

Design of Process Equipment

# Weld and Thread

Lecture

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Bratislava, February 2024

# Weld Symbols On Drawings

## Standards

Europe:  
EN 22553  
ISO 2553

USA:  
American Welding Society  
(AWS)  
ANSI/AWS A2.4-98



# Weld Symbols On Drawings

Welding.

What kind of weld will we use

/design, calculation/

Welding technology /MIG, TIG,

Electrode welding /

How do we mark welds on drawings?

Comparison between European and American standards

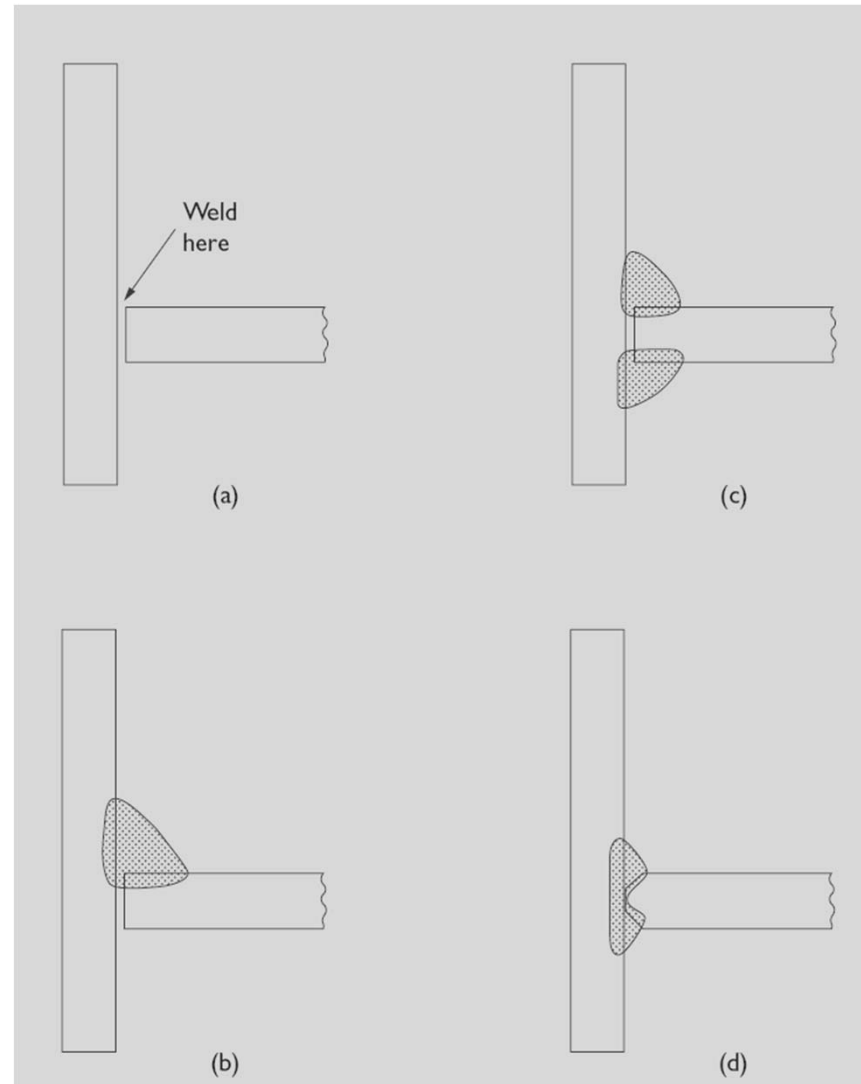
(AWS)

ANSI/AWS A2.4-98

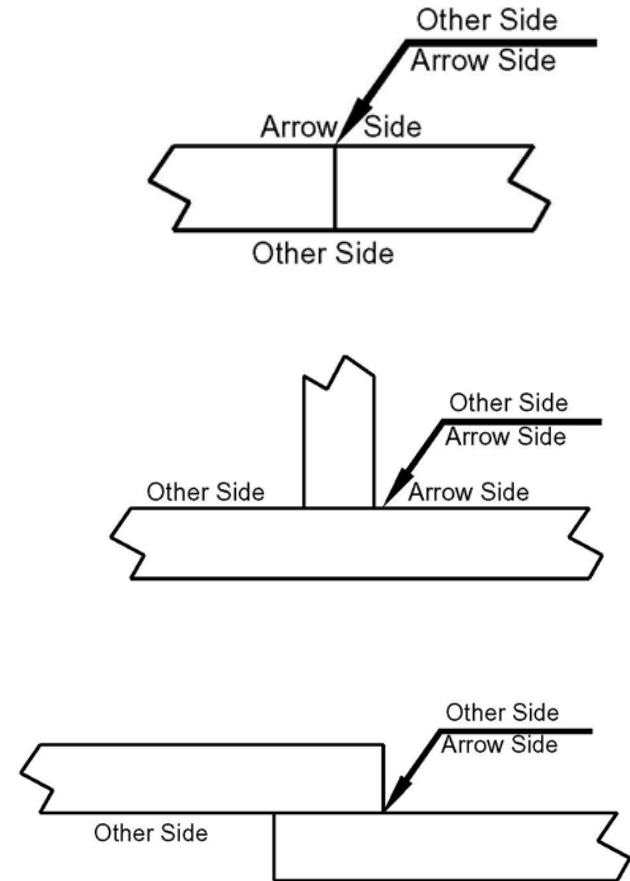
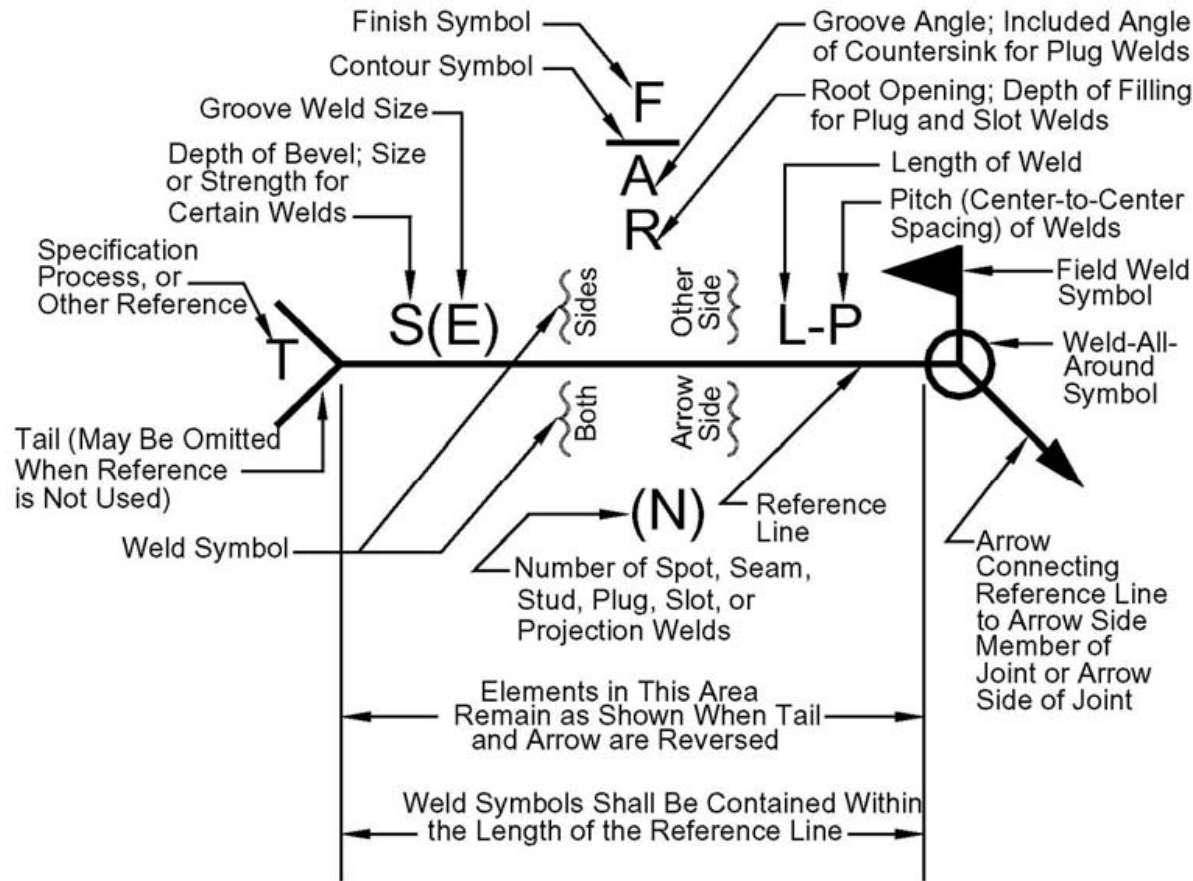
ISO 2553

vs.

ANSI/AWS A2.4-98



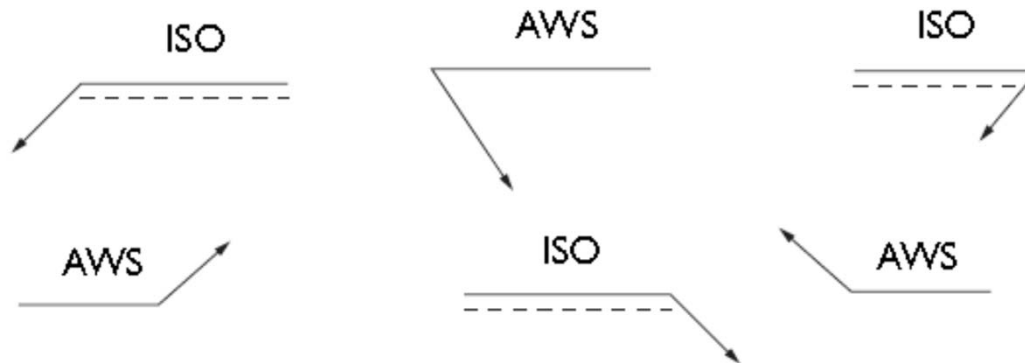
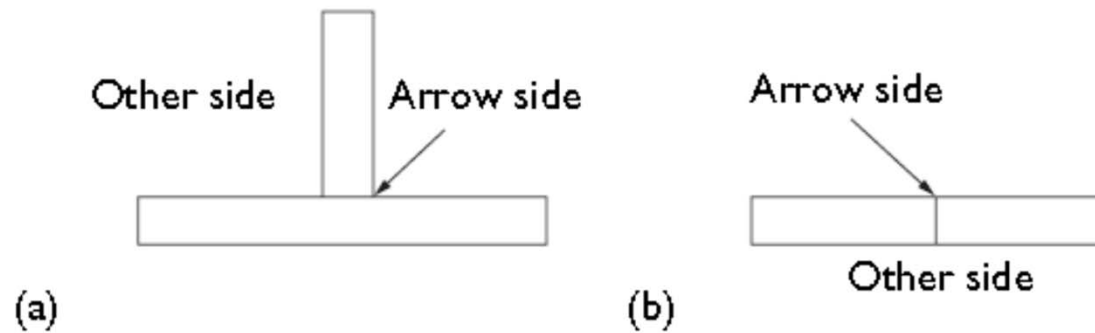
# Weld Symbols On Drawings



# Weld Symbols On Drawings

Arrow side  
(marked side)

Other side  
(the other side)

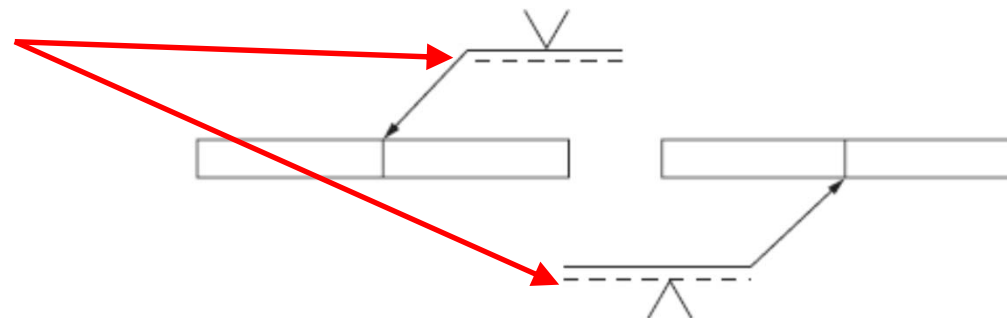


# Weld Symbols On Drawings

## ISO 2553

The weld that is on the ARROW SIDE (marked side, the side with an arrow) is shown by placing the weld mark ABOVE the reference (reference) line.

The dashed line indicates the position:  
It must be placed UNDER the reference line



# Weld Symbols On Drawings

ANSI/AWS A2.4-98

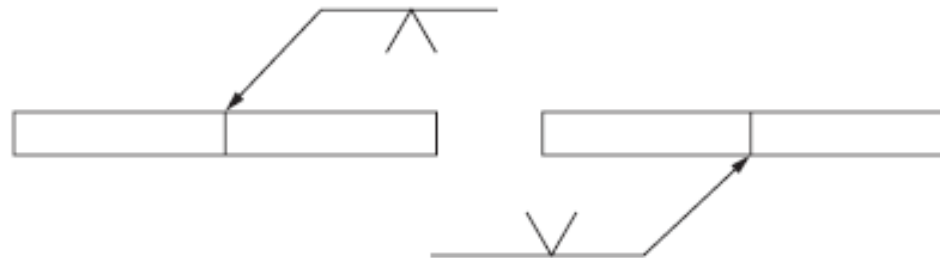
The weld that is on the ARROW SIDE (marked side, the side with an arrow) is shown by placing the weld mark UNDER the reference (reference) line.

American standard I don't use  
dashed line

The same notation applies to ISO  
2553:

The dashed line must be placed  
ABOVE the reference line

AWS



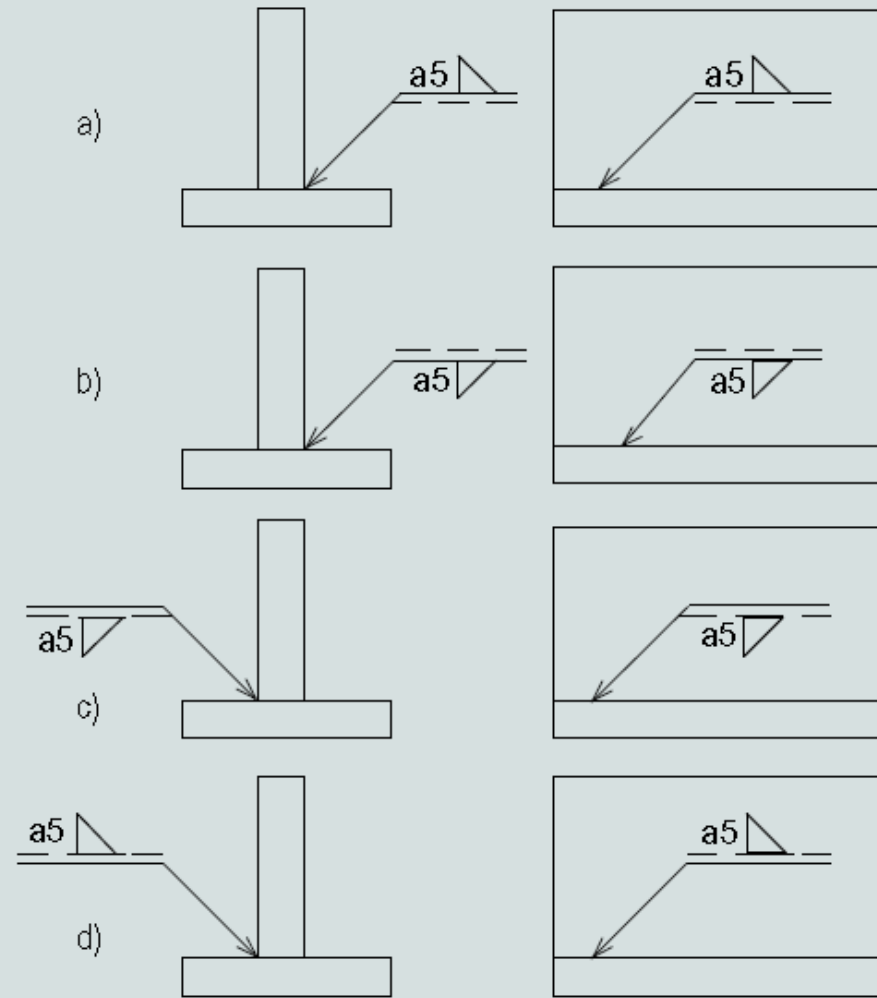
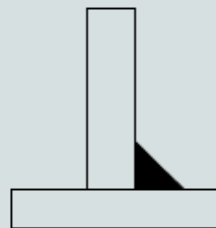
# Weld Symbols On Drawings

The position of the dashed line determines the position of the weld symbol

If the dashed line is down – the weld is above the reference line

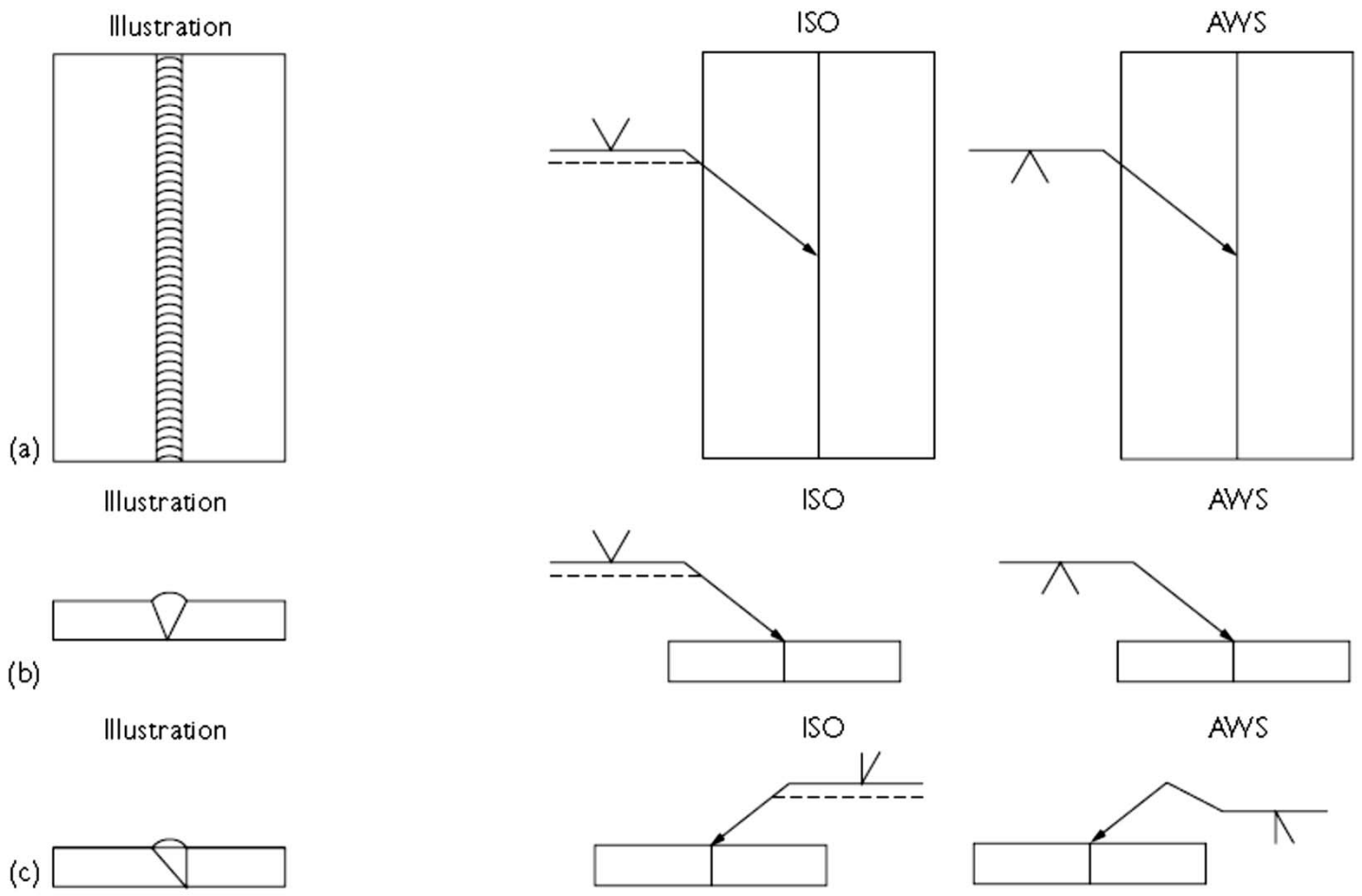
If the dashed line is up – the weld is below the reference line

zobrazenie zvaru





# Weld Symbols On Drawings



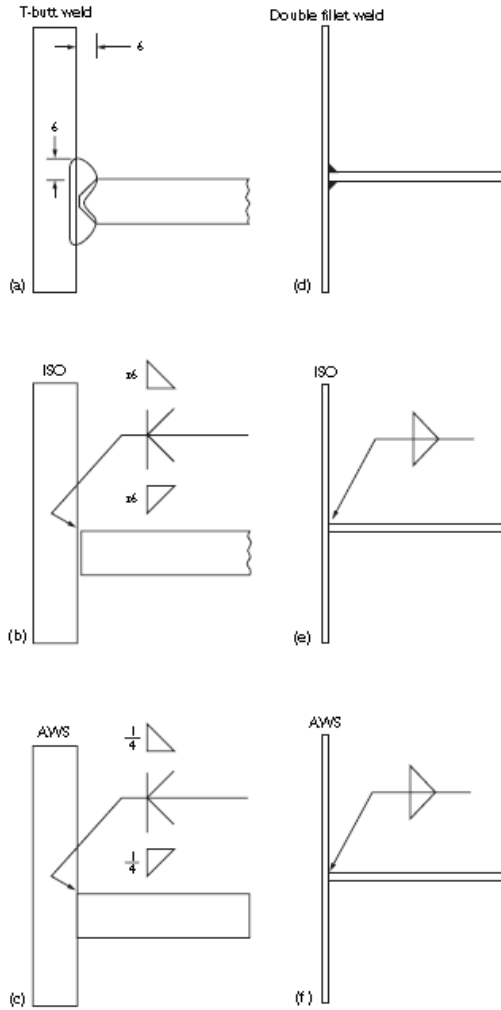
# Weld Symbols On Drawings

The same designation applies to double-sided welds.

ISO 2553

~

AWS 2.4-98



# Weld Symbols On Drawings

Designation	Illustration	Symbol
(a) Single-V butt/groove weld		
(b) Square butt/groove weld		
(c) Single bevel butt/groove weld		
(d) Single-U butt/groove weld		
(d) Single-U butt/groove weld		
(e) Single-J butt/groove weld		
(f) Butt weld between plates with raised edges (ISO) Edge weld on a flanged groove joint (AWS)		
(g) Single-V butt weld with broad root face		

# Weld Symbols On Drawings

Designation	Illustration	Symbol
(a) Fillet weld		
(b) Edge weld		
(c) Backing run (ISO) Back or backing weld (AVYS)		
(d) Flare-Y-groove weld (AVYS)		
(e) Flare-bevel-groove weld (AVYS)		

# Weld Symbols On Drawings

Designation	Illustration	Symbol
Resistance spot weld (Reference lines (ISO) shown for clarity)		
Arc spot weld (a)		
Resistance seam weld (Reference lines (ISO) shown for clarity)		
Arc seam weld (b)		
Surfacing (c)		
Steep flanked single-V butt weld (d)		
Steep flanked single-bevel butt weld (d)		

# Weld Symbols On Drawings

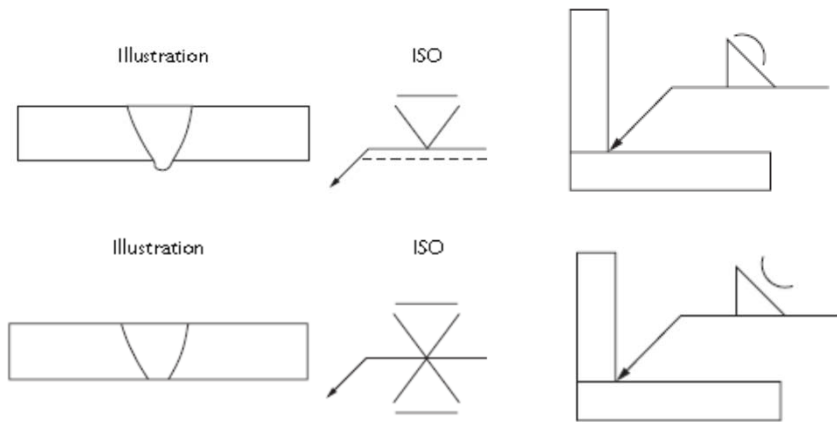
Názov zvaru	Zobrazenie	Značka	Názov zvaru	Zobrazenie	Značka
V zvar		∇	1/2 V zvar		∇
Dvojstranný V zvar		×	Dvojstranný 1/2 V zvar		∇
I zvar			Y zvar		Y
U zvar		∩	Dvojstranný Y zvar		Y
Dvojstranný U zvar		∩	V zvar so strmými zvarovými plochami		∇
Kútový zvar		△	Dierový zvar		∇
Bodový zvar		○	Švový zvar		⊕

# Weld Symbols On Drawings

## Additional symbols

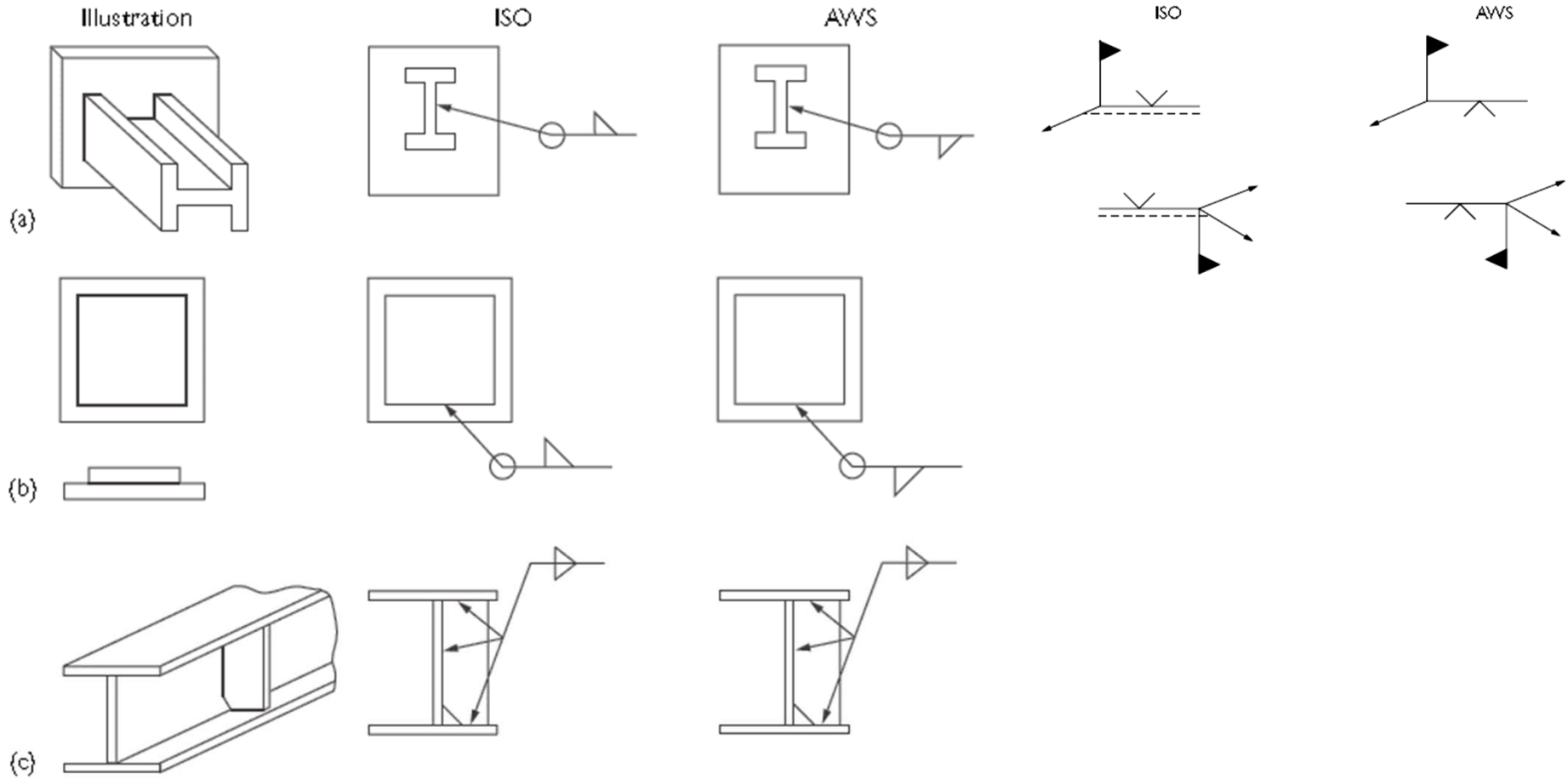
Above the base symbol.

On the reference line



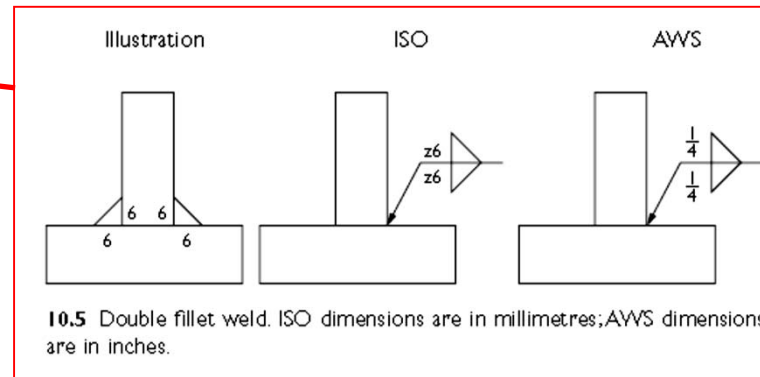
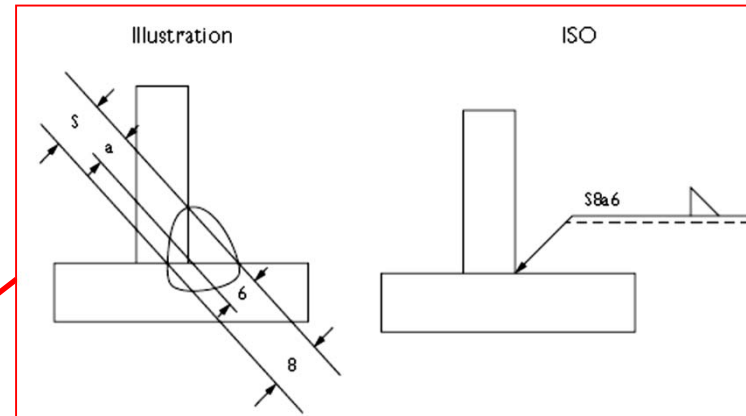
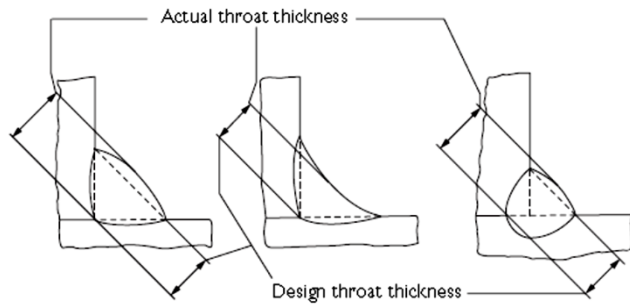
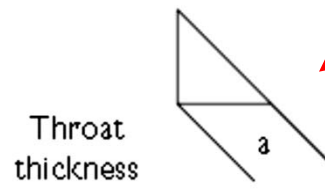
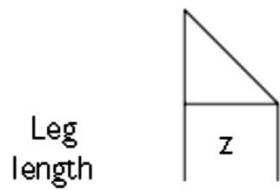
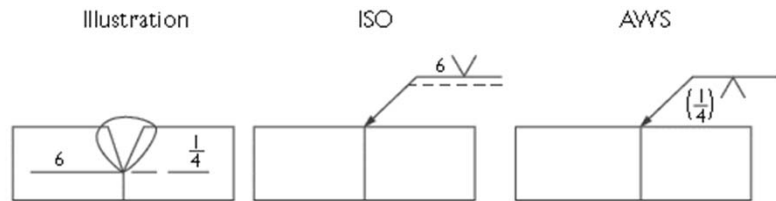
ISO	AWS	ISO	AWS
 Flat (usually finished flush)	 Flush or flat	No symbol	 Melt through
 Convex	 Convex	No symbol	 Consumable insert
 Concave	 Concave	 Peripheral weld	 Weld all round
 Toes shall be blended smoothly	No symbol	 Field or site weld	 Field weld
No symbol	 Spacer	 Permanent backing strip used	 Backing
No symbol	 Back or backing weld	 Removable backing strip used	 Removable backing

# Weld Symbols On Drawings

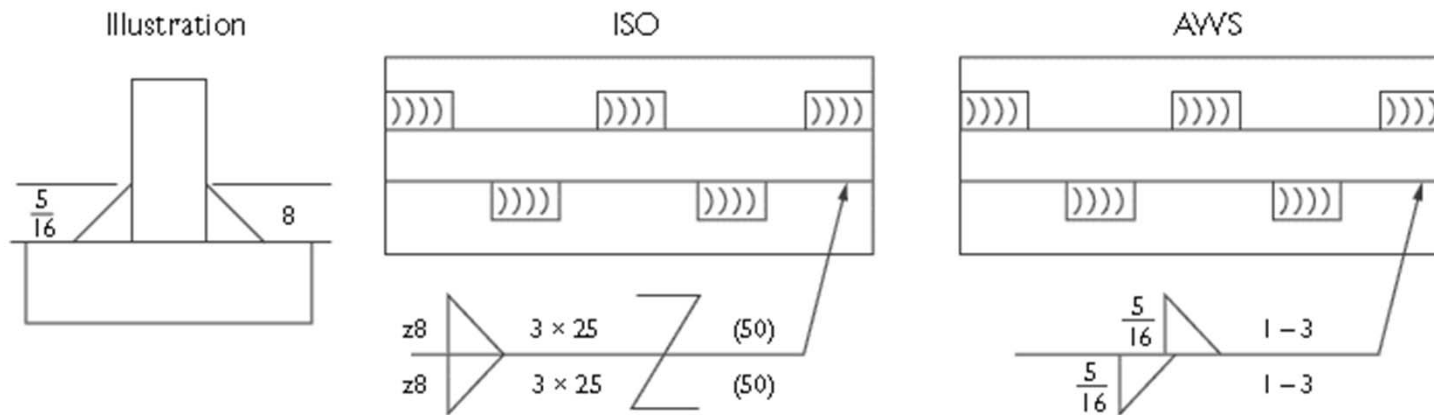
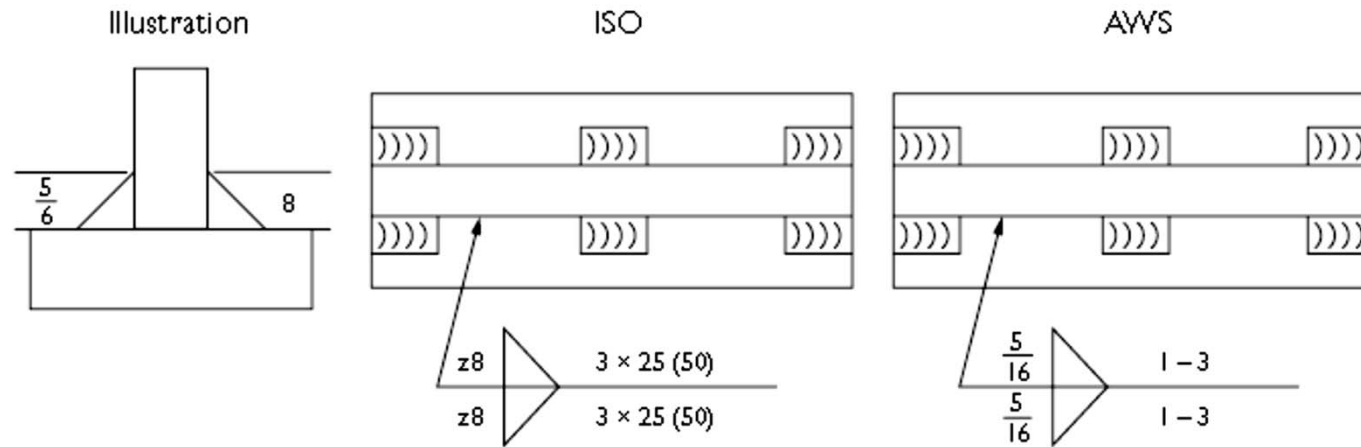




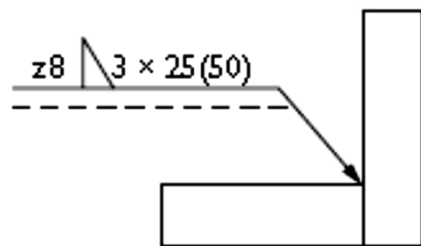
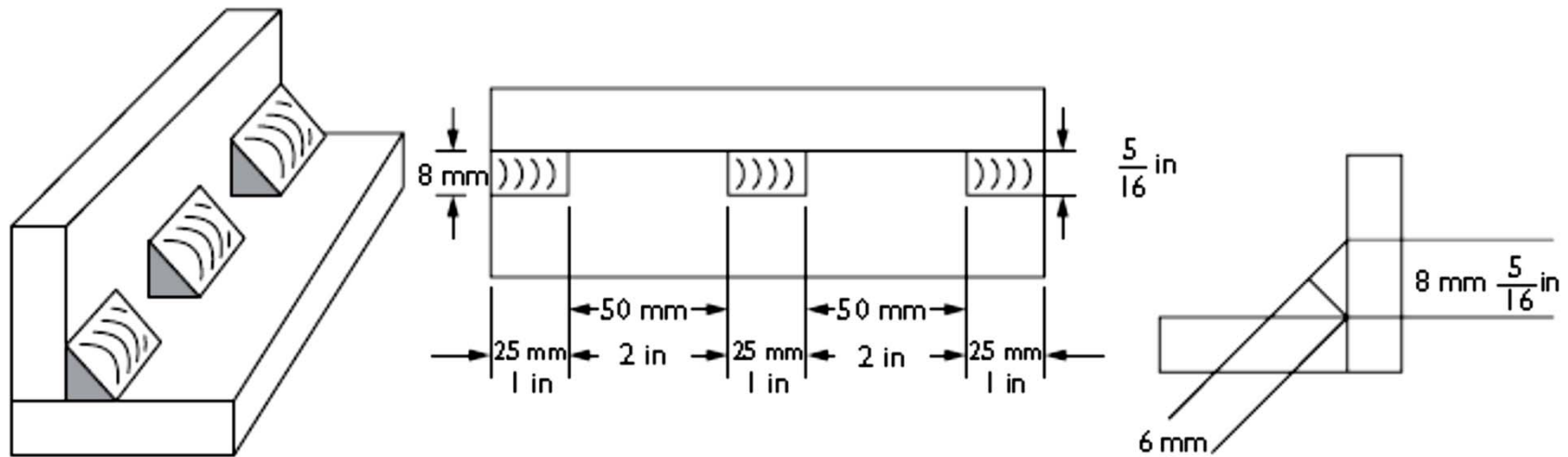
# Weld Symbols On Drawings



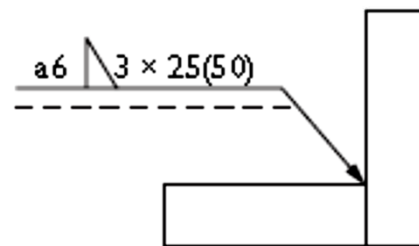
# Weld Symbols On Drawings



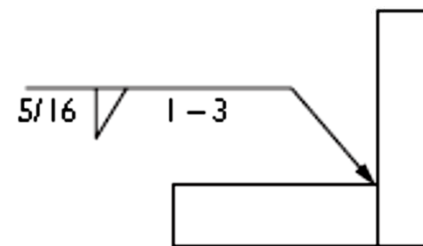
# Weld Symbols On Drawings



ISO (Leg length)

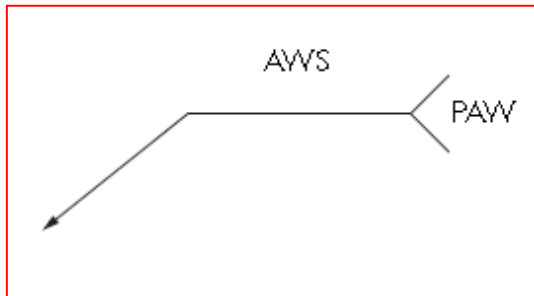
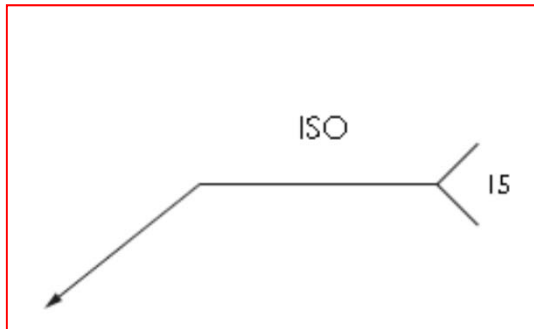


ISO (Throat thickness)



AWS (Leg length)

# Weld Symbols On Drawings



ISO 4063 : 1992		ANSI/AWS A2.4-98	
1	Arc welding	AW	Arc welding
111	Metal arc welding with covered electrode (manual metal arc welding)	SMAW	Shielded metal arc welding
114/136	Flux cored metal arc welding	FCAW	Flux cored arc welding
12	Submerged arc welding	SAW	Submerged arc welding
13	Gas shielded metal arc welding		
131	MIG welding	GMAW	Gas metal arc welding
135	MAG welding (non-inert gas)		
141	TIG welding	GTAW	Gas tungsten arc welding
15	Plasma arc welding	PAW	Plasma arc welding
2	Resistance welding	RW	Resistance welding
21	Spot welding	RSW	Resistance spot welding
22	Seam welding	RSEW	Resistance seam welding
23	Projection welding	RPW	Projection welding
24	Flash welding	FW	Flash welding
3	Gas welding	OPW	Oxyfuel gas welding
311	Oxy-acetylene welding	OAW	Oxyacetylene welding
42	Friction welding	FRW	Friction welding
43	Forge welding	FOW	Forge welding
71	Thermit welding	TW	Thermit welding
72	Electroslag welding	ESW	Electroslag welding
781	Arc stud welding	SW	Stud arc welding
91	Brazing	B	Brazing
94	Soldering	S	Soldering
97	Braze welding		

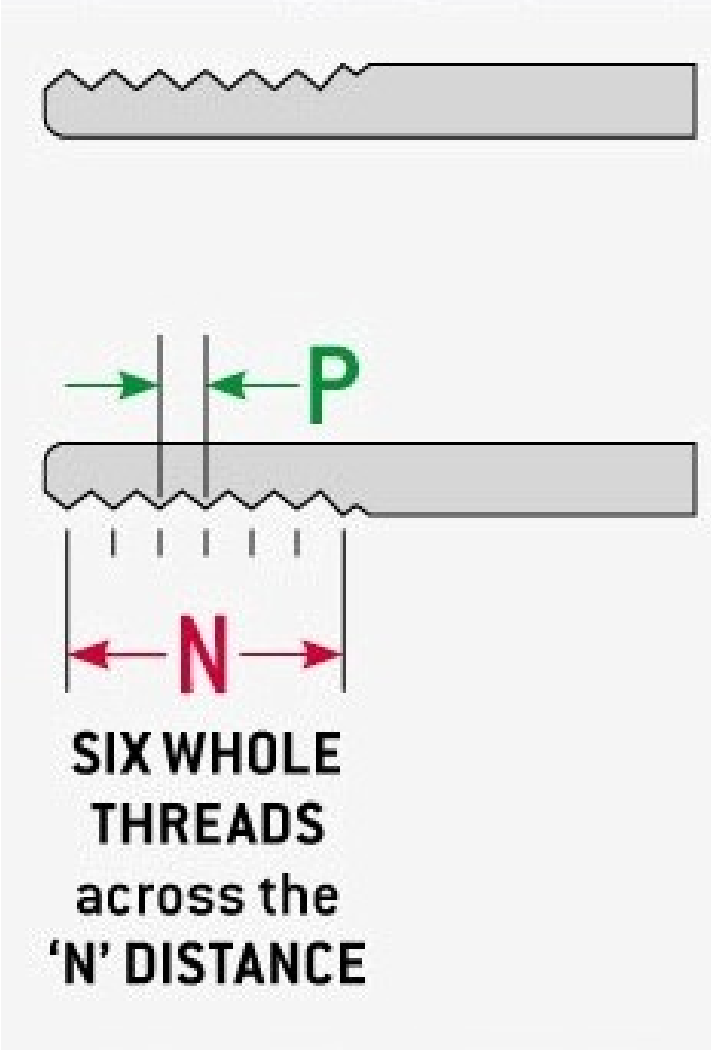
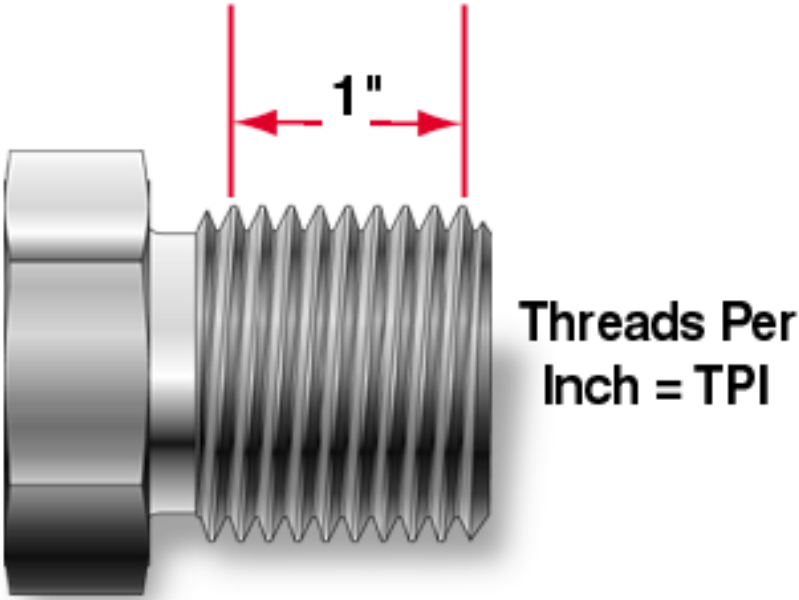
  

Suffixes	
MA	manual
SA	semi-automatic
AU	robotic
ME	machine



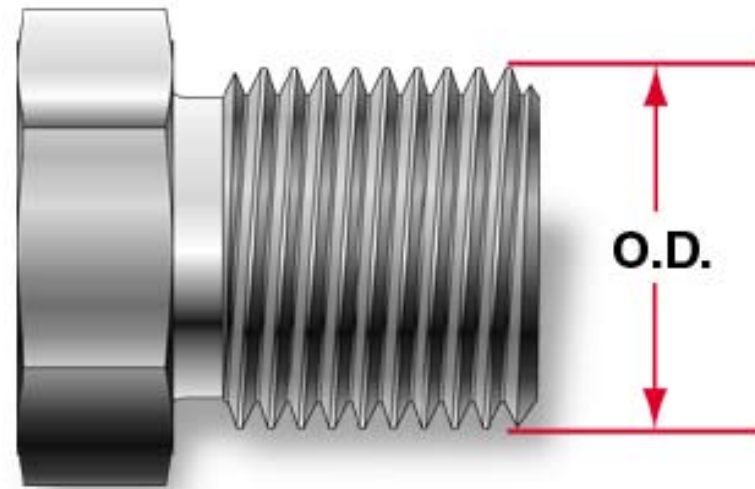
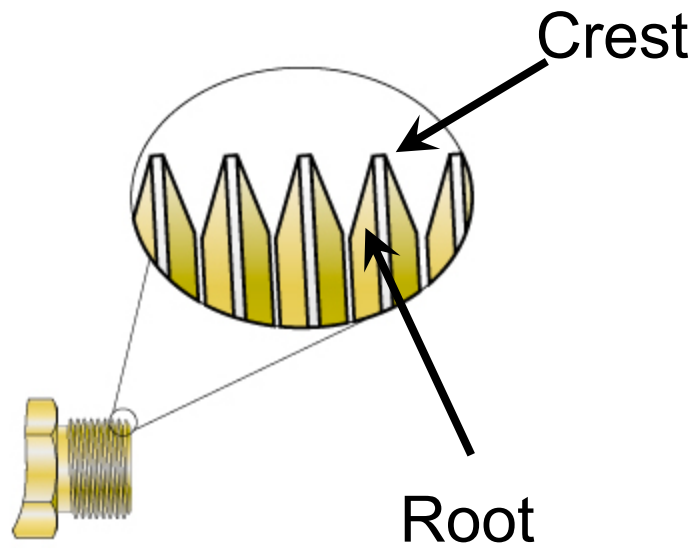
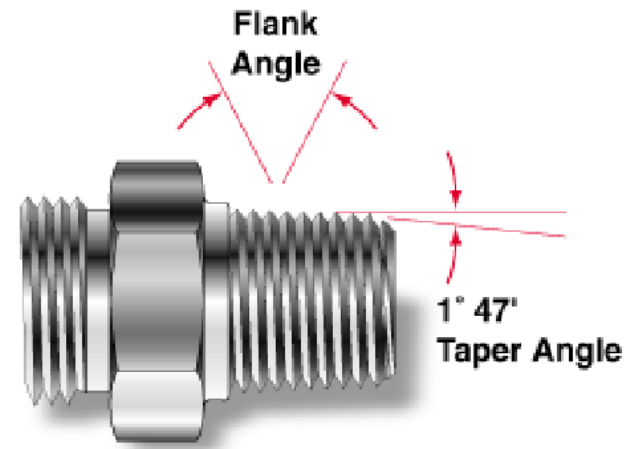
# Threads on drawings

Pitch is sometimes written as the number of threads within one inch distance



## Threads on drawings

- Flank /Thread/ Angle
- Taper Angle
- Crest
- Root
- O.D.



# Threads on drawings

## Thread Standards and Definitions

- *Pitch* – distance between adjacent threads.  
Reciprocal of threads per inch
- *Major diameter* – largest diameter of thread
- *Minor diameter* – smallest diameter of thread
- *Pitch diameter* – theoretical diameter between major and minor diameters, where tooth and gap are same width

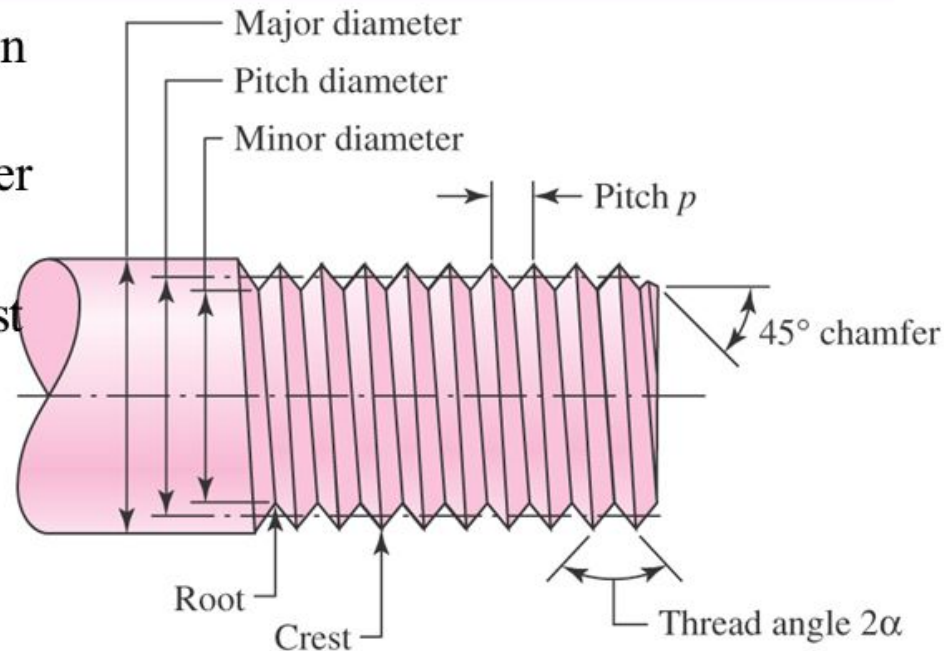
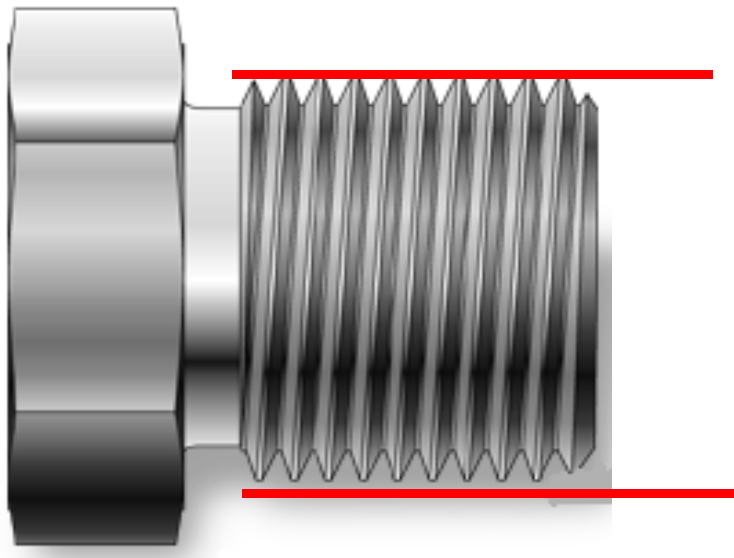


Fig. 8-1

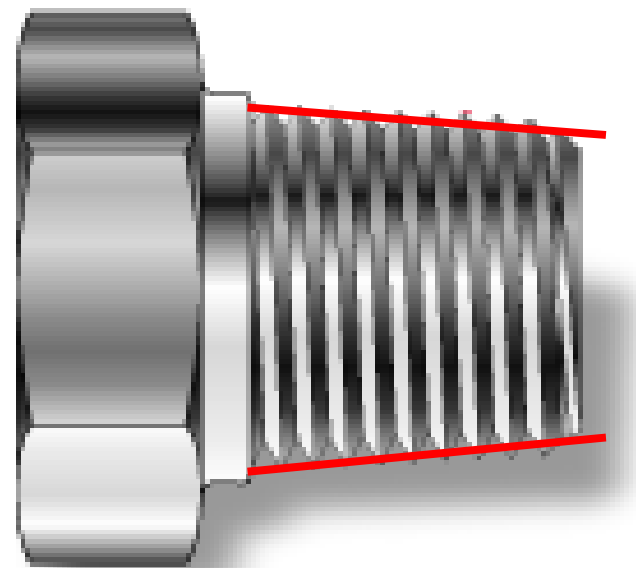


## Threads on drawings

Parallel  
Tapered



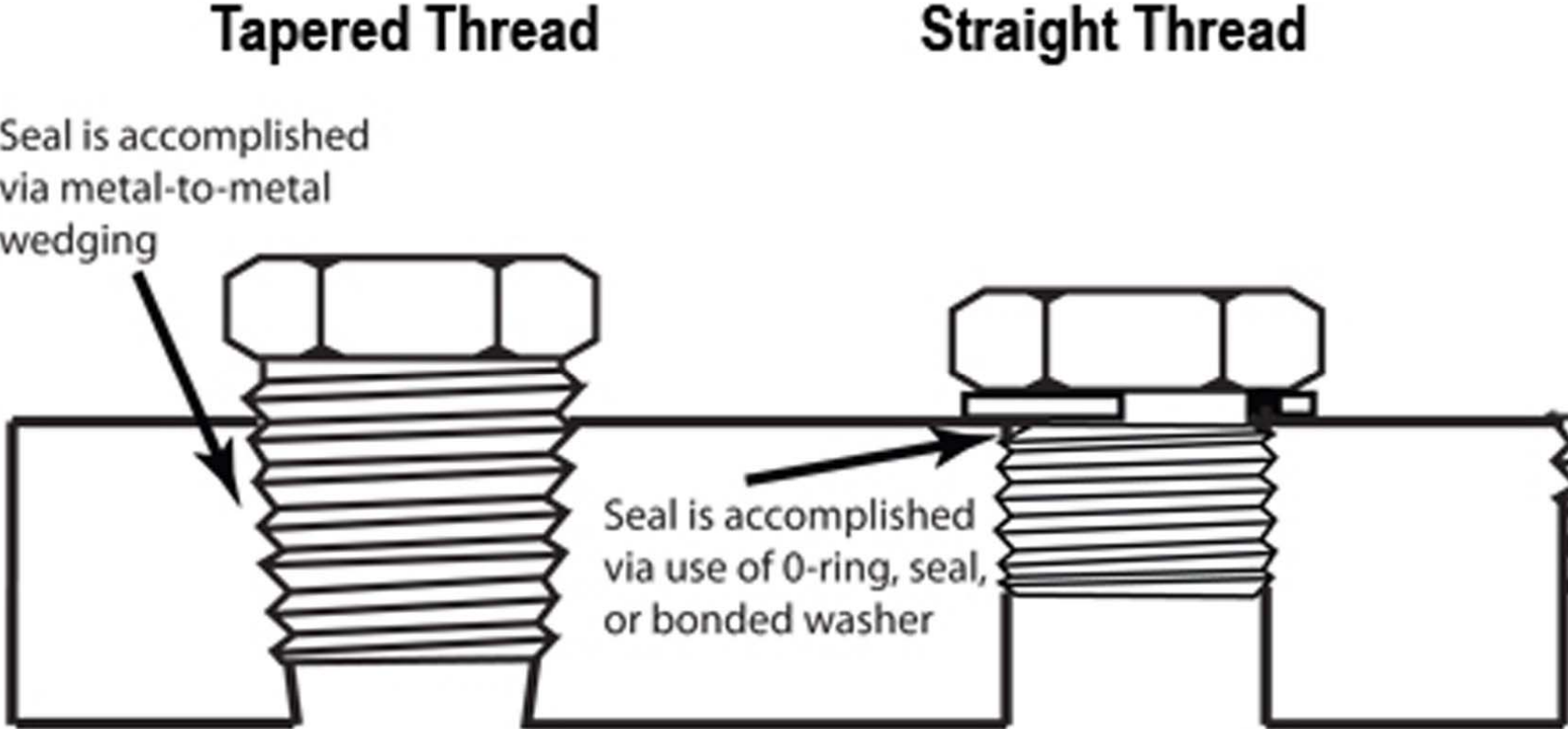
Parallel



Tapered

# Threads on drawings

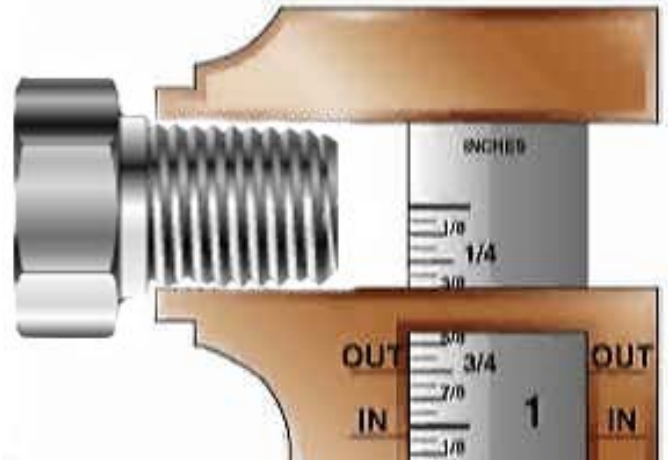
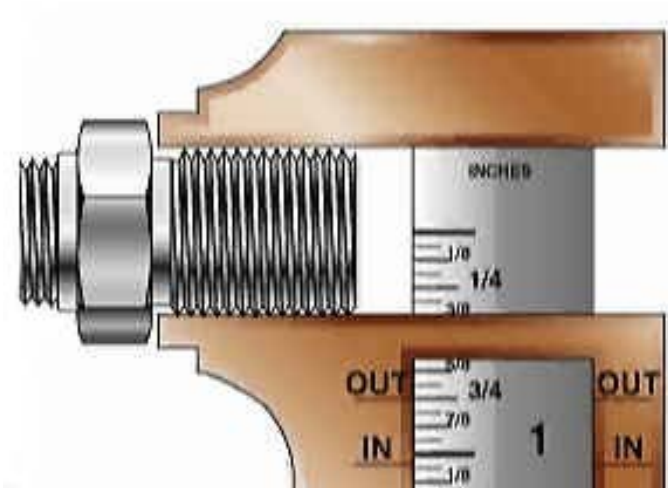
- Parallel
- Tapered



# Threads on drawings

Identification:

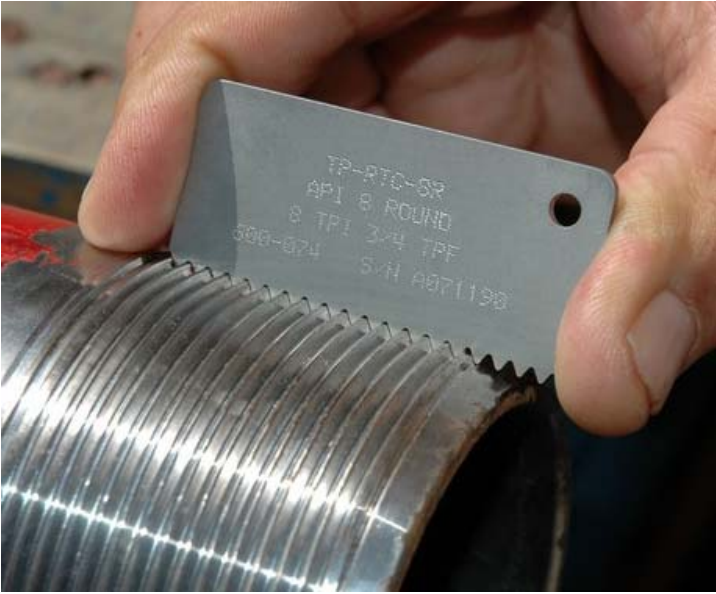
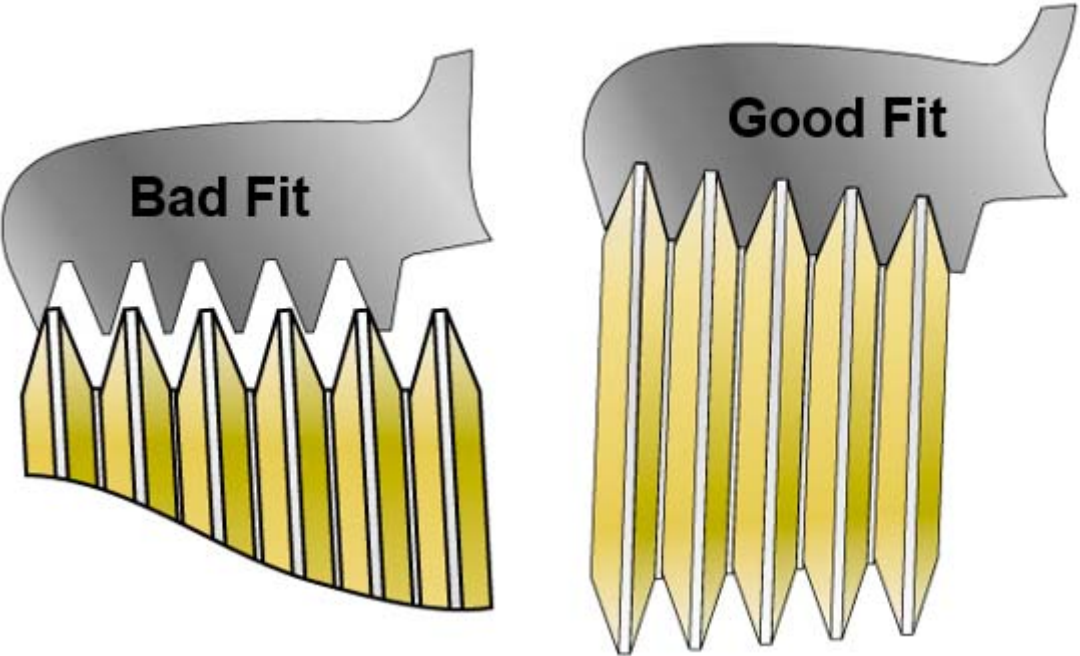
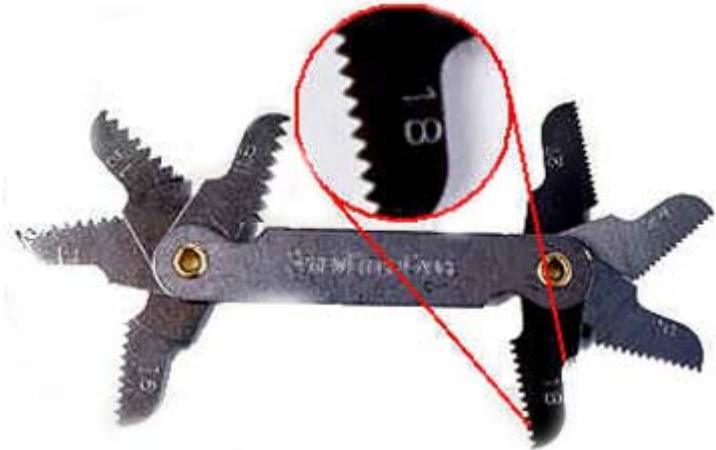
Caliper



# Threads on drawings

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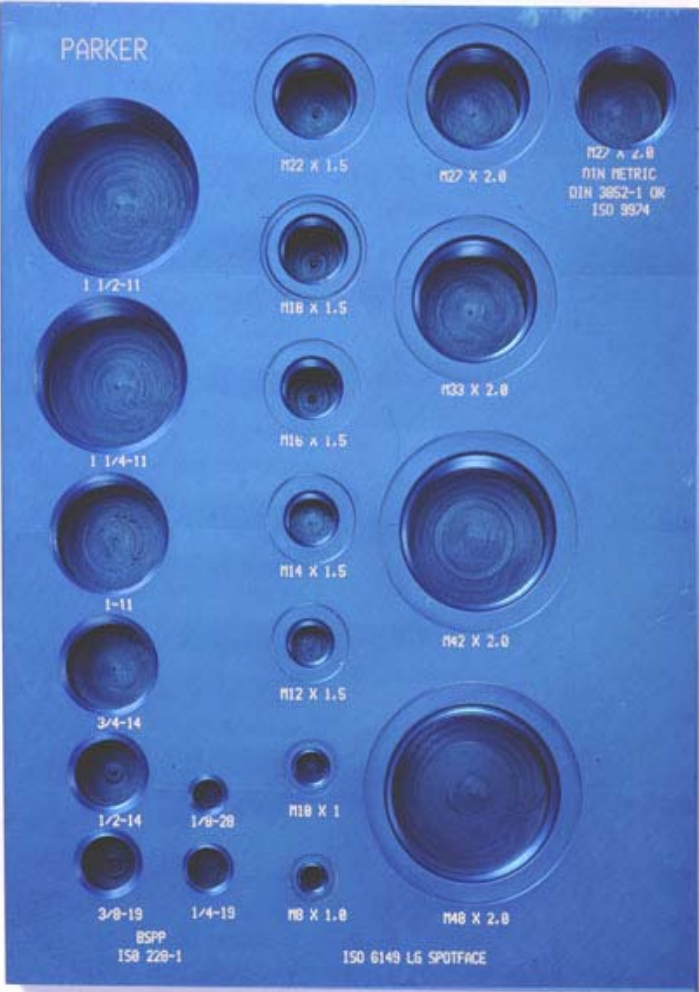
Thread gauge



# Threads on drawings

Identification:

Thread gauge



# Threads on drawings

Identification:

Thread gauge

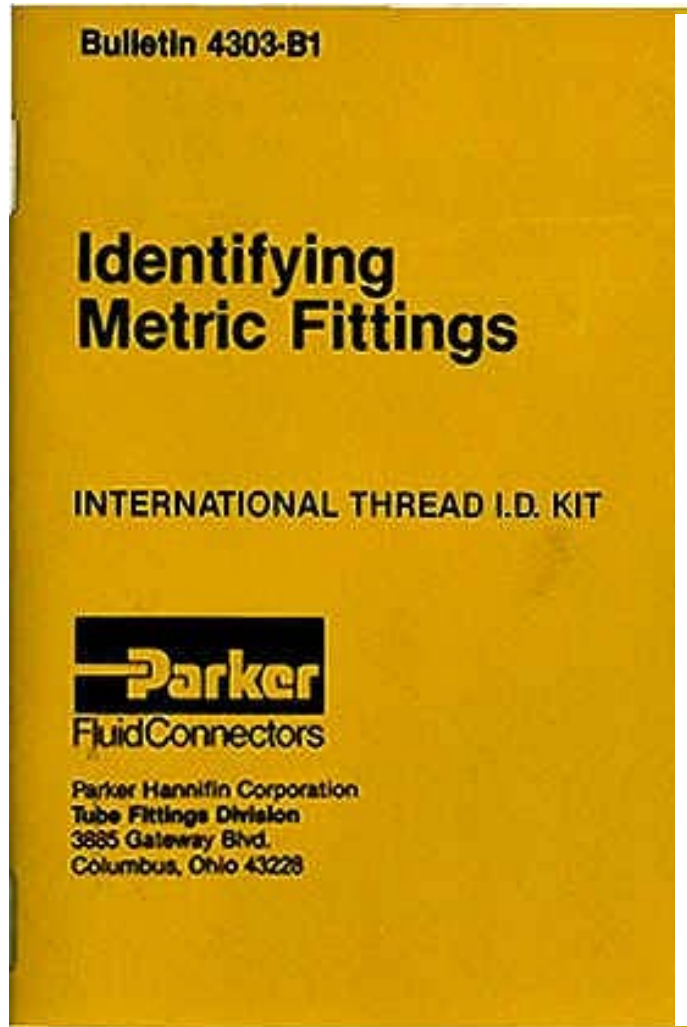


# Threads on drawings

Identification:

Instruction booklet.

/Contains specifications for various thread forms/

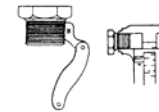


### Fitting Identification

**Fitting Thread Size Comparison Chart**  
 The male connections have (Male unified thread class 2 fit) UN-2A specification threads and the female connections have (Female unified thread class 2 fit) UN-2B specification threads. The exceptions are male and female pipe threads.

**Tube Fittings**  
 There are four basic types of tube fittings: Flare, Flareless, Straight Thread O-Ring, and Flat Face O-Ring Seal (FOR-SEAL™). Tube fittings seal in two ways. Flare and Flareless fittings use metal to metal contact joints. Straight Thread O-Ring and Flat Face O-Ring fittings use a rubber o-ring. Where extreme vibration is present, use Flareless.

Straight Thread or Flat Face O-Ring Seal fittings. **SIZING:** For accuracy, it is recommended the male thread be measured. Measure the outside diameter. For our example use 7/16". Next measure the threads per inch - use 20. Our fitting size measures 7/16-20. Refer to the thread chart on this page for appropriate tube size and illustration.



See page 425 for Thread Measuring Kits.

SIZE	PIPE	FOR-SEAL®	37° FLARE FLARE-TWIN®	ERRETO® 7000 SERIES	STRAIGHT THREAD O-RING SEAL	45° FLARE	INVERTED FLARE
1/8	1/8-27	—	5/16-24	5/16-24	5/16-24	5/16-24	5/16-28
3/16	—	—	3/8-24	3/8-24	3/8-24	3/8-24	3/8-24
1/4	1/4-18	9/16-18	7/16-20	7/16-20	7/16-20	7/16-20	7/16-24
5/16	—	—	1/2-20	1/2-20	1/2-20	1/2-20	1/2-20
3/8	3/8-18	11/16-16	9/16-18	9/16-18	9/16-18	9/16-18	9/16-18
7/16	—	—	—	—	—	11/16-16	11/16-18
1/2	1/2-14	13/16-16	3/4-16	3/4-16	3/4-16	3/4-16	3/4-18
5/8	—	1-14	7/8-14	7/8-14	7/8-14	7/8-14	7/8-18
3/4	3/4-14	1-3/16-12	1-1/16-12	1-1/16-12	1-1/16-12	1-1/16-14	1-1/16-16
7/8	—	—	1-3/16-12	1-3/16-12	1-3/16-12	—	1-3/16-16
1	1-11-1/2	1-7/16-12	1-5/16-12	1-5/16-12	1-5/16-12	—	1-5/16-16
1 1/4	1-1/4-11-1/2	1-11/16-12	1-5/8-12	1-5/8-12	1-5/8-12	—	—
1 1/2	1-1/2-11-1/2	2-12	1-7/8-12	1-7/8-12	1-7/8-12	—	—
2	2-11-1/2	—	2-1/2-12	2-1/2-12	2-1/2-12	—	—
2 1/2	2-1/2-8	—	3-12	—	—	—	—
3	3-8	—	3-1/2-12	—	—	—	—

**Pipe Fittings**  
 The American Society of Automotive Engineers in co-operation with industry set up a standard for improvement in pipe threads. This improvement is known as the Dryseal Pipe Thread. All Weatherhead pipe threads are American Standard Taper Dryseal Pipe Threads (NPTF). The metal to metal seal is formed by contact at the thread crest and root. Nominal pipe sizes do not

agree with either the I.D., O.D., or thread sizes. To determine pipe size (up to 1-1/4") measure the diameter of the threads and subtract 1/4" for example, subtract 1/4" from a 1" pipe to obtain the nominal pipe size of 3/4". Pipe sizes can also be given in "dash numbers." A dash number is always the numerator of an inch over 16th. For instance, if the pipe O.D. measures 1/2"

that would be converted to 16ths (8/16), but be written as -8.



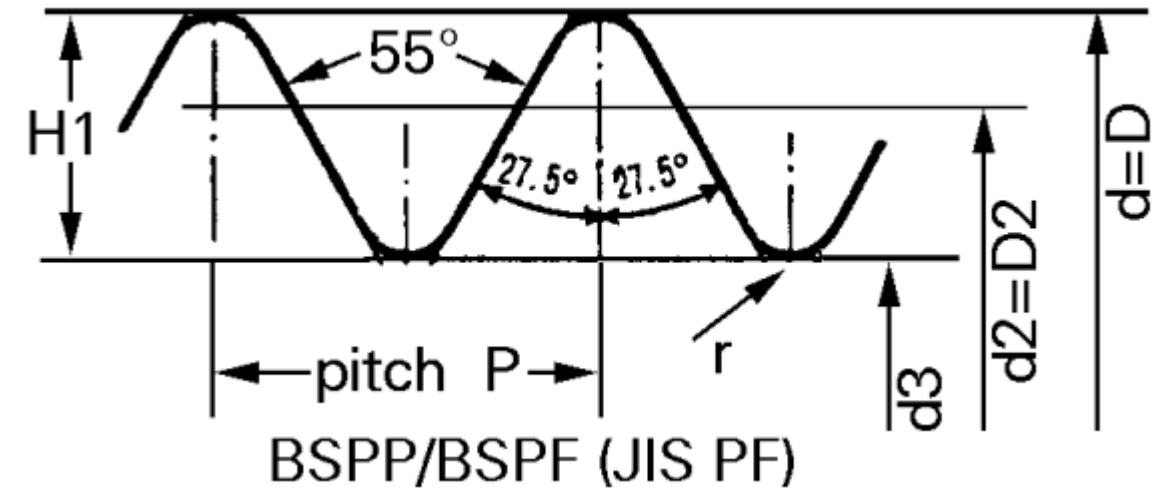
APPLICATION DATA  
 LOW & MEDIUM PRESSURE HOSE  
 HIGH PRESSURE HOSE  
 SPECIALTY HOSE  
 ACCESSORIES & ASSEMBLY INSTRUCTIONS  
 ADAPTERS & TUBE HOSE ENDS  
 HOSE ASSEMBLY EQUIPMENT  
 TECHNICAL DATA

# Threads on drawings

## PIPE THREADS

Pipe threads (threads for connecting pipes), or connections to pipes (outlets)

They are based on the WHITWORTH thread. (one of the first patented industrial standards)

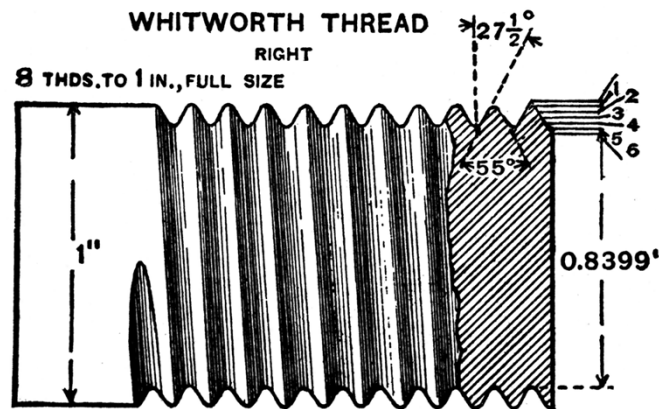


## WHITWORTH thread

Apex angle: 55°

Pitch: number of turns per 1"

Marking: W 1/2"



**JOSEPH  
WHITWORTH**  
UK 1841



# Threads on drawings

## PIPE THREADS

The most used thread for connecting pipes is derived from the Whitworth thread:

G 1"(33.249mm)  
 corresponds to a DN25 pipe (33.7 mm)

We use multiple threads.

Apex angle: 55°  
 Pitch: number of turns per 1"  
 Marking: G 1 ½", Rp 1 ½", R<sub>p</sub> 1 ½", R 1 ½",

- Sealing on the thread
- Sealing outside the thread
- /not sealing on the thread/

1	ISO 7/1		DIN 2999		BS 21		DIN ISO 228 part 1 <sup>2)</sup>		
2	<i>Pipe threads where pressure tight joints are made on the threads</i>		<i>Whitworth pipe threads for threaded pipes and fittings</i>		<i>Pipe threads for tubes and fittings where pressure tight joints are made on the threads</i>		<i>Pipe threads where pressure-tight joints are not made on the threads</i>		
3	<i>sealing on the thread</i>		<i>sealing on the thread</i>		<i>sealing on the thread</i>		<i>not sealing on the thread</i>		
4	<i>internal thread cylind.</i>	<i>external thread taper</i>	<i>internal thread cylindrical</i>	<i>external thread taper</i>	<i>internal thread cylind.</i>	<i>external thread taper</i>	<i>internal and external thread cylindrical</i>		
5	<b>R<sub>p</sub></b>	<b>R<sub>c</sub></b>	<b>R</b>	<b>R<sub>p</sub></b>	<b>R</b>	<b>R<sub>p</sub></b>	<b>R<sub>c</sub></b>	<b>R</b>	<b>G</b>
6	<i>taper limit plug gauge - ISO 7/2<sup>1)</sup></i>	<i>taper limit ring gauge - ISO 7/2<sup>1)</sup></i>	<i>taper limit plug gauge - DIN 2999-4</i>	<i>cylindrical limit ring gauge - DIN 2999-5</i>	<i>taper limit plug gauge - BS 21</i>	<i>taper limit ring gauge - BS 21</i>	<i>cylindrical Go / No Go plug gauge cyl. Go ring gauge tolerance A or B DIN ISO 228 part 2</i>		

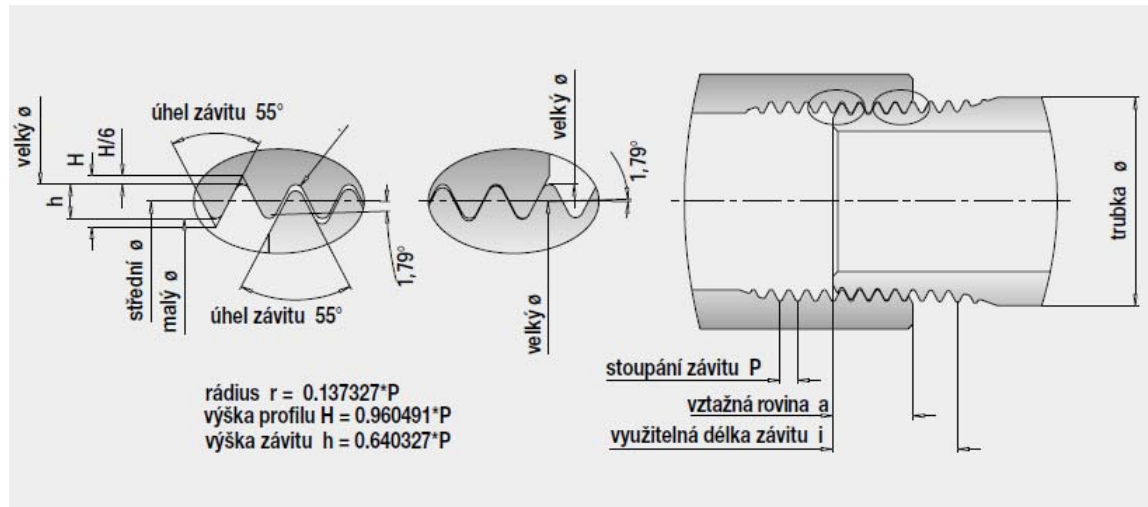
# Threads on drawings

PIPE THREADS  
**DIN EN 10226.**

DIN EN 10226  
 replaced the  
 earlier DIN 2999

**Rp**  
 DIN 2999-Rp-1/2  
**vnitřní závit válcový**  
**Parallel inside**

**R**  
 DIN 2999-R-1/2-1 **ISO 7/1**  
**vnější závit kuželový (kužel 1:16)**  
**Tapered outside (taper 1:16)**



**Description:**

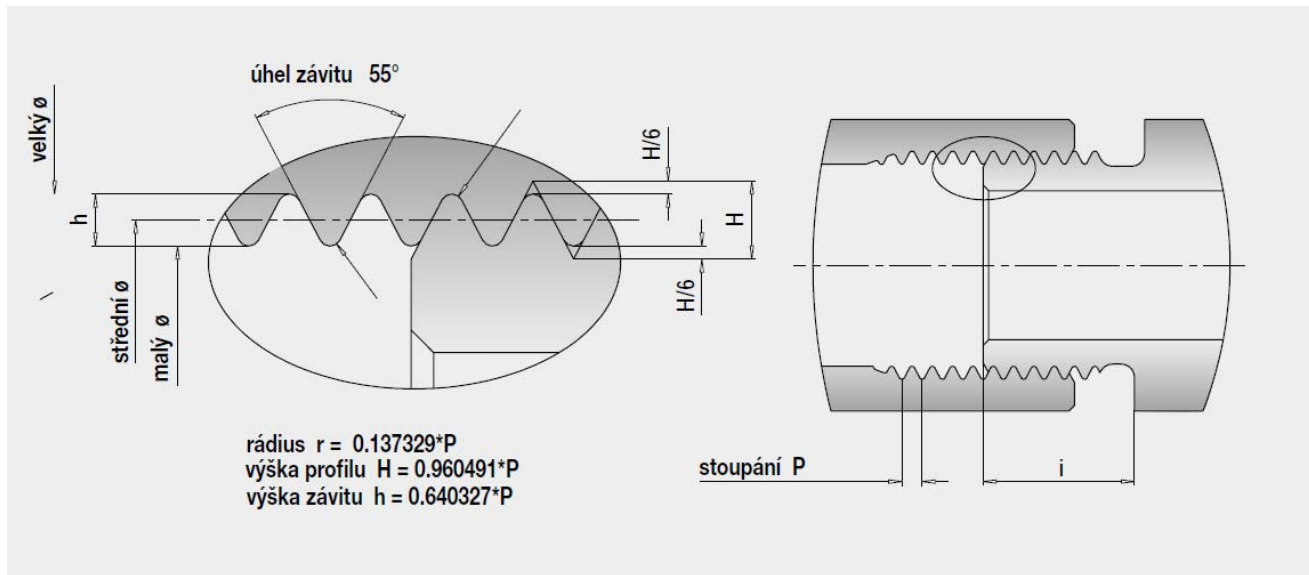
The tapered R outside thread has the same core, haunch and outside dia as the Rp inside thread, so that it can be threaded in by hand. The torque from the spanner lengthens the tapped hole and seals with the aid of a proprietary sealing material (eg. PTFE tape). **Comparison with ISO 228:** The parallel Rp inside thread of this Standard has the same nominal size for the thread dia and profile as for the inside thread to ISO 228. However, the G inside thread in core and haunch dia has only a positive deviation (from DIN 2999 +/- tolerance). Therefore a DIN 2999 tapered outside thread may be screwed into an ISO 228 parallel inside thread. The outside thread can be screwed 1 turn further. The likelihood of leaks occurring is increased due to larger core dia tolerance of the G thread which gives a larger clearance between the points of the threads. **In no circumstances** combine ISO 228 parallel G outside thread with DIN 2999 Rp parallel inside thread as the inside thread is too small.

# Threads on drawings

PIPE THREADS  
**EN ISO 228**

**G**  
 ISO 228-G 1/2"  
**vnitřní závit válcový**  
**parallel inside**

ISO 228-G 1/2" A  
**vnější závit válcový** (tol. třída A)  
**parallel outside** (Tol. class A)



## Description:

This thread is mainly used for mechanical connection of fittings. The seal results from the pressing together of two sealing faces outside the thread and from the use of a proprietary sealing material. Male studs (with sealing ring), Form B (with sealing edge) and Form E (on agreement) as well as the respective Form X tapped holes (with run out) and Form Y (with grooves), to DIN 3852 Part 2 have G threads to this standard.

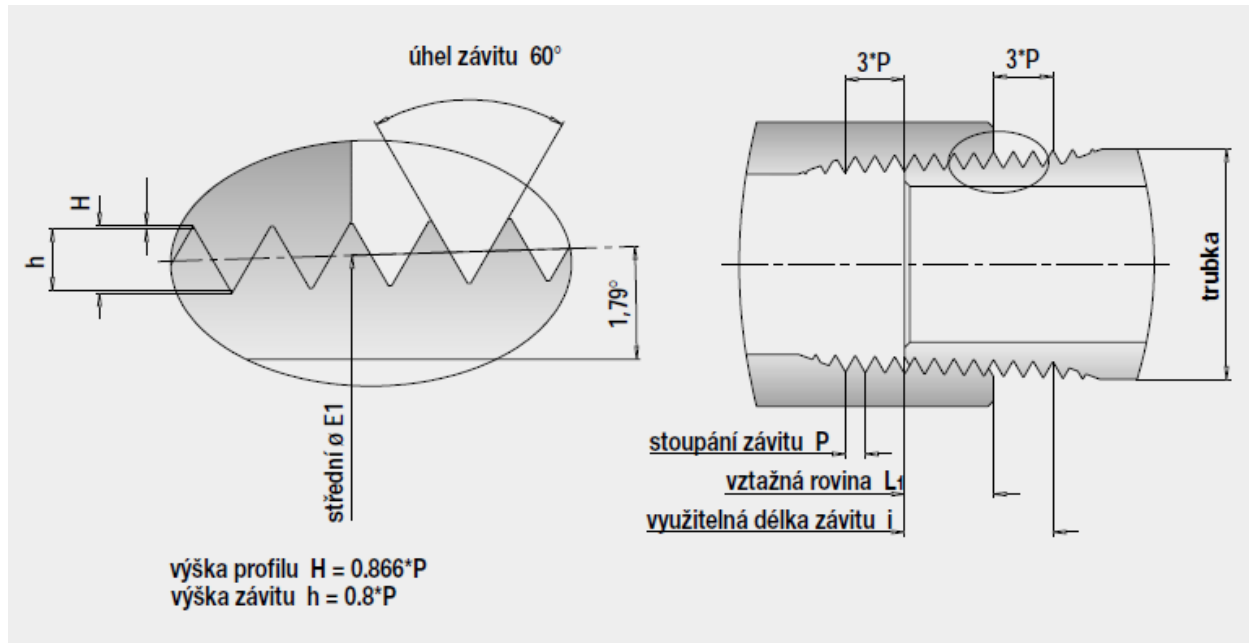
# Threads on drawings

PIPE THREADS  
NPT - ASME/ANSI  
B1.20.1

## NPT

3/8 - 18 NPT  
vnitřní závit kuželový  
Tapered inside

vnější závit kuželový (kužel 1:16)  
Tapered outside (taper 1:16)



### Description:

The tapered NPT outside thread has the same core, haunch and outside dia as the NPT inside thread at the start of the thread so that it can be screwed in by hand. The torque from the spanner lengthens the tapped hole and seals with the aid of a proprietary sealing material (eg PTFE tape). As both the inside and outside threads are tapered, the likelihood of leaks occurring is small.

# Threads on drawings

## PIPE THREADS

NPT -

ASME/ANSI B1.1

UNF 7/16-20

## UNF / UN

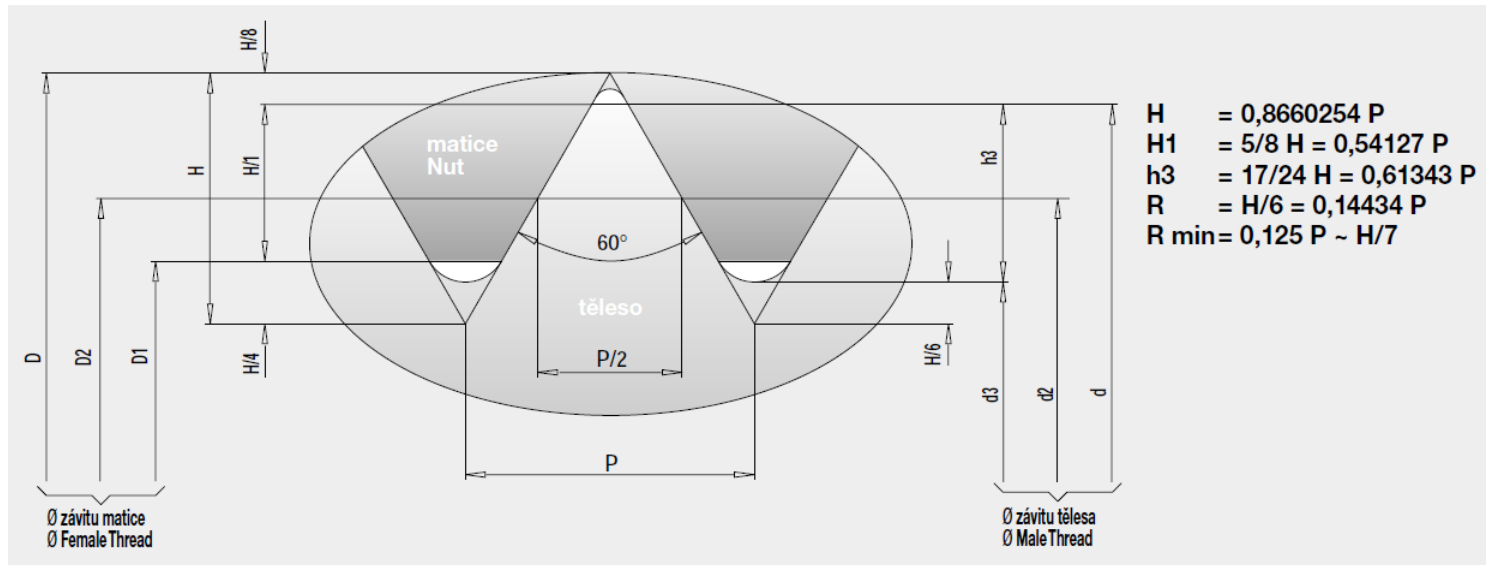
ANSI B 1.1 UNF 7/16-20

vnitřní válcový závit (tol. 2 B)

parallel inside (Tol. 2 B)

vnější válcový závit (tol.2 A)

parallel outside (Tol. 2 A)



### Description:

This thread is mainly used for mechanical connection of fittings. The seal results from the pressing together of two sealing faces outside the thread and from the use of a proprietary sealing material.

# Threads on drawings

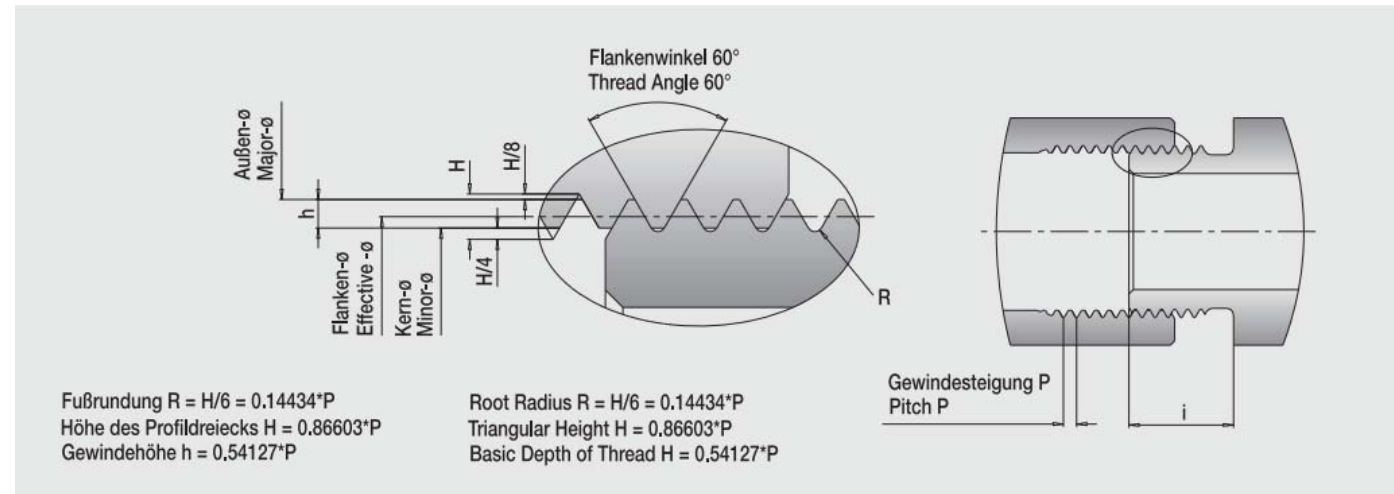
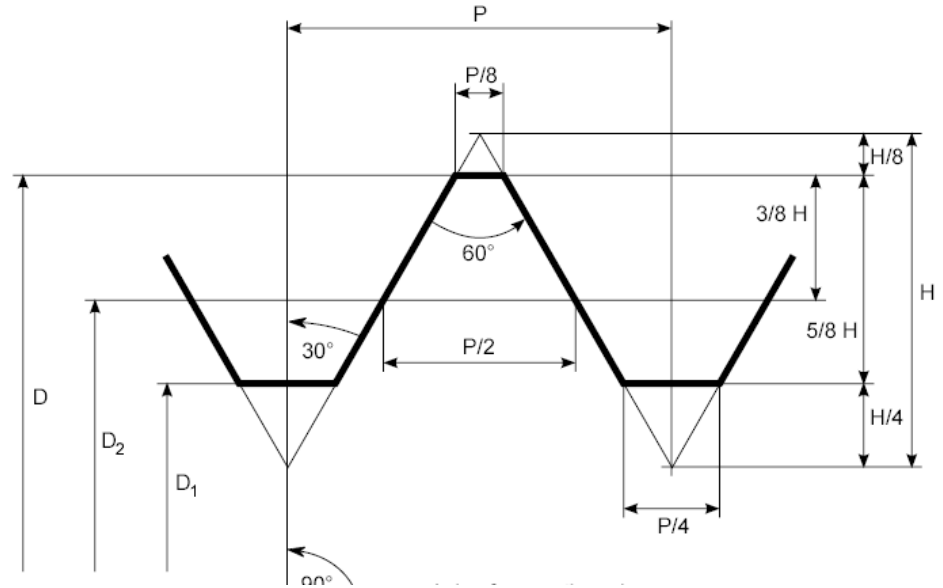
## Metric thread - DIN 13

It is mainly used for mechanical joining of parts.

Metric thread  
 Peak angle: 60°  
 Marking: M 12 x 1

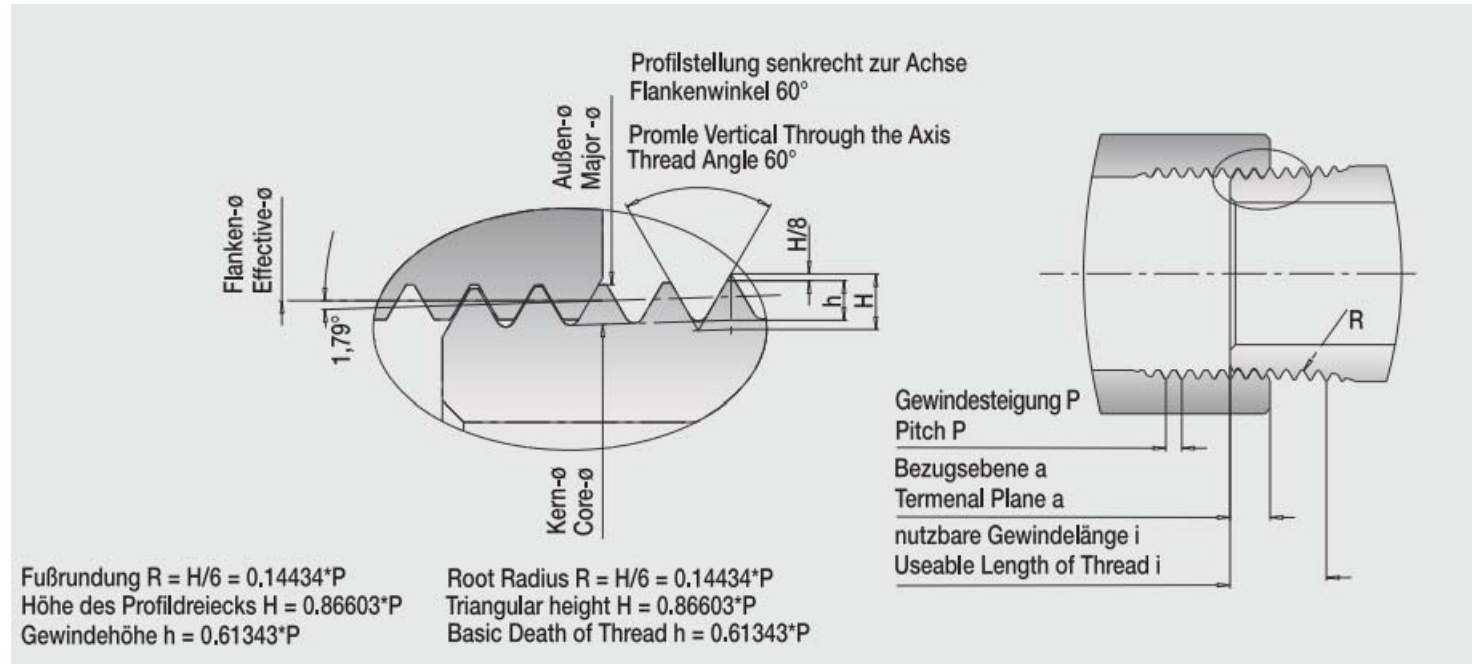
Pitch -Pitch (P)  
 LH – left

Both the internal and external threads are cylindrical.



# Threads on drawings

## Metric thread DIN 158



### Description:

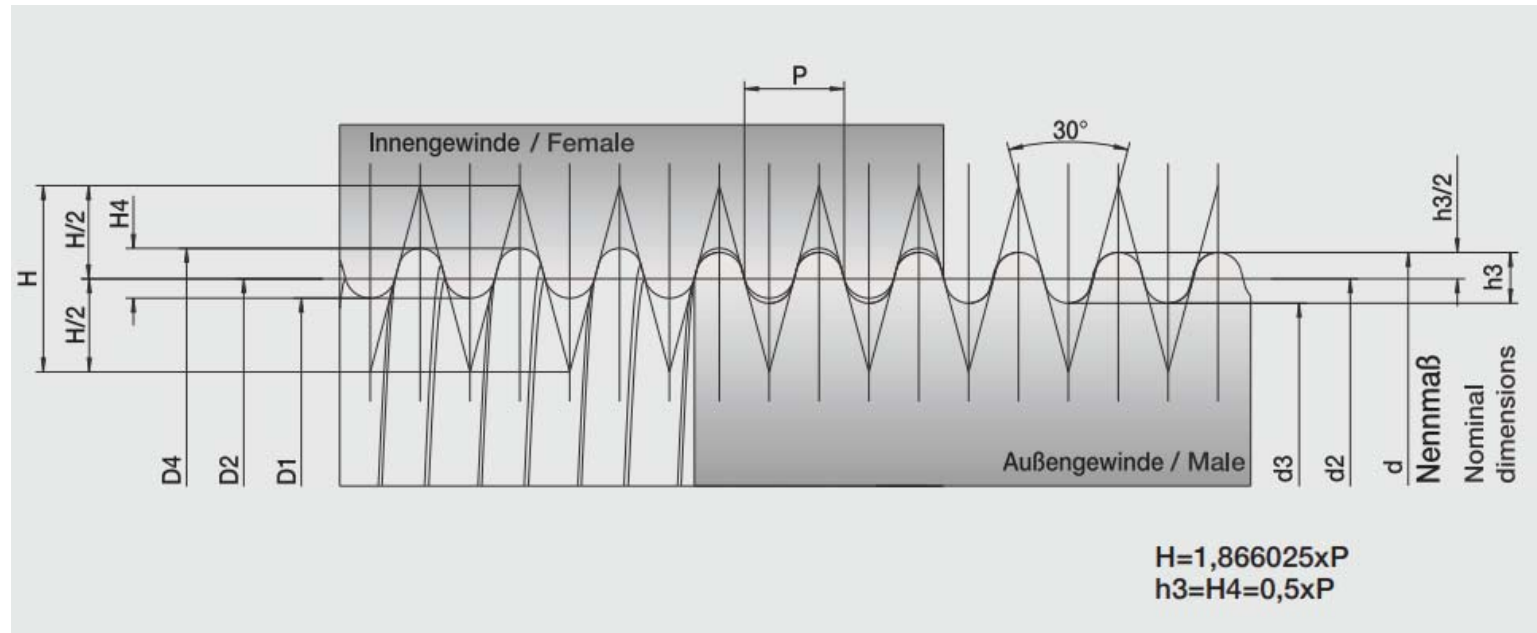
Threads to this Standard are used for **Pipe fittings with tapered male studs Form C, which are screwed into tapped holes Form Z, to DIN 3852 Part 1**. The distance **a** conforms to **DIN 3852 Part 1**. The tapered outside thread of this Standard has the same outside diameter as that of the inside parallel thread in DIN 13, enabling it to be screwed in by hand. The fitting does not need to be tightened too firmly and the seal is made with the aid of a proprietary sealing material (such as PTFE tape). All the diametres have the same tolerances and the middle values are shown in the table. The parallel inside thread should be to DIN 13, so that the clearance between the points of the thread and thereby the likelihood of leaks occurring, is minimised.

# Threads on drawings

Round thread  
 DIN 405

Marking: Rd

It is mainly used  
 for mechanical  
 joining of parts.



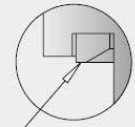
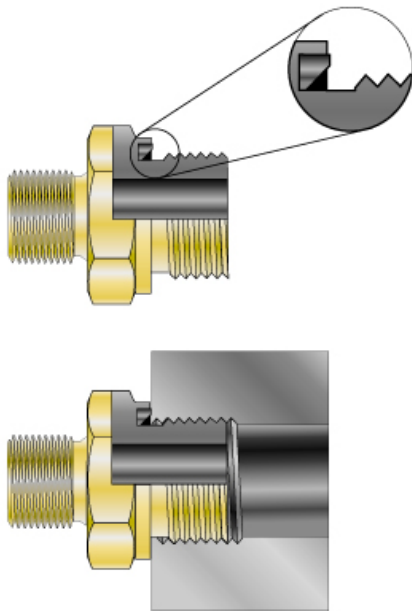
■ **Description:**

Knuckle threads are mainly used as fastening screw threads. The round form of the Knuckle thread makes it highly resistant against damages and fouling. Although the flanks overlap only a little bit, the thread can absorb major forces. Due to the round form a stress concentration is nearly impossible. Knuckle threads according that norm do have different profiles for the outside- and inside-thread. On the outside-thread the radiuses on the thread highs and lows are similar, on the inside-thread the radiuses are different. The major-, effective- and minor-aperture derives from the profil.



# Threads on drawings

Not Sealing on the  
thread – O-ring in  
groove



mëkké těsnění  
Captire seal

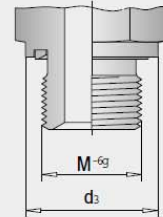
závitový čep  
s mëkkým těsněním

Male screwed plug  
with captive seal

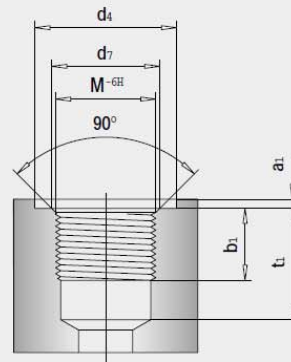
závitová díra  
forma X  
pro závitové čepy s  
mëkkým těsněním

Tapped holes  
Form X  
for studs  
with captive seal

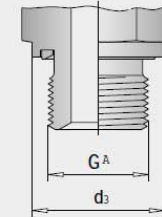
podle DIN 3852 - část 1:  
s válcovým metrickým  
závitem podle DIN 13



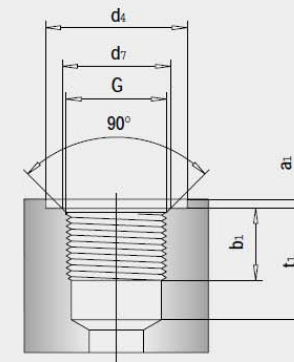
to DIN 3852 - Part 1:  
with parallel metric thread  
to DIN 13



podle DIN 3852 - část 2:  
s válcovým trubkovým závitem  
podle DIN/ISO 228



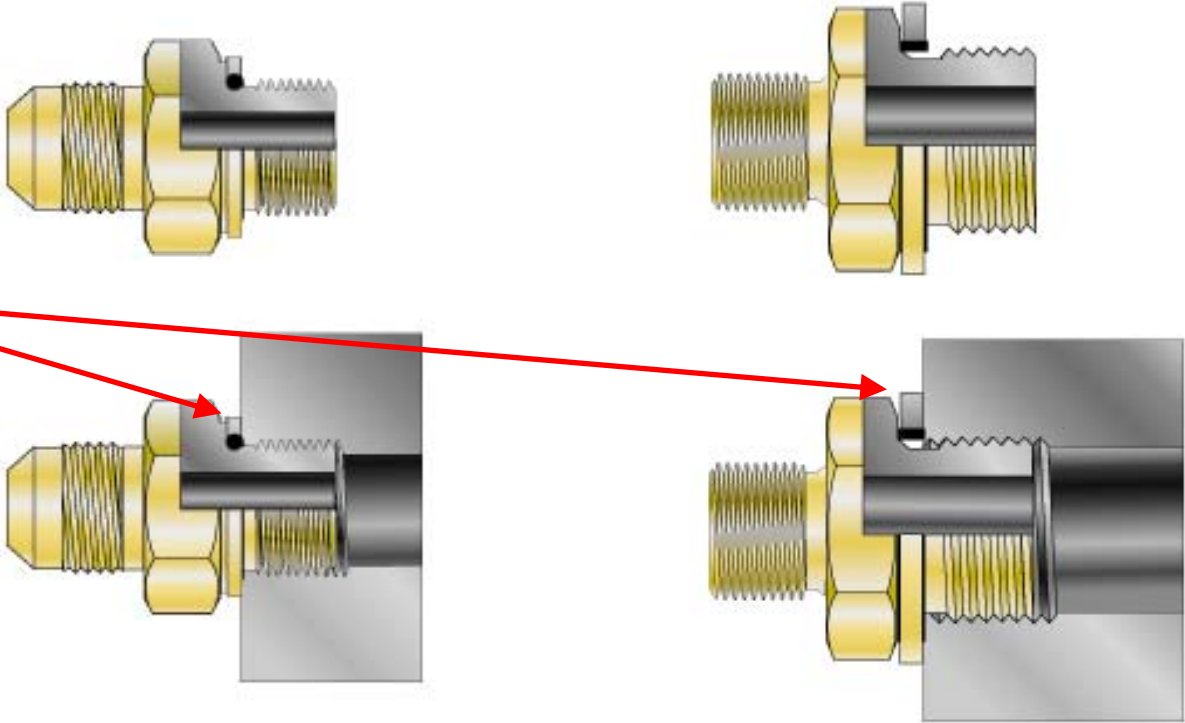
to DIN 3852 - Part 2:  
with parallel BSP thread  
to ISO 228



# Threads on drawings

Not Sealing on the  
thread – O-ring in  
groove

Retaining ring

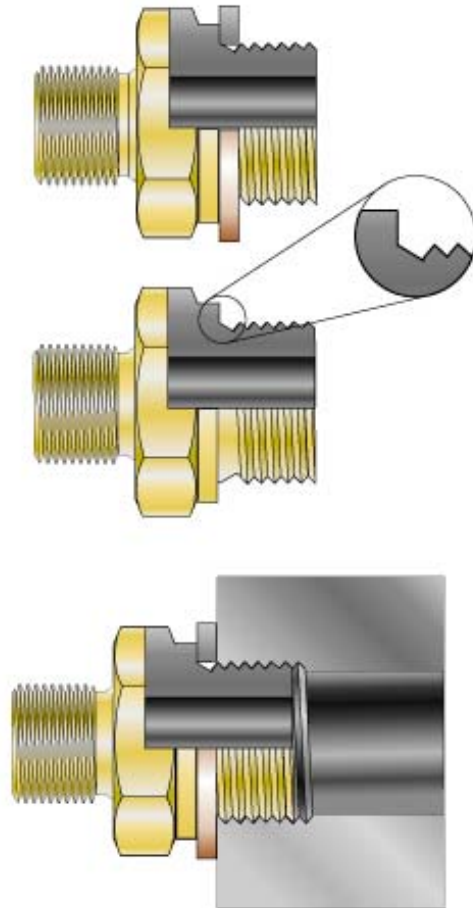


# Threads on drawings

Not Sealing  
on the thread

—

Soft Metal  
Seal , Copper

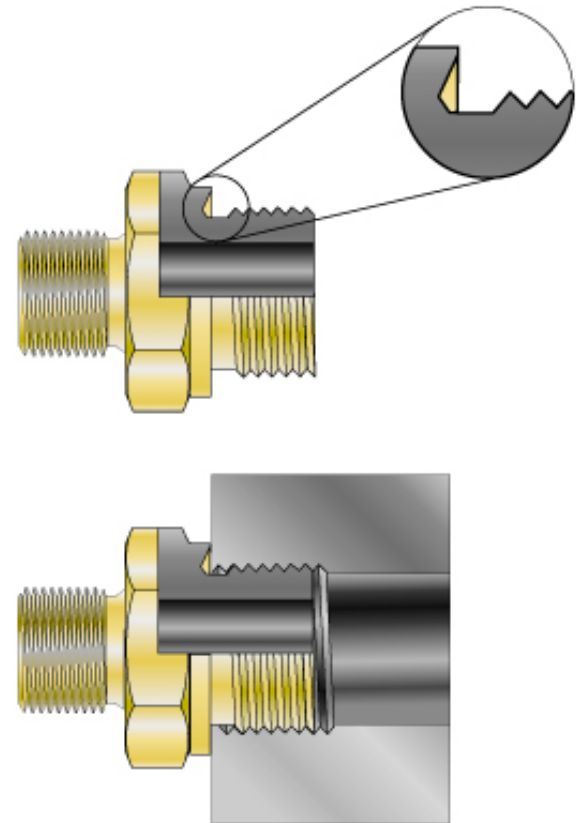
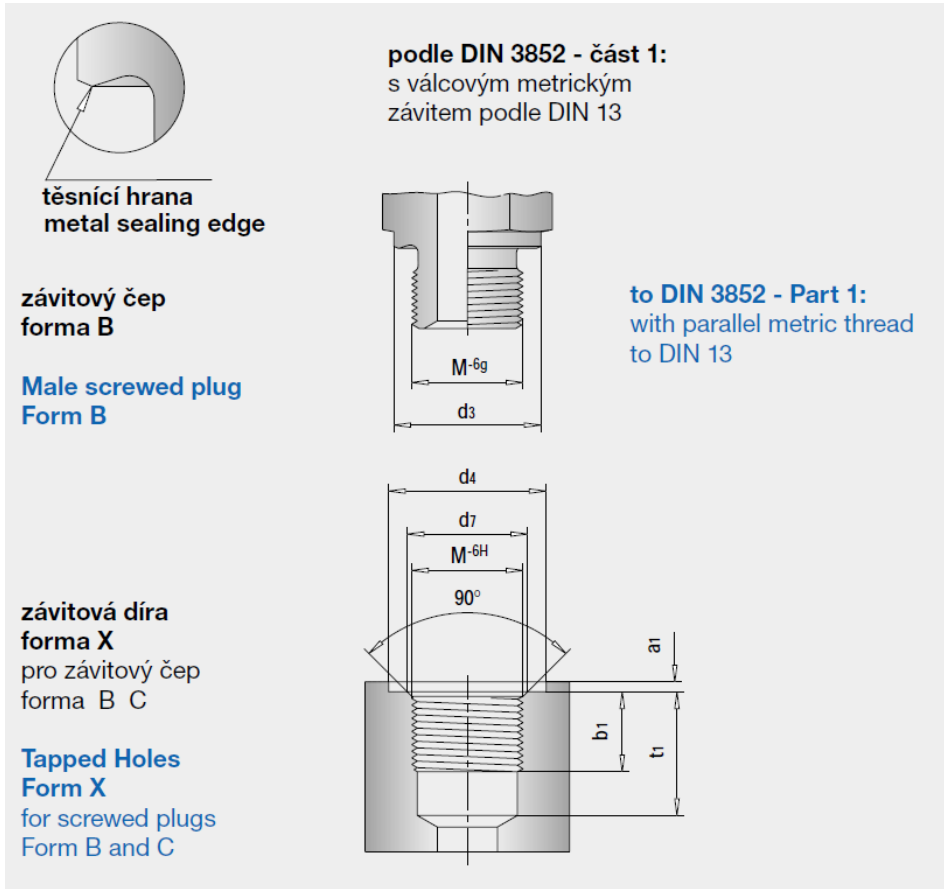


# Threads on drawings

Not Sealing  
 on the thread

—

Cutting Face  
 Seal



# Threads on drawings

Not Sealing on the thread –

Prone to galling

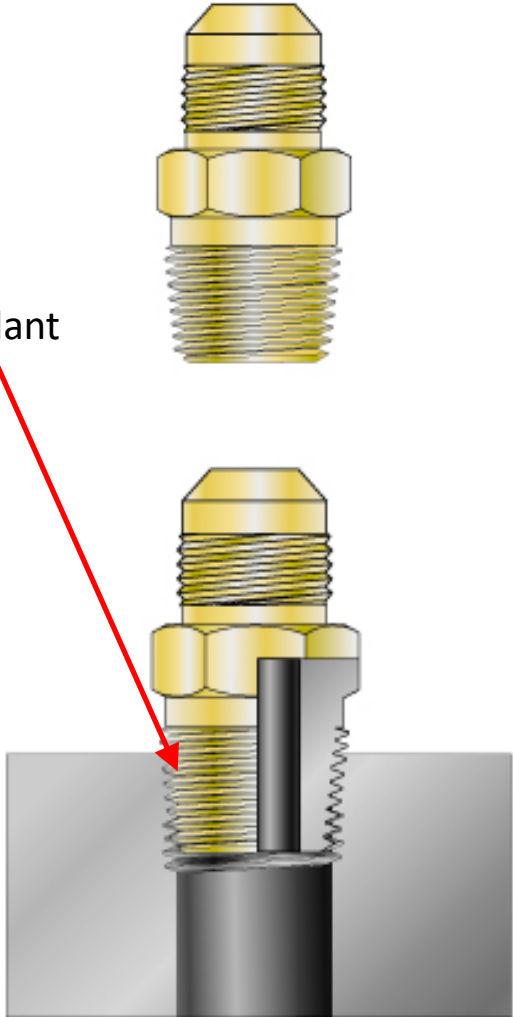
Sealing initiated by thread interference

Additional sealant usually required

Prone to fatigue failure



Sealant



## Threads on drawings

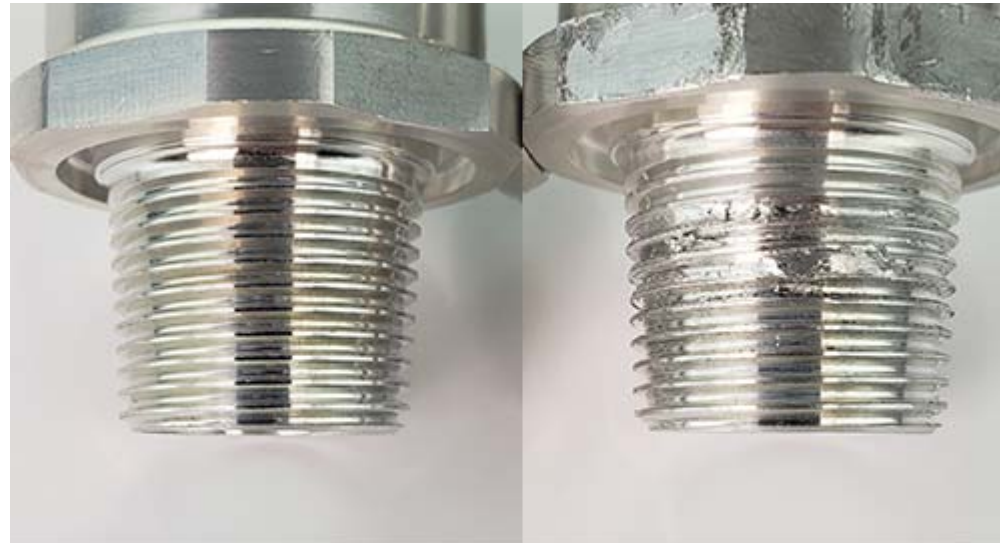
Not Sealing on the thread –

Prone to galling

Sealing initiated by thread interference

Additional sealant usually required

Prone to fatigue failure



No Galling

Galled Threads

“Kúsnutie závitů” Odieranie prípadne zadieranie závitů je spôsobené adhéziou medzi klznými plochami lícujúcich závitů. Stretnem sa s ním hlavne pri nerezových závitoch