Thermowell Assemblies

General Information

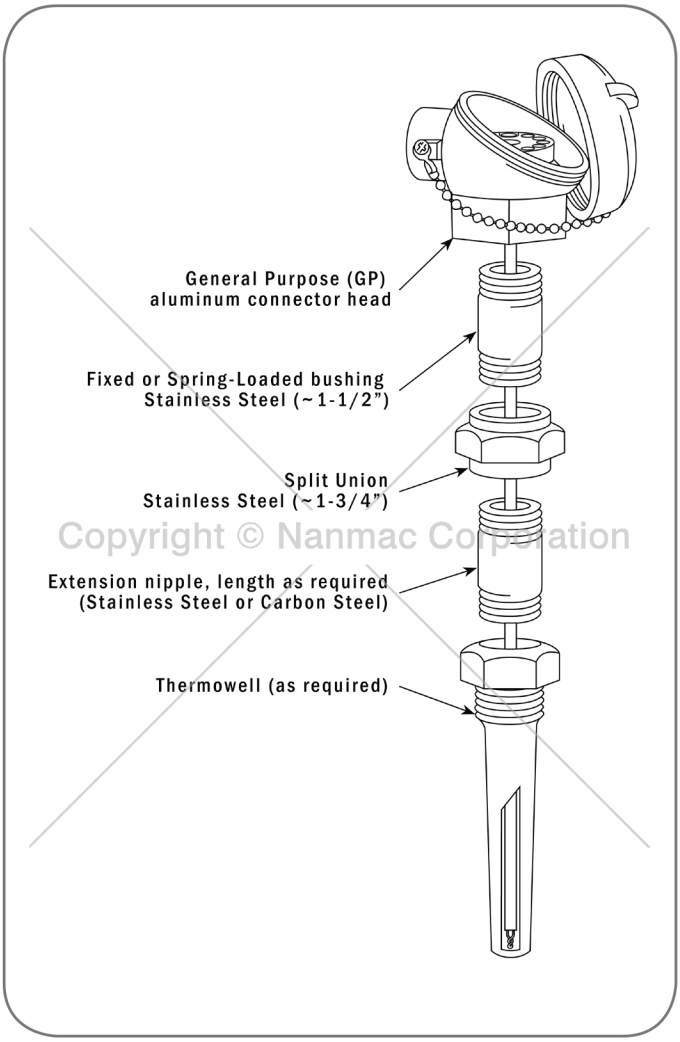
A17 Series

Most thermowell assemblies use female NPT threads for accepting male NPT pipe fittings. Because of normal tolerance and torque variations during assembly, variations as much as 5/8 inch element lengths can be encountered. When ordering replacement parts, care should be taken to allow for normal variations in length. When ordering complete assemblies, Nanmac will make the necessary adjustments to compensate for these variations in lengths.

Since all metal thermowells have a female NPT connection thread and all connection heads also have a female NPT thread; a nipple with male NPT threads on both ends is required to attach the connection head to the thermowell. A secondary purpose of the nipple is to physically remove the connection head from a hot thermowell to a safe distance so that an operator can safely open the connection head and make necessary replacements or repairs.

The steel union is used to connect two nipples together. This combination allows easy removal of the head and element from the well.

The outlet port of the connection head in the Nanmac standard connection head contains a 3/4 inch NPT female thread. This is used to connect to your conduit pipe containing the extension leads. Nipples and unions should also be used here to facilitate connecting and disconnecting the conduit pipe - they can also be used to add extensions to your conduit pipe where required.



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Special Notes:

- In addition to conventional thermocouple sensors installed in the metal thermowell, spring-loaded thermocouples can be installed in the metal thermowell.
- These units keep the thermal junction in good thermal contact with the thermowell at all times, thus improving the response time of the complete assembly.

Helpful Hints When Ordering Replacement Sensors:

- When ordering bare thermocouples with loose ceramic insulators, order one inch longer than required; then, trim to length by trimming off the excess at the connector end.
- When ordering metallic sheathed replacement thermocouples and/or RTDs always have some spare nipples of varying lengths on hand compensate for length variations.

Material - Thermowells consist of drilled bar stock. Standard well materials include brass (ASTM B-16), carbon steel (C-1018), and stainless steel (A.I.S.I B-16). Wells are also available in special grades of stainless steel, chrome-molybdenum alloys, silicon bronze, Hastelloy B and C, nickle, titanium, inconel, and monel. The particular choice is usually determined by the corrosive conditions under which the thermowell must operate-commensurate with the maximum service pressure and temperature. Before selecting the thermowell material, refer to the chart on Recommended Materials for various applications (next page) and the pressure-temperature ratings for each well type and material.

Accuracy - If all other variables are held constant, accuracy depends upon the insertion length "U." The distance between the tip of the well and the underside of the threads or attachment means... Where space and pressure-temperature ratings permit, accuracy can be improved by increasing the insertion length. The error in temperature measurement of short insertion length thermowells is created by the thermal conduction from the tip of the wall and thence to the outside atmosphere. This is commonly referred to as the error caused by "The Stem Effect."

Another source of error is "The Stem Effect" caused by the thermal sensor itself. Commonly used thermal sensors include thermocouples, RTDs, thermistors, Bimetal thermometers and liquid filled thermometers. Generally, the shorter the insertion length of the sensors, the greater error due to "The Stem Effect." This error can be reduced and even eliminated by the proper selection of thermal sensor. Thermowells with insertion lengths less than six inches in liquids and nine inches in gases can produce large errors due to the combined stem effect of the thermowell and "The Stem Effect" of the thermal sensor.

Tapered or Straight Shank - Tapered shank wells provide greater stiffness for the same sensitivity. The higher strength to weight ratio gives these wells higher natural frequency than for equivalent length straight shank wells; thus, permitting operation at higher fluid velocity.

Velocity Ratings - Well failures, in most cases are not due to "The Stem Effect" of pressure and temperature. The calculations necessary to provide adequate strength, under given conditions are familiar enough to permit proper choice of wall thickness and material. Fluid, flowing by the well, forms a turbulent wake (called the Von Karman Trail) which has a definite frequency based on the diameter of the well and the velocity of the fluid. It is important that never equal the natural frequency of the well itself. If the natural frequency of the well was to coincide with the wake frequency, the well would vibrate to destruction and break off in the piping.

On the next page a recommended maximum velocity rating can be found for every standard well length and material catalogued. For simplicity, the ratings given are based on operating temperatures of 1,000 degrees Fahrenheit for wells made of Carbon Steel (C-1018), Stainless Steel 304 & 316. Values for brass wells are based on 900 degrees Fahrenheit service. Slightly higher velocity is possible at lower temperatures.

Where single values appear in the velocity tables, these may be considered safe for water, steam, air, or gas. In the shorter insertion lengths, consideration is given to the velocity pressure effect of water flowing at high velocities. The values in parentheses therefore, represent safe values for water flow while the unbracketed value may be used for steam, air, gas, and similar density fluids.

If you have operating conditions requiring special well designs our Engineering Staff is available to assist you. In any case, Nanmac Corporation assumes no responsibility for failure of a thermowell except for its repair or replacement.

Please note the values given are intended primarily as a guide. Check each well with you own calculations!

Maximum Fluid Velocity - f.p.s.

Table	Exterior Thread "P"	Bore Diameter "B"	Material	Insertion Length "U"							
				2-1/2	4-1/2	7-1/2	10-1/2	13-1/2	16-1/2	19-1/2	22-1/2
1	1/2" NPT	0.260"	Brass	207 (59.3)	75.5 (32.2)	27.3 (19.7)	13.9	8.4	5.6	4.1	3.0
			Carbon Steel	209 (106)	105 (59)	38.2 (36.3)	19.4	11.8	7.8	5.7	4.2
			Stainless Steel 304 & 316	300 (148)	109 (82.2)	39.5	20.1	12.2	8.1	5.9	4.4
			Monel	261 (118)	95 (66.5)	34.4	17.5	10.5	7.1	5.2	3.8
	3/4" NPT	0.260"	Brass	207 (59.3)	89.1 (39.8)	32.2 (23.9)	16.4	9.9	6.6	4.8	3.6
			Carbon Steel	209 (106)	123 (71.2)	44.9 (42.7)	22.8	13.8	9.3	6.7	4.9
			Stainless Steel 304 & 316	300 (148)	128 (99.3)	46.4	23.6	14.3	9.6	6.9	5.1
			Monel	261 (118)	112 (79.8)	40.6	20.7	12.4	8.3	6.1	4.5
	1" NPT	0.260"	Brass	207 (59.3)	102 (47.6)	37.0 (28)	18.8	11.4	7.6	5.5	4.1
			Carbon Steel	209 (106)	143 (84.3)	51.6 (50.6)	26.2	15.9	10.6	7.6	5.7
			Stainless Steel 304 & 316	300 (148)	148 (117)	53.5	27.2	16.5	11.0	7.9	5.9
			Monel	261 (118)	128 (93.3)	46.7	23.7	14.4	9.5	6.9	5.1
2	3/4" & 1" NPT	0.385"	Brass	207 (59.3)	150 (80)	54.1 (48)	27.6	16.7	11.1	8.0	6.0
			Carbon Steel	290 (106)	192 (144)	69.5	35.4	20.5	14.3	10.3	7.7
			Stainless Steel 304 & 316	300 (148)	199	71.9	36.6	21.2	14.8	10.7	8.0
			Monel	261 (118)	189 (178)	68.1	34.8	20.8	14.0	10.0	7.5
3	3/4" & 1" NPT	0.385"	Brass	321 (150)	129 (83.5)	46.8	23.6	14.5	9.6	6.9	5.1
			Carbon Steel	410 (270)	249 (150)	90.3	45.6	27.8	18.5	13.2	9.8
			Stainless Steel 304 & 316	483 (350)	272 (208)	97.3	49.7	30.4	20.3	14.5	10.7
			Monel	396 (300)	214 (167)	77.5	39.2	23.8	16.0	10.3	7.7
4	3/4" NPT	0.260"	Brass	305 (97.5)	93.8 (54.1)	33.9	17.1	10.5	7.0	5.0	3.7
			Carbon Steel	386 (175)	180 (97.2)	65.3 (58.3)	33.0	20.1	13.4	9.6	7.1
			Stainless Steel 304 & 316	440 (243)	197 (135)	71.2	36.0	22.0	14.7	10.5	7.8
			Monel	354 (195)	155 (108)	56.1	28.4	17.3	11.6	7.5	5.6
	1" NPT	0.260"	Brass	354 (161)	108 (89.5)	39.4	19.8	12.2	8.1	5.8	4.3
			Carbon Steel	448 (289)	209 (161)	75.7	38.4	23.3	15.5	11.1	8.2
			Stainless Steel 304 & 316	490 (403)	228 (225)	82.5	41.8	25.5	17.1	12.2	9.1
			Monel	410 (322)	179 (178)	65.1	33.0	20.1	13.5	8.7	6.5
5		0.260"	Carbon Steel	209 (106)	105 (59)	38.2 (36.3)	19.4	11.8	7.8	5.7	4.2
			Stainless Steel 304 & 316	300 (148)	109 (82.2)	39.5	20.1	12.2	8.1	5.9	4.4
			Monel	261 (118)	95 (66.5)	34.4	17.5	10.5	7.1	5.2	3.8
		0.385"	Carbon Steel	209 (106)	123 (71.2)	44.9 (42.7)	22.8	13.8	9.3	6.7	4.9
			Stainless Steel 304 & 316	300 (148)	128 (99.3)	46.4	23.6	14.3	9.6	6.9	5.1
			Monel	261 (118)	112 (79.8)	40.6	20.7	12.4	8.3	6.1	4.5

Corrosive Service Guide to Materials

Corrodent	Temperature °F	Conc. %	Recommended Material
Acetic Acid	212	All	Monel
Acetic Anhydride	300		Nickel
Acetone	212	All	SS 304
Acetylene	400		SS 304
Alcohols	212	All	SS 304
Alum. (Potassium or Sodium)	300	All	Hastelloy C
Aluminum Chloride	212	All	Hastelloy B
Aluminum Sulfate	212	All	SS 316
Ammonia, Dry	212	All	SS 304, 316
Ammonia Hydroxide (Ammonia, Aqua)	212	All	SS 304, 316
Ammonia Chloride	300	50%	Monel
Ammonia Nitrate	300	All	SS 304
Ammonia Sulfate	212	All	SS 316
Amyl Acetate	300	All	SS 304
Aniline	75		Monel
Asphalt	250		SS 304
Atmosphere (Industrial and Marine)			SS 304
Barium Compound	See Calcium		
Beer	70		SS 304
Benzene (Benzol)	212		Steel
Benzoic Acid	212	All	SS 316
Bleaching Powder	70	15%	Monel
Borax	212	All	Brass
Bordeaux Mixture	200		SS 304
Boric Acid	400	All	SS 316
Bromine	125	Dry	Monel
Butane	400	All	Steel
Butyl Alcohol	See Alcohols		
Butyric Acid	212		Hastelloy C
Calcium Bisulphite	75	All	Hastelloy C
Calcium Chloride	212	All	Hastelloy C
Calcium Hydroxide	300	20%	Hastelloy C
Calcium Hypochlorite	See Bleaching Powder		
Carbolic Acid	See Phenol		
Carbon Dioxide, Dry	800	All	Brass
Carbonated Water	212	All	SS 304
Carbonated Beverages	212		SS 304
Carbon Disulfide	200		SS 304
Carbon Tetrachloride	125	All	Monel
Chlorine, Dry	100		Monel
Chlorine, Moist	100	All	Monel
Chloracetic Acid	212	All	Monel
Chloroform, Dry	212		Monel
Chromic Acid	300	All	Hastelloy C
Cider	300	All	SS 304
Citric Acid	212	All	Hastelloy C
Copper (10) Chloride	212	All	Hastelloy C
Copper (10) Nitrate	300	All	SS 316
Copper (10) Sulfate	300	All	SS 316

Corrodent	Temperature °F	Conc. %	Recommended Material
Copper Plating Solution (Cyanide)	180	All	SS 304
Copper Plating Solution (Acid)	75		SS 304
Corn Oil	200		SS 304
Creosote	200	All	SS 304
Crude Oil	300		Monel
Ethyl Acetate	See Lacquer Thinner		
Ethyl Chloride, Dry	500		Steel
Ethanol	See Alcohols		
Ethylene Glycol (Uninhibited)	212	All	SS 316
Ethylene Oxide	75		Steel
Fatty Acids	500	All	SS 316
Ferric Chloride	75	All	Hastelloy C
Ferric Sulfate	300	All	SS 304
Formaldehyde	212	40%	SS 316
Formic Acid	300	All	SS 316
Freon	300		Steel
Fluorine, Anhydrous	100		SS 304
Furfural	450		SS 316
Gasoline	300		Steel
Glucose	300		SS 304
Glue ph 6-8	300	All	SS 304
Glycerine	212	All	Brass
Hydrobromic Acid	212	All	Hastelloy C
Hydrochloric Acid (37-38%)	225	All	Hastelloy B
Hydrogen Chloride, Dry	500		SS 304
Hydrocyanic Acid	212	All	SS 304
Hydrofluoric Acid	212	60%	Monel
Hydrogen Fluoride, Dry	175		Steel
Hydrofluogilicic Acid	212	40%	Monel
Hydrogen Peroxide	125	10-100%	SS 304
Kerosene	300	All	Steel
Lacquers & Thinners	300	All	SS 304
Lactic Acid	300	All	SS 316
Lime	212	All	SS 316
Linseed Oil	75		Steel
Magnesium Chloride	212	50%	Nickel
Magnesium Hydroxide (or Oxide)	75	All	SS 304
Magnesium Sulfate	212	40%	SS 304
Mercuric Chloride	75	10%	Hastelloy C
Mercury	700	100%	Steel
Methylene Chloride	212	All	SS 304
Methyl Chloride, Dry	75		Steel
Milk, fresh or sour	180		SS 304
Molasses	See Glucose		
Natural Gas	70		SS 304
Nitric Acid	75	All	SS 316
Nitric Acid	300	All	SS 316
Oleic Acid	See Fatty Acids		

Corrosive Service Guide to Materials

Corrodent	Temperature °F	Conc. %	Recommended Material
Oxalic Acid	212	All	Monel
Oxygen	75	All	Steel
Photographic Bleaching	100	All	SS 304
Palmitic Acid	See Fatty Acids		
Phosphoric Acid	212	All	SS 316
Phenol	212	All	SS 316
Potassium Compounds	See Sodium Compound		
Propane	300		Steel
Rosin	700	100%	SS 316
Sea Water	75		Monel
Soap & Detergent	212	All	SS 304
Sodium Bicarbonate	212	20%	SS 316
Sodium Bisulphite	212	20%	SS 304
Sodium Bisulphate	212	20%	SS 304
Sodium Carbinate	212	40%	SS 316
Sodium Chloride	300	30%	Monel
Sodium Chromate	212	All	SS 316
Salt or Brine	See Sodium Chloride		
Sodium Cyanide	212	All	SS 304
Sodium Hydroxide	212	30%	SS 316
Sodium Hypochlorite	75	10%	Hastelloy C
Sodium Nitrate	212	40%	SS 304
Sodium Nitrite	75	20%	SS 316
Sodium Phosphate	212	10%	Steel
Sodium Silicate	212	10%	Steel
Sodium Sulfide	212	30%	SS 316
Sodium Sulfite	212	10%	SS 316
Sodium Sulfate	212	30%	SS 304
Sodium Thiosulfate	212	All	SS 304
Steam			SS 304
Stearic Acid	See Fatty Acids		
Sugar Solutions	See Glucose		
Sulfur	500		SS 304
Sulfur Chloride	75	Dry	SS 316
Sulfur Dioxide	500	Dry	SS 316
Sulfur Trioxide	500	Dry	SS 316
Sulfuric Acid	212	10%	SS 316
Sulfuric Acid	212	10-90%	Hastelloy B
Sulfuric Acid	212	90-100%	SS 316
Sulfuric Acid, Fuming	175		Hastelloy C
Sulfurous Acid	75	20%	SS 316
Titanium Tetrachloride	75	All	SS 316
Tannic Acid	75	40%	Hastelloy B
Toluene	75		Steel
Trichloracetic Acid	75	All	Hastelloy B
Trichlorethylene	300	Dry	Monel
Turpentine	75		SS 316
Varnish	150		Steel
Zinc Chloride	212	All	Hastelloy B
Zinc Sulfate	212	All	SS 316

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