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TNT EQUIVALENCY OF BENITE PROPELLANT

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

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

Benite propellant	Scaled blast pressure
TNT equivalency	Scaled distance
Scaled positive impulse	Scaled time of arrival
MMT - ammunition	Geometric configuration - Shape equivalency

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 Benite propellant, using configurations that simulate the handling of bulk material during processing and shipment. Quantities of 10.43 and 41.8 kg were tested in orthorhombic shipping containers and fiberboard boxes. TNT equivalency values for each test series were obtained as a function of scaled distance by comparison to known pressure, arrival time, and impulse

20. ABSTRACT (Continued)

characteristics for hemispherical TNT surface bursts. Pressure and impulse equivalencies were found to be less than 65% for all quantities tested.

ACKNOWLEDGMENTS

The authors wish to express their sincere appreciation to Mr. Charles Warneke of Dugway Proving Ground, Utah, and Messrs. Walter Badowski and Darl Westover, U.S. ARRADCOM, Dover, New Jersey, for their technical assistance.

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INTRODUCTION

In support of the Army-wide modernization program, the Manufacturing Technology Division of the U.S. Army Armament Research and Development Command (ARRADCOM) developed design standards for structures required to withstand the effects of an explosion. The employment of these standards--in a safe and cost effective manner--requires that the airblast characteristics of the energetic materials used by the Army be empirically determined. Since the air blast capabilities of Benite propellant are not available in the current literature, a TNT equivalency test program was initiated under MMT project 5774285.

The objective of the test program was to determine the maximum airblast output from the detonation of Benite propellant in terms of peak pressure and positive impulse compared to known characteristics of a hemispherical surface burst of TNT.

TEST PROGRAM

Material

Benite propellant conforming to Military Specification MIL-B-45451B, 23 February 1962, was used throughout the testing. Specifically, the test material consisted of extruded Benite strands (0.203 cm in diameter) from Radford Army Ammunition Plant, Lots RAD 1-132 (25.4 cm long) and RAD 77 F001-061 (45.8 cm long). The Benite was composed of:

40%	nitrocellulose
44.3%	potassium nitrate
6.3%	sulfur
9.4%	charcoal
0.5%	ethyl centralite (added)

Test Plan

A survey of a prototype explosive-manufacturing plant revealed that the production of solvent-wet Benite presents little danger of an explosive reaction during the manufacturing process, and does not constitute a potentially hazardous situation. On the other hand, the probability of a detonation during shipment and storage of Benite and/or Benite-loaded munitions exceeds the minimum acceptable risk. Consequently, a test plan was formulated (table 1), and loaded

shipping containers and mass storage (packout) areas were selected for TNT equivalency testing. Airblast output of the following test configurations was measured:

1. Simulated shipping container--an orthorhombic container (fig. 1a) made of wood and fiberboard, filled with 10.43 kg of Benite propellant.

2. Simulated packout area--an orthorhombic container (fig. 1b) filled with 41.8 kg of Benite propellant.

A conical-chaped booster charge of Composition C-4 high explosive was buried in the center of each container, with the apex protruding above or flush with the top surface (fig. 1). The booster was detonated with an engineers' special J-2 blasting cap inserted at the center of the cone's apex. The booster weights varied from 2% to 17% of the charge weight.

The test charge for each configuration was placed on a 0.61 by 0.61 by 0.0064-meter-thick 1010 carbon steel witness plate in the center of the test area (fig. 2). The area was regraded after each test and measurement of the crater diameter.

Instrumentation

Twelve Susquehanna Instruments Model ST-2, ST-4 side-on blast transducers were mounted in steel plates that were buried so that the sensor was at ground level in two arrays within the test area (fig. 3). Distances between transducers and charges (table 2) were calculated to correspond to scale distances of 1.19, 2.72, 3.57, 4.37, 7.15, and 15.87 meter/$kg^{1/3}$. The transducers were individually calibrated prior to each test series with pressure pulses from a standard solenoid-actuated air pressure calibration fixture, adjusted to correspond to expected blast pressure on an assumed TNT equivalency of 100%. This calibration was verified initially by measuring free-field blast pressures from a 11.34-kg bare hemispherical charge. C-4 signal line continuity and channelization were checked prior to each test.

Each transducer was connected to an underground coaxial system which led to the instrumentation trailer, approximately 175 meters from the test area. In order to capture the complete pressure-time pulse, the recording instrumentation response was synchronized with the blast-wave arrival times. The biomation recorder (200 microsecond period) was connected to the three gages in each array closest to the blast source, while the pulse-code modulation (PCM) unit (0.315 millisecond period) was connected in parallel with the biomation recorder and to all of the gages. All test data were recorded on this dual system.

Photographic coverage was limited to one test of each configuration (fig. 3). Motion picture coverage included a Fastax camera operated at 500 frames per second (fps) and a Mitchell camera operated at 24 fps. Standard meteorological data were recorded for each test.

RESULTS

Data Analysis

Peak blast overpressure, time of arrival, and scaled positive-impulse information were obtained in direct analog form from the oscillograph records. After exclusion of poor results that could be attributed to instrumentation malfunction, impingement of fragments on the transducer elements or improper calibration, average values for peak pressure and scaled positive impulse were calculated for each weight and scaled distance.

The average peak pressures were compared directly with the standard reference curve for a hemispherical TNT surface blast. These comparisons were used to derive TNT pressure equivalency (E_p) as a percentage by weight based on equivalent side-on blast pressure at equal distances from charge:

$$E_p = 100 \left[\frac{\text{Weight}_{TNT}}{\text{Weight}_{Benite}} \right]$$ Constant pressure and radial distance

The scaled positive impulses were also directly compared with the standard reference curve for a hemispherical TNT surface blast to derive TNT impulse equivalency (E_I) as a percentage by weight based on equivalent positive impulse at the same radial distance from the charge:

$$E_I = 100 \left[\frac{\text{Weight}_{TNT}}{\text{Weight}_{Benite}} \right]$$ Constant positive impulse and radial distance

The mathematical basis for pressure and impulse equivalencies are contained in reference 1. This technique provides a means of relating the peak pressure and impulse data from the detonation of

the test samples to that of a hemispherical surface burst of TNT while extracting the booster contribution.

Discussion

At the outset of testing, a 2% (by weight) Comp C-4 booster was chosen as the source of initiation. However, posttest investigation of the unsheared steel witness plate and the unburnt Benite strands in the vicinity of the test pad was not indicative of complete mass detonation. Data analysis substantiated this assumption for none of the computed equivalencies exceeded 35%. Since complete detonation was not achieved, the booster weight was incrementally increased to 17%. The magnitude and completeness of the explosive reaction did not significantly increase (less than 65% equivalency in all tests) even with the inordinately high percentage (17%) booster.

The size of the booster was not increased and the cumulative mean equivalency was reported for the following reasons:

1. The blast output of the booster would exceed that of the test sample.

2. Testing would be representative of a highly unlikely initiation condition in the munitions plant.

3. The percentage booster would not be comparable with any of the previous equivalency test programs.

Test Results

Benite propellant was detonated in full-scale and scaled-up configurations representative of both single and mass storage of orthorhombic shipping containers. Blast output parameters were measured and TNT equivalency was computed on the basis of comparison with TNT hemispherical surface bursts. Complete detonation of the Benite propellant was not achieved by boostering with Comp C-4 (up to 17% by weight). Pressure and impulse equivalencies were found to be less than 65% in all tests. The results of these tests are presented in table 3.

The TNT pressure and impulse standards for a hemispherical surface burst are shown in figures 4 and 5 in both metric and English units. Pressure and scaled positive data for Benite are summarized by test configuration in tables 4 and 5 and figures 6 through 9. Percent TNT equivalencies for both test configurations are shown in figures 10 through 13 as functions of scaled distance.

Figures 14 through 19 are selected pretest and posttest photographs. Data sheets for all tests with pertinent measures parameters are given in the appendix. (The test numbers shown are for local reference only and provide access to original range data files.)

CONCLUSIONS

1. The pressure and impulse TNT equivalency of stranded Benite in the two orthorhombic configurations tested varies with scaled distance and is less than 65%.

2. The blast output from the Benite test samples increased marginally with the size of the booster to a point where further testing was not cost effective. Complete mass detonation was not achieved even with a 17% Comp C-4 booster.

3. The orientation of the Benite strands within the shipping container (i.e., horizontal or vertical) had no discernible effect on the resulting blast output.

RECOMMENDATIONS

The TNT equivalency values determined from this test series should be used in the structural design of protective facilities containing Benite propellant. However, since cube-root scaling was not demonstrated, it is recommended that any extrapolation from the test configurations and constraints be verified by additional testing.

REFERENCES

1. J. J. Swatosh, Jr, and J. R. Cook "TNT Equivalency of M1 Propellant (Bulk)," Technical Report 4885, Picatinny Arsenal, Dover, NJ, December 1975.

2. "Structures to Resist the Effects of Accidental Explosions," (with Addenda), Department of the Army Technical Manual TM-1300, Washington, DC, June 1969.

3. F. L. McIntryre and Paul Price, "TNT Equivalency of M10 Propellant," Contractor Report ARLCD-CR-78008, ARRADCOM, Dover, NJ, December 1975.

Table 1. Test plan

Test no.	Strand orientation	Benite wt. kg (lb)	Booster wt. kg (lb)
1	Vertical	10.43 (23)	.23 (.5)
2	Vertical	10.43 (23)	.45 (1.0)
3 *	Vertical	10.23 (22.56)	.45 (1.0)
4	Horizontal	10.43 (23)	.45 (1.0)
5	Horizontal	10.43 (23)	.91 (2.0)
6	Horizontal	10.43 (23)	1.81 (4.0)
7	Horizontal	41.8 (92)	2.27 (5.0)

*NOTE: .2kg (.44 lb) removed from shipping box

Table 2. Pressure transducer placement

Transducer no.	Distance from charge, m (ft)			
	10.43 kg (23 lb)		41.8 kg (92 lbs)	
1A, 1B	2.16	(7.1)	3.44	(11.3)
2A, 2B	2.47	(8.1)	4.11	(13.5)
3A, 3B	9.81	(32.2)	9.81	(32.2)
4A, 4B	19.66	(64.5)	19.66	(64.5)
5A, 5B	34.68	(113.8)	34.68	(113.8)
6A, 6B	55.04	(180.6)	55.04	(180.6)

Table 3. Pressure and impulse TNT equivalency at scaled distance

Configuration mass (wt)	1.19 $m/kg^{1/3}$ (3.0 $ft/lb^{1/3}$) (%)		3.57 $m/kg^{1/3}$ (9.0 $ft/lb^{1/3}$) (%)		7.15 $m/kg^{1/3}$ (18.0 $ft/lb^{1/3}$) (%)		15.88 $m/kg^{1/3}$ (40.0 $ft/lb^{1/3}$) (%)	
	P	I	P	I	P	I	P	I
Shipping box 10.43 kg (23 lb)	23	47	30	32	30	30	21	25
Shipping box 41.8 kg (92 lb)	60	49	45	25	38	33	21	30

NOTE: P = pressure, I = impulse.

Table 4. Summary of test results, 10.43 kg (23 lb) shipping box

R, m (ft)	Z, $m/kg^{1/3}$ ($ft/lb^{1/3}$)	Peak pressure kPa (psi)	Scaled impulse $\frac{kPa\text{-}ms}{kg^{1/3}}$ ($\frac{psi\text{-}ms}{lb^{1/3}}$)	Pressure TNT equivalency (%)	Impulse TNT equivalency (%)
2.6 (8.53)	1.19 (3.0)	255.0 (37)	87.8 (9.8)	23	47
7.8 (25.6)	3.57 (9)	40.0 (5.8)	27.8 (3.1)	30	32
9.5 (31.3)	4.37 (11)	29.0 (4.2)	23.3 (2.6)	31	31
15.6 (51.2)	7.15 (18)	14.5 (2.1)	15.2 (1.7)	30	30
19.9 (65.4)	9.13 (23)	10.0 (1.45)	12.1 (1.35)	28	30
34.7 (113.7)	15.88 (40)	4.6 (0.67)	7.0 (0.78)	21	25

Table 5. Summary of test results, 41.8 kg (92 lb) shipping box

R, m (ft)	Z, $m/kg^{1/3}$ ($ft/lb^{1/3}$)	Peak pressure kPa (psi)	Scaled impulse $\frac{kPa\text{-}ms}{kg^{1/3}}$ ($\frac{psi\text{-}ms}{lb^{1/3}}$)	Pressure TNT equivalency (%)	Impulse TNT equivalency (%)
4.11 (13.5)	1.19 (3)	524 (76)	112 (12.5)	60	49
9.63 (31.6)	2.78 (7)	69.6 (10.1)	34.9 (3.9)	46	25
12.37 (40.6)	3.57 (9)	47.3 (6.9)	29.6 (3.3)	45	25
19.26 (63.2)	5.56 (14)	22.0 (3.2)	22.0 (2.45)	41	30
24.75 (81.2)	7.15 (18)	14.5 (2.1)	18.8 (2.1)	38	33
34.38 (112.8)	9.93 (25)	8.3 (1.21)	13.0 (1.50)	31	35
55.01 (180.5)	15.88 (40)	4.3 (.62)	7.2 (0.80)	21	30

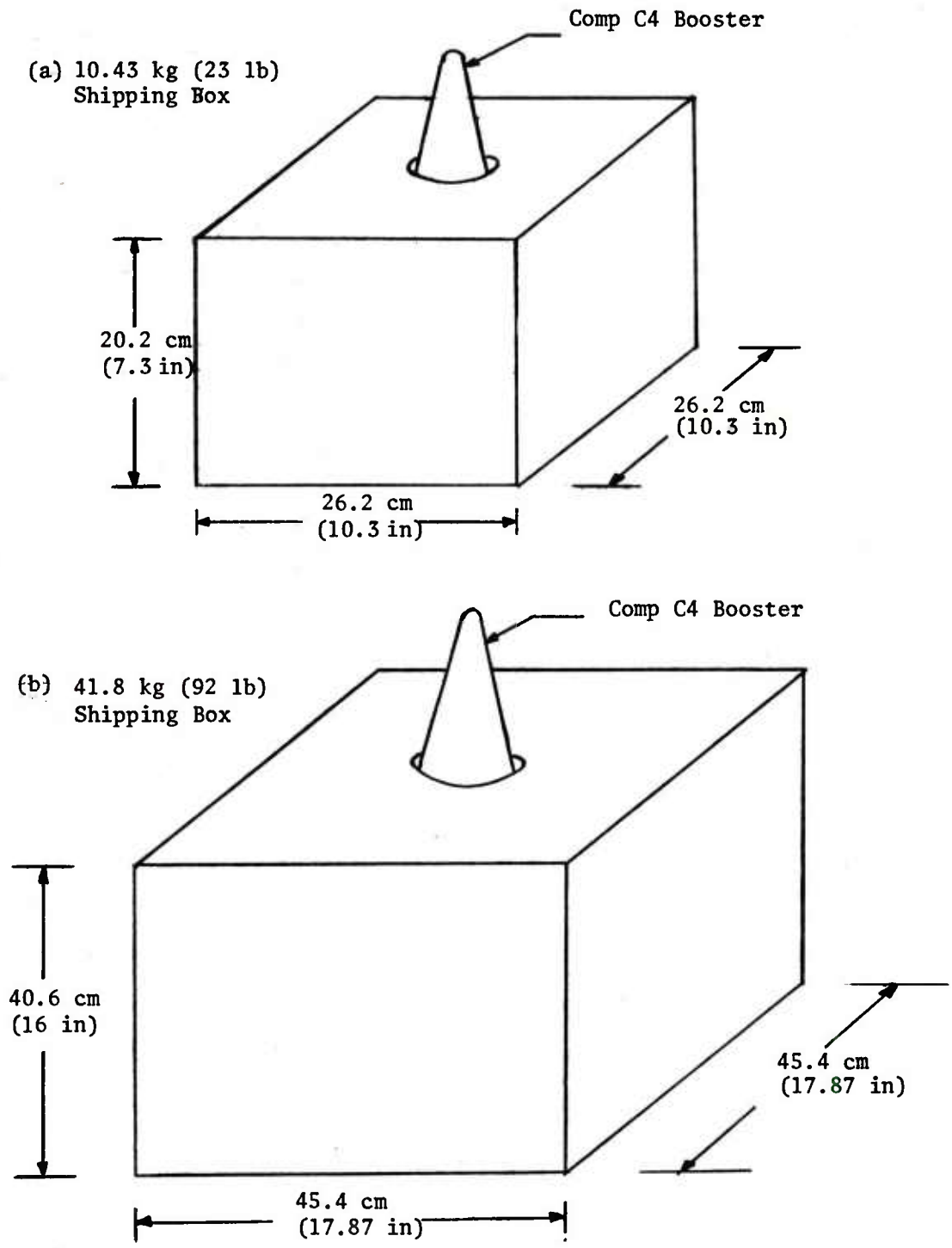


Figure 1. Benite test configurations.

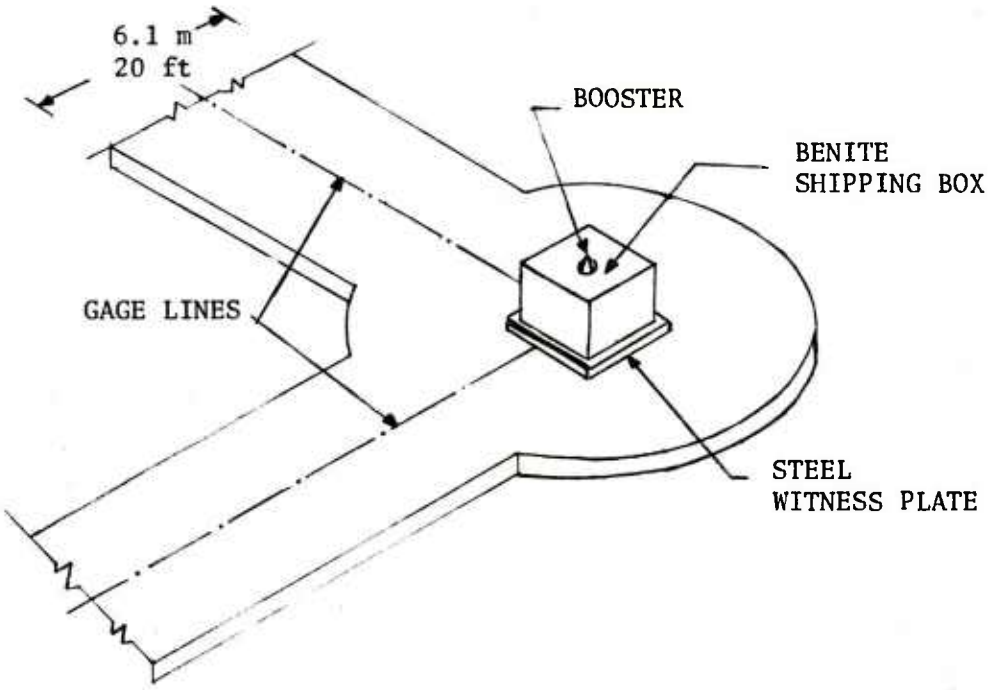


Figure 2. Test setup for equivalency tests.

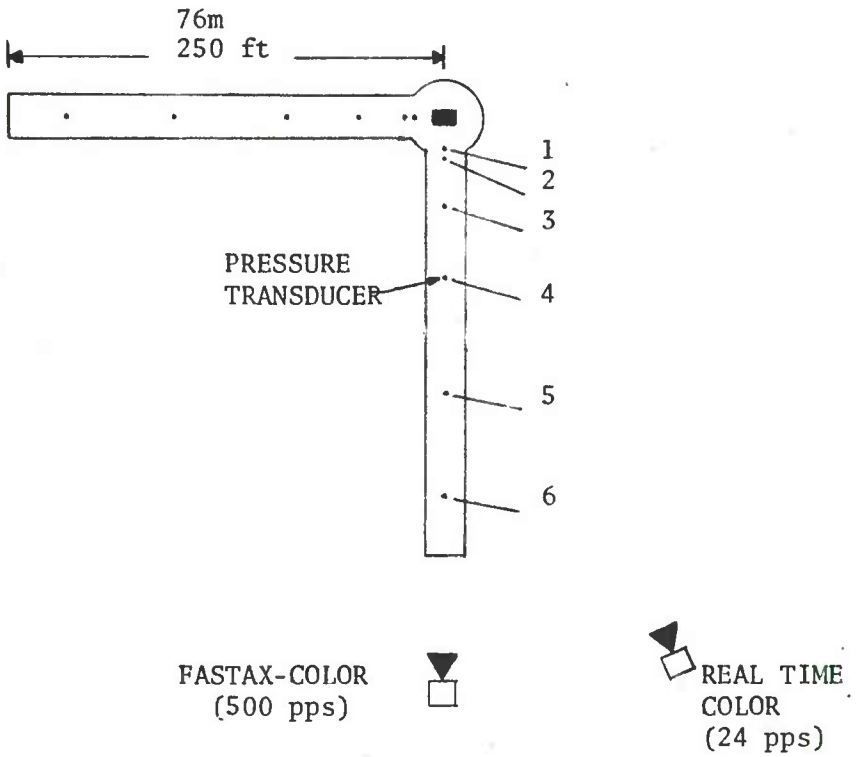


Figure 3. Test area showing transducer and camera placement.

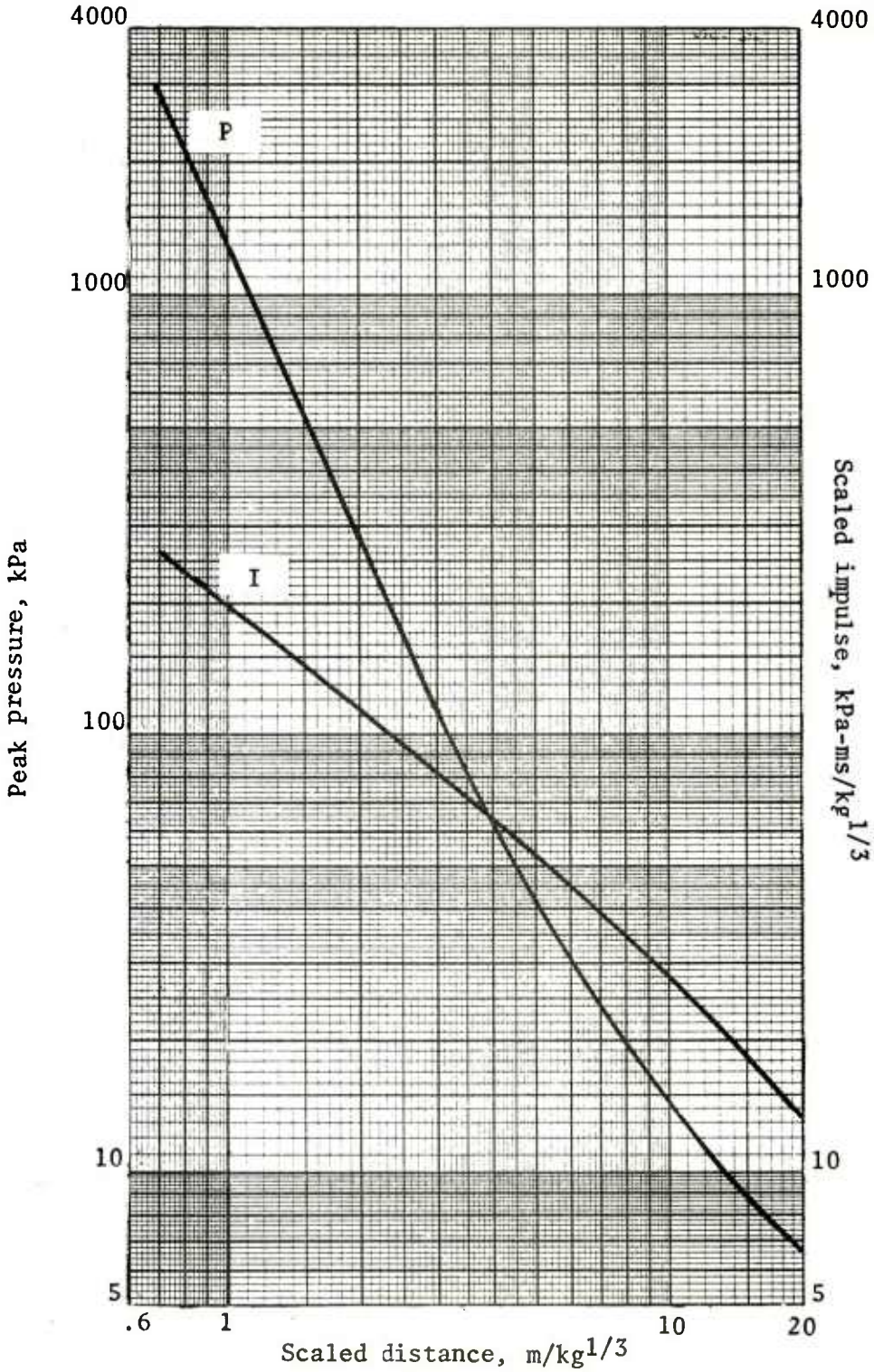


Figure 4. TNT pressure and impulse standards, metric units.

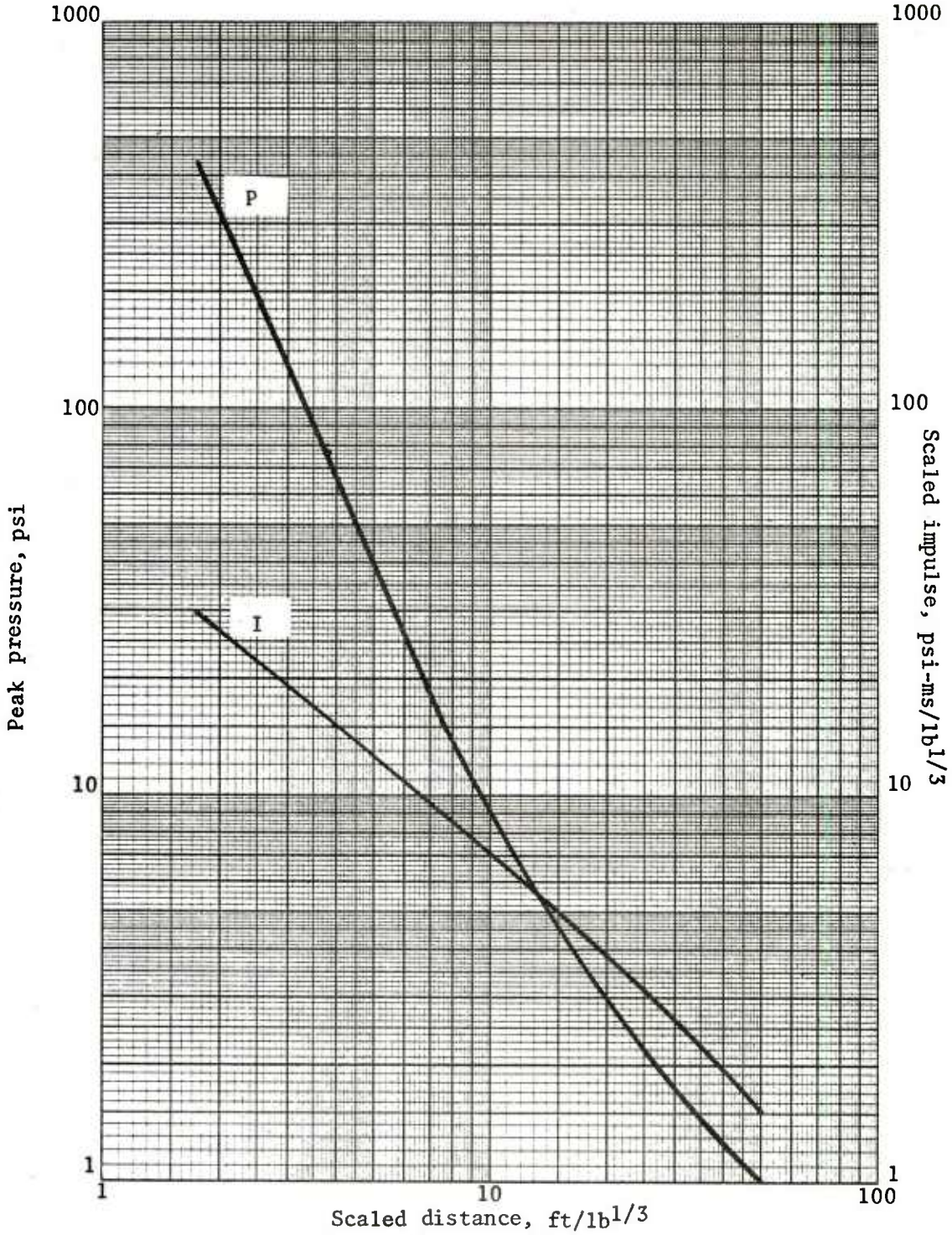


Figure 5. TNT pressure and impulse standards, English units.

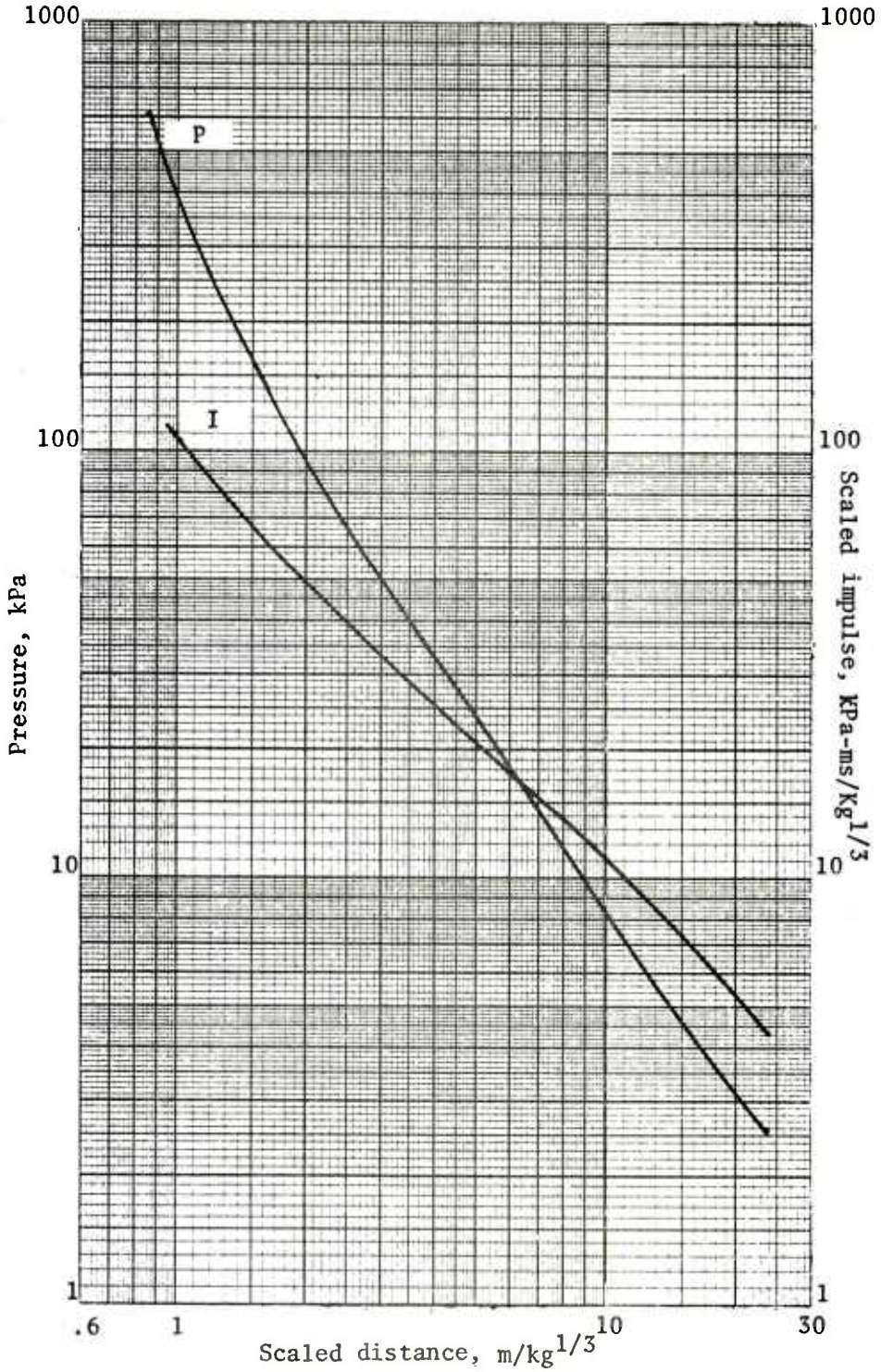


Figure 6. Pressure and scaled impulse curves for 10.43 kg Benite, shipping box.

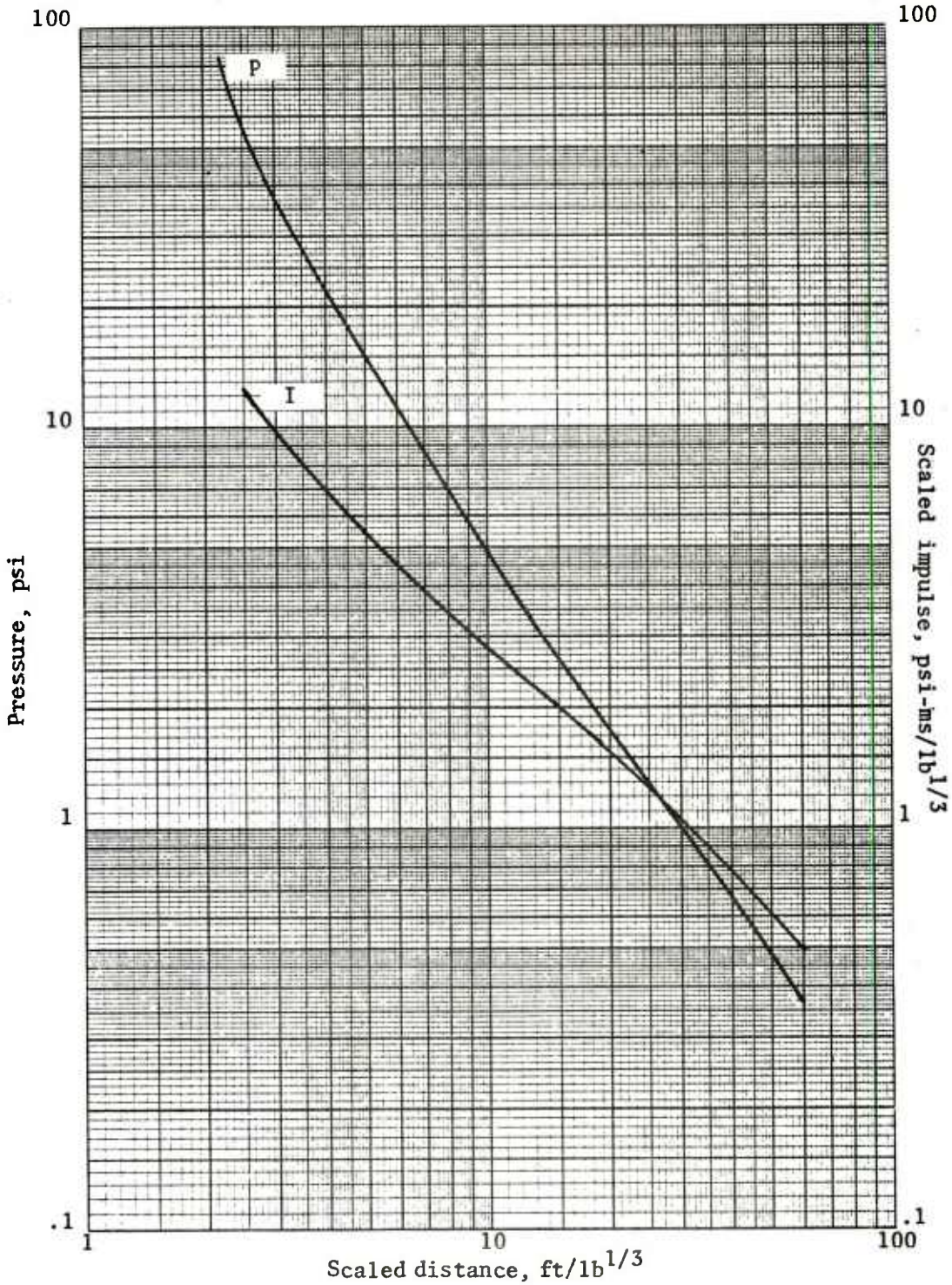


Figure 7. Pressure and scaled impulse curves for 23 lb Benite, shipping box.

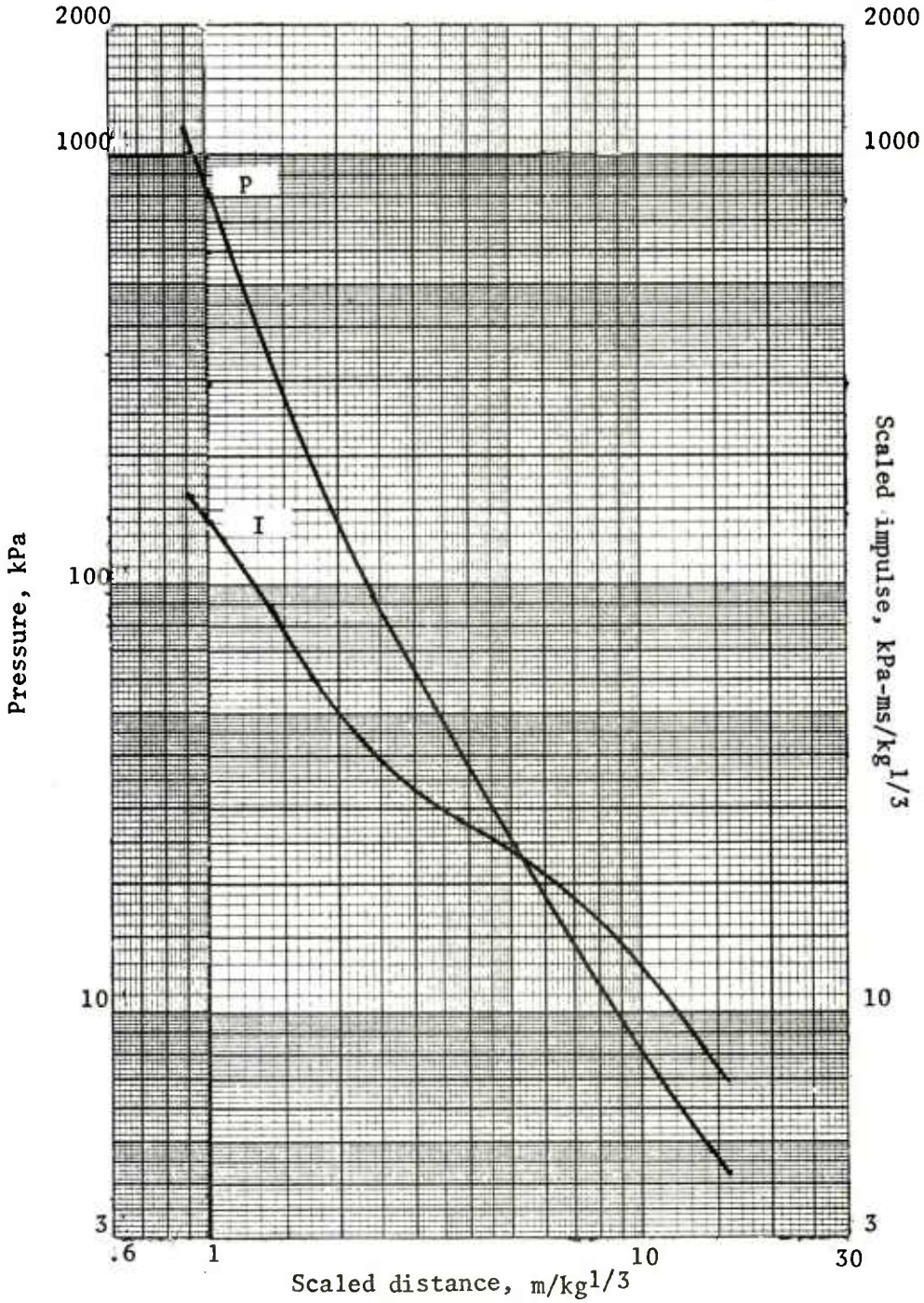


Figure 8. Pressure and scaled impulse curves for 41.8 kg Benite, shipping box.

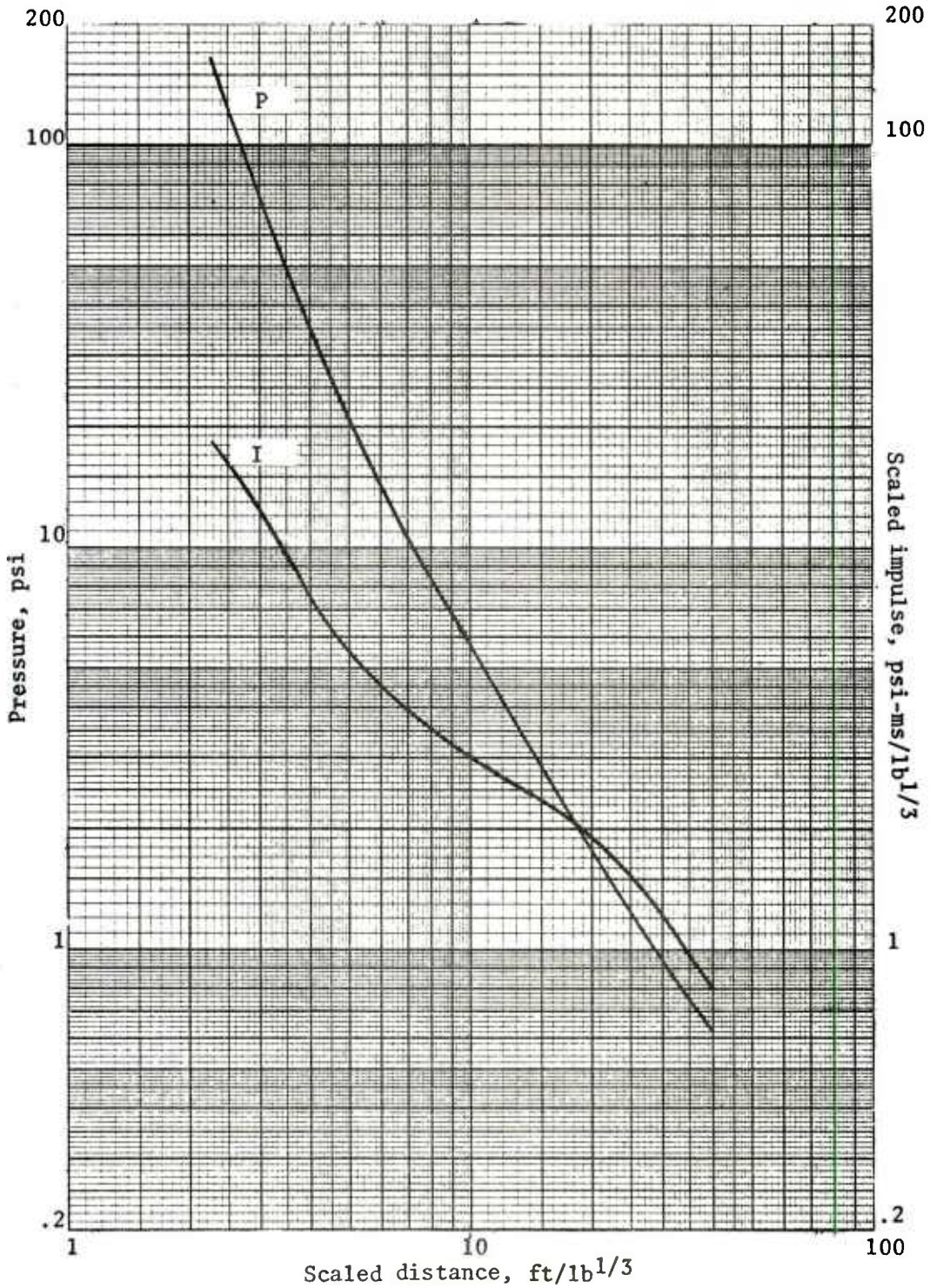


Figure 9. Pressure and scaled impulse curves for 92 lb Benite, shipping box.

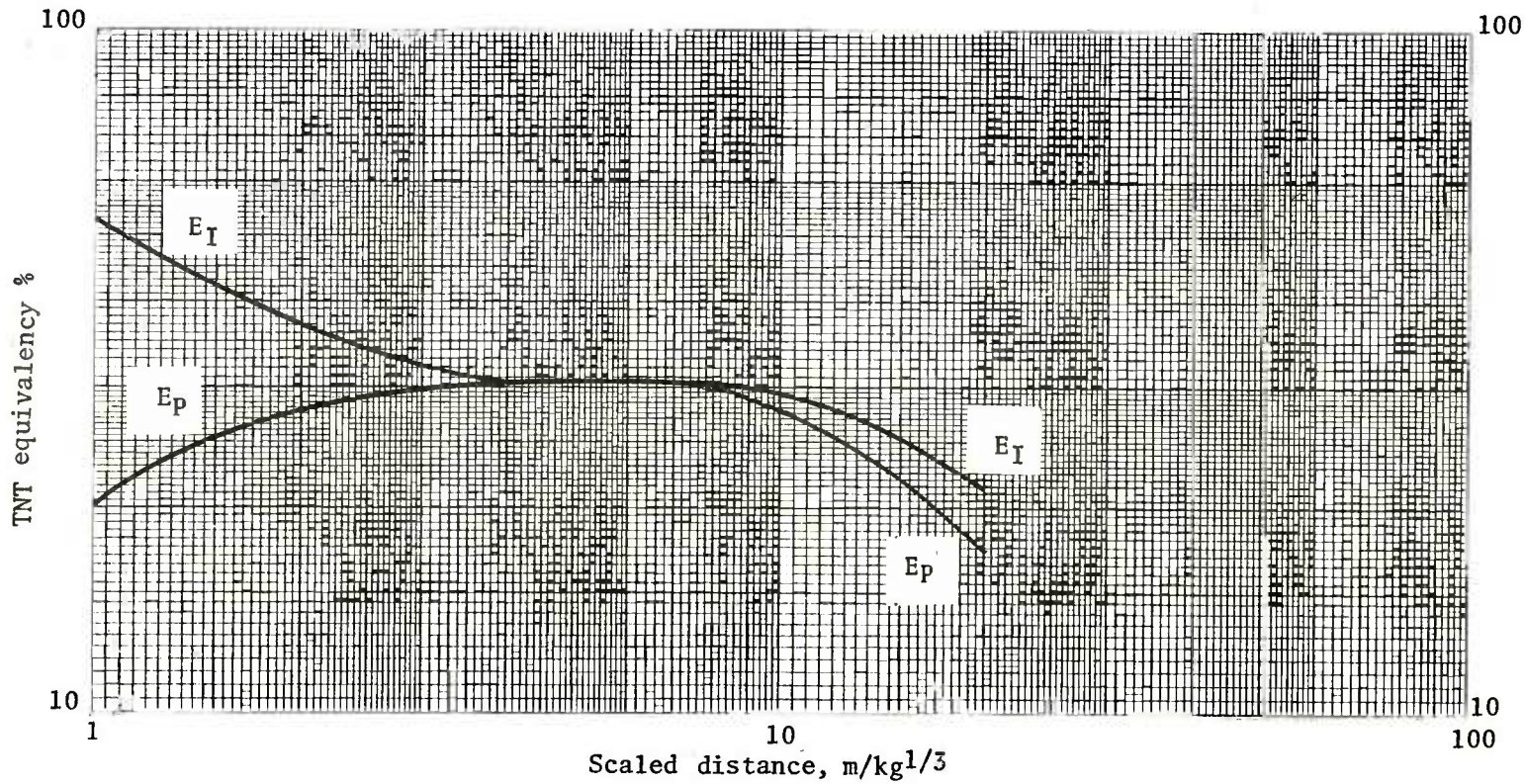


Figure 10. TNT equivalency of 10.43 kg of Benite, shipping box.

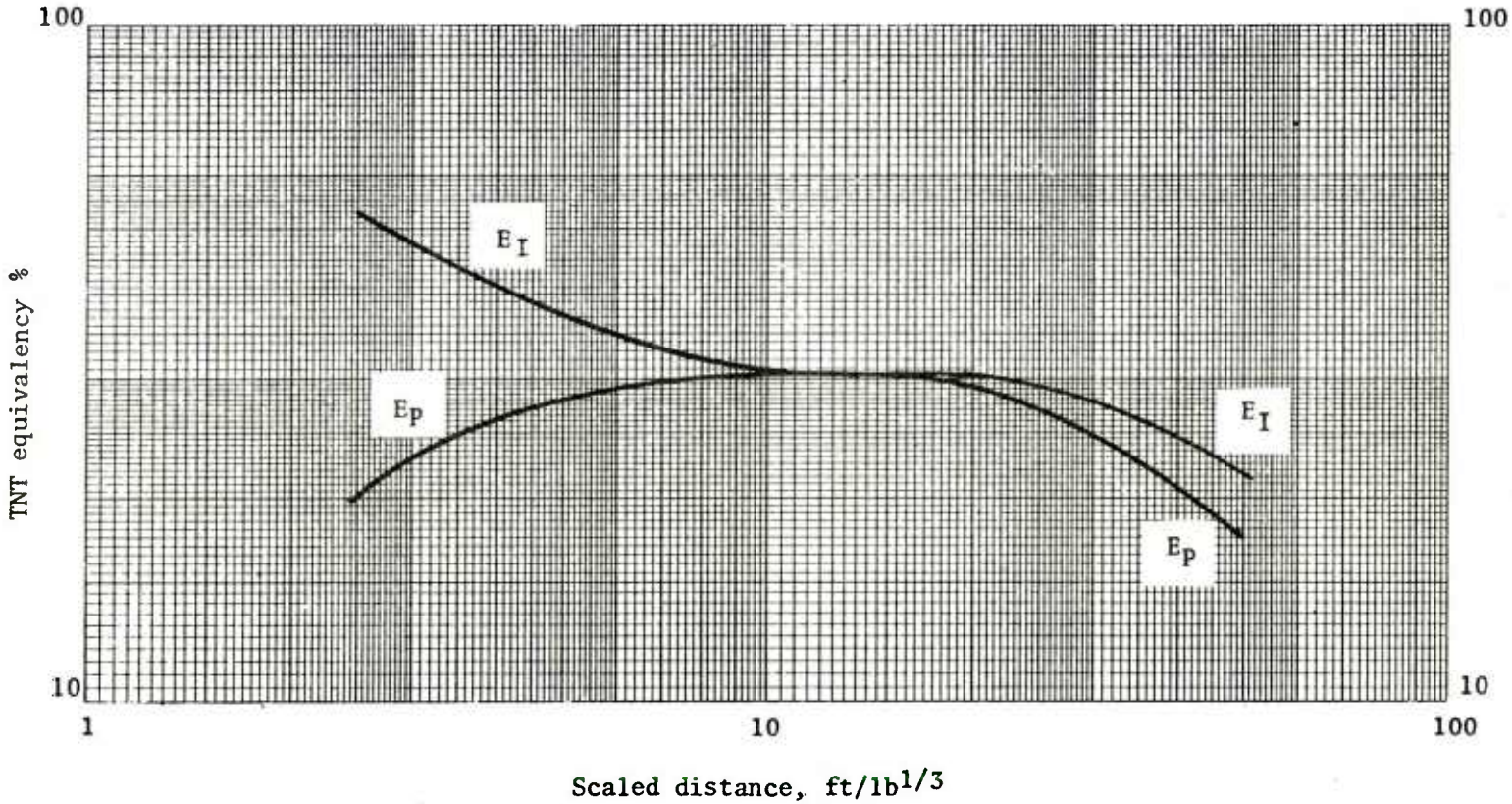


Figure 11. TNT equivalency of 23 lb of Benite, shipping box.

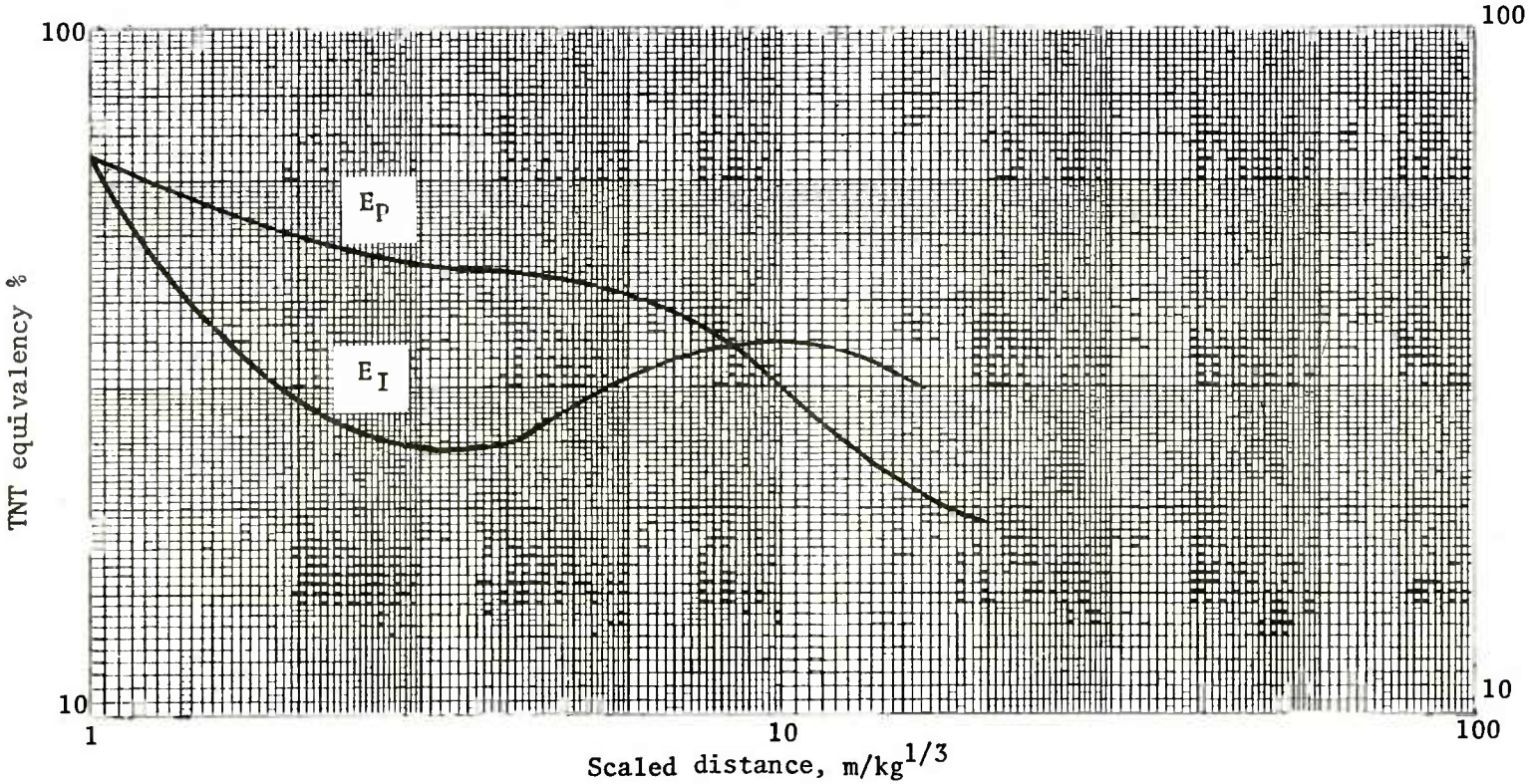


Figure 12. TNT equivalency of 41.8 kg of Benite, shipping box.

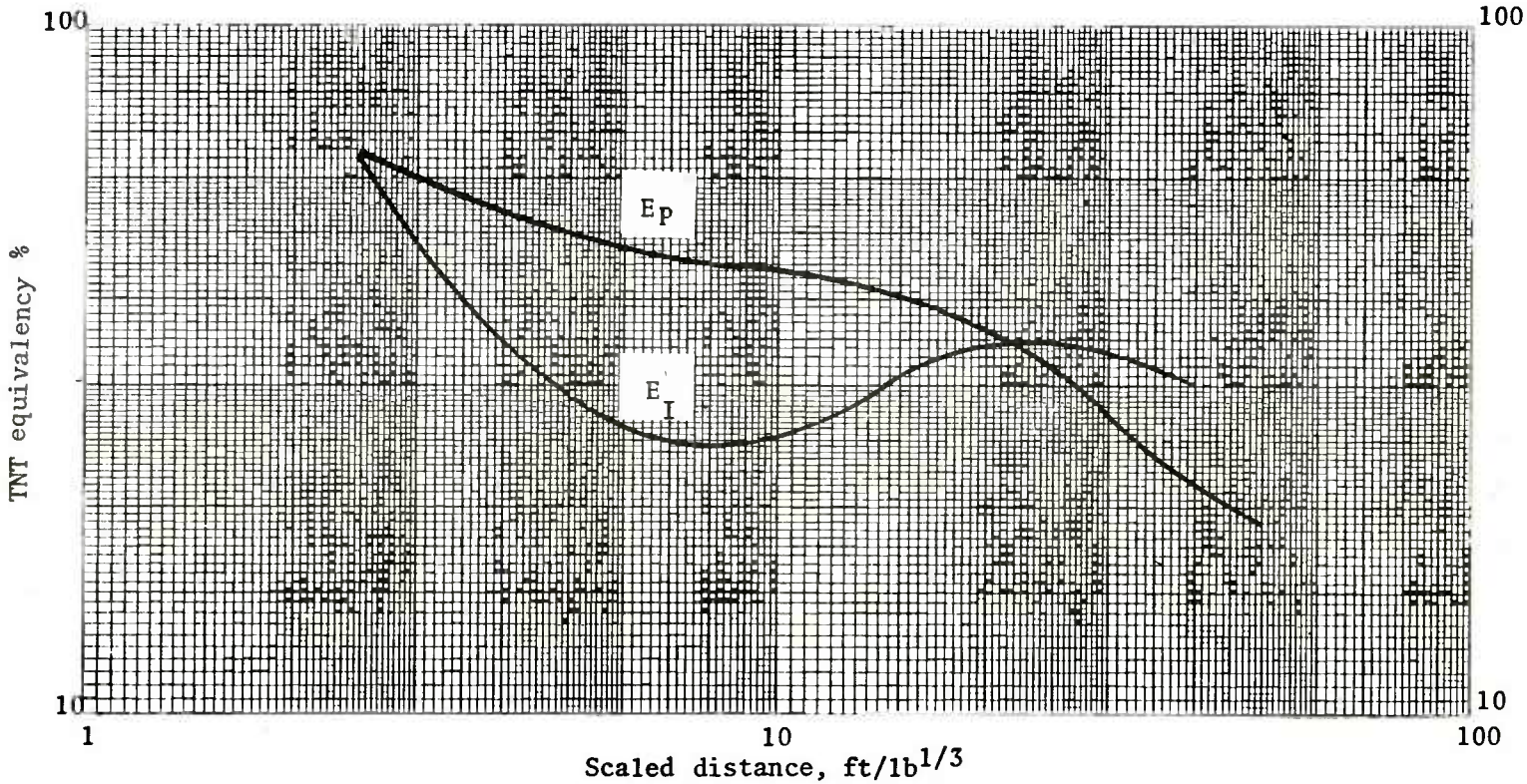


Figure 13. TNT equivalency of 92 lb of Benite, shipping box.

Figure 14. Typical pressure transducer in steel plate.

Figure 15. Pretest configuration, 10.43 kg shipping box.

Figure 16. Posttest crater, 10.43 kg shipping box.

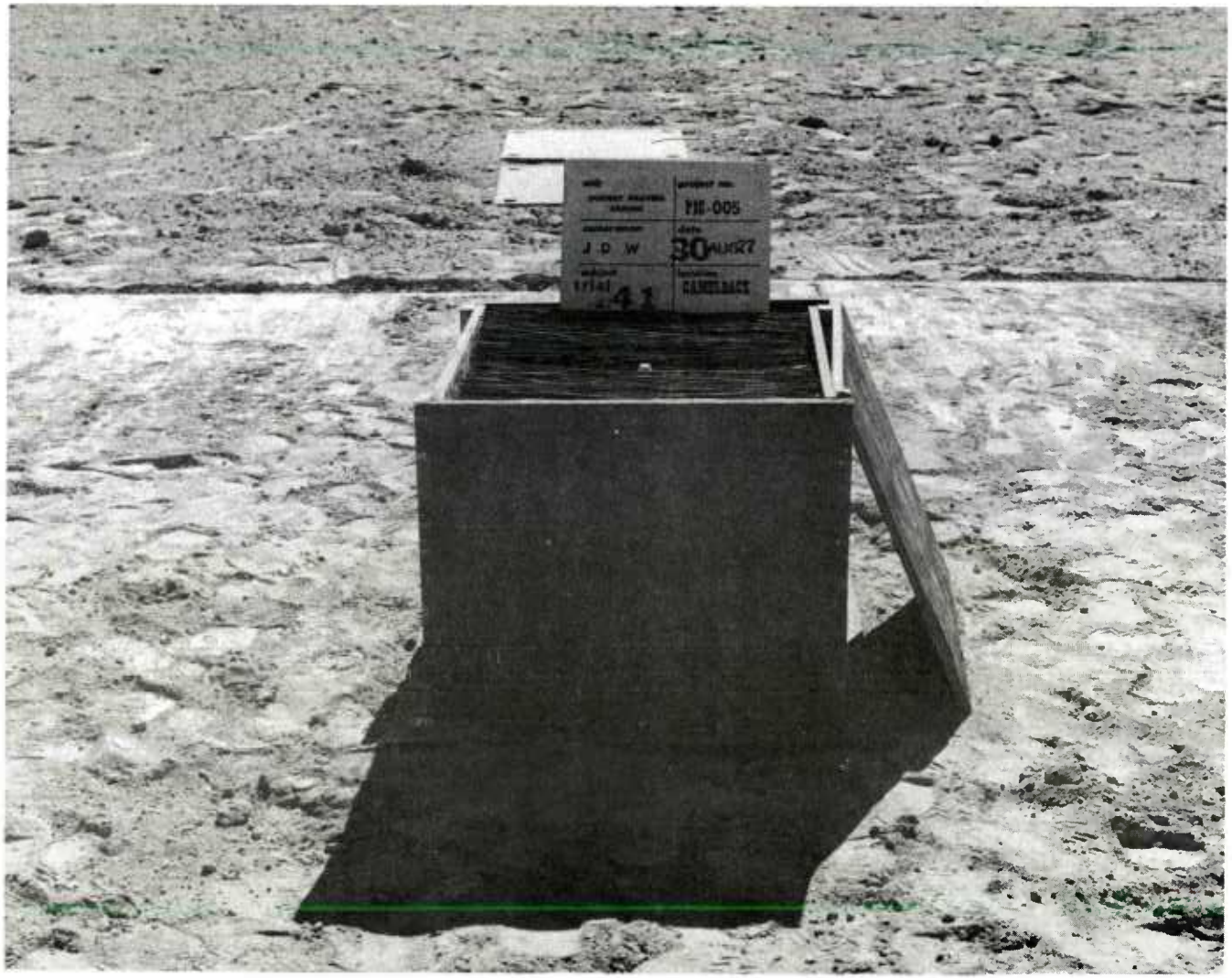


Figure 17. Pretest configuration, 41.8 kg shipping box.

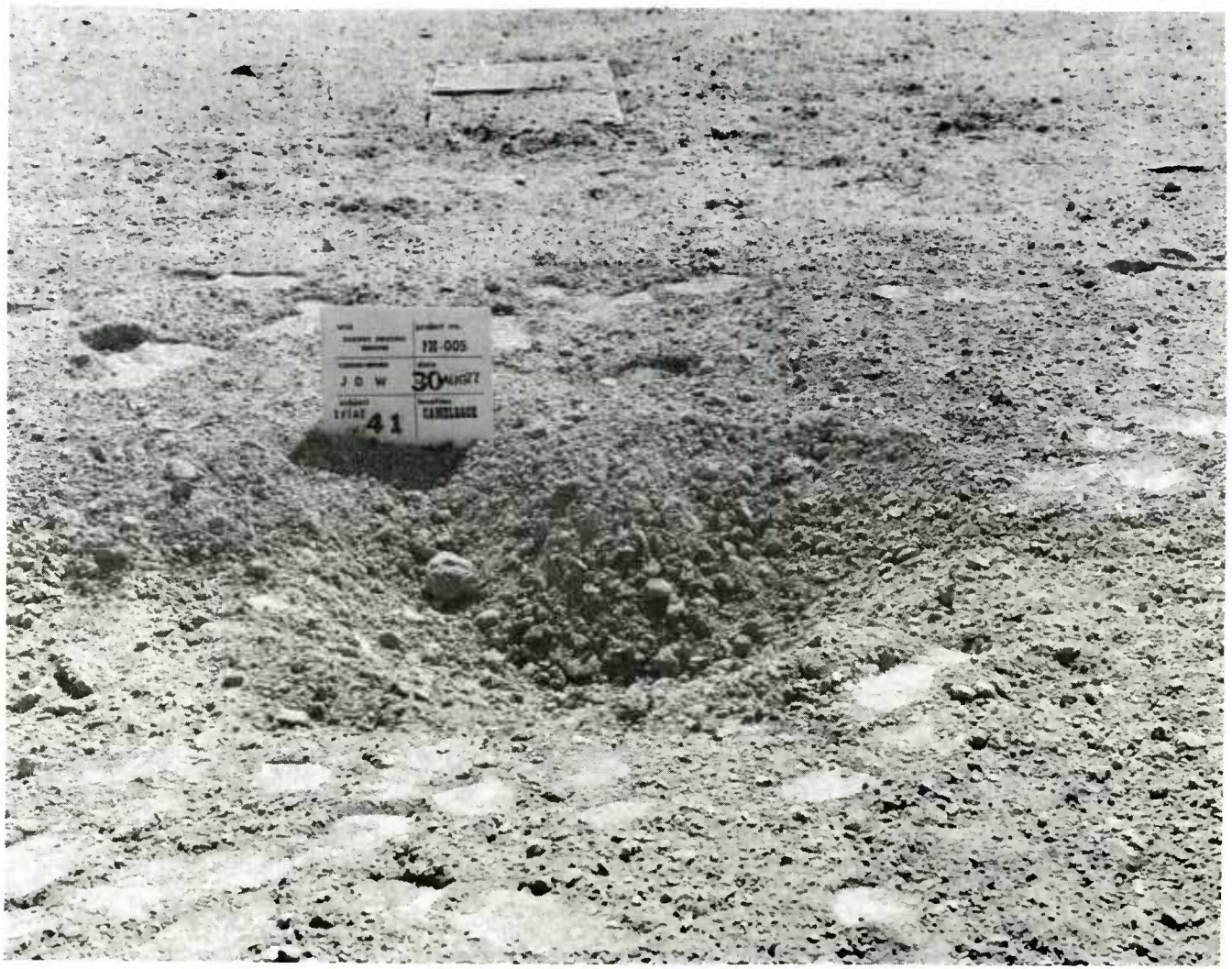


Figure 18. Posttest crater, 41.8 kg shipping box.

Figure 19. Posttest steel witness plates, incomplete detonation.

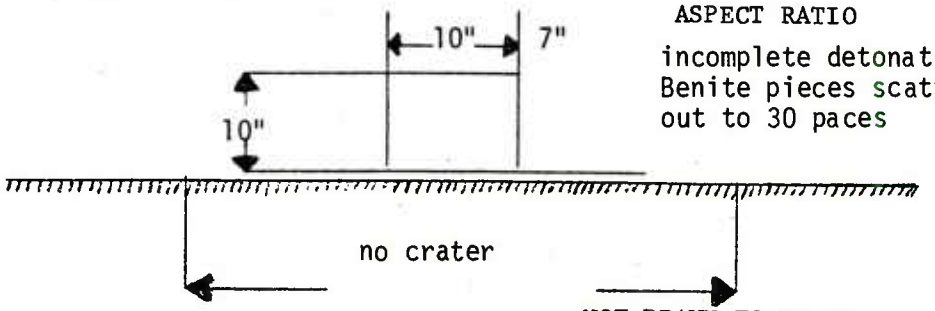
APPENDIX

FIELD DATA SHEETS

TEST DATA SHEETS, TNT EQUIVALENCY
10" Benite Lot "RAD 1-132 of 76

TEST TITLE	PIC-005	DATE	16 Aug 77
TEST SAMPLE	23 Benite	TIME	1330
SAMPLE WEIGHT		TEMP.	
IGNITION SOURCE		HUMIDITY	
BOOSTER WT.	0.5# C4 Cone	BAR. PRES.	
TEST NUMBER	29	WIND DIR.	195°
		WIND VEL.	4 m/s

COMPOSITION C-4 BOOSTER CHARGE



ASPECT RATIO

incomplete detonation
Benite pieces scattered
out to 30 paces

NOT DRAWN TO SCALE

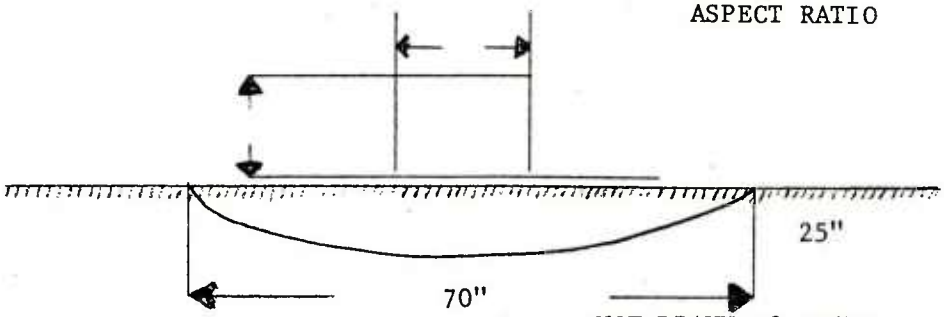
CHANNEL NUMBER	DISTANCE FT.	TIME OF ARRIVAL m sec	PEAK PRESSURE PSIG PCM	PEAK PRESSURE PSIG BIOMATION	POSITIVE IMPULSE psi-m sec PCM	POSITIVE IMPULSE psi-m sec BIOMATION	REMARKS
1A		15	29.4	no trigger	18.39		
1B	(7.1)	15	24			Bias level	change manual
2A		16	21.3	spike to	15.27		
2B	(8.1)	16	8.9	230.3	12.97		
3A		35	3.1	no trigger	6.8		
3B	(32.2)	33	2.2		4.48		
4A		62	0.8		2.31		
4B	(64.5)	62	0.17				
5A		104	0.36		1.31		
5B	(113.8)	104	0.34		1.17		
6A		161	0.22		1.58		
6B	(180.6)	162	0.18		0.79		

TEST DATA SHEETS, TNT EQUIVALENCY

TEST TITLE	PIC-005	DATE	16 Aug 77
TEST SAMPLE	25 C4 Hemisphere	TIME	1234
SAMPLE WEIGHT		TEMP.	
IGNITION SOURCE		HUMIDITY	
BOOSTER WT.		BAR. PRES.	
TEST NUMBER	Cal 6	WIND DIR.	
		WIND VEL.	

COMPOSITION C-4 BOOSTER CHARGE

ASPECT RATIO



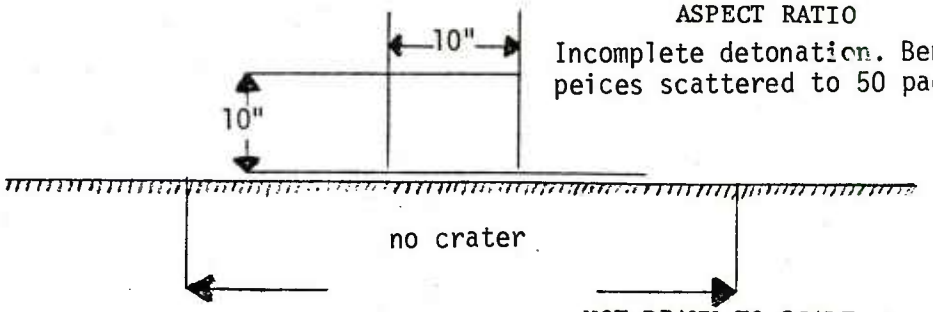
NOT DRAWN TO SCALE

CHANNEL NUMBER	DISTANCE FT.	TIME OF ARRIVAL m sec	PEAK PRESSURE PSIG PCM	PEAK PRESSURE PSIG BIOMATION	POSITIVE IMPULSE psi-m sec PCM	POSITIVE IMPULSE psi-m sec BIOMATION	REMARKS
1A		16	117.7	350			
1B	(7.1)	16	85	276			Ringing
2A		17	106.9	169			
2B	(8.1)	17	100.8	152			
3A		29	9.97	11.3			
3B	(32.2)	29	7.81				
4A		54	2.8				
4B	(64.5)	54	0.59				
5A		94	1.15				
5B	(113.8)	94	1.22				
6A		150	0.67				
6B	(180.6)	151	0.55				

TEST DATA SHEETS, TNT EQUIVALENCY

TEST TITLE	PIC-005	DATE	16 Aug
TEST SAMPLE	Benite	TIME	1513
SAMPLE WEIGHT	23# - 7 oz.	TEMP.	
IGNITION SOURCE		HUMIDITY	
BOOSTER WT.	1.0# C4 cone embedded	BAR. PRES.	
TEST NUMBER	29R1	WIND DIR.	340
		WIND VEL.	6.5 m/s

COMPOSITION C-4 BOOSTER CHARGE



ASPECT RATIO

Incomplete detonation. Benite peices scattered to 50 pace radius.

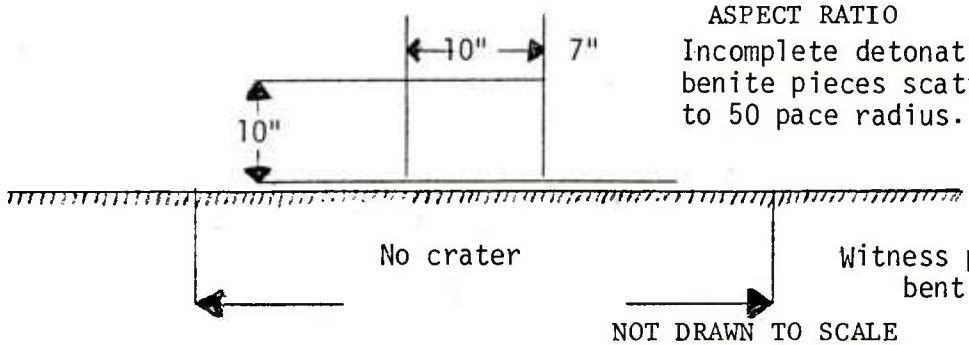
NOT DRAWN TO SCALE

CHANNEL NUMBER	DISTANCE FT.	TIME OF ARRIVAL m sec	PEAK PRESSURE PSIG PCM	PEAK PRESSURE PSIG BIOMATION	POSITIVE IMPULSE psi-m sec PCM	POSITIVE IMPULSE psi-m sec BIOMATION	REMARKS
1A		18	40.5	58.39			
1B	(7.1)	17	46.5	No trigger			
2A		18	39.7	43.64			
2B	(8.1)	18	26.7	42.35			
3A		35	4.56	4.97			
3B	(32.2)	34	3.75				
4A		61	1.2				
4B	(64.5)	60	0.25				
5A		102	0.48				
5B	(113.8)	101	0.61				
6A		158	0.22				
6B	(180.6)	158	0.36				

TEST DATA SHEETS, TNT EQUIVALENCY

TEST TITLE	PIC-005	DATE	16 Aug 77
TEST SAMPLE	Benite Vertical Strands	TIME	1430
SAMPLE WEIGHT	23#	TEMP.	
IGNITION SOURCE		HUMIDITY	
BOOSTER WT.	1.0# C4 Cone	BAR. PRES.	
TEST NUMBER	29R	WIND DIR.	325
		WIND VEL.	3.0 m/s

COMPOSITION C-4 BOOSTER CHARGE



ASPECT RATIO

Incomplete detonation benite pieces scattered to 50 pace radius.

NOT DRAWN TO SCALE

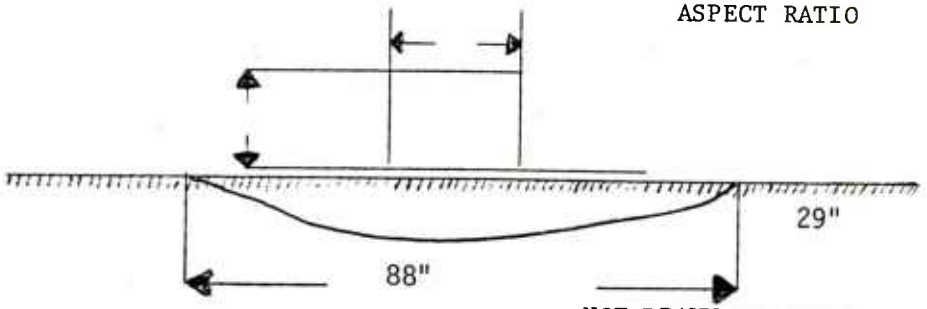
CHANNEL NUMBER	DISTANCE FT.	TIME OF ARRIVAL m sec	PEAK PRESSURE PSIG PCM	PEAK PRESSURE PSIG BIOMATION	POSITIVE IMPULSE psi-m sec PCM	POSITIVE IMPULSE psi-m sec BIOMATION	REMARKS
1A		16	40.5	No trigger			
1B	(7.1)	16	31.0				Data noisy
2A		17	21.4	No trigger			
2B	(8.1)	17	17.8				
3A		34	3.99	Spike-15.8			
3B	(32.2)	34	2.8				
4A		55	1.14				
4B	(64.5)	60	0.21				
5A		102	0.36				
5B	(113.8)	102	0.54				
6A		158	0.22				
6B	(180.6)	159	0.18				

TEST DATA SHEETS, TNT EQUIVALENCY

TEST TITLE	PIC-005	DATE	18 Aug 77
TEST SAMPLE	25 #C4 Hemisphere	TIME	1136
SAMPLE WEIGHT		TEMP.	
IGNITION SOURCE		HUMIDITY	
BOOSTER WT.		BAR. PRES.	
TEST NUMBER	Cal 7	WIND DIR.	175
		WIND VEL.	7.2 m/s

COMPOSITION C-4 BOOSTER CHARGE

ASPECT RATIO



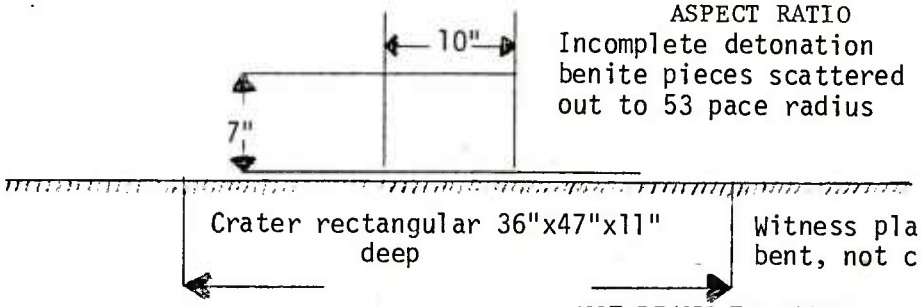
NOT DRAWN TO SCALE

CHANNEL NUMBER	DISTANCE FT.	TIME OF ARRIVAL m sec	PEAK PRESSURE PSIG PCM	PEAK PRESSURE PSIG BIOMATION	POSITIVE IMPULSE psi-m sec PCM	POSITIVE IMPULSE psi-m sec BIOMATION	REMARKS
1A		13	132.4	481, 248			
1B	(7.1)			353			Long flat response
2A		14	91.6	194			on PCM at 25
2B	(8.1)	14	74.1	165			
3A		26	9.97	11.3			
3B	(32.2)	26	7.19	7.93			
4A		51	2.4				
4B	(64.5)	51	0.55				
5A		92	1.09				
5B	(113.8)	92	1.22				
6A		149	0.45				
6B	(180.6)	150	0.55				

TEST DATA SHEETS, TNT EQUIVALENCY

TEST TITLE	PIC-005	DATE	18 Aug
TEST SAMPLE	23# Benite Horizontal strand	TIME	1273
SAMPLE WEIGHT		TEMP.	
IGNITION SOURCE		HUMIDITY	
BOOSTER WT.	1# C4 Cone embedded 1/2 way	BAR. PRES.	
TEST NUMBER	30	WIND DIR.	185
		WIND VEL.	3.7 m/s

COMPOSITION C-4 BOOSTER CHARGE



NOT DRAWN TO SCALE

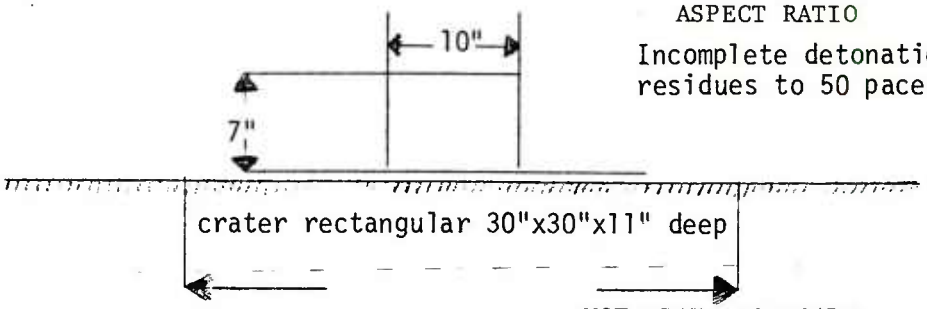
CHANNEL NUMBER	DISTANCE FT.	TIME OF ARRIVAL m sec	PEAK PRESSURE PSIG PCM	PEAK PRESSURE PSIG BIOMATION	POSITIVE IMPULSE psi-m sec PCM	POSITIVE IMPULSE psi-m sec BIOMATION	REMARKS
1A		11	66.2	No trigger	45.99		
1B	(7.1)	12	100.8	No trigger	73.91		
2A		12	64.1	No trigger	47.73		
2B	(8.1)	13	35.5	No trigger	36.13		
3A		29	6.55	5.88	10.41	8.77	
3B	(32.2)	28	3.44	3.47	8.19	6.47	
4A		55	1.2		4.13		
4B	(64.5)	55	0.25				
5A		97	0.6		2.79		
5B	(113.8)	97	0.68		2.71		
6A		155	0.45		1.04		
6B	(180.6)	156	0.18		0.73		

TEST DATA SHEETS, TNT EQUIVALENCY

TEST TITLE	PIC-005	DATE	18 Aug 77
TEST SAMPLE	Benite Horizontal	TIME	1253
SAMPLE WEIGHT	23#	TEMP.	
IGNITION SOURCE		HUMIDITY	
BOOSTER WT.	2#C4 cone 1 3/4" into Benite	BAR. PRES.	
TEST NUMBER	30R	WIND DIR.	200
		WIND VEL.	2.0 m/s

Photo identified as 31

COMPOSITION C-4 BOOSTER CHARGE



ASPECT RATIO

Incomplete detonation residues to 50 paces

NOT DRAWN TO SCALE

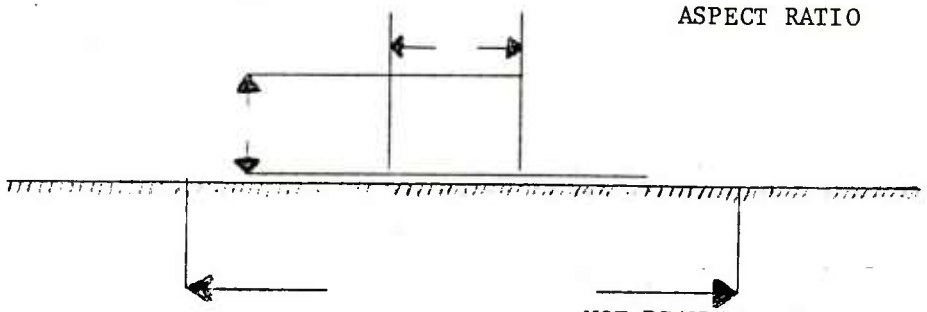
CHANNEL NUMBER	DISTANCE FT.	TIME OF ARRIVAL m sec	PEAK PRESSURE PSIG PCM	PEAK PRESSURE PSIG BIOMATION	POSITIVE IMPULSE psi-m sec PCM	POSITIVE IMPULSE psi-m sec BIOMATION	REMARKS
1A		16	121.4	116	72.43	54.31	
1B	(7.1)	16	89.2	No trigger	55.31		
2A		17	58.0	84	85.88	51.52	
2B	(8.1)	17	56.3	89.4	71.32	56.99	
3A		32	7.12	7.23	12.11	5.06	
3B	(32.2)	31	4.69	4.46	11.80	1.85	
4A		58	1.80		6.31		
4B	(64.5)	58	0.34				
5A		99	0.72		3.26		
5B	(113.8)	99	0.74		3.03		
6A		156	0.45		1.54		
6B	(180.6)	157	0.36		3.04		

TEST DATA SHEETS, TNT EQUIVALENCY

TEST TITLE	PIC-005	DATE	19 Aug 77
TEST SAMPLE	25# C4 Hemisphere	TIME	1044
SAMPLE WEIGHT		TEMP.	
IGNITION SOURCE		HUMIDITY	
BOOSTER WT.		BAR. PRES.	
TEST NUMBER	Cal 8	WIND DIR.	305
		WIND VEL.	1.5 m/s

COMPOSITION C-4 BOOSTER CHARGE

ASPECT RATIO



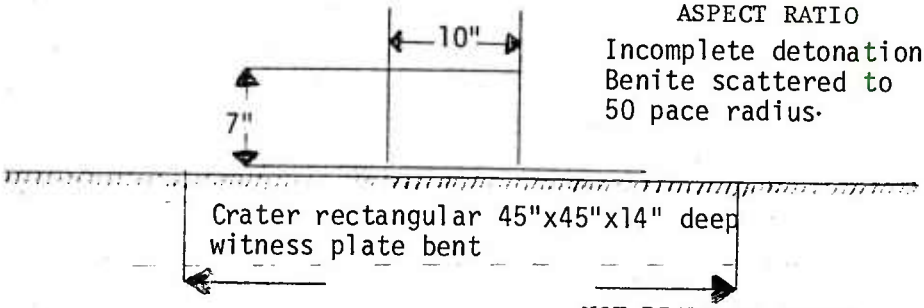
NOT DRAWN TO SCALE

CHANNEL NUMBER	DISTANCE FT.	TIME OF ARRIVAL m sec	PEAK PRESSURE PSIG PCM	PEAK PRESSURE PSIG BIOMATION	POSITIVE IMPULSE psi-m sec PCM	POSITIVE IMPULSE psi-m sec BIOMATION	REMARKS
1A		13	257	315			
1B	(7.1)	13	65.9	178			Ringing
2A		13	116	252			Ringing
2B	(8.1)	13	136	136			Ringing
3A				3.62			No data
3B	(32.2)	26	7.19	7.93			
4A		51	3.40				
4B	(64.5)	51	0.59				
5A		91	1.45				
5B	(113.8)						No data
6A		148	0.67				Noisy up to .9
6B	(180.6)						No data

TEST DATA SHEETS, TNT EQUIVALENCY

TEST TITLE	PIC-005	DATE	19 Aug 77
TEST SAMPLE	Benite	TIME	
SAMPLE WEIGHT	73#	TEMP.	
IGNITION SOURCE		HUMIDITY	
BOOSTER WT.	4# C4 Cone	BAR. PRES.	
TEST NUMBER	30R1	WIND DIR.	335
		WIND VEL.	1.5

COMPOSITION C-4 BOOSTER CHARGE



ASPECT RATIO

Incomplete detonation
Benite scattered to
50 pace radius.

NOT DRAWN TO SCALE

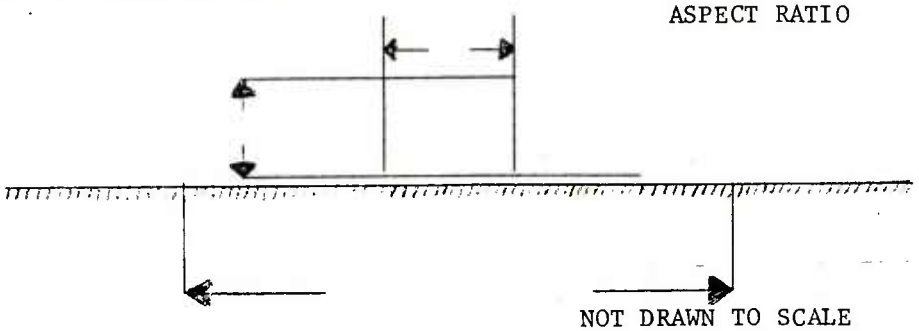
CHANNEL NUMBER	DISTANCE FT.	TIME OF ARRIVAL m sec	PEAK PRESSURE PSIG PCM	PEAK PRESSURE PSIG BIOMATION	POSITIVE IMPULSE psi-m sec PCM	POSITIVE IMPULSE psi-m sec BIOMATION	REMARKS
1A		15	77.3	192	52.88	67.27	
1B	(7.1)		No data				
2A		15	106.9	198	87.82	75.49	Ringing
2B	(8.1)	15	62.3	131	44.47	50.50	
3A					Bad data atypical wave form		
3B	(32.2)				interference appeared on all channels		
4A		55	2.8		9.25		
4B	(64.5)	55	.34				
5A		97	1.03		4.86		
5B	(113.8)		no data				
6A		154	0.45		2.65		
6B	(180.6)		no data				

TEST DATA SHEETS, TNT EQUIVALENCY

TEST TITLE	PIC-005	DATE	30 Aug 77
TEST SAMPLE	25#C4 Hemisphere	TIME	0947
SAMPLE WEIGHT		TEMP.	
IGNITION SOURCE		HUMIDITY	
BOOSTER WT.		BAR. PRES.	
TEST NUMBER	Cal 12	WIND DIR.	187
		WIND VEL.	2.7 m/s

COMPOSITION C-4 BOOSTER CHARGE

ASPECT RATIO



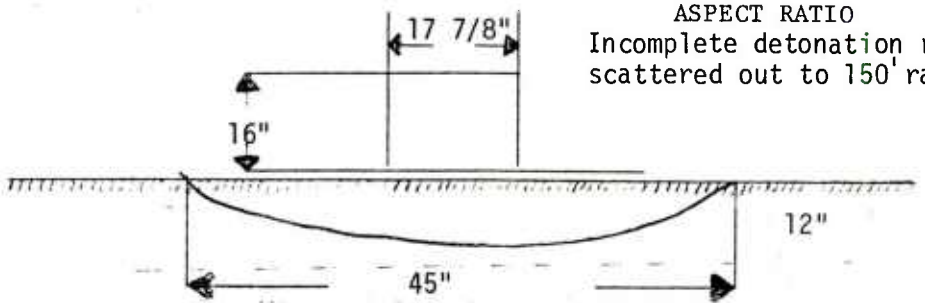
NOT DRAWN TO SCALE

CHANNEL NUMBER	DISTANCE FT.	TIME OF ARRIVAL m sec	PEAK PRESSURE PSIG PCM	PEAK PRESSURE PSIG BIOMATION	POSITIVE IMPULSE psi-m sec PCM	POSITIVE IMPULSE psi-m sec BIOMATION	REMARKS
1A		15	57.5	105			
1B	7.1	15	108.55	84.7			
2A		16	55.0	75			
2B	8.1	16	20.75	35.29			
3A		27	7.69	8.77			
3B	32.2	27	6.56	6.94			
4A		52	3.00				
4B	64.5	52	0.51				
5A		93	1.03				
5B	113.8	94	1.28				
6A		151	0.45				
6B	180.6	152	0.73				

TEST DATA SHEETS, TNT EQUIVALENCY

TEST TITLE	PIC-005	DATE	30 Aug 77
TEST SAMPLE	Benite	TIME	1114
SAMPLE WEIGHT	92#	TEMP.	
IGNITION SOURCE		HUMIDITY	
BOCSTER WT.	5# C4 cone 9" tall	BAR. PRES.	
TEST NUMBER	Embedded 41	WIND DIR.	215
		WIND VEL.	1.5 m/s

COMPOSITION C-4 BOOSTER CHARGE



ASPECT RATIO
Incomplete detonation residue scattered out to 150' radius

Witness plate bent not cut

NOT DRAWN TO SCALE

CHANNEL NUMBER	DISTANCE FT.	TIME OF ARRIVAL m sec	PEAK PRESSURE PSIG PCM	PEAK PRESSURE PSIG BIOMATION	POSITIVE IMPULSE psi-m sec PCM	POSITIVE IMPULSE psi-m sec BIOMATION	REMARKS
1A		13	84.6	163	83.04	81.06	Noise on channel early
1B		13	85.2	147	77.53		Early trigger
2A		13	91.6	96.97		71.48	Early trigger
2B		13	53.4	80	51.88	65.60	Poor wave shape
3A		23	13.39	12.66	20.29	17.81	
3B		22	10.62	10.91	19.91	20.01	
4A		46	3.60		11.88		
4B		45	0.64				
5A		87	1.15		7.11		
5B		86	1.49		8.52		
6A		144	0.67		4.39		Double peak
6B		143	0.73		1.64		

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