**DØ CRYO
CC HEATER
INSTALLATION**

**DØ ENGINEERING NOTE
3740.510-EN-301
JOHN URBIN
16 MAR 91**

REVIEWED: *C. T. W. [Signature]*

DATE: 3/25/91

CC HEATER INSTALLATION **DOCUMENTATION**

Nine pairs of heaters are installed in the bottom of the CC pressure vessel. The physical layout is shown in the CC internal development drawing, DØ dwg. 3740.510-ME-255523. Electrically the heater system is a delta configuration. Electrical details are found on DØ dwg. 3740.515-EC-273761. The feedthrough connectors for power to the heaters are located in the instrumentation box. Connector positions are found on DØ dwg. 3740.515-EC-273760. Original sketches for the above named drawings are included in this document.

The heaters and wiring were cleaned various times prior to and after installation with ethyl alcohol. At various stages in the installation hi-pot and continuity tests were successfully accomplished to verify the integrity of the system. The final hi-pot numbers are included in the documentation.

The heaters and wiring are kept separated from thermometry and purity cell wiring by SS sheetmetal barriers.

The fabrication, testing and installation was completed by M. Hentges and his crew from AD/Cryo.

CC CRYOSTAT HEATERS

FROM INSTRUMENT BOX

— 1- #6 AWG TEFLON COATED WIRE

— 2- #6 AWG TEFLON COATED WIRE

SEE D ϕ DWG 3740.515-EC-273761

JU/SEP88

C.C. HEATERS

50 KW @ 480VAC

16.6 KW/φ
2.8 K EACH HEATER
20.2 AMPS PER SET OF (2)
60.6 AMPS/φ

SEE DP DWG 3740.515-EC-273761

M. HASTINGS

C.C. HEATER WIRING

1 ϕ SHOWN

CONNECTOR: HSC SS 7062-29-61P

SOLDER : 60/40

NOTE: G10 SLEEVE IS STRAST EPOXIED AFTER SOLDERING

SEE D4 DWG: 3740.515-EB-273762

"CC" INSTRUMENTATION BOX CONNECTOR POSITIONS

LEGEND:

S_p = SPARE

L = LEVEL PROBE

H = HEATER

T_c = LA_n TEST CELL

T_{1-9} = THERMOMETRY (RTD's)

SEE DP DWG. 3740,515-EC-273760

Not More Than Three Conductors in Raceway or Cable or Earth (Directly Buried), Based on Ambient Temperature of 30°C (86°F)

CORRECTION FACTORS										
Ambient Temp. °C	For ambient temperatures over 30°C, multiply the ampacities shown above by the appropriate correction factor to determine the maximum allowable load current.									Ambient Temp. °F
31-40	.82	.88	.90	.91	.82	.88	.90	.91		86-104
41-50	.58	.75	.80	.82	.58	.75	.80	.82		105-122
51-60	....	.58	.67	.71	....	.58	.67	.71		123-141
61-70	....	.35	.52	.58	....	.35	.52	.58		142-158
71-80	....	....	.30	.41	....	....	.30	.41		159-176

* For dry locations only. See 75°C column for wet locations.

Single conductors in free air, based on ambient temperature of 30°C (86°F).

CORRECTION FACTORS									
Ambient Temp. °C	For ambient temperatures over 30°C, multiply the ampacities shown above by the appropriate correction factor to determine the maximum allowable load current.								Ambient Temp. °F
31-40	.82	.88	.90	.91	.82	.88	.90	.91	86-104
41-50	.58	.75	.80	.82	.58	.75	.80	.82	105-122
51-60	....	.58	.67	.71	....	.58	.67	.71	123-141
61-70	....	.35	.52	.58	....	.35	.52	.58	142-158
71-80	....	....	.30	.41	....	....	.30	.41	159-176

* For dry locations only. See 75°C column for wet locations.

Table 310-13 (Continued)

Mineral Insulation (Metal Sheathed)	MI	85°C 185°F 250°C 482°F	Dry and wet locations. For special application.	Magnesium Oxide	16-10 36 9-4 50 3-250 55	Copper
Underground Feeder & Branch-Circuit Cable-Single Conductor. (For Type UF cable employing more than one con- ductor see Article 339.)	UF	60°C 140°F	See Article 339	Moisture- Resistant	14-10 *60 8-2 *80 1-4/0 *95	Integral with insulation
		75°C** 167°F		Moisture- and Heat- Resistant		
Underground Service-En- trance Cable-Sin- gle Conductor. (For Type USE cable employing more than one conductor see Article 338.)	USE	75°C 167°F	See Article 338	Heat- and Moisture- Resistant	12-10 45 8-2 60 1-4/0 80 213-500 95 501-1000 110 1001-2000 125	Moisture- resistant non- metallic covering [See 338-1 (2).]

* Includes integral jacket.

** For ampacity limitation, see 339-1(a).

The nonmetallic covering over individual rubber-covered conductors of aluminum-sheathed cable and of lead-sheathed or multiconductor cable shall not be required to be flame retardant. For Type MC cable, see Section 334-20. For nonmetallic-sheathed cable, see Section 336-2. For Type UF cable, see Section 339-1.

For insulated aluminum and copper-clad aluminum conductors, the minimum size shall be No. 12. See Tables 310-16 through 310-19.

Table 310-13 (Continued)

Trade Name	Type Letter	Max. Operating Temp.	Application Provisions	Insulation	AWG or MCM	Thickness of Insulation	Mils	Outer Covering
Silicone- Asbestos	SA	90°C 194°F 125°C 257°F	Dry locations. For special application.	Silicone Rubber	14-10 45 8-2 60 1-4/0 80 213-500 95 501-1000 110 1001-2000 125			Asbestos or glass
Fluorinated Ethylene Propylene	FEP or FEPB	90°C 194°F 200°C 392°F	Dry locations. Dry locations — special ap- plications.	Fluorinated Ethylene Propylene Fluorinated Ethylene Propylene	14-10 20 8-2 30 14-8 14 6-2 14			None Glass braid Asbestos braid
Modified Fluorinated Ethylene Propylene	FEPW	75°C 90°C	Wet locations. Dry locations.	Modified Fluorinated Ethylene Propylene	14-10 20 8-2 30			None
Modified Ethylene Tetrafluoro- ethylene	Z	90°C 194°F 150°C 302°F	Dry locations. Dry locations — special ap- plications.	Modified Ethylene Tetrafluoro- ethylene	14-12 15 10 20 8-4 25 3-1 35 1/0-4/0 45			None
Modified Ethylene Tetrafluoro- ethylene	ZW	75°C 167°F 90°C 194°F 150°C 302°F	Wet locations. Dry locations. Dry locations — special ap- plications.	Modified Ethylene Tetrafluoro- ethylene	14-10 30 8-2 45			None

Table 310-36. Thickness of Varnished-Cambric Insulation for Multiconductor Cable, in Mils

Conductor Size AWG or MCM	For Voltages Not Exceeding									
	1000 C B		2000 C B		3000 C B		4000 C B		5000 C B	
14	60	0	80	0	80	30	95	45	95	60
12	60	0	80	0	80	30	95	45	95	60
10	60	0	80	0	80	30	95	45	95	60
8-2	60	0	80	0	80	30	95	45	95	60
1-4/0	80	0	95	0	95	30	95	45	95	60
213-500	95	0	95	0	95	30	95	45	110	60
501-1000	95	30	95	30	95	45	95	60	110	60
1001-2000	110	30	110	30	110	45	110	60	110	80

The thickness given in columns headed "C" are for the insulation on the individual conductors. Those given in the columns headed "B" are for the thickness of the over-all belt of insulation.

Table 310-37

Thickness of Asbestos and Varnished-Cambric Insulation for Single-Conductor Cable, Types AVA, AVB, and AVL, in Mils

Conductor	Asbestos 1st Wall		Varnished Cambric					Asbestos 2nd Wall
	For Voltages Not Exceeding							
	1000-5000	1000	2000	3000	4000	5000	1000-5000	
AWG or MCM								
14-2	15	45	60	80	100	120	25	
1-4/0	20	45	60	80	100	120	30	
213-500	25	45	60	80	100	120	40	
501-1000	30	45	60	80	100	120	40	
1001-2000	30	55	75	95	115	140	50	

310-38. Ampacity. The maximum continuous ampacities for copper and aluminum solid dielectric insulated conductors rated 2001 to 35000 volts shall be as given in Tables 310-39 through 310-54 and accompanying notes, while for conductors rated 601 to 2000 volts the maximum continuous ampacities shall be as given in Tables 310-16 through 310-19 and their accompanying notes.

Table 310-39

Allowable Ampacities for Insulated Single Copper Conductor Isolated in Air

Based on Conductor Temperature of 90°C and Ambient Air Temperature of 40°C

Conductor Size AWG-MCM	2001-5000 Volts Ampacity	5001-15,000 Volts Ampacity	15,001-35,000 Volts Ampacity
8	83	—	—
6	110	110	—
4	145	150	—
2	190	195	—
1	225	225	225
1/0	260	260	260
2/0	300	300	300
3/0	345	345	345
4/0	400	400	395
250	445	445	440
350	550	550	545
500	695	685	680
750	900	885	870
1000	1075	1060	1040
1250	1230	1210	1185
1500	1365	1345	1315
1750	1495	1470	1430
2000	1605	1575	1535

Table 310-40

Allowable Ampacities for Insulated Single Aluminum Conductor Isolated in Air

Based on Conductor Temperature of 90°C and Ambient Air Temperature of 40°C

Conductor Size AWG-MCM	2001-5000 Volts Ampacity	5001-15,000 Volts Ampacity	15,001-35,000 Volts Ampacity
8	64	—	—
6	85	87	—
4	115	115	—
2	150	150	—
1	175	175	175
1/0	200	200	200
2/0	230	235	230
3/0	270	270	270
4/0	310	310	310
250	345	345	345
350	430	430	430
500	545	535	530
750	710	700	685
1000	855	840	825
1250	980	970	950
1500	1105	1085	1060
1750	1215	1195	1165
2000	1320	1295	1265

Table 310-41

Allowable Ampacities of an Insulated Three Conductor Copper
Cable Isolated in Air

Based on Conductor Temperature of 90°C and Ambient
Air Temperature of 40°C

Conductor Size AWG-MCM	2001-5000 Volts Ampacity	5001-35,000 Volts Ampacity
8	59	—
6	79	93
4	105	120
2	140	165
1	160	185
1/0	185	215
2/0	215	245
3/0	250	285
4/0	285	325
250	320	360
350	395	435
500	485	535
750	615	670
1000	705	770

Table 310-42

Allowable Ampacities of an Insulated Three Conductor
Aluminum Cable Isolated in Air

Based on Conductor Temperature of 90°C and Ambient
Air Temperature of 40°C

Conductor Size AWG-MCM	2001-5000 Volts Ampacity	5001-35,000 Volts Ampacity
8	46	—
6	61	72
4	81	95
2	110	125
1	125	145
1/0	145	170
2/0	170	190
3/0	195	220
4/0	225	255
250	250	280
350	310	345
500	385	425
750	495	540
1000	585	635

Table 310-43

Allowable Ampacities of an Insulated Triplexed or Three Single
Conductor Copper Cables in Isolated Conduit in Air

Based on Conductor Temperature of 90°C and Ambient
Air Temperature of 40°C

Conductor Size AWG-MCM	2001-5000 Volts Ampacity	5001-35,000 Volts Ampacity
8	55	—
6	75	83
4	97	110
2	130	150
1	155	170
1/0	180	195
2/0	205	225
3/0	240	260
4/0	280	295
250	315	330
350	385	395
500	475	480
750	600	585
1000	690	675

Table 310-44

Allowable Ampacities of Insulated Triplexed or Three Single
Conductor Aluminum Cables in Isolated Conduit in Air

Based on Conductor Temperature of 90°C and Ambient
Air Temperature of 40°C

Conductor Size AWG-MCM	2001-5000 Volts Ampacity	5001-35,000 Volts Ampacity
8	43	—
6	58	65
4	76	84
2	100	115
1	120	130
1/0	140	150
2/0	160	175
3/0	190	200
4/0	215	230
250	250	255
350	305	310
500	380	385
750	490	485
1000	580	565

DEARBORN

U.L. LISTED HIGH TEMPERATURE TEFLON* WIRE

rating, voltage rating, service flexibility, resistance to abnormal temperature, oil resistance, water resistance and gasoline resistance where applicable. All of the following Underwriters styles are flame retardant and will satisfy the FR-1 designation of UL.

This section lists only the most commonly used conductors. In many instances, the Underwriter's Laboratories allow the use of other materials. Consult factory for further details.

* DuPont TM

Dearborn supplies a variety of high temperature insulated wires that are listed by the Underwriters Laboratories. The types shown here fall into the category of appliance wiring material (AWM) and are covered by the Flexible Cord and Fixture Wire Standard and UL Standard 758.1 for insulated single conductor appliance wiring material. Among a variety of requirements, the latter document assigns ratings regarding the duty group, flame retardance, temperature

U.L. STYLES 1164 & 1180

DEARBORN NO.	AWG SIZE	STRAND-ING	NOM. O.S. OVER INSULATION INCH (MM)
22801UL3	28	Solid	.042(1.07)
22807UL3	28	7/36	.045(1.14)
22819UL3	28	19/40	.045(1.14)
22601UL3	26	Solid	.045(1.14)
22607UL3	26	7/34	.048(1.22)
22619UL3	26	19/38	.048(1.22)
22401UL3	24	Solid	.049(1.24)
2407UL3	24	7/32	.053(1.35)
2419UL3	24	19/36	.053(1.35)
2201UL3	22	Solid	.054(1.37)
22207UL3	22	7/30	.060(1.52)
22219UL3	22	19/34	.060(1.52)
22001UL3	20	Solid	.061(1.55)
22007UL3	20	7/28	.068(1.73)
22019UL3	20	19/32	.068(1.73)
21807UL3	18	7/26	.079(2.00)
21819UL3	18	19/30	.079(2.00)
21619UL3	16	19/29	.086(2.18)
21419UL3	14	19/27	.102(2.59)
21219UL3	12	19/25	.120(3.05)

STOCK COLORS: 0-9

U.L. STYLES 1198 & 1199

DEARBORN NO.	AWG SIZE	STRAND-ING	NOM. O.S. OVER INSULATION INCH (MM)
22601UL6	28	Solid	.060(1.52)
22607UL6	28	7/34	.063(1.60)
22619UL6	28	19/38	.063(1.60)
22401UL6	24	Solid	.064(1.63)
22407UL6	24	7/32	.068(1.73)
22419UL6	24	19/36	.068(1.73)
22201UL6	22	Solid	.069(1.75)
22207UL6	22	7/30	.077(1.96)
22219UL6	22	19/34	.077(1.96)
22001UL6	20	Solid	.079(2.00)
22007UL6	20	7/28	.083(2.11)
22019UL6	20	19/32	.083(2.11)
21807UL6	18	7/26	.093(2.36)
21819UL6	18	19/30	.093(2.36)
21619UL6	16	19/29	.101(2.57)
21419UL6	14	19/27	.116(2.95)
21219UL6	12	19/25	.136(3.45)
21037UL6	10	37/26	.157(3.99)
28133UL6	8	133/29	.237(5.94)
26133UL6	6	133/27	.268(6.81)
24133UL6	4	133/25	.321(8.15)
22665UL6	2	665/30	.401(10.2)
21836UL6	1	836/30	.474(12.1)

STOCK COLORS: 0-9

U.L. STYLES 1212 & 1213

DEARBORN NO.	AWG SIZE	STRAND-ING	NOM. O.S. OVER INSULATION INCH (MM)
13201UL	32	Solid	.027(6.86)
13207UL	32	7/40	.029(7.34)
13219UL	32	19/44	.029(7.34)
13001UL	30	Solid	.029(7.34)
13007UL	30	7/38	.032(8.13)
13019UL	30	19/42	.032(8.13)
12801UL	28	Solid	.032(8.13)
12807UL	28	7/36	.035(8.89)
12819UL	28	19/40	.035(8.89)
12601UL	26	Solid	.035(8.89)
12607UL	26	7/34	.038(9.65)
12619UL	26	19/38	.038(9.65)
12401UL	24	Solid	.040(1.02)
12407UL	24	7/32	.043(1.09)
12419UL	24	19/36	.043(1.09)
12201UL	22	Solid	.046(1.17)
12207UL	22	7/30	.050(1.27)
12219UL	22	19/34	.050(1.27)
12001UL	20	Solid	.054(1.37)
12007UL	20	7/28	.058(1.47)
12019UL	20	19/32	.058(1.47)

STOCK COLORS: 0-9

U.L. STYLES 1330 & 1331

DEARBORN NO.	AWG SIZE	STRAND-ING	NOM. O.S. OVER INSULATION INCH (MM)
22601AUL6	28	Solid	.060(1.52)
22607AUL6	28	7/34	.063(1.60)
22619AUL6	28	19/38	.063(1.60)
22401AUL6	24	Solid	.064(1.63)
22407AUL6	24	7/32	.068(1.73)
22419AUL6	24	19/36	.068(1.73)
22201AUL6	22	Solid	.069(1.75)
22207AUL6	22	7/30	.077(1.96)
22219AUL6	22	19/34	.077(1.96)
22001AUL6	20	Solid	.079(2.00)
22007AUL6	20	7/28	.083(2.11)
22019AUL6	20	19/32	.083(2.11)
21807AUL6	18	7/26	.093(2.36)
21819AUL6	18	19/30	.093(2.36)
21619AUL6	16	19/29	.101(2.57)
21419AUL6	14	19/27	.116(2.95)
21219AUL6	12	19/25	.136(3.45)
21037AUL6	10	37/26	.157(3.99)
28133AUL6	8	133/29	.237(5.94)
26133AUL6	6	133/27	.268(6.81)
24133AUL6	4	133/25	.321(8.15)
22665AUL6	2	665/30	.401(10.2)
21836AUL6	1	836/30	.474(12.1)

STOCK COLORS: 0-9

OTHER U.L. STYLES AVAILABLE UPON REQUEST

UL STYLE	VOLTAGE	TEMP. (C)	INSULATION
1332	300	200°	FEP
1333	300	150°	FEP
1355		200°	FEP-H
1371		105°	TFE
1394		200°	TFE-H
1508	30	105°	Tetzel
1512		105°	TFE
1513		105°	Tetzel
1516		105°	Tetzel
1517		105°	Tetzel
1523		105°	Tetzel
1538	90	105°	FEP
1558		125°	Tetzel
1570	600	250°	TFE
1586		105°	Tetzel
1609	125	105°	Tetzel

U.L. STYLES 1226 & 1227

DEARBORN NO.	AWG SIZE	STRAND-ING	NOM. O.S. OVER INSULATION INCH (MM)
13201AUL	32	Solid	.027(6.86)
13207AUL	32	7/40	.029(7.34)
13001AUL	30	Solid	.029(7.34)
13007AUL	30	7/38	.032(8.13)
12801AUL	28	Solid	.032(8.13)
12807AUL	28	7/36	.035(8.89)
12601AUL	26	Solid	.035(8.89)
12607AUL	26	7/34	.038(9.65)
12619AUL	26	19/38	.038(9.65)
12401AUL	24	Solid	.040(1.02)
12407AUL	24	7/32	.043(1.09)
12419AUL	24	19/36	.043(1.09)
1201AUL	22	Solid	.046(1.17)
12207AUL	22	7/30	.050(1.27)
12219AUL	22	19/34	.050(1.27)
12001AUL	20	Solid	.054(1.37)
12007AUL	20	7/28	.058(1.47)
12019AUL	20	19/32	.058(1.47)

STOCK COLORS: 0-9

UL STYLES 1164 AND 1180

CONDUCTOR: Silver plated copper. On special order nickel plated copper conductors are available. INSULATION: Extruded "Teflon" TFE, .013" min. (average) wall. TEMPERATURE RATING: UL 1180-200°C. VOLTAGE RATING: 300 volts rms. USE: For internal wiring of appliances, also suitable for immersion in gasoline, gasoline vapor and 80°C oil. TEMPERATURE IDENTIFICATION MARKER: UL 1164-Brown, UL 1180-Black. Dearborn standard temperature identification is a longitudinally applied stripe in size 18 AWG and larger. Sizes 20 AWG and smaller do not require temperature identification. Upon request and at an additional charge, surface printing can be provided.

UL STYLES 1198 AND 1199

CONDUCTOR: Silver plated copper. On special order nickel plated copper conductors are available under series 3XTN-UL. INSULATION: Extruded "Teflon" TFE, .020" min. (average) wall. TEMPERATURE RATING: UL 1198-150°C. UL 1199-200°C. VOLTAGE RATING: 600 volts rms, 2500 volts peak for electronic use. USE: Internal wiring of appliances, also suitable for immersion in gasoline, gasoline vapor and 80°C oil. TEMPERATURE IDENTIFICATION MARKER: UL 1198-Brown, UL 1199-Black. Dearborn standard temperature identification is a longitudinally applied stripe in size 18 AWG and larger. Sizes 20 AWG and smaller do not require temperature identification. Upon request and at an additional charge, surface printing can be provided. Consult factory for availability of sizes 1/0 thru 4/0.

UL STYLES 1212 AND 1213

CONDUCTOR: Silver plated copper. On special order, nickel plated copper or silver plated high strength high conductivity copper alloy conductors are available. INSULATION: Extruded "Teflon" TFE, .008" min. (average) wall. TEMPERATURE RATING: UL 1212 and UL 1213-105°C. VOLTAGE RATING: Not specified. USE: In office appliances where exposed to temperatures not exceeding 80°C or 105°C or to oil at temperatures not exceeding 60°C, and where not subjected to undue mechanical abuse. Temperature identification on the wire is not required on these styles. Consult factory for tracer or stripe on special.

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UL STYLES 1226 AND 1227

CONDUCTOR: Tin plated copper. Constructions with silver plated copper or silver plated high strength high conductivity copper alloy are available on request. INSULATION: Extruded "Teflon" FEP, .008" min. (average) wall. TEMPERATURE RATING: UL 1226-80°C. UL 1227-105°C. VOLTAGE RATING: Not specified. USE: In office appliances where exposed to temperatures not exceeding 80°C and 105°C or oil at temperatures not exceeding 60°C, and where not subjected to undue mechanical abuse. Temperature identification of the wire is not required for these styles.

UL STYLES 1330 AND 1331

CONDUCTOR: Tin plated copper. INSULATION: Extruded "Teflon" FEP, .020" min. (average) wall, sizes 26-10 AWG, .030" min. (average) wall, sizes 8-2 AWG. TEMPERATURE RATING: UL 1330-200°C, may be used with tin plated copper conductors only where the individual strand diameter is .015" (26 AWG) or larger. UL 1331-150°C. VOLTAGE RATING: 600 volts rms. USE: For general appliance wiring where not subjected to temperatures exceeding 200°C for style 1330 (see above limiting note), or 150°C for style 1331. Suitable for immersion in gasoline, gasoline vapor and 80°C oil. Constructions with silver plated copper are available on request; this version has an unrestricted 200°C temperature rating for style 1330. For sizes 18 AWG and larger, temperature identification is indicated by a black marker thread for style 1330 and a brown marker thread for style 1331, located under the insulation. Sizes 20 AWG and smaller do not require temperature identification.

CSA APPROVED HIGH-TEMPERATURE TEFLON APPLIANCE WIRE

CSA INSULATION REQUIREMENT MIN. AVE. WALL	CSA VOLTAGE RATING	CSA TEMPERATURE RATING DEGREES (C)	WIRE SIZES
.010	150	150	32-16
.016(1/64")	300	200	28-12
.031(1/32")	600	200	28-12

THIN WALL INSULATION RATED AT 150 VOLTS AND 150°C

CONDUCTOR: Silver plated copper. Constructions with nickel plated copper or nickel conductor can be supplied. Consult factory for details. INSULATION: Extruded "Teflon" TFE, .010" (0.25mm) min. average wall thickness. Surface printed for product identification in sizes 24 AWG and larger. USE: For internal wiring of process control and computer equipment.

STOCK COLORS: AWG SIZES 18 THROUGH 24 = 6-2-8.
AWG SIZES 28 THROUGH 32 = 9-8.

* For availability of other color and stripe combinations, consult factory.

STANDARD WALL INSULATION RATED AT 300 VOLTS AND 200°C

CONDUCTOR: Silver plated copper; constructions with nickel plated copper or nickel conductors can be supplied. Consult factory for details. INSULATION: Extruded "Teflon" TFE, $\frac{1}{32}$ " (0.4mm) minimum wall thickness. Surface printed for product identification in sizes 24 AWG and larger. USE: For internal wiring of electronic, photographic, refrigeration and air conditioning equipment, ballast and incandescent lampholder leads, ovens, flood lights, business machines, clothes dryers and electric stoves.

STOCK COLORS: AWG SIZES 12 THROUGH 24 = 6-2-8.
AWG SIZES 28 THROUGH 32 = 9-8.

HEAVY WALL INSULATION RATED AT 600 VOLTS AND 200°C

CONDUCTOR: Silver plated copper. Constructions with nickel plated copper or nickel conductor can be supplied. Consult factory for details. INSULATION: Extruded "Teflon" TFE, $\frac{1}{16}$ " (0.7mm) min. wall thickness. Surface printed for product identification in sizes 24 AWG and larger. USE: For internal wiring of electronic, photographic, refrigeration and air conditioning equipment, ballast and incandescent lampholder leads, infrared ovens, flood lights, business machines, clothes dryers and electric stoves.

STOCK COLORS: 6-2-8.

THIN WALL

DEARBORN NO.	AWG SIZE	STRANDING	NOM. O.D. OVER INSULATION (INCH (MM))
13201CSA	32	Solid	.031(1.787)
13207CSA	32	7/40	.032(1.813)
13219CSA	32	19/44	.033(1.838)
13001CSA	30	Solid	.033(1.838)
13007CSA	30	7/38	.035(1.889)
13019CSA	30	19/42	.035(1.889)
12801CSA	28	Solid	.036(1.914)
12807CSA	28	7/36	.038(1.965)
12819CSA	28	19/40	.038(1.965)
12601CSA	28	Solid	.039(1.991)
12607CSA	28	7/34	.042(1.06)
12619CSA	28	19/38	.042(1.06)
12407CSA	24	7/32	.047(1.19)
12419CSA	24	19/36	.047(1.19)
12207CSA	22	7/30	.053(1.34)
12219CSA	22	19/34	.053(1.34)
12007CSA	20	7/28	.061(1.54)
12019CSA	20	19/32	.061(1.54)
11819CSA	18	19/30	.070(1.77)
11619CSA	16	19/0117	.079(2.01)

STANDARD WALL

DEARBORN NO.	AWG SIZE	STRANDING	NOM. O.D. OVER INSULATION (INCH (MM))
22801CSA	28	Solid	.048(1.29)
22807CSA	28	7/36	.050(1.34)
22819CSA	28	19/40	.050(1.34)
22601CSA	28	Solid	.051(1.37)
22607CSA	28	7/34	.054(1.45)
22619CSA	28	19/38	.054(1.45)
22401CSA	24	Solid	.055(1.40)
22407CSA	24	7/32	.059(1.59)
22419CSA	24	19/36	.059(1.59)
22201CSA	22	Solid	.060(1.52)
22207CSA	22	7/30	.065(1.75)
22219CSA	22	19/34	.065(1.75)
22001CSA	20	Solid	.068(1.73)
22007CSA	20	7/28	.073(1.96)
22019CSA	20	19/32	.073(1.96)
21819CSA	18	19/30	.082(2.21)
21619CSA	16	19/0117	.089(2.26)
21419CSA	14	19/0147	.103(2.62)
21219CSA	12	19/0185	.122(3.10)

HEAVY WALL

DEARBORN NO.	AWG SIZE	STRANDING	NOM. O.D. OVER INSULATION (INCH (MM))
22801CSA6	28	Solid	.078(2.10)
22807CSA6	28	7/36	.080(2.15)
22819CSA6	28	19/40	.080(2.15)
22601CSA6	28	Solid	.081(2.18)
22607CSA6	28	7/34	.084(2.26)
22619CSA6	28	19/38	.084(2.26)
22401CSA6	24	Solid	.085(2.16)
22407CSA6	24	7/32	.089(2.39)
22419CSA6	24	19/36	.089(2.39)
22201CSA6	22	Solid	.090(2.28)
22207CSA6	22	7/30	.095(2.55)
22219CSA6	22	19/34	.095(2.55)
22001CSA6	20	Solid	.097(2.46)
22007CSA6	20	7/28	.103(2.77)
22019CSA6	20	19/32	.103(2.77)
21819CSA6	18	19/30	.112(3.01)
21619CSA6	16	19/0117	.120(3.05)
21419CSA6	14	19/0147	.134(3.40)
21219CSA6	12	19/0185	.153(3.88)

COLOR CODE: 0-Black • 1-Brown • 2-Red • 3-Orange • 4-Yellow • 5-Green • 6-Blue • 7-Violet • 8-Grey • 9-White

Ferm

PUF (AS) POSITION
(SEE INSTRUCTIONS ON REVERSE SIDE)DATE
(OPTIONAL)

E 1

REQUESTED BY MIKE HENTGES	EMPLOYEE NO 02343	EXT 3254	ORGANIZATION UNIT ESCRB SYSTEMS	MAIL STATUS FOR PAPERWORK 357	REQUESTOR'S IDENTIFIER DD 5727	REQUISITION DATE
SUGGESTED VENDOR DEARBORN WIRE 250 WEST CARPENTER WHEELING, IL	PHONE NO 312 - 451 - 1000	PROJECT DESCRIPTION C.C. WARM-UP HEATERS		PREVIOUS P.O. (IF KNOWN)	APPROVALS <i>[Signature]</i> <i>[Signature]</i>	EMPLOYEE NO
ATTN. SCOTT		DELIVER TO (INCLUDE NAME & BUILDING NO.) MIKE HENTGES BOOSTER EAST II		BUS OFC DIR OFC		

QUANTITY	ITEM DESCRIPTION	ESTIMATED UNIT PRICE	DO NOT USE
300'	# 26133AUL60 - TYPE 1330-1331 UL 6AWG FEP TEFLON INSULATION 133/27 600V RMS RATED .268 DIA. #289.40/100'		HEATER WIRE
	.030 INSUL THICKNESS	\$868.20	
1500	HOOK-UP WIRE TYPE EE, 1000 VOLT # 22019 19/32 STRANDED 20AWG. 21.05/100' \$105.15/500 \$315.45/1500		CONNECTOR WIRE
	3 - 500' ROLLS COLORS BLACK, WHITE, BLUE .015 INSUL THICKNESS		
PICKED UP		TOTAL \$1183.65	

BUDGET CODE DCF	PROJECT CODE 22 SEP	PERCENTAGE	DOLLAR AMOUNT (LEAVE BLANK)	DIVISION APPROVAL STAMP DO NOT WRITE MS 357
VENDOR CODE		BUYER - DATE PLACED:	FOB	TERMS
SHIP VIA:		REPORTING CODE	REQUISITION NO	P.O. NO

DELLHOLLAND BOOSTER PTFAMPS

HEATERS

683L

ORDER NO.

841630

DCF

DELLHOLLAND

MS 357

41

B/S 01096

EX 3287

ROS IDENT D03240

UNIVERSITIES RESEARCH ASSOCIATION INC.
FERMI NATIONAL ACCELERATOR LABORATORY

P.O. BOX 500 BATAVIA, ILLINOIS 60510

Area Code 312 840-3000

PURCHASE ORDER

NO. 841630

PAGE

FILE CONTROLS

MCMASTER-CARR
P. O. BOX 4355
CHICAGO

IL 60680

PLEASE PUT THE ABOVE ORDER NUMBER ON ALL INVOICES, SHIPPING NOTICES, CORRESPONDENCE AND THE EXTERIOR OF ALL SHIPPING CONTAINERS.

SHIP TO

FERMILAB
RECEIVING DEPT.
BATAVIA, ILL. 60510

BILL TO

FERMILAB
ATTN: ACCT. DEPT.
P.O. BOX 500
BATAVIA, ILL. 60510

P.O. DATE	DATE REQUIRED AT DESTINATION	F.O.B.	TERMS: FROM RECEIPT OF GOODS OR INVOICE, WHICHEVER IS LATER	SHIP VIA:
073187	SEE BELOW	DESTINATION	28 - 10 NET 30	VENDOR'S CHOICE
ITEM	QUANTITY	DESCRIPTION	UNIT PRICE	TOTAL
1	20	FINNED STRIP HEATERS, STOCK #3575K31 30 1/2" LONG, 2800 WATTS, 240 VOLTS TYPE 304 STAINLESS STEEL SHEATH DELIVERY 20 DUE 09/04/87	\$70.46	\$1,409.20
<p><i>Calculation I</i></p> <p><i>factor (6) x 3 = 18 HEATERS.</i></p> <p><i>1 N 3/4 DELTA CIRCULAR @ 480</i></p> <p><i>18(2800W) = 50,400 W</i></p> <p><i>50,400 W = 1.73 I_L V_L</i></p> <p><i>I_L = $\frac{50,400}{1.73(V)}$ = $\frac{50,400}{838.4}$ = 60.0 A</i></p> <p>CONFIRMED TO CAROL SEVER 7/30/87 WSC/SMT REQ NO. 45051</p>				
				\$1,409.20

READ IMMEDIATELY

IF THIS ORDER DOES NOT AGREE WITH YOUR REQUIREMENTS
NOTIFY PURCHASING AT ONCE.
REFER TO PO NUMBER AND VENDOR NAME.

W COUCH

REQUISITIONER

70.46
20
1409.20

ALL CHANGES
MFC.

C. 1
DATE
(OPTIONAL)

04/87

REQUESTED BY V. T. Mutholandi	EMPLOYEE NO 1096	EXT X3287	ORGANIZATION UNIT AD-250-D	MAIL STATION FOR PAPERWORK 357	REQUESTORS IDENTIFIER D03240	REQUISITION DATE 7/23/87
SUGGESTED VENDOR McWaters Carr	PHONE NO	PROJECT DESCRIPTION D0 CC CRYSTAL		PREVIOUS P.O. (IF KNOWN)	APPROVALS H. T. Mutholandi HE Zick	EMPLOYEE NO
		DELIVER TO (INCLUDE NAME & BUILDING NO) Mutholandi Mutholandi, 357		BUS. OFC.		
				DIR. OFC.		

QUANTITY	ITEM DESCRIPTION	ESTIMATED UNIT PRICE	DO NOT USE
20	FINNED STRIP HEATERS, STK # 3J-75K31	# 59.08	
	30 1/2" LONG, 2000 WATTS, 240 VOLTS		
	TYPE 304 S.S. SHEATH		
	ESTIMATED TOTAL	# 1181.60	

Ed Electrical

CEIVED

~~JUL 27 1967~~

VISION APPROVAL STAMP

PERWORK
\$ 357

	BUDGET CODE	PROJECT
	DCF6	
VENDOR CODE	BUYER - DATE PLACED	
SHIP VIA	REPORTING CODE	

TERMS

PO NO	
-------	--

~~45651~~

Exterior Heaters & Mixers

953

Mica Band Heaters

Used for operations involving heating of cylindrical surfaces such as barrels on plastic extruders, injection and blow molding machines, holding tanks, drums, food warmer containers, vending machines, autoclaves, and blow molding equipment.

Capable of obtaining temperatures up to 800° F. Heaters with ID up to 2" are supplied with 10' long lead wires. Units over 2" ID have two screw terminals. Available in a wide range of ID's and widths for 120 volt or 240 volt operation.

4000 Dia.	5/8" (.622) Dia.
NET EACH	Watts No. NET EACH
358K210 \$15.60	100 3618K110 \$17.90
358K220 10.95	100 3618K120 11.75
358K211 12.08	150 3618K111 12.25
358K240 19.80	175 3618K112 13.12
358K250 13.88	190 3618K113 14.32
358K260 14.93	200 3618K114 14.85
358K270 25.00	240 3618K115 18.56
358K212 18.85	250 3618K116 18.75
358K280 27.20	285 3618K117 17.85
358K290 18.08	300 3618K118 18.35

4000 Dia.	5/8" (.622) Dia.
NET EACH	Watts No. NET EACH
358K111 \$15.45	
358K112 15.45	
358K113 16.35	250 3618K813 \$16.85
358K114 18.73	275 3618K814 18.32
358K115 16.45	500 3618K815 19.12
358K116 20.25	
358K117 20.70	500 3618K817 21.85
358K118 21.90	750 3618K818 23.10
358K119 23.18	750 3618K819 24.90
358K121 25.05	800 3618K821 25.85
358K122 25.13	1000 3618K822 25.95

120 VAC	240 VAC
No. NET EACH	No. NET EACH
3588K24 \$34.06	3588K59 34.06
3588K25 38.76	3588K61 38.76
3588K26 49.05	3588K62 49.05
3588K27 35.35	3588K63 66.70
3588K28 54.85	3588K64 35.35
3588K29 52.52	3588K65 54.85
3588K31 62.25	3588K66 52.52
3588K32 55.88	3588K67 62.25
3588K33 66.67	3588K68 55.88
3588K34 76.52	3588K69 66.67
	3588K71 78.52
	3588K72 77.62
	3588K73 80.48
3588K35 54.65	3588K74 54.65
	3588K75 70.98
3588K36 77.63	3588K76 77.63
3588K37 88.86	3588K77 88.86
3588K38 79.03	3588K78 79.03
3588K39 58.17	3588K79 58.17
	3588K81 76.01
3588K41 87.78	3588K82 87.78
3588K42 72.28	3588K83 72.28
3588K43 95.06	3588K84 95.06
	3588K85 133.57
	3588K86 70.98
	3588K87 100.85

Finned Strip Heaters

Used for mounting across air stream within forced air ducts, or to heat by convection in applications such as duct heating, space heaters, drying ovens, food warmers, air heating, curing, and for tempering the air on air conditioning systems.

Rust resistant type 304 stainless steel sheath is capable of obtaining temperatures up to 900°. Stainless steel screw terminals assure positive contact to the windings to provide maximum amperage carrying capacity.

Length	Watts	No.	120 Volts	No.	240 Volts
10 1/2"	500	3575K11	\$27.80	3575K21	\$27.80
12"	900	3575K12	28.78	3575K22	28.78
14"	1100	3575K13	34.17	3575K23	34.17
15 1/4"	1250	3575K14	36.78	3575K24	36.78
17 1/2"	1550	3575K15	41.86	3575K25	41.86
19 1/2"	1700	3575K16	43.73	3575K26	43.73
21"	1900	3575K17	45.31	3575K27	45.31
23 1/4"	2200			3575K28	48.42
25 1/2"	2400			3575K29	51.68
26 3/4"	2500			3575K30	52.53
30 1/2"	2800			3575K31	59.08
33 1/2"	3150			3575K32	63.88
35 1/2"	3450			3575K33	87.53
38 1/2"	3700			3575K34	71.39
42 1/2"	4150			3575K35	77.19

One Piece Band Heaters

These easy to install heavy duty heaters are used to heat barrels of plastic injection molding machines and extruders, burn out ovens, heated kettles, fluidized beds, and heat treating pipes. The unheated section between the heated halves functions as a hinge and permits repeated opening and closing and moving from one job to another.

A spring loaded nickel plated steel clamping bolt pulls the heater close to the work; common plate eliminates the need for a separate clamping band. Each heated section is rated 240 volts, permitting parallel connections in series for 480 volts. Stainless steel sheath. Width, 1 1/2". Sheath temperatures to 1200° F. Barrel temperatures to 900° F.

I.D.	Watts	No.	NET EACH
5"	770	3683K11	\$48.70
5 1/2"	1000	3683K12	50.51
6"	750	3683K13	52.60
6 1/2"	1000	3683K14	54.50
7"	1000	3683K15	58.58
8"	1200	3683K16	60.48
8 1/2"	1600	3683K17	62.47
9"	1500	3683K18	66.04
10 1/2"	1200	3683K19	74.08
12 1/2"	1500	3683K21	90.74

Lab Mixers

A EXPLOSIONPROOF AIR POWERED STIR-RER—Compact laboratory stirrer is ideal for stirring all types of solvents, paints, oils, and other low viscosity solutions. The speed can be varied from 200 to 10,000 RPM by merely turning the air supply valve.

Quiet, smooth running air motor produces 1/8 HP at 80 lbs. pressure. Requires air supply of only 35 to 100 lbs.

Stainless steel shaft and propeller provide maximum resistance to chemical attack and are easily cleaned. Shaft is 12" long and propeller is 2 1/2" diameter. Unit will start in all positions and cannot burn out from overload. An oil and air filter (not furnished) should be installed on air supply line. Includes 4 feet of air hose.

No. 1488T14..... NET EACH \$142.55

B RIM-CLAMP ELECTRIC LAB MIXERS—For continuous duty operation to mix, dissolve, or suspend liquids. Thoroughly mixes up to 25 gals. of thin liquids or small batches of heavier liquids and slurries.

Heavy duty clamp assembly permits mixer to be clamped on the rim of containers at any angle. Corrosion

resistant stainless steel shaft and propeller.

The totally enclosed, fancooled motor operates on 115V, 60 Hz. AC. Has on-off switch for single speed operation. Safety cord and plug included.

Lg.	Dia.	Motor	Speed	NET
		HP	RPM	EACH
12"	2"	1/20	1550	1488T14..... \$168.95
20"	3"	1/15	1700	1488T15..... 180.18

C VARIABLE SPEED LAB MIXERS—Continuous duty, shaded pole, sparkproof motor has aluminum housing and corrosion resistant stainless steel shaft and propeller. Nickel plated chuck. Three wire cord and plug. For ring stand mounting.

LIGHT DUTY MODEL: No. 1413T11—Mixes up to 2 liters of light liquids or a smaller volume of more

viscous liquids. Has rheostat speed control and a 115 volt, 50/60 Hz., single phase 15 watt motor.

MEDIUM DUTY MODEL: No. 1413T12—Mixes up to 5 gallons of light liquid and a smaller volume of heavier suspensions. Has solid state speed control and a 115 volt, 50/60 Hz., single phase 55 watt motor.

Length	Prop.	Motor	Speed	NET
		HP	RPM	EACH
8"	1 1/4"	1/200	100-1100	1413T11..... \$294.23
12"	2 1/4"	1/75	200-2200	1413T12..... 388.82

Built-In Thermocouple

Watts	No.	NET EACH
350	3592K11	\$101.28
365	3592K12	103.15
375	3592K13	86.82
375	3592K14	103.15
400	3592K15	109.83
400	3592K16	104.83
475	3592K17	122.44
400	3592K18	101.29
525	3592K19	111.31
550	3592K21	165.89
600	3592K22	174.18
625	3592K23	149.20
675	3592K24	157.59
725	3592K25	199.06

STER-CARR

From: FNAL::HENTGES 1-DEC-1988 10:24
To: URBIN
Subj: HI POTTING OF HEATER CONNECTORS

AN AC HI POT WAS DONE ON THE THREE HEATER CONNECTORS IN A GASEOUS ARGON ENVIRONMENT AT APPROX. -150 DEGREES C .

PHASE A [BLACK] 1100VAC AT 13 MICRO AMPS.

PHASE B [WHITE] 1180VAC AT 15 MICRO AMPS.

PHASE C [BLUE] 1090VAC AT 14 MICRO AMPS.

ANY QUESTIONS PLEASE CALL ME

From: FNAL::HENTGES 11-MAY-1990 11:12:57.61
To: MULHOLLAND,URBIN,HENTGES
CC:
Subj: CC HEATERS

GEORGE, THE HEATERS CHECKED OUT OK.

PHASE TO PHASE RESISTANCE

A-B 9.04 OHMS

B-C 9.00 OHMS

A-C 9.04 OHMS

PHASE TO GROUND RESISTANCE

A.> 10 MEG.

B.>10 MEG.

C.>10 MEG.

AC HIPOTT

PHASE TO GROUND

A.580VAC

B.575VAC

C.575VAC

DC HIPOTT

PHASE TO GROUND

A.1200VDC

B.1200VDC

C.1200VDC

GEORGE, JOHN, THERE ALL YOURS NOW. GOOD LUCK

HENTGES