



Standard for Measuring Archery Projectile Penetration Performance Under Controlled Laboratory Conditions

PNL TEST STANDARD
PNL-TS-002 REV 1.1

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1. Scope

1.1

PNL-TS-002 establishes the general minimum requirements for laboratory testing, measurement, and documentation of archery projectile penetration performance using controlled and documented target media. The purpose of testing conducted under this standard is to measure and compare projectile penetration behavior while minimizing uncontrolled variation in target resistance and test conditions.

1.2

This standard does not apply to penetration testing conducted on live animals, animal carcasses, biological specimens, or uncontrolled field targets. Such testing shall be addressed under applicable PNL field-testing standards.

1.3 This method applies to:

- Fixed blade broadheads
- Mechanical broadheads (when specified)
- Field points (comparison testing)
- Single-bevel and double-bevel broadheads

1.4

Results shall be reported using:

- Arrow weight (grains)
- Launch velocity (fps)
- Impact velocity (fps)
- Launch kinetic energy (ft-lb)
- Impact kinetic energy (ft-lb)
- Launch momentum (slug-ft/s)
- Impact momentum (slug-ft/s)
- Penetration depth

- Pass-through status

1.5

This standard improves repeatability by defining:

- Environmental conditions
- Equipment requirements
- Launch conditions
- Impact conditions
- Shot placement
- Reporting requirements

1.6

This standard does not predict hunting performance and should only be used for comparative testing.

1.7 Relationship to PNL Test Methods

This standard establishes the minimum requirements for laboratory measurement and documentation of archery projectile penetration performance.

Individual **PNL Test Methods (TM)** developed in accordance with this standard shall define the specific procedures, equipment, target media, measurements, and acceptance criteria required to perform a particular penetration test.

All applicable PNL Test Methods shall reference this standard and comply with its requirements unless specifically exempted by the test method.

2. Referenced Documents

2.1 Manufacturer documentation for chronograph or Doppler radar.

2.2 Manufacturer documentation for scales and measuring equipment.

2.3 PNL-TS-001 – Standard Test Method for Measuring Broadhead Edge Sharpness

3. Purpose

3.1 The purpose of this standard is to:

- Provide a standardized laboratory framework for measuring archery projectile penetration performance using controlled and documented target media.

- Reduce uncontrolled variation in target resistance and test conditions.
 - Establish common measurement, documentation, and reporting requirements.
 - Compare archery projectile systems using documented launch conditions, impact conditions, and target media.
 - Establish the general technical requirements for developing individual PNL laboratory penetration Test Methods.
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4. Definitions

The following definitions shall apply to this standard.

4.1 Projectile

The complete assembly consisting of the arrow shaft, insert or outsert, point or broadhead, nock, and fletching.

4.2 Arrow Weight

The total weight of the complete projectile, expressed in grains, including the shaft, insert or outsert, point or broadhead, nock, fletching, and any additional components.

4.3 Launch Velocity

The velocity of the projectile measured immediately after it leaves the bow, expressed in feet per second (fps).

4.4 Impact Velocity

The velocity of the projectile immediately prior to impact with the target medium, expressed in feet per second (fps).

4.5 Launch Kinetic Energy

The kinetic energy of the projectile at launch, calculated using the equation contained in Appendix A and expressed in foot-pounds (ft-lb).

4.6 Impact Kinetic Energy

The kinetic energy of the projectile immediately prior to impact with the target medium, calculated using the equation contained in Appendix A and expressed in foot-pounds (ft-lb).

4.7 Launch Momentum

The momentum of the projectile at launch, calculated using the equation contained in Appendix A and expressed in slug-ft/s.

4.8 Impact Momentum

The momentum of the projectile immediately prior to impact with the target medium, calculated using the equation contained in Appendix A and expressed in slug-ft/s.

4.9 Penetration Depth

The measured distance the projectile penetrates into the target medium, determined using the measurement procedure specified by the applicable PNL Test Method.

4.10 Pass-Through

A condition in which the projectile completely penetrates the target medium and exits the opposite side.

4.11 Broadhead

The cutting or penetrating point attached to the forward end of the projectile.

4.12 Test Standard (TS)

A PNL document that establishes the minimum technical requirements, terminology, calculations, documentation, and reporting criteria applicable to one or more PNL Test Methods.

4.13 Test Method (TM)

A PNL document that defines the detailed procedures, equipment, measurements, target media, and acceptance criteria necessary to perform a specific test in accordance with the applicable PNL Test Standard.

4.14 Launch Conditions

The measured conditions of the projectile at the point of release, include launch velocity, launch kinetic energy, and launch momentum.

4.15 Impact Conditions

The measured conditions of the projectile immediately prior to impact, including impact velocity, impact kinetic energy, and impact momentum.

5. Measurement Equipment Requirements

Equipment	Minimum Requirement
Arrow Scale	Resolution: 0.1 grain
Velocity Measurement Device	Accuracy: $\pm 0.5\%$
Distance Measurement Device	Resolution: 1 yard
Penetration Measurement Device	Resolution: 0.5 inch

6. Environmental Conditions

6.1 The following environmental conditions shall be recorded:

- Test date
 - Test location
 - Temperature
 - Relative humidity
 - Barometric pressure
 - Elevation
 - Wind speed
 - Wind direction
 - Indoor or outdoor testing
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7. Test Equipment Setup

7.1 The applicable test method shall define:

- Bow configuration
 - Projectile configuration
 - Velocity measurement method
 - Target distance
 - Impact velocity determination
 - Target setup.
-

8. Test Method Requirements

Every penetration test method developed in accordance with this standard shall define the following:

8.1 Projectile

- Projectile configuration
- Projectile weight
- Broadhead configuration
- Projectile preparation

8.2 Bow

- Bow specifications
- Draw weight
- Draw length
- Release method

8.3 Launch Conditions

- Launch velocity
- Launch kinetic energy
- Launch momentum

8.4 Impact Conditions

- Impact velocity
- Impact kinetic energy
- Impact momentum

8.5 Target Medium

The applicable test method shall define the target medium and test configuration sufficiently to minimize uncontrolled variation in resistance between test specimens and permit meaningful comparison of projectile penetration performance.

The test method shall define:

- Target material
- Preparation
- Dimensions
- Orientation
- Conditioning
- Target replacement, reuse, or shot-spacing requirements, as applicable

8.6 Shot Procedure

The test method shall specify:

- Shooting distance
- Impact angle
- Number of shots
- Shot sequence
- Acceptance criteria

8.7 Measurements

The test method shall specify how the following are measured:

- Penetration depth
 - Pass-through
 - Projectile damage
 - Broadhead damage
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9. Reporting Requirements

9.1

Every penetration test performed in accordance with this standard shall include a written test report.

9.2

The report shall contain, at a minimum:

- Test identification
- Date and location
- Name of tester(s)
- Reference to the applicable PNL Test Method (TM)
- Environmental conditions
- Bow specifications
- Projectile specifications
- Broadhead specifications
- Launch conditions
- Impact conditions
- Target medium description
- Test procedure used
- Number of shots
- Penetration measurements
- Projectile condition after testing
- Broadhead condition after testing
- Photographs or other supporting documentation
- Calculations performed

- Observations
- Conclusions

9.3

Any deviation from the applicable test method shall be documented within the report.

9.4

All calculations shall identify the equations, constants, and units used.

9.5

The report shall include sufficient information to allow another qualified tester to reproduce the test.

10. Precision and Repeatability

10.1

The objective of this standard is to promote repeatable and reproducible penetration testing through standardized documentation and measurement practices.

10.2

Each individual test method developed under this standard shall establish:

- Minimum number of test samples
- Minimum number of shots
- Equipment accuracy requirements
- Projectile tolerances
- Measurement tolerances
- Acceptance criteria
- Repeatability requirements

10.3

Comparable results are expected when testing is performed under equivalent conditions and within the tolerances established by the applicable PNL Test Method.

10.4

Any condition that may influence the repeatability of the test shall be documented in the final report.

Examples include:

- Environmental changes
- Equipment changes

- Projectile variations
 - Target variations
 - Operator error
 - Equipment malfunction
-

11. Data Sheet

11.1

Each test method developed under this standard shall provide a standardized data sheet for recording test results.

11.2

The data sheet shall include all measurements, observations, calculations, and supporting information required by the applicable test method.

11.3

The completed data sheet shall become part of the permanent test record.

12. Revision History

Revision	Issue Date	Description of Change
1.0	July 2, 2026	Initial issue.
1.1	July 9, 2026	Revised title, scope, and purpose to define PNL-TS-002 as a controlled laboratory penetration testing standard; excluded biological specimens and uncontrolled field targets; strengthened target-medium control requirements.

Appendix A – Calculations

A.1 Purpose

This appendix establishes the official equations, units, and conversion constants used by PNL Test Standards for calculating kinetic energy and momentum.

Unless otherwise specified by the applicable PNL Test Method, calculations performed in accordance with this standard shall use the equations contained in this appendix.

A.2 Units

Unless otherwise specified, calculations shall use the following units:

- Arrow Weight — grains (gr)
 - Velocity — feet per second (fps)
 - Kinetic Energy — foot-pounds (ft-lb)
 - Momentum — slug-ft/s
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A.3 Constants

Unless otherwise specified by the applicable test method, the following conversion constant shall be used:

Conversion Constant = 225218

The conversion constant **225218** is derived from the standard English engineering unit conversions used when projectile weight is expressed in grains and velocity is expressed in feet per second.

$$225218 = 7000 \times 32.174$$

where:

- **7000** = grains per pound
 - **32.174 ft/s²** = standard acceleration due to gravity
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A.4 Launch Kinetic Energy

$$KE = \frac{0.5 m v^2}{225218}$$

where:

- m = projectile weight (grains)
 - v = launch velocity (fps)
-

A.5 Impact Kinetic Energy

$$KE = \frac{0.5 m v^2}{225218}$$

where:

- m = projectile weight (grains)
 - v = impact velocity (fps)
-

A.6 Launch Momentum

$$M = \frac{m v}{225218}$$

where:

- m = projectile weight (grains)
 - v = launch velocity (fps)
-

A.7 Impact Momentum

$$M = \frac{m v}{225218}$$

where:

- m = projectile weight (grains)
- v = launch velocity (fps)

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