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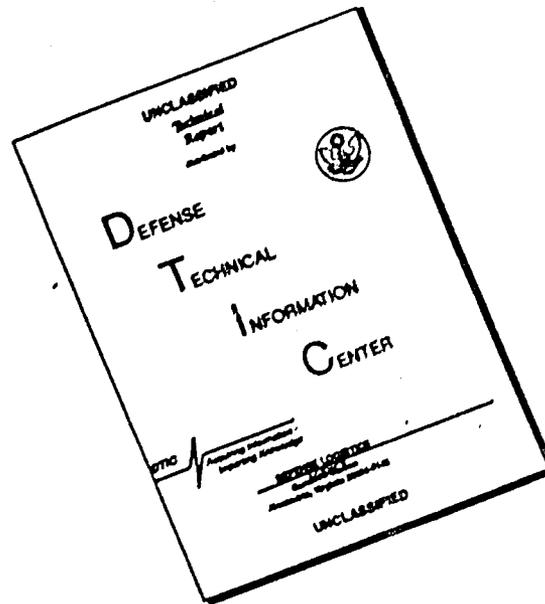
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QUARTERLY REPORT

NN-Q-1

Contract DAI-19-020-501-ORD-(P)-58

NATIONAL NORTHERN
West Hanover, Massachusetts

Confidential

FREE-AIR BLAST EVALUATION OF METALLIZED TNT

Contract DAI-19-020-501-ORD-(P)-58

FIRST QUARTERLY REPORT

NN-Q-1

April, May, June 1955

Copy No. 07

NATIONAL NORTHERN

West Hanover, Massachusetts

Confidential

The Technical Division of National Ordnance Corp.

APR 6 1955

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FREE-AIR BLAST EVALUATION OF METALLIZED TNT

Contract DAI-19-020-501-ORD-(P)-58

FIRST QUARTERLY REPORT

NN-Q-1

April, May, June 1955

Submitted by:

V. Philipchuk

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1.0 INTRODUCTION

This report covers the first quarter of testing accomplished for Picatinny Arsenal under Contract No. DAI-19-020-501-ORD-(P)-58.

2.0 OBJECT OF TEST

These tests were conducted to determine Free-Air blast measurements of experimental test samples consisting of TNT and metallized TNT having weights of approximately one pound each, spherical in shape, and uncased (bare).

3.0 CHARGE DATA

3.1 This report details the test data and results of the first group of HE shipped to National for test. The first group consisted of 120 rounds of spherical-shaped cast high explosives. The contract estimates 1000 rounds for test.

3.2 The 120 bare charges received by National were as follows:

Shape: Spherical, 3 1/4" diameter, cast in mold described by Drwg.

No. SK-43375

Booster: 1" x 1" tetryl pellet having a 0.315 diameter central cavity.

The tetryl was located in the center of the cast spherical charge.

Weights and Densities supplied by Picatinny Arsenal:

| <u>No. Charges</u> | <u>HE Code</u> | <u>% TNT</u> | <u>% Metal</u> | <u>Metal</u> | <u>Average wt. (grams)</u> | <u>Average Density</u> |
|--------------------|----------------|--------------|----------------|-------------------|----------------------------|------------------------|
| *50 | A | 100 | 0 | -- | 460 | 1.64 |
| 10 | B | 80 | 20 | Al | 488 | 1.74 |
| 10 | C | 80 | 20 | 65/35 Mg/Al | 477 | 1.70 |
| 10 | D | 80 | 20 | Ti H ₄ | 521 | 1.86 |
| 10 | E | 80 | 20 | Zr H ₄ | 523 | 1.87 |
| 10 | F | 80 | 20 | Sn | 507 | 1.81 |
| 10 | G | 80 | 20 | Zn | 533 | 1.90 |
| 10 | H | 80 | 20 | Zr-Ni | 521 | 1.86 |

*Only 10 of the 50 TNT charges were fired in this series. The remaining 40 are being held as control samples for future test series.

4.0 TEST EQUIPMENT

Static blast tests of the subject charges were conducted at National's Halifax Range at the Free-Air Blast Site. This site consists of a quadinstrument arrangement for detecting blast from a single charge. Details of this site and the Semi-Confined Blast Site (used to evaluate HE blast having partial confinement) are the subject of a separate report which will be released by National to contracting agencies in the near future. The details and instrumentation of the Free-Air Blast Site are briefly as follows:

4.1 Charge. The charge is placed 9 ft. above ground level. The axis of a cylindrical charge or projectile is always placed at 45° from the vertical or horizontal plane. In these tests, with the charges being spherical, the cap cavity was placed facing up in the vertical plane.

4.2 Gauges. Four detectors are located, each in different quadrants, around the charge and at various distances from it. Each instrument is placed to receive the free-air blast (incident) wave, i. e., no reinforcement from reflected or Mach waves. These four detectors are as follows:

4.2.1 Pendulum Gauge. Designed by National to record an integration of pressure-time, 290 lbs. in weight, 2 ft. square, and 3 ft. from the charge's center.

4.2.2 Catenary Diaphragm. Developed for use in high explosive blast determinations to record pressure-time, side-on to the blast wave, and 6' 8" from the charge's center.

4.2.3 Foilmeter. National's modification of the Bikini Gauge used to record peak pressure, face-on to the blast front at 5 feet from the charge's center. Foil is '0025 S aluminum.

4.2.4 5" N-T-C. Designed by National as a possible means for correlating with aircraft damage beyond an over-kill area. This gauge is 5" in diameter, facing the charge, and has steel tubular compartments (T-C) 6" in length with .0025 S aluminum foil between compartments. The face of No. 1 compartment is 6' from the charge's center.

5.0 TEST RESULTS

5.1 Detailed recordings of the individual charges are listed in the enclosed Tables I - IV inclusive and are summarized as follows:

Free-Air Blast

1 lb. Bare Spherical Charges, Averages

| <u>HE Type</u> | <u>HE</u> | <u>Pendulum (degrees)</u> | <u>Foilmeter</u> |
|----------------|-----------------------|---------------------------|------------------|
| A | TNT | 16.1 | 7.5 |
| B | TNT/Al | 18.2 | 8.0 |
| C | TNT/Mg-Al | 17.3 | 7.8 |
| D | TNT/Ti H ₄ | 17.9 | 8.3 |
| E | TNT/Zr H ₄ | 17.7 | 7.7 |
| F | TNT/Sn | 16.4 | 7.8 |
| G | TNT/Zn | 16.5 | 7.7 |
| H | TNT/Zr-Ni | 16.9 | 8.0 |

| <u>HE Type</u> | <u>Catenary</u> | | <u>5" N-T-C</u> |
|----------------|-----------------|---------------|-----------------|
| | <u>Δ psi.</u> | <u>mlsec.</u> | |
| A | 23.1 | .5 | 4.7 |
| B | 24.2 | .5 | 4.7 |
| C | 26.3 | .5 | 5.8 |
| D | 27.5 | .5 | 5.5 |
| E | 26.0 | .5 | 5.2 |
| F | 23.6 | .5 | 4.3 |
| G | 22.9 | .5 | 4.4 |
| H | 24.4 | .5 | 5.0 |

All HE compositions are 80% TNT and 20% of metal except type A which is 100% TNT.

5.2 The above tables of averages are for the following number of rounds:

| HE Type | No. Rds. Averaged | | | |
|---------|-------------------|------------------|-----------------|-----------------|
| | <u>Pendulum</u> | <u>Follmeter</u> | <u>5" N-T-C</u> | <u>Catenary</u> |
| A | 10 | 10 | 10 | 8 |
| B | 6 | 6 | 6 | 6 |
| C | 10 | 10 | 9 | 6 |
| D | 10 | 10 | 10 | 4 |
| E | 10 | 10 | 10 | 3 |
| F | 10 | 10 | 10 | 10 |
| G | 10 | 10 | 10 | 9 |
| H | 10 | 10 | 10 | 5 |

The first 3 rounds of Type B gave low reading on all four gauges (see Tables I-IV inclusive), and were not used in averaging. Rd. No. 4 of Type B was split open for inspection of the tetryl booster condition. The tetryl booster was found to be in good condition. It was decided by Picatinny and National to insert the blasting cap to the mid-point of the tetryl instead of to the bottom of the tetryl. Rds. 5-10 in all cases were detonated with the bottom of the blasting cap at mid-point of the tetryl booster. The odd number of Catenary readings is attributed to difficulties encountered with electrical pressure pick-ups.

6.0 CONCLUSIONS

6.1 The new metals and metal compounds showing promise for blast when mixed with TNT are:

1. Titanium hydride, TiH_4
2. Magnesium -- Aluminum alloy 65/35
3. Zirconium hydride, ZrH_4
4. Zirconium-nickel alloy

7.0 WORK STATUS

7.1 This report is the first quarterly report.

7.2 Eighty (80) rounds were fired during this first quarter (897 man-hours.)

7.3 Future firings will be determined by the Project Officer at Picatinny Arsenal. Forty (40) TNT charges remain on hand at National for control samples. These samples will be used with future firings.

8.0 DETAILED TEST DATA**8.1 Table I. Free-Air Pendulum**

| HE Type | Rd. | Pendulum Readings | | | | | | | | | | Avg. |
|------------|-----|-------------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|------|
| | | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> | <u>7</u> | <u>8</u> | <u>9</u> | <u>10</u> | |
| A | | 17 | 16 | 17.5 | 14.5 | 16.5 | 17.5 | 15 | 16 | 14 | 17 | 16.1 |
| B | | * | * | * | * | 17 | 19 | 17.5 | 19 | 20 | 17.5 | 18.3 |
| C | | 16.5 | 18 | 17 | 17 | 19 | 16.5 | 18 | 18 | 16.5 | 16.5 | 17.3 |
| D | | 17.5 | 18 | 19 | 17 | 17 | 18 | 18.5 | 18 | 18 | 17.5 | 17.9 |
| E | | 17 | 18 | 17.5 | 18 | 17 | 16 | 18 | 20 | 18 | 17 | 17.7 |
| F | | 16.5 | 16.5 | 16 | 17 | 15 | 16 | 16 | 17 | 17 | 16.5 | 16.4 |
| G | | 17.5 | 17 | 17 | 16.5 | 16 | 15.5 | 15 | 17 | 17 | 16 | 16.5 |
| H | | 18 | 16.5 | 16 | 17 | 17.5 | 17 | 16.5 | 16 | 17.5 | 17 | 16.9 |

*Rds. 1 - 3 were 14, 14.5, and 11 and these were not used in averaging. Blast-
ing cap position changed at this point. Rd. No. 4 was split open for inspection.

8.2 Table II. Foilmeter

| HE Type | Rd. | Foilmeter Readings | | | | | | | | | | Avg. |
|------------|-----|--------------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|------|
| | | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> | <u>7</u> | <u>8</u> | <u>9</u> | <u>10</u> | |
| A | | 8 | 8 | 7 | 8 | 7 | 8 | 7 | 7 | 7 | 8 | 7.5 |
| B | | * | * | * | * | 8 | 9 | 8 | 8 | 9 | 6 | 8.0 |
| C | | 9 | 9 | 7 | 7 | 9 | 8 | 7 | 7 | 9 | 7 | 7.8 |
| D | | 9 | 9 | 10 | 7 | 8 | 9 | 8 | 6 | 9 | 8 | 8.3 |
| E | | 9 | 9 | 7 | 8 | 6 | 9 | 7 | 7 | 10 | 6 | 7.7 |
| F | | 8 | 8 | 6 | 9 | 7 | 8 | 8 | 8 | 8 | 8 | 7.8 |
| G | | 8 | 8 | 7 | 8 | 8 | 7 | 6 | 7 | 6 | 8 | 7.7 |
| H | | 9 | 9 | 10 | 9 | 8 | 6 | 5 | 8 | 8 | 8 | 8.0 |

* See sub note on Pendulum, Table I.

8.3 Table III. Catenary Diagram

| HE Type | Rd. | Catenary Readings Δ psi. | | | | | | | | | | Avg. | |
|------------|-----|---------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|------|------|
| | | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> | <u>7</u> | <u>8</u> | <u>9</u> | <u>10</u> | | |
| A | | 24 | 23 | 23 | -- | 23 | -- | 23 | 23 | 23 | 23 | 23 | 23.1 |
| B | | * | * | * | * | 20 | 28 | 24 | 25 | 22 | 25 | 24.2 | |
| C | | -- | -- | 28 | 28 | -- | -- | 25 | 27 | 24 | 26 | 26.3 | |
| D | | 29 | -- | -- | -- | -- | -- | 25 | 29 | 28 | -- | 27.5 | |
| E | | -- | -- | -- | -- | -- | -- | 26 | -- | 27 | 25 | 26.0 | |
| F | | 21 | 22 | 25 | 23 | 25 | 28 | 24 | 25 | 20 | 25 | 23.6 | |
| G | | 22 | -- | 23 | 23 | 20 | 23 | 22 | 25 | 23 | 24 | 22.9 | |
| H | | -- | -- | -- | -- | -- | 24 | 24 | 24 | 26 | 24 | 24.4 | |

*See sub note on Pendulum, Table I.

The time durations of all impulses recorded at 6' 8" were .5 msec.

8.4 Table IV. 5" N - T - C

| HE Type | Rd. | 5" N - T - C Readings | | | | | | | | | | Avg. |
|------------|-----|-----------------------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|------|
| | | <u>1</u> | <u>2</u> | <u>3</u> | <u>4</u> | <u>5</u> | <u>6</u> | <u>7</u> | <u>8</u> | <u>9</u> | <u>10</u> | |
| A | | 5 | 3 | 4 | 4 | - | 4 | 5 | 4 | 5 | 5 | 4.3 |
| B | | * | * | * | * | 5 | 6 | 4 | 4 | 4 | 5 | 4.7 |
| C | | 4 | 6 | 4 | 7 | 7 | 6 | 5 | 7 | 7 | 5 | 5.8 |
| D | | 7 | 5 | 7 | 6 | 5 | 6 | 5 | 4 | 5 | 5 | 5.5 |
| E | | 6 | 5 | 5 | 5 | 7 | 5 | 5 | 4 | 5 | 5 | 5.2 |
| F | | 6 | 4 | 3 | 4 | 5 | 4 | 5 | 4 | 4 | 4 | 4.3 |
| G | | 4 | 3 | 4 | 4 | 4 | 4 | 4 | 7 | 4 | 6 | 4.4 |
| H | | 7 | 5 | 4 | 4 | - | 4 | 4 | 4 | 4 | 6 | 4.7 |

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