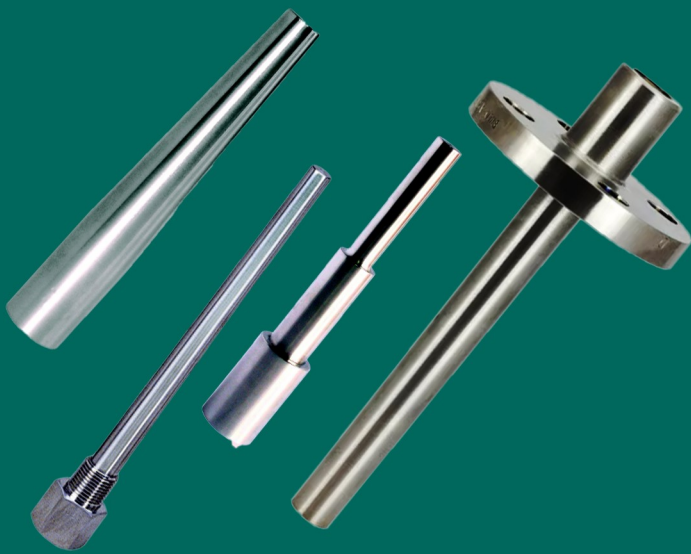




TEMPERATURE MEASURING WITH THERMOWELL



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Introductions

Aramak thermowells are available for light duty applications, high pressures, high temperatures, or high velocity applications; as well as meeting many general service industry needs. Selected on the basis of pressure, temperature, flow, vibration and corrosion parameters. The threaded type is generally the least costly and most versatile. Also available are custom thermo wells for unique applications. Proper thermo well selection is critical to most applications. To configure an ARAMAK thermowell part number follow the Selection Part.

Thermowell Selection

Operating Conditions Process Temperature

- 316L/1.4404 -200 ~ 800°C
- 316Ti/1.4571 -200 ~ 850°C
- Hastelloy C -200 ~ 1300°C.
- Alumina 1600°C.

Maximum Process Pressure

The pressure values to which the thermowell can be subjected at varying temperatures are illustrated in the below. A possible limitation can originate from process connections.

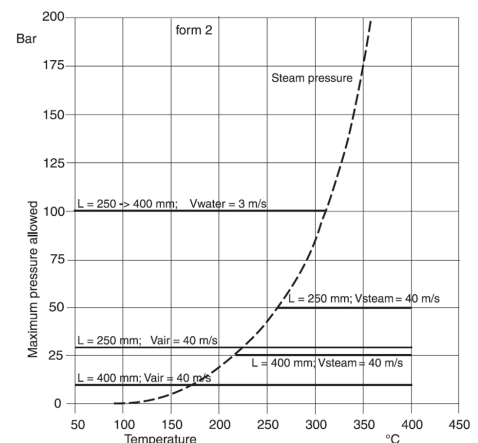
For tubes with a diameter of 9 mm, with a limited flow rate, the thermowell can tolerate the following maximum pressures:

- 50 bar at 20°C
- 33 bar at 250°C
- 24 bar at 400°C.

Maximum Flow Velocity

The highest flow velocity tolerated by the thermowell decreases as the length of the well/probe, exposed to the stream of the fluid, increases.

Some information is provided in the drawing of figures .





Specification

The following designs are available from ARAMAKS 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 welding is perfectly adequate in most circumstances; the weld is designed to be stronger than the required duty pressure.
- Welded with a 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 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 ARAMAK's weld-in or threaded designs.

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.

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. ARAMAK engineers are available to advise on this. Where the thermowell would become too short, a velocity collar can be used.



Dimension

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.



Materials

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

316/ 316L stainless steel

the most commonly used material for thermowells combining excellent corrosion resistance with good strength and availability.

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.

ASME PTC 19.3 2010 TW stress calculations

The only published international code for the evaluation of the stresses placed on thermowells in service. ARAMAK 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, ARAMAK 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.

Pressure testing

Two types of hydrostatic pressure test are offered by ARAMAK:

- 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.



Installation

The Thermometer shall assemble on Thermowell can mounted on the wall of pipes or vessels or other plant parts that may require them.

The interface components for the process connection and the related gaskets are not normally provided with the sensors and must be purchased by the customer.

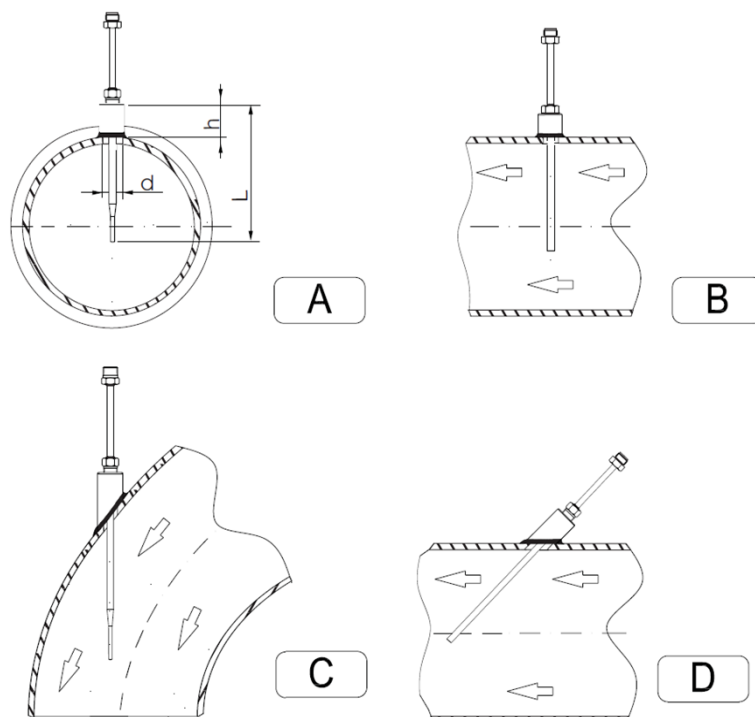
Immersion length may influence the accuracy of the measurement. If the immersion length is too low, an error may be generated in the temperature recorded due to the lower temperature of the process fluid near to the walls and heat transfer, which takes place through the sensor stem. The incidence of such an error can be relevant if there is a large difference between the process temperature and ambient temperature. In order to avoid this source of inaccuracy, the thermowell should have a small diameter

and the immersion length (L) should be, if possible, at least $80 \div 100$ mm.

For pipes with a small section, it is necessary to make sure that the tip of the probe reaches or slightly exceeds, if possible, the axis line of the duct (see fig. A-B). Insulation of the outer part of the sensor reduces the effect produced by a low immersion length. Another solution may be a tilted installation (see fig. C-D). For use in the food industry, it is best to follow the rule $h \leq d/2$.

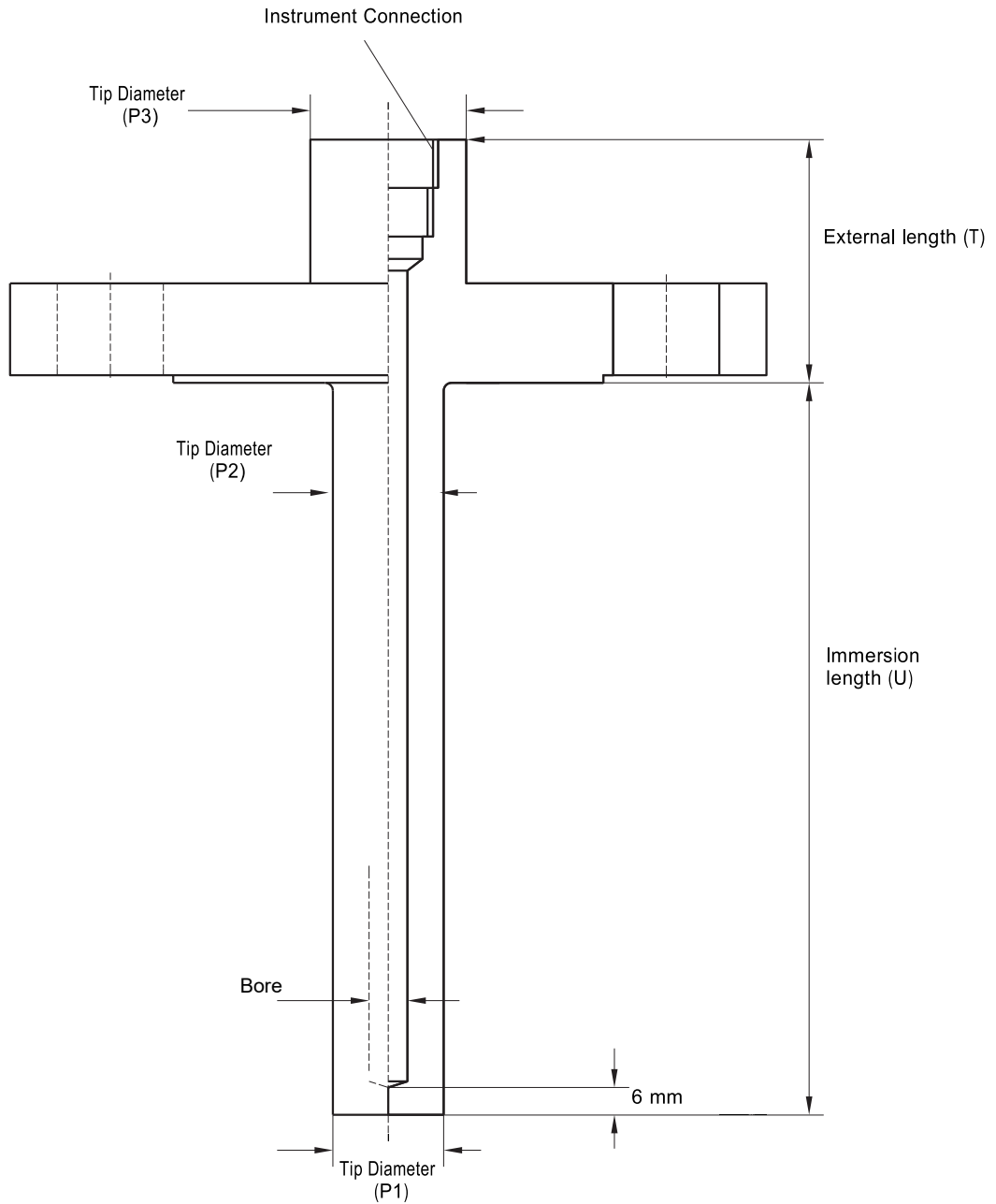
With regard to corrosion, the base material of the wetted parts (SS 316L/1.4404, SS 316Ti/1.4571, Hastelloy C) can tolerate the common corrosive media right up to even the highest temperatures.

For further information on specific applications, please contact the ARAMAK Customer Service.



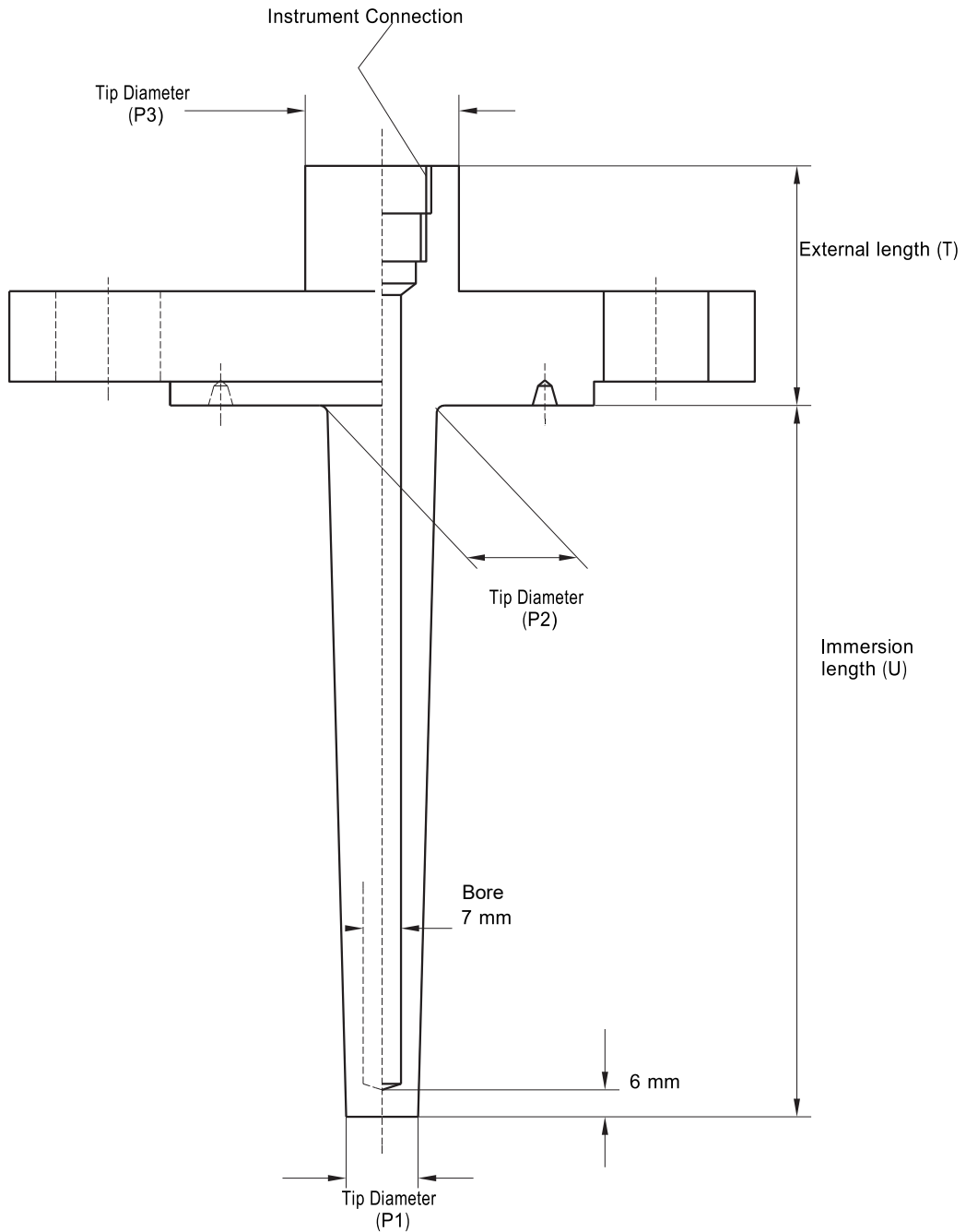


Flanged, Straight



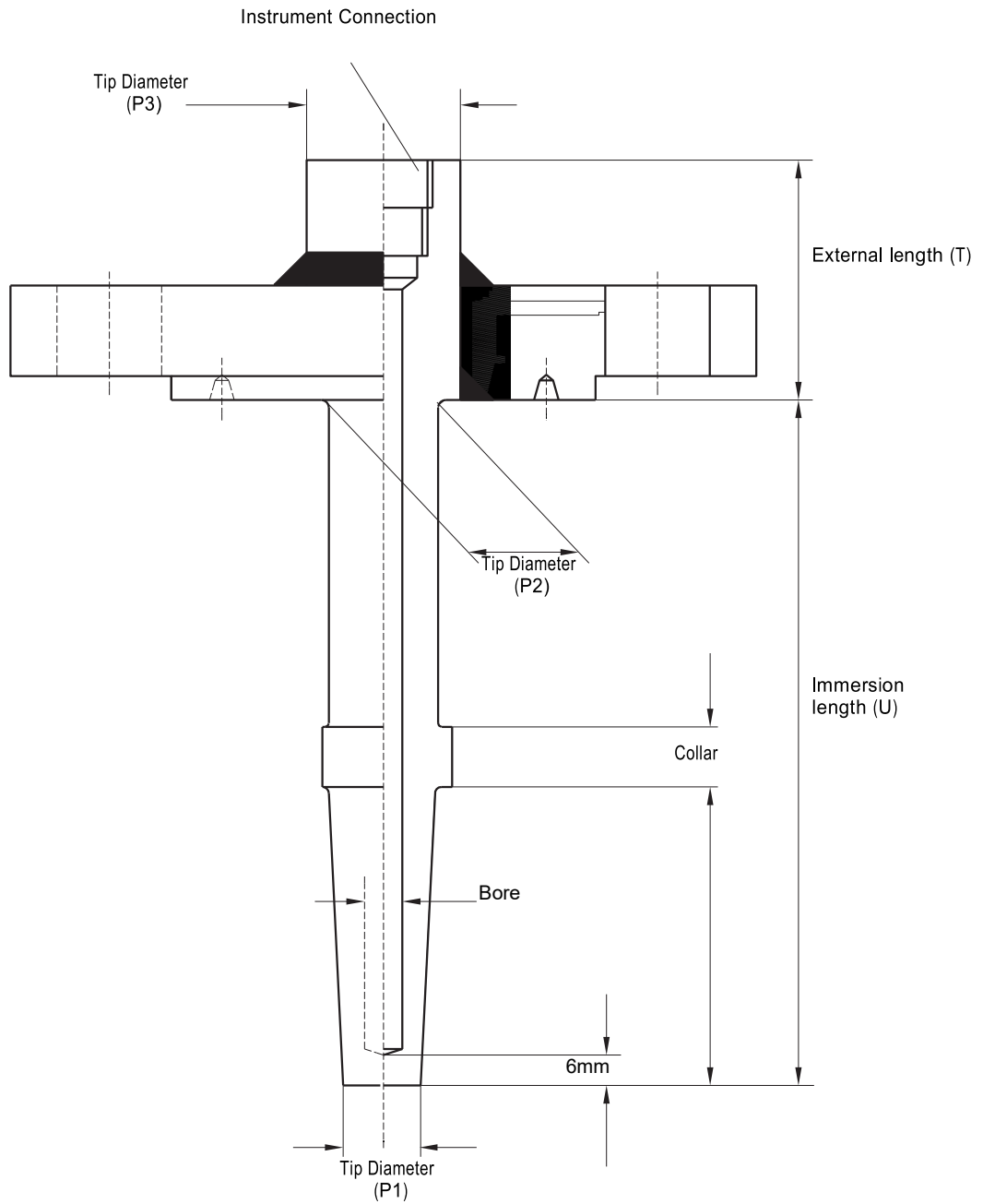


Flanged, Tappered



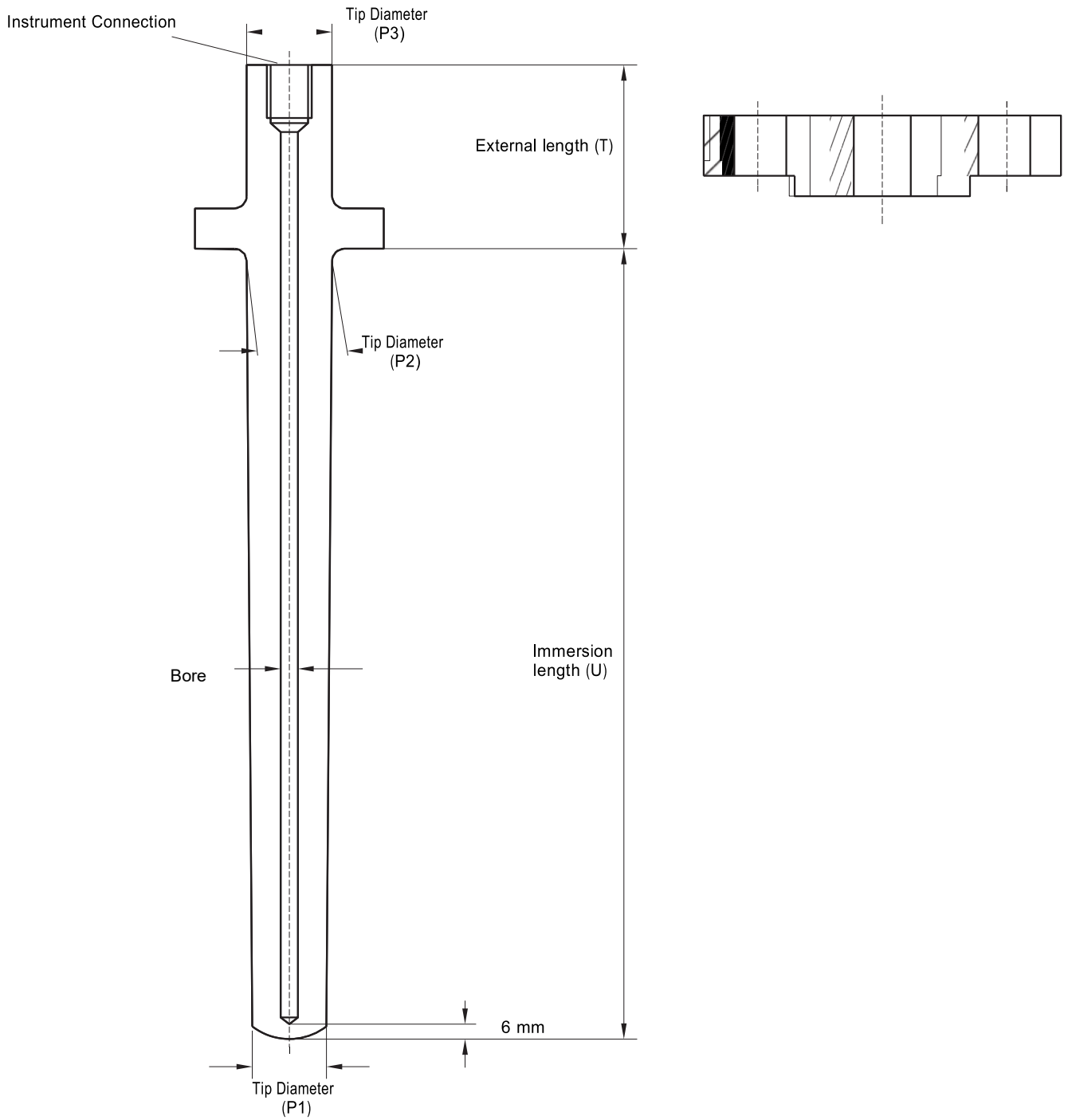


Flanged - Collar



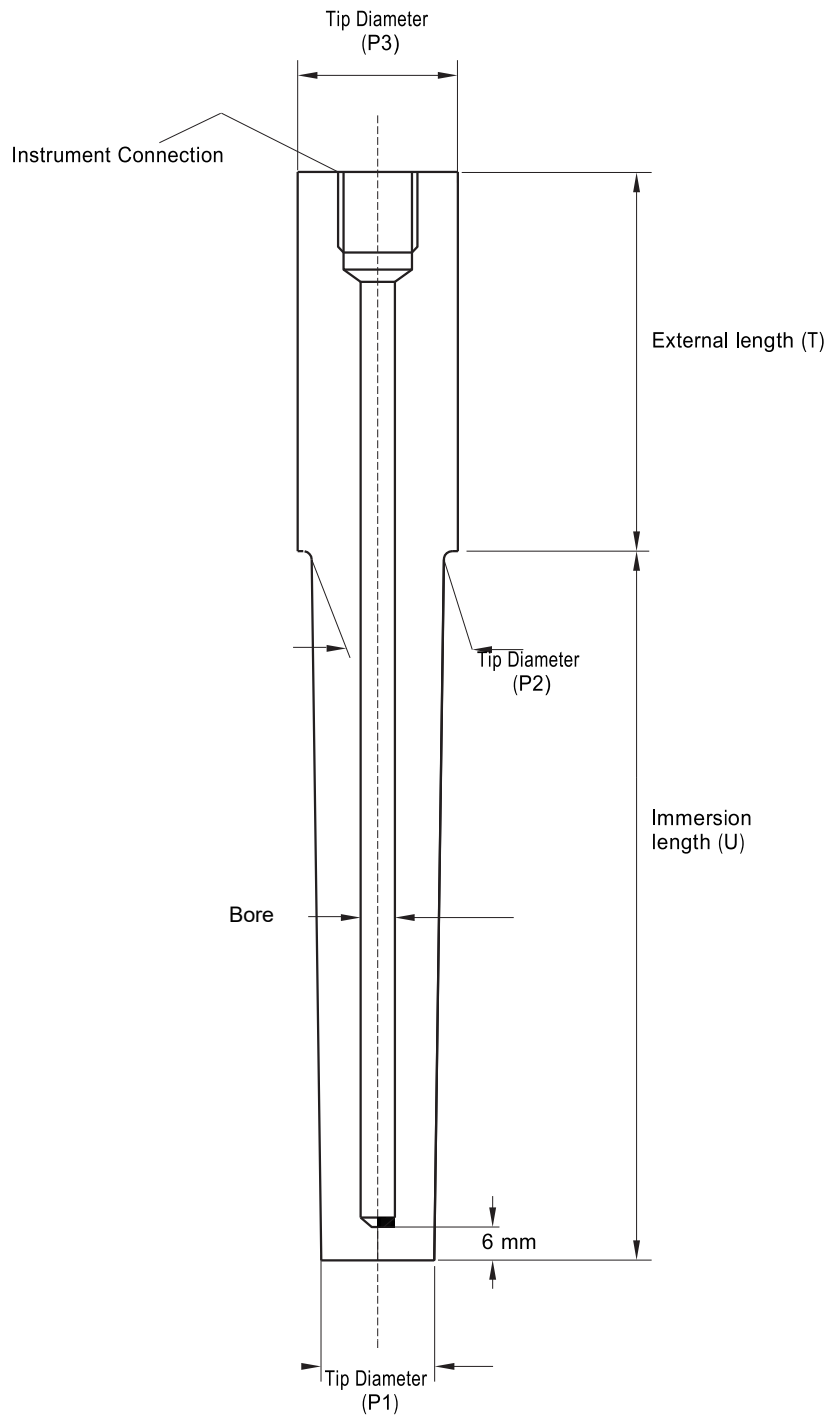


Van Stone – V



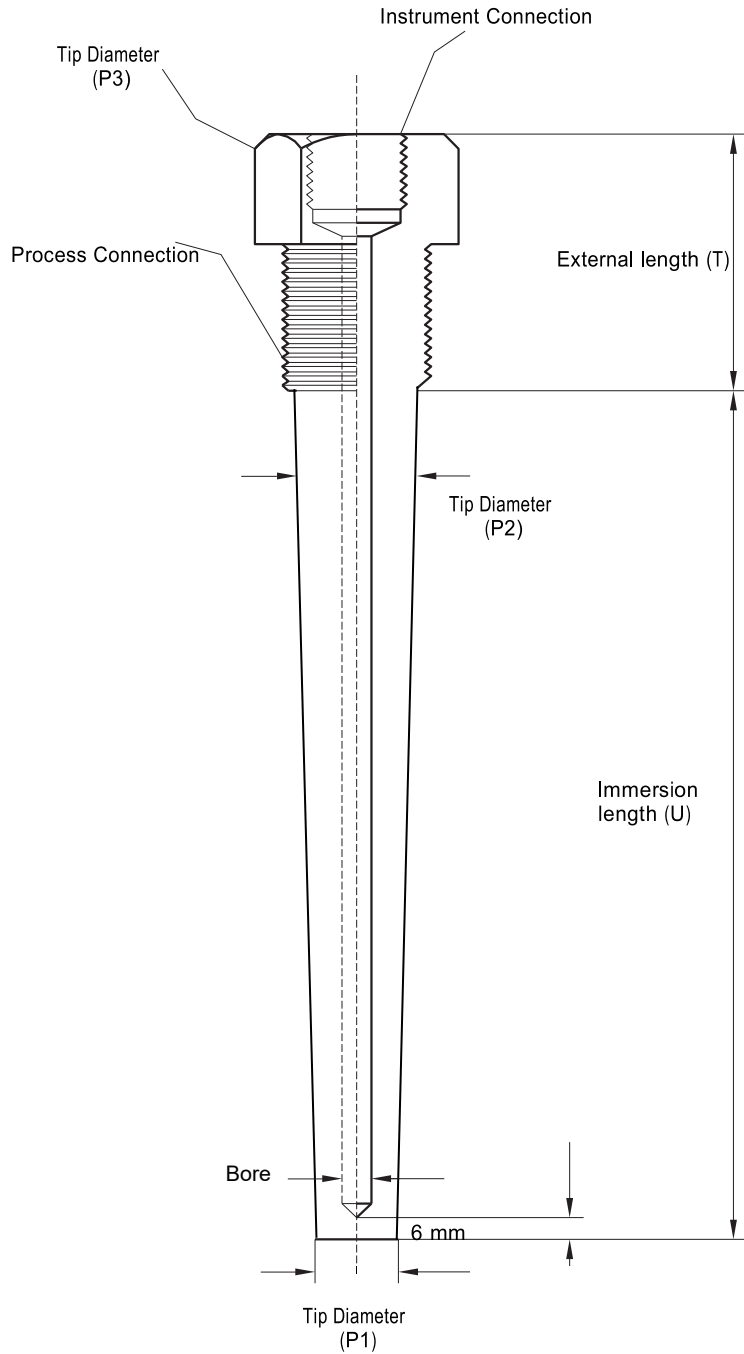


Welded – W





Thread – T





Ordering Information

Thermowell design	XXX	XXXX	XX	XX	XXX	X	XX	XX	XX	XX	XX	XXX	XX
Flanged, straight	FSW												
Flanged, tapered	FTW												
Flanged, stepped	FPW												
Flanged, straight, full penetration	FSP												
Flanged, tapered, full penetration	FTP												
Flanged, stepped, full penetration	FPP												
Flanged, straight with velocity collar	FSV												
Flanged, tapered with velocity collar	FTV												
Flanged, stepped with velocity collar	FPV												
Van Stone, straight	VSS												
Van Stone, tapered	VTS												
Van Stone, stepped	VPS												
Weld-in, straight	WSS												
Weld-in, tapered	WTS												
Weld-in, stepped	WPS												
Threaded, straight	TSS												
Threaded, tapered	TTS												
Threaded, stepped	TPS												
Flanged welded Pipe, straight	FWP												
Threaded welded Pipe, straight	TWP												
Other	OTH												
Immersion length (U)													
... mm (100 to 9999 mm)		XXXX											
Thermowell material													
Stainless steel 316L			S1										
Stainless steel 316Ti			S2										
Stainless steel 321			S3										
Stainless steel 310			S4										
Stainless steel 304L			S5										
Hastelloy C-276			H1										
Monel 400			H2										
Inconel 600			H3										
Duplex			H4										
Super duplex			H5										
Titanium			H6										
Others			H7										
Flanged material													
Stainless steel 316L			S1										
Stainless steel 316Ti			S2										
Stainless steel 321			S3										
Stainless steel 310			S4										
Stainless steel 304L			S5										
Hastelloy C-276			H1										
Monel 400			H2										



Ordering Information

Inconel 600		H3								
Duplex		H4								
Super duplex		H5								
Titanium		H6								
Others		H7								
Process connection type										
None		Y0								
Flanged 1 in. ASME B16.5 CL 150 RF		F10								
Flanged 1 in. ASME B16.5 CL 300 RF		F11								
Flanged 1 in. ASME B16.5 CL 600 RF		F12								
Flanged 1 in. ASME B16.5 CL 600 RTJ		F13								
Flanged 1 in. ASME B16.5 CL 900 RF		F14								
Flanged 1 in. ASME B16.5 CL 900 RTJ		F15								
Flanged 1 in. ASME B16.5 CL 1500 RF		F16								
Flanged 1 in. ASME B16.5 CL 1500 RTJ		F17								
Flanged 1 1/2 in. ASME B16.5 CL 150 RF		F18								
Flanged 1 1/2 in. ASME B16.5 CL 300 RF		F19								
Flanged 1 1/2 in. ASME B16.5 CL 600 RF		F20								
Flanged 1 1/2 in. ASME B16.5 CL 600 RTJ		F21								
Flanged 1 1/2 in. ASME B16.5 CL 900 RF		F22								
Flanged 1 1/2 in. ASME B16.5 CL 900 RTJ		F23								
Flanged 1 1/2 in. ASME B16.5 CL 1500 RF		F24								
Flanged 1 1/2 in. ASME B16.5 CL 1500 RTJ		F25								
Flanged 1 1/2 in. ASME B16.5 CL 2500 RTJ		F26								
Flanged 2 in. ASME B16.5 CL 150 RF		F27								
Flanged 2 in. ASME B16.5 CL 300 RF		F28								
Flanged 2 in. ASME B16.5 CL 600 RF		F29								
Flanged 2 in. ASME B16.5 CL 600 RTJ		F30								
Flanged 2 in. ASME B16.5 CL 900 RF		F31								
Flanged 2 in. ASME B16.5 CL 900 RTJ		F32								
Flanged 2 in. ASME B16.5 CL 1500 RF		F33								
Flanged 2 in. ASME B16.5 CL 1500 RTJ		F34								
Flanged 2 in. ASME B16.5 CL 2500 RTJ		F35								
Flanged DN 25 EN1092 PN 10		P1								
Flanged DN 25 EN1092 PN 16		P2								
Flanged DN 25 EN1092 PN 40		P3								
Flanged DN 40 EN1092 PN 10		P4								
Flanged DN 40 EN1092 PN 16		P5								
Flanged DN 40 EN1092 PN 40		P6								
Flanged DN 50 EN1092 PN 10		P7								
Flanged DN 50 EN1092 PN 16		P8								
Flanged DN 50 EN1092 PN 40		P9								
Threaded M20 x 1.5		T1								
Threaded M27 x		T2								
Threaded 1/2 in. NPT		T3								



Ordering Information

Threaded 3/4 in. NPT	T4							
Threaded 1 in. NPT	T5							
Others	O1							
Instrument connection								
1/2 in. NPT (standard)	1							
1/2 in. G	2							
M20 x 1.5	3							
Other	4							
External length (T)								
... mm (20 to 99 mm)		XX						
Instrument connection diameter (P3)								
30mm			30					
35 mm			35					
40 mm			40					
Others			XX					
Stem diameter (P2)								
... (mm)				XX				
Tip diameter (P1)								
... (mm)					XX			
Internal bore								
4						10		
7						11		
8						12		
10						13		
13						14		
Other						15		
Step position								
None							X00	
... (mm)							XXX	
Additional Options								
Material Certificate								N1
NACE Certificate								N2
Dimension Report								D1
Drawing Document								D2
Plug & chain								D3
Helium leak testing								U1
Pressure test external (water)								U2
Pressure test internal (water)								U3
Radiograph process connection								W1
Weld location report								W2
Weld qualification report								W3
Wake frequency calculation								W4
Hardness report								H1



Contact us

**Instrumentation
manufacturer
& designer**

Tel : 021-46069694

Aramakco.com

Info@aramakco.com

Sales@aramakco.com