TECHNICAL REPORT 3148

DEVELOPMENT OF GREEN BAG CHARGE FOR ZONE 1 FOR THE 175 MM GUN

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PICATINNY ARSENAL
DOVER, NEW JERSEY

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DEVELOPMENT OF XM124 (GREEN BAG) PROPELLING CHARGE FOR THE 175MM GUN

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FEBRUARY 1964

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INTRODUCTION

Ballistics of the 175mm gun at Zone 1 of the M86E1 Propelling Charge are unsatisfactory. It is necessary to expend about 25 rounds to condition the weapon before a stable velocity level is attained. Ten round groups fired from unconditioned guns give standard deviations as high as 35 fps. Even with conditioned guns, velocity dispersions are excessive; standard deviations in the order of 10-12 fps are being experienced. This poor velocity uniformity was reflected in poor range accuracy in field tests at Aberdeen Proving Ground and at the U. S. Artillery Board at Fort Sill.

A completely separate charge -- (green bag charge) especially tailored for Zone 1 -- was investigated. The development of this charge and the performance improvement obtained over Zone 1 of the M86E1 charge is the subject of this report. The study also covers some unsuccessful attempts to improve Zone 1 by ignition modifications.

SUMMARY

A green bag charge was developed using an 0.037 web, MP, M6 Propellant at a charge weight of about 17 pounds. Ignition is by means of a base pad containing eight ounces of A1 Black Powder. Ballistic reproducibility, both round to round and occasion to occasion, was excellent. Pertinent performance characteristics are:

Conditioning Effect -- It is virtually non-existent. At most, one round is required to attain stable velocity levels either with a cold tube or one previously firing M86 at Charge 2 or 3. Conversely, there is little or no conditioning effect when changing from the green bag charge to Charge 2 or 3 with the M86 Propelling Charge.

Uniformity -- The observed standard deviation on velocity for the green bag charge has varied from 1.3 to 3.3 fps. The over-all grand average was 2.4 fps -- opposed to standard deviations of 10-12 fps under optimum conditions with Zone 1 of the M86 Propelling Charge.

Range Accuracy -- Consistent with velocity uniformity, a significant improvement in range Probable Error (PE) is obtained. At 70% maximum range for Charge 1, the PE is 20-25 meters compared with 60 to 200 meters for the M86 Charge 1.

Extreme Temperature (-40 to 125°F) -- Performance is good. The velocity uniformity compares favorably to data obtained under ambient conditions. The temperature sensitivity is about two fps per 10°F.

Worn Tube -- Performance is the equal of new tube. Loss in velocity is approximately 10 fps over tube life as defined by 400 Charge 3 firings. Operating pressure is increased from about 11,000 to 15,000 psi.

CONCLUSIONS

*The green bag charge represents a significant performance improvement for Charge 1 for the 175mm Gun.

The green bag charge can be produced for about $7.35 "out of pocket" costs, as opposed to the present "out of pocket" cost of $37 for the M86E1 Propelling charge.

The green bag charge concept complicates the logistic problem for the 175mm Gun since it can only be provided as a separate (and new) item of issue. However, its use should yield a substantial operational savings particularly for practice or training use.

RECOMMENDATIONS

The development of a green bag charge for firing the 175mm Gun at Zone 1 should be considered complete through the Final Industrial Engineering Test phase.

Service Test firings should be conducted by U. S. Army Artillery Board (USAAB).

The charge should be considered for both training and tactical needs.

This charge should be standardized for the 175mm Gun produced and stocked as a separate item of issue.

Action Taken

Correspondence has been forwarded to the U.S. Army Munitions Command and subsequently to U.S. Army Materiel Command and U.S. Army Combat Development Command for decision (Appendix C).

* Prior to publication, the formal designation of "Charge, Propelling, 175mm: XM124" was assigned for the green bag charge as it is presented in this report.

STUDY

Background

The M86E1 Propelling Charge (and previously the M86 Propelling Charge) is now in production for use in the 175mm Gun. The weapon system components and a brief description of the M86E1 Propelling Charge is provided in Table 1 and 2. Ballistic performance for Charges 2 and 3 has been satisfactory. However, firing of M86E1 at Charge 1 was unsatisfactory.

First, an extensive conditioning effect takes place. As many as 25 rounds are required to attain stable velocity levels. This can be noted in Table 3, showing gun warming or conditioning for all propelling charge combinations.

Second, poor ballistic uniformity is observed. Velocity standard deviations as high as 35 rps are obtained for 10-round groups fired from unconditioned tubes. Even after a stable velocity level is obtained standard deviations on the order of 10-12 fps still result. For both reasons, range accuracy is poor. Range PE at about 70% of maximum range for Charge 1 varied from 60 meters to more than 200 meters. Range data plots out well with velocity data, showing that poor range PE is almost entirely attributable to interior ballistics rather than to the flight characteristics of the projectile.

Ignition Studies (for Zone 1, M86E1 Charge)

Studies of ignition modifications to improve Zone 1 ballistics were limited to the investigation of supplemental base ignition of the Zone 1 charge in order not to upset the sensitive ignition balance of the higher zones. For Charge 3, this involves emphasizing the axial or central core ignition with a small or reduced base ignition effect. For Charge 1, de-emphasis of the central delivery and predominant base ignition is desirable. No ballistic improvements were obtained with these modifications.

Studies also were conducted to determine the ballistic effect of varied location of the Zone 1 charge in the chamber. This was considered since random placement of the charge can vary over 30 inches in the chamber, and it seemed that this could have accounted for some of the ballistic non-uniformity. The tests show a lack of ballistic sensitivity to charge location.

Supplemental Ignition for Zone 1

Supplemental ignition was obtained by a doughnut-shaped igniter pad which fits around the existing base pad -- in effect forming a larger, pillow-shaped pad. The arrangement would permit practical field assembly.

Two increased levels of base ignition were studied, namely six and eight ounces of grade A1 Black Powder. Increment one of the M86 Propelling Charge which has a four ounce base pad was fired as a standard. All charges were fired with the polyurethane core removed, required for field firings of Zone 1. Weapon loading, rate of fire and other testing variables were maintained as uniformly as possible. A total of 66 rounds representing all three variations were fired, divided evenly between morning and afternoon (after a one-hour noon break).

The data, Table 5 and Figure 1, show an intolerably large and similar conditioning effect for both the standard charge and the two variations tested. About 25 rounds are required to reach the service velocity level. An initial sharp rise in velocity to near 100 fps over service velocity and then a gradual fall-off to service velocity was obtained in the morning firings -- starting with a cold gun. The same trend is observed in the afternoon firings, but to a lesser degree.

Ballistic uniformity for all three Zone 1 variations fired is unsatisfactory -- even when the large conditioning effect is discounted. The standard deviation on velocity discounting conditioning effect is on the order of 7 to 11 fps from this test; including this conditioning effect, standard deviations are in the order of 30 fps.

Effect of Charge Location in Chamber

Location of the charge in the chamber did not significantly affect ballistics (Table 4). The program was fired in three-round groups fired at four-inch intervals, starting with the charge touching the mushroom head and continuing until the charge rested against the base of the projectile. The firings were conducted in late afternoon and evening in a gun tube previously used on that day for a propellant acceptance test. Thus, the tube was warm or "conditioned." Note that there is little difference between velocities from Round 1 to 18, covering 0 to 20 inches in charge position from the breech end. At this point in the program, firing was interrupted for about one hour. During this interval sunset passed and an overcast and light rain developed. The significant change in ballistics

when firings were resumed (Round 19 through 30) is attributed to the weapon being sensitive to the delay and weather change. Note that in Rounds 19-30 the ballistic level is higher and not as uniform. For example, Rounds 1-3 and 28-30 were fired at the same condition of loading. When the gun is warm and "conditioned" as is in Round 1-3, the velocity is low and reproducible. When the gun is subject to changing conditions resulting in gun cooling and affecting heat balance as in Rounds 28-30, the velocity (and pressure) are higher and random.

Green Bag Charge

Since modification to the M86 Propelling Charge did not give an indication of improved performance, a separate propelling charge was developed especially tailored to meet Zone 1 ballistics. By convention, this was termed a "green bag charge." This technique has been successfully applied to other ballistic systems where design requirements to provide satisfactory higher zone performance preclude satisfactory low zone performance. Based on experience with these systems, the following design criteria -- as compared with Zone 1 of the M86 Propelling Charge -- were emphasized:

Higher peak pressure occurring sooner.

Less time in the gun with burn-out occurring sooner.

Loose loaded (as opposed to a laced charge).

Base ignition.

Studies to establish a final green bag charge design are discussed. The charges used in firing tests are essentially the design shown in the "Description of Charge" section of this report except that propellant charge weight varied, and cloth assemblies were not refined in the initial tests. These phases make up the program:

Computer studies to establish web.

Charge establishment.

Preliminary ballistic studies.

Final Industrial Engineering Tests.

Computer Studies

Simulated firings in an analog computer were made to establish propellant web. Initial rough approximations show that using M6 Propellant, pressure increase to about 15,000 psi is practical, with time in the gun on the order of 36 milliseconds. A more detailed computer program was conducted with a 0.037-inch web, MP, M6 Propellant which was available from excess propellant stocks. Figure 2 and 3 show pressure travel and pressure time curves. For comparison, the calculated curves on the same basis for Zone 1 of the M86 Propelling Charge are included (Figure 4 and 5).

Charge Establishment

To minimize testing costs, charge establishment firings were conducted as gun conditioning rounds or as rounds added to end of firing tests scheduled for other purposes. No standards were fired for direct ballistic comparison nor were corrections made for tube life, conditioning, shell weight, etc. Nevertheless, the data obtained (Table 6) was sufficient to permit propellant web selection and for a charge weight approximation adequate for the remaining ballistic testing.

Three web sizes of M6 Propellants were checked, 0.057, 0.047 and 0.037 inches. The largest web, 0.057 MP, gave a standard deviation of 10.6 fps, essentially the same as obtained with the Zone 1 of an M86 Charge. The variation decreases with decreasing web size to a standard deviation of 1.7 fps for the 0.037 MP web. Ballistic results with the 0.037 web closely match that predicted in the analog computer. Use of smaller web propellants was considered, including some M1 and M6 types for which excess stocks also exist. This was not explored since no further significant performance improvement can be expected and since this could be explored any time in the future should stocks of 0.037-inch web be exhausted.

Ballistic Studies

This test series, all using inert-loaded M437 Shell, includes firing in a new tube at normal and extreme temperatures and in a worn tube at 70°F only.

Two series of rounds were fired conditioned to 70°F in a new tube. The first series of 30 rounds was with the standard projectile; the second was a 10-round series using the M437 Shell with a modified rotating band. For each test series, a 10-round group using the M86 Standard Charge at

Zone 1 and matching shell was fired. This data is in Table 7 and 8, and Figure 6. Velocity uniformity for the green bag charge was excellent for both series, with standard deviations of 2.7 and 3.1 fps. Only one round was required for gun conditioning (Figure 6). This data was obtained in a manner similar to that of Figure 1, showing the extensive conditioning effect for the Zone 1 of the M86 Propelling Charge. The standard charges demonstrated typical sensitivity to gun conditions and poor ballistic uniformity.

The second series was fired primarily to investigate the ballistic effect of the modified rotating band. It is included here to show additional uniformity data for the green bag charge.

For worn tube performance, 20 rounds were fired; 10 rounds M86 Zone 1 and 10 rounds green bag, fired alternately. The data is in Table 9, and shows good performance for the green bag charge while the M86 at Charge 1 exhibits a typically higher standard deviation. Before these 20 rounds, the gun tube had been used for other tests and was conditioned. A worn tube is defined as a tube in the fourth quarter of life where total life is 400 Charge 3 firings. Velocity loss over tube life for the green bag charge is shown to be approximately 10 fps.

Extreme temperature testing (fired in a new tube) consisted of seven-round groups of both green bag charge and M86 Propelling Charge at Zone 1 fired at 70°, -40°, and 125°F. Ballistic uniformity again was excellent, the standard M86 Propelling Charge being typically poor, and the temperature dependence was significantly reduced. A velocity level shift of about 2 fps per 10°F as compared to 6 fps per 10°F or higher for the M86 Propelling Charge at Zone 1 was obtained.

Final Industrial Engineering Tests

Up to this point, all shells fired in connection with a Green Bag Test Program had been inert filled and with a dummy fuze. The remaining tests were all fired with M437 Shell, filled Composition B with Microcel, and with the XM572 Fuze. The purpose of these tests was to complete data collection for the green bag charge and to fire live shells to the extent required by U.S. Army Test & Evaluation Command (TECOM) to effect concurrence in a safety release. Through a meeting with TECOM, agreement was reached on a test program consisting of these phases:

Range firing (new tube) -- 20 rounds
Ballistic interaction with M86 at charge 2 and 3 -- 20 rounds green bag and 20 rounds M86
Extreme temperatures (worn tube) -- 30 rounds

A test result summary is given in Table 11 and round-by-round data is provided in Table 12. Continued good performance for the green bag charge is evident. Range PE is on the order of 25 meters. No interaction or gun tube conditioning problems exist between the green bag charge and higher zones of the M86 Propelling Charge. Worn tube performance at the temperature extremes of -65°F to 140°F is good. A summary of all uniformity groups fired with a green bag charge is given in Table 13. In summation, the velocity standard deviation ranged from 1.3 fps to 3.3 fps, and the over-all arithmetic average of data is 2.4 fps.

Note

All ballistic data in this report were informally obtained from Aberdeen Proving Ground (APG) by representatives from Picatinny Arsenal present during the tests. The APG firing records have not yet been issued. The data therefore are "raw" and are subject to changes pending final data reduction by APG.

Description of Charge

The green bag charge resulting from this program is shown by Drawing P-132691, (Figures 7-13). To meet the service velocity requirement of 1,675 fps a charge weight of about 16.90 pounds of 0.037-inch web, MP, M6 Propellant is required. This propellant is available in excess Army stocks in the approximate amount of 5,500,000 pounds. The propellant is loose-loaded in a cylindrical bag. Ignition is by means of a base pad containing eight ounces of A1 Black Powder. The cloth material is an acrylic viscose rayon. The loaded charge has an approximate outside diameter of 6.8 inches and length of 15.5 inches. The charges can be packed three to a container, using the M10A3 or XM460 Containers now standard for the M86E1 Propelling Charge.

Production Cost Estimate

The following cost figures approximate the present situation for production of M86E1 Propelling Charge and an estimate for production of the green bag charge. Figures should be considered approximate or representative rather than firm production estimates.

M86E1 Propelling Charge

Container, XM460	$10.00
Materials-cloth, thread, overpacking	5.25
Igniter Tubes (per set)	3.00
Load, Assemble & Pack (L.A.P.), Direct Labor	7.50
Overhead at 150%	11.25
Total Cost (out-of-pocket)*	$37.00
From Stock -- Black Powder	$ .50
From Stock -- Propellant (57 lbs. at .45/lb.)	25.70
Total Value	$63.20 each

Green Bag Charge

Container (1/3 per charge)	$3.35
Materials	.45
LAP, DL	1.42
OH at 150%	2.13
Total Cost (out-of-pocket)*	$7.35 each
From Stock -- Black Powder	$ .25
From Stock -- Propellant (17 lbs. at $.45/lb.)	7.65
Total Value	$15.25 each

The green bag charge then offers substantial cost saving for occasions requiring firing at Zone 1 considering that for every Zone 1 used as an M86E1, Zones 2 and 3 must be destroyed. The added logistic burdens and costs of supplying two charges (as is done with several other weapons) may be completely over-ridden by this cost differential. This should be significant to traing programs since it is understood that range limitations dictate that Charge 1 be used almost exclusively. The savings in production cost are:

Out-of-pocket* -- $29.65 per round
Total value -- $47.95 per round

*Out-of-pocket refers to current manufacturing costs based on use of excess propellant stocks. Total value per charge includes the propellant costs.

As a further consideration it is quite possible that future production of M86E1 Propelling Charge will exhaust the presently available propellant stocks. In that event, the need to produce new propellant will significantly increase the out-of-pocket or budgeted production cost, and the savings for a charge one firing would be $63.20 less $7.35 or $55.85 per round. This situation is not likely to occur for propellant stocks used for the green bag since 0.037- and 0.034-inch web, MP, M1 propellant is also available and could be used. The existing 5,500,000 pounds of 0.037-inch M6 is sufficient for about 320,000 green bag charges.

Miscellaneous

The green bag charge concept could be expanded to provide additional flexibility. By re-design to provide a multi-increment version, Zone 2 of the M86E1 Propelling Charge could be matched, and a sub-zone capability added. While neither variation has been tested, it is considered that either one or both could be built into the system with a minimal development program.

A velocity level higher than now required by Zone 2 (2,310 fps) is not considered possible since this region would approach pressure limitations of the weapon and the high L-to-D ratio of the charge would require a central core type of ignition (as in the M86E1) to maintain reproducible ignition behavior and good uniformity. No substantial basis exists for determining the minimum velocity level at this time. However, it is estimated that 1,250 fps would be reasonable. This would require a thorough check at extreme temperatures and may re-introduce uniformity and conditioning problems similar to those now prevalent with Zone 1 of the M86E1 Propelling Charge. No consideration has been made of potential problems of shell in flight resulting from a reduced velocity.

These comments are included only 1) to show that additional flexibility is possible and 2) point out that an additional cost reduction might be realized if Zone 2 were included in the green bag charge.

The basic problem at Zone 1 is resolved by use of the green bag charge in its present form and a firm basis for assessing the impact of logistic problems is not available. Therefore, no action to modify the green bag charge to include these suggestions is intended.

REFERENCES

1. Letter, Picatinny Arsenal to U.S. Army Munitions Command, Subject: Green Bag Charge for Zone 1 for 175mm Gun, dated 14 August 1963.

2. Letter, U.S. Army Munitions Command to U.S. Army Materiel Command, Subject: Short Range Capability of 175mm Gun, dated 22 November 1963.

APPENDICES

APPENDIX A

TABLES

TABLE 1

WEAPON SYSTEM COMPONENTS

Vehicle	-	175mm, SP, M107
Gun	-	175mm, M113
Shell	-	175mm, HE, M437, with PD fuze, M572 (and other companion shell)
Charge	-	Charge, Propelling, M86 or M86E1
Primer	-	Primer, Percussion, M82

TABLE 2

FEATURES OF M86E1 PROPELLING CHARGE

Propellant - M6, web 0.071 MP

Ignition Material - Black powder, Grade A1

Cloth Material - Acrylic viscose rayon

Construction - laced charge - 3 increments, with tie straps

Ignition type - Central core of foam polyurethane tubing containing 13-1/2 ounces black powder. Base pad containing four ounces black powder.

Zone	1	2	3
Propellant charge (approx)	20 lbs.	17.5	18
Igniter core charge	5.0 oz.	5.5	3.0
Muzzle velocity	1,675 fps	2,310	3,000
Pressure	11,000 psi	22,000	50,000

TABLE 3

GUN CONDITIONING EFFECTS - 175MM

Start with a gun-	Begin firing at	No. Cond. Rds. Req'd	Variations Observed
Cold	M86 Charge 3	1	0-1
"	M86 Charge 2	3	2-10
"	M86 Charge 1	20	10-25
"	M-Green Bag	1	0-1
Conditioned to Zone 3	M86 Charge 2	2	2-3
" "	M86 Charge 1	4	2-5
" "	M-Green Bag	1	0-1
Conditioned to Zone 2	M86 Charge 3	1	0-1
" "	M86 Charge 1	2	2-4
" "	M- Green Bag	1	0-1
Conditioned to Zone 1	M86 Charge 2	1	1-2
" "	M86 Charge 3	1	0-1
Conditioned Green Bag	M86 Charge 2	1	0-1
" "	M86 Charge 3	1	0-1

Table 4

EFFECT OF CHARGE LOCATION - LOT 63316

Rd. No.	Position of Charge	Mus. Vel fps	Piezo Equiv. Press, psi	Avg. for 3rd Group	
				Vel, fps	Press, psi
1	Touching Mushroom Head	1573	9100		
2	" "	1585	9700	1584	9400
3	" "	1593	9400		
4	Advanced 4 inches	1609	10,000		
5	" "	1578	9200	1592	9500
6	" "	1588	9300		
7	Advanced 8 inches	1588	8800		
8	" "	1587	9300	1573	8800
9	" "	1573	8400		
10	Advanced 12 inches	1585	9100		
11	" "	1594	9100	1591	9200
12	" "	1593	9400		
13	Advanced 16 inches	1582	9200		
14	" "	1577	9100	1586	9300
15	" "	1600	9500		
16	Advanced 20 inches	1584	9400		
17	" "	1579	9100	1580	9200
18	" "	1576	9000		
19	Advanced 24 inches	1695	12,300		
20	" "	1610	9900	1651	10,800
21	Advanced 24 inches	1637	10,100		
22	Advanced 28 inches	1635	10,200		
23	" "	1620	10,200	1643	10,500
24	" "	1674	11,100		
25	Advanced 32½ inches	1701	12,600		
26	" "	1695	11,600	1701	12,300
27	" "	1708	12,700		
28	Touching Mushroom Head	1705	12,700		
29	" "	1717	12,900	1679	11,800
30	" "	1615	9900		

NOTE: All rounds conditioned to 70°F

Table 5

ZONE 1 CONDITIONING EFFECT
AND IGNITION MODIFICATIONS

FIRED 25 MAY 1963

M86 Standard Chg. (4 ounce Base Pad) Prop. Lot 63312			M86 Standard Chg. w/4 oz. Supplement (Total 8 oz. Base Pad) Prop. Lot 63316			M86E1 Charge w/2 oz. Supplement (Total 6 oz. Base Pad) Prop. Lot 64297		
Rd. No.	Vel - fps	Press - psi	Rd. No.	Vel - fps	Press - psi	Rd. No.	Vel - fps	Press - psi
1	1741	14,100						
2	1748	14,300						
3	1764	15,000						
4	1767	15,100	5	1768	14,700	6	1735	13,300
7	1753	14,300	8	1749	14,300	9	1717	13,000
10	1720	13,100	11	1719	12,900	12	1675	11,500
13	1713	12,900	14	1696	11,600	15	1696	12,400
16	1698	12,300	17	1690	12,000	18	1685	11,400
19	1685	12,200	20	1672	11,800	21	1688	12,000
22	1680	11,600	23	1674	11,600	24	1677	11,800
25	1680	11,900	26	1678	11,700	27	1654	10,700
28	1662	11,100	29	1656	11,000	30	1665	11,200
31	1663	11,400	32	1655	11,000	33	1655	10,900
34	1664	11,400						
35	1683	12,000						
36	1661	11,600						
37	1665	11,400	38	1684	12,100	39	1688	11,900
40	1685	11,500	41	1667	11,100	42	1687	12,000
43	1683	11,800	44	1678	11,800	45	1694	11,900
46	1686	11,800	47	1666	11,500	48	1675	11,700
49	1674	11,600	50	1672	11,700	51	1684	12,100
52	1687	11,400	53	1666	11,600	54	1678	11,500
55	1662	11,300	56	1673	11,300	57	1684	11,700
58	1667	11,600	59	1660	11,400	60	1678	11,600
61	1667	11,300	62	1665	11,300	63	1682	11,800
64	1677	11,600	65	1666	11,500	66	1663	10,900

SUMMARY

	M86 Std. Charge Prop. Lot 63312		M86 Std. Charge w/4 oz. supplement Prop. Lot 63316		M86E1 Charge w/2 oz. Supplement Prop Lot 64297	
	Vel - fps	Press - psi	Vel - fps	Press - psi	Vel - fps	Press - psi
AM-RDS 4-33						
Average	1702	12,600	1696	12,300	1685	11,800
Max. Disp.*	105	4,000	113	3,700	81	2,600
Std. Dev.	>30	-	>30	-	>25	-
PE-Succ Diff	11.1	-	11.9	-	10.2	-
PM-RDS 37-66						
Average	1675	11,500	1670	11,500	1681	11,700
Max. Disp.*	25	500	24	1,000	31	1,200
Std. Dev.	9.6	180	7.1	290	8.5	340
PE-Succ Diff	9.1	-	8.2	-	7.5	-

NOTE: All rounds conditioned to 70°F.

* Maximum dispersion or spread.

Table 6

Charge Establishment - Summary

Prop Lot & Web	Nr. Rds.	Chg Wt. Lbs.	Velocity fps	Max. Disp. fps	Std Dev fps	Pressure psi
64216	3	22	1885	22	-	17,000
.057 inch	3	18	1737	11	-	16,500
	3	14	1521	4	-	12,700
	9	16.80	1666	29	10.6	14,000
33854	3	10	1264	64	-	8,600
.047 inch	3	12	1403	8	-	10,900
	3	14	1529	15	-	13,400
	7	15.85	1554	12	4.3	11,000
60446	3	12	1389	2	-	10,400
.037 inch	3	14	1510	8	-	12,400
	3	16	1624	6	-	14,400
	7	17	1680	4	1.7	14,900

Table 7

NEW TUBE (1st Qtr.) CONDITIONING AND UNIFORMITY TEST - Charge 1

Rd. No.	Mus. Vel. fps	Pressure psi	Rd. No.	Mus. Vel. fps	Pressure psi
Green Bag					
1	1657	16,000	21	1635	14,400
2	1636	14,300	22	1638	14,200
3	1636	13,900	23	1631	13,800
4	1634	14,500	24	1631	14,200
5	1634	14,600	25	1635	14,000
6	1630	14,200	26	1634	13,700
7	1636	14,400	27	1634	14,200
8	1636	14,200	28	1636	14,200
9	1633	14,400	29	1629	13,800
10	1637	14,300	30	1632	14,100
11	1633	13,900	M86 Charge		
12	1631	13,700	31	1546	8,400
13	1634	14,100	32	1567	9,000
14	1632	13,800	33	1557	8,000
15	1632	13,900	34	1560	8,600
16	1641	14,200	35	1566	8,700
17	1636	14,000	36	1565	8,500
18	1633	13,900	37	1567	8,600
19	1634	14,100	38	1561-	8,400
20	1629	14,000	39	1574	8,600
			40	1565	8,500

GREEN BAG - Prop Lot 60446 at 16 lbs.
M86 - Prop Lot 63312 at 20.58 lbs.

Weather - Clear

Temperature - 17.7°C.

Humidity - 52%

Winds - NW 8-14

New Tube No. 714

M437 Inert Shell

M73 Dummy Fuze

Fired 22 June 1963

	Green Bag Charge Prop. Lot 60446			M86 at Zone 1 Prop. Lot 63312
Nr. of Rds.	30	29		10
Velocity, Avg. fps	1,635	1,634		1,563
Max. Disp, fps	28	12		28
Std Dev, fps	-	2.7		7.5
S-Succ Diff, fps	-	2.4		7.0
Pressure, psi	14,200	14,100		8,600
Max, Disp., psi	-	900		600
Std. Dev. psi	-	240		190

Table 8

MODIFIED ROTATING BAND - FIRED AT CHARGE 1

Charge Prop Lot/Web. Chg. Wt.	Green Bag 60446/ .037 16.0 lbs.	M86 (Std) 63312/.071 20.58 lbs.
Nr. Rds.	10	10
Velocity, Avg. fps	1660	1623
Max. Disp, fps	17	106
Std Dev., fps	4.9	30.6
Std Dev - Succ Diff, fps	3.1	26.5
Pressure, psi	14700	9700
Max. Disp, psi	1400	1400
Std Dev, psi	210	520
Shell seating	60 3/8-60 9/16	60 3/8-60 9/16

Fired 22 June 1963

NOTES:

1. All M437 shell have modified rotating band
2. Rounds fired alternately

TABLE 9

GREEN BAG CHARGE IN WORN TUBE

Rd. No.	Charge	Vel., fps	Press., psi	Prop. Lot	Chg. Wt.	Temp. °F.
1	M86	1,596	9,700	63,312	20.58 lbs.	70
2	Green Bag	1,626	15,100	60,446	16.0 lbs.	
3	M86	1,590	9,600			
4	Green Bag	1,627	14,600			
5	M86	1,611	10,000			
6	Green Bag	1,625	15,100			
7	M86	1,587	9,300			
8	Green Bag	1,625	14,600			
9	M86	1,590	9,800			
10	Green Bag	1,626	14,700			
11	M86	1,600	9,600			
12	Green Bag	1,630	14,800			
13	M86	1,591	9,500			
14	Green Bag	1,629	14,600			
15	M86	1,581	9,200			
16	Green Bag	1,626	15,100			
17	M86	1,576	9,100			
18	Green Bag	1,625	14,700			
19	M86	1,583	9,200			
20	Green Bag	1,629	14,600			

SUMMARY

	Green Bag	M86
Velocity, fps	1,627	1,591
Max. Var., fps	5	35
Std. Dev., fps	2.1	10.3
Pressure, psi	14,800	9,500
Max. Var., psi	500	900

Tube No. 713
Fired July 1, 1963

TABLE 10

EXTREME TEMPERATURE TEST - NEW TUBE

Temperature, F	Green Bag Charge Lot 60446 Chg. Wt. 16.60 lbs. Vel. fps.	Press. psi	M86 Charge Lot 63312 Chg. Wt. 20.58 lbs. Vel. fps	Press. psi
70	1,654	15,900	1,584	9,300
70	1,655	15,600	1,583	9,400
70	1,656	15,400	1,548	8,300
70	1,662	15,700	1,563	8,900
70	1,659	15,300	1,555	8,600
70	1,653	15,200	1,540	8,800
70	1,655	15,300	1,556	8,800
-40	1,638	14,500	1,511	8,600
-40	1,632	14,000	1,503	8,400
-40	1,638	14,600	1,494	8,300
-40	1,630	14,700	1,483	8,300
-40	1,633	14,600	1,492	8,200
-40	1,636	14,400	1,485	8,200
-40	1,637	14,800	1,485	8,200
125	1,670	14,800	1,564	8,300
125	1,669	15,200	1,560	8,700
125	1,664	15,400	1,569	8,700
125	1,665	15,700	1,565	8,700
125	1,668	15,600	1,572	8,900
125	1,668	15,600	1,554	8,600
125	1,667	15,500	1,555	8,500

Tube No. 714
Fired July 3, 1963

SUMMARY

Temp. °F	Charge	Avg. Vel. fps	Max. Disp	Std. Dev.	Press., psi	Max. Disp. psi	Nr. Ros.
70	Green Bag	1,656	8	3.2	15,500	700	7
70	M86	1,561	44	16.7	8,900	1,100	7
-40	Green Bag	1,635	8	3.2	14,500	800	7
-40	M86	1,493	28	8.5	8,300	400	7
125	Green Bag	1,667	6	2.2	15,400	900	7
125	M86	1,563	18	6.8	8,600	600	7

TABLE 11

SUMMARY OF FIRINGS WITH LIVE SHELL

Charge Tube	No. Rds.	Velocity, fps			Pressure, psi		
		Avg.	Max. Disp.	Std. Dev.	Avg.	Max. Disp.	Std. Dev.
A. Range Program - fired 19 July 1963							
Green Bag - new	18	1,667	8	2.1	15,600	1,100	400
B. Conditioning - fired 20 July 1963							
M86 Chg. 3 - new	5	3,019	9	---	52,200	2,000	---
Green Bag - new	10	1,675	12	3.3	15,700	1,000	330
M86 Chg. 3 - new	5	3,023	11	---	51,800	2,300	---
M86 Chg. 2 - new	5	2,292	33	---	21,400	2,200	---
Green Bag - new	10	1,673	7	2.3	15,300	800	280
M86 Chg. 2 - new	5	2,284	15	---	20,600	1,100	---
C. Worn Tube fired 22 July 1963							
Green Bag - 70°F worn	10	1,667	6	2.1	14,800	1,100	380
Green Bag - -65°F worn	8	1,637	3	1.3	13,700	700	220
Green Bag - 140°F worn	10	1,688	8	2.6	15,600	700	220

TABLE 12

ROUND BY ROUND DATA - FIRINGS WITH LIVE SHELL

Purpose of Test	Charge	Propellant	Temp. °F	Test Rd. No.	Vel., fps	Press., psi
Range Firing 19 July 1963	Green Bag	60446 at 16.9 lbs.	70	1*	1,675	17,000
				2*	1,676	16,300
				3	1,670	16,500
				4	1,668	15,700
				5	1,666	15,800
				6	1,666	15,700
				7	1,668	15,600
				8	1,662	15,600
				9	1,667	15,400
				10	1,665	15,500
				11	1,664	15,700
				12	1,665	15,600
				13	1,665	15,500
				14	1,668	15,800
				15	1,666	15,700
				16	1,663	15,400
				17	1,665	15,600
				18	1,669	15,700
				19	1,666	15,500
				20	1,664	15,500
Conditioning Program 20 July 1963	M86 Charge 3	63318	70	22	3,022	52,300
				23	3,016	51,500
				24	3,025	52,100
				25	3,016	51,800
				26	3,016	53,500
	Green Bag	60446	70	27	1,682	16,300
				28	1,678	16,000
				29	1,676	15,800
				30	1,676	16,000
				31	1,672	15,500
				32	1,675	15,800
				33	1,676	15,500
				34	1,670	15,300
				35	1,670	15,300
				36	1,672	15,700
	M86 Charge 3	63318	70	37	3,022	15,300
				38	3,017	51,100
				39	3,025	53,200
				40	3,028	52,400
				41	3,025	50,900
	M86 C Charge 2	63310	70	42	2,316	23,000
				43	2,285	20,900
				44	2,297	21,300
				45	2,283	20,800
				46	2,283	20,800
	Green Bag	60446	70	47	1,677	15,000
				48	1,674	15,700
				49	1,672	15,500
				50	1,670	15,000
				51	1,671	15,100
				52	1,670	15,400
				53	1,675	15,200
				54	1,671	15,300
				55	1,675	15,100
				56	1,677	15,000

TABLE 12 (Cont'd)

Purpose of Test	Charge	Propellant	Temp. °F	Test Rd. No.	Vel., fps	Press., psi
	M86 Charge 2	63310	70	57	2,283	20,300
				58	2,283	20,300
				59	2,285	21,300
				60	2,278	20,200
				61	2,293	20,800
Worn Tube Safety Test 22 July 1963	Green Bag	60446	70	62	1,667	14,600
				63	1,665	15,100
				64	1,665	15,200
				65	1,668	14,800
				66	1,663	14,800
				67	1,669	14,800
				68	1,669	15,300
				69	1,669	14,200
				70	1,667	14,200
				71	1,665	14,600
			-65	72	1,637	13,800
				73	1,636	13,500
				74	1,637	13,300
				75	1,639	14,000
				76	1,636	13,600
				77**	1,654	15,100
				78	1,639	13,700
				79	1,637	13,800
				80	1,639	13,800
				81**	1,658	15,200
			140	82	1,685	15,600
				83	1,686	15,700
				84	1,693	16,100
				85	1,686	15,500
				86	1,687	15,500
				87	1,691	15,600
				88	1,686	15,600
				89	1,687	15,400
				90	1,690	15,400
				91	1,689	15,900

* Rounds 1 and 2 not used in summary of (range) data because of long delay between rounds 2 and 3.

** Rounds 77 and 81 not used in summary of data. These two rounds rammed 1/2 and 3/8 inch further than remaining 8 cold rounds, and gave a significantly different velocity and pressure.

TABLE 13

SUMMARY OF UNIFORMITY DATA FOR GREEN BAG CHARGE FOR 175MM GUN

NEW TUBE

No. Rds.	Chg. Wt.	Temp., °F.	Vel., fps	Vel. Std. Dev.	Press. psi	Test
7	17.0	70	1,680	1.7	14,900	Chg. estab.
29	16.0	70	1,634	2.4	14,100	Conditioning
7	16.6	70	1,656	3.2	15,500	New Tube Temp. Extremes
7	16.6	-40	1,635	3.2	14,500	
7	16.6	125	1,667	2.2	15,400	
18*	16.9	70	1,667	2.1	15,600	
10*	16.9	70	1,673	2.3	15,300	Zone 2 & 3 Conditioning
10*	16.9	70	1,675	3.3	15,700	

WORN TUBE

10	16.0	70	1,627	2.1	14,800	Worn Tube Uniformity
10*	16.9	70	1,667	2.1	14,800	
8*	16.9	-65	1,637	1.3	13,700	Worn Tube Temp. Extremes
10*	16.9	140	1,688	2.6	15,600	

* Fired with HE loaded shell.

APPENDIX B

FIGURES

Velocity vs. Round No. for M86 and M86E1
Fired at Charge 1

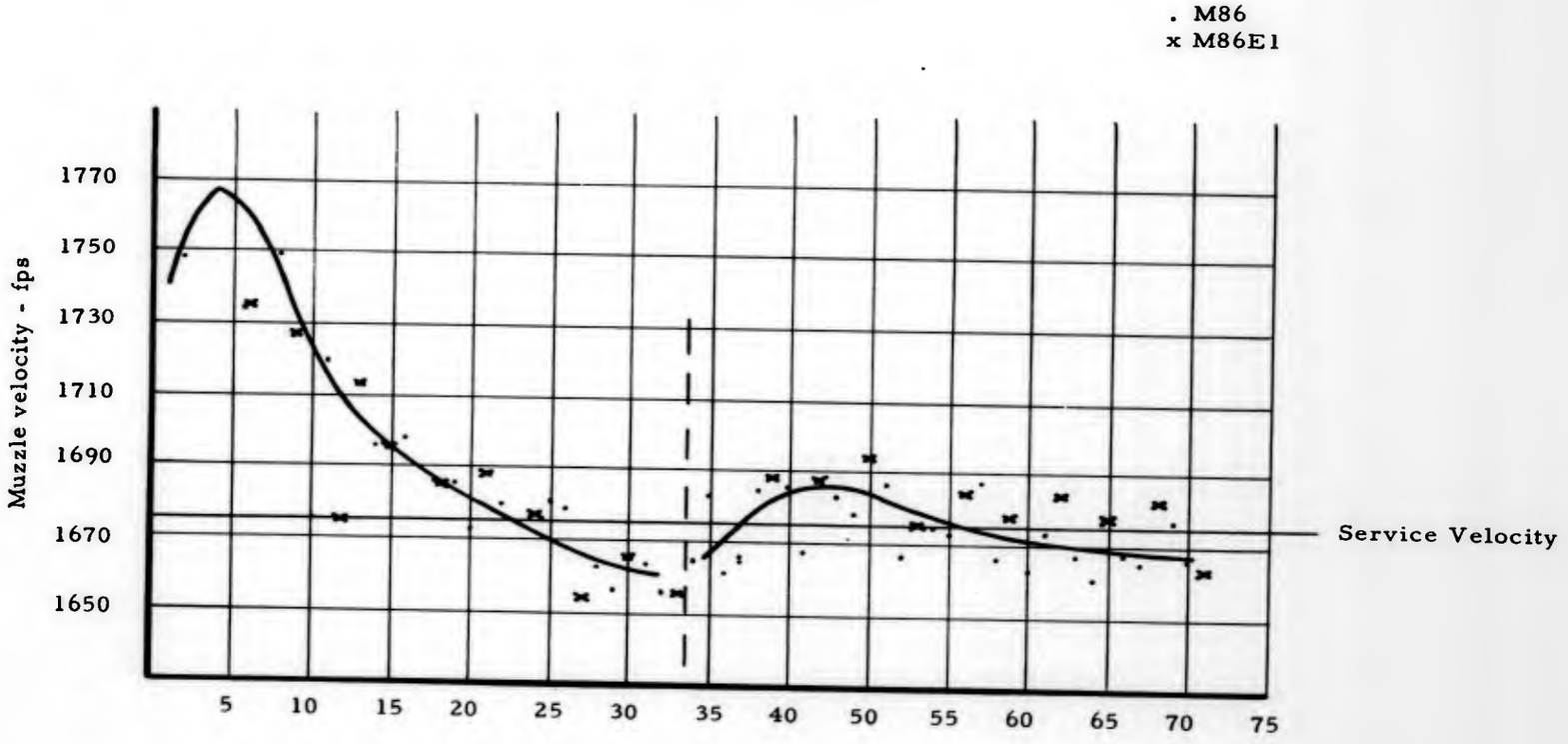

Figure 1

Pressure vs. Travel for Green Bag
Velocity vs. Travel for Green Bag

175mm Gun
w = 147 lbs
M6 Propellant
c = 17 lbs
web = 0.037 in. (M.P.)

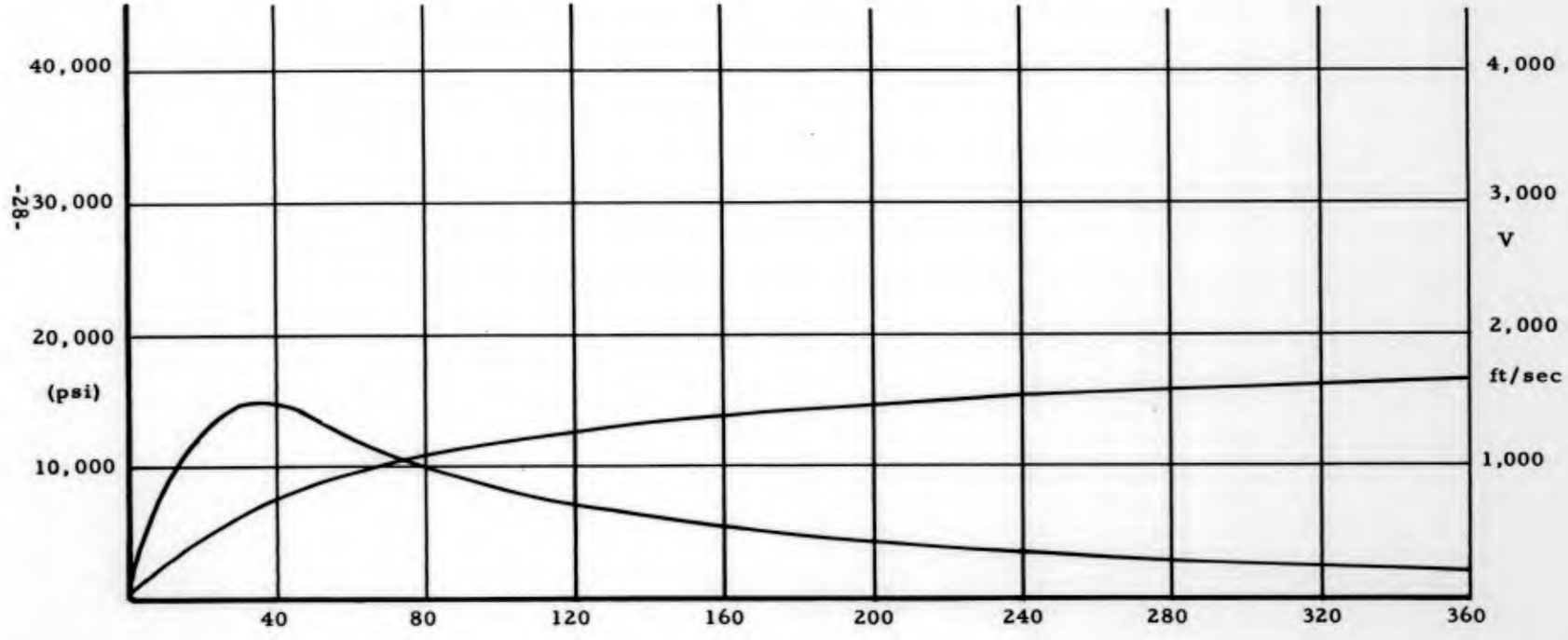

Figure 2

Pressure vs. Time for Green Bag
Velocity vs. Time for Green Bag

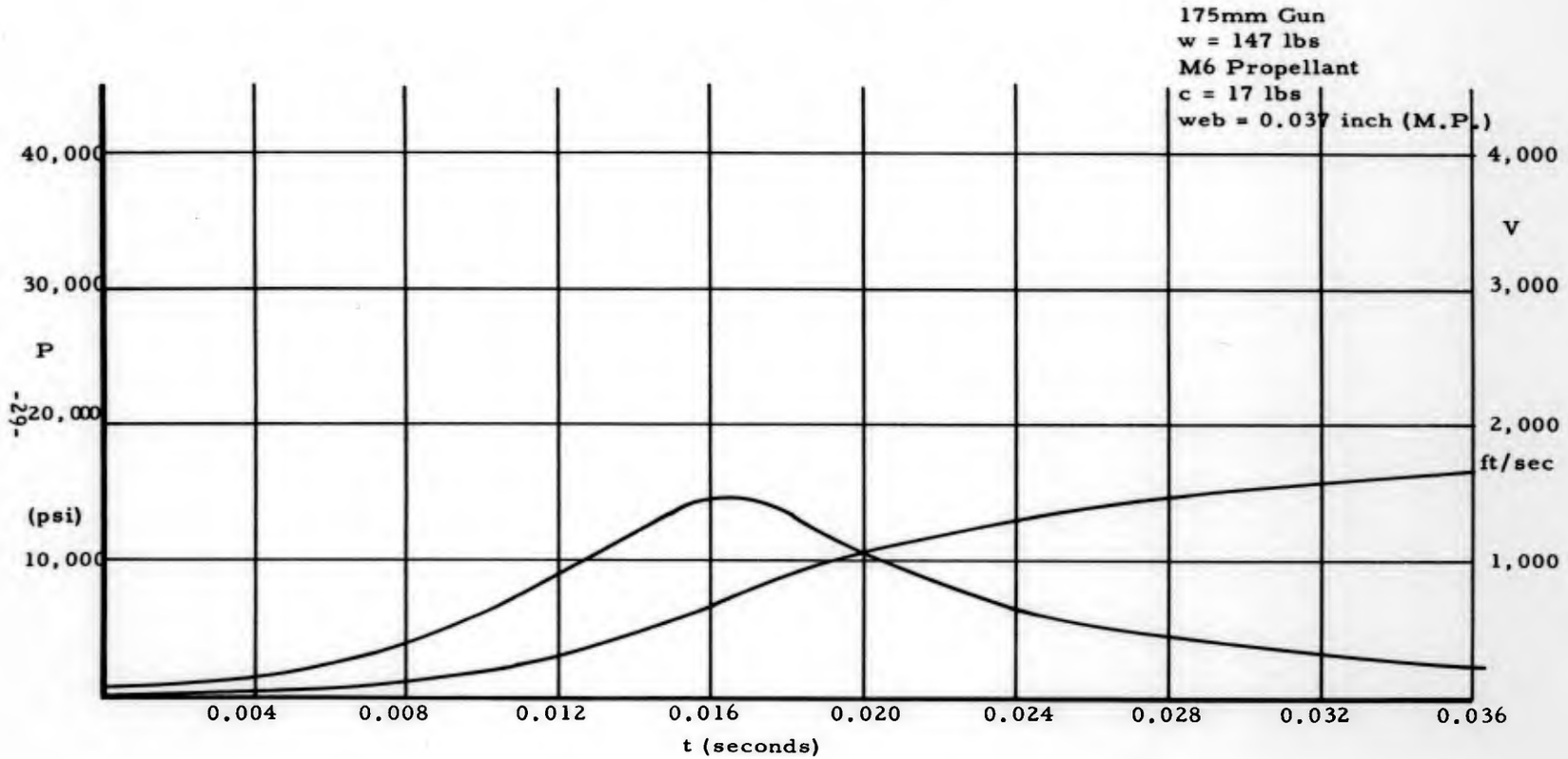

Figure 3

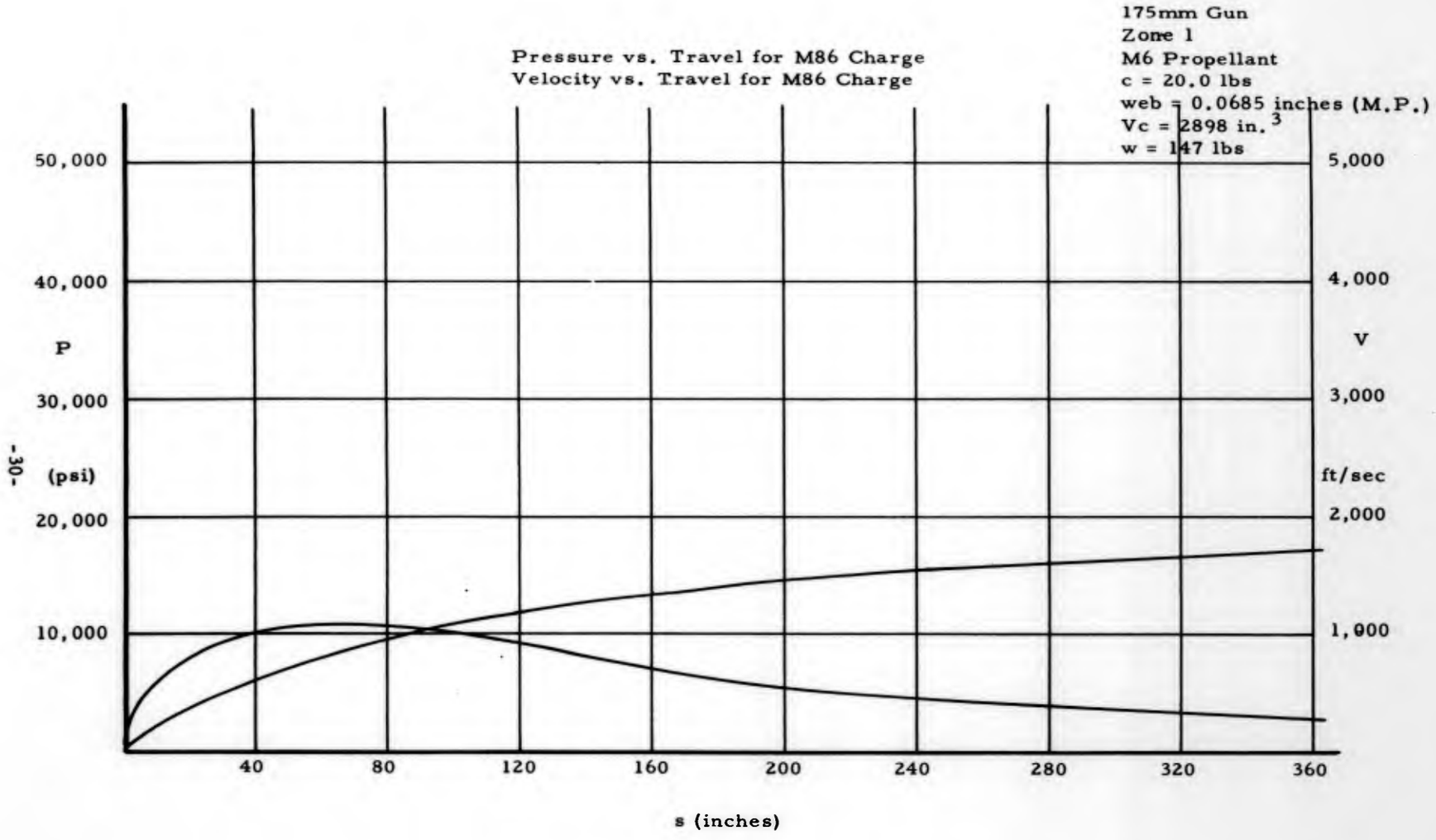
Pressure vs. Travel for M86 Charge
Velocity vs. Travel for M86 Charge
175mm Gun
Zone 1
M6 Propellant
c = 20.0 lbs
web = 0.0685 inches (M.P.)
Vc = 2898 in.3
w = 147 lbs
50,000
40,000
P
30,000
(psi)
20,000
10,000
5,000
4,000
V
3,000
ft/sec
2,000
1,000
40
80
120
160
200
240
280
320
360
s (inches)

Figure 4

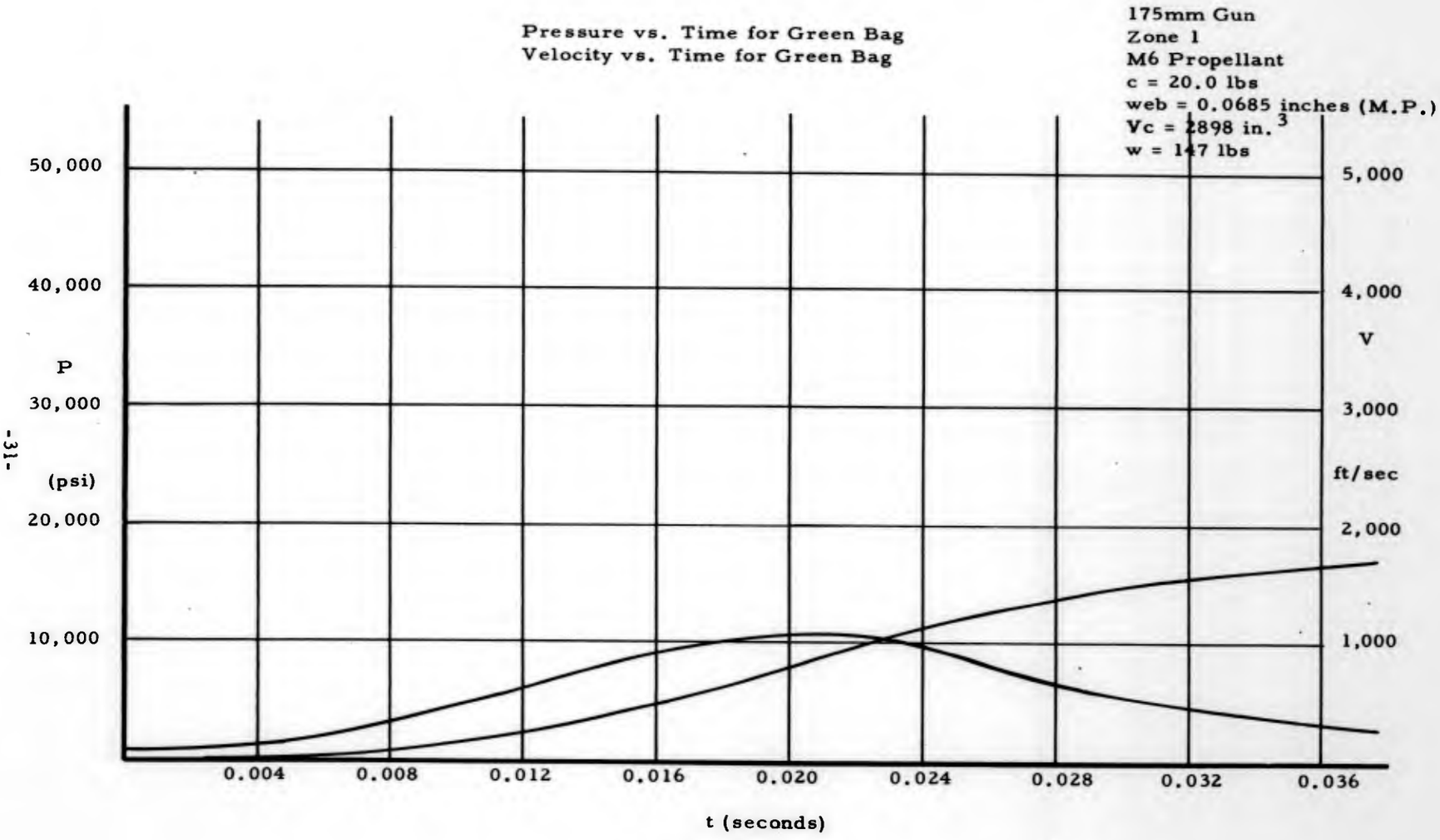
Pressure vs. Time for Green Bag
Velocity vs. Time for Green Bag
175mm Gun
Zone 1
M6 Propellant
c = 20.0 lbs
web = 0.0685 inches (M.P.)
Vc = 2898 in.3
w = 147 lbs
50,000
40,000
P
30,000
(psi)
20,000
10,000
5,000
4,000
V
3,000
ft/sec
2,000
1,000
0.004
0.008
0.012
0.016
0.020
0.024
0.028
0.032
0.036
t (seconds)

Figure 5

Velocity vs. Round No. for Green Bag
Velocity vs. Round No. for M86 Charge

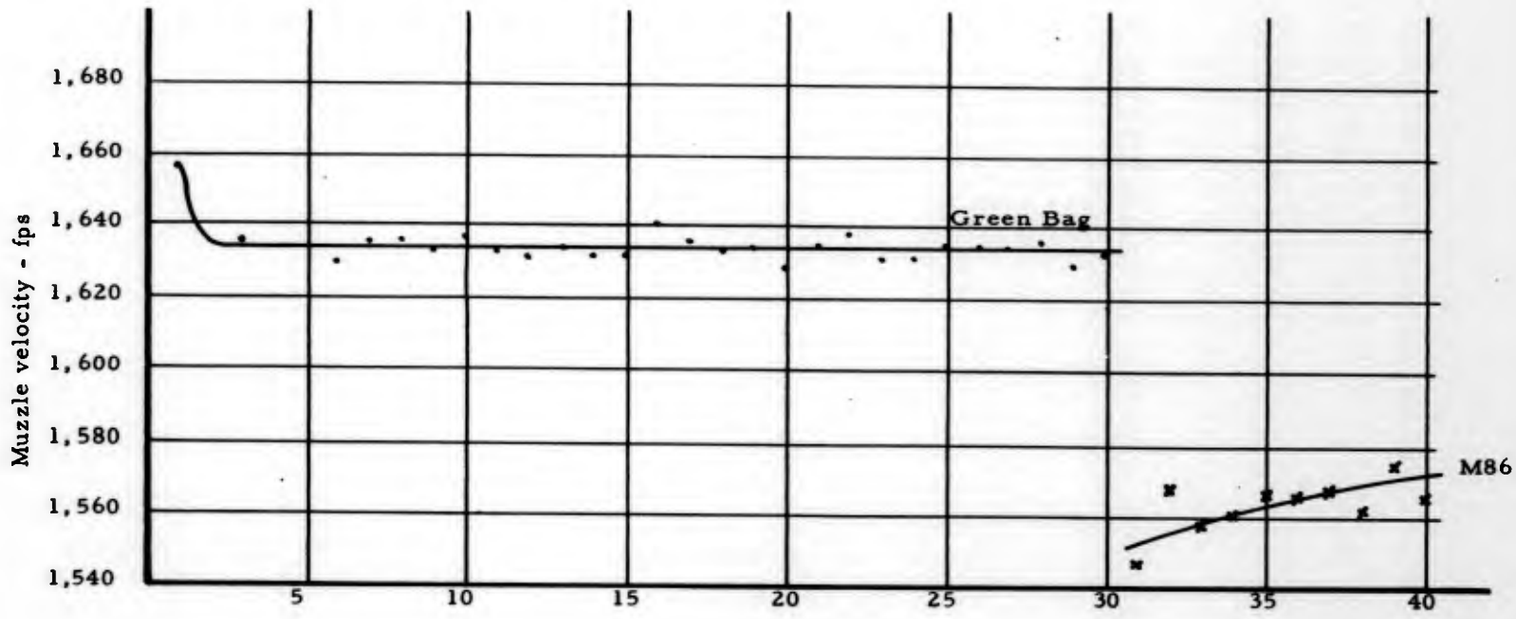

Figure 6

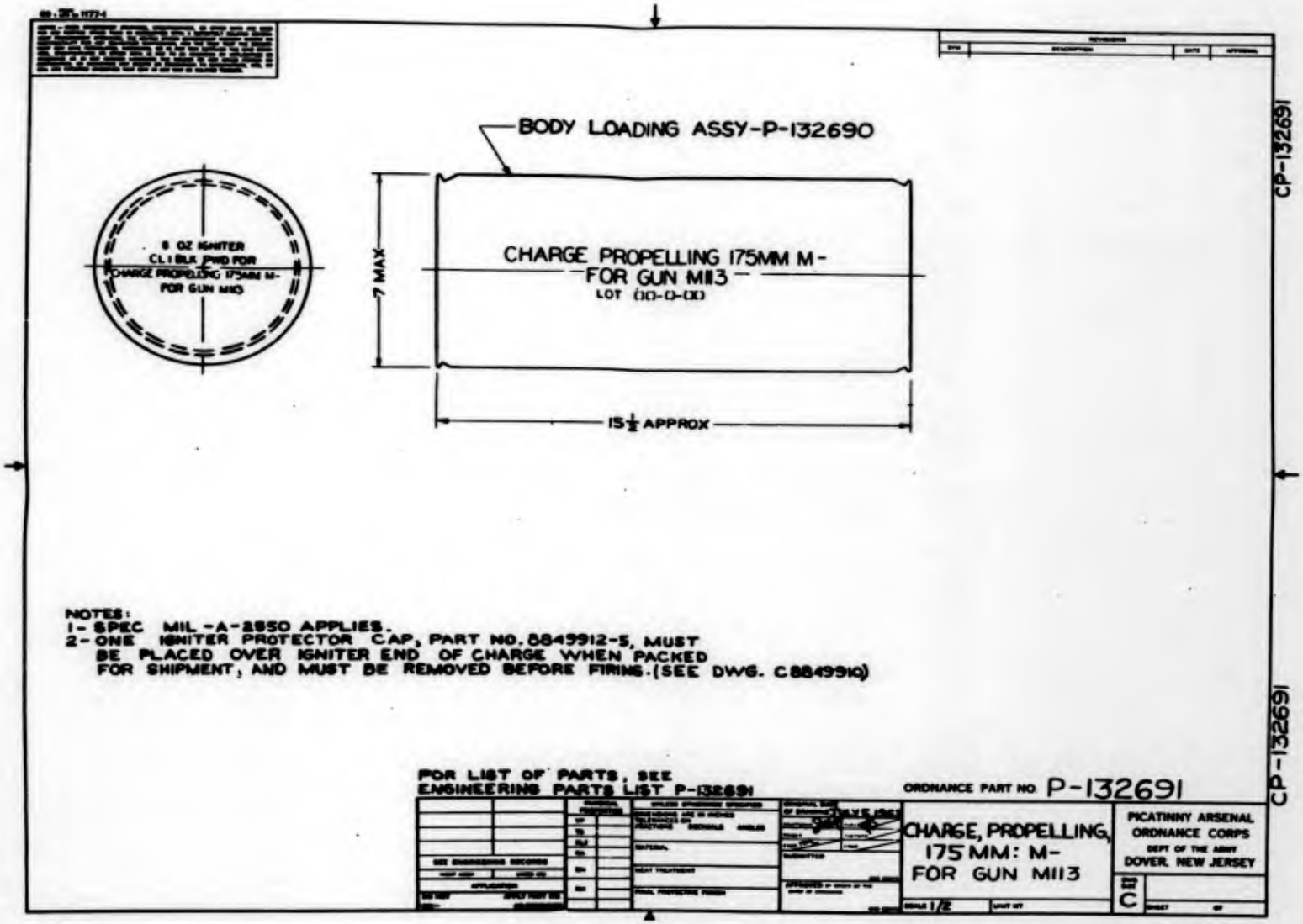
BODY LOADING ASSY-P-132690
8 OZ IGNITER
CLIBLK PWD FOR
CHARGE PROPELLING 175MM M-
FOR GUN M113
7 MAX
CHARGE PROPELLING 175MM M-
FOR GUN M113
LOT (00-0-00)
15½ APPROX
CP-132691
CP-132691
NOTES:
1- SPEC MIL-A-2550 APPLIES.
2- ONE IGNITER PROTECTOR CAP, PART NO. 8849912-5, MUST BE PLACED OVER IGNITER END OF CHARGE WHEN PACKED FOR SHIPMENT, AND MUST BE REMOVED BEFORE FIRING. (SEE DWG. C8849910)
FOR LIST OF PARTS, SEE ENGINEERING PARTS LIST P-132691
ORDNANCE PART NO. P-132691
CHARGE, PROPELLING, 175 MM: M- FOR GUN M113
PICATINNY ARSENAL
ORDNANCE CORPS
DEPT OF THE ARMY
DOVER, NEW JERSEY
SIZE C

Figure 7

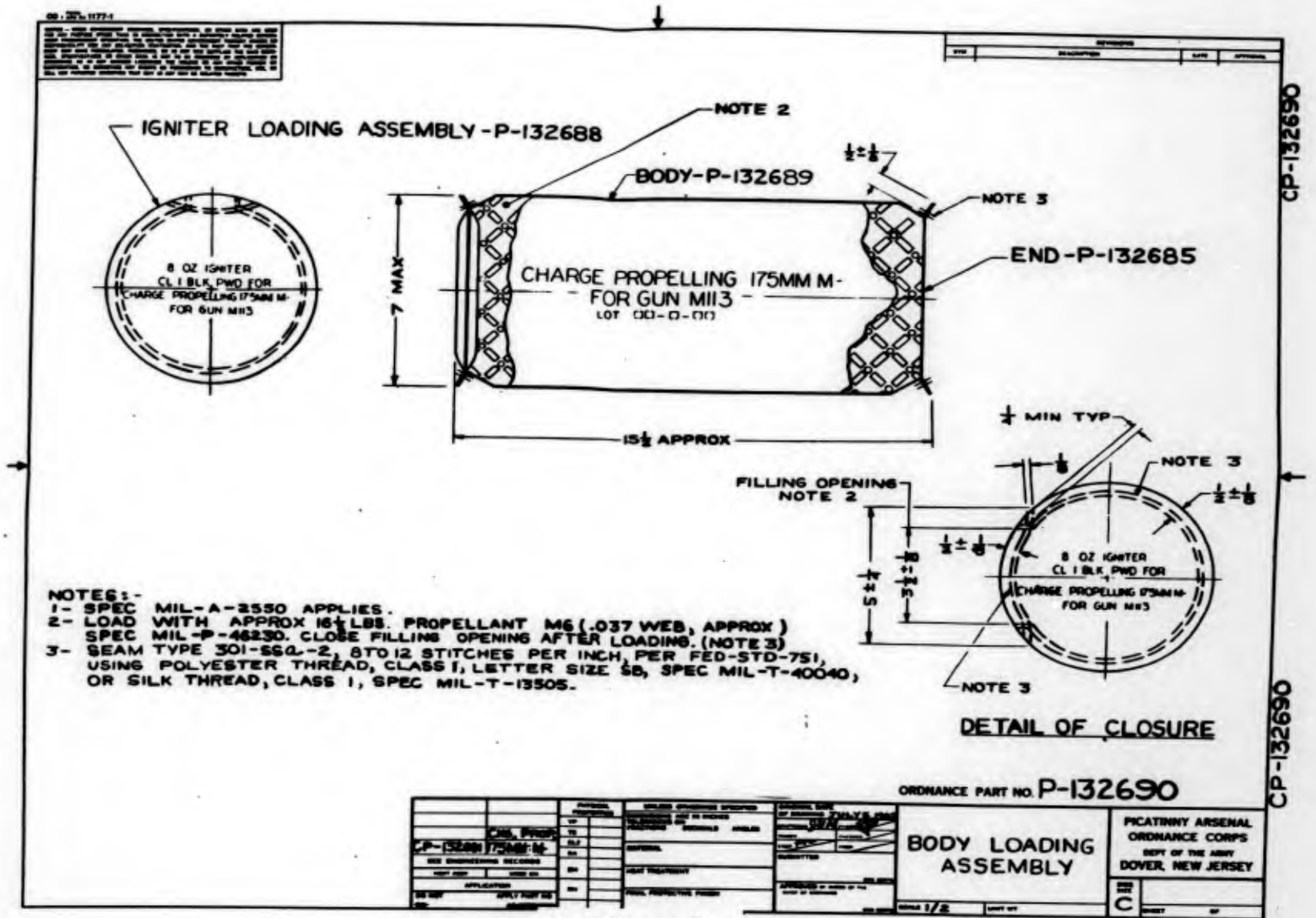
IGNITER LOADING ASSEMBLY - P-132688
NOTE 2
BODY-P-132689
NOTE 3
END-P-132685
8 OZ IGNITER CL 1 BLK PWD FOR CHARGE PROPELLING 175MM M- FOR GUN M113
7 MAX
CHARGE PROPELLING 175MM M- FOR GUN M113
LOT 00-0-00
15½ APPROX
¼ MIN TYP
NOTE 3
FILLING OPENING NOTE 2
8 OZ IGNITER CL 1 BLK PWD FOR CHARGE PROPELLING 175MM M- FOR GUN M113
NOTE 3
NOTES:-
1- SPEC MIL-A-3550 APPLIES.
2- LOAD WITH APPROX 16½ LBS. PROPELLANT M6 (.037 WEB, APPROX) SPEC MIL-P-46230. CLOSE FILLING OPENING AFTER LOADING. (NOTE 3)
3- SEAM TYPE 301-SSa-2, 8 TO 12 STITCHES PER INCH, PER FED-STD-751, USING POLYESTER THREAD, CLASS 1, LETTER SIZE SB, SPEC MIL-T-40040, OR SILK THREAD, CLASS 1, SPEC MIL-T-13505.
DETAIL OF CLOSURE
ORDNANCE PART NO. P-132690
BODY LOADING ASSEMBLY
PICATINNY ARSENAL ORDNANCE CORPS DEPT OF THE ARMY DOVER, NEW JERSEY
SIZE C
SCALE 1/2
CP-132690
CP-132690

Figure 8

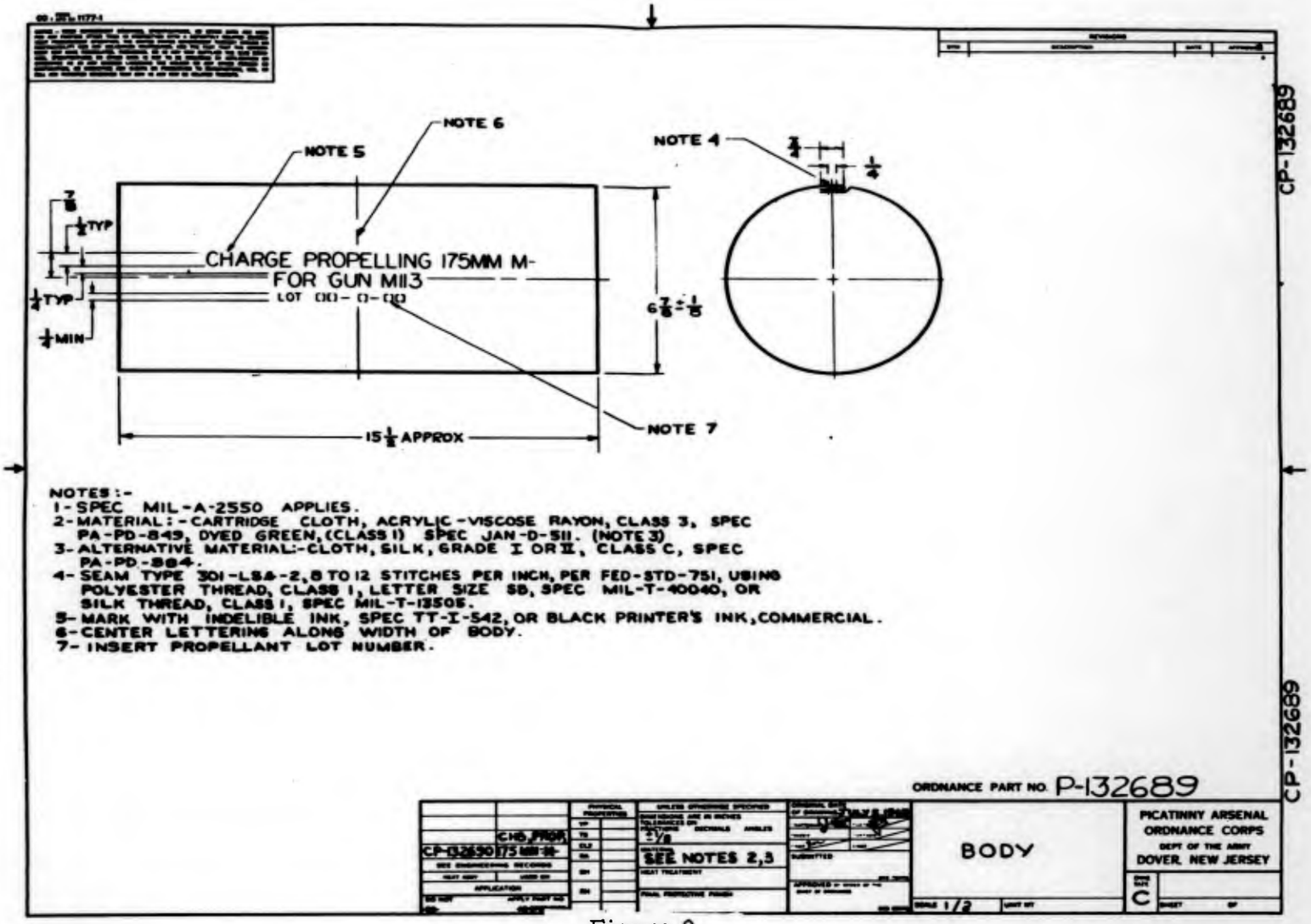
NOTE 6
NOTE 5
NOTE 4
CHARGE PROPELLING 175MM M-
FOR GUN M113
LOT [X]- []- [Z]
NOTE 7
15½ APPROX
CP-132689
CP-132689
NOTES:-
1-SPEC MIL-A-2550 APPLIES.
2-MATERIAL:-CARTRIDGE CLOTH, ACRYLIC-VISCOSE RAYON, CLASS 3, SPEC PA-PD-849, DYED GREEN, (CLASS 1) SPEC JAN-D-511. (NOTE 3)
3-ALTERNATIVE MATERIAL:-CLOTH, SILK, GRADE I OR II, CLASS C, SPEC PA-PD-884.
4-SEAM TYPE 301-LSA-2, 8 TO 12 STITCHES PER INCH, PER FED-STD-751, USING POLYESTER THREAD, CLASS 1, LETTER SIZE SB, SPEC MIL-T-40040, OR SILK THREAD, CLASS 1, SPEC MIL-T-13505.
5-MARK WITH INDELIBLE INK, SPEC TT-I-542, OR BLACK PRINTER'S INK, COMMERCIAL.
6-CENTER LETTERING ALONG WIDTH OF BODY.
7-INSERT PROPELLANT LOT NUMBER.
ORDNANCE PART NO. P-132689
SEE NOTES 2,3
BODY
PICATINNY ARSENAL
ORDNANCE CORPS
DEPT OF THE ARMY
DOVER, NEW JERSEY
C

Figure 9

1181-1

APPLICATION		AP-132685
NEXT ASSY	USED ON	
CP-132690	CHG. PROD. 175MM:M-	
SEE ENGINEERING RECORDS		
DO NOT ~~APPLY~~	APPLY PART NO ~~AS SPECIFIED~~	

REVISIONS

SYM	DESCRIPTION	DATE	APPROVAL

END

6 7/8 ± 1/8 DIA

NOTES:-

1 - SPEC MIL-A-2550 APPLIES.

2 - MATERIAL:- CARTRIDGE CLOTH, ACRYLIC-VISCOSE RAYON, CLASS 3, SPEC PA-PD-849, DYED GREEN, (CLASS 1) SPEC JAN-D-511. (NOTE 3)

3 - ALTERNATIVE MATERIAL:- CLOTH, SILK, GRADE I OR II, CLASS C, SPEC PA-PD-384.

ORDNANCE PART NO. P-132685

AP-132685

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ON.

ORIGINAL DATE OF DRAWING JUL 5 1963

DRAWN JBK CHECKED

TRACED CHECKED

ENGR

MATERIAL SEE NOTES 2 3

HEAT TREATMENT

FINAL PROTECTIVE FINISH

SUBMITTED ORD CORPS

APPROVED BY ORDER OF THE CHIEF OF ORDNANCE ORD CORPS

Figure 10

END

-36-

SCALE UNIT WT

PICATINNY ARSENAL
ORDNANCE CORPS
DEPT OF THE ARMY
DOVER, NEW JERSEY

DWG SIZE A

SHEET OF

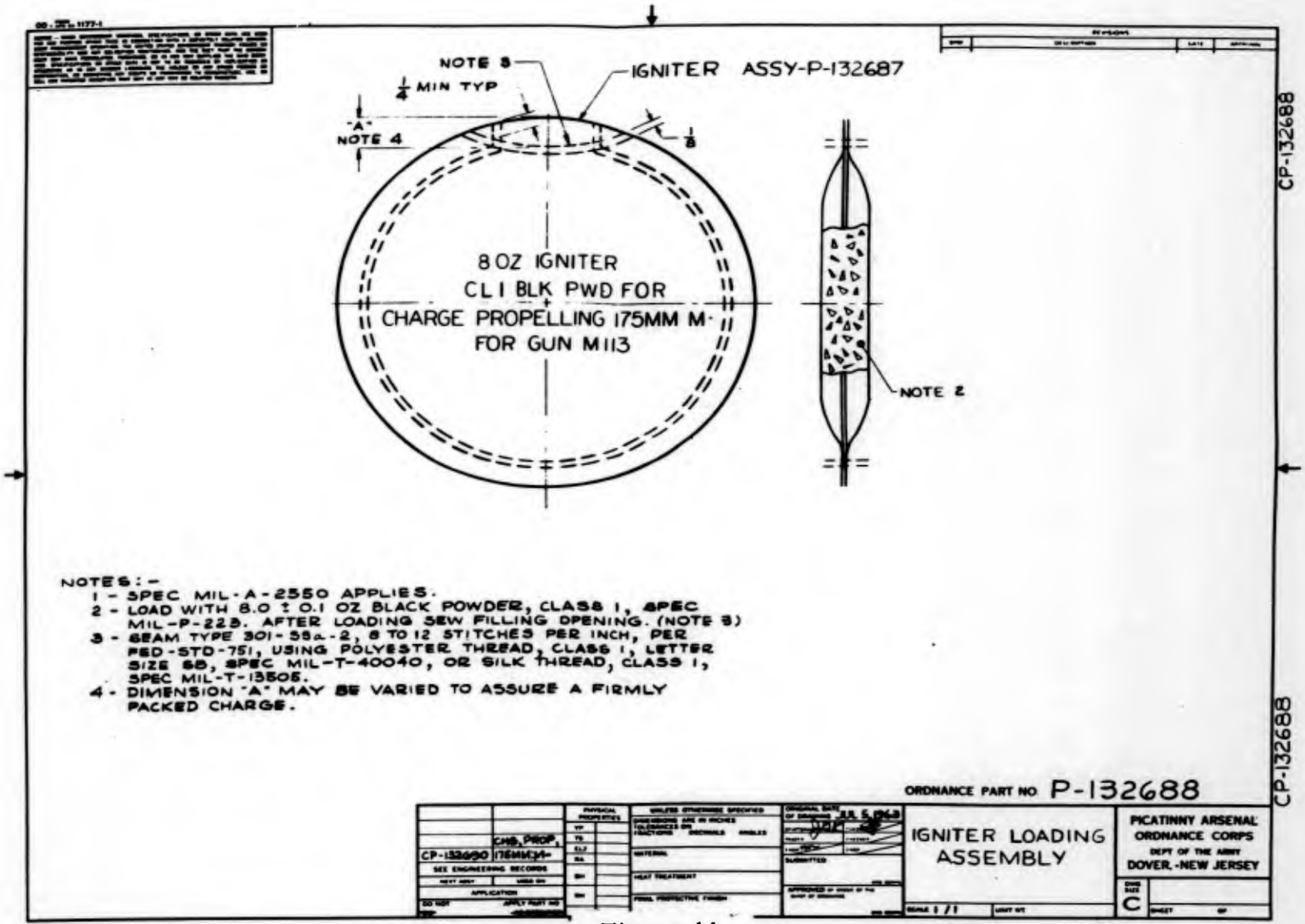
NOTE 3
IGNITER ASSY-P-132687
¼ MIN TYP
"A"
NOTE 4
⅛
8 OZ IGNITER
CL 1 BLK PWD FOR
CHARGE PROPELLING 175MM M
FOR GUN M113
NOTE 2
CP-132688
CP-132688
NOTES:-
1 - SPEC MIL-A-2550 APPLIES.
2 - LOAD WITH 8.0 ± 0.1 OZ BLACK POWDER, CLASS 1, SPEC MIL-P-223. AFTER LOADING SEW FILLING OPENING. (NOTE 3)
3 - SEAM TYPE 301-SSa-2, 8 TO 12 STITCHES PER INCH, PER FED-STD-751, USING POLYESTER THREAD, CLASS 1, LETTER SIZE 6B, SPEC MIL-T-40040, OR SILK THREAD, CLASS 1, SPEC MIL-T-13505.
4 - DIMENSION "A" MAY BE VARIED TO ASSURE A FIRMLY PACKED CHARGE.
ORDNANCE PART NO P-132688
IGNITER LOADING ASSEMBLY
PICATINNY ARSENAL
ORDNANCE CORPS
DEPT OF THE ARMY
DOVER, NEW JERSEY
C

Figure 11

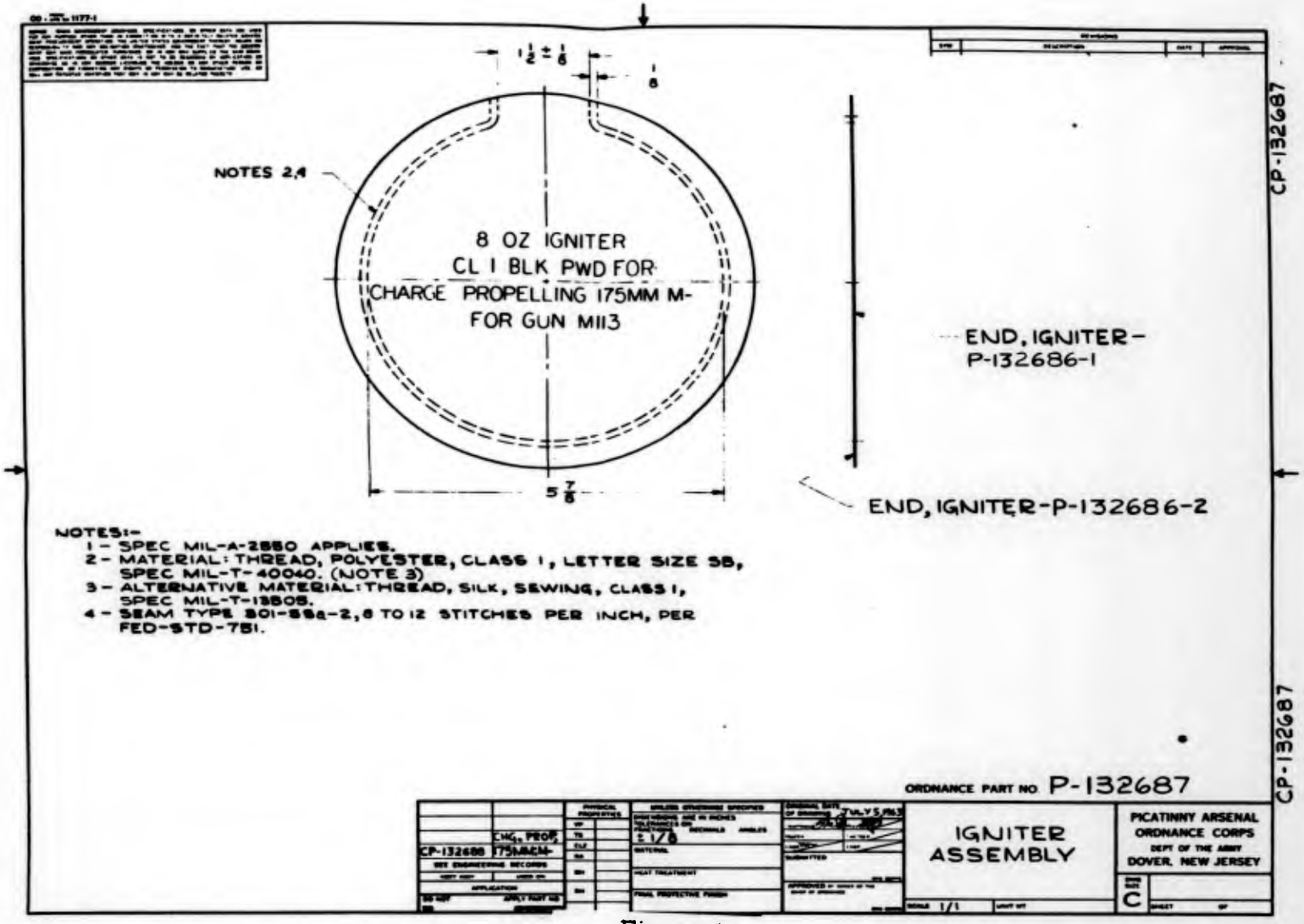
NOTES 2,4
8 OZ IGNITER
CL 1 BLK PWD FOR
CHARGE PROPELLING 175MM M-
FOR GUN M113
END, IGNITER-
P-132686-1
END, IGNITER-P-132686-2
CP-132687
CP-132687
NOTES:-
1 - SPEC MIL-A-2550 APPLIES.
2 - MATERIAL: THREAD, POLYESTER, CLASS 1, LETTER SIZE 5B, SPEC MIL-T-40040. (NOTE 3)
3 - ALTERNATIVE MATERIAL: THREAD, SILK, SEWING, CLASS 1, SPEC MIL-T-13808.
4 - SEAM TYPE 301-SSa-2, 8 TO 12 STITCHES PER INCH, PER FED-STD-751.
ORDNANCE PART NO. P-132687
IGNITER ASSEMBLY
PICATINNY ARSENAL
ORDNANCE CORPS
DEPT OF THE ARMY
DOVER, NEW JERSEY
C

Figure 12

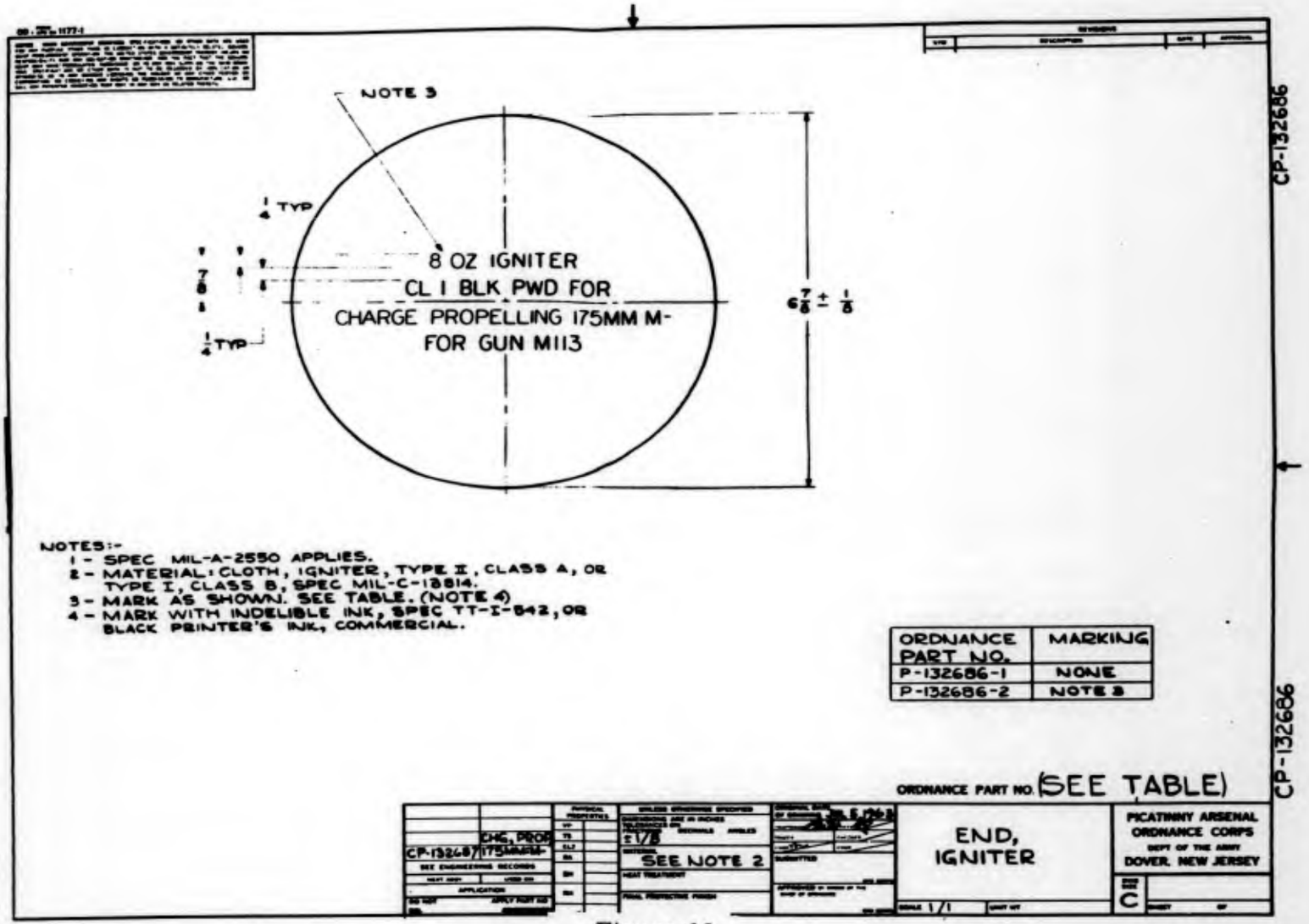
NOTE 3
1/4 TYP
7/8
1/4 TYP
8 OZ IGNITER
CL I BLK PWD FOR
CHARGE PROPELLING 175MM M-
FOR GUN M113
6 7/8 ± 1/8
CP-132686
CP-132686
NOTES:-
1 - SPEC MIL-A-2550 APPLIES.
2 - MATERIAL: CLOTH, IGNITER, TYPE II, CLASS A, OR TYPE I, CLASS B, SPEC MIL-C-13814.
3 - MARK AS SHOWN. SEE TABLE. (NOTE 4)
4 - MARK WITH INDELIBLE INK, SPEC TT-I-542, OR BLACK PRINTER'S INK, COMMERCIAL.
ORDNANCE PART NO. | MARKING
P-132686-1 | NONE
P-132686-2 | NOTE 3
ORDNANCE PART NO. (SEE TABLE)
CHG. PROP
CP-13268/175MM M-
SEE ENGINEERING RECORDS
APPLICATION
±1/8
SEE NOTE 2
END, IGNITER
PICATINNY ARSENAL
ORDNANCE CORPS
DEPT OF THE ARMY
DOVER, NEW JERSEY
SIZE C
SCALE 1/1

Figure 13

APPENDIX C

LETTERS

UNITED STATES ARMY
PICATINNY ARSENAL
DOVER, NEW JERSEY Mr. KRussell/mk/6297

IN REPLY
REFER TO:

14 Aug 1963

Ammo Engr Directorate
SMUPA-DE1

SUBJECT: Green Bag Charge for Zone 1 175mm Gun

TO: Commanding General
U.S. Army Munitions Command
ATTN: AMSMU, Mr. E. Rainier
Dover, New Jersey

REFERENCE: 1st Ind, P.A. to MUCOM, Subject: Ammo for 175mm Weapon System, dated 31 July 1963

1. As briefly reported in reference, a green bag charge has been developed for increment one for the 175mm Gun. This charge represents a significant performance improvement as compared to firing Charge 1 of the M86 Propelling Charge. This Arsenal recommends that immediate actions be taken to determine user position on needs for Zone 1; and to obtain a designation and initiate plan for production in the event that the user should desire this charge.

2. The development of a green bag charge was based on the inability of the M86 Charge at Zone 1 to give reproducible muzzle ballistics. As background information, the problems were (a) an extensive conditioning effect (20 to 25 rounds) and (b) relatively high velocity variation even in a warm gun. Several ignition variables were tested, none of which significantly improved either situation. The inability to reproduce muzzle ballistics resulted in relatively high range probable errors as have been noted in firings by both APG and the USAAB at Fort Sill. A completely separate charge, specially tailored to the low zone of fire was the only apparent solution to the problem.

3. Approximately 150 rounds have been fired in the green bag charge testing program. In summary, ballistic reproducibility, both round to round and occasion to occasion, has been excellent. Pertinent comments follow:

a. Conditioning effect - Is virtually non-existent. None or one round starting with a cold tube, or a tube previously firing M86 at Charge 2 or 3, is required to give a stable velocity level. Conversely,there is little or no conditioning effect when changing from the green bag charge to Charge 2 or 3 with the M86 Propelling Charge.

b. Uniformity - The observed standard deviation on velocity for the green bag charge has varied from 1.7 to 3.3 fps. The over-all grand average to date is 2.3 fps. This compares to standard deviations on the order of 12 fps under optimum conditions with Zone 1 of the M86 Charge.

c. Range Accuracy - Consistent with velocity, a significant improvement in range probable error data is obtained. At 70% maximum range for Charge 1, the PE for green bag charge is 20 to 25 meters as compared with 60 to 200 meters for M86 Charge 1.

d. Extreme Temperature - Performance is good and not different from data obtained under ambient conditions. The temperature effect is approximately 2 fps per 10^{o}F.

e. Worn Tube - Performance is the equal of new tube performance. Loss in velocity is approximately 10 fps over tube life as defined by 400 Charge 3 firings.

4. The (green bag) charge design is relatively simple. Propellant is loose loaded to a cylindrical development. Ignition is by means of a base pad containing 8.0 ounces of A1 Black Powder. The propellant is an M6, web of 0.037 inches MP at the approximate charge weight of 17 lbs. Excess Ordnance stocks show 5.5 million pounds of this propellant, or enough for approximately 320,000 charges. Three charges can be packed in the metal container standard for the M86 Charge. Based on the use of Ordnance stocks of propellant, the green bag charge could be produced for the approximate "out-of-pocket" cost of $7.00 each. The corresponding cost for a Zone 1, M86 Charge is approximately $55.00, since for each Zone 1 firing, Zones 2 and 3 are discarded. It is clear, therefore, that, despite the usual reluctance to issue a separate green bag charge, there is a substantial economic advantage in doing so in this case, at least for training rounds.

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5. This Arsenal has prepared drawings and draft specifications for the green bag charge. No additional firings are intended with the exception of USAAB tests at Fort Sill. These tests have been postponed until resolution of premature problem (reference). A technical report on this program will be issued in the near future. In the interim, detailed results of tests to date can be provided on request.

FOR THE COMMANDER: s/ D. KATZ
D. KATZ
Assistant

HEADQUARTERS
UNITED STATES ARMY MUNITIONS COMMAND
DOVER, NEW JERSEY - 07801

AMSMU-RE-EE

SUBJECT: Short Range Capability of 175mm Gun

TO: Commanding General
U.S. Army Materiel Command
ATTN: AMCRD-DW
Washington 25, D. C.

1. On 16 May 1963 this Command was advised by the Test and Evaluation Command that during the confirmatory test of the 175mm Projectile, M437, range dispersions were obtained during Charge 1 firings which were unacceptable. Expeditious development of an improved Charge 1 was recommended.

2. Because of the excellent ballistic performance in the higher zones (Charges 2 and 3), and since any change in Charge 1 would degrade this performance, no change to the M86 design itself was considered.

3. The inability of the M86 Charge to give reproducible ballistics is due primarily to the extensive conditioning effect (20-25 rounds) experienced before anything approaching a ballistic equilibrium is obtained. A completely separate green bag charge, specially tailored to the low zone of fire was the only apparent solution to this problem.

4. In the green bag testing program, 135 rounds have been fired. A summary of the test results is inclosed. Ballistic reproducibility, both round to round and occasion to occasion, has been excellent. Pertinent comments follow:

a. Conditioning effect:- Is virtually non-existent. None, or at most, one round starting with a cold tube, or a tube previously firing the M86 at Charge 2 or 3, is required to give a stable velocity level. Conversely, there is little or no conditioning effect when changing from the green bag charge to Charge 2 or 3 of the M86 Propelling Charge.

b. Uniformity - The observed standard deviation on velocity for the green bag charge has varied from 1.7 to 3.3. fps. The over-all grand average to date is 2.3 fps. This compares to standard deviations on the order of 12 fps under optimum conditions with Charge 1 of the M86 Charge.

c. Range Accuracy - Consistent with velocity, a significant improvement in range probable error data is obtained. At 70% maximum range, the PE for green bag charge is 20 to 25 meters as compared with 60 to 200 meters for the M86 Charge 1.

d. Extreme Temperature - Performance is good and not different from data obtained under ambient conditions. The temperature effect is approximately 2 fps per 10^{o}F.

e. Worn Tube - Performance is the equal of new tube performance. Loss in velocity is approximately 10 fps over tube life as defined by 400 Charge 3 firings.

5. The green bag charge design is relatively simple. Propellent is loose loaded into a cylindrical bag. Ignition is by means of a base pad containing 8.0 ounces of A1 Black Powder. The propellant is an M6, web of 0.037 inches MP at the approximate charge weight of 17 pounds. Excess Ordnance stocks show 5.5 million pounds of this propellant, or enough for approximately 320,000 charges. Three charges can be packed in the metal container standard for the M86 bag Charge. Based on the use of Ordnance stocks of propellant, the green bag charge could be produced for the approximate "out-of-pocket" cost of $7.00 each. The corresponding cost for an M86 Charge 1 is approximately $55 since for each Charge 1 firing, Charges 2 and 3 are discarded. It is clear, therefore, that despite the usual reluctance to issue a separate green bag charge, there is a substantial economic advantage in doing so in this case, at least for training rounds.

6. It is recommended that:

a. A separately issued green bag charge be adopted to meet the short range requirements of the 175mm system. This charge will have the advantage of low cost and will reduce the quantity of M86 Propelling Charges required for training.

AMSMU-RE-EE
SUBJECT: Short Range Capability of 175mm Gun

b. The Combat Development Command be advised of the results of the tests conducted and queried as to the suitability of proceeding on this development through service test and type classification.

c. In the event this approach is favorably received, requirements guidance be provided upon which to base a procurement program.

7. Upon favorable consideration of this approach by higher authority, action will be initiated to complete service testing, recommend type classification, and initiate a production program.

FOR THE COMMANDER:

1 Incl
1. Summary of Firings
(dupe)

CC
CG, TECOM, ATTN: AMSTE-BAF w/incl
CG, AMC, ATTN: AMCPP-MU w/incl
AMCMR
CO, APGA, ATTN: SMUAP-Q
SMUAP-A w/incl

s/JOHN W. SCHRODER
JOHN W. SCHRODER
Colonel, GS
Director of Research & Engineering

ABSTRACT DATA

ABSTRACT

Accession No. _____ AD _____

Picatinny Arsenal, Dover, New Jersey

DEVELOPMENT OF XM124 (GREEN BAG) PROPELLING CHARGE FOR THE 175MM GUN

John J. Vogel, Kenneth Russell

Technical Report 3148, February 1964, 47 pp, figures, tables. Unclassified report from the Process Engineering Laboratory, Ammunition Engineering Directorate.

A green bag charge was developed using an 0.037 web, MP, M6 Propellant at a charge weight of about 17 pounds. Ignition is by means of a base pad containing eight ounces of A1 Black Powder. Ballistic reproducibility, both round to round and occasion to occasion was excellent.

The green bag charge represents a significant performance improvement for Charge 1 for the 175mm Gun.

The green bag charge concept complicates the logistic problem for the 175mm Gun since it can only be provided as a separate (and new) item of issue. However, its use should yield a substantial operational savings particularly for practice or training use.

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