American National Standard

Voluntary Industry Performance Standards for Pressure and Velocity of Shotshell Ammunition for the Use of Commercial Manufacturers.

SAAMI®

SPORTING ARMS AND AMMUNITION MANUFACTURERS' INSTITUTE, INC.

SINCE 1926

Voluntary Industry Performance Standards for Pressure and Velocity of Shotshell Ammunition for the Use of Commercial Manufacturers.

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Approved April 23, 2019

Abstract   In the interests of safety and interchangeability, this Standard provides pressure and velocity performance and dimensional characteristics for shotshell ammunition. Included are procedures and equipment for determining these criteria.

American National Standard

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

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Foreword

The development of this voluntary industry performance standard was initiated under the auspices of the Sporting Arms and Ammunition Manufacturers' Institute, Inc. (SAAMI). A Products Standards Task Force was established by the Institute in 1975 and charged with the drafting of this and other standards with their subsequent periodic revisions.

The material presented provides the commercial manufacturer of factory-loaded ammunition with pressure and velocity performance and dimensional characteristics. Included are procedures and equipment for determining these criteria. For the purpose of this standard a commercial manufacturer is defined as one who produces ammunition by fabricating component parts from raw materials as opposed to remanufacture with parts originally made by others.

This standard for Shotshell Ammunition was first published in 1977. Subsequently it was revised at five year intervals, in 1982, 1988, 1992, 2015 and now again in 2019. Changes in the standard with each revision include minor adjustments of velocities, the addition of new load offerings, and updating of recommended equipment sources and the latest procedures for reporting reference ammunition assessments.

Suggestions for improvement of this standard will be welcome. They should be sent to: The Sporting Arms and Ammunition Manufacturers' Institute, Inc., 11 Mile Hill Road, Newtown, Connecticut 06470-2359.

Consensus for this standard was achieved by use of the Canvass Method.

The following individuals and organizations recognized as having an interest in the standardization of safety requirements for factory-loaded sporting ammunition were contacted prior to the approval of this standard. Inclusion in this list does not necessarily imply that the individual or organization concurred with the submittal of the standard to ANSI:

Interest Category	Name	Affiliation
Expert	Buford Boone	Boone Ballistics
Expert	George Kass	Forensic Ammunition Service
Expert	Carl Hildebrandt	Massachusetts Institute of Firearms Technology
General Interest	James Hamby	Association of Firearms & Tool Mark Examiners
General Interest	Ralph Nauman	Environ-Metal, Inc.
General Interest	Paul Szabo	Retried Ammunition Engineer, Expert Witness and AFTE Member
Government	Earl Griffith	Bureau of Alcohol, Tobacco, Firearms and Explosives
Government	Mark Greene	National Institute of Justice
Government	Kirk Rice	National Institute of Standards & Technology
Producer	Roberto Trujillo	Aguila Ammunition
Producer	Oldemar Fonseca Jr	Companhia Brasileira de Cartuchos (CBC)
Producer	Dave Manson	Manson Precision
Testing Laboratory	Wesley Mason	H.P. White Laboratory
Testing Laboratory	Richard Bowes	Natural Resources Canada
Testing Laboratroy	Richard Poaps	Royal Canadian Mounted Police
User	Doug Fisher	Naval Surface Warfare Center, Crane Division
User	Gary Svendsen	Retired Ammunition Engineer and Avid User
User	Ken Kees	Retired Ammunition Engineer and Avid User

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SHOTSHELL CARTRIDGES AND CHAMBERS
FULL NAMES AND METRIC EQUIVALENTS

The following list presents the recommended full names and metric equivalents of shotshells currently supplied for various types of firearms.

Full Name		Metric Equivalent	
Gauge	Nominal Length	Gauge	Nominal Length
10	3½"	10	89 mm
12	2¾"	12	70 mm
12	3"	12	76 mm
12	3½"	12	89 mm
16	2¾"	16	70 mm
20	2¾"	20	70 mm
20	3"	20	76 mm
28	2¾"	28	70 mm
410 bore	2½"	410 bore	65 mm
410 bore	3"	410 bore	76 mm

VELOCITY AND PRESSURE:
VELOCITY DATA INTERPRETATION

Velocity recommendations are stated on the basis of a nominal lot mean velocity as measured using equipment in accordance with the requirements of Section III and the procedures detailed in Section II. Due to the fact that sporting firearms for general distribution are typically manufactured to dimensional tolerances greater than those specified for test barrels, there should be no expectation that these velocities can be duplicated from any test utilizing firearms. This situation is further confounded by discrepancies in barrel length. Furthermore, once ammunition has left the control of the manufacturer, storage conditions outside those recommended by the manufacturer may cause variations in the velocity as measured using test equipment and procedures which conform to the requirements of this Manual.

The values presented on pages 6*ff* are recommended values for the use of ammunition producers at the time of manufacture. It is the responsibility of the manufacturer to establish sample sizes, sampling frequencies, and tolerances to ensure the performance of the ammunition obtained by the ultimate user meets all applicable safety and functional standards. Of particular importance in establishing velocity tolerances is the understanding that velocities significantly higher than the nominal lot mean can cause actual maximum range performance to exceed expected values.

Ammunition tested subsequent to manufacture using equipment and procedures conforming to these guidelines can be expected to produce velocities within a tolerance of ±90 fps of the tabulated values.

VELOCITY AND PRESSURE:
FACTORS AFFECTING PRESSURE MEASUREMENTS

One principal method of measuring shotshell pressures is recognized: the piezoelectric transducer method.

There are three principal factors affecting pressure measurements. These are instrumentation, ammunition and procedure. The following lists present the items in each category that may cause difficulties.

EQUIPMENT / INSTRUMENTATION

1. Condition of test barrel (whether minimum or maximum bore, chamber size and headspace, amount of erosion at forcing cone and bore).
2. Fit of transducer in barrel.
3. Location of transducer.
4. Tightness of barrel mounting in Universal Receiver, if used.
5. Shape, size and protrusion of firing pin beyond breech face.
6. Force of firing pin blow.
7. Characteristics of the transducer.
8. Quality of the transducer.
9. Quality of the read-out system.

AMMUNITION

1. Condition of shell.
2. Temperature of ammunition.

PROCEDURE

1. Failure to mount pressure barrel properly in Universal Receiver or other test action to assure minimum headspace.
2. Failure to fire warming shots.
3. Overheating barrel by excessive rate of fire.
4. Failure to clean bore and control metal fouling (leading).
5. Failure to protect transducer against contamination, such as oil or water.
6. Transducer calibration.
7. Read-out system calibration.

VELOCITY AND PRESSURE:
EXPLANATION OF PRESSURE TERMINOLOGY

The SAAMI Pressure data outlined in this section is based on a Maximum Average Pressure (MAP) for each shotshell and a Coefficient of Variation of 7.5%. The Coefficient of Variation (CV) of 7.5% was based on the CV that exists for the 12,000 psi pressure level and is calculated by dividing the population standard deviation ($\sigma = 900$) by the Maximum Average Pressure (MAP = 12,000 psi) which equals .075 (7.5%). All other pressure terminology is derived directly from these two terms.

SAAMI recognizes one pressure-measuring system for shotshell ammunition. That system is the piezoelectric transducer system with the bottom of the transducer mounted tangent to the chamber of the test barrel. Pressure developed by the burning propellant exerts force on the transducer through the shell case wall causing the transducer to deflect, creating a measurable electric charge. Pressures measured with this system are expressed in units of "pounds per square inch" (abbreviated psi).

<u>Maximum Average Pressure</u> - is the recommended maximum pressure level for loading commercial sporting ammunition. This pressure level is positioned two standard errors below the Maximum Probable Lot Mean (MPLM) pressure in order to assure there is a 97.5% probability that the Maximum Probable Lot Mean pressure is not exceeded. See Figure 1.
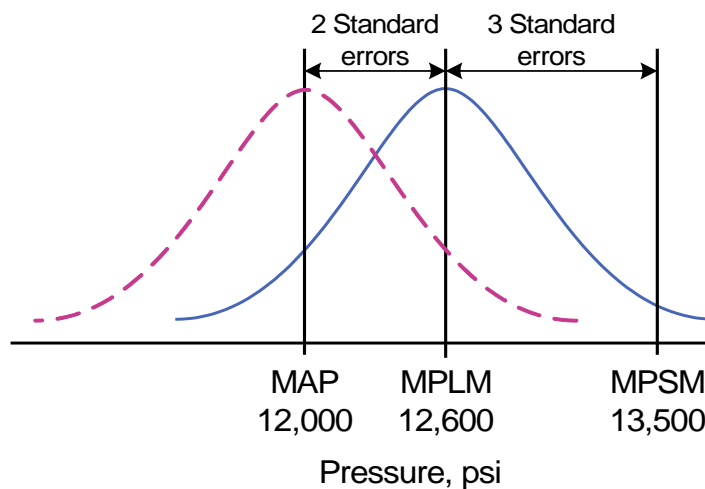
<u>Figure 1</u>

Standard Deviation (σ) - The Standard Deviation for each Maximum Average Pressure Level is based on a Coefficient of Variation of 7.5%. This 7.5% Coefficient of Variation is maintained throughout the SAAMI pressure spectrum providing a realistic Standard Deviation for each pressure level. To obtain the Standard Deviation for a particular MAP multiply the MAP by 0.075 (i.e., 12,000 psi x 0.075 = 900 psi).

Standard Error $\left(\sigma_{\bar{x}}\right)$ - The standard error is calculated by dividing the Standard Deviation (population S. D. = σ) by the square root of the sample size $\sigma_{\bar{x}} = \sigma/\sqrt{n}$.

Maximum Probable Lot Mean (MPLM) - The MPLM is calculated by adding two standard errors to the Maximum Average Pressure.

The SAAMI pressures are calculated based on a sample size of ten (10). The Maximum Probable Lot Mean represents the midpoint of the upper service pressure distribution. See Figure 1. For example, if the Maximum Average Pressure is 12,000 psi, the Maximum Probable Lot Mean (MPLM) is calculated as follows:

    MPLM = Maximum Average Pressure + 2 standard errors
    MPLM = 12,000 psi + [(12,000 psi x 0.075)/$\sqrt{10}$] x 2
    MPLM = 12,000 psi + (284 psi x 2) = 12,000 psi + 568 psi = 12,568 psi
                                                    rounded to 12,600 psi

Maximum Probable Sample Mean (MPSM) - is the maximum expected average pressure that may be observed in the testing of product subsequent to its manufacture and is not intended for use as a loading control point. The Maximum Probable Sample Mean is positioned three (3) standard errors above the Maximum Probable Lot Mean i.e., MPLM + 3 $\sigma_{\bar{x}}$. See Figure 1. The Maximum Probable Sample Mean defined here is the value previously referred to in the ANSI/SAAMI Standards as the Maximum Product Average.

Maximum Extreme Variation - The maximum allowable sample E.V. (Extreme Variation or Range) is a statistic derived from the knowledge of the population Standard Deviation. Applying table figures from the Relative Range Tables (Biometrika Tables for Statisticians) we calculate the Maximum E.V. or Range as (population σ) x 5.16 (table constant for sample of 10 at 99.0% confidence level) i.e., 900 psi x 5.16 = 4,644 psi (rounded to 4,600 psi).

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER

LEAD SHOT LOADS

Gauge	Shell Length	Shot Weight (ounces)	Velocity (fps) Nominal Mean @ 3' Test Bbl.	Pressure Limits (psi/100)[1]		
				Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
10	3½"	1⅞	1,225	110	115	123
			1,300			
		2	1,210			
			1,300			
		2¼	1,210			
12 (Continued on next page)	2¾" (Continued on next page)	24 gm	1,350	115	120	128
		26 gm	980			
		⅞	1,100			
			1,200			
			1,390			
		1	1,145			
			1,180			
			1,235			
			1,290			
			1,350			
			1,500			
		1⅛	900			
			1,145			
			1,200			
			1,255			
			1,310			
			1,450			
		1¼	1,165			
			1,220			
			1,275			
			1,330			
			1,400			
			1,500			

[1] Based on sample size η=10.

NOTE: All loads fired in test barrels with a choke constriction of .031 ± .005 (0.79 mm ± 0.13 mm). (Section III)

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

LEAD SHOT LOADS (continued)

Gauge	Shell Length	Shot Weight (ounces)	Velocity (fps) Nominal Mean @ 3' Test Bbl.	Pressure Limits (psi/100)[1]		
				Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
	2¾" (Continued from previous page)	1⅜	1,300	115	120	128
			1,450			
			1,500			
		1½	1,260			
			1,315			
		1⅝	1,250			
12 (Continued from previous page)	3"	1¼	1,450	115	120	128
		1⅜	1,295			
		1½	1,300			
		1⅝	1,280			
			1,350			
		1¾	1,200			
			1,300			
		1⅞	1,050			
			1,210			
		2	1,175			
	3½"	1⅞	1,225	140	147	157
		2	1,200			
			1,300			
		2⅛	1,050			
		2¼	1,150			

[1] Based on sample size η=10.

NOTE: All loads fired in test barrels with a choke constriction of .031 ± .005 (0.79 mm ± 0.13 mm). (Section III)

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

LEAD SHOT LOADS (continued)

Gauge	Shell Length	Shot Weight (ounces)	Velocity (fps) Nominal Mean @ 3' Test Bbl.	Pressure Limits (psi/100)[1]		
				Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
16	2¾"	1	1,165	115	120	128
			1,220			
		1⅛	1,185			
			1,240			
			1,295			
		1¼	1,260			
20	2¾"	22 gm	1,275	120	126	135
		¾	1,390			
		⅞	980			
			1,135			
			1,210			
			1,300			
			1,350			
		1	1,165			
			1,220			
			1,300			
			1,350			
		1⅛	1,175			
	3"	1⅛	1,285	120	126	135
		1³/₁₆	1,295			
		1¼	1,185			
			1,300			
		1⁷/₁₆	1,100			

[1] Based on sample size $\eta=10$.

NOTE: All loads fired in test barrels with a choke constriction of .031 ± .005 (0.79 mm ± 0.13 mm). (Section III)

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

LEAD SHOT LOADS (continued)

Gauge	Shell Length	Shot Weight (ounces)	Velocity (fps) Nominal Mean @ 3' Test Bbl.	Pressure Limits (psi/100)[1]		
				Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
28	2¾"	⅝	1,160	125	131	140
		¾	1,200			
			1,295			
		⅞	1,250			
		1	1,205			
410 Bore	2½"	½	1,200	125	131	140
			1,300			
		¹¹/₁₆	1,075[2]			
	3"	¹¹/₁₆	1,135	135	141	151
		¹⁵/₁₆	975[3]			

[1] Based on sample size $\eta = 10$.

[2] Original load introduced at this payload/velocity was combined lead shot and lead disks.

[3] Original load introduced at this payload/velocity was 4 discs over 16 – BB pellets.

NOTE: All loads fired in test barrels with a choke constriction of .031 ± .005 (0.79 mm ± 0.13 mm). (Section III)

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

NON-LEAD SHOT LOADS

Gauge	Shell Length	Shot Weight (ounces)	Velocity (fps) Nominal Mean @ 3' Test Bbl.	Pressure Limits (psi/100)[1]		
				Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
10	3½"	1⅜	1,425	110	115	123
			1,450			
			1,500			
		1½	1,450			
		1⅝	1,350			
		1¾	1,260			
			1,300			
		1⅞	1,225			
12 (Continued on next page)	2¾"	1	1,235	115	120	128
			1,300			
			1,375			
			1,450			
		1¹/₁₆	1,500			
		1⅛	1,145			
			1,300			
			1,365			
			1,400			
		1¼	1,275			
			1,325			
		1⅜	1,250			
	3" (Continued on next page)	1¹/₁₆	1,625	115	120	128
		1⅛	1,350			
			1,400			
			1,450			
			1,500			
			1,550			
			1,650			
			1,700			

[1] Based on sample size η=10.

NOTE: All loads fired in test barrels with a choke constriction of .005 ±.005 (0.13 mm ± 0.13 mm).
    (Section III)

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

NON-LEAD SHOT LOADS (continued)

Gauge	Shell Length	Shot Weight (ounces)	Velocity (fps) Nominal Mean @ 3' Test Bbl.	Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
12 (Continued from previous page)	3" (Continued from previous page)	1¼	1,300	115	120	128
		1¼	1,375			
		1¼	1,450			
		1¼	1,700			
		1⅜	1,265			
		1⅜	1,375			
		1⅜	1,450			
		1½	1,300			
		1⅝	1,225			
	3½"	1¼	1,625	140	147	157
		1⅜	1,450			
		1⅜	1,550			
		1⅜	1,650			
		1⅜	1,700			
		1½	1,400			
		1½	1,500			
		1⁹/₁₆	1,300			
		1⅝	1,350			
		1⅝	1,400			
		1¾	1,300			
		1⅞	1,225			
16	2¾"	⅞	1,300	115	120	128
		¹⁵/₁₆	1,350			

[1] Based on sample size η=10.

NOTE: All loads fired in test barrels with a choke constriction of .005 ±.005 (0.13 mm ± 0.13 mm).
(Section III)

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

NON-LEAD SHOT LOADS (continued)

Gauge / Bore	Shell Length	Shot Weight (ounces)	Velocity (fps) Nominal Mean @ 3' Test Bbl.	Pressure Limits (psi/100)[1]		
				Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
20	2¾"	¾	1,300	120	126	135
			1,425			
		⅞	1,210			
		1	1,135			
			1,350			
		1⅛	1,100			
	3"	⅞	1,200	120	126	135
			1,300			
			1,500			
			1,600			
		1	1,330			
		1¹/₁₆	1,250			
			1,350			
		1⅛	1,225			
			1,300			
		1¼	1,175			
			1,225			
28	2¾"	⅝	1,300	125	131	140
			1,350			
410 Bore	2½"			125	131	140
	3"	⅜	1,400	135	141	151

[1] Based on sample size $\eta=10$.

NOTE: All loads fired in test barrels with a choke constriction of .005 ±.005 (0.13 mm ± 0.13 mm). (Section III).

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

RIFLED SLUG LOADS[1]							
			Velocity (fps) Nominal Mean Test Barrel		**Pressure Limits** (psi/100)[2]		
Gauge	Shell Length	Slug Weight (ounces)	@ 3'	@ 15'	Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
10	3½"	1¾	1,265	1,235	110	115	123
12	2¾"	⅝	N/E[4]	1,610	115	120	128
			N/E	1,805			
		¾	1,510	1,450			
		⅞	1,820	1,770			
		1	1,195	1,170			
			1,550	1,520			
			1,605	1,585			
			1,680	1,650			
		1⅛	1,660	1,625			
		1¼	1,460	1,430			
		1⅜	1,150[3]	1,125[3]			
	3"	⅞	1,875	N/E	115	120	128
		1	1,760	1,730			
		1⅛	1,690	1,655			
16	2¾"	⅘	1,570	1,540	115	120	128

[1] Data shown is regardless of slug material(s) of construction (lead / non-lead) and is for loads intended to be fired from smooth-bore firearms.

[2] Based on sample size $\eta=10$.

[3] Original load introduced at this payload/velocity was a 1-ounce lead rifled slug with 3 lead 00 buck shot pellets.

[4] N/E = Not Established

NOTE: All loads fired in test barrels with a choke constriction of .031 ± .005 (0.79 mm ± 0.13 mm).
Test barrels with a choke constriction of .005 ± .005 (0.13 mm ± 0.13 mm) may be substituted for full choke barrels with no significant difference in test results. (Section III)

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

RIFLED SLUG LOADS[1] (Continued)

Gauge	Shell Length	Slug Weight (ounces)	Velocity (fps) Nominal Mean Test Barrel @ 3'	@ 15'	Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
					Pressure Limits (psi/100)[2]		
20	2¾"	½	1,810	1,770	120	126	135
		⅝	1,570	1,540			
		¾	1,570	1,540			
		⅞	1,540	1,505			
	3"	¾	1,800	1,755			
410 Bore	2½"	⅕	1,815	1,785	125	131	140
		¼	1,830	N/E[3]			

[1] Data shown is regardless of slug material(s) of construction (lead / non-lead) and is for loads intended to be fired from smooth-bore firearms.

[2] Based on sample size $\eta=10$.

[3] N/E = Not Established

NOTE: All loads fired in test barrels with a choke constriction of .031 ± .005 (0.79 mm ± 0.13 mm). Test barrels with a choke constriction of .005 ± .005 (0.13 mm ± 0.13 mm) may be substituted for full choke barrels with no significant difference in test results. (Section III)

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

SABOTED SLUG LOADS[2]

Gauge	Shell Length	Slug Weight	Velocity (fps) Nominal Mean Test Barrel @ 3'	@ 15'	Pressure Limits (psi/100)[1] Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
12	2¾"	300 gn	2,000	N/E[3]	115	120	128
		375 gn	1,720	1,700			
		385 gn	1,845	1,825			
		400 gn	1,460	1,450			
		400 gn	1,700	N/E			
		1 oz	1,200	N/E			
		1 oz	1,300	N/E			
		1 oz	1,450	N/E			
		1 oz	1,500	N/E			
		1⅛ oz	1,345	1,320			
		1¼ oz	1,545	1,525			
	3"	300 gn	2,065	2,050	115	120	128
		300 gn	2,330	2,300			
		375 gn	1,845	1,825			
		385 gn	1,895	1,875			
		1 oz	1,300	N/E			
		1 oz	1,400	N/E			
		1 oz	1,565	N/E			
		1⅜ oz	1,495	1,475			

[1] Based on sample size $\eta=10$.

[2] Includes saboted lead slugs, solid copper slugs or jacketed lead-core projectiles, and attached wad lead slugs that are intended for use in rifled-barrel shotguns and/or rifled choke tubes.

[3] N/E = Not Established

NOTE: All loads fired in rifled standard test barrels. (Section III).

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

SABOTED SLUG LOADS[2] (Continued)

Gauge	Shell Length	Slug Weight	Velocity (fps) Nominal Mean Test Barrel		Pressure Limits (psi/100)[1]		
			@ 3'	@ 15'	Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
20	2¾"	250 gn	1,790	1,775	120	126	135
			1,700	N/E[3]			
		260 gn	1,795	1,780			
			1,850	1,835			
			1,900	N/E			
		⅝ oz	1,400	N/E			
			1,500	N/E			
			1,600	N/E			
		⅞ oz	1,270	1,250			
		1 oz	1,445	1,420			
	3"	260 gn	1,845	1,830	120	126	135
			1,915	1,900			
		1 oz	1,495	1,465			
			1,550	1,540			

[1] Based on sample size $\eta=10$.

[2] Includes saboted lead slugs, solid copper slugs or jacketed lead-core projectiles, and attached wad lead slugs that are intended for use in rifled-barrel shotguns and/or rifled choke tubes.

[3] N/E = Not Established

NOTE: All loads fired in rifled standard test barrels. (Section III).

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

LEAD BUCKSHOT LOADS

Gauge	Length	Size Of Buck	Number Of Pellets	Velocity (fps) @3' Test Bbl.	Pressure Limits (psi/100)[1] Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
10	3½"	00	18	1,100	110	115	123
		4	54	1,100			
12	2¾"	000	8	1,325	115	120	128
		00	8	1,200			
		00	9	1,125			
				1,325			
			12	1,290			
		0	12	1,275			
		1	16	1,250			
			20	1,075			
		4	27	1,325			
			34	1,250			
	3"	000	10	1,225	115	120	128
		00	15	1,210			
		1	24	1,040			
		4	41	1,210			
	3½"	00	18	1,200	140	147	157
16	2¾"	1	12	1,225	115	120	128
20	2¾"	3	20	1,200	120	126	135
	3"	2	18	1,200	120	126	135
410 bore	2½"	000	3	1,300	125	131	140
	3"	000	5	1,080	135	141	151

[1] Based on sample size $\eta=10$.

NOTE: All loads fired in test barrels with a choke constriction of .031 ± .005 (0.79 mm ± 0.13 mm).
Test barrels with a choke constriction of .005 ± .005 (0.13 mm ± 0.13 mm) may be
substituted for full choke barrels with no significant difference in test results. (Section III)

VELOCITY AND PRESSURE:
VELOCITY AND PRESSURE DATA - TRANSDUCER (Cont'd)

NON-LEAD BUCKSHOT LOADS

Gauge	Length	Size Of Buck	Number Of Pellets	Velocity (fps) @3' Test Bbl.	Pressure Limits (psi/100)[1]		
					Maximum Average Pressure (MAP)	Maximum Probable Lot Mean (MPLM)	Maximum Probable Sample Mean (MPSM)
12	2¾"	00	8	1,200	115	120	128
				1,650			
			9	1,250			
				1,325			
				1,650			
		4	27	1,200			
				1,450			

[1] Based on sample size η=10.

NOTE: All loads fired in test barrels with a choke constriction of .031 ± .005 (0.79 mm ± 0.13 mm).
Test barrels with a choke constriction of .005 ± .005 (0.13 mm ± 0.13 mm) may be
substituted for full choke barrels with no significant difference in test results. (Section III)

10 Gauge 3½" Smooth Bore Barrel

Issued: 08/01/1988

Revised: 12/24/2018

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.933-.027
(23.70-0.69)

55° B

.8540-.0090 ✽
(21.692-0.229)

.015 (0.38) R MAX.

.840-.020
(21.34-0.51)

CAP HEIGHT OPTIONAL

.8900 B
(22.606)

.0624-.0160
(1.858-0.406)

.075 (1.91) ✽ Δ

3.110 (78.99) FOLDED

3.290 (83.57) ROLLED

3.510 (89.15) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.934
(23.72)

55° B

.8581 (21.796) ✽

.020+.005 (0.51+0.13) R

.775+.020 (19.69+0.51) BORE DIA.

.8410 (21.361) ✽

5°+0.0°
  -4.5°

.8900 B ⊗
(22.606)

0624 (1.585) MIN
0764 (1.941) MAX

⊗

.0736 (1.869) ✽ Δ

BREECH
BOLT
FACE

3.500 (88.90) MINIMUM ✽

3.8772 (98.481) @ 5° FORCING CONE ✽ Δ
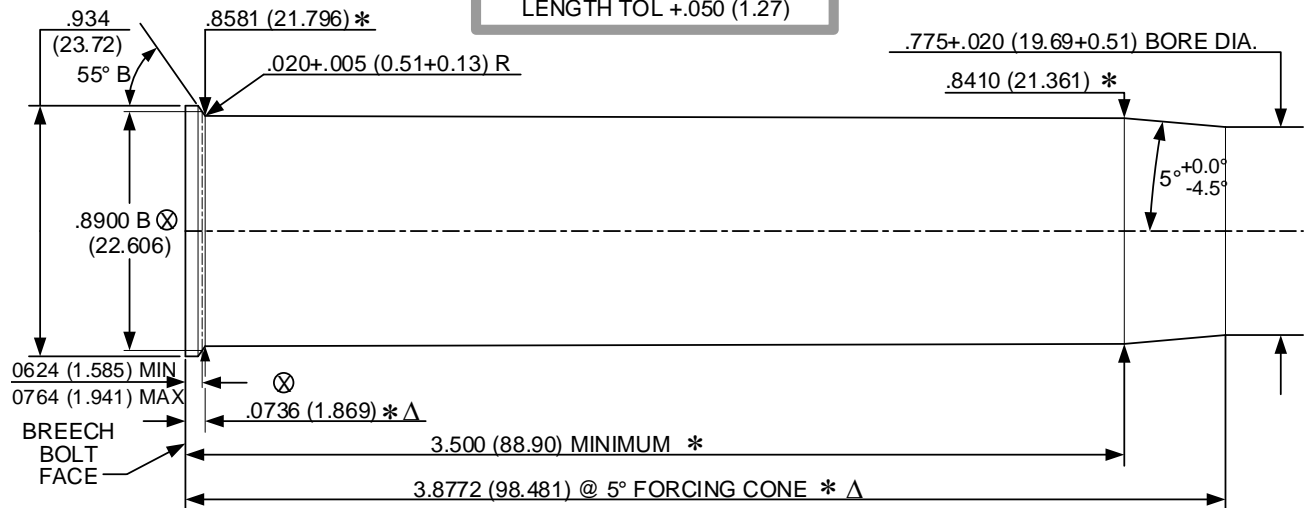
NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
✽ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

CHAMBER LENGTHS HAVE BEEN
INCREASED. FORMER CHAMBER
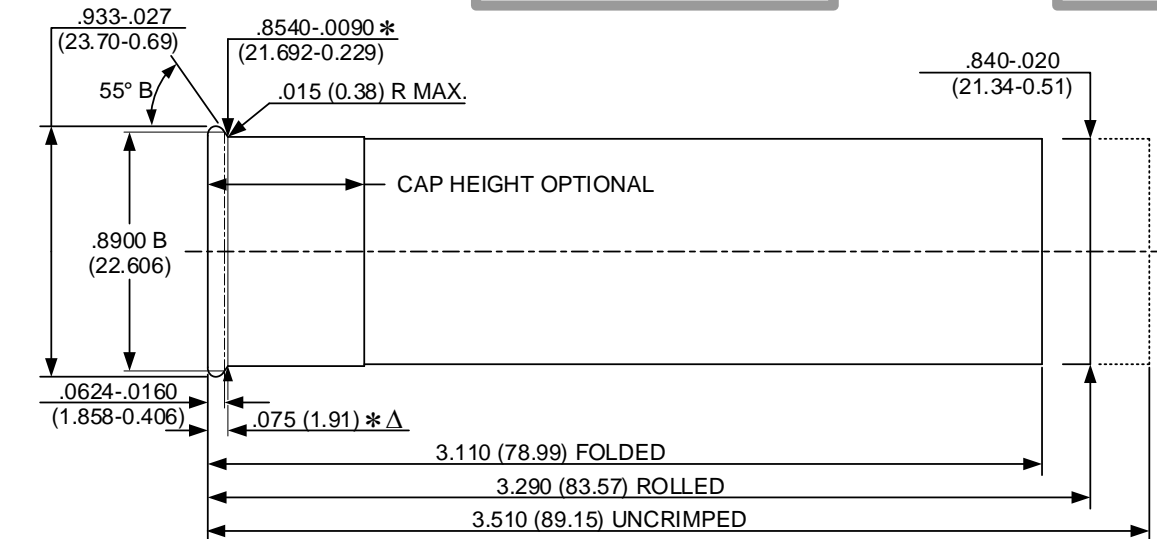DIMENSIONS ARE ALSO
CONSIDERED SAFE PRACTICE.

12 Gauge 2¾" Smooth Bore Barrel

Issued: 05/29/1979

Revised: 12/24/2018

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.886-.021
(22.50-0.53)

.8090-.0090 ∗
(20.549-0.229)

55° B

.015 (0.38) R MAX.

.797-.020
(20.24-0.51)

CAP HEIGHT OPTIONAL

.8500 B
(21.590)

.0576-.0140
(1.463-0.356)

.072 (1.83) ∗ Δ

2.405 (61.09) FOLDED

2.450 (62.23) ROLLED

2.760 - .100 (70.10 - 2.54) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.887
(22.53)

.8100 (20.574) ∗

55° B

.020+.005 (0.51+0.13) R

.725+.020 (18.42+0.51) BORE DIA.

.7980 (20.269)

$5°^{+0.0°}_{-4.5°}$

.8500 B ⊗
(21.590)

.0576 (1.463) MIN
.0716 (1.819) MAX

⊗

.0716 (1.819) ∗ Δ

BREECH
BOLT
FACE

2.750 (69.85) MINIMUM ∗

3.1672 (80.447) @ 5° FORCING CONE ∗ Δ

CHAMBER LENGTHS HAVE BEEN
INCREASED. FORMER CHAMBER
DIMENSIONS ARE ALSO
CONSIDERED SAFE PRACTICE.

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
∗ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

12-Gauge 2¾" Rifled Barrel

Issued: 08/26/1991

Revised: - -/- -/- - - -

DO NOT SCALE
FROM DRAWING

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

.886-.021
(22.50-0.53)

.8090-.0090 ✱
(20.549-0.229)

.015 (0.38) R MAX.

55° B

.797-.020
(20.24-0.51)

CAP HEIGHT OPTIONAL

.8500 B
(21.590)

.0576-.0140
(1.463-0.356)

.072 (1.83) ✱ Δ

2.450 (62.23) ROLLED

2.760 - .200 (70.10 - 5.08) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.719+.002 (18.263+0.051)
BORE DIA.

.727+.002 (18.466+0.051)
GROOVE DIA.

.887
(22.53)

.8100 (20.574) ✱

.020+.005 (0.51+0.13) R

.7980 (20.269)

55° B

.8500 B ⊗
(21.590)

5°

.0576 (1.463) MIN
.0716 (1.819) MAX

⊗

BREECH
BOLT
FACE

.0716 (1.819) ✱ Δ

2.750 (69.85) MINIMUM ✱

3.2015 (81.318) ✱ Δ

8 GROOVES .141±.002 (3.58±.05) WIDE	35 (889) RH TWIST (OPTIONAL)	MINIMUM BORE & GROOVE AREA .4105 IN^2 (264.838MM^2)

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
✱ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

12 Gauge 3" Smooth Bore Barrel

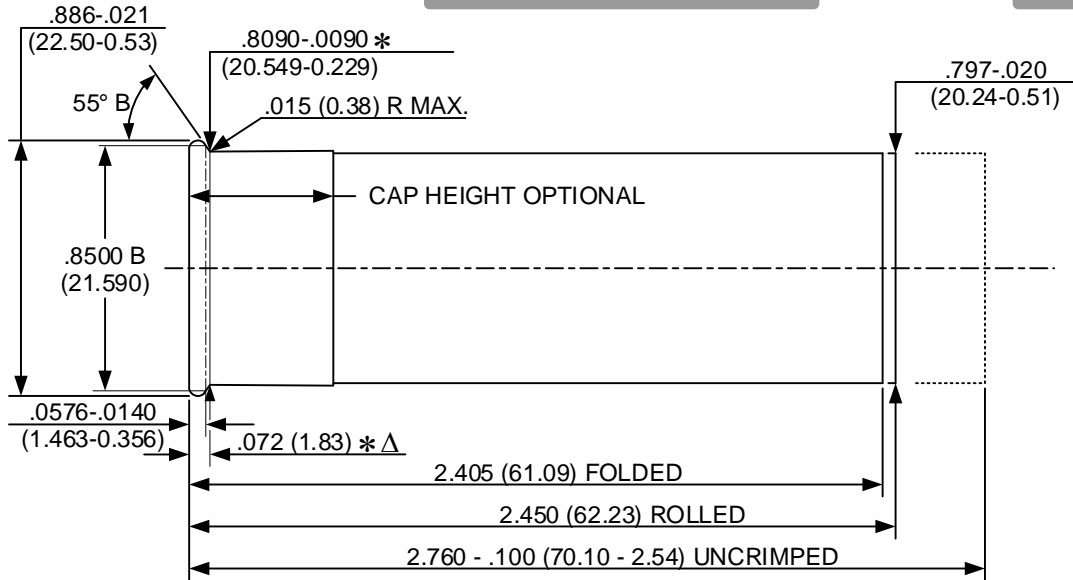Issued: 05/29/1979   Revised: 12/24/2018

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FDROM DRAWING

.886-.021
(22.50-0.53)

.8090-.0090 ∗
(20.549-0.229)

55° B

.015 (0.38) R MAX.

.797-.020
(20.24-0.51)

CAP HEIGHT OPTIONAL

.8500 B
(21.590)

.0576-.0140
(1.463-0.356)

.072 (1.83) ∗ Δ

2.655 (67.44) FOLDED

2.760 (70.10) ROLLED

3.010 - .100 (76.45 - 2.54) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.887
(22.53)

.8111 (20.602) ∗

.725+.020 (18.42+0.51) BORE DIA.

55° B

.020+.005 (0.51+0.13) R

.7980 (20.269)

.8500 B ⊗
(21.590)

5° +0.0°
-4.5°

.0576 (1.463) MIN
.0716 (1.819) MAX

⊗

.0712 (1.808) ∗ Δ

BREECH
BOLT
FACE

3.000 (76.20) MINIMUM ∗

3.4172 (86.797) @ 5° FORCING CONE ∗ Δ

CHAMBER LENGTHS HAVE BEEN
INCREASED. FORMER CHAMBER
DIMENSIONS ARE ALSO
CONSIDERED SAFE PRACTICE.

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
∗ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
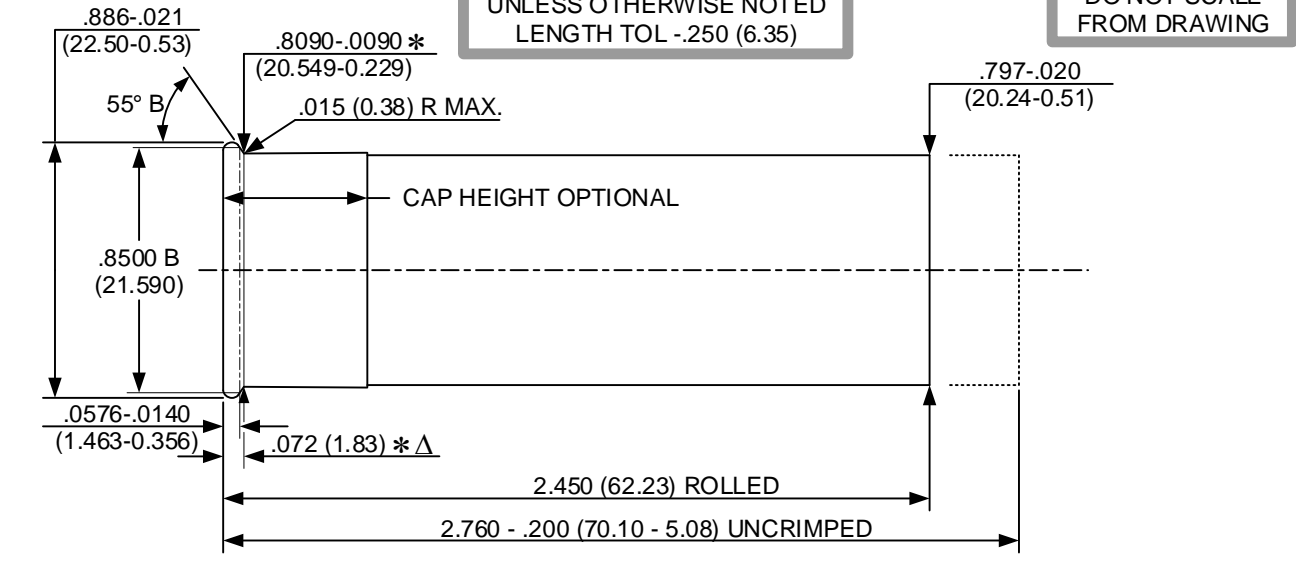ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

12-Gauge 3" Rifled Barrel

Issued: 05/29/1979

Revised: 06/16/2010

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.886-.021
(22.50-0.53)

.8090-.0090 ✱
(20.549-0.229)

55° B

.015 (0.38) R MAX.

.797-.020
(20.24-0.51)

CAP HEIGHT OPTIONAL

.8500 B
(21.590)

.0576-.0140
(1.463-0.356)

.072 (1.83) ✱ Δ

2.760 (70.10) ROLLED

3.010 - .150 (76.45 – 3.81) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.719+.002 (18.263+0.051)
BORE DIA.

.727+.002 (18.466+0.051)
GROOVE DIA.

.887
(22.53)

.8111 (20.602) ✱

55° B

.020+.005 (0.51+0.13) R

.7980 (20.269)

5°

.8500 B ⊗
(21.590)

.0576 (1.463) MIN
.0716 (1.819) MAX

⊗

.0712 (1.808) ✱ Δ

BREECH
BOLT
FACE

3.000 (76.20) MINIMUM ✱

3.4515 (87.668) ✱ Δ

| 8 GROOVES | 35 (889) RH TWIST | MINIMUM BORE & GROOVE |
| .141±.002 (3.58±.05) WIDE | (OPTIONAL) | AREA .4105 IN² (264.838MM²) |

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
✱ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
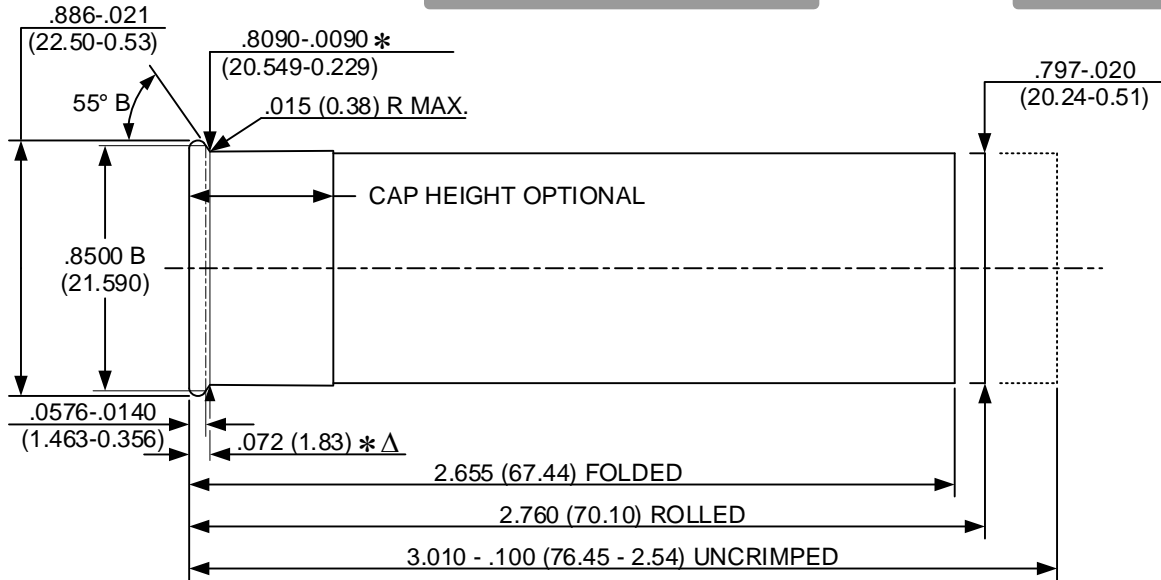ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)
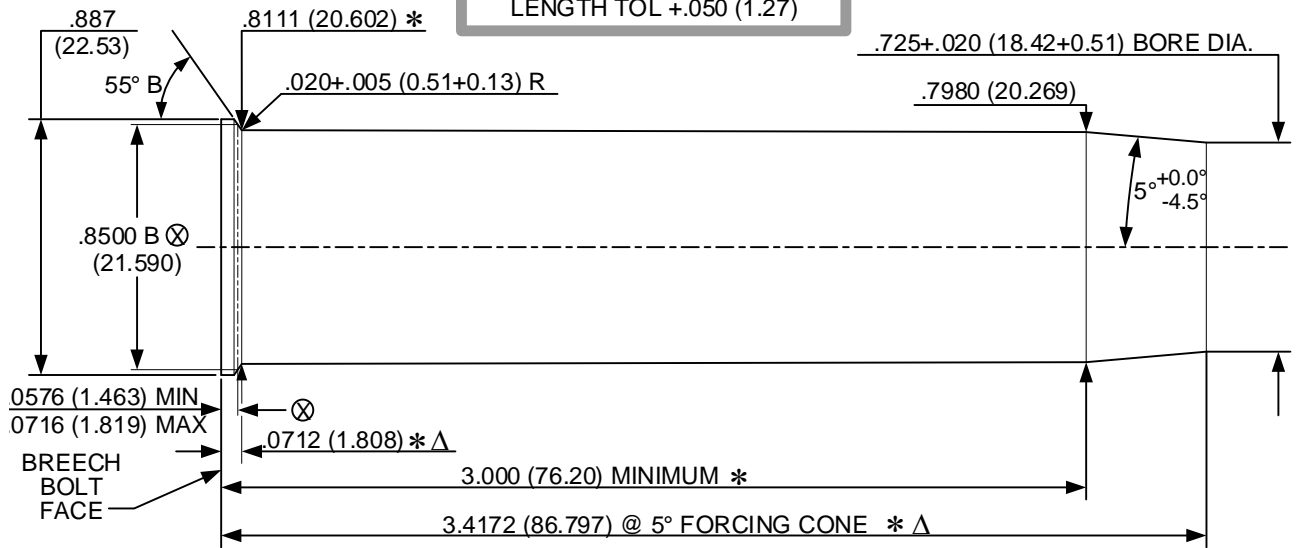
12 Gauge 3½" Smooth Bore Barrel

Issued: 08/01/1988

Revised: 12/24/2018

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.886-.021
(22.50-0.53)

.8090-.0090 ∗
(20.549-0.229)

.797-.020
(20.24-0.51)

55° B

.015 (0.38) R MAX.

CAP HEIGHT OPTIONAL

.8500 B
(21.590)

.0576-.0140
(1.463-0.356)

.072 (1.83) ∗ Δ

3.155 (80.14) FOLDED or ROLLED

3.510 (89.15) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.887
(22.53)

.8111 (20.602) ∗

.725+.020 (18.42+0.51) BORE DIA.

55° B

.020+.005 (0.51+0.13) R

.7980 (20.269) ∗

5°+0.0°
-4.5°

.8500 B ⊗
(21.590)

0576 (1.463) MIN
0716 (1.819) MAX

⊗

BREECH
BOLT
FACE

.0712 (1.808) ∗ Δ

3.500 (88.90) MINIMUM ∗

3.9172 (99.497) @ 5° FORCING CONE ∗ Δ

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
∗ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

16 Gauge 2¾" Smooth Bore Barrel

Issued: 05/29/1979

Revised: 12/24/2018

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.819-.019
(20.80-0.48)

.7440-.0090 *
(18.898-0.229)

.731-.020
(18.57-0.51)

55° B

.015 (0.38) R MAX.

CAP HEIGHT OPTIONAL

.7850 B
(19.939)

.0506-.0140
(1.285-0.356)

.065 (1.65) * Δ

2.440 (61.98) FOLDED

2.475 (62.87) ROLLED

2.760 - .100 (70.10 - 2.54) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.820
(20.83)

.7450 (18.923) *

.665+.020 (16.89+0.51) BORE DIA.

55° B

.020+.005 (0.51+0.13) R

.7320 (18.593)

.7850 B ⊗
(18.939)

$5°^{+0.0°}_{-4.5°}$

.0506 (1.285) MIN
.0646 (1.641) MAX

⊗

BREECH
BOLT
FACE

.0646 (1.641) * Δ

2.750 (69.85) MINIMUM *

3.1329 (79.576) @ 5° FORCING CONE * Δ

CHAMBER LENGTHS HAVE BEEN
INCREASED. FORMER CHAMBER
DIMENSIONS ARE ALSO
CONSIDERED SAFE PRACTICE.

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
* DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
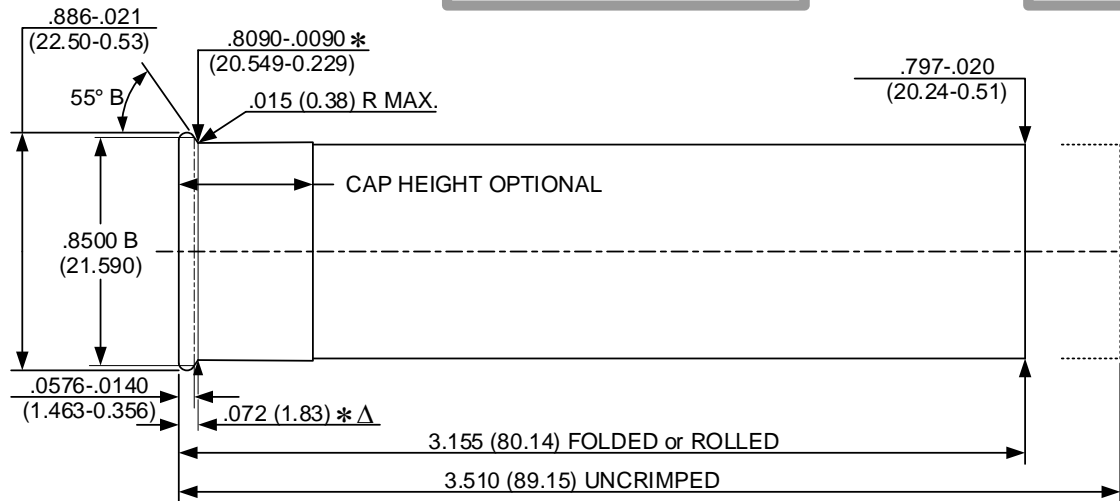ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

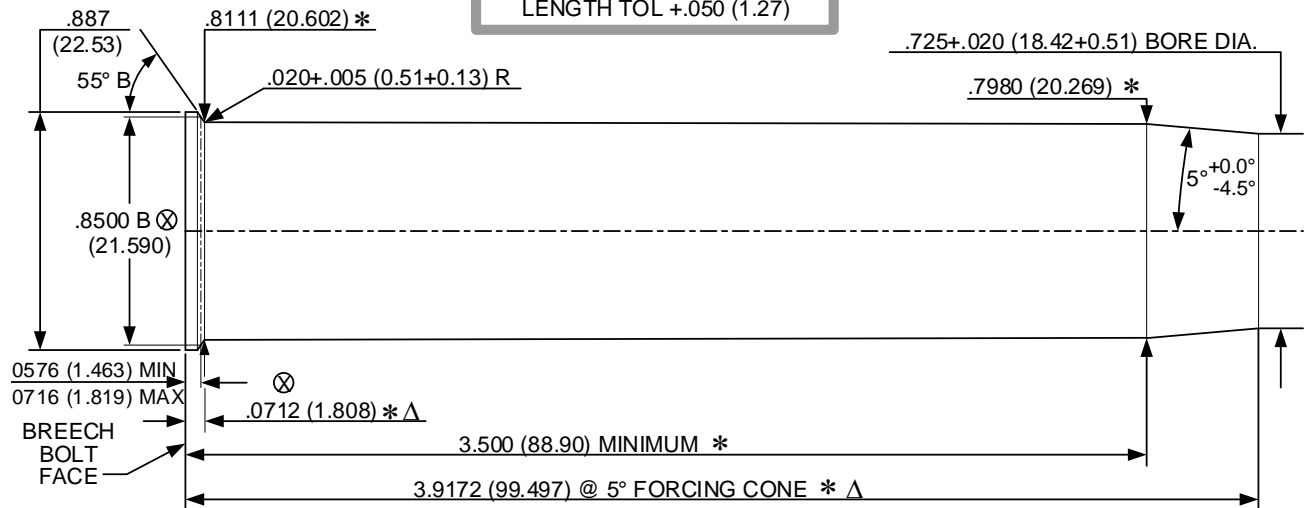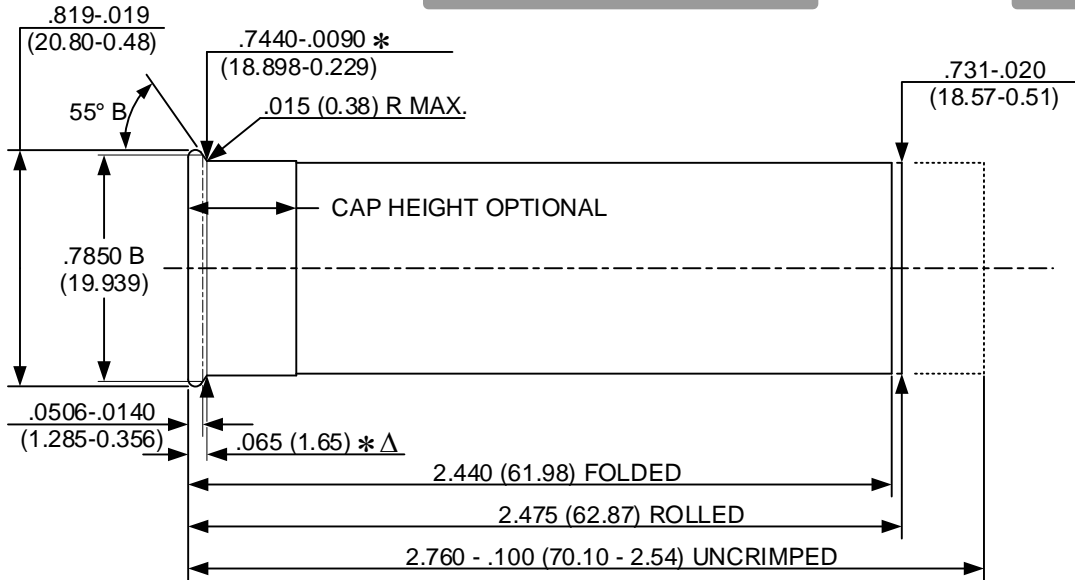## 20 Gauge 2¾" Smooth Bore Barrel
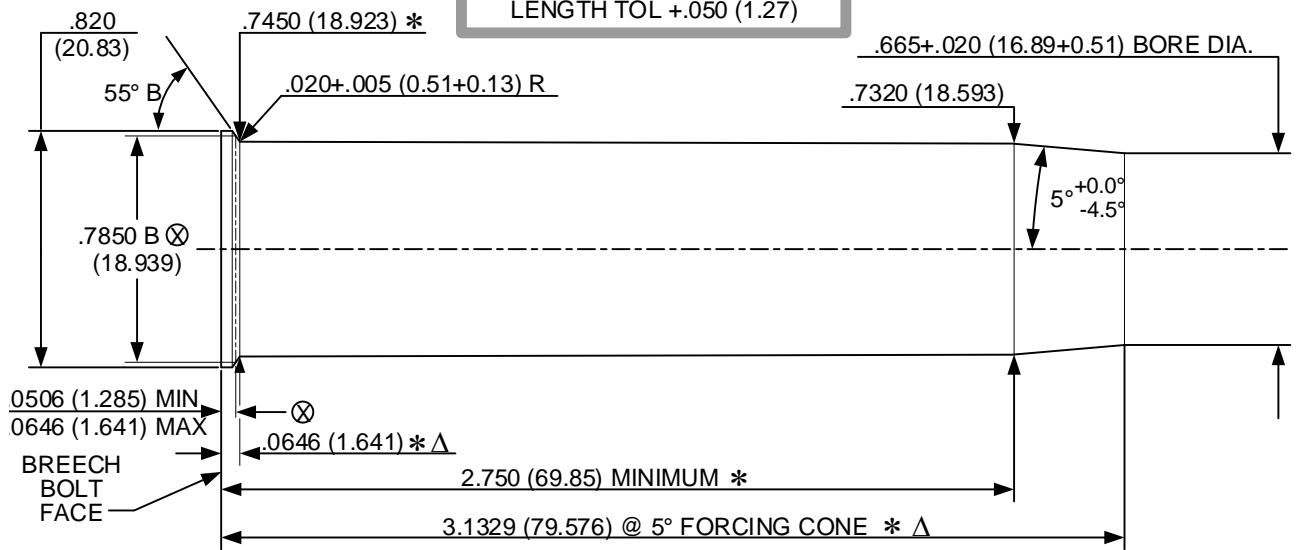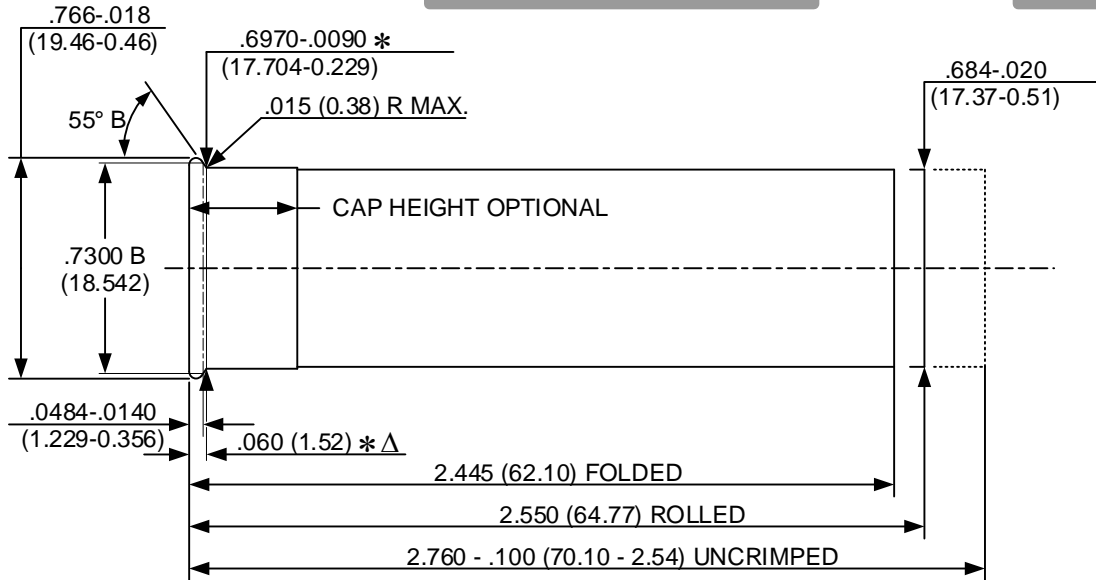
Issued: 05/29/1979

Revised: 12/24/2018

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.766-.018
(19.46-0.46)

.6970-.0090 ∗
(17.704-0.229)

.684-.020
(17.37-0.51)

55° B

.015 (0.38) R MAX.

CAP HEIGHT OPTIONAL

.7300 B
(18.542)

.0484-.0140
(1.229-0.356)

.060 (1.52) ∗ Δ

2.445 (62.10) FOLDED

2.550 (64.77) ROLLED

2.760 - .100 (70.10 - 2.54) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.767
(19.48)

.6980 (17.729) ∗

.615+.020 (15.62+0.51) BORE DIA.

55° B

.020+.005 (0.51+0.13) R

.6850 (17.399)

.7300 B ⊗
(18.542)

5° +0.0°
    -4.5°

.0484 (1.229) MIN
.0624 (1.585) MAX

⊗

BREECH
BOLT
FACE

.0596 (1.514) ∗ Δ

2.750 (69.85) MINIMUM ∗

3.1501 (80.013) @ 5° FORCING CONE ∗ Δ

CHAMBER LENGTHS HAVE BEEN
INCREASED. FORMER CHAMBER
DIMENSIONS ARE ALSO
CONSIDERED SAFE PRACTICE.

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
∗ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
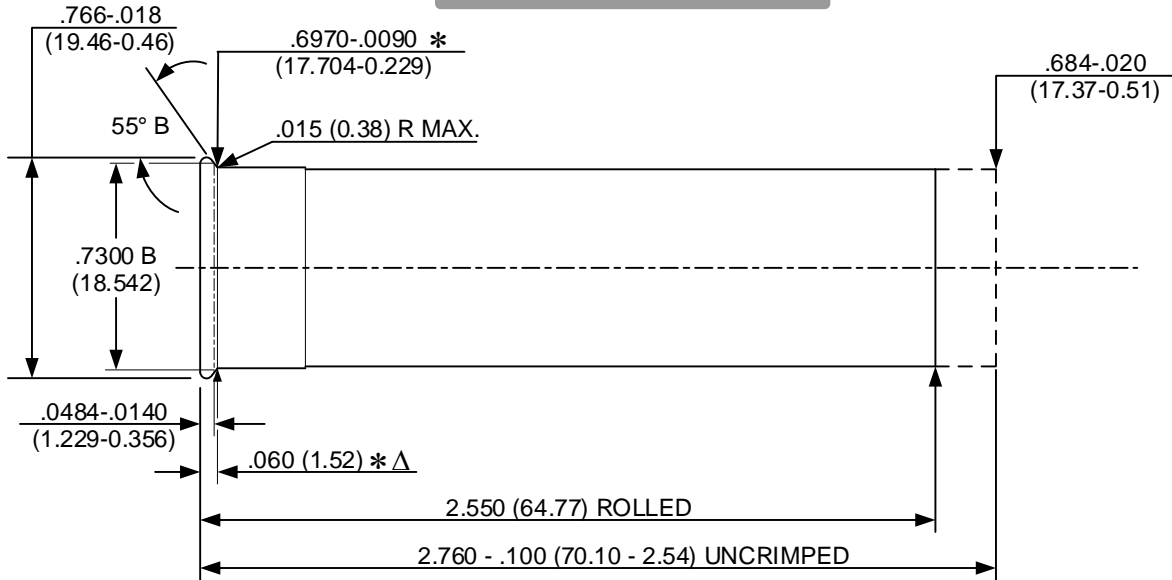ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

20 Gauge 2¾" Rifled Barrel

Issued: 01/08/1992

Revised: 01/26/2019

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.766-.018
(19.46-0.46)

.6970-.0090 ✳
(17.704-0.229)

.684-.020
(17.37-0.51)

55° B

.015 (0.38) R MAX.

.7300 B
(18.542)

.0484-.0140
(1.229-0.356)

.060 (1.52) ✳ Δ

2.550 (64.77) ROLLED

2.760 - .100 (70.10 - 2.54) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.767
(19.48)

.6980 (17.729) ✳

.609+.002 (15.47+.05) BORE DIA.
.618+.002 (15.70+.05) GROOVE DIA.

55° B

.020+.005 (0.51+0.13) R

.6850 (17.399)

5° B

.7300 B ⊗
(18.542)

.0484 (1.229) MIN
.0624 (1.585) MAX

⊗

.0596 (1.514) ✳ Δ

BREECH
BOLT
FACE

2.750 (69.85) MINIMUM ✳

3.1901 (81.029) ✳

Δ 8 GROOVES
Δ .119 ± .002 (3.02 ± 0.05)
TWIST 24 (609) ± .125 (3.18)
RH (OPTIONAL)
MIN BORE/GROOVE AREA:
.2955 IN² (190.645 MM²)

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
✳ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

20 Gauge 3" Smooth Bore Barrel

Issued: 05/29/1979

Revised: 12/24/2018

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.766-.018
(19.46-0.46)

.6970-.0090 ✱
(17.704-0.229)

.684-.020
(17.37-0.51)

55° B

.015 (0.38) R MAX.

CAP HEIGHT OPTIONAL

.7300 B
(18.542)

.0484-.0140
(1.229-0.356)

.060 (1.52) ✱ Δ

2.695 (68.45) FOLDED

2.800 (71.12) ROLLED

3.010 - .100 (76.45 - 2.54) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.767
(19.48)

.6992 (17.760) ✱

.615+.020 (15.62+0.51) BORE DIA.

55° B

.020+.005 (0.51+0.13) R

.6850 (17.399)

.7300 B ⊗
(18.542)

5° +0.0°
-4.5°

.0484 (1.229) MIN
.0624 (1.585) MAX

⊗

BREECH
BOLT
FACE

.0592 (1.504) ✱ Δ

3.000 (76.20) MINIMUM ✱

3.4001 (86.363) @ 5° FORCING CONE ✱ Δ

CHAMBER LENGTHS HAVE BEEN
INCREASED. FORMER CHAMBER
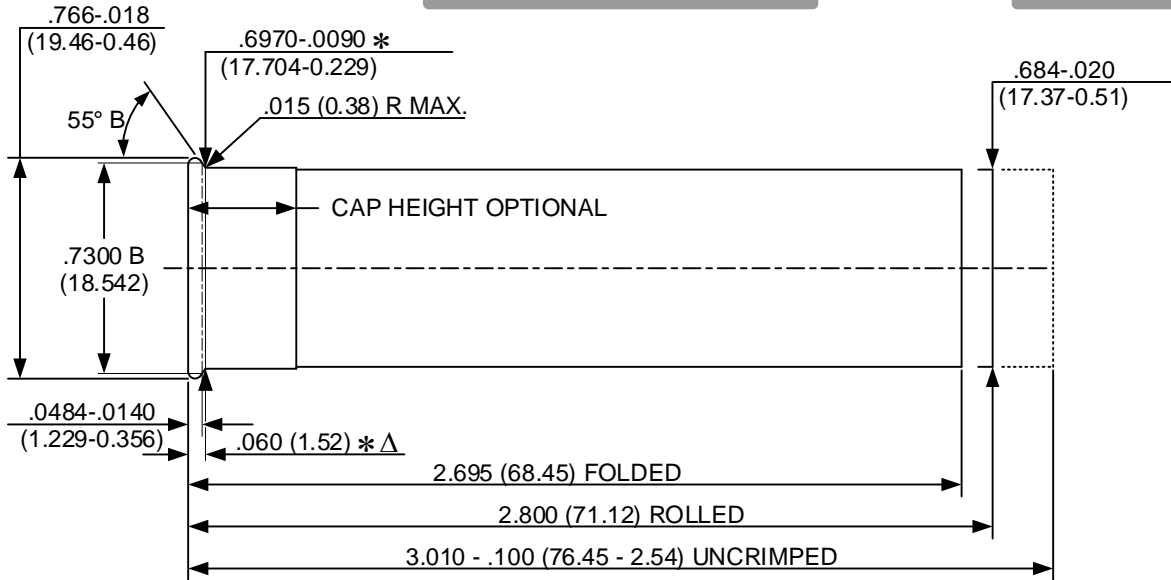DIMENSIONS ARE ALSO
CONSIDERED SAFE PRACTICE.

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
✱ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

20 Gauge 3" Rifled Barrel

Issued: 02/10/2004

Revised: 01/26/2019

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.766-.018
(19.46-0.46)

.6970-.0090 ✳
(17.704-0.229)

.684-.020
(17.37-0.51)

55° B

.015 (0.38) R MAX.

.7300 B
(18.542)

.0484-.0140
(1.229-0.356)

.060 (1.52) ✳ Δ

2.800 (71.12) ROLLED

3.010-.150 (76.45-3.81) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.767
(19.48)

.6992 (17.760) ✳

.609+.002 (15.47+.05) BORE DIA.
.618+.002 (15.70+.05) GROOVE DIA.

55° B

.020+.005 (0.51+0.13) R

.6850 (17.399)

.7300 B ⊗
(18.542)

5° B

.0484 (1.229) MIN
.0624 (1.585) MAX

⊗

BREECH
BOLT
FACE

.0592 (1.504) ✳ Δ

3.000 (76.20) MINIMUM ✳

3.4343 (87.231) ✳

Δ 8 GROOVES
Δ .119 ± .002 (3.02 ± 0.05)
TWIST 24 (889) ± .125 (3.18)
RH (OPTIONAL)
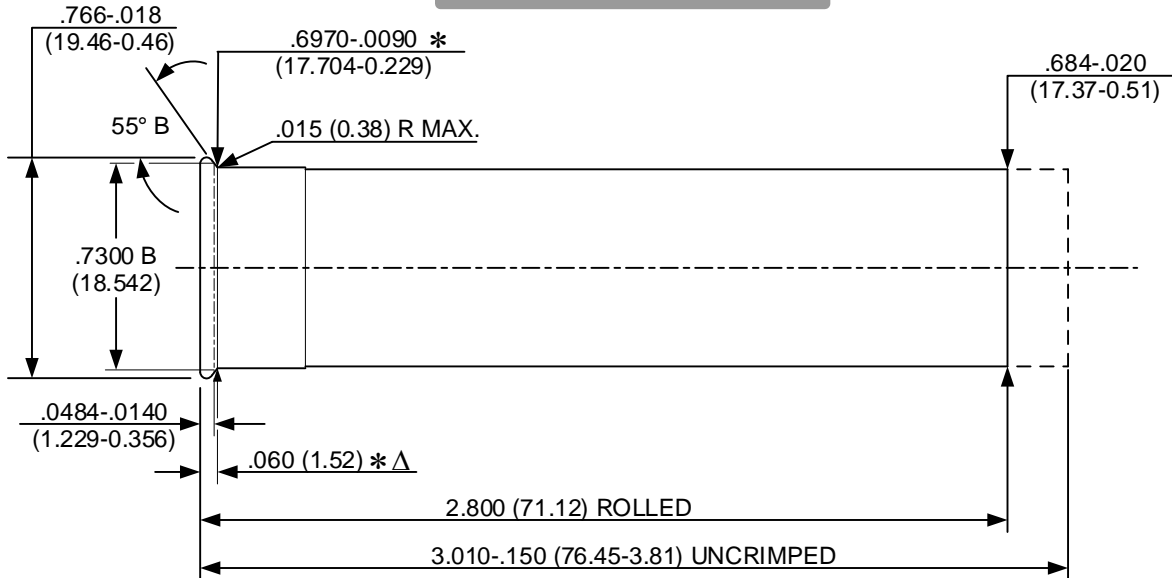MIN BORE/GROOVE AREA:
.2955 IN² (190.645 MM²)

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
✳ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

28 Gauge 2¾" Smooth Bore Barrel

Issued: 05/29/1979   Revised: 12/24/2018

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.687-.017
(17.45-0.43)

.6260-.0090 ∗
(15.900-0.229)

.613-.020
(15.57-0.51)

55° B

.015 (0.38) R MAX.

CAP HEIGHT OPTIONAL

.6550 B
(16.637)

.0508-.0140
(1.290-0.356)

.061 (1.55) ∗ △

2.500 (63.50) FOLDED

2.560 (65.02) ROLLED

2.760 - .100 (70.10 - 2.54) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.688
(17.48)

.6270 (15.926) ∗

.545+.020 (13.84+0.51) BORE DIA.

55° B

.020+.005 (0.51+0.13) R

.6140 (15.596)

.6550 B ⊗
(16.637)

5° +0.0°
  -4.5°

.0498 (1.265) MIN
.0638 (1.621) MAX

⊗

BREECH
BOLT
FACE

.0596 (1.514) ∗ △

2.750 (69.85) MINIMUM ∗

3.1443 (79.865) @ 5° FORCING CONE ∗ △

CHAMBER LENGTHS HAVE BEEN
INCREASED. FORMER CHAMBER
DIMENSIONS ARE ALSO
CONSIDERED SAFE PRACTICE.

NOTE:
B = BASIC   △ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
∗ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
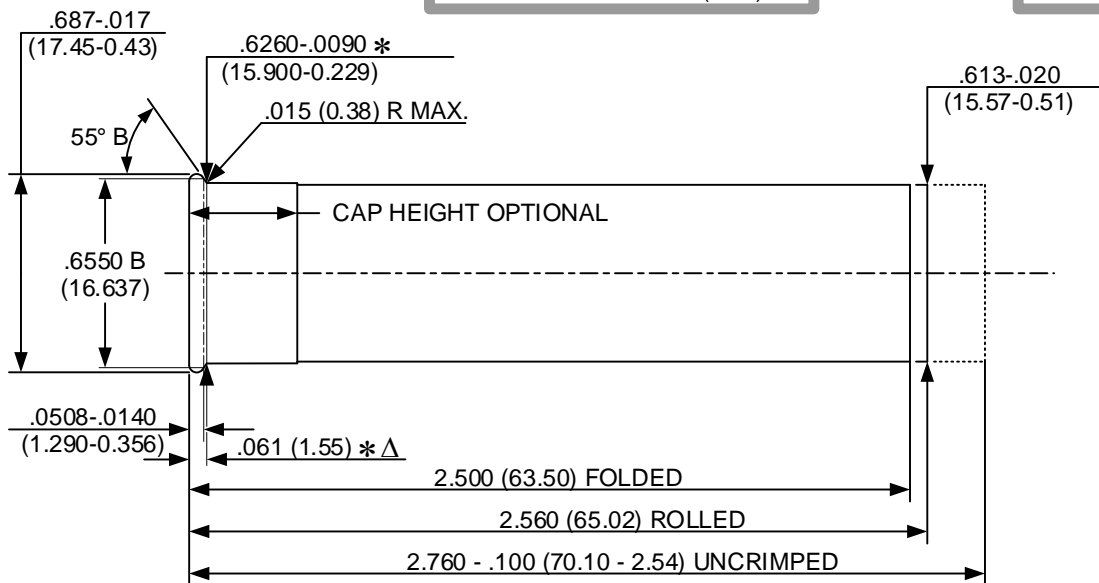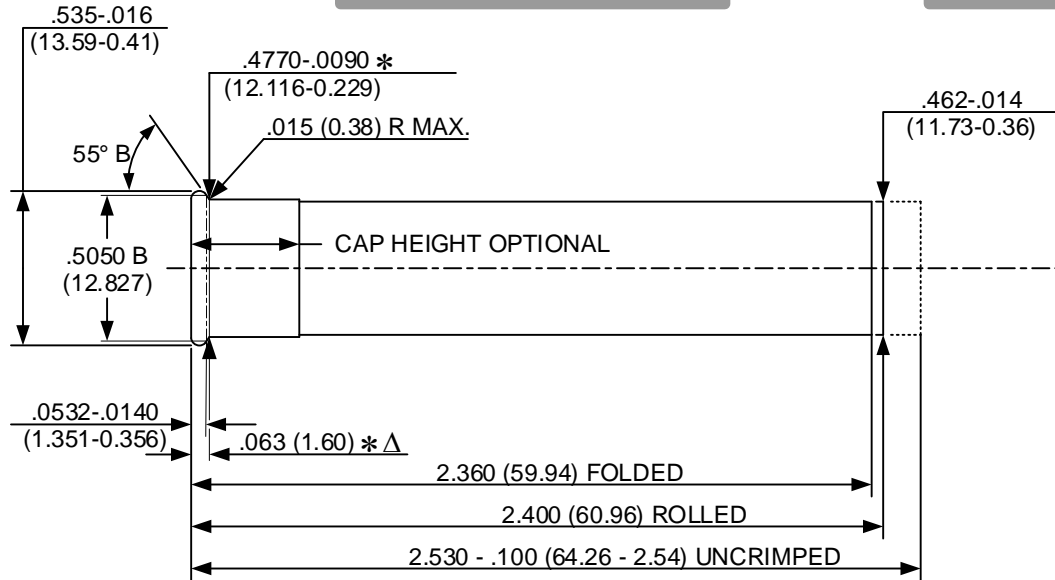ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

410 Bore 2½" Smooth Bore Barrel

Issued: 05/29/1979

Revised: 12/24/2018

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.535-.016
(13.59-0.41)

.4770-.0090 ✳
(12.116-0.229)

.015 (0.38) R MAX.

.462-.014
(11.73-0.36)

55° B

.5050 B
(12.827)

CAP HEIGHT OPTIONAL

.0532-.0140
(1.351-0.356)

.063 (1.60) ✳ Δ

2.360 (59.94) FOLDED

2.400 (60.96) ROLLED

2.530 - .100 (64.26 - 2.54) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.536
(13.61)

.4780 (12.141) ✳

.410+.020 (10.41+0.51) BORE DIA.

.020+.005 (0.51+0.13) R

.4630 (11.760)

5° +0.0°
  -4.5°

55° B

.5050 B ⊗
(12.827)

.0532 (1.351) MIN
.0672 (1.707) MAX

⊗

.0627 (1.593) ✳ Δ

BREECH
BOLT
FACE

2.500 (63.50) MINIMUM ✳

2.8029 (71.194) @ 5° FORCING CONE ✳ Δ

CHAMBER LENGTHS HAVE BEEN
INCREASED. FORMER CHAMBER
DIMENSIONS ARE ALSO
CONSIDERED SAFE PRACTICE.

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
✳ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
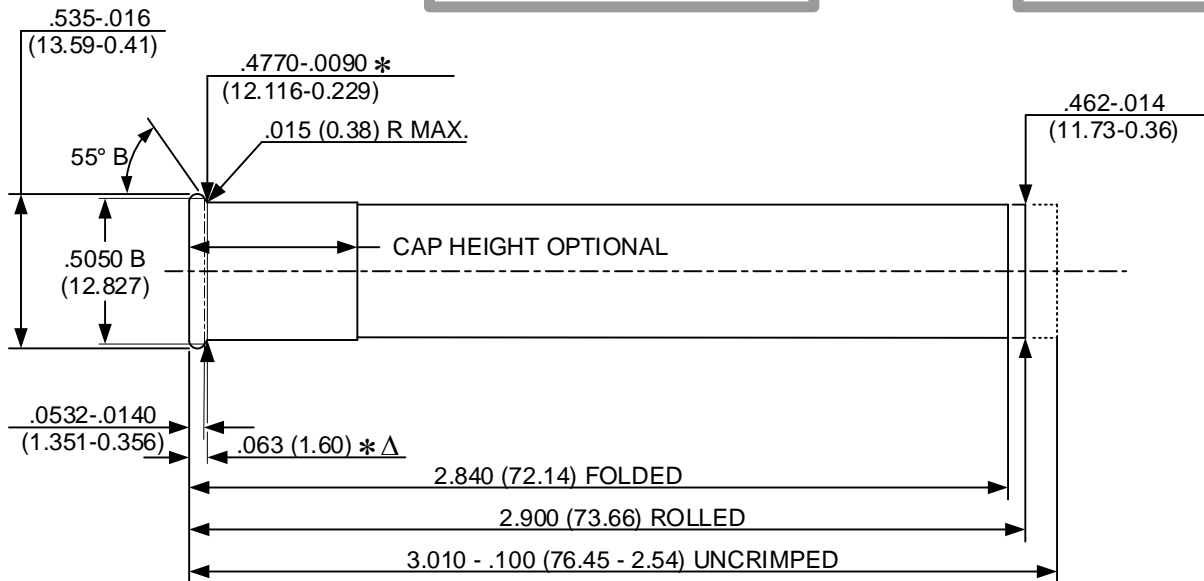ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

410 Bore 3" Smooth Bore Barrel

Issued: 05/29/1979

Revised: 12/24/2018

CARTRIDGE
UNLESS OTHERWISE NOTED
LENGTH TOL -.250 (6.35)

DO NOT SCALE
FROM DRAWING

.535-.016
(13.59-0.41)

.4770-.0090 ∗
(12.116-0.229)

.015 (0.38) R MAX.

.462-.014
(11.73-0.36)

55° B

.5050 B
(12.827)

CAP HEIGHT OPTIONAL

.0532-.0140
(1.351-0.356)

.063 (1.60) ∗ Δ

2.840 (72.14) FOLDED

2.900 (73.66) ROLLED

3.010 - .100 (76.45 - 2.54) UNCRIMPED

CHAMBER
UNLESS OTHERWISE NOTED
ALL DIA. +.005 (0.13)
LENGTH TOL +.050 (1.27)

.536
(13.61)

.4811 (12.220) ∗

.410+.020 (10.41+0.51) BORE DIA.

.020+.005 (0.51+0.13) R

.4630 (11.760)

5° +0.0°
-4.5°

55° B

.5050 B ⊗
(12.827)

.0532 (1.351) MIN
.0672 (1.707) MAX

⊗

.0616 (1.565) ∗ Δ

BREECH
BOLT
FACE

3.000 (76.20) MINIMUM ∗

3.3029 (83.894) @ 5° FORCING CONE ∗ Δ

CHAMBER LENGTHS HAVE BEEN
INCREASED. FORMER CHAMBER
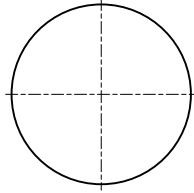DIMENSIONS ARE ALSO
CONSIDERED SAFE PRACTICE.

NOTE:
B = BASIC   Δ = REFERENCE DIMENSION   ⊗ = HEADSPACE DIMENSION
∗ DIMENSIONS ARE TO INTERSECTIONS OF LINES   (XX.XX) = MILLIMETERS
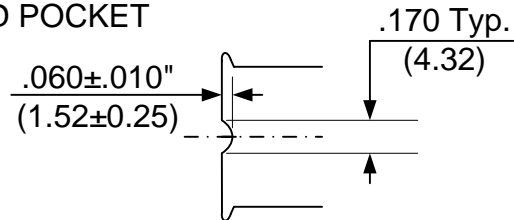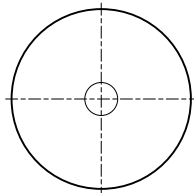ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

DUMMY CARTRIDGE -
GUN FUNCTIONING

OPTIONAL HEAD: NO PRIMER POCKET

OPTIONAL HEAD: INDENTED POCKET

.060±.010"
(1.52±0.25)

.170 Typ.
(4.32)

TYPICAL HEAD: DUMMY PRIMER
HEAD: HIGH OR LOW BASE CUP, OXIDIZED BLACK

DUMMY

UNCOLORED TUBE

CRIMP TYPE OPTIONAL

HEAD STAMP
OPTIONAL
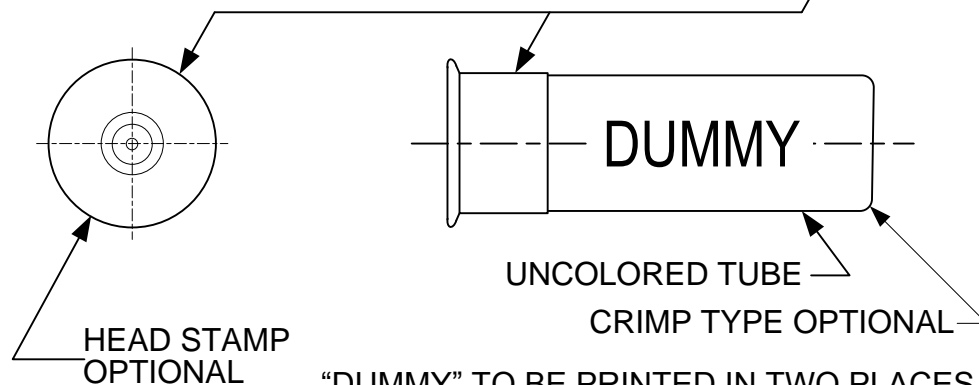
"DUMMY" TO BE PRINTED IN TWO PLACES,
LENGTHWISE, 180° APART, LETTERS
.38 (9.7) HIGH APPROXIMATELY

NOTES
1. ILLUSTRATES FORM ONLY -
    PERTINENT DIMENSIONS SHOWN ON
    APPROPRIATE SHOTSHELL CARTRIDGE DRAWING
2. (XX.XX) = MILLIMETERS

DUMMY CARTRIDGE - DISPLAY
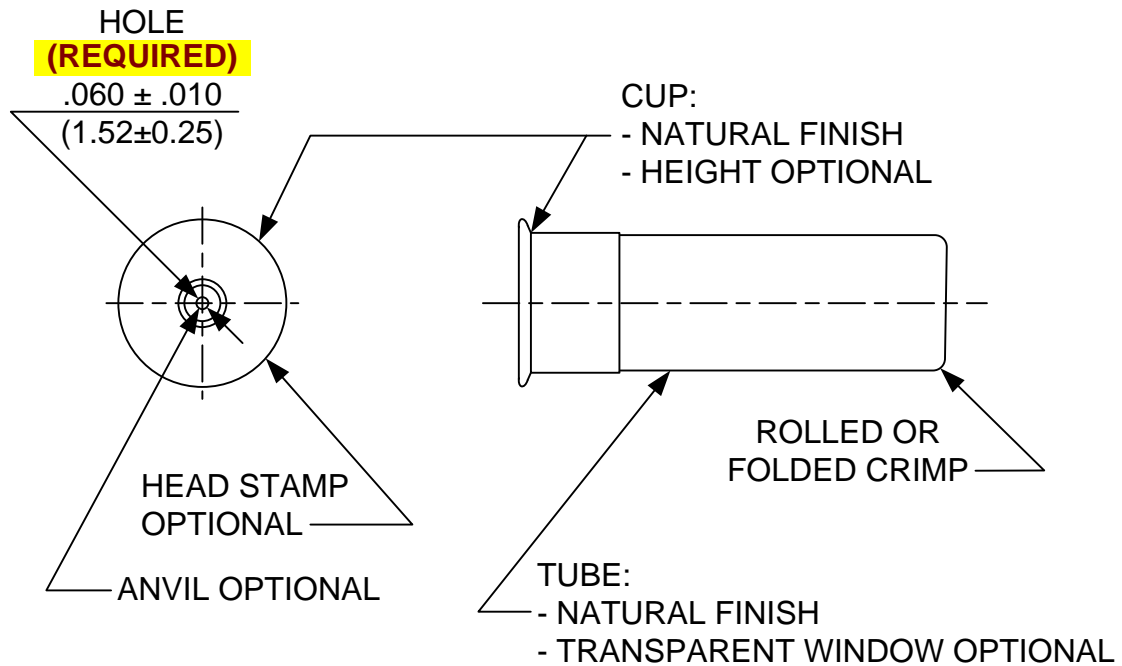
HOLE
(REQUIRED)
.060 ± .010
(1.52±0.25)

CUP:
- NATURAL FINISH
- HEIGHT OPTIONAL

HEAD STAMP
OPTIONAL

ANVIL OPTIONAL

ROLLED OR
FOLDED CRIMP

TUBE:
- NATURAL FINISH
- TRANSPARENT WINDOW OPTIONAL

NOTES
1. ILLUSTRATES FORM ONLY -
    PERTINENT DIMENSIONS SHOWN ON APPROPRIATE SHOTSHELL
    CARTRIDGE DRAWING
2. (XX.XX) = MILLIMETERS

MISCELLANEOUS:
RIFLED SLUGS - LOADED

BASE FILLER - OPTIONAL

HOLLOW POINT - OPTIONAL
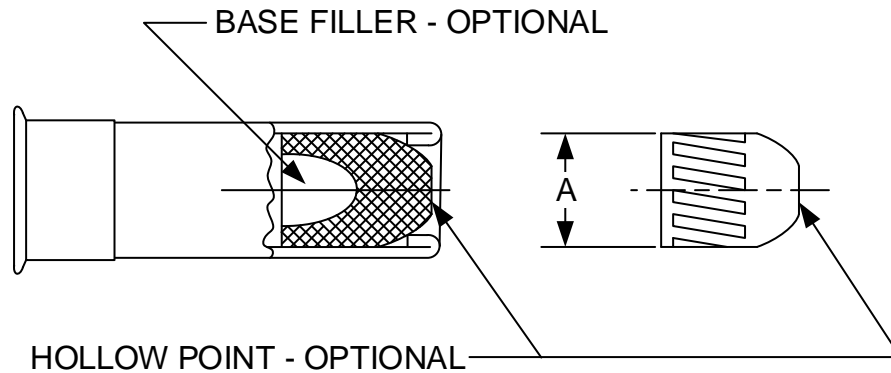
GAUGE/BORE	Max Dia. "A"
10 Gauge	.765 (19.43)
12 Gauge	.735 (18.67)
16 Gauge	.651 (16.54)
20 Gauge	.606 (15.39
28 Gauge	.535 (13.59)
410 Bore	.403 (10.24)

NOTES:

1. These diameters apply only to hollow base, rifled, soft lead slugs.

2. These diameters apply to all shell lengths within each gage/bore.

3. Illustrates form only – Pertinent dimensions shown on appropriate shotshell cartridge drawing.

4. (XX.XX) = millimeters

MISCELLANEOUS:
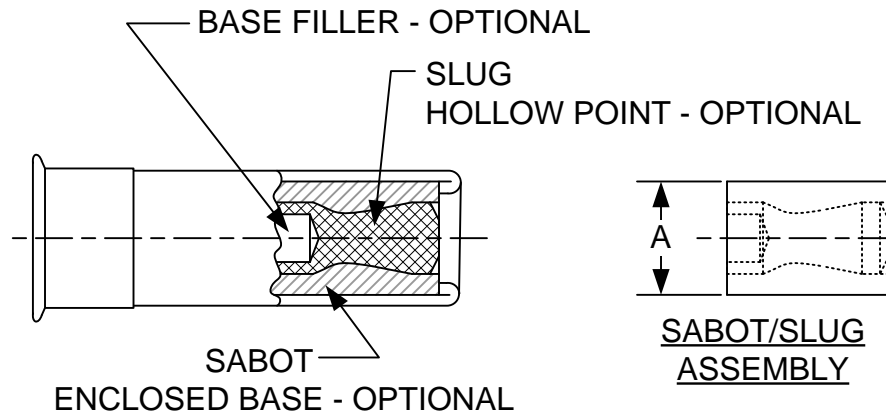## SABOTED SLUGS - LOADED

BASE FILLER - OPTIONAL

SLUG
HOLLOW POINT - OPTIONAL

A

SABOT/SLUG
ASSEMBLY

SABOT
ENCLOSED BASE - OPTIONAL

GAUGE	MAX. DIA. "A"
12 ga.	.745 (18.92)
20 ga.	.640 (16.26)

NOTES:

1. These assembly diameters apply only to plastic-saboted solid lead, solid copper or jacketed lead slugs/bullets and attached wad solid lead slugs.

2. Illustrates form only – Pertinent dimensions are shown on the appropriate cartridge drawing.

3. (XX.XX) = Millimeters.

MISCELLANEOUS:
SHOT SIZE / PELLET COUNT / TOLERANCES

LEAD SHOT - CALCULATED PELLET COUNT PER OUNCE
AMERICAN STANDARD SIZES

Shot Name		Nominal Dia. in	(mm)	PELLETS PER OUNCE* Nominal Antimony Content (weight percent)			
				0.5%	2%	4%	6%
Dust	•	0.040	(1.02)	4610	4637	4719	4799
12	•	0.050	(1.27)	2360	2374	2416	2457
11	•	0.060	(1.52)	1366	1374	1398	1422
10	●	0.070	(1.78)	860	865	880	895
9	●	0.080	(2.03)	576	579	589	599
8½	●	0.085	(2.16)	480	483	491	500
8	●	0.090	(2.29)	404	407	414	421
7½	●	0.095	(2.41)	344	346	352	358
7	●	0.100	(2.54)	295	296	302	307
6	●	0.110	(2.79)	221	222	226	230
5	●	0.120	(3.05)	170	171	174	177
4	●	0.130	(3.30)	134	135	137	139
3	●	0.140	(3.56)	107	108	110	111
2	●	0.150	(3.81)	87	87	89	91
1	●	0.160	(4.06)	72	72	73	74
B	●	0.170	(4.32)	60	60	61	62
Air Rifle	●	0.172	(4.37)	58	58	59	60
BB	●	0.180	(4.57)	50	50	51	52
BBB	●	0.190	(4.83)	43	43	44	44
T	●	0.200	(5.08)	36	37	37	38
TT	●	0.210	(5.33)	31	32	32	33
F	●	0.220	(5.59)	27	27	28	28
FF	●	0.230	(5.84)	24	24	24	25

*Actual pellet counts per ounce in a shotshell will vary from the calculated values tabulated above due to variation in antimony content of the shot in the shell and tolerances in shot diameters.

MISCELLANEOUS:
SHOT SIZE / PELLET COUNT / TOLERANCES (Cont'd)

LEAD BUCKSHOT - CALCULATED PELLET COUNT PER POUND

				APPROX. PELLETS PER POUND*	
Shot	Nominal Dia.			Nominal Antimony Content (weight percent)	
Name	in	(mm)		0.5% ("Soft")	("Hard")
No. 4 Buck	0.240	(6.10)	●	338	
No. 3 Buck	0.250	(6.35)	●	299	
No. 2 Buck	0.270	(6.86)	●	238	
No. 1 Buck	0.300	(7.62)	●	173	
No. 0 Buck	0.320	(8.13)	●	143	
No. 00 Buck	0.330	(8.38)	●	130	
No. 000 Buck	0.360	(9.14)	●	100	

*Actual pellet counts per pounds in a shotshell will vary from the calculated values tabulated above due to variation in antimony content of the shot in the shell and tolerances in shot diameters.

One pound = 0.45 kilogram

MISCELLANEOUS:
SHOT SIZE / PELLET COUNT / TOLERANCES (Cont'd)

TOLERANCES – SHOT SIZE AND WEIGHT PER SHELL

I. **Shot Weight per Shell**

    a. Game Loads   +4%   -7%

    b. Target Loads   +3%   -5%

II. **Pellet Count per Ounce**

    a. Nominal   ±10%

III. **Buck Shot Pellet Count per Shell**

    a. 0 and 00   Nominal -1 pellet

    b. 1 and smaller   Nominal -2 pellets

IV. **Diameter**

    a. Game Shot   Nominal ±0.010" (0.25 mm)

    b. Target Shot   Nominal ±0.005" (0.13 mm)

    c. Buck Shot   Nominal ±0.015" (0.38 mm)

MISCELLANEOUS:
SHOT SIZE / PELLET COUNT / TOLERANCES

STEEL SHOT - CALCULATED PELLET COUNT PER OUNCE
AMERICAN STANDARD SIZES

Shot Name		Nominal Dia. in	(mm)	PELLETS PER OUNCE*
Dust	•	0.040	(1.02)	6599
12	•	0.050	(1.27)	3363
11	•	0.060	(1.52)	1946
10	●	0.070	(1.78)	1226
9	●	0.080	(2.03)	821
8½	●	0.085	(2.16)	685
8	●	0.090	(2.29)	577
7½	●	0.095	(2.41)	490
7	●	0.100	(2.54)	420
6	●	0.110	(2.79)	316
5	●	0.120	(3.05)	243
4	●	0.130	(3.30)	191
3	●	0.140	(3.56)	153
2	●	0.150	(3.81)	125
1	●	0.160	(4.06)	103
B	●	0.170	(4.32)	86
Air Rifle	●	0.172	(4.37)	83
BB	●	0.180	(4.57)	72
BBB	●	0.190	(4.83)	61
T	●	0.200	(5.08)	53
TT	●	0.210	(5.33)	45
F	●	0.220	(5.59)	39
FF	●	0.230	(5.84)	35

*Actual pellet counts per ounce in a shotshell will vary from the calculated values tabulated above due to variation in density from that assumed for this table (0.284 lb/in^3) and tolerances in shot diameters.

MISCELLANEOUS:
DEFINITION OF SHOT HARDNESS

Shot hardness affects several characteristics of compatibility of ammunition with firearms. However, the hardness of the shot is not independently attributable to those effects and the overall performance can be substantially influenced by other design and manufacturing criteria. As such, SAAMI makes no specific recommendations on limiting values of shot hardness.

Principal in the interaction of non-lead shot and firearms is the protection of the internal surfaces of the barrel from shot materials which may be harder than barrel steel and the strain induced in the choke or firearms so equipped. Aside from the shot material characteristics, the wad design, wad material and payload velocity are significant contributors to potentially undesirable conditions.

It is the responsibility of the manufacturer of ammunition products to perform sufficient testing, whether using instrumented methods as detailed below, or with firearms known to be in common use, to assess the potential for new/changed ammunition products to be incompatible with a range of firearms.

In order to provide an aid to manufacturers in assessing the level of strain induced in choked barrels/choke tubes, one round has been identified within what were the current product offerings of member companies at the time it was established that induces the highest level of strain as measured by the test equipment detailed in Section II, pages 77*ff*. This round is known to have been in use without reports of negative effects on the broad spectrum encountered in the open market. This round is available for use as a relative reference for the measurement of choke strain for new or changed products. Testing has shown the comparative values of strain when tested in accordance with the guidance provided in Section II, pages 77*ff* provides an accurate relative value for choke strain. However, the absolute numbers can vary significantly between test stations and equipment arrangements such that no judgments of the suitability of any ammunition type or product with any specific firearm can be made from those values alone.

The previous method of assessing shot hardness as described in Section II, using the equipment listed in Section III, remains valid for reference testing in comparison to historical values, as needed.

For reference only, the prior guidelines were as follows:

LEAD SHOT

Lead shot pellet hardness is established by the amount of antimony alloyed with the lead in the pellets and is varied by the manufacturer depending on the purpose for which the shotshell is designed.

Hardness increases as the antimonial content increases.

Shot containing up to 0.5% antimony is generally called "soft shot". Shot containing more than 0.5% antimony is known as "hard shot".

In view of the above, pellet counts per shell increase with antimony content since shot charges are designated by weight and the addition of antimony decreases the individual pellet weight.

STEEL SHOT

Steel shot pellets are fabricated from low carbon steel wire and are in-process annealed so that the shot has an average maximum hardness of R15T 69 on the Rockwell Superficial Hardness Scale. No individual reading may exceed R15T 79. Hardness is to be measured using the procedure in Section II, Procedures and with the Steel Shot Countersunk Anvil described in Section III, Equipment.

MISCELLANEOUS:
BODY TUBE COLOR

The color yellow has been reserved for 20-gauge ammunition. This ammunition shall have a body tube that is primarily yellow. Yellow shall not be used for any other gauge/bore shotshell body.

No other recommendations are made as to the color of service body tubes for other gauges/bores.

VELOCITY & PRESSURE BARRELS: QUALIFICATION

All barrels are not necessarily suitable for use in determining pressure or velocity levels, even though they may conform to the dimensions given on the appropriate Standard Velocity and Pressure Barrel drawing in this Manual. New barrels may require a number of rounds to be fired to remove sharp corners or burrs resulting from the manufacturing process. Barrels in service do not have an unlimited life and may become unserviceable from wear and erosion. There is no predictable number of rounds to which a barrel should be exposed before use for pressure and velocity determinations, nor is there a predictable round life for such equipment.

The following procedure is suggested for determining the suitability of any barrel for pressure and velocity test use:

> Fire ten rounds of SAAMI Reference Ammunition following the procedures as shown in this Manual. The average velocity and pressure results of the test should be within the Inclusion Limits as given on the latest assessment of the lot fired.

In the case of a new barrel, the firing of more breaking-in shots may be indicated after which the Reference Ammunition test should be repeated.

In the case of barrels which have been in service, removal of fouling, or other corrective procedures may be implemented followed by a retest.

VELOCITY & PRESSURE BARRELS:
MOUNTING IN RECEIVERS

It is essential that close headspace be maintained in velocity-pressure testing equipment if reliable test results are to be achieved.

In mounting test barrels to Universal Receivers or test actions, a headspace not exceeding 0.005" (0.13 mm) over minimum should be maintained. This may be measured by headspace gages, shim stock or feeler gages, or a combination thereof whichever is most appropriate for the type of equipment being used.

Headspace adjustments with the Universal Receiver may be accomplished by several methods:

1. Formed shim stock behind the Firing-Pin Plate.

2. Formed shim stock on the rear bearing shoulder of the Barrel Collar.

3. Adjustment of the Breech Block Locking Screws.

<div align="center">

PROCEDURE:
VELOCITY & PIEZOELECTRIC TRANSDUCER PRESSURE TESTING

</div>

I. SCOPE

A. This procedure covers the testing of ammunition for assessment of velocity and pressure using piezoelectric pressure transducers ("transducers").

II. GENERAL

A. When testing using transducers, velocities and pressures are measured simultaneously.

B. Recommended values for velocity and pressure of all industrial shotshell loads are tabulated in Section I. When required, a retest of double the original quantity may be fired with statistically equivalent tolerances.

C. Velocities and pressures should be measured using horizontally-mounted test barrels in accordance with the drawings and descriptions listed in Section III.

III. TEST EQUIPMENT

A. TRANSDUCER CALIBRATION

ITEM	TYPE	ALTERNATE
1. Digital Voltmeter	Fluke, Model 45	or equivalent
2. Charge Amplifier	PCB, Model 443B02	or equivalent
3. Transducer Calibrator (Direct fluidic calibrator)	PCB Group; The Modal Shop, Inc.; Model K9905D	or equivalent
4. Insulation Tester	Kistler, Model 5491	or equivalent
5. Transducer	PCB, Model 118A07	or equivalent
6. Low Noise Cable	PCB, Model 003C*XX*	or equivalent
7. Calibration Adapter	PCB, Model 61M109	or equivalent

B. FIRING TEST

ITEM	TYPE	ALTERNATE
1. Charge Amplifier	PCB, Model 443B02	or equivalent
2. Voltmeter, Peak Capture	PCB, Model 444A152	or equivalent
3. Transducer	PCB, Model 118A07	or equivalent
4. Low Noise Cable	PCB, Model 003C*XX*	or equivalent
5. Integrated Data Acquisition System	Oehler Research, Inc. System 84/85[1]	or equivalent
6. Velocity measurement		
6.1 Inductance sensors	Oehler Model 71	or equivalent
6.2 Photoelectric screens	Oehler Model 55 or 57	or equivalent

---

[1] For materials that cannot be detected by inductance sensors or for saboted slug loads, an Oehler Model 85 Data Collection System and photoelectric screens may be used.

IV. HANDLING OF AMMUNITION

A. When the appropriate test barrel has been properly serviced and the chronograph reset, a cartridge should be seated in the chamber as far as practicable with the fingers. The bolt or breech mechanism should be closed gently.

B. The rate of fire should not be rapid enough to cause excessive heating of the barrel. The time between rounds depends on the equipment, as the barrel may be cooled by a constant stream of air on the outside or by directing air through the bore after each ten rounds.

C. Ammunition conditioning should be between 60° - 80°F (15.6° - 26.7°C).

D. A minimum of one and up to three warming shots should be fired before firing each series for record. The velocity and/or pressure of these shots may be recorded, but should not be included in the record of the sample.

V. EQUIPMENT PREPARATION

A. All instruments should be operational and calibrated per manufacturer specification.

B. The transducer calibrator and instruments used to calibrate the charge amplifier, peak detector and digital voltmeter should have a certified calibration traceable to the National Institute of Standards and Technology.

C. Transducers should be properly maintained per manufacturer recommendations or stored in a desiccator when not in use.

   CAUTION: When not in use, the cable, transducers, and instrument connectors should be stored with plastic caps in place to prevent contamination.

D. Measure the internal resistance of the transducer and low noise cable. If the resistance is less than 10^{12} ohms, bake-out transducer and low noise cable as described in Section VI, *Transducer Initialization*. If the resistance is in the 10^{12} to 10^{14} ohm range, proceed to Section VII, *Transducer Calibration*.

VI. TRANSDUCER INITIALIZATION

A. Clean transducer and low noise cable connectors using an acceptable solvent per the manufacturer's recommendations.

B. Bake-out transducer and low noise cable in a temperature-controlled oven for 24 to 48 hours at 250°F (121°C).

C. Allow oven to return to ambient temperature at a slow rate.

D. After removing the transducer and cable from the oven, check the internal resistance of the transducer. The resistance should be in the 10^{12} to 10^{14} ohm range.

E. Place protective caps on transducer and cable connectors to prevent contamination.

VII. TRANSDUCER CALIBRATION

A. INITIAL SET-UP

1. Turn on the electronic equipment and allow it to stabilize as recommended by the manufacturer.

2. Inspect the transducer mounting cavity to assure that the seal seat is free of dirt and any other foreign matter.

3. Mount transducer with a fresh seal, PCB Model 065A06 into calibration fixture as described in PCB Operating Instructions Manual.

4. Thread the transducer into the mounting port. When transducer bottoms, torque the transducer as recommended by the manufacturer.

5. Mount calibration fixture with transducer on the transducer calibrator.

6. Connect transducer and instrumentation as indicated on page 52.

7. Set the charge amplifier sensitivity to 0.999 and set the time constant switch to LONG.

8. Set DVM to 10-volt range.

B. CALIBRATION

1. Adjust the pressure readout indicator of the transducer calibrator to 0 psi with no pressure on hydraulic lines.

2. Reset charge amplifier and digital voltmeter (DVM) to obtain zero volts output.

3. Apply pressure in increments of 5,000 psi beginning at 5,000 psi and going to 30,000 psi. DO NOT exceed the maximum pressure established by the manufacturer for the fixture.

4. Record DVM reading after the pressure readout indicator is exactly at desired pressure level. Do not release the pressure until the 30,000 psi pressure level has been reached. Read the pressure at each increment. Do not overshoot the pressure points!

5. After reaching 30,000 psi, release the pressure slowly.

6. Repeat steps 1 through 5 until a minimum of three (3) times.

   CAUTION: Always increase pressure to desired level; never decrease pressure to desired level.

C. DATA REDUCTION

1. Calculate the average value for the output voltages recorded at each pressure increment. Multiply these average values by the charge amplifier sensitivity (pC/V) to obtain the transducer charge output (Q) at these pressure increments (P).

2. Obtain a least square line equation using the transducer charge output (Q) as the dependent variable and pressure (P) as the independent variable. $Q = mP \pm q$.

3. A manual method of calculating the least square line equation is given in tabular form on page 53. It is recommended that when using this technique, all numbers be carried to the third decimal place.

D. TRANSDUCER RECORDS

1. Date of calibration

2. The number of rounds to which the transducer has been exposed during test firing.

3. Calibration pressure (P), charge amplifier voltage output (V), and transducer charge output (Q).

4. Charge amplifier sensitivity.

5. Least square line equation.

6. Transducer identification.

7. Date of next calibration.

VIII. <u>FIRING TEST</u>

A. PRESSURE BARREL PREPARATION

1. Refer to the SAAMI recommended piezo pressure transducer installation in a pressure barrel illustrated in Section III.

B. INITIAL SET-UP

1. Turn on the electronic equipment and allow to stabilize as recommended by the manufacturer.

2. Inspect the transducer mounting cavity in the pressure barrel to assure that the seal seat is free of dirt and any other foreign matter.

3. Mount transducer with steel spacer rings into the test barrel as described in PCB Operating Instructions Manual.

4. Thread the transducer into the mounting port. When transducer bottoms, torque the transducer as recommended by the manufacturer.

5. It is essential that the sensing surface of the transducer be tangent with the chamber inside diameter. Care must be exercised to obtain correct depth. Depth adjustment is accomplished by the use of various thickness spacers.

6. Connect equipment as shown on pages 54*ff*.

   IMPORTANT: Always switch the OPERATE-GND switch to the "GND" position before making connections to the Model 462B52 and allow switch to remain in this

SECTION II – PROCEDURES   **VELOCITY & CONFORMAL PIEZOELECTRIC**
SHOTSHELL   **TRANSDUCER PRESSURE TESTING**
SAAMI VOLUNTARY PERFORMANCE STANDARDS

position during such connections. This protects the FET input stage against possible gate damage from excessive accumulated static charge.

7. Set the charge amplifier controls for short time constant, transducer sensitivity to the slope (m) obtained from the transducer least square line equation and set the GROUND/OPERATE switch to the OPERATE position.

8. Select digital peak meter, positive input, peak mode, and 10-volt range.

9. Inductance sensors should be arranged in accordance with the arrangement shown on page 80, "*Equipment: Schematic Layout of Inductance Coils*". Velocity screens should be arranged in accordance with the arrangement shown in pages 81*ff*, "*Equipment: Schematic Layout of Velocity Screens*".

10. A table of time of flight vs. velocity should be used to determine instrumental velocity at the appropriate distance from the gun muzzle (not required when using direct reading equipment).

11. It is recommended that a blast shield be positioned between the muzzle of the test barrel and the first inductance coil/velocity screen to minimize possibility of premature triggering of the velocity coils/screens. Inductance coils can be triggered by ionized gases that may be present at or near the muzzle. Large muzzle flash or muzzle blast events may cause false triggering of velocity (light) screens leading as well. Such events can lead to erroneous velocity readings, with the gases or blast reaching the first coil before the payload and prematurely starting the counter-chronometer and causing velocity readings to be low. Premature triggering of both sensors is typically associated with blast events and will result in velocity readings which correspond to the speed of sound for the conditions present at the test facility (approximately 1,120 fps at sea level and normal atmospheric conditions) for loads below this velocity.

    (a) The blast shield should be made of rigid, opaque material of sufficient strength to withstand the shock wave but not be resistant to the passage of the payload.

C. PROCEDURE

1. Reset all pressure instrumentation and assure that the peak meter digital display reads all zeros. Test rounds may now be fired.

2. For each round fired, the pressure reading on the digital display and the time of flight/velocity should be recorded and pressure instrumentation reset.

IX. RECORDING OF TEST RESULTS

A. The following data should be recorded for each series of shots fired for velocity and pressure.

1. Ammunition Data
    a. Date of test
    b. Nominal cartridge identification
    c. Cartridge gauge
    d. Payload weight, type, and buffer (if any)

e. Wadding
f. Powder charge, type, and lot
g. Priming
h. Code or date of loading

2. Average velocity, uncorrected.

3. Average pressure, uncorrected.

4. Maximum and minimum individual velocity.

5. Maximum and minimum individual pressure.

6. Extreme variation (range) of velocity.

7. Extreme variation (range) of pressure.

8. Other statistical indication of variation (optional).

9. Correction to results from firing Reference Ammunition (optional).

10. Corrected average velocity (optional).

11. Corrected average pressure (optional).

12. Recommended values

    12.1 Average velocity
    12.2 Average pressure
    12.3 Velocity and pressure variation

13. Test firearm and range data

    13.1 Barrel length and serial number
    13.2 Barrel history
    13.3 Transducer serial number
    13.4 Type of chronograph
    13.5 Coils or screens, and nominal mid-point distance

14. Test personnel.

TRANSDUCER CALIBRATION:
EQUIPMENT INTERCONNECTION

Low Noise Cable

RG-58/u Coax

Transducer
Calibrator

Charge
Amplifier

Digital
Voltmeter
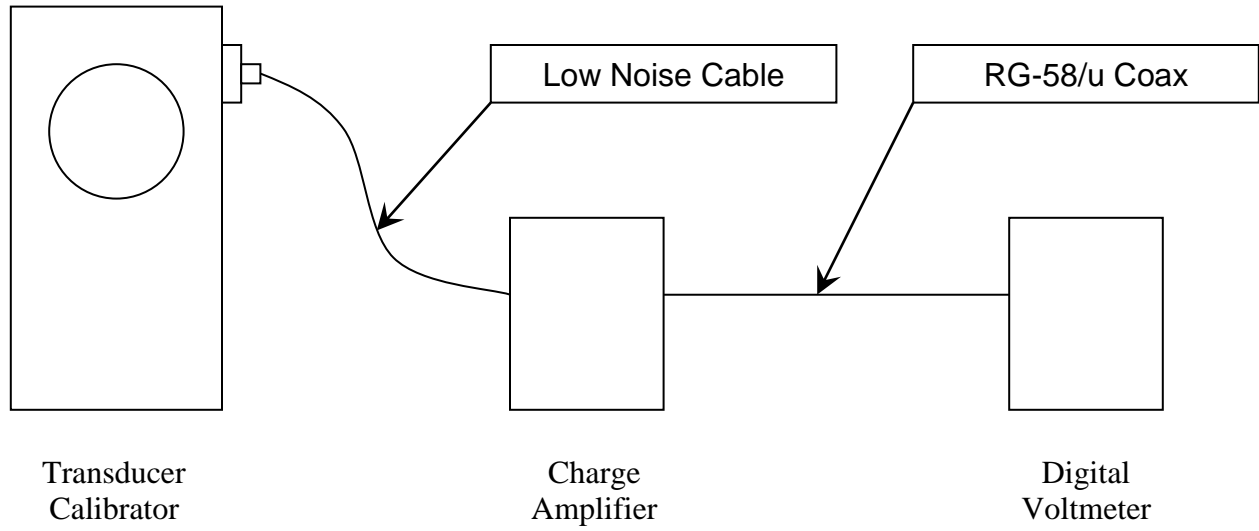
Figure 2

TRANSDUCER CALIBRATION:
LEAST SQUARE LINE COMPUTATION

$$Q = mP + q$$

$$m = \frac{\sum(PQ) - \dfrac{\sum P \sum Q}{n}}{\sum P^2 - \dfrac{(\sum P)^2}{n}} \qquad q = \frac{\sum P \sum(PQ) - \sum(P^2)\sum Q}{(\sum P)^2 - n\sum P^2}$$

Where:

n = Number of data points.

Q = Charge, in picocoulombs, pC.

m = Slope ($\Delta Q/\Delta P$); transducer sensitivity in pC/psi.

P = Pressure, in pounds per square inch, psi.

q = Charge intercept, in picocoulombs, pC.

V = Average output voltage at the indicated pressure, in volts, v.

S = Charge amplifier sensitivity.

$$Offset = \frac{q}{m}$$

P	S	V	Q (SV)	(PQ)	P^2
TOTAL $\sum P$ =			$\sum Q$ =	$\sum(PQ)$ =	$\sum(P^2)$ =

Figure 3

FIRING TEST:
EQUIPMENT INTERCONNECTION

Configuration 1
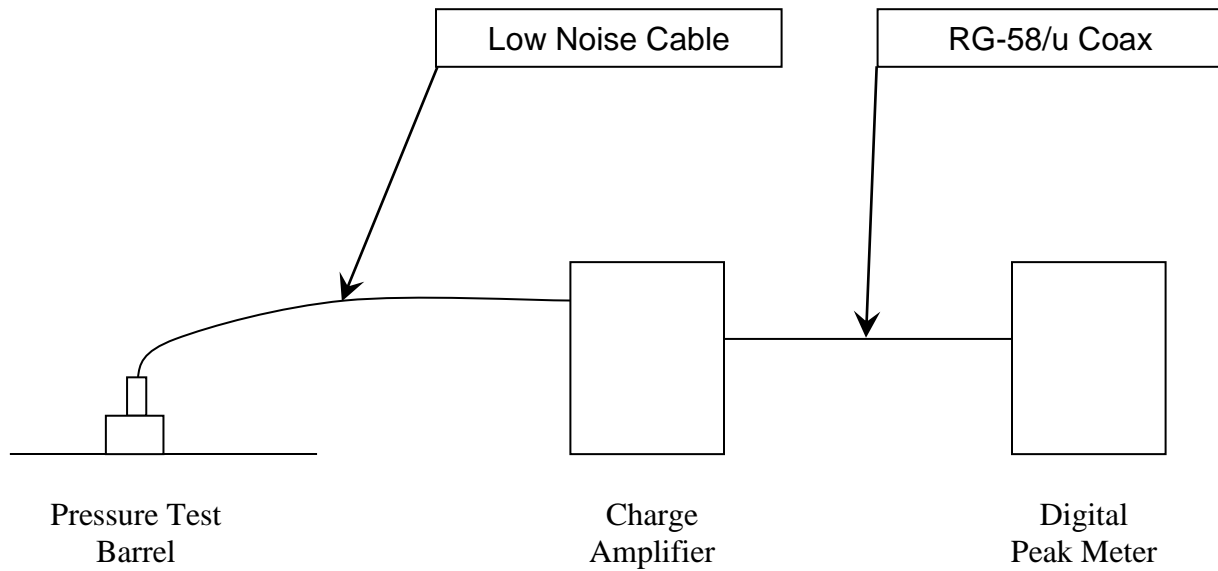
Figure 4

FIRING TEST:
EQUIPMENT INTERCONNECTION (cont'd)

Configuration 2

Low Noise Cable

RG-58/u Coax

Pressure Test
Barrel

Charge
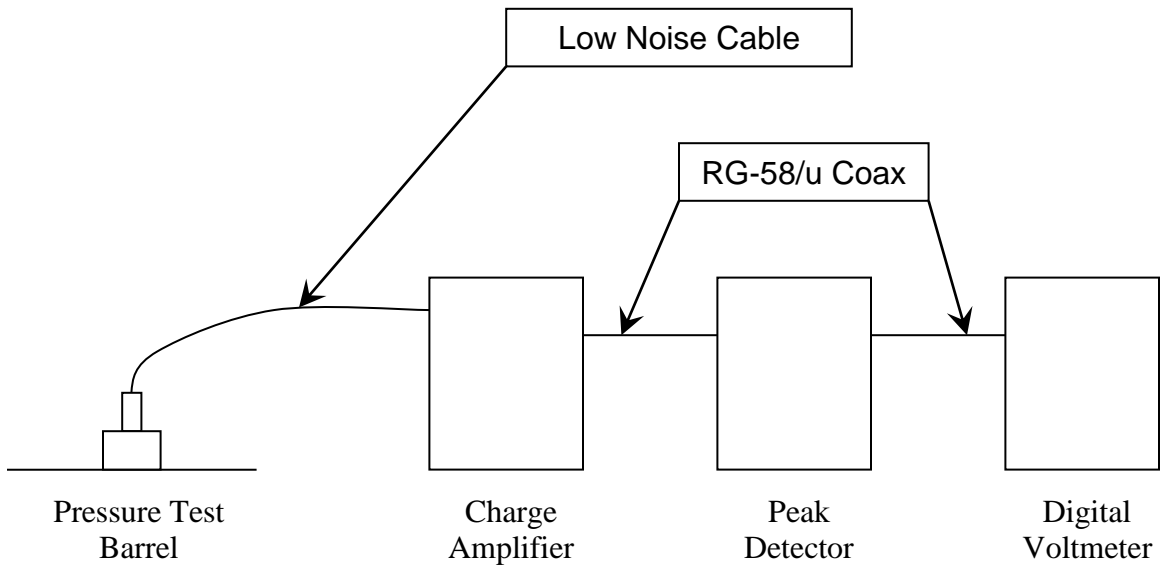Amplifier

Peak
Detector

Digital
Voltmeter

Figure 5

REFERENCE AMMUNITION:
USE

A. PURPOSE
   Reference Ammunition is for the purpose of relating pressure and velocity test results at all ranges.

B. PROCUREMENT
   Reference Ammunition is procured as noted on pages 108 and 109.

C. USE
   The use and usefulness of Reference Ammunition in connection with the testing of ammunition for velocity and pressure is predicated upon two basic assumptions as follows:

   1. Associated with a given batch of Reference Ammunition at a given time is an assessed average velocity, an assessed average pressure, as well as upper and lower limits for each, which the averages of any ten-round test may be expected to fall within when:

      a. The reference ammunition manufacturer has applied appropriate safeguards to ensure homogeneity of the lot.

      b. The ammunition is tested only after being conditioned under controlled temperature and humidity.

      c. The ammunition is tested in standard test equipment.

      d. The ammunition is handled in strict accordance with the specified method.

      e. All auxiliary measuring equipment is in proper working condition.

   2. Although there will be changes with time in the velocity and pressure assessments, the changes occur sufficiently slowly to be detected by periodic reassessments before they have achieved a magnitude sufficient to impair the usefulness of the reference rounds. In other words, the velocity and pressure assessments are reasonably stable with time.

The average velocity and pressure that may be developed by a sample of Reference Ammunition in any given standard test barrel under given test conditions may be different from the results obtained under the test conditions referred to above in assumption 1. Such values may be perfectly real, providing the auxiliary equipment introduces no errors. However, the average of any ten-round test with a lot of Reference Ammunition, fired under the conditions listed above should fall within the limits given with the assessment of that lot under the heading, "Inclusion Limits".

In order to realize the benefits of Reference Ammunition, some rules must be adhered to. Nevertheless, each individual user must make the final judgments concerning how often it is used and the use of the data. It is important, therefore, that there be a clear realization of what it can and what it cannot tell the ammunition tester.

Reference Ammunition cannot guarantee the absolute accuracy of any test system. It does, however, provide simple and direct data from any given ammunition test equipment to determine how closely it relates to the acceptable, average system as used by other SAAMI members.

In line with the preceding discussion, the following recommendations are made for the use of Reference ammunition:

A. Each Reference Lot should be conditioned before use.

B. How often Reference Ammunition is used shall be determined by the accuracy required.

C. The minimum sample shall be ten rounds.

D. The Upper and Lower "Inclusion Limits" for both velocity and pressure are the limits within which the averages of a ten-round test may be expected to fall 99.95% of the time.

E. A correction need not be applied to the test equipment as long as the velocity and pressure averages are within the Inclusion Limits.

F. If one average is outside of the Inclusion Limits and the other within, the average that exceeds the limits shall be corrected according to the procedure given in Step H.

G. If both averages are outside of the Inclusion Limits, a second ten-round test should be fired and the overall average for the total twenty rounds calculated to verify the data.

H. If the correction is to be applied the correction shall be the difference between the assessed value and the observed average of the twenty-round test.

D. APPLICATIONS
For each gauge/bore and chamber length, SAAMI recognizes one load for lead shot, non-lead shot, rifled slugs (smoothbore testing), and saboted slugs (for use in rifled test barrels). The table on the following page presents the load types for each application.

REFERENCE ROUND APPLICATION

NOTE: At the time the following practice was adopted, existing inventories of previously-used reference rounds were still available from member companies. While obsolete under these recommendations, the continued use of these rounds is considered appropriate and valid for the assessment of ranges for velocity and pressure testing until those inventories are depleted.

Load Type:	LEAD SHOT	NON-LEAD SHOT	RIFLED SLUGS	SABOTED SLUGS
Test barrel:	Full choke	IC choke	Full choke	Rifled
Velocity Assessment(s):	Coils @ 3'	Coils @ 3' Screens @ 6'	Coils @ 3' Screens @ 15'	Coils @ 3' Screens @ 15'
10-ga. 3½"	10F	103.5ST		
12-ga. 2¾"	12F[1]	[1]	12RS[1]	12SS[1]
12-ga. 3"	12F[1]	123MST[1]	12RS[1]	12SS[1]
12-ga. 3½"	123.5M	123.5ST		
16-ga. 2¾"	16F	16ST	16RS	
20-ga. 2¾"	20F[1]	[1]	20RS[1]	20SS[1]
20-ga. 3"	20F	203ST	20RS[1]	20SS
28-ga. 2¾"	28S	28S[4]	**28RS**[2]	
410 bore 2½"	[3]			
410 bore 3"	413F	413F[4]	413RS	

NOTES:

1. All 12- and 20-ga. 2¾" and 3" loads are tested in 3" chamber test barrels and corrected with the applicable SAAMI reference rounds. For 2¾" lead shot, rifled slug, and saboted slug loads use of a 2¾" chamber test barrel is optional. (For non-lead shot, only the use of a 3" chamber test barrel is recognized.) Reference round assessment firings are made in 3" chamber test barrels. No adjustment or correction is applied to the assessment values when using these rounds in 2¾" chamber test barrels.

2. The designation "28RS" is reserved for future use.

3. All types of 410-bore 2½" rounds are tested in a 3" chamber test barrel of the appropriate choke/bore treatment for the type of payload under test.

4. Test barrel corrections for 28 gauge and 410 bore non-lead shot loads are established using applicable SAAMI lead shot reference rounds.

REFERENCE AMMUNITION:
SECONDARY REFERENCE AMMUNITION

Occasionally, a test station will have a need for an inordinately large supply of Reference Ammunition in considerable excess to the usual volume. In order to minimize the premature exhaustion of any particular lot, it is suggested that the station create its own secondary reference lot to fill the special need.

A secondary reference lot should consist of a supply of off-the-shelf ammunition, each box bearing the same manufacturer's date/lot code. The secondary reference lot should be approximately equivalent to the Reference Ammunition that it replaces.

REFERENCE AMMUNITION:
NEW LOTS

I. GENERAL

Reference Ammunition lots have been established for those lots or loads designated by the Technical Committee. Responsibility for production of each of the selected lots is assigned to a member company that is responsible for maintaining a supply. A five-year supply is recommended. It is desirable that Reference Ammunition be consistent with tabulated nominal values for the particular round.

When a producer has prepared a new lot, it shall be his responsibility to announce the lot to the SAAMI Technical Office[2], giving a tentative assessment and other data. (An example of the recommended format for this announcement appears later in this subsection.)

The producer shall supply, at the time of the announcement of the new lot, to each member of the Reference Ammunition Group that has the capability to test that cartridge, a minimum of 25 rounds of the new lot for immediate test. A current list of the testing capabilities of the Reference Ammunition Group is available from the SAAMI Technical Office on request.

The SAAMI Technical Office will announce the availability of the new lot to the participating ranges, giving the tentative assessment and other pertinent data. (An example of the recommended format for this announcement appears later in this subsection.)

II. METHOD OF ASSESSMENT

Before announcing a new lot of reference ammunition to the SAAMI Technical Office, the manufacturer should make sufficient tests to determine Tentative Values of pressure and velocity for the new lot.

It is recommended the establishment of a Tentative Assessment be based on testing using as many test barrels as practicable and, if possible and applicable, using multiple pressure transducers. The use of multiple barrels/transducers strengthens the statistical validity of the assessment by including additional sources of routine variation in the mean values. Results from each unique combination of barrel / transducer should be reported separately on the announcement. (See page 66.)

1. The test barrels shall conform to the SAAMI specifications for internal dimensions, length and piezo gauge location. (Refer to Section III of this Volume.)

2. Counter-chronographs and inductance sensors or photoelectric screens (depending on the type of load) shall be used in velocity measurements. (See Section III.)

3. Ammunition shall be conditioned for a minimum of 72 hours at $70° \pm 2°F$ ($21.1° \pm 1.1°C$) with relative humidity of $60\% \pm 5\%$ before firing.

4. Only an approved transducer shall be used in pressure measurements.

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[2] Refer to page 79 for current contact information for the SAAMI Technical Office.

NEW REFERENCE LOT REPORTING FORM AND INSTRUCTIONS

These instructions pertain to the form shown in this Section, which is used for a Reference Ammunition producer to announce new lots to the SAAMI Technical Office, as well as for the SAAMI Technical Office to announce the new lot to participating ranges.

- -

SUBJECT: T-4015 Reference Ammunition – Shotshell
New Reference Lot

TO: *When used by a producer:*
SAAMI Technical Office[3]

When used by SAAMI Technical Office to notify test stations:
Current address of all stations and personnel.

(1) Name and address of source
for procurement as shown
in Section III

SIGNED: Authorized Person
Producer Company Name
Address (including zip
code)

DATE:

[3] Refer to page 79 for current contact information for the SAAMI Technical Office.

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ANNOUNCEMENT OF NEW REFERENCE AMMUNITION LOT

SUBJECT: T-4015 Reference Ammunition – Shotshell
New Reference Lot

TO:

SHELL _____   Lot No. _____

Order Symbol _____

- TENTATIVE ASSESSMENT –

* TRANSDUCER / COILS*		
	VELOCITY, (fps)	**PRESSURE, psi/100**
Bbl #_____ Mfr _____	_____ fps σ: _____	_____ Cpsi σ: _____
Bbl #_____ Mfr _____	_____ fps σ: _____	_____ Cpsi σ: _____
Bbl #_____ Mfr _____	_____ fps σ: _____	_____ Cpsi σ: _____
Bbl #_____ Mfr _____	_____ fps σ: _____	_____ Cpsi σ: _____
Bbl #_____ Mfr _____	_____ fps σ: _____	_____ Cpsi σ: _____
GRAND AVERAGE: _____fps		**GRAND AVERAGE:** _____ Cpsi

* TRANSDUCER / SCREENS*		
Screen spacing, ft: _____	**VELOCITY, fps**	**PRESSURE, psi/100**
Bbl #_____ Mfr _____	_____ fps σ: _____	_____ Cpsi σ: _____
Bbl #_____ Mfr _____	_____ fps σ: _____	_____ Cpsi σ: _____
Bbl #_____ Mfr _____	_____ fps σ: _____	_____ Cpsi σ: _____
Bbl #_____ Mfr _____	_____ fps σ: _____	_____ Cpsi σ: _____
Bbl #_____ Mfr _____	_____ fps σ: _____	_____ Cpsi σ: _____
GRAND AVERAGE: _____fps		**GRAND AVERAGE:** _____ Cpsi

Lot number this lot replaces: _____

Please test the ammunition and report the results to the SAAMI Technical Office on the proper form (Section II) as soon as possible.

SIGNED:

DATE:

REFERENCE AMMUNITION: IDENTIFICATION PROTOCOL

SAAMI Reference Ammunition

This ammunition is to be used only for calibration
of test gages for velocity and pressure.

LOT NUMBERING SYSTEM
(Typical numbers)

LOT 12 F 20 R

GAUGE/BORE

TYPE OF LOAD

LOT NUMBER
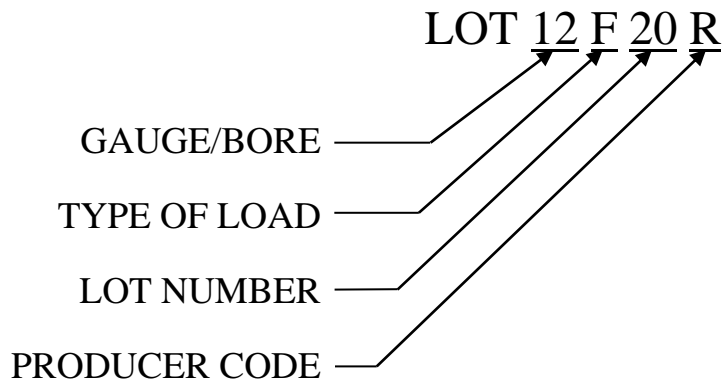
PRODUCER CODE

PRODUCER CODES

WW = Winchester Division, Olin Corporation

F = Federal Cartridge Co.

R = Remington Arms Company, LLC

LOAD TYPES

SS = Saboted Slug

RS = Rifled Slug

F = Field

S = Skeet

ST = Steel

3M = 3" (76 mm) Magnum

3.5M = 3½" (89 mm) Magnum

NOTE

BLACK LETTERING

REFERENCE AMMUNITION: PERIODIC ASSESSMENT

I. PROCUREMENT
Reference ammunition is procured as noted in Section III.

II. PERIODIC TESTS

A. STATIONS

1. All test conditions should conform as closely as possible to those prescribed in this Manual, and the following conditions should be met:

a) Tests should consist of ten (10) rounds for velocity and pressure fired during a single day.

b) Test barrels shall conform to SAAMI specifications for internal dimensions, length, and transducer location.

c) Counter-chronographs and inductance sensors or photoelectric screens (depending on the type of load) shall be used in velocity measurements. (See Section III.)

d) Ammunition shall be conditioned for 72 hours at 70° ± 2°F (21.1° ± 1.1°C) with relative humidity of 60% ± 5% before firing.

e) Only an approved transducer shall be used in pressure measurements.

2. Each station should report results of its firing in the test on approved forms to the SAAMI Technical Office[4]. A sample of this report form is presented later in this subsection.

B. CLEARING HOUSE

1. The SAAMI Technical Office serves as the clearinghouse for all Reference Ammunition ballistics and related information. It shall be the responsibility of the SAAMI Technical Office to schedule testing and to assemble and distribute results of periodic tests. This should be done on the proper Reference Ammunition report form, a sample of which appears in this subsection.

2. The Reference Ammunition Report shall contain the average pressure, velocity, and related standard deviations as reported by each station for that lot. From this data, the SAAMI Technical Office will calculate and report the Raw Average, Corrected Average, and Inclusion Limits.

3. To obtain the Raw Averages, the SAAMI Technical Office shall include the 10-round averages for the pressure and velocity of all reporting stations and the first

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[4] Refer to page 79 for current contact information for the SAAMI Technical Office.

and second previous assessment value. If the 10-round average from any station varies from the Raw Average by more than plus or minus 35 fps in velocity OR plus or minus 1,000 psi in pressure, the pressure or velocity data from that (those) station(s) should be discarded. The mean pressure and velocity data should be recalculated omitting the discarded data. The new mean is the "Corrected Average". If the mean pressure value of a station is outside of the limits as defined above, but the velocity is in, the pressure data should be dropped and the velocity data retained. The converse is true as well. Using the Corrected Averages, the Inclusion Limits are determined as follows:

VELOCITY: MEAN = Same as Corrected Average
              HIGH = MEAN + 35 fps
              LOW = MEAN – 35 fps

PRESSURE: MEAN = Same as Corrected Average
              HIGH = MEAN + 1,000 psi
              LOW = MEAN – 1,000 psi

T-4015 STATION REPORT
REFERENCE AMMUNITION – PERIODIC ASSESSMENT
SHOTSHELL

STATION _____   SAAMI REFERENCE LOT _____

DATE _____   PREVIOUS ASSESSMENT
                                                   Velocity _____

Pressure Barrel No. _____   Pressure _____
        Rounds to-date _____
Velocity Barrel No. _____   Type of Gage _____
        Rounds to-date _____   No. _____

	VELOCITY (@ 3' – Coils)	**VELOCITY (@ 15' – Screens)**	**PRESSURE**
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
FINAL AVERAGE			
$\sigma_{(\eta-1)}$			

TECHNICAL SERVICES REPORT – REFERENCE AMMUNITION

PERIODIC ASSESSMENT – SHOTSHELL

MARCH – 1990

LOT NO: 12T107R   GAGE: TRANSDUCER

	VELOCITY	**σ**	**PRESSURE**	**σ**
Federal	1218	15.0	117	3.8
Hercules	1215	16.0	113	5.8
Olin – Manufacturing	1207	13.1	129	4.7
Olin – R&D	1226	6.0	124	3.0
Olin – St. Marks	1226	9.0	117	3.2
Remington – Ilion	1236	8.0	116	3.0
Remington – Lonoke	1212	15.0	120	4.4
1st Previous Average	1213		121	
2nd Previous Average	1223		120	

	VELOCITY	**σ**	**PRESSURE**	**σ**
Raw Average	1220		120	
Corrected Average	1220		120	
Inclusion Limits @ 99.95%				
Upper Limit	1255		130	
Lower Limit	1185		110	

ASSESSMENT .... 1220... 120

PROCEDURE:
STEEL SHOT HARDNESS MEASUREMENT

I. The hardness is measured using the Rockwell Superficial R15T scale (15Kg 1/16" ball) according to ASTM E-18.

    1. Readings are taken on the spherical surface with no correction.

    2. A countersunk anvil is used to support the shot. See Section III, Equipment, page 107.

II. Procedure.

    1. A random sample of 30 pellets is to be tested.

    2. Each shot pellet is placed on the test anvil without regard for orientation or surface defects.

    3. The hardness is taken by following the normal R15T procedure.

    4. The arithmetic average hardness of the 30-piece sample must be R15T 69 or lower, and no individual reading may exceed R15T 79.

PROCEDURE:
DYNAMIC CHOKE STRAIN MEASUREMENT

OBJECTIVE

The purpose of this procedure is to establish an industry-standard procedure for dynamic choke strain measurement.

Consideration of dynamic choke strain may be important in both ammunition and firearm design. Dynamic choke strain use in ammunition may be to determine the amount of energy a given shotshell load transmits to the choke to produce deformation. In firearm design, particular barrel materials, choke design, wall thickness, etc. may affect the magnitude of the dynamic choke strain measured.

I. EQUIPMENT – GENERAL DESCRIPTION

The general type of equipment used to measure the amount of dynamic choke strain (or stress, if the modulus of elasticity of the barrel is known) in a shotgun barrel is the resistance strain gauge. The principle of the strain gauge is based on its ability to deform exactly as the choke does under firing conditions. Deformation of the choke produces like deformation of the strain gauge. With the proper electronic interface, dimensional changes in the choke are converted from resistance changes in the strain gauge to strain measurements of the choke.

II. LIST OF EQUIPMENT

Item	**Type**	**Alternate**
Strain Gauge	Micro-Measurements Co. Type EA-06-20CBW-120	Kulite-semi-conductor type or equivalent
Mainframe	Tektronix Co. Model TM503	Or equivalent
Power Supply	Tektronix Co. Model PS501-1 modified for Strain Gauge Testing	Or equivalent
Strain Gauge Adapter	Tektronix Co. Model 015-0169-00	Or equivalent
Differential Amplifier	Tektronix Co. Model AM502	Or equivalent
Digital Voltmeter	Tektronix Co. Model DM501	Or equivalent
Digital Peak Indicator	PCB Piezotronics Inc. Model 444A152	Or equivalent
Oscilloscope & Polaroid Camera	Tektronix Co.	Or equivalent

III.   STRAIN GAUGE INSTALLATION

The two most important requirements in strain gauge installation for the measurement of dynamic choke strain are gauge location and proper bonding.

Strain gauge location **should not** precede the choke or be located in the margin area. The gauge should be mounted circumferentially to record the barrel "hoop" stress. The best location for the gauge is somewhat forward (towards the muzzle) of mid-choke, approximately ¼" - ¾" (6.35 – 19.05) from the margin and choke intersection point. On typical full choke shotgun barrels, this location is anywhere from 1" to 1½" (25.4 – 38.1) from the muzzle. Accurate and repeatable strain readings can usually be read anywhere in this area.

Proper bonding of the strain gauge is essential for dynamic strain measurements. The object of the bond is to assure that the strain gauge and barrel are one integral unit. General surface preparation and bonding procedures as explained by the gauge manufacturer should be strictly adhered to. A general bonding procedure as defined by gauge manufacturer can be found on pages 75*ff*.

IV.   STRAIN GAUGE CALIBRATION AND INITIAL SET-UP

Strain gauge calibration must be performed prior to firing, such that actual dynamic strain values can be determined. Strain gauge calibration simply defines the relation of strain gauge resistance change to voltage output and consequently strain levels.

The following is the general procedure for initial strain gauge set-up and calibration. It is recommended that the manufacturer's recommendations be supplemented to this description.

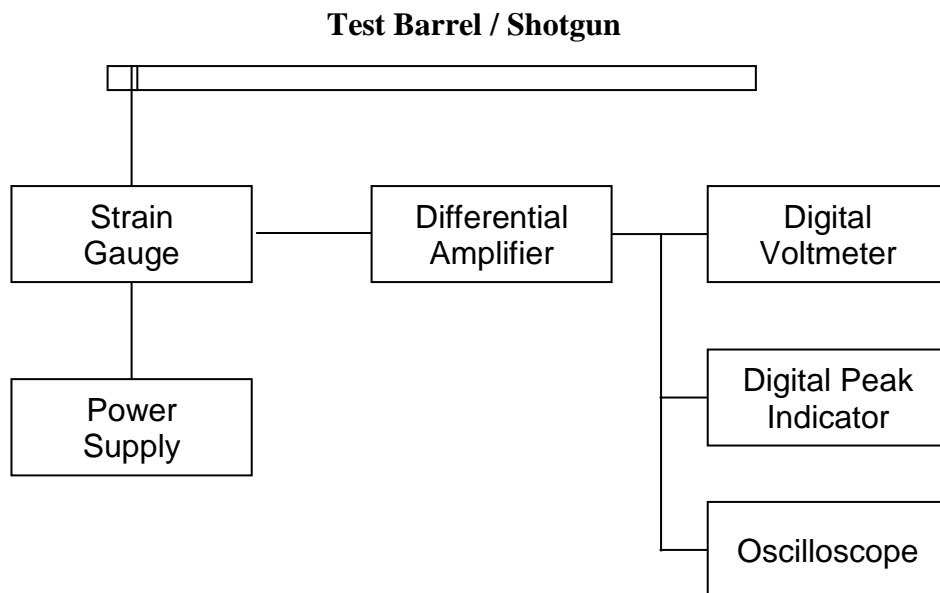1. Connect the instrumentation as indicated in Figure 1, below.

Test Barrel / Shotgun

Figure 1
Equipment Set-up

2. Set the instrumentation as follows:

    i.   Digital voltmeter - 20 volt DC range

    ii.   Differential amplifier

        1. Input coupling to DC

        2. Bandwidth switches to 100 Hz for LF-3DB and l MHz for HP-3DB

    iii.   Digital Peak Indicator - 10.0 volt range

    iv.   Oscilloscope

        1. Vertical gain to 1.0 volt per division

        2. Sweep rate to 0.1 mS per division

    v.   Power supply to 4.00 reading on voltage dial

3. Adjust the DC offset dial on Differential Amplifier for 0.00 volt reading on DVM.

4. Depress calibration button on Power Supply and set the Differential Amplifier gain switch to obtain 4 volt reading on DVM.

V.   FIRING TESTS

The subsequent gauge set-up will allow for the measurement of residual choke deformation as well as maximum dynamic choke strain for each particular shot.

Residual choke deformation indicates the cumulative effect of deformation. At the conclusion of the test, residual choke strain will monitor permanent deformation.

Dynamic choke strain will define the maximum strain in the choke (at the gauge location) when the shot is being constricted through the restricted area. Strain will be present both before and after the shot passes the gauge but will be a maximum only at one point in time. This maximum strain will define the energy in which the load transmits to the choke.

The following procedure should be employed after initial set-up and calibration. A sample suggested data tabulation page appears later in this sub-section.

1. Record the initial gauge resistance of the strain gauge as mounted on the barrel. A Wheatstone bridge or digital voltmeter should be used.

2. Fire one round of the subject ammunition and record the maximum change in voltage of the strain gauge on the digital peak indicator. (This voltage may be made to correspond directly to resistance if properly scaled.) If desired, the following may be recorded simultaneously for additional data:

    a.   Strain-time trace - this relationship may be found by use of an oscilloscope. Strain-time curves may give additional information on rate of strain application.

    b.   Maximum chamber pressure and instrumental velocity – This information may be desirable should a SAAMI pressure and velocity barrel be employed.

3. Allow barrel to cool for 30 seconds. This should insure that the barrel returns to room temperature, thus preventing temperature effects on the strain gauge. (Forced-air cooling may also be beneficial.)

4. Repeat steps 2 and 3 until a minimum of 20 rounds have been fired.

5. At the conclusion of the firing, recheck the gauge resistance. A significant increase in gauge resistance will indicate that permanent choke deformation has occurred in the area of the gauge.

VI.   DATA REDUCTION

The following steps are used to convert the data obtained in the firing test to actual strain values:

1. Determine the relationship of voltage to resistance changes in the strain gauge. This relationship will have been established during the calibration procedure, i.e. $100\Omega = 3.5$ volts, etc.

2. Convert all voltage values obtained on the peak indicator to resistance by the relationship obtained in step (1). If an oscilloscope was used, measure the maximum deflection in volts and convert values to resistance as in step (1).

3. Calculate the actual maximum dynamic choke strain by use of the following formula:

$$\varepsilon = \frac{\Delta R}{R} \times \frac{1}{K}$$

Where: ε =   Dynamic choke strain (in/in)
ΔR =   Change in resistance of gauge (Ω)
R =   Original gauge resistance (Ω)
K =   Gauge factor

NOTE: Convert strain to μ inches/inch units by multiplying ε by 10^6.

4. Calculate the residual choke strain by use of the following formula:

$$\varepsilon_r = \frac{R_F - R}{R} \times \frac{1}{K}$$

Where: ε_r =   Residual choke strain (in/in)
R_F =   Final gauge resistance after test (Ω)
R =   Original gauge resistance (Ω)
K =   Gauge factor

NOTE: Convert strain to μ inches/inch units by multiplying ε_r by 10^6.

SAMPLE SUGGESTED CHOKE STRAIN DATA TABULATION SHEET

Maximum Dynamic Choke Strain

Shot No.	ΔV (volts)	ΔR (ohms - Ω)	ε (μ in/in)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
11			
12			
13			
14			
15			
16			
17			
18			
19			
20			
		Average:	
		Std. Dev. (σ):	

Residual Choke Deformation

R_0 Original Gauge Resistance (ohms - Ω)	R_F Final Gauge Resistance (ohms - Ω)	$R_F - R_0$ (ohms - Ω)	ε_r (μ in/in)

PROCEDURE:
STRAIN GAUGE APPLICATION

OBJECTIVE

The purpose of this procedure is to establish an industry-standard method of applying strain gauges to test specimens using either M-Bond 200 or M-Bond 600 adhesives. This will insure that all gauges are applied identically and correctly which will result in repeatable and accurate strain measurement.

LIST OF EQUIPMENT

a.   320 Grit emery cloth
b.   Miller-Stephenson Chloroethene Nu Degreaser
c.   *M-Prep Conditioner A
d.   *M-Prep Neutralizer 5
e.   Ruler and scribe
f.   *Scotch tape (catalog #3M#157)
g.   Metal tweezers
h.   *Teflon film (.003" x 1" TFE Teflon film)
i.   Gum rubber (1⌨" thick)
j.   Clean tissue or cotton cloth
k.   *Hose clamp or spring clamp (1½" adjustable hose clamp or #1 Hargrove spring clamp)
l.   *M-Bond 600 kit or M-Bond 200 kit
m.   *M-Coat A Protective coating
n.   Large "Blue-M" oven or equivalent

INITIAL SET-UP

1.   Obtain specimen to be strain gauged and roughen area where strain gauge is to be placed with emery cloth being sure to remove all dirt, paint, rust, etc, down to the bare specimen.

2.   Using the ruler and scribe, mark the specimen with the necessary guide lines for proper placement of the strain gauge.

3.   Spray the specimen with Degreaser and wipe it clean with a clean tissue at least four times.

4.   Apply M-Prep Conditioner A" (acid base) to the specimen. After 15 or 20 seconds, wipe it off with a clean tissue.

5.   Apply a small amount of M-Prep Neutralizer 5; after a few seconds, wipe the specimen clean with one slow wipe across using a clean tissue. Be sure not to allow the Neutralizer to evaporate on the specimen in any quantity.

---

* Supplied by Micro-Measurements Inc., division of Vishay Precision Group
  www.vishaypg.com/micro-measurements/

6. Place the bending side of a gauge on a chemically clean work surface such as a glass plate or the gauge box.

7. Pick up the gauge with a strip of 3-M scotch tape and apply a terminal strip in the desired location. If bonding with M-Bond 200, the tape should cover the entire gauge, but with M-Bond 600, the tape should only cover a very small area on the terminal end of the gauge.

8. Position tape on specimen so that gauge alignment marks match gauge location lines on specimen surface.

ADHESIVE APPLICATION

1. M-Bond 600 Adhesive

    a. Using pair of tweezers, peel gauge/tape assembly back from surface.

    b. Coat specimen and back of gauge with adhesive and allow surfaces to air dry at least 5 minutes at room temperature. Do not allow adhesive applicator to touch tape mastic.

    c. Reposition gauge on surface and coat top of gauge with adhesive.

    d. Place a piece of Teflon film just slightly larger than the strain gauge over installation, secure one end of Teflon film with Mylar tape.

    e. Place a piece of silicone gum rubber slightly larger than the piece of Teflon over the installation.

    f. Clamp the installation with either a spring clamp or a hose clamp depending on the specimen. When using a hose clamp on a specimen, such as a shotgun barrel, be sure that the gauge installation does not wrinkle when the clamp is tightened.

    g. Place specimen in the oven at a temperature of 275°F (135°C) for approximately one (1) hour.

    h. After cure time, remove specimen from oven and allow to cool slowly. When cool, remove clamp, gum rubber, and tape and inspect the installation for a completely bonded gauge with a glue line of even thickness.

2. M-Bond 200 Adhesive

    a. Lift one end of tape at a shallow angle to surface (about 45°) until gauge and terminal are free from surface.

    b. Tuck loose end of tape under and press to surface so that the exposed bonding side of the gauge is parallel to the surface.

    c. Remove M-Bond 200 catalyst brush from bottle and wipe several times on neck of bottle to remove excess fluid.

    d. Apply catalyst to gauge by swabbing bonding surface without lifting brush. Swab towards terminal strip then lift brush off at one corner of the gauge.

    e. Allow catalyst to dry for at least one minute.

    f. Apply a drop of M-Bond 200 to surface at the point where the tape meets the specimen.

g.   Lift end of tape and bridge over adhesive at approximately a 45° angle.

h.   With a piece of tissue or Teflon film, make a single firm stroke over the length of the tape and within one second place thumb over installation and hold for at least 60 seconds.

i.   Remove tape by peeling back over gauge installation so that tape remains parallel to surface.

j.   Inspect installation for a complete bond and a thin glue line of even thickness.

APPLICATION OF PROTECTIVE COATING

After the strain gauge installation has been inspected, apply 3 or 4 coats of M-Coat A at approximately 20-minute intervals. Allow this to dry for at least 30 minutes and the gauge installation is ready for use.

EQUIPMENT:
VELOCITY & PIEZOELECTRIC PRESSURE TESTING

> **NOTE:** Refer to Section III, page 79, *Supplier Contact Information*, for detailed information on contacting the manufacturers of listed products.

1. Electronic Counter Chronograph – 100 kilohertz, minimum
   Oehler Research, Electronic Counters, Inc., or equivalent.

2. Table of velocity vs. time of flight or electronic calculator.

   NOTE: Items (1) and (2) may be replaced by a direct-reading velocity chronograph or integrated ballistic instrumentation system with equivalent accuracy and precision.

3. Inductance Sensors
   Oehler Research, Electronic Counters, Inc., or equivalent.

4. Photoelectric screens
   Oehler Research, Electronic Counters, Inc., or equivalent.

5. Universal Receiver
   a) Ulysses Machine Company
   b) Other equivalent.

6. Test Barrel (Drawings of test barrels are presented in Section III).
   a) H-S Precision, Inc.
   b) Bill Wiseman & Co., Inc.
   c) Wilson Arms Company
   d) Hart Rifle Barrels, Inc.
   e) Krieger Barrels, Inc.
   f) Or equivalent.

7. Digital voltmeter
   Fluke model 45 or equivalent

8. Charge amplifier with 20KHz low pass filter
   PCB Piezotronics, Inc. model 443B02 or equivalent

9. Peak meter
   PCB Piezotronics, Inc. model 444A152 or equivalent

   NOTE: Items (7) and (9) or (7), (8), and (9) may be replaced by an integrated ballistic instrumentation system of equivalent accuracy and precision.

10. Piezoelectric transducer
    PCB Piezotronics, Inc. model 118A07 or equivalent

11. Low noise cable
    PCB Piezotronics, Inc. model 003Cxx or equivalent

12. Transducer calibrator
    PCB Group; The Modal Shop, Inc.; Model K9905D or equivalent

13. Calibration adapter
   PCB Piezotronics, Inc. Model 61M109 or equivalent

14. Reference ammunition
   Refer to the SAAMI website: https://saami.org/technical-information/reference-proof-ammunition/ .

SUPPLIER CONTACT INFORMATION

Contact the SAAMI Technical Office using the information below or visit www.saami.org for a current list of supplier contact information.

SAAMI Technical Office
    11 Mile Hill Road
    Newtown, CT 06470
    Phone: 203-426-4358
    E-mail:
    Website: www.saami.org

EQUIPMENT:
SCHEMATIC LAYOUT OF INDUCTANCE COILS

3' - 0"
(91.44)

1' - 6"
(45.72)

3' - 0"
(91.44)

℄ SENSOR

℄ SENSOR

CHRONOGRAPH

XXXX

LINE
OF
FIRE

TEST ACTION
AND BARREL

SENSOR FRAME

SIGNAL LINE

AMPLIFIER
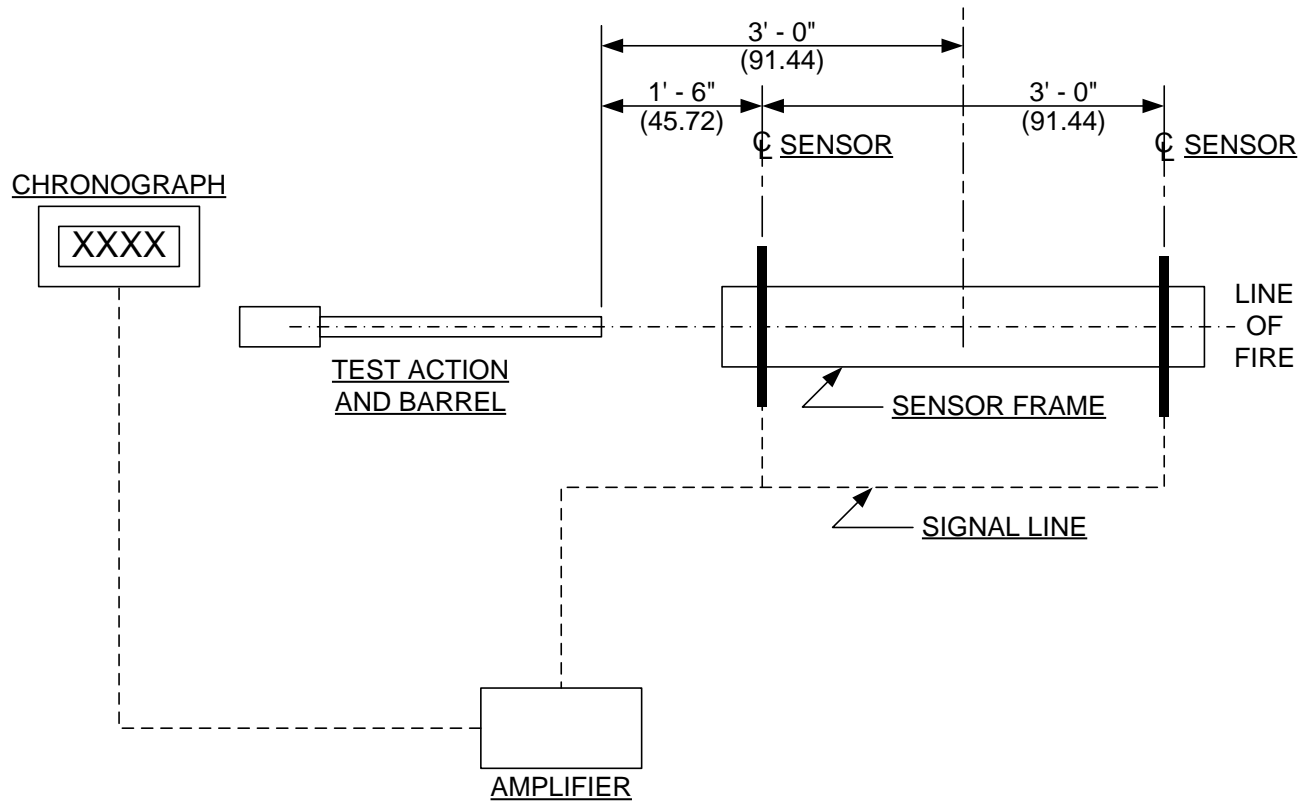
**SCHEMATIC VELOCITY TEST LAYOUT
FOR
INSTRUMENTAL VELOCITY AT 3 FEET (91.44)
OVER 3 FEET (91.44)**

NOTE:
(XX.XX) = CENTIMETERS

80

EQUIPMENT:
SCHEMATIC LAYOUT OF VELOCITY SCREENS

LAYOUT 1 – OPTIONAL FOR RIFLED/SABOTED SLUGS

Midpoint

20' - 0" ± ¼"
(6.096 ± 0.006)

15' (4.572)
Nominal

Light sources (2)

5' (1.524)
Nominal

Line of fire

Photoelectric cells (2)

Signal line

Test action and barrel

Chronograph

Amplifier

**SCHEMATIC VELOCITY TEST LAYOUT
FOR INSTRUMENTAL VELOCITY
AT 15 FEET (4.572) OVER 20 FEET (6.096)**
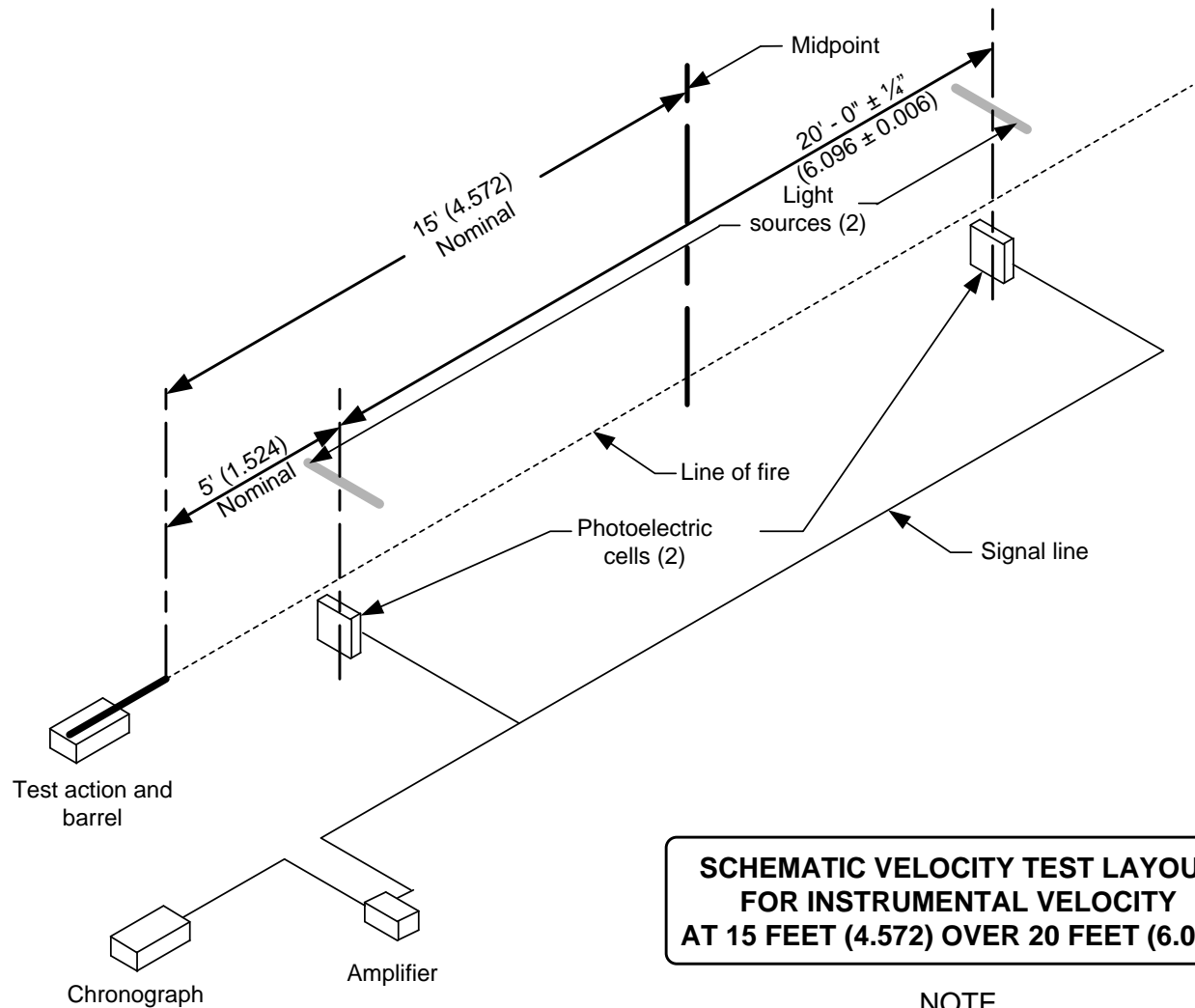
NOTE
(X.XXX) = METERS

LAYOUT 2 – OPTIONAL FOR NON-LEAD SHOT LOADS

Midpoint

8' (2.424) Nominal

6' - 0" ± ⅛" (1.818 ± 0.003)

5' (1.524) Nominal

LINE OF FIRE

LIGHT SOURCES (2)

PHOTOELECTRIC CELLS (2)

Signal line

Test action and barrel

Chronograph

Amplifier

SCHEMATIC VELOCITY TEST LAYOUT FOR INSTRUMENTAL VELOCITY AT 8 FEET (2.424) OVER 6 FEET (1.818)
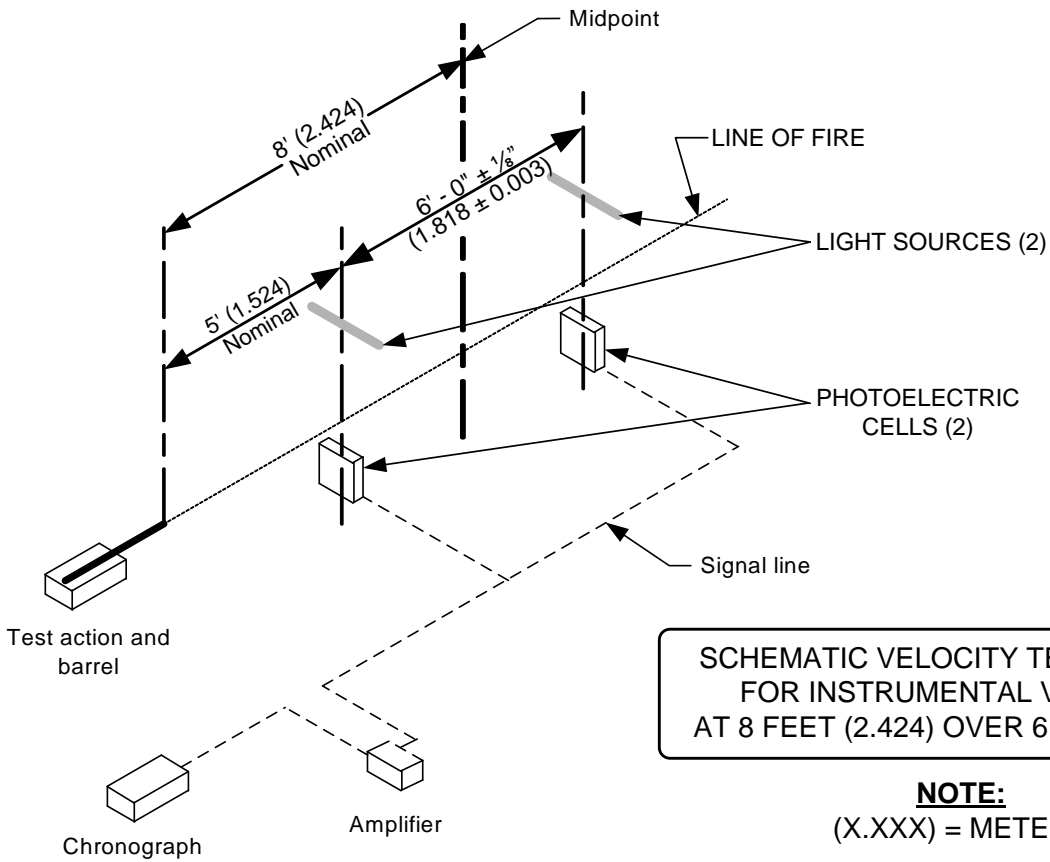
NOTE:
(X.XXX) = METERS

EQUIPMENT:
UNIVERSAL RECEIVER COLLAR & TEST BARREL

0.125 (3.18)

Extractor Slot

0.9374 (23.810)
0.9376 (23.815)

0.252 (6.40)
0.253 (6.43)

0.281 (7.14)
Keyway

0.187
(4.75)

0.380
(9.65)
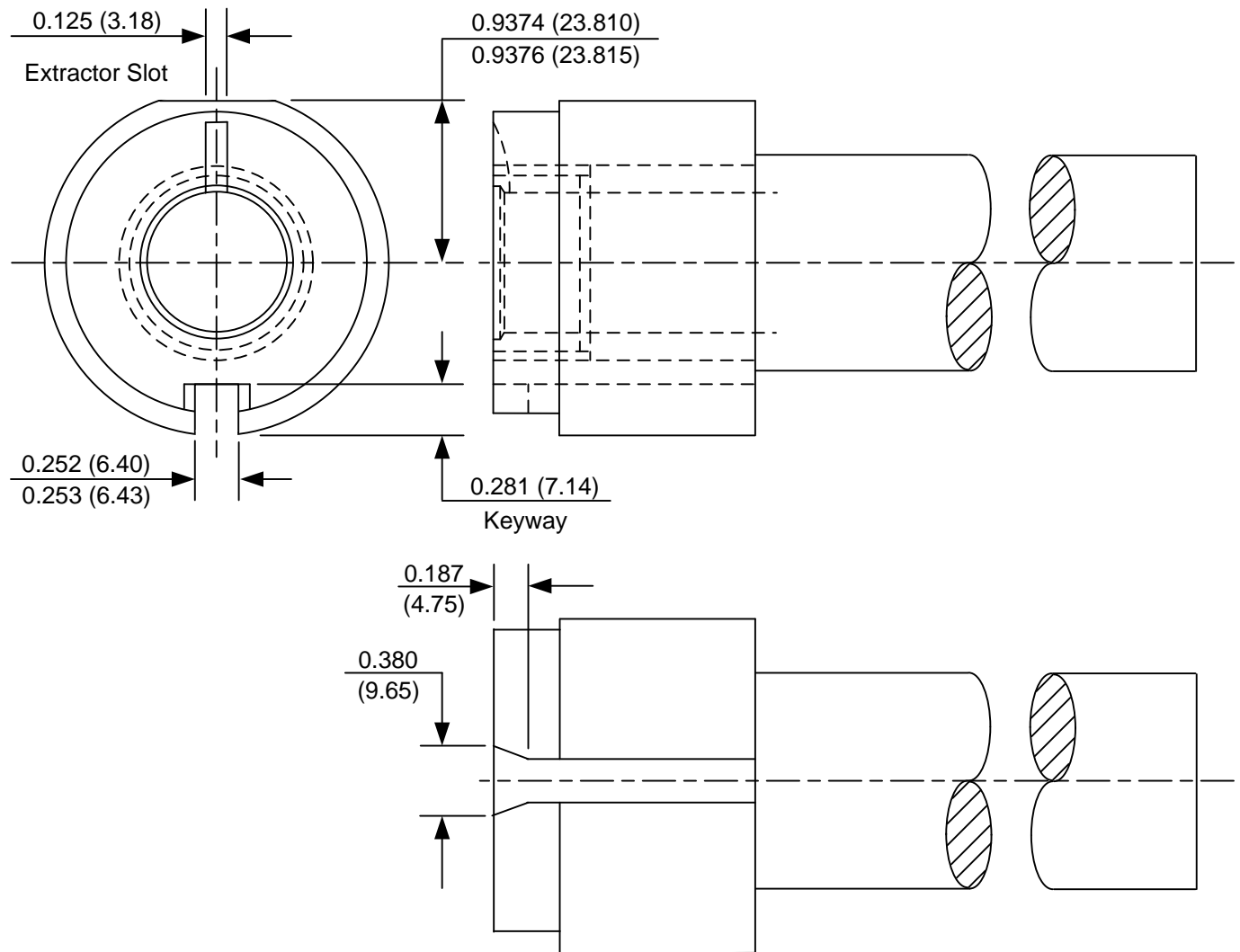
FOR DETAIL INFORMATION SEE FOLLOWING PAGE

NOTE: (XX.XX) = Millimeters

1.1250-12 UNF-2B

1.128 (28.65)
1.132 (28.75)

ADJUST FOR
HEADSPACE

0.386 (9.80)
0.388 (9.86)

0.562
(14.27)

1.515 (38.48)
1.525 (38.74)

1.746 (44.35)
1.748 (44.40)

1.996 (50.70)
1.998 (50.75)

1.1250-12 UNF-2A

1.125
(28.58)

1.250
(31.75)

.625 (15.88)

1.515 (38.48)
1.525 (38.74)

AS SPECIFIED

℄ OF EXTRACTOR
SLOT

℄ OF TRANSDUCER - FOR LOCATION SEE
APPROPRIATE TEST BARREL
DRAWING
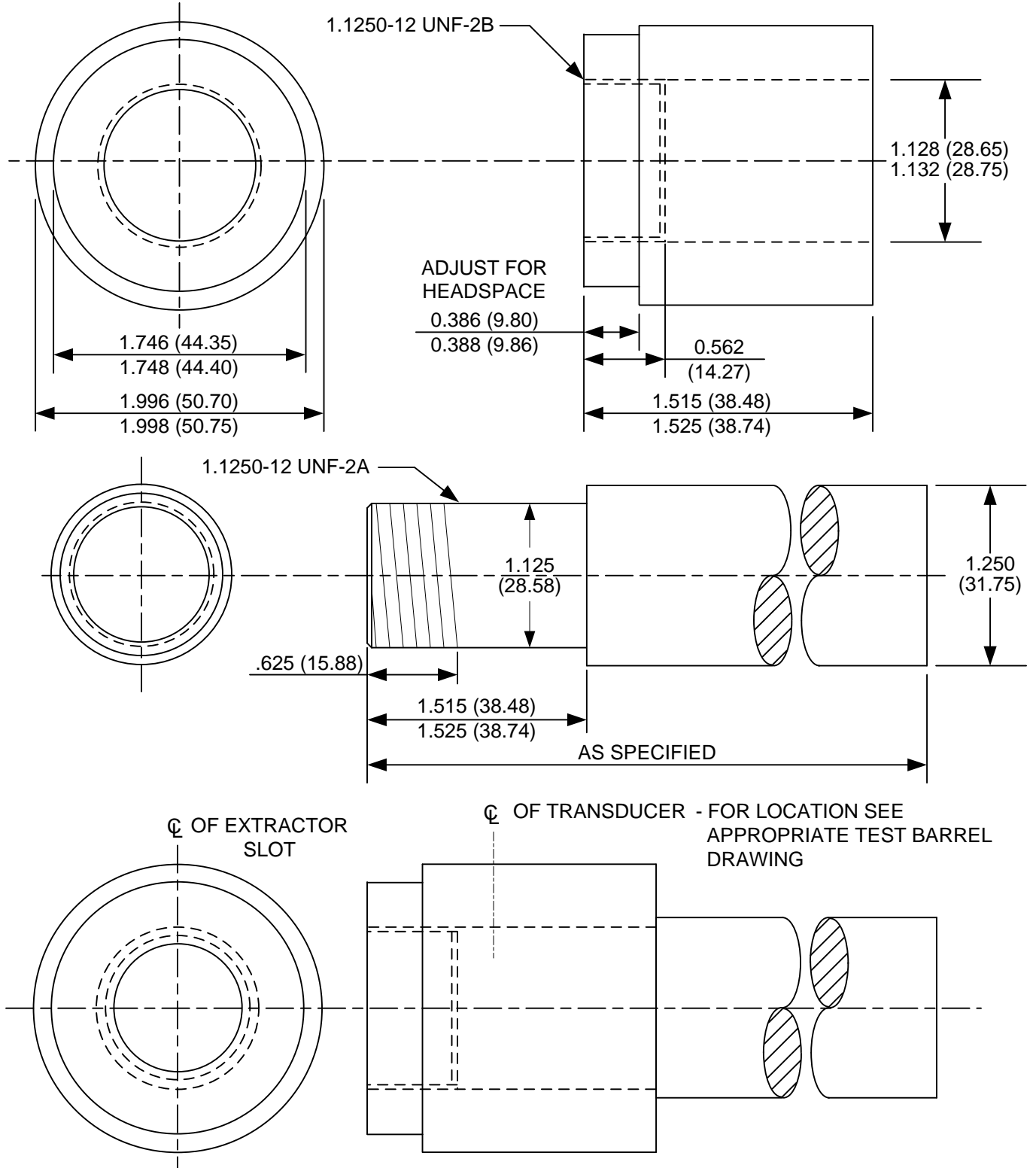
DRAW BARREL AND COLLAR TIGHT.
TRANSDUCER HOLE AND HEAD CUTS
MADE AFTER ASSEMBLY - SEE PAGE 73
NOTE: (XX.XX) = MILLIMETERS

MATERIAL: RESULFURIZED 4140 STEEL HEAT
TREAT PRIOR TO MACHINING TO BRINELL
HARDNESS 277 TO 321 (R_c 29 TO 35)
ACCEPTABLE ALTERNATE: 416 STAINLESS STEEL

UNIVERSAL RECEIVER TEST BARREL:
INSTALLATION OF PRESSURE TRANSDUCERS

SEE TRANSDUCER MANUFACTURER'S
INSTALLATION INSTRUCTIONS FOR
FURTHER DETAILS
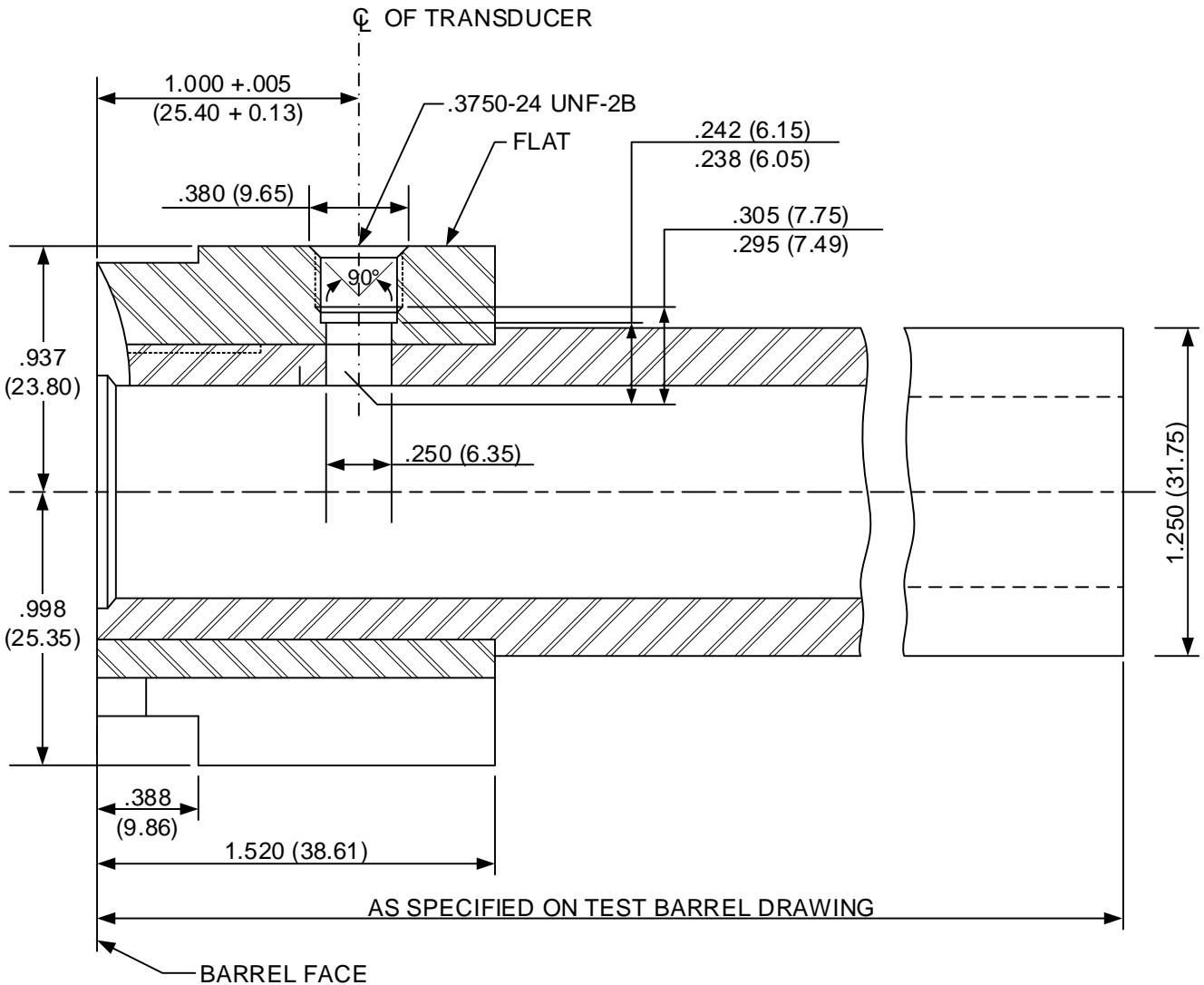
NOTE
(XX.XX) = MILLIMETERS

For collar data shown, see pages 83 and 84.

STANDARD V&P TEST BARRELS - GENERAL: PROCEDURES FOR DIMENSIONING CHAMBERS

Chamber and bore dimensions of velocity and pressure test barrels shall conform to the dimensions of the chamber and bore at Maximum Material Condition (MMC) for each cartridge as originally introduced. Fabrication tolerances, however, are much reduced.

It is recognized that changes may be made to cartridge or chamber dimensions in order to improve the velocity-pressure relationship, accuracy and patterns, or functioning in shotguns as production experience indicates. However, none of these changes should be of such nature that they would cause a significant increase in pressure level of a given lot of ammunition.

No changes shall be made to velocity and pressure barrel dimensions which would result in a reduction of the recorded pressure level of any given lot of ammunition. This would result in the possibility of future lots of ammunition being loaded with increased powder charges, which would cause increased pressure in existing shotguns.

Production barrels may be adapted for velocity and pressure testing provided that they conform to all dimensions shown on the appropriate test barrel drawing.

SECTION III – EQUIPMENT
SHOTSHELL
SAAMI VOLUNTARY PERFORMANCE STANDARDS

STANDARD V&P TEST BARRELS -GENERAL:
PROCEDURES FOR MEASURING
BARREL LENGTH

STANDARD V&P TEST BARRELS - GENERAL: PROCEDURES FOR MEASURING BARREL LENGTH

Shotgun test barrels are measured by inserting a rod down the bore from the muzzle until it touches the breech face with the action closed and the firing pin retracted.

A stop collar or other means is utilized to mark the point on the rod adjacent to the most forward part of the barrel or the bottom of the counter-bore in barrels having a counter-bore recess at the muzzle.

The rod is removed and the distance from the mark to the end of the rod is measured. This measurement is recorded as the barrel length.

It is recognized that shotguns designed for rifled slugs are sometimes manufactured with bore dimensions smaller than the dimensions shown on the cartridge and chamber drawings and on the test barrels drawings. Velocity and pressure tests in 12-gauge and 20-gauge have shown no significant effect on pressures.

10-GAUGE 3¹/₂ INCH STANDARD SMOOTHBORE V&P TEST BARREL

ISSUED: 04/10/1989

REVISED: 07/27/2015

CHOKES:

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF NON-LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .005±.005 (0.13±.01)

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .035±.005 (0.89±.01)

DO NOT SCALE
FROM DRAWING

.750-.250
(19.05-6.35)

3.422 (86.92)
APPROX. LENGTH OF CHOKE

.775+.005 BORE DIA.
(19.69+0.13)

.8410 (21.361)

5° B

32.000±.062 (812.80±1.57)

℄ OF TRANSDUCER

1.000+.005
(25.40+0.13)

.8581 *
(21.796)

.020+.005 (0.51+0.13) R
.0624+.0005 (1.585+0.013) ⊗
.0736 (1.869) * △
3.500+.010 (88.90+0.25)
3.8772 (98.481) △

BREECH BOLT FACE

55° B

.8900 B
(22.606)

.934+.005
(23.72+0.13)

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

NOTE:
B = BASIC
△ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

12-GAUGE 2¾ INCH STANDARD SMOOTHBORE V&P / ACCURACY TEST BARREL

ISSUED: 04/10/1989   REVISED: 07/27/2015

DO NOT SCALE
FROM DRAWING

CHOKES:

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF
NON-LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF
.005±.005 (0.13±.01)

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF
LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF
.031±.005 (0.79±0.01)

TEST BARRELS FOR ACCURACY TESTING OF RIFLED
SLUGS SHOULD HAVE A CHOKE CONSTRICTION OF
.007±.007 (0.178±0.02)

.875-.250
(22.23-6.35)

3.400 (86.36)
APPROX. LENGTH OF CHOKE

30.000±.062 (762.00±1.57)

₵ OF TRANSDUCER
(OPTIONAL FOR SLUG ACCURACY BARREL)

.725+.005 BORE DIA.
(18.42+0.13)

.7980 (20.269)

5° B

.020+.005 (0.51+0.13) R

.0576+.0005 (1.463+0.013) ⊗

.0716 (1.819) * △

2.750+.010 (69.85+0.25)

3.1672 (80.447) △

1.000+.005
(25.40+0.13)

.8100 *
(20.574)

55° B

.8500 B
(21.590)

.887+.005
(22.53+0.13)

BREECH BOLT FACE

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

NOTE:
B = BASIC
△ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

12 GAUGE 2³/₄ INCH STANDARD RIFLED V&P AND ACCURACY TEST BARREL

ISSUED: 08/26/1991

REVISED: 07/27/2015

DO NOT SCALE FROM DRAWING

℄ OF TRANSDUCER

.719+.002 (18.26+.05) BORE DIA.

.727+.002 (18.47+.05) GROOVE DIA.

.7980 (20.269)

5° B

3.2015 (81.318) △

30.000±0.062 (762.00±1.57)

2.750+.010 (69.85+0.25)

.0576+.0005 (1.463+0.013) ⊗

.0716 (1.819) * △

1.000+.005 (25.40+0.13)

.8100 (20.574) *

.020+.005 R (0.51+0.13)

55° B

.8500 B (21.590)

887+.005 (22.53+0.13)

BREECH BOLT FACE

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

△ 8 GROOVES
△ .141 ± .002 (3.58 ± 0.05) WIDE
TWIST 35 (889) ±.125 (3.18) RH (OPTIONAL)
MIN BORE/GROOVE AREA: .4105 IN² (264.838 MM²)

ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

NOTE:
B = BASIC
△ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

12-GAUGE 3 INCH STANDARD SMOOTHBORE V&P AND ACCURACY TEST BARREL

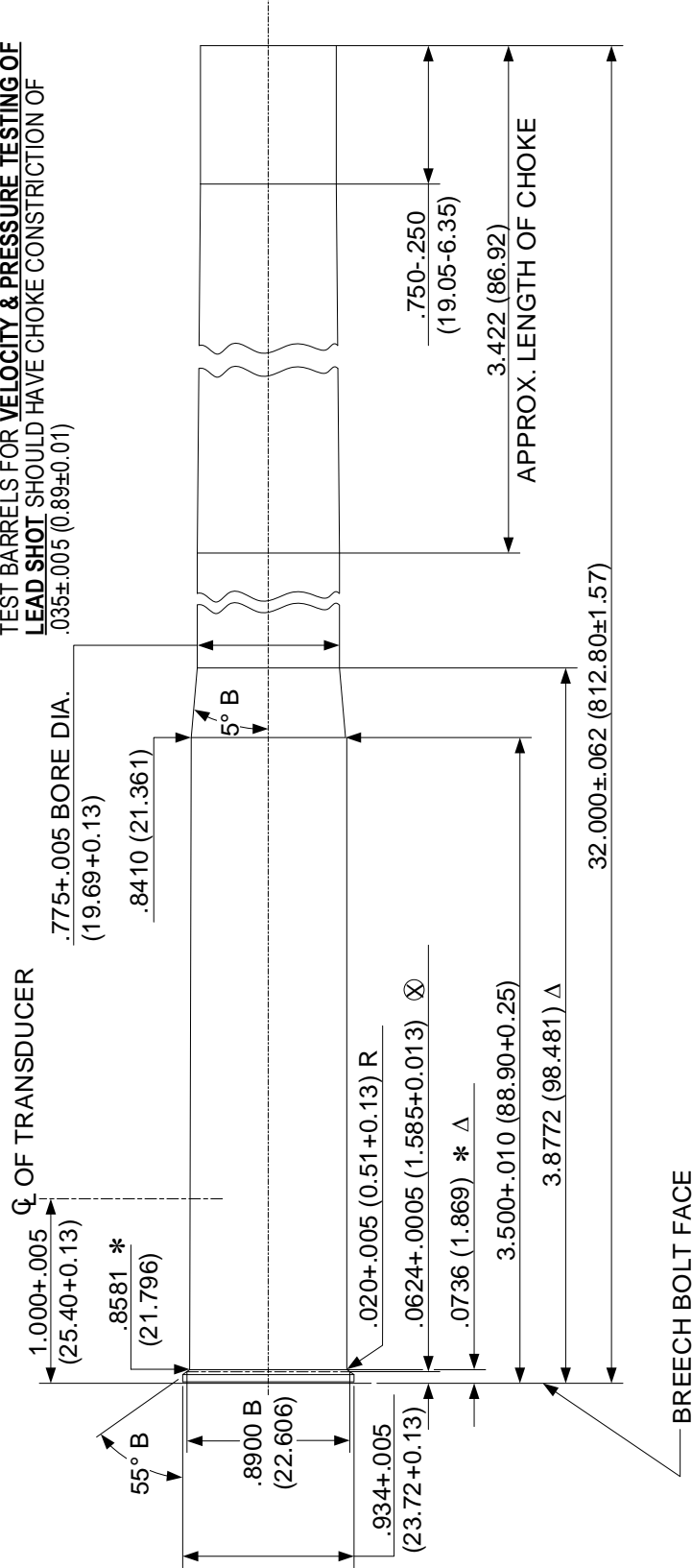ISSUED: 04/10/1989

REVISED: 07/27/2015

CHOKES:
TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF NON-LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .005±.005 (0.13±.01)

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .031±.005 (0.79±0.01)

TEST BARRELS FOR ACCURACY TESTING OF RIFLED SLUGS SHOULD HAVE A CHOKE CONSTRICTION OF .007±.007 (0.178±0.02)

DO NOT SCALE
FROM DRAWING

.875-.250
(22.23-6.35)

3.400 (86.36)
APPROX. LENGTH OF CHOKE

30.000±.062 (762.00±1.57)

℄ OF TRANSDUCER

.725+.005 BORE DIA.
(18.42+0.13)

.7980 (20.269)

5° B

1.000+.005
(25.40+0.13)

.8111 *
(20.602)

.020+.005 (0.51+0.13) R

.0576+.0005 (1.463+0.013) ⊗

.0712 (1.808) * △

3.000+.010 (76.20+0.25)

3.4172 (86.797) △

BREECH BOLT FACE

55° B

.8500 B
(21.590)

.887+.005
(22.53+0.13)

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

NOTE:
B = BASIC
△ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

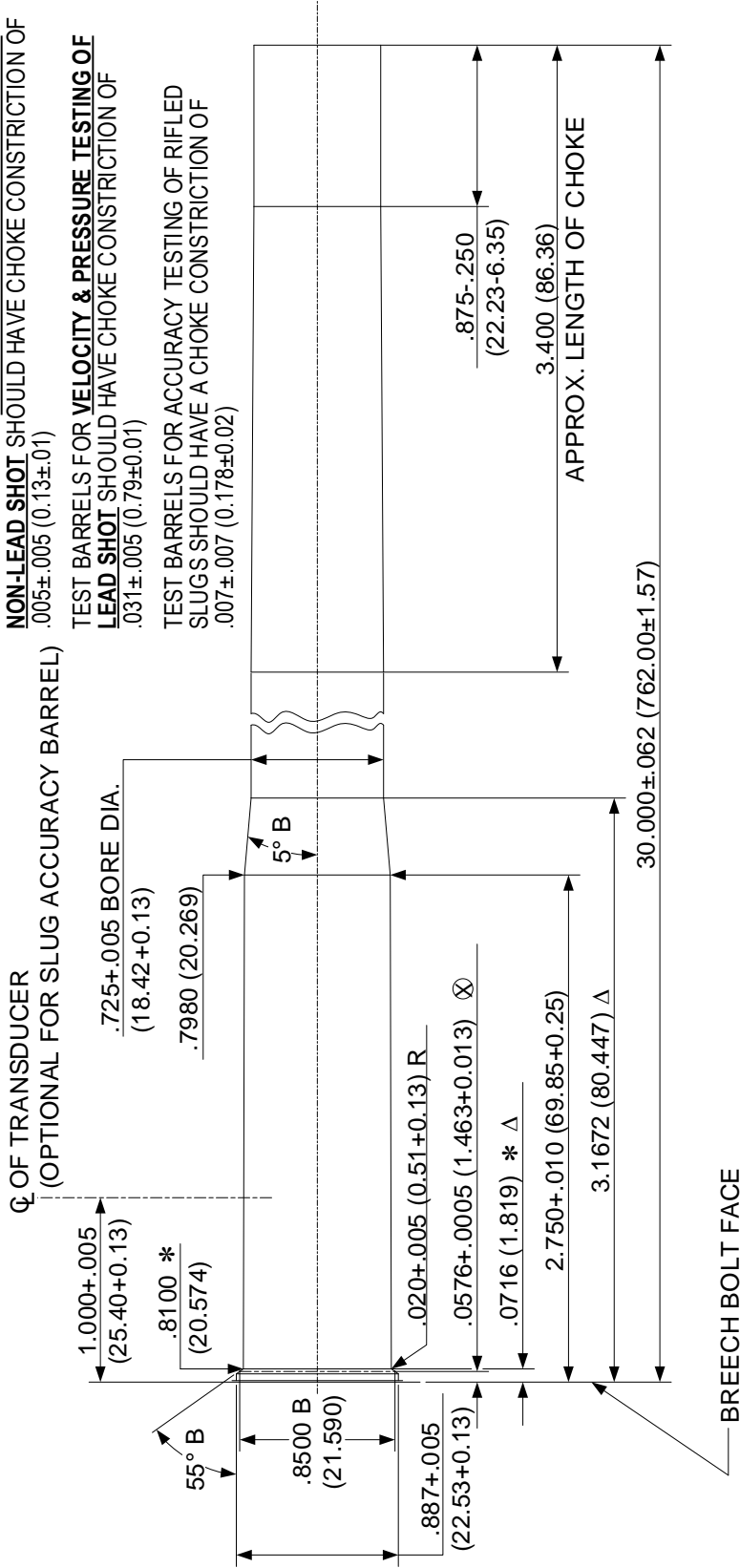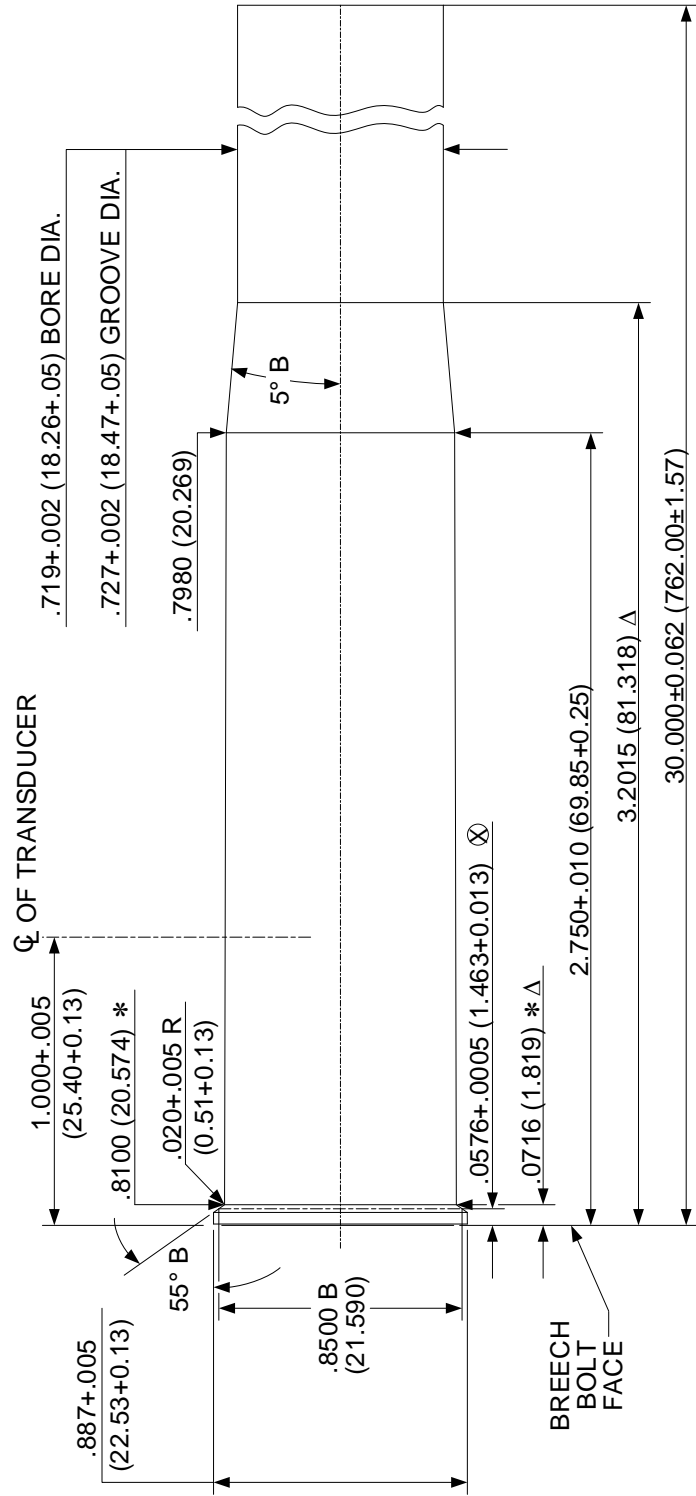ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

12 GAUGE 3 INCH STANDARD RIFLED V&P AND ACCURACY TEST BARREL

ISSUED: 08/26/1991

REVISED: 07/27/2015

DO NOT SCALE
FROM DRAWING

℄ OF TRANSDUCER

.719+.002 (18.26+.05) BORE DIA.

.727+.002 (18.47+.05) GROOVE DIA.

.7980 (20.269)

5° B

30.000±0.062 (762.00±1.57)

3.4515 (87.668) △

3.000+.010 (76.20+0.25)

.0576+.0005 (1.463+0.013) ⊗

.0712 (1.808) * △

1.000+.005
(25.40+0.13)

.8111 (20.602) *

.020+.005 R
(0.51+0.13)

55 ° B

.887+.005
(22.53+0.13)

.8500 B
(21.590)

BREECH
BOLT
FACE

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

△ 8 GROOVES
△ .141 ± .002 (3.58 ± 0.05) WIDE
TWIST 35 (889) ±.125 (3.18) RH (OPTIONAL)
MIN BORE/GROOVE AREA: .4105 IN^2 (264.838 MM^2)

NOTE:
B = BASIC
△ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

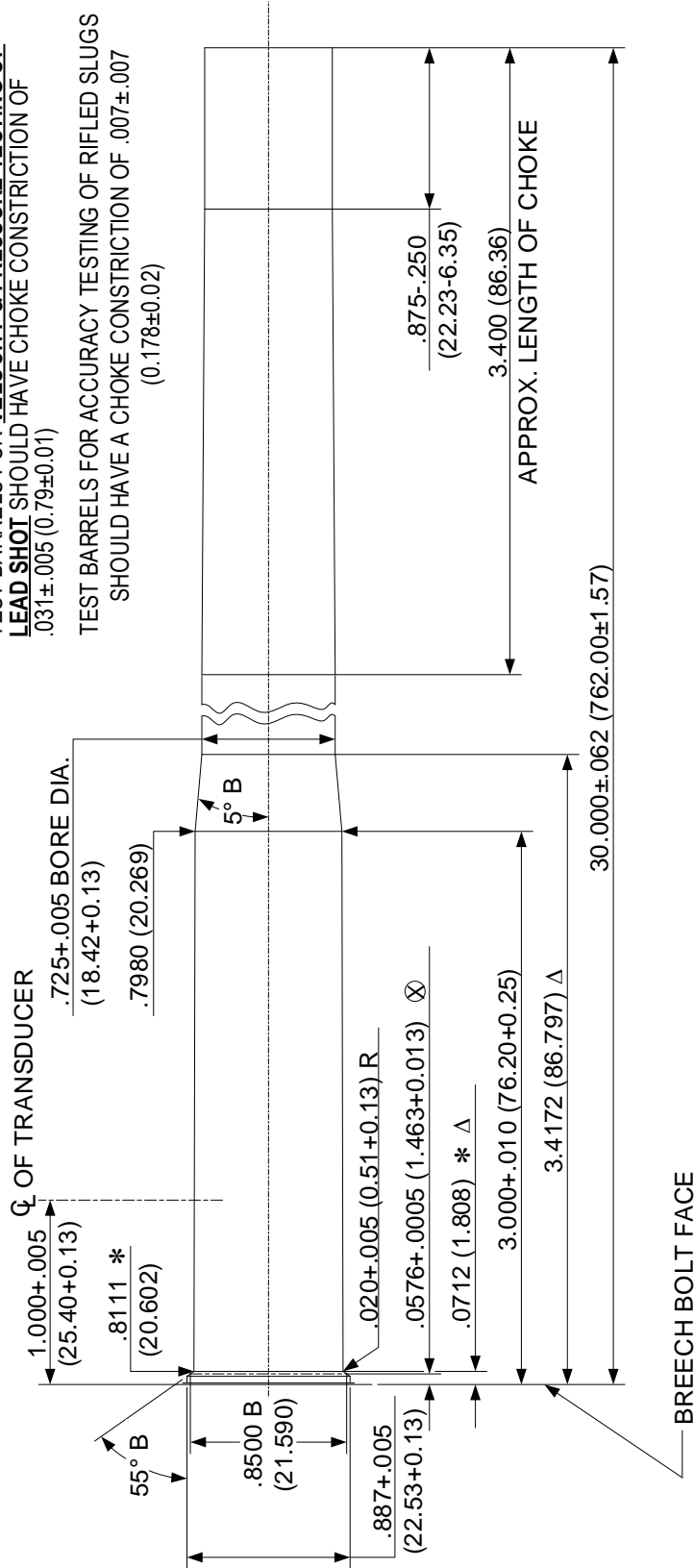# 12-GAUGE 3¹/₂ INCH STANDARD SMOOTHBORE V&P AND ACCURACY TEST BARREL

ISSUED: 04/10/1989

REVISED: 07/27/2015

DO NOT SCALE
FROM DRAWING

CHOKES:

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF NON-LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .005±.005 (0.13±.01)

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .031±.005 (0.79±0.01)

TEST BARRELS FOR ACCURACY TESTING OF RIFLED SLUGS SHOULD HAVE A CHOKE CONSTRICTION OF .007±.007 (0.178±0.02)

.875-.250
(22.23-6.35)

3.400 (86.36)
APPROX. LENGTH OF CHOKE

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

ℂ OF TRANSDUCER

.725+.005 BORE DIA.
(18.42+0.13)

.7980 (20.269)

5° B

30.000±.062 (762.00±1.57)

1.000+.005
(25.40+0.13)

.8111 *
(20.602)

.020+.005 (0.51+0.13) R

.0576+.0005 (1.463+0.013) ⊗

.0712 (1.808) * △

3.500+.010 (88.90+0.25)

3.9172 (99.497) △

55° B

.8500 B
(21.590)

.887+.005
(22.53+0.13)

BREECH BOLT FACE

NOTE:
B = BASIC
△ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
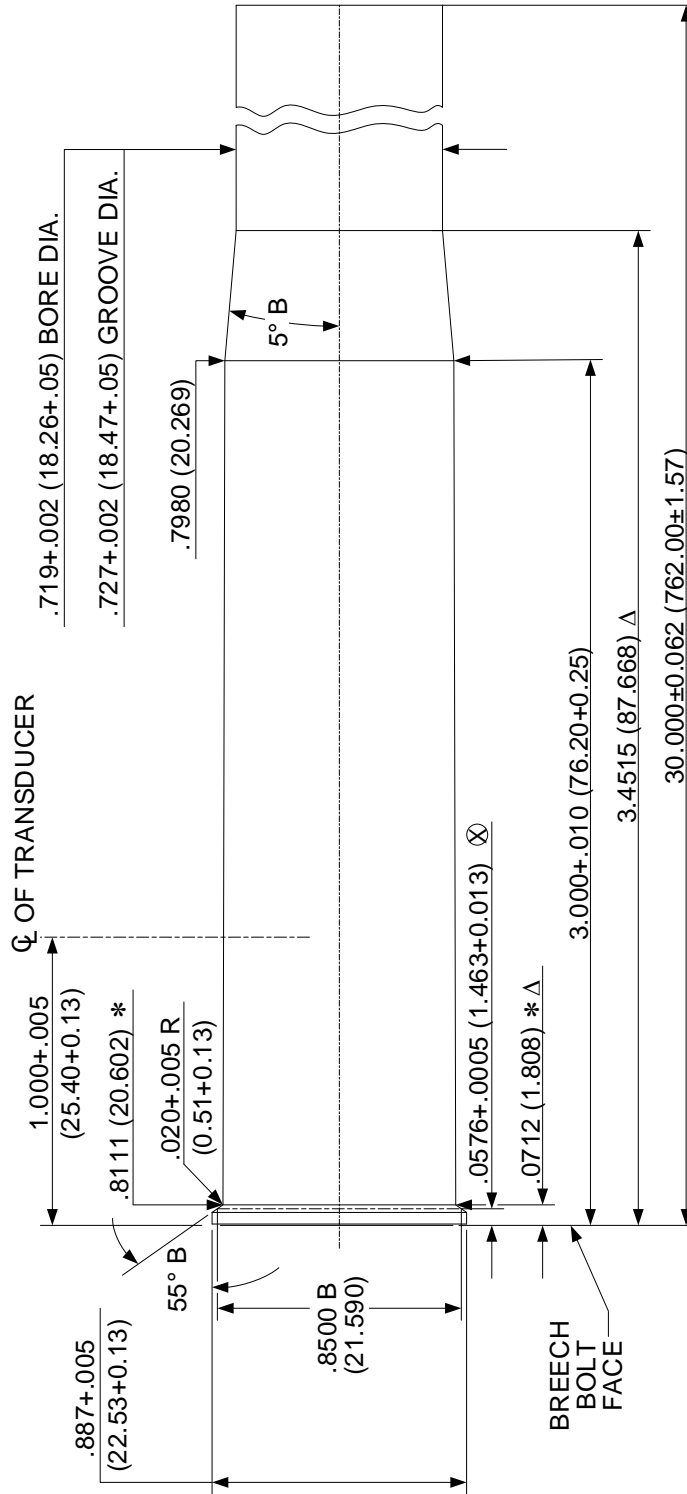* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

16-GAUGE 2³/₄ INCH STANDARD SMOOTHBORE V&P & ACCURACY TEST BARREL
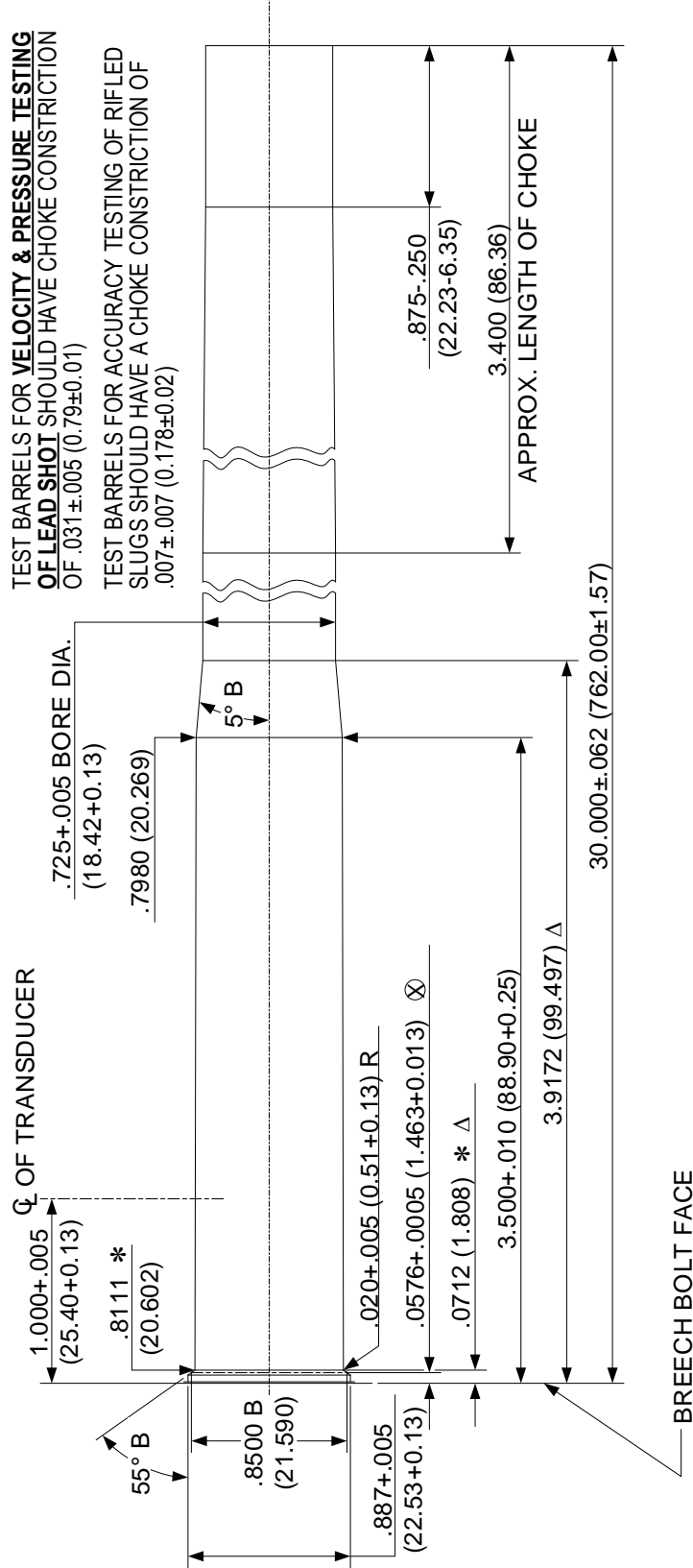
ISSUED: 04/10/1989   REVISED: 07/27/2015

DO NOT SCALE
FROM DRAWING

CHOKES:
TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF NON-LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .005±.005 (0.13±.01)

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .030±.005 (0.76±0.01)

TEST BARRELS FOR ACCURACY TESTING OF RIFLED SLUGS SHOULD HAVE A CHOKE CONSTRICTION OF .007±.007 (0.178±0.02)

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

.750-.250
(19.05-6.35)

3.223 (81.86)
APPROX. LENGTH OF CHOKE

.665+.005 BORE DIA.
(16.89+0.13)

.7320 (18.593)

5° B

CL OF TRANSDUCER

28.000±.062 (711.20±1.57)

.020+.005 (0.51+0.13) R

.0506+.0005 (1.285+0.013) ⊗

.0646 (1.641) * △

2.750+.010 (69.85+0.25)

3.1329 (79.576) △

1.000+.005
(25.40+0.13)

.7450 *
(18.923)

BREECH BOLT FACE

55° B

.7850 B
(19.939)

.820+.005
(20.83+0.13)

NOTE:
B = BASIC
△ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

20-GAUGE 2³/₄ INCH STANDARD SMOOTHBORE V&P AND ACCURACY TEST BARREL
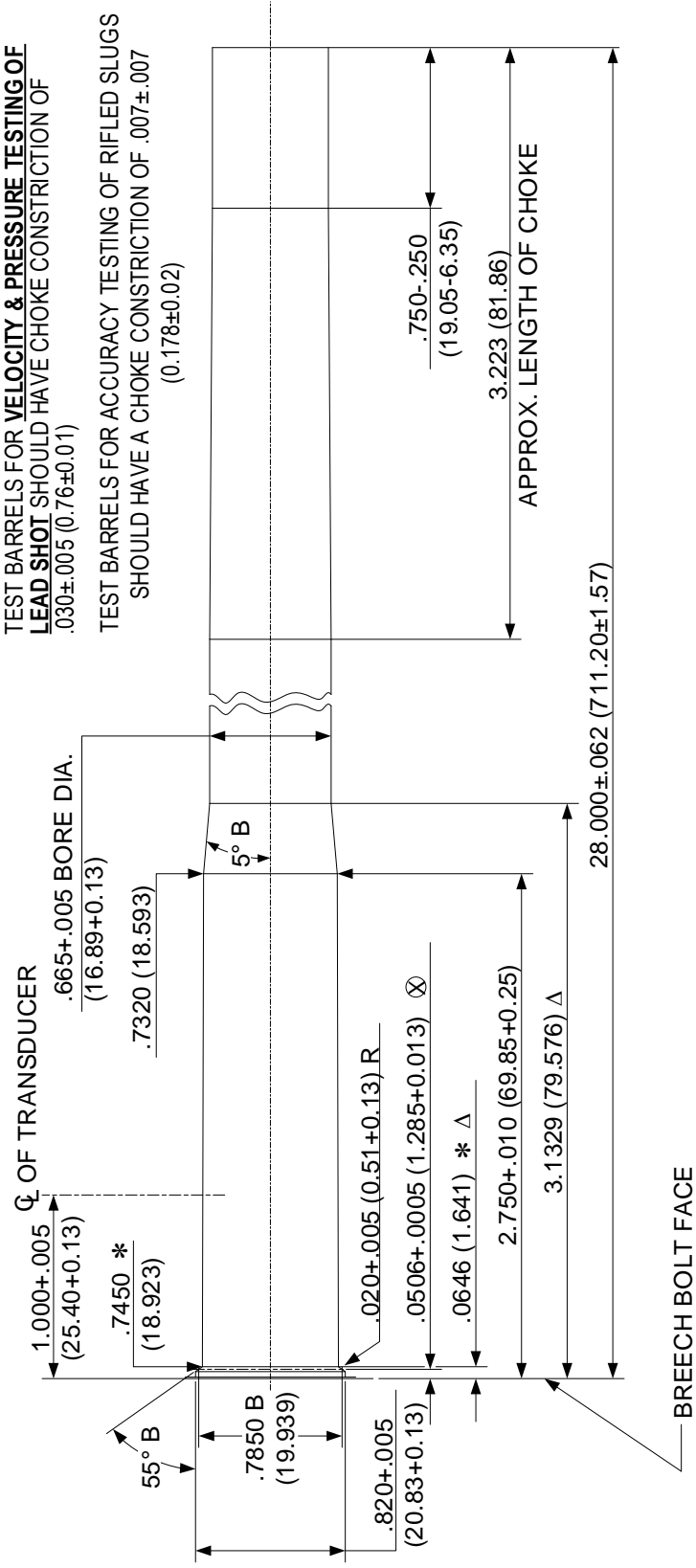
ISSUED: 04/10/1989   REVISED: 07/27/2015

DO NOT SCALE
FROM DRAWING

CHOKES:
TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF NON-LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .005±.005 (0.13±.01)

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .025±.005 (0.64±0.01)

TEST BARRELS FOR ACCURACY TESTING OF RIFLED SLUGS SHOULD HAVE A CHOKE CONSTRICTION OF .007±.007 (0.178±0.02)

.625-.250
(15.88-6.35)

3.008 (76.40)
APPROX. LENGTH OF CHOKE

Ꞓ OF TRANSDUCER

.615+.005 BORE DIA.
(15.62+0.13)

.6850 (17.399)

5° B

26.000±.062 (660.40±1.57)

1.000+.005
(25.40+0.13)

.6980 *
(17.729)

.020+.005 (0.51+0.13) R

.0484+.0005 (1.229+0.013) ⊗

.0596 (1.514) * △

2.750+.010 (69.85+0.25) △

3.1501 (80.013) △

BREECH BOLT FACE

55° B

.7300 B
(18.542)

.767+.005
(19.48+0.13)

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

NOTE:
B = BASIC
△ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

20 GAUGE 2³/₄ INCH STANDARD RIFLED V&P AND ACCURACY TEST BARREL

ISSUED: 01/08/1992

REVISED: 06/01/2016

DO NOT SCALE FROM DRAWING

℄ OF TRANSDUCER

.609+.002 (15.47+.05) BORE DIA.

.618+.002 (15.70+.05) GROOVE DIA.

.6850 (17.399)

5° B

26.000±0.062 (660.40±1.57)

3.1901 (81.029) Δ

2.750+.010 (69.85+0.25)

.0484+.0005 (1.229+0.013) ⊗

.0596 (1.514) * Δ

1.000+.005 (25.40+0.13)

.6980 (17.729) *

.020+.005 R (0.51+0.13)

55° B

.7300 B (18.542)

.767+.005 (19.48+0.13)

BREECH BOLT FACE

Δ 8 GROOVES
Δ .119 ± .002 (3.02 ± 0.05) WIDE
TWIST 24 (607) ± .125 (3.18) RH (OPTIONAL)
MIN BORE/GROOVE AREA: .2955 IN² (190.645 MM²)

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

NOTE:
B = BASIC
Δ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

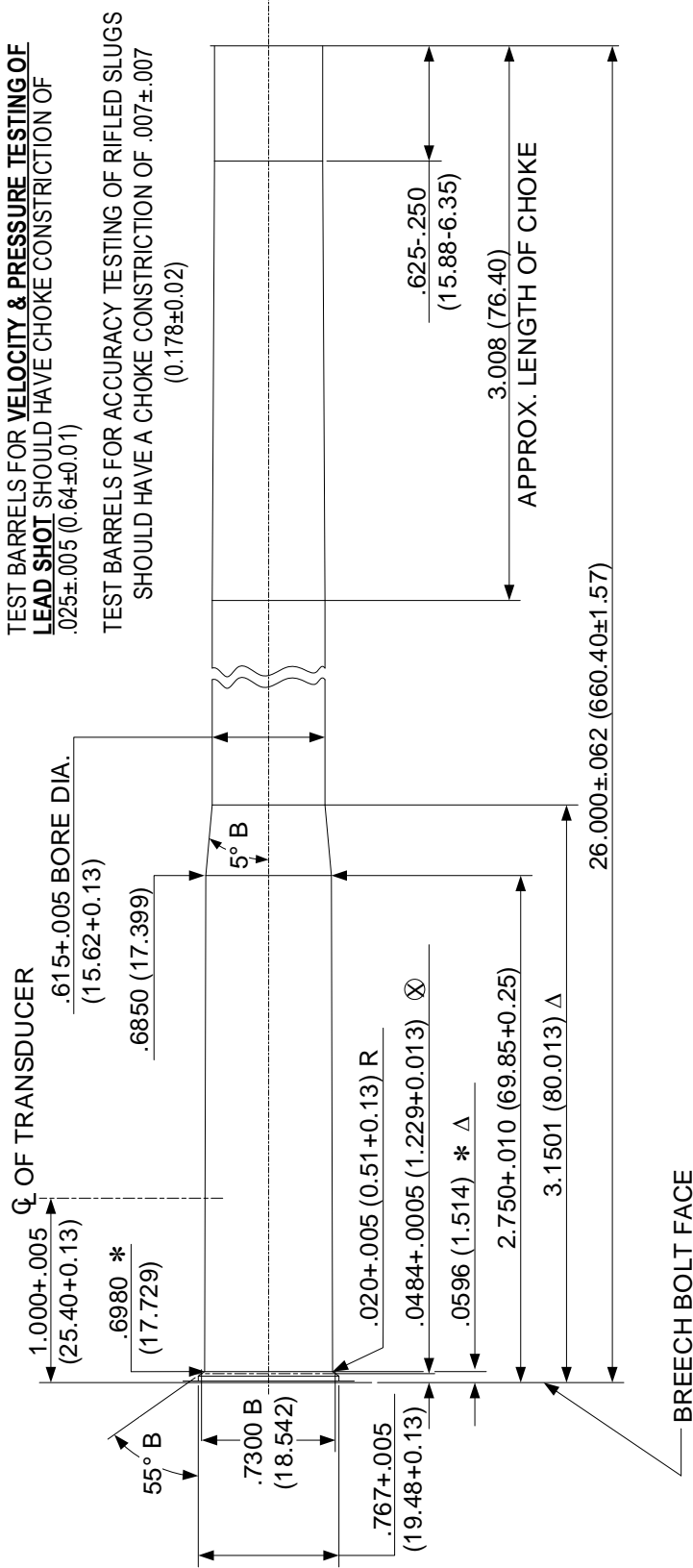ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

20-GAUGE 3 INCH STANDARD SMOOTHBORE V&P AND ACCURACY TEST BARREL

ISSUED: 04/10/1989   REVISED: 07/27/2015

DO NOT SCALE
FROM DRAWING

CHOKES:
TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF NON-LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .005±.005 (0.13±.01)

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .025±.005 (0.64±.01)

TEST BARRELS FOR ACCURACY TESTING OF RIFLED SLUGS SHOULD HAVE A CHOKE CONSTRICTION OF .007±.007 (0.178±0.02)

.625-.250
(15.88-6.35)
APPROX. LENGTH OF CHOKE

3.008 (76.40)

CL OF TRANSDUCER

.615+.005 BORE DIA.
(15.62+0.13)

.6850 (17.399)

5° B

B

30.000±.062 (762.00±1.57)

1.000+.005
(25.40+0.13)

.6992 *
(17.760)

.020+.005 (0.51+0.13) R

.0484+.0005 (1.229+0.013) ⊗

.0592 (1.504) * △

3.000+.010 (76.20+0.25)

3.4001 (86.363) △

55° B

.7300 B
(18.542)

.767+.005
(19.48+0.13)

BREECH BOLT FACE
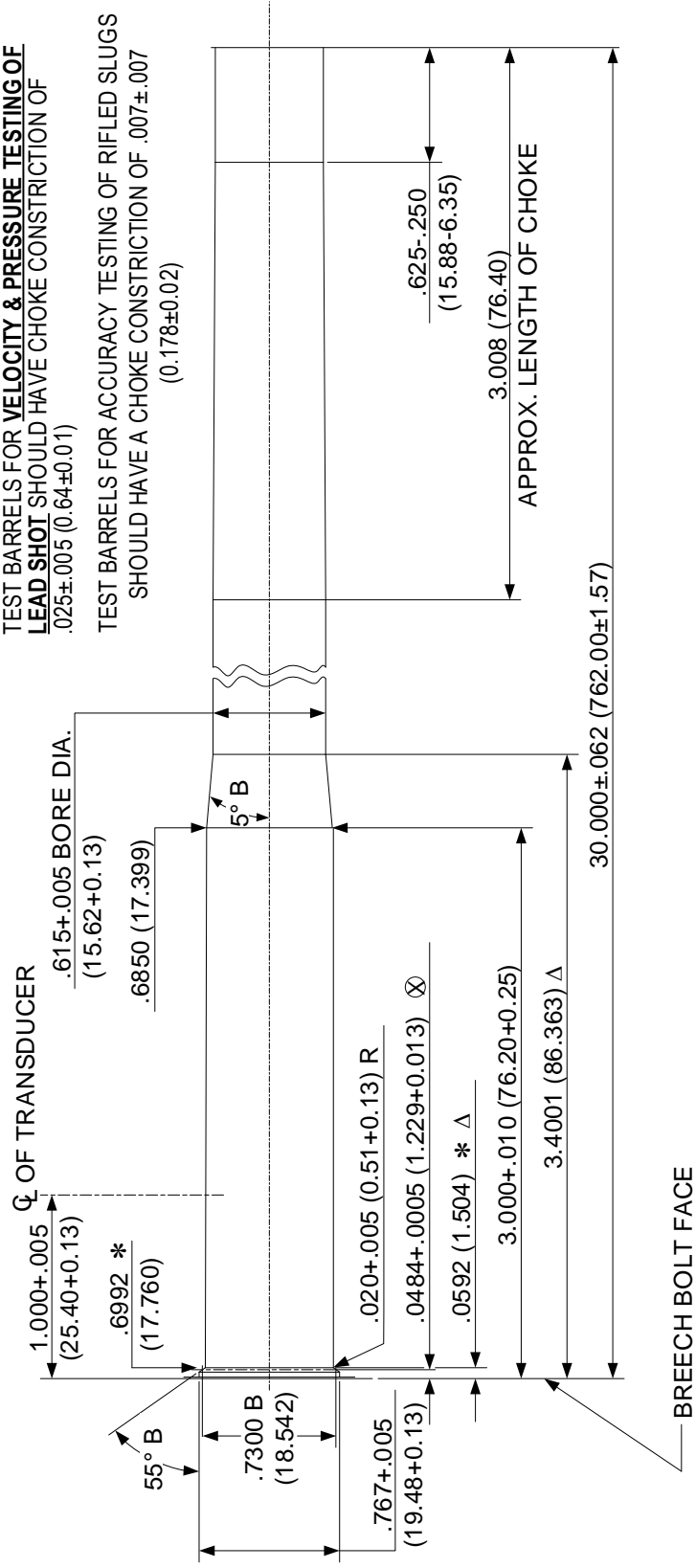
UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

NOTE:
B = BASIC
△ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
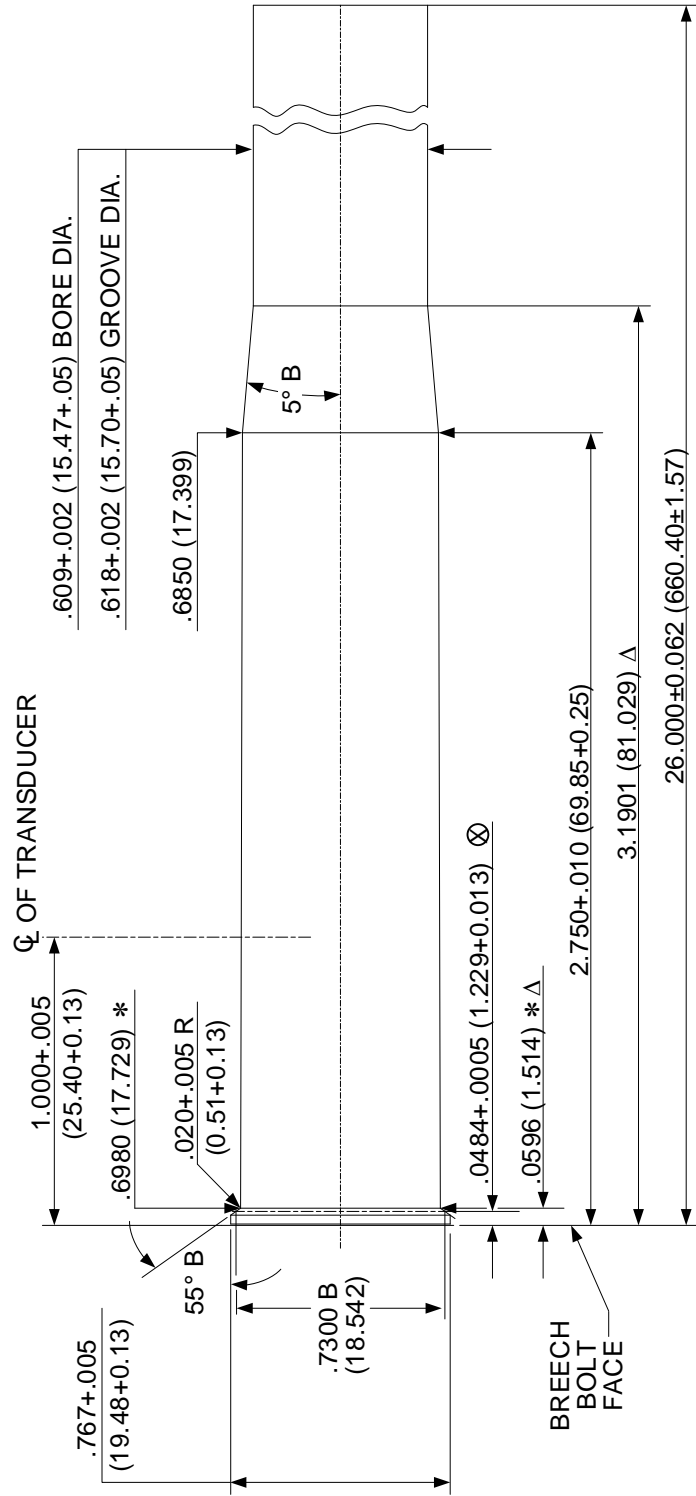* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

20 GAUGE 3 INCH STANDARD RIFLED V&P AND ACCURACY TEST BARREL

ISSUED: 02/10/2004

REVISED: 07/27/2015

DO NOT SCALE FROM DRAWING

℄ OF TRANSDUCER

.609+.002 (15.47+.05) BORE DIA.

.618+.002 (15.70+.05) GROOVE DIA.

.6850 (17.399)

5° B

26.000±0.062 (660.40±1.57)

3.4343 (87.231) Δ

3.000+.010 (76.20+0.25)

.0484+.0005 (1.229+0.013) ⊗

.0592 (1.504) *Δ

1.000+.005 (25.40+0.13)

.6992 (17.760) *

.020+.005 R (0.51+0.13)

55° B

.767+.005 (19.48+0.13)

.7300 B (18.542)

BREECH BOLT FACE

Δ 8 GROOVES
Δ .119 ± .002 (3.02 ± 0.05) WIDE
TWIST 24 (609) ± .125 (3.18) RH (OPTIONAL)
MIN BORE/GROOVE AREA: .2955 IN² (190.645 MM²)

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

NOTE:
B = BASIC
Δ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
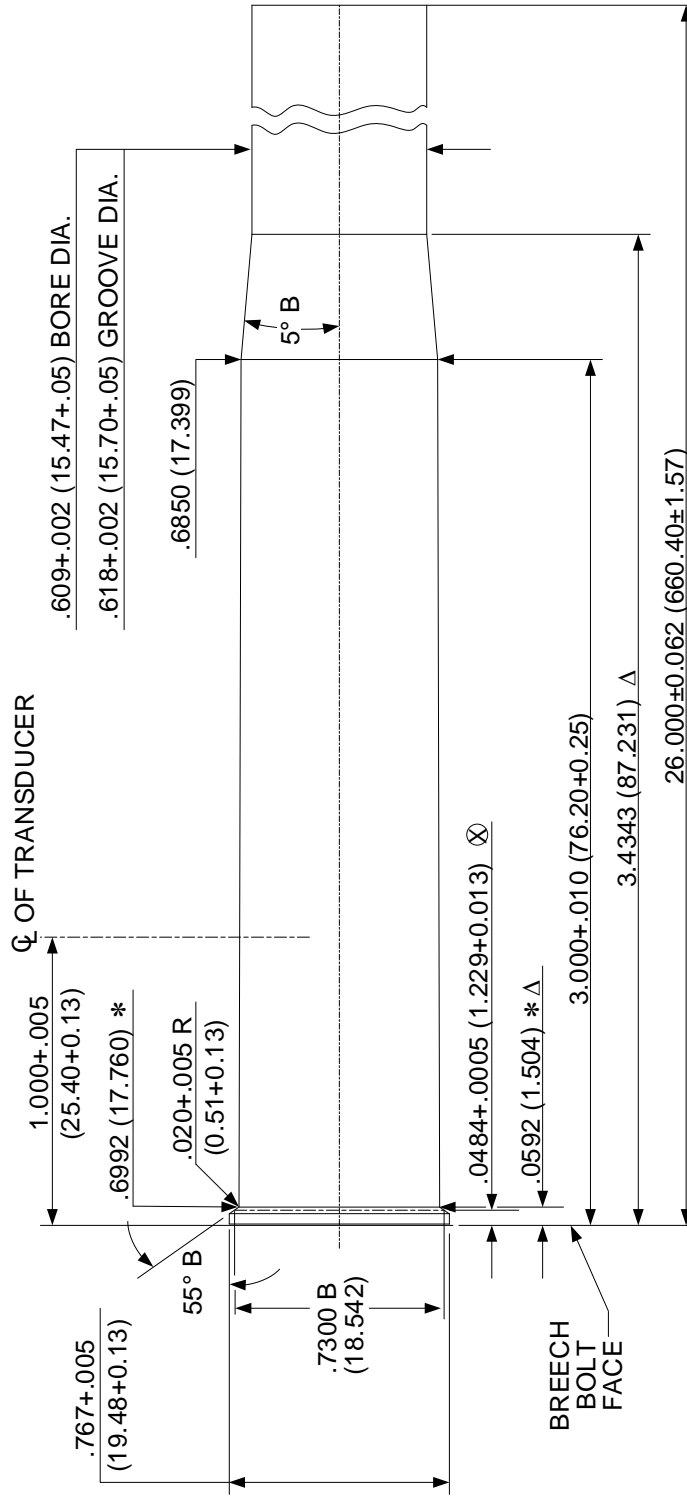* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

28-GAUGE 2³/₄ INCH STANDARD SMOOTHBORE V&P TEST BARREL

ISSUED: 03/01/1959

REVISED: 07/27/2015

**DO NOT SCALE
FROM DRAWING**

CHOKES:
TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF
NON-LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF
.005±.005 (0.13±.01)

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF
LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF
.022±.005 (0.56±.01)

.625-.250
(15.88-6.35)

2.748 (69.80)
APPROX. LENGTH OF CHOKE

.545+.005 BORE DIA.
(13.84+0.13)

.6140 (15.596)

5° B

26.000±.062 (660.40±1.57)

℄ OF TRANSDUCER

1.000+.005
(25.40+0.13)

.6270 *
(15.926)

.020+.005 (0.51+0.13) R

.0498+.0005 (1.265+0.013) ⊗

.0596 (1.514) * △

2.750+.010 (69.85+0.25) △

3.1443 (79.865) △

BREECH BOLT FACE

55° B

.6550 B
(16.637)

.688+.005
(17.48+0.13)

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

NOTE:
B = BASIC
△ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

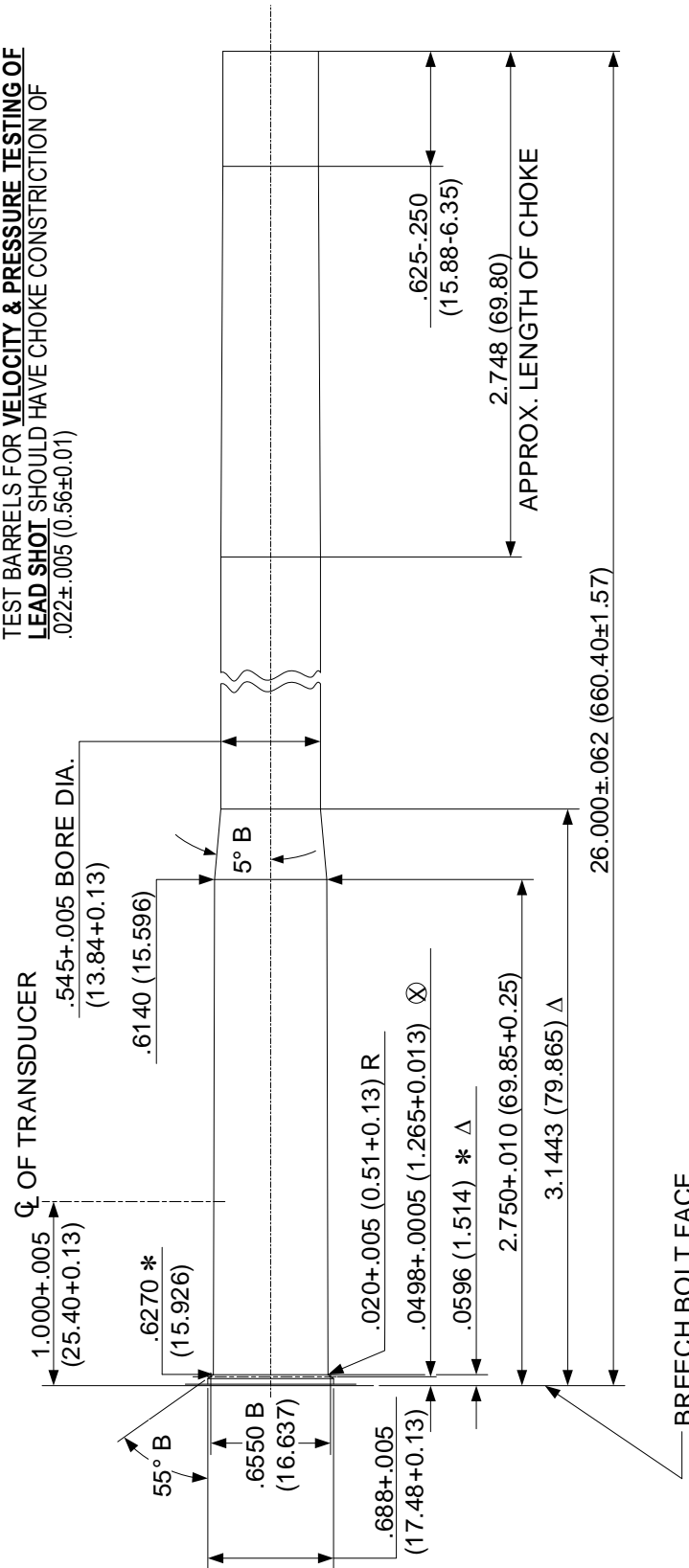ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

410 BORE 2½ & 3 INCH STANDARD SMOOTHBORE V&P AND ACCURACY TEST BARREL
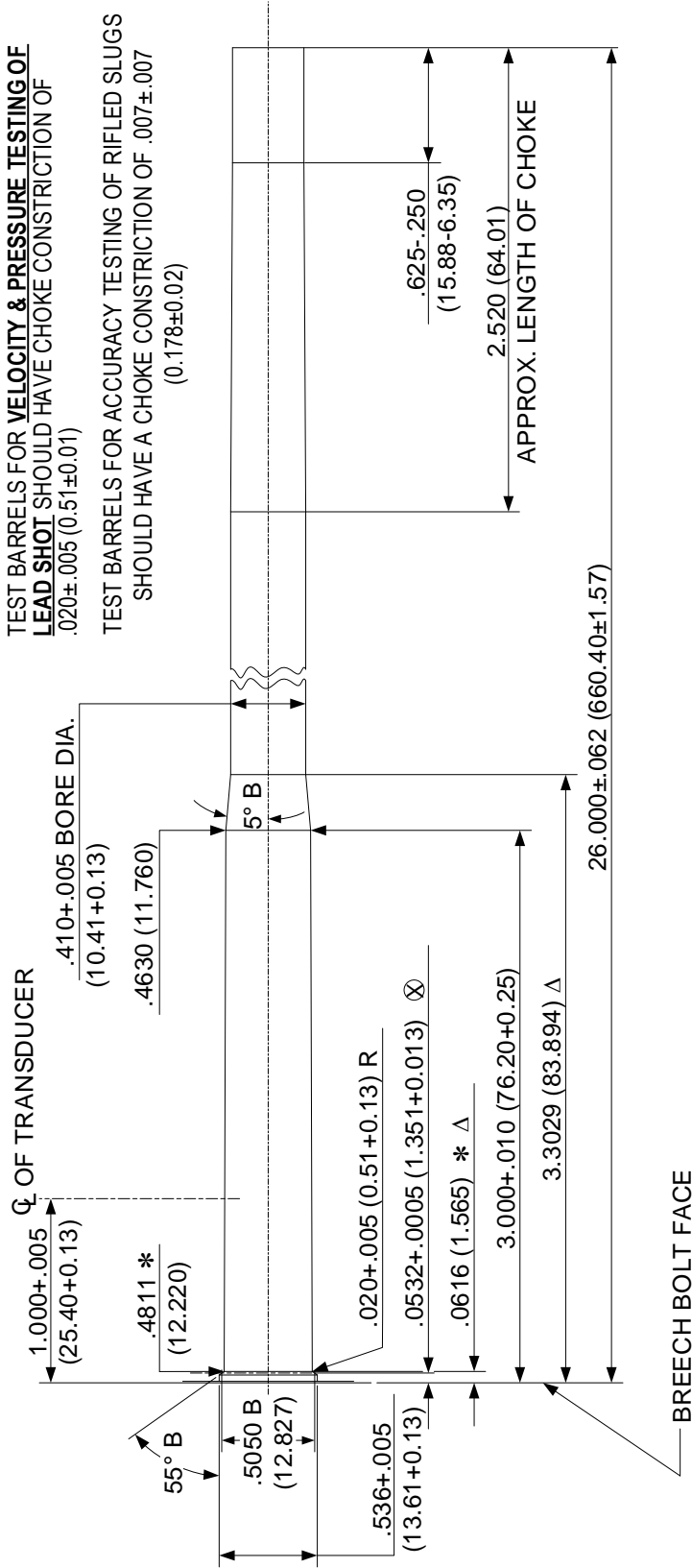
ISSUED: 03/01/1959   REVISED: 07/27/2015

DO NOT SCALE
FROM DRAWING

CHOKES:
TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF NON-LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .005±.005 (0.13±.01)

TEST BARRELS FOR **VELOCITY & PRESSURE TESTING OF LEAD SHOT** SHOULD HAVE CHOKE CONSTRICTION OF .020±.005 (0.51±.01)

TEST BARRELS FOR ACCURACY TESTING OF RIFLED SLUGS SHOULD HAVE A CHOKE CONSTRICTION OF .007±.007 (0.178±0.02)

.625-.250
(15.88-6.35)

2.520 (64.01)
APPROX. LENGTH OF CHOKE

CL OF TRANSDUCER

.410+.005 BORE DIA.
(10.41+0.13)

.4630 (11.760)

5° B

26.000±.062 (660.40±1.57)

1.000+.005
(25.40+0.13)

.4811 *
(12.220)

.020+.005 (0.51+0.13) R

.0532+.0005 (1.351+0.013) ⊗

.0616 (1.565) * △

3.000+.010 (76.20+0.25)

3.3029 (83.894) △

55° B

.5050 B
(12.827)

.536+.005
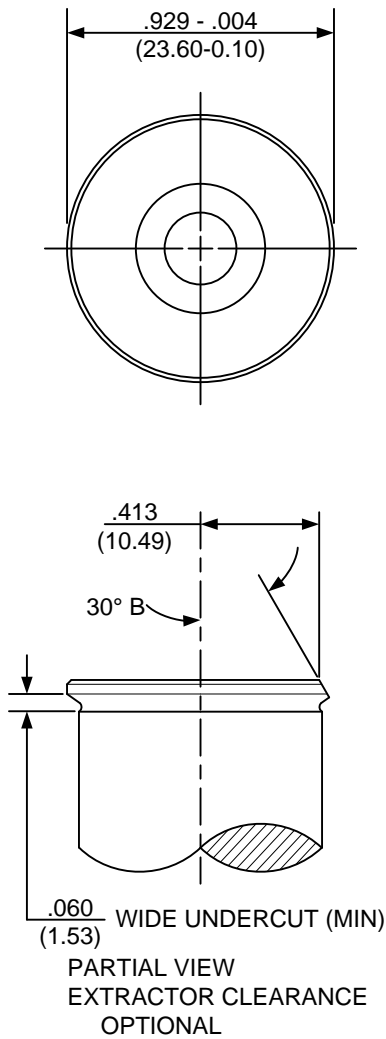(13.61+0.13)

BREECH BOLT FACE

UNLESS OTHERWISE NOTED
ALL DIA +.0005 (0.013)
LENGTH TOL +.005 (0.13)

NOTE:
B = BASIC
△ = REFERENCE DIMENSION
⊗ = HEADSPACE DIMENSION
* = INTERSECTIONS OF LINES
(XX.XX) = MILLIMETERS

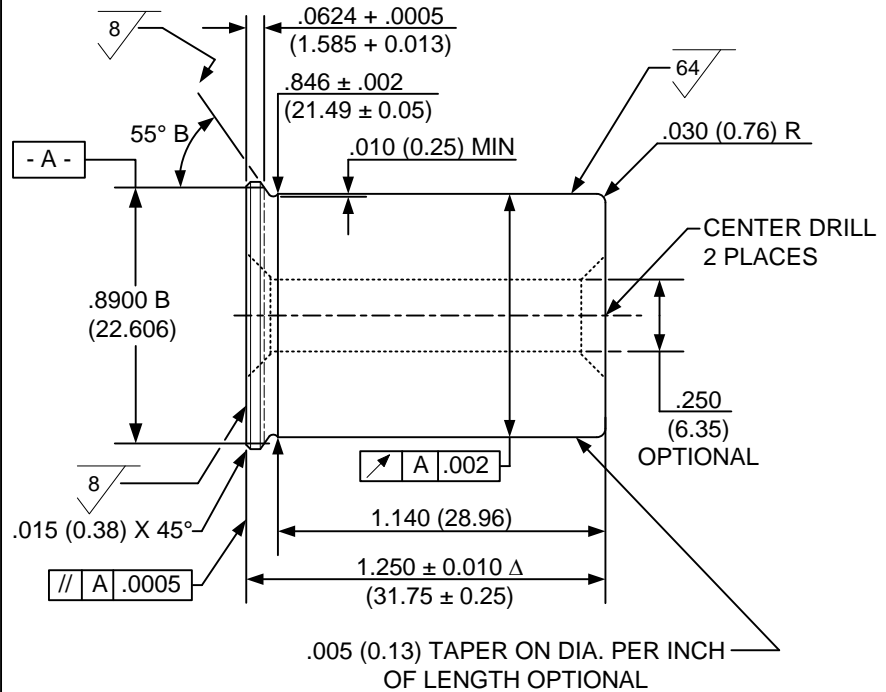ALL CALCULATIONS APPLY AT MAXIMUM MATERIAL CONDITION (MMC)

Shotshell Headspace Gauges – 10 Gauge

.929 - .004
(23.60-0.10)

.413
(10.49)

30° B

.060 WIDE UNDERCUT (MIN)
(1.53)

PARTIAL VIEW
EXTRACTOR CLEARANCE
OPTIONAL

MATERIAL: AISI-06 STEEL OR
EQUIVALENT
HEAT TREAT TO R_C 60-64

UNLESS OTHERWISE NOTED
ALL TOLERANCES TO BE ±.005
(±0.13)

NOTE:
B = BASIC
Δ= REFERENCE DIMENSION
(XX.XX) = MILLIMETERS

8

.0624 + .0005
(1.585 + 0.013)

.846 ± .002
(21.49 ± 0.05)

.010 (0.25) MIN

64

.030 (0.76) R

55° B

- A -

CENTER DRILL
2 PLACES

.8900 B
(22.606)

.250
(6.35)
OPTIONAL

8

A .002

.015 (0.38) X 45°

1.140 (28.96)

1.250 ± 0.010 Δ
(31.75 ± 0.25)

// A .0005

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MINIMUM GAUGE

8

.0764 - .0005
(1.941 - 0.013)

.846 ± .002
(21.49 ± 0.05)

.010 (0.25) MIN

64

.030 (0.76) R

55° B

- A -

CENTER DRILL
2 PLACES

.8900 B
(22.606)

.250
(6.35)
OPTIONAL

8

A .002

.015 (0.38) X 45°

1.140 (28.96)

1.250 ± 0.010 Δ
(31.75 ± 0.25)

// A .0005

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MAXIMUM GAUGE

Shotshell Headspace Gauges – 12 Gauge

.882 - .004
(22.40-0.10)

.391
(9.93)

30° B

.060 WIDE UNDERCUT (MIN)
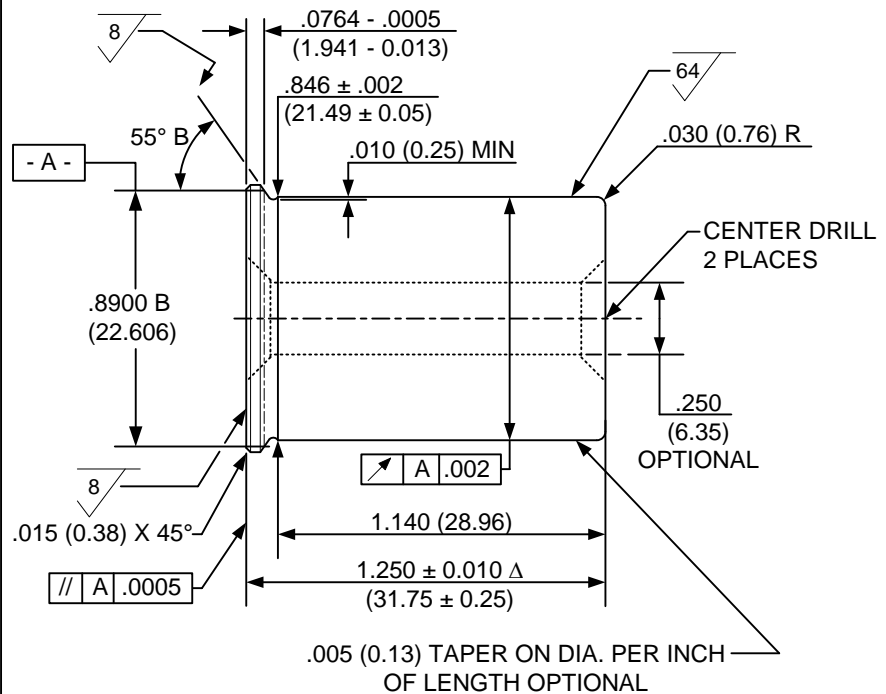(1.53)

PARTIAL VIEW
EXTRACTOR CLEARANCE
OPTIONAL

MATERIAL: AISI-06 STEEL OR
EQUIVALENT
HEAT TREAT TO R$_C$ 60-64

UNLESS OTHERWISE NOTED
ALL TOLERANCES TO BE ±.005
(±0.13)

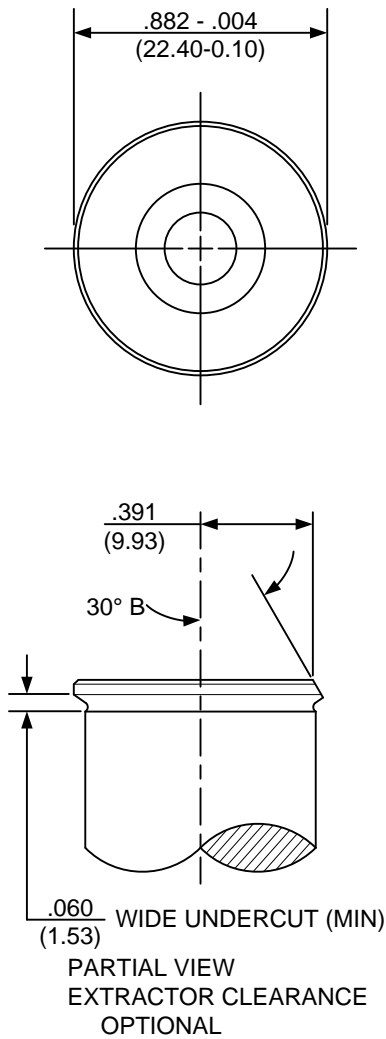**NOTE:**
B = BASIC
∆= REFERENCE DIMENSION
(XX.XX) = MILLIMETERS

.0576 + .0005
(1.463 + 0.013)
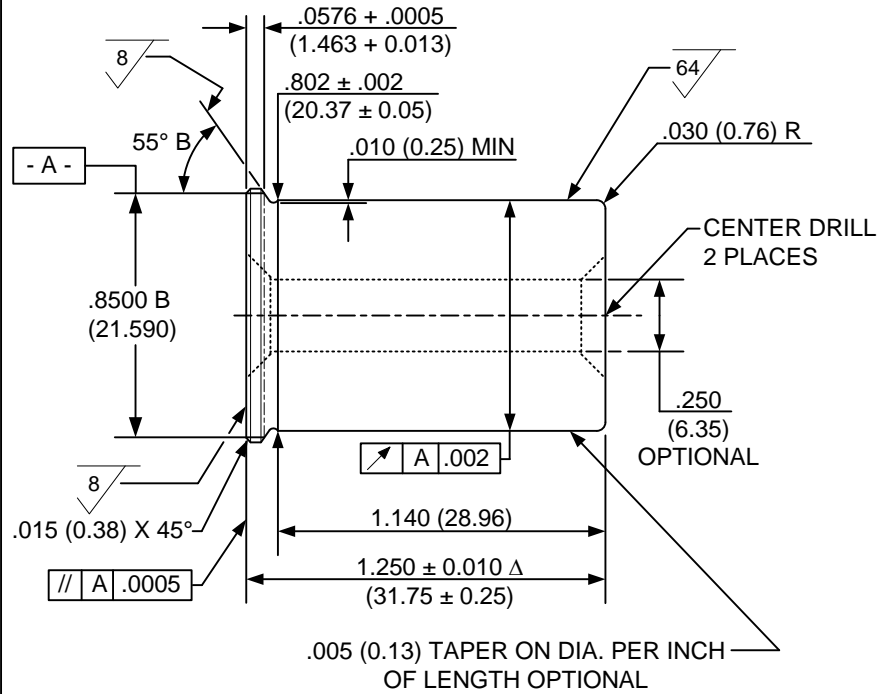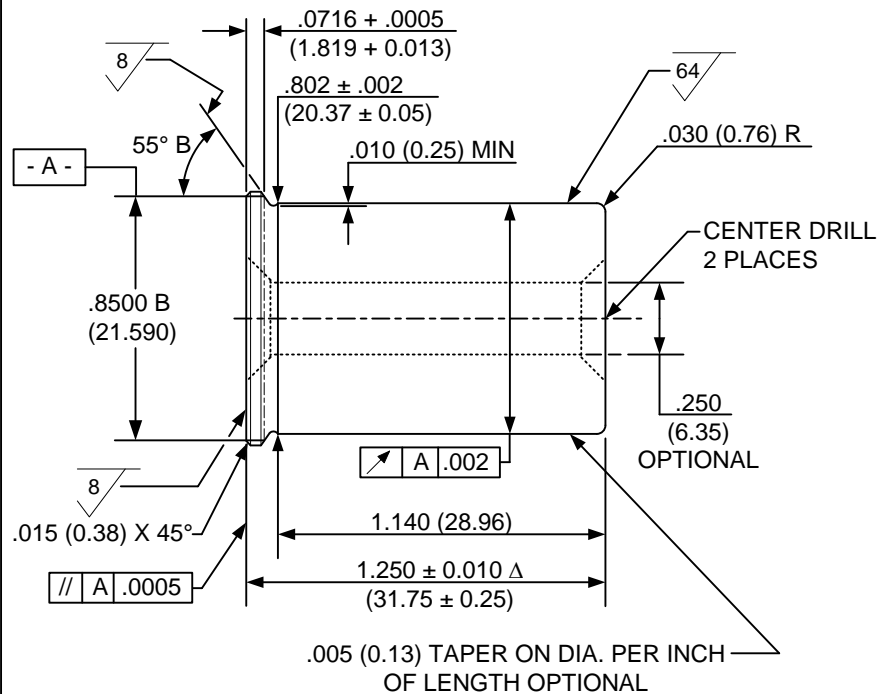
.802 ± .002
(20.37 ± 0.05)

.010 (0.25) MIN

64

.030 (0.76) R

8

55° B

- A -

.8500 B
(21.590)

CENTER DRILL
2 PLACES

.250
(6.35)
OPTIONAL

8

A .002

.015 (0.38) X 45°

1.140 (28.96)

1.250 ± 0.010 ∆
(31.75 ± 0.25)

// A .0005

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MINIMUM GAUGE

.0716 + .0005
(1.819 + 0.013)

.802 ± .002
(20.37 ± 0.05)

.010 (0.25) MIN

64

.030 (0.76) R

8

55° B

- A -

.8500 B
(21.590)

CENTER DRILL
2 PLACES

.250
(6.35)
OPTIONAL

8

A .002

.015 (0.38) X 45°

1.140 (28.96)

1.250 ± 0.010 ∆
(31.75 ± 0.25)

// A .0005

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MAXIMUM GAUGE

Shotshell Headspace Gages – 16 Gauge
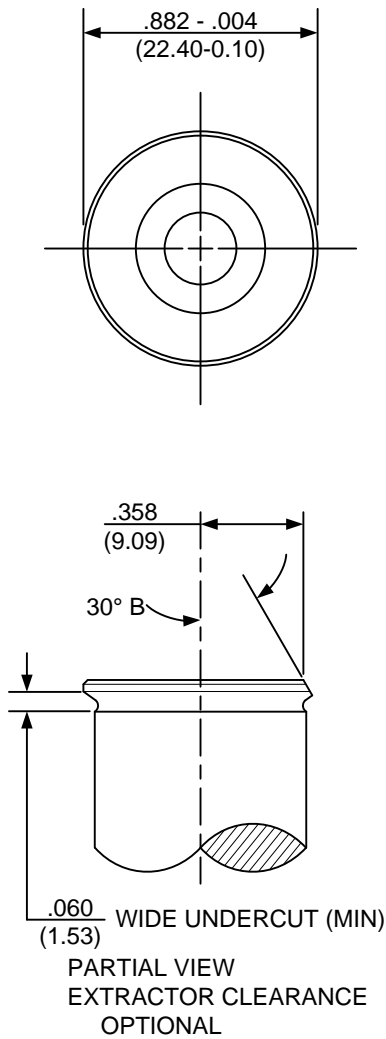
.882 - .004
(22.40-0.10)

.0506 + .0005
(1.285 + 0.013)

8

64

.736 ± .002
(18.69 ± 0.05)

.030 (0.76) R

55° B

.010 (0.25) MIN

- A -

CENTER DRILL
2 PLACES

.7850 B
(19.939)

.250
(6.35)
OPTIONAL

A .002

8

.015 (0.38) X 45°

1.140 (28.96)

// A .0005

1.250 ± 0.010 Δ
(31.75 ± 0.25)

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MINIMUM GAUGE

.358
(9.09)

30° B

.0646 + .0005
(1.641 + 0.013)

8

64

.736 ± .002
(18.69 ± 0.05)

.030 (0.76) R

55° B

.010 (0.25) MIN

- A -

CENTER DRILL
2 PLACES

.060 WIDE UNDERCUT (MIN)
(1.53)

PARTIAL VIEW
EXTRACTOR CLEARANCE
OPTIONAL

.7850 B
(19.939)

.250
(6.35)
OPTIONAL

A .002

MATERIAL: AISI-06 STEEL OR
EQUIVALENT
HEAT TREAT TO R_C 60-64

UNLESS OTHERWISE NOTED
ALL TOLERANCES TO BE ±.005
(±0.13)

8

.015 (0.38) X 45°

1.140 (28.96)

// A .0005

1.250 ± 0.010 Δ
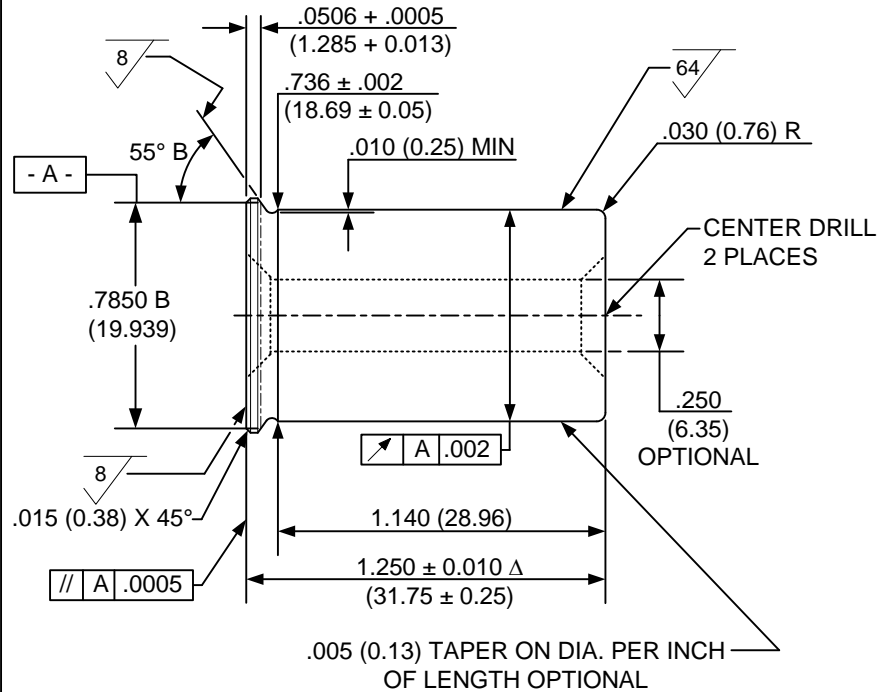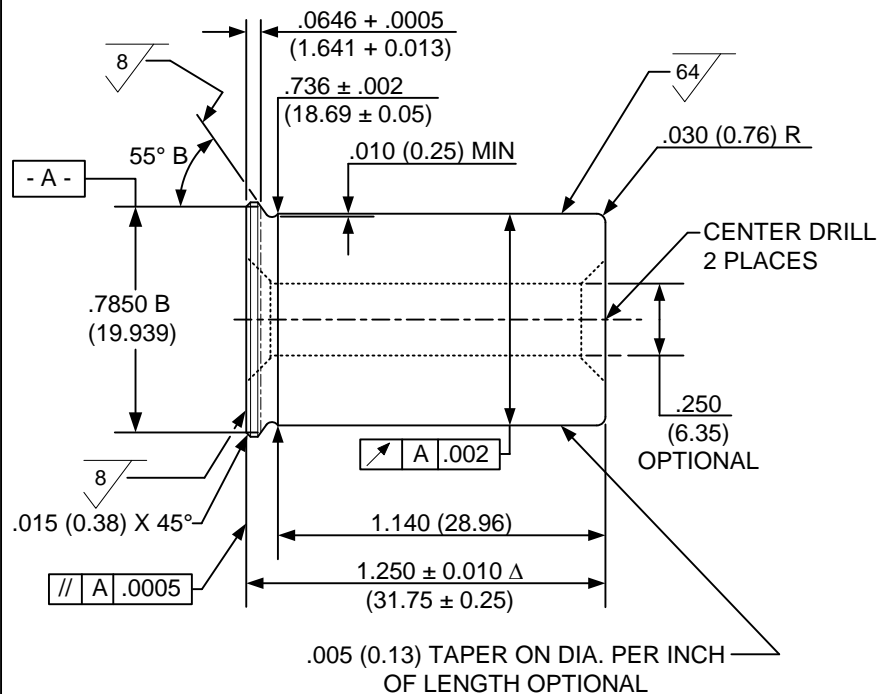(31.75 ± 0.25)

NOTE:
B = BASIC
Δ = REFERENCE DIMENSION
(XX.XX) = MILLIMETERS

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MAXIMUM GAUGE

Shotshell Headspace Gauges – 20 Gauge
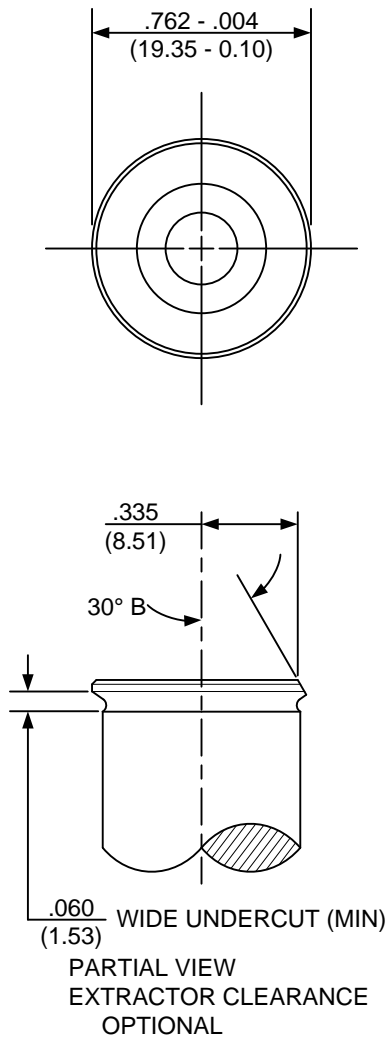
.762 - .004
(19.35 - 0.10)

.0484 + .0005
(1.229 + 0.013)

.689 ± .002
(17.50 ± 0.05)

.010 (0.25) MIN

64

.030 (0.76) R

8

55° B

- A -

.7300 B
(18.542)

CENTER DRILL
2 PLACES

.250
(6.35)
OPTIONAL

8

A .002

.015 (0.38) X 45°

1.140 (28.96)

// A .0005

1.250 ± 0.010 Δ
(31.75 ± 0.25)

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MINIMUM GAUGE

.335
(8.51)

30° B

.060 WIDE UNDERCUT (MIN)
(1.53)

PARTIAL VIEW
EXTRACTOR CLEARANCE
OPTIONAL

.0624 + .0005
(1.585 + 0.013)

.689 ± .002
(17.50 ± 0.05)

.010 (0.25) MIN

64

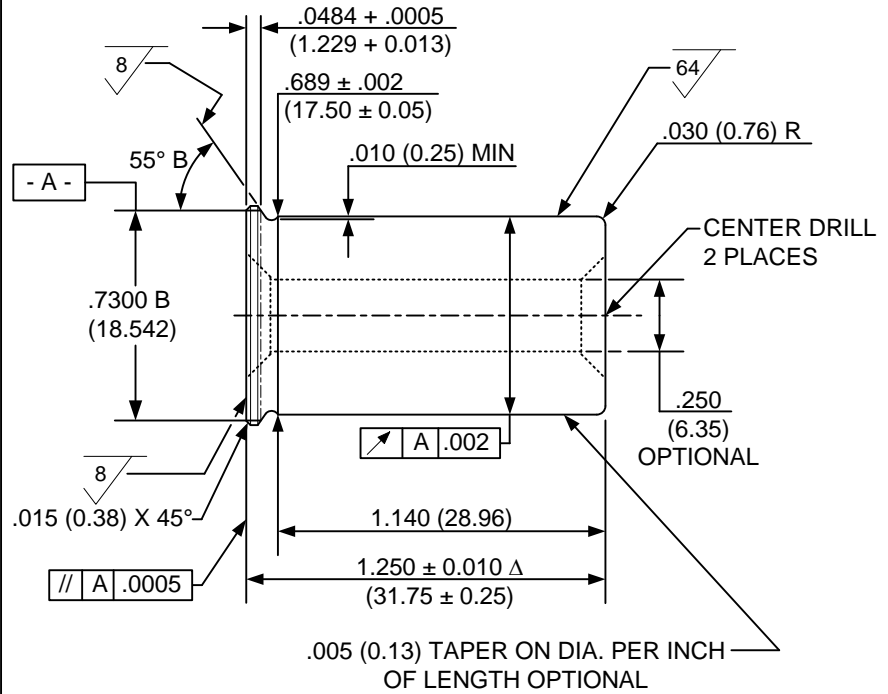.030 (0.76) R

8

55° B

- A -

.7300 B
(18.542)

CENTER DRILL
2 PLACES

.250
(6.35)
OPTIONAL
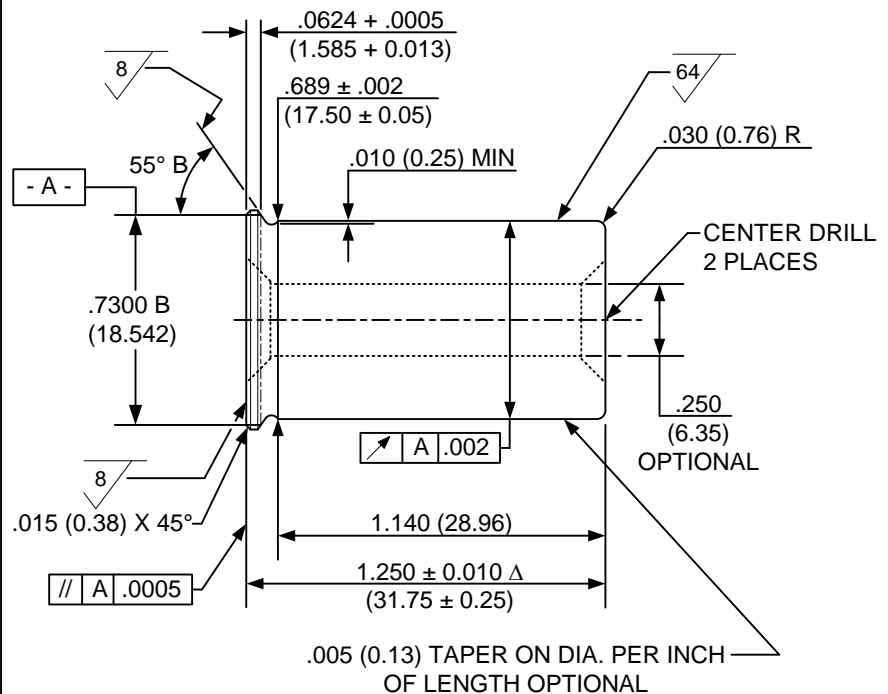
MATERIAL: AISI-06 STEEL OR
EQUIVALENT
HEAT TREAT TO R_C 60-64

UNLESS OTHERWISE NOTED
ALL TOLERANCES TO BE ±.005
(±0.13)

8

A .002

.015 (0.38) X 45°

1.140 (28.96)

// A .0005

1.250 ± 0.010 Δ
(31.75 ± 0.25)

NOTE:
B = BASIC
Δ = REFERENCE DIMENSION
(XX.XX) = MILLIMETERS

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MAXIMUM GAUGE

Shotshell Headspace Gauges – 28 Gauge

MINIMUM GAUGE

.683 - .004
(17.35 - 0.10)

.0498 + .0005
(1.265 + 0.013)

.618 ± .002
(15.70 ± 0.05)

.010 (0.25) MIN

64

.030 (0.76) R

8

55° B

- A -

.6550 B
(16.637)

CENTER DRILL
2 PLACES

.250
(6.35)
OPTIONAL

8

| ✓ | A | .002 |

.015 (0.38) X 45°

1.140 (28.96)

1.250 ± 0.010 Δ
(31.75 ± 0.25)

| // | A | .0005 |

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MAXIMUM GAUGE

.297
(7.54)

30° B

.060 WIDE UNDERCUT (MIN)
(1.53)

PARTIAL VIEW
EXTRACTOR CLEARANCE
OPTIONAL

.0638 + .0005
(1.621 + 0.013)

.618 ± .002
(15.70 ± 0.05)

.010 (0.25) MIN

64

.030 (0.76) R

8

55° B

- A -

.6550 B
(16.637)

CENTER DRILL
2 PLACES

.250
(6.35)
OPTIONAL

8

| ✓ | A | .002 |

.015 (0.38) X 45°

1.140 (28.96)

1.250 ± 0.010 Δ
(31.75 ± 0.25)

| // | A | .0005 |

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MATERIAL: AISI-06 STEEL OR
EQUIVALENT
HEAT TREAT TO R$_C$ 60-64

UNLESS OTHERWISE NOTED
ALL TOLERANCES TO BE ±.005
(±0.13)

NOTE:
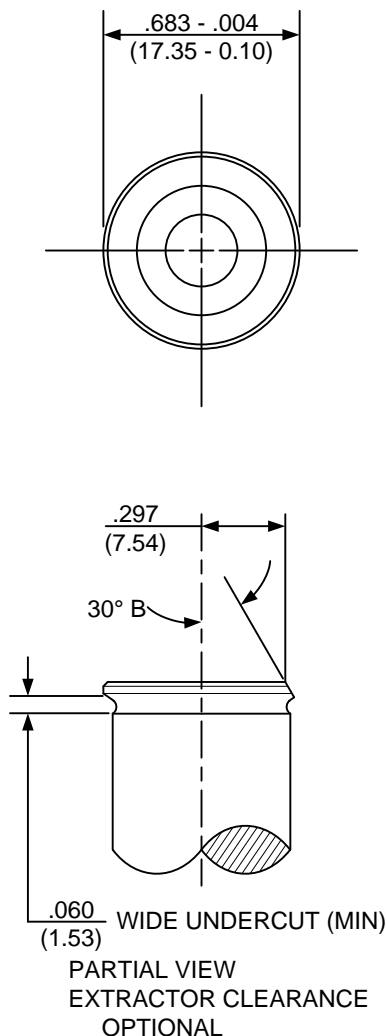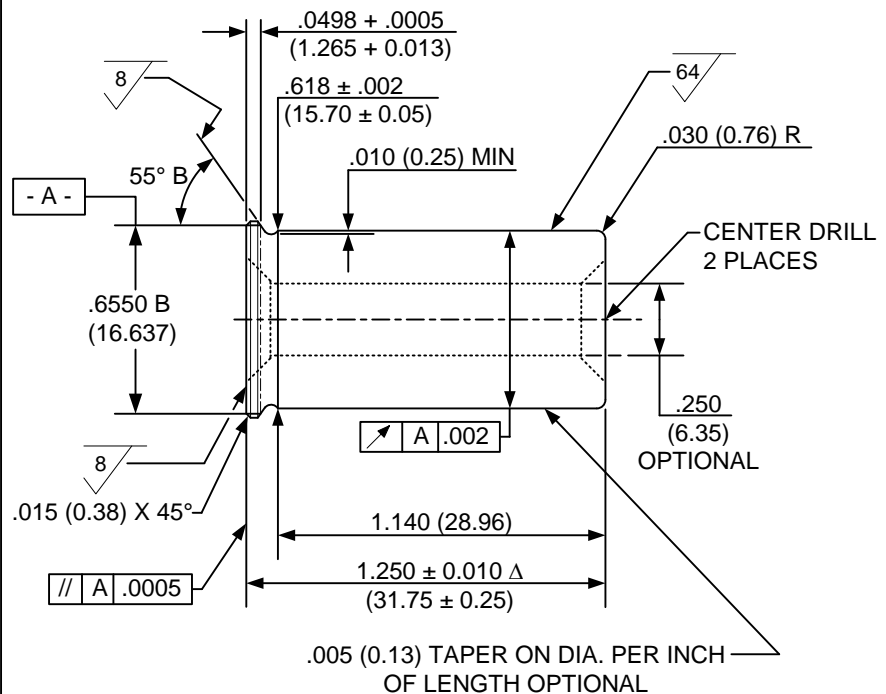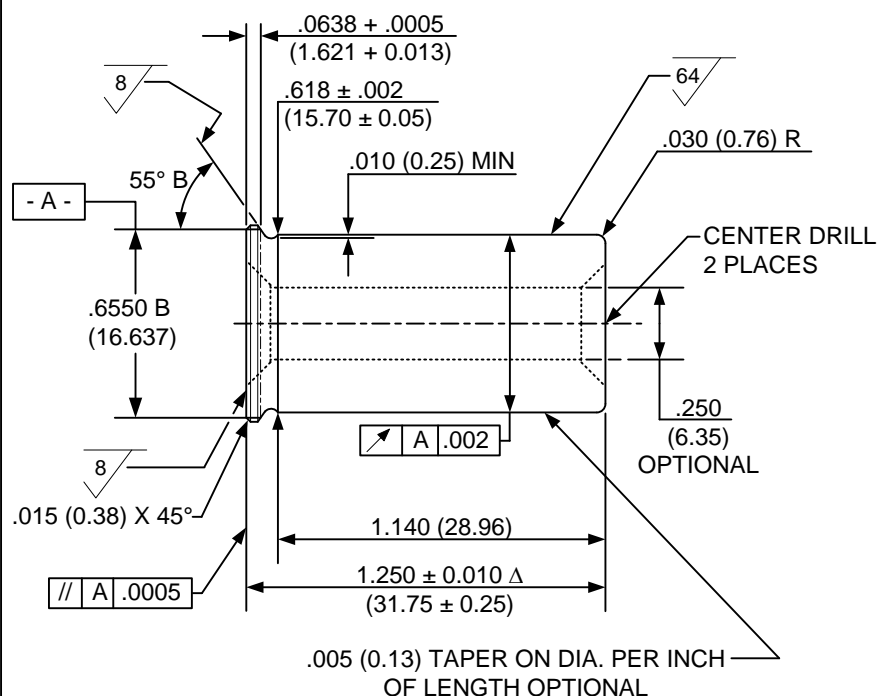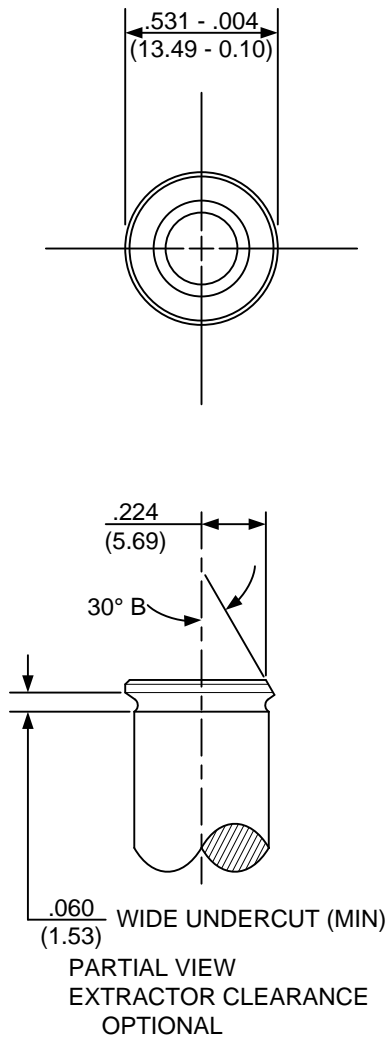B = BASIC
Δ= REFERENCE DIMENSION
(XX.XX) = MILLIMETERS

Shotshell Headspace Gauges – 410 Bore
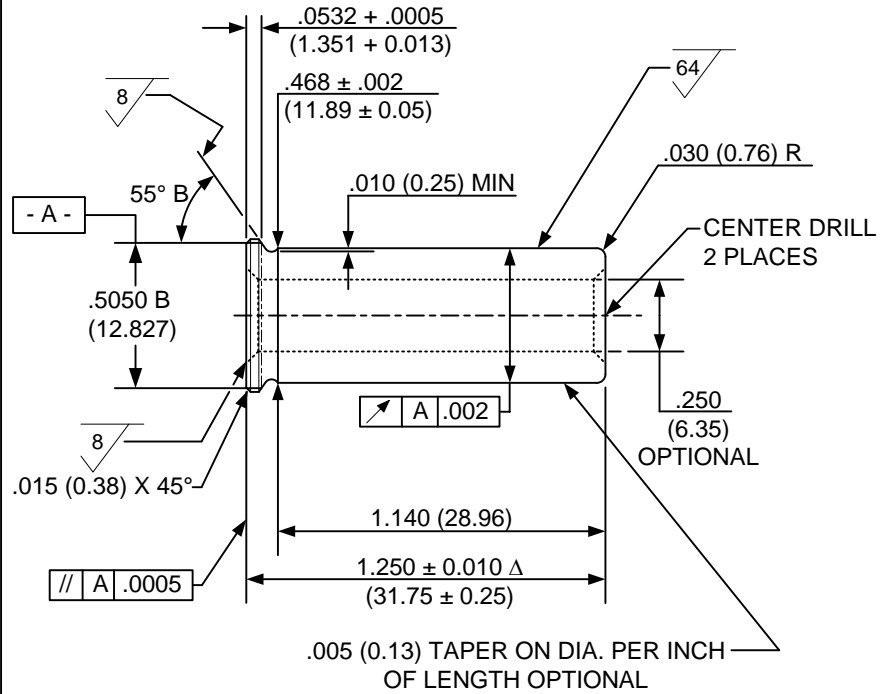

.531 - .004
(13.49 - 0.10)

.0532 + .0005
(1.351 + 0.013)

.468 ± .002
(11.89 ± 0.05)

64

8

.010 (0.25) MIN

.030 (0.76) R

- A -

55° B

CENTER DRILL
2 PLACES

.5050 B
(12.827)

A .002

.250
(6.35)
OPTIONAL

8

.015 (0.38) X 45°

1.140 (28.96)

// A .0005

1.250 ± 0.010 Δ
(31.75 ± 0.25)

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MINIMUM GAUGE

.224
(5.69)

30° B

.0672 + .0005
(1.707 + 0.013)

.468 ± .002
(11.89 ± 0.05)

64

8

.010 (0.25) MIN

.030 (0.76) R

- A -

55° B

CENTER DRILL
2 PLACES

.5050 B
(12.827)

A .002

.250
(6.35)
OPTIONAL

8

.015 (0.38) X 45°

.060 WIDE UNDERCUT (MIN)
(1.53)

PARTIAL VIEW
EXTRACTOR CLEARANCE
OPTIONAL

1.140 (28.96)

// A .0005

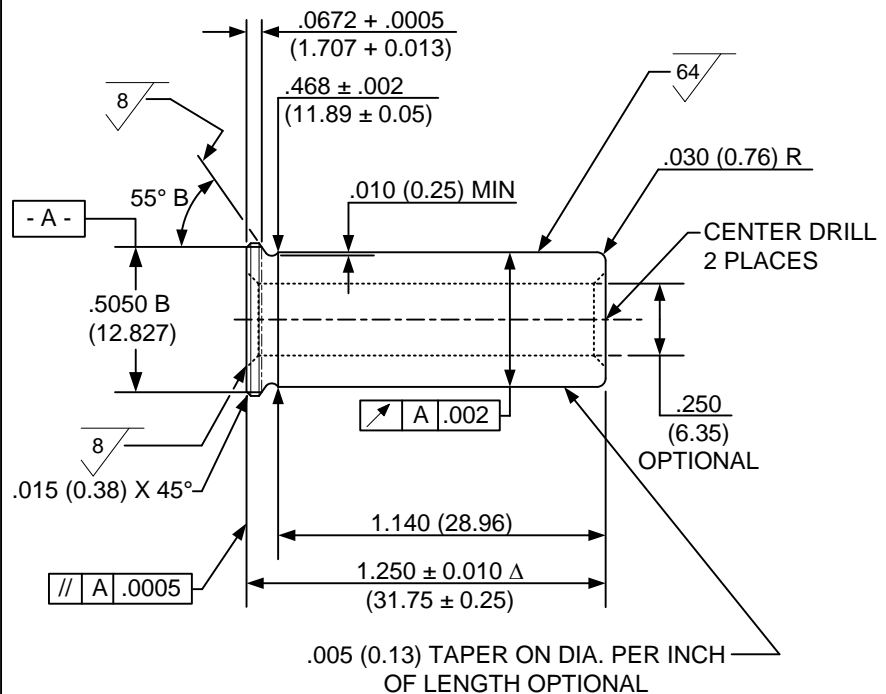1.250 ± 0.010 Δ
(31.75 ± 0.25)

MATERIAL: AISI-06 STEEL OR
EQUIVALENT
HEAT TREAT TO R_C 60-64

UNLESS OTHERWISE NOTED
ALL TOLERANCES TO BE ±.005
(±0.13)

NOTE:
B = BASIC
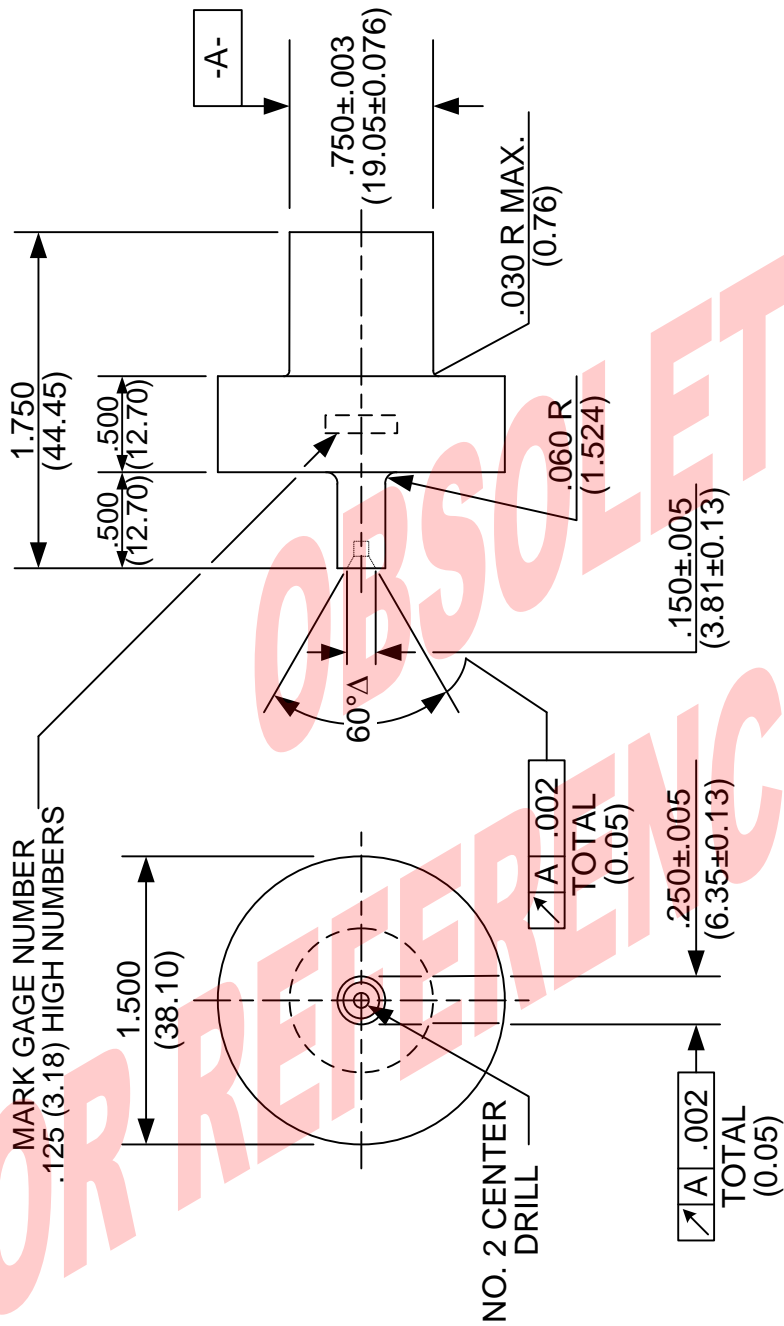Δ = REFERENCE DIMENSION
(XX.XX) = MILLIMETERS

.005 (0.13) TAPER ON DIA. PER INCH
OF LENGTH OPTIONAL

MAXIMUM GAUGE

MISCELLANEOUS:
STEEL SHOT COUNTERSUNK ANVIL

-A-

.750±.003
(19.05±0.076)

.030 R MAX.
(0.76)

1.750
(44.45)

.500
(12.70)

.500
(12.70)

.500
(12.70)

.060 R
(1.524)

.150±.005
(3.81±0.13)

60°△

A .002
TOTAL
(0.05)

.250±.005
(6.35±0.13)

1.500
(38.10)

A .002
TOTAL
(0.05)

MARK GAGE NUMBER
.125 (3.18) HIGH NUMBERS

NO. 2 CENTER
DRILL

△ NO. 2 CENTER DRILL DIMENSIONS

BODY DIA.	.1875 (4.7625)
DRILL DIA.	.078 (1.9812)
DRILL LGTH.	.078 (1.9812)
OVERALL LGTH.	1.875 (47.625)

NOTE
△ = REFERENCE DIMENSION
UNLESS OTHERWISE NOTED
ALL TOLERANCES ±.010 (0.25)
MATERIAL AISI-01
HARDEN R$_C$ 60-62

(XX.XX) = MILLIMETERS

EQUIPMENT:
REFERENCE AMMUNITION SUPPLY

> **NOTE:** Refer to Section III, page 79, *Supplier Contact Information*, for detailed information on contacting the manufacturers of listed products and the SAAMI Technical Office.

Shotshell reference ammunition are for the verification of ranges, barrels, and other equipment.

Information on procurement and assessment may be obtained from the SAAMI Technical Office. SAAMI policy does not allow the release of assessment values by the manufacturer of reference ammunition. All assessments are to be supplied by the SAAMI Technical Office.

Suppliers of SAAMI Reference Ammunition may also be found on the SAAMI website: https://saami.org/technical-information/reference-proof-ammunition/ .

EQUIPMENT:
REFERENCE AMMUNITION ORDER PROCEDURE

Each order should contain the following information, in the following order:

1. Number of rounds desired. (See NOTE, below.)

2. Appropriate order symbol, when given.

3. Designation "SAAMI Reference Ammunition".

4. Shell name.

5. SAAMI lot number. (Current lot numbers are given on latest assessment value sheets issued by the SAAMI Technical Office.)

    EXAMPLE:
    300 rounds, Order symbol SAM280-9
    SAAMI Reference Ammunition
    28 Gauge 2¾" ¾-ounce #9
    SAAMI Lot 28S61F

NOTE: Recommended maximum order = 500 rounds. If an individual user has requirements for larger quantities, refer to Section II, page 59.

Manufacturers of SAAMI reference ammunition may limit the order quantities honored to the recommended maximum in order to prevent premature consumption of a lot.

It is up to the discretion of the manufacturer to produce lots of sufficient size to reasonably provide a five-year supply.

DEFINITION AND PURPOSE

SAAMI Definitive Proof loads are shells commercially loaded by SAAMI member companies which develop pressure substantially exceeding those developed by normal service loads. The pressure levels are designed to assure gun safety when using ammunition loaded to service pressures in accordance with accepted American practices.

Proof loads are designed to stress firearms components which contain the cartridge in order to assure safety in the recommended use of the firearm during its service life.

It is important from the safety standpoint that Definitive Proof loads be used **only** for the proof of firearms. Adequate precaution must be taken to protect personnel performing firearms proof testing.

The supply of Definitive Proof cartridges will be the responsibility of the company that first introduced that particular shotshell to the Institute. Definitive Proof Cartridges should be loaded with the heaviest shot charge used at the time of introduction and the slowest powder which will meet the pressure values indicated for that particular shotshell to maintain effective pressure-distance relationship. Once established, the shot charge weight for the proof load does not change unless the charge weight becomes obsolete. All changes in Definitive Proof shells must be approved by the Joint Technical Committee.

PRESSURE DATA INTERPRETATION

The following specifications define the proof loads based on tests fired in standard test barrels with the ammunition at a temperature of 60°-80°F (15.6°-26.7°C). Tests shall be in accordance with the procedures and equipment shown in Sections II and III of this manual.

Pressure values are given on the following pages in terms of minimum and maximum averages and extreme variations for 10-round tests in standard test barrels.

The Standard Deviations for Definitive Proof Cartridges are the same as the Standard Deviations for service loads.

The minimum and maximum average Definitive Proof Pressures are computed as follows:

- The Minimum Average Definitive Proof Pressure is calculated by multiplying the Maximum Probable Lot Mean (MPLM) service pressure by 1.55 (55% over MPLM) and rounding **UP** to the nearest multiple of 500 psi.

- The Maximum Average Proof Pressure is calculated by multiplying the Maximum Probable Lot Mean (MPLM) service pressure by 1.70 (70% over MPLM) and rounding **DOWN** to the nearest multiple of 500 psi.

  NOTE: In the event the difference between the calculated Minimum and Maximum Average Proof Pressures is less than 1,500 psi, the Maximum Average Proof Pressure shall be positioned 1,500 psi above the Minimum Average Proof Pressure value.

- The Proof Maximum Extreme Variation (EV) is calculated by multiplying the Proof Standard Deviation (which in the case of Shotshell is equal to the Service Standard Deviation) by the constant 5.16[5]) and rounding **UP** to the next 100 psi.

- The Minimum Proof Individual (MPI) pressure is positioned three standard deviations (proof) below the Minimum Average Definitive Proof Pressure, with the calculated value being rounded **DOWN** to the next multiple of 100 psi.

Example:

Shotshell: 20 Gauge (2¾" & 3")   MPLM Pressure = 12,600 psi   S.D. = 900 psi

1. Minimum Average Proof Pressure = Maximum Probable Lot Mean Pressure x 1.55
   i.e., 12,600 psi x 1.55 = 19,530 psi rounded **up** to nearest 500 psi   = 20,000 psi

2. Maximum Average Proof Pressure = Maximum Probable Lot Mean Pressure x 1.70
   i.e., 12,600 psi x 1.70 = 21,420 psi rounded **down** to nearest 500 psi   = ~~21,000 psi~~
   Since this results in a difference between Minimum and Maximum Average Proof
   Pressures of only 1,000 psi, the Maximum Average Proof Pressure is set to
   Minimum Average Proof Pressure + 1,500 psi = 20,000 psi + 1,500 psi   = 21,500 psi

3. Max. Proof E.V. = Service Standard Deviation x 5.16
   i.e., 900 psi x 5.16 = 4,644 psi rounded **up** to next 100 psi   = 4,700 psi

4. Minimum Proof Individual = Min. Avg. Proof Pressure – (3 x $\sigma_{(PROOF)}$)
   i.e., 20,000 psi – (3 x 900 psi) = 17,300 psi rounded **down** to next 100 psi   = 17,300 psi

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[5] The Maximum Proof Pressure EV is a statistic derived from knowledge of the population standard deviation. Applying table figures from Relative Range Tables (Biometrika Tables for Statisticians), we calculate the maximum EV, or *Range*, equal to the population S.D. times the table constant 5.16 (for a sample of 10 at 99.0% confidence level).

PROOF PRESSURE DATA - TRANSDUCER

Cartridge	Shot Weight (Ounces)	SERVICE Maximum Average Pressure (psi/100)	Pressure Values of Proof Cartridges[1]		
			Minimum Average (psi/100)	Maximum Average (psi/100)	Maximum E.V. (psi/100)
10 Gauge 2$^7/_8$”	1⅝	110	180	195	43
10 Gauge 3$^1/_2$”	2¼	110	180	195	43
12-Gauge 2$^3/_4$”	1½	115	190	205	45
12-Gauge 3”	Use 12-gauge 2¾” proof loads for firearms with 3” chambers				
12-Gauge 3$^1/_2$”	1$^9/_{16}$	140	230	245	55
16-Gauge 2$^3/_4$”	1¼	115	190	205	45
20-Gauge 2$^3/_4$”	1⅛	120	200	215	47
20-Gauge 3”	Use 20-gauge 2¾” proof loads for firearms with 3” chambers				
28-Gauge 2$^3/_4$”	1	125	205	220	49
410 Bore 2$^1/_2$”	½	125	205	220	49
410 Bore 3”	$^{11}/_{16}$	135	220	235	53

(1) – For sample sizes η=10.

NOTE: All Definitive Proof Loads are fired in test barrels with a choke constriction of .031 ±.005 (0.79 ± 0.13). (Section III)
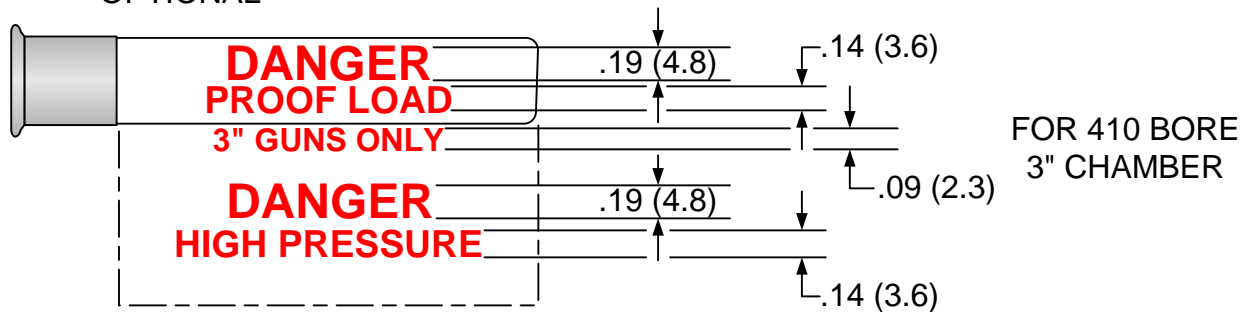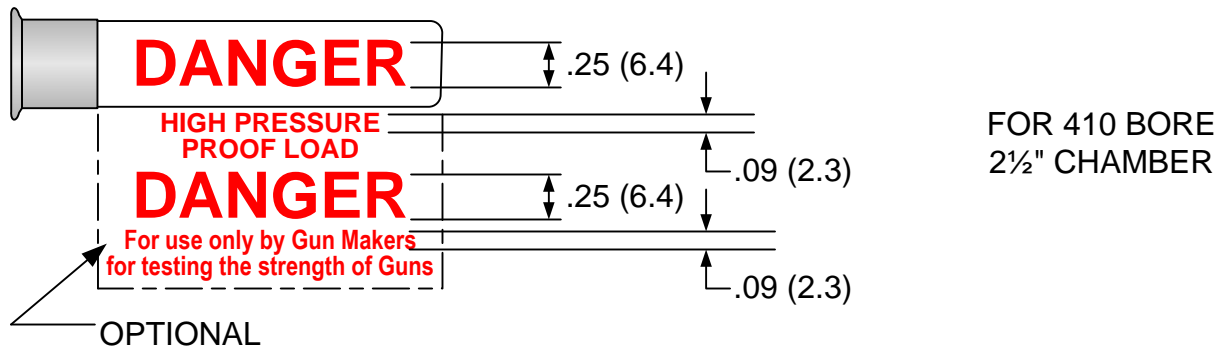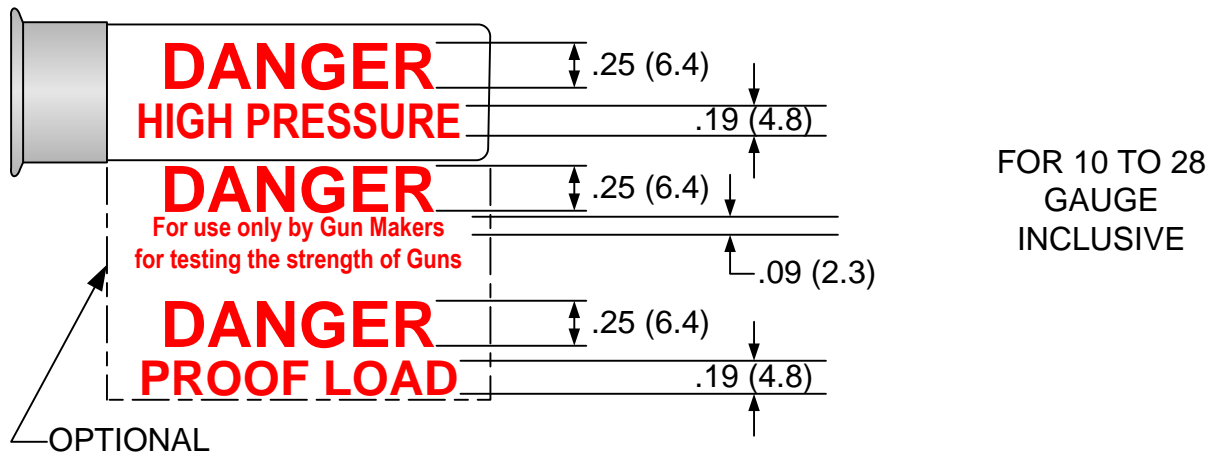
PROOF LOAD SUPPLY

NOTE: Refer to page 79, *Supplier Contact Information*, for detailed information on contacting the manufacturers of listed products.

Shotshell Definitive Proof Loads should be used for one purpose only: the proof testing of Shotshell firearms.

A list of current suppliers may be obtained from the SAAMI Technical Office. SAAMI-member companies supplying proof rounds may also be found on the SAAMI website: https://saami.org/technical-information/reference-proof-ammunition/ .

NOTE: Companies may have internal controls on the distribution of proof rounds in order to ensure their proper use and disposal.

PROOF CARTRIDGE IDENTIFICATION

DANGER
HIGH PRESSURE
.25 (6.4)
.19 (4.8)

DANGER
For use only by Gun Makers
for testing the strength of Guns
.25 (6.4)
.09 (2.3)

DANGER
PROOF LOAD
.25 (6.4)
.19 (4.8)

OPTIONAL

FOR 10 TO 28
GAUGE
INCLUSIVE

DANGER
HIGH PRESSURE
PROOF LOAD
.25 (6.4)
.09 (2.3)

DANGER
For use only by Gun Makers
for testing the strength of Guns
.25 (6.4)
.09 (2.3)

OPTIONAL

FOR 410 BORE
2½" CHAMBER

DANGER
PROOF LOAD
3" GUNS ONLY
.19 (4.8)
.14 (3.6)
.09 (2.3)

DANGER
HIGH PRESSURE
.19 (4.8)
.14 (3.6)

FOR 410 BORE
3" CHAMBER

NOTE:
SHOTSHELL BODY - UNCOLORED OR WHITE
PRINTING - RED LETTERS
HEAD - MATTE SURFACE TIN PLATE OR VISUAL EQUIVALENT
(XX.XX) = MILLIMETERS

DEFINITIVE PROOF PACKAGE IDENTIFICATION

HIGH PRESSURE PROOF LOADS

For Gun Manufacturers' Proof Test Use Only: Fire only from fixed rest with operator properly protected from injury should the firearm be damaged. Purchaser should restrict proof loads to manufacturing premises. To dispose of proof loads, contact producer for instructions.

DO NOT reload or dispose of fired proof shells in a manner that may make them available for reloading. **Failure to follow the foregoing can result in a personal injury.**

Shotshell proof loads are identified by a tin-plated case (or visual equivalent) and uncolored body with red printing on the body.

For consistent results, proof loads should be stored for 2 weeks at $70°F \pm 5°$ $(21.1° \pm 2.8°C)$, and 60% relative humidity before use.

Interior and exterior packaging should bear the following:

DANGER – HIGH PRESSURE
WARNING: KEEP OUT OF REACH OF CHILDREN

(Red lettering on white background)