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TECHNICAL REPORT NO. 74-16

105mm SUBCALIBER TRAINING DEVICE

Final Report

By
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Munitions Branch

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This is the final Report of the 105mm Subcaliber Training Device program. The purpose of this program was to design, test, and demonstrate feasibility of a Subcaliber Training Device which could be fired from the 105mm M68 Gun on the M60 and M60A1 Tanks. The Training Device would be used in training exercises where the actual round could not be used because of safety requirements. (continued)		

Continuation of Block 20:

The Training Device approximates the actual 105mm Round in size and weight. It consists of a .50 Caliber Spotting Rifle barrel and a specially designed bolt and breech mechanism inside a simulated 105mm shell body. The Caliber .50 M48A1 Spotter Tracer Round is fired from this simulated shell using the 105mm M68 Gun firing system on the M60 Tank. Compensation for the initial velocity difference (1780 fps versus 2400 fps) is accomplished by a special cam for the M13 Tank Gunfire Range Computer.

The final design was evaluated by 1st Armored Division in Germany and the results of these tests are included in this report.

FOREWORD

This program was conducted by the US Army Land Warfare Laboratory in response to a request from the Commanding General, USAREUR, for a 105mm training device. The 105mm Subcaliber Training Device Program was conducted under LWL Task 07-F-70 as authorized by DA R&D Project 2X663701D718.

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INTRODUCTION

Armored Forces in Europe are being more and more restricted in training exercises which use 105mm Rounds because of the reduction and restriction of ranges where the full-size rounds may be safely fired.

This training device simulates the operation and trajectory of the 105mm HEP-T Round. It is a self-contained unit with the same shape and weight as a regular shell and is fired from the M68 Gun System on the M60 Tank without modification to the gun, tank or firing system. The device was developed to allow training to be conducted in areas which have range limitations that do not permit main gun firing. In addition, the Subcaliber Device costs approximately \$1.00 for each firing, while the full-size rounds cost approximately \$70.00 to \$80.00 each.

DEVELOPMENT AND TESTING

1. General

In April 1970, the Commander, USALWL, visited USAREUR and the Commander of USAREUR indicated a need for a Subcaliber Training Device which would allow training at bases where the firing ranges were too short or too restricted to allow firing of the full-size 105mm rounds.

In June 1970, USALWL Project 07-F-70, 105mm Subcaliber Training Device was initiated. The original request was for a Caliber .50 M48A1 Spotter Tracer Round which would be modified or uploaded so that its velocity and trajectory would match the 105mm HEP-T Round out to 1500 meters. Investigation into this approach indicated that the round could not be significantly uploaded without increasing its volume. In addition, the barrel was too thin for any substantial increase in the gas pressure.

The cost of developing and testing a new or modified Caliber .50 Round appeared to be so prohibitive that this approach was discarded.

An investigation into training rounds of different calibers and the British L11A2 Spotter Tracer Round resulted in the decision to use the standard Caliber .50 M48A1 Spotter Tracer Round with a modification to the range cam in the M13 Gunfire Range Computer to compensate for the lower velocity.

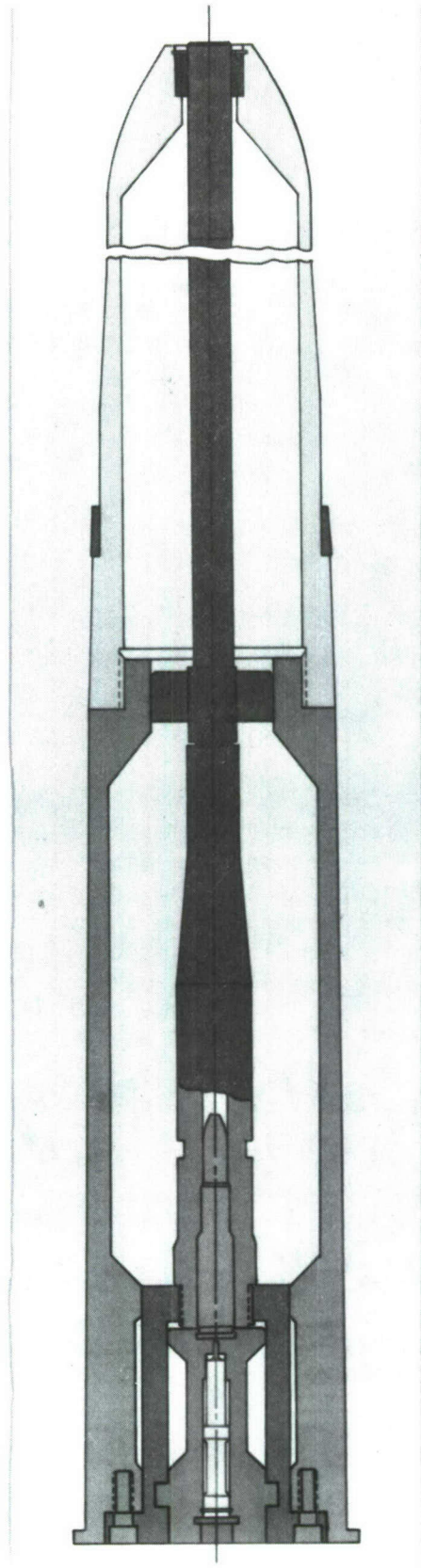
2. Description of Designs

A first design was completed (see Figure 1) and tests were started in December 1970. These tests, recorded in Appendix A, indicated a need to reduce the tolerance build-up between the component parts of the subcaliber barrel and the locating dimensions on the exterior diameters. In addition, the test firings indicated that decomposition products from the electrically initiated primer was causing residue to build up in the tube. After 10 to 20 shots, the firing pin in the bolt assembly tended to jam because of the carbon build-up.

A second design with three modifications was fabricated. These modifications included:

- a. A chamber into which the primer discharged and from which the gas pressure was vented into the firing pin.

- b. A component redesign so that the tolerance build-up between the subcaliber barrel and the mounting dimensions on the exterior of the training device was reduced by two-thirds. This was accomplished by combining two mating parts into one piece in a number of cases and reducing the tolerance on the other pieces.



105 MM SUBCALIBER TRAINING DEVICE

FIGURE 1

c. A safety feature which required that the bolt be rotated and locked in firing position before the insertion tool could be removed. This final design is shown in Figure 2. The bolt design is shown in Figure 3.

This new design never jammed from residue build-up even after several hundred firings. However, for maintenance purposes it was recommended that the bolt assembly be disassembled and cleaned after each day's firing.

3. Cam Design

The gunfire range cam was designed using the following information from FCDD-305, Department of the Army Notes on Development Type Material, Primary Fire Control System Tank, 90mm Gun, M48, pages 66-103 (this section of the report dealt with the M13 Gunfire Range Computer for the 105mm Gun). A copy of this report is available at the Aberdeen Proving Ground Technical Library.

$$D = 1.7782 - \frac{X^0 (.2655)}{122.3^0}$$

$$X^0 = 61.78 - 327.4068854 \log_e (1.5 - e^{0.1749987(2 \log_e R - 3.11528)})$$

Where: D = Diameter of Cam

R = Range, in 1000 yards

X = Angle of Cam Travel (at 0^0 , D = 1.7782")

The range is related to the mils superelevation of the gun by the constant:

$$3^0 \text{ cam rotation} = 1 \text{ mil superelevation}$$

or

$$1^0 \text{ cam rotation} = 1/3 \text{ mil superelevation}$$

Then when the range/mils superelevation relationship (firing table) is known for any shell or bullet, a cam which will give the proper superelevation of the gun for the desired range (which is input into the M13 Gunfire Range Computer through the range dial on the computer) can be designed.

A computer runout showing the relationship between range, cam angle, gun superelevation, and the diameter "D" of the gunfire range cam was used for designing the cam. The following chart shows how the cam design was constructed:

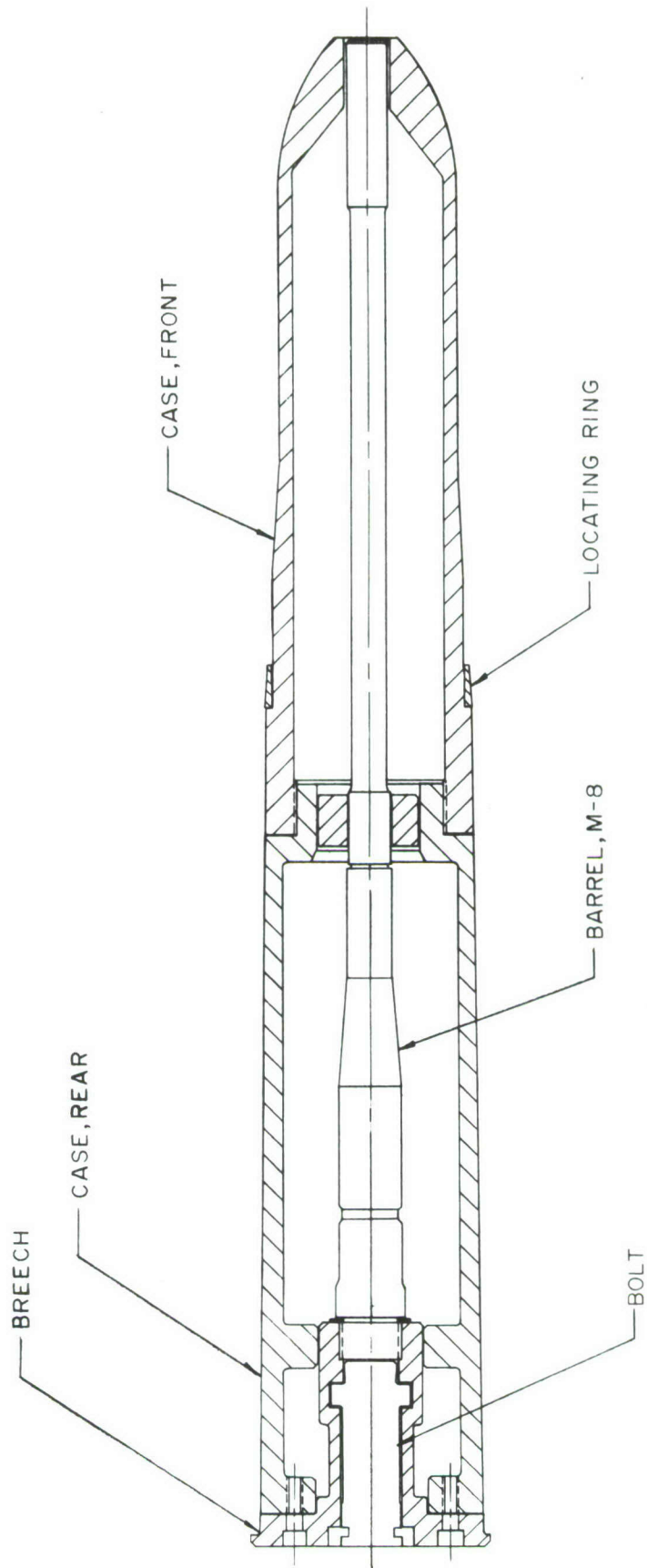


FIGURE 2. 105mm SUBCALIBER TRAINING DEVICE

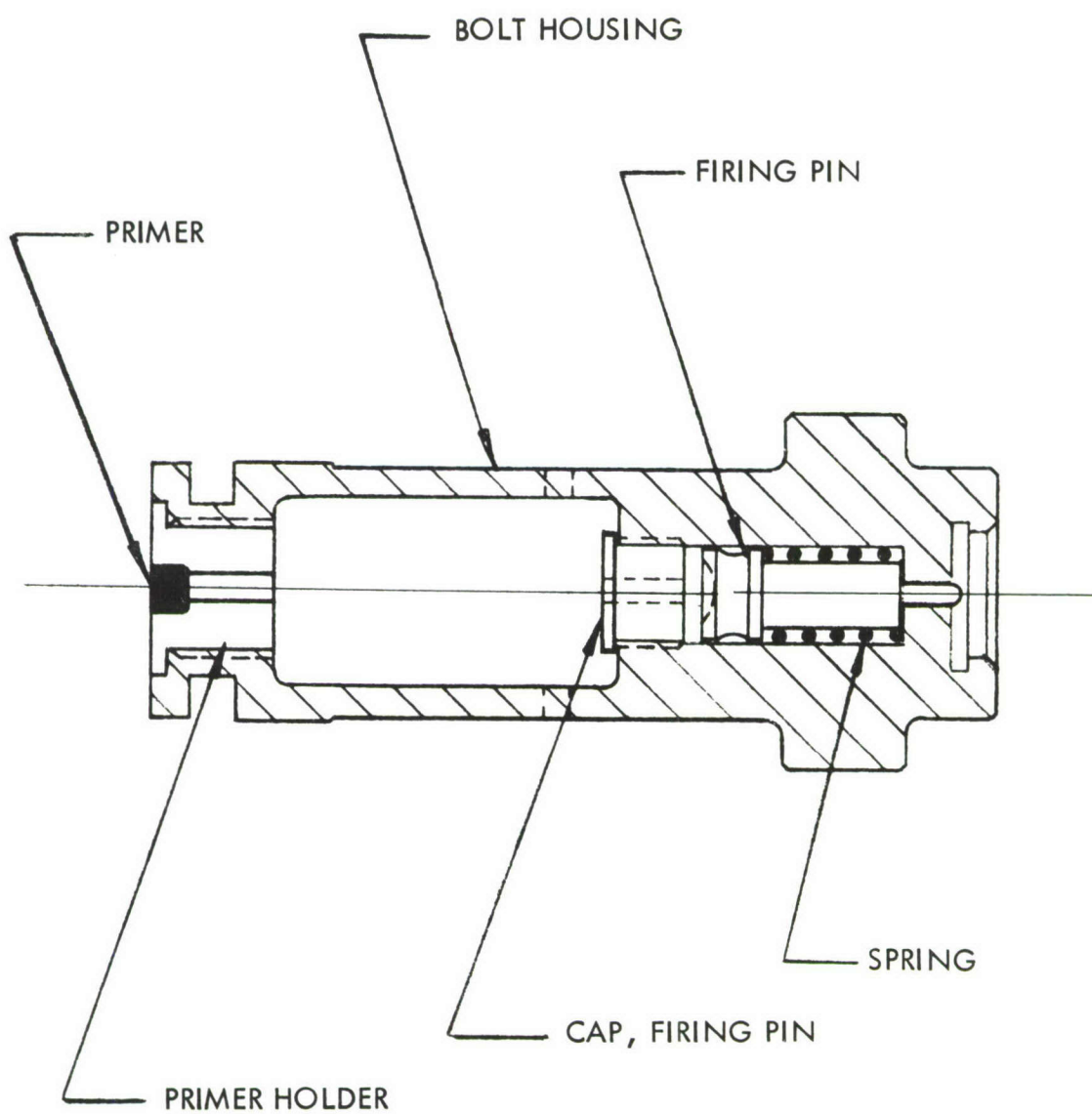


FIGURE 3. BOLT

Construction of Cam Design

Table 1

Step	X Cam Rotation Degree	Range Yards	Elevation Mils	Diameter "D"	Drop D ₁ -D ₂	Difference
0	-11°	0	0	1.8525	-	-
1	-10°	24.942	1/3	1.8525	0	0
2	-9°	43.761	2/3	1.8338	.01860	.01860
3	-8°	62.404	1	1.8198	.03270	.01409
4	-7°	80.873	1-1/3	1.8081	.04437	.01167
-	-	-	-	-	-	-
11	0°	205.43	3-2/3	1.7537*	.09737	.00612

* At 0° on the cam this value would normally be 1.7782 but it was moved back 3° to cause the superelevation produced by the cam to more nearly agree with the superelevation actually used when conducting accuracy and dispersion firings at a range of 1500 yards.

The cam detail is shown in Figures 4 and 5.

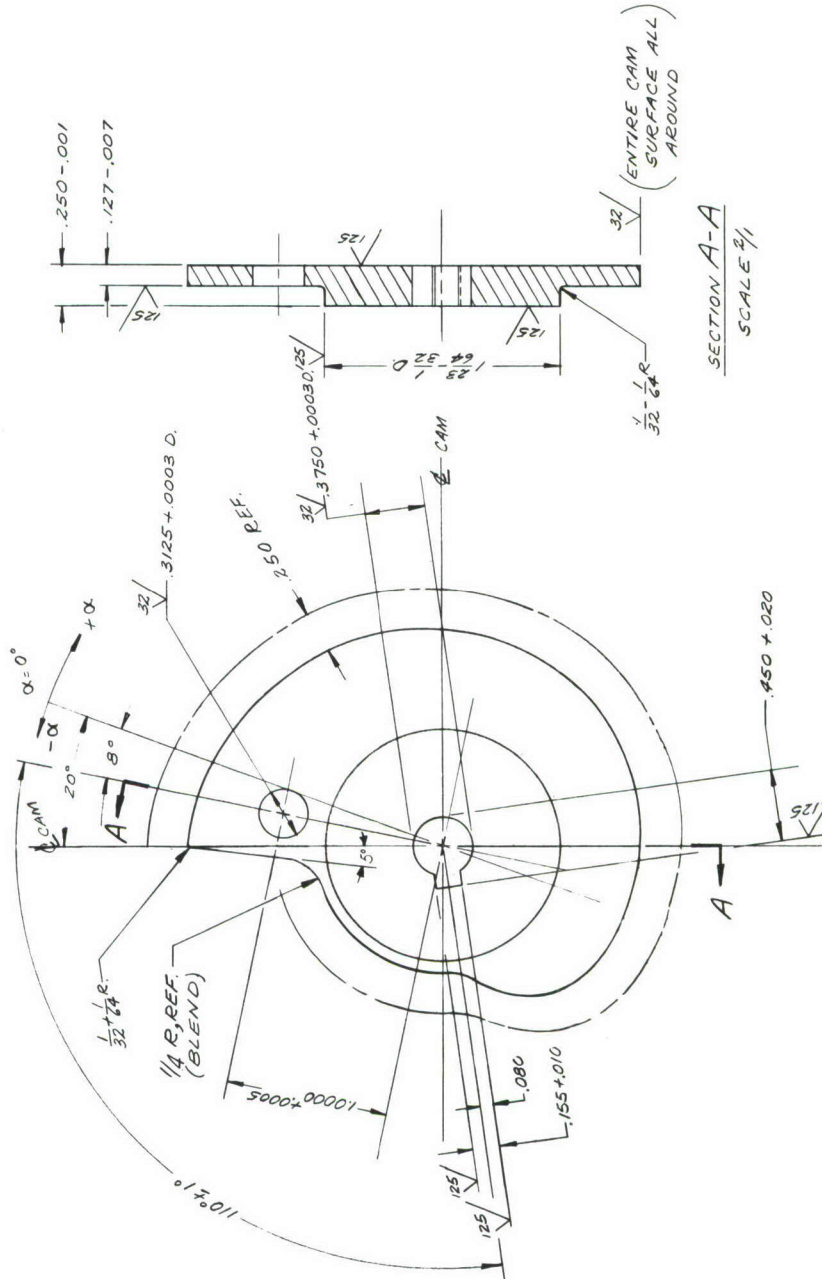
The cam was made and tested from 500 to 1500 meters. Since we had the mils superelevation used when firing accuracy and dispersion test at 500 and 1500 yards, a comparison of elevation used when firing at these two distances were made:

Comparison of Elevation

Table 2

<u>Range Yards</u>	<u>Firing Table Elevation Mils</u>	<u>Mils Used When Firing</u>	<u>Difference</u>
500	9.8	8.3	1.5 mils
1500	41.5	39.8	1.7 mils

Using these results, the cam zero or starting point was "moved back" approximately 1.5 mils so that the following relationship was developed. It was assumed that this adjustment was required to compensate for the increased muzzle velocity which resulted when the barrel pressure bleed hole was blocked off.



SECTION A-A
SCALE 2/1

[illegible]

Notes:

1. Can dimensions shown on Sheet 2 of 2.
2. "R" is the radial distance from the center of the can to the center of a 1/2" diameter cutter. The tolerance on "R" will be $\pm .002$ for all values of α except as shown below.
 $\pm .0003$ at $\alpha = -8^\circ$ to $+90^\circ$
3. Drop "R" is the radial displacement of a 1/2" diameter cutter from a 3.0336 diameter base circle (ref.).
4. The tolerance on α at all positions is $\pm 0.4^\circ$.

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REVISIONS									
LTR	DESCRIPTION	DATE	APPROVED						
A	MOD. CHART FROM 15A THRU 242°	8/1/74	KDK						
B	MOD. CHART FROM -20° THRU 320°	10/1/74	KDK						
C	MOD. CHART FROM 206° THRU 320°	10/5/74	B/A						

A

B

C

COL.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
1	230°	1.8525	0	0	44	23°	1.6594	1.1931	1.1304	87	122°	1.5034	1.4992	1.4960	1.4928	1.4896	1.4864	1.4832	1.4800	1.4768	1.4736	1.4704	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																							
2	190°				45	24°	1.6567	1.1958	1.1304	88	126°	1.4992	1.4960	1.4928	1.4896	1.4864	1.4832	1.4800	1.4768	1.4736	1.4704	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
3	180°				46	25°	1.6539	1.1986	1.1304	89	130°	1.4960	1.4928	1.4896	1.4864	1.4832	1.4800	1.4768	1.4736	1.4704	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																									
4	170°				47	26°	1.6512	1.2014	1.1304	90	134°	1.4928	1.4896	1.4864	1.4832	1.4800	1.4768	1.4736	1.4704	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										
5	160°				48	27°	1.6486	1.2038	1.1304	91	138°	1.4896	1.4864	1.4832	1.4800	1.4768	1.4736	1.4704	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
6	150°				49	28°	1.6461	1.2064	1.1304	92	142°	1.4864	1.4832	1.4800	1.4768	1.4736	1.4704	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																												
7	140°				50	29°	1.6430	1.2089	1.1304	93	146°	1.4832	1.4800	1.4768	1.4736	1.4704	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
8	130°				51	30°	1.6411	1.2114	1.1304	94	150°	1.4800	1.4768	1.4736	1.4704	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
9	120°				52	31°	1.6362	1.2162	1.1304	95	154°	1.4768	1.4736	1.4704	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																															
10	110°				53	32°	1.6316	1.2219	1.1304	96	158°	1.4736	1.4704	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
11	100°				54	33°	1.6277	1.2259	1.1304	97	162°	1.4704	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																	
12	90°				55	34°	1.6227	1.2298	1.1304	98	166°	1.4672	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
13	80°				56	35°	1.6184	1.2341	1.1304	99	170°	1.4640	1.4608	1.4576	1.4544	1.4512	1.4480	1.4448	1.4416	1.4384	1.4352	1.4320	1.4288	1.4256	1.4224	1.4192	1.4160	1.4128	1.4096	1.4064	1.4032	1.4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
14	70°				57	36°	1.6143	1.2382	1.1304	100	174°	1.4612	1.4579	1.4546	1.4513	1.4480	1.4447	1.4414	1.4381	1.4348	1.4315	1.4282	1.4249	1.4216	1.4183	1.4150	1.4117	1.4084	1.4051	1.4018	1.3985	1.3952	1.3919	1.3886	1.3853	1.3820	1.3787	1.3754	1.3721	1.3688	1.3655	1.3622	1.3589	1.3556	1.3523	1.3490	1.3457	1.3424	1.3391	1.3358	1.3325	1.3292	1.3259	1.3226	1.3193	1.3160	1.3127	1.3094	1.3061	1.3028	1.2995	1.2962	1.2929	1.2896	1.2863	1.2830	1.2797	1.2764	1.2731	1.2698	1.2665	1.2632	1.2599	1.2566	1.2533	1.2500	1.2467	1.2434	1.2401	1.2368	1.2335	1.2302	1.2269	1.2236	1.2203	1.2170	1.2137	1.2104	1.2071	1.2038	1.2005	1.1972	1.1939	1.1906	1.1873	1.1840	1.1807	1.1774	1.1741	1.1708	1.1675	1.1642	1.1609	1.1576	1.1543	1.1510	1.1477	1.1444	1.1411	1.1378	1.1345	1.1312	1.1279	1.1246	1.1213	1.1180	1.1147	1.1114	1.1081	1.1048	1.1015	1.0982	1.0949	1.0916	1.0883	1.0850	1.0817	1.0784	1.0751	1.0718	1.0685	1.0652	1.0619	1.0586	1.0553	1.0520	1.0487	1.0454	1.0421	1.0388	1.0355	1.0322	1.0289	1.0256	1.0223	1.0190	1.0157	1.0124	1.0091	1.0058	1.0025	9992	9959	9926	9893	9860	9827	9794	9761	9728	9695	9662	9629	9596	9563	9530	9497	9464	9431	9398	9365	9332	9299	9266	9233	9200	9167	9134	9101	9068	9035	9002	8969	8936	8903	8870	8837	8804	8771	8738	8705	8672	8639	8606	8573	8540	8507	8474	8441	8408	8375	8342	8309	8276	8243	8210	8177	8144	8111	8078	8045	8012	7979	7946	7913	7880	7847	7814	7781	7748	7715	7682	7649	7616	7583	7550	7517	7484	7451	7418	7385	7352	7319	7286	7253	7220	7187	7154	7121	7088	7055	7022	6989	6956	6923	6890	6857	6824	6791	6758	6725	6692	6659	6626	6593	6560	6527	6494	6461	6428	6395	6362	6329	6296	6263	6230	6197	6164	6131	6098	6065	6032	5999	5966	5933	5900	5867	5834	5801	5768	5735	5702	5669	5636	5603	5570	5537	5504	5471	5438	5405	5372	5339	5306	5273	5240	5207	5174	5141	5108	5075	5042	5009	4976	4943	4910	4877	4844	4811	4778	4745	4712	4679	4646	4613	4580	4547	4514	4481	4448	4415	4382	4349	4316	4283	4250	4217	4184	4151	4118	4085	4052	4019	3986	3953	3920	3887	3854	3821	3788	3755	3722	3689	3656	3623	3590	3557	3524	3491	3458	3425	3392	3359	3326	3293	3260	3227	3194	3161	3128	3095	3062	3029	2996	2963	2930	2897	2864	2831	2798	2765	2732	2699	2666	2633	2600	2567	2534	2501	2468	2435	2402	2369	2336	2303	2270	2237	2204	2171	2138	2105	2072	2039	2006	1973	1940	1907	1874	1841	1808	1775	1742	1709	1676	1643	1610	1577	1544	1511	1478	1445	1412	1379	1346	1313	1280	1247	1214	1181	1148	1115	1082	1049	1016	983	950	917	884	851	818	785	752	719	686	653	620	587	554	521	488	455	422	389	356	323	290	257	224	191	158	125	92	59	26	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

Range Elevation from Cam

Table 3

<u>Range Meters</u>	<u>Original Firing Table Elevation Mils</u>	<u>Modified Cam Design Mils</u>	<u>Superelevation Tank Gun Mils</u>	<u>Bench Check M13 Computer Mils</u>
500	10.9	9.4	9.2	9.2
600	13.4	11.4	11.7	11.9
700	16.2	14.7	14.6	14.9
800	19.2	17.2	17.4	17.7
900	22.6	21.1	20.6	21.3
1000	26.3	24.8	24.0	24.6
1100	30.2	28.7	27.6	28.3
1200	34.1	32.6	31.6	32.4
1300	38.5	37.0	35.8	36.6
1400	43.0	41.5	40.3	41.3
1500	47.5	46.0	45.1	45.9
1600	--	49.8	49.7	50.6

Toward the end of the project, after the muzzle velocity of the M48A1 Round had been established, the Ballistic Research Laboratories (BRL) was asked to give a computer run on the range/elevation relationship for the M48A1 using a muzzle velocity of 1785 fps (vs 1723); this gave the following:

Range Elevation from Firing Tables

Table 4

<u>Range Meters</u>	<u>Old Firing Table</u> <u>1723 fps Mils</u>	<u>New Firing Table</u> <u>1785 fps Mils</u>	<u>Difference</u> <u>Mils</u>
500	9.4	9.9	+ .5
600	11.9	12.4	+ .5
700	14.7	15.0	+ .3
800	17.2	17.9	+ .7
900	21.1	21.0	- .1
1000	24.8	24.3	- .5
1100	28.7	27.8	- .9
1200	32.6	31.6	-1.0
1300	37.0	35.5	-1.5
1400	41.5	39.7	-1.8
1500	46.0	44.1	-1.9
1600	49.8	48.6	-1.2

The discrepancy between these two firing tables probably accounts for the range limitation which developed during field testing in Germany where the accuracy of the computer was limited to 1000 meters after zero setting at 800 meters range. With an accurate range/elevation relationship available, the gunfire range cam should be very close, from 500 to 1500 meters after zero set at 800 meters.

As BRL pointed out, their range/elevation relationship is only computed and should be checked out by firing tests to establish an accurate trajectory for designing the gunfire range cam.

4. Testing and Test Results

The test plan for the Engineering Design Tests (EDT) is presented in Appendix A.

The results of the EDT are contained in Report No. APG-MT-4001, "Engineer Design Test of Training Device: Subcaliber Ranging/Spotting HEP-T 105mm Round for M60 Tank Final Letter Report," by John T. Matsco, December 1971.

The EDT results indicated that the Subcaliber Device was safe for field evaluation.

The accuracy and dispersion firings gave the following results:

Accuracy and Dispersion
Table 5

<u>Range</u>	<u>Device</u>	<u>EVD</u>	<u>MVD</u>	<u>VSD</u>	<u>EHD</u>	<u>MHD</u>	<u>HSD</u>	<u>ES</u>	<u>MR</u>	<u>CI</u>	
										<u>H</u>	<u>V</u>
500	Stationary	1.4	0.5	0.5	1.9	0.4	0.6	2.0	0.7	0.2	-0.3
500	Rotated	2.8	0.8	1.0	3.7	1.0	1.2	3.7	1.4	-0.2	-1.2
1500	Stationary	9.6	2.1	2.8	5.9	1.4	1.8	10.2	2.8	2.6	-1.5
1500	Rotated	12.5	3.2	4.2	9.7	2.7	3.4	14.0	4.7	2.1	-3.9

The firings indicate that the accuracy is twice as good and the dispersion is half as much when the device is left in the gun barrel as when the device is removed after each shot.

It might be pointed out that there are several design approaches which could be used to reduce the dispersion resulting from the use of a different firing device for each firing. These designs would need to be tested by conducting accuracy and dispersion firings.

The drop test portion of the EDT indicated that, although the Caliber .50 M48A1 Spotting Tracing Round is classified as neither drop safe nor bore safe, there was no detonation or combustion of the round when it was dropped 5 feet onto a steel plate. In addition, when the M48A1 Round was assembled in the bolt, the subassembly was dropped 5 feet and did not detonate or burn. To check the completely assembled device, it was dropped 5 feet onto a steel plate. The device fired the M48A1 Round into the steel plate. The firing pin was redesigned and the firing pin spring was strengthened. When the new firing pin and firing pin spring were tested, the device did not cause the M48A1 Round to burn or detonate.

CONCLUSIONS AND RECOMMENDATIONS

Contact with those who conducted the field test in Europe indicated a generally favorable reaction. The device adds realism, system test, training value, crew proficiency measurement and gunfire range computer training for those tank companies which use the device. The field evaluation report recommended that each tank company in Europe be issued five (5) of the training devices. The following points were made:

1. Realism. Because the 105mm Subcaliber Training Device has the same characteristics as service ammunition, to include hitting any target you are engaging, all members of a tank crew are required to perform every crew duty necessary in firing regular service ammunition. Maximum training value is derived by all crew members in performing each of their duties.
2. All Tank Systems Tested. All tank firing systems have to be fully operational to fire Table VII at Range 6 with the 105mm Device. All procedures, to include boresighting and zeroing of the main gun, are performed by the crew exactly as is done with service ammunition.
3. Overall Training Value and Cost. The 105mm Device trains all members of a tank crew simultaneously to fire main gun rounds at a nominal cost. Since loaders are normally new men in a tank unit in the grade of PFC (E-3) or less, the training derived from having to physically load the M73 machine-gun and main gun increases proficiency significantly.
4. Crew Deficiency Measurement. All crews can be graded as to their efficiency, speed, and expertise by using this Device. Since all three tank weapons systems are used, graders can determine and measure, by means of crew cuts, all good and bad characteristics of a tank crew in the same manner as if they were firing service ammunition.
5. Computer Training. If a gunner is made to index different types of ammunition into his computer before each main gun engagement, he will be forced to change the computer each time he fires or end up missing the target. This will enable him to develop the habit of indexing the correct ammunition into his computer each time he fires.
6. Burst-on-Target. The 105mm Device is an excellent aid in teaching gunners the correct burst-on-target methods for achieving second-round hits.
7. The weapons system was found to be accurate to 1000 meters in tank-to-target range.
8. Tank Commanders are required to range properly and constantly check subsequent coincidence reticle adjustment to be successful in achieving target hits.

The information extracted from the USAREUR Staff Study indicates the 105mm Subcaliber Training Device has substantial potential as a training device

which will increase tank crew training and capability. Further development is recommended. Improvement in rapidity of shots fired and an unlimited number of shots fired consecutively could be made. In addition, a better trajectory correlation between the Gunfire Range Cam and the bullet's flight path can be made so that accuracy from 500 meters to 1500 meters could be obtained.

APPROVED TEST PLAN

I DESCRIPTION:

A .50 caliber spotting round, barrel and breech mechanism has been adapted inside an M393 HEP-T 105MM round type body. The main gun firing circuit fires an electrical primer which actuates a mechanical firing pin to fire the percussion primer of the .50 caliber spotting round.

II TEST OBJECTIVE:

Provide comment and recommendations regarding safety of the 105MM Subcaliber Training Round for firing and usability for further field evaluation by USAREUR.

III PRIOR TESTING:

Preliminary tests have been conducted by the Infantry and Aircraft Weapons Division, Materiel Testing Directorate, APG. The test results are available for your use.

IV SECURITY CLASSIFICATION:

Unclassified.

V SAFETY:

Normal when working with small arms ammunition.

VI TEST SCHEDULE:

Test items will be available 1 July 71. Tests to be completed by 27 August 1971.

VII REPORT:

Letter Report, 10 copies forwarded to USALWL.

VIII TEST PLAN:

1. INTRODUCTION

The 105MM Subcaliber Training Rounds will not be lubricated. The rounds will be designated APG numbers 1 through 5.

2. REMOTE FIRING

2.1 Objective

To reasonably assure that weapons undergoing test will not subject test personnel to more than a minimum risk consistent with the nature of the test items.

2.2 Method

The method used is in accordance with test procedures set forth in paragraph 6.2.2 of USATECOM MTP 3-2-504. Each test weapon will have three (3) proof rounds and thirty (30) standard M48A1 rounds fired from it.

2.3 Data Required

Applicable portions of paragraph 6.2.2 of MTP 3-2-504.

2.4 Test Items Required

Four (4) 105MM Subcaliber Training Rounds will be required for this subtest. The fifth unit will be used for Accuracy and Dispersion Tests.

2.5 Ammunition Requirements

Fifteen (15) proof rounds and one hundred twenty (120) M48A1 rounds are required for this subtest.

3. ACCURACY, DISPERSION, AND VELOCITY

3.1 Objective

To determine accuracy, dispersion, and velocity characteristics of the 105MM Subcaliber Training Rounds.

3.2 Method

Fire three (3) 10-round groups at 500 and 1500 yard targets with the 105MM Subcaliber Training Round at controlled rotation of 36° for each round. Fire three (3) 10-round groups at 1500 yard target with shell in position 0 (i.e., not rotated).

3.3 Data Required

X and Y coordinates of each impact relative to the initial aiming point will be recorded to provide the following for each 10-round target and overall average for each three (3) 10-round target:

- a. Mean Radius
- b. Center of Impact
- c. Extreme Horizontal Dispersion

- d. Extreme Vertical Dispersion
- e. Extreme Spread
- f. Mean Vertical Deviation
- g. Mean Horizontal Deviation
- h. Vertical Standard Deviation
- i. Horizontal Standard Deviation

Instrumental velocity data will be recorded to provide the following:

- a. Maximum
- b. Minimum
- c. Extreme Variation
- d. Standard Deviation
- e. Average

3.4 Test Items Required

One 105MM Subcaliber Training Round will be required during this test.

3.5 Ammunition Requirements

One hundred twenty (120) M48A1 rounds will be required for this subtest.

4. SUPERELEVATION THROUGH CAM

4.1 Objective

To determine the accuracy of the M48A1 cam in the M13 computer in supplying proper superelevation data to the gun system when the weapon is laid to fire at a given range.

4.2 Method

The method used is in accordance with test procedures set forth in USATECOM MTP 3-2-700.

4.3 Data Required

Applicable portions of 6.3.2 of MTP 3-2-700.

4.4 Test Items Required

One 105MM Subcaliber Training Round will be required for this subtest.

4.5 Ammunition Requirement

As required.

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