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UNIFIED SCREW THREADS UN, UNR, UNK AND UNJ

INTRODUCTION

The Unified Screw Thread Standard is an integrated system of threads for fastening purposes. Since its adoption in 1948, and later extension of unification into smaller sizes, Unified screw threads have almost completely replaced and superseded the American National screw threads. The Unified thread system has been approved and adopted for use by all inch-using countries. "UN" in the thread symbol identifies the Unified thread sizes. Currently the system includes the UN, UNR, UNK and UNJ screw thread forms. Following is a simplified guide explaining the basic differences in UN, UNR, UNK and UNJ screw thread forms.

When new screw thread forms such as UNR, UNK and UNJ are developed to meet the needs of industry and the services, everyone concerned with fasteners should be made aware of these forms as soon as possible. However, it would not be unusual for years to elapse before final documented standards are published covering all the details required for the proper manufacture and control of such screw thread forms. In the meantime, false rumors and assumptions may arise concerning these threads, or the particular standards committee involved in establishing the standards may modify the original concepts.

For these reasons the American National Standards Institute (ANSI) Committee B1 has made available an interim identification guide for 60° screw threads (Page M—6). It is hoped that this guide or a current modification of it will appear in front of each new or revised screw thread standard produced by AN Committee B1 in the future.

The 60° screw thread identification guide answers many questions about differences, as well as similarities, among the several types of 60° screw threads now standardized or in the process of being standardized by Committee B1. It references existing ANSI Standards for screw threads and drafts of proposed standards for those threads now being considered by ANSI. The guide also previews the current intent for the profiles of those threads now in the process of standardization.

Manufacturers of screw threads are cautioned that this identification guide is **not a screw thread standard**. To produce screw threads identified in this guide, it is necessary to refer to the appropriate American National Standards Documents as indicated. Producing screw threads when standards documents are not yet available, invites the risk of not meeting requirements when such standards are published.

It has aptly been said that where too many conflicting standards exist, there is, in reality, no standard at all. This is why it is important to recognize the difference between a true universal "standard" and a "procurement document" which must necessarily be more limited in its application.

External Thread Forms

As the 60° screw thread identification guide shows, there are four types of 60° external screw threads, all of which could have root radii, but only three of which **must** have root radii.

The more familiar Unified (UN) external thread may have a flat root so long as the flat is no smaller in width than .125p. The same thread also may have a full radius root or combination of flat and rounding, so long as it clears a width of .250p, above which point the 60° thread form with 30° flank angles must be maintained. There is no tolerance specified for the minor diameter of UN external threads since this is taken care of

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by the widths of clearance and minimum flat permitted.

The UNR external thread form is similar to the UN in all respects including tolerances, except that the root **must be rounded**. A flat root is not permissible for UNR threads.

The UNK external thread form is similar in appearance to that of the UNR, except that the root radius and minor diameter must be inspected within the limits specified.

The UNJ external thread form is inspected in a manner similar to that for the UNK, except that the specified root radii are larger, thus creating a larger minor diameter.

Tools and Gages (external threads)
(See also Page M—24.)

Tools for producing UN external threads may have flat or rounded crests. Tools for producing UNR, UNK or UNJ external threads must have radius crests. The radius crests on tools for UNR and UNK would also produce UN external threads within the limits allowed, but UNJ external threads require larger radii on the tool crests than those on tools for UNR, UNK or UN external threads.

The same GO thread ring gage for a specific class of fit (for example, Class 3A) could be used for checking UN, UNR and UNK threads. This same gage could also be used for UNJ threads if the minor diameter of the gage were reworked to the larger diameter necessary to clear the enlarged root radius present in UNJ external threads.

While a LO (Not GO) thread ring or snap gage is used for UN and UNR threads, only snap or indicating gages are used for a minimum-material check of UNK and UNJ threads. For checking conformance of lead and angle, the appropriate gaging standards should be consulted.

Internal Thread Forms

The UN and UNJ internal 60° screw threads are similar in appearance, and neither has root radius requirements. The basic differences between these internal threads are the depth of the thread form and the tighter lead and angle control for the UNJ form. The UN internal thread depth will assemble with UN, UNR or UNK external threads, but could interfere with the enlarged root radius of the UNJ external thread if assembly were attempted. The UNJ internal thread, therefore, is designed with a larger minor diameter than that of the UN internal thread.

Tools and Gages (internal threads)
(See also Page M—24.)

The crests of tools for producing UN and UNJ internal threads are the same, and no radii are required. The same ground thread tap used to produce a Class 3B UN internal thread also is used to produce a Class 3B UNJ internal thread. A UNJ 3BG internal thread, however, requires a larger tap size than that used for the Class 3B threads.

However, the same tap drill hole limits used for Class 3B UN internal threads do not apply to UNJ. The UNJ internal thread is held to its own tap drill hole limits, and it is important that the minimum minor diameter be checked after tapping to make sure that burrs or spindown will not interfere with assembly. For this purpose, a special full-form UNJ GO thread plug gage, with a root radius simulating the maximum-material condition of the UNJ external thread form, can be used.

The same GO thread plug gage for a specific fit (for example, Class 3B) could be used for checking both UN and UNJ threads. This rule would also apply to the HI (Not GO) thread plug gage of the same class. UNJ 3BG threads would, however, require over-size gages in each case. For checking conformance of lead and angle, the appropriate gaging standards should be consulted.

Assembly

UN external threads are generally mated with UN internal threads for most common applica-

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UN, UNR, UNK AND UNJ

tions. Although UN external threads would also fit into UNJ internal threads, no advantage is gained in such an assembly, because the strength characteristics would usually be no better than those obtainable with the more economical UN internal thread.

UNR external threads have a stronger root form and, when thread rolled, are generally no more costly to produce than UN threads. They are generally mated with UN internal threads for the same reasons given above for UN external threads.

UNK external threads have a radius root form with greater control than that used for UNR threads. Their angle and lead are held to closer tolerances, similar to those of UNJ threads. Mating UNK external with UN internal threads might tend to nullify the advantage of their closer angle, lead, and other tolerances—and even more so when they are made from harder rather than ductile materials. When made from harder materials, therefore, UNK screws can be mated with UNJ internal threads to realize their maximum potential.

UNJ external threads, with their enlarged radius root, form and greater control and closer lead and angle tolerances, develop maximum strength for the most critical applications. Not designed to be assembled with UN internal threads, they should always be mated with a UNJ internal thread.

Future Use

As implied in the above discussion and the Committee B1 identification guide, there are or soon will be ANSI Standards covering a much larger selection of 60° screw threads than previously. Each thread is designed for specific applications. Hence, no one type is expected to replace another in the near future, except in limited fields or for certain methods of screw thread production.

IDENTIFICATION OF 60 DEGREE SCREW THREADS (WITHIN THE SCOPE OF AN STANDARDS COMMITTEE BI)

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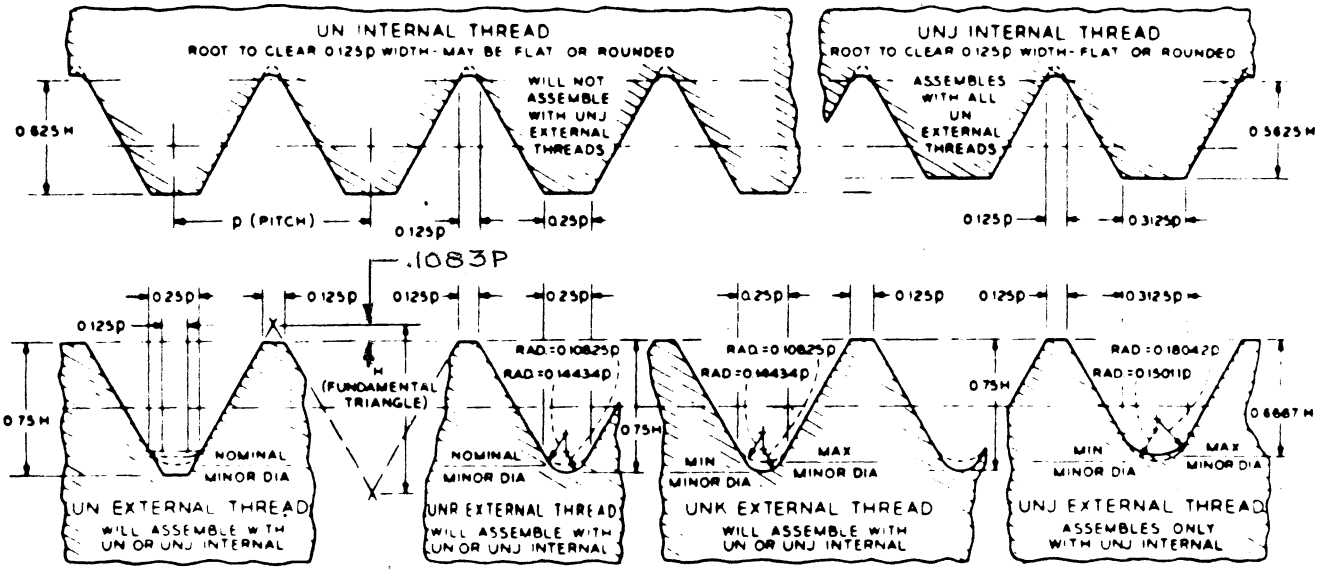
This page is not a screw thread standard, should not be used as a working sheet, and should only refer the reader to the proper ANSI Standards document wherein the full thread details on working data are contained.

60° SCREW THREAD NOMINAL FORMS (SEE ANSI STANDARDS FOR FURTHER DETAILS)



THREAD IDENTIFICATION	UN THREADS	UNR THREADS	UNK THREADS	UNJ THREADS
	Internal and External	External Only	External Only	Internal and External
ANSI[1] STANDARDS DOCUMENTS	Unified Screw Threads B1.1–1960 (See Page M–7) Metric Translation B1.1a–1968 Gages and Gaging for Unified Screw Threads B1.2–1966	Unified Screw Threads B1.1–1960 (See Page M–7) Metric Translation B1.1a–1968 (Draft) UNR Addendum to B1.1–1960 (See Page M–19) Gages and Gaging for Unified Screw Threads B1.2–1966	(Draft) B1.14 for Form and Conformance	(Draft) B1.15 for Form and Conformance (No Radius Required on Internal Thread)
EXTERNAL ROOT	External Thread Root may be Flat or Rounded	External Thread Root Radius Required	External Thread Root Radius Mandatory Check Required	External Thread Root Radius Mandatory Check Required
EXTERNAL MINOR DIAMETER	External Thread Minor Diameter is not Toleranced	External Thread Minor Diameter is not Toleranced	External Thread Minor Diameter is Toleranced	External Thread Minor Diameter is Toleranced
EXTERNAL THREADS	UN Classes 1A, 2A and 3A	UNR Classes 1A, 2A and 3A	UNK Classes 2A and 3A	UNJ Class 3A Mates only with UNJ Internal Threads
INTERNAL THREADS	UN Classes 1B, 2B and 3B	No Internal Threads Designated UNR UNR Mates with UN Internal Thread	No Internal Threads Designated UNK Mates with UN or UNJ Internal Thread	UNJ Classes 3B and 3BG (No Radius Required on Internal Thread)
ANGLE AND LEAD TOLERANCE	Individually Equivalent to 50% of P.D. Tolerance Checked only when Specified	Individually Equivalent to 50% of P.D. Tolerance Checked only when Specified	Individually Equivalent to 40% of P.D. Tolerance Mandatory Check Required	Individually Equivalent to 40% of P.D. Tolerance Mandatory Check Required

NOTES: 1. Refer to the appropriate Standards, as listed, for complete thread details and conformance data. The appropriate current Standard is the authoritative document for complete details and data, and takes precedence over this sheet.

2. These Standards may be obtained through ASME.

1970
Addendum to
ANSI B1.1
1960

UNR SCREW THREADS

Unified thread specifications provide for external threads with either a flat thread root or a rounded thread root. The USA adopted the flat root option, full details being given in ANSI B1.1—1960.

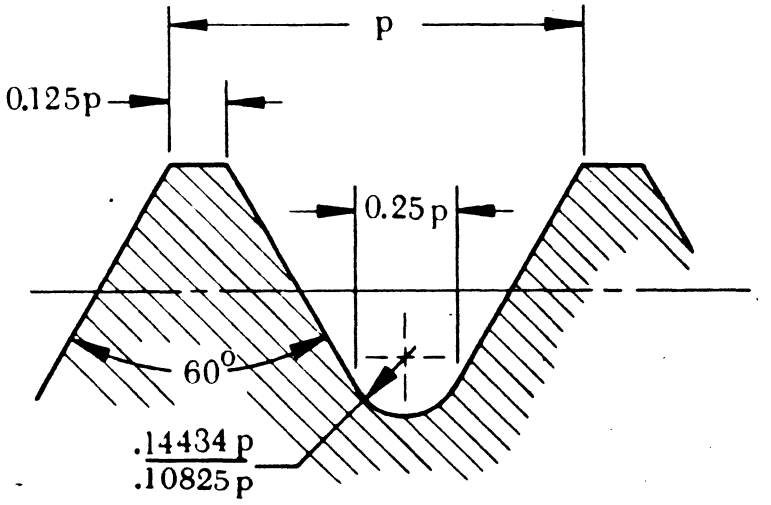
The need in the USA for commercially threaded parts having external threads with a mandatory radius root for assembly with UN internal threads increased steadily, and symbol UNR was selected to specify UNIFIED external threads having a mandatory radius root but otherwise to the requirements specified in ANSI B1.1—1960. The design form of the UNR thread is shown below.

External Thread

UNR threads provide higher resistance to fatigue than UN threads and are better suited for use with materials that are high in notch sensitivity. UNR threads may be specified for all B1.1 diameter-pitch combinations, and tolerance classes 1A, 2A and 3A. Tolerances and allowances are the same as for UN threads of the same diameter, pitch and class. Values for .10825 p and .14434 p are tabulated in ANSI B1.1—1960, Table 13. (See complete ANSI B1.1 Standard for this information.)

Conformance of size at maximum material limit is determined by the use of GO thread ring gages as specified in ANSI B1.2—1966. Conformance of size at minimum material limit is determined by the use of LO thread ring gages for Classes 1A and 2A, and by the use of LO thread snap gages for Class 3A as specified in ANSI B1.2—1966, however, the root is to be checked for the presence of a rounded contour. This can be accomplished by optical methods without the need to check the radius limits. Angle and lead variations permitted are based on ANSI B1.1—1960 requirements.

There are no UNR internal threads specified since UNR external threads are designed to assemble with UN internal threads as specified on Pages M—14 through M—18.



EXTERNAL THREAD

Acceptability of Screw Threads

In the manufacture of threads, it is necessary to control the material limits of size and the various thread elements so the threads produced will be acceptable with final conformance gages. It is intended that the diameter equivalent of deviation in any single thread element, such as lead or pitch (including uniformity of helix) and flank angle, for all classes of external and internal threads, should not consume the permissible specified percentage of the pitch diameter tolerance. Also, included within the material limits of size are other deviations such as taper, out of roundness and surface defects.

Maximum Material Limits

Maximum Size External Thread
Minimum Size Internal Thread

The dimensional acceptability for maximum material limits of size for all thread classes is based on gaging with GO thread ring and GO thread plug gages. These functional limit thread gages are used for final conformance checking of a thread and insure assemblability of mating parts by preventing such deviations as lead, helix, flank angle, taper, out of roundness and surface defects from interfering with assemblability.

GO thread ring gages provide an envelope conforming to the maximum-material limit of the product external thread and also a cumulative check of all thread elements except major diameter.

GO thread plug gages provide a cumulative check of all thread elements of a product internal thread except minor diameter and conform to the maximum-material-limit of the product internal thread.

GO thread ring and thread plug gages must turn freely for the full length of the product thread. It should be appreciated, when for economic reasons, snap or indicating gages are used to check maximum material limits of a product external thread with functional gaging elements similar to a GO thread ring gage, the measurements obtained do not necessarily conform to dimensional acceptability. The setting of these gages should be related to the size of the product thread accepted by a GO thread ring gage since indicating or snap gages do not always provide for deviations in cylindricity prevailing in the product thread.

The values yielded for the complete length of the product thread, when checked with an indicating thread gage utilizing gaging elements to determine Functional Diameter, should at no point along the thread exceed the specified maximum-material-limit.

GO plain cylindrical ring, snap or indicating gages must pass over the full length of the major diameter to assure that the major diameter of the product thread is acceptable and does not exceed the maximum major diameter limit. GO plain cylindrical or indicating plug gages must enter the full length of the internal thread to assure that the minor diameter does not exceed the minimum minor diameter limit.

Full form GO thread plug gages may be used also for gaging maximum material limits of internal UNJ threads. The use of full form threaded plug gages eliminates the requirement for a minimum minor plain plug gage check. Full form gages are made to the maximum material limits of the product external thread with a plus gagemakers tolerance. Full form threaded plug gages may be used also as a referee gage for minimum minor diameters.

Where out of roundness exists on a major diameter of an external thread, or when a major diameter of an external thread is not concentric with the pitch diameter, no portion of a major diameter should extend outside a maximum major diameter concentric with the pitch diameter. Also, where out of roundness exists in a minor diameter of an internal thread, no portion of a minor diameter should extend below a minimum minor diameter limit for size.

Minimum Material Limits

Minimum Size External Thread
Maximum Size Internal Thread

In view of the inter-relation of the elements affecting pitch diameter, deviations such as lead (including uniformity of helix) and flank angle

together with practical considerations affiliated with established production processes, product application and inspection procedures, it is customary to base acceptance at minimum material condition for UN Classes 2A and 2B threads on thread ring and thread plug gaging for various, mass produced bolts, screws, nuts and other similar fasteners and some custom threaded parts.

Unless otherwise specified on drawing or procurement document, dimensional acceptance at minimum material limits of size is based on functional gaging practice involving the use of LO thread ring gages for Classes 1A and 2A UN and UNR external threads, and HI thread plug gages for 1B, 2B and 3B UN and 3B UNJ internal threads. The minimum-material-limits for Classes 2A UNK and 3A UNK and UNJ external threads are based on single element gaging practice involving the use of LO thread snap or indicating gages with gaging elements of not more than two pitches in length.

NOT GO plain cylindrical ring, snap or indicating gages must not pass over any portion of the product external thread length to assure that the minimum-material-limit is not exceeded. NOT GO plain cylindrical plug or indicating gage must not enter any portion of the product internal thread to assure that the minimum material limit is not exceeded.

Verification of Product Thread Size

It is intended that diameter equivalents of any given elements (except pitch diameter), such as lead, including uniformity of helix, or flank angle deviations, shall not exceed more than 0.5 of the pitch diameter tolerances for all classes of UN and UNR threads and for lengths of thread engagements not exceeding 1-1/2 nominal diameters, or 15 pitches, depending upon the thread series. UNK Classes 2A and 3A and UNJ threads, Classes 3A and 3B, limit lead and flank angle deviations to 0.4 of the pitch diameter tolerances.

Tolerances for lead, flank angle and pitch diameter may be taken independently for each of these elements and also may be taken to the full extent allowed by the respective acceptable gaging practice. The tolerance on any one element must not be exceeded even though deviations in the other elements are smaller than the tolerance for those elements.

Dimensional acceptability at maximum and minimum material limits of size for UN, UNR, UNK and UNJ threads is summarized on Pages M—26 and M—27.

GO and LO thread ring gages must be set to applicable W tolerance setting thread plug gages to assure the thread ring gages are within maximum and minimum limits of size.

HI thread plug and LO thread ring gages should not be forced after the drag is definite. Special requirements such as exceptionally thin or ductile material, or small number of threads, may necessitate modification of this practice so as not to distort size.

Material Limits of Size VS. Pitch Diameter Limits

The maximum functional size and minimum material limit of size of a product thread are affected by the permissible deviations of the thread elements, such as lead, flank angle, roundness and surface defects, and the gaging element requirements. It is important to appreciate that the minimum material limits of size of an external product thread may be less than the corresponding minimum pitch diameter limits of size when there are deviations in the thread elements for UN and UNR threads. Also, maximum functional limits of size of internal threads may be larger than the corresponding pitch diameter limits of size when there are deviations in thread elements.

The amount of manufacturing working tolerance available is directly related to the magnitude of deviations in flank angle and lead existing in a product thread. The greater the deviations in lead and flank angle, the less the amount of working tolerance available for diameter size. Diameter working tolerances with LO single element gaging are of much smaller proportion of pitch diameter tolerance than those provided by LO thread ring gages. Taper and out of roundness have the effect of reducing available working tolerances for diameters of both internal and external threads.