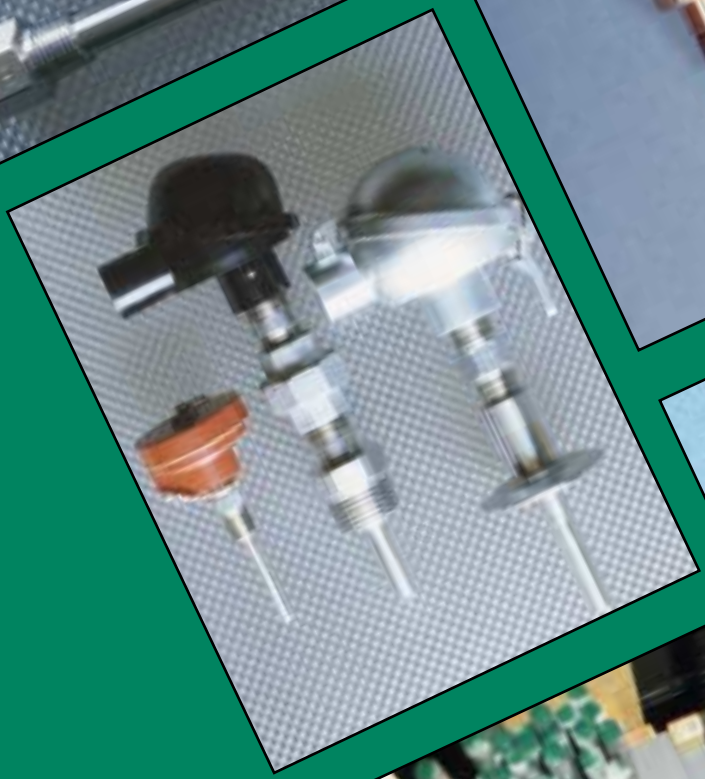
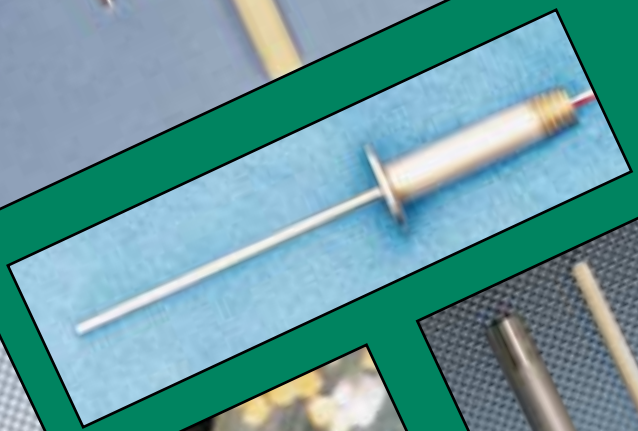
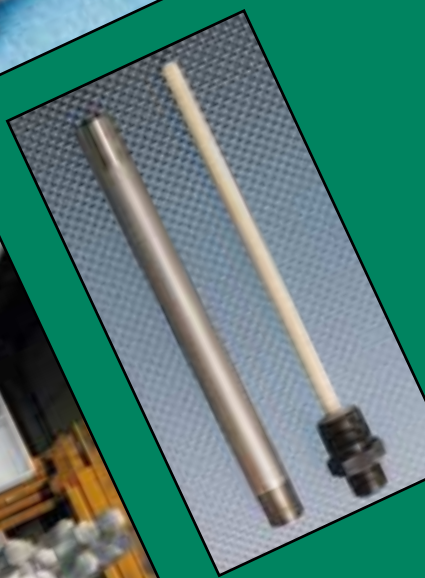
JMS Southeast, Inc.
Temperature Measurement

Thermowells, Protection Tubes, and Coatings







THERMOWELLS

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Click on Contents Description Above

THREADED AND SOCKET WELD THERMOWELLS

#1	SERIES [See pages 20-24 for complete information on dimensions, velocity ratings, and pressure ratings)
5	Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5W)

#2	THREADED WELLS / EXTERNAL THREAD	SOCKET WELL WELDELET SIZE
1	1/2" NPT	N/A
2	3/4" NPT (standard)	3/4" (standard)
3	1" NPT	1"
X	Other, specify	

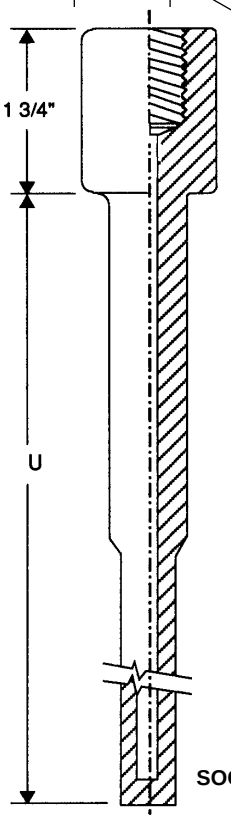
#3	SHANK STYLE [15]
A	Step shank (standard)
S	Straight shank
T	Tapered shank
B	Built up step shank (Recommended for over 22 1/2", see drawing on 5-2)
X	Other, specify

#4	THREADED OR SOCKET WELD WELLS
T	Threaded well design
S	Socket well design
V	Van stone
X	Other, specify

#5	BORE SIZE
2	.260" ID used for .250" OD sensors (standard)
3	.385" ID used for .375" OD sensors (straight or tapered only)
X	Other, specify

Note: Over 22 1/2" use "Built Up" design. See page 5-2 for drawing. Does not meet ASTM, ISA, ASTM, or IEC standards for thermowells.

#6	U (INSERTION) DEPTH [15]	STANDARD "T" DIMENSION	SENSOR LENGTH NO LAG	SENSOR LENGTH WITH LAG
B	2 1/2"	2	4	6
C	4 1/2"	3	6	9
D	6"	3	7 1/2	10 1/2
E	7 1/2"	3	9	12
F	10 1/2"	3	12	15
G	13 1/2"	3	15	18
H	16 1/2"	3	18	21
I	22 1/2"*	3	24	27
X	Other, specify			



SOCKET WELL DESIGN

[ ]BRACKETS INDICATE PAGE NUMBERS TO REFER TO FOR ADDITIONAL TECHNICAL INFORMATION

#7	T (LAG) EXTENSION [15]
T	Standard lag
U	N/A (No lag)
X	Other, specify

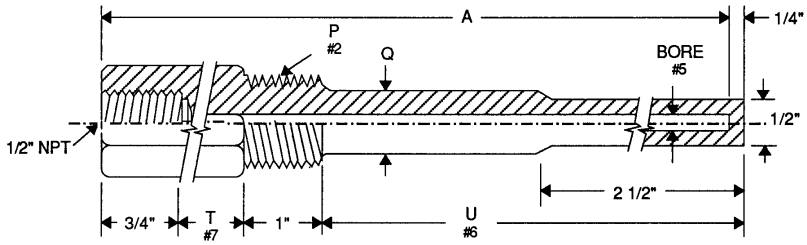
#8	WELL MATERIAL [31-34]
G	Carbon steel
H	304 Stainless steel
I	Low Carbon 304 Stainless steel
J	310 Stainless steel
K	316 Stainless steel (standard)
L	Low Carbon 316 Stainless steel
M	Inconel 600
N	Monel
O	Hastelloy B
P	Molybdenum
Q	Hastelloy C
R	Tantalum
S	Titanium
X	Other, specify (i.e.: Teflon, PVC, Nickle, etc.)

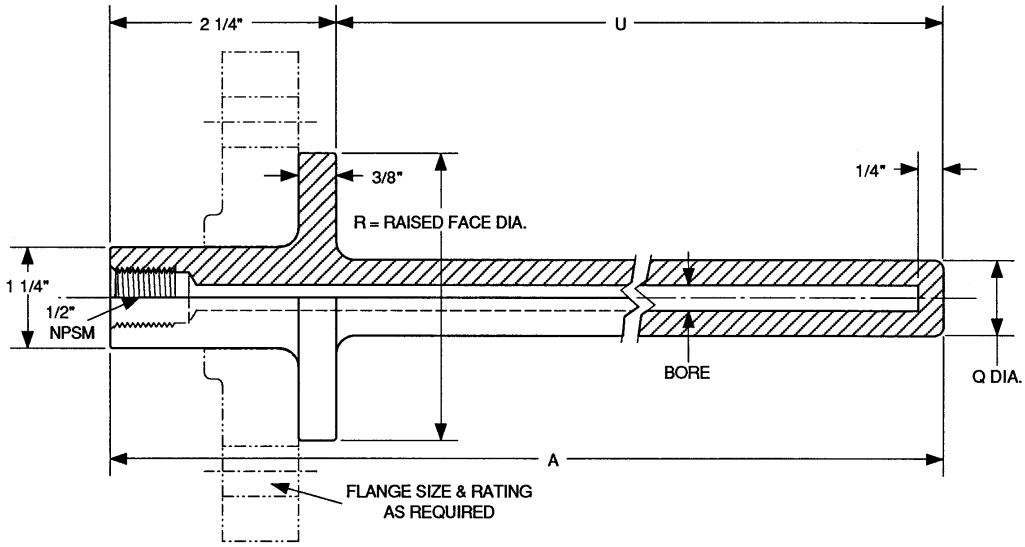
#9		TAGGING OPTIONS
1	TAGGING	Stainless steel tag
2		Plastic tag
3		Paper tag
4		Electroetch on probe
		Note: You must always specify information required on tag

5	2	A	T	2	E	T	H		

THREADED AND SOCKET WELD THERMOWELLS

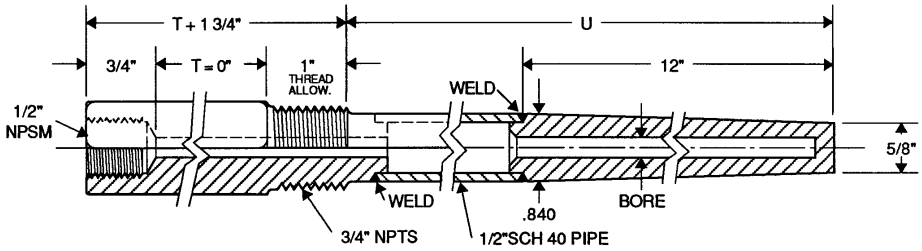
THREADED WELL WITH LAG EXTENSION





VAN STONE THERMOWELL

BUILT-UP THERMOWELL

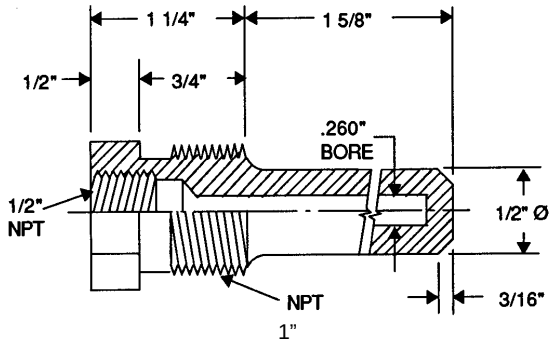


LIMITED SPACE THERMOWELLS

#1	SERIES
5L	Limited Space Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5LW)

#2	WELL MATERIAL
H	304 Stainless steel
K	316 Stainless steel
M	Inconel 600
X	Other, specify

Note:
Immersion length of a spring-loaded sensor to fit this well is 2 1/2".



5L	M	

FLANGED THERMOWELLS

#1	SERIES [See pages 25-27 for complete information on dimensions, velocity ratings, and pressure ratings)
5T	Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5TW)

#2	CONFIGURATION
A	Step shank (standard)
S	Straight shank
T	Tapered shank

#3	BORE SIZE
2	.260" ID used for .250" OD sensors (standard)
3	.385" ID used for .375" OD sensors (straight or tapered only)
X	Other, specify

#4	U (INSERTION) DEPTH [15]
A	2"
B	4"
C	7"
D	10"
E	13"
F	16"
G	22"*
X	Other, specify

Note: Over 22" use "Built Up" design. See page 5-2 for drawing.

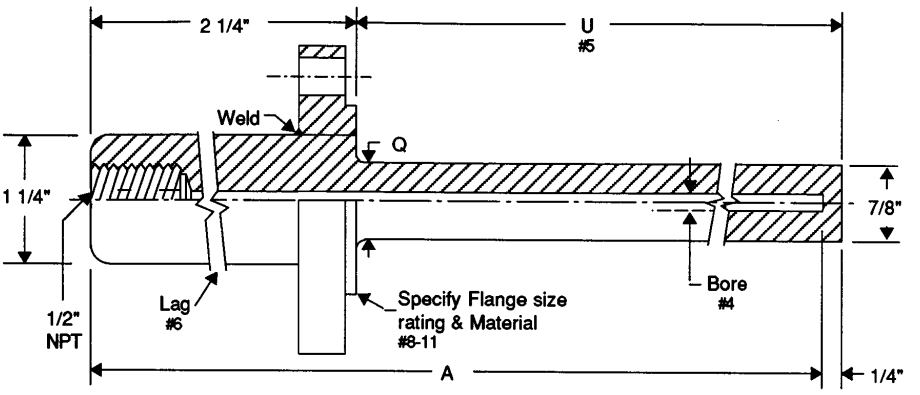
"U" DIMENSION	SENSOR LENGTH
2"	4
4"	6
7"	9
10"	12
13"	15
16"	18
22"	24

#5	T (LAG) EXTENSION [15]
T=__"	Length in inches
Z	N/A (Standard)

#6	WELL MATERIAL [31-34]
G	Carbon steel
H	304 Stainless steel
I	Low Carbon 304 Stainless steel
J	310 Stainless steel
K	316 Stainless steel
L	Low Carbon 316 Stainless steel
M	Inconel 600
N	Monel
O	Hastelloy B
P	Molybdenum
Q	Hastelloy C
R	Tantalum
S	Titanium
X	Other, specify

Note: Special jackets and coating are available for thermowells. Call our engineering department for more information. See pages 5-35 - 5-39.

[ ]BRACKETS INDICATE PAGE NUMBERS TO REFER TO FOR ADDITIONAL TECHNICAL INFORMATION



Series 5TS

5T	S	3	C	Z	H	

FLANGED THERMOWELLS

#7	SIZE OF FLANGE
3	1”
4	1 1/2”
5	2”
X	Other, specify

#8	*FLANGE RATING
A	150*
B	300*
C	400*
D	600*
E	900*
F	1500*
X	Other, specify

*Pounds rating per ANSI B-16.5

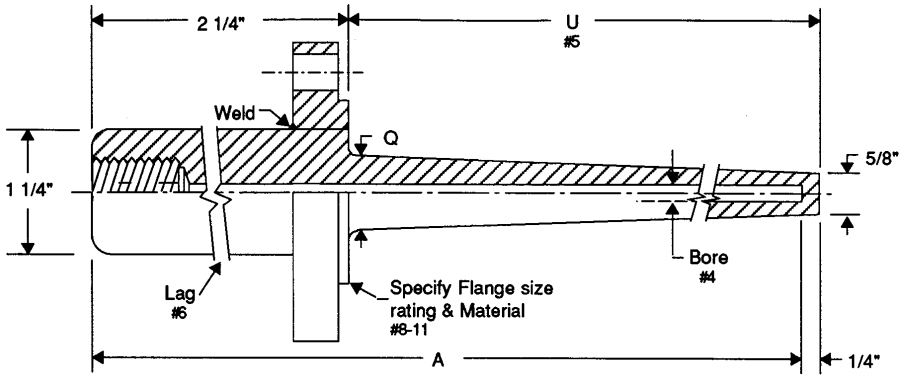
#9	FACING
1	Raised face (Standard)
2	Flat face

#10	FLANGE MATERIAL [31-34]
G	Carbon steel
H	304 Stainless steel
I	Low Carbon 304 Stainless steel
J	310 Stainless steel
K	316 Stainless steel
L	Low Carbon 316 Stainless steel
M	Inconel 600
N	Monel*
O	Hastelloy B*
P	Molybdenum*
Q	Hastelloy C*
R	Tantalum*
S	Titanium*
X	Other, specify

*An economical alternative is available for these materials. Rather than using the exotic material for the entire well, a less expensive material such as carbon steel or stainless steel can be used for the bulk of the well and a jacket of the exotic metal can be applied to all wetted parts. Use symbol “X” and specify jacket design and material. See pages 5-35 through 5-39.

Note: For complete information on flange dimensions see page 5-27.

[ ]BRACKETS INDICATE PAGE NUMBERS TO REFER TO FOR ADDITIONAL TECHNICAL INFORMATION



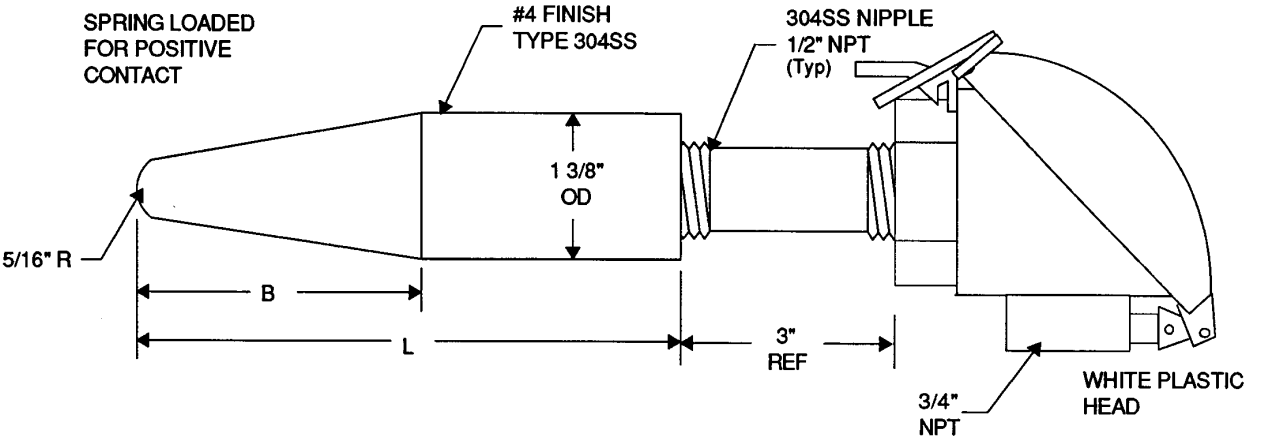
Series 5TT

4	A	1	H	

SECTION 5

3-A CERTIFIED SANITARY THERMOWELLS

Designed to be used with the sanitary 3-A certified probes (pages 4-13 and 4-14) these thermowells may be welded to a tank or vat with a full crevice-free fillet weld to avoid cracks or crevices. Each well is fabricated from Type 304 stainless steel and polished to a No. 4 finish. Use standard thermocouples and RTD's with these thermowells (1-1 and 1-3 , 2-1 and 2-2).



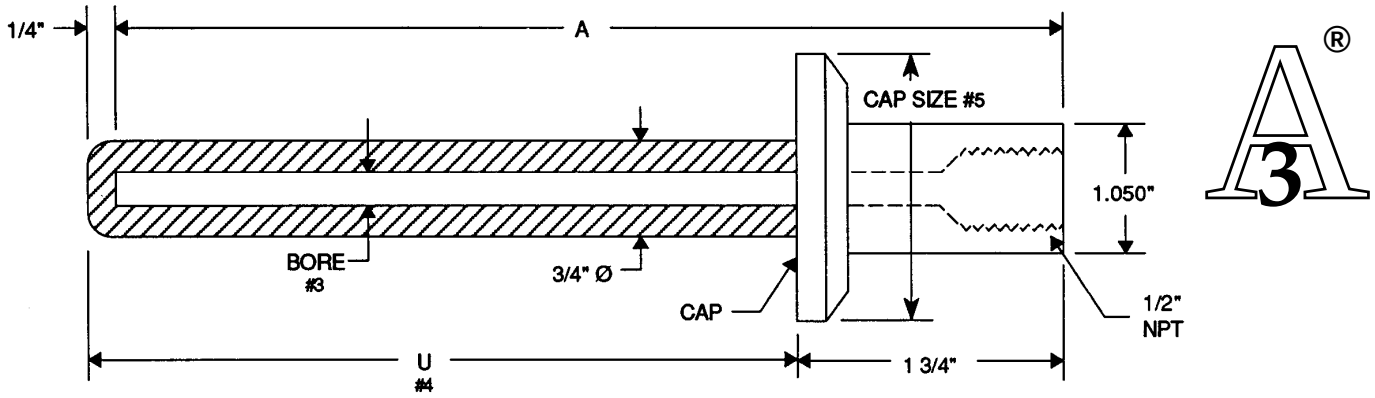
Replacement sensor part number's:	
Thermocouple:	1(insert type of T/C)1BKU(insert length)EZZGPA
RTD:	3ESBK(insert length)BEZZHWPA

#1	SERIES		
5C	3-A Certified Sanitary Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5CW)		
#2	**L, THERMOWELL LENGTH**	**B, TAPER LENGTH**	**SENSOR LENGTH (SPRING LOADED)**
10 1/8	10 1/8"	3 1/4"	14 1/8
11 7/8	11 7/8"	5"	15 1/2
13 1/8	13 1/8"	3 3/4"	17 1/8
14 1/8	14 1/8"	6 1/16"	18 1/8
16 5/8	16 5/8"	9 9/16"	20 5/8

Note: Does not include head and nipple.

5C	10 1/8	

SANITARY THERMOWELLS



Note: Straight Shank shown.
See page 5-20 for details.

#1	SERIES
5F	Sanitary Thermowells - Add "W" here for a plug with a chain attached to well. (i.e. 5FW)

#2	STYLE [25-27]
A	Step shank (standard)
S	Straight shank
T	Tapered shank

#3	BORE SIZE
2	.260" ID
3	.385" ID
X	Other, specify

#4	U (INSERTION) DEPTH [15]	"U" DIMENSION	SENSOR LENGTH
B	2 1/2"	2 1/2"	4
C	4 1/2"	4 1/2"	6
D	6"	6"	7 1/2
E	7 1/2"	7 1/2"	9
X	Other, specify		

#5	CAP SIZE [SECTION 4]
A	1"
B	1 1/2"
C	2"
X	Other, specify

#6	BRAND OF CAP
T	Tri-Clover (16 AMP)
A	Alloy Products (K16A)
B	Cherry Burrell (16AI - 14I)
X	Other, specify

All caps are mounted facing the hot end - unless specified here. ie. Use X + brand of cap + reverse mount

#7	MATERIAL
H	304 Stainless steel
K	316 Stainless steel
L	Low Carbon 316 Stainless steel
M	Inconel 600
X	Other, specify

#8	POLISH
H	High polish (#4 Finish) Standard
E	Electropolish
P	Passivate (After #4 Finish)

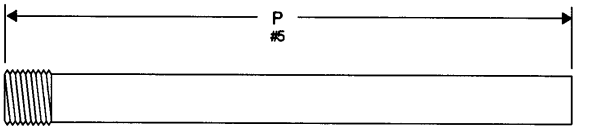
5F	A	2	D	A	T	K	H	

METAL PROTECTION TUBES

#1	SERIES
5P	Metal protection tube - Add “W” here for a cap and chain to fit over open end. (i.e. 5PW)

#2	RESPONSE TYPE
1	Fast response tip
2	Standard response tip

#3	ATTACHING DEVICES
B	Carbon steel bushing
K	Stainless steel bushing
J	Cast iron floor flange
H	Stainless steel floor flange
Z	N/A
X	Other, specify (i.e.: 3” 150 lb raised face.)



Style 5P2Z

#4	**NOMINAL SIZE	I.D.	O.D.	N.P.T. [30]	STANDARD BUSHING PROCESS CONNECTION	STANDARD FLOOR FLANGE SIZE
18	1/8”	.269	.405	1/8”	1/4” NPT	3”
14	1/4”	.364	.540	1/4”	1/2” NPT	3”
12	1/2”	.622	.840	1/2”	3/4” NPT	3”
34	3/4”	.824	1.050	3/4”	1 NPT	4”
10	1”	1.049	1.315	1”	1 1/4” NPT	4”
X	Other, specify					

**Refers to schedule 40 pipe. For other pipe schedules, use “X” in the above symbol and specify the pipe schedule in description.
Ex. 5P1BX1210G X=12 Schedule 80 pipe.

#5	OVERALL LENGTH (P)
A	12”
B	18”
C	24”
D	30”
E	36”
F	48”
G	60”
X	Other, specify

Note: Bends and elbows are available. Call your salesperson for drawing(s).

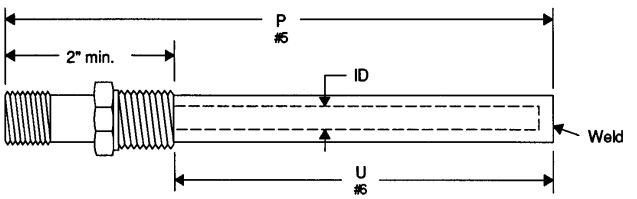
#6	FIXED OR ADJUSTABLE MOUNTING METHOD
__”	Insert “U” dimension. (Only if using a permanently fixed attaching device. See drawing below)
Z	N /A (Bushing if specified will be adjustable)

Note: Fixed flanges are attached by screwing to fixed threaded bushing.

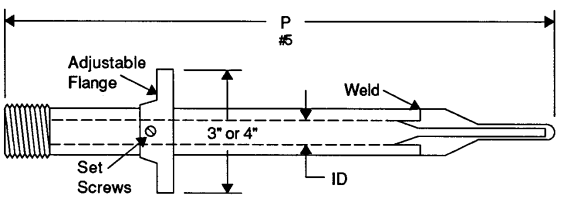
#7	Protection Tube Material [31-34]
G	Carbon steel
H	304 Stainless steel
J	310 Stainless steel
K	316 Stainless steel
M	Inconel 600
T	446 Stainless steel
X	Other, specify

[ ]BRACKETS INDICATE PAGE NUMBERS TO REFER TO FOR ADDITIONAL TECHNICAL INFORMATION

Style 5P2B12A9K



Style 5P1J12BZH



5P	2	B	12	A	9”	K	

CERAMIC PROTECTION TUBES

Alumina and mullite protection tubes are used at high temperatures that have a small slope of temperature change. Any thermocouple type can be used in these ceramic tubes; however, platinum-rhodium and chromel-alumel are used most often due to their high operating temperature range. "Alumina" is an alumina oxide ceramic (99.7% Al2O3) and "mullite" is a compound of alumina and silica. Alumina tubes can be used at 3400°F (1870°C) and mullite tubes can be used at 3100°F (1700°C). They are somewhat gas tight, sensitive to thermal shock, and can crack if one end of the tube is heated at a different rate than the other. If the tube is exposed to a significant sharp decline or rise in temperature, the tube may crack.

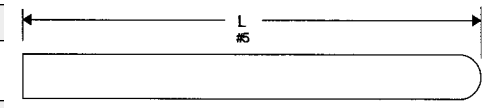
Platinum-Rhodium thermocouples should always be protected in a ceramic protection tube. Alumina should be used rather than mullite for all atmospheres except oxidizing, where mullite can be used. The silicon from the mullite can contaminate the platinum-rhodium thermocouple.

We recommend that the user preheat the entire tube to ≈ 900°F before installing it into a hot process environment.

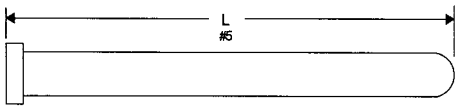
#1	SERIES
5D	Ceramic Protection Tubes - Add "W" here for a cap and chain to fit over open end. (i.e. 5DW)

#2	MATERIAL
A	Alumina
M	Mullite

Style 5DAO and 5DMO



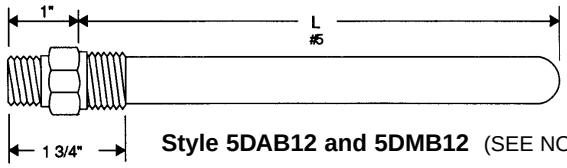
#3	ATTACHING DEVICE
O	No mounting fitting
P	Open both ends, no mounting fitting
C	Collar* (See chart below for collar dimensions)
B	Mounting bushing (Standard)
S	Carbon steel mounting sleeve - (4" long sleeve is standard)
X	Other, specify



Style 5DAC and 5DMC

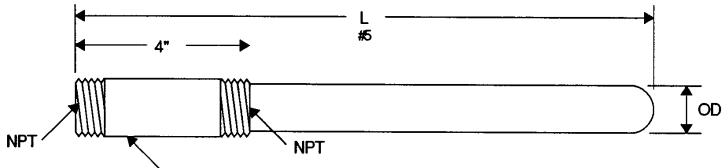
#4	TUBE SIZE I.D. x O.D.	*COLLAR OUTSIDE FOR APPROPRIATE TUBE SIZE
14	1/4" x 3/8"	5/8"
38	3/8" x 1/2"	3/4"
76	7/16" x 11/16"	1"
12	1/2" x 3/4" (Standard)	1 1/8"
34	3/4" x 1"	1 3/8"
10	1" x 1 1/4"	1 3/4"
X	Other, specify	

#5	LENGTH (L)
A	6"
B	12" (Standard)
C	18"
D	24" (Standard)
E	30"
F	36"
X	Other, specify



Style 5DAB12 and 5DMB12 (SEE NOTE)

NOTE:
Bushings are always 1/2" NPT head connection, and 3/4" NPT process connection.
Bushings are not standard for 3/4" x 1" or 1" x 1 1/4" ceramic tubes.
For tubes smaller than 11/16" OD, the "L" length will equal the total length including the bushing.



CS sleeve for tube NPT will equal tube OD (ie: 1" OD will use 1" NPT threads). It can be used to attach adjustable flanges and bushings as shown on page 5-7. Use "X" in symbol number 3 and describe.

5D	A	B	12	B

MULLITE/ALUMINA PROTECTION TUBES

The composition of this tube is 80% alumina and 20% silica. This protection tube has excellent thermal shock characteristics (3.0 x 10 -6 in/in/ degrees F). It can be characterized as a mullite tube with a higher percentage of alumina than a typical mullite tube would have. It has an outer diameter of 3/4" and an inner diameter of 1/2". It is a light green color. When fully supported, the tube can be exposed to 2900 degrees F. This protection tube is a compromise between mullite and alumina yielding a high quality ceramic tube with excellent thermal shock resistance. Due to the silica content, a platinum/rhodium thermocouple should not be used in it without a primary alumina tube to insulate the thermocouple.

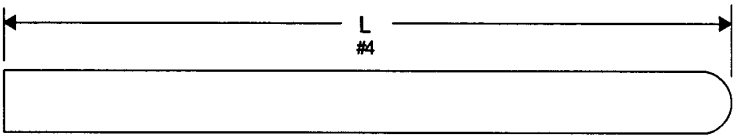
#1	SERIES
59	Mullite / Alumina Ceramic Protection Tube - Add "W" here for a cap and chain to fit over open end. (i.e. 59W)

#2	TUBE STYLE
B	Mounting Bushing - (1/2" NPT head connection and 3/4" NPT process connection)
Z	No Bushing
X	Other, specify

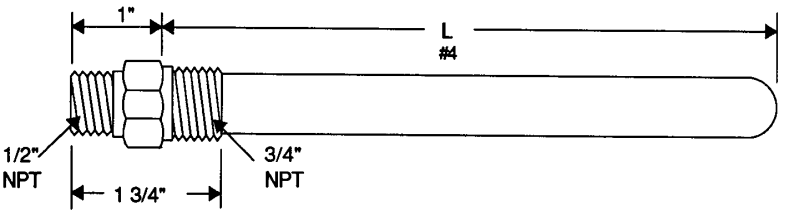
#3	NOMINAL TUBE SIZE	
	I.D.	O.D.
14	1/4"	3/8"
56	5/16"	1/2"
38	3/8"	1/2"
76	7/16"	11/16"
12	1/2"	3/4" (Standard)

#4	TUBE LENGTH (OVERALL)
A	12" (Standard)
B	18"
C	24" (Standard)
D	36"
X	Other, specify

NOTE:
Bushings are always 1/2" NPT head connection, and 3/4" NPT process connection. Bushings are not standard for 3/4" x 1" or 1" x 1 1/4" ceramic tubes.
For tubes smaller than 11/16" OD, the "L" length will equal the total length including the bushing.



Style 59Z12



Style 59B12

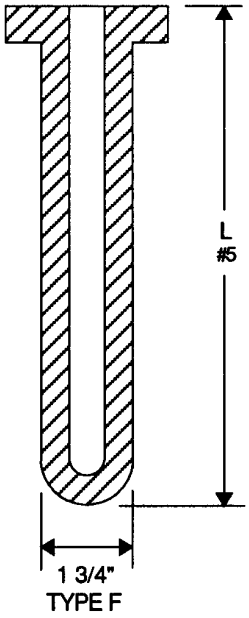
59	B	12	12"	

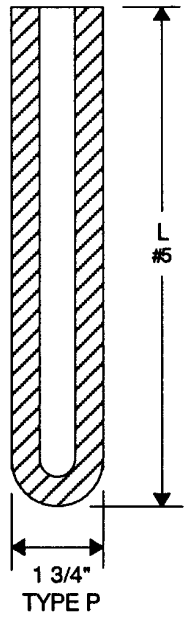
BONDED SILICON CARBIDE PROTECTION TUBES

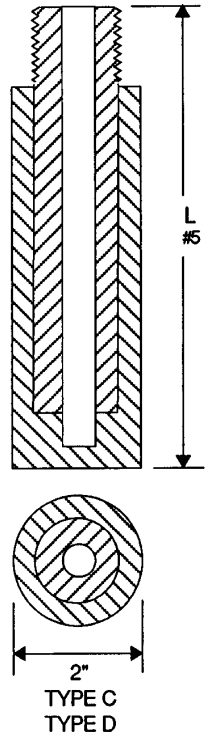
Silicon carbide protection tubes provide excellent thermal conductivity for quick response to temperature changes. They can be used to replace cast iron tubes, eliminating the possibility of iron pick-up. Spread surface treatment assures adequate protection of the thermocouple.

JMS Southeast offers two types of silicon carbide protection tubes. Type A and B are dense silica bonded silicon carbide and are manufactured with a flange or a plain end as the following drawings indicate.

Type C and D are carbon bonded silicon carbide and graphite. They are manufactured with a black steel pipe located down the center. They have a 1/2" or 3/4" NPT connection to thread into place instead of a flange for mounting as Type A.







#1	SERIES
5B	Protection Tube - Add "W" here for a cap and chain to fit over open end. (i.e. 5BW)

#2	MATERIAL
SC	Silicon carbide

#3	MOUNTING
F	Flange silicon carbide tube (1" I.D. x 1 3/4" O.D.)
P	Plain end silicon carbide tube (1" I.D. x 1 3/4" O.D.)
C	1/2" NPT threaded silicon carbide tube with reinforced pipe
D	3/4" NPT threaded silicon carbide tube with reinforced pipe

#4	SIZE
2	1/2" I.D. x 2" O.D.
3	3/4" I.D x 2" O.D.
4	1" I.D. x 1 3/4" O.D. (for symbols A & B above)

#5	LENGTH (L)
A	18"
B	24"
X	Other, specify

5B	SC	F	4	18"	

BONDED SILICON CARBIDE PROTECTION TUBES

TYPE 5BSCF CLASSIFICATION

Physical Data: (Typical)	**English Units**	**S.I. Units**
Porosity:	14-17%	14-17%
Bulk Density:	161-168 lb/ft3	2,570-2,690 kg/m3
True Specific Gravity:	.112-.113 lb/in3	3.10-3.12 gm/cm3
Crushing Strength (RT):	14000-18000 psi	96.5-124.0 MPa
Modulus of Rupture (RT):	3000-4000 psi	20.7-27.6 MPa
Modulus of Elasticity (RT):	9-13 x 106 psi	62-90 kPa
Load Test, Fail Temperature with 25 psi (172 kPa) Load:	Above 3000°F	Above 1650°C
Coef. of Thermal Expansion: (100 to 1000°C)	2.6 x 10-6/°F	4.7 x 10-6/K
Thermal Conductivity:	BTU/hr/ft2/°F/in 105	W/mK 15.1

Chemical Analysis: (Typical)		
Silicon Carbide	(SiC)	86.10%
Silica	(SiO2)	11.75%
Alumina	(Al2O3)	0.78%
Iron Oxide	(Fe2O3)	1.05%
Lime	(CaO)	0.21%
Magnesia	(MgO)	0.10%
Alkalies	(Na2O, K2O)	Trace

CARBON BONDED SILICON CARBIDE & GRAPHITE

TYPE 5BSCP, 5BSCC CLASSIFICATION

Physical Data: (Typical)	**English Units**	**S.I. Units**
Porosity:	27-33%	27-33%
Bulk Density:	112-125 lb/ft3	1800-2000 kg/m3
Crushing Strength (RT):	1500 psi	10.3 MPa
Modulus of Rupture (2250°F):	200-500 psi	1.4-3.4 MPa
Coef. of Thermal Expansion:	1.5 x 10-6/°F	2.7 x 10-6/K
Specific Heat	0.20 BTU/lb/°F	.84 kJ/kgK
Thermal Conductivity:	105 BTU/ft2/hr/°F/in	15.1 W/mK
Electrical Resistivity (@ RT) 0.012 ohm-cm (@ 2200°F)	0.0076 ohm-cm	
Thermal Shock Resistance	Excellent	

Chemical Analysis: (Typical)		
Silicon Carbide	(SiC)	44.52%
Carbon	(C)	28-36%
Silica	(SiO2)	11%
Alumina	(Al2O3)	5%
Iron Oxide	(Fe2O3)	0.7%
Glaze	–	3%

The information contained in this data sheet has been determined through the application of accepted engineering practice and is believed to be reliable. Since the conditions of application and use of our products are beyond our control, no warranty is expressed or implied regarding accuracy of the information, the results to be obtained from the use of the product, or that such use will not infringe on any patent. This information is furnished with the express condition that you will make your own tests to determine the suitability of the product for your particular use.

SILICON NITRIDE PROTECTION TUBE

SIALON

JMS Southeast, Inc. offers a protection tube for use in molten non-ferrus materials such as molten aluminum, brass, and copper. This special JMS protection tube material is a solid solution of alumina oxide in silicon nitride. Maximum temperature is 1250°C (2280°F) in molten metals. The physical properties are shown below.

TYPICAL PHYSICAL PROPERTIES (SIALON)

Bulk Density		(g/cm^3)	3.25
App. Specific Gravity		(g/cm^3)	3.26
Porosity		(%)	<1
Cold Bend Strength	(25°C)	(MPa)	945
		(kpsi)	137
Hot Bend Strength	(1200°C)	(MPa)	560
		(kpsi)	81
Elastic Modulus		(GPa)	288
		(x 10^6 psi)	42
Ther. Exp. Coeff. (20-1000°C)		(x $10^{-6}C^{-1}$)	3.04
Thermal Conduct	(400°C)	(W/mK)	21.3
Critical ΔT		(°C)	950
Hardness (VRN, 1 kg Load)			1650

#1	SERIES
5E	Silicon Nitride Protection Tube (Sialon)

#2	TUBE SIZES	BUSHING	THREAD SIZE
1	28mm OD x 16mm ID (1.1" OD x .630" ID)	1 1/4"	1 1/4"
2	22mm OD x 12mm ID (.866" OD x .472" ID)	1"	1"
3	16mm OD x 9mm ID (.630" OD x .354" ID)	3/4"	3/4"
4	12.5mm OD x 6.5mm ID (.492" OD x .256" ID)	1/2"	1/2"
X	Other, specify		

#3	TOTAL TUBE LENGTH
A	5.91" (150mm)
B	11.81" (300mm)
C	15.75" (400mm)
D	17.72" (450mm)
E	23.62" (600mm)
X	Other, specify

#4	TUBE STYLE
B	Mounting bushing
S	Carbon steel mounting sleeve - (4" long sleeve is standard)
X	Other, specify
Z	No fitting

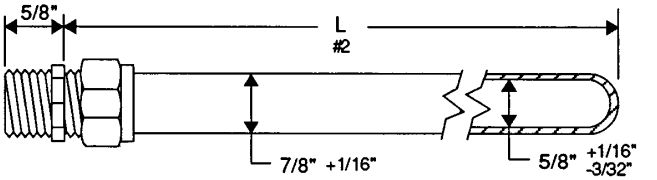
5E	1	A	S

MCPT - METAL CERAMIC PROTECTION TUBES

#1	SERIES
5G	Metal Ceramic Protection Tube 5/8" ID x 7/8" OD, 3/4" NPT Conduit Connector

#2	LENGTH (L)
1	9"
2	12"
3	18" (standard)
4	30" (standard)
5	36"
6	48" (standard)
X	Other, specify

Note: Length measured from bottom of threads to closed end.



5G	3	

The MCPT consists of a hard abrasion-resistant chromium and alumina oxide material. It has good strength at temperatures where many high-temperature metals melt. It is more susceptible to thermal shock than a metal protection tube, however, more resistant to shock than a ceramic protection tube.

The MCPT exhibits good wear resistance and abrasion resistance. It has a hardness of Rockwell C37, which indicates the crushing strength of the material rather than the true hardness of the entire body.

This protection tube serves as an excellent option in the following applications:

RECOMMENDED APPLICATIONS

1. Molten copper and brass to 2100°F intermittent and continuous immersions.
2. Corrosive SO_2 and SO_3 gas (to 2200°F) and SO_3 and HF gas (to 2000°F).
3. Open hearth furnace checker chambers to 2200°F.
4. Steel mill soaking pits to 2200°F.
5. Pelletizing chamber of Taconite refining operation to 2100°F.
6. Molten zinc to 1600°F.
7. Molten lead to 650°F.
8. Basic steels and slags to 300°F (intermittent and 2200°F (continuous in open hearth and general foundry practices).
9. Calcining kilns to 2200°F.
10. Barium titanate (barium oxide service to 2200°F).
11. Magnesium oxide calcining kilns.
12. Fluid bed cement process with severe corrosion and temperature to 2200°F (fluid method of producing builder's cement).
13. Gas and ethylene cracking atmosphere.
14. Atmosphere directly upon burning sodium (1800-2200°F).
15. Oil fired furnace chambers.
16. Atmosphere directly above molten glass in an open hearth glass furnace.
17. Molten silver solder.
18. Molten tin.
19. Borax flux.
20. Copper matte.
21. Boiling sulphuric acid-97%.
22. Blast furnace stove dome and bustle pipes.

NON-RECOMMENDED APPLICATIONS

1. Molten aluminum.
2. Cryolite.
3. Tin (stannous) chloride (750°F).
4. Acid slag.
5. Carbide slag.
6. Molten glass.
7. Boiling sulphuric acid-10%.
8. Carburizing atmospheres.
9. Nitriditing atmospheres.
10. Barium chloride salt bath.
11. Sodium Nitrate-nitrate salt bath.

This protection tube is most commonly used in molten metal applications. It is less common than ceramic and metal protection tubes in industrial application.

—5/8" I.D. x 7.8" O.D., 3/4" conduit connector.
—Any length.
—Accepts 8 gauge wire or smaller
—Superior oxidation resistance up to 2200°F.
—Above 2800°F, softening begins.
—Suggested pre-heating of tube to 900°F if application involves immersion in molten metal 2000°F or higher.
—Impermeable except under high vacuum.
—Maximum recommended continuous operating temperature is 2500°F.

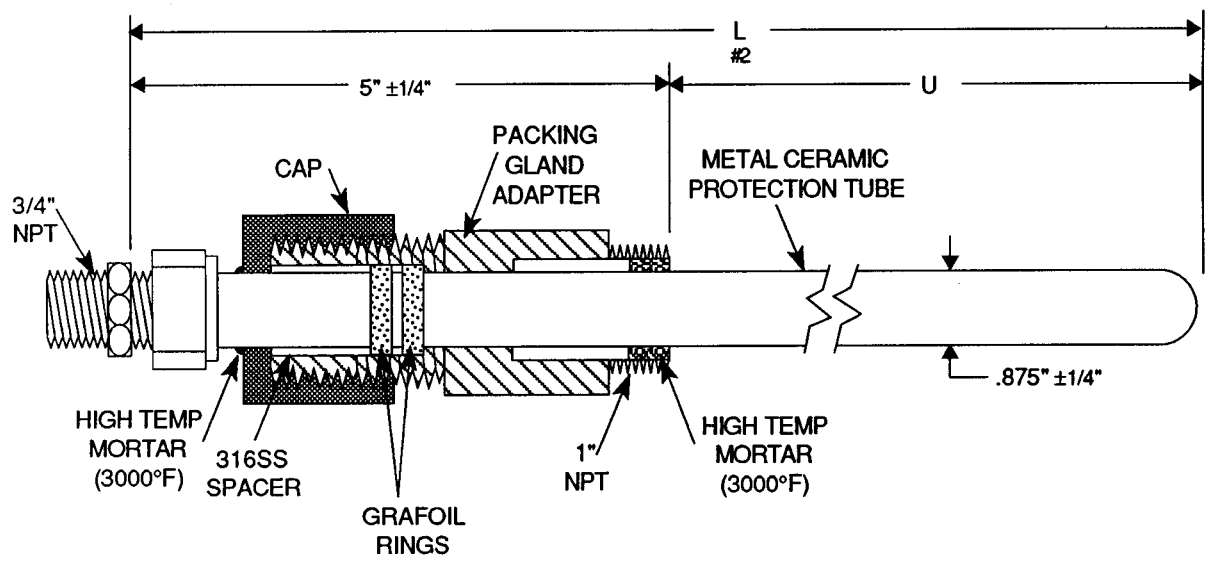
Note: A special fitting is available that is recommended for extreme conditions. See page 5-14 for additional information.

*UCAR® LT-1 Metal Ceramic is a product of Union Carbide Corp.

MCPT WITH OPTIONAL FITTING

JMS Southeast, Inc. offers the special optional fitting pictured below for mounting the metal ceramic protection tube in high temperature sealed environments.

The minimum “U” length available is 2.35”.



#1	SERIES
5J	Metal Ceramic Protection Tube With Optional Fitting

#2	LENGTH (L)
1	9”
2	12”
3	18” (standard)
4	30” (standard)
5	36”
6	48” (standard)
X	Other, specify

5J	3	

GENERAL THERMOWELL INFORMATION

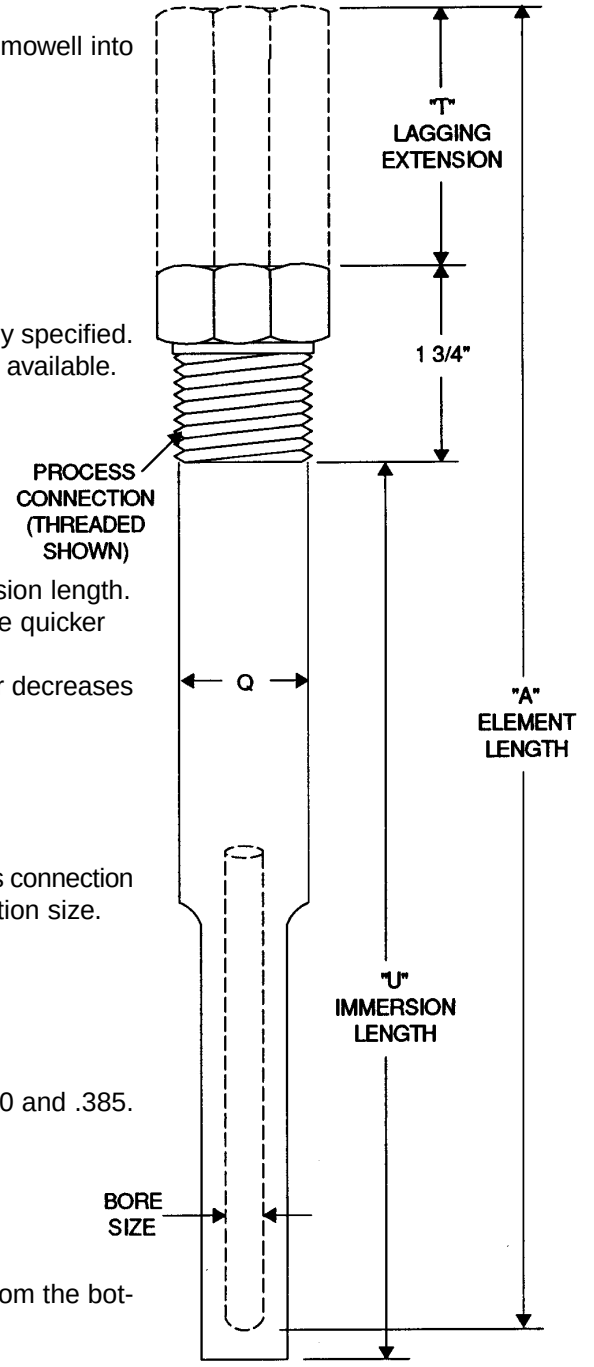
THERMOWELLS

Process Connection

Provides a means of mounting, supporting, and/or sealing the thermowell into the process system.

Types:

Threaded: Standard N.P.T.'s are 1/2", 3/4", and 1".
Socket Weld: Standard pipe sizes are 3/4" and 1" nominal.
JMS socket wells are 3000lb rated. Other rating must be separately specified.
Flanged Welded: Large variety of flange sizes and pound ratings available.



Shank Construction

Straight: The outside diameter is the same size along the immersion length.
Step: The outside diameter at the end of the well is 1/2" to provide quicker response time.
Tapered: Used for high velocity applications. The outside diameter decreases gradually along the immersion length.

Q Dimension

The thickest part of the shank of the well on the hot side of the process connection or flange. Its dependent on the bore size and the process connection size.

Bore Size

The inside diameter of a thermowell. Standard bore sizes are .260 and .385.

Immersion ("U") Length

Immersion length of the thermowell. The "U" length is measured from the bottom of the process connection to the tip of the thermowell.

Lagging Extension ("T") Length

The lagging extension exists behind the process connection and is used to extend the hex length and enable the probe to extend through insulation or walls.

Note: Design program on page 5-17.

Note:
JMS has a complete design guide on disc for your use. Call and ask for the Thermowell Design Guide.

STANDARD THERMOWELL MANUFACTURING TOLERANCES

JMS Thermowells meet or exceed the following standards:
(Copies are available from JMS Southeast, Inc., ANSI, or the issuing body.)

ASME B40.9 - Thermowells for Thermometer and Electrical Temperature Sensors
SAMA RC17-10-1963 - Bushings and Wells for Temperature Sensing Elements
ISA 1.02.01 - Thermowells
IEC 61520 - Functional Dimensions of Metal Thermowells for Thermometer Sensors

The following specifications are for .260 and .385 bore thermowells:
Lengths: ±1/16" on lengths 12" or less
±1/8" on lengths 12" or over
Wells up to 38" bore depths are drilled from solid bar stock to specified tip thickness (1/4" standard). A built-up design is necessary after 38 1/4" overall length.

Bore I.D. Tolerance:
±.001

O.D. Tolerances:
Fractional: ±.015
Decimal: ± .005 on .000 place
± .010 on .00 place

Concentricity of Bore to O.D.:
± 10% of minimum wall thickness

End Thickness:
Gun drill bottom, 1/4" ± 1/16".

Male Threads (NPT):
± 1 turn of thread gauge

Female Threads:
1/2" NPS standard, 1/2" NPT available upon request

Radius Under Threads and Flanges:
1/8" is standard, ± 1/16"
1/16" on Van Stone

Lagging Extension:
Lagging on wells is left as hex and is not turned. For material not available in hex, round bars with wrench flats will be furnished.

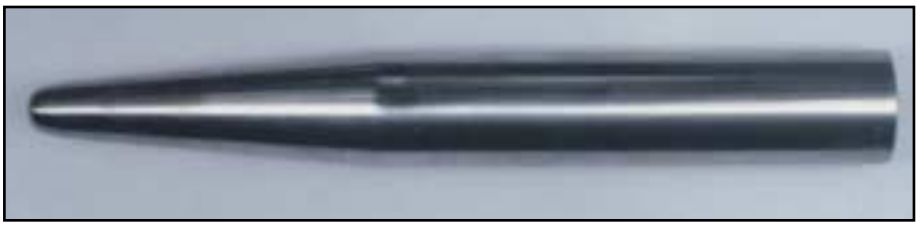
End of Wells:
Break corners. No burrs.

Wetted Surfaces Finish for "U" Dimension
63 ST is our standard surface finish. A mirror polish is available upon request. 8 RMS is our standard for a mirror polish, and must be specified on the order. Electropolish or electroplating is also available. There is an additional charge for mirror, electropolish or electroplating.

Stamping:
Material code and type of material is stamped on hex or round.

Flanged Wells:
Made in accordance with ANSI B16.5 with serrated raised face. We also furnish 125 RMS smooth face which must be specified when needed. Other surface finishes are available upon request.

Weld Configuration:
Front groove welds are 1/4" wide by 5/16" deep. Rear groove welds are 1/8" wide by 1/8" deep "V". Welds are machined, leaving 1/4" radius. Full penetration welds are available upon request.



THERMOWELL DESIGN GUIDELINES

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:

$$f_n = \frac{K_f}{L^2}\sqrt{\frac{E}{\gamma}} \quad \ldots\ldots [1]$$

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 temerature, psi
γ = 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:

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

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:

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

For $r \leq 0.8$

where

F_M = magnification factor, dimensionless
r = frequency ratio, (fw/fn), dimensionless

STRESS ANALYSIS

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

$$P = K_1 S \quad \ldots\ldots\ldots\ldots [4]$$

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:

$$L_{max} = \frac{K_2}{V}\sqrt{\frac{v(S - K_3 P_0)}{1 + F_M}} \quad \ldots [5]$$

where

L_{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
F_M = magnification factor as computed from Eq [3]
K_2, K_3 = stress constants obtained from Table 1-3.

TABLE 1.1 WELL DIMENSIONS. IN IN.

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

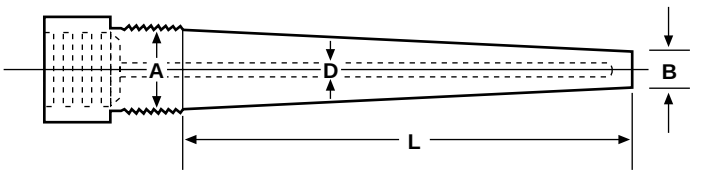
TABLE 1.2 VALUES OF K_f

Well Length L, in.	Kf
2½	2.06
4½	2.07
7½	2.08
10½	2.09
16	2.09
24	2.09

TABLE 1.3 VALUES OF STRESS CONSTANTS

Stress Constant	
K_1	0.412
K_2	37.5
K_3	0.116

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



THERMOWELL DESIGN GUIDELINES

Note: For high erosion and low pressure applications, ask for JMS drawing #8135. For high erosion and high pressure applications, ask for JMS drawing #11468. These are JMS-SE proprietary designs.

Table 4: Allowable Stress Values (PSI)[1]

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[2]	11,250	11,000	10,250	9,000	7,750	6,500	--
304SS	18,750	13,750	11,400	10,500	10,000	8,250	--
316SS	18,750	16,400	15,500	15,100	11,650	8,500	3,400
310SS	18,750	14,600	12,600	11,300	10,300	9,450	3,500
321 - 347SS	18,750	15,300	13,500	12,200	11,300	9,100	4,000
410SS	15,000	13,800	12,850	12,050	9,650	2,900	2,200
446SS	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	4,150
Incoloy 800[3]	15,600	12,100	10,400	9,600	9,100	8,800	--
Hastelloy B[4]	25,000	24,750	21,450	--	--	--	--
Hastelloy X[5]	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)

Note:
JMS has a complete design guide on disc for your use. Call and ask for the Thermowell Design Guide.

3 IMPORTANT THINGS TO REMEMBER WHEN ATTEMPTING TO DETERMINE THE INSERTION LENGTH OF A THERMOWELL

THERMOWELL SELECTION CRITERIA

1. Selecting the proper insertion length is critical to the accuracy of your sensor. In considering length, it is important to allow the entire sensitive portion of the sensor to extend into the medium being measured. The proper length for a sensor installed into a liquid is the sensitive portion plus at least 5 x Ø. For gas or air, a probe should be installed a minimum of 10 x Ø plus the sensitive length.

Generally, wire wound RTD's have a sensitive portion around 5/8". Shorter sensitive lengths are available with thin film and ceramic RTD's upon request. Both thermocouples and thermistors have small sensitive lengths so they are the best choice when working with short insertion lengths.

Note: It is important to consider the amount of the well passing through insulation, walls, fittings, etc., when determining the proper insertion length.

2. In selecting a thermowell, vibration is an important variable to be considered. When thermowells fail, they most often fail due to the vibrational effects they encounter. The pressure and temperature of a process does not usually have as much effect on the life of the thermowell as the fluid velocity of the media.

The media, flowing by the well forms a turbulent wake which has a definite frequency based on the diameter of the well and the flow of the fluid. The well must have sufficient stiffness so the wake frequency will never equal the natural frequency of the well itself. The flowing liquid generates a wake frequency around the well called the Von Karman Trail. Ask us about our Thermowell Program.

The tapered thermowell provides greater stiffness for the same sensitivity than straight thermowells.

The thermowell material chosen is mainly based on the corrosion conditions of the process and temperature range of the operation.

Pressure and velocity flow tables follow to aid our customers as a guide in the selection of thermowells.

Wells are safe if the resonant frequency is below the natural frequency of the well and if the fluid velocity is changing or fluctuating through the critical velocity point.

The values are very conservative and intended as a guide only.

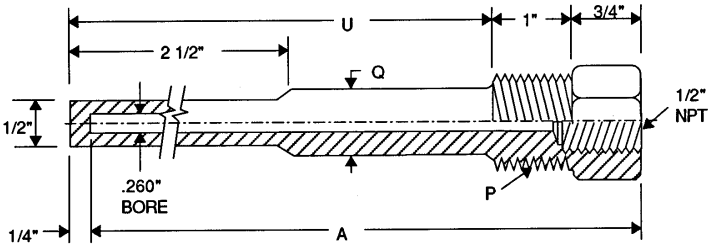
JMS Southeast will be happy to assist you in the event of questions concerning your application and the selection of thermowells.

3. Ask for our design disk which calculates the stem loss temperature errors and velocity ratings for all common materials and mounting methods for thermowells.

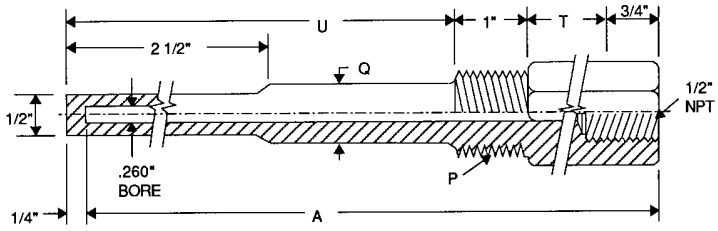
Note:
JMS has a complete design guide on disc for your use. Call and ask for the Thermowell Design Guide.

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

STANDARD THREADED
STEP SHANK .260" BORE THERMOWELLS
FOR 1/4" DIAMETER ELEMENTS



SERIES 51AT, 52AT, 53AT



SERIES 51AT, 52AT, 53AT with Lag

STEP SHANK .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	SHANK DIA Q
½'' NPT	51AT-U 2½	4	2½	1/2
	-U 4½	6	4½	5/8
	-U 7½	9	7½	5/8
	-U 10½	12	10½	5/8
	-U 13½	15	13½	5/8
	-U 16½	18	16½	5/8
	-U 22½	24	22½	5/8
3/4'' NPT	52AT-U 2½	4	2½	1/2
	-U 4½	6	4½	3/4
	U 7½	9	7½	3/4
	U 10½	12	10½	3/4
	-U 13½	15	13½	3/4
	-U 16½	18	16½	3/4
	-U 22½	24	22½	3/4
1'' NPT	53AT-U 2½	4	2½	1/2
	-U 4½	6	4½	7/8
	-U 7½	9	7½	7/8
	-U 10½	12	10½	7/8
	-U 13½	15	13½	7/8
	-U 16½	18	16½	7/8
	-U 22½	24	22½	7/8

STEP SHANK WITH LAG EXTENSION .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	LAG EXT. T	SHANK DIA Q
½'' NPT	51AT-U 2½ T2	6	2½	2	1/2
	-U 4½ T3	9	4½	3	5/8
	-U 7½ T3	12	7½	3	5/8
	-U 10½ T3	15	10½	3	5/8
	-U 13½ T3	18	13½	3	5/8
	-U 19½ T3	24	19½	3	5/8
3/4'' NPT	52AT-U 2½ T2	6	2½	2	1/2
	-U 4½ T3	9	4½	3	3/4
	-U 7½ T3	12	7½	3	3/4
	-U 10½ T3	15	10½	3	3/4
	-U 13½ T3	18	13½	3	3/4
	-U 19½ T3	24	19½	3	3/4
1'' NPT	53AT-U 2½ T2	6	2½	2	1/2
	-U 4½ T3	9	4½	3	7/8
	-U 7½ T3	12	7½	3	7/8
	-U 10½ T3	15	10½	3	7/8
	-U 13½ T3	18	13½	3	7/8
	-U 19½ T3	24	19½	3	7/8

MAXIMUM FLUID VELOCITY FEET PER SECOND

Well Type	Material	INSERTION LENGTH-"U" 2½	4½	7½	10½	13½	16½	19½	22½
½''-260 Bore and ½''-260 Bore with Lag Extension	Brass	207 (59.3)	75.5 (32.2)	27.3 (19.7)	13.9	8.4	5.6	4.1	3.0
	Carbon Steel	290 (106)	105 (59)	38.2 (36.3)	19.4	11.8	7.8	5.7	4.2
	A.I.S.I. 304 & 316	300 (148)	109 (82.2)	39.5	20.1	12.2	8.1	5.9	4.4
	Monel	261 (118)	95 (65.5)	34.4	17.5	10.5	7.1	5.2	3.8
¾''-260 Bore and ¾''-260 Bore with Lag Extension	Brass	207 (59.3)	89.1 (39.8)	32.2 (23.9)	16.4	9.9	6.6	4.8	3.6
	Carbon Steel	290 (106)	123 (71.2)	44.9 (42.7)	22.8	13.8	9.3	6.7	4.9
	A.I.S.I. 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''-260 Bore and 1''-260 Bore with Lag Extension	Brass	207 (59.3)	102 (47.6)	37.0 (28)	18.8	11.4	7.6	5.5	4.1
	Carbon Steel	290 (106)	143 (84.3)	51.6 (50.6)	26.2	15.9	10.6	7.6	5.7
	A.I.S.I. 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

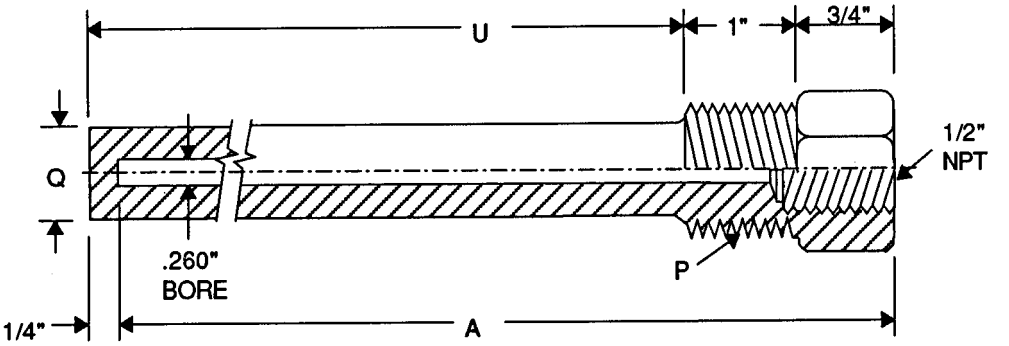
PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

Material	Temperature—°F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

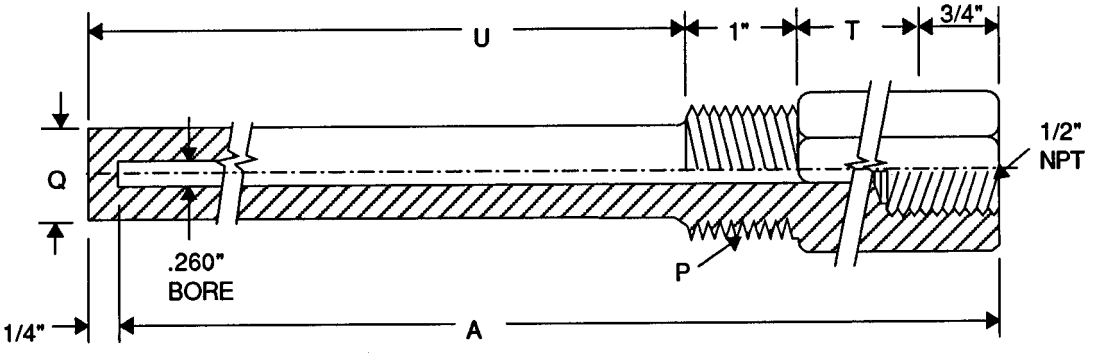
THERMOWELL DESIGN

STANDARD THREADED
STRAIGHT SHANK .260" BORE THERMOWELLS FOR 1/4" DIAMETER ELEMENTS



SERIES 51ST, 52ST, 53ST

Note:
JMS has a complete design guide on disc for your use. Call and ask for the Thermowell Design Guide.



SERIES 51ST, 52ST, 53ST with Lag

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

STRAIGHT SHANK .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	SHANK DIA Q
½" NPT	51ST-U 2½	4	2½	5/8
	-U 4½	6	4½	5/8
	-U 7½	9	7½	5/8
	-U 10½	12	10½	5/8
	-U 13½	15	13½	5/8
	-U 16½	18	16½	5/8
	-U 22½	24	22½	5/8
3/4" NPT	52ST-U 2½	4	2½	3/4
	-U 4½	6	4½	3/4
	U 7½	9	7½	3/4
	U 10½	12	10½	3/4
	-U 13½	15	13½	3/4
	-U 16½	18	16½	3/4
	-U 22½	24	22½	3/4
1" NPT	53ST-U 2½	4	2½	7/8
	-U 4½	6	4½	7/8
	-U 7½	9	7½	7/8
	-U 10½	12	10½	7/8
	-U 13½	15	13½	7/8
	-U 16½	18	16½	7/8
	-U 22½	24	22½	7/8

STRAIGHT SHANK WITH LAG EXTENSION .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	LAG EXT. T	SHANK DIA Q
½" NPT	51ST-U 2½ T2	6	2½	2	5/8
	-U 4½ T3	9	4½	3	5/8
	-U 7½ T3	12	7½	3	5/8
	-U 10½ T3	15	10½	3	5/8
	-U 13½ T3	18	13½	3	5/8
	-U 19½ T3	24	19½	3	5/8
3/4" NPT	52ST-U 2½ T2	6	2½	2	3/4
	-U 4½ T3	9	4½	3	3/4
	-U 7½ T3	12	7½	3	3/4
	-U 10½ T3	15	10½	3	3/4
	-U 13½ T3	18	13½	3	3/4
	-U 19½ T3	24	19½	3	3/4
1" NPT	53ST-U 2½ T2	6	2½	2	7/8
	-U 4½ T3	9	4½	3	7/8
	-U 7½ T3	12	7½	3	7/8
	-U 10½ T3	15	10½	3	7/8
	-U 13½ T3	18	13½	3	7/8
	-U 19½ T3	24	19½	3	7/8

MAXIMUM FLUID VELOCITY FEET PER SECOND

Well Type	Material	INSERTION LENGTH-"U" 2½	4½	7½	10½	13½	16½	19½	22½
½"-260 Bore and ½"-260 Bore with Lag Extension	Brass	207 (59.3)	75.5 (32.2)	27.3 (19.7)	13.9	8.4	5.6	4.1	3.0
	Carbon Steel	290 (106)	105 (59)	38.2 (36.3)	19.4	11.8	7.8	5.7	4.2
	A.I.S.I. 304 & 316	300 (148)	109 (82.2)	39.5	20.1	12.2	8.1	5.9	4.4
	Monel	261 (118)	95 (65.5)	34.4	17.5	10.5	7.1	5.2	3.8
¾"-260 Bore and 1"-260 Bore with Lag Extension	Brass	207 (59.3)	89.1 (39.8)	32.2 (23.9)	16.4	9.9	6.6	4.8	3.6
	Carbon Steel	290 (106)	123 (71.2)	44.9 (42.7)	22.8	13.8	9.3	6.7	4.9
	A.I.S.I. 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"-260 Bore and 1"-260 Bore with Lag Extension	Brass	207 (59.3)	102 (47.6)	37.0 (28)	18.8	11.4	7.6	5.5	4.1
	Carbon Steel	290 (106)	143 (84.3)	51.6 (50.6)	26.2	15.9	10.6	7.6	5.7
	A.I.S.I. 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

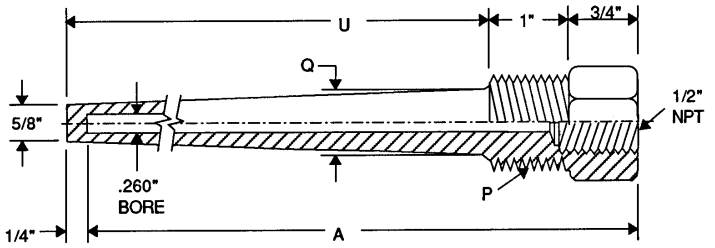
Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

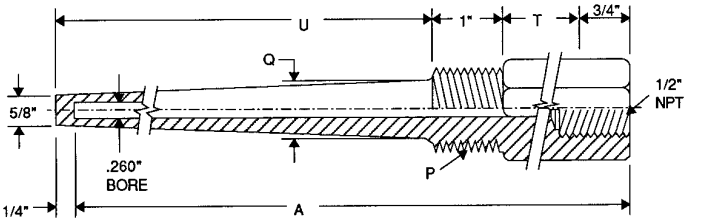
Material	Temperature—°F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

STANDARD THREADED
STRAIGHT SHANK .260" BORE THERMOWELLS FOR 1/4" DIAMETER ELEMENTS



SERIES 52TT, 53TT



SERIES 52TT, 53TT with Lag

TAPERED SHANK .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	SHANK DIA Q
¾" NPT	52TT-U 2½	4	2½	7/8
	-U 4½	6	4½	7/8
	-U 7½	9	7½	7/8
	-U 10½	12	10½	7/8
	-U 13½	15	13½	7/8
	-U 16½	18	16½	7/8
	-U 22½	24	22½	7/8
1" NPT	53TT-U 2½	4	2½	1 1/16
	-U 4½	6	4½	1 1/16
	U 7½	9	7½	1 1/16
	U 10½	12	10½	1 1/16
	-U 13½	15	13½	1 1/16
	-U 16½	18	16½	1 1/16
	-U 22½	24	22½	1 1/16

TAPERED SHANK WITH LAG EXTENSION .260 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	LAG EXT. T	SHANK DIA Q
¾" NPT	52TT-U 2½ T2	6	2½	2	7/8
	-U 4½ T3	9	4½	3	7/8
	-U 7½ T3	12	7½	3	7/8
	-U 10½ T3	15	10½	3	7/8
	-U 13½ T3	18	13½	3	7/8
	-U 19½ T3	24	19½	3	7/8
1" NPT	53TT-U 2½ T2	6	2½	2	1 1/16
	-U 4½ T3	9	4½	3	1 1/16
	-U 7½ T3	12	7½	3	1 1/16
	-U 10½ T3	15	10½	3	1 1/16
	-U 13½ T3	18	13½	3	1 1/16
	-U 19½ T3	24	19½	3	1 1/16

MAXIMUM FLUID VELOCITY FEET PER SECOND

Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

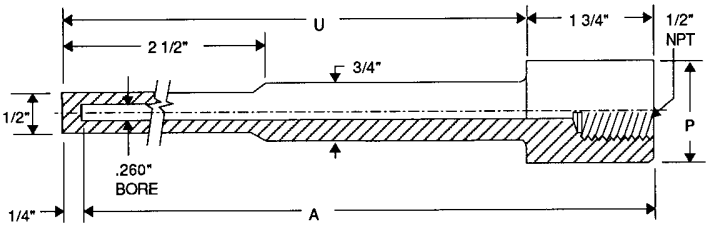
Well Type	Material	INSERTION LENGTH-"U" 2½	4½	7½	10½	13½	16½	19½	22½
¾"-260Bore and ¾"-260 Bore with Lag Extension	Brass	305 (97.5)	93.8 (54.1)	33.9	17.1	10.5	7.0	5.0	3.7
	Carbon Steel	386 (175)	180 (97.2)	65.3 (58.3)	33.0	20.1	13.4	9.6	7.1
	A.I.S.I. 304 & 316	440 (243)	197 (135)	71.2	36.0	22.0	14.7	0.5	7.8
	Monel	354 (195)	155 (108)	56.1	28.4	17.3	11.6	7.5	5.6
1"-260 Bore and 1"-260Bore with Lag Extension	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
	A.I.S.I. 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

PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

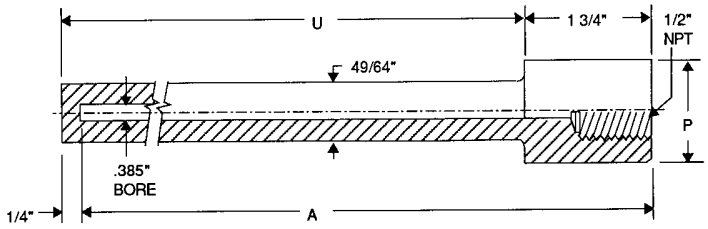
Material	Temperature—°F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5300	4750	1100	—	—	—	—
Carbon Steel	5950	5750	5450	5250	4000	1750	—
A.I.S.I. 304	7800	7050	6400	6150	6000	5190	1875
A.I.S.I. 316	7800	7800	7250	7100	6950	5800	2720
Monel	7450	6850	6150	6100	5940	175	—

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

SOCKET-WELD
.260" BORE, .385" BORE THERMOWELLS
FOR 1/4" AND 3/8" DIAMETER ELEMENTS



SERIES 52AS, 53AS



SERIES 52SS, 53SS

SOCKET-WELD THERMOWELLS .260 BORE

PIPE SIZE P	SYMBOL	STEM LGTH. A	LENGTH INSERT U
¾" Nominal (1.050 Dia.)	52AS-U 2½	4	2½
	-U 4½	6	4½
	-U 7½	9	7½
	-U 10½	12	10½
	-U 13½	15	13½
	-U 16½	18	16½
	-U 22½	24	22½
1" Nominal (1.315 Dia.)	53AS-U 2½	4	2½
	-U 4½	6	4½
	U 7½	9	7½
	U 10½	12	10½
	-U 13½	15	13½
	-U 16½	18	16½
	-U 22½	24	22½

SOCKET-WELD THERMOWELLS .385 BORE

PIPE SIZE P	SYMBOL	STEM LGTH. A	LENGTH INSERT U
¾" Nominal (1.050 Dia.)	52SS-U 2½	4	2½
	-U 4½	6	4½
	-U 7½	9	7½
	-U 10½	12	10½
	-U 13½	15	13½
	-U 16½	18	16½
	-U 22½	24	22½
1" Nominal (1.315 Dia.)	53SS-U 2½	4	2½
	-U 4½	6	4½
	U 7½	9	7½
	U 10½	12	10½
	-U 13½	15	13½
	-U 16½	18	16½
	-U 22½	24	22½

MAXIMUM FLUID VELOCITY FEET PER SECOND

Well Type	Material	INSERTION LENGTH-"U" 2½	4½	7½	10½	13½	16½	22½
¾"-260 Bore	Carbon Steel	290 (106)	123 (71.2)	44.9 (42.7)	22.8	13.8	9.3	4.9
	A.I.S.I.—304 & 316	300 (148)	128 (99.3)	46.4	23.6	14.3	9.6	5.1
1"-260 Bore	Carbon Steel	290 (106)	143 (84.3)	51.6 (50.6)	26.2	15.9	10.6	5.7
	A.I.S.I.—304 & 316	300 (148)	148 (117)	53.5	27.2	16.5	11.0	5.9
¾"-385 Bore and 1"-385 Bore	Carbon Steel	426 (260)	192 (144)	69.5	35.4	20.5	14.3	7.7
	A.I.S.I.-304 & 316	449 (360)	199	71.9	36.6	21.2	14.8	8.0

Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

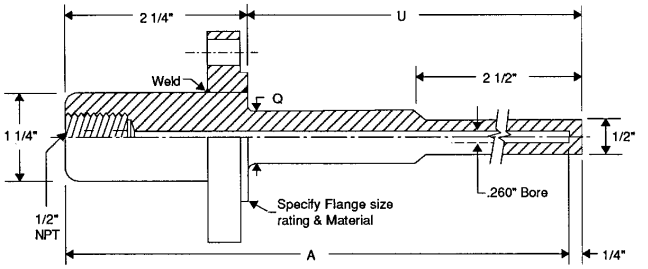
PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

Material	Temperature—°F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

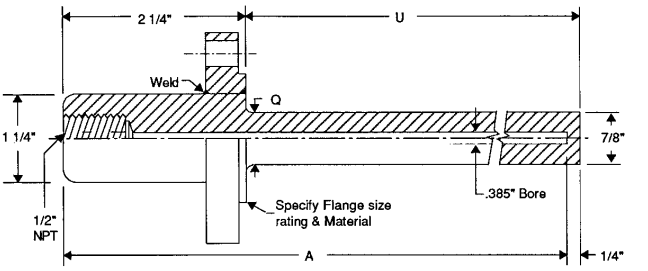
THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

FLANGED

STRAIGHT AND STEP SHANK .260" BORE, .385" BORE THERMOWELLS FOR 1/4" AND 3/8" DIAMETER ELEMENTS



SERIES 5T2A



SERIES 5TS3

FLANGED THERMOWELLS .260 BORE

SYMBOL	ELEM. LGTH. A	INSERT LGTH. U	SHANK DIA. Q
5TA2-U 2	4	2	¾
-U 4	6	4	¾
-U 7	9	7	¾
-U 10	12	10	¾
-U 13	15	13	¾
-U 16	18	16	¾
-U 22	24	22	¾

FLANGED THERMOWELLS .385 BORE

SYMBOL	ELEM. LGTH. A	INSERT LGTH. U	SHANK DIA. Q
5TS3-U 2	4	2	7/8
U 4	6	4	7/8
-U 7	9	7	7/8
-U 10	12	10	7/8
-U 13	15	13	7/8
-U 16	18	16	7/8
-U 22	24	22	7/8

MAXIMUM FLUID VELOCITY FEET PER SECOND

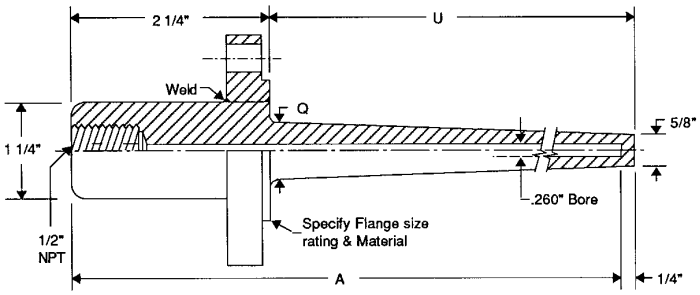
Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

Well Type	Material	INSERTION LENGTH-"U"						
		2	4	7	10	13	16	22
5TA2 and 5TS2	Carbon Steel A.I.S.I. 304 & 316	404 (129)	184 (71.2)	67.0 (42.7)	34.0	20.6	13.7	7.4
		430 (179)	192 (99.3)	69.7 (59.6)	35.4	21.5	14.3	7.7
	Monel	350 (143)	168 (79.8)	61 (47.7)	31.0	18.8	12.5	6.7
5TA3 and 5TS3	Carbon Steel A.I.S.I. 304 & 316	410 (152)	248 (84.3)	91.3 (50.6)	45.7	27.6	18.5	10.0
		444 (211)	258 (117)	95.2 (70.3)	47.6	28.8	19.3	10.4
	Monel	338 (168)	226 (93.3)	83.3 (56.0)	41.6	25.2	16.9	9.1

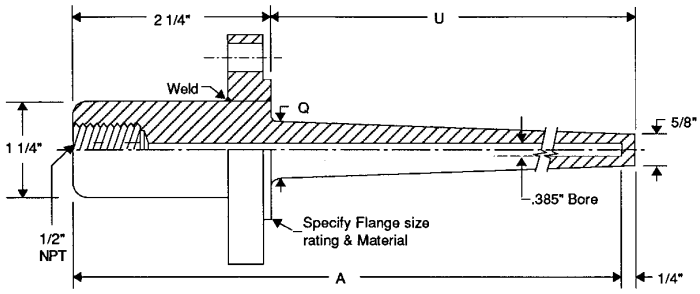
THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

FLANGED

TAPERED SHANK .260" BORE, .385" BORE THERMOWELLS FOR 1/4" AND 3/8" DIAMETER ELEMENTS



SERIES 5TT2



SERIES 5TT3

FLANGED THERMOWELLS .260 BORE

SYMBOL	ELEM. LGTH. A	INSERT LGTH. U	SHANK DIA. Q
5TT2-U 2	4	2	
-U 4	6	4	Specify
-U 7	9	7	Q
-U 10	12	10	Dimensions
-U 13	15	13	when
-U 16	18	16	making
-U 22	24	22	order

FLANGED THERMOWELLS .385 BORE

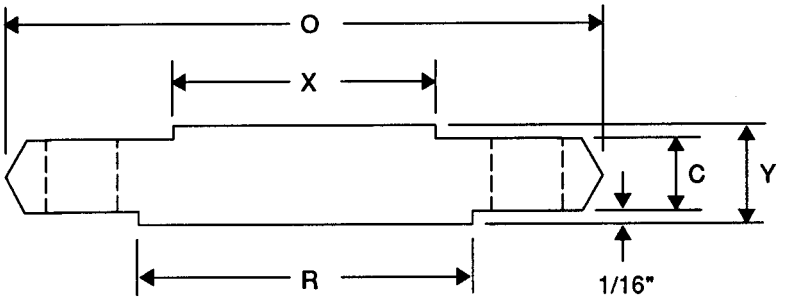
SYMBOL	ELEM. LGTH. A	INSERT LGTH. U	SHANK DIA. Q
5TT3-U 2	4	2	
-U 4	6	4	Specify
-U 7	9	7	Q
-U 10	12	10	Dimensions
-U 13	15	13	when
-U 16	18	16	making
-U 22	24	22	order

MAXIMUM FLUID VELOCITY FEET PER SECOND

Well Type	Material	INSERTION LENGTH-"U" 2	4	7	10	13	16	22
5TT2	Carbon Steel	603 (273)	227 (125)	74 (67)	36	21	14	7.5
	304 & 316	687 (379)	249 (170)	81	39.8	23.6	15.5	8.2
	Monel	553 (304)	196 (136)	64	31	18	12	6
5TT3	Carbon Steel	550 (356)	241 (144)	78.9	38	22.8	15	7.9
	304 & 316	648 (467)	257 (194)	83.8	41	24	16	8.4
	Monel	531 (398)	217 (169)	71	34.8	20.6	13	7

Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

DIMENSIONS FOR THERMOWELL FLANGES

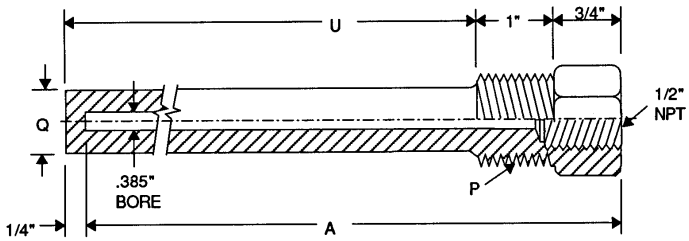


150 POUND 1/16" RAISED FACE MATERIALS AVAILABLE INCLUDE	Flange Size	Weight in lbs.	O Outside Diameter	C Thickness	X Diameter of Hub	Y Length	R Diameter of Raised Face
Carbon Steel							
304 Stainless Steel	1/2	1.05	3.50	.44	1.19	.62	1.38
Low Carbon 304 Stainless Steel	3/4	1.50	3.88	.50	1.50	.62	1.69
310 Stainless Steel	1	2.25	4.25	.56	1.94	.69	2.00
316 Stainless Steel	1 1/4	3.13	4.62	.62	2.31	.81	2.50
Low Carbon 316 Stainless Steel	1 1/2	3.97	5.00	.69	2.56	.88	2.88
Inconel 600	2	6.50	6.00	.75	3.06	1.00	3.62
Monel	2 1/2	9.30	7.00	.88	3.56	1.12	4.12
Hastelloy B	3	10.4	7.50	.94	4.25	1.19	5.00
Molybdenum	4	17.6	9.00	.94	5.31	1.31	6.19
Hastelloy C	5	19.0	10.00	.94	6.44	1.44	7.31
Tantalum	6	31.6	11.00	1.00	7.56	1.56	8.50
Titanium	8	53.6	13.50	1.12	9.69	1.75	10.62
300 POUND 1/16" RAISED FACE MATERIALS AVAILABLE INCLUDE	Flange Size	Weight in lbs.	O Outside Diameter	C Thickness	X Diameter of Hub	Y Length	R Diameter of Raised Face
Carbon Steel							
304 Stainless Steel	1/2	1.60	3.75	.56	1.50	.88	1.38
Low Carbon 304 Stainless Steel	3/4	3.03	4.62	.62	1.88	1.00	1.69
310 Stainless Steel	1	3.94	4.88	.69	2.12	1.06	2.00
316 Stainless Steel	1 1/4	4.50	5.25	.75	2.50	1.06	2.50
Low Carbon 316 Stainless Steel	1 1/2	7.38	6.12	.81	2.75	1.19	2.88
Inconel 600	2	8.28	6.50	.88	3.31	1.31	3.62
Monel	2 1/2	13.1	7.50	1.00	3.94	1.50	4.12
Hastelloy B	3	17.5	8.25	1.12	4.62	1.69	5.00
Molybdenum	4	31.2	10.00	1.25	5.75	1.88	6.19
Hastelloy C	5	41.6	11.00	1.38	7.00	2.00	7.31
Tantalum	6	55.2	12.50	1.44	8.12	2.06	8.50
Titanium	8	96.0	15.00	1.62	10.25	2.44	10.62

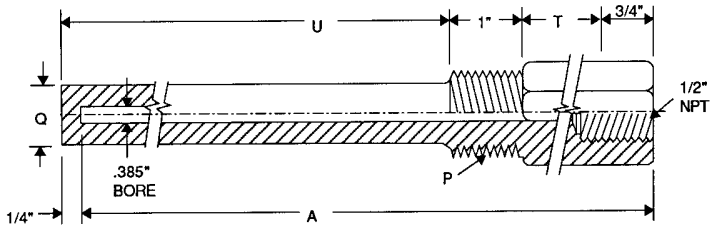
Dimensions are in inches.

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

STANDARD THREADED
STRAIGHT SHANK .385" BORE THERMOWELLS FOR 3/8" DIAMETER ELEMENTS



SERIES 52ST, 53ST



SERIES 52ST, 53ST with Lag

STRAIGHT SHANK .385 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	SHANK DIA Q
¾" NPT	52ST-U 2½	4	2½	49/64
	-U 4½	6	4½	49/64
	-U 7½	9	7½	49/64
	-U 10½	12	10½	49/64
	-U 13½	15	13½	49/64
	-U 16½	18	16½	49/64
	-U 22½	24	22½	49/64
1" NPT	53ST-U 2½	4	2½	7/8
	-U 4½	6	4½	7/8
	U 7½	9	7½	7/8
	U 10½	12	10½	7/8
	-U 13½	15	13½	7/8
	-U 16½	18	16½	7/8
	-U 22½	24	22½	7/8

STRAIGHT SHANK WITH LAG EXTENSION .385 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	LAG EXT. T	SHANK DIA Q
¾" NPT	52ST-U 2½ T2	6	2½	2	49/64
	-U 4½ T3	9	4½	3	49/64
	-U 7½ T3	12	7½	3	49/64
	-U 10½ T3	15	10½	3	49/64
	-U 13½ T3	18	13½	3	49/64
	-U 19½ T3	24	19½	3	49/64
1" NPT	53ST-U 2½ T2	6	2½	2	7/8
	-U 4½ T3	9	4½	3	7/8
	-U 7½ T3	12	7½	3	7/8
	-U 10½ T3	15	10½	3	7/8
	-U 13½ T3	18	13½	3	7/8
	-U 19½ T3	24	19½	3	7/8

MAXIMUM FLUID VELOCITY FEET PER SECOND

Material	INSERTION LENGTH-"U"							
	2½	4½	7½	10½	13½	16½	19½	22½
Brass	290 (145)	150 (80)	54.1 (48)	27.6	16.7	11.1	8.0	6.0
Carbon Steel	326 (260)	192 (144)	69.5	35.4	20.5	14.3	10.3	7.7
A.I.S.I.-304 & 316	349 (360)	199	71.9	36.6	21.2	14.8	10.7	8.0
Monel	316 (320)	189 (178)	68.1	34.8	20.8	14.0	10.0	7.5

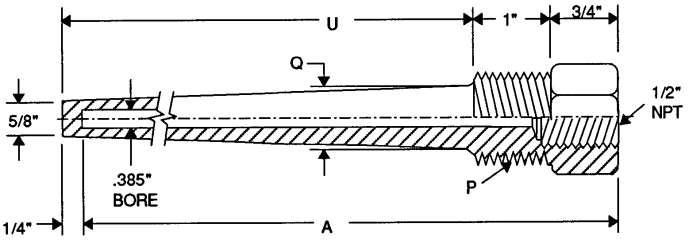
Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

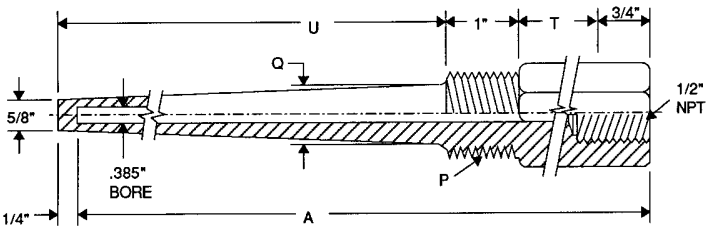
Material	Temperature—°F						
	70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

THERMOWELL DIMENSIONS, VELOCITY, AND PRESSURE RATING

HEAVY DUTY THREADED
TAPERED SHANK .385" BORE THERMOWELLS
FOR 3/8" DIAMETER ELEMENTS



SERIES 52TT, 53TT



SERIES 52TT, 53TT with Lag

TAPERED SHANK .385 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	SHANK DIA Q
¾'' NPT	52TT-U 2½	4	2½	7/8
	-U 4½	6	4½	7/8
	-U 7½	9	7½	7/8
	-U 10½	12	10½	7/8
	-U 13½	15	13½	7/8
	-U 16½	18	16½	7/8
	-U 22½	24	22½	7/8
1'' NPT	53TT-U 2½	4	2½	1 1/16
	-U 4½	6	4½	1 1/16
	U 7½	9	7½	1 1/16
	U 10½	12	10½	1 1/16
	-U 13½	15	13½	1 1/16
	-U 16½	18	16½	1 1/16
	-U 22½	24	22½	1 1/16

TAPERED SHANK WITH LAG EXTENSION .385 BORE

EXTERNAL THREAD P	SYMBOL	STEM LGTH. A	INSERT. LGTH. U	LAG EXT. T	SHANK DIA Q
¾'' NPT	52TT-U 2½ T2	6	2½	2	7/8
	-U 4½ T3	9	4½	3	7/8
	-U 7½ T3	12	7½	3	7/8
	-U 10½ T3	15	10½	3	7/8
	-U 13½ T3	18	13½	3	7/8
	-U 19½ T3	24	19½	3	7/8
1'' NPT	53TT-U 2½ T2	6	2½	2	1 1/16
	-U 4½ T3	9	4½	3	1 1/16
	-U 7½ T3	12	7½	3	1 1/16
	-U 10½ T3	15	10½	3	1 1/16
	-U 13½ T3	18	13½	3	1 1/16
	-U 19½ T3	24	19½	3	1 1/16

MAXIMUM FLUID VELOCITY FEET PER SECOND

Note: The values in parenthesis represent safe values for water flow while the values not in parenthesis may be used for steam, air, gas and fluids with similar density.

Well Type	Material	INSERTION LENGTH-"U" 2½	4½	7½	10½	13½	16½	19½	22½
¾''-385 Bore and ¾''-385 Bore with Lag Extension	Brass	276 (127)	124 (79)	44	22	13	8	6	4
	Carbon Steel	352 (228)	191 (114)	689	35	21	14	10	7.5
	304 & 316	415 (299)	203 (154)	73.2	37.3	22.5	15	11	8
	Monel	340 (255)	172 (134)	62	31	19	12.8	8	6
1''-385 Bore and 1''-385 Bore with Lag Extension	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
	304 & 316	483 (350)	272 (208)	97.3	49.7	30.4	20.3	14.5	10.7
	Monel	396 (306)	214 (167)	77.5	39.2	23.8	16	10.3	7.7

PRESSURE (LB. PER SQ. INCH)-TEMPERATURE

Material	Temperature—°F 70°	200°	400°	600°	800°	1000°	1200°
Brass	5000	4200	1000	—	—	—	—
Carbon Steel	5200	5000	4800	4600	3500	1500	—
A.I.S.I. 304	7000	6200	5600	5400	5200	4500	1650
A.I.S.I. 316	7000	7000	6400	6200	6100	5100	2500
Monel	6500	6000	5400	5300	5200	1500	—

DECIMAL EQUIVALENTS OF PIPE SIZES

Dimensions in Inches - Wall Thickness of:

PIPE SIZE	OUTSIDE DIAMETER	SCH 40 / INSIDE DIAMETER	SCH 80 / INSIDE DIAMETER	SCH 160 / INSIDE DIAMETER
1/8	.405	.068 / .269	.095 / .215	N/A
1/4	.540	.088 / .384	.119 / .302	N/A
3/8	.678	.091 / .493	.126 / .423	N/A
1/2	.840	.109 / .622	.147 / .548	.187 / .466
3/4	1.050	.113 / .824	.154 / .742	.218 / .614
1	1.315	.133 / 1.049	.179 / .957	.250 / .815
1 1/4	1.660	.140 / 1.380	.191 / 1.278	.250 / 1.160
1 1/2	1.900	.145 / 1.610	.200 / 1.500	.281 / 1.338
2	2.375	.154 / 2.067	.218 / 1.939	.343 / 1.689
6	6.625	.280 / 6.065	.432 / 5.761	.718 / 5.189
9	9.625	.342 / 8.941	.500 / 8.625	N/A
12	12.750	.406 / 11.938	.687 / 11.376	1.312 / 10.126
24	24.000	.375 / 23.25	500 / 23.00	2.344 / 19.312

THEORETICAL BURSTING AND COLLAPSING PRESSURES FOR PIPE

Stainless Steel (ASTM-A-312)

NOMINAL SIZE (INCHES)	SCHEDULE NUMBER	OUTSIDE DIAMETER (INCHES)	WALL THICKNESS (INCHES)	INSIDE DIAMETER (INCHES)	INTERNAL PRESSURE, PSI BURSTING	EXTERNAL PRESSURE, PSI COLLAPSING
1/8	40 80	0.405 0.405	0.068 0.095	0.269 0.215	25,185 35,185	10,761 15,441
1/4	40 80	0.540 0.540	0.088 0.119	0.384 0.302	24,444 33,055	10,415 14,445
3/8	40 80	0.678 0.678	0.091 0.126	0.493 0.423	20,192 27,876	8,397 12,021
1/2	40 80	0.840 0.840	0.109 0.147	0.622 0.548	19,464 26,250	8,084 11,260
3/4	40 80	1.050 1.050	0.113 0.154	0.824 0.742	16,142 22,000	6,529 9,271
1	40 80	1.315 1.315	0.133 0.179	1.049 0.957	15,171 20,418	6,075 8,530
1 1/4	40 80	1.660 1.660	0.140 0.191	1.380 1.278	12,650 17,259	3,895 7,052
1 1/2	40 80	1.900 1.900	0.145 0.200	1.610 1.500	11,447 15,789	4,332 6,364

NOTE: Burst Pressures for Stainless Steel in above chart were calculated using the specified minimum tensile strength, 75,000 p.s.i.

The information and data presented herein are typical or average values and are not a guarantee of maximum or minimum values. Applications specifically suggested for material described herein are made solely for the purpose of illustration to enable the reader to make his own evaluation and are not intended as warranties, either express or implied, of fitness for these or other purposes.

THEORETICAL BURSTING PRESSURES FOR TUBING (ASTM-A-632)

Corresponding to a fiber stress in wall of 10,000 pounds per square inch

OUTSIDE DIAMETER (INCHES)	WALL THICKNESS - DECIMAL INCH						
	BWG EQUIVALENT						
	.020 25	.028 22	.035 20	.049 18	.065 16	.095 13	.120 11
1/8	3200	5200	5600	7840			
3/16	2133	2987	3933	5227			
1/4	1600	2240	2800	3920	5200	7600	
5/16	1280	1792	2240	3136	4160	6100	
3/8	1057	1493	1867	2613	3467	5067	6400
1/2	800	1120	1400	1960	2600	3800	4800

The table (S=10,000) affords easy calculations with appropriate multipliers shown below. For theoretical bursting pressures, use tensile values. For theoreticalbulging pressures, use yield values. Working pressures will vary depending upon safety factors required for environmental conditions involved as determined by your design engineer and appropriate codes.

Material	Tensile (Multiplier)	Yield (Multiplier)
6061-T6 Aluminum	42,000 psi (x 4.2)	35,000 psi (x3.5)
Annealed Low Carbon Steel	55,000 psi (x 5.5)	25,000 psi (x 2.5)
Annealed 18-8 Stainless	75,000 psi (x 7.5)	30,000 psi (x3.0)
1/8 Hard 18-8 Stainless	105,000 psi (x 10.5)	75,000 psi (x7.5)
Cold Dr. 21-6-9 Stainless	142,000 psi (x 14.2)	120,000 psi (x 12.0)

The above table is based on the best known and most widely used formula for calculating the bursting pressure of tubes, namely Barlow's: $P=\frac{2St}{D}$

P = Internal pressure in p.s.i S = Fiber stress of tube in p.s.i. t = Wall thickness in inches D = Outside diameter in inches

The information and data presented herein are typical of averaging values and are not a guarantee of maximum or minimum values. Applications specifically suggested for material described herein are made solely for the purpose of illustration to enable the reader to make his own evaluation and are not intended as warranties, either express or implied, of fitness for these or other purposes.

MATERIAL SELECTION INFORMATION

The following information is a guide line for selecting thermocouple, RTD and thermowell materials based on the process fluid. Factors such as catalytic reaction, contaminations and electrolysis are taken into consideration. However, in many cases there are even more variables which must be examined.

These suggestions are to be used only as guide lines and are based on the most economical material selection. JMS Southeast will not take any responsibility if these recommendations are not satisfactory for specific applications. Consult JMS Southeast for special applications and our engineering department will assist you in your selection.

SUBSTANCE	CONDITIONS	RECOMMENDED METAL
Acetate Solvents	Crude or Pure	Monel or Nickel
Acetic Acid	10% - 70°F	304 Stainless Steel
" "	50% - 70°F	304 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
" "	99% - 70°F	430 Stainless Steel
" "	99% - 212°F	430 Stainless Steel
Acetic Anhydride		Monel
Acetone	212°F	304 Stainless Steel
Acetylene		304, Monel, Nickel
Alcohol Ethyl	70°F	304 Stainless Steel
" "	212°F	304 Stainless Steel
Alcohol Methyl	70°F	304 Stainless Steel
" "	212°F	304 Stainless Steel
Aluminum	Molten	Cast Iron
Aluminum Acetate	Saturated	304 Stainless Steel
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
Ammonium Chloride	All concentrations 212°F	316 Stainless Steel
Ammonium Nitrate	All concentrations 70°F	304 Stainless Steel
" "	All concentrations 212°F	304 Stainless Steel
Ammonium Sulphate	5% - 70°F	304 Stainless Steel
" "	10% - 212°F	316 Stainless Steel
" "	Saturated 212°F	316 Stainless Steel
Aniline	All concentrations 70°F	304 Stainless Steel
Amylacetate		Monel
Asphalt		Steel (C1018) Phosphor Bronze, Monel, Nickel
Barium Carbonate	70°F	304 Stainless Steel
Barium Chloride	5% - 70°F	Monel
" "	Saturated 70°F	Monel
" "	Aqueous - Hot	316 Stainless Steel
Barium Hydroxide		Steel (C1018)
Barium Sulphite		Nichrome
Benzaldehyde		Steel (C1018)
Benzene	70°F	304 Stainless Steel
Benzine		Steel (C1018) Monel, Inconel
Benzol	Hot	304 Stainless Steel
Boracic Acid	5% Hot or Cold	304 Stainless Steel
Bromine	70°F	Tantalum
Butadiene		Brass, 304
Butane	70°F	304 Stainless Steel
Butylacetate		Monel
Butyl Alcohol		Copper
Butylenes		Steel (C1018), Phosphor Bronze
Butyric Acid	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Calcium Bisulfite	70°F	316 Stainless Steel
Calcium Chlorate	Dilute 70°F	304 Stainless Steel
" "	Dilute 150°F	304 Stainless Steel
Calcium Hydroxide	10% - 212°F	304 Stainless Steel
" "	20% - 212°F	304 Stainless Steel
" "	50% - 212°F	317 Stainless Steel
Carbolic Acid	All 212°F	316 Stainless Steel
Carbon Dioxide	Dry	Steel (C1018), Monel
Carbon Dioxide	Wet	Aluminum, Monel, Nickel
Carbon Tetrachloride	10% - 70°F	Monel
Chlorex Caustic		316SS, 317SS
Chlorine Gas	Dry 70°F	317 Stainless Steel
" "	Moist 70°F	Hastelloy C
" "	Moist 212°F	Hastelloy C
Chromic Acid	5% - 70°F	304 Stainless Steel
" "	10% - 212°F	316 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
Citric Acid	15% - 70°F	304 Stainless Steel
" "	15% - 212°F	316 Stainless Steel
" "	Concentrated 212°F	317 Stainless Steel
Coal Tar	Hot	304 Stainless Steel
Coke Oven Gas		Aluminum
Copper Nitrate		304, 316
Copper Sulphate		304, 316
Core Oils		316 Stainless Steel
Cottonseed Oil		Steel (C1018), Monel, Nickel
Creosols		304 Stainless Steel
Creosote Crude		Steel (C1018), Monel Nickel
Cyanogen Gas		304 Stainless Steel
Dowtherm		Steel (C1018)
Epsom Salt	Hot and Cold	304 Stainless Steel
Ether	70°F	304 Stainless Steel
Ethyl Acetate		Monel
Ethyl Chloride	70°F	304 Stainless Steel
Ethylene Glycol		Steel (C1018)
Ethyl Sulphate	70°F	Monel
Ferric Chloride	1% - 70°F	316 Stainless Steel
" "	5% - 70°F	Tantalum
" "	5% - Boiling	Tantalum
Ferric Sulphate	5% - 70°F	304 Stainless Steel
Ferrous Sulphate	Dilute 70°F	304 Stainless Steel
Formaldehyde		304 Stainless Steel
Freon		Steel (C1018)
Formic Acid	5% - 70°F	316 Stainless Steel
" "	5% - 150°F	316 Stainless Steel
Gallic Acid	5% - 70°F	Monel
" "	5% - 150°F	Monel
Gasoline	70°F	304 Stainless Steel
Glucose	70°F	304 Stainless Steel
Glycerine	70°F	304 Stainless Steel
Glycerol		304 Stainless Steel
Heat Treating		446 Stainless Steel
Hydrobromic Acid	48% - 212°F	Hastelloy B
Hydrochloric Acid	1% - 70°F	Hastelloy C
" "	1% - 212°F	Hastelloy B
" "	5% - 70°F	Hastelloy C
" "	5% - 212°F	Hastelloy B
" "	25% - 70°F	Hastelloy B
" "	25% - 212°F	Hastelloy B
Hydrocyanic Acid		316 Stainless Steel
Hydrofluoric Acid		Hastelloy C
Hydrogen Peroxide	70°F	316 Stainless Steel
" "	212°F	316 Stainless Steel
Hydrogen Sulphide	Wet and dry	316 Stainless Steel
Iodine	70°F	Tantalum
Kerosene	70°F	304 Stainless Steel
Lactic Acid	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	316 Stainless Steel
" "	10% - 212°F	Tantalum
Lacquer	70°F	316 Stainless Steel
Latex		Steel (C1018)
Lime Sulphur		Steel (C1018), 304, Monel
Linseed Oil	70°F	304 Stainless Steel
Magnesium Chloride	5% - 70°F	Monel
" "	5% - 212°F	Nickel
Magnesium Sulphate	Cold and Hot	Monel
Malic Acid	Cold and Hot	316 Stainless Steel
Mercury		Steel (C1018), 304, Monel
Methane	70°F	Steel (1020)
Milk		304, Nickel
Mixed Acids (Sulphuric and Nitric — all temp. and %)		Carpenter #20
Molasses		Steel (C1018), 304, Monel, Nickel
Muriatic Acid	70°F	Tantalum
Naphtha	70°F	304 Stainless Steel
Natural Gas	70°F	304 Stainless Steel
Neon	70°F	304 Stainless Steel
Nickel Chloride	70°F	304 Stainless Steel
Nickel Sulphate	Hot and Cold	304 Stainless Steel
Nitric Acid	5% - 70°F	304 Stainless Steel
" "	20% - 70°F	304 Stainless Steel
" "	50% - 70°F	304 Stainless Steel
" "	50% - 212°F	304 Stainless Steel
" "	65% - 212°F	316 Stainless Steel
" "	Concentrated - 70°F	304 Stainless Steel
" "	Concentrated - 212°F	Tantalum
Nitrobenzene	70°F	304 Stainless Steel
Nitrous Acid		304 Stainless Steel
Oleic Acid	70°F	316 Stainless Steel
Oleum	70°F	316 Stainless Steel
Oxalic Acid	5% - Hot and Cold	304 Stainless Steel
" "	10% - 212°F	Monel
Oxygen	70°F	Steel (C1018)
Oxygen	Liquid	304 Stainless Steel
Palmitic Acid		316 Stainless Steel
Petroleum Ether		304 Stainless Steel
Phenol		304 Stainless Steel
Pentane		304 Stainless Steel
Phosphoric Acid	1% - 70°F	304 Stainless Steel
" "	5% - 70°F	304 Stainless Steel
" "	10% - 70°F	316 Stainless Steel
" "	10% - 212°F	Hastelloy C
" "	30% - 70°F	Hastelloy B
" "	30% - 212°F	Hastelloy B
" "	85% - 70°F	Hastelloy B
" "	85% - 212°F	Hastelloy B
Picric Acid	70°F	304 Stainless Steel
Potassium Bromide	70°F	316 Stainless Steel
Potassium Carbonate	1% - 70°F	304 Stainless Steel
Potassium Chlorate	70°F	304 Stainless Steel
Potassium Chloride	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Hydroxide	5% - 70°F	304 Stainless Steel
" "	25% - 212°F	304 Stainless Steel
" "	50% - 212°F	316 Stainless Steel
Potassium Nitrate	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Permanganate	5% - 70°F	304 Stainless Steel
Potassium Sulphate	5% - 70°F	304 Stainless Steel
" "	5% - 212°F	304 Stainless Steel
Potassium Sulphide	70°F	304 Stainless Steel
Propane		304 Stainless Steel
Pyrogallic Acid		304 Stainless Steel
Quinine Bisulphate	Dry	316 Stainless Steel
Quinine Sulphate	Dry	304 Stainless Steel
Resin		304 Stainless Steel
Rosin	Molten	304 Stainless Steel
Sea Water		Monel
Salommoniac		Monel
Salicylic Acid		Nickel
Shellac		304 Stainless Steel
Soap	70°F	304 Stainless Steel
Sodium Bicarbonate	All concentrations 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Sodium Bisulphate		Monel
Sodium Carbonate	5% - 70°F	304 Stainless Steel
" "	5% - 150°F	304 Stainless Steel
Sodium Chloride	5% - 70°F	316 Stainless Steel
Sodium Chloride	5% - 150°F	316 Stainless Steel
" "	Saturated - 70°F	316 Stainless Steel
" "	Saturated - 212°F	316 Stainless Steel
Sodium Fluoride	5% - 70°F	Monel
Sodium Hydroxide		304 Stainless Steel
Sodium Hypochlorite	5% still	316 Stainless Steel
Sodium Nitrate	Fused	317 Stainless Steel
Sodium Peroxide		304 Stainless Steel
Sodium Phosphate		Steel (C1018)
Sodium Silicate		Steel (C1018)
Sodium Sulphate	70°F	304 Stainless Steel
Sodium Sulphide	70°F	316 Stainless Steel
Sodium Sulphite	150°F	304 Stainless Steel
Steam		304 Stainless Steel
Stearic Acid		304 Stainless Steel
Sulphur Dioxide	Moist Gas - 70°F	316 Stainless Steel
" "	Gas - 575°F	304 Stainless Steel
Sulphur	Dry - Molten	304 Stainless Steel
"	Wet	316 Stainless Steel
Sulphuric Acid	5% - 70°F	Carp. 20, Hastelloy B
" "	5% - 212°F	Carp. 20, Hastelloy B
" "	10% - 70°F	Carp. 20, Hastelloy B
" "	10% - 212°F	Carp. 20, Hastelloy B
" "	50% - 70°F	Carp. 20, Hastelloy B
" "	50% - 212°F	Carp. 20, Hastelloy B
" "	90% - 70°F	Carp. 20, Hastelloy B
" "	90% - 212°F	Hastelloy D
Tannic Acid	70°F	304 Stainless Steel
Tar		Steel (C1018), 304, Monel, Nickel
Tartaric Acid	70°F	304 Stainless Steel
" "	150°F	316 Stainless Steel
Tin	Molten	Cast Iron
Tolvene		Aluminum, Phosphor Bronze, Monel
Trichloroethylene		Steel (C1018)
Turpentine		304 Stainless Steel
Varnish		304 Stainless Steel
Vegetable Oils		Steel (C1018), 304, Monel
Vinegar		304 Stainless Steel
Water	Fresh	Copper, Steel (C1018), Monel
Water	Salt	Aluminum Brass, Monel
Whiskey, Wine		304, Nickel
Xylene		Copper
Zinc	Molten	Cast Iron
Zinc Chloride		Monel
Zinc Sulphate	5% - 70°F	304 Stainless Steel
" "	Saturated - 70°F	304 Stainless Steel
" "	25% - 212°F	304 Stainless Steel

MATERIAL SELECTION INFORMATION

METALLIC THERMOWELL MATERIALS

SUMMARY TABLE

DESIGNATION	NOMINAL COMPOSITION	MAXIMUM TEMP. (cont. serv. air)	MELTING POINT RANGE
304SS	18% Chromium 9% Nickel	1652°F	2600 - 2750°F
310SS	25% Chromium 20% Nickel	2100°F	2500 - 2550°F
316SS	18% Chromium 12% Nickel 2-3% Molybdenum	1700°F	2500 - 2550°F
304LSS	Similar to 304SS with reduced carbon	800°F	2600 - 2750°F
Inconel 600	76% Nickel 15.5% Chromium 8.0% Iron	2100°F	2470 - 2575°F
Hastelloy B	67% Nickel 28% Molybdenum 5% Iron	2200°F	2375 - 2495°F
Hastelloy C	57% Nickel 16% Molybdenum 15.5% Chromium 4% Tungsten 5% Iron	2200°F	2415 - 2500°F
Monel	65% Nickel 32% Copper	1000°F	2450°F

MATERIAL SELECTION INFORMATION

COMPARATIVE CORROSION RATINGS

For Carbon Steel, Inconel, Monel, Nickel, 303 Stainless Steel, 304 Stainless Steel, 316 Stainless Steel, and Teflon.

The data in this chart is reprinted here with the permission of Hoke, Inc., One Tenakill Park, Cresskill, New Jersey 07626.

This chart is a guide to the selection of a corrosion resistant protection tube. Changes in temperature, concentration, pressure, agitation, aeration, and impurities can nullify these ratings. The only way to determine the suitability of a protection material in a media is by performance tests. Mechanical strength of the protection tube must also be considered. Unless otherwise marked, all pressures and temperatures are atmospheric. This listing does not imply that other materials are not suitable for use in the media listed.

IDENTIFICATION OF TRADENAMED MATERIALS

Inconel, Monel . . . . . International Nickel Co.
Teflon . . . . . E.I. DuPont

RATINGS

A Substantial Resistance-Preferred material of construction.
B Moderate Resistance-Satisfactory for use under most conditions; very slight swelling for elastomers.
C Questionable Resistance-Use with caution.
D Inadequate Resistance-Not recommended.
X No information available

LIMITATIONS

1. To 220° F.
2. Subject to stress corrosion at high temperatures and in concentrated solutions.
3. Subject to pitting at air solution line when solution is allowed to dry on metal surface.

Corrosive Media	Carbon Steel	Inconel	Monel	Nickel	303 & 304 Stainless Steel	316 Stainless Steel	Teflon
Acetate Solvents, Crude	D	A	B	B	A	A	A
Acetate Solvents, Pure	C	A	A	A	A	A	A
Acetaldehyde, 100%	X	B	A	B	A	A	A
Acetic Acid, 95%	D	A	A	A	B	A	A
Acetic Acid Vapors, 100%, Hot	B	B	B	B	D	E	A
Acetic Anhydride, Boiling	D	A	A	B	B	A	A
Acetone	B	A	A	A	A	A	A
Alcohols	B	A	A	A	A	A	A
Alum. Potassium, 10%	D	B	B	B	B-3	A	A
Aluminum Chloride, 10%	D	B	B	B	D	C-3	A
Aluminum Choloride, 10%, Boiling	D	C	C	B	D	D	A
Aluminum Sulfate, 10%	D	A	A	A	C	B	A
Aluminum Sulfate, <10%, Boiling	D	B	B	B	D	B	A
Aluminum Sulfate, >10%, Boiling	D	B	B	B	D	B	A
Amines	B	A	A	A	A	A	A
Ammonia, Anhydrous	B	A	A	A	A	A	A
Ammonium Chloride, 10%	C	A	A	A	B-3	A	A
Ammonium Chloride, <10%, Boiling	D	B	B	B	D	C-3	A
Ammonium Chloride, >10%, Boiling	D	C	B	B	D	C-3	A
Ammonium Hydroxide, Hot	B	A	D	D	A	A	A
Ammonium Nitrate	B	A	C	C	A	A	A
Ammonium Persulfate, 5%	D	A	D	D	A	A	A
Ammonium Phosphate, Dibasic, 5%	D	A	B	C	A	A	A
Ammonium Sulfate, <10%	C	B	A	B	B	B	A
Ammonium Sulfate, >10%, Boiling	D	B	B	B	C-3	B-3	A
Ammonium Sulfite, Boiling	D	D	C	D	C	B	A
Aniline Hydrochloride	D	B	B	B	D	C	A
Antimony Trichloride	D	B	B	B	D	C	A
Asphalt	B	A	A	B	A	A	A

Corrosive Media	Carbon Steel	Inconel	Monel	Nickel	316 Stainless Steel	303 & 304 Stainless Steel	Teflon
Barium Chloride, 5%	C	A	A	A	A	A	A
Barium Chloride, >5%, Hot	D	B	A	A	C-3	B-3	A
Barium Hydroxide	C	A	A	A	A	A	A
Barium Nitrate	C	B	C	C	A	A	A
Beer, 160°F	C	A	A	A	A	A	A
Beet Sugar, Liquor, Hot	B	A	A	A	A	A	A
Benzene, Hot	B	A	A	A	A	A	A
Benzoic Acid	B	A	A	A	A	A	A
Blood	D	A	A	A	A	A	A
Borax, Hot	B	A	A	B	A	A	A
Boric Acid, 5%, Hot	D	A	B	B	B	B	A
Bromine, Dry Gas	D	B	A	A	D	D	A
Bromine, Moist Gas	D	D	C	C	D	D	A
Buttermilk	D	A	A	A	A	A	A
Butyric Acid, Dilute	X	A	A	A	A	A	A
Butyric Acid, Hot, Conc.	D	B	B	C	C	B	A
Calcium Bisulfite, Hot	D	D	D	D	C	B	A
Calcium Chloride, Dilute	C	A	A	A	B-3	A-3	A
Calcium Hydroxide, 10%, Boiling	D	A	A	A	A	A	A
Calcium Hydroxide, 20%, Boiling	D	A	A	A	A	A	A
Calcium Hydroxide, 30%, Boiling	D	A	A	A	C	B	A
Calcium Hypochloride, <2%	C	B	C	C	C-3	B-3	A
Carbolic Acid, 90%	C	A	B	A	A	A	A
Carbon Dioxide, Dry	B	A	A	A	A	A	A
Carbon Disulphide	B	A	B	B	A	A	A
Carbon Tetrachloride, Dry, Hot	C	A	A	A	B	A	A
Carbonic Acid, Saturated	D	A	A	A	A	A	A
Chloroacetic Acid	D	B	B	B	D	C	A
Chloric Acid	D	C	C	C	D	C	A
Chlorinated Water, Sat.	D	C	C	C	D	C-3	A
Chlorine, Dry Gas	B	A	A	A	B	B	A
Chlorine, Moist Gas	D	D	C	C	D	C	A
Chlorosulfonis Acid, Dilute	D	B	B	A	D	B	A
Chromic Acid, Dilute	B	B	B	B	B	A	A
Chromic Acid, >10%, Boiling	D	C	C	D	C	B	A
Chromic Acid, >10%, Boiling	D	C	D	D	D	C	A
Citric Acid, Dilute	D	A	A	B	A	A	A
Citric Acid, Hot, Concentrated	D	B	B	B	C	B	A
Copper Nitrate, Hot, Concentrated	D	C	D	D	A	A	A
Copper Sulfate, Hot, Concentrated	D	B	C	C	B	A	A
Creosote, Hot	B	A	A	A	A	A	A
Cupric Chloride, <2%	D	C	B	B	B-3	B-3	A
Cupric Chloride, 5%	D	D	D	C	D	C-3	A
Dichlorethane, Boiling	D	B	A	A	B	B	A
Ethyl Chloride	A	A	A	A	A	A	A
Ethylene Glycol	A	A	A	A	A	A	A
Fatty Acids, 145°F	C	A	A	A	B	A	A
Ferric Chloride, <1%	D	B	C	B	C-3	B-3	A
Ferric Chloride, >1%	D	D	D	D	D	D	A
Ferric Chloride, <1%, Boiling	D	D	D	D	D	D	A
Ferric Chloride, >1%, Boiling	D	D	D	D	D	D	A
Ferric Nitrate, 5%	D	C	D	D	B	A	A
Ferric Sulfate, 5%	D	B	C	C	B-3	A	A
Ferrous Sulfate, 10%	C	B	A	A	A	A	A
Fluorine, Dry Gas	C	A	A	A	C	B	A
Fluorine, Dry, 300°F	D	B	A	A	D	C	D
Fluorine, Moist Gas	D	B	A	B	D	D	A
Formaldehyde, 40%	C	A	A	A	B	A	A
Formic Acid, <50%	D	A	B	B	B	A	A
Formic Acid, >50%	D	B	B	B	B	A	A
Formic Acid, <50%, Hot	D	B	B	B	B	A	A
Formic Acid, >50%, Hot	D	B	B	B	C	B	A
Freon, Wet	C	B	A	A	C	C	A
Fuel Oil, 140°F	A	A	B	B	A	A	A
Furfural	B	B	B	B	B	B	A
Gasoline, refined	A	A	A	A	A	A	A
Glycerine	A	A	A	A	A	A	A
Hydrochloric Acid, <1%	D	B	B	B	D	B	A
Hydrochloric Acid, 1-20%	D	C	B	B	D	D	A
Hydrochloric Acid, >20%	D	D	D	C	D	D	A
Hydrochloric Acid, <1/2%, 175°F	D	C	B	B	D	D	A
Hydrochloric Acid, 1/2-2%, 175°F	D	D	C	C	D	D	A
Hydrochloric Acid, >2%, 175°F	D	D	D	D	D	D	A

MATERIAL SELECTION INFORMATION

Corrosive Media	Carbon Steel	Inconel	Monel	Nickel	303 & 304 Stainless Steel	316 Stainless Steel	Teflon
Hydrochloric Acid, <1/4%, Boiling	D	C	B	B	D	D	A
Hydrochloric Acid, 1/4-1%, Boiling	D	C	C	C	D	D	A
Hydrochloric Acid, >1%, Boiling	D	D	D	D	D	D	A
Hydrofluoric Acid, <40%	C	C	B	B	D	D	A
Hydrofluoric Acid, >40%	C	C	B	C	D	D	A
Hydrofluoric Acid, Boiling	D	D	B	C	D	D	A
Hydrofluosilic Acid	D	B	A	B	D	C	A
Hydrogen Chloride, Dry	B	A	A	A	D	C	A
Hydrogen Chloride, Moist	D	D	C	C	D	D	A
Hydrogen Fluoride, Dry	C	A	A	A	D	C	A-1
Hydrogen Peroxide, Boiling	D	B	B	B	C	B	A
Hydrogen Sulfide, Dry	B	A	A	A	A	A	A
Hydrogen Sulfide, Moist	C	A	B	B	B	A	A
Iodine, Dry	D	A	A	A	D	B	A
Kerosene	A	A	A	A	A	A	A
Lactic Acid, 5%	D	A	B	B	B	A	A
Lactic Acid, 10%	D	A	B	B	B	A	A
Lactic Acid, Boiling, 5%	D	B	C	C	C	B	A
Lactic Acid, Boiling, 10%	D	B	C	C	D	B	A
Lead Acetate, Hot	D	B	B	C	A	A	A
Magnesium Chloride, Hot, 5%	D	A	A	A	C-3	B-3	A
Magnesium Hydroxide	B	A	A	A	A	A	A
Magnesium Sulfate	B	B	A	B	A	A	A
Magnesium Sulfate, Boiling	C	C	A	B	A	A	A
Mercury	B	A	B-2	A	A	A	A
Mercuric Chloride, <2%	D	D	D	D	D	D	A
Mercuric Chloride, <1/2%, Boiling	D	D	D	D	D	D	A
Mercuric Cyanide	D	B	D	B	B	B	A
Methyl Chloride, Dry	D	A	A	A	B	B	A
Milk	D	A	B	B	A	A	A
Molasses	B	A	A	A	A	A	A
Naptha	B	A	A	A	A	A	A
Nickel Chloride	D	B	B	B	C-3	B-3	A
Nickel Sulfate, Boiling	D	B	A	A	C	C	A
Nitric Acid, 20%	D	B	D	D	A	A	A
Nitric Acid, Fuming	D	B	D	D	B	B	A
Nitric Acid, Boiling, 20%	D	C	D	D	A	A	A
Nitric Acid, Boiling, 65%	D	D	D	D	B	B	A
Nitric Acid, Boiling, Conc.	D	D	D	D	D	D	A
Nitrous Acid	D	B	C	C	B	B	A
Oxalic Acid, <10%	C	A	A	A	A	A	A
Oxalic Acid, 10%	C	A	A	A	A	A	A
Oxalic Acid, Boiling, 10%	D	A	A	B	D	C	A
Oxalic Acid, Boiling, 50%	D	B	B	C	D	C	A
Phosphoric Acid (Ortho), <10%	D	A	B	B	B	A	A
Phosphoric Acid (Ortho), 10-50%	D	A	B	C	C	A	A
Phosphoric Acid (Ortho), >50%	D	A	B	C	C	A	A
Phosphoric Acid (Ortho), <20%, 175°F	D	C	B	D	D	A	A
Phosphoric Acid (Ortho), >20%, 175°F	D	D	B	D	D	B	A
Phosphoric Acid (Ortho), <10%, Boiling	D	D	C	D	D	B	A
Phosphoric Acid (Ortho), 85%, Boiling	D	D	D	D	D	C	A
Picric Acid	C	D	D	D	A	A	A
Potassium Bromide	D	A	A	A	C-3	B-3	A
Potassium Carbonate	B	A	A	A	A	A	A
Potassium Chlorate	B	A	B	B	A	A	A
Potassium Chloride	D	A	A	B	A-3	A-3	A
Potassium Chloride, Hot	D	B	A	B	C-3	B-3	A
Potassium Cyanide	B	B	B	B	B	B	A
Potassium Dichromate, Conc.	C	B	B	C	A	A	A
Potassium Ferricyanide, 5%	C	B	B	B	A	A	A
Potassium Ferrocyanide, 5%	C	X	B	B	A	A	A
Potassium Hydroxide, 50%	B	A	A	A	A	A	A
Potassium Hydroxide, 30%, 175°F	D	A	A	A	A	A	A
Potassium Hydroxide, 50%, 175°F	D	A	A	A	B	A	A
Potassium Hydroxide, 30%, Boiling	D	A	A	A	B	A	A
Potassium Hydroxide, 50%, Boiling	D	A	A	A	B	A	A
Potassium Hypochlorite, Dilute	D	X	D	C	C-3	B-3	A
Potassium Permanganate, Dilute	B	B	A	A	A	A	A
Potassium Sulfate, Dilute	B	A	A	A	A	A	A
Potassium Sulfate, Dilute, Boiling	D	B	B	B	B	B	A
Potassium Sulfide, Saturated	C	A	C	A	A	A	A

Corrosive Media	Carbon Steel	Inconel	Monel	Nickel	303 & 304 Stainless Steel	316 Stainless Steel	Teflon
Propane, Liquid and Gas	B	A	A	A	A	A	A
Pyrogallic Acid	B	B	A	A	A	A	A
Rosin, Molten	D	A	A	A	A	A	A
Salicylic Acid	D	B	B	B	B	B	A
Silver Bromide	D	C	B	C	B-3	A-3	A
Silver Chloride	D	C	B	C	D	D	A
Silver Nitrate	X	A	C	D	A	A	A
Sodium Acetate	C	A	A	A	A	A	A
Sodium Bisulfate	D	B	A	B	B	B	A
Sodium Bisulfate, 140°F	D	C	B	C	B	B	A
Sodium Bromide, Dilute	X	B	A	B	B-3	A-3	A
Sodium Carbonate, 5%, Hot	B	A	A	A	A	A	A
Sodium Chloride, Dilute	C	A	A	A	A	A	A
Sodium Chloride, Saturated, Boiling	D	A	A	A	C-3	B-3	A
Sodium Cyanide	B	B	A	B	B	B	A
Sodium Fluoride, 5%	D	B	A	A	B-3	A-3	A
Sodium Hydroxide, 50%	B	A	A	A	A	A	A
Sodium Hydroxide, <40%, 175°F	D	A	A	A	A	A	A
Sodium Hydroxide, 40-80%, 175°F	D	A	A	A	A	A	A
Sodium Hydroxide, <30%, Boiling	D	A	B	A	A	A	A
Sodium Hydroxide, >30%, Boiling	D	A	B	A	C	B	A
Sodium Hydroxide, Molten	D	B	B	A	D	D	D
Sodium Hypochlorite (Still), 5%	D	C	C	C	C-3	B-3	A
Sodium Hyposulfite	D	B	A	A	B	A	A
Sodium Nitrate	B	A	B	A	B	A	A
Sodium Perborate	C	A	B	B	A	A	A
Sodium Peroxide	C	A	B	B	A	A	A
Sodium Phosphate, Tribasic	C	A	A	A	A	A	A
Sodium Silicate	B	A	B	B	A	A	A
Sodium Sulfate (All concentrations)	B	B	A	A	B	A	A
Sodium Sulfate, Hot	D	B	A	B	C	B	A
Sodium Sulfide, Saturated	B	A	B	A	B-3	A	A
Sodium Sulfite, Hot	D	C	B	C	B	A	A
Sodium Thiosulfate	D	B	B	B	B	A	A
Stannic Chloride, <5%	D	D	B	B	D	D	A
Stannic Chloride, >5%	D	D	C	D	D	D	A
Stannic Chloride, SG 1.21, Boiling	D	D	D	D	D	D	A
Stannous Chloride, Saturated	D	B	B	B	D	B	A
Steam, 212°F	A	A	A	A	A	A	A
Steam, 600°F	C	A	A	A	A	A	D
Sulfite, Liquors	D	D	D	D	C	B	A
Sulfur, Molten, 266°F	B	A	A	A	B	A	A
Sulfur, Chloride	D	B	B	B	D	C	A
Sulfur Dioxide, 250°F, Dry	B	B	B	B	A	A	A
Sulfur Dioxide, Moist	D	D	D	D	B	A	A
Sulfuric Acid, <2%	D	B	B	B	C	B	A
Sulfuric Acid, 2-40%	D	B	B	B	D	D	A
Sulfuric Acid, 40%	D	B	B	B	D	D	A
Sulfuric Acid, Concentrated	B	B	D	D	B	B	A
Sulfuric Acid, <10%, Boiling	D	C	B	D	D	D	A
Sulfuric Acid, 10-80%, Boiling	D	D	C	D	D	D	A
Sulfuric Acid, Concentrated, Boiling	D	D	D	D	D	D	A
Sulfurous Acid, Saturated	D	D	D	D	B	B	A
Tannic Acid, 10%	D	B	A	A	A	A	A
Tar, Hot	B	A	B	B	A	A	A
Tartaric Acid, 120°F	D	A	A	A	B	A	A
Toluene	A	A	A	A	A	A	A
Trichlorethylene	B	A	A	A	A	A	A
Turpentine	B	A	A	A	A	A	A
Varnish, Hot	C	A	A	A	A	A	A
Vegetable Oils	B	A	B	B	A	A	A
Vinegar	D	A	A	A	A	A	A
Water, Acid Mine	D	A	C	C	A-3	A-3	A
Water, Boiler Feed	B	A	A	A	A	A	A
Water, Distilled	D	A	A	A	A	A	A
Water, Salt Sea	D	B	A	C	C-3	B-3	A
Whiskey, Boiling	D	A	C	B	A	A	A
Wine	D	A	C	B	A	A	A
Xylene, Boiling	X	A	A	B	A	A	A
Zinc Chloride, 5%	D	B	B	B	C-3	B-3	A
Zinc Chloride, 5%, Boiling	D	D	B	C	D	D	A
Zinc Sulfate, Boiling	D	B	A	B	A	A	A

CERAMIC AND METAL COATINGS

FOR THERMOWELLS, PROTECTION TUBES, AND BARE SENSORS

Increasing numbers of industrial firms are specifying reliable, high quality thermal coating for repair, restoration and enhancement of mechanical or process equipment. Knowledgeable operations personnel regularly take advantage of the many cost savings and performance improvements now available from these processes and materials; some of which were previously used only for aerospace applications.

BACKGROUND AND USES

Thermal spraying is a process which uses combustion, electric arc or gas plasma, combined with an inert feeder gas, to apply a wide variety of molten metals, ceramics, oxides, and carbides to a target substrate. Combining various substrates with particular coatings allows engineers to choose from using a coated component instead of a solid one.

Some of the major use categories for thermal spray coatings are to increase wear resistance, prevent corrosion, provide thermal barriers or electrical insulation, and restore parts to their original dimensions. In concert with each of these categories, advanced finishing techniques provide a broad spectrum of surface finishes ranging from 1 RMS to over 300 RMS to meet virtually any requirement.

Plasma Arc Spray

Plasma arc spraying is the workhorse of the thermal spray processes. The material to be sprayed is introduced in powder form in the plasma gas stream either in the torch nozzle or just outside the nozzle. The velocity of the plasma stream that exits the nozzle is about the velocity of sound in air. The velocity of spray is usually increased by constricting the torch nozzle. Argon and helium are popular plasma gases, and if these are properly used, the spray deposit will contain very little oxide. This is a process advantage over thermal spray processes that use air as gas to produce the consumable spray. The intense heat of the plasma does not produce substantial substrate heating. Most of the heat to the substrate comes from the heat from the impinging consumable droplets and substrate temperatures usually do not get over 250 degrees F. When substrate heating becomes a consideration, on for example thin wall tubes, auxiliary jets of inert gas are used for substrate cooling. Hundreds of powder consumables are available. They fall into four different categories: metals, ceramics (primarily oxides and carbides), cermets and composites. The most popular ceramic coatings are aluminum oxide and chromium oxide. They are used mostly for wear applications. Ceramics such as yttria-stabilized zirconia and magnesium zirconate are used for thermal barrier applications. The most popular cermet consumable used in plasma spraying is tungsten carbide/cobalt. The mechanical, physical, and chemical properties of a thermal spray deposit may be different from the properties of the same material in bulk. Plasma spraying has been so extensively used in critical components that there is significant data on the properties of many deposits. In general, the differences between spray and bulk properties are inconsequential.

CERAMIC AND METAL COATINGS

Thermal Combustion Spray

Thermal combustion jet spraying was first offered on a commercial basis in 1981. The consumable to be sprayed is introduced into the center of the jet stream from a powder feeder using a carrier that is compatible with the fuel gas mixture. Bond strength is the product of the particle velocity and temperature. The deposit densities are about 95% or better and porosity of the coating can be as little as 0.5%.

Thermal Combustion Wire Process

The materials that can be sprayed with the wire flame spray process include any material that can be made into flexible wire that will melt in the oxyacetylene flame. Many consumables are available, but the commonly sprayed materials are zinc and aluminum, and are used primarily for corrosion protection. The bronzes and hard steels are used for wear protection, and the soft steels and molybdenum are used as rebuilding material for repair jobs. There is no thickness limit to this process, and deposits as thick as 0.25: have been made. A common thickness for wire spray deposits is 0.030” to 0.050” for wear applications and rebuilding. For corrosion applications, deposits can be as thin as 0.001”.

QUALITY ASSURANCE PROGRAM

JMS Southeast, Inc. employs one of the most rigorous Quality Assurance programs in the industry. Our specially formulated powders can be traced from the location where they are mined, through each refining process, to the finished product ready for use at our plant. Each coating application undergoes analysis by either the metallographic or petrographic laboratory prior to release. This assures our customers of receiving consistently reproducible coatings of the highest quality.

CUSTOMER SERVICE

Because we use state-of-the-art coating systems, waste is virtually eliminated and high coating speeds are attained. These factors allow us to offer the highest quality coatings at the most competitive prices available today.

INDUSTRIAL PRODUCTS

Almost any industry can benefit from JMS Southeast’s coating experience and service. We have wells and other coated parts for the Textile Industry, Power Industry, Petrochemical Industry, Pulp and Paper, Steel Industry, Aluminum Plants, Glass Plants and Wire Drawing Industry just to name a few.

JMS also has the capabilities to teflon coat any thermowells, protection tubes or sensors as needed. Teflon coating will prolong the life of the sensor by protecting it from many forms of chemical attack.

Pleas contact JMS for prices on our many coatings services.

FREQUENTLY USED COATINGS

COATING DESIGNATION	NOMINAL CONSTITUENTS	COMMENTS
	PLASMA SPRAYS	
USSE-115-P	Molybdenum	Hardness, 350 DPH Bond Strength, 8300 psi
USSE-280-P	Cobalt-Chromium-Alumni-num-Yttrium (Co-Cr-Al-Y)	Bond strength 5000 psi
USSE-462-P	Tungsten-Carbide Chrome-Carbide Nickel	Hardness, 800 DPH Bond strength, 8700 psi Porosity, less than 3%
USSE-601-P	Aluminum Oxide	Hardness, 1100 DPH Bond strength, 7000 psi Porosity, less than 4%
USSE-660-P	Zirconium Dioxide-Yttria	Hardness, 260 DPH Bond varies between 2200 psi and 6300 psi
	THERMAL HVOF COMBUSTION SPRAYS	
USSE-205-M	Stellite 6-type Alloy	Hardness, 390 DPH Bond strength, 11,000 psi
USSE-230-M	Hastelloy-B-2 Type Alloy	Hardness, 315 DPH Bond strength, 10,000 psi
USSE-231-M	Hastelloy-C-276 Type Alloy	Hardness, 170 DPH Bond strength, 10,000 psi
USSE 282-M	Cobalt-Chrome-Aluminum-Yttrium (Co-Cr-Al-Y)	Hardness, 170 DPH Bond strength, 8000 psi
USSE-422-M	Cr3 C2-Ni Cr	Hardness, 870 DPH Porosity, less than 1% Bond strength, 10,000 psi
USSE-445-M	WC-9 Co	Hardness, 1220 DPH Porosity, less than 1% Bond strength 11,000 psi
USSE-475-M	Tungsten Carbide 10 Cobalt-4Chrome	Hardness, 390 DPH Bond strength, 11,000 psi
	WIRE TORCH	
USSE-118-W	Stellite 6-Type Alloy	Hardness, 390 DPH Bond strength, 4000 psi
USSE-206-W	Molybdenum	Hardness, 245 DPH Bond strength, 6000 psi
USSE-240-W	Monel-type composition	Hardness, 150 DPH Bond strength, 4300 psi
USSE-257-W	Nickel-Chrome	Hardness, 195 DPH Bond strength, 4000 psi

ADDITIONAL COATINGS

The following list includes an abbreviated list of additional coatings that are available. Although this list is not all inclusive, it does cover the majority of available coatings.

These lists of coating are for reference only. Please contact JMS's Engineering Department for application assistance. Our qualified staff will help you select the best coating for your application.

COATING DESIGNATION	NOMINAL CONSTITUENTS
PLASMA SPRAY	
USSE-120-P	Nickel
USSE-245-P	Nickel-Aluminum
USSE-247-P	NIckel-Graphite
USSE-255-P	Nickel-Chrome
USSE-420-P	Chrome Carbide-Ni Chrome
USSE-446-P	Tungsten Carbide-9 Cobalt
USSE-456-P	Tungsten Carbide-12 Cobalt
USSE-461-P	Tungsten Carbide-17 Cobalt
USSE-476-P	Tungsten Carbide-Cobalt-Chrome
USSE-610-P	Titanium Dioxide
USSE-615-P	Chrome Oxide
USSE-616-P	Chrome Oxide
USSE-680-P	Zirconium Dioxide-Calcium Oxide
USSE-701-P	Aluminum Oxide-40 Titanium Dioxide
	Ceramlon
THERMAL HVOF COMBUSTION SPRAY	
USSE-234-M	403 Stainless Steel
USSE-236-M	316 Stainless Steel
USSE-242-M	420 Stainless Steel
USSE-259-M	Nickel-Chrome
USSE-450-M	WC-1Z Co
USSE-460-M	WC-17 Co
USSE-463-M	Tungsten Carbide-Chrome Carbide-10 Nickel
USSE-481-M	TiC-60-Ni
WIRE TORCH	
USSE-101-W	Aluminum
USSE-122-W	Nickel
USSE-125-W	Zinc
USSE-208-W	Bronze
USSE-209-W	Aluminum-Bronze

TEMPERATURE COLOR SCALE*

Color	°F	°C
Black Heat	800 - 900	430 - 480
Faint Red	900 - 1050	480 - 570
Blood Red	1050 - 1170	570 - 630
Dark Cherry Red	1170 - 1240	630 - 670
Medium Cherry Red	1240 - 1370	670 - 740
Cherry or Dull Red	1370 - 1540	740 -840
Bright Red	1540 - 1650	840 - 900
Red-Orange	1650 - 1730	900 - 940
Orange	1730 - 1810	940 - 990
Lemon Yellow	1810 - 1880	990 - 1080
Light Yellow	1880 - 2190	1080 - 1200
White	2190 & above	1200 & above

*Observations made in a relatively dark place with no eye-shades. Observations in lighter areas will tend to shift temperatures higher.

JMS COATINGS APPLICATION CHECKLIST

The information requested below is a minimum requirement to enable JMS to provide a suitable application solution, particularly in the case of exotic metal and/or elements.

Jacket	____
Coating	____

1. Maximum temperature sensor will be exposed to:_____
   Continuous _____ Intermittent _____
2. Normal operating temperature _____
3. Process conditions:
   a) Gas, liquid, etc. _____
      (Please provide chemical concentration where possible)
   b) Approximate flow rate _____
   c) Special pressure or vibration considerations _____
   d) Any abrasive conditions _____
4. Temperature element details - RTD or Thermocouple type, etc. (This information is also requested in cases where JMS has been asked to supply only the thermowell.)

Platinum RTD	_____	E Thermocouple	_____
J Thermocouple	_____	R,B,S,Thermocouple	_____
K Thermocouple	_____	Other	_____

5. If a metal other than listed in the JMS catalog is specified (ex. - nickel or black steel), we need to know the content or appropriate ASTM, UNS, AISI-SAE number. _____
6. Is thermal shock a possibility? _____ Is the temperature cycled frequently? _____
   Does the probe remain immersed? _____
7. If in gas environment, is it oxidizing, reducing, or inert? _____
8. If this is to be a replacement application, information regarding the successes/failures of other units could be beneficial. When possible, please provide any manufacturer and part number information.
9. Other Comments _____
   _____

THERMAL PROCESSING / HEAT TREATING (ANNEALING)

If you wish to have your sensor annealed, you need to provide JMS with the correct time, temperature profiles.

All temperature treating processes start at room temperature.

Select Atmosphere: inert, vacuum, or ambient air

Select Portion of sensor to be temperature treated: hot end only, entire sensor, or component of sensor prior to assembly

Stage #1 Increase / decrease temperature to _____° F / C at a rate of _____° F/ C per minute. (Or instant, or doesn't matter)

Stage # 2 Allow to set at that temperature for _____hours / minutes.

Stage # 3 Increase / decrease temperature to _____° F / C at a rate of _____° F / C per minute. (Or instant, or doesn't matter)

Note: If water or other liquid quenching is required, please describe.

Specify if parts should be cleaned (buffed) free of any accumulated tarnishing caused by this process.