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U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

REPORT NO 1073

BOMBS AND ASSOCIATED COMPONENTS

50th Partial Report

BALLISTIC TEST OF 1000# LOW DRAG, G P. BOMB
TYPE EX 10 MOD 12

FINAL Report

Copy No. 29

Task

Assignment NPG-Re3c-321-1-52

Classification CONFIDENTIAL
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Ballistic Tests of 1000# Low Drag, G. P. Bomb Type EX 10 Mod 12
-----PART ASYNOPSIS

1. The tests reported herein were conducted to determine: (1) the maximum STS armor plate thickness which the 1000 lb. Low Drag G.P. Bomb Type EX 10 Mod 12 will penetrate at 1000 ft./sec. velocity and remain in effective bursting condition; (2) the maximum thickness of reinforced structural concrete the bomb will penetrate at 1000 ft./sec. velocity and remain in effective bursting condition; (3) in accordance with reference (c) to compare bombs finished by heat treating with those finished by normalizing; (4) any points of weakness or cause of failure in the design, and (5) chemical and metallurgical properties of the bomb body.

2. It is concluded that:

a. The maximum STS armor plate thickness which the normalized bomb will penetrate and remain in effective bursting condition, at a velocity of 1000 ft./sec. and 20° obliquity, is nominal 1 1/25 plate, as reported in NPG Confidential Report Number 748. Bomb body deformation is probably not severe enough to cause deflagration of an explosive filler.

b. Under the same conditions, the corresponding thickness for the quenched and drawn bomb is nominal 1 1/38 STS armor plate. The two rounds fired under the above conditions remained effective and intact. Body deformation was probably not severe enough to cause deflagration of an explosive filler. It appears that the heat treated bomb will penetrate a greater thickness of STS armor plate than will the bomb finished by normalizing.

c. The maximum thickness of reinforced concrete which the heat treated bomb will penetrate and remain in effective bursting condition, at 1000 ft./sec. striking velocity and 20° obliquity, is 24 inches. Two bombs were fired satisfactorily under these conditions. Two additional bombs fired at 30 and 36 inches of reinforced concrete were not effective, both bombs breaking into two pieces.

d. No bombs finished by normalizing were fired at reinforced concrete during this test. However, from the results of a previous test as reported in NPG Report Number 748, it is apparent that under the same conditions the maximum thickness of reinforced concrete for the normalized bomb is also 24 inches.

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Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12

e. Bombs heat treated by quenching in oil from 1500°F and drawing at 1100°F followed by a water quench have better ballistic qualities than those produced by normalizing only.

f. Quenched and drawn bombs have lower temperatures of transition from ductile to brittle behavior and thus would be more effective at low temperatures than normalized bombs.

3. It is recommended that the design of the nose fuze hole be reviewed for the purpose of strengthening the structures at this point.

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Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12
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Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12
-----PART BINTRODUCTION

1. AUTHORITY:

These tests were authorized by reference (a) and conducted under Task Assignment NPG-Re3c-321-1-52.

2. REFERENCES:

- a. BUORD Conf ltr Re3c-LME:edb NP9 Ser 25671 of 14 Sep 1951
- b. Task Assignment NPG-Re3c-321-1-52
- c. NPG Conf Report Number 646 C. S. 506-5
- d. NPG Conf Report Number 748
- e. National Tube Co. Preliminary Sk. Number 142

3. BACKGROUND:

In the development of a family of low drag bombs for external suspension on high speed aircraft, the Naval Proving Ground has conducted plate penetration tests and metallurgical examination on the 1000 lb. Low Drag G.P. Bomb Type EX 10 and Type EX 10 Mod 3. Reference (c) is a report on the performance of 1000 lb. Low Drag G.P. Bomb Type EX 10 together with recommendations for heat treatment of this bomb case to improve its metallurgical properties. Reference (d) is a report on the performance of 1000 lb. Low Drag G.P. Bomb Type EX 10 Mod 3 together with recommendations for heat treatment to improve its metallurgical properties. The Type EX 10 Mod 3 bomb differed from the Type EX 10 bomb in that inserts for screw-in suspension lugs were provided in the bomb body, the nose section of the bomb body was heavier, and the thread diameter of the nose fuze hole was increased to three inches.

This report deals with the performance of 1000 lb. Low Drag G.P. Bombs Type EX 10 Mod 12 in the heat-treated and in the normalized condition.

4. OBJECT OF TEST:

These tests were conducted to determine:

- a. The maximum armor plate or concrete thickness which each type of bomb will penetrate and remain in an effective bursting condition.

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Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12

b. The degree of acceptable deformation of each type of bomb resulting from impact.

c. The condition under which each type of bomb will fail.

d. The chemical and metallurgical properties of the bombs.

5. PERIOD OF TEST:

a. Date Project Letter	14 September 1951
b. Date Commenced Test	5 October 1951
c. Date Completed Test	5 November 1951

PART C

DETAILS OF TEST

6. DESCRIPTION OF ITEM UNDER TEST:

Twenty 1000 lb. Low Drag G.P. Bombs Type EX 10 Mod 12 described by reference (e), which is included as Figure 10 in this report. The Type EX 10 Mod 12 bombs differ from Type EX 10 Mod 3 bombs in that the threads for the nose fuze hole have been increased to 3-1/2" diameter. In addition, ten of the EX 10 Mod 12 bombs were submitted for test with heat treatment as recommended by references (c) and (d); that is quenched in oil from 1500°F and drawn at 1100°F, followed by a water quench. The remaining ten bombs were submitted for test in the normalized condition to conform to the treatment given the Type EX 10 and Type EX 10 Mod 3 bombs in order that comparative tests might be conducted between normalized and heat treated bombs.

The twenty EX 10 Mod 12 bombs used in this test were inert loaded with a vermiculite-cement filler of 1.55 specific gravity.

7. DESCRIPTION OF TEST EQUIPMENT:

Gun:	14"/50 Mk 11 Mod 0, No. 119L-2
Charge:	Various weights of Sphero-Hexagonal Black Cannon Powder
Targets:	Nominal 1-1/4", 1-3/8" and 1-1/2" STS armor plate 24", 30" and 36" structural concrete reinforced 3 ways with 3/4" rod on 6" centers.

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Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12

8. PROCEDURE:

The bombs were fired against STS armor plate targets of various thicknesses at velocities ranging from 838 ft./sec. to 922 ft./sec. The heat treated bombs were fired against the reinforced concrete targets at velocities ranging from 874 ft./sec. to 890 ft./sec. All tests were conducted with the target at 20° obliquity. The targets were secured in heavy butts and backed by a sand pile, which served as the recovery medium. Each type of bomb was recovered after firing and examined prior to firing the next test on this program. Velocities were measured in the standard manner, using solenoids and oscillographs. Samples were cut from each of the following listed bombs for metallurgical examination: NORM-2, NORM-9, Q & D-11, and Q & D-18.

9. RESULTS AND DISCUSSION:

a. Ballistic test conditions and results are given in detail in Tables III through XIV of Appendix (B) and Figures 1 through 9 of Appendix (C) and are summarized in Tables I and II of Appendix (A). Briefly, the results were as follows:

(1) Four of the normalized bombs were fired against STS armor. The first bomb was fired against 1!21 STS armor at 838 ft./sec. and was recovered in effective condition with moderate flattening on the body nose section. The next two bombs were fired against 1!38 STS at striking velocities of 922 ft./sec. and 865 ft./sec. Both bombs were recovered in ineffective condition, one being cracked from the nose to 26" back and the other having the nose section bent and broken open. The fourth round was fired against 1!21 STS at 899 ft./sec. and was recovered in an ineffective condition with the nose broken off. As a result of these tests, it was considered that the plate limit of the normalized 1000 lb. Low Drag G.P. Bomb Type EX 10 Mod 12 at these test conditions was less than nominal 1-1/4" STS armor plate.

(2) Four of the heat treated bombs were fired against STS armor plate. The first bomb was fired against 1!21 STS armor at 911 ft./sec. and was recovered in effective condition with moderate to severe flattening of the nose body section. The second bomb was fired against 1!38 STS armor at 855 ft./sec. and was recovered in effective condition with moderate flattening of the bomb body. The third round was fired against 1!50 STS armor at 872 ft./sec. and was recovered in ineffective condition being bent with the nose broken off. The fourth round was fired against

Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12

1#38 STS armor at 850 ft./sec. and was recovered in effective condition although severely worked on the nose section. As a result of these tests, it was considered that the plate limit of the heat treated 1000 lb. Low Drag G.P. Bomb Type EX 10 Mod 12 at these test conditions was nominal 1-3/8" STS armor plate.

(3) Four of the heat treated bombs were fired against reinforced concrete targets. The first bomb was fired against 24" reinforced concrete at a striking velocity of 888 ft./sec. and was recovered in effective condition with very little body deformation. The second bomb was fired against 36" reinforced concrete at 890 ft./sec. and was rendered ineffective as the bomb broke into two pieces in the target. The third bomb was fired against 24" reinforced concrete at 874 ft./sec. and was recovered in effective condition with very little body deformation. The fourth round was fired against 30" reinforced concrete at 886 ft./sec. and was rendered ineffective as the bomb broke into two pieces in the target. As a result of these tests, it was considered that the heat treated 1000 lb. Low Drag G.P. Bomb Type EX 10 Mod 12 would penetrate in effective condition 24" reinforced concrete.

b. Metallurgical Examination

Metallurgical examination was made of normalized bombs #2 and #9 and quenched and drawn bombs #11 and #18 shown after firing in Figures 2, 5, 2 and 8 respectively. The examination consisted of chemical and spectrographic analysis, tensile, Charpy impact and Brinell hardness tests, hot acid etch and microscopic examination. The test samples were cut from the least damaged sections of the side walls of the bombs after firing.

The results of chemical and spectrographic analyses were as follows:

<u>Bomb No.</u>	<u>C</u>	<u>Mn</u>	<u>P</u>	<u>S</u>	<u>Si</u>	<u>Mo</u>	<u>Cr</u>	<u>Ni</u>
2 NORM	.42	1.75	.016	.021	.22	.32	.08	Trace
9 NORM	.34	1.37	.020	.021	.18	.31	.09	"
11 Q&D	.41	1.64	.016	.024	.18	.29	.09	"
18 Q&D	.37	1.64	.016	.021	.21	.32	.10	"

Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12

Longitudinal tensile test and average Brinell hardness results are shown below:

Bomb No.	Yld. Str. .2% p.s.i.	Ult. Str. p.s.i.	Elong. %1.4"	R.A. %	B.H.N. 3000 Kg.
#2 NORM	95500	123670	17.9	49.3	251
#9 NORM	65850	101670	23.1	53.2	202
#11 Q&D	90870	119670	20.2	61.9	249
#18 Q&D	107500	127000	17.5	58.1	270

The tensile test results are averages of three specimens from each bomb.

Longitudinal Charpy V-notch impact tests with the notch normal to the plate surface were made in duplicate at 100°C, +25°C (room temperature), 0°C, -40°C and -78°C excepting for bomb #2. On this bomb, the testing at -78°C was omitted and additional tests were made at +65°C and +45°C. The results of impact tests are shown in Table XV and Figures 11 and 12, Appendix (E).

Transverse sections etched for 20 minutes in 50% HCl-50% H₂O at 160°F are shown in Figure 13.

Typical microstructures at 250X and 1000X are shown in Figures 14 to 21, inclusive. Chemical analyses represent a non-standard manganese - molybdenum steel which is similar in composition to the analysis of previous bombs reported in references (c) and (d). The analysis of bomb #9 is somewhat lower in carbon and manganese contents which accounts for its softer physical properties. The tensile properties of the quenched and drawn bombs are not appreciably different from those of the normalized bombs previously examined, bomb #18 being only slightly harder. However, the beneficial effects of the quenched and drawn heat treatment manifests itself in the tempered-martensitic microstructure in Figures 18 to 21, inclusive, and in the combination of higher values of tensile, hardness and impact strengths exhibited by bombs #11 and #18. The deep acid etch tests as shown in Figure 13 indicate sound steel in all four bombs.

Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12

Considering the points on the Charpy impact curves in Figures 11 and 12, where the fractures become 50% granular and 50% fibrous as the transition points between toughness and brittleness, it will be noted that the normalized bombs #2 and #9 become brittle at temperatures of approximately plus 25°C and 0°C respectively, whereas the quenched and drawn bombs #11 and #18 become embrittled at approximately minus 50°C and below minus 78°C respectively. This indicates that the quenched and drawn bombs will be more effective at sub-zero temperatures than the normalized bombs.

PART DCONCLUSIONS

10. It is concluded that:

a. The maximum STS armor plate thickness which the 1000 lb. Low Drag G.P. Bomb Type EX 10 Mod 12 in the normalized condition will penetrate and remain in effective bursting condition, at velocities ranging from 838 ft./sec. to 922 ft./sec. and 20° obliquity, is less than nominal 1-1/4" plate. This is to be compared with the 1000 lb. Low Drag G.P. Bomb Type EX 10 Mod 3 which effectively penetrated nominal 1-1/4" STS armor plate at the same test conditions. Both Mods of these Type EX 10 bombs are in the same heat treated condition, the only design difference being in the thread diameter of the nose fuze hole. Since the failures of the Type EX 10 Mod 12 bomb originated from or around the nose fuze hole, it is concluded that increasing the diameter of the nose fuze hole from 3" in the Type EX 10 Mod 3 bomb to 3-1/2" in the Type EX 10 Mod 12 bomb has resulted in decreasing the thickness of STS armor plate the bomb will penetrate in an effective condition.

b. The maximum STS armor plate thickness which the 1000 lb. Low Drag G.P. Bomb Type EX 10 Mod 12 in the heat treated condition will penetrate and remain in effective bursting condition, at velocities ranging from 850 ft./sec. to 911 ft./sec. and 20° obliquity, is nominal 1-3/8" plate.

Ballistic Tests of 1000^{lb} Low Drag, G.P. Bomb Type EX 10 Mod 12

c. The maximum thickness of reinforced concrete the 1000 lb. Low Drag G.P. Bomb Type EX 10 Mod 12 in the heat treated condition will penetrate and remain in effective bursting condition, at velocities of 874 ft./sec. and 888 ft./sec. and 20° obliquity, is 24".

d. Bombs heat treated by quenching in oil from 1500°F and drawing at 1100°F followed by a water quench have better ballistic qualities than those produced by normalizing only.

e. Quenched and drawn bombs have lower temperatures of transition from ductile to brittle behavior and thus would be more effective at low temperatures than normalized bombs.

PART ERECOMMENDATIONS

11. It is recommended that the design of the nose fuze hole be reviewed for the purpose of strengthening the structure at this point.

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Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12

The tests upon which this report is based were conducted by:

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NPG REPORT NO. 1073

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Fiftieth Partial Report

on

Bombs and Associated Components

Final Report

on

Ballistic Tests of 1000 $\frac{1}{2}$ Low Drag, G.P. Bomb

Type EX 10 Mod 12

JAN 22 1953

Project No.: NPG-Re3c-321-1-52

Date:

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Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12
-----TABLE ISummary of Firing Conditions and Ballistic Test Results

<u>Imp.</u> <u>No.</u>	<u>Bomb</u> <u>No.</u>	<u>Obl.</u>	<u>Thick-</u> <u>ness</u>	<u>Str. Vel.</u> <u>ft./sec.</u>	<u>Penet.</u>	<u>Thru</u> <u>Open</u>	<u>Condition</u>
39328	NORM-1	20	1821	838	C	14"X14"	Effective and intact. Moderate flattening.
39329	Q&D-12	20	1821	911	C	14"X14"	Effective and intact. Moderate to severe flattening.
39334	NORM-2	20	1838	922	C	14"X14"	Severely bent and drawn-sides flattened, cracked long from nose to 26" aft.
39335	Q&D-11	20	1838	855	C	14"X14"	Effective and intact. Moderate flattening.
39351	NORM-4	20	1838	865	C	14"X14"	Not effective- bent and broken open on nose section.
39352	Q&D-13	20	1850	872	C	14"X14"	Not effective- bent and broken open on nose section.
39364	Q&D-14	20	1838	850	C	14"X14"	Effective and intact. Severely worked on nose.
39365	NORM-9	20	1821	899	C	14"X14"	Not effective- broken open on nose.
39376	Q&D-19	20	24"	888	C	18"X18"	Effective and intact. Very slightly bent and worked.

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Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12

TABLE I (Continued)

<u>Imp.</u> <u>No.</u>	<u>Bomb</u> <u>No.</u>	<u>Obl.</u>	<u>Thick-</u> <u>ness</u>	<u>Str. Vel.</u> <u>ft./sec.</u>	<u>Penet.</u>	<u>Thru</u> <u>Open</u>	<u>Condition</u>
39387	Q&D-17	20	36"	890	35"	15"X20"	Bomb broke into 2 pieces. Nose through and off. Base stuck in block.
39416	Q&D-18	20	24"	874	C	19"X21"	Effective and intact. No. deformation.
39438	Q&D-20	20	30"	886	Inc.	8"X10"	Bomb broke into 2 pieces. Nose through and off. Base stuck in block.

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Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12

TABLE II

Comparison of Heat Treated Bombs

<u>Normalized</u>			<u>Quenched and Drawn</u>		
1821	838	OK	1821	911	OK
1838	922	NG	1838	855	OK
1838	865	NG	1850	872	NG
1821	899	NG	1838	850	OK
			24"	888	OK
			36"	890	NG
			24"	874	OK
			30"	886	NG

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APPENDIX A

File No.

Butt Firing

U. S. Naval Proving Ground

Dahlgren, Va. 10-5-51 194

IMPACT No. 39329

IMPACT DATE 10-5-51

BUTT No. K

OBJECT DELLITE TEST OF 14" L.R. LOW D.P. ROME
TYPE EX-10REFERENCE N.P.G. LETTER 7-10-51 1023 DATED 7-10-51

PLATE

Gauge 1.250
 Class 575
 Maker V.S. 7111
 No. 145690 Group U-36-778
 Contract N600-155-9728
 Date received 4-25-51
 Dimensions 250" X 82 1/2"
 No. of impact on plate 4
 Thickness at impact 1.21
 OBLIQUITY 20°
 Impact dimensions 14" X 15"
 PENETRATION Complete
 Flaking front C
 Flaking back C
 Dist. from top, bottom 55"
 Dist. from right, left 85"
 Dist. from nearest impact 27"
 Dish 4"
 Spur 6"
 Cracks - Bulge C
 Button (Thrown) (Started)
 Through Opening 14" X 14"

PROJECTILE

Caliber 12.97
 Maker N.T. Co.
 Type G.P. Low D.P. ROME
 Lot No. - Year of Specification -
 Mark EX-10 Mod. 12 No. DTQ-12
 Date received -
~~Capped or uncapped~~
~~Weight (capped)~~
 Weight (uncapped) 934 #
 Length (uncapped) 78.80
 Fuze NONE
 Filler VERMICULITE
 Flight by screen -
 Condition after firing:-
 EFFECTIVE or INEFFECTIVE

Moderate to severe
flaking



BALLISTIC DATA

NOTE:	-1- Desired	-2- Oscillograph	-3- Chronograph	-4- Limit, estimated for this thickness of impact.	-5- Actual adjusted to nominal gauge	-6- Limit, for nominal gauge, based on this impact only. (Adjusted from column 4)	-7- Limit, for nominal gauge, established from column 6 and previous impacts.
All limits are for this plate and this obliquity only.		<u>11.211</u>					
Striking velocity (f.s.)		<u>811</u>					

REMARKS

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Acceptance or Rejection recommended

Limit shots only

e/d.

F(e/d, e)

N.P.G. Photo. No. 111922

U.S. Navy

TABLE IV

GUN: 14"/50 MOD 7111922

File No.

Butt Firing

U.S. Naval Proving Ground
Dahlgren, Va. 10-9-51 194IMPACT No. 39334
IMPACT DATE 10-9-51
BUTT No. BOBJECT BALLISTIC TEST OF 1000 LB. LOW DRAG G.P. BOMB
TYPE EX 10REFERENCE N.P.G. LETTER Report No. 1023

DATED _____

PLATE

BOMB

PROJECTILE

Gauge 1.38
 Class STS
 Maker CARNEGIE
 No. 045701 Group C-526-392
 Contract ORDER-439-S-5000-C
 Date received SEPT. 11, 1944
 Dimensions 95 1/16" X 249 1/2"
 No. of impact on plate 4
 Thickness at impact 1.38
 OBLIQUITY 20°
 Impact dimensions 14" X 15"
 PENETRATION COMPLETE
 Flaking front 0
 Flaking back 0
 Dist. from top, bottom 29"
 Dist. from right, left 8.8"
 Dist. from nearest impact 72"
 Dish 3"
 Spur 4"
 Cracks - Bulge 0
 Button (Thrown) (Started)
 Through Opening 14" X 14"

Caliber 13.976
 Maker N.T. Co.
 Type LOW DRAG G.P.
 Lot No. - Year of Specification -
 Mark EX 10 Mod. 12 No. NORTH 2
 Date received -
 Gapped or uncapped -
 Weight (capped) -
 Weight (uncapped) 931.50 #
 Length (uncapped) 928.00 #
 Fuze NON F.
 Filler VEGETABLE OIL
 Flight by screen -
 Condition after firing:-
EFFECTIVE or INEFFECTIVE

Severely bent and deformed
sides flattened and cracked
long from nose to
26" aft.



BALLISTIC DATA

NOTE:	-1- Desired	-2- Oscillograph	-3- Chronograph	-4- Limit, estimated for this thickness of impact.	-5- Actual, adjusted to nominal gauge.	-6- Limit, for nominal gauge, based on this impact only. (Adjusted from column 4)	-7- Limit, for nominal gauge, established from column 6 and previous impacts.
All limits are for this plate and this obliquity only.		<u>MEAN</u>					
Striking velocity (f.s.)		<u>922</u>					

REMARKS

Limit shots only

e/d.

F(e/d, Θ)

N.P.G. Photo. No. NP9 51397**CONFIDENTIAL**

SECURITY INFORMATION

Acceptance or Rejection recommended

W.H. Hume
Ord. Insp.

U.S. Navy

TABLE V

GOW 14/50 MK 11 MOD - #11922

File No.

Butt. Firing

U. S. Naval Proving Ground
Dahlgren, Va. 10-9-51 194IMPACT No. 39335
IMPACT DATE 10-9-51
BUTT No. BOBJECT BALLISTIC TEST OF 1000 LOW DRAG G.P. BOMB
TYPE EX 10REFERENCE N.P.G. LETTER Report No. 1473

DATED

PLATE

BOMB

PROJECTILE

Gauge 1.38
 Class STS
 Maker CARRERIE
 No. 045701 Group C-526-392
 Contract ORDER-437-5-5000-C
 Date received SEPT. 11, 1944
 Dimensions 95-1/16" X 249-1/2"
 No. of impact on plate 5
 Thickness at impact 1.38
 OBLIQUITY 30°
 Impact dimensions 14" X 15"
 PENETRATION COMPLETE
 Flaking front 0
 Flaking back 0
 Dist. from top, bottom 67"
 Dist. from right, left 89"
 Dist. from nearest impact 33"
 Dish 3"
 Spur 6"
 Cracks - Bulge 0
 Button (Thrown) (Started)
 Through Opening 14" X 14"

Caliber 13.977
 Maker N.I. Co.
 Type G.P. LOW DRAG
 Lot No. - Year of Specification -
 Mark EX 10 Mod. 12 No. D-11
 Date received -
 Capped or uncapped -
 Weight (capped) -
 Weight (uncapped) 928.0#
 Length (uncapped) 78.70#
 Fuze NONE
 Filler VERMICULITE
 Flight by screen -
 Condition after firing:-
EFFECTIVE or INEFFECTIVE

Moderate flattening

BALLISTIC DATA

NOTE:	-1- Desired	-2- Oscillograph	-3- Chronograph	-4- Limit, estimated for this thickness of impact.	-5- Actual, adjusted to nominal gauge.	-6- Limit, for nominal gauge, based on this impact only. (Adjusted from column 4)	-7- Limit, for nominal gauge, established from column 6 and previous impacts.
All limits are for this plate and this obliquity only.		<u>MEAN</u>					
Striking velocity (f.s.)		<u>855</u>					

REMARKS

CONFIDENTIAL
SECURITY INFORMATION

Acceptance or Rejection recommended

Limit shots only

e/d

F(e/d, e)

N.P.G. Photo. No. NP-51397GUN: 14"/50 MK II mod - #11942W.D. Murray
Art. Eng.U.S. Navy

TABLE VI

File No.

Butt Firing

U. S. Naval Proving Ground
Dahlgren, Va. 10-11-51 194IMPACT NO. 39351
IMPACT DATE 10-11-51
BUTT NO. BOBJECT BALLISTIC TEST OF 1000 LB. G.P. LOW DRAG
BOMB TYPE EX 10REFERENCE N.P.G. LETTER 6-11-51 DATED 10-11-51

PLATE

BOMB

PROJECTILE

Gauge 1.38
Class STS
Maker CARNEGIE
No. 045701 Group C-526-392
Contract ORDER-437-S-5000-C
Date received SEPT. 11, 1944
Dimensions 9 5/16" x 2 49/64"
No. of impact on plate 6
Thickness at impact 1.38
OBLIQUITY 20°
Impact dimensions 14" x 15"
PENETRATION COMPLETE
Flaking front 0
Flaking back 0
Dist. from top, bottom 31"
Dist. from right, left 128"
Dist. from nearest impact 33"
Dish 3"
Spur 7"
Cracks - Bulge 0
Button (Thrown) (Started)
Through Opening 14" x 14"Caliber 1.3, 972.
Maker N. T. CO.
Type G.P. LOW DRAG
Lot No. - Year of Specification -
Mark EX 10 Mod. 12 No. NORM-4
Date received -
Capped or uncapped -
Weight (capped) -
Weight (uncapped) 938.0#
Length (uncapped) 78.70"
Fuze NONE
Filler VERTICULITE
Flight by screen -
Condition after firing:-EFFECTIVE or INEFFECTIVEBent and broken open
one nose section

BALLISTIC DATA

NOTE:	-1- Desired	-2- Oscillograph	-3- Chronograph	-4- Limit, estimated for this thickness of impact.	-5- Actual, adjusted to nominal gauge.	-6- Limit, for nominal gauge, based on this impact only. (Adjusted from column 4)	-7- Limit, for nominal gauge, established from column 6 and previous impacts.
All limits are for this plate and this obliquity only.		<u>MEAN</u>					
Striking velocity (f.s.)		<u>865</u>					

REMARKS

CONFIDENTIAL
SECURITY INFORMATION

Acceptance or Rejection recommended

Limit shots only

e/d

F(e/d, Θ)

N.P.G. Photo. No. NP 9 51393W. H. H. H. H.
Ord. Eng.

U. S. Navy

TABLE VII

RUN: 14"/50 MK II MOD - #11912

File No.

Butt Firing

U. S. Naval Proving Ground

Dahlgren, Va. 10-11-51 ~~194~~

IMPACT No. 39352.

IMPACT DATE 10-11-51

BUTT No. B

OBJECT BALLISTIC TEST OF 1000 LB. G.P. LOW DRAG
BOMB TYPE EX 10

REFERENCE N.P.G. LETTER

DATED

PLATE

BOMB

PROJECTILE

Gauge 1.50
 Class STS
 Maker UNITED STEEL
 No. 022615 Group U-526-773
 Contract N-600-155s-7939
 Date received 4-11-51
 Dimensions 95" X 25.0"
 No. of impact on plate
 Thickness at impact 1.50
 OBLIQUITY 20°
 Impact dimensions 15" X 16"
 PENETRATION COMPLETE
 Flaking front 0
 Flaking back 0
 Dist. from top, bottom 58"
 Dist. from right, left 144"
 Dist. from nearest impact 39"
 Dish 3"
 Spur 5"
 Cracks - Bulge 0
 Button (Thrown)(Started)
 Through Opening 14" X 14"

Caliber 13.973
 Maker NIT. CO.
 Type G.P. LOW DRAG
 Lot No. - Year of Specification -
 Mark EX 10 Mod. 12 No. D+G-13
 Date received -
 Capped or uncapped
 Weight capped
 Weight (uncapped) 917.0#
 Length (uncapped) 78.20"
 Fuze NONE
 Filler PERITHIOGLITE
 Flight by screen
 Condition after firing:-
 EFFECTIVE or INEFFECTIVE

Bent and broken open
 on nose section.



BALLISTIC DATA

NOTE:	-1- Desired	-2- Oscillograph	-3- Chronograph	-4- Limit, estimated for this thickness of impact	-5- Actual, adjusted for nose change	-6- Limit, for nominal gauges, based on this impact only (Adjusted from column 4)	-7- Limit, for nominal gauges, established from column 6 and previous impacts
All limits are for this plate and this obliquity only.		MEAN					
Striking velocity (f.s.)		872.					

REMARKS

CONFIDENTIAL

Limit shots only

SECURITY INFORMATION

Acceptance or Rejection recommended

e/d

F(e/d, e)

N.P.G. Photo. No. NP9-51399

G/N: 14750 MK II MOD - # 11912

W. W. Henderson
 Capt. USN

U. S. Navy

TABLE VIII

File No.

Butt Firing

U. S. Naval Proving Ground

Dahlgren, Va. 10-15-51 ~~194~~IMPACT No. 39369
IMPACT DATE 10-15-51
BUTT No. FOBJECT BALLISTIC TEST OF 1000 LB. E.P. LOW DRAG
~~BOMB TYPE EX 10~~REFERENCE N.P.G. LETTER ~~Report~~ 720 1073

DATED

PLATE

~~PROJECTILE~~

Gauge 1.38
Class STS
Maker CARNEGIE
No. 045701 Group C-526-392
Contract ORDER-437-S-5000-C
Date received SEPT. 11, 1944
Dimensions 95 1/16" x 249 1/2"
No. of impact on plate 7
Thickness at impact 1.38
OBLIQUITY 20°
Impact dimensions 14" x 11"
PENETRATION COMPLETE
Flaking front 0
Flaking back 0
Dist. from top, bottom 60"
Dist. from right, left 123"
Dist. from nearest impact 36"
Dish 3"
Spur 8"
Cracks- Bulge 0
Button (Thrown) (Started)
Through Opening 19" x 16"

Caliber 14"
Maker N.I.T. Co.
Type E.P. LOW DRAG
Lot No. Year of Specification
Mark EX 10 Mod. 12 No. DYG14
Date received
~~Capped or uncapped~~
Weight (capped)
Weight (uncapped) 938.0#
Length (uncapped) 76.40"
Fuze NONE
Filler VERMILITE
Flight by screen
Condition after firing:
EFFECTIVE or INEFFECTIVE

Severely warped on nose



BALLISTIC DATA.

NOTE:	-1- Desired	-2- Oscillograph	-3- Chronograph	-4- Limit, estimated for this thickness of impact	-5- Actual, adjusted to nominal range.	-6- Limit, for nominal gauge, based on the impact only. (Adjusted from column 4)	-7- Limit, for nominal gauge, established from column 6 and previous impacts
All limits are for this plate and this obliquity only.		MEAN					
Striking velocity (f.s.)		450					

REMARKS.

CONFIDENTIAL

SECURITY INFORMATION

Limit shots only

~~Acceptance or Rejection recommended~~

e/d.

F(e/d, 6)

N.P.G. Photo. No. NP951398

GUN: 14"/50 MK II #11912

W. H. H. H. H.
C. H. H. H. H.

U. S. Navy

TABLE IX

File No.

Butt Firing

U.S. Naval Proving Ground

Dahlgren, Va. 10-16-51 194...
 IMPACT No. 37265
 IMPACT DATE 10-16-51
 BUTT No. R

 OBJECT BALLISTIC TEST OF 10" 15" G.P. LOW DRAG
107118

 REFERENCE N.P.G. LETTER Project 200, 1023 DATED _____

PLATE

PROJECTILE

 Gauge 1.25
 Class STS
 Maker U.S. STEEL
 No. CH5690 Group 25-26-778
 Contract N610-1553-9928
 Date received 4-25-51
 Dimensions 88" X 250"
 No. of impact on plate 5
 Thickness at impact 1.210
 OBLIQUITY 20°
 Impact dimensions 14" X 16"
 PENETRATION COMPLETE
 Flaking front 0
 Flaking back 0
 Dist. from top, bottom 5"
 Dist. from right, left 118"
 Dist. from nearest impact 40"
 Dish 8"
 Spur 2"
 Cracks - Bulge 0
 Button (Thrown) (Started) _____
 Through Opening 14" X 15"

 Bomb
 Caliber 14"
 Maker N.T. Co.
 Type G.P. LOW DRAG
 Lot No. _____ Year of Specification _____
 Mark FX 10 Mod. 12 No. N111-9
 Date received _____
 Capped or uncapped _____
 Weight (capped) _____
 Weight (uncapped) 93 LBS
 Length (uncapped) 77.00
 Fuze None
 Filler 100% D.D.T.
 Flight by screen _____
 Condition after firing:-
 EFFECTIVE or INEFFECTIVE

Broken open on nose.



BALLISTIC DATA

NOTE:	-1- Desired	-2- Oscillograph	-3- Chronograph	-4- Limit, estimated for this thickness of impact.	-5- Actual, adjusted to nominal gauge.	-6- Limit, for nominal gauge, based on this impact only. (Adjusted from column 4)	-7- Limit, for nominal gauge, established from column 6 and previous impacts.
All limits are for this plate and this obliquity only.		MEAN					
Striking velocity (f.s.)		899					

REMARKS

CONFIDENTIAL

SECURITY INFORMATION

Limit shots only

Acceptance or Rejection recommended

e/d _____

F(e/d, θ) _____

N.P.G. Photo. No. NP9-51400GUN: 14" 50 MK. II #119L2
W. D. Thompson
Ord. Eng.

U.S. Navy

TABLE X

File No.

Butt Firing

U. S. Naval Proving Ground

Dahlgren, Va. 10-18-51 194 .

IMPACT No. 39376
IMPACT DATE 10-18-51
BUTT No. BOBJECT BALLISTIC TEST OF 1000 LB. C.C.BOMB TYPE EX 10 MOD 12REFERENCE N.P.G. LETTER Report No 1073 DATED

-PLATE-

Gauge 24" CONCRETE BLOCK
 Class
 Maker
 No. NO NUMBER Group
 Contract
 Date received
 Dimensions 10" X 10"
 No. of impact on plate
 Thickness at impact 24"
 OBLIQUITY 20°
 Impact dimensions 16" X 27"
 PENETRATION COMPLETE
 Flaking front 50" X 59"
 Flaking back 52" X 60"
 Dist. from top, bottom 72"
 Dist. from right, left 18"
 Dist. from nearest impact 0
 Dish 0
 Spur 0
 Cracks - Bulge 0
 Button (Thrown)(Started)
 Through Opening 15" X 24"

PROJECTILE

BOMB
 Caliber 13.974
 Maker N. T. Co.
 Type G. P. Low DASH
 Lot No. - Year of Specification -
 Mark EX 10 Mod. 12 No. D+G-19
 Date received
 Capped or uncapped
 Weight (capped)
 Weight (uncapped) 933.0#
 Length (uncapped) 78.50
 Fuze NONE
 Filler PERMUTE
 Flight by screen
 Condition after firing:-
EFFECTIVE or INEFFECTIVE
Intact -
Very slightly bent



BALLISTIC DATA

NOTE:	-1- Desired	-2- Oscillograph	-3- Chronograph	-4- Limit, estimated for this thickness of impact.	-5- Actual, adjusted to nominal gauge.	-6- Limit, for nominal gauge, based on this impact only. (Adjusted from column 4)	-7- Limit, for nominal gauge, established from column 6 and previous impacts.
All limits are for this plate and this obliquity only.		MEAN					
Striking velocity (f.s.)		888					

REMARKS Bomb modified for firing to the concrete block was 36" in diameter and 12" in length. Bomb effectively and intact very slightly bent and marked.

Limit shots only

e/d

F(e/d, ©)

N.P.G. Photo. No. NP9-51401

CONFIDENTIAL

SECURITY INFORMATION

Acceptance or Rejection recommended

Accepted
2000

U. S. Navy

GUN: 14"/50 MK 11 MOD 0 #11912TABLE XI

File No.

Butt Firing

U. S. Naval Proving Ground

Dahlgren, Va. 10/25/1951/194

IMPACT No. 39387

IMPACT DATE 10-25-51

BUTT No. B

OBJECT BALLISTIC TEST OF 1000 LB G.P. LOW DRAG
Bomb MK Ex 10-12REFERENCE N.P.G. LETTER ~~SP-1073~~ DATED

PLATE

Gauge 36" CONCRETE BLOCK

Class

Maker

No. 11 Group

Contract

Date received

Dimensions

No. of impact on plate 1

Thickness at impact 36"

OBLIQUITY 20°

Impact dimensions 36" X 37"

PENETRATION PARTIAL

Flaking front 70" X 80"

Flaking back NONE

Dist. from top, bottom 82"

Dist. from right, left 41"

Dist. from nearest impact 0

Dish NONE

Spur NONE

Cracks - Bulge NONE

Button (Thrown)(Started) NONE

Through Opening 15" X 20"

PROJECTILE

Caliber 14" Bomb

Maker N.T. Co

Type G.P. LOW DRAG

Lot No. Year of Specification

Mark Ex 10 Mod. 12 No. D+Q-17

Date received

Capped or uncapped

Weight (capped)

Weight (uncapped) 943.0 #

Length (uncapped) 78.65

Fuze NONE

Filler VERMICULITE

Flight by screen

Condition after firing:-

~~EFFECTIVE~~ or INEFFECTIVEBroke into two
pieces - Nose thoroughly
and side - Base struck
in hole

BALLISTIC DATA

NOTE:	-1- Desired	-2- Oscillograph	-3- Chronograph	-4- Limit, estimated for this thickness of impact.	-5- Actual, adjusted for nominal gauge,	-6- Limit, for nominal gauge, based on this impact only. (Adjusted from column 4)	-7- Limit, for nominal gauge, established from column 6 and previous impacts.
All limits are for this plate and this obliquity only.		MEAN					
Striking velocity (f.s.)		890					

REMARKS Block has 3/4" REINFORCING RODS SPACED AT 6"
CENTER LINES. The bomb broke in two. The
nose went through the concrete block
and the base of bomb struck in the
plate.

Limit only

e/d

F(e/d, Θ)

N.P.G. Photo. No. NP9-51402

GUN 14/50 MK 11-D No 119-L-2

U. S. Navy

TABLE XII

SECURITY INFORMATION

E. Levitt

LCDR

File No.

Butt Firing

U. S. Naval Proving Ground

Dahlgren, Va. 194

IMPACT No. 39416
IMPACT DATE 10/30/51
BUTT No. Butt "B"OBJECT Ballistic Test of 1000 Lb. G.P. Low Drag BombMK EX10-12 (D AND Q-18)REFERENCE N.P.G. LETTER SP-100-7-20-1023 DATED

PLATE

Gauge 24"
 Class CONCRETE Block
 Maker N.P.G.
 No. _____ Group _____
 Contract _____
 Date received _____
 Dimensions 144" X 144" X 24"
 No. of impact on plate 1
 Thickness at impact 24"
 OBLIQUITY 20°
 Impact dimensions 35" X 39"
 PENETRATION COMPLETE
 Flaking front 56" X 60"
 Flaking back 51" X 59"
 Dist. from top, bottom 74"
 Dist. from right, left 72"
 Dist. from nearest impact 0
 Dish NONE
 Spur NONE
 Cracks - Bulge NONE
 Button (Thrown) (Started) _____
 Through Opening 19" X 21"

PROJECTILE

Caliber 14"
 Maker N.T. Co.
 Type G.P. Low Drag
 Lot No. _____ Year of Specification _____
 Mark EX10 Mod. 12 No. DAG-18
 Date received _____
 Capped or uncapped _____
 Weight (capped) _____
 Weight (uncapped) 947 Lb
 Length (uncapped) 78.20
 Fuze _____
 Filler VERMICULITE
 Flight by screen _____
 Condition after firing:-
EFFECTIVE or INEFFECTIVE
INTACT
No Deformation



BALLISTIC DATA

NOTE:	-1- Desired	-2- Oscillograph	-3- Chronograph	-4- Limit, estimated for this thickness of impact	-5- Actual, adjusted to nominal gauge.	-6- Limit, for nominal gauge, based on this impact only. (Adjusted from column -4)	-7- Limit, for nominal gauge, established from column 6 and previous impacts.
All limits are for this plate and this obliquity only.							
Striking velocity (f.s.)	<u>1000</u>	<u>874</u>					

REMARKS Bomb Modified For Gun Firing CONCRETE Block
1740 34" REINFORCING RODS AT 6" CENTERS PERIOD
EFFECTIVE AND INTACT. NO DEFORMATION OF BOMB
DUE TO IMPACT.

Limit shots only

e/d

F(e/d, ©)

N.P.G. Photo. No. NP9-51403

CONFIDENTIAL

SECURITY INFORMATION

Acceptance or Rejection recommended

G. L. LEVINSKYF. L. LEVINSKY

LCDR. U. S. Navy

TABLE XIII

File No. _____

Butt Firing

U.S. Naval Proving Ground

Dahlgren, Va. 11-5-51 -194IMPACT No. 39438
IMPACT DATE 11-5-51
BUTT No. 1OBJECT BALLISTIC TEST OF 1000 LB. G. P. LOW DRAG
BOMB EX-10-12REFERENCE N.P.G. LETTER SP-200-7-220 1073 DATED _____

PLATE

Gauge CONCRETE TARGET, 30"
 Class CONCRETE
 Maker N.P.G.
 No. 12 Group _____
 Contract _____
 Date received _____
 Dimensions _____
 No. of impact on plate _____
 Thickness at impact 30"
 OBLIQUITY 30°
 Impact dimensions 33" X 45"
 PENETRATION PARTIAL
 Flaking front 33" X 56"
 Flaking back 28" X 36"
 Dist. from top, bottom 78"
 Dist. from right, left 51"
 Dist. from nearest impact 0
 Dish 0
 Spur 0
 Cracks - Bulge 0
 Button (Thrown)(Started) _____
 Through Opening 8" X 10"

BOMB G. P. LOW DRAG PROJECTILE

Caliber 18.962
 Maker N.T. Co.
 Type G. P. LOW DRAG
 Lot No. _____ Year of Specification _____
 Mark EX-10 Mod. 12 No. D7A-20
 Date received _____
 Capped or uncapped _____
 Weight (capped) _____
 Weight (uncapped) 931.00#
 Length (uncapped) 78.40
 Fuze NONE
 Filler VERMICULITE
 Flight by screen _____

Condition after firing:-

~~EFFECTIVE~~ or INEFFECTIVE

Bomb broke into
2 pieces - one through
and off - base stuck in
block.

**BALLISTIC DATA**

NOTE:	-1- Desired	-2- Oscillograph	-3- Chronograph	-4- Limit, estimated for this thickness of impact.	-5- Actual, adjusted to nominal gauge.	-6- Limit, for nominal gauge, based on this impact only. (Adjusted from column 4)	-7- Limit, for nominal gauge, established from column 6 and previous impacts.
All limits are for this plate and this obliquity only.		<u>MEAN</u>					
Striking velocity (f.s.)		<u>886</u>					

REMARKS _____

CONFIDENTIAL**SECURITY INFORMATION**

Limit shots only

e/d _____

F(e/d, 0) _____

N.P.G. Photo. No. NP9-51404GUN: 14" 50 MR 11-0 # 11953

Acceptance or Rejection recommended

W. H. Hager
Ord. Eng.

U.S. Navy

TABLE XIV

CONFIDENTIAL

5 October 1951

NP9-51396

Ballistic Test of 1000 lb. Low Drag, G.P. Bomb Type EX 10 Mod 12.

Imp. No.	Obl.	Thick.	S. V. f/s	Pene.
----------	------	--------	-----------	-------

39328	200	1121
39329	200	1103

39329 200 71121 911

Remarks

ineffective and intact-moderate flattening.

Effective and intact-moderate to severe flattening.

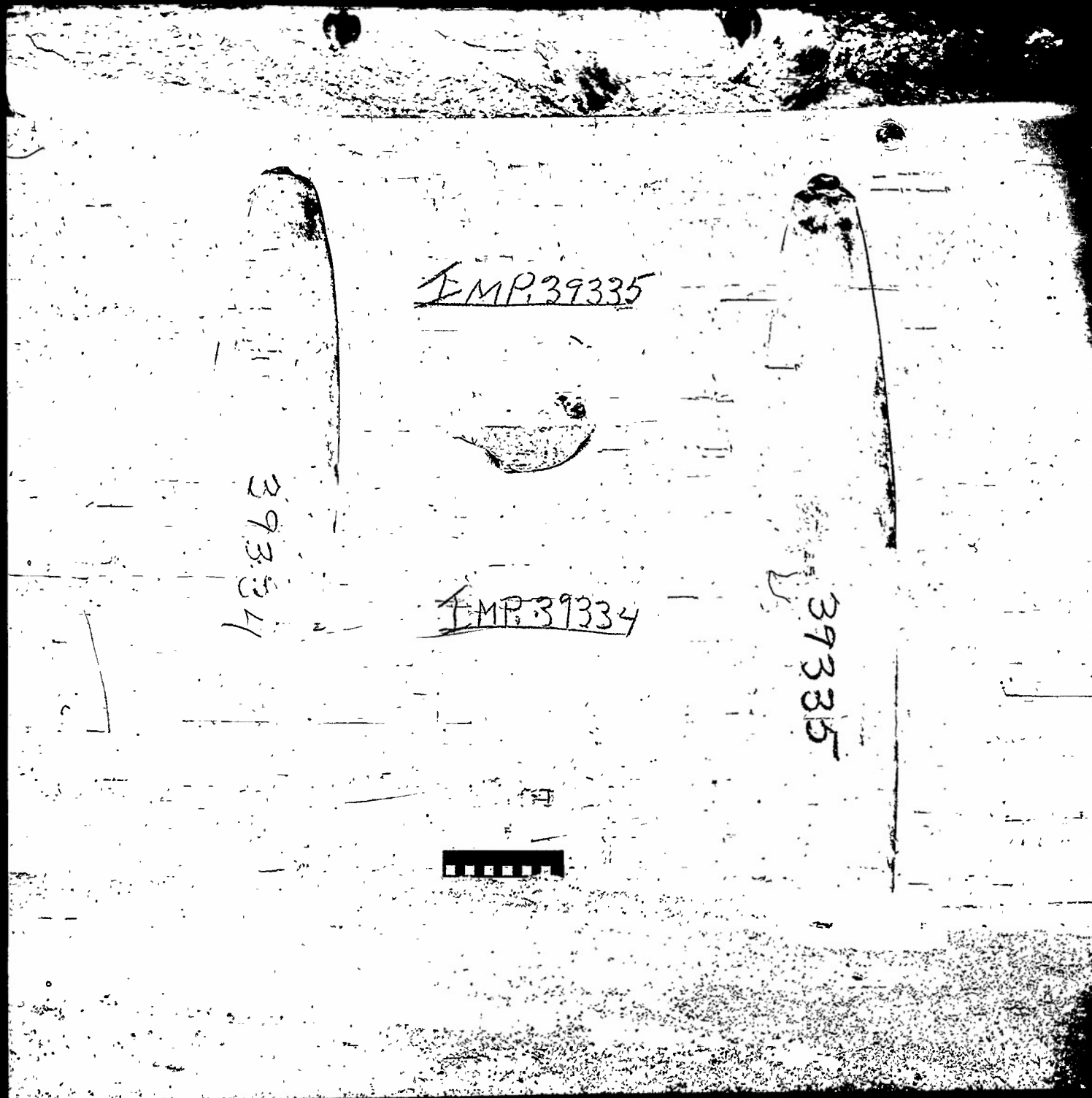
APPENDIX C

BOY

IMP 29329

MP: 39328

39329



NP9-51397

Figure 2

9 October 1951

CONFIDENTIAL

SECURITY INFORMATION

Ballistic Test of 1000 lb. Low Drag, G.P. Bomb Type EX 10 Mod 12

Imp. No.	Obl.	Thick.	S.V. f/s	Pene.	Remarks
39334	20°	1 3/8	922	C	Not effective - severely bent and drawn. Sides flattened cracked long from nose to 26" aft.
39335	20°	1 3/8	355	C	Effective and direct - moderate flattening.

APPENDIX C

11 and 15 October 1951

Figure 3

of 1000 lb. Low Drag, G.P., Bomb Type EX 10 Mod 12.

Thick. S.V. f/s Pene.

1138 865 850

1138

Remarks

Not effective - bent and broken open on nose section

Effective and intact - severely worked on nose.

APPENDIX C

NP9-51398

Ballistic Test

Imp. No. Obl.

39351 200

39364 200

IMP 39351

IMP 39364

39351

39364

IMP-39352

9

39352



NP9-51399 Figure 4 11 October 1951
Ballistic Test of 1000 lb. Low Drag, G.P. Bomb Type EX 10 Mod 12.

Imp. No.	Obl.	Thick.	S.v. f/s	Pene.
39352	20°	1450	372	0

Not effective - bent and broken open on nose section.

CONFIDENTIAL
SECURITY INFORMATION

APPENDIX C

NP9-51400

Ballistic Test of 1000 lb. Low Drag, G.P. Bomb Type FZ 10 and 12.

Imp. No. 39365
Obl. 200
Thick. 1421
S.V. f/s 899
Pené. C

Figure 5

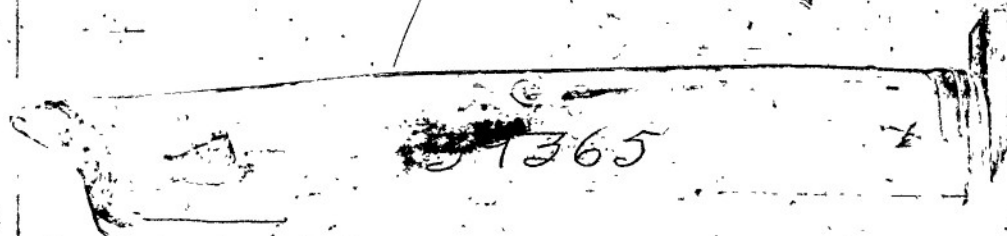
15 October 1951

Remarks

Not effective - broken on nose.

APPENDIX C

CONFIDENTIAL
SECURITY INFORMATION



CONFIDENTIAL
SECURITY INFORMATION

NP9-51401
Figure 6
Ballistic Test of 1000 lb. Low Drag, G.P. Bomb Type EX 10 Mod 12.

Imp. No. 39376
Obl. Thick. 24" 388
S.V. f/s Pene. C

Remarks
Effective and intact - very slightly bent and worked.
P. 51401 C



NP9-51402

Figure 7

Ballistic Test of 1000 lb. Low Drag, 7.6 P. Port. T. 12.
Imp. No. 39387 20" 36" 890 35"
3.7 f/s Pene.

25 October 1971
Port. T. 12.
Remarks
Port broke into 2 pieces - base through and off.
Base stuck in 1st.

APPENDIX C



NP9-51404

Ballistic Test of 1000 lb. Low Drag, G.P. Bomb Type EX 10 Mod 12.

Lmp. No. 39438

Obl. 200

Thick. 30"

S.V. f/s 886

Pene. Inc.

5 November 1951

Bomb Type EX 10 Mod 12.

Remarks

Bomb broke into 2 pieces - nose through and off.
Base stuck in block.

CONFIDENTIAL

SECURITY INFORMATION

APPENDIX C.



V-NOTCH CHARPY IMPACT STRENGTH IN FT. LBS.

40

30

20

10

0

-100

-40

0

rt

+45

+65

+100

TESTING TEMPERATURE - °C.

1000% LOW DRAG G.P. BOMB
TYPE EX 10 - MOD 12

Bomb No. 2 - Impact No. 39334
(Normalized)

V-NOTCH CHARPY IMPACT STRENGTH IN FT. LBS.

50

40

30

20

10

0

-100

-40

0

rt

+100

TESTING TEMPERATURE - °C.

Bomb No. 9 - Impact No. 39365.
(Normalized)

Code:

F = 100% Fibrous Fracture
50F = 50% Fibrous & 50% Granular Fracture
G = 100% Granular Fracture.

AFZ-156

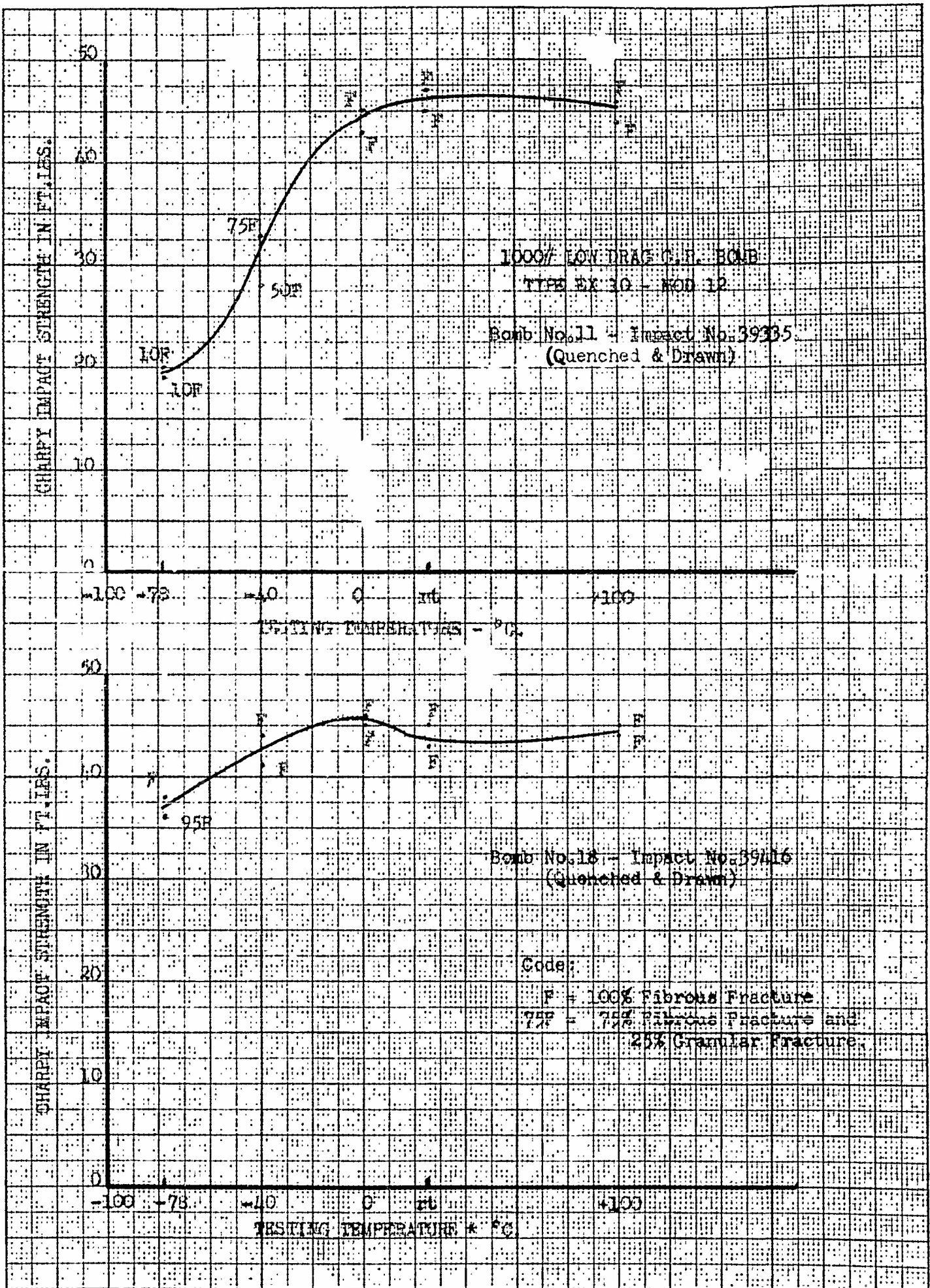
APPENDIX E

Figure 11.

CONFIDENTIAL
SECURITY INFORMATION

CONFIDENTIAL

NO 340 M DIETZGEN 15-
MILLIGRAMS



APZ-157

APPENDIX E

Figure 12.

CONFIDENTIAL
SECURITY INFORMATION

Ballistic Tests of 1000# Low Drag, G.P. Bomb Type EX 10 Mod 12

TABLE XVV-Notch Charpy Impact Tests at Various Temperatures

Testing Temp. °C	Bomb No. 2		Bomb No. 9		Bomb No. 11		Bomb No. 18	
	Charpy Ft.Lbs	Fracture *	Charpy Ft.Lbs	Fracture *	Charpy Ft.Lbs	Fracture *	Charpy Ft.Lbs	Fracture *
-78			10	G	19	10F	36	95F
			11	G	20	10F	38	F
-40	12	G	12	G	33	75F	44	F
	13	G	15	G	28	50F	41	F
0	18	10F	23	40F	45	F	45	F
	18	10F	27	50F	43	F	46	F
+25 (rt)	27	50F	48	F	45	F	43	F
	23	40F	47	F	47	F	45	F
+45	35	90F						
	30	70F						
+65	38	F						
	38	F						
+100	38	F	48	F	44	F	45	F
	38	F	48	F	46	F	44	F

* F denotes 100% Fibrous Fracture.

10F " 10% " " and 90% Granular Fracture.

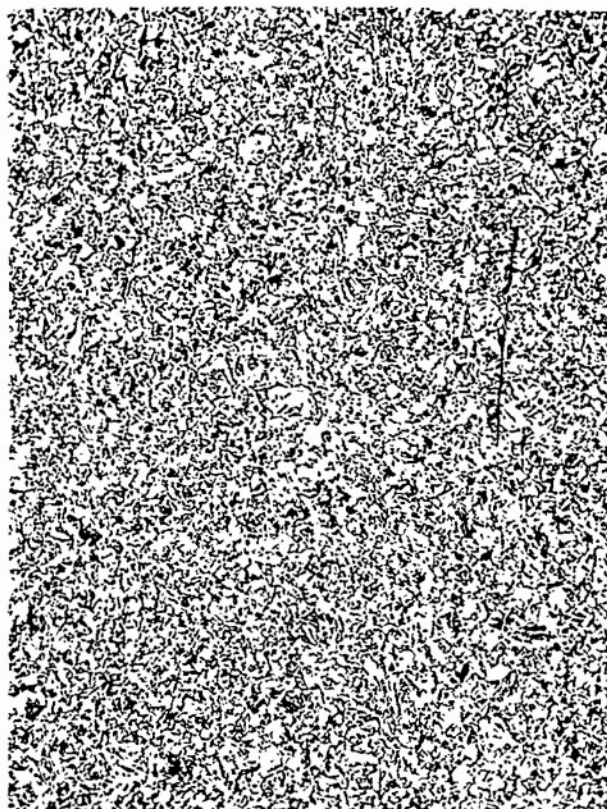
G " 100% Granular " .

NP9-49147

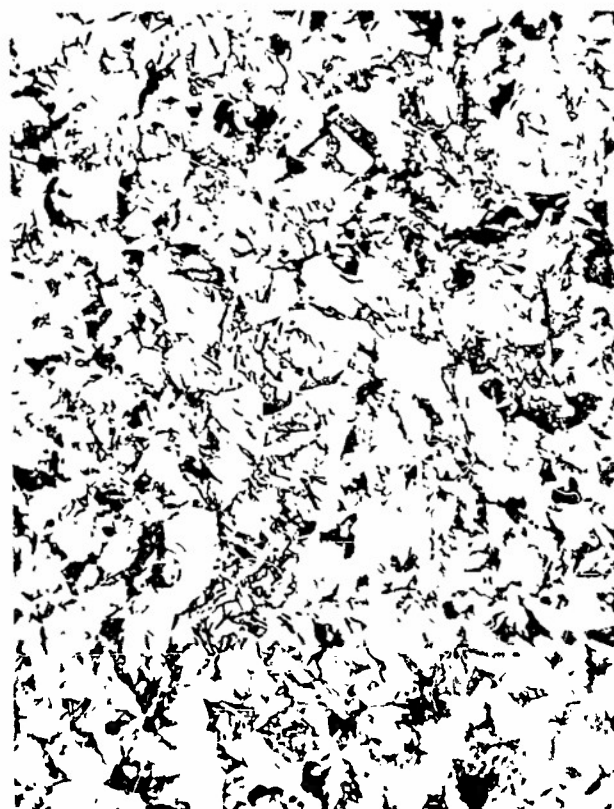
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SECURITY INFORMATION

Transverse sections of 1000# Low Drag G.P. Bombs
Type EX-10, Mod. 12. Numbers 2 - 9 - 11 - 13
respectively from top to bottom. Etched in
50% HCl - 50% H₂O for 20 minutes at 160°F. Magn. 1X

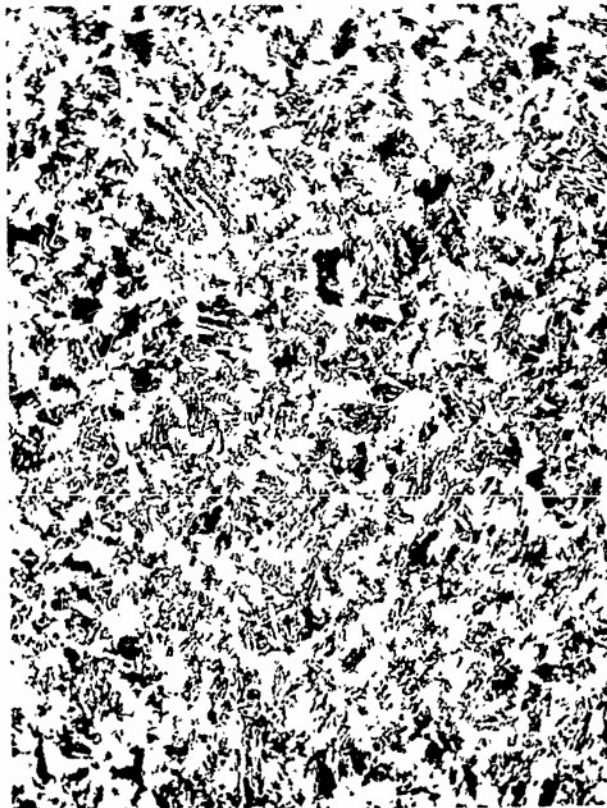
Figure 13. APPENDIX F



M-1957 Fig. 14
Bomb No. 2 - Normalized Nitral-
Picral Etch. Magn. 250X



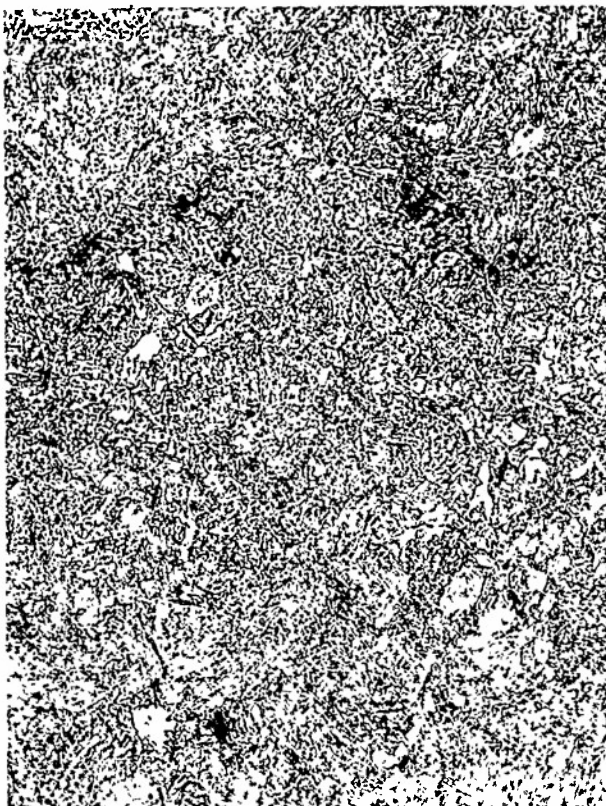
M-1956 Fig. 15
Bomb No. 2 Normalized Nitral-
Picral Etch. Magn. 1000X



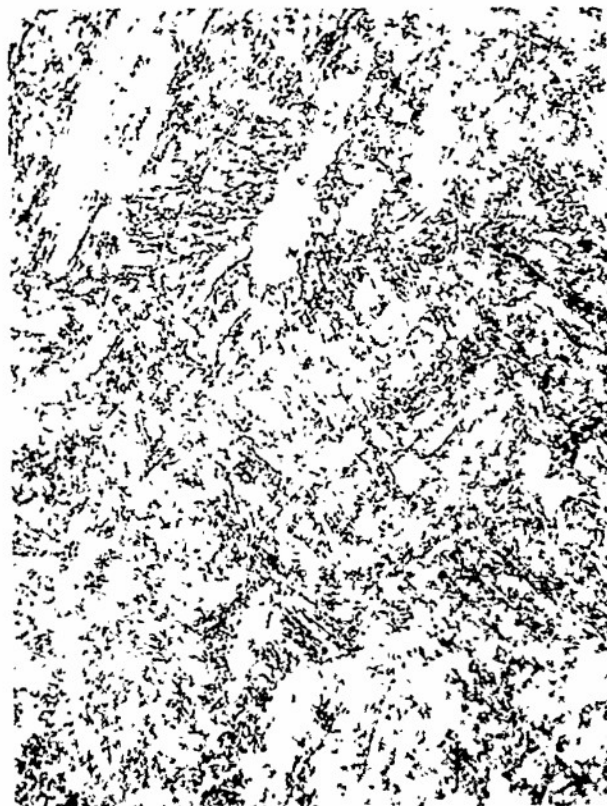
M-1955 Fig. 16
Bomb No. 9 - Normalized Nitral-
Picral Etch. Magn. 250X



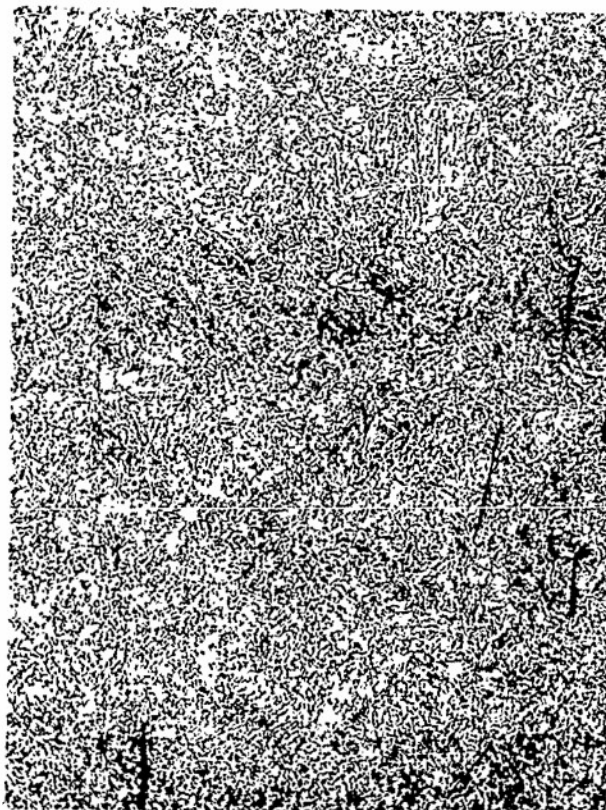
M-1954 Fig. 17
Bomb No. 9 - Normalized Nitral-
Picral Etch. Magn. 1000X



M-1953 Fig. 18
Bomb No. 11 - Quenched & Drawn
Nital-Picral Etch. Magn. 250X



M-1952 Fig. 19
Bomb No. 11 - Quenched & Drawn
Nital-Picral Etch. Magn. 1000X



M-1951 Fig. 20
Bomb No. 18 - Quenched & Drawn
Nital-Picral Etch. Magn. 250X



M-1950 Fig. 21
Bomb No. 18 - Quenched & Drawn
Nital-Picral Etch. Magn. 1000X

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