

## Thermowells

Thermowells are used to provide an isolation between a temperature sensor and the environment, either liquid, gas or slurry. A thermowell allows the temperature sensor to be removed and replaced without compromising either the ambient region or the process.

Care must be taken in determining the material used for the thermowell as well as other factors. Thermo Sensors offers design assistance that includes pressure, temperature and or corrosion as well as vibration effects of the fluids. This vibration can cause well stem failure.

Thermo Sensors thermowell materials include:

- Carbon Steel
- 304 & 316 Stainless Steel
- Monel
- Brass

Please refer to our order guide to assist in determining your needs. We can also provide technical design assistance and application suggestions. Give us a call.



## How to Select Thermowells

### Introduction

Thermowells are used to shield thermocouple elements against mechanical damage and corrosion. Many variations are available in a variety of materials to meet individual job specifications.

The chemical and physical properties of all standard bar stock materials are rigidly controlled. All bar stock wells are drilled by the gun drilling process. Use of specially designed and constructed measuring equipment enables standard guaranteed bore concentricity to be within  $\pm 10\%$  of wall thickness. Internal threads are within 1/2 turn of standard plug gauge. External threads are within 1/4 turn of standard ring gauge.

If required by purchase order, your thermowells undergo an internal hydrostatic test as a final precaution against pressure failure. Test pressures and duration are determined by the customer. Radiograph and other tests can be performed and results furnished upon request.

A variety of alloys suitable for every thermowell requirement is available. Thermowell material should be selected for ability to withstand the process environments, high thermal conductivity and low porosity to gases.

### Choosing Bore Sizes for Maximum Flexibility

Where several types of temperature measuring instruments are used, the selection of a standard bore diameter can provide greater efficiency and flexibility of use. The same well can accommodate either thermocouple, resistance thermometer, bi-metal thermometer or test thermometers. The bore sizes of wells shown on this website accommodate the most commonly used temperature sensing elements. For example:

.260 Diameter Bore:

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- Bi-Metal Thermometers (1/4" stem)
- Thermocouples (#14 Awg)
- 1/4" & 3/8" O.D. Cerampak Thermocouples & RTD's
- Liquid-in-glass Test Thermometers (unarmored)
- Other elements having .252 max. O.D.

.385 Diameter Bore:

- Bi-metal Thermometers (3/8" stem)
- Thermocouples (#14 Gauge)
- 1/4" & 3/8" O.D. Cerampak Thermocouples & 3/8" RTD's (Use .260 Bore for 1/4" RTD's)
- Liquid-in-glass Test Thermometers (armored)
- Other elements having .377 max. O.D.

## When to Use Tapered or Straight Thermowells

Tapered thermowells provide greater strength without sacrificing sensitivity. Because of its higher strength-to-weight ratio, the tapered thermowell provides greater resistance to high frequency vibrations than straight thermowells. This permits reliable operation at high fluid velocities. Thus, for higher fluid velocities, the tapered well should be chosen; for lower fluid velocities, the straight well. When choosing wells, refer to the [velocity rating charts](#) and other design information.

## Choosing the Material

A most important factor in selecting thermowell material is to determine the corrosive conditions to which the well will be exposed. Recommended materials for various services are given in the [Thermowell Material Guide](#). The high mirror polish given to all wells enhances its corrosion resistance capability.

Occasionally, the material consideration is one of strength rather than corrosion. For example, a stainless steel well may be required for high pressure water service, where a brass well might have been satisfactory from a corrosion viewpoint. It will be helpful to consult the [pressure-temperature ratings](#) given for each well type.

## Choosing the Proper Connection

In this website you will find standardized wells of threaded, flanged (ASA and Van Stone), and socket weld types with standard bore sizes. A provision for customer specifying design parameters or "weld-in" thermowells is also provided.

Threaded wells are made in readily weldable material. Standard flanged wells (other than Van Stone) have flanges welded front and back with "V" or "J" groove design. Full penetration double welded flanges are also available.

The double-welded construction eliminates possible crevice corrosion and stress cracking. Heat treated to NACE specs is available.

Socket weld of wells are especially simple to install. They fit ASA standard socket weld couplings or flanges to produce a clean, tight installation.

## Velocity Ratings of Thermowells

In some cases, well failures are due, not to the effect of pressure, temperature, or corrosion, but to the vibrational effects to which they are subjected. Fluid, flowing by the well, forms a turbulent wake (the Von Karman Trail) with a definite frequency based on well dimensions and fluid velocity. If the natural frequency of the well equals the wake frequency, the well stem will vibrate to destruction and break off in the piping. It is, therefore, important that the well have sufficient design to prevent a frequency equality condition.

In the following tables, a recommended maximum velocity rating can be found for several standard well lengths and materials. To simplify the information, ratings given are based on operating temperatures of 1000° F. for wells made of Carbon Steel (C-1018) and Stainless Steel (304 and 316). Values for brass wells are based on 350° F. Operation limits for Monel wells are based on 900° F service. Slightly higher velocity is possible at lower temperatures. Single values appearing in the velocity tables may be considered safe for water, steam, air or gas. In shorter insertion lengths, consideration is given to the velocity pressure effect of water flowing at higher velocities. The values in parenthesis, therefore, represent safe values for water flow while the unbracketed value may be used for steam, air, gas and similar density fluids.

| Maximum Fluid Velocity Feet per Second |              |                       |               |                |      |      |      |      |
|----------------------------------------|--------------|-----------------------|---------------|----------------|------|------|------|------|
| Well Type                              | Material     | Insertion Length -"U" |               |                |      |      |      |      |
|                                        |              | 2                     | 4             | 7              | 10   | 13   | 16   | 22   |
| 1V & 3V<br>1G & 3G<br>and<br>1F        | Carbon Steel | 404<br>(129)          | 184<br>(71.2) | 67.0<br>(42.7) | 34.0 | 20.6 | 13.7 | 7.4  |
|                                        | 304 & 316 SS | 430<br>(179)          | 192<br>(99.3) | 69.7<br>(59.6) | 35.4 | 21.5 | 14.3 | 7.7  |
|                                        | Monel        | 350<br>(143)          | 168<br>(79.8) | 61<br>(47.7)   | 31.0 | 18.8 | 12.5 | 6.7  |
| 2V & 4V<br>2G & 4G<br>and<br>2F        | Carbon Steel | 410<br>(152)          | 248<br>(84.3) | 91.3<br>(50.6) | 45.7 | 27.6 | 18.5 | 10.0 |
|                                        | 304 & 316 SS | 444<br>(211)          | 285<br>(117)  | 95.2<br>(70.3) | 47.6 | 28.8 | 19.3 | 10.4 |
|                                        | Monel        | 338<br>(168)          | 226<br>(93.3) | 83.3<br>(56.0) | 41.6 | 25.2 | 16.9 | 9.1  |

| Maximum Fluid Velocity Feet per Second |              |                       |                |                |        |        |        |        |        |
|----------------------------------------|--------------|-----------------------|----------------|----------------|--------|--------|--------|--------|--------|
| Well Type                              | 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 |
| 1A<br>and<br>1B                        | Brass        | 207<br>(59.3)         | 89.1<br>(39.8) | 32.2<br>(23.9) | 16.4   | 9.9    | 6.6    | 4.8    | 3.6    |
|                                        | Carbon Steel | 290<br>(106)          | 123<br>(71.2)  | 44.9<br>(42.7) | 22.8   | 13.8   | 9.3    | 6.7    | 4.9    |
|                                        | 304 & 316 SS | 300<br>(148)          | 128<br>(99.3)  | 46.4<br>(42.7) | 23.6   | 14.3   | 9.6    | 6.9    | 5.1    |
|                                        | Monel        | 261<br>(118)          | 112<br>(79.8)  | 40.6<br>(37.0) | 20.7   | 12.4   | 8.3    | 6.1    | 4.5    |
| 3A<br>and<br>3B                        | Brass        | 207<br>(59.3)         | 102<br>(47.6)  | 37.0<br>(28)   | 18.8   | 11.4   | 7.6    | 5.5    | 4.1    |
|                                        | Carbon Steel | 290                   | 143            | 51.6           | 26.2   | 15.9   | 10.6   | 7.6    | 5.7    |

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|  |              |              |               |                |      |      |      |     |     |
|--|--------------|--------------|---------------|----------------|------|------|------|-----|-----|
|  | 304 & 316 SS | (106)<br>300 | (84.3)<br>148 | (50.6)<br>53.5 | 27.2 | 16.5 | 11.0 | 7.9 | 5.9 |
|  | Monel        | (148)<br>261 | (117)<br>128  | (93.3)<br>46.7 | 23.7 | 14.4 | 9.5  | 6.9 | 5.1 |

| Maximum Fluid Velocity Feet per Second |              |                       |               |                |        |        |        |        |
|----------------------------------------|--------------|-----------------------|---------------|----------------|--------|--------|--------|--------|
| Well Type                              | Material     | Insertion Length -"U" |               |                |        |        |        |        |
|                                        |              | 2 1/2                 | 4 1/2         | 7 1/2          | 10 1/2 | 13 1/2 | 16 1/2 | 22 1/2 |
| 1S                                     | Carbon Steel | 290<br>(106)          | 123<br>(71.2) | 44.9<br>(42.7) | 22.8   | 13.8   | 9.3    | 4.9    |
|                                        | 304 & 316 SS | 300<br>(148)          | 128<br>(99.3) | 46.4           | 23.6   | 14.3   | 9.6    | 5.1    |
| 3S                                     | Carbon Steel | 290<br>(106)          | 143<br>(84.3) | 51.6<br>(50.6) | 26.2   | 15.9   | 10.6   | 5.7    |
|                                        | 304 & 316 SS | 300<br>(148)          | 148<br>(117)  | 53.5           | 27.2   | 16.5   | 11.0   | 5.9    |
| 2S<br>and<br>4S                        | Carbon Steel | 426<br>(260)          | 192<br>(144)  | 69.5           | 35.4   | 20.5   | 14.3   | 7.7    |
|                                        | 304 & 316 SS | 449<br>(360)          | 199           | 71.9           | 36.6   | 21.2   | 14.8   | 8.0    |

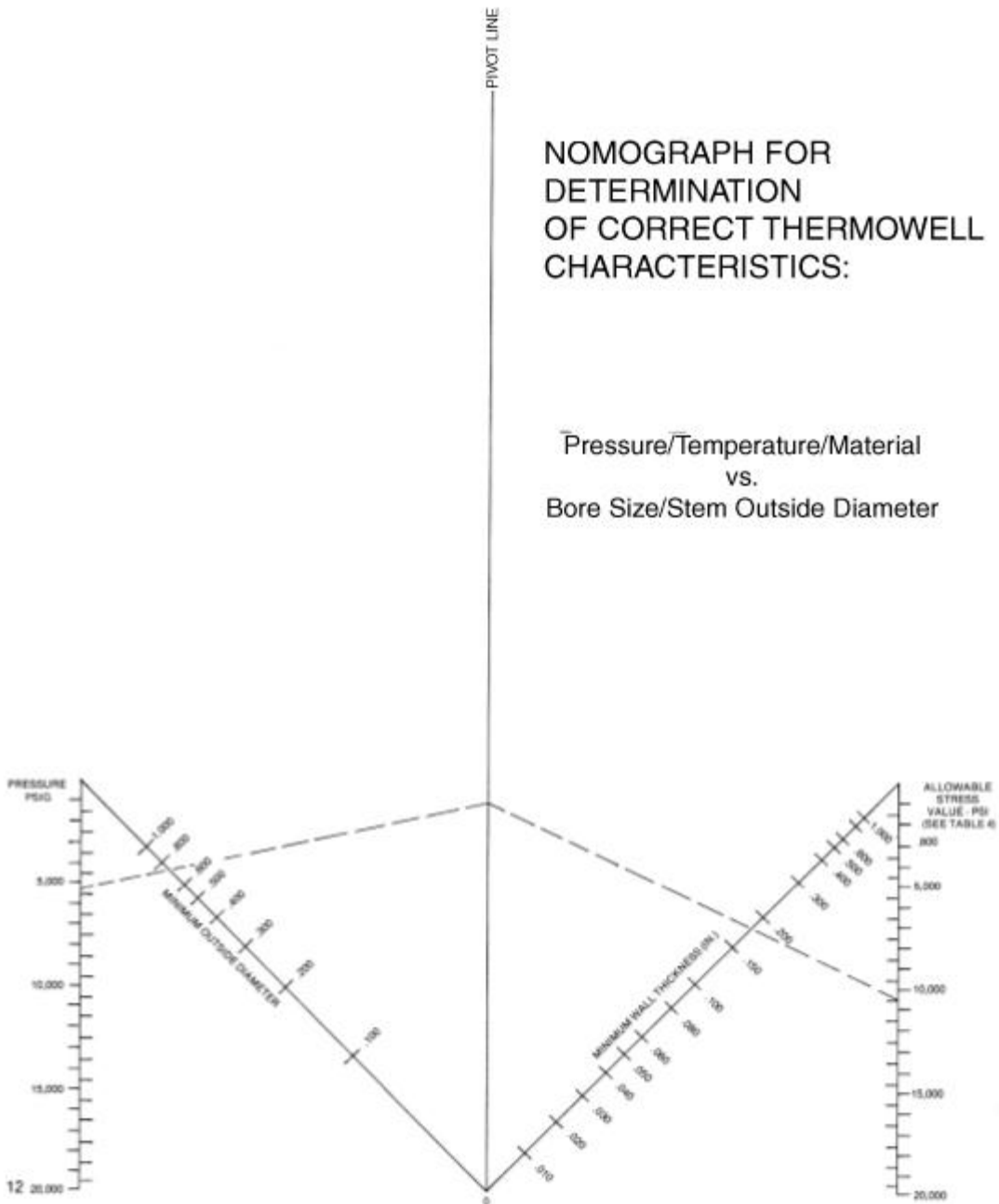
| Maximum Fluid Velocity Feet per Second |              |                       |             |             |        |        |        |        |        |
|----------------------------------------|--------------|-----------------------|-------------|-------------|--------|--------|--------|--------|--------|
| Well Type                              | 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 |
| 1C and 1D                              | 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    |
|                                        | 304 & 316 SS | 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    |
| 3C and 3D                              | 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    |
|                                        | 304 & 316 SS | 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    |

| Maximum Fluid Velocity Feet per Second |              |                       |              |              |        |        |        |        |        |
|----------------------------------------|--------------|-----------------------|--------------|--------------|--------|--------|--------|--------|--------|
| Well Type                              | 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 |
| 2A & 4A<br>and<br>2B & 4B              | Brass        | 290<br>(145)          | 150<br>(80)  | 54.1<br>(48) | 27.6   | 16.7   | 11.1   | 8.0    | 6.0    |
|                                        | Carbon Steel | 326<br>(260)          | 192<br>(144) | 69.5         | 35.4   | 20.5   | 14.3   | 10.3   | 7.7    |
|                                        | 304 & 316 SS | 349<br>(360)          | 199          | 71.9         | 36.6   | 21.2   | 14.8   | 10.7   | 8.0    |
|                                        | Monel        | 316<br>(320)          | 189<br>(178) | 68.1         | 34.8   | 20.8   | 14.0   | 10.0   | 7.5    |

| Maximum Fluid Velocity Feet per Second |              |                       |               |       |        |        |        |        |        |
|----------------------------------------|--------------|-----------------------|---------------|-------|--------|--------|--------|--------|--------|
| Well Type                              | 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 |
| 4C<br>and<br>4D                        | Brass        | 321<br>(150)          | 129<br>(83.5) | 46.8  | 23.6   | 14.5   | 9.6    | 6.9    | 5.1    |
|                                        | Carbon Steel | 410<br>(270)          | 249<br>(150)  | 90.3  | 45.6   | 27.8   | 18.5   | 13.2   | 9.8    |
|                                        | 304 & 316 SS | 483<br>(350)          | 272<br>(208)  | 97.3  | 49.7   | 30.4   | 20.3   | 14.5   | 10.7   |
|                                        | Monel        | 396<br>(300)          | 214<br>(167)  | 77.5  | 39.2   | 23.8   | 16.0   | 10.3   | 7.7    |

| Maximum Fluid Velocity Feet per Second |              |                       |              |       |        |        |        |        |        |
|----------------------------------------|--------------|-----------------------|--------------|-------|--------|--------|--------|--------|--------|
| Well Type                              | 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 |
| 2C<br>and<br>2D                        | Brass        | 319<br>(148)          | 141<br>(82)  | 51.0  | 25.0   | 15.6   | 10.4   | 7.0    | 5.3    |
|                                        | Carbon Steel | 358<br>(264)          | 234<br>(146) | 84.5  | 43.0   | 26.0   | 17.4   | 12.0   | 9.0    |
|                                        | 304 & 316 SS | 390<br>(355)          | 248<br>(203) | 89.0  | 45.0   | 27.5   | 18.0   | 13.2   | 9.9    |
|                                        | Monel        | 347<br>(315)          | 209<br>(165) | 75.0  | 38.0   | 22.0   | 15.0   | 10.0   | 7.6    |

## Nomograph



The Nomograph and Table 4 below may be applied in calculating wall thickness. The following example demonstrates the use of the nomograph in a typical problem situation.

**Problem:** To find maximum operating pressure of a thermowell, 304 stainless steel material, with a .385 inch bore and .750 minimum outside diameter whose maximum operating temperature will be 700°F.

**Solution:** Maximum allowable stress (Table 4) 10,500 PSI. Wall thickness (Min.) = .182.

A) Align 10,500 on right scale with .182 on wall thickness scale and mark intersection on pivot line.

B) Align pivot point intersection with correct outside diameter.

C) Read maximum pressure on left scale (5100 PSIG).

**Table 4 - Allowable Stress Values (PSI)<sup>1</sup>**

| Material                 | Temperature °F |        |        |        |        |        |       |
|--------------------------|----------------|--------|--------|--------|--------|--------|-------|
|                          | 0              | 300    | 500    | 700    | 900    | 1100   | 1300  |
| Aluminum (1100)          | 2,350          | 1,850  | -      | -      | -      | -      | -     |
| Aluminum (6061-T6)       | 6,000          | 5,000  | -      | -      | -      | -      | -     |
| Nickel                   | 10,000         | 10,000 | 9,500  | -      | -      | -      | -     |
| Steel <sup>2</sup>       | 11,250         | 11,000 | 10,250 | 9,000  | 7,750  | 6,500  | -     |
| 304 S. Stl.              | 18,750         | 13,750 | 11,400 | 10,500 | 10,000 | 8,250  | 3,400 |
| 316 S. Stl.              | 18,750         | 16,400 | 15,500 | 15,100 | 11,650 | 8,500  | 3,500 |
| 310 S. Stl.              | 18,750         | 14,600 | 12,600 | 11,300 | 10,300 | 9,450  | 4,000 |
| 321 - 347 S. Stl.        | 18,750         | 15,300 | 13,500 | 12,200 | 11,300 | 9,100  | 2,200 |
| 410 S. Stl.              | 15,000         | 13,800 | 12,850 | 12,050 | 9,650  | 2,900  | -     |
| 446 S. Stl.              | 17,500         | 16,100 | 15,000 | -      | -      | -      | -     |
| A182-F11                 | 16,150         | 16,150 | 16,150 | 16,150 | 13,100 | 4,000  | -     |
| A182-F22                 | 17,500         | 17,500 | 17,500 | 17,500 | 14,000 | 4,200  | -     |
| Copper                   | 6,000          | 5,000  | -      | -      | -      | -      | -     |
| Admiralty Brass          | 10,000         | 10,000 | -      | -      | -      | -      | -     |
| Monel 400                | 16,600         | 13,600 | 13,100 | 13,100 | 8,000  | -      | -     |
| Inconel 600              | 20,000         | 18,800 | 18,500 | 18,500 | 16,000 | 3,000  | -     |
| Incoloy 8003             | 15,600         | 12,100 | 10,400 | 9,600  | 9,100  | 8,800  | 4,150 |
| Hastelloy B <sup>4</sup> | 25,000         | 24,750 | 21,450 | -      | -      | -      | -     |
| Hastelloy X <sup>5</sup> | 23,350         | 18,850 | 16,000 | 15,500 | 15,500 | 15,500 | 9,500 |

1. Values from ASME Boiler and Pressure Vessel Code Section VIII - Unfired Pressure Vessels, 1965.
2. ASME Spec. Min. Tensile = 45,000 PSI
3. ASME Code (See Note 1), Case 1325 (special ruling)
4. ASME Code (See Note 1), Case 1323 (special ruling)
5. ASME Code (See Note 1), Case 1321 (special ruling)

## Pressure - Temperature Ratings

### Pressure-Temperature Rating\* lbs. per sq. Inch

| Well Type      | Material     | Temperature °F |      |      |      |      |       |       |
|----------------|--------------|----------------|------|------|------|------|-------|-------|
|                |              | 70°            | 200° | 400° | 600° | 800° | 1000° | 1200° |
| Series a (All) | Brass        | 5000           | 4200 | 1000 | ---  | ---  | ---   | ---   |
| Series B (All) | Carbon Steel | 5200           | 5000 | 4800 | 4600 | 3500 | 1500  | ---   |
| Series S (All) | 304SS        | 7000           | 6200 | 5600 | 5400 | 5200 | 4500  | 1650  |
| 2C, 4C         | 316SS        | 7000           | 7000 | 6400 | 6200 | 6100 | 5100  | 2500  |
| 2D, 4D         | Monel        | 6500           | 6000 | 5400 | 5300 | 5200 | 1500  | ---   |

\*Values based on allowable stress levels published in the 1956 edition of the a .S.M.E. Boiler Code, Section VIII.

### Pressure-Temperature Rating\* lbs. per sq. Inch

| Well Type         | Material     | Temperature °F |      |      |      |      |       |       |
|-------------------|--------------|----------------|------|------|------|------|-------|-------|
|                   |              | 70°            | 200° | 400° | 600° | 800° | 1000° | 1200° |
| 1C, 3C,<br>1D, 3D | Brass        | 5300           | 4750 | 1100 | ---  | ---  | ---   | ---   |
|                   | Carbon Steel | 5950           | 5750 | 5450 | 5250 | 4000 | 1750  | ---   |
|                   | 304SS        | 7800           | 7050 | 6400 | 6150 | 6000 | 5190  | 1875  |
|                   | 316SS        | 7800           | 7800 | 7250 | 7100 | 6950 | 5800  | 2720  |
|                   | Monel        | 7450           | 6850 | 6150 | 6100 | 5940 | 1750  | ---   |

\*Values based on allowable stress levels published in the 1956 edition of the a .S.M.E. Boiler Code, Section VIII.

### Pressure-Temperature Rating\* lbs. per sq. Inch

| Well Type      | Material     | Temperature °F |      |       |      |       |       |       |
|----------------|--------------|----------------|------|-------|------|-------|-------|-------|
|                |              | 70°            | 200° | 400°  | 600° | 800°  | 1000° | 1200° |
| Series F (All) | Carbon Steel | -----          | Up   | ----- | To   | 2500# |       |       |
| Series G       | 304SS        | -----          | Up   | ----- | To   | ----- | 2500# |       |
| (All)          | 316SS        | -----          | Up   | ----- | To   | ----- | ----- | 2500# |
| Series V (All) | Monel        | -----          | Up   | ----- | To   | 2500# |       |       |

\*Values based on allowable stress levels published in the 1956 edition of the a .S.M.E. Boiler Code, Section VIII and recommendations of ASA B 16, 5-1957.

## Design Procedure\*\*\*

The purpose of this design procedure is to enable the user to determine if a well selected for thermometry considerations is strong enough to withstand specific application conditions of temperature, pressure, velocity, and vibration. Well failures are caused by forces imposed by static pressure, steady state flow, and vibration. Separate evaluations of each of the above effects should be made in order to determine the limiting condition. This design procedure does not allow for effects due to corrosion or erosion.

The natural frequency of a well-designed in accordance with Fig. 1.1 and of the dimensions given in Table 1.1 is given by the following equation:

$$f_n = \frac{K_f}{L^2} \sqrt{\frac{E}{g}} \dots\dots [1]$$

where

$f_n$  = natural frequency of the well at use temperature, cycles per sec  
 $L$  = length of well as given in Fig. 1.1, in.  
 $E$  = modulus of elasticity of well material at use temperature, psi  
 $g$  = specific weight of well material at use temperature, lb per cu in.  
 $K_f$  = a constant obtained from Table 1.2

The wake or Strouhal frequency is given by:

$$f_w = \frac{V}{B} 2.64 \dots\dots [2]$$

where  $f_w$  = wake frequency, cycles per sec  
 $V$  = fluid velocity, fps  
 $B$  = diameter at tip (Fig. 1.1), in.

The ratio of wake to natural frequency ( $f_w/f_n$ ) shall not exceed 0.8, and when this condition is met, the Magnification Factor, relationship of dynamic to static amplitude is given by:

$$F_M = \frac{(f_w/f_n)^2}{1 - (f_w/f_n)^2} = \frac{r^2}{1 - r^2} \dots\dots [3]$$

For  $r \leq 0.8$

where

$F_M$  = magnification factor, dimensionless  
 $r$  = frequency ratio, ( $f_w/f_n$ ), dimensionless

## Stress Analysis

The maximum pressure that a thermometer well can withstand for a given material at a given temperature shall be computed from the following:

$$P = K_1 S \dots \dots \dots [4]$$

where

$P$  = maximum allowable static gage pressure, psi

$S$  = allowable stress for material at operating temperature as given in the ASME Boiler and Pressure Vessel or Piping Codes, psi

$K_1$  = a stress constant obtained from Table 1.3.

The maximum length that a thermometer well can be made for a given service is dependent upon both vibratory and steady state stress. The necessity for keeping the frequency ratio at 0.8 or less imposes one limitation on maximum length. The other limitation is one of steady state stress considerations, as given by the following equation:

$$L_{\text{max}} = \frac{K_2}{V} \sqrt{\frac{v(S - K_3 P_0)}{1 + FM}} \dots \dots [5]$$

where

$L_{\text{max}}$  = maximum value of  $L$  (as shown in Fig. 1.1) for a given service, in.

$V$  = fluid velocity, fps

$v$  = specific volume of the fluid, cu ft per lb.

$S$  = allowable stress for material at operating temperature as given in the ASME Boiler and Pressure vessel or Piping Codes, psi

$P_0$  = static operating gage pressure, psi

$FM$  = magnification factor as computed from Eq [3]

$K_2, K_3$  = stress constants obtained from Table 1.3

**Table 1.1 well dimensions, in Inches**

| Dimension   | Nominal Size of Sensing Element |
|-------------|---------------------------------|
|             | (1/4)                           |
| A (minimum) | 13/16                           |
| B (minimum) | 5/8                             |
| d (minimum) | 0.254                           |
| d (maximum) | 0.262                           |

**Fig. 1.1 power test code  
Thermometer wells**

| Well Length<br>L, in. | $K_f$ | Stress Constant |       |
|-----------------------|-------|-----------------|-------|
| 2-1/2                 | 2.06  | $K_1$           | 0.412 |
| 4-1/2                 | 2.07  | $K_2$           | 37.5  |
| 7-1/2                 | 2.08  | $K_3$           | 0.116 |
| 10-1/2                | 2.09  |                 |       |

|                              |      |                                         |  |
|------------------------------|------|-----------------------------------------|--|
| 16                           | 2.09 |                                         |  |
| 24                           | 2.09 |                                         |  |
| Table 1.2<br>values of $K_f$ |      | Table 1.3 values<br>of stress constants |  |

\*\*\* Power Test Code Thermometer Wells, J. W. Murdock, Journal of Engineering for Power, Trans. ASME, vol. 81, 1959

## Thermowell Material Guide

Thermowell materials for various average applications are listed in the following table. The list has been carefully prepared and takes into consideration such factors as contamination, electrolysis, catalytic reaction and other variables. Standard materials are recommended wherever possible. Service may vary, however, in industrial use as a result of temperature, pressure, concentration and impurities in the corrosive medium.

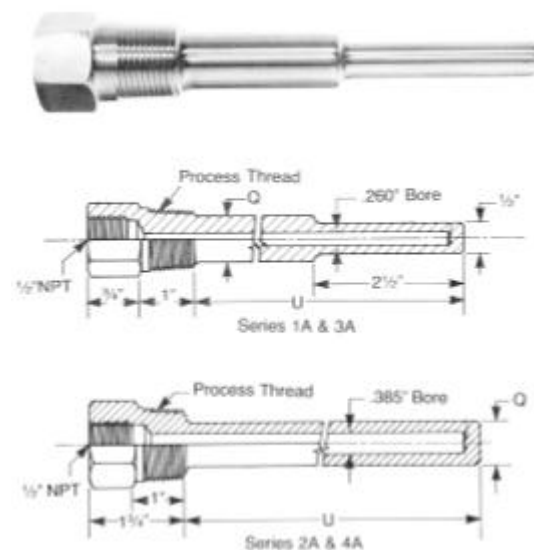
While the recommendations cannot guarantee service, they will serve as an effective guide. **Thermo Sensors Corporation** can provide consultation for special applications upon request.

| Industry        | Application                                                                                                                                               | Conditions                                                                                                                                             | Material                                                                                                                                                                                                                                                                                                    |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Cement and Lime | Kiln<br>hot end (clinker)<br>cool end (flue)<br>Clinker cooler<br>Exit Flue                                                                               | to 2600 °F<br>600-2000 °F<br>to 1200 °F                                                                                                                | C30 Ceramic<br>28% Chrome Iron - Inconel 601<br>Cerampak - 28% Chrome Iron - Inconel 601<br>Inconel 601, 28% Chrome Iron - Silicon Carbide, Silicon Nitride                                                                                                                                                 |
| Ceramic         | Dryers<br>Kilns-Brick<br>Vitreous enameling<br><br>Grinding wheels<br>Abrasive grits<br>Porcelain pottery                                                 | 1800-2200 °F<br>1600-2000 °F<br><br>to 500 °F<br>to 2300 °F<br>2000-2400 °F                                                                            | Carbon Steel - Silicon Carbide - Silicon Nitride - Wrought Iron<br>C30 Ceramic - Inconel 600 - Silicon Carbide - Silicon Nitride<br>Inconel 600 - Firebrick - 28 % Chrome Iron - Silicon Carbide - Silicon Nitride<br>Wrought Iron<br>C30 Ceramic<br>C30 Ceramic                                            |
| Chemical        | Acetate Solvents<br>Acetic Acid<br><br><br><br>Acetic Anhydride<br>Acetone<br>Acetone<br>Acetylene<br>Alcohol Ethyl<br><br>Alcohol Methyl<br><br>Aluminum | Crude or Pure<br>10%-70 °F<br>50%-70 °F<br>50%-212 °F<br>99%-70 °F<br>99%-212 °F<br><br><br>212 °F<br><br>70 °F<br>212 °F<br>70 °F<br>212 °F<br>Molten | Monel - Nickel<br>304 Stainless Steel<br>304 Stainless Steel<br>316 Stainless Steel - Monel<br>Monel<br>Monel<br><br>Monel - Nickel<br>304 Stainless Steel<br>304 Stainless Steel - Monel - Nickel<br>304 Stainless Steel<br>304 Stainless Steel<br>304 Stainless Steel<br>304 Stainless Steel<br>Cast Iron |

|                   |                           |                                                              |
|-------------------|---------------------------|--------------------------------------------------------------|
| Aluminum Acetate  | Saturated                 | 304 Stainless Steel                                          |
| Aluminum Chloride |                           | Hastelloy B                                                  |
| Aluminum Sulphate | 10%-70 °F                 | 304 Stainless Steel                                          |
|                   | Saturated 70 °F           | 304 Stainless Steel                                          |
|                   | 10%-212 °F                | 316 Stainless Steel                                          |
|                   | Saturated 212 °F          | 316 Stainless Steel                                          |
| Ammonia           | All concentrations 70 °F  | 304 Stainless Steel - 316 Stainless Steel                    |
| Ammonia Hydroxide |                           | 2024-T4 Aluminum - 304 Stainless Steel - 316 Stainless Steel |
| Ammonia Liquors   |                           | 2024-T4 Aluminum - 304 Stainless Steel - 316 Stainless Steel |
| Ammonia Phosphate |                           |                                                              |
| (Dibasic)         |                           | Monel                                                        |
| (Monobasic)       |                           | Phosphor Bronze                                              |
| (Tribasic)        |                           | Monel                                                        |
| Ammonium Chloride | All Concentrations 212 °F | 316 Stainless Steel                                          |
| Ammonium Nitrate  | All Concentrations 70 °F  | 304 Stainless Steel                                          |
|                   |                           | 304 Stainless Steel                                          |
| Ammonium Sulphate | All Concentrations 212 °F | 304 Stainless Steel                                          |
|                   |                           | 316 Stainless Steel                                          |
|                   | 5%-70 °F                  | 316 Stainless Steel                                          |
| Amylacetate       | 10%-212 °F                | Monel - 304 Stainless Steel                                  |
| Aniline           | Saturated 212 °F          | 304 Stainless Steel - Monel                                  |
| Asphalt           |                           | C1018 Steel - 304 Stainless Steel - Monel - Nickel           |
| Barium Carbonate  | All Concentrations 70 °F  | 304 Stainless Steel                                          |
| Barium Chloride   |                           | Monel                                                        |
|                   |                           | Monel - Hastelloy C                                          |
| Barium Hydroxide  | 70 °F                     | 316 Stainless Steel - Hastelloy C                            |
| Benzaldehyde      | 5%-70 °F                  | C1018 Steel                                                  |
| Benzene           | Saturated 70 °F           | C1018 Steel                                                  |
| Benzine           | Aqueous - Hot             | 304 Stainless Steel                                          |
| Benzol            |                           | C1018 Steel - 2024-T4 Aluminum - Monel - Inconel 600         |
| Boracic Acid      |                           | 304 Stainless Steel                                          |
| Brines            | 70 °F                     | 304 Stainless Steel                                          |
| Bromine           |                           | Monel                                                        |
|                   | Hot                       | Tantalum Sleeved                                             |
|                   | 5% Hot or Cold            | Monel                                                        |
| Butadiene         |                           | Brass - 304 Stainless Steel                                  |
| Butane            | 70 °F                     | 304 Stainless Steel                                          |
| Buthlacetate      | Dry 125 °F                | Monel                                                        |
| Butyl Alcohol     |                           | Copper - 304 Stainless Steel                                 |
| Butylenes         | 70°F                      | C1018 Steel - Phosphor Bronze                                |

## Threaded Thermowells - Straight/Stepped

### Series A: Threaded Straight Stem Thermowells

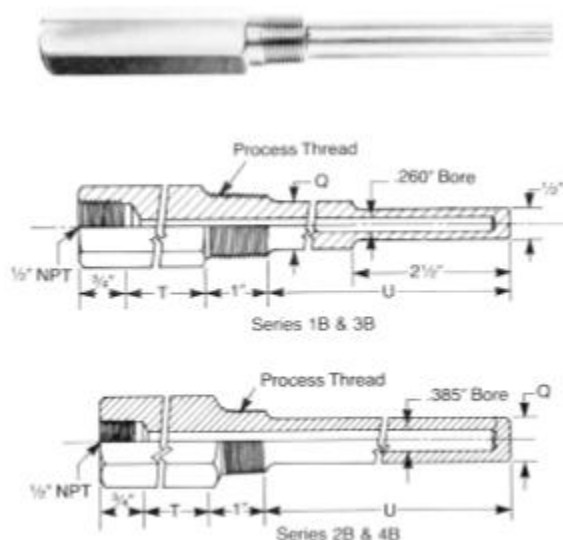


| Process Thread | Bore | Q      | Ordering Code |                                                |                                                                                       |
|----------------|------|--------|---------------|------------------------------------------------|---------------------------------------------------------------------------------------|
|                |      |        | Type          | Material                                       | "U"                                                                                   |
| 1/2" NPT       | .260 | 5/8"   | 1/2A          | Select Material Code from <a href="#">Here</a> | Specify in Inches                                                                     |
|                | -    | -      | -             |                                                | -----                                                                                 |
| 3/4" NPT       | .260 | 3/4"   | 1A            |                                                | Standard Lengths:<br>2 1/2", 4 1/2",<br>7 1/2", 10 1/2",<br>13 1/2", 16 1/2", 22 1/2" |
|                | .385 | 49/64" | 2A            |                                                |                                                                                       |
| 1" NPT         | .260 | 7/8"   | 3A            |                                                |                                                                                       |
|                | .385 | 49/64" | 4A            |                                                |                                                                                       |

### How to Order:

**Example:** 2A36-10 1/2  
 Process Thread = 3/4" NPT  
 Bore = .385"  
 Material = 316 Stainless Steel  
 "U" = 10 1/2"

## Series B: Threaded Straight Stem Lagging Thermowells



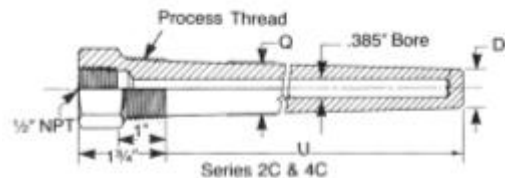
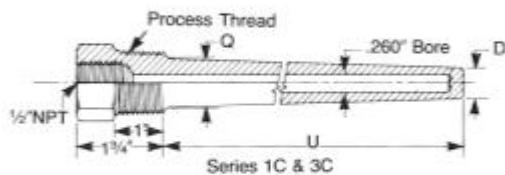
| Process Thread | Bore | Q      | Ordering Code |                                                |                                                                                                                                                          |     |
|----------------|------|--------|---------------|------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|                |      |        | Type          | Material                                       | "T"                                                                                                                                                      | "U" |
| 1/2" NPT       | .260 | 5/8"   | 1/2 B         | Select Material Code from <a href="#">Here</a> | Standard "T" & "U" Dimensions:<br>-----<br>Specify in Inches<br>"T" "U"<br>2" 2 1/2"<br>3" 4 1/2"<br>3" 7 1/2"<br>3" 10 1/2"<br>3" 13 1/2"<br>3" 19 1/2" |     |
| 3/4" NPT       | -    | -      | -             |                                                |                                                                                                                                                          |     |
|                | .260 | 3/4"   | 1B            |                                                |                                                                                                                                                          |     |
|                | .385 | 49/64" | 2B            |                                                |                                                                                                                                                          |     |
| 1" NPT         | .260 | 7/8"   | 3B            |                                                |                                                                                                                                                          |     |
|                | .385 | 49/64" | 4B            |                                                |                                                                                                                                                          |     |

### How to Order:

**Example:** 2B34-T3-4 1/2  
 Process Thread = 3/4" NPT  
 Bore = .385"  
 Material = 304 Stainless Steel  
 "T" = 3"  
 "U" = 4 1/2"

## Threaded Thermowells - Tapered

### Series C: Threaded Tapered Stem Thermowells

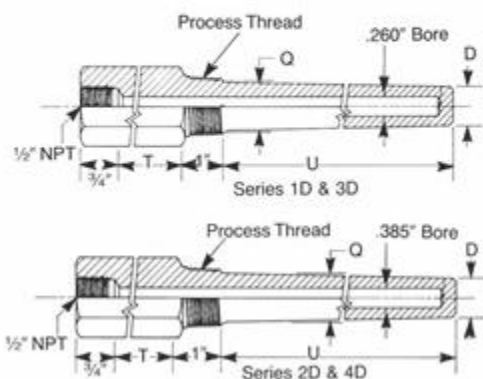


| Process Thread | Bore | Q       | D      | Ordering Code |                                                |                                                                                       |
|----------------|------|---------|--------|---------------|------------------------------------------------|---------------------------------------------------------------------------------------|
|                |      |         |        | Type          | Material                                       | "U"                                                                                   |
| 1/2" NPT       | .260 | 11/16"  | 5/8"   | 1/2 C         | Select Material Code from <a href="#">Here</a> | Specify in Inches<br>-----                                                            |
|                | -    | -       | -      | -             |                                                |                                                                                       |
| 3/4" NPT       | .260 | 7/8"    | 5/8"   | 1C            |                                                | Standard Lengths:<br>2 1/2", 4 1/2",<br>7 1/2", 10 1/2",<br>13 1/2", 16 1/2", 22 1/2" |
|                | .385 | 7/8"    | 49/64" | 2C            |                                                |                                                                                       |
| 1" NPT         | .260 | 1 1/16" | 5/8"   | 3C            |                                                |                                                                                       |
|                | .385 | 1 1/16" | 49/64" | 4C            |                                                |                                                                                       |

### How to Order:

**Example:** 3C60-7 1/2  
 Process Thread = 1" NPT  
 Bore = .260"  
 "Q" = 1 1/16"  
 "D" = 5/8"  
 Material = Inconel 600  
 "U" = 7 1/2"

## Series D: Threaded Tapered Stem Lagging Thermowells



| Process Thread | Bore | Q       | D      | Ordering Code |                                                |                                                                                                                                                              |     |
|----------------|------|---------|--------|---------------|------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|
|                |      |         |        | Type          | Material                                       | "T"                                                                                                                                                          | "U" |
| 1/2" NPT       | .260 | 11/16"  | 5/8"   | 1/2 D         | Select Material Code from <a href="#">Here</a> | Standard "T" & "U" Dimensions:<br>-----<br>Specify in Inches<br><br>"T" "U"<br>2" 2 1/2"<br>3" 4 1/2"<br>3" 7 1/2"<br>3" 10 1/2"<br>3" 13 1/2"<br>3" 19 1/2" |     |
| 3/4" NPT       | .260 | 7/8"    | 5/8"   | 1D            |                                                |                                                                                                                                                              |     |
|                | .385 | 7/8"    | 49/64" | 2D            |                                                |                                                                                                                                                              |     |
| 1" NPT         | .260 | 1 1/16" | 5/8"   | 3D            |                                                |                                                                                                                                                              |     |
|                | .385 | 1 1/16" | 49/64" | 4D            |                                                |                                                                                                                                                              |     |

### How to Order:

**Example:** 4D40-T2-2 1/2

Process Thread = 1" NPT

Bore = .385"

"Q" = 1 1/16"

"D" = 49/64"

Material = 410 Stainless Steel

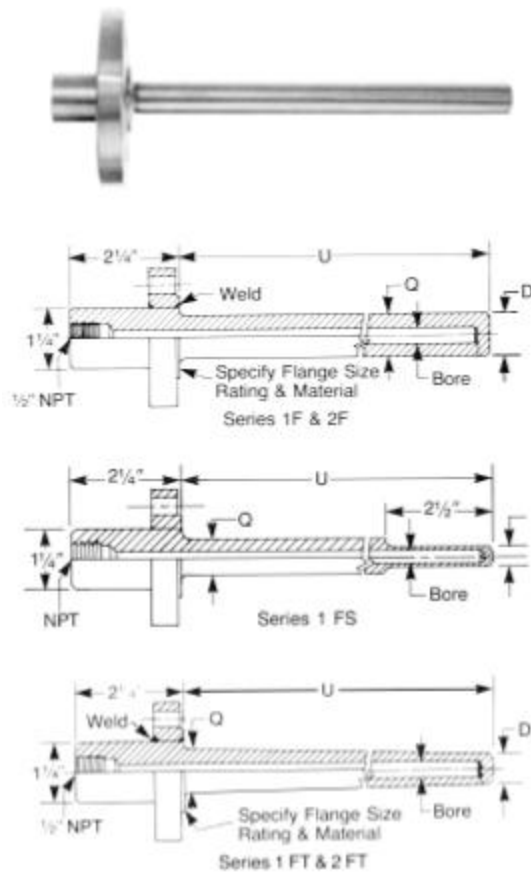
"T" = 2"

"U" = 2 1/2"

## Flanged Thermowells and Sleeves for Series 1F and 2F

### Series F: Flanged Thermowells

Type F - Straight Stem  
 Type FT - Tapered Stem  
 Type FS - Stepped Stem



| Bore  | Q       | D     | Ordering Code |                                                |                                                              |                                                                                     |
|-------|---------|-------|---------------|------------------------------------------------|--------------------------------------------------------------|-------------------------------------------------------------------------------------|
|       |         |       | Style         | Material                                       | "U"                                                          | Flange                                                                              |
| .260" | 3/4"    | 3/4"  | 1F            | Select Material Code from <a href="#">Here</a> | Specify in Inches                                            | **Series 1 ft & 2 ft Wells With 1" Flange Will Have Taper as Noted.                 |
|       | 3/4"    | 1/2"  | 1FS           |                                                | -----                                                        |                                                                                     |
| .260" | 1 1/16" | 5/8"  | 1FT           |                                                | Standard Lengths:<br>2", 4",<br>7", 10",<br>13", 16",<br>22" | Specify Flange Size, Rating, Facing, Material Only if Different Material than Stem. |
| .385" | 7/8"    | 7/8"  | 2F            |                                                |                                                              |                                                                                     |
| .385" | 1 1/16" | 49/64 | 2FT           |                                                |                                                              |                                                                                     |

## How to Order:

**Example:** 1F36-10-1 1/2" x 300 RF

Bore = .260"

"Q" = 3/4"

Material = 316 Stainless Steel Well

"U" = 10"

1 1/2" x 300#RF T316 Flange

Lagging: The 2.25" Head Dimension shown is standard. If additional length (LAG) is needed within the 2.25" dimension, specify by placing a "-T" followed by additional length required (in inches) between the material code and "U" dimension code.

**Example:** 2FT36-T3-10-1x150 RF

Note: The "T" dimension + 2 1/4" will be the length from the bottom of the flange to the open end of the well.

## Sleeves for Series 1F and 2F Thermowells



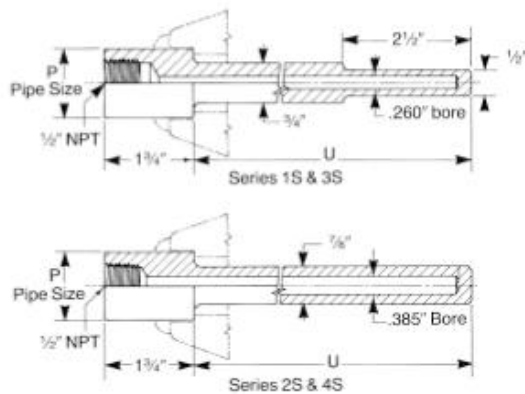
| Sleeve Material | Ordering Code |
|-----------------|---------------|
| Tantalum        | TS            |
| Zirconium       | ZS            |
| Specify         | (Other)       |

## How To Order:

Place Ordering Code as a Suffix Following the Flanged Well Part Number.

**Example:** 1F36-10-1 1/2"x 300 RF - TS Well as above with Tantalum Sleeve.

## Socket Weld Thermowells

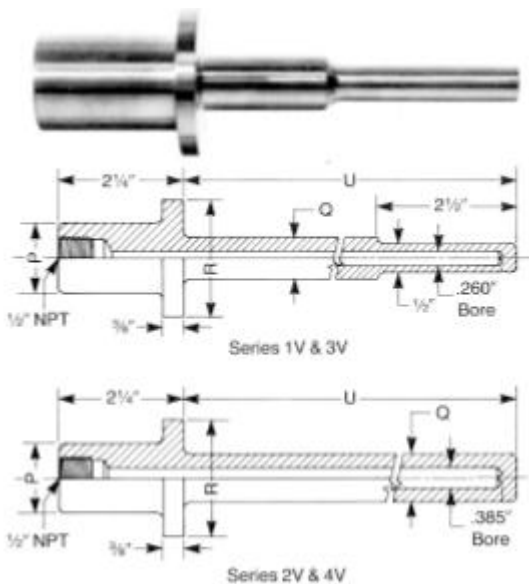


| Pipe Size "P"                 | Bore | Q    | Ordering Code |                                                |                                                                                                                     |
|-------------------------------|------|------|---------------|------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|
|                               |      |      | Type          | Material                                       | "U"                                                                                                                 |
| 3/4" Nominal<br>(1.050" Dia.) | .260 | 3/4" | 1S            | Select Material Code from <a href="#">Here</a> | Specify in Inches<br>-----<br>Standard Lengths:<br>2 1/2", 4 1/2",<br>7 1/2", 10 1/2",<br>13 1/2", 16 1/2", 22 1/2" |
|                               | .385 | 7/8" | 2S            |                                                |                                                                                                                     |
| 1" Nominal<br>(1.315" Dia.)   | .260 | 3/4" | 3S            |                                                |                                                                                                                     |
|                               | .385 | 7/8" | 4S            |                                                |                                                                                                                     |

## How to Order:

**Example:** 1S96-10 1/2  
"P" Dim. = 3/4" Nom. Pipe  
Bore = .260"  
Material = Monel  
"U" = 10 1/2"

## Van Stone Thermowells



Backing flanges for van stone wells are available.  
Specify as separate item giving flange size, rating and material.

| Pipe Size "P"                   | Bore | Q    | R      | Ordering Code |                                                |                                                           |
|---------------------------------|------|------|--------|---------------|------------------------------------------------|-----------------------------------------------------------|
|                                 |      |      |        | Type          | Material                                       | "U"                                                       |
| 1" Nominal<br>(1.315" Dia.)     | .260 | 3/4" | 2"     | 1V            | Select Material Code from <a href="#">Here</a> | Specify in Inches<br>-----                                |
|                                 | .385 | 7/8" | 2"     | 2V            |                                                | Standard Lengths:<br>2", 4",<br>7", 10",<br>13", 16", 22" |
| 1 1/2" Nominal<br>(1.900" Dia.) | .260 | 3/4" | 2 7/8" | 3V            |                                                |                                                           |
|                                 | .385 | 7/8" | 2 7/8" | 4V            |                                                |                                                           |

## How to Order:

### Example: 1V20-13

"P" Dim. = 1" Nom. Pipe

Bore = .260"

"Q" = 3/4"

"R" = 2"

Material - Carpenter 20

"U" = 13"

## Limited Space / Weld-In Thermowells

### Limited Space Thermowells

Limited space thermometer wells for 1/4" diameter stems with 2 1/2" stem lengths.

### Application

Bimetal thermometers, thermocouples and RTD's with 1/4" diameter stems and 2 1/2" length.

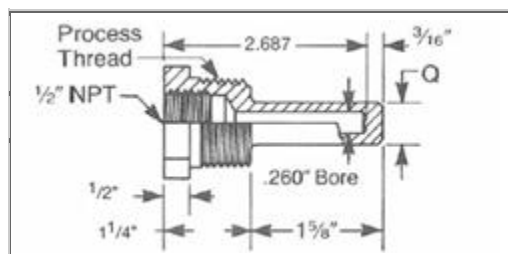
### Thread Connections

Standard wells have either a 3/4" or 1" NPT process connection and a 1/2" NPT internal thread. Other thread sizes are available.

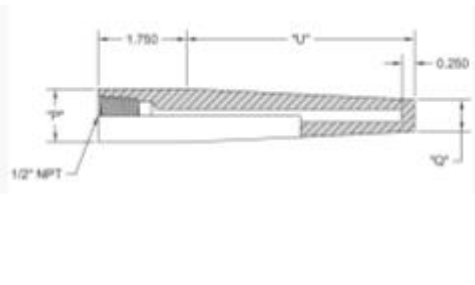
### Material

Thermometer wells are available in a wide selection of materials. [Click here](#) for material codes.

### Series 1H & 2H - Limited Space

|  |  | Process Thread | Q    | Stem Length | Insertion Length | Ordering Code |
|-------------------------------------------------------------------------------------|--|----------------|------|-------------|------------------|---------------|
|                                                                                     |  | 3/4" NPT       | 1/2" | 2 11/16"    | 1 5/8"           | 1H (Material) |
|                                                                                     |  | 1" NPT         | 1/2" | 2 11/16"    | 1 5/8"           | 3H (Material) |

## Weld-In Thermowells

|  | Pipe Size "P" | Bore | Actual Diameter "P" | Q     | Ordering Code |                                   |                   |
|-----------------------------------------------------------------------------------|---------------|------|---------------------|-------|---------------|-----------------------------------|-------------------|
|                                                                                   |               |      |                     |       | Type          | Material                          | "U"               |
| 3/4" Nominal                                                                      |               | .260 | 1.05                | .625" | 1W            | Select Material Code from Page 19 | Specify in Inches |
|                                                                                   |               | .385 | 1.05                | .765  | 2W            |                                   |                   |
| 1" Nominal                                                                        |               | .260 | 1.315               | .625  | 3W            |                                   |                   |
|                                                                                   |               | .385 | 1.315               | .765  | 4W            |                                   |                   |

### How to Order:

1. Determine process thread required and specify the corresponding part number listed in the "ordering code" column.
2. Replace "(Mat'l.)" with desired material code. Material codes are [here](#).

## Plug and Chain Options



A Plug and Chain is available as an option for all thermowells. It is used to keep the bore clean when the thermowell is not in use. Used to keep "test wells" bore clean when not in use.

| Material        | Order Code |
|-----------------|------------|
| Brass           | -B         |
| Stainless Steel | -S         |

### How to Order:

Determine the part number on the basic thermowell selected and add the desired order code shown in the table as a suffix.

**Example:** 3A36 - 10.5 - B

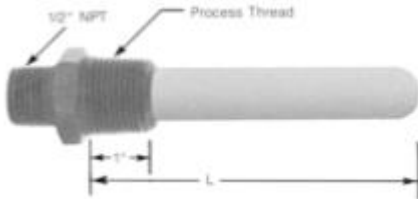
## Thermowell Material Ordering Codes

| Order Code      | Material                   |
|-----------------|----------------------------|
| 34              | 304 Stainless Steel        |
| 34L             | 304L Stainless Steel       |
| 39              | 309 Stainless Steel        |
| 30              | 310 Stainless Steel        |
| 36              | 316 Stainless Steel        |
| 36L             | 316L Stainless Steel       |
| 31              | 321 Stainless Steel        |
| 37              | 347 Stainless Steel        |
| 40              | 410 Stainless Steel        |
| 46              | 446 Stainless Steel        |
| 60              | Inconel 600                |
| 61              | Inconel 601                |
| 80              | Incoloy 800                |
| 81              | Incoloy 801                |
| 24              | Aluminum (2024-T4)         |
| 23              | Brass                      |
| 18              | Carbon Steel (C1018)       |
| 20              | Carpenter 20               |
| 11              | Chrome-Moly A182-F11       |
| 22              | Chrome-Moly A182-F22       |
| 86              | Cast Iron - Ceramic Coated |
| 87              | Cast Iron                  |
| 98              | Copper                     |
| 92              | Hastelloy B                |
| 94              | Hastelloy C                |
| 96              | Monel                      |
| 93              | Nickel                     |
| 21              | Phosphor Bronze            |
| 99              | Tantalum                   |
| 25              | Teflon                     |
| 26              | Titanium                   |
| Specify by name | Materials not listed       |

## Ceramic Protecting Tubes - Primary/Secondary

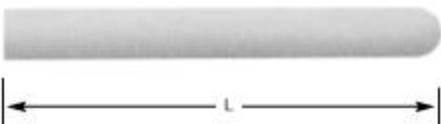
### Ceramic Protecting Tubes - Primary

#### With Double Threaded Bushing

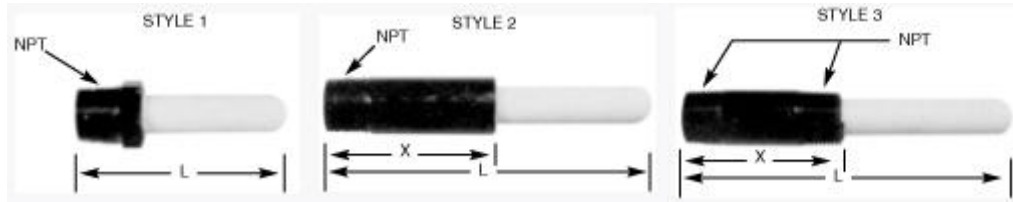


| Tube Size*<br>I.D. x O.D. | Process*<br>Thread | Part Number  |              |
|---------------------------|--------------------|--------------|--------------|
|                           |                    | C30 Ceramic  | C98 Ceramic  |
| 1/4" x 3/8"               | 3/4" NPT C.S.      | C30 140F-(L) | C98 140F-(L) |
| 3/8" x 1/2"               | 3/4" NPT C.S.      | C30 380F-(L) | C98 380F-(L) |
| 7/16" x 11/16"            | 3/4" NPT C.S.      | C30 716F-(L) | C98 716F-(L) |
| 9/16" x 3/4"              | 3/4" NPT C.S.      | C30 916F-(L) | C98 916F-(L) |
| 5/8" x 7/8"               | 1" NPT C.S.        | C30 580F-(L) | C98 580F-(L) |
| 3/4" x 1"                 | 1 1/4" NPT C.S.    | C30 340F-(L) | C98 340F-(L) |

#### Without Fitting



| Tube Size*<br>I.D. x O.D. | Part Number |             |
|---------------------------|-------------|-------------|
|                           | C30 Ceramic | C98 Ceramic |
| 1/4" x 3/8"               | C30 140-(L) | C98 140-(L) |
| 3/8" x 1/2"               | C30 380-(L) | C98 380-(L) |
| 7/16" x 11/16"            | C30 716-(L) | C98 716-(L) |
| 9/16" x 3/4"              | C30 916-(L) | C98 916-(L) |
| 5/8" x 7/8"               | C30 580-(L) | C98 580-(L) |
| 3/4" x 1"                 | C30 340-(L) | C98 340-(L) |



| Tube Size*<br>I.D. x O.D. | NPT**  | Style 1        |                | Style 2         |                 | Style 3         |                 |
|---------------------------|--------|----------------|----------------|-----------------|-----------------|-----------------|-----------------|
|                           |        | C30<br>Ceramic | C98<br>Ceramic | C30 Ceramic     | C98 Ceramic     | C30 Ceramic     | C98 Ceramic     |
| 1/4" x 3/8"               | 3/4"   | C30T140-(L)    | C98T140-(L)    | C30N140-(L)-(X) | C98N140-(L)-(X) | C30D140-(L)-(X) | C98D140-(L)-(X) |
| C98D140-(L)-(X)           | 3/4"   | C30T380-(L)    | C98T380-(L)    | C30N380-(L)-(X) | C98N380-(L)-(X) | C30D380-(L)-(X) | C98D380-(L)-(X) |
| 7/16" x 11/16"            | 3/4"   | C30T716-(L)    | C98T716-(L)    | C30N716-(L)-(X) | C98N716-(L)-(X) | C30D716-(L)-(X) | C98D716-(L)-(X) |
| 9/16" x 3/4"              | 3/4"   | C30T916-(L)    | C98T916-(L)    | C30N916-(L)-(X) | C98N916-(L)-(X) | C30D916-(L)-(X) | C98D916-(L)-(X) |
| 5/8" x 7/8"               | 1"     | C30T580-(L)    | C98T580-(L)    | C30N580-(L)-(X) | C98N580-(L)-(X) | C30D580-(L)-(X) | C98D580-(L)-(X) |
| 3/4" x 1"                 | 1 1/4" | C30T340-(L)    | C98T340-(L)    | C30N340-(L)-(X) | C98N340-(L)-(X) | C30D340-(L)-(X) | C98D340-(L)-(X) |

\* Other tube sizes and fittings are available on special order.

\*\* Other thread sizes may be specified using the optional fitting table below.

| Optional Fittings |                 |                   |             |
|-------------------|-----------------|-------------------|-------------|
| Process Thread    | Material        | Maximum Tube O.D. | Option Code |
| 1/2" NPT          | Carbon Steel    | 1/2" O.D.         | 4C          |
| 1/2" NPT          | Stainless Steel | 1/2" O.D.         | 4S          |
| 3/4" NPT          | Stainless Steel | 3/4" O.D.         | 6S          |
| 1" NPT            | Carbon Steel    | 1" O.D.           | 8C          |
| 1" NPT            | Stainless Steel | 1" O.D.           | 8S          |
| 1 1/4" NPT        | Carbon Steel    | 1 1/8" O.D.       | 10C         |
| 1 1/4" NPT        | Stainless Steel | 1 1/8" O.D.       | 10S         |
| 1 1/2" NPT        | Carbon Steel    | 1 1/2" O.D.       | 12C         |
| 1 1/2" NPT        | Stainless Steel | 1 1/2" O.D.       | 12S         |

## Ceramic Protecting Tubes - Secondary



| Material                              | I.D. x O.D. | Style     | Part Number    |
|---------------------------------------|-------------|-----------|----------------|
| Silicon Carbide                       | 1" x 13/4"  | Collar    | SCT 100 WC-(L) |
|                                       |             | No Collar | SCT 100 NC-(L) |
| Hardware to Connect"SCT100WC" to Head |             |           |                |

### How to Order:

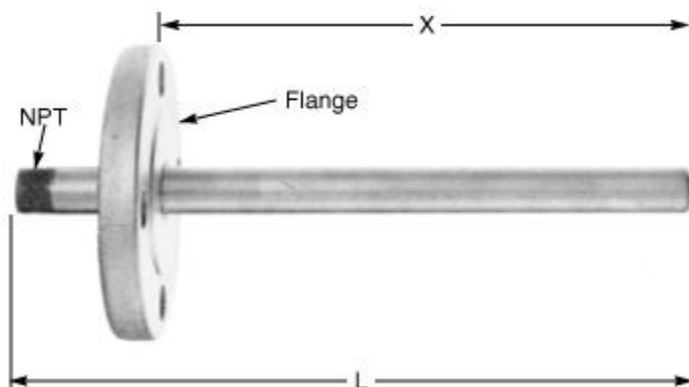
Select the tube size from the table and specify the part number shown for the desired material (C30 or C98), replacing the (L) and (X) with the required length in inches. If a fitting other than the standard thread is required, specify by adding the "option code" from the optional fitting table as a suffix to the part number.

#### Examples:

C98 716F-18-8S  
C30 916F-18-8C

## Metal Protecting Tube with Flange / Cast Iron Protecting Tube

### Metal Protecting Tube with Flange



| NPT  | O.D. x I.D. (Nom.)** | Ordering Code |                                                          |                   |                                        |                   |
|------|----------------------|---------------|----------------------------------------------------------|-------------------|----------------------------------------|-------------------|
|      |                      | Series        | Material                                                 | "L"               | Flange                                 | "X"               |
| 1/8" | .405" x .269"        | F18           | Select Material Code from <a href="#">Material Table</a> | Specify in Inches | Specify Size, Rating, Facing, Material | Specify in Inches |
| 1/4" | .540" x .364"        | F14           |                                                          |                   |                                        |                   |
| 1/2" | .840" x .622"        | F12           |                                                          |                   |                                        |                   |
| 3/4" | 1.050" x .824"       | F34           |                                                          |                   |                                        |                   |
| 1"   | 1.315" x 1.049"      | F10           |                                                          |                   |                                        |                   |

### How To Order:

1. Select series number.
2. Select material code from [Material Table](#) and add to series designation.
3. Specify desired "L" dimension in inches.
4. Specify desired flange by size, rating, facing and material.
5. Specify desired "X" dimension in inches.

### Example:

F1036 - 48 - 1 1/2-150#RF-316s.s. - 42

Series/Mat'l "L" Flange "X"

### Cast Iron Protecting Tube



Cast iron tubes are available both coated and uncoated. Coated tubes have a thin ceramic coating which resists wetting of the tube by molten metals with the advantage of longer life in molten aluminum, zinc and lead.

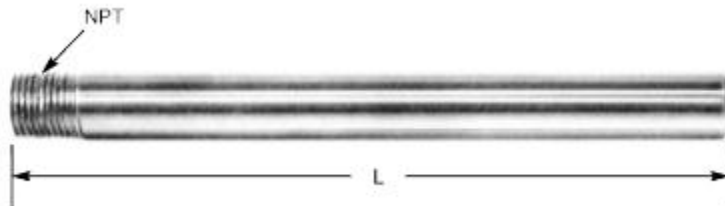
It is recommended that uncoated tubes be dipped frequently in ladle wash or similar material to prolong life.

## How to Order:

| Ordering Information                                                             |          |
|----------------------------------------------------------------------------------|----------|
| Coated                                                                           | 8634-(L) |
| Uncoated                                                                         | 8734-(L) |
| Specify "L" in inches.<br>Standard Lengths:<br>12", 18", 24", 30", 36", 42", 48" |          |

## Metal Protecting Tubes/Tubes With Bushings

### Metal Protecting Tube



| NPT  | O.D. x I.D. (Nom.)** | Ordering Code |                                                          |                   |
|------|----------------------|---------------|----------------------------------------------------------|-------------------|
|      |                      | Series        | Material                                                 | "L"               |
| 1/8" | .405" x .269"        | 18            | Select Material Code from <a href="#">Material Table</a> | Specify in Inches |
| 1/4" | .540" x .364"        | 14            |                                                          |                   |
| 1/2" | .840" x .622"        | 12            |                                                          |                   |
| 3/4" | 1.050" x .824"       | 34            |                                                          |                   |
| 1"   | 1.315" x 1.049"      | 10            |                                                          |                   |

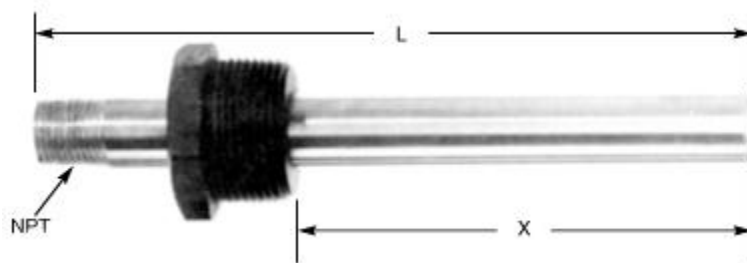
## How to order:

1. Select series number.
2. Select material code from [Material Table](#) and add to series.
3. Specify desired "L" dimension in inches.

**Example:**

1260 - 18  
 Series/Mat'l "L"

**Metal Protecting Tube with Bushings**



| NPT  | O.D. x I.D. (Nom.)** | Ordering Code |                                                          |                   |                                                                                                  |                   |
|------|----------------------|---------------|----------------------------------------------------------|-------------------|--------------------------------------------------------------------------------------------------|-------------------|
|      |                      | Series        | Material                                                 | "L"               | "P"                                                                                              | "X"               |
| 1/8" | .405" x .269"        | B18           | Select Material Code from <a href="#">Material Table</a> | Specify in Inches | Specify D for 1/2" NPT<br>F for 3/4" NPT<br>H for 1" NPT<br>K for 1 1/4" NPT<br>M for 1 1/2" NPT | Specify in Inches |
| 1/4" | .540" x .364"        | B14           |                                                          |                   |                                                                                                  |                   |
| 1/2" | .840" x .622"        | B12           |                                                          |                   |                                                                                                  |                   |
| 3/4" | 1.050" x .824"       | B34           |                                                          |                   |                                                                                                  |                   |
| 1"   | 1.315" x 1.049"      | B10           |                                                          |                   |                                                                                                  |                   |

**How to order:**

1. Select series number.
2. Select material code from [Material Table](#) and add to series designation.
3. Specify desired "L" dimension in inches.
4. Select desired "P" NPT size and insert the proper letter code.
5. Specify desired "X" dimension in inches.

**Example:**

B1834 - 24 - K - 18  
 Series/Mat'l "L" 1 1/4" NPT "X"

\* Welded bushings are carbon steel unless otherwise specified.  
 To specify a 304 s.s. bushing - insert "SS" between the bushing designation and the "X" dimension.  
 Example: -HSS8 for a 1" NPT 304 ss bushing with X=8"

\*\* These dimensions are for standard tubes made with schedule 40 pipes. To specify schedule 80 or 160 - insert "(80)" or "(160)" between the "Type" and "Material" selections in the ordering code table.

Example: 12(80)36-12, B112(80)34-18-H12 or F34(80)34-18-1x300RF-304-12 for schedule 80.

## Ceramic Protecting Tube Characteristics

Thermo Sensors Corporation ceramic tubes are high quality, fine grained, \* non-porous tubes. They are impervious to gases at temperatures near their melting point. Materials available range from mullite (C3 Ceramic) to high purity alumina (C98 Ceramic). Material selection depends upon operating conditions and performance requirements such as temperature, atmosphere, sensitivity to contamination and others.

### C30 Ceramic (Mullite)

Maximum operating temperature of 2900° F (1600° C). Impervious to air to 3000° F, to dry hydrogen and carbon monoxide to 2550° F. Low rate of thermal expansion ( $2.8 \times 10^{-6}/^{\circ}\text{F}$ ) enhances thermal shock resistance. Resistance to acid slag is good. Basic slag is fair. Recommended for J, K, N, and E type thermocouples.

### C98 Ceramic (99.8% alumina)

Maximum operating temperature 3450° F (1900° C) in both oxidizing and reducing atmospheres. Inert to hydrogen, carbon, platinum, rhodium and refractory metals under most conditions. High thermal conductivity for fast temperature response. Being more dense than C30, affords longer life in acids, alkalis, molten metals, molten salts and slags. Impervious to most industrial furnace gases even at high temperatures. Recommended for R, S and B type thermocouples.

### MCT Metal - Ceramic (LT-1)

Maximum operating temperature of 2800° F (1538° C). This tube is a combination of aluminum oxide and chromium. Stable in oxidizing atmospheres to 2200° F. Thermal and mechanical shock characteristics are better than pure ceramic tubes, but an extreme temperature span requires a slow insertion time to allow tube to preheat. Sulphur dioxide, sulphur trioxide and concentrated sulphuric acids have little effect on MCT tubes. Since copper, zinc, lead, brass and ferrous alloys do not "wet" MCT tubes their life is longer in such melts, abrasive resistance even at 2200° F. Do not use in acid or carbide slags or molten aluminum.

### SCT (Silicon Carbide)

Maximum operating temperature of 3000° F (1649° C). Suggested as primary tube in molten aluminum. Porous\* and affords protection from flame cutting. a secondary tube to provide thermal and mechanical shock resistance in assemblies using C30 and C98 as a primary.