

Tubular and Process Assemblies

WATROD Heating Elements

Single- and Double-Ended Elements

Available in single- or double-ended termination styles, the versatile and economical WATROD tubular heating element lends itself to virtually the entire range of immersion and air heating applications.

The single-ended WATROD tubular design has both terminals at one end. The opposite end is sealed. Standard 12-inch (305 mm) flexible lead wires are crimp connected to the terminal pin and have silicone-impregnated fiberglass oversleeves.

The double-ended WATROD, with its round cross-sectional geometry, is highly adaptable for bending—especially when bending is performed in the field.

Watlow's new double-sided multicoil tubular elements offer various combinations of resistor coils and thermocouples inside one sheath. They have the ability to sense the heater's internal temperature accurately every time, or offer three-phase capability in one element. Both single- and double-ended WATRODs share many construction features that deliver long life—the resistance wire is centered in the heater sheath and electrically insulated with compacted, high-grade magnesium oxide for superior heating performance.

WATROD heating elements have a variety of mounting and termination options that make them highly popular among industrial customers.

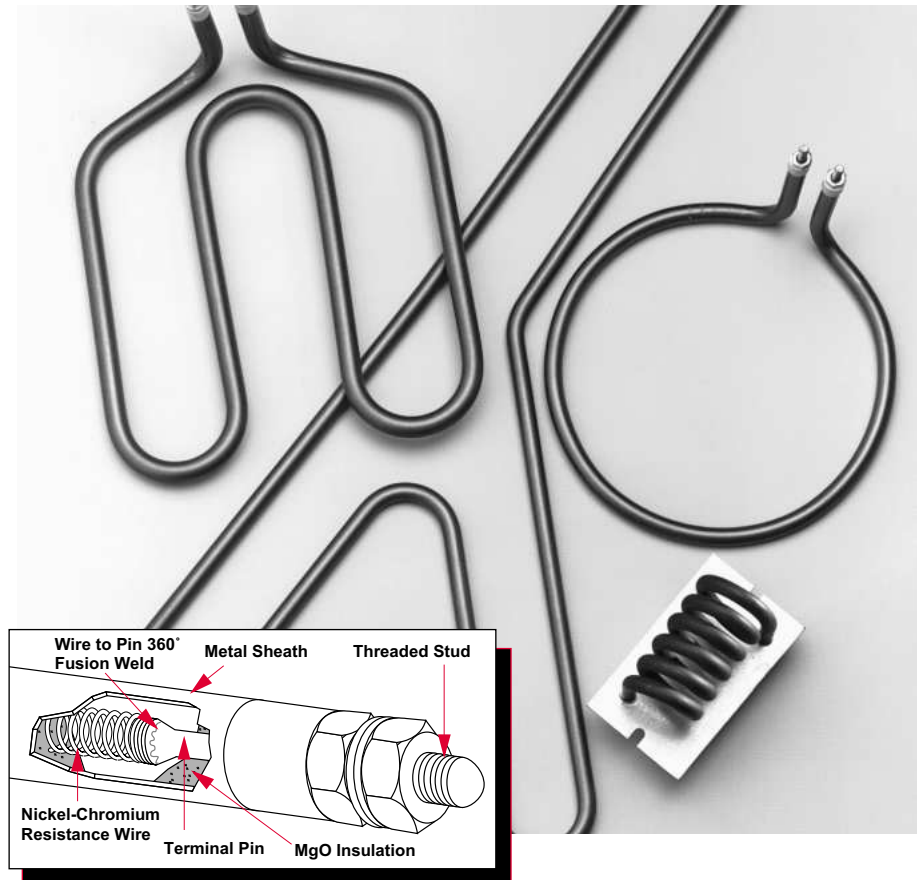
Single-Ended WATROD Performance Capabilities

- Watt densities to 45 W/in² (6.9 W/cm²)
- UL® and CSA component recognition to 240V~(ac)
- Incoloy® and stainless steel sheath temperatures to 1200°F (650°C)

Double-Ended WATROD Performance Capabilities

- Watt densities up to 120 W/in² (18.6 W/cm²)

UL® is a registered trademark of Underwriter's Laboratories, Inc.



- UL® and CSA component recognition to 480 and 600V~(ac) respectively
- Inconel® sheath temperatures to 1800°F (982°C)
- Incoloy® sheath temperatures to 1600°F (870°C)
- Stainless steel sheath temperatures to 1200°F (650°C)
- Steel sheath temperatures to 750°F (400°C)
- Copper sheath temperatures to 350°F (175°C)
- Inconel® 600 sheath temperatures to 1800°F (982°C)

Features and Benefits

- **Precision wound nickel-chromium resistance wire** distributes heat evenly to the sheath for optimum heater performance.
- **Silicone resin seals** protect against moisture contamination and are rated to 390°F (200°C).

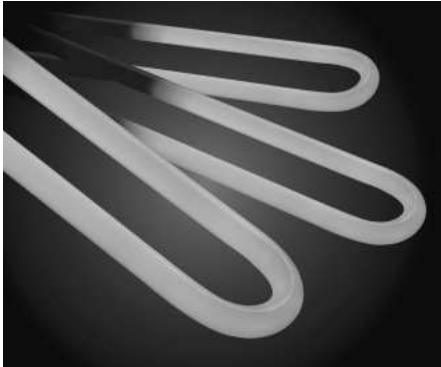
- **MgO insulation filled sheath** maximizes dielectric strength, heat transfer and life.
- **Standard sheath materials include:** copper, steel, 316 stainless steel and Incoloy®. Optional materials, available on made-to-order, include 304 stainless steel, Inconel® Monel® and titanium.
- **36 standard bend formations** allow forming the heating element to the application. Spirals, compound bends and multi-axis and multi-plane configurations.
- **Resistance wire fusion welded to the terminal pin** for a stronger, positive electrical connection.
- **Stainless steel studs** are fusion welded to terminal pins for mechanical strength with ceramic insulators.
- **Popular termination, mounting and moisture seal options available.**

Incoloy®, Inconel® and Monel® are registered trademarks of Special Metals Corporation.

Tubular and Process Assemblies

WATROD Heating Elements

High Temperature Tubular Double-Ended Elements



Watlow manufactures high temperature tubular heaters to bridge the gap between standard tubular heaters and Watlow multicell heaters. This new tubular is well suited for process air heating applications in excess of 1300°F (704°C), resulting in a maximum sheath temperature of 1800°F (983°C). Controlled lab testing between the new design and

current tubular designs show an increase in life of approximately 50 percent.

The high temperature tubular consists of an engineered tubing with an outer sheath of Inconel® 600 and a special internal construction. The outer sheath offers high temperature capabilities, reduced oxidation, as well as corrosion resistance.

The new tubular offering is available in 0.430 and 0.375 inch diameters that are configurable either as formed tubulars or process heaters. The heaters can also be welded to flanges and plates for mounting purposes. Maximum sheath length available is 275 inches for the 0.430 inch and 0.375 inch diameters. The factory should be contacted for longer sheath lengths.

Features and Benefits

- **Inconel® 600 sheath material and a special internal construction** assures high temperature performance and corrosion protection in tough applications.

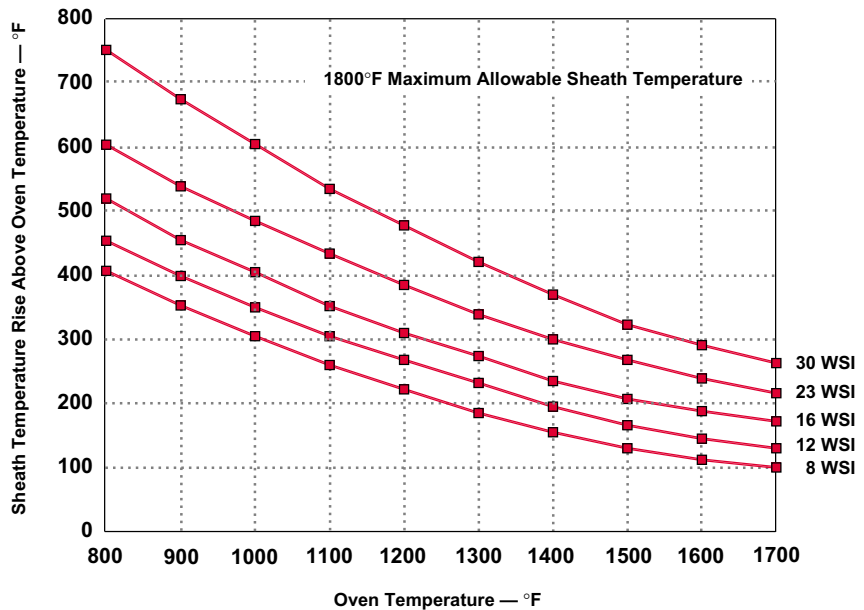
- **0.375 in and 0.430 in diameters** allow heater to be configured to existing tubular designs that may be experiencing short life.
- **Dual-ended termination** can be installed into flanges and screw plugs similarly to standard product configurations.
- **Bendable in standard formations** makes the heater easy to apply in a wide variety of applications.

Applications

- High temperature ovens and furnaces
- Radiant heating
- Drying
- Environmental—VOC abatement
- Process air heating: duct heaters, circulation heaters
- Vacuum applications
- Flue gas cleaning (desulphurization)
- Fluidized beds

Sheath Temperature Versus Oven Temperature at Various Watt Density

This chart is used to verify the correct watt density for an oven application assuming no air flow. To use the chart, first select the oven process temperature on the X axis, using the chosen watt density read the sheath temperature rise above oven temperature from the Y axis. This number should then be added to oven temperature. If this number is greater than 1800°F (982°C), a lower watt density should be chosen.



Tubular and Process Assemblies

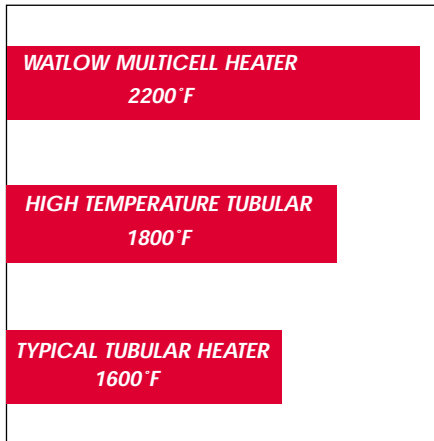
WATROD Heating Elements

High Temperature Tubular Double-Ended Elements

Continued

Heater Life Estimate Service

High Temperature Heater Comparisons



*Assuming normal design practices.

Watlow now provides an industry first service with the offering of the high temperature tubular. By providing operating parameters Watlow can provide customers with the estimated life of the heater. To get this information the following information should be provided:

- Heater voltage
- Heater wattage
- Heater diameter (0.430 in or 0.375 in)
- Heated length
- Bend configuration and dimensions (# of bends and radius)
- Application including process temperature
- Power switching device and cycle time (SCR, etc.)

WATROD

F.O.B.: Hannibal, Missouri

How to Order

To order please specify:

- Volts
- Watts
- Heater diameter (0.430 in or 0.375 in)
- Termination type or style (studs, lead wire)
- Heated length
- Cold end length
- Overall sheath length
- Formation
- Mounting option (bulkheads, brackets, etc.)

Tubular and Process Assemblies

WATROD Heating Elements

Multicoil Single- or Double-Ended Elements



Watlow's new tubular element with multiple coils and/or thermocouples inside one sheath answers the need for a versatile, innovative tubular heater. Our new, patent-pending method of packaging a thermocouple inside of a heater with one or more resistance coils, gives the ability to sense a heaters' internal temperature accurately, every time.

Moreover, this is the first tubular heater in the industry with three-phase capability. The three coil, three-phase heater will offer a lower amperage solution while delivering the full power required in a compact heater package.

Previously three separate heaters would have been required to do the same job; therefore Watlow's new multicoil heater capabilities save money.

Watlow has the capability to put up to two coils in a 0.375 or 0.430 diameter heater and up to three coils in a 0.475 or 0.490 diameter heater. Any one or more of these coils can be a resistance wire or a thermocouple. The bending formations are virtually limitless; while mounting options are similar to other Watlow tubular heaters. The three-phase multicoil heaters can be single ended with three leads for three-phase wye hook up. Watlow recommends using an epoxy moisture seal or silicone-based seal.

Watlow's multicoil heaters are available in all standard materials such as Incoloy®, 304 and 316 stainless steel, and can be formed into almost any configuration. Our five thermocouple and/or coil options for multicoil tubular configurations will meet most requirements; however, we are always interested in discussing the use of different materials or changing the number of coils and thermocouples.

Features and Benefits

- **Three-phase capability** results in one element versus three, lower amperage, reduced installation time and lower overall cost.
- **Internal thermocouple** allows responsive and accurate, internal, high-limit sensing and reduced assembly costs.
- **Single ended** allows for mounting in a ½ inch NPT or ¾ inch NPT fitting with three-phase capability.
- **Multiple coil options** reduce inventory by allowing dual voltage capability.
- **Versatile forming capabilities** can be formed into virtually any configuration.
- **Internal construction** allows space savings because drilling and tapping of flange is unnecessary; plus, the interior thermocouple eliminates contamination buildup around the external sensing tip, reducing the possibility of false readings.

Applications

- Foodservice
- Process
- Medical
- Milled groove
- Plastics
- Plating
- Oven heating
- Semiconductor

Tubular and Process Assemblies

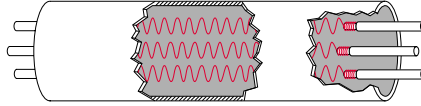
WATROD Heating Elements

Multicoil Single- or Double-Ended Elements

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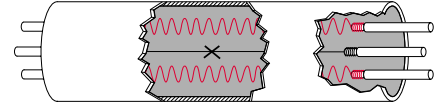
Options

Option A



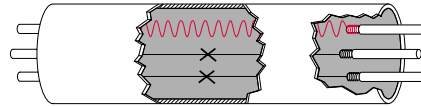
3-phase tubular, 0.475 and 0.490 inch diameter.

Option B



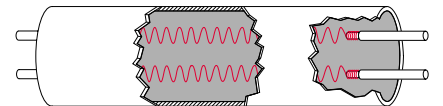
1-phase tubular with two resistance wires and one thermocouple, 0.475 and 0.490 inch diameter.

Option C



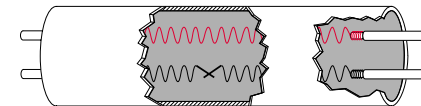
1-phase tubular with one resistance wire and two thermocouples, 0.475 and 0.490 inch diameter.

Option D



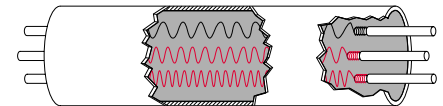
1-phase tubular with three different one phase circuits, 0.475 and 0.490 inch diameter.

Option E



1-phase tubular with two resistance coils, 0.375, 0.430, 0.475 and 0.490 inch diameter.

Option F



1-phase tubular with one resistance coil and one thermocouple, 0.375, 0.430, 0.475 and 0.490 inch diameter.

Specifications

Termination style is currently limited to lead wires 392°F (200°C) Sil-A-Blend™ or 482°F (250°C) GGS.

- Moisture seals** are required, options include:
- Standard epoxy with temperature rating to 266°F (130°C). Typical applications include water/oil immersion.
 - Lavacone with temperature rating to 300°F (148.9°C). Typical application includes air heating.
 - High-temp ceramic rated to 2800°F (1537.8°C).
 - Consult factory for other moisture seal options.
 - ULTRAGARD with temperature rating to 700°F (375°C).

Mounting options include:

- Mounting brackets
- Locator washers
- Mounting collars
- Water-tight bulkheads

Maximum trim length is 237 inches (6020 mm). Heater designs with trim length greater than 120 inches (3048 mm) must be reviewed with factory.

Sheath materials: Incoloy®, 304 and 316 stainless steel, consult factory for other sheath material options.

Internal thermocouple options: Type K is used, consult factory for Type J thermocouple options.

U.S. Patent Pending

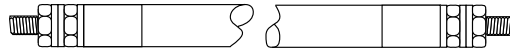
Sil-A-Blend™ is a trademark of Radix Wire Company.

Tubular and Process Assemblies

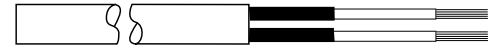
WATROD Heating Elements

Specifications

Double-Ended



Single-Ended



Applications	Direct immersion Hot runner mold (manifold) Forced air Ovens Radiant Clamp-on	Vacuums Semiconductor	Platens Forced air Deicing antennas Plastic wrap cutting Seal bars
Watt Density W/in ² (W/cm ²)	Stock: Made-to-Order (M-t-O):	up to 60 (9.3) up to 120 (18.6)	Stock: M-t-O: up to 20 (3.1) up to 45 (6.9)
Element Diameters and Surface Area per Linear	Dia. in²	Dia. (mm) cm²	Dia. in² Dia. (mm) cm²
inch (mm)	0.210 0.660	(5.3) (4.26)	0.375 1.178 (9.5) (7.600)
and Surface Area per Linear	0.260 0.817	(6.6) (5.27)	0.430 1.351 (10.9) (8.717)
inch (cm)	0.315 0.990	(8.0) (6.38)	0.475 1.492 (12.0) (9.626)
Diameter Tolerance	0.332 1.043	(8.4) (6.73)	0.490 1.539 (12.4) (9.930)
± 0.005 inch (0.13 mm)	0.375 1.178	(9.5) (7.60)	0.625 1.963 (15.9) (12.665)
	0.430 1.351	(10.9) (8.72)	
	0.475 1.492	(12.0) (9.63)	
	0.490 1.539	(12.4) (9.93)	
	0.625 1.963	(15.9) (12.66)	
Sheath Materials	Stock:	Incoloy® 1600°F (870°C)	Stock: Incoloy® 1200°F (650°C)
Maximum Operating Temperature		316 stainless steel 1200°F (650°C)	
		Steel 750°F (400°C)	
		Copper 350°F (175°C)	
	M-t-O:	Inconel® 600 1800°F (980°C)	M-t-O: Incoloy® 1600°F (870°C)
		Incoloy® 1600°F (870°C)	316 stainless steel 1200°F (650°C)
		316 stainless steel 1200°F (650°C)	304 stainless steel 1200°F (650°C)
		304 stainless steel 1200°F (650°C)	Steel 750°F (400°C)
		Steel 750°F (400°C)	
		Copper 350°F (175°C)	
		Monel® Consult Factory	
		Titanium Consult Factory	
Sheath Length By Diameter	Dia. Sheath Length	Dia. Sheath Length	Dia. Sheath Length
inch (mm)			
	Stock:		Stock:
	0.260 20 to 80	(6.6) (510 to 2030)	0.375 15 to 40 (9.5) (380 to 1015)
	0.315 12 to 100	(8.0) (305 to 2540)	
	0.375 11 to 180	(9.5) (275 to 4555)	
	0.430 15 to 120	(10.9) (380 to 3050)	
	0.475 20 to 157	(12.0) (510 to 3990)	
	M-t-O:		M-t-O:
	0.210 9 to 130	(5.3) (230 to 3300)	0.375 11 to 125 (9.5) (280 to 3175)
	0.260 9 to 275	(6.6) (230 to 6980)	0.430 11 to 106 (10.9) (280 to 2690)
	0.315 9 to 270	(8.0) (230 to 6850)	0.475 11 to 125 (12.0) (280 to 3175)
	0.332 9 to 125	(8.5) (230 to 3170)	0.490 11 to 125 (12.4) (280 to 3175)
	0.375 11 to 325	(9.5) (280 to 8255)	0.625 11 to 125 (15.9) (280 to 3175)
	0.430 11 to 268	(10.9) (280 to 6810)	
	0.475 11 to 275	(12.0) (280 to 6985)	
	0.490 11 to 275	(12.4) (280 to 6985)	
	0.625 11 to 275	(15.9) (280 to 6985)	

Tubular and Process Assemblies

WATROD Heating Elements

Specifications

Double-Ended



Single-Ended



Minimum No-Heat Length inch (mm)	Sheath	No-Heat	Sheath	No-Heat	Sheath	No-Heat	Sheath	No-Heat
	Length	Length	Length	Length	Length	Length	Length	Length
	11 to 20	1	(280 to 510)	(25)	11 to 20	1½	(280 to 5100)	(38)
	21 to 50	1½	(535 to 1270)	(32)	21 to 50	1½	(533 to 1270)	(44)
	51 to 80	1½	(1295 to 2030)	(38)	51 to 80	2½	(1295 to 2030)	(54)
	81 to 110	1½	(2055 to 2795)	(42)	81 to 110	2½	(2055 to 2795)	(60)
	111 to 140	1½	(2820 to 3555)	(44)	111 to 125	2½	(2820 to 3175)	(67)
	141 to 170	2	(3580 to 4320)	(51)				
	171 to 200	2½	(4345 to 5080)	(57)				
	201 & up	2½	(5105 & up)	(64)				
	½ inch (13 mm) No-heat length on all blunt ends							
Maximum Voltage/Amperage By Dia. inch (mm)	Dia.	Volts	Amps		Dia.	Volts	Amps	
	0.260 (6.6)	250V~(ac)	15		0.375 (9.5)	480V~(ac)	30	
	0.315 (8.0)	480V~(ac)	30		0.430 (10.9)	480V~(ac)	30	
	0.332 (8.5)	480V~(ac)	30		0.475 (12.0)	480V~(ac)	30	
	0.375 (9.5)	480V~(ac)	30		0.490 (12.4)	480V~(ac)	30	
	0.430 (10.9)	600V~(ac)	40		0.625 (15.9)	480V~(ac)	30	
	0.475 (12.0)	600V~(ac)	40					
	0.490 (12.4)	600V~(ac)	40					
	0.625 (15.9)	600V~(ac)	40					
Ohms Per Heated Inch By Dia. inch	Dia.	Minimum	Maximum		Dia.	Minimum	Maximum	
	0.210	0.100Ω	16Ω		0.375	0.200Ω	34Ω	
	0.260	0.080Ω	25Ω		0.430	0.200Ω	34Ω	
	0.315	0.050Ω	25Ω		0.475	0.200Ω	34Ω	
	0.332	0.050Ω	23Ω		0.490	0.200Ω	34Ω	
	0.375	0.020Ω	18Ω		0.625	0.200Ω	34Ω	
	0.430	0.025Ω	30Ω					
	0.475	0.030Ω	30Ω					
	0.490	0.030Ω	30Ω					
	0.625	0.030Ω	25Ω					
Terminations	Stock:	Threaded stud			Stock:	Flexible lead wires		
	M-t-O:	Threaded stud Screw lug (plate) Quick connect (spade) Flexible lead wires Rubber overmolds			M-t-O:	Flexible lead wires Rubber overmolds		
Seals	Stock:	Silicone resin	390°F	(200°C)	Stock:	Silicone resin	390°F	(200°C)
	M-t-O:	Ceramic base	2800°F	(1535°C)	M-t-O:	Silicone rubber (RTV)	500°F	(260°C)
		ULTRAGARD	700°F	(375°C)		ULTRAGARD	700°F	(375°C)
		Ceramic-to-metal	500°F	(260°C)		Silicone resin	392°F	(200°C)
		Silicone rubber (RTV)	500°F	(260°C)		Epoxy resin	266/350°F	(130/177°C)
		Silicone resin	392°F	(200°C)				
		Epoxy resin	266/350°F	(130/177°C)				
Mounting Options	Threaded bulkheads Mounting brackets Locator washers Mounting collars				Threaded bulkhead Locator washers Mounting collars			
Surface Finish Options	Belt polishing				Belt polishing			
	Passivation				Passivation			
Agency Recognition	UL® Component to 480V~(ac) (file # E52951/E56488)				UL® Component to 240V~(ac) (file # E52951)			
	CSA Component to 600V~(ac) (file # 31388)				CSA Component to 240V~(ac) (file # 31388) ①			

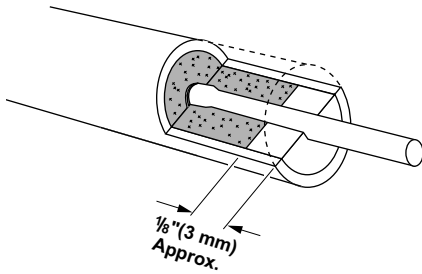
WATROD

① Not applicable to 0.375 inch diameter single-ended WATROD

Tubular and Process Assemblies

WATROD Heating Elements

Options



Moisture Resistant Seals

WATROD's MgO insulating material is hygroscopic. To prevent moisture contamination from entering the heater, an appropriate moisture seal must be used. Choosing the correct seal is important to the life and performance of the heater. Be sure

the maximum continuous use temperature is not exceeded at the seal location. Most end seals are applied with a small cavity in the end of the heater. The seal will also help prevent arcing at the terminal ends.

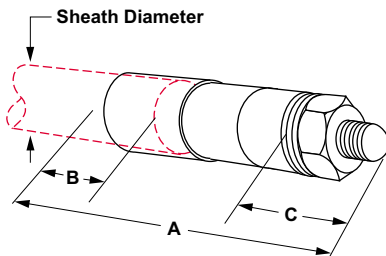
End Seal Options

End Seal	Code Number	Color	Seal Depth	UL® Recognition	Max. Cont. Use Temperature	Typical or General Usage/Application
Standard Epoxy	EC	Cream	3/16"	Yes	266°F (130°C)	General purpose for moisture resistance
Intermediate Epoxy	EB	Blue	3/16"	Yes	350°F (177°C)	Intermediate temp. rating for moisture resistance
High-Temp. Epoxy	HTE	Amber	3/16"	No	450°F (232°C)	Higher temp. rating for moisture resistance
Silicone Resin	SR	Clear	3/16"	Yes	392°F (200°C)	General usage on tubular products
Silicone Fluid	SF	Clear	N/A	No	392°F (200°C)	Moisture resistance of the MgO, or High-Temp. ceramic seal (storage only)
Lavacone	LC	Dark Brown	3/16"	Yes	392°F (200°C)	Porous seal for the FIREBAR
Silicone Rubber RTV	RTV	Red-Orange	3/16"	Yes	500°F (260°C)	General usage on FIREBAR applications
ULTRAGARD	UG	Clear	3/16"	Yes	700°F (350°C)	High temp. around seal area and for vacuum applications
High-Temp. Ceramic	HTC	White	3/16"	No	2800°F (1538°C)	Very high temperature applications

Ceramic-to-Metal End Seal

Sheath Diameter	A	B	C	Thread Size
inch (mm)	inch (mm)	inch (mm)	inch (mm)	
0.260 (6.6)	1 11/16 (40)	1/2 (13)	1 1/32 (10)	#8-32
0.315 (8)	1 1/8 (43)	1/2 (13)	1 1/32 (10)	#10-32
0.430 (10.9)	2 1/8 (54)	1/2 (13)	2 1/32 (10)	#1/4-28

To order specify, **ceramic-to-metal end seal**.



Ceramic-to-metal end seals with threaded stud terminations provide an air-tight seal for continuous terminal temperatures up to 500°F

(260°C). Watlow does not recommend this seal if terminations are exposed to temperatures exceeding 500°F (260°C).

External Finishes

Belt Polishing

Belt polishing sands the oxidized sheath to a bright finish. This finish is available only on alloy sheath materials.

To order, specify **belt polishing**.

Bright Annealing

A process that produces a smooth, metallic finish. It is a special annealed finish created in a non-oxidizing atmosphere. This finish is popular in the pharmaceutical and food and beverage markets.

To order, specify **bright annealing**.

Passivation

During the manufacturing process, particles of iron or tool steel may become embedded in the stainless steel or alloy sheath. If not removed, these particles may corrode, produce rust spots and/or contaminate the process. For critical sheath applications, passivation will remove free iron from the sheath.

To order, specify **passivation**.

Tubular and Process Assemblies

WATROD Heating Elements

WATROD Terminations

Double-ended WATROD elements are available with a variety of terminations. Single-ended WATROD elements are available with only flexible lead wires.

The following table and illustrations detail the terminations available with double- or single-ended WATRODs—for each available sheath diameter.

Standard flexible lead wires are 12 inches (305 mm), Sil-A-Blend™ 390°F (200°C) unless otherwise

specified. Insulation options include TGGT (480°F/250°C) plus other temperature ratings. Consult factory for availability.

Overmolds are available for flexible lead wires only. Available in silicone rubber (390°F/200°C), neoprene (212°F/90°C) and other materials. Consult factory for details.

WATROD Element	Sheath Diameter		Threaded Stud ^①	Screw Lug (Plate)				Quick Connect (Spade)			Flexible Lead Wires	Lead Wire Overmolds
	inch	(mm)		A	B	C	D	E	F	G		
Double-Ended	0.260	(6.6)	#6-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.315	(8.0)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.335	(8.5)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	0.375	(9.5)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	0.430	(10.9)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.475	(12.0)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	0.490	(12.4)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
Single-Ended	0.625	(15.9)	#10-32	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
	0.375	(9.5)	No	No	No	No	No	No	No	No	Yes	No
	0.430	(10.9)	No	No	No	No	No	No	No	No	Yes	Yes
	0.475	(12.0)	No	No	No	No	No	No	No	No	Yes	Yes
	0.490	(12.4)	No	No	No	No	No	No	No	No	Yes	No
	0.625	(15.9)	No	No	No	No	No	No	No	No	Yes	Yes

WATROD

A Threaded Stud

① Optional #8-32, ¼ inch and 4 or 5 mm studs available. Consult factory for details.

B Screw Lug (Plate)

E Quick Connect (Spade)

H Flexible Lead Wires

C Screw Lug (Plate)

F Quick Connect (Spade)

J Rubber Overmolds

Overmold Availability

Sheath Diameter		A		B	
inch	(mm)	inch	(mm)	inch	(mm)
0.260	(6.6)	2 ½	(63.5)	½	(13.0)
0.315	(8.0)	2 ½	(63.5)	½	(13.0)
0.375	(9.5)	2 ½	(63.5)	¾	(15.9)
0.430	(10.9)	2 ½	(63.5)	¾	(15.9)
0.475	(12.0)	2 ½	(63.5)	¾	(15.9)
0.625	(15.9)	2 ½	(63.5)	7/8	(22.2)

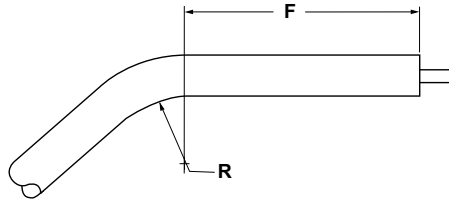
Tubular and Process Assemblies

WATROD Heating Elements

Double-Ended WATROD Bend Formations

Double-ended WATROD heating elements can be formed into spirals, compounds, multi-axis and multi-planes from 36 common bend configurations. Custom bending with tighter tolerances can be made to meet specific application needs. Formation is limited by the minimum bend radius (R) and the straight length (F) required beyond the bend. In order to locate the end of a heated length within a bend, the radius must be three inches (76 mm) or larger. Additionally, overall length tolerance (T) must be included in one or more of the straight lengths.

Minimum radius for various sheath diameters and lengths are shown in the *Bend Formations* chart below. Illustrated on **pages 282 to 286** are the 36 common bend configurations available on both stock and made-to-order WATROD heating elements.



Single-Ended WATROD Bend Formations

Watlow does not recommend field bending single-ended WATROD elements. Formation is limited by the minimum radius of a bend (R)

and the straight length (F) beyond the bend. The radius must be three inches (75 mm) or more for the heated length's end to be inside a bend.

Additionally, the overall length tolerance (T) must be provided for in one or more of the specified lengths.

The four common bend configurations available for standard and made-to-order single-ended WATROD elements are Figures 1, 6, 22 and 28.

To order a common bend formation, specify the **bend figure number**, dimensions and critical tolerances.

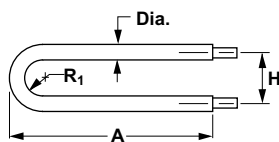
WATROD Length Tolerance (T)			
Sheath Length		Length Tolerance	
inch	(mm)	inch	(mm)
11-50	(280-1270)	±1/8	(±3)
51-110	(1295-2795)	±3/16	(±5)
111-170	(2820-4320)	±1/4	(±6)
171-200	(4345-5080)	±3/8	(±10)
201 & up	(5105 & up)	±1/2	(±13)

WATROD Minimum Radius							
Sheath Diameter		Field Bend R ^①		Factory R ^①		F ^② Dimension	
inch	(mm)	inch	(mm)	inch	(mm)	inch	(mm)
0.260	(6.6)	3/4	(19)	3/8	(10)	1/2	(13)
0.315	(8.0)	3/4	(19)	1/2	(13)	1/2	(13)
0.335	(8.5)	1	(25)	1/2	(13)	1	(25)
0.375	(9.5)	1	(25)	1/2	(13)	1/2	(13)
0.430	(10.9)	1	(25)	1/2	(13)	3/4	(19)
0.475	(12.0)	1	(25)	3/8	(16)	1	(25)
0.490	(12.5)	1	(25)	3/8	(16)	1	(25)
0.625	(15.9)	1 1/2	(38)	3/4	(19)	1 1/2	(38)

Bend Formations

- ① R is the inside radius of a bend.
- ② F is the distance from the sheath's end to the start of the first bend.

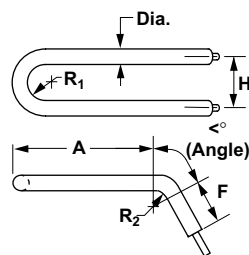
Figure 1



$$SL = 2A + 1.14R_1 - 0.43 \text{ Dia.}$$

(For pricing, use 1 bend)

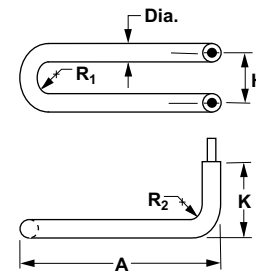
Figure 2



$$SL = 2A + 2F + 1.14R_1 + 0.0175 (\angle) (2R_2 + \text{Dia.}) - 0.43 \text{ Dia.}$$

(For pricing, use 3 bends)

Figure 3



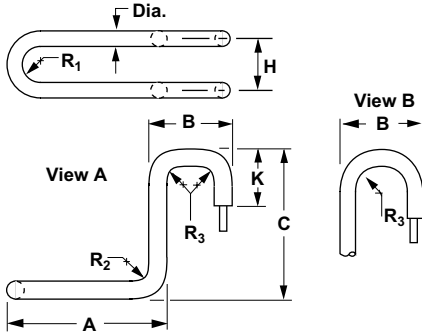
$$SL = 2K - 0.86R_2 - 2.86 \text{ Dia.} + 2A + 1.14R_1$$

(For pricing, use 3 bends)

Tubular and Process Assemblies

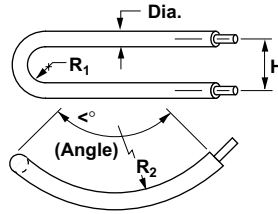
WATROD Heating Elements

Figure 4



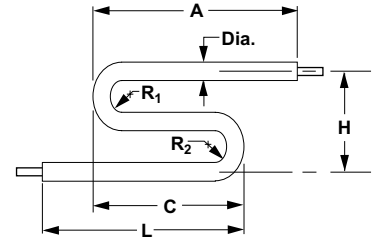
View A: $SL = 2K - 1.72R_3 - 7.72 \text{ Dia.} + 2C - 0.86R_2 + 2A + 1.14R_1$
 View B: $SL = 2K - 2.28R_3 - 3.72 \text{ Dia.} + 2C - 0.86R_2 + 2A + 1.14R_1$
 (For pricing, use 5 bends)

Figure 5



$SL = 0.0175(<^\circ) (2R_2 + \text{Dia.}) + 1.14R_1 + 0.43 \text{ Dia.}$
 (For pricing, use 3 bends)

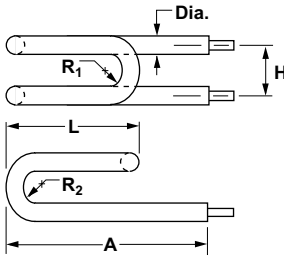
Figure 6



$SL = L + 1.14R_2 - 0.86 \text{ Dia.} + C + 1.14R_1 + A$
 (For pricing, use 2 bends)

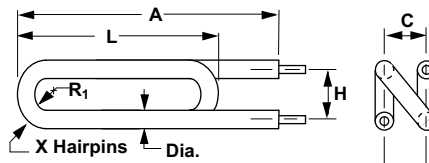
WATROD

Figure 7



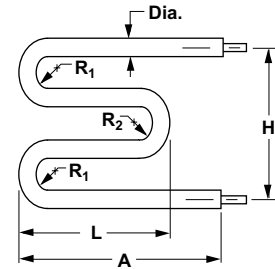
$SL = 2A + 2.28R_2 - 1.29 \text{ Dia.} + 2L + 1.14R_1$
 (For pricing, use 3 bends)

Figure 8



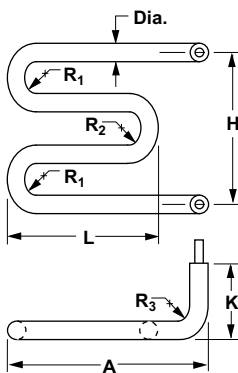
X = number of outside hairpins
 $SL = 2A + 3.42R_1 - 1.29 \text{ Dia.} + 2L$
 (For pricing, use 5 bends)

Figure 9



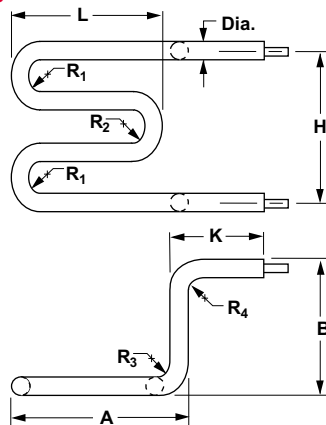
$SL = 2A + 2.28R_1 - 1.29 \text{ Dia.} + 2L + 1.14R_2$
 (For pricing, use 3 bends)

Figure 10



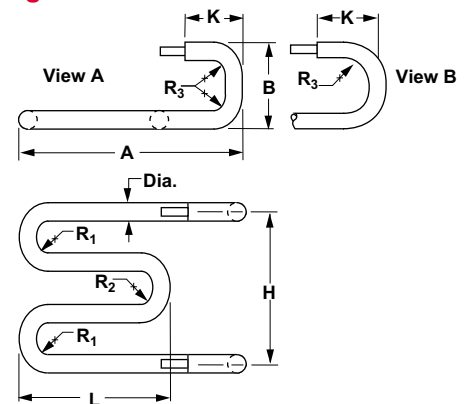
$SL = 2K - 0.86R_3 - 3.72 \text{ Dia.} + 2A + 2L + 2.28R_1 + 1.14R_2$
 (For pricing, use 5 bends)

Figure 11



$SL = 2K - 0.86R_3 - 0.86R_4 - 6.15 \text{ Dia.} + 2B + 2A + 2L + 2.28R_1 + 1.14R_2$
 (For pricing, use 7 bends)

Figure 12

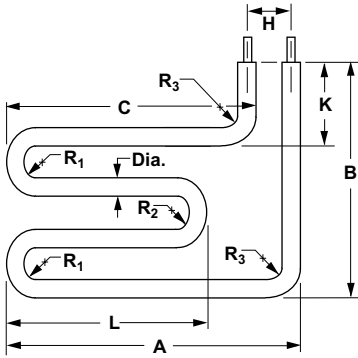


View A: $SL = 2K + 2B + 2A + 2L + 2.28R_1 + 1.14R_2 - 1.72R_3 - 6.15 \text{ Dia.}$
 View B: $SL = 2K + 2A + 2L + 2.28R_1 + 1.14R_2 - 2.28R_3 - 2.15 \text{ Dia.}$
 (For pricing, use 5 bends)

Tubular and Process Assemblies

WATROD Heating Elements

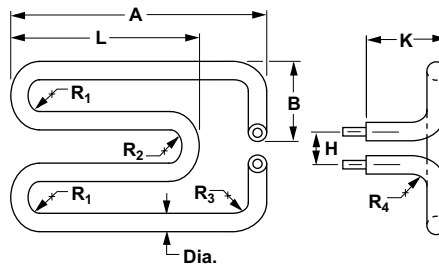
Figure 13



$$SL = 2B + 2A + 2L - 6.717 \text{ Dia.} - 1.717R_1 - H - 0.858R_2 - 0.858R_3$$

(For pricing, use 5 bends)

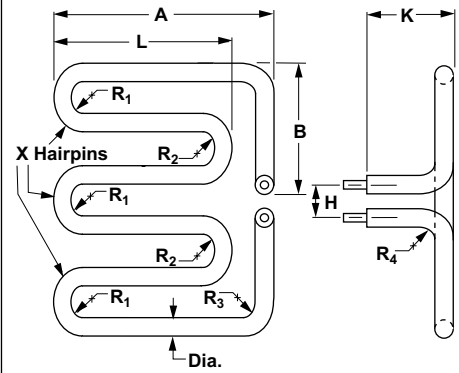
Figure 14



$$SL + 2K + 2A + 2L + 2.28R_1 + 1.14R_2 + 2B - 6.15 \text{ Dia.} - 0.86R_3 + 0.86R_4$$

(For pricing, use 7 bends)

Figure 15

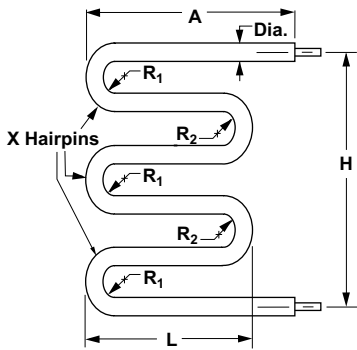


X = number of outside hairpins

$$SL = 2K + 2A + 2K(X - 1) + 2B - 0.86R_3 - 0.86R_4 + 1.14R_1(X) + 1.14R_2(X - 1) - 4.86 \text{ Dia.} - (2X - 1) 0.43 \text{ Dia.}$$

(For pricing, use 9 bends if X = 3 hairpins)

Figure 16

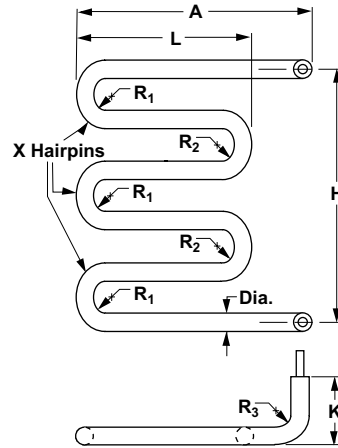


X = number of outside hairpins

$$SL = 2A + 0.43 \text{ Dia.} (1 - 2X) + 2L(X - 1) + 1.14R_1 + 1.14R_2(X - 1)$$

(For pricing, use 5 bends if X = 3 hairpins)

Figure 17

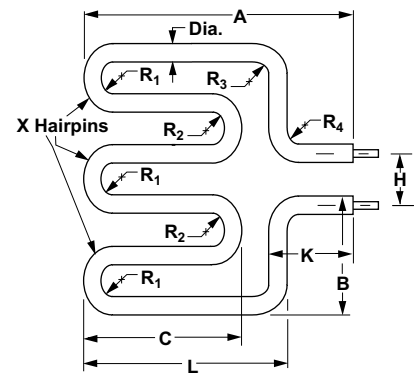


X = number of outside hairpins

$$SL = 1.14R_2 X - 0.88 \text{ Dia.} X - 1.14R_2 - 2 \text{ Dia.} + 1.14R_1 X - 0.86R_3 + 2L X - 2L + 2A + 2K$$

(For pricing, use 7 bends if X = 3 hairpins)

Figure 18



X = number of outside hairpins

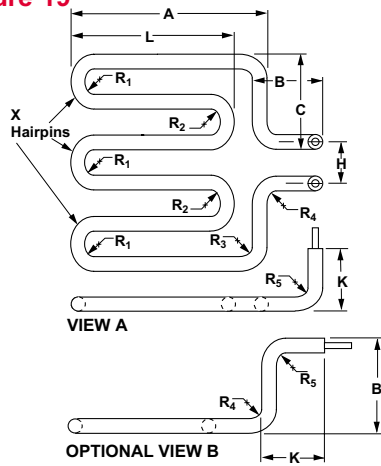
$$SL = 2L + 2K + 2B + 2C(X - 1) - 0.86R_3 - 0.86R_4 - 4.86 \text{ Dia.} + 1.14R_1(X) + 1.14R_2(X - 1) - (2X - 1) 0.43 \text{ Dia.}$$

(For pricing, use 9 bends if X = 3 hairpins)

Tubular and Process Assemblies

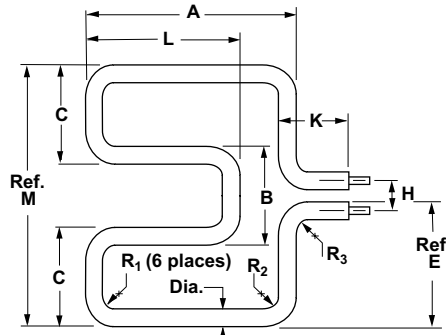
WATROD Heating Elements

Figure 19



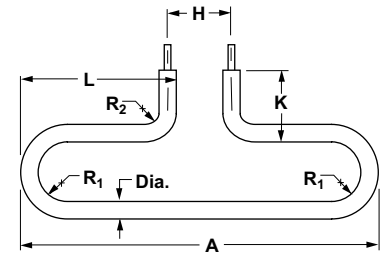
X = number of outside hairpins
 View A and B: $SL = 2K + 2A + 2B + 2C + 2L(X - 1) + 1.14R_1(X) + 1.14R_2(X - 1) - 0.86R_3 - 0.86R_4 - 0.86R_5 - 7.29 \text{ Dia.} - (2X - 1) 0.43 \text{ Dia.}$
 (For pricing, use 11 bends if X = 3 hairpins)

Figure 20



$SL = 2K + 2C + B + 2A + 2L - 2.58R_1 - 0.86R_2 - 0.86R_3 - 12.15 \text{ Dia.}$
 (For pricing, use 10 bends)

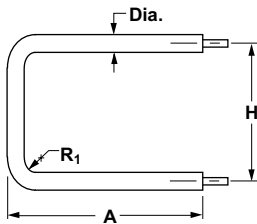
Figure 21



$SL = 2A + 2K - H - 2.28R_1 - 0.86R_2 - 3.29 \text{ Dia.}$
 (For pricing, use 4 bends)

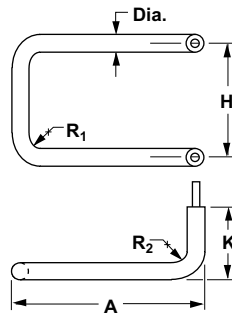
WATROD

Figure 22



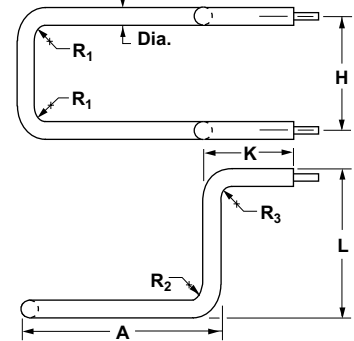
$SL = 2A - 0.86R_1 - 1.43 \text{ Dia.} + H$
 (For pricing, use 2 bends)

Figure 23



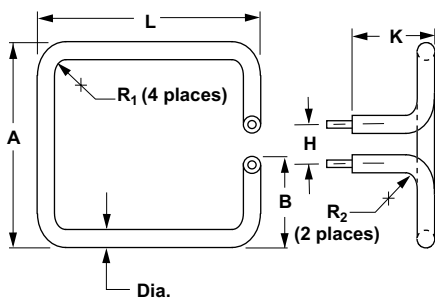
$SL = 2K - 0.86R_2 - 3.86 \text{ Dia.} + 2A - 0.86R_1 + H$
 (For pricing, use 4 bends)

Figure 24



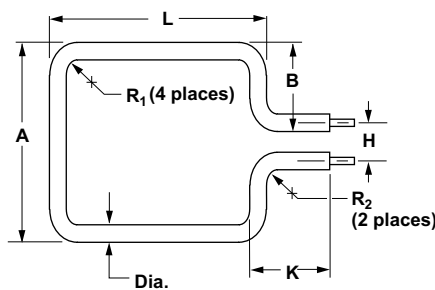
$SL = 2K + 2L + H - 0.86R_1 - 0.86R_2 - 0.86R_3 - 7.29 \text{ Dia.}$
 (For pricing, use 6 bends)

Figure 25



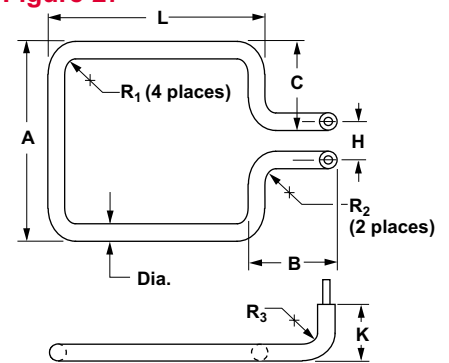
$SL = 2K + 2A + 2L - H - 1.72R_1 - 0.86R_2 - 6.92 \text{ Dia.}$
 (For pricing, use 6 bends)

Figure 26



$SL = 2K + 2A + 2L - H - 1.72R_1 - 0.86R_2 - 6.29 \text{ Dia.}$
 (For pricing, use 6 bends)

Figure 27

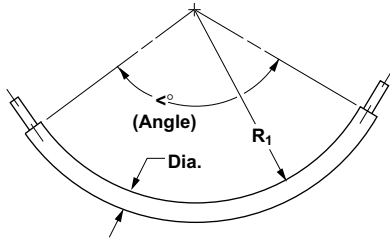


$SL = 2K + 2A + 2L + 2B - H - 1.72R_1 - 1.72R_2 - 8.72 \text{ Dia.}$
 (For pricing, use 8 bends)

Tubular and Process Assemblies

WATROD Heating Elements

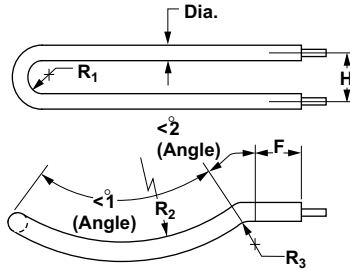
Figure 28



$$SL = 0.0175 <^\circ (R_1 + 0.5 \text{ Dia.})$$

(For pricing, use 1 bend)

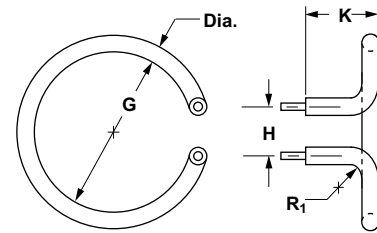
Figure 29



$$SL = 0.0175 <^\circ 1 (2R_2 + \text{Dia.}) + 2F + 1.14R_1 + 0.0175 <^\circ 2 (2R_3 + \text{Dia.}) - 0.43 \text{ Dia.}$$

(For pricing, use 5 bends)

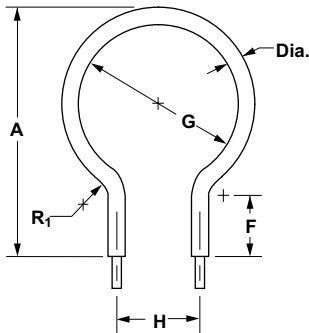
Figure 30



$$SL = (G + \text{Dia.}) 3.14 + 1.14R_1 + 2K + 3.28 \text{ Dia.} - H$$

(For pricing, use 4 bends)

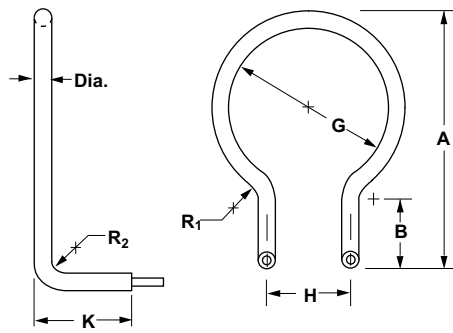
Figure 31



$$SL = (G + \text{Dia.}) 3.14 + 1.14R_1 + 2F + 3.71 \text{ Dia.} - H$$

(For pricing, use 4 bends)

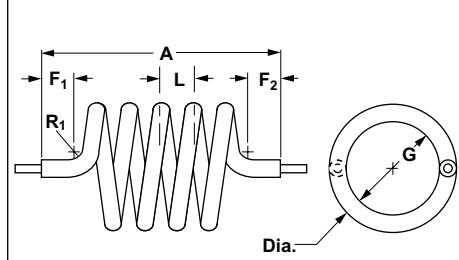
Figure 32



$$SL = (G + \text{Dia.}) 3.14 + 1.14R_1 + 2B + 1.14R_2 + 2K + 3.28 \text{ Dia.} - H$$

(For pricing, use 6 bends)

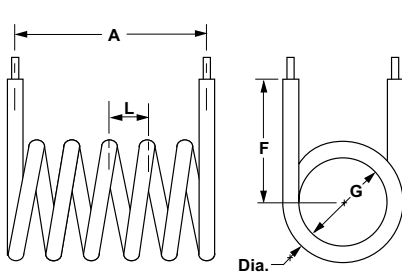
Figure 33



$$SL = [(G + \text{Dia.}) (3.14) (\text{Number of } 360^\circ\text{'s}) + F_1 + F_2]$$

(For pricing, consult factory)

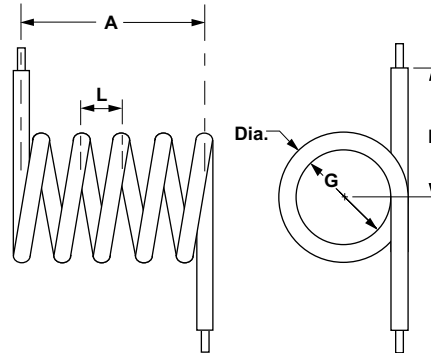
Figure 34



$$SL = [(G + \text{Dia.}) (3.14) (\text{Number of } 360^\circ\text{'s}) + 2F]$$

(For pricing, consult factory)

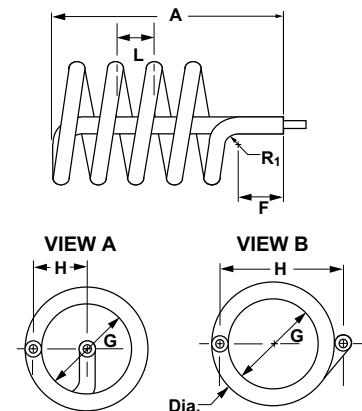
Figure 35



$$SL = [(G + \text{Dia.}) (3.14) (\text{Number of } 360^\circ\text{'s}) + 2F]$$

(For pricing, consult factory)

Figure 36



$$SL = [(G + \text{Dia.}) (3.14) (\text{Number of } 360^\circ\text{'s}) + (G + 2) + A + F]$$

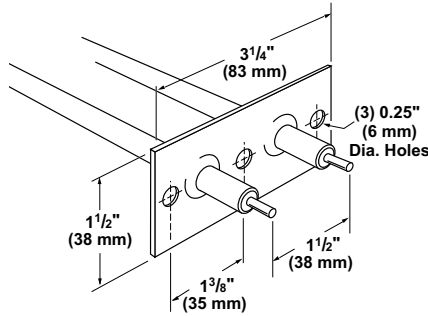
(For pricing, consult factory)

Tubular and Process Assemblies

WATROD Heating Elements

Mounting Methods

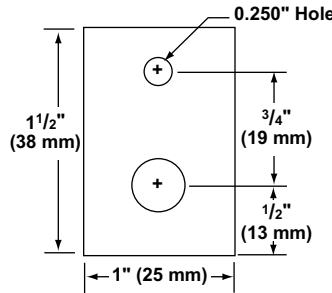
Brackets



A 0.065 inch (1.7 mm) thick stainless steel bracket provides element mounting in non-pressurized applications. Attached to the heater sheath, these brackets are not suited for liquid-tight mountings. The bracket is located 1/2 inch (13 mm) from the sheath's end, unless otherwise specified.

To order, specify **mounting bracket**.

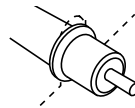
Single Leg Bracket



A 1 1/2 inch (38 mm) x 1 inch (25 mm) wide x 16 gauge stainless steel bracket with one element hole and one mounting hole 1/2 inch from end.

To order, specify **single leg bracket**.

Locator Washers

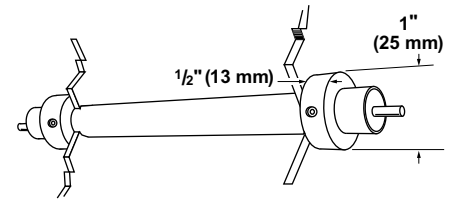


Stainless steel locator washers retain the heated area of the sheath

in the work zone, while allowing for expansion and contraction during cycling.

To order, specify **locator washer**, along with dimension from the heater's end.

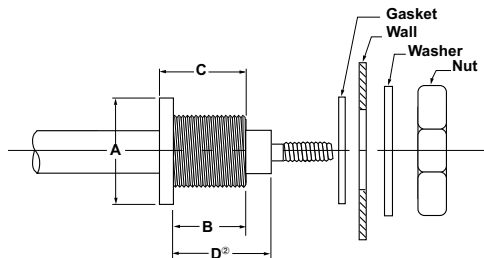
Mounting Collars



Plated steel mounting collars secure the heater sheath with set screws to serve as adjustable stops for through-the-wall mounting. Collars are shipped in bulk.

To order, specify **mounting collars**.

Threaded Bulkheads



A threaded bushing with flange on the heater sheath provides rigid, leak-proof mounting through the walls of tanks. A gasket, plated steel washer and hex nut are included. The threaded end of the bushing is flush with the sheath's end unless otherwise specified. Threaded bulkheads are available in brass, steel or stainless steel as indicated in the table.

To order, specify **threaded bulkheads** and the specifications from the table.

Threaded Bulkhead Specifications

Element Diameter inch (mm)	Material	Thread Size	A ^① Flange Size/Style inch (mm)	B Threaded Length inch (mm)	C Overall Length inch (mm)
0.260 (6.6)	Brass	1/2 - 20 UNF	3/4 Round (19)	5/8 (15.9)	3/4 (19)
0.260 (6.6)	Steel	1/2 - 20 UNF	3/4 Hex (19)	5/8 (15.9)	3/4 (19)
0.260 (6.6)	S. Steel	1/2 - 20 UNF	3/4 Round (19)	5/8 (15.9)	3/4 (19)
0.315 (8.0)	Brass	1/2 - 20 UNF	3/4 Round (19)	5/8 (15.9)	3/4 (19)
0.315 (8.0)	Steel	1/2 - 20 UNF	3/4 Hex (19)	3/4 (19.0)	15/16 (24)
0.315 (8.0)	S. Steel	1/2 - 20 UNF	3/4 Round (19)	3/4 (19.0)	27/32 (21)
0.375 (9.5)	Brass	1/2 - 20 UNF	3/4 Round (19)	5/8 (15.9)	3/4 (19)
0.375 (9.5)	Steel	1/2 - 20 UNF	3/4 Hex (19)	3/4 (19.0)	15/16 (24)
0.375 (9.5)	S. Steel	1/2 - 20 UNF	3/4 Round (19)	3/4 (19.0)	27/32 (21)
0.430 (10.9)	Brass	5/8 - 18 UNF	7/8 Hex (22)	3/4 (19.0)	15/16 (24)
0.430 (10.9)	Steel	5/8 - 18 UNF	7/8 Round (22)	3/4 (19.0)	15/16 (24)
0.430 (10.9)	S. Steel	5/8 - 18 UNF	1 Round (25)	3/4 (19.0)	15/16 (24)
0.475 (12.1)	Brass	5/8 - 18 UNF	7/8 Round (22)	3/4 (19.0)	15/16 (24)
0.475 (12.1)	Steel	5/8 - 18 UNF	1 Round (25)	1 (25.0)	1 1/8 (29)
0.475 (12.1)	S. Steel	5/8 - 18 UNF	1 Round (25)	3/4 (19.0)	15/16 (24)
0.490 (12.4)	Brass	3/4 - 16 UNF	1 Round (25)	3/4 (19.0)	1 (25)
0.490 (12.4)	Steel	3/4 - 16 UNF	1 Hex (25)	3/4 (19.0)	1 (25)
0.490 (12.4)	S. Steel	3/4 - 16 UNF	1 Round (25)	3/4 (19.0)	1 (25)
0.625 (15.9)	S. Steel	1/2 - 14 UNF	1 Round (25)	3/4 (19.0)	1 (25)

① Designates the dimension across flats for hex flange style and outside diameter for round flange style.

② Equal to "B" Dimension unless otherwise specified.

Tubular and Process Assemblies

WATROD Heating Elements

Tubular PLUS Program

Watlow's Tubular PLUS Program is an innovative stocking program that allows formed tubular heaters to be shipped in three to six days, instead of the four to six weeks it takes most manufacturers.

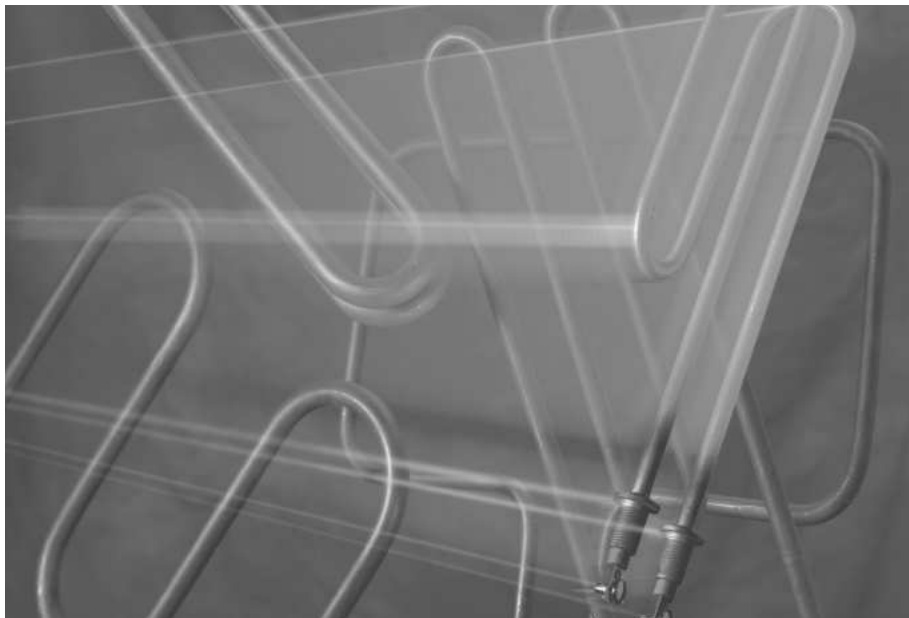
The Tubular PLUS Program allows customers to order the desired heated length, cold length, diameter, heater wattage, voltage, formation and termination option.

By utilizing stocked 0.315 inch or 0.430 inch diameter Incoloy® elements, an appropriate heater is selected from stock and modified to fit the physical description of the required heater. The heater is annealed to remove moisture and enable bending and then formed to the desired configuration. In most cases the only variation will be a slight difference in the heater wattage.

Because Watlow will now stock additional tubular elements, the Tubular PLUS Program reduces downtime, lowers inventories and increases overall customer value.

Features and Benefits

- **Availability of 0.315 inch and 0.430 inch diameters;** most commonly requested for formed tubular heaters.
- **Cold ends from one inch to 18 inches** provide increased capabilities for short and long cold ends.



- **Minimum heated lengths to four inches** provide shorter heated lengths than currently available using conventional tubulars.
- **Incoloy® 800 sheath material** provides the highest quality sheath material for immersion and air applications.

PLUS One

- **Quick delivery: three to six days vs. four to six weeks** results in reduced downtime, lower inventories and increased overall customer value.

PLUS Two

- **Precise location of cold ends and heated lengths** assists in applying heater and in proper bending, allows uniform heating in platens and puts the heat within the application.

PLUS Three

- **Longer element lengths** allows use of one element to replace multiple elements and reduces terminations.

Applications

- Plastics-Hot runner molds
- Packaging-Seal bars
- Semiconductor-CVD, PVD
- Cast-in heater platens

Options

- Maximum heated length: 118 inches, up to 18 inches cold length on each side.
- All standard WATROD options are available.
- Selection of formation numbers 1, 3, 6, 7, 8, 11, 15, 16, 17, 18, 21, 22, 23, 25, 26, 30 and 31 (**pages 282-286**) offer quick delivery. Special formations will increase delivery times. Please consult factory for details.
- To determine if program is applicable to your needs, please contact your local Watlow sales representative.