



ARi Industries Inc.

381 ARi Court
Addison, IL 60101
800-237-6725 Phone
630-953-9100 Phone
630-953-0590 Fax



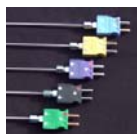
Visit our web site:
<http://www.ariindustries.com>
E-Mail: sales@ariindustries.com

BULLETIN



ARi Corporate Information

- **COMPANY PROFILE**
- **REPRESENTATIVES**



STANDARD THERMOCOUPLES

- **AEROPAK THERMOCOUPLES (UP TO 2200°F)**
- **PERMA MELT THERMOCOUPLES (FOR MOLTEN ALUMINUM)**

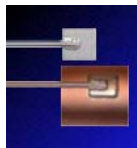
1.0
1.5



HIGH TEMP THERMOCOUPLES

- **HIGH TEMPERATURE THERMOCOUPLES (UP TO 4200°F)**
- **1600°C INDUSTRIAL GRADE THERMOCOUPLES**

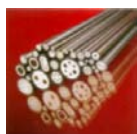
2.0
2.2 & 2.3



PAD STYLE THERMOCOUPLES

- **AEROPAD THERMOCOUPLES (FOR TUBE MEASUREMENTS)**

3.0



AEROPAK M.I. CABLE

- **AEROPAK THERMOCOUPLE and CONDUCTOR CABLE**
- **HIGH TEMPERATURE AEROPAK THERMOCOUPLE CABLE**
- **HELPFUL HINTS TO USE AEROPAK**
- **CONDUCTOR CABLE ASSEMBLIES**

4.0
4.1
EDF-4
4.4



HEATER ASSEMBLIES & HEATER CABLE

- **ELECTRIC HEATING CABLE**
- **FLEXIBLE HIGH WATT DENSITY ELECTRIC HEATER ASSY'S**
- **HEATER APPLICATION GUIDE**
- **THIN FILM DEPOSITION RESEARCH APPLICATION SHEET**

5.1
5.2
EDF-3
H-90-1



HARDWARE/ACCESSORIES

- **HARDWARE / THERMOCOUPLE & RTD ACCESSORIES**
- **AEROGARD THERMOWELLS**
- **TEMPERATURE TRANSMITTER SYSTEMS**

6.0
6.1
6.3



MULTILEVEL THERMOCOUPLES

- **MULTILEVEL TEMPERATURE PROFILING ASSEMBLY**

7.3



RTD ASSEMBLIES

- **ARIDET RESISTANCE TEMPERATURE DETECTORS**

8.0



ARI Industries, Inc

<http://www.ariindustries.com>
sales@ariindustries.com

Company Profile

- **Established in 1952 as Aero Research Instruments in Chicago, Illinois, ARI was one of the first companies to use mineral insulated cable technology to improve product performance and reliability. That same technology has been improved and refined over the years and is the heart of a wide variety of products that ARI manufactures today.**
- **ARI is recognized as an industry leader and quality supplier of metal-sheathed mineral insulated cable. All standard AerOpak® cable is supplied with high purity MgO insulation and accuracy per ASTM-E230 special limits of error. As well as maintaining a large inventory of finished cable, ARI also specializes in custom thermocouple, conductor, and heater cables to meet specific application requirements.**
- **ARI uses the same precision cable to manufacture a large selection of thermocouples, heaters, and RTD's. AerOpad® and Fan Type weld pad thermocouples are used in power plants and refineries throughout the world for accurate measurement of furnace heater tubes. Multipoint thermocouples and RTD's are used in temperature profiling applications of furnaces and reactors. Our rugged thermocouples and RTD's are used in aerospace applications including brake temperature measurements of commercial and military aircraft. ARI also supplies ultra high temperature thermocouples for applications up to 4000° F. using noble and refractory materials.**
- **ARI is also a leading supplier of mineral insulated heater assemblies and cable. AerOrod® high watt density heaters can supply up to 150 watts per square inch yielding quick response and long heater life in even the toughest applications. By using internally welded transitions between the hot and cold sections, possible cold end failures are greatly reduced. ARI heaters are used in semiconductor processing, furnace element manufacturing, aerospace and heat tracing applications.**
- **ARI can supply complete non-destructive testing and certification for all cable and finished assemblies. Calibration standards are traceable to the National Institute of Standards and Technology. ARI's quality management system meets the requirements of ISO9002 as certified by Lloyds Register Quality Assurance.**
- **ARI is a member of the Okazaki group of companies since 1980. Manufacturing facility and corporate offices are located in Addison, Illinois.**



ARi Industries Inc

381 ARi Court
Addison, IL 60101
630-953-9100 Tel
630-953-0590 Fax

REPRESENTATIVE LIST JUNE 2004

ALABAMA (Northern)
Pro Therm Industries
P.O. Box 8446
Hermitage, TN 37076
Ph: 800-811-3798
Fax: 615-834-5834

ALABAMA (Southern)
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

ARIZONA
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

ARKANSAS
Brice Company
4301 Greenbriar Dr.
Stafford, TX 77477
Ph: 281-240-1788
Fax: 281-240-0656

CALIFORNIA
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

COLORADO
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

CONNECTICUT
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

DELAWARE
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

FLORIDA
W.P. Brett Associates, LLC
3110 Bulkley Pl.
Eustis, FL 32726
Ph: 352-406-3050
Fax: 352-589-6962
E-Mail: wpbrett@aol.com

GEORGIA
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

IDAHO
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

ILLINOIS
Precision Measurement Products Inc.
510 Market Loop, Suite 202
West Dundee, IL 60118
Ph: 847-426-4446
Fax: 847-426-4489

INDIANA
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

IOWA
Precision Measurement Products Inc.
510 Market Loop, Suite 202
West Dundee, IL 60118
Ph: 847-426-4446
Fax: 847-426-4489

KANSAS
Precision Measurement Products Inc.
11648 Momarte Lane
St. Louis, MO 63146
Ph: 314-997-1755
Fax: 314-997-2114

KENTUCKY
Loesch Associates
24600 Detroit Rd.
Westlake, OH 44145
Ph: 440-250-3400
Fax: 440-250-3404

LOUISIANA
Brice Company
4301 Greenbriar Dr.
Stafford, TX 77477
Ph: 281-240-1788
Fax: 281-240-0656

MAINE
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

MARYLAND
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

MASSACHUSETTS
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

MICHIGAN
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

MINNESOTA
Precision Measurement Products Inc.
510 Market Loop, Suite 202
West Dundee, IL 60118
Ph: 612-333-7087
Fax: 847-426-4489

MISSISSIPPI
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

MISSOURI
Precision Measurement Products Inc.
11648 Momarte Lane
St. Louis, MO 63146
Ph: 314-997-1755
Fax: 314-997-2114

MONTANA
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

NEBRASKA
Precision Measurement Products Inc.
11648 Momarte Lane
St. Louis, MO 63146
Ph: 314-997-1755
Fax: 314-997-2114

NEVADA
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

NEW HAMPSHIRE
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

NEW JERSEY (Northern)
Applied Process Instruments
P.O. Box 68
Livingston, NJ 07039
Ph: 973-740-8641
Fax: 973-994-0277

NEW JERSEY (Southern)
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

NEW MEXICO
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101
Ph: 800-237-6725
Fax: 630-953-0590

NEW YORK
Applied Process Instruments
P.O. Box 68
Livingston, NJ 07039
Ph: 973-740-8641
Fax: 973-994-0277



Ari Industries Inc.

381 Ari Court
Addison, IL 60101
630-953-9100 Tel
630-953-0590 Fax

REPRESENTATIVE LIST JUNE 2004

NORTH CAROLINA

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

NORTH DAKOTA

Precision Measurement Products Inc.
510 Market Loop, Suite 202
West Dundee, IL 60118
Ph: 847-426-4446
Fax: 847-426-4489

OHIO (Northern)

Loesch Associates Inc.
24600 Detroit Rd., Suite 265
Westlake, OH 44145
Ph:440-250-3400
Fax:440-250-3404

OHIO (Southern)

Loesch Associates Inc
PO Box 54781
Cincinnati, OH 45254-0781
Ph:513-233-9977
Fax:513-588-6337

OKLAHOMA

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

OREGON

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

PENNSYLVANIA (Eastern)

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

PENNSYLVANIA (Western)

Measurement Instruments
P.O. Box 163
Blairsville, PA 15717
Ph:724-459-8090
Fax:724-459-9070

RHODE ISLAND

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

SOUTH CAROLINA

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

SOUTH DAKOTA

Precision Measurement Products Inc.
510 Market Loop, Suite 202
West Dundee, IL 60118
Ph: 847-426-4446
Fax: 847-426-4489

TENNESSEE

Pro Therm Industries
P.O. Box 8446
Hermitage, TN 37076
Ph:800-811-3798
Fax:615-834-5834

TEXAS

Brice Company
4301 Greenbriar Dr.
Stafford, TX 77477
Ph:281-240-1788
Fax:281-240-0656

UTAH

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

VERMONT

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

VIRGINIA

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

WASHINGTON

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

WEST VIRGINIA

Measurement Instruments
P.O. Box 163
Blairsville, PA 15717
Ph:724-459-8090
Fax:724-459-9070

WISCONSIN

Precision Measurement Products Inc.
1311 Pleasant St.
Lake Geneva, WI 53147
Ph: 262-249-7804
Fax: 262-249-7805

WYOMING

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

CANADA

Ari Industries, Inc.
381 Ari Court
Addison, IL 60101
Ph:800-237-6725
Fax:630-953-0590

ISRAEL

Thermocon Control Instruments Ltd.
P.O. Box 1166
Ramat Gan 52111, Israel
Ph: 011-972-3-5790122
Fax: 011-972-3-5798014

JAPAN

Okazaki Mfg. Co.
1-3 Gokodori 3-Chome
Chuo-Ku Kobe 651 Japan
Ph:011-81-78-2518200
Fax:011-81-78-2518210

MEXICO

Electronica Industrial Monclova
Padre Larios Y Bravo Sur 622
Apartado Postal 93
Monclova, Coahuila, Mexico 25700
Ph:011-52-866-631-13-44
Fax:011-52-866-636-05-52

EUROPE

Kamet Trading
Neuweg 211B
1214 GR Hilversum, Netherlands
Ph:011-31-35-628-2910
Fax:011-31-35-628-2912

NORWAY

Teck Instruments AS
Postboks 115
N-3421 Lierskogen, Norway
Ph:011-47-32851950
Fax:011-47-32852977

PUERTO RICO

Bill Parker Sales & Eng.
P.O. Box 9066
Santurce, Puerto Rico 00908-9066
Ph:787-722-3061
Fax:787-724-2960

UNITED KINGDOM

Ari Industries (UK) Ltd
Unit 2F Albany Park Frimley Road
Camberley, Surrey GU16 7PE
England
Ph:011-441-276692500
Fax:011-441-276692110



Quality Means High Reliability

AerOpak[®] THERMOCOUPLES

For

High reliability applications

Special calibration limits for type K,
J, E, T per ASTM E-230

High purity MgO insulation
Metallic Sheath

Highest purity MgO insulation to
yield maximum EMF stability and
minimum drift problems caused by
insulation impurities

Will manufacture specials to meet
your requirements



ARI Industries Inc

BULLETIN 1.0

MAY 2001

WIRE

Termination Thermocouples STANDARD DESIGNS

DESIGN NO. T-14 Lead wire termination with 1 inch bared wire.

DESIGN NO. T-22 Potting adaptor with an extension of solid 20 ga. thermocouple lead wire, fiberglass over each and fiberglass over all, silicone varnish impregnated. The transition of AerOpak® to lead wire is capable of operation to 175°C.

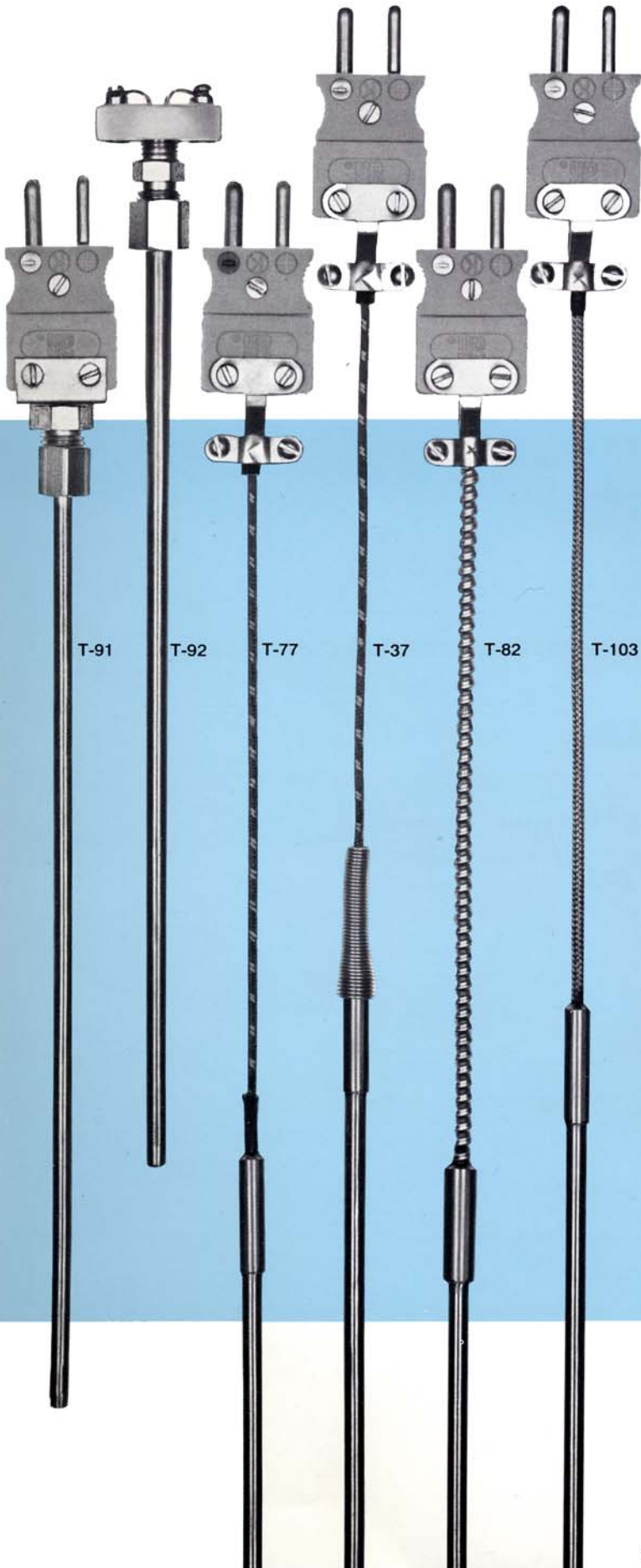
DESIGN NO. T-31 Potting adaptor with flex spring an extension of solid 20 ga. thermocouple lead wire, fiberglass over each and fiberglass over all, silicone varnish impregnated. The transition of AerOpak® lead wire is capable of operation to 175°C.

DESIGN NO. T-26 Potting adaptor with extension of solid 20 ga. thermocouple lead wire, fiberglass over each and fiberglass over all, silicone varnish impregnated. Stainless steel flexible tube placed over the lead wire to limit flexure and abrasion, transition of AerOpak to lead wire is capable of operation to 175°C.

DESIGN NO. T-99 Potting adaptor with an extension of solid 20 ga. thermocouple lead wire, fiberglass over each and fiberglass over all, silicone varnish impregnated. Stainless steel braid over the lead wire to limit flexure and abrasion. Transition of AerOpak® to lead wire is capable of operation to 175°C.

Note: Lead wire terminations are approx. 16" (40.6cm) long, unless specified otherwise.





PLUG

Termination Thermocouples STANDARD DESIGNS

T-91

T-92

T-77

T-37

T-82

T-103

DESIGN NO. T-91 Standard size male plug attached directly to the sheathed thermocouple.

DESIGN NO. T-92 Ceramic connector terminal block attached directly to sheathed thermocouple.

DESIGN NO. T-77 Potting adaptor with extension of solid 20 ga. thermocouple lead wire, fiberglass over each and fiberglass over all, silicone varnish impregnated. A standard size male plug attached to lead wire, transition of AerOpak® to lead wire is capable of operation to 175°C.

DESIGN NO. T-37 Potting adaptor with flex spring extension of solid 20 ga. thermocouple lead wire, fiberglass over each and fiberglass over all, silicone varnish impregnated. A standard size male plug attached to lead wire, transition of AerOpak® to lead wire is capable of operation to 175°C with standard size male plug attached.

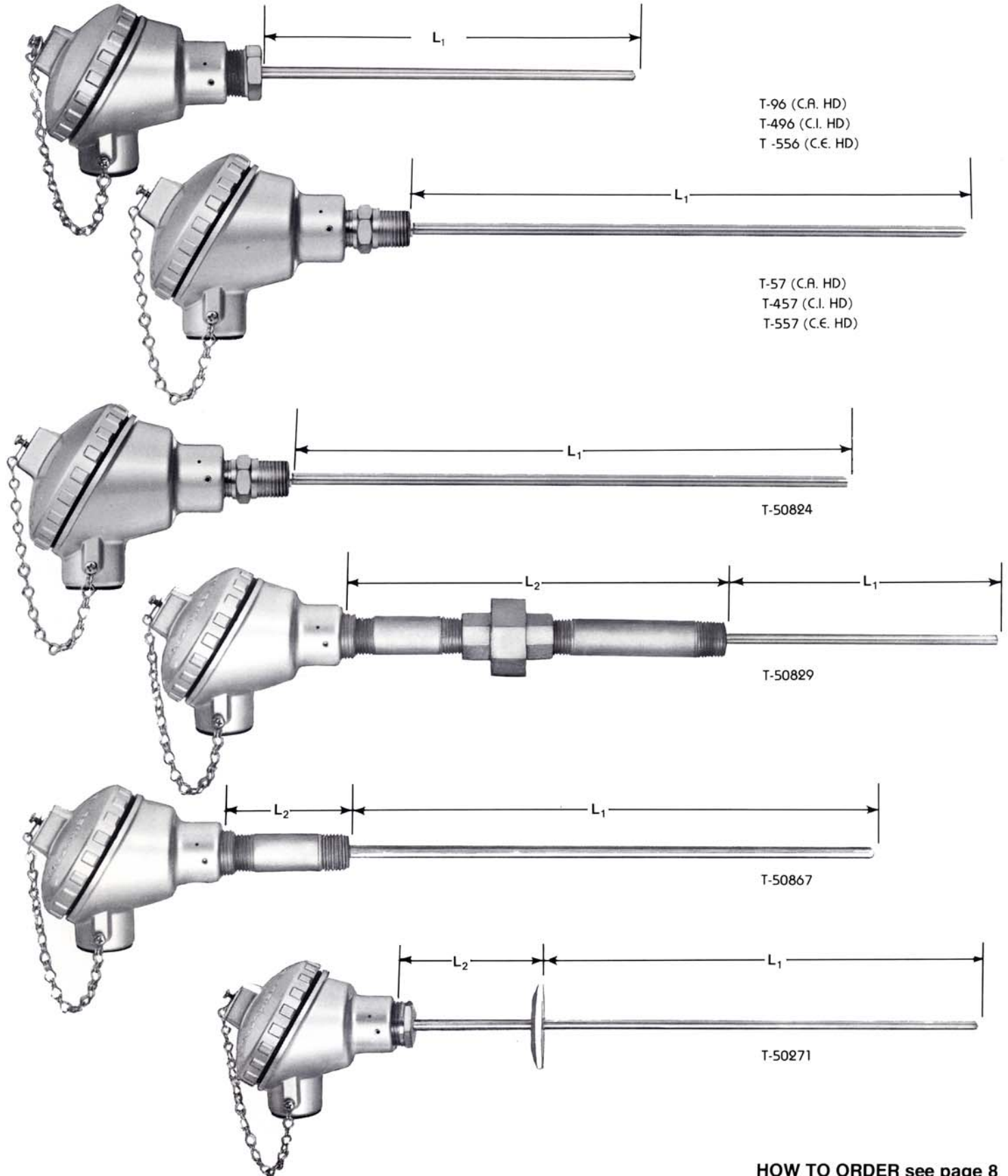
DESIGN NO. T-82 Potting adaptor with an extension of solid 20 ga. thermocouple lead wire, fiberglass over each and fiberglass over all, silicone varnish impregnated. Stainless steel flexible tube placed over lead wire, transition of AerOpak® to lead wire is capable of operation to 175°C.

DESIGN NO. T-103 Potting adaptor with an extension of solid 20 ga. thermocouple lead wire, fiberglass over each and fiberglass over all, silicone varnish impregnated. Stainless steel braid placed over the lead wire, with standard size male plug attached. Transition of AerOpak® to lead wire is capable of operation to 175°C.

HOW TO ORDER . . . see page 8

CONNECTION HEAD

Termination Thermocouples
STANDARD DESIGNS



HOW TO ORDER see page 8

HEADS (HD)

DESIGN NO. T-96 (CA) Connection head mounted directly on thermocouple.

DESIGN NO. T-496 (CI) Connection head mounted directly on thermocouple.

DESIGN NO. T-596 (CE) Connection head mounted directly on thermocouple.

DESIGN NO. T-57 (CA) Connection head mounted directly on the thermocouple with 1/2" NPT Hex nipple mounting fitting.

DESIGN NO. T-457 (CI) Connection head mounted directly on the thermocouple with 1/2" NPT nipple, mounting fitting.

DESIGN NO. T-557 (CE) Connection head mounted directly on the thermocouple with 1/2" NPT Hex nipple mounting fitting.

DESIGN NO. T-50824 Connection head assembly mounted directly on thermocouple with spring loaded 1/2" NPT Hex nipple mounting fitting.

DESIGN NO. T-50829 Connection head with spring loaded terminal block mounted directly on thermocouple and 1/2" NPT nipple, union, nipple mounting hardware.

DESIGN NO. T-50867 Connection head with spring loaded terminal block mounted directly on thermocouple with 1/2" NPT nipple for the mounting hardware.

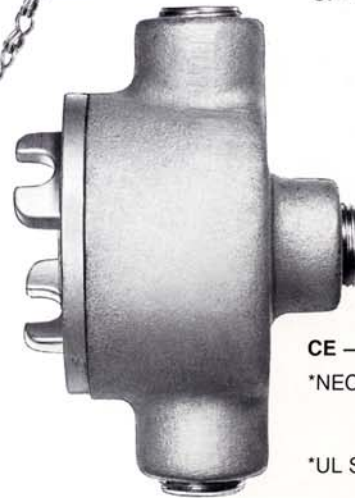
***DESIGN NO. T-50271** Connection head with fixed terminal block and sanitary cap welded to the thermocouple.

*Certified to the 3-A Sanitary Standards Symbol Council for Dairy Equipment.



CA — Die Cast Aluminum with gray enamel coating.

CI — Cast Iron



CE — Explosion Proof

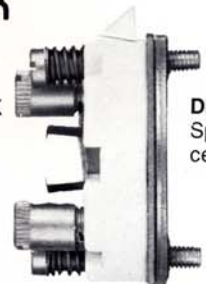
*NEC: Class I Groups C,D
Class II Groups E,F,G
Class III

*UL Standard: 886

TERMINATION BLOCK



FIXED CERAMIC BLOCK with plated brass terminals.



DIN TYPE Spring loaded ceramic block.

INSERTS



T-14



T-0050867 & T-0050829



T-0096



T-0057



MINIATURE

THERMOCOUPLE DESIGNS

DESIGN NO. T-114 Lead wire termination with 1/2" bared wire.

DESIGN NO. T-196 Miniature style connection head with fixed terminal block mounted directly to the thermocouple 1/4" exit threads.

DESIGN NO. T-122 Potting adaptor with extension of solid 24 ga. thermocouple lead wire with fiberglass over each and fiberglass over all, silicone varnish impregnated. The transition of AerOpak® to lead wire is capable of operation to 175°C.

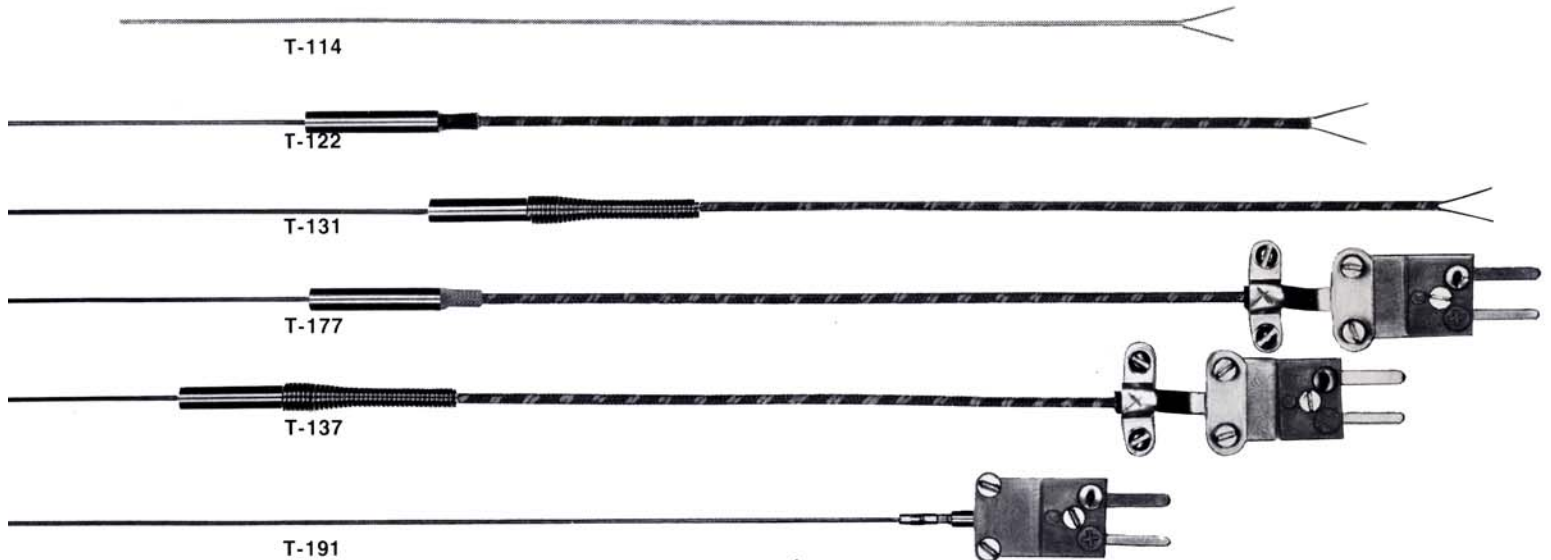
DESIGN NO. T-131 Potting adaptor with flex spring and extension of solid 24 ga. thermocouple lead wire with fiberglass over each and fiberglass over all, silicone varnish impregnated. The transition of AerOpak® to lead wire is capable of operation to 175°C.

DESIGN NO. T-177 Potting adaptor with an extension of solid 24 ga. thermocouple lead wire with fiberglass over each and fiberglass over all, silicone varnish impregnated. With miniature size male plug attached to lead wire. Transition of AerOpak® to lead wire is capable of operation to 175°C.

DESIGN NO. T-137 Potting adaptor with flex spring and extension of solid 24 ga. thermocouple lead wire with fiberglass over each and fiberglass over all, silicone varnish impregnated. Miniature size male plug attached to lead wire. Transition of AerOpak® to lead wire is capable of operation to 175°C.

DESIGN NO. T-191 Miniature plug connector attached to thermocouple.

Note: HOW TO ORDER SEE PAGE 8.



SPECIFICATIONS

TABLE 1 SHEATH & WIRE DIAMETER

ARI SYMBOL		L	A	B	D	E	F	G	I	K	P	R
SHEATH DIAMETER	inch	.020	.040	.062	.125	.188	.250	.313	.375	.500	.625	.750
	mm.	.50	1.00	1.67	3.17	4.75	6.35	8.00	9.52	12.7	15.9	19.1
WIRE DIAMETER	inch	.004	.006	.010	.020	.032	.040	.051	.064	.091	.114	.120
	mm.	.10	.15	.25	.50	.85	1.00	1.45	1.63	2.31	2.90	3.05
MAX. LENGTH	feet	30	200	290	290	135	81	45	30	30	20	13
	meters	9	61	88	88	41	25	14	9	9.1	6.1	4.0

TABLE 2 WIRE CALIBRATION SPECIAL LIMITS OF ERROR

CALIBRATION	ARI SYMBOL	ASTM E-230 SYMBOL	APPROXIMATE SIMILAR CALIBRATIONS
*Chromel P-Alumel (1)	KS	K	BS 1827, DIN 43710, NFE 18-001, JIS-C1602
*Iron-Constantan	JS	J	BS 1829, NFE 18-001
*Chromel P-Constantan (1)	ES	E	—
*Copper Constantan	TS	T	BS 1828, DIN 43710, NFE 18-001, JIS-C1602

*Calibrations are to special limits of error

(1) Registered T.M. of Hoskins Mfg. Co.

TABLE 3 HOT JUNCTION SYMBOLS

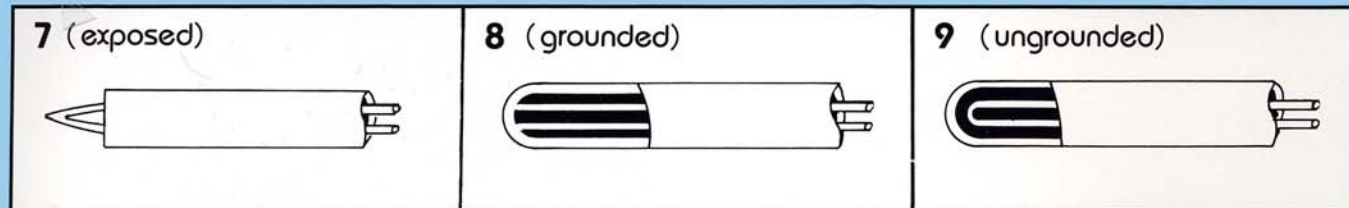


TABLE 4 SHEATH MATERIAL

SHEATH	ARI SYMBOL	MELTING POINT		USEABLE TEMP. IN AIR		EQUIVALENT ANALYSIS
		°F	°C	°F	°C	
AISI 347 ST/ST	F	2550	1400	1650	900	BS 3605 832Nb; DIN 4550; UNS S34700
Inconel 600 (3)	B	2570	1410	2100 (1)	1150	BS 3074-NA14; DIN 4816; UNS NO6600
AISI 304 ST/ST	A	2550	1400	1650 (2)	900	BS 3605-801; DIN 4301; UNS S30400
AISI 310 ST/ST	D	2570	1410	2100	1150	BS 3605-805; DIN 4878; UNS S31000
AISI 316 ST/ST	C	2550	1400	1650	900	BS 3605-845; DIN 4401; (2-3% Mo); UNS S31600
HASTELLOY X	V	2470	1355	2200	1222	TM CABOT CORP.

(1) Not recommended for use in sulfur atmosphere

(2) Do not use in 800 to 1600°F temperature range due to carbon intergranular precipitation

(3) Trademark of International Nickel Corp.

TIME CONSTANTS

SHEATH DIA.	Cond. A	Cond. B	Cond. C	Cond. D
5/16	0.5*	5.5	5.0	55.0
1/4	0.3	4.0	2.5	39.0
3/16	0.2	2.5	2.0	26.0
1/8	0.1	1.5	1.0	14.0
1/16	0.05	0.5	0.5	5.0
.040	0.01	0.3	0.1	2.5

*Time in seconds

Some typical time constants (time for the thermocouple temperature to reach 63.2% of a step change in gas or liquid temperature) for various sizes are listed for different media.

Cond. A: No. 7 hot junction in water moving at a velocity (V_0) of 1.5m/sec. (5 ft/sec).

Cond. B: No. 8 hot junction in water moving at a velocity (V_0) of 1.5m/sec. (5 ft/sec).

Cond. C: No. 7 hot junction in air moving at a mass velocity (G_0) of 29.3 Kg/sec. m² (6 lbs/sec. ft.²)

Cond. D: No. 8 hot junction in air moving at a mass velocity (G_0) of 29.3 Kg/sec. m² (6 lbs/sec. ft.²)

For time constants (τ) at other velocities (V) or mass velocities (G) use the equations below:

$$\tau = \tau_0 \sqrt{\frac{V_0}{V}} \quad (\text{for liquids})$$

$$\text{or } \tau = \tau_0 \sqrt{\frac{G_0}{G}} \quad (\text{for gases})$$

The results of these equations will be affected by using liquids other than water and gases other than air. However, the effect is small and can be neglected for many applications.

INSULATION MATERIAL: Symbol "N" 99.4% min. High Purity MgO meeting requirements of ASTM E-585 and E-608. Impurities minimized to yield maximum EMF stability, minimum drift problems.

LEAD WIRE LENGTH: 16 inch (40 cm) long normally supplied. If longer lengths are required designate in Part Number.

SHEATH LENGTH "L": Specified in inches in even increments of length from 2.54 cm (1 inch) to 88 meters (3465 inches). See Table 1 for maximum length for each diameter. Length tolerances to be: ± 3.2 mm ($\pm 1/8$ in.) up to 30.5 cm (12 in.); ± 8.0 mm ($\pm 5/16$ in.) up to 244 cm (96 in.); ± 50.8 mm (± 2 in.) over 244 cm (96 in.).

INSULATION RESISTANCE: 100 megohms or more @ 500 V DC for lengths of 15 meters (50 feet) or less for 1.67 to 8.0 mm (1/16 to 5/16") diameter. 10 megohms or more @ 1 1/2 V DC for lengths of 15 meters (50 feet) or less for 1.0 and .63 mm (0.04 and 0.025") diameters. This measurement is made prior to fabrication of hot junction.

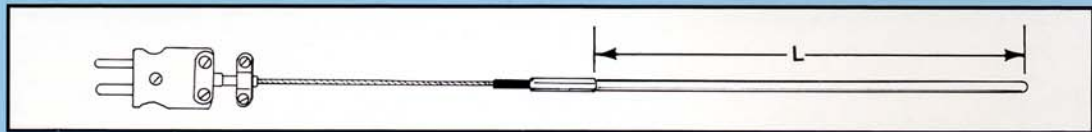
BEND INSULATION RESISTANCE: Minimum insulation resistance, after bending around a mandrel whose diameter is 4 times, the sheath diameter, to be 2.5 megohms @ 1 1/2 V DC.

HIGH TEMPERATURE INSULATION RESISTANCE: ALL AEROPAK thermocouple of lengths of 61 cm (24") or less will have a minimum insulation resistance of 10,000 ohms or more at 1 1/2 V DC at 1000°C (1800°F).

AVAILABILITY: 2 Wire (1 T/C circuit) sheath diameters: .50 to 19.1 mm (.020 to .750 inch).
4 Wire (2 T/C circuit) sheath diameters: 3.17 to 19.1 mm (.125 to .750 inch). Exposed, grounded, and ungrounded hot junction.

SPECIAL SPECIFICATIONS: To specific customer specifications, or to Nuclear grade requirements, i.e.:
MIL-T-23234A RDT C7-6T ASTM E-235 ASTM E-585 E-608
with complete testing per above specifications within ARi facilities.

PRESSURE RATING: AEROPAK® thermocouples using No. 8 or 9 hot junction are pressure tight to 3500 Kg/cm² (50,000 psi) at temperatures up to 649°C (1200°F). AEROPAK thermocouples using No. 7 junction are pressure tight to 350 Kg/cm² (5000 psi) if a seal is used at the cold end.



Example: Catalog No. T-77 N-6 D (KS) 8 F 16

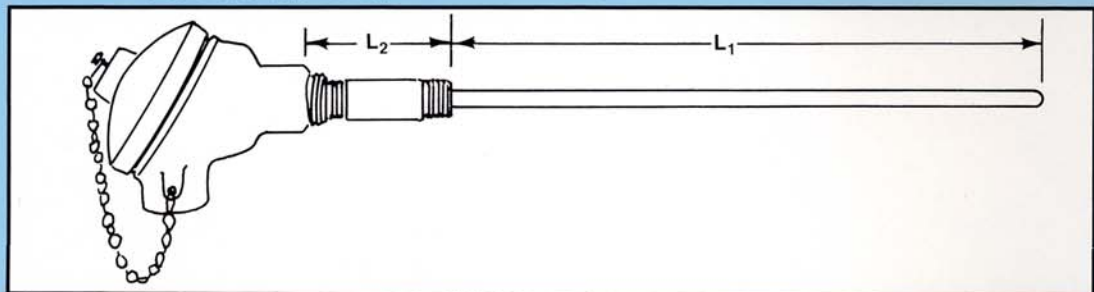
A B C D E F G H

- A Design No.** — (See page 2, T-77 in this example)
- B Insulation Material** — Symbol "N" (99.4% min MgO purity)
- C Sheath Length "L" in inches** — (6 inches in this example)
- D Sheath Diameter Symbol** — (See Table 1; 1/8" in this example)
- E Wire Calibration Symbol** — (See table 2; chromel-alumel; special limits of error in this example)
- F Junction Style Number** — (See table 3; grounded in this example)
- G Sheath Material Symbol** — (See table 4; 347 ST/ST in this example)
- H Length of Lead Wire** — If other than 16" please specify.

Note: When duplex circuit required add (.4) after the design number. For example: a (T-77N) in duplex circuit would be (T-77.4N)

HOW TO ORDER WIRE & PLUG ASSEMBLIES:

(Pages 2, 3 and 6)



Example: Catalog No. T-50867 N-6 F (KS) 8 A (CA) 3

A B C D E F G H I

- A Design No.** — (See page 4) T-50867 in this example.
- B Insulation Material** — Symbol "N" (99.4% min MgO Purity)
- C Sheath Length "L" in inches** — (6 inches in this example)
- D Sheath Diameter Symbol** — (See table 1; 1/8" in this example)
- E Wire Calibration Symbol** — (See table 2; chromel-alumel; special limits of error in this example)
- F Junction Style Number** — (See table 3; grounded in this example)
- G Sheath Material Symbol** — (See table 4; 347 ST/ST in this example)
- H Type of Connection Head** — (See page 5) Die Cast aluminum in this example
- I Length of Nipple** — (L₂)

Note: When duplex circuit required add (.4) after the design No. For example: a (T-50867N) in duplex circuit would be (T-50867.4N).

HOW TO ORDER CONNECTION HEAD ASSEMBLY:

(Pages 4 and 5)

PermAmelt[®]

Thermocouple

FOR MOLTEN ALUMINUM
TEMPERATURE MEASUREMENT



The short life of thermocouple protection tubes in molten aluminum service has always been a severe problem.

PermAmelt[®], a new approach to aluminum melt temperature sensing, has solved the problem of ceramic protection tube brittleness while retaining their heat, abrasion and corrosion resistance. Also, because of PermAmelt's[®] non-wetting and self-healing surface, these T/C's require no daily washing or coating, making them maintenance free over their entire life.

Easy to work with, PermAmelt[®] T/C's require no preheating due to their low thermal expansion coefficient and thermal impact resistance. Their low heat conductivity helps prevent temperature drops in the molten aluminum and contributes to energy conservation. Since the tubes are ceramic, there is no iron pickup to create inclusion in the aluminum.

ARi Industries Inc.

381 ARi Court, Addison, Illinois 60101, USA

BULLETIN 1.5

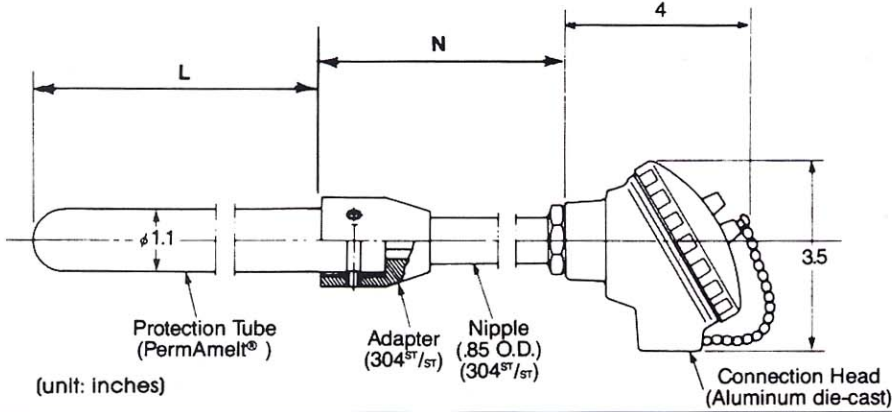
PermAmelt® THERMOCOUPLE

STYLE T-180

* - L - N

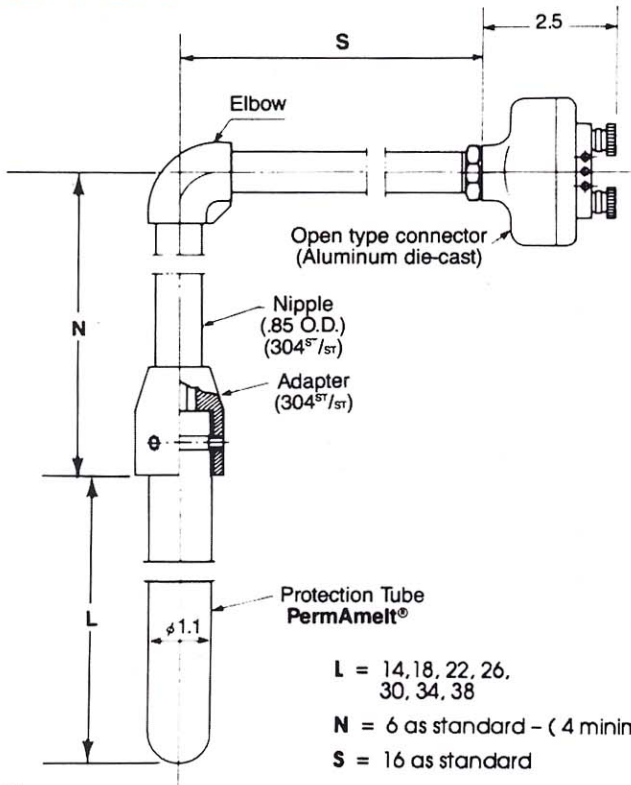
L = 14, 18, 22, 26, 30, 34, 38

N = 16 as standard



STYLE T-270

* - L - N - S



L = 14, 18, 22, 26, 30, 34, 38

N = 6 as standard - (4 minimum)

S = 16 as standard

ORDERING INFORMATION:

- 1) Select thermocouple element* (K, J, E), add its symbol after style number.
Note: Other thermocouple elements and styles available on special request.
- 2) Specify lengths if L, N, and S.

Bulk Density	--	3.2
Water Absorption	%	0
Vickers Hardness	Load 500g	GPa HRA 91
	R.T	Kpsi 86 MPa 590
Flexural Strength (4-Point Bending)	800°C	Kpsi 87 MPa 600
	1000°C	Kpsi 74 MPa 510
	1200°C	Kpsi 47 MPa 323
	1300°C	Kpsi 17 MPa 117
Fracture Toughness (K _{1C}) M.I.	MPa√m	5.7
Young's Modulus	R.T.	x 10 ⁶ psi 43 GPa 294
Poisson's Ratio	R.T.	-- 0.28
Coefficient of Linear Thermal Expansion	40 to 400°C	x 10 ⁻⁶ /°C 2.6
	40 to 800°C	3.2
Thermal Conductivity	R.T.	cal/cm·sec·°C 0.05 W/m·K 21
		cal/g·°C 0.16
Specific Heat	R.T.	cal/g·°C 0.16
Heat Shock Resistance	ΔT	°C 600
Volume Resistivity	R.T.	Ω·cm > 10 ¹⁴

UNIT CONVERSION TABLES

STRESS

MPa or N/mm ²	Kgf/mm ²	Kgf/cm ²	10 ³ lb/in ² (Kpsi)
1	1.0197 x 10 ⁻¹	1.0197 x 10	0.145
9.807	1	1 x 10 ²	1.422
9.807 x 10 ⁻²	1 x 10 ⁻²	1	1.422 x 10 ⁻²
6.985	0.703	70.3	1

THERMAL CONDUCTIVITY

W/m·K	Kcal/m·h·°C	cal/cm·sec·°C
1	0.86	2.39 x 10 ⁻³
1.163	1	2.78 x 10 ⁻³
418.7	360	1

TOLL FREE 1-800-237-6725

ARI Industries Inc

381 ARi Court, Addison, Illinois 60101, USA
Phone: 630-953-9100 Telefax: 630-953-0590

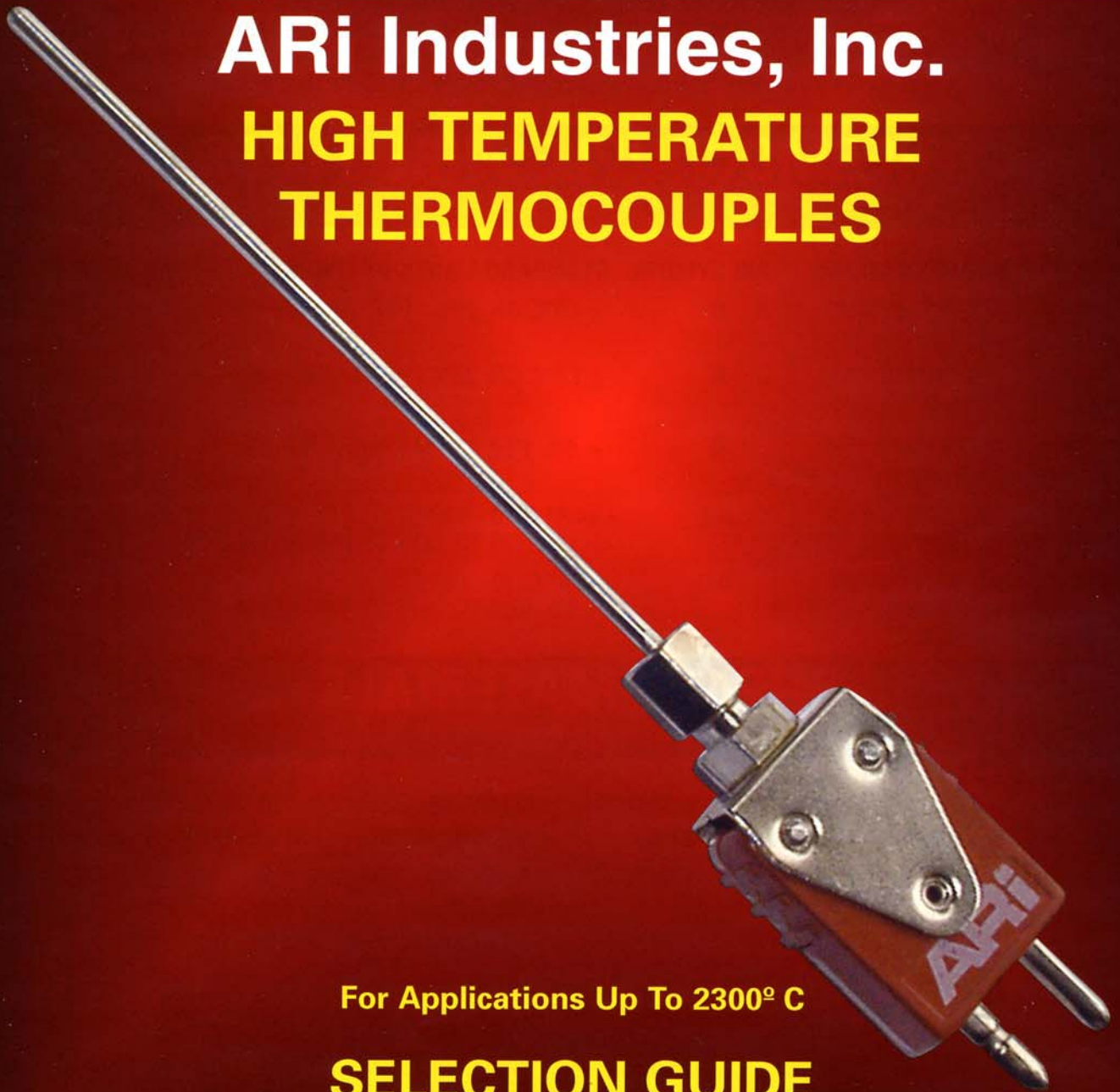
TOLL FREE 1-800-237-6725

E-mail: sales@ariindustries.com

Website: www.ariindustries.com

ARi Industries, Inc.

HIGH TEMPERATURE THERMOCOUPLES



For Applications Up To 2300° C

SELECTION GUIDE BULLETIN 2.0

9/1/01

381 ARI COURT

ADDISON IL 60101 USA

PH: 630-953-9100

TOLL FREE: 1-800-237-6725

FAX: 630-953-0590

E-MAIL: sales@ariindustries.com

WEB SITE: www.ariindustries.com

THERMOCOUPLE SELECTION

ARI HIGH TEMPERATURE THERMOCOUPLES ARE USED IN APPLICATIONS WHERE BASE METAL THERMOCOUPLES CANNOT BE USED BECAUSE OF EXCESSIVE TEMPERATURES OR SEVERE ATMOSPHERES. ARI CAN PROVIDE A WIDE VARIETY OF WIRE COMBINATIONS & SHEATH MATERIALS TO MEET THE HARSHTEST DEMANDS. BY SELECTING CERTAIN MATERIALS, TEMPERATURE MEASUREMENTS UP TO 2300° C CAN BE ACHIEVED.

ARI MANUFACTURES IT'S OWN MINERAL INSULATED CABLE AND MANY OF OUR THERMOCOUPLES ARE AVAILABLE IN BENDABLE SHEATHS & LONGER LENGTHS. THIS IN-HOUSE CAPABILITY ENABLES US TO MANUFACTURE A VARIETY OF CUSTOM MATERIAL COMBINATIONS. APPLICATIONS INCLUDE PROCESS CONTROL OF VACUUM FURNACES, GAS FURNACES, HIGH TEMP OVENS AND REACTION FURNACES. PROCESSES INCLUDE SINTERING, ANNEALING AND CARBURIZING.

WHILE MANY PROCESS VARIABLES AFFECT SERVICE LIFE, THERE ARE 2 IMPORTANT CONSIDERATIONS FOR SELECTING THE PROPER THERMOCOUPLE FOR A PARTICULAR APPLICATION. 1.) WHAT IS THE *TEMPERATURE RANGE* YOU WILL NEED TO MEASURE? 2.) WHAT IS THE *ATMOSPHERE* THE THERMOCOUPLE WILL BE EXPOSED TO DURING OPERATION? WITH THIS INFORMATION, IT IS POSSIBLE TO USE THESE TABLES TO SELECT A SUITABLE WIRE, SHEATH AND INSULATION COMBINATION. THE PHYSICAL REQUIREMENTS OF THE THERMOCOUPLE (SHEATH DIAMETER, JUNCTION TYPE AND TERMINATION STYLE) CAN THEN BE SELECTED TO COMPLETE THE DESIGN. OF COURSE, YOU CAN ALWAYS CONTACT OUR ARI SALES STAFF FOR HELP IN SELECTING THE PROPER THERMOCOUPLE.

THERMOCOUPLE WIRE TYPES

TABLE 1

THERMOCOUPLE COMBINATIONS	ARI SYMBOL	STANDARD LIMITS OF ERROR	RECOM. TEMP. RANGE
PLATINUM 10% RHODIUM (+) VS. PLATINUM (-) TYPE S	S	± 1.5°C OR .25% PER ASTM E-230	0 - 1450°C
PLATINUM 13% RHODIUM (+) VS. PLATINUM (-) TYPE R	R	± 1.5°C OR .25% PER ASTM E-230	0 - 1450°C
PLATINUM 30% RHODIUM (+) VS. PLATINUM 6% RHODIUM (-) TYPE B	B	± .5% PER ASTM E-230	870 - 1700°C
TUNGSTEN 5% RHENIUM (+) VS. TUNGSTEN 26% RHENIUM (-) TYPE C	AE	±4.4° C (0 - 426°C) ± 1% (426 TO 2315°C) PER ASTM E-988	0 - 2200°C
TUNGSTEN 3% RHENIUM (+) VS. TUNGSTEN 25% RHENIUM (-) TYPE D	AO	±4.4° C (0 - 426°C) ± 1% (426 TO 2315°C) PER ASTM E-988	0 - 2200°C

SHEATH MATERIALS

TABLE 2

SHEATH TYPE	ARI SYMBOL	RECOM. MAX. TEMP.	MELTING TEMP	ALLOWABLE ENVIRONMENT	STD SHEATH DIAMETERS	MIN. BEND RADIUS
INCONEL 600	B	1175°C	1345°C	INERT, VACUUM, OXIDIZING	.040", .062", .125", .188", .250"	5 X DIA.
PLATINUM 10% RHODIUM	AH	1550°C	1850°C	INERT, OXIDIZING	.040", .062", .125"	5 X DIA.
TANTALUM	N	2200°C	2995°C	INERT, VACUUM	.040", .062", .125"	10 X DIA.
MOLYBDENUM	O	2000°C	2620°C	INERT, VACUUM, REDUCING	.062", .125", .188", .250"	DO NOT BEND
NIOBIUM 1% ZIRCONIUM	AV	2200°C	2495°C	INERT, VACUUM	.062", .125"	10 X DIA.
COATED MOLYBDENUM	OCR	1600°C	2000°C	INERT, OXIDIZING	.125", .250"	DO NOT BEND

INSULATION MATERIALS

TABLE 3

INSULATION TYPE	ARI SYMBOL	RECOM.MAX. OPER. TEMP	APPROX. MELTING TEMP.	COMMENTS
MAGNESIUM OXIDE (MgO)	N	1700°C	2800°C	VERY HYGROSCOPIC AND USED MOSTLY IN COMPACTED SHEATHS
ALUMINA OXIDE (Al ₂ O ₃)	A	1550°C	2040°C	EXCELLENT WITH PLATINUM ALLOYS
HAFNIUM OXIDE (HfO ₂)	H	2200°C	2790°C	COMPARABLE TO BERYLLIA OXIDE AND SAFE TO HANDLE
BERYLLIUM OXIDE (BeO) *	B	2200°C	2650°C	EXCELLENT HIGH TEMP THERMAL CONDUCTIVITY AND RESISTIVITY

*BERYLLIUM IS CONSIDERED A TOXIC MATERIAL AND CAN CAUSE HEALTH PROBLEMS IF PARTICLES ARE INHALED.

SHEATH DIAMETER CODES

TABLE 4

SHEATH DIAMETER / LETTER CODE	.040" / A	.062" / B	.125" / D	.188" / E	.250" / F
-------------------------------	-----------	-----------	-----------	-----------	-----------

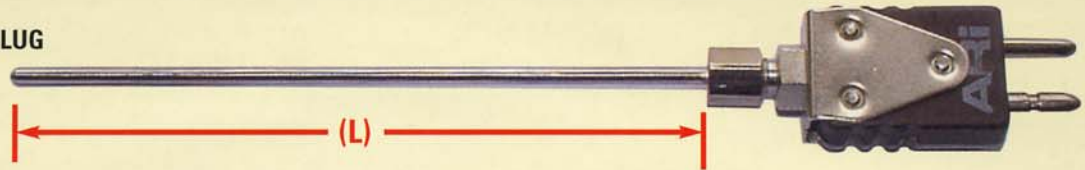
JUNCTION NUMBER CODES

TABLE 5

SHEATH TYPE	WIRE TYPE LETTER CODE	JUNCTION CODE GROUNDED	JUNCTION CODE UNGROUNDED
INCONEL 600	R, S, & B	(8.1)	9
PLAT 10% RH.	R, S, & B	8	9
COATED MOLY	AE & AO	N/A	(9.3)
TANTALUM	R, S, B, AE, & AO	(8.1)	(9.5)
MOLYBDENUM	R, S, & B	N/A	(9.4)
MOLYBDENUM	AE & AO	N/A	(9.3)
NIOBIUM 1% ZIRC.	AE & AO	(8.1)	(9.5)

STANDARD TERMINATION STYLES

T-91 200°C STD. MALE PLUG



T-107 200°C TRANSITION W/FIBERGLASS INSUL. EXT. WIRE



HI-T-91 427°C HIGH TEMP MALE PLUG



T-14 1/2" BARE WIRE LEADS W/EPOXY SEAL



T-77 200°C TRANS. W/FIBERGLASS INSUL. EXT. WIRE, STD. MALE PLUG



T-99 200°C TRANS. W/FIBERGLASS INSUL. EXT. WIRE WITH ST/ST OVERBRAID



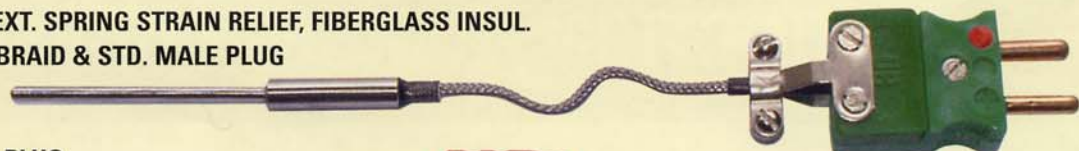
T-37 200°C TRANS. W/EXT. SPRING STRAIN RELIEF, FIBERGLASS INSUL. EXT. WIRE & STD. MALE PLUG



T-31 200°C TRANS. W/EXT. SPRING STRAIN RELIEF, FIBERGLASS INSUL. EXT. WIRE



T-103 200°C TRANS. W/EXT. SPRING STRAIN RELIEF, FIBERGLASS INSUL. EXT. WIRE W/ST/ST OVERBRAID & STD. MALE PLUG



T-191 200°C MINIATURE PLUG



PART NUMBER BREAKDOWN

EXAMPLE: T-107 N -12 B AE (8.1) N -24
 (1) (2) (3) (4) (5) (6) (7) (8)

SINCE ALMOST ALL OF OUR THERMOCOUPLES ARE MADE TO YOUR ORDER REQUIREMENTS, WE CAN EASILY SUPPLY ANY MODIFICATION OR CUSTOM DESIGN BASED ON YOUR APPLICATION.

- (1) INSERT STYLE NUMBER FROM ABOVE
- (2) INSERT INSULATION MATERIAL LETTER CODE FROM TABLE 3
- (3) INSERT SHEATH LENGTH (L) IN INCHES
- (4) INSERT SHEATH DIAMETER LETTER CODE FROM TABLE 4
- (5) INSERT Ari SYMBOL FOR WIRE TYPE FROM TABLE 1
- (6) INSERT JUNCTION CODE FROM TABLE 5
- (7) INSERT Ari SYMBOL FOR SHEATH MATERIAL FROM TABLE 2
- (8) INSERT LENGTH OF EXTENSION WIRE (A) IN INCHES (IF REQ). STANDARD LENGTH OF 16" SUPPLIED IF NOT SPECIFIED.

OPTIONS/MODIFICATIONS

HIGH TEMPERATURE TERMINATION

IN APPLICATIONS WHERE THE COLD END TERMINATION WILL SEE TEMPERATURES IN EXCESS OF 200°C, STANDARD EPOXY SEALS MAY BREAKDOWN CAUSING FAILURE. IN THIS CASE, ARi CAN SUPPLY A CERAMIC CEMENT SEAL WHICH CAN WITHSTAND TEMPERATURES UP TO 450°C. TO SPECIFY THIS OPTION, ADD THE PREFIX **HI-** IN FRONT OF THE PART NUMBER SELECTED.

EXAMPLE: HI-T-107N-12DAE(9.5)N

DUPLEX ELEMENT CONSTRUCTION

MOST THERMOCOUPLE COMBINATIONS WITH AN OUTSIDE SHEATH DIAMETER OF 1/8" OR LARGER ARE AVAILABLE IN DUPLEX ELEMENT CONSTRUCTION (2 SEPARATE MEASURING CIRCUITS IN 1 SHEATH). TO SPECIFY THIS OPTION, ADD THE SUFFIX **.4** AFTER THE STYLE NUMBER, **REPEAT THE JUNCTION CODE A 2ND TIME AND ADD PARENTHESES.**

EXAMPLE: T-91.4N -12FR(9.9)B OR T-91.4B-18DAE(9.3)(9.3)O

MATING JACK

IF REQUIRED WITH ANY OF OUR MALE PLUG TYPE THERMOCOUPLES (T-91, T-191, AND HI-T-91), WE CAN SUPPLY THE APPROPRIATE MATING JACK WITH THE ASSEMBLY. TO SPECIFY THIS MODIFICATION, ADD **(MOD)** AFTER THE PART NUMBER AND SPECIFY **"SUPPLIED WITH MATING JACK"**.

ARGON BACKFILL

IN ORDER TO MINIMIZE THE EFFECTS OF ANY RESIDUAL OXIDATION REMAINING INSIDE NON-COMPACTED SHEATH DESIGNS, ARi CAN EVACUATE AND BACKFILL THE SHEATH WITH INERT ARGON GAS PRIOR TO SEALING THE COLD END. TO SPECIFY THIS MODIFICATION, ADD **(MOD)** AFTER THE PART NUMBER AND SPECIFY **"WITH ARGON BACKFILL"** IN THE DESCRIPTION.

SPECIAL LIMITS OF ERROR

THERMOCOUPLES WITH R,S & B CALIBRATIONS MADE WITH MINERAL INSULATED CONSTRUCTION CAN BE SUPPLIED WITH SPECIAL LIMITS OF ERROR TOLERANCES PER ASTM E - 230 OR CLASS 1 PER IEC-584 SUBJECT TO AVAILABILITY OF MATERIAL FROM STOCK. TO SPECIFY THIS MODIFICATION, ADD **(MOD)** AFTER THE PART NUMBER AND SPECIFY **" PER SPECIAL LIMITS OF ERROR"** OR **"PER CLASS 1 TOLERANCE"** IN THE DESCRIPTION.

TEFLON INSULATED EXTENSION WIRES

FOR DESIGNS WHERE EXTENSION WIRE ATTACHMENT IS REQUIRED, ARi CAN SUPPLY MOISTURE RESISTANT TEFLON INSULATED EXTENSION WIRE IN PLACE OF OUR STANDARD FIBERGLASS. OTHER INSULATION TYPES CAN BE SUPPLIED SUBJECT TO AVAILABILITY. TO SPECIFY THIS MODIFICATION, ADD **(MOD)** AFTER THE PART NUMBER AND SPECIFY **"WITH TEFLON INSULATED LEADS"** IN THE DESCRIPTION.

METRIC SIZES

ARi MAINTAINS A WIDE VARIETY OF MINERAL INSULATED CABLE AND TUBING IN STOCK TO MANUFACTURE THERMOCOUPLES WITH METRIC SHEATH DIAMETER REQUIREMENTS. METRIC SIZES ARE SUBJECT TO AVAILABILITY. TO SPECIFY THIS OPTION, **INSERT DECIMAL EQUIVALENT IN PLACE OF THE SHEATH DIAMETER LETTER CODE** OF THE PART NUMBER.

EXAMPLE: FOR 3.0 MM (.118") SHEATH SIZE: T-91N-12(.118)AE(9.3)O

SPECIAL TESTING

SPECIAL NON-DESTRUCTIVE TESTING IS AVAILABLE ON IN-PROCESS AND FINISHED THERMOCOUPLE ASSEMBLIES. TYPE OF TESTS AVAILABLE INCLUDE: THERMOCOUPLE TEMPERATURE CALIBRATION (TEMP VS. EMF), RADIOGRAPHY, LIQUID PENETRANT, HELIUM LEAK, DIMENSIONAL, & INSULATION RESISTANCE. ALL ARi STANDARDS ARE TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST). ARi'S QUALITY MANAGEMENT SYSTEM MEETS THE REQUIREMENTS OF ISO 9002 AS CERTIFIED BY LLOYDS REGISTER QUALITY ASSURANCE.

SPECIAL PRODUCTS

BARE WIRE THERMOCOUPLE ELEMENTS

ARi CAN SUPPLY UN-SHEATHED BARE WIRE THERMOCOUPLE ELEMENTS WHERE QUICK TIME RESPONSE AND ACCURATE TEMPERATURE MEASUREMENTS ARE CRITICAL.

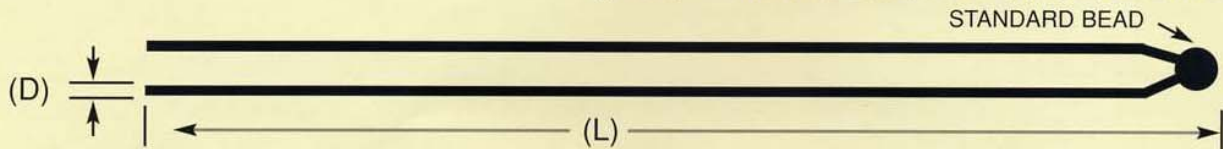
ELEMENTS CAN BE SUPPLIED IN THREE (3) STANDARD DIAMETERS, CUSTOM BUILT TO YOUR LENGTH REQUIREMENTS. TYPE R, S, AND B ARE SUPPLIED WITH A STANDARD BEAD TYPE JUNCTION, WHILE TUNGSTEN RHENIUM TYPES C AND D (ARi TYPE AE AND AO) ARE SUPPLIED WITH OUR PATENTED WIRE WOUND JUNCTION TYPE (9.3).

SPECIFY ARi P/N T-50994 - (L) - (D) - (TYPE)

(L) --- SPECIFY LENGTH IN INCHES

(D)--- SPECIFY WIRE DIAMETER (.010, .020 OR .032)

(TYPE) --- SPECIFY WIRE TYPE (R, S, B, AE OR AO)



CERAMIC PROTECTION TUBE ASSEMBLIES

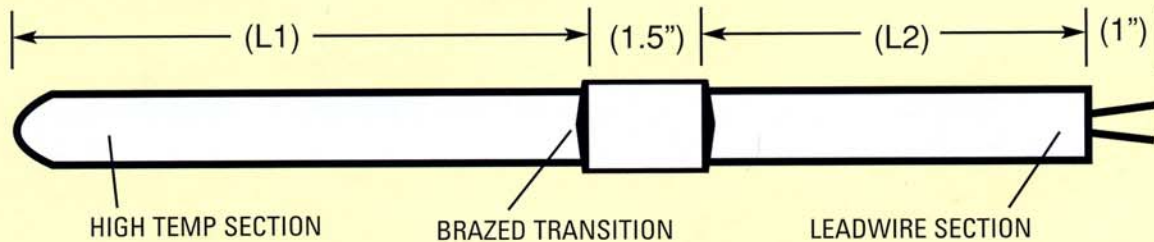
ARi OFFERS A VARIETY OF CERAMIC PROTECTION TUBE ASSEMBLIES FOR APPLICATIONS WHERE EXTREME TEMPERATURES AND ATMOSPHERES ARE TOO SEVERE FOR METAL TUBES. OUR DESIGNS ARE BUILT PER YOUR EXACTING SPECIFICATIONS:

MATERIAL TYPE	GRADE	LETTER CODE	MAXIMUM RECOM. TEMP.	THERMAL SHOCK RESISTANCE	COMMENT
ALUMINA	MIN. PURITY 99.7%	AL	1800°C	FAIR	GAS TIGHT. EXCELLENT IN OXIDIZING AND REDUCING ATMOSPHERES
SILICON CARBIDE	MIN. PURITY 75-90%	SiC	1400°C	GOOD	VERY HIGH THERMAL CONDUCTIVITY
RECRYSTALLIZED SILICON CARBIDE	MIN. PURITY 99 %	RSiC	1600°C	VERY GOOD	GOOD MECHANICAL STRENGTH CAN WITHSTAND UP TO 2000°C IN PROTECTED ATMOSPHERES
HEXOLOY®	SINTERED	HEX	1650°C	EXCELLENT	EXCEPTIONAL CORROSIVE / CHEMICAL RESISTANCE IN OXIDIZING /REDUCING ENVIRONMENTS

HEXOLOY® IS A REGISTERED TRADEMARK OF CARBORUNDUM CORP.

TRANSITION STYLE THERMOCOUPLES

WHEN EXOTIC APPLICATIONS REQUIRE LONG THERMOCOUPLES WITH EXPENSIVE NOBLE METAL OR REFRACTORY SHEATHS, ARi CAN SUPPLY CUSTOM MADE TRANSITION STYLE THERMOCOUPLES FOR SUBSTANTIAL COST SAVINGS. THERMOCOUPLES CAN BE SUPPLIED WITH SUITABLE HIGH TEMPERATURE "HOT SECTION" SHEATH AND INSULATING MATERIALS LONG ENOUGH TO REACH A COOLER ZONE IN THE FURNACE OR REACTOR (MAXIMUM 870°C). AT THIS POINT, A BRAZED TRANSITION CAN BE MADE TO A LESS EXPENSIVE THERMOCOUPLE OR COMPENSATING MATERIAL WITH INCONEL 600 OR ST/ST SHEATH. CONTACT ARi FOR SPECIFIC PART NUMBERS AND SPECIFICATIONS.



SPECIAL REFRACTORY SHEATHS

IN ADDITION TO THE SHEATHS LISTED IN TABLE 2, ARi CAN ALSO PROVIDE THE FOLLOWING SHEATHS ON SPECIAL ORDER. CONTACT ARi FOR DIMENSIONS AND AVAILABILITY:

SHEATH TYPE	LETTER CODE	RECOMMENDED MAXIMUM TEMP	MELTING TEMP	COMMENTS
TUNGSTEN	BC	2300°C	3410°C	VERY HIGH MELTING POINT AND LOW VAPOR PRESSURE FOR VACUUM APPLICATIONS
MOLYBDENUM 50% RHENIUM	BE	2300°C	2550°C	EASILY WELDABLE AND DUCTILE UP TO 2200°C SUITABLE FOR INERT, VACUUM, HYDROGEN, NITROGEN, AND AMONIA ATMOSHERES
UCAR® METAL CERAMIC LT-1 TUBES	BV	1371°C	1538°C	SUITABLE FOR VARIOUS MOLTEN METALS AND CORROSIVE GASES
MOLY DISILLCIDE	BW	1700°C	VARIES	CAN BE USED IN AIR UP TO 1700°C. SUITABLE FOR HEAT TREATING, SINTERING AND GLASS APPLICATIONS.

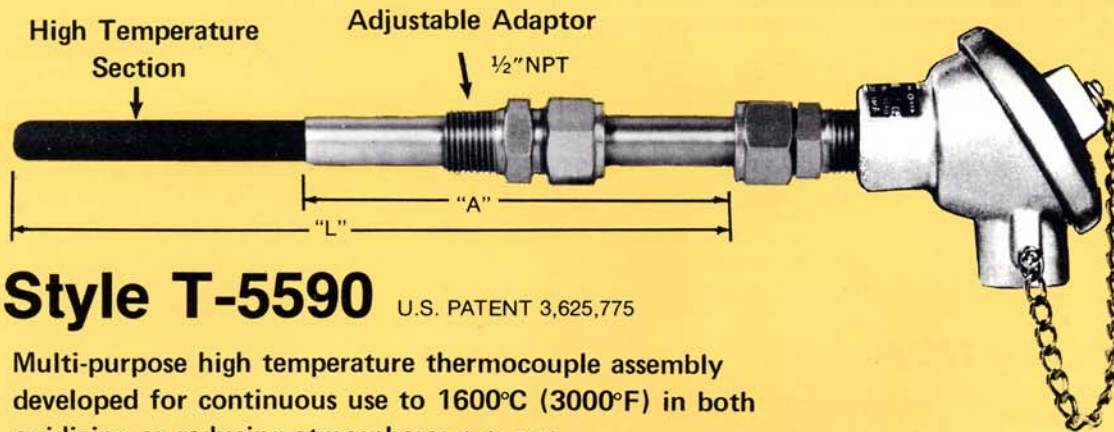
SPECIAL COATINGS FOR SHEATHS

IN ADDITION TO THE COATED MOLYBDENUM SHEATH (OCR) SHOWN IN TABLE 2, THE FOLLOWING COATINGS ARE ALSO AVAILABLE:

COATING TYPE	LETTER CODE	MAXIMUM TEMP	COMMENTS
TUNGSTEN (PLASMA SPRAY)	TPL	2200°C	FOR RESISTANCE TO GRAPHITE ATTACK IN VACUUM APPLICATIONS. APPLIED TO MOLYBDENUM SHEATH.
BORON NITRIDE	BN	1800°C	NON-WETTING WITH MOST MOLTEN METALS AND SLAGS. USE IN OXIDIZING ATMOSPHERES TO 1100°C



Industrial 1600°C thermocouple



Type E Head
shipped
separately

Style T-5590 U.S. PATENT 3,625,775

Multi-purpose high temperature thermocouple assembly developed for continuous use to 1600°C (3000°F) in both oxidizing or reducing atmospheres-pressures to 70 Kg/cm² (1000 psi)

HIGH TEMPERATURE SECTION: 12.7 mm (0.5 in.) diameter
LENGTHS FROM 76.3 to 433 mm (3 to 17 in.)

SUPPORT SECTION "A": 15.9 mm (0.625 in.) diameter
LENGTHS FROM 102 to 1525 mm (4 to 60 in.)

TOTAL LENGTH "L": 178 mm (7 in.) minimum, 1960 mm (77 in.) maximum

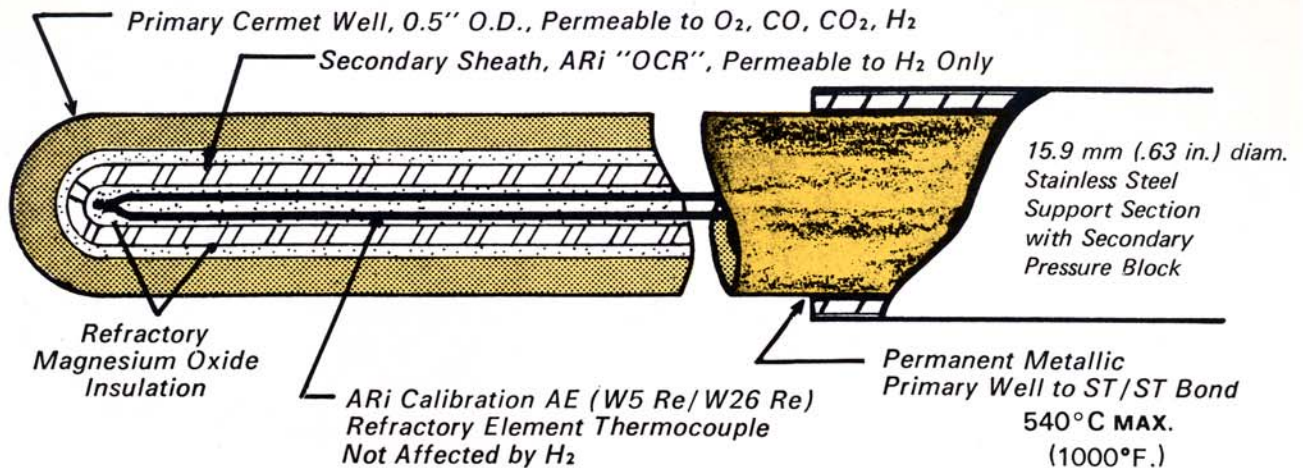
This thermocouple may be used for temperatures above the Chromel/Alumel range in environments that either destroy or render Platinum-Rhodium thermocouples ineffective due to drift or ageing affects. The refractory Tungsten 5% Rhenium/Tungsten 26% Rhenium element is protected against contamination or oxidation thru the unique double insulation-double wall construction that selectively eliminates all but the beneficial diffusion of Hydrogen. Internal thermocouple junction reliability is maintained thru a new (patent pending) wire wrap/welding procedure to eliminate the problems associated with thermal cycling welded junctions on refractory wires. This sensor combines the stability and sensitivity (4.4microvolts per ° C.) of the new refractory thermocouple combinations with the atmospheric resistance and strength of cermets.

ARI is a Registered US Trademark

ARI Industries Inc

BULLETIN 2.2

JULY 1998



APPLICATION

- Gas generator temperature indication and control
- Metal annealing, hardening and deoxidizing furnaces
- Calcining and glazing Kiln temperature survey and control
- Temperature control for alternating oxidizing and reducing processes
- Ceramic firing systems
- Diffusion furnaces
- Commercial 816 to 1600°C (1500 to 3000°F) ovens
- Liquid steady state metal temperature surveys in Aluminum, Tin, Copper, Copper-Silver alloys, Lithium
- Long term temperature indication for baths with acid salts and corrosive acids (Cyanide salts and molten borax excluded)
- Sulfur Recovery Unit, refractory protection

INSTALLATION

Compression fitting (1/2" NPT) with metal ferrule supplied with each sensor for immersion control and pressure tight mounting to any pre-drilled and tapped chamber wall. Insert threaded end and wrench tighten using hex head adjacent to threads. Insert thermocouple thru hex head cap to desired immersion depth. Tighten cap 1/4 turn beyond finger tightness.

Note: Thermocouple head is supplied with the necessary compression fitting for attachment to probe. Attach wires, tighten compression fittings on thermocouple head prior to process installation.

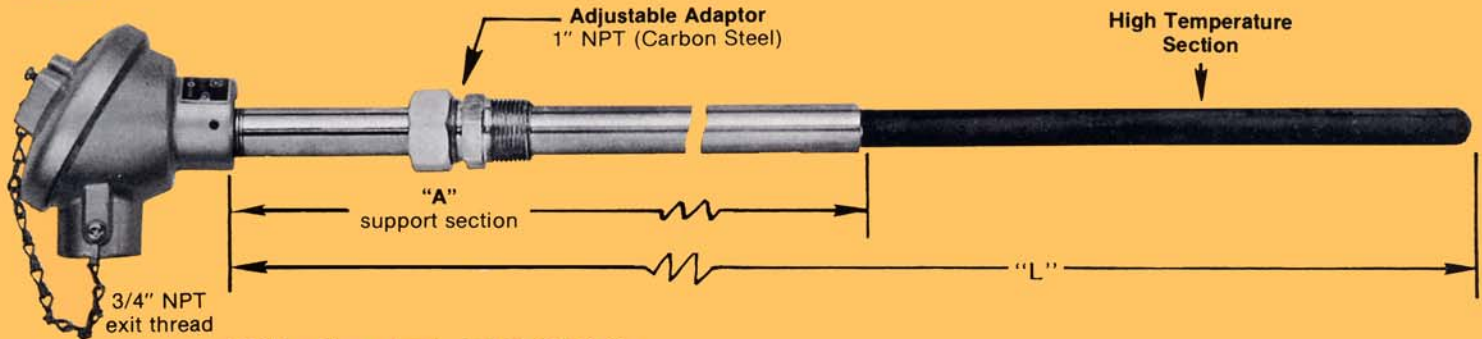
HOW TO ORDER

Specify Part Number T-5590—"L" AE "A" giving variables such as "L" and "A" dimensions in inches.

EXAMPLE: T-5590 - 30AE15
L=30 in., A=15 in.

Industrial 1600°C thermocouple

Type E Head
shipped
separately



Style T-50230

U.S. PATENT 3,625,775

HIGH TEMPERATURE SECTION ("L"- "A"): 19mm (.75") diameter cermet well to 430mm (17") long on the standard design.

SUPPORT SECTION ("A"): 25.4mm (1") diameter stainless steel support section 50 to 1500mm long (2" to 60"). Bonded to High Temp. Section.

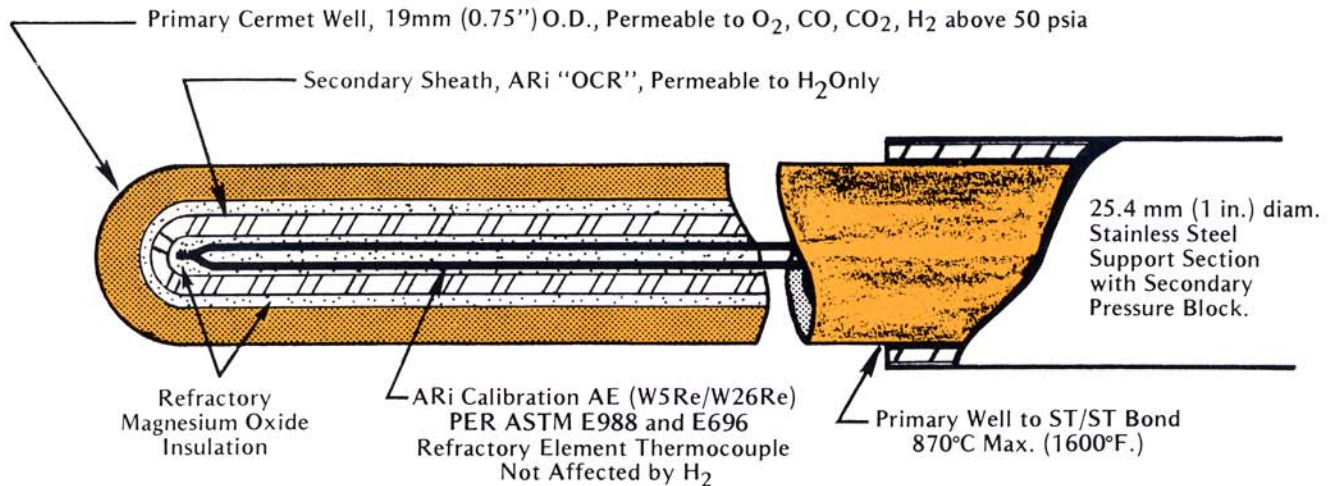
TOTAL LENGTH ("L"): 178mm (7") minimum, 1930mm (76") maximum.

The T-50230 thermocouple was developed as a more rugged version of the T-5590 thermocouple (ARi Bulletin 2.2) for the extreme environments found in sulfur recovery units and coal gasification reaction zones. It may be used in both oxidizing or reducing atmospheres and applications requiring resistance to H₂S or SO₂ that are destructive to platinum alloy and common base metal thermocouples. The Tungsten 5% Rhenium/Tungsten 26% Rhenium element is protected against contamination or oxidation thru the unique double insulation-double wall construction that selectively eliminates all but the beneficial diffusion of Hydrogen. Internal thermocouple junction reliability is maintained thru a new patented wire wrap/welding procedure to eliminate the problems associated with thermal cycling welded junctions with refractory wires. Toxic gas leakage or bypass flow thru the connection head is eliminated as a result of the unique double concentric well approach and secondary wire seal at connection head end.

ARi is a Registered US Trademark

ARi Industries Inc

BULLETIN 2.3
FEBRUARY 1997



ACCESSORY EQUIPMENT

COMPENSATING LEAD WIRE

For conduit wiring: 427°C (800°F) max. use ARi part number 01-2AEX-G/G-24 with fiberglass insulation over each and over the pair. Note: Should not be used in conduit where standing water or steam are present. Use ARi part number 01-2AEX-T/T 20 flexible teflon leadwire to avoid the effects of moisture.

TRANSMITTER

Style T-50230 can be provided with a 4-20 ma DC two wire transmitter, ARi part number 47042-AE- (temperature range), to eliminate the need for thermocouple lead wire. The transmitter is mounted in the cast iron connection head in place of the ceramic terminal block. The assembly is designated as TX-50230-(L)AE(A). Zero and span trimpots allow adjustment to $\pm 10\%$ minimum. Standard Ranges 0-1600°C or 0-3000°F available.

SELF-CONDUIT PERMANENT WIRING:

For 870°C (1600°F) max, use ARi part number 125-2M-B(AEX)-24 Aeropak mineral insulated cable, 3.2mm (0.125") diameter stainless steel sheath, compacted MgO insulation, AWG 24 compensating wires (Hoskins 405 and 426 alloy). Cable ends require epoxy sealing to prevent moisture entry. May be formed by hand as a replacement for conduit-lead wire approach. Max. length is 100 ft. See Bulletin 6 for PTM-D2SS compression fittings used for mounting.

DIGITAL THERMOMETER MODEL 640

Field selectable Fluke DTI, ARi part number 640 AE DTI, 100 to 2000°C or 200 to 4000°F digital (.56", 14mm character size) indication from ARi type "AE" W5Re/W26Re thermocouples. Accuracy (to AE temp/EMF table) $\pm 6^\circ\text{C}$ with T/C break indication and 1° max. error due to common or series mode AC signal injection. Power requirement: 115/230V, 50/60 HZ, 10 watts. Panel mounted.

ORDERING INFORMATION —

PROBE: Specify T-50230-(L)AE(A) add (L) and (A) in inches.

LEAD WIRE: Specify part number, length of each piece, and quantity.

DIGITAL THERMOMETER: Specify model number and quantity.

BULLETIN 3.0

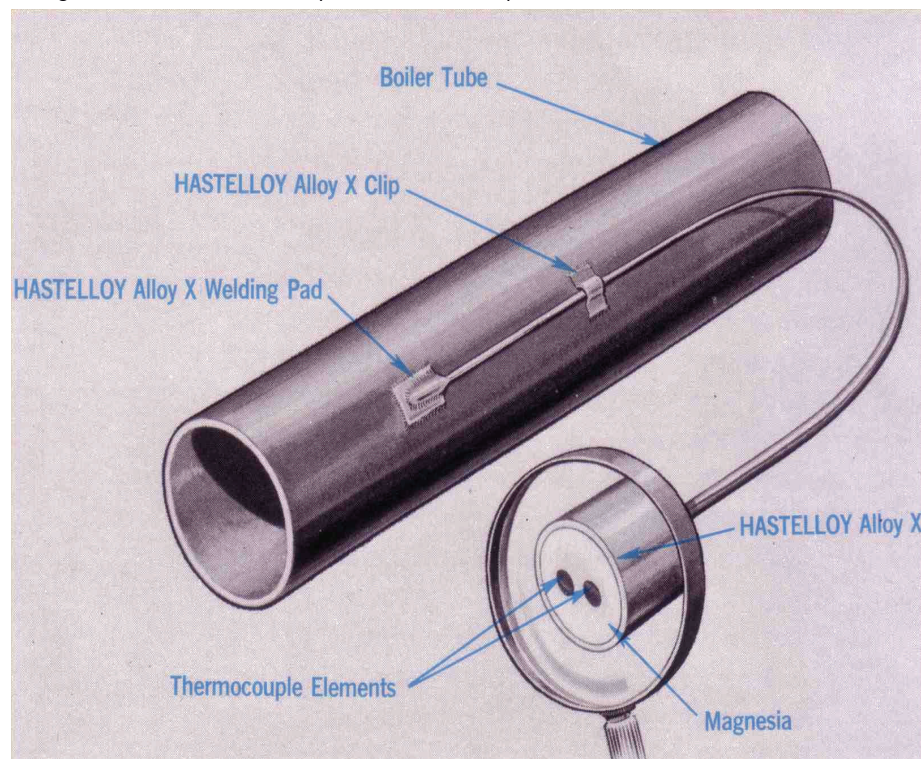
Features:

- Cut Start-up Time
- Operating Safety
- Minimize Fuel Waste
- Increase Tube Reliability
- Increase Tube Life
- Avoid Forced Boiler Shutdown
- Lower Maintenance Cost
- Prevent "Steam Starvation" of Super-heater Tubes
- Allow Complete Control of Flow and Fuel

SENSES TUBE SURFACE TEMPERATURE TO BETTER THAN $\pm 2\%$ ACCURACY

AEROPAD, A PAD TYPE THERMOCOUPLE ESPECIALLY DESIGNED FOR HIGHLY ACCURATE AND TROUBLE FREE MEASUREMENT OF TUBE SKIN TEMPERATURE.

AerOpad Thermocouples are designed for welding direct to boiler or process tubes. They sense tube surface temperatures to 1100°C (2012°F) with a corrected accuracy of at least $\pm 2\%$. Normally furnished with a Type 310 stainless steel sheath over the compacted magnesium oxide insulation, with type "K" thermocouple wires. The thermocouples can be provided with a sheath of Hastelloy X Alloy for superior resistance to the most corrosive atmospheres. AerOpad Thermocouples are easy to install, yet rugged enough to withstand the roughest handling. They have a usable range of -240 to 1100°C (-400 to 2012°F.)



ARI Industries, Inc.

381 ARi Court

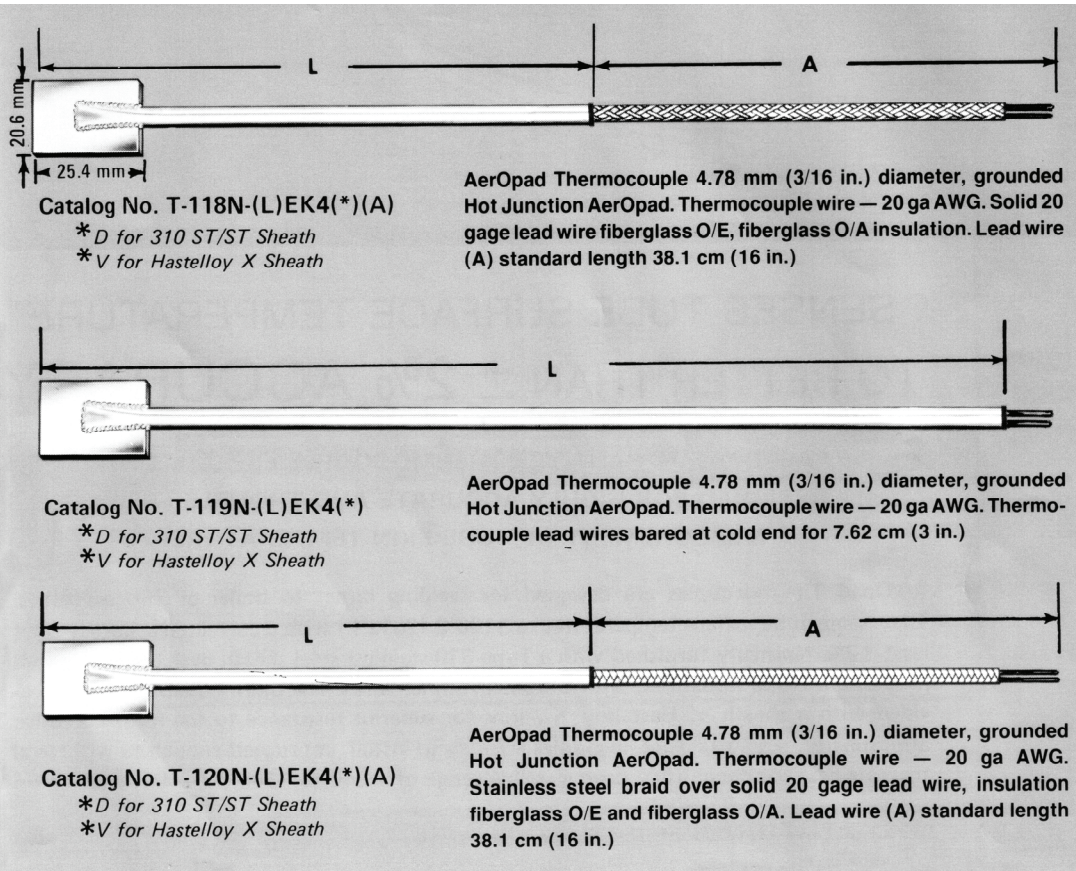
Addison, IL 60101

Phone: 800-237-6725 Fax: 630-953-0590

www.ariindustries.com Email: sales@ariindustries.com
Division of Okazaki Manufacturing Company

BULLETIN 3.0





Catalog No. T-118N-(L)EK4(*) (A)
 *D for 310 ST/ST Sheath
 *V for Hastelloy X Sheath

AerOpad Thermocouple 4.78 mm (3/16 in.) diameter, grounded Hot Junction AerOpad. Thermocouple wire — 20 ga AWG. Solid 20 gage lead wire fiberglass O/E, fiberglass O/A insulation. Lead wire (A) standard length 38.1 cm (16 in.)

Catalog No. T-119N-(L)EK4(*)
 *D for 310 ST/ST Sheath
 *V for Hastelloy X Sheath

AerOpad Thermocouple 4.78 mm (3/16 in.) diameter, grounded Hot Junction AerOpad. Thermocouple wire — 20 ga AWG. Thermocouple lead wires bared at cold end for 7.62 cm (3 in.)

Catalog No. T-120N-(L)EK4(*) (A)
 *D for 310 ST/ST Sheath
 *V for Hastelloy X Sheath

AerOpad Thermocouple 4.78 mm (3/16 in.) diameter, grounded Hot Junction AerOpad. Thermocouple wire — 20 ga AWG. Stainless steel braid over solid 20 gage lead wire, insulation fiberglass O/E and fiberglass O/A. Lead wire (A) standard length 38.1 cm (16 in.)

Basic internal components:

- THERMOCOUPLE WIRE:** 20 gage AWG ANSI MC 96.1 Standard limits of error. Calibration Type: K - Chromel-Alumel(2) with 310 Stainless Steel or Hastelloy x sheath. J - Iron-Constantan with 310 Stainless Steel sheath only. E - Chromel(2)-Constantan with 310 Stainless Steel sheath only.
- INSULATION:** Compacted Ceramic (MgO)
- SHEATH:** 310 Stainless Steel with type J, K & E wires or Hastelloy x sheath (for extra corrosion resistance) with type K wires only. Sheath diameter 4.78 mm (.188 in.).
- JUNCTION:** Grounded Hot Junction Type 4
- PAD SIZE:** 20.6 x 25.4 x 3.18 mm (1 x 3 / 4 x 1 / 8 in.). Supplied flat or curved to the following required radii: 12.7, 25.4, 50.80, 76.2, 101.60 mm (1 / 2, 1, 2, 3 or 4 in.).

NOTES: The name Chromel-Alumel is trade marked by Hoskins, Mfg. Co. The name Hastelloy-X is trade marked by Haynes International.

BULLETIN 3.0



Ari Industries, Inc.
 381 ARi Court
 Addison, IL 60101

Phone: 800-237-6725 Fax: 630-953-0590
 www.ariindustries.com Email: sales@ariindustries.com
 Division of Okazaki Manufacturing Company

Available Products:

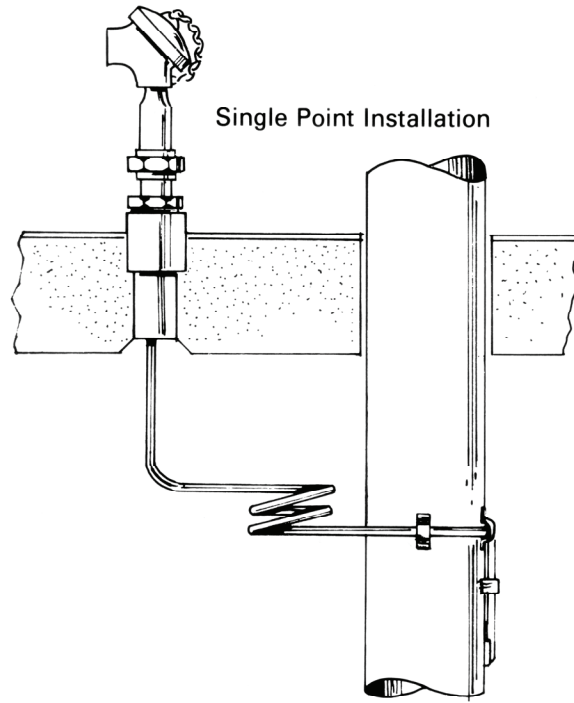
- Mineral insulated cable
- Base metal T/C cable:
 - Type E
 - Type J
 - Type K
 - Type T
- Nobel metal T/C cable:
 - Type B
 - Type R
 - Type S
- Refractory T/C cable:
 - Tungsten Rhenium
 - Type C
 - Type D
- Multipoint T/C assemblies for temperature profiling.
- Fan Junction for furnace tube temperature sensing:
 - Stainless Steel Sheaths
 - Hastelloy-X Sheaths
- Nuclear grade T/C's.
- RTD assemblies
- Thermowells
- Temperature transmitters
- MGO insulated conductor cable. 1 to 10 wire designs
- Self Powered Neutron Detectors.
- Metal sheathed electric heater cable:
 - Stocked sizes
 - Single ended
 - Double ended
 - Custom lengths
 - Multiple circuits
 - Custom formations
 - Heated & unheated sections
 - Vacuum designs
 - High Temp. Heat Tracing
- Tubular heater assemblies.
- Flexible silicone rubber heaters.
- ISO-9001-2000 Certified.
- Custom testing available:
 - X-Ray
 - Helium Leak
 - Heat Treating
 - Temperature calibration (traceable to NIST)

AerOpad thermocouple assemblies are available in a variety of calibrations and cable diameters.

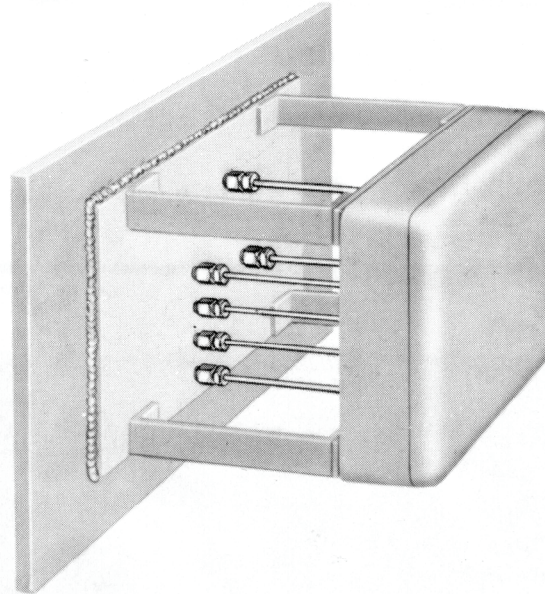
AerOpad sensors can be made to custom cable formations.

Expansion loops are offered to decrease sensor strain, resulting in increased sensor life.

Multipoint junction boxes are available with up to 32 sensors for convenient wiring connections.



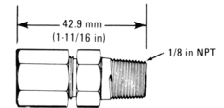
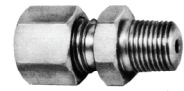
Multipoint Junction Box



Please call for engineering help on customizing your Thermocouples to meet your application specific needs.

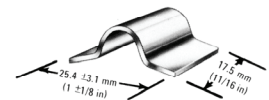
Hardware & Accessory options

ADJUSTABLE ADAPTORS



Stainless Steel: **Catalog No. PTM-E2-SS**
 Nickel Plated: **Catalog No. PTM-E2APNI**
 SEE BULLETIN 6.0 FOR DETAILS

HASTELLOY X STRAPS



- For mounting AerOpad® Thermocouples to tubes.
- Order one for each meter (39 in) of tube attachment length.
- Allow for thermocouple expansion by welding strap to tube only.

Catalog No. 490108

TYPE E THERMOCOUPLE HEAD



Cast Iron
 Single Thermocouple Head
 Catalog No. 47021

(3/4" NPT both sides to accommodate support nipple.)
 SEE BULLETIN 6.0 FOR DETAILS

BULLETIN 3.0



ARI Industries, Inc.
 381 ARI Court
 Addison, IL 60101

Phone: 800-237-6725 Fax: 630-953-0590

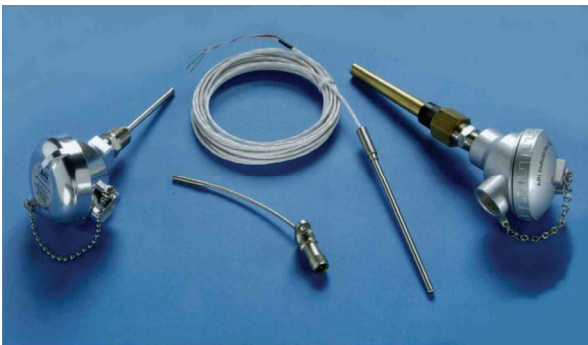
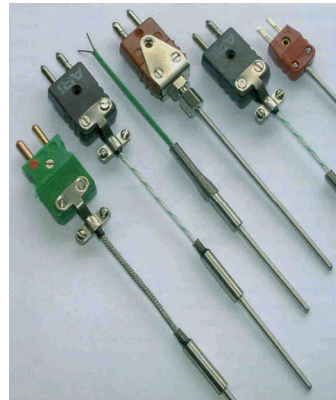
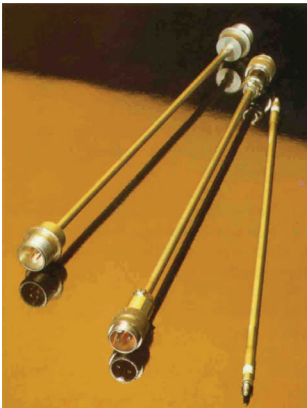
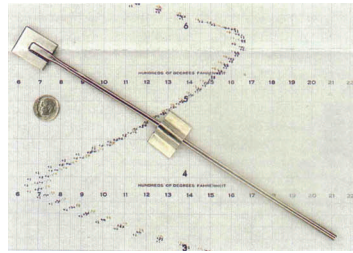
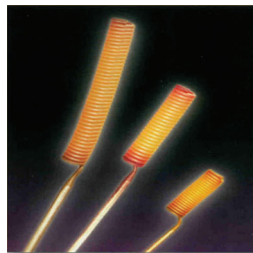
www.ariindustries.com Email: sales@ariindustries.com
 Division of Okazaki Manufacturing Company

ARi's Product Overview

ARi is Manufacturer of mineral insulated heaters, thermocouples, RTD's, Metal-sheathed cable. Our designs/products are being used in semiconductor, FPD, and vacuum furnace applications. Our heaters are used for industrial process heating, Aerospace applications, and have reached Mars. All base metal thermocouple types available. Noble and refractory metal types sensors suitable for vacuum service up to 2200°C. Both standard and custom products available.



ARi is a ISO 9001-2000 registered company



Available Products:

- Mineral insulated cable
- Base metal T/C cable:
 - Type E
 - Type J
 - Type K
 - Type T
- Nobel metal T/C cable:
 - Type B
 - Type R
 - Type S
- Refractory T/C cable:
 - Tungsten Rhenium
 - Type C
 - Type D
- Multipoint T/C assemblies for temperature profiling.
- Fan Junction for furnace tube temperature sensing:
 - Stainless Steel Sheaths
 - Hastelloy-X Sheaths
- Nuclear grade T/C's.
- RTD assemblies
- Thermowells
- Temperature transmitters
- MGO insulated conductor cable. 1 to 10 wire designs
- Self Powered Neutron Detectors.
- Metal sheathed electric heater cable:
 - Stocked sizes
 - Single ended
 - Double ended
 - Custom lengths
 - Multiple circuits
 - Custom formations
 - Heated & unheated sections
 - Vacuum designs
 - High Temp. Heat Tracing
- Tubular heater assemblies.
- Flexible silicone rubber heaters.
- ISO-9001-2000 Certified.
- Custom testing available:
 - X-Ray
 - Helium Leak
 - Heat Treating
 - Temperature calibration (traceable to NIST)

BULLETIN 3.0



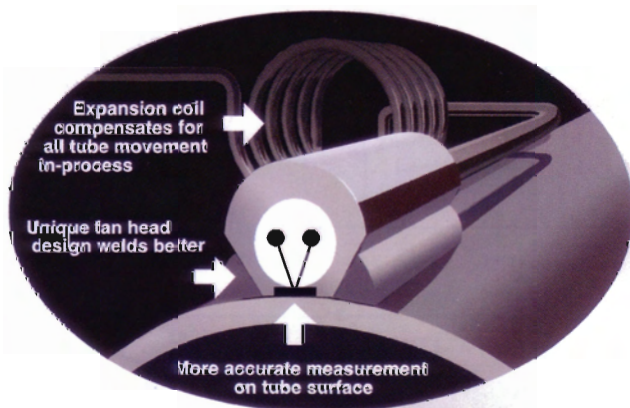
ARi Industries, Inc.
381 ARi Court
Addison, IL 60101

Phone: 800-237-6725 Fax: 630-953-0590
www.ariindustries.com Email: sales@ariindustries.com
Division of Okazaki Manufacturing Company



ARI Industries Inc.

FAN JUNCTION THERMOCOUPLES



For reliable and continuous tube temperature measurement in fired heaters

- More accurate measurement on tube surface
- Expansion coil compensates for all tube movement in-process
- Unique fan head design welds better

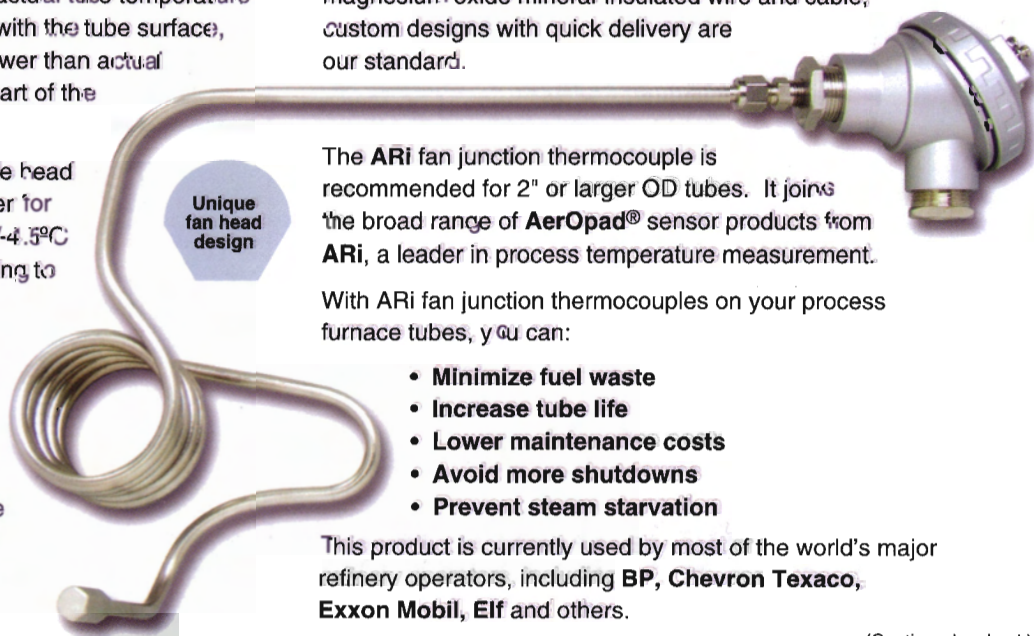
Furnace heater tube skin temperature measurements often vary greatly ($\pm 30^{\circ}\text{C}$) from the actual level, owing to the ambient conditions of air and flame around the tube. This can lead to significantly higher readings than the actual tube OD. Also, narrow-tipped thermocouple designs can cause a higher than actual tube temperature reading, due to improper contact with the tube surface, while shielded tips can result in lower than actual readings, because they insulate part of the tube from heat flux.

The ARI fan junction thermocouple head design offers superior heat transfer for improved accuracy, better than $\pm 4.5^{\circ}\text{C}$ at $\sim 500^{\circ}\text{C}$, as well as easier welding to the tube surface for improved installation integrity. Proper attachment of the sensor head to the tube surface is critical and the unique ARI design enables a more secure weld.

In addition, this ARI thermocouple features **Hastelloy X** sheath material, with excellent corrosion and heat resistance. It can be



manufactured in longer lengths and the standard 5/16" sheath is much more ductile and formable than 446 S.S., when required. This in-field formability allows the creation of expansion coils to offset heater tube movement. Because ARI manufactures its own compacted magnesium oxide mineral-insulated wire and cable, custom designs with quick delivery are our standard.



The ARI fan junction thermocouple is recommended for 2" or larger OD tubes. It joins the broad range of **AerOpad®** sensor products from ARI, a leader in process temperature measurement.

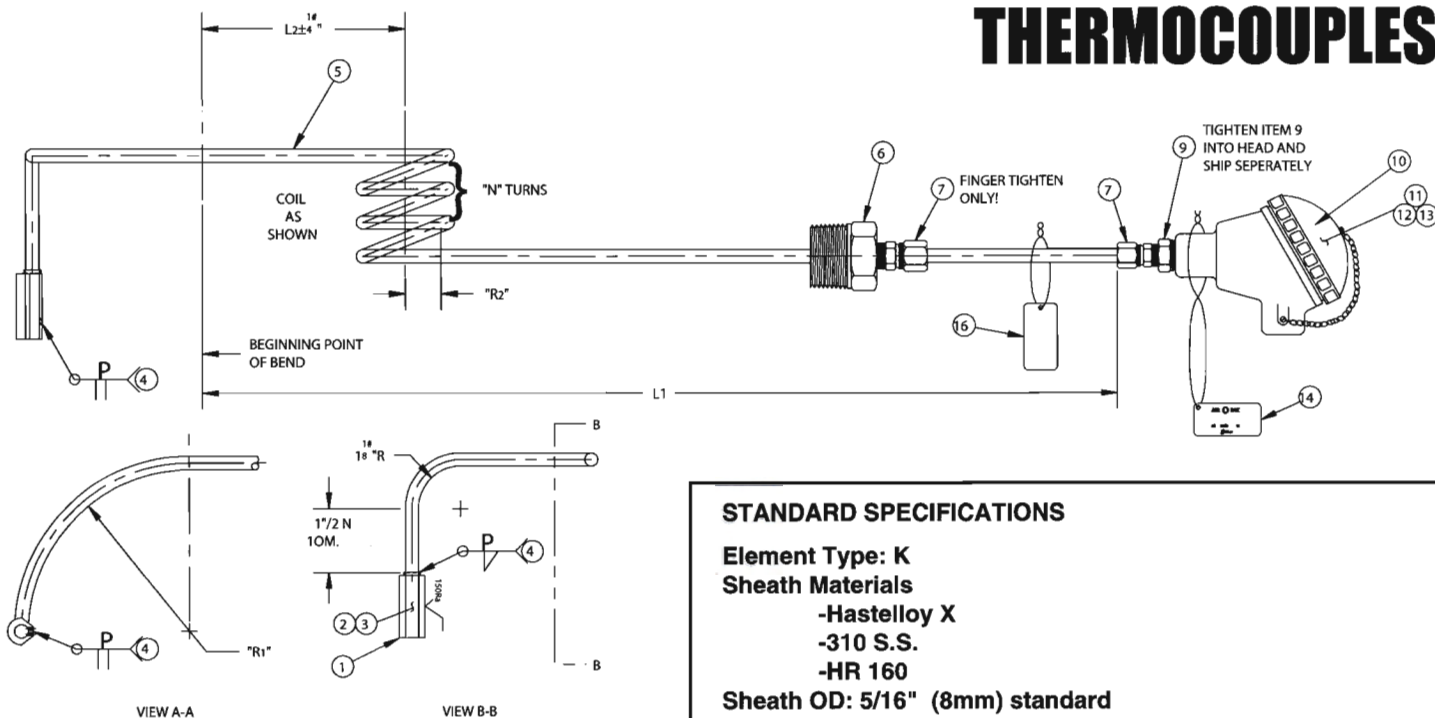
With ARI fan junction thermocouples on your process furnace tubes, you can:

- Minimize fuel waste
- Increase tube life
- Lower maintenance costs
- Avoid more shutdowns
- Prevent steam starvation

This product is currently used by most of the world's major refinery operators, including **BP, Chevron Texaco, Exxon Mobil, Elf** and others.

(Continued on back)

FAN JUNCTION THERMOCOUPLES



STANDARD SPECIFICATIONS

Element Type: K

Sheath Materials

- Hastelloy X
- 310 S.S.
- HR 160

Sheath OD: 5/16" (8mm) standard

Junction Types: Grounded or Ungrounded

Termination Styles:

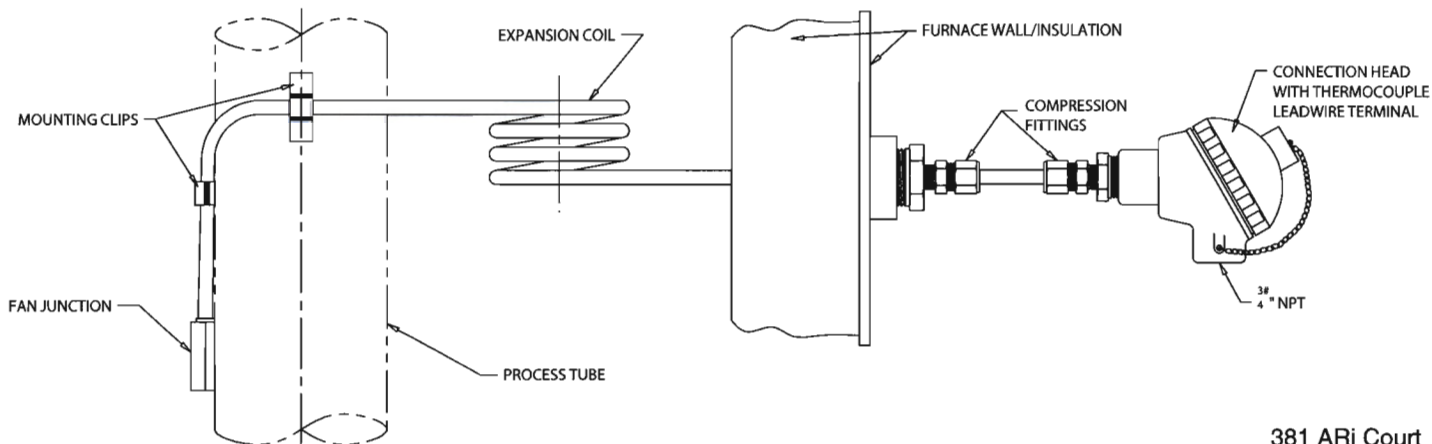
- Connection Head
 - Cast aluminum
 - Cast iron
 - Explosion-proof
- Extension Wire
 - Fiberglass insulated
 - Fiberglass with S.S. overbraid

Mounting Clips provided with assembly, compatible materials

Other materials offered, subject to availability and design considerations

"Hastelloy X" is a registered trademark of Haynes International. ARI is ISO 9001 Registered

TYPICAL INSTALLATION



ARI Industries Inc.

381 ARI Court
 Addison, Illinois 60101 USA
 Toll-Free: 800-237-6725
 Phone: 630-953-9100
 Fax: 630-953-0590
 Web: www.ariindustries.com
 Email: sales@ariindustries.com

BULLETIN 4.0**The Quality Standard for Mineral Insulated Cable.**

Usable under severe conditions that can destroy other types of thermocouple cable.

Withstands temperatures up to metal melting points.

Withstands corrosive conditions that are limited only by the choice of the outer sheath material.

Can be formed around a solid mandrel that is 2X's the sheath diameter without loss of integrity.

Can be welded, brazed, or soldered to other metals when proper techniques are used.

Variety of stock sizes, thermocouple types, and sheath materials available from ARi for immediate shipment.



AerOpak® Thermocouple Cable

The quality standard for mineral insulated cable



AerOpak® is made as either thermocouple, and/or conductor cable wire in compacted ceramic insulation encased in a metallic sheath. Conductor or thermocouple wires can range in quantity from 1 to 10 wire construction.

Compacted Ceramic Powder - Magnesia is one typical electrical insulating material used as the electrical insulation between each wire and the outer sheath. Other insulations available as needed for application specific needs.

Outer Seamless Metal Sheath - A variety of seamless metallic outer sheath materials provide environmental protection for the insulated conductors or sensor wires inside the cable. Sheath selection is typically application specific to provide the longest life possible for the application that the cable is to be used or subjected to.

Custom sizes and custom cable constructions are available - Let our sales engineers help assist you in selecting the proper fit to meet today's demanding requirements.

ARi Industries, Inc.®
381 ARi Court
Addison, IL 60101

Phone: 800-237-6725 Fax: 630-953-0590

www.ariindustries.com Email: sales@ariindustries.com
Division of Okazaki Manufacturing Company

BULLETIN 4.0

BULLETIN 4.0



Sheath Material	ARI Symbol	Melting temperature		Maximum Temperature in Air	
		F	C	F	C
ANSI 304 ST/ST	A	2550	1400	1650	900
ANSI 310 ST/ST	D	2550	1400	2000	1090
ANSI 316 ST/ST	C	2500	1370	1650	900
ANSI 347 ST/ST	F	2550	1400	1650	900
ANSI 446 ST/ST	AG	2600	1430	2000	1090
INCONEL 600	B(1)	2470	1350	2000	1090
HASTELLOY X	V	2300	1260	2200	1200

(1) Not recommended for use in sulfur atmosphere

Stocked thermocouple cable list showing: Cable O.D., Wire Type, Sheath material

Cable O.D.'s	A 304	C 316	D 310	F 347	B Inconel 600	V Hastelloy X	MFG Length (Ft)
0.020	KN	K			JK		Varies
0.040	JK	J	—	EJK	EJK	K	600
0.062	JK	JKT	JK	EJK	EJK	K	1000
0.120			K				700
0.125	EJK	EJKT	EJK	JK	EJK	K	700
0.188	EJK	EJKT	JK	JK	EJK	K	250
0.236			K		K		250
0.250	EJK	EJKT	JKE	JKE	EJK	K	250
0.313		K	K		K	K	100
0.375	JK	JKT	JK		JK	K	80
0.500			K		K	K	30
0.625		K			K		25
0.750					K		25

Calibration letters in **BOLD** indicate also available in DUPLEX (4 - wire construction) from stock

For wall thickness and wire size information refer to ASTM E-585.

Wire size to at least 15% of sheath O.D. with 10%

Calibration Temperature Range	ARI Symbol	Calibration Tolerances
Chromel - Alumel 32°F (0°C) to 2300°F (1260°C)	K	Use nominal value or percentage (whichever is greater). Standard Grade: 4.0°F(2.2°C) or 0.75% of reading. Special Grade: 2.0°F(1.1°C) or 0.4% of reading.
Chromel - Constantan 32°F (0°C) to 1600°F (870°C)	E	Standard Grade: 3.1°F(1.7°C) or 0.50% of reading. Special Grade: 1.8°F(1.0°C) or 0.4% of reading.
Iron - Constantan 32°F (0°C) to 1400°F (760°C)	J	Standard Grade: 4.0°F(2.2°C) or 0.75% of reading. Special Grade: 2.0°F(1.1°C) or 0.4% of reading.
Copper - Constantan 32°F (0°C) to 700°F (370°C)	T	Standard Grade: 1.8°F(1°C) or 0.75% of reading. Special Grade: 0.9°F(0.5°C) or 0.5% of reading.
Nicrosil - Nisil 32°F (0°C) to 2300°F (1260°C)	N	Standard Grade: 4.0°F(2.2°C) or 0.75% of reading. Special Grade: 2.0°F(1.1°C) or 0.4% of reading.

Calibration tolerances per ASTM E230 and ANSI MC96.1.

Special tolerances per AMS 2750D available upon request, stock is subject to current availability.

Available Products:

Temperature Sensors

- Mineral insulated cable
 - Base metal T/C cable:
 - Type E
 - Type J
 - Type K
 - Type T
 - Nobel metal T/C cable:
 - Type B
 - Type R
 - Type S
 - Refractory T/C cable:
 - Tungsten Rhenium
 - Type C
 - Type D
- Multipoint T/C assemblies for temperature profiling.
- Fan Junction for furnace tube temperature sensing:
 - Stainless Steel Sheaths
 - Hastelloy-X Sheaths
- Nuclear grade T/C's.
- RTD assemblies
- Thermowell's
- Temperature transmitters

Conductor Cable Assemblies

- MGO insulated conductor cable. 1 to 10 wire designs

Neutron Detectors

- Self Powered Neutron Detectors.

Electric Heaters

- Metal sheathed electric heater cable:
 - Stocked sizes
 - Single ended
 - Double ended
 - Custom lengths
 - Multiple circuits
 - Custom formations
 - Heated & unheated sections
 - Vacuum designs
 - High Temp. Heat Tracing
 - Furnace brazed parts
- Tubular heater assemblies.
- Flexible silicone rubber heaters.

Quality System

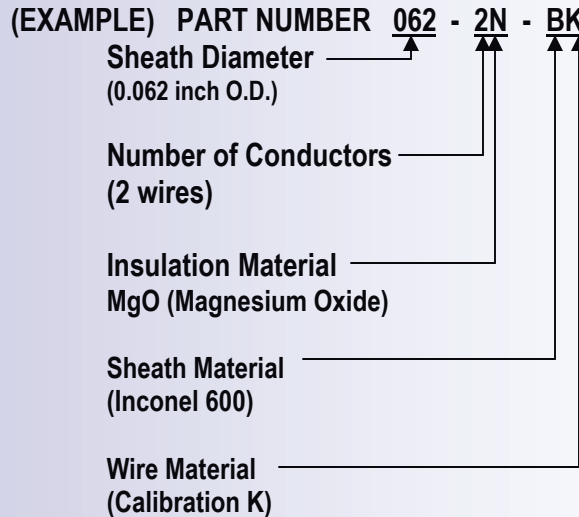
- ISO-9001-2000 Certified.

Testing Options / Services offered

- Custom testing available:
 - X-Ray
 - Helium Leak
 - Heat Treating
 - Temperature calibration (traceable to NIST)
- Custom Furnace Brazing

Thermocouple Cable Ordering information:

1. Specify by description.
Example: 1/16 inch Inconel 600 Sheath, Type K mineral insulated cable.
2. Specify by part number. The part number is defined per the following:



3. Specify total quantity. If cut lengths are required, specify length of each piece. Accuracy of a cut is +/- 1/2% of the length or +/- 1/2 inch (12.7mm), whichever is largest.
4. Sizes of 0.188 inch (4.78mm) or less can usually be shipped by insured parcel post or UPS. Sizes of 0.250 inch (4.78mm) up to 0.375 inch (9.53mm) can be shipped UPS.
5. Standard shipping coil sizes and weight:

Sheath O.D. (inch)	Coil O.D. (inch)	Approx. weight @ 100Ft
0.020	20-22	0.2
0.040		0.3
0.062	30	0.9
0.120		2.5
0.125		3.3
0.188		7.0
0.236	42	10.8
0.250		12.3
0.313		19.5
0.375		27.0
0.500	Shipped straight. 20 Ft. Maximum Lengths.	50.0
0.625		75.0
0.750		112.5

6. Shipping tolerance for random lengths is +15%, -10% unless specified otherwise.

ACKNOWLEDGEMENTS

ARi uses registered U.S. trademarks of others throughout this bulletin. The product and names supplied by the owners of these trademarks are well known and convenient identification to the user. They are:

Inconel and Incoloy - Registered U.S. Trademarks of International Nickel Company.
 Hastelloy X - Registered U.S. Trademark to Cabot Corporation.
 Chromel and Alumel - Registered U.S. Trademark of Hoskins Mfg. Company.
 AerOpak - Registered U.S. Tradename of ARi Industries, Inc.

Conductor cables can be manufactured from many ductile materials. Examples:

Wire Material	ARI Symbol	Resistivity Resistance	
		@ 20°C Ohms/CMF	@ #30AWG (0.010" O.D)
ANSI 304	304	430	4.3
ANSI 347	347	430	4.3
INCONEL 600	INC	620	6.2
Oxygen Free Copper	CU	10.3	0.10
Nickel Lo Carbon	NIL	60	0.60
Constantan	AQ	294	2.94
Chromel -P	KP	425	4.25
Alumel	AY	177	1.77
27%NI Clad Cu	NCU	15	0.15

MI CABLE SPECIFICATION

Sheath Diameter: ±0.002 inch (±0.05mm) or ±1% of nominal diameter, whichever is greater

Wall Thickness: ±0.0015 inch (±0.04mm) or ±15% of nominal wall thickness, whichever is greater, 10% of sheath diameter as a minimum

Wire Diameter ±0.001 inch (±0.03mm) or ±10% of nominal wire diameter, whichever is greater, 15% of sheath diameter as a minimum.

Thermocouple wire calibration: To meet Standard Limits of Error tolerance on calibration as defined in ASTM E-230. Cable with calibration tolerances meeting Special Limits of Error are identified with the symbol "S" after the calibration symbol in the part number.

Insulation Resistance at room temperature: AerOpak is shipped with room temperature insulation resistance greater than 1000 megohms@50VDC (sheath diameters of 0.080 inch to 0.040), and 1000 megohms@500VDC (sheath diameters of 0.120 inch and greater)

High Temperature Insulation Resistance: For 0.040" diameter AerOpak at 600°F (316°C), insulation resistance for one foot length will be in excess of 10 megohms. For 0.62 inch diameter and larger AerOpak at 600°F (316°C), insulation resistance for one foot length will be in excess of 100 megohms.

Dielectric Strength: These are reference values for application to conductor cable only. Data is at 60Hz and 70° F (21°C). Straight - 100VAC per mil of insulation thickness. Bent - 45VAC per mil of insulation thickness.

Temperature: Insulation is usable over temperature range of -450°F (-270°C) to 3000°F (1650°C) without change of phase or chemical reaction with adjacent metals. Melting temperature of insulation is 4800°F (2640°C). Limiting temperature is associated with metals used.

Pressure: Can withstand external pressure up to 50,000psi (3500kg/cm²)

Nuclear: Insulation can be subjected to a mean neutron flux of 2X10¹¹n.cm⁻²S⁻¹@100°C and a total peak irradiation of 8X10¹⁸n.cm⁻² with no significant change in characteristics.

Formability: AerOpak can be bent around a mandrel having a radius equal to twice the sheath diameter without rupturing sheath or causing loss of insulation resistance

Fabrication: AerOpak sheath can be welded brazed and soldered without changing insulation resistance using normal care for the metals and thickness involved.

Storage & Shipping: Each length of AerOpak cable is sealed at both ends with a silicone resin, or shrink sleeving, or both. This can be removed (preferably in a dry atmosphere) by a sharp knife or razor. This seal is suitable for short duration or air shipments. We suggest glob welding the cable ends for Ocean shipments, or when shipping to high humidity destinations.

Available Products:

Temperature Sensors

- Mineral insulated cable
 - Base metal T/C cable:
 - Type E
 - Type J
 - Type K
 - Type T
 - Nobel metal T/C cable:
 - Type B
 - Type R
 - Type S
 - Refractory T/C cable:
 - Tungsten Rhenium
 - Type C
 - Type D
- Multipoint T/C assemblies for temperature profiling.
- Fan Junction for furnace tube temperature sensing:
 - Stainless Steel Sheaths
 - Hastelloy-X Sheaths
- Nuclear grade T/C's.
- RTD assemblies
- Thermowell's
- Temperature transmitters

Conductor Cable Assemblies

- MGO insulated conductor cable. 1 to 10 wire designs

Neutron Detectors

- Self Powered Neutron Detectors.

Electric Heaters

- Metal sheathed electric heater cable:
 - Stocked sizes
 - Single ended
 - Double ended
 - Custom lengths
 - Multiple circuits
 - Custom formations
 - Heated & unheated sections
 - Vacuum designs
 - High Temp. Heat Tracing
 - Furnace brazed parts
- Tubular heater assemblies.
- Flexible silicone rubber heaters.

Quality System

- ISO-9001-2000 Certified.

Testing Options / Services offered

- Custom testing available:
 - X-Ray
 - Helium Leak
 - Heat Treating
 - Temperature calibration (traceable to NIST)
- Custom Furnace Brazing



ARi Industries, Inc.
 Phone: 800-237-6725 Fax: 630-953-0590
 www.ariindustries.com Email: sales@ariindustries.com
 Division of Okazaki Manufacturing Company



HIGH TEMPERATURE AEROPAK[®] THERMOCOUPLE CABLE

Metal Sheath, Ceramic Insulated Thermocouple Cable

For use at: 1100° C to 2200° C (2012° F to 3992° F)

ARi has developed a complete line of metallic sheath ceramic insulated thermocouple cable for operation in the range of 1100° C (2012° F) to 2200° C (3992° F). This is a high quality product employing clean room techniques in manufacturing and inspection. It is useable either for fabrication of high temperature thermocouples or leadwire cable for thermocouples. See ARi Bulletin 2.0 for a complete line of finished thermocouples.

INDUSTRIES:

**Furnaces, High Temperature
Laboratories, Research
Nuclear Reactors
Petrochemical
Aerospace**

**Glass Processing
Heat Treating
Gas Turbine
Jet Engine
Refractory Metal**

ARi is a Registered U.S. Trademark

**ARi Industries, Inc
381 Ari Court
Addison, IL 60101
800-237-6725 Phone
630-953-9100 Phone
630-953-0590 Fax**

BULLETIN 4.1

HIGH TEMPERATURE AEROPAK®

THERMOCOUPLE CABLE

TECHNICAL INFORMATION

SPECIFICATIONS:

1. Materials

A. SHEATH

Material	ARI Symbol	Max. Usage Temp. °C	Environment
Inconel 600 ⁽¹⁾	B	1150	Inert Vacuum Oxidizing
Platinum 6% Rhodium	AA	1650	Inert Oxidizing
Tantalum	N	2200	Inert Vacuum
310 St/St	D	1050	Inert Vacuum Oxidizing

B. INSULATION

Material	ARI Symbol
Magnesia 99.4+% (MgO)	N
Berylia 99.4+% (BeO)	B

C. THERMOCOUPLE WIRE

Material	ASTM E-230-81 Symbol	ARI Symbol	Calibration Tolerance Limits of Error
Platinum 13% Rodium-Platinum	R	R	±1.5° C from 0 to 600° C ±25% from 600° C to 1450° C
Platinum 10% Rhodium-Platinum	S	S	
Platinum 30% Rhodium Platinum 6% Rhodium	B	B	±0.5% 800 to 1700° C
Tungsten 5% Rhenium Tungsten 26% Rhenium	—	AE	±4.44° C to 427° C ±1% from 427° C to 2315° C

(1.) Registered U.S. Trademark, International Nickel Co.

2. Electrical Characteristics

INSULATION RESISTANCE:	Room temperature insulation resistance will be a minimum of 1000 megohms at 50 V.D.C. for 1 mm and 1.5 mm O.D. and 500 V.D.C. for 3.18, 4.78 and 6.35 mm O.D. Insulation resistance at 1000° C will be a minimum of 6100 ohms-meter at 6 volts D.C. Proper bending will not cause a loss of insulation resistance.
WIRE HOMOGENITY:	Will be such that a sharp gradient of 800° C will produce not more than a ±0.1 millivolt output.

3. Physical

FORMABILITY: Forming is limited to a minimum inside bend radius of 5 sheath diameters for Inconel 600 and Platinum alloys and 10 diameters for Tantalum.	
PRESSURE:	Can withstand external pressure of 3500 Kg/cm ² at room temperature.
FABRICATION:	AerOpak® can be GTAW welded and brazed without changing insulation resistance. Welding on Tantalum must be done in either vacuum or inert atmosphere. Random lengths will be provided unless requested otherwise. Specific lengths are available in all standard products, up to the maximum single length indicated in the Tables. Length tolerance: ±15 cm. Each section of AerOpak® is moisture-sealed at both ends with a suitable resin. When ordering, allow 2.5 cm to be removed from each end. Both ends can be provided with a storage seal (seal welding) in place of the temporary resin seal. AerOpak® in straight lengths will have a curvature not exceeding 6 mm in 1 meter as measured against a straight edge lying free.
DIAMETER:	Shall be within ±.05 mm of nominal. Ovality will not exceed 0.003 mm.
INTEGRITY:	There shall be no porosity, inclusions, pit or scratches which exceed 10% of wall thickness, or 0.003 mm (whichever is greater).

CLASS I UP TO 1100° C (2012° F) MgO (N) INSULATION

PART NUMBER	SHEATH DIA.		WIRE DIA.		SHEATH	WIRE	MAX. LENGTH**	
	mm	inch	mm	inch	MATERIAL	MATERIAL	Meter	inch
020-2N-DR-40	0.50	0.020	.076	.003	310 St/St	Pt/Pt13Rh	10.7	420
040-2N-BR-34	1.00	0.040	.152	.006	Inconel	Pt/Pt13Rh	11.6	456
040-2N-BS-34	1.00	0.040	.152	.006	Inconel	Pt/Pt10Rh	11.6	456
040-2N-BB-36	1.00	0.040	.152	.006	Inconel	Pt30Rh/Pt6Rh	11.6	456
060-2N-BR-31	1.50	0.060	.229	.009	Inconel	Pt/Pt13Rh	18.3	720
062-2N-DS-30	1.58	0.062	.254	.010	310 St/St	Pt/Pt10Rh	18.3	720
062-2N-BR-30	1.58	0.062	.254	.010	Inconel	Pt/Pt13Rh	18.3	720
062-2N-BS-30	1.58	0.062	.254	.010	Inconel	Pt/Pt10Rh	18.3	720
062-2N-BB-30	1.58	0.062	.254	.010	Inconel	Pt30Rh/Pt6Rh	18.3	720
120-2N-BR-30	3.00	0.120	.254	.010	Inconel	Pt/Pt13Rh	18.3	720
125-2N-DS-24	3.18	0.125	.508	.020	310 St/St	Pt/Pt10Rh	18.3	720
125-2N-DS-30	3.18	0.125	.254	.010	310 St/St	Pt/Pt10Rh	18.3	720
125-2N-BR-24	3.18	0.125	.508	.020	Inconel	Pt/Pt13Rh	18.3	720
125-2N-BR-30	3.18	0.125	.254	.010	Inconel	Pt/Pt13Rh	18.3	720
125-2N-BS-24	3.18	0.125	.508	.020	Inconel	Pt/Pt10Rh	18.3	720
125-2N-BS-30	3.18	0.125	.254	.010	Inconel	Pt/Pt10Rh	18.3	720
*125-4N-BS-29	3.18	0.125	.279	.011	Inconel	Pt/Pt10Rh	18.3	720
125-2N-BB-30	3.18	0.125	.254	.010	Inconel	Pt30Rh/Pt6Rh	18.3	720
188-2N-BR-26	4.78	0.188	.406	.016	Inconel	Pt/Pt13Rh	7.9	310
188-2N-BS-26	4.78	0.188	.406	.016	Inconel	Pt/Pt10Rh	7.9	310
250-2N-BR-24	6.35	0.250	.508	.020	Inconel	Pt/Pt13Rh	18.3	720
250-2N-BS-24	6.35	0.250	.508	.020	Inconel	Pt/Pt10Rh	18.3	720
250-2N-BB-24	6.35	0.250	.508	.020	Inconel	Pt30Rh/Pt6Rh	18.3	720

CLASS II UP TO 1650° C (3000° F) MgO (N) INSULATION

PART NUMBER	SHEATH DIA.		WIRE DIA.		SHEATH	WIRE	MAX. LENGTH**	
	mm	inch	mm	inch	MATERIAL	MATERIAL	Meter	Inch
040-2N-ARR-34	1.00	0.040	.152	.006	Pt6Rh	Pt/Pt13Rh	1.5	60
040-2N-AAS-34	1.00	0.040	.152	.006	Pt6Rh	Pt/Pt10Rh	1.5	60
040-2N-NR-34	1.00	0.040	.152	.006	Tantalum	Pt/Pt13Rh	3.6	140
040-2N-NS-34	1.00	0.040	.152	.006	Tantalum	Pt/Pt10Rh	3.6	140
040-2N-NAE-36	1.00	0.040	.127	.005	Tantalum	W5Re/W26Re	2.2	88
062-2N-AAR-30	1.58	0.062	.254	.010	Pt6Rh	Pt/Pt13Rh	1.5	60
062-2N-AAS-30	1.58	0.062	.254	.010	Pt6Rh	Pt/Pt10Rh	1.5	60
062-2N-NR-30	1.58	0.062	.254	.010	Tantalum	Pt/Pt13Rh	5.1	200
062-2N-NS-30	1.58	0.062	.254	.010	Tantalum	Pt/Pt10Rh	5.1	200
062-2N-NAE-30	1.58	0.062	.254	.010	Tantalum	W5Re/W26Re	2.2	88
125-2N-AAR-30	3.18	0.125	.254	.010	Pt6Rh	Pt/Pt13Rh	1.5	60
125-2N-AAS-30	3.18	0.125	.254	.010	Pt6Rh	Pt/Pt10Rh	1.5	60
125-2N-NR-30	3.18	0.125	.254	.010	Tantalum	Pt/Pt13Rh	4.6	180
125-2N-NS-30	3.18	0.125	.254	.010	Tantalum	Pt/Pt10Rh	4.6	180
125-2N-NAE-30	3.18	0.125	.254	.010	Tantalum	W5Re/W26Re	2.2	88

CLASS III UP TO 2200° C (3992° F) BeO (B) INSULATION

PART NUMBER	SHEATH DIA.		WIRE DIA.		SHEATH	WIRE	MAX. LENGTH**	
	mm	inch	mm	inch	MATERIAL	MATERIAL	Meter	Inch
062-2B-NAE-30	1.58	0.062	.254	.010	Tantalum	W5Re/W26Re	2.2	88
125-2B-NAE-30	3.18	0.125	.254	.010	Tantalum	W5Re/W26Re	2.2	88

* Duplex Wires (4 Wires)

** Lengths supplied will be between 18 inches to maximum length shown

MADE TO ORDER

ARi can supply mineral insulated cable for high temperature applications with other materials, such as:

A. Niobium 1% Zirconium Sheath

B. Tungsten 3% Rhenium/Tungsten 25% Rhenium Thermocouple Wires

HOW TO ORDER

(example)

Part Number 040 — 2 N — B R — 34

Sheath Diameter

Number of Conductors

Insulation Material

Wire Gage

Conductor Material

Sheath Material

1. Specify Part Number.
2. Specify Quantity.
(Quantity supplied will be in random lengths between 18 inches and manufactured length.)
Cut to length requirements will be supplied at additional cost.
3. All items will be shipped insured, F.O.B. Factory.

OTHER ARi PRODUCTS

- **AerOpak® Thermocouples** **Bulletin 1.0, 1.1, 1.3, 1.4 & 4.4**
- **High Temperature AerOpak® Thermocouples** **Bulletin 2.0, 2.2 & 2.3**
- **AerOpad® Boiler Tube Thermocouples** **Bulletin 3.0**
- **Base Metal AerOpak®** **Bulletin 4.0 & 4.2**
- **Resistance Temperature Detector** **Bulletin 8.0 & 8.4**

ARi Industries, Inc
381 ARi Court
Addison, IL 60101
800-237-6725 Phone
630-953-9100 Phone
630-953-0590 Fax

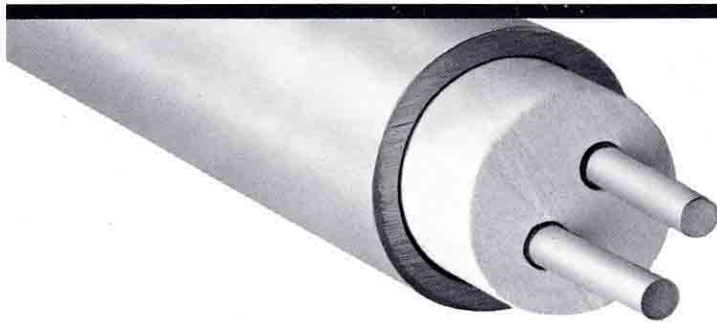
WebSite: <http://www.ariindustries.com>
E-Mail: sales@ariindustries.com

ARi Industries, Inc
381 ARi Court
Addison, IL 60101
800-237-6725 Phone
630-953-9100 PPhone
630-952-0590 Fax



<http://www.ariindustries.com>
E-Mail: sales@ariindustries.com

EDF4
AUGUST 1997



AEROPAK[®]

THERMOCOUPLE & CONDUCTOR CABLE

HELPFUL HINTS TO USE AEROPAK[®]

EXPOSING WIRE — Wire can be exposed by removing the sheath in a lathe. The cable (AerOpak[®]) is chucked in the headstock with length of about 10 x diameter exposed. Use a small tool, high speed, and light cuts. Wire can also be exposed by using a saw or file or sheath stripper. A complete cut through the tube should be made about 1/4 inch from the end. The cut portion is then squeezed until the MgO powder drops out leaving the sheath loose. This process can be repeated until the desired length of wire is exposed. Commercial sheath strippers are available.

STORAGE SEALING — Material supplied has been sealed at exposed ends to prevent moisture absorption. When cutting special lengths, the exposed ends should be coated with a plastic varnish by either dip or brush method or other suitable technique. We recommend using Dow Corning Silicone Resin I-2577 for a temporary seal and welding if a permanent moisture block is desired. Remove moisture from insulation before resealing.

ANNEALING — Anneal in reducing or neutral atmosphere to relieve cold work added by forming or bending. Follow standard procedure for annealing stainless steel unless enclosed wires are of a material not compatible with this procedure.

BENDING — Bending can be accomplished with ordinary tube benders. Material can be bent to a minimum radius of 2 sheath diameters. It is advisable to make sure that the region of bending is annealed after forming. Repeated flexing at one point will result in work hardening and eventual fracture of sheath.

WELDING — Any form of welding may be performed upon the sheath without destroying the insulation. Avoid welding on sheath when adjacent to low temperature materials. Remove moisture before welding. If moisture is not removed and material is subjected to high temperature, rupture of the sheath may occur from the steam generated.

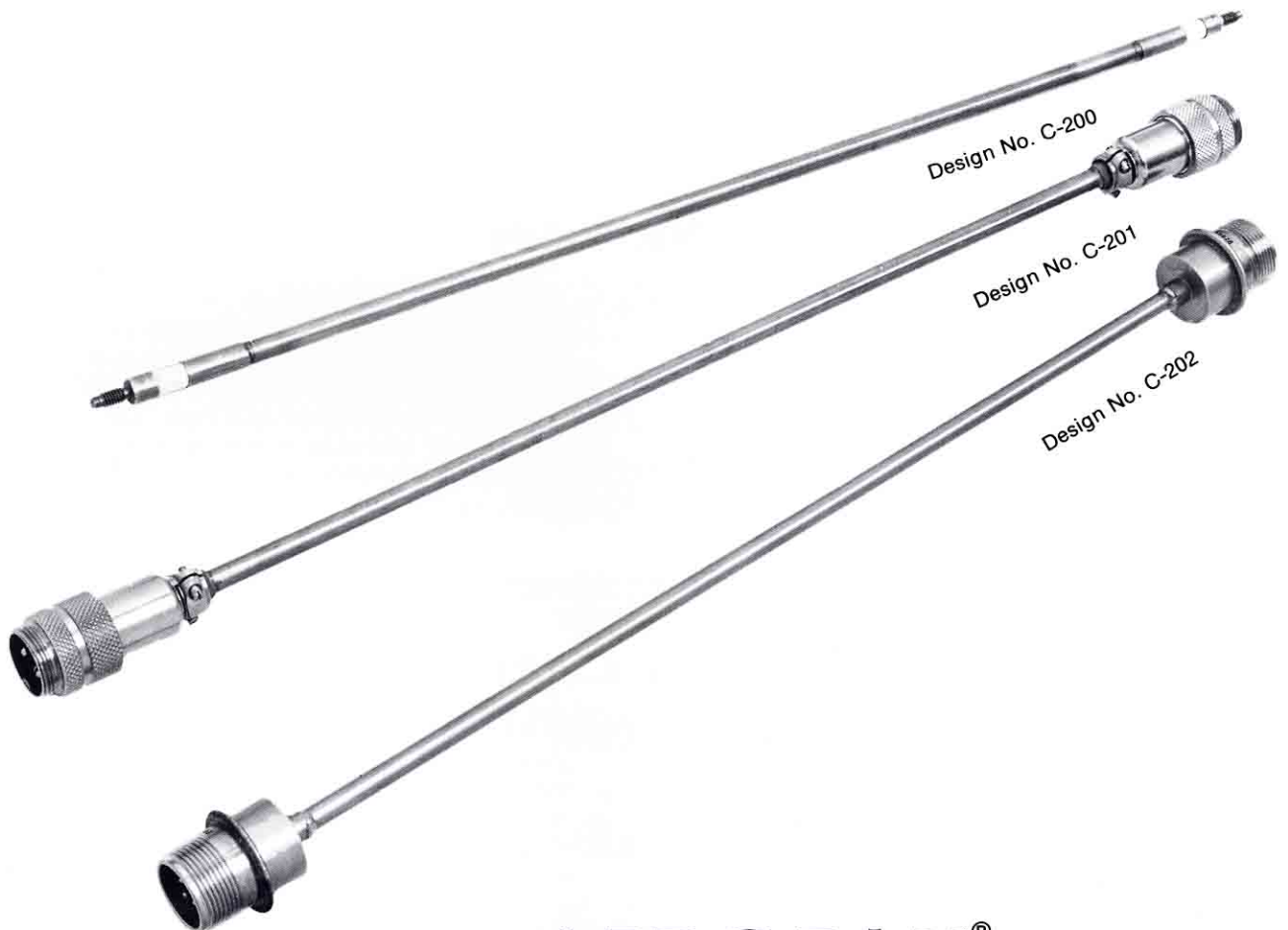
HIGH TEMPERATURE SEALING — ARi has developed a patented sealant known as AerOseal[®] to prevent moisture absorption by the ceramic. This seal is effective over the temperature range of -240 to +420°C (-400 to +788°F). It can withstand thermal shock from 420°C (788°F) to -185°C (-300°F) in 2 seconds. Exposure to temperatures above 420°C (788°F) will cause the seal to deteriorate without affecting insulation resistance properties.

PRECAUTIONS:

- Remove storage seal from ends before processing material; otherwise, varnish can burn to carbon and short out the conductors. We suggest cutting off 1/4" of varnished ends. Do not use solvents to remove seal. Shrink tube seals may be cut off.
- When welding or brazing, keep all fluxes away from exposed end of AerOpak[®]. These fluxes will soak into the insulation and cause a low resistance short.
- Keep exposed AerOpak[®] ends capped or sealed when not in use to prevent moisture absorption by ceramic insulation.
- To remove moisture, bake AerOpak[®] at 200°C (392°F) minimum in an oven until desired minimum insulation resistance is obtained. Seal exposed ends of AerOpak[®] immediately; exposed ceramic may absorb moisture in a matter of seconds in humid atmospheres.
- Avoid welding on sheath when adjacent to low temperature materials.
- Remove moisture before sealing both ends pressure tight. If moisture is not removed and material is subjected to high temperature, rupture of the sheath may occur.



ARI Industries Inc



AEROPAK[®]

CONDUCTOR CABLE ASSEMBLIES

For normal industrial use to severe service for high temperature, corrosive and exotic application.

ARI is a Registered US Trademark

- These cables complete with leads or connectors are ready for installation.
- Eliminate the replacement of cables which deteriorate in radiation, severe heat or corrosive environments.
- Stainless steel sheath construction and MgO insulation for the cable body. Hermetically sealed connectors for exposure up to 1600° F .
- Cables are flexible and can be obtained in large variety of sheath and conductor materials and outer diameters.
- Will assist in the design and manufacture of assemblies to suit your application.



Design No. C-200

CABLEavailable from 1/4" O.D. to 1/2" O.D. 300 series stainless steel or inconel 600 sheath, MgO insulation single conductors of 300 series st/st, inconel 600, nickel clad copper or copper.

SEALhermetically sealed to AerOpak® cable, materials of nickel with ceramic insert voltage rating at room temperature of 1500 VDC Max. operating temperature - 1600° F.



Design No. C-201

CABLEavailable from 1/8" O.D. to 1/4" O.D. stainless steel or inconel 600 sheath, MgO insulation, up to (4) conductors of st/st, inconel 600 nickel clad copper or copper.

SEALnot hermetically sealed to AerOpak® cable, materials, aluminum with bakelite insert. Max operating temperature 500° F.



Design No. C-202

CABLEavailable from 1/8" O.D. to 1/2" O.D. stainless steel or inconel 600 sheath, MgO insulation, up to (6) conductors of st/st, inconel 600 nickel clad copper or copper.

SEALhermetically sealed to AerOpak® cable, materials of stainless steel with glass insulated pins, Max operating temperature 500° F.

Notes:

Cables must be supplied cut to length, sealed and connectors installed to assure insulation resistance. Bulk cable without connectors can be supplied in random lengths if desired with instructions for stripping the ends, but insulation resistances cannot be warranted.

TABLE 1

Conductor Dimensions									
O.D. Nominal		No. of Wires							
		1		2		3		4	
		Nominal Wire Size in inches/mm							
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
.500	12.7	.080	2.03	.080	2.03	.080	2.03	.080	2.03
.375	9.55	.063	1.6	.063	1.6	.063	1.6	.063	1.6
.313	8.00	.051	1.30	.051	1.30	.051	1.30	.051	1.30
.250	6.35	.042	1.07	.042	1.07	.042	1.07	.042	1.07
.188	4.75	.032	.81	.032	.81	.032	.81	.032	.81
.125	3.18	.021	.053	.021	.053	.021	.053	.021	.053

TABLE 2

Insulation Resistance at 500 V in Megohm - Ft.						
O.D.		Temp. °F	No. of Wires			
in.	mm		1	2	3	4
.500	12.7	500	10 ⁹	10 ⁸	10 ⁸	10 ⁸
		1000	10 ⁸	10 ⁷	10 ⁷	10 ⁷
		1500	10 ⁶	10 ⁵	10 ⁵	10 ⁵
.375	9.55	500	10 ⁹	10 ⁸	10 ⁸	10 ⁸
		1000	10 ⁸	10 ⁷	10 ⁷	10 ⁷
		1500	10 ⁶	10 ⁵	10 ⁵	10 ⁵
.313	8.00	500	10 ⁹	10 ⁸	10 ⁸	10 ⁸
		1000	10 ⁷	10 ⁶	10 ⁶	10 ⁶
		1500	10 ⁶	10 ⁵	10 ⁵	10 ⁵
.250	6.35	500	10 ⁸	10 ⁷	10 ⁷	10 ⁷
		1000	10 ⁷	10 ⁶	10 ⁶	10 ⁶
		1500	10 ⁶	10 ⁵	10 ⁵	10 ⁵
.188	4.75	500	10 ⁸	10 ⁷	10 ⁷	10 ⁷
		1000	10 ⁷	10 ⁶	10 ⁶	10 ⁶
		1500	10 ⁶	10 ⁵	10 ⁵	10 ⁵
.125	3.18	500	10 ⁸	10 ⁷	10 ⁷	10 ⁷
		1000	10 ⁷	10 ⁶	10 ⁶	10 ⁶
		1500	10 ⁶	10 ⁵	10 ⁵	10 ⁵

TABLE 3

Nominal Capacitance PFD/FT. at Room Temp.									
O.D.		Number of Wires							
		1		2		3		4	
in.	mm	W-W	W-S	W-W	W-S	W-W	W-S	W-W	W-S
.500	12.7	-	85.2	56.0	91.0	70.3	104.7	67.0	118.0
.375	9.55	-	83.4	54.0	89.9	64.4	99.7	64.9	115.9
.313	8.00	-	81.9	57.8	89.2	67.7	102.8	71.5	125.7
.250	6.35	-	80.4	62.0	101.6	63.6	98.0	69.1	117.5
.188	4.75	-	79.3	60.0	85.5	60.0	91.7	65.6	110.9
.125	3.18	-	78.1	59.3	87.7	59.0	90.5	64.0	108.6

Note: Capacitance PFD/ft. will not change appreciatively up to 1100° F (600° C)



AerOcoax® AerObiax® ELECTRIC HEATING CABLE



AerOcoax®

SHEATH DIAMETER		CONTINUITY RESISTANCE		INSUL. SPACING	NORMAL LENGTH		SHEATH MATL.	PART NUMBER
Inch ±0.005	mm ±0.13	Ohms/ft ±10%	Ohms/mtr ±10%	Inch ±15%	Feet See Note 1	Meter	See Note 2	
0.040	1.0	16.3	53.5	0.009	500	152	B	IHN040B- 16.3
.063	1.6	1.6	5.2	.011	1000	304	B	IHN063B- 1.6
.063	1.6	6.5	21.3	.014	200	61	B	IHN063B- 6.5
.080	2.0	3.9	12.8	.023	150	46	B	IHN080B- 3.9
.093	2.4	3.0	9.8	.023	700	213	B	IHN093B- 3.0
.093	2.4	1.5	4.9	.023	800	244	B	IHN093B- 1.5
.125	3.2	0.24	0.79	.018	900	274	B	IHN125B- 0.24
.125	3.2	0.40	1.3	.024	900	274	B	IHN125B- 0.40
.125	3.2	0.80	2.6	.030	900	274	B	IHN125B- 0.80
.125	3.2	1.6	5.2	.034	400	122	B	IHN125B- 1.6
.180	4.6	0.18	0.59	.033	400	122	B	IHN180B- 0.18
.180	4.6	0.73	2.4	.048	400	122	B	IHN180B- 0.73
.188	4.8	0.70	2.3	.051	800	244	B	IHN188B- 0.70
.250	6.4	0.35	1.1	.070	200	61	B	IHN250B- 0.35



AerObiax®

0.040	1.0	30.0	98.4	0.004	500	152	B	2HN040B- 30.0
.063	1.6	13.0	42.6	.007	200	61	B	2HN063B- 13.0
.093	2.4	6.0	19.7	.011	400	122	B	2HN093B- 6.0
.125	3.2	3.2	10.5	.016	900	274	B	2HN125B- 3.2
.188	4.8	1.4	4.6	.024	400	122	B	2HN190B- 1.4
.250	6.4	0.70	2.3	.031	200	61	B	2HN250B- 0.70

Note:

1. Lengths shown are normal manufactured length. However, due to cutting for specific ordered quantities, the lengths supplied will be between 15 feet (4 meters) and NORMAL LENGTH.
2. Sheath material is Inconel 600 (Symbol B).

GENERAL NOTES

This cable is made by a multiple pass drawing operation. When shipped, the ends are sealed to prevent moisture absorption by the MgO insulation. Once the seal is broken, the MgO will absorb moisture from the atmosphere and rapid loss of insulation resistance and dielectric strength can occur. Destructive arcing between the wire and sheath can occur if the wet cable is energized. Unsealed cable can be dried by a 24 hour oven bakeout at 250°F or higher or by self-heating at low voltage.

In general, there is very little temperature difference between the sheath and wires. With the cable sheath operating at temperatures less than 1000°F, ARI recommends not exceeding 150 watts/in (area measured at the sheath surface), when ends are properly terminated.

As temperature increases above 1000°F, the maximum watt density should be decreased.

Heater life in any specific application is difficult to predict. However, life generally decreases as temperature and/or the number of thermal cycles increases.

Maximum recommended operating temperature is 1800°F.

SPECIFICATIONS

Sheath:	Inconel* 600
Insulation:	Magnesia, compacted. Minimum content of MgO is 99.4%
Wire:	Nickel-Chrome-Iron with resistivity of 620 OHMS/CMF @20°C (68°F)
Tolerances:	Sheath Diameter — ± 0.005 inches (± 0.13 mm) Continuity resistance — $\pm 10\%$ of nominal
Insulation Resistance:	1000 megohm — ft. @ 500 VDC @ 20°C (68°F) 100 megohm — ft. @ 500 VDC @ 317°C (600°F)
Dielectric Strength:	100 volts/.001 inch of insulation thickness — Straight cable 50 volts/.001 inch of insulation thickness — 5D radius bend. Cable ends must be coated to prevent arcing

*Registered Trademark of International Nickel Corp.

HOW TO ORDER:

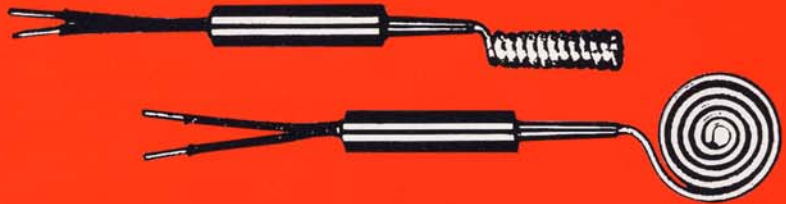
1. Specify "Part Number" and total quantity.
2. Best pricing is to accept material in random lengths. Random lengths will be 40 ft. or longer except 10% or less of the total quantity ordered can be as short as 15 feet.
3. All items shown are normally stocked.

See Bulletin 5.2 for finished heaters made from AerObiax electric heater cable.

ARI Industries Inc

381 ARI COURT, ADDISON, IL 60101, USA Phone: (630) 953-9100 Telefax: (630) 953-0590
CALL TOLL FREE 1-800-237-6725 1-800-AEROPAK

IN THE UK: CONTACT ARI INDUSTRIES, (UK) LTD., Unit 2F, Albany Park, Frimley Road, Camberley, Surrey GU15 2PL England
Phone: 0276-69-2500. Fax: 0276-69-2110



FLEXIBLE HIGH WATT DENSITY ELECTRIC HEATERS

NO OTHER ELECTRIC HEATER CAN CLAIM THE SIMULTANEOUS ADVANTAGES:

- **FLEXIBILITY.** The element can be readily bent by hand or production machinery to a desired configuration and it can retain that configuration after repetitive heating and cooling cycles. This feature permits placing the heater where the heat is required and thus eliminating hot spots.
- **HIGH WATT DENSITY.** By choice of materials it is possible to obtain 150 watts per square inch of surface area without loss of other performance characteristics.
- **FAST TIME RESPONSE.** By elimination of unnecessary volume, the weight and therefore heating time is greatly reduced.
- **CORROSION RESISTANCE.** By choice of Inconel 600* sheath material, the heater can be immersed in many corrosive fluids without deterioration.
- **LONG LIFE.** By new and patented methods of lead wire attachment, we eliminated the source of 70% of electric heater failures. We've used these types of heaters in aircraft applications and warranted 8000 hours of flight time (notice this isn't energized time) which means that the total "on" time would exceed 20,000 hours. Industrial applications probably do not have as long a useful life since the environment is varied and often more severe.
- **NUCLEAR APPLICATION.** By choice of materials, these heaters can withstand long time exposures in the core of a power nuclear reactor with negligible deterioration.

*Reg. T.M. International Nickel Corp.

AEROROD® BXD HEATERS

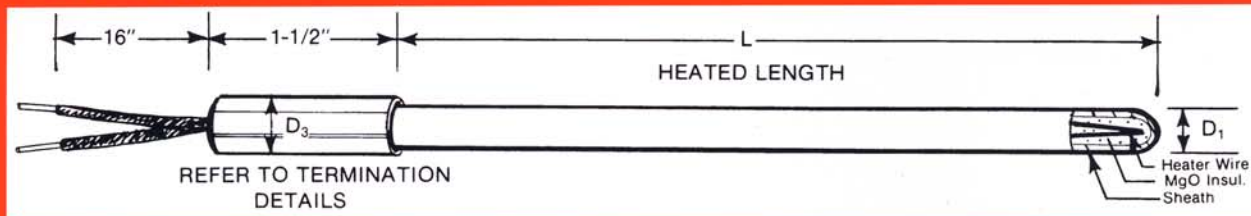


TABLE 1

HEATED DIAMETER D_1 INCHES	POWER AT 115 VOLTS WATTS	POWER DENSITY AT 115 VOLTS WATTS/IN ²	POWER AT 230 VOLTS WATTS	POWER DENSITY 230VOLTS WATTS/IN ²	HEATED LENGTH L INCHES	PART NUMBER
0.040	75	8	—	—	71	BXD-04B-71-K
	100	15	—	—	53	BXD-04B-53-K
	150	34	—	—	35	BXD-04B-35-K
0.062	200	17	—	—	61	BXD-06B-61-K
	300	38	—	—	41	BXD-06B-41-T
	400	66	—	—	31	BXD-06B-31-T
0.093	300	12	1200	46	88	BXD-09B-88-T
	500	32	—	—	53	BXD-09B-53-T
	700	63	—	—	38	BXD-09B-38-T
0.125	600	18	2400	73	83	BXD-13B-83-T
	800	33	—	—	62	BXD-13B-62-T
	1000	51	—	—	50	BXD-13B-50-T
0.188	900	12	3600	48	126	BXD-19B-126-T
	1200	22	—	—	94	BXD-19B-94-T
	1500	33	—	—	76	BXD-19B-76-T

The above heaters are normally in stock. Please consult factory for wattages not listed or other special requirements you may have.

NOTES: (Apply To Table 1)

1. For power at other voltages, multiply power at 115 volts by $(\text{new voltage}/115)^2$.
Tolerance on wattages is $\pm 10\%$.
2. Tolerance on diameter D_1 is ± 0.005 inches.
3. Tolerance on length (L) is $\pm 5\%$.
4. Sheath material is Inconel 600.
5. Wire material is nickel-chrome iron with resistivity of 620 ohms – cmf at 68°F. (20°C.)
6. These heaters can be coiled or formed to meet your requirements. Please consult factory with your requirements.

AEROROD® BXX HEATERS

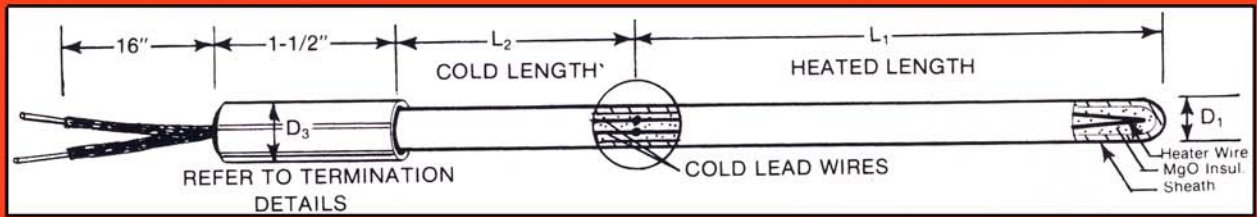


TABLE 2

HEATED DIAMETER D1 INCHES	POWER AT 115 VOLTS WATTS	POWER DENSITY AT 115 VOLTS WATTS/IN ²	POWER AT 230 VOLTS WATTS	POWER DENSITY 230VOLTS WATTS/IN ²	HEATED LENGTH L1 INCHES	COLD LENGTH L2 INCHES	PART NUMBER
0.040	115	20	—	—	46	4	BXX-04B-46-4K
0.062	300	38	—	—	41	4	BXX-06B-41-4K
	400	66	—	—	31	4	BXX-06B-31-4T
	500	107	—	—	24	4	BXX-06B-24-4T
0.093	300	12	1200	47	88	4	BXX-09B-88-4T
	500	32	2000	129	53	4	BXX-09B-53-4T
	700	63	—	—	38	4	BXX-09B-38-4T
	900	106	—	—	29	4	BXX-09B-29-4T
0.125	600	18	2400	74	83	4	BXX-13B-83-4T
	800	33	—	—	62	4	BXX-13B-62-4T
	1000	51	—	—	50	4	BXX-13B-50-4T
	1500	116	—	—	33	4	BXX-13B-33-4T
0.188	1200	22	4800	86	94	5	BXX-19B-94-5T
	1500	33	—	—	76	5	BXX-19B-76-5T
	2000	59	—	—	57	5	BXX-19B-57-5T
	2500	94	—	—	45	5	BXX-19B-45-5T
0.250	1800	18	7200	73	126	5	BXX-25B-126-5T
	2000	23	—	—	113	5	BXX-25B-113-5T
	2500	35	—	—	91	5	BXX-25B- 91-5T
	3500	69	—	—	65	5	BXX-25B- 65-5T

The above heaters are normally in stock. Please consult factory for wattages not listed or other special requirements you may have.

NOTES: (Apply To Table 2 and 3)

- For power at other voltages, multiply power at 115 volts by $(\text{new voltage}/115)^2$.
Tolerance on wattages is $\pm 10\%$.
- Tolerance on diameter D_1 is ± 0.005 inches.
- Tolerance on heated length (L_1) is $\pm 5\%$.
- Tolerance on cold length L_2 is ± 1.0 inch.
- Sheath material is Inconel 600.
- Wire material is nickel-chrome iron with resistivity of 620 ohms – cmf at 68°F. (20°C.)
- These heaters can be coiled or formed to meet your special requirements. Please consult factory with your requirements.
- The standard cold lead lengths are 4 or 5 inches, for our stock heaters.
- Cold lead wire material is nickel internally spliced to the heater wires.

AEROROD® BXB HEATERS

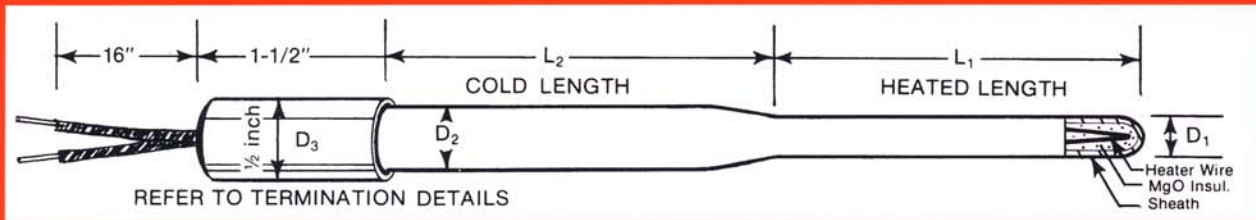
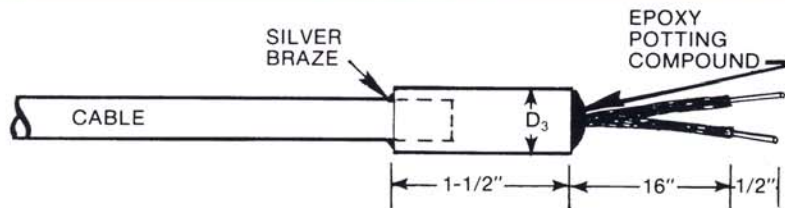


TABLE 3

HEATED DIAMETER D1 INCHES	COLD LEAD DIAMETER D2 INCHES	POWER AT 115 VOLTS WATTS	POWER DENSITY AT 115 VOLTS WATTS/IN ²	POWER AT 230 VOLTS WATTS	POWER DENSITY 230VOLTS WATTS/IN ²	HEATED LENGTH L1 INCHES	COLD LENGTH L2 INCHES	PART NUMBER
0.188	0.375	1575	37	6000	141	72	5	BXB-19B-72-5T
0.188	.0375	3000	141	—	—	36	5	BXB-19B-36-5T

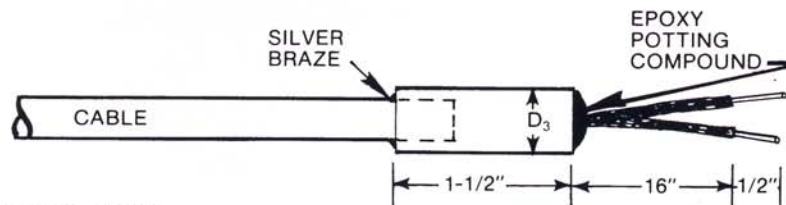
The above heaters are normally in stock. Please consult factory for wattages not listed or other special requirements you may have.

TERMINATION DETAILS



“K” - TERMINATION:

- 1) RATED FOR CONTINUOUS OPERATION OF 400°F. (204°C.)
- 2) $D_3 = 1/4"$ FOR .040 TO .188" CABLE DIAMETER
 $D_3 = 1/2"$ FOR .250 TO .375" CABLE DIAMETER
- 3) STANDARD LEAD WIRE LENGTH APPROXIMATELY 16"

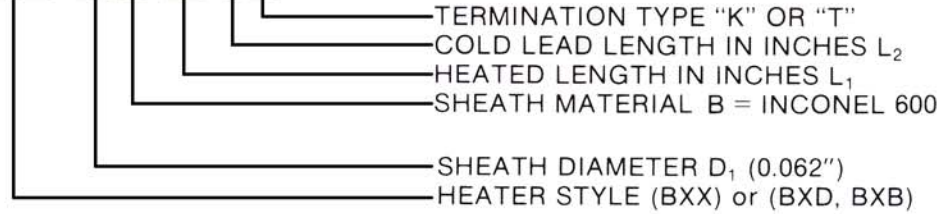


“T” - TERMINATION:

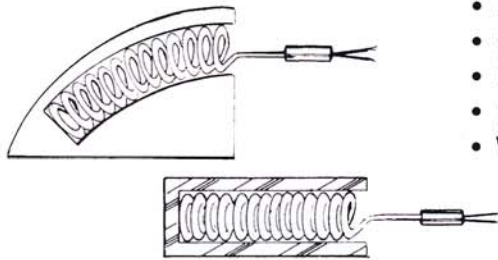
- 1) RATED FOR CONTINUOUS OPERATION OF 800°F. (427°C.)
- 2) $D_3 = 3/8"$ FOR .040 TO .188" CABLE DIAMETER
 $D_3 = 1/2"$ FOR .250 TO .375" CABLE DIAMETER
- 3) STANDARD LEAD WIRE LENGTH APPROXIMATELY 16"

EXPLANATION OF PART NUMBER:

BXX-06B-61-4K



ARiCoil™



Flexible Cartridge Heater made from ARi Heaters.

- Fast Time response
- Inserted into rough-drilled hole or curved hole
- Good contact with walls of hole
- Flexible
- Easy to remove from blind hole — does not seize
- Withstands shock & vibration

AerOpak® Thermocouples

AerOpak® assemblies incorporate thermocouple wires insulated in compacted MgO within a st/st sheath. Usable temp. range -400° to 2000° F. AerOpak® thermocouples can be furnished either as complete assemblies or replacement elements.

BULLETINS 1.0, 1.3, 1.4, 7.3

ACCESSORIES

AerOpak® High Temperature Thermocouples

Designed for non-cooled applications in steel mills, nuclear reactors, petrochemical plants, aircraft, and process industries, these thermocouples are suitable for use at temperatures from 2000° to 4000° F.

BULLETINS 2.0, 2.2, 2.3

ARiDET®

Resistance Temperature Detector

$\pm 0.1^{\circ}$ F accuracy with industrial ruggedness. Strain free platinum element with mineral insulation and stainless steel sheath for use in an application from -300° F to $+1000^{\circ}$ F.

BULLETINS 8.0, 8.4

BVX AerOrod Heater

Features:

- Ultra low heat generated in cold sections.
- Electrical connections sealed inside of electrically isolated metal sheath.
- Variety of sizes and lengths possible for customers needs.
- Reduction in heat at cold end allows moisture seals to survive even in extreme process temperatures.
- Vacuum sealing "O" rings can survive when sealed against the BVX cold section. Previous cold sections could generate enough heat to melt silicone and viton seals.
- All welded construction to minimize any possible contamination to customers system.
- Available in stainless steel and Inconel 600 outer metal sheaths.
- BVX offered as direct replacement for traditional BXX series heater designs
- BVX heaters have been successfully used at temperatures approaching 1600°F on the heated section.

ARI Introduces BVX heaters for Improved cold end efficiency.

ARI's new BVX series AerOrod heater offers a vast improvement in heated cable to cold end efficiency. ARI's AerOrod heaters have always provided outstanding high temperature electrical heating. Today's demands in semiconductors and aerospace have driven us to take a very successful product and built upon it's current features and improve them beyond where current heaters fail.

The new BVX series of AerOrod heaters allows the end user to focus the heat where the customer wants it. After the heated section a cold section that extends away from the heated section provides only a fraction of the heating that previous heaters generated.

**Old to new comparison example:**

Current BXX series heaters offer a 10 to 1 ratio on heating vs cold cable. 1 Ft of heated cable that generated 50 watts would generate 5 watts/Ft in 1 Ft of the cold section cable. The new BVX series heaters in the same application would generate only 0.5 to 1 watt of heat in 1 Ft of cold section. Values shown are nominal values and can vary with standard tolerance ranges.

Customer applications benefit from the focused heat in the area where they want it without introducing heat into unwanted areas. Unwanted areas could be in the insulation barrier that surrounds the heated section, or even passing through a vacuum where heat is not wanted on the cold section

Power connections remain much cooler when using the improved cold sections. Previous high voltage cold sections generated excessive temperature to point where ceramic insulations were needed at the potting adapter to lead wire. Typical moisture seals at the ends of the cold cable can withstand 250°F (121°C), and 500°F (260°C).

Environmental seals when exiting vacuum chambers are not exposed to excessive temperature generated from the cold ends of the BVX series. Typical seal temperature ratings are:

Buna "O" ring seals are rated for 176°F. (80°C)

Viton seals are rated for 356° F. (180°C)

Silicone "O" ring seals are rated for 400°F. (200°C).

Radiant heat is the best form of heat transfer in a vacuum. Electric heaters need to be over 1000°F before metal surfaces start to radiate heat away from the surface of the heater. Keeping that heat in the area of the process and away from the cold section of cable brings a new generation of efficiency to vacuum process heating. (continued on back)

ARi Industries, Inc.

381 ARi Court

Addison, IL 60101

Phone: 800-237-6725 Fax: 630-953-0590

www.ariindustries.com Email: sales@ariindustries.com
Division of Okazaki Manufacturing Company

BVX AerOrod Heater



ARI's Product Overview

ARI is Manufacturer of mineral insulated heaters, thermocouples, RTD's, Metal-sheathed cable. Our designs/products are being used in semiconductor, FPD, and vacuum furnace applications. Our heaters are used for industrial process heating, Aerospace applications, and have reached Mars. All base metal thermocouple types available. Noble and refractory metal types sensors suitable for vacuum service up to 2200°C. Both standard and custom products available.



ARI is a ISO 9001-2000 registered company

(BVX Series Heaters continued)

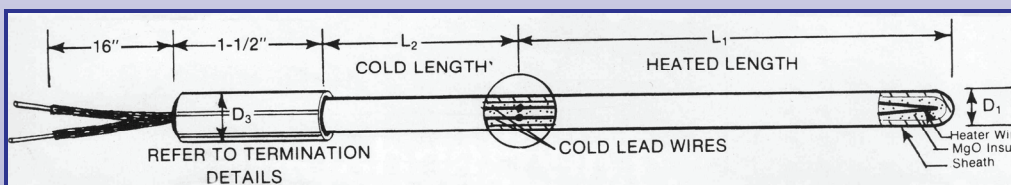
Vacuum applications act like heat traps until those radiant temperatures are achieved. Sensing temperatures from metal heater surfaces in a vacuum can also be difficult.

ARI offers high temperature furnace brazing of sensors

to attach thermocouples directly to the metal sheath. Proper Sensor attachment allows the parts to remain in contact in a vacuum and not rely on radiant heat transfer. Having that sensing point for feedback to the control system allows excellent repeatability for process control and management.

The BVX Heaters can be made as direct replacements for the BXX series of cable heaters currently in use around the world. Custom shapes and custom bend formations can be developed for your application specific needs (see above photo).

BVX example are shown below:



ARI offers heaters from 0.0335 inch O.D. & larger. Custom sizes and lengths are available to meet your applications needs. Contact our sales/engineers for any questions, or pricing inquiries.

BVX AerOrod Heaters



ARI Industries, Inc.

381 ARI Court

Addison, IL 60101

Phone: 800-237-6725 Fax: 630-953-0590

www.ariindustries.com Email: sales@ariindustries.com
Division of Okazaki Manufacturing Company

Available Products:

Temperature Sensors

- Mineral insulated cable
 - Base metal T/C cable:
 - Type E
 - Type J
 - Type K
 - Type T
 - Nobel metal T/C cable:
 - Type B
 - Type R
 - Type S
 - Refractory T/C cable:
 - Tungsten Rhenium
 - Type C
 - Type D
- Multipoint T/C assemblies for temperature profiling.
- Fan Junction for furnace tube temperature sensing:
 - Stainless Steel Sheaths
 - Hastelloy-X Sheaths
- Nuclear grade T/C's.
- RTD assemblies
- Thermowell's
- Temperature transmitters

Conductor Cable Assemblies

- MGO insulated conductor cable. 1 to 10 wire designs

Neutron Detectors

- Self Powered Neutron Detectors.

Electric Heaters

- Metal sheathed electric heater cable:
 - Stocked sizes
 - Single ended
 - Double ended
 - Custom lengths
 - Multiple circuits
 - Custom formations
 - Heated & unheated sections
 - Vacuum designs
 - High Temp. Heat Tracing
 - Furnace brazed parts
- Tubular heater assemblies.
- Flexible silicone rubber heaters.

Quality System

- ISO-9001-2000 Certified.

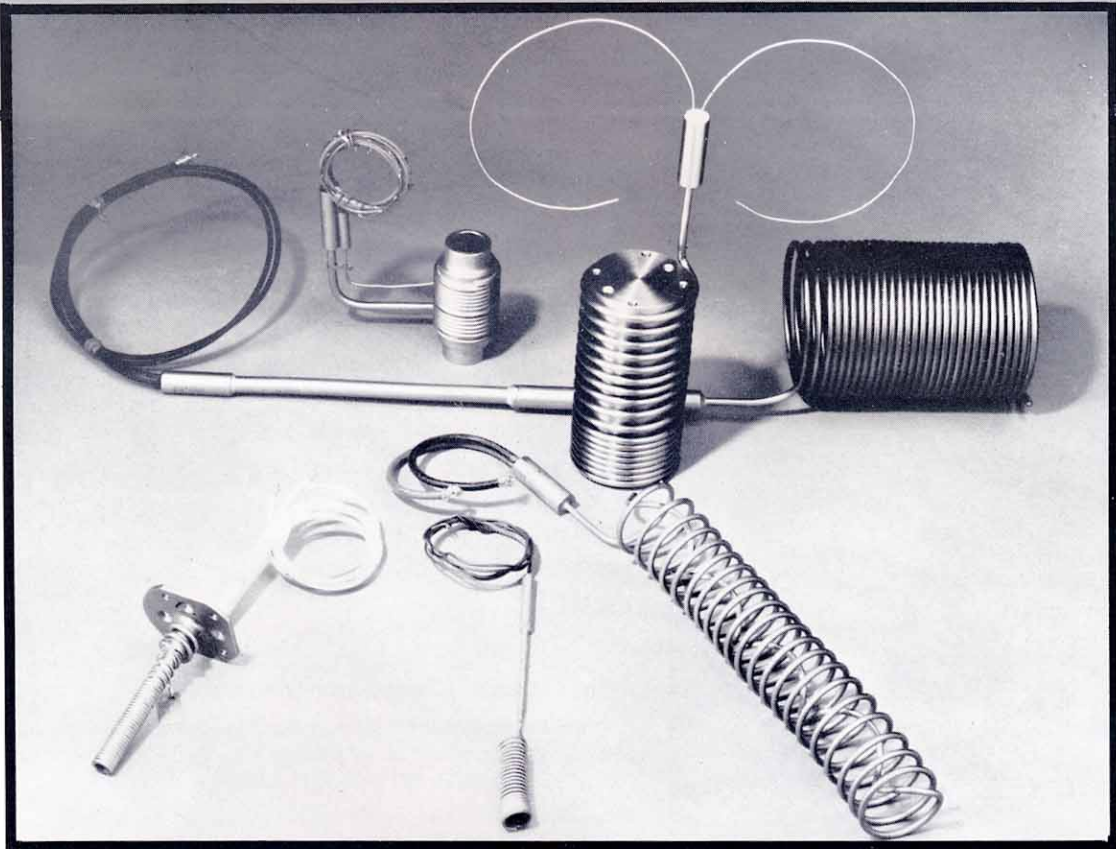
Testing Options / Services offered

- Custom testing available:
 - X-Ray
 - Helium Leak
 - Heat Treating
 - Temperature calibration (traceable to NIST)
- Custom Furnace Brazing



AerOrod®

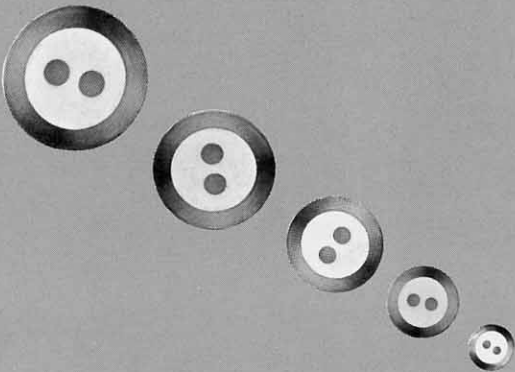
ENGINEERING DATA FILE 3
APPLICATION GUIDE
MINERAL INSULATED
HEATERS



ARI is a registered U.S. Trademark

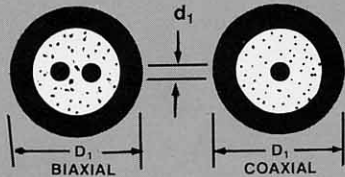
ARI Industries Inc

EDF 3
APRIL 1999



AerOrod[®] Heaters and Heater Cable are manufactured with highly compacted MgO insulation in a multiple reduction process that yields a uniform cross-section and minimum wire to sheath spacing for efficient heat transfer. This material can be easily formed, clamped or brazed in place to give maximum power levels in difficult situations.

Typical cross sections:



This application guide has been prepared to simplify the selection of heaters for most industrial applications. Materials data and selection curves are given to allow use of common sense and simple mathematics to solve otherwise exotic heat transfer problems.

EDF-3 Definitions

Aerobias — Two wire M.I. heater cable

Aerocoax — Single concentric wire in M.I. cable

Area — For round sheath surface area or wire area in square inches. $A=3.1415 \text{ DL (inch)}^2$ with diameter and length in inches.

BTU (British Thermal Unit). Defined as the amount of heat (Q) needed to raise the temperature of 1 pound of pure water 1°F. 1 BTU=.2928 watt-hours. 1 BTU/MIN=17.57 watts=.252 Kg CAL/MIN.

Cold End BXX style heater. M.I. cable with an internal welded transition between 620 Ω/CMF inconel 600 heater wire and 60Ω CMF nickel wire used to thermally isolate heated section from temperature sensitive termination.

Convection Heat Loss

$$(Q_c) \text{ (BTU/HR/FT}^2\text{)}, Q_c=0.296 (T_s-T_a)1.25 \sqrt{\frac{V + 68.9}{68.9}}$$

Where: T_s =Surface Temp in °F

T_a =Air Temp in °F

V =Wind velocity in ft/min (1 mph = 88 ft/min)

Density Weight of a unit volume of material, pounds per cubic foot.

Heat Tracing The addition of heat to process piping systems to compensate for heat losses or to maintain liquids above solidification or freezing temperatures. Additional heat obtained with steam, electrical heaters or direct skin effect electrical heating of metal piping.

Line Voltage 115 or 230 V, 60 Hz, single phase.

M.I. Mineral Insulation Usually refers to compacted magnesium oxide (MgO) powder used as internal insulation.

Ohms Law $E(\text{volts}) = I (\text{amps}) \times R(\text{ohms})$

O.D. Outer or external diameter of heater or thermocouple with circular cross-section

Power Electrical energy dissipation $P \text{ watts} = \frac{(E_{\text{volts}}) (I_{\text{amps}})}{(R_{\text{ohms}})}$
 $= (I_{\text{amps}})^2 (R_{\text{ohms}})$

Note: Assumes power factor of 1.0 for a resistive load at 60 Hz.

Resistivity Resistance to current flow for a given material at a specified temperature. For wires it is expressed as ohms per circular mil foot 1 mil = 0.001" (.010" = 10 mils)

Sheath Continuous outer metal jacket of M.I. cable

Specific Heat Amount of thermal energy required to raise the temperature of one pound of a material by 1 °F as compared to water (specific heat of water = 1 BTU/pound/°F)

Temperature Coefficient of Resistivity Relationship of change in resistance or resistivity to temperature change. Expressed as ohms per ohm per °C or °F.

Termination An enlarged transition area for AeroRod[®] heaters between M.I. cable and flexible insulated lead wires. Termination is usually filled with epoxy or ceramic compound.

Thermal Conductivity Heat transfer value for a material within a specified temperature range. Expressed in BTU/hour, °F, Ft²/Ft.

Watt Density Power dissipation per unit area. Expressed as watts per square inch of sheath surface area. (power density) related to surface temperature.

Index

Definitions	Page 1
Heater Power Level Determination	Page 2
Heater Selection	Page 5
Heater Application	Page 7
Selection & Application of Temperature Sensors	Page 9
Stantrol[®] 2-Wire Systems	Page 10
Heat Tracing	Page 11

Heater Power Determination:

The majority of heating situations require highest power during the warm-up period where a given mass must be brought from ambient to an elevated temperature within a given time. The total power required is influenced by the type and size of material involved. Time period, and the method of thermally coupling heater to heated surface. Determination of warm-up power requirements and the use a time proportioning controller will insure adequate initial power with maximum heater life under operating conditions. Warm-up power calculations include a 20% power addition to allow for heat losses in static systems.

This general rule may not be valid if flowing metals, liquids, or high velocity gases are involved. Calculation of operating power loss should be added for these situations to avoid the need for expensive booster heaters and unnecessarily complex control systems.

1. Determine weight of material to be heated and desired temperature rise. Obtain power requirement from Table 1. Multiply weight X specific power requirement X temp rise in °F to obtain power for a 60 minute heat up period.

Approximate power required to heat materials from ambient to an elevated temperature within one hour heating period. The specific power values include a 20% factor for distributed heat losses.

Formula:
$$\frac{\text{Weight (lbs.)} \times \text{Specific Heat} \times \text{Temp Rise (}^\circ\text{F)}}{3.412} = \text{Watts/Lb/}^\circ\text{F}$$
 (Specific power requirements for 1 hour heat up)
 3.412 (1 Watt = 3.412 BTU/HR)

2. Determine operating heat losses from appropriate formula or curve from following pages.

Desired heater power level will then be the highest of these two.

Examples:

1. 10 lbs. of copper to be heated from 70°F to 350°F in one hour: 10 lbs. X .035 W/LB/°F X 280°F = 98 watts.
 To decrease heating period from 60 minutes to 5 minutes: $\frac{60}{5} \times 98W = 1176 \text{ Watts}$

2. 5 lb. steel container with 8 lbs of water to be heated from 40°F to 200°F in 10 min.:

Watts (Steel) = 5 lbs. X .042 W/LB/°F X 160°F = 33.6

Watts (Water) = 8 lbs. X .352 W/LB/°F X 160°F = 450.6

Total: 484.2 Watts

To decrease heating period from $\frac{60}{10}$ to 10 minutes: $60 \times 484.2 \text{ Watts} = 2905.2 \text{ Watts}$

Operating Heat Losses

1. Conduction losses to adjacent materials. Use Table 1 power requirements for the materials involved, assuming a temperature rise plus external surface losses as follows:

2. Surface losses, convection and radiation:

A) Oil or paraffin
 Watts = $\frac{1.5 (\text{temperature in } ^\circ\text{F} - 100)}{\text{Surface area in square feet}}$

C) Insulated walls (ovens, pipes, tanks, etc).
 Watts = $\frac{0.2 (\text{temperature difference in } ^\circ\text{F} - 100)}{\text{surface area in square feet}}$ (insulation thickness, inches)

B) Molten Metals
 Watts = $\frac{2.28 (\text{temperature in } ^\circ\text{F} - 380)}{\text{surface area in square feet}}$

D) Oxidized metal surfaces (see Figure 1)
 E) Open top water tanks (see Figure 2)

FIGURE 1
SURFACE HEAT LOSSES
 From Oxidized Metals to 70°F Still Air, Watts/Ft.² vs °F

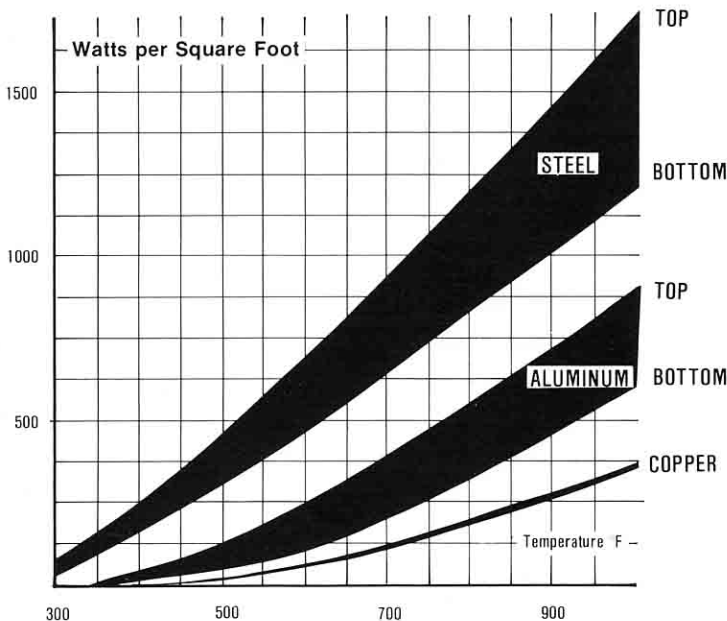


FIGURE 2
SURFACE HEAT LOSSES
 From Water Tanks to 70°F Air, Watt Density vs Water Flow Rate and Air Humidity

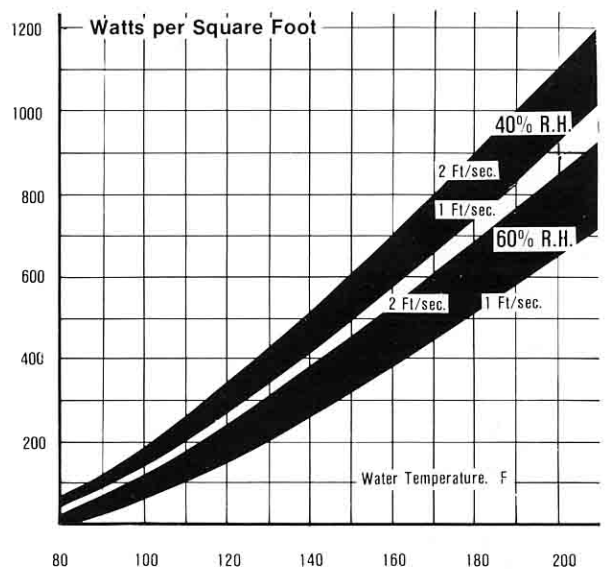


Table 1

Material		Specific Power Requirement Watts/Lb/°F	Specific Heat BTU/Lb/°F	Density Lbs/Ft ³	Thermal Conductivity (K) BTU/Hr °F Ft ² /Ft	Maximum Power Density Watts/In ²
S O L I D S	Aluminum	0.082	.23	160	117	
	Antimony	.0176	.05	423	14	
	Brass	.035	.10	525	130	
	Copper	.035	.10	550	224	
	Epoxy	.156	.45	—	80	
	Glass	.070	.20	165	.70	
	Iron, Cast	.046	.13	450	28	
	Iron, Wrought	.042	.12	450	35	
	Lead	.011	.03	710	20	
	Nickel	.039	.11	550	36	
	Nylon	.176	.50	—	.15	
	Paper	.108	.45	58	.60	
	Paraffin	.245	.70	—	56	
	Plastic, Ave	.13	.37	—	.15	
	Rubber	.14	.40	95	13	
	Silver	.021	.06	655	242	
	Stainless Steel	.042	.12	485	9	
	Steel	.042	.12	490	39	
	Teflon	.088	.25	—	.15	
	Tin	.021	.06	455	37	
Zinc	.035	.10	455	65		
L I Q U I D S	Acetic Acid	.165	.47	66	—	40
	Alcohol	.228	.65	55	.11	—
	Asphalt	.14	.40	65	—	10
	Benzine	.165	.45	56	—	—
	Ether	.176	.50	46	—	—
	Freon	.084	.24	81	.05	3
	Gasoline	.176	.50	46	—	3
	Glycerine	.204	.58	79	—	40
	Kerosene	.176	.50	51	.09	3
	Lead	.014	.04	710	—	35
	Mercury	.011	.04	845	4.8	20
	Oil, Hydraulic	.14	.40	58	—	20
	Petroleum	.178	.51	56	—	18
	Tin	.021	.060	460	37	20
Water	.352	1.0	62.4	.343	55	
G A S E S	Air	0.123	.35	.075	.025	
	Ammonia	.183	.52	.05	—	
	Carbon Dioxide	.070	.20	.12	—	
	Carbon Monoxide	.084	.24	.08	—	
	Chlorine	.046	.13	.20	—	
	Helium	.44	1.25	.01	.08	
	Hydrogen	1.20	3.41	.005	.10	
	Methane	.21	.60	.05	—	
	Nitrogen	.088	.25	.08	.014	
Oxygen	.072	.22	.09	.014		

Do not exceed recommended power density values when heating liquids unless local boiling or breakdown can be tolerated. Check Figure 3 to be sure.

FIGURE 3

AerOrod® Heater Surface
Temperature vs Watt Density
in 70° F Still Air

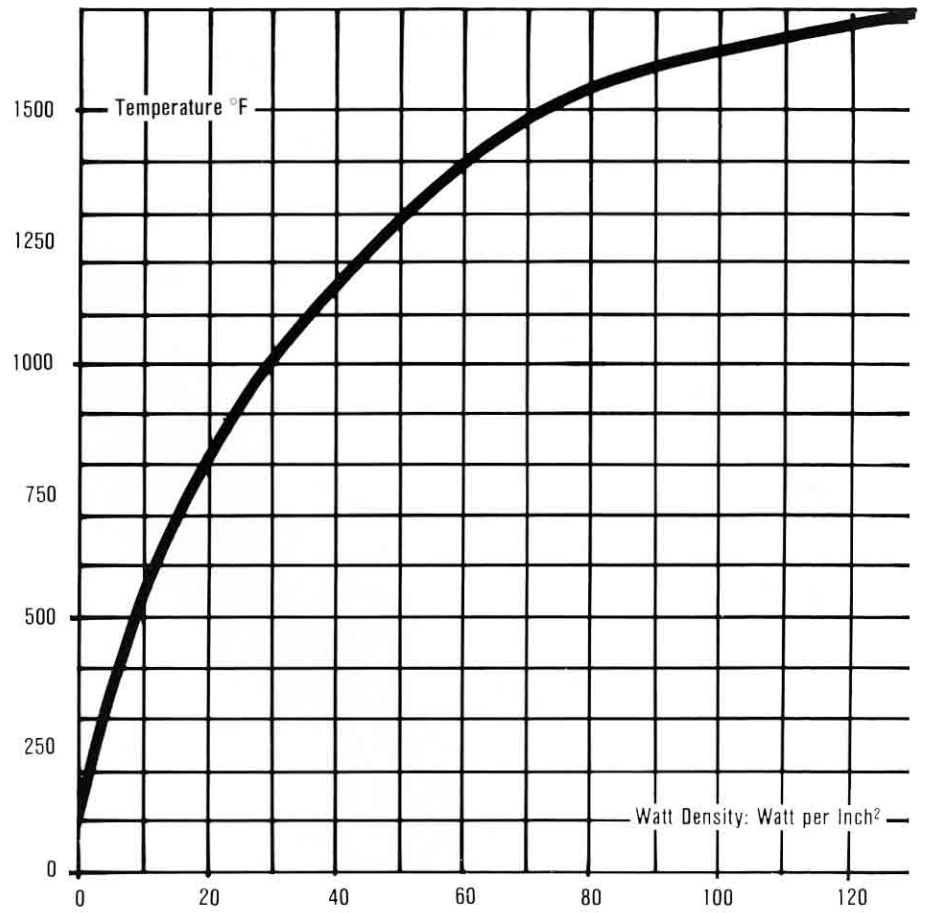
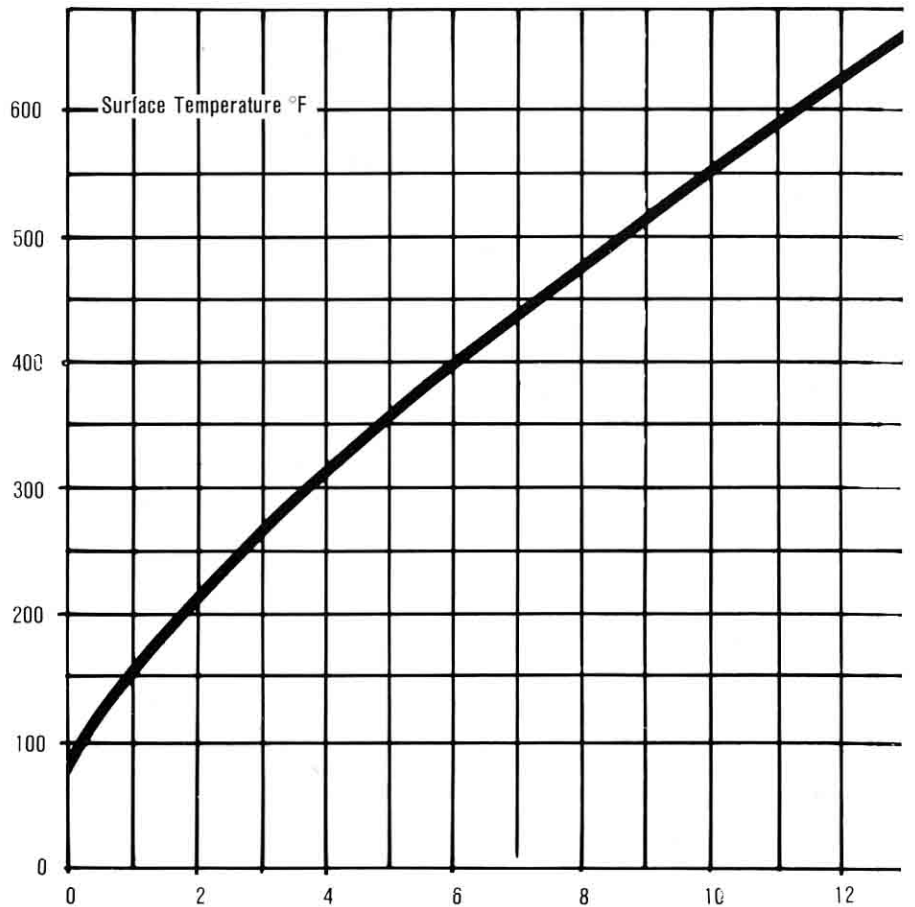


FIGURE 3A

EXPANDED FIG. 3 CURVE

From 70°F to 600°F
0 to 12 watts/in²



Heater Selection Methods

Given:

**A. Surface Temperature
Any Voltage**

**B. Power
At 115V 50/60 Hz
Line Voltage**

**C. Heated Length
At 115V 50/60 Hz**

**D. Voltage and Power
Voltage Other
Than 115V**

**E. Power and Heated Length
at a Voltage Other
Than 115V**

Selection Approach:

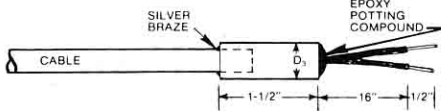
	<ol style="list-style-type: none"> 1. Obtain power density from Figure 3 or 3A in watts/in². 2. Select heater from Bulletin 5.2 options using power density column in Bulletin 5.2.
	<ol style="list-style-type: none"> 1. Check Bulletin 5.2 for options using 115V column. 2. If Bulletin 5.2 stock heater cannot be used, determine heater length vs. heater O.D. from the following calculation: <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div style="text-align: center;"> $.040'' \text{ O.D. } \frac{5290}{\text{Power}} = \text{length in inches}$ </div> <div style="text-align: center;"> $.125'' \text{ O.D. } \frac{49532}{\text{Power}} = \text{length in inches}$ </div> </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div style="text-align: center;"> $.062'' \text{ O.D. } \frac{12245}{\text{Power}} = \text{length in inches}$ </div> <div style="text-align: center;"> $.188'' \text{ O.D. } \frac{113034}{\text{Power}} = \text{length in inches}$ </div> </div> <div style="display: flex; justify-content: space-between; margin-top: 5px;"> <div style="text-align: center;"> $.093'' \text{ O.D. } \frac{26450}{\text{Power}} = \text{length in inches}$ </div> <div style="text-align: center;"> $.250'' \text{ O.D. } \frac{228017}{\text{Power}} = \text{length in inches}$ </div> </div> 3. Derive part number per Bulletin 5.2. 4. Determine total surface area from column 4 of table 2. Use this area to determine power density $(\frac{\text{Total Power}}{\text{Total Heated Area}}) = W/IN^2$ and surface temperature from Figure 3 or 3A.
	<ol style="list-style-type: none"> 1. Check Bulletin 5.2 for length vs. heater sheath O.D. and power options. 2. If desired heated length is not listed in Bulletin 5.2, use the constant from Step B.2 above to obtain power vs. sheath O.D. options. $\text{Constant} = \frac{\text{Power at 115V}}{\text{heated length}}$ 3. Determine total surface area from column 4 of Table 2. Determine power density $(\frac{\text{Total Power}}{\text{Total Heated Area}})$ and then surface temperature from Figure 3 or 3A.
	<ol style="list-style-type: none"> 1. Determine Heater Resistance $R(\text{ohms}) = \frac{(\text{voltage})^2}{\text{Power}}$ 2. Determine heater length options using column 3, Table 2 resistance per inch. $\frac{\text{Heater Resistance}}{\text{ohms per inch}} = \text{heater length in inches}$ 3. Derive part number per Bulletin 5.2.
	<ol style="list-style-type: none"> 1. Determine total resistance for O.D. options from column 3 of Table 2 $(\text{heated length}) \times (\text{ohms/inch}) = \text{heater resistance.}$ 2. Determine voltage using power and resistance. $\text{Voltage} = \sqrt{(\text{power}) \times (\text{resistance})}$ 3. Determine heater area using column 4 from Table 2 $(\text{heated length}) \times (\text{in}^2/\text{in}) = \text{area.}$ 4. Determine power density $\frac{\text{total power}}{\text{total area}} = W/IN^2$ power density 5. Determine heater surface temperature from Figure 3 or 3A.

Caution: Do not exceed the maximum applied voltage or current limits of Table 2 or watt density limitation on terminations per Table 5.

Table 2

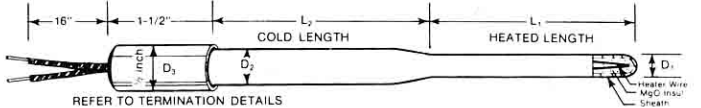
Heater Style	Sheath O.D. ±.005"	Ohms Per Inch Of Heated Length	Surface Area Per Inch of Heated Length (in) ²	Max Applied Voltage	Max Current (Amps)	Max Hi Pot Voltage (VAC) at 60 Hz
1	2	3	4	5	6	7
BXD-04 BXX-04	.0045"	2.5	.141	120	2	250
BXD-05 BXX-06	.0063"	1.08	.196	120	4	350
BXD-09 BXX-09	.0093"	0.50	.292	230	7	500
BXD-13 BXX-13	.0125"	0.267	.393	240	9	750
BXB-19 BXD-19 BXX-19	.0188"	0.117	.591	350	17	1100
BXX-25	.0250"	0.058	.785	450	23	1500

TERMINATION DETAILS

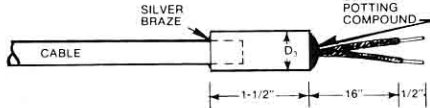


“K”-Termination:

- 1) Rated for continuous operation of 300° F (149° C)
- 2) $D_3=1/4"$ for .040 to .188" cable diameter
 $D_3=1/2"$ for .250 to .375" cable diameter
- 3) Standard lead wire length approximately 16"

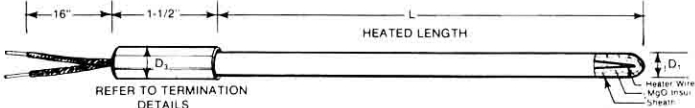


Style BXB

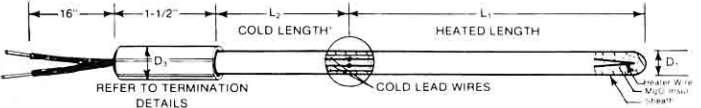


“T” Termination:

- 1) Rated for continuous operation of 800° F. (427° C.)
- 2) $D_3=3/8"$ for .040 to .188" cable diameter
 $D_3=1/2"$ for .250 to .375" cable diameter
- 3) Standard lead wire length approximately 16"



Style BXD



Style BXX

ARiCoil™ Cartridge Heater Design Procedure

ARiCoil™ Cartridge Heater

Straight AerOrod heaters formed into a coil form for insertion into tubes or blind holes. Can be used inside formed tubes or blind holes with drilling offset where traditional cartridge heaters cannot be used.

Required Data: 1) Power and applied voltage
2) Coil O.D. and coil length

Note: If power in watts is not known, refer to the heater selection methods. Power density (watts/in²) must be derived using effective surface area, if coiling pitch is equal to the sheath diameter up to twice sheath diameter.

$$A = \pi (\text{Coil I.D.} + \text{Coil O.D.}) \text{Coil Length}$$

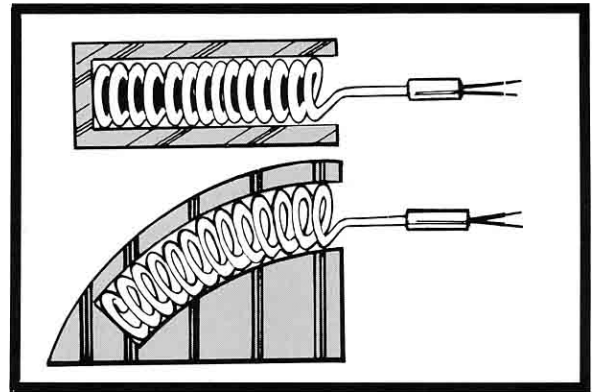


Table 4
Heater Coil Inner Diameter vs.
Ohms Per Inch of Tightly Wound Heaters

Coil I.D.	Heater Sheath O.D.					
	.040	.062	.090	.125	.188	.250
.180"	35.2Ω	Coil I.D. is too small for heater sheath O.D. in this range.				
.188"	37.0Ω					
.250"	49.0Ω					
.313"	61.2Ω					
.375"	73.5Ω					
.437"	85.7Ω					
.500"	98.0Ω					
.562"	110.2Ω					
.625"	122.5Ω					
.750"	147.2Ω					
.812"	159.2Ω	13.5Ω	16.9Ω	6.5Ω	7.5Ω	3.3Ω
.875"	171.7Ω	20.3Ω	23.6Ω	8.6Ω	9.6Ω	3.7Ω
1.000"	196.2Ω	27.0Ω	30.3Ω	10.7Ω	11.7Ω	4.1Ω
		33.8Ω	37.0Ω	13.0Ω	14.0Ω	4.9Ω
		40.7Ω	44.0Ω	14.0Ω	15.1Ω	5.4Ω
		47.5Ω	54.0Ω	15.1Ω	17.2Ω	5.8Ω
		54.0Ω	64.0Ω	17.2Ω	18.0Ω	6.6Ω
						1.4Ω
						1.5Ω
						1.6Ω
						1.8Ω
						0.72Ω

If preformed on an undersized mandrel, assume a total coil I.D. spring back equal to heater sheath diameter.

To determine power dissipation

$$\text{Power (watts)} = \frac{(\text{voltage})^2}{\text{total resistance}}$$

$$\text{Power at 115V } P = \frac{13225}{\text{ohms}}$$

$$\text{Power at 230V* } P = \frac{52900}{\text{ohms}}$$

*For 0.090" sheath diameter and larger heaters.

Procedure

Given power in watts, voltage, coil dimensions

1. Determine total resistance in ohms $R = \frac{(\text{voltage})^2}{\text{power}}$
2. Refer to Table 4. Multiply coil length in inches by resistance per coil inch to obtain total resistance.
3. Compare resistances from steps 1 and 2 to obtain best match.

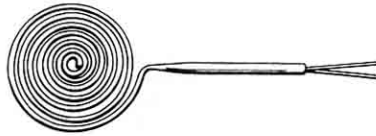
Note: Tightly wound coils can be opened up to a spacing of 3 times sheath diameter between turns.

Flat (archimedes) spiralled heaters

A flat pancake shaped coil is one of the most efficient methods of heating flat surfaces. Any of the AerOrod® heaters in the BXB, BXD, or BXX configurations can be used to form spiral heaters when the straight length is known. Considerations of applied voltage, power and power density (temperature) apply as derived in previous sections. For close wound (touching turns) spiral coils, the following table can be used if outer coil diameter is known and the innermost coil diameter is 4 times heater sheath O.D.

Straight heater length (in inches) = (constant) (coil diameter)²

Sheath O.D.	Constant
.040"	19.63
.062"	12.66
.090"	8.72
.125"	6.28
.188"	4.18
.250"	3.14



For flat coils with a uniform space between turns, the center to center space between adjacent turns is defined as the pitch, used in the following formula

$$\text{Length (inches)} = \frac{.785 (\text{coil diameter})^2}{\text{Pitch (in inches)}}$$

General Application of AerOrod® Heaters

The following section is specifically aligned towards the successful application of AerOrod® Heaters.

AerOrod® heaters consist of one or more resistance wires completely embedded in compacted magnesium oxide (MgO) and enclosed in a continuous Inconel 600 sheath. Material is tubular in nature with wire or wires straight and uniformly spaced within the sheath. Note: AerOrod® differs from electric stove type heating elements. Stove elements normally contain an internal helical coil of resistance wire. The use of the following approaches on heaters of the cartridge, blanket, or internal helix wire types are not recommended without a careful comparison of characteristics.

Maximum Temperatures:

Inconel 600 sheath: 2000° F
 1500° F sulphurous
 Magnesium Oxide: 3000° F
 Heater Wires: 1800° F

Forming Limitations

Heater O.D. (Heated Section)	Minimum Bend Radius
.045	.09"
.062	.125"
.125	.250"
.250	.500"
.313	.625"

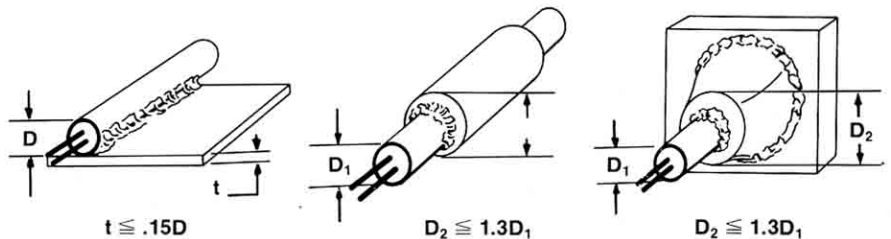
TABLE 5

Watt Density Limitations on Terminations

Heater Style	Term Type	Sheath Diameter in Inches					
		.040	.062	.093	.125	.188	.250
BXD	K	30	25	20	15	10	10
	T	100	100	100	75	50	40
BXX	K	80	65	55	40	25	25
	T	150	150	150	140	100	100
BXB	K	150	130	110	80	50	40
	T	150	150	150	150	150	140

Welding:

Sheath may be heliarc welded, if done carefully. Current limited DC systems and the following weld geometries are recommended.



Note: Capacitance discharge welding to sheath is not recommended. Any breach in the sheath can cause a rapid drop in insulation resistance that will result in heater failure.

Brazing: Use minimum clearance between heater sheath and adjacent material. Restrain ends of heater.

Torch Brazing:

For 1000° F max. service: Handy & Harmon Easy Flo. 1160° F melt.

For 1200° F max. service: Eutectic Eutecrod 1400 or Equal — 1425° F melt

Furnace Brazing:

1400-1800° F service, copper — 1982° F melt, Nicrobraz 50 — 1800° F flow

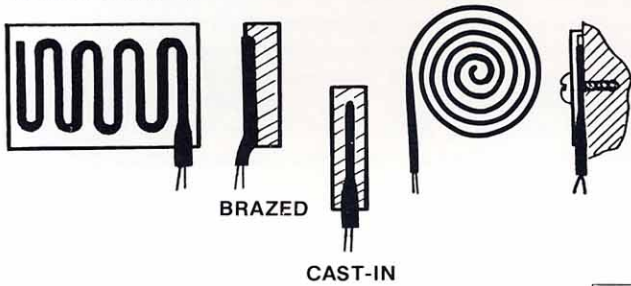
Note: Heater should be mechanically clamped or heliarc tack welded to brazing surface to avoid separation during a furnace brazing cycle.

Application of Heater

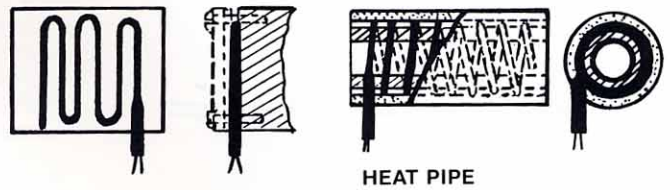
After the heater power level has been determined per the preceding section, follow-up action is required to insure correct application. In general, insuring good thermal contact throughout the desired temperature range will yield both the highest efficiency and closest temperature control. Mechanical methods using a clamping force or straps will usually suffice for operating temperatures below 500°F or heater watt densities below 10 watts per square inch. Above either 10 watts/in. or 500°F surface oxidation on metals or heater sheath itself will add an insulating barrier. The lower thermal conductivity of such oxides will create an appreciable temperature drop between heater and heated surface, requiring additional power to maintain a given surface temperature and adding a controller setting error. In all cases, this temperature drop will shorten heater life and increase the deviation from set point. A 600°F ± 3°F system can be degraded to 600°F ± 20°F by adding an oxide coating between heater and heated metal surface. The following recommendations are based on experience in applying AerOrod heaters to obtain maximum efficiency and life. (Maximum efficiency defined as the minimum power needed to attain and accurately hold a specified temperature)

Temperatures Below 500°F, Metal Surfaces:

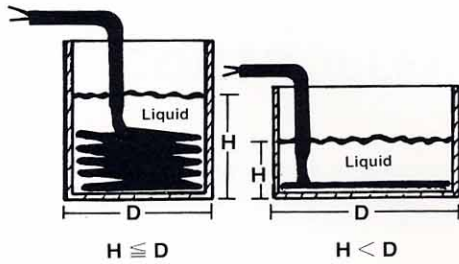
1. Heater Built-In



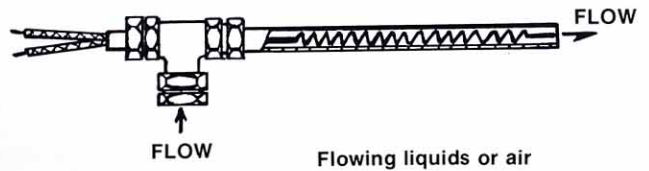
2. Replaceable Heater



3. Heating Liquids

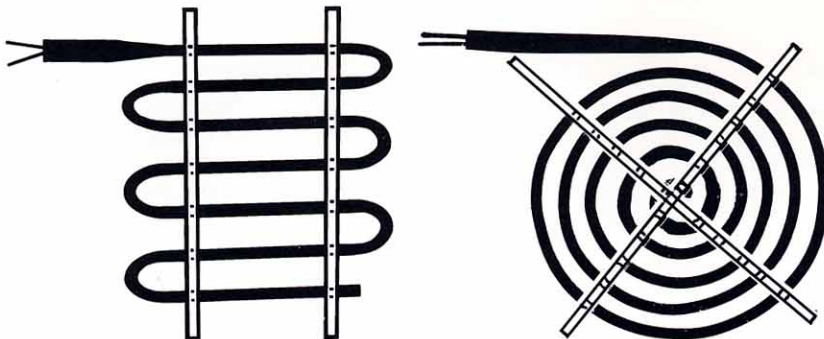


Inner Sleeve		Outer Sleeve	
To Heat O.D.	To Heat I.D.	To Heat O.D.	To Heat I.D.
Ceramic Stainless Steel	Copper Aluminum Steel	Copper Aluminum Steel	Ceramic Stainless Steel

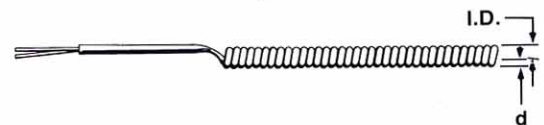


4. Radiant, 1000°F

Open grid pattern normally required. Form to fit desired heating pattern with a minimum of insulating or low conductivity supports to maintain shape. With AerOrod heaters, wire or strap of stainless steel may be used. Strap or wire thickness should be no more than 10% of heated section O.D.

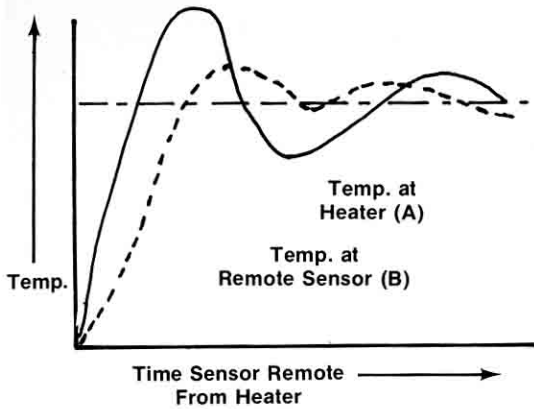


5. Radiant, Cartridge

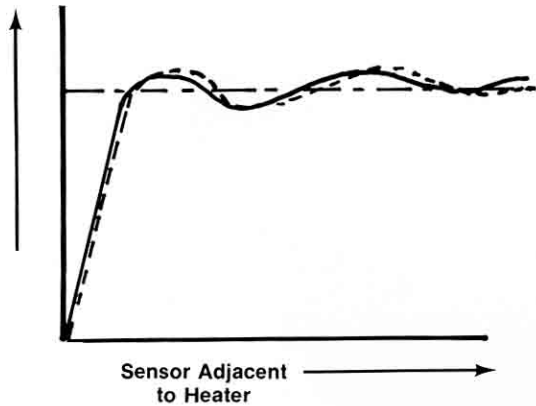


Spacing Between Adjacent Coils should be Equal

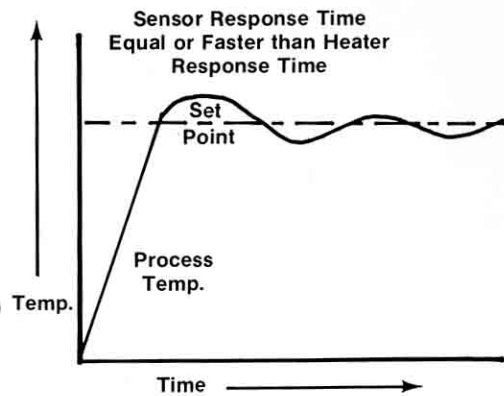
Temperature Sensors



General: Both the location and mass of temperature sensors will affect control system performance. Best response to process changes is normally obtained by locating sensor adjacent to heat source. Location effects during process temperature change:

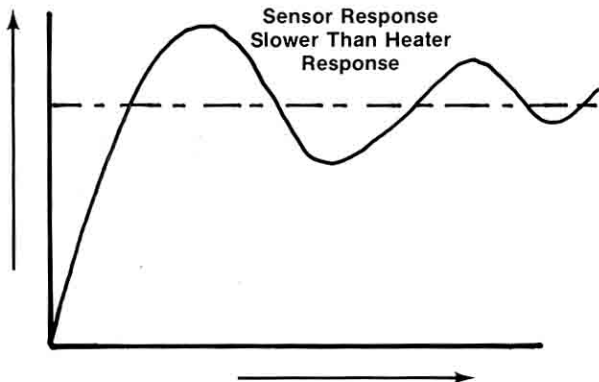


The mass or size of the sensor determines time response to process changes. If the sensor mass differs from the heater mass, the time response difference will cause excessive control system hunting, increasing temperature swings. It is possible to add anticipatory circuits to overcome this error, better to eliminate the need for compensation by selecting components that are compatible to each other and to the process.



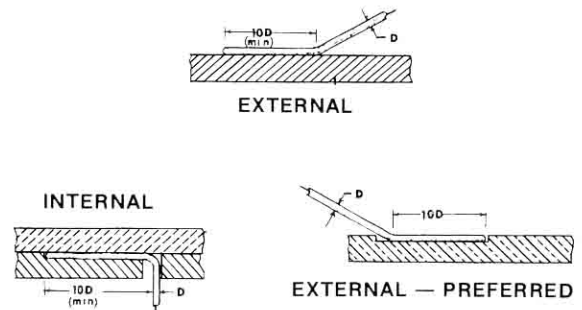
Sensor Response

Heater-Sensor or Heater-Load mismatch and location problems may be overcome by adding system variables to the controller such as: variable proportional band, manual or automatic reset and rate. A more reliable and economical system can normally be obtained thru careful selection and matching of sensor and controller to the load. This approach will also result in the lowest possible power demand. Stan-Trol series 300 control system employs the unique approach of combining heater and sensor within one sheath, completely eliminating the possibility of sensor dislocation or time response mismatch.



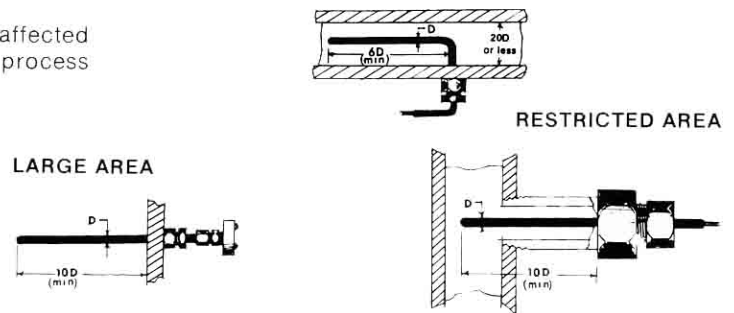
SENSOR ATTACHMENT & MOUNTING

Temperature sensors must accurately generate a signal that is related to the media to be controlled. Therefore, immersion in gases and liquids or attachment to solids must result in minimum random errors caused by the method of installation. The following methods are recommended to decrease installation or application error that will cause control temperature errors or excessive temperature variations.



THERMOCOUPLE, METAL SHEATHED TYPE (M.I.)

Thermocouples are always tip sensitive sensors, but can be affected by stem conduction. If insufficient sheath length is at process temperature.



CONTROLLER SELECTION, MATCHED SYSTEMS

The following selection criteria is based on the philosophy of matching heater and sensor to the application, and matching a temperature controller to the selected heater and sensor. This approach will usually result in the most efficient system that will yield lowest cost as based on the initial purchase price and operating costs per hour.

A. TWO-WIRE CONTROLLERS.

Where sensor installation or long term sensor reliability are problem areas, the combined sensor/heater approach to temperature control is recommended. The model 300 controllers are unique in that the special heater is manufactured with a positive temperature coefficient wire to combine the functions of both heat source and resistance thermometer. When combined with the appropriate controller, the heater resistance is sensed by an input bridge circuit. Power demand then becomes a function of the difference in resistance between set point potentiometer and actual heater/sensor resistance. This approach yields a minimum component control systems that allows system accuracies to $\pm 1^\circ\text{F}$ with fail-safe features. The positive temperature coefficient wire that is used will limit the power to approximately 50% of that at room temperature in the event that full power is applied continuously — acting as a power proportioning device to avoid the runaway that is possible with previous industrial heater systems. In addition, the heater/sensor employs an averaging effect as the entire heater is also an RTD. Therefore, the controlled temperature will represent the average temperature along the length of the heater/sensor — providing either a large volume temperature uniformity or shaped gradients as a function of the heater forming.

POWER LEVEL:
INPUT VOLTAGE:
HEATER-SENSOR MATCHING:
HEATER-SENSOR APPLICATION:

Determined from initial section of this guide.
 110 VAC line, limited to 1000 watts per circuit.
 Not required. Heater and sensor are the same unit.
 "Prior art" control approaches requiring oversize heaters with large thermal masses added to the two-wire controller system will decrease system accuracy. Highest efficiency and accuracy can be obtained with minimum thermal mass between heater and process as the control system will automatically compensate for changes in heat demand. Minimum mass insures fastest heater sensing and response to such changes in demand.



ARI Industries Inc.

381 ARi Court
Addison, IL 60101
USA

DATE: November 2001
NO. H-90-1

THIN FILM DEPOSITION REESEARCH

Physics Departments in Universities throughout the world are experimenting on Thin Film Deposition using 900 to 1000°C (1652 to 1832°F) heated substrates.

The requirements are a physically small radiation or conduction type of heater for use under high vacuum conditions as a source for localized heating of a very small surface area (of the order of a few cm²). The heater has to be capable of raising the temperature of the crystal substrates to approximately 900°C to completely clean the substrate. The substrate temperature is then lowered for the deposition process.

Experimenters typically choose heater cable (from Bulletin 5.1)

1HN040B-16.3	2HN040B-30
1HN063B-6.5	2HN063B-13
1HN063B-1.6	

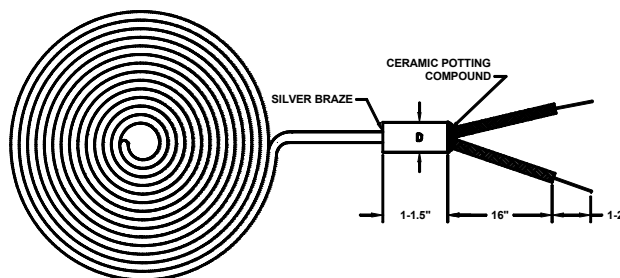
or completed heaters such as

BXX06B24-4T or BXX09B29-4T (from Bulletin 5.2)

and finally "made to order"

BXX06B24-11T or BXX09B29-11T

All of these are usually coiled to a flat Archimedes spiral of 2 to 3" overall diameter (EDF-3, page 7)



In a hard vacuum, the lower power dissipation in heater cold ends is still enough to overheat "T" style terminations, leading to the 11" cold end requirement and added cold end heat sinks in some cases.

**A
P
P
L
I
C
A
T
I
O
N

S
H
E
E
T**

Phone: 630-953-9100
Toll Free: 1-800-237-6725
Fax: 630-953-0590
E-Mail: sales@ariindustries.com
Web Site: <http://www.ariindustries.com>



ARI Industries Inc

HARDWARE
THERMOCOUPLE/RTD
ACCESSORIES



CONNECTORS

CONNECTION HEADS

COMPRESSION FITTINGS

THERMOCOUPLE LEAD WIRE



BULLETIN 6.0

OCT. 98

CONNECTION HEADS

ARi Type E Heads

STANDARD SIZE

DIE CAST ALUMINUM BODY

WITH GRAY ENAMEL COATING

Part No.	47003	(ARi Logo) 3/4" X 3/4" NPT
	47053	(No Logo) 3/4" X 3/4" NPT
	47052	(No Logo) 1/2" X 1/2" NPT

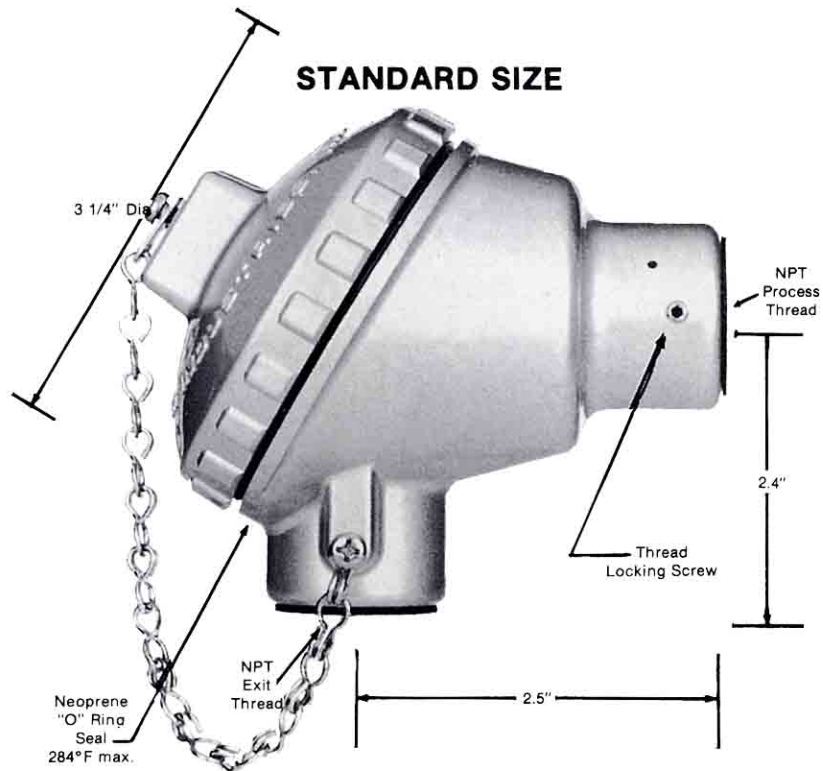
CAST IRON BODY

Part No.	47021	(ARi Logo) 3/4" X 3/4" NPT
-----------------	--------------	-------------------------------

CAST 316 STAINLESS STEEL BODY (Used with Style C Terminal Block only)

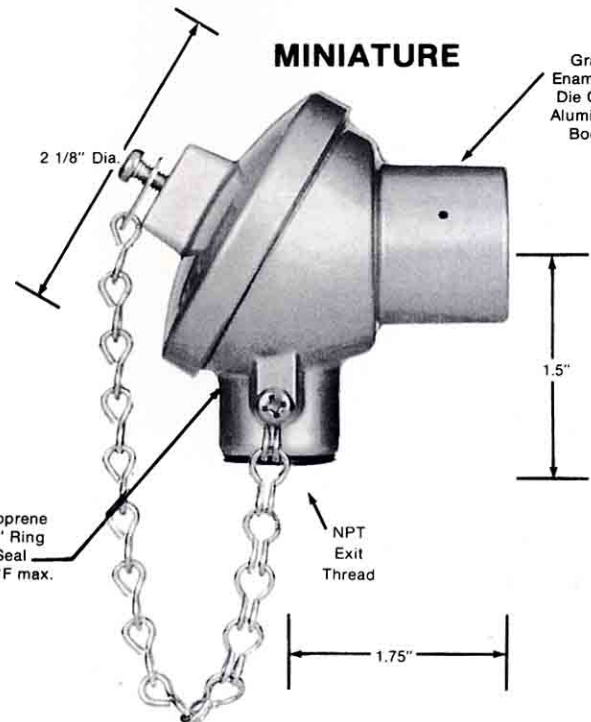
Part No.	47056	(No Logo) 3/4" X 3/4" NPT
-----------------	--------------	------------------------------

Note: If 1/2" NPT required, purchase part no. 33157 reducing bushing



MINIATURE

Gray Enameled Die Cast Aluminum Body



MINIATURE SIZE

Part No. 31146

With fixed 3 pole terminal block Style D, 1/8" process, 1/4" exit threads.

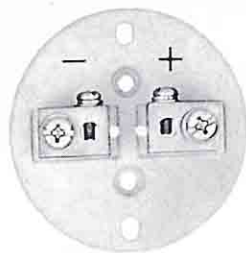
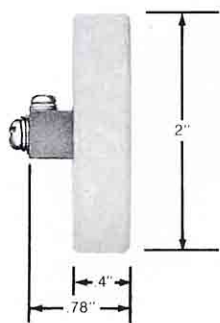
Part No. 31147

With fixed 2 pole terminal block Style D, 1/8" process, 1/4" exit threads.

TERMINAL BLOCKS

Style A

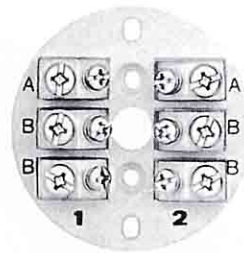
Fixed ceramic block with plated brass terminals. Supplied with two mounting screws. Used with connection heads 47003, 47053, 47052 and 47021.



2 Pole
Part No. 16131



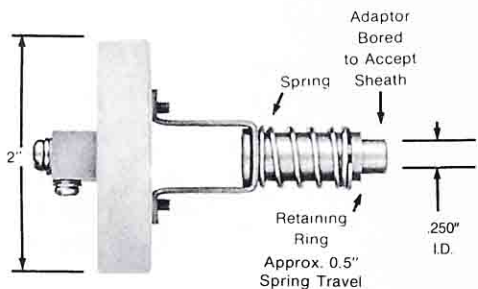
4 Pole
Part No. 16137



6 Pole
Part No. 16132

Style B

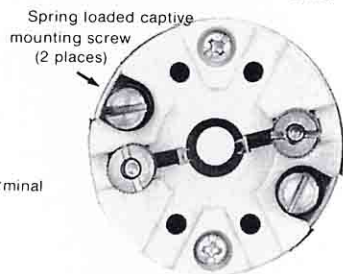
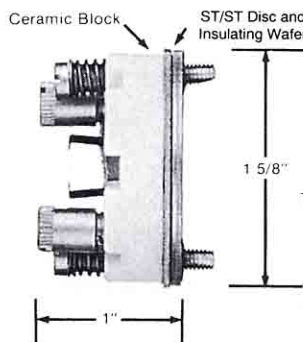
Spring loaded feature added to Style A fixed terminal block. Supplied with two mounting screws. Sheath diameter 0.250". Used with connection heads 47003, 47053, 47052 and 47021.



Consists of: Spring, Bracket & Screws
Part No. 24149
(Style A Blocks to be ordered separately)

Style C

Din Type Spring Loaded ceramic block. Approx. 0.375" spring travel. Stainless steel plate drilled to accept 0.250" O.D. Sheath Size. Used with connection heads 47003, 47053, 47052, 47021 and 47056.



2 Pole
Part No. 0052500-2-2



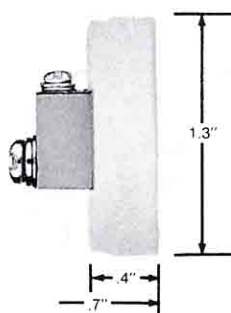
4 Pole
Part No. 0052500-2-4



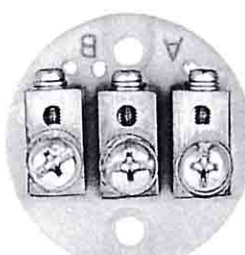
6 Pole
Part No. 0052500-2-6

Style D

Fixed ceramic block with plated brass terminals. Used only with miniature connection heads 31146 and 31147. Not sold separately.



2 Pole For
31147 Head



3 Pole For
31146 Head

CONNECTORS

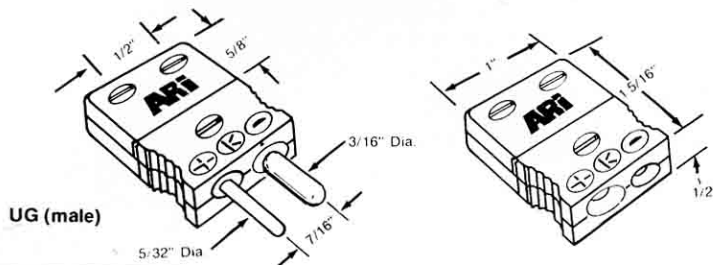
SPECIFY PART NUMBER AND QUANTITY

ARI Type B Two Pin Quick Disconnect Thermocouple Connector System

STANDARD SIZE

Thermocouple Connectors

Supplied in both 400°F and 800°F temperature rating.



400°F TEMPERATURE RATING

PLUG — MALE		JACK—FEMALE	
Part Number	Calibration Symbol	Body Color	Part Number
13118	E	Violet	14118
13101	J, Y	Black	14101
13100	K	Yellow	14100
13105	R, S	Green	14104
13104	T	Blue	14105
13146	AEX ⁽¹⁾⁽³⁾	Brown	14138
13112	B, AO ⁽²⁾	White	14109
13156	N ⁽³⁾	Orange	14148

800°F TEMPERATURE RATING

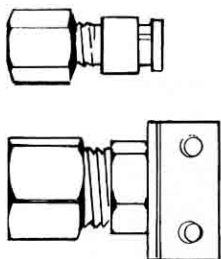
PLUG — MALE		JACK—FEMALE	
Part Number	Calibration Symbol	Part Number	Part Number
13151	J	14143	
13130	K	14144	
13152	R, S ⁽²⁾	14145	
13153	AEX ⁽¹⁾	14146	

Color code — None. All are red.
 (1) Compensating materials for W5Re/W26Re
 (2) Copper/copper Non-compensating
 (3) Use 800°F Temp. Sheath Adaptor

Sheath Adaptors

For 400°F Temp. rating connectors

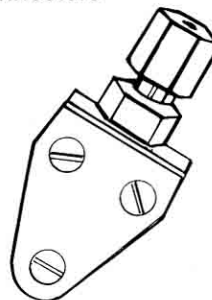
Part Number	Tube or Sheath O.D.
12133	.040"
12104	.062"
12103	.125"
12102	.188"
12101	.250"
12100	.313"



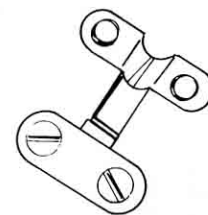
Sheath Adaptors

For 800°F Temp. rating connectors

Part Number	Tube or Sheath O.D.
12148	.040"
12141	.062"
12142	.125"
12149	.188"
12150	.250"
12151	.313"

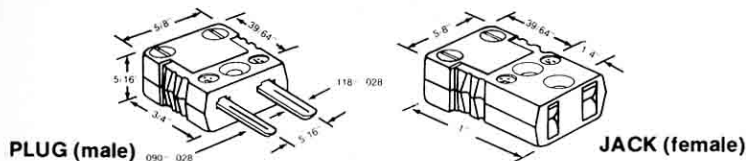


Cable Clamp Part No. 20109



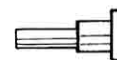
Miniature Blade Type

Thermocouple Connectors 400°F max. temperature exposure.



PLUG (MALE)		PLUG (FEMALE)		
Part Number	Calibration Symbol	Body Color	Part Number	Calibration Symbol
13142	J	Black	14134	J
13143	K	Yellow	14135	K
13144	R, S	Green	14136	R, S
13147	T	Blue	14139	T
13145	Copper/ Copper	White	14137	Copper/ copper

Optional Crimp-on Sheath Adaptors for Mini Plugs



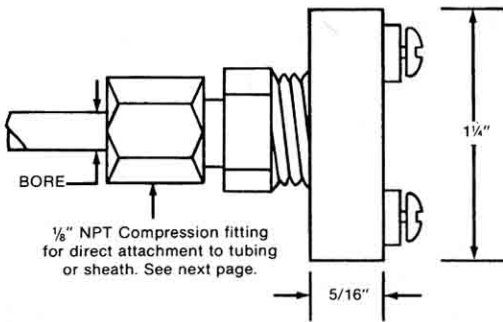
Crimp

Part Number	To Fit Sheath O.D.
12136	0.040"
12137	0.062"
12139	0.125"

SPECIFY PART NUMBER AND QUANTITY

ARi Type F High Temp (1000°F) ARi Patent 2,994,733

Wire to Wire Connector. Ceramic block with captive screw terminals, nickel plated brass.



2 Pole

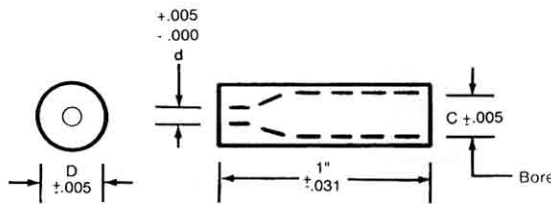
Part No. 0016100-1



4 Pole

Part No. 0016107-1

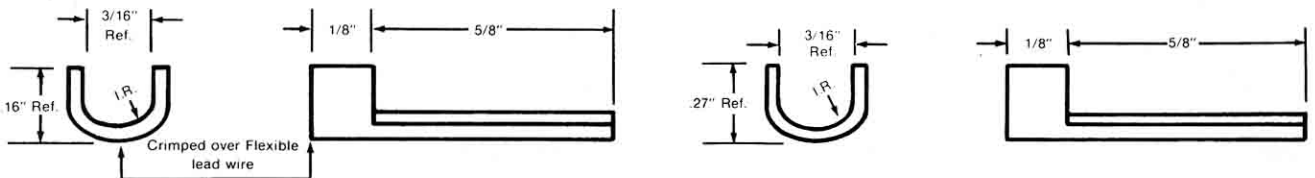
STAINLESS STEEL POTTING SHELLS



Part Number	Shell O.D. (D)	Sheath Clearance Hole (d)	Bore (C)
10106	.250"	.025"	.209"
10107	.250"	.040"	.209"
10108	.250"	.062"	.209"
10109	.250"	.125"	.209"
10110	.250"	.188"	.194"
10111	.313"	.250"	.256"

STAINLESS STEEL STRAIN RELIEFS (fully bright annealed)

U.S. Patent 3,144,507



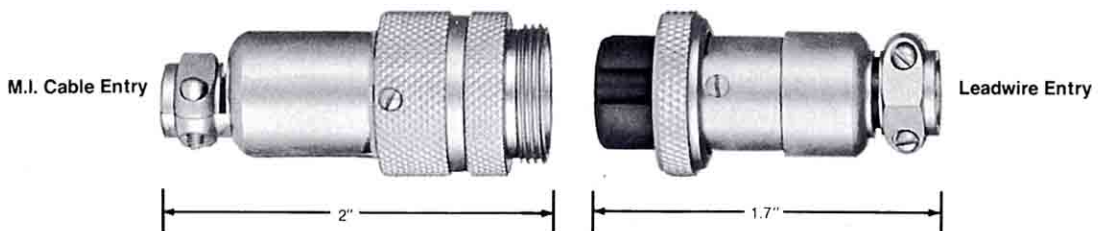
Part No. 490571

Part No. 490960

1/8" wide tang welded or brazed to sheath

ARi Patent 3,144,507

ARi Type A RTD 4 Pin Keyed Connector



PLUG

JACK

Part No. 19289

Mated Length 3.25"

Part No. 19290

(Sold as a set. Not sold separately.)

Compression Fittings

Specify Part Number and Quantity

MATERIALS:

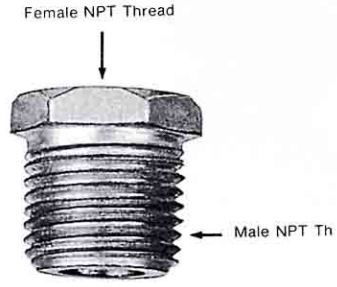
APNI = Nickel Plated Brass

CS = Steel

SS = Stainless Steel



Reducing Bushings



Bore in Inches	Thread (NPT)	Part Number	*Teflon Ferrules Part Number
.062	1/8	PTM-B2SS	
.125	1/8	PTM-D2APNI	47016
.125	1/8	PTM-D2SS	
.188	1/8	PTM-E2APNI	47017
.188	1/8	PTM-E2SS	
.250	1/8	PTM-F2APNI	47018
.250	1/8	PTM-F2SS	
.250	1/4	PTM-F4SS	
.313	1/4	PTM-G4SS	
.375	1/2	PTM-18SS	
.500	1/2	PTM-K8SS	
.625	1/2	PTM-P8CS	
.750	3/4	PTM-Q12CS	
1.0	1	PTM-S16SS	
1.0	1	PTM-S16CS	

Male Thread	Female Thread	Part Number	Materials
1/2	1/8	33128	Nickel Plated Brass
1/2	1/4	33127	Nickel Plated Brass
3/4	1/8	33139	Nickel Plated Brass
3/4	1/2	33157*	Nickel Plated Brass
1/2	1/8	33155	Stainless Steel
1/2	1/4	33141	Stainless Steel
3/4	1/8	33150	Stainless Steel
3/4	1/4	33154	Stainless Steel

*Flush bushing. Does not have hex head as shown.

*Accessory Single Piece Teflon Ferrules to Fit Nickel Plated Brass Compression Fittings.

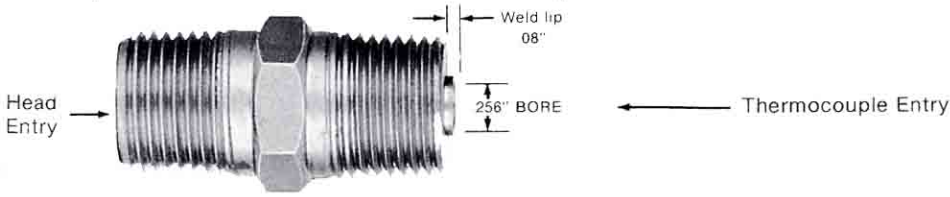
Sheath Stripping Tools

Aluminum Body Part Number	Nominal O.D.		Tool Bits Part Number	Image
	Inches	mm	Part Number	
ST025A	.025	0.64	TB125	
ST032A	.032	0.82	TB125	
ST040	.040	1.00	TB188	
ST062	.062	1.57	TB188	
—	.065	1.65	TB188	
ST079	.079	2.00	TB188	
ST090	.090	2.28	TB188	
ST118	.118	3.00	TB250	
ST125	.125	3.18	TB250	
ST125B	.125	3.18	TB250	
—	.177	4.50	TB250	
ST187B	.187	4.75	TB250	
ST236B	.236	6.00	TB250	
ST250B	.250	6.35	TB250	



Power Adaptor
*Supplied upon request only.

Special Threaded Adaptors



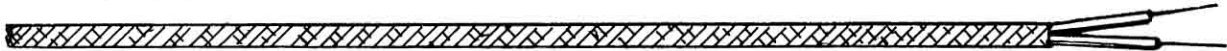
Part No. 47012 1/2" NPT x 1/2" NPT 304 st/st Fitting with weld lip for 0.250" O.D. sensors



Part No. 47013 1/2" NPT x 1/2" NPT 304 st/st Spring Loaded Fitting for 0.250" O.D. sensors spring travel 0.75" min.

Thermocouple Lead Wire

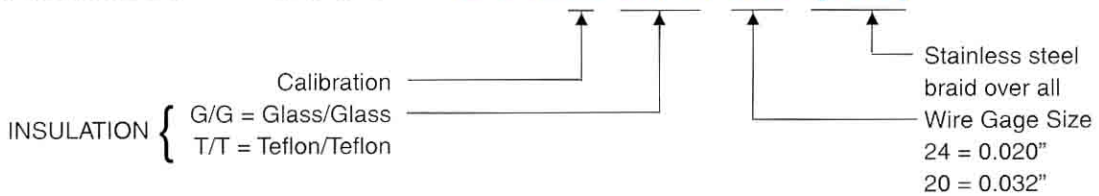
Thermocouple grade lead wire, solid conductors. All meet initial limits of error per ASTM E-230.



Calibration Symbol	Part Number
E	012EGG20 012EGG20SS
J	012JGG24 012JGG20 012JGG20SS
K	012KGG24 012KGG20 012KTT24 012KGG20SS

Calibration Symbol	Part Number
N	012NGG20 012NTT20
T	012TGG20 012TGG20SS
R, S Type SX (CU/#11 Alloy)	012SXGG24 012SXGG20
ARi Type AEX (For W5Re/W26Re)	012AEXGG24 012AEXTT24 012AEXGG24SS

Part Number Code 01-2E-G/G-20-(SS)



AerOseal®

Liquid absorption for creating a moisture free "Neutral Zone" in compacted MgO insulated material. U.S. Patent 3,032,444. Package in 32 fluid ounce containers.

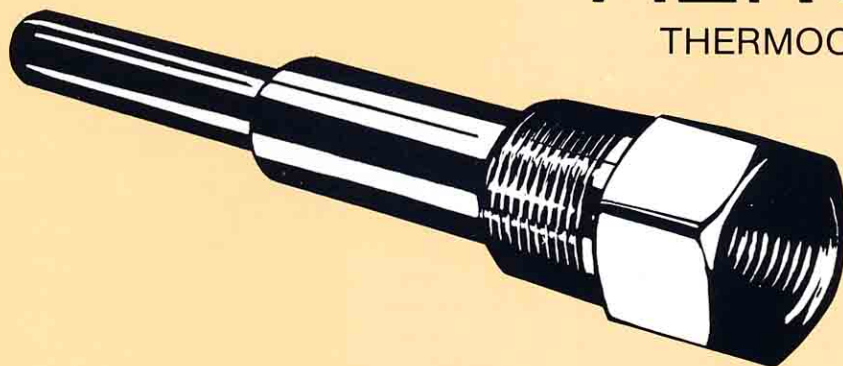
PART NUMBER 61226-2—For surface shipments in U.S. only.

61226-3—For Air Freight shipments.

(Special packaging requirements)

AEROGARD[®]

THERMOCOUPLE WELLS



FEATURING:

- Large Range of Standard Thermowells
- Precision machined
- Competitively Priced
- Fast Delivery

SPECIFICATIONS:

STANDARD MATERIAL: A.I.S.I. 304 and 316 ST/ST
 SPECIAL MATERIAL: Brass (ASTM B-16), Carbon Steel (C-1018), Monel, Inconel 600, Hastelloy B, Hastelloy C, Nickel, others on special order.

DIMENSIONAL TOLERANCES: Fraction $\pm 0.03''$

Pressure Rating psi at Temperature, °F

BORE INCH	MATERIAL	TEMPERATURE-°F						
		70°	200°	400°	600°	800°	1000°	1200°
0.260	AISI-304	7800	7050	6400	6150	6000	5190	1875
	AISI-316	7800	7800	7250	7100	6950	5800	2720
0.385	AISI-304	7000	6200	5600	5400	5200	4500	1650
	AISI-316	7000	7000	6400	6200	6100	5100	2500

ARI is a registered Trademark.

ARI Industries Inc

BULLETIN 6.1
August 1997

CORROSIVE SERVICE GUIDE TO MATERIALS

CORRODENT	TEMP. °F.	CONC. %	RECOM. MATERIAL	CORRODENT	TEMP. °F.	CONC. %	RECOM. MATERIAL	CORRODENT	TEMP. °F.	CONC. %	RECOM. MATERIAL
Acetic Acid	212	ALL	Monel	Copper Plating Solution (Cyanide)	180		304 SS	Oleic Acid			SEE FATTY ACIDS
Acetic Anhydride	300		Nickel	Copper Plating Solution (Acid)	75		304 SS	Oxalic Acid	212	ALL	Monel
Acetone	212	ALL	304 SS	Corn Oil	200		304 SS	Photographic Bleaching	100	ALL	304 SS
Acetylene	400		304 SS	Creosote	200	ALL	304 SS	Palmitic Acid			SEE FATTY ACIDS
Alcohols	212	ALL	304 SS	Crude Oil	300		Monel	Phosphoric Acid	212	ALL	316 SS
Alum. (Potassium or Sodium)	300	ALL	Hast. C	Ethyl Acetate			SEE LACQUER THINNER	Phenol	212	ALL	316 SS
Aluminum Chloride	212	ALL	Hast. B	Ethyl Chloride, Dry	500		Steel	Potassium Compounds			SEE SODIUM COMPOUNDS
Aluminum Sulfate	212	ALL	316 SS	Ethanol			SEE ALCOHOLS	Propane	300		Steel
Ammonia, Dry	212	ALL	304, 316 SS	Ethylene Glycol (Uninhibited)	212	ALL	304 SS	Rosin	700	100%	316 SS
Ammonium Hydroxide (Ammonia, Aqua)	212	ALL	304, 316 SS	Ethylene Oxide	75		Steel	Sea Water	75		Monel
Ammonium Chloride	300	50%	Monel	Fatty Acids	500	ALL	316 SS	Soap & Detergents	212	ALL	304 SS
Ammonium Nitrate	300	ALL	304 SS	Ferric Chloride	75	ALL	Hast. C	Sodium Bicarbonate	212	20%	316 SS
Ammonium Sulfate	212	ALL	316 SS	Ferric Sulfate	300	ALL	304 SS	Sodium Bisulphite	212	20%	304 SS
Amyl Acetate	300	ALL	304 SS	Formaldehyde	212	40%	316 SS	Sodium Bisulphate	212	20%	304 SS
Aniline	75		Monel	Formic Acid	300	ALL	316 SS	Sodium Carbinatate	212	40%	316 SS
Asphalt	250		304 SS	Freon	300		Steel	Sodium Chloride	300	30%	Monel
Atmosphere, (Industrial and Marine)			304 SS	Fluorine, Anhydrous	100		304 SS	Sodium Chromate	212	ALL	316 SS
Barium Compounds			SEE CALCIUM	Furfural	450		316 SS	Salt or Brine			SEE SODIUM CHLORIDE
Beer	70		304 SS	Gasoline	300		Steel	Sodium Cyanide	212	ALL	304 SS
Benzene (Benzol)	212		Steel	Glucose	300		304 SS	Sodium Hydroxide	212	30%	316 SS
Benzoic Acid	212	ALL	316 SS	Glue ph 6-8	300	ALL	304 SS	Sodium Hypochlorite	75	10%	Hast. C
Bleaching Powder	70	15%	Monel	Glycerine	212	ALL	Brass	Sodium Nitrate	212	40%	304 SS
Borax	212	ALL	Brass	Hydrobromic Acid	212	ALL	Hast. C	Sodium Nitrite	75	20%	316 SS
Bordeaux Mixture	200		304 SS	Hydrochloric Acid (37-38%)	225	ALL	Hast. B	Sodium Phosphate	212	10%	Steel
Boric Acid	400	ALL	316 SS	Hydrogen Chloride, Dry	500		304 SS	Sodium Silicate	212	10%	Steel
Bromine	125	DRY	Monel	Hydrocyanic Acid	212	ALL	304 SS	Sodium Sulfate	212	30%	316 SS
Butane	400	ALL	Steel	Hydrofluoric Acid	212	60%	Monel	Sodium Sulfide	212	10%	316 SS
Butyl Alcohol			SEE ALCOHOLS	Hydrogen Fluoride, Dry	175		Steel	Sodium Sulfite	212	30%	304 SS
Butyric Acid	212		Hast. C	Hydrofluogilicic Acid	212	40%	Monel	Sodium Thiosulfate	212	ALL	304 SS
Calcium Bisulphite	75	ALL	Hast. C	Hydrogen Peroxide	125	10-100%	304 SS	Steam			304 SS
Calcium Chloride	212	ALL	Hast. C	Kerosene	300	ALL	Steel	Stearic Acid			SEE FATTY ACIDS
Calcium Hydroxide	300	20%	Hast. C	Lacquers & Thinners	300	ALL	304 SS	Sugar Solutions			SEE GLUCOSE
Calcium Hypochlorite			SEE BLEACHING POWDER	Lactic Acid	300	ALL	316 SS	Sulfur	500		304 SS
Carbolic Acid			SEE PHENOL	Lime	212	ALL	316 SS	Sulfur Chloride	75	DRY	316 SS
Carbon Dioxide, Dry	800	ALL	Brass	Linseed Oil	75		Steel	Sulfur Dioxide	500	DRY	316 SS
Carbonated Water	212	ALL	304 SS	Magnesium Chloride	212	50%	Nickel	Sulfur Trioxide	500	DRY	316 SS
Carbonated Beverages	212		304 SS	Magnesium Hydroxide (or Oxide)	75	ALL	304 SS	Sulfuric Acid	212	10%	316 SS
Carbon Disulfide	200		304 SS	Magnesium Sulfate	212	40%	304 SS	Sulfuric Acid	212	10-90%	Hast. B
Carbon Tetrachloride	125	ALL	Monel	Mercuric Chloride	75	10%	Hast. C	Sulfuric Acid, Fuming	212	90-100%	316 SS
Chlorine, Dry	100		Monel	Mercury	700	100%	Steel	Sulfurous Acid	75	20%	316 SS
Chlorine, Moist	100	ALL	Monel	Methylene Chloride	212	ALL	304 SS	Titanium Tetrachloride	75	ALL	316 SS
Chloroacetic Acid	212	ALL	Monel	Methyl Chloride, Dry	75		Steel	Tannic Acid	75	40%	Hast. B
Chloroform, Dry	212		Monel	Milk, fresh or sour	180		304 SS	Toluene	75		Steel
Chromic Acid	300	ALL	Hast. C	Molasses			SEE GLUCOSE	Trichloroacetic Acid	75	ALL	Hast. B
Cider	300	ALL	304 SS	Natural Gas	70		304 SS	Trichlorethylene	300	DRY	Monel
Citric Acid	212	ALL	Hast. C	Nitric Acid	75	ALL	304 SS	Turpentine	75		316 SS
Copper (10) Chloride	212	ALL	Hast. C	Nitric Acid	300	ALL	316 SS	Varnish	150		Steel
Copper (10) Nitrate	300	ALL	316 SS	Oxygen	75	ALL	Steel	Zinc Chloride	212	ALL	Hast. B
Copper (10) Sulfate	300	ALL	316 SS					Zinc Sulfate	212	ALL	316 SS

In recommending the above materials, consideration has been given to providing good service life without undue cost. Where two or more materials are satisfactory, the least expensive is listed. Consult the factory for information on materials or services not given.

OTHER MATERIALS SUCH AS: NICKEL, HASTELLOY "B" OR "C" CAN BE PROVIDED. PLEASE CONSULT FACTORY FOR PRICE AND DELIVERY.

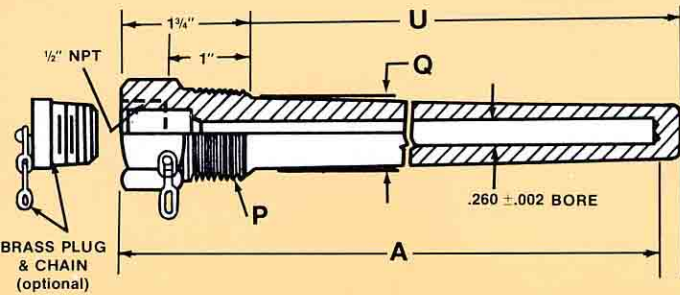
FOR 1/4" OD

AerOpak® Thermocouple

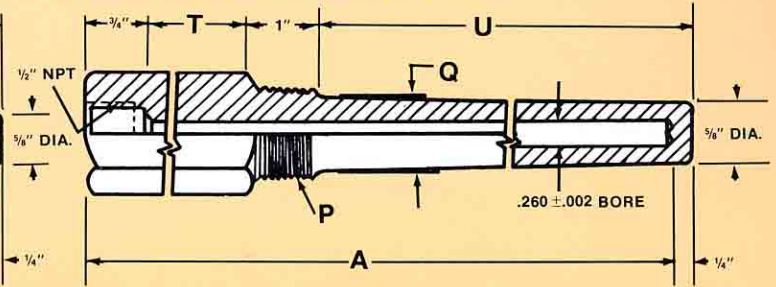
CAP & CHAIN: (At Added Cost)

Brass captive cap is available for keeping gird bore clean when not in use.

GENERAL USE



LAGGING EXTENSION TYPE



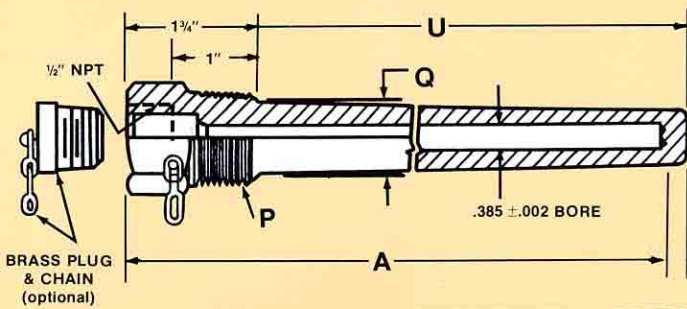
PART NUMBER	ELEM. LGTH.	INSERT. LGTH.	SHANK DIA.	EXTERNAL THREAD
	A	U	Q	P
36139	4	2½	7/8	¾" NPT
36140	6	4½	7/8	
36141	9	7½	7/8	
36142	12	10½	7/8	
36143	15	13½	7/8	
36144	18	16½	7/8	
36145	24	22½	7/8	
36146	4	2½	1-1/16	1" NPT
36147	6	4½	1-1/16	
36148	9	7½	1-1/16	
36149	12	10½	1-1/16	
36150	15	13½	1-1/16	
36151	18	16½	1-1/16	
36152	24	22½	1-1/16	

PART NUMBER	LAG. EXT.	ELEM. LGTH.	INSERT. LGTH.	SHANK DIA.	EXTERNAL THREAD
	T	A	U	Q	P
36153	2	6	2½	7/8	¾" NPT
36154	3	9	4½	7/8	
36155	3	12	7½	7/8	
36156	3	15	10½	7/8	
36157	3	18	13½	7/8	
36158	3	24	19½	7/8	
36159	2	6	2½	1-1/16	
36160	3	9	4½	1-1/16	
36161	3	12	7½	1-1/16	
36162	3	15	10½	1-1/16	
36163	3	18	13½	1-1/16	
36164	3	24	19½	1-1/16	

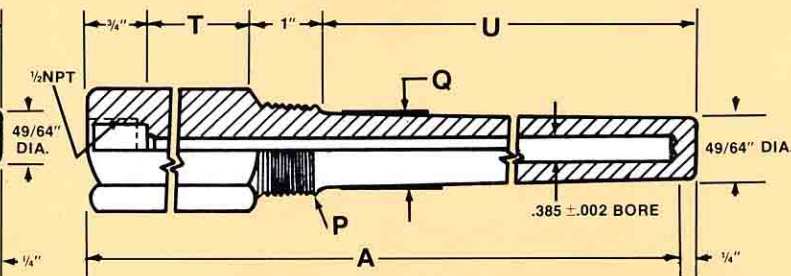
FOR 3/8" OD

AerOpak® Thermocouple

GENERAL USE



LAGGING EXTENSION TYPE



PART NUMBER	ELEM. LGTH.	INSERT. LGTH.	SHANK DIA.	EXTERNAL THREAD
	A	U	Q	P
36191	4	2½	1-1/16	1" NPT
36192	6	4½	1-1/16	
36193	9	7½	1-1/16	
36194	12	10½	1-1/16	
36195	15	13½	1-1/16	
36196	18	16½	1-1/16	
36197	24	22½	1-1/16	

PART NUMBER	LAG. EXT.	ELEM. LGTH.	INSERT. LGTH.	SHANK DIA.	EXTERNAL THREAD
	T	A	U	Q	P
36198	2	6	2½	1-1/16	1" NPT
36199	3	9	4½	1-1/16	
36200	3	12	7½	1-1/16	
36201	3	15	10½	1-1/16	
36202	3	18	13½	1-1/16	
36203	3	24	19½	1-1/16	

FLANGED

For 1/4" and 3/8" OD AerOpak® Thermocouple

FLANGE SIZES:

STANDARD-1" and 1 1/2" Flanges with raised face and 150 psi pressure rating. Other sizes are available upon request.



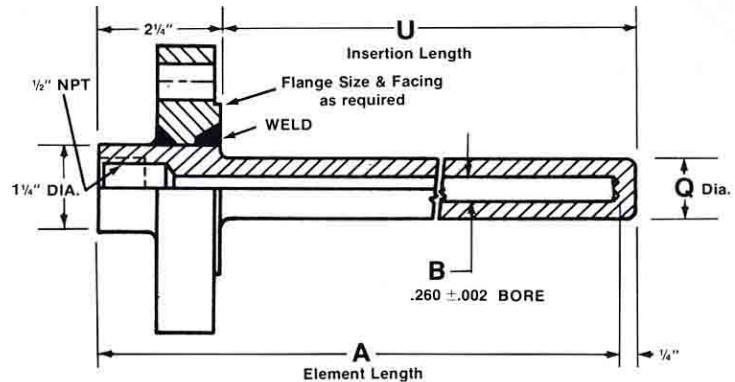
CAP & CHAIN:

(At Added Cost)

Brass captive cap is available for keeping gard bore clean when not in use.

WELDING:

Primary gard is "J" groove type, secondary weld is 45 bevel groove. Welding is performed by NAVY certified welders using gas shielded arc.



FOR 1/4" OD

AerOpak® Thermocouple

PART NUMBER	ELEM. LGTH.	INSERT. LGTH.	SHANK DIA.	BORE DIA.
	A	U	Q	B
36204	4	2	3/4	.260
36205	6	4	3/4	
36206	9	7	3/4	
36207	12	10	3/4	
36208	15	13	3/4	
36209	18	16	3/4	
36210	24	22	3/4	

FOR 3/8" OD

AerOpak® Thermocouple

PART NUMBER	ELEM. LGTH.	INSERT. LGTH.	SHANK DIA.	BORE DIA.
	A	U	Q	B
36211	4	2	7/8	.385
36212	6	4	7/8	
36213	9	7	7/8	
36214	12	10	7/8	
36215	15	13	7/8	
36216	18	16	7/8	
36217	24	22	7/8	

Maximum Flange Pressure Temperature Rating Lbs. Per Sq. Inch

MATERIAL	TEMPERATURE -°F						
	0°	200°	400°	600°	800°	1000°	1125°
AISI-304	_____ UP _____ TO _____						2500 psi
AISI-316	_____ UP _____ TO _____						2500 psi

HOW TO ORDER:

1. Specify Part Number and Quantity.

example: **36139-A**

1. **PART NUMBER** _____
(as listed in Tables)

2. **MATERIAL** _____
(use ARi Symbol)

ARi SYMBOL	MATERIAL
A	304 STAINLESS STEEL
C	316 STAINLESS STEEL



THERMOCOUPLE

2 Wire (4-20 MA)

Temperature Transmitter Systems

2 Year Transmitter Warranty

Temperature Transmitter Features:

- Fits into a waterproof screw cap Connection Head. Eliminates the requirements for separate junction box and mounting.
- Available for Thermocouple type calibration J, K, E, and T.
- RFI and EMI protected.
- Available with spring load thermocouple assemblies.



ARI Industries Inc

BULLETIN 6.3

OCTOBER 1996



Thermocouple Temperature Transmitter Assemblies (2-Wire 4-20MA)

STYLE TX-57

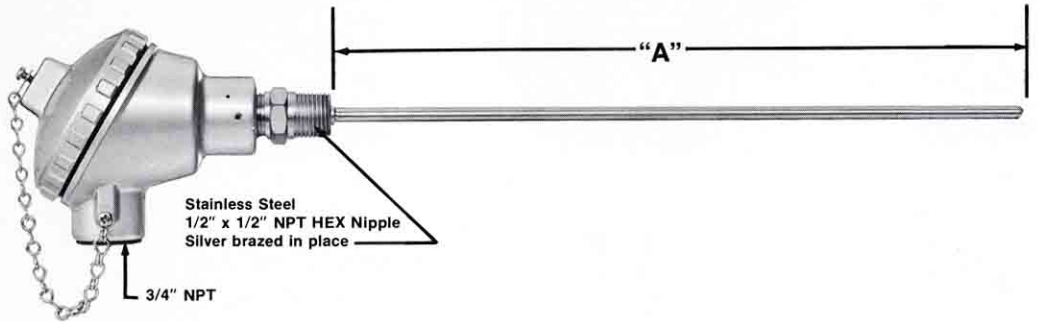
"CA" Aluminum
Connection Head

STYLE TX-457

"CI" Cast Iron
Connection Head

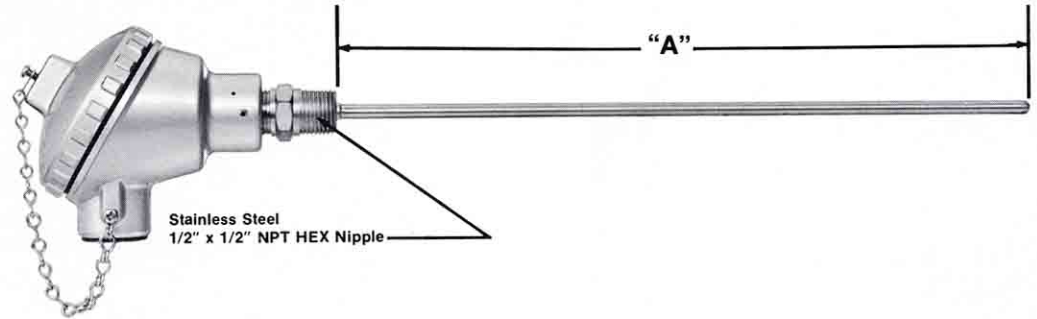
Note: TXSL-57
TXSL-457

For Spring Loaded
Fitting



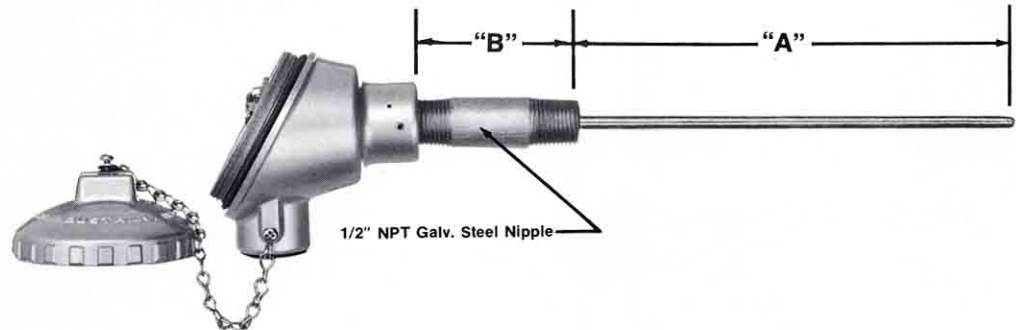
STYLE TX-50824

Spring Loaded
Connection Head
Assembly



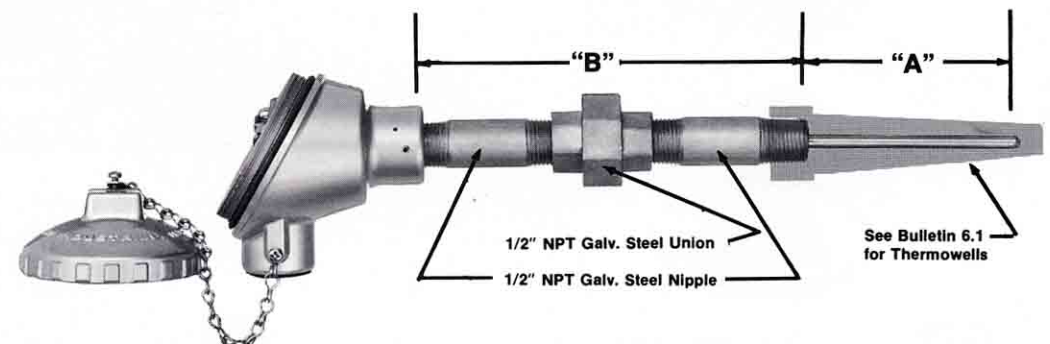
STYLE TX-50867

Spring Loaded
Connection Head
Assembly



STYLE TX-50829

Spring Loaded
Connection Head
Assembly



Thermocouple Temperature Transmitter

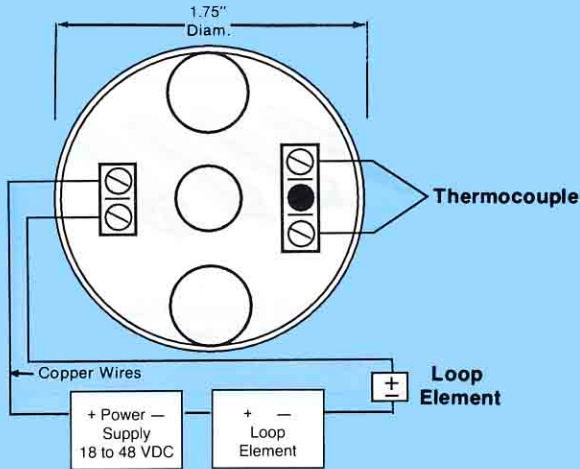


Part No. 47075

SPECIFICATIONS:

Output	4-20mA
Min. current	2.5mA
Max. current	28mA
Supply voltage	9-36 V DC
Supply voltage variation effect	Less than 0.001% for 1 volt change
Self heating effect	Less than 0.2% at max. power
Calibration inaccuracy	Less than 0.1% of input span
Linearity	Better than 0.03% of span
Trim stability	Better than 0.05%
Input adjustability	Zero — $\pm 45\%$ of span Span — $\pm 35\%$ of span
Temperature stability (drift)	Zero — better than 0.01% 1°C Span — better than 0.01% 1°C
Operating temp	-20 +70°C
Ambient storage temperature	-40 \pm 100°C
Minimum operating range span	50°C
Dimensions	1.7 inch (43mm) diameter x 1.17 inch (40mm) high
Mounting	Inside ARi Aluminum or Cast Iron Connection Head

INSTALLATION WIRING



HOW TO ORDER Temperature Transmitter:

Specify Part No. of Temperature Transmitter and indicate temperature span.

Example: Calibration K to produce 4-20MA over temperature span of 0 to 1000°F

Part No. is: **47075-K-0 to 1000°F**

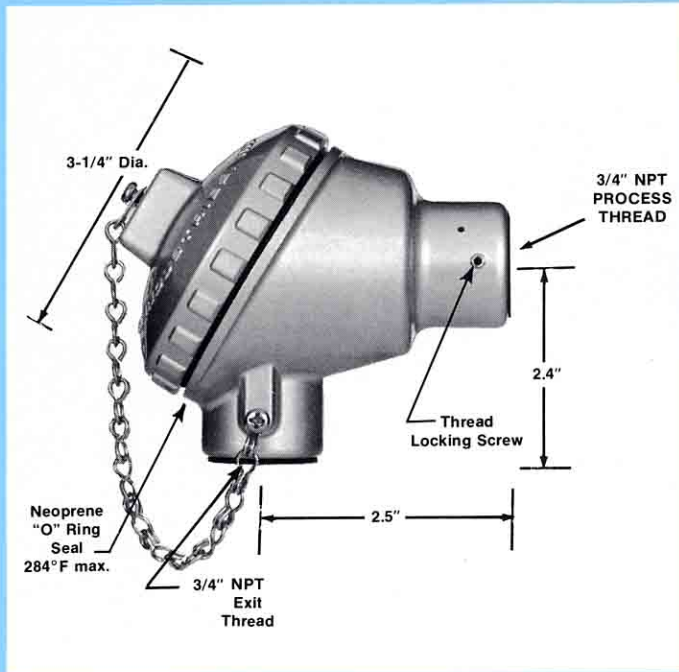
RANGE CHART

TYPE	Calib. Symbol	Range °F
Iron/Constantan	J	32-1400°F
Chromel/Alumel ¹	K	32-2000°F
Copper/Constantan	T	32-700°F
Chromel/Constantan	E	32-1600°F

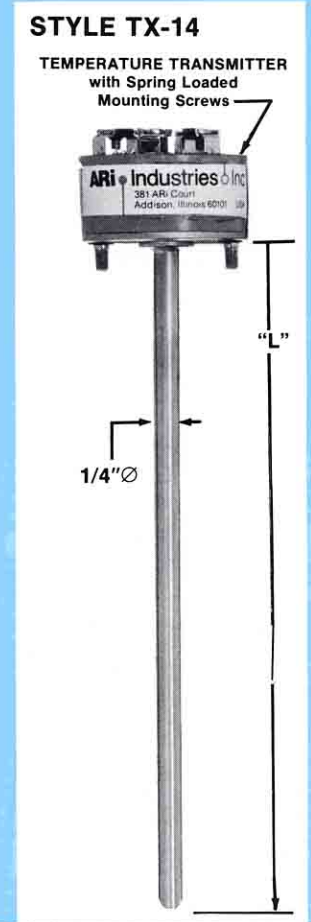
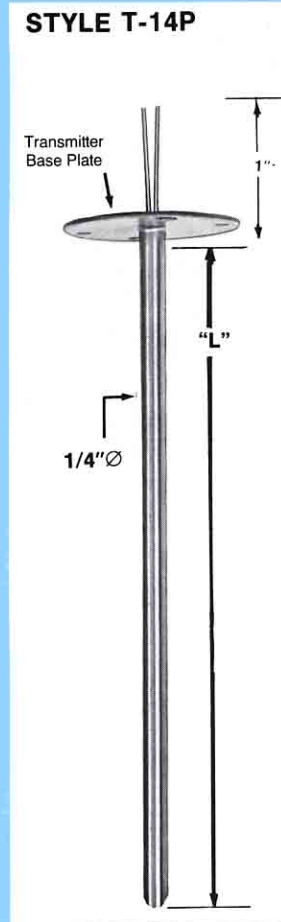
¹Trade Mark of Hoskins Mfg. Co.

Connection Head

Basic Thermocouple Insert



PART NUMBER	MATERIAL	NPT THREADS
47003	ALUMINUM	3/4" x 3/4"
47021	CAST IRON	3/4" x 3/4"
47052	ALUMINUM	1/2" x 1/2"



PROGRAMMABLE DIGITAL INDICATOR

with Transmitter Loop Power Supply

MODEL 610 PROGRAMMABLE DIGITAL INDICATOR



Model 610 is a dual purpose Digital Indicator and DC Power Supply that completes the Transmitter System both Zero and Span can be adjusted to match Transmitter temperature ranges with indicating ranges of -199.9 to +199.9 (°C or °F), or -400 to +1999 (°C or °F). Isolated 1 mv/degree analog voltage output or 2 point alarm options are available. Operates from 115V AC Line. Model 610 has resolution of 1°C or 1°F.

PANEL CUTOUT DIMENSIONS: 1.77" high x 3.625" wide x 5" deep

HOW TO ORDER:

THERMOCOUPLE ASSEMBLIES WITH TEMPERATURE TRANSMITTERS IN CONNECTION HEAD

1. Specify Part Number as follows:

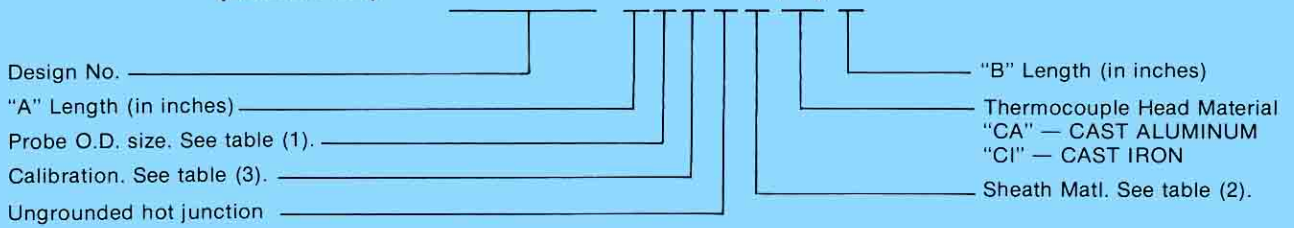
FOR STYLE T-14P, TX-14, TX-57, TX-457

(EXAMPLE): TX - 57 - 24 E K 9 C



FOR STYLE TX-50824, TX-50867, TX-50829

(EXAMPLE): TX - 50829 - 6 F K 9 C (CI) 6



- Specify temperature span for 4-20MA output at 24 VDC.
- Specify quantity and any special tests required.
- Shipped either Motor Freight or UPS depending upon weight and package size. F.O.B. Addison, Illinois.

**TABLE 1
Sheath & Wire Diameter**

Ari Symbol		D	E	F	I
Sheath Diameter	inch	.125	.188	.250	.375
	m.m.	3.17	4.75	6.35	9.52
Wire Diameter	inch	.025	.036	.045	.072
	m.m.	.64	.91	1.14	1.83

**TABLE 2
Sheath Material**

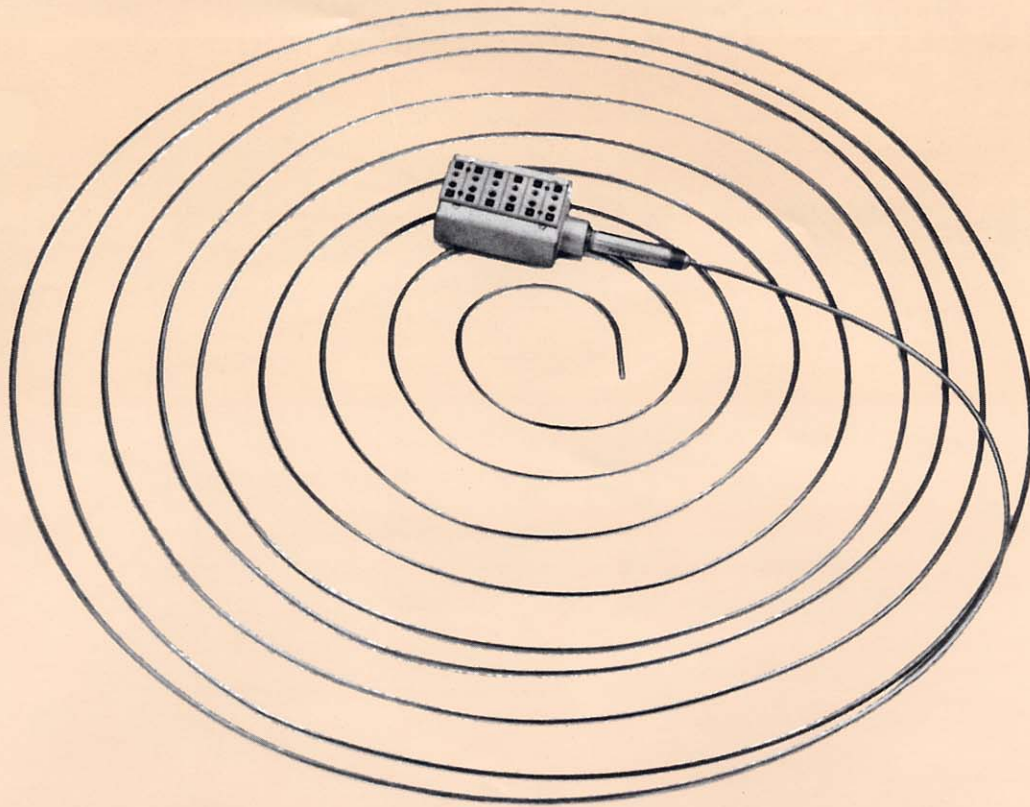
Ari Symbol	Sheath Material
B	Inconel 600*
A	AISI 304 ST/ST
C	AISI 316 ST/ST

*Trademark of International Nickel Corp.

**TABLE 3
Thermocouple Wire Calibration**

CALIBRATION*	ASTM E-230 SYMBOL	APPROXIMATE SIMILAR CALIBRATIONS
Chromel P-Alumel (1)	K	BS 1827, DIN 43710, NFE 18-001, JIS-C1602
Iron-Constantan	J	BS 1829, NFE 18-001
Chromel P-Constantan (1)	E	---
Copper Constantan	T	BS 1828, DIN 43710, NFE 18-001, JIS-C1602

(1) Registered Trademark of Hoskins Mfg. Co.
 *All calibrations are to standard limits of error.



Multilevel Temperature Profiling Assembly

US Patents 3,280,627; 3,302,458; 3,144,507; others pending

made with Aeropak®
Thermocouple Cable



- ARI® can now offer multiple element assemblies small enough to replace single point thermocouples. Also, large multiple element assemblies to replace expensive thermowells. It is now possible to insert a multicouple assembly directly into a pressurized process chamber with minimum flow restriction and a response time that is measured in seconds. This fast response time will allow detection of abnormal process temperature conditions - before damage can occur.
- Multiple level temperature sensor. Measuring junctions spaced to provide continuous temperature profiles under extreme process applications.
- Sensing end on fast response sensor may be formed or snaked around offsets.
- Withstands external pressures: 1/8" - 3000 psig, 1/2" - 4000 psig
- Sheath may be welded or brazed in place, or installed with a single compression fitting.
- Available with:
 - Type "J" for -300 to 1,000°F (-184 to 540°C)
 - Type "K" for 32 to 1,800°F (0 to 980°C)
 - Type "E" for -400 to 1,800°F (-240 to 980°C)
- Individual thermocouple circuits may either be fully insulated from each other or with junctions grounded to inner sheaths for faster response.
- Can be installed into existing thermowells or into fast response protection tubes.
- Ultra-fast time responses for critical process protection. Time constant of 3 seconds at 3 m/s water velocity can be attained with miniature .125 in. (3.18 mm) diameter assembly.
- Multiple element thermocouple assemblies are used to obtain continuous temperature data at preselected points. Previous approaches required installation of a number of thermocouples into rather large thermowells.
- Can be moved through an offset in instrument guide tubes to obtain temperature profile of vessel.

ARI is a Registered U.S. Trademark

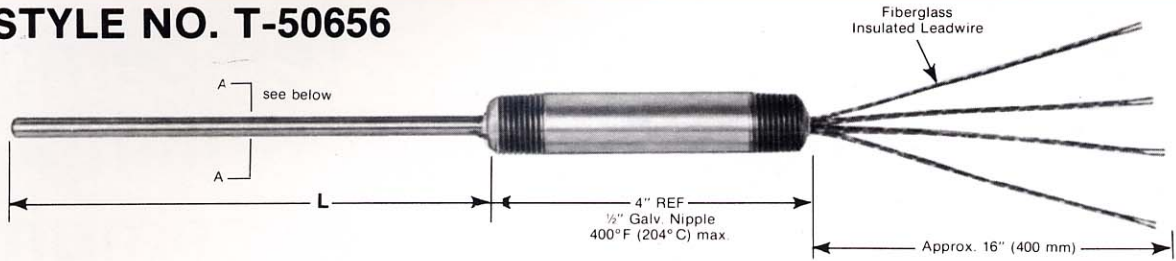
ARI Industries Inc

BULLETIN 7.3
August 2002

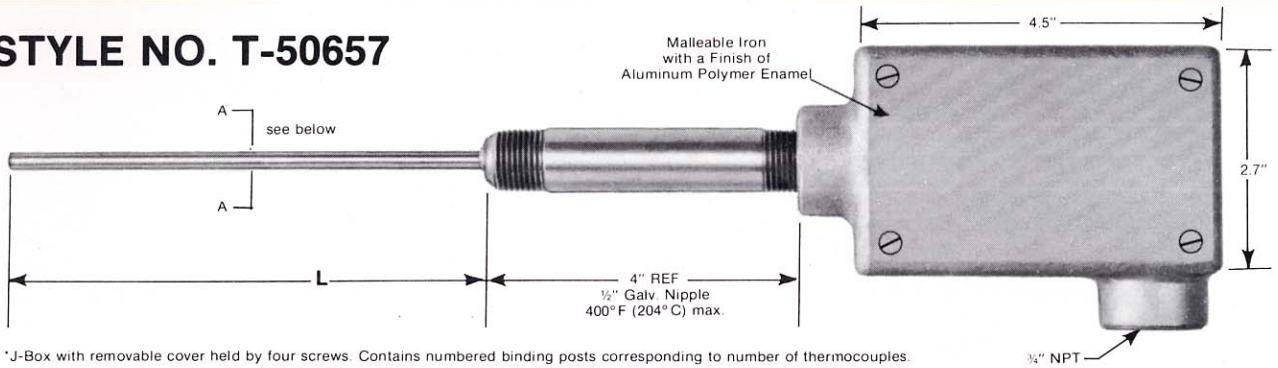
TYPICAL CONSTRUCTION

Fast Response Multilevel Probe

STYLE NO. T-50656

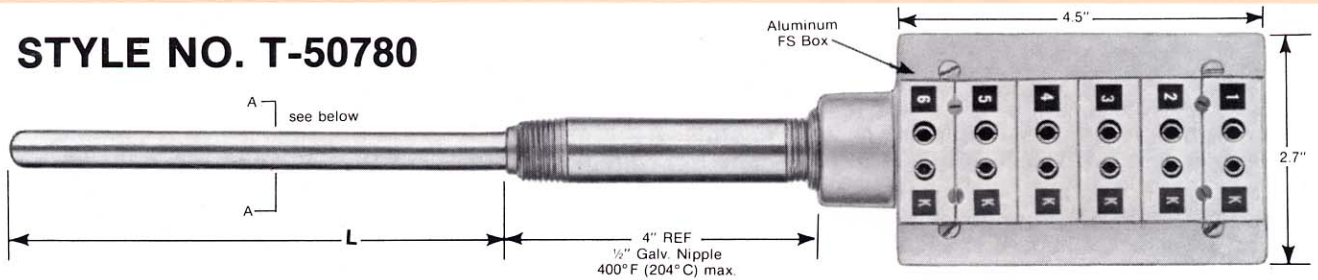


STYLE NO. T-50657

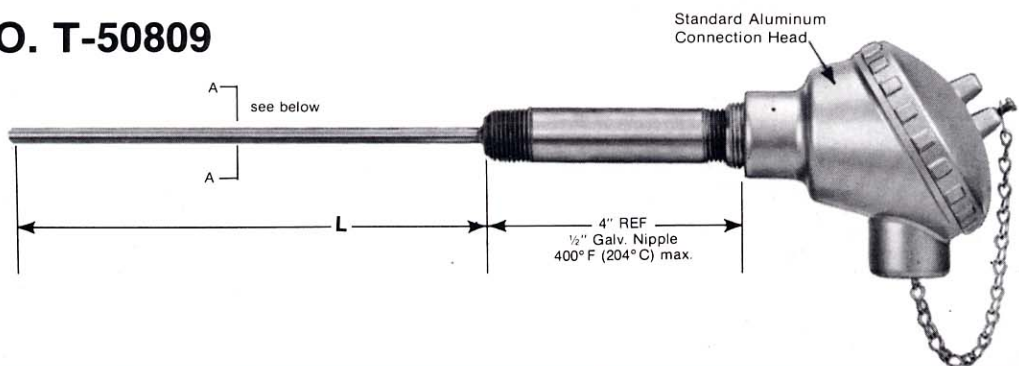


*J-Box with removable cover held by four screws. Contains numbered binding posts corresponding to number of thermocouples.

STYLE NO. T-50780



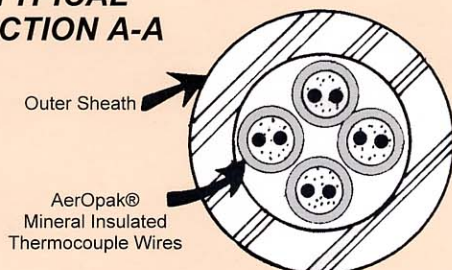
STYLE NO. T-50809



Note: Other Termination Designs are available per your requirement.

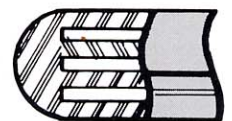
JUNCTIONS

TYPICAL SECTION A-A



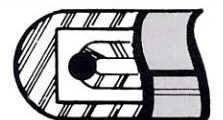
#8

GROUND
HOT
JUNCTION



#9

INSULATED
HOT
JUNCTION



SPECIFICATIONS:

STYLE	T-50656		T-50657 & T-50780		T-50809	
OUTER DIAMETER*	0.125" ± .002" (3.18 mm)	0.500" ± .005" (12.7 mm)	0.125" ± .002" (3.18 mm)	0.500" ± .005" (12.7 mm)	0.125" ± .002" (3.18 mm)	0.500" ± .005" (12.7 mm)
TRANSITION SECTION	1/2" NPT NIPPLE x 4" Long (102 mm)	1/2" NPT NIPPLE x 4" Long (102 mm)	1/2" NPT NIPPLE x 4" Long (102 mm)	1/2" NPT NIPPLE x 4" Long (102 mm)	1/2" NPT NIPPLE x 4" Long (102 mm)	1/2" NPT NIPPLE x 4" Long (102 mm)
LENGTH RANGE (L)	6" to 240" ±1" Tolerance (152-6096 mm)	12" to 240" ±1" Tolerance (305-6096 mm)	6" to 240" ±1" Tolerance (152-6096 mm)	12" to 240" ±1" Tolerance (305-6096 mm)	6" to 240" ±1" Tolerance (152-6096 mm)	12" to 240" ±1" Tolerance (305-6096 mm)
MAX. PRESSURE AT 100°F	3000 psig	4000 psig	3000 psig	4000 psig	3000 psig	4000 psig
TIME CONSTANT τ at 3 MPS Water velocity (grounded junction)	3 Seconds	10 Seconds	3 Seconds	10 Seconds	3 Seconds	10 Seconds
WEIGHT per UNIT LENGTH	.03 Lb./Ft. .045 Kg/M	0.45 Lb./Ft. .675 Kg/M	.03 Lb./Ft. .045 Kg/M	0.45 Lb./Ft. .675 Kg/M	.03 Lb./Ft. .045 Kg/M	0.45 Lb./Ft. .675 Kg/M
MINIMUM BENDING Radius for (L) Section to avoid a Permanent Set	0.5" (12.7 mm)	12" (304.8 mm)	0.5" (12.7 mm)	12" (304.8 mm)	0.5" (12.7 mm)	12" (304.8 mm)
NUMBER OF POINTS AVAILABLE Note: Junction equally spaced or provided with locations per customer requirements.	2 to 18	2 to 18	2 to 4	2 to 6	2 to 3	2 to 3

*Available in intermediate sizes on special order. Consult Factory.

MAXIMUM OPERATING TEMPERATURES

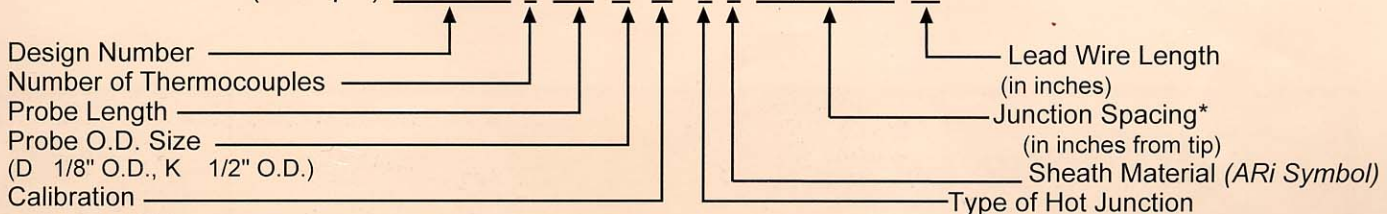
MAXIMUM TEMPERATURE	°F	1000	1600	1800
	°C	540	871	980
THERMOCOUPLE CALIBRATION Per ASTM E-230-81 (standard limits of error)		J	K E	K E
OUTER SHEATH MATERIAL	ARi Symbol "A" (304 ST/ST) "B" (Inconel 600)** "C" (316 ST/ST) "F" (347 ST/ST)	304 ST/ST INCONEL 600** 316 ST/ST 347 ST/ST	304 ST/ST 316 ST/ST 347 ST/ST	INCONEL 600**

The effect of corrosion on outer sheath should be considered as a modifying factor for this table.

*Reg. T.M. of Hoskins Mfg. Co. **Reg. T.M. International Nickel Co.

EXPLANATION OF PART NUMBER:

(example) **T- 50656.4-120 D K 8 B 12, 14, 20-16**



*Note when Junctions are to be equally spaced, indicate First Number (in inches) from Tip.

HOW TO ORDER

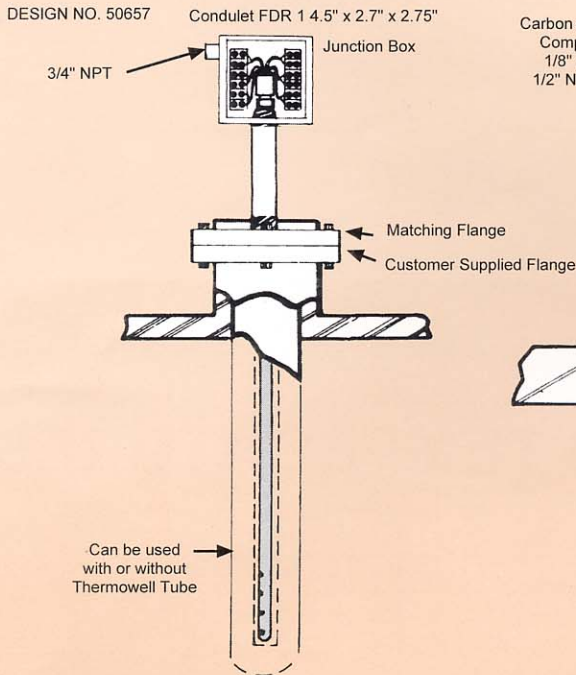
1. Generate Part Number as described under "Explanation of Part Number."
2. Specify quantity and any special tests if required.
3. Shipped by Motor Freight or UPS, insured, depending upon size and weight.
4. Shipping form. Shipped straight for lengths of 120 inch (3050mm). Longer lengths will be shipped coil (unless requested otherwise) as follows:

Sheath Dia., inch (mm)
 0.125 (3.18)
 0.500 (12.7)

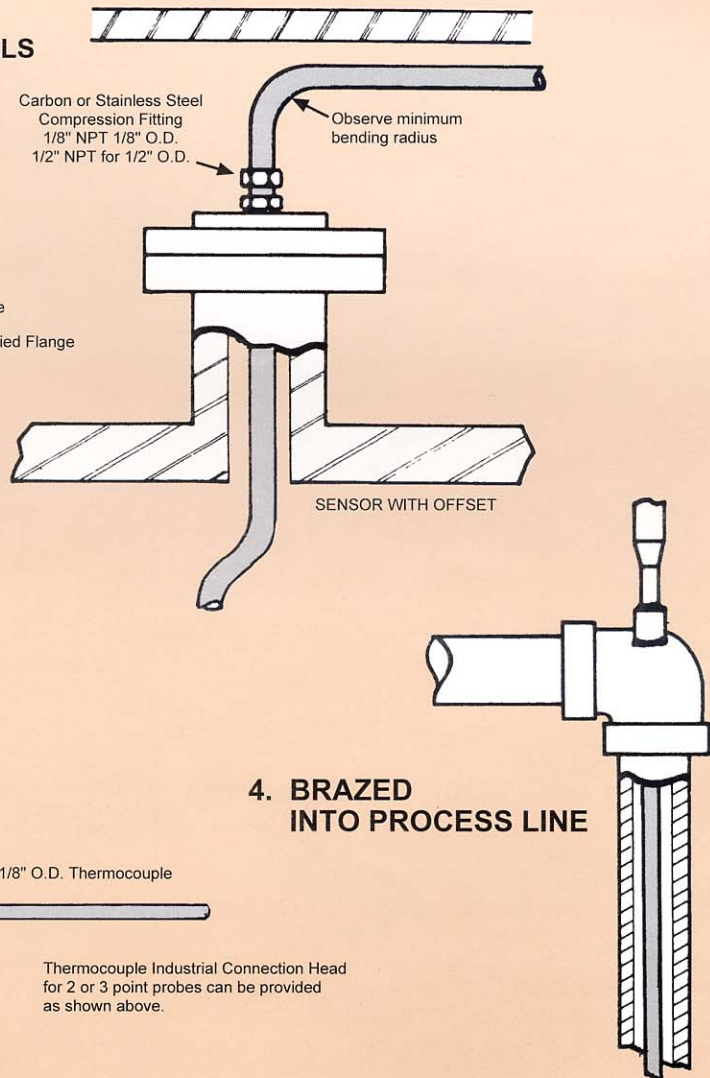
Coil Dia., inch (mm)
 48 (1,220)
 96 (2,400)

Application Notes:

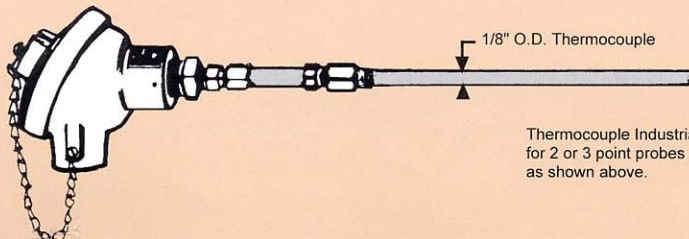
1. TO REPLACE SINGLE POINT SENSORS IN EXISTING THERMOWELLS



2. INSTALLED IN A LOW CLEARANCE LOCATION

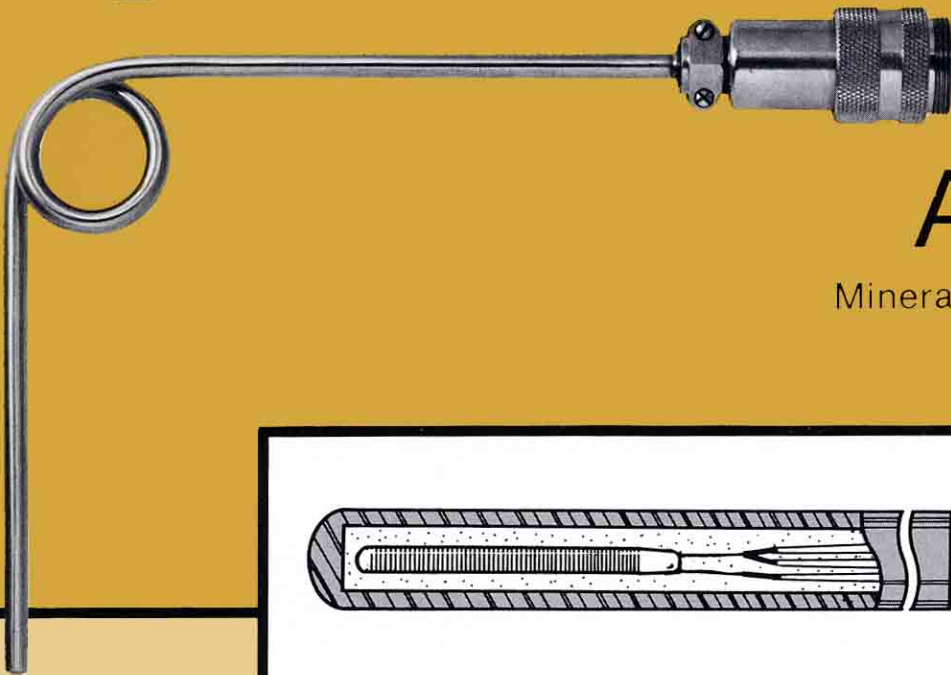


3. FAST RESPONSE UNIT PROTECTION TUBE



4. BRAZED INTO PROCESS LINE

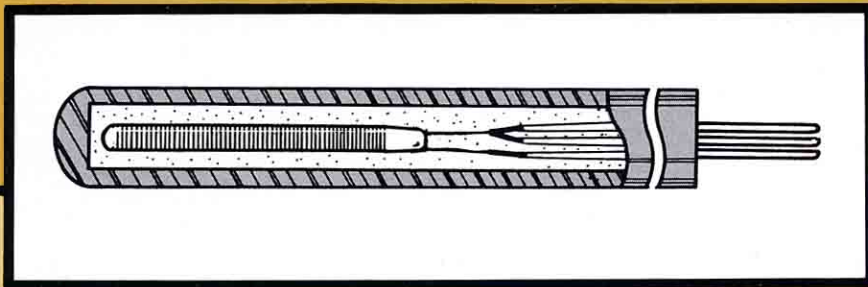
Thermocouple Industrial Connection Head for 2 or 3 point probes can be provided as shown above.



RESISTANCE
TEMPERATURE
DETECTORS

ARiDET®

Mineral Insulated RTD Elements



FEATURES

- Time Constant of 2.2 sec and less
- Temperature Range: -200 to +600°C (-320 to +1110°F)
- Pressure Range: Vacuum to +50,000 psia
- Shock Resistance to 1000G in all 3 axis
- Withstand vibration of +50G, 60 to 2000 Hz
- Accuracy: ± 0.1 ohm @ 0°C ($\pm 0.1\%$ for 100 Ω)
- Reproducibility: $\pm 0.1\%$ of resistance for 100 Ω element
- Very long lengths. Entire length can be exposed to high temperature
- Available with 4-20 ma temperature transmitter/amplifier
- Superior Corrosion Resistance with low carbon 316 ST/ST sheaths
- Can be sharply bent with no change in performance.

LABORATORY ACCURACY WITH INDUSTRIAL RUGGEDNESS

Platinum resistance thermometers are used for interpolation between the IPTS-68 fixed temperature points of ice and antimony (0°C to 630.74°C), generally used where accuracy and stability are most important.

The ARiDET® approach to RTD's will bring $\pm 0.05^\circ$ laboratory accuracy to the toughest industrial process — without special handling considerations. **ARI INDUSTRIES, INC.** has combined the inherent accuracy of a precisely wound Platinum Resistance element with Aeropak® compacted ceramic insulated cable. The result is a low cost yet rugged sensor that will take factory handling — retaining the stability needed for today's process control.

Available with either the 99.999% high purity JIS C-1604-81 or 99.99% DIN 43760 temperature vs resistance curve.

See temperature vs resistance tables for how to obtain laboratory accuracy.

ARI is a Registered US Trademark Protected by US Patents 3,032,444; 3,048,641; 3,625,775; 3,144,507; 2,994,733 and 4,087,775. In Canada Patent No. 1040456 In UK Patent No. 1564175

ARI Industries Inc

BULLETIN 8.0

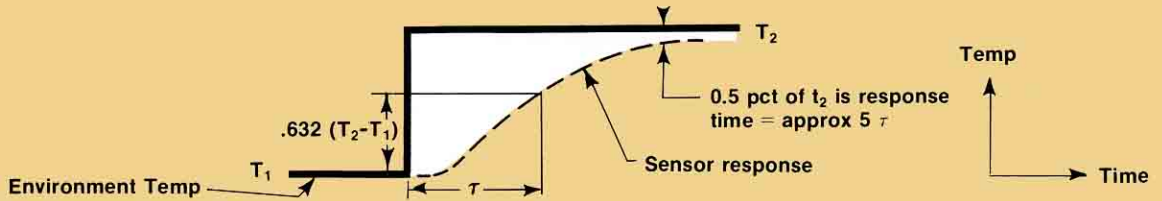
MAY 1996

TIME RESPONSE CHARACTERISTICS

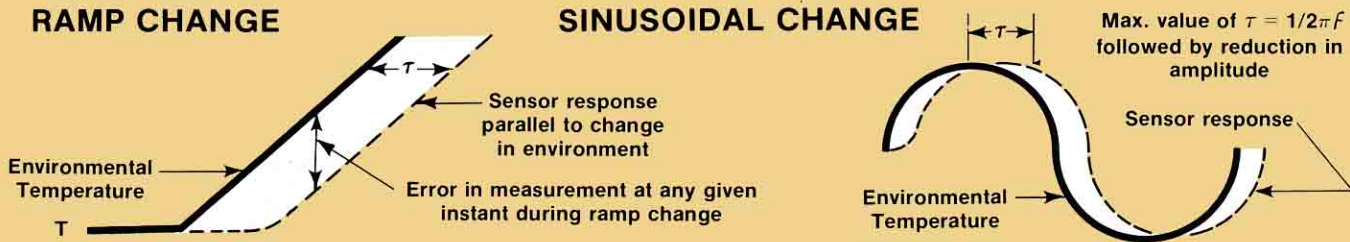
The response of an ARi Resistance Temperature Detector is defined by two notable characteristics when exposed to an instantaneous (step) change in environment temperature. These are:

- Time Constant (τ). The time to reach 63.2 pct of the complete step change in temperature.
- Response Time. Time to reach within 0.5 pct of final temperature in a step change. This is approximately equal to 5 times the Time Constant.

The response of a temperature sensor to a step change in environment temperature tends to follow a second order differential equation. However, this is approximate, since if the mass of the sensor is small in relation to the mass of the fluid passing over it (such as in the case of a liquid), the response may approach a first order differential equation. A typical response is as follows:



Time Constant has application for more common experiences in process control, ie, ramp change or sinusoidal changes in environmental temperature. The response of a sensor under these conditions are:



Time constant is related to the environmental conditions by the following approximate relation (Ref NASA TN 2599)

$$\tau = f \frac{(D)^{1.5}}{(\rho V)^{0.5}}$$

Where D = Diameter of sensor
 ρ = Density of fluid or gas
 V = Velocity of fluid

Knowing the time constant (τ) for a given sensor at one given set of conditions, it can be computed for another set of conditions.

Time constant data for ARi ARiDET® Resistance Temperature Detectors are as follows:

Condition 1 In water at a flow rate of 3 ft per second and $T_2 - T_1 = 190^\circ\text{F}$, perpendicular to axis of sensor.

SENSOR DIAM, inches	0.125	.188	.250
TIME CONSTANT, sec.	0.8	1.6	2.2

Condition 2 In air at a flow rate of 65 ft/sec and density of 0.769 lb/ft³. Mass velocity of 5 lbm/ft² sec and $T_2 - T_1 = 61^\circ\text{F}$. Flow perpendicular to axis of sensor.

SENSOR DIAM, inches	0.125	.188	.250
TIME CONSTANT, sec	7.5	14.5	20.5

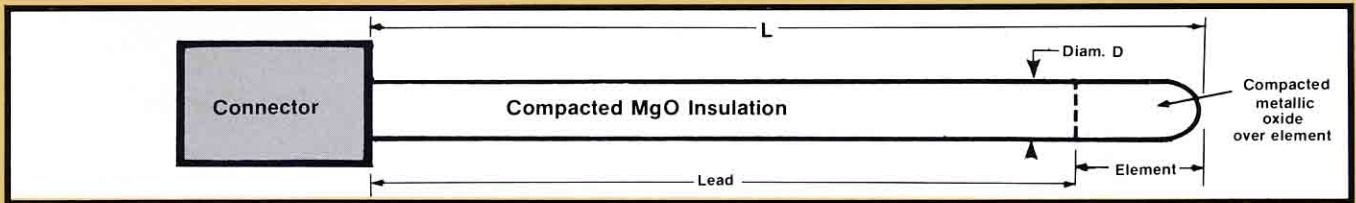
SELECTION/MATCHING

Completed probes may be matched in pairs to the nearest 0.01 ohm at 0°C for differential temperature measurements to 0.05°C.

Completed probes may be supplied with selected ice point resistances within a narrow band to eliminate the need for compensation in indicating circuits.

SPECIFICATIONS

ARi ARiDET® consists of a specially installed platinum resistance element completely encased in compacted metallic oxide insulation of high thermoconductivity to insure minimum temperature differential between the sensor surface and the element. Standard sensors have 3 constantan equi-resistance lead wires in lead portion with compacted MgO insulation. Sheath material is 316 L st/st in fully annealed condition. Performance specifications are shown for the element portion and the lead portion.



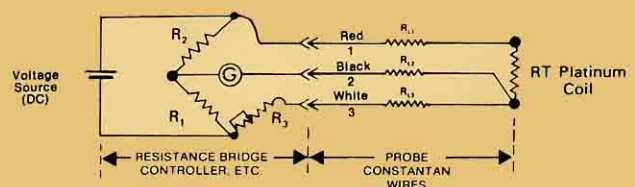
	LEAD	ELEMENT
Accuracy		±0.01 ohm at 0°C
Stability <i>Maximum ice point shift after long term thermal cycling</i>		-130 to +93°C ±.05% -130 to 315°C ±.10% 315 to 600°C ±.5%
Temperature Range	-250 to +1000°C	-200 to +600°C
Measuring Current		10 milliamps DC max
Vibration Shock	Vibration: ±50G, 60 to 2000 Hz Shock: 1000G Along all three mutually perpendicular axes when correctly mounted.	
Temp/Res. Curve (0 to 100°C)		0.00385Ω/Ω/°C per DIN 43760 0.003916Ω/Ω/°C per JIS C 1604-81
Individual Calib.		To nearest ±0.01 ohm @ 0°C
Self Heating Error		Less than 0.02°C/MW
Max. External Pressure	50,000 psi (3510 Kg/cm ²)	
Stock Length L	24 inch (610 mm)	

SENSOR PARAMETERS			
Diameter, inch (mm)	0.125 (3.18)	0.188 (4.78)	0.250 (6.35)
Temp. sensitive length, inch (mm)	1.1 (28.0)	1.1 (28.0)	1.1 (28.0)
Bending Restriction, Distance from tip to be left straight, inch (mm)	2.1 (53.3)	2.1 (53.3)	2.1 (53.3)
Minimum Bending Radius, inch (mm)	0.5 (12.7)	0.75 (19.0)	1.0 (25.4)
Maximum length feet (meter)	700 (213)	300 (91)	175 (53)
Minimum length inch (mm)	4 (102)	4 (102)	4 (102)
Constantan 3 wire leads, resistance in ohms per inch-each wire	0.061	0.025	0.015

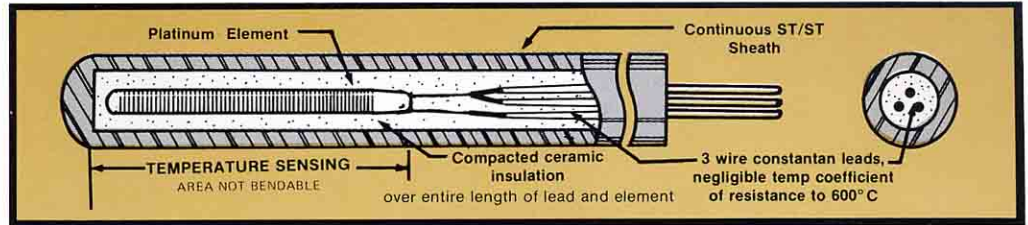
TYPICAL 3 WIRE MEASURING CIRCUIT FOR RTD'S

A 3-wire system may be used to eliminate the effect of lead wire resistance changes by introducing R_L (lead wire resistance) into each leg of a bridge. The third lead wire is added to the detector circuit without affecting bridge balance. The resultant circuit is sensitive only to resistance element temperature changes.

$R_{L1} = R_{L2} = R_{L3}$ (Lead Wire Resistance)
 $R_1 = R_2$
 $R_3 =$ Variable Resistance, Equal to RT Range
 $G =$ Galvanometer



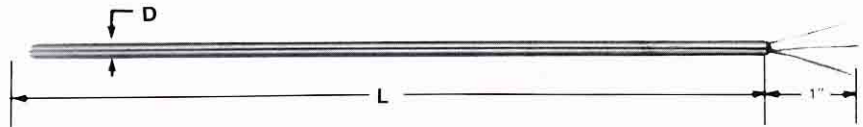
UNIQUE
ARiDET®
CONSTRUCTION



MINERAL INSULATED ARiDET® RTD SENSORS

Style PRT-14.3

Basic unit, constantan wires bared for direct attachment to terminals.



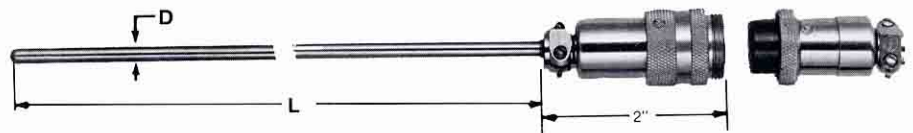
Style PRT-22.3

Teflon insulated and shielded lead wires attached to basic probe, epoxy potting compound, U.S. Patent 3,144,507 strain relief.



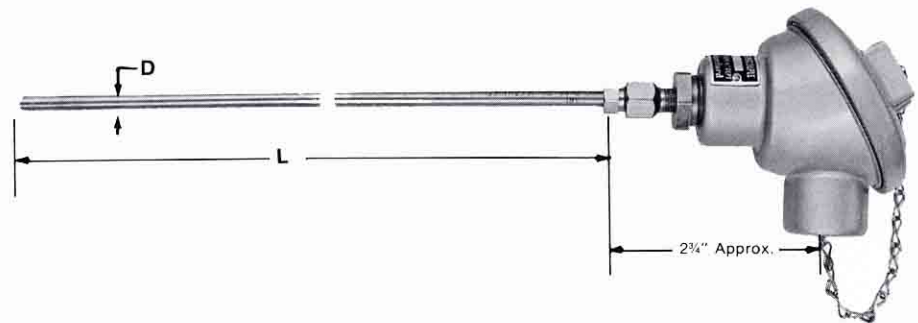
Style PRT-90.3

with quick disconnect
Sealed, vibration resistant connector with extra pin for shielding, mate supplied overall connector length 3.25" when mated.



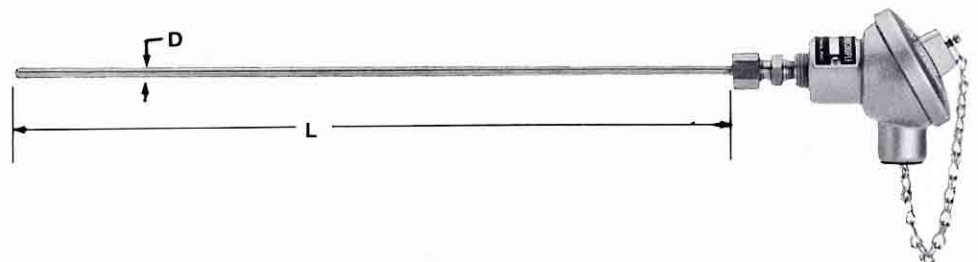
Style PRT-96.3

with standard size connection head
Industrial weatherproof aluminum head with internal screw terminals 3/4" NPT exit thread for hard wiring.



Style PRTX-96.3

with temperature transmitter.

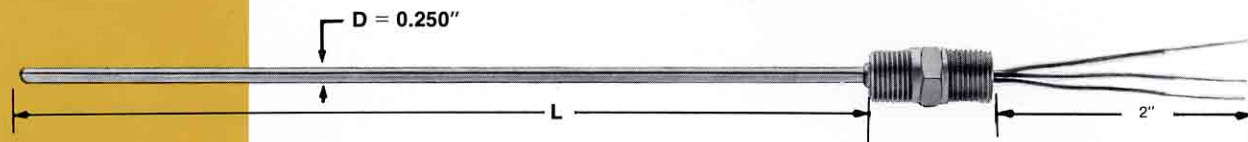


Style PRT-50733.3

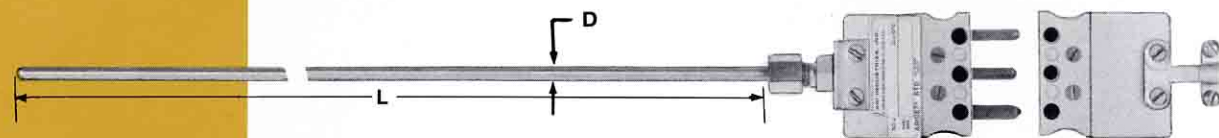
with miniature size connection head
Miniature weatherproof Aluminum Connection head with internal screw terminals. 1/2" NPT exit thread for hard wiring.



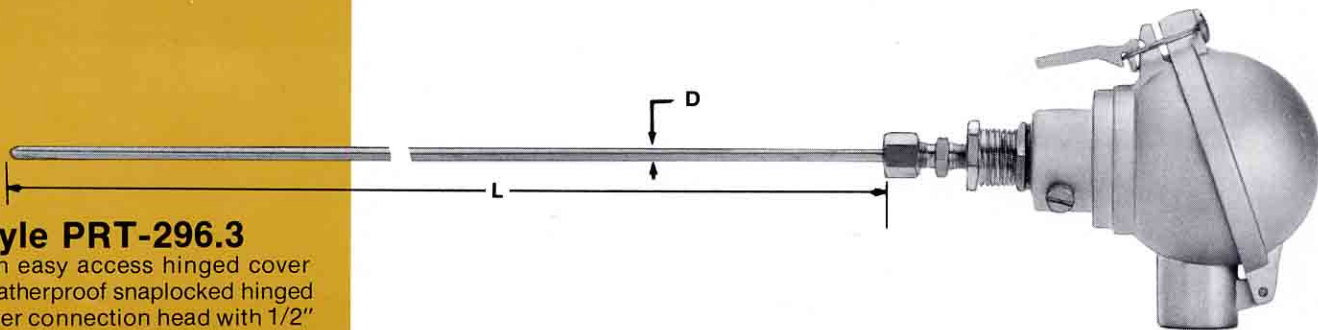
Style PRT-52400.3
with fixed hex nipple
Replacement element with 1/2"
NPT hex nipple silver brazed to
sheath.



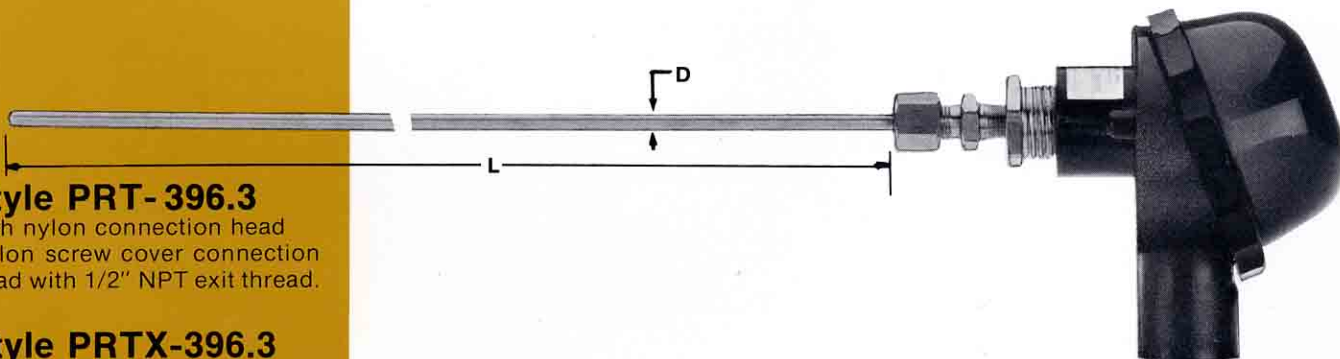
Style PRT-50735.3
with spring loaded Hex Nipple
Replacement element with 1/2"
NPT hex nipple spring loaded.



Style PRT-91.3
with 3 prong quick disconnect
Quick disconnect and mate.



Style PRT-296.3
with easy access hinged cover
Weatherproof snaplocked hinged
cover connection head with 1/2"
NPT exit thread.

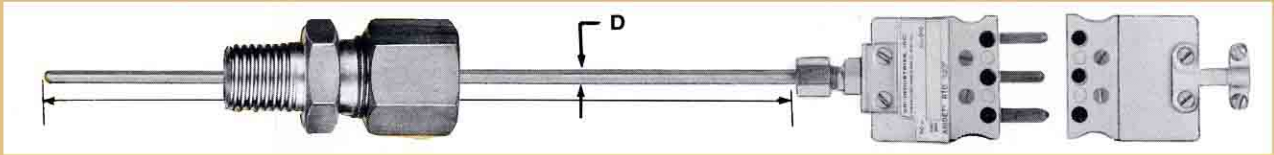


Style PRT-396.3
with nylon connection head.
Nylon screw cover connection
head with 1/2" NPT exit thread.

Style PRTX-396.3
with temperature transmitter

INSTALLATION ACCESSORIES

Pressure or Vacuum Tight Applications

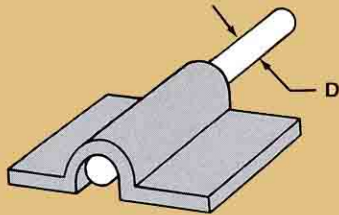


COMPRESSION FITTINGS

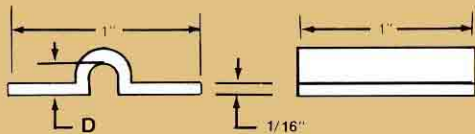
300 series stainless steel with 1/8" NPT thread for setting immersion and pressure tight entry into vessels, process lines, etc. Useable to 4000 psi differential pressure.

Diam. D, inch	0.125	.188	.250
Part Number	PTM-D2SS	PTM-E2SS	PTM-F2SS

SURFACE OR PIPE MEASUREMENTS

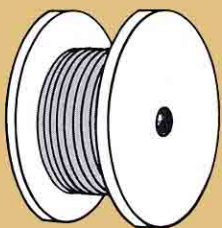


300 series st/st clamp that can be welded, brazed, spot welded or glued to the surface of the item being measured. The wide tabs insure adequate heat flow between the sensor and measured object to keep conduction errors at a minimum.



Diam. D, inch	0.125	.188	.250
Part Number	490999-D	490999-E	490999-F

3-CONDUCTOR LEAD WIRE



PART NO. 012529

3 Conductor stranded Nickel 20 ga. Teflon over each with tinned copper braid overall and teflon wrap overall. Color coded, 2 black, 1 red.

TEMPERATURE TRANSMITTERS

Spring Loaded

PART NO. 47041

fits T-96.3, T-296.3, T-396.3

Specify calibration and span



HOW TO ORDER

ARiDET® RTD's are available in three diameters.

Diam. D, inch	0.125	.188	.250
ARi Symbol	D	E	F

Elements made with 100Ω at 0°C and two calibrations.

Calibration Ω/ Ω/ °C	0.00385	0.003916
ARi Symbol	100 DIN	100

1. Establish Part Number:

STYLE — L D CALIB.

Select Style
from Pages 4 or 5

Length in inches
stocked lengths are 24"
(min. length is 4")

Use ARi Symbol from
above for calib.

Use ARi Symbol from
above for Diameter

2. Specify quantity and any special tests.
3. Specify installation accessories and quantity.
4. If temperature transmitter is required to produce 4-20ma with 24VDC excitation, use Style PRTX. Specify span. See ARi Bulletins on temperature transmitters for standard spans.
5. Shipped by UPS, insured or motor freight, insured.

TEMPERATURE VS RESISTANCE DATA IN °F

**TEMPERATURE COEFFICIENT OF .003916Ω/Ω/° C.
REF. JIS-C-1604-81**

100 OHMS AT 32° F					FUNDAMENTAL INTERVAL 39.16 OHMS													
F	-300	-200	-100	0	F	0	100	200	300	400	500	600	700	800	900	1000	1100	°F
-0	24.08	47.53	70.52	92.93	0	92.93	114.93	136.59	157.88	178.81	199.37	219.58	239.44	258.92	278.05	296.76	315.14	0
-10	21.71	45.20	68.26	90.70	10	95.13	117.11	138.73	159.99	180.88	201.41	221.59	241.40	260.85	279.95	298.61	316.97	10
-20	19.23	42.96	66.00	88.47	20	97.35	119.29	140.87	162.09	182.95	203.44	223.58	243.36	262.78	281.85	300.56	318.80	20
-30	16.83	40.62	63.70	86.24	30	99.56	121.47	143.01	164.20	185.02	205.47	225.57	245.32	264.70	283.66	302.31	320.63	30
-40		38.27	61.40	84.00	40	101.77	123.64	145.16	166.29	187.08	207.50	227.56	247.27	266.62	285.56	304.16		40
-50		35.91	59.10	81.77	50	103.97	125.80	147.28	168.39	189.14	209.52	229.54	249.22	268.53	287.51	305.99		50
-60		33.54	56.79	79.52	60	106.17	127.97	149.40	170.48	191.20	211.54	231.52	251.17	270.44	289.36	307.82		60
-70		31.18	54.48	77.28	70	108.36	130.13	151.53	172.57	193.25	213.55	233.50	253.13	272.35	291.21	309.65		70
-80		28.82	52.17	75.04	80	110.56	132.28	153.65	174.65	195.30	215.57	235.48	255.06	274.25	293.06	311.48		80
-90		26.45	49.85	72.80	90	112.75	134.44	155.77	176.73	197.33	217.57	237.46	256.99	276.15	294.91	313.31		90
-100		24.08	47.53	70.52	100	114.93	136.59	157.88	178.81	199.37	219.58	239.44	258.92	278.05	296.76	315.14		100
Ω/° F Ave.	.242	.234	.230	.224		.220	.217	.213	.209	.205	.202	.199	.195	.191	.187	.184	.183	

**TEMPERATURE COEFFICIENT .00385 Ω/Ω/° C.
REF. DIN 43760**

100 OHMS AT 32° F					FUNDAMENTAL INTERVAL 38.50 OHMS													
°F	-300	-200	-100	0	°F	0	100	200	300	400	500	600	700	800	900	1000	1100	°F
-0	25.1	48.38	70.95	93.01	0	93.01	114.68	135.97	156.90	177.48	197.69	217.55	237.06	256.20	274.99	293.43	311.50	0
-10	22.71	46.09	68.72	90.81	10	95.20	116.82	138.08	158.97	179.51	199.70	219.52	238.99	258.10	276.85	295.25	313.29	10
-20	20.33	43.80	66.49	88.61	20	97.38	118.97	140.18	161.04	181.55	201.69	221.48	240.92	259.99	278.71	297.07	315.07	20
-30	17.97	41.49	64.25	86.41	30	99.57	121.10	142.29	163.11	183.58	203.69	223.44	242.84	261.88	280.56	298.89	316.86	30
-40		39.18	62.00	84.21	40	101.74	123.24	144.38	165.17	185.61	205.68	225.40	244.76	263.76	282.41	300.70		40
-50		36.87	59.75	82.01	50	103.90	125.37	146.48	167.23	187.63	207.67	227.35	246.68	265.64	284.26	302.51		50
-60		34.54	57.49	79.81	60	106.06	127.50	148.57	169.29	189.65	209.65	229.30	248.59	267.52	286.10	304.32		60
-70		32.21	55.22	77.61	70	108.22	129.62	150.66	171.34	191.67	211.63	231.24	250.50	269.40	287.93	306.12		70
-80		29.87	52.95	75.39	80	110.38	131.74	152.74	173.39	193.68	213.61	233.19	252.40	271.27	289.77	307.92		80
-90		27.48	50.67	73.18	90	112.53	133.86	154.82	175.43	195.69	215.58	235.12	254.31	273.13	291.60	309.71		90
-100		25.1	48.38	70.95	100	114.68	135.97	156.90	177.48	197.69	217.55	237.06	256.20	274.99	293.43	311.50		100
Ω/° F Ave.	.237	.233	.226	.221		.217	.213	.209	.206	.202	.199	.195	.191	.188	.184	.181	.179	

TEMPERATURE VS RESISTANCE DATA IN °C

**TEMPERATURE COEFFICIENT OF .003916Ω/Ω/°C
REF. JIS C-1604-81**

100 OHMS AT 0° C			FUNDAMENTAL INTERVAL 39.16 OHMS								
°C	-100	0	°C	0	100	200	300	400	500	600	°C
-0	59.79	100.00	0	100.00	139.16	177.14	213.95	249.59	284.04	317.33	0
-10	55.47	96.02	10	103.97	143.01	180.88	217.57	253.09	287.43	320.59	10
-20	51.32	92.03	20	107.93	146.85	184.60	221.17	256.57	290.79	323.84	20
-30	47.16	88.02	30	111.87	150.68	188.31	224.77	260.05	294.15	327.08	30
-40	42.97	84.00	40	115.81	154.49	192.01	228.35	263.51	297.50		40
-50	38.76	79.97	50	119.73	158.30	195.70	231.92	266.96	300.83		50
-60	34.53	75.93	60	123.64	162.09	199.37	235.47	270.40	304.15		60
-70	30.27	71.87	70	127.54	165.87	203.03	239.02	273.83	307.47		70
-80	25.98	67.79	80	131.42	169.64	206.69	242.55	277.25	310.76		80
-90	21.66	63.70	90	135.30	173.40	210.33	246.08	280.65	314.05		90
-100	17.31	59.59	100	139.16	177.14	213.95	249.59	284.04	317.33		100
Ω/°C Ave.	.423	.404		.390	.380	.368	.356	.345	.333	.325	

**TEMPERATURE COEFFICIENT OF .00385Ω/Ω/°C
REF. DIN 43760**

100 OHMS AT 0° C			FUNDAMENTAL INTERVAL 38.5 OHMS								
°C	-100	0	°C	0	100	200	300	400	500	600	°C
-1	60.20	100.00	0	100.00	138.50	175.84	212.03	247.06	280.93	313.65	0
-10	56.13	96.07	10	103.90	142.28	179.51	215.58	250.50	284.26	316.86	10
-20	52.04	92.13	20	107.79	146.06	183.17	219.13	253.93	287.57	320.05	20
-30	47.93	88.17	30	111.67	149.82	186.82	222.66	257.34	290.87	323.24	30
-40	43.80	84.21	40	115.54	153.57	190.46	226.18	260.75	294.16		40
-50	39.65	80.25	50	119.40	157.32	194.08	229.69	164.14	297.43		50
-60	35.48	76.28	60	123.24	161.04	197.70	233.19	267.52	300.70		60
-70	31.28	72.29	70	127.07	164.76	201.30	236.67	270.89	303.95		70
-80	27.03	68.28	80	130.89	168.47	204.88	240.15	274.25	307.20		80
-90	22.71	64.25	90	134.70	172.16	208.46	243.61	277.60	310.43		90
-100	18.44	60.20	100	138.50	175.84	212.03	247.06	280.93	313.65		100
Ω/°C Ave.	.418	.398		.385	.373	.362	.350	.339	.327	.320	

LABORATORY ACCURACY

Each ARIDET® RTD can be supplied with an exact (±.01 ohm) resistance value obtained at 32°F (0°C). This individual calibration data can be used to obtain accuracies of ±0.05°F at 32°F and ±0.01% of resistance thruout the range.

The temperature vs resistance tables are based on a 32°F ice point resistance of 100.00 ohms (R₀). From 32°F to sensor upper limit, the RTD equation is R_t=R₀(1+At+Bt²) where R₀, A and B are constants. These temperature vs resistance tables are based on the A and B constants for the platinum wire used in place of 100.00 ohms, the tabular data can be factored to yield ±0.01% accuracy for that particular RTD sensor.

Example:

If the calibrated R₀ value is 99.89 ohms, multiply tabular values by 0.9989 to derive a corrected R vs T table. At 100°C the new value for a DIN 43760 RTD would be 138.35 ohms instead of 138.50 ohms.

MADE TO ORDER PRT ASSEMBLIES

CALIBRATION: All assemblies shown can be supplied with a different calibration and 0°C resistance value.

LENGTHS: Standard lengths for the 3 diameters is 24 inch (610mm). Longer lengths of compacted MgO insulated lead portion can be supplied up to the following:

Diameter D, inch (mm)	0.125 (3.18)	0.188 (4.78)	0.250 (6.35)
Max. length feet (meters)	700 (213)	300 (91)	175 (53)

Duplex elements at 0.250 inch diameter will be approximately same length.

DUPLEX ELEMENTS:

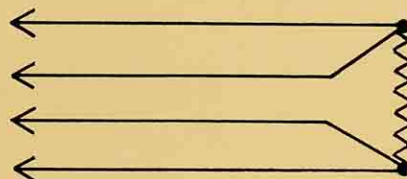
Can be supplied at 0.250 inch diameter only where suitable terminations can be made. Temperature Transmitters for Duplex circuits are not available for internal mounting in Connection Heads. The following styles can be made with Duplex Elements. Specify the 6-wire style for Duplex elements.

3-WIRE STYLE	PRT-14.3	PRT-22.3	PRT-96.3	PRT-296.3	PRT-396.3
6-WIRE STYLE	PRT-14.6	PRT-22.6	PRT-96.6	PRT-296.6	PRT-396.6

SINGLE CIRCUIT

-4 WIRE:

PRT type assemblies can be made with four leadwires with the following circuit.



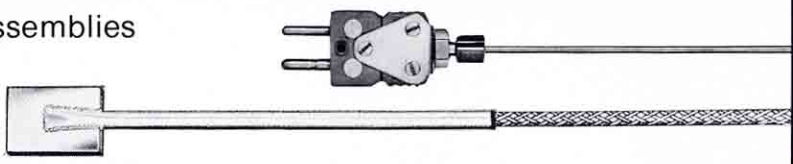
Send us your drawings/sketches for prompt quotations.

OTHER ARI PRODUCTS

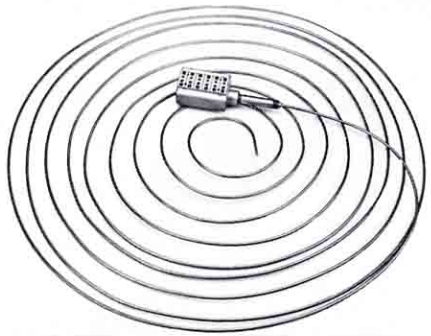
Thermowells and
Temperature Transmitters
Bulletin 6.1, 6.2, 6.3



AerOpak® Thermocouple Assemblies
Bulletin 1.0, 2.0, 3.0



Multilevel Temperature Profiling Assemblies
Bulletin 7.3



Electric Heaters
Bulletin 5.1, 5.2, 5.3



AerOpak®
Mineral Insulated Cable
Bulletin 4.0, 4.1

