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Ballistic Test of Cool Propellants EX-6985 and EX-7006

PART A

SYNOPSIS

1. This is the seventeenth partial report on Task Assignment NPG-Re2d-64-1-53, the "Development of a Cool Propellant for the 3"/50 Caliber Gun", and the final report on the "Ballistic Test of Cool Propellants, EX-6985 and EX-7006."

2. From the results of the subject tests, it is concluded that:

a. EX-6985 with the XC-D22/250 primer and 0.4 lb. of SPDN-4438 placed at the bottom of the case with the balance of the charge consisting of EX-6985 on top of SPDN-4438 is considered to be a satisfactory replacement for EX-6735.

b. EX-7006 with the Mk 42 primer plus 150 grams of NPFB-223 in a pyralin container placed around the forward end of the primer is a satisfactory replacement for EX-6649.

c. EX-6985 and EX-7006 are ballistically satisfactory for the continuation of the rapid fire erosion studies in the 3"/50 caliber gun except as noted in sub-paragraph (h) of paragraph 8.

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Ballistic Test of Cool Propellants EX-6985 and EX-7006

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PART B

INTRODUCTION

1. AUTHORITY:

The tests reported herein were conducted under Task Assignments NPG-Re2d-62-1-53 and NPG-Re2d-64-1-53 as authorized by references (a) and (b).

2. REFERENCES:

a. BUORD Conf ltr Re2d-CNB:aph NP9 Ser 42305 of 21 July 1952
b. BUORD Conf ltr Re2d-CNB:bac NP9 Ser 42307 of 21 July 1952
c. BUORD Conf ltr Re2d-CNB:df NP9 Ser 41584 of 2 July 1952
d. BUORD Conf ltr Re2d-ERD:aph NP9 Ser 43457 of 12 Aug 1952
e. NPG Report No. 770 (Conf) of 9 June 1951
f. NPG Report No. 503 (Conf) of 14 Mar 1950
g. Description Sheets of Manufacture and Closed Bomb Data (Conf)

3. BACKGROUND:

References (a) and (b) established the general task assignments for the Development of Cool Propellants for the 3"/70 and 3"/50 caliber guns, respectively.

Reference (c) requested that EX-6985 be fired for ballistic assessment in the 3"/50 caliber gun and described it as a cool NH powder made to replace EX-6735 (reference (e)) for continuation of the erosion trials in the 3"/50 caliber gun.

Reference (d) described EX-7006 as a cool picrite powder made to replace EX-6649 (reference (f)) and requested ballistic tests of the subject powder in the 3"/50 caliber gun to determine its suitability for use in a special erosion program under preparation for the 3"/50 caliber gun.

4. OBJECT OF TEST:

The subject tests were conducted to determine whether EX-6985 and EX-7006 are satisfactory replacements for EX-6735 and EX-6649, respectively, in the continuation of erosion trials in the 3"/50 caliber gun.

5. PERIOD OF TEST:

a.	Dates Project Letters	2 July 1952 21 July 1952 12 August 1952
b.	Date Material Received	23 August 1952
c.	Date Commenced Test	31 July 1952
d.	Tests Completed	17 September 1952

PART C

DETAILS OF TESTS

6. DESCRIPTION OF ITEMS UNDER TEST:

a. EX-6985 and EX-7006 are cool composition propellants whose calculated flame temperatures are 1816°K and 1949°K, respectively, and whose nominal compositions, as given in reference (g), are as follows:

Composition	EX-6985	EX-7006
Nitrocellulose (13.20%N)	74.69%	20.26%
Dinitrotoluene	13.51	-
Dibutylphthalate	10.80	9.20
Diphenylamine	1.00	-
Nitroglycerin	-	8.25
Nitroguanidine	-	60.57
Centralite	-	1.72

b. Grain Geometry and Closed Bomb Data:

Sample	Length (in.)	Diam. (in.)	Av. Web (in.)	No. of Perfs.	R.Q. (%)	R.F. (%)
EX-6985	0.4300	0.1368	0.0247	7	94.8(a)	98.6(a)
"	"	"	"	7	133.3(b)	95.7(b)
EX-7006	0.3110	0.1210	0.0205	7	111.0(b)	95.8(b)
"	"	"	"	7	96.0(c)	98.5(c)

(a) Based on EX-6735 as 100% at 90°F.
(b) Based on EX-6586 as 100% at 90°F.
(c) Based on EX-6649 as 100% at 90°F.

7. PROCEDURE:

EX-6985 and EX-7006 were fired for ballistic assessment in several 3"/50 caliber guns under conditions similar to those reported in references (e) and (f). Muzzle velocities, maximum pressures (copper crusher), and ejection times were recorded. All rounds were assembled at PPD (Production Packing Depth). Pressure-time records were obtained for the various conditions tested.

8. RESULTS AND DISCUSSION:

The results of the subject tests are given in detail in the Appendices and are summarized below:

a. Ballistic Tests of EX-6985 and EX-7006:

Gun: 3"/50 Caliber

Mk	Mod	No.	ESR	D_o
22	4	13092 (Worn)	2145.9	3"052
22	5	20385 (New)	183.0	3"002
21	0	5917 (Worn)	3217.4	3"096
22	3	19923 (New)	152.7	3"004

Projectile: Mk 33 (13.00 lbs.) Epsom Salt Loaded

Cartridge Case: Mk 9, Steel, Rubber Crimped

Primer: Mk 42 and XC-D22/250 (as indicated)

Lead Foil: 45 grams per charge with EX-6985
30 grams per charge with EX-7006

Wad and Spacer: Cardboard, NGF Dwg. No. 132664, Pc. Nos. 13 and 4

Powder Temp.: 90°F

Uniformity

Date	Gun No.	Powder	Ignition	PPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Carbon (%)	No. of Rds.
7-31-52	13092	SPCG-10135	XC-D22/250	10.1	4.16	2678±8	15.3±0.2	-	0	5
"	"	EX-6985(a)	"	9.7	3.60	2294±3	9.3±0.2	-	0	3
"	"	"	"	6.9	4.48	2665±11	14.4±0.2	-	0	5
"	"	EX-6985	"	6.7	4.88	2626±10	13.3±0.1	-	75(c)	2
"	"	EX-6735	"	6.4	4.89	2670±0	14.6±0.3	-	100	2
8-5-52	13092	EX-6985	XC-D22/250	5.9	5.06	2697±5	14.9±0.3	-	75(c)	3
"	"	EX-6985(a)	"	6.7	4.51	2692±13	15.1±0.2	-	0	3
"	"	EX-6735	"	6.2	4.89	2681±10	15.0±0.3	-	100	2
"	"	EX-6735(b)	"	6.4	4.49	2697±27	15.8±0.7	-	0	2
8-18-52	20385	SPCG-10135	XC-D22/250	10.1	4.16	2717±4	15.9±0.2	-	0	5
"	"	EX-6985(a)	"	9.7	3.60	2343±7	10.0±0.1	-	0	3
"	"	"	"	6.9	4.51	2747±5	15.5±0.2	-	0	5
"	"	EX-6985	"	6.0	5.21	2804±5	16.5±0.1	-	0	3
9-9-52	20385	SPCG-10135	Mk 42	10.1	4.16	2701±2	15.2±0.3	0.014±0.001	0	5
"	"	EX-7006	"	10.3	4.00	2242±11	9.4±0.1	0.016±0.001	0	2
"	"	"	"	7.3	5.00	2720±8	19.9±0.5	0.015±0.001	0	5
9-10-52	5917	SPCG-10135	Mk 42	10.1	4.16	2635±8	13.7±0.2	-	0	5
"	"	EX-7006	"	10.3	4.00	2158±10	8.2±0.4	-	0	3
"	"	"	"	7.4	4.96	2659±19	18.7±1.2	-	0	5
9-11-52	5917	SPCG-10135	Mk 42	10.1	4.16	2636±5	13.9±0.2	0.015±0.002	0	5
"	"	EX-7006(d)	"	7.5	4.00	2100±34	7.9±0.1	0.022±0.000	0	2
"	"	"	"	4.3	4.96	2493±17	11.8±0.5	0.016±0.001	0	5
"	"	EX-7006(e)	"	10.3	3.50	2131±4	7.8±0.2	0.016±0.001	0	3
"	"	"	"	7.0	4.60	2634±8	16.0±0.3	0.017±0.002	0	5

Date	Gun No.	Powder	Ignition	PPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Carbon (%)	No. of Rds.
9-16-52	19923	SPCG-10135	Mk 42	10.1	4.16	2702±2	16.1±0.1	0.013±0.001	0	5
"	"	EX-7006(d)	"	7.5	4.00	2301±14	10.5±0.4	0.019±0.001	0	2
"	"	"	"	4.1	5.00	2628±17	14.5±0.6	0.015±0.001	0	5
"	"	EX-7006(e)	"	7.0	4.60	2624±4	14.5±0.3	0.012±0.000	0	5
"	"	"	"	10.3	3.50	2197±2	8.8±0.3	0.014±0.000	0	3
9-17-52	5917	SPCG-10135	Mk 42	10.1	4.16	2596±7	13.2±0.3	0.015±0.002	0	5
"	"	EX-7006(e)	"	8.8	4.00	2296±4	9.8±0.3	0.019±0.000	0	2
"	"	"	"	6.2	4.80	2658±12	15.5±0.3	0.016±0.002	0	4
"	"	EX-7006(f)	"	8.8	4.00	2344±8	10.0±0.2	0.016±0.001	0	2
"	"	"	"	6.2	4.80	2726±8	19.6±0.3	0.015±0.002	0	4
"	"	EX-7006	"	7.3	4.94	2624±34	17.2±1.3	0.017±0.001	0	3
"	"	EX-7006(d)	"	3.2	5.23	2534±16	12.4±0.2	-	0	3
"	"	EX-7006(e)	"	5.9	4.80	2679±17	15.2±0.3	0.016±0.000	0	3

(a) 0.40 lbs. SPDN-4438 in bottom of case. Balance of charge consists of EX-6985 on top of SPDN-4438.
(b) 0.40 lbs. SPDN-4438 in bottom of case. Balance of charge consists of EX-6735 on top of SPDN-4438.
(c) Carbon deposition relative to EX-6735 as 100%.
(d) Plus 2 empty pyralin containers end on end around primer.
(e) Plus 150 grams of NPFB-223 in pyralin container around top of primer.
(f) Plus 150 grams of NPFB-223 in pyralin container around bottom of primer.

b. Charge determination:

Gun data are the same as in sub-paragraph (a) above.

Master Powder: SPCG-10135 (4.16 lbs.)

Powder	Gun	Velocity (f/s)	Charge (lbs.)*	Pressure (t.s.i.)
EX-6985(a)	13092 (Worn)	2700	4.91	14.9
EX-6985(a)	20385 (New)	2700	4.84	14.8
Mean of new and worn guns (a)		2700	4.88	14.9
EX-7006	20385 (New)	2700	4.96	19.9
EX-7006	5917 (Worn)	2700	4.91	20.2
EX-7006(b)	5917 (Worn)	2700	5.31	15.0
EX-7006(b)	19923 (New)	2700	5.23	15.7
EX-7006(c)	5917 (Worn)	2700	4.60	17.8
EX-7006(c)	5917 (Worn)	2700	4.53	18.8
EX-7006(d)	19923 (New)	2700	4.66	16.6
EX-7006(d)	5917 (Worn)	2700	4.80	16.0
Mean of new and worn guns (d)		2700	4.73	16.3

* All charges obtained by the Matched Powder Method

(a) 0.4 lbs. of SPDN-4438 on bottom of case. Balance of charge consists of EX-6985 on top of SPDN-4438.
(b) Mk 42 primer plus 2 empty pyralin containers end on end around primer.
(c) Mk 42 primer plus 150 grams of NPFB-223 in pyralin container around bottom of primer.
(d) Mk 42 primer plus 150 grams of NPFB-223 in pyralin container around top of primer.

c. Satisfactory ballistic uniformity was obtained when EX-6985 was fired with the XC-D22/250 primer plus 0.4 lb. of SPDN-4438 and when EX-7006 was fired with the Mk 42 primer plus 150 grams of NPFB-223 in a pyralin container around the forward end of the primer.

d. Although the pressure-time records obtained were not of desired smoothness, in view of the excellent ballistic performance obtained under the above conditions, the subject powders are considered satisfactory for use in the continuation of the rapid fire erosion studies in the 3"/50 caliber gun.

e. Appendix (B) shows the pressure-time records obtained with EX-6985 and EX-7006 with the various ignition systems tested. Ignoring the high frequency oscillations attributable to the pressure-time gage, EX-7006 with the Mk 42 primer plus two (2) empty pyralin containers placed end on end around the primer gave the smoothest pressure-time curves.

f. EX-6985 with the XC-D22/250 primer gave slightly less carbon deposition than EX-6735, as reported in reference (e). While EX-6985, plus the scavenger powder SPDN-4438 (0.4 lb.) completely eliminated the carbon deposition, the amount of black smoke remained the same as with EX-6985 without the scavenger.

g. Comparative results of EX-6735 and EX-6649 along with their replacement powders EX-6985 and EX-7006 are as follows:

Powder	Velocity (f/s)	Charge (lbs.)	Pressure (t.s.i.)
EX-6735(a)	2700	4.89	15.0
EX-6985(a)	2700	4.88	14.9
EX-6649(b)	2700	4.68	16.2
EX-7006(b)	2700	4.73	16.3

(a) 0.4 lbs. of SPDN-4438 on bottom of case. Balance of charge consists of EX-6985 on top of SPDN-4438.
(b) Mk 42 primer plus 150 grams of NPFB-223 in a pyralin container around forward end of the primer.

h. EX-6985, as noted in sub-paragraph (g) above, shows a final pressure of 14.9 t.s.i. (based on new and worn gun firings). This pressure, while 0.1 t.s.i. below the minimum allowable for the 3"/50 caliber gun, matches so closely the ballistics obtained in reference (e) that it is considered a satisfactory replacement for EX-6735.

PART D

CONCLUSIONS

9. From the results of the subject tests, it is concluded that:

a. EX-6985 with the XC-D22/250 primer and 0.4 lb. of SPDN-4438 placed at the bottom of the case with the balance of the charge consisting of EX-6985 on top of SPDN-4438 is considered to be a satisfactory replacement for EX-6735.

b. EX-7006 with the Mk 42 primer plus 150 grams of NPFB-223 in a pyralin container placed around the forward end of the primer is s satisfactory replacement for EX-6649.

c. EX-6985 and EX-7006 are ballistically satisfactory for the continuation of the rapid fire erosion studies in the 3"/50 caliber gun except as noted in sub-paragraph (h) of paragraph 8 above.

Ballistic Test of Cool Propellants EX-6985 and EX-7006

- -

The tests upon which this report is based were conducted by:
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NPG REPORT NO. 1075

U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Seventeenth Partial Report

on

Development of a Cool Propellant for the 3"/50 Caliber Gun

- -

Final Report

on

Ballistic Test of Cool Propellants EX-6985 and EX-7006

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SECURITY INFORMATION

Ballistic Test of Cool Propellants EX-6985 and EX-7006

TABULATION OF FIRING DATA

Gun: 3"/50 Caliber

Number	Mk	Mod	ESR	D_o
13092	22	4	2145.9	3".052
20385	22	5	183.0	3".002
5917	21	0	3217.4	3".096
19923	22	3	152.7	3".004

Projectile: Mk 33 (13.00 lbs.) Epsom Salt Loaded

Cartridge Case: Mk 9 (Steel) Rubber Crimped

Lead Foil: 30 grams per round with SPCG-10135
45 grams per round with all others

Wad and Spacer: Cardboard, NGF Dwg. No. 132664
Pc. Nos. 13 and 4

Primer: As indicated

Powder Temp.: 90°F

TABULATION OF FIRING DATA (Continued)

Date: 31 July 1952
Gun No. 13092

Rd. No.	Powder	Primer	PPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)	Carbon (%)(b)
1	SPCG-10135	XC-D22/250	10.1	4.16	2651	14.9	-	100	100	0
2	"	"	"	"	2662	15.2	-	"	"	"
3	"	"	"	"	2672	14.9	-	"	"	"
4	"	"	"	"	2682	15.6	-	"	"	"
5	"	"	"	"	2687	15.2	-	"	"	"
6	"	"	"	"	2685	15.6	-	"	"	"
Mean of 5 rounds				4.16	2678±8	15.3±0.2				
7	EX-6985(a)	XC-D22/250	9.7	3.60	2296	9.4	-	0	200*	0
8	"	"	"	"	2289	9.4	-	0	"	"
9	"	"	"	"	2299	9.5	-	0	"	"
10	"	"	"	"	2294	9.1	-	0	"	"
Mean of 3 rounds				3.60	2294±3	9.3±0.2				
11	EX-6985(a)	XC-D22/250	7.8	4.20	2396	12.6	-	0	200*	0
12	"	"	6.9	4.48	2674	14.6	-	0	"	"
13	"	"	"	"	2659	14.1	-	0	"	"
14	"	"	"	"	2666	14.2	-	0	"	"
15	"	"	"	"	2644	14.2	-	0	"	"
16	"	"	"	"	2681	14.7	-	tr	"	"
Mean of 5 rounds				4.48	2665±11	14.4±0.2				
17	EX-6985(a)	XC-D22/250	6.0	4.78	2665	14.0	-	0	200*	0
18	EX-6985	"	6.7	4.88	2616	13.4	-	0	250*	75
19	"	"	"	"	2636	13.2	-	0	"	"
Mean of 2 rounds				4.88	2626±10	13.3±0.1				

TABULATION OF FIRING DATA (Continued)

Date: 31 July 1952 (Continued)
Gun No. 13092

Rd. No.	Powder	Primer	PPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)	Carbon (%)(b)
20	EX-6735	XC-D22/250	6.4	4.89	2670	14.3	-	0	250*	100
21	"	"	"	"	2670	14.8	-	0	"	"
Mean of 2 rounds				4.89	2670±0	14.6±0.3				

(a) 0.40 lbs. SPDN-4438 in bottom of case. Balance of charge consisted of EX-6985 on top of SPDN-4438.
(b) Carbon deposition in gun and case relative to EX-6735 as 100%
* Black Smoke

TABULATION OF FIRING DATA (Continued)

Date: 5 August 1952
Gun No. 13092

Rd. No.	Powder	Primer	PPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)	Carbon (%)(c)
1	EX-6985	XC-D22/250	6.1	5.06	2665	14.2	-	0	200*	75
2	"	"	5.9	"	2690	14.4	-	0	"	"
3	"	"	"	"	2704	15.3	-	0	"	"
4	"	"	"	"	2698	15.0	-	0	"	"
Mean of 3 rounds				5.06	2697±5	14.9±0.3				
5	EX-6985(a)	XC-D22/250	6.7	4.51	2672	14.7	-	0	200*	0
6	"	"	"	"	2702	15.3	-	0	"	"
7	"	"	"	"	2701	15.2	-	0	"	"
Mean of 3 rounds				4.51	2692±13	15.1±0.2				
8	EX-6735	XC-D22/250	6.2	4.89	2671	14.7	-	0	225*	100
9	"	"	"	"	2690	15.3	-	0	"	"
Mean of 2 rounds				4.89	2681±10	15.0±0.3				
10	EX-6735(b)	XC-D22/250	6.4	4.49	2670	15.1	-	0	225*	0
11	"	"	"	"	2724	16.4	-	0	"	"
Mean of 2 rounds				4.49	2697±27	15.8±0.7				

(a) 0.40 lbs. SPDN-4438 in bottom of case. Balance of charge consists of EX-6985 on top of SPDN-4438
(b) 0.40 lbs. SPDN-4438 in bottom of case. Balance of charge consists of EX-6735 on top of EX-6735
(c) Carbon deposition relative to EX-6735 as 100%
* Black Smoke

TABULATION OF FIRING DATA (Continued)

Date: 18 August 1952
Gun No. 20385

Rd. No.	Powder	Primer	PPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)	Carbon (%)(b)
1	SPCG-10135	XC-D22/250	10.1	4.16	-	15.1	-	0	150	0
2	"	"	"	"	2720	15.8	-	"	"	"
3	"	"	"	"	2724	16.3	-	"	"	"
4	"	"	"	"	2715	15.7	-	"	"	"
5	"	"	"	"	2711	15.6	-	"	"	"
6	"	"	"	"	2715	16.0	-	"	"	"
Mean of 5 rounds				4.16	2717±4	15.9±0.2				
7	EX-6985(a)	XC-D22/250	9.7	3.60	2315	9.3	-	0	200*	0
8	"	"	"	"	2340	10.0	-	"	"	"
9	"	"	"	"	2353	10.2	-	"	"	"
10	"	"	"	"	2336	9.9	-	"	"	"
Mean of 3 rounds				3.60	2343±7	10.0±0.1				
11	EX-6985(a)	XC-D22/250	6.9	4.51	2744	15.4	-	0	200*	0
12	"	"	"	"	2753	15.8	-	"	"	"
13	"	"	"	"	2753	15.7	-	"	"	"
14	"	"	"	"	2742	15.4	-	"	"	"
15	"	"	"	"	2741	15.4	-	"	"	"
Mean of 5 rounds				4.51	2747±5	15.5±0.2				
16	EX-6985(a)	XC-D22/250	6.2	4.81	2855	17.4	-	0	200*	0
17	EX-6985	"	6.0	5.21	2799	16.6	-	"	"	75
18	"	"	"	"	2802	16.6	-	"	"	"
19	"	"	"	"	2811	16.4	-	"	"	"
Mean of 3 rounds				5.21	2804±5	16.5±0.1				

(a) 0.40 lbs. SPDN-4438 in bottom of case. Balance of charge consists of EX-6985 on top of SPDN-4438
(b) Carbon deposition relative to EX-6735
* Black Smoke

TABULATION OF FIRING DATA (Continued)

Date: 10 September 1952
Gun No. 5917

Rd. No.	Powder	Primer	PFD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)
1	SPCG-10135	Mk 42	10.1	4.16	2609	13.4	-	0	150
2	"	"	"	"	2648	14.2	-	"	"
3	"	"	"	"	2642	13.6	-	"	"
4	"	"	"	"	2622	13.4	-	"	"
5	"	"	"	"	2634	13.7	-	"	"
6	"	"	"	"	2630	13.6	-	"	"
Mean of 6 rounds				4.16	2635±8	13.7±0.2	-		
7	EX-7006	Mk 42	10.3	4.00	2160	8.4	-	0	150
8	"	"	"	"	2161	8.4	-	"	"
9	"	"	"	"	2170	8.6	-	"	"
Mean of 3 rounds				4.00	2158±10(a)	8.2±0.4(a)	-		
10	EX-7006	Mk 42	7.4	4.96	2622	16.7	-	0	150
11	"	"	"	"	2693	20.2	-	"	"
12	"	"	"	"	2667	19.6	-	"	"
13	"	"	"	"	2650	17.7	-	"	"
14	"	"	"	"	2664	19.2	-	"	"
Mean of 5 rounds				4.96	2659±19	18.7±1.2			
15	EX-7006	Mk 42	10.3	4.00	2142	7.7	-	0	150

(a) Based on rounds 8, 9, and 15.

TABULATION OF FIRING DATA (Continued)

Date: 9 September 1952
Gun No. 20385

Rd. No.	Powder	Primer	PPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)
1	SPCG-10135	Mk 42	10.1	4.16	2680	14.2	0.014	0	150
2	"	"	"	"	2703	15.0	0.013	"	"
3	"	"	"	"	2701	15.1	0.014	"	"
4	"	"	"	"	2702	15.5	0.016	"	"
5	"	"	"	"	2703	15.4	0.016	"	"
6	"	"	"	"	2697	15.1	0.013	"	"
Mean of 5 rounds				4.16	2701±2	15.2±0.3	0.014±0.001		
7	EX-7006	Mk 42	11.8	3.50	2038	7.4	0.017	0	150
8	"	"	10.3	4.00	2231	9.3	0.015	"	"
9	"	"	"	"	2252	9.5	0.017	"	"
Mean of 2 rounds				4.00	2242±11	9.4±0.1	0.016±0.001		
10	EX-7006	Mk 42	8.8	4.50	2460	12.8	0.013	0	150
11	"	"	7.3	5.00	2710	19.0	0.017	"	"
12	"	"	"	"	2713	19.7	0.015	"	"
13	"	"	"	"	2720	19.7	0.013	"	"
14	"	"	"	"	2735	21.3	0.014	"	"
Mean of 4 rounds				5.00	2720±8	19.9±0.5	0.015±0.001		
15	EX-7006	Mk 42	10.3	4.00	2265	10.2	0.015	0	150

TABULATION OF FIRING DATA (Continued)

Date: 11 September 1952
Gun No. 5917

Rd. No.	Powder	Primer	PPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)
1	SPCG-10135	Mk 42	10.1	4.16	2641	14.1	0.014	0	150
2	"	"	"	"	2636	13.7	-	"	"
3	"	"	"	"	2643	13.7	0.012	"	"
4	"	"	"	"	2640	13.9	0.016	"	"
5	"	"	"	"	2630	13.8	0.017	"	"
6	"	"	"	"	2629	14.3	0.014	"	"
Mean of 5 rounds				4.16	2636±5	13.9±0.2	0.015±0.002		
7	EX-7006(a)	Mk 42	7.5	4.00	2119	7.6	0.021	0	150
8	"	"	"	"	2066	8.0	0.022	"	"
9	"	"	"	"	2134	7.8	-	"	"
Mean of 2 rounds				4.00	2100±34	7.9±0.1	0.022±0.000		
10	EX-7006(a)	Mk 42	4.3	4.96	2457	11.3	0.016	0	150
11	"	"	"	"	2487	11.1	0.015	"	"
12	"	"	"	"	2511	12.2	0.015	"	"
13	"	"	"	"	2492	11.7	0.016	"	"
14	"	"	"	"	2519	12.5	0.019	"	"
Mean of 5 rounds				4.96	2493±17	11.8±0.5	0.016±0.001		
15	EX-7006(b)	Mk 42	10.3	3.50	2127	8.0	0.015	0	150
16	"	"	"	"	2136	7.7	0.015	"	"
Mean of 3 rounds				3.50	2131±4(c)	7.8±0.2(c)	0.016±0.001		

TABULATION OF FIRING DATA (Continued)

Date: 11 September 1952 (Continued)
Gun No. 5917

Ex. No.	Powder	Primer	FPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)
17	EX-7006(b)	Mk 42	9.5	3.75	2242	9.5	0.016	0	150
18	"	"	7.3	4.50	2586	14.2	0.014	"	"
19	"	"	6.5	4.75	2729	19.0	0.017	"	"
20	"	"	7.0	4.60	2626	15.6	0.018	"	"
21	"	"	"	"	2628	15.9	0.018	"	"
22	"	"	"	"	2629	15.8	0.014	"	"
23	"	"	"	"	2642	16.1	0.015	"	"
24	"	"	"	"	2646	16.5	0.018	"	"
Mean of 5 rounds				4.60	2634±8	16.0±0.3	0.017±0.002		
25	EX-7006(b)	Mk 42	10.3	3.50	2129	7.6	0.017	0	150

(a) 2 empty pyralin containers end on end around primer.
(b) Plus 150 grams of NPFB-223 in pyralin container around bottom of primer.
(c) Based on rounds 15, 16, and 25.

TABULATION OF FIRING DATA (Continued)

Date: 16 September 1952
Gun No. 19923

Rd. No.	Powder	Primer	PFD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)
1	SPCG-10135	Mk 42	10.1	4.16	2665	16.0	0.016	0	150
2	"	"	"	"	2705	16.1	0.012	"	"
3	"	"	"	"	2701	16.1	0.012	"	"
4	"	"	"	"	2699	15.7	0.013	"	"
5	"	"	"	"	2703	16.4	0.012	"	"
6	"	"	"	"	2701	16.1	0.014	"	"
Mean of 5 rounds				4.16	2702±2	16.1±0.1	0.013±0.001		
7	EX-7006(a)	Mk 42	7.5	4.00	2393	13.1	0.021	0	150
8	"	"	"	"	2315	10.9	0.018	"	"
9	"	"	"	"	2287	10.1	0.020	"	"
Mean of 2 rounds				4.00	2301±14	10.5±0.4	0.019±0.001		
10	EX-7006(a)	Mk 42	4.1	5.00	2630	14.9	0.015	0	150
11	"	"	"	"	2611	13.7	0.014	"	"
12	"	"	"	"	2654	14.9	0.017	"	"
13	"	"	"	"	2602	14.0	0.014	"	"
14	"	"	"	"	2641	15.2	0.017	"	"
Mean of 5 rounds				5.00	2628±17	14.5±0.6	0.015±0.001		
15	EX-7006(a)	Mk 42	2.9	5.30	2732	16.7	0.012	0	150
16	EX-7006(b)	"	7.0	4.60	2623	14.7	0.012	"	"
17	"	"	"	"	2619	14.0	0.012	"	"
18	"	"	"	"	2630	15.1	0.012	"	"
19	"	"	"	"	2619	14.3	0.012	"	"
20	"	"	"	"	2627	14.4	0.012	"	"
Mean of 5 rounds				4.60	2624±4	14.5±0.3	0.012±0.000		

TABULATION OF FIRING DATA (Continued)

Date: 16 September 1952
Gun No. 19923

Rd. No.	Powder	Primer	PPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)
21	EX-7006(b)	Mk 42	6.2	4.80	2720	16.4	0.012	0	150
22	"	"	10.3	3.50	2197	8.3	0.013	"	"
23	"	"	"	"	2199	9.0	0.014	"	"
24	"	"	"	"	2194	8.4	0.014	"	"
Mean of 3 rounds				3.50	2197±2	8.6±0.3	0.014±0.000		

(a) Plus 2 empty pyralin containers
(b) Plus 150 grams of NPFB-223 in pyralin container around top of primer.

TABULATION OF FIRING DATA (Continued)

Date: 17 September 1952
Gun No. 5917

Rd. No.	Powder	Primer	PPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)
1	SPCG-10135	Mk 42	10.1	4.16	2618	13.8	0.013	0	150
2	"	"	"	"	2598	12.9	0.013	"	"
3	"	"	"	"	2606	13.6	0.015	"	"
4	"	"	"	"	2602	13.6	0.013	"	"
5	"	"	"	"	2589	13.0	0.016	"	"
6	"	"	"	"	2586	12.7	0.018	"	"
Mean of 5 rounds				4.16	2596±7	13.2±0.3	0.015±0.002		
7	EX-7006(a)	Mk 42	8.8	4.00	2288	9.1	0.017	0	150
8	"	"	"	"	2299	10.1	0.019	"	"
9	"	"	"	"	2292	9.5	0.019	"	"
Mean of 2 rounds				4.00	2296±4	9.8±0.3	0.019±0.000		
10	EX-7006(a)	Mk 42	6.2	4.80	2652	15.4	0.015	0	150
11	"	"	"	"	2682	13.0	0.014	"	"
12	"	"	"	"	2647	15.0	0.019	"	"
13	"	"	"	"	2651	15.6	0.016	"	"
Mean of 4 rounds				4.80	2658±12	15.5±0.3	0.016±0.002		
14	EX-7006(a)	Mk 42	5.8	5.00	2767	18.7	0.015	0	150
15	EX-7006(b)	Mk 42	8.8	4.00	2336	10.1	0.015	"	"
16	"	"	"	"	2352	9.8	0.016	"	"
Mean of 2 rounds				4.00	2344±8	10.0±0.2	0.016±0.001		

TABULATION OF FIRING DATA (Continued)

Date: 17 September 1952 (Continued)
Gun No. 5917

Rd. No.	Powder	Primer	PPD (in.)	Charge (lbs.)	Velocity (f/s)	Pressure (t.s.i.)	Ej. Time (sec.)	Flash (%)	Smoke (%)
17	EX-7006(b)	Mk 42	6.2	4.80	2723	19.9	0.013	0	150
18	"	"	"	"	2741	20.0	0.018	"	"
19	"	"	"	"	2723	19.0	0.016	"	"
20	"	"	"	"	2716	19.6	0.014	"	"
Mean of 4 rounds				4.80	2726±8	19.6±0.3	0.015±0.002		
21	EX-7006(b)	Mk 42	5.8	5.00	2830	25.6	0.015	0	150
22	EX-7006	"	7.3	4.94	2657	18.5	0.016	"	"
23	"	"	"	"	2642	17.8	0.017	"	"
24	"	"	"	"	2573	15.3	0.018	"	"
Mean of 3 rounds				4.94	2624±34	17.2±1.3	0.017±0.001		
25	EX-7006(c)	Mk 42	3.2	5.23	2543	12.7	-	0	150
26	"	"	"	"	2572	12.1	-	"	"
27	"	"	"	"	2547	12.3	-	"	"
Mean of 3 rounds				5.23	2554±16	12.4±0.2			
28	EX-7006(a)	Mk 42	5.9	4.80	2690	15.4	0.016	0	150
29	"	"	"	"	2654	14.7	0.015	"	"
30	"	"	"	"	2694	15.5	0.016	"	"
Mean of 3 rounds				4.80	2679±17	15.2±0.3	0.016±0.000		

(a) Plus 150 grams booster around top of primer
(b) Plus 150 grams booster around bottom of primer
(c) Plus 2 empty pyralin containers end on end around primer

PRESSURE-TIME CURVES

Gun: 3"/50 Caliber

Number	Mk	Mod	ESR	Do
13092	22	4	2145.9	3".052
5917	21	0	3217.4	3".096

Primer: XC-D22/250 on 8-5-52
Mk 42 on 9-17-52

Projectile: Mk 33 (13.00 lbs.) Epsom Salt Loaded

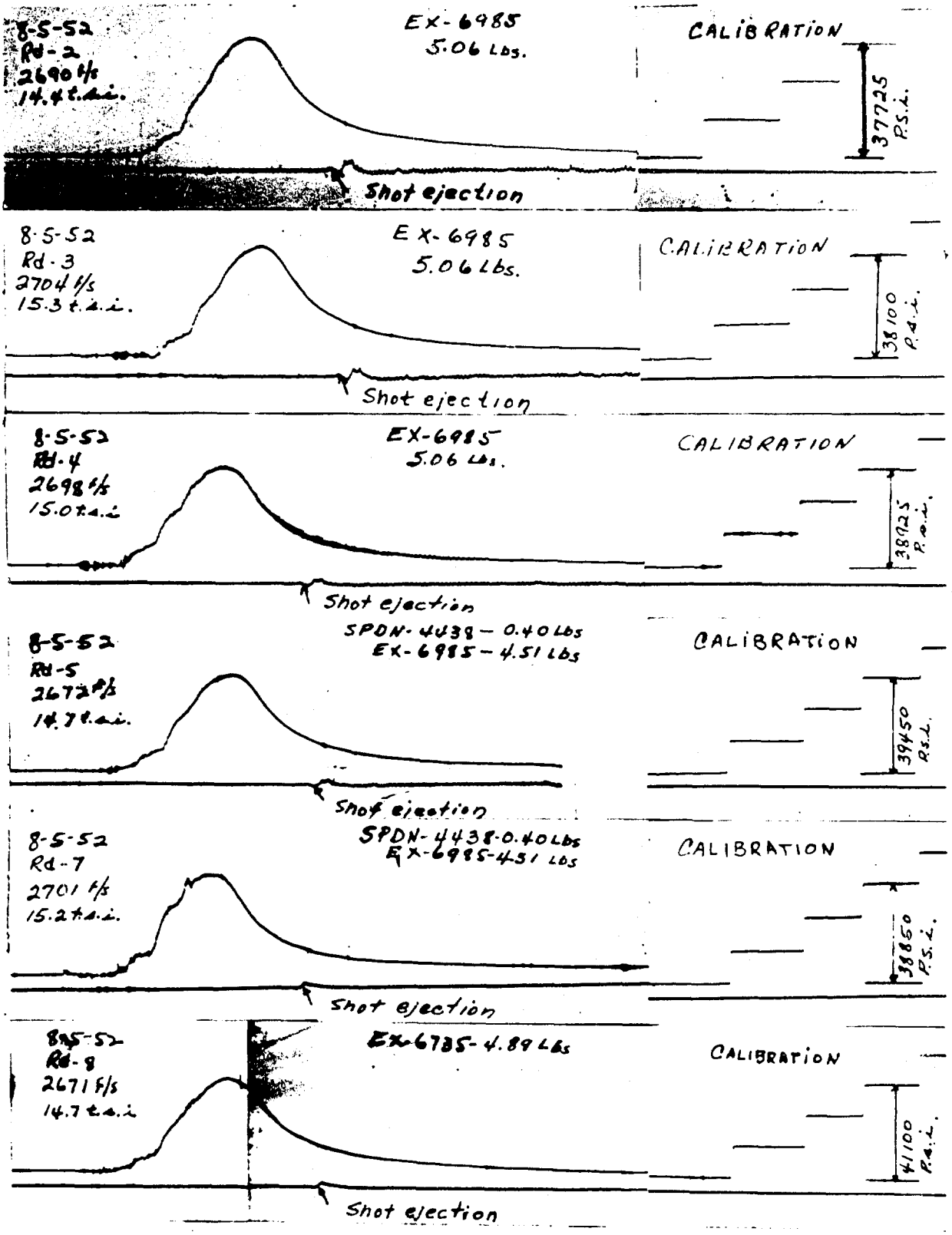
Cartridge Case: Mk 9, Steel, Rubber Crimped

Lead Foil: 45 grams per round

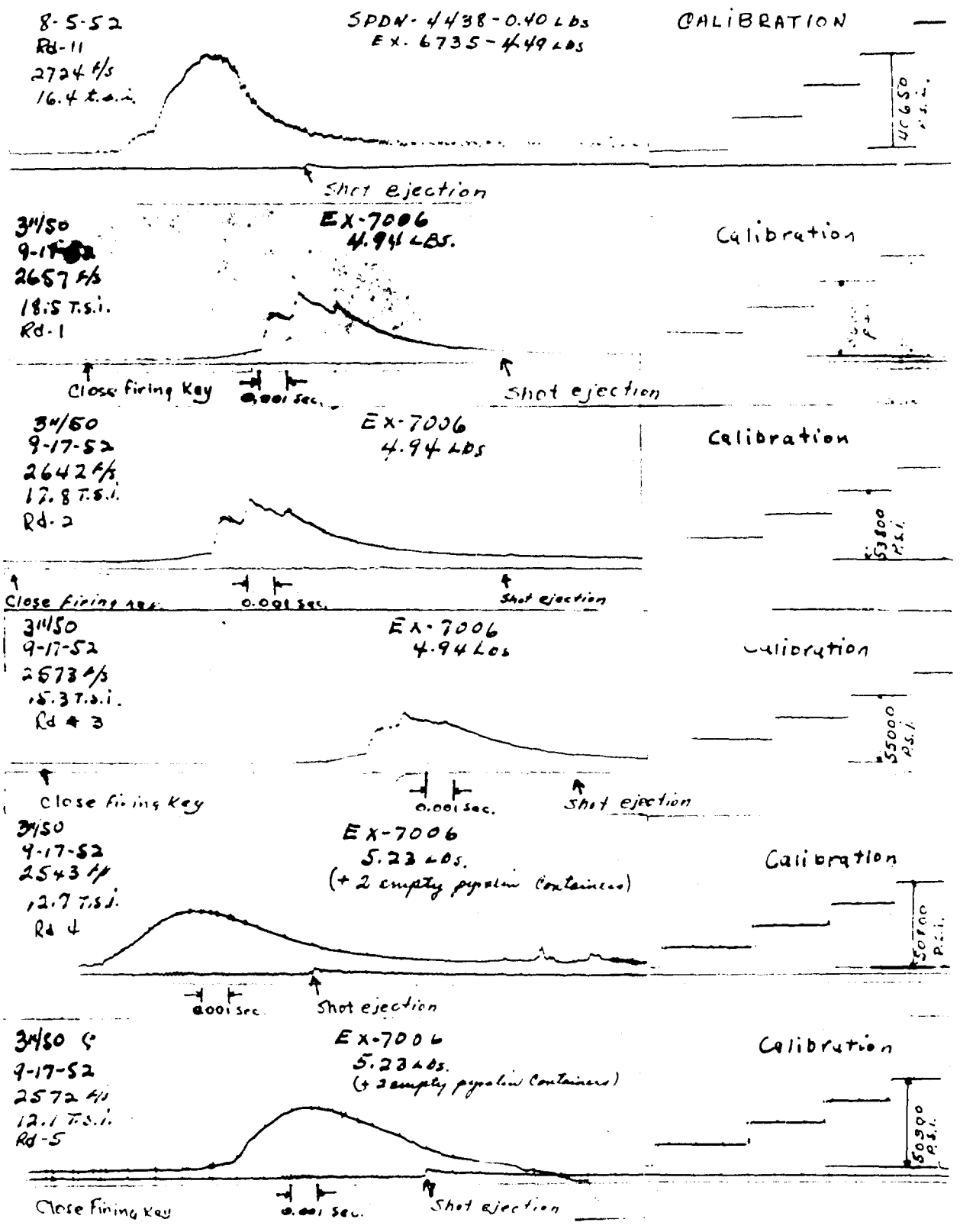
Wad and Spacer: Cardboard, NGF Dwg. No. 132664
Pc. Nos. 13 and 4

Powder Temp.: 90°F

Ballistic Test of Cool Propellants [illegible]



Ballistic Test of Cool Propellants EX-6985 and EX-7006



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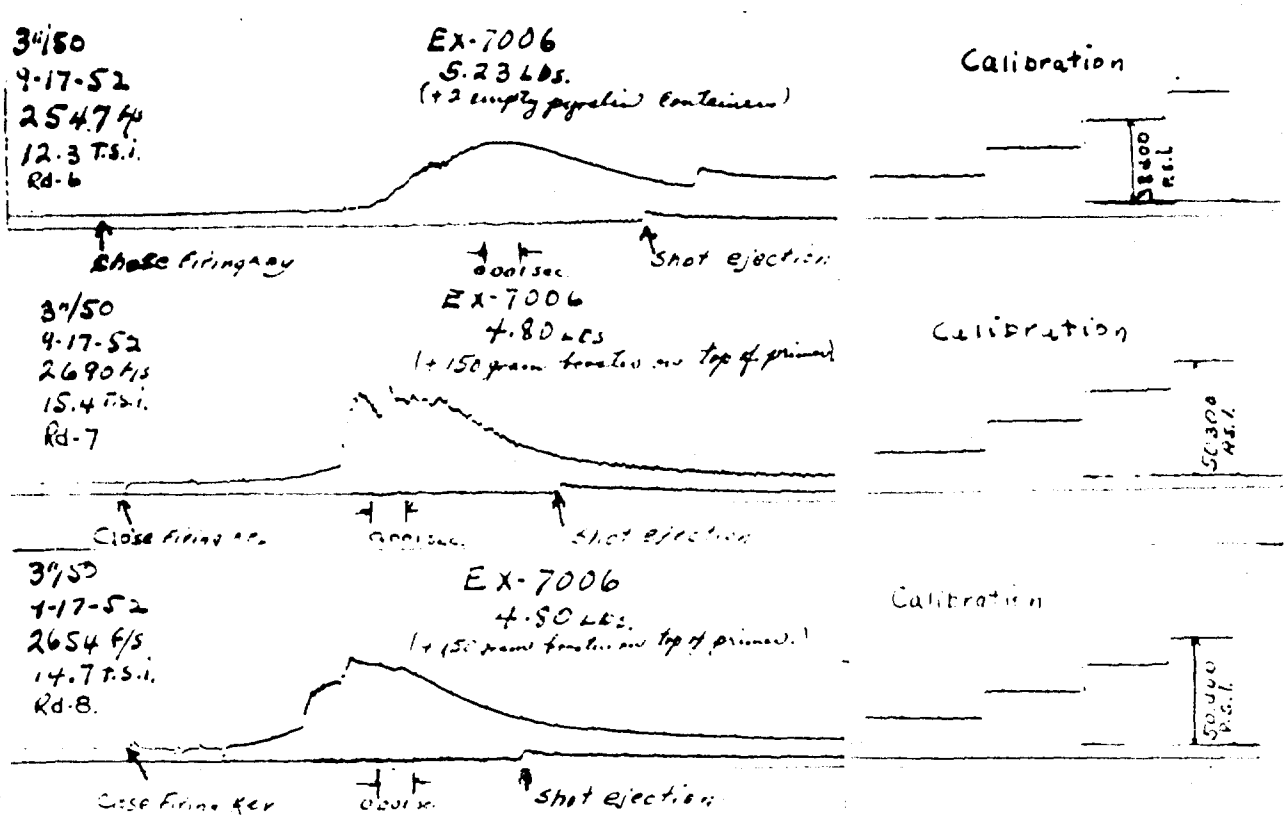
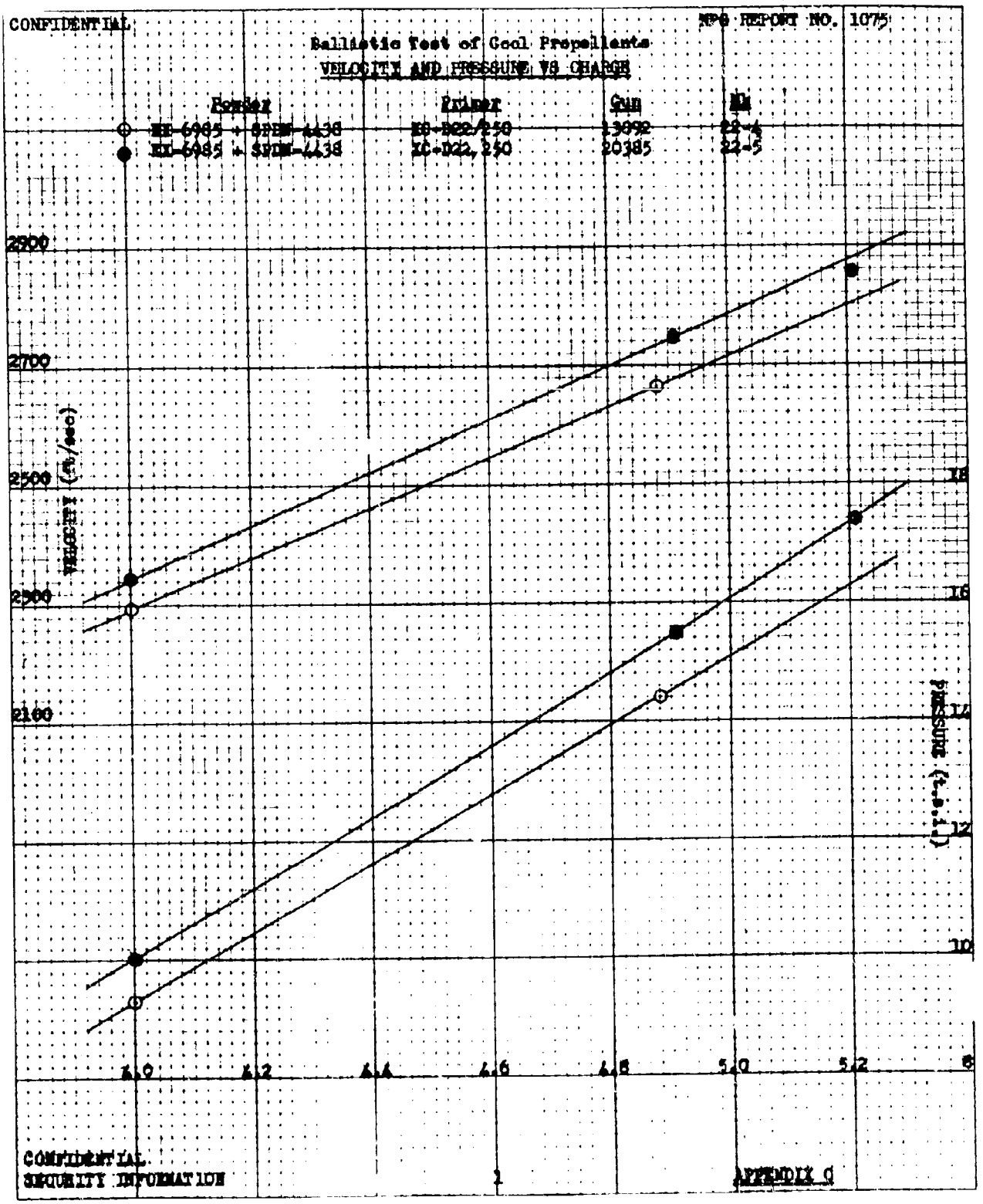


Ballistic Test of Cool Propellants

VELOCITY AND PRESSURE VS CHARGE



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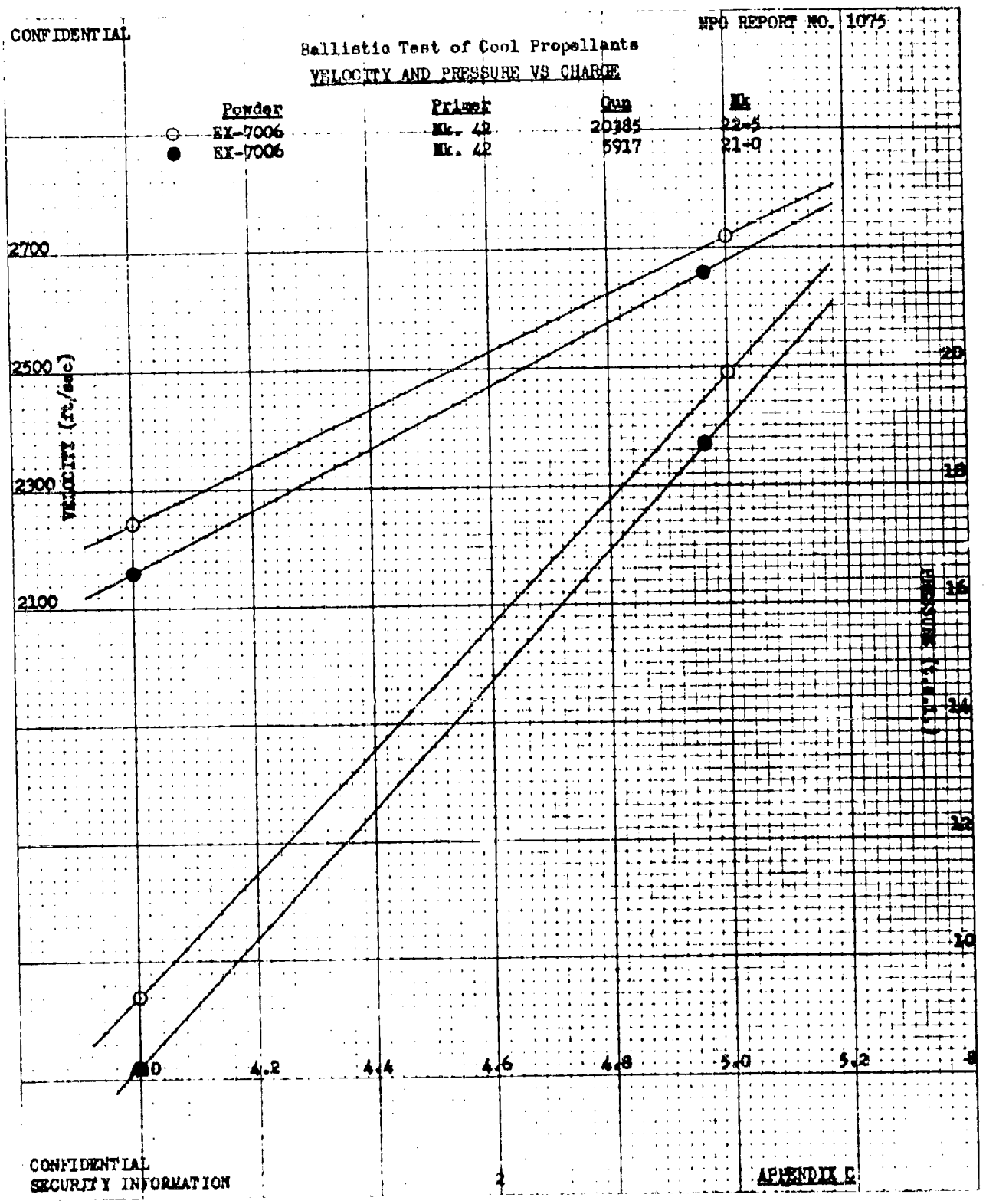
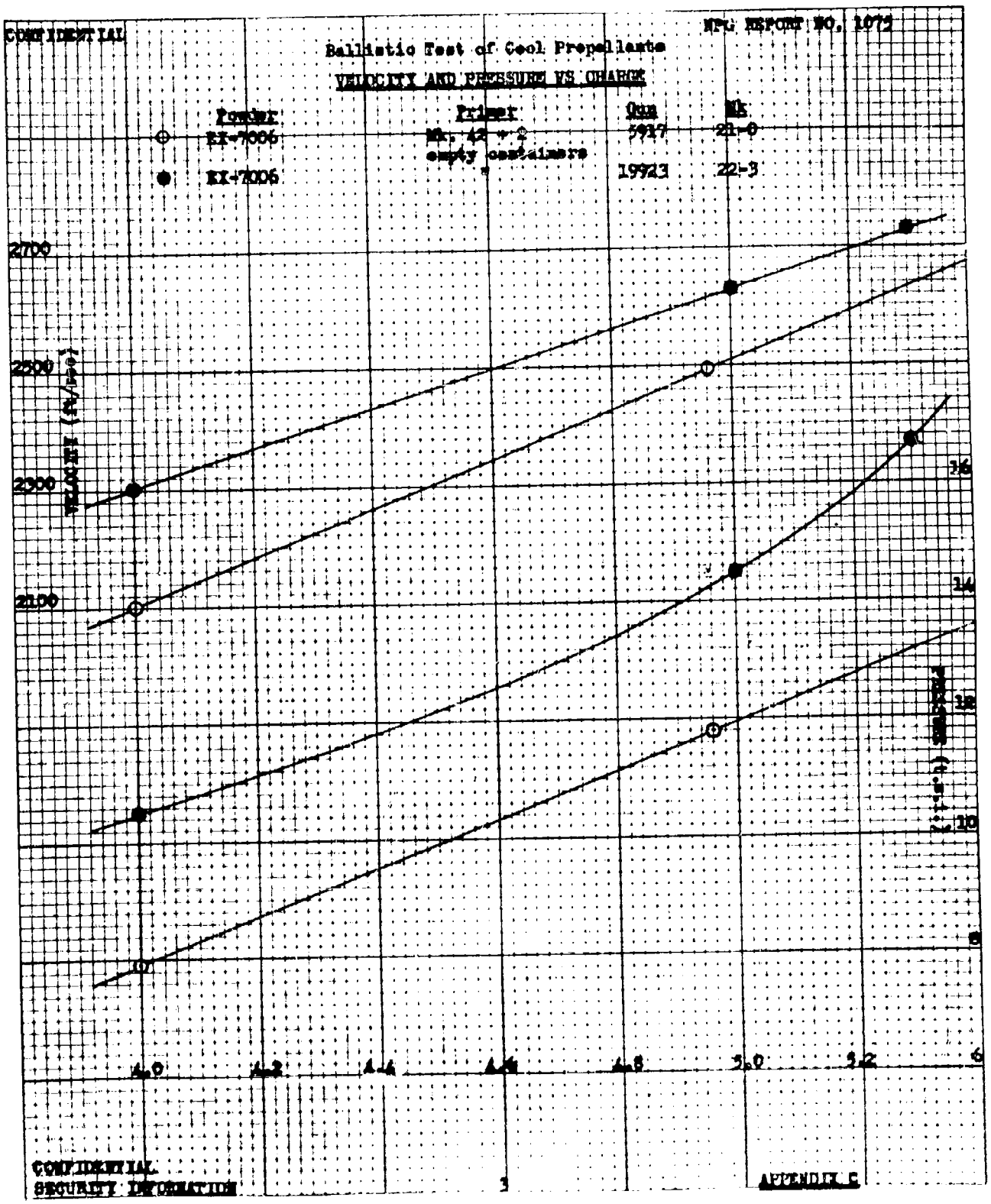
VELOCITY AND PRESSURE VS CHARGE



Ballistic Test of Cool Propellants

VELOCITY AND PRESSURE VS CHARGE

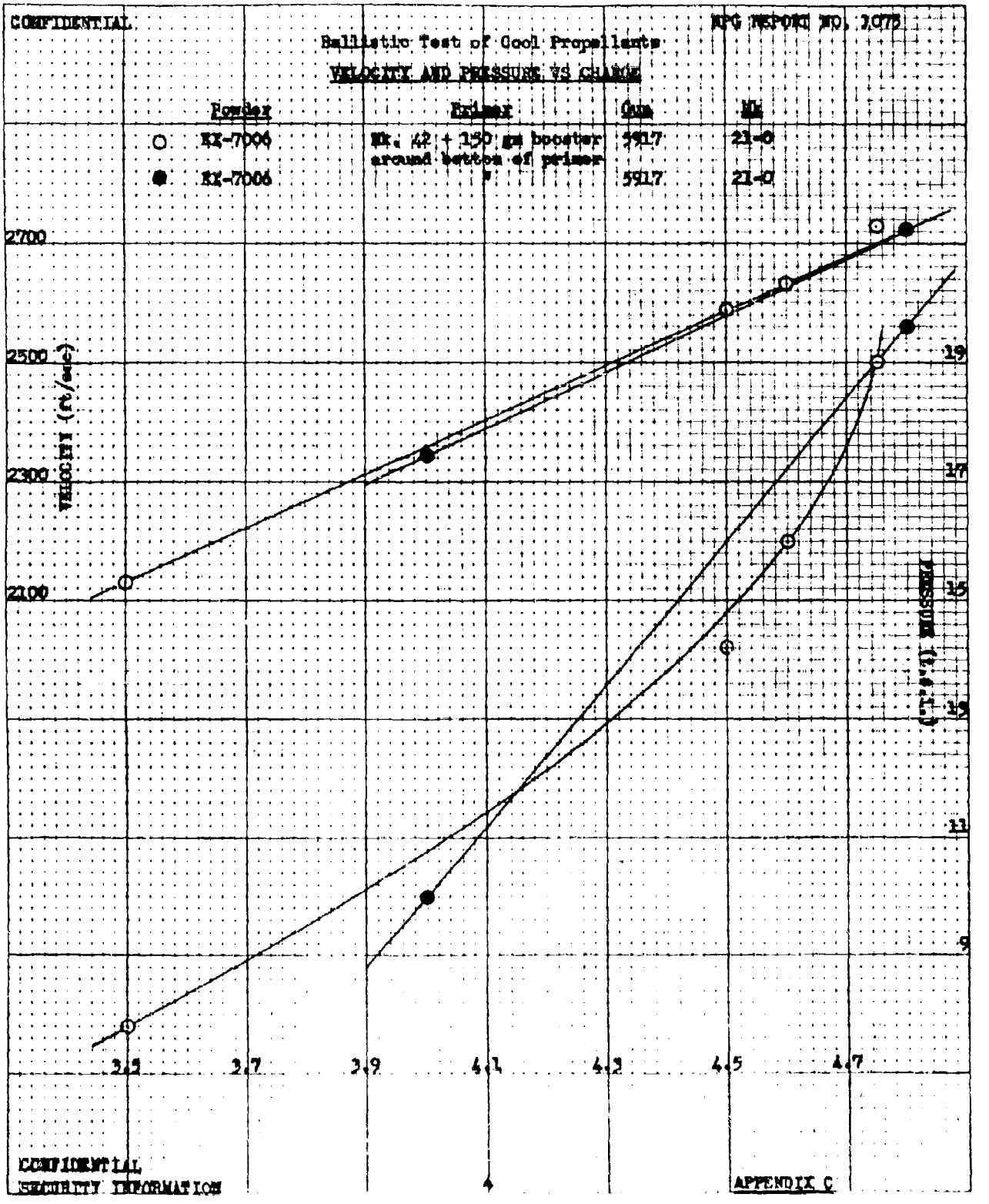
Powder	Primer	Gun	Mk
○ EX-7006	Mk. 42 w/2 empty containers	5917	21-0
● EX-7006	"	19923	22-3



Ballistic Test of Cool Propellants

VELOCITY AND PRESSURE VS CHARGE

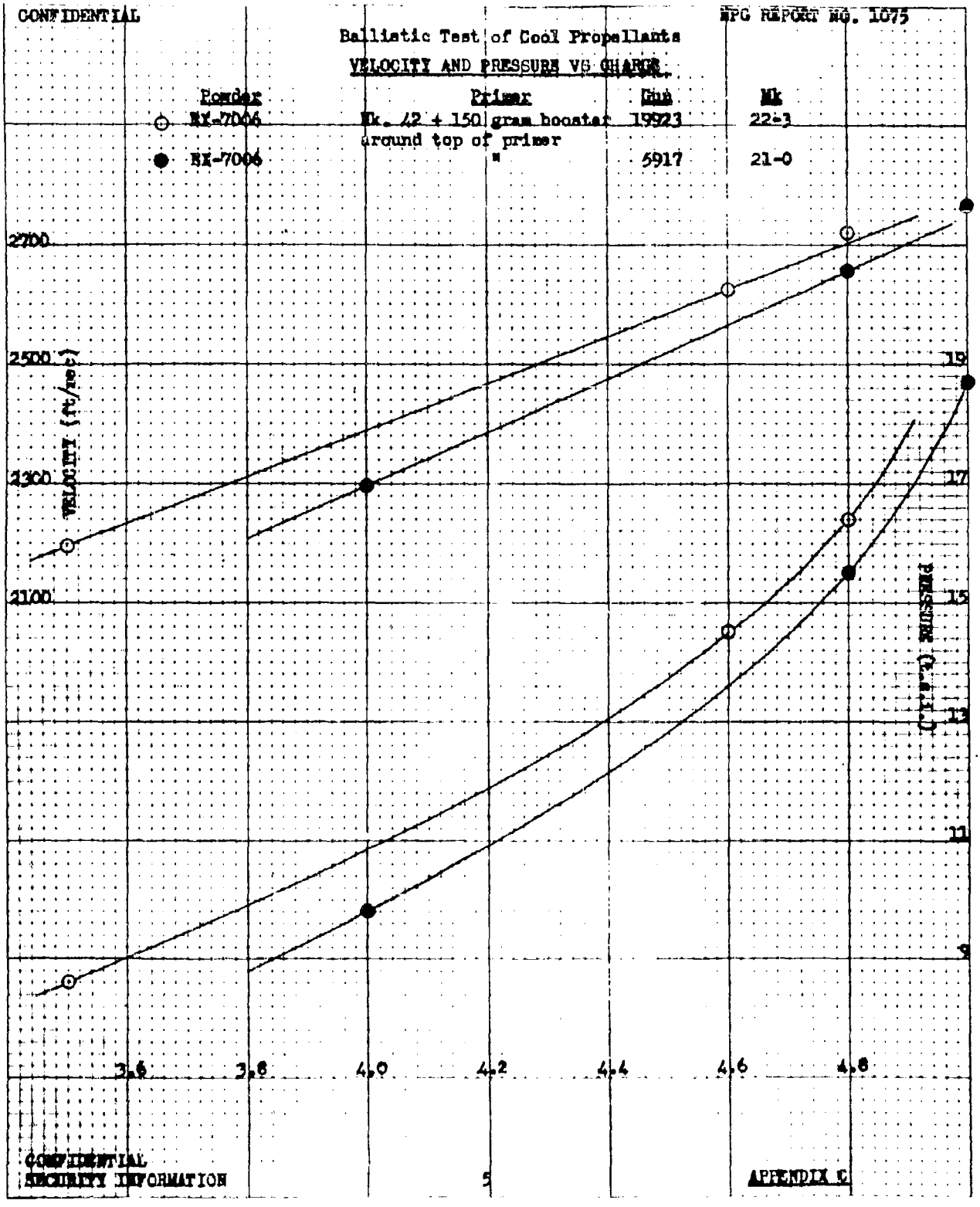
	Powder	Primer	Gun	Mk
○	KX-7006	Mk. 42 + 150 gm booster around bottom of primer	5917	21-0
●	KX-7006	"	5917	21-0



Ballistic Test of Cool Propellants

VELOCITY AND PRESSURE VS CHARGE

	Powder	Primer	Gun	Mk
⊙	NX-7006	Mk. 42 + 150 gram booster around top of primer	19923	22-3
●	NX-7006	"	5917	21-0



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