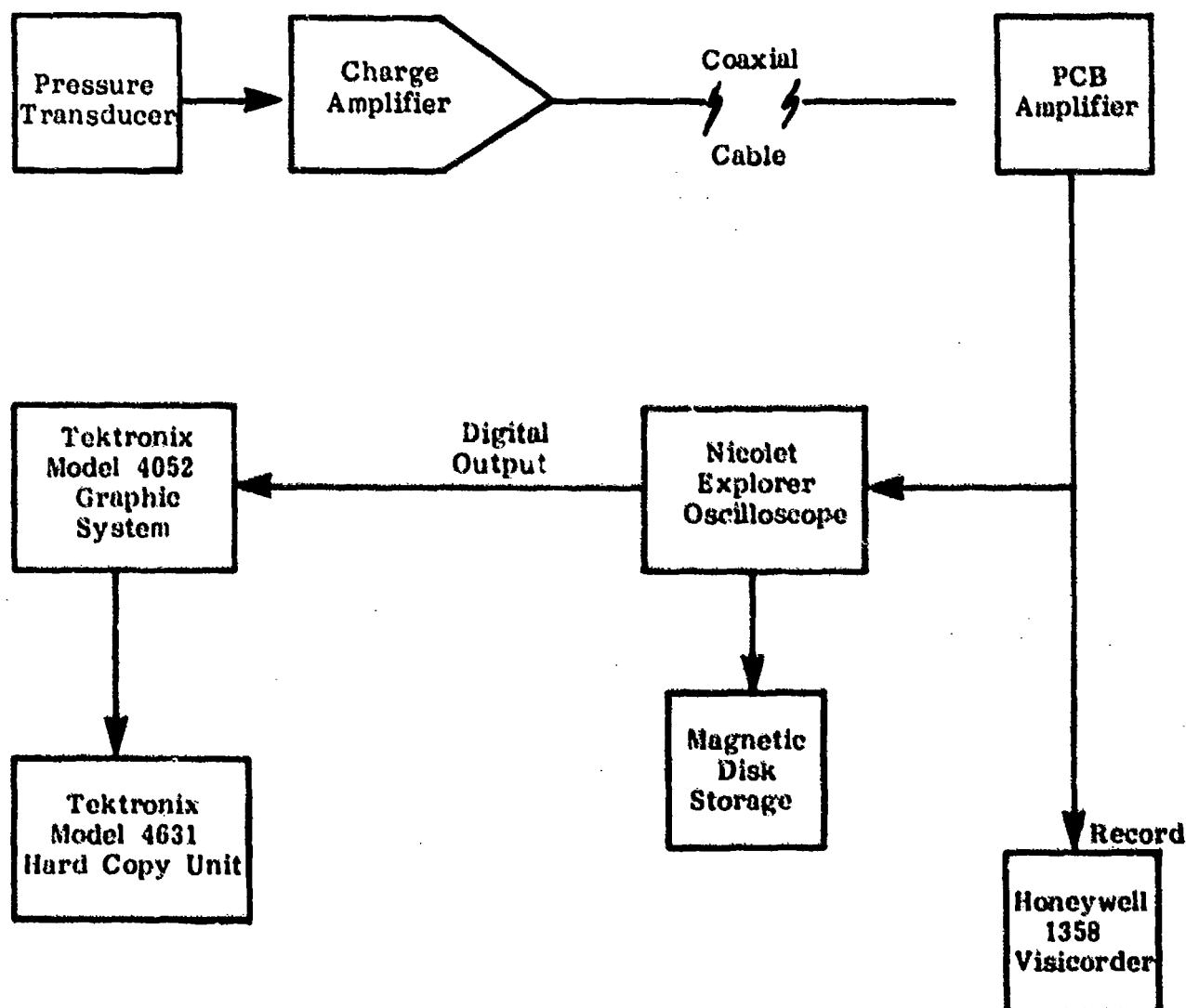
APPENDIX B

DATA SHEETS

TEST TITLE TNT EQUIVALENCY   DATE 31 OCT 1984

TEST SAMPLE EAK EXPLOSIVE   TIME _____

SAMPLE WEIGHT 11.34 kg (25 lb)   TEMP. _____

IGN. SOURCE J2 BLASTING CAP   HUMIDITY _____

BOOSTER WT. 1.13 kg (2.5 lb)   BAR. PRESS. _____

TEST NO. 44-84-05   WIND DIR. _____

CONTRACT NO. NAS 13-50   WIND VEL. _____

BOOSTER CHARGE   L/D = 0.5?
COMP. C4
CONICALLY SHAPED   INITIATOR J-2 CAP

WITNESS PLATE

GROUND ZERO

NOT DRAWN TO SCALE

FIELD EVALUATION

CHANNEL NUMBER	DISTANCE meters (ft)	PEAK PRESSURE kPa (psi)	SCALED POSITIVE IMPULSE $kPa\ msec/kg^{1/3}$ ($psi\ msec/lb^{1/3}$)	TIME OF ARRIVAL (msec)
1	2.67	910.1 (132.0)	250.9 (27.96)	1.57
2	(8.77)	1075.6 (156.0)	173.6 (19.35)	1.60
3	3.57	494.5 (71.72)	169.5 (18.89)	2.70
4	(11.70)	353.0 (51.20)	139.3 (15.52)	2.83
5	4.81	206.9 (30.0)	77.1 (8.59)	4.74
6	(15.79)	217.2 (31.5)	93.7 (10.44)	5.14
7	8.02	82.1 (11.90)	43.5 (4.85)	12.01
8	(26.32)	96.1 (13.94)	48.7 (5.43)	12.08
9	16.04	--	--	--
10	(52.63)	--	--	--
11	35.65	--	--	--
12	(116.96)	--	--	--

25

TEST TITLE TNT EQUIVALENCY   DATE 31 OCT 1984
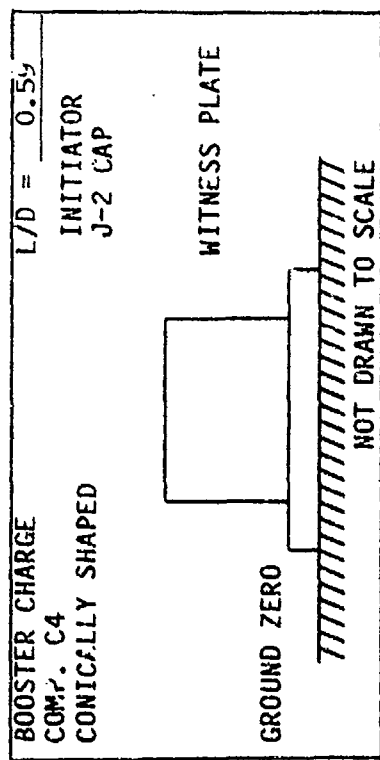
TEST SAMPLE EAK EXPLOSIVE   TIME _____

SAMPLE WEIGHT 11.34 kg (25 lb) TEMP. _____

IGN. SOURCE J2 BLASTING CAP   HUMIDITY _____

BOOSTER WT. ____ kg (3.0 lb)   BAR. PRESS. _____

TEST NO. 44-84-06   WIND DIR. _____

CONTRACT NO. NAS 13-50   WIND VEL. _____

BOOSTER CHARGE   L/D = 0.59
COMP. C4   INITIATOR
CONICALLY SHAPED
          J-2 CAP

          WITNESS PLATE

GROUND ZERO

/////////////////////////
NOT DRAWN TO SCALE

FIELD EVALUATION

CHANNEL NUMBER	DISTANCE meters (ft)	PEAK PRESSURE kPa (psi)	SCALED POSITIVE IMPULSE kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	TIME OF ARRIVAL (msec)
1	2.67	1075.6 (156.00)	149.4 (16.65)	1.61
2	(8.77)	1034.3 (150.00)	144.5 (16.15)	1.52
3	3.57	539.5 (78.24)	93.9 (10.46)	2.73
4	(11.70)	551.6 (80.00)	91.7 (10.22)	2.60
5	4.81	227.5 (33.0)	75.7 (8.43)	4.81
6	(15.79)	268.9 (39.00)	88.9 (9.91)	4.72
7	8.02	77.4 (11.22)	60.7 (6.76)	11.68
8	(26.32)	84.4 (12.24)	63.4 (7.07)	11.55
9	16.04	29.5 (4.28)	37.7 (4.20)	31.62
10	(52.63)	28.5 (4.14)	23.3 (2.60)	32.12
11	35.65	8.1 (1.17)	18.0 (2.01)	85.20
12	(116.95)	6.8 (0.98)	13.2 (1.47)	86.40

CHANNEL NUMBER	DISTANCE meters (ft)	PEAK PRESSURE kPa (psi)	SCALED POSITIVE IMPULSE kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	TIME OF ARRIVAL (msec)
1	2.67	1034.3 (150.00)	159.6 (17.78)	1.52
2	(8.77)	951.5 (138.00)	140.4 (15.65)	1.60
3	3.57	485.4 (70.40)	95.2 (10.61)	2.62
4	(11.70)	430.2 (62.40)	89.5 (9.97)	2.77
5	4.81	165.5 (24.0)	73.3 (8.17)	4.72
6	(15.79)	248.2 (36.00)	102.9 (11.47)	4.84
7	8.02	96.1 (13.94)	49.4 (5.50)	11.44
8	(26.32)	96.1 (13.94)	31.9 (3.56)	11.48
9	16.04	21.6 (3.13)	21.5 (2.40)	31.75
10	(52.63)	29.1 (4.22)	36.5 (4.07)	31.85
11	35.65	7.0 (1.02)	12.7 (1.41)	85.20
12	(116.96)	7.4 (1.07)	15.4 (1.72)	85.60

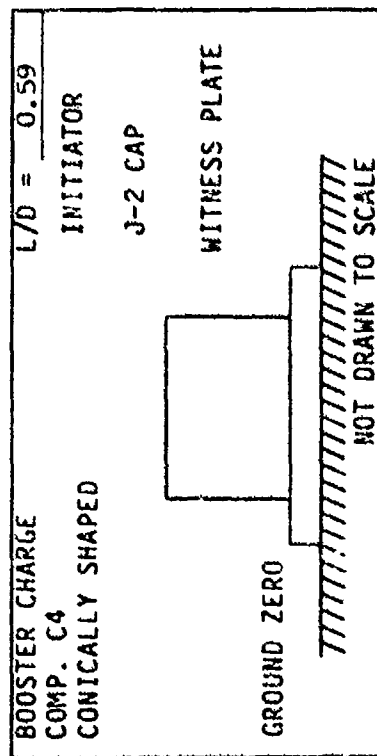TEST TITLE TNT EQUIVALENCY   DATE 1 NOV 1984

TEST SAMPLE EAK EXPLOSIVE   TIME

SAMPLE WEIGHT 11.34 kg (25 lb) TEMP.

IGN. SOURCE J2 BLASTING CAP   HUMIDITY

BOOSTER WT.   kg (3.75 lb)   BAR. PRESS.

TEST NO. 44-84-07   WIND DIR.

CONTRACT NO. NAS 13-50   WIND VEL.

BOOSTER CHARGE   L/D = 0.59
COMP. C4   INITIATOR
CONICALLY SHAPED
     J-2 CAP

     WITNESS PLATE

GROUND ZERO

NOT DRAWN TO SCALE

FIELD EVALUATION

27

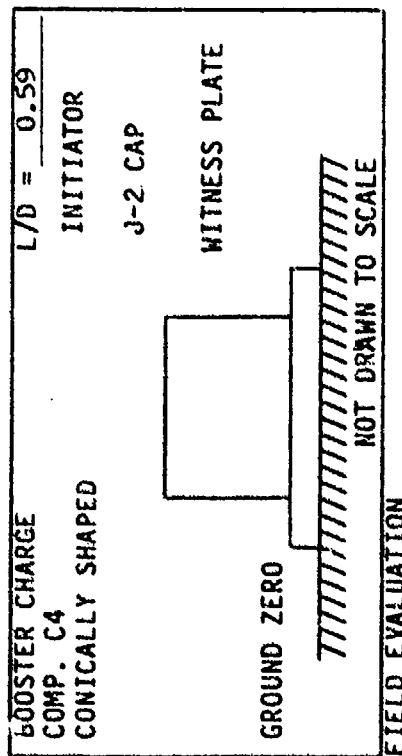TEST TITLE TNT EQUIVALENCY   DATE 7 NOV 1984

TEST SAMPLE EAK EXPLOSIVE   TIME

SAMPLE WEIGHT 11.34 kg (25 lb) TEMP.

IGN. SOURCE J2 BLASTING CAP   HUMIDITY

BOOSTER WT.   kg (3.75 lb)   BAR. PRESS.

TEST NO. 45-84-04   WIND DIR.

CONTRACT NO. NAS 13-50   WIND VEL.

L/D = 0.59

BOOSTER CHARGE
COMP. C4
CONICALLY SHAPED

INITIATOR

J-2 CAP

WITNESS PLATE

GROUND ZERO

NOT DRAWN TO SCALE

FIELD EVALUATION

CHANNEL NUMBER	DISTANCE meters (ft)	PEAK PRESSURE kPa (psi)	SCALED POSITIVE IMPULSE kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	TIME OF ARRIVAL (msec)
1	2.67	1097.1 (159.12)	181.5 (20.23)	1.67
2	(8.77)	951.5 (138.00)	145.7 (16.24)	1.64
3	3.57	441.3 (64.00)	109.2 (12.17)	2.90
4	(11.70)	507.5 (73.60)	98.0 (10.92)	2.84
5	4.81	224.1 (32.50)	67.3 (7.50)	4.94
6	(15.79)	244.8 (35.50)	100.0 (11.14)	4.93
7	8.02	82.1 (11.90)	73.6 (8.20)	11.66
8	(26.32)	105.5 (15.30)	38.7 (4.31)	11.60
9	16.04	33.3 (4.83)	22.5 (2.51)	32.00
10	(52.63)	21.9 (3.17)	32.8 (3.65)	32.20
11	35.65	8.3 (1.20)	15.3 (1.70)	86.70
12	(116.96)	8.6 (1.25)	16.6 (1.85)	86.90

28

CHANNEL NUMBER	DISTANCE meters (ft)	PEAK PRESSURE kPa (psi)	SCALED POSITIVE IMPULSE kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	TIME OF ARRIVAL (msec)
1	2.67	1265.9 (183.60)	101.4 (11.30)	1.47
2	(8.77)	1323.8 (192.00)	109.4 (12.19)	1.66
3	3.57	485.4 (70.40)	127.0 (14.15)	2.69
4	(11.70)	463.3 (67.20)	126.7 (14.12)	2.82
5	4.81	188.2 (27.30)	77.6 (8.65)	4.79
6	(15.79)	225.2 (32.66)	100.2 (11.17)	5.01
7	8.02	70.3 (10.20)	46.2 (5.15)	11.70
8	(26.32)	96.1 (13.94)	28.5 (3.18)	11.66
9	16.04	35.2 (5.11)	57.4 (6.40)	31.85
10	(52.63)	22.7 (3.29)	30.4 (3.39)	32.50
11	35.65	7.9 (1.15)	13.0 (1.45)	86.50
12	(116.96)	8.3 (1.20)	13.1 (1.46)	87.20

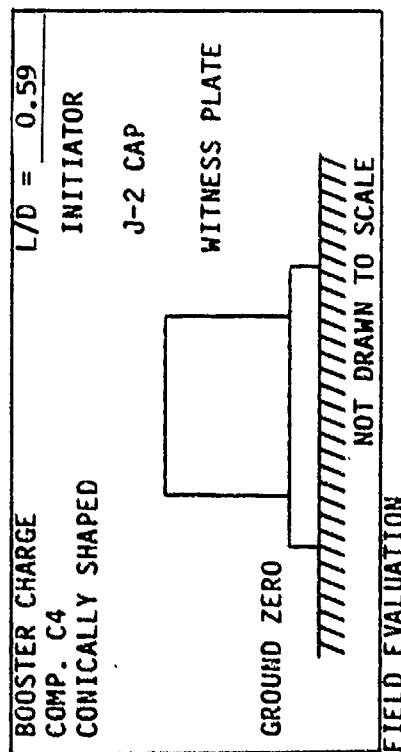TEST TITLE TNT EQUIVALENCY   DATE 7 NOV 1984

TEST SAMPLE EAK EXPLOSIVE   TIME

SAMPLE WEIGHT 11.34 kg (25 lb)   TEMP.

IGN. SOURCE J2 BLASTING CAP   HUMIDITY

BOOSTER WT.   kg (3.75 lb)   BAR. PRESS.

TEST NO. 45-84-05   WIND DIR.

CONTRACT NO. NAS 13-50   WIND VEL.

BOOSTER CHARGE   L/D = 0.59
COMP. C4
CONICALLY SHAPED   INITIATOR

J-2 CAP

WITNESS PLATE

GROUND ZERO

NOT DRAWN TO SCALE

FIELD EVALUATION

CHANNEL NUMBER	DISTANCE meters (ft)	PEAK PRESSURE kPa (psi)	SCALED POSITIVE IMPULSE kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	TIME OF ARRIVAL (msec)
1	3.37	1163.5 (168.75)	178.9 (19.94)	1.68
2	(11.05)	1117.0 (162.00)	174.6 (19.46)	1.97
3	4.49	528.2 (76.61)	98.4 (10.96)	2.99
4	(14.74)	495.8 (71.90)	120.3 (13.41)	3.30
5	6.06	227.5 (33.00)	70.3 (7.83)	5.73
6	(19.89)	310.3 (45.00)	99.3 (11.07)	5.75
7	10.11	122.0 (17.70)	70.7 (7.88)	13.75
8	(33.16)	120.9 (17.54)	41.2 (4.59)	13.80
9	20.21	24.4 (3.54)	58.2 (6.49)	38.90
10	(66.31)	33.3 (4.88)	42.9 (4.78)	38.90
11	44.92	9.0 (1.30)	19.9 (2.22)	106.40
12	(147.36)	8.5 (1.24)	14.5 (1.62)	106.60

TEST TITLE TNT EQUIVALENCY   DATE 1 NOV 1984
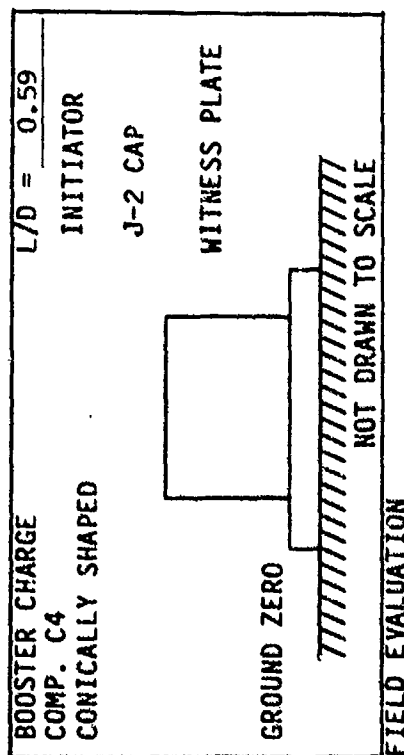
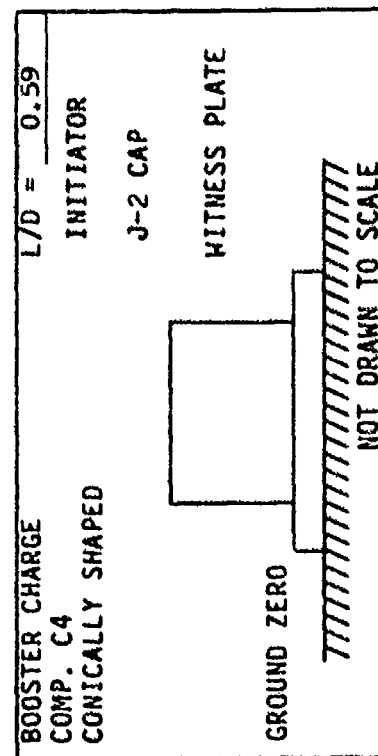TEST SAMPLE EAK EXPLOSIVE   TIME ____

SAMPLE WEIGHT 22.68 kg (50 lb)   TEMP. ____

IGN. SOURCE J2 BLASTING CAP   HUMIDITY ____

BOOSTER WT. 3.4 kg (7.5 lb)   BAR. PRESS. ____

TEST NO. 44-84-08   WIND DIR. ____

CONTRACT NO. NAS 13-50   WIND VEL. ____

BOOSTER CHARGE   L/D = 0.59
COMP. C4   INITIATOR
CONICALLY SHAPED

J-2 CAP

WITNESS PLATE

GROUND ZERO

NOT DRAWN TO SCALE

FIELD EVACUATION

CHANNEL NUMBER	DISTANCE meters (ft)	PEAK PRESSURE kPa (psi)	SCALED POSITIVE IMPULSE kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	TIME OF ARRIVAL (msec)
1	3.37	732.6 (106.25)	228.1 (25.42)	2.20
2	(11.05)	992.9 (144.00)	140.7 (15.68)	2.06
3	4.49	584.4 (84.76)	8.21 (9.15)	3.48
4	(14.74)	616.3 (89.38)	108.5 (12.09)	3.27
5	6.06	220.1 (31.92)	83.1 (9.26)	6.00
6	(19.89)	234.3 (33.98)	88.3 (9.84)	5.72
7	10.11	82.1 (11.90)	63.7 (7.10)	14.25
8	(33.16)	135.8 (19.69)	54.5 (6.07)	14.00
9	20.21	23.6 (3.43)	25.0 (2.79)	40.50
10	(66.31)	24.1 (3.50)	7.2 (0.80)	40.00
11	44.92	8.5 (1.23)	9.4 (1.05)	109.20
12	(147.36)	9.6 (1.39)	11.6 (1.29)	108.20

TEST TITLE TNT EQUIVALENCY   DATE 6 Nov 1984

TEST SAMPLE EAK EXPLOSIVE   TIME _____

SAMPLE WEIGHT 22.68 kg (50 lb) TEMP. _____

IGN. SOURCE J2 BLASTING CAP   HUMIDITY _____

BOOSTER WT. 3.4 kg (7.5 lb)   BAR. PRESS. _____

TEST NO. 45-84-01   WIND DIR. _____

CONTRACT NO. NAS 13-50   WIND VEL. _____

BOOSTER CHARGE   L/D = 0.59
COMP. C4   INITIATOR
CONICALLY SHAPED

J-2 CAP

WITNESS PLATE

GROUND ZERO

NOT DRAWN TO SCALE

FIELD EVALUATION

TEST TITLE TNT EQUIVALENCY   DATE 6 Nov 1984

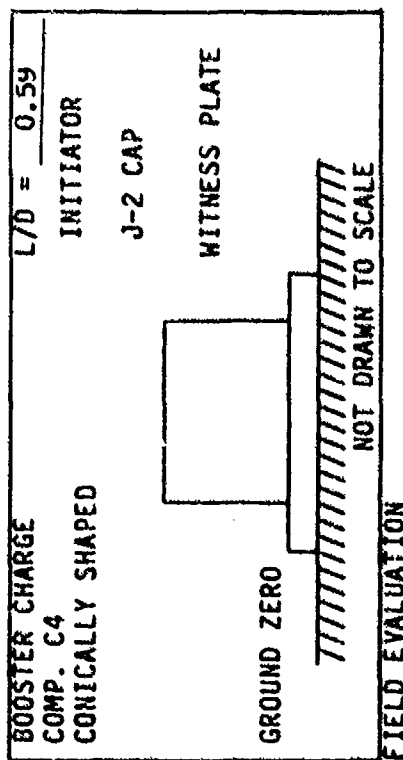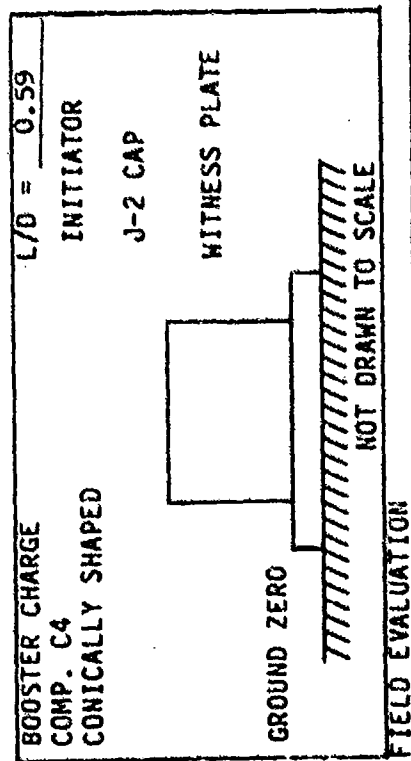TEST SAMPLE EAK EXPLOSIVE   TIME _____

SAMPLE WEIGHT 22.68 kg (50 lb)   TEMP. _____

IGN. SOURCE J2 BLASTING CAP   HUMIDITY _____

BOOSTER WT. 3.4 kg (7.5 lb)   BAR. PRESS. _____

TEST NO. 45-84-02   WIND DIR. _____

CONTRACT NO. NAS 13-50   WIND VEL. _____

CHANNEL NUMBER	DISTANCE meters (ft)	PEAK PRESSURE kPa (psi)	SCALED POSITIVE IMPULSE kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	TIME OF ARRIVAL (msec)
1	3.37	991.2 (143.75)	215.7 (24.04)	1.92
2	(11.05)	910.1 (132.00)	143.6 (16.00)	1.90
3	4.49	494.5 (71.72)	106.6 (11.88)	3.43
4	(14.74)	462.2 (67.03)	93.3 (10.40)	3.29
5	6.06	229.7 (33.31)	84.6 (9.43)	6.02
6	(19.89)	273.4 (39.65)	93.3 (10.40)	5.89
7	10.11	75.0 (10.88)	71.5 (7.97)	14.55
8	(33.16)	125.9 (18.26)	44.0 (4.90)	14.00
9	20.21	31.9 (4.62)	43.3 (4.82)	40.40
10	(66.31)	25.0 (3.63)	11.4 (1.27)	39.60
11	44.92	8.1 (1.18)	21.2 (2.36)	109.40
12	(147.36)	9.2 (1.34)	11.3 (1.26)	108.20

BOOSTER CHARGE
COMP. C4
CONICALLY SHAPED

L/D = 0.59

INITIATOR

J-2 CAP

WITNESS PLATE

GROUND ZERO

NOT DRAWN TO SCALE

FIELD EVALUATION

CHANNEL NUMBER	DISTANCE meters (ft)	PEAK PRESSURE kPa (psi)	SCALED POSITIVE IMPULSE kPa msec/kg$^{1/3}$ (psi msec/lb$^{1/3}$)	TIME OF ARRIVAL (msec)
1	3.37 (11.05)	991.2 (143.75)	198.5 (22.12)	2.10
2		1199.7 (174.00)	137.7 (15.34)	2.01
3	4.49 (14.74)	494.5 (71.72)	102.9 (11.47)	3.44
4		462.2 (67.03)	111.2 (12.39)	3.52
5	6.06 (19.89)	208.8 (30.28)	105.7 (11.78)	6.02
6		258.5 (37.49)	90.0 (10.03)	6.14
7	10.11 (33.16)	80.6 (11.69)	72.0 (8.02)	14.65
8		103.1 (14.96)	41.4 (4.61)	14.45
9	20.21 (66.31)	35.2 (5.11)	22.6 (2.52)	40.30
10		23.9 (3.46)	17.7 (1.97)	40.20
11	44.92 (147.36)	8.9 (1.29)	17.8 (1.98)	108.80
12		8.8 (1.27)	22.8 (2.54)	109.60

TEST TITLE TNT EQUIVALENCY   DATE 7 Nov 1984

TEST SAMPLE EAK EXPLOSIVE   TIME
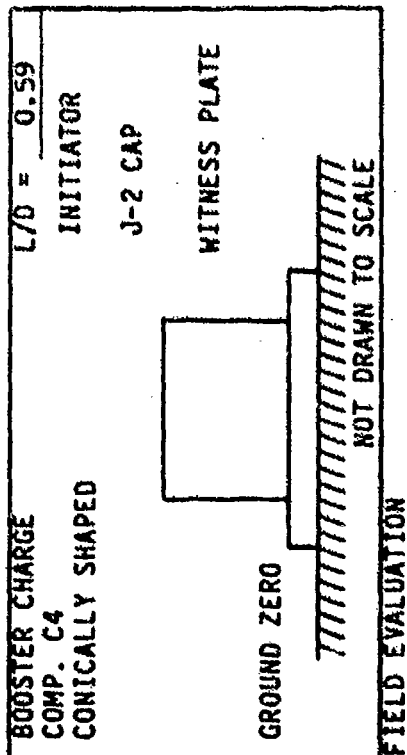
SAMPLE WEIGHT 22.68 kg (50 lb) TEMP.

IGN. SOURCE J2 BLASTING CAP   HUMIDITY

BOOSTER WT. 3.4 kg (7.5 lb)   BAR. PRESS.

TEST NO. 45-84-03   WIND DIR.

CONTRACT NO. NAS 13-50   WIND VEL.

BOOSTER CHARGE   L/D = 0.59
COMP. C4   INITIATOR
CONICALLY SHAPED   J-2 CAP

                                     WITNESS PLATE

GROUND ZERO

                NOT DRAWN TO SCALE

FIELD EVALUATION

APPENDIX C

SELECTED PHOTOGRAPHS

Figure C-1. Physical characteristics of EAK

Figure C-2. Typical pretest configuration for TNT equivalency
testing of EAK in a cylindrical shipping container

Figure C-3. Typical posttest results for TNT equivalency testing
of EAK explosive in a cylindrical shipping container

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U.S. Army Armament, Munitions and
    Chemical Command
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        SMCAR-LCM
        SMCAR-LCM-SP (12)
        SMCAR-LCU-P
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       AMSMC-IRC-E
       AMSMC-ISE
       AMSMC-LC
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       AMCIS-RI-IC
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    Safety Board
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Weapon System Concept Tbam/CSL
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