ASTIA attn: TISSCP-2

CONFIDENTIAL

ORDBG 322--20 Oct 51

Aberdeen Proving Ground

MARYLAND

REFERENCE COPY

CODE SHEET INCLUDED

CARTRIDGE, HEAT, 57MM, M307A1 (MOD) WITH MODIFIED COPPER LINERS (U)

THIS DOCUMENT CONSISTS OF 57 PAGES

NO. 9 OF 19 COPIES

D.A. Project No. 504-07-001

DEVELOPMENT AND PROOF SERVICES

First Report OCO Project No. TA3-5204

Regrading data cannot be determined

ARMY—OS—ABERDEEN PROVING GROUND, MD.—415

FC

DEVELOPMENT AND PROOF SERVICES
ABERDEEN PROVING GROUND
MARYLAND

AUTHORITY: ORDBB-TJ1, 471.5/6-91
AFG (C) 471/307

CJLichtinger/maj
26 September 1957

CARTRIDGE, HEAT, 57MM, M307A1 (MOD)
WITH MODIFIED COPPER LINERS (U)

FIRST REPORT ON ORDNANCE CORPS PROJECT NO. TA3-5204

DATES OF TEST: 26 FEBRUARY 1957 TO 12 JUNE 1957

ABSTRACT

OBJECTIVE

This test was designed to obtain information concerning 57mm, spin-compensated HEAT ammunition.

SUMMARY

Shells with fluted conical liners were tested for dynamic penetration of armor plate.

The multi-piece modified shells were tested at excess pressure for metal parts security.

Shells were fired with inert boosters to check fuze functioning.

CONCLUSIONS

Substantial improvement in penetration was obtained with fluted liners as compared to known performance of smooth liners.

Observations from this test indicate that the modified M307A1 projectiles can withstand excess pressure conditions.

Results indicate that the M90A1 fuze was functioning properly and was not bypassing the booster in initiating the Composition B bursting charge.

RECOMMENDATIONS

Development and testing of fluted liners to counteract undesirable rotational effects associated with spin-stabilized rounds should be continued.

CONTENTS

I INTRODUCTION

A. The primary objective of this test was to obtain information from dynamic tests of modified 57mm, HEAT ammunition, and, by comparing it with existing data for the standard 57mm HEAT round, to determine the effectiveness of the fluted liner in compensating for the rotational effect on penetration.

B. In Phase One of this program the M307A1 (Mod.) projectiles, containing fluted liners made by the rubber-covered-punch process, were fired against homogeneous armor plate to determine the penetration characteristics of the round.

C. In Phase Two the modified M307A1 projectiles were subjected to excess pressure conditions to determine if the new design was of adequate strength. The standard M307A1 projectile had a one-piece body. The body of the modified projectile was made from two pieces joined together by a screw thread.

D. The third and final phase of this program was to determine if the M90A1 Fuze would initiate the main charge of Composition B if an inert booster was used.

II DESCRIPTION OF MATERIEL

A. Cartridge, HEAT, 57mm, M307A1 (Mod) with PBX booster pellet and live auxiliary detonator, 180 each, Lot PA-E-24034. (Reference Appendix D, Dwg. 75-1-215; Appendix C, Data Card No. 83539.)

B. Cartridge, HEAT, 57mm, M307A1 (Mod) with PBX booster pellet and a dummy auxiliary detonator, 100 each, Lot PA-E-24037. (Reference Appendix D, Dwg. 75-1-215; Appendix C, Data Card No. 83542.)

C. Cartridge, HEAT, 57mm, M307A1 with inert booster pellet, 25 each, Lot PA-E-24035.

D. Cartridges from Lots PA-E-24034 and 24035 were received as complete rounds and X-Rayed by this proving ground to determine quality of loading. Ammunition data cards for these lots are inclosed in Appendix C.

E. Cartridges from Lot PA-E-24037 were received as complete rounds less propellant and were loaded at this proving ground with enough propellant to reach 7280 psi (112% of rated maximum pressure), at a temperature of: +125°F.

III DETAILS OF TEST

A. PROCEDURE FOR PHASE I

Phase I of this test consisted of firing 180 rounds, Lot PA-B-24034, as follows:

1. Forty-five cartridges were conditioned to 70° ± 5° F. for a minimum of 16 hours. These rounds were fired against 4-inch homogeneous armor plate with a one-inch witness plate six inches behind the target.

2. Forty-five cartridges were conditioned to 70° ± 5° F. for a minimum of 16 hours. These rounds were fired against five-inch homogeneous armor plate with a one-inch witness plate five inches behind the target.

3. Forty-five cartridges were conditioned to -65° ± 5° F. for a minimum of 16 hours. However, due to poor ignition of the propellant at a temperature of -65° F, the conditioning temperature was changed to -40° F after 21 rounds had been fired. These rounds were fired against four-inch homogeneous armor plate with a one-inch witness plate six inches behind the target.

4. Forty-five cartridges were conditioned to -40° ± 5° F. for a minimum of 16 hours. These rounds were fired against five-inch homogeneous armor plate with a one-inch witness plate five inches behind the target. The rounds were observed for premature functioning and the depth of penetration was recorded. Any round which impacted three-hole diameters from the edge of the plate or another impact was considered as an unfair hit.

B. RESULTS FOR PHASE I

1. Table I is a summary of firing of Phase I of this test.

2. Detailed round-by-round results may be found in firing record No. P-62641, Appendix A of this report.

3. Aberdeen Proving Ground photographs, Nos. B-23806 to B-23819, which show the entrance and exit views of penetrations of the target and witness plate, are inclosed in Appendix B.

TABLE I

SUMMARY OF FIRING

FIRING REPORT NO. P-62641 | RANGE: BTD | GUN TO TARGET: 150 ft. | DATES OF TEST: 26, 27, 28 Feb and 7 March 1957

	4" PLATE AMMUNITION AT 70°F.	5" PLATE AMMUNITION AT 70°F.	4" PLATE AMMUNITION AT * -65°F AND -40°F	5" PLATE AMMUNITION AT -40°F
Total No. of Rounds	45	45	45	45
Failure to Function	4	4	2	2
Improper Ignition of Prop.	—	—	3	—
Rounds Omitted (Unfair Hits)	1	4	—	1
Total No. of Valid Rounds	40	37	40	42
Total Rounds Penetrating:				
4" Plate	28	—	28	—
5" Plate	—	12	—	23
1" Witness Plate	11	2	3	8
Total No. of Penetrations greater than 3"	36	28	35	39

*Note: Rounds 1 - 21 conditioned at: -65°F.
Rounds 22- 45 conditioned at: -40°F.

Due to improper ignition of the propellant at -65°F, specifically rounds 277, 278, and 283, the conditioning temperature was changed to -40°F.

C. PROCEDURE FOR PHASE II

In Phase II of this test 100 rounds of Lot PA-E-24037 were fired under the following conditions:

1. Cartridge cases contained enough propellant to develop 7280 psi, 112% of maximum rated pressure, after the rounds had been conditioned to +125°F for a minimum of 40 hours.

2. These rounds were fired for land impact at a range of approximately 4000 yards and observed for evidence of functioning. (Failure of the metal parts would be expected to result in instability or premature functioning in the bore or at the muzzle.)

D. RESULTS FOR PHASE II

There was no evidence of instability or of premature functioning or functioning on ground impact.

E. PROCEDURE FOR PHASE III

1. In Phase III of this program 25 rounds, Lot PA-E-25035 were conditioned to +70°F and fired against five-inch homogeneous armor plate.

2. The rounds were fired to determine if the M90A1 Fuze would initiate the Composition B in an inert boostered shell.

F. RESULTS FOR PHASE III

1. No plate penetrations were obtained. Examination of the target area disclosed large quantities of Composition B, indicating that the projectiles were either breaking up or deflagrating on impact to varying degrees.

2. Many base plugs were recovered from the shells. The base plugs had holes in them caused by the auxiliary detonator. This verified that the jet formed by the nose element of the fuze was properly directed to the booster rather than penetrating side of the spit-back tube or the cone proper. (Eccentricities in the auxiliary detonator were believed capable of yielding fuze failures.)

IV CONCLUSIONS

A. It is concluded that:

1. Results from this test show that the M307A1 projectile with the fluted liners made by the rubber-covered-punch process is capable of defeating 4 to 5 inches of homogeneous armor plate and is therefore superior to the standard hemispherical liner which cannot be relied upon to consistently penetrate 3 inches of armor plate. (Included in the reference is a list of reports which give the characteristics of the standard M307A1 projectile with hemispherical liner.)

2. The modified M307A1 projectile can withstand excess pressure conditions for the 57mm, M18, Rifle.

3. The nose element of the M90A1 fuse supplied with these projectiles was functioning properly.

V RECOMMENDATION

It is recommended that:

Development and testing of spin-compensating methods be continued to obtain a HEAT round which has optimum penetration characteristics.

SUBMITTED:

CARL F. EICHINGER
SFP3 OFDC
Project Engineer

REVIEWED:

O. MORROW
Chief, Mortar and
Recoilless Rifle Branch

H. A. BECKER
Chief
Artillery Division

APPROVED:

H. A. NOBLE
Assistant to the Deputy Director
for Engineering Testing
Development and Proof Services

REFERENCES

CLIFT, G. D., Performance of 57mm Shell Containing Fluted Liners Coined by the Rubber-Covered-Punch Process (C), Picatinny Arsenal Technical Report 2293, July 1956.

FIRING RECORD NO. P-47934

To determine the effect of clearance between shell bourrelet and rifle barrel on plate performance of Shell, HEAT, M307A1 with Fuze PD, M90A1, 57mm Rifle.

FIRING RECORD NO. P-49028

To develop Fuze, PI, T189E1 for use in Shell, HEAT, 57mm, M307 or M307A1.

OBSERVERS

Mr. Jacobsen . . . . Picatinny Arsenal
Mr. McCarry . . . . Picatinny Arsenal

Mr. Simon . . . Ballistic Research Labs

Code A

Code B

APPENDICES

DEVELOPMENT AND PROOF SERVICES
ABERDEEN PROVING GROUND, MARYLAND
FIRING RECORD

APPENDIX A

OBJECT OF TEST: To obtain information concerning 57mm, spin-compensated HEAT Ammunition

DATE OF TEST: 26 February to 12 June 1957
FIRING RECORD NO.: P-62641
SHEET 1 OF 13
AUTHORITY: ORDMB-TdI, 471.5/6-9) APG(C) 471/307
WORK ORDER NO.: 32-254-50

DEVELOPMENT
PROJECT NO.: TA3-5204

MATERIEL

Rifle, 57mm, M18, No. 3871, with tripod mount.

TEST AMMUNITION

180 Cartridges, HEAT, 57mm, M307A1 (Mod), which contain PBX booster pellet and spit-back tube liner No. P-83961A Lot PA-E-24034, Data Card No. 83539.

100 Cartridges, HEAT, 57mm, M307A1 (Mod), except that shell contains a PBX booster pellet and a dummy auxiliary detonator in the fuze also, spit-back liner No. 85762A Lot PA-E-24037, Data Card No. 83542.

25 Cartridges, HEAT, 57mm, M307A1, except that shell contains an inert booster pellet. The standard hemispherical liner is used in this shell. Lot PA-E-24035, Data Card 83540.

PLATE DATA

4" Plate No.	0129398A2		0154414	
BHN	241-241/255-255		302-302/302-293	
Charpy Impact Value at: -40°F.	55		49	
5" Plate No.	0137600A1		0169625A	
BHN	255-255/255-262		269-262/277-269	
Charpy Impact Value at: -40°F.	No value		No value	
1" Witness Plate No.	A-139	A-145	A-124	A-138
BHN	352-363	352-363	352-358	341-341
Charpy Impact Value at: -40°F.	18.75	14.1	17.5	17.1

PHASE I OF TEST

DATE: 25 Feb. 1957 TIME: 1000 to 1600 Hours
RANGE: NTD Area TEMPERATURE OF CARTRIDGE: 70° F.
CARTRIDGE LOT NO.: RA-8-24034
TARGET: Vertical armor plate 150 ft. from muzzle, consisting of 4 inch plate (No. CL29398A-2), 6 inch air space, followed by 1 inch witness plate (No. A-139).

RIFLE RD NO.	PROJ. NO.	COPPER CHAMBER PRESS, psi	PENETRATION inches	REMARKS
148	Lost	4300	4	Marked witness plate
149	Lost	——	0	
150	Lost	——	4	
151	Lost	——	4	Marked witness plate
152	171	——	0	
153	168	Lost	4	Marked witness plate
154	84	——	——	Unfair hit
155	62	——	3 1/2	Bulged back of target
156	56	——	3 1/2	Bulged back of target
157	150	——	4	
158	143R	4400	5	Completely penetrated witness plate
159	133	——	5	Completely penetrated witness plate
160	54	——	2 3/4	
161	82	——	4	
162	131R	——	5	Completely penetrated witness plate
163	101	4400	4	Marked witness plate
164	57	——	3 1/8	Bulged back of target
165	9	——	3 3/8	Bulged back of target
166	103R	——	2 3/4	
167	100	——	4	
168	231	4400	5	Completely penetrated witness plate
169	26	——	4	
170	128	——	3 3/4	Bulged back of target
171	Lost	——	3 7/8	Bulged back of target
172	86	——	3 7/16	
173	193	4300	4	Marked witness plate
174	107	——	4	
175	79	——	2 7/16	
176	110	——	4	Marked witness plate
177	70	4400	5	Completely penetrated witness plate
178	172	——	0	
179	109	——	4	Marked witness plate
180	48	——	4	Marked witness plate
181	24	——	4	Marked witness plate
182	39	Lost	5	Completely penetrated witness plate
183	45	——	4	
184	108	——	5	Completely penetrated witness plate

RIFLE RD NO.	PROJ. NO.	COPPER CHAMBER PRESS, psi	PENETRATION inches	REMARKS
185	43	----	3 5/8	
186	237	----	5	Completely penetrated witness plate
187	28	4000	5	Completely penetrated witness plate
188	122	----	5	Completely penetrated witness plate
189	21	----	----	Unable to measure due to slug in hole
190	53	----	5	Completely penetrated witness plate
191	34R	----	4	
192	71	4200	0	

NOTE: Where "Marked witness plate" is listed in remarks, no appreciable penetration occurred.

PRESENT AT TEST: Mr. Jacobsen - Picatinny Arsenal

Mr. Simon - Ballistic Research Lab

DATE: 27 and 28 Feb. 1957 TIME: 1025 to 1530 Hours
RANGE: BTD Area CONDITIONING OF CARTRIDGE: 70°F.
CARTRIDGE LOT NO.: RA-E-24034
COIL DISTANCES: Gun to First - 44.2 - 44.2 ft.
Between 1st and 2nd - 30.05- 30.00 ft.
Second to Plate - 72.9 ft.
TARGET: Vertical armor plate 150 ft. from muzzle, consisting of 5 inch plate (No. C137600-A1), 5 inch air space, followed by 1 inch witness plate (No. A-145).

RIFLE RD. NO.	PROJ NO.	COPPER CHAMBER PRESS, psi	MUZZLE VEL. fps	STRIKING VEL. fps	PENETRATION inches	REMARKS
218	170	4300	(Velocities were		0	
219	106	——	recorded on		3 1/2	
220	128	——	rounds 252 to		2	
221	31R	——	261)		0	
222	91R	4400			3 1/16	
223	165	——			3 5/8	
224	89	——			——	Unfair hit
225	102	——			——	Unfair hit
226	239	——			2 7/8	
227	49	——			6	Completely penetrated witness plate.
228	132	4800			3 1/4	
229	69	——			5	Marked witness plate
230	16	——			5	
231	7R	——			2 7/16	
232	60	——			4 1/8	
233	76	4500			5	
234	184	——			3	
235	22	——			0	
236	87	——			4 3/4	Bulged rear of target
237	147	4600			3 3/4	
238	46	——			3 3/4	
39	64	——			3 1/8	
40	65	——			3 1/2	
241	42	——			[illegible]	Marked witness plate
242	105	4400			[illegible] 7/8	
243	85	——			5	Marked witness plate
244	Lost	——			4 1/2	Bulged rear of target
245	11	——			2 5/8	
246	30R	——			——	Unfair hit
247	160	4300			——	Unfair hit
248	181	——			5	Marked witness plate
249	13	——			3 3/4	
250	55	——			2 1/2	
251	140	——			5	Marked witness plate

[redacted]

[redacted]

RIFLE NO.	PROJ NO.	CHAMBER PRESS. psi	MUZZLE VEL. fps	STRIKING VEL. fps	PENETRATION inches	REMARKS
252	66	4900	1169	1135	0	
253	44	——	1160	1127	2 15/16	
254	195	——	Lost	Lost	6	Completely penetrated witness plate
255	47	——	1151	1119	2 3/4	
256	A 71	——	1156	1123	3 1/4	
257	124	4800	1161	1128	5	
258	6	——	Lost	Lost	2 3/4	
259	38	——	Lost	Lost	4	
260	192	——	1156	1123	4 15/16	Bulged back of target
261	142	——	1153	1121	5	
262	195	4800			5	

NOTE: Where "Marked witness plate" is listed in remarks, no appreciable penetration occurred.

PRESENT AT FIRING: Mr. Jacobsen - Picatinny Arsenal

Mr. Simon - Ballistic Research Lab

Code A

Code B

DATE: 5 and 7 March 1947 TIME: 0900 to 1200 Hours
RANGE: APG Area TEMPERATURE OF CARTRIDGE: -65°F and -40°F
CARTRIDGE LOT NO.: TS-6-2403A
COIL RESISTANCES: Gun to First: 44.25 - 44.3 ft.
Between 1st and 2nd: 30. - 30.05 ft.
Second to Plate: 72.85 ft.
TARGET: Vertical armor plate 150 ft. from muzzle, consisting of 4 inch plate (No. T154A1A), 6 inch air space, followed by 1 inch witness plate (No. A124).

RIFLE RD NO.	PROJ NO.	COPPER CHAMBER PRESS,psi	MUZZLE VEL. fps	STRIKING VEL. fps	PENETRATION inches	REMARKS
263	177	3100	(Velocities were		4	Marked witness plate
264	162	——	recorded on		4	Marked witness plate
265	127	——	Rounds 200 to 307)		4	
266	178	——			3 1/2	
267	96	——			3 1/2	
268	94	3100			4	Marked witness plate
269	242	——			2 3/8	
270	179	——			3 3/4	Bulged back of target
271	196	——			4	Marked witness plate
272	164	——			4	
273	185	2500(Est)			4	
274	125	——			0	
275	17	——			4	Marked witness plate
276	69	——			2 3/4	
277	236	——			0	Poor ignition - found projectile 10 ft. in front of target - No evidence of hitting plate.
278	67	0			0	Poor ignition - found projectile 40 ft. in front of gun.
279	121R	3400			4	
280	82				4	Marked witness plate
281	138R				3 7/8	Bulged back of target
282	129R				4	
283	149	0			0	Poor ignition - found proj.20 ft.in front of gun

Above 21 rounds were fired on March 5th at -65°F
Following 24 rounds were fired on March 7th at -40°F

284	148	3100			5	Completely penetrated witness plate
285	141R	——			4	
286	158	——			2 7/16	
287	190	——			4	
288	12R	3200			4	Marked witness plate
289	97	——			4	

ROUND NO.	PROJ NO.	IMPACT CHAMBER PRESS, psi	STRIKING VEL fps	STRIKING VEL fps	PENETRATION inches	REMARKS
290	142	----	1053	1031	4	Marked witness plate
291	174	----	1046	1024	4	
292	136	----	1022	1002	2 7/16	
293	119	3600	1039	1019	0	
294	59	----	1035	1015	3	
295	186	----	1056	1034	4	
296	8	----	1054	1032	4	
297	58	----	1056	1034	4	Marked witness plate
298	27	3500	1063	1040	4	
299	232	----	1058	1036	4	Marked witness plate
300	137	----	1045	1023	4	
301	10	----	1073	1049	5	Completely penetrated witness plate
302	234	----	1043	1022	2 1/4	
303	189	3300	1056	1034	4	Marked witness plate
304	14R	----	1051	1029	3 1/2	Bulged back of target
305	74	----	1065	1042	3 5/8	Bulged back of target
306	78	----	Lost	Lost	4	Marked witness plate
307	187	----	Lost	Lost	4	Marked witness plate

NOTE: Where "Marked witness plate" is listed in remarks, no appreciable penetration occurred.

PRESENT AT FIRING: Mr. McGarry - Picatinny Arsenal
Mr. Simon - Ballistic Research Lab

DATE: 7 March 1957 TIME: 1300 TO 1400 Hours
RANGE: BTD Area TEMPERATURE OF CARTRIDGE -40°F.
CARTRIDGE LOT NO.: FA-8-24034
COIL DISTANCES: Gun to First - 44.3 - 44.2 ft.
Between 1st and 2nd - 30.2 - 30.3 ft.
Second to Target - 72.65 ft.
TARGET: Vertical armor plate 150 ft. from muzzle, consisting of 5 inch plate (No. C169625A), 5 inch air space, followed by 1 inch witness plate (No. A138).

RIFLE RD NO.	PROJ NO.	COPPER CHAMBER PRESS, psi	MUZZLE VEL. fps	STRIKING VEL. fps	PENETRATION inches	REMARKS
308	183	3800	1075	1051	6	Completely penetrated witness plate
309	81	——	1049	1027	5	Marked witness plate
310	98	——	1030	1010	6	Completely penetrated witness plate
311	41	——	1063	1040	6	Completely penetrated witness plate
312	75	——	1055	1033	5	Marked witness plate
313	72	3500	1042	1020	5	
314	93	——	1062	1039	6	Completely penetrated witness plate
315	50	——	1063	1040	5	Marked witness plate
316	154	3300	1054	1032	2 7/16	
317	161	——	1044	1022	6	Completely penetrated witness plate
318	19	3600	1061	1039	4 1/4	Bulged back of target
319	197R	——	1068	1045	4 7/16	Bulged back of target
320	167	——	1057	1035	3 5/16	
321	18	——	1046	1024	6	Completely penetrated witness plate
322	72	——	1054	1032	5	Marked witness plate
323	15	3600	1062	1039	5	
324	157	——	1056	1034	3 3/8	
325	130	——	1046	1024	5	
326	Lost	——	1071	1047	5	Marked witness plate
327	95	——	1036	1015	4 1/8	Bulged back of target
328	163	——	1042	1020	4 3/16	Bulged back of target
329	29	3500	1045	1023	3 7/16	
330	73	——	1062	1039	5	Marked witness plate
331	182	——	1059	1036	0	
332	4	——	1064	1041	5	Marked witness plate
333	88	——	1063	1040	5	
334	166	——	1046	1024	3 9/16	
335	33	3500	1051	1029	6	Completely penetrated witness plate
336	1	——	1064	1041	3	

RIFLE RD NO.	PROJ NO.	COPPER CHAMBER PRESS, psi	MUZZLE VEL fps	STRIKING VEL fps	PENETRATION inches	REMARKS
337	83	----	1042	1020	5	
338	61	3100	1033	1013	4	Bulged back of target
339	3	----	1056	1034	0	
340	52	----	1051	1029	4 1/8	Bulged back of target
341	111R	3600	1058	1036	3 1/2	
342	134	----	1064	1041	2 7/8	
343	25	3900	1062	1035	----	Unfair hit
344	180R	----	1046	1024	4	Bulged back of target
345	120R	----	1065	1042	3 3/16	
346	135	----	1059	1036	5	
347	68	----	1057	1035	5	Marked witness plate
348	5	3600	1059	1036	5	Marked witness plate
349	176	----	1048	1026	3 3/4	
350	99	----	1056	1034	5	Marked witness plate
351	117	----	1059	1036	3 15/16	
352	175	----	1079	1047	6	Completely penetrated witness plate

NOTE: Where "Marked witness plate" is listed in remarks, no appreciable penetrations occurred.

PHASE II OF TEST

DATE OF FIRING: 28 March and 12 June 1957 TEMPERATURE: + 125°F.
RANGE: BTD AMMUNITION LOT NO. HA-8-2403?
TARGET: 9600 Yard Recovery Field

RIFLE RD NO.	PROJECTILE NO.	CHAMBER PRESSURE psi	REMARKS
353			(See below)
354	21 R		
355	89		
356	94 R		
357	---	7600	
358	18		
359	1 R	8000	
360	51 R		
361	2		
362	50 R	7200	
363	49 R		
364	C		
365	6 R	8500	
366	46 R		
367	68	8000	
368	19 R		
369	31 C		
370	71		
371	13 R		
372	83 R	7300	
373	65		
374	29 R		
375	72		
376	55 R		
377	70	8300	
378	79		
379	40 R		
380	37		
381	77 R		
382	100 R	8400	
383	23		
384	78 R		
385	—		
386	91 R		
387	56		
388	38	8100	
389	35 R		
390	33		Rounds 353 to 392 inclusive:
391	82		No evidence of premature function-
392	39	8500	ing or function upon ground impact.

PHASE II OF TEST

DATE OF FIRING: 28 March and 12 June 1957 (Continued)

RIFLE RD NO.	PROJECTILE NO.	CHAMBER PRESSURE psi	REMARKS
			(See below)
393	81		
394	43		
395	7		
396	9 R		
397	12 R	8200	
398			
399	278		
400	54		
401	30		
402	28		
403	32		
404	59		
405	84		
406	90		
407	85		
408	66		
409	20	7900	
410	10		
411	57		
412	22		
413	45		
414	8		
415	93		
416	64		
417	27		
418	41		
419	7		
420	48		
421	92		
422	99		
423	34		
424	16		
425	95		
426	11		
427	1	7200	
428	69		
429	62		
430	44	7700	Rounds 393 to 430 inclusive: No evidence of premature functioning or function upon ground impact.
431	97		

PHASE II OF TEST

DATE OF FIRING: 28 March and 12 June 1957 (Continued)

RIFLE RD NO.	PROJECTILE NO.	CHAMBER PRESSURE psi	REMARKS
			(See below)
432	5	7900	
433	29		
434	24	7400	
435	86		
436	---		
437	88		
438	53		
439	96		
440	61		
441	---		
442	87		
443	98		
444	76		
445	31	7400	
446	---		
447	---		
448	47		
449	---		
450	---		
451	42		
452	3		

No evidence of premature functioning or fraction upon ground impact.

At intervals throughout test chamber pressure was recorded with TIAL copper pressure gages, inserted in the front of the chamber open end towards breech.

ROUND-BY-ROUND DATA

PHASE XI OF TEST

DATE OF FIRING: 27 February 1957 TEMPERATURE: + 70°F.
RANGE: BTD AMMUNITION LOT NO. FA-E-24035 (inert booster)
TARGET: Homogeneous Armor Plate

PRESENT FOR TEST: Mr. Jacobsen - Picatinny Arsenal
Mr. Simon - Ballistic Research Labs
Code A
Code B

TIME OF FIRING: 0930

RIFLE RD NO.	PROJECTILE NO.	CHAMBER PRESSURE psi	REMARKS
193	4		No penetration - Comp B on ground
194	7 R		" " " " "
195	1 R	4300	" " - No impact on plate heard
196	16 R		" " - Impact heard.
197	26 R		" " - " "
198	24 R		" " " "
199	27 R		" " " "
200	20 R		" " " "
201	14		" " " "
202	18 R		" " " "
203			" " " "
204	9 R	4700	" " " "
205	21		No Pene. - Impact heard
206	5 R		" " " "
207	B 12		" " " "
208	22 R		" " " "
209	29 R		" " " "
210	B-2		" " " "
211	3 R		" " " "
212	17 R	4100	" " " "

TIME OF FIRING: 1015

213	10 R	"	"	"	"	
214	30 R	"	"	"	"	
215	8 R	"	"	"	"	
216	15 R	"	"	"	"	
217	2 R	"	"	"	"	TIME: 1030

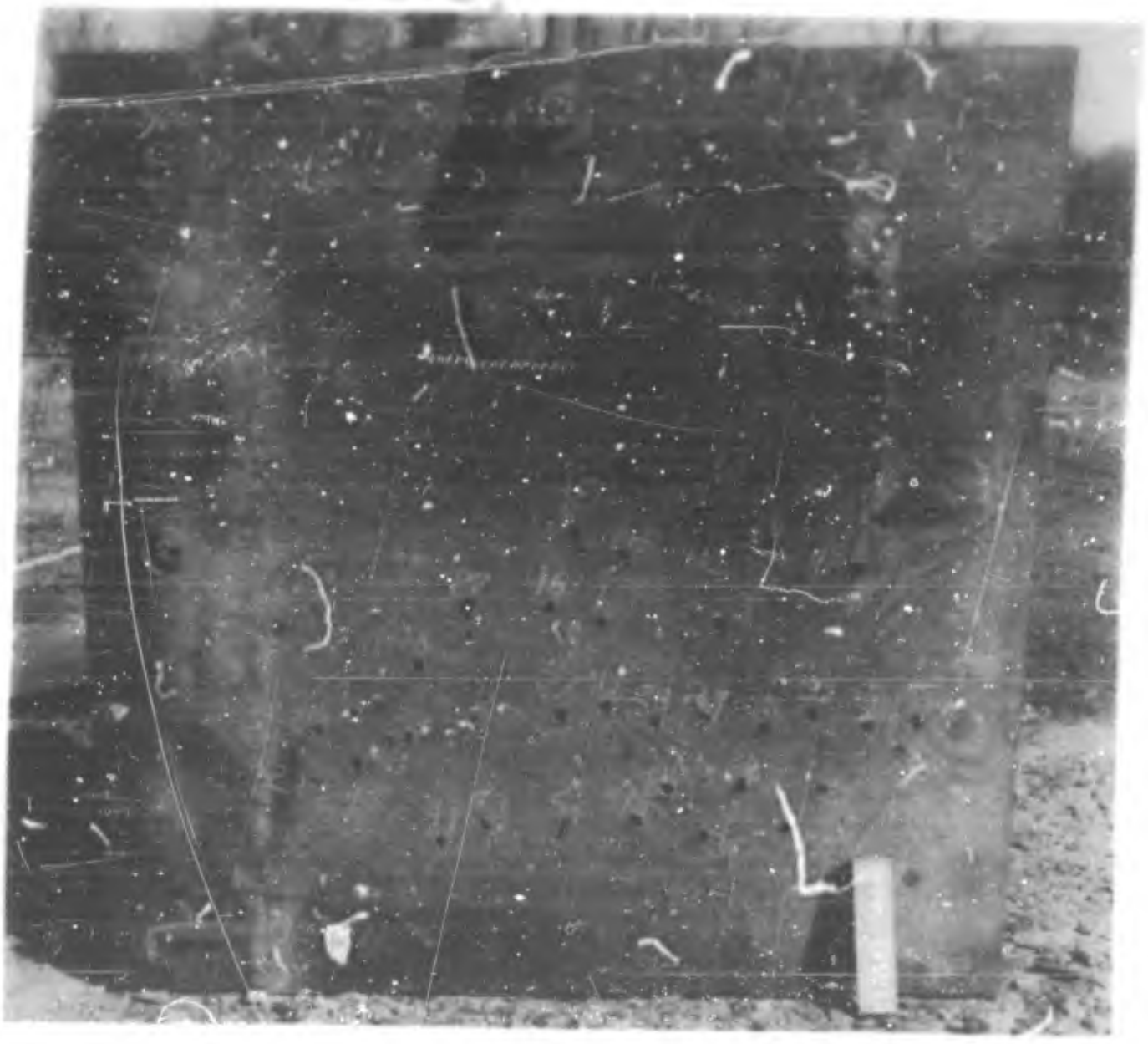
APPROVED:

H. A. BECHTOL
Chief
Artillery Division

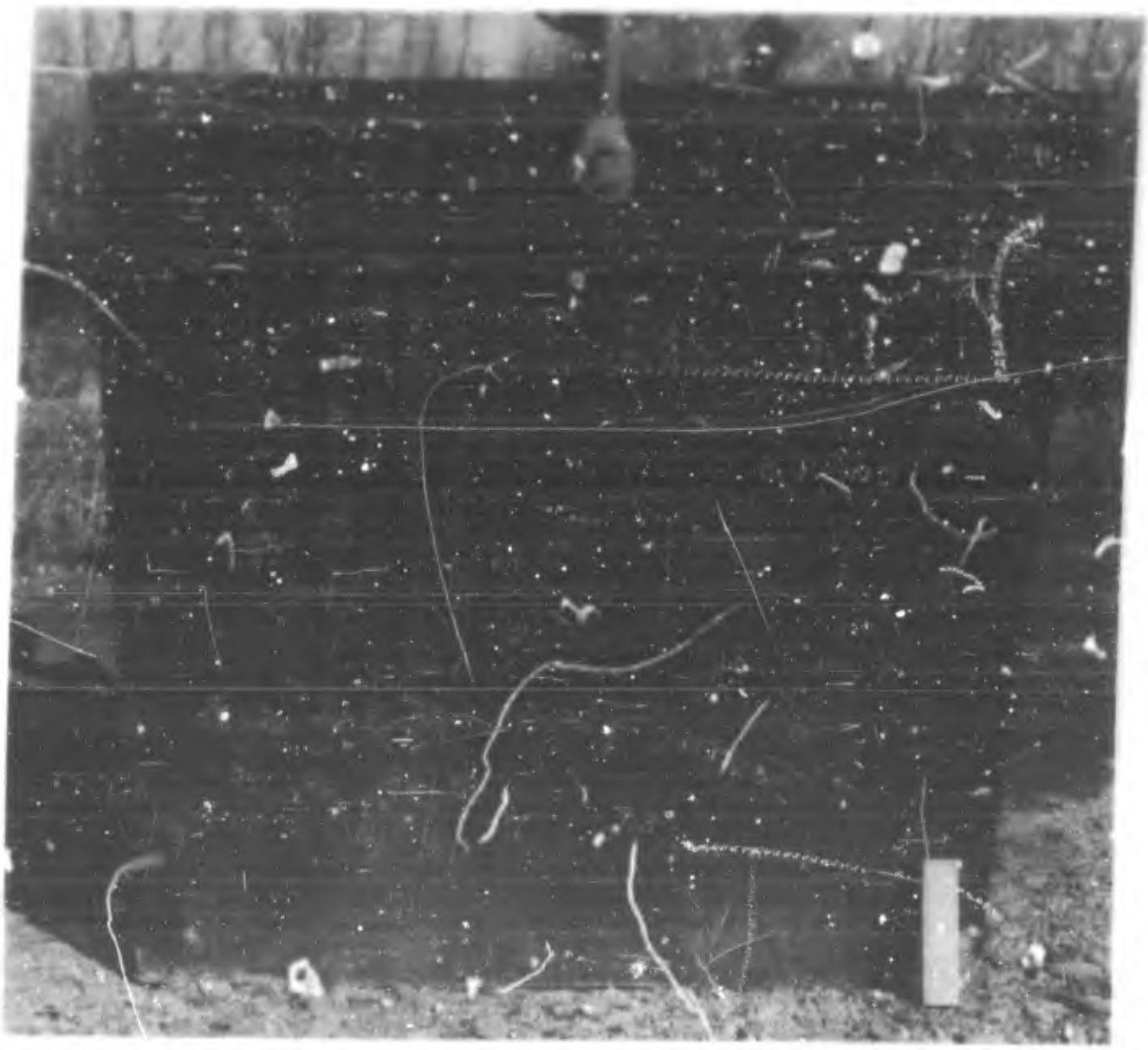
G. MORROW
Chief, Mortar and
Recoilless Rifle Br.

C. J. EICHINGER
SP3 Ord Corps
Project Engineer

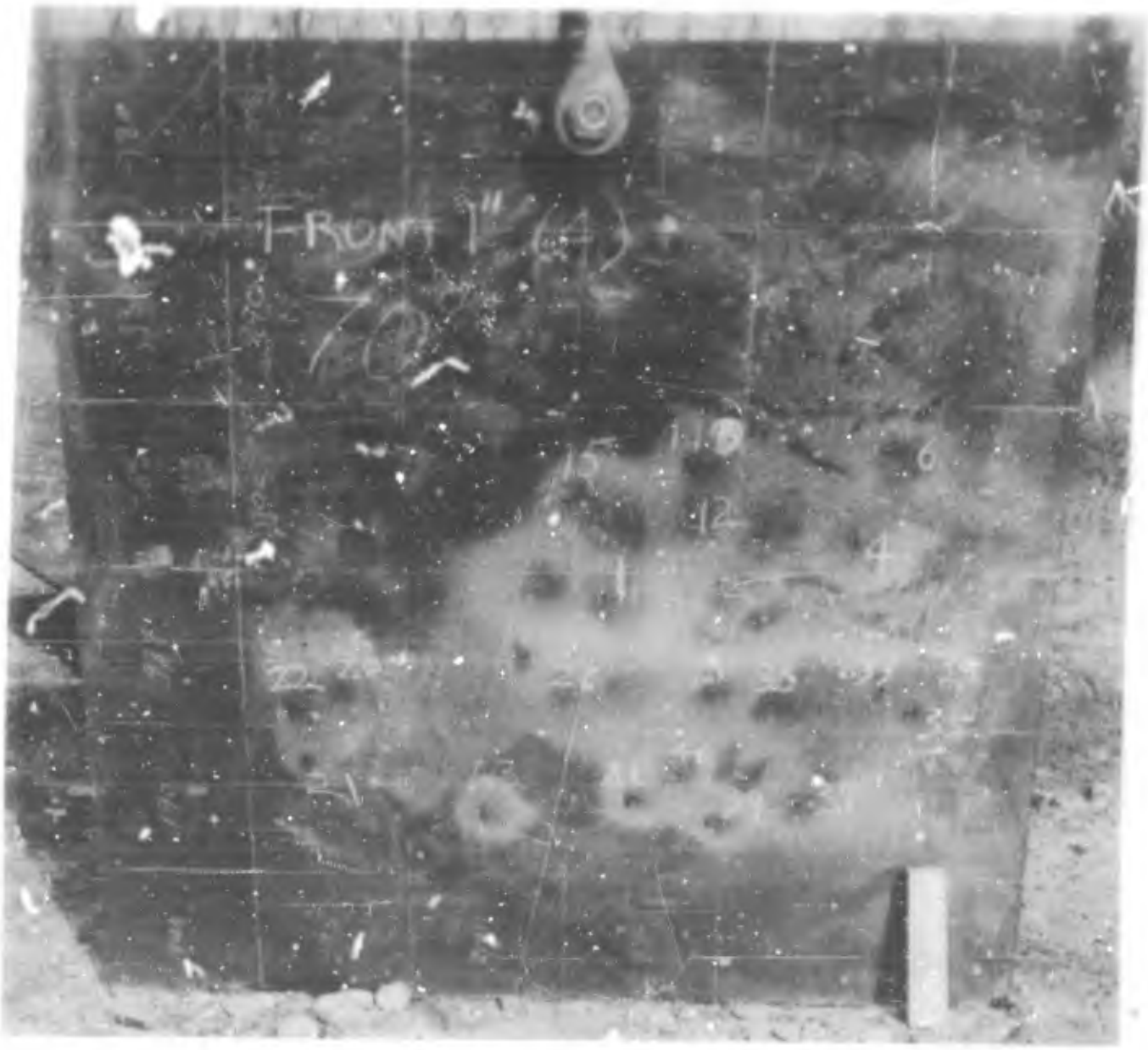
APPENDIX B



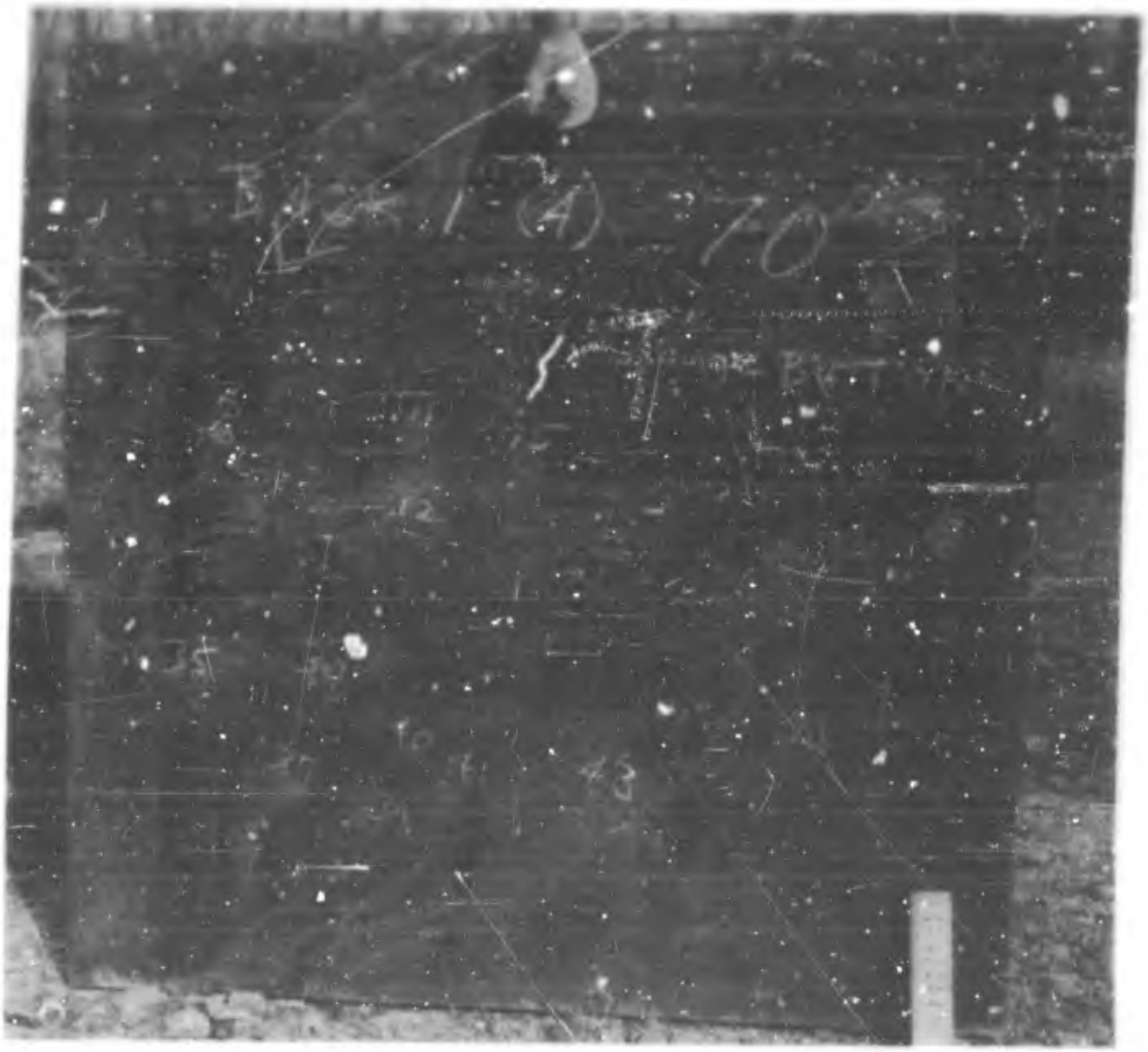
B23808 - Penetrations in 4 inch thick target plate with ammunition conditioned at 70°F. Plate normal to the line of fire.



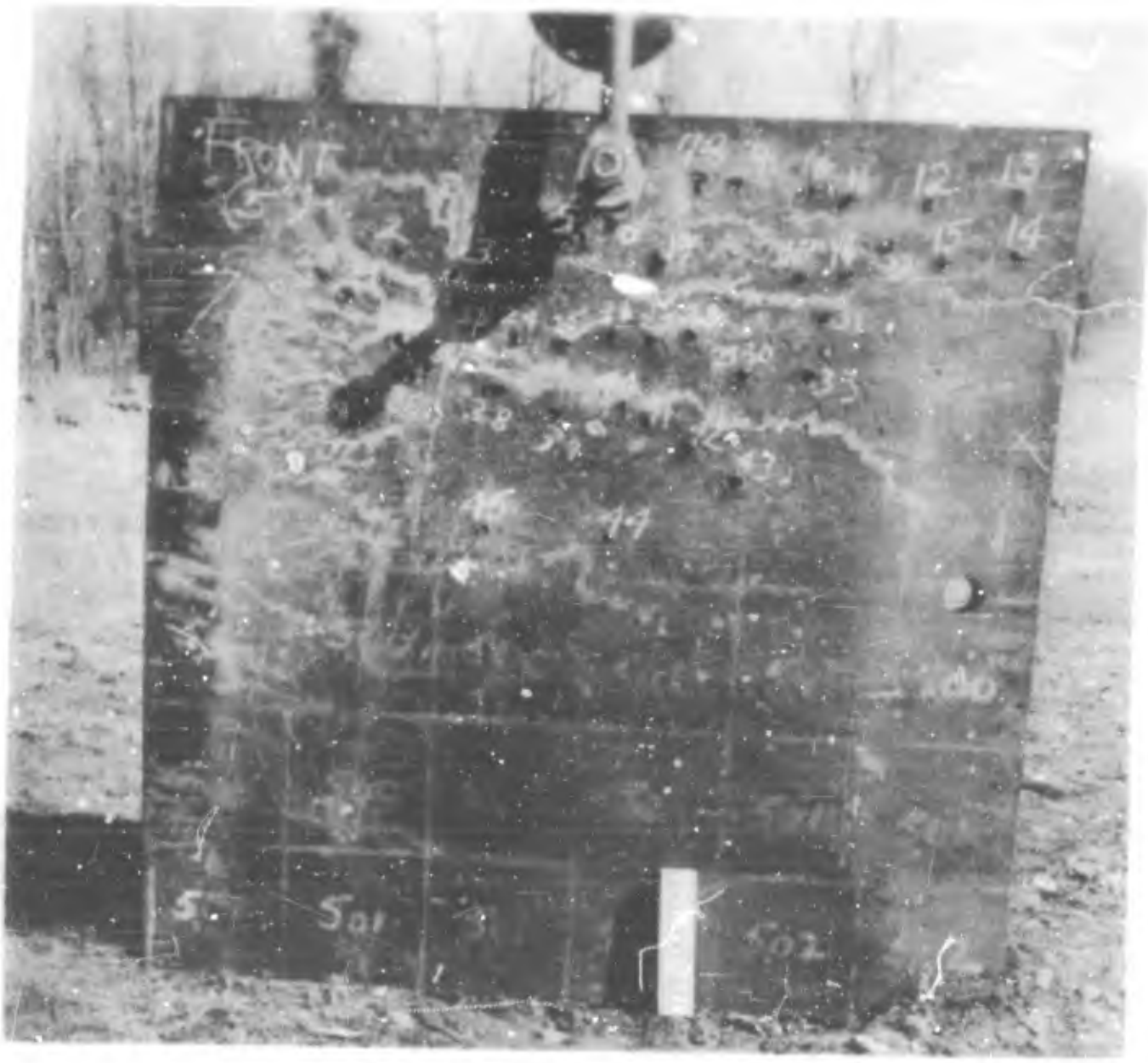
B23809 - Penetrations in 4 inch thick target plate with ammunition conditioned at 70°F. Plate normal to the line of fire.



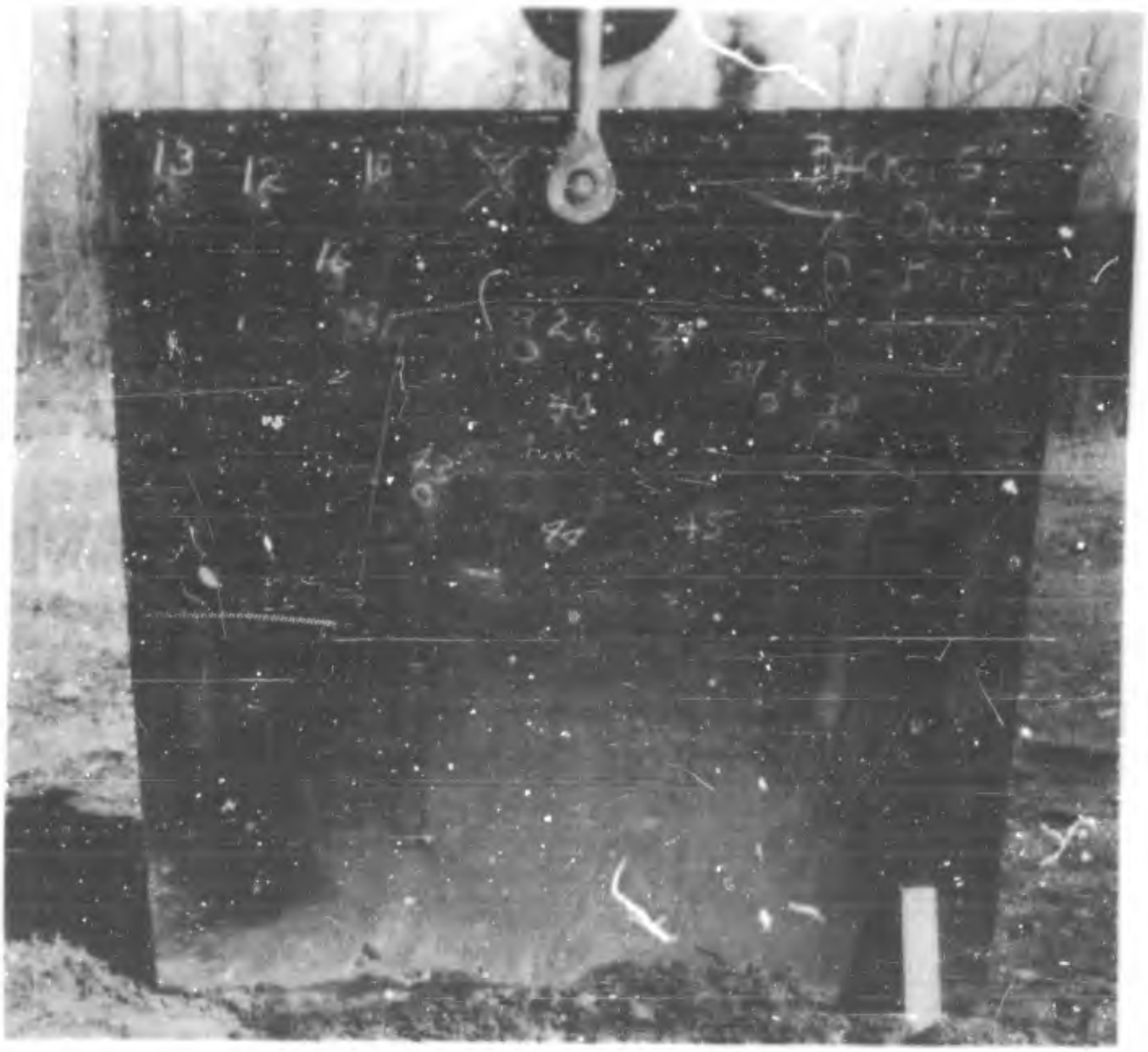
B23810 - Penetrations in 1 inch thick witness plate positioned 6 inches behind 4 inch thick target plate.



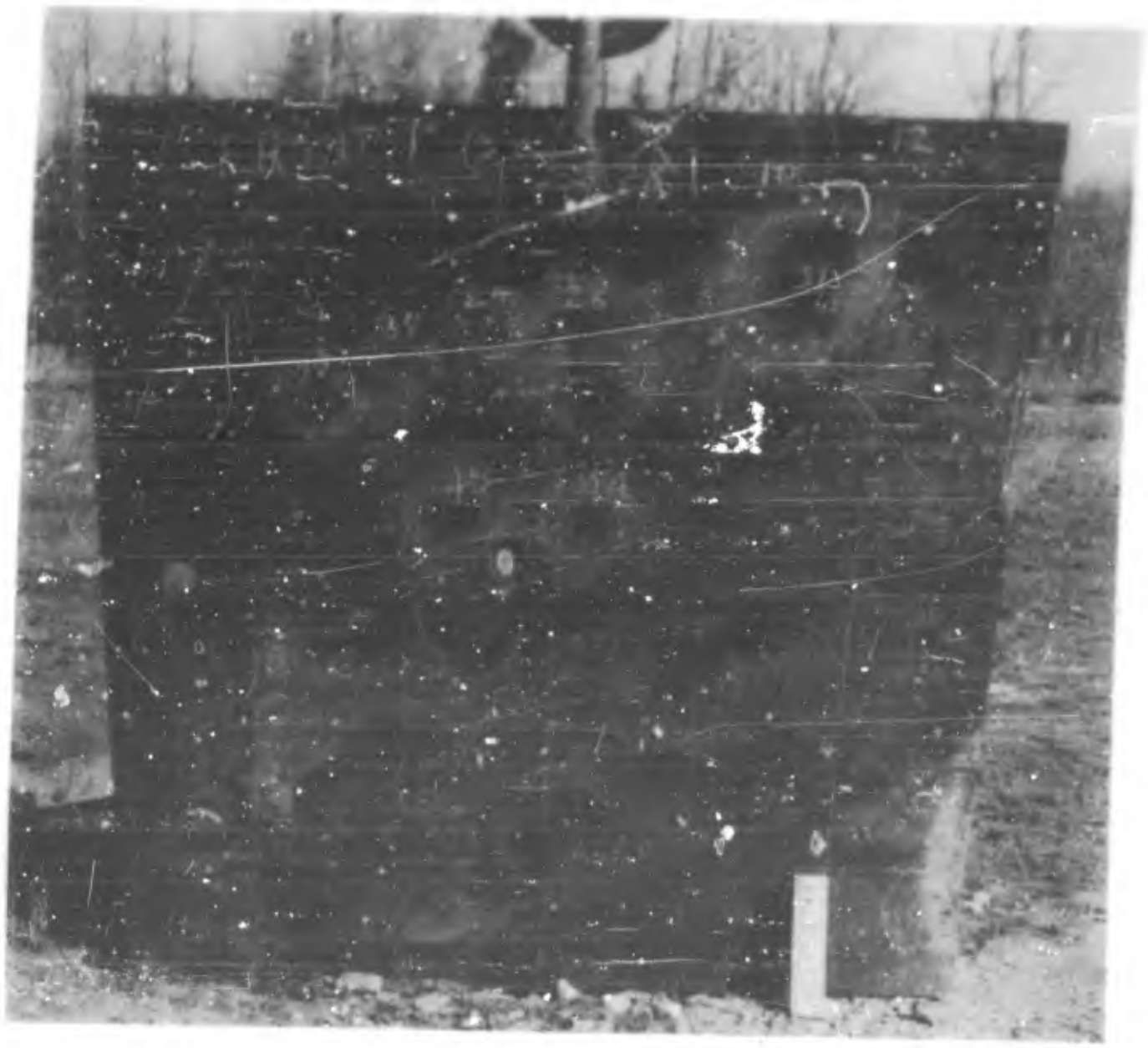
B23811 - Penetrations in 1 inch thick witness plate positioned 6 inches behind 4 inch thick target plate.



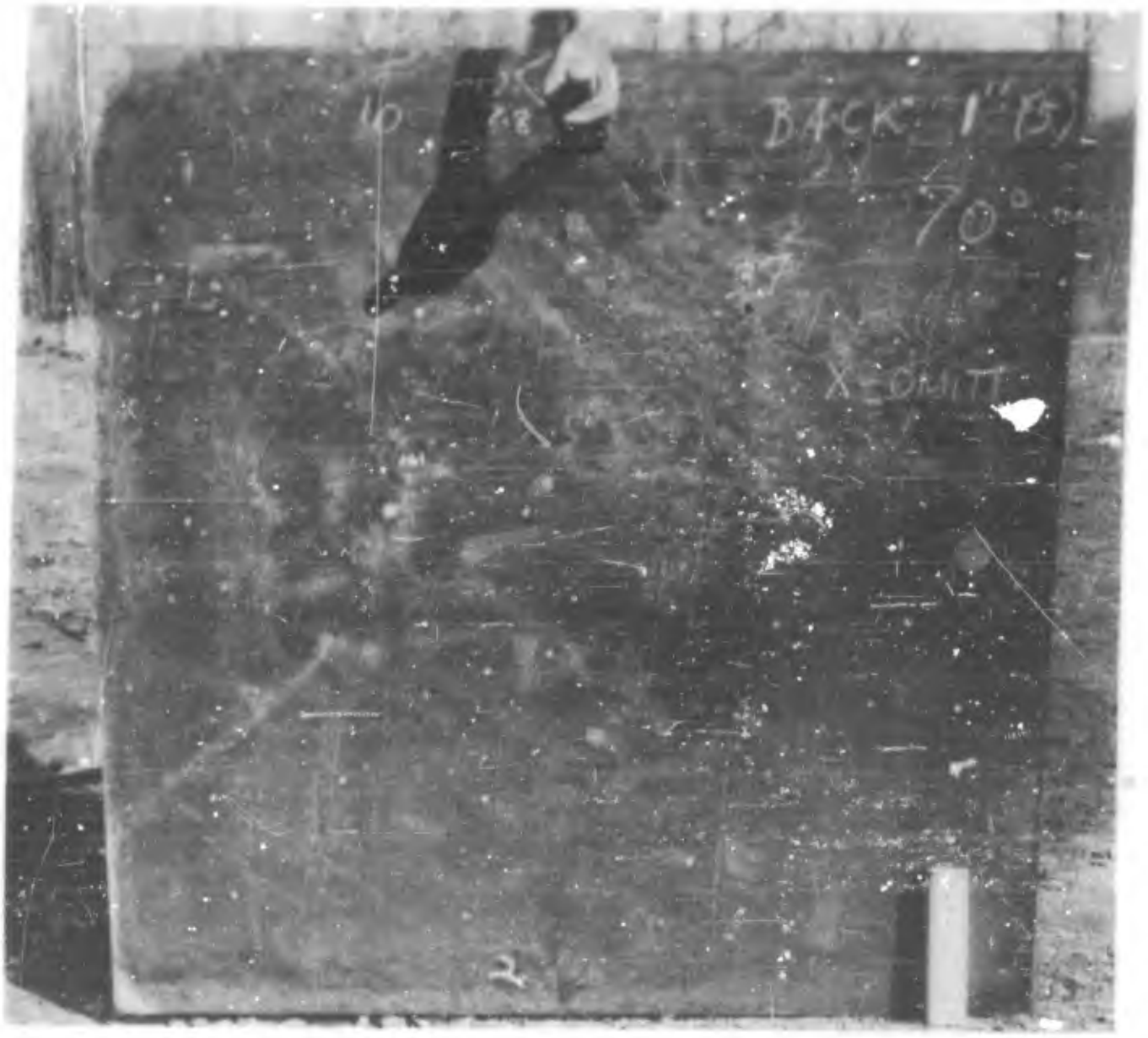
B23812 - Penetrations in 5 inch target plate with ammunition conditioned at 70°F. Plate normal to line of fire.



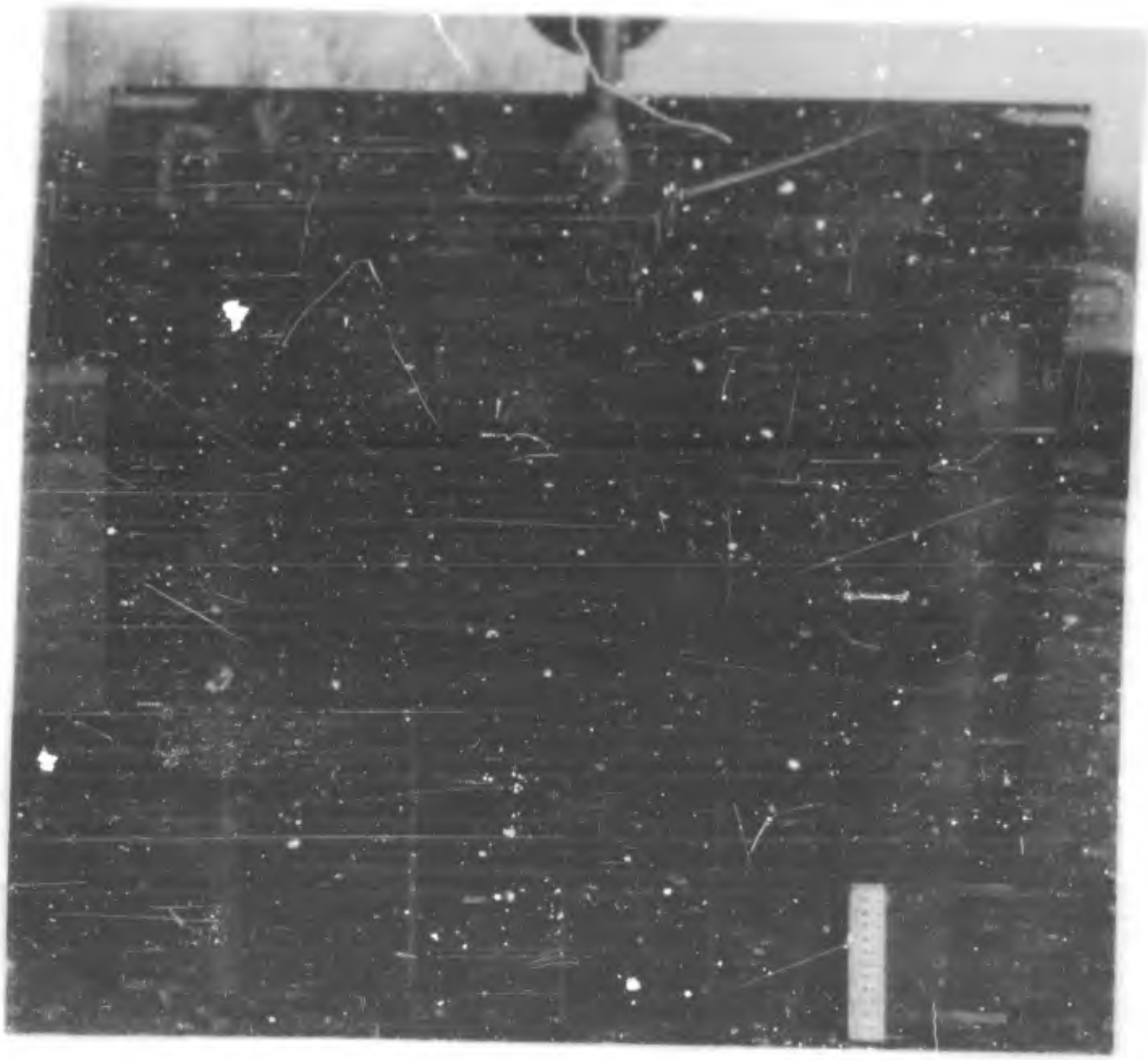
B23813 - Penetrations in 5 inch target plate with ammunition conditioned at 70°F. Plate normal to line of fire.



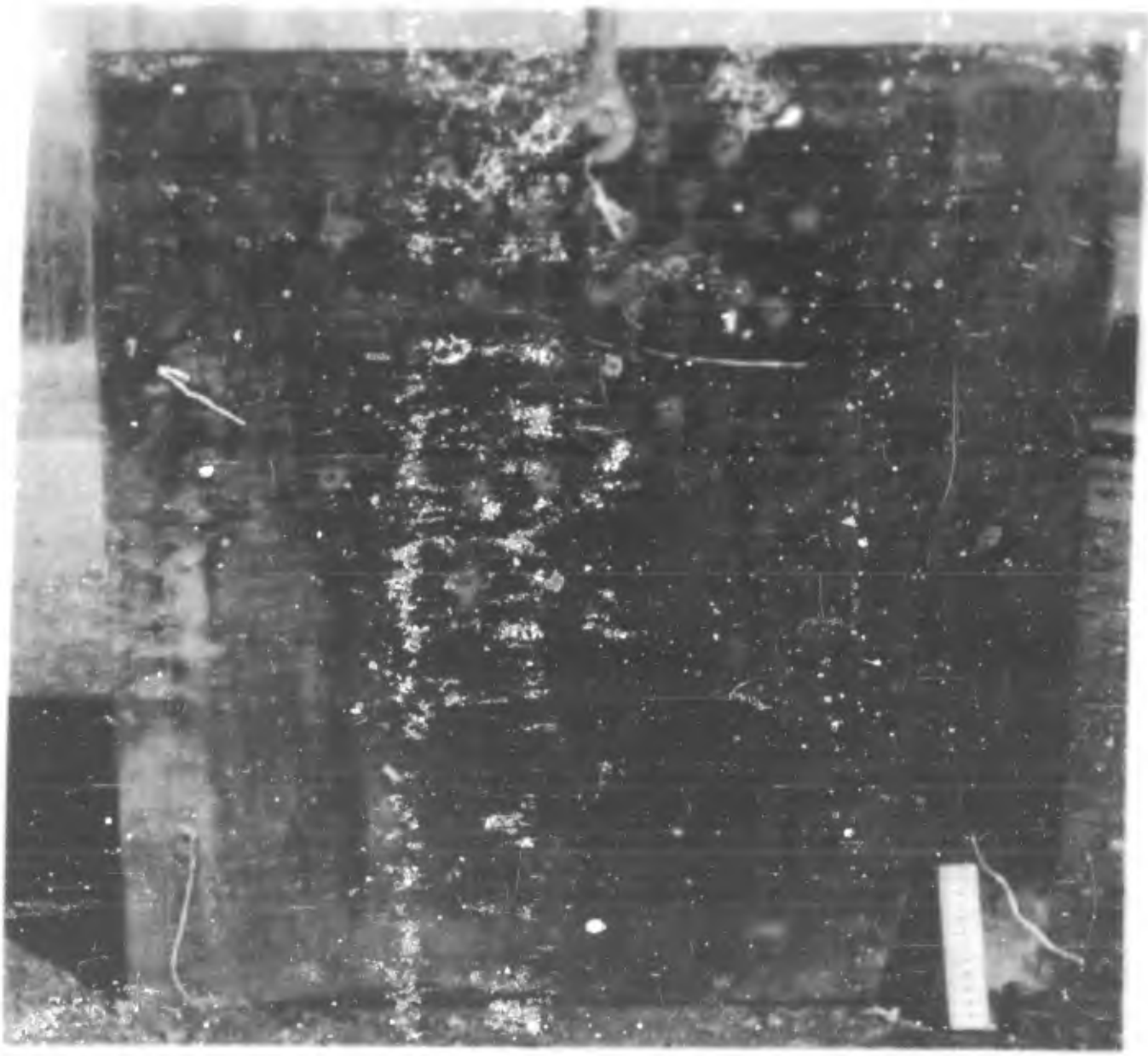
B23814 - Penetrations in 1 inch thick witness plate positioned 5 inches behind 5 inch thick target plate.



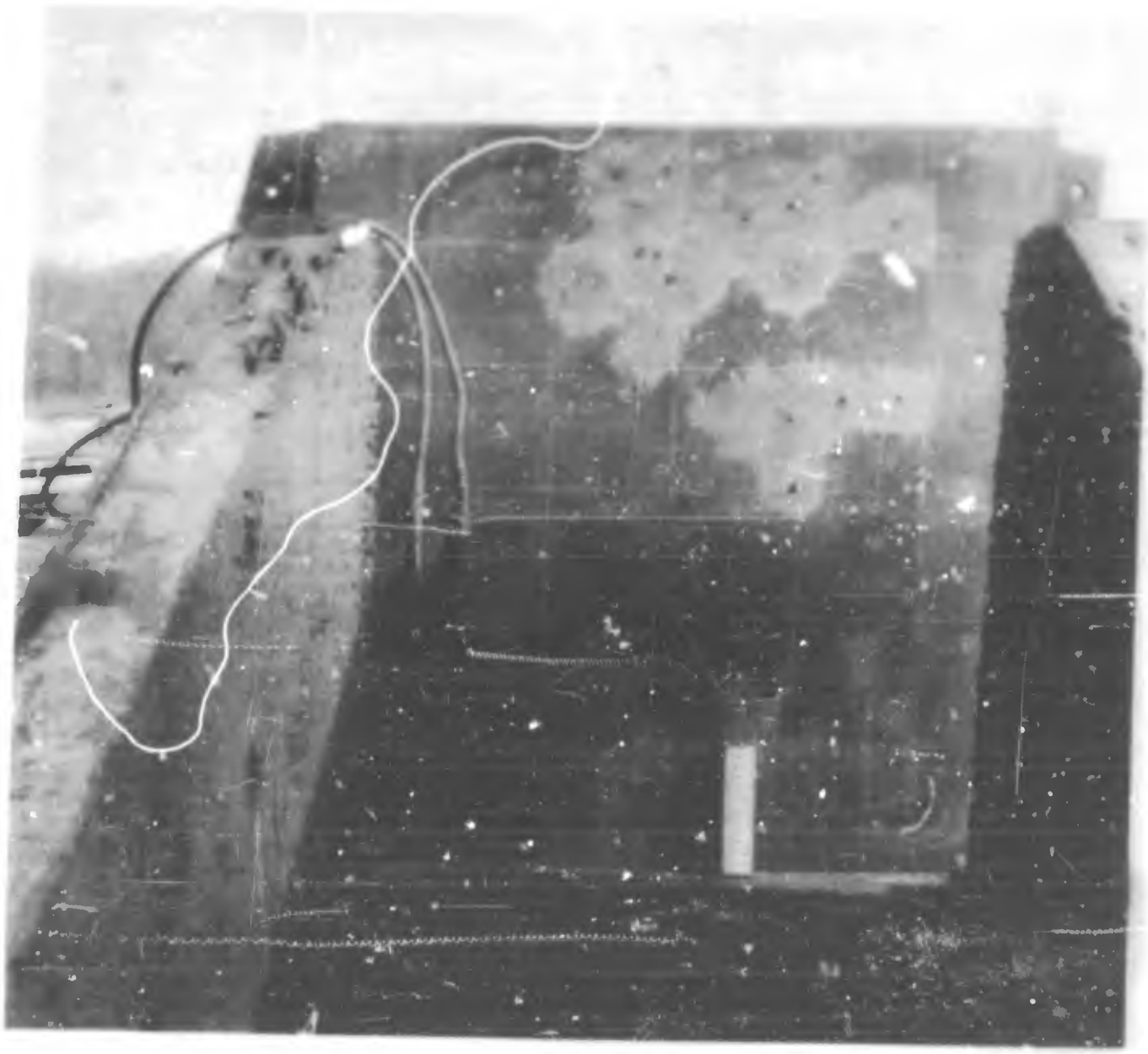
B23815 - Penetrations in 1 inch thick witness plate positioned 5 inches behind 5 inch thick target plate.



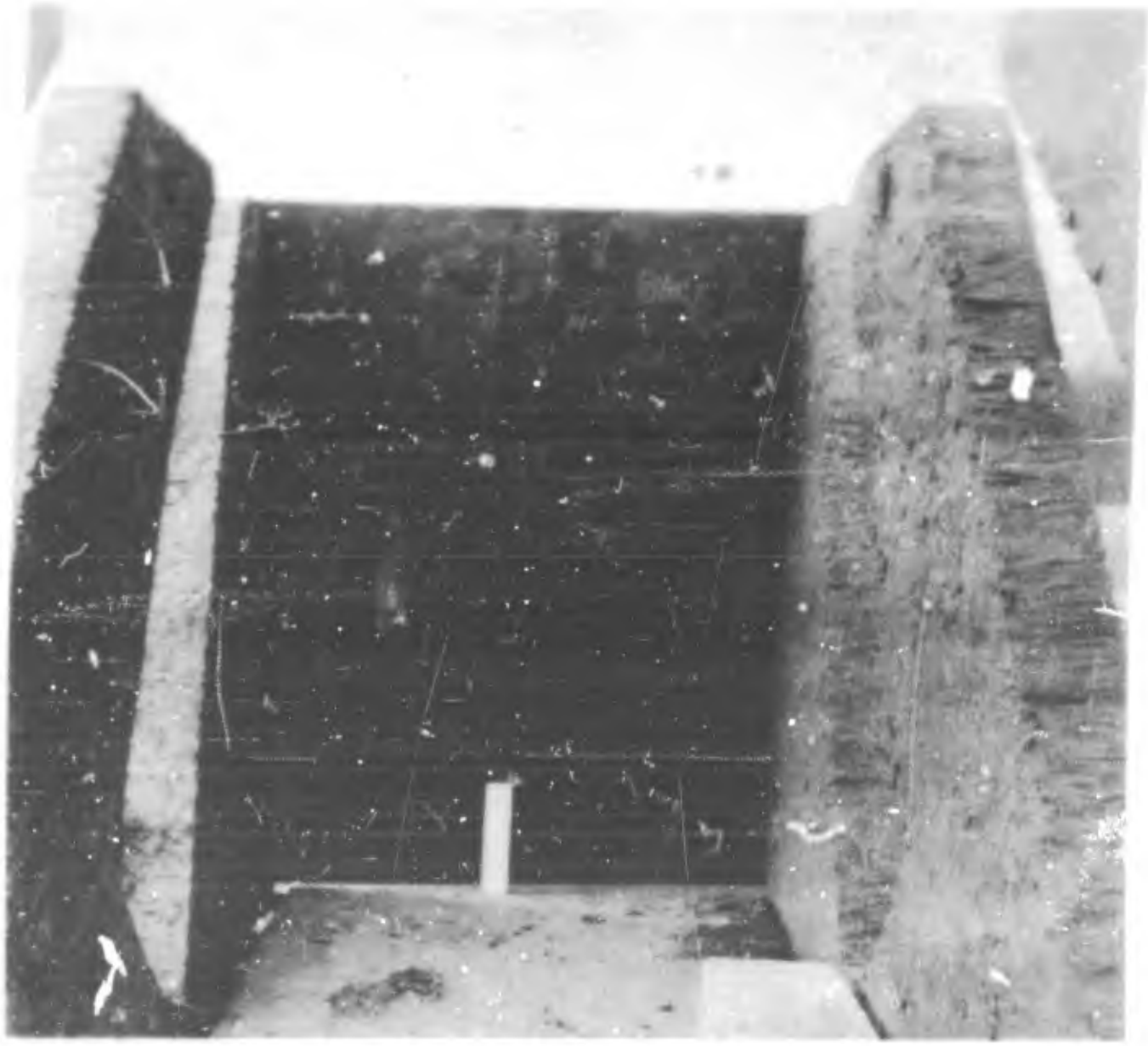
B23816 - Penetrations in 5 inch target plate with ammunition conditioned at -40°F. Plate normal to line of fire.



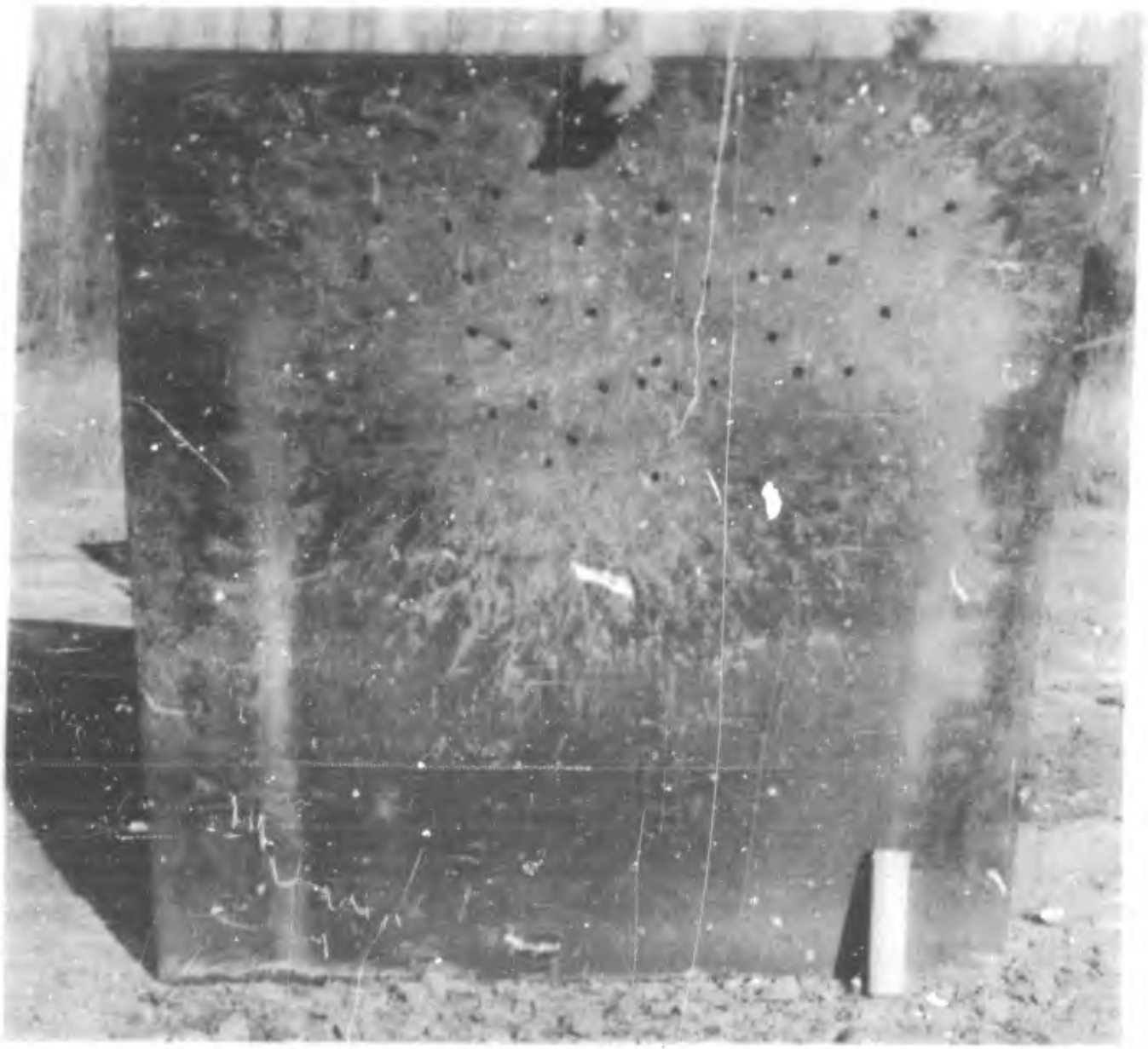
B23617 - Penetrations in 5 inch target plate with ammunition conditioned at -40°F. Plate normal to line of fire.



B23818 - Penetrations in 1 inch thick witness plate positioned 5 inches behind 5 inch thick target plate.

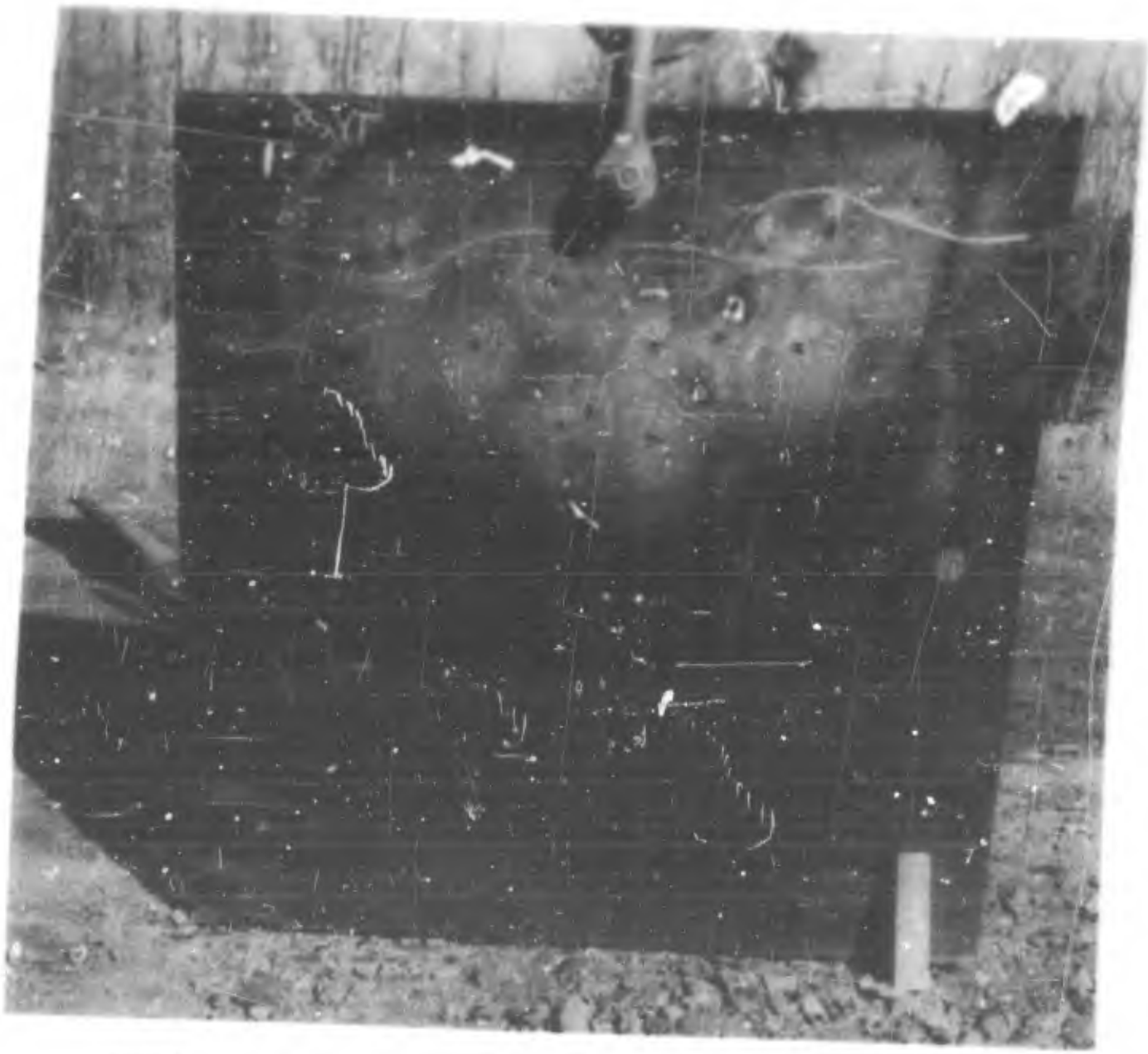


B23819 - Penetrations in 1 inch thick witness plate positioned 5 inches behind 5 inch thick target plate.

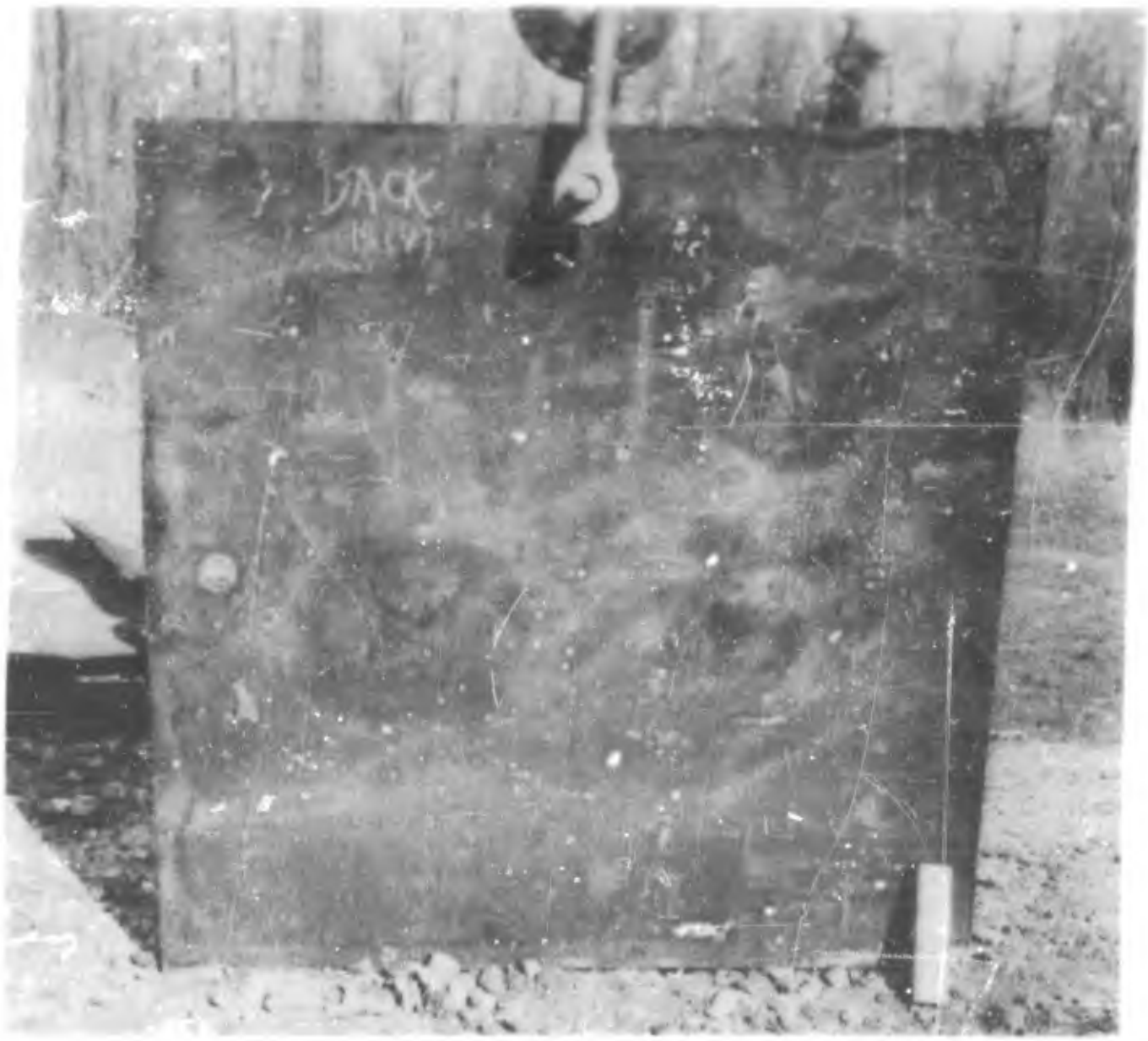


D23820 - Penetrations in 4 inch thick target plate with rounds: 1-21 conditioned to: -65°F and 22-45 conditioned to: -40°F. Plate normal to line of fire.

B23821 - Penetrations in 4 inch thick target plate with rounds: 1-21 conditioned to: -65°F and 22-45 conditioned to: -40°F. Plate normal to line of fire.



B23822 - Penetrations in 1 inch thick witness plate positioned 6 inches behind 4 inch thick target plate.



P23823 - Penetrations in 1 inch thick witness plate positioned 6 inches behind 4 inch thick target plate.

APPENDIX C

EXPERIMENTAL AMMUNITION DATA CARD

Cartridge, 40MM, M385A1 (Mod) With Fuze PD, M904A1
For 40MM Rifle

150

DWG. NO.	DWG. DATE OR REV.	ADDED VENTS	PROJECT NO.	BAG OR TAPE NO.	QUANTITY IN SHIPMENT
75-1-813	8-25-55		TA3-0804		
F.S.S.D.	PRIM CHARGE	EXPLOSIVE D.V.	EXPECTED PRESSURE	ASSEMBLED BY	DATE OF ASSEMBLY
3756-05-300	14.16 mgm	1200 Ft./sec	5000 lbs/sq in.	PA	October, 1956

REMARKS: Packed: 1 Cartridge/fiber container; 4 fiber containers/wood box.
Wt of Projectile 2.75 lbs. Shell loaded in accordance with drawing PX-13-1641 dated 28 January 1954. Pellet Booster Pent. 75-14-472C manufactured of PBX minimum density 1.60. Liner and Tube Assembly are numbered and this number is stenciled on outside of each shell. To be tested at APG in accordance with test program request No. 4605. Tes. of 2C rounds at PA: 6 rounds at ambient temp, 7 rounds conditioned at -65°F for 16 hours and fired (Over)

COMPONENT	Base Cartg	Primer	Liner	Powder	Shell HEAT	Fuze PD	Spacer
KIND	37MM	Perc	Polyethylene	Propellant	M307A1 (Mod)	M904A1	Felt
	M30A1B2	M66A1		M10	37MM MPTS		
DWG. NO.	FD-15105	74-2-68	71-2-153		PX-13-1462	73-2-236	75-11-472D
DWG. DATE OR REV.	Rev. 7	Rev. 7	9-14-53		9-8-53	Rev. 1	Rev. 7
MFG'D. BY	FA	Kingsbury	unk	Indiana	**	PA	PA
DATE	1949	1954	unk	1953	1956	1951	1956
LOT NO.	FA-4-2	KOP-53-3	unk	IA-29015	none	PA-403-10	None

PREPARED BY A. Kurtulik — CERTIFIED TO BY: W. Kishpaugh — INSPECTOR

Ars Opers — DIVISION

PICATINNY ARSENAL 916
DOVER, NEW JERSEY

Inspection — DIVISION

Card No. 83539

REMARKS: at -65°F, and 7 rounds conditioned at 125°F for 16 hours and fired at 125°F. 3" Class B Homogeneous Armor Plate used as target for all rounds. M18 Rifle placed 150 ft. away from the target plate with lineof fire at angle of 36° with a perpendicular to the plate (i.e an angle of 54° between the plane of the plate and the line of Fire).
Two 1" thick mild steel witness plates placed together and parallel to the armor plate. 6" Air space between armor plate and witness plates. Depth of penetration produced by each round measured by probing to nearest 0.1". Non-functioning or mal-functioning recorded. **Shells mfg'd by FA and Mod by PA. Liner and Tube Assembly furnished by SFAL.

COMPONENT	Pellet	Charge
KIND	Booster PBX	Bursting
DRG. NO.	75-14-472C	
DWG. DATE OR REV.		
MFG'D. BY	PA	Holston
DATE	1956	1956
LOT NO.	none	HOL-7-1694

Exp. Amm. Data Card No. 83539 - Lot No. PA-E-24034

APPENDIX C

EXPERIMENTAL AMMUNITION DATA CARD

NO. 83540

	KIND: Cartridge, HEAT, M307A1 With Fuze, PI, M90A1 57MM Rifle	AMM. LOT NO.: PA-E-24035
SPEC. NO.: PA-PD-558/ECO-127125-S, 130283-S		QUANTITY IN LOT: 25

DRG. NO.	DWG. DATE OR REV.	ALLOT. ADVICE	PROJECT NO.	RAD OR EPO NO.	QUANTITY IN SHIPMENT
75-1-215	3-25-55		TA3-5204		
P.A.I.O.	**PROP. CHARGE**	**EXPECTED M.V.**	**EXPECTED PRESSURE**	**ASSEMBLED BY**	**DATE OF ASSEMBLY**
3056-06-300	14.16 ozs*	1200 ft/sec.	5000 lbs/sq in	PA	October, 1956

REMARKS: Packed: 1 Cartridge/fiber container; 4 fiber containers/wood box. *Wt Projectile 2.75 lbs. Shell loaded in accordance with Dwg 75-14-472, Rev. 4-28-53 with ANR'S 24208 and 24951. Pallet Booster Pcmk. 75-14-472C mfg'd Inert. To be tested at APG in accordance with Test Program request No. 4605. Shell loaded in accordance with Dwg. 75-14-472 Rev. 4-28-53/ANR'S 24208 and 24951.

(Over)

COMPONENT	Case Cartg	Primer	Liner	Pwd Prop	Shell HEAT	Fuze PI	Spacer
KIND	57MM M30A1B1	Perc. M60A1	Polyethylene	M10	M307A1 57MM MPTS	M90A1	
DRG. NO.	FD-15105	74-2-68	71-2-153		75-2-353	73-2-236	75-14-472D
DRG. DATE OR REV.	Rev. 7	Rev. 7	9-14-53		4-28-53	Rev. 7	
MFG'D BY	FA	Kingsbury	unk	Indiana	FA	PA	PA
DATE	1949	1954	unk	1953	unk	1951	1956
LOT NO.	FA-4-2	KOP-59-3	unk	IA-39015	Mixed	PA-409/10	none

PREPARED BY A. Kurtulik, Ars Opers DIVISION

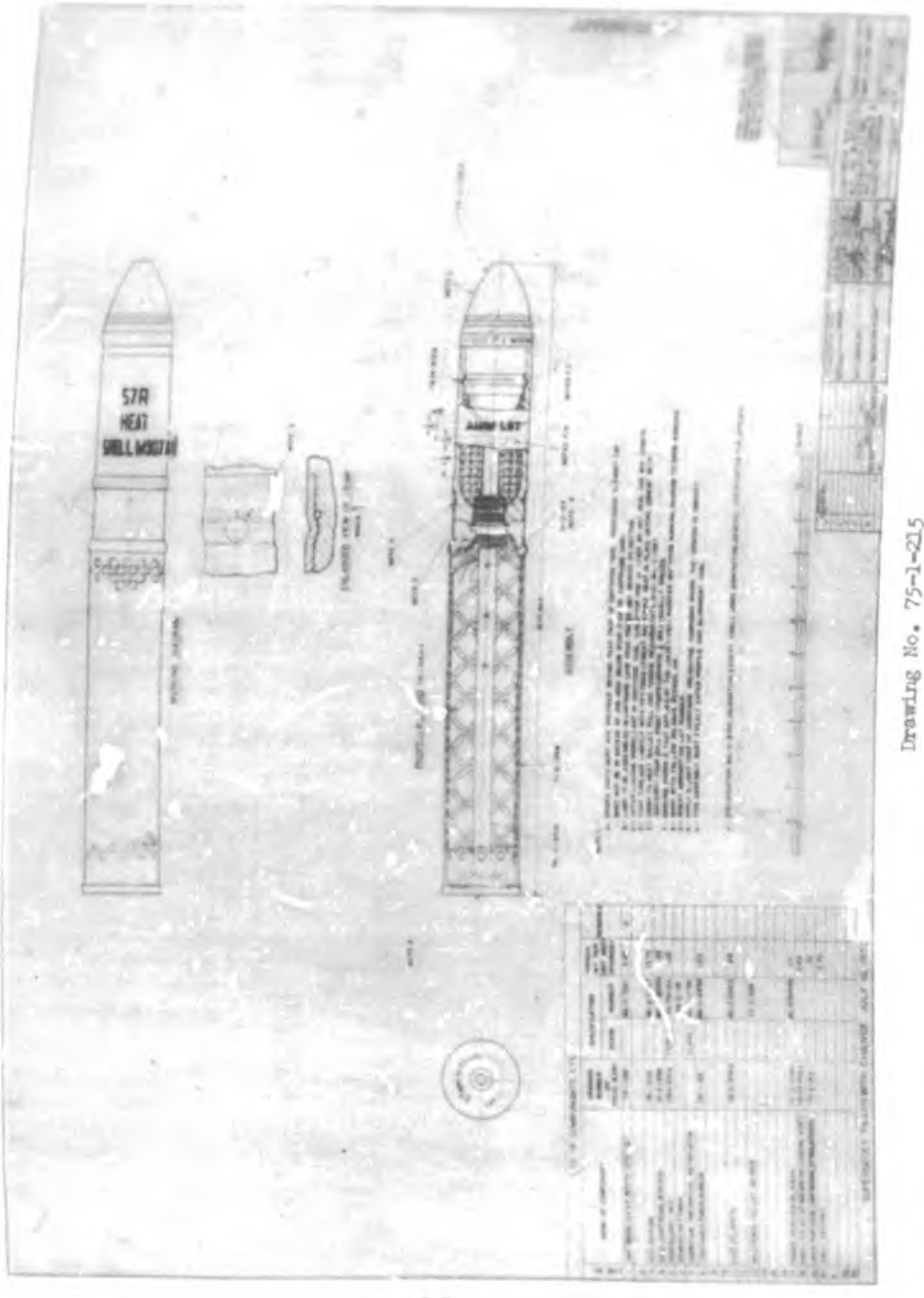
PICATINNY ARSENAL 916
DOVER, NEW JERSEY

CERTIFIED TO BY: W. Kishpaugh INSPECTOR, Inspection DIVISION

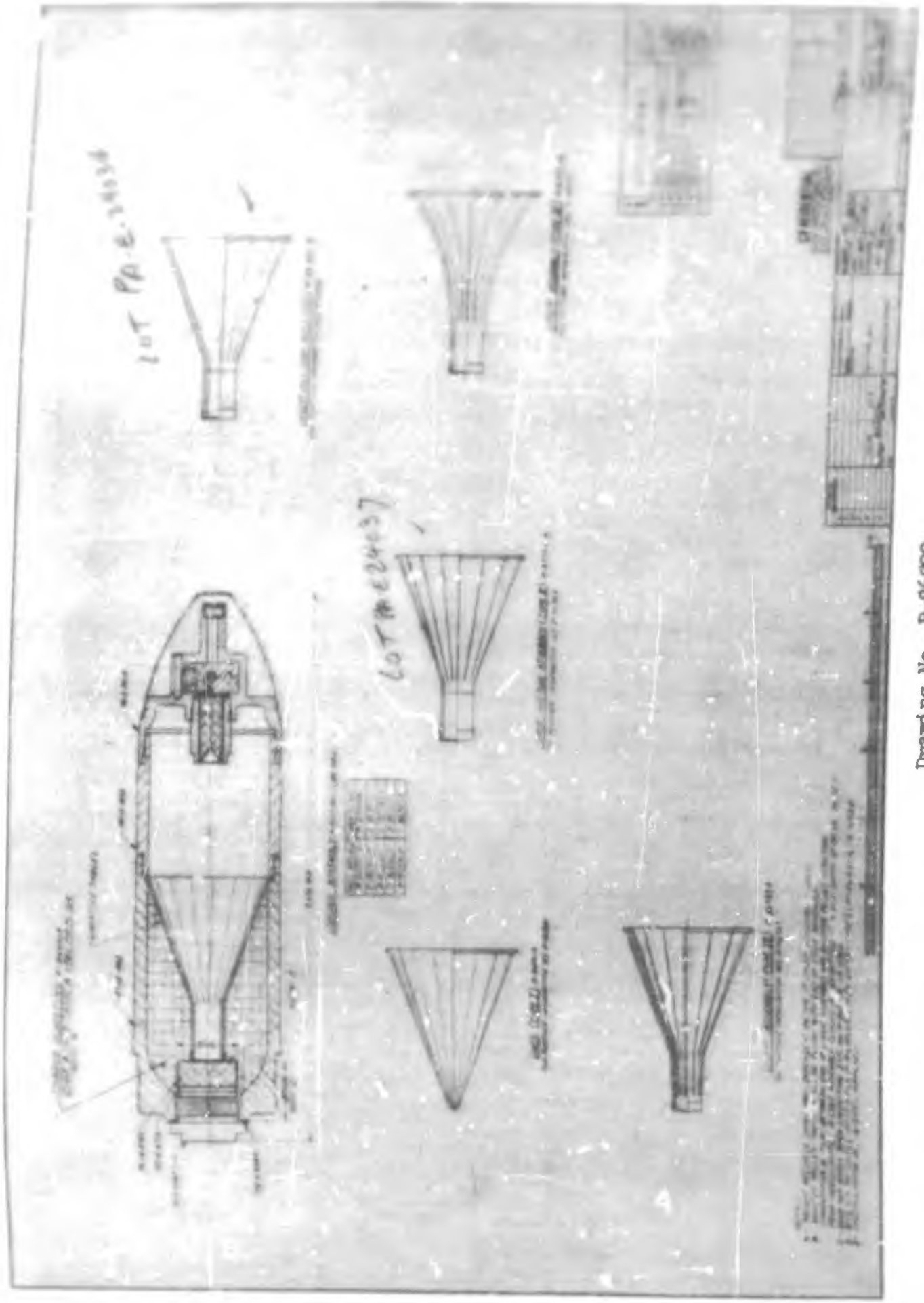
Card No. 83540

COMPONENT		
KIND	Pellet Booster Inert	Charge Bursting Comp. B
DRG. NO.	75-14-472C	
DRG. DATE OR REV.		
MFG'D. BY	PA	Holston
DATE	1956	1956
LOT NO.	none	HOL-7-1694

Exp. Amm. Data Card No. 83540 - Lot No. PA-E-24035



Drawing No. 75-1-215


LOT P8-E-24034
LOT P8-E-24037
Drawing No. P-86890

CONFIDENTIAL

APPENDIX I

IN REPLY
REFER TO:

OCT 16 '56 - 11 AM

ORDBG-TJ1 472.5/6-01 APG(C)472/306 1956

SUBJECT: Test Program Request Number TJ-1 Cartridge, HEAT, 57 mm, M307A1 (Modified) (U)

TO: Commanding General
Aberdeen Proving Ground
Maryland
ATTENTION: ORDBG-DPS

1. Inclosed is Test Program Request Number TJ-1 (C), D/A Priority 1B, for testing of subject items. These items, the descriptions of which are furnished in the inclosed test program request, will be shipped to your Proving Ground during the week of 8 October 1956.

2. Funding Data

Funds are available under Sub-Project Order No. 7040553O-01-30901-01, and Job Order No. 3056-06-901. The inclosed TPR was initially identified as No. 4605 but has been renumbered as TJ-1 (C).

3. Coordination

a. OCC-ORDTA

b. APG-D&PS

c. APG-BRL, Dr. R. J. Eichelberger

d. Picatinny Arsenal - Engineer primarily responsible for the test is Mr. C. E. Jacobson, phone Picatinny Arsenal, Extension 5220.

4. Notification for Test Attendance

Mr. C. E. Jacobson will attend the tests. Notice, two days prior to the firings, is requested.

FOR THE COMMANDER:

/s/
C. S. DAVIS
Assistant

1 Incl
1. TPR No. TJ-1
w/incls (6 cys)

CC
OCO-ORDTA w/incl 1
APG- Comp Office w/incl 1

"REGRADED UNCLASSIFIED WHEN SEPARATED FROM INCLOSURES"

CONFIDENTIAL

TEST PROGRAM REQUEST (PRELIMINARY ENGINEERING OR DEVELOPMENT TEST)

C.E.Jacobson/gek/5220
Test Program Request No.TJ-1(C)
(Job Order No.3056-06-901)
Picatinny Arsenal, Dover,N.J.
5 October 1956

1. Material for Test:

a. 180 - Cartridge, HEAT, 57mm, M307A1 (Modified), Dwg 75-1-215, rev 8/25/55, except for shell, PcMk P-868902, which contains a PBX booster pellet; Lot PA-E-24034, Data Card No. 83539

b. 100 - Shell, HEAT, 57mm, M307A1 (Modified), PcMk P-868900, except that shell contains a PBX booster pellet and a dummy auxiliary detonator in the fuze; Lot PA-E-24035, Data Card No. 83540

c. 25 - Cartridge, HEAT, 57mm, M307A1, Dwg 75-1-215, rev 8/25/55, except that shell contains an inert booster pellet; Lot PA-E-24037, Data Card No. 83542

2. Project Authority:

a. Ordnance Project Number: TA3-5204

b. Department of the Army Number: D/A 5204-07-001

c. Funds available under Sub-Project Order Number 70405530-01-30901-01, and Job Order Number indicated above.

d. D/A Priority 1B

3. Object of Development or Experiment:

To determine the effectiveness of 57mm HEAT ammunition containing shaped charge liners made by the rubber-covered-punch process.

4. History Sketch:

It is known that spin-stabilized HEAT ammunition gives poorer performance when fired dynamically than when fired statically without rotation. This has been found to be caused by rotation and spreading of the jet from the liner. To counteract rotational effects, a number of methods of spin-compensation have been devised. Both theoretical considerations and initial experimental tests indicated that a fluted liner was the best means

of compensating for spin. A number of test firings have been conducted with 57mm shell containing fluted liners made by the rubber-covered-punch process. The results obtained indicated superiority over 57mm shell containing the standard hemispherical liner (See para 10 - Reference). Further static tests were performed to determine the optimum wall thickness and forming pressure of fluted liners made by the rubber-covered-punch process.

5. Description in Detail of Improvements Made Since Last Proving Ground Test:

There have been no proving ground tests conducted under this project.

6. Local Tests:

Static spin and dynamic tests have been conducted (See para 10 - Reference). Additional static spin tests showed that fluted liners made with a forming load of 200 tons from blanks having an .065" wall gave optimum penetration values.

7. Object of Test:

a. To determine the effectiveness in dynamic tests of 57mm HEAT shell containing rubber-covered-punch process liners formed at 200 tons load and having an .065" wall.

b. To determine if the M90A1 fuze will initiate the Composition B bursting charge in an inert-boostered shell.

8. Precautions in Handling and Testing:

All precautions ordinarily taken when assembling and firing HEAT shell which may burst prematurely should be observed.

9. Recommended Test Program:

Fire all shell in this program using an M18 rifle at a range of 150 ft against an armor plate target placed perpendicular to the line of flight. Set up a 1" thick witness plate 6" behind the target. Detailed firing instructions are given below:

a. Fire 180 cartridges of Lot PA-E-24034 as follows:

(1) Subject 90 cartridges to conditioning at 70° ± 5°F for at least 16 hours. Fire 45 of these cartridges against 4" Class B armor plate and the remaining 45 cartridges against 5" Class B armor plate.

(2) Subject 90 cartridges to conditioning at -65° ± 5°F for at least 16 hours. Fire 45 of these cartridges against 4" Class B armor plate and the remaining 45 cartridges against 5" Class B armor plate.

(3) Observe and record the depth and character of penetration and note any premature bursts. Also record any instances in which the point of impact of any shell is closer than 3 hole diameters from the edge of the plate or another impact.

b. Assemble the 100 shell of Lot PA-E-24037 (See Dwg 75-1-215, rev 8/25/55) with cartridge cases containing enough propellant to develop 7280 psi which is 112% of the maximum rated pressure for the round. This pressure must be developed when the round is fired at a temperature of 125°F. Subject the cartridges to conditioning at 125°F ± 5°F for a minimum of 40 hours just before they are fired. Fire them for land impact and observe for evidence of functioning. Recovery of duds is not desired.

c. Subject the 25 cartridges of Lot PA-E-24035 to conditioning at 70° ± 5°F for a minimum of 16 hours. Fire the cartridges against any available target plate. Record evidence of smoke, flash, or noise at impact and depth of penetration obtained, if any.

d. All cartridges, when fired, shall be as close to the conditioning temperature as possible.

10. Reference:

Clift, G.D., Performance of 57mm Shell Containing Fluted Liners Coined by the Rubber-Covered-Punch Process (C), Picatinny Arsenal Technical Report 2293, July 1956.

11. Report Distribution:

a. Test Report security classification - Confidential.

b. 1 Copy - OCO-ORDTA, Mr. M. F. Massey
1 Copy - OCO-ORDTB, Mr. M. C. Miller
1 Copy - APG, D&PS
1 Copy - APG, BRL, Dr. R. J. Eichelberger
3 Copies - Picatinny Arsenal:
1 Copy - Attn: Inspection Division
1 Copy - Attn: ORDBB-TJ1
1 Copy - Attn: ORDBB-TH8

2 Incls
1. Dwg No. 75-1-215
2. Dwg No. P-86890

/s/ P. B. Tweed
for D. R. BERMAN
Acting Director, Samuel Feltman
Ammunition Laboratories

/s/
C. S. DAVIS
Assistant

REGRADING DATA CANNOT BE PREDETERMINED

ORDBB 471.1/31 2d Ind Mr.C.E.Jacobsen/vlm/3120
ATTN: ORDBB-TJ1
APG 471.1/361
SUBJECT: Ballistic tests of Modified M307A1 57mm Shell

Ord Corps, Picatinny Arsenal, Dover, N. J., OCT 2 '56 11 AM

TO: Commanding General, Aberdeen Proving Ground, Md.,
ATTN: ORLBG-DP-TA

1. The $3650. required to perform the subject tests is being transferred to your proving ground. The project on which this work is to be done is TA3-5204. The Job Order No. is 3056-06-901.

2. The question raised in paragraph 2 of the 1st Indorsement was answered during a telephone call from Mr. B. A. Rausch of this Arsenal to Mr. J. C. Moore of D & PS on 24 September 1956. As was explained then, this Arsenal will furnish the 25 standard M307A1 57mm HEAT cartridges. The 100 modified M307A1 57mm HEAT shell, referred to in paragraph 1c of the basic letter, will be furnished as fused projectiles. It will be necessary for your proving ground to furnish the other components, such as cartridge cases, primers, and propellant, and to assemble the complete round.

3. Due to a change in Arsenal procedures, the Test Program Request for this work has been renumbered as Test Program Request No. TJ-1. It is expected that the Test Program Request will be transmitted to Aberdeen Proving Ground in about two weeks.

FOR THE COMMANDER:

/s/

PAUL B. TWEED
Assistant

ORDEC-DP-31 1st Ind Mr.JCMocre/jlw/32154
APG 471.1/361
PA 471.1/31
SUBJECT: Ballistic Tests of Modified M307A1 57mm Shell

Ord Corps, Development and Proof Services, Aberdeen Proving Ground, Md.

TO: Commanding Officer, Picatinny Arsenal, Dover, New Jersey SEP 17 1956
ATTN: ORDEB-TJ.

1. Reference is made to Paragraph 1 of basic communication. The cost estimate of the tests as outlined is $3650.00.

2. A review of the stock records at this proving ground has indicated that there are not any Pentolite loaded M307A1 (original) shell available for the firings referred to in Paragraph 1.c. It is, therefore, requested that your arsenal furnish the twenty-five standard Cartridge, HEAT, Pentolite loaded, M307A1, 57mm Rifle, M18A1, along with the 280 modified Shell, HEAT, M307A1.

3. Your arsenal will be notified of the firing schedule in advance so that interested personnel may be present.

/s/

T. F. COLLEGAN
Director

E-6

ORDNANCE CORPS
PICATINNY ARSENAL
DOVER, NEW JERSEY

IN REPLY
REFER TO:
SAMUEL FELTMAN AMMUNITION LABORATORIES
ORDBB-TJ1 471.1/31

Mr.B.A.Rausch/vka/6275

APG 471.1/361 (1956

SUBJECT: Ballistic Tests of Modified M307A1 57mm Shell

TO: Commanding General
Aberdeen Proving Ground
Maryland
ATTENTION: Development and Proof Services

1. A test program has been planned to evaluate ballistically a number of modified M307A1 57mm shell. This Arsenal requests an estimate of the cost of the following tests:

a. Firing of 180 Modified M307A1 57mm HEAT cartridges, 90 against 4" and 90 against 5" homogeneous armor plate (Class B). Six inches behind the armor plate and parallel to it, there should be a 1" thick mild steel witness plate. A record of depth and character of penetration will be required.

b. Firing of 100 Modified M307A1 57mm HEAT shell at 125°F for ground impact. In preparation for firing these shell are to be assembled by Aberdeen Proving Ground with cartridge cases and enough propellant to give 7280 psi, which is 112% of the maximum rated pressure for the round. Any pressures shall be recorded.

c. Firing of 25 Standard M307A1 57mm HEAT cartridges against 4" armor plate. No witness plate is necessary. A record of depth and character of penetration will be required.

2. Picatinny Arsenal Test Program Request No. 4605 giving a detailed description of the work outlined above is being prepared and will be transmitted to Aberdeen Proving Ground in the near future.

FOR THE COMMANDER:

/s/

C. S. DAVIS
Assistant