

TSW400 series Thermowells

Safe, tough and reliable thermowells for
the Oil & Gas industry

Measurement made easy



Engineered to international standards

- ISO19001:2000

Manufactured with full material control

- 3.1 certification
- Traceability to producing mill
- X-Ray PMI available

Documented to Oil & Gas industry standards

- Documents compiled on electronic media
- Material certification
- Welding certification

Applications

- Oil & Gas downstream
- Oil & Gas upstream
- Arduous applications requiring high specification

TSW400 series Thermowells

Available designs

The following designs are available from ABB's standard range of thermowells. However, many organizations have their own standard designs and these can be accommodated by selecting 'other design' and providing a drawing for quotation.

Flanged

Flanged thermowells are available in three manufacturing options:

Welded with a fillet and groove weld

- fillet and groove welding is perfectly adequate in most circumstances; the weld is designed to be stronger than the required duty pressure.

Welded with a full penetration weld

- full penetration welding provides a stronger weld joint and is specified when absolute assurance of pipe-work integrity is required.

Manufactured from a single piece, shaped forging

- fully forged thermowells are manufactured from a shaped forging formed to closely resemble the final shape of the finished thermowell. This ensures correct granular alignment of all the thermowell components – absolutely vital in ensuring resistance to corrosion cracking.

Weld-in and threaded

Manufactured from a single piece of high quality material, there is no welding in any of ABB's weld-in or threaded designs.

Profiles

Three basic profiles are available:

Straight

- the stem diameter is consistent from the root to the tip

Tapered

- the profile tapers from the root to the tip

Stepped

- the lower portion of the thermowell steps to a smaller diameter.

A version of the stepped profile is available in the DIN designs where the step is a taper towards the tip. See the illustrations on pages 4 to 25 for details.

Velocity collars

There are times when thermowell design fails to satisfy ASME PTC19.3 2010 TW criteria. Under these circumstances, it is advisable to shorten the thermowell and change the diameters of the stem root and tip. ABB engineers are available to advise on this. Where the thermowell would become too short, a velocity collar can be used.

Caution. A velocity collar relies on an interference fit between the thermowell collar and the mounting branch. The interference fit is the responsibility of the installation team and, although ABB can advise on the procedure, ABB cannot be held responsible for incorrect fitting of velocity collars.

Dimensions

The key dimensions of a thermowell are related to the stem. The dimensions of the flange or screw thread are given by international standards.

Immersion length (U)

- the length of the thermowell from the underside of the flange to the tip. This is the unsupported length of the thermowell and, in the case of a threaded thermowell, is measured from the start of the screw thread. In the case of a threaded, tapered thermowell, it is normally measured 10 mm (4 in.) in from the start of the thread and for a threaded, parallel thermowell it is measured from the back of the thread.

External length (T)

- the additional length of the thermowell.
U + T gives the total length of the thermowell.

Tip diameter (P1)

- the diameter of the stem at the tip (the part of the thermowell furthest from the process connection).

Stem diameter (P2)

- the diameter of the stem on the process side of the connection (also referred to as the stem root).

Instrument connection diameter (P3)

- the diameter of the stem where it connects to the instrument.

Internal bore

- the diameter of the hole in the stem.

Step position

- the distance from the tip to the beginning of the step. A stepped thermowell is a straight thermowell with a step down to a smaller diameter near the tip. A number of the DIN designs taper from the stepped position to the tip diameter.

Velocity collar position

- the position from the tip to the underside of the velocity collar.

Velocity collar diameter

- the diameter of the velocity collar (specified to the nearest millimeter).

Tip thickness

- the standard tip thickness is 6 mm.

Note. If a different tip thickness is required, *it must be specified when ordering*. Failure to specify will result in the order being completed with the standard 6 mm tip thickness.

Stem-to-flange radius

- the standard stem-to-flange radius is 3 mm.

Note. If a different stem-to-flange radius is required, *it must be specified when ordering*. Failure to specify will result in the order being completed with the standard 3 mm stem-to-flange radius.

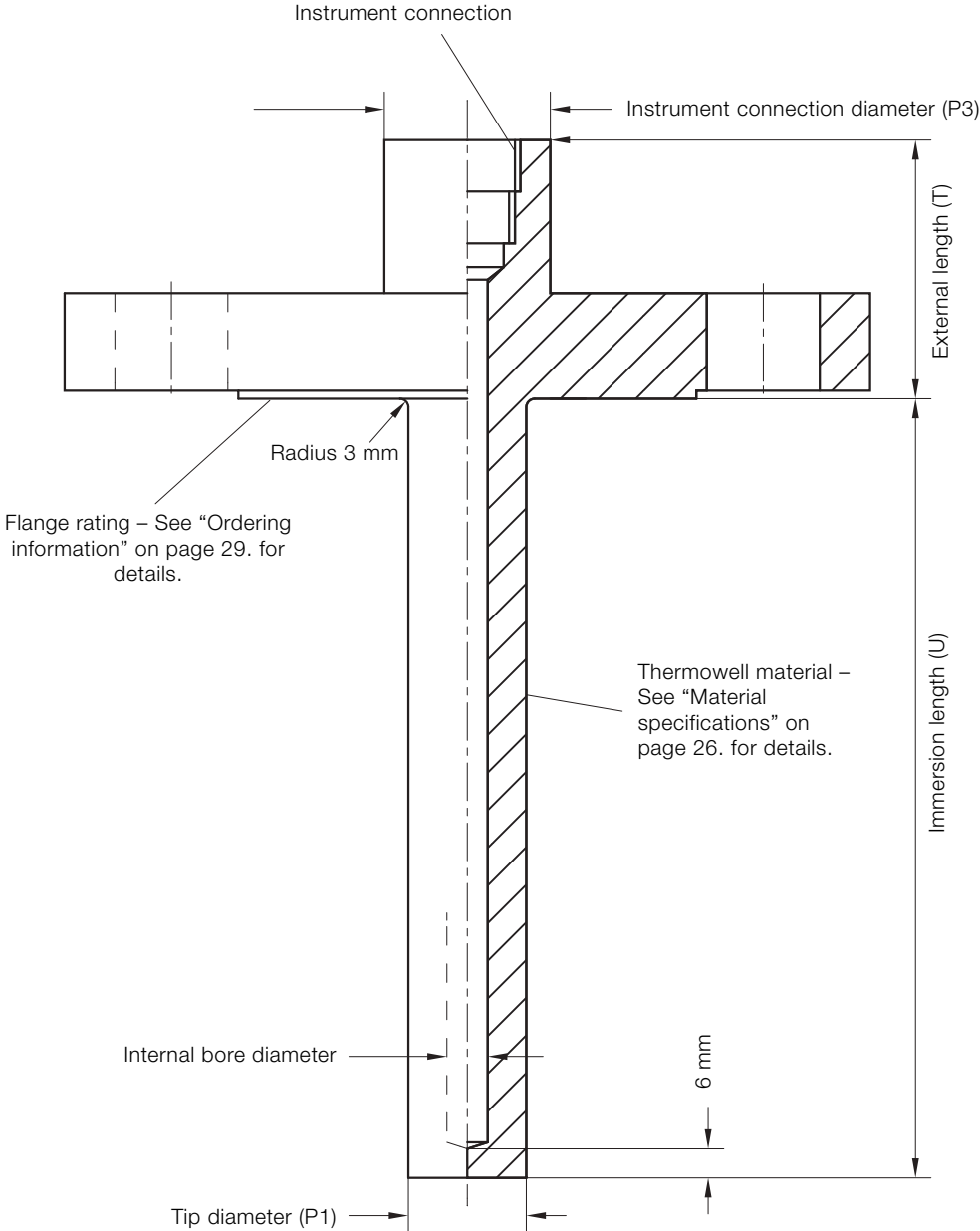
The thermowell style illustrations on pages 4 to 25 each give the dimension of the solid portion of the thermowell from the end of the bore to the end of the tip.

TSW400 series Thermowells

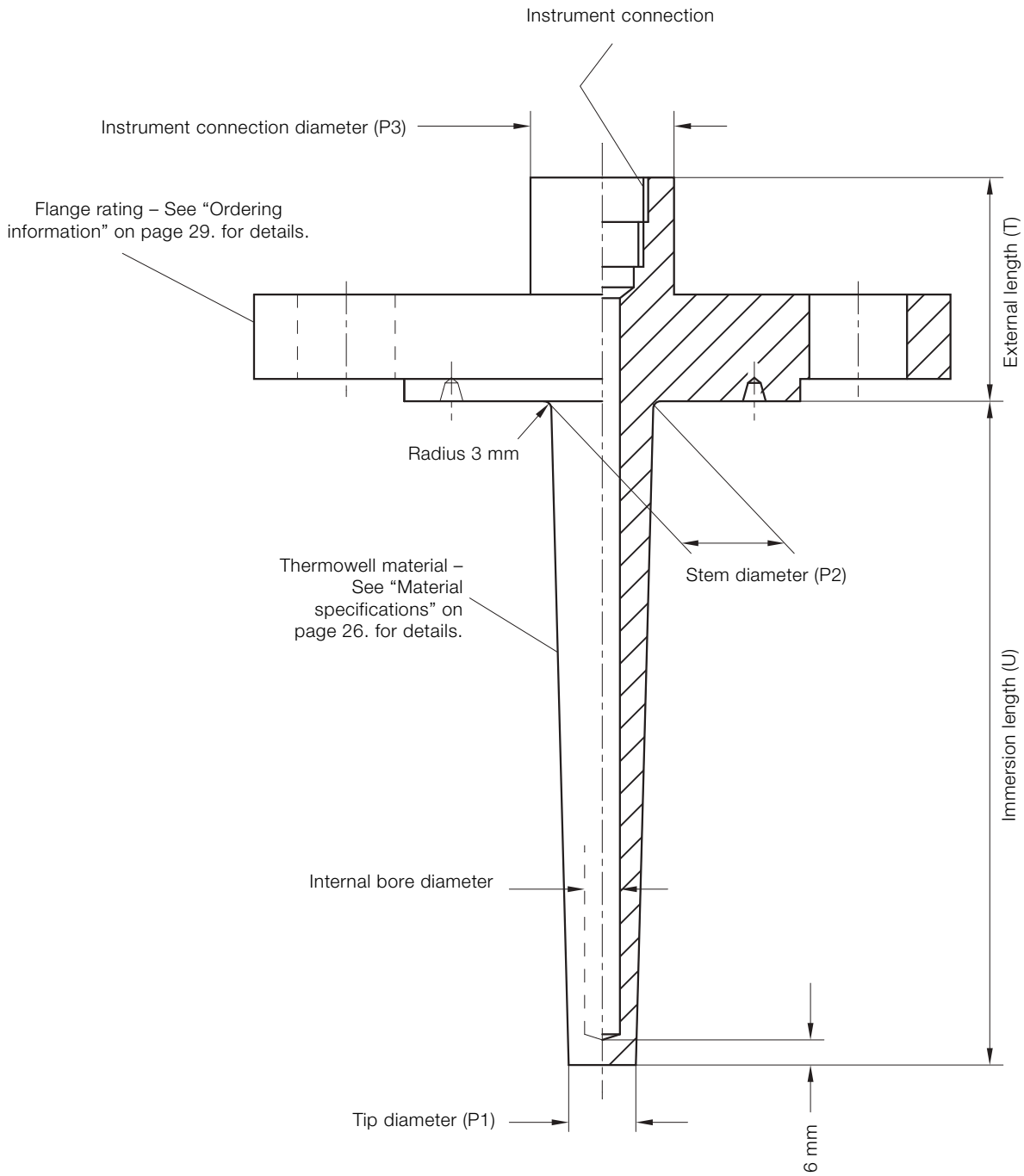
Thermowell styles

Pages 4 to 25 show the style of thermowell available and is the first consideration when selecting a thermowell.

Flanged, straight, forged – E1

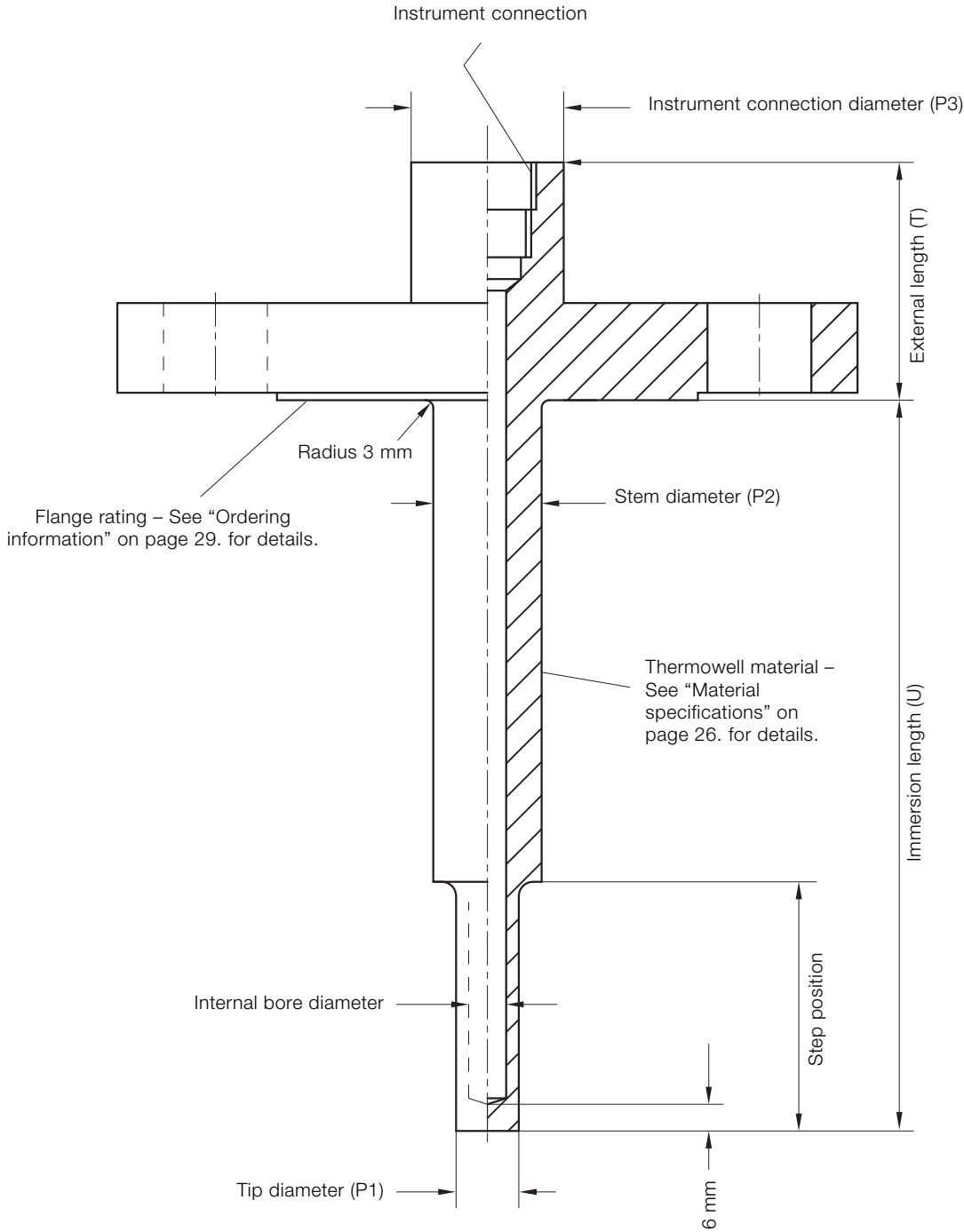


Flanged, tapered, forged – E2

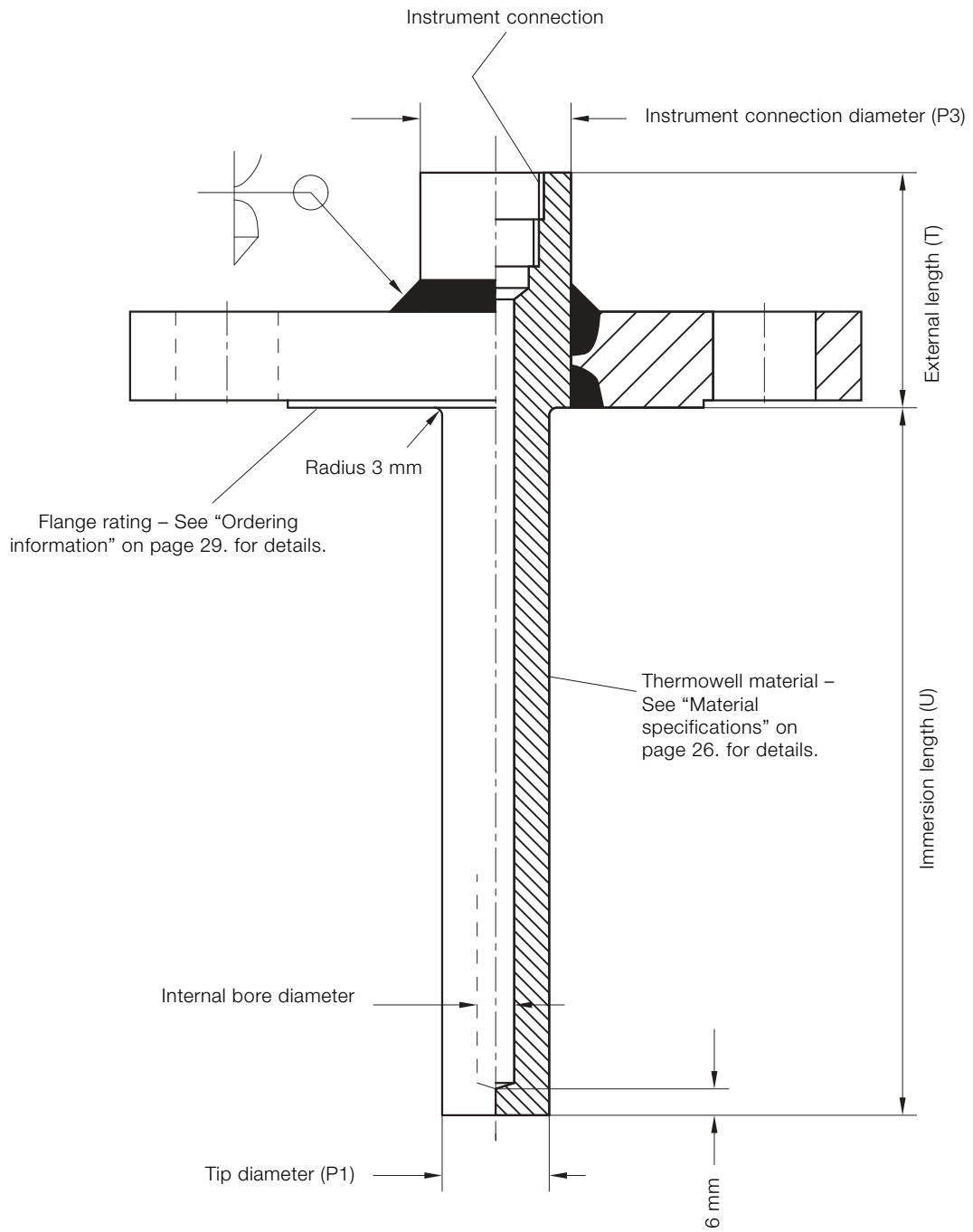


TSW400 series Thermowells

Flanged, stepped, forged – E3

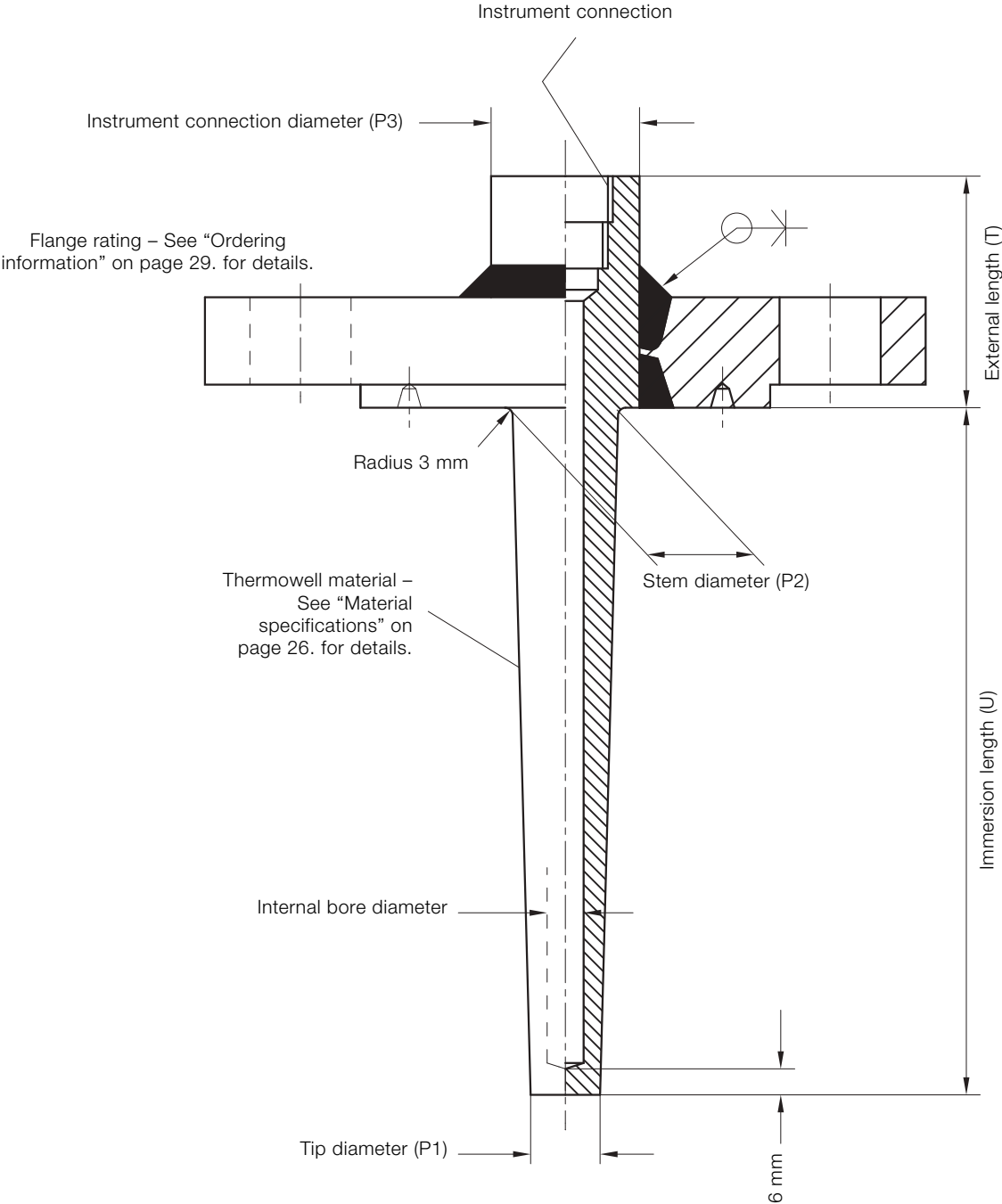


Flanged, straight, full penetration weld – E4

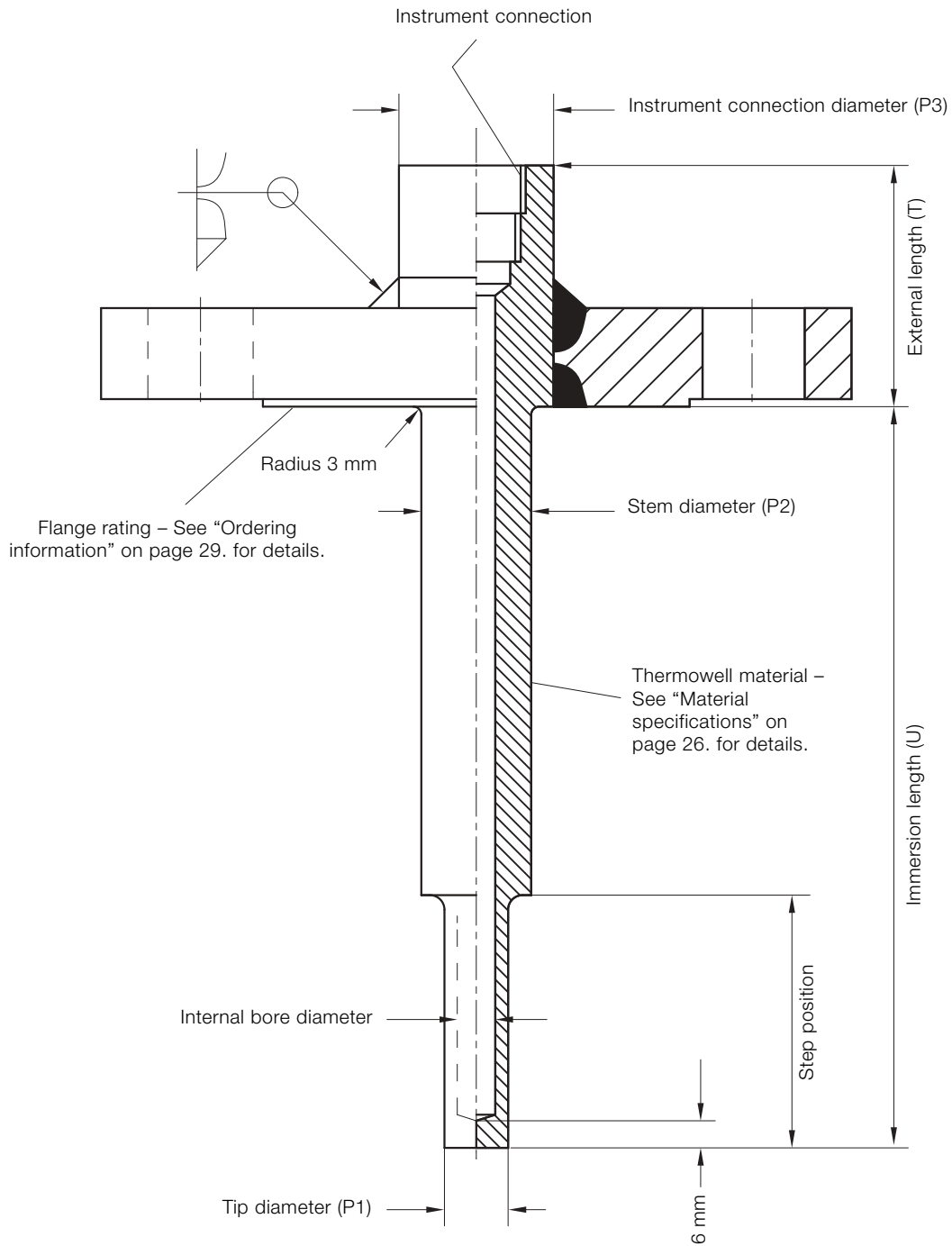


TSW400 series Thermowells

Flanged, tapered, full penetration weld – E5

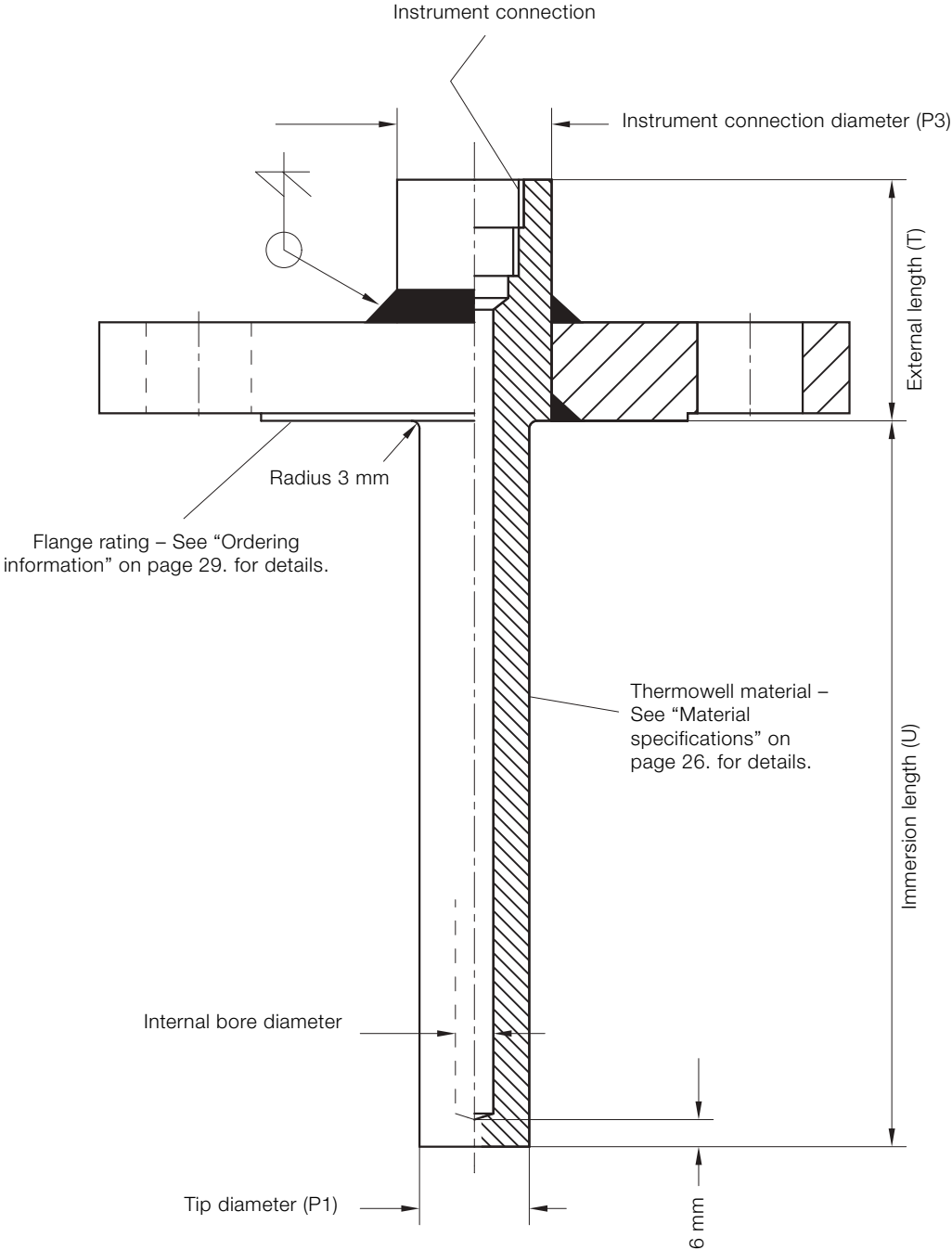


Flanged, full penetration weld – E6

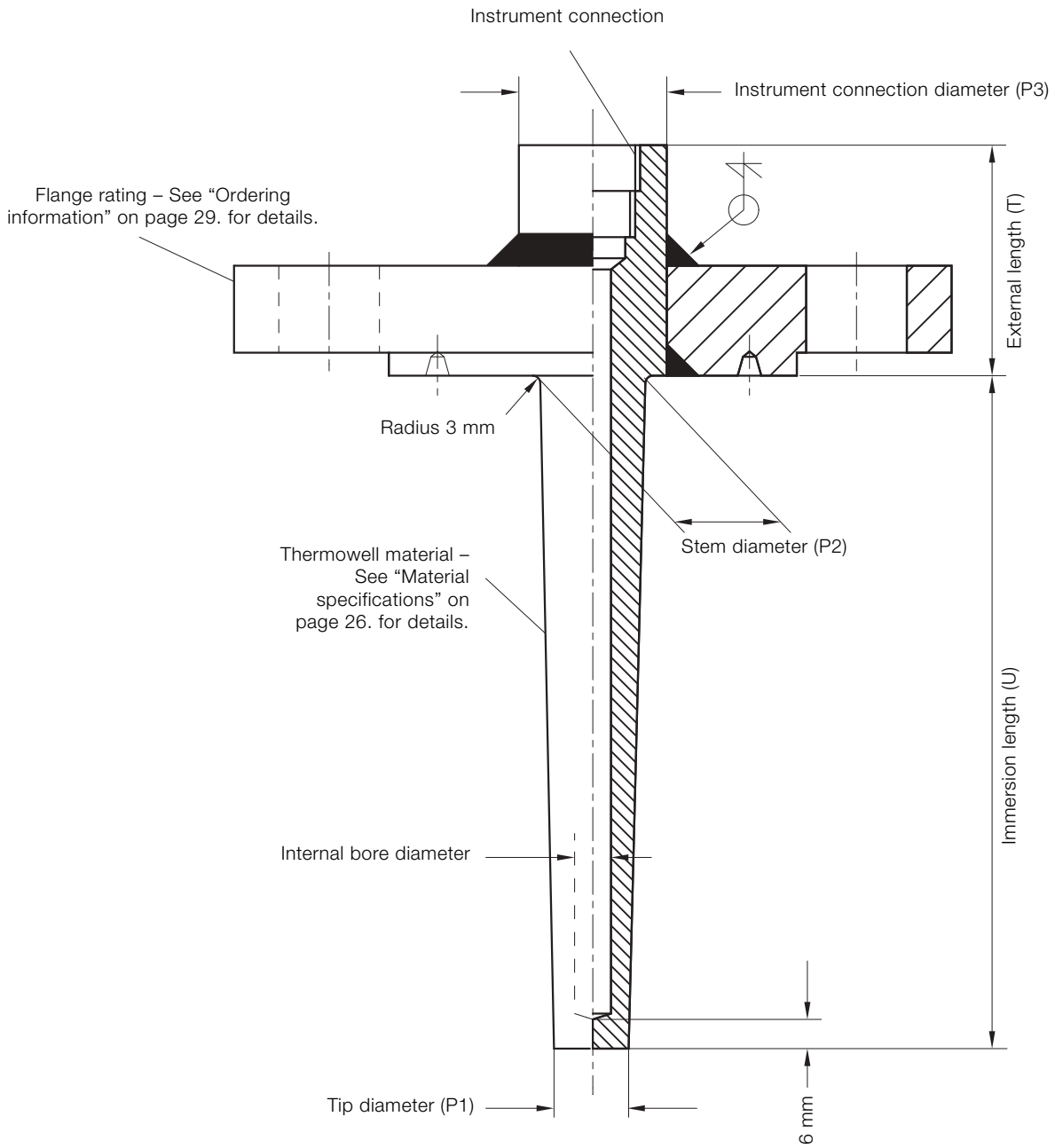


TSW400 series Thermowells

Flanged, straight, fillet and groove weld – E7

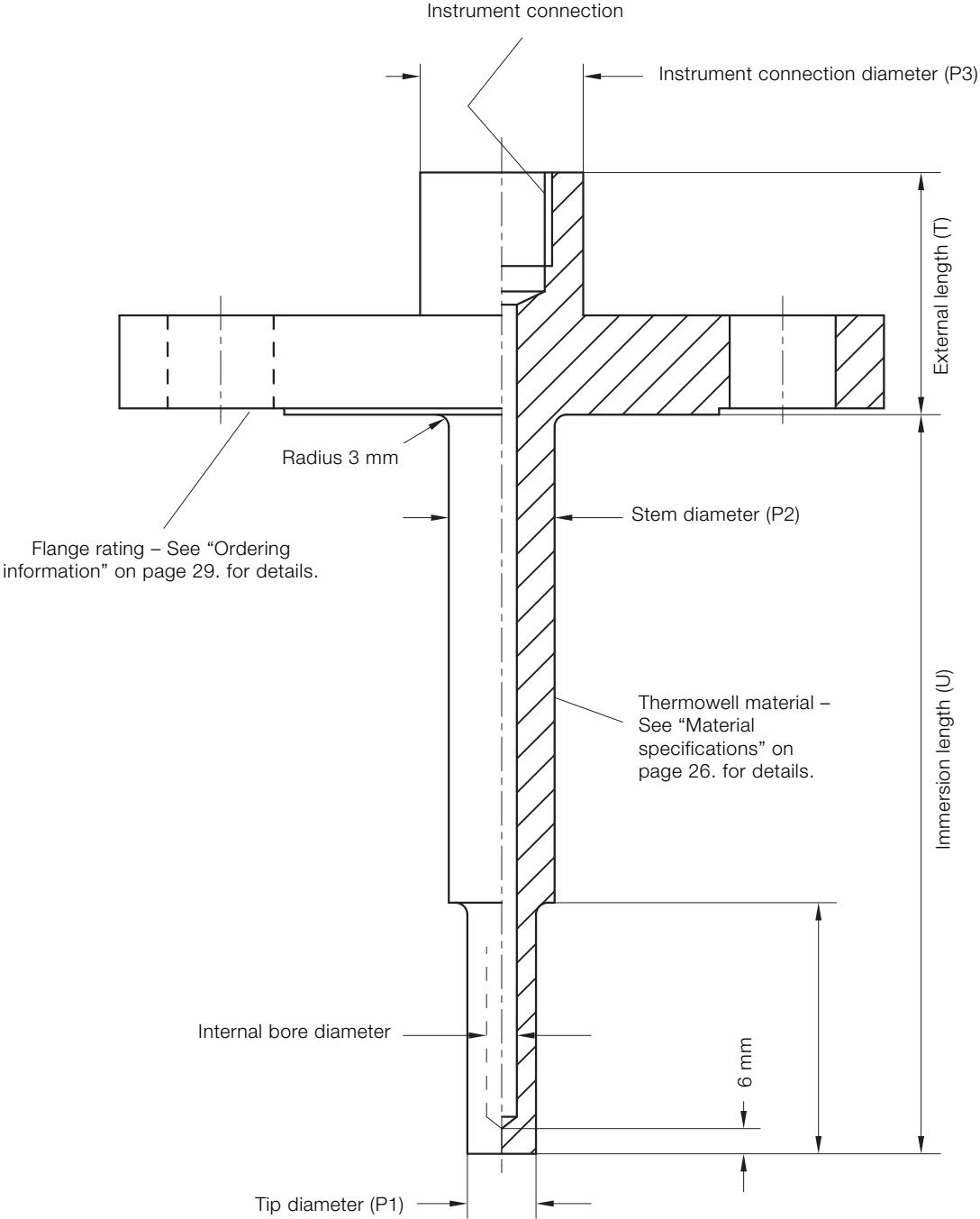


Flanged, tapered, fillet and groove weld – E8

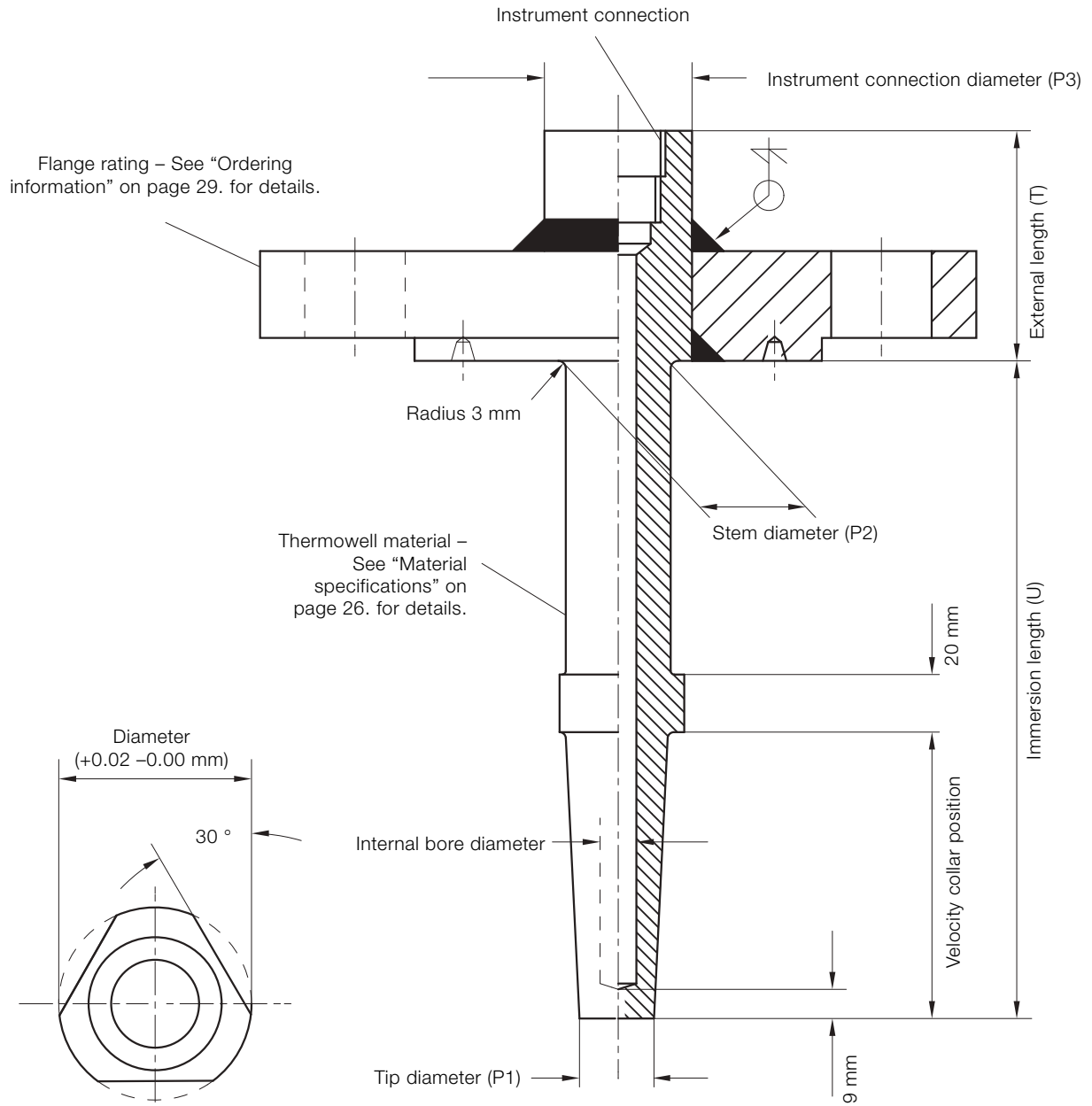


TSW400 series Thermowells

Flanged, stepped, fillet and groove weld – G1



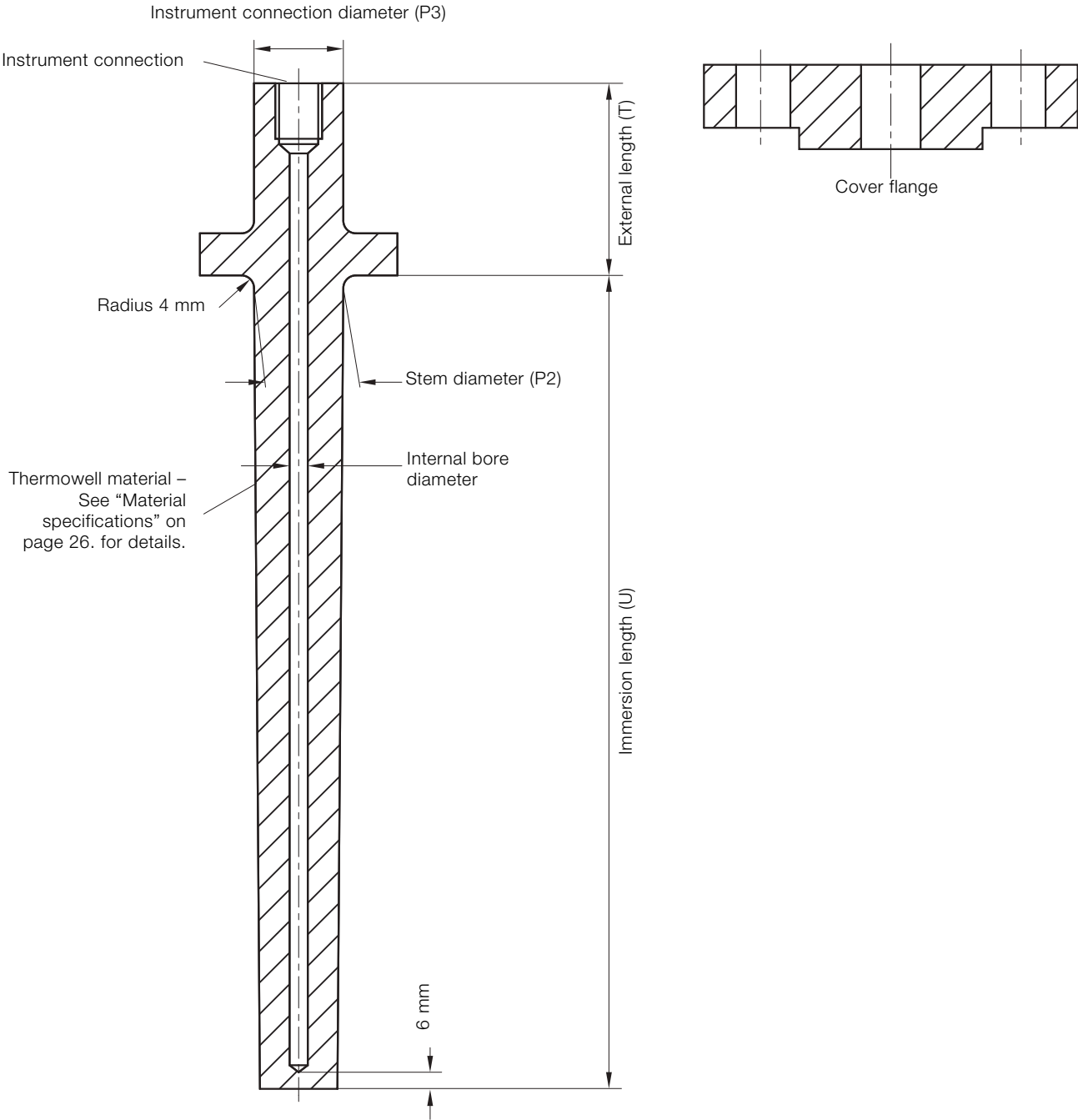
Flanged, tapered, fillet and groove weld with velocity collar – H1



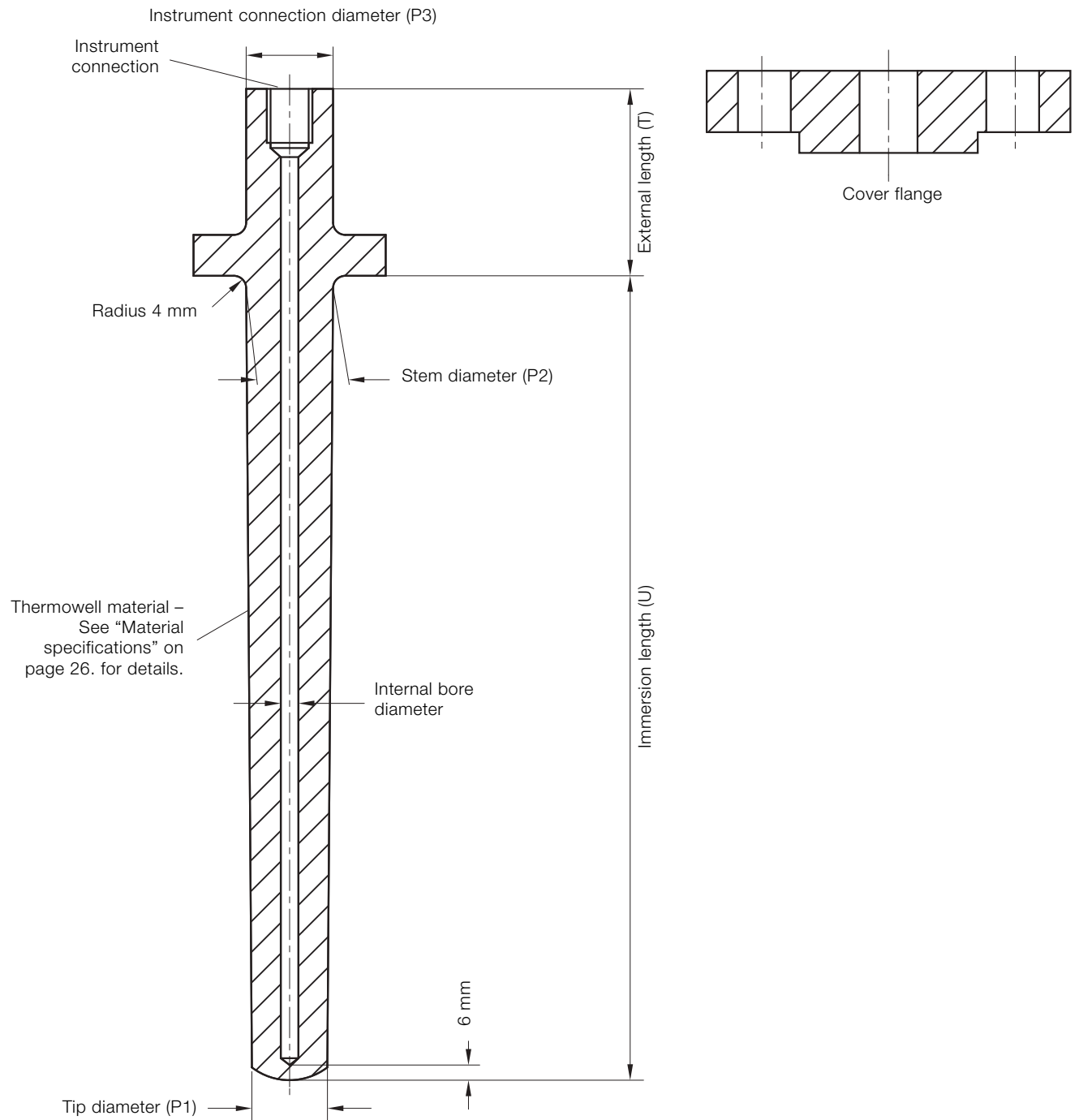
Velocity collar detail showing chamfers.
 Applies also to G2, G3, G4, G5, G6, G7, G8,
 H1 and H2

TSW400 series Thermowells

Van Stone, straight with cover flange – H3

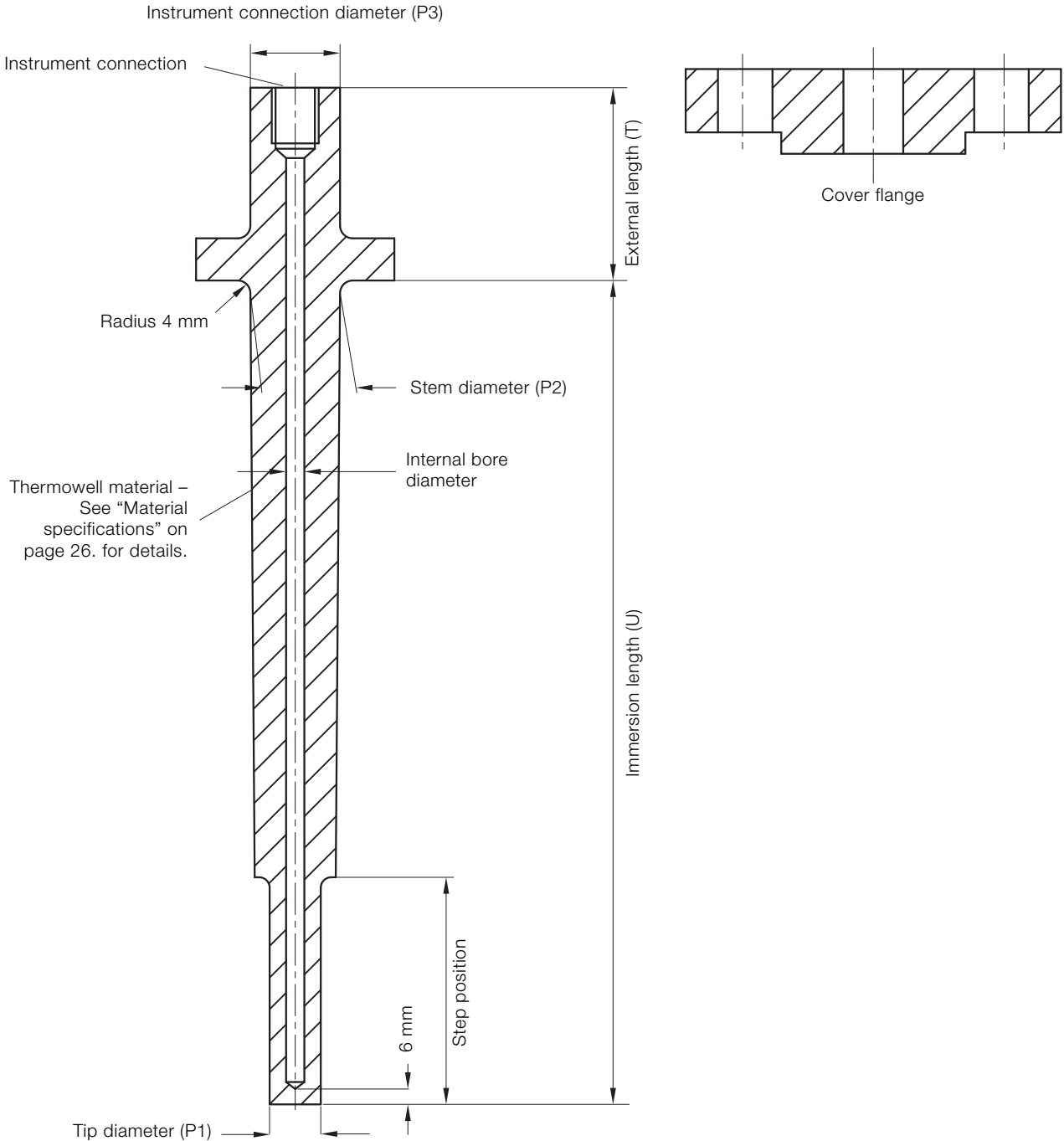


Van Stone, tapered with cover flange – H4

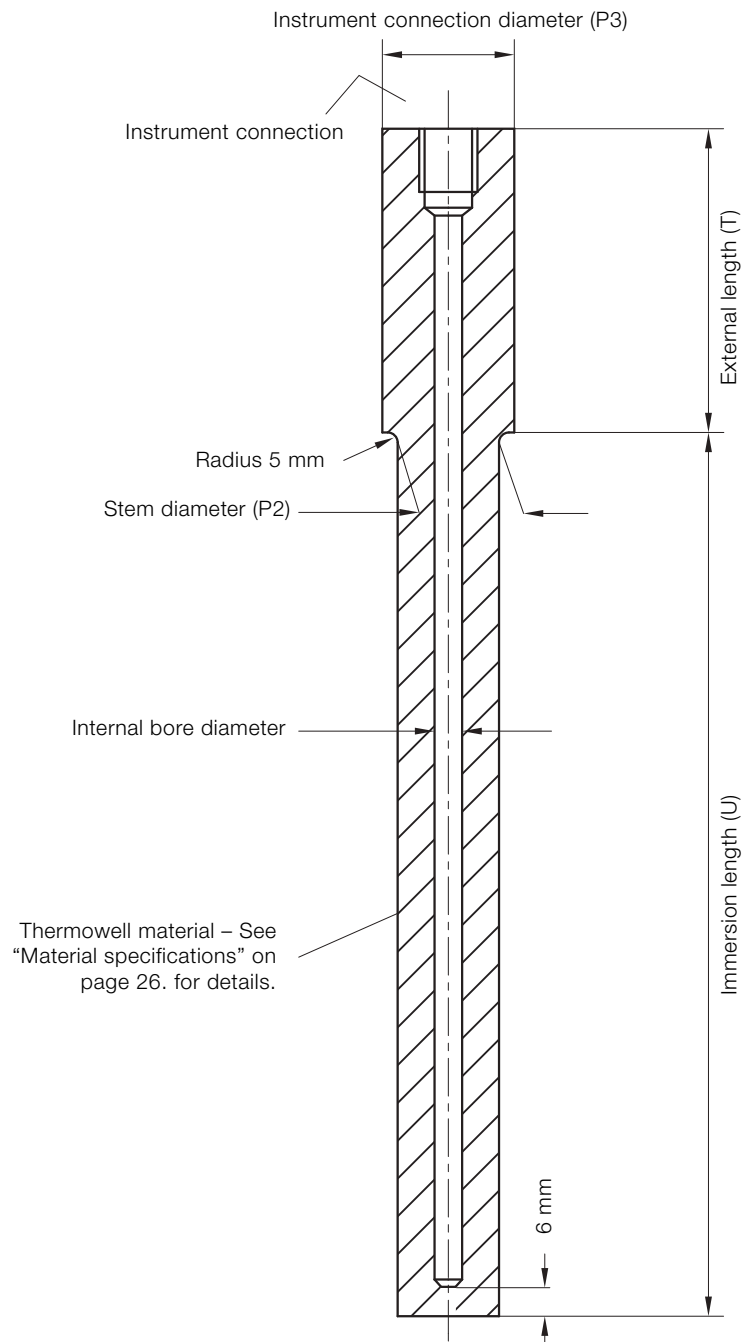


TSW400 series Thermowells

Van Stone, stepped with cover flange – H5

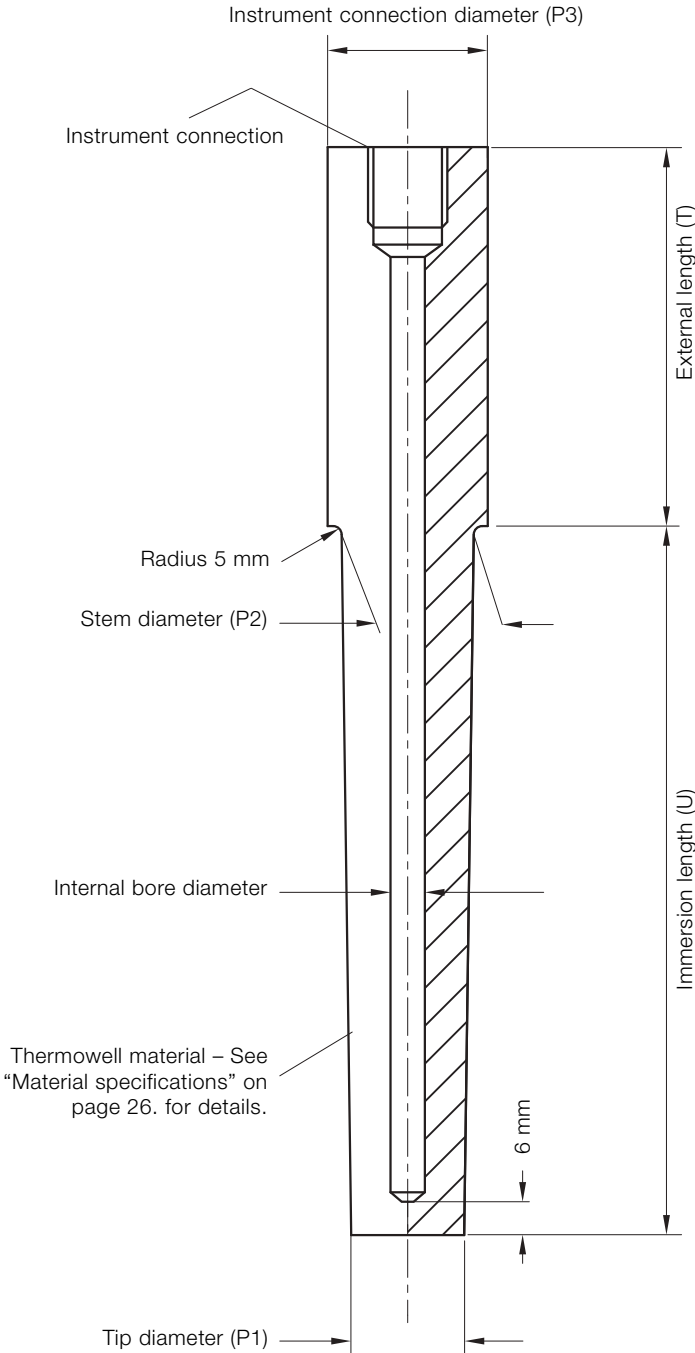


Weld-in, straight – J1

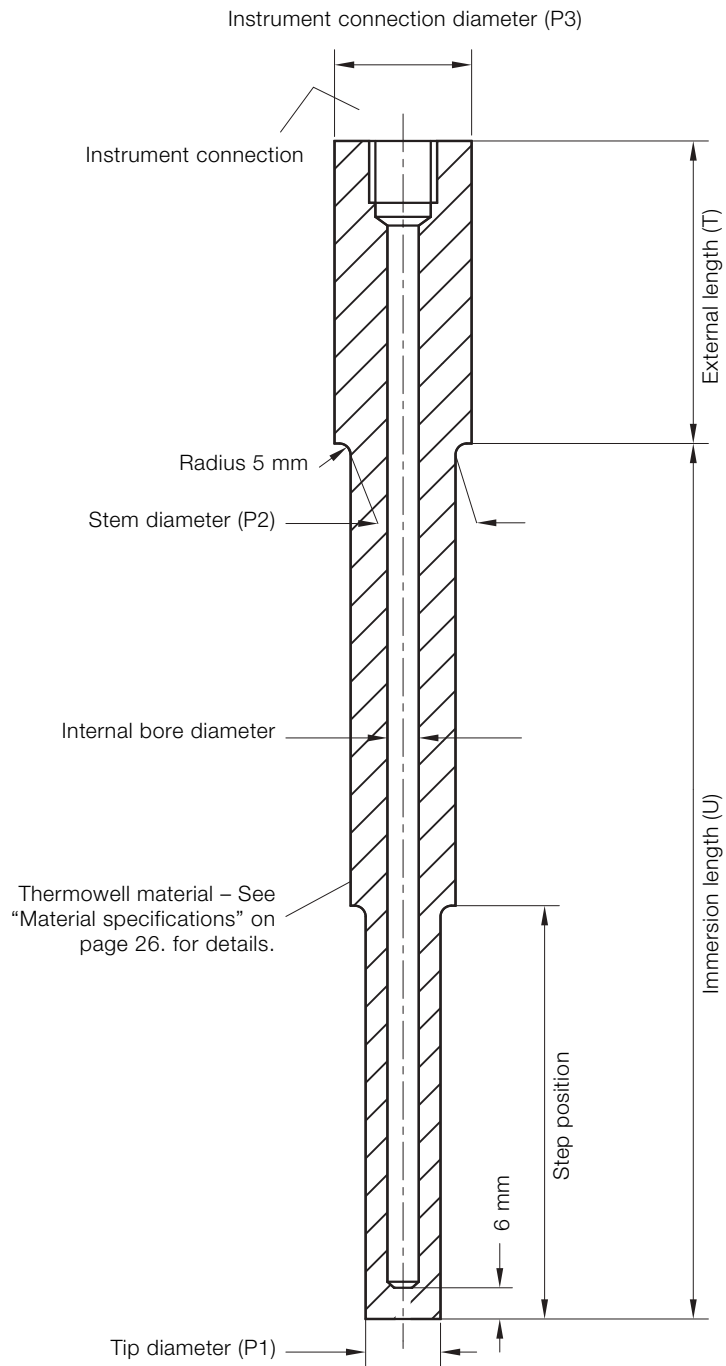


TSW400 series Thermowells

Weld-in, tapered – J2

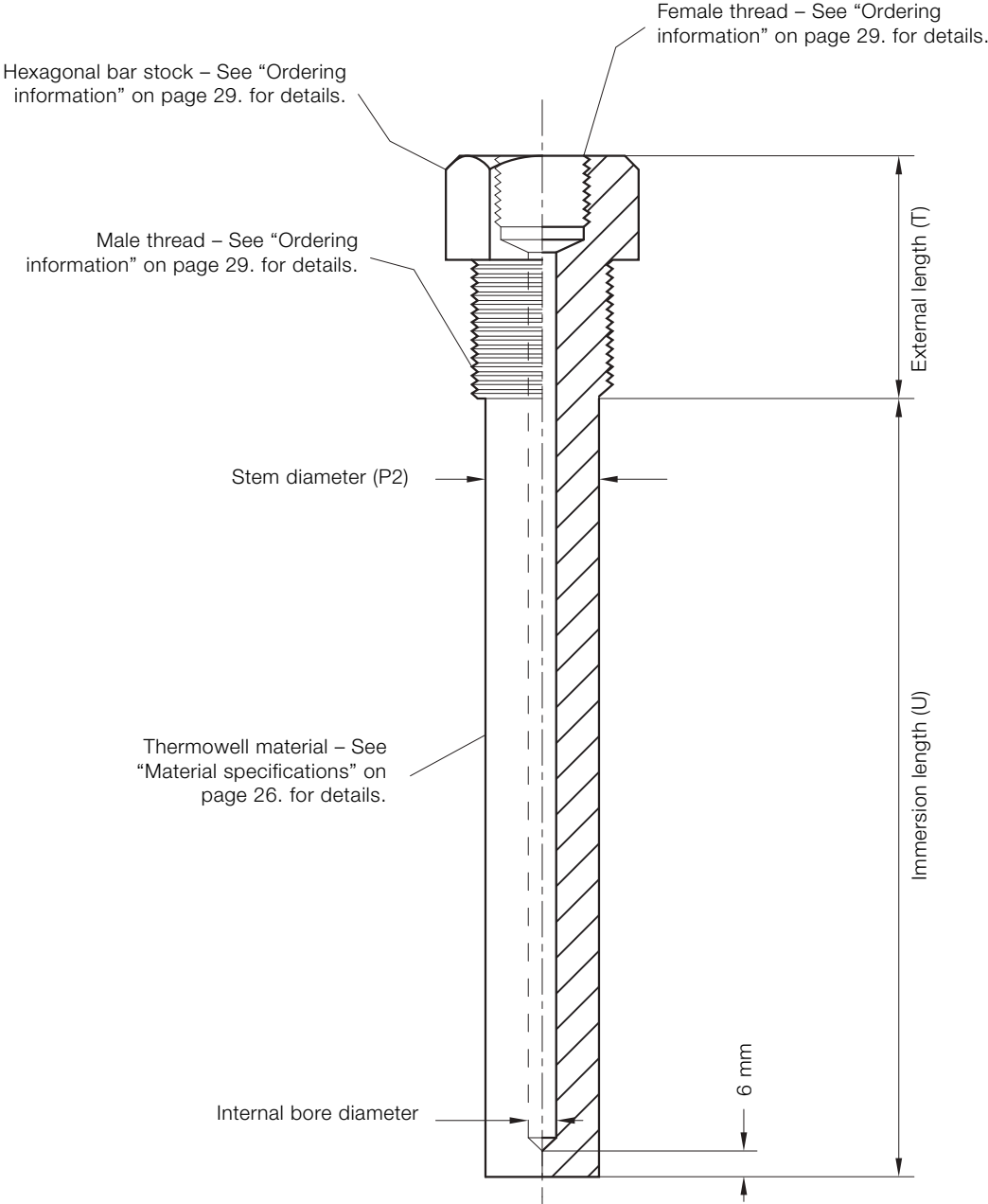


Weld-in, stepped – J3

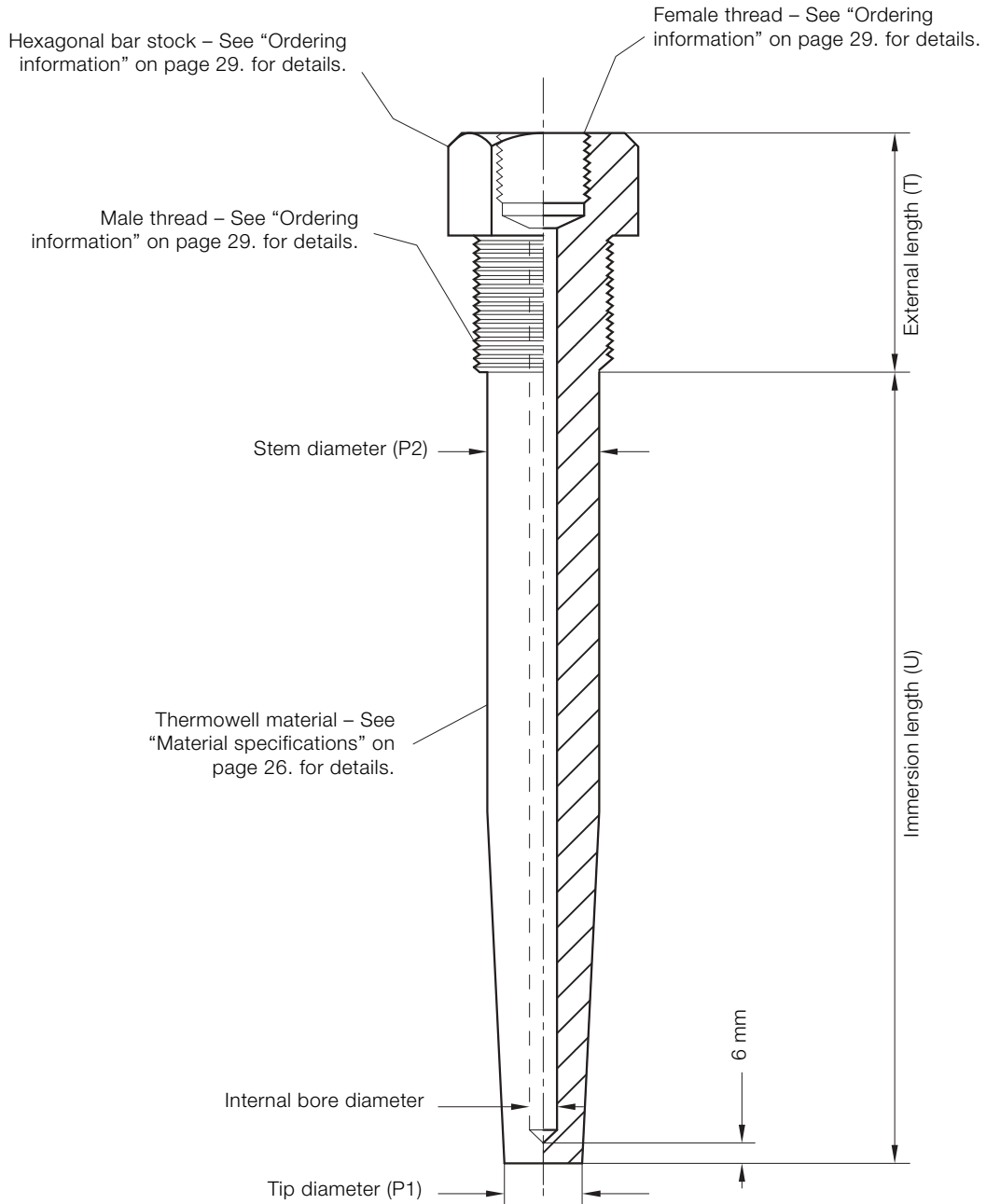


TSW400 series Thermowells

Threaded, straight – J4

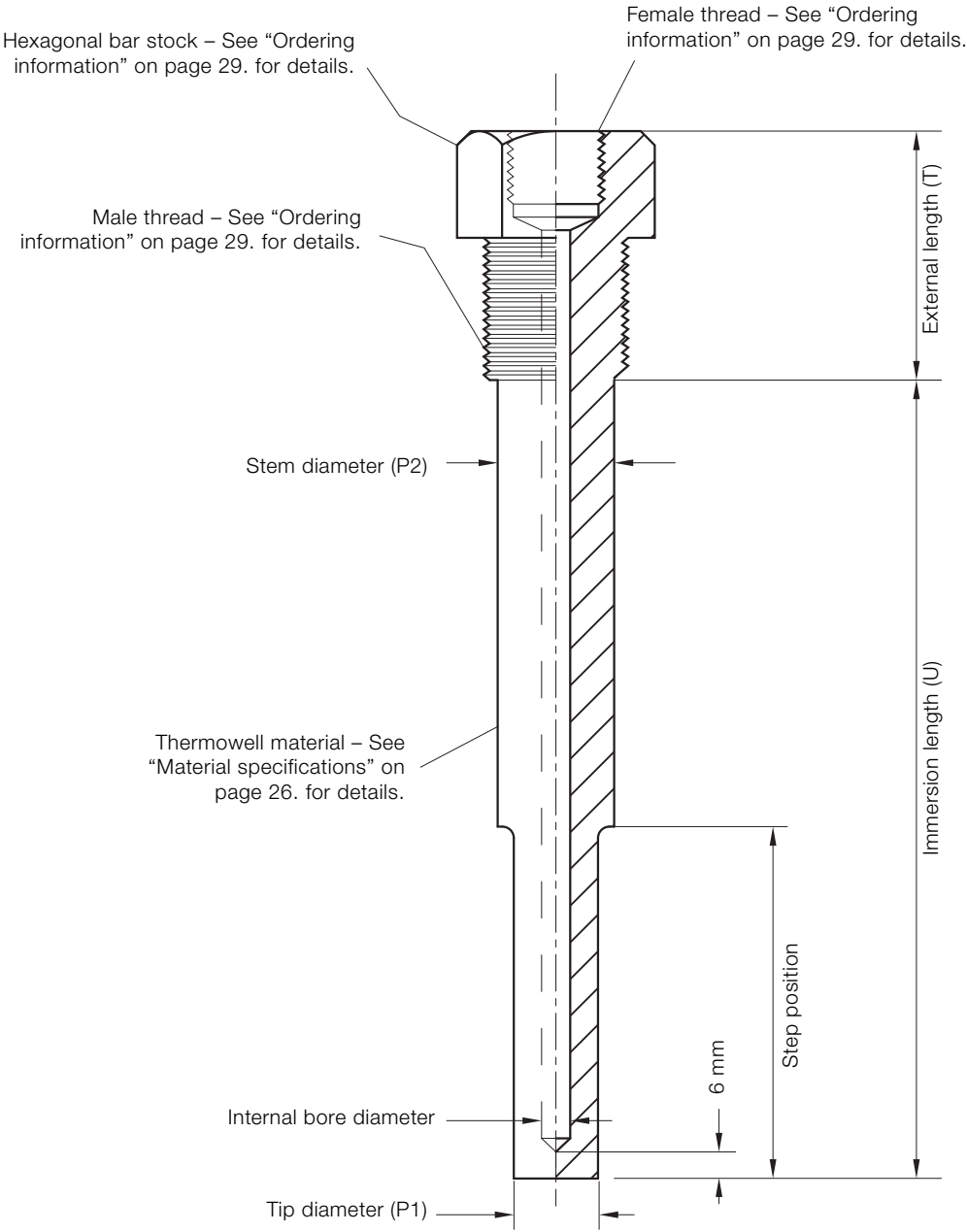


Threaded, tapered – J5

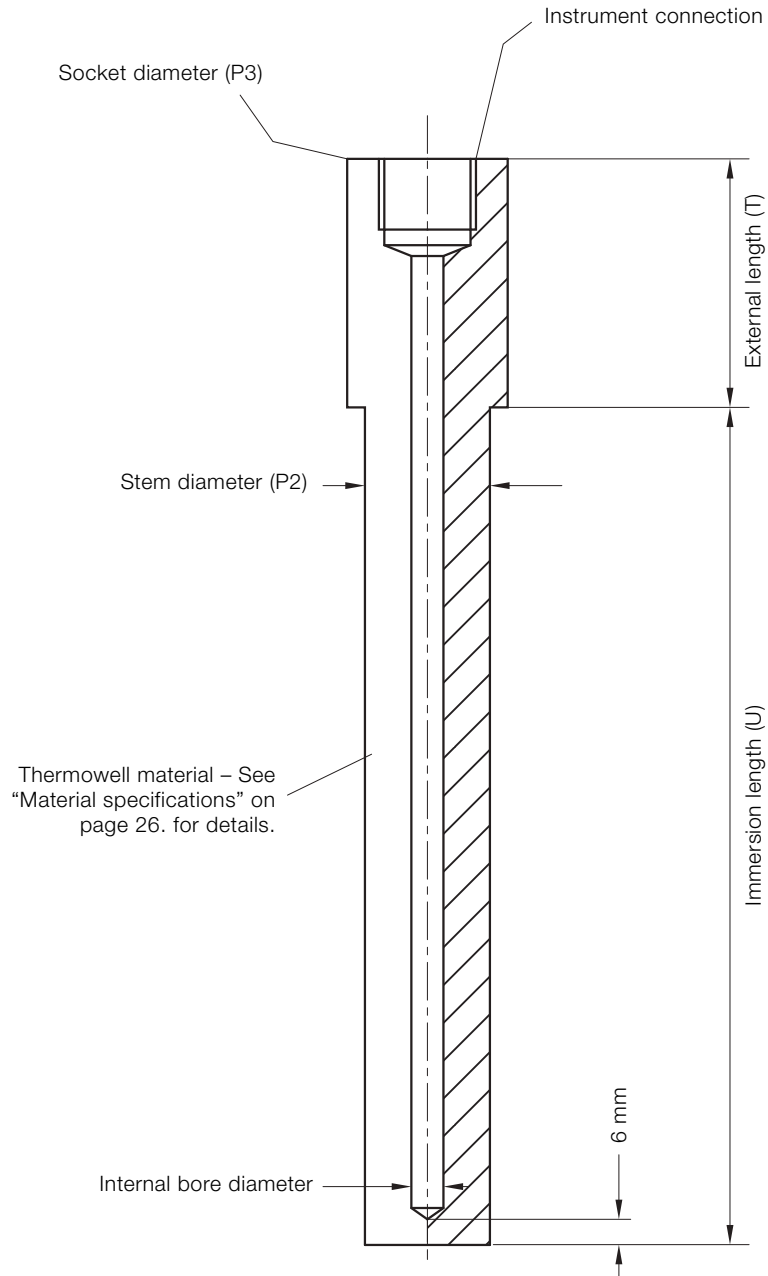


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Threaded, stepped – J6

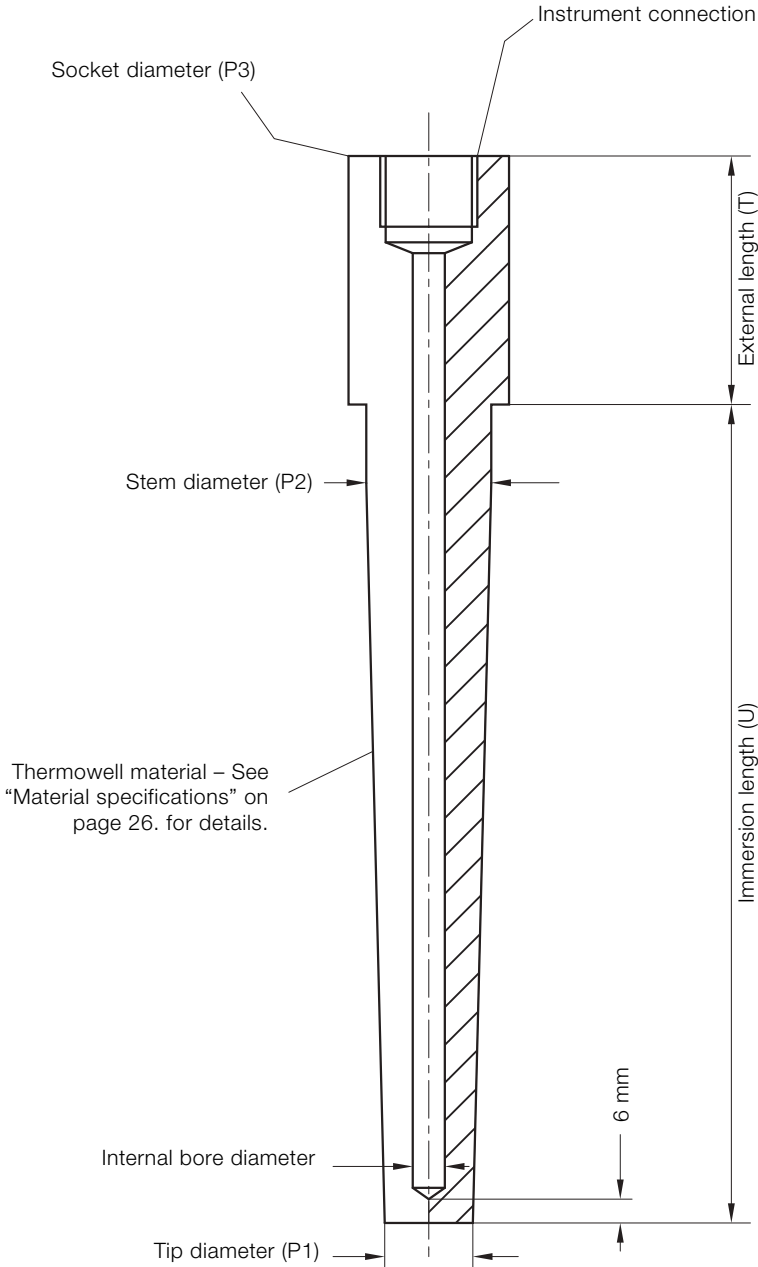


Socket-weld, straight – J7

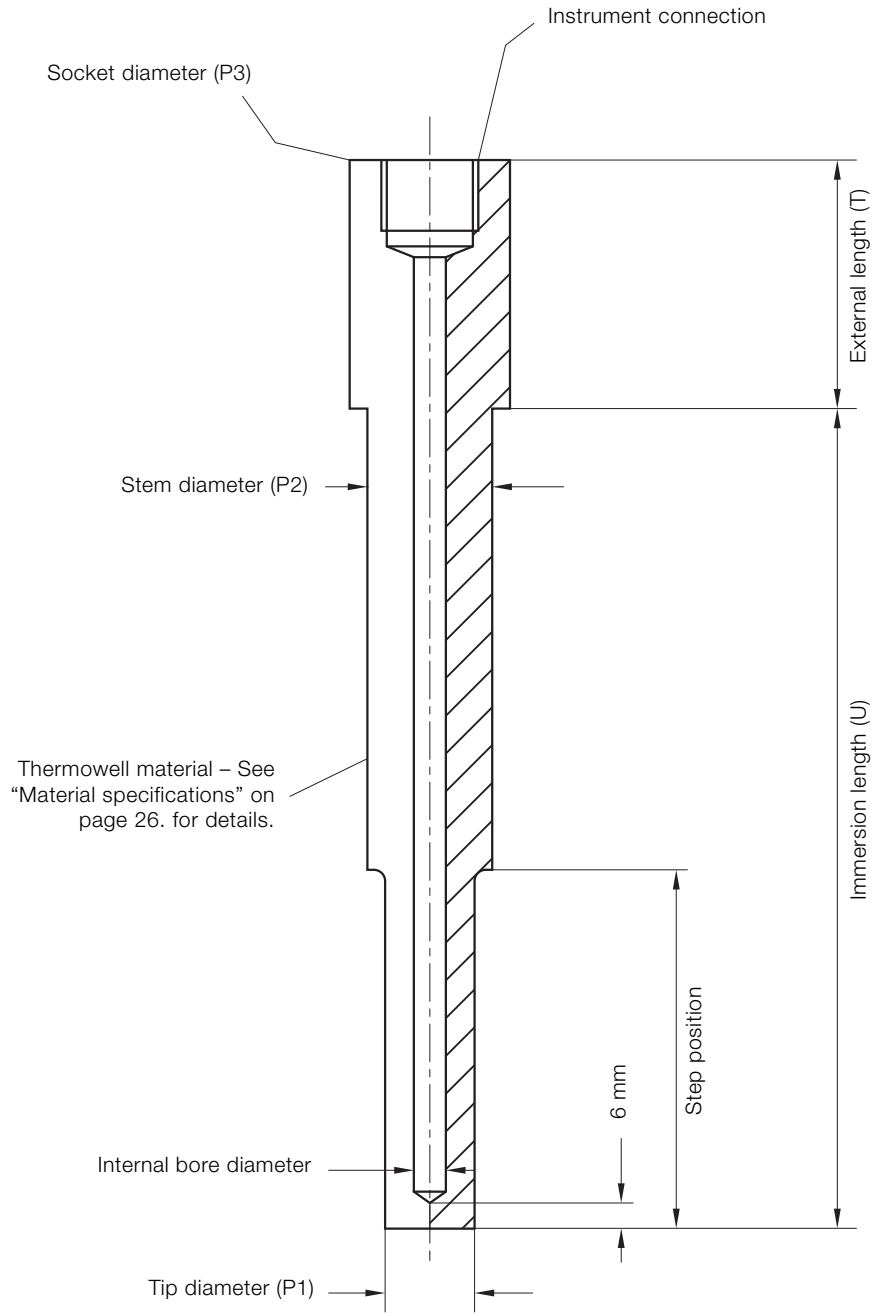


TSW400 series Thermowells

Socket-weld, tapered – J8



Socket-weld, stepped – L1



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Material specifications

ABB can manufacture thermowells from almost any commercially available material. If the material required is not in the following list, contact ABB for advice.

- **316/ 316L stainless steel**
the most commonly used material for thermowells combining excellent corrosion resistance with good strength and availability.
- **316Ti stainless steel**
an enhanced version of 316 – a small amount of titanium is added to help stabilize the material at temperatures over 800 °C (1472 °F).
- **321 stainless steel**
offers similar properties to 316 and 316Ti but is more suitable for operation at higher temperatures.
- **Hastelloy C-276**
a material favored for chloride atmospheres and processes. 300 series stainless steels are not recommended for use in high chloride and low oxygen environments.
- **Inconel 600**
a high nickel alloy containing chromium – suitable for use at high temperatures and in both oxidizing and reducing atmospheres.
- **Monel 400**
a high nickel alloy containing copper – highly resistant to corrosion in a wide variety of environments.
- **Duplex**
a stainless steel designed specifically for use in salt water environments where it offers excellent corrosion resistance.
- **Super duplex**
a variant of duplex steel that includes a small amount of copper – preferred over duplex for its enhanced high temperature properties.

Note. ABB are unable to specify a particular material for a process plant as this requires detailed process knowledge. However, ABB can discuss the implications of such choices on speed of delivery and cost. In addition, ABB welding engineers are available to advise on welding procedures for all materials.

Additional material specifications

Materials for use in 'sour' environments (environments containing high concentrations of hydrogen sulphide) normally demand material that complies with the NACE standard. ABB can comply fully with all these requirements.

Certain countries require that materials conform to particular requirements (for example, the NORSOK standard for materials for use in the North Sea).

ASME PTC 19.3 2010 TW stress calculations

The only published international code for the evaluation of the stresses placed on thermowells in service. ABB engineers can perform a calculation to the ASME code on request. Certification is supplied when requested.

X-ray fluorescence PMI

When absolute verification of the material supplied is required, ABB can perform an in-house X-ray fluorescence examination. This technique provides a quantitative analysis of the heavy elements in the chemical makeup of the material. The result can then be compared to the certification supplied by the producing mill.

Pressure testing

Two types of hydrostatic pressure test are offered by ABB:

- **External**
tests the thermowell with pressure applied externally to the thermowell at 1.5 times the flange rating.
- **Internal**
tests the thermowell internally for leaks.

Weld integrity testing

Weld integrity can be determined using:

- **dye penetrant**
to detect external flaws in the weld
- **X-ray**
to look deeply into the weld to detect internal flaws.

Only X-ray testing produces a permanent record of the weld integrity test in the form of a photograph (X-ray radiograph).

Bore concentricity

The concentricity of the thermowell bore is vitally important to the performance and safety of the thermowell. ABB uses specially designed, deep-hole drilling machines to produce an absolute confidence in bore concentricity. Additional ultrasonic testing of bore concentricity is standard practice in ABB factories. Additional verification is available in the form of two-axis radiographs that show the concentric bore.

Stainless steel surface treatment

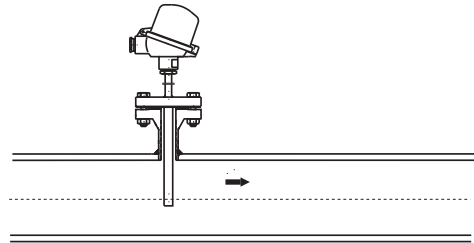
Stainless steels retain their stainless properties by virtue of a thin chromium oxide layer. This layer can be damaged by contaminants during manufacturing. The removal of these contaminants to enable the oxide layer to rebuild is vital for thermowell corrosion integrity. ABB standard practice is to thoroughly degrease each thermowell, both externally and internally, before delivery.

Upon request, ABB can also arrange for a separate 'pickling and passivation' procedure. This is done by first immersing the thermowell in a hot acid bath to remove any contaminants. The thermowell is then 'passivated' to rebuild the chromium oxide layer.

Other considerations

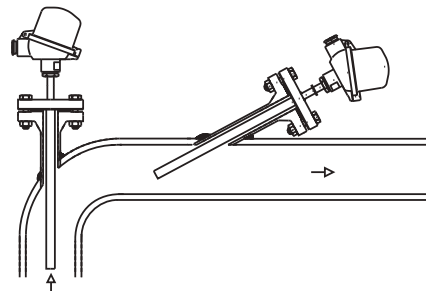
Thermowell insertion depth

Ideally, the thermowell tip should be positioned in the center third of the pipe. In this position, the temperature measured is an accurate representation of the process temperature.



Additionally, the stem of the thermowell must be at least ten times longer than the tip diameter to minimize heat conduction errors. For example, a thermowell with a tip diameter of 16 mm (0.63 in.) must have a stem that is at least 160 mm (6.3 in.) long.

Narrow pipelines may prevent these two conditions from being met. In this case, it is acceptable to fit the thermowell into the pipe-line at angle or in a bend to accommodate the minimum recommended stem length.



However, if the pipeline is well lagged, a shorter thermowell may also provide a high degree of accuracy.

TSW400 series Thermowells

Speed of response

The factors that affect speed of response are many and varied. They include:

- the thermal conductivity of the medium
- the flow rate of the medium
- the thermal conductivity of the thermowell material
- the thermowell dimensions

All these factors play a part in the eventual speed of response.

In general, thermowell-mounted instruments respond to changes in temperature faster than the process itself. If an increased rate of response is required, it can be achieved only by reducing the amount of material surrounding the measuring element therefore a stepped design thermowell must be used. However, a compromise must be made between the rate of response achievable and the strength required from the thermowell design.

Special designs

There may be occasions where a design of thermowell is required that cannot be developed from the available codes. ABB engineers can help with such a requirement. ABB has experience of delivering specialist designs within the Oil & Gas industry and can quote for such a need.

Some customers require approval before manufacture of designs; this can be achieved using ABB-engineered special designs.

Whatever the need – be it a special design or a problem with erosion or corrosion – ABB engineers can help.

Ordering information

TSW 400 series thermowells	TSW400	Main code										Optional code						
		XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX	XX	XXX	XX	XX	XX	XX
Thermowell design																		
Flanged, straight, forged	E1																	
Flanged, tapered, forged	E2																	
Flanged, stepped, forged	E3																	
Flanged, straight, full penetration weld	E4																	
Flanged, tapered, full penetration weld	E5																	
Flanged, stepped, full penetration weld	E6																	
Flanged, straight, fillet & groove	E7																	
Flanged, tapered, fillet & groove	E8																	
Flanged, stepped, fillet & groove	G1																	
Flanged, straight, forged with velocity collar	G2																	
Flanged, tapered, forged with velocity collar	G3																	
Flanged, stepped, forged with velocity collar	G4																	
Flanged, straight, full penetration weld with velocity collar	G5																	
Flanged, tapered, full penetration weld with velocity collar	G6																	
Flanged, stepped, full penetration weld with velocity collar	G7																	
Flanged, straight, fillet & groove with velocity collar	G8																	
Flanged, tapered, fillet & groove with velocity collar	H1																	
Flanged, stepped, fillet & groove with velocity collar	H2																	
Van Stone, straight	H3																	
Van Stone, tapered	H4																	
Van Stone, stepped	H5																	
Van Stone, straight with velocity collar	H6																	
Van Stone, tapered with velocity collar	H7																	
Van Stone, stepped with velocity collar	H8																	
Weld-in, straight	J1																	
Weld-in, tapered	J2																	
Weld-in, stepped	J3																	
Threaded, straight	J4																	
Threaded, tapered	J5																	
Threaded, stepped	J6																	
Socket-weld, straight	J7																	
Socket-weld, tapered	J8																	
Socket-weld, stepped	L1																	
DIN 43772 form 4	D1																	
ABB form 4S	D2																	
ABB form PW	P1																	
DIN 43772 form 4F	D3																	
ABB form 4FS	D4																	
ABB form PF	P2																	
ABB form PS	P3																	
Other	Z9																	

See page 34

Continued on next page ...

TSW400 series Thermowells

TSW 400 series thermowells	TSW400	Main code										Optional code							
		XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX	XX	XXX	XX	XX	XX	XX	
	See page 29																		
Immersion length (U)																			
50 to 100 mm																			A5
101 to 150 mm																			B1
151 to 200 mm																			B5
201 to 250 mm																			C1
251 to 300 mm																			C5
301 to 350 mm																			D1
351 to 400 mm																			D5
401 to 450 mm																			E1
451 to 500 mm																			E5
501 to 550 mm																			F1
551 to 600 mm																			F5
601 to 650 mm																			G1
651 to 700 mm																			G5
701 to 750 mm																			H1
751 to 800 mm																			H5
801 to 850 mm																			J1
851 to 999 mm																			J5
Thermowell material																			
Stainless steel 1.4404 / 316L																			S1
Stainless steel 1.4571 / 316Ti																			S2
Stainless steel 1.4541 / 321L																			S6
Hastelloy C-276 / 2.4819																			N1
Monel 400																			N4
Inconel 600																			N5
Duplex																			D1
Super duplex																			D2
Others																			Z9

Continued on next page ...

TSW 400 series thermowells

TSW400 **XX** **XX** **XX** **XXX** **X** **XX** **X** **XX** **XX** **X** **XXX**
 See pages 29 and 30

Main code

Optional code

XX **XXX** **XX** **XX** **XX** **XX** **XX**
 See page 34

Process connection type

None	Y00
Flanged 1 in. ASME B16.5 CL 150 RF	F07
Flanged 1 in. ASME B16.5 CL 300 RF	F08
Flanged 1 in. ASME B16.5 CL 600 RF	F09
Flanged 1 in. ASME B16.5 CL 600 RTJ	J09
Flanged 1 in. ASME B16.5 CL 900 RF	F21
Flanged 1 in. ASME B16.5 CL 900 RTJ	J21
Flanged 1 in. ASME B16.5 CL 1500 RF	F22
Flanged 1 in. ASME B16.5 CL 1500 RTJ	J22
Flanged 1½ in. ASME B16.5 CL 150 RF	F11
Flanged 1½ in. ASME B16.5 CL 300 RF	F12
Flanged 1½ in. ASME B16.5 CL 600 RF	F13
Flanged 1½ in. ASME B16.5 CL 600 RTJ	J13
Flanged 1½ in. ASME B16.5 CL 900 RF	F14
Flanged 1½ in. ASME B16.5 CL 900 RTJ	J14
Flanged 1½ in. ASME B16.5 CL 1500 RF	F25
Flanged 1½ in. ASME B16.5 CL 1500 RTJ	J25
Flanged 1½ in. ASME B16.5 CL 2500 RTJ	J26
Flanged 2 in. ASME B16.5 CL 150 RF	F15
Flanged 2 in. ASME B16.5 CL 300 RF	F16
Flanged 2 in. ASME B16.5 CL 600 RF	F17
Flanged 2 in. ASME B16.5 CL 600 RTJ	J17
Flanged 2 in. ASME B16.5 CL 900 RF	F18
Flanged 2 in. ASME B16.5 CL 900 RTJ	J18
Flanged 2 in. ASME B16.5 CL 1500 RF	F19
Flanged 2 in. ASME B16.5 CL 1500 RTJ	J19
Flanged 2 in. ASME B16.5 CL 2500 RTJ	J20
Flanged DN 25 EN1092 PN 10	D21
Flanged DN 25 EN1092 PN 16	D22
Flanged DN 25 EN1092 PN 40	D24
Flanged DN 40 EN1092 PN 10	D41
Flanged DN 40 EN1092 PN 16	D42
Flanged DN 40 EN1092 PN 40	D44
Flanged DN 50 EN1092 PN 10	D51
Flanged DN 50 EN1092 PN 16	D52
Flanged DN 50 EN1092 PN 40	D54
Threaded M20 x 1.5	S07
Threaded M27 x 2	S08
Threaded ½ in. NPT	S04
Threaded ¾ in. NPT	S05
Threaded 1 in. NPT	S06
Others	Z99

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TSW 400 series thermowells	Main code										Optional code								
	TSW400	XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX	XX	XXX	XX	XX	XX	XX	
	See pages 29 to 31										See page 34								
Instrument connection																			
1/2 in. NPT (standard)																			A
M20 x 1.5																			D
1/2 in. BSP																			E
External length (T)																			
0 mm to...																			00
90 mm																			90
Instrument connection diameter (P3)																			
32 mm																			A
35 mm																			B
40 mm																			C
Others																			Z
Stem diameter (P2)																			
16 mm to...																			16
38 mm																			38

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TSW 400 series thermowells

Main code

TSW400

XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX
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See pages 29 to 32

Optional code

XX	XXX	XX	XX	XX	XX	XX
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See page 34

Tip diameter (P1)

12 mm	A1
12.5 mm	A2
13 mm	A3
13.5 mm	A4
14 mm	A5
14.5 mm	A6
15 mm	A7
15.5 mm	A8
16 mm	A9
16.5 mm	B0
17 mm	B1
17.5 mm	B2
18 mm	B3
18.5 mm	B4
19 mm	B5
19.5 mm	B6
20 mm	B7
20.5 mm	B8
21 mm	B9
21.5 mm	C0
22 mm	C1
22.5 mm	C2
23 mm	C3
23.5 mm	C4
24 mm	C5
24.5 mm	C6
25 mm	C7
25.5 mm	C8
26 mm	C9
26.5 mm	D0
27 mm	D1
27.5 mm	D2
28 mm	D3
28.5 mm	D4
29 mm	D5
29.5 mm	D6
30 mm	D7

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TSW400 series Thermowells

TSW 400 series thermowells	Main code											Optional code										
	TSW400	XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX	XX	XXX	XX	XX	XX	XX	XX			
	See pages 29 to 33																					
Internal bore																						
3.5 mm																				A		
6.5 mm																				B		
7.0 mm																				C		
8.0 mm																				D		
9.0 mm																				E		
9.5 mm																				F		
10 mm																				G		
13 mm																				H		
Step position																						
None																				000		
50 mm to...																				050		
150 mm																				150		
Usage certifications																						
3.1 cert materials traceability report																				C2		
Certificate of conformity																				C4		
Dimensional report																				C6		
NACE material certification																				CN		
Other usage certifications																						
Russia, Metrological and GOST-R certificate																				CG1		
NORSOK																				CN2		
Plug and chain																						
Plug and chain (stainless steel)																				H8		
Documentation language																						
German																				M1		
Spanish																				M3		
French																				M4		
English																				M5		
Non-destructive tests																						
X-ray fluorescence PMI																				N1		
Dye penetration of weld integrity																				N2		
Ultrasonic tip concentricity																				N3		
Helium leak testing																				N4		
Pressure test external (water)																				N5		
Pressure test internal (water)																				N6		
Radiograph process connection																				N7		
Radiograph tip concentricity																				N8		

Continued on next page ...

TSW 400 series thermowells

Main code											Optional code							
TSW400	XX	XX	XX	XXX	X	XX	X	XX	XX	X	XXX	XX	XXX	XX	XX	XX	XX	XX
See pages 29 to 34											See page 34							

Reporting options

Weld location report	ND
Weld qualification report	NE
Wake frequency calculation	NG
Hardness report	NH

Operations options

De-pip, to produce a flat bore end	SB
Non standard flange to stem weld radius	SW
Non Standard tip thickness	ST
Non Standard tip profile (chamfered)	SH
Non Standard tip profile (domed)	SR
Pickling and passivation	SC
Material source limitations apply	SD
European only materials	SE

Added characteristics

- Actual immersion length (mm)
- Velocity collar diameter (mm)
- Velocity collar position (mm)
- Tag number
- Material source limitations
- Non standard flange to stem weld radius
- Non standard tip thickness

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Service