AD NUMBER	
AD111463	
CLASSIFICATION CHANGES	
TO:	**UNCLASSIFIED**
FROM:	**CONFIDENTIAL**
LIMITATION CHANGES	
TO: **Approved for public release; distribution is unlimited.**	
FROM: **Distribution authorized to U.S. Gov't. agencies and their contractors; Administrative/Operational Use; OCT 1956. Other requests shall be referred to Picatinny Arsenal, Samuel Feltman Ammunition Labs., Dover, NJ.**	
AUTHORITY	
ARRADCOM ltr 13 Feb 1980 ; ARRADCOM ltr 13 Feb 1980	

AD- 111463

SECURITY REMARKING REQUIREMENTS

DOD 5200.1-R, DEC 78

REVIEW ON 28 OCT 76

EXCLUDED

FROM GENERAL CLASSIFICATION SCHEDULE IN ACCORDANCE WITH INFORMATION SECURITY PROGRAM REGULATION

DATED - JULY 1972

DOD 5000.1R & EXECUTIVE ORDER 11652
(EXECUTIVE ORDER 10501 AMENDED)

BY

Defense Documentation Center
Defense Supply Agency
Cameron Station
Alexandria, Virginia 22314

DEC 1972

UNCLASSIFIED

AD 111463

CLASSIFICATION CHANGED
TO: UNCLASSIFIED
FROM: CONFIDENTIAL
AUTHORITY:
ARRADCOM
ltr, 13 Feb 80

UNCLASSIFIED

CONFIDENTIAL

TECHNICAL REPORT 2355

PROPERTIES OF DESENSITIZED TORPEX-TYPE BOMB FILLERS (U)

STANLEY J. LOWELL

OCTOBER 1956

FC

SAMUEL FELTMAN AMMUNITION LABORATORIES
PICATINNY ARSENAL
DOVER, N. J.

ORDNANCE PROJECT TA3-5002
DEPT. OF THE ARMY PROJECT 5A04-01-011

COPY 20

CONFIDENTIAL

REGRADING DATA CANNOT BE PREDETERMINED

PROPERTIES OF DESENSITIZED TORPEX-TYPE BOMB FILLERS (U)

by

Stanley J. Lowell

October 1956

Picatinny Arsenal
Dover, New Jersey

Technical Report 2355

Ordnance Project TA3-5002

Dept of the Army Project 5A04-01-011

Approved:
Robert Frye
for D. R. BEEMAN
Acting Director,
Samuel Feltman
Ammunition Laboratories

TABLE OF CONTENTS

OBJECT

To investigate the properties of torpex-type bomb fillers containing 8% N-octadecylphthalimide (NODP) desensitizer.

SUMMARY

A high-blast explosive superior to 80/20 tritonal and less sensitive than the torpex explosives was needed for use in general purpose bombs. The following aluminized explosive compositions containing NODP as a desensitizer were developed at Picatinny Arsenal in an attempt to satisfy this need:

Comp. A124-3 (Comp B/TNT/aluminum/NODP 67/5/20/8)

Comp. A131-1 (Comp B/aluminum/NODP 82/10/8)

Five 500-lb AN-M64A1 GP bombs loaded with each of these compositions and five with 80/20 tritonal were subjected to blast tests. Neither of the 2 compositions containing NODP was superior to tritonal in impulse, but Comp A124-3 was superior to the other 2 compositions in peak pressure. When tests were conducted with 8-lb bare spherical charges, H-6 charges were included for comparison. It was shown in these tests that the calculated peak pressure and impulse values of H-6 were higher in 2 gage positions than the values for Comp A124-3, and higher in all 3 gage positions than the values for Comp A131-1 or 80/20 tritonal. Comp A124-3 gave higher impulse values than Comp A131-1 in 3 gage positions and higher than 80/20 tritonal in 2 gage positions.

The advisability of using an explosive composition containing NODP was seriously questioned when it was observed that each of these compositions exuded about 25 drops within the first day of storage and 40 ml in 8 days of storage at 160°F. An additional undesirable feature of these desensitized compositions is the immiscibility of NODP in TNT.

CONCLUSIONS

H-6 is slightly superior to Composition A124-3 (Comp B/TNT/aluminum/NODP 67/5/20/8) in blast characteristics. Both these explosives are superior to Comp. A131-1 and 80/20 tritonal.

Comp A124-3 exudes profusely when stored at 160°F. The NODP contained in the composition is immiscible with TNT.

RECOMMENDATION

It is recommended that H-6 be considered for possible use as the filler in GP bombs.

INTRODUCTION

1. During the second World War the Navy recognized the excellent blast characteristics of the torpex-type explosives (RDX/TNT/aluminum) and used them extensively in torpedoes. The explosives were later found to be supersensitive and unstable. Picatinny Arsenal conducted laboratory studies with various desensitizers and found that adding 8% N-octadecylphthalimide (NODP) to torpex compositions reduced their impact sensitivity (Ref 1). The question remained, however, whether the additive would also reduce the blast characteristics of the explosive to an objectionable extent. To resolve this question Picatinny recommended (Ref 2) that five each 500-lb AN-M64A1 GP bombs be loaded with the following two most promising desensitized torpex compositions reported in Ref 1 and be subjected to blast tests:

Comp A124-3 (Comp B/TNT/aluminum/NODP 67/5/20/8)

Comp A131-1 (Comp B/aluminum/NODP 82/10/8)

2. Five bombs loaded with the standard 80/20 tritonal were included in these tests for control and comparison purposes. An attempt was made at the same time to obtain additional comparative blast information by testing ½-lb and 8-lb bare spherical charges, produced from the same explosive compositions as were used in the bombs, and also H-6. The latter explosive is known to have outstanding air blast characteristics.

3. This report covers the results of blast tests of the 500-lb bombs and 8-lb bare spheres. It also details the difficulties encountered in attempting to conduct such tests with ½-lb and 8-lb spheres.

RESULTS

4. Blast tests were conducted with fifteen 500-lb AN-M64A1 GP bombs. Five each of these bombs contained Comp A124-3, A131-1, and 80/20 tritonal. The latter was used as the standard for comparing the experimental fillers. Of 84 possible gage readings, only 26 readings were valid. A summary of the results in Table 1 shows:

a. In comparing the impulse values, A124-3, A131-1, and 80/20 tritonal were each highest at one of the three gage positions.

b. In the computation of the peak pressures from velocities, A124-3 gave the highest and 80/20 tritonal gave the lowest peak pressure at all 3 gage positions.

c. As measured directly by gage readings, Comp A131-1 gave the highest peak pressure at two of the positions and Comp A124-3 gave the highest at one position.

5. Groups of 8-lb bare spherical charges prepared at Picatinny Arsenal with the same fillers as were loaded in the bombs and containing 0.25-lb centrally located 50/50 pentolite boosters were tested along with 8-lb charges of 50/50 pentolite and H-6 prepared at Aberdeen Proving Ground. During the preparation of the test items at Picatinny, it was observed that in those compositions containing NODP, the latter partially separated from the molten TNT in the kettle. The formulations of the five explosives tested are given in Table 2. The average positive impulse and peak pressure results for all five explosives corrected to an equal volume basis are given in Table 3 and are summarized as follows:

a. In a comparison of the explosives according to their average impulse at each gage position: (1) H-6 was best at 2 positions and Comp A124-3 was best at 1 position, (2) Comp A131-1 was inferior to H-6 and A124-3 at all 3 gage positions, (3) H-6 was the only explosive superior to 80/20 tritonal at all positions.

b. In a comparison of the explosives according to their average peak pressure at each gage position: (1) H-6 was the highest at 2 positions and Comp A124-3 was highest at one position, (2) H-6 was higher than Comp A131-1 and 80/20 tritonal at all positions.

6. Unsuccessful attempts were made to obtain blast information with ½-lb bare spherical charges containing centrally located 0.03-lb 50/50 pentolite boosters. In blast tests of 8-lb bare spherical charges containing centrally located 0.03-lb 50/50 pentolite boosters and the same fillers as were used in the bombs, many low-order detonations were obtained. The data as given in Table 4 show that the peak pressure of Comp A124-3 is superior to Comp A131-1 in one position and equal to it in the other position, and also that Comp A131-1 is in turn superior to 80/20 tritonal in one position and equal to it in the other position.

7. Although it is known that a shell loaded with 93/7 Comp B/NODP exuded profusely after several hours storage at 160°F, Aberdeen Proving Ground and Yuma Test Station reported no visible indication of explosive exudate from the bombs which were loaded and stored for about two years before they were tested. When 90 mm M71 HE shell loaded with the various explosives were stored at 160°F, H-6 yielded one drop of exudate after 49 days storage, 80/20 tritonal gave 4 drops by the 9th day, while Comp A124-3 and A131-1 each gave approximately 25 drops within the first day and 40 ml of exudate in 8 days of storage.

8. According to observations in the laboratory (Ref 1), no segregation of materials occurred with mixtures of

TNT/NODP. However, when explosive compositions containing these ingredients were prepared in the loading plant, a partial separation of NODP and TNT was clearly evident.

9. Rifle bullet tests conducted with 30-caliber ball using test bombs conducted according to type III in Figure 3 gave the following results (10 bombs were used for each explosive): All test bombs loaded with H-6, 80/20 tritonal, Comp A124-3, and Comp A131-1 produced smoke; the H-6 loaded bombs produced flash in addition to the smoke.

DISCUSSION OF RESULTS

10. In an attempt to evaluate the relative blast characteristics of Comp A124-3, A131-1, and 80/20 tritonal, these explosives were loaded at Picatinny Arsenal into 500-lb general purpose bombs, 8-lb bare spheres with 0.25-lb boosters, 8-lb bare spheres with 0.03-lb boosters, and ½-lb bare spheres with 0.03-lb boosters. All the items were submitted to Aberdeen Proving Ground for testing. The 500-lb bombs were later reshipped by Aberdeen Proving Ground to Yuma Test Station where facilities were more readily available at the time.

11. According to the results of the 500-lb bomb tests, each of the explosive compositions tested, namely Comp A124-3, Comp A131-1, and 80/20 tritonal, gave a high average impulse reading in one of the three gage positions (Table 1). It can only be concluded, therefore, that neither of the 2 experimental compositions is superior in blast to tritonal, according to the bomb test results. It should be noted that this conclusion is based on the overall concept of blast and not on peak pressure.

12. Out of a total of 84 possible impulse values for all the bombs tested, only 34 impulse values in various positions were recorded in Reference 3; the others were lost. Of those recorded, eight were doubtful and could not be included in the computation of data for Table 1. This difficulty in obtaining data points up the weakness of the blast test technique; consequently, the reliability of the numerical values may be open to question. However, the conclusion that the three explosives tested in the bombs are qualitatively comparable in blast would appear to be valid.

13. The peak pressure information is included because it may prove useful and interesting. It must be remembered that pressure is one of the coordinates in the graphic concept of blast. Time, which is the other coordinate, must also be included. For an accurate presentation of true blast, the area under the pressure-time curve is significant. Impulse is the term used to express the value under the curve in units of pound-milliseconds per square inch.

14. In the same bomb tests, Comp A124-3 produced higher computed peak pressure than Comp A131-1 at all positions and tritonal was inferior in this respect at

all positions. The peak pressures obtained by direct gage readings show Comp-A131-1 to be superior to Comp A124-3 in 2 positions. Since peak pressure values computed from velocity are generally considered to be more accurate than those obtained directly from the gages, the calculated values are preferred and it follows that Comp A124-3 probably produces superior peak pressure.

15. Air blast tests of the three explosives supplied by Picatinny Arsenal in the form of 8-lb spheres with 0.25-lb pentolite boosters were conducted in the standard manner making use of piezoelectric blast gages. Charges of 50/50 pentolite and H-6 cast at Aberdeen Proving Ground were fired together with the three test explosives as a means of control. Because the charges prepared in the different installations were formed using different molds it is not surprising that the sizes of the charges varied noticeably. In order to make a fair comparison, therefore, corrections were made to permit the data to be presented on an equal volume basis (see Table 3). H-6 gave superior impulse in 2 of the 3 gage positions while Comp A124-3 gave superior impulse in the other position. The same comparative order of superiority is shown in average peak pressures. According to the impulse values obtained in this test it can be concluded (a) that H-6 is the best air blast explosive, (b) that Comp A124-3 is superior in blast to 80/20 tritonal, and (c) that Comp A131-1 is comparatively inferior.

16. Throughout the tests of the 8-lb spherical charges manufactured with 0.03-lb pentolite boosters, no consistent velocity records could be obtained for the three aluminized explosive compositions. On the other hand, test spheres of 50/50 pentolite were fired for check purposes, and excellent velocity results were recorded. It appears from this that inadequate boostering of the spheres of 80/20 tritonal, Comp A124-3, and Comp A131-1 caused low-order detonation and consequently produced questionable velocity records. According to the direct peak pressure readings as shown in Table 4, Comp A124-3 had high mean values in the two gage positions of the test. There was a total of 75 tourmaline gage readings in this test out of a possible 126 readings. The loss in readings was in large measure due to the low-order detonations. It is strongly suspected that another reason for the questionable values was disruption of the gage by unburned aluminum flecks which impinged on the gages and disturbed the records.

17. Attempts to conduct blast experiments with ½-lb spherical charges proved unsuccessful. Investigation of the cause of the poor test results revealed that particles of unburned aluminum were being projected past the blast gages by the force of the explosion, thus setting up miniature Mach waves that interfered with the gages and records.

18. Although it has been shown to some extent in this report that Comp A124-3 may be worth considering as a blast explosive, the excessive exudation from compositions containing 7% NODP as pointed out in paragraph 7, raises serious doubt concerning its usability. It is known that exudate is a rather important defect in that it may impair the functioning of the end item, create morale and house-cleaning problems, and necessitate expensive periodic removal. As previously stated, no exudation was actually noted on any of the bombs tested even though they had been stored for two years. However, it is required that all ammunition should withstand storage at 160°F. Quite likely the bombs never reached this temperature during their long period of storage at Aberdeen Proving Ground and much shorter period of storage at Yuma Test Station.

19. Limited data (Ref 1) obtained in the laboratory show that the aluminized explosive compositions containing NODP are relatively less sensitive to mechanical shock than HBX-type compositions when measured by the Bureau of Mines impact test and rifle bullet impact test. However, there are not enough data to establish a firm conclusion. Furthermore, the impact test results obtained with the Picatinny Arsenal apparatus did not substantiate results obtained with the Bureau of Mines apparatus for all the aluminized explosives containing NODP (Ref 1). The validity of the bullet impact results obtained in the laboratory is questionable because these tests were conducted with pipe nipples and it is now believed that the loaded nipples are not a reliable test medium. It is now evident that tests with rifle bullet bombs as shown in Fig 3 should be conducted before it can be reliably concluded that there is any substantial difference in sensitivity between Compositions A124-3 or A131-1 and any of the HBX explosives.

20. The fact that the separation of NODP from TNT was not discernible in the laboratory but was readily observed in the production plant is not surprising. The novel and unexpected are frequently encountered during the development phase, when larger batches of explosives are produced in the plant. Immiscibility of NODP in TNT is undesirable since it results in incomplete or uneven distribution of the desensitizer throughout the explosive charge and thereby diminishes the effectiveness and reliability of the desensitizer.

21. It appears that the need for a blast explosive superior to tritonal can best be met by the use of H-6. This explosive should, therefore, be given serious consideration for application in general purpose bombs. It should be noted in this connection that the Navy is standardizing H-6 for low-drag bombs.

EXPERIMENTAL PROCEDURE

21. The 500-lb GP bombs were loaded according to Dwg. 82-14-37 rev 12-15-50. The explosives were cast into the bombs

using a conventional pellet-loading technique. Spherical charges were manufactured using split molds and a specially designed contrivance for centering the small spherical 50/50 pentolite booster within the mold during the casting process. To determine the blast characteristics of the explosives in the bombs, six pressure gages of the Atlantic Research Laboratory type and twelve velocity gages of similar type were used. These gages were arranged in Figure 1.

22. The field test setup for the 8-lb charges, as shown in Figure 2, consisted of six tourmaline, piezoelectric wave-form gages and eight barium titanate velocity gages. The tourmaline gages were placed in two groups of three gages each, with one group at the 9-ft range and one at the 17-ft range. The velocity gages were so placed that two groups of two gages each were made to span each pressure range, thereby giving two velocity readings for each pressure range. By means of the well-known Rankine-Hugoniot relationship, the velocities were used to infer peak pressure. Type II special blasting caps were used to initiate the detonation. Each charge was oriented so that the longitudinal axis of the cap was perpendicular to the ground.

23. Rifle bullet tests were conducted as described in Reference 4, using test bombs constructed according to type III in Figure 3.

24. The exudation tests were conducted with 90 mm M71 shell. These were loaded with the various explosives and assembled with M73 dummy fuzes. The shell were supported on racks with the nose ends slightly lower than the bases. The exudate was collected in tared beakers and was examined daily.

REFERENCES

1. A. L. Forchielli, *Desensitized Explosives, RDX Comp B of Reduced Mechanical Sensitivity*, Picatinny Arsenal Technical Report 1865, 13 March 1952

2. 8th Ind from Picatinny Arsenal to OCO, subject: "Desensitized Explosive - RDX Composition B of Reduced Mechanical Sensitivity," 7 May 1952, ORDBB 471.86/2083-13, 00 471.86/2083-13

3. Aberdeen Proving Ground, *Test of Blast Effect of 500-lb General Purpose Bombs Loaded with Experimental Fillers*, Third Report, OCO Project No. TA2-9110

4. S. D. Stein, M. Pollack, *Development of an Improved Rifle Bullet Impact Sensitivity Test*, Picatinny Arsenal Technical Report 2247, May 1956

TABLE 1

Blast Tests of 500-lb General Purpose Bombs
Data for Each Gage Position

Explosive	Position 1	Position 2	Position 3
Average Impulse, lb-milliseconds/in^2			
Comp A124-3	32.1	18.4	14.3
Comp A131-1	27.3	26.6	18.8
80/20 Tritonal	16.5	13.0	23.4
Average Peak Pressure Computed from Velocity, psi			
Comp A124-3	6.60	3.42	2.30
Comp A131-1	6.00	3.09	1.97
80/20 Tritonal	5.94	2.88	1.94
Average Peak Pressure Measured by Gages, psi			
Comp A124-3	6.08	2.92	1.96
Comp A131-1	5.74	3.06	1.98
80/20 Tritonal	5.78	2.75	1.82

TABLE 2

Compositions of Explosives Tested (Parts)

	Explosives				
	50/50 Pentolite	Comp A124-3	Comp A131-1	80/20 Tritonal	H-6
PETN[a]	50				
Comp B[b]		67	82		74
TNT[c]	50	5		80	
Aluminum powder[d]		20	10	20	21
Comp D-2[e]					5
Calcium chloride[f]					0.5
NODP[g]		8	8		

---

[a] Specification X-PA-PD-205, Class 3, 11 Jan 1956

[b] Specification PA-PD-24 (Rev 1), Grade A, 13 Aug 1953

[c] Specification JAN-T-248, Grade 1, 29 Sept 1945

[d] Specification JAN-A-289, Type C, Class d, 30 Jan 1946

[e] Specification MIL-C-18164, 4 Nov 1954

[f] Specification MIL-C-13573, 9 Aug 1954

[g] Commercial product having a melting point range of 71° to 73°C

TABLE 3

Average Impulses and Pressures of 8-lb Spheres Corrected to Equal Volume Basis

	Impulse, lb-milliseconds/in.²			Average Peak Pressure, psi		
Gage Distance, ft	9.5	12.5	17.5	9.5	12.5	17.5
H-6*	23.2	19.0	14.2	42.1	19.8	10.6
Comp A124-3*	26.5	18.3	13.6	44.4	18.7	9.4
Comp A131-1*	21.6	17.7	12.4	38.8	18.4	9.6
80/20 Tritonal*	21.2	18.4	12.6	38.7	19.7	9.4
50/50 Pentolite	22.5	18.1	13.1	41.6	19.6	10.0

* With 0.25-lb pentolite booster

TABLE 4

Tests of 8-lb Spherical Charges*
Mean Peak Pressures Obtained Directly from Gages

Explosive	Position, 9 ft** Peak Pressure, psi Mean	Std Dev	Position, 17 ft** Peak Pressure, psi Mean	Std Dev
Comp A124-3	43.98	2.236	10.38	0.289
Comp A131-1	43.98	0.574	10.25	0.607
80/20 Tritonal	43.19	1.854	10.25	0.331

* With 0.03-lb pentolite boosters
** From center of charge

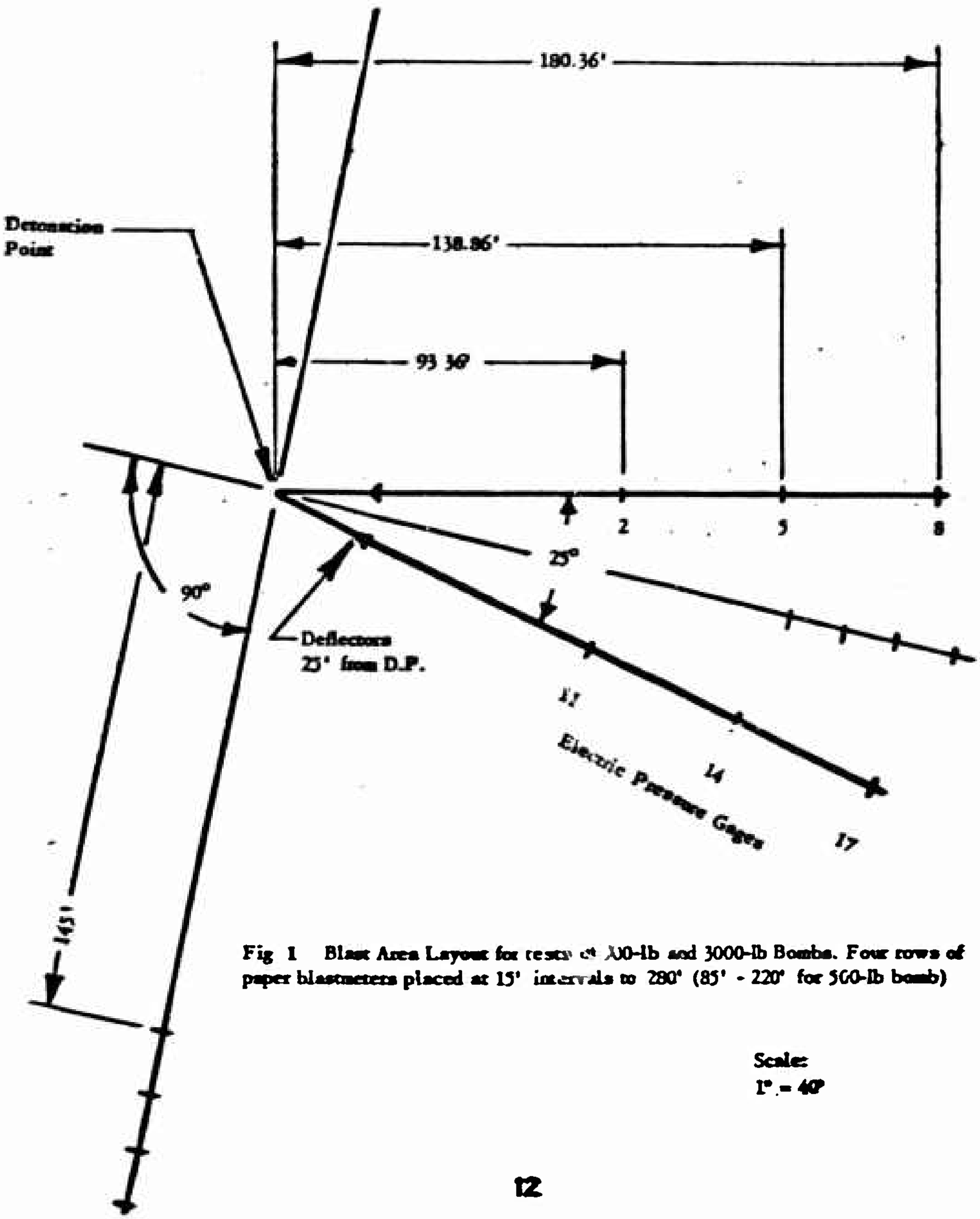

Fig 1 Blast Area Layout for tests of 500-lb and 3000-lb Bombs. Four rows of paper blastmeters placed at 15' intervals to 280' (85' - 220' for 500-lb bomb)

Scale:
1" = 40'

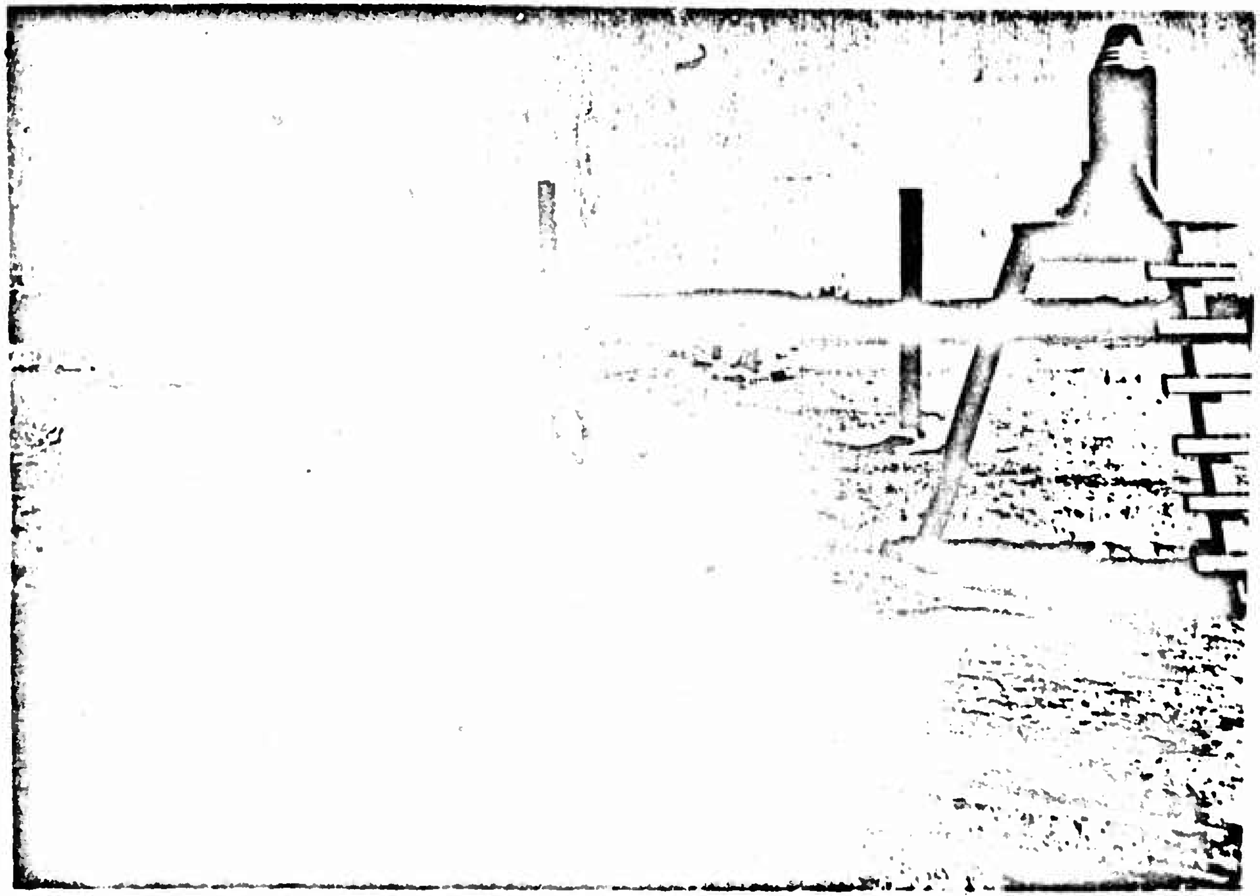

Fig 2 Blast Test of 500-lb GP Bomb at Yuma, Arizona. Bomb shown in test position before detonation. Also shown are electric blast pressure and velocity gages, and one row of APG paper blastmeters.

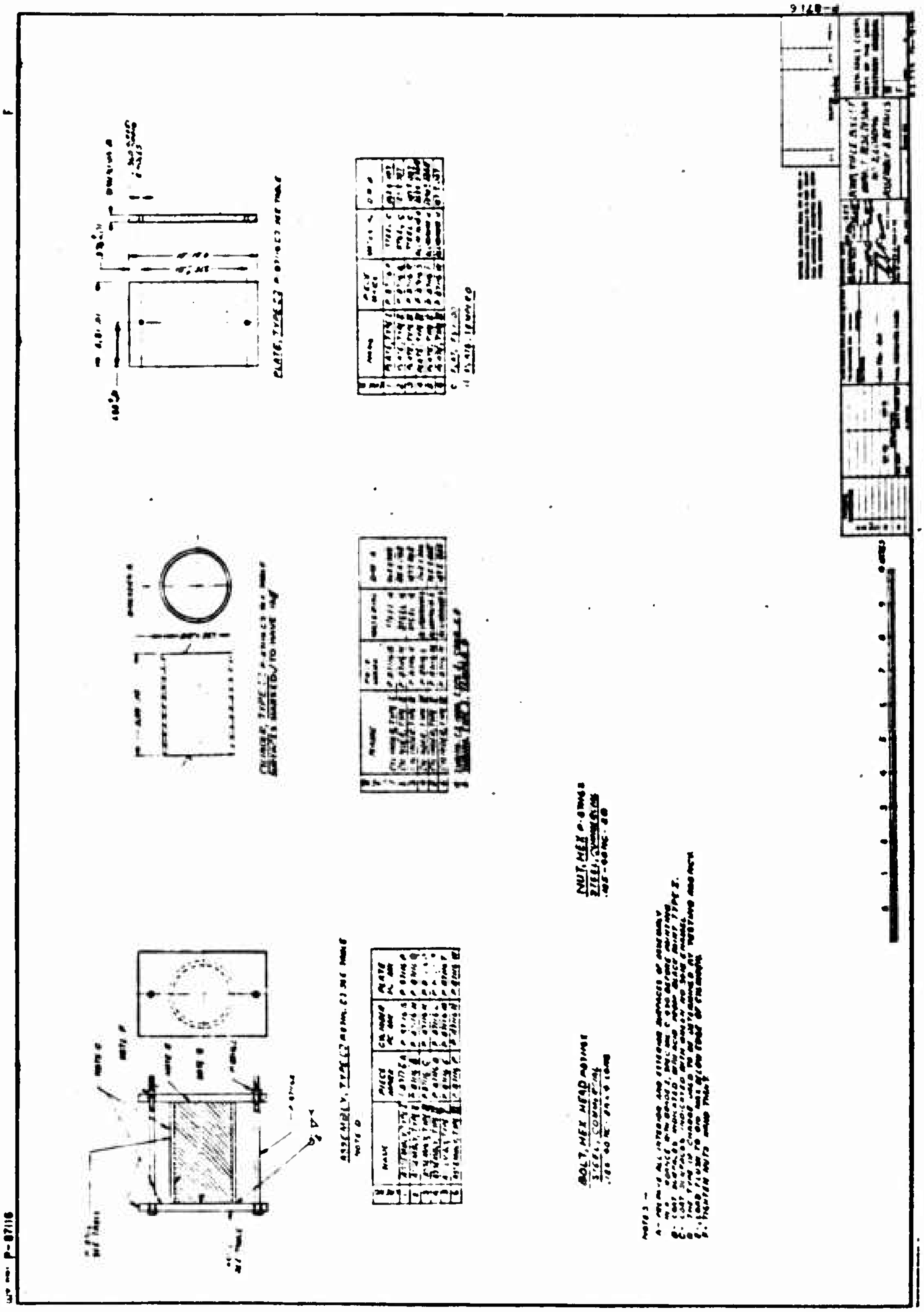

FIG. 3 Loading Assembly and Details of Rifle Bullet Impact Test Bomb No. 2

DISTRIBUTION LIST

	Copy No.
Commanding Officer Picatinny Arsenal Dover, N. J. ATTN: Technical Information Section	1 - 5
Chief of Ordnance Dept of the Army Washington 25, D. C. ATTN: ORDTA - Dr. L. R. Littleton	6
ORDTX-AR	7
ORDTU	8
ORDIM	9
Chief of Staff U. S. Dept of the Air Force Washington 25, D. C.	10
Commanding Officer Army Chemical Center Maryland	11
Department of the Navy Bureau of Ordnance Washington 25, D. C. ATTN: ReU3a	12
Ad3	13
Naval Proving Ground Dahlgren Virginia	14
Commanding General Aberdeen Proving Ground Maryland ATTN: TIB	15
Terminal Ballistics Division, H. L. Rosenberg	16

	Copy No.
Commander U. S. Naval Ordnance Laboratory White Oak, Silver Spring Maryland ATTN: Library	17
Commanding General Ordnance Ammunition Command Joliet, Illinois ATTN: ARAC- Mr. E. G. Rapp	18
Armed Services Technical Information Agency Document Service Center Knott Building Dayton 2 Ohio ATTN: DSC-SD	19 - 28
National Fireworks Ordnance Corporation West Hanover Massachusetts	29
Arthur D. Little, Inc. 30 Memorial Drive Cambridge 42, Massachusetts ATTN: Dr. Kreidl VIA: Boston Ordnance District Army Base South Boston 10, Massachusetts	30
Commanding Officer Naval Mine Depot Yorktown, Virginia ATTN: Research and Development Laboratories	31
Commanding General Air Research & Development Command P.O. Box 1395 Baltimore 3, Maryland	32

	Copy No.
Commander U. S. Naval Ordnance Test Station Inyokern, China Lake California ATTN: Technical Library Branch	33
Headquarters Air Force Armament Center Eglin Air Force Base Eglin, Florida ATTN: ACXB	34
Denver Research Institute University of Denver Denver 10, Colorado	35