

STAINLESS

TECHNICAL BULLETIN

No. 1, April 1997

Stainless Steel Threaded Fittings

For many years, stainless steel low pressure threaded fittings have been manufactured generally to dimensions of cast (ANSI B16.3) malleable iron and wrought steel (BS 1740) fittings standards. These standards have governed the majority of readily available stainless steel products in Australia. Castings have largely been supplied in accordance with ASTM A351 (usually CF8M). High pressure fittings have been manufactured to forged (ASME B16.11) fittings, socket-welding and threaded standards.

The stainless steel industry has, however, seen problems with the supply of low pressure fittings, particularly from substantial manufacturing centres where cast fittings are dimensionally manufactured to American Standards (ANSI B16.3 and B16.14, which are designed to be threaded with a National Pipe Taper thread in accordance with ANSI B1.20.1) and subsequently threaded to R series for male taper and Rp for female parallel as described in Australian Standard AS 1722.1 Part 1 (commonly known as BSPT and BSPP respectively), or G series for females, as in AS 1722.2 Part 2 (commonly known as gas threads).

In practice, R threaded male and Rp threaded female fittings which have been dimensionally manufactured to American Standards will seal provided the threads are cut to adequate depths, but male threads have insufficient length to produce a thread in full compliance with the R series specification. If female parts are machined with a G series thread, there will be conflict between the R and G thread standards. It is likely that inadequate sealing will result.

High pressure (Class 3,000 and 6,000) fittings that are to be threaded in accordance with the NPT standard have also been found to be failing in two areas:

1. Non-compliance with the thread standard by not meeting the essential elements of the thread form; and
2. Insufficient thread engagement of mating male and female threads which meet the standard but could lead to fitting blow-out at moderate to high pressure.

R & G "BSP" Threaded Fittings

The most common pipe threads produced on threaded fittings available in Australia are the R series (used across a broad range of industries), the G series (which predominate in the hydraulics industry), and the NPT series (extensively used in the petrochemical industry).

The R series and the G series are commonly referred to as BSP (British Standard Pipe) threads, but the use of such a common term has given rise to the mismatching of the two thread standards.

R series threads are sealing pipe threads of the Whitworth form as described in AS 1722.1 Part 1. The basic thread form has a 55° flank angle (see Figure 1) and the number of pitch per inch depends upon the size of pipe to be threaded. To effect a seal, the threads are to be connected by either of the following two methods:

1. An R (external male taper pipe thread) screwed together with an Rc (internal female taper pipe thread) (see Figure 2). The cone tapers on both threads are 1 in 16 on diameter, which equates to 1 degree 47 minutes.
2. An R (external male taper pipe thread) screwed together with an Rp (internal female parallel pipe thread) (see Figure 3).

The matching of these threads with the use of a jointing medium (e.g. Teflon thread tape) is sufficient to effect a seal between the mating parts.

It should be noted that the connection between a male taper and a female parallel pipe thread would, theoretically, only make contact at one single point. But, owing to the elasticity of the material, they will, in practice, have a sealing contact on approximately one and a half turns. It is recommended that this method of jointing be limited to moderate pressures - for high pressures, the use of taper on taper threads is recommended.

Figure 1 Basic Whitworth thread form

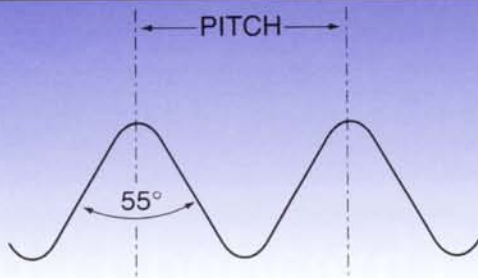


Figure 2 Taper to taper, R and Rc threads

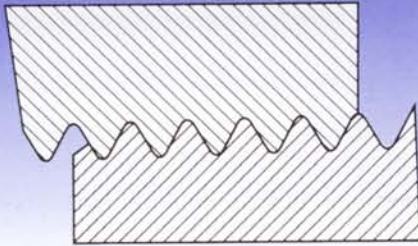


Figure 3 Taper to parallel, R and Rp threads

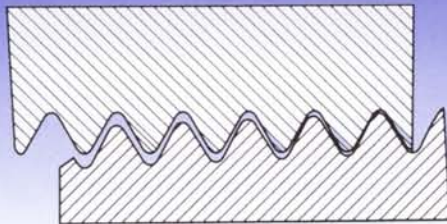
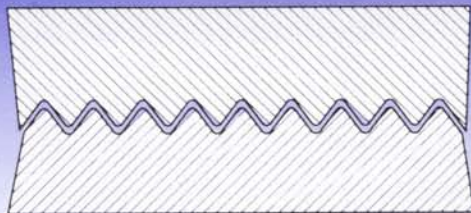


Figure 4 G series pipe threads



G series are fastening pipe threads of the Whitworth form as in AS 1722.2 Part 2. Again, the basic thread form and pitch are common to the R series, but that is where the similarity ends. A seal is not achieved by the threads and another means of sealing must be introduced (e.g. gasket or o-ring). Both the male and female threads are parallel, the female having a positive tolerance and the male having a negative tolerance on the basic diameters, thus producing clearance between the two (see Figure 4).

This combination of threads is used extensively in the hydraulics industry and, with the correct selection of an appropriate sealing material or seal form for the application, high pressures can be maintained.

Equivalent International Standards

Australian Standard AS 1722.1 Part 1

British Standard Institution BS 21
International Standards Organisation ISO 7
Deutsche Industrie-Normen DIN 2999

Australian Standard AS 1722.2 Part 2

British Standard Institution BS 2779
International Standards Organisation ISO 228
Deutsche Industrie-Normen DIN 259

NPT Threaded Fittings

National Pipe Taper (NPT) threads are manufactured to ANSI/ASME B1.20.1, where the basic thread form has a 60° flank angle and the number of pitch per inch is dependent on the pipe size to be threaded. Again, the cone taper on male and female threads is 1 in 16 on diameter or 1 degree 47 minutes, with the flank angle being perpendicular to the centreline axis. The thread form is sharper in appearance than the Whitworth form, incorporating a truncation (flat) rather than a radius on the roots and crests of the thread (see Figure 5).

NPT male and female threads are designed to seal on the flanks of the thread form (see Figure 6). But, with the combination of various tolerances in the form, some crushing of the crests or roots may occur. The use of a thread sealant or lubricant will assist in sealing and also inhibit galling, which is a risk with stainless steel. This combination of threads is used extensively in high pressure applications.

Figure 5 Basic NPT thread form

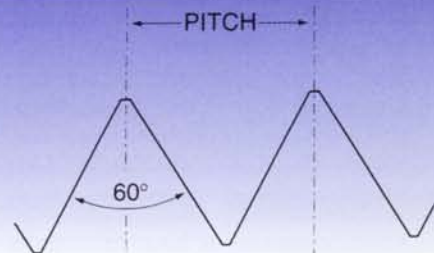
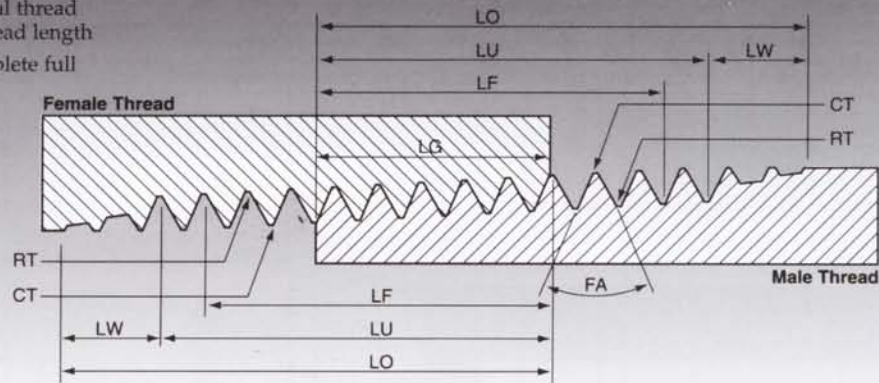


Figure 6 Taper to taper NPT threads



Common Terms used with Threads

- LO = Overall length of thread
- LU = Length of useful thread or effective thread length
- LF = Length of complete full thread form
- LG = Gauge length or hand tight engagement
- CT = Crest of thread
- LW = Length of washout or vanish thread
- RT = Root of thread
- FA = Flank angle



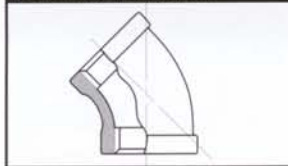
Common Problems when using Threads

1. Pipe sizes 15NB(1/2") and 20NB(3/4") have the same pitch and cone taper angle on R and NPT series threads and may appear to screw together without any mismatch. Please remember the two series of threads are completely different in all other respects and it is recommended that the mixing of the two thread standards *does not* occur.
 2. Joining of an R series male thread with a G series female thread is not recommended. The two thread standards are independent of each other – while the two threads may appear to connect together without any mismatch, problems may occur:
 - (a) The male thread may screw into the female thread further than it has been designed to and a leak may result.
 - (b) The beginning of the male thread may interfere with the end of the female thread. This is a common problem encountered with valves that have been threaded with the G series – usually the female thread length is insufficient to accommodate the male thread.
 3. Fittings originally cast to the American Standards ANSI B16.3 and B16.14 that are designed to be machined with an NPT thread, but are subsequently machined with an R series thread, may cause problems. The length of the fitting as cast is found to be too short to accommodate production of an R series thread to its correct length.
 4. R series threads may lock up in the washout part of the thread. This is easy to check: male threads should have two to three threads of full profile exposed after hand tightened engagement with a female thread. This is to allow the joint to be wrench tightened.
 5. If the Rp threads are machined or tapped oversize, the male thread will engage too deeply and lock up could occur in the washout of the thread or the front face of the fitting could foul with the end of the female thread.
 6. Where NPT male and female threads have been manufactured to maximum and minimum tolerances respectively, the amount of engagement could be limited to as little as one turn. Fittings blow-out may occur with the introduction of high pressure.
 7. NPT threads machined with the incorrect thread form could leak or blow-out.
- If you are concerned about these problems, discuss with your supplier.
- While further information may be obtained from the appropriate standard, ASSDA concedes there are problems in relation to the availability of appropriate standards, particularly for low pressure, or Class 150, stainless steel fittings. Class 150 stainless steel fittings are dimensionally covered by standards such as BS 1740 and ANSI B16.3/MSS SP 114. MSS SP 114 is currently the only standard known to cover cast Class 150 stainless steel fittings.
- ASSDA recognises that this situation is not ideal and is working towards a solution. The Association is currently lobbying the Technical Committee responsible for ISO 4144 for inclusion of cast stainless steel fittings under this title.

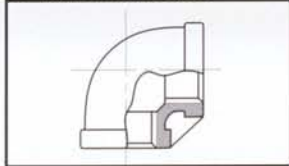
Fittings Commonly Available in Australia

Low Pressure

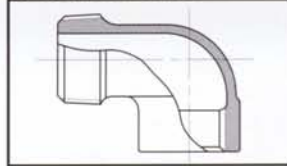
45° female to female elbow



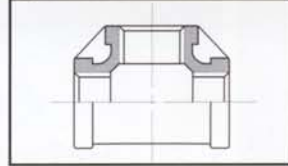
90° female to female elbow



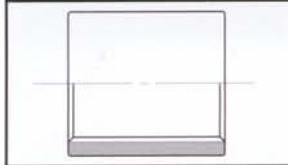
90° male to female elbow



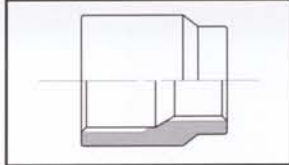
Equal female tee



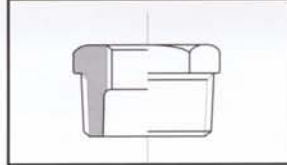
Standard socket



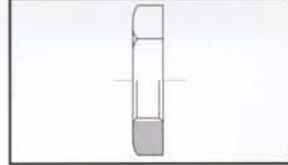
Reducing socket



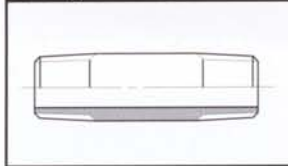
Reducing bush



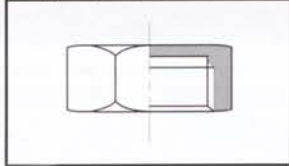
Locknut



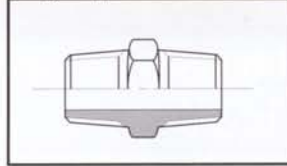
Barrel nipple



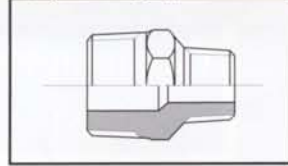
Hexagon cap



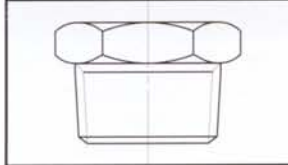
Hexagon nipple



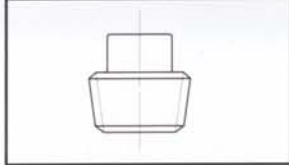
Hexagon reducing nipple



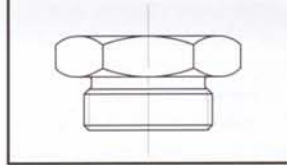
Taper hexagon head plug



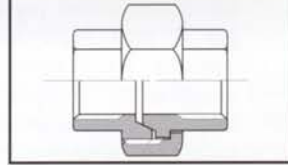
Taper square head plug



Parallel hexagon head plug



Female to female union taper or flat seat

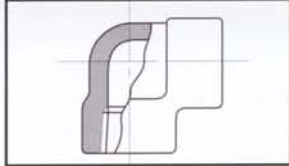


High Pressure

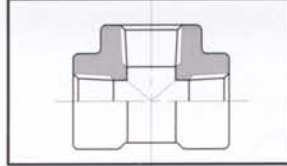
45° female to female elbow



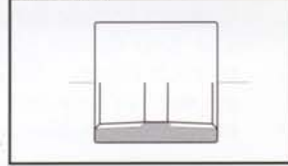
90° female to female elbow



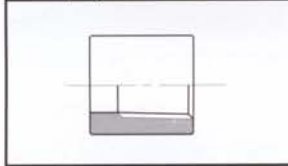
Equal female tee



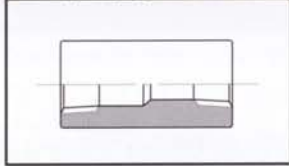
Full coupling



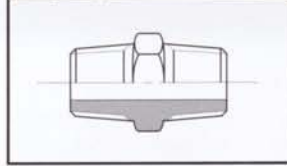
Half coupling



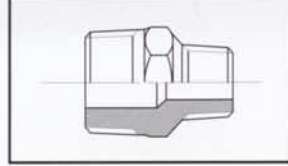
Reducing coupling



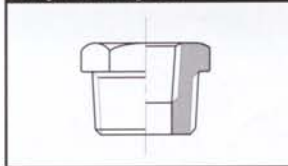
Hexagon nipple



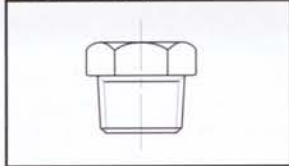
Hexagon reducing nipple



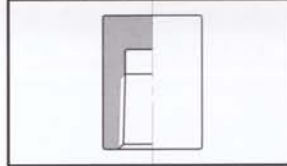
Hexagon reducing bush



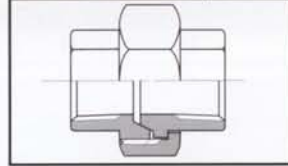
Hexagon head plug



Round cap



Female to female union taper seat



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