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Guidelines for Barrel and Overall Length Measurements for Firearms

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Guidelines for Barrel and Overall Length Measurements for Firearms

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Foreword

Barrel lengths and overall lengths are dimensional specifications of firearms that can be used as descriptors or that can be mandated by law. This document describes procedures for measuring the barrel length and overall length of firearms and for estimating the uncertainty of those measurements. Procedures are outlined for different types of firearms to determine their conformance to the specifications. Estimation of uncertainty is achieved through repeated measurements by all lab personnel responsible for barrel length and overall length measurements. Annex A provides an example illustrating measurement results and uncertainty evaluation.

This document was revised, prepared, and finalized as a standard by the Firearms and Toolmarks Consensus Body of the AAFS Standards Board. The draft of this standard was developed by the Firearms and Toolmarks Subcommittee of the Organization of Scientific Area Committees (OSAC) for Forensic Science.

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Keywords: barrel, bore, firearm, integral chamber, length, measurand, revolver, rifle, shotgun, uncertainty.

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Guidelines for Barrel and Overall Length Measurements for Firearms

1 Scope

This document provides the guidelines for measuring and reporting barrel length and overall length (BL-OL) of firearms, including guidelines for measurement traceability and estimating uncertainty of BL-OL measurements. This document does not apply to descriptive measurements of firearms.

2 Normative References

There are no normative reference documents. Annex B, Bibliography, contains informative references.

3 Terms and Definitions

Terms specific to firearms, such as muzzle, bore, forcing cone, breech face, action, chamber, barrel, firing pin, and bolt (breech bolt) are described in the Sporting Arms and Ammunitions Manufacturers' Institute (SAAMI) *Glossary*^[11].

3.1 measurand

Quantity intended to be measured ^([9], Sec. 2.3).

3.2 metrological traceability, traceability

Property of a measurement result whereby the result can be related to a reference through a documented unbroken chain of comparisons, each contributing to the measurement uncertainty ^([9], Sec 2.41).

4 Recommendations

4.1 Background

Federal and State laws of the United States of America, and international laws contain requirements for the minimum barrel lengths and minimum overall lengths of rifles, shotguns and other firearms not classified as handguns. These requirements may vary for different jurisdictions. Examples of minimum length requirements in federal law ^[12] include: 16 in. barrel length for rifles, 18 in. barrel length for shotguns, and 26 in. overall length for rifles, shotguns and other firearms not classified as handguns. This document provides procedures for measuring barrel and overall length (BL-OL), information on measurement traceability, and procedures for calculating measurement uncertainty.

4.2 General

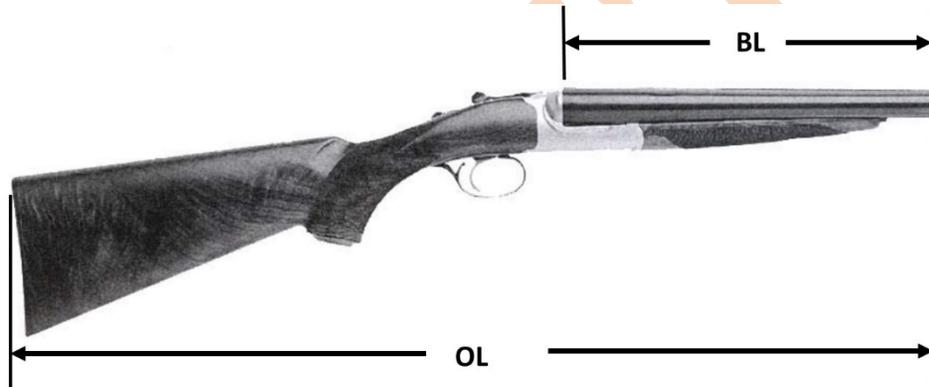
4.2.1 When handling any firearm, even for the purposes of measuring, safety is the first concern. Ensure the firearm is unloaded before conducting measurements. If there is any doubt about the operation of a firearm, consult with a qualified firearms instructor (if available), protocols, or manufacturers' literature before handling a firearm for measuring.

4.2.2 When measuring barrel or overall length, ensure that the firearm is free from movement, stable for measuring, and is located in an area with proper lighting. The measuring devices should have current calibration certificates that provide traceability to the international unit of length through accredited calibration laboratories.

4.2.3 Common devices used to measure barrel and overall lengths (BL-OL) are measuring tapes, steel rulers, measuring rods, and caliper devices. The unique identifier(s) for the device(s) used should be recorded in the examination record.

4.2.4 Measurements for altered or uneven barrels should include the longest portion.

4.2.5 Measurands: The quantities to be measured for BL-OL are described elsewhere^[11, 12] and illustrated in Figure 1.



Additional provisions and highlights are described in Sections 4.3, 4.4, and 4.5.

Figure 1—Illustration of Barrel Length (BL) and Overall Length (OL) Measurands
(adapted from [12])

4.3 Barrel Length Measurements

4.3.1 Revolvers

4.3.1.1 When measuring a revolver barrel, the distance parallel to the bore axis from the rear of the forcing cone to the farthest end of the muzzle represents the length of the barrel.

4.3.1.2 Ruler/Measuring Tape: A revolver barrel may be measured by placing a steel ruler/measuring tape on the exterior of the barrel, parallel to the axis of the bore to determine the barrel length. The ruler marks should then be perpendicular to the muzzle bore.

4.3.1.3 Measuring Rod: A measuring rod may be used to measure barrel length; however, it may be difficult to determine the starting point for the measuring rod. Consideration should be taken to determine how the starting point can be accurately achieved. A block at the muzzle or forcing cone end of the firearm, which is perpendicular to the axis of the bore, may be used to represent the starting point for the measuring rod to determine barrel length. The material of the measuring rod should be sufficiently soft that it does not scratch the barrel.

4.3.1.4 Caliper: A revolver barrel may be measured by placing a caliper on the exterior of the barrel, parallel to the axis of the bore to determine the barrel length.

4.3.2 Integral Chamber Barrels

4.3.2.1 When measuring the barrel of a firearm that has an integral chamber, the distance parallel to the bore axis from the muzzle end to the breech face (with the action closed) represents the length of a barrel. All measurements should be made perpendicular to the bore axis at the farthest point of the barrel.

4.3.2.2 Ruler/Measuring Tape: An integral chamber barrel can be measured by placing a steel ruler/measuring tape on the exterior of the barrel, parallel to the axis of the bore.

4.3.2.3 Measuring rod: Before measuring an integral chamber barrel, ensure that the firing pin is not impeding the measuring rod from making contact with the breech face. It may be necessary to cock the firearm in order to withdraw a protruding firing pin. In the case of a fixed firing pin, be certain it is not reducing the barrel length measurement. Ensure that the measuring rod, when inserted in the barrel, is parallel to the bore axis.

4.4 Overall Length Measurements

4.4.1 When measuring the overall length of a firearm, the measurement should be taken along a line which is parallel to the axis of the bore from a perpendicular tangential line which touches the rearmost point of the firearm to a perpendicular tangential line that touches the furthest point of the muzzle.

4.4.2 The overall firearm length should be determined using a measuring device or fixture that can provide indications of length increments parallel to the bore axis illustrated in Figure 1.

4.4.3 For firearms with folding or retractable stocks, the laboratory standard operating procedures shall define whether the stocks should be extended during measurement unless already defined by applicable law.

4.5 Uncertainty and Measurement Traceability for Barrel and Overall Length Measurements

4.5.1 Estimating the uncertainty of length measurements is essential to achieving traceability of the measurements to the international unit of length. This section provides essential steps for laboratory studies to estimate the uncertainty of those BL-OL measurements that are reported by the laboratory to external parties.

Measurement traceability should include the calibration certificate of the measuring device.

4.5.2 The uncertainty of a laboratory's BL-OL measurements should be estimated with data from a study of repeated measurements of several firearms by all those in the laboratory responsible for measuring and reporting BL-OL. It is recommended that the study employ firearms similar to those found in case work and which are close to the relevant statutory minimum lengths, such as 16 in., 18 in., and 26 in. ^[12], required by applicable laws. The same type of measuring device should be used for all measurements for a given uncertainty study.

4.5.3 Measurements of BL-OL should be performed in accordance with the procedures outlined in Sections 4.2, 4.3, and 4.4.

4.5.4 Key factors, which may potentially be sources of uncertainty, are as follows.

- Different lengths to be measured (for example 16 in., 18 in., and 26 in., Section 4.1).
- Different models of firearms, which may need to be handled or fixtured differently.
- Different observers performing the measurements.
- Inherent uncertainty associated with the measurement device. A different uncertainty budget should be developed for each type of device used for these measurements.
- Uncertainty in any physical standards used to calibrate the device with respect to the international unit of length.
- Misreading the fractions on a length scale during a manual measurement. Observers responsible for manual measurements should be trained to avoid this error. In addition, the laboratory should have a clear policy for identifying and dealing with outlier data points, which result from this type of error.

NOTE The first two items relate to the measurand and the last four relate to the measurement.

4.5.5 For each type of measurement, barrel and overall length, at least 70 measurements should be obtained in the study, with at least two measurements of each barrel length and overall length by each observer, extending over more than one day. The firearms measured should have slightly different lengths close to the defined values.

4.5.6 For example, if there are five observers in the laboratory, the number of measurements taken to estimate the BL or OL measurement uncertainty might be $(4 \text{ models of firearm}) \times (5 \text{ observers}) \times (4 \text{ repeated measurements}) = 80 \text{ measurements}$.

4.5.7 For laboratories with fewer observers, the number of models or the number of repeated measurements should be increased so that at least 70 measurements are taken altogether.

4.5.8 The data obtained by any extra observers should be identifiable in the data analysis.

4.5.9 To complete the analysis, the measured results should be recorded, their statistical variations should be calculated, and uncertainty components from all sources should be estimated and integrated together. The “Blank Measurement Uncertainty Estimation Template”^[10], an online spreadsheet, may be used for this purpose.

4.5.10 An example spreadsheet of simulated data and analysis results for a laboratory study to establish measurement uncertainty is available via Annex A.

4.5.11 Once uncertainties for BL-OL measurements are established, at least two measurements should be obtained in case work for each quantity to be measured. Any difference between them should be consistent with the uncertainty as assessed above.

4.5.12 The stability of the measurement process should be monitored by control chart(s) ^[3, 8], of measurements of the laboratory's physical check standard(s) guided by its quality procedures.

4.5.13 The process described in Sections 4.5.2 to 4.5.9 or an equivalent process should be repeated when a change occurs in the laboratory procedure for measurement of barrel length or overall length, such as the acquisition of a measuring device or the addition of new observers.

5 Records

The laboratory should maintain ^[4,5,6,10]:

- an uncertainty budget;
- control charts;
- a data log;
- records of calibration of physical standards used for these measurements;
- records of calibration procedures and maintenance of measurement devices used for these measurements.

Annex A (informative)

Example Spreadsheet for Calculating Uncertainty for Measurement of Overall Length and Barrel Length

The spreadsheets (Tables 1 through 3) provide example data, calculations, and component estimates for a laboratory study to estimate uncertainty of barrel length and overall length measurements. Tables 2 and 3 are adapted with one minor change from *The Blank Measurement Uncertainty Estimation Template*^[11]. An active, source-code version of the spreadsheets may be obtained online at [\(link to be provided at time of publication\)](#). A number of cells in the online version of Table 2 contain informative notes, which do not show on the version below. Because errors can find their way into such documents when data are added or substituted, users must verify for themselves that the numerical formulas do not contain omissions or errors and that the calculated results are accurate.

The spreadsheet begins on Sheet 1 with simulated data involving 80 measurements each for barrel length and overall length, shown in columns D and E. The 80 measurements include five observers taking four measurements each on four firearms. The calculations here yield a mean value for the overall length and barrel length of each firearm and a Type A standard uncertainty (Stdev) calculated from 80 measurements by all observers. The four values of standard uncertainty are pooled to yield a value of statistical reproducibility for OL and BL measurements, shown in yellow. These values are carried onto Sheets 2 and 3, respectively, as one component of a summary uncertainty budget tabulated in a format originally described by ASCLD/LAB.

Table A.1—Example Spreadsheet for Calculating Uncertainty for Measurement of Overall Length and Barrel Length November 14, 2017 (Updated November 4, 2019)

UserName	EntryDate	SerialNumber	Overall	Barrel	Serial Number	Overall Stats		Barrel Stats	
All dimensions in inches					Means	Stdevs	Means	Stdevs	
Al	01-Jan-15	11	20.4375	9.6875					
Al	01-Jan-15	22	28.6875	11.875					
Al	01-Jan-15	33	18.5	12.25	#11	20.43438	0.024627	9.734375	0.028932
Al	01-Jan-15	44	20.1875	13.625					
Betty	01-Jan-15	11	20.4375	9.75	#22	28.68125	0.027951	* 11.02813	0.201225
Betty	01-Jan-15	22	28.6875	11					
Betty	01-Jan-15	33	18.5	12.25	#33	18.7125	0.076948	12.25	0.020278
Betty	01-Jan-15	44	20.25	13.5625					
Carl	01-Jan-15	11	20.4375	9.6875	#44	20.23355	0.027766	13.61842	0.019237
Carl	01-Jan-15	22	28.6875	11					
Carl	01-Jan-15	33	18.6875	12.25	#22*	*The first value for SN 22 widely differs from the mean. It is removed here as an example of a possible action for dealing with outliers.		10.98355	0.028276
Carl	01-Jan-15	44	20.1875	13.625					
Denise	01-Jan-15	11	20.4375	9.75					
Denise	01-Jan-15	22	28.5625	10.9375					
Denise	01-Jan-15	33	18.6875	12.25					
Denise	01-Jan-15	44	20.25	13.625					
Ed	01-Jan-15	11	20.4375	9.75					
Ed	01-Jan-15	22	28.6875	11					
Ed	01-Jan-15	33	18.6875	12.25					
Ed	01-Jan-15	44	20.1875	13.625					
Betty	02-Jan-15	44	20.25	13.625					
Betty	02-Jan-15	11	20.4375	9.6875					
Betty	02-Jan-15	22	28.6875	11					
Betty	02-Jan-15	33	18.6875	12.25					
Carl	03-Jan-15	44	20.25	13.625					
Carl	03-Jan-15	11	20.4375	9.75					
Carl	03-Jan-15	22	28.6875	11					
Carl	03-Jan-15	33	18.75	12.25					
Denise	04-Jan-15	44	20.25	13.625					
Denise	04-Jan-15	11	20.5	9.75					
Denise	04-Jan-15	22	28.6875	11					
Denise	04-Jan-15	33	18.75	12.25					
Ed	05-Jan-15	44	20.25	13.625					
Ed	05-Jan-15	11	20.4375	9.6875					
Ed	05-Jan-15	22	28.6875	10.9375					
Ed	05-Jan-15	33	18.75	12.25					
Al	06-Jan-15	44	20.25	13.625					
Al	06-Jan-15	11	20.4375	9.75					
Al	06-Jan-15	22	28.6875	10.9375					
Al	06-Jan-15	33	18.75	12.25					
Al	08-Jan-15	33	18.75	12.25					
Al	09-Jan-15	44	20.25	13.625					
Al	10-Jan-15	11	20.4375	9.75					
Al	11-Jan-15	22	28.6875	11					
Ed	08-Jan-15	33	18.75	12.25					
Ed	09-Jan-15	44	20.25	13.625					
Ed	10-Jan-15	11	20.4375	9.75					
Ed	11-Jan-15	22	28.6875	11					
Denise	08-Jan-15	33	18.75	12.25					
Denise	09-Jan-15	44	20.25	13.625					
Denise	10-Jan-15	11	20.4375	9.75					
Denise	11-Jan-15	22	28.6875	11					
Carl	08-Jan-15	33	18.75	12.3125					
Carl	09-Jan-15	44	20.25	13.625					
Carl	10-Jan-15	11	20.4375	9.75					
Carl	11-Jan-15	22	28.6875	11					
Betty	08-Jan-15	33	18.75	12.25					
Betty	09-Jan-15	44	20.25	13.625					
Betty	10-Jan-15	11	20.375	9.6875					
Betty	11-Jan-15	22	28.6875	10.9375					
Ed	14-Jan-15	22	28.6875	11					
Ed	14-Jan-15	33	18.75	12.25					
Ed	14-Jan-15	44	20.25	13.625					
Ed	14-Jan-15	11	20.375	9.75					
Denise	18-Jan-15	22	28.6875	10.9375					
Denise	18-Jan-15	33	18.75	12.25					
Denise	18-Jan-15	44	20.25	13.5625					
Denise	18-Jan-15	11	20.4375	9.75					
Carl	22-Jan-15	22	28.6875	11					
Carl	22-Jan-15	33	18.75	12.1875					
Carl	22-Jan-15	44	20.1875	13.625					
Carl	22-Jan-15	11	20.4375	9.75					
Betty	26-Jan-15	22	28.6875	11					
Betty	26-Jan-15	33	18.75	12.25					
Betty	26-Jan-15	44	20.1875	13.625					
Betty	26-Jan-15	11	20.4375	9.75					
Al	31-Jan-15	22	28.6875	11					
Al	31-Jan-15	33	18.75	12.25					
Al	31-Jan-15	44	20.25	13.625					
Al	31-Jan-15	11	20.4375	9.75					

Table A.2—Measurement Uncertainty Estimation Form for Overall Length of the Firearm

Measurement Uncertainty Estimation Form										
Measurement:		Overall Length of a Firearm								
Range of measurement values:		19 inch to 29 inch								
Procedure name and revision:		Example Uncertainty Budget								
Estimation prepared by:		Task Group on Uncertainty of Measurement					Date Prepared:			11/3/2019
Attention! See explanatory notes on row 7, column A, and cells B7 and C19.										
Line Item	Uncertainty Component	Value	Units	Type	Statistical Distribution	Divisor	Degrees of Freedom	Standard Uncertainty	Component Contribution %	
1	Measurement Process Reproducibility (from page 1)	0.0458	inch	A	normal	1.00	>60	0.0458	86.4	
2	Length scale readability (1/16 inch)	0.0625	inch	B	rectangular	3.46	∞	0.0181	13.4	
3	Measuring scale calibration uncertainty	0.0014	inch	A	normal	1.00	19	0.0014	0.1	
4	Reference length standard calibration uncertainty (obtained from vendor)	0.0002	inch	B	normal	2.00	∞	0.0001	0.0	
5	Thermal expansion of measuring tool for ± 5 °C (conservative choices)	0.0023	inch	B	rectangular	1.73	∞	0.0013	0.1	
6	Other sources of uncertainty,....									
Sum									100	
Combined Standard Unc u_c								0.04929185		
Expanded Unc U ($k=2$)								0.0985837		
Expanded Unc U ($k=3$)								0.14787554		
Reported Uncertainty		0.099		$k=2$						
Reported Uncertainty		0.148		$k=3$						

Line Item	Component Contribution %
1	86.4
2	13.4
3	0.1
4	0.0
5	0.1

NOTE: Regardless of the number of digits that are showing in a cell, Excel carries the maximum number of significant figures in the background and will use the entire number for further calculations

Table A.3—Measurement Uncertainty Estimation Form for Barrel Length of the Firearm

Measurement Uncertainty Estimation Form										
Measurement:		Barrel Length of a Firearm								
Range of measurement values:		9.7 inch to 13.5 inch								
Procedure name and revision:		Example Uncertainty Budget								
Estimation prepared by:		Task Group on Uncertainty of Measurement					Date Prepared:			11/2/2019
Attention! See explanatory notes on row 7, column A, and cells B7 and C19.										
Line Item	Uncertainty Component	Value	Units	Type	Statistical Distribution	Divisor	Degrees of Freedom	Standard Uncertainty	Component Contribution %	
1	Measurement Process Reproducibility (from page 1)	0.0251	inch	A	normal	1.00	>60	0.0251	65.6	
2	Length scale readability (1/16 inch)	0.0625	inch	B	rectangular	3.46	∞	0.0180	34.0	
3	Measuring scale calibration uncertainty	0.0014	inch	A	normal	1.00	19	0.0014	0.2	
4	Reference length standard calibration uncertainty (obtained from vendor)	0.0002	inch	B	normal	2.00	∞	0.0001	0.0	
5	measuring tool for ± 5 °C (conservative choices)	0.0021	inch	B	rectangular	1.73	∞	0.0012	0.2	
6	Other uncertainty sources, etc.									
Sum									100	
Combined Standard Unc u_c								0.03093931		
Expanded Unc U ($k=2$)								0.06187861		
Expanded Unc U ($k=3$)								0.09281792		
Reported Uncertainty		0.062		$k=2$						
Reported Uncertainty		0.093		$k=3$						

Line Item	Component Contribution %
1	65.6
2	34.0
3	0.2
4	0.0
5	0.2

NOTE: Regardless of the number of digits that are showing in a cell, Excel carries the maximum number of significant figures in the background and will use the entire number for further calculations

Annex B (informative)

Bibliography

This is not meant to be an all-inclusive list as the group recognizes other publications on this subject may exist. At the time this standard was drafted, these were the publications used for reference. Additionally, any mention of a particular software tool or vendor as part of this bibliography is purely incidental, and any inclusion does not imply endorsement.

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- 12] U.S. Department of Justice, Bureau of Alcohol, Tobacco, Firearms and Explosives, Office of Enforcement Programs and Services (ATF-NFA), *ATF National Firearms Act Handbook*, ATFE-Publication 5320.8, Chapter 2, April 2009^h.

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