Gauging and Inspection of Casing, Tubing, and Line Pipe Threads

API RECOMMENDED PRACTICE 5B1
FIFTH EDITION, OCTOBER 1999

REAFFIRMED, MAY 2015

AMERICAN PETROLEUM INSTITUTE

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Upstream Segment

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FOREWORD

This recommended practice is under the jurisdiction of the API Subcommittee on Standardization of Tubular Goods.

No provision of this recommended practice shall be cause for rejection of casing or tubing provided the threads are in accordance with the requirements of the latest edition of API Standard 5B.

This recommended practice is presented as a guide and instructional tool for pipe mill inspectors, third party inspectors, and users interested in developing skills in inspection of threads on oil country tubular goods and line pipe. It includes pictures of numerous gauges and measuring instruments. Every effort has been made to present gauges without regard to the origin of manufacture. Additionally, inclusion of certain gauges should not be construed as an endorsement of the instrument or its manufacture. Similarly, the exclusion of any gauge is not an indication of dissatisfaction with that instrument.

Suggested revisions are invited and should be submitted to the general manager of the Upstream Segment, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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Gauging and Inspection of Casing, Tubing, and Line Pipe Threads

1 Introduction

The ability of line pipe and oil country tubular goods (such as, oil and gas well casing and tubing) to perform properly depends on the physical integrity of the pipe body and connections. Threads at each end of the pipe provide a means of joining the pipe segments into a continuous "string" of pipe. There are many thread configurations applied to oil country tubular goods. However, they all have two functions in common: they must resist leakage and tensile failures. This is accomplished by applying threads which are specially designed and accurately machined. Laboratory and prototype testing prior to marketing of the connection verifies the proper design. Accurate machining depends on a repetitive process to simulate tool wear. Excessive tool wear and/or damage after machining reduces the thread's performance.

This recommended practice provides guidance and instruction on the correct use of thread inspection techniques and equipment to assure dimensionally accurate connections. The inspector carries a heavy responsibility. This responsibility can be discharged properly only if the inspector is adequately trained. This recommended practice provides the training and insight necessary to perform an adequate inspection of line pipe and oil country tubular goods connections.

1.1 BACKGROUND

Casing and *tubing* are two terms which are used to describe oil country tubular goods that become part of a completed oil and gas well.

When these terms are used in field drilling and production operations, the term "casing" applies to pipe that is used to line the drilled hole to protect the well from formation fluid flow or formation collapse. It is a permanent part of the well in which bottom sections of casing are cemented in place. At times, cement is circulated to the surface. Among the various types of casing are conductor pipe, surface casing, intermediate or protective casing, and production casing (Figure 1). These casing strings extend to the surface. A section of the hole lined with pipe that does not reach the surface is called a liner. Liners may or may not be cemented in place.

The term "tubing" applies to the innermost pipe in a well. Well fluids are brought to the surface through the tubing. The tubing may be isolated from the casing by a production packer. Tubing is frequently removed from the hole and at times is replaced.

The terms *casing* and *tubing*, when used in a steel mill or in API specifications, are oriented to size and not necessarily to end use. The mills may not know what will be the end use of their pipe. Accordingly, in mill practice and in API specifications, casing generally covers pipe $4^1/_2$-in. OD or larger. Tubing generally covers pipe $4^1/_2$-in. OD and smaller. This publication uses the terms casing and tubing in the mill/API sense. In most cases, this will also conform to the end use description.

Each of the pipe connections must be capable of withstanding internal and/or external pressure without leakage. The competence of the design and the accuracy of manufacture of the connection provides assurance of the required leak resistance. API connections are among the most accurately machined threads currently mass produced. Each component shape and size is designed and machined to interact with the mating component to form a fluid seal.

Inspecting the threaded ends of pipe determines if the manufactured product is in compliance with the design specification. Oil country tubular goods and line pipe are inspected at the manufacturer's facility prior to shipment. Additionally, the pipe may be inspected at the pipe yard, job site, and/or drilling rig.

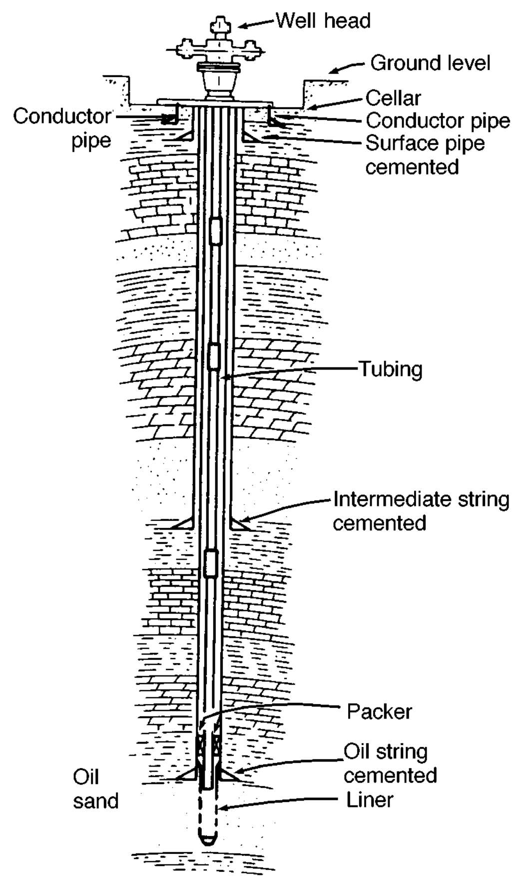


Figure 1—Schematic Diagram of an Oil or Gas Well Completed with a Hung Liner

The manufacturer's inspection is not normally an inspection of each individual connection. Rather, it is normally an inspection of a statistically designed sample based on manufacturer's experience. The field inspection generally is an inspection of each threaded end. The scope of the field inspection varies based on the owner's desires and the inherent constraints of field inspection.

Corrosion resistance and sealing ability of connections are improved by plating the threads, usually in the coupling or box, with zinc, tin, or metallic phosphate. The plating produces a beneficial effect; however, it generally interferes with the precision of gauging of these threads because it's difficult to plate threads uniformly. This is particularly true of zinc and tin, which are electroplated. The portion of the thread closest to the anode receives the greatest thickness of plated metal. Some manufacturers may prefer to apply the coating to the pipe (pin end) member, particularly on special or premium-type connections. In all cases, coatings are applied for the purposes of (a) antigalling during makeup, (b) anticorrosion while in storage, or (c) as an aid to sealing (in threads) for leak resistance.

Gauging of threads by manufacturers is performed prior to coating. Field gauging of coated threads may be less accurate than gauging at the manufacturer's facility. Discretion should be used, therefore, in interpreting the results of field gauging of coated threads. Additionally, manufacturer gauging is performed prior to assembly of the pipe components. Accordingly, gauging of assembled (made-up) threaded components can result in the components not conforming with the specification values because of makeup distortion.

Off-specification components of coated, but unmade-up components can be recognized by field gauging. If a dispute arises, however, the coating shall be removed and the component regauged.

The manufacturers make a conscious effort to eliminate off-specification tubular goods within the financial and statistical constraints of the manufacturer. Users, particularly at critical wells or pipelines, desire an inspection at the drilling rig or field site to eliminate any thread damage which occurred during shipment, or any off-specification threads which may not have been found at the manufacturer's facility.

It is important to locate and eliminate damaged or off-specification pipe. Rejecting "good" pipe, however, results in a financial burden being imposed on the manufacturer and/or operator. Thus, inspection shall be performed with care and reason.

1.2 SCOPE

Information contained in this recommended practice is intended for use of pipe manufacturer inspectors, quality control personnel, field inspectors, threading unit operators, and users and purchasers of oil country tubular goods and line pipe.

This publication was prepared under the auspices of the API Subcommittee of Tubular Goods and the Resource Group on Threading and Gauging. As such, the scope is limited to inspection of API casing, tubing, and line pipe connections. However, the basic techniques of gauge usage apply to any threads for which the thread element specifications are known. Specifically, this recommended practice was written to supplement and augment the latest editions of API Specifications 5CT and 5L, which mandate physical and mechanical properties of casing, tubing, and line pipe. Additionally, this recommended practice is designed to be used with the latest edition of API Specification 5B, *Specification for Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads*. It does not duplicate the massive dimensional tables contained in the latest edition of API Spec 5B. Instead, it provides instruction in inspection techniques appropriate to comparing the dimension of the product with specified dimensions and tolerances for that product. Accordingly, the primer can be used for the inspection of API thread elements without direct reference to the latest edition of Spec 5B. In all cases, the latest edition of Spec 5B takes precedence if a dispute arises between parties.

This publication uses photographs to demonstrate the proper use of representative gauges normally used by thread inspectors. Gauges presented are limited to those appropriate to both mill and field use. Thus, nonportable instruments such as comparators and contour readers are not included. However, there is no intent to limit the use of such instruments or methods by inspectors.

2 References

This specification includes by reference, either in total or in part, the following:

API

Spec 5B	*Specification for Threading, Gauging, and Thread Inspection of Casing, Tubing, and Line Pipe Threads*
Spec 5CT	*Specification for Casing and Tubing*
Spec 5L	*Specification for Line Pipe*
RP 5A5	*Recommended Practice for Field Inspection of New Casing, Tubing, and Plain End Drill Pipe*

2.1 REQUIREMENTS

Requirements of other standards included by reference in this specification are essential to the safety and interchange ability of the equipment produced.

2.2 EQUIVALENT STANDARDS

Other nationally or internally recognized standards shall be submitted to and approved by API for inclusion in this specification prior to their use as equivalent standards.

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1 addendum: The addendum of an external thread is the radial distance between the major and pitch cylinders or cones, respectively. The addendum of an internal thread is the radial distance between the minor and pitch cylinders or cones, respectively.

3.2 basic size: The theoretical size from which all variations are measured.

3.3 black-crested threads: Threads that are not fully crested have historically been and continue to be referred to as "black-crested threads," because the original mill surface has not been removed. Black-crested threads is a useful descriptive term; however, it should be pointed out that there can be non-full-crested threads that are not black-crested.

3.4 chamfer: The beveled surface, beginning at the end of the pipe or coupling, in which the thread form starts.

3.5 crest: The top of the thread.

3.6 crest clearance: The distance between the crest and root of mating threads.

3.7 crest truncation: The distance between the sharp crest (crest apex) and the finished crest.

3.8 dedendum: The distance between the pitch line and root of thread.

3.9 effective thread length: (See Figures 1, 3 and 8 in Spec 5B). The dimension designated as L2 for line pipe and round thread tubing and casing. This is the theoretical point at which the vanish cone angle begins.

3.10 external thread: A thread on the external surface of a pipe.

3.11 flank angle: The angle between the individual flanks and the perpendicular to the axis of the thread measured in an axial plane. A flank angle of a symmetrical thread is commonly termed the half angle of the thread.

3.12 flank or side: The surface of the thread which connects the crest with the root.

3.13 full-crest thread length: The length measured parallel to the thread axis from the end of the pipe to the first non-full-crested thread.

Note: The partial threads in the chamfer are considered to be within the full-crest thread length.

3.14 hand-tight: Threaded connection that has been made up by hand without the aid of tongs or other mechanical devices.

3.15 hand-tight mating standoff: The length at hand-tight engagement from the face of the coupling to the vanish point of the threads for casing and tubing round threads and line pipe threads; and to the base of the triangle for buttress threads.

3.16 handling-tight: Sufficiently tight that the coupling cannot be removed except by use of a wrench.

3.17 height of thread: The distance between the root and crest of the thread measured normal (perpendicular) to the thread axis.

3.18 imperfect thread length: The buttress threads located beyond the L7 plane (away from the pipe ends).

3.19 included angle: The angle between the flanks of the threads measured in an axial plane.

3.20 internal thread: Thread on the internal surface of a coupling or pipe.

3.21 last engaged thread: The last thread on a pin contacting the coupling threads.

3.22 last scratch (vanish point): The last visible evidence of the continuous machined root as it stops or runs out (buttress thread).

3.23 lead: The distance from a point on a thread to a corresponding point on the next thread turn, measured parallel to the thread axis. Lead tolerances are expressed in terms of "per inch of threads" and "cumulative", and lead errors must be determined accordingly. For interval measurements over lengths other than 1 inch the observed deviation should be calculated to the per inch basis. For cumulative measurements observed deviations represent the cumulative deviation.

3.24 leading or front flank (stab flank): The flank of the pipe thread facing the near open end of pipe. The flank of the coupling thread facing the open end of the coupling. See Figures 3 through 7.

3.25 length of thread engagement: The length of contact between two mated parts measured axially.

3.26 load or pressure flank: The flank of the pipe thread facing away from the open end of the pipe. The flank of the coupling or box thread facing away from the open end of the coupling. The 3° flank on buttress thread. (Figures 3 through 7.)

3.27 major cone: An imaginary cone which would bound the crest of an external taper thread or the roots of an internal taper thread.

3.28 major diameter: The crest diameter of the external thread and the root diameter of the internal thread.

3.29 manufacturer: As used throughout this recommended practice, includes pipe manufacturers, processors, threaders, and manufacturers of couplings, pup joints, and connectors, as applicable.

3.30 may: Used to indicate that a provision is optional.

3.31 mill end: The end of the pipe to which the coupling is applied at the mill. Referred to as the box end of the integral joint pipe.

3.32 minor cone: An imaginary cone which passes over the root of the external thread and crest of internal thread.

3.33 minor diameter: The root diameter of the external thread and the crest diameter of the internal thread.

3.34 perfect thread length: The last perfect thread location on external threads shall be L_4-g for tubing and line pipe, L_7 for buttress, and last scratch (last thread groove) – 0.500 in. for casing round threads. The last perfect thread location on internal threads is J + 1p measured from the physical center of the coupling or from the small end of the box for integral joint tubing.

3.35 pin end: The externally threaded end of pipe without a coupling applied.

3.36 pitch: See *lead*.

3.37 pitch cone: An imaginary cone which passes through the thread profile at approximately the thread center.

3.38 pitch diameter: On a taper thread, the pitch diameter at a given position on the thread axis is the diameter of the pitch cone at that position. On buttress threads, this is midway between the major and minor diameter.

3.39 power-tight: A threaded connection that has been fully made up by mechanical means using power tongs or a screw-on machine.

3.40 recess: The counter-bored section at the end of line pipe and casing and tubing round thread coupling. It facilitates stabbing the threads.

3.41 right-hand thread: A thread that winds in a clockwise receding direction when viewed axially.

3.42 root: The bottom of the thread.

3.43 root truncation: The distance between the sharp root (root apex) and the finished root.

3.44 runout (buttress threads): Intersection of the thread root and the pipe outside surface.

3.45 shall: Used to indicate that provision is mandatory.

3.46 should: Used to indicate that a provision is not mandatory, but recommended as good practice.

3.47 standoff: A distance from coupling face to pipe thread vanish point on line pipe and round casing and tubing threads; and from coupling face to the base of the triangle on buttress threads.

3.48 taper: For round threads and line pipe threads, taper shall be defined as the increase in the pitch diameter of the thread, in inches per inch of thread. For buttress threads, taper is defined as the change in diameter along the minor cone of the external threads and the major cone of the internal threads. On all threads, taper tolerances are expressed in terms of "inch-per-inch of thread" and taper deviation shall be determined accordingly. The measurements are made for the specific interval lengths and the observed deviation shall be calculated to the inches-per-inch basis.

3.49 thread axis: The axis of the pitch cone, the longitudinal central line through the threads. In the basic thread design, all length measurements are related to the thread axis.

3.50 thread form: The form of thread is the thread profile in an axial plane for a length of one pitch.

3.51 threads per inch: The theoretical number of threads in one inch of thread length.

3.52 tolerance: The permissible deviation from the specified value.

3.53 torque: A force that tends to produce rotation—the force causing a threaded connection to makeup.

4 API Threaded Connections

A threaded connection consists of two members: a pipe or pin member and a coupling or box member. The externally threaded member is called the pipe or pin member. The internally threaded member is called the coupling or box member. Two pin members are connected together by means of a coupling, which is a short segment of pipe slightly larger in diameter than the pipe, but threaded internally from each end (Figure 2). The pins may be the same thickness as the pipe body (non-upset) or thicker than the pipe body (upset). All API threaded and coupled (T&C) casing and line pipe are non-upset.

Tubing is manufactured with either non-upset or external upset ends. The approximate internal diameter of the pipe ends is equal to that of the pipe body (Figure 2). However, the outside diameter (OD) at the upset ends is larger than the pipe body (Figure 2). API integral joint tubing connections are upset on both ends.

Threads, as applied to tubular connections, are used to mechanically hold two pieces of pipe together in axial alignment. The threads may or may not be required to act as a leak resistant element.

API tubular good specifications cover four styles of threads, namely line pipe threads (Figure 3); round threads (Figure 4); buttress threads (Figures 5 and 6); and extreme-line threads (Figure 7). Line pipe, round, and buttress threads are required to fit together in made-up assembly such that with sealant they will resist leakage through the threads. The threads in extreme-line casing are not designed to be leak tight. Leak resistance of the extreme-line connection is accomplished by the use of a metal-to-metal seal (Figure 7).

On a threaded connection, the stab or front flank of a thread is the radial surface facing the nearest end of the pipe (Figures 3, 4, 5, and 7). The load or back flank is the radial surface facing toward the pipe body. The top and bottom of a thread are designated as crest and root, respectively (Figures 3, 4, 5, and 7). On a pipe member, the crest is the largest diameter of a thread and the root is the smallest diameter, with the coupling member, the largest diameter is called the root, and the crest is the smaller diameter (Figures 3, 4, 5, and 7).

4.1 LINE PIPE THREAD

The thread is a 60° Vee-type thread with the included angle between flanks being 60° (Figure 3). The crests and roots are truncated on a cone parallel with the taper. When the joint is assembled, the crest and root clearance will be 0.005 in. radially. This void can be a leak path unless a suitable thread compound is used. The stab and load flanks are interference-bearing surfaces when the connection is properly made up, and unless these flank surfaces are damaged or malformed, they will prevent leakage from crest to root (or vice versa). If such a thread is made up with insufficient interference between pin and coupling members, the coupling (or box) member will not retain enough contact load on the thread flanks to resist high internal pressure. Leakage will then occur radially over the thread flanks.

4.2 ROUND TUBING AND CASING THREADS

This thread is basically the same thread form as used on line pipe except that the thread crests and roots are truncated with a radius (Figure 4). The purpose of the round top (crests) and round bottom (roots) is to: (a) improve the resistance of the threads from galling in makeup, (b) provide a controlled clearance between made-up thread crest and root for foreign particles or contaminants, and (c) make the crests less susceptible to harmful damage from minor scratches or dings.

If insufficient interference is applied during makeup, the leak path through this connection could be through the annular clearance between mated crest and roots. Again, proper thread compound is necessary to ensure leak resistance.

The clearance (radially) between an assembled thread crest and root is approximately 0.003 in., but unlike line pipe, the round thread clearance is a crescent shape (Figure 4).

Superficial scratches, minor dings, and surface irregularities on the thread surface are occasionally encountered and may not necessarily be detrimental. Because of the difficulty in defining superficial scratches, minor dings, and surface irregularities, the degree to which they affect thread performance can not be established. As a guide to acceptance, the most critical consideration is to ensure that there are no detectable protrusions on the threads to peel off the protective coating on the coupling threads or score mating surfaces. Cosmetic repair of thread surfaces by hand is permitted.

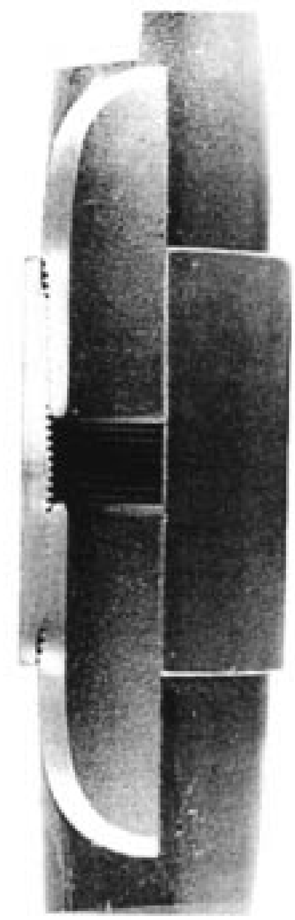


Figure 2—Typical Pipe Coupling

4.3 BUTTRESS THREAD-CASING (THREADED AND COUPLED)

Buttress threads are designed to resist high axial tension or compression loading in addition to offering resistance to leakage.

For sizes $4^1/_2$ in. through $13^3/_8$ in. (Figure 5), the threads are 5 pitch (pitch = 0.200 in.) per in. on a $^3/_4$-in. taper per ft on diameter. The stab flank is 10° from radial, and the load flank is 3° from radial. The crests and roots are conical and parallel with the taper. The stab flank radius at the crest is large (0.030 in. *R*) as compared to the load flank radius at the crest (0.008 in. *R*). This is to aid in stabbing and running. The threads are full-form fit when assembled resulting in a maximum thread crest-to-root clearance of 0.002 inch. Inherent machining variations in threading may cause the threads to bear on one thread flank at one end of the thread element of the connection and on the opposite thread flank at the other end of the element. In any event, leak resistance is again accomplished with use of the proper thread compound and/or thread coating agent. Leak resistance is controlled by proper assembly (interference) within the perfect thread length only.

The thread root of this connection runs out on a continuous cone to the OD of the pipe body, and the coupling (box) member engages the root diameter of the imperfect threads which extend from the last full thread (on the pin) to the vanishing point or from the last imperfect thread on the pipe OD.

The 3° load flank offers resistance to disengagement under high axial tension loading, while the 10° stab flank offers resistance to high axial compressive loading. Attempted repair by hand dressing should be done with discretion and limited to a small part of the perfect thread length. Discretionary repair to the imperfect thread area of the pin does not affect leakage control.

Buttress casing threads on sizes 16-in. diameter and larger have five threads per inch on a 1-in. taper per ft on diameter and have flat crests and roots parallel to the pipe axis (Figure 6). This is to aid in stabbing and running casing. All other dimensions and thread radii are the same as those for $13^3/_8$ in. and smaller sizes.

The application of proper thread compound and a suitable thread coating are essential for assurance of leak resistance.

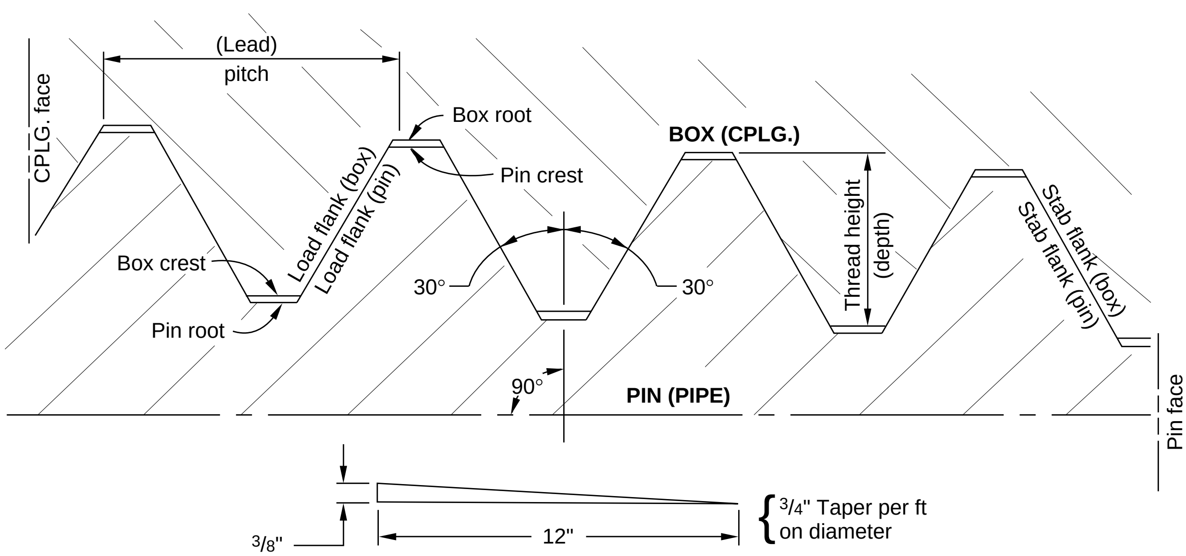


Figure 3—Line Pipe Thread Configuration

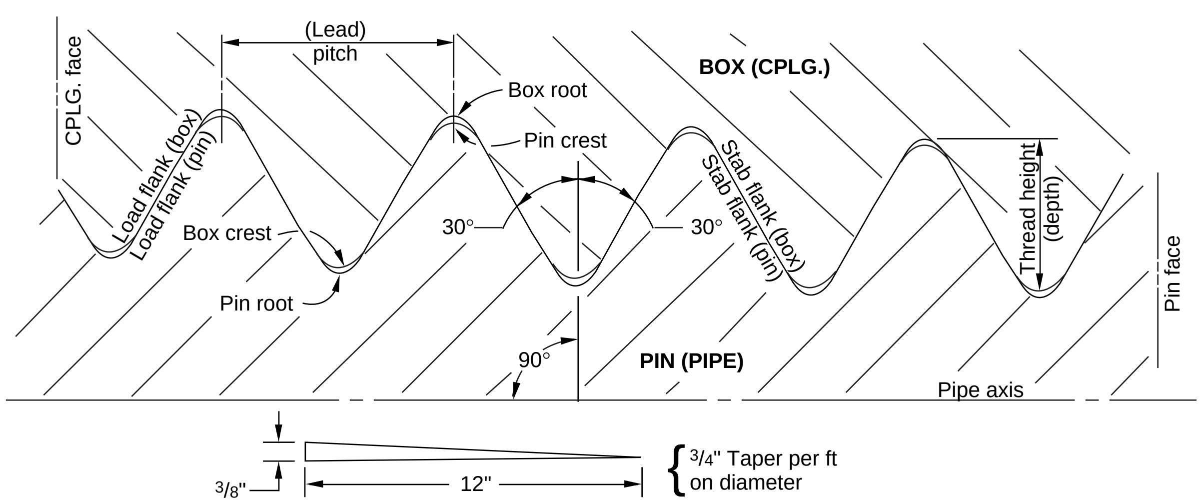


Figure 4—Round Thread Casing and Tubing Thread Configuration

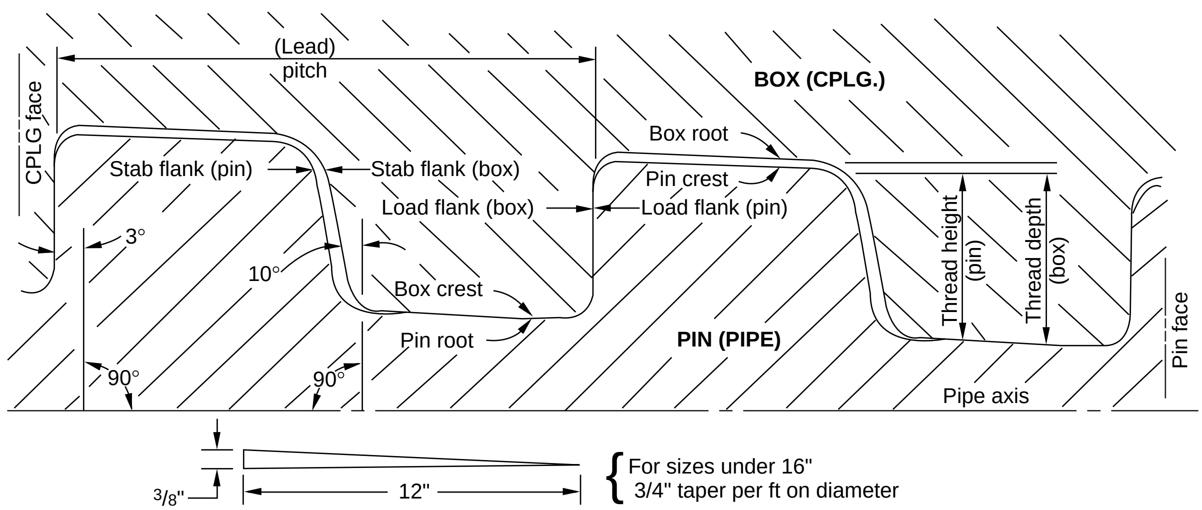


Figure 5—Buttress Thread Configuration for $13^3/_8$-in. OD and Smaller Casing

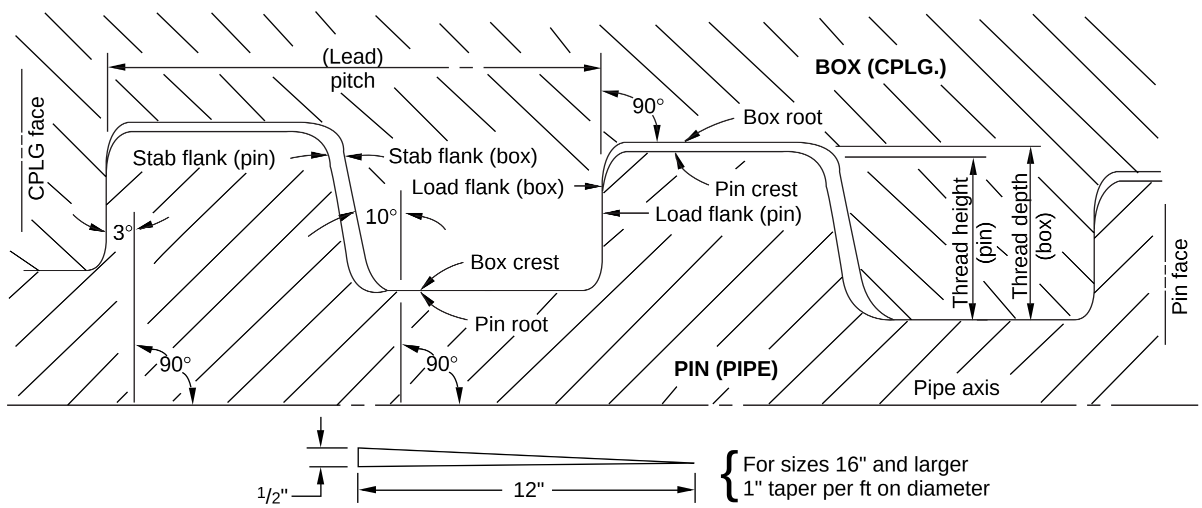


Figure 6—Buttress Thread Configuration for 16-in. OD and Larger Casing

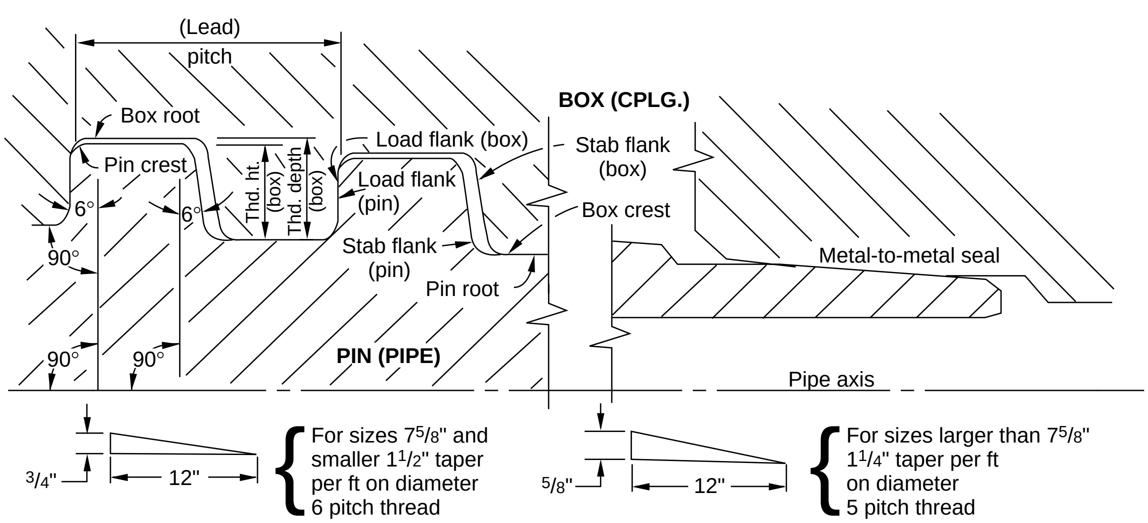


Figure 7—Extreme-Line Casing Thread Configuration

4.4 EXTREME-LINE THREAD (INTEGRAL CONNECTION)

Extreme-line casing in all sizes uses a modified Acme-type thread having a 12° included angle between stab and load flanks, and all threads have crests and roots flat and parallel to the pipe axis (Figure 7). For sizes 5 in. through $7\frac{5}{8}$ in., the threads are of 6 pitch (six threads per inch) on a taper of $1\frac{1}{2}$ in. per ft on diameter. For sizes $8\frac{5}{8}$ in. through $10\frac{3}{4}$ in., the threads are of 5 pitch (five threads per inch) on a taper of $1\frac{1}{4}$ in. per ft on diameter. For all sizes, the threads are not intended to be leak resistant when made up. Threads are used purely as a mechanical means to hold the joint members together during axial tension loading. The connection uses upset pipe ends for pin and box members that are an integral part of the pipe body. Axial compressive load resistance is primarily offered by external shouldering of the connection on makeup.

Box (or internal) member threads make up with the pin member threads by interference bearing between the box thread crests and pin thread roots. The pin crests and stab flanks of all threads have radial clearance ranging from 0.005 in. to 0.009 in. between crest of pin and root of box threads and 0.005 in. to 0.011 in. between mated stab flanks. Therefore, the load flanks and pin root to box crests are in bearing load contact makeup.

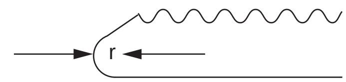
Leak resistance is obtained on makeup by interference of metal-to-metal seal between a long, radius curved seal surface on the pin member engaging a conical metal seal surface of the box member (Figure 7).

Thread compound is not necessarily a critical agent to ensure leak resistance but instead is used primarily as an anti-galling or antiseizure agent.

All threads, including partial depth threads, are functional in axial tension load resistance. Therefore, discretionary repairs for minor damage to threads only may be made without adversely affecting leak resistance of the connection. No hand dressing or repair to seal surfaces is advisable.

4.5 ROUNDED NOSE

In lieu of the conventional corner breaks on the threaded ends of tubing, the "round" or "bullet-nose" end may be supplied at the manufacturer's option or may be specified by the purchaser. The modified end shall be rounded to provide for coatable service, and the radius transition shall be smooth with no sharp corners, burrs, or slivers on the ID or OD chamfer surfaces. See the following figure for an illustration and dimensions. It is recognized that the above dimensions are recommended values but are not subject to measurement to determine acceptance or rejection of the product.



Size	Radius, r, in inches (See Note 1)
$2\frac{3}{8}$	$\frac{3}{32}$
$2\frac{7}{8}$	$\frac{3}{32}$
$3\frac{1}{2}$	$\frac{1}{8}$
4	$\frac{1}{8}$
$4\frac{1}{2}$	$\frac{1}{8}$

Notes:
1. These dimensions are for reference only and are not subject to measurement for determining product acceptance.
2. See API Spec 5B for details.

5 Visual Thread Inspection

5.1 VISUAL THREAD INSPECTION (VTI)

Visual thread inspection is a procedure for locating thread imperfections without the use of magnetic particles or thread gauges other than a profile gauge. This inspection applies to exposed round threads on casing and tubing, and exposed buttress threads on casing. Visually evident manufacturing defects or mechanical damage to the threads are detected by this inspection.

Note: Extreme-line threads are excluded from these inspection procedures. For Extreme-line threads refer to API Spec 5B.

5.1.1 Evaluation Tools

Though imperfections may be visually located during this inspection, other tools may be used to evaluate the magnitude of the imperfections found:

5.1.1.1 A steel scale for accuracy determining the L_c area on the pin and perfect thread length of internal threads.

5.1.1.2 Mirror for inspection of load flanks and roots of internal threads.

5.1.1.3 Bright light resulting in 100 footcandles at the inspection surface for inspection of internal threads.

5.1.1.4 Profile gauge, a tool for detection of thread profile errors.

5.1.1.5 Flexible steel measuring tape for measuring circumferential non-full-crested or black-crested thread length on buttress threads.

5.1.1.6 Additionally, a copy of the latest edition of API Spec 5B and this RP shall be available on location.

5.1.2 Thread Repair

Repair of threads is not a part of this inspection. Cosmetic (minor) repair of threads may be done.

5.1.3 Thread Protectors

Remove the thread protectors and stack them out of the way so that they will not be a work hazard. From this step, until the thread protectors are reinstalled, great care shall be used to ensure that two lengths of pipe do not strike each other and damage the unprotected threads. Pipe should never be loaded, unloaded, or removed to another rack without thread protectors installed. Never leave threads exposed to moisture or condensation overnight. Use of light corrosion inhibitor is recommended.

Note: Martensitic Chromium Steels (9 Cr and 13 Cr, Spec 5CT, Group 2) are sensitive to galling. Special precautions may be necessary for thread surface treatment and/or lubrication to minimize galling.

5.1.4 Cleaning

Clean all exposed threads thoroughly. Ensure that no thread compound, dirt, or cleaning material remains on the threads.

CAUTION: Solvents and other cleaning agents may contain hazardous material. Solvents are normally volatiles and may build up pressure in containers. Material Safety Data Sheets should be read and the precautions observed when handling products of this type. Storage, transport, use, and disposal of excess materials and containers should be considered. Observe appropriate regulations relative to disposal of used solvents and generated waste materials.

5.1.5 Thread Inspection Areas of Round and Buttress Threads

5.1.5.1 Determine the L_c length of pin end threads.

Note: Internal threads do not have an L_c area. All of the threads within the interval from the counterbore to a plane located at a distance *J* plus one thread turn from the center of the coupling or small end of Integral Joint, are to be inspected to the L_c area requirements. This area is defined as the internal Perfect Thread length (PTL).

5.1.5.2 Thread classification depends on the location of an imperfection. Imperfections located in the L_c area of external threads or PTL of the internal threads have different criteria for acceptance and rejection than those outside these regions. Measurements may be required to determine if imperfections are in the L_c or box PTL.

5.1.6 Thread Examination

Slowly roll individual lengths at least one full revolution while examining the threads.

5.1.6.1 External Threads

Inspect for imperfections on the face, chamfer, L_c, and non-L_c area. The thread profile gauge may be applied to the threads to detect machining errors.

5.1.6.2 Internal Threads

Inspect for imperfections in the counterbore, PTL, and threaded area beyond the PTL. Seal-ring grooves shall be inspected for fins, wickers and ribbons that are loose or can become loose on each side of the groove. The profile gauge may be applied to the threads to detect machining errors. Caution shall be used when applying the profile gauge to avoid damaging thread coating. If the profile gauge bridges the ring groove, the metal moved in machining the groove may give a false indication of thread machining errors.

5.1.6.3 Prove-Up

Exploratory grinding or filing to determine the depth of an imperfection is not permitted in the L_c area of external threads or the total length of internal threads.

5.1.7 Categories of Imperfections

Types of imperfections that may cause thread rejection are listed in 5.1.7.1 through 5.1.7.4.

5.1.7.1 Threaded Area Imperfections

a. Arc burns.
b. Broken threads.
c. Burrs.
d. Cuts.
e. Chattered threads.
f. Cracks.
g. Dents.
h. Dinges.
i. Fins.
j. Galls.
k. Grinds.
l. Handling damage.
m. Improper thread form.
n. Improper thread height.
o. Laps.
p. Narrow threads (shaved threads).
q. Pits.
r. Seams.
s. Shoulder or steps.
t. Thick threads.
u. Threads not extending to the center of the coupling (threads within the *J*-area may not be perfect).
v. Threads not full-crested (including black-crested threads).
w. Tool marks.

x. Torn threads (tears).
y. Wavy or drunken threads.
z. Wicker (or whisker.)
aa. Imperfections, other than those listed above, that break the continuity of the thread.

Note: Threads that are not full-crested have historically been and continue to be referred to as "black-crested threads" because the original mill surface has not been removed. Black-crested thread is a useful descriptive term; however, it should be pointed out that there can also be non-full-crested threads that may not be black.

5.1.7.2 Chamfer Area Imperfection

5.1.7.2.1 Chamfer Area (Conventional)

a. Not present 360°.
b. Thread running out on the face.
c. Razor edge.
d. Feather edge.
e. Burrs.
f. False starting thread engaging actual starting thread.
g. Mashes.
h. Cuts.

Note: The surface of the chamfer need not be perfectly smooth. Chamfers on the pipe ends have no effect on the sealing capability of the threads.

5.1.7.2.2 Round or Bullet Nose for Tubing

a. Radius transition not smooth.
b. Sharp corners.
c. Burrs.
d. Slivers.
e. False starting thread engaging actual starting thread.
f. Mashes.
g. Cuts.

5.1.7.3 Pipe End Imperfections (Inside and Outside)

a. Burrs.
b. Fins.
c. Dents/mashes.

5.1.7.4 Box Face and Counterbore Imperfections

a. Tool marks.
b. Mashes.
c. Burrs.
d. Arc burns.

5.2 PROCEDURE FOR EVALUATION OF VISUALLY LOCATED THREAD IMPERFECTIONS

Good judgment and discretion should be exercised in examination of exposed threads on line pipe, casing and tubing. Some surface irregularities will not affect the joint strength or the pressure sealing performance unless they are large enough to act as a leak channel. Keep in mind that thread crests of round threads do not engage the roots of the threads of the mating piece. Therefore, minor chatter, tears, cuts, or other surface irregularities on the crest or roots of round threads may not be cause for rejection.

5.2.1 Some surface roughness may even be beneficial to proper makeup by holding thread compound in place as the thread is engaged during makeup.

5.2.2 Superficial scratches, minor dings, and surface irregularities on threads are occasionally encountered and may not necessarily be detrimental. Because of the difficulty in defining superficial scratches, minor dings, and surface irregularities, and because of the degree to which they can affect thread performance, no blanket waiver of such imperfections can be established. The thread flanks in the L_c area of round threads are the critical sealing elements.

5.2.3 Minor (cosmetic) field repair of threads and other repairs stated in 5.2 shall only be performed by agreement between the owner and the agency.

5.2.4 Arc burns are rejectable anywhere in the threaded areas.

5.2.5 Refer to Tables 1 and 2 to determine the length of specific thread areas (e.g., L_c and PTL).

5.2.6 Reject Criteria in the Non-L_c Area

5.2.6.1 Pits, seams, laps, cuts, and other imperfections are rejectable if they penetrate through the root of the thread, or if they exceed $12^1/_2$% of the specified wall thickness body as measured from the projected pipe surface, whichever is greater.

5.2.6.2 Detectable protrusions on the threads are rejectable if they can peel off the protective coatings on the coupling threads or score mating surfaces.

5.2.7 Reject Criteria in the L_c Area

5.2.7.1 Threads shall be free of any visible imperfections, as listed in 5.1.7.1, that break the continuity of the threads.

5.2.7.2 Detectable protrusions on the threads are rejectable if they can peel off the protective coatings on the coupling threads or score mating surfaces.

5.2.7.3 On round threads, all threads within the L_c area shall have full crests or they are rejectable.

5.2.7.4 In buttress casing, a single thread showing the original outside surface of the pipe for more than 25% of the circumference is cause for rejection. If there are more than two threads showing the original outside surface of the pipe this is also cause for rejection.

Table 1—Tubing Pin L_c and Box PTL

	Non-Upset		External Upset		Integral Joint	
Size	Pin L_c	Box PTL	Pin L_c	Box PTL	Pin L_c	Box PTL
1.050	0.300	0.994	0.300	1.025	—	—
1.315	0.300	1.025	0.350	1.150	0.225	1.025
1.660	0.350	1.150	0.475	1.275	0.350	1.150
1.900	0.475	1.275	0.538	1.338	0.475	1.275
2.063	—	—	—	—	0.538	1.338
$2^3/_8$	0.725	1.525	0.938	1.813	—	—
$2^7/_8$	1.163	1.963	1.125	2.000	—	—
$3^1/_2$	1.413	2.213	1.375	2.250	—	—
4	1.375	2.250	1.500	2.375	—	—
$4^1/_2$	1.563	2.438	1.625	2.500	—	—

Table 2—Casing Pin L_c and Coupling PTL

		STC		LTC		Buttress	
Size	Normal Weight	Pin L_c	Box PTL	Pin L_c	Box PTL	Pin L_c	Box PTL
$4^1/_2$	9.50	0.875	2.500	—	—	—	—
$4^1/_2$	Others	1.500	2.500	1.875	2.875	1.2535	3.7375
5	11.50	1.375	2.625	—	—	—	—
5	Others	1.625	2.625	2.250	3.250	1.3785	3.8625
$5^1/_2$	All	1.750	2.750	2.375	3.375	1.4410	3.9250
$6^5/_8$	All	2.000	3.000	2.750	3.750	1.6285	4.1125
7	17.00	1.250	3.000	—	—	—	—
7	Others	2.000	3.000	2.875	3.875	1.8160	4.3000
$7^5/_8$	All	2.125	3.125	3.000	4.000	2.0035	4.4875
$8^5/_8$	24.00	1.875	3.250	—	—	—	—
$8^5/_8$	Others	2.250	3.250	3.375	4.375	2.1285	4.6125
$9^5/_8$	All	2.250	3.250	3.625	4.625	2.1285	4.6125
$10^3/_4$	32.75	1.625	3.375	—	—	—	—
$10^3/_4$	Others	2.375	3.375	—	—	2.1285	4.6125
$11^3/_4$	All	2.375	3.375	—	—	2.1285	4.6125
$13^3/_8$	All	2.375	3.375	—	—	2.1285	4.6125
16	All	2.875	3.875	—	—	2.7245	4.6125
$18^5/_8$	87.50	2.875	3.875	—	—	2.7245	4.6125
20	All	2.875	3.875	4.125	5.125	2.7245	4.6125

Note: Dimensions are not subject to measurement to determine acceptance or rejection of the product.

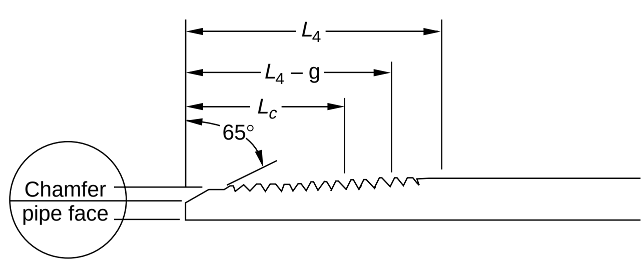


Figure 8—External Thread Inspection Parameters

5.2.7.5 Minor pitting and thread discoloration may also be encountered and may not necessarily be detrimental. Because of the difficulty in defining pitting and discoloration and the degree to which they affect thread performance, no blanket waiver of such imperfections can be established. As a guide to acceptance, most critical considerations are that any corrosion products protruding above the surface of the threads be removed and that no leak path exists. Filing or grinding to remove pits is not permitted.

5.2.7.6 *In Field Inspection*. Heat tinting on threads from thermal cutting to remove couplings or protectors may indicate localized hardening of the threads. This may be cause for rejection by agreement between the agency and the owner.

5.2.8 Reject Criteria in Chamfer Area

5.2.8.1 OD chamfer not present for a full 360° circumference is cause for rejection.

5.2.8.2 A thread root which runs out on the face of the pipe (and not on the chamfer), or produces a featheredge is cause for rejection. See Figure 9.

5.2.8.3 Excessive OD chamfer which produces a knife edge (razor edge) on the face of the pipe is cause for rejection. See Figure 10.

5.2.8.4 A burr on the starting thread within the chamfer is not cause for rejection unless the burr is loose or protrudes into the mating thread form. The burr shall be removed if any of these possibilities exist.

5.2.8.5 A false starting thread is not cause for rejection, if it does not extend into the true starting thread. An interrupted started thread is not cause for rejection but may indicate chamfer or thread misalignment. Those conditions should be evaluated.

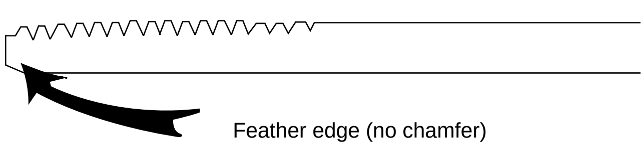


Figure 9—Featheredge (No Chamfer)

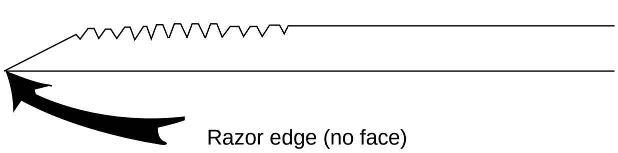


Figure 10—Razor Edge (No face)

5.2.8.6 Dents or mashes that cause out-of-tolerance thread dimensions are cause for rejection.

Note: Tapping machines may not produce uniform threads in the "*J*" area since they tap from each side using multi-toothed chasers. During the tapping of the second side, the lead side of the chaser taps the threads in the "*J*" area of the first side that has been tapped.

5.2.9 Reject Criteria for Pipe Ends

5.2.9.1 Pipe ends with burrs or fins that cannot be removed by grinding or filing shall be rejected.

5.2.9.2 Dents or mashes that cause out-of-tolerance thread dimensions are cause for rejection.

5.2.10 Reject Criteria for Round or Bullet Nose Tubing

5.2.10.1 Ends with sharp corners or abrupt radius changes are cause for rejection.

5.2.10.2 For other rejection criteria refer to 5.2.12.

5.2.11 Reject Criteria for Miscellaneous Items

5.2.11.1 Other visually evident imperfections that are not specifically covered in the preceding sections, whether in the L_c area or not, that may be detrimental to the makeup, strength, sealing capacity of the thread, or could result in galling, should be reported to the owner.

5.2.12 Reject Criteria for the PTL Area of Box or Coupling Threads

The threads in the PTL have the same reject criteria as the L_c area (see 5.2.7). The PTL area is defined in 5.1.5.

5.2.13 Reject Criteria for Threads Beyond the PTL Area of Box or Coupling Threads

Threads not extended to the center of the coupling or to a distance of L_4 plus 0.500 in. from the box face of integral joint shall be cause for rejection. Threads in this area need not be full-crested.

5.2.14 Reject Criteria for Coupling or Box Face and Counterbore

5.2.14.1 Faces with burrs or fins that cannot be removed by grinding or filing shall be rejected.

5.2.14.2 Dents or mashes that cause counterbore diameter reduction or out-of-tolerance thread dimensions are cause for rejection.

5.2.14.3 Tool marks on the counterbore are not cause for rejection but may indicate incorrect counterbore diameter, counterbore misalignment or thread misalignment. Those conditions should be evaluated.

5.2.14.4 On buttress thread, roots which start on the face of the coupling or produce a featheredge shall be a cause for rejection.

5.2.15 Reject Criteria for Seal-Ring Grooves

Fins, wickers, and ribbons that are loose or can become loose and fold into the thread form are cause for rejection unless removed.

5.3 PROCEDURE FOR COUPLING MAKE-UP POSITION

5.3.1 Buttress Thread

5.3.1.1 Triangle Location

Verify the location of the triangle stamp on the field end of each length of buttress thread casing. Using a metal scale, measure from the end of the pin to the base of triangle, holding the scale parallel to the longitudinal axis of the pipe. If the triangle cannot be located or is in the wrong position (outside $\pm\ ^1/_{32}$ in. from A_1), it shall be cause for rejection.

5.3.1.2 Coupling Makeup

Determine the distance $N - A_1$, where N is the actual measured coupling length. This is the nominal position of the end of the pin in the coupling. Measure the distance from the end of the coupling to the end of the pin inside the coupling. If the measured distance is different from the nominal distance by more than + 0.200 in. (+ 0.300 for $13^3/_8$ and smaller), or – 0.375 in., *the condition should be reported to the owner.* It shall be cause for rejection.

5.3.2 Round Thread

5.3.2.1 Triangle Location

Verify the location of the triangle stamp on the field end of each length of 16-, $18^{5/}{}_8$- and 20-in. round thread casing. Using a metal scale, measure from the end of the pin to the base of the triangle. Hold the scale parallel to the longitudinal axis of the pipe. If the triangle stamp cannot be located or if the triangle is in the wrong position ($\pm\ ^1/_{32}$ in.) it shall be reported to the owner. The base of the triangle will aid in locating the vanishing point for basic power-tight makeup; however, the position of the coupling with respect to the base of the triangle shall not be a basis for acceptance or rejection of the product.

5.3.2.2 Coupling Makeup (Not API, but Provided as a Guide)

For all sizes, determine the distance $N - L_4$, where N is the actual measured coupling length. This is the nominal position of the end of the pin in the coupling. Measure the distance from the end of the coupling to the end of the pin inside the coupling. If the measured distance is different from the nominal distance by more than ± 0.250 in., the condition should be reported to the owner.

6 Care of Inspection Gauges

6.1 GENERAL

Gauges used for the inspection of tubular goods are delicate and subject to damage, if mishandled. Extreme care and cleanliness must be observed in the storing, handling, verifying, and using of thread element gauges.

Two types of gauges are used for thread inspection: dial indicator gauges and fixed gauges. As the name implies, dial indicator gauges are provided with a dial indicator (Figure 11), which when placed on the thread must read within a certain range if the element is within specification. The fixed gauge (Figure 12) is a rigid gauge which is screwed onto the thread. The thread is properly machined if the other thread elements are within specification and the fixed gauge standoff is within specifications.

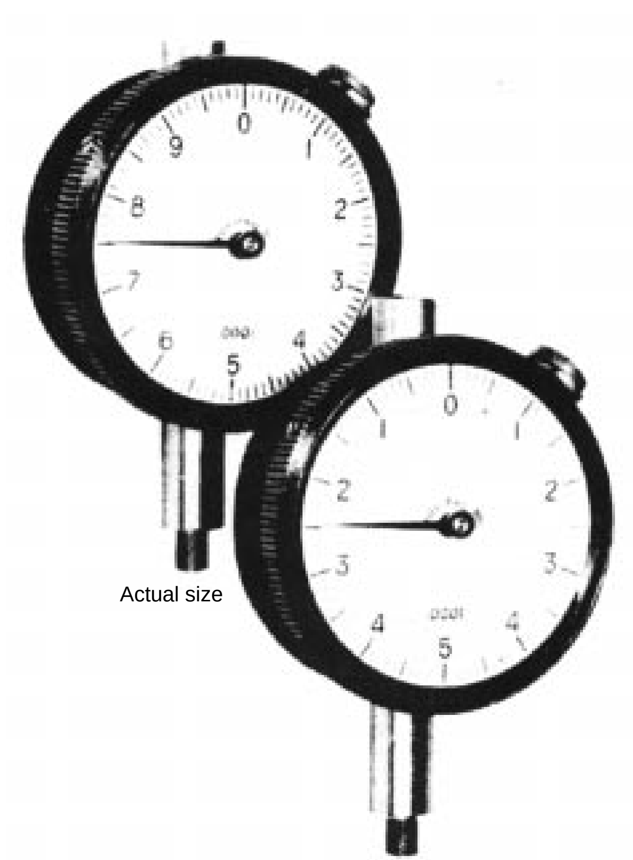


Figure 11—Dial-Indicator Type Gauges

Figure 12—Fixed-Type Gauge

6.2 STORAGE

All gauges should be stored in a fitted box equipped with a dry desiccant bag (Figure 13). The gauge surfaces should be lightly oiled with engine oil prior to storage. In some mills gauges are retained in glass cases located in air conditioned rooms. Storage of gauges used in field inspection require boxing. Do not remove the gauge from the box until immediately before verifying (dial gauge) and/or using (fixed gauges).

6.3 HANDLING

Gauges shall be handled in as clean an environment as practicable. Prior to and after use, the gauge should be wiped clean with a soft clean cloth. Foreign matter entering the working mechanism or abrading the gauge surfaces will quickly deteriorate the gauge. All surfaces being inspected shall be clean prior to fitting the gauge to that surface.

6.4 USE

The thread shall be clean when the gauge is being applied. The temperature of the gauge shall be as close as practical to the temperature of the product being inspected for accurate gauging. Place the gauge gently on the product to be inspected. Don't let the gauge remain on the product while the gauge is unattended. Return the gauge temporarily to the case and cover with a cloth if work must be performed between inspection operations.

7 Calibration and Verification of Dial Indicators and Fixed Gauges

7.1 CALIBRATION

Calibration is the process of determining if a dial indicator, ring gauge, or plug gauge operates accurately. This process includes determining the accuracy of dial indicators over the entire range of plunger travel. In case of ring and plug gauges, calibration permits determining whether the standoff between the working gauge and the master gauge has not changed or if a change has occurred, the amount of change is known.

Calibration normally is not performed in the field or at the inspection table since the measuring equipment is precise and subject to deterioration outside of a laboratory environment. Accordingly, details can be found in API Spec 5B.

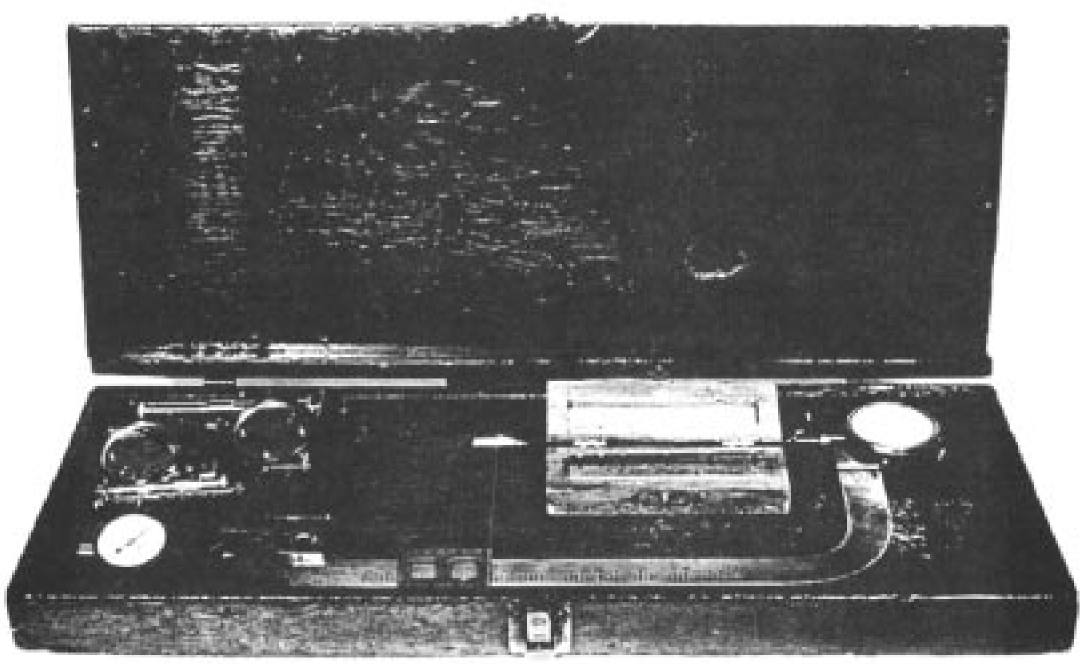


Figure 13—Gauge Storage Box

Figure 14—Thread Depth Gauge Setting Standard

7.2 VERIFICATION

Verification is the process of determining if the dial indicator is accurate at the intended dial reading. Verification of the gauge should be determined at the beginning of each inspection, the first time an out-of-specification thread is found or after 25 pieces have been inspected, whichever occurs first. However, if the gauge has been dropped or hit, the gauge should be immediately reverified.

8 Thread Inspection

8.1 INTRODUCTION

Inspection of threaded connections provides a means of quality assurance at the manufacturer's facility and field locations. Each type of thread is inspected by similar procedures, but the dimensions vary. This section discusses the use of each gauge for measuring the accuracy of the thread elements.

Correct thread element limits and/or tolerances are published in the latest edition of API Spec 5B. All dimensions necessary for proper gauging of API threads are contained in this publication.

API threads are gauged from the end of the pipe or the face of the coupling except for internal taper which can be measured from J + 1p position out toward the face. The vanish point is the last visible evidence of the continuous machined thread root as it stops on round or line pipe threads or runs out on buttress thread. For round or line pipe threads the length from the end of the pipe to the vanish point is known as the L_4 dimension (Figure 15).

Inspection of the threaded connection consists of verifying the dimensions of the following thread elements:

a. Round, buttress, and line pipe threads.
   1. Thread length (except buttress threads).
   2. Thread height.
   3. Thread lead.
   4. Thread taper.
   5. Standoff.
   6. Thread runout (buttress only).
   7. Make-up triangle location, as appropriate.
   8. L_c Length.

b. Extreme-line threads.
   1. Thread height.
   2. Thread width.
   3. Thread lead.
   4. Thread taper.
   5. Thread and seal size.
   6. Length measurements.

8.2 INSPECTION PROCEDURE

Pipe shall be prepared for inspection by removing the thread protector and cleaning the threads of lubricant, dirt, scale, and other foreign material with a brush and/or solvent.

It is recommended that a longitudinal line be drawn on the pin end threads using a felt tipped pen, crayon or a soft pencil. This line should pass through the last tool mark to facilitate thread length measurements (Figure 16). Mark inspection intervals of 1-in. length along the longitudinal line starting with the first perfect thread (pin end). The last inspection interval shall coincide with the last perfect thread, or an overlapping interval shall be provided. An overlapping interval is provided by starting at the last perfect thread and marking toward end of the pin until the new interval overlaps the previously marked interval (Figure 16). For the gauging of external or internal threads, measurements shall be made at the first

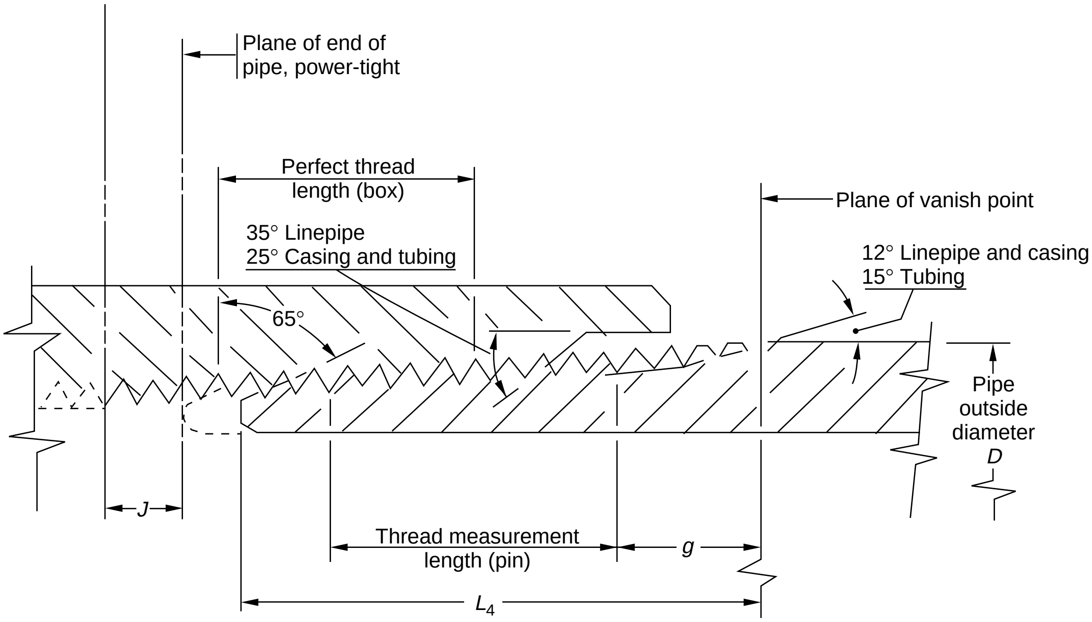


Figure 15—Basic Dimensions of Line Pipe Threads and Casing and Tubing Round Threads (Hand-Tight Makeup)

and last perfect threads where full-crested threads exist, and continued from either 1-in. intervals for products having a distance between the first and last perfect threads of more than 1 in.; $^1/_2$-in. intervals for products having a distance between the first and last perfect threads of 1 in. to $^1/_2$ in.; and intervals consisting of 4 threads for products having $11^1/_2$ threads per inch.

A similar longitudinal line should be drawn on the threads of the box or coupling to be inspected. Mark inspection intervals of 1-in. length along the longitudinal line starting with the first perfect thread at the open end of the box or coupling. Marks should be placed at (a) five threads from the center of the casing and tubing coupling (8-round thread); (b) six threads for 10-round thread tubing; (c) the last perfect thread from the coupling center (Vee thread); or (d) the perfect thread length on a buttress coupling.

8.3 ROUND THREAD INSPECTION

8.3.1 Total Thread Length

Total thread length, the L_4 dimension (Tables 3 through 6) is measured parallel to the thread axis from the end of the pipe to the vanish point of the thread tool-mark (Figure 17). The measurement is made using a metal scale or caliper.

L_4 is acceptable if the distance from the end of the pipe to the vanish plane (at the point where the outside diameter of the pipe is a maximum) is within the minus tolerances as expressed in Tables 3 through 6; or if the distance from the end of the pipe to the vanish plane (where the outside diameter of the pipe is a minimum) is within the plus tolerances of Tables 3 through 6 (Figure 17).

The coupling length, N_L, is a minimum length (Tables 3 through 6). This measurement is performed by placing the steel rule or caliper longitudinally along the outside surface of the coupling.

The inside of the coupling should have a recess at each end.

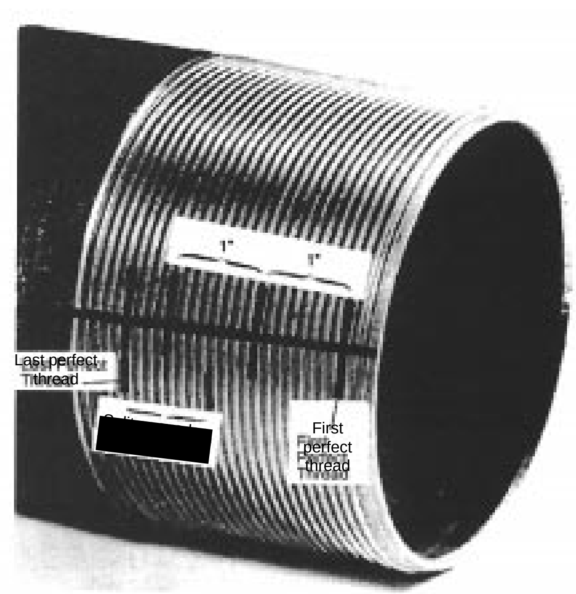


Figure 16—Pin End Thread on Which is Drawn a Longitudinal Line to Facilitate Inspection—Coupling Longitudinal Line is Drawn in Similar Manner

8.3.2 Thread Height

Thread height (depth) is the measurement of the distance from the thread root to the thread crest normal to the thread axis (Figure 4).

8.3.2.1 Gauges

Two types of thread height gauges are used for round threads: external/internal gauges (Figure 18) and internal gauges (Figure 19). Two types of dial indicators are provided on these gauges: balanced-dial type (Figure 18) and continuous-reading type (Figure 19). All round thread gauges are equipped with contact points having an included angle of 50° (Table 7). Accordingly, care must be taken to apply the correct contact points to the gauge. The recommended contact point radius for casing and tubing is 0.006 inch. (Table 7). The accuracy of each type of gauge shall be verified by use of setting standards appropriate for the product to be inspected (Figure 20).

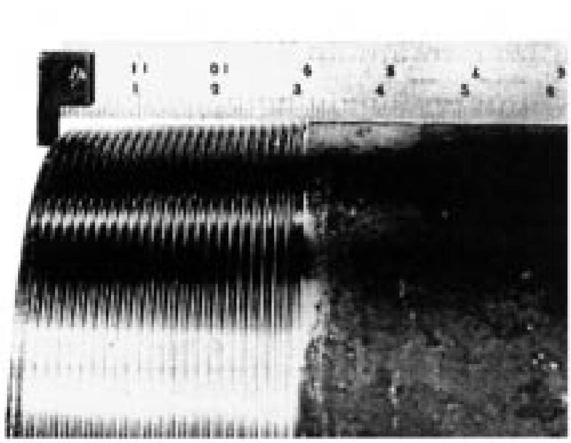


Figure 17—Picture of Scale Correctly Held for Total Thread Length Determination

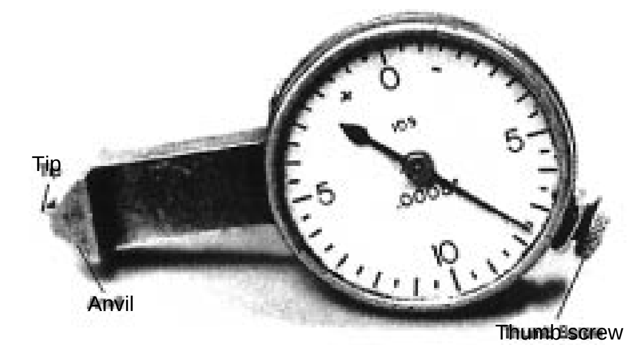


Figure 18—Balanced-Dial Type Gauge for Measuring Thread Height of Internal Threads and All External Threads

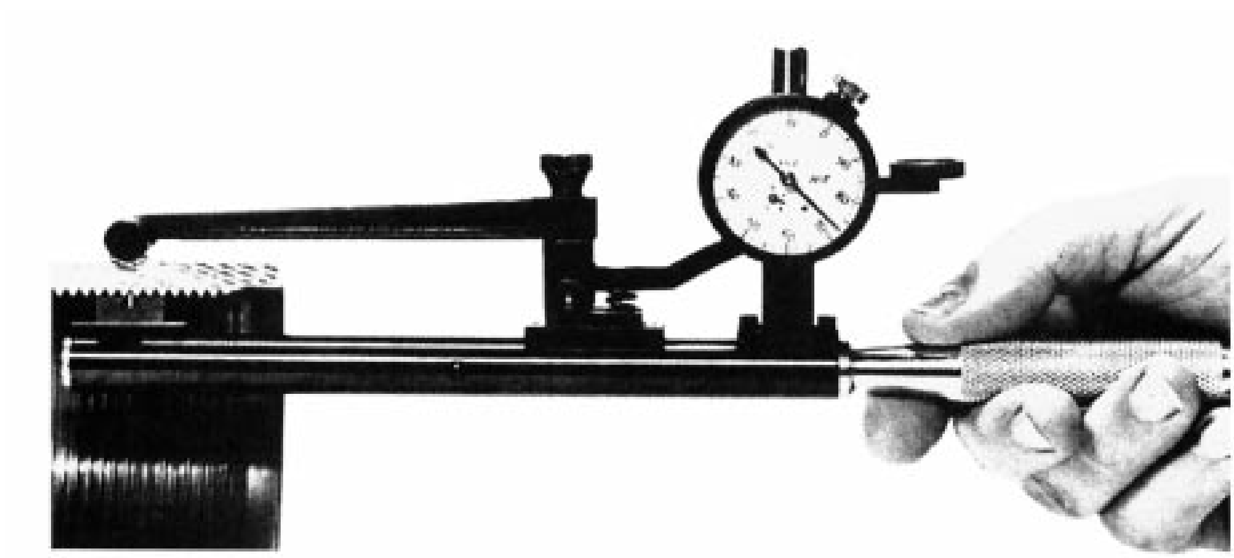


Figure 19—Thread Height Gauge for Internal Threads 3-in. OD and Smaller (Continuous-Dial Type)

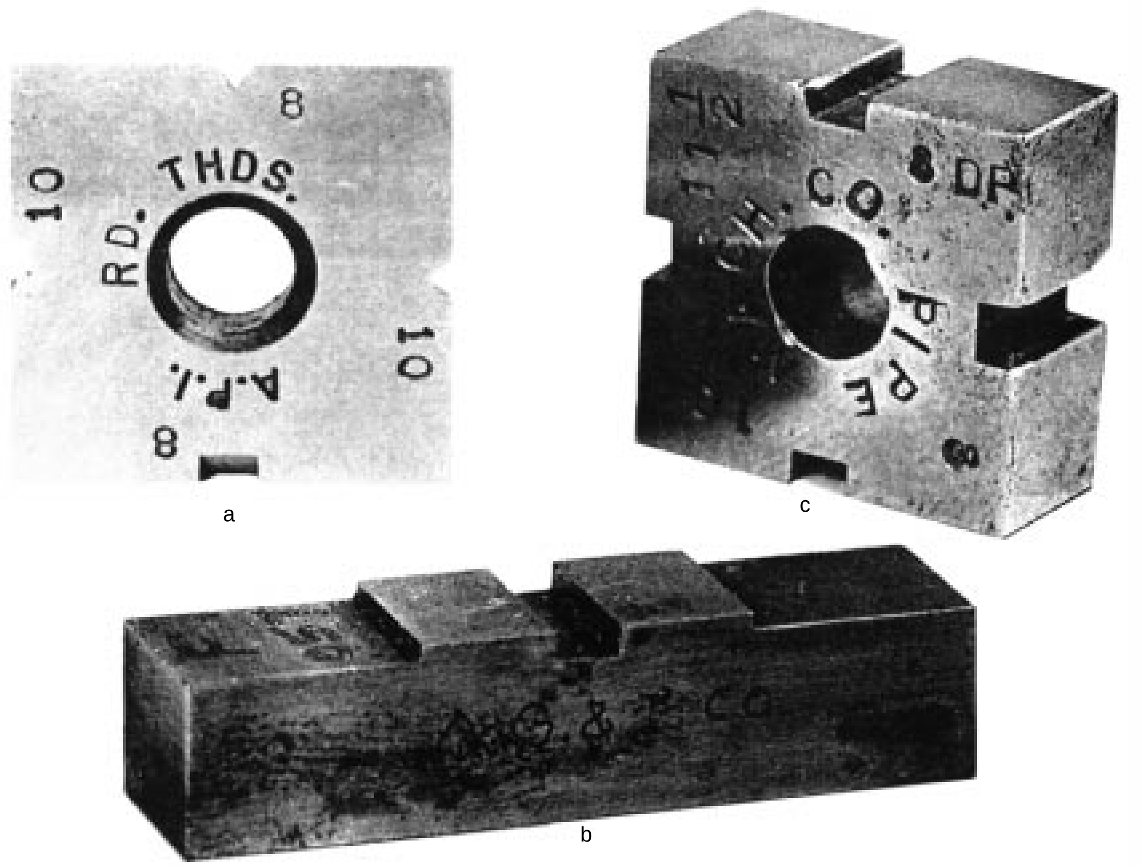


Figure 20—Setting Standards for (a) API Round and Vee-Type Threads, (b) Extreme-Line and 16-in. and Larger Buttress Threads, and (c) Vee-Block Setting Standard for Contact and Point Verification

Figure 21—Height Gauge Applied to Setting Standard (Balanced-Type)

8.3.2.1.1 Balanced-Dial Type

Balanced-dial type gauges establish the difference (error) between the setting standard notch depth and the thread height being inspected. The balanced-dial type gauge can be recognized by the equal "plus" and "minus" divisions on each side of zero on the dial indicator (Figure 18). The accuracy of the gauge is verified by placing the gauge on the setting standard (Figure 20) with the contact point within the U-notch and contacting the bottom of the notch (Figure 21). The dial indicator should register zero. If not, the thumb screw should be loosened and the dial revolved until the indicator reads zero. The gauge should be rechecked on the setting standard after the dial thumb screw is tightened. Additionally, the round thread contact point wear should be verified by applying the gauge to the Vee block (Figures 20 and 22). The dial indicator shall read within ± 0.0005 in. of zero, or the contact point shall be replaced and the gauge reverified.

8.3.2.1.2 Continuous-Reading Dial Type

A continuous-reading dial-type gauge measures the distance from the thread crest to the thread root. This gauge is recognized by the continuous-reading dial indicator (Figure 19).

The accuracy of the gauge shall be verified by placing the gauge on the setting standard with the contact point within the U-notch and contacting the bottom of the notch (Figure 23). The dial indicator should register the value appropriate to the thread configuration being inspected (Table 8).

The thumb screw (Figure 21) should be loosened and the dial revolved until the indicator registers the value appropriate to the thread configuration being inspected (Table 8).

The gauge should be rechecked on the setting standard after the dial thumb screw is tightened. Additionally, round thread contact point wear should be verified by applying the gauge to the Vee block (Figures 20c and 22). The dial indicator shall read within ± 0.0005 in. of the appropriate thread depth, i.e., 0.071 in. for 8-round and 0.056 in. for 10-round (Table 8).

Table 3—Casing Short Thread Dimensions

1	2	3	4	5	6	7
OD Size (in.)	Nominal Weight (lbs/ft)	Total Thread Length L_4 (in.)	Thread Length Tolerance (in.)	Minimum Length Full-Crest Thread L_c (in.)	Minimum Coupling Length N_L (in.)	J Dimension (in.)
$4^1/_2$	9.50	2.000(2)	± 0.125	0.875 ($^{28}/_{32}$)	$6^1/_4$	1.125
$4^1/_2$	Others	2.625($2^{20}/_{32}$)	± 0.125	1.500 ($1^{16}/_{32}$)	$6^1/_4$	0.500
5	11.50	2.500 ($2^{16}/_{32}$)	± 0.125	1.375 ($1^{12}/_{32}$)	$6^1/_2$	0.750
5	Others	2.750 ($2^{24}/_{32}$)	± 0.125	1.625 ($1^{20}/_{32}$)	$6^1/_2$	0.500
$5^1/_2$	All	2.875 ($2^{28}/_{32}$)	± 0.125	1.750 ($1^{24}/_{32}$)	$6^3/_4$	0.500
$6^5/_8$	All	3.125 ($3^4/_{32}$)	± 0.125	2.000 (2)	$7^1/_4$	0.500
7	17.00	2.375 ($2^{12}/_{32}$)	± 0.125	1.250 ($1^8/_{32}$)	$7^1/_4$	1.250
7	Others	3.125 ($3^4/_{32}$)	± 0.125	2.000 (2)	$7^1/_4$	0.500
$7^5/_8$	All	3.250 ($3^8/_{32}$)	± 0.125	2.125 ($2^4/_{32}$)	$7^1/_2$	0.500
$8^5/_8$	24.00	3.000 (3)	± 0.125	1.875 ($1^{28}/_{32}$)	$7^3/_4$	0.875
$8^5/_8$	Others	3.375 ($3^{12}/_{32}$)	± 0.125	2.250 ($2^8/_{32}$)	$7^3/_4$	0.500
$9^5/_8$	All	3.375 ($3^{12}/_{32}$)	± 0.125	2.250 ($2^8/_{32}$)	$7^3/_4$	0.500
$10^3/_4$	32.75	2.750 ($2^{24}/_{32}$)	± 0.125	1.625 ($1^{20}/_{32}$)	8	1.250
$10^3/_4$	Others	3.500 ($3^{16}/_{32}$)	± 0.125	2.375 ($2^{12}/_{32}$)	8	0.500
$11^3/_4$	All	3.500 ($3^{16}/_{32}$)	± 0.125	2.375 ($2^{12}/_{32}$)	8	0.500
$13^3/_8$	All	3.500 ($3^{16}/_{32}$)	± 0.125	2.375 ($2^{12}/_{32}$)	8	0.500
16	All	4.000 (4)	± 0.125	2.875 ($2^{28}/_{32}$)	9	0.500
$18^5/_8$	87.50	4.000 (4)	± 0.125	2.875 ($2^{28}/_{32}$)	9	0.500
20	All	4.000 (4)	± 0.125	2.875 ($2^{28}/_{32}$)	9	0.500

Note: Figures within brackets represent the approximate equivalent length in inches and 32nds of an inch.

Table 4—Casing Long Thread Dimensions

1	2	3	4	5	6
OD Size (in.)	Total Thread Length L_4 (in.)	Thread Length Tolerance (in.)	Minimum Length Full-Crest Thread L_c (in.)	Minimum Coupling Length N_L (in.)	J Dimension (in.)
$4^1/_2$	3.000 (3)	± 0.125 ($^4/_{32}$)	1.875 ($1^{28}/_{32}$)	7	0.500
5	3.375 ($3^{12}/_{32}$)	± 0.125 ($^4/_{32}$)	2.250 ($2^8/_{32}$)	$7^3/_4$	0.500
$5^1/_2$	3.500 ($3^{16}/_{32}$)	± 0.125 ($^4/_{32}$)	2.375 ($2^{12}/_{32}$)	8	0.500
$6^5/_8$	3.875 ($3^{28}/_{32}$)	± 0.125 ($^4/_{32}$)	2.750 ($2^{24}/_{32}$)	$8^3/_4$	0.500
7	4.000 (4)	± 0.125 ($^4/_{32}$)	2.875 ($2^{28}/_{32}$)	9	0.500
$7^5/_8$	4.125 ($4^4/_{32}$)	± 0.125 ($^4/_{32}$)	3.000 (3)	$9^1/_4$	0.500
$8^5/_8$	4.500 ($4^{16}/_{32}$)	± 0.125 ($^4/_{32}$)	3.375 ($3^{12}/_{32}$)	10	0.500
$9^5/_8$	4.750 ($4^{24}/_{32}$)	± 0.125 ($^4/_{32}$)	3.625 ($3^{20}/_{32}$)	$10^1/_2$	0.500
20	5.250 ($5^8/_{32}$)	± 0.125 ($^4/_{32}$)	4.125 ($4^4/_{32}$)	$11^1/_2$	0.500

Note: Figures within brackets represent the approximate equivalent length in inches and 32nds of an inch.

Table 5—Non-Upset Thread Dimensions

1	2	3	4	5	6	7
OD Size (in.)	Total Thread Length L_4 (in.)	Thread Length Tolerance (in.)	Minimum Length Full-Crest Thread L_c (in.)	Minimum Coupling Length N_L (in.)	J Dimension (in.)	L_4–g
1.050	1.094 (1$^3/_{32}$)	± 0.150 ($^5/_{32}$)	0.300 ($^{10}/_{32}$)	3$^3/_{16}$	0.500	0.594
1.315	1.125 (1$^4/_{32}$)	± 0.150 ($^5/_{32}$)	0.300 ($^{10}/_{32}$)	3$^1/_4$	0.500	0.625
1.660	1.250 (1$^8/_{32}$)	± 0.150 ($^5/_{32}$)	0.350 ($^{11}/_{32}$)	3$^1/_2$	0.500	0.750
1.900	1.375 (1$^{12}/_{32}$)	± 0.150 ($^5/_{32}$)	0.475 ($^{15}/_{32}$)	3$^3/_4$	0.500	0.875
2$^3/_8$	1.625 (1$^{20}/_{32}$)	± 0.150 ($^5/_{32}$)	0.725 ($^{23}/_{32}$)	4$^1/_4$	0.500	1.125
2$^7/_8$	2.063 (2$^2/_{32}$)	± 0.150 ($^5/_{32}$)	1.163 (1$^5/_{32}$)	5$^1/_8$	0.500	1.563
3$^1/_2$	2.313 (2$^{10}/_{32}$)	± 0.150 ($^5/_{32}$)	1.413 (1$^{13}/_{32}$)	5$^5/_8$	0.500	1.813
4	2.375 (2$^{12}/_{32}$)	± 0.125 ($^4/_{32}$)	1.375 (1$^{12}/_{32}$)	5$^3/_4$	0.500	1.875
4$^1/_2$	2.563 (2$^{18}/_{32}$)	± 0.125 ($^4/_{32}$)	1.563 (1$^{18}/_{32}$)	6$^1/_8$	0.500	2.063

Note: Figures within brackets represent the approximate equivalent length in inches and 32nds of an inch.

Table 6—External Upset Tubing Thread Dimensions

1	2	3	4	5	6	7
OD Size (in.)	Total Thread Length L_4 (in.)	Thread Length Tolerance (in.)	Minimum Length Full-Crest Thread L_c (in.)	Minimum Coupling Length N_L (in.)	J Dimension (in.)	L_4–g
1.050	1.125 (1$^4/_{32}$)	+ 0.150 ($^5/_{32}$) – 0.075 ($^2/_{32}$)	0.300 ($^{10}/_{32}$)	3$^1/_4$	0.500	0.625
1.315	1.250 (1$^8/_{32}$)	+ 0.150 ($^5/_{32}$) – 0.075 ($^2/_{32}$)	0.350 ($^{11}/_{32}$)	3$^1/_2$	0.500	0.750
1.660	1.375 (1$^{12}/_{32}$)	+ 0.150 ($^5/_{32}$) – 0.075 ($^2/_{32}$)	0.475 ($^{15}/_{32}$)	3$^3/_4$	0.500	0.875
1.900	1.438 (1$^{14}/_{32}$)	+ 0.150 ($^5/_{32}$) – 0.075 ($^2/_{32}$)	0.538 ($^{17}/_{32}$)	3$^7/_8$	0.500	0.938
2$^3/_8$	1.938 (1$^{30}/_{32}$)	± 0.125 ($^4/_{32}$)	0.938 ($^{30}/_{32}$)	4$^7/_8$	0.500	1.438
2$^7/_8$	2.125 (2$^4/_{32}$)	± 0.125 ($^4/_{32}$)	1.125 (1$^4/_{32}$)	5$^1/_4$	0.500	1.625
3$^1/_2$	2.375 (2$^{12}/_{32}$)	± 0.125 ($^4/_{32}$)	1.375 (1$^{12}/_{32}$)	5$^3/_4$	0.500	1.875
4	2.500 (2$^{16}/_{32}$)	± 0.125 ($^4/_{32}$)	1.500 (1$^{16}/_{32}$)	6	0.500	2.000
4$^1/_2$	2.625 (2$^{20}/_{32}$)	± 0.125 ($^4/_{32}$)	1.625 (1$^{20}/_{32}$)	6$^1/_4$	0.500	2.125

Note: Figures within brackets represent the approximate equivalent length in inches and 32nds of an inch.

Table 7—Thread Height Gauge Recommended Contact Point Dimensions

1	2	3	4
	Contact Point Dimensions (in.)		
Thread Form	Length	Large Radius	Small Radius
Casing and Tubing (round thread)	—	—	0.006
Line Pipe	—	—	0.002
Extreme-Line (5" through 7$^5/_8$")	0.125	0.062	0.050
Extreme-Line (8$^5/_8$" through 10$^3/_4$")	0.125	0.079	0.050

Table 8—Thread Depth for Various Thread Forms

1	2
Thread Form	Nominal Reading (in.)
Casing and Tubing (8-round)	0.071
Tubing (10-round)	0.056
Line Pipe (27 V)	0.028
Line Pipe (18 V)	0.042
Line Pipe (14 V)	0.054
Line Pipe ($11^1/_2$ V)	0.066
Line Pipe (8 V)	0.095
Buttress	0.062
Extreme-Line	
(5" through $7^5/_8$") Box	0.061
(5" through $7^5/_8$") Pin	0.054
($8^5/_8$" through $10^3/_4$") Box	0.081
($8^5/_8$" through $10^3/_4$") Pin	0.074

8.3.2.2 Applying the Gauge to the Product

The accuracy of the determination of thread height depends on the anvil resting on top of full-crested threads. The first few threads are slightly truncated (Figure 15) by the pipe end bevel. The amount of truncation depends on the pipe and the bevel diameters and the degree of bevel. Care must be taken to make thread height measurements at a point no closer to the pipe end than a location that has full-crested threads on both sides of the thread root for the anvil to rest upon.

The last perfect thread location on external threads shall be L_4–g for tubing and last scratch (Last Thread Groove), – 0.500 in. for casing round threads. For casing, the distance from the end of the pipe to the Last Perfect Thread is called the Thread Element Control Length, or TECL. The last perfect thread location on internal threads is J + 1p, measured from the physical center of the coupling or from the small end of the box for integral joint tubing.

Place the tip of the thread height gauge (Figure 24) in the thread groove and anvil of the gauge resting on top of full-crested threads. The anvil shall be held in firm contact with the thread crests. The gauge shall be aligned with the axis of threads by rocking the gauge about the longitudinal axis of the anvil (Figure 24). The thread height is indicated correctly when the dial indicator stops moving near the center of the rocking motion, the null point.

The dial indicator reads the actual thread height (Table 8) at the null point if a continuous-dial type gauge is used (Figure 24), or the dial indicator reads the error in the thread height at the null point if a balanced-dial type gauge is used (Figure 25). The maximum permissible thread height error is + 0.002 inch to – 0.004 inch.

Verification of thread height should be performed at the first and last full-crested threads within the perfect threads and at intervals as specified in Section 8.2 (Figure 16). For inspection purposes, the coupling full-crested threads extend from the first perfect thread to the J + 1p thread length (fifth threads and sixth threads from coupling center for 8-round and 10-round, respectively, or small end of the box for integral joint tubing) (Figure 15). Press the anvil of the thread height gauge firmly to the full-crested threads. Caution should be exercised when attempting to obtain accurate height measurements of the first and last perfect threads since the anvil may rest on non-full-crested threads.

8.3.3 Lead

Lead is the distance from a point on a thread to the corresponding point on the next thread turn measured parallel to the thread axis. The distance is small. Thus, the required accuracy would be excessive if lead was determined from thread to thread. Accordingly, lead is usually measured at 1-in. intervals. Cumulative lead is measured over the L_4–g crested threads from the end of the pipe. Only perfect (full-crested) threads shall be included in the cumulative lead measurement. The thread should be provided with a longitudinal line divided into 1-in. ($^1/_2$-in.) intervals as discussed in Inspection Procedure (8.2 and Figure 16). For the gauging of external or internal threads, lead measurements shall be made starting at the first or last perfect thread and continued from either 1-in. intervals for products having a distance between the first and last perfect threads of more than 1 in.; $^1/_2$-in. intervals for products having a distance between the first and last perfect threads of $^1/_2$ in. to 1 in.; and intervals consisting of 4 threads for products having $11^1/_2$ threads per inch. The gauging of cumulative lead on external or internal threads shall be measured over an interval (between the first and last perfect threads), which has a length equal to the largest multiple of $^1/_2$ in. for an even number of threads per inch, or 1 in. for an odd number of threads per inch.

8.3.3.1 Gauges

Several types of gauges are available (Figure 26).

The accuracy of a gauge shall be verified by applying the gauge to the lead setting standard (Figure 27).

Prior to adjusting the lead gauge, the contact point diameter shall be checked with a micrometer. The recommended contact point dimensions for 8- and 10-round threads are listed in Table 9. Points having more than ± 0.002-in. tolerance shall be replaced.

Two contact points are provided—a fixed point and a movable point (Figure 26).

8.3.3.2 Adjusting the Gauge

The lead gauge shall register zero when applied to the setting standard (Figure 27). Adjustment is necessary if the gauge does not register zero. The gauge should be removed from the standard and reapplied to the standard to confirm correctness of the adjustment. The setting standard is provided with intervals of $^1/_2$ inch up to a maximum of 4 inches. This permits the inspection of cumulative lead error.

Figure 22—Continuous-Dial Height Gauge Applied to a Vee Block

Figure 23—Continuous-Dial Type Gauge Applied to a Setting Standard

Figure 24—External/Internal Thread Height Gauge Applied to a Thread
(Arcing Lines Show Direction of Rocking Motion)

Figure 25—Balanced-Dial Type Gauge Applied to Thread Showing Small Error in Thread Height

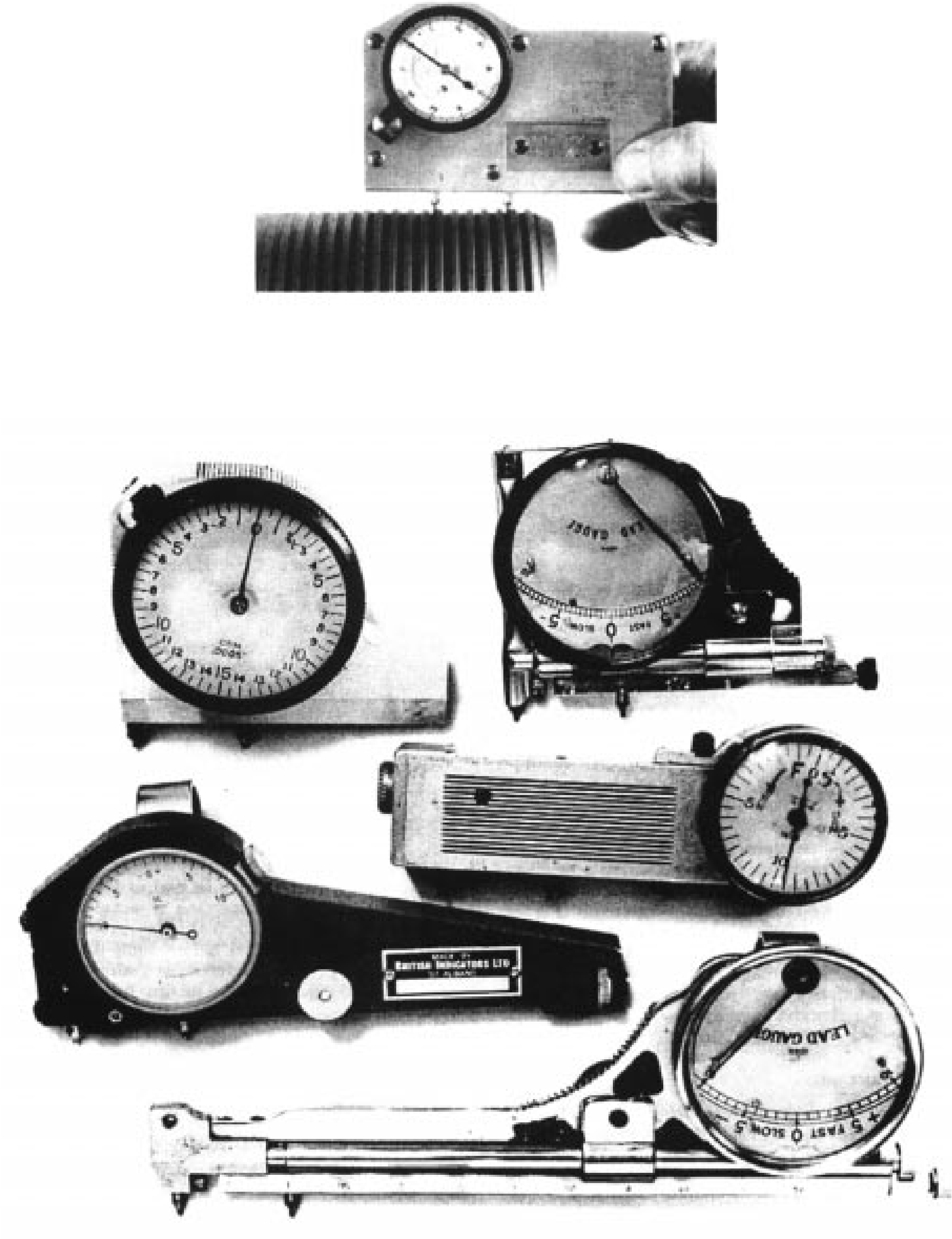


Figure 26—Lead Gauges

Table 9—Recommended Contact Point Dimensions for Lead Gauge

1	2	3
Threads per in.	Thread Form	Contact Point Diameter (in.)
8	Round	0.072
8	Line Pipe	0.072
10	Round	0.057
10	Line Pipe	0.057
$11^1/_2$	Line Pipe	0.050
5	Buttress	0.062
5	Extreme-Line	0.105[a]
6	Extreme-Line	0.087[a]

[a]Truncated 0.023 in.(0.58 mm) from crest of the diameter.

8.3.3.3 Applying the Gauge

8.3.3.3.1 Per-Inch Measurement

The gauge is used in the same fashion for inspecting external and internal threads. The gauge shall be properly adjusted prior to applying the gauge to the product. The length of the threads from the first perfect thread through the last perfect thread shall be inspected.

The first perfect thread location is the thread nearest the chamfer on the pin or face of the coupling with a root having a full crest on both sides.

The last perfect thread location on external threads shall be L_4–g for tubing and line pipe, L_7 for buttress, and last scratch (last thread groove) – 0.500 in. for casing round threads. For casing, the distance from the end of the pipe to the Last Perfect Thread is called the Thread Element Control Length, or TECL. The last perfect thread location on internal thread is J + 1p, measured from the physical center of the coupling or from the small end of the box for integral joint tubing.

The fixed gauge point is placed on the line in the first full thread groove near the small diameter of the thread (Figure 16). With the movable point (Figure 27) in the thread groove (Figure 26), the gauge should be pivoted in a small arc about the fixed point on either side of the longitudinal line. The maximum deviation from zero in either the fast (+) or slow (–) direction represents the error in lead.

For inspection purposes, the coupling full-crested thread length extends from the first perfect thread (third thread root from end of recess) to the J + 1 thread length (fifth thread and sixth thread from coupling center for 8-round and 10-round, respectively) [Tables 3 through 6].

The lead tolerance is ± 0.003 in. per inch (± 0.0015 in. per $^1/_2$ inch).

8.3.3.3.2 Cumulative Lead Measurement

Cumulative lead is the lead measured between the first and last perfect threads over an interval (in excess of 1 inch) which is the largest multiple of $^1/_2$ inch (Tables 3 through 6). The lead gauge is applied to the product as for the 1-in. interval, that is, the fixed point is placed in the first full groove at the end of the thread. The movable point is placed on the longitudinal line in the groove appropriate to the distance between gauge points.

The maximum lead tolerance is ± 0.006 in. regardless of the length over which it is measured.

8.3.3.3.3 Lead Measurements in Couplings With Seal Rings

When a seal-ring groove is present in a coupling, lead measurements shall be taken with all contact points placed where full thread forms are on each side of the contact points. The partial threads adjacent to the groove shall be avoided when measuring any thread element.

8.3.4 Taper

Taper is the change in the pitch diameter of the thread expressed as inches per foot or inches per inch of thread length. The taper caliper (Figure 28) should not be capable of measuring a thread for a pipe more than three times the size being inspected.

8.3.4.1 Taper Calipers With Dial Indicators

The following types of calipers are available for inspecting thread taper:

a. External—thread taper caliper (Figure 28).

b. Internal—thread taper calipers (Figure 29 and 30).

These calipers always are provided with a continuous-dial type indicator. The gauge contact points shall be fitted with contact points of diameter as listed in Table 10. These contact points are ball-type. The point diameter should be checked with a micrometer. The point shall be discarded if there is more than 0.002-in. wear. Two contact points are provided—a fixed point and a movable point (Figure 28).

Table 10—Recommended Contact Point Dimensions for Taper Calipers

1	2	3
Threads per in.	Type Thread	Contact Point Diameter (in.)
8	Round	0.072
8	Line Pipe	0.072
10	Round	0.057
10	Line Pipe	0.057
$11^1/_2$	Line Pipe	0.050
5	Buttress	0.090
5	Extreme-Line	0.060[a]
6	Extreme-Line	0.060[a]

[a]Pin-type.

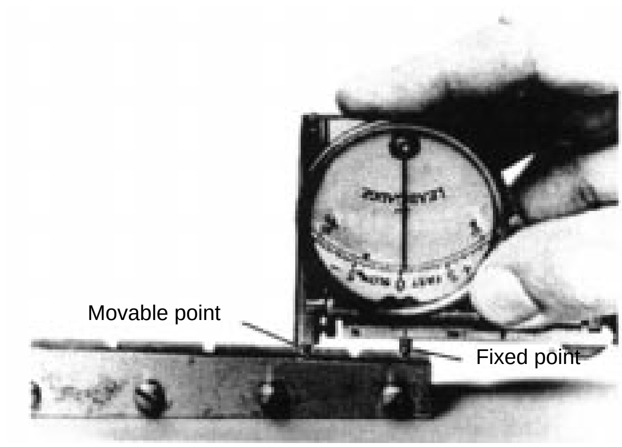


Figure 27—Lead Setting Standard with External/Internal Lead Gauge Applied

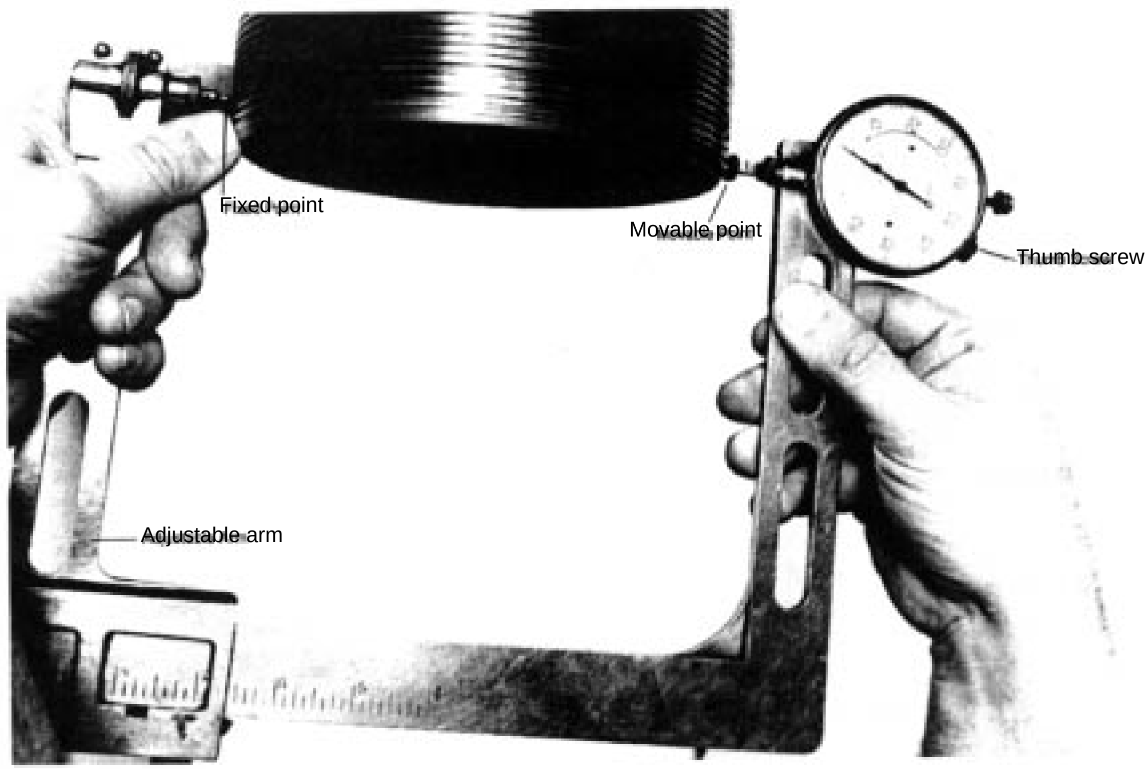


Figure 28—External Thread Taper Caliper

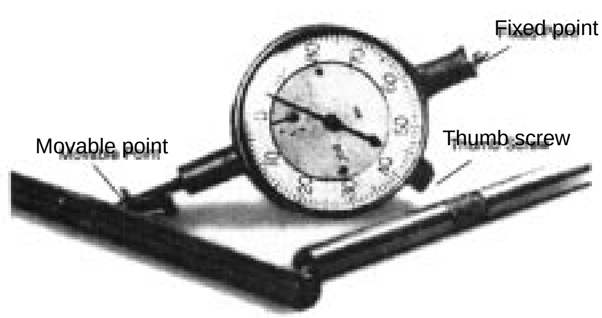


Figure 29—Internal Taper Caliper for $4^1/_2$-in. OD and Larger Showing Gauge Extensions

The external taper caliper (Figure 28) is provided with an arm adjustable to the appropriate pipe OD. Depending on the caliper type, the internal taper caliper is adjusted to fit the coupling by installing extensions on the indicator plunger shaft (Figure 29) or by sliding the arm to the corresponding pipe OD size (Figure 30).

8.3.4.2 External Threads

8.3.4.2.1 Adjusting the Caliper

Taper calipers are adjusted on the pipe to be inspected. The threads should be provided with a longitudinal line divided into 1-in. ($^1/_2$-in.) intervals as discussed in Inspection Procedure (Section 8.2 and Figure 16). The caliper is adjusted (zeroed) by placing the fixed contact point (Figure 28) on the longitudinal line in the groove past the full-crested thread.

The first perfect thread location is the thread nearest the chamfer on the pin or face of the coupling with a root having a full crest on both sides.

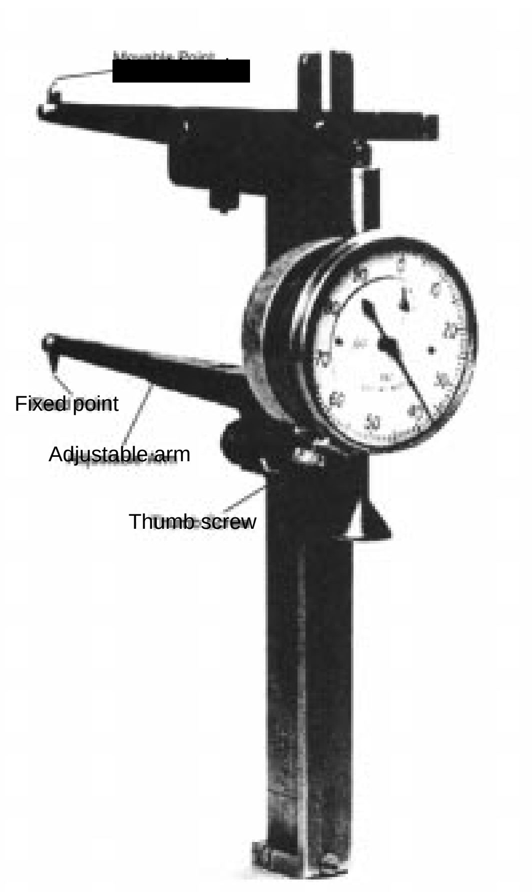


Figure 30—Internal Thread Taper Caliper for Pipe Less Than $4^1/_2$-in. OD

The last perfect thread location on external threads shall be L_4–g for tubing and last scratch (Last Thread Groove) – 0.500 in. for casing round threads. For casing, the distance from the end of the pipe to the Last Perfect Thread is called the Thread Element Control Length, or TECL. The movable contact point (Figure 28) should be placed in the same groove diametrically opposite the fixed contact point. The fixed point should be held firmly within the thread groove while the movable point is oscillated through an arc within the groove. The dial pointer should indicate zero at the maximum reading. The dial pointer indicator should be adjusted if the reading is not zero. This adjustment is made by loosening the thumb screw and rotating the dial until a zero reading is indicated. Tighten thumb screw and recheck the dial for a zero reading.

8.3.4.2.2 Applying the Caliper

The external taper caliper is applied in the same fashion as during adjustment. The caliper is applied at 1-inch intervals from the small toward the large diameter of the thread.

The taper is designated in API Spec 5B as $^3/_4$-in. taper per ft of thread length (Figure 4). However, for inspection purposes this taper, including the appropriate tolerance, is rounded to the equivalent of 0.060 to 0.068 in. per in. The use of a $^1/_2$-in. gauge length results in dividing tolerances by two, or 0.030 to 0.034 in. per inch.

Taper is measured over the perfect thread length for tubing and the TECL length for round thread casing. If the last interval of measurement is less than 1 in., the gauge should be placed in the last (large end of the thread) full thread groove on the longitudinal line and the measurement made toward the end of the pipe. One 1-in. reading will provide overlap if the last interval overlaps the one interval previously inspected. The same tolerances apply.

8.3.4.3 Internal Threads

8.3.4.3.1 Adjusting the Gauge

The gauge is adjusted on the coupling. The coupling threads should be provided with a longitudinal line divided into 1-in. intervals as discussed in Section 8.2 (see also Figure 16). For inspection purposes, the coupling full-crested thread length extends from the first perfect thread (perfect crest on either side of the roots) to the $J + 1$ thread length (fifth thread and sixth thread from coupling center for 8-round and 10-round, respectively) (Figure 15).

Several types of internal calipers are provided (Figures 29 and 30). The *large internal taper caliper* for couplings $4^1/_2$-in. OD and larger is adjusted by installing fixed gauge extensions (Figure 29) of sufficient length to bring the dial indicator approximately to the center of dial travel.

The large internal taper gauge should be inserted into the coupling so the movable contact point (short end) is at the top of the coupling and the fixed contact point (large end) is at the bottom of the coupling (Figure 31). The gauge is adjusted by placing the fixed contact on the longitudinal line in a thread groove five threads from the center of the coupling for 8-round and six threads for 10-round threads, The movable point shall be placed in the same groove 180° opposite from the fixed point. The dial indicator should be at zero at the null point as the movable point is moved through a small transverse arch. If not, the thumb screw shall be loosened and the dial face rotated until the indicator reads zero. Tighten the thumb screw and recheck the dial for a zero reading.

8.3.4.3.2 Measuring Taper

The taper is measured by taking successive readings at 1-in. intervals moving toward the near opening of the coupling. The difference is the taper in in. per in. The permissible tolerance is 0.060 in. per inch to 0.068 in. per inch.

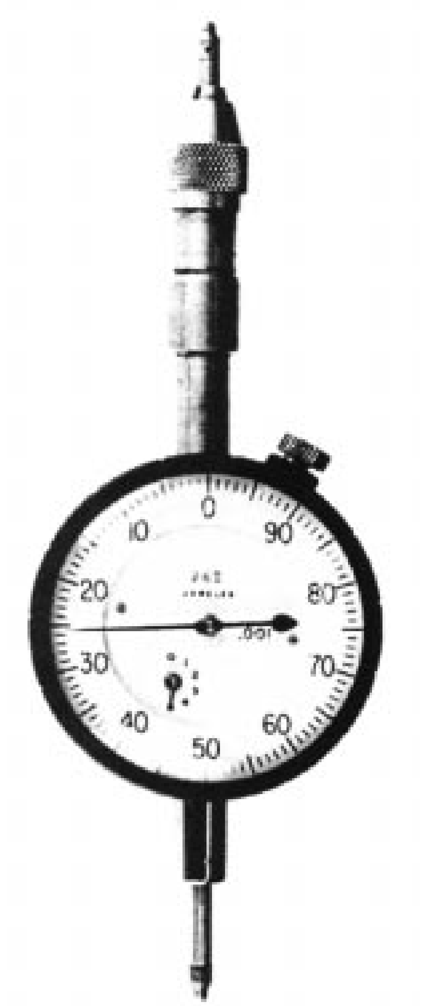


Figure 31—Assembled Internal Taper Gauge for $4^1/_2$-in. OD and Larger Pipe

The *small internal taper gauge* (Figure 30) is adjusted and used in the same fashion as the large internal taper gauge except that the dial indicator is placed on an extension arm permitting the contact pins to reach into the small diameter coupling. The taper may be checked directly by comparing the difference between two adjacent 1-in. readings to the tolerance above. The tolerance is reduced to 0.030 in. to 0.034 in. per inch for adjacent $^1/_2$ in. readings.

8.3.5 Standoff

Standoff is the distance measured axially between the end of the pipe or coupling and the standoff position of the ring or plug gauge (Figures 32 and 33). There are two levels of ring and plug gauges:

a. Working gauges, which are applied to the piece being inspected.

b. Certified master gauges, which are used to verify the accuracy of the working gauges (certified as specified in API Spec 5B).

Normally, inspection is made using a working gauge unless a dispute arises, at which time the certified master gauge may be used to resolve the dispute.

Ring and plug gauges for 8-round threads are made in both short- and long-thread configurations.

8.3.5.1 External Threads—Ring Gauge

The ring gauge is used by screwing the ring gauge hand-tight onto the pin to be inspected. A short casing thread gauge may be used to inspect a long thread pin. However, the pin will extend beyond the gauge point. Thus, tolerance must be measured from this new gauge point.

The tolerance is ± 1 thread (± $1^1/_2$ thread on 10-round) on either side of the reference point. Accurate inspection may be affected by plating on the threads.

Figure 32—Flush-Type Ring Gauge

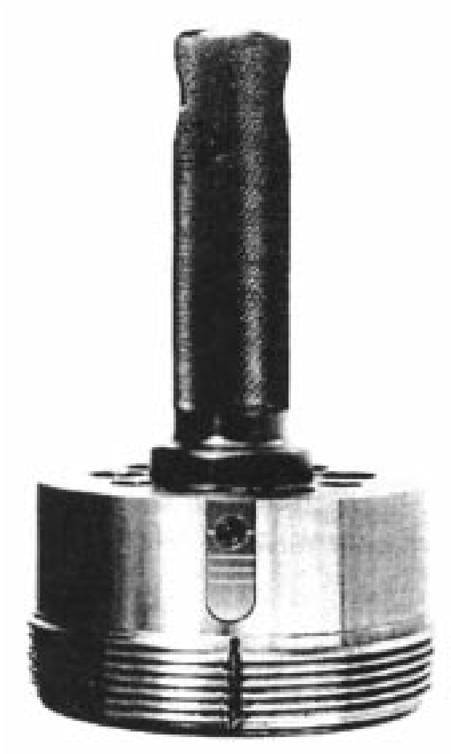


Figure 33—Insert Style Plug Gauge

Some ring gauges are flush-type where the end of the pipe is flush with the end of the gauge when the thread size is at zero tolerance (Figure 32). Other ring gauges are fitted with step plates extending beyond the gauge proper. The zero tolerance is equivalent to the end of the pipe being flush with the middle step (Figure 34). The first step on either side of the middle step represents the tolerance. Old-style ring gauges were provided with a template. The template was marked with zero and the plus and minus tolerances (Figure 35).

The use of a short-casing thread ring gauge on a long thread requires determination of the distance the pin extends beyond the gauge end. Flush gauges and template-type gauges require the use of a steel scale, calipers, or templates on which the extensions and ± tolerances are marked. Step gauges are provided with two sets of tolerance steps, one for long thread inspection and another for short thread inspection.

The distance the long pin extends beyond the short ring gauge is determined from Formula 8.3.5.1:

$$\text{Distance} = L_1\ (\text{long}) - L_1\ (\text{short}) - P_1$$

where

L_1 (long) = is the length from the end of long pin to hand-tight plane,

L_1 (short) = is the length from the end of the short pin to hand-tight plane,

P_1 = is the standoff between the short working ring gauge and the certified master plug gauge (Figure 36).

Values of (L_1 (long) – L_1 (short)) have been determined and tabulated (Table 11) since they are a function of pipe diameter.

The distance the long pin extends beyond the short ring gauge may not exceed the “distance” (Formula 8.3.5.1) ± 1 thread.

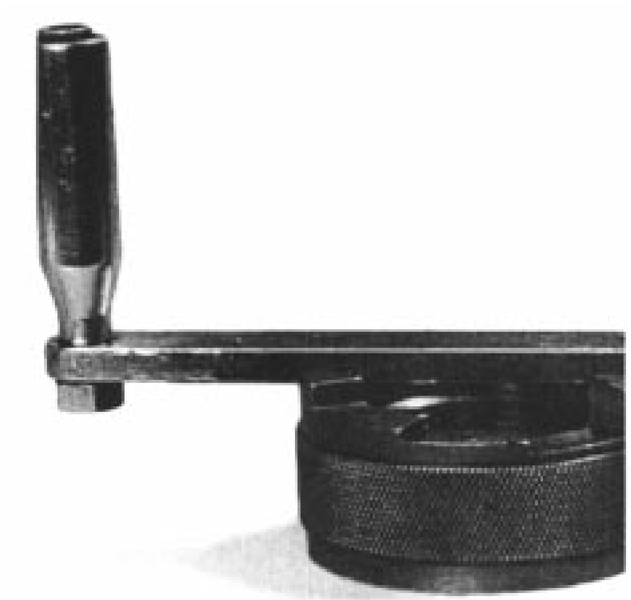


Figure 34—Step-Type Ring Gauge

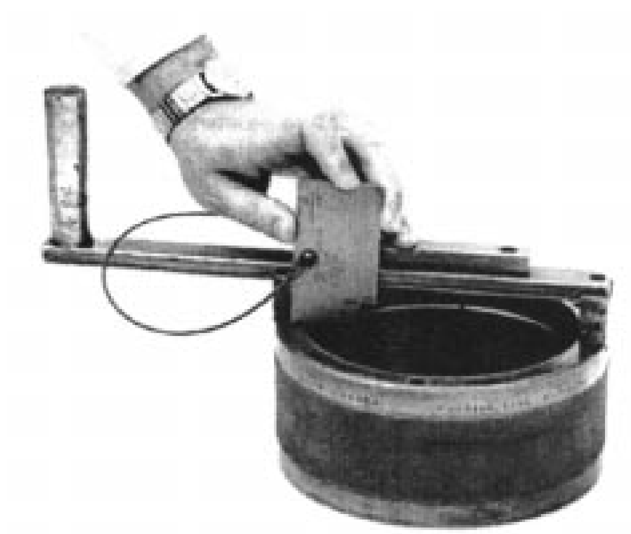


Figure 35—Template-Type Ring Gauge

Table 11—Casing Long-Thread L_1–Short-Thread L_1

1	2	3
OD Size	Nominal Weight (lb/ft)	L_1 Long – L_1 Short (in.)
$4^1/_2$	9.50	1.000
$4^1/_2$	Others	0.375
5	11.50	0.875
5	Others	0.625
$5^1/_2$	All	0.625
$6^5/_8$	All	0.750
7	17.00	1.625
7	Others	0.875
$7^5/_8$	All	0.875
$8^5/_8$	24.00	1.500
$8^5/_8$	Others	1.125
$9^5/_8$	All	1.375
20	94.00	1.250

8.3.5.2 Internal Threads—Plug Gauge

The plug gauge for small sizes (5 in. and less) normally is held in a jig (holding device) so the coupling can be screwed onto the gauge hand-tight. However, for large sizes, the coupling normally is held in a jig and the gauge screwed into the coupling. Accurate gauging can only be performed prior to thread coating. Also, accurate gauging of a coupling which has been installed power-tight on a pin is not possible. This is true even if the coupling has been removed from the pin.

When a seal-ring groove has been cut in a coupling, accurate gauging may not be possible because of interference from the yielded featheredge fade-out where the threads enter and leave the seal-ring groove. Plug gauge readings can be taken before cutting the seal ring or after removing the yielded featheredge fade-out. The method used to remove the featheredge fade-out shall not damage the remaining threads.

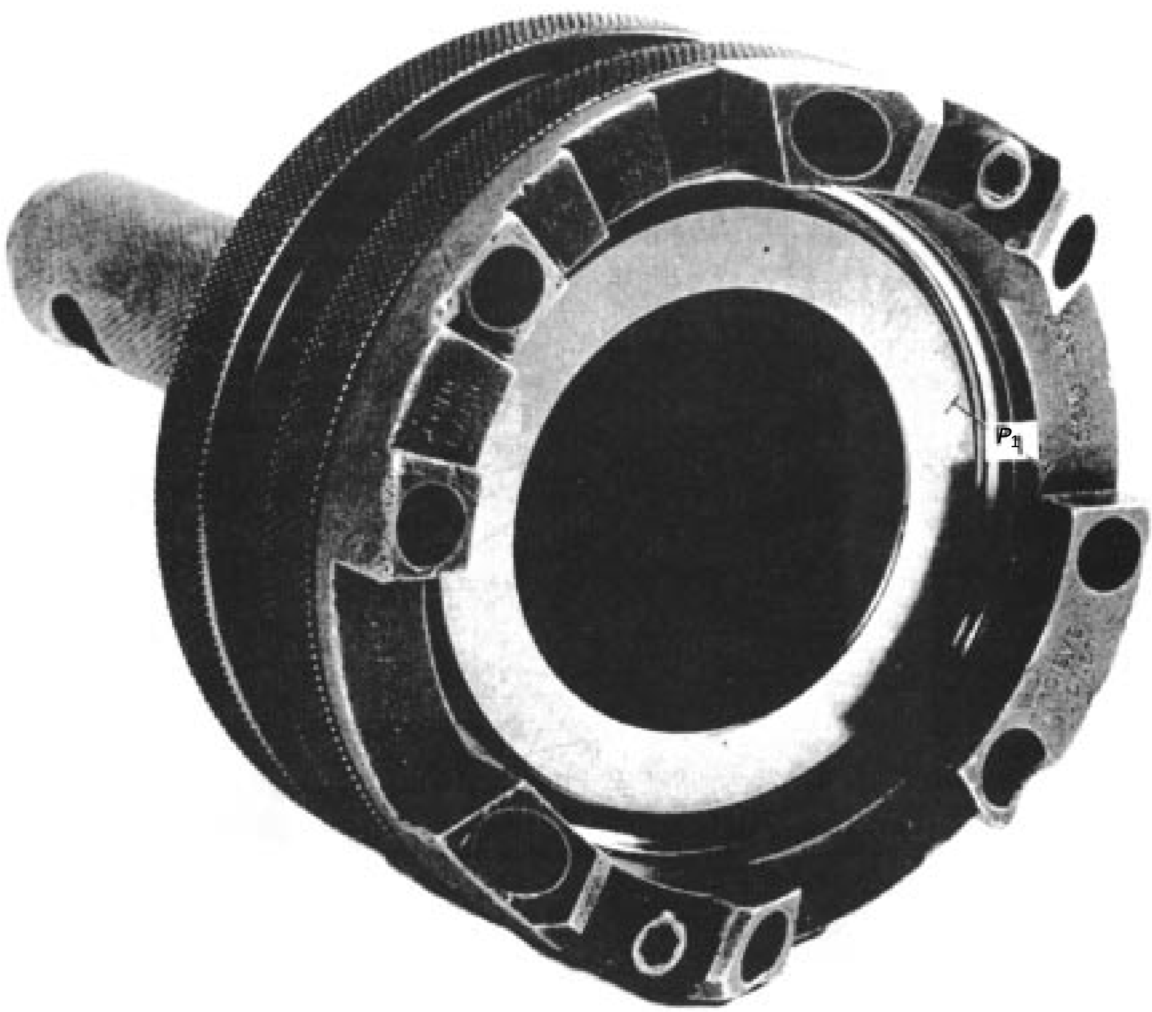


Figure 36—Standoff of Master Plug and Working Ring Gauges

Plug gauges are made in three styles: insert, standoff lines, and template. The insert style gauge is provided with an insert containing three scribe lines. The middle represents the basic size. The ±1 thread pitch (± $1^1/_2$ for 10-round threads) is indicated from the middle line by lines ahead and behind the basic line (Figure 33). The standoff lines style of plug gauge is provided with three lines representing the tolerance and the basic size and a fourth line representing the vanish point (Figure 37). The orientation of the lines is the same as for the insert-style. The template style plug gauge has no lines. Instead, the tolerance is measured from the back shoulder of the plug to the end of the coupling (Figure 38) using a template, scale or caliper.

8.4 LINE PIPE THREAD INSPECTION

API line pipe threads vary in pitch from 8 to 27 threads per inch (Table 12).

Line pipe thread diameters vary from $^1/_8$-in. nominal diameter to 20-in. OD (Table 12). Threads cut on pipe less than 1-in. nominal diameter are not gauged for thread height, lead or taper. Instead, these small diameter pipe threads are checked for standoff only.

8.4.1 Total Thread Length

Total thread length, the L_4 dimension (Table 12) is measured parallel to the pipe axis from the end of pipe to the vanish point of the thread (Figure 15).

The measurement shall be made using a metal scale ($^1/_{32}$-in. minimum dimension) (Figure 17). The total thread length is acceptable if L_4 is within ±1 pitch (Table 12).

L_4 is acceptable if the distance from the end of the pipe to the vanish plane (at the point where the outside diameter of the pipe is a maximum) is within the minus tolerances as expressed in Table 12; or, if the distance from the end of the pipe to the vanish plane (where the outside diameter of the pipe is a minimum) is within the plus tolerances of Table 12.

8.4.2 Thread Height

Thread height is the measurement of the distance from the thread root to the thread crest normal to the thread axis (Figure 3, 4, 5, 6, and 7). All line pipe threads are Vee threads. Two types of thread height gauges are used for line pipe threads: (a) external/internal gauges for threads $3^1/_2$-in. OD and larger (Figure 18), and (b) internal gauges for threads 3-in. OD and smaller (Figure 19).

All line pipe thread height gauges are equipped with contact points having an included angle of 50° (Table 7). Two types of dial indicators are provided on the thread height gauge: (a) balanced-dial type (Figure 18), and (b) continuous-reading type (Figure 19). Refer to 8.3.2.1 for details on the two types of dial indicators and their adjustments.

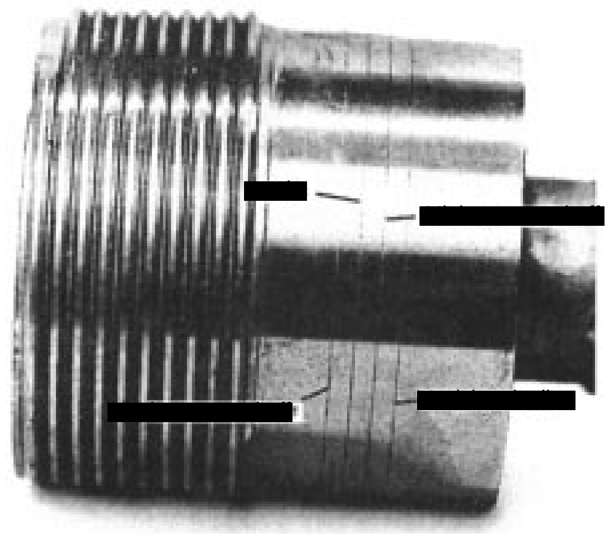


Figure 37—Standoff Lines Style Plug Gauge

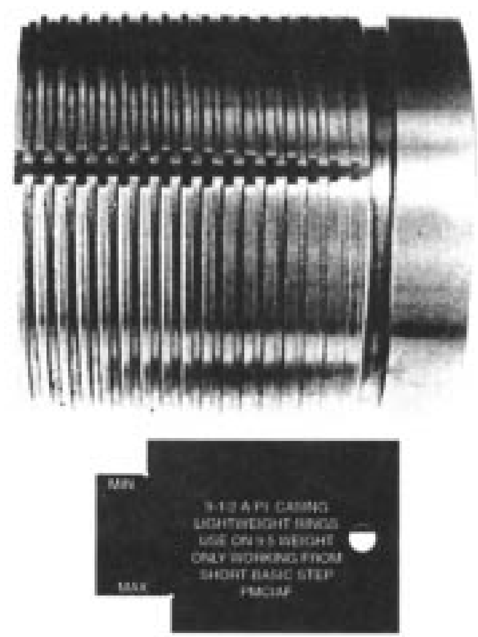


Figure 38—Template Style Plug Gauge

The measured thread height for 1-in. nominal pipe diameter and larger pipe threads are compared with the theoretical values (Table 8).

Applying the height gauge to a line pipe thread is performed in the same manner as for the round thread form. Also, the first perfect thread is located in a manner similar to that for the round thread (perfect crests on either side of the thread root).

The length to the last perfect thread (Figure 15) is established by L_4–g.

For inspection purposes, the coupling full-crested thread length extends from the first perfect thread (perfect crests on either side of the thread root) to the $J + 1$ thread from the coupling center.

The maximum permissible thread height error is + 0.002 in., – 0.006 in. from the nominal reading (Table 8). Verification of thread height should be performed at the first and last full-crested thread and within the perfect thread length.

8.4.3 Lead

Lead is the distance from a specific point on a thread to the corresponding point on the next thread measured parallel to the thread axis.

The distance is small. Thus, the required accuracy would be excessive if lead were determined from thread-to-thread. Accordingly, lead is measured at 1-in. intervals, $^1/_2$-in. intervals or at 4-thread intervals depending on the thread length. The 1-in. interval applies to line pipe greater than 6-in. nominal diameter. The $^1/_2$-in. interval applies to $2^1/_2$-in. through 6-in. nominal diameter.

The 4-thread interval applies to threads on pipes 1-, $1^1/_4$-, $1^1/_2$-, and 2-nominal diameter (Table 12).

8.4.3.1 Gauges

The gauge for measuring lead tolerance is equipped with two contact points and a balanced dial-type indicator. Examples of lead gauges are shown in Figure 26.

The accuracy of lead gauges is verified by applying the gauge to the lead-setting standard (Figure 27). Prior to adjusting the lead gauge, the contact point size should be checked with a micrometer. The contact point dimensions for line pipe threads shall be within ± 0.002 in. of the API recommended size (Table 9).

8.4.3.2 Adjusting the Gauge

The lead gauge should register zero when applied to the setting standard (Figure 27). It must be noted the normal lead-setting standard (Figure 27) cannot be used for line pipe with $11^1/_2$ threads per inch.

Accordingly, a special 4-thread, lead-setting standard shall be used. Adjustment is necessary if the gauge does not register zero. Adjustment is performed as described in 8.3.3.

Table 12—Line Pipe Thread Dimensions

1	2	3	4	5	6	7	8
Nominal Size	Number of Threads per in.	Total Thread Length L_4[a] (in.)	Thread Length Tolerance (in.)	Minimum Length Full-Crest Thread L_c	L_4–g	Minimum Coupling Length N_L (in.)	J Dimensions (in.)
$^1/_8$	27	0.3924($^{12}/_{32}$)	± 0.037 ($^1/_{32}$)	—	—	$1^1/_{16}$	0.1389
$^1/_4$	18	0.5946 ($^{19}/_{32}$)	± 0.055 ($^2/_{32}$)	—	—	$1^5/_8$	0.2119
$^3/_8$	18	0.6006 ($^{19}/_{32}$)	± 0.055 ($^2/_{32}$)	—	—	$1^5/_8$	0.2119
$^1/_2$	14	0.7815 ($^{25}/_{32}$)	± 0.0714 ($^2/_{32}$)	—	—	$2^1/_8$	0.2810
$^3/_4$	14	0.7935 ($^{25}/_{32}$)	± 0.0714 ($^2/_{32}$)	—	—	$2^1/_8$	0.2690
1	$11^1/_2$	0.9845 ($^{31}/_{32}$)	± 0.0870 ($^3/_{32}$)	0.3325	0.4845	$2^5/_8$	0.3280
$1^1/_4$	$11^1/_2$	1.0085 (1)	± 0.0870 ($^3/_{32}$)	0.3565	0.5085	$2^3/_4$	0.3665
$1^1/_2$	$11^1/_2$	1.0252 ($1^1/_{32}$)	± 0.0870 ($^3/_{32}$)	0.3732	0.5252	$2^3/_4$	0.3448
2	$11^1/_2$	1.0582 ($1^2/_{32}$)	± 0.0870 ($^3/_{32}$)	0.4062	0.5582	$2^7/_8$	0.3793
$2^1/_2$	8	1.5712 ($1^{18}/_{32}$)	± 0.125 ($^4/_{32}$)	0.6342	1.0712	$4^1/_8$	0.4913
3	8	1.6337 ($1^{20}/_{32}$)	± 0.125 ($^4/_{32}$)	0.6967	1.1337	$4^1/_4$	0.4913
$3^1/_2$	8	1.6837 ($1^{22}/_{32}$)	± 0.125 ($^4/_{32}$)	0.7467	1.1837	$4^3/_8$	0.5038
4	8	1.7337 ($1^{23}/_{32}$)	± 0.125 ($^4/_{32}$)	0.7967	1.2337	$4^1/_2$	0.5163
5	8	1.8400 ($1^{27}/_{32}$)	± 0.125 ($^4/_{32}$)	0.9030	1.3400	$4^5/_8$	0.4725
6	8	1.9462 ($1^{30}/_{32}$)	± 0.125 ($^4/_{32}$)	1.0092	1.4462	$4^7/_8$	0.4913
8	8	2.1462 ($2^5/_{32}$)	± 0.125 ($^4/_{32}$)	1.2092	1.6462	$5^1/_4$	0.4788
10	8	2.3587 ($2^{11}/_{32}$)	± 0.125 ($^4/_{32}$)	1.4217	1.8587	$5^3/_4$	0.5163
12	8	2.5587 ($2^{18}/_{32}$)	± 0.125 ($^4/_{32}$)	1.6217	2.0587	$6^1/_8$	0.5038
14 OD	8	2.6837 ($2^{22}/_{32}$)	± 0.125 ($^4/_{32}$)	1.7467	2.1837	$6^3/_8$	0.5038
16 OD	8	2.8837 ($2^{28}/_{32}$)	± 0.125 ($^4/_{32}$)	1.9467	2.3837	$6^3/_4$	0.4913
18 OD	8	3.0837 ($3^3/_{32}$)	± 0.125 ($^4/_{32}$)	2.1467	2.5837	$7^1/_8$	0.4788
20 OD	8	3.2837 ($3^9/_{32}$)	± 0.125 ($^4/_{32}$)	2.3467	2.7837	$7^5/_8$	0.5288

Note: Figures within brackets represent the approximate equivalent length in inches and 32nds of an inch.

8.4.3.3 Applying the Gauge

The gauge is used in the same manner as for round threads. Line pipe threads are inspected over the entire length of perfect threads (Refer to 8.4.2).

The error in the lead shall be reported in inches of error per inch of thread. The reading is direct for 1-in. intervals. The 1-in. tolerance is divided by two for $^1/_2$-in. intervals and 2.875, for 4-thread intervals. The 1-in. lead tolerance is ± 0.003 in. per inch Thus, the observed tolerance is ± 0.0015 in. for $^1/_2$-in. intervals and ± 0.001 in. for 4-thread intervals.

In addition to the per-inch inspection, the thread should be inspected for cumulative lead.

8.4.3.4 Cumulative Lead

Cumulative lead is measured over the L_4 length from the end of the pipe, only perfect (full-crested) threads shall be included in the cumulative lead measurement. Cumulative lead on external or internal threads shall be measured over an interval (between the first and last perfect threads) which has a length equal to the largest multiple of $^1/_2$ in. for an 8-pitch thread and 1 in. for $11^1/_2$-pitch thread.

8.4.4 Taper

Taper is the change in pitch diameter of the thread expressed as inches per foot or inches per inch of thread length. A taper caliper (Figure 28) should not be capable of measuring a thread for a pipe more than three times the size being inspected.

8.4.4.1 Taper Calipers

Various types of calipers are available for inspecting thread taper:

a. External—thread taper caliper (Figure 28).
b. Large internal—thread taper caliper (Figure 29).
c. Small internal—thread taper caliper (Figure 30).

These calipers are provided with a continuous-dial type indicator. The recommended caliper contact points must fit the thread being inspected. Line pipe taper caliper contact points range from 0.072 inch to 0.050 inch (Table 10). The contact points are ball-type. The contact diameters should be checked with a micrometer prior to starting an inspection. The tolerance for the contact points is ± 0.002 inch. Two contact points are provided: a fixed point and a movable point (Figure 28).

The taper caliper (Figure 28) is provided with an adjustable arm. The large internal taper caliper is adjusted to fit the coupling by installing extensions (Figure 29). The small internal taper caliper is adjusted to the coupling size by sliding the adjustable arm to the corresponding pipe OD size (Figure 30).

8.4.4.2 External Threads

8.4.4.2.1 Adjusting the Caliper

Taper calipers are adjusted on the pipe thread. Refer to 8.3.4 for details.

8.4.4.2.2 Applying the Caliper

The taper caliper is applied to line pipe as it is to casing and tubing. Refer to the round thread section for details. Refer to 8.4.2 for first and last perfect thread locations. The tolerance for taper is the same as for round threads: 0.060 to 0.068 in. per inch.

This tolerance applies directly when a 1-in. gauge length is used (Table 12). The tolerance is divided by two for $^1/_2$-gauge length. For $11^1/_2$ thread pipe the tolerance is 0.021 to 0.023 in. per inch.

The perfect thread length shall be inspected. Thus, the same overlapping procedure should be followed for line pipe as described for round thread.

8.4.4.3 Internal Threads

8.4.4.3.1 Adjusting the Caliper

The caliper is adjusted on the coupling as described in 8.3.4. Coupling full-crested thread length extends from the first perfect thread (full-crested threads on either side of the root) to the J + 1 thread length from the coupling center. (Table 12). The perfect thread length shall be inspected for taper. The same tolerances apply to the coupling as apply to the pin.

8.4.5 Standoff

The diametral size of line pipe threads can be measured with ring and plug gauges (Figures 32 and 33). There are two levels of ring and plug gauges. These levels are the same discussed in 8.3.5.

8.4.5.1 External Thread—Ring Gauge

The ring gauge is used by screwing the gauge hand-tight onto the pin to be inspected and observing the number of threads between the end of the pin and the reference point of the ring gauge. The standoff tolerance is ± 1 thread pitch on either side of the reference point (end of gauge, step or template mark). Refer to 8.3.5 for details on the types of ring gauges available.

8.4.5.2 Internal Threads—Plug Gauge

The plug gauge is used by screwing the gauge hand-tight into the coupling to be inspected. The coupling should not be made-up on a pin since the resulting stresses will deform the coupling. The number of threads between the reference point of a gauge and the face of the coupling should be observed.

The standoff tolerance is ± 1 thread pitch on either side of the reference point (end of gauge, step or template mark). Refer to 8.3.5 for details on the types of plug gauges available. Accurate inspection may be affected by plating of the threads.

8.5 BUTTRESS THREAD INSPECTION

8.5.1 Thread Length

Three lengths must be determined when inspecting a buttress thread pin. These are:

a. Length of full-crested threads, L_c.
b. Length to the base of triangle stamp, A_1 (Table 13).
c. Perfect thread length (Table 13).

The measurements of the thread and triangle distances are made from the end of the pipe parallel to the pipe axis. A metal scale having $^1/_{32}$-in. (or smaller) divisions should be used (Figure 39).

The full-crested thread length, L_c (Table 13), should be marked on the pin. A maximum of two threads showing outside surface of the pipe on the crests (black threads) for a maximum of 25% of the circumferential distance of the pipe is acceptable. The remaining threads within the L_c distance shall be full-crested threads.

The distance from the end of the pin to the base of the triangle stamp, A_1 (Figure 39 and Table 13), is made in a manner similar to the L_4 length for round thread casing (Figures 17 and 39). The tolerance for the A_1 dimension is $\pm^1/_{32}$ inch.

The coupling length, N_L (Table 13), is the minimum permissible length. The measured length of the coupling must equal or exceed the N_L value (Table 13).

The perfect thread length is the L_7 distance (Table 13).

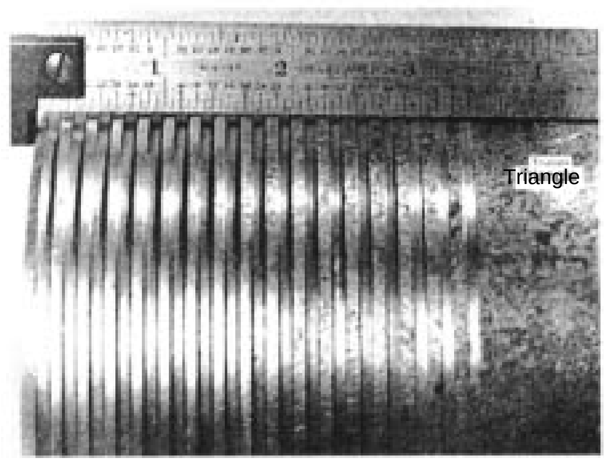


Figure 39—Full-Crested Threads and Triangle Stamp Measurement on a Buttress Thread Pin

Table 13—Buttress Thread Casing Dimensions

1	2	3	4	5	6	7
OD Size (in.)	Total Thread Length L_4[a] (in.)	Minimum Length Full-Crest Thread L_c[b] (in.)	Length Perfect Threads L_7	Length End of Pipe to Triangle Stamp A (in.)	Minimum Coupling Length N_L (in.)	J Dimension (in.)
$4^1/_2$	3.6375 ($3^{20}/_{32}$)	1.2535 ($1^8/_{32}$)	1.6535	$3^{15}/_{16}$	$8^7/_8$	0.500
5	3.7625 ($3^{24}/_{32}$)	1.3785 ($1^{12}/_{32}$)	1.7755	$4^1/_{16}$	$9^1/_8$	0.500
$5^1/_2$	3.8250 ($3^{26}/_{32}$)	1.4410 ($1^{14}/_{32}$)	1.8410	$4^1/_8$	$9^1/_4$	0.500
$6^5/_8$	4.0125 (4)	1.6285 ($1^{20}/_{32}$)	2.0285	$4^5/_{16}$	$9^5/_8$	0.500
7	4.2000 ($4^6/_{32}$)	1.8160 ($1^{26}/_{32}$)	2.2160	$4^1/_2$	10	0.500
$7^5/_8$	4.3875 ($4^{12}/_{32}$)	2.0035 (2)	2.4035	$4^{11}/_{16}$	$10^3/_8$	0.500
$8^5/_8$	4.5125 ($4^{16}/_{32}$)	2.1285 ($2^4/_{32}$)	2.5285	$4^{13}/_{16}$	$10^5/_8$	0.500
$9^5/_8$	4.5125 ($4^{16}/_{32}$)	2.1285 ($2^4/_{32}$)	2.5285	$4^{13}/_{16}$	$10^5/_8$	0.500
$10^3/_4$	4.5125 ($4^{16}/_{32}$)	2.1285 ($2^4/_{32}$)	2.5285	$4^{13}/_{16}$	$10^5/_8$	0.500
$11^3/_4$	4.5125 ($4^{16}/_{32}$)	2.1285 ($2^4/_{32}$)	2.5285	$4^{13}/_{16}$	$10^5/_8$	0.500
$13^3/_8$	4.5125 ($4^{16}/_{32}$)	2.1285 ($2^4/_{32}$)	2.5285	$4^{13}/_{16}$	$10^5/_8$	0.500
16	4.6125 ($4^{20}/_{32}$)	2.7245 ($2^{23}/_{32}$)	3.1245	$4^{13}/_{16}$	$10^5/_8$	0.500
$18^5/_8$	4.6125 ($4^{20}/_{32}$)	2.7245 ($2^{23}/_{32}$)	3.1245	$4^{13}/_{16}$	$10^5/_8$	0.500
20	4.6125 ($4^{20}/_{32}$)	2.7245 ($2^{23}/_{32}$)	3.1245	$4^{13}/_{16}$	$10^5/_8$	0.500

[a]Thread Length Tolerance not specified because of type of thread.
[b]Within the L_c Length, as many as two threads showing the original outside surface of the pipe on their crests for a circumferential distance not exceeding 25% of the pipe circumference is permissible.

8.5.2 Thread Height

Thread height is the measurement of the distance from the thread root to the crest normal to the thread axis (Figures 5 and 6). The following two styles of thread height gauges are used for inspection:

a. Straight-anvil-type external/internal height gauge (Figure 18) used for buttress pin and coupling threads $13^3/_8$-in. OD and smaller.
b. Step-anvil-type external/internal height gauge (Figure 40) used for buttress pin and coupling threads of 16-in., $18^5/_8$-in., and 20-in. diameter.

A balanced-dial (Figure 18) gauge shall be used.

Thread height gauges for buttress threads can use a cone point or a ball-type, provided the contact point does not contact the thread flanks and does not exceed 0.092 in diameter. The cone point shall have a maximum angle of 50°.

8.5.2.1 Adjusting the Gauge

The accuracy of each type of gauge is verified by use of setting standards. The setting standard for the height gauge used on $13^3/_8$-in. OD and smaller buttress threads is similar to the standard for round and line pipe threads (Figure 20). A step-type setting standard is used for the height gauge associated with 16-in., $18^5/_8$-in., and 20-in. buttress casing (Figure 40). The step provides correct positioning of the contact within the thread to assure a correct reading.

This same step causes the standard to be unidirectional. Accordingly, care shall be exercised when using a stepped standard to position the gauge on the product in the same direction as on the setting standard.

The balanced-dial type indicator should read zero when placed in the U-groove setting standard (Figure 20).

8.5.2.2 Applying the Gauge

Applying the gauge to the product is performed by placing the contact point of the thread height gauge (Figure 25) in the thread groove. The anvil must be held in firm contact with the thread crest. The gauge shall be aligned with the axis of the pipe. This is best accomplished by rocking the gauge about the longitudinal axis of the anvil (Figure 25). The thread height is correct when the dial indicator stops moving near the center of the rocking motion, the null point.

Verification of buttress thread depth shall be performed at the first perfect thread (full-crested threads on either side of the root) and at 1-in. intervals along the pin until the first black-crested thread is encountered within the L_7 length.

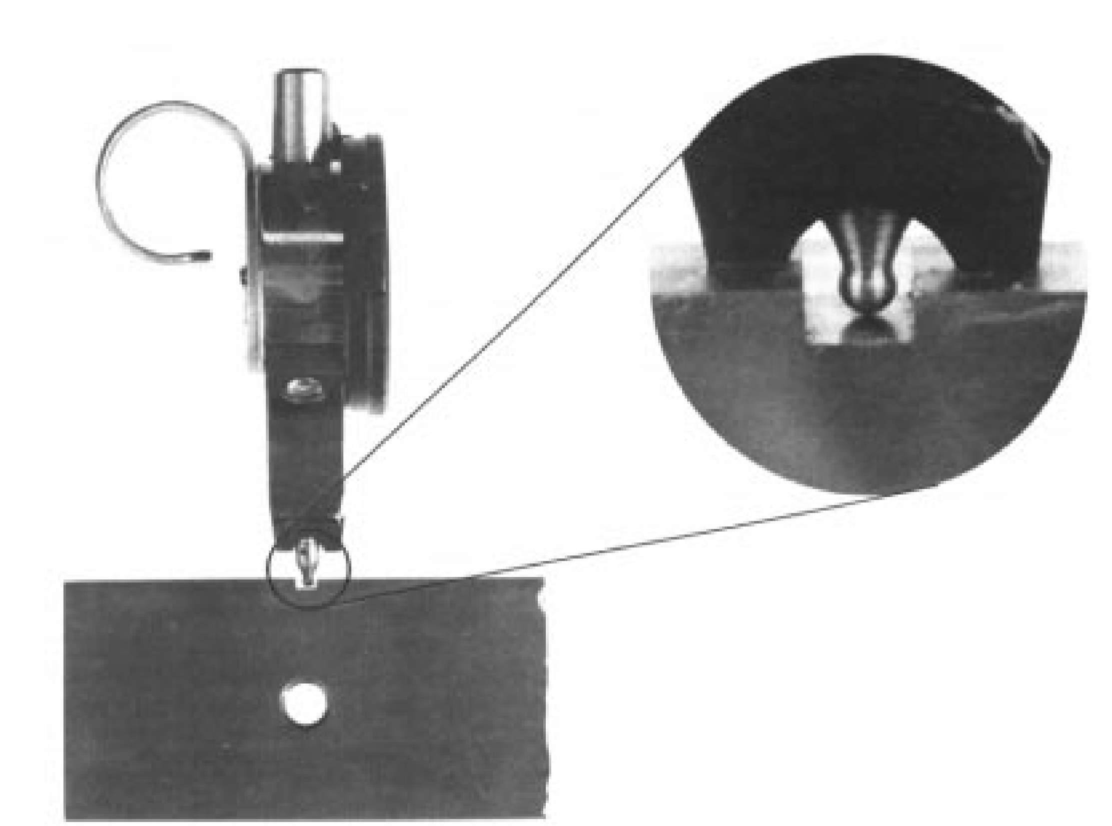


Figure 40—Step-Type External/Internal Buttress Thread Height Gauge for 16-in., $18^5/_8$-in., and 20-in. Diameter Pipe and Couplings and All Extreme-Line Casing Threads

Do not inspect black-crested threads because they are not full-crested threads and will not support the anvil properly. Any perfect thread interval which cannot be inspected, because less than 1 in. remains between the last perfect thread and the last 1-in. interval inspected, shall be inspected by starting at the last perfect thread and gauging the thread at 1-in. intervals toward the end of the pin. This provides one overlapping interval to assure complete coverage.

The coupling thread height inspection commences at $J + 1$ thread from the center of the coupling and progresses at 1-in. intervals to the first perfect thread (first root from the open end of coupling having full-crested threads on both sides). Again, an overlapping 1-in. interval near the coupling face may be necessary to provide complete gauging coverage of the coupling threads. The tolerance for coupling thread height (Table 6) is ± 0.001 inch.

8.5.3 Lead

Lead is the distance from a specific point on a thread to the corresponding point on the next thread measured parallel to the thread axis. The distance is small. Accordingly, the required accuracy would be excessive if lead were determined from thread to thread. Thus, lead is determined at 1-in. intervals and over the perfect thread length.

8.5.3.1 Gauge

The lead gauge used for buttress thread inspection is the same as used for larger round threads. (Figures 26 and 27). The recommended contact points are 0.062 in. in diameter (Table 9). Points varying more than ± 0.002-in. tolerance shall be replaced.

8.5.3.2 Adjusting the Gauge

The gauge should register zero when applied to the setting standard (Figure 27). The adjustment to establish the zero reading is the same as outlined in 8.3. Pressure shall be applied against the gauge so the thread contact points are in contact with the load flank (3° flank) and thread root simultaneously (Figures 5, 6, and 27).

8.5.3.3 Applying the Gauge

8.5.3.3.1 Per-Inch Measurement

The gauge is used in the same fashion for inspecting external and internal threads. The procedure is identical with that outlined in 8.3, except that the contact points should simultaneously touch the root and the 3° flank of the threads (Figure 26). Lead is inspected over the perfect thread length as discussed in the buttress thread height section 8.5.2.

The tolerance is ± 0.002 in. for buttress threads of $13^{3}/_{8}$ OD and smaller, and ± 0.003 in. for buttress threads of 16 OD and larger.

8.5.3.3.2 Cumulative Lead Measurement

Cumulative lead is the lead measured starting with the first perfect thread over an interval which is the largest multiple of 1 inch (Table 13). The gauge is applied to the product as discussed above for the per-inch measurement, except the cumulative lead length may include partial threads as long as the gauge contact point is in contact with the thread root and the flank of the partial thread, provided that the partial thread has at least half of the nominal height. The cumulative lead tolerance is ± 0.004 in.

8.5.3.3.3 Lead Measurements in Couplings With Seal Rings

When a seal-ring groove is present in a coupling, lead measurements shall be taken with the fixed contact point of the gauge simultaneously touching the root and the 3° flank of a full-crested thread form. The partial threads adjacent to the groove shall be avoided when measuring any thread element.

8.5.4 Taper

Taper is defined as the change in diameter along the minor cone of the external threads and the major cone of the internal threads. On all threads, taper tolerances are expressed in terms of "inches-per-inch of thread" and taper deviation shall be determined accordingly. The measurements are made for the specific interval lengths and the observed deviation shall be calculated to the inches-per-inch basis.

8.5.4.1 Caliper

The following types of calipers are available for inspecting thread taper:

a. External—thread taper caliper (Figure 28).
b. Internal—thread taper caliper (Figure 29).

These have continuous-dial type indicator gauges.

The recommended contact points for taper calipers are 0.090 in. in diameter (Table 18) and of the ball-type. The points should be checked with a micrometer. The points shall be replaced if the diameter exceeds the tolerance of ± 0.002 inch. Refer to the round thread section for additional details.

8.5.4.2 External Threads

8.5.4.2.1 Adjusting the Caliper

Taper calipers are adjusted to the pipe to be inspected. The procedure outlined in the round thread section should be followed.

8.5.4.2.2 Applying the Caliper

The taper caliper is applied to the product in the same fashion as during adjustment. Unlike other threads, two areas of the buttress threads must be inspected: the perfect threads and the imperfect threads. The taper of the perfect threads is inspected at 1-in. intervals, overlapping as necessary to inspect the entire length (Table 13). A similar procedure is applied to the imperfect thread up to runout. Taper ranges and corresponding tolerances are listed in Table 14.

8.5.4.3 Internal Threads

8.5.4.3.1 Adjusting the Caliper

The taper caliper is adjusted on the coupling. The procedure discussed in the round thread section 8.3.4.3.2 should be followed.

8.5.4.3.2 Applying the Caliper

The taper caliper is applied to the product in the same fashion as during adjustment. The round thread inspection procedure is followed. The interval thread inspection starts at the first perfect thread (first root from the open end of coupling having full-crested threads on both sides) and proceeds to the $J + 1$ thread pitch from the coupling center.

Only perfect thread tapers and tolerances are determined.

8.5.5 Thread Runout

Thread runout is the measurement of the abruptness with which the buttress thread is terminated at the triangle end of the thread. A rapid pullout of the cutting toll results in steep slope at the end of the thread. This causes high stress at the contact point when the coupling is made-up.

8.5.5.1 Gauge

The runout gauge is a three-point gauge having two fixed points and one movable point attached to a balanced-dial indicator (Figure 41).

The runout gauge (see Figure 41) shall be used to check the runout thread root and ensure that the external thread is sufficiently long and is a true runout thread. The runout gauge indicator shall be set to zero using a flat surface as a setting standard for size $13^3/_8$ and smaller. For size 16 and larger casing, the runout gauge indicator shall be set to zero using the perfect thread roots as a setting standard. These perfect thread roots shall be checked for acceptable taper prior to setting the runout gauge. If the indicator does not read zero, the dial is adjusted by unscrewing the thumb screw (Figure 41), turning dial to zero and tightening the thumb screw. The gauge zero should be verified after tightening the thumb screw.

8.5.5.2 Applying the Gauge

Two possible thread runout conditions can occur: (a) before the apex of the triangle (A_1 + 0.375 inches) (nearer the pipe end), and (b) at or beyond the apex of the triangle.

Table 14—Buttress Thread Acceptable Taper

1	2	3
Pipe Sizes OD (in.)	Perfect Threads (in. per in.)	Imperfect Threads (in. per in.)
External Threads		
$13^3/_8$ OD and smaller	0.061 – 0.066	0.061 – 0.067
16 OD and larger	0.082 – 0.087	0.082 – 0.088
Internal Threads		
$13^3/_8$ OD and smaller	0.060 – 0.067	—
16 OD and larger	0.081 – 0.088	—

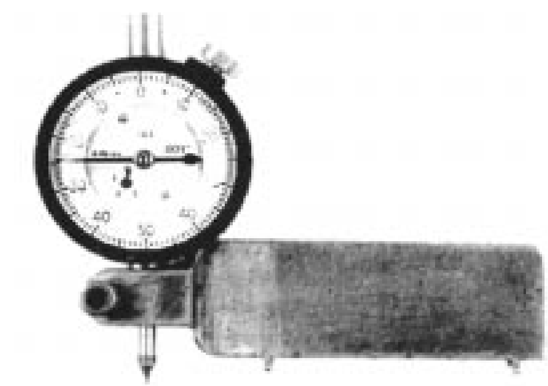


Figure 41—Buttress Thread Runout Gauge

If the thread terminates before the apex of the triangle (Table 13), the movable pointer is placed in the last thread groove 90° prior to the thread termination and the gauge traversed clockwise until the pointer exits the thread groove and rides on the pipe surface.

If the thread terminates at or beyond the apex, place the movable pointer in the thread groove 90° prior to the apex and traverse the gauge clockwise until the pointer passes the triangle apex.

The runout is satisfactory if the dial indicator does not exceed + 0.005 in. during the traverse of the thread groove. A dial indicator reading in excess of + 0.005 in. is not acceptable. Readings + 0.005 in. and less, and all negative readings are acceptable.

A runout measurement of the coupling is not required since the thread is continuous as it exits the coupling.

8.5.6 Standoff

Standoff is the distance measured axially from the end of the pipe or coupling to the standoff position on the ring or plug gauge (Figures 38 and 42).

Figure 42—Buttress Thread Ring Gauge

8.5.6.1 External Threads—Ring Gauge

The ring gauge is used by screwing the ring gauge hand-tight onto the pin to be inspected. The reference point of a buttress ring gauge is the bottom of the notch or the end of the gauge (Figure 42). The thread is acceptable if the end of the pipe is flush with the end of the gauge or visible within the notch.

8.5.6.2 Internal Threads—Plug Gauges

Some buttress plug gauges are of the template-type (Figure 38). Two faces are provided on the template representing a Go-No-Go gauge. Both faces must be used during the inspection. Other buttress plug gauges use steel scales or other suitable measuring devices to determine proper standoff.

The plug of $7^5/_8$ and smaller OD pipe normally is held in a jig so the coupling may be screwed hand-tight onto the plug gauge. Plug gauges for couplings larger than $7^5/_8$ OD should be provided with a means of support so the gauge can be screwed into the coupling. A counterweight device works well. The coupling shall be held firmly while installing the gauge since the weight of the gauge will cause the coupling to turn. When the gauge is in place, the template—one face at a time—is placed on the end of the coupling. The short face step shall either contact the end of the coupling and the end of the plug, or there shall be a space between the step and the gauge end. Similarly, the long face step must either contact the end of the coupling and the end of the gauge or there shall be a space between the step and the end of the plug (Figure 38).

Both conditions must be satisfied for the coupling to be acceptable. Accurate gauging can only be performed prior to thread coating. Also, accurate gauging of a coupling that has been installed power-tight on a pin is not possible. This is true even if the coupling had been removed from the pin.

When the seal-ring groove has been cut in a coupling, accurate gauging may not be possible on some couplings because of interference from the yielded featheredge fade-out where the threads enter and leave the seal-ring groove. Plug gauge readings may be made either before cutting the seal ring or after removing the yielded featheredge fade-out. The method used to remove the featheredge fade-out shall not damage the remaining threads.

8.6 EXTREME-LINE THREAD INSPECTION

8.6.1 Thread Length

The various lengths associated with extreme-line threads can be inspected using a scale (0.01-in. markings) or templates. Either method is satisfactory. Inspection is facilitated using the templates since the various lengths and tolerances are inscribed on the templates (Figure 43). However, the templates shall be verified for accuracy using a toolmaker's microscope or other laboratory technique.

Two templates are required for the range of extreme-line pipe sizes: (a) 5-in. through $7^5/_8$-in. OD, and (b) $8^5/_8$-in. through $10^3/_4$-in. OD.

Four lengths shall be measured separately on the pin and box threads (Figures 44 and 45 and Table 15). The scale or template is aligned parallel with the thread axis. The dimensions are read directly from the scale or template (Figures 46 and 47). The length to the tangent point is measured in a similar fashion after the tangent point is established using the ring gauge (to be discussed later).

The thread length is satisfactory if all of the values are within specified limits (Table 15).

Table 15—Extreme-Line Lengths

1	2	3	4	5	6	7	8	9
	5" through $7^3/_8$"				$8^5/_8$" through $10^3/_4$"			
	Pin (in.)		Box (in.)		Pin (in.)		Box (in.)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Thread	3.7825	3.8225	—	—	4.9950	5.0250	—	—
Seal Shoulder	3.8725	3.9175	3.9950	3.9950	5.0950	5.1250	5.1890	5.2390
Tangent Point	4.1720	4.2340	—	—	5.4534	5.5315	—	—
End of Joint	4.5600	4.6000	—	—	6.0325	6.0725	—	—
Total Length of Thread	—	—	3.8425	3.8825	—	—	5.0640	5.1140
Seal Runout	—	—	4.3730	4.4230	—	—	5.6890	5.7390
Joint Shoulder	—	—	4.7050	4.7750	—	—	6.1775	6.2475

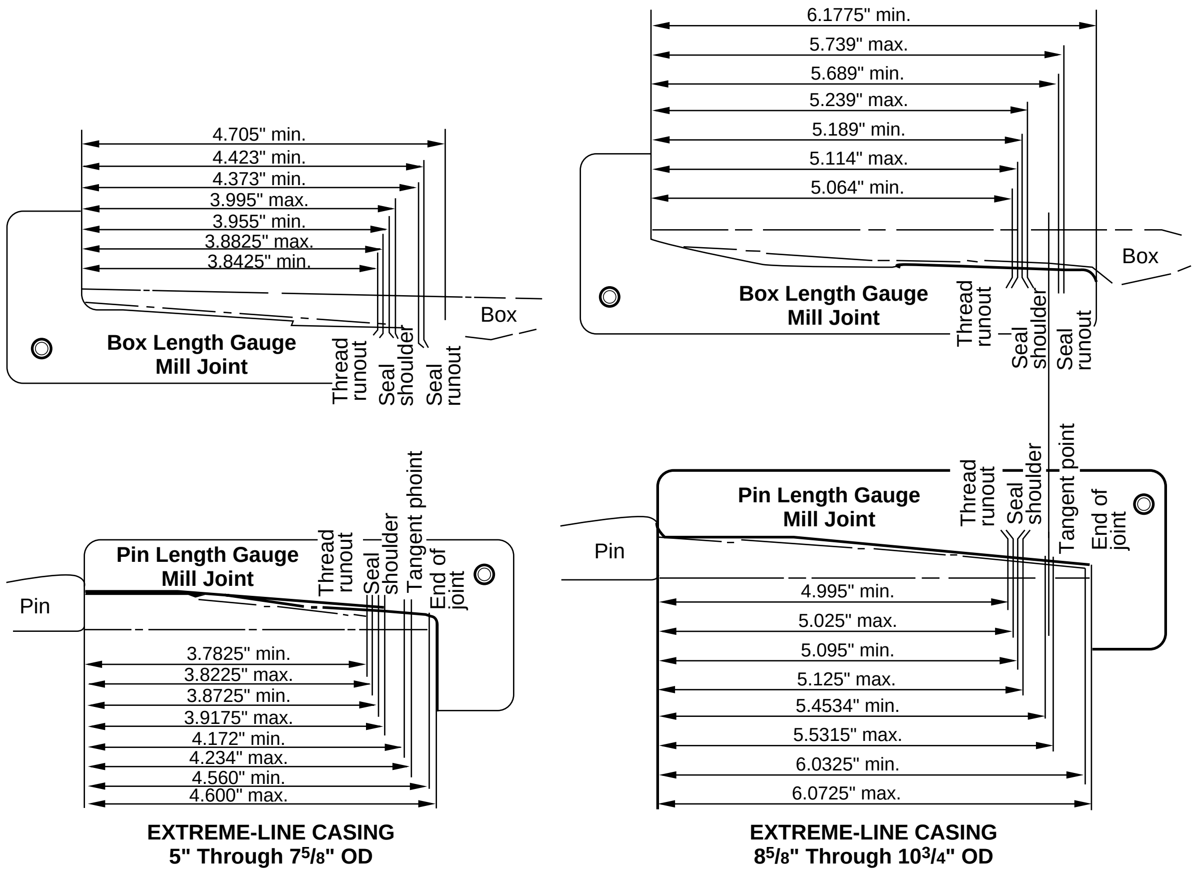


Figure 43—Extreme-Line Length Templates

8.6.2 Thread Height

Thread height is the measurement of the distance from the thread root to the thread crest normal to the thread axis (Figure 7). The same type of gauge is used for all sizes of extreme-line casing (Figure 18).

For 5-in. through $7^5/_8$-in. OD product, the recommended contact points are tapered for $^1/_8$ in. from 0.062 in. to 0.050 inch. For $8^5/_8$-in. through $10^3/_4$-in. product, the recommended contact points are tapered for $^1/_8$ in. from 0.079 in. to 0.050 inch (Table 7).

8.6.2.1 Adjusting the Gauge

The accuracy of the gauge is verified by using a setting standard having two plateaus and a 12° included-angle groove (Table 16 and Figure 48). The balanced-dial type indicator should be adjusted to read zero when the contact point is seated in the 6° flank groove (Figure 48). The continuous-dial type indicator should read the thread height marked on the setting standard when the contact point is seated in the bottom of the groove (Table 17). No contact-point diameter measurement is required, since the point does not rely on flank or Vee contact for accuracy.

8.6.2.2 Applying the Gauge

The balanced-dial type gauge establishes the difference between the setting-standard depth and the thread height being inspected. The same procedures of alignment and rocking apply as discussed in the round thread section 8.3. The allowable tolerance is ± 0.001 in. The thread should be inspected within tapers A and B (Figures 44 and 45).

The continuous-reading dial-type gauge measures the distance from the line of crests to the thread root. Again, the precautions of alignment and rocking of the gauge apply. The permissible error is ± 0.001 in. from the setting-standard depth (Table 17). The thread should be checked within tapers A and B (Figures 44 and 45).

8.6.3 Lead

Lead is the distance from a specific point on a thread to the corresponding point on the next thread measured parallel to the thread axis.

A standard lead gauge (Figure 26) equipped with a flattened bottom ball-type contact having a 0.023-in. diameter flat (Table 9) is used for inspecting extreme-line pipe.

The adjustment of a lead gauge used for extreme-line threads is identical with the adjustment for round thread.

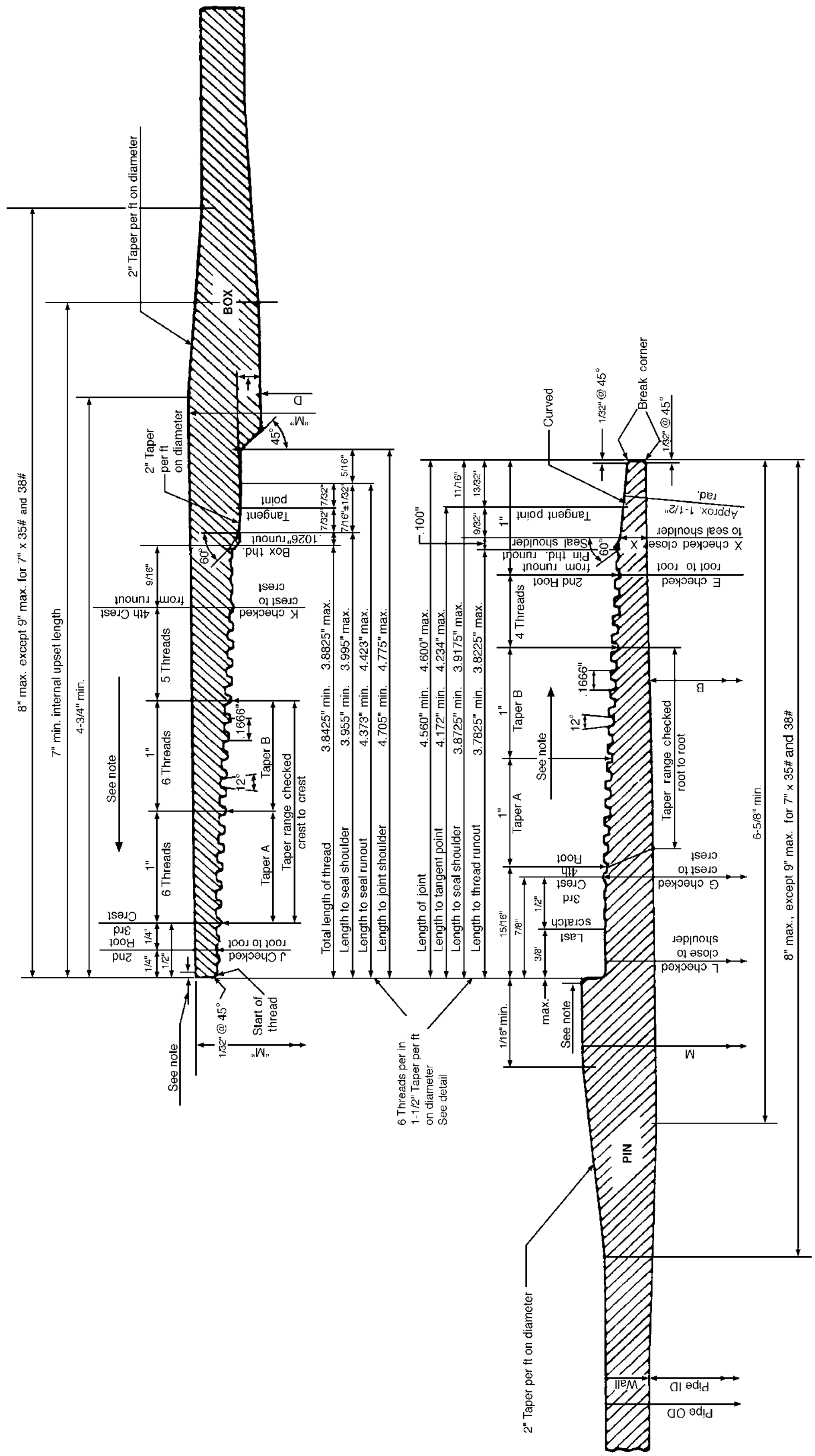


Figure 44—Extreme-Line Casing Configuration 5-in. through $7^5/_8$-in. OD

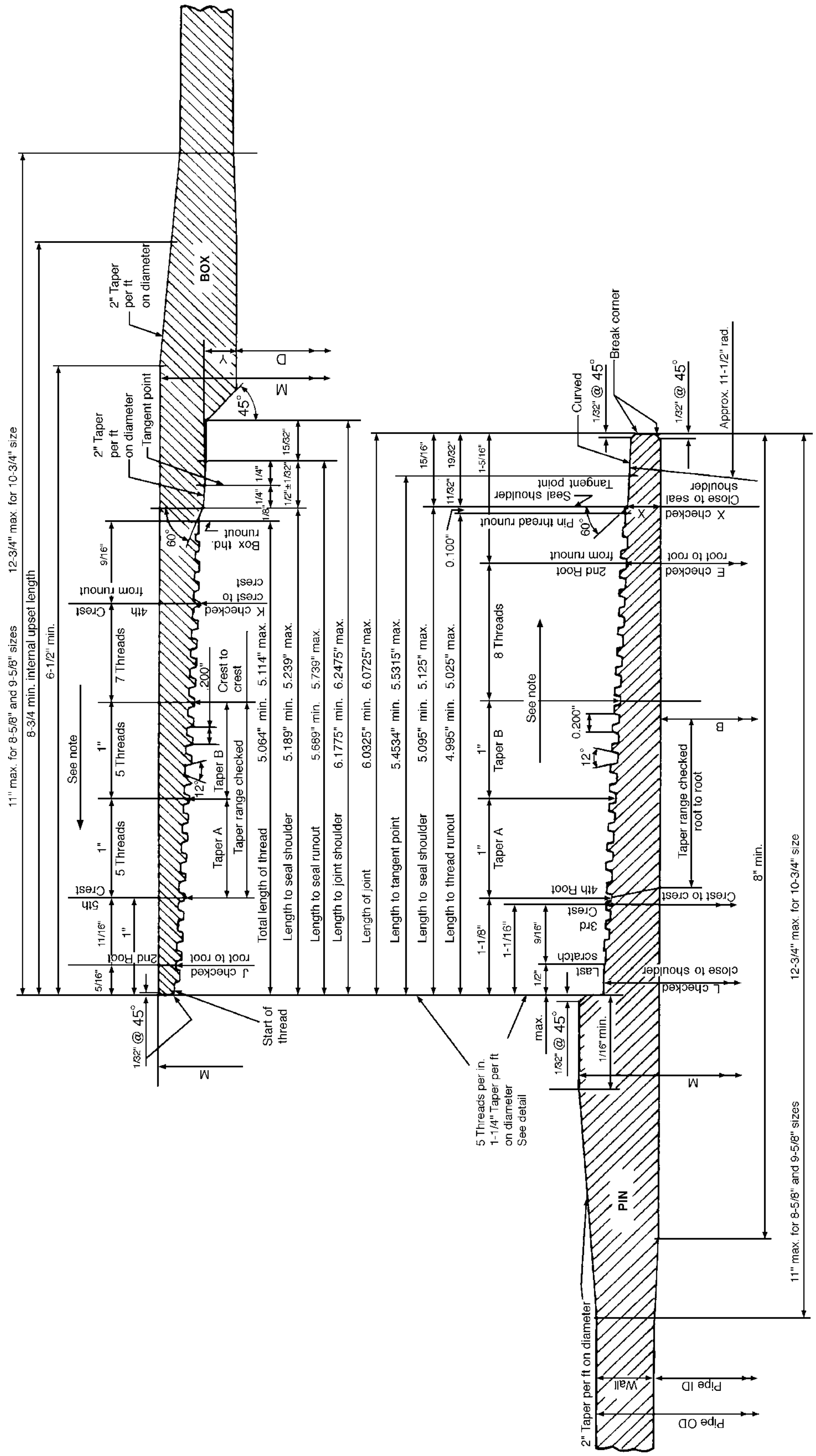


Figure 45—Extreme-Line Casing Configuration $8^5/_8$ through $10^3/_4$-in. OD

Table 16—Extreme-Line Height Gauge Setting Standard Dimensions

1	2	3
	Pin (in.)	Box (in.)
Casing OD 5" through $7^{5}/_{8}$"		
Width of groove at base of 6" flank	0.0800	0.0800
Depth of groove from first plateau	0.0488	0.0558
Depth of groove from second plateau	0.0592	0.0662
Casing OD $8^{5}/_{8}$" through $10^{3}/_{4}$"		
Width of groove at base of 6" flanks	0.1000	0.1000
Depth of groove from first plateau	0.0688	0.0758
Depth of groove from second plateau	0.0792	0.0862

Table 17—Extreme-Line Thread Height

1	2	3	4	5
	Pin (in.)		Box (in.)	
Pipe Size OD (in.)	Minimum	Maximum	Minimum	Maximum
5" through $7^{5}/_{8}$"	0.053	0.055	0.060	0.062
$8^{5}/_{8}$" through $10^{3}/_{4}$"	0.073	0.075	0.080	0.082

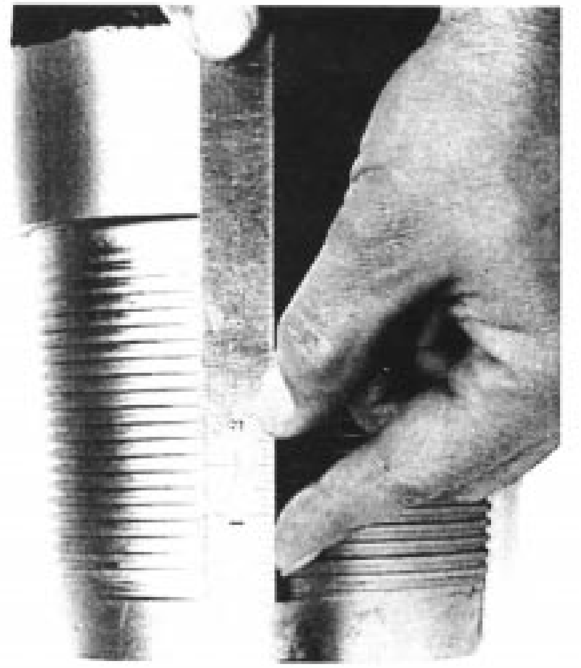


Figure 46—Scale Positioned on Extreme-Line Pin for Measuring the Thread Length

8.6.3.1 Per-Inch Measurement

8.6.3.1.1 External Threads

The area in which the lead can be checked is restricted to about $1^{1}/_{2}$ in. starting about $1^{1}/_{2}$ in. from the pin shoulder for all sizes (Figures 44 and 45). Accordingly, only one 1-in. lead measurement need be made. The procedure is identical with the round thread procedure previously discussed. The lead tolerance is ± 0.003 in. per inch for all sizes.

8.6.3.1.2 Internal Threads

The area in which the lead can be measured is restricted to about $1^{1}/_{2}$ in. starting about $1^{1}/_{2}$ in. from the box end (Figures 44 and 45). Accordingly, only one 1-in. lead measurement need be made. The procedure is identical to that discussed in 8.3.3. The lead tolerance is ± 0.003 in. per inch for all sizes.

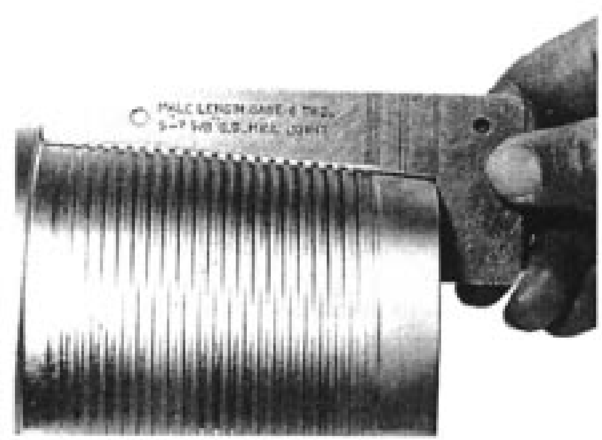


Figure 47—Extreme-Line Length Measurement Using Templates

8.6.3.2 Cumulative Lead Measurement

8.6.3.2.1 External Threads

The cumulative lead is determined over tapers A and B (Figures 44 and 45). For 5 in. through $7^{5}/_{8}$ in., the cumulative lead measurement starts in the fourth thread root from the thread runout adjacent to the seal. For $8^{5}/_{8}$ in. through $10^{3}/_{4}$ in., the cumulative lead measurement starts in the sixth thread root from the thread runout adjacent to the seal. The cumulative lead length and lead tolerance are 2 in. and ± 0.006 in., respectively, for all sizes.

8.6.3.2.2 Internal Threads

The cumulative lead is determined over tapers A and B (Figures 44 and 45). For 5 in. through $7^{5}/_{8}$ in., the cumulative lead measurement starts in the sixth thread root from the open end of the box. For $8^{5}/_{8}$ in. through $10^{3}/_{4}$ in., the cumulative lead measurement starts in the eighth thread root from the open end of the box. The cumulative lead length and lead tolerance are 2 in. and ± 0.006 in., respectively, for all sizes.

Figure 48—Extreme-Line Thread Height Gauge Setting Standard

8.6.4 Taper

Taper is the change in pitch diameter of the thread expressed as inches per foot of thread length. The taper on the extreme-line box shall be measured from crest-to-crest (API Spec 5B). Pin taper is measured root-to-root.

8.6.4.1 Gauge

The following types of gauges are used for measuring taper:

a. External—thread taper caliper (Figure 28).

b. Internal—thread taper gauge for threads $4\frac{1}{2}$-in. OD and larger (Figure 29).

c. Internal micrometer (Figure 49).

The dial gauges are provided with continuous-dial type indicators.

The gauge-recommended contact points are 0.060-in. diameter pin-type having flattened contact ends (Table 10). No dimensional tolerance is necessary for the contact point since it makes no flank contact.

Two different tapers are included in each extreme-line box and pin thread (Figures 44 and 45). Accordingly, each taper shall be located and inspected separately.

The use of the gauges is identical with the procedure discussed in 8.3.4.

8.6.4.2 Applying the Gauge

8.6.4.2.1 External Threads

Taper A for 5-in. through $7\frac{5}{8}$-in. OD (Figure 44) is located $\frac{15}{16}$ in. from the pin shoulder ($1\frac{1}{8}$ in. for $8\frac{5}{8}$-in. through $10\frac{3}{4}$-in. OD), [Figure 45] (in the thread root), and extends 1 in. toward the small end of the pin. Taper B for 5-in. through $7\frac{5}{8}$-in. OD (Figure 44) is located $1\frac{15}{16}$ in. from the pin shoulder ($2\frac{1}{8}$ in. for $8\frac{5}{8}$-in. through $10\frac{3}{4}$-in. OD), Figure 45, in the same thread root as Taper A. It also extends 1 in. toward the seal end of the connection.

The same instructions apply to adjusting the taper gauge (Figures 28 and 31) on each taper (A and B) of the extreme-line thread as apply to round threads. However, the gauge must be adjusted twice, once for each taper. The 1-in. inspection interval shall be determined carefully so the gauge interval includes only one taper.

The pin taper tolerances are:

Outside Pipe Diameter (in.)	Tapers A & B (in. per in.)	
	Minimum	Maximum
5 through $7\frac{5}{8}$	0.123	0.127
$8\frac{5}{8}$ through $10\frac{3}{4}$	0.102	0.106

8.6.4.2.2 Internal Threads

Taper A for 5-in. through $7\frac{5}{8}$-in. OD (Figure 44) is located $\frac{1}{2}$ in. ($1\frac{1}{2}$ in. for $8\frac{5}{8}$-in. through $10\frac{3}{4}$-in. OD), (Figure 45), from the face to the open end of the box on the third thread crest and extends 1 in. toward the seal area. Taper B for 5-in. through $7\frac{5}{8}$-in. OD (Figure 44) is located $1\frac{1}{2}$ in. [$2\frac{1}{8}$ in. for $8\frac{5}{8}$-in. through $10\frac{3}{4}$-in. OD], (Figure 45), from the face of the open end of the box (the same thread crest as the small diameter of Taper A). This taper also extends 1 in. toward the seal end of the connection.

The round thread instructions for taper inspection also apply to the extreme-line threads with the exception that two separate inspections must be made (Tapers A and B). Additionally, the inspection is made from crest-to-crest (Figure 49).

8.6.4.2.3 Internal Micrometer

The internal micrometer (Figure 49) cannot be zeroed. Accordingly, the difference is read between the internal diameters (crest-to-crest) one inch apart.

The crest-to-crest tapers for the box member are:

Measurement of Extreme-Line Thread Taper

Outside Pipe Diameter (in.)	Taper (in. per in.)			
	A		B	
	Minimum	Maximum	Minimum	Maximum
5 through $7\frac{5}{8}$	0.123	0.128	0.123	0.127
$8\frac{5}{8}$ through $10\frac{3}{4}$	0.102	0.107	0.102	0.106

8.6.5 Thread Width

Thread width is the measure of (a) the spacing between thread flanks and (b) the shape of the thread groove.

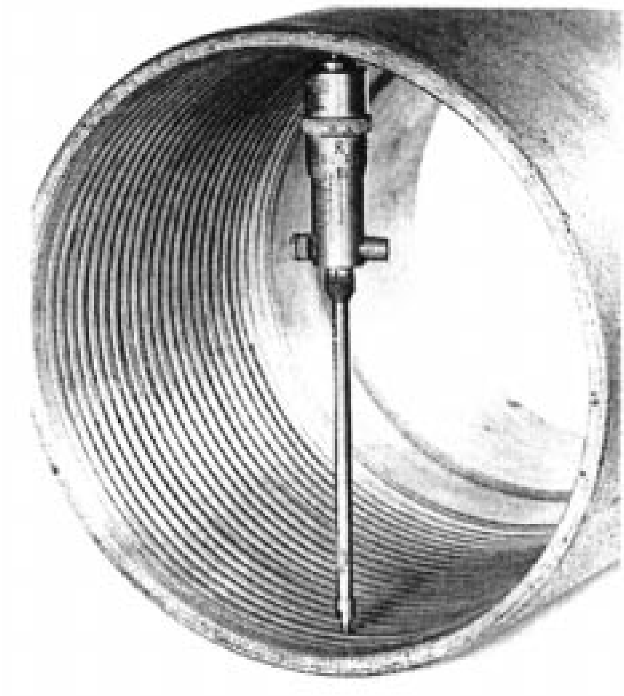


Figure 49—Internal Micrometer Fitted with Flat Contacts for Crest-to-Crest Measurement

8.6.5.1 Gauges

Thread width is inspected using a Go-No-Go gauge (Figure 51) or thread microscope (Section 9). Two sizes of Go-No-Go gauges are required: one gauge for 6-thread products (5 in. through $7^{5}/_{8}$ in.) and another for 5-thread products ($8^{5}/_{8}$ in. through $10^{3}/_{4}$ in.). Inspection need be made at only one point on the thread, preferably at or near the intersection of tapers A and B.

8.6.5.2 Applying the Gauge

External and internal thread widths can be measured using the same Go-No-Go gauge (Figure 50) or by using the thread contour microscope. The Go-No-Go gauge is more convenient to use that the microscope. Accordingly, it will be discussed here. The tips of the Go-No-Go gauge are coated with Prussian blue so thread root-to-gauge contact can be noted. The No-Go end of the gauge, after bluing, is inserted into the full depth thread on the longitudinal inspection line (Figure 16) near the intersection of tapers A and B ($1^{15}/_{16}$ in. from the pin shoulder for 5 in. through $7^{5}/_{8}$ in., $2^{1}/_{8}$ in. from the pin shoulder for $8^{5}/_{8}$ in. through $10^{3}/_{4}$ in.). Contact between the gauge end and the thread root bottom should not occur. Thus, no bluing should be transferred to thread root bottom. Remove gauge and observe to verify that no bluing was transferred.

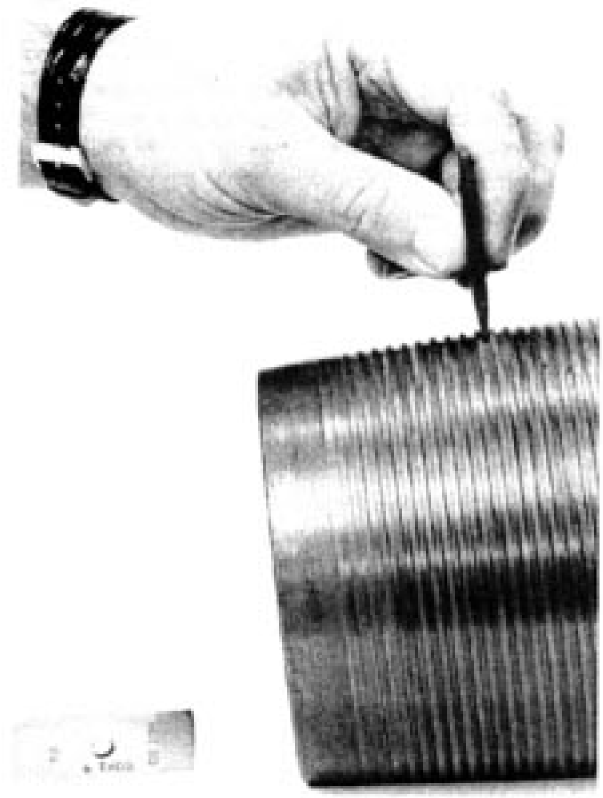


Figure 50—Extreme-Line Thread Width Go-No-Go Gauge

Invert the gauge. The Go end of the gauge, after bluing, is inserted into the thread root at the same place as the No-Go gauge. Contact between the gauge end and the thread root should occur. Thus, bluing should be transferred to the thread root. Remove gauge and observe to verify that the bluing was transferred.

The thread width is satisfactory if both above conditions are satisfied.

8.6.6 Standoff

Standoff is the distance measured axially between the end of the pipe or box and a fixed position on the ring or plug gauge. The proper diametrical size of the thread and seals is measured using ring and plug gauges (Figures 51 and 52) in conjunction with Go-No-Go gauges. Extreme-line ring and plug gauges are provided for each size of casing to be inspected. However, the different Go-No-Go feeler gauges (Figures 51 and 52) may be required for various weights per foot of casing (Table 18). Each feeler gauge has the ability to measure four dimensions across the faces (Figures 53 and 54).

The same levels of gauges exist for extreme-line threads as for round thread gauges. Again, inspection is made with the working gauge unless a dispute arises.

Figure 51—Extreme-Line Thread Ring Gauge with Sliding Seal Gauging Ring

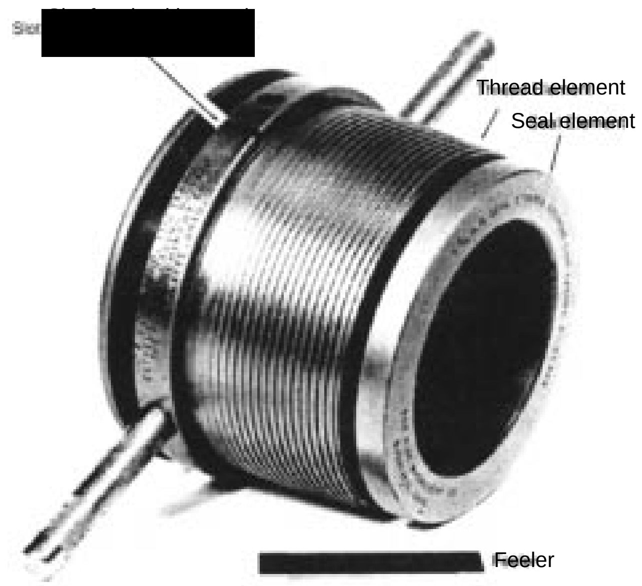


Figure 52—Extreme-Line Thread Plug Gauge with Sliding Seal Gauging Element

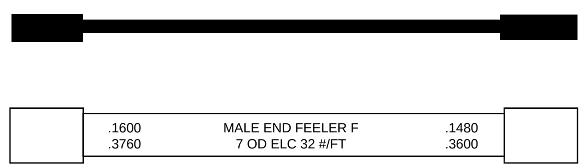


Figure 53—Go-No-Go Feeler Gauge for Extreme-Line Ring Gauge

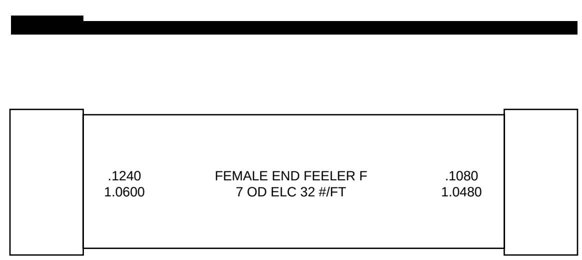


Figure 54—Go-No-Go Feeler Gauge for Extreme-Line Plug Gauge

8.6.6.1 External Threads—Ring Gauge

The extreme-line ring gauge is a two-element gauge (Figure 51). One element gauges the thread diameter. The other element makes contact with the curved seal near the small end of the pin (Figures 43 and 45). The seal contact surface of the gauge is coated with Prussian blue before mating the gauge with the thread to be inspected. Bluing is not required each time the ring gauge is used. Generally, bluing is performed when a seal problem is suspected.

The gauge is advanced onto the thread while the seal gauge ring is fully retracted (pulled away from the pipe thread). Additionally, the thread ring gauge is advanced while applying axial back pull (pulling away from the pipe) so all clearance is removed between the makeup flanks of the gauge and the threads of the product. The seal ring is rotated and pushed (advanced) into contact with the pin seal using the heels of the hands after the thread ring gauge is installed hand-tight. The seal ring will mark the seal tangent point as a blue line so that length measurement (Figures 44 and 45) can be performed after removing the ring gauge. Additionally, a continuous line of blue shall be observed on the pin seal for the member to be acceptable.

To measure the *thread diameter,* insert the Go-No-Go gauge (Figure 53) between the front of the ring gauge and the product pin shoulder (Figure 55). The smaller of the wide ends of the Go-No-Go gauge shall slip into the space, but the larger end must not enter the space. If these conditions are satisfied, the pin member thread diameter is acceptable.

To measure the *seal diameter,* insert the Go-No-Go gauge (Figure 53) (now turned 90°) between the end of the pin and seal element face (Figure 56). The small end of the Go-No-Go gauge must slip into the space at the end of the slide pin, but the large end shall not enter this space. If these conditions are satisfied, the pin member seal diameter is acceptable.

The product pin seal contact surface shall have a continuous ring of bluing observed after the ring gauge is removed. Otherwise, the pin is not acceptable.

When the seal gauge is advanced into position, the gauge will be secured onto the pin. Thus, the gauge handles should be struck a sharp blow with the heels of the hands to unthread the gauge.

8.6.6.2 Internal Threads—Plug Gauge

The extreme-line plug gauge is a two-element gauge (Figure 52). One element gauges the thread diameter. The other element makes contact with the straight seal near the small end of the box (Figures 44 and 45). The seal contact surface of the gauge is coated with Prussian blue before mating the gauge with the box to be inspected. The seal need not be blued each time the gauge is used. Generally, bluing is performed when a seal problem is suspected.

The gauge is threaded into the box element while the seal element is fully retracted (pulled away from the pipe). Additionally, the thread plug gauge is advanced into the box element while applying axial back-pull (pulling away from the pipe) so all clearance is removed between the makeup flanks of the gauge and the threads of the box element. The seal plug is pushed and rotated (advanced) into contact with the box element seal using the heels of the hands after the thread plug gauge is installed hand-tight. The seal plug will transfer the Prussian blue to the seal surface of the box. There shall be a continuous contact line of bluing on the seal surface of the box for the product to be acceptable. This contact line may be observed after the gauge is removed from the box element.

Table 18—Go-No-Go Feeler Gauge Dimensions for Extreme-Line Ring and Plug Gauges

1	2	3	4	5	6	7	8	9	10
		Gauge to Product Standoff (in.)							
		Ring to Pin				Plug to Box			
	Nominal	Seal		Thread		Seal		Thread	
OD Size (in.)	Weight (lbs/ft)	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
5	15.00	0.144	0.156	0.326	0.342	1.042	1.054	0.720	0.880
	18.00	0.144	0.156	0.326	0.342	1.042	1.054	0.720	0.880
	15.50	0.139	0.151	0.310	0.326	1.039	1.051	0.060	0.076
	17.00	0.139	0.151	0.310	0.326	1.039	1.051	0.060	0.076
$5^1/_2$	20.00	0.139	0.151	0.310	0.326	1.039	1.051	0.060	0.076
	23.00	0.136	0.148	0.306	0.322	1.036	1.048	0.056	0.072
	24.00	0.148	0.160	0.358	0.374	1.048	1.060	0.108	0.124
$6^3/_8$	28.00	0.145	0.157	0.354	0.370	1.045	1.057	0.104	0.120
	32.00	0.142	0.154	0.350	0.366	1.042	1.054	0.100	0.116
	23.00	0.151	0.163	0.364	0.380	1.051	1.063	0.112	0.128
	26.00	0.151	0.163	0.364	0.380	1.051	1.063	0.112	0.128
	29.00	0,151	0.163	0.364	0.380	1.051	1.063	0.112	0.128
7	32.00	0.148	0.160	0.360	0.376	1.048	1.060	0.108	0.124
	35.00	0.145	0.157	0.356	0.372	1.045	1.057	0.104	0.120
	38.00	0.145	0.157	0.356	0.372	1.045	1.057	0.104	0.120
	26.40	0.157	0.169	0.350	0.366	1.057	1.069	0.104	0.120
$7^5/_8$	29.70	0.157	0.169	0.350	0.366	1.057	1.069	0.104	0.120
	33.70	0.154	0.166	0.346	0.362	1.054	1.066	0.100	0.116
	39.00	0.151	0.163	0.342	0.358	1.051	1.063	0.096	0.112
	32.00	0.160	0.172	0.355	0.374	1.060	1.072	0.106	0.125
$8^5/_8$	36.00	0.160	0.172	0.355	0.374	1.060	1.072	0.106	0.125
	40.00	0.157	0.169	0.350	0.370	1.057	1.069	0.101	0.120
	44.00	0.154	0.166	0.346	0.365	1.054	1.066	0.096	0.115
	49.00	0.151	0.163	0.341	0.360	1.051	1.063	0.091	0.110
	40.00	0.160	0.172	0.355	0.374	1.060	1.072	0.106	0.125
	43.50	0.160	0.172	0.355	0.374	1.060	1.072	0.106	0.125
$9^5/_8$	47.00	0.160	0.172	0.355	0.374	1.060	1.072	0.106	0.125
	53.50	0.154	0.166	0.346	0.365	1.054	1.066	0.096	0.115
	45.50	0.154	0.166	0.346	0.365	1.054	1.066	0.096	0.115
	51.00	0.154	0.166	0.346	0.365	1.054	1.066	0.096	0.115
$10^3/_4$	55.50	0.154	0.166	0.346	0.365	1.054	1.066	0.096	0.115
	60.70	0.154	0.166	0.346	0.365	1.054	1.066	0.096	0.115

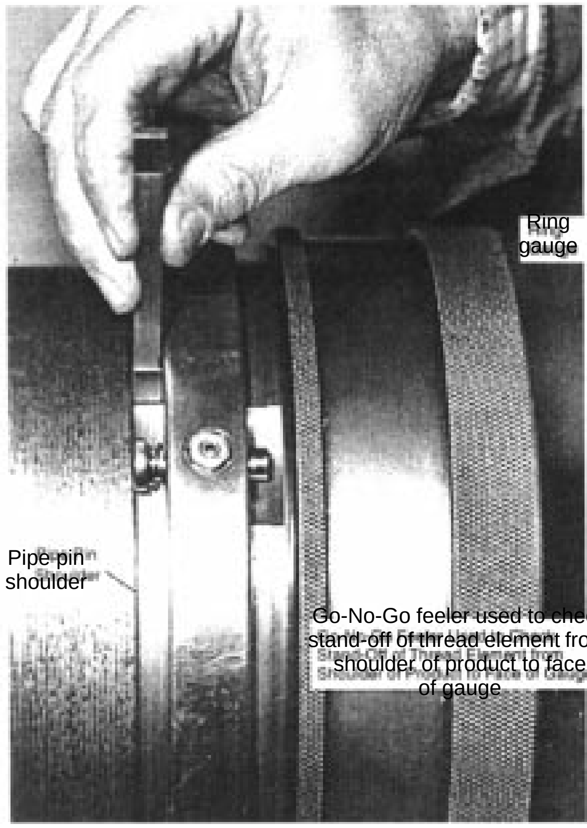


Figure 55—Extreme-Line Thread Ring Gauge Installed Hand-Tight and Seal Ring Advanced (Note use of Go-No-Go Gauge)

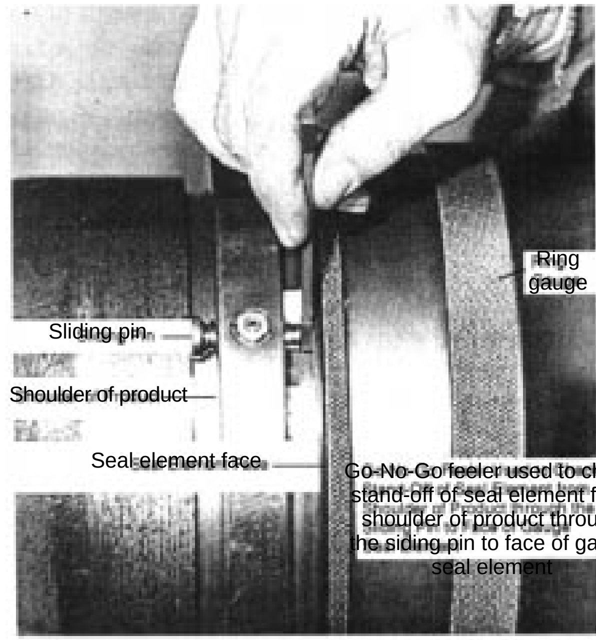


Figure 56—Extreme-Line Thread Ring Gauge Installed Hand-Tight and Seal Ring Advanced. (Go-No-Go in Place for Measuring Seal Diameter)

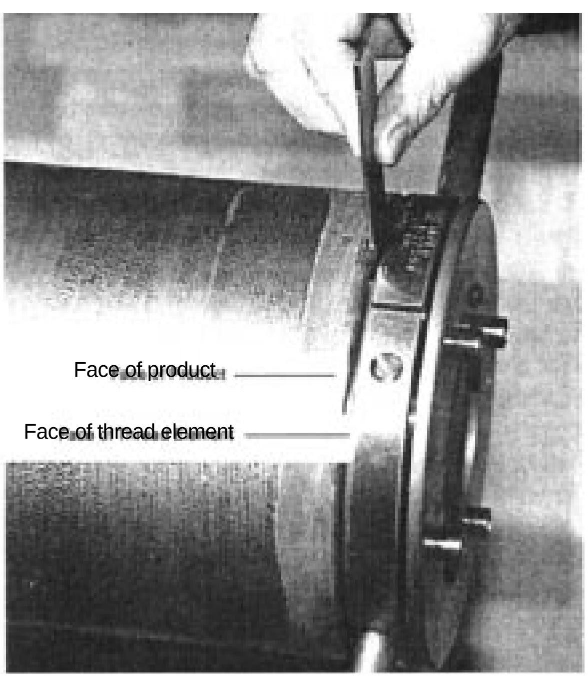


Figure 57—Extreme-Line Thread Plug Gauge Installed Hand-Tight and Seal Plug Advanced (Note use of Go-No-Go Gauge.)

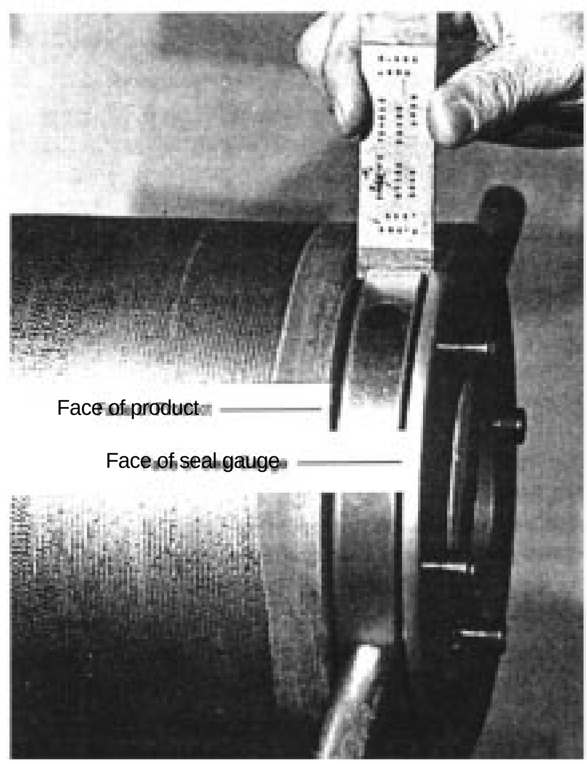


Figure 58—Extreme-Line Thread Plug Gauge Installed Hand-Tight and Seal Plug Advanced (Go-No-Go in Place for Measuring Seal Diameter)

To measure the *thread diameter*, insert the Go-No-Go gauge (Figure 54) between the plug-gauge thread element and the end of the box member (Figure 57). The smaller end of the Go-No-Go gauge shall slip into the space, but the larger end shall not enter. If these conditions are satisfied, the box member thread diameter is acceptable.

To measure the *seal diameter*, insert the Go-No-Go gauge (now turned 90°) into the slot provided in the plug gauge (Figures 52 and 58) between the end of the product box member and the face of the seal gauge element (Figure 58). The smaller end of the Go-No-Go gauge shall slip into the slot, but the larger end shall not enter this slot. If these conditions are satisfied, the box member seal diameter is acceptable.

The product box seal contact surface must have a continuous ring of bluing observed after the plug gauge is removed. Otherwise the box member is not acceptable.

When the seal element is advanced into position, the plug gauge will be secured onto the box member. Thus, the gauge handles should be struck a sharp blow with the heels of the hands to unscrew the gauge.

9 Supplemental Measurements

9.1 THREAD CONTOUR MICROSCOPE

Thread forms and angles can be examined by the thread contour microscope (Figure 59). These microscopes are manufactured by several companies. Each style is different in configuration and operation. Therefore, no attempt is made here to describe the operation of the microscope. Instead, refer to the manufacturer's instructions supplied with the microscope.

Use the thread contour microscope to examine flank angles or thread forms of external thread. The microscope is fitted to the thread in accordance with the manufacturer's instructions (Figure 59), a thread form template is installed and adjusted to conform to the thread being inspected, and the error, if any, is read on the scale provided.

To use the microscope for internal threads replicate the thread with material such as plaster of Paris. The replicate is viewed in the microscope as a negative image of the product thread.

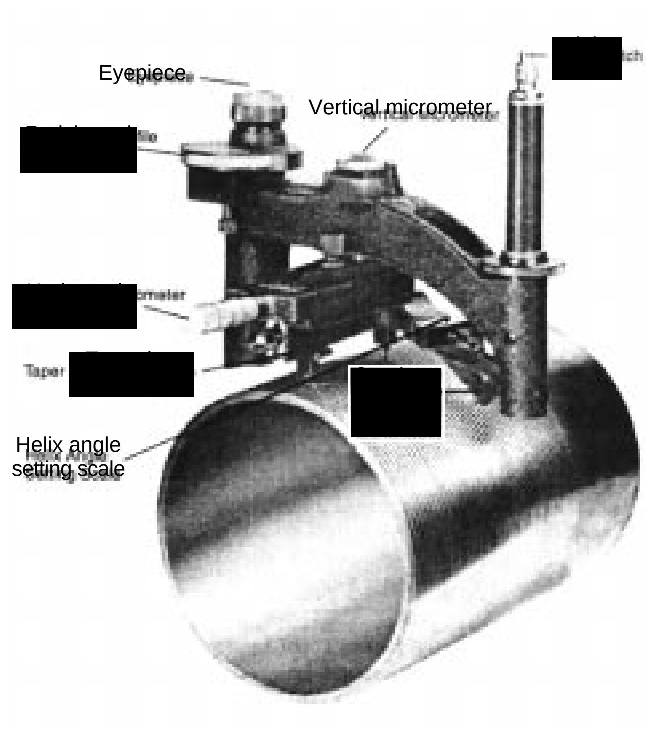


Figure 59—Thread Contour Microscope

9.2 SEAL-RING GROOVE RELATIVE DEPTH AND CONCENTRICITY GAUGING

Use a thread height gauge with a flat-type tip. With the anvil of the gauge resting on the thread crests and the penetrant in the seal-ring groove against the side nearest the center of the coupling, read radial depths from the thread crests to the seal-ring groove bottom on selected increments over the circumference of the groove (Figures 60 and 61). Avoid placing anvil near featheredge fade-outs. If the maximum differences in indicated reading exceed 0.020 in., the coupling is rejected. Alternate contact tip configurations are shown in Figure 62.

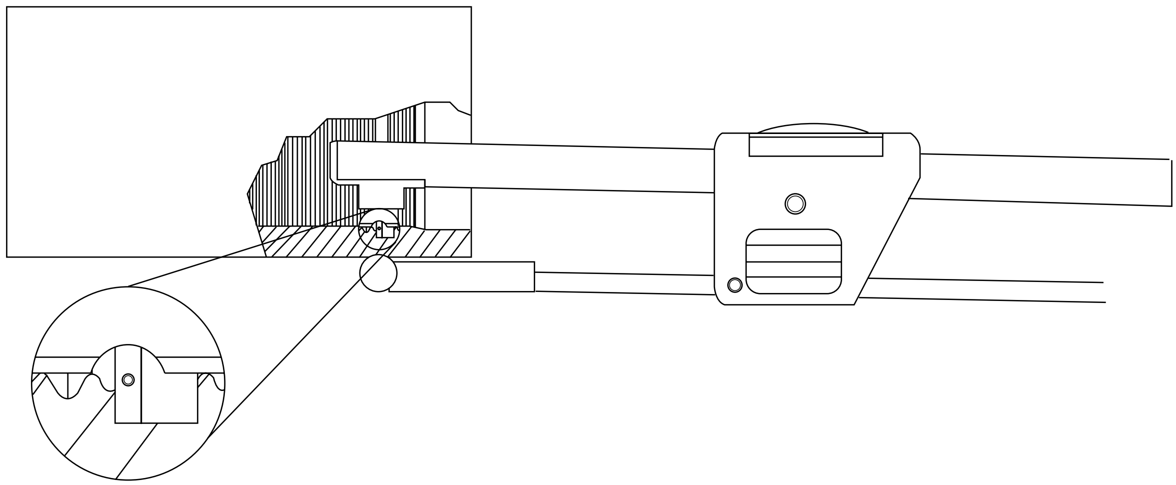


Figure 60—Gauging of Tubing Coupling Grooves

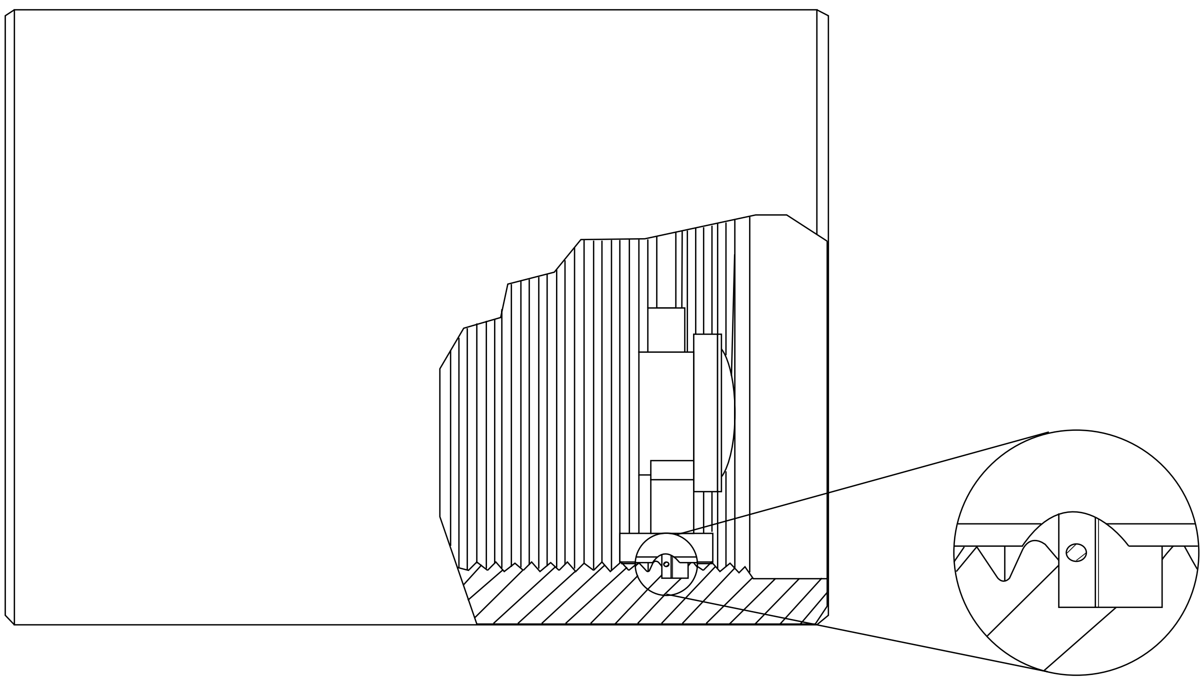


Figure 61—Gauging of Casing Coupling Grooves

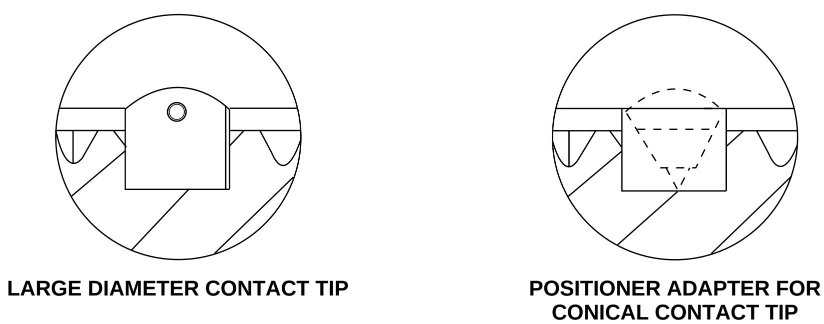


Figure 62—Detail of Alternate Acceptable Contact Tip Configurations

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