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30 Apr 1965, DoDD 5200.10; Pre-dates formal DoD distribution statements. Treat as DoD only.
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PART A

SYNOPSIS

1. The object of this test was to obtain experimental data on the interior and exterior ballistics of a gun firing several projectiles from a common cartridge case through parallel bores drilled in one (1) piece of metal.

2. Based on the limited number of rounds fired from the Seven Shot 30mm Ballistics Gun, it is concluded that:

   a. Firing identical 30mm "Aden" projectiles, there is a variation of about 4.5 percent in the velocities of the leading and trailing projectiles.

   b. Firing identical 30mm "Aden" projectiles, the center projectile usually emerges first, has the highest velocity, and the least yaw.

   c. Yaw as high as 31° occurs at 150 feet.

   d. Weighting the center projectile so that it emerges last does not improve the pattern of the others or correct the excessive yaw.

   e. The average maximum dispersion is 28.6 mils at 2000 inches.
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**APPENDIX A - NPG PHOTOGRAPHS OF SEVEN SHOT 30mm BALLISTICS GUN AND AMMUNITION**

FIGURES 1-6 (Incl)

**APPENDIX B - BALLISTIC SYNCHRO PHOTOGRAPHS OF PROJECTILES IN FLIGHT.**

FIGURES 7-13 (Incl)

**APPENDIX C - PLOTTED PATTERNS SHOWING DISPERSION AND DEGREES OF YAW.**

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**APPENDIX D - GRAPH OF CALCULATED VELOCITY vs CHARGE WEIGHT TABLE**

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**APPENDIX E - TABULATED FIRING DATA**

TABLE II

**APPENDIX F - CALCULATED VELOCITIES**

TABLE III

**APPENDIX G - DESCRIPTION AND DISCUSSION OF THE BALLISTIC SYNCHRO CAMERA**

1-2 (Incl)

**APPENDIX H - DISTRIBUTION**

1-2 (Incl)

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PART B

INTRODUCTION

1. AUTHORITY:


2. OBJECT OF TEST:

   The object of this test was to obtain experimental data on the interior and exterior ballistics of seven (7) 30mm projectiles when fired from a common case through seven (7) parallel rifled bores.

3. REPRESENTATIVES PRESENT:

   Mr. Frank R. Marquardt of Re8a, Bureau of Ordnance, the Liaison Officer designated in the Task Assignment, was present during the firings.

PART C

DETAILS OF TEST

4. DESCRIPTION OF ITEM UNDER TEST:

   The Seven Shot 30mm Ballistic Gun was manufactured by the Naval Gun Factory, and consists of the following major parts.

   a. Barrel (Bureau of Ordnance Sketch 147748)
   b. Breech (Bureau of Ordnance Sketch 147749)
   c. Receiver (Bureau of Ordnance Sketch 147750)
   d. Rear Support (Bureau of Ordnance Sketch 147751)
   e. Front Support (Bureau of Ordnance Sketch 147752)
   f. Front Support Plate (Bureau of Ordnance Sketch 147753)
   g. Yoke (Bureau of Ordnance Sketch 147754)
   h. Tray (Bureau of Ordnance Sketch 148856)
Seven Shot 30mm Ballistics Gun

This gun is basically an experimental device designed to permit the firing of seven (7) 30mm projectiles from a common case through seven (7) parallel rifled holes drilled in one (1) barrel. It is a single shot weapon with its cup-like breech secured to the barrel by means of interrupted threads. The recoil is cushioned by four (4) 40mm hydraulic buffers and counterrecoil is accomplished by a 3"/50 barrel spring. Six (6) of the rifled holes are arranged in a circle, 60° apart, around the seventh, which is centered. There is 15/64 inches of metal between the grooves of each bore and those adjacent to it. The length of the barrel is 59-1/2 inches and the total weight of this experimental gun is 827 pounds. The gun is shown in Figures 1 and 2.

Ammonition consists of modified 3"/50 cases which have been turned down as shown in Figure 3, and shortened to an overall length of 6-1/2 inches. A brass plate 1/2 inch thick, having seven (7) 30mm diameter holes matching the holes in the barrel, properly positions the seven (7) 30mm British "Aden" ball projectiles. A Mk 27 electric 3 inch caliber primer was used to initiate the propellant charge.

5. PROCEDURE:

As the normal muzzle velocity of the 30mm British "Aden" projectiles used in this test is 2150 feet per second when fired in the "Aden" gun, calculations were made to determine the proper charge weight to approximate this velocity. A graph of the results of these calculations is given as Table I. This graph, based on IMR 4903 powder, showed that .85 pounds of propellant should give the desired velocity, and this charge weight was used in all rounds fired as it was found to give satisfactory pressures and velocities. Two (2) copper crusher gages were strapped to the primer extension tube in each of the first three (3) rounds fired, but were not used thereafter as the pressures were found to be well within the designed limit of the breech. Complete firing data are given in Table II.

Each projectile was painted with a design so that it could be identified in high speed photographs. The projectiles and rifled holes were also numbered, starting with No. 1 at the one o'clock position looking at the breech of the gun and then clockwise around the outer ring with No. 7 in the center. The first designs, as shown in Figures 3 and 4, were changed after the first 5 rounds, as the projectiles could not be properly identified in the photographs, and the designs shown in Figures 5 and 6 were used thereafter.
Seven Shot 30mm Ballistics Gun

A shorting muzzle contact and a shorting double screen of copper wire were used to start and stop a Potter Counter Chronograph and obtain the time of flight of the leading projectile. From this the average velocity of this leading projectile over a fixed distance was computed. On the first two (2) rounds, the screen was placed 25 feet from the muzzle but when it was found that blast upset the screen it was moved to 140 feet on rounds 3, 4, and 5, and 145 feet on rounds 6, 7, and 8. A Ballistic Syncro camera was set up 6 inches in front of the muzzle and 6 feet to the right of the line of fire to record the emergence of the projectiles. The film speed of this camera was 900 inches per second and the results obtained are shown in Figure 7. To obtain a group picture of the projectiles in flight, an experimental Ballistic Drum Camera with a film speed of 1050 inches per second was set up 133 feet in front of the muzzle and 49 feet to the right of the line of fire. These photographs are given as Figures 8 through 13 and computed velocities of each projectile are given in Table III. A description and discussion of the Ballistic Synchro Camera is included as Appendix (G).

Patterns of the first five (5) rounds were taken at 2000 inches and the yaw of each projectile was measured. These patterns with the yaw indicated are given as Figures 14 through 18. In an attempt to improve the patterns and decrease yaw, the No. 7 or center projectile was weighted to .73 pounds on round 4 and to .74 pounds on round 5 so that it would emerge last. The average weight of the normal projectiles is .61 pounds. It was thought that the shock wave from this projectile was effecting the flight of the others, but this did not prove to be correct.

6. RESULTS AND DISCUSSION:

The results of this investigation are presented in the form of photographs, diagrams, graphs and Tables in Appendices (A) through (F).

PART D

CONCLUSIONS

7. Based on the limited number of rounds fired from the Seven Shot 30mm Ballistics Gun, it is concluded that:

a. Firing identical 30mm "Aden" projectiles, there is a variation of about 4.5 percent in the velocities of the loading and trailing projectiles.
Sovor Shot 30mm Ballistics Gun

b. Firing identical 30mm "Aden" projectiles, the center projectile usually emerges first, has the highest velocity, and has the least yaw.

c. Yaw as high as 31° occurs at 150 feet.

d. Weighting the center projectile so that it emerges last does not improve the pattern of the others or correct the excessive yaw.

e. The average maximum dispersion is 28.6 mils at 2000 inches.

PART E

RECOMMENDATIONS

9. Because of the unsatisfactory exterior ballistics obtained in these firings, it is recommended that no further tests be conducted on this gun firing "Aden" projectiles, as it is thought that these projectiles may be unstable when fired from a single barrel gun. If additional information is desired on a multibore weapon, it is recommended that firings be conducted with projectiles designed for higher velocities.

PART F

DISPOSITION OF MATERIALS

9. The gun and remaining ammunition components are being held at the Naval Proving Ground pending disposition instructions from the Bureau of Ordnance.
Seven Shot 30mm Ballistics Gun

The investigation upon which this report is based was conducted by:
L. D. RUCKER, Lieutenant Commander, USNR
Aircraft Armament Officer
Aviation Ordnance Department

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Aircraft Armament Officer
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Ordnance Officer
By direction
U. S. NAVAL PROVING GROUND
DAHLGREN, VIRGINIA

Final Report
on
Seven Shot 30mm Ballistics Gun

Project No.: NPG-Re8a-115-2-52
Copy No.: 5
No. of Pages: 7

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Date: APR 9 1953
Figure 2
View of Muzzle of Seven Shot 30mm Ballistic Gun.
Figure 3. Photograph of projectiles assembled in case, rounds 1 through 5.
Figure 5
Photograph of projectiles assembled in case, rounds 6, 7, and 8.
Figure 8:
Ballistic Synchro Photograph of first six projectiles in round No. 4. Center projectile (No. 7) has been weighted and trails (See Figures 9 and 10).

APPENDIX E
Figure 10

Strip Ballistic Synchro Photographs of Projectiles, fired from rounds 4 and 5, showing relative position of trailing weighted (No. 7) projectiles.

APPENDIX B

ROUND NO 4

ROUND NO 5
Figure 11
Ballistic Synchro Photograph of projectiles fired from round No.
APPENDIX B
PATTERN ROUND NO. 1 AT 2000 ft
YAW OF EACH PROJECTILE SHOWN IN DEGREES
PATTERN ROUND NO 2 AT 2000".
YAW OF EACH PROJECTILE SHOWN IN DEGREES.
### TABLE II

**FIRING RECORD**

- **Caliber:** 30mm
- **Serial:** Sketch 147750
- **Type:** Prototype
- **Prototype:** Naval Gun Factory
- **5 Previous Rounds**

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<th>Date</th>
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<th>No.</th>
<th>Time</th>
<th>Temp.</th>
<th>Recoil</th>
<th>Powder Pressure</th>
<th>Velocity</th>
<th>Action Time</th>
<th>Remarks</th>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(psi)</td>
<td>(fps)</td>
<td>(at Ft)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Ga #1</td>
<td>Ga #2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8/4</td>
<td>1</td>
<td>1510</td>
<td>82°</td>
<td>5 7/8&quot;</td>
<td></td>
<td>12,500</td>
<td>16,500</td>
<td>Lost</td>
<td>Lost</td>
</tr>
<tr>
<td>8/5</td>
<td>2</td>
<td>1050</td>
<td>78°</td>
<td>5 15/16&quot;</td>
<td></td>
<td>10,100</td>
<td>11,400</td>
<td>2163</td>
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<td>8/5</td>
<td>3</td>
<td>1330</td>
<td>82°</td>
<td>6&quot;</td>
<td></td>
<td>10,200</td>
<td>12,600</td>
<td>2081</td>
<td>70'</td>
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<tr>
<td>8/5</td>
<td>4</td>
<td>1350</td>
<td>82°</td>
<td>6 3/16&quot;</td>
<td></td>
<td>---</td>
<td>---</td>
<td>2118</td>
<td>70'</td>
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<tr>
<td>8/5</td>
<td>5</td>
<td>1420</td>
<td>82°</td>
<td>6 1/16&quot;</td>
<td></td>
<td>---</td>
<td>---</td>
<td>2111</td>
<td>70'</td>
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<tr>
<td>8/19</td>
<td>6</td>
<td>1430</td>
<td>88°</td>
<td>5 3/2&quot;</td>
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<td>---</td>
<td>---</td>
<td>Lost</td>
<td>70 1/2'</td>
</tr>
<tr>
<td>8/19</td>
<td>7</td>
<td>1514</td>
<td>90°</td>
<td>5 7/8&quot;</td>
<td></td>
<td>---</td>
<td>---</td>
<td>2109</td>
<td>72 1/2'</td>
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<tr>
<td>8/19</td>
<td>8</td>
<td>1532</td>
<td>92°</td>
<td>5 7/8&quot;</td>
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<td>---</td>
<td>---</td>
<td>2134</td>
<td>72 1/2'</td>
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*Action time is time from firing impulse to emergence of first projectile.*
### TABLE III

CALCULATED VELOCITIES

<table>
<thead>
<tr>
<th>Round No. 4</th>
<th>Projectile Number</th>
<th>4</th>
<th>3</th>
<th>1</th>
<th>6</th>
<th>5</th>
<th>2</th>
<th>(Weighted) 7</th>
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<tr>
<td>Velocity ft./sec. at 120'</td>
<td>2144</td>
<td>2139</td>
<td>2113</td>
<td>2109</td>
<td>2084</td>
<td>2052</td>
<td>1864</td>
<td></td>
</tr>
<tr>
<td>Muzzle velocity</td>
<td>2214</td>
<td>2209</td>
<td>2183</td>
<td>2179</td>
<td>2154</td>
<td>2122</td>
<td>1934</td>
<td></td>
</tr>
<tr>
<td>Velocity differential, ft./sec. from Leading Projectile</td>
<td>0</td>
<td>5</td>
<td>31</td>
<td>35</td>
<td>60</td>
<td>92</td>
<td>280</td>
<td></td>
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<tr>
<td>Percent of Velocity of Leading Projectile</td>
<td>100</td>
<td>99.8</td>
<td>98.6</td>
<td>98.4</td>
<td>97.3</td>
<td>95.8</td>
<td>87.4</td>
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<th>Round No. 5 (Identification difficult)</th>
<th>Projectile Number</th>
<th>?</th>
<th>1</th>
<th>?</th>
<th>2</th>
<th>?</th>
<th>?</th>
<th>(Weighted) 7</th>
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<tbody>
<tr>
<td>Velocity ft./sec. at 120'</td>
<td>2142</td>
<td>2139</td>
<td>2113</td>
<td>2109</td>
<td>2084</td>
<td>2052</td>
<td>1864</td>
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<tr>
<td>Muzzle velocity</td>
<td>2212</td>
<td>2209</td>
<td>2183</td>
<td>2179</td>
<td>2154</td>
<td>2122</td>
<td>1954</td>
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<td>Velocity differential, ft./sec. from Leading Projectile</td>
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<td>3</td>
<td>29</td>
<td>33</td>
<td>58</td>
<td>90</td>
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<td>Percent of Velocity of Leading Projectile</td>
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<td>99.9</td>
<td>98.7</td>
<td>98.5</td>
<td>97.4</td>
<td>95.9</td>
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<th>Round No. 8</th>
<th>Projectile Number</th>
<th>7</th>
<th>2</th>
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<th>3</th>
<th>1</th>
<th>4</th>
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<td>Velocity at 13314, ft./sec.</td>
<td>2116</td>
<td>2102</td>
<td>2075</td>
<td>2064</td>
<td>2038</td>
<td>2019</td>
<td>2016</td>
<td></td>
</tr>
<tr>
<td>Muzzle velocity</td>
<td>2193</td>
<td>2180</td>
<td>2153</td>
<td>2141</td>
<td>2115</td>
<td>2096</td>
<td>2093</td>
<td></td>
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<tr>
<td>Velocity differential, ft./sec. from Leading Projectile</td>
<td>0</td>
<td>13</td>
<td>40</td>
<td>52</td>
<td>78</td>
<td>97</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>Percent of Velocity of Leading Projectile</td>
<td>100</td>
<td>99.4</td>
<td>98.2</td>
<td>97.6</td>
<td>96.4</td>
<td>95.6</td>
<td>95.5</td>
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(Note: The probable error of a single velocity is ±20 ft./sec.)

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APPENDIX F
Seven Shot 30mm Ballistics Gun

DESCRIPTION AND DISCUSSION OF THE BALLISTIC SYNCHRO CAMERA

The Ballistic Synchro Camera, with which the pictures of the 30mm projectiles were taken, operates by matching the velocity of the IMAGE of the projectile with that of a film moving behind a slit placed transversely across the film. Since the image speed is lower than the object speed by the same ratio as the image is smaller than the object, it follows that by taking a small enough picture, the image speed can be reduced to a point where it is possible to match this speed with the speed of the film. It also follows that if the film can be moved faster the ratio between object distance and image distance can be manipulated to give a larger picture. If the matching is perfect, and the projectile not spinning, a point on the projectile image will remain on the same point of the film during the time the image crosses the slit.

For a spinning projectile the cross motion of a point on the projectile surface must be limited, by the width of the slit, to an amount which will cause no more blur than can be tolerated. Calculation shows that this cross motion is only one eighth (1/8) of the forward motion for a projectile with a spin of one (1) turn in twenty five (25) calibers. Therefore, eight (8) times as long an exposure can be used with the Ballistic Synchro camera as would have to be used to "stop" the projectile with other types of cameras.

The size of picture which can be taken of a small object is limited by the highest speed at which the film can be transported. For a large object, the size of picture obtainable is also limited by the width of the film. The group of projectiles under consideration covers a good deal of space, which increases as it gets farther from the muzzle. It must therefore be considered as a large object, and since the individual projectiles are small, a large image is especially desirable in order to see as much detail as possible.

A Ballistic Synchro Camera of the drum type, which moves a film 3.5 inches wide at a maximum speed of 1500 inches a second was therefore provided for the pictures taken 126 feet from the muzzle of the gun. This camera is equipped with a lens which has a focal length of 23.6 inches. It has an opening of f/3.5. The camera can therefore be placed far enough from the trajectory to be safe, and at the same time obtain a good sized image. The film speed used for the first picture was 1050 inches per second. The greater film speed possible will provide for taking pictures of projectiles which have a velocity of 3000 ft/sec at the same ratio of image to object used for this picture. (1:24)
Sovon Shot 30mm Ballistics Gun

DESCRIPTION AND DISCUSSION OF THE BALLISTIC SYNCHRO CAMERA

The picture of the projectiles emerging from the muzzle taken with a camera having a 35mm film moving at 900 inches per second. The focal length of the lens used on this camera was 2 inches. The maximum film speed for this camera is 1020 inches per second, giving a ratio of image to object for the muzzle camera of 1:28.

Since the gun was under a canopy, a rack of flash bulbs was used to cover the time of emergence. The light from these bulbs was about 50 milliseconds, which is enough to cover the passage of the projectiles through the field of view of the muzzle camera. Auxiliary illumination was needed for the larger camera, as the sun was obscured by a light overcast.