



# Standard for Measuring Archery Projectile Penetration Performance

PNL TEST STANDARD  
PNL-TS-002 REV 1.0

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## 1. Scope

### 1.1

This standard establishes the minimum requirements for measuring and documenting the penetration performance of complete archery projectiles under documented launch and impact conditions.

### 1.2 This method applies to:

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

### 1.3

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

### 1.4

This standard improves repeatability by defining:

- Environmental conditions
- Equipment requirements
- Launch conditions

- Impact conditions
- Shot placement
- Reporting requirements

## 1.5

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

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## 1.6 Relationship to PNL Test Methods

This standard establishes the minimum requirements for measuring and documenting 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.

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## 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

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## 3. Purpose

### 3.1 The purpose of this standard is to:

- Provide a standardized methodology for penetration testing.
  - Reduce variability between tests.
  - Establish a common reporting method.
  - Compare arrow systems using documented launch and impact conditions.
  - Provide a standardized framework for measuring and documenting penetration performance.
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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.

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#### **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.

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#### **4.3 Launch Velocity**

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

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#### **4.4 Impact Velocity**

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

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#### **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).

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#### **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).

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#### **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.

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#### **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.

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#### **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.

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#### **4.10 Pass-Through**

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

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#### **4.11 Broadhead**

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

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#### **4.12 Test Standard (TS)**

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

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#### **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.

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#### **4.14 Launch Conditions**

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

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#### **4.15 Impact Conditions**

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

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## 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

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## 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.
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## 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 test method shall define:

- Target material
- Preparation
- Dimensions
- Orientation
- Conditioning

## 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.

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## **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

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## **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.

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## 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.

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### 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/s<sup>2</sup>** = 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)
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### A.5 Impact Kinetic Energy

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

where:

- $m$ = projectile weight (grains)
  - $v$ = impact velocity (fps)
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### A.6 Launch Momentum

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

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### A.7 Impact Momentum

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