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INDUSTRIAL ENGINEERING DIVISION

Lake City Arsenal
Independence, Missouri

STUDY OF HEAVY PELLET M52A3B1 ELECTRIC PRIMERS

I. E. D. REPORT NR. 61-9



XEROX

PROJECT: OAC 56-184
56-184-1-1

JUNE 1961

\$3.60

Industrial Engineering Division
Lake City Arsenal
Independence, Missouri

STUDY OF HEAVY PELLET M52A3BL ELECTRIC PRIMERS


Industrial Engineering Division
Report No. 61-9

Project No. OAC 56-184
Subproject No. OAC 56-184-I-1


June 1961

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I. ABSTRACT

The purpose of this test program was to determine what effect heavy weight pellets in M52A3B1 electric primers would have on the pressure level of 20mm M55 Ball ammunition loaded with WC 870 ball propellant. The normal pellet weight selected was 2.75 gr. and the heavy pellet weight was 3.00 gr. No significant difference in pressure levels was observed for the pellet weight difference considered.

II. INTRODUCTION

Control of pellet weight in the electric primer M52A3B1 became of primary importance with the introduction of the Gatling-type, high cyclic rate, electrically operated automatic weapon for use in aircraft.

A method was developed for control of the lower limit in the permissible pellet weight range to insure freedom from light weights, which were known to be a cause of long action time. Such control was then made a primer specification requirement.

No formal specification provisions were made, however, for the control of the upper limit of the pellet weight range as no malfunctioning or other undesirable ballistics was anticipated from overweight pellets of the magnitude expected.

Subsequently work was conducted at Frankford Arsenal on pellet weight versus pressure in weight ranges around 4.0 grains and dangerously high chamber pressures were developed.

It was therefore concluded that an investigation of pellet weight versus pressure in the weight range from 3.0 to 3.5 grains should be conducted. This weight range was chosen because 3.0 grains was the maximum permitted on the applicable drawing (74-2-79). It had also been determined previously in studies conducted by both the Olin-Mathieson Chemical Corporation and the Remington Arms Company that the maximum weight which might be expected, even when pellet weight controls during manufacture where in the upper range, was approximately 3.25 grains.

This program was then undertaken to determine whether more positive manufacturing controls should be applied to the upper limit of primer pellet weight, and whether a requirement for such control should be added to the electric primer specification, OAC-PD-28.

III. PROCEDURE

Two groups of M52A3B1 electric primers, having normal (2.75 grains nominal) and heavy (3.00 grains nominal) weight pellets, were obtained from each of two primer manufacturers, Western Cartridge Division, Olin-Mathieson Corp., and Remington Arms Company, Lake City Arsenal. Extreme pellet weight spread, for both normal and heavy weights, was approximately .6 grains. These primers were then assembled into complete rounds and segregated into various subgroups for the required test program, which was divided into two phases.

In the phase I portion of the program the Remington Arms Company-LCA primers were assembled into 20MM M55A1 Ball cartridges using M103 cases,

M55A1 ball projectiles and IMR 7005 type propellant. The propellant charge established (593 grains) for the particular propellant lot to yield service velocity (3380 \pm 50 fps) was used. The same propellant charge was adequate for both normal and heavy weight primer pellets. Identity of the test cartridges having normal primer pellets and those having heavy pellets was maintained using lot number 257A for the normal weight and 257B for the heavy weight. These cartridges were then fired for velocity, pressure and action time at both ambient and cold (-65°F) temperatures.

In the phase II portion of the program the primers of Olin-Mathieson Corp. manufacture were assembled into 20MM M55A1 Ball cartridges using M103 cases and M55A1 projectiles. Loading with IMR 7005 and WC 870 ball types of propellants was accomplished as follows: IMR type, normal and heavy pellet weight primers, 10 cartridges each at 575, 580, 585, 590 and 595 grains; WC 870 ball type, normal and heavy pellet weight primers, 10 each at 595, 600, 605, 610 and 615 grains. These test cartridges were then fired for velocity, pressure and action time, the cartridges for all tests being at ambient temperature. Forty-five (45) cartridges in each of the four primer-propellant categories were loaded to charges established to produce service velocity. Forty cartridges of each group were fired for function in an M39 gun and P-T traces, using a Piezo cage, were obtained on the remaining five cartridges.

IV. RESULTS

The phase II firings for velocity and pressure are graphically compared on charts A and B, while the action time results are shown on chart C. A tabulation of the velocities and pressures, only, for both phases is given below. Complete results are contained in appendix B.

Phase I

<u>IMR 7005</u> <u>Propellant</u>	<u>Temperature</u>	<u>Average</u> <u>Velocity</u> (<u>Corr.</u>)	<u>Average</u> <u>Pressure</u> (<u>Corr.</u>)	<u>Action Time</u>
Normal Primer	Ambient	3394 f/s	50900 psi	2.61 ms
Heavy Primer	Ambient	3416	52150	2.61
Normal Primer	-65°	3360	54000	2.69
Heavy Primer	-65°	3368	52750	*

* Insufficient ammunition was available to complete the action time firings.

Phase II

<u>IMR 7005</u>	<u>575 gr.</u>	<u>580 gr.</u>	<u>585 gr.</u>	<u>590 gr.</u>	<u>595 gr.</u>
Velocity (Corr.)					
Normal Primer	3368 f/s	3388	3409	3429	3446
Heavy Primer	3377	3396	3421	3437	3447
Pressure (Corr.)					
Normal Primer	52340 psi	53740	54780	55720	56430
Heavy Primer	53700	54380	56290	56440	56720
<u>WC 870 Ball</u>	<u>595 gr.</u>	<u>600 gr.</u>	<u>605 gr.</u>	<u>610 gr.</u>	<u>615 gr.</u>
Velocity (Corr.)					
Normal Primer	3346 f/s	3357	3380	3415	3440
Heavy Primer	3315	3334	3360	3382	3392
Pressure (Corr.)					
Normal Primer	48330 psi	48910	51500	53260	54900
Heavy Primer	46430	47180	49040	50270	50890

It will be noted from the above tabulations and the charts covering phase II testing that with IMR type propellant velocity and pressure levels increased in ammunition primed with heavy pellet primers and action time decreased. With the WC ball type propellant, however, the velocity and pressure levels decreased in ammunition primed with heavy pellet primers and there was no significant difference in action time.

Phase I firings conducted at ambient temperatures using the same IMR propellant charge weight for both normal and heavy primer pellet weights also showed higher velocity and pressure levels for the heavy pellet primer. In the cold temperature (-65°F) tests for this phase, however, the pressure levels apparently were reversed and the cartridges having heavy pellet primers had a lower pressure than those with the normal pellet primers. Further, the pressure level of the cartridges with normal primer pellet weight was higher at cold temperature than at ambient temperature. Neither of these results can be explained and possibly are spurious.

The pressure-time traces for the two primer pellet weights using IMR propellant, at ambient temperature, showed no significant differences in either rate of pressure rise or peak pressure. The curves for the WC ball propellant showed a slower rate of rise and a lower peak pressure for the heavy primer pellet as compared with the normal primer pellet.

V. CONCLUSIONS

The results of the various tests conducted using IMR and ball propellants with normal and heavy weight primer pellets demonstrate that no adverse effect, so far as velocity and pressure are concerned, is obtained with heavy weight primer pellets in the range used (max. 3.25 gr.).

Somewhat better ignition was obtained with IMR propellant with the heavier pellet as evidenced by the slight increase in velocity and pressure and lower action time.

With ball propellant, action time remained relatively constant, whereas, there was a slight drop in the velocity and pressure level with the heavier pellet. This may result from a larger amount of unburned propellant being expelled from the barrel because of the increased brisance of the heavier primer pellet. This assumption is based on the fact that with ball powder, under normal conditions, a greater amount of unburned powder is expelled than is the case with IMR propellant. It also may indicate that, with the heavy primer pellet, to obtain the desired velocity level a slight reduction in charge with IMR propellant is possible, whereas, with ball propellant the charge would increase.

VI. RECOMMENDATIONS

The performance of 20MM M55A1 Ball ammunition assembled with primers having heavy weight (3.0 - 3.25 grs) primer pellets indicated that no adverse effect on velocity, pressure or action time results from such overpriming. The limited M39 function firing did not reveal any increased percentage incidence of primer casualties. Therefore, control of the upper limit of the primer pellet weight range is not critical and it is recommended that no formal quality assurance be established for its control.

Establishment of such a quality assurance would increase unnecessarily the cost of the M52A3B1 electric primer.

APPENDIX A
DETAILED FIRING REPORTS AND MISFIRE ANALYSIS

Subject: Test Request Nr. 211259

Object: To determine difference in pressure level of regular and heavy weight pellet M52A3B1 primer of W. C. manufacture.

Lot Nrs: IED 27-261, IMR Propellant
IED 27-262, W. C. 870 Ball Propellant

Dates of Firing: 16 thru 18 July 1957, inclusive

I. Test Procedure

A. Velocity, pressure and action time

1. The test ammunition was loaded as follows:

Number of Rounds		Propellant Type	Army Lot	Charge (Grs.)
Normal Primer	Heavy Primer			
10	10	IMR 7005	41892	575
10	10	IMR 7005	41892	580
10	10	IMR 7005	41892	585
10	10	IMR 7005	41892	590
10	10	IMR 7005	41892	595
10	10	W. C. 870	41940	595
10	10	W. C. 870	41940	600
10	10	W. C. 870	41940	605
10	10	W. C. 870	41940	610
10	10	W. C. 870	41940	615

2. The test was fired through a standard pressure test barrel using standard velocity and pressure procedures.
3. The Aberdeen Proving Ground chronograph was used for instrumentation to record the action time.
4. All phases of the test loaded with IMR type propellant was fired prior to firing the W. C. ball propellant.

B. Piazco; time-pressure

1. The following groups and quantities were fired for time pressure using the Piazco electric gage.

Number of Rounds		Propellant Type	Army Lot	Charge (Grs.)
Normal Primer	Heavy Primer			
5	5	IMR 7005	41892	585
5	5	W. C. 870	41940	610

C. Function and casualty, M39A1 gun

1. The following groups and quantities were fired for primer leaks in the M39A1 gun.

Number of Rounds		<u>Propellant</u> <u>Type</u>	<u>Army</u> <u>Lot</u>	<u>Charge</u> <u>(Grs.)</u>
<u>Normal Primer</u>	<u>Heavy Primer</u>			
40	40	IMR 7005	41892	585
40	40	W. C. 870	41940	610

II. Results

A. See attached sheet.

II. Results

A. Velocity, pressure and action time

IMR Propellant Charge	575 Grs		580 Grs		585 Grs		590 Grs		595 Grs	
	Norm Primer	Hvy Primer	Norm Primer	Hvy Primer	Norm Primer	Hvy Primer	Norm Primer	Hvy Primer	Norm Primer	Hvy Primer
Velocity, f/s	3368	3377	3388	3396	3409	3421	3429	3437	3446	3447
Std. Dev.	15.0	7.0	8.0	10.0	10.0	6.0	7.0	8.0	11.0	7.0
Pressure, psi	52340	53700	53740	54380	54780	56290	55720	56440	56430	56720
Std. Dev.	1400	800	700	1300	800	1100	1000	1000	1200	1200
Av. Action Time m/s	2.63	2.59	2.61	2.55	2.59	2.54	2.57	2.53	2.58	2.53

WC 870 Ball Propellant Charge	595 Grs		600 Grs		605 Grs		610 Grs		615 Grs	
	Norm Primer	Hvy Primer	Norm Primer	Hvy Primer	Norm Primer	Hvy Primer	Norm Primer	Hvy Primer	Norm Primer	Hvy Primer
Velocity, f/s	3346	3315	3357	3334	3388	3360	3415	3382	3440	3398
Std. Dev.	18.0	5.0	20.0	4.0	25.0	12.0	18.0	9.0	19.0	14.0
Pressure, psi	48330	46430	48910	47180	51500	49040	53260	50270	54900	50890
Std. Dev.	1800	700	1700	800	2300	1300	1700	800	1400	1700
Av. Action Time, m/s	2.65	2.63	2.62	2.62	2.59	2.60	2.57	2.58	2.54	2.54

B. Piazzo; time-pressure

	Velocity, f/s	
	Normal Primer	Heavy Primer
Five (5) rounds, IMR Propellant, Charge 585 Grs.	3416	3414
Five (5) rounds, W.C. 870, Ball Propellant, Charge 610 Grs.	3420	3388

Photographs of the time pressure curve are included in this report.

C. Machine gun function and casualty, M39A1 gun

Rounds Fired	Primer	Propellant Type	Results
40	Normal	IMR 7005	Three (3) small escape of gas
40	Heavy	IMR 7005	One (1) very small escape of gas
40	Normal	W.C. 870	Two (2) small escape of gas
40	Heavy	W.C. 870	One (1) small escape of gas

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request Nr.
211253

Nomenclature Elec., 20MM (steel cases) (AMBIENT)	Lot No IED 27-257 Group A (I)	Date Tested
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RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	637	-

VELOCITY F.S.				PRESSURE P.S.I.		Velocity Tested at		78	Feet
DRY		WET				Barometer		29.43	Inches
Corr. Mean				Corr. Mean		FIRING DRY	76	°F	
Mean Inst.	3384			Mean Inst.	50405	ROOM WET	66	°F	
Max. Inst.	3421			Max. Inst.	51800	R. H.	59	%	
Min. Inst.	3360			Min. Inst.	48200	Instrument Room	76	°F	
Ex. Var.	61			Ex. Var.	3600	Ammunition	70	°F	
Std. Dev.	15.0			Std. Dev.	1000	Range Temperature	76	°F	
						Velocity Barrel Corr.	F.S.		
						Pressure Barrel Corr.	P.S.I.		

SHOT No.	DRY		WATERPROOF	VELOCITY IN GAGE	PRESSURE	CHECK AMMUNITION	
						Value	F.S. PSI
1	3363	48500					
2	3385	50900					
3	3387	50200					
4	3360	48200					
5	3379	50600					
6	3377	50600					
7	3386	50700					
8	3419	51400					
9	3395	51500					
10	3377	50300					
11	3368	50500					
12	3381	49200					
13	3381	49600					
14	3379	51000					
15	3369	49200					
16	3378	49800					
17	3421	50600					
18	3386	51500					
19	3396	51500					
20	3387	51800					
Total	67674	1008100					
Mean	3384	50405					

REMARKS:
IMR 7005, AL 41313, Chg. 593.0

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request Nr.
211253

Nomenclature Elec., 20MM (steel cases) (AMBIENT)	Lot No IED 27-257 Group A (II)	Date Tested
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RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	637	-

VELOCITY F.S.				PRESSURE P.S.I.				Velocity Tested at	
DRY		WET						Barometer	Feet
Corr. Mean				Corr. Mean				FIRING DRY	°F
Mean Inst.	3396			Mean Inst.	51200			ROOM WET	°F
Max. Inst.	5416			Max. Inst.	52400			R. H.	%
Min. Inst.	3379			Min. Inst.	48600			Instrument Room	°F
Ex. Var.	37			Ex. Var.	2800			Ammunition	°F
Std. Dev.	12.0			Std. Dev.	800			Range Temperature	°F
								Velocity Barrel Corr.	F.S.
								Pressure Barrel Corr.	P.S.I.

SHOT No.	DRY		WATERPROOF	VELOCITY IN GAGE	PRESSURE	CHECK AMMUNITION	
						Value	F.S. PSI
1	3392	50300					
2	3395	50400					
3	3392	51300					
4	3396	50800					
5	3392	50600					
6	3382	50700					
7	3406	50500					
8	3403	51400					
9	3388	49600					
10	3400	51000					
11	3416	52300					
12	3379	51000					
13	3399	51800					
14	3410	51900					
15	3381	50900					
16	3389	52400					
17	3381	52300					
18	3416	52300					
19	3385	50200					
20	3413	52300					
Total	67915	1024000					
Mean	3396	51200					

REMARKS:

IMR 7005, AL 41313, Chg. 535.0

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request Nr.
211253

Manufacturer Mfg., 20MM (steel cases) (AMBIENT)	Lot No LRD 27-257 Group A (III)	Date Tested
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RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE

VELOCITY F.S.			PRESSURE P.S.I.		Velocity Tested at	
DRY		WET	Barometer		76 Feet	
Corr. Mean			Corr. Mean		29.43	Inches
Mean Inst.	3402		Mean Inst.	50980	FIRING DRY	76 °F
Max. Inst.	3428		Max. Inst.	53400	ROOM WET	66 °F
Min. Inst.	3372		Min. Inst.	47400	R. H.	59 %
Ex. Var.	50		Ex. Var.	5000	Instrument Room	76 °F
Std. Dev.	13.0		Std. Dev.	1200	Ammunition	70 °F
					Range Temperature	76 °F
					Velocity Barrel Corr.	F.S.
					Pressure Barrel Corr.	P.S.I.

SHOT No.	DRY		WATERPROOF	VELOCITY IN GAGE	PRESSURE	CHECK AMMUNITION	
						Value	F.S.
1	3392	50400					
2	3392	51100					
3	3372	47400					
4	3388	49900					
5	3409	50700					
6	3400	51000					
7	3422	52900					
8	3400	49800					
9	3393	50900					
10	3414	52500					
11	3400	51700					
12	3392	50700					
13	3395	51000					
14	3428	53400					
15	3420	50700					
16	3409	51300					
17	3394	50600					
18	3410	50600					
19	3400	51700					
20	3418	51100					
Total	68048	1019600					
Mean	3402	50980					

REMARKS:
IMR 7005, AL 41813, Cng. 503.00

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request Nr.
211253

Nomenclature Elec., 20MM (steel cases) (AMBIENT)	Lot No IED 27-257 Group B (I)	Date Tested
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RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	658	-

VELOCITY F.S.				PRESSURE P.S.I.				Velocity Tested at 78 Feet	
DRY		WET						Barometer 29.43 Inches	
Corr. Mean				Corr. Mean		FIRING DRY 76 °F			
Mean Inst.	3418			Mean Inst.	52260	ROOM WET 66 °F			
Max. Inst.	3438			Max. Inst.	54400	R. H. 59 %			
Min. Inst.	3387			Min. Inst.	49200	Instrument Room 76 °F			
Ex. Var.	51			Ex. Var.	5200	Ammunition 70 °F			
Std. Dev.	11.0			Std. Dev.	1300	Range Temperature 76 °F			
								Velocity Barrel Corr.	F.S.
								Pressure Barrel Corr.	P.S.I.

SHOT No.	DRY		WATERPROOF	VELOCITY IN GAGE	PRESSURE	CHECK AMMUNITION	
						Value	F.S. PSI
1	3387	49200					
2	3429	54400					
3	3411	50900					
4	3422	52400					
5	3420	52300					
6	3428	52000					
7	3414	51600					
8	3415	51800					
9	3415	51100					
10	3424	52200					
11	3417	51800					
12	3417	52400					
13	3397	50300					
14	3410	52700					
15	3421	52400					
16	3418	52900					
17	3430	53900					
18	3428	53000					
19	3438	54300					
20	3423	53600					
Total	68364	1045200					
Mean	3418	52260					

REMARKS:

IMR 7005, AL 41313, Chg. 503.0

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request
Nr. 211253

Nomenclature Elec., 20MM (steel cases) (AMBIENT)	Lot No IED 27-257 Group B (II)	Date Tested
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RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	658	-

VELOCITY F.S.				PRESSURE P.S.I.		Velocity Tested at 78 Feet	
DRY		WET				Barometer 29.43 Inches	
Corr. Mean				Corr. Mean		FIRING DRY 76 °F	
Mean Inst.	3413			Mean Inst.	52035	ROOM WET 66 °F	
Max. Inst.	3430			Max. Inst.	54200	R. H. 59 %	
Min. Inst.	3377			Min. Inst.	48000	Instrument Room 76 °F	
Ex. Var.	53			Ex. Var.	6200	Ammunition 70 °F	
Std. Dev.	16.0			Std. Dev.	1500	Range Temperature 76 °F	
						Velocity Barrel Corr.	F.S.
						Pressure Barrel Corr.	F.S.I.

SHOT No.	DRY		WATERPROOF		VELOCITY IN GAGE	PRESSURE	CHECK AMMUNITION	
							Value	F.S.
1	3428	53200						
2	3422	52700						
3	3420	53300						
4	3377	48000						
5	3396	49600						
6	3423	53000						
7	3425	52600						
8	3395	51700						
9	3423	52400						
10	3415	51400						
11	3414	51000						
12	3430	53000						
13	3421	53800						
14	3424	51800						
15	3417	52100						
16	3403	51400						
17	3379	51200						
18	3424	53500						
19	3429	54200						
20	3396	50800						
Total	68261	1040700						
Mean	3413	52035						

REMARKS:

IMR 7005, AL 41313, Chg. 593.0

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request Nr.
 211253

Nomenclature Elec., 20MM (steel cases) (COLD TEST - CONDITIONED AT -65° F.)	Lot No IED 27-257 Group A (I)	Date Tested
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RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	742	--

VELOCITY F.S.				PRESSURE P.S.I.		Velocity Tested at	
	DRY	WET					78 Feet
Corr. Mean			Corr. Mean		Barometer	29.25	Inches
Mean Inst.	3364		Mean Inst.	54730	FIRING DRY	80	° F
Max. Inst.	3411		Max. Inst.	60000	ROOM WET	70	° F
Mn. Inst.	3331		Mn. Inst.	50700	R. H.	61	%
Ex. Var.	80		Ex. Var.	9300°	Instrument Room	80	° F
Std. Dev.	25.0		Std. Dev.	3000	Ammunition	70	° F
					Range Temperature	80	° F
					Velocity Barrel Corr.		F.S.
					Pressure Barrel Corr.		P.S.I.

SHOT No.	DRY		WATERPROOF		VELOCITY IN GAGE		PRESSURE		CHECK AMMUNITION	
									Value	F.S. / PSI
1	3360	55500								
2	3340	52000								
3	3373	53500								
4	3391	59600								
5	3399	57800								
6	3354	53900								
7	3369	54200								
8	3342	52700								
9	3387	50700								
10	3362	54600								
11	3344	55100								
12	3411	58100								
13	3352	54400								
14	3366	52700								
15	3342	53000								
16	3395	60000								
17	3335	51800								
18	3380	56100								
19	3403	59400								
20	3351	49500								
Total	67287	1094500								
Mean	3364	54730								

REMARKS:

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VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request Nr.
211253

Nomenclature

Elec., 20MM (steel cases)
(COLD TEST - CONDITIONED AT -65° F.)

Lot No

IED 27-257
Group A (II)

Date Tested

RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	742	-

VELOCITY F.S.			PRESSURE P.S.I.		Velocity Tested at	
Corr. Mean	DRY	WET	Corr. Mean		Barometer	
Mean Inst.	3355		Mean Inst.	53505		29.25
Max. Inst.	3391		Max. Inst.	56800	FIRING DRY	80 °F
Min. Inst.	3320		Min. Inst.	49600	FIRING WET	70 °F
Ex. Var.	71		Ex. Var.	7200	ROOM R. H.	61 %
Std. Dev.	18.0		Std. Dev.	2200	Instrument Room	80 °F
					Ammunition	70 °F
					Range Temperature	80 °F
					Velocity Barrel Corr.	F.S.
					Pressure Barrel Corr.	P.S.I.

SHOT No.	DRY		WATERPROOF	VELOCITY IN GAGE	PRESSURE	CHECK AMMUNITION	
						Value	
1	3354	54400					
2	3368	55900					
3	3369	55800					
4	3342	52300					
5	3355	49600					
6	3364	56800					
7	3320	50600					
8	3347	52300					
9	3349	52400					
10	3370	53900					
11	3356	56600					
12	3342	51400					
13	3344	51400					
14	3348	54100					
15	3363	53500					
16	3325	50100					
17	3359	53100					
18	3364	52800					
19	3385	56700					
20	3391	56400					
Total	67095	1070100					
Mean	3355	53505					

REMARKS:

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request Nr.
211253

Nomenclature <p style="text-align: center;">Elec., 20MM (steel cases) (COLD TEST - CONDITIONED AT -65° F.)</p>	Lot No <p style="text-align: center;">IED 27-257 Group A (III)</p>	Date Tested
--	--	-------------

RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	742	-

VELOCITY F.S.				PRESSURE P.S.I.			
DRY		WET		DRY		WET	
Corr. Mean				Corr. Mean			
Mean Inst.	3361			Mean Inst.	53863		
Max. Inst.	3377			Max. Inst.	56100		
Min. Inst.	3341			Min. Inst.	50100		
Ex. Var.	36			Ex. Var.	6000		
Std. Dev.	11.0			Std. Dev.	1900		

Velocity Tested at	78	Feet
Barometer	29.25	Inches
FIRING DRY	80	°F
ROOM WET	70	°F
F. H.	61	%
Instrument Room	80	°F
Ammunition	70	°F
Range Temperature	80	°F
Velocity Barrel Corr.		F.S.
Pressure Barrel Corr.		P.S.I.

SHOT No.	DRY °		WATERPROOF		VELOCITY IN GAGE		PRESSURE		CHECK AMMUNITION	
									Value	
1	3370	54500								
2	3364	56100								
3	3364	56000								
4	3375	56100								
5	3359	54400								
6	3349	55200								
7	3369	54100								
8	3356	52500								
9	3341	50100								
10	3344	54100								
11	3343	51300								
12	3361	52900								
13	3377	53800								
14	3371	55600								
15	3362	50600								
16	3364	54500								
17										
18										
19										
20										
Total	53769	861800								
Mean	3361	53863								

REMARKS:

This last firing is four (4) short of regular test, due to misfires.

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request Nr. 211253

Nomenclature

Elec., 20MM (steel cases)
(COLD TEST - CONDITIONED AT -65° F.)

Lot No

IED 27-257

Date Tested

Group B (I)

RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	762	-

VELOCITY F.S.				PRESSURE P.S.I.		Velocity Tested at	
DRY		WET				78 Feet	
Corr. Mean				Corr. Mean		Barometer	29.25 Inches
Mean Inst.	3369			Mean Inst.	53095	FIRING DRY	80 °F
Max. Inst.	3396			Max. Inst.	56100	ROOM WET	70 °F
Min. Inst.	3354			Min. Inst.	49200	R. H.	61 %
Ex. Var.	42			Ex. Var.	6900	Instrument Room	80 °F
Std. Dev.	11.0			Std. Dev.	1900	Ammunition	70 °F
						Range Temperature	80 °F
						Velocity Barrel Corr.	F.S.
						Pressure Barrel Corr.	P.S.I.

SHOT No.	DRY		WATERPROOF	VELOCITY IN GAGE	PRESSURE	CHECK AMMUNITION	
						Value	F.S. / PSI
1	3356	55600					
2	3396	56100					
3	3389	55700					
4	3369	51100					
5	3364	52600					
6	3361	53000					
7	3376	53000					
8	3364	53300					
9	3354	49200					
10	3368	49900					
11	3378	53800					
12	3371	53700					
13	3365	54000					
14	3380	54100					
15	3363	53600					
16	3382	55900					
17	3355	51100					
18	3363	52400					
19	3364	51600					
20	3354	52200					
Total	67372	1061900					
Mean	3369	53095					

REMARKS:

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Test Request Nr.
211253

Nomenclature

Elec., 20MM (steel cases)
(COLD TEST - CONDITIONED AT -65° F.)

Lot No

IED 27-257
Group B (II)

Date Tested

RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD-SPACE
				Elec.	64	762	-°

VELOCITY F.S.		PRESSURE P.S.I.		Velocity Tested at	
DRY	WET				
Corr. Mean		Corr. Mean		Barometer	78 Feet
Mean Inst.	3367	Mean Inst.	52425		29.25 Inches
Max. Inst.	3397	Max. Inst.	56100	FIRING DRY	80 °F
Min. Inst.	3335	Min. Inst.	47600	ROOM WET	70 °F
Ex. Var.	64	Ex. Var.	8500	R. H.	61 %
Std. Dev.	15.0	Std. Dev.	1900	Instrument Room	80 °F
				Ammunition	70 °F
				Range Temperature	80 °F
				Velocity Barrel Corr.	F.S.
				Pressure Barrel Corr.	P.S.I.

SHOT No.	DRY		WATERPROOF	VELOCITY IN GAGE	PRESSURE	CHECK AMMUNITION	
						Value	F.S. PSI
1	3333	47600					
2	3362	51000					
3	3370	53800					
4	3369	53000					
5	3363	51200					
6	3397	56100					
7	3393	56500					
8	3372	53000					
9	3380	52800					
10	3352	51600					
11	3345	49700					
12	3350	52100					
13	3362	52900					
14	3368	52500					
15	3379	53600					
16	3357	52100					
17	3369	53200					
18	3369	54300					
19	3376	51000					
20	3366	51500					
Total	67332	1048500					
Mean	3367	52425					

REMARKS:

Test Request Nr. 211253

PROPELLANT			LAKE CITY ARSENAL						LOT NO. IED 27-257A					
TYPE	A L NO.	CHG	ACTION TIME - ACCEPTANCE REPORT						PRIMER TYPE M52A3B1					
IMR 7005	41313	593	CALIBER & TYPE						PRIMER LOT NO.					
			Ctg., 20MM, Pall, M55A1						BARREL TYPE Mann					
			SPECIFICATION			REV	AMD	BARR EL NO. 114						
			DATE OF TEST					RDS. ON BARREL 725						
ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	
1	2.72	26	2.61	51	2.72	76	2.72	101		126		151		176
2	2.36	27	2.71	52	2.74	77	2.73	102		127		152		177
3	2.63	28	2.69	53	2.64	78		103		128		153		178
4	2.64	29	2.65	54	2.69	79		104		129		154		179
5	2.45	30	2.75	55	2.60	80		105		130		155		180
6	2.23	31	2.79	56	2.76	81		106		131		156		181
7	2.62	32	2.61	57	2.67	82		107		132		157		182
8	2.65	33	2.76	58	2.70	83		108		133		158		183
9	2.61	34	2.65	59	2.82	84		109		134		159		184
10	2.63	35	2.68	60	2.63	85		110		135		160		185
11	2.72	36	2.76	61	2.66	86		111		136		161		186
12	2.69	37	2.80	62	2.73	87		112		137		162		187
13	2.58	38	2.75	63	2.72	88		113		138		163		188
14	2.69	39	2.69	64	2.66	89		114		139		164		189
15	2.66	40	2.71	65	2.71	90		115		140		165		190
16	2.59	41	2.71	66	2.69	91		116		141		166		191
17	2.73	42	2.73	67	2.84	92		117		142		167		192
18	2.73	43	2.73	68	2.79	93		118		143		168		193
19	2.69	44	2.68	69	2.60	94		119		144		169		194
20	2.74	45	2.59	70	2.80	95		120		145		170		195
21	2.77	46	2.62	71	2.84	96		121		146		171		196
22	2.57	47	2.67	72	2.62	97		122		147		172		197
23	2.68	48	2.65	73	2.62	98		123		148		173		198
24	2.60	49	2.73	74	2.63	99		124		149		174		199
25	2.59	50	2.74	75	2.73	100		125		150		175		200
TOTAL						207.03								
MEAN						2.69								
			RECORD		LIMIT		FIRED BY							
			2.84											
			2.45				RECORDED BY							
EYE VARIATION			.39											
REMARKS														
(COLD TEST - CONDITIONED AT -65° F.)														
Twenty-three (23) rounds failed to fire.														

PROPELLANT			LAKE CITY ARSENAL				LOT NO. IED 27-257B	
TYPE	A L NO.	CHG	ACTION TIME - ACCEPTANCE REPORT				PRIMER TYPE M52A3B1	
IMR 7005	41313	593	CALIBER & TYPE				PRIMER LOT NO.	
			Ctg., 20MM, Ball, M55A1				BARREL TYPE Mann	
			SPECIFICATION		REV	AMD	BARREL NO. 114	
			DATE OF TEST				RDS. ON BARREL 560	
ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME
1 2.77	26 2.57	51	76	101	126	151	176	
2 2.65	27 2.59	52	77	102	127	152	177	
3 2.57	28 2.58	53	78	103	128	153	178	
4 2.60	29 2.61	54	79	104	129	154	179	
5 2.59	30 2.57	55	80	105	130	155	180	
6 2.57	31 2.60	56	81	106	131	156	181	
7 2.59	32 2.62	57	82	107	132	157	182	
8 2.61	33 2.60	58	83	108	133	158	183	
9 2.61	34 2.55	59	84	109	134	159	184	
10 2.58	35 2.67	60	85	110	135	160	185	
11 2.59	36 2.57	61	86	111	136	161	186	
12 2.63	37 2.57	62	87	112	137	162	187	
13 2.67	38 2.58	63	88	113	138	163	188	
14 2.59	39 2.60	64	89	114	139	164	189	
15 2.52	40 2.63	65	90	115	140	165	190	
16 2.58	41 2.77	66	91	116	141	166	191	
17 2.61	42 2.64	67	92	117	142	167	192	
18 2.55	43 2.62	68	93	118	143	168	193	
19 2.53	44 2.66	69	94	119	144	169	194	
20 2.53	45 2.61	70	95	120	145	170	195	
21 2.59	46 2.70	71	96	121	146	171	196	
22 2.60	47 2.64	72	97	122	147	172	197	
23 2.58	48 2.66	73	98	123	148	173	198	
24 2.67	49 2.60	74	99	124	149	174	199	
25 2.69	50 2.61	75	100	125	150	175	200	
TOTAL		130.49						
MEAN		2.61						
MAX	2.77	RECORD	LIMIT	FIRED BY				
MIN	2.52			RECORDED BY				
EXTREME VARIATION	0.25							
REMARKS								
(AMBIENT TEST)								

PROPELLANT			LAKE CITY ARSENAL						LOT NO. IED 27-257A				
TYPE	AL NO.	CHG	ACTION TIME - ACCEPTANCE REPORT						PRIMER TYPE M52A3BI				
IMR 7005	41313	593	CALIBER & TYPE						PRIMER LOT NO.				
			Ctg., 20MM, Ball, M55A1						BARREL TYPE Mann				
			SPECIFICATION						BARREL NO. 114				
			DATE OF TEST						RDS. ON BARREL				
ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME	ACTION TIME
1 2.70	26 2.57	51 2.52	76 2.58	101	126	151	176						
2 2.65	27 2.62	52 2.55	77 2.61	102	127	152	177						
3 2.62	28 2.67	53 2.59	78 2.61	103	128	153	178						
4 2.59	29 2.63	54 2.57	79 2.57	104	129	154	179						
5 2.69	30 2.61	55 2.59	80 2.59	105	130	155	180						
6 2.64	31 2.61	56 2.58	81 2.55	106	131	156	181						
7 2.56	32 2.60	57 2.60	82 2.59	107	132	157	182						
8 2.63	33 2.59	58 2.59	83 2.56	108	133	158	183						
9 2.58	34 2.62	59 2.66	84 2.65	109	134	159	184						
10 2.69	35 2.61	60 2.56	85 2.72	110	135	160	185						
11 2.57	36 2.58	61 2.67	86 2.63	111	136	161	186						
12 2.63	37 2.64	62 2.64	87 2.59	112	137	162	187						
13 2.65	38 2.61	63 2.65	88 2.62	113	138	163	188						
14 2.64	39 2.62	64 2.60	89 2.59	114	139	164	189						
15 2.55	40 2.64	65 2.59	90 2.64	115	140	165	190						
16 2.63	41 2.61	66 2.56	91 2.61	116	141	166	191						
17 2.66	42 2.62	67 2.63	92 2.56	117	142	167	192						
18 2.64	43 2.58	68 2.53	93 2.69	118	143	168	193						
19 2.66	44 2.58	69 2.59	94 2.59	119	144	169	194						
20 2.75	45 2.52	70 2.60	95 2.58	120	145	170	195						
21 2.56	46 2.64	71 2.57	96 2.62	121	146	171	196						
22 2.59	47 2.63	72 2.60	97 2.61	122	147	172	197						
23 2.61	48 2.62	73 2.67	98 2.61	123	148	173	198						
24 2.67	49 2.61	74 2.60	99 2.60	124	149	174	199						
25 2.54	50 2.60	75 2.60	100 2.55	125	150	175	200						
TOTAL			261.14										
MEAN			2.61										
MAX		2.75	RECORD	LIMIT		FIRED BY							
MIN		2.51				RECORDED BY							
EXTREME VARIATION		0.24											
REMARKS													
(AMBIENT TEST)													
Thirteen (13) rounds failed to fire.													

LAKE CITY ARSENAL
VELOCITY & PRESSURE - ACCEPTANCE REPORT

Nomenclature Ctg., 20MM, Ball, M55A1	Lot No IED 27-257A IED 27-257B	Date Tested
---	--	-------------

RECEIVER TYPE	BARREL TYPE	PISTON TYPE	HEAD- SPACE	GAGE RECEIVER No.	BARREL No.	TIMES FIRED	HEAD- SPACE
Piston	hole location 2.100"	a.	b.	Elec.	2 Piezo	43	-
Piston	hole location 4.386"	c.	d.	Elec.	3 Piezo	35	-

VELOCITY F.S.			PRESSURE P.S.I.		Velocity Tested at		Feet
DRY			WET		Barometer		Inches
Corr. Mean			Corr. Mean		FIRING	DRY	° F
Mean Inst.			Mean Inst.		ROOM	WET	° F
Max. Inst.			Max. Inst.			R. H.	%
Min. Inst.			Min. Inst.		Instrument Room		° F
Ex. Var.			Ex. Var.		Ammunition		° F
Std. Dev.			Std. Dev.		Range Temperature		° F
					Velocity Barrel Corr.		F.S.
					Pressure Barrel Corr.		P.S.I.

SHOT No.	a. VELOCITY		b. PRESSURE		c. VELOCITY		d. PRESSURE		CHECK AMMUNITION	
	IED 27-257B		IED 27-257A		IED 27-257B		IED 27-257A		Value	F.S. PSI
1	3374		3380		3385		3370			
2	3367		3372		3369		3360			
3	3388				3389		3399			
4	3385				3396		3378			
5					3380		3377			
6										
7										
8										
9										
10										
11										
12										
13										
14										
15										
16										
17										
18										
19										
20										
Total										
Mean										

REMARKS:

Round Nr. 3 of Group a. did not record on the oscilloscope
 Three (3) rounds of Group d. failed to fire.
 Groups c. and d. were fired in a pressure barrel with the piston hole located at 4.386 inch.

IMR 7005, AL 41313, Chg. 593 grs.

VELOCITY

PRESSURE

IED-MIR NO 144

MALFUNCTION INVESTIGATION REPORT

AMMUNITION LOT NO: 27-257 BQUANTITY 2TYPE OF MALFUNCTION MISFIRE

REQUESTED BY _____

AMMUNITION TYPE 20 MM

INVESTIGATION BY _____

APPLICABLE SIP: FAPD NO. SP-19

INSPECTION RESULTS

PRIMER ASSEMBLY

VISUAL EXAMINATION.

SAMPLE

- NO. 1. Top edge of outer cup deeply scratched all the way around. Button deeply scratched.
2. Punch out in outer cup not complete; extends over insulator approximately 1/5 it's circumference. Does not touch button, but button has what appears to be a scorched spot on it, indicating that there had been a connection between outer cup and button and that it burned off.

GAGING

SAMPLE NO.	ASSEMB. HEIGHT	DIA. O. CUP	BRIDGE THICK	BUTTON DEPTH
1.	.238	.3305	.179	.0035
2.	.244	.3305	.151	.007

RESISTANCE

SAMPLE NO.	RESISTANCE
1.	400,000 Ohms.
2.	16,000 "

PELLET

CONDITION	WEIGHT
1. Very soft pellet, no consolidation, appeared moist, moisture content checked at .27%.	2.72
2. Normal appearing pellet	2.84.

REMARKS

Listed below are resistance values as recorded by the Aberdeen Proving Ground chronograph ohmmeter for misfires encountered in the test.

Lot IED 27-257A:

Ambient Test

Ohms Resistance

3.0 meg.
2.5 meg.
7.5 meg.
6.0 meg.
4.6 meg.
9.2 meg.
1.6 meg.
9.3 meg.
4.2 meg.
11.0 meg.
500 K (500,000)
17.0 meg.
3.6 meg.
1.3 meg.
10.5 meg.
2.5 meg.
11.0 meg.
4.2 meg.
2.4 meg.
7.6 meg.
11.5 meg.
20.0 meg.

Cold Test

Ohms Resistance

5.0 meg.
3.2 meg.
5.1 meg.
5.3 meg.
10.0 meg.
7.2 meg.
3.6 meg.
8.3 meg.
9.7 meg.
7.0 meg.
11.6 meg.
46.0 meg.
7.5 meg.
700 K (700,000)
32.0 meg.
26.0 meg.
10.7 meg.
1.0 meg.
4.8 meg.
7.3 meg.
10.7 meg.
6.0 meg.
6.2 meg.
13.0 meg.
4.0 meg.
6.6 meg.
5.8 meg.

Lot IED 27-257B:

Ambient Test

Ohms Resistance

12 K
7.5 meg.

APPENDIX B
VELOCITY, PRESSURE AND ACTION TIME CHARTS

CHART A

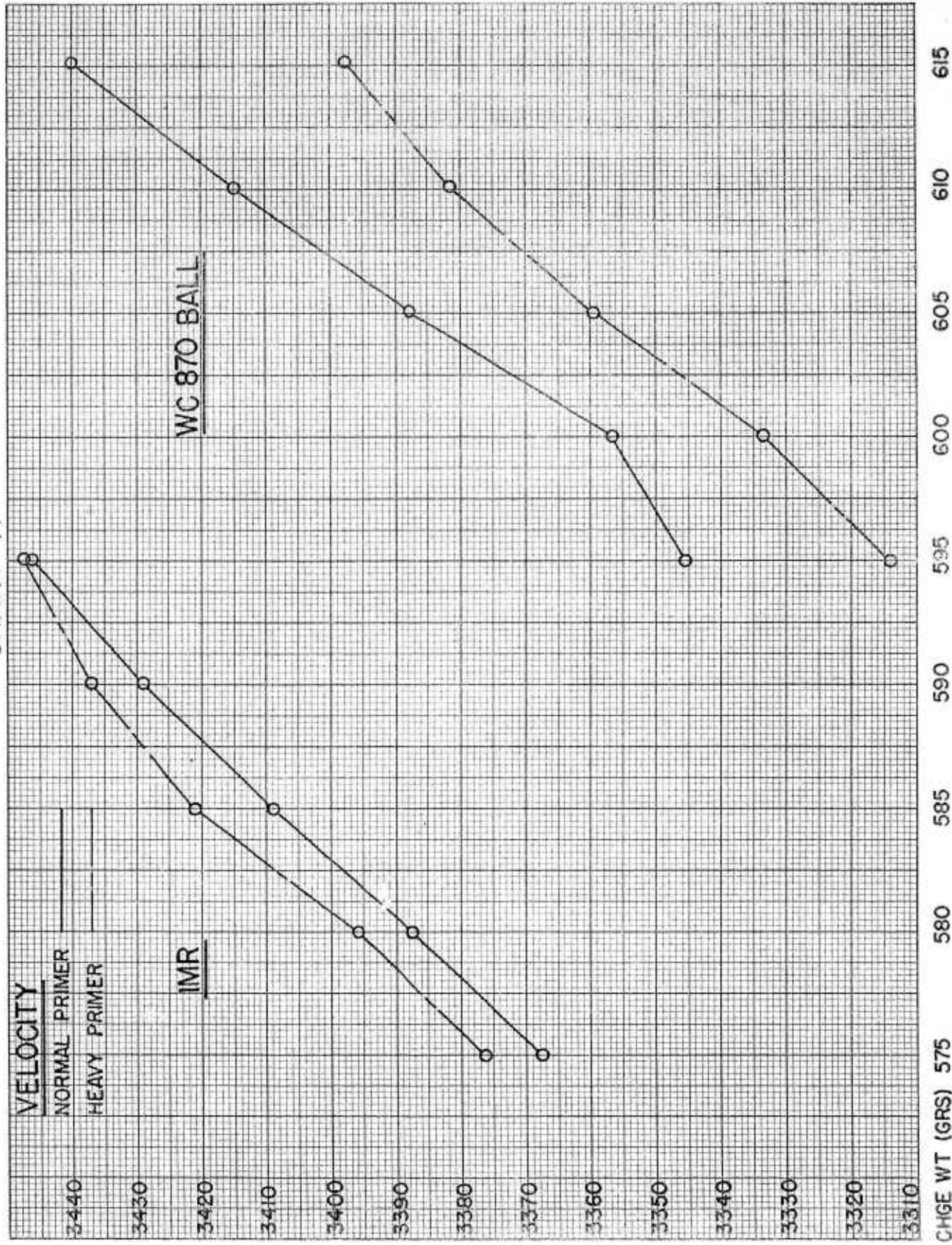


CHART B

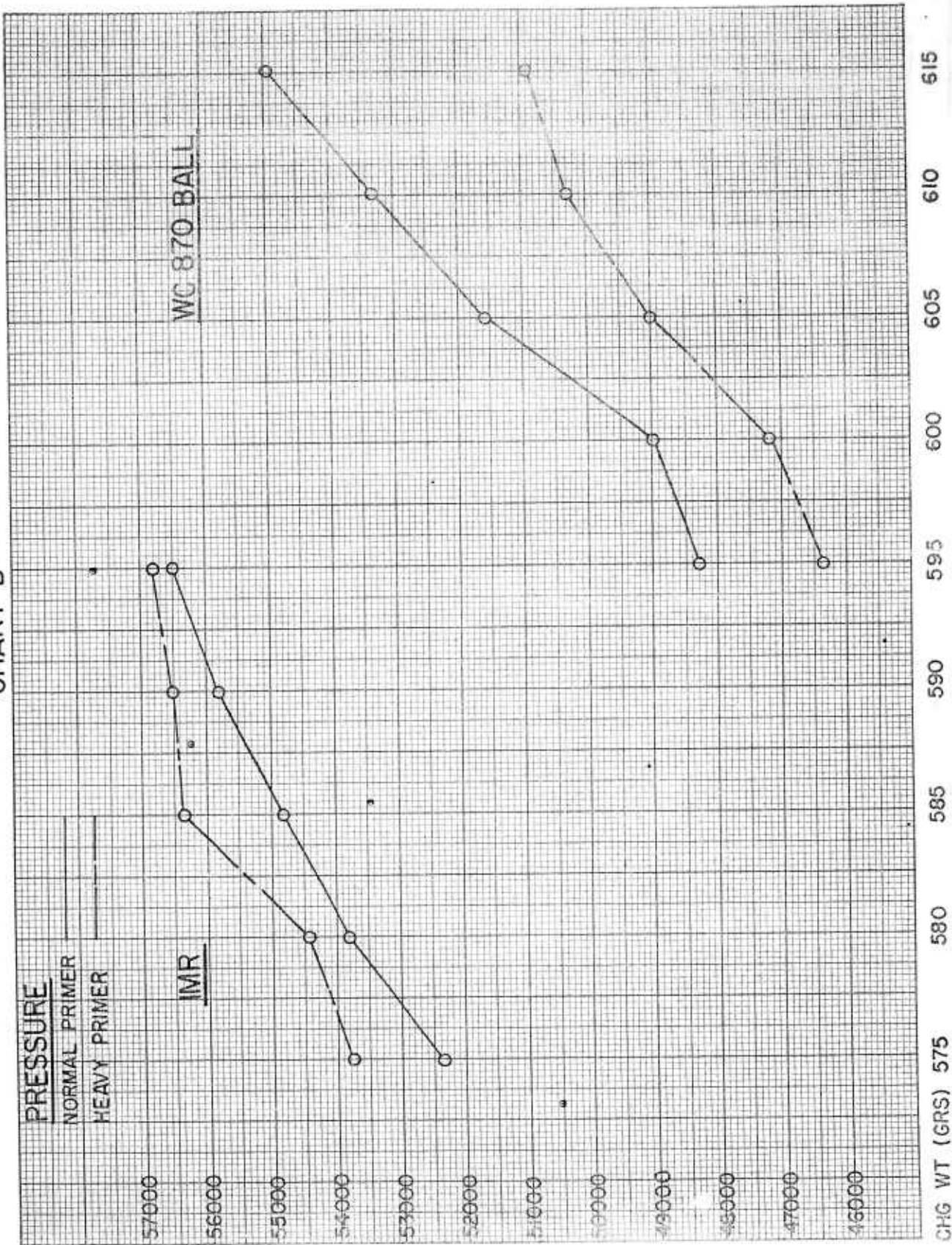
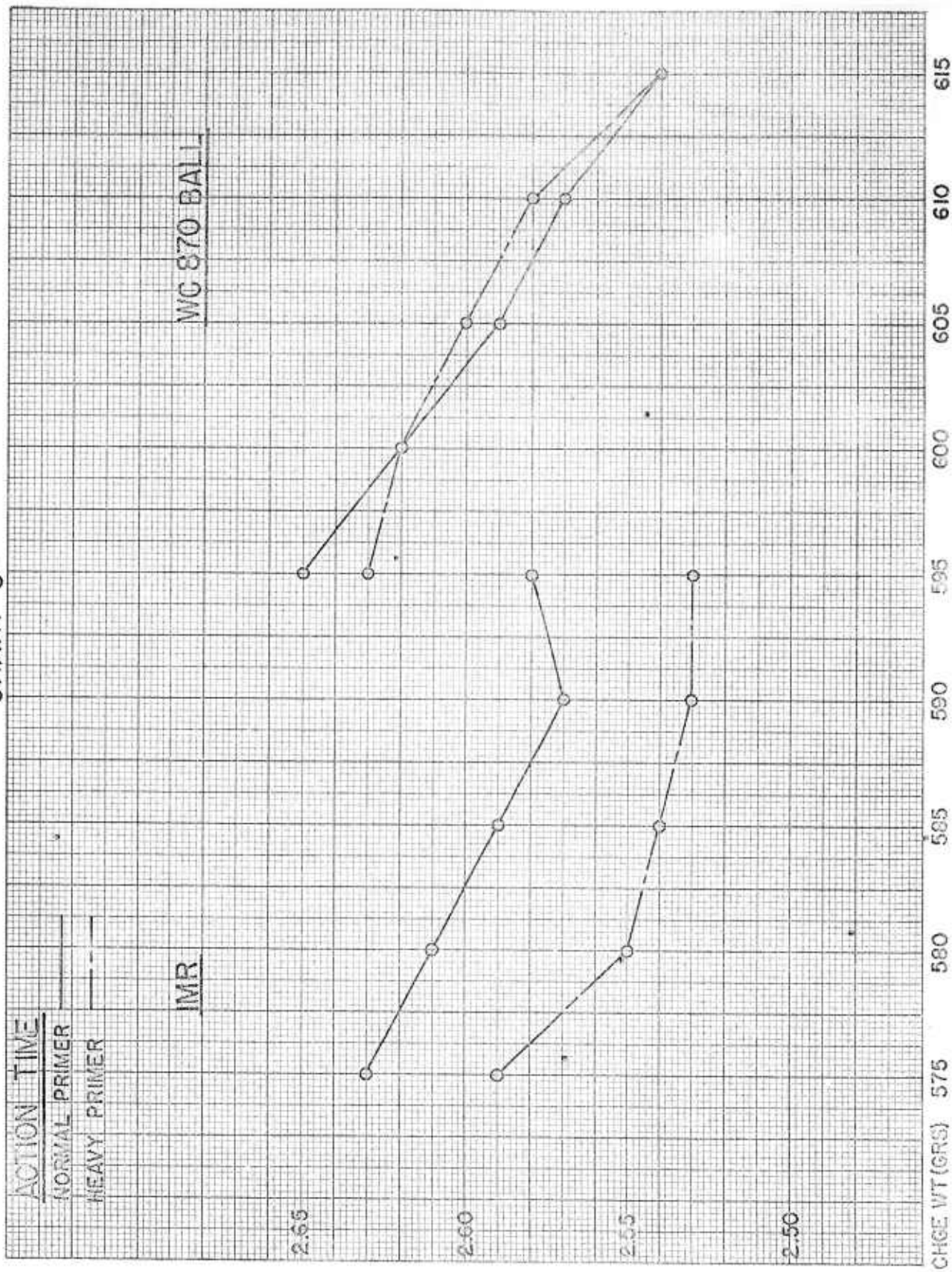


CHART C



APPENDIX C
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DISTRIBUTION

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