PULL C to B

COMPUTED RAB DATE 8-24-85
CHECKED JRB DATE 8-27-85

T_{36} Horizontal Straight $T = K L W_t = .42 \times 2.67 \times .73$

$= 0.82\#$

T_{35} Vertical Bend (90°) $T = T_{36} e^{K\theta} = 0.82\, e^{.42 \times \pi/2} = .82 \times 1.93$

$= 1.58\#$

T_{34} Down Ramp (78°) $T = W_t L (K \cos\alpha - \sin\alpha) + T_{35}$

$= .73 \times \frac{13}{12} (.42 \cos 78° - \sin 78°) + 1.58$

$= 0.88\#$

T_{33} Vertical Bend (12° $T = T_{34} e^{K\theta} = 0.88\, e^{.42 \times .21} = 0.88 \times 1.09$

$= 0.96\#$

T_{32} Vertical Straight (Down) $T = T_{33} - W_t L = 0.96 - .73 (31 + \frac{5.75}{12})$

$= -22.02\#$

T_{31} Vertical Bend (90°) $T = T_{32} e^{K\theta} = -22.02\, e^{.42 \times \pi/2} = -42.60\#$

Since a negative pulling force is built up, the cable reel will be braked to counteract it. Thus restart calculation @ T_{30}.

T_{30} Horiz. Straight $T = K L W_t + T_{31}^{\,0} = .42 \times (0 + \frac{11}{12}) \times .73 + 0$

$= 3.35\#$

T_{29} Horizontal Bend (10°) $T = T_{30} e^{K\theta} = 3.35\, e^{.42 \times .17} = 3.35 \times 1.08$

$= 3.60\#$

COMPUTED RHB DATE 8-2?-85
CHECKED JRB DATE 8-27-85

T_{28} Horiz. Straight $\quad T = \underline{K} L W_t + T_{29}$

$= .42 \times .5 \times .73 + 3.6$

$= 3.75\#$

T_{27} Horiz. Bend (10°) $\quad T = T_{28} e^{K\theta} = 3.75\, e^{.42 \times .17} = 3.75 \times 1.08$

$= 4.04\#$

T_{26} Horiz. Straight $\quad T = \underline{K} L W_t + T_{27} = .42 \times 6 \times .73 + 4.04$

$= 5.88\#$

T_{25} Vertical Bend (30°) $\quad T = T_{26} e^{K\theta} = 5.88\, e^{.42 \times .52} = 5.88 \times 1.25$

$= 7.33\#$

T_{24} Up Ramp (30°) $\quad T = W_t L (\sin\alpha + \underline{K}\cos\alpha) + T_{25}$

$= .73 \times \frac{11}{12} (\sin 30° + .42 \cos 30°) + 7.33$

$= 7.90\#$

T_{23} Vertical Bend (30°) $\quad T = T_{24} e^{\underline{K}\theta} = 7.9\, e^{.42 \times .52} = 7.9 \times 1.25$

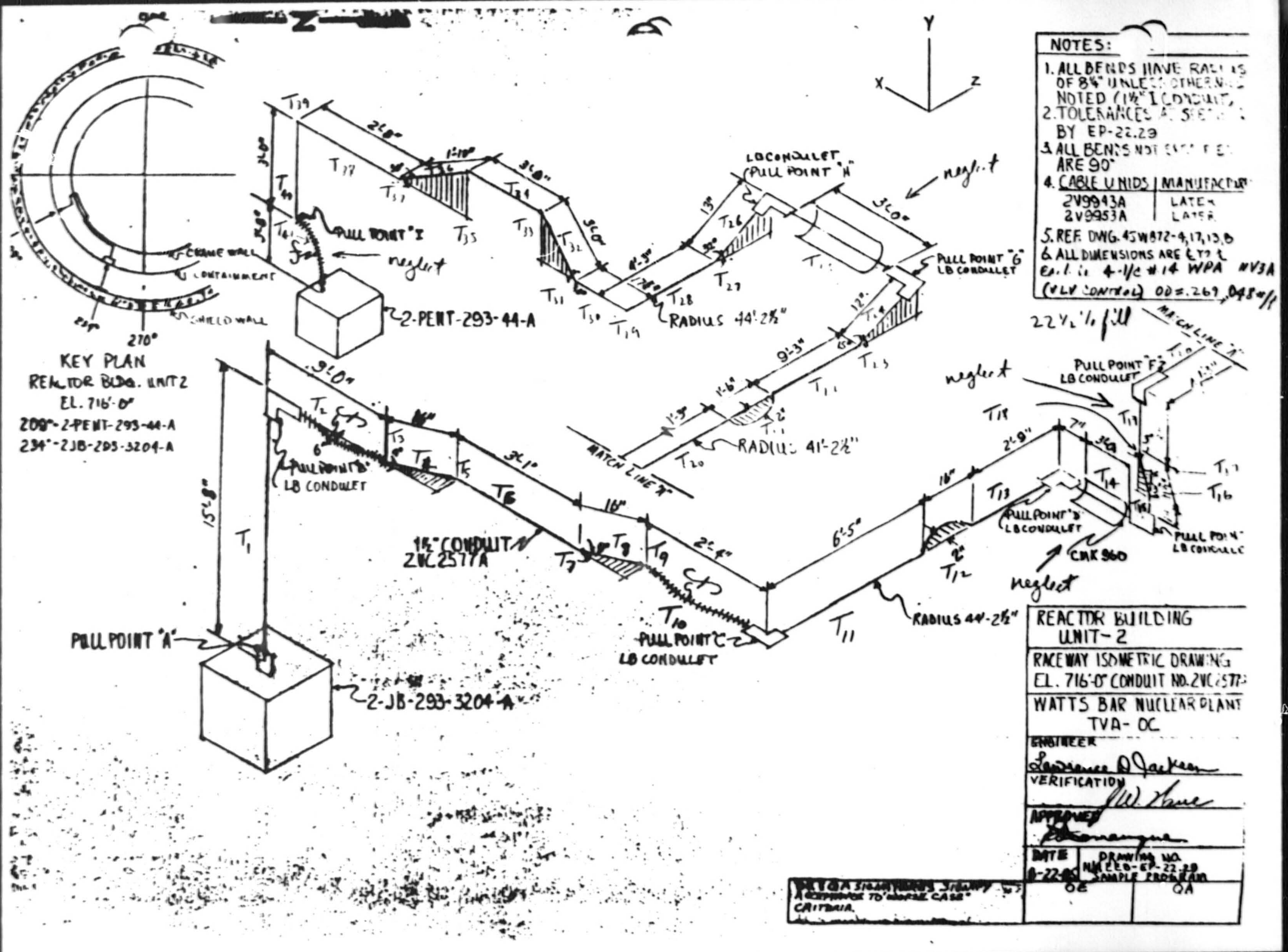
$= 9.85$

T_{22} Horiz. Straight $\quad T = \underline{K} L W_t + T_{23} = .42 \times \frac{11.5}{12} \times .73 + 9.85$

$= 10.14\#$

$SWP_{cb} = W_c T / 2R = \frac{1.4 \times 9.85}{2 \times .62}$

$SWP_{c.c} = 11.12\ \#/ft$



NOTES:
1. ALL BENDS HAVE RADIUS OF 8¼" UNLESS OTHERWISE NOTED (1½" I CONDUIT)
2. TOLERANCES AS SPECIFIED BY EP-22.29
3. ALL BENDS NOT SPECIFIED ARE 90°
4. CABLE UNIDS | MANUFACTURER
2V9943A | LATER
2V9953A | LATER
5. REF. DWG. 45W872-4,17,13,B
6. ALL DIMENSIONS ARE ℄ TO ℄
4-1/c #14 WPA NV3A
(VLV CONTROL) OD=.269, .048
22½% fill
KEY PLAN
REACTOR BLDG. UNIT 2
EL. 716'-0"
208°-2-PENT-293-44-A
234°-2JB-293-3204-A
270°
CRANE WALL
CONTAINMENT
SHIELD WALL
2-PENT-293-44-A
PULL POINT "I"
neglect
PULL POINT "H"
LB CONDULET
PULL POINT "G"
LB CONDULET
RADIUS 44'-2½"
RADIUS 41'-2½"
MATCH LINE "A"
PULL POINT "F"
LB CONDULET
PULL POINT "B"
LB CONDULET
1½" CONDUIT
2VC2577A
PULL POINT "A"
2-JB-293-3204-A
PULL POINT "C"
LB CONDULET
RADIUS 44'-2½"
PULL POINT "D"
LB CONDULET
CHK 960
PULL POINT "E"
LB CONDULET
REACTOR BUILDING
UNIT-2
RACEWAY ISOMETRIC DRAWING
EL. 716'-0" CONDUIT NO. 2VC2577A
WATTS BAR NUCLEAR PLANT
TVA-OC
ENGINEER
VERIFICATION
APPROVED
DATE
DRAWING NO.
NICEB-EP-22.29
SAMPLE PROGRAM
OE
QA

CONDUIT 2VC-2577A
(8-1/C cables)

SHEET 1 OF 5

$K = .3$, $W_t = 8 \times .048 = .384$, $W_c = 1.4$
$\underline{K} = W_c K = 1.4 \times .3 = .42$

COMPUTED RHB DATE 8-27-85
CHECKED JRB DATE 8-29-85

PULL A to B (0°)

T_1 Vertical Straight (Up) $T = W_t L = .384 \times \left(15 + \frac{8}{12}\right)$
$= 6.02\#$

There is no SideWall Pressure calculation need here since there are no bends.

PULL B to C (26°)

T_2 Horiz. Straight (Assumed; Actually a flex w/ slight offset.) $T = \underline{K} L W_t = .42 \times 3.0 \times .384$
$= .48\#$

T_3 Horiz. Bend (4°) $T = T_4 e^{\underline{K}\theta} = .48\, e^{.42 \times .07} = .48 \times 1.03$
$= .50\#$

T_4 Horiz. Straight $T = \underline{K} L W_t + T_3 = .42 \times \frac{16}{12} \times .384 + .50$
$= .71\#$

T_5 Horiz. Bend (4°) $T = T_4 e^{\underline{K}\theta} = .71\, e^{.42 \times .07} = .71 \times 1.03$
$= .73\#$

T_6 Horiz. Straight $T = \underline{K} L W_t + T_5 = .42 \times \left(3 + \frac{1}{12}\right) \times .384 + .73$
$= 1.23\#$

T_7 Horiz. Bend (9°) $T = T_6 e^{\underline{K}\theta} = 1.23\, e^{.42 \times .16} = 1.23 \times 1.07$
$= 1.32\#$

T_8 Horiz. Straight $T = \underline{K} L W_t + T_7 = .42 \times \frac{16}{12} \times .384 + 1.32$
$= 1.53\#$

T_9 Horiz. Bend (9°) $T = T_8 e^{\underline{K}\theta} = 1.53\, e^{.42 \times .16} = 1.53 \times 1.07$
$= 1.64\#$

COMPUTED RHB DATE 8-27-85
CHECKED JRB DATE 8-29-85

T_{10} Horiz. Straight (Flex) $T = \underline{k} L W_t + T_9 = .42 \times (2 + \frac{4}{12}) \times .384 + 1.64 = 2.01\#$

$SWP_{BC} = X \frac{T_9}{R} = .51 \times \frac{1.64}{.62}$, where $X = .51$ from interpolating table of values in G-38 (Section 3.4.1.6.1)

$SWP_{BC} = 1.35\ \#/ft$

PULL C to D (180' → Saddle)

T_{11} Horiz. Straight (Actually a curved section, but radius is so large, it is negligible.) $T = \underline{k} L W_t = .42 \times (6 + \frac{5}{12}) \times .384 = 1.03\#$

T_{12} Horiz. Bend (180° saddle) $T = T_{11} e^{k\theta} = 1.03\, e^{.42 \times \pi} = 1.03 \times 3.74 = 3.87\#$

T_{13} Horiz. Straight $T = \underline{k} L W_t + T_{12} = .42 \times (2 + \frac{9}{12}) \times .384 + 3.87 = 4.32\#$

$SWP_{CD} = X \frac{T_{12}}{R} = .51 \times \frac{3.87}{.62}$

$SWP_{CD} = 3.18\ \#/ft$

COMPUTED RHB DATE 8-27-85
CHECKED JRB DATE 8-29-85

PULL D to E (0°)

Negligible pull, due to short run w/ no bends.

PULL E to F (6°)

Negligible pull, due to short (vertical rise) w/ two 3° bends.

PULL F to G [195° (includes 180° saddle)]

T_{20} Horiz. Straight $T = \underline{K} L W_t = .42 \times 1.25 \times .384$
$= .20\#$

T_{21} Horiz. Bend (180° Saddle) $T = T_{20} e^{\underline{K}\theta} = .2e^{.42\pi} = .2 \times 3.74$
$= .75\#$

T_{22} Horiz. Straight $T = \underline{K} L W_t + T_{21} = .42 \times 9.25 \times .384 + .75$
$= 2.25\#$

T_{23} Vertical bend (15°) $T = T_{22} e^{\underline{K}\theta} = 2.25e^{.42 \times .26} = 2.25 \times 1.12$
$= 2.51\#$

T_{24} Up Ramp (15°) $T = L W_t (\sin\alpha + \underline{K}\cos\alpha) + T_{23}$
$= 1 \times .384 (\sin 15° + .42 \cos 15°) + 2.51$
$= 2.76\#$

$$SWP_{FG} = X \frac{T_{23}}{R} = .51 \times \frac{2.51}{.62}$$

$$\boxed{SWP_{FG} = 2.06 \ \#/ft}$$

TVA 11030 (WM-7-75)

COMPUTED RHS DATE 8-27-85
CHECKED JRB DATE 8-29-85

PULL G to H (0°)

Negligible, due to short, straight run.

PULL I to H (332°)

T_{40} Vertical Straight (up) $T = LW_t = 3 \times .384$
$= 1.15\#$

T_{39} Vertical Bend (90°) $T = T_{40} e^{Kb} = 1.15 e^{.21\pi} = 1.15 \times 1.93$
$= 2.23\#$

T_{38} Horiz. Straight $T = \underline{K} L W_t + T_{37} = .42 \times (2 + \frac{8}{12}) \times .384 + 2.23$
$= 2.66\#$

T_{37} Vertical Bend (30°) $T = T_{38} e^{Kb} = 2.66 e^{.42 \times \pi/6} = 2.66 \times 1.25$
$= 3.31\#$

T_{36} Up Ramp (30°) $T = LW_t (\sin\alpha + \underline{K} \cos\alpha) + T_{37}$
$= (1 + \frac{10}{12}) \times .384 (\sin 30° + .42 \cos 30°) + 3.31$
$= 3.92\#$

T_{35} Vertical Bend (30°) $T = T_{36} e^{Kb} = 3.92 e^{.07\pi} = 3.92 \times 1.25$
$= 4.88\#$

T_{34} Horiz. Straight $T = \underline{K} L W_t + T_{35} = .42 \times 3.75 \times .384 + 4.88$
$= 5.49\#$

T_{33} Vertical Bend (30°) $T = T_{34} e^{Kb} = 5.49 e^{.07\pi} = 5.49 \times 1.25$
$= 6.84\#$

T_{32} Down Ramp (30°) $T = LW_t (\underline{K} \cos\alpha - \sin\alpha) + T_{33}$
$= 3 \times .384 (.42 \cos 30° - \sin 30°) + 6.84$
$= 6.68\#$

T_{31} Vertical Bend (30°) $T = T_{32} e^{Kb} = 6.68 e^{.07\pi} = 6.68 \times 1.25$
$= 8.33\#$

TVA 11030 (WM-7-75)

COMPUTED RHH DATE 8-27-85
CHECKED JRB DATE 8-29-85

T_{30} Horiz. Straight $T = K L W_t + T_{31} = .42 \times \frac{17.5}{12} \times .384 + 8.33$
$= 8.56\#$

T_{29} Horiz. Bend (90°) $T = T_{30} e^{K\theta} = 8.56\, e^{.42 \times \pi/2} = 8.56 \times 1.93$
$= 16.56\#$

T_{28} Horiz Straight $T = K L W_t + T_{29} = .42 \times 4.25 \times .384 + 16.56$
$= 17.25\#$

T_{27} Vertical Bend (32°) $T = T_{28} e^{K\theta} = 17.25 e^{.42 \times .56} = 17.25 \times 1.26$
$= 21.80\#$

T_{26} Up Ramp (32°) $T = L W_t (\sin\alpha + K \cos\alpha) + T_{27}$
$= \frac{13}{12} \times .384 (\sin 32° + .42 \cos 32°) + 21.8$
$= 22.17\#$

$$SWP_{IH} = X \frac{T_{27}}{R} = .51 \times \frac{21.8}{.62}$$

$$\boxed{SWP_{IH} = 17.93 \ \#/ft}$$ Worst Case!

PULL 2-PENT-293-44-A to I

Negligible due to short vertical run of flex conduit.

PULL's H to I, G to F, D to C, C to B, B to A

These are insignificant compared to the ones already calculated, due to more downward lengths.

ATTACHMENT 7.3

WATTS BAR NUCLEAR PLANT
ELECTRICAL CABLE DATA

7/30/84

The following data on cable size and weight was compiled as a guide for design consideration in determining conduit and cable tray loading. Exact size and weight should be obtained from manufacturer's test data. Size and weight will vary even from the same manufacturer.

*Do not use unless specifically instructed to do so by the supervising engineer.

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS PER 1000 FT
WBM	#14 S/C 600V THHN BLACK	.125	.0123	NC	75	
WBN	#12 S/C 600V THHN WHITE	.12	.0145	NC	75	24
WBN-1	#12 S/C 600V THHN BLACK	.12	.0145	NC	75	24
WBN-2	#12 S/C 600V [illegible]	.12	.0145	NC	75	24
[illegible]	#12 [illegible]	[illegible]	.0145	[illegible]	[illegible]	24
[illegible]	# [illegible] S/C 600V [illegible]	.15	[illegible]	NC		
[illegible]	#10 S/C 600V THHN BL[illegible]	.15	[illegible]	[illegible]		
[illegible]	[illegible]			[illegible]	[illegible]	
[illegible]	#10 S/C 600V THHN BLUE	.15	[illegible]	NC	[illegible]	[illegible]
[illegible]	[illegible]					[illegible]
[illegible]	[illegible]		[illegible]			
[illegible]	[illegible] S/C 600V [illegible]	[illegible]				94
[illegible]	# [illegible]	[illegible]	[illegible]		[illegible]	154
WBU	#4/0 [illegible]					[illegible]
WB[illegible]	#12 S/C 600V [illegible]					[illegible]
[illegible]	#12 S/C [illegible]					[illegible]
						24

[illegible] cable availability [illegible] J.A. Ferr[illegible]

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS PER 1000 FT
WBW-2	#12 S/C 600V XHHW RED	.12	.0145	NC	75	24
WBW-3	#12 S/C 600V XHHW BLUE	.12	.0145	NC	75	24
WBW-4	#10 S/C 600V XHHW WHITE	.15	.0227	NC	75	37
WBW-5	#10 S/C 600V XHHW BLACK	.15	.0227	NC	75	37
WBW-6	#10 S/C 600V XHHW RED	.15	.0227	NC	75	37
WBW-7	#10 S/C 600V XHHW BLUE	.15	.0227	NC	75	37
WDA	#10 S/C 600V CPJ WHITE	.214	.036	NC	90	54
WDA-1	#10 S/C 600V PXJ WHITE	.214	.036	IE	90	54
WDB	#10 S/C 600V CPJ BLACK	.223	.039	NC	90	54
WDB-1	#10 S/C 600V PXJ BLACK	.223	.039	IE	[illegible]	[illegible]
[illegible]	#10 S/C 600V CPJ RED	.217	.0366	[illegible]		[illegible]
[illegible]	[illegible] PXJ BLUE	.217	.0266	[illegible]	[illegible]	54
WDC-2	#10 S/C 600V PXJ [illegible]	[illegible]	.0366	IE	90	54
WDC-3	#10 S/C 600V PXJ BLUE	.217	[illegible]	IE	90	54
[illegible]	[illegible]	[illegible]	[illegible]	IE	90	83
WDD-1	#8 S/C 600V PXJ	.323	.08[illegible]	IE	90	83
WDE	#6 S/C [illegible]			[illegible]	[illegible]	115
WDE-1	[illegible]				[illegible]	115
[illegible]	#6 S/C [illegible]					170
[illegible]	#4 S/C [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	170
WD[illegible]-2	#4 S/C 600V [illegible]	[illegible]		[illegible]	[illegible]	180
WDG	#2 S/C 600V CPJ	[illegible]	[illegible]	[illegible]	[illegible]	256
WDG-1	#2 S/C 600V PXJ	[illegible]	[illegible]	[illegible]	[illegible]	256
WDH	#1/0 S/C 600V [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	401
						[illegible].0[illegible]

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS PER 1000 FT
WDH-1	#1/0 S/C 600V PXJ	.616	.298	IE	90	401
WDJ	#2/0 S/C 600V CPJ	.664	.346	IE	90	494
WDJ-1	#2/0 S/C 600V PXJ	.664	.346	IE	90	494
WDK	#4/0 S/C 600V CPJ	.780	.478	IE	90	757
WDK-1	#4/0 S/C 600V PXJ	.780	.478	IE	90	750
WDN	300 MCM 600V CPJ	.960	.724	IE	90	1063
WDN-1	300 MCM 600V PXJ	.960	.724	IE	90	1063
WDO	400 MCM 600V CPJ	1.051	.867	IE	90	1398
WDO-1	400 MCM 600V PXJ	1.051	.865	IE	90	1398
WDP	500 MCM 600V CPJ	1.161	1.058	IE	90	1722
WDP-1	[illegible]	1.161	1.058	IE	90	[illegible]
WDP-[illegible]	[illegible]	1.12	.985	IE	90	[illegible]
[illegible]	[illegible]	1.269	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	750 MCM 600V PXJ	1.269	[illegible]	IE	90	2561
[illegible]	#12 AWG S/C 600V CPJ WHITE	[illegible]	[illegible]	[illegible]	[illegible]	40
WDV	#12 AWG S/C [illegible] CPJ BLACK	.214	[illegible]	IE	90	40
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40
[illegible]	#12 AWG [illegible]	.214	[illegible]	[illegible]	[illegible]	40
[illegible]	#12 AWG S/C [illegible] PXJ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40
[illegible]	#12 AWG S/C 600V CPJ [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	40
[illegible]-1	#12 AWG S/C 600V PXJ BLUE	[illegible]	[illegible]	[illegible]	90	40
[illegible]	[illegible]	[illegible]	[illegible]	IE	90	40
[illegible]	#2 AWG S/C [illegible]	1.0[illegible]	[illegible]	IE	90	[illegible]
W[illegible]	#4 AWG S/C [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	715

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS PER 1000 FT
WFA-3	#6 AWG 3/C 600V PXMJ	1.000	.786	IE	90	500
WFA-4	#8 AWG 3/C 600V PXMJ	.868	.592	IE	90	419
WFA-15	#6 AWG 3/C 600V PXMJ LOCA	1.000	.786	IE	90	500
WFB	#10 AWG 2/C 600V PJJ	.397	.124	IE	75	156
WFB-1	#10 AWG 2/C 600V PXMJ	.397	.124	IE	90	156
WFC	#10 AWG 3/C 600V PJJ	.487	.186	IE	75	236
WFC-1	#10 AWG 3/C 600V PXMJ	.487	.186	IE	90	236
WFD	#10 AWG 4/C 600V PJJ	.562	.248	IE	75	265
WFD-1	#10 AWG 4/C 600V PXMJ	.610	.292	IE	90	265
WFE	#10 AWG 5/C 600V PJJ	.620	.302	IE	73	312
WFE-1	#10 AWG 5/C 600V PXMJ	.675	.350	[illegible]	90	312
WFG	#[illegible] AWG 7/C 600V PJJ	.670	[illegible]	[illegible]	[illegible]	600
[illegible]	[illegible]	[illegible]	.353	[illegible]	90	400
WFH	#10 AWG 9/C 600V PJJ	.828	.538	IE	75	526
WFH-1	#10 AWG 9/C 600V PXMJ	[illegible]	[illegible]	[illegible]	[illegible]	526
[illegible]	[illegible]	[illegible]	.654	IE	75	691
[illegible]-1	#10 AWG 12/C 600V PXMJ	[illegible]	[illegible]	[illegible]	[illegible]	691
[illegible]	#1[illegible] AWG 2[illegible]	[illegible]	[illegible]	IE	75	100
[illegible]-1	#12 AWG 2/C 600V P[illegible]	[illegible]	[illegible]	[illegible]	90	100
JGC	#12 AWG 3/C 600V PJJ	.4[illegible]	.146	[illegible]	75	140
JGC-1	#12 AWG 3/C 600V PXMJ	.4[illegible]	.14[illegible]	[illegible]	90	140
GD	#12 AWG 4/C 600V PJJ	.475	.177	IE	75	180
GD-1	#12 AWG 4/C 600V PXMJ	.475	.177	[illegible]	90	180
[illegible]	#12 AWG 5/C 600V PJJ	[illegible]	[illegible]	[illegible]	75	240

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS PER 1000 FT
WGE-1	#12 AWG 5/C 600V PXMJ	.610	.292	IE	90	240
*WGG	#12 AWG 7/C 600V PJJ	.598	.281	IE	75	295
WGG-1	#12 AWG 7/C 600V PXMJ	.598	.281	IE	90	295
*WGH	#12 AWG 9/C 600V PJJ	.694	.378	IE	75	374
WGH-1	#12 AWG 9/C 600V PXMJ	.762	.456	IE	90	374
*WGK	#12 AWG 12/C 600V PJJ	.779	.476	IE	75	450
WGK-1	#12 AWG 12/C 600V PMXJ	.830	.541	IE	90	450
*WGM	#12 AWG 16/C 600V PJJ	.912	.653	IE	75	640
WGM-1	#12 AWG 16/C 600V PXMJ	.980	.528	IE	90	640
*WGN	#12 AWG 19/C 600V PJJ	.956	.718	IE	75	715
WGN-1	#12 AWG 19/C 600V PXMJ	1.03	.833	IE	90	715
[illegible]	#14 AW[illegible] P[illegible]	[illegible]	[illegible]	[illegible]	75	70
WHB-	# [illegible] AW[illegible] 2/C 600V P[illegible]	.309	[illegible]	IE	90	70
WHC	# [illegible] AW[illegible] 3/C 600V [illegible]	[illegible]	[illegible]	[illegible]	75	110
[illegible]	[illegible] AWG 3/C 600V [illegible]	.46[illegible]	[illegible]	IE	90	110
WHC-2	#14 AW[illegible] 3/C 600V P[illegible] LOCA	.30[illegible]	[illegible]	[illegible]	[illegible]	110
[illegible]	#14 A[illegible] 600V [illegible]J	[illegible]	[illegible]		75	132
WHD-1	[illegible] AWG 4/C 600V PX[illegible]	.42[illegible]	.1[illegible]	[illegible]	90	132
WH[illegible]	#14 AWG 5/C 600V P[illegible]	.4[illegible]	.1[illegible]	[illegible]	75	165
WHE-1	#14 AWG 5/C 600[illegible] PXMJ	[illegible]	[illegible]	I[illegible]	90	[illegible]65
[illegible]HE-2	#14 AWG 5/C 600V PXMJ LOCA	.50[illegible]	.19[illegible]	I[illegible]	90	[illegible]70
WHG	#14 AWG 7/C 600V PJJ	.51[illegible]	.20[illegible]	I[illegible]	75	195
WHG-1	#14 AWG 7/C 6[illegible] PXMJ	.5[illegible]	.20[illegible]	I[illegible]	90	195
[illegible]	#14 AWG 9/C 60[illegible] PJ[illegible]	.6[illegible]	.29[illegible]	I[illegible]	75	253

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS PER 1000 FT
WHH-1	#14 AWG 9/C 600V PXMJ	.624	.306	IE	90	253
*WHJ	#14 AWG 12/C 600V PJJ	.694	.378	IE	75	336
WHJ-1	#14 AWG 12/C 600V PXMJ	.795	.496	IE	90	336
WHJ-2	#14 AWG 12/C 600V PXMJ LOCA	.694	.378	IE	90	336
*WHL	#14 AWG 16/C 600V PJJ	.720	.407	IE	75	425
WHL-1	#14 AWG 16/C 600V PXMJ	1.125	1.000	IE	90	500
*WHM	#14 AWG 19/C 600V PJJ	.820	.528	IE	75	507
WHM-1	#14 AWG 19/C 600V PXMJ	.930	.679	IE	90	507
*WHS	#16 AWG 3/C 600V PJJ	.360	.102	IE	75	80
WHS-1	#16 AWG 3/C 600V PXMJ	.425	.142	IE	90	6[illegible]
[illegible]	#18 AWG 1/C 600V SIS	.11[illegible]	.01[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible] 600V SIS	.12[illegible]	[illegible]	[illegible]	[illegible]	15
[illegible]	#16 AWG 1/C 600V [illegible]	[illegible]	[illegible]	IE	150	16
[illegible]	#14 AWG 1/C 600V SIS	.145	.0165	IE	90	20
[illegible]	[illegible]	[illegible]	[illegible]	IE	150	25
WJH	#12 AWG 1/C 600V SIS	.162	.0201	IE	90	28
WJH-1	#12 AWG [illegible]	[illegible]	[illegible]	[illegible]	[illegible]	30
WJJ	#10 AWG 1/C 600V SIS	[illegible]	.02[illegible]	[illegible]	90	42
WJJ-1	#10 AWG 1/C 600V TEFZEL	.200	.03[illegible]	IE	150	50
WJK	#8 AWG 1/C 600V SIS	.26[illegible]	.05[illegible]	IE	90	70
WJK-1	#8 AWG 1/C 600V TEFZEL	.270	.0572	IE	150	80
WJN	#16 AWG 1/C 600V TEFLON	.127	.013	IE	200	11
WJN-1	#16 AWG 1/C 600V TEFLON GREEN	.127	.013	IE	200	11
WJP	#20 AWG 1/C 600V TEFLON	.058	.003	IE	200	6

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS PER 1000 FT
WJQ	#2 AWG 1/C 600V SIS	.51	.204	IE	90	240
WLB	#12 AWG 2/C 600V CPJJ	.454	.162	IE	90	150
WLC	#12 AWG 3/C 600V CPJJ	.557	.244	IE	90	205
WLG	#12 AWG 7/C 600V CPJJ	.765	.460	IE	90	405
WLH	#12 AWG 9/C 600V CPJJ	.892	.625	IE	90	595
WLJ	#12 AWG 12/C 600V CPJJ	1.05	.866	IE	90	660
WLK	#12 AWG 19/C 600V CPJJ	1.22	1.169	IE	90	1010
WLN	#10 AWG 2/C 600V CPJJ	.492	.190	IE	90	200
WLO	#10 AWG 3/C 600V CPJJ	.647	.327	IE	90	265
WLP	#10 AWG 4/C 600V CPJJ	.71	.396	IE	90	350
WLS	#10 AWG 7/C 600V CPJJ	[illegible]	[illegible]	IE	90	532
W[illegible]	[illegible] AWG [illegible] 600V CPJJ	[illegible]	[illegible]	IE	90	265
W[illegible]	#[illegible] AWG 2/C 600V CPJJ	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	.986	IE	90	600
WM[illegible]	#[illegible] AWG [illegible] 600V CPJJ	[illegible]	[illegible]	IE	90	975
WN[illegible]	#2/0 AWG 1/C 8KV CPSJ	1.11[illegible]	.980	IE	90	710
[illegible]	#2/0 AWG 1/C 8KV EPSJ	1.11[illegible]	.980	IE	[illegible]	710
WNC	#4/0 AWG 1/C 8KV CPSJ	1.21[illegible]	1.155	IE	90	1070
[illegible]C-1	#4/0 AWG 1/C 8KV EPSJ	1.21[illegible]	1.155	IE	90	1070
WND	#300 MCM 1/C 8KV CPSJ	1.29[illegible]	1.310	IE	90	1325
WND-1	#300 MCM 1/C 8KV EPSJ	1.291	1.310	IE	90	1325
WN[illegible]	#400 MCM 1/C 8KV CPSJ	1.33[illegible]	1.400	IE	90	1685

Mark No.	Description	OD	CSA	CLASS	C - TEMP	LBS PER 1000 FT
WNE-1	#400 MCM 1/C 8KV EPSJ	1.335	1.400	IE	90	1685
WNF	#500 MCM 1/C 8KV CPSJ	1.439	1.626	IE	90	2030
WNF-1	#500 MCM 1/C 8KV EPSJ	1.439	1.626	IE	90	2030
WNG	#750 MCM 1/C 8KV CPSJ	1.534	1.848	IE	90	2920
WNG-1	#750 MCM 1/C 8KV EPSJ	1.534	1.848	IE	90	2920
WNL	#6 AWG 3/C 8KV EPSJ	1.95	2.985	IE	90	1000
WPA	#14 AWG 1/C 600V SROAJ LOCA	.269	.0572	IE	90	48
WBP	#12 AWG 1/C 600V SROAJ LOCA	.290	.0663	IE	125	60
WPC	#10 AWG 1/C 600V SROAJ LOCA	.313	.077	IE	125	80
WPD	#8 AWG 1/C 600V SROAJ LOCA	.391	.120	IE	125	120
[illegible]	[illegible] 600V SROAJ LOCA	.431	.146	IE	125	[illegible]
[illegible]	[illegible] SROAJ LOCA	[illegible]	[illegible]	IE	200	170
[illegible]	[illegible] AWG [illegible] 600 [illegible]	[illegible]	[illegible]	IE	125	250
WPH	[illegible] AWG [illegible] 600V SROAJ LOCA	[illegible]	[illegible]	IE	200	350
[illegible]	[illegible]	[illegible]	.337	IE	125	550
[illegible]	#2/0 AWG 1/C 600V SROAJ LOCA	.70[illegible]	.38[illegible]	IE	125	700
WPM	[illegible] 600V [illegible]	.93[illegible]	.962	IE	125	1360
[illegible]	#12 AWG 3/C 600V SROJJ LOCA	.524	.216	IE	125	171
WRG	#12 AWG 7/C 600V SROJJ LOCA	.691	.375	IE	125	400
WRO	#10 AWG 3/C 600V SROJJ LOCA	.580	.264	IE	125	233
WRW	#8 AWG 4/C 600V SROJJ LOCA	.858	.578	IE	125	350
WRX	(2)#8 AWG (4) AWG 600V SROJJH	.800	.503	IE	200	400
WRY	#4 AWG 2/C 600V SROJJ LOCA	.915	.658	IE	125	460

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS PER 1000 FT
WST	#6 AWG 4/C TYPE SO	1.000	.785	NC	75	500
WTA	#19 AWG 50PR W/SHIELD	1.140	1.020	NC	90	660
WTB	#19 AWG 25PR W/SHIELD	.881	.610	NC	90	364
WTC	#19 AWG 18PR W/SHIELD	.759	.452	NC	90	284
WTD	#19 AWG 12PR W/SHIELD	.638	.320	NC	90	212
WTE	#19 AWG 6PR W/SHIELD	.540	.229	NC	90	135
WTF	#22 AWG 50PR W/SHIELD	.950	.441	NC	90	365
WTF-1	#22 AWG 2PR W/SHIELD	.404	.128	NC	90	
WTF-2	#22 AWG 3PR W/SHIELD	.400	.12[illegible]	NC	90	
WTF-3	#22 AWG 6PR W/SHIELD	.520	.21[illegible]	NC	90	95
WTF-[illegible]	#22 AWG [illegible] W/SHIELD	.5[illegible]	[illegible]	[illegible]	9[illegible]	
[illegible]	#22 AWG [illegible] W/[illegible]	[illegible]	.22[illegible]	NC	[illegible]	[illegible]
WTF-[illegible]	[illegible] SHIELD	[illegible]	.785	NC	90	1400
WTF-6	#[illegible] AWG 15/[illegible]	[illegible]	[illegible]	NC	90	130
[illegible]	#2[illegible] AWG [illegible]	[illegible]	.12[illegible]	NC	125	
WTF-1[illegible]	#2[illegible] AW[illegible] 2PR	.17[illegible]	.0241	NC	90	
WTG	#19 AWG 3PR W/SHIELD	.357	.100	NC	90	93
WTG-[illegible]	#19 AWG 3PR W/SHIELD	.55	.229	NC	90	110
WTH	#22 AWG 26PR W/SHIELD	.559	.245	NC	90	218
WTH-2	#22 AWG 15/C	.32	.080	NC	90	140
WTH-3	#20 AWG 7/C	.265	.055	NC	90	80
WTI	#22 AWG 50 PR	.710	.396	NC	75	770
WTI-1	#22 AWG 26 PR	.540	.229	NC	75	220
WTI-2	#22 AWG 25PR	.540	.229	NC	75	

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS PER 1000 FT
WTI-3	#22 AWG 2PR	.210	.0346	NC	75	
WTJ-2	#5 1/2" HELIAX 50 OHMS	.560	.246	NC	80	160
WTJ-3	#7 1/2" HELIAX SUPERFLEXIBLE 50 OHMS	.500	.497	NC	80	140
WTJ-4	#5 7/8" HELIAX 50 OHMS	.875	.601	NC	80	
WTJ-6	#14 1/4" HELIAX 50 OHMS	.250	.049	NC	80	
WTJ-7	#18 COAX RG 6/U	.272		NC		
WTK	#22 COAX RG59B/U	.246	.048	IE	80	50
WTK-3	#22 COAX RG59/U	.178	.025	NC	80	32
WTK-6	#22 COAX RG59B/U	.246	.048	NC	80	50
WTL-1	#18 COAX RG-11A/U	.405	.129	NC	80	96
WTL-2	#18 COAX RG-11/U	.405	.129	NC	80	96
WTL-4	#22 COAX RG58/U	.125	.0123	IE	80	
WTM-1	#[illegible] COAX RG [illegible]	.412	.133	N[illegible]	80	
WTM-5	[illegible] TWIN AX [illegible] OHMS	[illegible]		[illegible]		
WTO	#[illegible] AWG TWISTED PR	[illegible]	[illegible]77	[illegible]	90	65
WT[illegible]	#18 AW[illegible] TWISTED PR [illegible] SHIELD	.29	.06[illegible]	NC	90	70
WT[illegible]	#16 AWG TWISTED PR	[illegible]	.0[illegible]	NC	90	72
W[illegible]	#16 AWG TWISTED PR W/SHIELD	23[illegible]	.0434	NC	90	75
WTO-6	#16 AWG 2/C	21[illegible]	.0246	NC	90	
WTO-7	#18 AWG 2/C W/SHIELD	.19[illegible]	.0299	NC	90	
WTQ	#24 AWG 100PR	1.024	.817	NC	75	440
WT[illegible]	#14 AWG COAX RG34A/U	.638	.32	NC	80	274
WTU	#20 AWG TRIAX RG[illegible]/U	.476	.178	IE	110	165
WTX	#12 AWG COAX RG8/U	.419	.138	NC	80	110
WTY	#22 AWG COAX RG62/U	.250	.049	NC	80	40
WTY-1	#21 AWG COAX RG58C/U	.195	.030	IE	90	

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS.PER 1000 FT
WTY-3	#18 AWG COAX RG141/U TEFLON	.195	.030	NC	200	
WTY-4	#20 AWG COAX RG58/U	.200	.031	NC	80	27
WUB-1	T-C COPPER CONST #16 W/SHIELD	.339	.090 .209	NC	90	80
WUB-2	T-C COPPER CONST #16 W/SHIELD TEFLON	.223	.039	NC	200	75
WUP-1	T-C IRON CONST #16 W/SHIELD, TEFZEL	.223	.039	NC	150 90	80
WUP-3	T-C COPPER-CONST #16 W/SHIELD TEFZEL. 180		.025	IE	150	
WUY	T-C CHROMEL ALUMEL #20 W/SHIELD	.151	.018	NC	90	60
WVA	#16 AWG 2/C, SHIELD SIGNAL LOCA	.387	.118	IE	90	75
WVA-1	#18 AWG 2/C, SHIELD SIGNAL LOCA	.339	.090	IE	9[illegible]	58
WVA-3	#18 AWG 2/C, SHIELD TEFLON LOCA	.199	[illegible]	[illegible]	[illegible]	60
[illegible]	#16 AWG 3/C, SHIELD LOCA	.3[illegible]	.11[illegible]	IL	90	80
W[illegible]	[illegible] AWG [illegible]/C, SHIELD LOCA	[illegible]	.126	IE	90	1[illegible]
[illegible]	#20 [illegible] SHIELD LOCA	32[illegible]	.03[illegible]	IE	90	
[illegible]	[illegible]	44[illegible]	[illegible]	IE	90	126
WVE	#16 AWG 7/C, SHIELD LOCA	.536	.226	IE	90	17[illegible]
WVF	#16 AWG 9/C, SHIELD LOCA	.562	.248	IE	90	22[illegible]
WVG	#16 AWG 12/C, SHIELD LOCA	.638	.320	IE	90	27[illegible]
WVH	#16 AWG 19/C, SHIELD LOCA	.754	.446	IE	90	43[illegible]
WVI	#16 AWG 27/C, SHIELD LOCA	.920	.665	IE	90	584
WVJ	#16 AWG 37/C, SHIELD LOCA	1.00	.787	IE	90	764
WVK	#16 AWG 2/C LOCA	.353	.098	IE	90	65
WVL	#12 AWG 2/C, SHIELD LOCA	.401	.126	IE	90	95

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS PER 1000 FT
WWK	(1 PR) #22 (1 PR) #20 (2) #27 COAX	.501	.197	IE	150	170
WWL	#16 AWG 3PR, SHIELD	.600	.283	NC	80	186
WWM	#16 AWG 9PR, SHIELD	.901	.637	NC	80	430
WWN-1	#22 AWG 6PR, SHIELD (823265)	.67	.353	NC	90	190
WWN-1	#22 AWG 6PR, SHIELD	.43	.145	NC	90	95
WWN-2	#22 AWG 6PR (823265)	.65	.332	NC	90	190
WWN-2	#22 AWG 6PR	.42	.138	NC	90	93
WWN-3	#22 AWG 12 SHLD PR	1.10	.950	NC	90	
WWN-4	#16 3 SHLD PR 600V, S/C 1000V TEFZEL	.470	.173	IE	150	
WWN-5	#16 3 SHLD PR 600V, S/C 1000V TEFLON	.470	.173	NC	200	
WWZ-4	#16 AWG [illegible]	.870	.595	IE	90	
[illegible]	#20 AWG 3 SHLD PR LOCA[illegible]	[illegible]	.419	IE	90	
[illegible]	[illegible] AWG [illegible] GREEN [illegible]	[illegible]	[illegible]	NC	60	28
[illegible]AQ	#10 AWG TW GREEN, [illegible]	.167	.022	NC	60	42
WXR	#8 AWG TW GREEN, 1/C	.228	.041	NC	60	70
XFB	1000 MCM BARE COPPER	1.152	1.042	NC	N/A	3088
XFC	500 MCM BARE COPPER	.831	.542	NC	N/A	1544
XFD	4/0 AWG BARE COPPER	.528	.219	NC	N/A	653
XFE	2/0 AWG BARE COPPER	.419	.138	NC	N/A	411
XFF	1/0 AWG BARE COPPER	.373	.109	NC	N/A	326
XFG	#2 AWG BARE COPPER	.292	.067	NC	N/A	205

Mark No.	Description	OD	CSA	CLASS	C TEMP	LBS PER 1000 FT
XFH	#4 AWG BARE COPPER	.232	.042	NC	N/A	129
XFJ	#6 AWG BARE COPPER	.184	.027	NC	N/A	81
XFK	#8 AWG BARE COPPER	.146	.017	NC	N/A	51

ALL BARE COPPER CLASS "B" STRANDING

ATTACHMENT 7.4

B43 '850829 912

Guenter Wadewitz, Project Manager, Watts Bar Nuclear Plant, OC (3)

J. W. Coan, Project Manager, Watts Bar Engineering Project, P-104 SB-K

August 29, 1985

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2 - INSULATED CONDUCTOR VENDOR DATA RELATED TO SIDEWALL PRESSURE ISSUE - CLASS 1E - NSRS AUDIT FINDING I-85-06-WBN-02

An inquiry of cable manufacturers has been initiated in order to support OE's response to NSRS audit finding I-85-06-WBN-02. Letters dated July 26, 1985 (sample attached) were sent to 30 cable manufacturers requesting information related to cable furnished to TVA on each contract by each manufacturer. A total of six responses have been received as of this date. Some responses declined to provide any information. Each manufacturer's response is applicable only to his cable.

The following directives must be followed for each respective manufacturer.

Brand-Rex

Contracts: 70C7-54179-1, 71C7-54617, 71X7-54761-2, 72X7-74885-1, 72C7-75328-1, 67C3-91618-2, 68C7-61737-2, 77K5-822000, 79K5-824279-1, 80K5-824853, 80K6-825419, 81K5-828072, 82PN7-829867, 84K6-835633, 85PN2-837101, 85P7-837104, 81K9-828797, 83KN2-832166, 83K5-832289, 84K06-835633, and 84KN2-835806

1. The maximum side wall pressure allowed for each type of cable is as follows:

Unshielded Cables	500 lbs/ft.
Shielded Cables	250 lbs/ft.
Coax/Triax/Communications Cables	100 lbs/ft.

2. The nominal values of diameters have been submitted with each routine test report. Weights were not given.

Collyer Insulated Wire

Contracts: 77K5-8221733 for 2/0, 400, and 500 MCM Type EPSJ rated 8 kV; 78K5-824822 for 750 MCM Type EPSJ rated 8 kV

1. Sidewall pressure is 300 pounds per foot of radius of bend.

2. The nominal value of outside diameter, cross-sectional area, and weight are:

	2/0	400	500	750
OD (in.)	.985	1.300	1.385	1.685
Area (in^2)	.762	1.327	1.507	2.230
Weight (lb/ft.)	.85	1.87	2.23	3.31

Guenter Wadewitz
August 29, 1985

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2 - INSULATED CONDUCTOR VENDOR DATA RELATED TO SIDEWALL PRESSURE ISSUE - CLASS 1E - NSRS AUDIT FINDING I-85-06-WBN-02

General Electric

Contracts: 68C7-61985, 72C7-75025, 72C7-83426, 78K5-824443-2, and 80XN4-827518

1. The maximum sidewall pressure on new cable is estimated to be 300 times the bend radius in feet.

2. Nominal values of outside diameter, cross-sectional area, and weight:

No. Cond.	Size	Mark	No. OD	CMA* Cir Mills	Weight Lb/Ft	Sidewall++ Pressure
2	14	WHB	.370	4100	.0916	300
3	14	WHC	.390	4100	.1133	300
9	14	WHH	.628	4100	.2840	300
2	12	WGB	.409	6530	.1183	500
1	12	WDU	.185	6530	.0308	300
1	12	WDV	.185	6530	.0308	300
1	12	WDW	.185	6530	.0308	300
1	12	WDX	.185	6530	.0308	300
1	10	WDA	.210	10380	.0458	300
1	10	WDB	.210	10380	.0458	300
1	10	WDC	.210	10380	.0458	300
1	10	WDC-1	.210	10380	.0458	300
1	8	WDD	.305	16510	.0741	300
1	6	WDE	.310	26240	.1058	300
1	2	WDG	.424	66360	.2416	300

*The circular mill area applies to single metallic conductor of the size specified. For multi-conductor cables the total area is obtained by multiply the CMA by number of conductors.

++Multiply by radius of the bend in feet.

The Okonite Company

Contracts: 68C7-61986-2, 68C7-61988-2, 72C7-74910-2, 74C7-85527-2, 78K5-823412-2, 78K5-824443-1, 78K13-824701, 78K5-824749, 79K5-824754, 80K5-824920, 79K5-824930, 79K5-825342-1, 80K6-827320-2, 81K5-827750, 81K5-827928, 81K6-828538-1, 82K5-830040-1, 82K8-830135, 83PN1-832963, 84K8-835699, and 85KN8-837102

1. Maximum Sidewall Pressure

Power Cables Low and High Voltage Shielded and Nonshielded

Sizes 1/0 AWG and Larger

One 1/C Cable = 500 lbs. per ft.
Two or Three 1/C Cables = 1000 lbs. per ft.

Sizes 1 AWG and Smaller

One 1/C Cable - 300 lbs. per ft.
Two or three 1/C Cables = 500 lbs. per ft.

Multiconductor Control Cables

One Cable = 300 lbs. per ft.
Two or More = 500 lbs. per ft.

Multiconductor Instrumentation Cables

One Cable = 300 lbs. per ft.
Two or More = 500 lbs. per ft.

2. Maximum Allowable Tension

n = Number of conductors per cable
CMA = Circular mil area of each conductor
N = Number of cables

Single Conductor Cables

1 or 2 cables = .008 x N x CMA
Single Conductors Twisted (e.g., Triplex) = .008 x N x CMA
3 Conductors Parallel = .008 x (n-1) x CMA
4 or more Conductors Parallel = .008 x N x CMA x 0.6

Multiconductor Cables (2 or more conductors under a common jacket)

1 or 2 Cables Parallel = .008 x N x n x CMA
3 or more Cables Parallel = .008 x N x n x CMA x 0.6

These formulae assume all cables have the same number of conductors.

3. Nominal values of weight were not given. Nominal values of diameter are given in routine test reports.

Other data will be transmitted to your Floyd Smith as it becomes available. Questions may be directed to OE's F. B. Rosenzweig at extension 2624.

J. W. Coan

FWC:AWT:BB
Attachments
cc: RIMS, SL26 C-K
F. W. Chandler, W8C126 C-K
R. R. Reeves, P-110 SB-K

Principally Prepared By: A. W. Thomas, Extension 4795.

035238.05

ATTACHMENT 74

B43 851011 915

Guenter Wadewitz, Project Manager, Watts Bar Nuclear Plant, OC (3)

J. W. Coan, Project Manager, Watts Bar Engineering Project, W-104 SB-K

October 7, 1985

8510230011 (7)

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2 - INSULATED CONDUCTOR VENDOR DATA RELATED TO SIDEWALL PRESSURE ISSUE - CLASS 1E - NSRS AUDIT FINDING I-85-06-WBN-02

This supplements my memorandum to you dated August 29, 1985 (B43 850829 912), with additional vendor responses. Of the 30 vendors contacted, to date 13 have provided written responses (3 of whom declined to provide any pertinent information) and 2 have responded orally.

The following directives apply only to those cables furnished by the respective manufacturer.

American Insulated Wire Corporation

CONTRACTS: 75K5-865001, 77K5-821609-1, 77K5-822173-2, 77K5-822401, 77K5-822502, 77K13-822556, 78K5-822803-1, 78K5-823128, 78K5-823412-1, 78K5-824164, 78K13-824482, 79K5-824717, 79K5-824597, 79K5-824965, 79K7-825180, 79K7-825247, 79K5-825342-2, 79K8-825668-2, 78K5-825687, 79K7-825714, 79K8-825848, 80K7-827727, 80K8-827292, 80K7-827594, 81K5-827749, 81K6-828714, 81K8-828824, 81K5-828920-3, and 81K6-828538-2

Based on a telecon between OE's Rob Brooks and AIW's Bill Firth on September 10, 1985, the following maximum sidewall pressures apply to the cables provided on the above contracts:

Cross-Linked Polyethylene (XLPE) Cables	300 lbs/ft
Ethylene-Propylene Rubber (EPR) Cables	500 lbs/ft

Anaconda-Ericsson (now Ericsson-Continental Wire and Cable)

CONTRACTS: 68C7-61737-3, 68C7-61986-1, 72C7-74910-1, 72C7-83944, 73C7-83999, 74C7-85112, 74C7-85527-1, 75C7-85838, 75C7-85861, 76K5-87232, 79K5-824279-2, 78K5-824447, 79K5-825018, 79K6-825722-2, 80K6-825997, 80K5-827297, and 80K8-827380

Based on the vendor's letter to F. W. Chandler dated August 13, 1985 (B43 850923 007), and confirmed in a followup telecon between Rob Brooks and A-E's Tom Gardner on September 17, 1985, the following maximum sidewall pressures are allowed for the cables provided on the above contracts:

Power Cables (No. 8 AWG and larger)	500 lbs/ft
Control Cables (smaller than No. 8 AWG)	300 lbs/ft
Instrument and Signal Cables	100 lbs/ft

A copy of the vendor's cable installation manual which accompanied their letter is attached.

005274.02

Boston Insulated Wire and Cable

CONTRACTS: 71C7-54335, 72C7-83849, and 77K5-820991

This vendor was non-responsive, but in his letter to F. W. Chandler of September 20, 1985 (B43 850923 016), offered to provide the requested information for a fee of $450 per 8-hour day. This will be pursued.

Eaton Corporation - Samuel Moore Operations

CONTRACTS: 77K5-821722, 79K5-824860, 79K7-825651, 79K13-825696, 79K6-825772, 79K5-825852, 79K5-825874, 80K8-826598, 84K6-834607, and 85PN1-837090

Based on a telecon between Rob Brooks and Eaton's Al Clements, the following maximum sidewall pressure applies:

All Cables (above contracts)	500 lbs/ft

The Okonite Company

CONTRACTS: 68C7-61986-2, 68C7-61988-2, 72C7-74910-2, 74C7-85527-2, 78K5-823412-2, 78K5-824443-1, 78K13-824701, 78K5-824749, 79K5-824754, 80K5-824920, 79K5-824930, 79K5-825342-1, 80K6-827320-2, 81K5-827750, 81K5-827928, 81K6-828538-1, 82K5-830040-1, 82K8-830135, 83PN1-832963, 84K8-835699, and 85KF8-837102

NOTE: THE PREVIOUSLY RELEASED SIDEWALL PRESSURE LIMITATIONS FOR OKONITE CABLES PROVIDED ON THE ABOVE CONTRACTS HAVE BEEN REVISED AND ARE NOW AS FOLLOWS [based on a second vendor letter to F. W. Chandler dated September 5, 1985 (B43 850909 029)]:

1. **Sidewall Pressures**

   Low Voltage (600V-2000V) Cables

One 1/C Cable, No. 14 to No. 8 AWG	300 lbs/ft
One 1/C Cable, No. 6 AWG and Larger	500 lbs/ft
Multiple 1/C Cables, No. 14 to No. 8 AWG	500 lbs/ft
Multiple 1/C Cables, No. 6 AWG and Larger	1000 lbs/ft
Multi-Conductor Cables, No. 14 to No. 8 AWG	500 lbs/ft
Multi-Conductor Cables, No. 6 AWG and Larger	1000 lbs/ft

   Medium Voltage (5-15 kV) Shielded Cables

   Sidewall pressures are same as those listed above for low voltage cables.

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2 - INSULATED CONDUCTOR VENDOR DATA RELATED TO SIDEWALL PRESSURE ISSUE - CLASS 1E - NRC AUDIT FINDING I-85-06-WBN-02

__Boston Insulated Wire and Cable__

CONTRACTS: 71C7-54335, 72C7-83849, and 77K5-820991

This vendor was non-responsive, but in his letter to F. W. Chandler of September 20, 1985 (B43 850923 [illegible]), offered to provide the requested information for a fee of $450 per 8-hour day. This will be pursued.

__Eaton Corporation - Samuel Moore Operations__

CONTRACTS: 77K5-821722, 7[illegible]-[illegible]4[illegible]0, 79K7-825651, 79K12-825686, 79K6-825772, 79K5-825852, 79[illegible], 80K8-826398, 84K6-[illegible]607, and 85PHI-837090

Based on a telecon between Rob Brooks and Eaton's Al Clements, the following maximum sidewall pressure applies:

All Cables (above contracts) 500 lbs/ft

__The Okonite Company__

CONTRACTS: 68C7-61986-2, 68C7-61989-2, 72C7-74910-2, 74C7-83527-2, 78K5-823412-2, 78K5-824443-1, 78K13-824701, 78K5-824749, 79K5-824754, 80K5-824920, 79K5-824[illegible]0, 79K5-825342-1, 80K6-827320-2, 81K5-827750, 81K5-827925, 81K6-828538-1, 82K[illegible]-830046-1, 82K8-830135, 83PHI-832963, 84K8-835699, and 85KH8-837102

NOTE: THE PREVIOUSLY RELEASED SIDEWALL PRESSURE LIMITATIONS FOR OKONITE CABLES PROVIDED ON THE ABOVE CONTRACTS HAVE BEEN REVISED AND ARE NOW AS FOLLOWS [based on a second vendor letter to F. W. Chandler dated September 5, 1985 (B43 850909 029)]:

1. __Sidewall Pressures__

__Low Voltage (600V-2000V) Cables__

One 1/C Cable, No. 14 to No. 8 AWG	300 lbs/ft
One 1/C Cable, No. 6 AWG and Larger	500 lbs/ft
Multiple 1/C Cables, No. 14 to No. 8 AWG	500 lbs/ft
Multiple 1/C Cables, No. 6 AWG and Larger	1000 lbs/ft
Multi-Conductor Cables, No. 14 to No. 8 AWG	500 lbs/ft
Multi-Conductor Cables, No. 6 AWG and Larger	1000 lbs/ft

__Medium Voltage (5-15 kV) Shielded Cables__

Sidewall pressures are same as those listed above for low voltage cables.

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2 - INSULATED CONDUCTOR VENDOR DATA RELATED TO SIDEWALL PRESSURE ISSUE - CLASS 1E - NSRS AUDIT FINDING I-85-06-WBN-02

__Boston Insulated Wire and Cable__

CONTRACTS: 71C7-54335, 72C7-83849, and 77K5-820991

This vendor was non-responsive, but in his letter to F. W. Chandler of September 20, 1985 (B43 850923 016), offered to provide the requested information for a fee of $450 per 8-hour day. This will be pursued.

__Eaton Corporation - Samuel Moore Operations__

CONTRACTS: 77K5-821722, 79K5-824860, 79K7-825651, 79[illegible]-8[illegible]5686, 79K6-825772, 79K5-825852, 79K5-825874, 80K8-826598, 84K6-83[illegible]07, and 85PN1-837090

Based on a telecon between Rob Brooks and Eaton's Al Clements, the following maximum sidewall pressure applies:

All Cables (above contracts)	500 lbs/ft

__The Okonite Company__

CONTRACTS: 68C7-61986-2, 68C7-61988-2, 72C7-74910-2, 74C7-85527-2, 78K5-823412-2, 78K5-824443-1, 78K13-824701, 78K5-824749, 79K5-824754, 80K5-824920, 79K5-824930, 79K5-825342-1, 80K6-827320-2, 81K5-827750, 81K5-827928, 81K6-828538-1, 82K5-830040-1, 82K8-830135, 83PN1-832963, 84K8-835699, and 85KN8-837102

NOTE: THE PREVIOUSLY RELEASED SIDEWALL PRESSURE LIMITATIONS FOR OKONITE CABLES PROVIDED ON THE ABOVE CONTRACTS HAVE BEEN REVISED AND ARE NOW AS FOLLOWS [based on a second vendor letter to F. W. Chandler dated September 5, 1985 (B43 850909 029)]:

1. __Sidewall Pressures__

   __Low Voltage (600V-2000V) Cables__

One 1/C Cable, No. 14 to No. 8 AWG	300 lbs/ft
One 1/C Cable, No. 6 AWG and Larger	500 lbs/ft
Multiple 1/C Cables, No. 14 to No. 8 AWG	500 lbs/ft
Multiple 1/C Cables, No. 6 AWG and Larger	1000 lbs/ft
Multi-Conductor Cables, No. 14 to No. 8 AWG	500 lbs/ft
Multi-Conductor Cables, No. 6 AWG and Larger	1000 lbs/ft

   __Medium Voltage (5-15 kV) Shielded Cables__

   Sidewall pressures are same as those listed above for low voltage cables.

The Okonite Company (Continued)

Instrumentation Cables (includes shielded and non-shielded pairs, Triads, and Quads No. 16 AWG and smaller) — 300 lbs/ft

NOTE: THESE VALUES REVISE THE LOWER VALUES CURRENTLY PUBLISHED IN OKONITE'S "INSTALLATION PRACTICES MANUAL"

2. Testing

Where the sidewall pressure limits, listed under item 1 above, have been exceeded, Okonite recommends the following:

A. Visual examination of the pulling end of the installed cable. Any obvious damage (split jacket, deformation or flattening of the cable) could have been a result of excessive sidewall pressure.

B. A dc dielectric withstand test at 80 percent factory test voltage should be performed on all cables which were subjected to excessive sidewall pressure. The test voltage should be applied between adjacent conductors and ground in nonshielded cables.

Philadelphia Insulated Wire Company

CONTRACT: 79K13-825319

This vendor was non-responsive [based on vendor letter to F.W. Chandler dated July 31, 1985 (B43 850806 012)].

Pirelli Cable Corporation

CONTRACT: 78K5-823741

The following data for outside diameter, cross-sectional area, weight, and maximum sidewall pressure for the cables under this contract was furnished by Pirelli in a letter to F. W. Chandler dated September 3, 1985 (B43 850909 028):

Cable	Type	O.D.	C.S.A.	Wt. (lbs/MFT)	Maximum Sidewall Pressure
1/C 16 AWG 19/.0113 Bare-Copper Tefzel 280 Switchboard Wire	TZ16-1929(BC)-018 Mark WJB-1	.092	.2890	10.48	209

Pirelli Cable Corporation (Continued)

Cable	Type	O.D.	C.S.A.	Wt. (lbs/MFT)	Maximum Sidewall Pressure
1/C 14 AWG 19/.0142 Bare-Copper Tefzel 280 Switchboard Wire	TZ14-1927(BC)-020 Mark WJG-1	.110	.34	16.06	278
1/C 12 AWG .9/.0179 Bare-Copper Tefzel 280 Switchboard Wire	TZ12-1925(BC)-020 Mark WJB-1	.129	.4053	23.84	378
1/C 10 AWG 37/.0159 Bare-Copper Tefzel 280 Switchboard Wire	TZ10-3726(BC)-026 Mark WJJ-1	.162	.5089	37.18	464
1/C 8 AWG 37/.0211 Bare-Copper Tefzel 280 Switchboard Wire	TZ8-3724(BC)-026 Mark WJK-1	.216	.6786	61.47	610

The surveillance program for monitoring of reduction in qualified life of Class 1E cables if the maximum sidewall pressures are exceeded is recommended by Pirelli as follows:

1. Dynamic cut through test
2. Crush test
3. Conductor resistance test

If after exceeding the maximum sidewall pressure in installation the parameters above are within specification limits there is no reason to believe that there has been an effect on qualified life.

Raychem Corporation

CONTRACTS: 76K13-820363, 76K5-820642, 77K5-821043, 77K72-821104, 77K13-822100

In his letter to F. W. Chandler dated September 9, 1985 (B43 850916 005), the vendor provided an installation guide (attached) which details maximum pulling tensions depending upon type of pull mechanism (section 2.4). While not addressing sidewall pressure limitations per se, he does provide a figure for maximum tension at a bend which can be interpreted as a sidewall pressure limit of 500 lbs/ft (see section 2.4.2.3) for cables furnished on the above contracts.

The Rockbestos Company

CONTRACTS: 69C3-64863-1, 69C7-64923, 69C7-64924, 76K5-87235, 77K5-821042, 77K5-821729, 77K5-822173-1, 77K5-823265, 78K5-823428, 78K5-823577, 78K5-824171, 78K5-824308, 80K5-825730, 79K13-826045, 81K5-830078, 82K5-831192, 83K5-832816, and 85P7-837104-1

1. Based on their letter to F. W. Chandler dated August 14, 1985 (B43 850819 001), Rockbestos recommends the following maximum allowable sidewall pressure in pounds-per-foot of bend radius based on generic type cables furnished on the above contracts:

A.	Power, Control, Instrumentation Cables Without Shields - EPR & XLPE Insulated-Neoprene, Hypalon, PVC, XL Jacketed	1000
B.	Control, Instrumentation Cables With Foil/Polyester Shields - EPR & XLPE Insulated - Neoprene, Hypalon, PVC, XL Jacketed	1000
C.	All Cables with Copper Tape or Copper Braid Shields	500
D.	Silicone Insulated Cables	300
E.	Coaxial and Triaxial Cables	
	Solid Dielectric	200
	Foam Dielectric	150
F.	Corrugated Aluminum Sheath or Interlocked Armor Cables	400
G.	Steel Interlocked Armor Cables	500

2. Rockbestos knows of no practical test that can be made on installed cable which could establish that degradation of qualified life of Class 1E cables had occurred if recommended sidewall pressures were exceeded. Possibly some analysis such as an Arrhenius study on insulation samples could be made, but even these results would be subjected to interpretation. However, some tests could be made--such as: conductor resistance, dc voltage withstand, and insulation resistance--and based on a comparison of these results with the actual operating parameters of the cable, an engineering judgment could be made as to the present condition of the stressed cable. Once cable is in service, a repeat of these tests could be made after 1 year and results compared.

For coaxial cables, Rockbestos suggests that a check be made of other electrical parameters required for proper cable operation.

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2 - INSULATED CONDUCTOR VENDOR DATA RELATED TO SIDEWALL PRESSURE ISSUE - CLASS 1E - NSRS AUDIT FINDING 1-85-06-WBN-02

Rome Cable Corporation (formerly Cyprus)

CONTRACTS: 71C7-54762-1, 72C7-75328-3, 72C7-83874-2, 74C7-85069-1, 75K7-86150-1, 75K5-86506-3, 77K5-821609-3, and 80P5-827235

In Rome's letter to Allen Thomas dated July 29, 1985 (B43 850925 007), the following maximum cable sidewall pressure was recommended:

All Cable Types (on above contracts) 300 lbs/ft

Tamaqua Cable Products Corporation

CONTRACT: 72C7-75328-2

The vendor was non-responsive in his letter to F. W. Chandler, dated August 21, 1985 (B43 850827 010).

Triangle-Plastic Wire and Cable

CONTRACTS: 67C3-91618-1, 70C7-54179-2, 71C7-54317, 71C7-54762-2, 71C7-75128, 72C7-75228-1, 72C7-83483, 72C7-83874-1, 73C7-84528-1, 74C7-85069-2, 74C7-85528, 75C7-85744, and 75K7-86150-2

Based on a telecon between Rob Brooks and Triangle's George Strapiero on September 25, 1985, and confirmed in the vendor's letter received on September 27, 1985 (B43 850927 015), the following sidewall pressure limitation applies:

All Cables (above contracts) 100 lbs/ft

An exception to this limit is allowed for those cables installed in accordance with conditions and cable types and sizes specified in EPRI Report No. EL 3333, Volume I, Project 1519-1, entitled "Maximum Safe Pulling Length for Solid Dielectric Insulated Cable" (600V-138 kV insulation), which includes the upgraded limitations.

United Technologies, Essex Group

CONTRACTS: 72C7-75533-1, 70C7-92430, 76K5-820013, 79K8-825668-1, 79K5-825722-1, 80K6-827320-1, 81K5-828920-1, 74C7-85333, 77K5-821609-2, 79K5-825342-3, AND 84KN2-835113

Based on the vendor's letter dated September 27, 1985 (B43 850930 005), the following maximum sidewall pressure limitation applies:

All Cables (above contracts) 300 lbs/ft

-7

Guenter Wadewitz
October 7, 1985

WATTS BAR NUCLEAR PLANT UNITS 1 AND 2 - INSULATED CONDUCTOR VENDOR DATA RELATED TO SIDEWALL PRESSURE ISSUE - CLASS 1E - NRRS AUDIT FINDING
2-85-06-935-02

__United Technologies, Essex Group (Continued)__

Cables exceeding this sidewall pressure limit can be tested by applying 80 percent factory test voltage, i.e., 8.4 kV dc, for a duration not to exceed 15 minutes. Each conductor should be energized at this level, with all others in the conduit being grounded (also ground the conduit). The results should then be compared by testing similar cables which did not exceed the above limit.

We will provide you with further updates as appropriate.

J. W. Coan

RHB

FWC:RHB:RB
Attachments
cc: RIMS, SL 26 C-K
F. W. Chandler, WS C126 C-K
R. R. Reeves, P-110 SB-K

Principally Prepared By: R. H. Brooks, Jr., Extension 3344.

9-623
9-653
9-245
9-246
9-408
9-732
9-864
9-894

B05274.07

ITEM 16

Describe the manner in which the techniques used to resolve Watts Bar cable pulling and bend radii concerns have been or will be applied to the Sequoyah cable system.

RESPONSE

SQN specific cable pulling questions will be addressed in detail in TVA's response to NRC letter, B. J. Youngblood to S. A. White, dated August 29, 1986.

ENCLOSURE 2

G-38 TRAINING REQUIREMENTS FOR ELECTRICAL CRAFT AT WBNP

Training requirements for construction craft personnel at WBNP are outlined in WBN-QCI 1.11-1. As stated in QCI 1.11-1, the construction craft organization is responsible for implementing and conducting or arranging by others, on a continuing basis, training sessions on applicable QCIs, QCPs, QCTs and project and general construction specifications. In addition, the construction craft organization may choose to incorporate information from applicable quality-related documents in craft training modules for specific work. A craft training module is defined as: an accumulation of applicable information derived from QCIs, QCPs, QCTs, process specifications, general construction specifications and other design documents that contain necessary information for a craftsman to make an acceptable installation.

Organization supervisors are required to develop training matrices for individuals within their units for minimum requirements and maintain unit records of training activities. Training is always given for updating to QCI,QCP or QCT revisions after a review by the construction craft organization and the quality managers organization determine there is no change in the acceptance criteria detailed in the training module. This determination is documented in attachment C of QCI 1.11-1.

ENCLOSURE 3

ENCLOSURE 3

WBN EMPLOYEES CONCERNS RELATED TO NRC QUESTIONS ON CABLE PULLING

Concern Number	Category	Subcategory
EX-85-076-003	CO	10900
EX-85-092-003	CO	10900
HI-85-084-N03	QA	80203
HI-85-105-001	IH/QA	00000/ 80203
HI-85-113-N02	CO	10900
	CO	11300
IN-85-018-004	CO	10900
IN-85-046-N09	QA	80203
IN-85-046-001	CO	10900
IN-85-055-001	MP	70602
IN-85-097-018	NU	00000
IN-85-112-001	OP	30401
IN-85-138-X07	IH	00000
	QA	80203
IN-85-138-001	CO	19200
IN-85-138-002	NP	70200
	QA	80203
IN-85-201-001	CO	19200
IN-85-201-002	CO	10900
IN-85-201-003	CO	19200
IN-85-207-001	EN	23800
IN-85-207-002	OP	30402
IN-85-213-001	CO	10900
IN-85-241-N11	CO	10900
IN-85-241-007	CO	10900
	IH	00000
IN-85-255-001	CO	10900
IN-85-295-003	CO	10900
IN-85-300-002	CO	10900
IN-85-314-001	CO	10900
IN-85-318-001	CO	10900
IN-85-318-002	CO	10900
IN-85-318-003	CO	10900
IN-85-323-002	CO	10900
IN-85-325-005	CO	10900
IN-85-367-001	EN	23800
IN-85-425-004	CO	10900
IN-85-433-002	CO	10900
IN-85-506-001	EN	23800
IN-85-527-001	CO	10900
	MP	71600
IN-85-533-001	CO	10900
IN-85-581-001	CO	10900
IN-85-652-001	QA	80000
IN-85-743-006	EN	23900
IN-85-743-008	EN	23800
IN-85-774-006	CO	10900
IN-85-878-X01	CO	10900

1937T

IN-85-856-004	CO	19200
IN-85-856-005	CO	10900
IN-85-862-002	OP	30402
IN-85-919-001	EN	23800
IN-85-935-001	CO	10900
	CO	15100
IN-85-978-001	CO	10900
IN-85-993-001	CO	10900
	QA	80202
IN-85-978-013	CO	10100
	CO	10200
	CO	10900
	MC	40400
	MP	70605
	QA	80000
IN-85-978-012	QA	80000
	QA	80104
IN-86-028-001	CO	10900
IN-86-034-001	EN	23800
IN-86-036-001	EN	23800
IN-86-036-002	CO	10900
In-86-119-001	CO	19200
IN-86-199-001	CO	10900
IN-86-201-001	CO	10900
IN-86-206-001	EN	23800
IN-86-212-001	CO	10900
IN-86-212-002	QA	80203
IN-86-254-001	CO	10900
IN-86-254-002	CO	10900
IN-86-254-006	CO	10900
	QA	80000
	QA	80203
	QA	80502
IN-86-259-002	CO	10900
IN-86-259-004	CO	10900
	MP	71600
IN-86-259-014	CO	10900
IN-86-262-003	CO	10900
IN-86-266-X09	QA	80203
IN-86-266-001	CO	10900
IN-86-266-006	CO	10900
IN-86-310-001	EN	23800
IN-86-314-001	CO	10900
IN-86-314-002	CO	10900
OO-85-005-003	QA	80203
OW-85-007-012	CO	10900
WI-85-046-016	QA	80104
WI-85-100-012	CO	10900

ENCLOSURE 4

B43 '86 0903 904

QA Record

TO : Those listed

FROM : W. S. Raughley, Chief Electrical Engineer, W8 C126 C-K

DATE : September 2, 1986

SUBJECT: ALL NUCLEAR PLANTS - ELECTRICAL ISSUES - CLASS 1E CABLE BEND RADIUS

The purpose of this memorandum is to provide advance direction concerning the project specific actions which are necessary to resolve the outstanding concerns on the bend radius of Class 1E cables. Resolution of these concerns has been tied to plant restart/fuel load and should be scheduled for implementation accordingly.

The Electrical Engineering Branch has evaluated the adequacy of the bend radius to which Class 1E cables were installed. The basis for the evaluation was the comprehensive investigation conducted by the Nuclear Safety Review Staff on the same subject during February to April 1985. The measures specified herein are expected to comprise the majority of any project specific corrective actions resulting from this investigation. EEB's final report documenting the evaluation and providing conclusions and recommendations based upon an independent review of our evaluation will be issued in September 1986.

Each project should proceed immediately to perform the following inspections, as applicable, and to forward the results to the respective engineering projects.

1. The Watts Bar and Bellefonte projects shall inspect the installed bend radius of all Class 1E medium voltage power cable furnished by The Okonite Company. The cable shall be verified to be installed to a radius equal to 8 times its outside diameter. This inspection need not address the bend radius in standard conduit bends as this has been addressed generically in PIRGENEEB8605. The inspection of the bend radius in condulets is covered in item 2 below. Therefore, provided the project establishes that all cable tray fittings were procured with a radius equal to or greater than 8 times the outside diameter of the largest cable in question and that all conduit bends meet the minimum requirements of DS-E13.1.7, this inspection may be limited to cables in free air (transitions from raceway to raceway or raceway to equipment) and to the points of termination.

   All installations which do not conform to the specified 8 times factor shall be documented as a nonconformance and forwarded to the respective engineeering project for disposition. The documentation shall include the cable and, if applicable, the raceway number, the location of the violation, the actual installed bend radius and the results of a visual inspection noting any discernible stress on the cable jacket in the area of the bend or any cuts or ripples in the cable jacket which could indicate shield deformation.

Effective immediately, the Watts Bar and Bellefonte projects shall take the steps necessary to ensure that all medium voltage power cable furnished by The Okonite Company is installed to a bend radius of 8 times its outside diameter as opposed to the previous direction of DS-E12.1.5. This design standard is being revised accordingly.

2. All projects shall perform a field inspection of all conduits containing Class 1E medium voltage power cables for the existence of any straight-thru pull box or condulet type (C, ELL, TEE, etc.) raceway fitting or any conduit raceway fitting other than a standard conduit bend around which a cable is bent. The existence of any such fittings, including the raceway number and size, the fitting description, manufacturer (if available) and size, and the location shall be documented as a nonconformance and forwarded to the respective engineering project for disposition.

3. All projects shall determine the minimum size conduit that the following coaxial, triaxial, and twinaxial cables, if utilized in Class 1E applications and routed in conduit, are installed in. If any of these cables are installed in Class 1E applications and in a conduit smaller than indicated below, the project shall perform a field inspection for the existence of condulets of any type (ELL, TEE, etc) in which the cable is bent. The existence of any such fittings, including the raceway number and size, the fitting description, manufacturer (if available) and size and the location shall be documented as a nonconformance and forwarded to the respective engineering project for disposition. In addition, each project shall verify that the following list includes all coaxial, triaxial, and twinaxial cables installed in Class 1E applications. A positive statement to this effect or a list of additional cable mark numbers shall be addressed to my attention.

Cable Mark No.	Description	Minimum Condulet Size (Inches)
WTJ	Coax RG6A/U	2
WTJ-5	1/c #21 Coax Solid Cu Clad Steel	2
WTK	#22 Coax RG59B/U	1-1/2
WTK-1	Coax RG59B/U XLP	1-1/2
WTL	Coax RG216/U Except 3 Shlds	3
WTL-4	Coax 55 ohm #22 AWG	1-1/2
WTM	Coax RG114A/U Except 3 Shlds & ST	3
WTM-6	1/c Coax #26, 7 Strands, LOCA	3
WTY-1	#21 AWG, Coax, RG58C/U	1-1/2
WTU	#20 Triax RG 11/U	3
WTN	Triax RG-59U #22, 2 Shlds LOCA	2
WTN-1	Triax Similar to RG11/U LOCA	3
WTN-2	Twinax RG22B/U	3
WWK	TP #22 W/SH TP #20 2/c #22 2-Coax	3

4. The Watts Bar project shall perform a field inspection of all Class 1E coaxial, twinaxial, and triaxial cables which were installed or modified during the period of May 25, 1979 to May 18, 1981, under the guidance of Design Information Request (DIR) No. E-9. In addition, all projects shall inspect all Class 1E coaxial and twinaxial cables which were installed or modified during the period of September 20, 1983 to April 23, 1986, under the direction of DS-E12.1.5 Rev 0. The cable shall be verified to be installed to a bend radius equal to 8 times its outside diameter. This inspection need not address the bend radius in standard conduit bends as this has been addressed generically in PIRGENEEB8605. The inspection of the bend radius in condulets is covered in item 3 above. Therefore, provided the project establishes that all cable tray fittings were procured with a radius equal to or greater than 8 times the outside diameter of the largest cable in question or that the cable was restricted to use in conduit and that all conduit bends meet the minimum requirements of DS-E13.1.7, this inspection may be limited to cables in free air (transitions from raceway to raceway or raceway to equipment) and to the points of termination.

   All installations which do not conform to the specified 8 times factor shall be documented as a nonconformance and forwarded to the respective engineering project for disposition. The documentation shall include the cable and, if applicable, the raceway number, the location of the violation, the actual installed bend radius and the results of a visual inspection noting any discernible stress on the cable jacket in the area of the bend or any ripples in the cable jacket which could indicate shield deformation.

Each Lead Engineer should prepare a fragnet reflecting the individual project's approach and schedule for resolving these issues. Please submit a copy of this fragnet to me for my use and information.

W. S. Raughley

J. D. Collins, P-205 SB-K
G. T. Hall, DNE, DSC-A, Sequoyah
D. F. Faulkner, A7-BFN
J. L. Springer, 9-111 SB-K

TMS TMS:TLT
cc: RIMS, SL 26 C-K
R. R. Mealy, 9-113 SB-K
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Principally Prepared By: T. M. Shea, Extension 2672

TVA 64705-8-68

UNITED STATES GOVERNMENT

Memorandum

TENNESSEE VALLEY AUTHORITY

B43 '86 0717 905

QA Record

TO : Those listed

FROM : W. S. Raughley, Chief Electrical Engineer, W8 C126 C-K

DATE : July 16, 1986

SUBJECT: ALL NUCLEAR PLANTS - ELECTRICAL ISSUES - SUPPORT OF CABLES IN VERTICAL CONDUITS

PLEASE RESPOND BY AUGUST 1, 1986

Refer to my subject memorandum to Those listed dated May 21, 1986 (B43 860522 914).

The purpose of this memorandum is to provide additional direction on the evaluation process to be implemented as part of the corrective action inspection for this issue as well as to provide detailed technical guidance for the assessment of any conduits found to be deviating from the specified requirements. This memorandum supersedes the corrective action stipulated in the May 21, 1986 memorandum.

All previously installed vertical conduit runs containing Class 1E cables shall be identified and evaluated against the latest requirements of General Construction Specification G-38 for support of cables in vertical conduits. It is recommended that this effort be accomplished by a group walkdown with representatives from NUC CON, including a Quality Control (QC) inspector and the DNE Engineering Project. In determining the cable support requirements for conduits which are composed of other than straight vertical sections, the effective vertical length is equal to the nonhorizontal (vertical and inclined) sections length minus the length of the horizontal sections located directly above it. A support shall be installed whenever this effective length, as measured upward from the bottom of any nonhorizontal section, exceeds 25 percent of the spacing specified in Table 300-19(a) of the NEC. This support shall be installed at a point before the sum exceeds the spacing specified in the above table. This method recognizes the inherent support provided by a horizontal conduit run located above a nonhorizontal conduit. However no credit may be assumed for this horizontal section providing support to vertical sections located above it.

All deviations to the above shall be properly documented as nonconformances and forwarded to the DNE Engineering Project for disposition. This documentation shall include the conduit number as well as an approximate isometric diagram indicating the length of the conduit sections and the location of ELL or TEE conduit bodies if at the top of a cable run as well as the location and degree of conduit bends. For the purpose of the isometric diagram the estimated lengths for horizontal sections, when in doubt, should be conservatively shortened while nonhorizontal lengths should be conservatively lengthened. When specifying the degree of bends the conservative approach is to specify the bend in a manner which indicates a greater degree of vertical run. If an ELL or TEE conduit body exists at the top of a vertical cable run which exceeds the NEC limitations and is accessible, the cover of the conduit body shall be removed and the cable(s) inspected for adherence to the minimum bend radius requirements of G-38(DS-E12.1.5). The documentation shall clearly state whether the conduit body was inspected and identify any nonconforming conditions.

Upon receipt of the documented nonconformances, the DNE Engineering Project shall evaluate each conduit to ensure the following:

A. That the vertical cable weight does not, at any point in the run, exceed the maximum working load of the conductor. This is determined by the folowing equation which is applicable to cables with copper and thermocouple conductors of equal cross-sectional area:

$$\text{Maximum Effective Vertical Length Between Supports (ft)} = \frac{(24000)n\left(A \times \frac{\pi}{4{,}000{,}000}\right)}{7W}$$

where n = number of conductors in cable
A = circular mil area of each conductor
W = weight of cable (lb/ft) (use Max. value per mark letter)

This limitation shall be determined for each cable in the conduit.

For other conductor materials or for cables with various size conductors, contact the cable specialist.

B. That the vertical cable weight does not result in excessive cable bearing pressure being exerted on the cable(s) as it passes around a raceway bend. This is determined by the following equation:

$$\text{Maximum Effective Vertical Length Between Supports (ft)} = \frac{25 \times R \times OD}{\Sigma W \times C}$$

where R = radius of bend of conduit or support surface in inches
OD = outside diameter (use Avg. value per mark letter) of smallest cable in the conduit in inches
ΣW = sum of cable weights in lbs/ft (use Max. value per mark letter)
C = 1.0 for one cable in the conduit
.5 for more than one cable in the conduit
NOTE: The quantity (ΣW x C) shall not be less than the weight of the heaviest cable in the conduit.

This limitation shall be determined once for each conduit based on the smallest bend in the vertical run and on the smallest cable OD.

C. That the vertical cable weight does not contribute any tension, beyond that inherent in the NEC (Article 300-19) limitations, to the termination point(s) of the cable(s).

D. That the bend radius of cables in vertical conduit runs which have an ELL or TEE conduit body at the top has not been exceeded. The DNE Engineering Project shall mandate in the disposition of the nonconformance the inspection of those conduit bodies identified but not inspected during the initial walkdown as well as specifying the fix of those identified originally as nonconforming.

Conduit sections which meet the above criteria are acceptable as is. For sections that do not, engineering shall specify the location of the new supports to be added to ensure compliance with the above criteria.

In determining the Effective Vertical Length Between Supports, the DNE Engineering Project shall utilize slight modifications of the equations provided in G-38 for expected Pulling Force. This will account for the reduction in tension afforded by bends, inclines and horizontal sections located above vertical cable drops. Each project should consult with the cable specialist to review the equation modifications prior to beginning the evaluation.

Attached are sample calculations demonstrating proper application of the above principles. The technical guidelines addressed herein will be incorporated into General Construction Specification G-38..

Each Lead Engineer should revise the fragnet provided in the previous memorandum to reflect the individual project's approach and schedule for resolving this issue. Please submit a copy of this fragnet to me for my use and information by August 1, 1986.

W. S. Raughley

J. D. Collins, P-205 SB-K
G. T. Hall, DNE, DSC-A, Sequoyah
D. F. Faulkner, A7-BFN ENG
J. L. Springer, 9-111 SB-K

TMS:BB
Attachment
cc (Attachment):
RIMS, SL 26 C-K
R. R. Hoesly, 9-113 SB-K
M. L. Rayfield, P-104 SB-K
J. P. Stapleton, A10-BFN ENG
D. W. Wilson, DNE, DSC-A, Sequoyah

Principally Prepared By: T. M. Shea, Extension 2672.   036192.04

ATTACHMENT 1

A. Calculate the effective vertical length (V_E)

$V_{E1} = 0 + 10 = 10$
$V_{E2} = 10 - 20 = 0$ Note 1
$V_{E3} = 0 + 20 = 20$ Note 2
$V_{E4} = 20 + 20 = 40$
$V_{E5} = 40 - 15 = 25$
$V_{E6} = 25 + 20 = 45$
$V_{E7} = 45 + 25 = 70$ Note 3
$V_{E8} = 70 + 10 = 80$ Note 4
$V_{E9} = 80 + 20 = 100$
$V_{E10} = 100 - 50 = 50$
$V_{E11} = 50 + 25 = 75$

NOTES: 1. Since horizontal sections cannot provide support to vertical sections located above them, the effective vertical length cannot be less than 0.

2. This value exceeds 25 percent of the NEC spacing. This conduit therefore does not conform to the requirements and should be documented for further engineering evaluation.

3. The inclined section (nonhorizontal) is added as a vertical section when initially determining the effective vertical length.

4. This value equals the NEC specified spacing and, in lieu of further engineering evaluation, a support would have to be installed at some point between V_{E3} and V_{E8}. A new effective vertical length would then be determined from the point of support upward.

At this point this conduit would be documented as a nonconformance and forwarded to the DNE Engineering Project for disposition.

B. Upon receipt of the documented nonconformance, the DNE Engineering Project shall evaluate the conduit as follows:

1. Calculate the Maximum Effective Vertical Length Between Supports based on the working load of the conductor.

$$= \frac{1 \times (133{,}100\ cm \times \frac{\pi}{4{,}000{,}000})\ (24000)}{7\ (.535)}$$

$= 670$ ft

This is applicable to all three cables in the conduit since they are of equal cross-sectional area and weight. Since the effective vertical length does not at any point exceed this value, the installation is aceptable as is for this criterion.

2. Calculate the Maximum Effective Vertical Length Between Supports based on the bearing pressure limits of the cable.

$$= \frac{25 \times 8.465 \times .625}{(3 \times .535)\ .5}$$

.. = 165 ft

Since the effective vertical length at any bend does not exceed this value, the installation is acceptable as is for this criterion.

3. Calculate the effective tension on the termination point.

NEC allows a maximum of 25 percent of 80 feet or 20 feet. V_{E11} is 75 feet.

Therefore, a cable support is required at the top of the last conduit section.

4. If ELL or TEE condulets exist at the top of any of the nonhorizontal sections, they shall be inspected to verify proper cable bend radius.

<u>Summary</u>

This conduit when inspected in the field would be identified as a nonconformance. It would be appropriately documented and an isometric similar to that shown would be submitted to engineering. Following the above analytical steps, engineering would specify the installation of a single cable support located at the V_{E11} node. Note that this analysis did not take credit for the additional frictional support afforded by the bends and inclines in the conduit run. This would further reduce the effective vertical length however it would not alter the outcome as the vertical drop from node V_{E11} to V_{E10} (25') alone exceeds the maximum 25 percent value (20') allowed by the NEC.

TVA 489H (EN DES-2-78) TENNESSEE VALLEY AUTHORITY SHEET OF

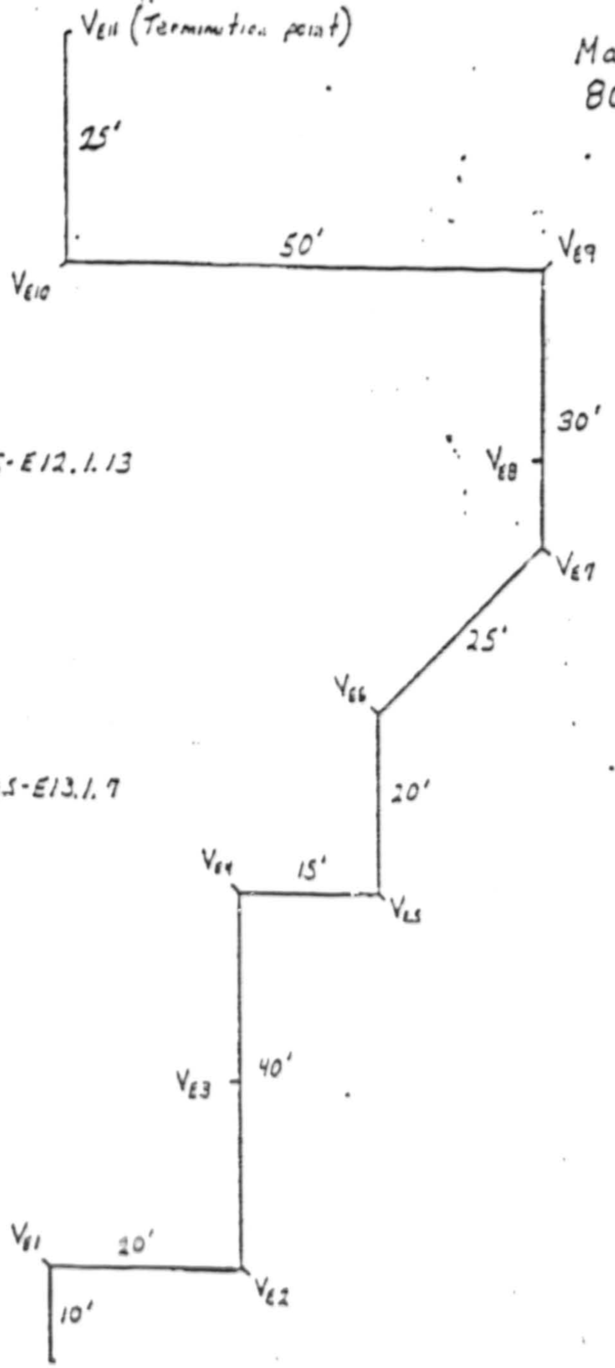
SUBJECT: Support of Cables In Vertical Conduits PROJECT: All Nuclear Plants

COMPUTED BY DATE CHECKED BY DATE

Attachment #1

3 - 1/c 2/0 Cables WDJ-4
2" Conduit

Maximum Spacing Per NEC
80 Feet



From Design Standard DS-E12.1.13

For WDJ-4
Avg OD = .625 inches
Max Wt = .535 lbs/ft

From Design Standard DS-E13.1.7

For 2" Conduit
R = 8.465 inches

2/0 Cable = 133,100 cm