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Report No. 7

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

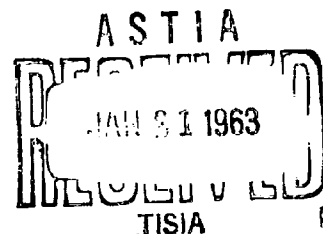
Prepared by

Arthur D. Little, Inc.
Cambridge, Mass.

For

Commanding Officer
Picatinny Arsenal
Dover, New Jersey

28 September 1962



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ABSTRACT

This is the seventh in a series of monthly reports on an experimental program dealing with the sensitivity of certain cased explosives and propellants to impact by regular fragments. 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.

This report discusses the firing of 0.2 oz fragments for velocity calibration and assessment of fragment damage. Receiver charge detonability tests were also fired. No detonations were recorded.

SENSITIVITY OF CASSED EXPLOSIVE MATERIALS TO

IMPACT BY REGULAR FRAGMENTS (U)

INTRODUCTION

This is the seventh report on an experimental program covering the progress of Contract DA-19-020-ORD-5617 for Picatinny Arsenal. This report covers the period 31 August to 28 September 1962. The objective of the program is to determine the sensitivity of certain cased explosives and propellants to impact by regular fragments. A technique of explosive fragment acceleration is being used to cover the range of velocities of interest. This method appears feasible, is economical, and almost mandatory for high velocities. The explosive launch of fragments is presently being used for all test firings. During this report period effort has been devoted to the firing of 0.2 oz fragments (3/8 x 3/8 x 3/16 inches thick). Velocity calibration and assessment of fragment launch damage have been completed. Detonability tests using cased explosives were conducted at velocities up to 8300 feet/sec. No receiver charge detonations took place.

TEST FIRING

All test firings conducted during the report period are listed in Table I. Two firings using the 1/2" cubes (0.54 oz) were made into the exposed end of the receiver charge at velocities of 5,970 ft/sec and 4,690 ft/sec and no detonations resulted. The receiver charge cases were severely damaged and over one half of the explosive material was thrown out of the casing. The next four firings were made using a 220 Swift rifle firing a 48 grain (.11 oz) copper jacketed lead bullet (impact velocity in all cases was approximately 3600 ft/sec). The first shot which was fired into the exposed end of the charge threw out one half of the explosive material with some minor burning (all burning took place outside of the casing). The second round was fired through the 1/16" plate,

the projectile hit the thick wall of the receiver charge igniting the explosive material, which burned very slowly within the case. A third firing was again made through the 1/16" cover plate. The 1/4" thick casing was split along its axis and one half of the explosive material was thrown out of the casing and burned. The explosive material inside the casing remained intact. A fourth firing was made with the receiver charge assembled and a witness plate bolted to the exposed end. The firing was made through the 1/16" plate (no velocity record was obtained on this firing). The bolts holding the witness plate were broken and all explosive material was moved outward approximately 1/8". The 1/16" thick plate was twisted outward. There was a slight puff of smoke upon impact. However, all explosive material was intact (there was some evidence of a minimum amount of burning at the point of entry of the bullet). Smaller fragments weighing approximately 0.2 oz (mild steel cubes whose dimensions were 3/8 x 3/8 x 5/16 in. thick) were obtained and a series of calibration firings to assess fragment damage and obtain fragment velocities were made. Five additional firings at velocities up to 8300 ft/sec were made with this fragment into the exposed end of the receiver charge. There was no detonation or burning (No. 77 through 86, Table I). Two additional firings through the 1/16" plate were made with this small fragment at a maximum velocity of 4870 ft/sec. There was no evidence of burning and no detonation. However, since these charges were assembled with witness plates securely bolted on the exposed end and with four heavy bolts, damage to receiver charges appeared to be considerably less than in any previous impacts. Data obtained from the firings reported herein (using cubes) continues to show a fragment mass velocity to charge detonation relationship which varies considerably with existing data from other independent sources.

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VISIT TO PICATINNY ARSENAL

On September 11, 1962, representatives of Arthur D. Little, Inc. met with representatives of Picatinny Arsenal in Dover, New Jersey, to discuss the status of the program under this contract. The following points were resolved at this meeting:

1. Several firings with a small fragment (0.2 oz) would be made at a velocity level easily attainable with present donor booster charge design.
2. The firing schedule will be reduced pending arrival of the more sensitive receiver charges and/or the apparently inconsistencies which are occurring are satisfactorily answered.
3. Picatinny would arrange to fire some small fragments (gun launched) into cast charges similar to those being used in this test program as a check on results being obtained by explosive launch.
4. Picatinny would cast some pentolite charges (a more sensitive explosive) and forward them for testing at as early a date as possible.
5. A visit to Arthur D. Little, Inc. test facility to witness the firing of the small fragments (0.2 oz) would be arranged at an early date (this visit took place on September 20, 1962, see paragraph below).

VISIT TO TEST SITE

On September 20, 1962, two representatives of Picatinny Arsenal visited the Winchester, New Hampshire test facility of Arthur D. Little, Inc. and witnessed the previously discussed five firings of 0.2 oz fragments into the exposed end of the receiver charges (firings No. 82 through No. 86, Table I). As a result it

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was agreed that firings into these charges would be stopped after two additional firings through 1/16" cover plates (rounds 87 and 88, Table I). Cast Pentolite explosive charges would be expedited and forwarded for testing at an early date. Any additional firings using these receiver charges, calibration or test, would be coordinated with Picatinny Arsenal.

FUTURE WORK

Testing is to be stopped pending arrival of new receiver charges from Picatinny Arsenal. Effort will be devoted to making a more efficient test arrangement such that the test firing rate can be increased when new charges are received. Plans for the next report period also include some high speed camera coverage of an explosively launched fragment to obtain photographic evidence of the fragments performance.

MAN HOURS EXPENDED

Total inclusive man hours to date on this program are 1521 or 52% of the total. Of this, 311 man hours or 11% were expended during the current report period.

TABLE I

FRAGMENT IMPACT FIRINGS

<u>Firing No.</u>	<u>Date</u>	<u>Fragment Size</u> <u>Dim</u> <u>in.</u>	<u>Wt</u> <u>03</u>	<u>Fragment Velocity</u> <u>ft./sec.</u>	<u>Remarks</u>
71	9/5/62	1/2 x 1/2 x 1/2	0.54	5970	No detonation - no burning - fragment fired into exposed end of receiver charge - 1/2 explosive material thrown out of receiver charge - no apparent damage to metal parts.
72	9/5/62	"	"	4690	Same as above
73	9/6/62	48 grain (0.11g) copper jacketed lead 22 caliber		3600	Fired into exposed end of charge no witness plate - 1/2 explosive material thrown out and burned, that remaining in receiver charge undamaged.
74	9/6/62	rifle bullet fired from 220 swift rifle.		3540	Fired through 1/16-in. cover plate. Thick (1/4") wall of cylinder struck. All material burned slowly - some thrown out by bullet impact.
75	9/6/62	Same as above		3570	Fired through 1/16-in cover plate, good hit (center) 1/4" cylinder split open along axis 1/2 explosive material thrown out and burned that explosive remaining in cylinder was undamaged.
76	9/7/62	Same as above			Fired through 1/16" cover plate. 1" thick witness plate bolted securely to exposed end of charge - good hit in center. Bolts holding witness plate broken. Cover plate bulged outward. Slight puff of smoke on impact - essentially all explosive material intact - some evidence of minor burning at entrance hole.

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TABLE I (Cont)

FRAGMENT IMPACT FIRINGS

Firing No.	Date	Fragment Size		Calibration firings	Remarks
		Dim in	Wt oz		
77	9/18/62	3/8 x 3/8 x 5/16	0.2 oz	to assess new	Fragment damage was minimum. Slight mushrooming at rear surface of fragment at launch. fragment weight remained essentially unchanged over launch velocity range 2600 1/sec to 5300 1/sec. Evidence of more tumbling with smaller fragment.
78	9/18/62	"	"	sized	
79	9/19/62	"	"	fragment	
80	9/19/62	"	"	damage and check	
81	9/19/62	"	"	instrumentation with this fragment.	
Rounds 82 through 86 were fired into exposed end of charge. (two velocity measuring devices were used on each firing)					
82	9/20/62	3/8 x 3/8 x 5/16	0.2 oz	2620 2685	Missed charge - hit edge of plate.
83	9/20/62	"	"	3095 3110	Hit edge of heavy wall tubing missed charge
84	9/20/62	"	"	3110 3080	Fragment hit heavy steel baffle plate missed charge
85	9/20/62	"	"	8610 8380	Good hit - close to edge of charge bulged 1/4" casing. 1/2 explosive material thrown out - explosive broken up in fine pieces. No burning. No detonation.
86	9/20/62	"	"	7310 8700	Good hit - center of charge split 1/4" casing - 1/2 explosive material thrown out. Frag. recovered - No burning. No detonation.

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TABLE 1 (Cont)

SHOOTER IMPACT TESTS

Firing No.	Date	Fragment Size		Fragment Velocity	Remarks
		Dim In.	Weight Lb		
87	9/24/62	3/8 x 5/16	0.2oz	4060	On these two firings the witness plate was securely clamped to the receiver charge with 4-1/4" threaded rods. Fragments penetrated 1/16" plate - bulged plate upward but did not throw out much explosive material. Receiver charges stood impact better. No detonation.
88	9/24/62	"	"	4860	

REPORT DISTRIBUTION

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