

ASME B1.20.5-1991

(REVISION OF ANSI B1.20.5-1978)

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GAGING FOR DRYSEAL PIPE THREADS (INCH)

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The American Society of
Mechanical Engineers

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FOREWORD

(This Foreword is not part of ASME B1.20.5-1991.)

In 1973, the American National Standards Committee B2, which had formerly been responsible for pipe thread standards, was absorbed by ANSI Standards Committee B1 and reorganized as subcommittee 20. A complete rewrite of the B2.2-1968 Standard on Dryseal Pipe Threads was completed with the publication of ANSI B1.20.3-1976 for product threads and the ANSI B1.20.5-1978 Standard for Gaging.

The product thread standard ANSI B1.20.3 establishes two classes of dryseal pipe threads: Class 1 and Class 2. The classes differ only in inspection requirements. With Class 1 threads, inspection of root and crest truncation is not specified. Class 2 threads are identical to Class 1 threads except that inspection of root and crest truncation is required. This gaging standard includes 6-step crest and root check gages, which, within their limitations, should be helpful in establishing the degree of conformance of product threads.

When 6-step crest or root check gages are to be used, it is necessary to classify the product thread size into a size range (minimum, basic, or maximum) as shown in Fig. 1. The use of 3-step L1 thread gages for NPTF threads requires estimating the one third of a turn, plus or minus, from the basic notch on the gage to classify the thread as basic. Use of this same one third turn estimation is required to determine minimum and maximum ranges. This Standard includes 4-step taper thread gages to eliminate the need for estimating the one third turn deviation from basic necessary with 3-step or basic step gages. 3-step taper thread gages are included in Appendix A for those who may prefer to use them.

Crest and root check gages for NPTF threads are also covered in this Standard. Prior to the publication of ANSI B1.20.5-1978 many gage manufacturers had calculated diameters for and made such gages based on methods used for ANPT (MIL-P-7105) 6-step gages, which were calculated to the extremes of the minimum and maximum zones, where most product threads should never be, and which, further, is not the same logic used in calculating the pair of basic steps. The NPTF 6-step gages tabulated herein are based on the mid-point of each range as determined by the L_1 plug gage (minimum, basic, or maximum) for calculation of the truncation limits where most of the product threads should be (see Fig. 2).

It should be noted that all references to the turns of engagement method for inspection of product threads have been withdrawn from this Standard. Results obtained by that method were found to quite often disagree with those obtained by the step limit method described here within. Also, inconsistencies in the end threads on the product and gages do not provide for a constant disengagement point between the two. This does not however preclude the use of this method in any way as an acceptable means of inspecting taper pipe threads. When this method is chosen, customer and vendor should agree on gaging procedures and minimum/maximum acceptance limits on the turns of engagement. Information on this method can be found in Appendix D for reference.

The gaging data in this Standard supersedes that given in ANSI B1.20.5-1978. The proposed standard was submitted by Standards Committee B1 to the Secretariat and the American National Standards Institute. It was approved and formally designated as an American National Standard on January 22, 1991.

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Standardization and Unification of Screw Threads

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CONTENTS

Foreword	iii
Standards Committee Roster	v
1 Gaging	1
1.1 Scope	1
1.2 How Dryseal Works	1
1.3 Limitations	1
1.4 Product Thread Designations	1
1.5 Inspection of Product Threads	2
1.6 Methods of Gaging Product Threads	2
1.7 Coordination of Gages	3
1.8 Use of Gages	3
1.9 Direct Measurement of Crest and Root Truncation	5
1.10 Inspection of Gages	5
2 Gages	7
2.1 Types and Functions of Gages	7
2.2 Taper Thread Gages	8
2.3 Thread Form	8
2.4 Gage Tolerance	8
2.5 Working Gage Dimensions	9
2.6 Master Gage Dimensions	9
Figures	
1 Classification of NPTF Product Thread Size Using 4-Step Gages	4
2 Identification of Steps on 6-Step Crest or Root Check Gage	4
3 Relative Position Plus and Minus Standoff	6
4 Relative Position of Master Plugs and Rings to Working Gages	10
Tables	
1 Gages and Tolerances	2
2 Function and Application of Gages Covered in ASME B1.20.5-1991	7
3 Tolerances for Working Plug and Ring Gages	11
4 Tolerances for Master Plug and Ring Gages	12
5 Diameter Equivalent of Variation in Load for Tools and Gages	13
6 Diameter Equivalent of Variation in Half Included Angle for Tools and Gages	14
7 Basic Dimensions for L_1 Ring Gages	16
8 Basic Dimensions for L_1 Short Ring Gages	18
9 Basic Dimensions for L_2 Ring Gages	20
10 Basic Dimensions for L_2 Short Ring Gages	22
11 Basic Dimensions for Crest Check Ring Gages	24

12	Basic Dimensions for Root Check Ring Gages	26
13	Basic Dimensions for L_1 Plug Gages, NPTF	28
14	Basic Dimensions for L_1 Short Plug Gages	30
15	Basic Dimensions for L_1 Plug Gages, NPSI	32
16	Basic Dimensions for L_3 Plug Gages	34
17	Basic Dimensions for L_3 Short Plug Gages	36
18	Basic Dimensions for Crest Check Plug Gages	37
19	Basic Dimensions for Root Check Plug Gages	38
20	Basic Dimensions of Master Ring Gages for L_1 and L_3 Taper Plug Gages	39
21	Basic Dimensions of Master Plug Gages for L_1 and L_2 Taper Ring Gages	40
22	Basic Dimensions of Master Gages for 6-Step Crest Ring and 6-Step Crest Plug Gages	41
23	Basic Dimensions of Master Gages for 6-Step Root Ring Gages and 6-Step Root Plug Gages	42
Appendices		
A	3-Step Gages for Checking NPTF Threads	43
A1	Working Gage Dimensions	43
B	Measurement of Pitch Diameter of Taper Threads Having an Included Taper of 0.0625 Inch per Inch	49
B1	Measurement of Pitch Diameter of Taper Thread Plug Gage	49
B2	Measurement of Pitch Diameter of Taper Thread Ring Gage	53
C	Formulas For Calculating 6-Step Taper Plug and Ring Gage Dimensions	57
D	The Turns Engagement Method of Gaging Product Threads	59
Figures		
B1	Measurement of Pitch Diameter of Taper Thread Gages by the 2-Wire Method	50
B2	Horizontal Measurement of Pitch Diameter of Taper Thread Gages by the 3-Wire Method Using Sine Block	51
B3	Vertical Measurement of Pitch Diameter of Taper Thread Gages by the 3-Wire Method Using a Sine Fixture	52
B4	Measurement of Pitch Diameter E_o of Taper Thread Gages by the 4-Wire Method	53
B5	Measurement of Pitch Diameter E_m of Taper Thread Gages by the 4-Wire Method	54
B6	Measurement of Pitch Diameter of Taper Thread Ring Gage on Coordinate Measuring Machine With Ball Probe	55
Tables		
A1	Basic Dimensions for L_1 3-Step Ring Gages	44
A2	Basic Dimensions for L_2 3-Step Ring Gages	45
A3	Basic Dimensions for L_1 3-Step Plug Gages, NPTF	46
A4	Basic Dimensions for L_3 3-Step Plug Gages	48
D1	Basic Turns Engagement	59

GAGING FOR DRYSEAL PIPE THREADS (INCH)

1 GAGING

1.1 Scope

The scope of this Standard is to provide information regarding practical dryseal thread inspection methods and commonly used gages for production evaluation purposes. All dimensions are in inches unless otherwise specified.

1.1.1 Federal Government Use. When this Standard is approved by the Department of Defense and the Federal agencies and is incorporated into FED-STD-H28/8, Screw-Thread Standards for Federal Services, Section 8, the use of this Standard by the Federal Government is subject to all the requirements and limitations of FED-STD-H28/8.

1.2 How Dryseal Works

The principle of dryseal threads is based on crest and root contact at handtight engagement at both major and minor diameters. Conformance to L_1 , L_2 , and L_3 functional size gages alone will not assure that the threads will be drysealed to ANSI B1.20.3 design specifications. In addition to functional size, the dryseal crest and root truncations must be held on both external and internal threaded products in order to be dryseal. This applies to both straight and taper dryseal threads.

1.3 Limitations

Industry has developed gaging practices over many years which have resulted in the common use of L_1 , L_2 , L_3 , and plain taper plug and ring gages to evaluate dryseal pipe threads. These are functional gages intended to aid the manufacturer in the control of threading operations. It must be recognized that conformance to a functional gage or series of gages is not conclusive evidence of conformance to the design requirements of ANSI B1.20.3. For critical applications more extensive inspection and testing, not covered in this Standard, may be required in order to insure an acceptable seal.

1.3.1 These gaging practices used with proper tool configuration control, sound manufacturing and part support practices, and visual inspection have provided pipe threads that sealed acceptably for many producers of pipe threads.

1.3.2 These gages and gaging practices are intended to evaluate unused pipe threads. Once a thread joint is made up wrench tight, metal is deformed by design and may not be found acceptable using these described gages and methods. It is the user's responsibility to determine if the used thread will perform satisfactorily in its intended application.

1.4 Product Thread Designations

Dryseal pipe threads are designated by specifying in sequence the nominal size, threads per inch, thread symbol, and class where required.

EXAMPLES:

1/8-27 NPTF-1
1/8-27 NPTF-2
1/8-27 PTF-SAE SHORT
1/8-27 NPSF
1/8-27 NPSI

Each of the letters in the symbols has a definite significance as follows:

N = National (American) Standard
P = Pipe
T = Taper
S = Straight
F = Fuel and Oil
I = Intermediate

For further information see ANSI B1.20.3.

1.4.1 Reference Documents. The latest issues of the following documents form a part of this Standard to the extent specified herein.

ANSI/ASME B1.7
Nomenclature, Definitions and Letter Symbols for Screw Threads
ANSI B1.20.3
Dryseal Pipe Threads
ANSI B47.1
Gage Blanks

TABLE 1 GAGES AND TOLERANCES

Thread to be Gaged	Gaged With	Product Thread Tolerance Applied to Basic Size [Note (1)]		Limit Method of Gaging [Note (1)] Tolerance
		Plus (small)	Minus (large)	
NPTF, external	L_1 or L_1 short and [Note (2)] L_2 or L_2 short ring gages	1 turn	1 turn	Threads are within the allowable tolerance when the product reference point is on or between the maximum and minimum step of the L_1 gage
PTF-SAE SHORT, external		0 turn	1.5 turn	
NPTF, internal	L_1 or L_1 short and [Note (3)] L_3 or L_3 short plug gages	1 turn	1 turn	
PTF-SAE SHORT, internal		0 turn	1.5 turn	
NPSF, internal	L_1 or L_1 short plug gage	0 turn	1.5 turn	
NPSI, internal		1 turn	0.5 turn	

NOTES:

- (1) Step limit gages with 4 (or 3) steps should be used.
 (2) The difference in engagement of the L_1 versus L_2 ring gages shall not exceed 0.5 turn. See para. 1.8.4.
 (3) The difference in engagement of the L_1 versus L_3 plug gages shall not exceed 0.5 turn. See para. 1.8.4.

1.5 Inspection of Product Threads

1.5.1 Inspection of NPTF Class 1 Threads and PTF-SAE Short Threads. Acceptability is determined by coordinated use of L_1 and L_2 gages for external product threads and L_1 and L_3 gages for internal product threads. Crest and root truncation is generally considered to be controlled by tooling or other means.

1.5.2 Inspection of NPTF Class 2 Threads. Acceptability is determined, in part, by coordinated use of L_1 and L_2 gages for external product threads and L_1 and L_3 gages for internal product threads. Direct measurement of crest and root truncation is a method that ensures a high degree of accuracy in determining compliance with this Standard for both external and internal threads, but may not be necessary or practicable. It does not preclude the use of other gaging methods or inspection techniques such as L_1 and L_2 snap or indicating gages, 6-step crest or root check gages and in-process control of tooling. This Standard covers the 6-step crest check gages and 6-step root check gage for NPTF threads. (See para. 1.8.6.)

1.5.3 Inspection of NPSF and NPSI Internal Threads. Functional size is determined by use of the applicable L_1 taper thread gage (see Table 1) since these

product threads are intended to assemble with taper dry-seal external threads. Crest and root truncation is generally considered to be controlled by tooling or other means and can be verified by direct measurement.

1.6 Methods of Gaging Product Threads

1.6.1 The method of gaging dryseal pipe threads described in this Standard is commonly called the limit method. The limit method is intended for L_1 and L_2 ring gages and L_1 and L_3 plug gages of the corresponding 4(or 3)-step design. Basic step plug and ring gages may also be used. The 4-step design facilitates the use of the 6-step crest and root check gages.

1.6.2 When the limit method is used NPTF external and internal threads should be gaged with NPTF length gages with steps to indicate the size range to which the product thread qualifies (minimum range, basic range, or maximum range). PTF-SAE short product threads should be gaged with NPTF gages modified with steps to indicate the short length of hand tight engagement for

that application. Both L_1 and L_2 gages for the external threads and L_1 and L_3 gages for internal threads are used to inspect these types of dryseal pipe threads.

When the turns engagement method of gaging is used, the NPTF length and short length gages can be used interchangeably, since the pitch diameter size at the small end of the gage is the same in both cases, and the step location is not used for the turns location method of gaging.

NPSF and NPSI straight internal threads should be gaged with NPTF gages modified with steps to indicate the minimum and maximum pitch diameters assigned to the respective type of thread. Only the L_1 type gages are used on NPSF and NPSI straight internal threads (GO and NOT GO straight gages are not recommended for size acceptance).

1.7 Coordination of Gages

As described in paragraphs under 2.1 the L_1 and L_2 ring gages and the L_1 and L_3 plug gages provide a check of the functional diameter (excluding crest and root truncation) of the product threads. Additionally, the coordinated use of these gages provides a check on the taper of the product thread. Proper use of the 6-step crest and root check gages also requires coordination with the L_1 ring or L_1 plug gage.

1.7.1 Order of Gaging. The L_1 gage is always used first. The L_2 or L_3 gage is used second and if root and/or crest check gages are used, they are applied last.

1.7.2 Gage and Product Thread Reference Points. Since dryseal pipe threads (except NPSF and NPSI) and the gages covered by this Standard are tapered, the gages will only engage the product thread a finite amount. Consequently, gaging is based on the relative position of the gage to the product thread.

1.7.2.1 For the limit method of gaging, the reference points of the gages are the steps. In order to provide a common reference point and eliminate variations due to chamfer or uneven surface, the reference point of external and internal product threads is the end of the pipe or fitting, provided the chamfer does not exceed the major diameter of the internal thread or be less than the minor diameter of the external thread. Allowance

must be made for excessive chamfer at the small end of the external thread and the large end of the internal thread. When this condition exists customer and vender should agree upon a common reference point to be used in inspection.

1.7.3 Classification of Product Thread Size (NPTF). When 6-step crest and/or root check gages are used, it is necessary that the product thread be classified either as a "maximum thread," "basic thread," or "minimum thread." Classification is based on the position of the L_1 ring or L_1 plug gages.

1.7.3.1 For the limit method of gaging, the product thread reference point may not directly coincide with the L_1 ring or L_1 plug reference points (maximum, basic, or minimum step). Therefore, the distance between the maximum step and minimum step is divided into three equal ranges as shown in Fig. 1. The ranges may be determined by use of 4-step L_1 taper thread gages or may be approximated by eye or by turns of the gage on the product thread. If the reference point of the product thread lies in the minimum range, basic range or maximum range, it is termed a "minimum thread," "basic thread," or "maximum thread" respectively.

1.8 Use of Gages

1.8.1 Prior to gaging threads, it is important that the gage and product threads are clean and free from burrs.

1.8.2 In all cases when a gage is used, it is inserted or screwed handtight onto or into the product thread. The next steps of the gaging procedure are detailed in the following paragraphs, and unless noted otherwise, L_1 , L_2 , and L_3 are synonymous with L_1 Short, L_2 Short, and L_3 Short. An outline of the gages and gaging tolerances are given in Table 1.

1.8.3 L_1 Gages. For the limit method of gaging using 4(or 3)-step gages, the product thread reference point must lie between the appropriate steps. If the 6-step crest and/or root gages are to be used, the product thread must be classified to be either a "maximum thread," "basic thread," or "minimum thread" (see para. 1.7.3).

1.8.4 L_2 Gage or L_3 Gage. The L_1 gage is the sizing gage and L_2 and L_3 gages are relationship gages. When assembled with the L_2 or L_3 gage the position of the product thread reference point may not vary more

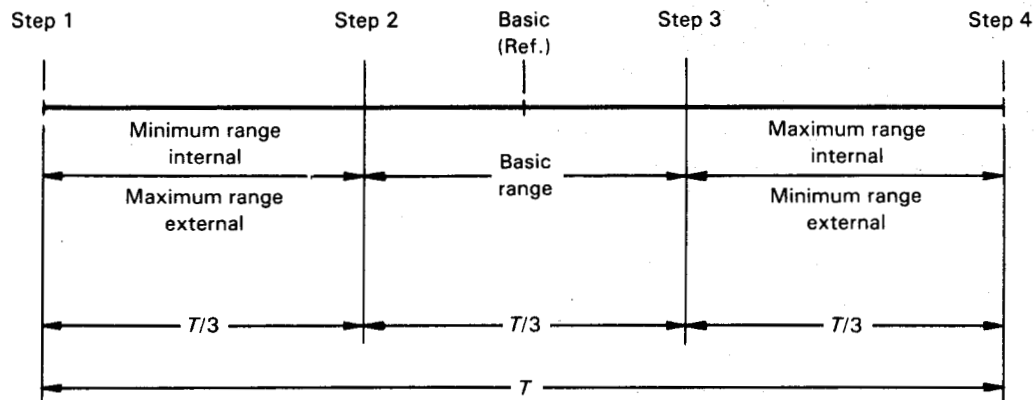
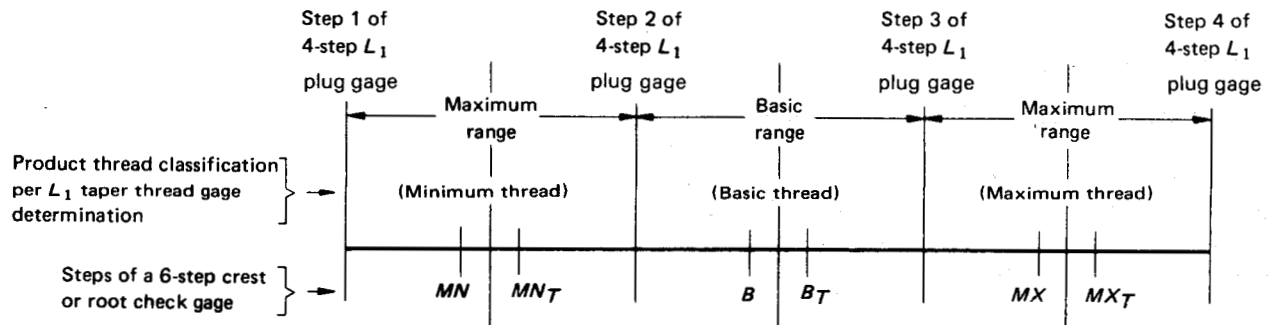
GENERAL NOTE: $T = 2$ turns

FIG. 1 CLASSIFICATION OF NPTF PRODUCT THREAD SIZE USING 4-STEP GAGES



GENERAL NOTE:

Example shown is for the inspection of internal product thread.

Step	Corresponds to:
MN	Minimum thread with minimum truncation
MN_T	Minimum thread with maximum truncation
B	Basic thread with minimum truncation
B_T	Basic thread with maximum truncation
MX	Maximum thread with minimum truncation
MX_T	Maximum thread with maximum truncation

FIG. 2 IDENTIFICATION OF STEPS ON 6-STEP CREST OR ROOT CHECK GAGE

than $\pm 1/2$ turn from the position as established when assembled with the L_1 gage. When using 4(or 3)-step L_2 or L_3 gages the product thread reference point is not required to lie between the same set of steps as when assembled with the L_1 gage and may lie beyond the maximum and minimum steps. Steps on L_2 and L_3 gages are for reference only.

1.8.5 6-Step Crest Check Gage or 6-Step Root Check Gage. When using the limit method of gaging, the gage must correlate to the product thread classification as determined by the L_1 gage. Specifically, if the product thread is classified as a "maximum thread," the product thread reference point must lie between the two steps of the gage marked MX and MX_T . If the product thread is classified as a "basic thread," the product thread reference point must lie between the steps of the gage marked B and B_T . If the product thread is classified as a "minimum thread," the product thread reference point must lie between the steps of the gage marked MN and MN_T . An identification of the six steps is shown in Fig. 2.

1.8.6 Limitations on Reliability of 6-Step Gages for Establishing Truncation and Width of Flats on Product Threads. Use of the 6-step gage in conjunction with the L_1 thread gage presumes a perfect thread flank contact of the gage to product thread which can never exist except on a thread with perfect flank angles, lead, and taper. The product thread groove is always wider than the gage thread ridge which fits into it. The product thread root flat is therefore always wider than indicated by the position of the 6-step gage while the crest flat is always narrower. (See para. 1.5.2.)

1.9 Direct Measurement of Crest and Root Truncation

One method of direct measurement of truncation is by optical projection. With this method, it is difficult to measure truncation as defined. Therefore, measurement of the equivalent width of flat is a common practice. External threads can be directly projected, but internal threads must either be sectioned and projected by reflection or cast¹ and the cast used for direct projection. Magnification should not be less than 20X and may need to be greater for accurate resolution of small size threads.

¹ Some silicon rubber molding compounds have been found to be good casting material.

1.10 Inspection of Gages

1.10.1 Periodic inspection of gages is necessary in order to detect gages worn beyond the limits specified in para. 2.4. Since gage wear is directly related to gage use, frequency of inspection must be determined by each user.

1.10.2 Working gages are generally inspected by using master gages. Master gages provide a functional check of all thread elements (except crest and root truncation) but will not detect uneven wear. Consequently, the individual thread elements (pitch diameter, lead, taper, half angle, truncation, and major or minor diameter) of working gages should be measured occasionally. Measurement of these thread elements can be made by the user but because of the relatively elaborate equipment and procedures required, it may be most economical to send the gages to a gage manufacturer or to a measurement laboratory.

1.10.3 Methods of Measuring Externally Threaded Gages. Two-wire, three-wire, and four-wire methods described in Appendix B, are used for measuring pitch diameter for taper threads. The choice from these methods is a matter of preference and more often depends on the availability of fixtures and measuring equipment. Lead and taper can be measured on measuring machines, half angle, and truncation (width of flat), by optical projection.

1.10.4 Methods of Measuring Internally Threaded Gages. Internal threads are generally much more difficult to measure directly than external threads. There are no standard methods for measuring pitch diameter although it is generally determined by mating the ring gage to a master taper thread plug gage as described in Appendix B. Measurement of pitch diameter can also be made by using the ball probe method described in Appendix B. Lead and taper can be measured on measuring machines, half angle, and truncation, by optical projection of a cast.

1.10.5 Standoff. The relative position of a gage when mated to another gage or workpiece (see Fig. 3). It is recommended that the standoff of each working gage from its respective master be determined and that the value be taken into consideration when the working gage is used. Working gages should be replaced when the standoff is more than one-half turn from basic size.

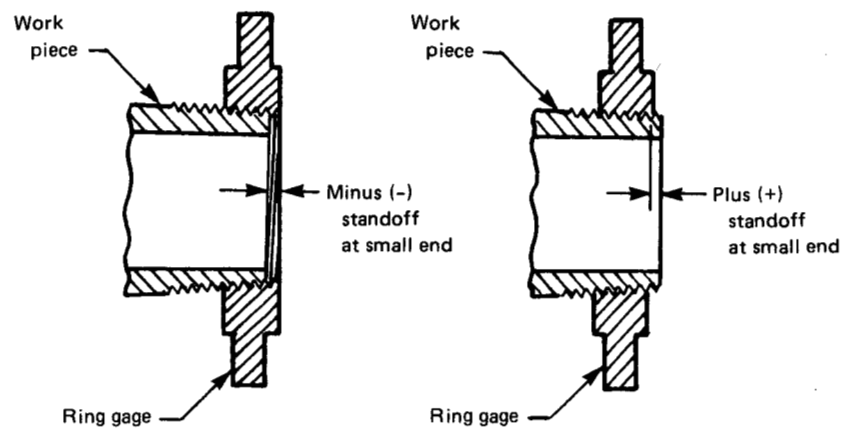
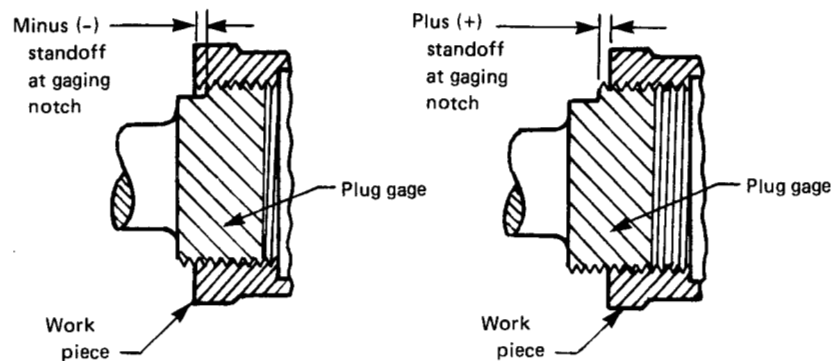
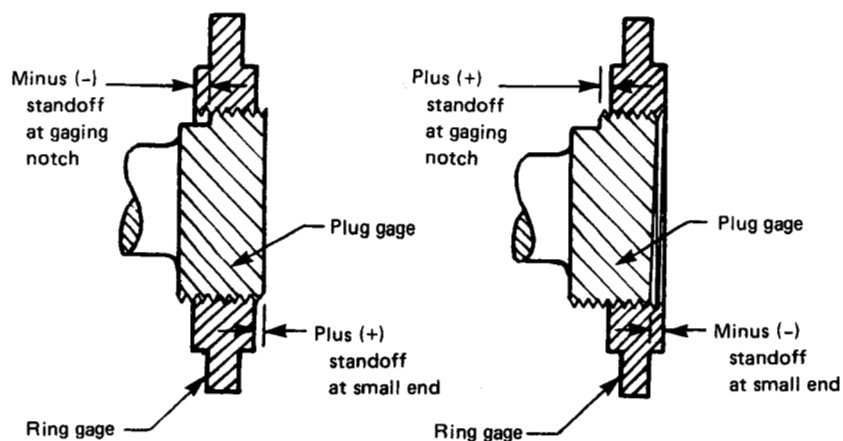
(a) L_1 Ring Gage With Work Piece(b) L_1 Plug Gage With Work Piece(c) L_1 Plug Gage With L_1 Ring Gage

FIG. 3 RELATIVE POSITION PLUS AND MINUS STANDOFF

**TABLE 2 FUNCTION AND APPLICATION OF GAGES COVERED IN
ASME B1.20.5-1991**

WORKING GAGES					
NPTF			PTF-SAE SHORT		
L_1 ring	4-step	Table 7	L_1 short ring	3-step	Table 8
L_1 ring	Basic step	Table 7	L_2 short ring	3-step	Table 10
L_1 ring	3-step	Table A1	L_1 short plug	3-step	Table 14
L_2 ring	4-step	Table 9	L_3 short plug	3-step	Table 17
L_2 ring	Basic step	Table 9			
L_2 ring	3-step	Table A2			
Crest ring	6-step	Table 11			
Root ring	6-step	Table 12		NPSF	
L_1 plug	4-step	Table 13			
L_1 plug	Basic step	Table 13	L_1 short plug	3-step	Table 14
L_1 plug	3-step	Table A3			
L_3 plug	4-step	Table 16			
L_3 plug	Basic step	Table 16			
L_3 plug	3-step	Table A4		NPSI	
Crest plug	6-step	Table 18			
Root plug	6-step	Table 19	L_1 plug	3-step	Table 15

MASTER GAGES	
Ring for L_1 and L_3 taper plug	Table 20
Plug for L_1 and L_2 taper ring	Table 21
Ring for 6-step crest plug	Table 22
Plug for 6-step crest ring	Table 22
Ring for 6-step root plug	Table 23
Plug for 6-step root ring	Table 23

2 GAGES

2.1 Types and Functions of Gages

Although inspection of dryseal pipe threads may involve instruments for direct measurement as well as gages, this section covers only gages. The types of gages listed below are ring and plug gages; however, snap or indicating gages may be used provided that the functions listed below are satisfied. It should be noted, however, that standard thread gages for dryseal pipe threads are designed to provide a functional check rather than to measure individual thread elements. The gages covered in this Standard are listed according to function and application in Table 2.

2.1.1 Gages for Checking External Threads

2.1.1.1 L_1 Taper Thread Ring Gage or L_1 Short Taper Thread Ring Gage. Checks the functional diameter and minimum height of thread form (excluding root and crest truncation) of that portion of the

thread engaged when mating dryseal pipe threads are assembled handtight.

2.1.1.2 L_2 Taper Thread Ring Gage or L_2 Short Taper Thread Ring Gage. Checks the functional diameter (excluding root and crest truncation) of the threads provided for wrench make-up beyond the L_1 length, and in relation to the position of the L_1 ring, provides an indication of taper deviation, or excessive root truncation.

2.1.1.3 Crest Check Ring Gage. Checks the major diameter (crest truncation) of the external thread.

2.1.1.4 Boot Check Ring Gage. Checks the minor diameter (root truncation) of the external thread.

2.1.2 Gages for Checking Internal Threads

2.1.2.1 L_1 Taper Thread Plug Gage or L_1 Short Taper Thread Plug Gage. Checks the functional diameter and minimum height of thread form (ex-

cluding root and crest truncation) of that portion of the thread engaged when mating dryseal pipe threads are assembled handtight.

2.1.2.2 L_3 Taper Thread Plug Gage or L_3 Short Taper Thread Plug Gage. Checks the functional diameter, (excluding root and crest truncation) of the threads provided for wrench make-up beyond the L_1 length, and in relation to the position of the L_1 plug, provides an indication of taper deviation, or excessive root truncation.

2.1.2.3 Crest Check Plug Gage. Checks the minor diameter (crest truncation) of the internal thread.

2.1.2.4 Root Check Plug Gage. Checks the major diameter (root truncation) of the internal thread.

2.1.3 All dimensions in this Standard, including all tables are in inches unless otherwise specified.

2.2 Taper Thread Gages

There are two kind of gages: working gages and master gages.

2.2.1 Working gages are used to check product threads during manufacture and for acceptance. Each set of working gages consists of L_1 and L_2 ring gages and L_1 and L_3 plug gages. For Class 2 product threads, crest check and root check gages should also be included in a set of working gages.

2.2.2 Master gages are used as a reference to check new working gages and for surveillance of used working gages and classification of them as to standoff. However, it is not necessary to have master gages if other methods of inspecting working gages are employed. Each set of master gages consists of an L_1/L_3 master ring gage and an L_1/L_2 master plug gage. (See Fig. 4.)

2.3 Thread Form

2.3.1 L_1 and L_2 Taper Thread Ring Gages and L_1 and L_3 Taper Thread Plug Gages. L_1 and L_2 ring gages and L_1 and L_3 plug gages have a triangular thread form with truncated crests and cleared roots. The angle between the flanks of the threads is 60 degrees when measured on an axial plane and the line bisecting this angle is perpendicular to the axis of the threads making each half angle equal to 30 degrees. L_1 ring and plug gages have a truncation parallel to the pitch line, equal to the maximum root truncation of the product thread, while crests of L_2 ring and L_3 plug gages have a truncation of $0.20p$. The form of the thread root is optional, but must clear a $0.042p$ flat ($0.036p$ truncation).

NOTE: The maximum width of root relief permissible equals the maximum product root width (see ANSI B1.20.3).

2.3.2 Root Check Ring and Plug Gages. Root check ring and plug gages have a triangular thread form with truncated crests and cleared roots. The angle between the flanks of the threads is 50 degrees when measured on an axial plane and the line bisecting this angle is perpendicular to the axis of the threads. (The 50 degree thread angle enables the gage to contact only at the root of the product thread so that root truncation can be checked.) Crests are truncated to provide a gage maximum flat width that is 0.001 inch smaller than the minimum flat width of the product thread root. The form of the thread root is optional, but must clear a $0.15p$ flat.

2.3.3 Crest Check Ring and Plug Gages. Crest check ring and plug gages are plain (cylindrical) taper gages.

2.3.4 Optical Projection of Thread Form. Visual method of inspection may be used in lieu of the root check and crest check ring and plug gages. The threads of tools and the threads of a percentage of the product external threads, or casts in the case of internal threads, may be visually checked by optical comparator projection (at least 20X) for thread form and truncation.

2.4 Gage Tolerance

In the manufacture of gages, variations from basic dimensions are unavoidable. Furthermore, gages will wear in use. In order to fix the maximum allowable variations of gages, tolerances have been established and are applied to the basic dimensions given in Section 2.5.

2.4.1 Working Gage Tolerance. Manufacturing tolerances for working gages are given in Table 3. The maximum wear on a working gage shall not be more than the equivalent of one-half turn as determined by the master gage.

2.4.2 Master Gage Tolerance. Master gage tolerances are shown in Table 4. Master gages should be a matched set (plug and ring) and accompanied by a record of the amount they vary from being flush to basic in terms of standoff specified in three decimal places.

2.4.3 Relationship of Lead and Angle Variations to Pitch Diameter Tolerance

2.4.3.1 Functional size of pitch diameter is affected by variations in lead and angle and the effect of these variations can be expressed as an equivalent variation in diameter. Diameter equivalents of variations in lead and half angle are given in Tables 4 and 5 respectively.

2.4.3.2 These corrections are always added to the pitch diameter in the case of external threads and subtracted in the case of internal threads regardless of whether the lead or angle variations are plus or minus.

2.4.3.3 The diameter equivalent for lead and angle variations plus the pitch diameter variation multiplied by 16 gives the longitudinal variation from basic at the gaging notch.

2.5 Working Gage Dimensions

The basic dimensions given in the following paragraphs pertain to working gages. Both 4-step and basic notch gage designs are covered for L_1 and L_2 ring gages and L_1 and L_3 plug gages. Only the 6-step design is covered for crest and root check gages. The 4-step gages are included because they facilitate the use of the 6-step crest and root gages. Although the basic notch gage is more difficult to use in conjunction with the 6-step crest and root gages, it is more economical to manufacture and may be used for checking both NPTF threads, and PTF-SAE SHORT threads.

2.5.1 L_1 Ring Gage (for checking NPTF threads). The 3-step design is included in Appendix A for reference. (See Table 7.)

2.5.2 L_1 Short Ring Gage (for checking PTF-SAE SHORT threads). See Table 8.

2.5.3 L_2 Ring Gage (for checking NPTF threads). The 3-step design is included in Appendix A for reference. (See Table 9.)

2.5.4 L_2 Short Ring Gage (for checking PTF-SAE SHORT threads). See Table 10.

2.5.5 Crest Check Ring Gage (for checking NPTF threads). See Table 11.

2.5.6 Root Check Ring Gage (for checking NPTF threads). See Table 12.

2.5.7 L_1 Plug Gage (for checking NPTF threads). See Table 13. The 3-step design is included in Appendix A for reference.

2.5.8 L_1 Short Plug Gage (for checking PTF-SAE SHORT and NPSF threads). See Table 14.

2.5.9 L_1 Plug Gage, NPSI (for checking NPSI threads). See Table 15.

2.5.10 L_3 Plug Gage (for checking NPTF threads). See Table 16.

2.5.11 L_3 Short Plug Gage (for checking PTF-SAE SHORT threads). See Table 17.

2.5.12 Crest Check Plug Gage (for checking NPTF threads). See Table 18.

2.5.13 Root Check Plug Gage (for checking NPTF threads). See Table 19.

2.6 Master Gage Dimensions

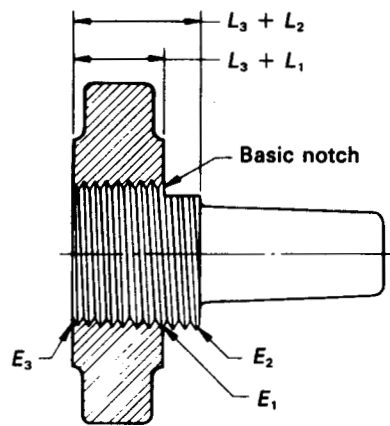
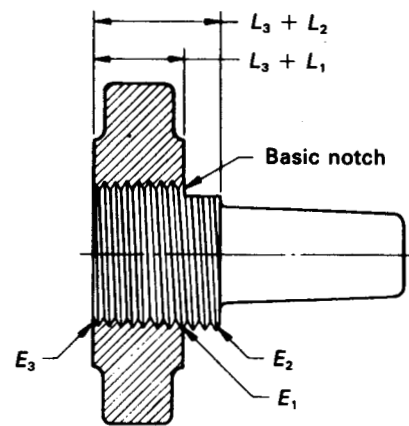
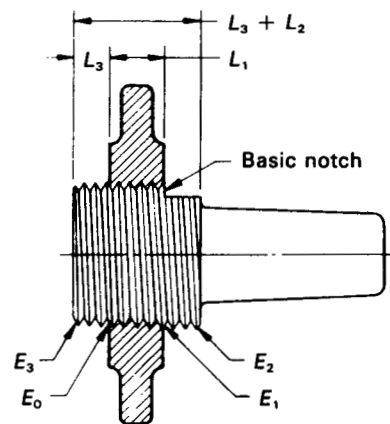
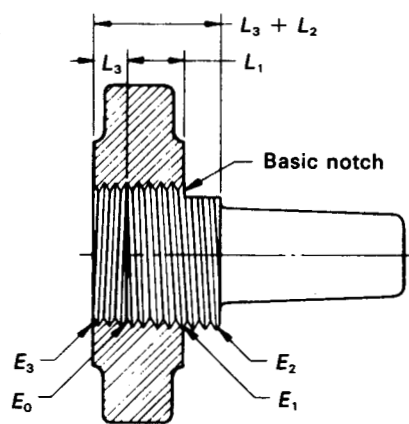
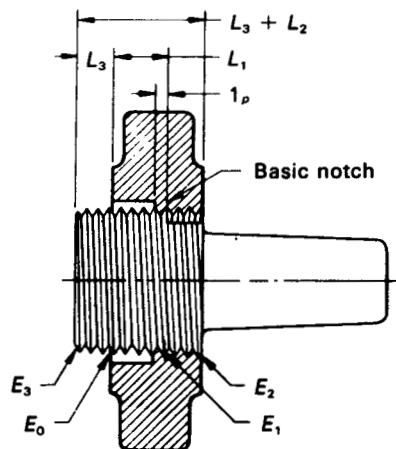
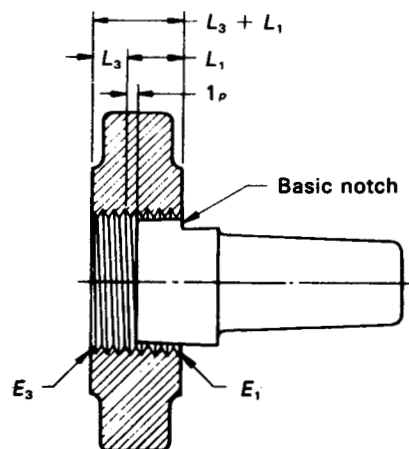
The basic dimensions given in the following tables pertain to master gages for NPTF threads.

2.6.1 Master Ring Gage (for checking NPTF Working Plug Gages). See Table 20.

2.6.2 Master Plug Gage (for checking NPTF Working Ring Gages). See Table 21.

2.6.3 Master Ring and Plug Gages (for checking NPTF 6-Step Working Crest Ring and Plug Gages). See Table 22.

2.6.4 Master Ring and Plug Gages (for checking NPTF 6-Step Working Root Ring and Plug Gages). See Table 23.

(a) L_1/L_2 Master Plug With L_1/L_3 Master Ring(d) L_1/L_3 Master Ring With L_1/L_2 Master Plug(b) L_1/L_2 Master Plug With L_1 Ring(e) L_1/L_3 Master Ring With L_1 Plug(c) L_1/L_2 Master Plug With L_2 Ring(f) L_1/L_3 Master Ring With L_3 Plug**GENERAL NOTE:**

Master gage set consists of one full-form L_1/L_2 master taper thread plug gage and one full-form L_1/L_3 master taper thread ring gage.

FIG. 4 RELATIVE POSITION OF MASTER PLUGS AND RINGS TO WORKING GAGES

TABLE 3 TOLERANCES FOR WORKING PLUG AND RING GAGES

Nominal Size	Tolerance [Note (1)] on Pitch Diam. ($\pm$)	Tolerance on Lead [Notes (2), (3)]		Tolerance [Note (4)] on Half-Angle, Minutes		Tolerance on Taper [Notes (3), (5)]		Tolerance on Major Diam.	Tolerance on Minor Diam.	Total Cumulative [Note (6)] Tolerances on Pitch Diam.		Stand-off [Notes (7), (8)]
		Plugs	Rings	Plugs ($\pm$)	Rings ($\pm$)	Plugs (+)	Rings (-)	Plugs (-)	Rings (+)	Plugs	Rings	
1	2	3	4	5	6	7	8	9	10	11	12	13
$1/16$ - 27	0.0002	0.0002	0.0003	15	20	0.0003	0.0006	0.0012	0.0012	0.00080	0.00105	0.030
$1/8$ - 27	0.0002	0.0002	0.0003	15	20	0.0003	0.0006	0.0012	0.0012	0.00080	0.00105	0.030
$1/4$ - 18	0.0002	0.0002	0.0003	15	20	0.0004	0.0007	0.0012	0.0012	0.00092	0.00122	0.034
$3/8$ - 18	0.0002	0.0002	0.0003	15	20	0.0004	0.0007	0.0012	0.0012	0.00092	0.00122	0.034
$1/2$ - 14	0.0003	0.0002	0.0003	10	15	0.0006	0.0009	0.0015	0.0015	0.00097	0.00130	0.036
$3/4$ - 14	0.0003	0.0002	0.0003	10	15	0.0006	0.0009	0.0015	0.0015	0.00097	0.00130	0.036
1 - 11 $1/2$	0.0003	0.0003	0.0004	10	15	0.0008	0.0012	0.0015	0.0015	0.00121	0.00157	0.044
1 $1/4$ - 11 $1/2$	0.0003	0.0003	0.0004	10	15	0.0008	0.0012	0.0015	0.0015	0.00121	0.00157	0.044
1 $1/2$ - 11 $1/2$	0.0003	0.0003	0.0004	10	15	0.0008	0.0012	0.0015	0.0015	0.00121	0.00157	0.044
2 - 11 $1/2$	0.0003	0.0003	0.0004	10	15	0.0008	0.0012	0.0015	0.0015	0.00121	0.00157	0.044
2 $1/2$ - 8	0.0005	0.0004	0.0005	7	10	0.0010	0.0014	0.0019	0.0019	0.00158	0.00193	0.056
3 - 8	0.0005	0.0004	0.0005	7	10	0.0010	0.0014	0.0019	0.0019	0.00158	0.00193	0.056

GENERAL NOTES:

- (a) The tolerances for the length from small end to gaging notch of the L_1 and L_3 plug gages shall be +0.000 and -0.001 for sizes $1/16$ to 2 inclusive and +0.000 and -0.002 for sizes 2 $1/2$ and larger.
- (b) The tolerances for the overall thread length L_2 of the plug gage shall be $+1/64$ and -0 for sizes $1/16$ to 2 inclusive and $+1/32$ and -0 for sizes 2 $1/2$ and larger.
- (c) Tolerance for the thickness of the L_1 and L_2 ring gages shall be -0.000 and +0.001 for sizes $1/16$ to 2 inclusive and -0.000 and +0.002 for sizes 2 $1/2$ and larger.
- (d) The tolerances for step lengths of all 4-step gages is as follows:
 Step 1, +0.002 and -0.000
 Step 2, ± 0.001
 Step 3, ± 0.001
 Step 4, +0.000 and -0.002

NOTES:

- (1) To be measured at the gaging notch of plug gage.
- (2) Allowable variation in lead between any two threads in L_1 length of gage.
- (3) The lead and taper on plug and ring gages shall be measured along the pitch line omitting the incomplete threads at each end.
- (4) In solving for the correction in diameter for angle variation the average variation in half angle for the two sides of thread regardless of their signs, should be taken.
- (5) Allowable variation in taper in L_1 length of gage.
- (6) Total cumulative tolerance on pitch diameter = PD tolerance + diameter equivalent of lead variation + diameter equivalent of half angle variation.
- (7) Between the plug gage gaging notch and the large end of the ring gage when dimensions are at opposite extremes of the tolerance limits.
- (8) Maximum possible interchange standoff, any ring against any plug other than its master plug, may occur when taper variations are zero and all other dimensions are at opposite extreme tolerance limits. Actual standoff should be well within these maximum limits. Refer to Tables 5 and 6 for diameter equivalents of lead and half angle variations respectively.

TABLE 4 TOLERANCES FOR MASTER PLUG AND RING GAGES

Nominal Size	Tolerance [Note (1)] on Pitch Diam. ($\pm$)	Tolerance [Notes (2), (3)] on Lead		Tolerance [Note (4)] on Half Angle, min		Tolerance [Notes (3), (5)] on Taper		Tolerance on Major Diam.	Tolerance on Minor Diam.	Total Cumulative [Note (6)] Tolerances on Pitch Diam.		Stand-off [Notes (7), (8)] ($\pm$)
		Plugs	Rings	Plugs ($\pm$)	Rings ($\pm$)	Plugs (+)	Rings (-)	Plugs (-)	Rings (+)	Plugs	Rings	
1	2	3	4	5	6	7	8	9	10	11	12	13
$1/16$ - 27	0.0001	0.0001	0.00015	8	12	0.00015	0.0003	0.0006	0.0006	0.0004	0.00056	0.002
$1/8$ - 27	0.0001	0.0001	0.00015	8	12	0.00015	0.0003	0.0006	0.0006	0.0004	0.00056	0.002
$1/4$ - 18	0.0001	0.0001	0.00015	8	12	0.0002	0.0003	0.0006	0.0006	0.00047	0.00066	0.002
$3/8$ - 18	0.0001	0.0001	0.00015	8	12	0.0002	0.0003	0.0006	0.0006	0.00047	0.00066	0.002
$1/2$ - 14	0.00015	0.0001	0.00015	6	10	0.0003	0.0004	0.0007	0.0007	0.00051	0.00073	0.002
$3/4$ - 14	0.00015	0.0001	0.00015	6	10	0.0003	0.0004	0.0007	0.0007	0.00051	0.00073	0.002
1 - 11 $1/2$	0.00015	0.00015	0.0002	6	10	0.0004	0.0005	0.0007	0.0007	0.00064	0.00089	0.002
1 $1/4$ - 11 $1/2$	0.00015	0.00015	0.0002	6	10	0.0004	0.0005	0.0007	0.0007	0.00064	0.00089	0.002
1 $1/2$ - 11 $1/2$	0.00015	0.00015	0.0002	6	10	0.0004	0.0005	0.0007	0.0007	0.00064	0.00089	0.002
2 - 11 $1/2$	0.00015	0.00015	0.0002	6	10	0.0004	0.0005	0.0007	0.0007	0.00064	0.00089	0.002
2 $1/2$ - 8	0.00025	0.0002	0.00025	5	7	0.0005	0.0006	0.0009	0.0009	0.00088	0.00107	0.003
3 - 8	0.00025	0.0002	0.00025	5	7	0.0005	0.0006	0.0009	0.0009	0.00088	0.00107	0.003

GENERAL NOTES:

- The tolerances for the length L_1 from small end to gaging notch of the plug gage shall be +0.000 and -0.0005 for sizes $1/16$ to 2 inclusive and +0.000 and -0.001 for sizes 2 $1/2$ and larger.
- The tolerances for the overall thread length L_2 of the plug gage shall be +0.000 and -0.001 for sizes $1/16$ to 2 inclusive and +0.000 and -0.002 for sizes 2 $1/2$ and larger.
- Tolerances for the thickness of the ring gage shall be -0.000 and +0.001 for sizes $1/16$ to 2 inclusive and -0.000 and +0.002 for sizes 2 $1/2$ and larger.
- Refer to Tables 6 and 7 for diameter equivalents of lead and half angle variations respectively.

NOTES:

- To be measured at the gaging notch of plug gage.
- Allowable variation in lead between any two threads in L_1 length of gage.
- The lead and taper on plug and ring gages shall be measured along the pitch line omitting the incomplete threads at each end.
- In solving for the correction in diameter for angle variations, the average variation in half angle for the two sides of thread regardless of their signs, should be taken.
- Allowable variation in taper in L_1 length of gage.
- Total cumulative tolerance on pitch diameter = PD tolerance + diameter equivalent of lead variation + diameter equivalent of half angle variation.
- Between master plug at gaging notch and the large end of the master ring gage.
- Tolerances listed are standoff limits for master ring to its original master plug gage. Master plug to working ring or master ring to working plug standoff may exceed the standoff shown but should not exceed one-half extreme standoff listed in Table 3, column 13.