ARMY RESEARCH LABORATORY

Capabilities of Experimental Facilities 110G and 110E

by Eleanor C. Deal

ARL-TN-239 **April 2005**

NOTICES

Disclaimers

The findings in this report are not to be construed as an official Department of the Army position unless so designated by other authorized documents.

Citation of manufacturer's or trade names does not constitute an official endorsement or approval of the use thereof.

Destroy this report when it is no longer needed. Do not return it to the originator.

Army Research Laboratory
Aberdeen Proving Ground, MD 21005-5066

ARL-TN-239 **April 2005**

Capabilities of Experimental Facilities 110G and 110E

Eleanor C. Deal
Weapons and Materials Research Directorate, ARL

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)*	2. REPORT TYPE	3. DATES COVERED (From - To)
April 2005	Final	February 2004–February 2005

4. TITLE AND SUBTITLE
Capabilities of Experimental Facilities 110G and 110E

5a. CONTRACT NUMBER

5b. GRANT NUMBER

5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Eleanor C. Deal

5d. PROJECT NUMBER
AH80

5e. TASK NUMBER

5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
U.S. Army Research Laboratory
ATTN: AMSRD-ARL-WM-TC
Aberdeen Proving Ground, MD 21005-5066

8. PERFORMING ORGANIZATION REPORT NUMBER
ARL-TN-239

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSOR/MONITOR'S ACRONYM(S)

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT
The capabilities of Experimental Facilities 110E and 110G are explained in this technical note. The comparisons between the gun sizes and the launch weights are shown on the various tables.

15. SUBJECT TERMS
ballistic testing, gun performances, launch weights

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			Eleanor Deal
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL	24	19b. TELEPHONE NUMBER (*Include area code*) 410-278-6953

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

Contents

List of Figures

List of Tables

Acknowledgments

The author would like to thank Mr. Walt Rowe, Mr. Matthew Burkins, and Mr. Tim Farrand for their guidance and consultations on this technical note.

INTENTIONALLY LEFT BLANK.

1. Introduction

Experimental Facility 110 (EF110) has two facilities for testing various penetrators and armor targets. Targets consist of single or multiple elements of metals, composites, and ceramics. EF110G is used exclusively for nondepleted uranium (DU) penetrators. EF110E has additional exhaust filtration to permit testing DU, as well as non-DU, penetrators. Full scale experiments for small arms through 40 mm and up to 1/3 of full scale are conducted in these facilities. Both are indoor facilities with temperature controlled environments. Figure 1 shows EF110G. EF110E is similar in set-up: however, the target chamber is 65 ft long, compared to the 14 1/2-ft EF110G. This report is being written to provide customers with information on the capabilities of EF110E and EF110G. (Reactive armor experiments can be conducted in sister facility EF309A.)

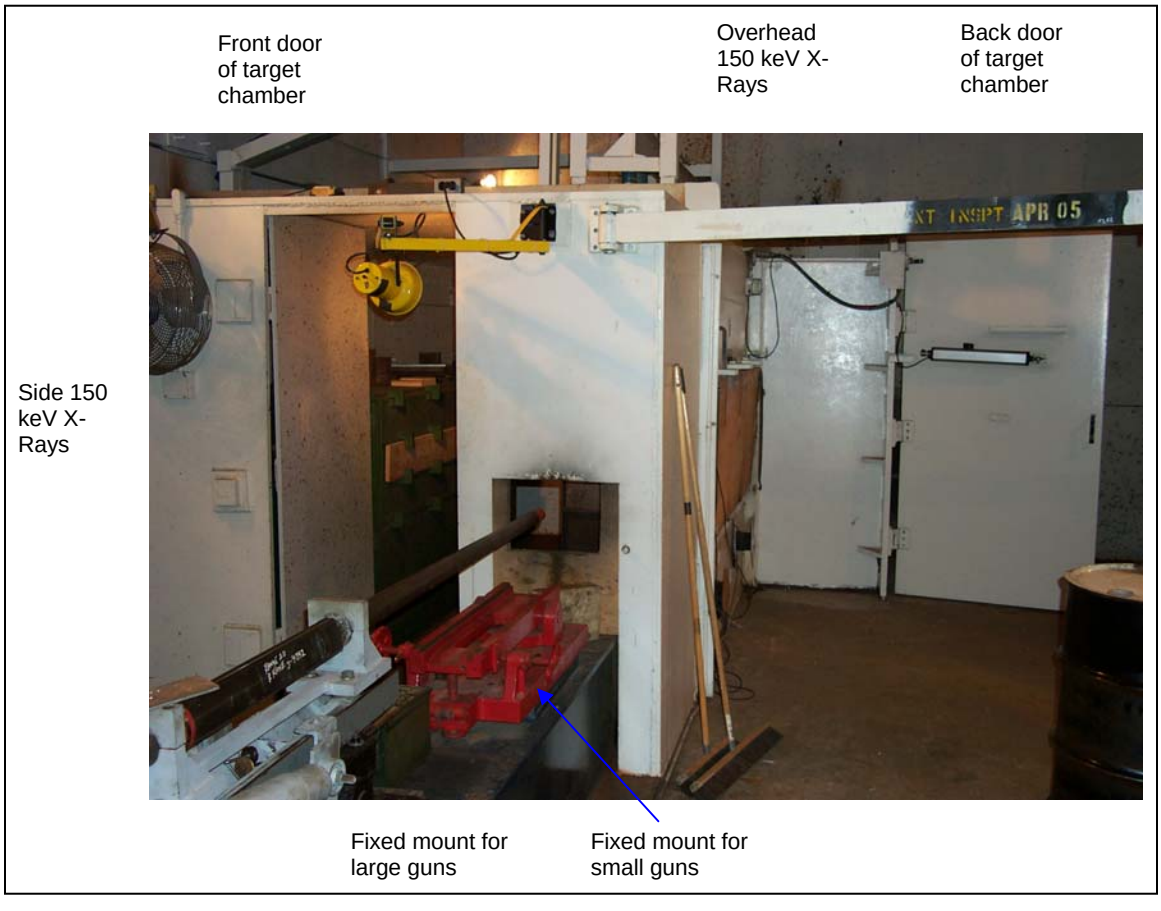

Figure 1. Experimental facility 110G.

2. X-ray Coverage

EF110G and EF110E each have a 10-channel 150 KV radiograph system. (Two overhead and eight side view pictures are possible with the standard setup.) All film is processed on site after each shot (see figure 2). From the film, the striking velocity, residual velocity, yaw, and pitch are determined by using an x-ray digitizer for rapid data reduction. EF110E is also equipped with a single channel 1-MeV x-ray system.

For more explanation of the x-ray system, please see Zook et al.[1]

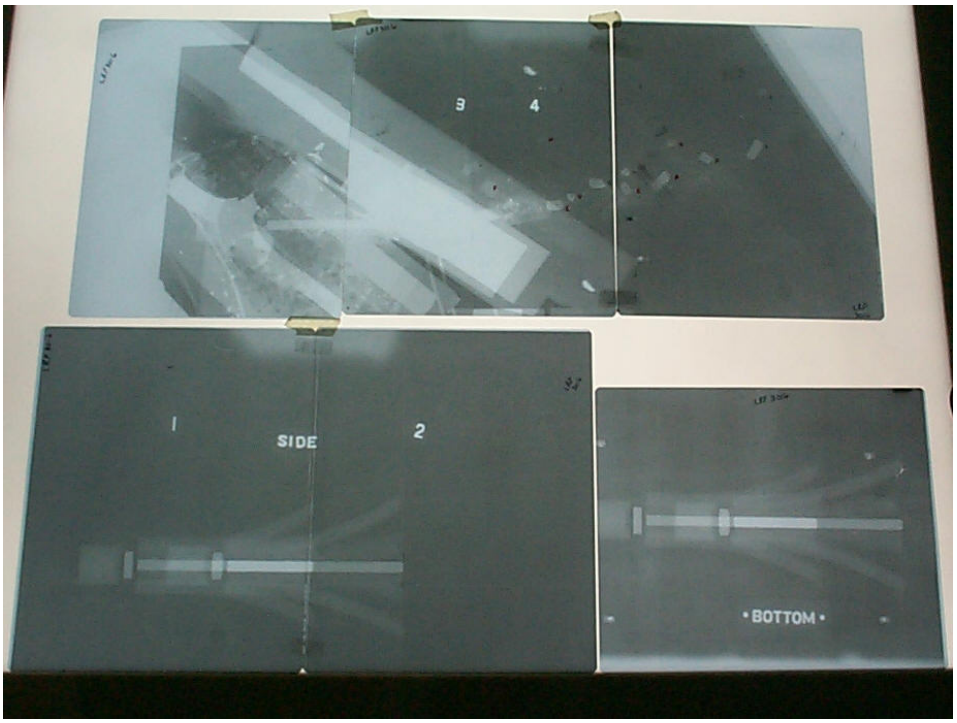

Figure 2. X-rays showing side, overhead, and residual pictures.

3. Loading Room

EF110 has an approved ammunition loading room for measuring the propellant. The propellant load is varied to obtain the required velocity. The loading room has calibrated scales capable of

[1] Zook, J.; Frank, K.; Silsby, G. *Terminal Ballistics Test and Analysis Guidelines for the Penetration Mechanics Branch*; BRL-MR-3960; U.S. Army Ballistics Research Laboratory: Aberdeen Proving Ground, MD, 1992.

accurately measuring propellant from a .22 cal. to a 40-mm gun system. There is also an ammunition storage magazine with up to 100 lb of ammunition storage capacity.

4. Guns Available

There are a wide variety of small arms and medium caliber laboratory and fielded guns available in these facilities. They are as follows:

- .22 caliber
- 7.62 mm
- 14.5 mm
- 20 mm
- .50 cal
- Gau 8/30 mm
- .30 cal
- 25-mm rifled bore
- 25–30-mm smoothbore (with a 37-mm breech)
- 40 mm (EF 110E only)

The 25–30-mm smoothbore gun tubes come in 10 to 15 ft in length. The breech end is chambered for a 37-mm case and breech. The standard gun tube is machined out to a 1.042-in inside diameter (ID). These tubes can last up to 100 shots, depending on the velocity requested. (At high velocities the guns wear out faster.) After declaring the gun tube worn out, these tubes can be rebored to the following IDs: 1.090, 1.105, 1.125, 1.150, and 1.181 in. After 1.181 in, there is not enough metal left for reboring and they are destroyed.

EF110G is capable of firing up to 1600 m/s with the 25-mm smoothbore gun tube, with a muzzle distance of 5 ft or more.

EF110E is capable of firing up to 2000 m/s with the 40-mm gun tube system (depending on the mass of the projectile). Muzzle to target distance can be 10 ft or more.

Figures 3–5 show some of the gun systems used in the facility.

Figure 3. The 25/37-mm breech gun system.

Figure 4. The 14.5-mm gun system.

Figure 5. The 50-cal. gun system.

5. Gun Performance

Figures 6–11 provide typical smoothbore gun performances, with velocity as a function of projectile mass and propellant mass. Tables 1–5 provide the same information in a tabular format.

6. Summary

The capabilities of EF110G and EF110E are described in this technical note. These facilities provide launch platforms from .22 cal. to 40-mm gun systems, including DU penetrators. Typical smoothbore performance curves are provided to allow a prospective user to determine whether a desired velocity is possible for a given projectile launch weight. These facilities are well-equipped to perform penetrator development, as well as armor development testing.

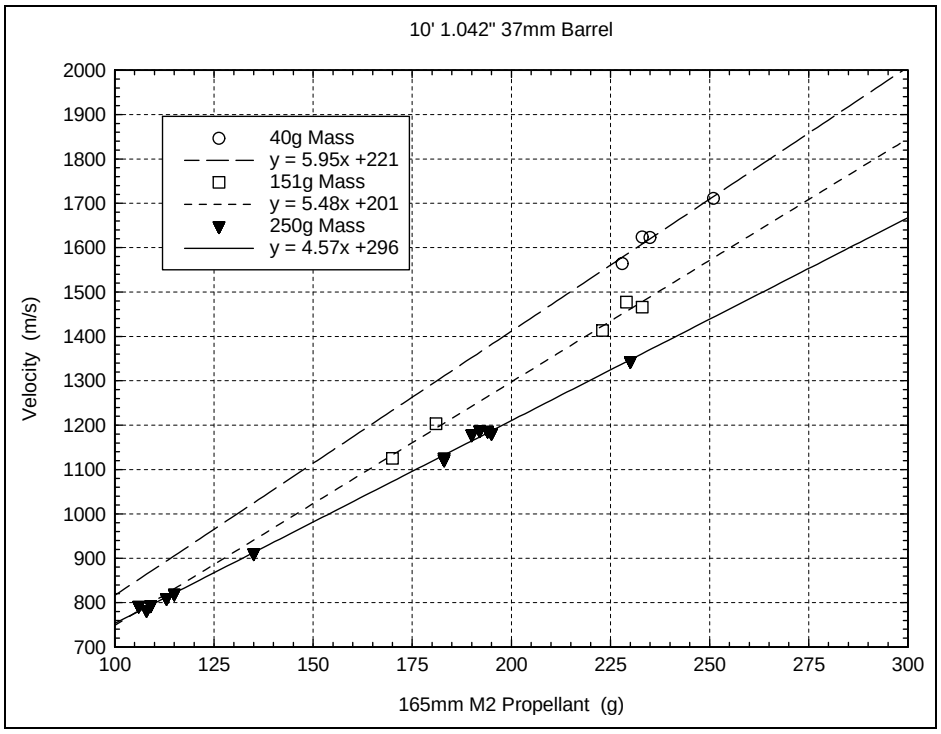

Figure 6. Velocity vs. 165-mm M2 propellant for a 1.042-in ID gun barrel.

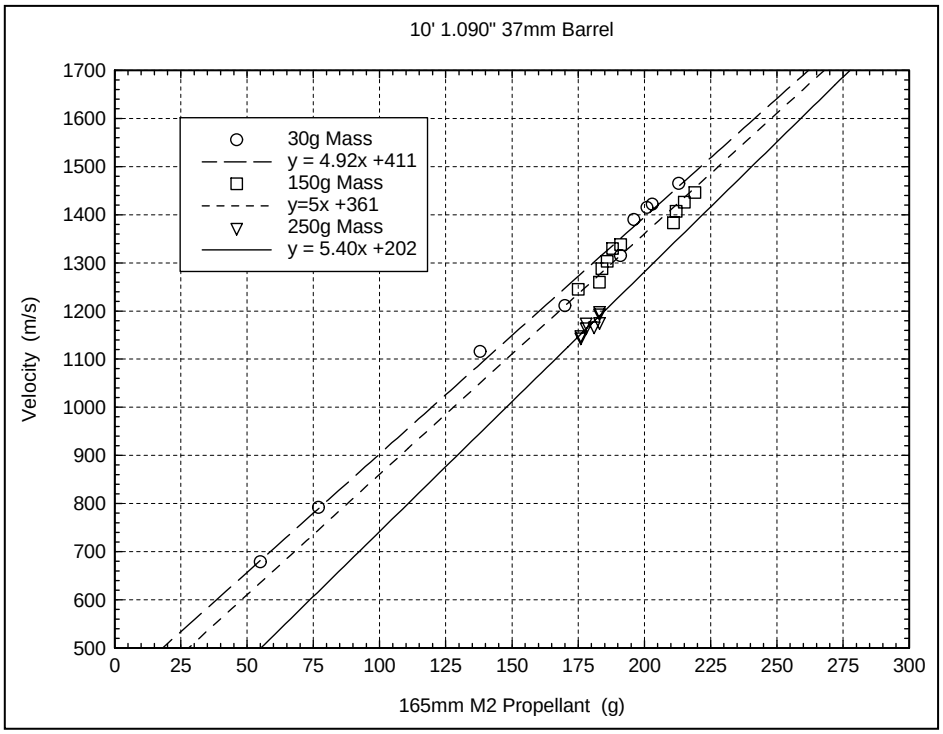

Figure 7. Velocity vs. 165-mm M2 propellant for a 1.090-in ID 37-mm gun barrel.

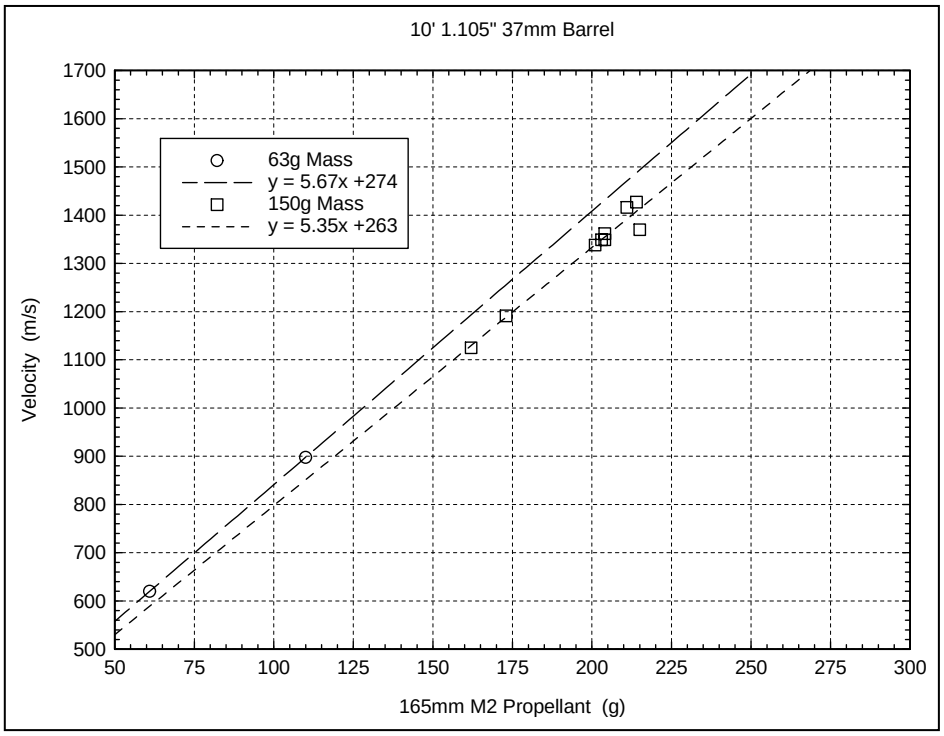

Figure 8. Velocity vs. 165-mm M2 propellant for a 1.105-in ID 37-mm gun barrel.

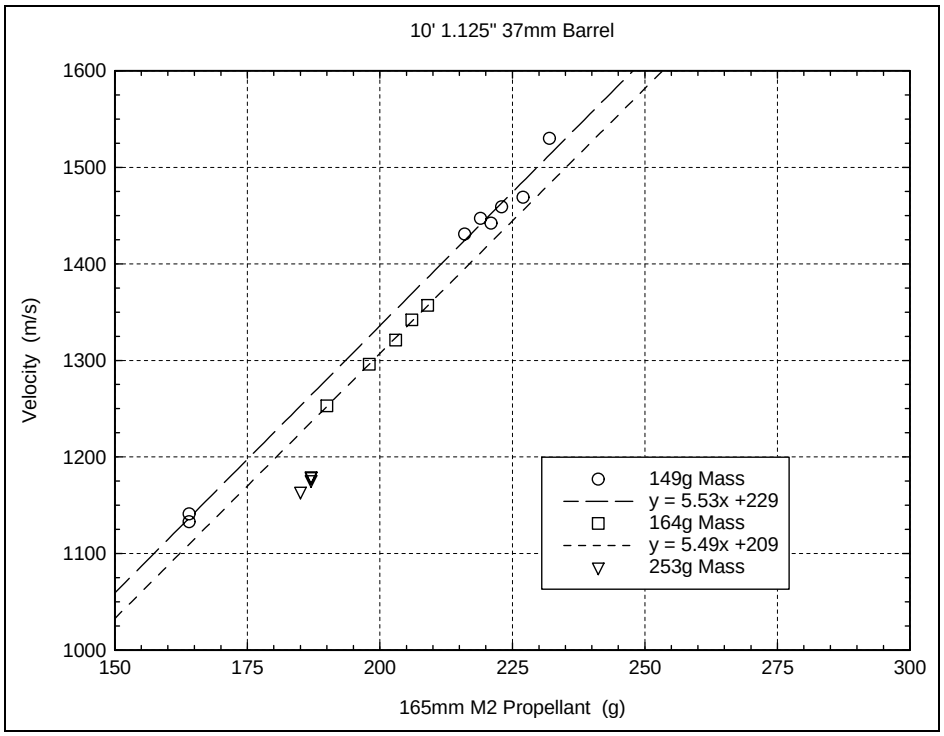

Figure 9. Velocity vs. 165-mm M2 propellant for a 1.125-in ID 37-mm gun barrel.

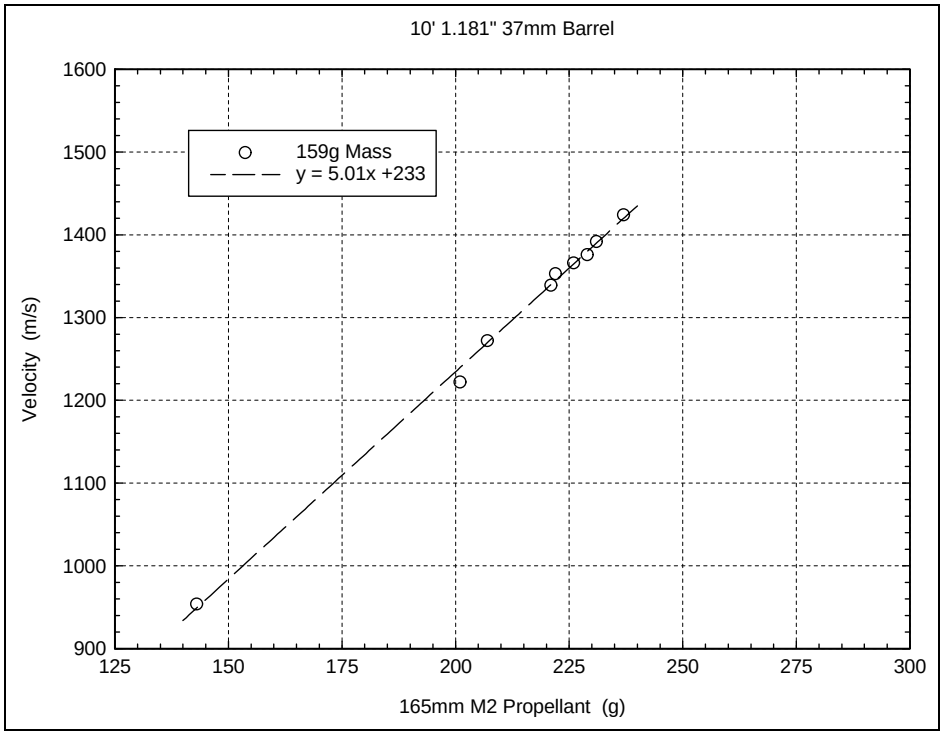

Figure 10. Velocity vs. 165-mm M2 propellant for a 1.181-in ID 37-mm gun barrel.

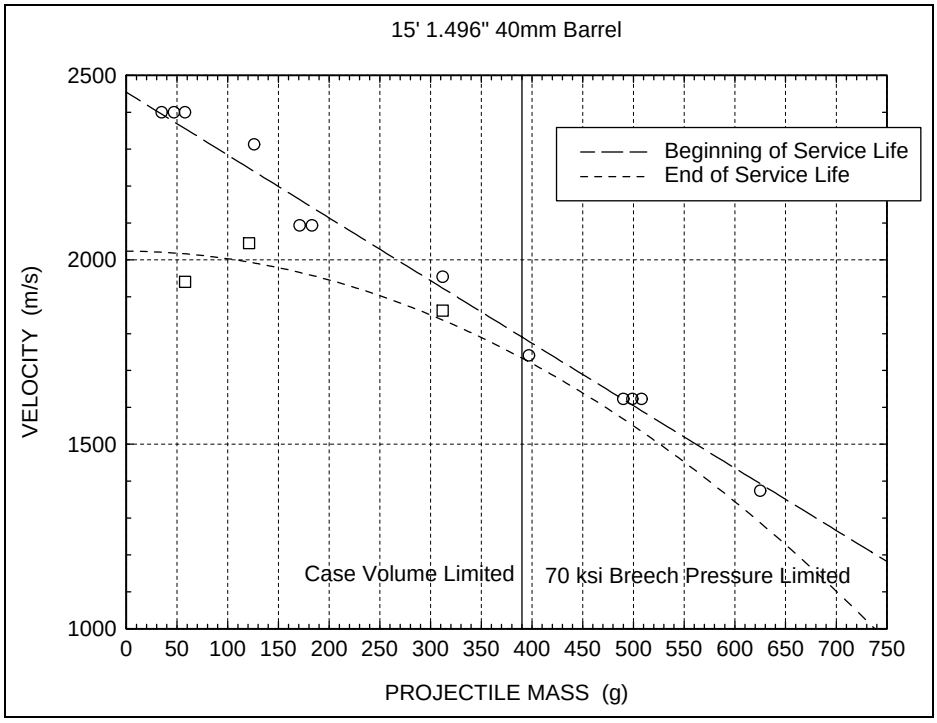

Figure 11. The projectile mass vs. the velocity for a 40-mm barrel.

Table 1. Velocity and powder for the 1.042-in gun.

Propellant 165-mm .035 WEB		
Launch Wt. (g)	**Powder Wt. (g)**	**Velocity (m/s)**
40	251	1711
	235	1623
	228	1564
	233	1624
151	170	1125
	181	1203
	229	1477
	233	1466
	223	1413
250	109	794
	106	793
	113	810
	115	820
	108	783
	135	911
	230	1344

Table 2. Velocity and powder for the 1.090-in gun.

Propellant 165-mm .035 WEB		
Launch Wt. (g)	**Powder Wt. (g)**	**Velocity (m/s)**
25	170	1211
	191	1315
	213	1465
	196	1390
34	55	679
	77	792
	138	1116
	201	1415
	203	1422
146	211	1383
	215	1426
	219	1446
	183	1260
	212	1407
153	188	1330
	186	1303
	191	1338
	184	1288
	175	1245
251	183	1177
	181	1168
	176	1145
	176	1150

Table 3. Velocity and powder for the 1.105-in gun.

Propellant 165-mm .035 WEB		
Launch Wt. (g)	**Powder Wt. (g)**	**Velocity (m/s)**
63	110	898
	61	620
146	218	1463
	215	1370
	211	1416
	214	1427
	162	1125
	173	1191
153	204	1349
	204	1362
	201	1338
	203	1349

Table 4. Velocity and powder for the 1.125-in gun.

Propellant 165-mm .035 WEB		
Launch Wt. (g)	**Powder Wt. (g)**	**Velocity (m/s)**
149	164	1141
	164	1133
	221	1442
	223	1459
	227	1469
	232	1530
	219	1447
	216	1431
164	206	1342
	190	1253
	198	1296
	203	1321
	209	1357
253	185	1164
	187	1180
	187	1179
	187	1176

Table 5. Velocity and powder for the 1.181-in gun.

Propellant 165-mm .035 WEB		
Launch Wt. (g)	**Powder Wt. (g)**	**Velocity (m/s)**
159	222	1353
	231	1392
	221	1339
	229	1376
	226	1366
	237	1424
	207	1272
	201	1222
	143	954

NO. OF COPIES ORGANIZATION

1 (PDF ONLY) DEFENSE TECHNICAL INFORMATION CTR
DTIC OCA
8725 JOHN J KINGMAN RD
STE 0944
FORT BELVOIR VA 22060-6218

1 US ARMY RSRCH DEV & ENGRG CMD
SYSTEMS OF SYSTEMS INTEGRATION
AMSRD SS T
6000 6TH ST STE 100
FORT BELVOIR VA 22060-5608

1 INST FOR ADVNCD TCHNLGY
THE UNIV OF TEXAS
AT AUSTIN
3925 W BRAKER LN STE 400
AUSTIN TX 78759-5316

1 US MILITARY ACADEMY
MATH SCI CTR EXCELLENCE
MADN MATH
THAYER HALL
WEST POINT NY 10996-1786

1 DIRECTOR
US ARMY RESEARCH LAB
IMNE ALC IMS
2800 POWDER MILL RD
ADELPHI MD 20783-1197

3 DIRECTOR
US ARMY RESEARCH LAB
AMSRD ARL CI OK TL
2800 POWDER MILL RD
ADELPHI MD 20783-1197

3 DIRECTOR
US ARMY RESEARCH LAB
AMSRD ARL CS IS T
2800 POWDER MILL RD
ADELPHI MD 20783-1197

NO. OF COPIES ORGANIZATION

ABERDEEN PROVING GROUND

1 DIR USARL
AMSRD ARL CI OK TP (BLDG 4600)

NO. OF
COPIES ORGANIZATION

1 CONCURRENT TECH CORP
G NICKODEMUS
100 CTC DR
JOHNSTOWN PA 15904-1935

ABERDEEN PROVING GROUND

15 DIR USARL
AMSRD ARL WM MD
S GHIORSE
G GLIDE
M KLUEWITZ
M STACKER
AMSRD ARL WM TA
M BURKINS
W GOOCH
E HORWATH
A MIHALCIN
W ROWE
AMSRD ARL WM TC
R COATES
A COPLAND
T FARRAND
L MAGNESS
B PETERSON
B SCHUESTER