Glastonbury Southern Gage Erin, TN

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INTRODUCTION TO FIXED LIMIT GAGING

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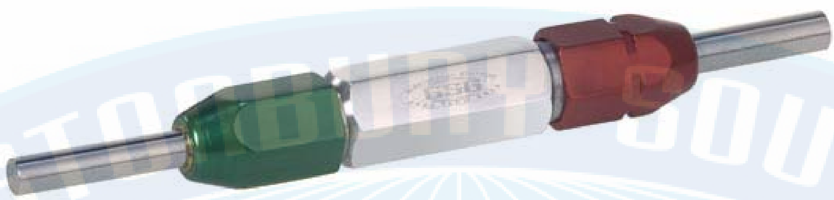
Introduction:

The objective of this publication is to offer, in usable, simple terms, a basic summary, and source of information for those individuals given responsibility for the purchase and use of attribute or fixed limit gages. No intention has been made here to plagiarize, accept credit, and/or otherwise infringe on the work of others in the gage and metrology industries.



Go / Nogo plain cylindrical plug gage to check an Internal Diameter (ID)

History of Attribute or Fixed Limit Gages

The word 'gage' is about as general and unspecified in its meaning as the word 'tool.' Therefore, it is necessary to clarify that we are discussing 'Attribute' gages, also known as 'Fixed Limit' or 'Limit' gages, but most commonly known as 'Go / NoGo' gages.

A quick, simple, cost effective method of checking product was needed as a result of the industrial revolution and batch type production. Assembly line concepts required ease of use, little to no training, and fixed limit gages were the answer to this need. When manufacturing undertakes to produce a complex assembly, usually involving many components, it is generally more economical to assign the production to specialized departments, and in some cases, other manufacturing plants and/or subcontractors, where specialized machinery, equipment and skills are available. This allows large numbers of manufactured parts to be stock piled at the assembly plant without having to be test fitted or customized (the fundamental philosophy behind Eli Whitney's interchangeable part theory). Gaging components separately, make it possible to select any part in stock (at random) and fit them together into a fully functioning assembly unit. Fixed limit gaging, therefore, became an integral part of the process.

Machine operators, working on parts with critical dimensions were provided with gages so they could keep a "real time" check on the wearing of tools, and other problems which prevent uniformity in the production process. This same method could be used on the Original Equipment Manufacturer's (OEM's) manufacturing line, the inspection department, or at a subcontractor's facility. Moreover, confirmation was possible using comparisons between results achieved at multiple locations using "like" gages.

Benefits:

The advantages and benefits of using fixed limit gaging are varied.

- The cost per piece gaged is the lowest of all inspection methods making fixed limit gaging the most cost effective of all methods.
- Fixed limit gaging is both fast and portable.

- The size range, both small and large, is constrained by manufacturing “part size” limitations only.
- It is certifiable; offering traceability to industry accepted standards.
- And, fixed limit gaging, when properly manufactured and calibrated, offers a unique “assurance of fit” with mating parts unavailable using virtually any other gaging method.
- Is the most conducive to using in a factory floor environment

Materials

Attribute gages, while not limited to specific types of materials, are generally made of steel, chrome, or carbide. These materials offer the best combination of wear resistance, thermal coefficients, and machine-ability. The generally accepted hardness is 58 – 62 on a Rockwell C scale. Chrome based coatings and carbide are considerably harder, and less susceptible to corrosion. However, it must be remembered, the manufacture and use of fixed limit gaging is, first and foremost, an exercise in compromise where hardness is concerned. A harder gage will generally check more parts because it wears less, but it is also usually more brittle and easier to damage when handling or storing.

Definitions & Terms:

Comprehensive Listing

Go / Nogo plain Cylindrical plug gage to check Inside Diameter in product.

Go / Nogo Thread gage to check Tapped (Threaded) holes in Product.

Types:

The most common fixed limit gages can be broken down into two (2) basic configurations, those used to inspect the inside diameter of parts (ID’s) and those used to inspect the outside diameter of parts (OD’s). Within these two broad configurations there are at least two additional significant categories of fixed limit gages, cylindrical and threaded. There are fixed limit gages for other applications such as groove widths or depths, and lengths, but we will limit this discussion to the cylindrical and threaded diameter applications.

Cylindrical gaging

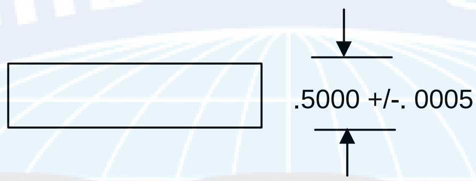
Exercise in deciding size and tolerance - plug gage

Cylindrical plug gages are used to check hole diameters. The style or type may vary because of size or manufacturer, but the basic concept of deciding gage size and tolerance is universal for cylindrical gages.

The concept is to have two gages, one at each end of the product tolerance or limits. If the diameter being inspected is 'in size', (made to the product specifications) the smaller or 'Go' gage will easily enter the hole, while the larger or 'NoGo' gage will not enter the hole. This concept will not tell us the size of the hole, but it will tell us if the hole is correct or incorrect, making it quick and easy to accept or reject a part.

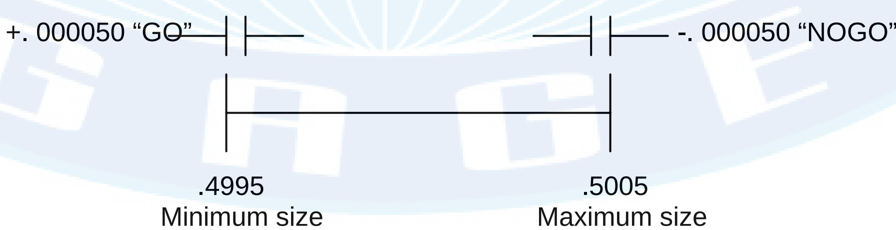
The gage shown below is a Reversible Wire style go/nogo with handle.

To determine the GO and NOGO gage sizes and the gage tolerance required we must first start with the part dimensions to be checked. For discussion purposes we will use as an example a part hole of .5000 +/- .0005.



Because the tolerance in this case is applied in both directions (bilaterally), we will have to subtract to find the low limit (minimum size) and add to find the high limit (maximum size). The low limit is .4995 (.5000 minus .0005) and the high limit is .5005 (.5000 plus .0005) therefore, we will need a .4995 go gage and a .5005 nogo gage.

The gages must also have a manufacturing tolerance, and there are several standard options. To decide which option is best we use the generally accepted theory that a measuring instrument should, if possible, be 10 times more accurate. In our example we have a tolerance on the hole diameter of + / - .0005, which is a total tolerance of .001. We want to use a maximum of 10% for both the Go and NoGo gages, so we compute 5% for each gage, which comes to .00005 (50 millionths of an inch). We apply the gage tolerance as a plus tolerance for the smaller gage and as a minus tolerance for the larger gage, as shown in the following illustration.



The concept used to apply the gage tolerance is to guarantee the gage size is within the manufacturing limits for the part. This decreases the usable part tolerance, but it also guarantees we will always reject out of tolerance parts.

Now we have to take this one step farther to see if we can use a standard tolerance grade for the gages. Our .00005 or 5% is the maximum tolerance we want to use, so we check our gagemaker's tolerance chart for cylindrical plain gages from the standard, ANSI B89.1.5. Using the size range row for our hole size, we are looking for .00005 or something smaller. The class X tolerance is .00004, slightly less, so we will use the class X gage tolerance.

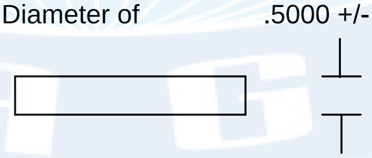
GAGEMAKER'S TOLERANCE CHART						
Above	**To & Incld.**	**CL - XXX**	**CL – XX**	**CL - X**	**CL - Y**	**CL - Z**
0.010" .254mm	0.825" 20.95mm	.000010 0.25um	.000020 0.5um	.000040 1.0um	.000070 1.75um	.0001 2.5um
0.825" 20.95mm	1.510" 38.35mm	.000015 0.38um	.000030 0.75um	.000060 1.5um	.000090 2.25um	.00012 3.0um
1.510" 38.35mm	2.510" 63.75mm	.000020 0.50um	.000040 1.0um	.000080 2.0um	.00012 3.0um	.00016 4.0um
2.510" 63.75mm	4.510" 114.55mm	.000025 0.63um	.000050 1.25um	.0001 2.5um	.00015 3.75um	.00020 5.0um
4.510" 114.5mm	6.510" 165.35mm	.000033 0.83um	.000065 1.625um	.00013 3.25um	.00019 4.75um	.00025 6.25um
6.510" 165.35mm	9.010" 228.85mm	.000040 1.00um	.000080 2.0um	.00016 4.0um	.00024 6.0um	.00032 8.0um
9.010" 228.85mm	12.010" 305.05mm	.000050 1.25um	.0001 2.5um	.0002 5.0um	.0003 7.5um	.0004 10um
12.010" 305.05mm	15.010" 381.25mm	.000075 1.88um	.00015 3.75um	.0003 7.5um	.00045 11.25um	.0006 15um
15.010" 381.25mm	18.010" 457.45mm	.0001 2.50um	.0002 5um	.0004 10um	.0006 15um	.00080 20um
18.010" 457.45mm	21.010" 533.65mm	.000125 3.13um	.00025 6.25um	.0005 12.5um	.00075 18.75um	.001 25um

Cylindrical gaging

Exercise in deciding size and tolerance - ring gage

This exercise is very similar to the one we just completed for plugs.

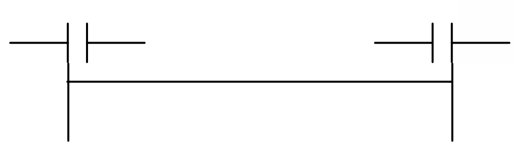
We have a shaft or part with an Outside Diameter of .5000 +/- .0005



Click here for diagram of gage position in the product tolerance.

To measure with fixed limit gages, we now will use Ring Gages with a .5005 GO and .4995 NOGO. When we use them to check the part, the GO gage should freely slide over the shaft and the NOGO should not go on to the shaft.

+. 000050 “NOGO”
-. 000050 “GO”



.4995
Minimum size

.5005
Maximum size

Notice the GO gage is the larger or maximum size and the NOGO is the smaller or minimum size, therefore the GO gage has a MINUS tolerance and the NOGO has a PLUS tolerance.

When we look at the “Gage Makers Tolerance Chart” we can find the tolerance class to order our gage. Notice in our chart that .000040 is less than .000050 therefore our gage needs to be Class X.

Tolerancing and Product Limits (material conditions):

If a GO plug gage passes through a particular part feature we are assured that we have not exceeded the maximum material condition (too much material left in the hole). If it does not fit, the hole is too small, leaving the part with too much material. NOGO plug gages provide assurances that we have not dropped below the minimum material condition (too much material removed). Using the example above, if the NOGO plug gage does not fit, this indicates that the functional hole size is not larger than .5005”. If the NOGO plug went into the hole, it would indicate that the hole is too large and the hole has too little material left. Referring to the shaft, the NOGO ring gage will not fit as long as the shaft is at least .4995”. If it does, we know that the shaft is undersized.

With one set of GO/NOGO OD gages (to check the hole), and another set of ID gages (shaft), it is relatively simple to determine whether the parts are within the limits of the product tolerances, and the maximum and minimum material conditions. No other gaging system offers this functional assurance of assemble-ability between mating parts in such a cost-effective manner.

Care & Use:

Product features to be gaged must be clean and free from burrs to prevent gaging interference and damage. The gage should be turned slowly into or onto the part being checked. The gage should not be forced. Air flats on a go gage can facilitate the inspection of blind holes where air pressure is a problem. Due to the effects of thermal expansion on like and unlike materials (gage and parts) the temperature of the gage and the part should be the same. (Calibration of gage sizes are performed at 68 degrees F.) Gages should be protected from exposure to temperature extremes, moisture, corrosion, and mishandling. After use gages should be cleaned, and coated with a thin film of corrosion preventative.

Fixed limit gages should be stored in a secure place protected from possible mis-use, damage, and deterioration. Dirt, drafts (temperature extremes), vibration, moisture, unnecessary handling, and physical damage are to be meticulously avoided. When stored, the use of an oil-wax based dip seal is suggested.

Alterations should be done by gage making professionals (only) due to material displacement and the need for re-calibrations after the alteration is complete.

When shipping, gages should be packaged separately with sufficient material to prevent rust, contact with any other material (including other gages) and/or damage by freight carriers.

Standardization:

For over 50 years the use of GO/NOGO gaging has resulted in the standardization of gage designs. The American National Standards Institute (ANSI) defines the details of most plain cylindrical, thread, snap, and other common gages. Uniform specifications for gage blanks, dimensions and contours have made possible a great economy in the manufacture, calibration, use, and availability of these gages. These detailed specifications have been established separately from gage tolerances and are known as the American Gage Design (AGD). Manufacturers maintain stocks of standard gage blanks ready to finish and ship, thereby minimizing costs and delays. Uniformity of gage design and gaging practices has made possible improved agreement between inspectors, vendors and users of parts.

Ordering:

Generally speaking, when ordering gages, one must keep two things in mind. 1) The tolerance of the GO and NOGO gages should consume less than 10% of the part tolerance whenever possible. This is usually divided equally, 5% to the GO gage and 5% to the NOGO gage. 2) Higher precision gages (closer tolerance gages) will accept slightly more product but with less wear life and greater expense.

Why GSG:

When it comes to gages there is simply no margin for error. At GSG these are words we live by every day with every product we produce. Our dedication has rewarded us with many long-standing customers and a reputation as a manufacturer worthy of our client's confidence and trust.

The secret to our success is quite simple: un-compromised standards of excellence. Dedication to this goal has established our company as the industry leader with over 50 years of manufacturing experience. At GSG, quality control is more than a catch phrase. Our investment in engineering, equipment, and people is evidence of our commitment to creating superior products. Our quality manual is meticulously followed. We are A2LA accredited. Highly trained inspectors monitor our products at all critical points in the manufacturing process and provide written documentation that our stringent standards are being met. As a final test of quality, certified inspection technicians evaluate each item before shipment.

For a company to truly be a leader, they must have excellent customer service. At GSG we want every interaction with our company to be a positive experience. Whether you are discussing specifications with our engineering staff, or ordering a gage, we hope you sense that we are personally committed to serving you. We prove our commitment with a toll free customer hotline, technical seminars, and staff assistance in application design. It is not surprising that demanding companies in the aerospace, military, automotive and medical manufacturing industries have formally recognized GSG’s achievements by awarding us their highest levels of approval.

The demands of today’s market require world class products. Only one gage manufacturer is uniquely prepared and qualified to assist in meeting these requirements. Your quality requirements are dependent on your gage supplier. Turn to GSG for a higher measure of quality.

UNDERSTANDING MILLIONTHS

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1.0000	One Inch
.1000	One Hundred Thousandths
.010	Ten Thousandths
.001	One Thousandth
.0001	One Tenth (One Ten thousandth)
.00001	Ten Millionths
.000001	One Millionth

.000001 Inches = 1 Microinch

.0002 = 200 Millionths

Micro inches and Millionths are interchangeable

GSG certifications for cylindrical gages read in Microinches or Micrometers.
This is the way that the metrology industry is going and so will GSG.

Inches X 25.4 = millimeters

Millimeters divided by 25.4 = inches

Microinches X .0254 = micrometers

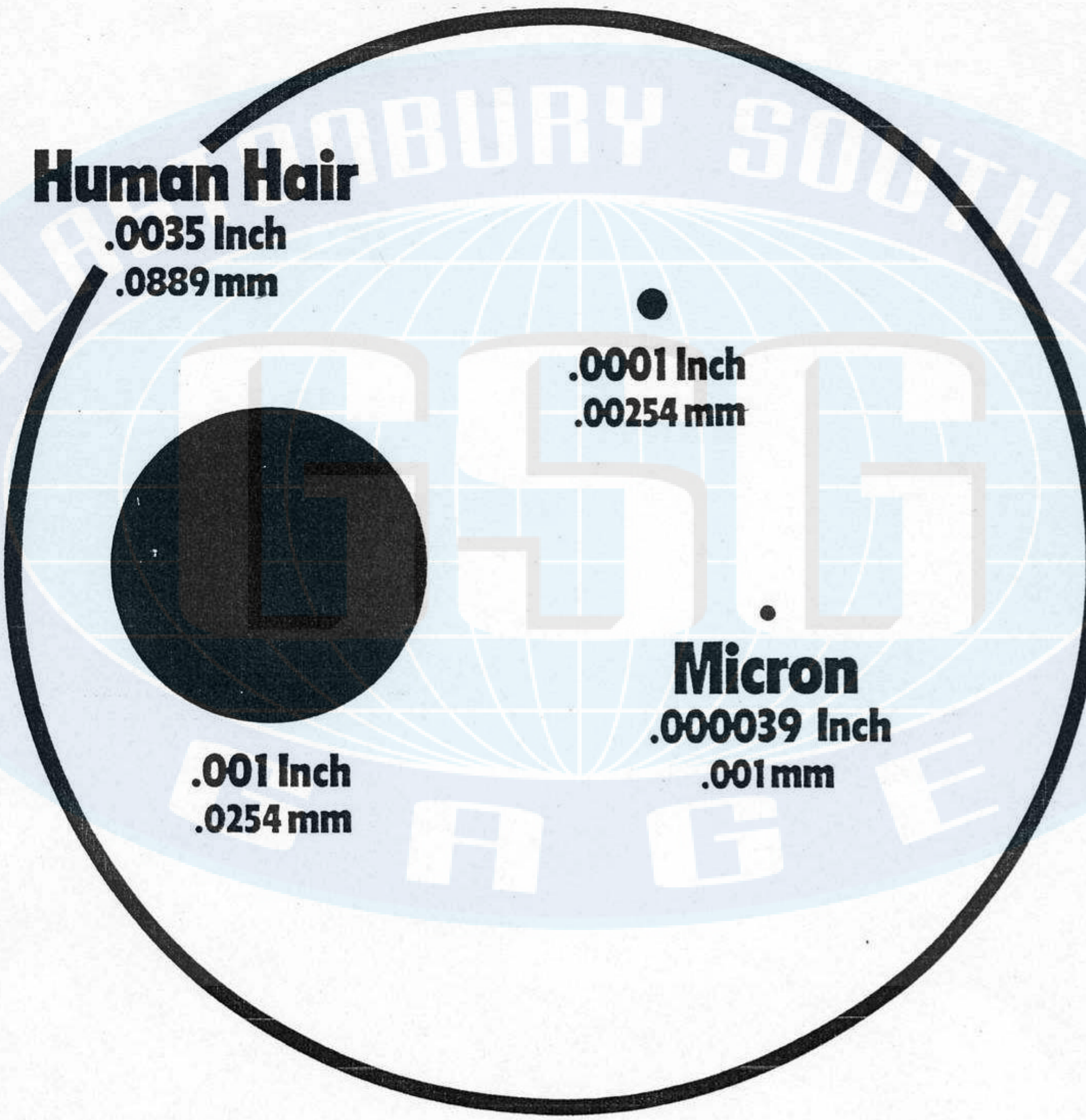
Micrometers divided by .0254 = microinches

39.37 microinches =.00003937 inches = 1 micrometer (micron)

.0001 millimeters =1 micrometer

.0254 micrometers =.0000254 millimeters

How big is a Micron?



What's Uncertainty?

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Many people talk about uncertainty, what does that mean? When we discuss uncertainty, we in the dimensional measuring field, are talking about the influences that affect the measurement being made. Some of the affects are the environment, equipment, methods, personnel, instrument used, procedure, etc.

Some examples are:

The room in which the measurement is being performed. We say that the temperature is 68 degrees plus or minus 1 degree, however the temperature at the measuring surface could be at 67 or 69 degrees. That difference could make a large difference in the true measured size. At 6.3 millionths per degree per inch size difference (coefficiency of expansion) in steel. A steel disc 1.000 class XX (+/-.000015") diameter could measure .999994 or 1.000006 respectfully. Half of the tolerance is lost with only considering uncertainty in temperature. Imagine the measurement not taken in a controlled environment!

Another example is equipment; you could measure the same disc using any instrument you choose. A highly accurate measuring instrument measuring in millionths of an inch would typically produce a lower uncertainty than a vernier caliper measuring in thousandths of an inch. No one can tell the customer what instrument they will use, however the uncertainty measuring with a vernier caliper would be quit large and well outside the tolerance of the 1.000 disc. For example the uncertainty using the highly accurate measuring instrument measuring in millionths of an inch might be .000005 and the vernier caliper might be .003 inches. Neither method is wrong; however ignoring the uncertainty may mean the measurement is unusable.

CYLINDRICAL STANDARDS

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B47	Gage Blanks
B89.1.5	Measurement of Plain External Diameters for use as Master Discs and Plug Gages
B89.1.6	Measurement of Qualified Plain Internal Diameters for use as Master Rings and Ring Gages
B89.3.1	Measurement of Out of Roundness
B89.6.2	Temperature and Humidity Environment for Dimensional Measurement

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Catagory	**Thread Designations**	**Thread Series**	**Applicable Standard**	**Flank Angles**
ACME	ACME -C	Acme Threads, Centralizing	ANSI B1.5	29 Incl.
	ACME -G	Acme Threads, General Purpose	ANSI B1.5	29 Incl.
	STUB ACME	Stub Acme threads	ANSI B1.8	29 Incl.
	STUB ACME M1	Stub Acme Modified Form 1	ANSI B1.8	29 Incl.
	STUB ACME M2	Stub Acme Modified Form 2	ANSI B1.8	29 Incl.
MICROSCOPE	AMO	American Standard microscope objective threads	ASA B1.11	60 Incl.
PIPES	ANPT	Aeronautical National Form taper pipe threads	Mil Std MIL-P-7105B	60 Incl.
	F-PTF	Dryseal, fine taper pipe thread series	ANSI B1.20.3	60 Incl.
	NGO	National gas outlet threads	ANSI B57.1	60 Incl.
	NGS	National gas straight threads	ANSI B57.1	60 Incl.
	NGT	National gas taper threads	ANSI B57.1	60 Incl.
	NH	American Standard hose coupling threads of full form	ANSI B1.20.7	60 Incl.
	NPSC	American Standard straight pipe threads in pipe couplings	ANSI B1.20.1	60 Incl.
	NPSF	Dryseal American Standard fuel Internal straight pipe threads	ANSI B1.20.3	60 Incl.
	NPSH	American Standard straight hose	ANSI B1.20.7	60 Incl.
	NPSI	Dryseal American Standard intermediate Internal straight pipe threads	ANSI B1.20.3	60 Incl.
	NPSL	American Standard straight pipe threads for loose fitting mechanical joints with locknuts	ANSI B1.20.1	60 Incl.
	NPSM	American Standard straight pipe threads for free fitting mechanical joints for fixtures	ANSI B1.20.1	60 Incl.
	NPT	American Standard taper pipe threads for general use	ANSI B1.20.1	60 Incl.
	NPTF	Dryseal American Standard taper pipe threads	ANSI B1.20.3	60 Incl.
	NPTR	American Standard taper pipe threads for railing joints	ANSI B1.20.1	60 Incl.
	PTF-SAE SHORT	Dryseal SAE short taper pipe threads	ANSI B1.20.3	60 Incl.
	PTF-SPL SHORT	Dryseal special short taper pipe threads	ANSI B1.20.3	60 Incl.
	PTF-SPL EXTRA SHORT	Dryseal special extra short taper pipe threads	ANSI B1.20.3	60 Incl.
	SGT	Special Gas taper threads	ANSI B57.1	60 Incl.

Catagory	Thread Designations	Thread Series	Applicable Standard	Flank Angles
	SPL-PTF	Dryseal special taper pipe threads	ANSI B1.20.3	60 Incl.
BUTTRESS	BUTT	Buttress Threads, pull type	ANSI B1.9	7 x 45
	PUSH - BUTT	Buttress Threads, push type	ANSI B1.9	7 x 45
METRIC	M	Metric Screw Threads - M Profile, with basic ISO 68 profile	ANSI B1.13M	60 Incl.
	MJ	Metric Screw Threads - MJ Profile, with rounded root of radius .15011P to .18042P	ANSI B1.21M	60 Incl.
	MJS	Metric Screw Threads - MJ Profile, special series Class 5 Interference fit Internal Threads	ANSI B1.21M	60 Incl.
NATIONAL	NC	American National coarse thread series	Federal Standard H28	60 Incl.
	NF	American National fine thread series	Federal Standard H28	60 Incl.
	NEF	American National extra-fine thread series	Federal Standard H28	60 Incl.
	8N	American National 8-thread series	Federal Standard H28	60 Incl.
	12N	American National 12-thread series	Federal Standard H28	60 Incl.
	16N	American National 16-thread series	Federal Standard H28	60 Incl.
	NM	National Miniature thread series	Federal Standard H28	60 Incl.
	NS5 IF	Entire ferrous material range	ANSI B1.12	60 Incl.
	NC5 INF	Entire nonferrous material range	ANSI B1.12	60 Incl.
UNIFIED	UN	Unified Inch Screw Thread, constant pitch series	ANSI B1.1	60 Incl.
	UNC	Unified Inch Screw Thread, coarse pitch series	ANSI B1.1	60 Incl.
	UNF	Unified Inch Screw Thread, fine pitch series	ANSI B1.1	60 Incl.
	UNEF	Unified Inch Screw Thread, extra-fine pitch series	ANSI B1.1	60 Incl.
	UNJ, UNJC, UNJF, UNJEF	Unified Inch Screw Thread, with rounded root radius .15011P to .18042P on external thread only	MIL-STD-8879C	60 Incl.
	UNR, UNRC, UNRF, UNREF	Unified Inch Screw Thread, with rounded root radius of radius not less than .108P, external thread only	ANSI B1.1	60 Incl.
	UNM	Unified miniature thread series	ANSI B1.10	60 Incl.
	UNS	Unified Inch Screw Thread, special diameter pitch or length of engagement	ANSI B1.1	60 Incl.
BRITISH	BA	Brittish Association	BS 93	55 Incl.
	BSC	Brittish Cycle	BS 811	60 Incl.
	BSF	Brittish Whitworth Fine	BS 84	55 Incl.
	BSW	Brittish Whitworth Coarse	BS 84	55 Incl.
	BSPP	Brittish Straight Pipe	BS 2779	55 Incl.
	BSPT	Brittish Taper Pipe	BS 21	55 Incl.
	WHIT	Brittish Whitworth Special	BS 84	55 Incl.

Catagory	Thread Designations	Thread Series	Applicable Standard	Flank Angles
	G	Brittish Internal Straight Pipe for Mechanical Joints	BS 2779	55 Incl.
	Rc	Brittish Internal Taper Pipe for Pressure Tight Joints	BS 21	55 Incl.
	Rp	Brittish Internal Straight Pipe for Pressure Tight Joints	BS 21	55 Incl.
	GxA	Brittish External Straight Pipe for Mechanical Joints, System A	BS 2779	55 Incl.
	GxB	Brittish External Straight Pipe for Mechanical Joints, System B	BS 2779	55 Incl.
	R	Brittish External Taper Pipe for Pressure Tight Joints	BS 21	55 Incl.

GLASTONBURY SOUTHERN GSG GAGE

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GAGEMAKER'S TOLERANCE CHART

Above	To & Incld.	CL - XXX	CL – XX	CL - X	CL - Y	CL - Z
0.010" .254mm	0.825" 20.95mm	.000010 0.25um	.000020 0.5um	.000040 1.0um	.000070 1.75um	.0001 2.5um
0.825" 20.95mm	1.510" 38.35mm	.000015 0.38um	.000030 0.75um	.000060 1.5um	.000090 2.25um	.00012 3.0um
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12.010" 305.05mm	15.010" 381.25mm	.000075 1.88um	.00015 3.75um	.0003 7.5um	.00045 11.25um	.0006 15um
15.010" 381.25mm	18.010" 457.45mm	.0001 2.50um	.0002 5um	.0004 10um	.0006 15um	.00080 20um
18.010" 457.45mm	21.010" 533.65mm	.000125 3.13um	.00025 6.25um	.0005 12.5um	.00075 18.75um	.001 25um

Diamond NoGo Gages

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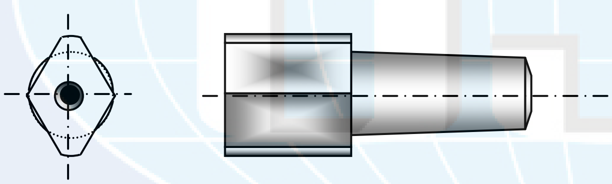
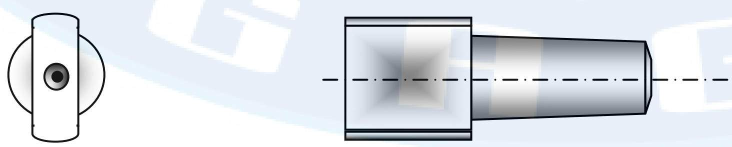
Cylindrical NoGo gages can be ground to a diamond shape to allow the gage to indicate when a hole being measured has out of roundness conditions that cause the maximum limits of the hole to be exceeded in an even numbered lobing condition. In other words, if an out of round hole has an even numbered lobing condition, a diamond shaped NoGo is a quick way to diagnose the problem. There are some limitations to the diamond shaped NoGo being effective for use in this scenario.

1. The out of roundness must exceed the hole's maximum limitation by enough to allow easy entry of the NoGo.
2. The circular length of out of roundness must exceed the amount of gaging surface on the gage. (This gage works best for holes with an egg shape, i.e. oval.)
3. The gage must be used properly. Attempt to insert the gage into the hole while rotating the gage a minimum of 180 degrees.

Diamond NoGo gages have four flats that are positioned to give it a diamond shape when viewed from the end. The amount of gaging surface left after the flats are ground will approximate 30% of the diameter.

Cost of diamond NoGo gages is standard catalog price + $50.00. Delivery will be 1 week longer than normally quoted.





Product Tolerance Diagram

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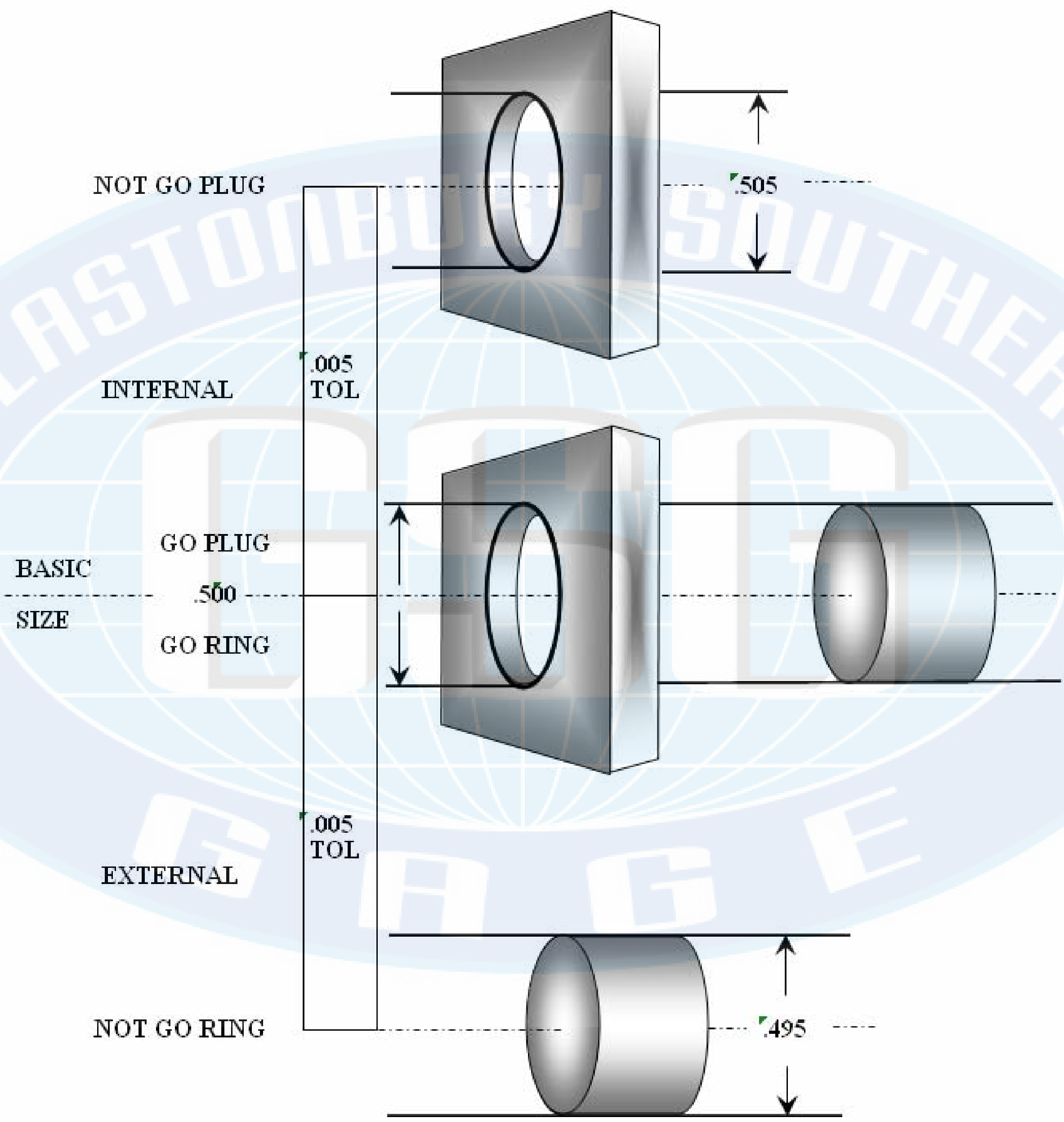

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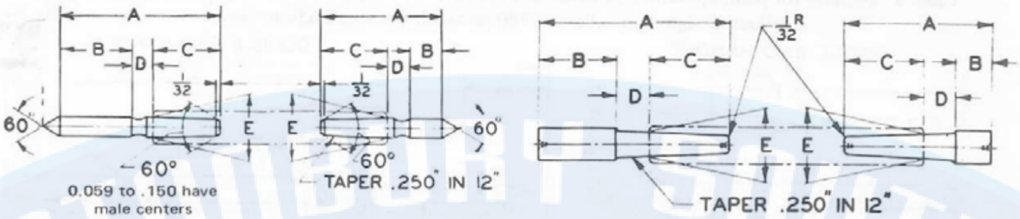
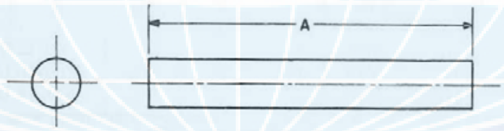
Table 10 Plain cylindrical plug gaging members, taper lock design, range above 0.059 to and including 0.230 inch.



Handle size No.	Range in diameters		General dimensions											
			"Go"						"Not go"					
	Above–	To and including	*A*	*B*	*C*	*D*	*E* Min.	*E* Max.	*A*	*B*	*C*	*D*	*E* Min.	*E* Max.
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
000	0.059	0.105	1 1/16	3/8	1/2	3/16	0.125	0.126	7/8	3/16	1/2	3/16	0.125	0.126
00	.105	.150	1 1/8	3/8	9/16	3/16	.155	.156	31/32	7/32	9/16	3/16	.155	.156
0	.150	.230	1 9/32	13/32	5/8	1/4	.180	.181	1 5/32	9/32	5/8	1/4	.180	.181

NOTE: Progressive style plain plug blanks would have "B" gaging lengths of 11/16, 23/32 and 13/16 respectively, which allows for GO and NOT GO sections of standard length plus a 1/8" recess in between.

Table 11 Plain cylindrical plug gage blanks, wire type design, range above 0.010 to and including 1.010 inch.



Handle size No.	Range in diameter		"Go" and "Not go" length, A[1]
	Above–	To and including–	
	in.	*in.*	*in.*
1W, 1W-S, or 1W-A	0.010	0.075	1
2W, 2W-S, or 2W-A	.075	.180	1 1/4
3W, 3W-S, or 3W-A	.180	.281	1 1/2
4W, 4W-S, or 4W-A	.281	.406	1 3/4
5W, 5W-S, or 5W-A	.406	.510	2
6W, 6W-S, or 6W-A	.510	.635	2
7W, 7W-S, or 7W-A	.635	.760	2
8W, 8W-S, or 8W-A	.760	1.010	2

[1] Lengths shown for *A* in ranges above 0.010 in. to and including 1.010 in. are minimum. Commercially available lengths exceeding these values shall be considered as acceptable alternates.

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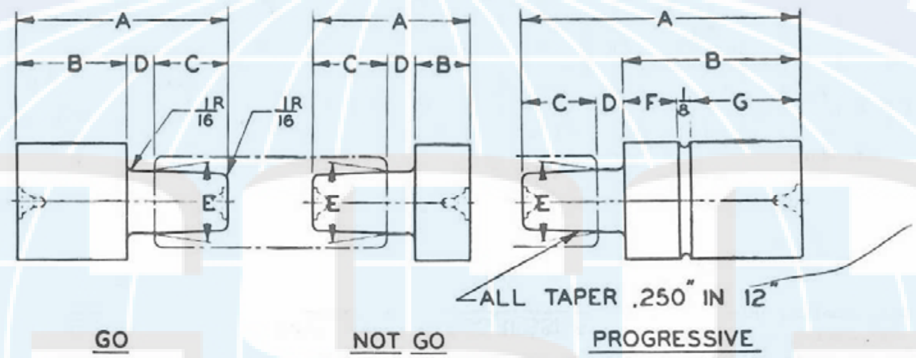
Table 12 Plain cylindrical plug gaging members, taper lock design, range above 0.230 to and including 1.510 inches.



Handle size No.	Range in diameters		General dimensions																			
			"Go"						"Not go"						Progressive							
	Above–	To and includ-ing–	A	B	C	D	E Min.	E Max.	A	B	C	D	E Min.	E Max.	A	B	C	D	E Min.	E Max.	F	G
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	0.230	0.365	1 3/4	3/4	3/4	1/4	0.239	0.240	1 5/16	5/16	3/4	1/4	0.239	0.240	2 3/16	1 3/16	3/4	1/4	0.239	0.240	5/16	3/4
2	.365	.510	2	1	3/4	1/4	.309	.310	1 3/8	3/8	3/4	1/4	.309	.310	2 1/2	1 1/2	3/4	1/4	.309	.310	3/8	1
3	.510	.825	2 1/4	1 1/4	3/4	1/4	.408	.410	1 1/2	1/2	3/4	1/4	.408	.410	2 7/8	1 7/8	3/4	1/4	.408	.410	1/2	1 1/4
4	.825	1.135	2 11/16	1 1/2	7/8	5/16	.608	.610	1 13/16	5/8	7/8	5/16	.608	.610	3 5/16	2 1/8	7/8	5/16	.608	.610	5/8	1 3/8
5	1.135	1.510	3	1 5/8	1	3/8	.808	.810	2 1/8	3/4	1	3/8	.808	.810	3 3/4	2 3/8	1	3/8	.808	.810	3/4	1 1/2

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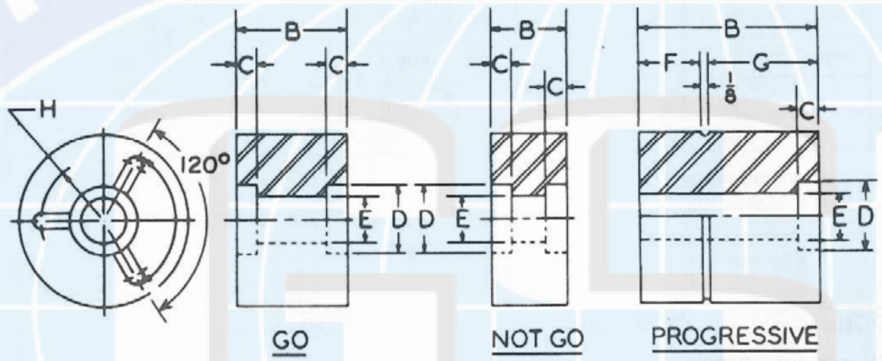
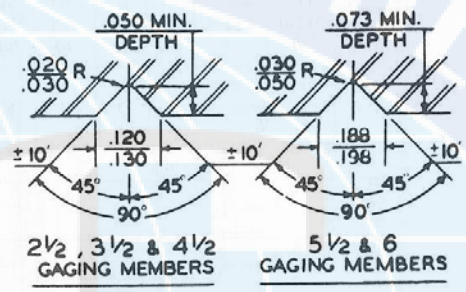
Table 13 Plain cylindrical plug gaging members, trilock design, range above .760 to and including 2.510 inches.





Enlarged section of internal locking grooves—3 required on both ends of all except "progressive" gages (see note).

Handle Size No.	Plain Plug Diameters				"Go"				"Not Go"				"Progressive"						H
	Nominal Range Incl.		Decimal Range																
	From	To	Above	To & Incl.	B	C	D	E	B	C	D	E	B	C	D	E	F	G	
2 1/2	3/4	15/16	.760	.947	1 1/4	1/4	25/64	17/64	3/4	1/4	25/64	17/64	*						15/64
3 1/2	15/16	1 1/8	.947	1.135	1 3/8	1/4	25/64	17/64	3/4	1/4	25/64	17/64	*						21/64
4 1/2	1 1/8	1 1/2	1.135	1.510	1 1/2	3/8	37/64	25/64	3/4	1/4	37/64	25/64	*						27/64
5 1/2	1 1/2	2	1.510	2.010	1 7/8	1/2	25/32	17/32	7/8	5/16	25/32	17/32	2 7/8	1/2	25/32	17/32	7/8	1 7/8	9/16
6	2	2 1/2	2.010	2.510	2	1/2	25/32	17/32	7/8	5/16	25/32	17/32	3	1/2	25/32	17/32	7/8	2	5/8

*NOTE—See Table 12 for taperlock "Progressive" members in range from .760 through 1.510.

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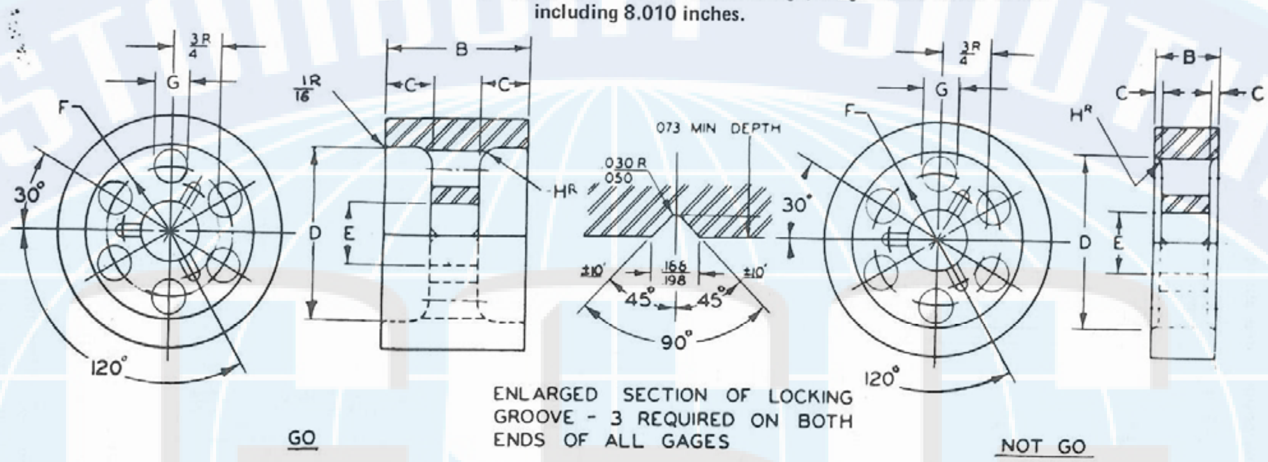
Table 14 Plain cylindrical plug gaging members, trilock design, range above 2.510 to and including 8.010 inches.



Handle size No.	Plain plug diameters				"Go"							"Not go"						
	Nominal range, inclusive		Decimal range		B	C	D	E	F	G	H	B	C	D	E	F	G	H
	From–	To–	Above–	To and including–														
	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
7	2 1/2	3	2.510	3.010	2	5/8	1 7/8	29/32	–	–	3/16	1	1/8	1 7/8	29/32	–	–	3/16
7	3	3 1/2	3.010	3.510	2	5/8	2 1/4	29/32	–	–	5/16	1	1/8	2 1/4	29/32	–	–	3/16
7	3 1/2	4	3.510	4.010	2 1/8	11/16	2 5/8	29/32	–	–	5/16	1	1/8	2 5/8	29/32	–	–	3/16
7	4	4 1/2	4.010	4.510	2 1/8	11/16	3	29/32	1 1/16	3/4	5/16	1	1/8	3	29/32	1 1/16	3/4	3/16
7	4 1/2	5	4.510	5.010	2 1/8	11/16	3 7/16	29/32	1 3/16	13/16	5/16	1	1/8	3 7/16	29/32	1 3/16	13/16	3/16
7	5	5 1/2	5.010	5.510	2 1/8	11/16	3 7/8	29/32	1 1/4	7/8	5/16	1	1/8	3 7/8	29/32	1 1/4	7/8	3/16
7	5 1/2	6	5.510	6.010	2 1/8	11/16	4 5/16	29/32	1 3/8	1	5/16	1	1/8	4 5/16	29/32	1 3/8	1	3/16
7	6	6 1/2	6.010	6.510	2 1/8	11/16	4 3/4	29/32	1 1/2	1 1/8	5/16	1	1/8	4 3/4	29/32	1 1/2	1 1/8	3/16
7	6 1/2	7	6.510	7.010	2 1/8	11/16	5 1/4	29/32	1 5/8	1 1/4	5/16	1	1/8	5 1/4	29/32	1 5/8	1 1/4	3/16
7	7	7 1/2	7.010	7.510	2 1/8	11/16	5 3/4	29/32	1 3/4	1 3/8	5/16	1	1/8	5 3/4	29/32	1 3/4	1 3/8	3/16
7	7 1/2	8	7.510	8.010	2 1/8	11/16	6 1/4	29/32	1 7/8	1 1/2	5/16	1	1/8	6 1/4	29/32	1 7/8	1 1/2	3/16

NOTE–Blanks for *progressive* style plain plug gages are same as those on Table 26 for truncated type setting plugs "for *thick* rings." This provides total gaging lengths that allow GO and NOT GO sections of standard lengths, per above, plus a 1/8" recess in between. Progressive blanks require handle screw no. 2, having a 2¾" length under the head.

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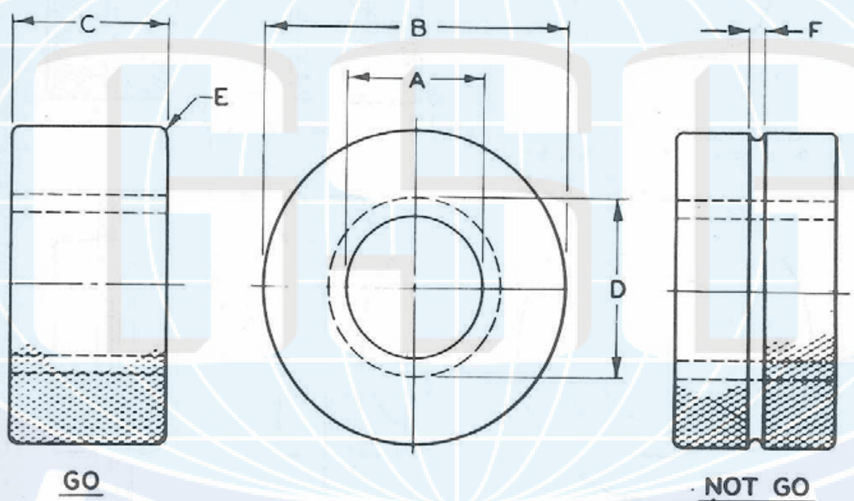
3.4 Plain Ring Gage Blanks

3.4.1 The use of the solid ring gage design for size control being well established, the committee's work on plain ring gages was concerned chiefly with matters of proportion. In the smaller sizes of plain ring gages a hardened bushing may be pressed into a soft gage body, in place of the one-piece ring gage. This design is optional in the range above 0.010 to and including 0.510 inch. However, the single-piece gage may be employed in this range, and it is standard in all cases above 0.510 inch. Gages in sizes above 1.510 inches are flanged, in order to eliminate unnecessary weight and to facilitate handling. General details of construction are shown in figure 4, page 34, and dimensions are given in tables 29 and 30, pages 33 and 35.

3.4.2 No dimensional difference exists between "go" and "not go" blanks of identical size range and service class, but an annular groove is provided in the periphery of "not go" blanks as a means of identification.

Table 29 Plain ring gages, range above 0.010 to and including 1.510 inches.



Ring size No.	*A* Range		General dimensions					
	Above–	To and including–	*B* Outside diameter	*C* Thickness	*D* Bushing diameter[1]	*E* Radius	*F* "Not go" groove width	Length of bushing
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	
000	0.010	0.040	15/16	1/16 (4)	3/8	1/32	1/32	(1,2)
00	0.040	0.150	15/16	3/16	3/8	1/32	1/32	(1,2)
0	.150	.230	15/16	3/8	7/16	1/32	1/16	(1,2)
1	.230	.365	1 1/8	9/16	9/16	1/16	3/32	(1,2)
2	.365	.510	1 3/8	3/4	3/4	1/16	3/32	(1,2)
3	.510	.825	1 3/4	15/16	(3)	3/32	3/32	(3)
4	.825	1.135	2 1/8	1 1/8	(3)	3/32	3/32	(3)
5	1.135	1.510	2 1/2	1 5/16	(3)	3/32	3/32	(3)

[1] Ring gages of sizes 000, 00, 0, 1, and 2, may be of the bushing type or of the solid type, at the option of the manufacturer.

[2] Bushings may be 1/16 inch longer than ring thickness, but are ground flush after hole is finished.

[3] Sizes 3, 4, and 5 are solid.

[4] Thickness of 1/16 inch on 000 blank is minimum.

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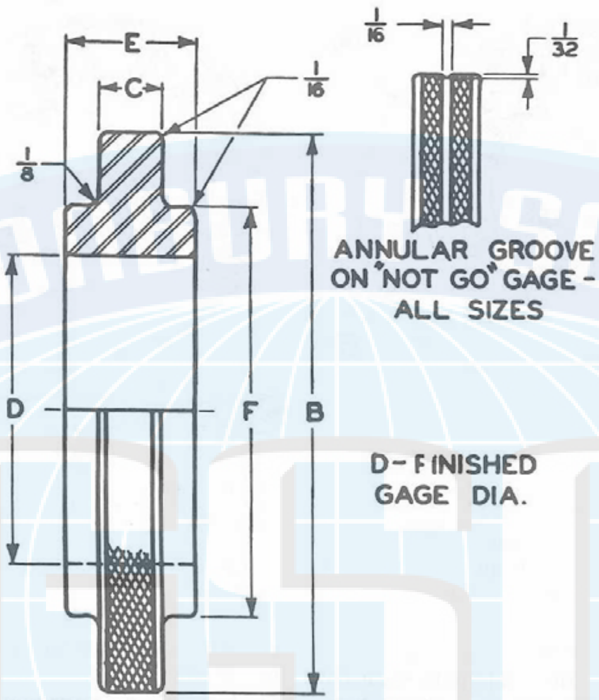
Table 30 Plain ring gages, range above 1.510 to and including 12.260 inches.



Ring size No.	A (range for D)		Inspection, working, ring gages			
	Above–	To and including–	B	C	E	F
	in.	in.	in.	in.	in.	in.
6	1.510	2.010	4	1/2	1 1/2	2 7/8
7	2.010	2.510	4 1/2	9/16	1 1/2	3 3/8
8	2.510	3.010	5	5/8	1 1/2	4
9	3.010	3.510	5 1/2	11/16	1 1/2	4 1/2
10	3.510	4.010	6 3/8	3/4	1 1/2	5 1/8
11	4.010	4.760	7 1/4	7/8	1 1/2	5 7/8
12	4.760	5.510	8 1/4	1	1 1/2	6 5/8
13	5.510	6.260	9 1/4	1	1 1/2	7 3/8
14	6.260	7.010	10 1/4	1	1 1/2	8 1/8
15	7.010	7.760	11 1/4	1	1 1/2	8 7/8
16	7.760	8.510	12 1/4	1	1 1/2	9 5/8
17	8.510	9.260	13 1/4	1	1 1/2	10 3/8
18	9.260	10.010	14 1/4	1	1 1/2	11 1/8
19	10.010	10.760	15 1/4	1	1 1/2	11 7/8
20	10.760	11.510	16 1/4	1	1 1/2	12 5/8
21	11.510	12.260	17 1/4	1	1 1/2	13 3/8

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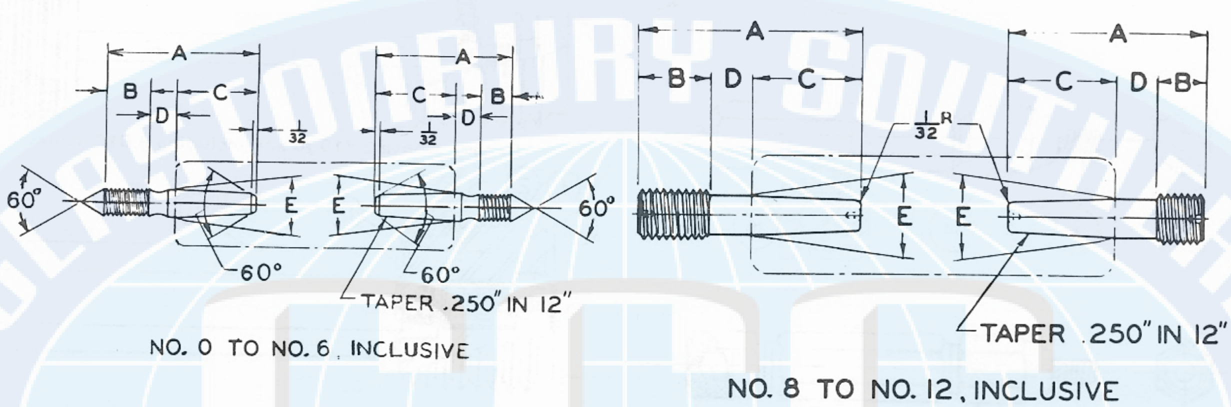
Table 16 Thread plug gaging members, taper lock design, range from No. 0 to No. 12, inclusive



Handle size No.	Range, thread plug diameters				General dimensions											
	Nominal, inclusive		Decimal		"Go"						"HI"*					
	From–	To–	Above–	To and including–	A	B	C	D	E Min.	E Max.	A	B	C	D	E Min.	E Max.
	No.	No.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
000	0	3	0.059	0.105	15/16	1/4	1/2	3/16	0.125	0.126	7/8	3/16	1/2	3/16	0.125	0.126
00	4	6	.105	.150	1 1/16	5/16	9/16	3/16	.155	.156	31/32	7/32	9/16	3/16	.155	.156
0	8	12	.150	.230	1 9/32	13/32	5/8	1/4	.180	.181	1 5/32	9/32	5/8	1/4	.180	.181

*"HI" Formerly Known as "NOT GO"

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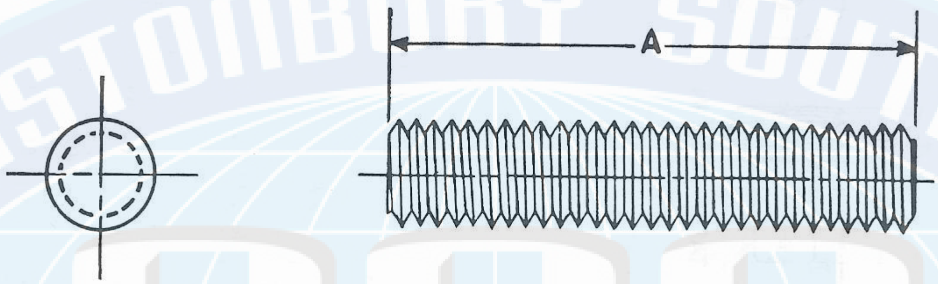
Table 17 Thread plug gaging members, wire type design, range above 0.030 to and including 1.010 inch



Handle size No.	Thread diameters				A–Length[1]		Fine-pitch instrument lengths	
	Nominal range, inclusive		Decimal range					
	From–	To–	Above–	To and including–	"Go"	"HI"*	TPI finer than	Go & HI "A" length
	No. or in.	*No. or in.*	*in.*	*in.*	*in.*	*in.*		
1W, 1W-S, or 1W-A	No. 0	No. 1	0.030	0.075	1/2	1/2		
2W, 2W-S, or 2W-A	No. 2	No. 5	.075	.130	5/8	5/8		
2W, 2W-S, or 2W-A	No. 6	No. 8	.130	.180	3/4	3/4		
3W, 3W-S, or 3W-A	No. 10	1/4	.180	.281	7/8	7/8	48	3/4
4W, 4W-S, or 4W-A	1/4	5/16	.281	.320	1	1	40	3/4
4W, 4W-S, or 4W-A	5/16	3/8	.320	.406	1 1/8	1 1/8	40	7/8
5W, 5W-S, or 5W-A	3/8	7/16	.406	.450	1 1/4	1 1/4	36	1
5W, 5W-S, or 5W-A	7/16	1/2	.450	.510	1 3/8	1 3/8	36	1
6W, 6W-S, or 6W-A	1/2	5/8	.510	.635	1 1/2	1 3/8	32	1 1/8
7W, 7W-S, or 7W-A	5/8	3/4	.635	.760	1 3/4	1 3/8	32	1 1/4
8W, 8W-S, or 8W-A	3/4	1	.760	1.010	2	1 1/2	32	1 1/4

[1] These lengths apply to standard and special diameter-pitch combinations not covered by table 22. Lengths shown for A in ranges above 0.030 in. to and including 1.010 in. are minimum. Commercially available lengths exceeding these values shall be considered as acceptable alternates.

*"HI" Formerly Known as "NOT GO"

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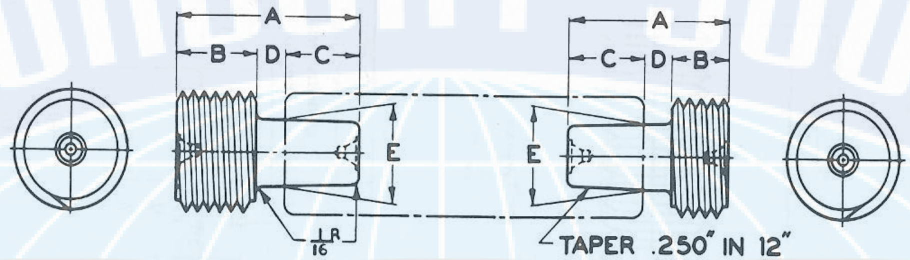
Table 18 Thread plug gaging members, taper lock design, range from 1/4 to 1 1/2 inches, inclusive.



[Not less than three full threads must remain on "HI" plug]

Handle size No.	Range: Thread plug diameters: Nominal range, inclusive: From–	Nominal range, inclusive: To–	Decimal range: Above–	Decimal range: To and including–	Threads per inch	General dimensions: "Go": A	"Go": B	"Go": C	"Go": D	"Go": E Min.	"Go": E Max.	"HI"*: A	"HI"*: B	"HI"*: C	"HI"*: D	"HI"*: E Min.	"HI"*: E Max.
	in.	in.	in.	in.		in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	1/4	5/16	0.230	0.365		1 1/2	1/2	3/4	1/4	0.239	0.240	1 5/16	5/16	3/4	1/4	0.239	0.240
2	3/8	1/2	.365	.510		1 3/4	3/4	3/4	1/4	.309	.310	1 3/8	3/8	3/4	1/4	.309	.310
3	9/16	3/4	.510	.825		1 7/8	7/8	3/4	1/4	.408	.410	1 1/2	1/2	3/4	1/4	.408	.410
4	7/8	1 1/8	.825	1.135		2 3/16	1	7/8	5/16	.608	.610	1 13/16	5/8	7/8	5/16	.608	.610
5	1 1/4	1 1/2	1.135	1.510	Coarser than 12	2 5/8	1 1/4	1	3/8	.808	.810	2 1/8	3/4	1	3/8	.808	.810
5	1 1/4	1 1/2	1.135	1.510	12 and finer	2 3/8	1	1	3/8	.808	.810	2 1/8	3/4	1	3/8	.808	.810

NOTE–Taper lock gaging members are standard for all taper pipe-thread plug gages to and including 2-in. nominal pipe size. (See tables 27, 28, pp. 31–32.)

*"HI" Formerly Known as "NOT GO"

GLASTONBURY SOUTHERN GSG

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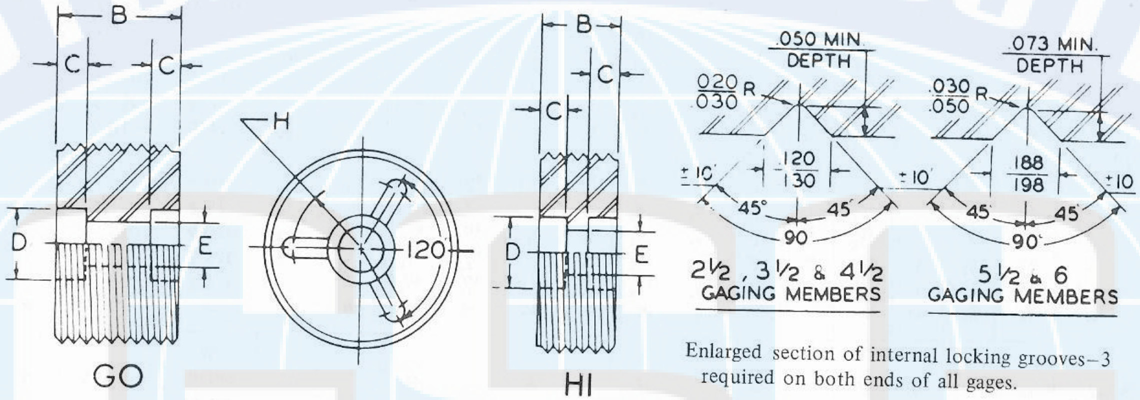
Table 19 Thread plug gaging members trilock design, range above 3/4 to and including 2 1/2 inches.



Enlarged section of internal locking grooves—3 required on both ends of all gages.

Handle size No.	Thread plug diameters				"Go"												"HI"*				H
	Nominal range incl.		Decimal range		7 Pitch and coarser				Finer than 7 T.P.I. & coarser than 13				13 T.P.I. and finer				All pitches				
	From	To	Above	To & incl.	B	C	D	E	B	C	D	E	B	C	D	E	B	C	D	E	
2 1/2	3/4	15/16	.760	.947	1 1/4	1/4	25/64	17/64	1	1/4	25/64	17/64	1	1/4	25/64	17/64	3/4	1/4	25/64	17/64	15/64
3 1/2	15/16	1 1/8	.947	1.135	1 3/8	1/4	25/64	17/64	1 1/8	1/4	25/64	17/64	1	1/4	25/64	17/64	3/4	1/4	25/64	17/64	21/64
4 1/2	1 1/8	1 1/2	1.135	1.510	1 1/2	3/8	37/64	25/64	1 1/4	3/8	37/64	25/64	1	3/8	37/64	25/64	3/4	1/4	37/64	25/64	27/64

Handle size No.	Thread plug diameters				"Go"												"HI"				H
	Nominal range incl.		Decimal range		7 T.P.I. and coarser				Finer than 7 T.P.I. & coarser than 16				16 T.P.I. and finer				All pitches				
	From	To	Above	To & incl.	B	C	D	E	B	C	D	E	B	C	D	E	B	C	D	E	
5 1/2	1 1/2	2	1.510	2.010	1 7/8	1/2	25/32	17/32	1 1/4	3/8	25/32	17/32	7/8	5/16	25/32	17/32	7/8	5/16	25/32	17/32	9/16
6	2	2 1/2	2.010	2.510	2	1/2	25/32	17/32	1 3/8	3/8	25/32	17/32	7/8	5/16	25/32	17/32	7/8	5/16	25/32	17/32	5/8

NOTE—Dimensions are in inches.
*"HI" Formerly Known as "NOT GO"

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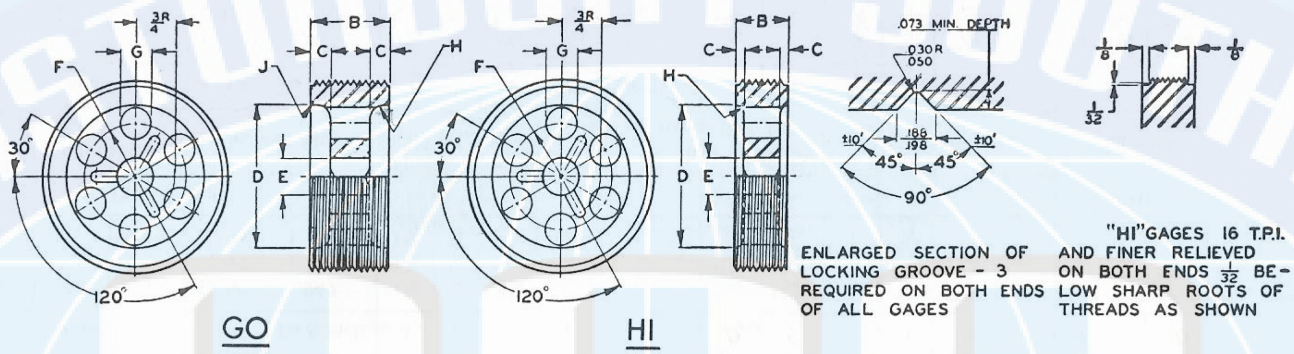
Table 20 Thread plug gaging members, trilock design, range above 2 1/2 to and including 8 inches.



Handle size No.	Thread plug diameters				"Go"											"HI"*			All			
	Nominal range, inclusive		Decimal range		7 threads per inch and coarser				Finer than 7 threads per inch and coarser than 16				16 threads per inch and finer			All pitches			All pitches			
	From–	To–	Above–	To and includ-ing–	*B*	*C*	*H*	*J*	*B*	*C*	*H*	*J*	*B*	*C*	*H*	*B*	*C*	*H*	*D*	*E*	*F*	*G*
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
7	2 1/2	3	2.510	3.010	2	5/8	5/16	1/16	1 1/2	3/8	3/16	1/16	1	1/8	3/16	1	1/8	3/16	1 7/8	29/32	–	–
7	3	3 1/2	3.010	3.510	2	5/8	5/16	1/16	1 1/2	3/8	1/4	1/16	1	1/8	3/16	1	1/8	3/16	2 1/4	29/32	–	–
7	3 1/2	4	3.510	4.010	2 1/8	11/16	5/16	1/16	1 1/2	3/8	1/4	1/16	1	1/8	3/16	1	1/8	3/16	2 5/8	29/32	–	–
7	4	4 1/2	4.010	4.510	2 1/8	11/16	5/16	1/16	1 1/2	3/8	1/4	1/16	1	1/8	3/16	1	1/8	3/16	3	29/32	1 1/16	3/4
7	4 1/2	5	4.510	5.010	2 1/8	11/16	5/16	1/16	1 1/2	3/8	1/4	1/16	1	1/8	3/16	1	1/8	3/16	3 7/16	29/32	1 3/16	13/16
7	5	5 1/2	5.010	5.510	2 1/8	11/16	5/16	1/16	1 1/2	3/8	1/4	1/16	1	1/8	3/16	1	1/8	3/16	3 7/8	29/32	1 1/4	7/8
7	5 1/2	6	5.510	6.010	2 1/8	11/16	5/16	1/16	1 1/2	3/8	1/4	1/16	1	1/8	3/16	1	1/8	3/16	4 5/16	29/32	1 3/8	1
7	6	6 1/2	6.010	6.510	2 1/8	11/16	5/16	1/16	1 1/2	3/8	1/4	1/16	1	1/8	3/16	1	1/8	3/16	4 3/4	29/32	1 1/2	1 1/8
7	6 1/2	7	6.510	7.010	2 1/8	11/16	5/16	1/16	1 1/2	3/8	1/4	1/16	1	1/8	3/16	1	1/8	3/16	5 1/4	29/32	1 5/8	1 1/4
7	7	7 1/2	7.010	7.510	2 1/8	11/16	5/16	1/16	1 1/2	3/8	1/4	1/16	1	1/8	3/16	1	1/8	3/16	5 3/4	29/32	1 3/4	1 3/8
7	7 1/2	8	7.510	8.010	2 1/8	11/16	5/16	1/16	1 1/2	3/8	1/4	1/16	1	1/8	3/16	1	1/8	3/16	6 1/4	29/32	1 7/8	1 1/2

*"HI" Formlery Known as "NOT GO"

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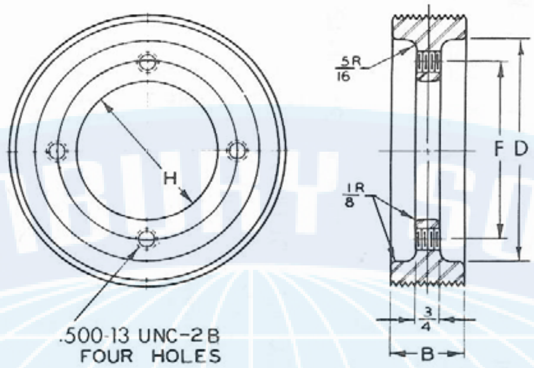
Table 21 Thread plug gaging members, annular design, range above 8.010 inches.



Ball Handle size No.[1]	Thread plug diameters				"Go"			"HI"*	All		
	Nominal range, inclusive		Decimal range		7 threads per inch and coarser	Finer than 7 threads per inch and coarser than 16	16 threads per inch and finer	All pitches	All pitches		
	From–	To–	Above–	To and includ-ing–	*B*				*D*	*F*	*H*
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
7	8	$8\frac{1}{2}$	8.010	8.510	$2\frac{1}{4}$	$1\frac{1}{2}$	1	1	$6\frac{1}{2}$	$5\frac{1}{4}$	4
7	$8\frac{1}{2}$	9	8.510	9.010	$2\frac{1}{4}$	$1\frac{1}{2}$	1	1	$6\frac{15}{16}$	$5\frac{5}{8}$	$4\frac{3}{8}$
7	9	$9\frac{1}{2}$	9.010	9.510	$2\frac{1}{4}$	$1\frac{1}{2}$	1	1	$7\frac{3}{8}$	6	$4\frac{3}{4}$
7	$9\frac{1}{2}$	10	9.510	10.010	$2\frac{1}{4}$	$1\frac{1}{2}$	1	1	$7\frac{13}{16}$	$6\frac{1}{2}$	$5\frac{1}{8}$
7	10	$10\frac{1}{2}$	10.010	10.510	$2\frac{1}{4}$	$1\frac{1}{2}$	1	1	$8\frac{1}{4}$	7	$5\frac{1}{2}$
7	$10\frac{1}{2}$	11	10.510	11.010	$2\frac{1}{4}$	$1\frac{1}{2}$	1	1	$8\frac{11}{16}$	$7\frac{1}{2}$	$5\frac{7}{8}$
7	11	$11\frac{1}{2}$	11.010	11.510	$2\frac{1}{4}$	$1\frac{1}{2}$	1	1	$9\frac{1}{8}$	8	$6\frac{1}{4}$
7	$11\frac{1}{2}$	12	11.510	12.010	$2\frac{1}{4}$	$1\frac{1}{2}$	1	1	$9\frac{9}{16}$	$8\frac{1}{2}$	$6\frac{5}{8}$

[1] Two required per gage.
*"HI" Formerly Known as "NOT GO"

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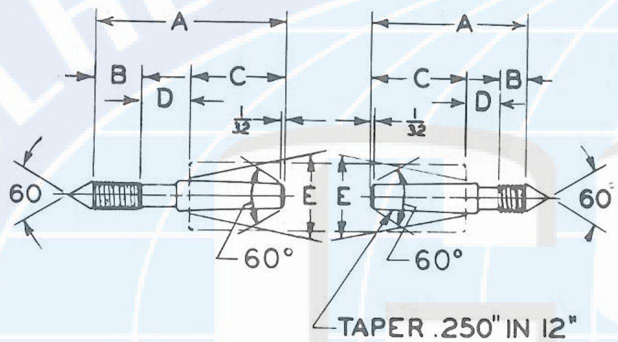
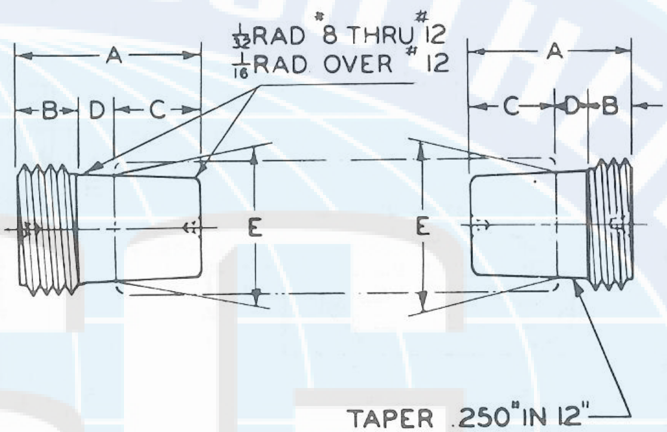
Table 22 Fine-pitch instrument thread plug gaging members, taper lock design, range No. 0 to 1½ inches, inclusive.



NO. 0 TO NO. 6 INCLUSIVE



NO. 8 TO 1½" INCLUSIVE

Handle size No.	Thread plug diameters				TPI finer than–	General dimensions											
	Nominal range, inclusive		Decimal range			"Go"						"HI"*					
	From–	To–	Above–	To and including–		A	B	C	D	E Min.	E Max.	A	B	C	D	E Min.	E Max.
	No. or in.	No. or in.	in.	in.		in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
000	No. 0	No. 3	0.059	0.105	80	7/8	3/16	1/2	3/16	0.125	0.126	13/16	1/8	1/2	3/16	0.125	0.126
00	No. 4	No. 6	.105	.150	60	31/32	7/32	9/16	3/16	.155	.156	29/32	5/32	9/16	3/16	.155	.156
0	No. 8	No. 12	.150	.230	48	1 5/32	9/32	5/8	1/4	.180	.181	1 3/32	7/32	5/8	1/4	.180	.181
1	1/4	5/16	.230	.365	40	1 5/16	5/16	3/4	1/4	.239	.240	1 1/4	1/4	3/4	1/4	.239	.240
2	3/8	1/2	.365	.510	36	1 3/8	3/8	3/4	1/4	.309	.310	1 5/16	5/16	3/4	1/4	.309	.310
3	9/16	3/4	.510	.825	32	1 1/2	1/2	3/4	1/4	.408	.410	1 3/8	3/8	3/4	1/4	.408	.410
4	7/8	1 1/8	.825	1.135	28	1 13/16	5/8	7/8	5/16	.608	.610	1 5/8	7/16	7/8	5/16	.608	.610
5	1 1/4	1 1/2	1.135	1.510	28	2 1/8	3/4	1	3/8	.808	.810	1 7/8	1/2	1	3/8	.808	.810

*"HI" Formerly Known as "NOT GO"

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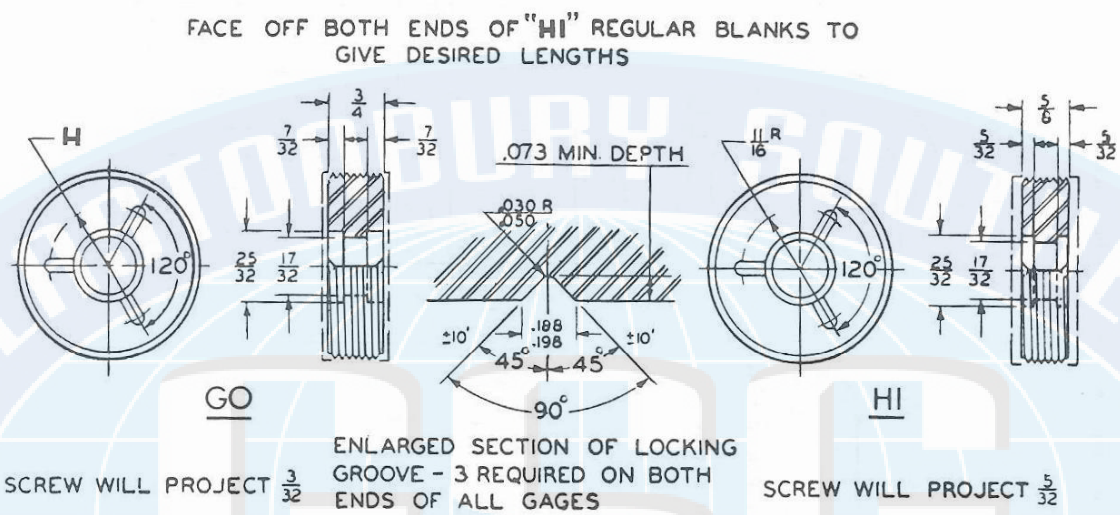
Table 23 Fine-pitch instrument thread plug gaging members, trilock design, range above $1^1/_2$ to and including $2^1/_2$ inches.



Handle size No.	Thread plug diameters				Threads per inch finer than–	H
	Nominal range, inclusive		Decimal range			
	From–	To–	Above–	To and including–		
	in.	in.	in.	in.		
5½	1½	2	1.510	2.010	28	9/16
6	2	2½	2.010	2.510	28	5/8

*"HI" Formerly Known as "NOT GO"

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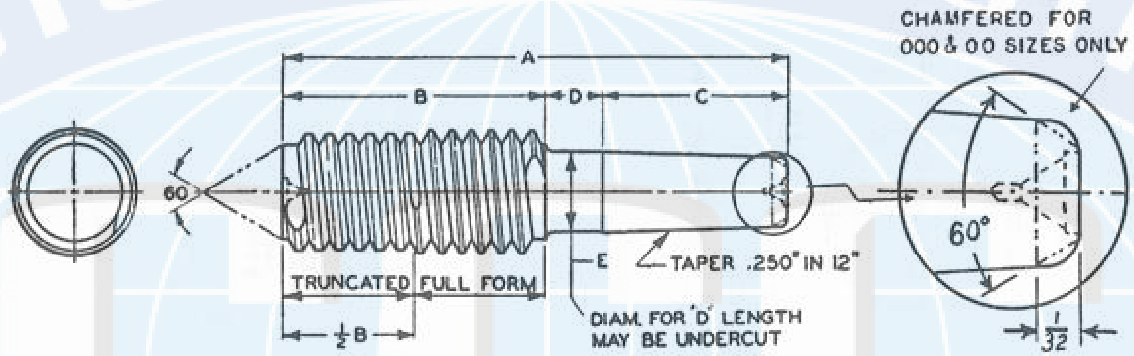
Table 24 Thread-setting plug gaging members, truncated type, range No. 0 to 1 1/2 inches, inclusive



Handle size No.	Thread diameters				General dimensions									
	Nominal range, inclusive		Decimal range		For thin ring		For thick ring		For fine-pitch instrument thread ring		C	D	E	
	From–	To–	Above–	To and including–	A	B	A	B	A	B			Min	Max
	No. or in.	No. or in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
000	No. 0	No. 2	.059	.090	29/32	7/32	–	–	–	–	1/2	3/16	.125	.126
000	No. 3	No. 3	.090	.105	1 1/16	3/8	–	–	–	–	1/2	3/16	.125	.126
00	No. 4	No. 6	.105	.150	1 1/8	3/8	–	–	–	–	9/16	3/16	.155	.156
0	No. 8	No. 12	.150	.230	1 9/32	13/32	–	–	–	–	5/8	1/4	.180	.181
1	1/4	5/16	.230	.365	1 3/4	3/4	–	–	1 9/16	9/16	3/4	1/4	.239	.240
2	3/8	1/2	.365	.510	2	1	–	–	1 11/16	11/16	3/4	1/4	.309	.310
3	9/16	3/4	.510	.825	2 1/4	1 1/4	2 7/8	1 7/8	2	1	3/4	1/4	.408	.410
4	7/8	1 1/8	.825	1.135	2 11/16	1 1/2	3 5/16	2 1/8	2 5/16	1 1/8	7/8	5/16	.608	.610
5	1 1/4	1 1/2	1.135	1.510	3	1 5/8	3 3/4	2 3/8	2 11/16	1 5/16	1	3/8	.808	.810

NOTE–For full form (basic crest) setting plugs, use go thread plug gaging members–tables 16 and 18. For fine pitch instrument threads–table 22.

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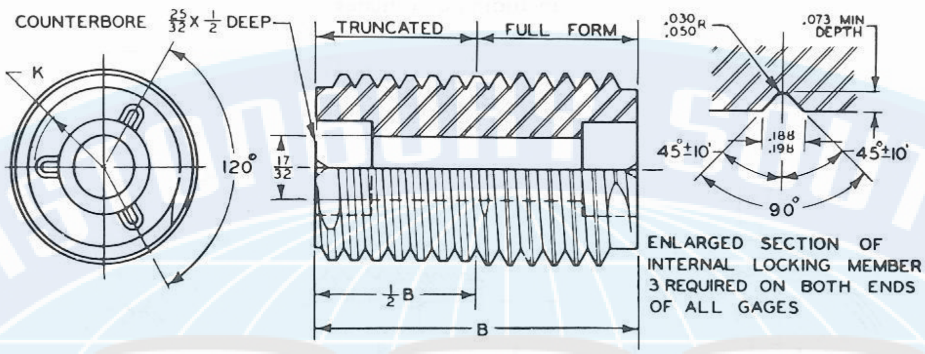
Table 25 Thread-setting plug gaging members, truncated type, range above 1½ to and including 2½ inches



Handle size No.	Thread diameters				K (radius)	B		
	Nominal range		Decimal range			For thin ring	For thick ring	For fine-pitch instrument thread ring
	From–	To–	Above–	To and including–				
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
5½	1½	2	1.510	2.010	9/16	1⅞	2⅞	1 5/16
6	2	2½	2.010	2.510	⅝	2	3	1 7/16

NOTE–For full form (basic crest) setting plug, use go thread plug gaging members–table 19. For fine pitch instrument threads–table 23.

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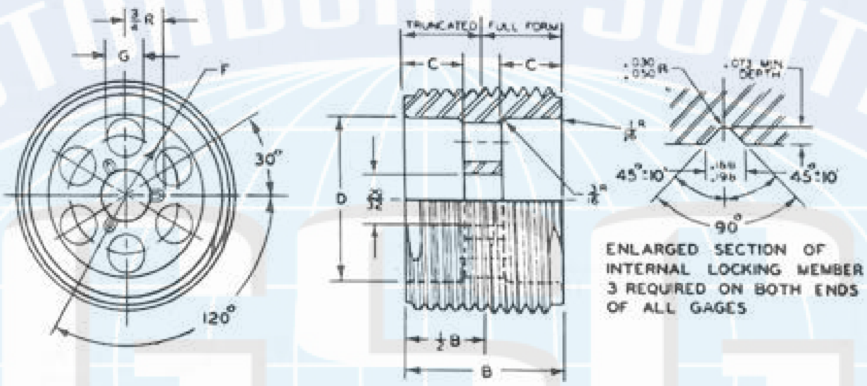
Table 26 Thread-setting plug gaging members, truncated type, range above $2^1/_2$ to and including $6^1/_2$ inches



Handle size No.	Thread diameters				General dimensions						
	Nominal range		Decimal range		For thin ring		For thick ring		*D*	*F* (radius)	*G*
	From–	To–	Above–	To and including–	*B*	*C*	*B*	*C*			
	in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
7	2½	3	2.510	3.010	2	⅝	3⅛	11/16	1⅞	–	–
7	3	3½	3.010	3.510	2	⅝	3⅛	11/16	2¼	–	–
7	3½	4	3.510	4.010	2⅛	11/16	3¼	¾	2⅝	–	–
7	4	4½	4.010	4.510	2⅛	11/16	3¼	¾	3	1 1/16	¾
7	4½	5	4.510	5.010	2⅛	11/16	3¼	¾	3 7/16	1 3/16	13/16
7	5	5½	5.010	5.510	2⅛	11/16	3¼	¾	3⅞	1¼	⅞
7	5½	6	5.510	6.010	2⅛	11/16	3¼	¾	4 5/16	1⅜	1
7	6	6½	6.010	6.510	2⅛	11/16	3¼	¾	4¾	1½	1⅛

NOTE–For full form (basic crest) setting plug, use go thread plug gaging members–table 20.

NOTE–Truncated setting plug blanks for thick rings require handle screw no.2 having 2¾" length under the head. See footnote Table 9.

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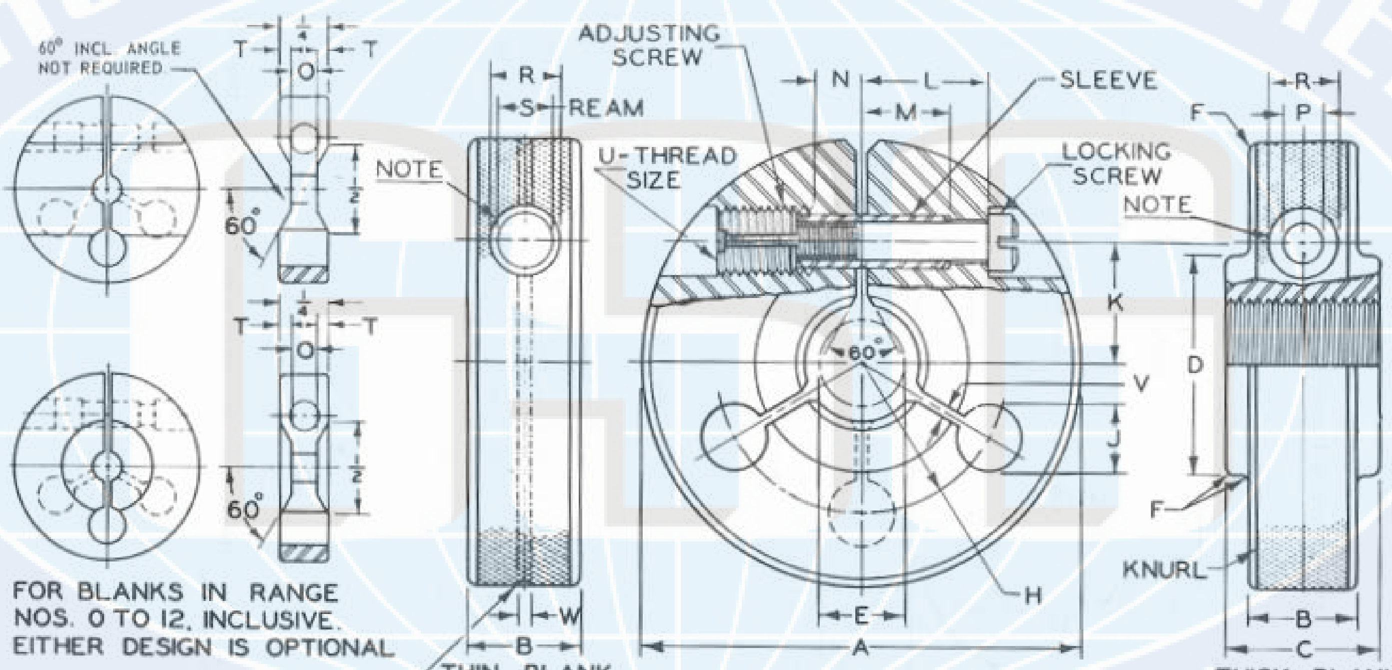
Table 32 Thread ring gages, range No. 0 to and including 4¾ inches; also fine-pitch instrument thread ring gages, No. 0 to and including No. 12



RANGE INCLUSIVE	O	T
NO. 0 TO 2	3/32	5/64
NO. 3 TO 6	5/32	3/64
NO. 8 TO 12	3/16	1/32

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Table 32 (Cont.) Thread ring gages, range No. 0 to and including 4¾ inches; also fine-pitch instrument thread ring gages, No. 0 to and including No. 12

Ring Size No.	Nominal range, inclusive	Decimal range, above and including–	A	B	C	D	E	F	H	J	K	L	M ±1/64	N ±1/64	P Drill size	R Drill size	S Ream Min.	S Ream Max.	U Size	U Pitch diameter Min.	U Pitch diameter Max.	V	W
	No. or in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	No. or in.	in.	in.	in.		in.	in.	in.	in.
1-T	Nos. 0 to 6[1]	0.059 / .150	1	1/4	–	–	–	1/32	5/16	5/32	5/16	7/32	5/32	1/16	No. 41 (0.0960)	11/64 (0.1719)	0.1370	0.1373	.164-36	0.1400	0.1478	0.010 (2)	1/32
1-T	Nos. 8 to 12[1]	.150 / .230	1	1/4	–	–	–	1/32	5/16	5/32	5/16	7/32	5/32	1/16	No. 41 (0.0960)	11/64 (0.1719)	.1370	.1373	.164-36	.1460	.1478	1/64	1/32
2-T	1/4 to 5/16	.230 / .365	1 3/8	11/32	–	–	5/32	1/32	7/16	3/16	5/8	11/32	1/4	1/8	No. 31 (0.1200)	7/32 (0.2187)	.1810	.1813	.216-28	.1928	.1950	1/32	1/16
3-T	3/8 to 1/2	.365 / .510	1 3/4	7/16	–	–	3/16	3/32	19/32	1/4	23/32	1/2	3/8	1/16	No. 25 (0.1495)	17/64 (0.2656)	.2150	.2153	.250-28	.2268	.2290	1/32	3/32
4-T	9/16 to 3/4	.510 / .825	2 3/16	9/16	3/8	1 5/16	11/32	1/16	3/4	5/16	13/16	17/32	13/32	7/32	No. 7 (0.2010)	21/64 (0.3281)	.2720	.2723	.3125-24	.2854	.2878	1/16	3/32
5-T	7/8 to 1 1/8	.825 / 1.135	2 5/8	11/16	15/16	1 1/2	5/16	1/16	31/32	5/16	7/8	17/32	15/32	9/32	No. 1 (0.2280)	25/64 (0.3906)	.3340	.3344	.375-24	.3479	.3503	1/16	3/32
6-T	1 1/4 to 1 1/2	1.135 / 1.510	3 1/4	3/4	1 1/8	1 7/8	23/32	1/16	1 3/16	3/8	1 1/8	1/8	7/16	3/16	17/64 (0.2656)	29/64 (0.4531)	.3890	.3894	.4375-20	.4050	.4076	1/16	3/32
7-T	1 5/8 to 2	1.510 / 2.010	3 3/4	13/16	1 1/4	2 3/8	1 3/16	3/32	1 7/16	3/8	1 5/8	1/8	7/16	3/16	17/64 (0.2565)	29/64 (0.4531)	.3890	.3894	.4375-20	.4050	.4076	1/16	1/8
8-T	2 1/8 to 2 1/2	2.010 / 2.510	4 1/2	7/8	1 5/16	2 7/8	1 19/32	3/32	1 3/4	7/16	1 11/16	13/16	9/16	7/16	21/64 (0.3281)	33/64 (0.5156)	.4510	.4515	.500-20	.4675	.4701	3/32	1/8
9-T	2 5/8 to 3	2.510 / 3.010	5	7/8	1 3/8	3 3/8	2	3/32	2	7/16	1 15/16	13/16	9/16	7/16	21/64 (0.3281)	33/64 (0.5156)	.4510	.4515	.500-20	.4675	.4701	3/32	1/8
10-T	3 1/8 to 3 1/2	3.010 / 3.510	5 1/2	15/16	1 7/16	3 7/8	2 7/16	3/32	2 7/32	7/16	2 5/16	13/16	9/16	7/16	21/64 (0.3281)	33/64 (0.5156)	.4510	.4515	.500-20	.4675	.4701	3/32	1/8
11-T	3 5/8 to 4	3.510 / 4.010	6 3/4	15/16	1 1/2	4 5/8	2 13/16	3/32	2 5/8	1/2	2 9/16	1	3/4	1/8	13/32 (0.4062)	41/64 (0.6406)	.5710	.5715	.625-18	.5889	.5919	3/32	1/8
12-T	4 1/8 to 4 3/4	4.010 / 4.760	7 1/4	1	1 1/2	5 5/8	3 5/8	3/32	3 1/32	1/2	3	1	3/4	1/8	13/32 (0.4062)	41/64 (0.6406)	.5710	.5715	.625-18	.5880	.5919	3/32	1/8

Columns A through R (with S, U, V, W) are grouped under "General dimensions".

[1] Blanks for the range Nos. 0 to 12, inclusive, may be either counterbored or milled, as shown in illustration for table 32. [2] Approximate.

NOTE–Thin gage blanks are to be used for all "LO" thread ring gages. For "go" thread ring gages, use thin or thick blanks as follows:

"LO" Formerly Known as "NOT GO."

Diameter	Thin blank	Thick blank
From No. 0 to 1/2 inch, inclusive	All pitches.	
Above 1/2 to 1 1/8 inches, inclusive	Pitches 12 threads per inch and finer except 9/16–12	Pitches coarser than 12 threads per inch.
Above 1 1/8 inches to 6 inches, inclusive	Pitches 10 threads per inch and finer	Pitches coarser than 10 threads per inch.
~~Above 6 inches.~~		~~All pitches.~~

NOTE–Special thicker blanks are sometimes required for checking long lengths of engagement or exceptionally coarse pitch threads.

NOTE–*Solid* "working" thread ring gages are of similar standard thickness and furnished without adjustment feature. Outside diameter of solid ring blanks may be smaller to suit particular requirements. See Table 39 for solid "setting and master" thread ring gage blanks.

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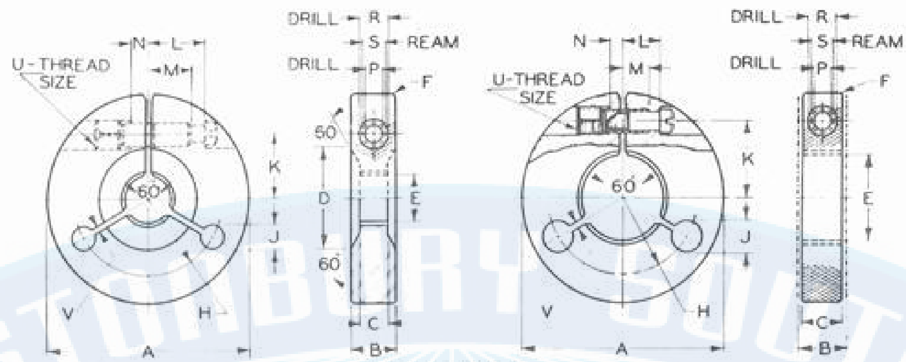
Table 33 Fine-pitch instrument thread ring gages, range above 0.240 and including 2.510 inches



GAGES ABOVE .230 TO .510 INC.–KNURL FINISH RECESS BOTH ENDS

ANNULAR GROOVE TO DESIGNATE "LO" GAGE "W"=WIDTH. "W"/2=DEPTH.

GAGES ABOVE .510 TO 2.510 INC.–KNURL FINISH FACE BOTH ENDS

"LO" Formerly Known as "NOT GO."

Nominal range, inclusive	Decimal range		TPI finer than–	General dimensions											
	Above–	To and including–		A	B	C	D	E	F	H	J	K	L	M ±1/64	N ±1/64
in.	in.	in.		in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1/4 to 5/16	0.230	0.365	40	1 3/8	11/32	1/4	3/4	5/32	1/32	7/16	3/16	3/8	11/32	1/4	1/8
3/8 to 1/2	.365	.510	36	1 3/4	7/16	5/16	1	3/16	3/64	19/32	1/4	15/32	1/2	3/8	3/16
9/16 to 3/4	.510	.825	32	2 3/16	9/16	15/32	–	11/32	1/16	3/4	5/16	11/16	17/32	13/32	7/32
7/8 to 1 1/8	.825	1.135	28	2 5/8	11/16	17/32	–	9/16	1/16	31/32	5/16	7/8	17/32	13/32	9/32
1 1/4 to 1 1/2	1.135	1.510	28	3 1/4	3/4	5/8	–	27/32	1/16	1 5/16	3/8	1 1/8	5/8	7/16	5/16
1 5/8 to 2	1.510	2.010	28	3 3/4	13/16	5/8	–	1 3/16	3/32	1 7/16	3/8	1 3/8	5/8	7/16	5/16
2 1/8 to 2 1/2	2.010	2.510	28	4 1/2	7/8	11/16	–	1 19/32	3/32	1 3/4	7/16	1 11/16	13/16	9/16	7/16

Nominal range, inclusive	General dimensions								
	P Drill size	R Drill size	S Ream		U			V	W
			Min.	Max.	Size	Pitch diameter Min.	Pitch diameter Max.		
in.	No. or in.	in.	in.	in.		in.	in.	in.	in.
1/4 to 5/16	No. 31 (0.1200)	7/32 (0.2187)	0.1810	0.1813	.216-28	0.1928	0.1950	1/32	1/16
3/8 to 1/2	No. 25 (.1495)	17/64 (.2656)	.2150	.2153	.250-28	.2268	.2290	1/32	3/32
9/16 to 3/4	No. 7 (.2010)	21/64 (.3281)	.2720	.2723	.3125-24	.2854	.2878	1/16	3/32
7/8 to 1 1/8	No. 1 (.2280)	25/64 (.3906)	.3340	.3344	.375-24	.3479	.3503	1/16	3/32
1 1/4 to 1 1/2	17/64 (.2656)	29/64 (.4531)	.3890	.3894	.4375-20	.4050	.4076	1/16	3/32
1 5/8 to 2	17/64 (.2656)	29/64 (.4531)	.3890	.3894	.4375-20	.4050	.4076	1/16	1/8
2 1/8 to 2 1/2	21/64 (.3281)	33/64 (.5156)	.4510	.4515	.500-20	.4676	.4701	3/32	1/8

NOTE–Solid "working" thread ring gages are of similar thickness and furnished without adjustment feature. Outside diameter of solid ring blanks may be smaller to suit particular requirements. See Table 39 for solid "setting" or "master" thread ring gage blanks.

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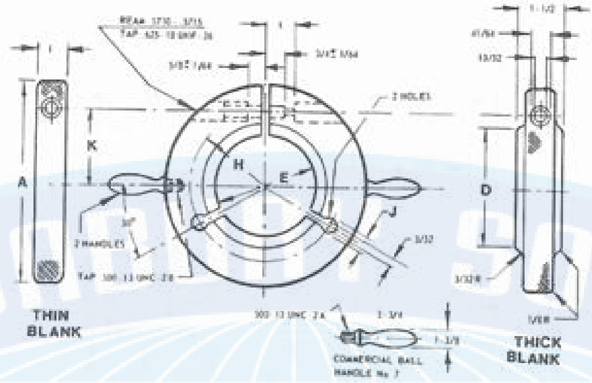
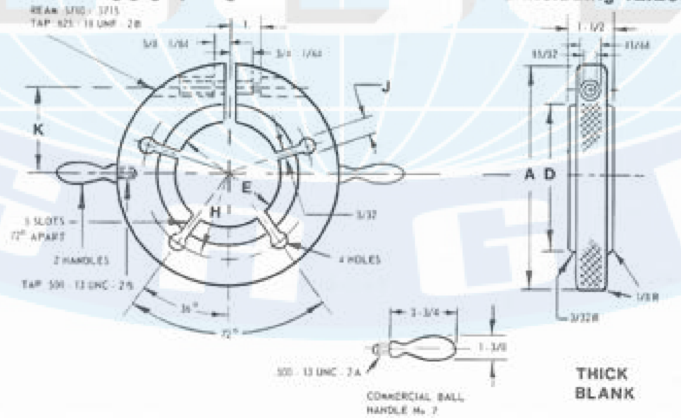
Table 34 Thread ring gages, range above 4.760 inches to and including 8.510 inches.



Ring size No.	Nominal range, inclusive	Decimal range		*A*	*D*	*E*	*H*	*J*	*K*
		Above	To & including						
13-T	4 3/4 to 5 1/2	4.760	5.510	8 1/4	6 5/8	4	3 9/16	1/2	3 1/2
14-T	5 1/2 to 6 1/4	5.510	6.260	9 1/4	7 3/8	4 3/4	4 1/16	1/2	3 15/16
15-T	6 1/4 to 7	6.260	7.010	10 1/4	8 1/8	5 1/2	4 1/2	1/2	4 3/8
16-T	7 to 7 3/4	7.010	7.760	11 1/4	8 7/8	6 1/4	4 7/8	5/8	5
17-T	7 3/4 to 8 1/2	7.760	8.510	12 1/4	9 5/8	7	5 5/16	5/8	5 1/8

NOTE—For use of thin or thick blanks, see note, table 32, page 41. Locking device is the same size in the range above 3 5/8 to and including 12¼ inches.
NOTE—See footnotes on table 32 for solid thread ring gages.

Table 35 Thread ring gages, range above 8.510 inches to and including 12.260 inches.



Ring size No.	Nominal range, inclusive	Decimal range		*A*	*D*	*E*	*H*	*J*	*K*
		Above	To & including						
18-T	8 1/2 to 9 1/4	8.510	9.260	13 1/4	10 3/8	7 3/4	5 13/16	5/8	5 5/8
19-T	9 1/4 to 10	9.260	10.010	14 1/4	11 1/8	8 1/2	6 7/32	11/16	6 1/8
20-T	10 to 10 3/4	10.010	10.760	15 1/4	11 7/8	9 1/4	6 23/32	11/16	6 5/8
21-T	10 3/4 to 11 1/2	10.760	11.510	16 1/4	12 5/8	10	7 1/4	3/4	7 1/4
22-T	11 1/2 to 12 1/4	11.510	12.260	17 1/4	13 3/8	10 3/4	7 5/8	3/4	7 5/8

NOTE—See footnotes on Table 32 for solid thread ring gages.

NOTE—Special thicker blanks are sometimes required for checking long lengths of engagement or exceptionally coarse pitch threads.

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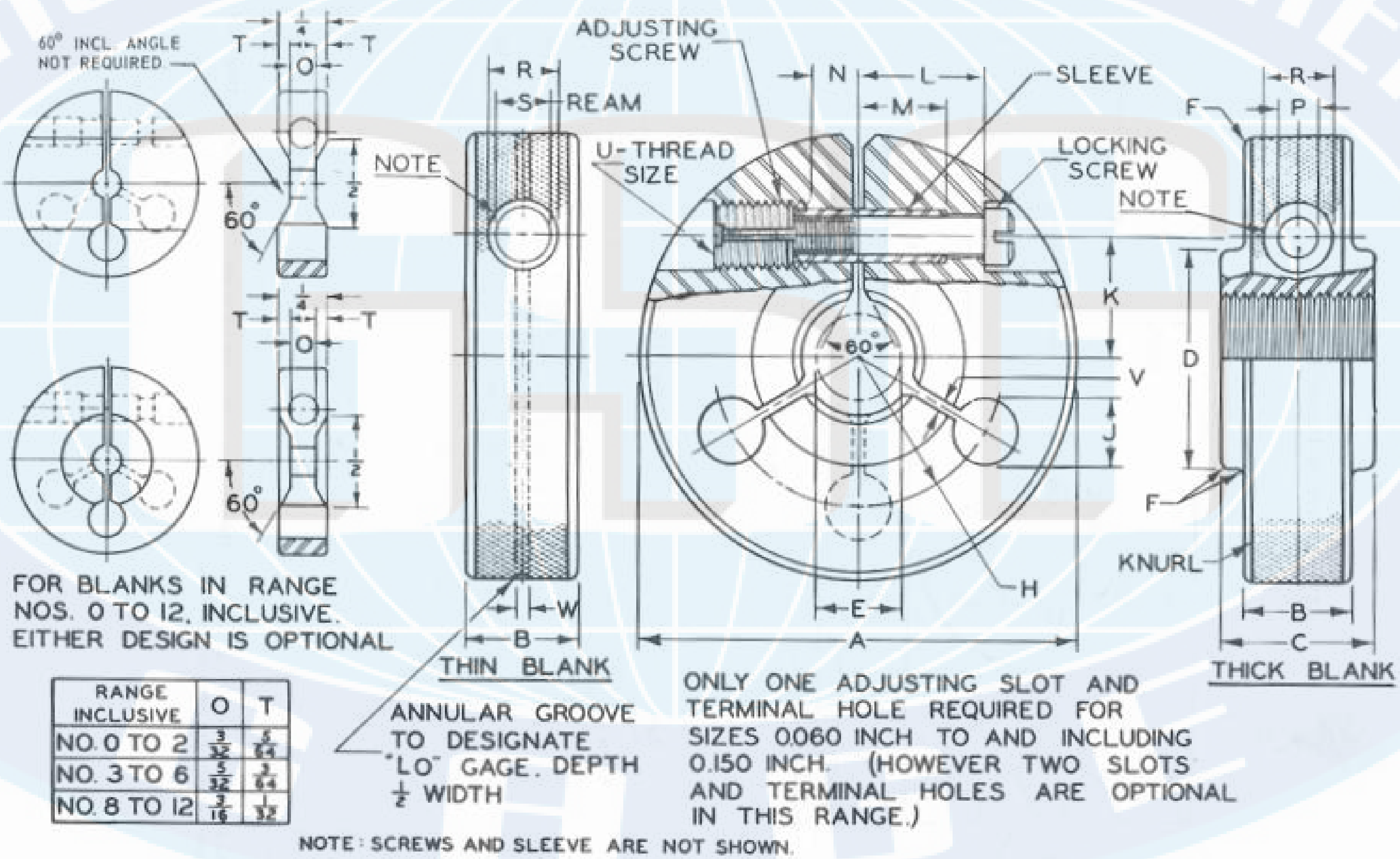
Table 32 Thread ring gages, range No. 0 to and including 4¾ inches; also fine-pitch instrument thread ring gages, No. 0 to and including No. 12



RANGE INCLUSIVE	O	T
NO. 0 TO 2	3/32	5/64
NO. 3 TO 6	5/32	3/64
NO. 8 TO 12	3/16	1/32

"LO" Formerly Known as "NOT GO."

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Table 32 (Cont.) **Thread ring gages, range No. 0 to and including 4¾ inches; also fine-pitch instrument thread ring gages, No. 0 to and including No. 12**

Ring Size No.	Nominal range, inclusive	Decimal range, above and including—	General dimensions: A	B	C	D	E	F	H	J	K	L	M ±1/64	N ±1/64	P Drill size	R Drill size	S Ream: Min.	S Ream: Max.	U: Size	U: Pitch diameter Min.	U: Pitch diameter Max.	V	W
	No. or in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	No. or in.	in.	in.	in.		in.	in.	in.	in.
1-T	Nos. 0 to 6[1]	0.059 .150	1	1/4	—	—	—	1/32	5/16	5/32	5/16	7/32	5/32	5/16	No. 41 (0.0960)	11/64 (0.1719)	0.1370	0.1373	.164-36	0.1400	0.1478	0.010 ([2])	1/32
1-T	Nos. 8 to 12[1]	.150 .230	1	1/4	—	—	—	1/32	5/16	5/32	5/16	7/32	5/32	5/16	No. 41 (0.0960)	11/64 (0.1719)	.1370	.1373	.164-36	.1460	.1478	1/64	1/32
2-T	1/4 to 5/16	.230 .365	1 3/8	11/32	—	—	5/32	1/32	7/16	3/16	5/8	11/32	1/4	1/8	No. 31 (0.1200)	7/32 (0.2187)	.1810	.1813	.216-28	.1928	.1950	1/32	1/16
3-T	3/8 to 1/2	.365 .510	1 3/4	7/16	—	—	5/16	3/32	19/32	1/4	19/32	1/2	3/8	5/16	No. 25 (0.1495)	17/64 (0.2656)	.2150	.2153	.250-28	.2268	.2290	1/32	3/32
4-T	9/16 to 3/4	.510 .825	2 3/16	9/16	3/8	1 5/16	11/32	1/16	3/4	7/16	11/16	17/32	13/32	7/32	No. 7 (0.2010)	21/64 (0.3281)	.2720	.2723	.3125-24	.2854	.2878	1/16	3/32
5-T	7/8 to 1 1/8	.825 1.135	2 5/8	11/16	15/16	1 1/2	9/16	1/16	21/32	5/16	7/8	17/32	13/32	9/32	No. 1 (0.2280)	25/64 (0.3906)	.3340	.3344	.375-24	.3479	.3503	1/16	3/32
6-T	1 1/4 to 1 1/2	1.135 1.510	3 1/4	3/4	1 1/8	1 7/8	23/32	1/16	1 3/16	3/8	1 1/8	1/8	7/16	5/16	17/64 (0.2656)	29/64 (0.4531)	.3890	.3894	.4375-20	.4050	.4076	1/16	3/32
7-T	1 5/8 to 2	1.510 2.010	3 3/4	13/16	1 1/4	2 3/8	1 3/16	3/32	1 7/16	3/8	1 3/8	1/8	7/16	5/16	17/64 (0.2565)	29/64 (0.4531)	.3890	.3894	.4375-20	.4050	.4076	1/16	1/8
8-T	2 1/8 to 2 1/2	2.010 2.510	4 1/2	7/8	1 5/16	2 7/8	1 19/32	3/32	1 3/4	7/16	1 11/16	13/16	9/16	7/16	21/64 (0.3281)	33/64 (0.5156)	.4510	.4515	.500-20	.4675	.4701	3/32	1/8
9-T	2 5/8 to 3	2.510 3.010	5	7/8	1 3/8	3 3/8	2	3/32	2	7/16	1 15/16	13/16	9/16	7/16	21/64 (0.3281)	33/64 (0.5156)	.4510	.4515	.500-20	.4675	.4701	3/32	1/8
10-T	3 1/8 to 3 1/2	3.010 3.510	5 1/2	15/16	1 7/16	3 7/8	2 7/16	3/32	2 7/32	7/16	2 5/16	13/16	9/16	7/16	21/64 (0.3281)	33/64 (0.5156)	.4510	.4515	.500-20	.4675	.4701	3/32	1/8
11-T	3 5/8 to 4	3.510 4.010	6 3/4	15/16	1 1/2	4 3/8	2 13/16	3/32	2 5/8	1/2	2 9/16	1	3/4	5/8	13/32 (0.4062)	41/64 (0.6406)	.5710	.5715	.625-18	.5889	.5919	3/32	1/8
12-T	4 1/8 to 4 3/4	4.010 4.760	7 1/4	1	1 1/2	5 5/8	3 3/8	3/32	3 1/32	1/2	3	1	3/4	5/8	13/32 (0.4062)	41/64 (0.6406)	.5710	.5715	.625-18	.5880	.5919	3/32	1/8

[1] Blanks for the range Nos. 0 to 12, inclusive, may be either counterbored or milled, as shown in illustration for table 32. [2] Approximate.

NOTE—Thin gage blanks are to be used for all "LO" thread ring gages. For "go" thread ring gages, use thin or thick blanks as follows:

"LO" Formerly Known as "NOT GO."

Diameter	Thin blank	Thick blank
From No. 0 to 1/2 inch, inclusive	All pitches.	
Above 1/2 to 1 1/8 inches, inclusive	Pitches 12 threads per inch and finer except 7/16–12	Pitches coarser than 12 threads per inch.
Above 1 1/8 inches to 6 inches, inclusive	Pitches 10 threads per inch and finer	Pitches coarser than 10 threads per inch.
~~Above 6 inches~~		~~All pitches.~~

NOTE—Special thicker blanks are sometimes required for checking long lengths of engagement or exceptionally coarse pitch threads.

NOTE—*Solid* "working" thread ring gages are of similar standard thickness and furnished without adjustment feature. Outside diameter of solid ring blanks may be smaller to suit particular requirements. See Table 39 for solid "setting and master" thread ring gage blanks.

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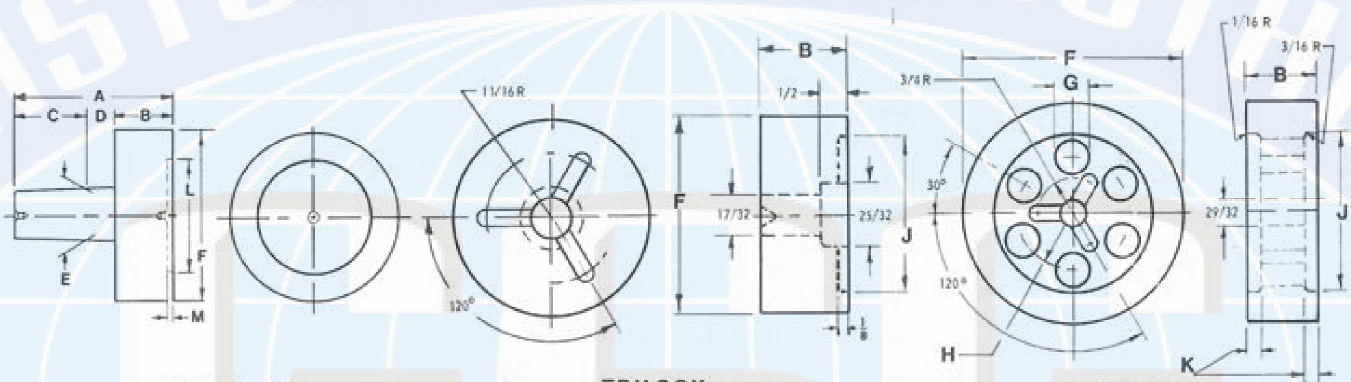
AMERICAN NATIONAL STANDARD GAGE BLANKS

Table 27 Taper pipe-thread plug gaging members (*L*-1) range 1/16 to 6 inches, inclusive.



TAPERLOCK 1 16" THRU 2"

TRILOCK 2-1/2" & 3"

TRILOCK 3-1 2" TO 6" INCL(*)

Nominal pipe size	Type blank	Handle size No.	General dimensions													
			A	*B*	*C*	*D*	*E* Min.	*E* Max.	*F*	*G*	*H*	*J*	*K*	*L*	*M* Min.
1/16	Taperlock	1	1.300	.300	3/4	1/4	.239	.240	3/8					—	—
1/8	"	2	1.310	.310	3/4	1/4	.309	.310	7/16					3/16	1/32
1/4	"	3	1.450	.450	3/4	1/4	.408	.410	9/16					7/32	1/32
3/8	"	3	1.460	.460	3/4	1/4	.408	.410	11/16					1/4	1/32
1/2	"	4	1.768	.580	7/8	5/16	.608	.610	7/8					5/16	1/32
3/4	"	4	1.788	.600	7/8	5/16	.608	.610	1 1/16					1/2	1/32
1	"	5	2.115	.740	1	3/8	.808	.810	1 3/8					5/8	1/32
1 1/4	"	5	2.145	.770	1	3/8	.808	.810	1 11/16					1	1/32
1 1/2	"	5	2.165	.790	1	3/8	.808	.810	1 15/16					1 1/4	1/32
2	"	5	2.205	.830	1	3/8	.808	.810	2 7/16					1 5/8	1/32
2 1/2	Trilock	6		1.210					3			2			
3	"	6		1.300					3 5/8			2 1/2			
3 1/2	"	7		1.350					4 1/8			2 5/8	9/32		
4	"	7		1.425					4 5/8	3/4	1 1/16	3	3/8		
5	"	7		1.550					5 11/16	1	1 3/8	4 5/16	3/8		
6	"	7		1.700					6 3/4	1 1/4	1 5/8	5 1/4	3/8		

(*)Without holes, *G*, 3 1/2" only.

NOTE–Sizes and dimensions in inches.

ANSI B47.1-1981

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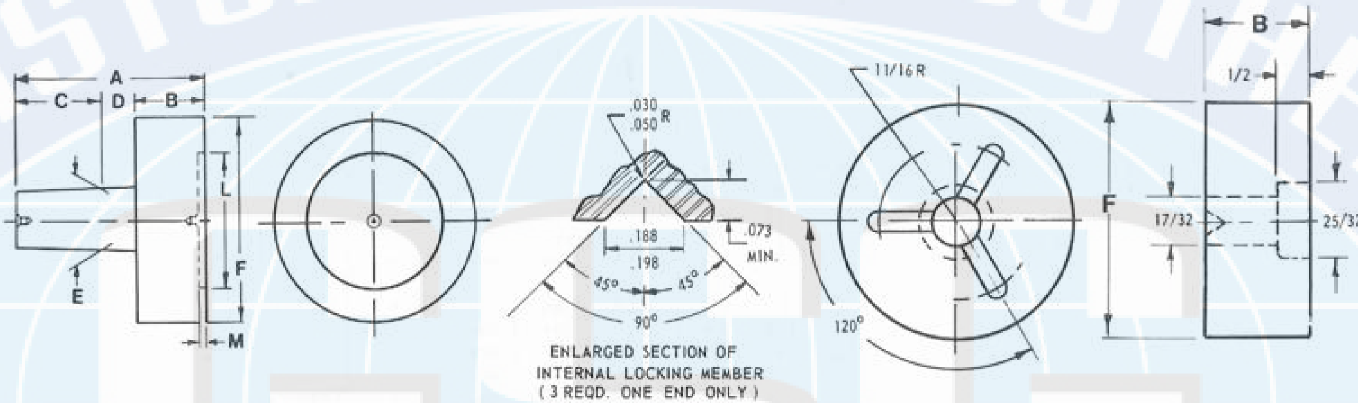
Table 28 Taper pipe thread plug gaging members, for *L*-3 and minor diameter check (6 step).



TAPERLOCK
1/16" THRU 2"

TRILOCK
2-1/2" & 3"

Nominal pipe size	Type blank	Handle size No.	General dimensions								
			A	*B*	*C*	*D*	*E*		*F*	*L*	*M*
							Min.	Max.			Min.
1/16	Taperlock	1	1.420	.420	3/4	1/4	.239	.240	3/8	–	–
1/8	"	2	1.460	.460	3/4	1/4	.309	.310	7/16	3/16	1/32
1/4	"	3	1.550	.550	3/4	1/4	.408	.410	9/16	7/32	1/32
3/8	"	3	1.620	.620	3/4	1/4	.408	.410	11/16	1/4	1/32
1/2	"	4	1.928	.740	7/8	5/16	.608	.610	7/8	5/16	1/32
3/4	"	4	1.968	.780	7/8	5/16	.608	.610	1 1/16	1/2	1/32
1	"	5	2.315	.940	1	3/8	.808	.810	1 3/8	5/8	1/32
1 1/4	"	5	2.315	.940	1	3/8	.808	.810	1 11/16	1	1/32
1 1/2	"	5	2.315	.940	1	3/8	.808	.810	1 15/16	1 1/4	1/32
2	"	5	2.315	.940	1	3/8	.808	.810	2 3/8	1 5/8	1/32
2 1/2	Trilock	6	–	1.580	–	–	–	–	2 15/16	–	–
3	"	6	–	1.580	–	–	–	–	3 1/2	–	–

NOTE–Sizes and dimensions in inches.

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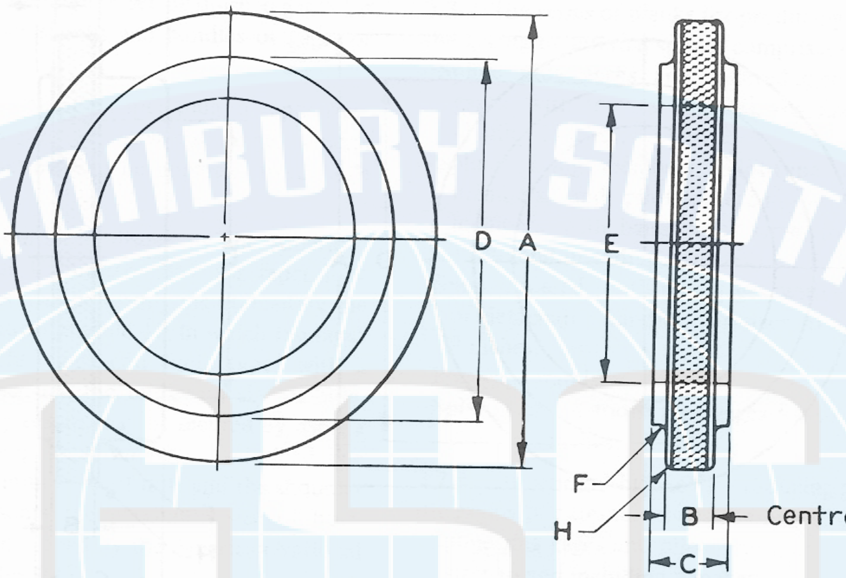
Table 40. Taper pipe thread ring gages L_1 and L_2 range 1/16 to 8 inches, inclusive. (standard basic notch design)



Nominal pipe size	A	B	C L_1	C L_2	D	E	F	H
in.	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*	*in.*
1/16	1 1/8	7/64	7/32	5/16	11/16	3/16	1/32	1/32
1/8	1 1/8	7/64	7/32	5/16	11/16	9/32	1/32	1/32
1/4	1 3/8	9/64	5/16	31/64	7/8	3/8	1/32	1/32
3/8	1 1/2	9/64	11/32	1/2	1	1/2	1/32	1/32
1/2	1 3/4	3/16	27/64	5/8	1 1/4	5/8	3/64	1/32
3/4	2	13/64	7/16	41/64	1 7/16	13/16	3/64	1/32
1	2 1/2	17/64	1/2	25/32	1 13/16	1	3/64	1/32
1 1/4	3	9/32	33/64	51/64	2 3/16	1 11/32	3/64	3/64
1 1/2	3 1/4	9/32	33/64	13/16	2 3/8	1 9/16	3/64	3/64
2	3 3/4	19/64	17/32	27/32	2 15/16	2 1/32	1/16	3/64
2 1/2	4 1/4	1/2	13/16	1 1/4	3 3/8	2 7/16	3/32	1/16
3	5	9/16	29/32	1 5/16	4	3 1/16	3/32	1/16
3 1/2	5 3/4	5/8	61/64		4 5/8	3 9/16	3/32	1/16
4	6 1/2	21/32	1		5 3/16	4 1/16	3/32	1/16
5	7 1/2	23/32	1 1/16		6 1/4	5 1/8	3/32	3/32
6	9	23/32	1 3/32		7 1/2	6 1/8	3/32	3/32
8	11	13/16	1 3/16		9 1/2	8 1/8	1/8	3/32

NOTE—Master ring gage for checking L_1 and L_2 working plug gages can be made from "C" L_2 blanks.

NOTE—As an alternate standard L_2 basic notch ring gages can be made from same blanks as the PTF-SAE L_2 short step limit blanks shown in table 40(a).

CERTIFICATION / INSPECTION SERVICES

(Click on the links below for the document)

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Which certification do I need?
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GSG offers two complete information certifications, or as we call them, 'Long Form' certifications: Standard Long Form and Accredited Long Form. If you do not specify which one you need or prefer we will supply and bill for the Standard Long Form Certification.

Standard Long Form Certification
If your quality system or your customer's quality system is ISO 9000 certified / registered the standard long form certification is probably sufficient for your system.

A2LA Accredited Long Form Certification
If your quality system or your customer's quality system is certified / accredited / registered you probably need the Accredited Long Form Certification. For QS-9000 (automotive), AS-9100 (aerospace), Guide 25, ISO 17025, or NCSL Z540-1 (Laboratory) you don't have a choice, your system requires the Accredited Long Form Certification.

The 'Accredited' cert is more expensive because the gages are inspected 100% in a separate laboratory area after being 100% inspected at 'Final Inspection' in the laboratory. The result is a 200% inspection. The certificate will contain our accreditor's logo (A2LA).

If you have any further questions, don't hesitate to contact our Corporate Quality Director.

Certification Requirements Misconceptions

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There are several common misconceptions of what is required on a calibration certificate for Inspection, Measurement, and Test Equipment (IM&TE) according to ISO Guide 25 (now ISO-17025), or ANSI/NCSL Z540-1. The requirements for a calibration certificate are listed in the previously mentioned standards in a section specific and only for calibration certificates. Misconceptions arise because the sections in the standards that apply to the 'Quality System' supporting the IM&TE are incorrectly applied to the calibration certificate.

Some calibration labs and companies have designed their calibration certificate to supply anything and everything their customers might want whether listed in the properly applied section of the standards or listed in other and improperly applied sections of the standards. This eliminates the questions that arise from their customers, and may be some of the source for the misconceptions. Glastonbury Southern Gage takes a very active role in many ANSI standards writing committees, and organizations like AMTMA, and we believe the standards should be applied properly as written because they were conceived, written and published to create consistency in industry.

Attached is a comparison of the requirements in the two standards for calibration certificates, and also a column for ISO 10012-1, which is for the 'Quality (Calibration) System' supporting the IM&TE, not the certificate. Please note the section numbers listed in the header as these detail the section of the standards where this information is found.

Listing the instrument used to obtain the calibration results, and its calibration information is not an item in the requirements list. In attempting to understand where this misconception is originating, we zero in on two things. 1) Item h, in both lists, but this is specific to the procedure not the instrument used. 2) Traceability statement, required in Z540 but not Guide 25 for the certificate, and definitely required as a part of the 'Quality System' in all three standards. To help people understand the application of this requirement we have added a sentence to our certifications that states "The user's calibration source for NIST traceability is GSG."

In conclusion, we at GSG would like to offer our services in interpreting and applying these calibration standards. Any customer you have that is demanding things not required by the standards, give them a copy of the attached list. If this doesn't solve the problem, have them get out their copy of the standard and find the requirement they are demanding. You will discover they are in a section other than the appropriate section for calibration certificates. If you need assistance in helping them understand which section they should be looking in or how to properly apply the requirements they are looking at, we will be more than happy to talk with them.

For that group of customers who have designed their quality system without adhering to the standard, and now require more than the standards do for calibration certificates, we will be glad to furnish a calibration certificate with any and all information the customer desires. Have your customer list all the additional items they want on the certificate, be sure they are clearly stated on your request for quote so the appropriate costs can be added for this additional work. Be sure also that this same list is prominently displayed on your purchase order, because special handling is required to comply with these special requests. If you would like to discuss our fees for these special services, please contact GSG's Customer Service at 800-251-4243.

Click here for a chart comparing the requirements of different standards.

Glastonbury Southern Gage

Erin, TN

Comparison of Information Required on the Calibration Certificate Information to that required by the User's Quality / Calibration System Annotated with Some Common Misconceptions

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Item	ISO/IEC 17025 (5.10.2*, 5.10.4**) Calibration Report Requirements	ISO Guide 25 (Obsolete) (13.2) Calibration Report Requirements	Z540-1 (13.2) Calibration Report Requirements	ISO 10012-1 (4.8) Lab IM&TE Records Requirements	Common Misconceptions
Title	2 a) a title, (e.g. "Test Report" or "Calibration Certificate");	a) a title, e.g. "Calibration Certificate", "Test Report" or "Test Certificate"	a) a title, e.g. "Calibration Report" or "Calibration Certificate"		
Lab name & location	2 b) the name and address of laboratory, and location where the test and/or calibration were carried out, if different from the address of the laboratory;	b) name and address of laboratory, and location where the calibration or test was carried out if different from the address of the laboratory.	b) name and address of laboratory, and location where the calibration was carried out if different from the address of the laboratory.		
Certificate document number & page(s) information	2 c) unique identification of the certificate or report (such as serial number) and on each page an identification in order to ensure that the page is recognized as a part of the test report or calibration certificate, and a clear identification of the end of the test report or calibration certificate. 2 Note 1) Hard copies of test reports and calibration certificates should also include the page number and total number of pages.	c) unique identification of the certificate or report (such as serial number) and of each page, and the total number of pages.	c) unique identification of the certificate or report (such as serial number) and of each page, and the total number of pages.	n) unique identification (such as serial numbers) of any calibration certificates and other relevant documents concerned.	
Customer name	2 d) name and address of client;	d) name and address of client, where appropriate.	d) name and address of customer, where appropriate.		
Description of item calibrated	2 f) a description of, the condition of, and unambiguous identification of the item(s) tested or calibrated;	e) description and unambiguous identification of the item calibrated or tested.	e) description and unambiguous identification of the calibration item.	a) description and unique identification of equipment	A unique (to the user) serial number must be applied to certificate by calibration lab. Calibration stickers must be supplied by cal. lab.
New / Old As found conditions	(see 2f above) 5.10.4.3 When an instrument for calibration has been adjusted or repaired, the	f) characterization and condition of the calibration or test item	f) characterization and condition of the calibration item	c) the calibration results obtained after and, where relevant, before any adjustment and repair.	Certificates for fixed / non-adjustable items must have "as found" and "as let" conditions.

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Comparison of Information Required on the Calibration Certificate Information to that required by the User's Quality / Calibration System Annotated with Some Common Misconceptions

	calibration results before and after adjustment or repair, if available, shall be reported.				
Date of receipt Date of calibration	2 g) the date of receipt of the test or calibration item(s) where this is critical to the validity and application of the results, and the date(s) of performance of the test or calibration;	g) date of receipt of calibration or test item and date(s) of performance of calibration or test, where appropriate.	g) date(s) of performance of calibration, where appropriate.	b) the date on which each confirmation was completed.	Receipt date is relevant to any calibration
Calibration interval	5.10.4.4 A calibration certificate (or calibration label) shall **not** contain any recommendation on the calibration interval except where this has been agreed with the client.			d) the assigned confirmation interval	Calibration certificate must give 'Re-calibration, Recall, or Due Date"
Calibration procedure identification	2 e) identification of the method used; 2 h) reference to sampling plan and procedures used by the laboratory or other bodies where these are relevant to the validity or application of the results.	h) identification of the calibration or test method used, or unambiguous description of any non-standard method used.	h) identification of the calibration procedure used, or unambiguous description of any non-standard method used.	e) identification of the confirmation procedure.	Copy of calibration procedure used must be included with or contained within certificate. Instrument and artifact used must be included.
Sample plan	2 h) reference to sampling plan and procedures used by the laboratory or other bodies where these are relevant to the validity or application of the results.	i) reference to sampling procedure, where relevant	i) reference to sampling procedure, where relevant		
Deviation information if calibration procedure wasn't followed exactly (Environment)	4.1a) the conditions (e.g. environmental) under which the calibrations were made that have an influence on the measurement results;	j) any deviations from, additions to or exclusions from the calibration or test method, and any other information relevant to a specific calibration or test, such as environmental conditions.	j) any deviations from, additions to or exclusions from the calibration method, and any other information relevant to a specific calibration, such as environmental conditions.	h) the relevant environmental conditions and statement about any corrections thus necessary	Environmental condition(s) at exact time of calibration must be on certificate.
Calibration results	2 i) the test or calibration results with, where appropriate, the units of measurement;	k) measurements, examinations and derived results, supported by tables, graphs, sketches and photographs as appropriate, and any failures identified.	k) measurements, examinations and derived results, supported by tables, graphs, sketches and photographs as appropriate, and any failures identified.	c) the calibration results obtained after and, where relevant, before any adjustment and repair.	Calibration results must be given in same format and denomination as characteristic.

Glastonbury Southern Gage

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Comparison of Information Required on the Calibration Certificate Information to that required by the User's Quality / Calibration System Annotated with Some Common Misconceptions

Permissible error (or tolerance)				f) the designated limits of permissible error	Certificate must contain tolerance or limits
Adjustments	5.10.4.3 When an instrument for calibration has been adjusted or repaired, the calibration results before and after adjustment or repair, if available, shall be reported.			j) details of any maintenance such as servicing, adjustment, repairs or modifications carried out.	
Uncertainty	4.1b) the uncertainty of measurement and/or a statement of compliance with an identified metrological specification or clauses thereof; (***See Note 1)	l) a statement of the estimated uncertainty of the calibration or test result, where relevant.	l) a statement of the estimated uncertainty of the calibration result, where relevant.	i) a statement of the uncertainties involved in calibrating the equipment and of their cumulative effect	
Calibrator				l) identification of the person(s) performing the confirmation.	Certificates must contain two signatures
Responsible person's signature, title, and date	2 j) the name(s), function(s) and signature(s) or equivalent identification of person(s) authorizing the test report or calibration certificate;	m) a signature and title, or an equivalent identification of the person(s) accepting responsibility for the content of the certificate or report (however produced) and date of issue.	m) a signature and title, or an equivalent identification of the person(s) accepting responsibility for the content of the certificate or report (however produced) and date of issue.	m) identification of person(s) responsible for ensuring the correctness of the recorded information	
Disclaimer to any unmentioned items	2 k) where relevant, a statement to the effect that the results relate only to the items tested or calibrated.	n) where relevant, a statement to the effect that the results relate only to the items calibrated or tested.	n) where relevant, a statement to the effect that the results relate only to the items calibrated.		
Reproduction statement	2 Note 2) It is recommended that laboratories include a statement specifying that the test report or calibration certificate shall not be reproduced except in full, without written approval of the laboratory.	o) a statement that the certificate or report shall not be reproduced except in full, without he written approval of the laboratory.	o) a statement that the certificate or report shall not be reproduced except in full, without he written approval of the laboratory.		
Limitations of use			p) special limitations of use	k) any limitations in use	
Traceability statement	4.1c) evidence that the measurements are traceable		q) traceability statement	g) the source of the calibration used to obtain traceability	Every detail of traceability path to NIST must be on certificate. Calibration information for artifact and instrument used must be supplied.

PART TYPE MASTERS

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Part Type Masters are used extensively in the automotive industry. Typically used on shop floor inspection equipment as artifacts that reference the equipment, typical applications are: rotor, drum, connecting rod, camshaft, piston and crankshafts.

Master	Features	Master Tolerance
Rotor	Check Diameter & Run Out	10% of part tolerance to .000040”
Drum	Check Diameter & Run Out	10% of part tolerance to .000040”
Connecting Rod	Check Pin & Crank Bores for Diameters, Centerline Dimensions & Squareness of bores to faces.	XX Gage Tolerances, faces flat & parallel within .0001”
Camshaft	Check Index, Throws & Diameters	XX Gage Tolerances, concentricity of diameters within .000050”.
Crankshaft	Check Index, Throws & Diameters	XX Gage Tolerances, concentricity of diameters within .000050”.
Piston Masters	Check Diameters, Wrist Pin Bore Diameter & Location, Check Groove Locations & Diameters.	XX Gage Tolerance on Diameter & +/-.0001” on groove Diameters & Locations

However almost every variable gage in use has a part master associated with it and these are just a few applications that GSG have manufactured.

All masters are made out of tool steel, hardened to 62 RC and doubled stabilized. Chrome plate is available (not used in areas where carbide probes touch the master). In cases where the gage might be used in a corrosive environment, 440-C Stainless Steel may be used. Certain tight manufacturing tolerance applications may need min., mean and max. condition masters for greater accuracy when setting the gage fixture.

Our Engineering department will be pleased to review your part master needs.

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GAGE DESIGN AND BUILD

Glastonbury Southern Gage designs and builds gage fixtures to measure parts that would require a single or multiple features to be measured at the same time. The gages are designed and built to be used by the average operator on the shop floor. GSG incorporates many of our standard products including the GSG zero spindle with the AD swing arm and thread attachment measuring units, GSG can include automation to the gage fixture to ease the operator use and add some SPC and math functionality to the application.

GSG has a stringent design and build procedure including project verification, design approval, gage R&R and customer run off. Design of gages also uses a common approach meaning that our gages are built with a set of components that are the same between gages thus reducing the customer inventory on spares and reducing overall cost. In addition this approach allows GSG to reduce risk on newer designs by basing them on proven and tried designs.

GSG can also manufacture gages to the customers design

Typical Gage Applications

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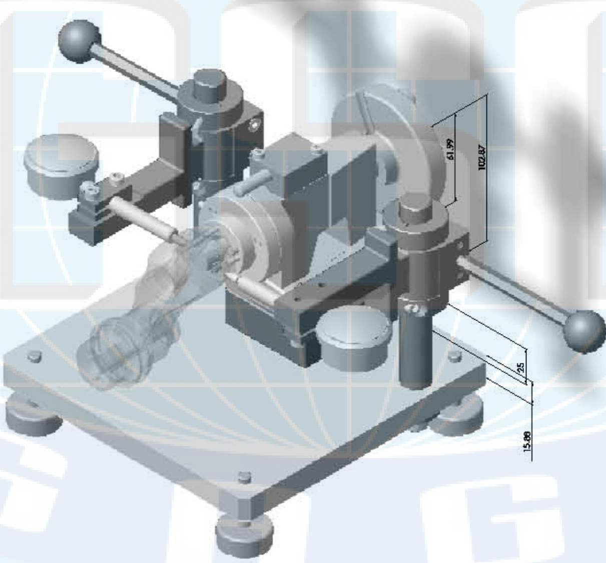
TRUNION RUN-OUT GAGE FIXTURE

GSG designed and built this gage fixture to measure the stator end of the trunion. The gage consists of a base plate with the GSG Zero Spindle and Collet to hold the part on the bore datum. Measuring the run-out are 2 GSG AD swing am units with customer supplied indicators.

The unique problem this gage overcame was to accommodate the weight of the part while clamping on a shallow bore, the Collet and zero spindle solved this problem.



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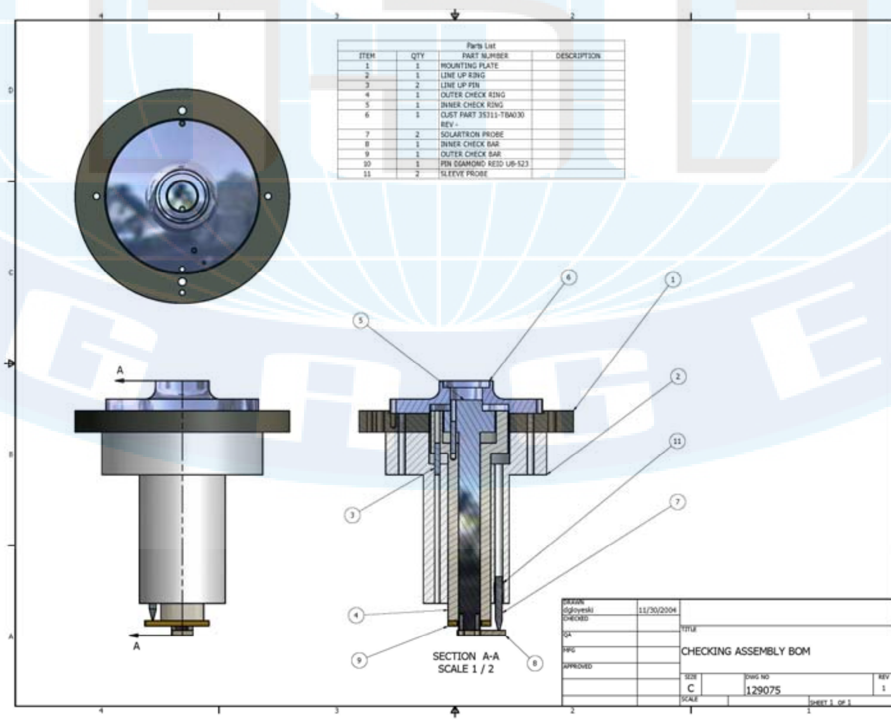
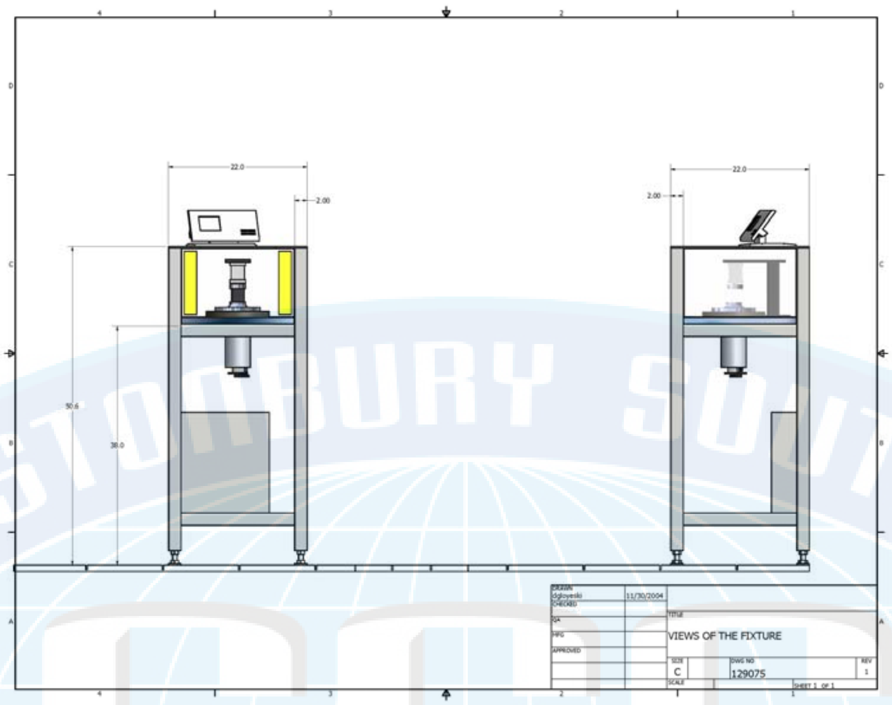
OIL PUMP HOUSING DEPTH GAGE FIXTURE

The gage was designed and built on a substantial base for rigidity and stability. On the base was mounted an orientation plate with a diamond pin and a boss to orientate the part. Two spring loaded bosses are located on an upper plate where the entire surface of the drive and driven gear faces were contacted and measured. The bosses measured the distance from the end face with one transducer in each. The boss assembly had two positions to accommodate the 1mm difference between the 4 and 5 gear units.

The operator loads the part onto the orientation fixture and presses a button which will raise the fixture and part up to the measuring heads. The readouts are given as a size and a class from 1-5 set at the tolerance bands the customer supplied and chart on a digital display with data collection and connection to a network available.

For added safety there was a light guard to prevent the operator getting their hands caught while the gage is performing its measuring cycle. The gage was free standing and mounted on its independent frame. (See Page 2)




22.0
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22.0
2.00
50.6
38.0
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QA
MFG
APPROVED
TITLE
VIEWS OF THE FIXTURE
SIZE
C
DWG NO
129075
REV
1
SCALE
SHEET 1 OF 1

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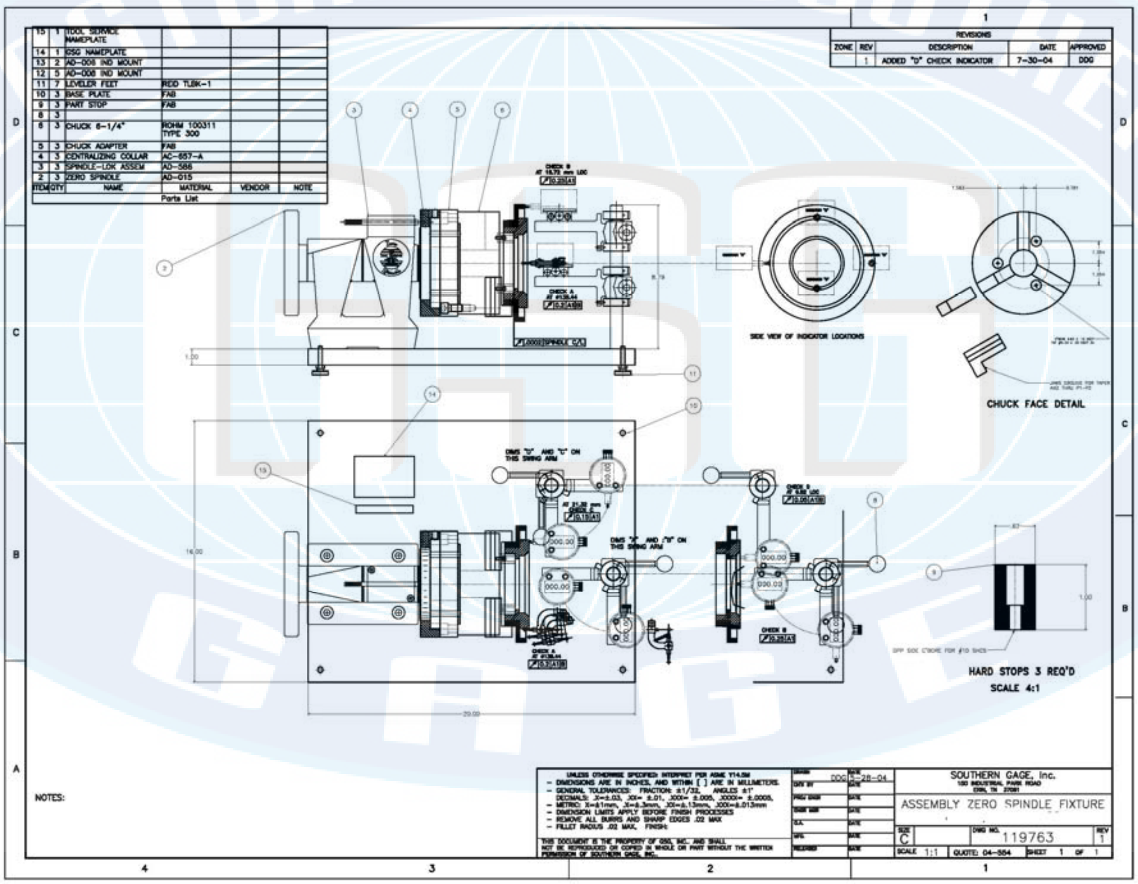
HOUSING RUN-OUT GAGE FIXTURE

GSG designed and built the gage fixture to measure the run-out of several features using the GSG zero spindle and the GSG AD swing arm units. The operator would load the part on the precision 3 jaw chuck and swing in all the AD swing arm units. The part is then rotated where the operator takes the reading.

These gages have been supplied with automatic rotation and data collection.



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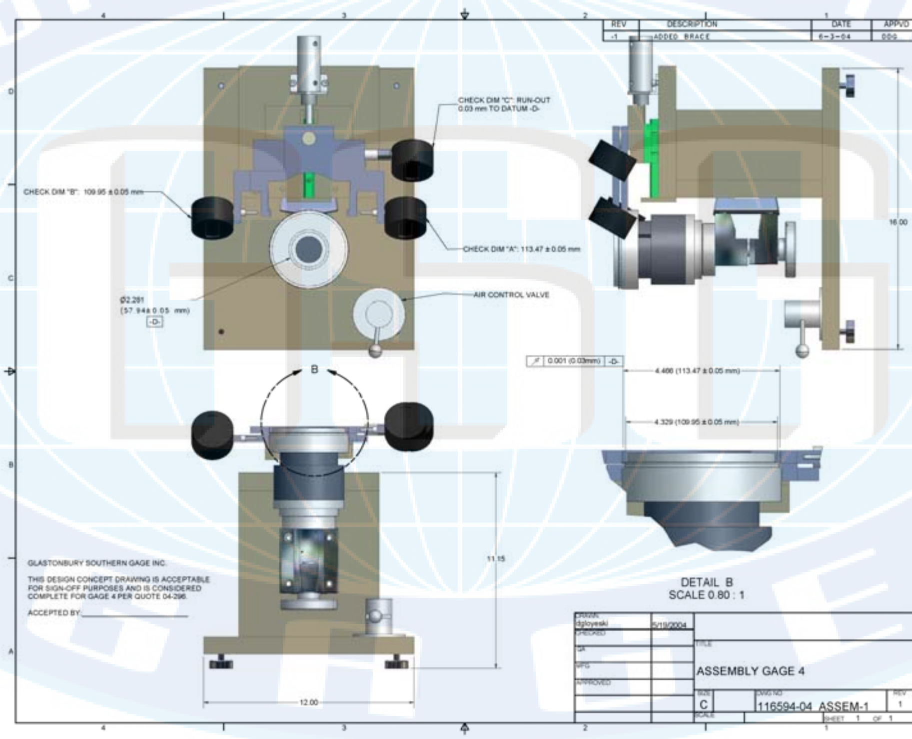
RUN-OUT AND DIAMETER GAGE FIXTURE

GSG designed and built the gage to measure diameters and positions. The part was loaded into a zero spindle with a precision 3 jaw chuck, and clamped on the datum. A horizontal slide advances the measuring units onto the diameters where the measurements are taken.

The zero spindle is rotated allowing the run-out of the diameter to be measured.

The gage is properly interlocked to prevent damage to the part and the gage.



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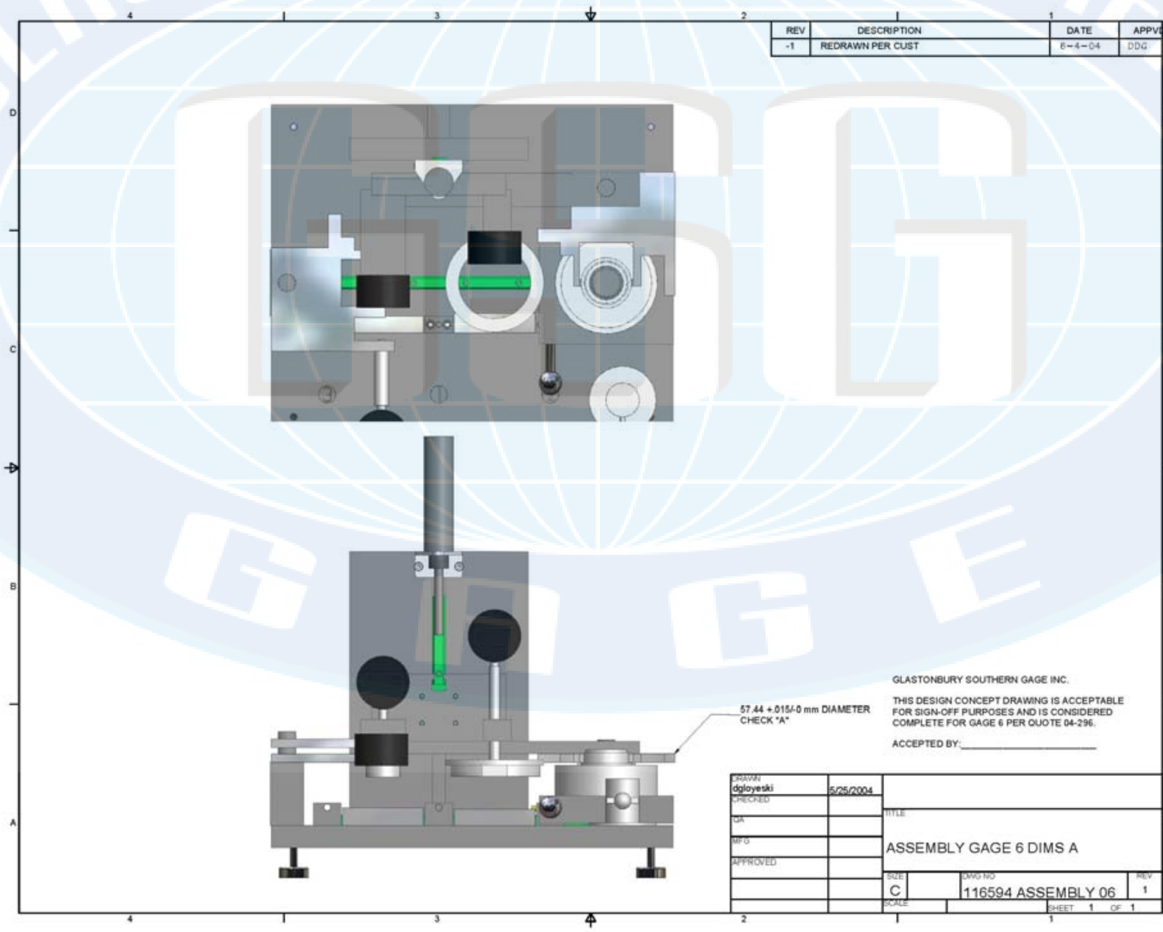
3 POISTION GAGE FIXTURE

GSG designed and built the gage so multiple features could be measured at the same time. To accommodate this, the gage was designed to have 3 gage positions. The part was loaded over a guide mandrel and onto three carbide datum pads placed 120º around the circumference of the end surface. The operator lowers a vertical slide where a plunger locates the part firmly onto the datum pads. Retraction from the measuring units is removed allowing the diameters to be measured. The measurements included the internal grove diameters.

The gage is properly interlocked to prevent damage to the part and the gage.



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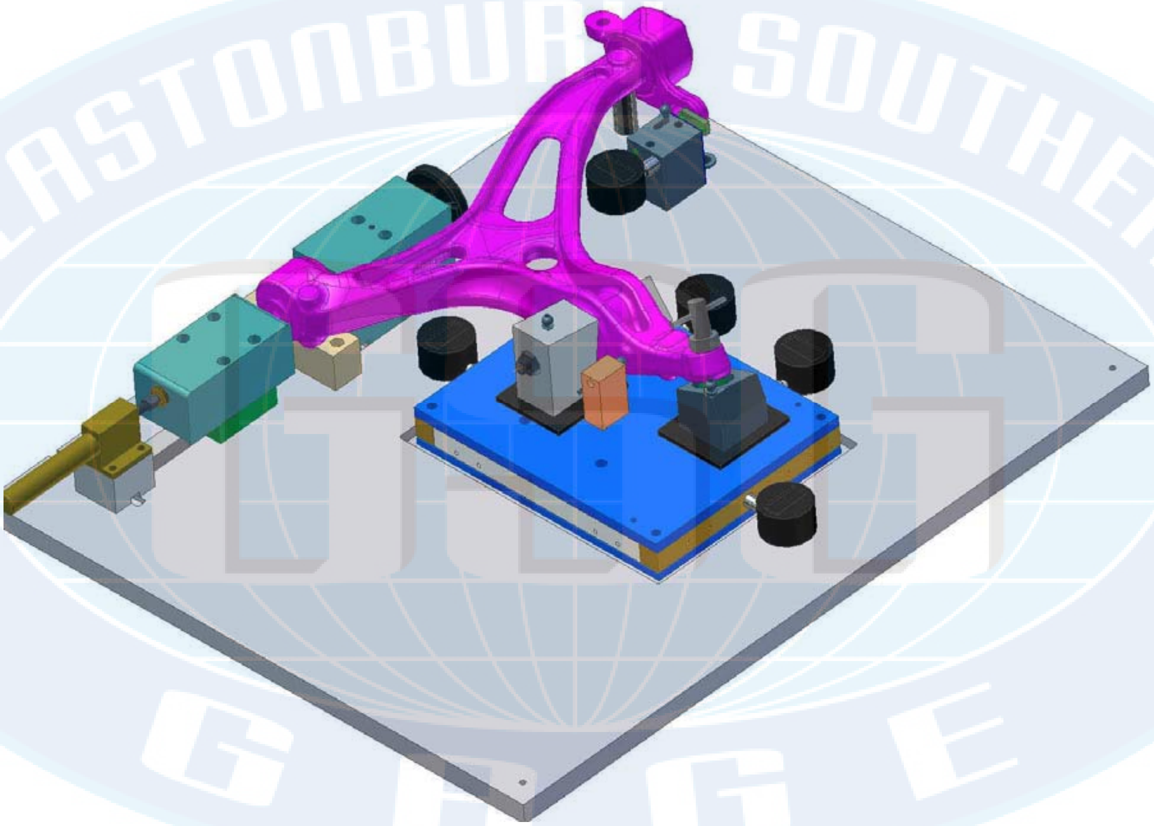
STEERING ARM HOLE LOCATION FIXTURE

GSG designed and built the gage fixture to measure the machining and hole locations of both the left and right hand knuckles of the upper and lower steering arm. The gage was designed to replicate the measurements of the CMM on the shop floor for quick and repeatable measurement of the arms.



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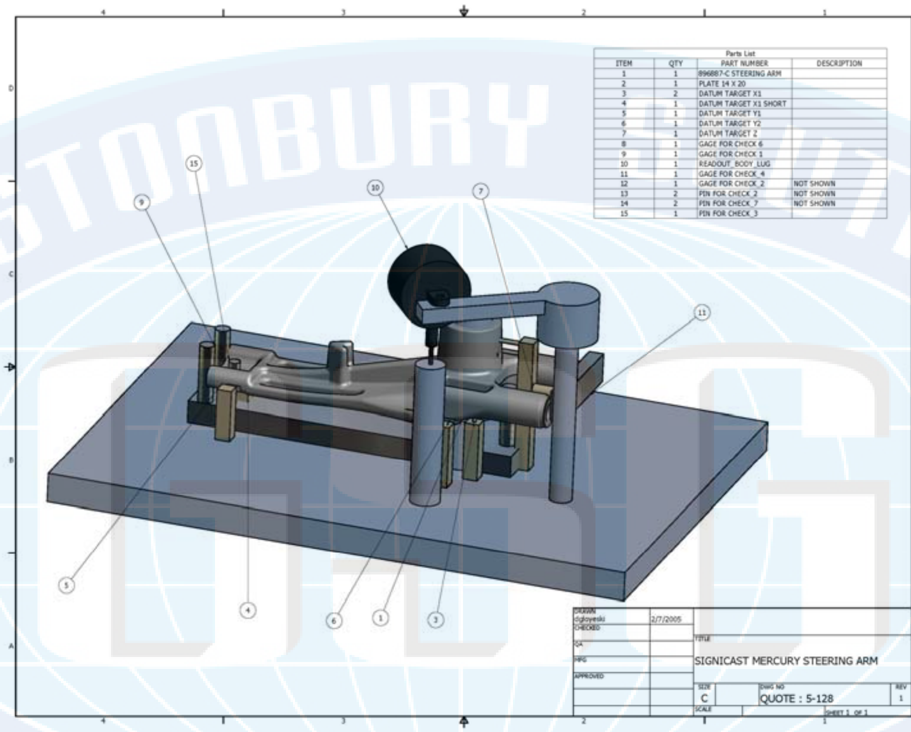
SWEEP GAGE FIXTURE

GSG designed and built the gage fixture to check the height of the casting boss from the machine datum's before machining.



Glastonbury Southern Gage Erin, TN

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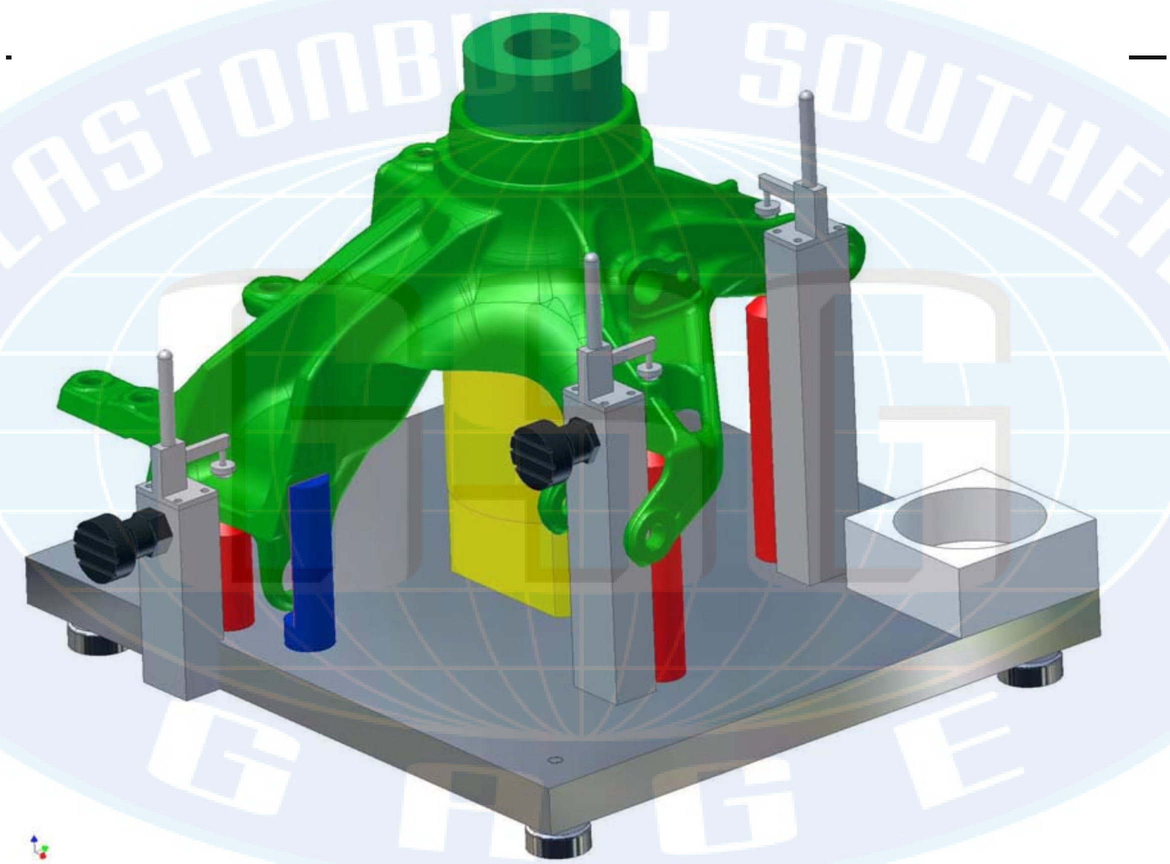
ARRTIBUTE HOLE LOCATION GAGE FIXTURE

GSG designed and built the gage fixture to check the true position of the spindle bore to the specified datum's. These types of gages make excellent use of GSG recourses in close tolerance machining and fixed limit gages



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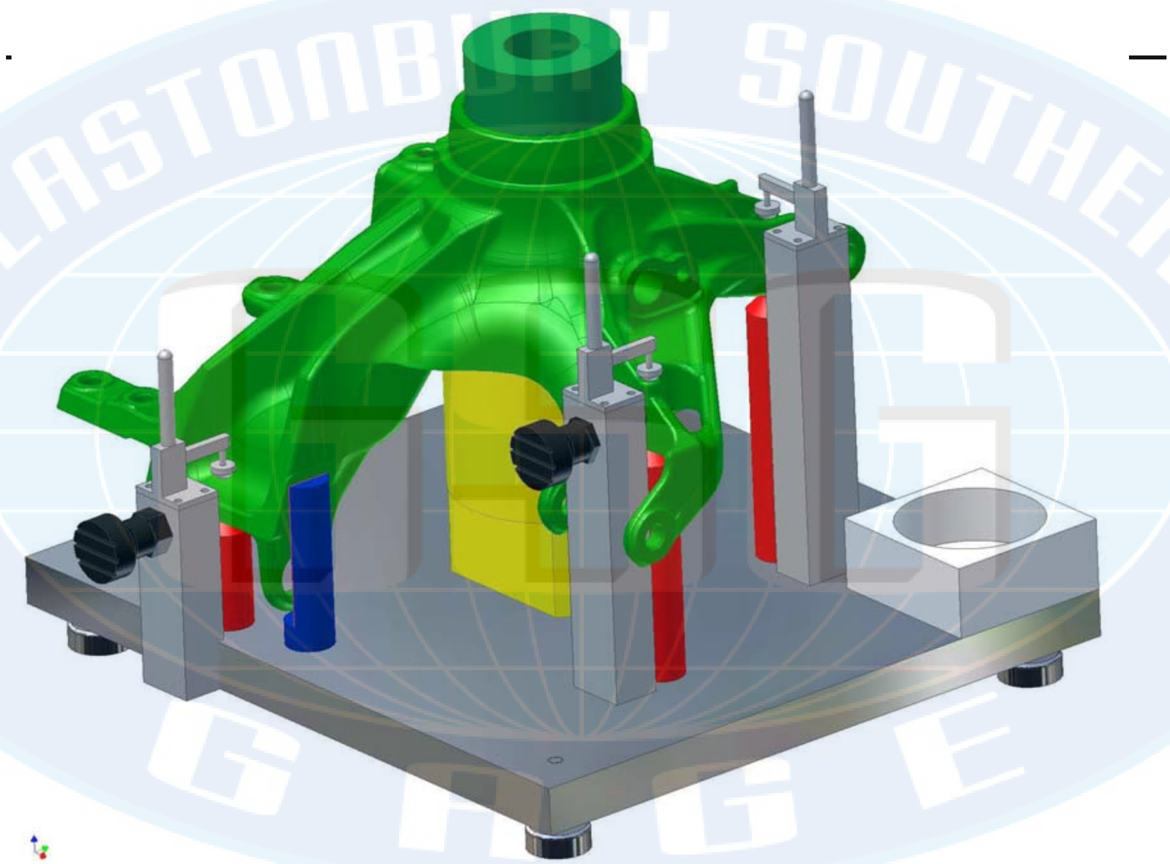

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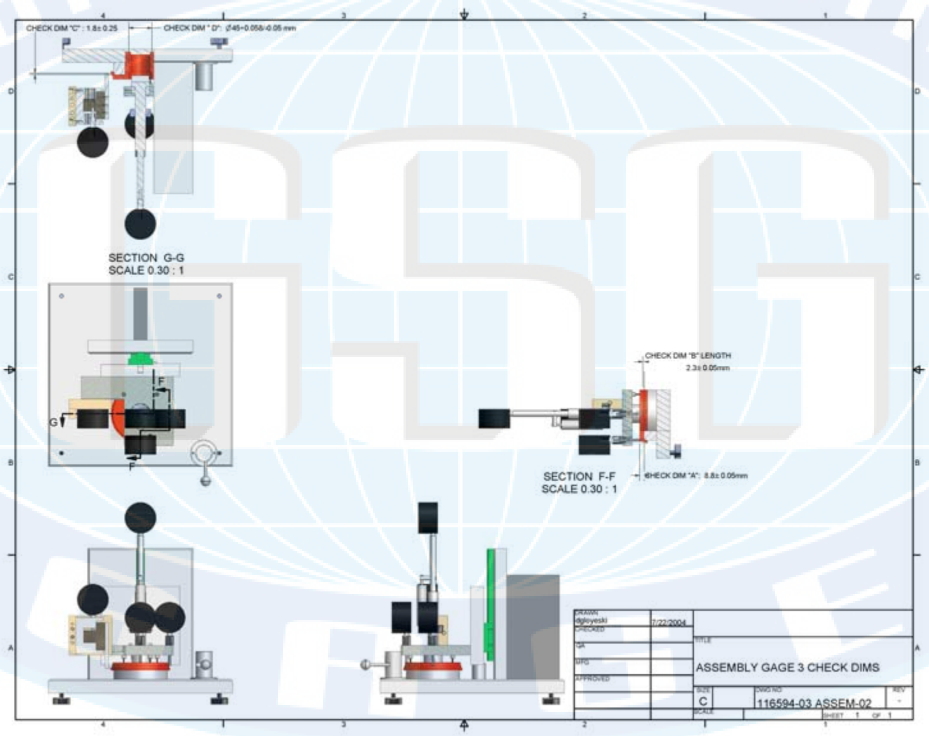
OD GROOVE AND DIAMETER GAGE FIXTURE

GSG designed and built the gage to measure diameters and positions. The part was loaded over a guide mandrel and onto three carbide datum pads placed 120º around the circumference of the end surface. The operator lowers a vertical slide where a plunger locates the part firmly onto the datum pads and indicators give the height checks. Once the slide is lowered a horizontal slide traverses into the groove where the groove position is measured.

The gage is properly interlocked to prevent damage to the part and the gage.



Glastonbury Southern Gage

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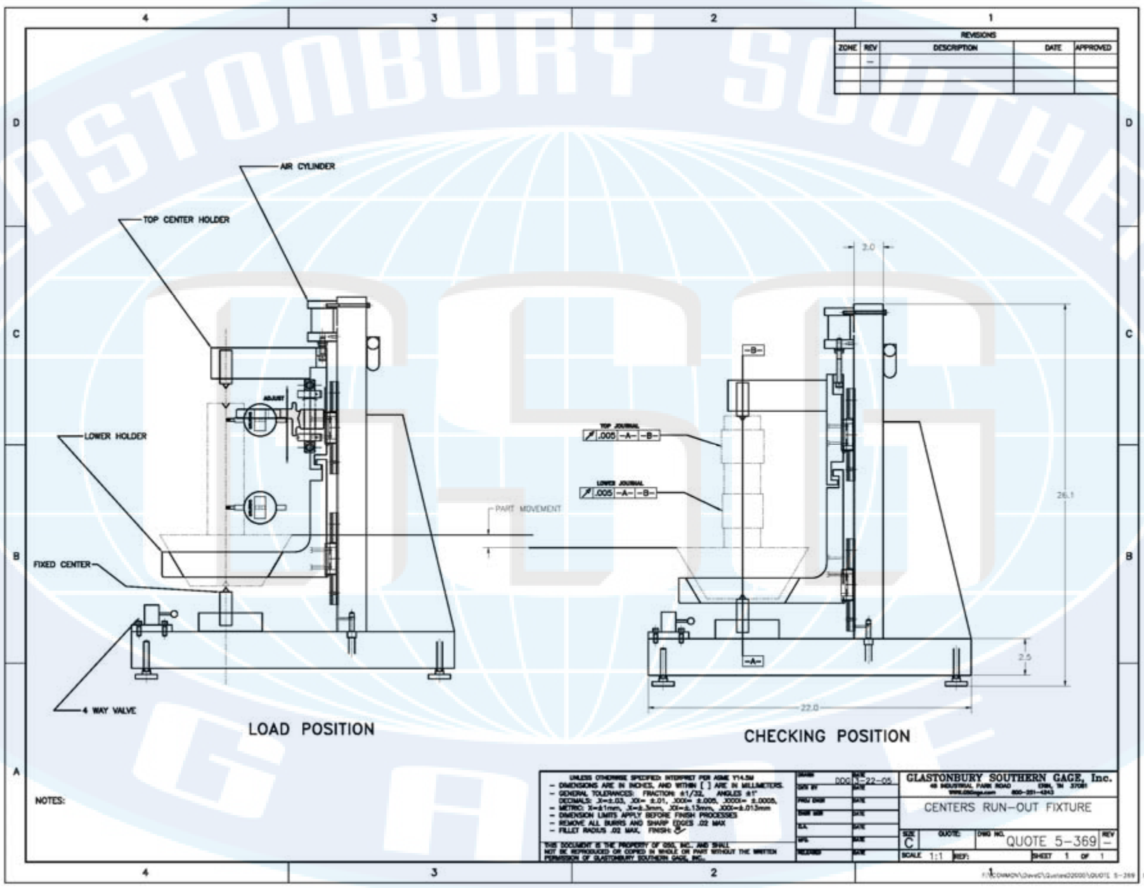
BEARINGS JOURNAL RUN-OUT GAGE FIXTURE

GSG designed and built the gage fixture to measure the run-out of the bearing journals on the shaft of the large pinion gear blank. This gage included air retraction of the measuring elements for ease of operator use.



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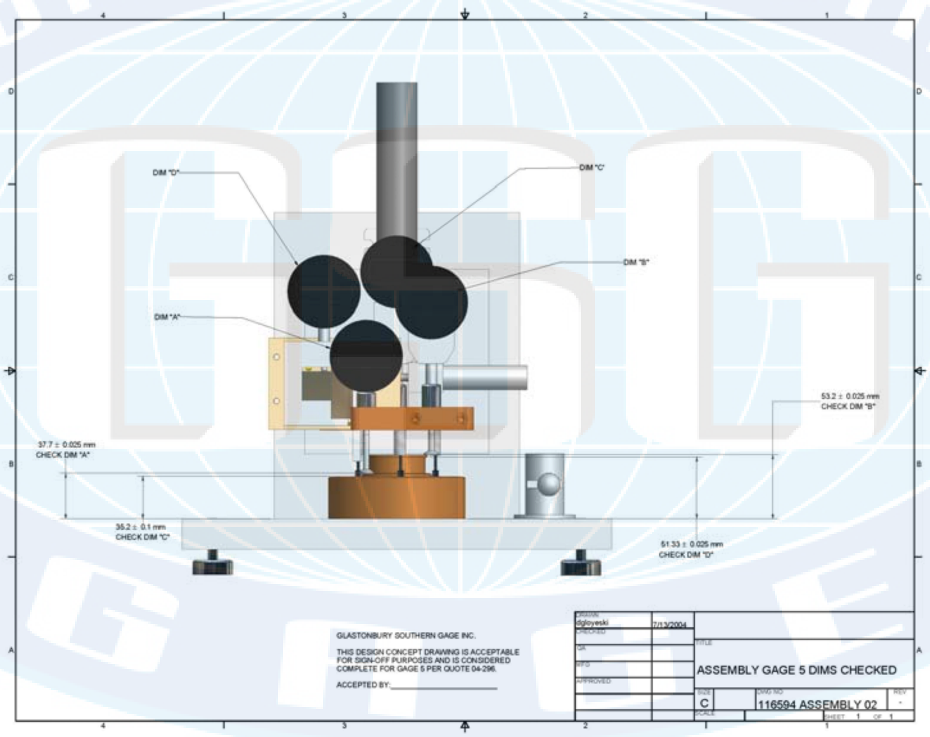
GROOVE POISTION AND DIAMETER GAGE FIXTURE

GSG designed and built the gage to measure groove diameters and positions. The part loads over a guide mandrel and onto three carbide datum pads placed 120º around the circumference of the end surface. The operator lowers a vertical slide where a plunger locates the part firmly onto the datum pads and indicators give the height checks. Once the slide is lowered a horizontal slide traverses into the groove where the groove position is be measured.

The gage is properly interlocked to prevent damage to the part and the gage.



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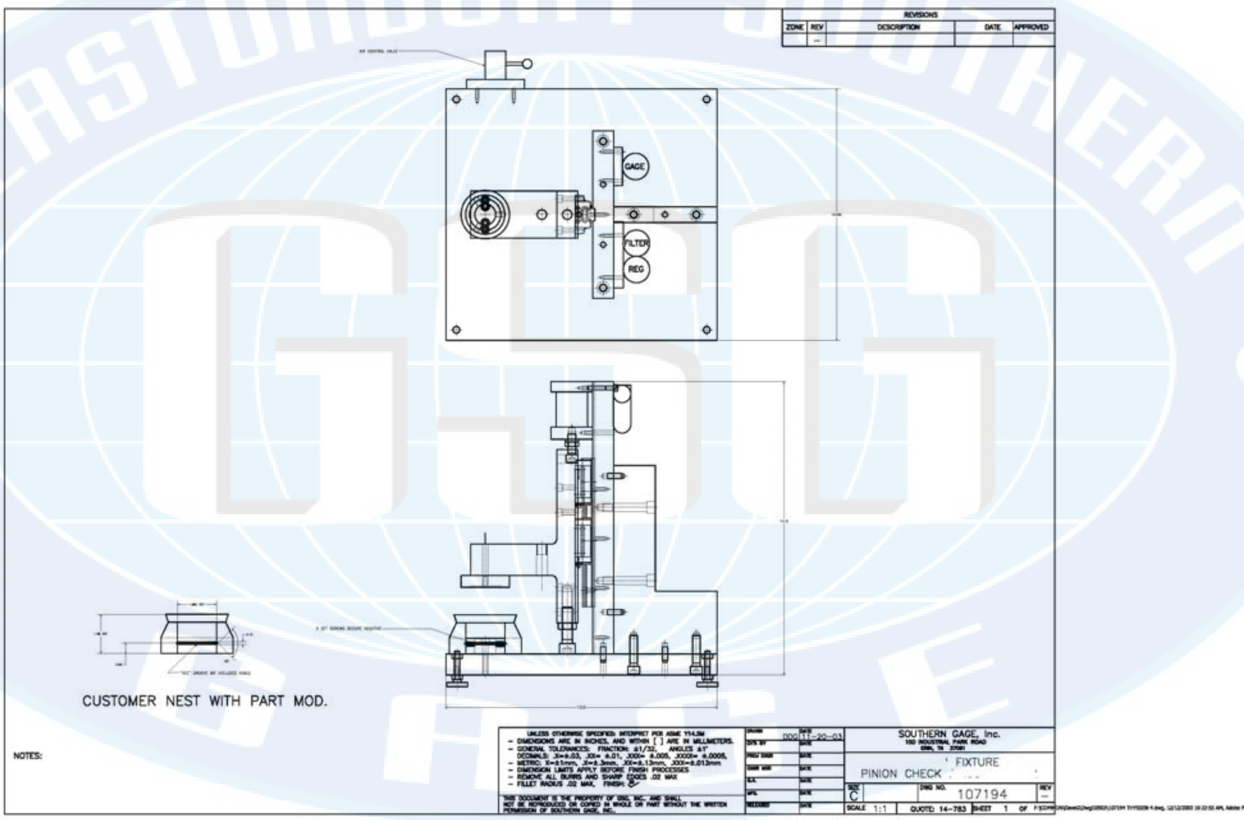
PINION GEAR SEAT HEIGHT GAGE FIXTURE

GSG designed and built the gage fixture to measure the hub gear face height. The gage incorporated a float mechanism to find the true center line of the hub height, the Z axis was air activated by the operator via a switch. These gage shave been built measuring not only the face height but also the bore and hub diameters at the same time.



PRODUCTS AND SERVICES

(Click on the links below for the document)

GSG PRODUCTS AND CAPABILITIES

CYLINDRICAL AND SPECIAL GAGING CAPABILITIES

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Glastonbury Southern Gage Products & Capabilities

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Services

- Calibration and Certification of fixed limit gages
- Premium / Redline Service – Expedited Delivery
- Technical assistance
- Thread characteristics
- Reference standards - personnel on ANSI committees
- Custom gages
- Special designed gages
- Gage Calibration Seminars at Erin, TN
- Seminars at customer's facilities
- Fixed limit gage calibration
- Thread gages & gaging
- Comparator gages & gaging

Gage Stock

THREAD WORK PLUG GAGES
  Taperlock, Trilock, & Reversible
THREAD SET PLUG GAGES
  Truncated & Full Form
THREAD RING GAGES
  AGD & Southern Style
PIPE RING & PLUG GAGES
  NPT, NPTF, & ANPT
FLEX PLUGS
SNAP GAGES
  Model C, MC, & A
VARIABLE THREAD GAGES
  Tri-Rolls, ITC's & STC's
ZERO SPINDLE FIXTURES & COMPONENTS

Gage / Product Manufacturing Capabilities

Threads
  Plugs Diameters: Min. #00 (.047", 1.2MM) Max. 14 3/4", 375.0MM
    Threads Per Inch: To 120 TPI
  Rings Diameters: Min. #0 (.060"), 1.52MM Max. 14 1/2", 368MM
    Length: Max.: 6 1/2"
    Threads Per Inch: 1/2 TO 105 TPI
Cylindricals
  Internal Diameters: .040" – 22.5"
  External Diameters: .010" – 22.0"
  Lengths: .010" – 36.0"
  External Tapered Diameters: .010" – 12.0"
  Internal Tapered Diameters: .160" – 12.0"

Surveillance / Calibration Masters

Micrometer Masters
Caliper Masters
Depth Micrometer Masters
Geometric Chek
CMM Masters - QuikChek
Z Axis Chek
Cam, Crankshaft, Brake Masters
Special Masters

Cylindrical / Special Gaging Capabilities

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ID and OD to 32 inches
Grinding to .000050 inch
Rock Grinding

Wire EDM
ID/OD & Flat Lapping

Design & Build Fixtures
Jig Grinding
Laser Marking

Special Gaging Capabilities

Square & Hex Plug Gages
Concentricity Gages
Flush Pin Gages
Hole Location Gages
Alignment Gages
Template Gages

Brake Drum Masters
Piston Masters
Crankshaft Masters
Rotor Masters
Connecting Rod Masters
Cam Shaft Masters

Special Thread Profiles

Acme
Stub Acme
British
Buttress
Whitworth
Assemetric

Multiple Starts
Special Angles
JIS
DIN
Concentricity
Special Lengths

Thread Gage Manufacturing Capabilities

Thread Plugs

Styles

- Reversible #00 ~ 3/4"
- Taperlock #00 ~ 1 1/2"
- Trilock 3/4"~8.010"
- Annular > 8.010"

Diameters: Minimum #00 (.047") (1.2MM)
Maximum 14 3/4" (375MM)
Length: Maximum 30" (762MM), Depending on Tolerance
Threads per inch: 1/4 to 120 (.21MM), Depending on the Diameter
Convolute: 32 TPI and coarser if larger than #6 (.138") (3.5MM)
Chip / Dirt Groove: Larger than #8 (.164) (4MM)
3 ~ 4 Threads
Full length upon request
Depth Steps: Upon request

Limitations: Flank angles must be greater than 2 1/2 degrees.

Thread Rings

Styles

- AGD American Gage Design
- Southern Style

Diameters: Minimum #0 (.060") (1.5MM)
Maximum 14 1/2" (368MM)
Length: Maximum 6 1/2" (165MM)
Threads per inch: 1/2 ~ 102 (.25MM) Depending on the Diameter
Convolute: 20 TPI (1.25MM) and coarser if 3/8" (9.5MM) diameter or larger
Available for #10 (.190") (5MM) and larger
Limitations: Flank angle must be greater than 5 degrees.

MISCELLANEOUS INFORMATION

(Click on the links below for the document)

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COEFFICIENT OF EXPANSION

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52100 STEEL: .0000064"(6.4µ")/INCH/DEGREE F
11.5µ"/INCH/DEGREE C
.292µm/INCH/DEGREE C
.0115µm/mm/DEGREE C

TOOL STEEL: .0000063"(6.3µ")/INCH/DEGREE F
11.3µ"/INCH/DEGREE C
.287µm/INCH/DEGREE C
.0113µm/mm/DEGREE C

CERAMIC: .00000555"(5.55µ)/INCH/DEGREE F
(10.0µ)/INCH/DEGREE C
.254µm/INCH/DEGREE C
.0100µm/mm/DEGREE C

CHROMIUM CARBIDE: .0000047"(4.7µ)/INCH/DEGREE F
(8.5µ)/INCH/DEGREE C
.216µm/INCH/DEGREE C
.0085µm/mm/DEGREE C

CARBIDE: .0000042"(4.2µ)/INCH/DEGREE F
(7.6µ)/INCH/DEGREE C
.193µm/INCH/DEGREE C
.0076µm/mm/DEGREE C

TUNGSTEN CARBIDE: .00000175"(1.75µ)/INCH/DEGREE F
(3.2µ)/INCH/DEGREE C
.081µm/INCH/DEGREE C
.0032µm/mm/DEGREE C

$\Delta L = C\ L\ \Delta t$

Δ Change
L Length
C Coefficient of Expansion
t Temperature

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Proper handling and storage of gages

Gages are an important part of your overall manufacturing process.

- Gages should always be stored in a secure place, protected from possible misuse or damage.
- When stored, use an oil-wax based dip seal to protect the gages from rust or damage.
- Gages should be handled with care and not forced into or on the part being checked.
- Any alterations should be done by gage making professionals due to material displacement and the need for re-calibrations after the alteration is complete.
- When shipping gages, they should be packaged separately with sufficient packaging material to prevent rust or damage by freight carriers.

Properly handled and stored gages will result in longer gage life and consistent product quality.

GLASTONBURY GAGE — Commitment to Quality

Glastonbury Southern Gage
87 Upton Road
Colchester, CT 06415

1-800-251-4243

Glastonbury Southern Gage
46 Industrial Park Road
Erin, TN 37061

Order Placement Requirements
(Back to Contents)

Generic information needed

- Bill to Address PO #
- Ship to Address PO #
- Ship via. (ups, acct #'s)
- Contact Name,
- Phone #, Fax #
- Quote # if previously quoted
- Certs required
- Special Instructions
- Marking Instructions

Thread Plug

- Work or Set
- Class of fit (2B, 3B or 6H work), (2A, 3A or 6g set)
- Pitch Dia. if supplied by end user
- Go or Nogo
- EDP # if supplied by end user
- Handle (Single End or Double End)
- Cert required

Thread Ring

- AGD or Southern Style (AGD will be supplied if not noted SS)
- Class of fit (2A, 3A or 6g if metric)
- Pitch Diameter if supplied by end user
- Go or Nogo
- EDP # if supplied by end user
- Set & Sealed
- Cert required

Cylindrical Plug & Ring Gages

- Exact Size
- Go, Nogo, Master, Min, Max
- Class XXX, XX, X, Y, Z
- Steel, Chrome, Carbide
- Handles/holders
- Cert required

Pipe Plug

- L1, L3 or 6 step
- Handle
- EDP # if supplied by end user
- Cert required

Pipe Ring

- L1, L2 or 6 step
- EDP # if supplied by end user
- Cert required

Snap Gage

- Size (Go /Nogo)
- Frame #
- Set and Sealed
- Cert required

Flex Plug

- Size or EDP#

Tri-Roll / ITC/ Zero Spindle

- EDP #
- Other than Stock Contact Factory

Frequently Asked Questions

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Are there quantity price breaks on stock items?	No. Stock items are manufactured in large quantities based on yearly sales. The "price break" is already in the stock price list.
What's the difference in Steel, Chrome and Carbide?	Gages are manufactured from **steel** and hardened to 60 - 62 Rc, unless specified otherwise by the customer. **Chrome** is a plating process that increases the hardness/wearablity and protects the gage from corrosion. **Carbide** is a solid carbon, sintered metal with a harder wear surface than steel and chrome with a comparable hardness of 79 - 81 Rc, but it is also brittle.
What is the difference between Adjustable Thread Rings and Solid Thread Rings?	Adjustable Thread Rings (working gages) are as the name implies, adjustable. As the ring gage is used it will wear outside the allowable tolerance but can be re-adjusted back into tolerance increasing its wear life. In the US, Solid Thread Rings are usually master rings used for setting Internal Thread comparators. Outside the US, the standard design of working gages is a solid ring. The adjustable thread ring is an American design.
What is A2LA?	A2LA is ***The American Association for Laboratory Accreditation*.** A2LA is recognized throughout the world as a registrar for laboratories. GSG is one of very few gage manufacturers that have this level of accreditation for our laboratories.
What are "Part Type Masters"?	Part Type Masters are used to set up gaging systems typically in a manufacturing line. Due to GSG's unique capability to manufacture part masters with very close, gage-like tolerances, we have developed this market to serve gage system manufacturers. Typical masters such as brake drums, rotors, connecting rods, crank shafts, pistons of all sizes, etc., are furnished to the auto industry, but many other industries can improve their processes by using part masters.

What is API?	API is the American Petroleum Institute. GSG is licensed to produce and calibrate API gages for the oil drilling industry and their suppliers to API standards: Spec 5B - Casing, Tubing & Line Pipe Threads Spec 7 - Rotary Drill Stem Elements Spec 11B - Sucker Rod
What is Helical Coil (STI)?	Helical Coil plug gages are used to check threaded holes prior to inserting a **S**crew **T**hread **I**nsert (STI).

CYLINDRICAL GAGING

(Click on the links below for the document)

Cylindrical Plug Gage Designs

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Cylindrical plug gages come in different designs based on size and application. The following is a discussion of the different designs.

Taperlock Design

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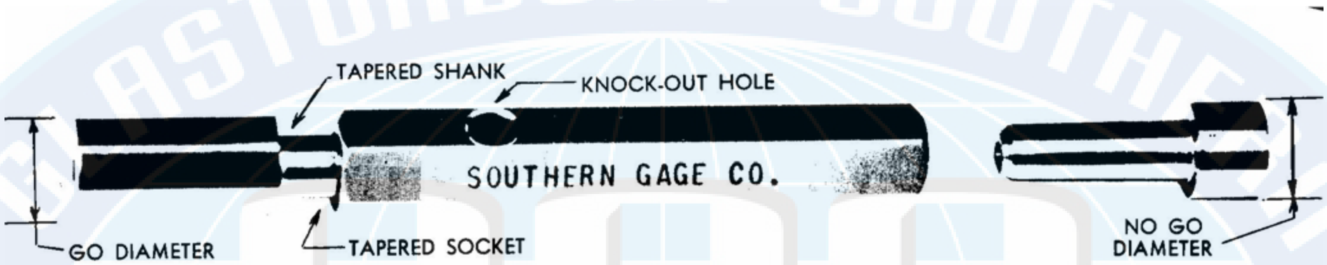
The taperlock gage is so-called because of the tapered shank, which locks into the tapered hole in the end of the handle. It is the time honored standard of the American Gage Design Committee, for gages up to 1 ½ inches in diameter.



There is an advantage in the fact that these gages have the size and tolerance marked on the shank of the members. If or when they are removed from the handles there is no confusion as to what they are. As a further aid in identification, the Go and NoGo members have a different length of gaging surface. It is permissible to make the NoGo gage shorter because it is not supposed to enter the part.

Progressive Design

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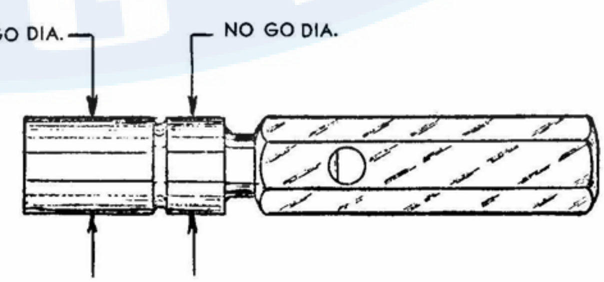
In some special cases, a little gaging time can be saved by putting the Go and NoGo diameters on a single gage member. A progressive plug, for example, is suitable for checking a short hole, which is open at both ends. Obviously, the hole cannot be deeper than the Go section of the plug.



Progressive style gages are usually in the taperlock style, but any of the designs can be made progressive.

Reversible Design

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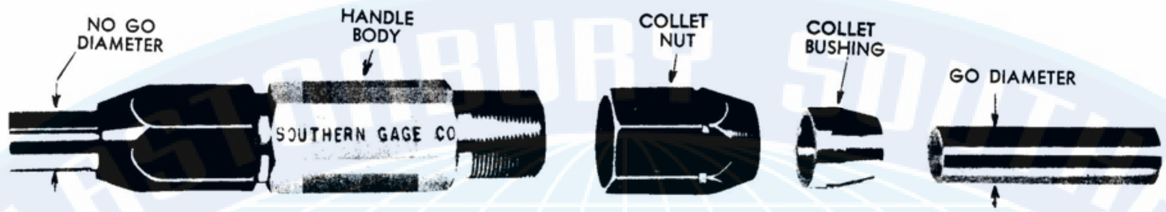
Now, let us look at the alternate design for cylindrical plug gages. The reversible plug gage was more recently introduced and standardized, after it became possible to reach the necessary precision with centerless grinding and lapping techniques. It has the advantage that it can be reversed and used at the opposite end when one end becomes worn and goes out of tolerance.



The gaging members are simple pins that can be removed from the handle by loosening the collet nuts at the ends. Larger gage members can be identified by marking the size and tolerance on the ends. When the gage is too small to permit this, it is not possible to distinguish between the Go and NoGo members without resorting to measuring instruments. The collet nuts at the ends of the handle are different colors – green for Go and red for NoGo. This traffic light system is often used in attribute gaging.

Trilock Design

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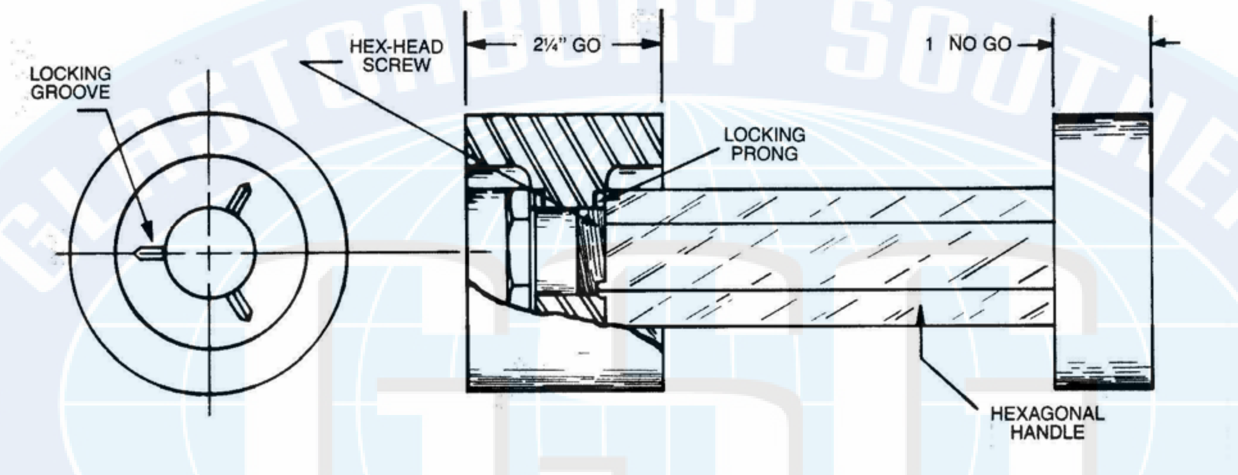
The taperlock and pin (reversible) type designs are not well suited for large, heavy gages. The trilock design has been found best suited for gages between 1 ½ and 8 inches in diameter. The trilock feature is the source for the name of this design. The handle has three prongs on the ends, which fit into three grooves equally spaced around the central hole of the gage members. A bolt holds the member to the handle and the trilock grooves and prongs stabilize the member.



Like the pin (reversible) type, trilocks are reversible, since either face can be locked to the handle. Thus, if the reversibility feature, allowing double the use, is important to the user, he can order reversible gages for all size ranges.

Military standards, which military contractors are generally required to follow, call for pin type reversible gages from the smallest sizes up to .510 inches and for taperlocks from .510 to 1.510 inches. Trilocks are recommended for the sizes from 1.510 to 8.010 inches.

CYLINDRICAL GAGE TOLERANCE

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The tolerance of the gage is based on the tolerance of the part it is to inspect. The rule of thumb is to use a maximum of 10% of the part tolerance for the gages. This allows the part manufacturer to use 90% of the tolerance for their manufacturing window, as the gages are made within the part tolerance to assure quality. The 10% is split between the Go and NoGo gages.

are held plus; NoGo cylindrical plugs, and Go cylindrical rings are held minus.

Straightness, taper, and out-of-roundness must be held within 1/2 of the diameter tolerance. Tolerances for Cylindrical Plug

For example: If the product has a range of .499 - .500 diameter, 10% would be .0001, which split becomes .00005 (50 millionths). Looking at the tolerance chart you would use class X gages, or better.

The tolerances given in this chart are to be applied to the diameter of the gage. Go cylindrical plugs, and NoGo cylindrical rings

Gages used to check the minor diameter of internal threads, and Cylindrical Ring Gages used to check the major diameter of external threads, are specified in the thread standard as Class Z.

GAGE TOLERANCE FOR PLAIN CYLINDRICAL GAGES

SIZE RANGE		TOLERANCE IN INCHES					
Above	To	XXX	XX	X	Y	Z	ZZ
0.020	0.825	.000010	.000020	.000040	.000070	.00010	.000200
0.825	1.510	.000015	.000030	.000060	.000090	.000120	.000240
1.510	2.510	.000020	.000040	.000080	.000120	.000160	.000320
2.510	4.510	.000025	.000050	.000100	.000150	.000200	.000400
4.510	6.510	.000032	.000065	.000130	.000190	.000250	.000500
6.510	9.510	.000040	.000080	.000160	.000240	.000320	.000640
9.510	12.010	.000050	.000100	.000200	.000300	.000400	.000800

Cylindrical Tapers Gages

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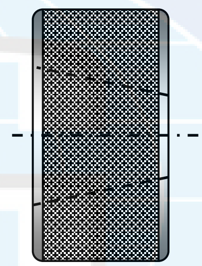
LINK TO FULL CERTIFICATION

Glastonbury Southern Gage has specialized in cylindrical taper gages for several years. It uses specially modified equipment for grinding and more importantly measuring a taper. The ANSI standard on Machine Tapers is confusing to the average user. These standards are written for the machine tool builder and tool holder manufacturer, not the gage manufacturer or the customer trying to measure machine tapers. If you order a taper ring and plug gage to the ANSI standard they will not blue to each other. The machine taper ID is made with an decreasing taper, while the tool holder's OD is made with an increasing taper. The proper ordering procedure is to order a PLUG to the standard and a "check ring" to check the plug for wear, and vise versa the RING to the plug.

The standard machine tapers are listed below.



NATIONAL MACHINE TAPERS								
Taper #	Large End	Small End	Length		Taper #	Large End	Small End	Length
5	.500	.2995	.6875		35	1.500	.8438	2.2500
10	.625	.3698	.8750		40	1.750	1.0026	2.5625
15	.750	.4401	1.0625		45	2.250	1.2839	3.3125
20	.875	.4922	1.3125		50	2.750	1.5833	4.0000
25	1.000	.5443	1.5625		55	3.500	1.9870	5.1875
30	1.250	.7031	1.8750		60	4.250	2.3906	6.3750

JARNO TAPERS - W/O TANG .6000" TPF								
Taper #	Large End	Small End	Length		Taper #	Large End	Small End	Length
1	.125	.100	.500		11	1.375	1.100	5.50
2	.250	.200	1.00		12	1.500	1.200	6.00
3	.375	.300	1.50		13	1.625	1.300	6.50
4	.500	.400	2.00		14	1.750	1.400	7.00
5	.625	.500	2.50		15	1.875	1.500	7.50
6	.750	.600	3.00		16	2.000	1.600	8.00
7	.875	.700	3.50		17	2.125	1.700	8.50
8	1.000	.800	4.00		18	2.250	1.800	9.00
9	1.125	.900	4.50		19	2.375	1.900	9.50
10	1.250	1.000	5.00		20	2.500	2.000	10.00

MORSE TAPERS				
Taper #	Large End	Small End	Length	TPF
0	.3561	.2520	2.00	.62460
1	.4750	.3690	2 1/8	.59858
2	.7000	.5720	2 9/16	.59941
3	.9380	.7780	3 3/16	.60235
4	1.2310	1.0200	4 1/16	.62326
4 1/2	1.500	1.2660	4 1/2	.62400
5	1.7480	1.4750	5 3/16	.63151
6	2.4940	2.1160	7 1/4	.62565
7	3.2700	2.7500	10	.62400

BROWN & SHARPE TAPERS				
Taper #	Large End	Small End	Length	TPF
1	.23922	.20000	15/16	.50200
2	.29968	.250000	1 3/16	.50200
3	.37525	.31250	1 1/2	.50200
4	.42060	.35000	1 11/16	.50240
5	.53880	.45000	2 1/8	.50160
6	.59960	.50000	2 3/8	.50329
7	.72010	.60000	2 7/8	.50147
8	.89870	.75000	3 9/16	.50100
9	1.07750	.90010	4 1/4	.50085
10	1.25970	1.04465	5.00	.51612
11	1.49780	1.24995	5 15/16	.50100
12	1.79680	1.50010	7 1/8	.49973
13	2.07310	1.75005	7 3/4	.50020
14	2.34380	2.00000	8 1/4	.50000
15	2.61460	2.25000	8 3/4	.50000
16	2.88540	2.50000	9 1/4	.50000
17	3.15630	2.75000	9 3/4	.50000
18	3.42710	3.00000	10 1/4	.50000

GAGE TOLERANCE FOR PLAIN CYLINDRICAL GAGES

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SIZE RANGE		TOLERANCE IN INCHES					
Above	To	XXX	XX	X	Y	Z	ZZ
0.020	0.825	.000010	.000020	.000040	.000070	.00010	.000200
0.825	1.510	.000015	.000030	.000060	.000090	.000120	.000240
1.510	2.510	.000020	.000040	.000080	.000120	.000160	.000320
2.510	4.510	.000025	.000050	.000100	.000150	.000200	.000400
4.510	6.510	.000032	.000065	.000130	.000190	.000250	.000500
6.510	9.510	.000040	.000080	.000160	.000240	.000320	.000640
9.510	12.010	.000050	.000100	.000200	.000300	.000400	.000800

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REQUEST FOR QUOTE

SPECIAL TAPERS

PLEASE FURNISH WHAT INFORMATION YOU HAVE ON YOUR SPECIAL GAGING REQUIREMENTS. MARK UP DRAWING(S) TO SHOW ANY ADDITIONAL CHARACTERISTICS.

FAX TO: 860-537-7345

FROM:

NAME ____________________

COMPANY ____________________

PHONE ____________________

FAX ____________________

TAPER RING GAGE

∅ AT SMALL END / TOL. ________ / ________

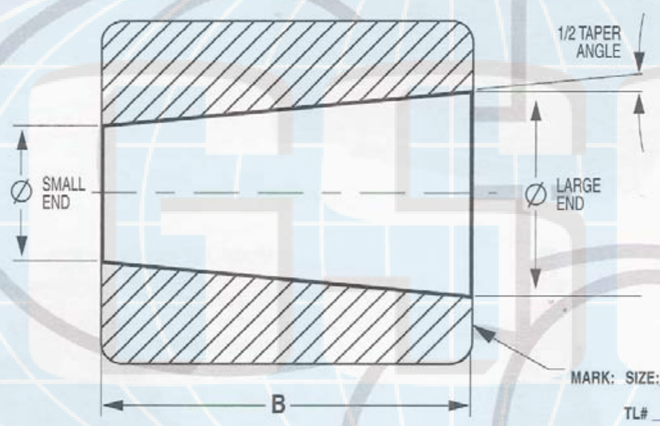
∅ AT LARGE END / TOL. ________ / ________

B OVERALL LENGTH OF TAPER / TOL. ________ / ________

TAPER PER FT. ________

TAPER PER IN. ________ OR ________ 1/2 TAPER ANGLE

TAPER / TOL. ________ / ________ IN. / IN. (IF DIFFERENT)



MARK: SIZE: ________

TL# ________

NOTE:
Special tapers are held to **±.0001"** at large end dia., small end dia. and overall length are reference only to **±.000050"** of. taper. Please specify if your requirements are different.

TAPER PLUG GAGE

∅ AT SMALL END / TOL. ________ / ________

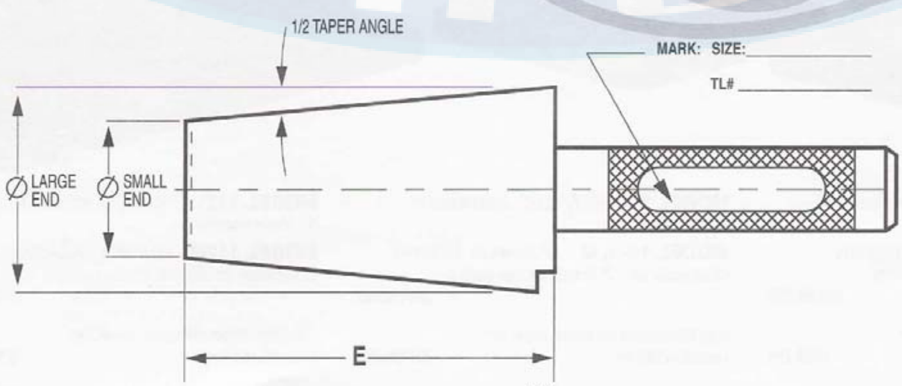
∅ AT LARGE END / TOL. ________ / ________

E OVERALL LENGTH OF TAPER / TOL. ________ / ________

TAPER PER FT. ________

TAPER PER IN. ________ OR ________ 1/2 TAPER ANGLE

TAPER / TOL ________ / ________ IN. / IN. (IF DIFFERENT)



Cylindrical Master Disc Gages

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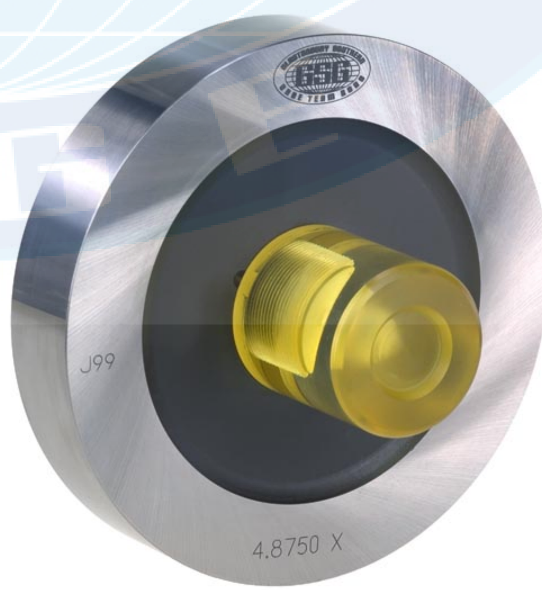
Cylindrical Master Discs are used to set measuring instruments that check the part. Unlike Plug gages that check the hole in the part.
Master disc are specified some times as Setting discs. Master discs are specified as **MASTER** with bilateral tolerance, **MIN** with unilateral plus tolerance, **MAX** with unilateral minus tolerance, **MEAN** with bilateral tolerance. Some but few manufacturers of air and electronic gaging specify their MIN & MAX setting discs with bilateral tolerance. This is not the normal practice but be safe and ask if you are not sure.

Cylindrical Master Disc Gage Designs

Cylindrical master disc gages come in different designs based on size.
The designs for cylindrical disc gages are described in ASME standard B47.1. Discs below 1.510 are manufactured with nibs on both ends that are used in manufacturing and later used to glue on an insulating grip. Like the example below.

The picture above is a style 2 which has a min and max diameter on the same gage.

Above 1.510 cylindrical discs are manufactured with a through hole as pictured below. Larger sizes are manufactured with lightning holes. The removal of excess material from the web diameter lightens up the weight for easier use by the operator. GSG will always manufacture master discs larger than 8.010 using the trilock style not the annular style described in B47.1



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TAPER CALIBRATION CERTIFICATE

Cert #:
GG #:
Date:

Customer:	Customer P.O. #:

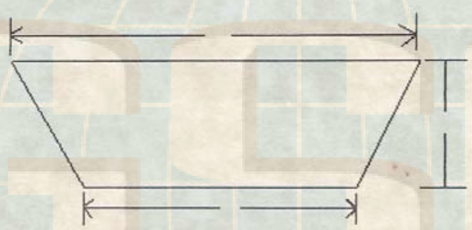
Description: Taper Plug Gage   B/P#   S/N

This item is certified to be In tolerance

Inspection Procedure: GIT-62	NIST Ref.: 821/261181	Dated: 02/02/99
Blocks:	Temperature: 68° Humidity: 45%	
Inspection Equipment: Federal 136B-3	Applicable Standard: ANSI/B5.10	

This certificate applies only to the item and item dimensions listed. All dimensions listed are both 'as found' and 'as left' unless otherwise noted. This certificate may not be reproduced except in full without written permission from GSG. The calibration system supporting this certificate complies with ISO Guide 17025, ANSI Z540-1, & ISO 10012-1. The user's calibration source for NIST traceability is GSG. The user must determine the re-calibration interval for this item. Measurement Uncertainty has been determined to be within .00001 Microinches

All results stated from the prescribed are given in Microinches



	NOMINAL	ACTUAL		NOMINAL	ACTUAL
Taper Per Inch			**Large End Diameter**		
Taper Per Foot			**Small End Diameter**		
"A" Angle			**"L" Length**		
Included Angle			**Gage Line**		
Steps					

All dimensions not listed have been found to be within all B/P or specified requirements.

Reported by: ____________________

Inspector's name
Calibration Technician

Cylindrical Ring Gages

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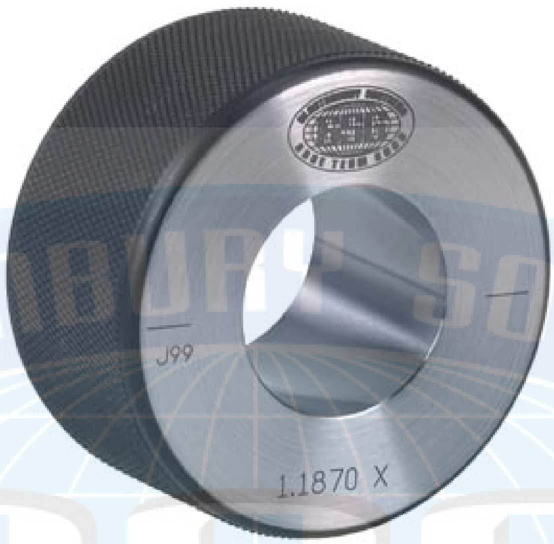
Cylindrical Ring Gages have several uses unlike cylindrical plug gages. Plug gages check the hole in the part. Cylindrical ring gages check the outside diameter of a part but also can be used to set an instrument , air or electronic.

When used to check the part directly the rings are specified as **GO** or **NOGO**. When used to set an instrument that checks the part they are referred to as Setting Rings. Setting rings are specified as **MASTER** with bilateral tolerance, **MIN** with unilateral plus tolerance, **MAX** with unilateral minus tolerance, **MEAN** with bilateral tolerance. Some but few manufacturers of air and electronic gaging specify their MIN & MAX setting rings with bilateral tolerance. This is not the normal practice but be safe and ask if you are not sure.

Cylindrical Ring Gage Designs

Cylindrical ring gages come in different designs based on size.

The designs for cylindrical ring gages are described in ASME standard B47.1. Rings below 1.510 are manufactured without a flange outer diameter. Like the example below.



Above 1.510 cylindrical rings are manufactured with a flanged diameter as pictured below. The removal of excess material from the outside diameter lightens up the weight for easier use by the operator.

Pictured below is a CARBIDE ring. The insert is solid carbide with the outside jacketed with steel. A solid carbide ring would be heavy and accessible to damage on the outside do to carbide being hard but brittle.

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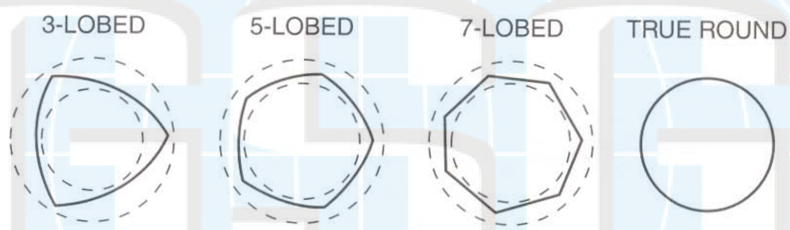
QUESTION: WHY DO GLASTONBURY REVERSIBLE PLUG GAGES LAST LONGER?

ANSWER: ROUNDNESS

The inherent problem of centerless grinding is the three, five, or seven point lobing which occurs on the pin gage. Most gage manufacturers simply roll lap the pin for size and finish. The appearance is good but the lobing is still there. GLASTONBURY GAGE *ring laps every pin* which removes the lobing and produces a truly round pin which typically far exceeds roundness specifications.



When in use, contacting the piece part at 360° rather than 3, 5, or 7 points gives you, the user, gage longevity and confidence in your inspection process.

ANSWER: STRAIGHTNESS AND TAPER

The GLASTONBURY GAGE process also includes *spider lapping.* This process is lapping of the pins between two flat plates which produces straightness and taper typically far exceeding gage specifications. Another reason to buy GLASTONBURY GAGE — Quality — Value.

SCREW THREADS / THREAD GAGING

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Back to Main Contents

Fixed Limit Thread Gaging

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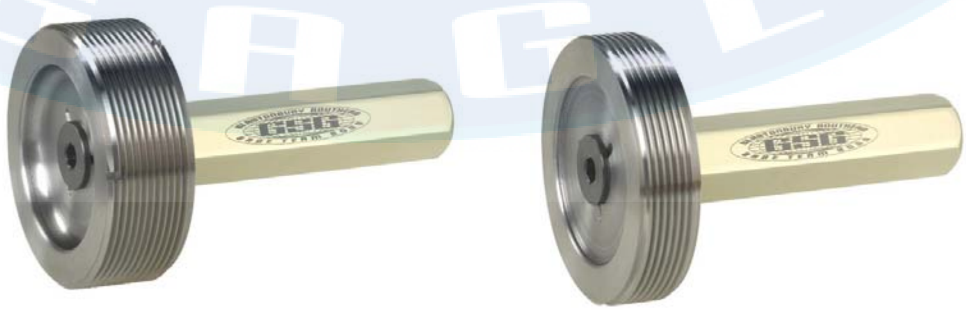
Fixed limit gaging means a fixed gage with no moving parts or indicators. Lets now discuss plug gaging to check a tapped hole. Plug gages come in different styles based on size (diameter) the same as cylindrical gages.
A “GO” gage checks the minimum major diameter and the minimum pitch diameter size in the part, the “NOGO” checks for the hole not to exceed the maximum pitch diameter size in the part.

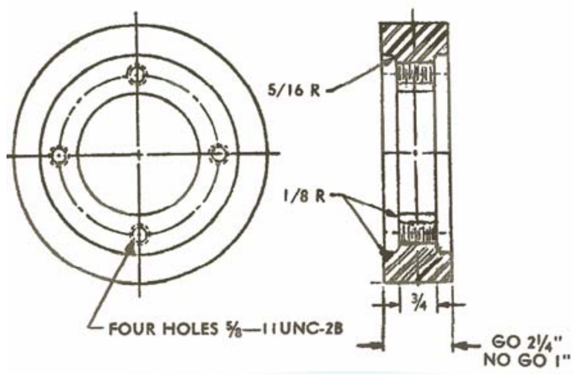
Chip grooves are provided on all Go members on sizes #10 (.190) , M5 and larger. Chip grooves, also called dirt grooves, are located at the entering end of the go gage. They assist in catching dirt and debris from the internal product thread. Thread plug gages are furnished with a class X gage tolerance unless otherwise specified.

Reversible style thread work plug gages are available up to and including ¾” (19.05mm). Reversible gages can be reversed end for end in the handle resulting in double the wear life.

Taperlock style thread work plug gages are available up to and including 1 ½” (38.1mm). Taperlocks are the most popular style in thread plug gaging.



Trilock style thread work plugs are available for ¾” (19.05mm) and larger. This gage also can be reversed on the handle resulting in a longer wear life. Gages ¾” (19.05mm) up to and including 1 ½” (38.1mm) are always assumed Taperlock design unless Trilock is specified when ordered. Shown are go and nogo on separate handles which helps in use due to the weight with large sizes.

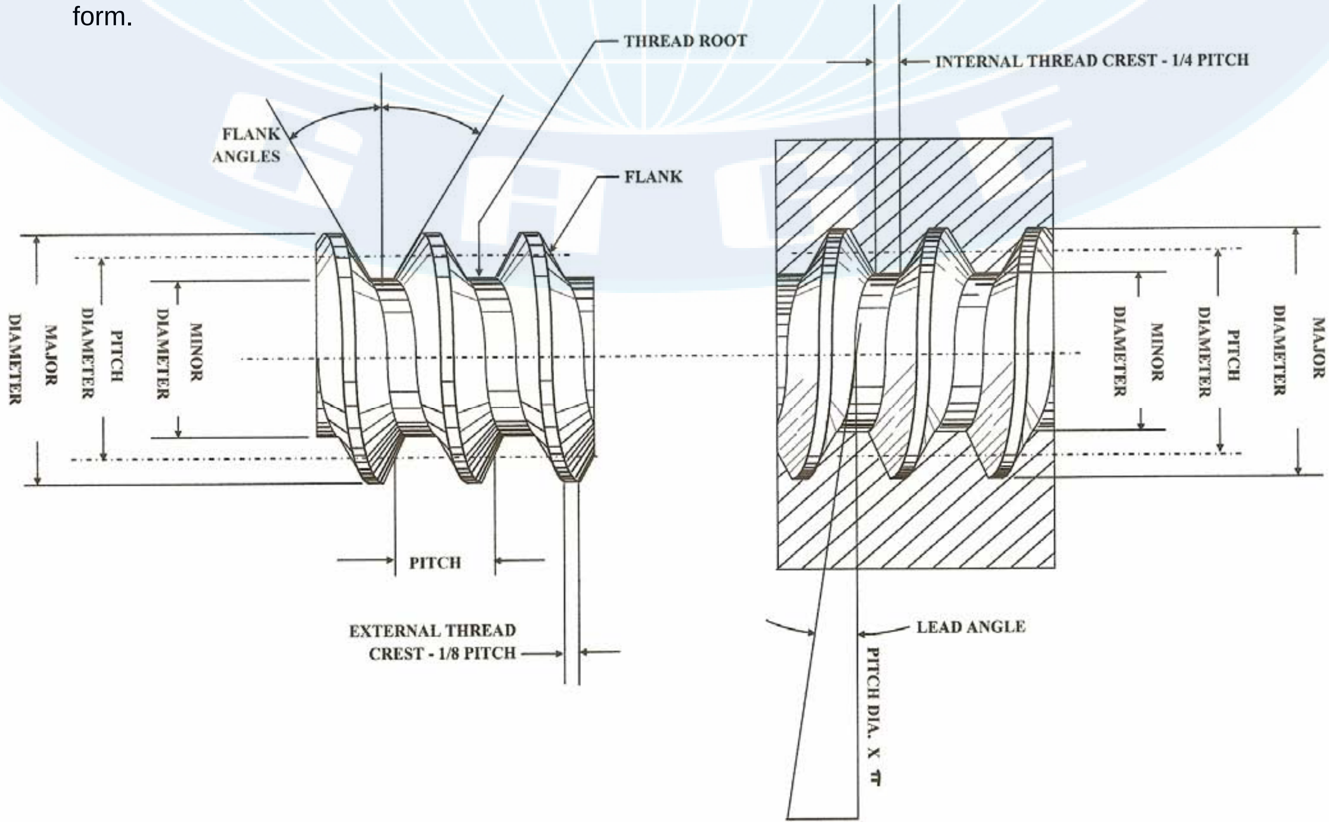


Annular style thread work plugs are available when specified for gages larger than 8.010" (203.45mm) and utilizes 2 ball handles for ease of handling. Annular design also helps to reduce weight of the larger gages.

Helical (STI) work plugs are used to gage threaded holes prior to the insertion of the "Screw Thread Insert" and they are typically Taperlock design. Screw thread inserts are used to repair a damaged thread or provide a stronger threaded assembly. Class W must be requested if desired.

Basic Screw Thread Terminology

This simplified drawing of an external and internal thread illustrates basic thread geometry. This illustration helps to visualize the critical dimensions, which must be controlled for correct thread form.



Fixed limit gaging means a fixed gage with no moving parts or indicators. Lets now discuss Thread Rings which are considered fixed gaging but has an adjustment unlike plug gages. The adjustment feature allows multiple adjustments back to an in tolerance condition which provides additional life or wear. When thread rings are adjusted they are sealed so as to not allow movement or tampering. Thread rings come in different styles AGD (American Gage Design) and SS (Southern Style). When adjustments are made the AGD style will adjust with a tri-lobe affect where the SS adjusts round.
A "GO" gage checks the maximum minor diameter and the maximum pitch diameter size of the part, the "NOGO" checks for the hole not to exceed the minimum pitch diameter size in the part.

GO NOGO
AGD (American Gage Design) style thread ring gages.

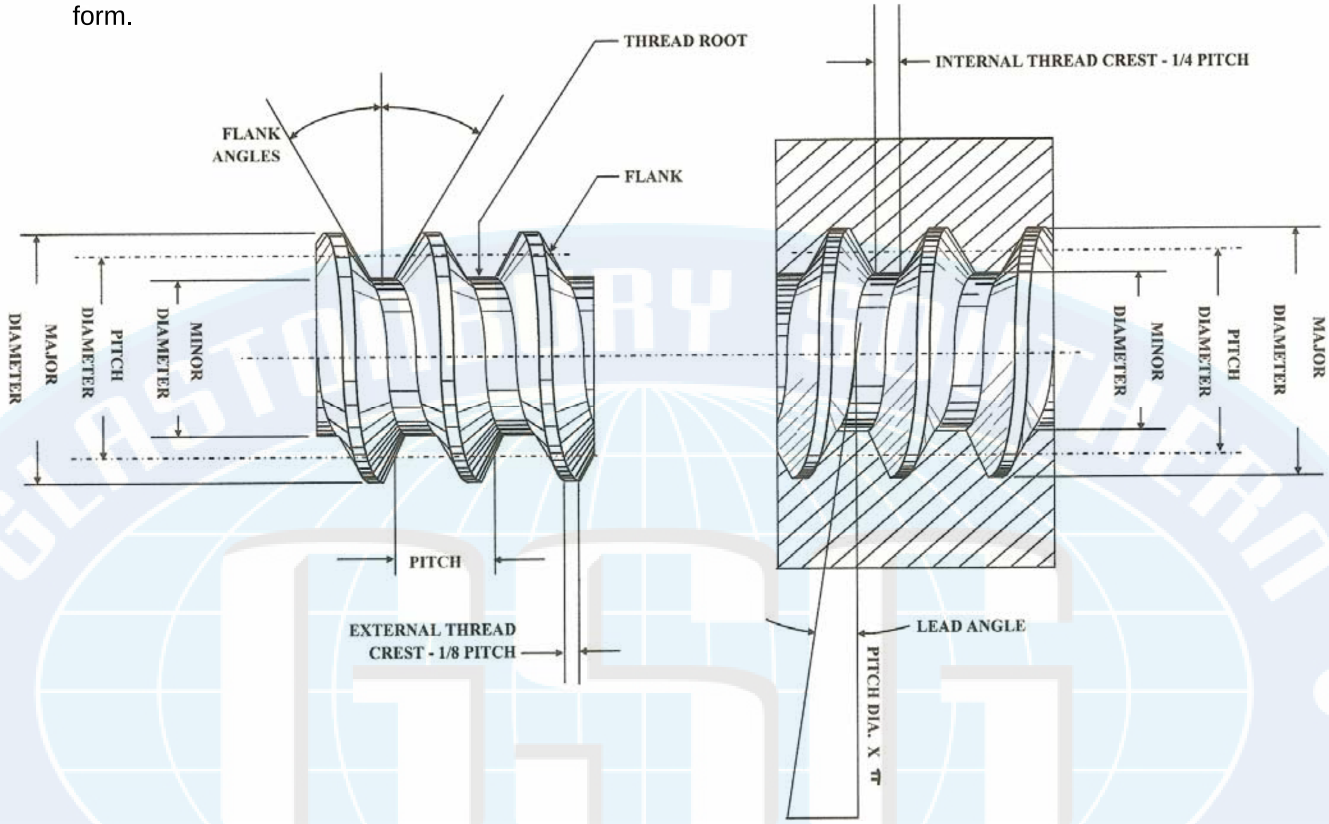
Southern style thread rings have an aluminum housing anodized green for go, red for nogo for easy identification. The aluminum housing also lessens the weight of the gage.

Pictured is a Go and NOGO Truncated (Master) Set Plug. Truncated (Master) Set Plugs are used to set thread rings for proper fit and feel. Truncated (Master) Set Plugs have a common pitch diameter the full thread length of the go or nogo section. The crest of the thread is truncated in diameter for the first half of the set plug and "full form" the remaining length. The truncated section is used to set the pitch diameter and the full form is used to detect flank angle problems or undersize major diameters in the thread rings.

Basic Screw Thread Terminology

(Back to Contents)

This simplified drawing of an external and internal thread illustrates basic thread geometry. This illustration helps to visualize the critical dimensions, which must be controlled for correct thread form.



Fixed Limit Thread Gaging

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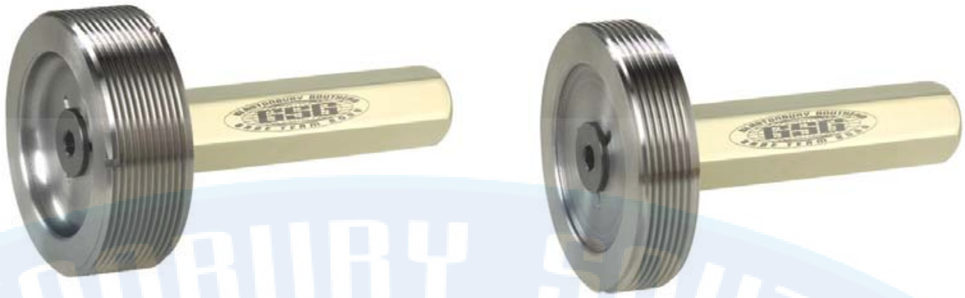

Trilock style thread work plugs are available for ¾” (19.05mm) and larger. This gage also can be reversed on the handle resulting in a longer wear life. Gages ¾” (19.05mm) up to and including 1 ½” (38.1mm) are always assumed Taperlock design unless Trilock is specified when ordered. Shown are go and nogo on separate handles which helps in use due to the weight with large sizes.

Fixed Limit Thread Gaging

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Taperlock style thread work plug gages are available up to and including 1 ½" (38.1mm). Taperlocks are the most popular style in thread plug gaging.

Fixed Limit Thread Gaging

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Thread Rings which are considered fixed gaging but has an adjustment unlike plug gages. The adjustment feature allows multiple adjustments back to an in tolerance condition which provides additional life or wear. When thread rings are adjusted they are sealed so as to not allow movement or tampering. Thread rings come in different styles AGD (American Gage Design) and SS (Southern Style). When adjustments are made the AGD style will adjust with a tri-lobe affect where the SS adjusts round.

Southern style thread rings have an aluminum housing anodized green for go, red for nogo for easy identification. The aluminum housing also lessens the weight of the gage.

Fixed Limit Thread Gaging

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Fixed limit gaging means a fixed gage with no moving parts or indicators. Lets now discuss Thread Rings which are considered fixed gaging but has an adjustment unlike plug gages. The adjustment feature allows multiple adjustments back to an in tolerance condition which provides additional life or wear. When thread rings are adjusted they are sealed so as to not allow movement or tampering. Thread rings come in different styles AGD (American Gage Design) and SS (Southern Style). When adjustments are made the AGD style will adjust with a tri-lobe affect where the SS adjusts round.

A “GO” gage checks the maximum minor diameter and the maximum pitch diameter size of the part, the “NOGO” checks for the hole not to exceed the minimum pitch diameter size in the part.

GO NOGO

AGD (American Gage Design) style thread ring gages.

INSPECTION / SETTING PROCEDURE

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AGD THREAD RING

1. CLEAN

Thoroughly clean the threads with a bristle brush and solvent, wipe clean with isopropyl alcohol and clean with kim wipe. Visually inspect the thread ring for nicks, dings or foreign material buildup.

2. INSPECT ID

Using a calibrated tapered pin, set of parallels, bore gage or other accurate method inspect the ID (minor diameter) of ring gage and record the size.

3. INSPECT PD

a. Lubricate the setting master plug with a thin film of light viscosity oil before inserting into the ring gage.

b. Turn the ring onto the setting plug 1 1/2 to 2 threads at the front. If ring will not go onto setting plug go to operation 4. There should be some resistance or drag even at this short engagement. To test for taper or bellmouth, place the ring on its face on a workbench and test for shake or looseness with the setting plug, being very careful not to damage the end threads.

c. Turn ring further onto the truncated section, remembering the feel at the 1 1/2 to 2 thread engagement. The drag should remain approximately the same although it may be slightly greater at full engagement due to more flank contact.

d. Remove the ring from the setting plug and repeat operations 3b & 3c on the opposite side of the thread ring gage.

e. The fit should be approximately the same on both sides of the ring to insure proper straightness. Remember if a setting plug is manufactured or worn smaller at the front, it will falsely indicate taper or bellmouth in the ring gage. Setting plugs must be reasonably straight.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

g. If at this point nothing is found which indicates a problem skip to operation 7.

4. SET RING

NOTE: If ring will go onto setting plug skip to operation 4c.

a. Turn the locking screw counter-clockwise until it is loosened.

b. Turn the adjusting screw clockwise, this will open the ring to a larger pitch diameter than the setting plug.

c. Turn the ring gage onto the setting plug truncated section so that approximately one thread of setting plug extends beyond the ring. (This will promote uniform wear over the entire thread length of the setting plug.)

d. If it has not already been done, turn the locking screw counter-clockwise until it is loosened. Turn the adjusting screw counter-clockwise to tighten or clockwise to loosen until there is a slight drag between the ring and the setting plug.

e. Turn the locking screw clockwise until tight. This locks the adjusting screw so that the size of the ring gage remains fixed. There should be noticeable drag between the ring and setting plug.

NOTE: Operations 5c – 5e may need to be repeated more than once to obtain the proper drag or feel.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

5. INSPECT PD

Repeat section 3a – 3f. If at this point nothing is found which indicates a problem continue to operation 6.

6. INSPECT ID

Using a calibrated tapered pin, set of parallels, or bore gage inspect the ID (minor diameter) of ring gage.

NOTE: If an adjustment was necessary to establish the proper feel on the setting plug use the following formula to obtain the as found pitch diameter. (Setting plug pitch diameter) plus (ID size before adjustment)minus (ID size after adjustment.)

7. SEAL

Cover the adjusting and locking screws with sealing wax to prevent unauthorized tampering with the setting of the ring gage.

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Basic Thread Form Terms

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The following basic terms are necessary to understand threads of any form. The sketch illustrates each term. A listing of more thread terms is included in a glossary at the end.

CREST: The top of the thread form. The major diameter of an external thread, or the minor diameter of an internal thread.

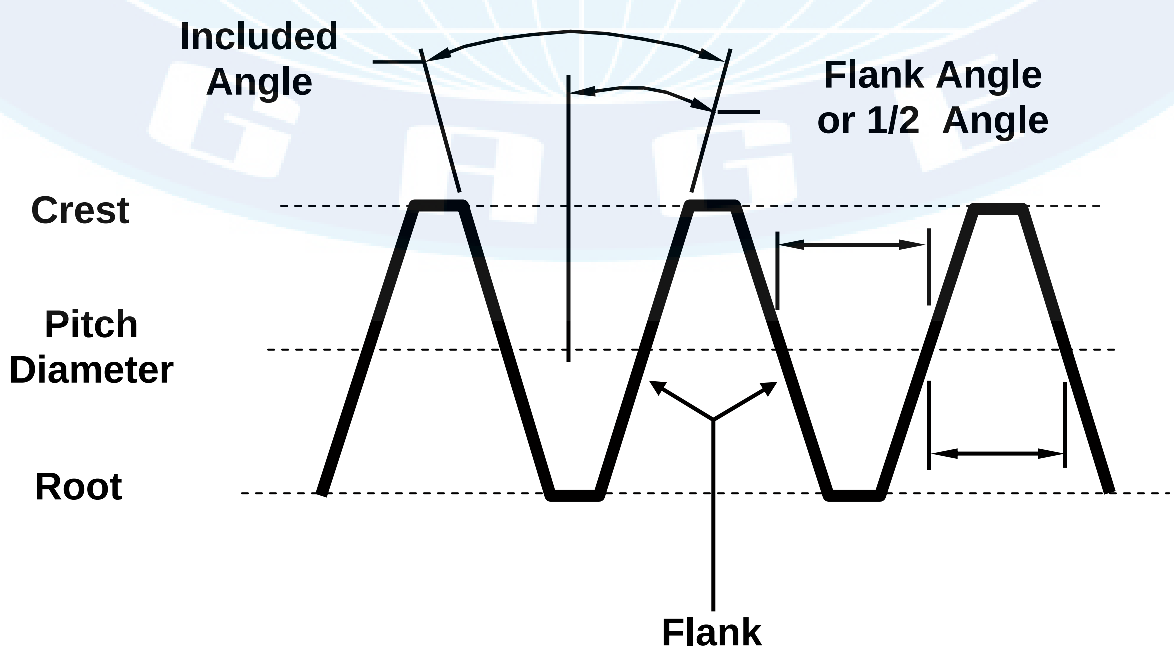
ROOT: The bottom of the thread form. The major diameter of an internal thread and the minor diameter of an external thread.

PITCH DIAMETER: The theoretical diametrical plane, which passes through a thread at the point where the width of the thread tooth and groove are equal.

FLANKS: The sides of the thread form or groove, connecting the crest and the root.

FLANK ANGLE: The angle between the flank and a line perpendicular to the axis of the thread. Also referred to as half angle or lead angle. Some exceptions to this definition will be encountered, such as tapered thread flank angles measured perpendicular to the taper, and should be noted.

INCLUDED ANGLE: Total of the two flank angles of a thread form.



INTERNAL THREAD BASICS

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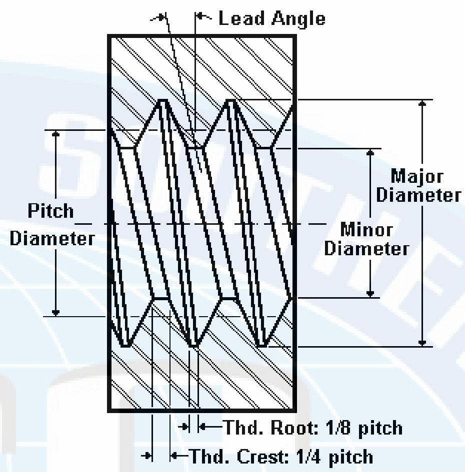
Figure #1 Internal Thread Basics



MAJOR DIAMETER - ROOT:

Must clear the major diameter of the mating external thread part.

MINOR DIAMETER - CREST:

Controls the strength or shear of the thread.

PITCH DIAMETER:

Controls the fit of the mating parts, looseness & tightness.

GO THREAD PLUG GAGES

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Plus tolerance on OD (Outer or Major Diameter), & PD (Pitch Diameter)

Functional check; checks minimum pitch diameter, minimum major diameter, flank angles, and lead.

Engages for full length of thread free and easy

NOGO, NOTGO, HI THREAD PLUG GAGES

(Back to Contents)

Minus tolerance on OD (Major Diameter), & PD (Pitch Diameter)

Checks one feature only: maximum functional pitch diameter

Engagement

Inch: Acceptable when gage does not enter product more than three complete turns. Thin or soft material, or small number of threads may require altering three-turn limit. Per ANSI B1.2-1983, page 13, par. 4.2.1

Metric: Acceptable when a definite drag from contact with the product material results on or before the second turn of entry. Per ANSI B1.16M-1984, page 15, par. 4.2.1

EXTERNAL THREAD BASICS

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MAJOR DIAMETER - BASIC:

All thread dimensions, internal & external are based on this dimension.

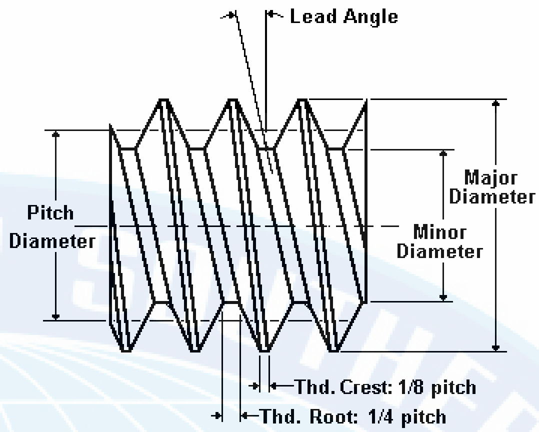
MINOR DIAMETER - ROOT:

Must clear the mating product's minor diameter.

PITCH DIAMETER:

Controls the fit of the mating parts, looseness & tightness.

Figure #2 External Thread Basics



GO THREAD RING GAGES

(Back to Contents)

Minus tolerance on ID (Inner or Minor Diameter) and PD (Pitch Diameter)

Functional check; checks maximum pitch diameter, maximum minor diameter, flank angles, and lead.

Engages for full length of thread free and easy

NOGO, NOTGO, LO THREAD RING GAGES

(Back to Contents)

Plus tolerance on ID (Inner or Minor Diameter) and PD (Pitch Diameter)

Checks one feature only: minimum functional pitch diameter

Engagement

Inch: Acceptable when gage does not enter product more than three complete turns. Thin or soft material, or small number of threads may require altering three-turn limit. Per ANSI B1.2-1983, page 128, par. 5.2.1

Metric: Acceptable when a definite drag from contact with the product material results on or before the second turn of entry. Per ANSI B1.16M-1984, page 75, par. 5.2.1

TPI / PITCH / LEAD

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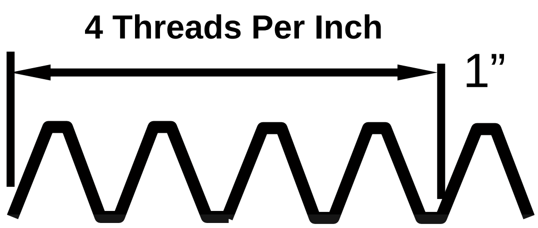
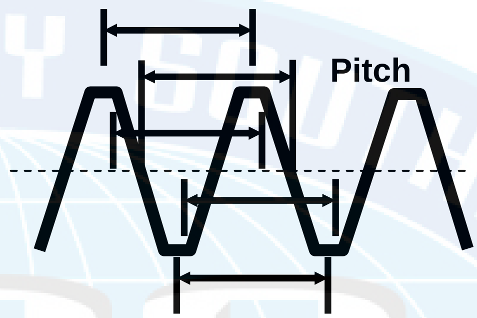
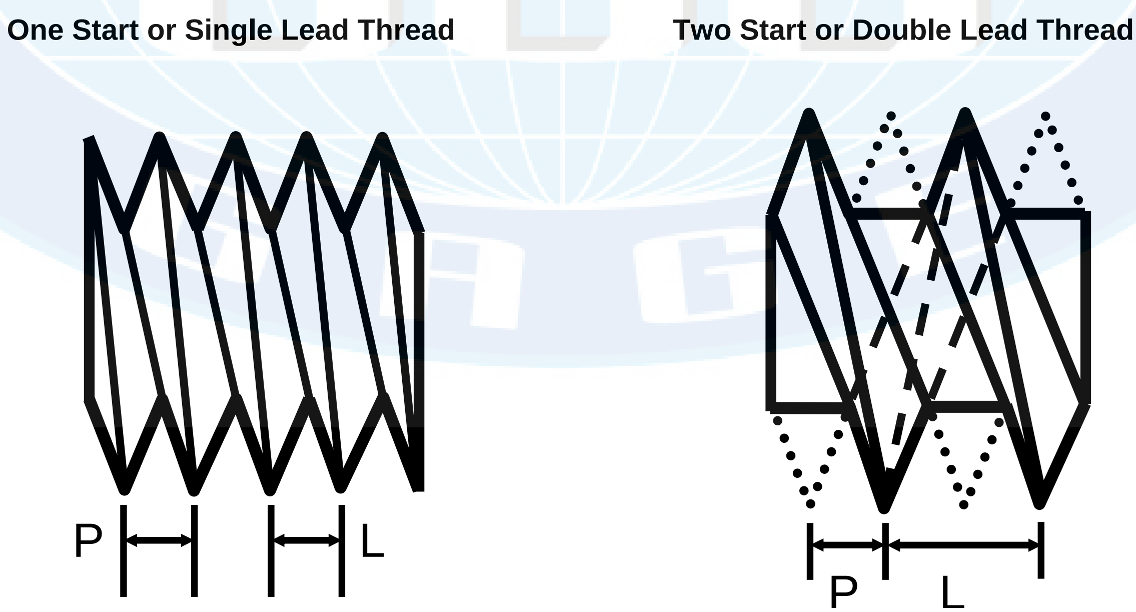
THREADS PER INCH:
The number of threads within one inch, measured along the axis of the thread.



PITCH:
The distance between corresponding points on adjacent threads.



LEAD:
The distance advanced by a thread when rotated 360 degrees on its mating thread.



Pitch x (# of Starts) = Lead

Allowance / Clearance

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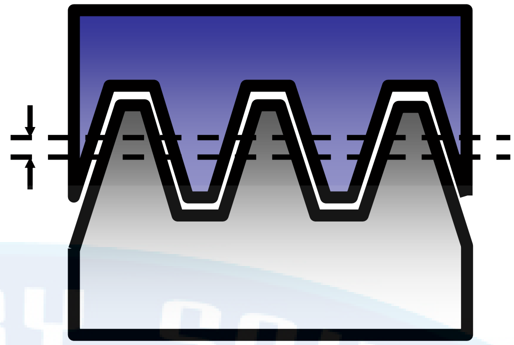
ALLOWANCE:

The minimum clearance between two mating parts. The variations from the basic size which are prescribed to permit the desired amount of play in a metal-to-metal fit. For threads, the difference in pitch diameters.



Feather Edge Removal

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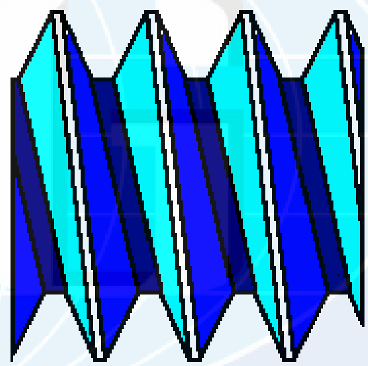
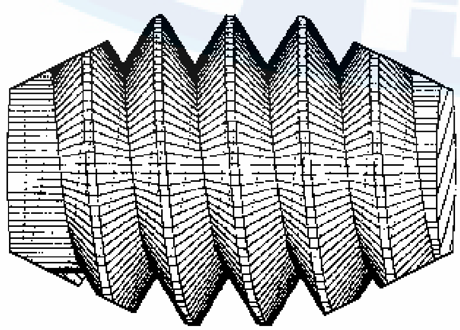
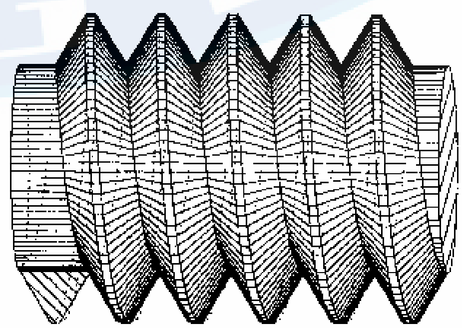
When a part is threaded, whether internally or externally, the beginning and/or ending of the thread is a partial or feather thread. The partial thread must be removed for two reasons.
1) Safety. The feather edge will cut like a razor on metal parts.
2) Function. The feather edge will roll over blocking the thread vee and not allowing the threads to assemble.





Removal by Chamfer



Removal by Convolute

THREAD FORMING

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There are three common methods of creating threads.

Tap / Die

After the part is formed close to the finished diameter, major diameter for external parts and minor diameter for internal parts, the threads are cut into the part using an instrument that has the thread form on it. Slots or flutes are cut along the axis of the tap or die to create cutting surfaces. The tap or die is screwed into or onto the part, forming the thread.

Roll

Like the tap / die method, the part is formed close to the finished diameter, but with the diameters controlled for the rolling process. Thread rolls are applied to the parts with intense pressure causing the material to be displaced by the roll's thread form and extruded into the valley between the roll's threads, forming the thread on the part.

Single-point

This method is used in most lathe thread forming processes. A single cutter with the form of the thread is forced against the part, removing material in a spiral path created by the axial movement of the cutter in combination with the axial turning of the part forming the vee of the thread. Several passes of the cutter may be required to achieve the desire vee depth to form the thread.

Plastic and soft material parts are sometimes created by a form or mold. The thread formed or molded is an inverse duplication of the mold thread. The mold thread will usually be created by one of the methods mentioned above.

All threads, regardless of method, must conform to the same criteria. The same gage will check threads made from any method.

HISTORY

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Prior to 1957 the only US Govt. published and recognized product and gage thread dimensions and tolerances, was the American National Series (also known as the National Series). Because of problems and a desire in the manufacturing sector for a better series of standardized threads, the Unified National Series was created and published. The 1957 publication of the government screw thread standard H-28 included this new series of threads (Unified National) along with the National Series. Manufacturers had the option of using either, but were advised to use and/or change over to the new series. This continued with each publication until 1969 when the National Series was dropped from the standard and only the Unified Series was recognized and recommended.

PRODUCT DIMENSIONS

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All product dimensions are computed from a base of the basic pitch diameter. The Pitch Diameter of a thread is a theoretic diametric plane where the width of the tooth and the width of the groove are equal. The basic pitch diameter can be found by starting with the nominal size (using our example it would be 1/2 or .5000), and subtracting .64952p (p = pitch, pitch is the same as the lead for a single start thread). Using the example, the pitch would be .076923 or 1/13 (a good calculator will do this for you using the 1/x key).

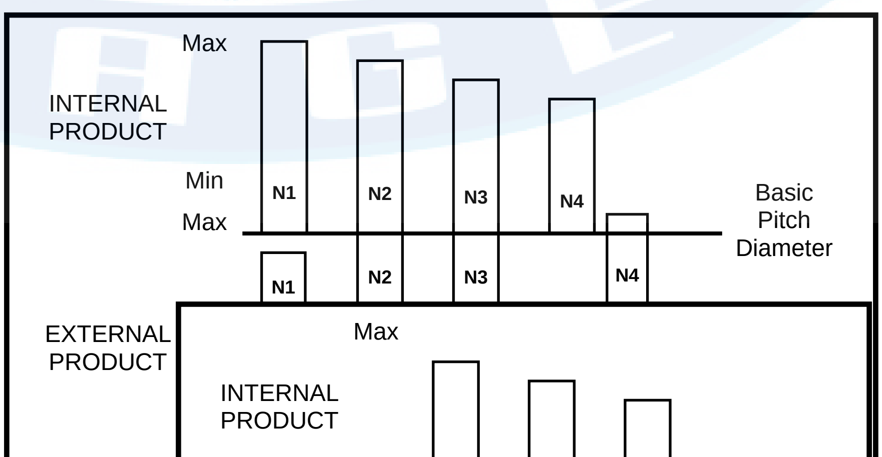
Using the basic pitch diameter the product limits for the internal and external thread can be computed. The basic pitch diameter becomes the minimum size for the internal thread and the maximum size (either as is or after adjustment) for the external thread. This becomes the manufacturing window for the product. The gages are made to the extreme limits of the product tolerance or window, with the tolerance of the gages configured to guarantee the gages are inside of the product tolerance zone (maximum being minus, and minimum being plus).

Another feature, which must be considered, is the allowance. This computed amount is subtracted from the basic pitch diameter to attain an adjusted maximum size for the external product. The purpose of this is to guarantee ease of assembling the internal and external products. For National class 1 and Unified classes 1A and 2A, the allowance is included. For National classes 2 and 3, and Unified class 3A have an allowance of zero. National classes 4 & 5 are a special case designed to create an interference fit having the allowance added to the maximum instead of subtracted.

The number designation in National and Unified Series determines the size of the product tolerance or window. The larger the number, the smaller the manufacturing window for the product.

National SERIES

In the National Series screw thread the class 2 was designed as the 'Nuts & Bolts' fit. The class 1 is also a 'Nuts & Bolts' fit but with an allowance factor between the products creating a guaranteed assembly scenario. Class 3 is the 'Machine' fit. Classes 4 & 5 are 'Interference' fit.



UNIFIED SERIES

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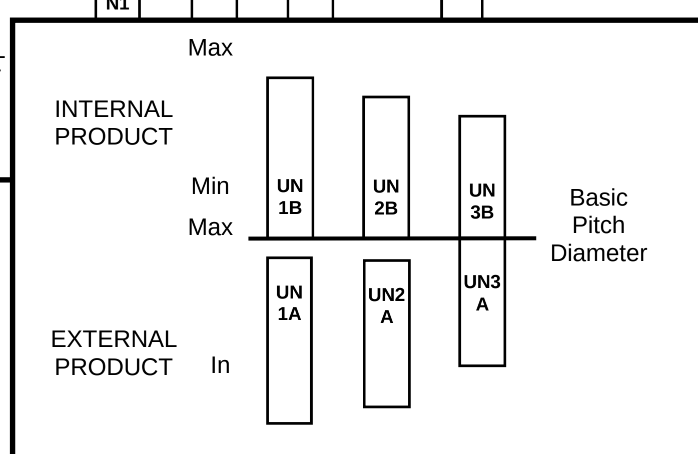
In the Unified National Series the internal product minimum size, which



is also the size of the Go plug gage, is always the basic pitch diameter. The internal product maximum size, which is also the size of the Notgo gage, varies with the class. The external product maximum size, which is also the size of the Go ring gage, is basic pitch diameter or basic pitch diameter minus the allowance. The external product minimum size, which is also the size of the Notgo ring gage, varies with the class.

The 2A / 2B fit is generally referred to as the 'nuts and bolts fit' because of the guaranteed gap between the mating parts, where tightness is accomplished by contact against a face. The class 1A / 1B is also a 'Nuts & Bolts' fit will a larger manufacturing window and coined as 'Quick Assembly.'

The 3A / 3B fit is generally referred to as the 'machine fit' because it usually gives a tighter fit of the threads of the mating parts.

There is no class 4. Class 5 was retained but moved to a difference standard more commensurate to its application.

Thread NOMENCLATURE Philosophy

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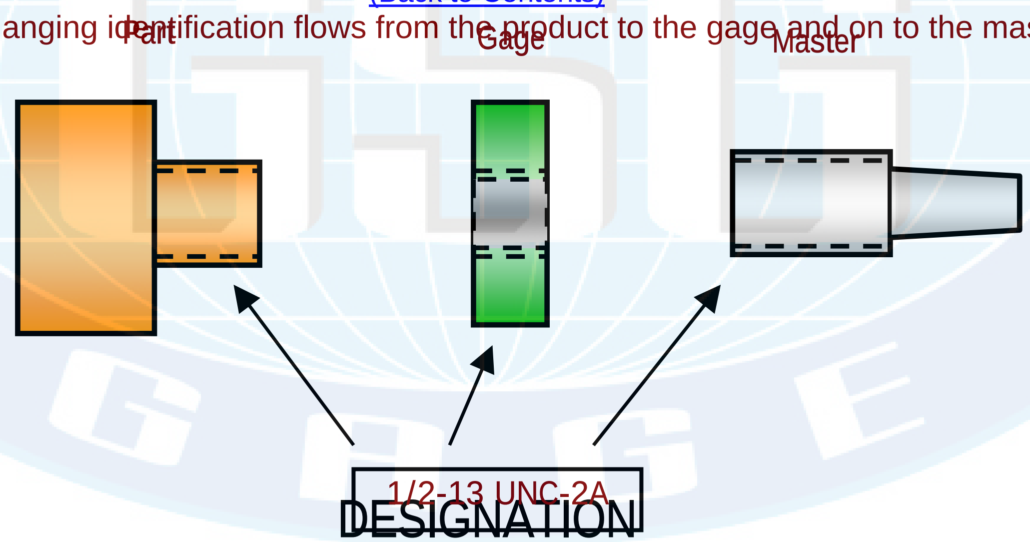
An unchanging identification flows from the product to the gage and on to the master.



DESIGNATION

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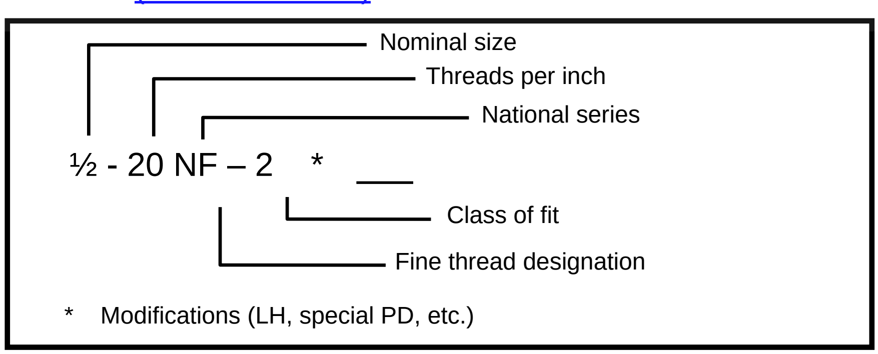
Screw Thread

Designation

NATIONAL

SYSTEM



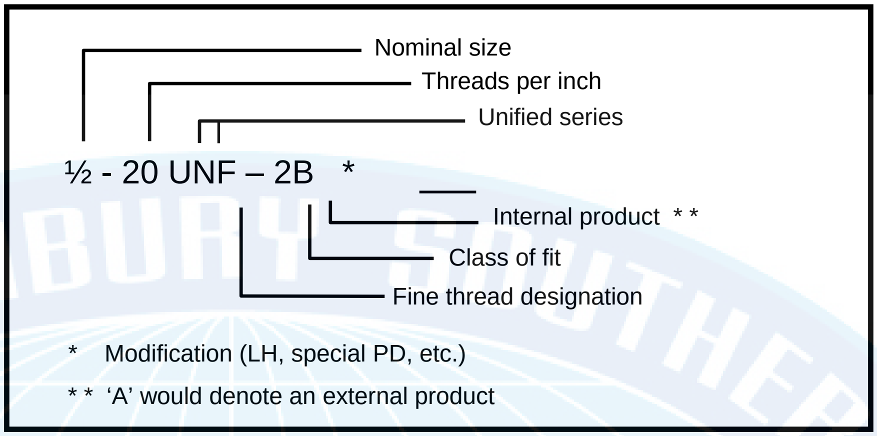
With the creation of the Unified Series, the letter designation was added to distinguish between the internal & external threaded products. The letter 'A' denotes external and the letter 'B' denotes internal. This letter follows the class of fit in the nomenclature. With the National Series, there was no way to differentiate between internal & external.

Screw Thread

Designation

UNIFIED

SYSTEM



Mismatching Series

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National 1/4-20 NC-2

Unified 1/4-20 UNC-2B

X 1/4-20 NC-2B

X 1/4-20 UNC-2

It should be noted that it is incorrect to mix the designations of the National and Unified Series threads. For instance, it is incorrect to specify a thread as N-2A, N-3B, UN-2, or UN-3. To make this simple, just remember: If there is a 'U' (for unified) there must also be an A or B (internal or external). If there is not a 'U' (therefore National) there cannot be an A or B.

If you have a thread designation with mismatched information, it is time to go back to the customer or engineer for clarification.

In the nomenclature, other letters are used to further clarify the type of thread. This is true for National and Unified Series threads. For instance; F-fine, C-coarse, EF-extra fine, S-standard or special. The additional letter or letters always follow the 'N'. For example: 1/2-20 UNF-2A, 1/2-13 UNC-2B, 5/8-11 NC-2.

Thread gages are always identified with the exact nomenclature of the thread they are used to inspect.

Thread plug gage nomenclatures are the same as internal threaded products, thread ring gages are the same as external threaded products, and masters are the same as the working gage they inspect. This is why a truncated set plug has a nomenclature of an external threaded product; it checks the thread ring, which checks the external threaded product.

INCH NOMENCLATURE EXAMPLES

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(Size) - (TPI) (Type) - (class) (Modifiers)

4 .250-28 UNF-3A LH

4 1/4-28 NF-2

4 1.00-.050P-.100L UN-2A

8 1/2-13 GH5

MULTIPLE LEAD THREADS nomenclature

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With multiple lead, or multiple start threads all the nomenclature information is the same except for the designation for the threads per inch, as it is necessary to specify the distance between the individual threads as well as the individual leads or starts. This is accomplished by designating the pitch and lead in decimal form, rounded to 4 decimal places.

For example: A thread with a nominal size of 1/2 inch, and 20 threads per inch, with 2 starts, unified series, class 2 internal, would be given the nomenclature;

1/2 - .0500P-.1000L UNF-2B

The inverse of 20 (or 1 divided by 20) equals .0500 which is the pitch, the distance from one thread to the next thread. The lead is found by multiplying the pitch by the number of starts or leads.

TAPs Vs GAGES

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A gage size is based on the product tolerance dimensions known, or computable from the standards, based on the nomenclature.

A tap size is computed from the basic pitch diameter, adding .0005 times the tap size.

Using the product or gage size, the best tap size **can** be calculated. Using the tap size, the product or gage size **cannot** be calculated.

A product size (nomenclature) specifies a range of dimensions, whereas a tap size only specifies a particular dimension that will fall somewhere within the product range of dimensions.

For instance, using the 1/2-13 example;

A tap GH5 would be made to a pitch diameter of .4525 with a tolerance of minus .0005: [.4500 being the basic pitch diameter, and adding .0005 times 5 or .0025].
{.4500 + (.0005 x 5)} = .4525

A product of UN-2B would be made to a pitch diameter between .4500 & .4565.

The gages would be made to the tolerance limits of the products, therefore the Go gage would be made to .4500 with a plus tolerance, and the NoGo gage would be made to .4565 with a minus tolerance.

Jeweler Sizes
.060 +/- .013 per increment

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#000 = .034	#4 = .112	#9 = .177
#00 = .047	#5 = .125	#10 = .190
#0 = .060	#6 = .138	#11 = .203
#1 = .073	#7 = .151	#12 = .216
#2 = .086	#8 = .164	#13 = .229
#3 = .099		#14 = .242

Jeweler sizes were originally created for the jewelry industry as a method for designating small sizes. Several commonly used small thread sizes use this method of specifying the nominal size of the product thread. Jeweler sizes are by theory indefinite, but seldom will a jeweler size be used beyond the 1/4 or .250 inch diameter size.

METRIC THREADS

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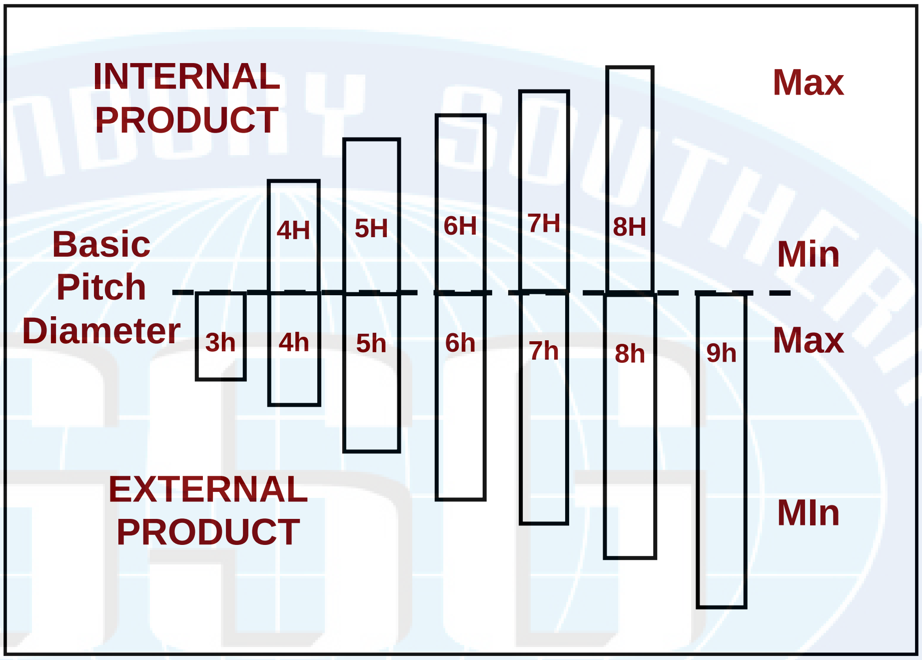
The best way to explain and understand metric threads is by comparison to inch threads. **The first and one of the most important things to remember about metric threads, is that, like inch threads, knowing the tap size is not enough information to manufacture a gage.** A proper and complete nomenclature for the gage or the product is necessary.



Metric threads have been engineered to allow for much variation while still being able to be considered a standardized product. The metric screw thread has five standard internal product classes and seven standard external product classes. The product tolerance or manufacturing window for metric screw threads is the opposite of the inch design. With metric screw threads the larger the number designation for the class, the larger the product tolerance.

The most common metric product screw thread is the class 6g external product, and the class 6H internal product, which creates a very similar assembly scenario to the inch 2A / 2B 'Nuts and Bolts' fit. Companies that stock metric gages, usually stock class '6H' plug gages for internal threads and '6g' ring and set plug gages for external threads, because this comprises 80%+ of the metric thread gage market.

Metric Allowances

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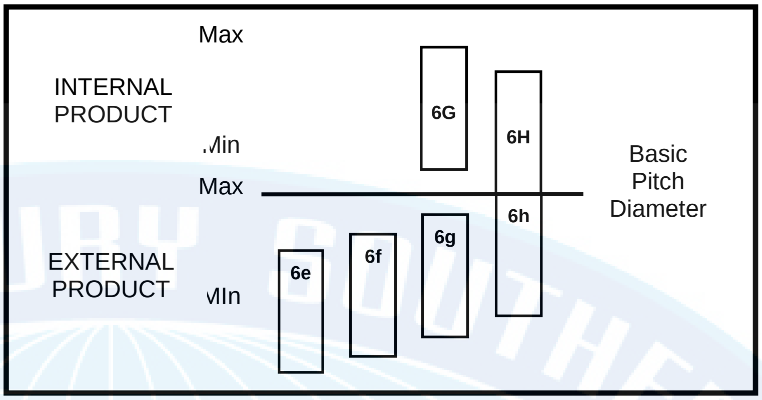
The 'g' & 'H' are commonly confused with the unified method of denoting internal and external of 'A' & 'B'. Here the metric uses a method that is not present in the inch series. **The internal and external threads in metrics are denoted by the case of the letter used,** lower case for external, and upper case for internal.



The letter used denotes the amount of allowance adjustment applied to the basic size. For external threads, allowances available are 'e, f, g, & h'. For internal threads, allowances available are 'G & H'.

Here again we see a difference in the inch and metric systems. In the Unified, there is only one allowance available and it is only applied to the external thread. For metric, you can apply allowances to the internal also. In both the internal and external the 'h or H' signifies an allowance factor of zero. The 'G' is the only allowance for internal threads and the 'g' is the smallest allowance available for external, the 'f' being more, and the 'e' being the greatest allowance.

Metric DESIGNATION

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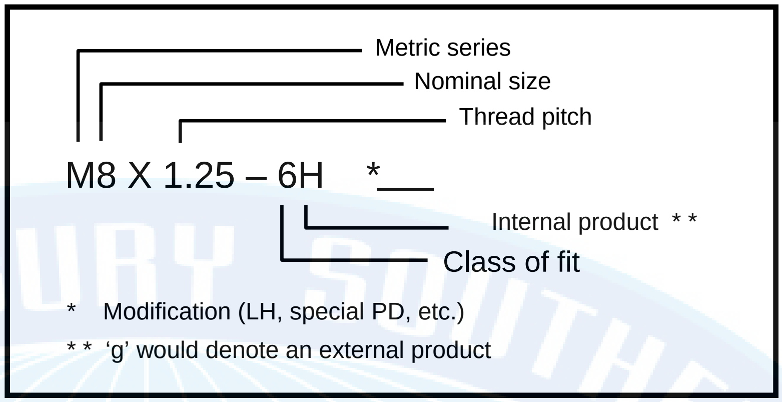

The nomenclature of metric threads begins with the letter M. This is the designation showing the metric series. Other letters may be added after the M showing modifications to the standard metric series. This can be compared to the UN for Unified National, or N for National in the English thread nomenclature. Notice that in metrics, the series designation precedes the nominal size and pitch, unlike in the inch series, which follows the nominal size and pitch.

The nominal size is the first number that follows the metric series designation, followed by the pitch. The nominal size and pitch are separated by the letter 'X', which is pronounced as 'by'. In the inch series the nominal size is followed by the threads per inch, whereas in metric the inverse of the threads per inch, the pitch, the actual distance from one thread to the next, follows the nominal size.

Following the pitch is the class of fit. The designation that denotes internal or external also signifies allowance. When the class of fit is specified with two different classes, such as 4g6g, the first one, 4g, is the tolerance applied to the product pitch diameters, and the second one, 6g, is the tolerance applied to the product major and minor diameters.

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METRIC NOMENCLATURE EXAMPLES

(Type)(Size) x (Pitch) - (Class)(Allow.) (Mod.)

4 M10x1.25-6H

4 M8x.75-4g6g

4 MJ12x1.75-6G LH

8 M6 D5

Internal / External Designation

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Inch	'A' - External 'B' - Internal	Metric	'e,f,g,h' - External 'G,H' - Internal

The nomenclature designation in the unified inch series is denoted by the 'A' representing the external product, and the 'B' representing the internal product. Metric series uses the case of the letter to designate the difference between internal and external products. The lower case is for external products and the upper case is for internal products. It is important to note that blueprints, specifications and purchase orders should always show the nomenclature properly, especially the letter case.

PRODUCT Acceptability

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The acceptability of a product is established by the level of quality required by the user or design. Currently, many manufacturers are using 3 levels of acceptability as given in the ANSI standard B1.3M.

Level 21; Lowest level of acceptability

Functional limit inspection. Functional limit gages are used to inspect the threads. Used in applications where functionality is the major consideration and failure is unlikely to be fatal.

Level 22; Middle level of acceptability

A maximum material limit functional go gage may be used with an actual pitch diameter measurement made at the minimum material limit. This and all levels may be modified to include a special feature. Ex: ½-13 UNC-2A (22)(R) The (R) requires that the root radius be inspected for conformance. Used in all military applications, and in applications where failure would probably result in fatality.

Level 23; Highest level of acceptability

All elements be inspected. The functional pitch diameter and actual pitch diameter must also be compared. The difference between the two cannot be greater than ½ the part pitch diameter tolerance (40% for "J" thread). Used in many nuclear applications. Used in applications where failure would result in catastrophic fatalities. Also used in research and development applications.

Note: Variable gaging may be used for levels 22 and 23. Both Functional segments and single element (best wire, cone & vee) segments or rolls are required. In addition, optical comparators may be needed.

ACCUMULATIVE ERROR OF THREADS

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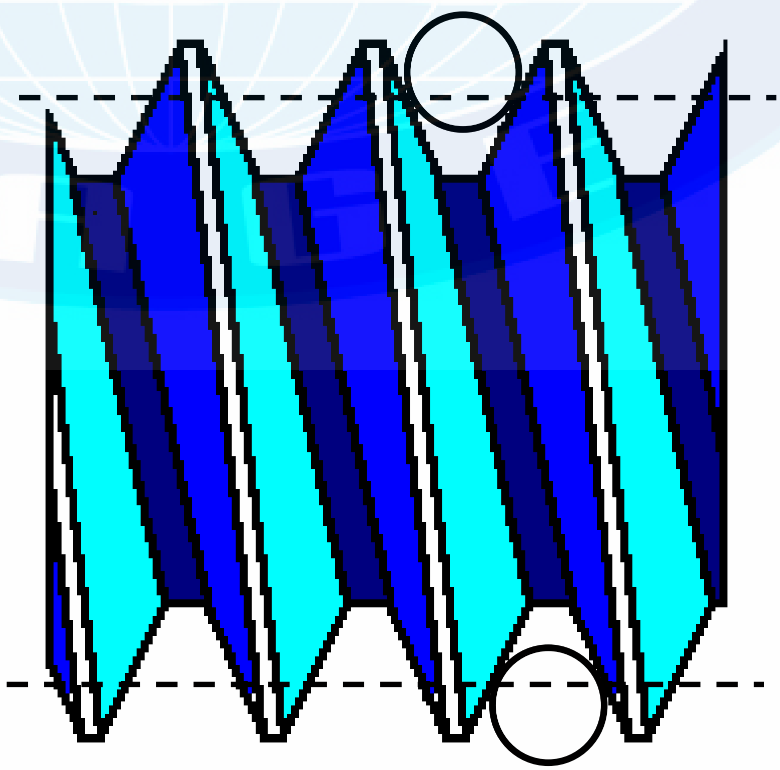
When inspecting threads, especially product threads, you must take into account the accumulative error that develops because of the geometric intricacy of threads. This accumulative error is the deviation of functional size from measured size. Each geometric element of the thread; lead, pitch, flank angle, helical path, & pitch diameter, is manufactured within a specified tolerance. The variation for each element will vary, some being positive, some negative, some bilateral, from the exact specification. The deviation from the exact specification will affect the functional size of the thread. Depending on the geometric element, the ratio of affect on the functional size will vary.

Accumulative error will always affect an external thread, whether a product or a gage, by making the functional size larger than the measured size, and will always affect an internal thread, whether a product or a gage, by making the functional size smaller than the measured size.

Functional size is the real world reaction experienced when internal and external threads are assembled together. Fixed limit gages, which is an attribute gaging system, will measure the functional limits of the product. Pitch mics, wire methods, and single rib roll indicating instruments, cannot truly measure functional size. Three roll indicating instruments, with full profile functional rolls having multiple ribs, either straight or with a developing helical path, can be used to measure functional size, but is not as accurate as fixed limit gages.

A pitch diameter is measured by placing wires or balls into the vee of the thread at a point that is tangent or contacts at the theoretical diametrical plane of the pitch diameter. This creates a geometric configuration making it possible to formulate the measuring the pitch diameter by measuring over the wires or balls.

This type measurement does not take into consideration the errors of the flanks or helical path and therefore do not give a functional size.



THREAD MEASUREMENT FORMULAE

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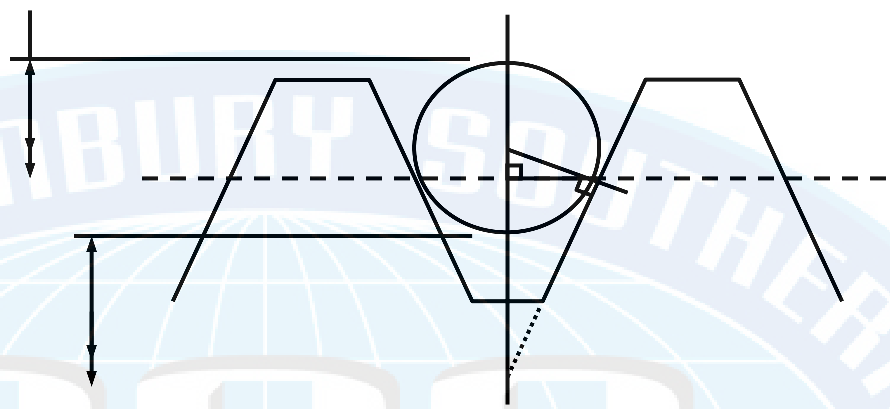
$$E - \frac{\cot\alpha}{2n} + w\left[1 + \frac{\cos ec^{2}\alpha + \cot^{2}\alpha\tan^{2}\lambda'}{2}\right]$$



$$E - \frac{\cot\alpha}{2n} - 2w + w\left[1 + \frac{\cos ec^{2}\alpha + \cot^{2}\alpha\tan^{2}\lambda'}{2}\right]$$

The upper formula is used when measuring an external thread over wires. The lower formula is used when measuring internal diameters over balls.

ERROR OF PITCH DIAMETER SIZE

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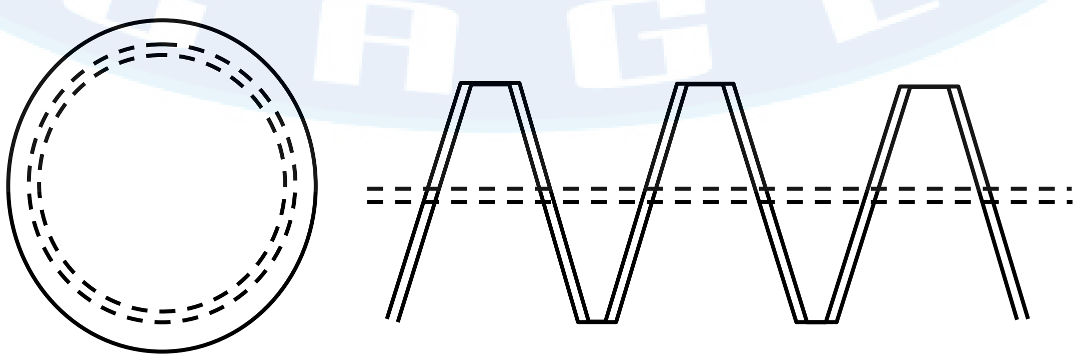

The pitch diameter of any thread is designed with a tolerance, whether a product or a gage. The variation in the pitch diameter from the specified size is error that will affect the functional assemble-ability of the thread.

ERROR OF ROUNDNESS

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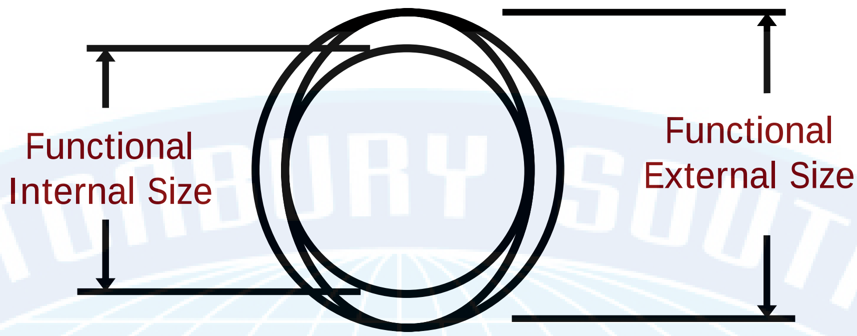

There is not such thing as a perfectly round product or gage or thread. The error of the roundness in the example is called ovality because it is two point out of round. This is not always the case as roundness error can take geometric forms of many points or even erratic forms. A two point measurement is capable of revealing even lobing errors, and a three point measurement is capable of revealing odd lobing errors.

ERROR OF eccentricity

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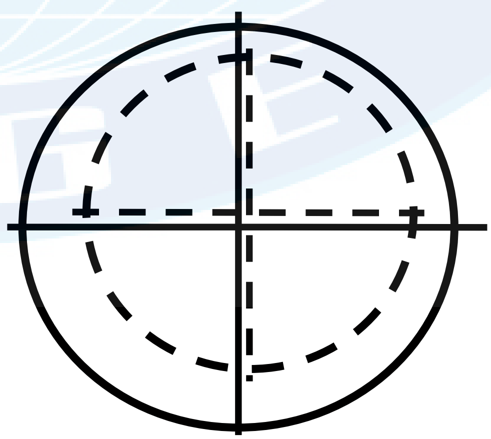
The pitch diameter of the thread of a product may not always be concentric to the crest of the thread. The crest of the thread for an external product would be the outer diameter, and for an internal product would be the inter diameter. Because many threads are formed in a manner that does not affect the major or minor, the eccentricity can functionally affect the thread size.



One of the areas this is most noticed is with thread ring gages that are reset during calibration. Thread rings must always be inspected for this error when calibrated.

When a thread ring is reset, the minor of the ring can become eccentric to the point of being out of its tolerance, and potentially creating a gage that will interfere at the minor diameter of the product, creating the likelihood of rejecting good product.

angle error

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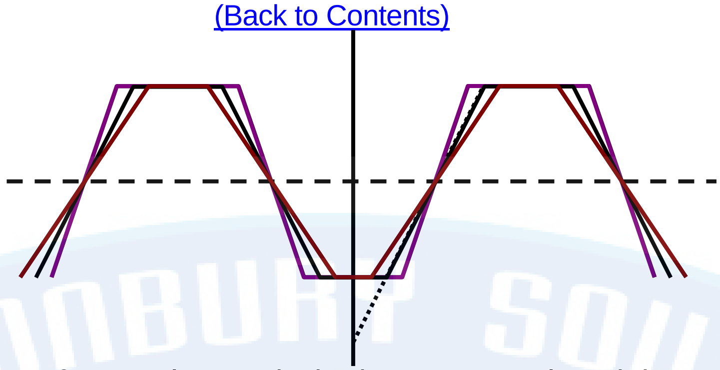

Threads do not have perfect angles, and whether open or closed the angle changes the functional size of the thread.

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lead error

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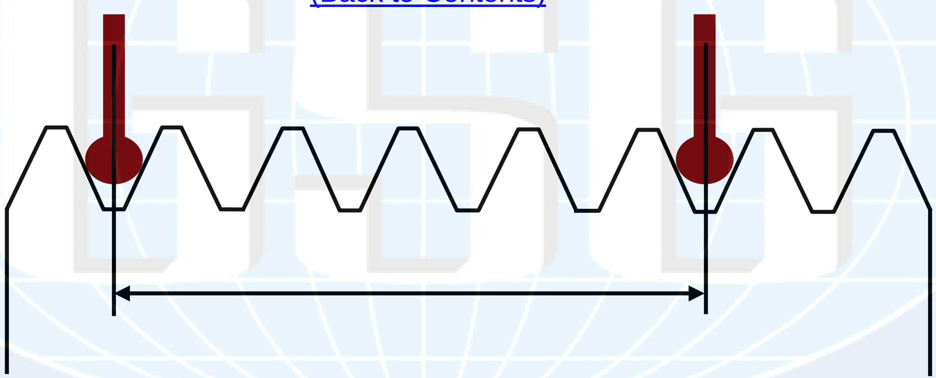

Lead error is specified as the amount of lead variation that can occur over a given length or number of pitches of a thread.

Pitch error

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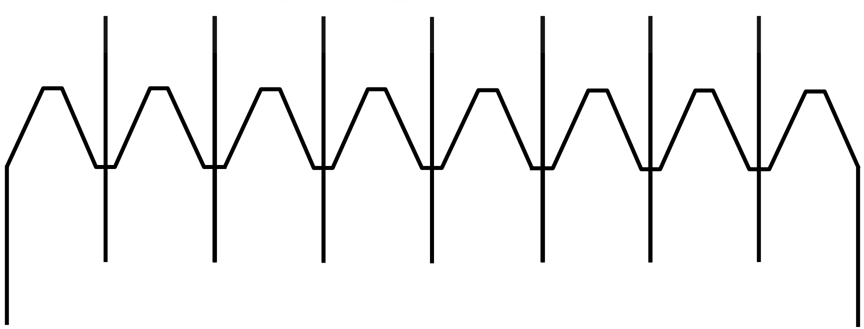

Pitch error is the error that is the difference between the maximum and minimum pitches of a thread.

Actual size VS Functional size

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The difference between the measured size and the functional size is the result of the accumulation of the errors of all the thread attributes. Some of the errors will add to the difference in the actual or measured size and the functional size and some will subtract from it.

Plug gage contact to part

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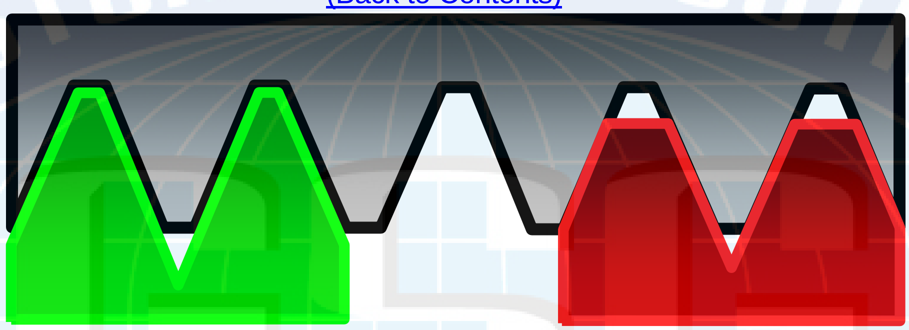

Go Gage

Minimum Major
Minimum PD
Flanks and Angles

NoGo Gage

Maximum PD

ring gage contact to part

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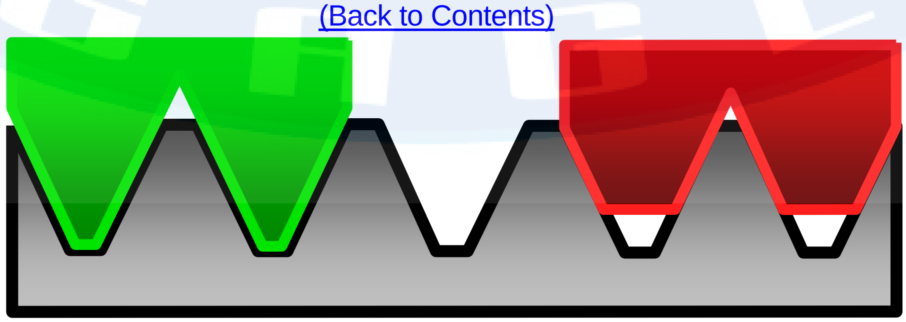

Go Gage

Maximum Minor
Maximum PD
Flanks and Angles

NoGo Gage

Minimum PD

ring gage application to part

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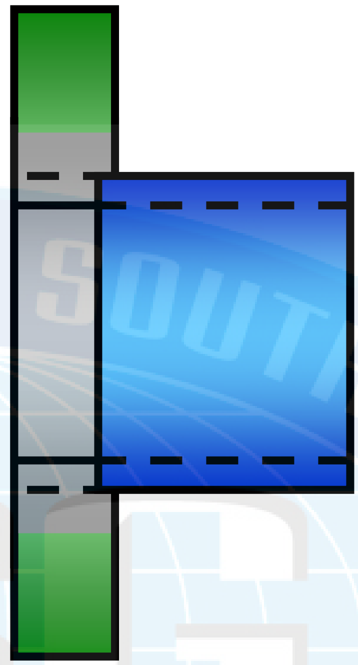
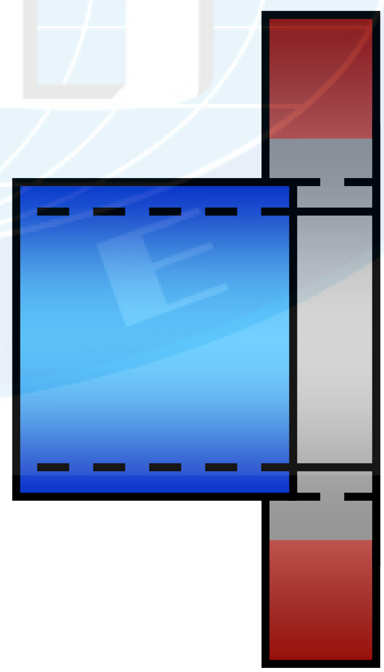


Go Gage
Full Length
Free & Easy

The Go gage should pass completely across or onto the product threads. Application of force to engage the Go gage member with the product indicates the product is larger than the maximum allowable size. Forcing the Go gage to engage with the product will decrease the size of the product making it acceptable but wear the gage unnecessarily resulting in a sharp decrease in the life of the Go gage.



NoGo Gage
Inch:
Not more than three complete turns

Metric:
Definite drag before the second turn

Modification of the above requirements may be necessary when the product is thin having few complete threads or when the product is of a material that may stretch or give.

For inch threads, the NoGo should never go beyond the third thread or less if modified. For metric threads the NoGo could theoretically go the full length but should not be continued once the definite drag is felt. If the NoGo engages with the product more than the specified requirements the product is smaller than the minimum acceptable size.

plug gage application to part

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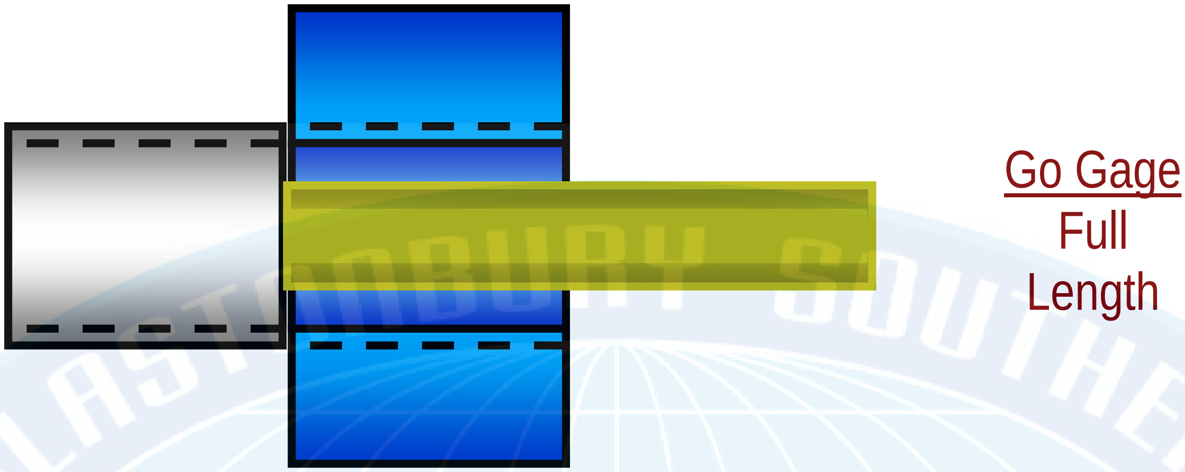
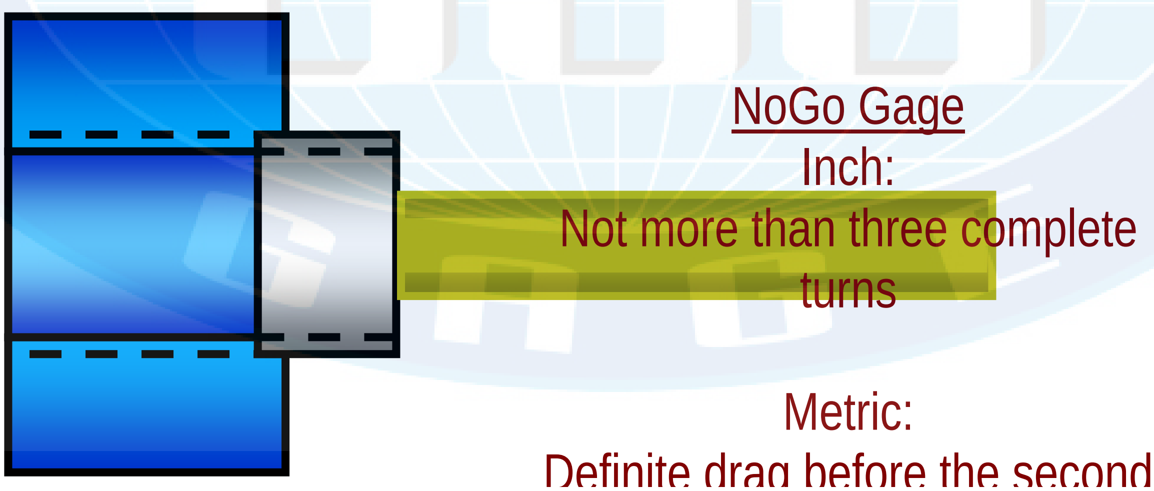


The Go gage should pass completely across or into the product threads. Application of force to engage the Go gage member with the product indicates the product is smaller than the minimum allowable size. Forcing the Go gage to engage with the product will increase the size of the product making it acceptable but wear the gage unnecessarily resulting in a sharp decrease in the life of the Go gage.



Modification of the above requirements may be necessary when the product is thin having few complete threads or when the product is of a material that may stretch or give.

For inch threads, the NoGo should never go beyond the third thread or less if modified. For metric threads the NoGo could theoretically go the full length but should not be continued once the definite drag is felt. If the NoGo engages with the product more than the specified requirements the product is smaller than the minimum acceptable size.

Thread set plug gages

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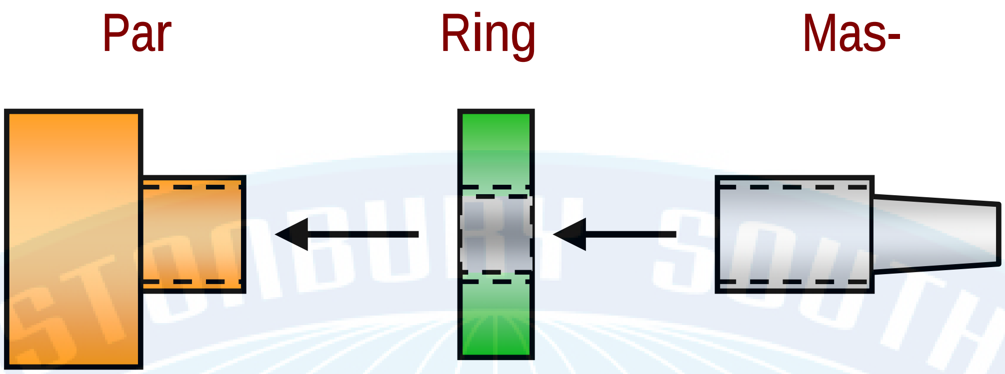

The ring gage inspects the product, and the set plug / master plug / truncated plug inspects the ring gage. Maybe because it is commonly known as the 'set plug', many lab technicians think the set plug is only for the purpose of setting the ring to the proper size. It also has the function of inspecting the ring gage for wear.

Truncated set plug gages

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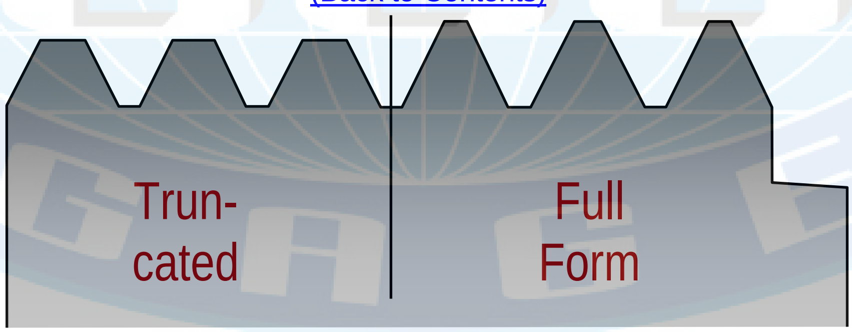

The above picture is a cut-away view of the thread form of the truncated set plug. The thread pitch diameter is the same on both sections and requiring back taper. Back taper is when the measured size of the pitch diameter is less on the back, close to the shank, than on the front. The allowable taper is half of the tolerance of the pitch diameter. Set plugs with front taper should be replaced.

When using a set plug gage to check the ring, the ring should always be engaged across the full length of the plug to create consistent wear and retain the back taper condition. Set plugs become out-of-tolerance with a front taper condition because of the ring being engaged on the front portion only, many more times than on the back portion. So, contrary to normal logic, the set plug is actually given more life by more use.

ring gage wear plane

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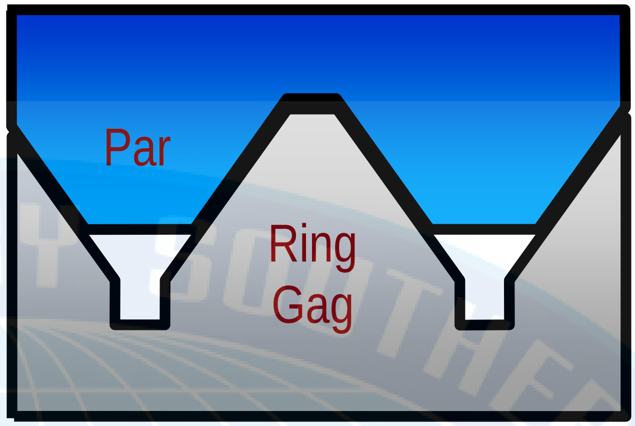
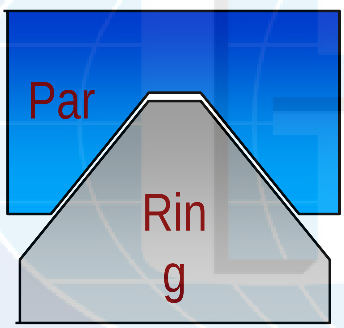
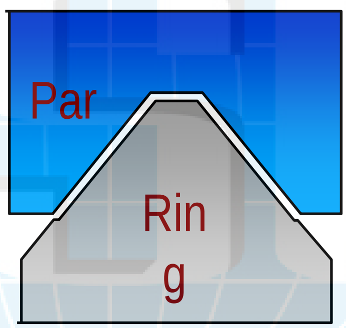
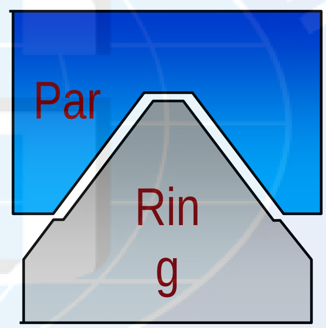
Product is produced in a manner that is designed to make the product as consistent as possible. This creates a scenario where the thread flank of the gages are contacted in the same general area consistently every time a part is inspected. This area we call the **wear plane**. As a gage is used it wears. Plug gages wear and are replaced when they wear outside of the tolerance limit. Ring gages are adjustable, and therefore present a problem we don't experience with plugs.





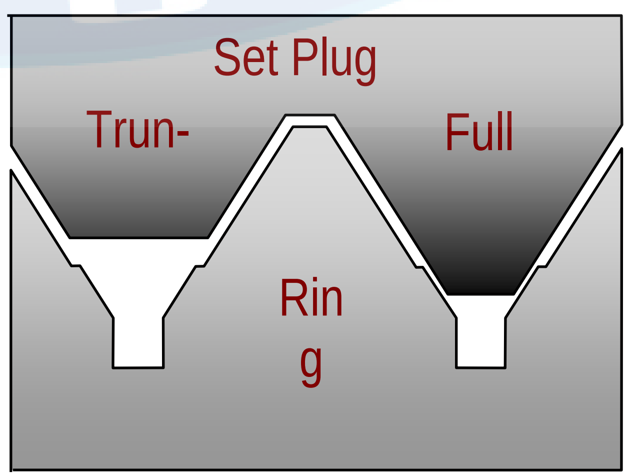




As a ring gage is used it wears, but it can be readjusted to be brought back into size. This means that the wear can continue until the flank is no longer a straight line. This is commonly referred to as the flank having a step wore in it.

The truncated set plug gage is designed to allow the truncated (front) section to contact the ring gage within the wear plane, While the full form (back) section is designed to contact beyond the wear plane.

When the flanks of a ring gage have a step wore in them the ring will feel much looser on the truncated section than on the full form section. This indicates the ring should be repaired or replaced.



Master Setting plug Design

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For Thread Ring Diagnostics & Setting

The Truncated Master Setting Plug Gage is designed for two functions; to set the adjustable thread ring gage, and to inspect the ring gage for wear. Two methods of using the setting plug are suggested to optimize the life of the setting plug. Pitch diameter taper on the setting plug is specified to always be in the minus direction, i.e. the PD on the front of the plug should always be larger than the PD on the back of the plug.

The first method addressed is used to inspect new ring gages, assuming your gages are not previously set by the manufacturer to your master plug. The ring should be set to the front or truncated portion, then continue onto the full form portion to inspect for root clearance, and consistent feel. The setting plug should be inserted a maximum of two threads into each end of ring for shake, inspecting for taper.

The second method addressed is used to re-inspect rings for wear after use on the product. The ring should be set to the full form portion, then backed off to the truncated portion for feel. The setting plug should be inserted a maximum of two threads into each end of ring for shake, inspecting for taper.

The front or truncated portion of the setting plug is designed to contact the flanks of the ring in the wear plane, similar to a product. The full form portion is designed to contact the flanks of the ring beyond the wear plane. When a ring is run across the plug there will be a slight difference in the feel or tightness because there is more contact with the flanks on the full form portion of the setting plug, thus more resistance and a tighter feel.

If a significant difference in feel is noted, the ring has wear on the flank and should be repaired or replaced. Setting a ring with wear in the flanks will cause possible interference with the product major and does not properly inspect the product threads.

Tightness of Fit

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There are no established torque values for degree of drag. Some judgment and common sense must be used. The resistance or drag for a small size gage should be less than for a larger size gage. A spin fit is obviously much too loose, and too tight a fit could damage or cause excessive wear on the ring or the setting plug. In-between is a fairly smooth drag. This tells you that the size of the ring is essentially the same as the setting plug.

On properly set gages with accurate lapped threads, a very little change to size (adjustment of the ring gage) will effect a noticeable difference in drag. Two different setting plugs both within class W tolerance may feel entirely different in the same ring gage. One could be too tight and the other too loose. It must be realized that a ring gage set on one setting plug does not necessarily mean it will fit another setting plug. This is due to the allowable tolerance of the set plug.

In addition to pitch diameter variations, there may be a slight difference in the flank angle or lead of the ring versus the setting plug. This can also cause a small increase in the degree of drag a full engagement versus partial engagements. One should not expect absolute perfection. These differences are not serious within reason as both the ring and setting plug may be well within their respective tolerances. A ring may feel noticeably different on the set plug when engaged with the marking facing the set plug or facing away from the set plug. This is usually the result of flank angle error in the ring and the set plug. In one direction the errors interfere while in the other direction they do not. When this happens the ring should be positioned where the flanks do not interfere (the looser fitting) and set for the proper feel. When this is done the set plug will probably not go in the ring if the ring is turned around, but this gives the closest pitch diameter size for the ring gage and is most likely to pass good product and fail bad product.

INSPECTION / SETTING PROCEDURE

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AGD THREAD RING

1. CLEAN

Thoroughly clean the threads with a bristle brush and solvent, wipe clean with isopropyl alcohol and clean with kim wipe. Visually inspect the thread ring for nicks, dings or foreign material buildup.

2. INSPECT ID

Using a calibrated tapered pin, set of parallels, bore gage or other accurate method inspect the ID (minor diameter) of ring gage and record the size.

3. INSPECT PD

a. Lubricate the setting master plug with a thin film of light viscosity oil before inserting into the ring gage.

b. Turn the ring onto the setting plug 1 1/2 to 2 threads at the front. If ring will not go onto setting plug go to operation 4. There should be some resistance or drag even at this short engagement. To test for taper or bellmouth, place the ring on its face on a workbench and test for shake or looseness with the setting plug, being very careful not to damage the end threads.

c. Turn ring further onto the truncated section, remembering the feel at the 1 1/2 to 2 thread engagement. The drag should remain approximately the same although it may be slightly greater at full engagement due to more flank contact.

d. Remove the ring from the setting plug and repeat operations 3b & 3c on the opposite side of the thread ring gage.

e. The fit should be approximately the same on both sides of the ring to insure proper straightness. Remember if a setting plug is manufactured or worn smaller at the front, it will falsely indicate taper or bellmouth in the ring gage. Setting plugs must be reasonably straight.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

g. If at this point nothing is found which indicates a problem skip to operation 7.

4. SET RING

NOTE: If ring will go onto setting plug skip to operation 4c.

a. Turn the locking screw counter-clockwise until it is loosened.

b. Turn the adjusting screw clockwise, this will open the ring to a larger pitch diameter than the setting plug.

c. Turn the ring gage onto the setting plug truncated section so that approximately one thread of setting plug extends beyond the ring. (This will promote uniform wear over the entire thread length of the setting plug.)

d. If it has not already been done, turn the locking screw counter-clockwise until it is loosened. Turn the adjusting screw counter-clockwise to tighten or clockwise to loosen until there is a slight drag between the ring and the setting plug.

e. Turn the locking screw clockwise until tight. This locks the adjusting screw so that the size of the ring gage remains fixed. There should be noticeable drag between the ring and setting plug.

NOTE: Operations 5c – 5e may need to be repeated more than once to obtain the proper drag or feel.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

5. INSPECT PD

Repeat section 3a – 3f. If at this point nothing is found which indicates a problem continue to operation 6.

6. INSPECT ID

Using a calibrated tapered pin, set of parallels, or bore gage inspect the ID (minor diameter) of ring gage.

NOTE: If an adjustment was necessary to establish the proper feel on the setting plug use the following formula to obtain the as found pitch diameter. (Setting plug pitch diameter) plus (ID size before adjustment)minus (ID size after adjustment.)

7. SEAL

Cover the adjusting and locking screws with sealing wax to prevent unauthorized tampering with the setting of the ring gage.

SOUTHERN STYLE THREAD RING

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1. CLEAN

Thoroughly clean the threads with a bristle brush and solvent, wipe clean with isopropyl alcohol and clean with kim wipe. Visually inspect the thread ring for nicks, dings or foreign material buildup.

2. INSPECT ID

Using a calibrated tapered pin, set of parallels, or bore gage inspect the ID (minor diameter) of ring gage and record the size.

3. INSPECT PD

a. Lubricate the setting master plug with a thin film of light viscosity oil before inserting into the ring gage.

b. Turn the ring onto the setting plug 1 1/2 to 2 threads at the front. If ring will go onto the setting plug go to operation 4. There should be some resistance or drag even at this short engagement. To test for taper or bellmouth, place the ring on its face on a workbench and test for shake or looseness with the setting plug, being very careful not to damage the end threads.

c. Turn ring further onto the truncated section, remembering the feel at the 1 1/2 to 2 thread engagement. The drag should remain approximately the same although it may be slightly greater at full engagement due to more flank contact.

d. Remove the ring from the setting plug and repeat operations 5b & 5c on the opposite side of the thread ring gage.

e. The fit should be approximately the same on both sides of the ring to insure proper straightness. Remember if a setting plug is manufactured or worn smaller at the front, it will falsely indicate taper or bellmouth in the ring gage. Setting plugs must be reasonably straight.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

g. If at this point nothing is found which indicates a problem skip to operation 5.7.

4. SET RING

NOTE: If ring will go onto setting plug skip to operation 4c.

a. Turn the locking screw counter-clockwise 1/4 turn.

b. Turn the adjusting screw clockwise 1/8 turn maximum to enlarge ring PD. Repeat, if necessary, until ring will go onto setting plug.

c. Turn the ring gage onto the setting plug truncated section so that approximately one thread of setting plug extends beyond the ring. (This will promote uniform wear over the entire thread length of the setting plug.)

d. Turn the adjusting screw counter-clockwise to loosen or clockwise to tighten.

e. Turn the locking screw clockwise until tight. This locks the adjusting screw so that the size of the ring gage remains fixed. There should be noticeable drag between the ring and setting plug.

NOTE: Operations 4c – 4e may need to be repeated more than once to obtain the proper drag or feel.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

5. INSPECT PD

Repeat section 3a – 3f. If at this point nothing is found which indicates a problem continue to operation 6.

6. INSPECT ID

Using a calibrated tapered pin, set of parallels, or bore gage inspect the ID (minor diameter) of ring gage.

NOTE: If an adjustment was necessary to establish the proper feel on the setting plug use the following formula to obtain the as found pitch diameter. (Setting plug pitch diameter) plus (ID size before adjustment) minus (ID size after adjustment.)

7. SEAL

Cover the adjusting and locking screws with sealing wax to prevent unauthorized tampering with the setting of the ring gage.

COMPUTING GAGE DIMENSIONS

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Dimensions for gages can be found in the ANSI B1.2 standard. Charts for standard sizes of threads will give pitch diameters, $\sqrt[3]{p^2}$ major diameters, and minor diameters. If the size of thread is not listed in the B1.2 then the next procedure is to look in the ANSI B1.1 and compute the pitch diameter limits for the product thread. The formulae required are not included because the charts in the standards should be consulted before computing the pitch diameter limits. Once the pitch diameters are known, the following formulae may be used to compute the other gages dimensions.

h = 0.64952p **H = 0.8660254p**

THREAD WORK PLUGS

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Go Major = Go PD + h
NoGo Major = NoGo PD + H/2

setting/master plugs

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Go Full Form Major = Go PD + h
Go Truncated Major = Go FF Maj. - .060 + .017

NoGo Full For Major = Go FF Maj. or
Go FF Maj. + .216506p - (Go PD - NoGo PD + .0017") whichever is smaller
NoGo Truncated Major = NoGo PD + H/2

THREAD RINGS

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Go Minor = Go Pd - H/2
NoGo Minor = NoGo PD - .25H

INTERNAL PRODUCT THREAD DEPTH

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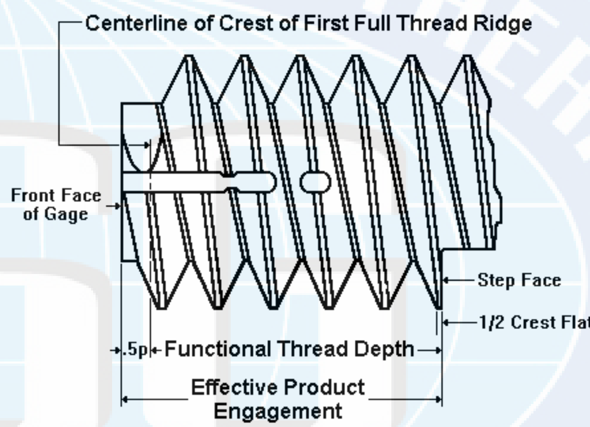
The depth of internal product threads can be measured quickly and easily with very little extra time by put depth notches or steps on the Go thread plug gage member. If the criteria for the product specifies minimum depth only, one step is all that is needed. If the criteria for the product specifies a minimum and a maximum, then two steps are needed.

The Go member is inserted into the product until fully engaged without the application of significant force, which could tend to deform the product material. The position of the steps in relation to the face of the product is noted to determine conformance. A minimum step should be below the face, a maximum step should be above the face.

When specifying the length of the step or steps we must take into account what we want to measure, whether full functional thread depth or effective external product engagement.

When measuring the full functional thread depth, the step is measured from the centerline of the crest on the first full thread ridge of the Go plug gage to the step face. When measuring the effective external product engagement, the step is measured from the front face of the Go plug gage to the step face, and the distance from the front face to the centerline of the crest on the first full thread ridge should be held to .5p maximum.

The length of the thread depth step is marked on the Go plug gage and on the handle. Both methods are acceptable practice, however, for consistency each company should establish which method is to be used. It is possible a company would need to use both methods, which would necessitate additional marking or notes to identify which method is used on each individual gage as well as on the blueprints for the products and the gages.



Thread Depth Figure

Design of the product is controlled by the application. The application is the controlling factor for which method should be utilized. If product engagement controls the design criteria then we should measure from the face of the gage to the step. If product thread depth controls the design, we should measure from the centerline of the first full thread to the step. Designs using product thread depth may be necessary because the bolt length or engagement length of the mating product could vary, as in situations where replacement parts are made by different manufacturers.

common THREAD forms

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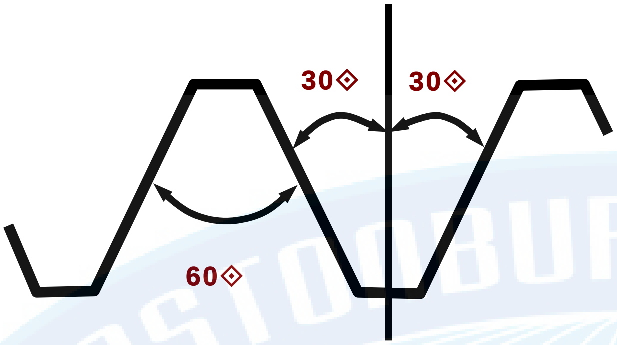

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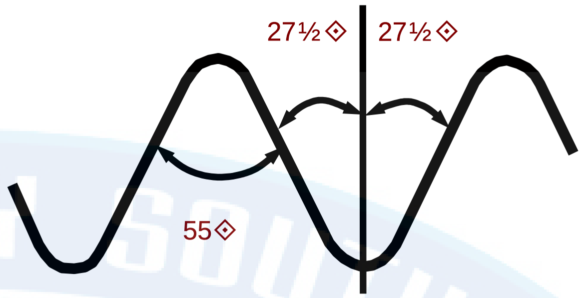

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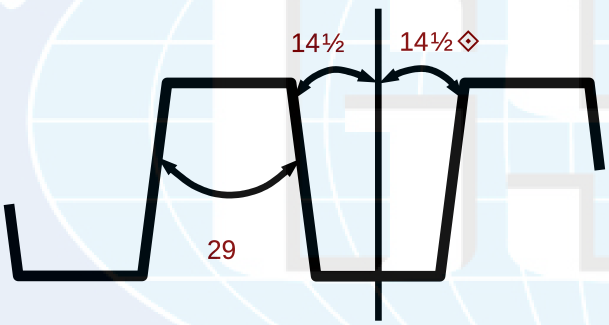
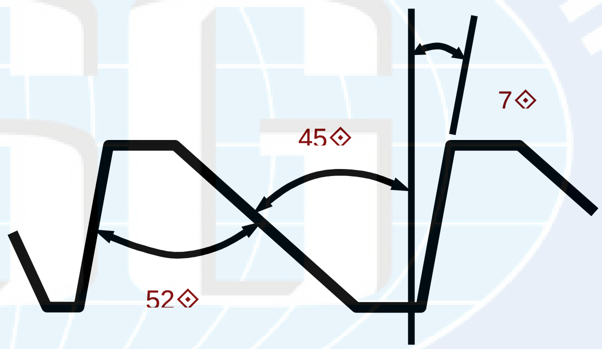


Acme / Stub Acme



Buttress

PIPE THREADS

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Pipe threads are threads that seal. Pipe threads seal by various methods, but the ones we are going to concern ourselves with here are those that are designed to seal at the threads. For threads to seal there are two ways to accomplish a seal, assemble two tapered threads or assemble a straight thread with a tapered thread.

Tapered threads use a completely different system to determine size than the Go / NoGo system used in straight threads, (the standard inch and metric series are straight threads). There are many different types and styles of pipe threads, far too numerous to try to address here individually. The most common is the NPT, which is used in many various applications and which is the basis of which many of the other styles are modifications.

With straight threads, the Go and NoGo gages tell you that your part is within the acceptable limitations of size. With a tapered thread, this system does not work as a gage inserted into a hole or engaged with an external thread will at some point lock together with the part. The method used is an indirect measurement where you measure the distance from a datum point on the part to a datum point on the gage and adjust for the ratio of taper to know the part size. This is not as complicated as it sounds.

The NPT and most of the other pipe threads are made on a taper of .750" per foot, or .0625" per inch. This is an even ratio of 16:1. In other words, when you travel along the axis of the thread .016 you will experience a diametrical change of .001.

Knowing this ratio it is easy to measure the diametrical size when compared to a gage of known size.

Sealing theory

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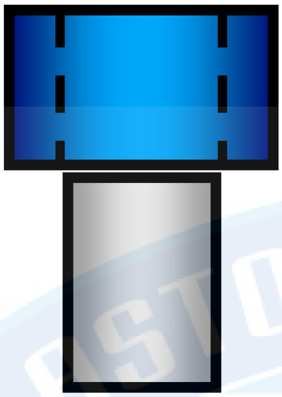
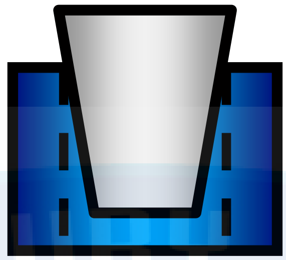
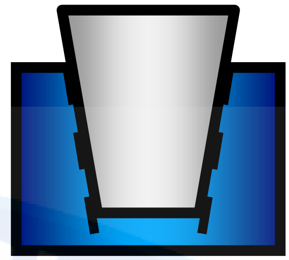


Straight to Straight
No Seal



Taper to Straight



Taper to Taper

When a straight external thread is assembled with a straight internal thread if it assembles then it will continue through the thread without sealing. When a tapered external thread is assembled with a straight internal thread it will at some point lock together and seal. When a tapered external thread is assembled with a tapered internal thread it will lock together and seal. That is the theory that is used when the seal has to be accomplished at the threads. A seal would also be accomplished using a straight external thread and a tapered internal thread, but this configuration is not used because there would be too much shake making for an unstable connection that would not remain sealed.

Pipe nomenclature

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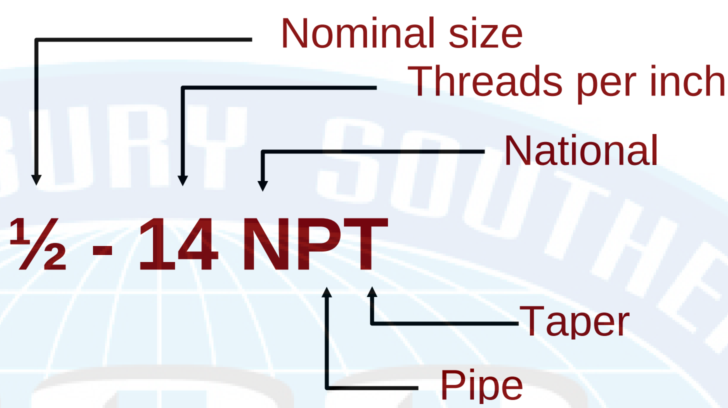
The letters following the nominal size and pitch indicate the pipe thread application. The following letters are used:

A - Aeronautical
C - Coupling
F - Dryseal (Fuel)
G - Gas
H - Hose
I - Intermediate
L - Loose
M - Mechanical
N - National
P - Pipe
R - Railing
S - Straight
T - Tapered



Straight Pipe Threads Nomenclature

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With straight pipe threads (the internal thread is straight, and assembled with a tapered external thread) there should always be four letters to designate the application. Without the fourth letter the application is not known and therefore the parts or gages may be incorrect causing failure of the seal.

You may encounter situations where a straight pipe thread is indicated as NPS without the fourth letter. An inquiry may result in the response, "Just give me the standard one." This response is unacceptable as there is no such thing as a standard one. The application must be known and will be indicated by the fourth letter.

Common pipes

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NPT - National Pipe Taper

Gages required	L1 Ring Gage
	L1 Plug Gage

NPTF - National Pipe Tapered Dryseal

Gages required	L1 Ring, L2 Ring, 6 Step Ring Gages
	L1 Plug, L3 Plug, 6 Step Plug Gages

ANPT - Aeronautical National Pipe Taper

Gages required	L1 Ring, L2 Ring, 6 Step Ring Gages
	L1 Plug, L2 Plug, 6 Step Plug Gages

Indirect measurement

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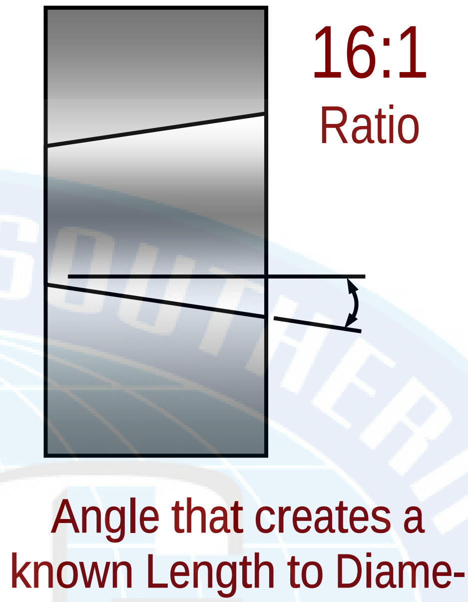
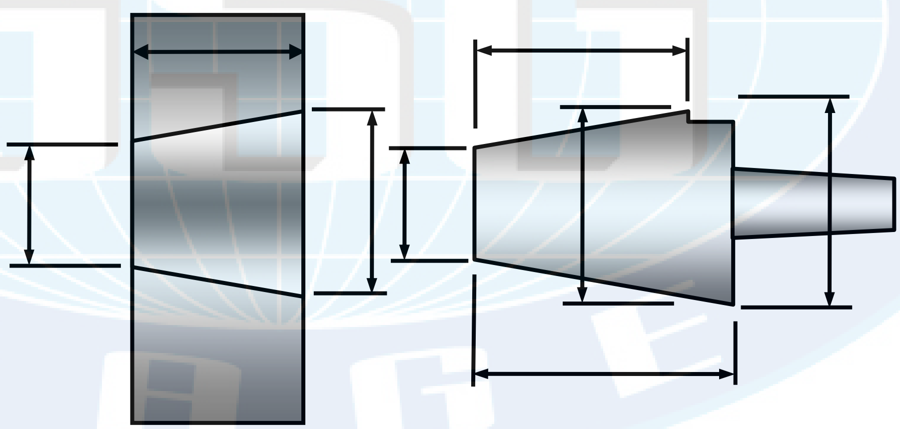
Tapered pipe fittings (nipples - external thread, coupling - internal thread) and the tapered gages used for them are all measured by a method called indirect measurement. This means simply that one feature or dimension is measured by measuring some other feature instead.



The pitch diameter of the thread cannot be easily measured directly because it is a spiral taper. A means is needed to measure product that is simple, conclusive and accurate. Indirect measurement satisfies these requirements.

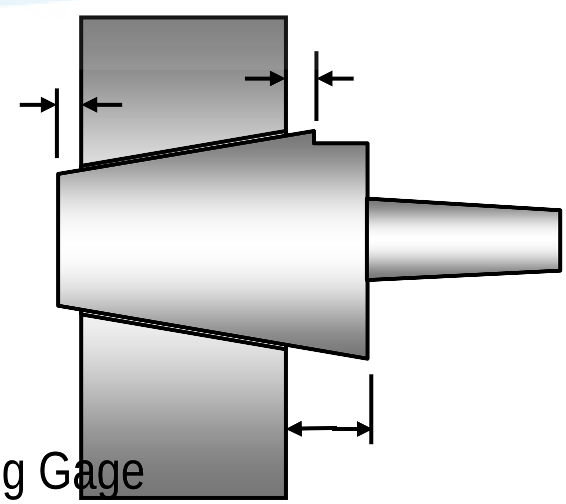
The gages have been designed for quick visual use by an operator with little instruction. Understanding the method and how it works is somewhat complicated, but using the gages to measure product is not complicated.

A ring gage with known (calibrated) dimensions can be used to measure an external part or gage. A plug gage with known (calibrated) dimensions can be used to measure an internal part or gage.



The gage and product or master and gage are assembled and the axial distance is measured. The measured distance can then be multiplied by the ratio (16 in the case of a standard taper) and added to or subtracted from the known dimension to find the dimension of the part or gage being measured.

This basic theory is used to measure the size of product pitch diameters with the L1 plug and ring gages, and is pre-calculated to make the use of these gages visually simple.



L-1 plug and Ring Gage

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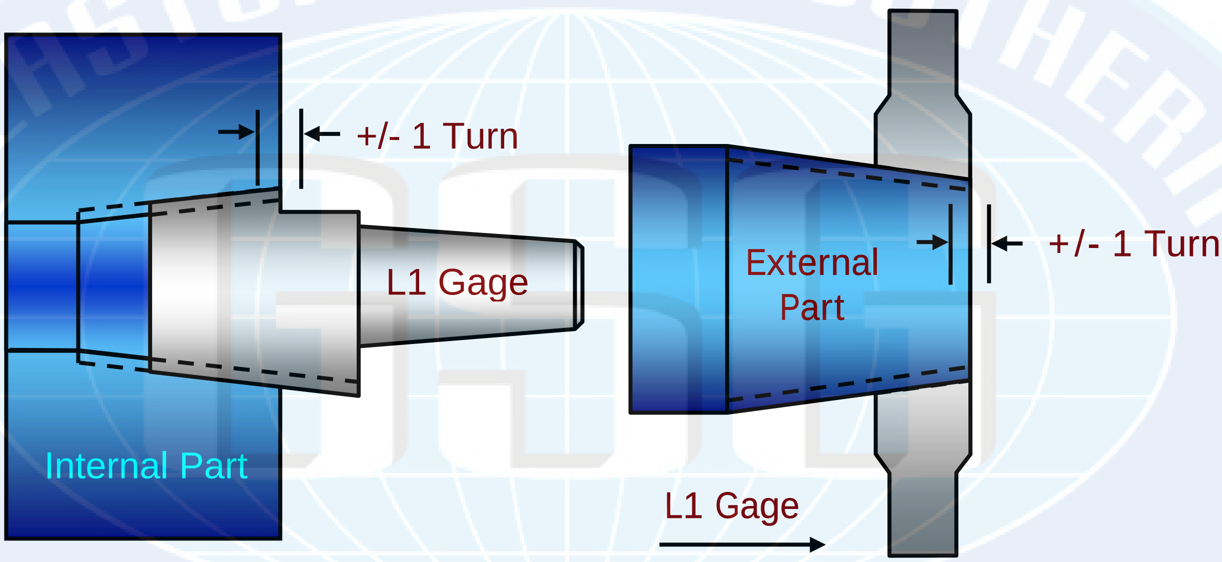
The purpose of the L1 gage is to measure the size of the product. To translate this measurement method into a usable form, the NPT gage designated as the L-1 is built with the thread having a .750" taper per foot, and a notch or step cut into the thread showing the plane perpendicular to the axis where the diameter of the part is to be measured. This L-1 gage is screwed into the part (internal) or onto the part (external) using hand tight engagement. If the taper of the product is correct, the gage will seat firmly, but if the taper is beyond the allowable tolerance in either direction there will be noticeable shake in the gage. The distance is measured between the step and the scratch of the first thread (most technicians measure from the face) of the part, and if the step is anywhere within 1 turn then you have a good part.



If any element of the threaded part is incorrect the gage will not seat properly or stop in the measurement zone. This may sound like too broad a statement, but the NPT thread is designed on the premise that the mating parts will be sealed with an agent that will compensate for minor irregularities in the mating threads.

Many companies find it necessary to measure NPT threads more thoroughly than the standard requires to fully satisfy their customers. In those cases, the NPTF system is used, but not the NPTF gages.

If more precise measurement is needed than the L-1 alone gives, then the ANPT L-2, L-3, and 6-step gages are used with the NPT L-1. These ANPT gages will have the ‘A’ removed from the identification to eliminate confusion on the part of the user. This is the standard practice in the gage industry. If the gages are not properly marked to check NPT threads, they may not be used as they could be modified or altered. Another reason the marking must be correct is to please the quality auditors. They would disapprove use of a gage with a thread designation different from that which the specification for a part indicates is proper.

L-2 ring / l-3 plug

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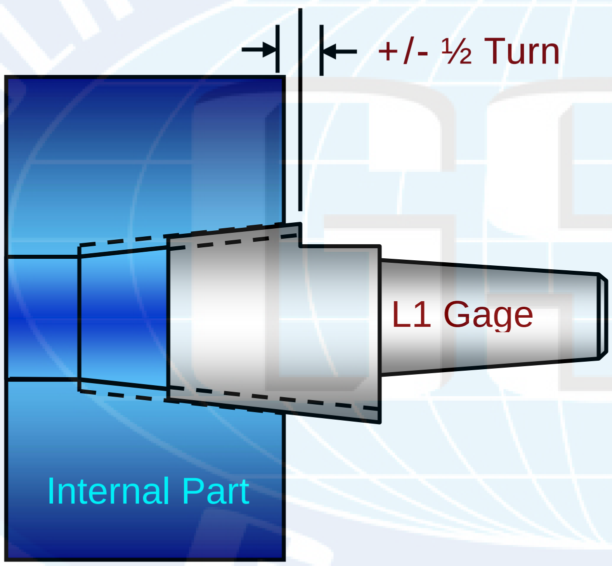
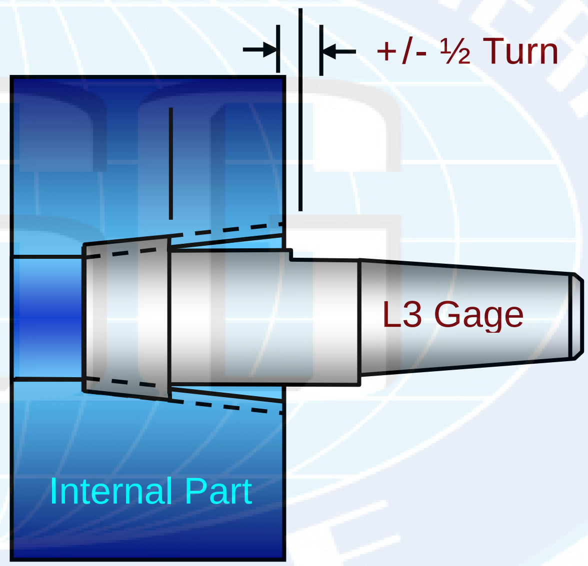
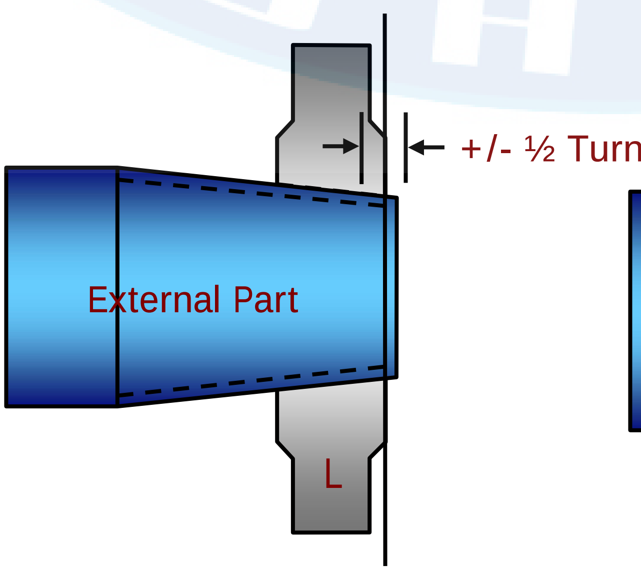
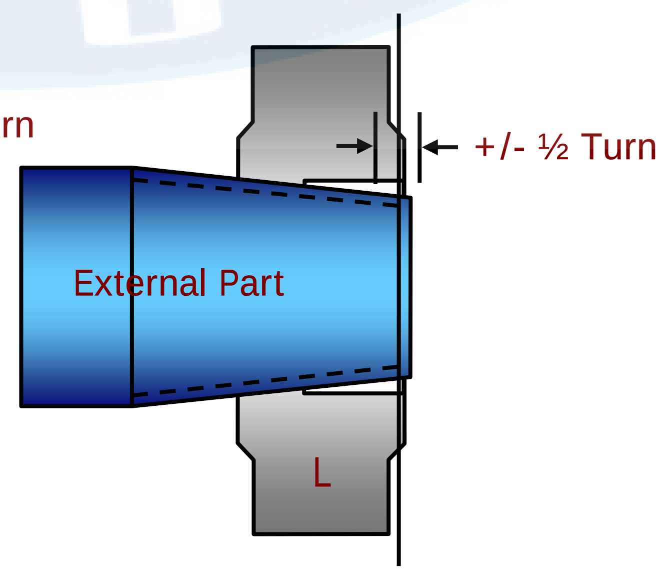
The purpose of the L2 Ring and the L3 plug is to measure the taper of the part. This gage does not check size, it checks taper only. The L2 ring and L3 plug are used as a comparative measurement to the L1 ring or plug.

After using the L-1 gage the L2 ring or L3 plug is assembled with the part and must stop within 1/2 turn plus or minus of where the L1 stopped. The L-2 ring and L-3 plug are designed to clear the threads of the part that the L-1 assembled with and assemble with the threads further on or in the part. This measures the taper of the thread of the part by comparing the front threads and the back threads of the part. If the taper is too severe or too straight, the L-2 ring or L-3 plug will not stop within 1/2 turn from the point where the L-1 stopped.

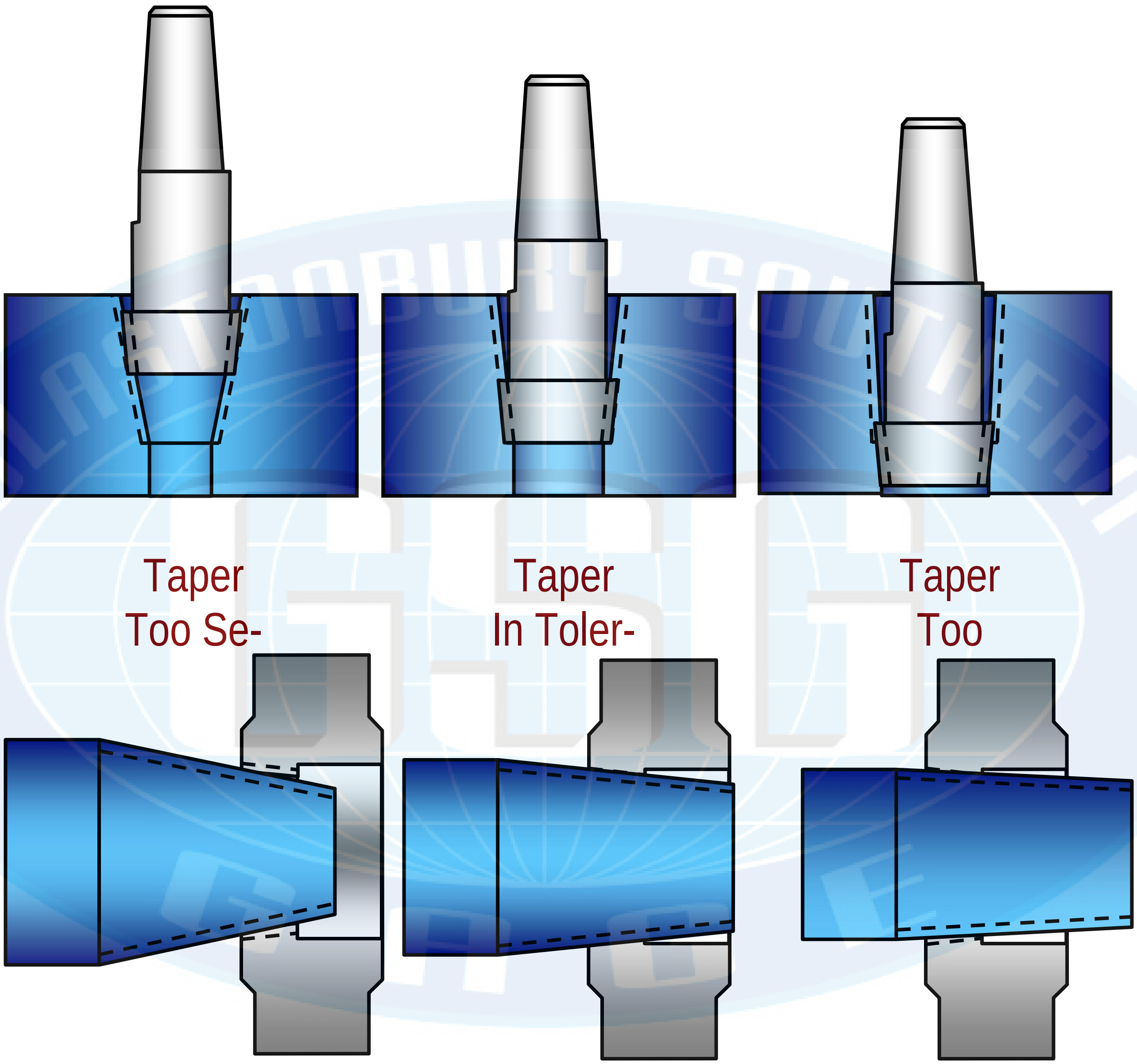








The following illustrates the three possible outcomes when using the L2 and L3 gage.



When the taper of the product is too severe the L2 or L3 gage will lock up before reaching the point of the 1/2 turn limit.

When the taper of the product is correct the L2 or L3 gage will lock up within the 1/2 turn limit zone.

If the taper of the product is too straight, not severe enough, the L2 or L3 gage will engage farther into or onto the product and beyond the 1/2 turn limit.

Remember, this gage has one purpose, to check the taper. It cannot be used to check the size of the product and can only be used after the L1 has been used to know where the 1/2 turn limit is for the product being inspected.

dryseal

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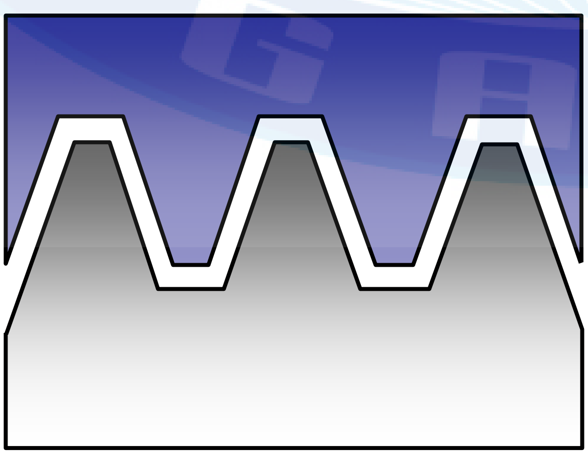
The NPTF design is different from the NPT in that it is designed to create a seal without the use of any type of sealants, i.e. Dryseal. The standard for NPTF threads (ANSI B1.20.3) allows Class 1 and Class 2 applications.

The Class 1 applications do not require inspection of the crest and root diameters. Consequently, Class 1 threads are intended for applications where close control of tooling is required for conformance of truncation or where sealing is allowed to be accomplished by means of a sealant applied to the threads. Class 2 applications require the inspection of the crest and root truncation, to create more assurance of a pressure-tight seal where sealants are not used.

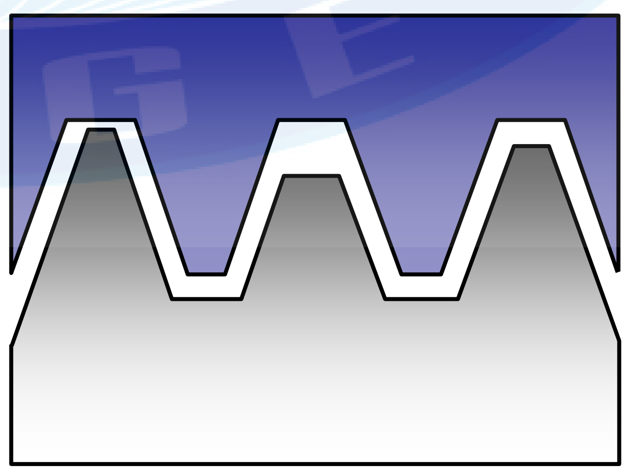
The ANPT design is not a dryseal design, but because of the use of these threads in aeronautical applications, which is safety critical, the NPTF inspection method is employed to assure complete inspection to guarantee maximum product application qualities.

For the dryseal application to be accomplished the threads of the internal product and the external product have to contact at very near the same time. After the two products have been assembled hand tight, the system calls for two or three more turns of engagement. This causes the threads to tear into each other, or as we say 'displace material.' For the dryseal to occur a full thread form material displacement must occur. Without this full thread form displacement the product would not seal and a leak would result.

A leak in a dryseal application could be catastrophic as dryseal applications are used in situations where high pressure could eject any sealant or in applications where corrosive agents are used and the corrosive agent could dissolve the sealant.

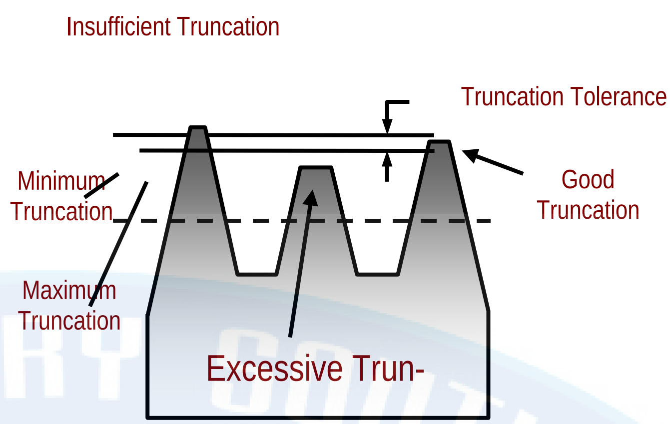


In this illustration a dryseal could be achieved because the threads would contact at near the same time along the full thread form.



In this illustration a dryseal could not be achieved because the threads would not contact at near the same time along the full thread form.

The thread form is measured by measuring the amount of thread removed from a theoretical sharp thread. Removing part of the thread height is referred to as truncating the thread. The amount of truncation is measured as a relationship to the pitch diameter. This allows us to compare the crest of the thread to the pitch diameter of the thread. In other words, we can use a gage as a comparison to the L1 gage.



6 step plug and ring

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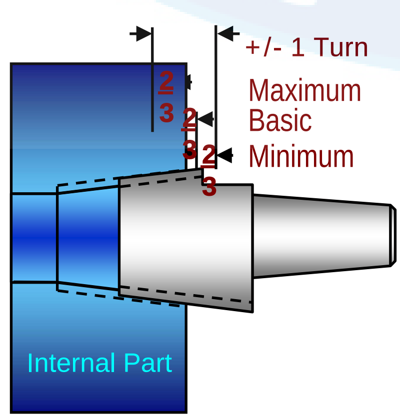
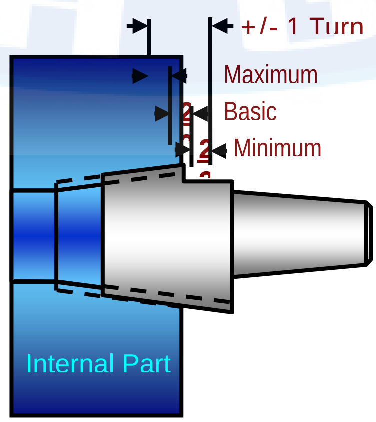
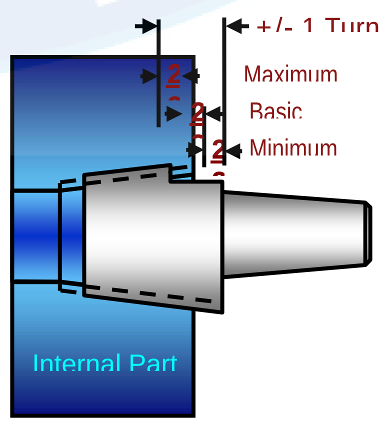
The NPTF system begins with the use of the L-1 gage having a 1 turn in or out limit (2 turns total) the same as the NPT system. The purpose of this gage is to measure the pitch diameter size of the part. It is necessary to refine the standoff (distance from the step to the part) to a more accurate measurement because the 2-turn total tolerance limit must be divided into 3 equal zones. These three zones are known as the minimum, basic, and maximum zones, and the part is referred to as a minimum part, basic part, or maximum part.

The basic zone is the linear area within 1/3 turn from the face of the part, in or out. If the plug gage is standing out from the face (or datum point) of the internal part more than 1/3 of a turn you have a minimum part because the step on the gage stops within the minimum zone. Likewise, if the plug stands in more than 1/3 of a turn you have a maximum part. The larger the hole is, the deeper the plug will enter into it. A smaller hole, but within tolerance, is a minimum part. A larger hole, but within tolerance, is a maximum part. A hole close to the target size (within 1/3 turn) is a basic part.



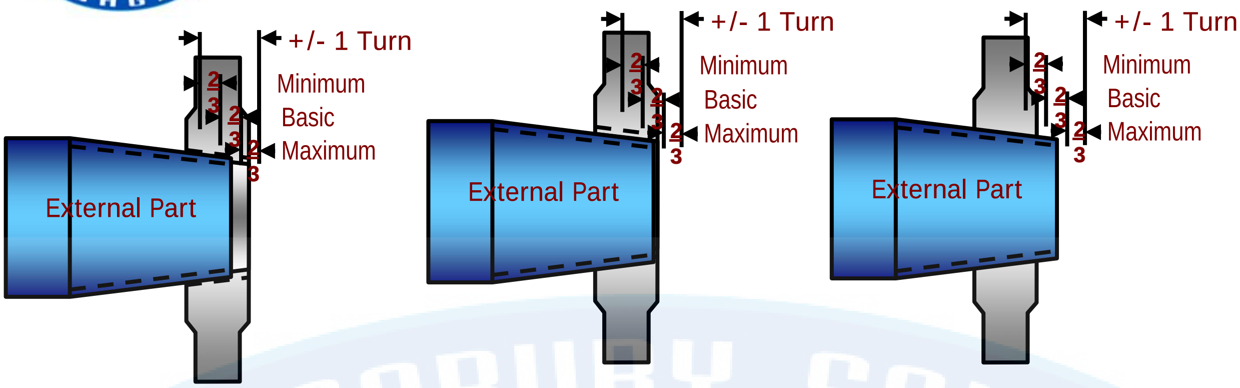




Minimum Part

Basic Part

Maximum Part



Maximum Basic Part Minimum

The same ideology is true for the external product but reversed. Again, It is necessary to refine the standoff (distance from the step to the part) to a more accurate measurement because the 2-turn total tolerance limit must be divided into 3 equal zones. These three zones are known as the minimum, basic, and maximum zones, and the part is referred to as a minimum part, basic part, or maximum part.

The basic zone is the linear area within 1/3 turn from the face of the part, in or out. If the ring gage is standing out from the face (or datum point) of the external part more than 1/3 of a turn you have a maximum part because the face on the gage stops within the maximum zone. Likewise, if the ring stands in more than 1/3 of a turn you have a minimum part. The smaller the part is, the farther the ring will engage onto it. A larger part, but within tolerance, is a maximum part. A smaller part, but within tolerance, is a minimum part. A part close to the target size (within 1/3 turn) is a basic part.

Zones and truncation limits

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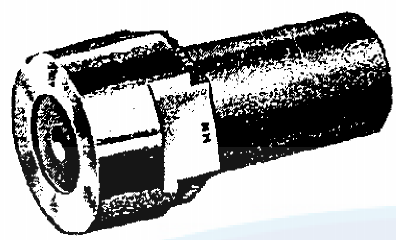
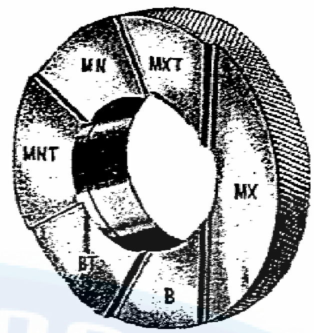
Zones	Truncation Limits	6 Steps
Minimum	Minimum	Mn
	Maximum	Mnt
Basic	Minimum	B
	Maximum	Bt
Maximum	Minimum	Mx
	Maximum	Mxt

The three zones represent different pitch diameter size limits. There is a minimum and maximum limit for the proper amount of truncation that would create full thread form displacement. With three size zones and two limits each there are six possible scenarios represented by the six steps on the 6 step ring and 6 step plug.

This may all sound a bit complicated, but the actual use is very simple. Only two of the six steps are used. The L1 gage identifies the part as being a minimum, maximum, or basic part. The two appropriate steps are chosen Mn and Mnt for minimum parts, B and Bt for basic parts, or Mx and Mxt for maximum parts. The 6 step gage is pushed into or onto the part and if the face comes to rest between the two appropriate steps, the part is acceptable.



6-STEP PLUG



6-STEP RING

It is not easy to measure by eye where these zones begin and end. Gages can be made with three steps or four steps that simplifies this for the user. The other option is to measure the distance with an instrument. 1 turn of a thread can be easily computed with the formula (1 divided by the threads per inch). This gives you the pitch. Divide the pitch by 3 and you can measure the standoff to find the type of part you have. You must know the type of part (min., basic, or max.) to use the 6-step gage.

Inspection with the non-threaded 6-step gage shown here will inspect the thread crest truncation. The root truncation should also be inspected. This can be accomplished by means of a threaded 6-step gage using the same principles of application as the non-threaded 6-step gage.

Parts that conform to product specifications, whether minimum, basic or maximum parts, may be assembled and will achieve a dry seal. It is not necessary to mate parts together that are both basic, or both maximum, or both minimum, so there is no need to categorize the parts.

Interchangeability

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The first consideration in gaging pipe threads is the type of gages used. Gages are specifically designed per the appropriate standard for each type of pipe thread. It is not proper to interchange or substitute gage type and pipe thread type when the correct gage is not available. For example; using NPTF gages on NPT parts.

The manufacturing tolerances for gages vary with type and this causes the gages to vary as to size, giving different inspection results.

The formula for computing the major diameters of pipe plugs gages, and minor diameters of pipe ring gages differ with each type of pipe, because of the difference in the formulas used to compute the major and minor diameters of the various types of pipe threads. This causes the thread form of the gages to mate with the thread form of the product differently when comparing different gages (of various pipe types) to the same product thread.

Using gages **not** designed for the product being gaged can result in contact at the major or minor diameter instead of the flanks and cause incorrect inspection results.

It is possible to inspect one type of pipe with another type of gage and get a reading that says the product is good, but you do not have any assurance your inspection results are correct. It is much more likely that you will not get a correct measurement.

NPT & ANPT threads are designed to mate and be sealed with some type of sealant. NPTF threads are designed to mate and seal without using any type of sealant (this is the reason they are called Dryseal threads). The design of NPTF dryseal threads is not just a tightening of the standard pipes (NPT), but rather a modification. It is an incorrect assumption that you can make a better NPT product thread by using dryseal gaging. What you usually get is an incorrectly manufactured NPT product thread.

The conclusion; use the gage that is specifically designed for that particular product thread. If different pipe gages give different results, the gage designed for the product thread type has the final say, assuming of course, that the gages being used are good gages.

STRAIGHT PIPE THREADS

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There are several pipe threads where the internal and external threads are both straight. In these cases the products threads are inspected using Go/NoGo type gages. These threads will always have to have a sealant applied to assure sealing.

In the cases of pipe threads where the internal product is straight, and the external product is tapered, the product must be inspected with tapered gages to measure functional fit. When the tapered plug gage is applied to a straight internal thread, the gaging notch should be flush with the product face (or datum point) within plus or minus one and one-half turns.

CYLINDRICAL GAGE TOLERANCE

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The tolerance of the gage is based on the tolerance of the part it is to inspect. The rule of thumb is to use a maximum of 10% of the part tolerance for the gages. This allows the part manufacturer to use 90% of the tolerance for their manufacturing window, as the gages are made within the part tolerance to assure quality. The 10% is split between the Go and NoGo gages.

are held plus; NoGo cylindrical plugs, and Go cylindrical rings are held minus.

Straightness, taper, and out-of-roundness must be held within 1/2 of the diameter tolerance. Tolerances for Cylindrical Plug

For example: If the product has a range of .499 - .500 diameter, 10% would be .0001, which split becomes .00005 (50 millionths). Looking at the tolerance chart you would use class X gages, or better.

The tolerances given in this chart are to be applied to the diameter of the gage. Go cylindrical plugs, and NoGo cylindrical rings

Gages used to check the minor diameter of internal threads, and Cylindrical Ring Gages used to check the major diameter of external threads, are specified in the thread standard as Class Z.

GAGE TOLERANCE FOR PLAIN CYLINDRICAL GAGES

SIZE RANGE		TOLERANCE IN INCHES					
Above	**To**	**XXX**	**XX**	**X**	**Y**	**Z**	**ZZ**
0.020	0.825	.000010	.000020	.000040	.000070	.00010	.000200
0.825	1.510	.000015	.000030	.000060	.000090	.000120	.000240
1.510	2.510	.000020	.000040	.000080	.000120	.000160	.000320
2.510	4.510	.000025	.000050	.000100	.000150	.000200	.000400
4.510	6.510	.000032	.000065	.000130	.000190	.000250	.000500
6.510	9.510	.000040	.000080	.000160	.000240	.000320	.000640
9.510	12.010	.000050	.000100	.000200	.000300	.000400	.000800

GLOSSARY

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ALLOWANCE: The minimum clearance between two mating parts. The variations from the basic size which are prescribed to permit the desired amount of play in a metal-to-metal fit.

BASIC SIZE: The theoretical size (usually the same as the nominal size), from which the design size limits are derived by the application of tolerances and allowances.

CLEARANCE: The radial distance between an external diameter and an internal diameter.

CONVOLUTE: Removal of the incomplete threads at the end faces of a threaded part.

CREST: The top of the thread form. The major diameter of an external thread, or the minor diameter of an internal thread.

FIT: The term used to designate the tightness or looseness of two mating parts, resulting from a combination of tolerances and allowances applied to the basic size of the parts.

FLANKS: The sides of the thread form or groove, connecting the crest and the root.

FLANK ANGLE: The angle between the flank and a line perpendicular to the axis of the thread. Also referred to as half angle or lead angle. Some exceptions to this definition will be encountered, such as tapered thread flank angles measured perpendicular to the taper, and should be noted.

FUNCTIONAL DIAMETER: The actual (measured) pitch diameter of a thread adjusted by the cumulative effects of lead error and angle error, which is always added to external threads and subtracted from internal threads.

INCLUDED ANGLE: Total of the two flank angles of a thread form.

LEAD: The distance advanced by a thread when rotated 360 degrees on its mating thread.

LIMITS: The largest and smallest extremes in the size of a dimension.

MAJOR DIAMETER: The largest diameter of a thread form. The root diameter of an internal thread and the crest diameter of an external thread.

MINOR DIAMETER: The smallest diameter of a thread form. The bore or crest diameter of an internal thread and the root diameter of an external thread.

NOMENCLATURE: In relation to a thread, the complete identification, including the nominal size, threads per inch or pitch, thread series, class of fit, and possibly a designation for internal or external.

NOMINAL SIZE: The size used for purposes of identification. Usually the same as the basic size.

PITCH: The distance between corresponding points on adjacent threads. The inverse of the threads per inch.

PITCH DIAMETER: The theoretical diametrical plane, which passes through a thread at the point where the width of the thread tooth and groove are equal.

RELIEF: Removal of material from portions of a surface or diameter to avoid contact with the mating part when it is engaged.

REFERENCE GAGE: A master gage generally held to close tolerance limits which is preserved for periodic comparison with working gages. A truncated setting plug is a reference gage that is used to inspect as well as set adjustable thread ring gages.

ROOT: The bottom of the thread form. The major diameter of an internal thread and the minor diameter of an external thread.

THREAD ANGLE: The included angle of the thread form, which has the two thread flanks as sides.

TOLERANCE: The amount of variation permitted from the designated dimension, or the difference between the minimum and maximum dimensions.

TRUNCATE: To remove the crest of a thread, thus reducing its height, usually done to guarantee non-interference.

COMMON THREAD TYPES

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ACME	29 Degree included angle
ACME-C	Centralizing, eliminates radial displacement
ACME-G	General purpose
AMO	American standard microscope objective
ANPT	Aeronautical National Pipe Taper
BUTT	Buttress – Unequal flank angles Pull type – pressure away from mating parts
PUSH BUTT	Buttress with pressure toward mating parts
DIN	Deutschland (Germany) Industrial National
F-PTF	Dryseal fine taper series
Helicalcoil	Oversize internal thread for thread inserts
JIS	Japanese Industrial Standard
M	Metric Screw Threads, Standard profile 60 degrees
MJ	Metric series with rounded root & crest for strength, eliminates stress or break points
MJS	Metric J series for internal thread Class 5 interference fit
N	American national series
NC	N Coarse pitch series
NF	N Fine pitch series
NEF	N Extra Fine pitch series
NS5	National series special internal thread interference fit
NS5 IF	NS5 form for entire ferrous material range
NS5 INF	NS5 form for entire nonferrous material range
NGO	National Gas Outlet
NGS	National Gas Straight
NGT	National Gas Taper
NH	National Hose coupling full form thread
NPSC	National Pipe Straight Coupling
NPSF	National Pipe Straight Fuel, Dryseal internal thread
NPSH	National Pipe Straight Hose, coupling threads for joining to standard taper pipe threads
NPSI	National Pipe Straight Intermediate, Dryseal internal thread
NPSL	National Pipe Straight Loose, for loose fitting mechanical joints with locknuts
NPSM	National Pipe Straight Mechanical, for free fitting mechanical joints for fixtures
NPT	National Pipe Taper, for general use
NPTF	National Pipe Taper Dryseal, used in high pressure applications where sealant may not be acceptable
NPTR	National Pipe Taper Railing joints
PTF-SAE Short	NPTF modified short threads for thin wall tubing
PTF-SPL Short	PTF-SAE Short modified for thinner wall tubing
PTF-SPL Extra Short	PTF-SAE Short modified for extremely thin wall tubing
SGT	Special Gas Taper
SPL-PTF	Special NPTF
STI	Screw Thread Insert, same as Helicalcoil

STUB ACME	Shallow thread ACME form
STUB ACME M1	STUB ACME Modified Form 1
STUB ACME M2	STUB ACME Modified Form 2
UN	Unified Screw Thread series
UNC	UN Coarse pitch series
UNF	UN Fine pitch series
UNEF	IN Extra Fine pitch series
UNJ	UN modified radius root & crest for strength, eliminates stress or break points
UNJC	UNJ Coarse pitch series
UNJF	UNJ Fine pitch series
UNJEF	UNJ Extra Fine pitch series
UNR	UN modified external thread with Rounded root radius
UNRC	UNR Coarse pitch series
UNRF	UNR Fine pitch series
UNREF	UNR Extra Fine pitch series
UNM	UN Miniature series
UNS	UN Special diameter, pitch, length of engagement, pitch diameter, etc. Qualifying information must follow nomenclature if any other than diameter.

COMMON BRITISH THREADS

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BSC	British Cycle
BSF	British Standard Fine
BSW	British Standard Coarse
BSPP	British Standard Pipe Parallel (straight mechanical joints)
BSPT	British Standard Pipe Taper (pressure tight joints)
WHIT	British Whitworth Special
G	BSPP (internal)
GxA	BSPP (external, class A)
GxB	BSPP (external, class B)
R	BSPT (external)
Rc	BSPT (internal, tapered)
Rp	BSPT (internal, straight)

INSPECTION / SETTING PROCEDURE

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SOUTHERN STYLE THREAD RING

1. CLEAN

Thoroughly clean the threads with a bristle brush and solvent, wipe clean with isopropyl alcohol and clean with kim wipe. Visually inspect the thread ring for nicks, dings or foreign material buildup.

2. INSPECT ID

Using a calibrated tapered pin, set of parallels, or bore gage inspect the ID (minor diameter) of ring gage and record the size.

3. INSPECT PD

a. Lubricate the setting master plug with a thin film of light viscosity oil before inserting into the ring gage.

b. Turn the ring onto the setting plug 1 1/2 to 2 threads at the front. If ring will go onto the setting plug go to operation 4. There should be some resistance or drag even at this short engagement. To test for taper or bellmouth, place the ring on its face on a workbench and test for shake or looseness with the setting plug, being very careful not to damage the end threads.

c. Turn ring further onto the truncated section, remembering the feel at the 1 1/2 to 2 thread engagement. The drag should remain approximately the same although it may be slightly greater at full engagement due to more flank contact.

d. Remove the ring from the setting plug and repeat operations 5b & 5c on the opposite side of the thread ring gage.

e. The fit should be approximately the same on both sides of the ring to insure proper straightness. Remember if a setting plug is manufactured or worn smaller at the front, it will falsely indicate taper or bellmouth in the ring gage. Setting plugs must be reasonably straight.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

g. If at this point nothing is found which indicates a problem skip to operation 5.7.

4. SET RING

NOTE: If ring will go onto setting plug skip to operation 4c.

a. Turn the locking screw counter-clockwise 1/4 turn.

b. Turn the adjusting screw clockwise 1/8 turn maximum to enlarge ring PD. Repeat, if necessary, until ring will go onto setting plug.

c. Turn the ring gage onto the setting plug truncated section so that approximately one thread of setting plug extends beyond the ring. (This will promote uniform wear over the entire thread length of the setting plug.)

d. Turn the adjusting screw counter-clockwise to loosen or clockwise to tighten.

e. Turn the locking screw clockwise until tight. This locks the adjusting screw so that the size of the ring gage remains fixed. There should be noticeable drag between the ring and setting plug.

NOTE: Operations 4c – 4e may need to be repeated more than once to obtain the proper drag or feel.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

5. INSPECT PD

Repeat section 3a – 3f. If at this point nothing is found which indicates a problem continue to operation 6.

6. INSPECT ID

Using a calibrated tapered pin, set of parallels, or bore gage inspect the ID (minor diameter) of ring gage.

NOTE: If an adjustment was necessary to establish the proper feel on the setting plug use the following formula to obtain the as found pitch diameter. (Setting plug pitch diameter) plus (ID size before adjustment) minus (ID size after adjustment.)

7. SEAL

Cover the adjusting and locking screws with sealing wax to prevent unauthorized tampering with the setting of the ring gage.

GAGING CRITERIA

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REFERENCE DOCUMENTS

H-28	Federal Specifications for Screw Threads
B1.1	Unified Inch Screw Threads
B1.2	Gages and Gaging for Unified Inch Screw Threads
B1.13M	Metric Screw Threads - Profile
B1.16	American Gaging Practice for Metric Screw Threads
B1.20.1	Pipe Thread, General Purpose (Inch)
B1.20.3	Dryseal Pipe Threads - Inch
B1.20.4	Dryseal Pipe Threads - Metric
B1.20.5	Gaging for Dryseal Pipe Threads
B4.4M	Inspection of Workpieces
B89.6.2	Temperature and Humidity Environment for Dimensional Measurement
Y 14.6	Screw Thread Representation
MIL-STD-120	Gage Inspection

GAGE CRITERIA

Thread Plugs
- Major Diameter (Size & Straightness)
- Pitch Diameter (Size & Straightness)
- Minor Diameter for clearance only
- Flank Angle Formation
- Lead
- Material (Hardness)

Thread Rings
- Minor Diameter (Size & Straightness)
- Pitch Diameter (Size & Straightness)
- Major Diameter (Root Relief)
- Flank Angle Formation
- Lead
- Material (Hardness)

Cylindrical Rings & Plugs
- Diameter
- Straightness
- Roundness
- Material (Hardness)

Common Thread Forms

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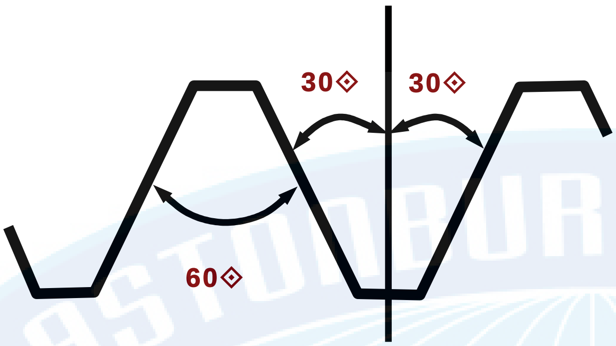
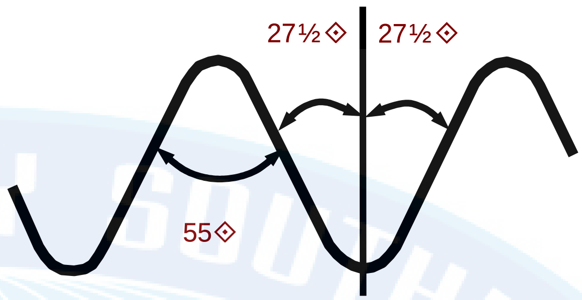
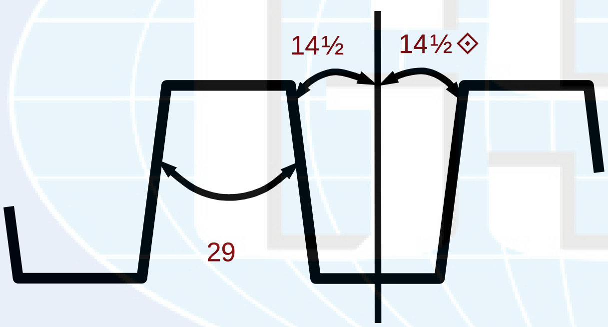


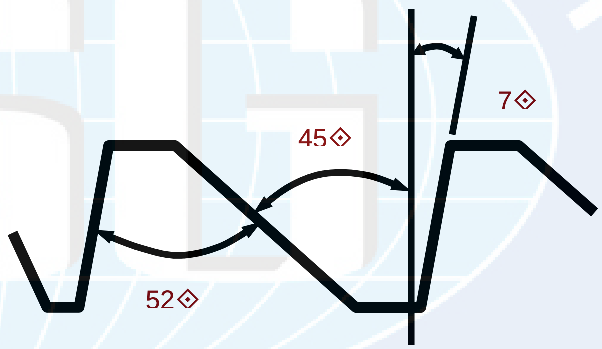
American Inch & Metric



British / Whitworth



Acme / Stub Acme



Buttress

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GLASTONBURY SOUTHERN GAGE

METRIC PITCH DIAMETER

STANDARD SERIES METRIC THREADS — **EXTERNAL** THREADS ONLY (CLASS 6g)
Reference: ANSI-B1.13-1989 and/or FED-STD H28/21

PHONE 800-251-4243
FAX 800-242-7142

BASIC THREAD DESIGNATION	DIMENSIONS IN MILLIMETERS							DIMENSIONS IN INCHES						
	NOMINAL O.D.	PITCH	MAJOR DIA. MAX.	MAJOR DIA. MIN.	PITCH DIA. MAX. GO	PITCH DIA. MIN. LO	MINOR DIA. (FLAT ROOT) MAX.	NOMINAL O.D.	THREADS PER INCH	MAJOR DIA. MAX.	MAJOR DIA. MIN.	PITCH DIA. MAX. GO	PITCH DIA. MIN.	MINOR DIA. (FLAT ROOT) MAX.
M1.6x0.35	1.6	0.35	1.581	1.496	1.354	1.291	1.202	.06299	72.57	.06224	.05890	.05331	.05083	.04732
M2x0.4	2.0	0.40	1.981	1.886	1.721	1.654	1.548	.07874	63.50	.07799	.07425	.06776	.06512	.06094
M2.5x0.45	2.5	0.45	2.480	2.380	2.188	2.117	1.993	.09843	56.44	.09764	.09370	.08614	.08335	.07846
M3x0.5	3.0	0.50	2.980	2.874	2.655	2.580	2.439	.11811	50.80	.11732	.11315	.10453	.10157	.09602
M3.5x0.6	3.5	0.60	3.479	3.354	3.089	3.004	2.829	.13780	42.33	.13697	.13205	.12161	.11827	.11138
M4x0.7	4.0	0.70	3.978	3.838	3.523	3.433	3.220	.15748	36.29	.15661	.15110	.13870	.13516	.12677
M5x0.8	5.0	0.80	4.976	4.826	4.456	4.361	4.110	.19685	31.75	.19591	.19000	.17543	.17169	.16181
M6x1	6.0	1.00	5.974	5.794	5.324	5.212	4.891	.23622	25.40	.23520	.22811	.20961	.20520	.19256
M8x1.25	8.0	1.25	7.972	7.760	7.160	7.042	6.619	.31496	20.32	.31386	.30551	.28189	.27724	.26059
M8x1	8.0	1.00	7.974	7.794	7.324	7.212	6.891	.31496	25.40	.31394	.30685	.28835	.28394	.27130
M10x1.5	10.0	1.50	9.968	9.732	8.994	8.862	8.344	.39370	16.93	.39244	.38315	.35409	.34890	.32850
M10x1.25	10.0	1.25	9.972	9.760	9.160	9.042	8.619	.39370	20.32	.39260	.38425	.36063	.35598	.33933
M10x0.75	10.0	0.75	9.978	9.838	9.491	9.391	9.166	.39370	33.87	.39283	.38732	.37366	.36972	.36087
M12x1.75	12.0	1.75	11.966	11.701	10.829	10.679	10.072	.47244	14.51	.47110	.46067	.42634	.42043	.39654
M12x1.5	12.0	1.50	11.968	11.732	10.994	10.854	10.344	.47244	16.93	.47118	.46189	.43283	.42732	.40724
M12x1.25	12.0	1.25	11.972	11.760	11.160	11.028	10.619	.47244	20.32	.47134	.46299	.43937	.43417	.41807
M12x1	12.0	1.00	11.974	11.794	11.324	11.206	10.891	.47244	25.40	.47142	.46433	.44583	.44118	.42878
M14x2	14.0	2.00	13.962	13.682	12.663	12.503	11.797	.55118	12.70	.54969	.53866	.49854	.49224	.46445
M14x1.5	14.0	1.50	13.968	13.732	12.994	12.854	12.344	.55118	16.93	.54992	.54063	.51157	.50606	.48598
M15x1	15.0	1.00	14.974	14.794	14.324	14.206	13.891	.59055	25.40	.58953	.58244	.56394	.55929	.54689
M16x2	16.0	2.00	15.962	15.682	14.663	14.503	13.797	.62992	12.70	.62843	.61740	.57728	.57098	.54319
M16x1.5	16.0	1.50	15.968	15.732	14.994	14.854	14.344	.62992	16.93	.62866	.61937	.59031	.58480	.56472
M17x1	17.0	1.00	16.974	16.794	16.324	16.206	15.891	.66929	25.40	.66827	.66118	.64268	.63803	.62563
M18x1.5	18.0	1.50	17.968	17.732	16.994	16.854	16.344	.70866	16.93	.70740	.69811	.66906	.66354	.64346
M20x2.5	20.0	2.50	19.958	19.623	18.334	18.164	17.252	.78740	10.16	.78575	.77256	.72181	.71512	.67921
M20x1.5	20.0	1.50	19.968	19.732	18.994	18.854	18.344	.78740	16.93	.78614	.77685	.74780	.74228	.72220
M20x1	20.0	1.00	19.974	19.794	19.324	19.206	18.891	.78740	25.40	.78638	.77929	.76079	.75614	.74374
M22x2.5	22.0	2.50	21.958	21.623	20.334	20.164	19.252	.86614	10.16	.86449	.85130	.80055	.79386	.75795
M22x1.5	22.0	1.50	21.968	21.732	20.994	20.854	20.344	.86614	16.93	.86488	.85559	.82654	.82102	.80094
M24x3	24.0	3.00	23.952	23.577	22.003	21.803	20.704	.94488	8.47	.94299	.92823	.86626	.85839	.81512
M24x2	24.0	2.00	23.962	23.682	22.663	22.493	21.797	.94488	12.70	.94339	.93236	.89224	.88555	.85815
M25x1.5	25.0	1.50	24.968	24.732	23.994	23.844	23.344	.98425	16.93	.98299	.97370	.94465	.93874	.91906
M27x3	27.0	3.00	26.952	26.577	25.003	24.803	23.744	1.06299	8.47	1.06110	1.04634	.98437	.97650	.93480
M27x2	27.0	2.00	26.962	26.682	25.663	25.493	24.797	1.06299	12.70	1.06150	1.05047	1.01035	1.00366	.97626
M30x3.5	30.0	3.50	29.947	29.522	27.674	27.462	26.158	1.18110	7.26	1.17902	1.16228	1.08953	1.08118	1.02984
M30x2	30.0	2.00	29.962	29.682	28.663	28.493	27.797	1.18110	12.70	1.17961	1.16858	1.12846	1.12177	1.09437
M30x1.5	30.0	1.50	29.968	29.732	28.994	28.844	28.344	1.18110	16.93	1.17984	1.17055	1.14150	1.13559	1.11591
M33x2	33.0	2.00	32.962	32.682	31.663	31.493	30.797	1.29921	12.70	1.29772	1.28669	1.24657	1.23988	1.21248
M35x1.5	35.0	1.50	34.968	34.732	33.994	33.844	33.344	1.37795	16.93	1.37669	1.36740	1.33835	1.33244	1.31276
M36x4	36.0	4.00	35.940	35.465	33.342	33.118	31.610	1.41732	6.35	1.41496	1.39626	1.31268	1.30386	1.24449
M36x2	36.0	2.00	35.962	35.682	34.663	34.493	33.797	1.41732	12.70	1.41583	1.40480	1.36469	1.35799	1.33059
M39x2	39.0	2.00	38.962	38.682	37.663	37.493	36.797	1.53543	12.70	1.53394	1.52291	1.48280	1.47610	1.44870

GLASTONBURY SOUTHERN GAGE

METRIC PITCH DIAMETER

STANDARD SERIES METRIC THREADS — **INTERNAL** (Nut) THREADS ONLY (CLASS 6H)
Reference: ANSI-B1.13-1989 and/or FED-STD H28/21

PHONE 800-251-4243
FAX 800-242-7142

BASIC THREAD DESIGNATION	DIMENSIONS IN MILLIMETERS								DIMENSIONS IN INCHES							
	NOMINAL O.D.	PITCH	MAJOR DIA. MIN. (MUST CLEAR)	PITCH DIA. MIN. GO	PITCH DIA. MAX. HI	MINOR DIA. MIN.	MINOR DIA. MAX.		NOMINAL O.D.	THREADS PER INCH	MAJOR DIA. MIN. (MUST CLEAR)	PITCH DIA. MIN. GO	PITCH DIA. MAX. HI	MINOR DIA. MIN.	MINOR DIA. MAX.	
M1.6x0.35	1.6	0.35	1.600	1.373	1.458	1.221	1.321		.06299	72.57	.06299	.05406	.05740	.04807	.05201	
M2x0.4	2.0	0.40	2.000	1.740	1.830	1.567	1.679		.07874	63.50	.07874	.06850	.07205	.06169	.06610	
M2.5x0.45	2.5	0.45	2.500	2.208	2.303	2.013	2.138		.09843	56.44	.09843	.08693	.09067	.07925	.08417	
M3x0.5	3.0	0.50	3.000	2.675	2.775	2.459	2.599		.11811	50.80	.11811	.10531	.10925	.09681	.10232	
M3.5x0.6	3.5	0.60	3.500	3.110	3.222	2.850	3.010		.13780	42.33	.13780	.12244	.12685	.11220	.11850	
M4x0.7	4.0	0.70	4.000	3.545	3.663	3.242	3.422		.15748	36.29	.15748	.13957	.14421	.12764	.13472	
M5x0.8	5.0	0.80	5.000	4.480	4.605	4.134	4.334		.19685	31.75	.19685	.17638	.18130	.16276	.17063	
M6x1	6.0	1.00	6.000	5.350	5.500	4.917	5.153		.23622	25.40	.23622	.21063	.21654	.19358	.20287	
M8x1.25	8.0	1.25	8.000	7.188	7.348	6.647	6.912		.31496	20.32	.31496	.28299	.28929	.26169	.27213	
M8x1	8.0	1.00	8.000	7.350	7.500	6.917	7.153		.31496	25.40	.31496	.28937	.29528	.27232	.28161	
M10x1.5	10.0	1.50	10.000	9.026	9.206	8.376	8.676		.39370	16.93	.39370	.35535	.36244	.32976	.34157	
M10x1.25	10.0	1.25	10.000	9.188	9.348	8.647	8.912		.39370	20.32	.39370	.36173	.36803	.34043	.35087	
M10.0.75	10.0	0.75	10.000	9.513	9.645	9.188	9.378		.39370	33.87	.39370	.37453	.37972	.36173	.36921	
M12x1.75	12.0	1.75	12.000	10.863	11.063	10.106	10.441		.47244	14.51	.47244	.42768	.43555	.39787	.41106	
M12x1.5	12.0	1.50	12.000	11.026	11.216	10.376	10.676		.47244	16.93	.47244	.43409	.44157	.40850	.42031	
M12x1.25	12.0	1.25	12.000	11.188	11.368	10.647	10.912		.47244	20.32	.47244	.44047	.44756	.41917	.42961	
M12x1	12.0	1.00	12.000	11.350	11.510	10.917	11.153		.47244	25.40	.47244	.44685	.45315	.42980	.43909	
M14x2	14.0	2.00	14.000	12.701	12.913	11.835	12.210		.55118	12.70	.55118	.50004	.50839	.46594	.48071	
M14x1.5	14.0	1.50	14.000	13.026	13.216	12.376	12.676		.55118	16.93	.55118	.51283	.52031	.48724	.49906	
M15x1	15.0	1.00	15.000	14.350	14.510	13.917	14.153		.59055	25.40	.59055	.56496	.57126	.54791	.55720	
M16x2	16.0	2.00	16.000	14.701	14.913	13.835	14.210		.62992	12.70	.62992	.57878	.58713	.54469	.55945	
M16x1.5	16.0	1.50	16.000	15.026	15.216	14.376	14.676		.62992	16.93	.62992	.59157	.59906	.56598	.57780	
M17x1	17.0	1.00	17.000	16.350	16.510	15.917	16.153		.66929	25.40	.66929	.64370	.65000	.61886	.63594	
M18x1.5	18.0	1.50	18.000	17.026	17.216	16.376	16.676		.70866	16.93	.70866	.67031	.67780	.64472	.65654	
M20x2.5	20.0	2.50	20.000	18.376	18.600	17.294	17.744		.78740	10.16	.78740	.72346	.73228	.68087	.69858	
M20x1.5	20.0	1.50	20.000	19.026	19.216	18.376	18.676		.78740	16.93	.78740	.74906	.75654	.72346	.73528	
M20x1	20.0	1.00	20.000	19.350	19.510	18.917	19.153		.78740	25.40	.78740	.76181	.76811	.74476	.75406	
M22x2.5	22.0	2.50	22.000	20.376	20.600	19.294	19.744		.86614	10.16	.86614	.80220	.81102	.75961	.77732	
M22x1.5	22.0	1.50	22.000	21.026	21.216	20.376	20.676		.86614	16.93	.86614	.82780	.83528	.80220	.81402	
M24x3	24.0	3.00	24.000	22.051	22.316	20.752	21.252		.94488	8.47	.94488	.86815	.87858	.81701	.83669	
M24x2	24.0	2.00	24.000	22.701	22.925	21.835	22.210		.94488	12.70	.94488	.89374	.90256	.85965	.87441	
M25x1.5	25.0	1.50	25.000	24.026	24.226	23.376	23.676		.98425	16.93	.98425	.94591	.95378	.92031	.93213	
M27x3	27.0	3.00	27.000	25.051	25.316	23.752	24.252		1.06299	8.47	1.06299	.98626	.99669	.93512	.95480	
M27x2	27.0	2.00	27.000	25.701	25.925	24.835	25.210		1.06299	12.70	1.06299	1.01185	1.02067	.97776	.99252	
M30x3.5	30.0	3.50	30.000	27.727	28.007	26.211	26.771		1.18110	7.26	1.18110	1.09161	1.10264	1.03193	1.05398	
M30x2	30.0	2.00	30.000	28.701	28.925	27.835	28.210		1.18110	12.70	1.18110	1.12996	1.13878	1.09587	1.11063	
M30x1.5	30.0	1.50	30.000	29.026	29.226	28.376	28.676		1.18110	16.93	1.18110	1.14276	1.15063	1.11717	1.12898	
M33x2	33.0	2.00	33.000	31.701	31.925	30.835	31.210		1.29921	12.70	1.29921	1.24807	1.25689	1.21398	1.22874	
M35x1.5	35.0	1.50	35.000	34.026	34.226	33.376	33.676		1.37795	16.93	1.37795	1.33961	1.34748	1.31402	1.32559	
M36x4	36.0	4.00	36.000	33.402	33.702	31.670	32.270		1.41732	6.35	1.41732	1.31504	1.32685	1.24685	1.27047	
M36x2	36.0	2.00	36.000	34.701	34.925	33.835	34.210		1.41732	12.70	1.41732	1.36618	1.37500	1.33209	1.34685	
M39x2	39.0	2.00	39.000	37.701	37.925	36.835	37.210		1.53543	12.70	1.53543	1.48429	1.49311	1.45020	1.46496	

GLASTONBURY SOUTHERN GAGE

PITCH DIAMETER CHART

FOR **EXTERNAL** THREADS ONLY – AMERICAN NATIONAL & UNIFIED SERIES

PHONE 800-251-4243
FAX 800-242-7142

NOMINAL SIZE	AMERICAN NATIONAL GO CL. 2 & 3	AMERICAN NATIONAL NO GO CL. 2	AMERICAN NATIONAL NO GO CL. 3	UNIFIED GO CL. 3A	UNIFIED GO CL. 2A	UNIFIED NO GO CL. 2A	UNIFIED NO GO CL. 3A
#0-80 NF, UNF	.0519	.0502	.0506	.0519	.0514	.0496	.0506
#1-64 NC, UNC	.0629	.0610	.0615	.0629	.0623	.0603	.0614
#1-72 NF, UNF	.0640	.0622	.0627	.0640	.0634	.0615	.0626
#2-56 NC, UNC	.0744	.0724	.0729	.0744	.0738	.0717	.0728
#2-64 NF, UNF	.0759	.0740	.0745	.0759	.0753	.0733	.0744
#3-48 NC, UNC	.0855	.0833	.0839	.0855	.0848	.0825	.0838
#3-56 NF, UNF	.0874	.0854	.0859	.0874	.0867	.0845	.0858
#4-40 NC, UNC	.0958	.0934	.0941	.0958	.0950	.0925	.0939
#4-48 NF, UNF	.0985	.0963	.0969	.0985	.0978	.0954	.0967
#5-40 NC, UNC	.1088	.1064	.1071	.1088	.1080	.1054	.1069
#5-44 NF, UNF	.1102	.1079	.1086	.1102	.1095	.1070	.1083
#6-32 NC, UNC	.1177	.1150	.1158	.1177	.1169	.1141	.1156
#6-40 NF, UNF	.1218	.1194	.1201	.1218	.1210	.1184	.1198
#8-32 NC, UNC	.1437	.1410	.1418	.1437	.1428	.1399	.1415
#8-36 NF, UNF	.1460	.1435	.1442	.1460	.1452	.1424	.1439
#10-24 NC, UNC	.1629	.1596	.1605	.1629	.1619	.1586	.1604
#10-32 NF, UNF	.1697	.1670	.1678	.1697	.1688	.1658	.1674
#12-24 NC, UNC	.1889	.1856	.1865	.1889	.1879	.1845	.1863
#12-28 NF, UNF	.1928	.1897	.1906	.1928	.1918	.1886	.1904
#12-32 NEF, UNEF	.1957	.1926	.1935	.1957	.1948	.1917	.1933
1/4-20 NC, UNC	.2175	.2139	.2149	.2175	.2164	.2127	.2147
1/4-28 NF, UNF	.2268	.2237	.2246	.2268	.2258	.2225	.2243
1/4-32 NEF, UNEF	.2297	.2265	.2275	.2297	.2287	.2255	.2273
5/16-18 NC, UNC	.2764	.2723	.2734	.2764	.2752	.2712	.2734
5/16-24 NF, UNF	.2854	.2821	.2830	.2854	.2843	.2806	.2827
5/16-32 NEF, UNEF	.2922	.2889	.2899	.2922	.2912	.2880	.2898
3/8-16 NC, UNC	.3344	.3299	.3312	.3344	.3331	.3287	.3311
3/8-24 NF, UNF	.3479	.3446	.3455	.3479	.3468	.3430	.3450
3/8-32 NEF, UNEF	.3547	.3513	.3523	.3547	.3537	.3503	.3522
7/16-14 NC, UNC	.3911	.3862	.3875	.3911	.3897	.3850	.3876
7/16-20 NF, UNF	.4050	.4014	.4024	.4050	.4037	.3995	.4019
7/16-28 NEF, UNEF	.4143	.4107	.4118	.4143	.4132	.4096	.4116
1/2-12 N, UN	.4459	.4403	.4419	.4459	.4443	.4389	.4419
1/2-13 NC, UNC	.4500	.4448	.4463	.4500	.4485	.4435	.4463
1/2-20 NF, UNF	.4675	.4639	.4649	.4675	.4662	.4619	.4643
1/2-28 NEF, UNEF	.4768	.4731	.4742	.4768	.4757	.4720	.4740
9/16-12 NC, UNC	.5084	.5028	.5044	.5084	.5068	.5016	.5045
9/16-18 NF, UNF	.5264	.5223	.5234	.5264	.5250	.5205	.5230

NOMINAL SIZE	AMERICAN NATIONAL GO CL. 2 & 3	AMERICAN NATIONAL NO GO CL. 2	AMERICAN NATIONAL NO GO CL. 3	UNIFIED GO CL. 3A	UNIFIED GO CL. 2A	UNIFIED NO GO CL. 2A	UNIFIED NO GO CL. 3A
9/16-24 NEF, UNEF	.5354	.5314	.5326	.5354	.5342	.5303	.5325
5/8-11 NC, UNC	.5660	.5601	.5618	.5660	.5644	.5589	.5619
5/8-18 NF, UNF	.5889	.5848	.5859	.5889	.5875	.5828	.5854
5/8-24 NEF, UNEF	.5979	.5938	.5950	.5979	.5967	.5927	.5949
11/16-24 NEF, UNEF	.6604	.6563	.6575	.6604	.6592	.6552	.6574
3/4-10 NC, UNC	.6850	.6786	.6805	.6850	.6832	.6773	.6806
3/4-16 NF, UNF	.7094	.7049	.7062	.7094	.7079	.7029	.7056
3/4-20 NEF, UNEF	.7175	.7129	.7143	.7175	.7162	.7118	.7142
13/16-20 NEF, UNEF	.7800	.7754	.7768	.7800	.7787	.7743	.7767
7/8-9 NC, UNC	.8028	.7958	.7979	.8028	.8009	.7946	.7981
7/8-14 NF, UNF	.8286	.8237	.8250	.8286	.8270	.8216	.8245
7/8-20 NEF, UNEF	.8425	.8378	.8392	.8425	.8412	.8368	.8392
15/16-20 NEF, UNEF	.9050	.9003	.9017	.9050	.9036	.8991	.9016
1"-8 NC, UNC	.9188	.9112	.9134	.9188	.9168	.9100	.9137
1"-12 N, UNF	.9459	.9403	.9419	.9459	.9441	.9382	.9415
1"-14 NS, UNS	.9536	.9487	.9500	.9536	.9519	.9463	.9494
1"-20 NEF, UNEF	.9675	.9627	.9641	.9675	.9661	.9616	.9641
1 1/16-12 N, UN	1.0084	1.0028	1.0044	1.0084	1.0067	1.0010	1.0042
1 1/16-18 NEF, UNEF	1.0264	1.0213	1.0228	1.0264	1.0250	1.0203	1.0228
1 1/8-7 NC, UNC	1.0322	1.0237	1.0263	1.0322	1.0300	1.0228	1.0268
1 1/8-12 NF, UNF	1.0709	1.0653	1.0669	1.0709	1.0691	1.0631	1.0664
1 1/8-18 NEF, UNEF	1.0889	1.0837	1.0853	1.0889	1.0875	1.0828	1.0853
1 3/16-12 N, UN	1.1334	1.1278	1.1294	1.1334	1.1317	1.1259	1.1291
1 1/16-18 NEF, UNEF	1.1514	1.1462	1.1478	1.1514	1.1499	1.1450	1.1478
1 1/4-7 NC, UNC	1.1572	1.1487	1.1513	1.1572	1.1550	1.1476	1.1517
1 1/4-12 NF, UNF	1.1959	1.1903	1.1919	1.1959	1.1941	1.1879	1.1913
1 1/4-18 NEF, UNEF	1.2139	1.2086	1.2102	1.2139	1.2124	1.2075	1.2103
1 5/16-12 N, UN	1.2584	1.2528	1.2544	1.2584	1.2567	1.2509	1.2541
1 5/16-18 NEF, UNEF	1.2764	1.2711	1.2727	1.2764	1.2749	1.2700	1.2728
1 3/8-6 NC, UNC	1.2667	1.2566	1.2596	1.2667	1.2643	1.2563	1.2607
1 3/8-12 NF, UNF	1.3209	1.3153	1.3169	1.3209	1.3190	1.3127	1.3162
1 3/8-18 NEF, UNEF	1.3389	1.3335	1.3351	1.3389	1.3374	1.3325	1.3353
1 7/16-12 N, UN	1.3834	1.3778	1.3794	1.3834	1.3816	1.3757	1.3790
1 7/16-18 NEF, UNEF	1.4014	1.3960	1.3976	1.4014	1.3999	1.3949	1.3977
1 1/2-6 NC, UNC	1.3917	1.3816	1.3846	1.3917	1.3893	1.3812	1.3856
1 1/2-12 NF, UNF	1.4459	1.4403	1.4419	1.4459	1.4440	1.4376	1.4411
1 1/2-18 NEF, UNEF	1.4639	1.4584	1.4601	1.4639	1.4624	1.4574	1.4602

Above taken from Fed. Std. H-28-1957, Part 1 / ANSI B1.1-1997

PITCH DIAMETER CHART

GLASTONBURY SOUTHERN GAGE

FOR **INTERNAL** THREADS ONLY – AMERICAN NATIONAL & UNIFIED SERIES

PHONE 800-251-4243
FAX 800-242-7142

NOMINAL SIZE	GO BASIC ALL CLASSES ALL SERIES	NO GO			
		AMERICAN NATIONAL		UNIFIED	
		CL. 2	CL. 3	CL. 2B	CL. 3B
#0-80 NF, UNF	.0519	.0536	.0532	.0542	.0536
#1-64 NC, UNC	.0629	.0648	.0643	.0655	.0648
#1-72 NF, UNF	.0640	.0658	.0653	.0665	.0659
#2-56 NC, UNC	.0744	.0764	.0759	.0772	.0765
#2-64 NF, UNF	.0759	.0778	.0773	.0786	.0779
#3-48 NC, UNC	.0855	.0877	.0871	.0885	.0877
#3-56 NF, UNF	.0874	.0894	.0889	.0902	.0895
#4-40 NC, UNC	.0958	.0982	.0975	.0991	.0982
#4-48 NF, UNF	.0985	.1007	.1001	.1016	.1008
#5-40 NC, UNC	.1088	.1112	.1105	.1121	.1113
#5-44 NF, UNF	.1102	.1125	.1118	.1134	.1126
#6-32 NC, UNC	.1177	.1204	.1196	.1214	.1204
#6-40 NF, UNF	.1218	.1242	.1235	.1252	.1243
#8-32 NC, UNC	.1437	.1464	.1456	.1475	.1465
#8-36 NF, UNF	.1460	.1485	.1478	.1496	.1487
#10-24 NC, UNC	.1629	.1662	.1653	.1672	.1661
#10-32 NF, UNF	.1697	.1724	.1716	.1736	.1726
#12-24 NC, UNC	.1889	.1922	.1913	.1933	.1922
#12-28 NF, UNF	.1928	.1959	.1950	.1970	.1959
#12-32 NEF, UNEF	.1957	.1988	.1979	.1998	.1988
1/4-20 NC, UNC	.2175	.2211	.2201	.2224	.2211
1/4-28 NF, UNF	.2268	.2299	.2290	.2311	.2300
1/4-32 NEF, UNEF	.2297	.2329	.2319	.2339	.2328
5/16-18 NC, UNC	.2764	.2805	.2794	.2817	.2803
5/16-24 NF, UNF	.2854	.2887	.2878	.2902	.2890
5/16-32 NEF, UNEF	.2922	.2955	.2945	.2964	.2953
3/8-16 NC, UNC	.3344	.3389	.3376	.3401	.3387
3/8-24 NF, UNF	.3479	.3512	.3503	.3528	.3516
3/8-32 NEF, UNEF	.3547	.3581	.3571	.3591	.3580
7/16-14 NC, UNC	.3911	.3960	.3947	.3972	.3957
7/16-20 NF, UNF	.4050	.4086	.4076	.4104	.4091
7/16-28 NEF, UNEF	.4143	.4179	.4168	.4189	.4178
1/2-12 N, UN	.4459	.4515	.4499	.4529	.4511
1/2-13 NC, UNC	.4500	.4552	.4537	.4565	.4548
1/2-20 NF, UNF	.4675	.4711	.4701	.4731	.4717
1/2-28 NEF, UNEF	.4768	.4805	.4794	.4816	.4804
9/16-12 NC, UNC	.5084	.5140	.5124	.5152	.5135
9/16-18 NF, UNF	.5264	.5305	.5294	.5323	.5308

NOMINAL SIZE	GO BASIC ALL CLASSES ALL SERIES	NO GO			
		AMERICAN NATIONAL		UNIFIED	
		CL. 2	CL. 3	CL. 2B	CL. 3B
9/16-24 NEF, UNEF	.5354	.5394	.5382	.5405	.5392
5/8-11 NC, UNC	.5660	.5719	.5702	.5732	.5714
5/8-18 NF, UNF	.5889	.5930	.5919	.5949	.5934
5/8-24 NEF, UNEF	.5979	.6020	.6008	.6031	.6018
11/16-24 NEF, UNEF	.6604	.6645	.6633	.6656	.6643
3/4-10 NC, UNC	.6850	.6914	.6895	.6927	.6907
3/4-16 NF, UNF	.7094	.7139	.7126	.7159	.7143
3/4-20 NEF, UNEF	.7175	.7221	.7207	.7232	.7218
13/16-20 NEF, UNEF	.7800	.7846	.7832	.7857	.7843
7/8-9 NC, UNC	.8028	.8098	.8077	.8110	.8089
7/8-14 NF, UNF	.8286	.8335	.8322	.8356	.8339
7/8-20 NEF, UNEF	.8425	.8472	.8458	.8482	.8468
15/16-20 NEF, UNEF	.9050	.9097	.9083	.9109	.9094
1"-8 NC, UNC	.9188	.9264	.9242	.9276	.9254
1"-12 N, UNF	.9459	.9515	.9499	.9535	.9516
1"-14 NS, UNS	.9536	.9585	.9572	.9609	.9590
1"-20 NEF, UNEF	.9675	.9723	.9709	.9734	.9719
1 1/16-12 N, UN	1.0084	1.0140	1.0124	1.0158	1.0139
1 1/16-18 NEF, UNEF	1.0264	1.0315	1.0300	1.0326	1.0310
1 1/8-7 NC, UNC	1.0322	1.0407	1.0381	1.0416	1.0393
1 1/8-12 NF, UNF	1.0709	1.0765	1.0749	1.0787	1.0768
1 1/8-18 NEF, UNEF	1.0889	1.0941	1.0925	1.0951	1.0935
1 3/16-12 N, UN	1.1334	1.1390	1.1374	1.1409	1.1390
1 3/16-18 NEF, UNEF	1.1514	1.1566	1.1550	1.1577	1.1561
1 1/4-7 NC, UNC	1.1572	1.1657	1.1631	1.1668	1.1644
1 1/4-12 NF, UNF	1.1959	1.2015	1.1999	1.2039	1.2019
1 1/4-18 NEF, UNEF	1.2139	1.2192	1.2176	1.2202	1.2186
1 5/16-12 N, UN	1.2584	1.2640	1.2624	1.2659	1.2640
1 5/16-18 NEF, UNEF	1.2764	1.2817	1.2801	1.2827	1.2811
1 3/8-6 NC, UNC	1.2667	1.2768	1.2738	1.2771	1.2745
1 3/8-12 NF, UNF	1.3209	1.3265	1.3249	1.3291	1.3270
1 3/8-18 NEF, UNEF	1.3389	1.3443	1.3427	1.3452	1.3436
1 7/16-12 N, UN	1.3834	1.3890	1.3874	1.3910	1.3891
1 7/16-18 NEF, UNEF	1.4014	1.4068	1.4052	1.4079	1.4062
1 1/2-6 NC, UNC	1.3917	1.4018	1.3988	1.4022	1.3996
1 1/2-12 NF, UNF	1.4459	1.4515	1.4499	1.4542	1.4522
1 1/2-18 NEF, UNEF	1.4639	1.4694	1.4677	1.4704	1.4687

Above taken from Fed. Std. H-28-1957, Part 1 / ANSI B1.1-1997

PLUG GAGE APPLICATION TO PART

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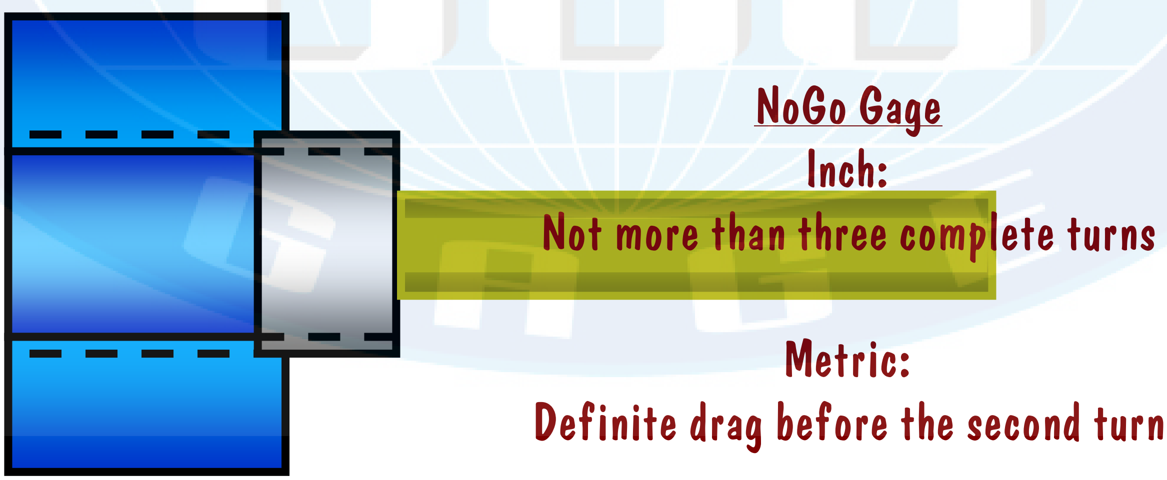
The Go gage should pass completely across or into the product threads. Application of force to engage the Go gage member with the product indicates the product is smaller than the minimum allowable size. Forcing the Go gage to engage with the product will increase the size of the product making it acceptable but wear the gage unnecessarily resulting in a sharp decrease in the life of the Go gage.



Modification of the above requirements may be necessary when the product is thin having few complete threads or when the product is of a material that may stretch or give.

For inch threads, the NoGo should never go beyond the third thread or less if modified. For metric threads the NoGo could theoretically go the full length but should not be continued once the definite drag is felt. If the NoGo engages with the product more than the specified requirements the product is smaller than the minimum acceptable size.

RING GAGE APPLICATION TO PART

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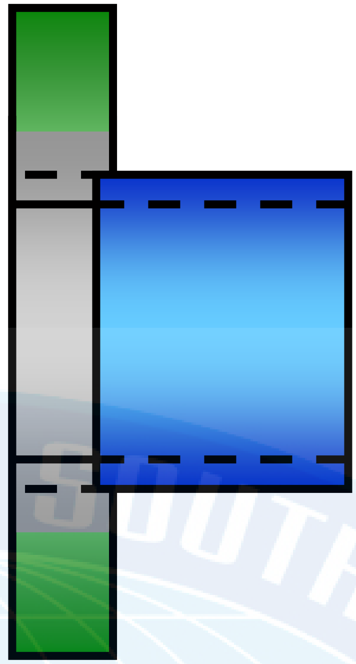
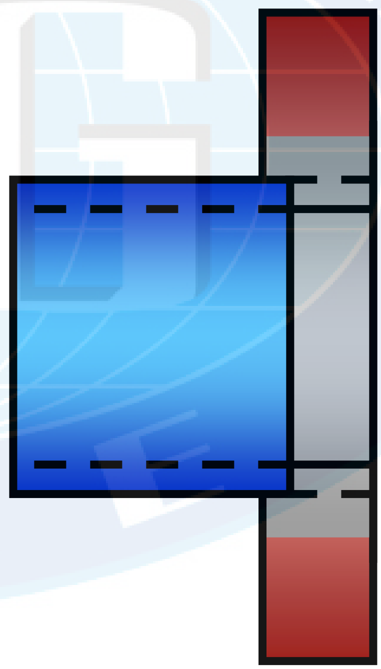


Go Gage
Full Length
Free & Easy

The Go gage should pass completely across or onto the product threads. Application of force to engage the Go gage member with the product indicates the product is larger than the maximum allowable size. Forcing the Go gage to engage with the product will decrease the size of the product making it acceptable but wear the gage unnecessarily resulting in a sharp decrease in the life of the Go gage.



NoGo Gage
Inch:
Not more than three complete turns

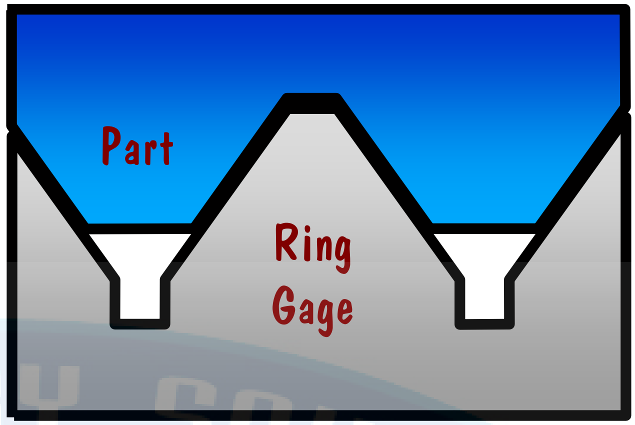
Metric:
Definite drag before the second turn

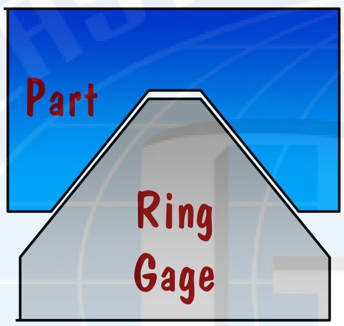
Modification of the above requirements may be necessary when the product is thin having few complete threads or when the product is of a material that may stretch or give.

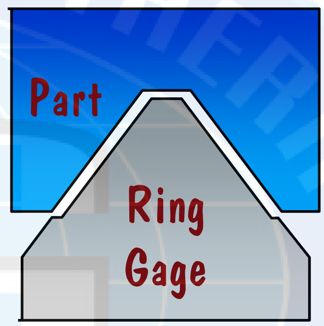
For inch threads, the NoGo should never go beyond the third thread or less if modified. For metric threads the NoGo could theoretically go the full length but should not be continued once the definite drag is felt. If the NoGo engages with the product more than the specified requirements the product is smaller than the minimum acceptable size.

RING GAGE WEAR PLANE

Product is produced in a manner that is designed to make the product as consistent as possible. This creates a scenario where the thread flank of the gages are contacted in the same general area consistently every time a part is inspected. This area we call the **wear plane**. As a gage is used it wears. Plug gages wear and are replaced when they wear outside of the tolerance limit. Ring gages are adjustable, and therefore present a problem we don't experience with plugs.



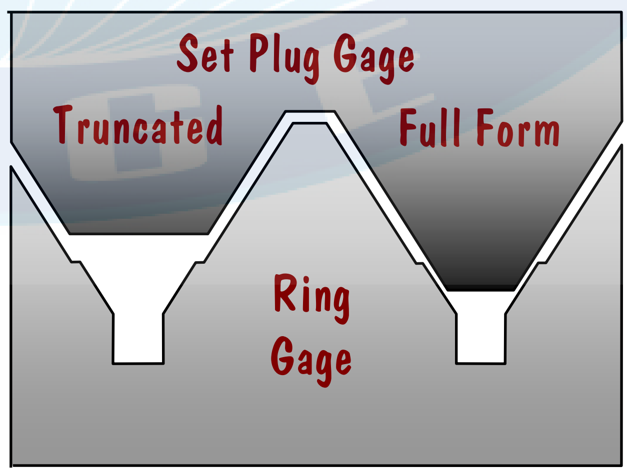




As a ring gage is used it wears, but it can be readjusted to be brought back into size. This means that the wear can continue until the flank is no longer a straight line. This is commonly referred to as the flank having a step wore in it.

The truncated set plug gage is designed to allow the truncated (front) section to contact the ring gage within the wear plane, While the full form (back) section is designed to contact beyond the wear plane.

When the flanks of a ring gage have a step wore in them the ring will feel much looser on the truncated section than on the full form section. This indicates the ring should be repaired or replaced.



INSPECTION / SETTING PROCEDURE

AGD THREAD RING

1. CLEAN

Thoroughly clean the threads with a bristle brush and solvent, wipe clean with isopropyl alcohol and clean with kim wipe. Visually inspect the thread ring for nicks, dings or foreign material buildup.

2. INSPECT ID

Using a calibrated tapered pin, set of parallels, bore gage or other accurate method inspect the ID (minor diameter) of ring gage and record the size.

3. INSPECT PD

a. Lubricate the setting master plug with a thin film of light viscosity oil before inserting into the ring gage.

b. Turn the ring onto the setting plug 1 1/2 to 2 threads at the front. If ring will not go onto setting plug go to operation 4. There should be some resistance or drag even at this short engagement. To test for taper or bellmouth, place the ring on its face on a workbench and test for shake or looseness with the setting plug, being very careful not to damage the end threads.

c. Turn ring further onto the truncated section, remembering the feel at the 1 1/2 to 2 thread engagement. The drag should remain approximately the same although it may be slightly greater at full engagement due to more flank contact.

d. Remove the ring from the setting plug and repeat operations 3b & 3c on the opposite side of the thread ring gage.

e. The fit should be approximately the same on both sides of the ring to insure proper straightness. Remember if a setting plug is manufactured or worn smaller at the front, it will falsely indicate taper or bellmouth in the ring gage. Setting plugs must be reasonably straight.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

g. If at this point nothing is found which indicates a problem skip to operation 7.

4. SET RING

NOTE: If ring will go onto setting plug skip to operation 4c.

a. Turn the locking screw counter-clockwise until it is loosened.

b. Turn the adjusting screw clockwise, this will open the ring to a larger pitch diameter than the setting plug.

c. Turn the ring gage onto the setting plug truncated section so that approximately one thread of setting plug extends beyond the ring. (This will promote uniform wear over the entire thread length of the setting plug.)

d. If it has not already been done, turn the locking screw counter-clockwise until it is loosened. Turn the adjusting screw counter-clockwise to tighten or clockwise to loosen until there is a slight drag between the ring and the setting plug.

e. Turn the locking screw clockwise until tight. This locks the adjusting screw so that the size of the ring gage remains fixed. There should be noticeable drag between the ring and setting plug.

NOTE: Operations 5c – 5e may need to be repeated more than once to obtain the proper drag or feel.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

5. INSPECT PD

Repeat section 3a – 3f. If at this point nothing is found which indicates a problem continue to operation 6.

6. INSPECT ID

Using a calibrated tapered pin, set of parallels, or bore gage inspect the ID (minor diameter) of ring gage.

NOTE: If an adjustment was necessary to establish the proper feel on the setting plug use the following formula to obtain the as found pitch diameter. (Setting plug pitch diameter) plus (ID size before adjustment)minus (ID size after adjustment.)

7. SEAL

Cover the adjusting and locking screws with sealing wax to prevent unauthorized tampering with the setting of the ring gage.

SOUTHERN STYLE THREAD RING

1. CLEAN

Thoroughly clean the threads with a bristle brush and solvent, wipe clean with isopropyl alcohol and clean with kim wipe. Visually inspect the thread ring for nicks, dings or foreign material buildup.

2. INSPECT ID

Using a calibrated tapered pin, set of parallels, or bore gage inspect the ID (minor diameter) of ring gage and record the size.

3. INSPECT PD

a. Lubricate the setting master plug with a thin film of light viscosity oil before inserting into the ring gage.

b. Turn the ring onto the setting plug 1 1/2 to 2 threads at the front. If ring will go onto the setting plug go to operation 4. There should be some resistance or drag even at this short engagement. To test for taper or bellmouth, place the ring on its face on a workbench and test for shake or looseness with the setting plug, being very careful not to damage the end threads.

c. Turn ring further onto the truncated section, remembering the feel at the 1 1/2 to 2 thread engagement. The drag should remain approximately the same although it may be slightly greater at full engagement due to more flank contact.

d. Remove the ring from the setting plug and repeat operations 5b & 5c on the opposite side of the thread ring gage.

e. The fit should be approximately the same on both sides of the ring to insure proper straightness. Remember if a setting plug is manufactured or worn smaller at the front, it will falsely indicate taper or bellmouth in the ring gage. Setting plugs must be reasonably straight.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

g. If at this point nothing is found which indicates a problem skip to operation 5.7.

4. SET RING

NOTE: If ring will go onto setting plug skip to operation 4c.

a. Turn the locking screw counter-clockwise 1/4 turn.

b. Turn the adjusting screw clockwise 1/8 turn maximum to enlarge ring PD. Repeat, if necessary, until ring will go onto setting plug.

c. Turn the ring gage onto the setting plug truncated section so that approximately one thread of setting plug extends beyond the ring. (This will promote uniform wear over the entire thread length of the setting plug.)

d. Turn the adjusting screw counter-clockwise to loosen or clockwise to tighten.

e. Turn the locking screw clockwise until tight. This locks the adjusting screw so that the size of the ring gage remains fixed. There should be noticeable drag between the ring and setting plug.

NOTE: Operations 4c – 4e may need to be repeated more than once to obtain the proper drag or feel.

f. Turn the ring gage from the truncated section onto the full form section at the back. The drag should be approximately the same on both sections which insures good flank angle contact.

5. INSPECT PD

Repeat section 3a – 3f. If at this point nothing is found which indicates a problem continue to operation 6.

6. INSPECT ID

Using a calibrated tapered pin, set of parallels, or bore gage inspect the ID (minor diameter) of ring gage.

NOTE: If an adjustment was necessary to establish the proper feel on the setting plug use the following formula to obtain the as found pitch diameter. (Setting plug pitch diameter) plus (ID size before adjustment) minus (ID size after adjustment.)

7. SEAL

Cover the adjusting and locking screws with sealing wax to prevent unauthorized tampering with the setting of the ring gage.

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GLOSSARY

ALLOWANCE: The minimum clearance between two mating parts. The variations from the basic size which are prescribed to permit the desired amount of play in a metal-to-metal fit.

BASIC SIZE: The theoretical size (usually the same as the nominal size), from which the design size limits are derived by the application of tolerances and allowances.

CLEARANCE: The radial distance between an external diameter and an internal diameter.

CONVOLUTE: Removal of the incomplete threads at the end faces of a threaded part.

CREST: The top of the thread form. The major diameter of an external thread, or the minor diameter of an internal thread.

FIT: The term used to designate the tightness or looseness of two mating parts, resulting from a combination of tolerances and allowances applied to the basic size of the parts.
FLANKS: The sides of the thread form or groove, connecting the crest and the root.

FLANK ANGLE: The angle between the flank and a line perpendicular to the axis of the thread. Also referred to as half angle or lead angle. Some exceptions to this definition will be encountered, such as tapered thread flank angles measured perpendicular to the taper, and should be noted.

FUNCTIONAL DIAMETER: The actual (measured) pitch diameter of a thread adjusted by the cumulative effects of lead error and angle error, which is always added to external threads and subtracted from internal threads.

INCLUDED ANGLE: Total of the two flank angles of a thread form.

LEAD: The distance advanced by a thread when rotated 360 degrees on its mating thread.

LIMITS: The largest and smallest extremes in the size of a dimension.

MAJOR DIAMETER: The largest diameter of a thread form. The root diameter of an internal thread and the crest diameter of an external thread.

MINOR DIAMETER: The smallest diameter of a thread form. The bore or crest diameter of an internal thread and the root diameter of an external thread.

NOMENCLATURE: In relation to a thread, the complete identification, including the nominal size, threads per inch or pitch, thread series, class of fit, and possibly a designation for internal or external.

NOMINAL SIZE: The size used for purposes of identification. Usually the same as the basic size.

THREAD SET PLUG GAGES

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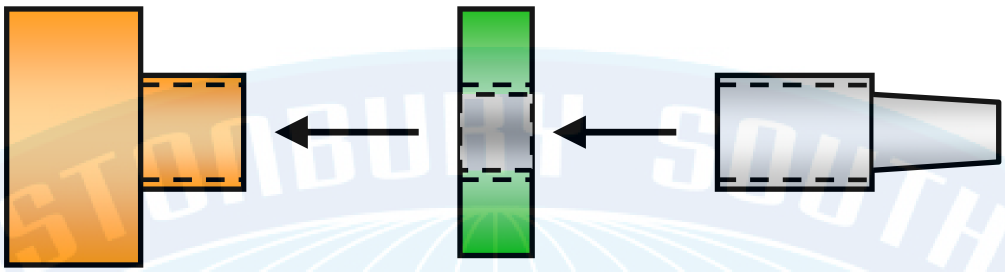
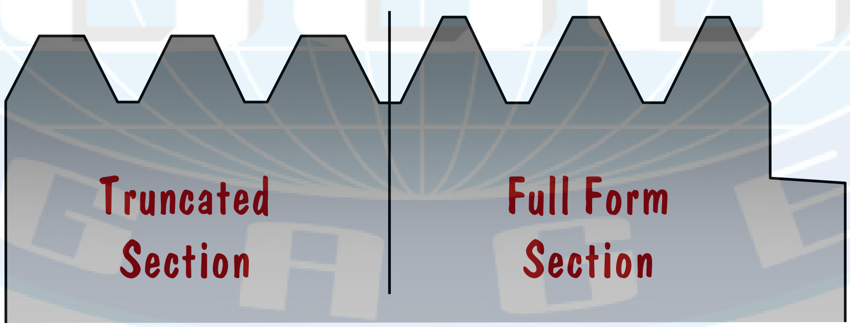


The ring gage inspects the product, and the set plug / master plug / truncated plug inspects the ring gage. Maybe because it is commonly known as the 'set plug', many lab technicians think the set plug is only for the purpose of setting the ring to the proper size. It also has the function of inspecting the ring gage for wear.

TRUNCATED SET PLUG GAGES

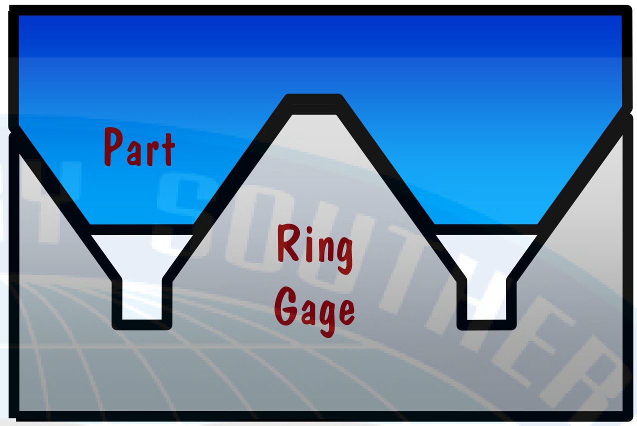


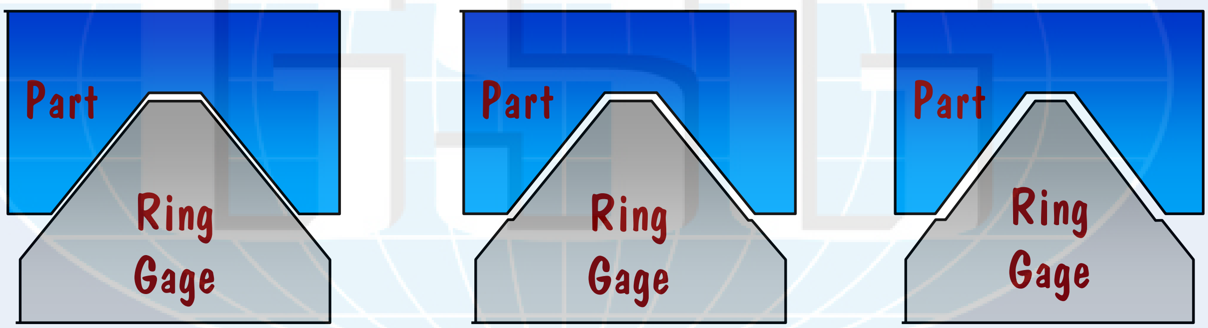
The above picture is a cut-away view of the thread form of the truncated set plug. The thread pitch diameter is the same on both sections and requiring back taper. Back taper is when the measured size of the pitch diameter is less on the back, close to the shank, than on the front. The allowable taper is half of the tolerance of the pitch diameter. Set plugs with front taper should be replaced.

When using a set plug gage to check the ring, the ring should always be engaged across the full length of the plug to create consistent wear and retain the back taper condition. Set plugs become out-of-tolerance with a front taper condition because of the ring being engaged on the front portion only, many more times than on the back portion. So, contrary to normal logic, the set plug is actually given more life by more use.

RING GAGE WEAR PLANE

Product is produced in a manner that is designed to make the product as consistent as possible. This creates a scenario where the thread flank of the gages are contacted in the same general area consistently every time a part is inspected. This area we call the **wear plane**. As a gage is used it wears. Plug gages wear and are replaced when they wear outside of the tolerance limit. Ring gages are adjustable, and therefore present a problem we don't experience with plugs.

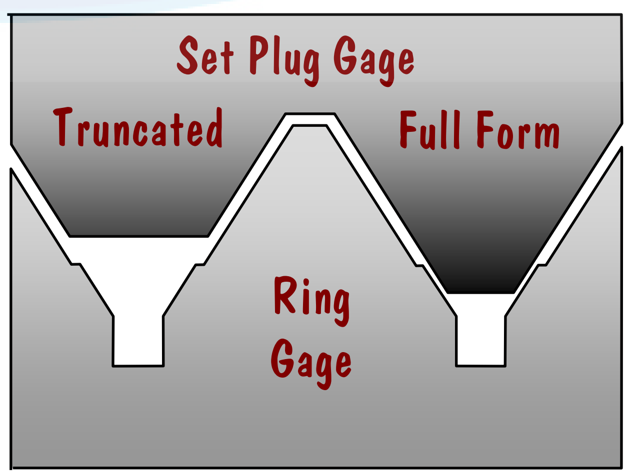




As a ring gage is used it wears, but it can be readjusted to be brought back into size. This means that the wear can continue until the flank is no longer a straight line. This is commonly referred to as the flank having a step wore in it.

The truncated set plug gage is designed to allow the truncated (front) section to contact the ring gage within the wear plane, While the full form (back) section is designed to contact beyond the wear plane.

When the flanks of a ring gage have a step wore in them the ring will feel much looser on the truncated section than on the full form section. This indicates the ring should be repaired or replaced.



MASTER SETTING PLUG DESIGN

For Thread Ring Diagnostics & Setting

The Truncated Master Setting Plug Gage is designed for two functions; to set the adjustable thread ring gage, and to inspect the ring gage for wear. Two methods of using the setting plug are suggested to optimize the life of the setting plug. Pitch diameter taper on the setting plug is specified to always be in the minus direction, i.e. the PD on the front of the plug should always be larger than the PD on the back of the plug.

The first method addressed is used to inspect new ring gages, assuming your gages are not previously set by the manufacturer to your master plug. The ring should be set to the front or truncated portion, then continue onto the full form portion to inspect for root clearance, and consistent feel. The setting plug should be inserted a maximum of two threads into each end of ring for shake, inspecting for taper.

The second method addressed is used to re-inspect rings for wear after use on the product. The ring should be set to the full form portion, then backed off to the truncated portion for feel. The setting plug should be inserted a maximum of two threads into each end of ring for shake, inspecting for taper.

The front or truncated portion of the setting plug is designed to contact the flanks of the ring in the wear plane, similar to a product. The full form portion is designed to contact the flanks of the ring beyond the wear plane. When a ring is run across the plug there will be a slight difference in the feel or tightness because there is more contact with the flanks on the full form portion of the setting plug, thus more resistance and a tighter feel.

If a significant difference in feel is noted, the ring has wear on the flank and should be repaired or replaced. Setting a ring with wear in the flanks will cause possible interference with the product major and does not properly inspect the product threads.

Tightness of Fit

There are no established torque values for degree of drag. Some judgment and common sense must be used. The resistance or drag for a small size gage should be less than for a larger size gage. A spin fit is obviously much too loose, and too tight a fit could damage or cause excessive wear on the ring or the setting plug. In-between is a fairly smooth drag. This tells you that the size of the ring is essentially the same as the setting plug.

On properly set gages with accurate lapped threads, a very little change to size (adjustment of the ring gage) will effect a noticeable difference in drag. Two different setting plugs both within class W tolerance may feel entirely different in the same ring gage. One could be too tight and the other too loose. It must be realized that a ring gage set on one setting plug does not necessarily mean it will fit another setting plug. This is due to the allowable tolerance of the set plug.

On properly set gages with accurate lapped threads, a very little change to size setting plug. This can also cause a small increase in the degree of drag a full engagement versus partial engagements. One should not expect absolute perfection. These differences are not serious within reason as both the ring and setting plug may be well within their respective tolerances. A ring may feel noticeably different on the set plug when engaged with the marking facing the set plug or facing away from the set plug. This is usually the result of flank angle error in the

In addition to pitch diameter variations, there may be a slight difference in the flank angle or lead of the ring versus the

ring and the set plug. In one direction the errors interfere while in the other direction they do not. When this happens the ring should be positioned where the flanks do not interfere (the looser fitting) and set for the proper feel. When this is done the set plug will probably not go in the ring if the ring is turned around, but this gives the closest pitch diameter size for the ring gage and is most likely to pass good product and fail bad product.

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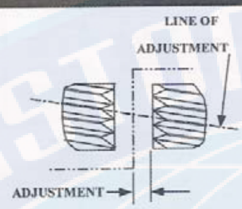
ADJUSTABLE THREAD RING GAGES

The Southern Style

Featuring superior design and unique advantages over conventional AGD style.

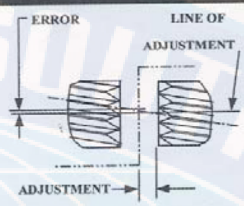
ACCURATE
POSITIVE IDENTIFICATION
TOUGH
LIGHTWEIGHT

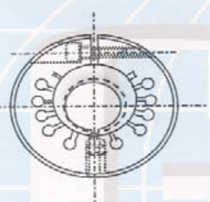
SOUTHERN STYLE ← COMPARISON → AGD STYLE



The Southern Style features the unique Automatic Helix Adjustment. The Helix path of the thread along the line of adjustment remains true and in alignment throughout the entire life of the gage.

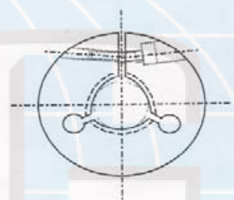
The conventional AGD Style presents a mis-alignment of the threads at the adjusting slot when reset.

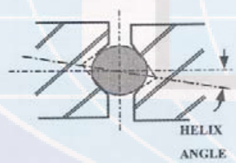




The Southern Style sets round and stays round through all adjustments, due to the eccentric design and opposing pressures of the adjusting and locking mechanisms.

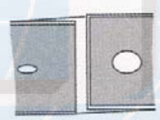
The AGD Style hinges at the two terminal holes and becomes more and more egg-shaped as the ring is adjusted.





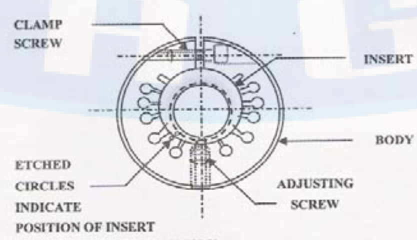
The Southern Style Adjusting Screw contacts the conical seat of the insert, maintaining a rigid setting and holding the two thread ends in perfect alignment even through rough handling.

The AGD Style sleeve assembly permits the gage faces to become mis-aligned at the adjusting slot.



SETTING THE SOUTHERN STYLE THREAD RING GAGE: ALWAYS LOOSEN THE CLAMP SCREW FIRST-INSERT THE SET PLUG

If too tight or if set plug will not enter:
(a) loosen clamp screw 1/4 turn
(b) advance adjusting 1/8 turn
(c) tighten clamp screw
(d) if still too tight, repeat procedure



If too loose:
(a) loosen clamp screw 1/4 turn
(b) back out adjusting 1/8 turn
(c) tighten clamp screw
(d) if still too tight, repeat procedure

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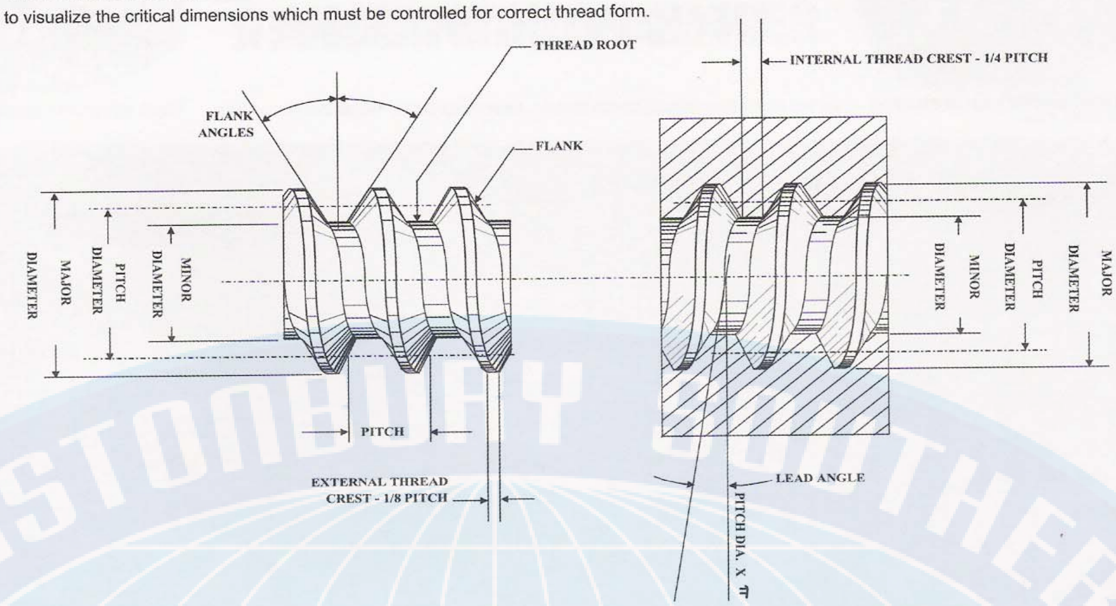
BASIC SCREW THREAD DESIGNATIONS

These simplified drawings of an external and internal thread will illustrate basic thread geometry.They make it possible to visualize the critical dimensions which must be controlled for correct thread form.



1. Unified Inch Screw Threads: per ASME B1.1
Federal Std H28/2
Military Std MIL-S-7742D

- Nominal Size (Basic Major Diameter expressed as a fraction, decimal or machine screw number).
- Number of Threads per Inch (TPI).
- Thread Form & Series (UN, UNC, UNF, UNEF, or UNS.
- Class of Fit (1A,2A, or 3A external) (1b, 2B, or 3B internal (or SPL for special).
- Gaging System per ASME B1.3M (21,22, or 23).

1/4 - 20 UNC - 2A (21)

2. Inch "J" Series Screw Threads: per Military Standard MIL-S-8879C (25 July 1991).

- Nominal Size (Basic Major Diameter expressed as a 4-place inch decimal ONLY).
- Number of Threads per Inch (TPI)
- Thread Form & Series (UNJ, UNJC, UNJF, UNEF, or UNJS).
- Class of Fit (3A external, 3B internal).
- Application Category (Safety Critical or Other Thread).
- Military Standard Number

.2500 - 20 UNJC - 3A Safety Critical Thread MIL-S-8879

3. Metric Screw Threads: per ASME B1.13M,
Federal Std H28/21

- Metric Thread Symbol, ISO 68 Metric Thread Form.
- Normal Size (Basic Major Diameter in millimeters)
- Pitch (in millimeters)
- Tolerance Class
- Gaging System per ASME B1.3M (21,22, or 23)

M 6 X 1 - 4g6g (22)

- Allowance / Tolerance — Major Dia. Ext. Thd,. or Minor Dia. Int. Thd.
- Allowance / Tolerance — Pitch Diameter

Standard Allowance Grades:
Internal Threads G and **H** shown as capital letter.
External Threads e, f, **g** and **h** shown as lower case letter.

Standard Tolerance Grades:
Internal Threads
Pitch and Minor Diameter 4, 5, **6**, 7 and 8.

External Threads
Pitch Diameter 3,**4**,5,**6**,7,8 and 9.
Major Diameter 4, 6 and 8.

The most common tolerance and allowance Grades for standard series threads are shown in **bold print**.

TAPERED THREAD PIPE GAGES

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PIPE THREADS

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Pipe threads are threads that seal. Pipe threads seal by various methods, but the ones we are going to concern ourselves with here are those that are designed to seal at the threads. For threads to seal there are two ways to accomplish a seal, assemble two tapered threads or assemble a straight thread with a tapered thread.

Tapered threads use a completely different system to determine size than the Go / NoGo system used in straight threads, (the standard inch and metric series are straight threads). There are many different types and styles of pipe threads, far too numerous to try to address here individually. The most common is the NPT, which is used in many various applications and which is the basis of which many of the other styles are modifications.

With straight threads, the Go and NoGo gages tell you that your part is within the acceptable limitations of size. With a tapered thread, this system does not work as a gage inserted into a hole or engaged with an external thread will at some point lock together with the part. The method used is an indirect measurement where you measure the distance from a datum point on the part to a datum point on the gage and adjust for the ratio of taper to know the part size. This is not as complicated as it sounds.

The NPT and most of the other pipe threads are made on a taper of .750" per foot, or .0625" per inch. This is an even ratio of 16:1. In other words, when you travel along the axis of the thread .016 you will experience a diametrical change of .001.

Knowing this ratio it is easy to measure the diametrical size when compared to a gage of known size.

SEALING THEORY

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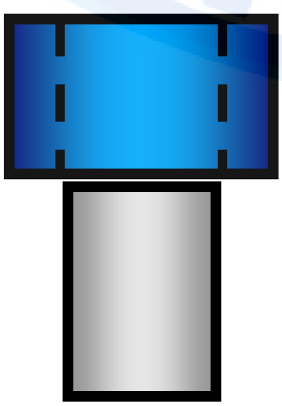
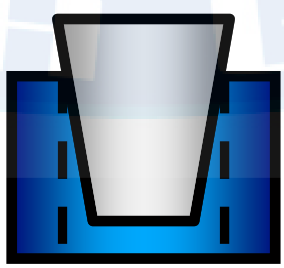
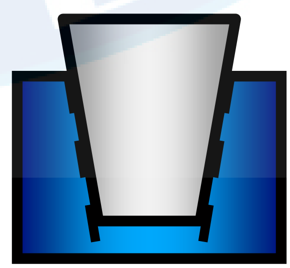


Straight to Straight No Seal



Taper to Straight Seals



Taper to Taper - Seals

When a straight external thread is assembled with a straight internal thread if it assembles then it will continue through the thread without sealing. When a tapered external thread is assembled with a straight internal thread it will at some point lock together and seal. When a tapered external thread is assembled with a tapered internal thread it will lock together and seal. That is the theory that is used when the seal has to be accomplished at the threads. A seal would also be accomplished using a straight external thread and a tapered internal thread, but this configuration is not used because there would be too much shake making for an unstable connection that would not remain sealed.

PIPE NOMENCLATURE

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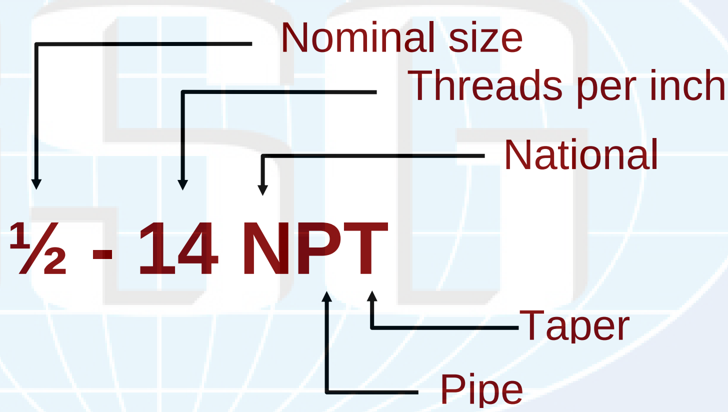
The letters following the nominal size and pitch indicate the pipe thread application. The following letters are used:

A - Aeronautical
C - Coupling
F - Dryseal (Fuel)
G - Gas
H - Hose
I - Intermediate
L - Loose
M - Mechanical
N - National
P - Pipe
R - Railing
S - Straight
T - Tapered



Straight Pipe Threads Nomenclature

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With straight pipe threads (the internal thread is straight, and assembled with a tapered external thread) there should always be four letters to designate the application. Without the fourth letter the application is not known and therefore the parts or gages may be incorrect causing failure of the seal.

You may encounter situations where a straight pipe thread is indicated as NPS without the fourth letter. An inquiry may result in the response, "Just give me the standard one." This response is unacceptable as there is no such thing as a standard one. The application must be known and will be indicated by the fourth letter.

COMMON PIPES

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NPT - National Pipe Taper
Gages required L1 Ring Gage
L1 Plug Gage

NPTF - National Pipe Tapered Dryseal
Gages required L1 Ring, L2 Ring, 6 Step Ring Gages
L1 Plug, L3 Plug, 6 Step Plug Gages

ANPT - Aeronautical National Pipe Taper
Gages required L1 Ring, L2 Ring, 6 Step Ring Gages
L1 Plug, L2 Plug, 6 Step Plug Gages

INDIRECT MEASUREMENT

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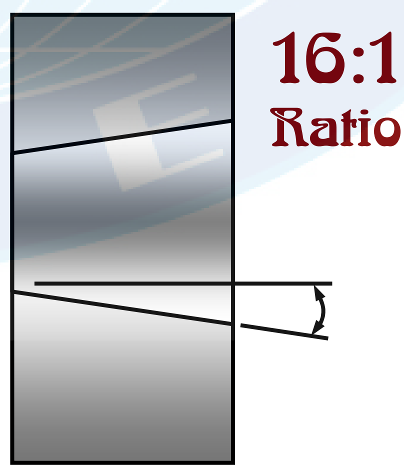
Tapered pipe fittings (nipples - external thread, coupling - internal thread) and the tapered gages used for them are all measured by a method called indirect measurement. This means simply that one feature or dimension is measured by measuring some other feature instead.

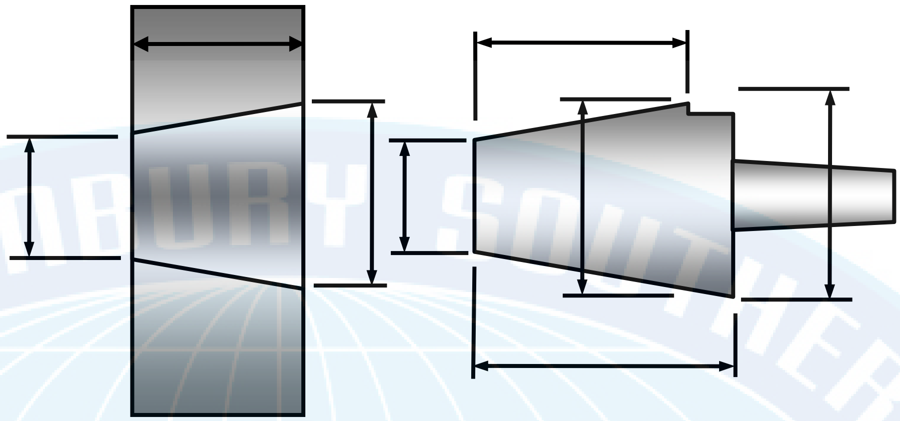


The pitch diameter of the thread cannot be easily measured directly because it is a spiral taper. A means is needed to measure product that is simple, conclusive and accurate. Indirect measurement satisfies these requirements.

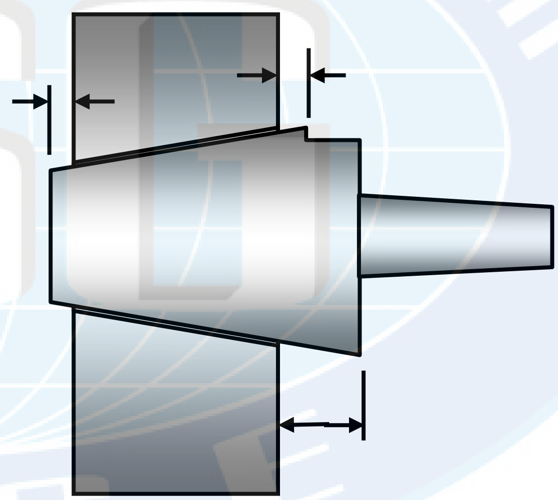
The gages have been designed for quick visual use by an operator with little instruction. Understanding the method and how it works is somewhat complicated, but using the gages to measure product is not complicated.

Angle that creates a known Length to Diameter ratio

A ring gage with known (calibrated) dimensions can be used to measure an external part or gage. A plug gage with known (calibrated) dimensions can be used to measure an internal part or gage.



The gage and product or master and gage are assembled and the axial distance is measured. The measured distance can then be multiplied by the ratio (16 in the case of a standard taper) and added to or subtracted from the known dimension to find the dimension of the part or gage being measured.



This basic theory is used to measure the size of product pitch diameters with the L1 plug and ring gages, and is pre-calculated to make the use of these gages visually simple.

L-1 PLUG AND RING GAGE

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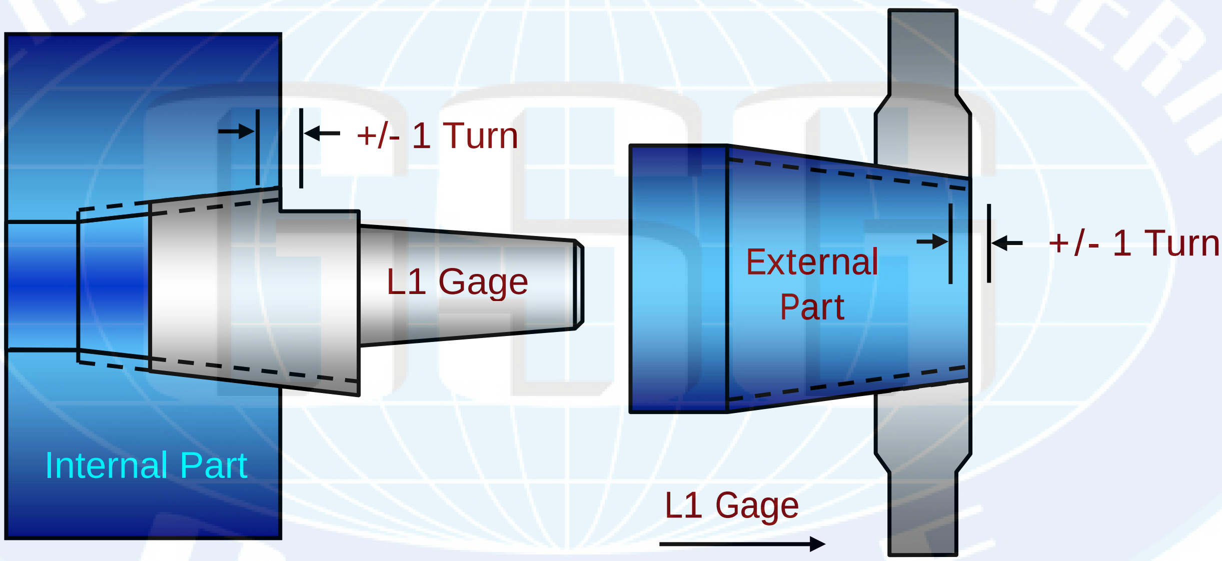
The purpose of the L1 gage is to measure the size of the product. To translate this measurement method into a usable form, the NPT gage designated as the L-1 is built with the thread having a .750" taper per foot, and a notch or step cut into the thread showing the plane perpendicular to the axis where the diameter of the part is to be measured. This L-1 gage is screwed into the part (internal) or onto the part (external) using hand tight engagement. If the taper of the product is correct, the gage will seat firmly, but if the taper is beyond the allowable tolerance in either direction there will be noticeable shake in the gage. The distance is measured between the step and the scratch of the first thread (most technicians measure from the face) of the part, and if the step is anywhere within 1 turn then you have a good part.



If any element of the threaded part is incorrect the gage will not seat properly or stop in the measurement zone. This may sound like too broad a statement, but the NPT thread is designed on the premise that the mating parts will be sealed with an agent that will compensate for minor irregularities in the mating threads.

Many companies find it necessary to measure NPT threads more thoroughly than the standard requires to fully satisfy their customers. In those cases, the NPTF system is used, but not the NPTF gages.

If more precise measurement is needed than the L-1 alone gives, then the ANPT L-2, L-3, and 6-step gages are used with the NPT L-1. These ANPT gages will have the ‘A’ removed from the identification to eliminate confusion on the part of the user. This is the standard practice in the gage industry. If the gages are not properly marked to check NPT threads, they may not be used as they could be modified or altered. Another reason the marking must be correct is to please the quality auditors. They would disapprove use of a gage with a thread designation different from that which the specification for a part indicates is proper.

L-2 RING / L-3 PLUG

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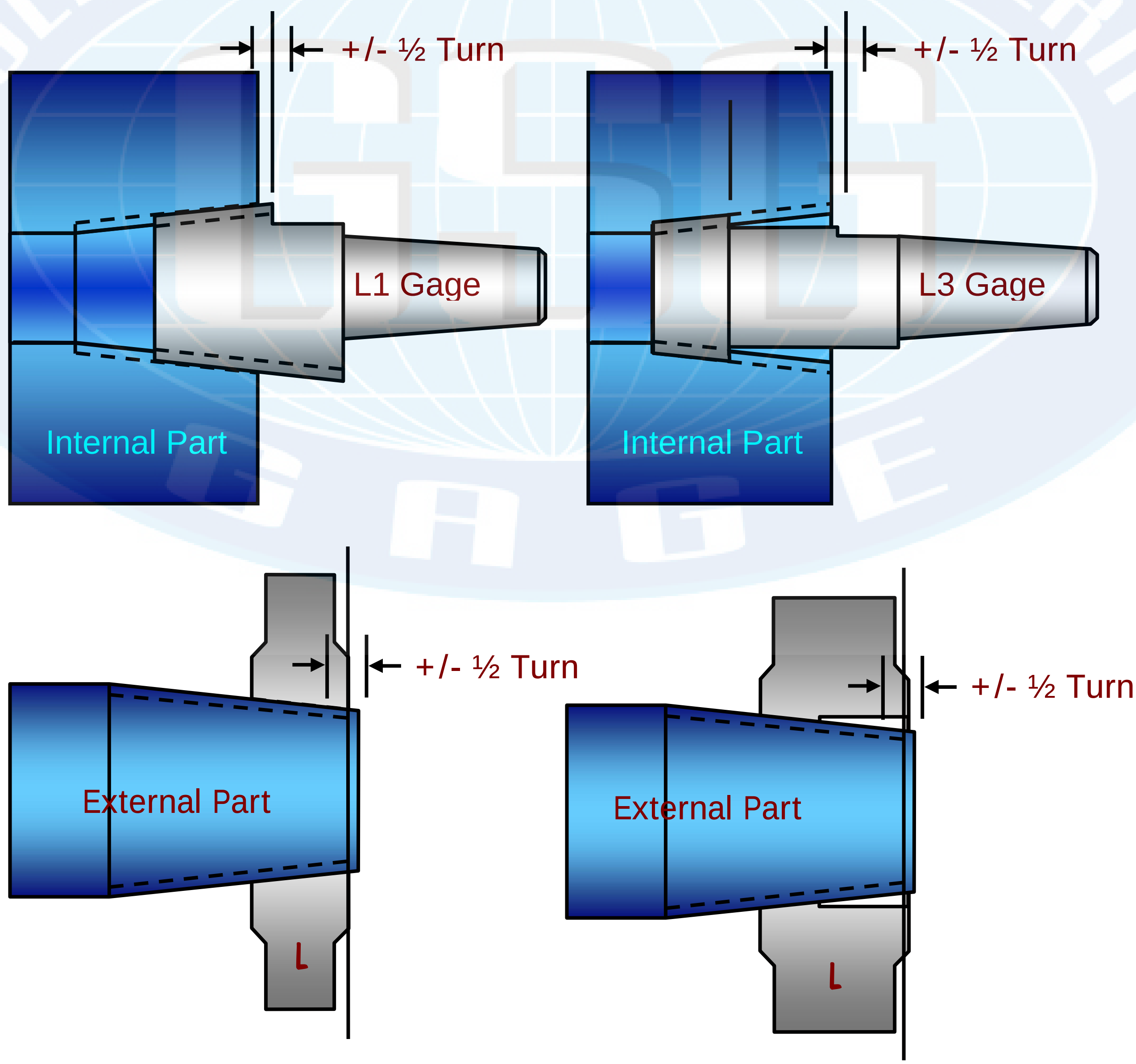
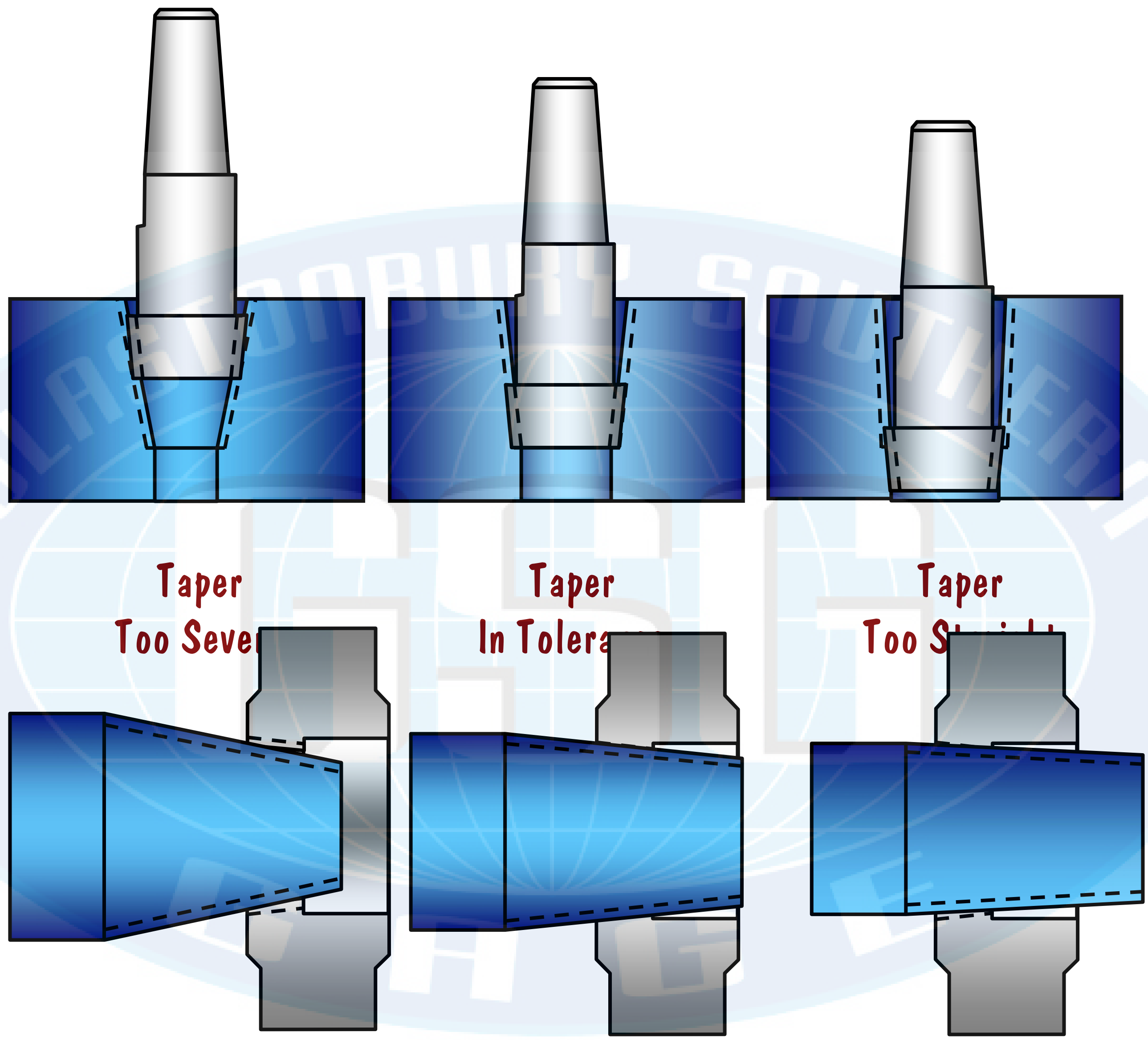
The purpose of the L2 Ring and the L3 plug is to measure the taper of the part. This gage does not check size, it checks taper only. The L2 ring and L3 plug are used as a comparative measurement to the L1 ring or plug.

After using the L-1 gage the L2 ring or L3 plug is assembled with the part and must stop within 1/2 turn plus or minus of where the L1 stopped. The L-2 ring and L-3 plug are designed to clear the threads of the part that the L-1 assembled with and assemble with the threads further on or in the part. This measures the taper of the thread of the part by comparing the front threads and the back threads of the part. If the taper is too severe or too straight, the L-2 ring or L-3 plug will not stop within 1/2 turn from the point where the L-1 stopped.



The following illustrates the three possible outcomes when using the L2 and L3 gage.



When the taper of the product is too severe the L2 or L3 gage will lock up before reaching the point of the 1/2 turn limit.

When the taper of the product is correct the L2 or L3 gage will lock up within the 1/2 turn limit zone.

If the taper of the product is too straight, not severe enough, the L2 or L3 gage will engage farther into or onto the product and beyond the 1/2 turn limit.

Remember, this gage has one purpose, to check the taper. It cannot be used to check the size of the product and can only be used after the L1 has been used to know where the 1/2 turn limit is for the product being inspected.

DRYSEAL

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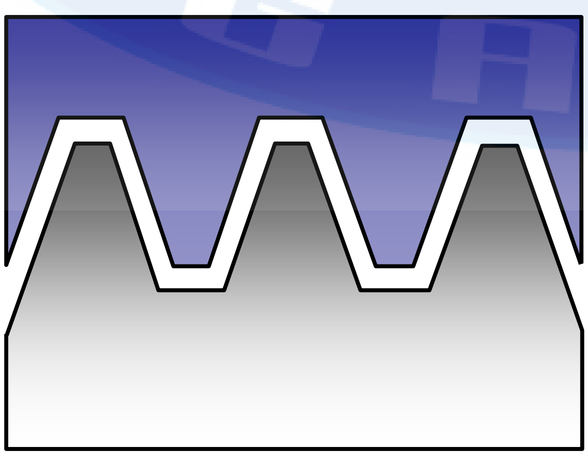
The NPTF design is different from the NPT in that it is designed to create a seal without the use of any type of sealants, i.e. Dryseal. The standard for NPTF threads (ANSI B1.20.3) allows Class 1 and Class 2 applications.

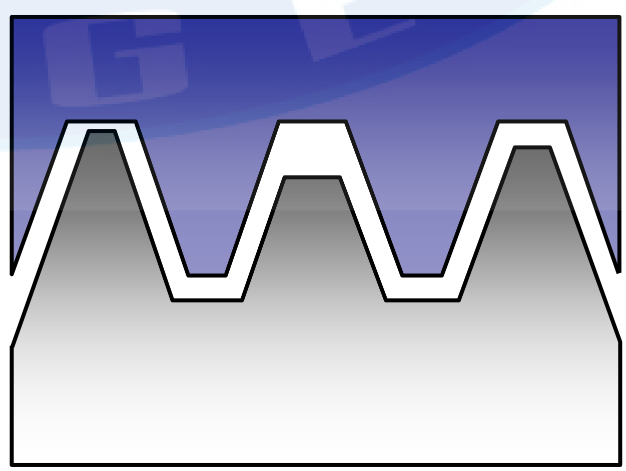
The Class 1 applications do not require inspection of the crest and root diameters. Consequently, Class 1 threads are intended for applications where close control of tooling is required for conformance of truncation or where sealing is allowed to be accomplished by means of a sealant applied to the threads. Class 2 applications require the inspection of the crest and root truncation, to create more assurance of a pressure-tight seal where sealants are not used.

The ANPT design is not a dryseal design, but because of the use of these threads in aeronautical applications, which is safety critical, the NPTF inspection method is employed to assure complete inspection to guarantee maximum product application qualities.

For the dryseal application to be accomplished the threads of the internal product and the external product have to contact at very near the same time. After the two products have been assembled hand tight, the system calls for two or three more turns of engagement. This causes the threads to tear into each other, or as we say 'displace material.' For the dryseal to occur a full thread form material displacement must occur. Without this full thread form displacement the product would not seal and a leak would result.

A leak in a dryseal application could be catastrophic as dryseal applications are used in situations where high pressure could eject any sealant or in applications where corrosive agents are used and the corrosive agent could dissolve the sealant.

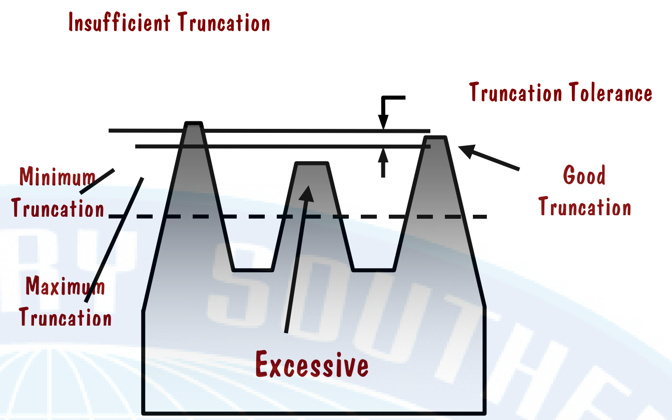




In this illustration a dryseal could be achieved because the threads would contact at near the same time along the full thread form.

In this illustration a dryseal could not be achieved because the threads would not contact at near the same time along the full thread form.

The thread form is measured by measuring the amount of thread removed from a theoretical sharp thread. Removing part of the thread height is referred to as truncating the thread. The amount of truncation is measured as a relationship to the pitch diameter. This allows us to compare the crest of the thread to the pitch diameter of the thread. In other words, we can use a gage as a comparison to the L1 gage.



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6 STEP PLUG AND RING

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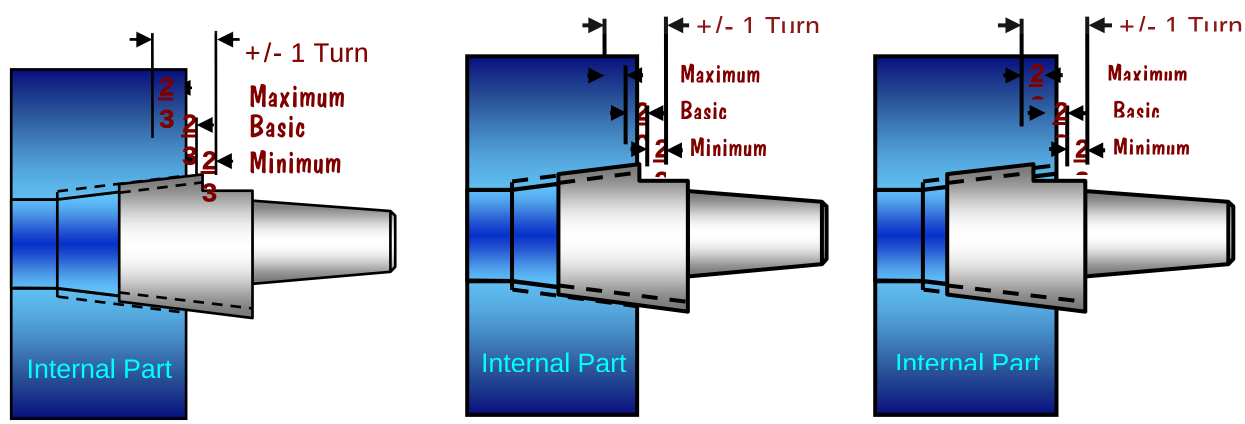
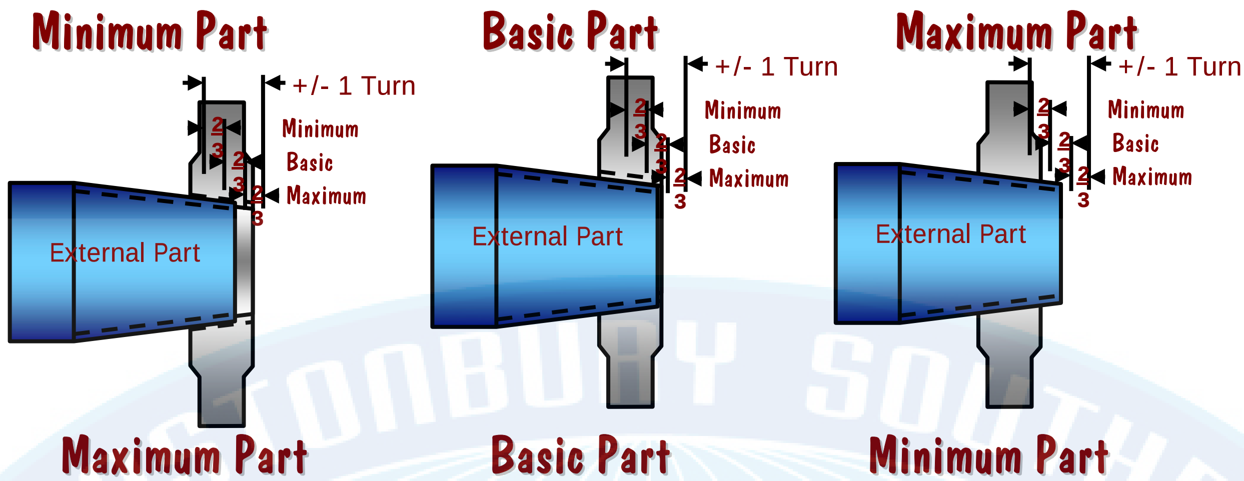
The NPTF system begins with the use of the L-1 gage having a 1 turn in or out limit (2 turns total) the same as the NPT system. The purpose of this gage is to measure the pitch diameter size of the part. It is necessary to refine the standoff (distance from the step to the part) to a more accurate measurement because the 2-turn total tolerance limit must be divided into 3 equal zones. These three zones are known as the minimum, basic, and maximum zones, and the part is referred to as a minimum part, basic part, or maximum part.

The basic zone is the linear area within 1/3 turn from the face of the part, in or out. If the plug gage is standing out from the face (or datum point) of the internal part more than 1/3 of a turn you have a minimum part because the step on the gage stops within the minimum zone. Likewise, if the plug stands in more than 1/3 of a turn you have a maximum part. The larger the hole is, the deeper the plug will enter into it. A smaller hole, but within tolerance, is a minimum part. A larger hole, but within tolerance, is a maximum part. A hole close to the target size (within 1/3 turn) is a basic part.





The same ideology is true for the external product but reversed. Again, It is necessary to refine the standoff (distance from the step to the part) to a more accurate measurement because the 2-turn total tolerance limit must be divided into 3 equal zones. These three zones are known as the minimum, basic, and maximum zones, and the part is referred to as a minimum part, basic part, or maximum part.

The basic zone is the linear area within 1/3 turn from the face of the part, in or out. If the ring gage is standing out from the face (or datum point) of the external part more than 1/3 of a turn you have a maximum part because the face on the gage stops within the maximum zone. Likewise, if the ring stands in more than 1/3 of a turn you have a minimum part. The smaller the part is, the farther the ring will engage onto it. A larger part, but within tolerance, is a maximum part. A smaller part, but within tolerance, is a minimum part. A part close to the target size (within 1/3 turn) is a basic part.

ZONES AND TRUNCATION LIMITS

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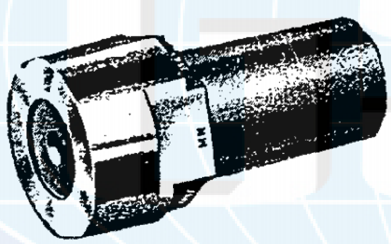
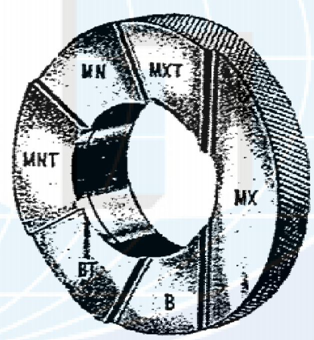
Zones	Truncation Limits	6 Steps
Minimum	Minimum	Mn
	Maximum	Mnt
Basic	Minimum	B
	Maximum	Bt
Maximum	Minimum	Mx
	Maximum	Mxt

The three zones represent different pitch diameter size limits. There is a minimum and maximum limit for the proper amount of truncation that would create full thread form displacement. With three size zones and two limits each there are six possible scenarios represented by the six steps on the 6 step ring and 6 step plug.

This may all sound a bit complicated, but the actual use is very simple. Only two of the six steps are used. The L1 gage identifies the part as being a minimum, maximum, or basic part. The two appropriate steps are chosen Mn and Mnt for minimum parts, B and Bt for basic parts, or Mx and Mxt for maximum parts. The 6 step gage is pushed into or onto the part and if the face comes to rest between the two appropriate steps, the part is acceptable.



6-STEP PLUG



6-STEP RING

It is not easy to measure by eye where these zones begin and end. Gages can be made with three steps or four steps that simplifies this for the user. The other option is to measure the distance with an instrument. 1 turn of a thread can be easily computed with the formula (1 divided by the threads per inch). This gives you the pitch. Divide the pitch by 3 and you can measure the standoff to find the type of part you have. You must know the type of part (min., basic, or max.) to use the 6-step gage.

Inspection with the non-threaded 6-step gage shown here will inspect the thread crest truncation. The root truncation should also be inspected. This can be accomplished by means of a threaded 6-step gage using the same principles of application as the non-threaded 6-step gage.

Parts that conform to product specifications, whether minimum, basic or maximum parts, may be assembled and will achieve a dry seal. It is not necessary to mate parts together that are both basic, or both maximum, or both minimum, so there is no need to categorize the parts.

INTERCHANGEABILITY

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The first consideration in gaging pipe threads is the type of gages used. Gages are specifically designed per the appropriate standard for each type of pipe thread. It is not proper to interchange or substitute gage type and pipe thread type when the correct gage is not available. For example; using NPTF gages on NPT parts.

The manufacturing tolerances for gages vary with type and this causes the gages to vary as to size, giving different inspection results.

The formula for computing the major diameters of pipe plugs gages, and minor diameters of pipe ring gages differ with each type of pipe, because of the difference in the formulas used to compute the major and minor diameters of the various types of pipe threads. This causes the thread form of the gages to mate with the thread form of the product differently when comparing different gages (of various pipe types) to the same product thread.

Using gages **not** designed for the product being gaged can result in contact at the major or minor diameter instead of the flanks and cause incorrect inspection results.

It is possible to inspect one type of pipe with another type of gage and get a reading that says the product is good, but you do not have any assurance your inspection results are correct. It is much more likely that you will not get a correct measurement.

NPT & ANPT threads are designed to mate and be sealed with some type of sealant. NPTF threads are designed to mate and seal without using any type of sealant (this is the reason they are called Dryseal threads). The design of NPTF dryseal threads is not just a tightening of the standard pipes (NPT), but rather a modification. It is an incorrect assumption that you can make a better NPT product thread by using dryseal gaging. What you usually get is an incorrectly manufactured NPT product thread.

The conclusion; use the gage that is specifically designed for that particular product thread. If different pipe gages give different results, the gage designed for the product thread type has the final say, assuming of course, that the gages being used are good gages.

STRAIGHT PIPE THREADS

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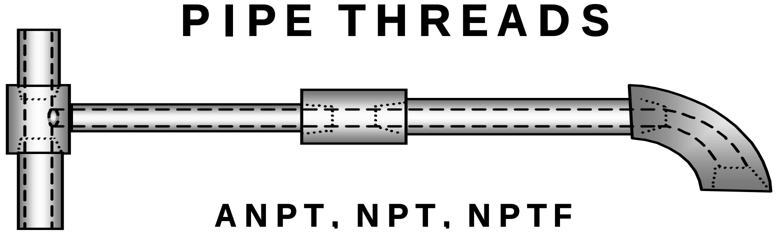
There are several pipe threads where the internal and external threads are both straight. In these cases the products threads are inspected using Go/NoGo type gages. These threads will always have to have a sealant applied to assure sealing.

In the cases of pipe threads where the internal product is straight, and the external product is tapered, the product must be inspected with tapered gages to measure functional fit. When the tapered plug gage is applied to a straight internal thread, the gaging notch should be flush with the product face (or datum point) within plus or minus one and one-half turns.

PIPE THREADS



ANPT, NPT, NPTF

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Pipe threads are with some exceptions a tapered self-locking thread produced on the outside diameter of a piece of pipe, tubing or fitting, and in the inside of the mating coupling, port, or fitting. As pipe is identified by the inside diameter of the pipe, so the pipe threads are identified. Therefore a ¼-18 NPT fitting has a ¼" diameter through hole. Pipe threads are designed to be assembled by hand 4 to 7 turns, depending on size, and drawn together an additional 2 turns by means of a pipe wrench or other mechanical device, locking the threads together.

Prior to the 1800's, pipes and couplings were manufactured as matched sets with little regard to formal thread profile or size. In 1820, Robert Briggs of the Pascal Iron Works of the Morris Tasker Co., began work to develop the first "pipe threads". In 1834 he made the first gage to inspect internal pipe threads, a L1 threaded plug. In 1862 Mr. Briggs developed a mating threaded ring gage for the external threads and published a standard for what was called the Briggs Standard Pipe Thread. By 1886, a large majority of manufactures threaded pipe to the Briggs standard, and acting jointly with A.S.M.E., they adopted it as a national standard.

Around 1905, The American Society of Mechanical Engineers, along with various government and military agencies, started the American Standards Association (ASA) with the purpose of developing the standards to be used nationally. In 1919 the ASA, using the Briggs Standard Pipe Thread as it basis created the National Pipe Taper (NPT) pipe threads and published the B2.1 standard complete with all taper pipe and straight pipe specifications and gaging. In 1927, to serve the automotive industry and create a self sealing (Dryseal) thread form, the ASA B2.2 standard was created using a modified form of the NPT pipe thread called the National Pipe Taper Fuel (NPTF) pipe thread.

In 1961, the military, wanting a higher quality NPT thread created MiIL-P-7105, creating the "Aeronautical National Pipe Taper" (ANPT) Threads. The threads were the same as the NPT threads up to 2 ½" diameter, but required additional gaging and gage variation must be considered when gaging the threads.

SEALING THEORY

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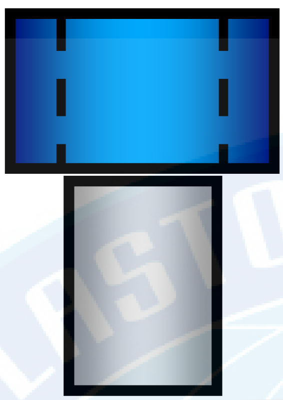
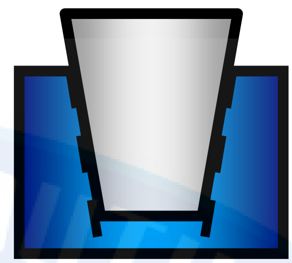


Straight to Straight No Seal

Taper to Straight Seals



Taper to Taper - Seals

When a straight external thread is assembled with a straight internal thread if it assembles then it will continue through the thread without sealing. When a tapered external thread is assembled with a straight internal thread it will at some point lock together and seal. When a tapered external thread is assembled with a tapered internal thread it will lock together and seal. That is the theory that is used when the seal has to be accomplished at the threads. A seal would also be accomplished using a straight external thread and a tapered internal thread, but this configuration is not used because there would be too much shake making for an unstable connection that would not remain sealed.

PIPE NOMENCLATURE

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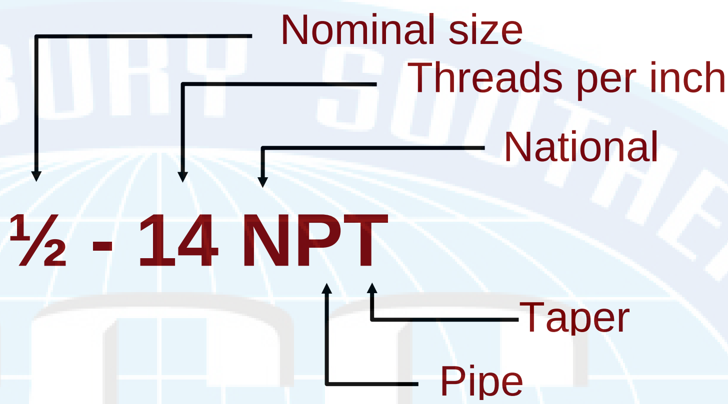
The letters following the nominal size and pitch indicate the pipe thread application. The following letters are used:

A - Aeronautical
C - Coupling
F - Dryseal (Fuel)
G - Gas
H - Hose
I - Intermediate
L - Loose
M - Mechanical
N - National
P - Pipe
R - Railing
S - Straight
T - Tapered



Straight Pipe Threads Nomenclature

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With straight pipe threads (the internal thread is straight, and assembled with a tapered external thread) there should always be four letters to designate the application. Without the fourth letter the application is not known and therefore the parts or gages may be incorrect causing failure of the seal.

You may encounter situations where a straight pipe thread is indicated as NPS without the fourth letter. An inquiry may result in the response, "Just give me the standard one." This response is unacceptable as there is no such thing as a standard one. The application must be known and will be indicated by the fourth letter.

COMMON PIPES

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NPT - National Pipe Taper

Gages required	L1 Ring Gage
	L1 Plug Gage

NPTF - National Pipe Tapered Dryseal

Gages required	L1 Ring, L2 Ring, 6 Step Ring Gages
	L1 Plug, L3 Plug, 6 Step Plug Gages

ANPT - Aeronautical National Pipe Taper

Gages required	L1 Ring, L2 Ring, 6 Step Ring Gages
	L1 Plug, L2 Plug, 6 Step Plug Gages

INDIRECT MEASUREMENT

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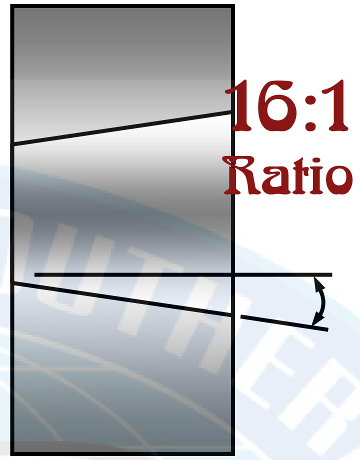

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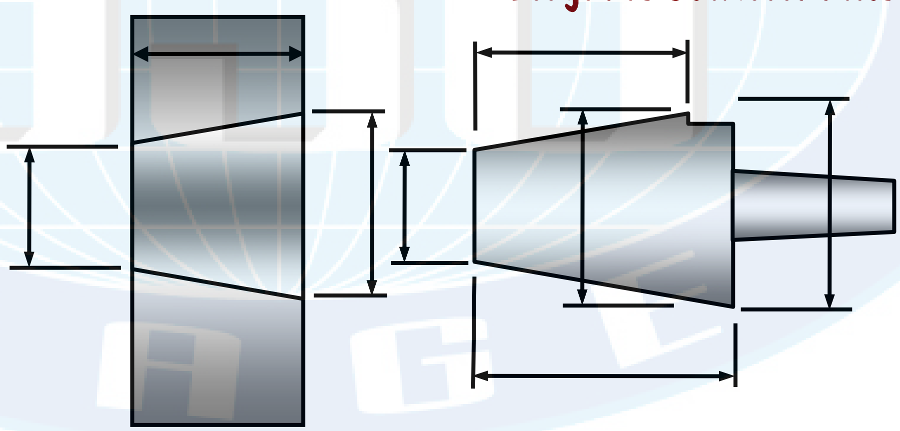

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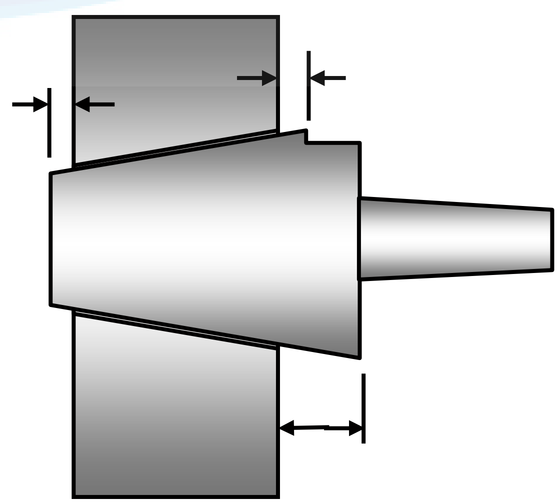

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L-1 PLUG AND RING GAGE

(Back to Contents)

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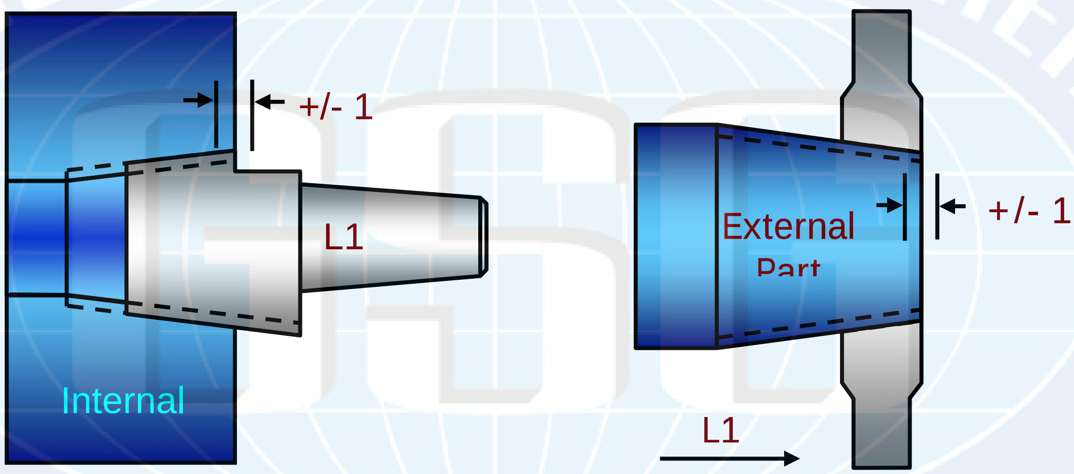

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(Back to Contents)

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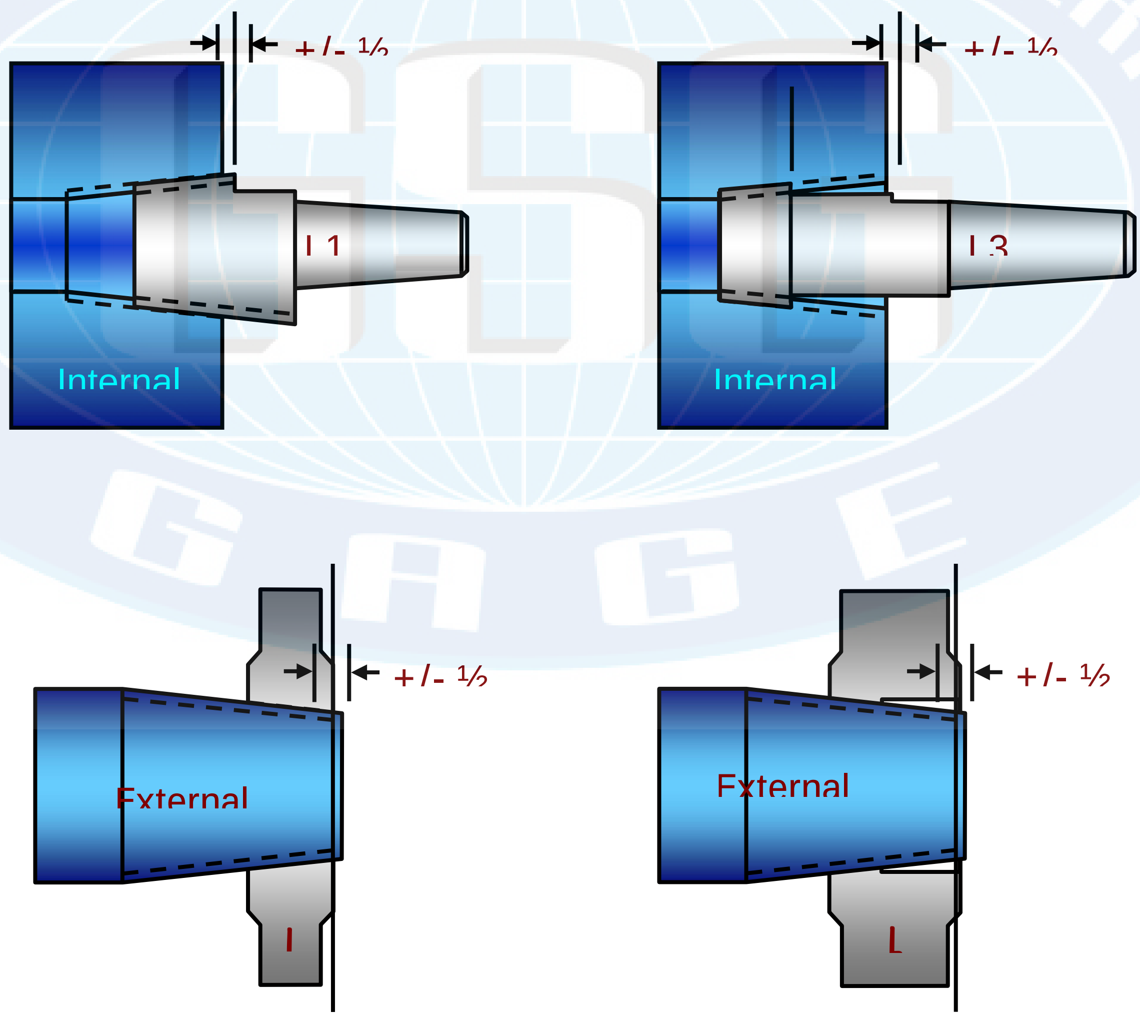

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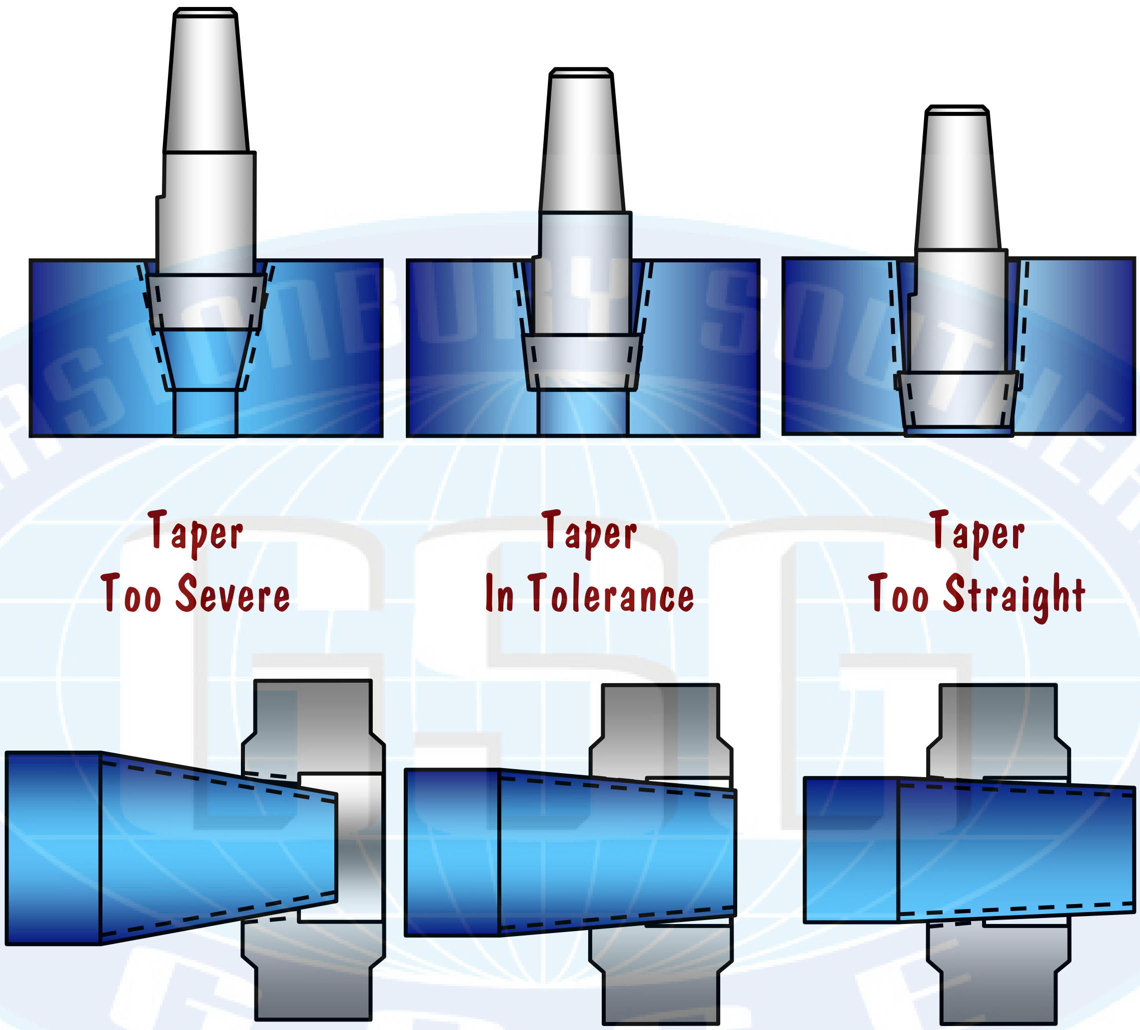

When the taper of the product is too severe the L2 or L3 gage will lock up before reaching the point of the 1/2 turn limit.

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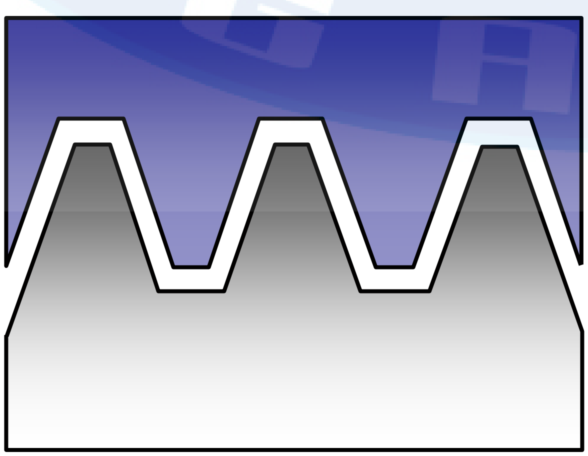
The NPTF design is different from the NPT in that it is designed to create a seal without the use of any type of sealants, i.e. Dryseal. The standard for NPTF threads (ANSI B1.20.3) allows Class 1 and Class 2 applications.

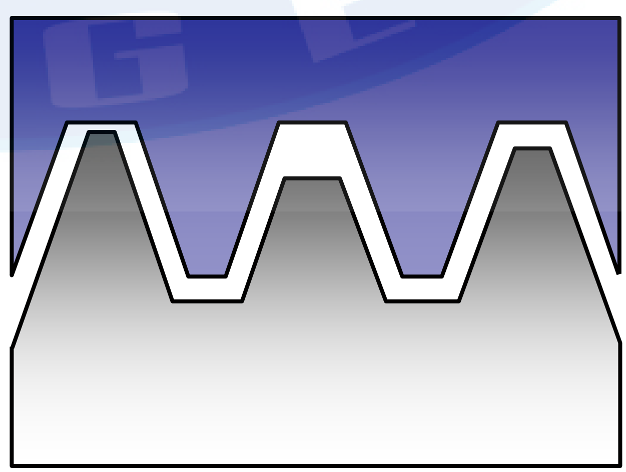
The Class 1 applications do not require inspection of the crest and root diameters. Consequently, Class 1 threads are intended for applications where close control of tooling is required for conformance of truncation or where sealing is allowed to be accomplished by means of a sealant applied to the threads. Class 2 applications require the inspection of the crest and root truncation, to create more assurance of a pressure-tight seal where sealants are not used.

The ANPT design is not a dryseal design, but because of the use of these threads in aeronautical applications, which is safety critical, the NPTF inspection method is employed to assure complete inspection to guarantee maximum product application qualities.

For the dryseal application to be accomplished the threads of the internal product and the external product have to contact at very near the same time. After the two products have been assembled hand tight, the system calls for two or three more turns of engagement. This causes the threads to tear into each other, or as we say 'displace material.' For the dryseal to occur a full thread form material displacement must occur. Without this full thread form displacement the product would not seal and a leak would result.

A leak in a dryseal application could be catastrophic as dryseal applications are used in situations where high pressure could eject any sealant or in applications where corrosive agents are used and the corrosive agent could dissolve the sealant.

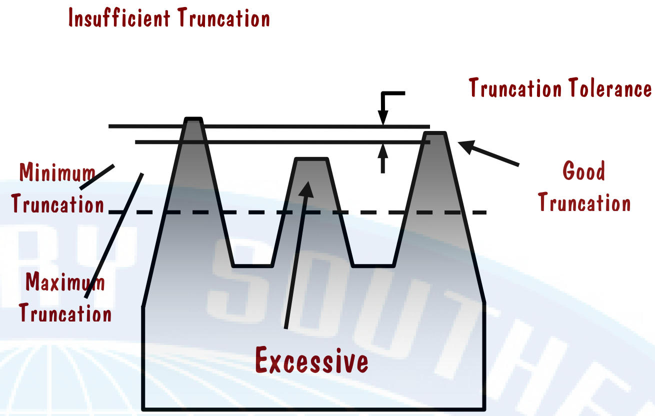




In this illustration a dryseal could be achieved because the threads would contact at near the same time along the full thread form.

In this illustration a dryseal could not be achieved because the threads would not contact at near the same time along the full thread form.

The thread form is measured by measuring the amount of thread removed from a theoretical sharp thread. Removing part of the thread height is referred to as truncating the thread. The amount of truncation is measured as a relationship to the pitch diameter. This allows us to compare the crest of the thread to the pitch diameter of the thread. In other words, we can use a gage as a comparison to the L1 gage.



6 STEP PLUG AND RING

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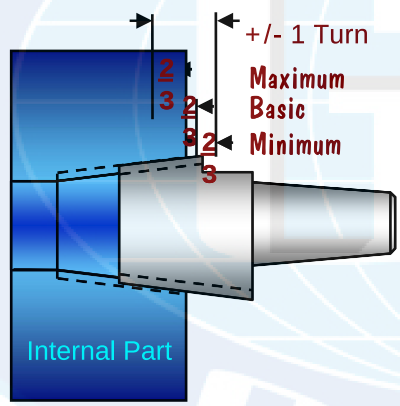
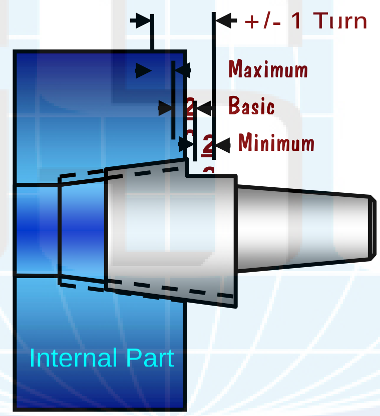
The NPTF system begins with the use of the L-1 gage having a 1 turn in or out limit (2 turns total) the same as the NPT system. The purpose of this gage is to measure the pitch diameter size of the part. It is necessary to refine the standoff (distance from the step to the part) to a more accurate measurement because the 2-turn total tolerance limit must be divided into 3 equal zones. These three zones are known as the minimum, basic, and maximum zones, and the part is referred to as a minimum part, basic part, or maximum part.

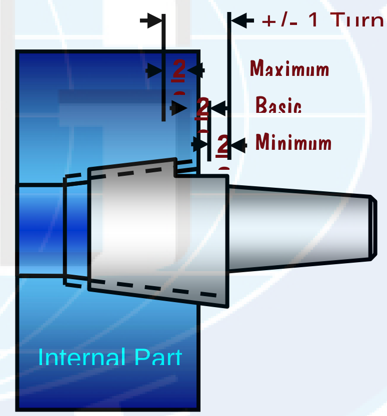
The basic zone is the linear area within 1/3 turn from the face of the part, in or out. If the plug gage is standing out from the face (or datum point) of the internal part more than 1/3 of a turn you have a minimum part because the step on the gage stops within the minimum zone. Likewise, if the plug stands in more than 1/3 of a turn you have a maximum part. The larger the hole is, the deeper the plug will enter into it. A smaller hole, but within tolerance, is a minimum part. A larger hole, but within tolerance, is a maximum part. A hole close to the target size (within 1/3 turn) is a basic part.



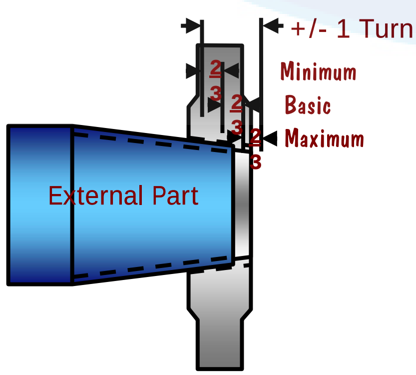
Minimum Part



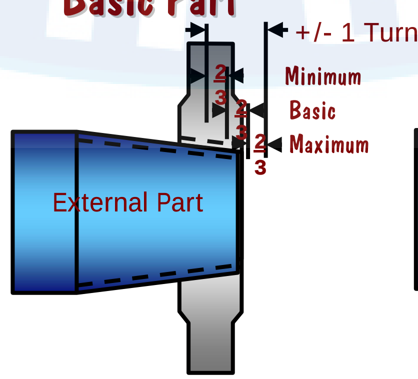
Basic Part



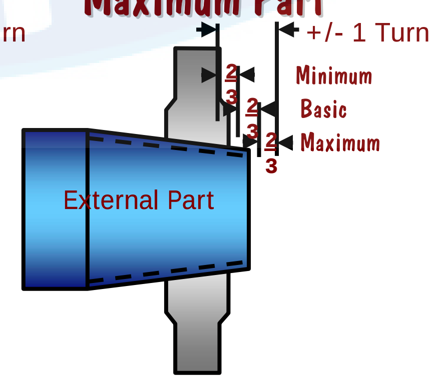
Maximum Part



Maximum Part



Basic Part



Minimum Part

The same ideology is true for the external product but reversed. Again, It is necessary to refine the standoff (distance from the step to the part) to a more accurate measurement because the 2-turn total tolerance limit must be divided into 3 equal zones. These three zones are known as the minimum, basic, and maximum zones, and the part is referred to as a minimum part, basic part, or maximum part.

The basic zone is the linear area within 1/3 turn from the face of the part, in or out. If the ring gage is standing out from the face (or datum point) of the external part more than 1/3 of a turn you have a maximum part because the face on the gage stops within the maximum zone. Likewise, if the ring stands in more than 1/3 of a turn you have a minimum part. The smaller the part is, the farther the ring will engage onto it. A larger part, but within tolerance, is a maximum part. A smaller part, but within tolerance, is a minimum part. A part close to the target size (within 1/3 turn) is a basic part.

ZONES AND TRUNCATION LIMITS

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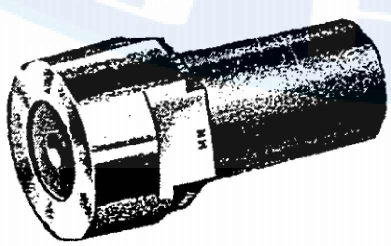
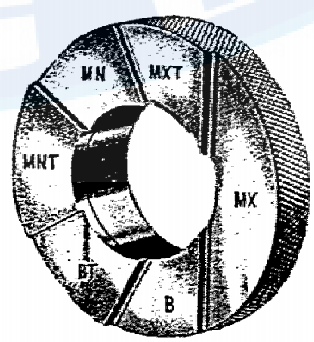
Zones	Truncation Limits	6 Steps
Minimum	Minimum	Mn
	Maximum	Mnt
Basic	Minimum	B
	Maximum	Bt
Maximum	Minimum	Mx
	Maximum	Mxt

The three zones represent different pitch diameter size limits. There is a minimum and maximum limit for the proper amount of truncation that would create full thread form displacement. With three size zones and two limits each there are six possible scenarios represented by the six steps on the 6 step ring and 6 step plug.

This may all sound a bit complicated, but the actual use is very simple. Only two of the six steps are used. The L1 gage identifies the part as being a minimum, maximum, or basic part. The two appropriate steps are chosen Mn and Mnt for minimum parts, B and Bt for basic parts, or Mx and Mxt for maximum parts. The 6 step gage is pushed into or onto the part and if the face comes to rest between the two appropriate steps, the part is acceptable.



6-STEP PLUG



6-STEP RING

It is not easy to measure by eye where these zones begin and end. Gages can be made with three steps or four steps that simplifies this for the user. The other option is to measure the distance with an instrument. 1 turn of a thread can be easily computed with the formula (1 divided by the threads per inch). This gives you the pitch. Divide the pitch by 3 and you can measure the standoff to find the type of part you have. You must know the type of part (min., basic, or max.) to use the 6-step gage.

Inspection with the non-threaded 6-step gage shown here will inspect the thread crest truncation. The root truncation should also be inspected. This can be accomplished by means of a threaded 6-step gage using the same principles of application as the non-threaded 6-step gage.

Parts that conform to product specifications, whether minimum, basic or maximum parts, may be assembled and will achieve a dry seal. It is not necessary to mate parts together that are both basic, or both maximum, or both minimum, so there is no need to categorize the parts.

INTERCHANGEABILITY

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The first consideration in gaging pipe threads is the type of gages used. Gages are specifically designed per the appropriate standard for each type of pipe thread. It is not proper to interchange or substitute gage type and pipe thread type when the correct gage is not available. For example; using NPTF gages on NPT parts.

The manufacturing tolerances for gages vary with type and this causes the gages to vary as to size, giving different inspection results.

The formula for computing the major diameters of pipe plugs gages, and minor diameters of pipe ring gages differ with each type of pipe, because of the difference in the formulas used to compute the major and minor diameters of the various types of pipe threads. This causes the thread form of the gages to mate with the thread form of the product differently when comparing different gages (of various pipe types) to the same product thread.

Using gages **not** designed for the product being gaged can result in contact at the major or minor diameter instead of the flanks and cause incorrect inspection results.

It is possible to inspect one type of pipe with another type of gage and get a reading that says the product is good, but you do not have any assurance your inspection results are correct. It is much more likely that you will not get a correct measurement.

NPT & ANPT threads are designed to mate and be sealed with some type of sealant. NPTF threads are designed to mate and seal without using any type of sealant (this is the reason they are called Dryseal threads). The design of NPTF dryseal threads is not just a tightening of the standard pipes (NPT), but rather a modification. It is an incorrect assumption that you can make a better NPT product thread by using dryseal gaging. What you usually get is an incorrectly manufactured NPT product thread.

The conclusion; use the gage that is specifically designed for that particular product thread. If different pipe gages give different results, the gage designed for the product thread type has the final say, assuming of course, that the gages being used are good gages.

STRAIGHT PIPE THREADS

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There are several pipe threads where the internal and external threads are both straight. In these cases the products threads are inspected using Go/NoGo type gages. These threads will always have to have a sealant applied to assure sealing.

In the cases of pipe threads where the internal product is straight, and the external product is tapered, the product must be inspected with tapered gages to measure functional fit. When the tapered plug gage is applied to a straight internal thread, the gaging notch should be flush with the product face (or datum point) within plus or minus one and one-half turns.

Glastonbury Southern Gage Erin, TN

API (American Petroleum Institute) Gages

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Services Offered

Manufacturing
To API Spec 5B, 7, &11B
CNC Grinding Equipment
Special Requests Welcome

Calibration
Licensed by API
"State of the Art" Lab
Lab Equipment Modified for API Gages

Engineering
Industry "Experts"
Design and Build

Products

Rotary Connections
Line Pipe
Tubing
Casing
Sucker Rods
Tapered Gages
Special Orders

Specification / Application	Nominal Size		TPI	TPF
	From	To		
Spec 5B (Plug/Ring)				
Casing - Buttress	4 1/2	13 3/8	5	3/4
Casing - Round	4 1/2	14 3/4	8	3/4
Line Pipe	1/8	14 3/4	8 - 27	3/4
Tubing - Non Upset	1.050	3 1/2	10	3/4
	4	4 1/2	8	3/4
Tubing - External Upset	1.050	1.900	10	3/4
	2 3/8	4 1/2	8	3/4
Tubing - Buttress	2 3/8	4 1/2	8	3/4
Extreme Line Casing	5	7 5/8	6	1 1/2
	8 5/8	10 3/4	5	1 1/4
Spec 7 (Plug/Ring)				
NC Connections	NC 10	NC 16	6	1 1/2
	NC 23	NC 50	4	2
	NC 56	NC 77	4	3
Regular	1 1/4	8 5/8	4 - 7	2, 3
Full Hole	2 7/8	6 5/8	4 - 5	2, 3
Internal Flush	2	6 5/8	4	2
Other Rotary Connections (Plug/Ring)				
H-90	2 3/8	8 5/8	3 - 3 1/2	1 1/4, 2, 3
Slim Hole	2 3/8		4	2
Extra Hole	2 7/8	5	4	2
Wide Open	2 3/8		4	2
AOH	2 3/8	4 1/2	4	1 1/2
PAC	2 3/8	3 1/2	4	1 1/2
XH	2 7/8	3 1/2	4	2
Spec 11B				
Sucker Rods B1 to B6	1/2	1 1/8	10	
Sucker Rods P1 to P8	1/2	1 1/8	10	
Specials				
Mining: BECO, DI-22, DI-42				
American National Special Threads				
Tapered Thread Gages				

SURVEILLANCE MASTERS

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Surveillance Masters

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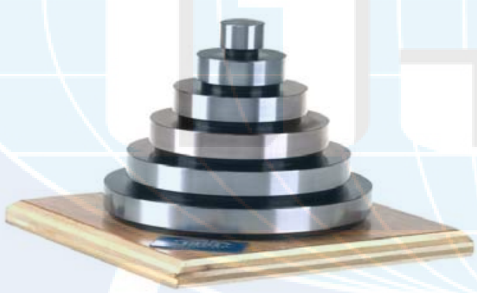
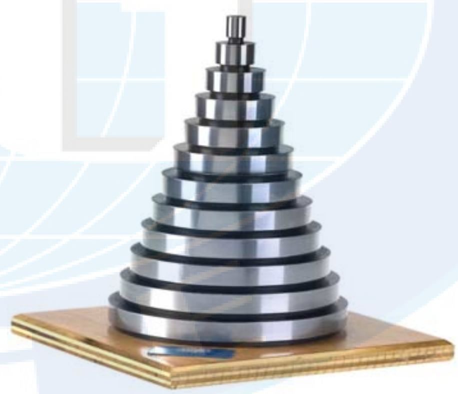
Micrometer Masters are used to periodically check/calibrate micrometers.

A micrometer, like all other measuring equipment, needs to be calibrated on a regular cycle. Gage blocks are one method of accomplishing this. Unfortunately, this practice can be hard on the gage block surface, will negatively affect the wringing ability prematurely, and requires significant skill levels to become proficient. Gage blocks can also produce errors in calibrating micrometers due to a flat surface verses a diameter. This is typically what is being measured. Micrometer masters are easy to use and simulate the parts being checked. The GSG 01-1 for one-inch micrometers, for example, has two (2) odd steps, one at .512 and the other at .762. These steps allow you to check the micrometer at 90 and 180 degrees from the fixed anvil respectfully, thereby checking the parallelism of the anvils.

Micrometer masters are available in four (4) standard styles in inch (standard) or metric (must be specified at time of order).

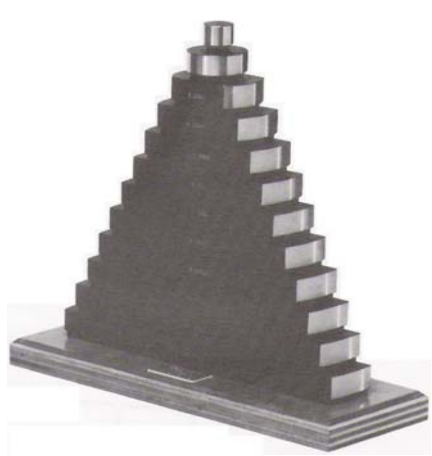


Model 16-1



Model 16–1/2
Model 112

Model 01-1



Model 16-1:

Range: 1.00” (25 mm) to 6.00” (150 mm) in one-inch (25 mm) increments.
Material: Tool Steel, case hardened, stabilized, chrome
Tolerance: Ground & lapped to +/- .0001” (.0025 mm)
Certification available

Model 16- ½

Range: ½” (12.5 mm) to 6.00” (150 mm) in ½ “ (12.5 mm) increments
Material: Tool Steel, case hardened, stabilized, chrome
Tolerance: Ground & lapped to +/- .0001” (.0025 mm)
Certification available

Model 01-1

Range: 0” (0 mm) to 1” (25 mm) in ten increments
Material: Stainless Steel, hardened, stabilized
Tolerance: Ground & lapped to +/- .0001” (.0025 mm)
Certification available

Model 112

Range: 1” (25 mm) to 12” (300 mm) in 1” increments
Material: Tool Steel, case hardened, stabilized with chrome gaging surfaces.
Tolerance: Ground & lapped to +/- .0001” (.0025 mm)
Certification available

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Vernier Caliper Masters are used to periodically check/calibrate Vernier calipers.

Vernier Calipers, like all other types of measuring equipment require frequent calibration on a regular, established inspection cycle. This is true regardless of their relative sophistication (mechanical, or dial types). This can be done using gage blocks or pins. The GSG Vernier Caliper Master provides multiple checks (outside jaws, inside jaws and parallelism of jaws) of the caliper, which is necessary due to the typical rack & gear design or glass scale design. The VC-1 inch provides 1 inch, through 6-inch checks on the outside caliper along with ½ inch to 4-½ inch on the inside caliper. These multiple checks verify the caliper’s accuracy throughout its range of use.

Available in inch (standard) or metric (must be specified at time of order). Lapped gaging surfaces are accurate within +/- .0002” (.005 mm) from nominal size. Certification is available. Black oxided to prevent rust. Larger models are available upon request up to 24”.

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Depth micrometer masters are used to periodically check/calibrate depth micrometers

Like all measuring equipment, depth micrometers, including mechanical and/or indicating styles, require calibration at regular intervals. This can be accomplished using gage blocks. However, this practice puts unnecessary wear on the blocks, thereby reducing their capacity to ring true, and requires significant skill levels to maintain proficiency. The GSG Alpha Depth Master provides multiple checks of the depth micrometer.

Available in inch (standard) or metric (must be specified at time of order). Made from tool steel, hardened, stabilized and black oxided. Models available to check ½" (12.5 mm) to 5.500" (137.5 mm) in 1" (25 mm) steps accurate to +/- .0002" (.005 mm) and ½" (12.5 mm) to 11.500" (287.5 mm) in 1" (25 mm) steps accurate to +/- .0002" (.005 mm).

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Geometric Chek is used to periodically check/calibrate Roundness Machines.

Roundness machines are typically designed to check roundness of a part, concentricity of multiple diameters, (internal or external) cylindricity and squareness of a face to diameter. Roundness machines are highly accurate utilizing precision air bearing tables, have sophisticated electronics and are usually computerized. Like other measuring machines that operate on mechanical bearings and are computer driven, they to need to be calibrated periodically to insure accurate results. The GOEMETRIC CHEK is ideal for this purpose, with dimensional tolerances and geometry to XX tolerances. The internal and external diameters are purposely out of concentricity to exaggerate the error of the machine being checked.

All Geometric Cheks are supplied with a case and a certification that includes roundness and concentricity in three planes, perpendicularity (squareness) check and parallelism. Made from stainless steel hardened and stabilized.

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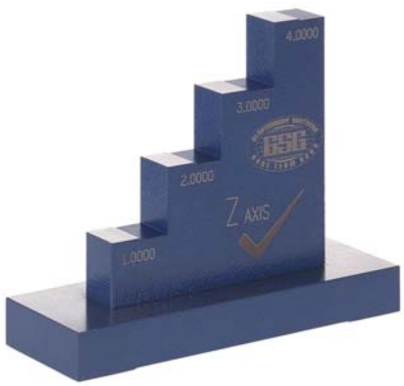
Z Axis Chek is used to periodically check/calibrate the “Z” axis of Vision Machines



Vision machines are three (3) dimensional (X, Y, Z) machines, similar to Coordinate Measuring Machines (CMM), which utilize photographic lens technology. Vision equipment is quite accurate in X and Y planes using pixels or a grid of small blocks. However, the Z-axis, or focus plane, can be difficult to calibrate. The need for this capability spawned the GSG Z AXIS CHEK. This unit has multiple steps (depending on the machine) that are calibrated to 10 microinches in height allowing the operator to calibrate the focus (Z-axis) accurately. The Z-AXIS CHEK is made of

Stainless Steel for corrosion resistance, and has undergone multiple stabilizing processes to minimize dimensional changes through the years.

It can be ordered with a ground (less reflection) or lapped finish.

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QUIKCHEK is used to periodically check/calibrate CMM Machines

Due to the continuing emphasis on quality and the ever-increasing number of applied standards in the manufacturing environment annual gage / tool inspection by a qualified outside calibration service is no longer adequate. This is particularly true with respect to Coordinate Measuring Machines (CMM's). By performing inspection checks often one can be more assured that the CMM is working within the manufacturer's specifications. Moreover, if a problem is discovered there are fewer parts to re-examine and potentially fewer bad parts produced.

Several checks should be performed on a CMM with the most important being confirmation of: diameter, length, squareness and volumetric accuracy. The instrument used should be highly calibrated, reliable, easy to use and be similar in nature to the types of parts being checked.

The Glastonbury Southern Gage "QUIKCHEK" utilizes three holes in a triangular pattern allowing the following checks to be easily made, specific features certified and traceable to the National Institute of Standards and Technology.

Diameter: holes calibrated and round within .000010" on the 8-inch model and .000020" on the 16-inch model.
Length: centerline to centerline
Squareness: angles calculated to within one arc second accuracy
Volumetric: utilizing hypotenuse of triangle positioned anywhere on the table

The QUIKCHEK is an excellent training tool allowing new personnel to become acclimated and more comfortable measuring with the CMM, the use of touch probes, and general inspection processes.

The unit is made of 440C Stainless Steel material, stress relieved, hardened to 62Rc and triple stabilized so it will maintain its accuracy for years. The QUIKCHEK comes with certification, application procedure and lockable storage case.

By comparing the calibrated values generated from your CMM frequently, the machine can be tracked statistically period to period. Problems can be detected before they become critical. Maintaining these inspection results can help during company quality audits by helping to eliminate equipment concerns within the inspection department.

In summary the QUIKCHEK is a highly calibrated artifact using multiple hole patterns calibrated outside of the Coordinate Measuring machine by conventional methods traceable to NIST, is certified, and simulates actual parts being inspected with hole locations, true positions, and bolt circle call outs.

The Glastonbury Southern Gage "QUIKCHEK" helps provide assurance that your CMM is working properly.

Special sizes available upon request.

8" Specifications:

Hole Diameters	1.0000"
C to C of holes 2 legs	8.0000"
Hypotenuse	11.3137"
Calibrated Accuracies:	
Diameter roundness within	.000010"
Length measurement uncertainty	.000020"
Angle	less than 1 second
Flat & parallel within	.000050"

16" Specifications:

Hole Diameters	2.0000"
C to C of holes 2 legs	16.0000"
Hypotenuse	22.6274"
Calibrated Accuracies:	
Diameter roundness within	.000020"
Length measurement uncertainty	.000040"
Angle	less than 1 second
Flat & parallel within	.0002"

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Surveillance Masters

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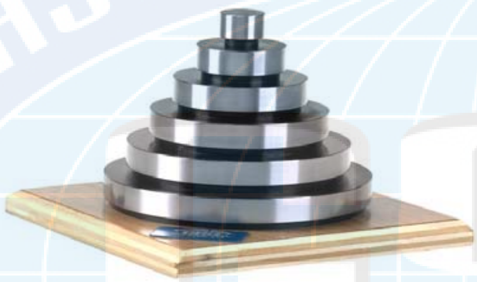
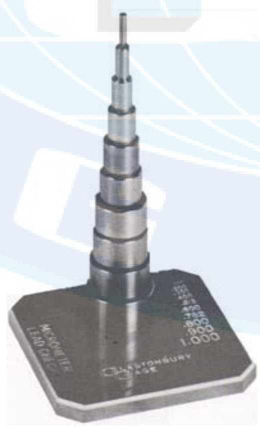
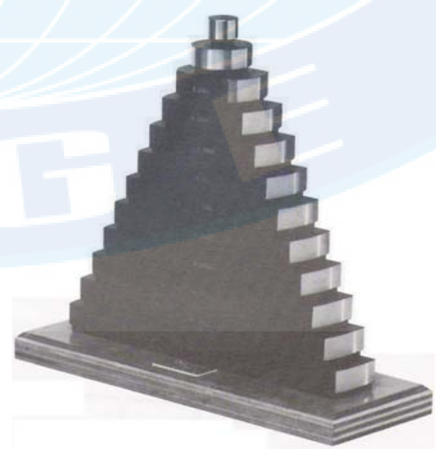
Micrometer Masters are used to periodically check/calibrate micrometers.

A micrometer, like all other measuring equipment, needs to be calibrated on a regular cycle. Gage blocks are one method of accomplishing this. Unfortunately, this practice can be hard on the gage block surface, will negatively affect the wringing ability prematurely, and requires significant skill levels to become proficient. Gage blocks can also produce errors in calibrating micrometers due to a flat surface verses a diameter. This is typically what is being measured. Micrometer masters are extremely handy being fixed in place and simulating the parts being checked. The GSG 01-1 for one-inch micrometers, for example, has two (2) odd steps, one at .512 and the other at .762. These steps allow you to check the micrometer at 90 and 180 degrees from the fixed anvil respectfully, thereby checking the parallelism of the anvils.

Micrometer masters are available in four (4) standard styles.







Surveillance Masters

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Surveillance Masters

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Depth micrometer masters are used to periodically check/calibrate depth micrometers

Like all measuring equipment, depth micrometers, including mechanical and/or indicating styles, require calibration at regular intervals. This can be accomplished using gage blocks. However, this practice puts unnecessary wear on the blocks, thereby reducing their capacity to ring true, and requires significant skill levels to maintain proficiency. The GSG Alpha Depth Master provides multiple checks of the depth micrometer. It is fully traceable to NIST, and comes with all required dimensions fully certified.

Surveillance Masters

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Geometric Chek is used to periodically check/calibrate Roundness Machines.

Roundness machines designed to check roundness of a part, concentricity of multiple diameters, (internal or external) cylindricity and squareness of a face to diameter. Roundness machines are highly accurate utilizing precision air bearing tables, have sophisticated electronics and are usually computerized. Like other measuring machines that operate on mechanical bearings, and are computer driven, they to need to be calibrated periodically to insure accurate results. The GOEMETRIC CHEK is ideal for these purposes, with dimensional tolerances and geometry to XX tolerances. The internal and external diameters are purposely out of concentricity to exaggerate the error of the machine being checked.

Surveillance Masters

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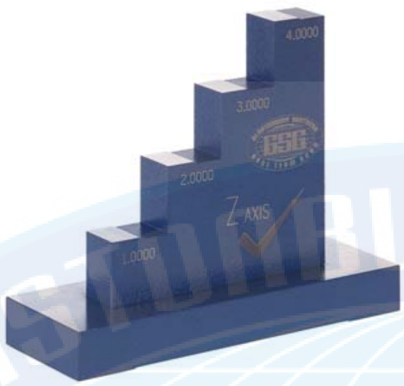
Z Axis Chek is used to periodically check/calibrate the "Z" axis of Vision Machines



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Surveillance Masters

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QUIKCHEK is used to periodically check/calibrate CMM Machines

Due to the continuing emphasis on quality and the ever-increasing number of applied standards in the manufacturing environment annual gage / tool inspection by a qualified outside calibration service is no longer adequate. This is particularly true with respect to Coordinate Measuring Machines (CMM's). By performing inspection checks often one can be more assured that the CMM is working within the manufacturer's specifications. Moreover, if a problem is discovered there are fewer parts to re-examine and potentially fewer bad parts produced.

Several checks should be performed on a CMM with the most important being confirmation of : diameter, length, squareness and volumetric accuracy. The instrument used should be highly calibrated, reliable, easy to use and be similar in nature to the types of parts being checked.

The Glastonbury Southern Gage "QUIKCHEK" utilizes three holes in a triangular pattern allowing the following checks to be easily made, specific features certified, and manufactured traceable to the National Institute of Standards and Technology.

Diameter: holes calibrated and round within .000010 on the 8-inch model and .000020 on the 16-inch model.
Length: centerline to centerline
Squareness: angles calculated to within one arc second accuracy
Volumetric: utilizing hypotenuse of triangle positioned anywhere on the table

The QUIKCHEK is an excellent training tool allowing new personnel to become acclimated an more comfortable measuring with the CMM, the use of touch probes, and general inspection processes.

The unit is made of 440C Stainless Steel material, stress relieved, hardened to 62Rc and triple stabilized so it will maintain its accuracy for years. The QUIKCHEK comes with certification, application procedure and lockable storage case.

By comparing the calibrated values generated from your CMM frequently, the machine can be tracked statistically period to period. Problems can be detected before they become critical. Maintenance of these inspection results can help during company quality audits by helping to eliminate equipment concerns within the inspection department.

In summary the QUIKCHEK is a highly calibrated artifact using multiple hole patterns calibrated outside of the Coordinate Measuring machine by conventional methods traceable to NIST, is certified, and simulates actual parts being inspected with hol locations, true positions, and bolt circle call outs.

The Glastonbury Southern Gage "QUIKCHEK" help provide assurances that your CMM is working properly.

Special sizes available upon request.

(Back to Contents)
(EXAMPLE OF QUIKCHEK CERTIFICATION)
(QUIKCHEK APPLICATION PROCEDURE)

QUIKCHEK

Pat. No. 5,313,410

The emphasis on quality in the manufacturing environment and the requirements of ISO Standards mean the annual inspection by an outside service of your Coordinate Measuring Machine(s) (CMM) is not adequate to assure it's daily accuracy.

By performing an interim check on a weekly basis you can assure the CMM is working within the manufacturer's specifications and if a problem is discovered you would have only one week to go back and reexamine suspicious results.

Several checks should be performed on a CMM, the most important being: diameter, length, squareness and volumetric. The instrument used should be highly calibrated, reliable, easy to use and be similar in nature to types of parts being checked.

The GlastonburySouthern Gage "QUIKCHEK" utilizes three holes in a triangular pattern allowing the following checks to be made:

Diameter - holes calibrated and round within .000010” on the 8 inch model
and .000020” on the 16 inch model.
Length - centerline to centerline.
Squareness - angle calculated to within one second accuracy.
Volumetric - utilizing hypotenuse of triangle positioned anywhere on the table.

Procedures are easy and quick to understand and implement. See separate “Application Procedure”.

Each QUIKCHEK comes with a certification traceable to The National Institute of Standards and Technology with the following calibrated accuracy’s: diameter, three lengths centerline to centerline, and a 90 degree angle to less than one second accuracy for a squareness check.

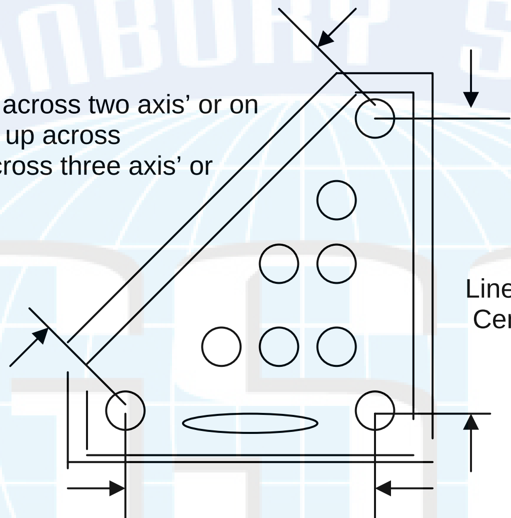
The QuikChek can also be used for training of new personnel on the CMM and checking machine travel on touch probe machining centers.

The QuikChek is made of 440c Stainless Steel material, stress relieved, hardened to 62Rc and triple stabilized so it will virtually never wear out.

By comparing the calibrated values generated from your CMM weekly, one can track the machine statistically week to week and detect a problem before it becomes one. During outside audits by your customers you now have factual information of the CMM accuracy since it's last calibration.

In summary the QuikChek is a highly calibrated artifact using multiple hole patterns calibrated outside of the Coordinate Measuring Machine by conventional methods traceable to N. I. S. T. and is a tangible product that simulates actual parts being inspected with hole locations, true positions, and bolt circle call outs. The QuikChek comes with certification, application procedure and lockable storage case.

The Glastonbury Southern Gage "QUIKCHEK" finally provides the assurance your CMM is working properly.



Financial Advantages

a> Less time lost re-checking work due to uncertainties of first time machine results.
b> QuikChek would referee correlation disputes between manufacturing and/or other CMM's in plant, therefore reducing lost unproductive man-hours.
c> In the event a problem is detected during your weekly check, only one-week maximum of reexamination may be needed rather than month(s) of questionable product shipped.
d> Man-hours saved by using QuikChek rather than current interim checking methods, which are more time consuming and produce less result.
e> QuikChek can be used to keep outside suppliers in correlation with your incoming inspection department.

Metrology Advantages

a> QuikChek performs 4 checks in one unit Diameter, linear length, squareness and volumetric.
b> Highly calibrated artifact that resembles piece parts.
c> Traceability to N. I. S. T.
d> Machines can be tracked statistically for performance.
e> Data which can be used for outside audits by your customers and ISO certification.
f> Probe is included in the check.

Specifications

	8 Inch Model	**16 Inch Model**

Hole Diameter	1.0000”	2.0000”
Centerline to Centerline		
2 legs	8.0000”	16.0000”
Hypotenuse	11.3137”	22.6274”

Calibrated Accuracy’s

Diameter Roundness Within	.000010”	.000020”
Length Measurement uncertainty	.000020”	.000040”
90 Degree Angle	> 1 second	> 1 second
Flat & Parallel Within	.000050”	.0002”

Glastonbury Southern Gage
87 Upton Road
Colchester, CT 06415

Cert #:
GG #:
Date:

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Calibration Certificate

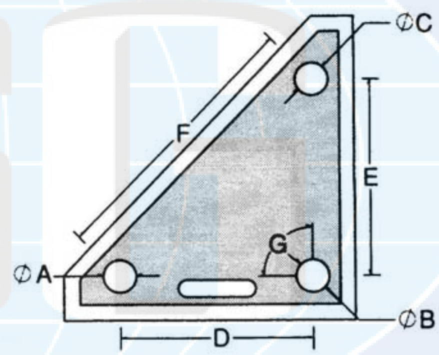
Customer:	Customer Code: Customer P.O. #:

Description: 16 inch Quik - Chek
Condition of item when received: Good
This item is certified to be In tolerance

Inspection Procedure: QDW4.10.1-02 Int. Dia.	NIST Ref.: 821/261181	Dated: 02/02/99
Blocks:	Temperature: 68°F +/- 1°F	Humidity: 40% +/- 20%
Inspection Equipment: Federal 136B-3	Applicable Standard: N/A	

All results are deviations from the prescribed and are given in Inches

Dimension	Prescribed Size	Actual
Diameter A	2.0000	
Diameter B	2.0000	
Diameter C	2.0000	
℄ to ℄ D	16.0000	
℄ to ℄ E	16.0000	
℄ to ℄ F	22.6274	
Angle	90° 0' 0"	° ' "
G Squareness error over E Length	0	



Notes:

Note: Measurements taken at center 1/2 of bores only. (Diameter A measured left to right, Diameter B first measurement - left to right, second - top to bottom, Diameter C measured top to bottom. Angle calculated from three hole pattern. All measurements are based on the international inch (1.00 in = 25.4 MM).

This certificate applies only to the item(s) and item(s) dimensions listed.

All dimensions listed are both 'as found' and 'as left' unless otherwise noted.

This certificate may not be reproduced except in full without written permission from GSG.

The calibration system supporting this certificate complies with ISO 17025 & ISO 10012-1.

The user's calibration source for NIST traceability is GSG. The user must determine the re-calibration interval for this item.

The Expanded Uncertainty associated with the length measurements is U = Microinches using a coverage factor of K=2 which provides a confidence level of approximately 95%.

Reported by: ________________________________

Calibration Technician

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GLASTONBURY SOUTHERN GSG GAGE

Glastonbury Southern Gage
46 Inductrial Park Rd.
Erin, TN 37061
800-251-4243
F: 800-242-7142
www.gsgage.com

QUIKCHEK
(Patent # 5,313,410)
APPLICATION PROCEDURE
8" MODEL

The continuing proliferation of coordinate measuring machines (CMM) in manufacturing has created the need for an instrument to cost effectively verify the repeatability of CMM's on a routine basis. To date existing methods, when performed, are time consuming and as often as not, unreliable.

Glastonbury Southern Gage recognized the need for a device to ensure that your CMM is operating within the specifications of the manufacturer. **Quikchek** is a certified instrument that will afford you a cost effective method of routinely confirming the performance of your CMM for critical functions such as; **Diameter, Length, Squareness, & Volumetric repeatability.**

Quikchek employs three one-inch diameter holes, certified to, +/-10 millionths, within a triangular geometric gage to calibrate critical CMM performance characteristics. Each **Quikchek** is flat and parallel within 50 millionths.

Quikchek is certified to the following calibrated accuracies:

- Diameters - Round within 10 millionths.
- Lengths - Calibrated with a measurement uncertainty of 20 millionths.
- Angles - Less than one second.

Quikchek CMM Verification Procedure:

1. Place **Quikchek** on the CMM surface plate, with the right angle sides approximately in line with the X and Y axis.
2. Establish the leveling plane on the top surface.
3. Establish an alignment along either the X or Y side.
4. Check diameter A for size, then check diameter B for size and linear length center line to center line on X axis.
5. Check diameter C for size and linear length on the Y axis. Now you have performed a squareness check X to Y axis.
6. Check back diameter A for a volumetric check across the XY.

Repeat steps 1 through 6 with **Quikchek** in the upright position in XZ and YZ planes. A slot is conveniently located at the bottom for clamping to assure that **Quikchek** does not move during the measuring process.
Note: Position **Quikchek** upright across XY axis diagonal and check diameter A and C for a true volumetric check across XYZ axis.

Quikchek has verified the repeatability of the CMM for diameters, squareness, and linear distance in all three planes. Using **Quikchek** you can establish the volumetric repeatability within an 8 inch cube.

The **Quikchek** procedure may be executed in the software controlled or manual mode.

VARIABLE THREAD GAGING

(Click on the links below for the document)

Back to Main Contents

Back to Main Contents

INTRODUCTION TO VARIABLE THREAD GAGING

(Back to Contents)

Variable thread gaging is typically used when manufacturing large quantities of threaded product (examples: nuts, bolts and other fasteners) and where actual values for certain thread attributes are required. (System 22 & 23 checks) Thread comparators are quickly and easily used to verify thread components. Initial set-up is easily made with a set master and accurate inspection can be accomplished in a fraction of the time required to use fixed limit gaging (go / no go gaging) thus reducing your inspection time and increasing your profits. Variable gaging provides quantitative information which allows manufacturing and the operator information regarding actual product values within the tolerance range. Rather than just knowing the thread is functionally correct as with fixed limit gaging (go / nogo gaging) variable thread gaging allows you to measure specific features of the thread such as functional diameter, pitch diameter, major diameter and the minor diameter. This information not only allows you to manufacture a higher quality product but will help you isolate problems within your manufacturing process.

GSG gaging systems satisfy the requirements of the FASTNER SAFTEY ACT and ASNI / ASME specifications including system 21, system 22 and system 23 gaging of screw threads per ASME B1.3M.

The rigid construction and constant gaging pressure of the GSG gaging frames assures you consistent and precise readings. Rolls revolve with the work and segments snap into place greatly reducing wear compared to fixed limit gaging allowing your gage replacement costs to be reduced. Frame sizes are provided to cover diameter ranges from .060” through 12” on external product and .190” though 8” on internal product.

Even after extended use in the shop environment, GSG frames can be reworked to new condition for typically less than 50% of the cost of a new frame.

Rolls and segments are quickly and easily interchanged within the range of the frame to measure specific diameter / pitch combinations or different features of the same thread. The thread geometry of the GSG rolls and segments are held to the same high standards as our fixed limit gaging.

GSG recommends using a class-w full form master on the external units and a class-w solid master ring on the internal units. Many popular sizes can be purchased from stock and special applications can be quoted upon request.

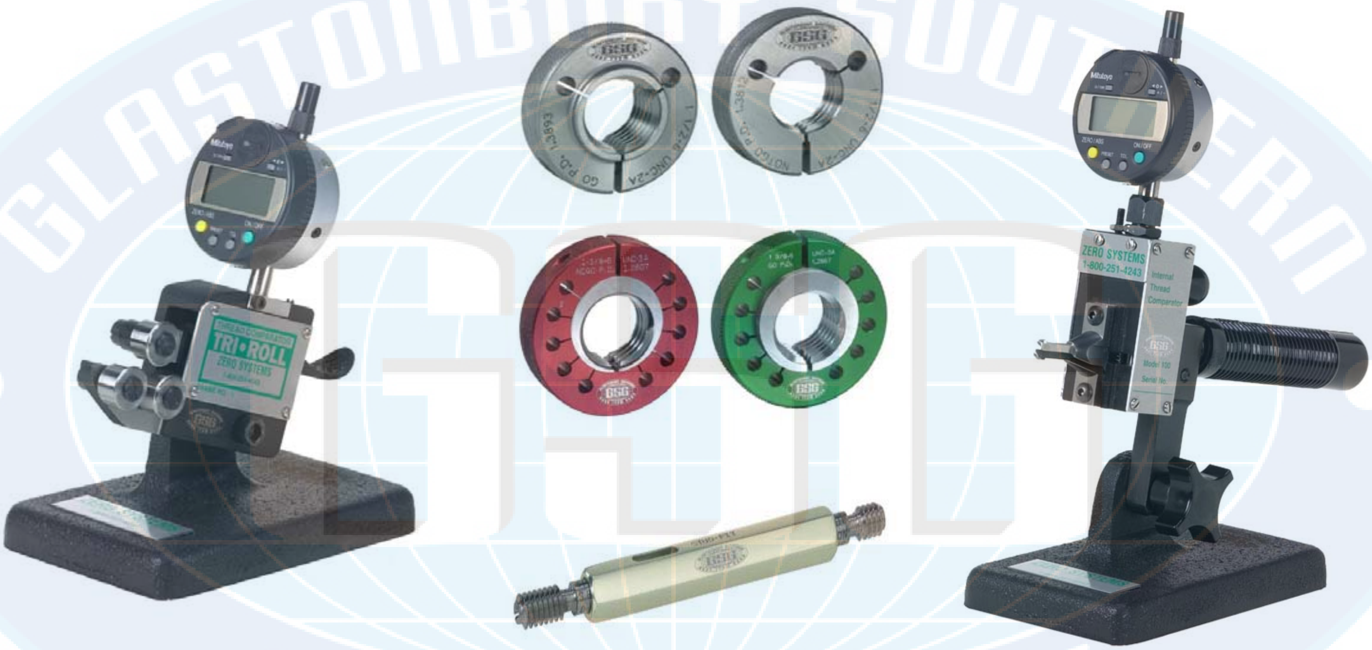
GSG also provides an adjustable tri-roll system with a diameter range of .112” through .750” for those who require the versatility of an adjustable frame. Basic nominal diameter on the GSG adjustable frame is set using an inexpensive setting template and pitch is controlled with the rolls

GSG variable gaging systems provide a means for statistical process control (SPC). Set-up with an electronic indicator and used in conjunction with a data collection unit, GSG variable gaging allows you to meet your SPC requirements on threaded product. GSG offers a selection of electronic and dial indicators available from stock.

THREAD GAGING SYSTEMS

(Back to Screw Threads/Thread Gaging Contents)
(Back to Variable Thread Gaging Contents)

A thread gaging system comprises a list of thread characteristics that must be inspected and the gaging necessary to inspect these characteristics to assure product acceptability. Many organizations through their quality system provide methods / systems for the inspection and acceptability of their product. ASME has set an industry standard of gaging systems for screw threads known as ASME B1.3M. These systems provide different levels of inspection to insure dimensional conformance has been achieved.



System 21

System 21 provides for interchangeable assemble with respect to functional size only. Functional size must be measured at the maximum material limit within the length of standard gaging elements. The characteristic known as NO GO functional diameter must also be verified. This can be accomplished by using fixed limit gaging or variable gaging with functional elements.

SYSTEM 21A (FOR METRIC THREADS IN ACCORDANCE WITH ANSI B1.18M)

System 21A provides for interchangeable assemble with functional size verified at the maximum material limit using standard length gaging elements. This can be accomplished using fixed limit gaging or variable gaging with functional elements. System 21A also states that the minimum material limit (minimum pitch diameter) must be verified by inspecting two thread flank locations over the length of the thread. This can be accomplished by using variable gaging or thread roll snap gages with pitch diameter elements.

SYSTEM 22

System 22 provides for the interchangeable assemble with functional size verified at the maximum material limit using standard length gaging elements. This can be accomplished using fixed limit gaging or variable gaging with functional diameter elements. System 22 also states that the minimum material limit (minimum pitch diameter) must be verified over the full length of the thread. This can be accomplished using variable gaging with pitch diameter elements.

SYSTEM 23

System 23 provides for interchangeable assemble with functional size verified at the maximum material limit using standard length gaging elements and minimum material limit (minimum pitch diameter) must be verified over the full length of the thread. The gaging requirements for SYSTEM 22 would also apply here but in SYSTEM 23 other thread characteristics such as lead, flank angles, taper and roundness my have to be independently verified. Only thread characteristics, which are specified, will have to be inspected for SYSTEM 23 compliance.

See ASME B1.3M for a complete explanation of gaging systems and gage compliance before selecting gaging for your application.

THREAD GAGING SYSTEMS

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System 21

System 21 provides for interchangeable assemble with respect to functional size only. Functional size must be measured at the maximum material limit within the length of standard gaging elements. The characteristic known as NO GO functional diameter must also be verified. This can be accomplished by using fixed limit gaging or variable gaging with functional elements.

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SYSTEM 22

System 22 provides for the interchangeable assemble with functional size verified at the maximum material limit using standard length gaging elements. This can be accomplished using fixed limit gaging or variable gaging with functional diameter elements. System 22 also states that the minimum material limit (minimum pitch diameter) must be verified over the full length of the thread. This can be accomplished using variable gaging with pitch diameter elements.

SYSTEM 23

System 23 provides for interchangeable assemble with functional size verified at the maximum material limit using standard length gaging elements and minimum material limit (minimum pitch diameter) must be verified over the full length of the thread. The gaging requirements for SYSTEM 22 would also apply here but in SYSTEM 23 other thread characteristics such as lead, flank angles, taper and roundness my have to be independently verified. Only thread characteristics, which are specified, will have to be inspected for SYSTEM 23 compliance.

See ASME B1.3M for a complete explanation of gaging systems and gage compliance before selecting gaging for your application.

TRI-ROLL COMPARATOR

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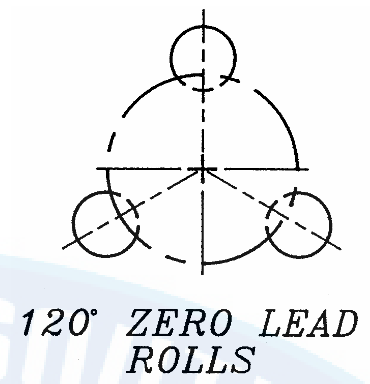


TRI-ROLL COMPONENTS

1. **BASE** - One solid cast base is applicable to all gage frames.
2. **GAGE FRAME** - Various gage frames are provided to cover all sizes from .060" to 3 3/8" diameter.
3. **INDICATOR** - Dial or electronic indicators are available.
4. **STOP ADJUSTING TOOL** - Combination screwdriver is for adjusting the lever stop screw for protection of the indicator.
5. **GAGING ROLLS** - Various interchangeable rolls are available for threaded or cylindrical gaging applications.

BASIC SPECIFICATIONS

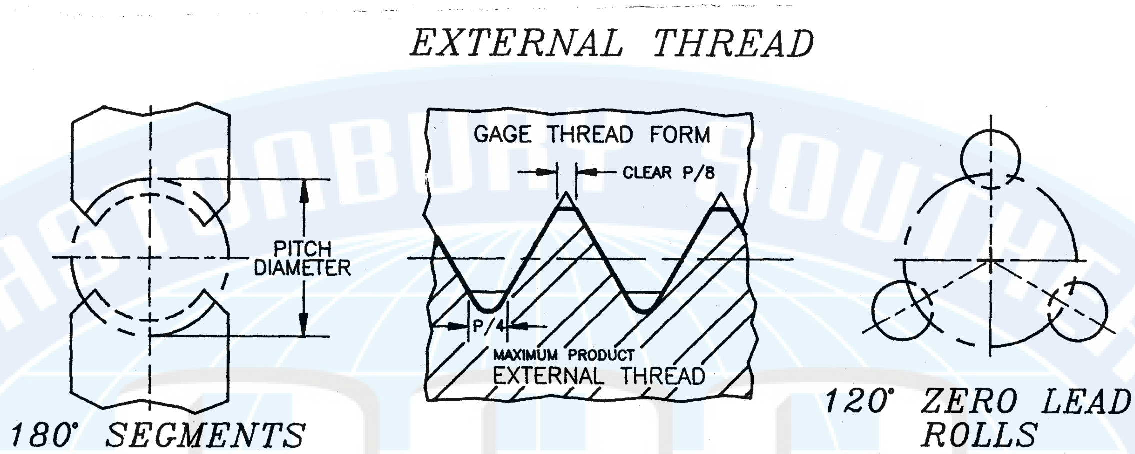
FRAME NO.	RANGE - NOMINAL SIZE				FOR THREADS PER INCH	ROLL LENGTH
	INCH		METRIC (mm)			
	ABOVE	TO & INCL.	ABOVE	TO & INCL.		
0	.059	.073	1.5	1.8	80 To 64	.223
1	.073	.099	1.8	2.5	64 To 48	.223
2	.099	.164	2.5	4.2	48 To 32	.223
3	.164	.313	4.2	7.9	32 To 18	.424
4	.313	.500	7.9	12.7	32 To 12	.424
5	.500	.750	12.7	19.0	28 To 10	.626
6	.750	1.125	19.0	28.5	28 To 6	.931
7	1.125	1.500	28.5	38.1	28 To 6	.931
8	1.500	1.875	38.1	47.6	28 To 4	.931
9	1.875	2.250	47.6	57.1	28 To 4	.931
10	2.250	2.625	57.1	66.7	28 To 4	.931
11	2.625	3.000	66.7	76.2	28 To 4	.931
12	3.000	3.375	76.2	85.7	28 To 4	.931

Sizes and pitches—and special forms—not listed are furnished on application.
When ordering a Tri-Roll, please specify thread diameter to be measured.

ROLL AND SEGMENT SELECTION

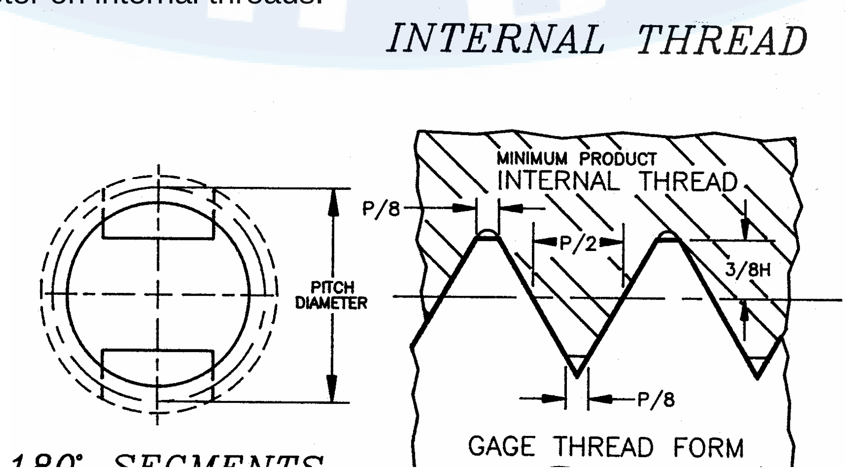
(Back to Contents)

Routinely thread comparators are used to analyze and distinguish the following characteristics of a thread: functional diameter, pitch diameter, major diameter, minor diameter and lead and / or flank angle deviation. The following guide should help you simplify the selection of gaging rolls and segments to fit your applications.

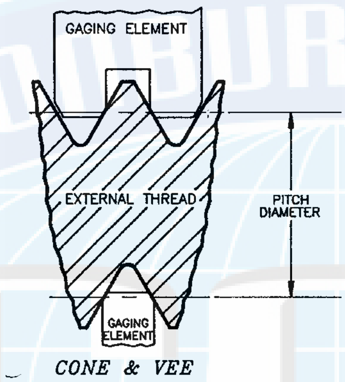


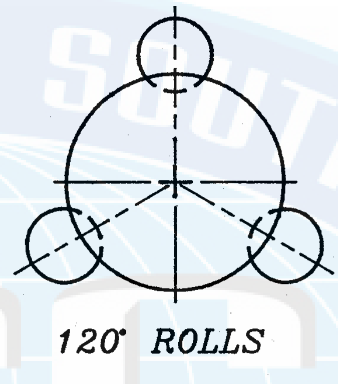
Functional diameter: The functional diameter of a thread is the actual pitch diameter adjusted by the cumulative effects of lead error, flank angle error, taper and out of round. GSG can supply two types of gaging for the inspection of functional diameter on external product. The Tri-Roll comparator, whether the fixed frame models or the adjustable model, may be used to inspect functional diameter in most applications especially when 120- degree out of round (lobing) is a consideration. The STC comparator may be used to inspect functional diameter and is the proper choice when 180 degree out of round (ovality) or an extreme helix angle of the thread is a consideration.

The ITC comparator and functional segments are the proper choice for the inspection of functional diameter on internal threads.

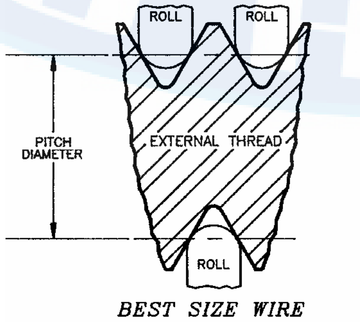


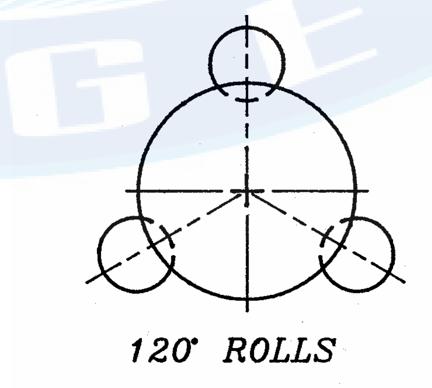
PITCH DIAMETER: The pitch diameter of a thread is the theoretical plane, which passes through a thread at the point where the thread tooth and thread groove are equal. The tri-roll thread comparator, whether the fixed frame models or the adjustable model, may be used to inspect the pitch diameter of an external thread. You may select from two styles of roll to inspect pitch diameter on external product. The type-4 or cone & vee rolls are a relieved 60-degree thread form, which allows pitch/10 thread engagement at the pitch line of a single thread. EXAMPLE: 10 PITCH THREAD (.100 / 10 = .010 THREAD CONTACT)



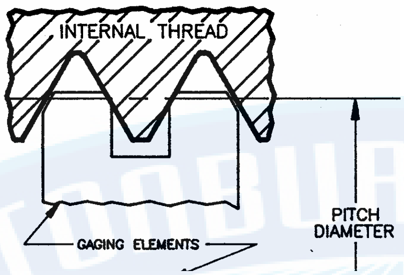


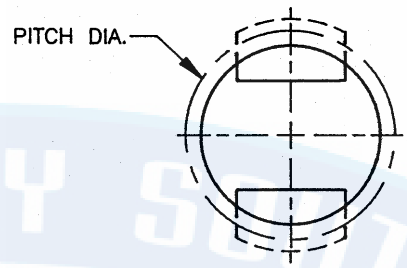
The type-5 rolls are a radius profile roll with an included angle manufactured to clear the flank angles of the product thread. The radius sizes are manufactured to the best wire size of the applicable thread. This method is similar to the 3-wire method of thread inspection.



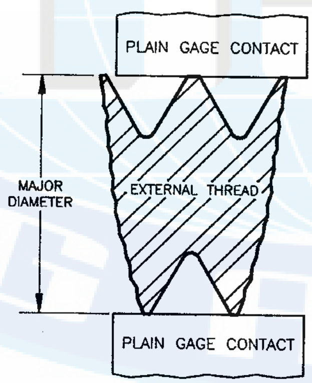


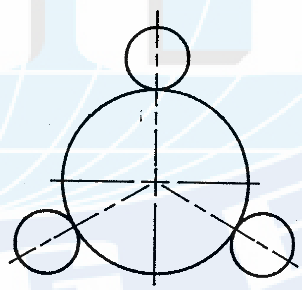
The ITC frame with cone & vee segments is the proper choice for the inspection of pitch diameter of internal threads. The cone & vee segments of the ITC comparator are the same thread profile as the type-4 rolls with P/10 thread engagement.





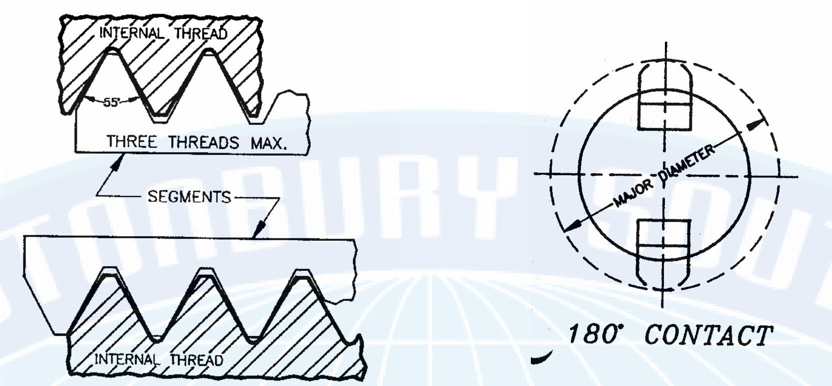
MAJOR DIAMETER: The major diameter is the largest diameter of a thread form also known as the crest. The tri-roll thread comparator whether the fixed frame models or the adjustable model can be used to inspect the major diameter of a thread or cylindrical product where tolerances permit. The type-6 plain cylindrical rolls are the proper choice for inspecting the major diameter of an external thread and can be mastered with a simple cylindrical master.



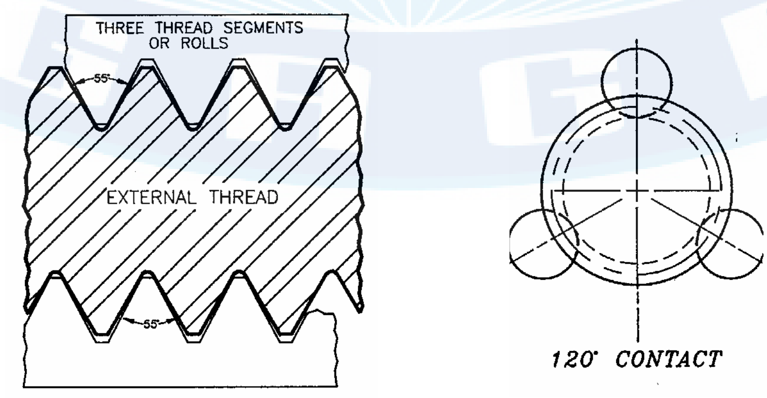


120° CONTACT

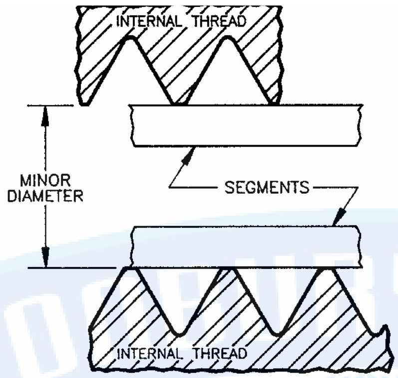
The major diameter of an internal thread is the root diameter of the thread. The ITC comparator with major diameter segments are the proper choice for inspecting the major diameter of an internal thread. Major diameter segments are manufactured with flank angles to clear the product thread and can be mastered with a simple cylindrical ring.

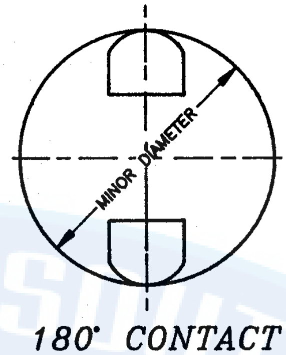


MINOR DIAMETER: The minor diameter of a thread is the smallest diameter of a threaded form. The root diameter of an external thread is the minor diameter; A common application of external thread minor diameter inspection is in safety critical unj series threads. The tri-roll comparator, whether the fixed frame models or the adjustable model, can be used with type-7 minor diameter rolls to inspect the minor diameter of external threads. The type-7 rolls are manufactured with a radius crest profile and flank angles designed to clear the product thread and can be mastered with a simple cylindrical master.



The crest diameter of an internal thread is the minor diameter. The ITC comparator with cylindrical segments may be used to inspect the minor diameter of an internal thread and can be mastered with a simple cylindrical ring.





DIFFERENTIAL ANALISIS: Deviation in lead / flank angle is inspected by comparing functional size and pitch diameter size. Theoretically identical readings would indicate perfect lead and form. In actual practice functional size is almost always larger than pitch diameter on an external thread and smaller than the pitch diameter on an internal thread. If the difference between the two is excessive the lead / flank angle variations inherent in the thread can cause problems with assemble or compromise the integrity of the fit. As a general rule the deviation between these two readings should not exceed 50% of the total pitch diameter tolerance. However in certain safety critical applications this difference is held to within 40% of the pitch diameter tolerance. EXAMPLE: PITCH DIAMETER TOLERANCE =. 0036 (.0018(50%) LEAD / FLANK ANGLE DEVIATION TOLERANCE).

By mounting multiple gaging frames on the same base and using functional elements on one frame and using pitch diameter elements on the other frame differential gaging can be made easy by making quick comparisons between functional and pitch diameter. Differential gaging also allows you to replace tooling and make machine adjustments before bad product is produced.

GSG offers the multi-mounting bar that can be used with the standard base or the sturdy dual frame base assemble for multiple mounting of all our standard gaging frames.

SELECTING GAGING ROLLS

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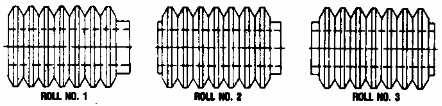
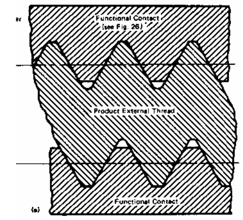
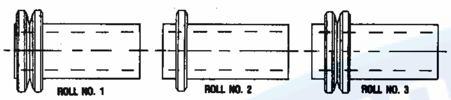


TYPE 3
Full Profile-Functional Diameter Size

Full ribbed rolls for functional diameter size for pitches coarser than 48 T.P.I.
or 48 T.P.I. and finer the ribs locate on alternate threads)

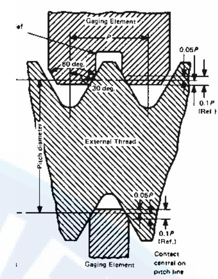
THE FUNTIONAL DIAMETER IS THE ACTUAL PITCH DIAMETER OF A THREAD ADJUSTED BY THE CUMLATIVE EFFECTS OF LEAD ERROR AND ANGLE ERROR. SELECT TYPE –3 FUNCTIONAL ROLLS OR THE STC FUNCTIONAL SEGMENTS WHEN GAGING FUNCTIONAL DIAMETER. GSG CAN ALSO HELP YOU WITH A WIDE RANGE OF SPECIAL THREAD FORMS (ACME, BUTRESS AND MULTI-START THREADS). STANDARD STOCK ROLLS MAY ALSO BE MODIFIED TO ACCOMMODATE UNJ SERIES THREADS.





TYPE 4
Cone and Vee-Single Element Pitch Diameter

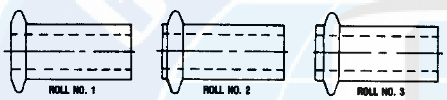
Two ribs ("vee" type) on lower rolls (No.1 and 3)
One rib ("cone" type) on upper roll (No. 2)
Flank contact limited to .1 pitch.



THE PITCH DIAMETER OF A THREAD IS THE THEORETICAL PLANE WHICH PASSES THROUGH A THREAD AT THE POINT WHERE THE WIDTH OF THE THREAD TOOTH AND GROOVE ARE EQUAL.

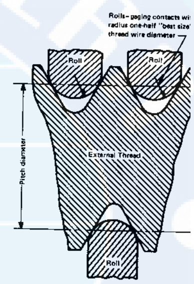
SELECT TYPE-4 CONE & VEE ROLLS OR TYPE-5 RADIUS PROFILE ROLLS WHEN GAGING PITCH DIAMETER.

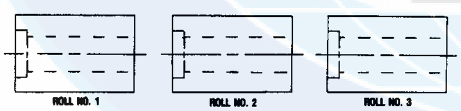
THE PITCH DIAMETER OF SPECIAL THREAD FORMS MAY ALSO BE INSPECTED USING THE TYPE-4 AND TYPE-5 ROLLS. GSG CAN ALSO DESIGN AROUND MANY OTHER APPLICATIONS SUCH AS ANNULAR GROOVES AND SELF-TAPPING SCREW THREAD FORMS.



TYPE 5
"Best Wire" Size Radius-Single Element Pitch Diameter

Single ribs only with "best wire" size radius for any given pitch (T.P.I.).

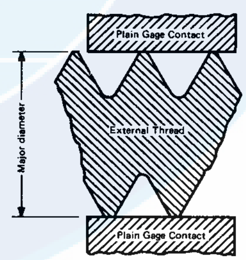


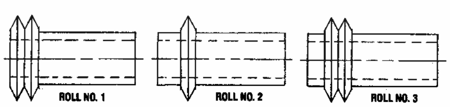


TYPE 6
Plain Rolls-Thread Major Dia. and Plain Cylindrical Parts

Straight cylindrical rolls for checking diameter and out-of-roundness.

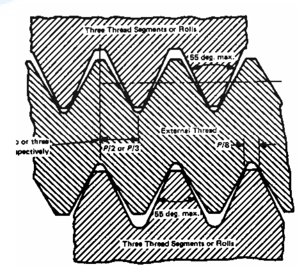
THE MAJOR DIAMETER IS THE LARGEST DIAMETER OF A THREAD FORM. THE CREST DIAMETER OF AN EXTERNAL THREAD IS THE MAJOR DIAMETER. SELECT TYPE-6 CYLINDRICAL ROLLS WHEN GAGING THE MAJOR DIAMETER OF A THREAD.
WHEN PART TOLERANCES ALLOW THE TYPE-6 ROLLS CAN ALSO BE USED TO INSPECT PLAIN CYLINDRICAL PARTS.

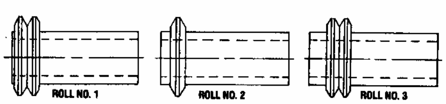




TYPE 7
Minor Diameter
(55° Included Angle)
Two full profile "vee" rolls (No. 1 and 3)
One full profile "cone" roll (No. 2).

THE MINOR DIAMETER OF A THREAD IS THE SMALLEST DIAMETER OF A THREAD FORM. THE ROOT DIAMETER OF AN EXTERNAL THREAD IS THE MINOR DIAMETER.
SELECT TYPE-7 MINOR DIAMETER ROLLS WHEN GAGING THE MINOR DIAMETER OF AN EXTERNAL THREAD.
TYPE-7 ROLLS FOR UNJ SERIES THREADS ARE MANUFACTURED WITH CREST RADII SLIGHTLY SMALLER THAN THE MINIMUM ALLOWED RADIUS OF THE APPLICAPLE THREAD.

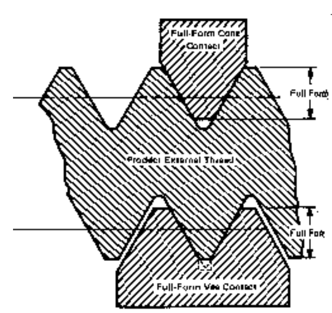




TYPE 8
Lead/Flank Angle

Two full profile "vee" rolls (No. 1 and 3) with outside flanks relieved
One full profile "cone" roll (No. 2).

THE TYPE-8 LEAD /FLANK ANGLE ROLLS ARE USED IN DIFFERENTIAL GAGING TO HELP ISOLATE LEAD AND FLANK ANGLE DEVIATION.
WHEN INSPECTING FUNCTIONAL AND PICTH DIAMETER AS GENERAL RULE YOU SOULD SEE NO MORE THAN 50% OF THE PART TOLERACE DIFFERENCE.



THE TRI-ROLL COMPARATOR SYSTEM

OPERATING INSTRUCTIONS

The tri-roll comparator system provides a fast and efficient means of definitive thread inspection. Also, variable data output makes this gage a perfect statistical process control device. Routinely, the tri-roll is used to analyze and distinguish the following characteristics; Functional diameter size, Pitch diameter size, Lead and/or flank angle deviation, Taper and 120 degree out-of-round (lobing).

FUNCTIONAL DIAMETER SIZE

The functional size of a screw thread is defined as that diameter which relates the diameter effects of variations in the above characteristics as they apply to assembly with its mating part. In other words, it is the result of the cumulative effect of variations in these characteristics along the full length of engagement. Any variation in these characteristics will always cause the functional diameter of an external thread to increase, and an internal thread to decrease. This diameter is commonly referred to as the Maximum Material Condition of the product thread.

INSPECTING FUNCTIONAL DIAMETER SIZE

Using the functional (Type 3) rolls, set the comparator with a master set plug manufactured to the desired pitch diameter. Class W tolerance is recommended, however, a standard class X master is acceptable. For greatest accuracy, use the stated pitch diameter on the long form certification. Place the product thread in the gage locating the full length of the functional rolls. Oscillate the thread slightly to insure proper seating. Index the part in the rolls 60 degrees. Record the largest reading as Maximum Material Functional size.

PITCH DIAMETER SIZE

Pitch diameter size is defined as an imaginary cylinder, concentric and parallel to the thread axis, at which the thread ridge and thread groove are of equal width. Pitch diameter is the predominant factor used in the control of size and fit of product threads. This measurement isolates one thread, disregarding the cumulative effect of variations in functional size. Therefore, it is proper to refer to minimum pitch diameter as the Minimum Material Condition of the thread.

Continued on next page

INSPECTING PITCH DIAMETER SIZE

Using the pitch diameter rolls (best wire radius or cone and vee), set the comparator with same master used for functional size inspection. Place the product thread on the gage locating two full threads from the front. Rotate the part 120 degrees. Record the smallest reading. Repeat the process at the center and back of the thread. Record the smallest reading as Minimum Pitch Diameter Size. Record the difference of the three readings in the same plane as taper. Record the rotational T.I.R. as out-of-round.

LEAD AND FLANK ANGLE

Lead: The axial distance a screw thread moves, when rotated about its axis one complete rotation. On a basic single start thread, the lead is equal to the pitch (1/TPI).
Flank angle: The angle created by the thread flank and a line perpendicular to the thread axis. This is often referred to as the half angle of the thread.
The term drunken lead is a broad reference to variations in helical path. This must be added to the axial lead variation to obtain total lead variation.

DIFFERENTIAL ANALYSIS: LEAD/FLANK ANGLE

Deviation in lead/flank angle is inspected by comparing functional size and pitch diameter size. Theoretically, identical readings would indicate perfect lead and form. In actual practice, functional size is almost always larger than pitch diameter size. If the difference between the two is excessive, the lead/flank angle variation inherent in the thread can cause problems with assembly or compromise integrity of fit. The value at which these variations can be termed excessive is usually dependent upon application. Military specifications for safety critical threads limit the acceptable differential to 40% of the total pitch diameter tolerance. However, as a general rule, 50% is sufficient for most commercial manufacturing.

Example: .375–24 UNF–3A
Max. P.D. .3479
Min. P.D. .3450
Tolerance: .0029 x .50 = .0015 Max. allowable differential, functional diameter to pitch diameter with limit set at 50% of total pitch diameter tolerance.

RECOMMENDATIONS

1. No single gaging method can guarantee that a product thread will assemble and conform dimensionally. Use a "GO" thread ring gage to verify assembly!!!
2. Avoid the production of threaded parts in the upper or lower 15% - 20% of the pitch diameter tolerance. Most disagreements between gages and problems in assembly occur in these zones.
3. Do not turn product parts through the tri-roll as you would a thread ring. This will cause excessive and unnecessary wear on the gaging rolls, as well as prohibit consistent readings. Always lift the lever arm and index the part unless inspection requires rotation of the part.
4. Set roll screws so that rolls rotate without lateral movement. See attached instruction card for proper calibration procedure.

STC SEGMENT TYPE COMPARATOR

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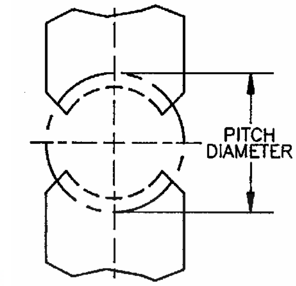
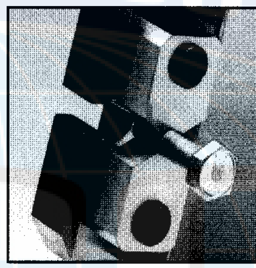


80° SEGMENTS



GAGING SEGMENTS

- **FUNCTIONAL SIZE**

(Maximum Material Condition)
Use full form gaging segments.
Use when 180° contact is specified.

There are 4 components that comprise a complete STC Comparatc
To assist you in ordering, we have separated each of the four comp
pricing tables with the order number, size and/or range and price.

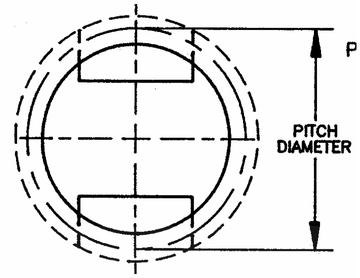
1. BASE			
EDP No.			
351094			
2. FRAMES			
EDP No.	**Frame No.**	**Range-Nominal Size Above Inch (Metric)**	**To & Including Inch (Metric)**
357120	STC-101	.111 -	.750
357121	STC-201	.750 -	2.00
3. DIAL INDICATOR			
EDP No.		**Graduations**	
351514		.0001 Inch	
351515		.00025 Inch	
351516		.002mm Metric	
Electronic Indicator (.0001 Resolution)			
351520	Electronic Indicator		
351518	Charger for Electronic Indicator		
4. GAGING SEGMENTS			
Range			
.112 - .750			
.750 - 2.000			

STC COMPONENTS

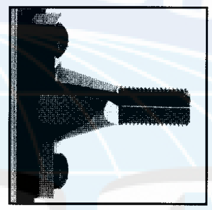
1. BASE - Solid cast base for firm mounting.
2. FRAME - One frame for range #10 through 3/4" diameter.
3. INDICATOR - Dial or electronic indicators available.
4. SEGMENTS - Functional size (Maximum Material Condition) and two-point (ovality) inspection.

ITC INTERNAL THREAD COMPARATOR

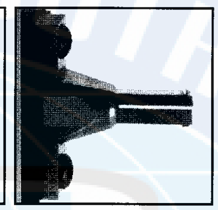
(Back to Contents)



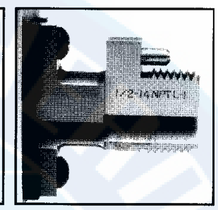
180° SEGMENTS



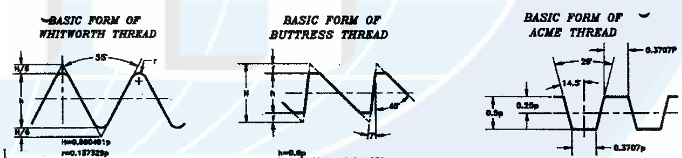
GAGING SEGMENTS
• FUNCTIONAL SIZE
(Maximum Material Condition) Use full profile functional gaging segments



GAGING SEGMENTS
• PITCH DIAMETER SIZE
(Minimum Material Condition) Use single element gaging segments- Cone and Vee



GAGING SEGMENTS
Taper Pipe Threads (priced on request)



MANY SPECIAL THREAD FORMS AVALIABLE UPON REQUEST

ITC COMPONENTS

1. **BASE W/ADAPTER** - Solid cast base for firm mounting.
2. **FRAME** - One frame for entire range #10 through 2 1/2" diameter.
3. **INDICATOR** - Dial or electronic indicators available.
4. **SEGMENTS** - Functional or single element pitch diameter segments for size-pitch combinations listed.

1. BASE WITH ADAPTER				
EDP No.				
351094 w/101700				$
2. FRAMES				
EDP No.	**Frame No.**	**Range-Nominal Size** Above Inch (Metric)	To & Including Inch (Metric)	
100001	100	.189 (4.8mm)	2.500 (63.5mm)	$5
101721	200	2.500 (63.5mm)	5.000 (127mm)	7
101881	300	5.000 (127.0mm)	8.000 (203.2mm)	8
3. DIAL INDICATOR				
EDP No.		**Graduations**		
100135		.0001 Inch		$1
100136		.00025 Inch		1
100137		.002mm Metric		1
Electronic Indicator (.0001 Resolution)				
351520	Electronic Indicator			
351518	Charger for Electronic Indicator			

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THE ITC COMPARATOR SYSTEM

OPERATING INSTRUCTIONS

The ITC comparator system provides a fast and efficient means of definitive internal thread inspection. Also, variable data output makes this gage a perfect statistical process control device. Routinely, the ITC is used to analyze and distinguish the following characteristics; Functional diameter size, Pitch diameter size, Lead and/or flank angle deviation, Taper and 180 degree out-of-round (ovality).

FUNCTIONAL DIAMETER SIZE

The functional size of a screw thread is defined as that diameter which relates the sum of the diameter effects of variations in the thread characteristics mentioned above as they apply to assembly with its mating part. In other words, it is the result of the cumulative effect of variations in these characteristics along the full length of engagement. Any variation in these characteristics will always cause the functional diameter of an internal thread to decrease, and an external thread to increase. This diameter is commonly referred to as the Maximum Material Condition of the product thread.

INSPECTING FUNCTIONAL DIAMETER SIZE

Using the functional size segments, set the comparator with a solid, class W master set ring manufactured to the desired pitch diameter. For greatest accuracy, use the stated pitch diameter on the long form certification. Place the product thread on the gage locating the full length of the functional segments. Oscillate the thread slightly to insure proper seating. Index the part 90 degrees. Record the smallest reading as Maximum Material Functional size.

PITCH DIAMETER SIZE

Pitch diameter size is defined as an imaginary cylinder, concentric and parallel to the thread axis, at which the thread ridge and thread groove are of equal width. Pitch diameter is the predominant factor used in the control of size and fit of product threads. This measurement isolates one thread, disregarding the cumulative effect of variations in functional size. Therefore, it is proper to refer to maximum pitch diameter as the Minimum Material Condition of the thread.

Continued on next page

INSPECTING PITCH DIAMETER SIZE

Using the cone and vee pitch diameter segments, set the comparator with same master used for functional size inspection. Place the product thread on the gage locating two full threads from the front. Rotate the part 180 degrees. Record the largest reading. Repeat the process at the center and back of the thread. Record the largest reading as maximum pitch diameter size. Record the difference of the three readings in the same plane as taper. Record the rotational T.I.R. as out-of-round.

LEAD AND FLANK ANGLE

Lead: The axial distance a screw thread moves, when rotated about its axis one complete rotation. On a basic single start thread, the lead is equal to the pitch (1/TPI).
Flank angle: The angle created by the thread flank and a line perpendicular to the thread axis. This is often referred to as the half angle of the thread.
The term drunken lead is a broad reference to variations in helical path. This must be added to the axial lead variation to obtain total lead variation.

DIFFERENTIAL ANALYSIS: LEAD/FLANK ANGLE

Deviation in lead/flank angle is inspected by comparing functional size and pitch diameter size. Theoretically, identical readings would indicate perfect lead and form. In actual practice, functional size is almost always smaller than pitch diameter size. If the difference between the two is excessive, the lead/flank angle variation inherent in the thread can cause problems with assembly or compromise integrity of fit. The value at which these variations can be termed excessive is usually dependent upon application. Military specifications for safety critical threads limit the acceptable differential to 40% of the total pitch diameter tolerance. However, as a general rule, 50% is sufficient for most commercial manufacturing.

Example: .375–24 UNF–3B
Min. P.D. .3479
Max P.D. .3516
Tolerance: .0037 x .50 = .0019 Max. allowable differential, functional diameter to pitch diameter with limit set at 50% of total pitch diameter tolerance.

RECOMMENDATIONS

1. No single gaging method can guarantee that a product thread will assemble and conform dimensionally. Use a "GO" working plug gage to verify assembly!!!
2. Avoid the production of threaded parts in the upper or lower 15% - 20% of the pitch diameter tolerance. Most disagreements between gages and problems in assembly occur in these zones.
3. Do not turn product parts through the gage as you would a thread plug. This will cause excessive and unnecessary wear on the gaging segments, as well as prohibit consistent readings. Always depress top segment and index part unless inspection requires rotation.
4. Important: It is normal to see more variation in readings when variably gaging internal threads, due to the difficulties involved in accurately manufacturing them. Threads which are tapped are especially prone to this variation.

SNAP GAGES

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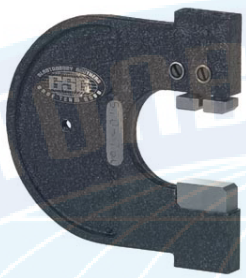
Snap gages are a quick way to check the Outside diameter of a shaft while still in a machine or an OD that is difficult to locate/reach with ring gages. Snap gages are available in three (3) styles. Type "A" with pin type anvils, Type "C" with flat square anvils (most common), and Type "U" with knife edge anvils for checking grooves/undercuts. Anvils are available with steel or carbide wear surfaces. Snap gages can be "Set" several times as they wear during use. Snap gages can be purchased "Set & Sealed " from the factory or set and sealed in your facility.



Model "C"
(Also Available In Midget Style)

Model " A"

- Gaging surfaces are hardened, ground and lapped.

- Maximum error in parallelism of anvils over range
  Frames 1-10 (0 to 6 inch) .0002 inch, .005 mm
  Frames 10-16 (6 to 12 inch) .0003 inch, .008 mm

- Snap gages are made in accordance to AGD B47.1

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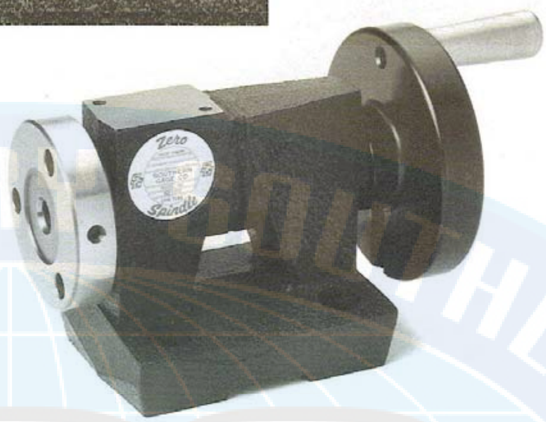
(ZERO SPINDLE INSIDE DIAMETER APPLICATION GUIDE)
(ZERO SPINDLE OUTSIDE DIAMETER APPLICATION GUIDE)

Zero Spindles are an accurate way to check parts for runout, T.I.R., etc. The Zero Spindle accuracy is .000020”/.0005mm total runout before adding holding devices which allow you to have an accurate platform to start your measuring process. Zero spindles are used with Diaphragm Push Arbors, Dual-Flex Push Arbors, Tork-Lok Arbors, Three and Four Jaw Chucks, Magnetic Chucks, ODC Collects, 1 & 5C Collets, and face plates.
On this CD is a CAD pack that you can down load to design your fixtures using the Zero Spindle.

ZERO SPINDLE®

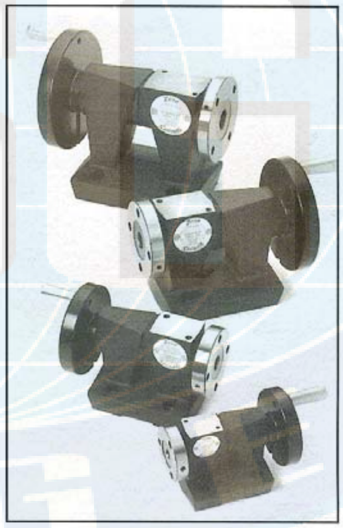


A complete inspection system for checking concentricity, squareness and roundness.

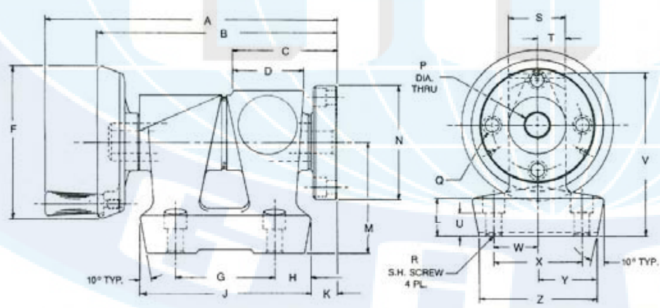
THE ZERO SPINDLE SYSTEM FEATURES:

- Precision spindles accurate to less than .000025 T.I.R.
- Precision arbors for internal locating - plain, threaded and splined diameters
- Precision chucks for internal and external locating - plain and threaded diameters
- Precision magnetic and tapped hole face plates
- Everything you need to build your own Zero Spindle Inspection Fixtures

- **ACCURATE** - To less than .000025 T.I.R.
- **RUGGED** - Sturdy enough for the production floor. Needs no pampering.
- **VERSATILE** - Combine with arbors, chucks, face plates or specially designed fixtures.
- **ECONOMICAL** - Laboratory accuracy at shop floor prices.



GENERAL DIMENSIONS



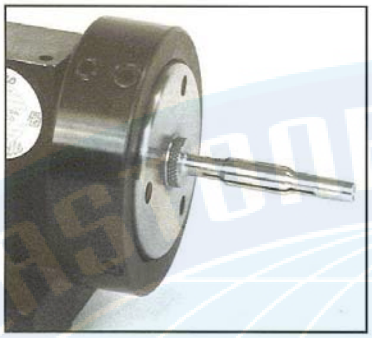
Model No.	A	B	C	D	F	G	H	J	K	L	M	N
AD-012	6.567	5.005	2.099	1.375	3.25	2.250	.562	3.375	.599	.750	2.187	2.2500 / 2.2498
AD-013	7.879	6.317	2.739	1.875	4.00	2.625	.937	4.500	.724	1.000	2.937	3.0000 / 2.9998
AD-014	9.723	7.723	3.333	2.375	5.50	3.562	1.031	5.625	.786	1.125	3.875	3.7500 / 3.7498
AD-015	10.942	8.942	3.864	2.875	6.50	4.375	1.187	6.750	.786	1.250	5.250	4.5000 / 4.4998

P	Q	R	S	T	U	V	W	X	Y	Z	WEIGHT
.375	(3) 1/4 SOC. HD. SCR ON 1.687 B.C.	5/16 DIA. SCR.	1.125	.562	.437	3.312	.906	1.812	1.250	2.500	4 1/2#
.593	(4) 5/16 SOC. HD. SCR ON 2.375 B.C.	3/8 DIA. SCR.	1.500	.750	.625	4.312	1.156	2.312	1.562	3.125	9 3/4#
.781	(4) 3/8 SOC. HD. SCR ON 2.875 B.C.	3/8 DIA. SCR.	1.875	.937	.812	5.375	1.375	2.750	1.812	3.625	18#
1.000	(4) 3/8 SOC. HD. SCR ON 3.625 B.C.	1/2 DIA. SCR.	2.250	1.125	.812	6.875	1.750	3.500	2.250	4.500	29 1/2#

ZERO SPINDLES

ORDER NO.	PRICE
AD-012	
AD-013	
AD-014	
AD-015	

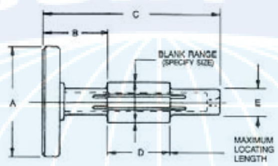
ZERO SPINDLE® DIAPHRAGM PUSH ARBOR COMBINATION



- Consistently controlled concentricity to less than .0001 T.I.R.
- Guaranteed repeatability

EACH COMBO INCLUDES:

.000025 T.I.R. Zero Spindle
Diaphragm Push Arbor
Centralizing Collar



BLANK RANGE	COMBO NO.	ARBOR NO.	USED ON ZERO SPINDLE	MAXIMUM PART TOLERANCES	GENERAL DIMENSIONS A	B	C	D	E
.250 – .375	AD–2220	AD–3222	AD–012	.003	2.19	1.19	2.69	.75	.24
.375 – .500	AD–2240	AD–3224	AD–012	.003	2.19	1.31	3.44	1.25	.37
.500 – .750	AD–2290	AD–3228	AD–012	.003	2.19	1.44	3.94	1.50	.49
.750 – 1.000	AD–2340	AD–3233	AD–013	.004	3.38	1.75	4.88	1.75	.74
1.000 – 1.375	AD–2440	AD–3243	AD–014	.004	4.12	2.00	6.19	2.25	.99
1.375 – 1.750	AD–2540	AD–3253	AD–015	.004	5.50	2.19	6.56	2.38	1.37
1.750 – 2.125	AD–2640	AD–3263	AD–015	.004	5.50	2.12	7.06	2.75	1.74

ZERO SPINDLE DIAPHRAGM PUSH ARBOR COMBINATIONS	
ORDER NO.	PRICE
AD – 2220	
AD – 2240	
AD – 2290	
AD – 2340	
AD – 2440	
AD – 2540	
AD – 2640	

DIAPHRAGM PUSH ARBORS (FLANGE TYPE)	
ORDER NO.	PRICE
AD – 3222	
AD – 3224	
AD – 3228	
AD – 3233	
AD – 3243	
AD – 3253	
AD – 3263	

BETWEEN CENTERS DIAPHRAGM PUSH ARBOR

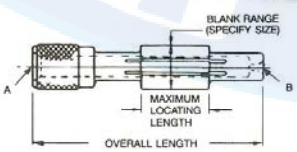
- Consistently controlled concentricity to less than .0001 T.I.F
- Guaranteed Repeatability

IMPORTANT:

A part print or sketch must be provided on which the following is marked:

1. Locating diameter and tolerance
2. Overall length of locating diameter
3. Stop face
4. Desired concentricity and/or squareness

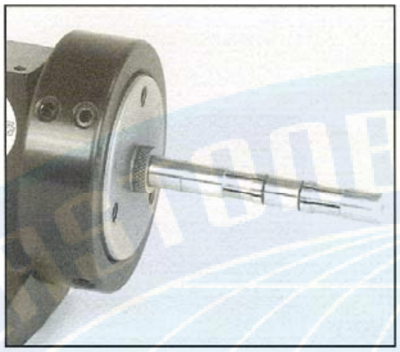
Blue print specifications must be within the semi-finished blank size range and maximum locating length shown on the chart to be priced as standard All others will be quoted as "Specials".



BLANK RANGE	MODEL NO.	MAXIMUM PART TOLERANCES	MAXIMUM LOCATING LENGTH	OVERALL LENGTH	CENTERS A	CENTERS B
.250 – .375	AD–3221–A	.003	.75	3.00	3/16" DIA.	D–1R RING SEAT
.375 – .500	AD–3223–A	.003	1.25	3.75	5/16" DIA.	D–1R RING SEAT
.500 – .750	AD–3225–A	.003	1.50	4.50	13/32" DIA.	E–2R RING SEAT
.750 – 1.000	AD–3230–A	.004	1.75	5.50	F–2R RING SEAT	F–2R RING SEAT
1.000 – 1.375	AD–3240–A	.004	2.25	6.88	J–2R RING SEAT	J–2R RING SEAT
1.375 – 1.750	AD–3250–A	.004	2.38	7.25	M–2R RING SEAT	M–2R RING SEAT
1.750 – 2.125	AD–3260–A	.004	2.75	8.00	N–2R RING SEAT	N–2R RINGSEAT

BETWEEN CENTERS DIAPHRAGM PUSH ARBOR	
ORDER NO.	PRICE
AD – 3221–A	
AD – 3223–A	
AD – 3225–A	
AD – 3230–A	
AD – 3240–A	
AD – 3250–A	
AD – 3260–A	

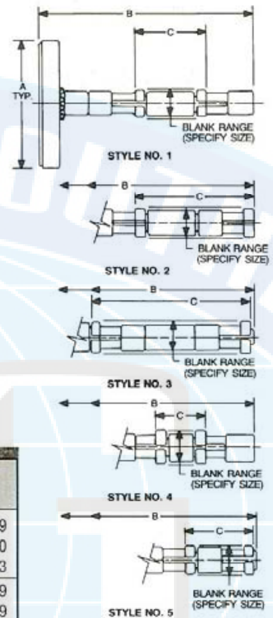
ZERO SPINDLE® DUAL-FLEX PUSH ARBOR COMBINATION



- Consistently controlled concentricity to less than .0001 T.I.R.
- Guaranteed repeatability.
- Unique construction allows arbor to locate straight or slightly tapered bores on true center line
- 5 styles available-determined by part length ("C" dim.)

EACH COMBO INCLUDES:

.000025 T.I.R. Zero Spindle
Dual-Flex Arbor
Centralizing collar



BLANK RANGE	COMBO NO.	ARBOR NO.	USED ON ZERO SPINDLE	MAXIMUM PART TOLERANCES	GENERAL DIMENSIONS STYLE No. 1	STYLE No. 2	STYLE No. 3	STYLE No. 4	STYLE No. 5
1/4 – 5/16	DF–200–C	DF–200–F	AD–012	.003	A = 2.19 B = 2.50 C = .69	A = 2.19 B = 2.50 C = 1.25	A = 2.19 B = 2.50 C = 1.78	A = 2.19 B = 2.50 C = .50	A = 2.19 B = 2.50 C = .83
5/16 – 3/8	DF–300–C	DF–300–F	AD–012	.003	A = 2.19 B = 2.69 C = .75	A = 2.19 B = 2.69 C = 1.38	A = 2.19 B =2 .69 C = 1.94	A = 2.19 B = 2.69 C = .53	A = 2.19 B = 2.69 C = .91
3/8 – 1/2	DF–400–C	DF–400–F	AD–012	.003	A = 2.19 B = 3.56 C = 1.13	A = 2.19 B = 3.56 C = 2.00	A= 2.19 B = 3.56 C = 2.81	A = 2.19 B = 3.56 C = .73	A = 2.19 B = 3.56 C = 1.16
1/2 – 5/8	DF–500–C	DF–500–F	AD–012	.003	A = 2.19 B = 4.31 C = 1.63	A = 2.19 B = 4.31 C = 2.63	A = 2.19 B = 4.31 C = 3.56	A = 2.19 B = 4.31 C = 1.05	A = 2.19 B = 4.31 C = 1.41
5/8 – 3/4	DF–600–C	DF–600–F	AD–013	.004	A = 3.38 B = 4.38 C = 1.63	A = 3.38 B = 4.38 C = 2.63	A = 3.38 B = 4.38 C = 3.56	A = 3.38 B = 4.38 C = 1.05	A = 3.38 B = 4.38 C = 1.41
3/4 – 1	DF–700–C	DF–700–F	AD–013	.004	A = 3.38 B = 4.88 C = 1.75	A = 3.38 B = 4.88 C = 2.94	A = 3.38 B = 4.88 C = 4.06	A = 3.38 B = 4.88 C = 1.11	A = 3.38 B = 4.88 C = 1.59
1 – 1 1/4	DF–800–C	DF–800–F	AD–014	.005	A = 4.12 B = 5.56 C = 2.25	A = 4.12 B = 5.56 C = 3.50	A = 4.12 B = 5.56 C = 4.69	A = 4.12 B = 5.56 C = 1.42	A = 4.12 B = 5.56 C = 1.78
1 1/4 – 1 1/2	DF–900–C	DF–900–F	AD–014	.005	A = 4.12 B = 6.19 C = 2.38	A = 4.12 B = 6.19 C = 3.88	A = 4.12 B = 6.19 C = 5.25	A = 4.12 B = 6.19 C = 1.52	A = 4.12 B = 6.19 C = 2.06
1 1/2 – 1 5/8	DF–1000–C	DF–1000–F	AD–015	.005	A = 5.50 B = 6.44 C = 2.50	A = 5.50 B = 6.44 C = 4.06	A = 5.50 B = 6.44 C = 5.50	A = 5.50 B = 6.44 C = 1.61	A = 5.50 B = 6.44 C = 2.25
1 5/8 – 1 3/4	DF–1100–C	DF–1100–F	AD–015	.005	A = 5.50 B = 6.56 C = 2.56	A = 5.50 B = 6.56 C = 4.16	A = 5.50 B = 6.56 C = 5.96	A = 5.50 B = 6.56 C = 1.67	A = 5.50 B = 6.56 C = 2.28
1 3/4 – 2 1/2	DF–1200–C	DF–1200–F	AD–015	.005	A = 5.50 B = 7.06 C = 3.00	A = 5.50 B = 7.06 C = 4.63	A = 5.50 B = 7.06 C = 6.13	A = 5.50 B = 7.06 C = 1.95	A = 5.50 B = 7.06 C = 2.44

ZERO SPINDLE DUAL–FLEX PUSH ARBOR COMBINATIONS

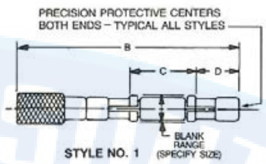
ORDER NO.	PRICE
DF–200–C	
DF–300–C	
DF–400–C	
DF–500–C	
DF–600–C	
DF–700–C	
DF–800–C	
DF–900–C	
DF–1000–C	
DF–1100–C	
DF–1200–C	

DUAL–FLEX PUSH ARBOR (FLANGE TYPE)

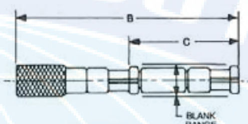
ORDER NO.	PRICE
DF–200–F	
DF–300–F	
DF–400–F	
DF–500–F	
DF–600–F	
DF–700–F	
DF–800–F	
DF–900–F	
DF–1000–F	
DF–1100–F	
DF–1200–F	

BETWEEN CENTERS DUAL-FLEX PUSH ARBOR

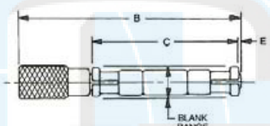
- Consistently controlled concentricity to less than .0001 T.I.R.
- Guaranteed repeatability
- Unique construction allows arbor to locate straight or slightly tapered bores on true center line
- 5 styles available-determined by part length ("C" dim.)



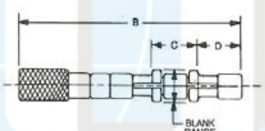
STYLE NO. 1



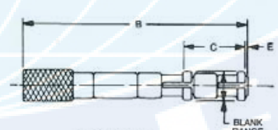
STYLE NO. 2



STYLE NO. 3



STYLE NO. 4



STYLE NO. 5

IMPORTANT:

A part print or sketch must be provided on which the following is marked:

1. Locating diameter and tolerance
2. Overall length of locating diameter
3. Stop face
4. Desired concentricity and/or squareness

BLANK RANGE	ARBOR NO.	MAXIMUM PART TOLERANCES	GENERAL DIMENSIONS				
			STYLE No. 1	STYLE No. 2	STYLE No. 3	STYLE No. 4	STYLE No. 5
1/4 – 5/16	DF–200	.003	B = 2 9/16 C = 1 1/16 D = 9/16	B = 2 9/16 C = 1 1/4	B = 2 9/16 C = 1 25/32 E = 1/64	B = 2 9/16 C = 1/2 D = 9/16	B = 2 9/16 C = 53/64 E = 1/64
5/16 – 3/8	DF–300	.003	B = 2 3/4 C = 3/4 D = 5/8	B = 2 3/4 C = 1 3/8	B = 2 3/4 C = 1 15/16 E = 1/32	B = 2 3/4 C = 17/32 D = 5/8	B = 2 3/4 C = 29/32 E = 1/32
3/8 – 1/2	DF–400	.003	B = 3 3/4 C = 1 1/8 D = 7/8	B = 3 3/4 C = 2	B = 3 3/4 C = 2 13/16 E = 1/32	B = 3 3/4 C = 47/64 D = 7/8	B = 3 3/4 C = 1 5/32 E = 1/32
1/2 – 5/8	DF–500	.004	B = 4 3/4 C = 1 5/8 D = 1	B = 4 3/4 C = 2 5/8	B = 4 3/4 C = 3 9/16 E = 1/32	B = 4 3/4 C = 13/64 D = 1	B = 4 3/4 C = 1 13/32 E = 1/32
5/8 – 3/4	DF–600	.004	B = 4 7/8 C = 1 5/8 D = 1	B = 4 7/8 C = 2 5/8	B = 4 7/8 C = 3 9/16 E = 1/32	B = 4 7/8 C = 13/64 D = 1	B = 4 7/8 C = 1 13/32 E = 1/32
3/4 – 1	DF–700	.004	B = 5 1/2 C = 1 3/4 D = 1 3/16	B = 5 1/2 C = 2 15/16	B = 5 1/2 C = 4 1/16 E = 1/32	B = 5 1/2 C = 1 7/64 D = 1 3/64	B = 5 1/2 C = 1 19/32 E = 1/32
1 – 1 1/4	DF–800	.005	B = 6 1/4 C = 2 1/4 D = 1 1/4	B = 6 1/4 C = 3 1/2	B = 6 1/4 C = 4 11/16 E = 1/32	B = 6 1/4 C = 1 27/64 D = 1 1/4	B = 6 1/4 C = 1 25/32 E = 1/32
1 1/4 – 1 1/2	DF–900	.005	B = 6 7/8 C = 2 3/8 D = 1 1/2	B = 6 7/8 C = 3 7/8	B = 6 7/8 C = 5 1/4 E = 1/16	B = 6 7/8 C = 1 33/64 D = 1 1/2	B = 6 7/8 C = 2 1/16 E = 1/16
1 1/2 – 1 5/8	DF–1000	.005	B = 7 1/8 C = 2 1/2 D = 1 9/16	B = 7 1/8 C = 4 1/16	B = 7 1/8 C = 5 1/2 E = 1/16	B = 7 1/8 C = 1 39/64 D = 1 9/16	B = 7 1/8 C = 2 1/4 E = 1/16
1 5/8 – 1 3/4	DF–1100	.005	B = 7 1/4 C = 2 9/16 D = 1 19/32	B = 7 1/4 C = 4 5/32	B = 7 1/4 C = 5 5/8 E = 1/16	B = 7 1/4 C = 1 43/64 D = 1 19/32	B = 7 1/4 C = 2 9/32 E = 1/16
1 3/4 – 2 1/2	DF–1200	.005	B = 8 C = 3 D = 1 5/8	B = 8 C = 4 5/8	B = 8 C = 6 1/8 E = 1/16	B = 8 C = 1 61/64 D = 1 5/8	B = 8 C = 2 7/16 E = 1/16

BETWEEN CENTERS DUAL-FLEX PUSH ARBORS

ORDER NO.	PRICE
DF-200	
DF-300	
DF-400	
DF-500	
DF-600	
DF-700	
DF-800	
DF-900	
DF-1000	
DF-1100	
DF-1200	

ZERO SPINDLE® TORK-LOK COMBINATION

(Drawbar Actuated/Expanding Collet)

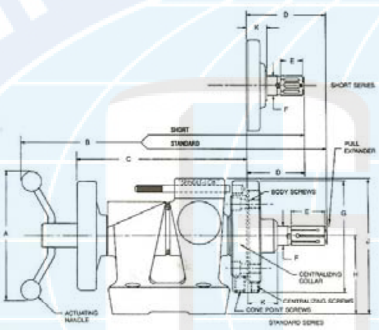
Off-the-shelf delivery with concentricity accuracy guaranteed to less than .0005 T.I.R. (Custom Arbors available for even greater accuracy). The Zero Spindle and Tork-Lok Arbor Combo combine the .000025 T.I.R. accuracy of the Zero Spindle and versatile utility of the Tork-Lok Collet Arbor. Can be used horizontally or vertically.

"TORK-LOK" COLLET ARBORS FEATURE:

- **Greater Accuracy** - Inclined flats on collet and arbor remain in constant contact
- **Less Collet Breakage** - Built in safety stops limit contraction and expansion
- **Geometrically Sealed** - Metal to metal contact excludes foreign matter thus reduces wear and assures accuracy
- **Interchangeability** - Several sizes of standard and short series arbors and collets fit the same Zero Spindle (see chart below)

Both standard and short series are available from stock.

Part stops available on request.



EACH COMBO INCLUDES:

.000025 T.I.R. Zero Spindle
Tork-Lok Arbor
Centralizing Collar
Spindle-Lok
Drawbar with actuating handle

ZERO SPINDLE TORK–LOK ARBOR COMBINATIONS (STANDARD SERIES LESS COLLET)	
ORDER NO.	PRICE
AC – 4110	
AC – 4210	
AC – 4310	
AC – 4410	
AC – 4510	
AC – 4610	
AC – 4710	
AC – 4810	
AC – 4910	

ZERO SPINDLE TORK–LOK ARBOR COMBINATIONS (SHORT SERIES LESS COLLET)	
ORDER NO.	PRICE
AC – 10110	
AC – 10210	
AC – 10310	
AC – 10410	
AC – 10510	
AC – 10610	
AC – 10710	

TORK–LOK ARBOR (STANDARD SERIES LESS COLLET)	
ORDER NO.	PRICE
AC – 2110	
AC – 2210	
AC – 2310	
AC – 2410	
AC – 2510	
AC – 2610	
AC – 2710	
AC – 2810	
AC – 2910	

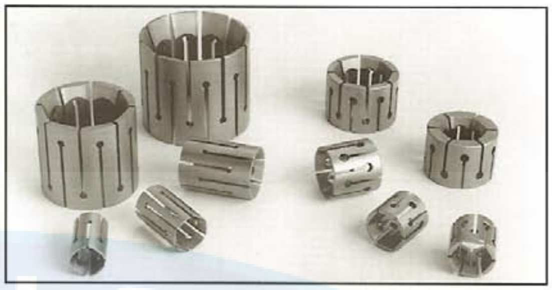
TORK–LOK ARBOR (SHORT SERIES LESS COLLET)	
ORDER NO.	PRICE
AC – 8100	
AC – 8200	
AC – 8300	
AC – 8400	
AC – 8500	
AC – 8600	
AC – 8700	

RANGE		STANDARD SERIES		"ZERO SPINDLE"	SHORT SERIES	
		COMBO (LESS COLLET)	ARBOR ONLY(LESS COLLET)		COMBO (LESS COLLET)	ARBOR ONLY(LESS COLLET)
STANDARD	SHORT	NO.	NO.	NO.	NO.	NO.
.500 – .655	.500 – .655	AC – 4110	AC – 2110	AD – 013	AC – 10110	AC – 8100
.593 – .780	.593 – .797	AC – 4210	AC – 2210		AC – 10210	AC – 8200
.718 – 1.000	.718 – 1.000	AC – 4310	AC – 2310		AC – 10310	AC – 8300
.875 – 1.249	.875 – 1.299	AC – 4410	AC – 2410	AD – 014	AC – 10410	AC – 8400
1.125 – 1.624	1.125 – 1.642	AC – 4510	AC – 2510		AC – 10510	AC – 8500
1.468 – 2.092	1.468 – 2.104	AC – 4610	AC – 2610	AD – 015	AC – 10610	AC – 8600
1.937 – 2.843	1.937 – 2.821	AC – 4710	AC – 2710		AC – 10710	AC – 8700
2.562 – 3.593	Special	AC – 4810	AC – 2810		Collet expansion: .015 up to .750; .030 from .751 up.	
3.312 – 4.467	Special	AC – 4910	AC – 2910			

RANGE		A	B		C	D		E		F	G	H	J	K	
STD.	SHORT		STD.	SHORT		STD.	SHORT	STD.	SHORT					STD.	SHORT
.500 – .655	.500 – .655	4.75	11.02	10.34	6.317	2.49	1.81	.88	.59	.4702 .4692	4.12	2.937	5.06	1.12	.75
.593 – .780	.593 – .797	4.75	11.22	10.50	6.317	2.69	1.97	1.06	.72	.5796 .5786	4.12	2.937	5.06	1.12	.75
.718 – 1.000	.718 – 1.000	4.75	11.49	10.68	6.317	2.96	2.15	1.25	.84	.7046 .7036	4.12	2.937	5.06	1.12	.75
.875 – 1.249	.875 – 1.299	4.75	13.42	12.19	7.723	3.58	2.35	1.44	.94	.8452 .8442	4.88	3.875	6.38	1.46	.74
1.125 – 1.624	1.125 – 1.642	4.75	13.73	13.43	7.723	3.89	2.59	1.62	1.13	1.0796 1.0786	4.88	3.875	6.38	1.46	.74
1.468 – 2.092	1.468 – 2.104	7.00	15.92	14.71	8.942	4.14	2.93	1.82	1.22	1.4077 1.4067	6.50	5.250	8.12	1.40	.80
1.937 – 2.843	1.937 – 2.821	7.00	16.24	14.76	8.942	4.46	2.98	2.00	1.31	1.8452 1.8442	6.50	5.250	8.12	1.34	.80
2.562 – 3.593	Special	7.00	16.61		8.942	4.83		2.25		2.4390 2.4385	6.50	5.250	8.12	1.34	
3.312 – 4.467	Special	7.00	16.75		8.942	4.97		2.50		3.1885 3.1880	6.50	5.250	8.12	1.24	

ZERO SPINDLE® TORK-LOK COLLETS

- Precision ground flats
- Collets interchangeable on all arbors within specified range
- Self releasing-preload feature assures easy part removal
- High grade steels, precisely heat-treated
- Threaded and splined collets available upon request



STANDARD SERIES TORK-LOK COLLETS

COLLETS FOR USE ON NO. AC-2110 ARBOR
LENGTH .88

RANGE	COLLET NO.
.500 – .515	AC 101
.516 – .530	102
.531 – .546	103
.547 – .561	104
.562 – .577	105
.578 – .592	106
.593 – .608	107
.609 – .623	108
.624 – .639	109
.640 – .655	110

COLLETS FOR USE ON NO. AC-2210 ARBOR
LENGTH 1.06

RANGE	COLLET NO.
.593 – .608	AC 201
.609 – .624	202
.625 – .639	203
.640 – .655	204
.656 – .670	205
.671 – .686	206
.687 – .702	207
.703 – .717	208
.718 – .733	209
.734 – .749	210
.750 – .764	211
.765 – .780	212

COLLETS FOR USE ON NO. AC-2310 ARBOR
LENGTH 1.25

RANGE	COLLET NO.
.718 – .733	AC 301
.734 – .749	302
.750 – .764	303
.765 – .780	304
.781 – .796	305
.797 – .812	306
.813 – .827	307
.828 – .843	308
.844 – .858	309
.859 – .874	310
.875 – .890	311
.891 – .905	312
.906 – .921	313
.922 – .936	314
.937 – .952	315
.953 – .967	316
.968 – .983	317
.984 – .999	318

COLLETS FOR USE ON NO. AC-2410 ARBOR
LENGTH 1.44

RANGE	COLLET NO.
.875 – .905	AC 401
.906 – .936	402
.937 – .967	403
.968 – .999	404
1.000 – 1.030	405
1.031 – 1.061	406
1.062 – 1.092	407
1.093 – 1.124	408
1.125 – 1.155	409
1.156 – 1.186	410
1.187 – 1.217	411
1.218 – 1.249	412

COLLETS FOR USE ON NO. AC-2510 ARBOR
LENGTH 1.62

RANGE	COLLET NO.
1.125 – 1.155	AC 501
1.156 – 1.186	502
1.187 – 1.217	503
1.218 – 1.249	504
1.250 – 1.280	505
1.281 – 1.311	506
1.312 – 1.342	507
1.343 – 1.374	508
1.375 – 1.405	509
1.406 – 1.436	510
1.437 – 1.467	511
1.468 – 1.499	512
1.500 – 1.530	513
1.531 – 1.561	514
1.562 – 1.592	515
1.593 – 1.624	516

COLLETS FOR USE ON NO. AC-2610 ARBOR
LENGTH 1.82

RANGE	COLLET NO.
1.468 – 1.499	AC 601
1.500 – 1.530	602
1.531 – 1.561	603
1.562 – 1.592	604
1.593 – 1.624	605
1.625 – 1.655	606
1.656 – 1.686	607
1.687 – 1.717	608
1.718 – 1.749	609
1.750 – 1.780	610
1.781 – 1.811	611
1.812 – 1.842	612
1.843 – 1.874	613
1.875 – 1.905	614
1.906 – 1.936	615
1.937 – 1.967	616
1.968 – 1.999	617
2.000 – 2.030	618
2.031 – 2.061	619
2.062 – 2.092	620

COLLETS FOR USE ON NO. AC-2710 ARBOR
LENGTH 2.00

RANGE	COLLET NO.
1.937 – 1.967	AC 701
1.968 – 1.999	702
2.000 – 2.030	703
2.031 – 2.061	704
2.062 – 2.092	705
2.093 – 2.124	706
2.125 – 2.155	707
2.156 – 2.186	708
2.187 – 2.217	709
2.218 – 2.249	710
2.250 – 2.280	711
2.281 – 2.311	712
2.312 – 2.342	713
2.343 – 2.374	714
2.375 – 2.405	715
2.406 – 2.436	716
2.437 – 2.467	717
2.468 – 2.499	718
2.500 – 2.530	719
2.531 – 2.562	720
2.563 – 2.593	721
2.594 – 2.624	722
2.625 – 2.655	723
2.656 – 2.686	724
2.687 – 2.718	725
2.719 – 2.749	726
2.750 – 2.780	727
2.781 – 2.811	728
2.812 – 2.843	729

COLLETS FOR USE ON NO. AC-2810 ARBOR
LENGTH 2.25

RANGE	COLLET NO.
2.562 – 2.593	AC 801
2.594 – 2.624	802
2.625 – 2.655	803
2.656 – 2.686	804
2.687 – 2.718	805
2.719 – 2.749	806
2.750 – 2.780	807
2.781 – 2.811	808
2.812 – 2.843	809
2.844 – 2.874	810
2.875 – 2.905	811
2.906 – 2.936	812
2.937 – 2.968	813
2.969 – 2.999	814
3.000 – 3.030	815
3.031 – 3.061	816
3.062 – 3.093	817
3.094 – 3.124	818
3.125 – 3.155	819
3.156 – 3.186	820
3.187 – 3.218	821
3.219 – 3.249	822
3.250 – 3.280	823
3.281 – 3.311	824
3.312 – 3.343	825
3.344 – 3.374	826
3.375 – 3.405	827
3.406 – 3.436	828
3.437 – 3.468	829
3.469 – 3.499	830
3.500 – 3.530	831
3.531 – 3.561	832
3.562 – 3.593	833

COLLETS FOR USE ON NO. AC-2910 ARBOR
LENGTH 2.50

RANGE	COLLET NO.
3.312 – 3.343	AC 901
3.344 – 3.374	902
3.375 – 3.405	903
3.406 – 3.436	904
3.437 – 3.468	905
3.469 – 3.499	906
3.500 – 3.530	907
3.531 – 3.561	908
3.562 – 3.593	909
3.594 – 3.624	910
3.625 – 3.655	911
3.656 – 3.686	912
3.687 – 3.718	913
3.719 – 3.749	914
3.750 – 3.780	915
3.781 – 3.811	916
3.812 – 3.843	917
3.844 – 3.874	918
3.875 – 3.905	919
3.906 – 3.936	920
3.937 – 3.968	921
3.969 – 3.999	922
4.000 – 4.030	923
4.031 – 4.061	924
4.062 – 4.093	925
4.094 – 4.124	926
4.125 – 4.155	927
4.156 – 4.186	928
4.187 – 4.217	929
4.218 – 4.249	930
4.250 – 4.280	931
4.281 – 4.311	932
4.312 – 4.342	933
4.343 – 4.374	934
4.375 – 4.405	935
4.406 – 4.436	936
4.437 – 4.467	937

SHORT SERIES TORK-LOK COLLETS

COLLETS FOR USE ON NO. AC-8100 ARBOR
LENGTH .59

RANGE	COLLET NO.
.500 – .510	AC 7101
.511 – .520	7102
.521 – .531	7103
.532 – .541	7104
.542 – .552	7105
.553 – .562	7106
.563 – .572	7107
.573 – .582	7108
.583 – .592	7109
.593 – .603	7110
.604 – .613	7111
.614 – .624	7112
.625 – .634	7113
.635 – .645	7114
.646 – .655	7115

COLLETS FOR USE ON NO. AC-8200 ARBOR
LENGTH .72

RANGE	COLLET NO.
.593 – .603	AC 7201
.604 – .613	7202
.614 – .624	7203
.625 – .634	7204
.635 – .645	7205
.646 – .655	7206
.656 – .666	7207
.667 – .676	7208
.677 – .687	7209
.688 – .697	7210
.698 – .707	7211
.708 – .717	7212
.718 – .727	7213
.728 – .737	7214
.738 – .747	7215
.748 – .757	7216
.758 – .767	7217
.768 – .777	7218
.778 – .787	7219
.788 – .797	7220

COLLETS FOR USE ON NO. AC-8300 ARBOR
LENGTH .84

RANGE	COLLET NO.
.718 – .727	AC 7301
.728 – .737	7302
.738 – .747	7303
.748 – .757	7304
.758 – .767	7305
.768 – .777	7306
.778 – .787	7307
.788 – .797	7308
.798 – .807	7309
.808 – .817	7310
.818 – .827	7311
.828 – .837	7312
.838 – .847	7313
.848 – .856	7314
.857 – .866	7315
.867 – .874	7316
.875 – .884	7317
.885 – .895	7318
.896 – .905	7319
.905 – .916	7320
.917 – .926	7321
.927 – .937	7322
.938 – .947	7323
.948 – .958	7324
.959 – .968	7325
.969 – .979	7326
.980 – .989	7327
.990 – 1.000	7328

COLLETS FOR USE ON NO. AC-8400 ARBOR
LENGTH .94

RANGE	COLLET NO.
.875 – .895	AC 7401
.896 – .916	7402
.917 – .937	7403
.938 – .958	7404
.959 – .979	7405
.980 – 1.000	7406
1.001 – 1.021	7407
1.022 – 1.042	7408
1.043 – 1.063	7409
1.064 – 1.084	7410
1.085 – 1.104	7411
1.105 – 1.124	7412
1.125 – 1.146	7413
1.147 – 1.168	7414
1.169 – 1.190	7415
1.191 – 1.212	7416
1.213 – 1.234	7417
1.235 – 1.256	7418
1.257 – 1.278	7419
1.279 – 1.299	7420

COLLETS FOR USE ON NO. AC-8500 ARBOR
LENGTH 1.125

RANGE	COLLET NO.
1.125 – 1.146	AC 7501
1.147 – 1.168	7502
1.169 – 1.190	7503
1.191 – 1.212	7504
1.213 – 1.234	7505
1.235 – 1.256	7506
1.257 – 1.278	7507
1.279 – 1.299	7508
1.300 – 1.320	7509
1.321 – 1.341	7510
1.342 – 1.362	7511
1.363 – 1.383	7512
1.384 – 1.404	7513
1.405 – 1.425	7514
1.426 – 1.446	7515
1.447 – 1.467	7516
1.468 – 1.489	7517
1.490 – 1.511	7518
1.512 – 1.533	7519
1.534 – 1.555	7520
1.556 – 1.577	7521
1.578 – 1.599	7522
1.600 – 1.621	7523
1.622 – 1.642	7524

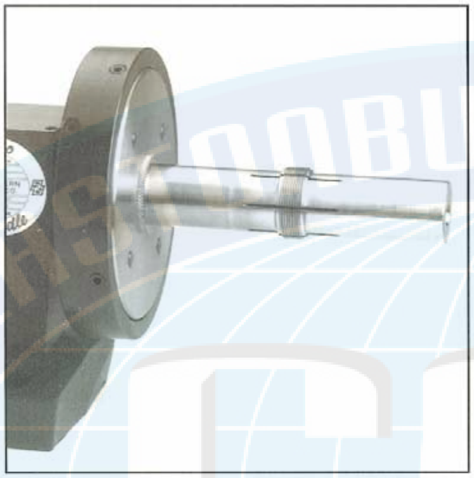
COLLETS FOR USE ON NO. AC-8600 ARBOR
LENGTH 1.22

RANGE	COLLET NO.
1.468 – 1.489	AC 7601
1.490 – 1.511	7602
1.512 – 1.533	7603
1.534 – 1.555	7604
1.556 – 1.577	7605
1.578 – 1.599	7606
1.600 – 1.621	7607
1.622 – 1.642	7608
1.643 – 1.663	7609
1.664 – 1.684	7610
1.685 – 1.705	7611
1.706 – 1.726	7612
1.727 – 1.747	7613
1.748 – 1.768	7614
1.769 – 1.789	7615
1.790 – 1.810	7616
1.811 – 1.831	7617
1.832 – 1.852	7618
1.853 – 1.873	7619
1.874 – 1.894	7620
1.895 – 1.915	7621
1.916 – 1.936	7622
1.937 – 1.957	7623
1.958 – 1.978	7624
1.979 – 1.999	7625
2.000 – 2.020	7626
2.021 – 2.041	7627
2.042 – 2.062	7628
2.063 – 2.083	7629
2.084 – 2.104	7630

COLLETS FOR USE ON NO. AC-8700 ARBOR
LENGTH 1.31

RANGE	COLLET NO.
1.937 – 1.957	AC 7701
1.958 – 1.978	7702
1.979 – 1.999	7703
2.000 – 2.020	7704
2.021 – 2.041	7705
2.042 – 2.062	7706
2.063 – 2.083	7707
2.084 – 2.104	7708
2.105 – 2.125	7709
2.126 – 2.146	7710
2.147 – 2.167	7711
2.168 – 2.188	7712
2.189 – 2.209	7713
2.210 – 2.230	7714
2.231 – 2.251	7715
2.252 – 2.272	7716
2.273 – 2.293	7717
2.294 – 2.314	7718
2.315 – 2.335	7719
2.336 – 2.356	7720
2.357 – 2.377	7721
2.378 – 2.398	7722
2.399 – 2.419	7723
2.420 – 2.440	7724
2.441 – 2.461	7725
2.462 – 2.481	7726
2.482 – 2.501	7727
2.502 – 2.521	7728
2.522 – 2.541	7729
2.542 – 2.561	7730
2.562 – 2.583	7731
2.584 – 2.604	7732
2.605 – 2.625	7733
2.626 – 2.646	7734
2.647 – 2.667	7735
2.668 – 2.689	7736
2.690 – 2.711	7737
2.712 – 2.733	7738
2.734 – 2.755	7739
2.756 – 2.777	7740
2.778 – 2.799	7741
2.800 – 2.821	7742

ZERO SPINDLE® ACCU-FLEX THREAD ARBOR COMBINATION



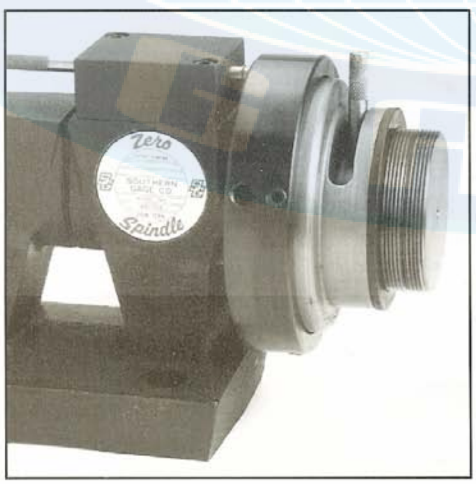
- Consistently controlled concentricity to less than .0001 T.I.R.
- Guaranteed repeatability
- Locates on the true pitch diameter centerline
- Firmly grips any thread within standard pitch diameter tolerances

EACH COMBO INCLUDES:
.000025 Zero Spindle
Accu-Flex Thread Arbor
Centralizing Collar

Combining the inherently accurate qualities of both the Accu-Flex Thread Arbor and the .000025 T.I.R. Zero Spindle provides the ultimate in close tolerance inspection of internally threaded parts for concentricity and/or squareness to related diameters and surfaces.

These combinations are identical to the Diaphragm Push Arbor combinations in construction, general dimensions (see page 63), and component parts. Because of the complexity of thread forms, the Accu-Flex Thread Arbors will be priced on request. Please submit your part print and requirements for quotation.

ZERO SPINDLE® OFF-LEAD THREAD ARBOR COMBINATION

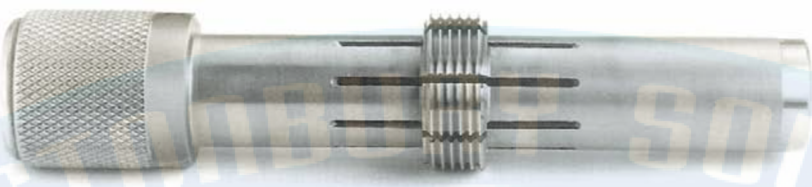


- Consistently controlled concentricity to less than .0001 T.I.R.
- Guaranteed repeatability
- Wide tolerance range
- Extremely positive and rigid gripping

EACH COMBO INCLUDES:
.000025 T.I.R. Zero Spindle
Off-Lead Thread Arbor
Centralizing Collar

The Off-Lead Thread Arbor provides a most accurate means of locating the pitch diameter of a thread. One of two thread sections can rotate to permit locking of the internal thread on opposing flanks for positive and accurate positioning. Because of the complexity of thread forms, the Off-Lead Thread Arbor will be priced on request. Please submit your part print and requirements for quotation.

BETWEEN CENTERS ACCU-FLEX THREAD ARBORS

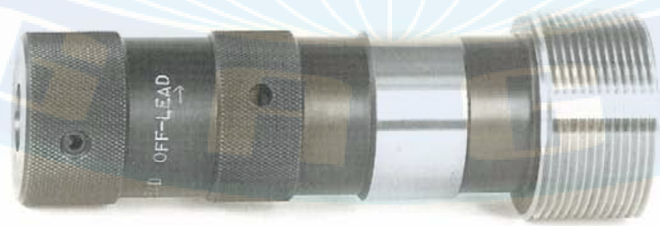


- Consistently controlled concentricity to less than .0001 T.I.R.
- Locate both straight and slightly tapered bores on the true pitch diameter center line
- Firmly grips any thread within standard thread tolerances

Accu-Flex Thread Arbors consist of a high quality, one-piece spring steel body ground to the high limit of the pitch diameter. Upon insertion into the threaded hole, the thread segments deflect and accurately locate the diameters to be gaged by spring tension.

Priced on request.

BETWEEN CENTERS OFF-LEAD THREAD ARBORS

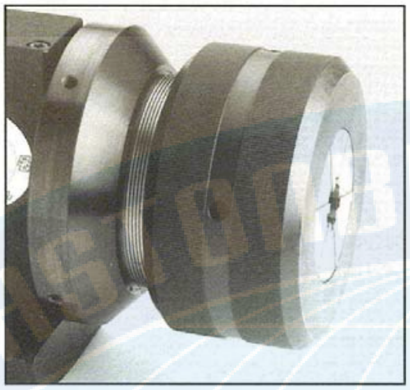


- Concentricity consistently controlled to less than .0001 T.I.R.
- Wide tolerance range
- Extremely positive and rigid gripping

The Off-Lead Thread Arbor provides a most accurate means of locating on the pitch diameter of a thread. One of two thread sections can rotate to permit locking of the internal thread on opposing flanks for positive and accurate positioning.

Priced on request.

ZERO SPINDLE® ODC COLLET CHUCK COMBINATION



- Guaranteed repeatability
- 1/8" stepless gripping range
- External gripping capacity from 1/16" to 2 1/2"
- Off-the-shelf delivery

Featuring Multisize Collets with 1/8" gripping range and eccentricity guaranteed to be less than .0003 T.I.R. at collet nose. Can be used horizontally or vertically.

EACH COMBO INCLUDES:

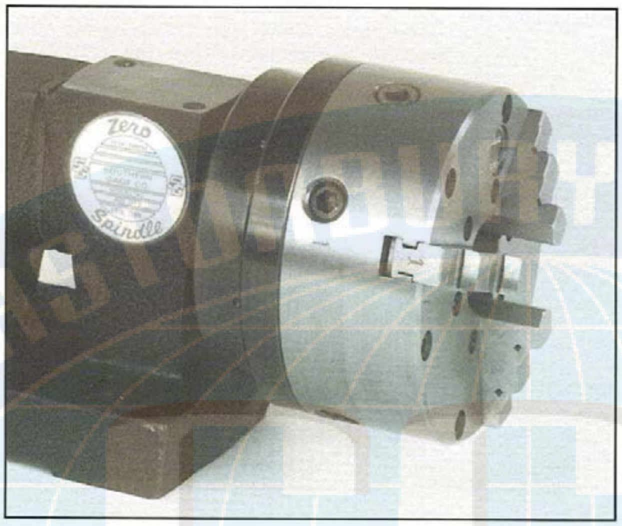
.000025 T.I.R. Zero Spindle
Collet Chuck
Spindle-Lok

Standard part stops are available if required.

COMBO # ODC-12 INCLUDES: ZERO SPINDLE #AD-012 COLLET CHUCK #SEC-12 SPINDLE-LOK #AD-286			COMBO #ODC-13 INCLUDES: ZERO SPINDLE #AD-013 COLLET CHUCK #SEC-13 SPINDLE-LOK #AD-386			COMBO #ODC-14 INCLUDES: ZERO SPINDLE #AD-014 COLLET CHUCK #SEC-14 SPINDLE-LOK #AD-486		
COLLETS			COLLETS			COLLETS		
NO.	CLAMPING LENGTH	RANGE	NO.	CLAMPING LENGTH	RANGE	NO.	CLAMPING LENGTH	RANGE
EA-2	7/8"	1/6 – 3/16	EC-2	1 1/2"	1/16 – 3/16	ED-4	2"	1/4 – 3/8
EA-3	7/8"	1/8 – 1/4	EC-3	1 1/2"	1/8 – 1/4	ED-5	2"	3/8 – 1/2
EA-4	7/8"	1/4 – 3/8	EC-4	1 1/2"	1/4 – 3/8	ED-6	2"	1/2 – 5/8
EA-5	7/8"	3/8 – 1/2	EC-5	1 1/2"	3/8 – 1/2	ED-7	2"	5/8 – 3/4
EA-6	7/8"	1/2 – 5/8	EC-6	1 1/2"	1/2 – 5/8	ED-8	2"	3/4 – 7/8
EA-7	7/8"	5/8 – 3/4	EC-7	1 1/2"	5/8 – 3/4	ED-9	2"	7/8 – 1
EA-8	7/8"	3/4 – 7/8	EC-8	1 1/2"	3/4 – 7/8	ED-10	2"	1 – 1 1/8
EA-9	1 1/8"	7/8 – 1	EC-9	1 1/2"	7/8 – 1	ED-11	2"	1 1/8 – 1 1/4
			EC-10	1 1/2"	1 – 1 1/8	ED-12	2"	1 1/4 – 1 3/8
			EC-11	1 1/2"	1 1/8 – 1 1/4	ED-13	2"	1 3/8 – 1 1/2
			EC-12	1 1/2"	1 1/4 – 1 3/8	ED-14	2"	1 1/2 – 1 5/8
			EC-13	2"	1 3/8 – 1 1/2	ED-15	2"	1 5/8 – 1 3/4
						ED-16	2"	1 3/4 – 1 7/8
						ED-17	2 1/2"	1 7/8 – 2

ZERO SPINDLE ODC COLLET CHUCK COMBINATIONS (LESS COLLET)	
ORDER NO.	PRICE
ODC-12	
ODC-13	
ODC-14	
SEC COLLET CHUCK (LESS COLLET)	
ORDER NO.	PRICE
SEC-12	
SEC-13	
SEC-14	
COLLETS FOR SEC-12	
EA-2 Thru EA-9	
COLLETS FOR SEC-13	
EC-2 Thru EC-13	
COLLETS FOR SEC-14	
ED-4 Thru ED-17	

ZERO SPINDLE® 3 JAW CHUCK COMBINATION



- Guaranteed repeatability
- Wide internal and external chucking capacity
- Off-the-shelf delivery

Featuring precision scroll type 3 Jaw Chuck for internal or external chucking with T.I.R. accuracy to .0001 at chuck nose when centralized on a given part diameter. Can be used horizontally or vertically.

EACH COMBO INCLUDES:
.000025 T.I.R. Zero Spindle
3 Jaw Chuck Assembly

Extended ranges, Jaw modification and other Zero Spindle 3 Jaw Chuck Combinations available upon request.

COMBO #BSC–13
Includes • Zero Spindle #AD–013 • 4" 3 Jaw Chuck Assembly # CA–13
Internal Chucking Range 1.30 – 3.70
External Chucking Range .125 – 3.94
COMBO #BSC–15
Includes • Zero Spindle #AD–015 • 5" 3 Jaw Chuck Assembly #CA–15
Internal Chucking Range 1.46 – 4.84
External Chucking Range .125 – 4.92

ZERO SPINDLE 3 JAW CHUCK COMBINATION	
ORDER NO.	PRICE
BSC–13	
BSC–15	

ZERO SPINDLE® 5 C COLLET CHUCK COMBINATION

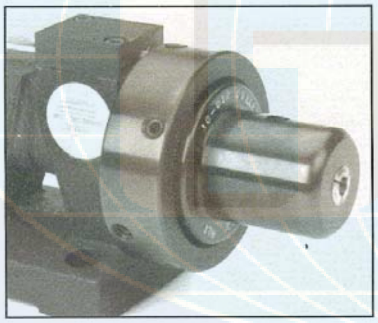
- Guaranteed repeatability
- Consistently controlled concentricity to less than .0001 T.I.R. at chuck nose

Featuring Precision Collet Chuck for use with Standard 5 C Collets and eccentricity guaranteed to less than .0001 T.I.R. at chuck nose. Precision 5 C Collets available on request.

EACH COMBO INCLUDES:
.000025 T.I.R. Zero Spindle (#AD-013)
Range: .016-1.062
5 C Collet Chuck
Centralizing Collar
Spindle-Lok
Drawbar with actuating handle

ZERO SPINDLE 5 C COLLET CHUCK COMBINATION	
ORDER NO.	PRICE
CFC–13	
Precision 5 C Collets Available on Request.	

ZERO SPINDLE® 1 C COLLET CHUCK COMBINATION



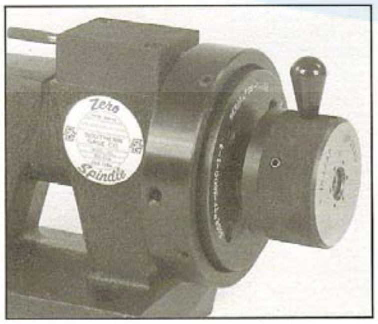
- Guaranteed repeatability
- Consistently controlled concentricity to less than .0001 T.I.R. at chuck nose

Featuring Precision Collet Chuck for use with Standard 1 C Collets and eccentricity guaranteed to less than .0001 T.I.R. at chuck nose. Precision 1 C Collets available on request.

EACH COMBO INCLUDES:
.000025 T.I.R. Zero Spindle (#AD-012)
1 C Collet Chuck
Centralizing Collar
Spindle-Lok
Drawbar with actuating handle

ZERO SPINDLE 1 C COLLET CHUCK COMBINATION	
ORDER NO.	PRICE
CFC–12	
Precision 1 C Collets Available on Request.	

ZERO SPINDLE® OFF-LEAD THREAD CHUCK COMBINATION

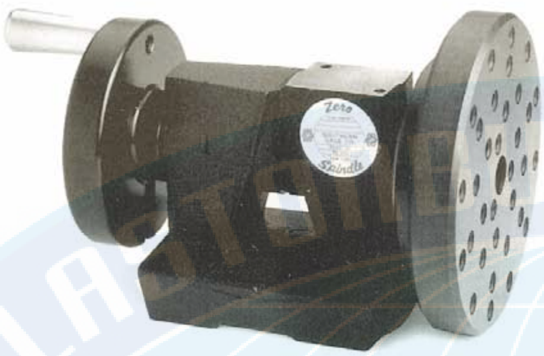


- Consistently controlled concentricity to less than .0001 T.I.R.
- Guaranteed repeatability
- Wide tolerance range
- Extremely positive and rigid gripping

EACH COMBO INCLUDES:
.000025 T.I.R. Zero Spindle
Off-Lead Thread Chuck
Centralizing Collar

The Off-Lead Thread Chuck provides a most accurate means of locating the pitch diameter of a thread for inspection of related diameters and surfaces. One of two thread sections can rotate to permit locking of the external thread on opposing flanks for positive and accurate positioning. Because of the complexities of thread forms, these chucks are engineered to the job and therefore are priced on request. Please submit your part prints and requirements for a quotation.

ZERO SPINDLE® TAPPED HOLE FACE PLATE COMBINATION



COMBO NO.	FACE PLATE DIAMETER	FACE PLATE NO.	USED ON ZERO SPINDLE NO.
TPC-12	4 1/8"	TP-12	AD-012
TPC-13	5 1/2"	TP-13	AD-013
TPC-14	7 1/2"	TP-14	AD-014
TPC-15	10"	TP-15	AD-015

Priced on request.

- Available with any practical hole pattern and face configuration
- Can be used either horizontally or vertically
- Universal application

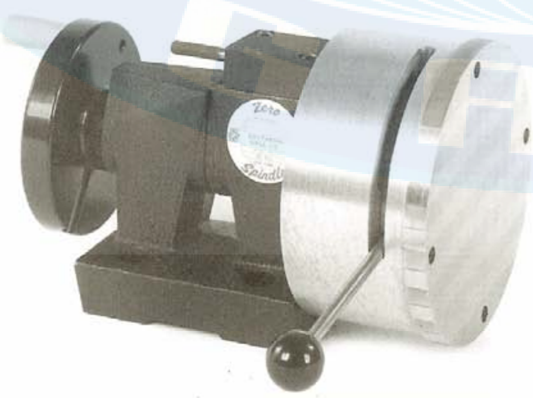
EACH COMBO INCLUDES:
.000025 T.I.R Zero Spindle
Tapped Hole Face Plate

Tapped Hole Style Face Plates are designed to hold virtually every part in their size range. They provide an economical and universal method of checking concentricity, squareness and roundness.

These plates are made from high quality steel, heat treated and ground to precision tolerances.

This style face plate can be equipped with various types of clamps, staging plates and locators to make excellent production inspection fixtures at a low price.

ZERO SPINDLE® MAGNETIC FACE PLATE COMBINATION



COMBO NO.	FACE PLATE DIAMETER	FACE PLATE NO.	USED ON ZERO SPINDLE NO.
MPC-12	4"	MP-12	AD-012
MPC-13	5 1/4"	MP-13	AD-013
MPC-14	6"	MP-14	AD-014
MPC-15	8"	MP-15	AD-015

Priced on request.

- Fast and easy positioning of work pieces
- Variable power permanent magnet featuring swing type on-off control
- Can be used in horizontal or vertical positions

EACH COMBO INCLUDES:
.000025 T.I.R Zero Spindle
Magnetic Face Plate
Actuating Handle
Spindle-Lok

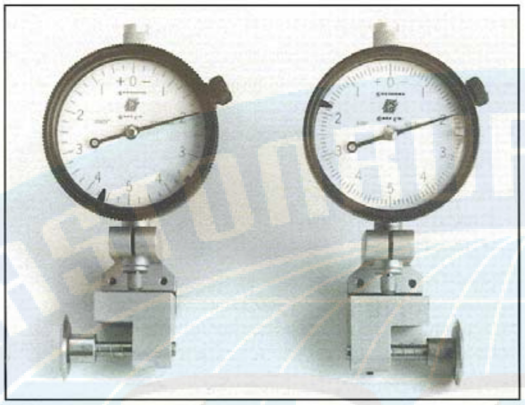
The Magnetic Style Face Plates and Zero Spindle offer an extremely useful and versatile combination for checking squareness, concentricity and roundness of parts fabricated from ferrous materials.

These face plates are available in a variety of sizes to fit every requirement.

Specially designed top plates can be manufactured to fit unusually shaped work pieces.

THREAD CHECKING ATTACHMENTS

FOR USE WITH DIAL OR ELECTRONIC INDICATORS



- Fast and accurate reading
- Can be used in any position
- Thread rolls are interchangeable
- Universal application

Thread Checking Attachments for dial indicators offer a highly accurate and economical means of checking the runout of a thread to related diameters or surfaces.

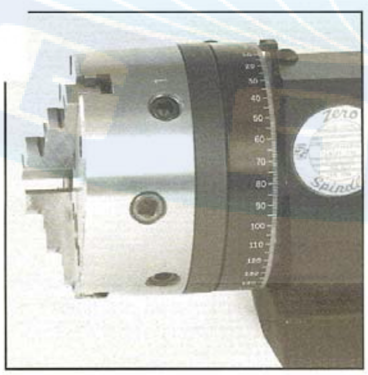
They are mounted on the indicator. The contact point of the indicator locates on the thread roll carrier, which transmits any eccentric motion to the indicator as the roll rides on the thread P.D.

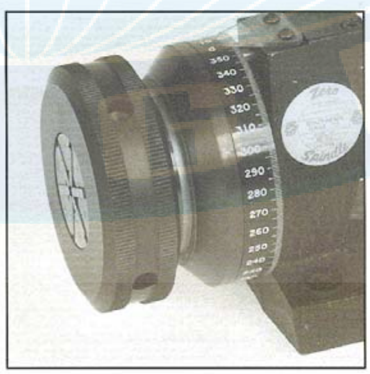
Thread Checking Attachments are engineered to give lasting accuracy.

Note: Always specify right or left hand assembly and pitch of thread.

Thread Checking Attachments	
ORDER NO.	PRICE
AD-1200-R	
AD-1200-L	
Rolls for Above	

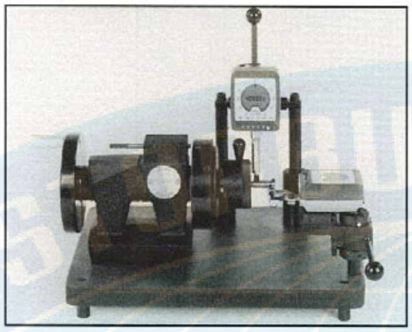
INDEXING DIALS





Indexing Dials for Zero Spindle Chuck Combinations.
Available with pointers or verniers. Accuracy to 6 minutes.
Priced on request.

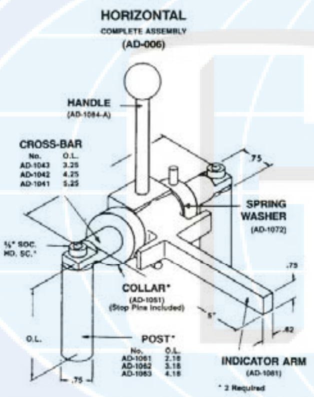
ZERO SPINDLE® FIXTURE ACCESSORIES

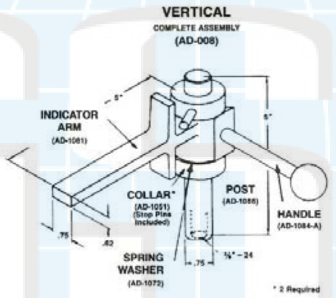


INDICATOR MOUNT ASSEMBLIES

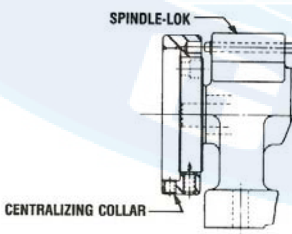
Indicator Mount Assemblies are stocked in a combination of sizes to accommodate a multiplicity of positions. These assemblies include the indicator mount arm, upright posts, cross shafts, retaining collars, stop pins and spring washers. A knobbed handle is provided for ease of operation. Retaining collars with stop pins are adjustable to protect indicators and speed positioning.

IMPORTANT: When ordering, state mount assembly number, cross shaft number and upright post number.





INDICATOR MOUNT ASSEMBLIES	
ORDER NO.	PRICE
AD-006	
AD-008	



CENTRALIZING COLLAR AND SPINDLE-LOK

ZERO SPINDLE NO.	CENTRALIZING COLLAR CATALOG NO.	SPINDLE-LOK ASSEMBLY CATALOG NO.
AD-012	AC-257	AD-286
AD-013	AC-157-A	AD-386
AD-014	AC-457-A	AD-486
AD-015	AC-657-A	AD-586

CENTRALIZING COLLAR	
ORDER NO.	PRICE
AC-257	
AC-157-A	
AC-457-A	
AC-657-A	
SPINDLE-LOK	
ORDER NO.	PRICE
AD-286	
AD-386	
AD-486	
AD-586	

FIXTURE BASES

CATALOG NO.	DIMENSIONS WIDTH	LENGTH	THICKNESS
AD-1032	10"	12"	1"
AD-1033	12"	16"	1"
AD-1034	14"	18"	1 1/8"
AD-1035	16"	24"	1 1/4"

Fine grain cast iron is normalized, faces are ground for flatness, all corners are rounded and all edges are broken on these inspection bases.

FIXTURE BASES	
ORDER NO.	PRICE
AD-1032	
AD-1033	
AD-1034	
AD-1035	

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The diagram below illustrates several different alternatives for holding inside diameter components on the Zero Spindle

ZERO SPINDLE COMPONENTS TO CHECK PARTS HELD ON INSIDE DIAMETERS OR FEMALE THREADS

ZERO SPINDLES:

* AD-012 "M" = 2.187"
* AD-013 "M" = 2.937"
* AD-014 "M" = 3.875"
* AD-015 "M" = 5.250"
* WITH CENTRALIZING COLLAR
* WITH SPINDLE LOCK
* SPINDLE CAN BE MOTORIZED

TORK-LOK ARBORS

* WITH EXPANDABLE COLLETS
* SPLINE CUT COLLETS

PUSH ARBORS

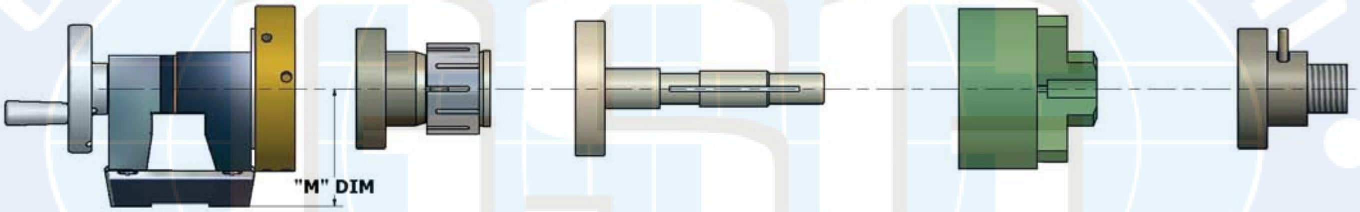
* DIAPHRAGM
* DUAL FLEX
* THREAD CUT
* SPLINE CUT

CHUCKS

* 3 JAW OR 4 JAW CHUCKS
* 3.5 TO 8.0 " SCROLL CHUCK
* INTERNAL / EXTERNAL JAWS
* SPLIT THREAD RINGS
* FULL CIRCLE WELDED JAWS

OFF-LEAD THREAD CHUCK

* FEMALE THREADS
* METRIC AND INCH



INSIDE DIAMETERS AVALIABLE	.50 TO 5.0 INCHES	.25 TO 3.00 INCH	1.0 TO 12.0 USING WELDED JAWS	.18 TO 8.0 INCH THREADS
MAX PART TOLERANCE	.015 "	.003 TO .004 "	NONE	PER THREAD SPEC
ACCURACY	.0005 " TIR	.0001 " TIR	.0001 " TIR	.0001 " TIR
MODE OF ACTUATION	HANDLE AND DRAW BAR	NONE	CHUCK KEY	ACTUATING HANDLE

ALL GAGING SYSTEMS CAN ACCOMODATE:

* A SERIES OF POT CHUCKS FOR DIFFERENT PARTS USING ONE SPINDLE
* ADDITION OF A THREAD CHECKING ATTACHMENT
* SPECIFIC PART STOPS
* ETCHED INDEX DIALS
* ZERO SPINDLE CAN BE MOUNTED FOR VERTICAL LOADING
* ADDITIONAL COMPONENTS AVAILABLE: MAGNETIC, AIR CHUCKS, ETC..

DRAWN dgloyeski	4/4/2005	GLASTONBURY SOUTHERN GAGE 800-251-4243 GSGage.com	
CHECKED		TITLE ZERO SPINDLE COMPONENTS	
QA			
MFG			
APPROVED		SIZE C	DWG NO 5-26-2005 DDG REV
		SCALE	SHEET 1 OF 1

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he diagram below illustrates several different alternatives for holding outside diameter components on the Zero Spindle

ZERO SPINDLE COMPONENTS TO CHECK PARTS HELD ON OUTSIDE DIAMETERS OR MALE THREADS

ZERO SPINDLES:
* AD-012 "M" = 2.187"
* AD-013 "M" = 2.937"
* AD-014 "M" = 3.875"
* AD-015 "M" = 5.250"
* WITH CENTRALIZING COLLAR
* WITH SPINDLE LOCK
* SPINDLE CAN BE MOTORIZED

ODC COLLET CHUCK
* WIDE GRIP LENGTH
* INTERCHANGEABLE COLLETS
* PART STOPS AVAILABLE

CHUCKS
* 3 JAW CHUCKS STANDARD
* 4 JAW CHUCKS FOR THIN PARTS
* 3.5" TO 8.0" SCROLL CHUCK
* INTERNAL / EXTERNAL JAWS
* FULL CIRCLE WELDED JAWS

COLLET CHUCKS
* PRECISION 5C
* PRECISION 1C
* PART STOPS

OFF-LEAD THREAD ARBOR
* MALE THREADS
* METRIC AND INCH

OUTSIDE DIAMETERS EFFECTED	.50 TO 5.0 INCHES	.125 TO 10.0 INCHES	.016 TO 1.062 INCHES	.250 TO 6.0 " THREADS
MAX PART TOLERANCE	NONE	NONE	REF. COLLET SPECS	PER THREAD SPECS
ACCURACY	.0003" TIR	.0001" TIR	.0001" TIR	.0001 " TIR
METHOD OF ACTUATION	ROTATE NUT TO SECURE	CHUCK KEY	DRAW BAR	HANDLE & DRAW BAR

ALL GAGING SYSTEMS CAN ACCOMODATE:
* A SERIES OF POT CHUCKS FOR DIFFERENT PARTS USING ONE SPINDLE
* ADDITION OF A THREAD CHECKING ATTACHMENT
* SPECIFIC PART STOPS
* ETCHED INDEX DIALS
* ZERO SPINDLE CAN BE VERTICAL MOUNTED TO EASE PART LOADING
* ADDITIONAL COMPONENTS AVAILABLE: MAGNETIC, AIR CHUCKS, ETC..

DRAWN dgloyeski 5/2/2005
CHECKED
QA
MFG
APPROVED

GLASTONBURY SOUTHERN GAGE
800-251-4243 GSGage.com
TITLE ZERO SPINDLE O.D. COMPONENTS
SIZE C DWG NO 5-26-2005 DDG REV
SCALE SHEET 1 OF 1

Flex Plugs/ Threaded Hole Location Gages

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FLEX PLUG

Flex plugs are commonly used to measure the location of tapped holes. It is difficult to accurately measure the location of tapped holes using conventional methods; i.e. CMM's or indicating type methods. Flex plugs are manufactured deliberately with the pitch diameter oversize then slotted, which allows the threaded section to collapse while being threaded into the tapped hole. With this method the Flex Plug will screw in tightly, locating on the pitch diameter of the tapped hole. A measurement can then be taken from the datum point to the cylindrical diameter on the Flex plug to determine location. For very small sizes GSG does not slot the plug but manufactures the thread with a gradual taper, which will lock up on the product thread. The disadvantage of the tapered plug is that the thread only locates at the front end of the product thread.

LEADLOCK

The GSG LEADLOCK is a method of locking on the pitch diameter of a thread, INTERNAL or EXTERNAL, for inspection or some light grinding applications. The entire threaded portion of the LEADLOCK is manufactured on lead, then a portion of the threaded area is rotated, which provides the most accurate means of locating on the pitch diameter of a thread. T.I.R. can be achieved of less than .0001.