Lawrence Livermore Laboratory

TAAMM SUBMUNITION PROJECT (U)

Progress Report No. 8

1-31 July 1979

F. E. Walker

15 August 1979

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MONTHLY REPORT
TAAMM SUBMUNITION PROJECT
1-31 July 1979
Report No. 8

JULY ENGINEERING REPORT ON THE TAAMM SUBMUNITION WARHEAD

The following is a brief summary of the activities on the TAAMM submunition during the month of July:

Schedule

A schedule for the LLL activities on the TAAMM submunition has been developed and is shown on Attachment A. The schedule covers the development effort necessary to demonstrate the Type III warhead during the FY 80 period. The schedule will be reiterated after comments are obtained from General Dynamics and the JCMP0.

Gun 5 Dynamic Test

Gun 5 was the last test of the old case design. The experiment was performed because of the availability of the hardware and hopefully to shed some additional light on the case fracturing problem. Unfortunately, the velocity augmentor misfired preventing a proper impact of the FT. No further testing is planned with the old case design. All future tests will be with the new version.

Velocity Augmentor Optimization

Attachment B describes the latest analytical results in the Velocity Augmentor optimization study. An optimum has been calculated and hardware is being fabricated to experimentally confirm the analytical results.

Forward Charge Studies

A series of shaped charge tests were performed at various angles against concrete. Attachment C summarizes the results. Although there is a longer path length through the concrete at shallow angles, the borehole geometry appears adequate for follow through perforation at angles as low as 50°. Additional studies will be performed to further confirm these results.

Follow Through Delay Detonator

A small quantity of delay detonators was obtained from S³ for evaluation as a possible FT delay detonator. Major differences between the S³ detonator and the ET detonator already being considered are that the S³ unit is an all secondary explosive flying plate detonator while the ET is a more conventional primary explosive unit.

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See

TABLE 1

TAAMM BUDGET
(FY-1979)

	MAN MONTHS				S&E	TOTAL \$				
	PLAN	ACT	CUM	ACT	PLAN	PLAN	ACT	CUM	ACT	DIFF
October	3	3.62	3	3.62	8	30	33.6	30	33.6	- 3.6
November	4	4.45	7	8.07	10	40	34.5	70	68.1	+ 1.9
December	5	6.23	12	14.3	12	40	32.7	110	100.8	+ 9.2
January	7	7.77	19	22.1	16	50	45.2	160	146.0	+16.0
February	8	14.9	27	37.0	26	60	94.4	220	240.4	-20.4
March	8	12.6	35	49.6	40	80	147.6	300	388.0	-88.0
April	9	16.2	44	65.7	40	+130	105.0	430	493.0	-63.0
May	10	16.6	54	82.3	40	+170	137.3	600	630.3	-30.3
June	5	16.3	59	98.6	20	70	117.1	670	747.4	-77.4
July	3	14.1	62	112.7	16	50	117.4	720	864.8	-144.8
August	-		-		-	-		-		
September	-		-		-	-		-		

TAAMM BUDGET-SCHEDULE (FY-1979)

FIGURE 1

FY 1979 UPDATE 1 PLAN		TOMAHAWK PROGRAM (6680-6680) FY 1979 - END OF JULY COST ANALYSIS K\$																
		TOTAL			AVERAGE													
		PLAN	ACTUAL	REMAIN	PLAN	ACTUAL	REMAIN	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG
COST																		
MANPOWER																		
WAGE EXPENSE		292			29.2			10.3	10.7	13.9	18.7	35.0	48.1	40.6	39.6	40.9	34.6	
SUPP. BURDEN		54			5.4			2.2	1.4	2.1	2.6	6.3	8.1	7.5	7.3	8.5	7.9	
OVERHEAD		209			20.9			7.9	8.2	8.8	13.4	25.0	34.4	29.1	28.3	29.3	24.7	
TOT MANPOWER		555			55.5			20.5	20.3	24.8	34.7	66.3	90.5	77.2	75.2	78.7	67.1	
EXPENSES																		
STORES		15			1.5			.3	.7	1.1	.7	1.6	2.9	1.4	1.6	.5	4.4	
TRAVEL		12			1.2			.9	2.8	.7	.4	.5	.1	.2	2.0	1.0	3.1	
MINOR PROCURE		22			2.2			.6	.4	.4	2.1	.9	1.6	2.3	12.4	.4	1.7	
CONSULTANTS		1			.1							1.0	.4					
CONT. LABOR		2			.2								1.3	.2	.1		.1	
BERKELEY-MPWR																		
SUMMER																		
MATLS FAB-OUT		13			1.3				1.6		.7	1.6	2.5		1.4	4.1	.5	
NON CAP ALTER																		
OTHER		63			6.3			12.1	8.0	2.0	1.0	3.0	6.7	.7	18.5	5.5	5.6	
SUB S + E		127			12.7			12.6	13.5	4.3	4.9	8.7	15.3	4.8	36.0	11.6	15.5	
MAJOR PROCURE		24			2.4								23.6					
TOT EXPENSES		151			15.1			12.6	13.5	4.3	4.9	8.7	38.9	4.8	36.0	11.6	15.5	
FACILITY																		
MATLS FAB-INT		121			12.1			.5	.6	1.9	2.5	17.6	13.8	18.1	18.5	21.8	25.3	
ACCEL																		
REACT+PU+TRIT																		
COMPUTERS		38			3.8					1.7	3.1	1.9	4.4	5.0	7.7	5.0	9.4	
UNDIS. FUNDS																		
TOTAL COST		865			86.5			33.6	34.5	32.7	45.2	94.4	147.6	105.0	137.3	117.0	117.4	
COST PROJ		1038	=====	=====	=====	=====	=====											
MANPOWER-LLL																		
AVG FTE		12.0			ADJ			3.6	4.5	6.2	7.8	14.9	19.2	16.2	16.6	16.3	14.1	
EFFORT FACTOR		.870			.4			.920	.831	.780	.842	.878	.881	.914	.874	.891	.818	
ST EFFORT		10.4			.4			3.3	3.7	4.9	6.5	13.1	16.9	14.8	14.5	14.5	11.6	
OVERTIME		.1						.5			.2	.1		.1		.2		
TOTAL EFFORT		10.5			.4			3.8	3.7	4.9	6.7	13.1	16.9	14.8	14.5	14.7	11.6	
EFFORT RATES		ANNUAL	ANNUAL	ANNUAL	MO	MO	MO											
WAGE EXPENSE		33423				2785		2720	2889	2853	2792	2667	2845	2743	2730	2793	2988	
MANPOWER		63465				5289		5383	5485	5105	5172	5051	5356	5207	5187	5372	5803	
S+E		14527				1211		3327	3653	880	737	660	905	321	2482	789	1338	
SUP BURD RATE		.184			.184			.212	.131	.153	.137	.179	.168	.183	.185	.208	.227	
OVERHEAD RATE		.715			.715			.767	.767	.636	.715	.715	.715	.715	.715	.715	.715	
LIENS																		
MINOR PROCURE		6							.4	2.1	2.7	9.5	6.9	11.9	4.6	3.5	5.8	
MAJOR PROCURE											23.6	23.6						

(6680)

TOMAHAWK

SCHEDULE 017

Budget Summary

The expenditures for July 1979 on TAAMM Project Order No. N00019-78-iP-89001 were \$117,400. The balance for 1 August 1979 is \$289,360. We have received \$440,000 for the balance of FY-79. The total effort to date is 112.7 man months. See Table 1 and Figure 1 for the budget and schedule summaries. Our cost analysis for the TAAMM Project is included as Table 2.

F. E. Walker
Deputy Program Leader
Non-Nuclear Ordnance Program

FEW:mms

ATTACHMENT A

TAAMM TYPE III LLL SCHEDULE

79

79

80

718 AUGUST 819 SEPT 910 OCT 011 NOV 1112 DEC 1211 JAN 112 FEB 213 MARCH 314 APRIL 415 MAY 516 JUNE 617 JULY 718 AUGUST 819 SEPT 910
50 31 1013 1720 2427 31 710 1417 2124 28 518 1215 1922 2629 215 912 1619 2330 31 710 1417 21 2831 417 1114 1821 2528 114 811 15 2225 293 710 1417 21 2831 417 1114 1821 2528 215 912 1619 23 302 619 1316 2023 2730 7 1114 1821 2528 114 811 1518 2225 29 517 1215 1922 2629 3

COMPUTER ANALYSIS OF FC, FT & VA

DRAWN 7/24/79 VLV
REV. 8/2/79

AAA79-110174-0A ④

Attachment 4

ATTACHMENT B

VELOCITY AUGMENTOR OPTIMIZATION

DEAN B. TUFT

We are continuing work on optimization of the TAAMM submunition follow-thru charge velocity augmentor. Last month we reported results of velocity and strain computations for equal radial and longitudinal tamping. (1) The computations show that with equal 1/8" thick ~~radial~~ ^{tantalum} and longitudinal tamping, LX-10 explosive and a 3/8" titanium attenuator that a maximum velocity of 86 m/sec is obtained and that maximum radial case strain is 12.9%. The calculated optimum velocity augmentor geometry is shown in Fig. 1.

To continue the optimization process, calculations for unequal radial and longitudinal tamping were carried out. Tamping thicknesses were varied slightly around the already defined optimum of 1/8" tamping. Results for rigid-body velocity as a function of tamping thickness for both equal and unequal radial and longitudinal tamping are shown in Fig. 2 and maximum radial case strain is shown in Fig. 3. An increase of about 1 m/sec is obtained by increasing the longitudinal tamping to 3/16" while keeping the radial tamping at 1/8". Otherwise the results indicate that no improvement in rigid-body velocity can be obtained by unequal tamping.

Within the accuracy limitations of these calculations, the maximum rigid-body velocities for equal and unequal tamping are essentially the same. Even if we could discern between 86 and 87 m/sec, the added weight and cost of the additional tamping would probably not be worth the extra 1 m/sec velocity. Thus, within the accuracy of the calculations, the velocity obtained with equal 1/8" radial and longitudinal tamping is equal to or greater than that obtained by any other tamping configuration studied.

(1) Memo to F. Walker from Ron Varosh, June Engineering Report on the TAAMM Submunition Warhead.

Figure 1. Calculated optimum velocity augmentor geometry.

Figure 2. Effect of unequal tamping on FT rigid-body velocity.

TAAM AUGMENTOR STUDY
LX-10 H.E. .375" ATTENUATOR

Figure 3. Effect of unequal tamping on maximum radial case strain.

In all of the calculations discussed thus far, the H.E. has been point initiated at the center of the rear face. For the optimum tamping configuration defined above, calculations were performed to determine the effect of lighting configuration. The lighting point was moved to the H.E. centroid and to the front face and the results tabulated in Table 1. Front face lighting increased rigid-body velocity from 86 to 88 m/sec over rear face lighting but also increased the maximum case strain from 12.9 to 13.4%. Rear-face ring lighting produced 84 m/sec and 12.5% radial case strain but increased the case bottom-center deformation by about 20%.

Table 1. Effect of H.E. Lighting Configuration and Attenuator Shape

1/8" Tamping, LX-10 H.E.

Lighting Configuration	Titanium Attenuator	Rigid-body Velocity m/sec	Maximum Radial Strain %
point, rear face	3/8" plate	86	12.9
point, H.E. centroid	3/8" plate	86	13.2
point, front face	3/8" plate	88	13.4
ring, rear face	3/8" plate	84	12.5
point, rear face	equal mass cone	88	13.4
ring, rear face	equal mass cone	88	12.9

By holding the mass of the attenuator constant and changing its shape to a cone as shown in Fig. 4, more attenuation can be provided along the center line where the case is thinnest and deformations are high. Results for point and ring lighting with a cone shaped attenuator are given in Table 1. The cone attenuator provides a more nearly normal shock wave incidence for ring lighting and was therefore expected to enhance coupling. The results indicate, however, that point and ring lighting produce equal rigid-body velocity with the cone attenuator.

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Figure 4. Velocity augmentor with cone shaped attenuator.

A series of experiments aimed at verifying the augmentor tamping calculations have been designed. In these experiments we will measure velocity as a function of uniform tamping thickness. We will test various thickness titanium and tungsten tampers and measure the velocity of a 10 lb. cylindrical mass. Since deformation of the mass plays a role in the final velocity, we will compare the experimental results to calculations of the exact experimental configuration.

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ATTACHMENT C

Interdepartmental letterhead

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Ext:

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July 30, 1979

MEMORANDUM

TO: R. E. Varosh
FROM: J. D. Longwith
SUBJECT: FORWARD CHARGE (FC) STUDIES

Four FC's were fired for effects into concrete. Angles from the horizontal were 50°, 60°, and 70°.

The 70° shot was duplicated with an aluminum cased shaped charge. This charge was put together with surplus hardware. The rear cone angle was different and the liner case was longer resulting in slightly less than ten percent more explosive. One would expect the two effects (case vs. extra HE) to cancel themselves.

In Fig. 1, the 50° and 60° craters are shown. The photos to the left have been cleared of rubble to expose the bore hole. Figure 2 similarly displays the 70° craters. Figure 3 shows the cross sectional geometry.

The test objective was to aid in the consideration of a more severe angle of approach for Gun 5. Although the data doesn't rule out this consideration, the loss of time and additional costs do. The 70° angle is fixed by I beam supports welded to the blast plate. See Fig. 4. Any change will take the crew at least one extra day.

The tests indicate further FC optimization is practical.

J. D. Longwith
N.E.E.D.
Mechanical Engr. Dept.

JDL:frm

Attachments

University of California

LAWRENCE LIVERMORE LABORATORY

FIGURE 1

FIGURE 2

NO. 1 50°

NO. 2 60°

NO. 3 70°

NO. 4 A70°

TAAMM

FIGURE 3

FIGURE 4

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