

1. GENERAL

All UN, UNJ, M, and MJ thread form gages shall be calibrated using the commonly accepted metrology techniques described in this standard using properly maintained standard metrology equipment. The practices described in this standard are minimum calibration requirements. If alternative calibration methods or equipment are used, it is the user's responsibility to verify that the measurements obtained are accurate and correlate with measurements generated when employing the methods and equipment described in this standard. The calibration methods contained in ASME B1.2 or FED-STD-H28 are acceptable, but their use does not absolve the user from verifying their measurement capability.

This standard describes two different categories of calibration, **Initial Calibration** and **Subsequent Calibration**.

Initial Calibration applies to all new thread gages. All thread gages either used to verify product conformance or to calibrate gages shall be calibrated for all characteristics specified in this document.

Subsequent Calibration is the evaluation performed on a periodic basis as set by the user following the **Initial Calibration**. There are fewer required measurements in the Subsequent Calibration than in the Initial Calibration because it does not take as many measurements to detect gage wear or damage as it does to determine a gage's initial acceptability to the standard requirements. After the adoption of this standard, gage users shall have an **Initial Calibration** certificate on file for a gage prior to the performance of a Subsequent Calibration on that gage.

Refer to ASME B1 Technical Report "Measurement Uncertainty for 60 degree Screw Thread Gage Element Measurement Inch and Metric" to resolve any gage acceptability disputes.

2. REFERENCE STANDARDS

ANSI/NCSL Z540.2, US Guide to the Expression of Uncertainty in Measurement
ASME B1.2, Gages and Gaging for Unified Inch Screw Threads
ASME B1.3, Screw Thread Gaging Systems for Acceptability: Inch and Metric Screw Threads (UN, UNR, UNJ, M and MJ)
ASME B1.7, Nomenclature, Definitions, and Letter Symbols for Screw Threads
ASME B1.15, Unified Inch Screw Threads (UNJ Thread Form)
ASME B1.16M, Gages and Gaging for Metric M Screw Threads
ASME B1.22M, Gages and Gaging for Metric MJ Screw Threads
ASME B1 Technical Report, Measurement Uncertainty for 60 degree Screw Thread Gage Element Measurement Inch and Metric
NIST Technical Note 1297, the ISO Guide to the Expression of Uncertainty in Measurement (GUM)
FED-STD-H28, Screw-thread standards for Federal Services for Unified Inch Screw Threads - UN and UNR Thread Forms
ISO/IEC 17025, General requirements for the competence of testing and calibration laboratories

3. DEFINITIONS

The definitions for all terms in this standard are contained within ASME B1.2, B1.16M, or ASME B1.7.

4. MEASUREMENT UNCERTAINTY

Measurement uncertainties must be applied and reported per National and International Standards as explained in NIST Technical Note 1297, the ISO Guide to the Expression of Uncertainty in Measurement (GUM) or ANSI/NCSL Z540.2 which is the U.S. equivalent of the GUM. Laboratories may either calculate their uncertainties or use the values in the ASME B1 Technical Report "Measurement Uncertainty for 60 degree Screw Thread Gage Element Measurement Inch and Metric". The uncertainty values in the ASME Report are considered the maximum accepted values (see Appendix V).

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5. CALIBRATION ENVIRONMENT

This document recommends that all measurements are to be made at 68 degrees F +/- 2 degrees (20° C +/-1 degree) using calibrated thermometry and known expansion coefficients. Items must be allowed to stabilize at the laboratory environmental conditions prior to calibration as documented in the calibration laboratory procedures. For all laboratory controls and procedures not specifically covered in this standard consult ISO/IEC 17025 for guidance.

6. GAGE TOLERANCES

There are two tolerance classes related to thread gages, W and X, as specified in ASME B1.2 (inch) and B1.16M (metric) (see Appendix IA, IB, IC, and ID). The class W tolerance range is less than that of the X. Setting and working gage calibration requirements and the related tolerance classes are specified in Section 11.

7. DIRECTION OF TOLERANCES

The extreme limits of the pitch diameter of all setting and working gages are equal to the extreme limits of the associated product tolerance. All gage tolerances are inward toward the product mean limits.

Example:

½ (0.5000) -20 UNF 3A external product thread pitch diameter
0.4675 – 0.4643

½ (0.5000) -20 UNF 3A X tolerance GO setting plug pitch diameter
0.4675 – 0.4672

½ (0.5000) -20 UNF 3A X tolerance NOT GO setting plug pitch diameter
0.4646 – 0.4643

8. TYPES OF GAGES – WORKING AND SETTING

8.1. Working Gages

Working gages are gages (attribute or indicating type) which directly inspect/evaluate the product thread for conformance. The pitch, half-angle, pitch diameter, major or minor diameters shall be within class X tolerance and the presence of root relief shall be verified.

8.2. Setting Gages

8.2.1. New Setting Gages for Fixed Limit Gages

Setting gages for setting fixed limit gages shall have X tolerance on half-angle, W tolerance on pitch, major or minor diameter, and may have either a class X or W tolerance on the pitch diameter as designated by the purchaser. During subsequent calibrations the pitch diameter of setting gages that were originally W tolerance are still considered acceptable when they wear into, but do not go beyond, the class X tolerance zone.

8.2.2. New Setting Gages for Indicating Gages

Setting gages for indicating type gages shall have X tolerance for half-angle and class W tolerance for pitch. The major and minor diameters may be within class X tolerance. The pitch diameter size of the setting gage may be at any size within +/- 0.005 inches (0.127 mm) of the basic pitch diameter size provided the variation among the three or six pitch diam-

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eter measures obtained during calibration is not greater than 0.0003 inches (0.0078 mm). Setting gages for indicating gages provide a reference position for gage setting and the absolute size is not critical.

This practice is advantageous as it eliminates the necessity for having specific pitch diameter setting gages for each of the various classes of threads as well as those thread sizes with special pitch diameter limits. Modification of limits of product pitch diameter size, to provide allowance for coating and limits of pitch diameter size after coating, may be readily established in the indicating gage by using the certified pitch diameter size of the thread setting gage.

9. MARKING REQUIREMENTS

The certified pitch diameter size of all gages shall be indicated on the calibration certificate and, if possible, marked on the gage by any practical and suitably durable means.

10. GAGE SIZE REFERENCES

For thread gage sizes refer to the following standards:

UN, UNR, and UNJ inch thread forms - ASME B1.2.

For the ring gage minor diameter size of UNJ and MJ threads see Appendix IIIA and IIIB.

M metric thread form - ASME B1.16M

MJ metric thread form - ASME B1.22M

11. CALIBRATION REQUIREMENTS FOR THREAD GAGES

When a UNJ or MJ GO gage provides questionable product inspection results, the runout (FIM) of the major diameter to the pitch diameter on thread gages for internal threads, and the minor diameter to the pitch diameter on thread gages for external threads should be evaluated as a possible cause (see Appendix VI). For NOT GO gages and other thread forms this is not a relevant issue.

11.1. Threaded Setting Plug Gages

THREADED SETTING PLUG - FULL FORM OR TRUNCATED GAGE CHARACTERISTICS TO BE CALIBRATED							
Calibration Type	Major Diameter		Pitch Diameter		Half Angle Tolerance Class		Pitch
	Location	Tolerance Class	Location	Tolerance Class	Leading	Trailing	
INITIAL	Front & Back ₍₂₎	W ₍₁₎	Six Measurements Front, Middle & Back Rotate 90 Deg Front, Middle & Back	W or X _(1, 3, 4)	X ₍₁₎	X ₍₁₎	W _(1, 5)
SUBSEQUENT	N/A	N/A	Three Measurements Front, Middle & Back	X ₍₁₎	N/A	N/A	N/A
See Sec. No.	13		12.1		16.1		17.1
Note 1: W and X designates the applicable tolerance class (see Appendix IA, IB, IC, and ID).							
Note 2: When measuring truncated setting plugs, the full-form and truncated portions are measured independently.							
Note 3: The selection of pitch diameter tolerance class W or X is based on the user's choice.							
Note 4: Roundness and taper are acceptable when all pitch diameter measurements are within the required tolerance class.							
Note 5: The length of engagement over which pitch is measured is equal to the thickness of a GO ring gage or 9 pitches, whichever is less (see Appendix II).							
Note 6: Root clearance shall be present. The shape of the clearance is optional.							

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11.2. Threaded Working Plug Gages

THREADED WORKING PLUG GAGE CHARACTERISTICS TO BE CALIBRATED							
Calibration Type	Major Diameter		Pitch Diameter		Half Angle Tolerance Class		Pitch
	Location	Tolerance Class	Location	Tolerance Class	Leading	Trailing	
INITIAL	Front & Back	X ₍₁₎	Six Measurements Front, Middle & Back Rotate 90 Deg Front, Middle & Back	X _(1, 2)	X ₍₁₎	X ₍₁₎	X _(1, 3)
SUBSEQUENT	N/A	N/A	Three Measurements Front, Middle & Back	X ₍₁₎	N/A	N/A	N/A
See Sec. No.	13		12.1		16.1		17.1
Note 1: X designates the applicable tolerance class (see Appendix IA, IB, IC, and ID).							
Note 2: Roundness and taper are acceptable when all pitch diameter measurements are within the required tolerance class.							
Note 3: The length of engagement over which pitch is measured is equal to the thickness of a GO ring gage or 9 pitches, whichever is less (see Appendix II).							

11.3. Threaded Setting Ring (Solid)

THREADED SOLID SETTING RING CHARACTERISTICS TO BE CALIBRATED								
Calibration Type	Minor Diameter		Pitch Diameter		Half Angle Tolerance Class		Pitch	Functional Diameter
	Location	Tolerance Class	Location	Tolerance Class	Leading	Trailing		
INITIAL	Front and Back	X ₍₁₎	Six Measurements Front, Middle & Back Rotate 90 Deg Front, Middle & Back	W or X _(1, 2, 3)	X _(1, 5)	X _(1, 5)	W _(1, 4, 5)	X _(1, 6)
SUBSEQUENT	N/A	N/A	Three Measurements Front, Middle & Back	X ₍₁₎	N/A	N/A	N/A	N/A
See Sec. No.	14		12.2		16.1		17.2	15.2
Note 1: W and X designates the applicable tolerance class (see Appendix IA, IB, IC, and ID).								
Note 2: The selection of pitch diameter tolerance class W or X is based on the user's choice.								
Note 3: Roundness and taper are acceptable when all pitch diameter measurements are within the required tolerance class.								
Note 4: The length of engagement over which pitch is measured is the total number of complete threads in the ring or nine threads, whichever is less.								
Note: 5 The half-angle and pitch are measured using some facsimile method on sizes over 3/4 inch (M18). Sizes smaller than 3/4 inch (M18) do not require half-angle and pitch measurements.								
Note 6: The certification of functional diameter is required only if the setting ring will be used to set functional diameter measuring segments.								

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11.4. Threaded Working Ring (Split)

SPLIT THREADED WORKING RING GAGE CHARACTERISTICS TO BE CALIBRATED			
Calibration Type	Minor Diameter		Functional Diameter
	Location	Tolerance Class	Tolerance Class of Setting Plug
INITIAL	Front & Back	X ₍₁₎	X _(1, 2)
SUBSEQUENT	Front & Back	X ₍₁₎	X _(1, 2)
See Sec. No.	14		15.1

Note 1: X designates the applicable tolerance class (see Appendix IA, IB, IC, and ID).
Note 2: The functional diameter of the working ring is set to the functional diameter size of the combined characteristics of the setting plug.

11.5. Gaging Rolls for Indicating Gages for the Inspection of External Threads – Pitch Diameter Rolls (Cone & Vee)

PITCH DIAMETER GAGING ROLL SET CHARACTERISTICS TO BE CALIBRATED				
Calibration Type	Profile Characteristics	Half Angle Tolerance Class		Axial Relationship of the profiles on the three rolls in a set
	Tolerance Class	Leading	Trailing	
INITIAL	X ₍₁₎	X ₍₁₎	X ₍₁₎	X ₍₁₎
SUBSEQUENT	N/A	X ₍₁₎	X ₍₁₎	N/A
See Sec. No.	19.4.2.2			19.4.1

Note 1: X designates the applicable tolerance class (see Appendix IA, IB, IC, and ID).
Note 2: There may be two rolls with the cone profile and one with a vee profile in the set or there may be two vee profile rolls and one cone profile roll in a set.

11.6. Gaging Roll Set for Indicating Gages for the Inspection of External Threads – "BEST SIZE" Rolls

"BEST SIZE" (GROOVE) DIAMETER GAGING ROLL SET CHARACTERISTICS TO BE CALIBRATED		
Calibration Type	Profile Radius	Axial Relationship of the profiles on the three rolls in a set
	Tolerance Class	
INITIAL	X ₍₁₎	X ₍₁₎
SUBSEQUENT	X ₍₁₎	N/A
See Sec. No.	19.4.2.3	19.4.1

Note 1: X designates the applicable tolerance class (see Appendix IA, IB, IC, and ID).
Note 2: There is one radius profile on each of the three rolls of the set.

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11.7. Gaging Roll Set for Indicating Gages for the Inspection of External Threads – Functional Diameter Rolls

FUNCTIONAL DIAMETER GAGING ROLL SET CHARACTERISTICS TO BE CALIBRATED				
Calibration Type	Profile Characteristics	Half Angle Tolerance Class		Axial Relationship of the profiles on the three rolls in a set
	Tolerance Class	Leading	Trailing	
INITIAL	X ₍₁₎	X ₍₁₎	X ₍₁₎	X ₍₁₎
SUBSEQUENT	N/A	X ₍₁₎	X ₍₁₎	N/A
See Sec. No.	19.4.2.1			19.4.1
Note 1: X designates the applicable tolerance class (see Appendix IA, IB, IC, and ID).				
Note 2: The axial length of the functional form on the three rolls shall be equal to the thickness of a GO ring gage (see Appendix II).				

11.8. Gaging Elements for Indicating Gages for the Inspection of External Threads – Functional Diameter Segments

EXTERNAL THREAD FUNCTIONAL DIAMETER SEGMENT SET CHARACTERISTICS TO BE CALIBRATED	
Calibration Type	Functional Diameter
	Tolerance Class of Setting Plug
INITIAL	X _(1, 2, 3)
SUBSEQUENT	X ₍₁₎
See Sec. No.	19.2.1
Note 1: X designates the applicable tolerance class (see Appendix IA, IB, IC, and ID). Note 2: The thickness of the functional diameter segments is equal to the thickness of a GO ring gage (see Appendix II). Note 3: The minor diameter of the gaging segments must be reviewed during the initial calibration to assure that it will not contact the maximum minor diameter of the product thread (See Section 19.2.1).	

11.9. Gaging Elements for Indicating Gages for the Inspection of Internal Threads – Pitch Diameter (Cone & Vee)

INTERNAL THREAD PITCH DIAMETER GAGING SEGMENT SET CHARACTERISTICS TO BE CALIBRATED				
Calibration Type	Profile Characteristics	Half Angle Tolerance Class		Relationship of threads on the segment set
	Tolerance Class	Leading	Trailing	
INITIAL	X ₍₁₎	X ₍₁₎	X ₍₁₎	X ₍₁₎
SUBSEQUENT	N/A	X ₍₁₎	X ₍₁₎	N/A
See Sec. No.	19.4.4			19.3
Note 1: X designates the applicable tolerance class (see Appendix IA, IB, IC, and ID).				

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11.10. Gaging Elements for Indicating Gages for the Inspection of Internal Threads – Functional Diameter Segments

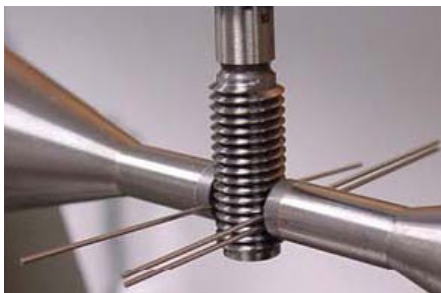
FUNCTIONAL DIAMETER GAGING SEGMENT SET CHARACTERISTICS TO BE CALIBRATED				
Calibration Type	Profile Characteristics	Half Angle Tolerance Class		Relationship of threads on the segment set
	Tolerance Class	Leading	Trailing	
INITIAL	X ₍₁₎	X ₍₁₎	X ₍₁₎	X ₍₁₎
SUBSEQUENT	N/A	X ₍₁₎	X ₍₁₎	N/A
See Sec. No.	19.4.3			19.3
Note 1: X designates the applicable tolerance class (see Appendix IA, IB, IC, and ID).				

11.11. Indicating Gage Frames

EXTERNAL & INTERNAL THREAD INDICATING GAGE FRAME CHARACTERISTICS TO BE CALIBRATED			
Calibration Type	Measurement Linearity	Frame Rigidity	Spring Tension
INITIAL	X ₍₁₎	X ₍₁₎	SEE SECTION 19.1.3
SUBSEQUENT	X ₍₁₎	X ₍₁₎	SEE SECTION 19.1.3
See Sec. No.	19.1.1	19.1.2	19.1.3
Note 1: X designates the applicable tolerance class (see Appendix IA, IB, IC, and ID).			

12. GAGE CALIBRATION PROCEDURES FOR PITCH DIAMETER

12.1. Pitch Diameter, Plug Gages (Working and Setting)



Setting Plug Gage



Working Plug Gage

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Perform a measurement over wires (MOW) using the three wire method as described in the B1.2 Standard. Select an appropriately sized wire set (preferably "best size") and apply the recommended measurement force per the ASME 1.2 and ASME B1.16 Standard shown in the table below. Wire sets must be calibrated and must satisfy the requirements for diameter and form variation per ASME B1.2.

Measurements over wires shall be made at front, middle, and back at 0 and 90 degrees during Initial Calibration procedures. During Subsequent Calibration procedures measure the pitch diameter front, middle, and back in only one orientation.

The thread pitch diameter for gages is calculated using the general formula for pitch diameter of a thread having symmetrical flank angles as described per ASME B1.2. The certified pitch diameter size of a plug gage is the average of all of the pitch diameter measurements obtained during the calibration process. The gage is non-conforming if any measurement is outside the applicable limits even if the average value is within the limits.

Inch (ref. ASME B1.2)		Metric (ref. ASME B1.16M)	
TPI Range	Force +/- 10%	Pitch Range	Force +/- 10%
20 or less	2.5 lbf (11.1N)	0.2 - 0.25	1.1 N (4 ozf)
24 - 40	1.0 lbf (4.5N)	0.35 - 0.5	2.2 N (8 ozf)
44 - 80	8 ozf (2.2N)	0.6 - 1.0	4.5 N (1 lbf)
Over 80	4 ozf (1.1N)	1.25 and larger	11.1 N (2.5 lbf)

Plug Gage Measuring Pressure



Internal thread
measuring ball stylus



Ball stylus engaged on
one side of ring



Ball stylus engaged on
opposite side of ring

12.2. Pitch Diameter, Solid Setting Ring Gages

Measuring Pitch Diameter:

Using a universal measuring machine or equivalent equipment with a resolution of 0.000010 inch (0.00025 mm) and the measuring forces listed below affix a solid cylindrical ring to the machine's table and calibrate the machine.

Replace the cylindrical ring with the setting ring to be measured. Lower the stylus into the ring and engage one ball into the thread such that the ball contacts the two facing flanks of the ring's thread in a position near the top of the ring. Locate the point in the ring's thread at which the largest value is indicated by moving the table. Zero the machine in that position. Move the table to engage the opposite stylus ball 180 degrees from the point at which the machine was zeroed. Take care to contact the ball in the same thread on the opposite side of the ring. Move the table until the largest value is indicated. Add the "constant" that was provided with the stylus to the machine's indicated value. That resulting value is the pitch diameter of the ring.

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With the setting ring still affixed to the machine's table repeat this process two more times. Make the next measurement approximately in the middle of the ring and the last measurement near the bottom of the ring. In the initial calibration rotate the setting ring 90 degrees and measure the pitch diameter at the top, middle, and bottom of the ring again as described above.

Inch		Metric	
TPI Range	Force +/- 10%	Pitch Range	Force +/- 10%
32-21	.250 lbf (1.1N)	0.8-1.0	1.1N (.250 lbf)
20-9	.375 lbf (1.7N)	1.25-2.5	1.7N (.375 lbf)
8 and fewer	.500 lbf (2.2N)	3 and larger	2.2N (.500 lbf)

Setting Ring Measuring Pressure



Working Plug



Setting Plug



13. GAGE CALIBRATION PROCEDURES FOR PLUG GAGE MAJOR DIAMETER

The major diameter is measured between plane parallel anvils using a universal measuring machine or equivalent. Calibrate the machine using certified gage blocks or cylindrical pin gages of a size close to the major diameter being measured. When measuring the major diameter of a truncated setting plug the full-form portion and the truncated portion shall be measured independently in one orientation. When measuring major diameter of working plugs, measure front and back.

The largest value measured is to be used for the assigned value of major diameter. The measuring force shall be as specified below.

Inch (ref. ASME B1.2)		Metric (ref. ASME B1.16)	
TPI Range	Force +/- 10%	Pitch Range	Force +/- 10%
20 or less	2.5 lbf (11.1N)	0.2 - 0.25	1.1 N (4 ozf)
24 - 40	1.0 lbf (4.5N)	0.35 - 0.5	2.2 N (8 ozf)
44 - 80	8 ozf (2.2N)	0.6 - 1.0	4.5 N (1 lbf)
Over 80	4 ozf (1.1N)	1.25 and larger	11.1N (2.5 lbf)

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Plug Gage Measuring Pressure



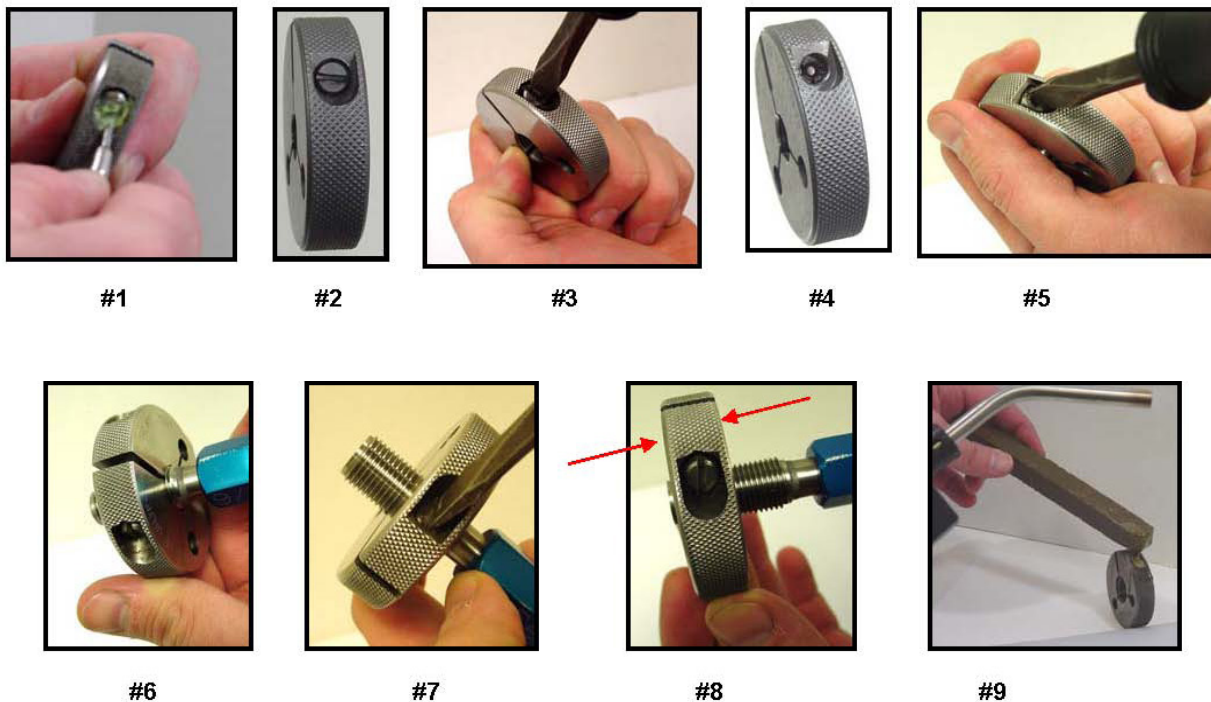
14. GAGE CALIBRATION PROCEDURES FOR RING GAGE MINOR DIAMETER

The minor diameter of split threaded working rings and solid setting rings shall be calibrated using class Z pin gages. Class Z has a tolerance of 0.0001 inches (0.0025 mm). On working rings the functional diameter must be set before the minor diameter is evaluated.

Insert pin gages in 0.0005 inch (0.00127 mm) increments or less into the minor diameter of the ring gage until the largest size pin that will enter the gage is found. The minor diameter must be within limits on both sides of the ring. The certified size of the minor diameter is the mid-point between the pin gage that will enter and the one that will not enter.

The minor diameter of solid setting rings may also be calibrated using other suitable equipment, such as bore gages, universal type measuring machines, or CMM equipment.

15. GAGE CALIBRATION PROCEDURES FOR GAGE FUNCTIONAL DIAMETER



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15.1. Threaded Working Ring (Split)

Clean the threads of the working ring thoroughly before starting the calibration process.

Insert the proper size setting plug to evaluate the fit of the plug to the ring.

If the ring needs adjusting, remove the sealing wax from both the locking and adjusting screws (see #1).

Loosen the locking screw to allow the working ring to open (see #2 and #3) and then the adjusting screw (see #4 and #5).

Screw the setting plug into the ring until the full-form portion of the plug is completely in the ring (see #6).

Tighten the adjusting screw until the setting plug is in contact with the ring such that the plug can be turned with a slight rotational resistance. Tighten the locking screw (see #7).

Screw the setting plug out of the ring until only the truncated portion of the setting plug is still engaged in the ring (see #8). The rotational resistance of the plug in the ring should be similar to that in the first position on the full-form portion of the setting plug. Attempt to move the ring face to face, back and forth (see #8 arrows). If the rotational resistance is significantly less on the truncated portion versus the full-form portion of the setting plug or if the ring can be moved noticeably face to face, back and forth, the ring is worn and should be replaced. For the ring to be acceptable the plug must provide the same rotational resistance when the plug is inserted into both sides of the ring. Apply the sealing wax to both the locking and adjusting screws after the gage is acceptably set (see #9).

The certified pitch diameter size of the ring gage is recorded as the certified size of setting plug used to set the ring.

Note: It may take more than one attempt to obtain a setting that provides a uniform amount of rotational resistance on both portions of the setting plug.

15.2 Threaded Setting Ring Gage (Solid)

Solid setting rings only need to be calibrated for functional diameter if the ring will be used for setting functional diameter measuring segments used on an internal thread indicating gage.

The functional diameter of setting rings is determined by the use of a series of full-form W class setting plugs having progressively sized pitch diameters. The various diameters may be on separate plugs or more than one pitch diameter size may be on one plug (progressive plug).

Find a setting plug that will completely enter the setting ring without any shake or looseness between the ring and the plug. Try the next larger setting plug to assure that it will not enter the setting ring. For the ring to be acceptable the plugs shall provide the same results when entry is attempted from both sides of the ring. The difference in pitch diameter size of the two plugs must not be greater than 0.0005 inches (0.0127 mm).

The certified functional diameter size of the setting ring will be recorded as the size mid-way between the plug that will fully enter the ring and the plug that will not enter the setting ring.

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