1. PURPOSE

1.1. This procedure defines the control method for thread inspection to ensure that product meets design requirements.

2. SCOPE

2.1. This procedure applies to manufactured and procured components and tooling with internal or external threads.

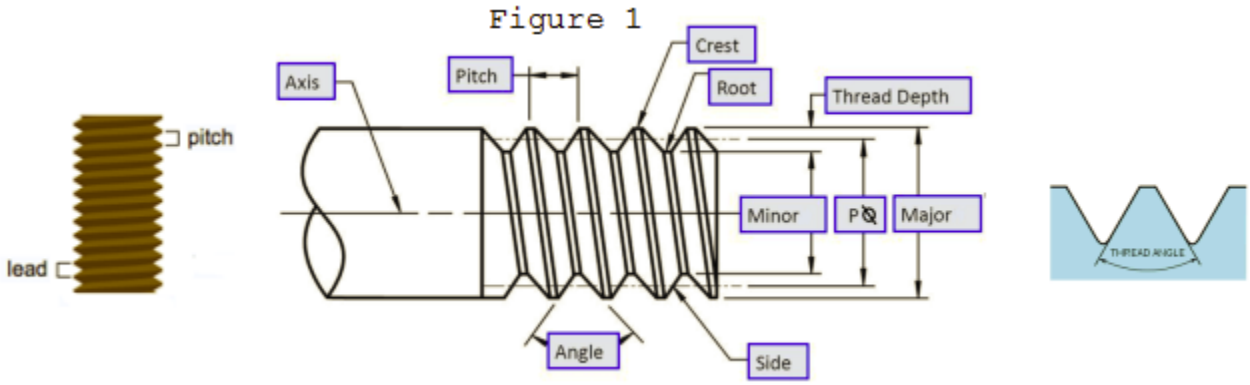
3. DEFINITIONS

3.1. Thread - A helical structure used to convert between rotational and linear movement or force. A screw thread is a ridge wrapped as a helix around either a cylinder (a straight thread) or a cone (a tapered thread). Threads can be used as a simple machine or as a fastener. Threads can be left or right-handed and internal or external. Thread form is the cross-sectional form of a thread.

Inch threads are typically documented by stating the diameter of the thread followed by the threads per inch, such as 3/8-18 which is a 3/8 inch diameter thread with 18 threads per inch, or by thread angle, which is the angle between the threads. This angle determines the style or type of thread (i.e. NPT, pipe thread).

Metric threads are defined by their pitch. Example: M16 x 1.25 x 30 has a pitch of 1.25 and a 16mm major diameter and a length of 30mm.

Figure 1



3.2. Lead Angle - On the straight thread, it is the angle made by the helix of the thread at the pitch line with a plane perpendicular to the axis. Lead angle is measured in an axial plane.

3.3. Flank Angle - The angle made by the flank of a thread which is perpendicular to the axis of a thread.

3.4. Included Angle - The angle between the flanks or slope of the thread measured in an axial plane.

3.5. Flank - Straight edges which connect the crest with the root of the thread.

3.6. Crest - The top most surface joining the two sides or flanks.

3.7. Thread Depth - The distance between the crest and root of the thread. This can also mean the length of the thread.

3.8. Lead - The distance the nut moves parallel to the screw axis when the nut is given one turn. For a single thread, the lead is the same as the pitch of the screw thread.

3.9. Pitch - The distance from the crest of one thread to the next. It is the reciprocal of threads per inch. (Example: 1/8-18 thread has 18 threads per inch so its pitch is 1/18.) Metric threads are defined by their pitch. (Example: M16 x 1.25 x 30 has a pitch of 1.25 and a 16mm major diameter and a length of 30 mm.)

3.10. Pitch Diameter (PD) - The diameter of a cylindrical surface which intersects the thread flanks at equidistant points which is one half the pitch distance. (See Figure 1)

3.11. Major Diameter - The larger or two extreme diameters delimiting the height of the thread profile. For an external thread, this is its outside diameter (OD). The major diameter of an internal thread may not be directly measured, but is may be tested with GO and NOGO gages.

3.12. Minor Diameter - The lower extreme diameter of the thread. The height of the thread = (Major - Minor) / 2. The minor diameter of an internal thread is it's inside diameter. The minor diameter of an external thread can be measured with GO and NOGO gages or directly with an optical comparator.

3.13. Thread Types - Unified Coarse (UNC), Unified Fine (UNF), Unified Extra Fine (UNEF), Unified Special (UNS), ISO Metric (M), British Standard Pipe Metric (Tapered (R, G), National Pipe Thread (Tapered) (NPT), National Pipe Thread Fuel (NPTF), Unified Justified (UNJ), and Aerospace Metric (MJ) are the most common types of standard threads.

4. RESPONSIBILITY

4.1. Quality Technicians, Machinists, and Production Technicians

4.1.1. Shall be responsible for the inspection and approval of thread configurations per this specification, engineering drawings and/or purchase order.

4.1.2. Ensures all gages used for inspection have a current calibration sticker with a Flexial gage ID and meet the test accuracy ratio required by **QP220** for the product tolerances being inspected.

5. PROCEDURE

5.1. Visual Inspection of Threads

5.1.1. All part threads and gage threads should be cleaned of any debris at work station before testing.

5.1.2. Visually inspect for contamination, rough edges, and burrs that can end up damaging gages. Refer to **API00006** for possible visual defects.

5.1.2.1. Visual inspection should be done without magnification unless otherwise specified by the drawing or routing.

5.1.3. Threads should be protected through proper packaging and handling methods to ensure threads are not damaged in subsequent handling or processing.

5.2. Inspection of Internal Threads

5.2.1. Checking the Minor Diameter

5.2.1.1. Match the thread information from the drawing to the information on the thread plug gage handle. If you have no pre-fabricated plug gage with handle available, use a pin gage from the gage pin set. The largest pin that can be fully inserted and extracted using only light finger grip on the sides of the gage is what will determine the hole size. Choose your GO and NOGO pins by finding the high and low allow per the specification.

Example: For a specification of 0.150 +.004/-.002, choose a GO pin of 0.148 (=0.150 - .002) and a NOGO pin of 0.154 (=0.150 + .004). If NOGO pin will not fit, but the GO pin can be fully inserted without interference, the part is acceptable on the low end of the tolerance. If the NOGO pin fits without interference, then the hole is oversized and the part should be rejected.

5.2.2. Checking the Root Radius

5.2.2.1. A mold must be taken, and then a CMM, comparator or vision system can be used to check the root radius.

5.2.2.2. Use the ReproRubber cartridge (or equivalent) to dispense molding compound into cavity or onto part feature that needs to be measured. Use thin pour for internal small features.

	REPRORUBBER THIN POUR	REPRORUBBER MEDIUM BODY ORANGE
Mix Time	15-30 seconds	15-30 seconds
Working Time (Manipulation Time)	2 minutes	2.5 minutes
Setting Time (at room temperature)	10-15 minutes	5-6 minutes
Permanent Deformation	0.2%	0.3%
Dimensional Stability	Less than 0.50%	Less than 0.40%
Tear Strength	44psi	300psi
Elongation	60% at break	70% at break
Durometer (Shore A-2)	30 (at 15 minutes)	40 (at 10 minutes)
Temperature Stability	1 week @ 23°C (72°F)	1 week @ 23°C (72°F)
Detail Reproduction	EXCELLENT	EXCELLENT

5.2.2.3. After full cure time is reached, carefully peel mold away and measure the features of the mold that correlate to the features of the part.

5.2.3. Checking the Pitch Diameter Using GO and NOGO Thread Plug Gages

5.2.3.1. The use of the GO gage must allow for free acceptance. This means minimal force (torque) is required to install and thread the thread plug gage throughout the entire length of specified thread area. Thread the gage until finger-tight using 3 fingers. Do not over-torque as this will damage the gage and possibly the part. Do not use your palm or fist as this will over-torque.

5.2.4. Measuring the Pitch Diameter

5.2.4.1. The three-wire method is the physical method used to measure pitch diameter of external threads.

5.2.4.2. A thread micrometer with a V-anvil and a conical spindle tip may also be used.

5.2.4.3. CMM, optical comparator, or vision system is typically used to measure pitch diameter. Molding may be required.

5.2.5. Checking the Thread Depth or Length Measurement Using Thread Plug Gages

5.2.5.1. Notched Thread Plugs

5.2.5.1.1. A notched thread plug is used as a functional acceptance of thread depth. Thread the plug into the part. When the 1st notch is flush with the top of the hole, the minimum depth has been reached. When flush with the second notch, the maximum thread depth has been reached. Typically, notched gages are specified for one part number. Some gages may have only one notch per the specification requirements.

5.2.5.2. Thread Plugs Without Notches

5.2.5.2.1. Threads are measured starting from the center of the first full thread. To calculate the depth, you must know how many inches per thread. For example, a 1/4-28 has 28 threads per inch or 1 inch/28 threads, which is 0.0357 inches per thread. In this example, the depth is 6 threads, so 6 x 0.0357, or 0.2142". (See Diagram A) The distance should be measured starting from the first full thread on the GO segment end of the gage to the end of the NOGO segment using an optical comparator or other vision gage. This measurement should be recorded on the gage handle as a reference. Fully insert the gage into the tapped hole thread and measure the remaining distance between the face of the part to the end of the NOGO segment. Subtract this reading from the original measurement which gives you the full thread depth. (See Diagram B)

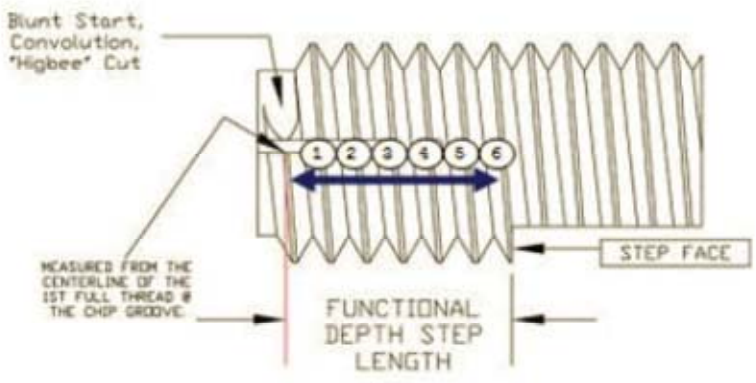
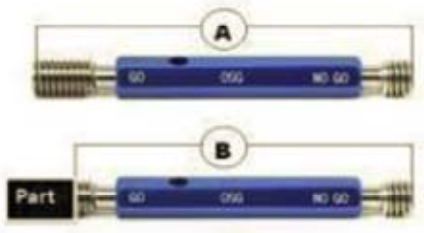


DIAGRAM A



A-B=Thread Depth

DIAGRAM B

5.2.5.3. Thread Plugs with Lock Nuts

5.2.5.3.1. A thread plug with lock nuts is also a functional test for thread depth. The lock nut will be set by quality to the proper position and the test will be performed as with a notch. Flush to the lock nut is minimum depth. Look for a gap between the lock nut and the surface of the part to ensure the thread is fully flush.

5.3. Inspection of External Threads

5.3.1. Checking the Major Diameter

5.3.1.1. Use a micrometer and apply only light pressure so there is no damage to the part.

5.3.2. Checking Root Radius

5.3.2.1. Use a CMM, comparator, or vision system to check the root radius on external threads.

5.3.3. Checking the Pitch Diameter of Threads Using GO and NOGO Thread Ring Gages

5.3.3.1. The use of the GO gage must allow for free acceptance. This means minimal force (torque) is required to install and thread the ring gage throughout the entire length of specified thread area. Thread gage until finger-tight using 3 fingers. Do not over-torque as this will damage the gage and possibly the part. Do not use your palm or fist as this will over-torque.

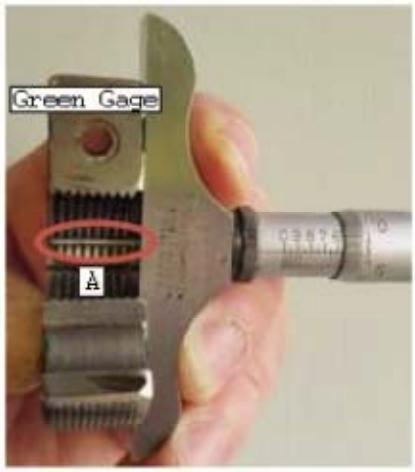
5.3.3.2. The NOGO gage should be accepted for no more than half (1/2) a turn for parts with 3 threads or less and no more than three (3) turns for parts with more than 3 threads.

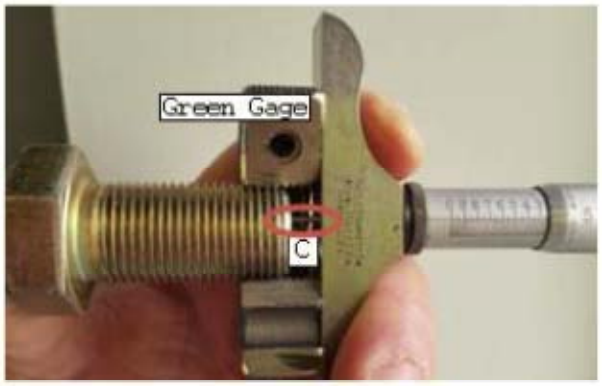
5.3.4. Checking the Thread Depth or Length Measurement Using Thread Ring Gages

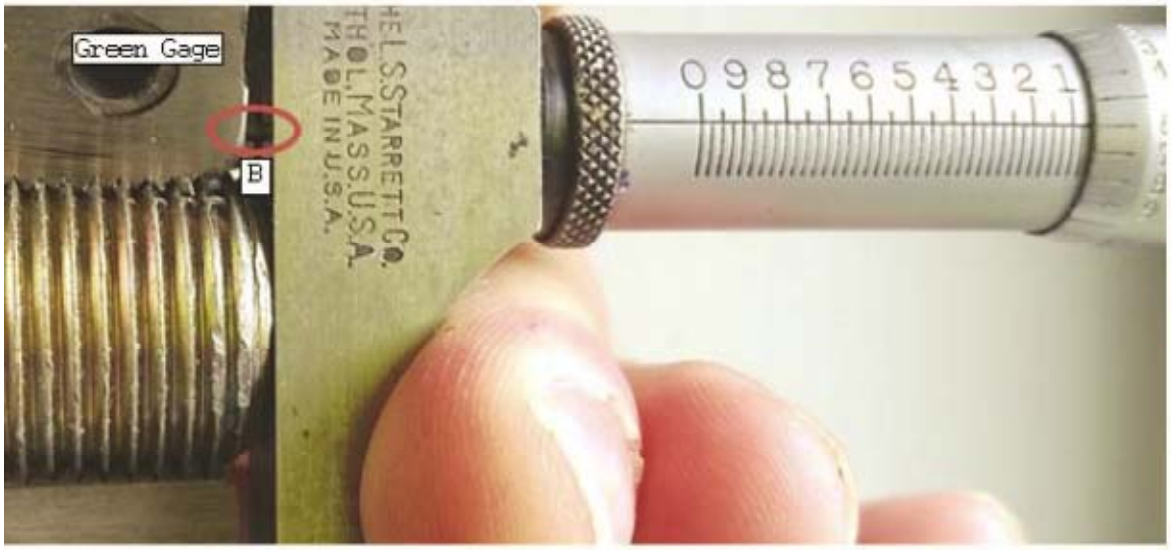
5.3.4.1. Using a depth micrometer, measure the GO gage from the face of the ring to the center of the lead thread on the other side of the gage (A).

5.3.4.2. Thread gage onto part and subtract or add the difference to your measurement. Depth = A - C

5.3.4.3. When part extends past the face of the thread ring, Depth = B + A.







5.4. Acceptance by any one gage in current calibration specified for a characteristic shall be acceptable.

5.5. All exceptions must be approved by Engineering via a TDN per **QP122** prior to shipment or further processing.

5.6. In order to calculate the distance of one complete turn of a thread, use the information on thread size.
Example: On a 3/8-18 NPT pipe thread you would take 1.00 and divide it by the threads per inch which is 18 in this example.
1.00 divided by 18 = .055" = 1 full turn
1.00 divided by 18 = .055" = 1 full turn divided by 2 = .027" = 1/2 turn

6. RECORDS

6.1. Inspection records are retained per **QP130** when required by **QP200**.

7. REFERENCE DOCUMENTS

7.1. API00006 Visual Inspection Criteria - Machined Components
7.2. QP122 Planning and Control of Changes
7.3. QP130 Control of Records
7.4. QP200 Inspection and Testing
7.5. QP220 Control of Monitoring and Measuring Equipment