



Pioneers in Precision

PLAINTIFF'S
EXHIBIT

CHV-45

LEEDS & NORTHRUP COMPANY 2442 S DOWNING ST • DENVER, COLORADO 80210 • 303 744-1047

January 9, 1970

Chevron Oil Company
P. O. Box 20002
El Paso, Texas 79998

Attention: Mr. J. E. Bimler
Purchasing Dept.

Reference: Your Order EPR-30984

Gentlemen:

We thank you for the above-referenced order. The thermocouple heads #PI-181 listed as your Item 1 are priced at \$8.50 each.

For your Item 2, we cannot supply the specified insulation on thermocouple extension wire. We suggest a wire part #16r51-2 as a substitute. This wire has asbestos insulation on each wire with asbestos braid overall, and it is priced at \$0.22 per foot. We are enclosing Data Sheet D1.1311 which gives the specifications on our extension wire, which we hope you will find useful.

We are holding your order here in the Denver Office until you advise how we should proceed on Item 2.

Very truly yours,

LEEDS AND NORTHRUP COMPANY

Rosemarie Dodrill
Customer Service

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Enc.

*NOT
ACCEPTABLE*
*TOLD SHEPPARD
1/22/70*

L&N Thermocouple Extension Wires

D1.1311 • 1968

To secure the advantages of automatic reference junction compensation, the extension wires connecting thermocouples to instruments must be of the same materials as the thermocouples, or of materials having essentially the same temperature-emf relationship over the ambient temperature range.

Extension wires are available with various insulations, chosen with a view to durability in the surroundings to which they may be exposed. The following table should provide a guide to your choice.

INSULATION CHARACTERISTICS

Upper Temp. Limit*	Lower Temp. Limit**	Insulation	Abrasion Resistance	Moisture Absorption Resistance	Remarks
500 F	- 40 F	Silicone-Impregnated Asbestos	Good up to 400 F	Good up to 400 F	Above 400 F, abrasion and moisture absorption resistance destroyed. Limited to 500 F to prevent sulphur corrosion.
500 F	+ 32 F	Asbestos, Moisture- and Heat-Resistant Compound	Fair up to 250 F	Good up to 250 F	Above 250 F, moisture-absorption resistance permanently destroyed. Limited to 500 F to prevent sulphur corrosion.
475 F	- 90 F	Extruded Teflon	Excellent	Excellent	Above 600 F, tends to give off small amounts of noxious vapor. Resistant to most acids and vapors. Material will soften above 480 F.
250 F	- 40 F	Extruded Nylon (Type 103)	Excellent	Good	General purpose, except for some chemical applications; should not be used in water, or high humidity.
220 F	0 F	Polyvinyl Chloride (105 C)	Very Good	Excellent	General purpose. Material will soften and flow above 225 F.
200 F	0 F	Cotton, Silk, or Enamel	Fair	Enamel: Excellent	Becomes brittle and eventually disintegrates above 212 F.
195 F	- 40 F	Neoprene (90 C)	Excellent	Very good	Very good resistance to oil.
165 F	- 65 F	Heat-Resistant Rubber	Very Good	Very Good	Provides good insulation when subject to temperature, but eventually becomes hard and brittle. Not resistant to oil.
165 F	- 40 F	Buna S	Very Good	Very Good	
150 F	- 40 F	Lead Sheath	Good	Excellent	Resistant to water and corrosive fluids which do not attack lead.
200 F	- 40 F	Rayon, Cellulose Acetate Lacquer	Good	Good	Used as protective braid.

*For some materials heat causes softening, for others, embrittlement. Materials listed will withstand higher, short-term temperatures than those shown; the upper limit is a relative figure at which continuous, long-term operation may be expected.

**Low temperatures cause insulating material to stiffen and become less flexible. Insulations listed will withstand much lower temperatures than those shown, providing the wires are not flexed; this limit is a relative figure at which the wire can be considered flexible.

EXTENSION WIRES

Duplex . . . Stranded Conductors

Thermocouple	Extension Wires	Insulation		AWG	ISA Code	Wire Number
		On Each Conductor	Overall			
Platinum-Rhodium, Platinum	Copper and #11 Alloy	Enamel, Asbestos	Asbestos Braid	16	SX16H	16-60-1*
		Heat-Resistant Rubber	Buna S or Polychloroprene	18	—	18-60-7*
Iron-Constantan	Iron and Constantan	Enamel, Asbestos	Asbestos Braid	16	JX16H	16-51-4*
Chromel-Alumel**	Chromel and Alumel	Enamel, Asbestos	Asbestos Braid	16	KX16H	16-59-3*

*Stocked in "packaged" quantities. See back page.

**Tradenames of Hoskins Mfg. Co.

LEEDS & NORTHRUP COMPANY *Pioneers in Precision*

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Duplex . . . Solid Conductors

Thermocouple	Extension Wires	Insulation		AWG	Approx. Dimensions (Inches)	ISA Code	Wire Number
		On Each Conductor	Overall				
Platinum-Rhodium, Platinum	Copper and #11 Alloy	Enamel, Asbestos	Asbestos Braid	16	$\frac{5}{16} \times \frac{13}{16}$	SX16H	16-60-2*
		Heat-Resistant Rubber	Weatherproof Braid	16	$\frac{13}{16} \times \frac{5}{16}$	—	16-60-3*
Iron-Constantan	Iron and Constantan	Enamel, Asbestos	Asbestos Braid	16	$\frac{5}{16} \times \frac{13}{16}$	JX16H	16-51-2* ¹
		Polyvinyl	Polyvinyl, Lead Sheath	16	$\frac{9}{16} \times \frac{1}{4}$	JX16L	16-51-3
		Polyvinyl	Polyvinyl	16	$\frac{11}{16} \times \frac{1}{4}$	JX16M	16-51-15*
		Polyvinyl	Nylon	16	$\frac{7}{16} \times \frac{3}{16}$	—	16-51-16* ¹
Chromel-Alumel	Chromel and Alumel	Enamel, Asbestos	Asbestos Braid	16	$\frac{5}{16} \times \frac{13}{16}$	KX16H	16-59-2*
		Polyvinyl	Polyvinyl, Lead Sheath	16	$\frac{9}{16} \times \frac{1}{4}$	KX16L	16-59-4
		Polyvinyl	Polyvinyl	16	$\frac{11}{16} \times \frac{1}{4}$	KX16M	16-59-16*
Copper-Constantan	Copper and Constantan	Enamel, Asbestos	Asbestos Braid	16	$\frac{5}{16} \times \frac{13}{16}$	TX16H	16-56-2* ¹
		Polyvinyl	Polyvinyl, Lead Sheath	16	$\frac{9}{16} \times \frac{1}{4}$	TX16L	16-56-3
		Polyvinyl	Polyvinyl	16	$\frac{11}{16} \times \frac{1}{4}$	TX16M	16-56-18* ¹

*Stored in "packaged" quantities. See back page.

¹For stored conductors selected to special limits of error (see table below), add suffix "A". Other conductors can be similarly selected at additional charge.

Multi-Conductor Extension Wire Cables. Primarily for installations using multiple-point instruments where a remote reference junction is desirable, these multi-conductor cables provide either 28, 40 or 48 copper conductors, and an iron, a constantan, an Alumel and a Chromel conductor, (all AWG #22), permitting the use of the cable with either iron-constantan or Chromel-Alumel couples. Individual conductors are insulated with polyvinyl plastic, with the overall covering of Mylar wrap, metal braid, and a polyvinyl plastic sheath. Color coding: all copper conductors, black;

iron, white; constantan, red; Chromel, yellow; Alumel, green.

22-65-2 32-Conductor Extension Wire Cable. Consists of 1 pair of iron and constantan conductors, 1 pair of Chromel and Alumel conductors, and 28 individual copper conductors.

22-37-6 44-Conductor Extension Wire Cable. Same as 22-65-2, except has 40 individual copper conductors.

22-65-3 52-Conductor Extension Wire Cable. Same as 22-65-2, except has 48 individual copper conductors.

LIMITS OF ERROR FOR STANDARD AND ALTERNATE EXTENSION WIRES

Type of Thermocouple	Corresponding Extension Wire		Extension Wire Limits of Error	
	Type	Temperature Range	Standard	Special*
Copper-Constantan (38) (T)	Copper and Constantan (38) (T)	-75 to 200 F	$\pm 1\frac{1}{2}$ F	$\pm \frac{1}{4}$ F
Iron-Constantan (J)	Iron and Constantan (J)	0 to 400 F	± 4 F	± 2 F
Chromel-Alumel (K)	Chromel and Alumel (K)	0 to 400 F	± 4 F	± 2 F
Chromel-Constantan (E)	Chromel and Constantan (E)	0 to 400 F	± 3 F	± 2 F
Plat., Rhodium-Plat. (R,S)	Copper and #11 Alloy	75 to 400 F	± 12 F**	—

*For conductors selected to special limits of error, see table above.

**Applicable for a reference junction temperature of 75 F only. Special limits of error are not available.

I.S.A. EXTENSION WIRE COLOR CODE AS NOW USED BY L&N

Thermocouple Material	Wire Insulation Color Code		Outer Insulation
	Positive (+)	Negative (-)	
Duplex Wires			
Plat.-Rhodium, Plat. (R, S)	Copper (Black)	#11 Alloy (Red)	Green
Iron-Constantan (J)	Iron (White)	Constantan (Red)	Black
Chromel-Alumel (K)	Chromel (Yellow)	Alumel (Red)	Yellow
Copper-Constantan (38) (T)	Copper (Blue)	Constantan (Red)	Blue
Single Conductors			
Plat.-Rhodium, Plat. (R, S)	Copper (Black)	#11 Alloy (Red, black tr.)	_____
Iron-Constantan (J)	Iron (White)	Constantan (Red, white tr.)	_____
Chromel-Alumel (K)	Chromel (Yellow)	Alumel (Red, yellow tr.)	_____
Copper-Constantan (38) (T)	Copper (Blue)	Constantan (Red, blue tr.)	_____

Duplex Extension Wires in Conduit. Dimensions of duplex extension wires are included in the table on the preceding page. Data on the

approximate number of No. 16 AWG extension wires which may be run in conduit of given size are as follows:

Wires	Insulation	Gauge	Size of Conduit (Inches)											
			1/2	3/4	1	1 1/4	1 1/2	2	2 1/4	3	3 1/4	4	4 1/4	5
Heat-Resistant Rubber, Waxed Braid	16	3	5	9	16	22	36	52	80	107	139	173	218	315
Enamel, Asbestos Wrap, Cellulose Acetate Wrap, Asbestos Braid	16	1	3	5	9	12	21	30	46	62	80	100	126	182
Heat-Resistant Rubber, Waxed Braid, Lead Sheath	16	1	2	3	5	7	12	18	27	37	48	60	75	109
Polyvinyl Plastic, Weatherproof Braid	16	4	7	11	20	28	46	67	103	138	177	222	279	404
Heat-Resistant Rubber, Weatherproof Braid	16	3	5	9	16	22	36	52	80	107	139	173	218	315
Polyvinyl Plastic, Polyvinyl Plastic	16	3	6	10	18	25	41	58	90	120	154	193	243	340
Polyvinyl Plastic, Nylon	16	6	10	17	29	40	65	93	143	192	247	310	390	560

Resistance of Duplex Extension Wires.

Extension Wires	Nominal Resistance, Duplex Pairs, in Ohms per 100 Ft at 20 C		
	AWG		
	16	18	22
Iron & Constantan	14.0	—	56.7
Chromel & Alumel	23.2	—	93.9
Copper & Constantan	11.7	—	—
Copper & #11 Alloy	1.48	2.40	—

PACKAGED QUANTITIES OF EXTENSION WIRES

Wires marked with (*) on the first and second pages are stocked at the L&N plant for prompt delivery in "packaged" quantities, consisting of a number of connected unit lengths.

For continuous lengths less than 500 feet, the minimum unit length is 25 feet; for lengths between 500 feet and 1000 feet (the maximum continuous length), the minimum unit length is 50 feet. Other unit lengths are 75, 100, 250, and 1000 feet.

Ordering packaged quantities in this manner speeds deliveries, since selection of the specified length becomes merely a matter of cutting stocked wire (pre-marked at unit lengths) at a point equal to the number of units required.

Therefore, to facilitate handling of orders, we reserve the right to supply a packaged quantity of the nearest larger integral length when a non-standard, in-between length is ordered.

The table below gives the minimum unit length (as the numerical part of the suffix) and the number of unit lengths, for each packaged quantity of continuous length. It should be emphasized that, although only one length of wire is ordered and shipped, invoicing is based on the number of unit lengths. For example, on an order for a continuous length of 175 feet of 16-60-2 wire, such a length would be shipped, but invoicing would be for 7 16-60-2-F-25.

Ordering Data For Packaged Quantities								
Continuous Length	Quantity	Suffix	Continuous Length	Quantity	Suffix	Continuous Length	Quantity	Suffix
25	1	F-25	275	11	F-25	550	11	F-50
50	1	F-50	300	8	F-100	600	6	F-100
75	1	F-75	325	13	F-25	650	13	F-50
100	1	F-100	350	14	F-50	700	14	F-100
125	5	F-25	375	15	F-75	750	15	F-250
150	6	F-50	400	16	F-100	800	16	F-100
175	7	F-25	425	17	F-25	850	17	F-50
200	2	F-100	450	18	F-75	900	18	F-100
225	3	F-75	475	19	F-25	950	19	F-50
250	1	F-250	500	1	F-500	1000	1	F-1000

How to Order

1. Specify Wire Number.
2. Specify either:
 - (a) the length required, in feet, or
 - (b) where applicable, the number of "pack-

aged" quantities required, as described in the table above.

Note: For conductors selected to special limits of error available from stock (suffix "-A"), minimum order is 500 feet. "Packaged" ordering does not apply.



LEEDS & NORTHRUP COMPANY *Pioneers in Precision • North Wales, Pa. 19454*

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