# Standard Test Method for the Determination of Percent of Let-Off for Archery Bows[1]

This standard is issued under the fixed designation F 1880; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method covers the procedure to be used to determine the percent of let-off for archery bows.

1.2 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:* [2]

F 1832 Test Method for Determining the Force-Draw and Let-Down Curves for Archery Bows

## 3. Terminology

3.1 *Definitions:*

3.1.1 *ATA*—an acronym for the Archery Trade Association.

3.1.2 *ATA draw length*, *n*—the perpendicular distance from the point where the shooting string of the bow contacts the bottom of the nock slot of the arrow to a line parallel to the string at brace height through the pivot or low point of the hand grip (draw length-pivot point), plus a standard dimension of 1¾ in. (44.5 mm). Draw length shall be measured with the arrow in the full-draw position.

3.1.3 *brace height*, *n*—the distance in inches or millimetres from the shooting string of a bow to the pivot or low point of the hand grip, measured perpendicular to the string.

3.1.4 *compound bow*, *n*—a type of bow that imposes a secondary system of control of the force-draw characteristic on the usual limb geometry control system of the conventional bow. This secondary control system can be composed of cams, levers, cables, or other elements, or a combination thereof. The dual control system permits great versatility in the design of the force-draw characteristic and simplifies the inclusion of let-off. In general, it is normal for compound bows to have greater stored energy than conventional bows for a given level of peak or maximum draw weight.

3.1.5 *conventional bow*, *n*—a bow constructed in the conventional manner, having two flexing limbs extending outwardly in opposite directions from a handle. A single shooting string of a length shorter than the bow, connects the extreme ends of the limbs causing them to assume a prestressed flexed condition. Drawing the bow causes additional bending and stressing of the limbs, storing the energy necessary to propel the arrow. Control of the force-draw characteristic of the bow is exercised entirely by the static and dynamic geometry of the flexing limbs.

3.1.6 *draw*, *n*—to move the shooting string of a bow from the rest or brace position toward the fully drawn position by applying force to said string. Such action causes the limbs of the bow to bend and store energy. Moving the string from brace height to the full-draw position corresponds to the draw cycle of a bow.

3.1.7 *draw force*, *n*—that level of force necessary and coincidental with drawing a bow to a specific position within its draw length.

3.1.8 *force-draw curve*, *n*—the curve obtained when the draw force is plotted versus the draw length for a given bow.

3.1.9 *full draw*, *n*—the position in a draw cycle of a bow from which the string of the bow is released and the force applied to the rear of the arrow to commence the launch. The full-draw position of individual archers will vary due to personal physical characteristics and shooting style. Archery bows are specified as to the range of draw length that they will accommodate to permit archers to select a size that will fit them. Precise draw length is less of a factor on conventional bows as compared with compound bows, since it is ideal to match the draw length of the archer to the position of maximum let-off in the draw cycle of the compound bow. The position of maximum let-off for compound bows usually is adjustable within specified limits.

3.1.10 *holding force*, *n*—the force required to retain the bowstring of a drawn bow at a specific draw length.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3.1.11 *let-down curve*, *n*—the curve obtained when the force necessary to restrain the bow from returning to brace height is plotted versus the draw length.

3.1.12 *let-down force*, *n*—the force required to retain the bowstring of the drawn bow at a specific draw length during the let-down cycle. This force differs from the draw force at the same length by the amount of static hysteresis.

3.1.13 *let-off*, *n*—that characteristic of an archery bow that results in a reduction in the force necessary to increase the draw length of the bow after the highest level of draw force has been reached. This is a characteristic generally associated with, but not restricted to, compound type bows.

3.1.14 *let-off force*, *n*—the minimum force required to retain the bowstring of the drawn bow subsequent to peak draw force under a condition of constant tension on the bowstring.

3.1.15 *peak or maximum draw force*, *n*—the maximum force required to retain the bowstring of the drawn bow at a specific draw length under a condition of constant tension on the bowstring. No relaxation of the drawing force is permitted when measuring this force, since this introduces static hysteresis. The peak or maximum force for compound bows usually occurs about half way through the draw cycle, while on conventional bows it normally occurs at the end of the draw cycle since there is no let-off.

3.1.16 *percent of let-off*, *n*—the difference between the peak or maximum draw force reached during the draw cycle of a bow and the lowest level of draw force reached subsequent to that peak, expressed as a percentage of the peak force.

3.1.17 *power-stroke*, *n*—the distance in inches or millimetres from brace height to full draw.

3.1.18 *static hysteresis*, *n*—the difference in pounds or newtons, measured under static conditions, between the draw force and the let-down force for any given draw length. Integrated over the full power stroke of the bow, the static hysteresis is expressed as foot-pounds or joules of energy.

3.1.19 *stored energy*, *n*—the energy required to draw a bow from brace height to full draw, usually expressed in foot-pounds or joules.

3.1.20 *zero intercept*, *n*—the point of zero intercept is defined as the brace height plus 1¾ in. (44.5 mm). It is the zero force position on the force-draw curve.

## 4. Significance and Use

4.1 It is recognized that certain designs of the cams used in the compounding systems of archery bows cause variation in the percent of let-off with change in draw length, draw weight, or both. This is true particularly with the style of cam that achieves draw length adjustment by effectively altering the length of the shooting string by any of several methods. In this case, the mid-draw length and the maximum draw weight obtainable (but not to exceed the maximum rated weight of the bow) shall be used to determine the official percent of let-off for the bow in question.

4.2 Historically, two methods have been in use to establish the percent of let-off for archery bows. The most common method uses the peak draw force and the minimum holding force read from the force-draw curve to calculate the percent of let-off. The second method uses the peak draw force from the force-draw curve and the minimum holding force from the let-down for this calculation. This test method defines the two methods and distinguishes between them.

## 5. Determination of the ATA Percent of Let-Off

5.1 *Use of the Force-Draw Curve*—The values of peak force and let-off force used to calculate the ATA percent of let-off shall be taken from the force-draw curve. The peak force is the maximum force obtained during the draw cycle. The let-off force is the low force read at the rated draw length. In all cases, the force shall be read within 2 s under continual pull conditions, without relaxation to reach the draw length specified. This technique eliminated the hysteresis effect, which can distort the reading. Refer to Test Method F 1832 for the method to be used in determining the force-draw curve.

5.2 *Method of Calculation*—The percent of let-off shall be calculated using the following formula:

$$\text{percent let}-\text{off} = 100\ (\text{peak force} - \text{let}-\text{off force}) / \text{peak force} \quad (1)$$

5.3 *Hysteresis*—The reduction due to hysteresis shall not be considered in the determination of the force value at either peak or let-off condition when determining the ATA percent of let-off.

5.4 *Rating Conditions*—The bow shall be rated for percent of let-off with the draw length set in mid-range and the peak draw weight adjusted to the maximum rated value for that specific draw length.

## 6. Effective Percent of Let-Off

6.1 *Hysteresis Effect*—The difference in force at the full draw condition between the draw and let-down curves is normally in the range of 6 to 10 % of the peak draw force. Under certain conditions, this hysteresis can increase the effective percent of let-off, however, the exact effect is dependent on the specific bow design. The hysteresis becomes a factor when the bow is drawn past full draw and let down or relaxed to the anchor position. It is not a factor when the bowstring is drawn to the anchor position without incipient let-down. For this reason, it can influence let-off, but its effect is dependent upon the technique used to bring the bowstring to the anchor position.

## 7. Precision and Bias

7.1 *Precision*—It is not practical to specify the precision of the procedure in this test method because it has not yet been determined.

7.2 *Bias*—The procedure described in this test method has no bias because the percent of let-off is defined only in terms of this test method.

## 8. Keywords

8.1 brace height; draw length; force-draw curve; full-draw; let-off