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Report No. 11

SENSITIVITY OF CASED EXPLOSIVE MATERIALS TO IMPACT BY REGULAR FRAGMENTS (U)

Contract No. DA-19-020-ORD-5617

PA Control No. PA-AG-62-1

Prepared by

Arthur D. Little, Inc.
Cambridge, Mass.

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For

Commanding Officer
Picatinny Arsenal
Dover, New Jersey

28 February 1963

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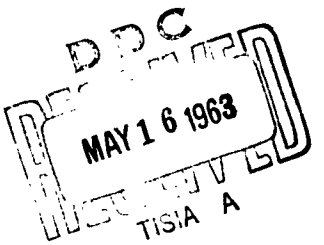

For

Commanding Officer

Picatinny Arsenal

Dover, New Jersey

28 February 1963

C-64514

ABSTRACT

This is the eleventh in a series of progress reports on an experimental program dealing with the sensitivity of certain cased explosives and propellants to impact by high-velocity particles. The program is designed to aid in determining a more realistic quantity-distance relationship for the storage of ordnance explosive material. It is the intent of this project, through an experimental program, to establish a limiting fragment mass vs impact velocity relationship for the detonation of certain explosives and/or propellants enclosed in casings of different thicknesses.

Tests conducted to date have confirmed the expected sensitivity of cased Pentolite. Limited firings with Cyclotol have not resulted in detonation even with velocities well in excess of those believed to be necessary.

SENSITIVITY OF CASED EXPLOSIVE MATERIALS TO IMPACT BY REGULAR FRAGMENTS (U)

Introduction

This is the eleventh progress report on an experimental program covering the progress of work under Contract DA-19-020-ORD-5617 for Picatinny Arsenal. This report covers the period from 28 December 1962 to 28 February 1963. The objective of the program is to determine the sensitivity of certain cased explosives and propellants by regular fragments. Acceleration of the fragments is accomplished by explosive means.

Improvements have been made in the technique during this reporting period and a limited number of firings have been made into both Pentolite and Cyclotol receiver charges. The Pentolite has detonated at velocities that are consistent with the fragment velocity-mass relationship established by Picatinny Arsenal. Cyclotol has not detonated even when fragment velocities were greatly in excess of that required according to the above relationships.

Previous Work

Photographs of fragments in flight have demonstrated that the velocities previously recorded by contact screens were in error. The results of this work and the corrected velocities for fragments fired into receiver charges were given in the last report (No. 10).

Additional work was carried out with metal substituted for the plaster surround. It was demonstrated that no false triggering of the screens by the surround material occurred. Good correlation between photographs and velocity screen measurements was obtained and the data reported.

Current Work

Calibration Firings

During this report period additional firings were made with the metal surround. Fragments of the required length to width ratio were used and measurements with velocity screens resulted in a good correlation with the velocities obtained previously, for fragments of equal thicknesses. The results of these tests are given in Table I. Velocities of all of the calibration firings with metal surround are plotted in Figure 1. All of the recent calibration firings have been made with an accelerating explosive charge of 4 inches in diameter and 4 inches long. Tests with fragments of various thicknesses and buffer material (lucite) between the fragment and explosive in the initial firings with the metal surround have established maximum velocities attainable with fragments of different weights for this accelerating explosive charge. The mass-velocity coverage that has been demonstrated as being attainable is given in Figure 2.

Firings into Receiver Charges

A limited number of firings were also made with the 0.44 oz fragment (1/2 x 1/2 x 3/8 in) and a metal surround into both Cyclotol and Pentolite receiver charges. The results of these tests are presented in Table II along with the velocities (as established by the Picatinny Arsenal relationships) necessary to cause detonation. The recorded velocities were consistent with those measured previously with the 3/8-in thick fragment (see Table I) and, hence, it is expected that the same range of velocities also occurred in those firings where no record was obtained.

High order detonations were experienced in all firings with Pentolite. In all but one test the measured (or expected) velocity exceeded that required for detonation to occur. In the firings with the 7/16 in cover plate the fragment velocity (expected on the basis of measurements in other tests) was lower than required.

No detonations were experienced with Cyclotol. In the two firings with the 1/16 in cover plate the fragment velocities (measured or expected) were significantly greater than that required by the Picatinny Arsenal relationships. The measured velocity in the test involving the 5/16-in cover plate was lower than that required. That is, the probability of detonation would have been expected to be much less than 50%.

Future Work

It can be established by theory relative to the effect of the shock wave produced by an explosive on a metal fragment that higher fragment velocities than those attained so far in this program may be achieved by increasing the dimensions of the accelerating explosive. Experimental data has shown this to be true, particularly, in the range of lighter fragments.

We have estimated that the mass-velocity coverage attainable without fragment break up with a charge 8 inches in diameter by 8 inches long to be that shown in Figure 3. Tests are planned to confirm that these velocities are attainable and it is expected that a limited number of tests will be made with receiver charges at the higher velocities.

Man Hours Expended

All of the available man hours (100%) on this project have been expended. The continued effort described as future work in this report is being carried out at no expense to the government because of our strong interest in this program.

Report Distribution

Commanding Officer
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Table I

Fragment Velocities with Metal Surround - Velocity Screen Measurements Only

Firing No.	Fragment Dimensions in.	Fragment Weight oz.	Lucite Thickness in.	Velocity ft/sec
U-2	3/8 x 3/8 x 5/16	0.2	0.03	5100
U-8	3/8 x 3/8 x 5/16	0.2	0.03	5450
U-9	3/8 x 3/8 x 5/16	0.2	0.03	5500
U-10	3/8 x 3/8 x 5/16	0.2	2.00	2240
U-11	3/8 x 3/8 x 5/16	0.2	2.00	2210
U-1	1/2 x 1/2 x 3/8	0.43	0.030	4570
U-4	1/2 x 1/2 x 7/16	0.48	0.030	3990
U-5	1/2 x 1/2 x 7/16	0.48	0.030	3780
U-13	1/2 x 1/2 x 7/16	0.48	1.50	2270
U-3	5/8 x 5/8 x 9/16	1.0	0.060	3560
U-15	5/8 x 5/8 x 9/16	1.0	1.50	2400

Table II

Results of Tests Using Metal Surround

Receiver Charge Type	Receiver Charge Cover Plate Thickness (in)	Fragment Dimensions (in)	Fragment Weight (oz)	Velocity Established by Screen ft/sec	Estimated Velocity Required for Det. ft/sec	Remarks
Pentolite	3/16	1/2x1/2x3/8	.44	---	3150	High Order Det.
Pentolite	5/16	1/2x1/2x3/8	.44	4740	4250	High Order Det.
Pentolite	3/16	1/2x1/2x3/8	.43	4840	3150	High Order Det.
Pentolite	7/16	1/2x1/2x3/8	.43	5660	6200	High Order Det.
Cyclotol	1/16	1/2x1/2x3/8	.43	---	3000	No Det. (1)
Cyclotol	5/16	1/2x1/2x3/8	.42	4650	5250	No Det. (1)
Cyclotol	1/16	1/2x1/2x3/8	.41	4680	3000	No Det. (1)

(1) The results of each firings were very similar. The casing was split open its entire length. Cover plates severely damaged or missing. Very little pulverized explosive material in area. No evidence of burning. Witness plates when recovered were undamaged.

Figure 1

Fragment Velocity Vs Thickness of Lucite

All propelling charges 3.5' dia x 4" long.
(Dashed portion of curves have not been confirmed by actual firings).
All fragments undamaged.

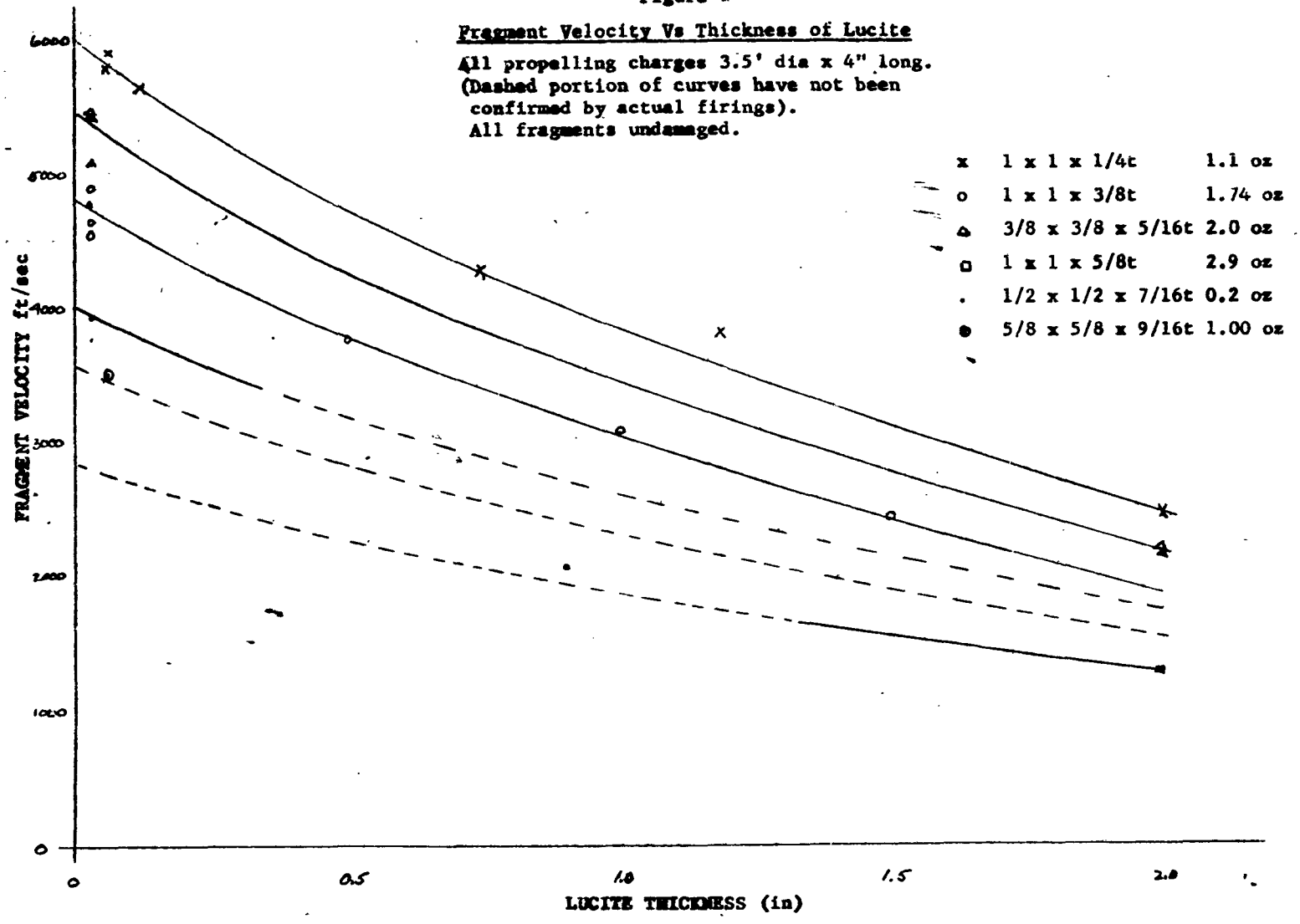


Figure 2

Masses and Velocities of Undamaged Fragments

Obtainable with a 4 inch Donor Charge

(Metal Surround)

x - Represents points actually fired

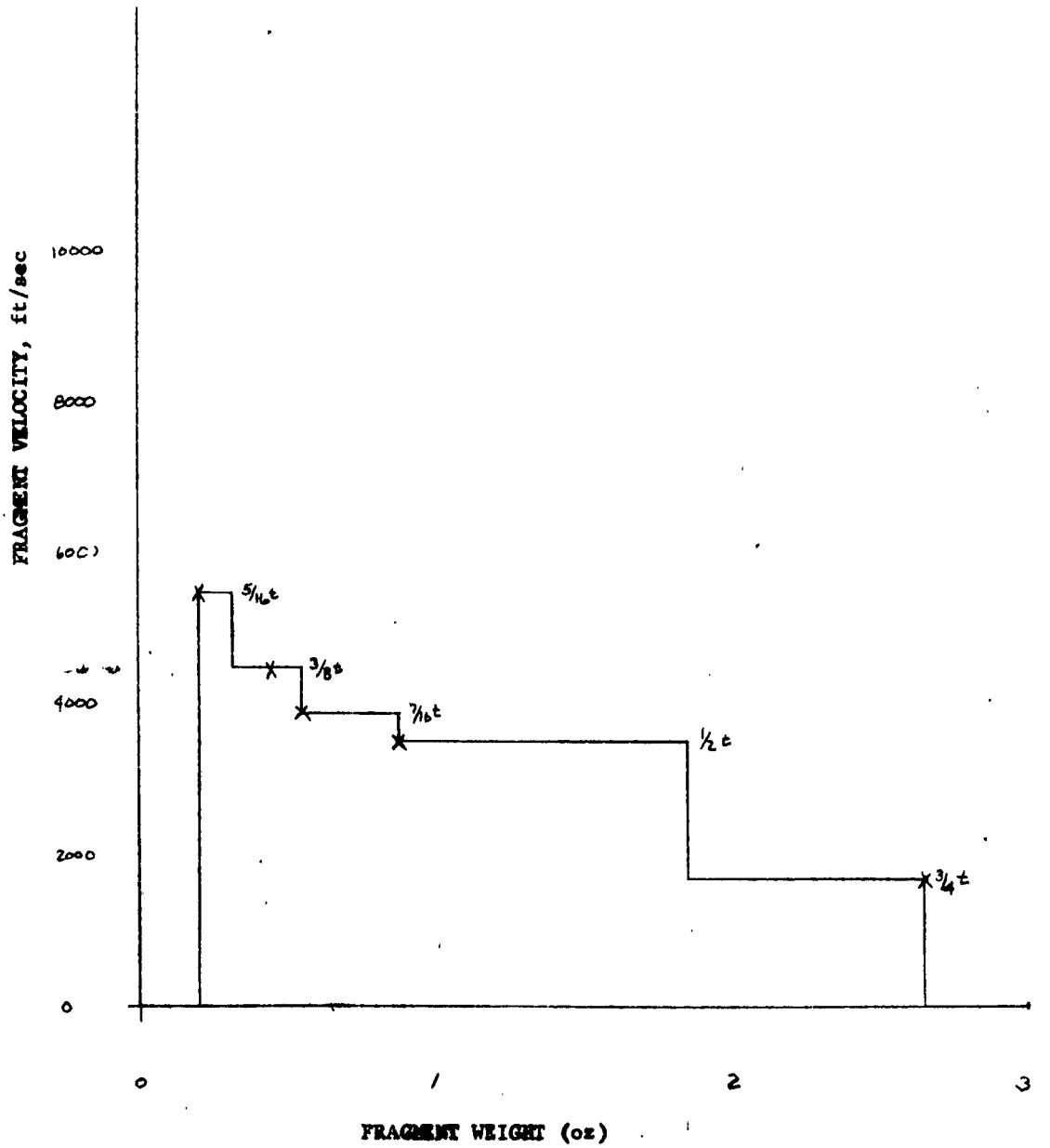
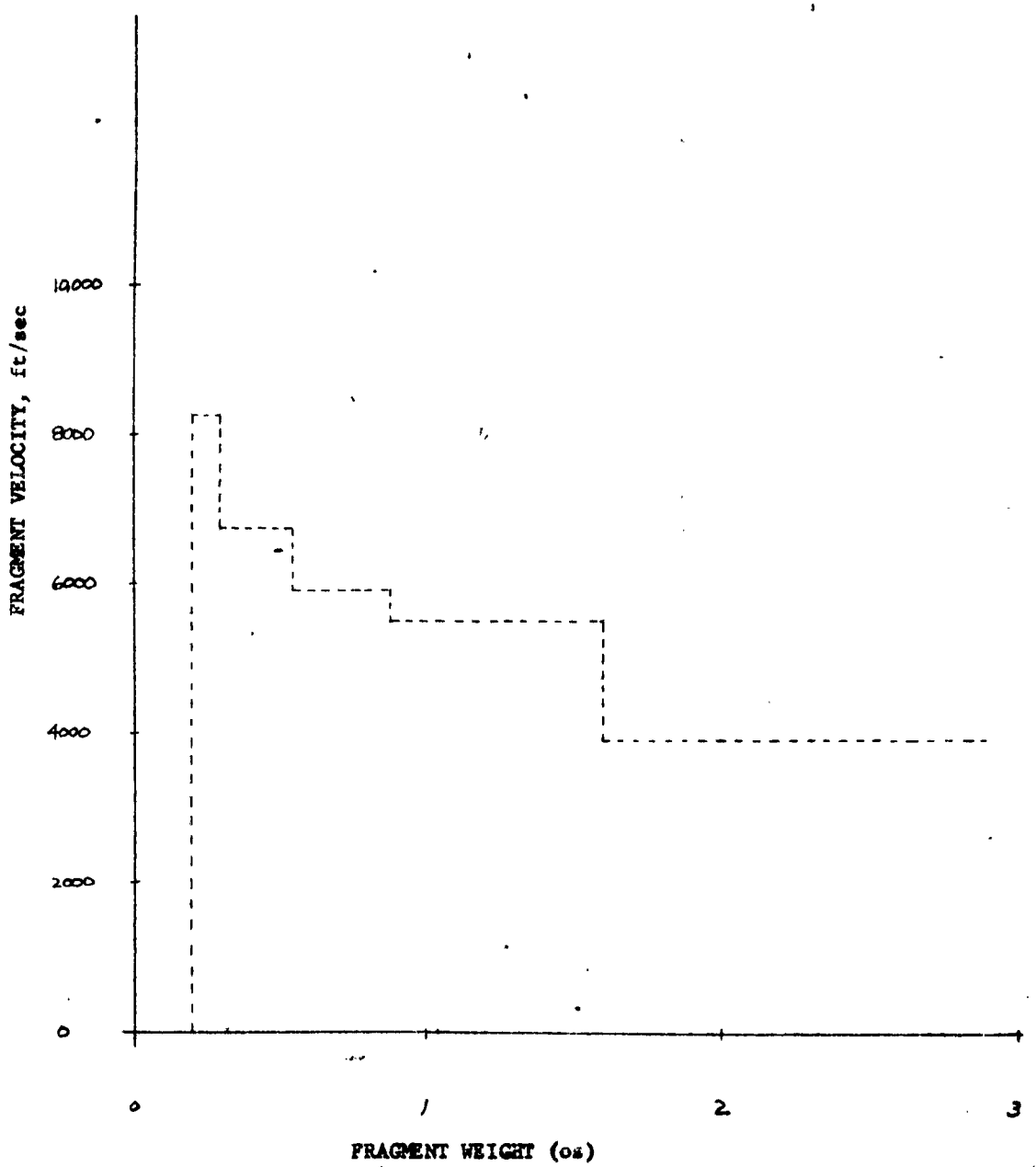


Figure 3

Estimated Masses and Velocities of Undamaged Fragments Obtainable with an 8 inch Donor Charge



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