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CONTRACTOR REPORT ARLCD-CR-77003

BLAST PARAMETERS OF BS-NACO PROPELLANT

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P. PRICE
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APRIL 1977

U.S. ARMY
ARRADCOM
US ARMY ARMAMENT RESEARCH AND DEVELOPMENT COMMAND
LARGE CALIBER
WEAPON SYSTEMS LABORATORY
DOVER, NEW JERSEY

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER Contractor Report ARLCD-CR-77003	2. GOVT ACCESSION NO.
	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) BLAST PARAMETERS OF BS-NACO PROPELLANT	5. TYPE OF REPORT & PERIOD COVERED Final Report
	6. PERFORMING ORG. REPORT NUMBER IITRI-J6342-8
7. AUTHOR(s) J. J. Swatosh, and J. R. Cook of IITRI P. Price (Project Coordinator) of ARRADCOM	8. CONTRACT OR GRANT NUMBER(s) DAAA21-74-C-0521
9. PERFORMING ORGANIZATION NAME AND ADDRESS IIT Research Institute 10 West 35th Street Chicago, IL 60616	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS ARRADCOM, LCWSL Manufacturing Technology Division Dover, NJ 07801	12. REPORT DATE April 1977
	13. NUMBER OF PAGES 56
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)	15. SECURITY CLASS. (of this report) Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release, distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

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

Peak blast pressure
Positive impulse
TNT equivalency
BS-NACO propellant

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

Experiments were performed with BS-NACO propellant in subscale and full-scale shipping/storage drum configurations and in full-scale conically shaped feed hopper configurations to determine the air-blast pressure and positive impulse resulting from the detonation of the material. Peak pressure and positive impulse were measured in the scaled distance range of approximately 2 to 25 ft/lb$^{1/3}$. TNT equivalency curves for both pressure and impulse were developed as a function of scaled distance. Based on the test results, BS-NACO propellant should be considered QD Class 2 material while in-process.

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ACKNOWLEDGEMENTS

IIT Research Institute (IITRI) had conducted a program to determine the TNT equivalency of BS-NACO propellant. This work was conducted for Picatinny Arsenal, Manufacturing Technology Directorate (MTD), Dover, New Jersey, under Contract DAAA21-74-C-0521.

Technical guidance was provided by Messrs. P. Price, D. Westover, and S. Levmore of MTD. Personnel who contributed to the large-scale experiments conducted at Dugway Proving Ground, Dugway, Utah include A. K. Keetch and P. E. Miller of the Hazards Evaluation Office. Small-scale tests were conducted at IITR's explosive test site near LaPorte, Indiana.

IITRI staff who made major contributions to this effort include: M. Amor, J. Cook, C. Foxx, D. Hrdina, R. Joyce, G. Kutzer, H. Napadensky, and J. Swatosh, Jr.

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SUMMARY

Shipping containers and full-scale simulated feed hoppers containing 110 and 330 lb of BS-NACO propellant, respectively, were ignited with explosive boosters. Blast output was measured and TNT equivalency was computed based upon a comparison with the explosive blast output of a surface burst of a hemispherically shaped TNT charge. The results of these computations in terms of a TNT equivalency profile are presented in Table 1, and in Figures 1, 2, and 3.

Table 1

TNT equivalency of BS-NACO propellant

	TNT equivalency (%)					
	3 ft/lb$^{1/3}$		9 ft/lb$^{1/3}$		18 ft/lb$^{1/3}$	
Configuration	P	I	P	I	P	I
Shipping container (110 lb)						
Short side	30	10	15	10	–	–
Long side	30	20	15	10	–	–
Feed hopper (330 lb)	25	45	30	35	25	35

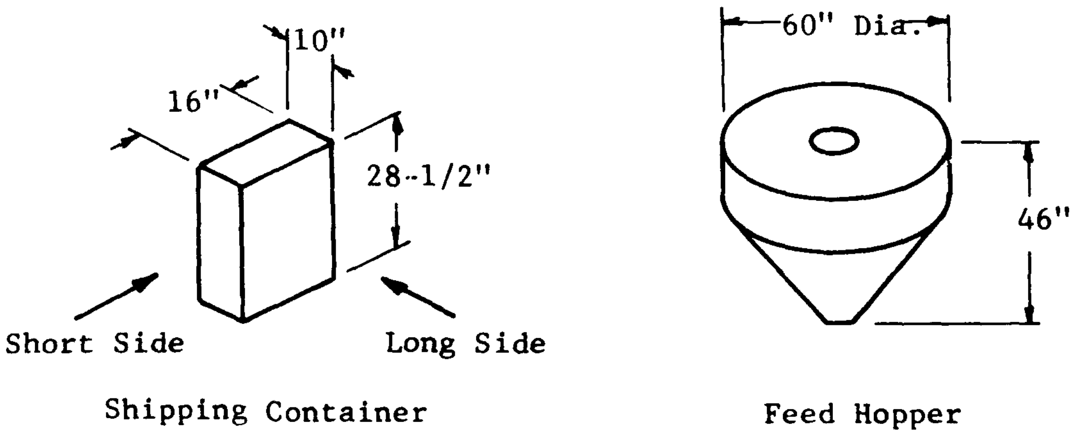

Fig 1 Equivalency profiles

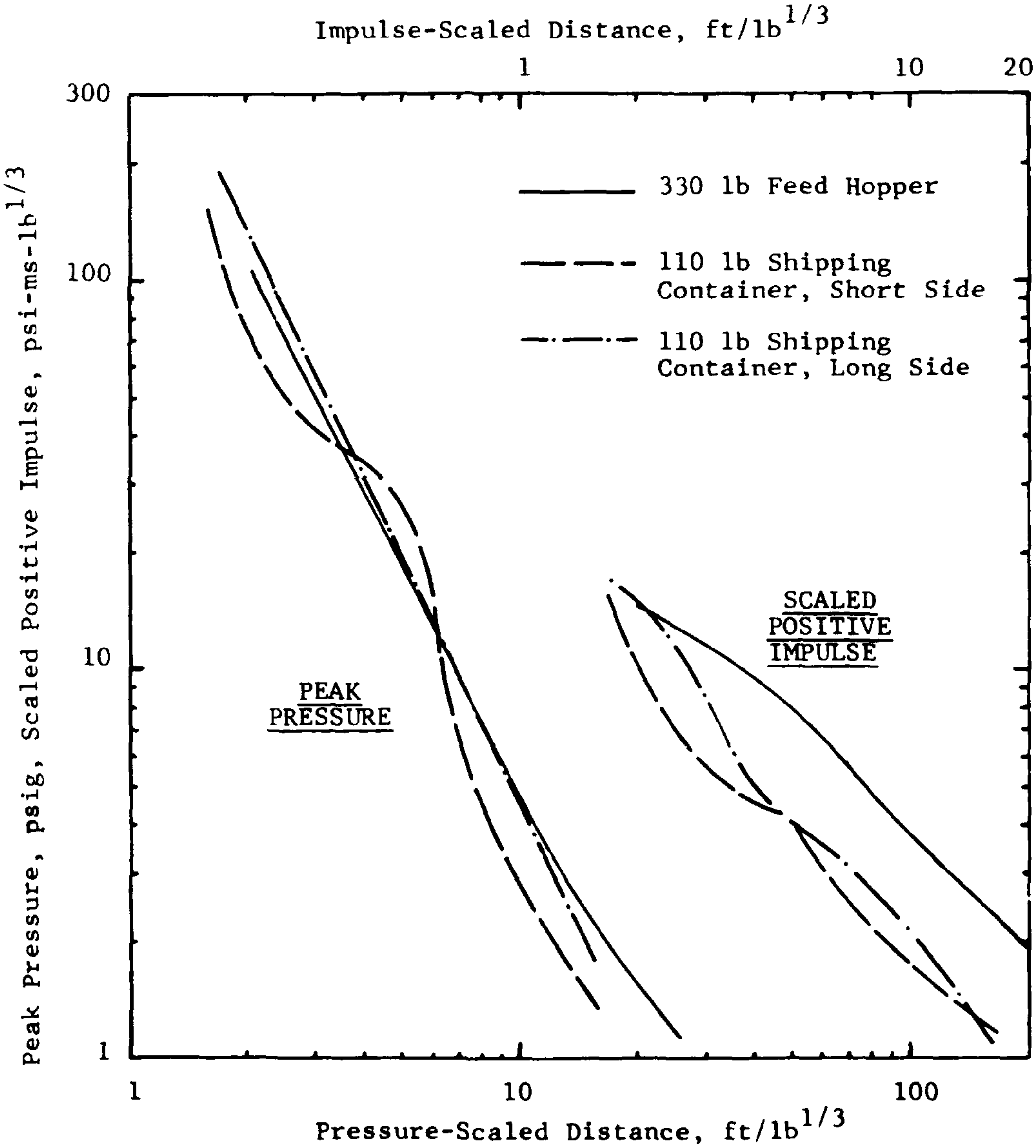

Fig 2 Peak pressure and positive impulse, BS-NACO

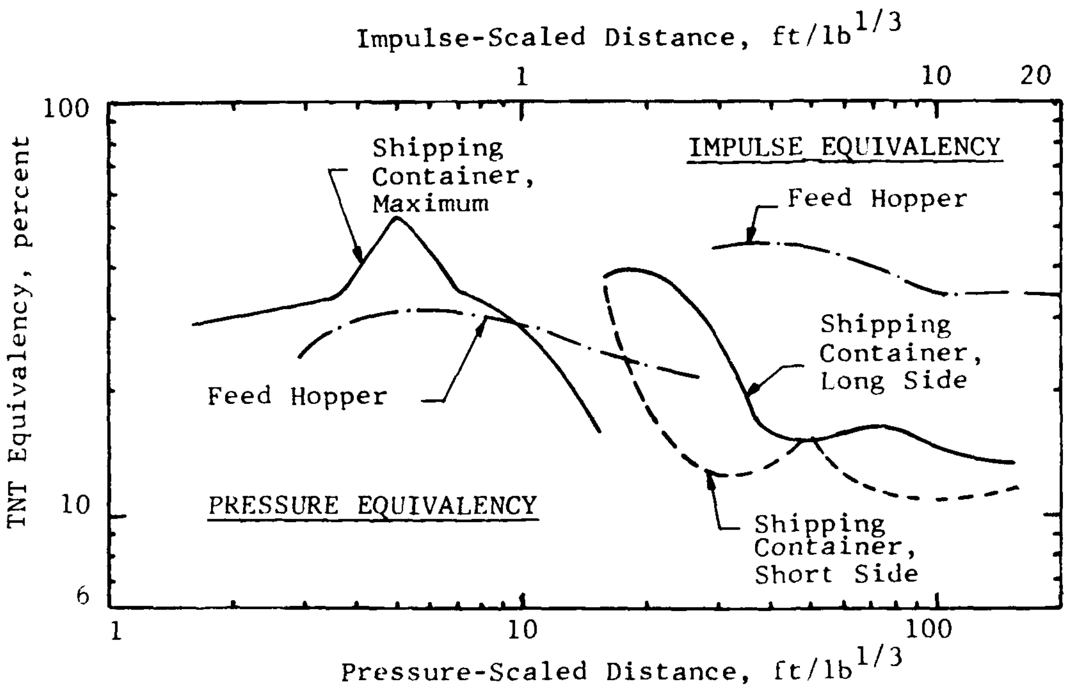

Fig 3 TNT equivalency, BS-NACO

INTRODUCTION

Background

The US Army Materiel Command initiated a program to upgrade the safety standards of new and existing ammunition plants. In support of this program, the Manufacturing Technology Directorate of Picatinny Arsenal developed design standards for hardening protective structures to withstand the effects of the detonation of high explosives. Design and safety engineers require data pertinent to the maximum strength of a blast wave that may originate from any of the explosive or deflagrateable materials present in the plant. Since the airblast capabilities of BS-NACO propellant could not be obtained from the available literature, the Arsenal sought to establish TNT equivalencies of these materials.

Past methods for siting and the design of individual components of explosive manufacturing and related facilities have been based on gross quantities of explosives or propellants. Present day technology has shown that cost effective yet safe facilities can be built, if design criteria is based on the actual explosive output of the materials involved.

A facility designer requires information on the blast pressure-time history, characterized by peak pressure and positive impulse. A considerable amount of prior work has been performed in establishing the airblast parameters of TNT. Consequently, for facility designs involving other energetic materials the design information can be expressed in terms of TNT equivalency. In this report information is presented for peak pressure, positive impulse, pressure TNT equivalency, and impulse TNT equivalency.

Benefits to be realized through this study include significant cost savings, by avoiding the overdesign of structures, and improved safety of personnel by the installation of adequate blast protection.

Objectives

Experimentally determine the maximum airblast output; peak overpressure and positive impulse of BS-NACO propellant.

Determine the TNT equivalencies of BS-NACO propellant by comparing its measured pressure and positive impulse with those produced by the detonation of an unconfined hemispherical charge of TNT.

TEST PROCEDURES

Test Sites

Subscale tests were conducted at the IITRI explosive research laboratory near LaPorte, Indiana. A schematic diagram of the test area physical arrangement is shown in Figure 1. It consists of two concrete slabs 75 ft long by 10 ft wide in which 12 pressure transducers were installed. The pressure transducers were mounted flush with the top surface of the concrete slab in mechanically isolated steel plates. The charges were located at ground zero (GZ) as indicated on Figure 4. The BS-NACO charges were always set on a steel witness plate, on level ground.

Large-scale tests were performed at Dugway Proving Ground, Utah at a remote desert site. A schematic plan view of the test site is shown in Figure 5. Radiating from GZ were two 40-ft-wide by 500-ft-long level land areas cleared of brush.

Pressure gages were located at discrete intervals in the cleared areas of the test site. The gages were flush-mounted in steel plates which in turn were flush-mounted with the ground surface. Determination of the location of a particular gage was based on anticipated overpressures from the test material.

Test Configurations

Three test configurations were tested. The first was a cylindrical cardboard drum full of BS-NACO multiperforated (0.048 inch web size) propellant. The cardboard drum was 19 inches long by 11 inches in diameter. Each contained 50 lb of propellant. Figure 6 illustrates how cylindrical Comp C4* explosive boosters were placed into the BS-NACO propellant at the top of the charge. The cylinderical Comp C4 boosters had a 1:1 aspect ratio. A cardboard cover was placed over the top of each drum. A small hole was cut into the cover so that the blasting cap could be put into the system last.

The second test configuration was a full-size metal shipping container, measuring 10 by 16 inches by 28-1/2 inches high. They were of rugged steel construction and offered heavy confinement to the propellant. Each shipping container contained 110 lb, net weight, of BS-NACO. Cylinderical Comp C4 boosters were located inside the containers near the top of the charge. The containers were set upright on the ground at GZ over a steel witness plate.

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*Composition C4, a plastic explosive containing 91% RDX, 2.1% polyisobutylene, 1.6% motor oil, 5.3% di (2-ethylhexyl) sebacate.

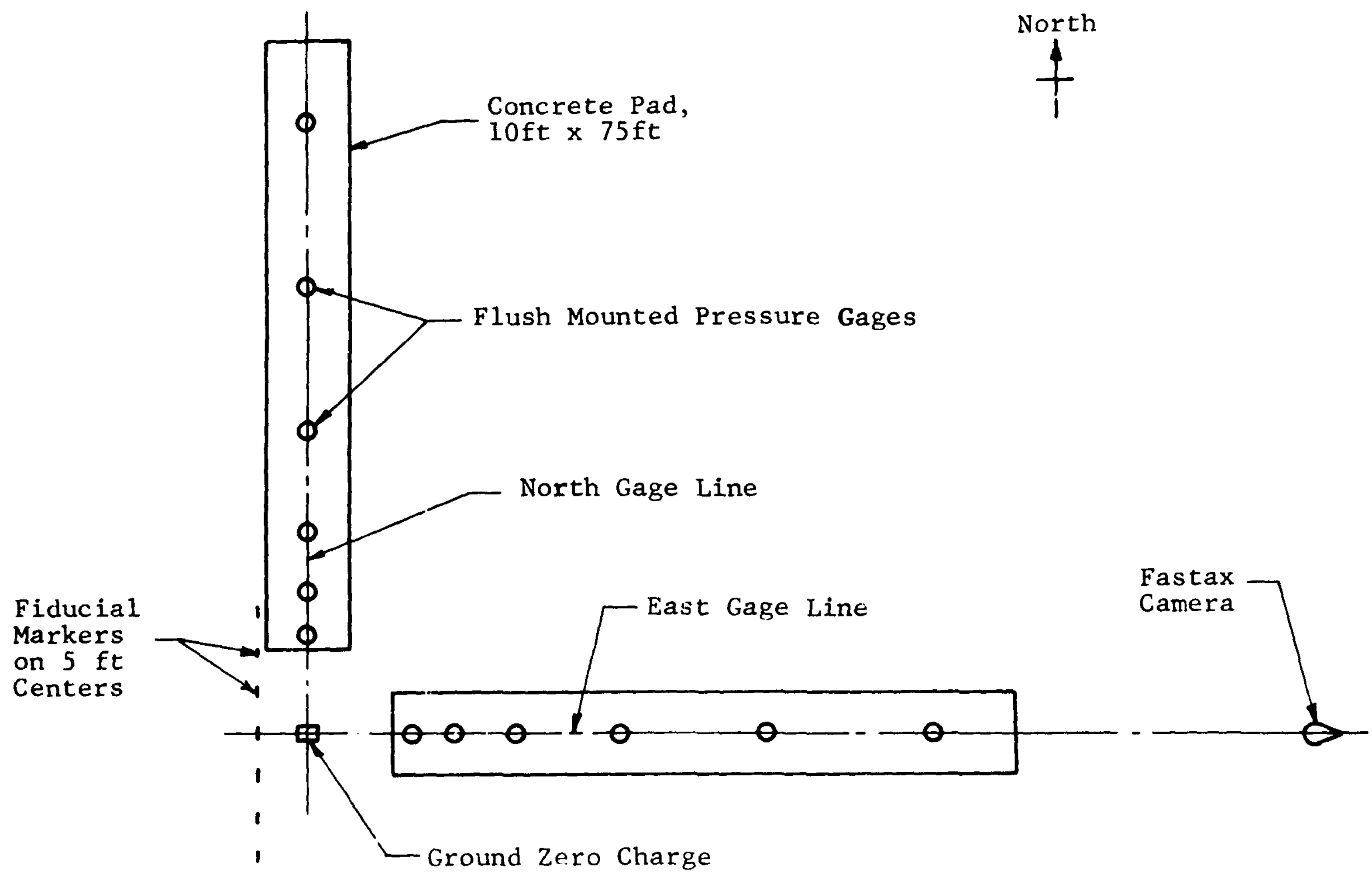

Fig 4 IITRI test area

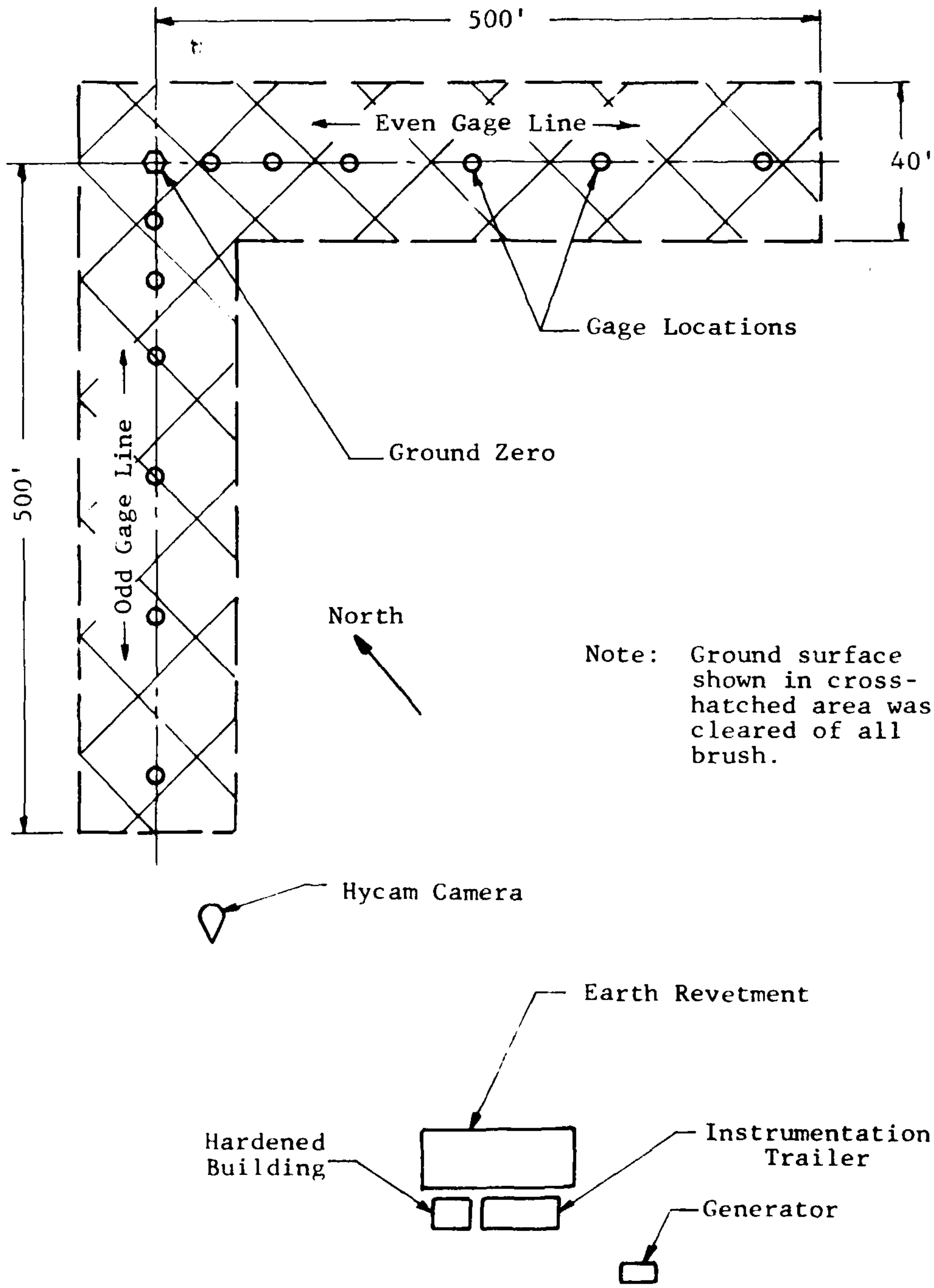

Fig 5 DPG test area

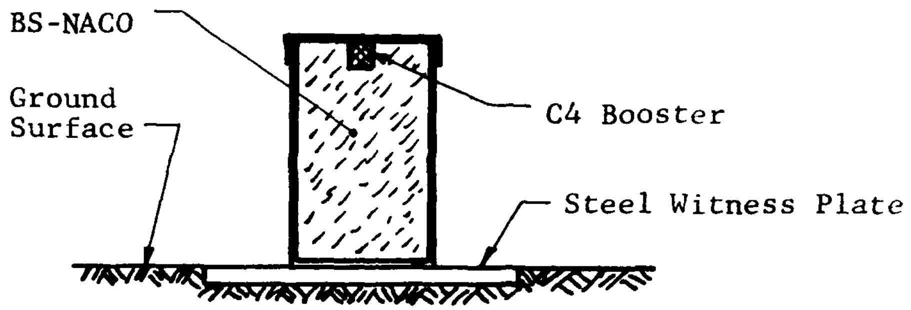

Fig 6 Cylindrical drum configuration

The third configuration was a full-scale feed hopper configuration as shown in the cutaway illustration in Figure 7. The feed hopper was constructed from 0.25-inch-thick 6061 T651 aluminum sheets rolled and welded into the shape shown. Aluminum supports, Figure 8, were welded into the lower conically shaped portion of the hopper to steady the hopper in an upright position.

The hoppers were loaded with approximately 330 lb of BS-NACO propellant through an 8-inch diameter hole in the top. The propellant was allowed to mound up in the hoppers as shown in Figure 7. Fifteen pound cubic shaped Comp C4 explosive boosters were positioned in the propellant as shown.

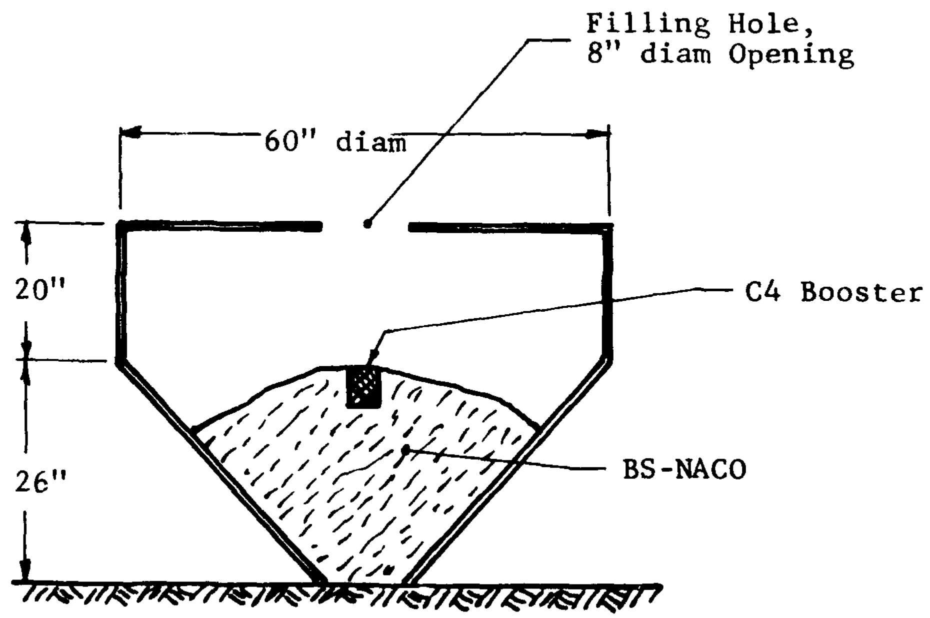

Fig 7 Feed hopper configuration

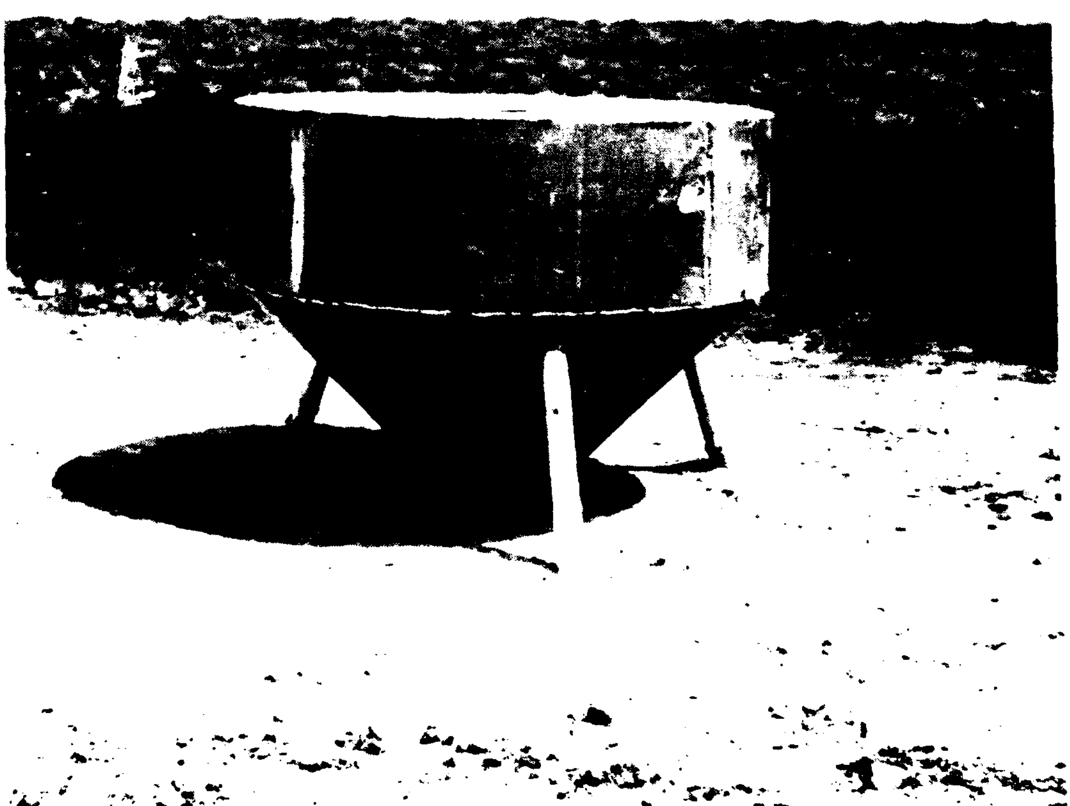

Fig. 8 Simulated full-scale feed hopper

Verification Tests

During the course of this test program several field verification tests were performed to confirm the recording accuracy of the pressure and impulse measuring systems. They consisted of measuring the peak pressure and positive impulse from 5 to 100 lb hemispherical Comp C4 explosive charges. Each charge was set on a steel witness plate at ground level.

Pressure and impulse data obtained from the Comp C4 verification shots are compared to established TNT hemispherical surface burst data (the increased energetics of Comp C4 is accounted for). All of the gage systems used in these tests had been previously calibrated in a laboratory using accepted standards. The laboratory calibrations were used throughout the program. The verification tests indicated that the instrumentation systems were functioning properly.

The resulting pressure and impulse data points for the various scaled distances of the verification shots are plotted in Figure 9. The close groupings of the various sets of points provides a good basis of confidence in proper functioning of the blast gages. The line that passes through the "peak overpressure" gage points is a TNT pressure curve used as a standard; it was generated by Kingery, BRL 1344, 1966. The line passing through the "scaled positive impulse" points was generated by IITRI for Comp C4. It utilizes a 1.25 factor to convert the weight of Comp C4 to the equivalent weight of TNT. Both of these reference curves are built into the IITRI computer program. Consequently, all of the TNT equivalencies shown in this report are computed from these reference curves.

TEST RESULTS

The appendixes of this report contain field data sheets which give test descriptions and evaluations of each test after they were shot. They also contain the raw test data and the computer printout of TNT equivalencies for individual data points. All of the scaled quantities noted in this report have been corrected to include the weight of the booster, in terms of its equivalent weight of BS-NACO in the total charge weight.

All of the tests conducted with BS-NACO propellant are tabulated in Table 2. After every test uninitiated propellant was observed in the test area. In addition the pressure-time waveforms were multipeaked indicating that the reactions were nonideal. The peak pressures reported herein are the maximum values measured and are not necessarily the first peak pressure in the pressure-time pulse.

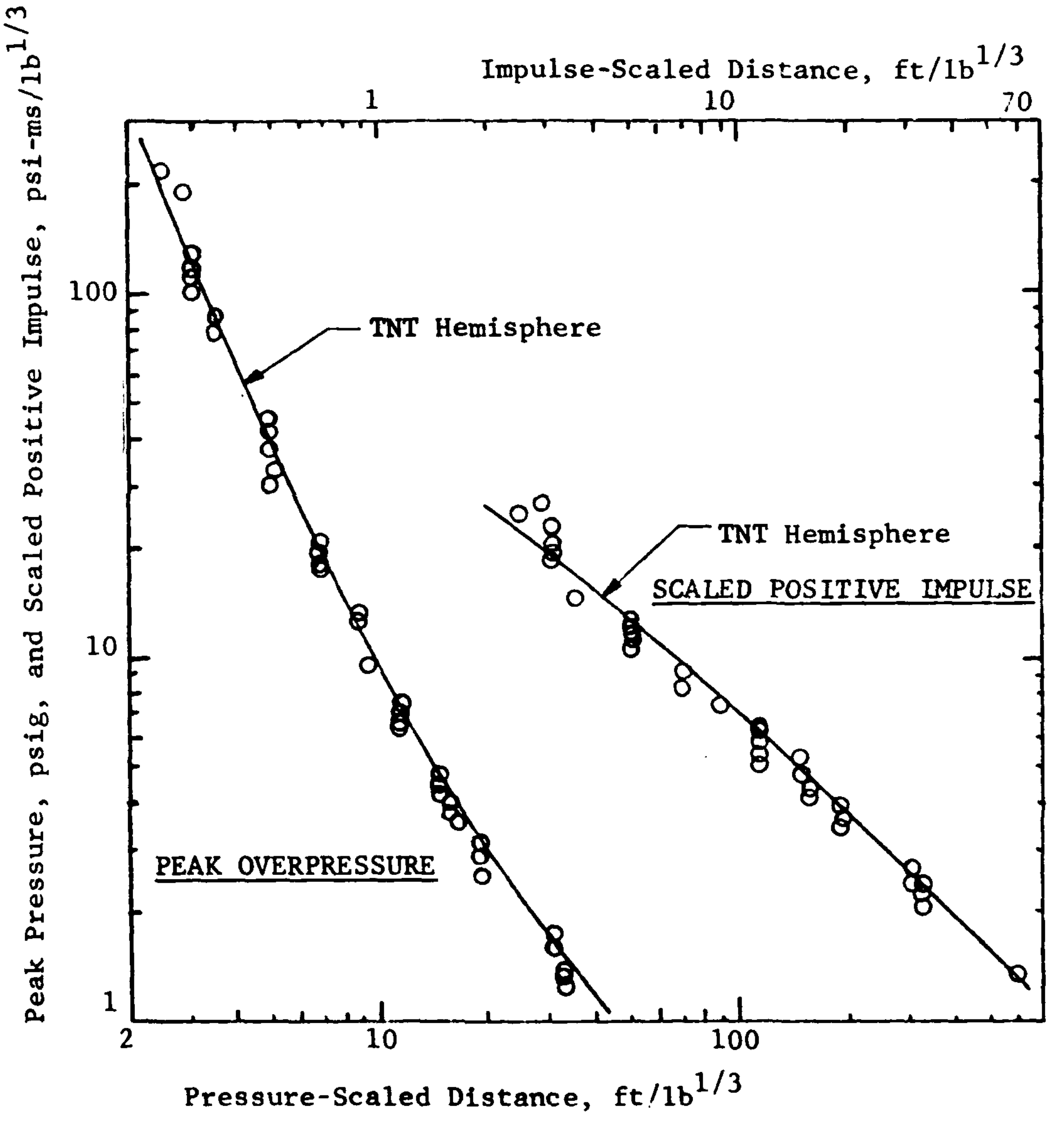

Fig 9 TNT hemisphere pressure and impulse curves

Table 2

BS-NACO propellant tests

Test	Configuration	Charge Weight (W_c, lb)	Booster Weight (W_b, lb)	W_b/W_c (percent)	Comments
NA-1	Cardboard Drum	50	2.5	5.0	Incomplete Ignition
NA-2	Cardboard Drum	50	5.0	10.0	Incomplete Ignition
NA-3	Shipping Container	110	5.0	4.5	Incomplete Ignition
NA-4	Shipping Container	110	5.0	4.5	Incomplete Ignition
NA-5	Shipping Container	110	5.0	4.5	Incomplete Ignition
NA-6	Shipping Container	110	5.0	4.5	Incomplete Ignition
C-NACO-1	Feed Hopper	332-3/4	15.0	4.5	Incomplete Ignition
C-NACO-2	Feed Hopper	328	15.0	4.6	Incomplete Ignition
C-NACO-3	Feed Hopper	335-1/4	15.0	4.5	Incomplete Ignition

The two 50 lb tests, NA-1 and 2, were conducted to determine the TNT equivalency range of the material and to determine the booster size for maximum blast output. The results of the 50 lb cardboard drum tests have been plotted in Figure 10. The highest peak pressures and positive impulses were recorded when the larger, 5 lb, booster was used to ignite the BS-NACO propellant. This size represents 10% of the BS-NACO charge weight. Since the TNT equivalency of BS-NACO propellant turns out to be very small the booster weight in equivalent pounds of BS-NACO is large. Consequently the data become distorted when a large booster weight correction factor is applied to obtain the total charge weight. For this reason a smaller size, 4.5% by weight, booster was used for the remainder of the tests.

The peak pressure and positive impulse data recorded during the full-size metal shipping container tests have been plotted in Figures 11 and 12. The containers were oriented such that the small side of the container was normal to one gage line and the larger side of the container was normal to the other gage line. One would expect the blast output profiles in the two normal directions to be dissimilar due to the asymmetry of the shipping container. However, the peak pressure data are so scattered that no generalization can be made as to which direction the pressure is greater. The amount of material detonating was different in each of the three tests as evidenced by the scatter in the peak pressure data. Curves are drawn through the maximum pressure points. A designer should assume that the worse case condition, in terms of peak pressure, may occur.

Positive impulse measurements show less data scatter between tests, however, curves have been drawn through the maximum scaled impulse points. In general, scaled positive impulse is greater in the direction normal to the long side of the shipping container.

Three tests were conducted with BS-NACO propellant in a simulated full-scale feed hopper configuration. The results of the pressure and positive impulse measurements are plotted in Figure 13. There is comparatively little scatter in the data between tests. Average eye-fit curves have been drawn through all of the data points for both peak pressure and scaled positive impulse.

TNT Equivalency Calculations

TNT equivalency calculations were made for 110 and 330 lb test results. TNT equivalency is defined as the ratio of charge weights (i.e., TNT weight divided by test material weight) that will give the same peak pressure (or positive impulse) at the same radial distance from the charge. The weight of the booster, in an equivalent test

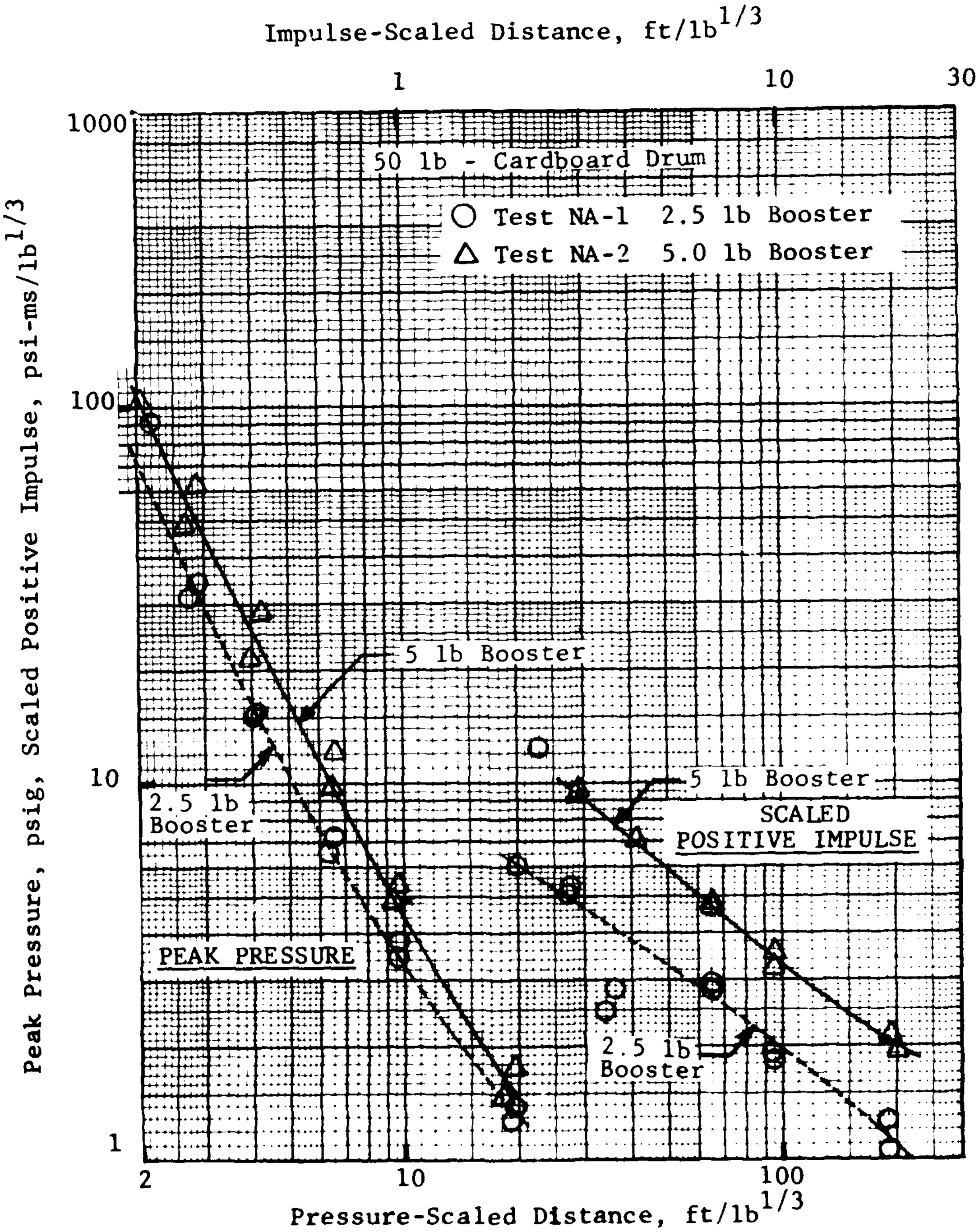

Fig 10 Peak pressure and scaled impulse, 50 lb BS-NACO

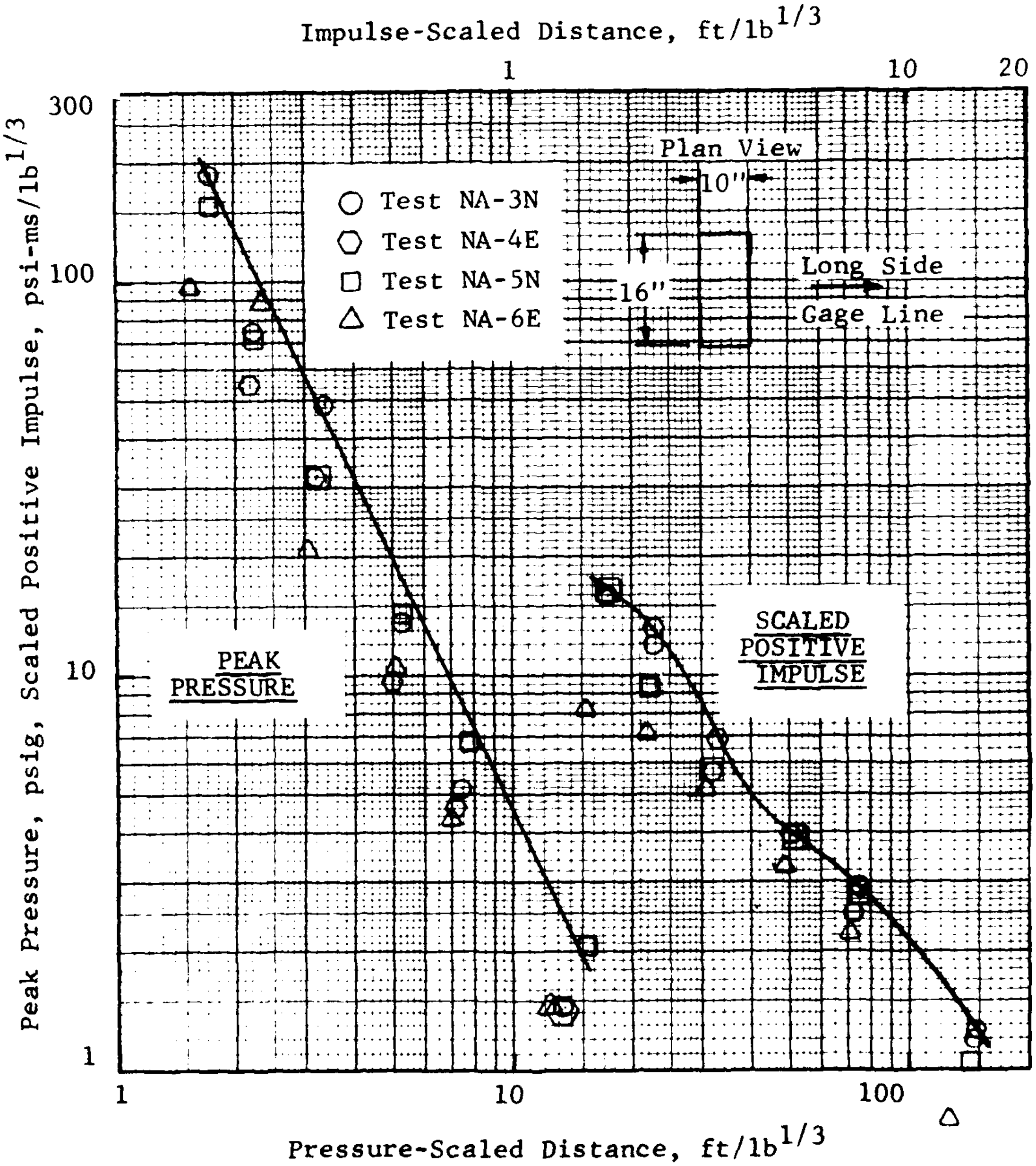

Fig 11 Peak pressure and scaled impulse, BS-NACO, long side of shipping container, 110 lb

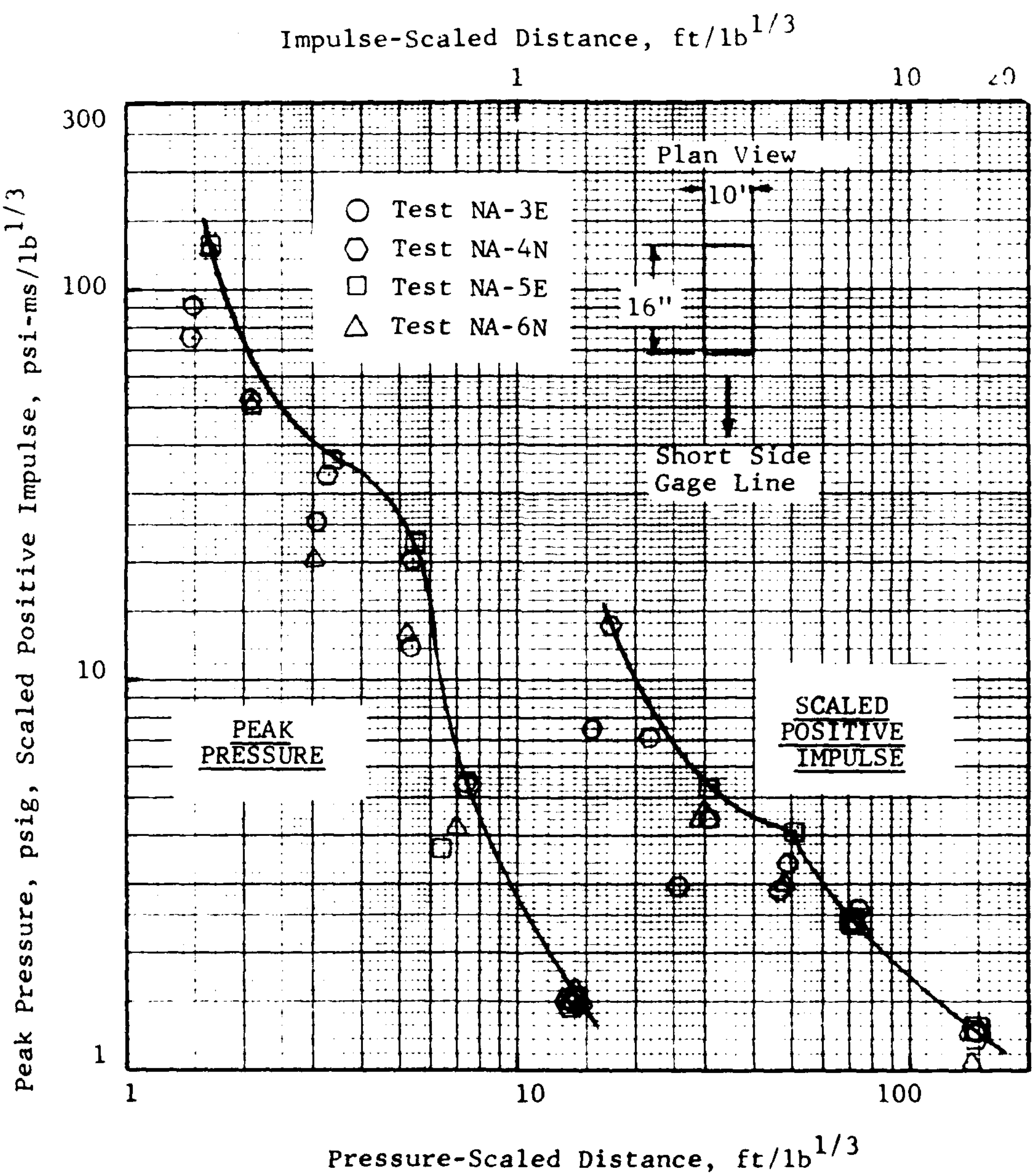

Fig 12 Peak pressure and scaled impulse, BS-NACO, short side shipping container, 110 lb

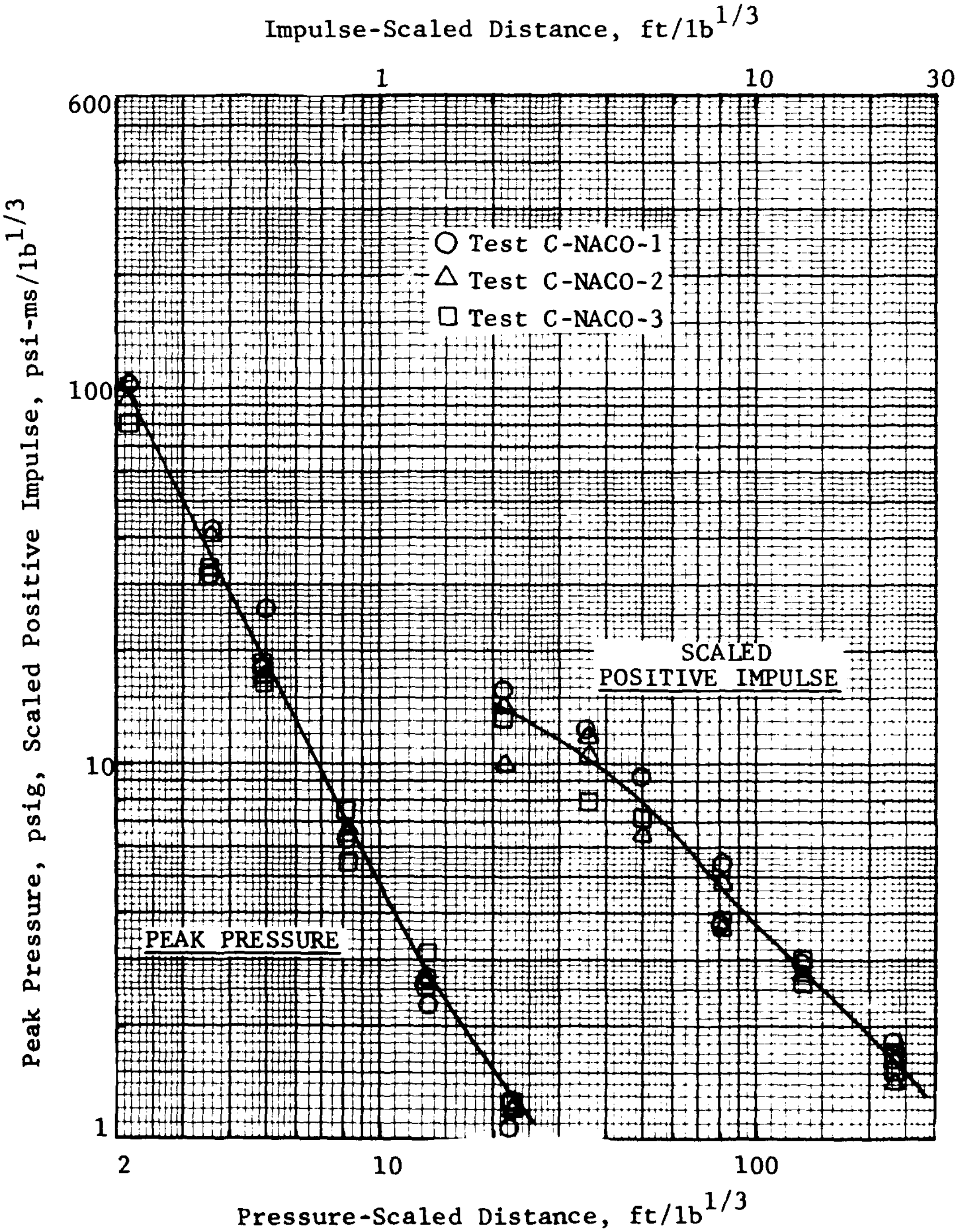

Fig 13 Peak pressure and scaled impulse, BS-NACO, feed hopper configuration, 330 lb

material weight measure, is included in the total charge weight during the computational procedure. Calculations were made from the average peak pressure and scaled positive impulse eye-fit curves of the 330 lb test data. The maximum scaled positive impulse curves for the 110 lb tests was used to compute TNT equivalency. However, the greater of the two maximum peak pressure curves, Figures 11 and 12, was used to compute peak pressure equivalency for the 110 lb shipping container configuration. Consequently the peak pressure TNT equivalency for this configuration is applicable to both measurement directions, Figure 14. TNT equivalency for the 330 lb feed hopper is shown in Figure 15. Positive impulse TNT equivalency is considerably higher for the 330 lb tests than it is for the 110 lb tests. The equivalencies values quoted in the summary section of this report are based upon the results illustrated in Figures 14 and 15.

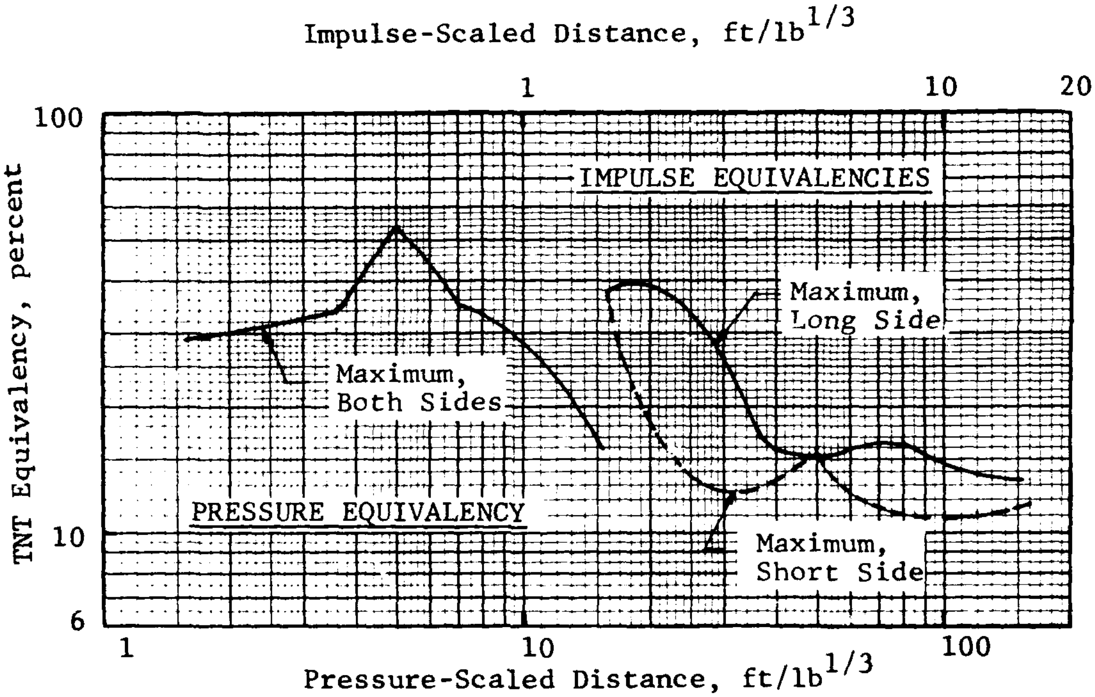

Fig 14 TNT equivalence, 110 lb shipping container

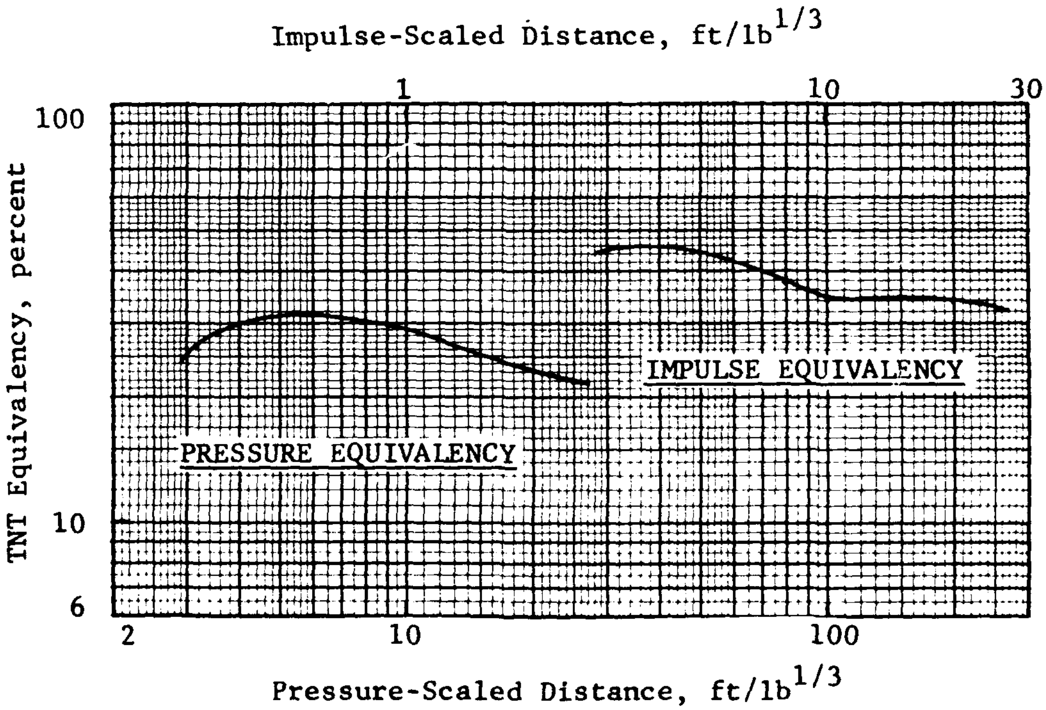

Fig 15 TNT equivalency, 330 lb feed hopper

APPENDIX A

FIELD DATA SHEETS

TEST MATERIAL BS-NACO PROPELLANT

TEST NO.	CHARGE WEIGHT	CONFIGURATION	BOOSTER WEIGHT	COMMENTS
NA-1	50#	CARDBOARD DRUM, 19"x11" DIAM	2.5# C4	UNBURNT NACO IN AREA POSTTEST
NA-2	50#	DITTO	5.0# C4	DITTO
NA-3	110#	STEEL SHIPPING CONTAINER	5.0# C4	DITTO
NA-4	110#	DITTO	5.0# C4	DITTO
NA-5	110#	DITTO	5.0# C4	DITTO
NA-6	110#	DITTO	5.0# C4	DITTO

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IITRI PROJECT NO. J6342 **DATA SHEET NO.** ______

TEST TITLE C-NACO-1 FEED HOPPER **DATE** 4-16-75

TEST SAMPLE NACO PROPELLANT **TIME** 1620 HRS.

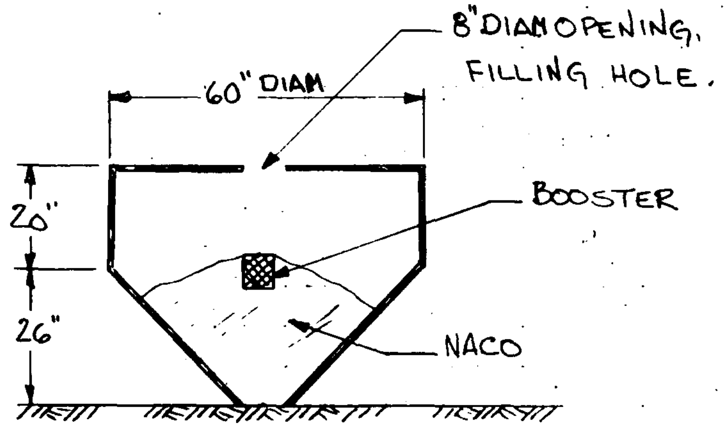
SAMPLE WEIGHT 332 3/4 LB. **TEMP** 53°F

IGNITER 2-ENGINEER SPECIALS (#8) **HUMID** 39%

BOOSTER 15 LB. C4 BLOCK, ≈ 6 1/4" CUBE **BARO** 25.33 IN. HG.

HIGH SPEED CAMERA (1000 cps) YES **WIND** 210° @ 21 KNOTS

0.25" TK. CONALCO 6061 T651 ALUM.



FIELD EVALUATION:

APPARENT CRATER SIZE: ≈ 9' DIAM x 16" DEPTH

INCOMPLETE IGNITION. A SMALL QUANITY OF BLACKENED GRAINS FOUND IN AREA POSTTEST.

SMALL PIECES OF FEED HOPPER RECOVERED.

TEST ENGINEER: J. SWATOSH

IITRI PROJECT NO. J6342

DATA SHEET NO. ____

TEST TITLE IC-NACO-2 FEED HOPPER

DATE 4-17-5[illegible]

TEST SAMPLE NACO PROPELLANT

TIME 430 [illegible]

SAMPLE WEIGHT 328 LB.

TEMP 44°F

IGNITER 2-ENGINEER SPECIALS (#8)

HUMID 65%

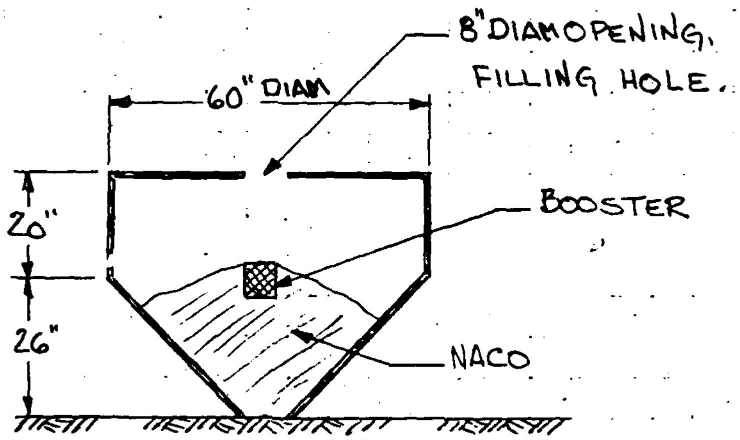
BOOSTER 15 LB. C4 BLOCK, ≈ 6 1/4" CUBE

BARO 25.29 IN. HG.

HIGH SPEED CAMERA (1000 cps) YES

WIND 3[illegible]0° @ 11 KNOTS

0.25" TK. CONALCO 6061 T651 ALUM.



FIELD EVALUATION:

APPARENT CRATER SIZE: ≈ 9 1/2' DIAM x 14" DEPTH

CON[illegible] BACKFILL

LARGE BLACKENED PIECES OF ALUM. RECOVERED.

BURNT PIECES OF NACO FOUND IN CRATER POST TEST.

TEST ENGINEER: [illegible]

IITRI PROJECT NO. J6342 — **DATA SHEET NO.** ____

TEST TITLE C-NACO-3 FEED HOPPER — **DATE** 4-18-5

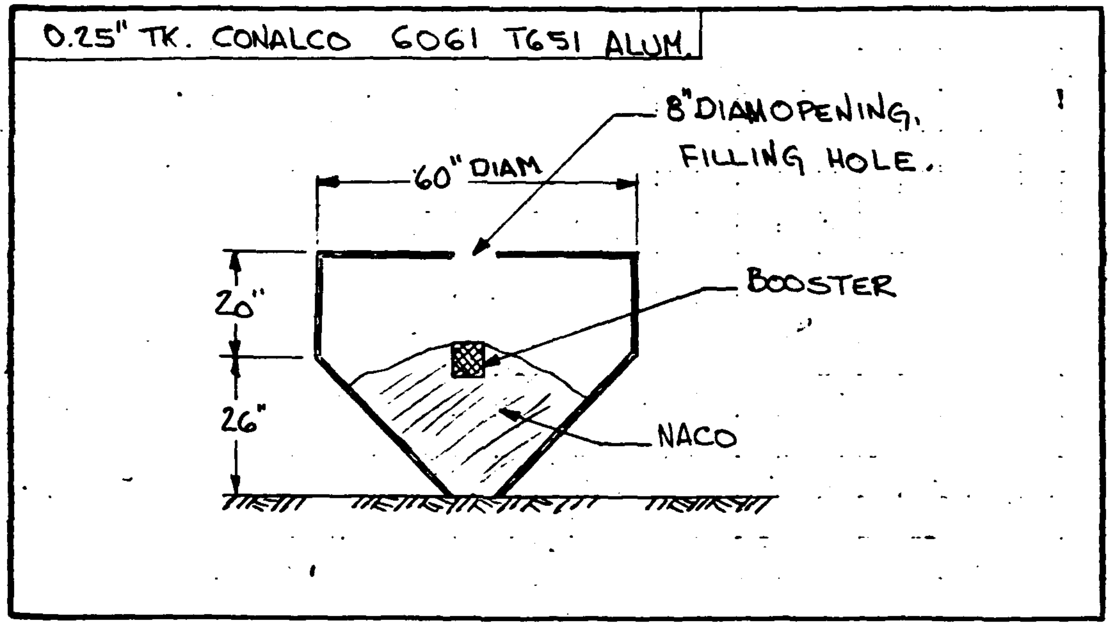
TEST SAMPLE NACO PROPELLANT — **TIME** 1400 HRS.

SAMPLE WEIGHT 335 1/4 LB. — **TEMP** 47°F

IGNITER 2-ENGINEER SPECIALS (#8) — **HUMID** 51%

BOOSTER 15 LB. C4 BLOCK, ≈ 6 1/4" CUBE — **BARO** 25.57 IN. HG.

HIGH SPEED CAMERA (1000 cps) NO — **WIND** 330° @ 11 KNOTS



FIELD EVALUATION:

APPARENT CRATER SIZE: ≈ 11' DIAM x 14" DEPTH.

LARGE BLACKENED PIECES OF ALUM. RECOVERED.

BURNT PIECES OF NACO FOUND IN CRATER AFTER TEST.

TEST ENGINEER: J. SWATOSH

APPENDIX B
TEST DATA

TEST DATA

R (FT)	P (PSIG)	I (PSI-MS)
NA-1 50 LBS (2.5 LB) DRUM L/D = 1.7		
8.75	31.20	49.40
8.79	90.90	27.10
11.72	31.00	22.90
11.98	34.40	22.00
16.98	15.10	13.40
16.98	15.30	12.30
26.97	7.08	11.80
27.00	6.05	12.20
39.47	3.76	8.23
39.73	3.44	7.87
80.68	1.39	5.16
80.71	1.26	4.45
NA-2 50 LBS (5 LB) DRUM L/D = 1.7		
8.75	104.00	- -
11.72	48.40	39.20
11.98	60.20	39.00
16.94	28.10	10.30
16.98	21.90	29.40
26.97	9.74	19.40
27.00	12.00	20.00
39.47	5.43	13.30
39.73	4.77	14.30
80.68	1.74	7.81
80.71	1.47	6.86

TEST DATA

R (FT)	P (PSIG)	I (PSI-MS)

NA-3N, 110 LB (5LB), STEEL SHIPPING CONTAINER, LONG SIDE

R (FT)	P (PSIG)	I (PSI-MS)
8.86	187.00	80.20
11.77	75.50	60.70
17.03	49.70	30.30
27.03	13.30	19.60
39.79	5.22	13.50
80.78	1.46	6.57

NA-3E, 110 LB (5LB), STEEL SHIPPING CONTAINER, SHORT SIDE

R (FT)	P (PSIG)	I (PSI-MS)
8.78	92.40	42.90
16.96	25.60	25.00
26.99	12.10	18.70
39.49	5.52	13.10
60.69	1.49	6.81

NA-4N, 110 LB (5LB), STEEL SHIPPING CONTAINER, SHORT SIDE

R (FT)	P (PSIG)	I (PSI-MS)
8.86	76.90	71.00
11.77	52.40	39.00
17.03	33.50	19.20
27.03	20.50	16.50
39.79	5.54	14.20
80.78	1.49	6.75

NA-4E, 110 LB (5LB), STEEL SHIPPING CONTAINER, LONG SIDE

R (FT)	P (PSIG)	I (PSI-MS)
8.76	136.00	- -
11.97	55.20	66.30
16.96	31.50	36.20
26.99	9.85	21.00
39.49	4.73	15.40
80.69	1.41	6.92

NA-5N, 110 LB (5LB), STEEL SHIPPING CONTAINER, LONG SIDE

R (FT)	P (PSIG)	I (PSI-MS)
8.86	156.00	82.60
11.77	71.40	48.20
17.03	32.30	30.70
27.03	14.20	20.60
39.79	6.82	14.90
80.78	2.09	5.99

TEST DATA

NA-5E, 110 LB (5LB), STEEL SHIPPING CONTAINER, SHORT SIDE

H (FT)	P (PSIG)	I (PSI-MS)
8.78	131.00	- -
16.96	47.40	28.90
26.99	22.50	21.70
39.49	3.71	13.20
80.69	1.55	6.96

NA-6N, 110 LB (5LB), STEEL SHIPPING CONTAINER, SHORT SIDE

H (FT)	P (PSIG)	I (PSI-MS)
8.66	129.00	- -
11.77	50.60	13.00
17.03	20.30	25.50
27.03	13.00	17.10
39.79	4.22	13.00
80.78	1.55	5.86

NA-6E, 110 LB (5LB), STEEL SHIPPING CONTAINER, LONG SIDE

H (FT)	P (PSIG)	I (PSI-MS)
8.78	97.00	45.50
16.96	20.80	28.40
26.99	10.70	18.20
39.49	4.38	12.50
60.69	1.46	4.56

TEST DATA

R (FT)	P (PSIG)	I (PSI-MS)
(C)NACO-1, 332.75# NACO AND 15# C4		
16.04	102.00	114.00
26.04	42.20	89.70
26.09	31.80	- -
36.04	25.50	65.70
36.08	17.50	- -
60.03	7.38	28.00
60.08	6.18	39.00
100.10	2.69	21.50
100.10	2.28	20.50
169.10	1.28	13.10
169.20	1.07	11.10
(C)NACO-2, 328# NACO AND 15# C4		
16.04	104.00	104.00
16.09	62.70	75.30
26.04	41.30	76.20
36.04	17.10	46.50
36.08	16.90	- -
60.03	6.48	26.90
60.08	6.64	34.40
100.10	2.66	19.80
100.10	2.63	19.30
169.10	1.22	11.70
169.20	1.19	10.40
(C)NACO-3, 335.25# NACO AND 15# C4		
16.04	64.30	96.40
26.04	33.50	58.30
26.09	32.00	85.20
36.04	17.50	52.40
36.08	16.10	- -
60.03	5.35	27.40
60.08	7.42	39.30
100.10	3.11	21.70
100.10	2.57	19.10
169.10	1.24	12.40
169.20	1.26	11.00

SUMMARY OF EXPERIMENTAL RESULTS

NORTH AND EAST BLAST LINES

BASED ON INDIVIDUAL DATA POINTS

TEST TYPE	R (FT)	P (PSI)	$I/W^{1/3}$ $(PSI-MS/LB^{1/3})$	LAMBDA-P $(FT/LB^{1/3})$	LAMBDA-I $(FT/LB^{1/3})$	EQ-P (%)	EQ-I (%)
NA-1	50 LBS (2.5 LB) DRUM		L/D = 1.7				
	8.75	31.20	12.69	1.32	2.25	1.26	34.17
	8.79	90.90	6.16	2.21	2.00	23.56	8.73
	11.72	31.00	5.32	2.75	2.73	11.13	10.45
	11.98	34.40	5.08	2.90	2.77	15.07	9.87
	16.98	15.10	2.84	4.06	3.59	13.34	5.51
	16.98	15.30	2.45	4.08	3.39	13.84	4.03
	26.97	7.08	2.80	6.63	6.39	17.92	12.14
	27.00	6.05	2.92	6.41	6.45	12.36	13.14
	39.47	3.76	1.95	9.70	9.33	17.76	11.80
	39.73	3.44	1.83	9.58	9.26	14.37	10.66
	80.68	1.39	1.27	19.87	19.92	18.24	18.73
	80.71	1.26	1.07	19.33	19.39	13.37	13.80

SUMMARY OF EXPERIMENTAL RESULTS

NORTH AND EAST BLAST LINES

BASED ON INDIVIDUAL DATA POINTS

TEST TYPE	R (FT)	P (PSI)	$T/W^{1/3}$ $(PSI-MS/LB^{1/3})$	LAMBDA= $(FT/LB^{1/3})$	LAMBDA-I $(FT/LB^{1/3})$	EQ-P (%)	EU-I (%)
VA-2 50 LBS (5 LB) DRUM L/D = 1.7							
	8.75	104.00	- -	2.05	- -	22.73	- -
	11.72	48.40	9.43	2.69	2.82	18.69	28.10
	11.98	60.20	9.41	2.91	2.89	31.65	28.94
	16.94	26.10	.39	4.14	.64	33.57	.02
	16.98	21.90	7.10	3.94	4.10	20.68	29.21
	26.97	9.74	4.67	6.49	6.49	28.28	27.94
	27.00	12.00	4.84	6.74	6.54	43.69	29.98
	39.47	5.43	3.17	9.69	9.41	35.24	25.65
	39.73	4.77	3.47	9.49	9.64	26.12	30.54
	80.68	1.74	1.91	19.43	19.78	28.37	34.47
	80.71	1.47	1.64	18.06	19.29	15.56	26.20

SUMMARY OF EXPERIMENTAL RESULTS

NORTH AND EAST BLAST LINES

BASED ON INDIVIDUAL DATA POINTS

TEST TYPE	R (FT)	P (PSI)	$I/W^{1/3}$ (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	EQ-P (%)	EQ-I (%)
NA-3N, 110 LB (5LB), STEEL SHIPPING CONTAINER, LONG SIDE							
	8.86	187.00	15.97	1.75	1.76	31.27	36.72
	11.77	75.50	12.02	2.26	2.33	19.82	32.71
	17.03	49.70	5.67	3.40	3.18	39.13	14.30
	27.03	13.30	3.68	5.26	5.02	24.18	13.35
	39.79	5.22	2.49	7.47	7.33	15.04	12.26
	80.78	1.46	1.20	13.85	14.70	6.92	10.84
NA-3E, 110 LB (5LB), STEEL SHIPPING CONTAINER, SHORT SIDE							
	8.78	92.40	7.61	1.54	1.56	8.20	8.91
	16.96	25.60	4.43	3.14	3.01	12.91	8.85
	26.99	12.10	3.43	5.19	4.95	20.15	11.69
	39.49	5.52	2.39	7.48	7.21	16.69	11.28
	80.69	1.49	1.25	13.98	14.80	7.45	11.71

SUMMARY OF EXPERIMENTAL RESULTS

NORTH AND EAST BLAST LINES

BASED ON INDIVIDUAL DATA POINTS

TEST TYPE	R (FT)	P (PSI)	$I/W^{1/3}$ $(PSI-MS/LB^{1/3})$	LAMBDA-P $(FT/LB^{1/3})$	LAMBDA-I $(FT/LB^{1/3})$	EQ-P (%)	EQ-I (%)
NA-4N, 110 LB (5LB), STEEL SHIPPING CONTAINER, SHORT SIDE							
	8.86	76.90	13.97	1.47	1.74	5.54	28.83
	11.77	52.40	7.21	2.12	2.18	10.20	12.72
	17.03	33.50	2.98	3.28	2.64	21.10	3.90
	27.03	20.50	2.91	5.44	4.77	49.66	8.55
	39.79	5.54	2.64	7.56	7.41	17.35	13.71
	80.78	1.49	1.24	14.01	14.79	7.49	11.52
NA-4E, 110 LB (5LB), STEEL SHIPPING CONTAINER, LONG SIDE							
	8.78	136.00	- -	1.67	- -	17.51	- -
	11.97	55.20	13.24	2.21	2.39	12.25	39.80
	16.96	31.50	6.98	3.24	3.27	18.73	20.83
	26.99	9.85	3.95	5.01	5.07	13.22	15.16
	39.49	4.73	2.91	7.22	7.46	11.31	16.08
	80.69	1.41	1.27	13.47	14.85	5.87	12.13
NA-5N, 110 LB (5LB), STEEL SHIPPING CONTAINER, LONG SIDE							
	8.86	156.00	16.48	1.72	1.77	23.01	38.89
	11.77	71.40	9.27	2.24	2.26	18.04	20.38
	17.03	32.30	5.76	3.27	3.19	19.86	14.72
	27.03	14.20	3.86	5.30	5.06	27.30	14.57
	39.79	6.82	2.80	7.81	7.48	27.46	15.21
	80.78	2.09	1.06	15.63	14.27	22.12	8.63

SUMMARY OF EXPERIMENTAL RESULTS

NORTH AND EAST BLAST LINES

BASED ON INDIVIDUAL DATA POINTS

TEST TYPE	R (FT)	P (PSI)	$I/W^{1/3}$ $(PSI-MS/LB^{1/3})$	LAMBDA-P $(FT/LB^{1/3})$	LAMBDA-I $(FT/LB^{1/3})$	EQ-P (%)	EQ-I (%)
NA-5E, 110 LB (5LB), STEEL SHIPPING CONTAINER, SHORT SIDE							
	8.78	131.00	- -	1.66	- -	16.37	- -
	16.96	47.40	5.35	3.37	3.14	35.96	12.74
	26.99	22.50	4.10	5.46	5.10	56.90	16.27
	39.49	3.71	2.42	6.43	7.23	5.05	11.47
	80.69	1.55	1.28	14.26	14.87	8.64	12.29
NA-6N, 110 LB (5LB), STEEL SHIPPING CONTAINER, SHORT SIDE							
	8.86	129.00	- -	1.68	- -	16.51	- -
	17.03	20.30	4.55	2.98	3.04	8.06	9.40
	27.03	13.00	3.05	5.25	4.82	23.19	9.37
	39.79	4.22	2.37	7.00	7.27	8.33	11.26
	80.78	1.55	1.03	14.28	14.17	8.69	8.17
NA-6E, 110 LB (5LB), STEEL SHIPPING CONTAINER, LONG SIDE							
	8.78	97.00	8.25	1.56	1.59	9.09	10.51
	11.97	89.80	6.32	2.35	2.16	28.08	10.09
	16.96	20.80	5.23	2.98	3.12	8.35	12.23
	26.99	10.70	3.32	5.09	4.92	15.77	10.98
	39.49	4.38	2.25	7.01	7.10	8.99	10.00
	80.69	1.46	.71	13.83	12.48	6.88	3.82

SUMMARY OF EXPERIMENTAL RESULTS

ODD AND EVEN BLAST LINES

BASED ON INDIVIDUAL DATA POINTS

TEST TYPE	R (FT)	P (PSI)	$I/W^{1/3}$ (PSI-MS/LB$^{1/3}$)	LAMBDA-P (FT/LB$^{1/3}$)	LAMBDA-I (FT/LB$^{1/3}$)	EQ-P (%)	EQ-I (%)
(C)NACO-1, 332.75# NACO AND 15# C4, FEED HOPPER CONF.							
	16.04	102.00	15.87	2.17	2.23	26.18	49.44
	26.04	42.20	12.59	3.59	3.65	37.19	64.22
	26.09	31.80	- -	3.52	- -	24.21	- -
	36.04	25.50	9.20	5.03	5.05	52.72	59.23
	36.08	17.50	- -	4.92	- -	29.34	- -
	60.03	7.38	3.81	8.27	8.16	37.25	27.91
	60.08	6.18	5.44	8.14	8.38	26.20	51.06
	100.10	2.69	2.97	13.50	13.84	24.41	40.32
	100.10	2.28	2.82	13.04	13.79	15.51	37.06
	169.10	1.28	1.81	22.65	23.38	22.32	40.53
	169.20	1.07	1.52	21.68	23.10	12.90	30.36
(C)NACO-2, 328# NACO AND 15# C4, FEED HOPPER CONF.							
	16.04	104.00	14.46	2.19	2.23	27.39	42.14
	16.09	62.70	10.12	2.05	2.16	11.54	22.19
	26.04	41.30	10.65	3.60	3.64	36.54	48.39
	36.04	17.10	6.39	4.92	4.95	28.53	31.85
	36.08	16.90	- -	4.92	- -	28.08	- -
	60.03	6.48	3.66	8.21	8.16	29.23	26.25
	60.08	6.64	4.78	8.24	8.35	30.80	41.41
	100.10	2.66	2.73	13.52	13.82	23.93	35.53
	100.10	2.63	2.66	13.49	13.79	23.24	33.75
	169.10	1.22	1.61	22.54	23.29	19.67	33.77
	169.20	1.19	1.42	22.43	23.07	18.30	27.40

SUMMARY OF EXPERIMENTAL RESULTS

ODD AND EVEN BLAST LINES

BASED ON INDIVIDUAL DATA POINTS

TEST TYPE	R (FT)	P (PSI)	$I/W^{1/3}$ ($PSI-MS/LB^{1/3}$)	LAMBDA-P ($FT/LB^{1/3}$)	LAMBDA-I ($FT/LB^{1/3}$)	EQ-P (%)	EQ-I (%)
(C)NACO-3, 335.25# NACO AND 15# C4, FEED HOPPER CONF.							
	16.04	64.30	13.23	2.03	2.20	11.68	35.63
	26.04	33.50	7.92	3.52	3.54	25.92	28.53
	26.09	32.00	11.90	3.51	3.64	24.27	58.24
	36.04	17.50	7.22	4.89	4.96	28.90	38.97
	36.08	16.10	- -	4.87	- -	25.29	- -
	60.03	5.35	3.71	7.93	8.12	18.76	26.59
	60.08	7.42	5.47	8.26	8.36	37.46	51.37
	100.10	3.11	2.99	13.72	13.81	34.45	40.68
	100.10	2.57	2.61	13.34	13.66	21.41	32.40
	169.10	1.24	1.70	22.45	23.23	20.20	36.58
	169.20	1.26	1.50	22.54	23.02	21.22	29.65

APPENDIX C

SAFETY APPROVAL

DEPARTMENT OF THE ARMY
HEADQUARTERS, UNITED STATES ARMY ARMAMENT COMMAND
ROCK ISLAND, ILLINOIS 61201

REPLY TO
ATTENTION OF:

21 AUG 1975

AMSAR-SFA
SUBJECT: Preliminary Report, TNT Equivalency of BS-NACO Propellant

Commander, US Army Materiel Command, ATTN: AMCSF-E

Inclosed test report is forwarded for your review and approval. Based on the test results, it is recommended that BS-NACO propellant be considered a wholly Class 2 propellant with Class 2 QD requirements being the separation distances.

FOR THE COMMANDER:

1 Incl

Glenn S. Leach
GLENN S. LEACH
Safety Manager

CF:
AMSAR-PPI-C w/o incl

AMCSF-E (21 Aug 75) 1st Ind
SUBJECT: Preliminary Report, TNT Equivalency of BS-NACO Propellant

HQ, US Army Materiel Command, 5001 Eisenhower Ave., Alexandria, VA 22333
17 September 1975

TO: Commander, US Army Armament Command, ATTN: AMSAR-SFA, Rock Island, IL 61201

Based on the information submitted, this office agrees that subject propellant should be considered QD Class 2 material while in-process.

FOR THE COMMANDER:

Incl wd

WALTER G. QUEEN
Chief
Safety Office

DISTRIBUTION LIST

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