# Test Report

## Bornea Dynamics Limited

| | |
|---|---|
| **Project Name** | Nemesis Munitions Testing – 7.62 Load Testing |
| **Project ID** | 220008 |
| **Test Name** | 7.62 Comparison Testing |
| **Test ID** | 220008- T1 & T2 & T3 & T4 |
| **Test Date** | T1 - September 17, 2022,<br><br>T2 - September 23, 2022<br><br>T3 - September 29, 2022<br><br>T4 – October 3, 2022 |
| **Contract ID** | BD-RDD-B-220008-1 |
| **Release Date** | October 11, 2022 |
| **Technical Authority** | Hayden Maass, Bornea Dynamics \| hayden.maass@bornea.ca |
| **Client** | Jacob Salk, Next Dynamics Inc. \| jacob@nextdynamicscorp.com |
| **Testing Completed Summary** | The purpose of this experiment is to compare the performance of Next Dynamics Inc. novel 7.62 projectile against current state-of-the-art in the military industrial complex. Projectiles were fired from a mounted .308 rifle on an outdoor 900-foot (300 yard) range with several linear IR gates to measure velocity. |

Bornea Dynamics
Procure Innovation

## Table of Contents

# Contents



### Table of Figures



### Table of Tables

# Section 1.0 – Background & Testing Approach

## 1.1 – Discussion

The warfighter requires ever advancing technology to maintain their dominance, capability, and effectiveness above and beyond that of the adversary. In the modern conflict space, the technical sophistication of our adversaries is increasing, and approaching our own. In pursuit of technical dominance for Canada and our FVEY allies, Next Dynamics Inc. has developed a novel, velocity and accuracy improved small arms round. These rounds leverage a booster cut-out and with no additional powder to provide up to a 30% improvement in velocity at range, and major reductions to in-flight drag. Therefore, these rounds provide the warfighter the increased lethality and accuracy at-range required to maintain technical dominance over our peer-adversaries. This document outlines Bornea Dynamics inspection, testing, and analysis of Next Dynamics novel 7.62 copper projectile with booster, in the context of modern conflict.

The goal of this testing is to compare the performance of Next Dynamics 'Nemesis' 7.62 copper round with booster against current state-of-the-art in the military industrial complex. Testing includes firing several rounds through a series of linear IR gates towards a tear-able target to measure muzzle velocity, mid-flight velocity, 300-yard impact velocity, and accuracy.

An experimental approach was developed, fabricated, executed, and the resultant data analysed to provide the needed comparison points for evaluation of the Nemesis projectile with booster, when compared to a traditional projectile. This process is described in detail within this document.

**Terminology**:

Nemesis Cartridge = 7.62 projectile with booster, large rifle primer, Starline .308 Brass

Berger Cartridge = 168 Match Grain .308 cartridge

Winchester Cartridge = 150 GN .308 Winchester Super-X cartridge (X3085)

## 1.2 - Method

### 1.2.1 – Experimental Setup

Bornea Dynamics used a range representative of the North American and European climate. The range used is described in this report. The following equipment was used in testing:

- Rifle 1-> A 'Remington 700 SPS Tactical, Bolt Action' modified to fit onto our custom testing rig, and fire using the electronic/robotic assembly was used to fire the Nemesis cartridges and the Berger cartridges.
- Firing Assembly -> A steel baseplate firmly secured to a plywood table, itself mounted to the poured concrete base of our ranges firing post to reduce recoil shift was used to hold Rifle 1, itself connected to the Rifle using a carbon-fibre nylon 3D printed assembly and stainless-steel fasteners.
- Detector 1 -> A custom-fabricated Infrared gate, consisting of two extremely high frequency IR gates spaced 30cm apart. The detector connects to a network using ethernet cables. The detector is capable of measuring average velocity at the detector, and when chained together, average acceleration between detectors. This detector has an error of +- 0.001 m/s.
- Detector 2, 3, 4, 5 -> Four custom-fabricated Infrared gate, consisting of two high frequency IR gates spaced 30cm apart. The detector connects to a network using ethernet cables. The detector is capable of measuring average velocity at the detector, and when chained together, average acceleration between detectors. This detector has an error of +- 0.01 m/s.
- Target -> A stretched sheet of paper mounted to a plywood frame, with a central printed target for sighting of the rifle and tracking of accuracy.
- MATLAB Raspberry Pi Library & Ethernet Toolkit -> The software tool used to (1) acquire experimental data from the networked detectors, control the firing assembly, and analyse data post testing in the lab.

Rifle 1 was mounted to a steel baseplate using a 3D printed carbon-fibre nylon assembly and fasteners. An electronic, remotely triggered robotic system was used to fire each round for safety, and to synchronise the detectors.

The projectiles were as follows:

Berger Cartridge: The baseline (state-of-the-art) 168 GN projectile for this testing was Berger .308 Match Grade Ammunition, 168 GN total weight, procured in a cardboard retail box from a local sport supply store. Based on web research, this cartridge accurately represents state-of-the-art in line with size, weight, load, and casing requirements of the Nemesis cartridge. This projectile is heavier than the 7.62 with booster (by approximately 25 GN).

Winchester Cartridge: The baseline (state-of-the-art) 150GN projectile for testing, manufactured by Winchester and purchased in cardboard retail case at a local sports supply store. Based on web research, this cartridge accurately represents the novel 7.62 without a booster, and matches the projectile mass.

Nemesis Cartridge: Bornea Dynamics technician team loaded new Starline .308 brass with: 7.62 projectile with booster, CCI large rifle primer, and 42.1 +- 0.01 GN of Hodgdon 4350 powder by hand, using a digital electronic scale and custom electronic press.

The detectors, rifle, and target were arranged as follows:

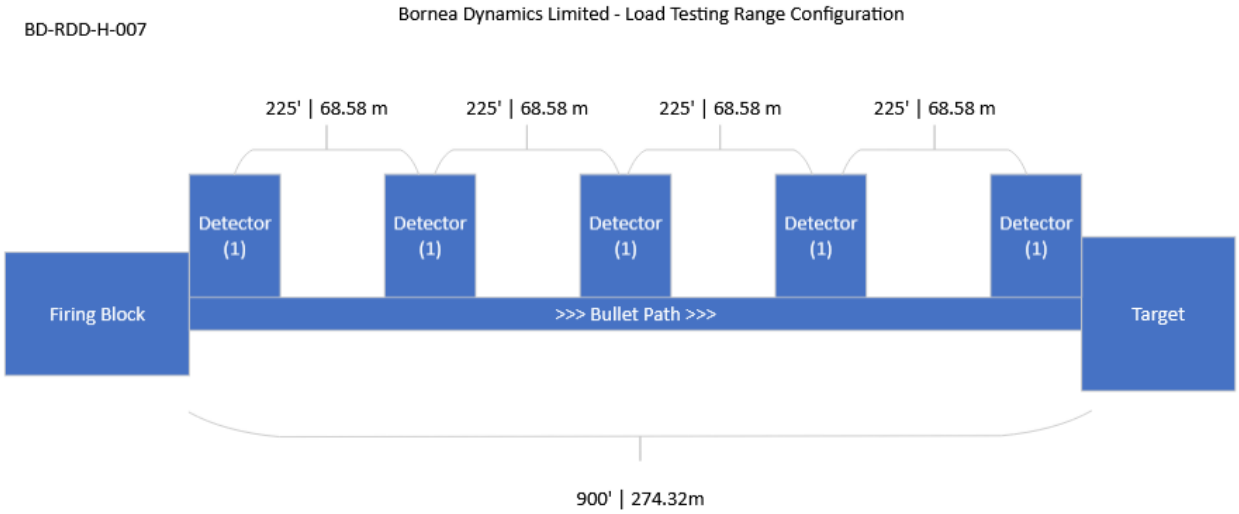


*Figure 1: Experimental Configuration*

Crosswind was determined to be insufficient to effect projectile flight. Other conditions at the range during testing are described in the table below. These conditions were measured with instrumentation at the range, within one hour of conducting the tests by Bornea Dynamics technician team.

*Table 1: Range Conditions*

| Test | Parameter | Condition |
|---|---|---|
| T1 – September 17, 2022 | Air Temperature | 23 Celsius |
| | Barometric Pressure | 102.61 kPA |
| | Humidity | 67% |
| | Precipitation | None |
| | Wind Speed | Negligible (Sub 10 km/hr) |
| | Wind (Heading) | Negligible (Not measured) |
| T2 – September 23, 2022 | Air Temperature | 15 Celsius |
| | Barometric Pressure | 103.21 kPA |

| | | |
|---|---|---|
| | Humidity | 59% |
| | Precipitation | None |
| | Wind Speed | Negligible (Sub 10 km/hr) |
| | Wind (Heading) | Negligible (Not measured) |
| T3 – September 29, 2022 | Air Temperature | 14 Celsius |
| | Barometric Pressure | 101.49 kPA |
| | Humidity | 49% |
| | Precipitation | None |
| | Wind Speed | Negligible (Sub 10 km/hr) |
| | Wind (Heading) | Negligible (Not measured) |
| T4 – October 3, 2022 | Air Temperature | 15 Celsius |
| | Barometric Pressure | 101.12 kPA |
| | Humidity | 51% |
| | Precipitation | None |
| | Wind Speed | Negligible (Sub 10 km/hr) |
| | Wind (Heading) | Negligible (Not measured) |

### 1.2.2 – Experimental Method

To conduct the test, our team completed the following steps:

1. Nemesis Loading:
    a. Loading of the rounds was initially conducted to fabricate subject rounds for testing and enable the test to be conducted. Rounds were loaded by a trained technician under the supervision of an engineer.
    b. Nemesis rounds were loaded using Starline .308 brass with large rifle primer pocket, a large rifle primer, 42.1 GN of Hodgdon 4350 smokeless powder, and a Nemesis 7.62 projectile with booster. The rounds were loaded using a hand-forced, electronically governed bullet press, individually. Rounds were prepared in a controlled environment laboratory and transported to the range individually packaged in a polymer reloading kit. Rounds were transported to the range in a small vehicle, approximately 12 km on local and highway roads.
    c. Berger ammunition was procured from a local sports supply store in cardboard retail packaging.
    d. Winchester ammunition was procured from a local sport supply store in cardboard retail packaging.
2. Laboratory Measurements
    a. Before field testing, the Bornea Dynamics team took field measurements of the projectiles to establish their standard sizing and deviation of that sizing. These results are included in this report.
3. Experimental Fabrication
    a. For this test, a custom rig was built to mount the rifle to the test stand. The rig was designed, fabricated, and assembled by Bornea Dynamics engineering team, and validated in a laboratory setting before field use.
    b. After fabrication, all equipment was packaged before transportation to the field range location.
4. Experimental Setup
    a. The project team setup all equipment, fixtures, targets, and the rifle according to the above-described diagram and connected the measurement equipment to a field computer.
    b. Several test shots of 7.62x39 were fired from a modified AK-47 to test the equipment. All data from these test shots was discarded, to ensure it did not affect the experimental shots.
5. Range Operations
    a. Each round was fired individually towards the target in thirty-second intervals, with pause time to reset instruments and download the data
    b. Safety officers, operational equipment verification/calibrations, etc. were conducted before and during range testing phase

6. Data Archiving & Analysis
    a. Data returned from the range was imaged, archived, and analysed according to the methods and approach discussed in Section 3.0 – Analysis.

Specifically, the test gathered the following data per shot:

- 1 entry for muzzle velocity (2-dimensional)
- 1 entry for each downrange sensor (4 sensors, 2-dimensional)
- 1 entry for grouping deviation at 300 yards (900 feet) per full cartridge (2-dimensional)

The Nemesis cartridge, the Berger cartridge, and the Winchester cartridge were fired, ten cartridges each in this arrangement, with the data described above collected and stored on a range computer for later analysis. Velocity detectors report data as timestamps for later processing. Firing of the rifle via an electronic connection triggers the timers on each unit, which correct for processing delays in their measurements. Results from this testing, and their analysis and comparison are included in the next sections.

The Nemesis 7.62 round with booster data was gathered under T2. The Berger cartridge data was gathered under T3. The Winchester cartridge data was gathered under T4.

# Section 2.0 – Results

## 2.1 – Field Measurements

**Velocity Performance**: (M/S)

| Powder | Round ID | Muzzle Velocity (0 Yards) | Detector 2 Velocity (225 Feet) | Detector 3 Velocity (550 Feet) | Detector 4 Velocity (775 Feet) | Detector 5 Velocity (900 Feet) |
|---|---|---|---|---|---|---|
| **4350 @ 42.1 GN (7.62 w/ Booster)** | 1 | 866.292 | 833.37 | 801.70 | 771.24 | Miss |
| | 2 | 845.660 | 813.52 | 782.61 | 752.87 | 724.26 |
| | 3 | 817.402 | 786.34 | 756.46 | 727.71 | 700.06 |
| | 4 | 843.074 | 811.04 | 780.22 | 750.57 | 722.05 |
| | 5 | 853.725 | 821.28 | 790.07 | 760.05 | 731.17 |
| | 6 | 887.608 | 853.88 | 821.43 | 790.22 | 760.19 |
| | 7 | 856.836 | 824.28 | 792.95 | 762.82 | 733.83 |
| | 8 | 853.081 | 820.66 | 789.48 | 759.48 | 730.62 |
| | 9 | 859.029 | 826.39 | 794.98 | 764.77 | 735.71 |
| | 10 | 835.517 | 803.77 | 773.22 | 743.84 | 715.58 |
| **Average** | | 851.822 | 819.45 | 788.31 | 758.36 | 728.16 |
| **Standard Deviation** | | 17.71 | 17.04 | 16.39 | 15.77 | 15.39 |
| **Berger .308 Match Grade** | 1 | 817.808 | 781.82 | 744.30 | 707.08 | 670.31 |
| | 2 | 808.006 | 772.45 | 735.38 | 698.61 | 662.28 |
| | 3 | 818.963 | 782.93 | 745.35 | 708.08 | 671.26 |
| | 4 | 807.402 | 771.88 | 734.83 | 698.08 | 661.78 |
| | 5 | 817.391 | 781.43 | 743.92 | 706.72 | 669.97 |
| | 6 | 811.380 | 775.68 | 738.45 | 701.52 | 665.04 |
| | 7 | 819.025 | 782.99 | 745.40 | 708.13 | 671.31 |
| | 8 | 814.477 | 778.64 | 741.27 | 704.20 | 667.58 |
| | 9 | 818.686 | 782.66 | 745.10 | 707.84 | 671.03 |
| | 10 | 816.405 | 780.48 | 743.02 | 705.87 | 669.16 |
| **Average** | | 814.954 | 779.10 | 741.70 | 704.61 | 667.97 |
| **Standard Deviation** | | 4.255 | 4.07 | 3.87 | 3.68 | 3.49 |
| **Winchester .308 Super-X 150 GN (X3085)** | 1 | 862.598 | 790.86 | 724.20 | 665.10 | 602.22 |
| | 2 | 860.292 | 791.80 | 728.41 | 664.67 | 604.70 |
| | 3 | 855.734 | 791.19 | 726.94 | 666.93 | 602.84 |
| | 4 | 857.608 | 788.09 | 725.33 | 666.80 | 601.84 |
| | 5 | 855.020 | 790.23 | 723.11 | 658.19 | 594.10 |
| | 6 | 864.134 | 791.803 | 725.293 | 666.681 | 602.506 |
| | 7 | 858.937 | 790.904 | 728.380 | 663.878 | 602.943 |
| | 8 | 857.170 | 791.431 | 728.816 | 668.893 | 604.033 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 9 | 856.631 | 786.592 | 724.943 | 665.570 | 599.898 |
| | 10 | 853.507 | 788.332 | 722.121 | 656.625 | 592.105 |
| **Average** | | 858.163 | 790.123 | 725.754 | 664.333 | 600.719 |
| **Standard Deviation** | | 3.19 | 1.72 | 2.20 | 3.72 | 4.02 |

*Table 2: M/S Velocity*

**Velocity Performance**: (F/S)

| Powder | Round ID | Muzzle Velocity (0 Yards) | Detector 2 Velocity (225 Feet) | Detector 3 Velocity (550 Feet) | Detector 4 Velocity (775 Feet) | Detector 5 Velocity (900 Feet) |
|---|---|---|---|---|---|---|
| **4350 @ 42.1 GN (7.62 w/ Booster)** | 1 | 2842.165 | 2734.16 | 2630.26 | 2530.31 | Miss |
| | 2 | 2774.475 | 2669.04 | 2567.62 | 2470.05 | 2376.19 |
| | 3 | 2681.766 | 2579.86 | 2481.82 | 2387.52 | 2296.79 |
| | 4 | 2765.989 | 2660.88 | 2559.77 | 2462.50 | 2368.92 |
| | 5 | 2800.934 | 2694.50 | 2592.11 | 2493.61 | 2398.85 |
| | 6 | 2912.101 | 2801.44 | 2694.99 | 2592.58 | 2494.06 |
| | 7 | 2811.142 | 2704.32 | 2601.55 | 2502.70 | 2407.59 |
| | 8 | 2798.821 | 2692.47 | 2590.15 | 2491.73 | 2397.04 |
| | 9 | 2818.336 | 2711.24 | 2608.21 | 2509.10 | 2413.75 |
| | 10 | 2741.197 | 2637.03 | 2536.82 | 2440.43 | 2347.69 |
| **Average** | | 2794.693 | 2688.49 | 2586.33 | 2488.05 | 2388.99 |
| **Standard Deviation** | | 58.11 | 55.90 | 53.78 | 51.74 | 50.48 |
| **Berger .308 Match Grade** | 1 | 2683.098 | 2565.04 | 2441.92 | 2319.82 | 2199.19 |
| | 2 | 2650.938 | 2534.30 | 2412.65 | 2292.02 | 2172.83 |
| | 3 | 2686.886 | 2568.66 | 2445.37 | 2323.10 | 2202.30 |
| | 4 | 2648.955 | 2532.40 | 2410.85 | 2290.30 | 2171.21 |
| | 5 | 2681.730 | 2563.73 | 2440.67 | 2318.64 | 2198.07 |
| | 6 | 2662.007 | 2544.88 | 2422.72 | 2301.59 | 2181.91 |
| | 7 | 2687.091 | 2568.86 | 2445.55 | 2323.28 | 2202.47 |
| | 8 | 2672.170 | 2554.59 | 2431.97 | 2310.38 | 2190.24 |
| | 9 | 2685.978 | 2567.79 | 2444.54 | 2322.31 | 2201.55 |
| | 10 | 2678.493 | 2560.64 | 2437.73 | 2315.84 | 2195.42 |
| **Average** | | 2673.735 | 2556.09 | 2433.40 | 2311.73 | 2191.52 |
| **Standard Deviation** | | 13.961 | 13.35 | 12.71 | 12.07 | 11.44 |
| **Winchester .308 Super-X 150 GN (X3085)** | 1 | 2830.046 | 2594.68 | 2375.97 | 2182.07 | 1975.80 |
| | 2 | 2822.479 | 2597.76 | 2389.81 | 2180.67 | 1983.91 |
| | 3 | 2807.526 | 2595.77 | 2384.96 | 2188.09 | 1977.84 |
| | 4 | 2813.674 | 2585.60 | 2379.69 | 2187.66 | 1974.54 |
| | 5 | 2805.183 | 2592.62 | 2372.42 | 2159.41 | 1949.14 |
| | 6 | 2835.084 | 2597.78 | 2379.57 | 2187.27 | 1976.72 |
| | 7 | 2818.034 | 2594.83 | 2389.70 | 2178.08 | 1978.16 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | 8 | 2812.237 | 2596.56 | 2391.13 | 2194.53 | 1981.74 |
| | 9 | 2810.468 | 2580.68 | 2378.42 | 2183.63 | 1968.17 |
| | 10 | 2800.220 | 2586.39 | 2369.17 | 2154.28 | 1942.60 |
| **Average** | | 2815.495 | 2592.27 | 2381.08 | 2179.57 | 1970.86 |
| **Standard Deviation** | | 10.455 | 5.63 | 7.22 | 12.22 | 13.19 |

*Table 3: F/S Velocity*

| Powder | Variable | Value |
|---|---|---|
| **4350 @ 42.1 GN (7.62 w/ Booster)** | Ballistic Coefficient | 526.12 kg/m$^2$ |
| | Drag Coefficient | 0.3712 |
| | Average Flight V Change | 405.7 F/S |
| **Berger .308 Match Grade** | Ballistic Coefficient | 529.30 kg/m$^2$ |
| | Drag Coefficient | 0.3689 |
| | Average Flight V Change | 482.21 F/S |
| **Winchester .308 Super-X 150 GN (X3085)** | Ballistic Coefficient | 532.39 kg/m$^2$ |
| | Drag Coefficient | 0.4891 |
| | Average Flight V Change | 844.64 F/S |

*Table 4: Performance Summary*

**Accuracy Performance**:

| Powder | Variable | Value |
|---|---|---|
| **4350 @ 42.1 GN (7.62 w/ Booster)** | Dinner Plate (100 Yards, Estimated) | 4.82 cm |
| | Dinner Plate (200 Yards, Estimated) | 7.11 cm |
| | Dinner Plate (300 Yards, Actual) | **9.79 cm (3.85 Inch)** |
| | Perceived Tumble | <0.2% (Negligible) |
| **Berger .308 Match Grade** | Dinner Plate (100 Yards, Estimated) | 4.98 cm |
| | Dinner Plate (200 Yards, Estimated) | 7.79 cm |
| | Dinner Plate (300 Yards, Actual) | **9.51 cm (3.74 Inch)** |
| | Perceived Tumble | <0.2% (Negligible) |
| **Winchester .308 Super-X 150 GN (X3085)** | Dinner Plate (100 Yards, Estimated) | 6.1 cm |
| | Dinner Plate (200 Yards, Estimated) | 8.61 cm |
| | Dinner Plate (300 Yards, Actual) | **12.91 cm (5.08 Inch)** |
| | Perceived Tumble | <0.2% (Negligible) |

*Table 5: Accuracy Summary*

*'Dinner Plate' represents the diameter a plate would need to be for all ten shots to land on it, as measured by estimate or actual. (Estimate = model based on velocity and range projection. Actual = measurement using paper target at the range)

**Nemesis Shots**

Note: 5 shots per image. Shot one on the top left image was a miss.

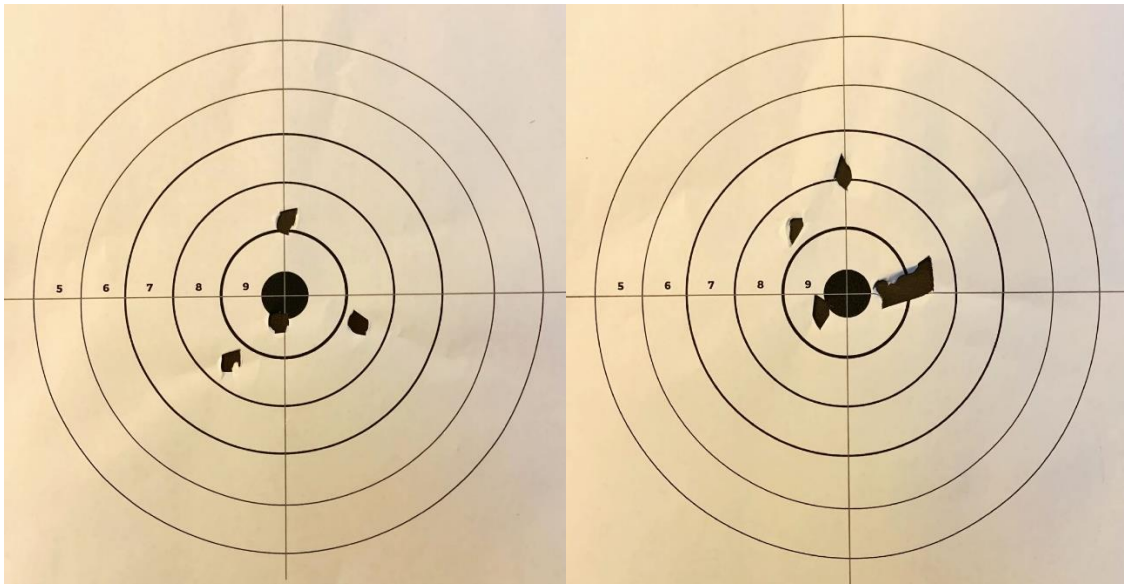


*Figure 2: Nemesis Shots 1 - 10*

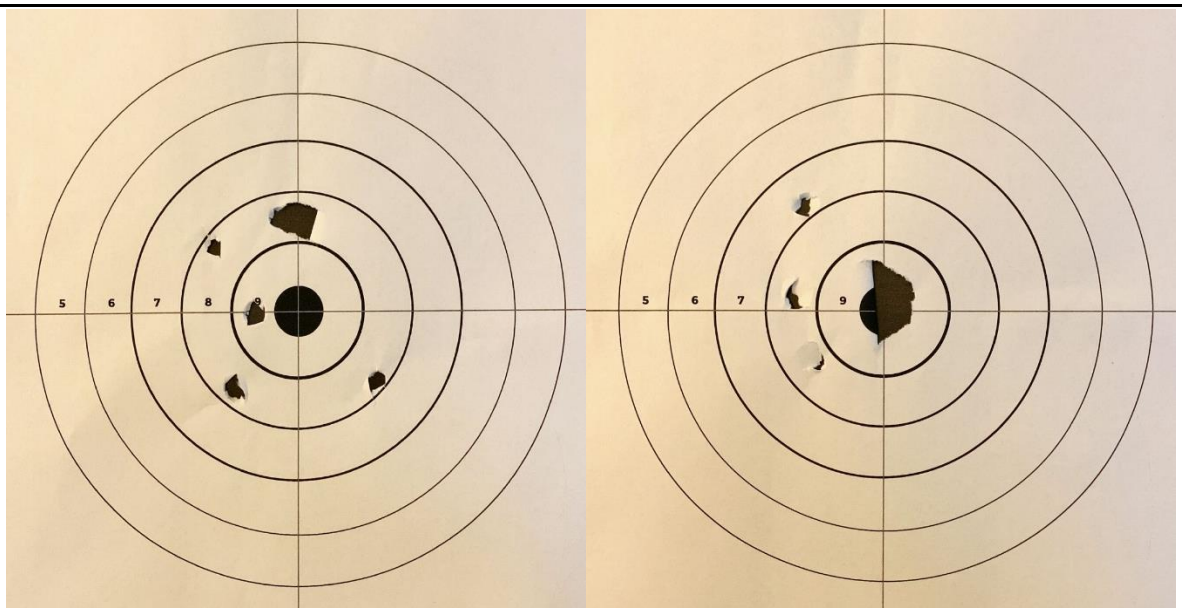


*Figure 3: Berger Shots 1 – 10*

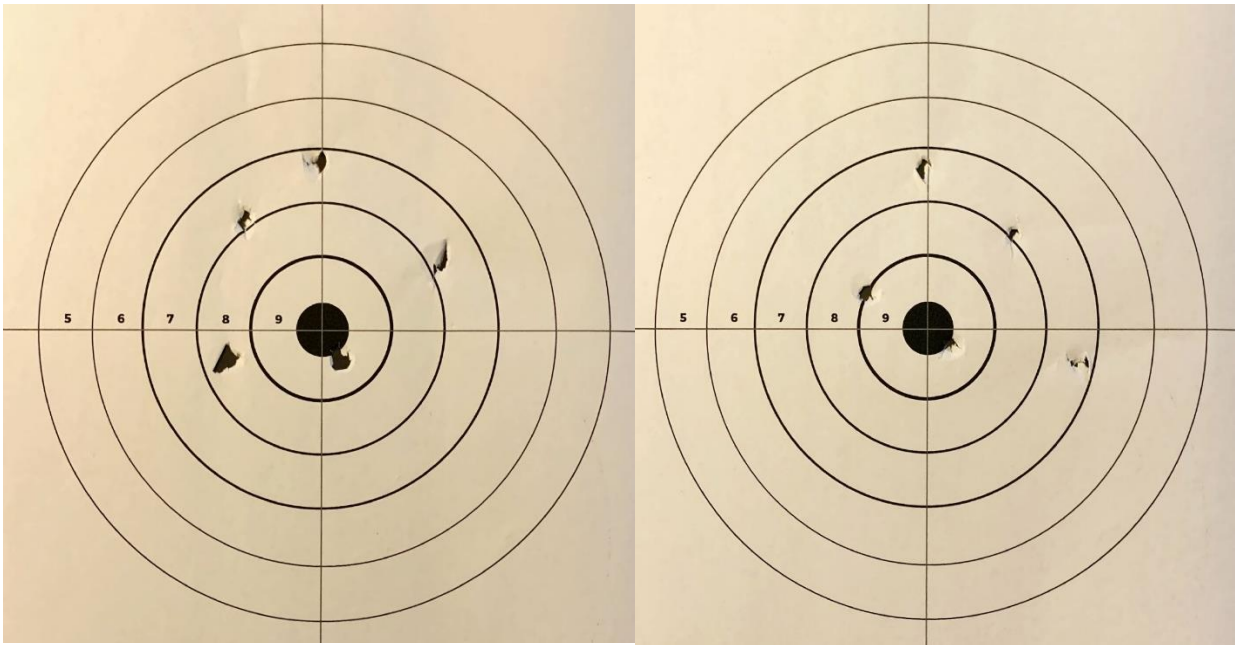


*Figure 4: Winchester Shots 1 - 10*

# Section 3.0 – Analysis

## 3.1 – Performance

**Nemesis Velocity**

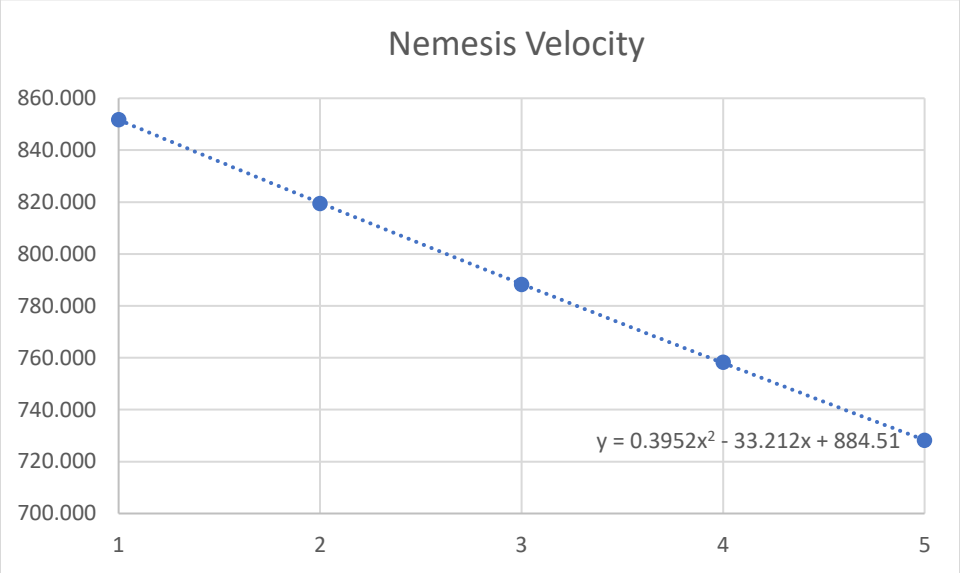


*Figure 5: Nemesis Velocity Graph*

**Berger Velocity**

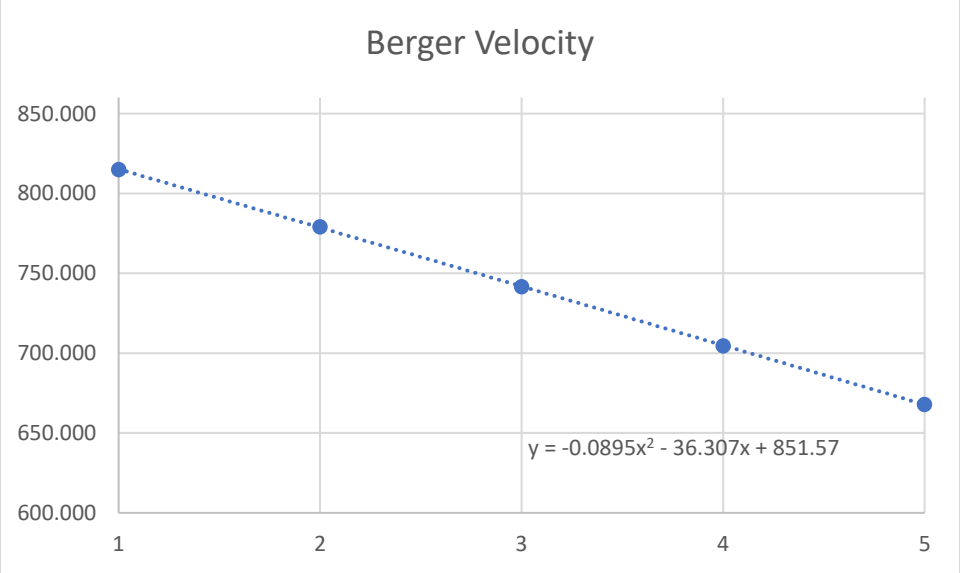


*Figure 6: Berger Velocity Graph*

**Winchester Velocity**

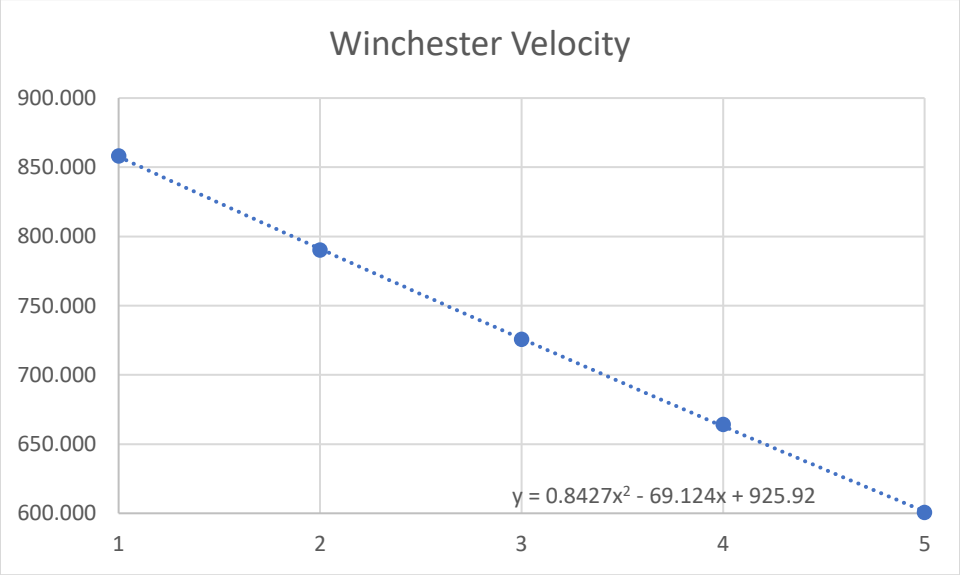


*Figure 7: Winchester Velocity*

**Comparison Chart**

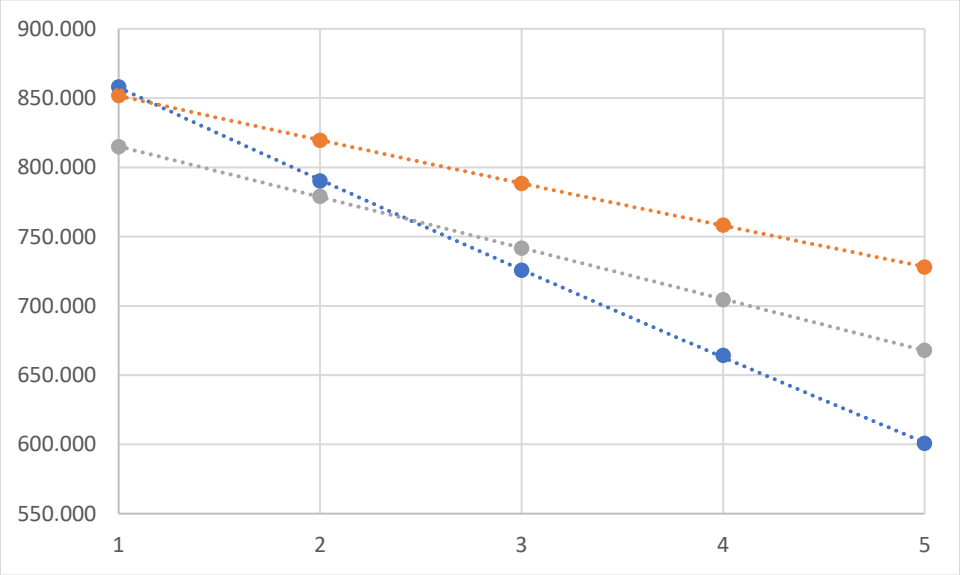


*Figure 8: Comparison Chart*

Orange = Nemesis Cartridge | Blue = Winchester Cartridge | Gray = Berger Cartridge

## 3.2 – Conclusion

**Our Findings**: Through the measurements obtained, we conclude that statistically significant velocity performance improvements in the range of +**4.524%** at the muzzle, and +**9.012%** 300 yards downrange occur when utilizing the 7.62 round with a booster, as compared to a traditional Berger round. We also conclude that statistically significant velocity performance improvements of -**0.739%** at the muzzle and +**26.242%** 300 yards downrange occur when utilizing the 7.62 round with booster as compared to a traditional .308 Winchester round. Specifically, our testing observed the average performance increase in the 7.62 booster round when compared to the traditional rounds. Furthermore, we concluded that no change in accuracy occurs between a traditional rounds and the Nemesis round with a booster. Higher standard deviations observed in the Nemesis rounds can be attributed to handloaded deviances, including compression and primer insertion. This may warrant further investigation, including the use of a high-accuracy electronic or hydraulic press.

Therefore, we conclude that the Nemesis 7.62 copper projectile with a booster demonstrates superior performance to a traditional Berger round of higher projectile mass, and superior performance to a traditional Winchester round of similar projectile mass, when compared at the velocity and accuracy metrics.

<END OF DOCUMENT>