

# APPENDIX VI

## CONDUCTING CABLE WORKSHOP 0.322" CABLE PERFORMANCE TEST RESULTS

96-10-30 TEST STATION 992 DOWNRACE @ 75 m/min.

USING WHOIE CTO 4-L X 24 BOTTLE FRAME  
WITH CTO 9

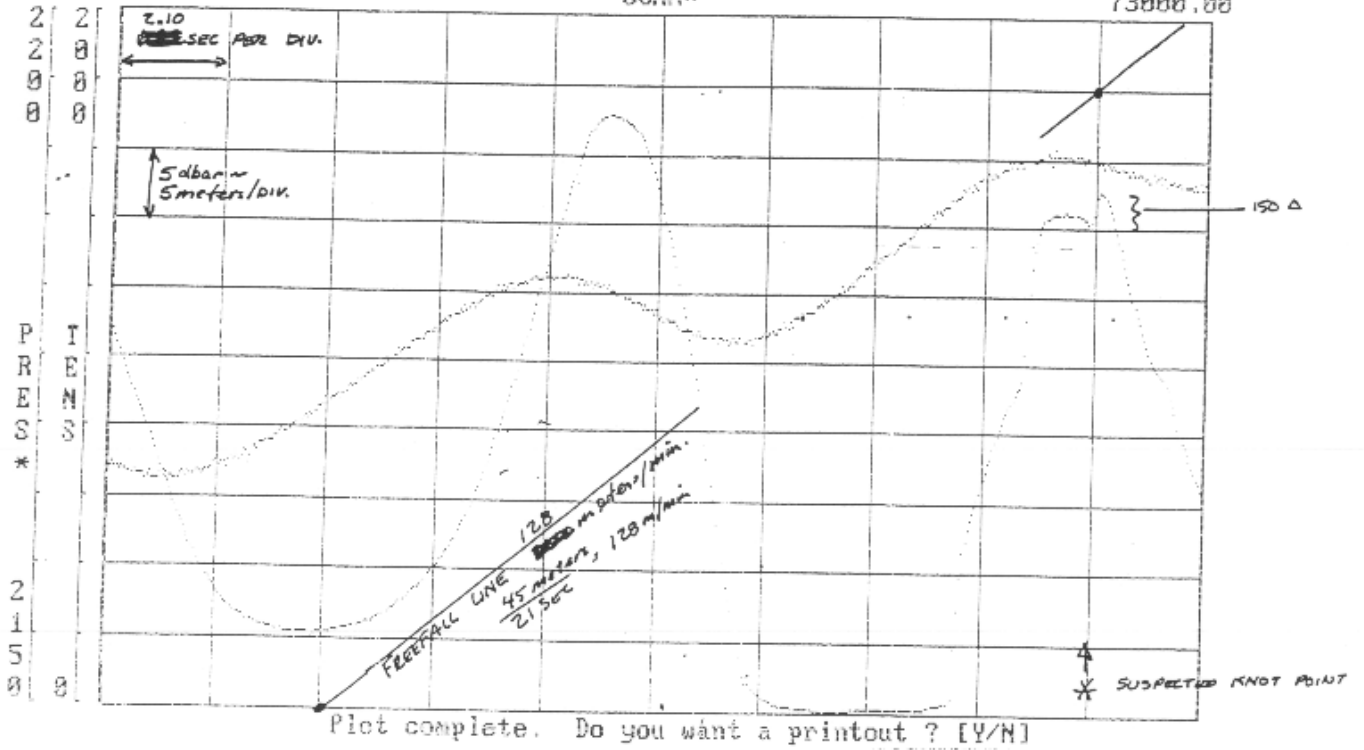
File - KN47D992.EDT

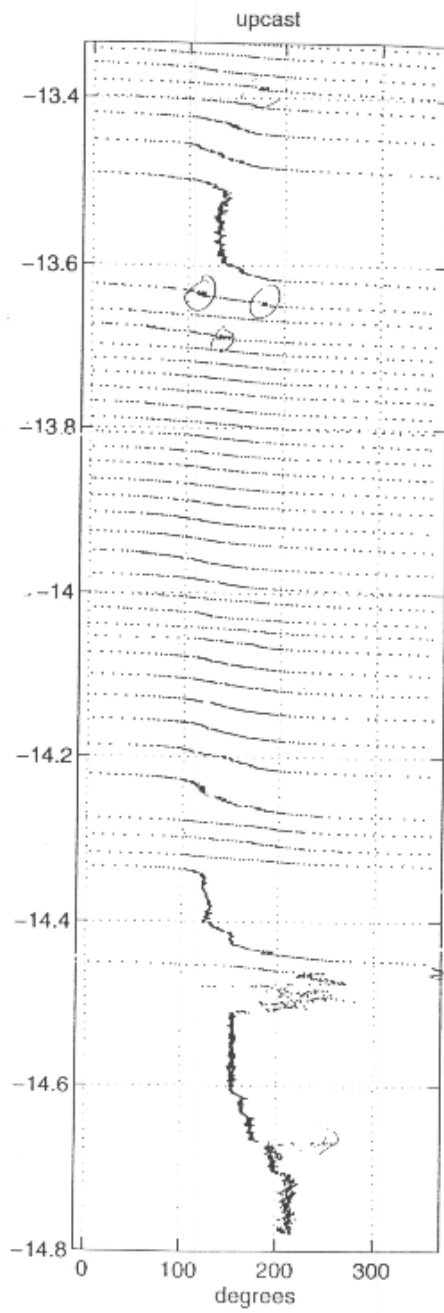
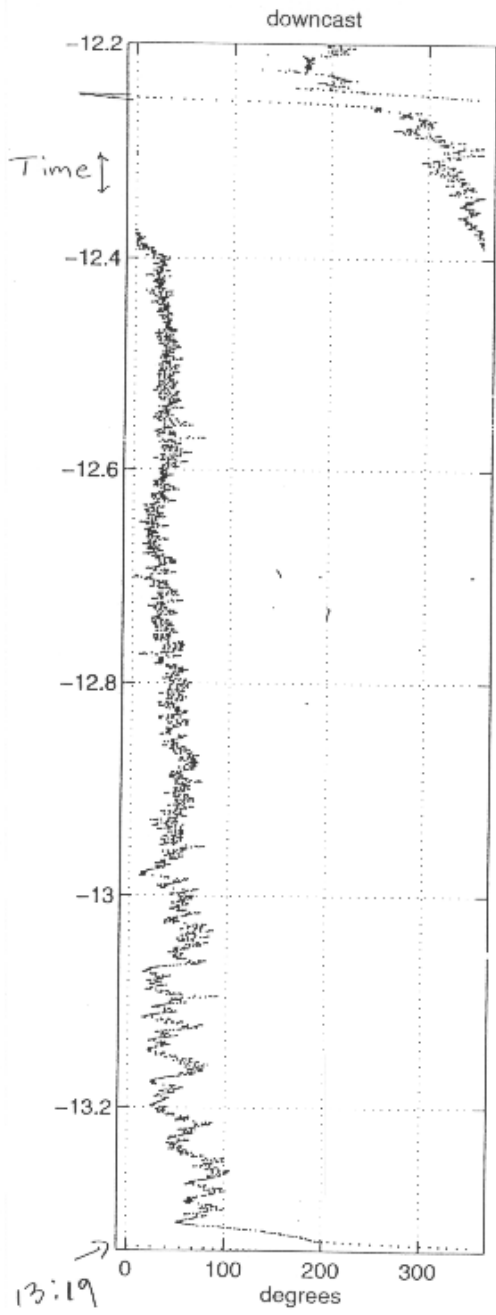
M. Swartz 96-10-31

72500

--SCAN#--

73000.00





13:19

transit: test cast k992

kinky

5000 Tension (lb)

**bmb** tension member technology  
HUNTINGTON BEACH, CA  
FIGURE  
SPECIMEN *W40T/UNVOLGAL*  
DATE *30 October 1986*

4000

*Relation vs. Tension*

*4 Cycles Hand 20 to 5,000 lb.*

461510

3000

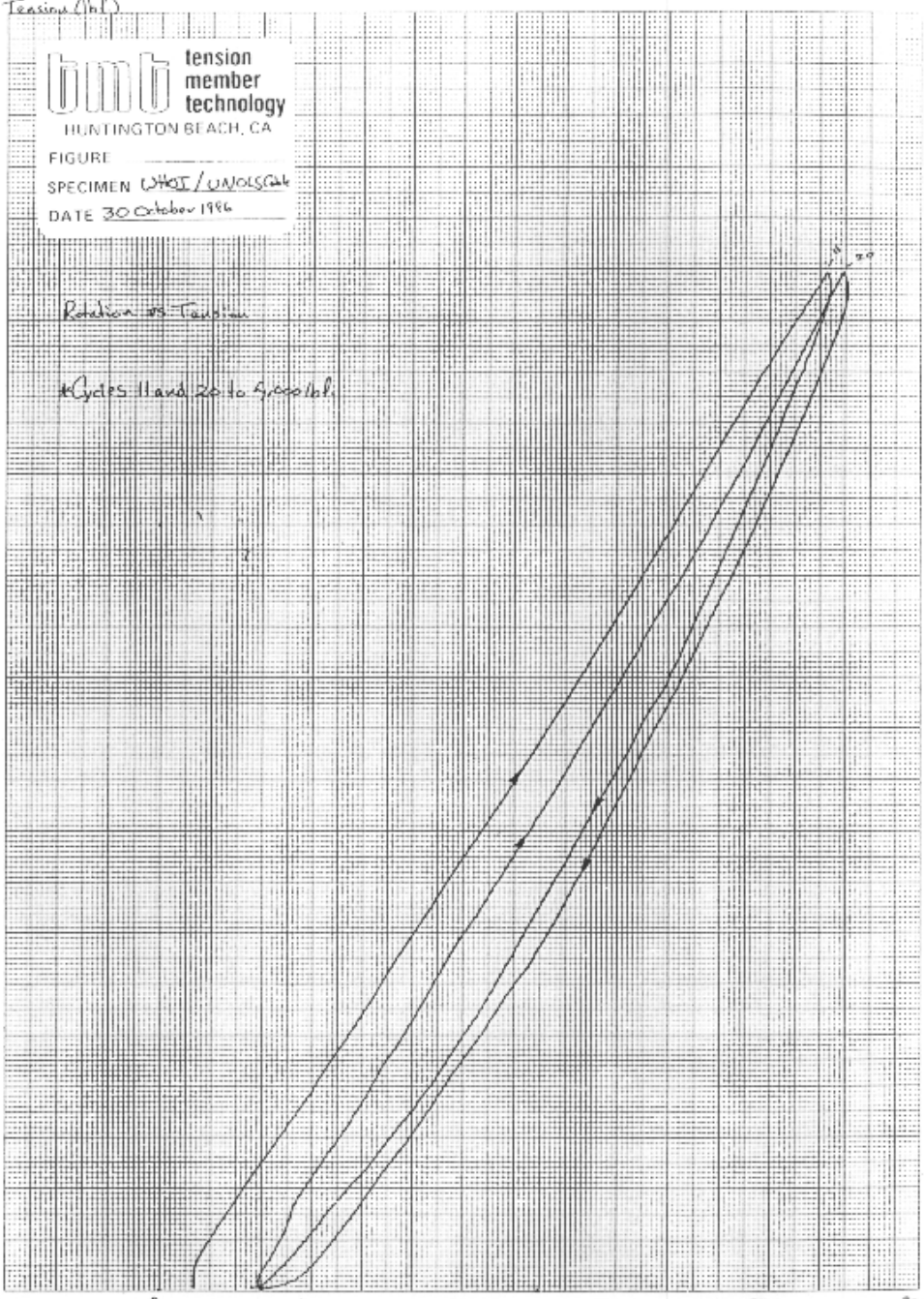
2000

1000

0

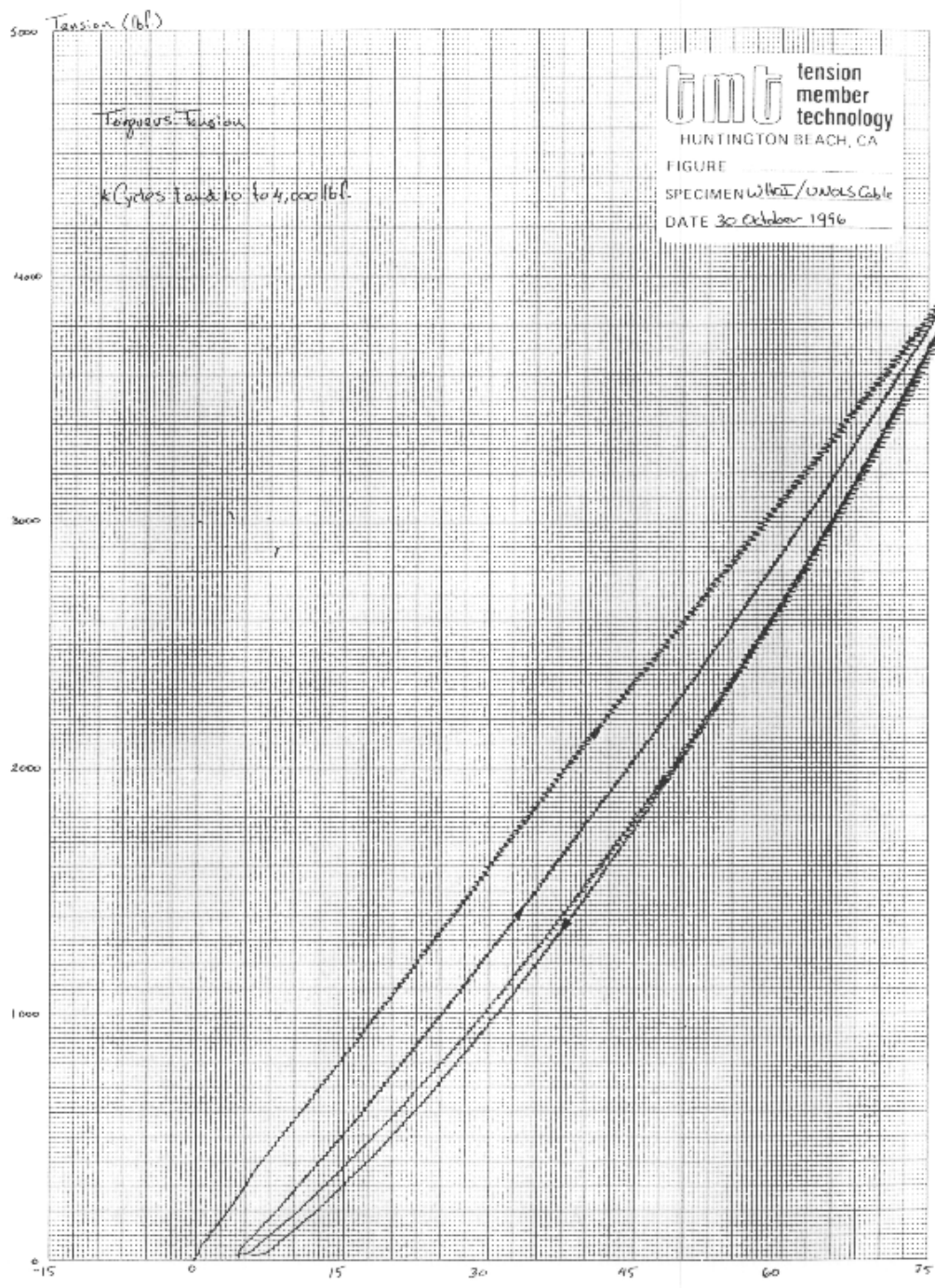
-6.0 0 6.0 12.0 18.0 24.0 30.0

10 X 10 TO THE CENTIMETER  
SCALE. 10 DIVISIONS PER INCH.  
10 X 10 TO THE CENTIMETER  
SCALE. 10 DIVISIONS PER INCH.



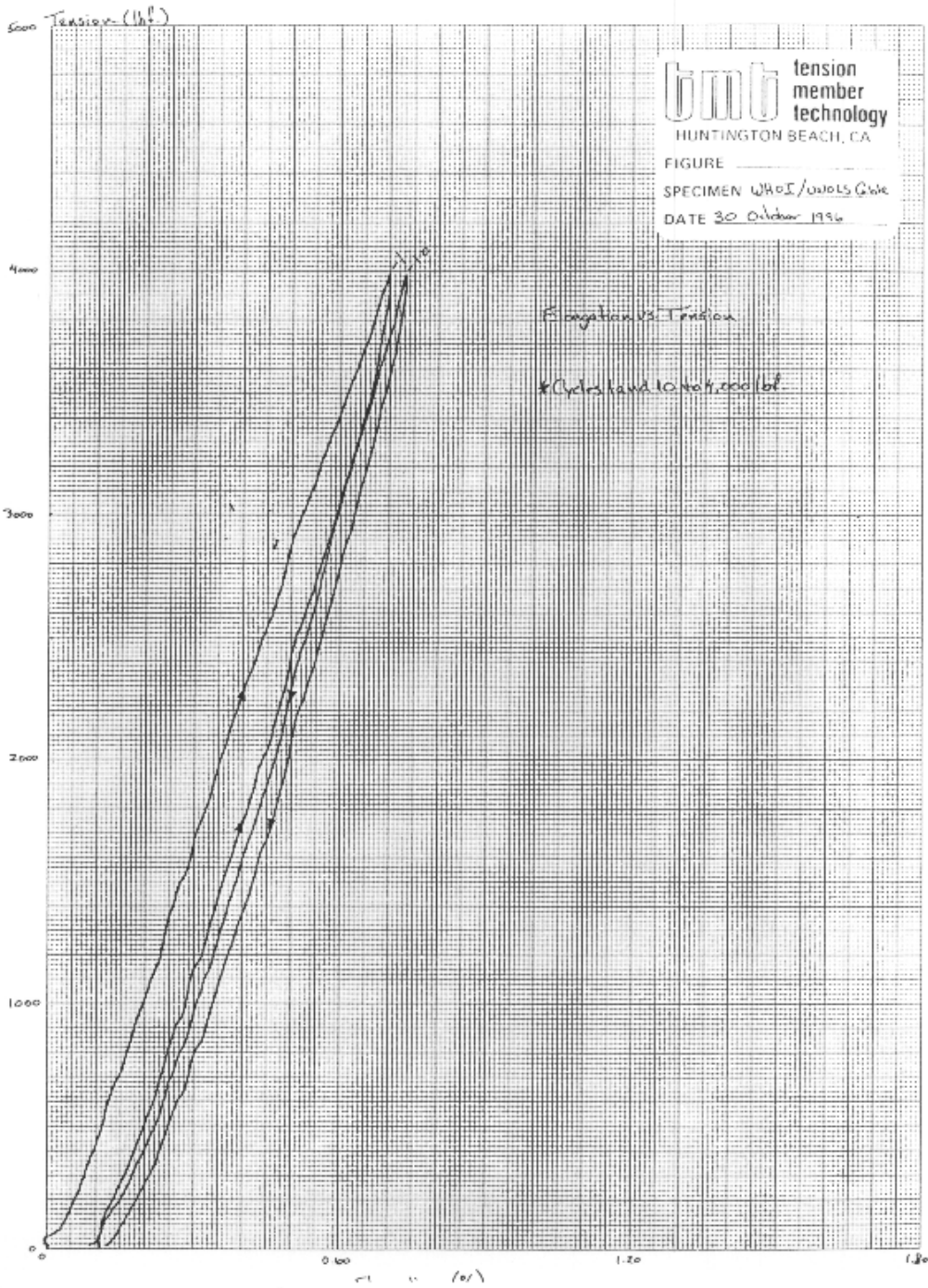
46 1510

K&E  
0.1 X 10 TO THE CENTIMETER  
GROUPED BY CSEER CO. JAN. 11 1951



10 X 10 TO THE CENTIMETER 10 X 25 CM  
K&E KUMHIL & ESSER CO. MADE IN U.S.A.

46 1510



DESIGN: UNOLS-1  
DESCRIPTION: 0.322-inch Diameter 3-Conductor Cable

LAYER 1 #19 AWG Conductors

LAYER DESIGNATION	-> CONDUCTOR
NUMBER OF CONDUCTORS	= 3
CONDUCTOR DIA. (in)	= 0.0349
CONDUCTOR INSULATION DIA. (in)	= 0.0710
LAYER O.D. (in)	= 0.1530
LAY LENGTH (in)	= 1.300
LAY DIRECTION	-> LEFT
TENSILE MODULUS (Mpsi)	= 15.000
ULTIMATE STRESS (kpsi)	= 40.0
YIELD STRESS (kpsi)	= 30.0
POISSON'S RATIO	= 0.33
THERMAL EXPANSION COEF (10 <sup>-6</sup> /deg F)	= 9.0
SPECIFIC GRAVITY	= 8.90
SPECIFIC GRAVITY OF INSULATION	= 0.90

LAYER 2 Core Jacket

LAYER DESIGNATION	-> NON-HELICAL
ROD OR TUBE	-> TUBE
TUBE I.D. (in)	= 0.1300
TUBE O.D. (in)	= 0.1800
TENSILE MODULUS (Mpsi)	= 0.100
ULTIMATE STRESS (kpsi)	= 5.0
YIELD STRESS (kpsi)	= 3.0
POISSON'S RATIO	= 0.45
THERMAL EXPANSION COEF (10 <sup>-6</sup> /deg F)	= 70.0
SPECIFIC GRAVITY	= 0.96

LAYER 3 Inner Armor

LAYER DESIGNATION	-> ARMOR
NUMBER OF WIRES	= 16
WIRE DIA. (in)	= 0.0375
LAYER O.D. (in)	= 0.2500
LAY LENGTH (in)	= 1.596
LAY DIRECTION	-> RIGHT
TENSILE MODULUS (Mpsi)	= 28.000
ULTIMATE STRESS (kpsi)	= 300.0
YIELD STRESS (kpsi)	= 265.0
POISSON'S RATIO	= 0.30
THERMAL EXPANSION COEF (10 <sup>-6</sup> /deg F)	= 6.0
SPECIFIC GRAVITY	= 7.60

DESIGN: UNOLS-1  
 DESCRIPTION: 0.322-inch Diameter 3-Conductor Cable

LAYER 4 Outer Armor

LAYER DESIGNATION -> ARMOR  
 NUMBER OF WIRES = 22  
 WIRE DIA. (in) = 0.0375  
 LAYER O.D. (in) = 0.3250  
 LAY LENGTH (in) = 2.685  
 LAY DIRECTION -> LEFT  
 TENSILE MODULUS (Mpsi) = 28.000  
 ULTIMATE STRESS (kpsi) = 300.0  
 YIELD STRESS (kpsi) = 265.0  
 POISSON'S RATIO = 0.30  
 THERMAL EXPANSION COEF (10<sup>-6</sup>/deg F) = 6.0  
 SPECIFIC GRAVITY = 7.80

CORE Belt Over Power Conductors

INITIAL CORE I.D. (in) = 0  
 INITIAL CORE O.D. (in) = 0.1800  
 BULK MODULUS (kpsi) = 100.0  
 VOID VOLUME (%) = 0  
 SPECIFIC GRAVITY OF VOID FILLER = 0  
 THERMAL EXPANSION COEF (10<sup>-6</sup>/deg F) = 0

MAXIMUM CUSP FILL (%) = 90  
 CUSP FILL PRESSURE PARAMETER (psi) = 1000  
 HERMETIC CABLE JACKET -> NO

CABLE SOLVER 1 V4.09 CS1000 11-07-1996  
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DESIGN: UNOLS-1  
 DESCRIPTION: 0.322-inch Diameter 3-Conductor Cable

LAYER DESCRIPTION

LAYER 1 #19 AWG Conductors  
 LAYER 2 Core Jacket  
 LAYER 3 Inner Armor  
 LAYER 4 Outer Armor  
 CORE Belt Over Power Conductors

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DESIGN: UNOLS-1  
 DESCRIPTION: 0.322-inch Diameter 3-Conductor Cable

MATERIAL PROPERTIES TABLE

LAYER NUMBER	1	2	3	4
LAYER DESIGNATION	COND	NHL	ARMOR	ARMOR
TENSILE MOD (Mpsi)	15.000	0.100	28.000	28.000
ULTIMATE (kpsi)	40.0	5.0	300.0	300.0
YIELD (kpsi)	30.0	3.0	265.0	265.0
SHEAR MOD (Mpsi)	5.639	0.034	10.769	10.769
POISSON'S RATIO	0.33	0.45	0.30	0.30
TEC (10 <sup>-6</sup> /deg F)	9.0	70.0	6.0	6.0
SPECIFIC GRAVITY	8.90	0.96	7.80	7.80
SG OF INSULATION	0.90	n/a	n/a	n/a

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DESIGN: UNOLS-1  
 DESCRIPTION: 0.322-inch Diameter 3-Conductor Cable

INITIAL DESIGN

CORE: INITIAL CORE I.D. (in) = 0  
 INITIAL CORE O.D. (in) = 0.1800  
 BULK MODULUS (kpsi) = 100.0  
 VOID VOLUME (%) = 0 (4.6)  
 SPECIFIC GRAVITY OF VOID FILLER = 0  
 MASS OF VOID FILLER (lbm/ft) = 0  
 THERMAL EXPANSION COEF (10<sup>-6</sup>/deg F) = 0

LAYER OVER CORE = LAYER 3  
 INITIAL CUSP FILL (%) = 74  
 MAXIMUM CUSP FILL (%) = 90  
 CUSP FILL PRESSURE PARAMETER (psi) = 1000  
 NO HERMETIC CABLE JACKET

CONFIGURATION TABLE

LAYER NUMBER / LAYER DESIGNATION	1 COND	2 NHL	3 ARMOR	4 ARMOR
NO. OF ELEMENTS	3	1	16	22
ELMNT DIA. (in)	0.0349	n/a	0.0375	0.0375
INSLTN DIA. (in)	0.0710	n/a	n/a	n/a
LAYER I.D. (in)	0.0110	0.1300	0.1750	0.2500
LAYER P.D. (in)	0.0820	0.1550	0.2125	0.2875
LAYER O.D. (in)	0.1530	0.1800	0.2500	0.3250
DELTA O.D. (in)	0	0	0	0
DIA. BIAS (in)	0	0	0	0
LAY LENGTH (in)	1.300	n/a	1.596	2.685
LAY ANGLE (deg)	11.21	0	22.70	18.59
LAY DIRECTION	Left	n/a	Right	Left
R OF CURV (in)	1.1	n/a	0.7	1.4
COVERAGE (%)	100.8	n/a	97.8	96.6
STRENGTH (lb)	110	60	4890	6910
MASS (lbm/ft)	0.01	0.01	0.06	0.09

STRAIN (%) = 0  
 TENSION (lb) = 0  
 TORQUE (lb-in) = 0  
 ROTATION (deg/ft) = 0  
 CORE PRESSURE (psi) = 0  
 TENSILE STRENGTH SUM (lb) = 11970  
 MASS SUMMATION (lbm/ft) = 0.17

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DESIGN: UNOLS-1  
 DESCRIPTION: 0.322-inch Diameter 3-Conductor Cable

INITIAL TENSION (lb) = 0  
 FINAL TENSION (lb) = 4000  
 INCREMENT OF TENSION (lb) = 500  
 END CONDITION -> FIXED (NO ROTATION)  
 COMPRESSIBLE CORE MODEL  
 TENSION DEPENDENT CUSP FILL  
 NO BIAS

CORE: INITIAL CORE I.D. (in) = 0  
 INITIAL CORE O.D. (in) = 0.1800  
 BULK MODULUS (kpsi) = 100.0  
 VOID VOLUME (%) = 0 (4.6)  
 SPECIFIC GRAVITY OF VOID FILLER = 0  
 MASS OF VOID FILLER (lbm/ft) = 0

LAYER OVER CORE = LAYER 3  
 INITIAL CUSP FILL (%) = 74  
 MAXIMUM CUSP FILL (%) = 90  
 CUSP FILL PRESSURE PARAMETER (psi) = 1000  
 NO HERMETIC CABLE JACKET

PERFORMANCE TABLE

TENSION (lb)	STRAIN (%)	TORQUE (lb-in)	ROTATION (deg/ft)	DIAMETER (in)	PRESSURE (psi)	TEMPERATURE (deg F)
0	0	0	0	0.3250	0	0
500	0.10	15	0	0.3240	0	0
1000	0.20	27	0	0.3232	0	0
1500	0.28	38	0	0.3225	0	0
2000	0.37	49	0	0.3219	0	0
2500	0.46	60	0	0.3212	0	0
3000	0.54	71	0	0.3206	0	0
3500	0.63	81	0	0.3200	0	0
4000	0.71	91	0	0.3194	0	0

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DESIGN: UNOLS-1  
 DESCRIPTION: 0.322-inch Diameter 3-Conductor Cable

INITIAL TENSION (lb) = 0  
 FINAL TENSION (lb) = 4000  
 INCREMENT OF TENSION (lb) = 500  
 END CONDITION -> FREE TO ROTATE  
 COMPRESSIBLE CORE MODEL  
 TENSION DEPENDENT CUSP FILL  
 NO BIAS

CORE: INITIAL CORE I.D. (in) = 0  
 INITIAL CORE O.D. (in) = 0.1800  
 BULK MODULUS (kpsi) = 100.0  
 VOID VOLUME (%) = 0 (4.6)  
 SPECIFIC GRAVITY OF VOID FILLER = 0  
 MASS OF VOID FILLER (lbm/ft) = 0

LAYER OVER CORE = LAYER 3  
 INITIAL CUSP FILL (%) = 74  
 MAXIMUM CUSP FILL (%) = 90  
 CUSP FILL PRESSURE PARAMETER (psi) = 1000  
 NO HERMETIC CABLE JACKET

PERFORMANCE TABLE

TENSION (lb)	STRAIN (%)	TORQUE (lb-in)	ROTATION (deg/ft)	DIAMETER (in)	PRESSURE (psi)	TEMPERATURE (deg F)
0	0	0	0	0.3250	0	0
500	0.13	0	5.8	0.3237	0	0
1000	0.24	0	10.6	0.3227	0	0
1500	0.34	0	15.0	0.3219	0	0
2000	0.44	0	19.3	0.3211	0	0
2500	0.54	0	23.6	0.3204	0	0
3000	0.64	0	27.9	0.3196	0	0
3500	0.74	0	32.3	0.3188	0	0
4000	0.84	0	36.6	0.3181	0	0

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DESIGN: UNOLS-1  
 DESCRIPTION: 0.322-inch Diameter 3-Conductor Cable

TENSION (lb) = 4000  
 END CONDITION -> FIXED (NO ROTATION)  
 COMPRESSIBLE CORE MODEL  
 TENSION DEPENDENT CUSP FILL  
 NO BIAS

CORE: INITIAL CORE I.D. (in) = 0  
 INITIAL CORE O.D. (in) = 0.1800  
 EFFECTIVE CORE O.D. (in) = 0.1749  
 DELTA CORE O.D. (in) = -0.0051  
 BULK MODULUS (kpsi) = 100.0  
 VOID VOLUME (%) = 0 (4.6)  
 SPECIFIC GRAVITY OF VOID FILLER = 0  
 MASS OF VOID FILLER (lbm/ft) = 0

LAYER OVER CORE = LAYER 3  
 INITIAL CUSP FILL (%) = 74  
 MAXIMUM CUSP FILL (%) = 90  
 CUSP FILL PRESSURE PARAMETER (psi) = 1000  
 CUSP FILL (%) = 90  
 NO HERMETIC CABLE JACKET

CONFIGURATION TABLE

LAYER NUMBER	1	2	3	4
LAYER DESIGNATION	COND	NHL	ARMOR	ARMOR
NO. OF ELEMENTS	3	1	16	22
ELMNT DIA. (in)	0.0349	n/a	0.0375	0.0375
INSLTN DIA. (in)	0.0710	n/a	n/a	n/a
LAYER I.D. (in)	0.0107	0.1263	0.1694	0.2444
LAYER P.D. (in)	0.0797	0.1506	0.2069	0.2819
LAYER O.D. (in)	0.1487	0.1749	0.2444	0.3194
DELTA O.D. (in)	-0.0043	-0.0051	-0.0056	-0.0056
DIA. BIAS (in)	0	0	0	0
LAY LENGTH (in)	1.309	n/a	1.607	2.704
LAY ANGLE (deg)	10.83	0	22.02	18.14
LAY DIRECTION	Left	n/a	Right	Left
R OF CURV (in)	1.1	n/a	0.7	1.5
COVERAGE (%)	101.4	n/a	100.0	98.3
STRENGTH (lb)	110	60	4890	6910
MASS (lbm/ft)	0.01	0.01	0.06	0.09

STRAIN (%) = 0.71      CORE PRESSURE (psi) = 4870  
 TENSION (lb) = 4000      TENSILE STRENGTH SUM (lb) = 11970  
 TORQUE (lb-in) = 91      MASS SUMMATION (lbm/ft) = 0.17  
 ROTATION (deg/ft) = 0

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DESIGN: UNOLS-1  
 DESCRIPTION: 0.322-inch Diameter 3-Conductor Cable

TENSION (lb) = 4000  
 END CONDITION -> FIXED (NO ROTATION)  
 COMPRESSIBLE CORE MODEL  
 TENSION DEPENDENT CUSP FILL  
 NO BIAS

CORE: INITIAL CORE I.D. (in) = 0  
 INITIAL CORE O.D. (in) = 0.1800  
 EFFECTIVE CORE O.D. (in) = 0.1749  
 DELTA CORE O.D. (in) = -0.0051  
 BULK MODULUS (kpsi) = 100.0  
 VOID VOLUME (%) = 0 (4.6)  
 SPECIFIC GRAVITY OF VOID FILLER = 0  
 MASS OF VOID FILLER (lbm/ft) = 0

LAYER OVER CORE = LAYER 3  
 INITIAL CUSP FILL (%) = 74  
 MAXIMUM CUSP FILL (%) = 90  
 CUSP FILL PRESSURE PARAMETER (psi) = 1000  
 CUSP FILL (%) = 90  
 NO HERMETIC CABLE JACKET

STRESS/STRAIN TABLE

LAYER NUMBER	1	2	3	4
LAYER DESIGNATION	COND	NHL	ARMOR	ARMOR
TEN STRESS (kpsi)	39.7	0.7	61.6	124.2
TEN STRAIN (%)	0.58	0.71	0.22	0.44
SHR STRESS (kpsi)	0	0	0.4	0.1
SHR STRAIN (%)	0	0	0	0
MXTOR STRESS (kpsi)	2.0	0	1.8	0.8
MXTOR STRAIN (%)	0.04	0	0.02	0.01
MXBEN STRESS (kpsi)	*0*	0	22.5	10.4
MXBEN STRAIN (%)	*0*	0	0.08	0.04
MXEFP STRESS (kpsi)	39.8	0.7	84.1	134.6
TENSION (lb)	110	10	1010	2870
TORQUE (lb-in)	1	0	-41	132
RAD FORCE (lb/in)	100	0	1570	2180
RAD PRESS (psi)	410	0	2420	2460

LAYER(S) 1 MxEFF STRESS ABOVE YIELD.  
 STRAIN (%) = 0.71 CORE PRESSURE (psi) = 4870  
 TENSION (lb) = 4000 TENSILE STRENGTH SUM (lb) = 11970  
 TORQUE (lb-in) = 91  
 ROTATION (deg/ft) = 0

DESIGN: UNOLS-1  
 DESCRIPTION: 0.322-inch Diameter 3-Conductor Cable

TENSION (lb) - 4000  
 END CONDITION -> FREE TO ROTATE  
 COMPRESSIBLE CORE MODEL  
 TENSION DEPENDENT CUSP FILL  
 NO BIAS

CORE: INITIAL CORE I.D. (in) = 0  
 INITIAL CORE O.D. (in) = 0.1800  
 EFFECTIVE CORE O.D. (in) = 0.1734  
 DELTA CORE O.D. (in) = -0.0066  
 BULK MODULUS (kpsi) = 100.0  
 VOID VOLUME (%) = 0 (4.6)  
 SPECIFIC GRAVITY OF VOID FILLER = 0  
 MASS OF VOID FILLER (lbm/ft) = 0

LAYER OVER CORE = LAYER 3  
 INITIAL CUSP FILL (%) = 74  
 MAXIMUM CUSP FILL (%) = 90  
 CUSP FILL PRESSURE PARAMETER (psi) = 1000  
 CUSP FILL (%) = 90  
 NO HERMETIC CABLE JACKET

CONFIGURATION TABLE

LAYER NUMBER	1	2	3	4
LAYER DESIGNATION	COND	NHL	ARMOR	ARMOR
NO. OF ELEMENTS	3	1	16	22
ELMNT DIA. (in)	0.0349	n/a	0.0375	0.0375
INSLTN DIA. (in)	0.0710	n/a	n/a	n/a
LAYER I.D. (in)	0.0106	0.1252	0.1681	0.2431
LAYER P.D. (in)	0.0790	0.1493	0.2056	0.2806
LAYER O.D. (in)	0.1474	0.1734	0.2431	0.3181
DELTA O.D. (in)	-0.0056	-0.0066	-0.0069	-0.0069
DIA. BIAS (in)	0	0	0	0
LAY LENGTH (in)	1.325	n/a	1.588	2.771
LAY ANGLE (deg)	10.61	0	22.13	17.65
LAY DIRECTION	Left	n/a	Right	Left
R OF CURV (in)	1.2	n/a	0.7	1.5
COVERAGE (%)	101.5	n/a	100.7	98.5
STRENGTH (lb)	110	60	4890	6910
MASS (lbm/ft)	0.01	0.01	0.06	0.09

STRAIN (%) = 0.84 CORE PRESSURE (psi) = 6410  
 TENSION (lb) = 4000 TENSILE STRENGTH SUM (lb) = 11970  
 TORQUE (lb-in) = 0 MASS SUMMATION (lbm/ft) = 0.17  
 ROTATION (deg/ft) = 35.6

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