ATTACHMENT

Consumers Power Company
Palisades Plant
Docket 50-255

Determination of Useful Life of Feeder Cables From the Station Power Transformer To The E-Bus Using The Arrhenius Methodology

May 25, 1988

138 Pages

OC0588-0021-NL04

Objective -

The objective of this Engineering Analysis is to determine the useful life of the General Electric Butyl Rubber insulated cable which provides power to the E-Bus from the Station Power Transformer. The useful life of the cable is to be determined using accelerated aging relationships of the Arrhenius methodology.

References

1) General Electric Data Sheet CM-646 page 3 and 8 Comparison Data on Insulations effective July 19, 1965 (page 3), effective March 30, 1964 (page 8). Data sheet WCD-112 effective October 2, 1972. (Attachment C)
2) EA-D-PAL-86-198-01 Dated 8/8/86 (Attachment D)
3) General Electric Wire and Cable Handbook, Application Data, Determination of Conductor Size, page 7. (Attachment E)
4) Palisades Workorder No. 24606784
5) Computer Program, FIECAG cable ampacity program owned by the Canadian Electrical Association. (See Attachment B)
6) EPRI Publication NP-1558, A Review of Equipment Aging Theory and Technology, provides the accelerated aging rate and incorporation of multiple operating temperatures concepts used in the analysis.

Input Analysis

1) Reference 1 provides data on the cable under analysis, General Electric Butyl Insulated, SI-58243, 1/C, 500 mcm, 5KV cable.
2) Reference 2 provides information on the cable application
3) Reference 3 includes an Arrhenius Plot of the useful life of Butyl rubber.
4) Reference 4 describes the removal of conduit and installation of tray which provides the raceway for the cable being analyzed. The conduit configuration values were used as inputs to the cable capacity/conductor temperature computer program.
5) Reference 5 is the computer program which models cable/raceway configuration and cable characteristics to determine steady state cable ampacity/temperature relationships. Section I of Attachment B is a description of the program, Section II lists assumptions and copies of the data input screens, Section III includes the ampacity results in combination with conductor temperatures for cable in conduit. Section IV includes a test report by Phillips Cables which compared cable test values with the computer program, ICEA tables, and manufacturers catalog data.

Assumptions

Cable actual currents were collected from historical records contained on microfilm.
Data on the E bus from 1972 to present has been utilized in this analysis.

1) The largest value (increased to the next 10 amps) recorded in a particular day was used in the analysis. On occasion this maximum was achieved for only a one hour duration, thus considerable margin is introduced.
2) The E Bus normally receives power from the Station power transformer but is powered from the Start-up transformer during plant shutdown except when backfeeding. The analysis assumes power is always supplied by the station power transformer, again introducing margin.
3) The General Electric Arrhenius Plot for Butyl rubber does not provide lifetime for temperatures less than 80°C. The analysis determines the current at which 80°C is reached. Current values less than those producing 80°C would increase the useful life of the cable but as the plot does not include this lower range, all lesser currents are assumed to produce 80°C.
4) The start of reduction of useful life of the cable is assumed to be March 1971, the start of the plant. Prior ambient temperatures for Butyl rubber would not reduce its useful life significantly.
5) Data that was unavailable or unreadable is assumed to produce a cable temperature of 90°C (Fully Loaded).

Analysis

The analysis determines the useful life of the Butyl rubber using the Arrhenius methodology. This methodology relates the rate of material degradation to the temperature the material experiences. Reference 3 provides a temperature-lifetime relationship. This relationship can be used to predict a useful life of a material exposed to a single temperature. The plot can also be used to relate multiple temperatures experienced by reducing amounts of lifetime from an overall "lifetime pool".

As a starting point, the 100% loading capability for the cable insulation, 90°C is selected. From the plot, this temperature yields 19 years of useful life. This value (19 years) will be the "lifetime pool" from which time will be subtracted.

In order to properly account for changes to the 90°C lifetime, the actual time duration the different temperature was experienced must be subtracted from the lifetime pool at an appropriate rate determined by the Arrhenius Plot.

A computer program has been used to model the field configuration. The computer program yields the following values:

CABLE CURRENT	CABLE TEMPERATURE, °C
1100	97°
1090	96°
1080	95°
1070	95°
1060	94°
1050	93°
1040	93°
1030	92°
1020	91°
1010	90°
840	80°

To simplify calculations and to introduce significant margin, all recorded currents less than 840 amps are assumed to produce a cable temperature of 80°C.

From the data on attachment A;
Number of Days at or below 840A is 4784 days

To simplify calculations, currents producing temperatures between 80°C and 90°C, which would increase useful life at 90°C, will be assumed to produce 90°C.

Reductions to useful life occur when currents produce temperatures greater than 90°C. From the data of attachment A;

Current*	Number of Days*	(From the Arrhenius Plot)**	
1020	10	91°C	15 years
1030	1	92°C	10 years
1040	4	93°C	7 years
1050	1	93°C	7 years
1060	2	94°C	7 years
1070	0	95°C	7 years
1080	0	95°C	7 years
1090	0	96°C	6 years
1100	1	97°C	6 years
>1100	0	-	-

* Overload currents (producing conductor temperatures > 90°C) and corresponding durations experienced at Palisades.

** Computer generated temperatures and corresponding useful lifetimes from Arrhenius Plot.

Corrections:

Current	Correction Factor		Duration (days)		Reduction to 90°C Life Pool (years)
≦ 840	- 19÷50	x	4784	÷ 365 =	- 4.98
1010	- 19÷19	x	1447	"	- 3.96
1020	- 19÷15	x	10	"	- 0.04
1030	- 19÷10	x	1	"	- 0.01
1040	- 19÷7	x	4	"	- 0.03
1050	- 19÷7	x	1	"	- 0.01
1060	- 19÷7	x	2	"	- 0.02
1070	- 19÷7	x	0	"	0
1080	- 19÷7	x	0	"	0
1090	- 19÷6	x	0	"	0
1100	- 19÷6	x	1	"	- 0.01
				Total Correction	= -9.1 years

From the Arrhenius Plot:
Useful life at 90°C (100% cable load) is 19 years.

Incorporating Correction to Useful Life:
19 years - 9.1 years = 9.9 years useful life at 90°C from 5/16/88.

Conclusion

The 9.9 year remaining value is a product of actual cable currents experienced since 1971 and assumes a 90°C cable temperature.

Fifteen hundred horsepower circulating water pumps, part of the original plant design (one of which was powered from E-Bus) are not now in use.

This factor and a review of the last few years E-Bus current data provides assurance that the larger cable currents experienced early in plant operation will not cause future cable aging at a rate greater than that which is anticipated and included in the analysis.

Attachment A

Data
Cable Ampacity
Station Transformer
to E-Bus Feeder

Cable Ampacity: Station Transformer To E-Bus Feeder: Data Reduction

AMPS	# OF DAYS
0 to 150	195
160	48
170	33
180	56
190	35
200	56
210	23
220	47
230	26
240	50
250	40
260	71
270	76
280	80
290	61
300	212
310	73
320	108
330	74
340	90
350	63
360	63
370	44
380	39
390	17
400	48
410	26
420	24

AMPS	# OF DAYS
430	16
440	44
450	31
460	51
470	29
480	41
490	33
500	89
510	42
520	117
530	36
540	52
550	49
560	55
570	55
580	93
590	63
600	130
610	52
620	50
630	36
640	43
650	34
660	56
670	59
680	99
690	74
700	99

AMPS	# OF DAYS
710	44
720	52
730	38
740	60
750	44
760	115
770	60
780	112
790	71
800	231
810	132
820	183
830	110
840	126
850	69
860	86
870	41
880	40
890	20
900	17
910	2
920	11
930	7
940	20
950	14
960	17
970	12
980	22

AMPS	# OF DAYS
990	11
1000	23
1010	7
1020	10
1030	1
1040	4
1050	1
1060	2
1070	0
1080	0
1090	0
1100	1
1110	0
1120	0

MONTH/ YEAR	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
1972																			
JANUARY	560	500	520	500	620	490	510	500	?	660	645	690	690	670	700	610	670	670	690
FEBRUARY	655	680	670	520	500	490	510	540	500	520	540	480	490	520	540	520	530	600	520
MARCH	570	640	540	610	660	640	540	680	660	660	655	645	660	690	640	610	570	490	490
APRIL	640	640	810	810	940	940	980	940	940	950	940	770	770	620	800	800	820	830	830
MAY	500	480	500	500	460	460	490	500	460	500	490	100	460	520	510	600	650	540	540
JUNE	650	680	630	640	840	840	840	840	840	800	800	830	820	860	810	840	805	820	870
JULY	800	800	800	620	?	670	840	820	820	830	820	850	840	860	625	590	830	830	840
AUGUST	870	840	880	860	840	825	860	840	860	840	840	820	820	890	840	860	840	830	780
SEPTEMBER	500	610	630	805	870	850	840	800	800	805	815	820	615	500	510	460	460	470	500
OCTOBER	800	840	820	835	840	840	820	830	820	800	860	850	870	760	620	810	805	850	580
NOVEMBER	530	530	520	540	520	550	520	520	660	560	580	620	740	860	860	830	820	830	980
DECEMBER	830	760	750	790	770	760	770	790	580	645	680	?	870	860	860	760	770	800	790
1973												Tip Eight							
JANUARY	570	540	520	530	550	510	570	520	530	580	490	520	500	500	580	580	505	500	520
FEBRUARY	580	590	660	650	660	810	835	950	940	890	940	950	940	940	940	940	920	930	930
MARCH	950	980	970	960	702	960	970	?	?	1000	1000	1000	1000	970	970	960	1000	1000	1010
APRIL	1060	1000	1020	980	960	970	1000	980	1000	980	1000	950	980	1000	1000	1000	1000	990	630
MAY	1010	990	985	1020	1020	1040	1020	1010	980	995	1020	1040	950	1100	960	920	970	1020	1040
JUNE	985	950	940	920	960	950	940	980	1020	1020	950	1015	1045	915	980	980	960	950	920
JULY	925	940	940	930	990	990	960	960	960	1010	800	520	540	595	540	540	540	490	500
AUGUST	490	490	490	540	500	520	500	480	490	535	500	500	500	520	490	460	490	480	500
SEPTEMBER	500	525	525	500	520	470	470	525	540	560	530	530	490	480	500	520	620	560	550
OCTOBER	200	210	190	190	215	210	230	215	220	200	200	200	200	210	210	260	230	190	220
NOVEMBER	220	195	230	220	230	240	250	220	140	220	190	180	180	180	190	150	180	150	130
DECEMBER										Folded so		I couldn't read it							

MONTH/ YEAR	20	21	22	23	24	25	26	27	28	29	30	31
1972												
JANUARY	670	670	650	640	650	660	710	680	680	670	660	690
FEBRUARY	500	540	520	520	520	670	590	570	580	550		
MARCH	510	625	530	630	645	690	660	650	670	680	670	690
APRIL	820	820	690	795	820	510	510	500	490	460	470	
MAY	490	470	530	530	530	570	510	480	500	480	520	520
JUNE	860	880	850	620	460	610	830	810	840	830	860	
JULY	860	810	800	820	840	820	845	850	790	470	640	650
AUGUST	770	780	760	860	400	920	890	890	?	500	660	640
SEPTEMBER	500	510	640	815	840	860	820	815	790	800	780	
OCTOBER	790	760	760	550	510	500	500	480	460	460	490	490
NOVEMBER	980	1000	980	970	980	970	940	960	860	840	860	
DECEMBER	770	825	840	820	810	770	800	780	810	810	780	760
1973												
JANUARY												
FEBRUARY	520	530	570	525	520	520	500	130	220			
MARCH	980	1000	1000	1005	970	970	1010	?	800	980	970	?
APRIL	1000	960	960	995	1040	1060	1000	1000	980	955	1015	
MAY	510	520	490	450	110	590	590	470	630	670	695	980
JUNE	980	1010	1000	990	910	945	945	960	960	950	1025	
JULY	970	915	990	980	990	980	940	930	940	920	950	920
AUGUST	520	500	500	520	530	500	500	520	500	540	530	520
SEPTEMBER	490	500	470	460	500	500	500	520	500	490	470	
OCTOBER	510	150	150	170	200	210	200	210	190	210	200	210
NOVEMBER	220	210	170	210	200	150	210	220	230	240	220	
DECEMBER	120	120	125	110	140	110	120 →		150	180	120 →	

← some were very light + hard to read this month

MONTH/ YEAR	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
1974																			
JANUARY	120	130	130	150	160	140	160	200	180	270	200	110	110	160	130	120	130	125	110
FEBRUARY	160	200	190	220	220	220	230	220	140	120	150	160	150	150	180	150	125	130	150
MARCH	220	180	180	210	210	160	220	175	180	170	180	200	200	200	175	130	110	130	130
APRIL	120	125	120	125	125	120	110	120	190	180	180	170	160	150	190	190	190	175	150
MAY	160	180	180	150	170	170	110	110	100	120	110	100	100	100	180	190	160	240	320
JUNE	130	130	170	140	130	140	150	130	130	130	130	150	150	140	130	130	130	120	140
JULY	180	180	180	160	170	160	180	160	175	170	160	170	150	150	150	150	140	130	130
AUGUST	140	130	130	120	170	215	220	160	180	190	170	200	330	260	240	310	240	260	260
SEPTEMBER	250	270	290	290	270	260	290	190	200	200	200	200							
OCTOBER					440								460						
NOVEMBER						260								200					
DECEMBER																			
1975			Sept 74 → Jan 75 - Blankenship motor files																
JANUARY														180	220	170	200	190	→
FEBRUARY	150	160	150	160	→		170	180	170	155	150	140	220	150	→	140	150	→	
MARCH	150	→		140	150	→	160	175	150	→	140	→		150	→	160	150	140	160
APRIL	270	265	430	→	420	410	420	570	580	560	580	570	560	550	→	570	580	600	590
MAY	570	→	590	570	550	560	580	570	560	550	560	560	580	550	550	550	550	560	570
JUNE	590	600	570	615	580	570	510	580	590	550	590	600	590	580	→	600	→		580
JULY	300	446	460	570	→	580	610	600	615	600	580	→	590	580	610	→	580	575	560
AUGUST	600	580	590	600	610	600	→	580	570	580	575	440	600	600	610	700	330	210	
SEPTEMBER	615	620	620	600	→	580	200	290	280	310	400	620	620	610	→	610	600	620	610
OCTOBER	620	600	620	610	630	640	640	665	640	—	→			650	630	→	600	580	590
NOVEMBER	445	590	600	640	620	610	→	600	→	620	→		→	600	595	610	→	590	600
DECEMBER	600	580	590	440	→	→	430	440	460	440	460	580	560	→	590	590	600	→	→

MONTH/ YEAR	20	21	22	23	24	25	26	27	28	29	30	31
1974												
JANUARY	~~2100~~	130	150	150	130	130	120	100	120	190	190	230
FEBRUARY	150	150	140	150	160	180	220	240	230			
MARCH	120	120	120	120	120	125	120	200	130	120	110	110
APRIL	130	110	110	190	190	190	190	160	170	160	170	
MAY	190	250	180	160	180	140	160	150	160	160	160	150
JUNE	150	150	180	190	180	170	175	170	180	180	190	
JULY	130	130	120	130	150	130	140	130	140	150	130	140
AUGUST	250	250	240	240	240	240	240	300	260	200	190	180
SEPTEMBER								410				
OCTOBER		450	1~		44c							
NOVEMBER			190									
DECEMBER												
1975												
JANUARY	200	190	200 →		180 →		200	190	200	200	180	160
FEBRUARY	140 →		150	130 →		150	→		140			
MARCH	170	→		200	160	170	155	190	200	220	340	270
APRIL	540	600	590	300	450	590	590	450 →		580	590	
MAY	570	565	515	570	580	590	570	580 →		585	580	590
JUNE	590	260	220	200	→	180	190	195	170	250	260	
JULY	540	600	580 →		670	630	600 →		300	290	310	620
AUGUST	210 →		330	→		490	620	630 →		610	→	600
SEPTEMBER	610	620	610	610	625	670	620	610	620	650	650	
OCTOBER	600	600	610	615	610	600	575	620 →		270	240 →	
NOVEMBER	600	→			?	620	610	600 →			?	
DECEMBER	580	200	180	155	150 →			?	160	190	165	160

MONTH/ YEAR	20	21	22	23	24	25	26	27	28	29	30	31
1976												
JANUARY	130	150	170	160	180	150	150	180	200	180	320	300
FEBRUARY	270	→	→	290	300	210	280	→	270	240		
MARCH	260	280	300	270	260	265	270	280	270	265	250	270
APRIL	247	248	245	330	→	260	270	265	245	150	110	
MAY	?	460	610	→	620	640	→	680	→	670	680	660
JUNE	670	680	→	700	→	680	690	670	680	700	690	
JULY	690	320	220	240	330	340	640	700	→	→	690	695
AUGUST	700	680	670	700	435	330	370	350	340	510	650	660
SEPTEMBER	510	710	700	680	700	690	650	690	600	550	680	
OCTOBER	650	220	300	180	170	190	300	360	520	660	→	→
NOVEMBER	670	690	710	690	660	350	640	340	480	670	680	
DECEMBER	892	860	850	860	890	800	850	860	860	840	840	840
1977												
JANUARY	820	→	810	780	900	820	810	820	810	820	830	790
FEBRUARY	790	810	800	780	820	780	815	810	—	~	~	~
MARCH	800	810	—	—	→	460	395	730	670	720	→	800
APRIL	500	500	720	700	710	740	720	700	760	740	700	
MAY	170	180	170	300	320	—	480	510	650	680	→	660
JUNE	680	—	—	—	?	690	680	700	→	685	700	
JULY	680	690	→	700	700	710	700	685	700	685	670	505
AUGUST	170	180	175	300	→	→	660	→	?	680	→	→
SEPTEMBER	680	710	695	700	680	340	350	680	→	→	690	
OCTOBER	690	680	680	660	→	680	710	690	690	675	675	665
NOVEMBER	730	720	740	705	780	→	8	550	400	700	720	
DECEMBER	770	780	760	750	720	780	790	770	745	760	780	750

MONTH/ YEAR	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
1976																			
JANUARY	250	150	160	150	160	165	160	150 →	130	140	150 →	→	→	180	160	150 →			
FEBRUARY	300	320	300	330 →	340	320	300	330	310	310	300	290	320	290	300	→			
MARCH	(280) →	270	270	290	280	300	280	260	270	300	270	300 →	280	300	→	280			
APRIL	280 →	260	280	250	220	260	295	265	260	290	260	260	240	→	235	240	250		
MAY	230 →	240	260	270	300	280	300	280	300	290	300	150	280	275	280	290	300	300	
JUNE	670	650 →	→	640 →	→	650	660	→	650	660	670	680	690	675	680	670			
JULY	650	340 →	320	360	690 →	700	690	660	670	680	690	680 →	690	680	665	680			
AUGUST	690	700	→	690	680	710 →	715	710	700 →	680 →	710	690	720	690	720				
SEPTEMBER	660	690	700	680 →	670	690	700 →	690 →	680	660	700	690	700	680 →	660				
OCTOBER	700	670	660	680	670	695	690	700	700	660	660	660	670 →	680	680	670	680	685	
NOVEMBER	670	660 →	670	→	680	→	670	695	645	200	190	200	300	340	475	660			
DECEMBER	700	340	520	720	710	715	780	770	760	770	800 →	810	780	760	780	800	780	770	
1977																	one missing		
JANUARY	820	→	→	840 →	780	820 →	830	~~830~~ 780	480	800	790	870	920	780	820	91			
FEBRUARY	800	840	800	820	840	830	820	790	800	760	780	790	800	810	830	840	820	810	780
MARCH	830	810	795	760	750	740	750 →	720	→	→	700	730	760	740	780	820	820		
APRIL	760	720	760	730	790 →	720	620	740	720	690	700	680	700	680	660	670	680	670	
MAY	680	690	710	700	680	670	660	680	670	660	→	650 →	630	200 →	180	180			
JUNE	700	680	690	670	680	670	680	→	→	690	680	690	700	680	680	700	670	690	
JULY	690	675	680	680	700	680	690	700	680	685	700	680	700	690	680 →	640	660	690	
AUGUST	700 →	→	→		?	670	690	685	690	680	690	640	690	690	655	?	?	245?	
SEPTEMBER	700	680	690	675	680	690	690	?	700	690	680	700	690	670	670	680	?	670	680
OCTOBER	695	680	690	670 →	→	710	→	→	700 →	710	700	710	690 →	730	690	670			
NOVEMBER	670 →	660	640	660	→	→	670	720 →	700	720 →	810	730	760	→					
DECEMBER	725	710	760	740	730 →	750	775	765	710	420	570	700	735	740	735	730	715	730	

MONTH/ YEAR	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
1978	1978																		
JANUARY	760	→	→	→	770	?	370	380	→	325	300	330	300	310	→	280	290	300	310
FEBRUARY	?	305	295	310	→	330	340	300	320	300	?	300	230	300	290	300	→	320	300
MARCH	300	→	280	315	280	290	300	260	280	300	?	270	280	→	290	270	280	→	270
APRIL	260	240	250	280	270	270	300	330	350	440	420	400	350	375	380	415	380	445	?
MAY	740	420	265	270	280	260	370	400	365	410	420	→	700	770	760	720	740	700	710
JUNE	760	700	710	710	700	710	[illegible]	700	720	690	700	?	700	560	710	→	730	700	710
JULY	290	270	400	360	725	750	715	430	540	→	700	700	→	720	730	720	730	740	730
AUGUST	290	320	290	280	400	400	710	710	720	730	710	710	705	720	730	→	?	760	710
SEPTEMBER	300	→	410	290	310	→	315	355	350	440	450	695	685	310	300	555	680	700	740
OCTOBER	730	690	?	360	220	340	650	640	720	660	270	300	230	285	410	680	700	730	750
NOVEMBER	800	760	→	740	735	785	760	790	800	760	→	770	770	800	→	790	780	780	770
DECEMBER	300	→	→	→	→	>	410	460	→	→	660	450	440	420	475	?	450	620	640
1979																			
JANUARY	600	570	590	585	610	→	650	630	640	635	650	635	610	600	650	610	570	600	610
FEBRUARY	570	500	590	600	610	620	600	610	600	610	630	610	590	600	600	590	610	600	640
MARCH	630	580	600	→	580	760	740	720	740	750	760	750	750	715	760	→	750	?	720
APRIL	540	→	590	600	580	590	550	460	→	440	570	560	580	600	580	?	580	585	600
MAY	?	240	240	245	280	250	260	235	260	300	260	275	280	→	250	260	250	340	40
JUNE	560	590	580	600	→	560	560	570	540	420	→	?	?	?	580	?	390	550	540
JULY	530	540	570	560	560	590	600	590	560	600	590	620	600	580	580	575	570	580	580
AUGUST	580	600	570	550	545	570	590	600	→	→	→	580	600	590	565	620	550	560	525
SEPTEMBER	580	→	→	600	610	590	590	590	460	410	290	330	360	255	290	280	300	→	275
OCTOBER	270	→	→	290	?	280	270	?	260	270	220	230	235	210	200	240	230	210	260
NOVEMBER	280	250	230	225	220	270	300	360	300	250	245	260	240	→	→	280	240	270	270
DECEMBER	300	?	280	310	290	→	300	305	315	275	270	300	→	→	340	290	300	230	240

MONTH/ YEAR	20	21	22	23	24	25	26	27	28	29	30	31
1978												
JANUARY	300	330	300	?	370	270	280	→	→	290	320	300
FEBRUARY	330	300	?	300	290	325	285	300	260			
MARCH	265	240	260	235	260 →	→	→	→	→	→	250	260
APRIL	?	400	430	440	560	570	660	710	680	700	720	
MAY	?	710	700	?	610	690	?	680	700	700	740	740
JUNE	710	720	740	740	720	700	700	720	740	?	320	
JULY	750	760	760	?	715 →	→	?	725	730	715	690	695
AUGUST	715	740	→	→	780	755	740	735	760	420	380	330
SEPTEMBER	750	720	745	330	290	405	560	690	710	730	700	
OCTOBER	740	750	730	800	750	760	→	→	730	770	775	775
NOVEMBER	750	800	780	805	770	730	770	815	800	450	295	
DECEMBER	630 →	→	625	610	630	600	610 →	→	600	620 →	→	610
1979												
JANUARY	580	600	→	→	570	560	570	560	630	560 →	→	600
FEBRUARY	580	600	600	620	600	590	580	640	655			
MARCH	740	760	750	730	720	710	720	730	740	730	580	550
APRIL	520	550	540	540	550	585	550	590	580	600	580	[illegible]
MAY	380	420	570 →	→	580 →	→	590	570	590 →	→	600	590
JUNE	560	550	600	540	560	540	?	240	410	575	530	
JULY	560	550	540	580	600 →	→	560	550	590	540	560	630
AUGUST	530	600	610	600	570	470	430	580	545	575	610	600
SEPTEMBER	260	230	270	260	300 →	→	285	270	285	300	280	—
OCTOBER	240	----	→	270	305	?	280	240	220 →	→	260 →	→
NOVEMBER	240	260	270	245	305	300	285	280	310	360	310	
DECEMBER	295	300	270	→	250 →	→	260	300	300	290	275	260

Check 2 48 etc!

MONTH/ YEAR	20	21	22	23	24	25	26	27	28	29	30	31
1980												
JANUARY	320	300 →		320	300	315	280	290	315	320	350 →	
FEBRUARY	340 →		300	300	320 →				→	360	—	
MARCH	280 →		295	280 →		300	330	280	300	280	260	255
APRIL	160	170	160	180	200	175	205	250	260 →		280	—
MAY	380	325	340	350	350	360	370	325	535	545	590	580
JUNE	600	560	570	580	640	630	640	635	?	600	600	—
JULY	630	615	600	600	650	630	640	600	—			→
AUGUST	610	600	?	590	560	590	580	540	460	330	360	470
SEPTEMBER	600	580	600	580	590	610	570	575	570	580	570	
OCTOBER	750	740	740	740	730	710	760	710	760	790	790	420
NOVEMBER	250	260	300	220	230	240	220	200	200	200	200	200
DECEMBER	900	840	870	470	820	780	860	830	810	800	815	825
JANUARY												
FEBRUARY												
MARCH												
APRIL												
MAY												
JUNE												
JULY												
AUGUST												
SEPTEMBER												
OCTOBER												
NOVEMBER												
DECEMBER												

MONTH/ YEAR	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
1980																			
JANUARY	260	360	300	——→		280	310	320	335	330	300	325	310	300	320	310	300	→	310
FEBRUARY	300	305	310	305	300	290	275	260	→	310	350	320	400	410	400	→	380	330	340
MARCH	320	340	300	340	360	375	340	310	300	→	320	——→		310	315	260	320	300	280
APRIL	300	——→		350	270	250	240	295	300	→	270	295	210	290	270	310	280	230	150
MAY	?	275	290	260	→	255	270	265	→	365	400	375	420	→	425	390	320	380	400
JUNE	560	→	570	550	595	570	560	550	570	560	→	→	600	590	600	555	440	440	580
JULY	600	580	400	380	230	230	360	330	450	420	440	580	760	640	430	615	615	575	620
AUGUST	600	——→		560	620	615	600	→	580	620	600	590	610	600	→	550	→	570	560
SEPTEMBER	590	630	580	720	580	585	570	580	?	580	610	600	580	600	→	590	580	560	600
OCTOBER	560	570	730	730	700	720	710	700	740	400	730	760	→	750	720	780	720	710	→
NOVEMBER	300	——→		320	290	300	300	200	170	220	220	260	260	300	250	160	220	220	220
DECEMBER	230	400	360	450	?	375	380	350	450	470	440	480	460	630	770	770	800	825	830
JANUARY																			
FEBRUARY																			
MARCH																			
APRIL																			
MAY																			
JUNE																			
JULY																			
AUGUST																			
SEPTEMBER																			
OCTOBER																			
NOVEMBER																			
DECEMBER																			

MONTH/ YEAR	01	02	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
1981	8																		
JANUARY	820	→	520	840 500	840 710	870	930	880	880	860	850	860	810	820	→	850	850	820	830
FEBRUARY	845	850	860	850	840	→	810	840	880	840	885	890	840	810	840	870	800	780	830
MARCH	820	810	840	830	840	→	820	—	810	820	840	840	830	820	855	830	820	820	830
APRIL	740	780	800	780	810	810	800	810	820	800	790	800	790	800	—	→	770	→	820
MAY	760	745	740	→	770	770	800	770	740	760	800	820	800	840	800	760	—	→	→
JUNE	?	790	800	790	830	840	800	820	?	800	760	800	—	→	810	820	780	810	820
JULY	800	—	→	780	800	810	830	810	→	780	750	440	340	340	200	250	270	→	280
AUGUST	300	→	340	360	460	420	430	410	?	600	500	630	820	810	780	→	800	760	800
SEPTEMBER	275	250	240	240	220	200	→	220	240	290	250	260	220	260	220	230	220	250	220
OCTOBER	370	350	360	370	350	—	→	440	350	380	340	310	330	360	400	350	370	360	400
NOVEMBER	300	320	340	—	—	→	320	270	340	→	330	370	350	360	320	300	210	230	300
DECEMBER	240	290	250	260	360	340	350	340	450	530	540	360	360	530	510	500	560	550	→
1982																			
JANUARY	550						810	810	830	890	860	370	→	→	→	900	880	—	→
FEBRUARY	830	—	→		540	540	350	360	360	400	350	→	360	330	340	300	270	240	270
MARCH	500	590	590	860	850	→	820	850	860	520	800	820	470	450	470	450	500	775	840
APRIL	320	300	350	370	→	380	375	390	390	320	—	→	330	310	280	260	—	→	300
MAY	290	440	480	460	480	400	340	310	410	530	800	440	460	→	410	→	500	460	→
JUNE	740	→	760	780	740	770	740	760	780	740	800	710	400	515	740	750	790	760	770
JULY	760	805	780	750	770	780	800	790	780	740	725	460	430	330	350	340	350	320	360
AUGUST	340	330	370	340	340	320	—	—	→	→	480	→	510	450	470	510	480	470	480
SEPTEMBER	500	460	820	800	740	→	750	760	—	—	—	→	780	800	780	760	760	?	750
OCTOBER	750	760	740	800	→	810	770	→	750	740	800	800	770	740	760	750	760	800	810
NOVEMBER	770	?	770	?	860	840	800	810	830	860	790	→	820	790	840	830	790	830	800
DECEMBER	830	→	800	780	810	830	850	860	—	→	840	—	—	→	860	850	840	820	810

MONTH/ YEAR	20	21	22	23	24	25	26	27	28	29	30	31
1981												
JANUARY	840	→	820	815	810	800	820	→		840	830	830
FEBRUARY	800	770	820	800	770	800	800	840	800			
MARCH	810	800	→		820	→		780	820	800	790	790
APRIL	790	800	→		810	780	800	780	800	780	750	
MAY	760	760	780	770	790	760	800	740	790	810	790	760
JUNE	880(?)	730	780	780	770	800	→	780	760	760	800	[illegible]
JULY	310	300	280	295	280	→	400	350	315	300	→	330
AUGUST	760	→	810	770	800	→	765	800	820	800	460	380
SEPTEMBER	210	220	240	320	→	280	210	200	320	320 [illegible]	[illegible]	↔20
OCTOBER	340	360	410	430	390	350	450	380	340	→	400	350
NOVEMBER	300	→	270	260	300	—	270	320	295	290	290	
DECEMBER	540	530	500	540	550	560	530	500	520	530	530	530
1982												
JANUARY	930	810	870	840	840		560	560	600	550	550	700
FEBRUARY	300	340	450	300	340	400	370	340	500	—	—	—
MARCH	800	820	810	850	480	470	370	360	→	320	300	290
APRIL	300	290	→	260	250	240	280	300	—	—	→	
MAY	480	470	420	430	450	→	430	770	750	→	740	730
JUNE	750	760	780	760	780	760	760	770	800	775	770	
JULY	320	320	350	340	300	—	→	360	340	350	330	320
AUGUST	470	450	440	?	340	320	350	340	320	420	300	470
SEPTEMBER	740	760	780	—	→	860	740	800	770	790	800	
OCTOBER	800	850	820	→	800	830	800	→	740	490	700	760
NOVEMBER	?	770	810	840	—	→	850	800	825	830	820	
DECEMBER	860	850	830	810	800	790	800	820	→	870	850	840

TABLES OF BUS 1E CABLE LOADINGS
1983 THROUGH 1988

Palisades Bus 1e Station Power Load
Normal Conditions*

	Day	1E kv	1E amps	1E mw
1	01-Jan-83	2.4	820	3
2	02-Jan-83	2.4	820	3
3	03-Jan-83	2.4	860	3.15
4	04-Jan-83	2.4	880	3.3
5	05-Jan-83	2.4	850	3.15
6	06-Jan-83	2.4	835	3
7	07-Jan-83	2.4	850	3.2
8	08-Jan-83	2.4	820	3.05
9	09-Jan-83	2.4	820	3.05
10	10-Jan-83	2.38	870	3.1
11	11-Jan-83	2.4	860	3.15
12	12-Jan-83	2.4	830	3.1
13	13-Jan-83	2.4	860	3.2
14	14-Jan-83	2.4	850	3.1
15	15-Jan-83	2.4	830	3.1
16	16-Jan-83	2.4	830	3
17	17-Jan-83	2.4	860	3.2
18	18-Jan-83	2.4	850	3.2
19	19-Jan-83	2.4	880	3.25
20	20-Jan-83	2.4	890	3.3
21	21-Jan-83	2.4	870	3.2
22	22-Jan-83	2.4	880	3.3
23	23-Jan-83	2.4	830	3.2
24	24-Jan-83	2.4	860	3.2
25	25-Jan-83	2.4	860	3.2
26	26-Jan-83	2.4	800	3.1
27	27-Jan-83	2.4	800	3
28	28-Jan-83	2.4	860	3.2
29	29-Jan-83	2.4	820	3
30	30-Jan-83	2.4	830	3
31	31-Jan-83	2.4	850	3.2
32	01-Feb-83	2.4	860	3.2
33	02-Feb-83	2.4	870	3.2
34	03-Feb-83	2.43	870	3.3
35	04-Feb-83	2.4	900	3.3
36	05-Feb-83	2.4	880	3.25
37	06-Feb-83	2.4	880	3.2
38	07-Feb-83	2.4	880	3.3
39	08-Feb-83	2.4	880	3.3
40	09-Feb-83	2.4	880	3.25
41	10-Feb-83	2.4	885	3.3
42	11-Feb-83	2.4	900	3.3
43	12-Feb-83	2.4	850	3.2
44	13-Feb-83	2.4	850	3.2
45	14-Feb-83	2.4	870	3.2
46	15-Feb-83	2.4	870	3.25
47	16-Feb-83	2.4	900	3.2
48	17-Feb-83	2.4	860	3.15
49	18-Feb-83	2.38	880	3.25
50	19-Feb-83	2.37	870	3.2
51	20-Feb-83	2.37	840	3.1
52	21-Feb-83	2.38	840	3.1

53	22-Feb-83	2.4	860	3.2
54	23-Feb-83	2.4	860	3.2
55	24-Feb-83	2.4	880	3.3
56	25-Feb-83	2.4	890	3.3
57	26-Feb-83	2.4	870	3.3
58	27-Feb-83	2.4	830	3.1
59	28-Feb-83	2.4	870	3.2
60	01-Mar-83	2.4	840	3.1
61	02-Mar-83	2.4	870	3.2
62	03-Mar-83	2.4	830	3
63	04-Mar-83	2.4	795	2.85
64	05-Mar-83	2.4	780	2.85
65	06-Mar-83	2.4	760	2.8
66	07-Mar-83	2.39	790	2.9
67	08-Mar-83	2.38	830	3
68	09-Mar-83	2.39	830	3
69	10-Mar-83	2.4	840	3.1
70	11-Mar-83	2.4	860	3.2
71	12-Mar-83	2.4	860	3.1
72	13-Mar-83	2.4	820	3.1
73	14-Mar-83	2.4	820	3.1
74	15-Mar-83	2.4	820	3
75	16-Mar-83	2.39	820	3
76	17-Mar-83	2.38	820	3
77	18-Mar-83	2.4	860	3.1
78	19-Mar-83	2.39	830	3.05
79	20-Mar-83	2.37	820	3
80	21-Mar-83	2.4	800	3.05
81	22-Mar-83	2.4	880	3.3
82	23-Mar-83	2.4	860	3.2
83	24-Mar-83	2.4	870	3.25
84	25-Mar-83	2.4	860	3.2
85	26-Mar-83	2.4	870	3
86	27-Mar-83	2.4	850	3.1
87	28-Mar-83	2.4	880	3.6
88	29-Mar-83	2.4	860	3.2
89	30-Mar-83	2.4	850	3.2
90	31-Mar-83	2.4	860	3.2
91	01-Apr-83	2.39	845	3.15
92	02-Apr-83	2.4	840	3.1
93	03-Apr-83	2.4	830	3.05
94	04-Apr-83	2.4	850	3.1
95	05-Apr-83	2.4	870	3.2
96	06-Apr-83	2.4	830	3.05
97	07-Apr-83	2.4	840	3.2
98	08-Apr-83	2.4	800	2.95
99	09-Apr-83	2.4	800	2.95
100	10-Apr-83	2.46	800	2.95
101	11-Apr-83	2.4	810	3
102	12-Apr-83	2.4	830	3.1
103	13-Apr-83	2.4	800	2.8
104	14-Apr-83	2.4	820	3
105	15-Apr-83	2.4	840	3.1
106	16-Apr-83	2.4	810	3
107	17-Apr-83	2.4	840	3.1
108	18-Apr-83	2.4	830	3

109	19-Apr-83	2.4	850	3.15
110	20-Apr-83	2.46	840	3
111	21-Apr-83	2.4	820	2.95
112	22-Apr-83	2.4	800	2.9
113	23-Apr-83	2.4	810	3
114	24-Apr-83	2.4	880	2.9
115	25-Apr-83	2.4	850	3.1
116	26-Apr-83	2.4	810	3
117	27-Apr-83	2.38	800	2.9
118	28-Apr-83	2.38	870	3
119	29-Apr-83	2.38	800	3
120	30-Apr-83	2.39	800	2.9
121	01-May-83	2.37	800	2.9
122	02-May-83	2.37	810	2.9
123	03-May-83	2.4	870	3.15
124	04-May-83	2.4	810	3
125	05-May-83	2.4	810	3
126	06-May-83	2.38	790	2.85
127	07-May-83	2.4	760	2.8
128	08-May-83	2.4	790	2.9
129	09-May-83	2.38	820	3
130	10-May-83	2.4	850	3.1
131	11-May-83	2.38	800	2.9
132	12-May-83	2.36	820	2.95
133	13-May-83	2.39	830	3.05
134	14-May-83	2.38	810	2.9
135	15-May-83	2.4	810	2.9
136	16-May-83	2.39	860	3.15
137	17-May-83	2.4	840	3.1
138	18-May-83	2.4	830	3
139	19-May-83	2.4	800	2.9
142	22-May-83	2.42	770	2.2
143	23-May-83	2.4	780	2.8
144	24-May-83	2.4	800	2.9
145	25-May-83	2.4	770	2.85
146	26-May-83	2.4	790	2.9
147	27-May-83	2.4	780	2.85
148	28-May-83	2.4	770	2.7
149	29-May-83	2.4	760	2.7
150	30-May-83	2.4	760	2.8
151	31-May-83	2.39	780	2.85
152	01-Jun-83	2.39	780	2.8
153	02-Jun-83	2.38	810	2.9
154	03-Jun-83	2.4	800	2.9
155	04-Jun-83	2.37	800	2.8
156	05-Jun-83	2.38	800	2.85
157	06-Jun-83	2.39	800	2.9
158	07-Jun-83	2.4	808	2.9
159	08-Jun-83	2.4	800	2.9
160	09-Jun-83	2.4	815	2.9
161	10-Jun-83	2.39	800	2.85
162	11-Jun-83	2.4	800	2.85
163	12-Jun-83	2.45	800	2.9
164	13-Jun-83	2.4	805	2.9
165	14-Jun-83	2.4	840	3.1
166	15-Jun-83	2.4	820	2.95

167	16-Jun-83	2.4	800	2.95
168	17-Jun-83	2.4	820	2.95
169	18-Jun-83	2.4	760	2.7
170	19-Jun-83	2.4	800	2.8
171	20-Jun-83	2.4	800	2.95
172	21-Jun-83	2.43	840	3.1
173	22-Jun-83	2.4	850	3.1
174	23-Jun-83	2.45	860	3.1
175	24-Jun-83	2.4	840	3.05
176	25-Jun-83	2.4	800	2.75
177	26-Jun-83	2.4	820	2.9
178	27-Jun-83	2.42	840	3
179	28-Jun-83	2.4	810	2.9
180	29-Jun-83	2.39	820	2.9
181	30-Jun-83	2.4	820	2.92
327	22-Nov-84	2.45	830	3.2
328	23-Nov-84	2.48	890	3.15
329	24-Nov-84	2.45	820	3.1
330	25-Nov-84	2.45	780	2.8
331	26-Nov-84	2.45	790	3.05
332	27-Nov-84	2.46	800	3
333	28-Nov-84	2.47	860	3.4
334	29-Nov-84	2.48	840	3.2
335	30-Nov-84	2.47	820	3.1
336	01-Dec-84	2.5	840	3.2
337	02-Dec-84	2.48	840	3.25
338	03-Dec-84	2.46	860	3.3
339	04-Dec-84	2.47	880	3.3
340	05-Dec-84	2.48	890	3.45
341	06-Dec-84	2.5	850	3.3
342	07-Dec-84	2.5	850	3.3
343	08-Dec-84	2.5	840	3.4
344	09-Dec-84	2.5	840	3.3
345	10-Dec-84	2.5	850	3.25
346	11-Dec-84	2.5	820	3.3
347	12-Dec-84	2.48	830	3.2
348	13-Dec-84	2.48	820	3.2
349	14-Dec-84	2.47	865	3.3
350	15-Dec-84	2.5	860	3.3
351	16-Dec-84	2.5	800	3.1
352	17-Dec-84	2.46	820	3.18
353	18-Dec-84	2.45	860	3.4
354	19-Dec-84	2.46	905	3.5
355	20-Dec-84	2.48	860	3.3
356	21-Dec-84	2.47	880	3.4
357	22-Dec-84	2.47	860	3.35
358	23-Dec-84	2.47	875	3.35
359	24-Dec-84	2.45	840	3.2
360	25-Dec-84	2.45	850	3.2
361	26-Dec-84	2.45	860	3.35
362	27-Dec-84	2.5	860	3.3
363	28-Dec-84	2.5	840	3.3
364	29-Dec-84	2.5	830	3.2
365	30-Dec-84	2.5	860	3.4
366	31-Dec-84	2.5	830	3.2
1	01-Jan-85	2.5	870	3.4

2	02-Jan-85	2.45	880	3.4
3	03-Jan-85	2.48	900	3.4
4	04-Jan-85	2.46	900	3.5
5	05-Jan-85	2.48	860	3.3
6	06-Jan-85	2.47	870	3.3
7	07-Jan-85	2.45	860	3.3
8	08-Jan-85	2.45	900	3.7
9	09-Jan-85	2.43	870	3.5
10	10-Jan-85	2.45	960	3.5
11	11-Jan-85	2.46	880	3.4
12	12-Jan-85	2.47	860	3.3
13	13-Jan-85	2.46	880	3.7
14	14-Jan-85	2.47	880	3.5
15	15-Jan-85	2.45	880	3.4
16	16-Jan-85	2.47	880	3.4
17	17-Jan-85	2.47	880	3.45
18	18-Jan-85	2.47	900	3.5
19	19-Jan-85	2.47	900	3.5
20	20-Jan-85	2.45	900	3.5
21	21-Jan-85	2.46	930	3.6
22	22-Jan-85	2.45	890	3.4
23	23-Jan-85	2.45	890	3.6
24	24-Jan-85	2.45	860	3.3
25	25-Jan-85	2.45	990	3.4
26	26-Jan-85	2.42	870	3.4
27	27-Jan-85	2.45	920	3.55
28	28-Jan-85	2.45	860	3.4
29	29-Jan-85	2.45	900	3.6
30	30-Jan-85	2.45	850	3.3
31	31-Jan-85	2.45	850	3.5
32	01-Feb-85	2.45	880	3.4
33	02-Feb-85	2.45	860	3.3
34	03-Feb-85	2.45	870	3.4
35	04-Feb-85	2.46	885	3.4
36	05-Feb-85	2.45	880	3.3
37	06-Feb-85	2.48	880	3.4
38	07-Feb-85	2.49	880	3.4
39	08-Feb-85	2.47	870	3.7
40	09-Feb-85	2.48	860	3.4
41	10-Feb-85	2.49	700	2.75
42	11-Feb-85	2.48	840	3.3
43	12-Feb-85	2.47	860	3.3
44	13-Feb-85	2.46	830	3.3
45	14-Feb-85	2.48	850	3.4
46	15-Feb-85	2.46	870	3.3
47	16-Feb-85	2.45	835	3.2
48	17-Feb-85	2.45	830	3.2
49	18-Feb-85	2.47	820	3.25
50	19-Feb-85	2.48	850	3.2
51	20-Feb-85	2.48	840	3.2
52	21-Feb-85	2.45	830	3.2
53	22-Feb-85	2.46	820	3.2
54	23-Feb-85	2.45	860	3.1
55	24-Feb-85	2.45	810	3.05
56	25-Feb-85	2.46	870	3.1
57	26-Feb-85	2.46	810	3.1

58	27-Feb-85	2.45	840	3.4
59	28-Feb-85	2.45	810	3.1
60	01-Mar-85	2.44	800	3
61	02-Mar-85	2.43	780	2.9
62	03-Mar-85	2.44	830	3.15
63	04-Mar-85	2.45	820	3.15
64	05-Mar-85	2.45	860	3.1
65	06-Mar-85	2.48	820	3.14
66	07-Mar-85	2.45	820	3.1
67	08-Mar-85	2.45	800	3
68	09-Mar-85	2.45	780	3.8
69	10-Mar-85	2.45	760	2.9
70	11-Mar-85	2.45	750	2.8
71	12-Mar-85	2.45	790	3.95
72	13-Mar-85	2.47	800	3
73	14-Mar-85	2.47	780	3
74	15-Mar-85	2.45	775	2.9
75	16-Mar-85	2.45	780	2.9
76	17-Mar-85	2.45	780	3
77	18-Mar-85	2.47	800	3.1
78	19-Mar-85	2.48	780	2.9
79	20-Mar-85	2.45	780	3
80	21-Mar-85	2.45	800	3.1
81	22-Mar-85	2.46	800	2.95
82	23-Mar-85	2.45	810	3
83	24-Mar-85	2.44	810	3.05
84	25-Mar-85	2.45	800	3
85	26-Mar-85	2.48	800	3
86	27-Mar-85	2.45	810	3
87	28-Mar-85	2.44	800	2.9
88	29-Mar-85	2.46	810	3.1
89	30-Mar-85	2.45	800	3
90	31-Mar-85	2.45	800	3.1
91	01-Apr-85	2.45	850	3.3
92	02-Apr-85	2.47	820	3.2
93	03-Apr-85	2.43	850	3.15
94	04-Apr-85	2.43	800	3
95	05-Apr-85	2.45	830	3
96	06-Apr-85	2.44	820	3.1
97	07-Apr-85	2.45	830	3.2
98	08-Apr-85	2.45	860	3.2
99	09-Apr-85	2.45	840	3.2
100	10-Apr-85	2.46	840	3.15
101	11-Apr-85	2.48	780	2.9
102	12-Apr-85	2.47	680	2.5
103	13-Apr-85	2.46	790	2.9
104	14-Apr-85	2.45	810	3
105	15-Apr-85	2.44	800	3
106	16-Apr-85	2.46	800	3
107	17-Apr-85	2.45	820	3.2
108	18-Apr-85	2.48	800	2.9
109	19-Apr-85	2.5	830	3.1
110	20-Apr-85	2.45	800	2.9
111	21-Apr-85	2.42	820	3
112	22-Apr-85	2.45	830	3.1
113	23-Apr-85	2.46	810	3

114	24-Apr-85	2.45	830	3.1
115	25-Apr-85	2.46	820	3
116	26-Apr-85	2.47	830	3.05
117	27-Apr-85	2.48	775	2.9
118	28-Apr-85	2.48	780	2.9
119	29-Apr-85	2.46	810	3
120	30-Apr-85	2.48	815	3.05
121	01-May-85	2.5	800	2.95
122	02-May-85	2.45	820	3.05
123	03-May-85	2.45	800	3
124	04-May-85	2.47	765	2.83
125	05-May-85	2.47	780	2.9
126	06-May-85	2.43	805	3.05
127	07-May-85	2.46	810	3
128	08-May-85	2.48	800	3
129	09-May-85	2.43	810	3
130	10-May-85	2.47	860	3.2
131	11-May-85	2.46	850	3.1
132	12-May-85	2.5	820	3
133	13-May-85	2.45	860	3.2
134	14-May-85	2.48	820	3.1
135	15-May-85	2.45	820	2.95
136	16-May-85	2.42	800	2.9
137	17-May-85	2.45	820	3.1
138	18-May-85	2.45	820	3.1
139	19-May-85	2.45	800	2.93
140	20-May-85	2.43	800	3
141	21-May-85	2.44	800	2.95
142	22-May-85	2.42	800	2.9
143	23-May-85	2.45	790	2.8
144	24-May-85	2.5	830	3.1
145	25-May-85	2.5	800	3
146	26-May-85	2.45	810	2.9
147	27-May-85	2.45	800	2.82
148	28-May-85	2.45	800	2.9
149	29-May-85	2.44	795	2.9
150	30-May-85	2.45	820	3
151	31-May-85	2.45	820	3
152	01-Jun-85	2.42	800	2.9
153	02-Jun-85	2.44	780	2.8
154	03-Jun-85	2.47	800	3
155	04-Jun-85	2.45	785	2.9
156	05-Jun-85	2.45	780	2.95
157	06-Jun-85	2.45	800	2.9
158	07-Jun-85	2.48	800	2.85
159	08-Jun-85	2.43	810	2.9
160	09-Jun-85	2.42	820	2.95
161	10-Jun-85	2.45	790	2.9
162	11-Jun-85	2.45	780	2.8
163	12-Jun-85	2.45	770	2.85
164	13-Jun-85	2.45	800	3
165	14-Jun-85	2.45	800	3
166	15-Jun-85	2.48	760	2.8
167	16-Jun-85	2.45	780	2.85
168	17-Jun-85	2.45	810	3
169	18-Jun-85	2.45	820	3

170	19-Jun-85	2.45	820	3.1
171	20-Jun-85	2.45	810	2.95
172	21-Jun-85	2.45	840	3.1
173	22-Jun-85	2.43	890	3
174	23-Jun-85	2.45	800	2.9
175	24-Jun-85	2.45	800	2.9
176	25-Jun-85	2.43	840	3
177	26-Jun-85	2.45	830	3.1
178	27-Jun-85	2.5	810	3
179	28-Jun-85	2.5	820	3
180	29-Jun-85	2.45	760	2.8
181	30-Jun-85	2.44	800	2.9
182	01-Jul-85	2.45	810	3
183	02-Jul-85	2.45	850	3.2
184	03-Jul-85	2.45	820	3.2
185	04-Jul-85	2.45	805	2.9
186	05-Jul-85	2.42	810	2.95
187	06-Jul-85	2.41	815	2.95
188	07-Jul-85	2.45	780	2.85
189	08-Jul-85	2.48	840	3.15
190	09-Jul-85	2.5	890	3.4
191	10-Jul-85	2.47	860	3.15
192	11-Jul-85	2.45	810	2.9
193	12-Jul-85	2.45	850	3.1
194	13-Jul-85	2.48	845	3
195	14-Jul-85	2.45	820	2.95
196	15-Jul-85	2.48	805	3
197	16-Jul-85	2.41	820	2.9
198	17-Jul-85	2.45	830	2.9
199	18-Jul-85	2.45	860	3
200	19-Jul-85	2.45	830	2.95
201	20-Jul-85	2.43	800	2.9
202	21-Jul-85	2.42	805	2.9
203	22-Jul-85	2.45	800	2.9
204	23-Jul-85	2.45	800	2.9
205	24-Jul-85	2.44	810	2.9
206	25-Jul-85	2.45	830	3.1
207	26-Jul-85	2.42	800	2.85
208	27-Jul-85	2.45	800	2.9
209	28-Jul-85	2.42	810	2.9
210	29-Jul-85	2.44	825	2.9
211	30-Jul-85	2.45	810	2.9
212	31-Jul-85	2.43	790	2.85
213	01-Aug-85	2.46	800	2.9
214	02-Aug-85	2.45	820	3
215	03-Aug-85	2.43	780	2.8
216	04-Aug-85	2.44	760	2.8
217	05-Aug-85	2.43	840	3.05
218	06-Aug-85	2.44	820	2.95
219	07-Aug-85	2.45	850	3.1
220	08-Aug-85	2.45	850	3.1
221	09-Aug-85	2.46	830	3
222	10-Aug-85	2.43	790	2.8
223	11-Aug-85	2.42	780	2.8
245	02-Sep-85	2.46	770	2.8
246	03-Sep-85	2.46	800	2.95

247	04-Sep-85	2.48	820	3
248	05-Sep-85	2.45	860	3.1
249	06-Sep-85	2.45	830	3
250	07-Sep-85	2.45	760	2.8
251	08-Sep-85	2.45	760	2.8
253	10-Sep-85	2.45	800	2.9
254	11-Sep-85	2.46	800	2.9
255	12-Sep-85	2.46	780	2.9
256	13-Sep-85	2.45	780	2.9
257	14-Sep-85	2.45	740	2.7
259	16-Sep-85	2.45	880	3
260	17-Sep-85	2.43	820	3.05
261	18-Sep-85	2.45	800	2.9
262	19-Sep-85	2.46	845	3.1
263	20-Sep-85	2.44	865	3.2
264	21-Sep-85	2.45	780	2.8
265	22-Sep-85	2.46	790	2.87
266	23-Sep-85	2.45	840	3.1
267	24-Sep-85	2.47	780	2.8
268	25-Sep-85	2.45	760	2.9
269	26-Sep-85	2.46	800	2.8
270	27-Sep-85	2.45	760	2.8
271	28-Sep-85	2.46	760	2.8
272	29-Sep-85	2.46	760	2.8
273	30-Sep-85	2.45	800	2.92
274	01-Oct-85	2.45	780	2.9
275	02-Oct-85	2.45	770	2.9
276	03-Oct-85	2.45	790	2.9
277	04-Oct-85	2.45	780	2.9
278	05-Oct-85	2.45	760	2.9
279	06-Oct-85	2.48	760	2.8
280	07-Oct-85	2.47	790	2.9
281	08-Oct-85	2.45	800	3
282	09-Oct-85	2.46	760	2.85
283	10-Oct-85	2.45	770	2.9
284	11-Oct-85	2.46	780	2.9
285	12-Oct-85	2.45	760	2.8
286	13-Oct-85	2.47	760	2.8
287	14-Oct-85	2.45	785	2.9
288	15-Oct-85	2.45	770	2.85
293	20-Oct-85	2.46	600	2.4
294	21-Oct-85	2.45	800	2.9
295	22-Oct-85	2.45	810	3
296	23-Oct-85	2.45	790	2.9
297	24-Oct-85	2.43	820	3
298	25-Oct-85	2.45	800	2.9
299	26-Oct-85	2.45	790	2.9
300	27-Oct-85	2.45	800	2.9
301	28-Oct-85	2.42	820	3
302	29-Oct-85	2.47	790	2.9
303	30-Oct-85	2.46	800	3
304	31-Oct-85	2.45	810	3
305	01-Nov-85	2.45	790	2.8
306	02-Nov-85	2.45	780	2.85
307	03-Nov-85	2.46	800	2.95
308	04-Nov-85	2.45	810	3

309	05-Nov-85	2.45	800	2.9
310	06-Nov-85	2.45	790	3
311	07-Nov-85	2.45	800	3
312	08-Nov-85	2.45	800	2.9
313	09-Nov-85	2.45	790	2.9
314	10-Nov-85	2.45	800	3
315	11-Nov-85	2.45	820	3.1
316	12-Nov-85	2.45	820	3.1
317	13-Nov-85	2.5	820	3
318	14-Nov-85	2.47	840	3.2
319	15-Nov-85	2.48	840	3.2
320	16-Nov-85	2.48	820	3.1
321	17-Nov-85	2.5	820	3.05
322	18-Nov-85	2.48	820	3.1
323	19-Nov-85	2.47	810	3.05
324	20-Nov-85	2.48	850	3.3
325	21-Nov-85	2.5	830	3.2
326	22-Nov-85	2.5	840	3.2
327	23-Nov-85	2.5	840	3.18
328	24-Nov-85	2.47	820	3.1
329	25-Nov-85	2.45	860	3.4
330	26-Nov-85	2.45	840	3.15
331	27-Nov-85	2.48	820	3.1
332	28-Nov-85	2.48	830	3.15
333	29-Nov-85	2.45	850	3.2
334	30-Nov-85	2.47	830	3.1
64	05-Mar-86	2.45	510	1.3
65	06-Mar-86	2.45	840	2.2
66	07-Mar-86	2.45	820	2.3
87	28-Mar-86	2.46	745	1.8
88	29-Mar-86	2.45	800	2.05
89	30-Mar-86	2.42	750	1.9
90	31-Mar-86	2.47	770	1.9
91	01-Apr-86	2.4	760	1.9
92	02-Apr-86	2.45	800	2.12
93	03-Apr-86	2.44	790	2.05
94	04-Apr-86	2.43	790	2.03
95	05-Apr-86	2.43	760	1.95
96	06-Apr-86	2.42	740	1.9
97	07-Apr-86	2.43	780	2.02
98	08-Apr-86	2.44	780	2
99	09-Apr-86	2.42	810	2.1
100	10-Apr-86	2.43	800	2.1
103	13-Apr-86	2.45	620	1.6
104	14-Apr-86	2.47	780	2.05
105	15-Apr-86	2.45	820	2.15
106	16-Apr-86	2.45	820	2.2
107	17-Apr-86	2.43	830	2.2
108	18-Apr-86	2.44	740	1.9
109	19-Apr-86	2.42	740	1.9
110	20-Apr-86	2.43	780	2
111	21-Apr-86	2.42	800	2.1
112	22-Apr-86	2.43	800	2.1
113	23-Apr-86	2.45	820	2.2
114	24-Apr-86	2.45	810	2.1
115	25-Apr-86	2.45	780	2

116	26-Apr-86	2.43	740	1.9
117	27-Apr-86	2.42	770	1.95
118	28-Apr-86	2.44	800	2
119	29-Apr-86	2.43	780	2
120	30-Apr-86	2.45	780	2
121	01-May-86	2.43	760	1.95
122	02-May-86	2.45	780	2
123	03-May-86	2.43	760	1.9
124	04-May-86	2.4	760	2
125	05-May-86	2.42	800	2
126	06-May-86	2.42	820	2
127	07-May-86	2.42	775	2
128	08-May-86	2.45	760	1.95
129	09-May-86	2.42	790	2
130	10-May-86	2.42	780	1.9
131	11-May-86	2.42	770	1.9
132	12-May-86	2.42	780	2
133	13-May-86	2.41	800	2
134	14-May-86	2.45	750	1.9
135	15-May-86	2.43	800	2
136	16-May-86	2.45	780	2
137	17-May-86	2.4	750	1.9
138	18-May-86	2.43	760	1.92
139	19-May-86	2.42	800	2
140	04-Apr-87	2.43	500	1.95
141	05-Apr-87	2.44	520	2
142	06-Apr-87	2.45	630	2.4
143	07-Apr-87	2.43	620	2.35
144	08-Apr-87	2.42	650	2.5
145	09-Apr-87	2.4	630	2.5
146	10-Apr-87	2.45	630	2.4
147	11-Apr-87	2.43	760	2.9
148	12-Apr-87	2.5	770	2.95
149	13-Apr-87	2.43	500	1.9
150	14-Apr-87	2.43	490	1.9
151	15-Apr-87	2.42	465	1.8
152	16-Apr-87	2.43	480	1.8
153	17-Apr-87	2.43	510	2
154	18-Apr-87	2.45	540	2.7
155	19-Apr-87	2.4	760	2.8
156	20-Apr-87	2.38	820	2.9
157	21-Apr-87	2.4	790	2.95
158	22-Apr-87	2.39	810	3
159	23-Apr-87	2.39	790	3
160	24-Apr-87	2.42	780	3
161	25-Apr-87	2.4	820	3.1
162	26-Apr-87	2.41	785	2.95
163	27-Apr-87	2.4	800	3
164	28-Apr-87	2.4	830	3.1
165	29-Apr-87	2.4	780	2.8
166	30-Apr-87	2.4	780	2.8
167	01-May-87	2.4	880	3
168	02-May-87	2.4	810	3
169	03-May-87	2.4	800	2.95
170	04-May-87	2.4	810	3
171	05-May-87	2.4	810	3

172	06-May-87	2.4	800	3
173	07-May-87	2.4	805	2.9
174	08-May-87	2.4	800	3
175	09-May-87	2.4	800	3
176	10-May-87	2.4	800	2.95
177	11-May-87	2.4	800	3
178	12-May-87	2.4	790	2.9
179	13-May-87	2.4	800	2.9
180	14-May-87	2.4	820	3
181	15-May-87	2.4	810	3
182	16-May-87	2.4	810	2.95
183	17-May-87	2.4	490	1.8
184	18-May-87	2.4	500	2.8
185	19-May-87	2.42	480	1.8
186	23-May-87	2.45	600	2.3
187	24-May-87	2.4	750	2.85
188	25-May-87	2.42	750	2.85
189	26-May-87	2.4	800	3
190	27-May-87	2.4	850	3.15
191	28-May-87	2.4	820	3
192	29-May-87	2.4	830	3.95
193	30-May-87	2.4	830	3
194	31-May-87	2.4	810	2.92
195	01-Jun-87	2.4	825	3
196	02-Jun-87	2.4	815	3
197	03-Jun-87	2.4	820	3
198	04-Jun-87	2.4	790	2.9
199	05-Jun-87	2.4	790	2.9
200	06-Jun-87	2.4	820	3
201	07-Jun-87	2.4	810	3
202	08-Jun-87	2.4	840	3.05
203	09-Jun-87	2.4	800	3
204	10-Jun-87	2.4	810	3
205	11-Jun-87	2.4	790	2.95
206	12-Jun-87	2.4	810	2.95
207	13-Jun-87	2.48	810	3
208	14-Jun-87	2.4	800	2.98
209	15-Jun-87	2.4	800	3
210	16-Jun-87	2.4	825	3
211	17-Jun-87	2.4	830	3.1
212	18-Jun-87	2.4	810	3
213	19-Jun-87	2.42	830	3.5
214	20-Jun-87	2.44	810	3
215	26-Jun-87	2.42	640	2.3
216	27-Jun-87	2.43	630	2.4
217	28-Jun-87	2.42	650	2.5
218	29-Jun-87	2.43	840	3.2
219	30-Jun-87	2.4	880	3.2
220	01-Jul-87	2.4	840	3.1
221	02-Jul-87	2.4	820	3
222	03-Jul-87	2.4	810	3
223	04-Jul-87	2.4	810	3
224	05-Jul-87	2.4	840	3
225	06-Jul-87	2.4	840	3.1
226	07-Jul-87	2.4	840	3.1
227	08-Jul-87	2.4	880	3.25

228	09-Jul-87	2.42	860	3.2
229	26-Jul-87	2.44	800	2.95
230	27-Jul-87	2.4	810	3
231	28-Jul-87	2.42	840	3.1
232	29-Jul-87	2.41	830	3
233	30-Jul-87	2.4	820	3.1
234	31-Jul-87	2.4	860	3.1
235	01-Aug-87	2.38	820	3
236	02-Aug-87	2.37	820	3
237	03-Aug-87	2.4	850	3.1
238	04-Aug-87	2.4	850	3.2
239	05-Aug-87	2.39	800	3
240	06-Aug-87	2.4	860	3.1
241	07-Aug-87	2.4	860	3.2
242	08-Aug-87	2.37	830	3.1
243	09-Aug-87	2.37	830	3.1
244	10-Aug-87	2.37	870	3.1
245	11-Aug-87	2.4	815	3.1
246	12-Aug-87	2.37	860	3.12
247	13-Aug-87	2.38	850	3.2
248	14-Aug-87	2.37	860	3.15
249	15-Aug-87	2.43	510	1.9
250	16-Aug-87	2.41	810	2.95
251	19-Aug-87	2.38	800	3
252	20-Aug-87	2.37	835	3.1
253	21-Aug-87	2.38	830	3.2
254	22-Aug-87	2.36	845	3.1
255	26-Aug-87	2.43	810	3
256	27-Aug-87	2.4	810	3
257	28-Aug-87	2.4	790	2.95
258	29-Aug-87	2.4	790	2.9
259	30-Aug-87	2.4	820	2.98
260	31-Aug-87	2.4	830	3.1
261	01-Sep-87	2.38	830	3.05
262	02-Sep-87	2.38	820	3
263	03-Sep-87	2.4	820	3.1
264	04-Sep-87	2.4	840	3.2
265	05-Sep-87	2.39	810	2.95
266	06-Sep-87	2.38	840	3.1
267	07-Sep-87	2.38	830	3.05
268	08-Sep-87	2.38	850	3.15
269	09-Sep-87	2.37	820	3.1
270	10-Sep-87	2.37	830	3.1
271	11-Sep-87	2.39	840	3.15
272	12-Sep-87	2.37	830	3.05
273	13-Sep-87	2.38	810	2.95
274	14-Sep-87	2.4	820	3.1
275	15-Sep-87	2.4	840	3.1
276	16-Sep-87	2.39	830	3.1
277	17-Sep-87	2.4	840	3.1
278	18-Sep-87	2.4	830	3.1
279	19-Sep-87	2.4	820	3
280	20-Sep-87	2.4	820	3
281	21-Sep-87	2.4	820	3.2
282	24-Sep-87	2.42	800	3
283	25-Sep-87	2.4	840	3.2

284	26-Sep-87	2.4	820	3.1
285	27-Sep-87	2.4	805	3
286	28-Sep-87	2.4	830	3.1
287	29-Sep-87	2.4	860	3.2
288	30-Sep-87	2.4	840	3.1
289	13-Nov-87	2.45	620	2.4
290	14-Nov-87	2.4	800	3.1
291	15-Nov-87	2.4	800	3.1
292	16-Nov-87	2.4	820	3.1
293	17-Nov-87	2.4	720	2.7
294	18-Nov-87	2.4	840	3.18
295	19-Nov-87	2.38	850	3.25
296	20-Nov-87	2.4	890	3.45
297	21-Nov-87	2.4	840	3.3
298	22-Nov-87	2.41	865	3.35
299	23-Nov-87	2.4	820	3.2
300	24-Nov-87	2.42	820	3
301	25-Nov-87	2.4	820	3.2
302	26-Nov-87	2.4	820	3.15
303	27-Nov-87	2.38	820	3.1
304	28-Nov-87	2.38	800	3.05
305	29-Nov-87	2.38	800	3.1
306	30-Nov-87	2.4	820	3.25
307	01-Dec-87	2.42	818	3.2
308	02-Dec-87	2.42	830	3.3
309	03-Dec-87	2.4	840	3.2
310	04-Dec-87	2.4	860	3.35
311	28-Jan-88	2.42	700	2.75
312	29-Jan-88	2.4	850	3.25
313	30-Jan-88	2.4	800	3
314	31-Jan-88	2.4	790	3
315	01-Feb-88	2.4	850	3.25
316	02-Feb-88	2.4	860	3.3
317	03-Feb-88	2.4	830	3.15
318	04-Feb-88	2.4	860	3.35
319	05-Feb-88	2.4	950	3.65
320	06-Feb-88	2.4	940	3.63
321	07-Feb-88	2.4	875	3.4
322	08-Feb-88	2.4	870	3.35
323	09-Feb-88	2.4	890	3.38
324	10-Feb-88	2.4	870	3.3
325	11-Feb-88	2.4	870	3.3
326	12-Feb-88	2.4	900	3.5
327	13-Feb-88	2.4	900	3.5
328	14-Feb-88	2.46	890	3.3
329	15-Feb-88	2.4	880	3.3
330	16-Feb-88	2.4	900	3.45
331	17-Feb-88	2.4	850	3.2
332	18-Feb-88	2.42	850	3.2
333	19-Feb-88	2.4	860	3.25
334	20-Feb-88	2.42	840	3.2
335	21-Feb-88	2.42	860	3.3
336	22-Feb-88	2.42	830	3.2
337	23-Feb-88	2.4	880	3.1
338	24-Feb-88	2.4	900	3.4
339	25-Feb-88	2.4	890	3.35

340	26-Feb-88	2.4	860	3.4
341	27-Feb-88	2.4	830	3.15
342	28-Feb-88	2.4	870	3.25
343	29-Feb-88	2.4	820	3.15
	MAX VALUE	2.5	990	3.95

Palisades Bus 1e Station Power Load
Cold Shutdown Conditions"

	Day	1E kv	1E amps	1E mw
224	12-Aug-85	2.43	440	1.5
225	13-Aug-85	2.42	380	1.25
226	14-Aug-85	2.43	370	1.28
227	15-Aug-85	2.45	380	1.3
228	16-Aug-85	2.43	390	1.3
229	17-Aug-85	2.45	350	1.28
230	18-Aug-85	2.42	370	1.6
231	19-Aug-85	2.45	330	1.2
232	20-Aug-85	2.45	330	1.18
233	21-Aug-85	2.45	360	1.2
234	22-Aug-85	2.45	450	1.8
235	23-Aug-85	2.42	460	1.75
236	24-Aug-85	2.45	460	1.65
237	25-Aug-85	2.45	320	1.05
238	26-Aug-85	2.43	450	1.7
239	27-Aug-85	2.4	490	1.8
240	28-Aug-85	2.4	500	1.8
241	29-Aug-85	2.5	475	1.8
242	30-Aug-85	2.48	495	1.85
243	31-Aug-85	2.48	440	1.6
244	01-Sep-85	2.45	560	2.1
252	09-Sep-85	2.46	510	1.75
258	15-Sep-85	2.45	550	1.6
289	16-Oct-85	2.45	325	1.1
290	17-Oct-85	2.45	440	1.6
291	18-Oct-85	2.44	400	1.4
292	19-Oct-85	2.45	440	1.7
335	01-Dec-85	2.45	440	1.7
336	02-Dec-85	2.41	450	1.7
337	03-Dec-85	2.45	440	1.6
338	04-Dec-85	2.45	540	2
339	05-Dec-85	2.45	520	2
340	06-Dec-85	2.45	480	1.8
341	07-Dec-85	2.45	440	1.8
342	08-Dec-85	2.45	460	1.7
343	09-Dec-85	2.45	480	1.8
344	10-Dec-85	2.45	450	1.6
345	11-Dec-85	2.45	440	1.7
346	12-Dec-85	2.45	510	1.9
347	13-Dec-85	2.45	520	1.9
348	14-Dec-85	2.45	550	2.1
349	15-Dec-85	2.45	510	1.9
350	16-Dec-85	2.45	540	2
351	17-Dec-85	2.44	540	2.05
352	18-Dec-85	2.45	580	2.2
353	19-Dec-85	2.45	530	2
354	20-Dec-85	2.43	560	2.15
355	21-Dec-85	2.46	570	2.3
356	22-Dec-85	2.46	550	2.1
357	23-Dec-85	2.46	500	1.85
358	24-Dec-85	2.47	440	1.8
359	25-Dec-85	2.46	440	1.7

360	26-Dec-85	2.45	500	2.1
361	27-Dec-85	2.46	470	1.8
362	28-Dec-85	2.45	500	1.8
363	29-Dec-85	2.48	400	1.5
364	30-Dec-85	2.5	390	1.4
365	31-Dec-85	2.5	410	1.5
1	01-Jan-86	2.48	440	1.7
2	02-Jan-86	2.45	470	1.7
3	03-Jan-86	2.49	460	1.7
4	04-Jan-86	2.5	475	1.7
5	05-Jan-86	2.5	500	1.8
6	06-Jan-86	2.5	510	2
7	07-Jan-86	2.5	480	1.8
8	08-Jan-86	2.5	320	1.3
9	09-Jan-86	2.5	460	1.75
10	10-Jan-86	2.5	440	1.65
11	11-Jan-86	2.5	400	1.52
12	12-Jan-86	2.5	425	1.65
13	13-Jan-86	2.47	480	1.35
14	14-Jan-86	2.45	460	1.2
15	15-Jan-86	2.45	440	1.2
16	16-Jan-86	2.45	340	0.85
17	17-Jan-86	2.45	300	0.8
18	18-Jan-86	2.45	300	0.75
19	19-Jan-86	2.45	300	0.8
20	20-Jan-86	2.45	420	1.1
21	21-Jan-86	2.45	400	1
22	22-Jan-86	2.47	540	1.4
27	27-Jan-86	2.45	255	0.7
30	30-Jan-86	2.45	210	0.55
31	31-Jan-86	2.45	200	0.6
32	01-Feb-86	2.5	260	0.65
33	02-Feb-86	2.48	350	0.85
34	03-Feb-86	2.45	350	0.9
35	04-Feb-86	2.45	375	0.9
36	05-Feb-86	2.45	360	0.9
37	06-Feb-86	2.43	370	1
38	07-Feb-86	2.51	400	1
39	08-Feb-86	2.43	390	1
40	09-Feb-86	2.43	410	1
41	10-Feb-86	2.43	380	1
42	11-Feb-86	2.41	410	1.1
43	12-Feb-86	2.44	480	1.3
44	13-Feb-86	2.42	400	1
45	14-Feb-86	2.43	400	1.1
46	15-Feb-86	2.42	390	1
47	16-Feb-86	2.42	420	1.1
48	17-Feb-86	2.44	400	1
49	18-Feb-86	2.42	430	1.15
50	19-Feb-86	2.41	500	1.35
51	20-Feb-86	2.42	490	1.3
52	21-Feb-86	2.4	540	1.4
53	22-Feb-86	2.42	520	1.4
54	23-Feb-86	2.42	500	1.3
55	24-Feb-86	2.4	500	1.35
56	25-Feb-86	2.4	500	1.35

57	26-Feb-86	2.41	550	1.5
58	27-Feb-86	2.41	460	1.3
59	28-Feb-86	2.42	480	1.35
60	01-Mar-86	2.46	470	1.3
61	02-Mar-86	2.45	480	1.3
62	03-Mar-86	2.41	530	1.4
63	04-Mar-86	2.41	500	1.3
67	08-Mar-86	2.44	500	1.35
68	09-Mar-86	2.46	390	1
69	10-Mar-86	2.45	280	0.75
70	11-Mar-86	2.45	360	0.9
71	12-Mar-86	2.43	350	0.9
72	13-Mar-86	2.45	350	0.9
73	14-Mar-86	2.46	320	0.8
74	15-Mar-86	2.45	300	1.25
75	16-Mar-86	2.47	320	0.8
76	17-Mar-86	2.45	330	0.9
77	18-Mar-86	2.45	340	0.85
78	19-Mar-86	2.45	510	1.3
79	20-Mar-86	2.43	530	1.35
80	21-Mar-86	2.43	350	0.9
81	22-Mar-86	2.45	350	0.9
82	23-Mar-86	2.45	450	1.2
83	24-Mar-86	2.43	460	1.2
84	25-Mar-86	2.48	450	1.3
85	26-Mar-86	2.47	460	1.2
86	27-Mar-86	2.42	480	1.28
101	11-Apr-86	2.45	460	1.3
102	12-Apr-86	2.45	460	1.2
139	20-May-86	2.4	500	1.3
140	21-May-86	2.4	460	1.2
141	22-May-86	2.43	470	1.2
142	23-May-86	2.45	320	0.8
143	24-May-86	2.45	315	0.75
144	25-May-86	2.45	330	0.7
145	26-May-86	2.5	330	0.7
146	27-May-86	2.43	300	0.7
147	28-May-86	2.45	300	0.85
148	29-May-86	2.44	320	0.7
149	30-May-86	2.45	320	0.75
150	31-May-86	2.46	310	0.7
151	01-Jun-86	2.48	300	0.65
152	02-Jun-86	2.46	300	0.7
153	03-Jun-86	2.47	310	0.7
154	04-Jun-86	2.45	300	0.7
155	05-Jun-86	2.45	305	0.7
156	06-Jun-86	2.45	300	0.7
157	07-Jun-86	2.45	310	0.7
158	08-Jun-86	2.7	370	0.6
159	09-Jun-86	2.45	300	0.7
160	10-Jun-86	2.44	320	0.75
161	11-Jun-86	2.43	350	0.75
162	12-Jun-86	2.45	300	0.7
163	13-Jun-86	2.45	300	0.7
164	14-Jun-86	2.47	270	0.6
165	15-Jun-86	2.45	360	0.6

166	16-Jun-86	2.42	310	0.7
167	17-Jun-86	2.47	290	0.7
168	18-Jun-86	2.47	290	0.7
169	19-Jun-86	2.45	320	0.7
170	20-Jun-86	2.43	290	0.7
171	21-Jun-86	2.45	300	0.68
172	22-Jun-86	2.43	300	0.7
173	23-Jun-86	2.42	300	0.75
174	24-Jun-86	2.45	270	0.65
175	25-Jun-86	2.45	280	0.7
176	26-Jun-86	2.45	290	0.7
177	27-Jun-86	2.41	300	0.75
178	28-Jun-86	2.42	290	0.7
179	29-Jun-86	2.45	270	0.65
180	30-Jun-86	2.45	270	0.65
181	01-Jul-86	2.45	290	0.7
182	02-Jul-86	2.45	300	0.8
183	03-Jul-86	2.45	280	0.65
184	04-Jul-86	2.48	250	0.6
185	05-Jul-86	2.44	300	0.7
186	06-Jul-86	2.42	290	0.6
187	07-Jul-86	2.42	300	0.8
188	08-Jul-86	2.4	330	0.85
189	09-Jul-86	2.4	310	0.75
190	10-Jul-86	2.42	320	0.75
191	11-Jul-86	2.42	340	0.8
192	12-Jul-86	2.42	340	0.8
193	13-Jul-86	2.4	350	0.8
194	14-Jul-86	2.4	340	0.8
195	15-Jul-86	2.41	390	1.3
196	16-Jul-86	2.41	370	1.3
197	17-Jul-86	2.4	370	1.3
198	18-Jul-86	2.4	380	1.3
199	19-Jul-86	2.42	340	1.15
200	20-Jul-86	2.42	160	1.2
201	21-Jul-86	2.4	370	1.2
202	22-Jul-86	2.4	320	1.1
203	23-Jul-86	2.4	340	1.2
204	24-Jul-86	2.42	350	1.3
205	25-Jul-86	2.42	340	1.2
206	26-Jul-86	2.45	305	1.05
207	27-Jul-86	2.43	310	1
208	28-Jul-86	2.43	330	1.15
209	29-Jul-86	2.4	320	1.1
210	30-Jul-86	2.4	330	1.2
211	31-Jul-86	2.4	340	1.2
212	01-Aug-86	2.4	310	1.1
213	02-Aug-86	2.45	300	1.1
214	03-Aug-86	2.45	300	1
215	04-Aug-86	2.42	320	1.2
216	05-Aug-86	2.42	320	1.1
217	06-Aug-86	2.41	310	1.1
218	07-Aug-86	2.41	320	1.2
219	08-Aug-86	2.42	320	1.1
220	09-Aug-86	2.42	330	1.1
221	10-Aug-86	2.42	330	1.1

222	11-Aug-86	2.42	320	1.1
223	12-Aug-86	2.42	310	1.1
224	13-Aug-86	2.42	320	1.15
225	14-Aug-86	2.42	320	1.1
226	15-Aug-86	2.4	310	1.1
227	16-Aug-86	2.4	300	1.1
228	17-Aug-86	2.42	300	1
229	18-Aug-86	2.4	300	1.15
230	19-Aug-86	2.42	320	1.1
231	20-Aug-86	2.42	300	1
232	21-Aug-86	2.42	310	1.1
233	22-Aug-86	2.42	320	1.1
234	23-Aug-86	2.4	330	1.1
235	24-Aug-86	2.43	280	1
236	25-Aug-86	2.41	330	1.15
237	26-Aug-86	2.41	320	1.1
238	27-Aug-86	2.43	380	1
239	28-Aug-86	2.45	300	1.1
240	29-Aug-86	2.42	310	1.1
241	30-Aug-86	2.42	300	1.1
242	31-Aug-86	2.42	298	0.95
243	01-Sep-86	2.43	280	1
244	02-Sep-86	2.4	310	1.1
245	03-Sep-86	2.4	300	1
246	04-Sep-86	2.4	310	1.1
247	05-Sep-86	2.4	320	1.2
248	06-Sep-86	2.4	300	1
249	07-Sep-86	2.43	260	0.95
250	08-Sep-86	2.42	300	1.1
251	09-Sep-86	2.42	300	1.1
252	10-Sep-86	2.41	320	1.2
253	11-Sep-86	2.42	330	1.18
254	12-Sep-86	2.44	300	1.1
255	13-Sep-86	2.5	270	1
256	14-Sep-86	2.45	280	1
257	15-Sep-86	2.43	300	1.1
258	16-Sep-86	2.42	300	1.1
259	17-Sep-86	2.43	280	1
260	18-Sep-86	2.4	300	1.1
261	19-Sep-86	2.45	330	1.2
262	20-Sep-86	2.46	300	1
263	21-Sep-86	2.48	270	0.9
264	22-Sep-86	2.45	320	1.15
265	23-Sep-86	2.43	300	0.95
266	24-Sep-86	0	310	0
267	25-Sep-86	0	330	0
268	26-Sep-86	2.43	320	1.1
269	27-Sep-86	2.45	320	1.1
270	28-Sep-86	2.45	300	1
271	29-Sep-86	2.44	320	1.2
272	30-Sep-86	2.45	320	1.1
273	01-Oct-86	2.45	290	1.1
274	02-Oct-86	2.45	280	1.1
275	03-Oct-86	2.45	300	1.1
276	04-Oct-86	2.45	270	1
277	05-Oct-86	2.47	270	1

278	06-Oct-86	2.45	300	1.1
279	07-Oct-86	2.5	290	1
280	08-Oct-86	2.45	310	1.1
281	09-Oct-86	2.45	300	1.1
282	10-Oct-86	2.5	320	1.3
283	11-Oct-86	2.5	320	1.3
284	12-Oct-86	2.47	280	1
285	13-Oct-86	2.46	305	1.15
286	14-Oct-86	2.47	320	1.2
287	15-Oct-86	2.47	305	1.2
288	16-Oct-86	2.47	300	1.15
289	17-Oct-86	2.46	300	1.1
290	18-Oct-86	2.48	320	1.2
291	19-Oct-86	2.48	320	1.18
292	20-Oct-86	2.47	320	1.1
293	21-Oct-86	2.47	310	1.1
294	22-Oct-86	2.46	300	1.05
295	23-Oct-86	2.5	320	1.2
296	24-Oct-86	2.45	310	1.15
297	25-Oct-86	2.46	320	1.2
298	26-Oct-86	2.47	310	1.1
299	27-Oct-86	2.45	300	1.2
300	28-Oct-86	2.45	300	1.1
301	29-Oct-86	2.45	300	1.15
302	30-Oct-86	2.46	290	1.1
303	31-Oct-86	2.5	300	1.1
304	01-Nov-86	2.5	280	1
305	02-Nov-86	2.5	300	1.1
306	03-Nov-86	2.5	310	1.2
307	04-Nov-86	2.47	300	1.2
308	05-Nov-86	2.47	310	1.2
309	06-Nov-86	2.45	310	1.2
310	07-Nov-86	2.47	300	1.1
311	08-Nov-86	2.45	320	1.1
312	09-Nov-86	2.45	310	1.15
313	10-Nov-86	2.45	320	1.2
314	11-Nov-86	2.45	370	1.25
315	12-Nov-86	2.45	340	1.3
316	13-Nov-86	2.5	380	1.5
317	14-Nov-86	2.46	380	1.45
318	15-Nov-86	2.5	330	1.25
319	16-Nov-86	2.45	330	1.3
320	17-Nov-86	2.45	340	1.3
321	18-Nov-86	2.45	340	1.3
322	19-Nov-86	2.46	360	1.4
323	20-Nov-86	2.45	340	1.3
324	21-Nov-86	2.45	350	1.28
325	22-Nov-86	2.45	490	1.95
326	23-Nov-86	2.45	470	1.85
327	24-Nov-86	2.43	500	1.9
328	25-Nov-86	2.45	500	1.95
329	26-Nov-86	2.45	500	1.9
330	27-Nov-86	2.45	520	2.1
331	28-Nov-86	2.45	520	2.05
332	29-Nov-86	2.45	510	2
333	30-Nov-86	2.42	505	2

334	01-Dec-86	2.42	540	2.1
335	02-Dec-86	2.43	550	2.2
336	03-Dec-86	2.43	540	2.15
337	04-Dec-86	2.43	550	2.18
338	05-Dec-86	2.44	410	1.55
339	06-Dec-86	2.46	360	1.4
340	07-Dec-86	2.45	350	1.3
341	08-Dec-86	2.45	350	1.3
342	09-Dec-86	2.46	340	1.3
343	10-Dec-86	2.46	350	1.4
344	11-Dec-86	2.45	380	1.45
345	12-Dec-86	2.45	370	1.45
346	13-Dec-86	2.46	380	1.45
347	14-Dec-86	2.5	360	1.5
348	15-Dec-86	2.5	340	1.3
349	16-Dec-86	2.46	330	1.23
350	17-Dec-86	2.45	360	1.4
351	18-Dec-86	2.42	400	1.5
352	19-Dec-86	2.51	370	1.4
353	20-Dec-86	2.48	350	1.3
354	21-Dec-86	2.48	400	1.6
355	22-Dec-86	2.47	380	1.48
356	23-Dec-86	2.47	350	1.3
357	24-Dec-86	2.5	330	1.2
358	25-Dec-86	2.52	320	1.2
359	26-Dec-86	2.5	350	1.3
360	27-Dec-86	2.47	340	1.3
361	28-Dec-86	2.48	330	1.25
362	29-Dec-86	2.47	360	1.3
363	30-Dec-86	2.5	340	1.2
364	31-Dec-86	2.5	320	1.3
365	01-Jan-87	2.5	310	1.2
366	02-Jan-87	2.5	330	1.2
367	03-Jan-87	2.48	330	1.22
368	04-Jan-87	2.48	330	1.2
369	05-Jan-87	2.48	360	1.4
370	06-Jan-87	2.5	310	1.15
371	07-Jan-87	2.48	410	1.5
372	08-Jan-87	2.47	430	1.65
373	09-Jan-87	2.48	445	1.7
374	10-Jan-87	2.49	400	1.5
375	11-Jan-87	2.48	270	1
376	12-Jan-87	2.5	310	1.15
377	13-Jan-87	2.45	340	1.4
378	14-Jan-87	2.45	370	1.35
379	15-Jan-87	2.42	350	1.3
380	16-Jan-87	2.42	370	1.4
381	17-Jan-87	2.45	360	1.35
382	18-Jan-87	2.43	350	1.3
383	19-Jan-87	2.46	380	1.4
384	20-Jan-87	2.5	360	1.4
385	21-Jan-87	2.5	340	1.3
386	22-Jan-87	2.45	370	1.4
387	23-Jan-87	2.45	400	1.5
388	24-Jan-87	2.45	380	1.4
389	25-Jan-87	2.47	360	1.3

390	26-Jan-87	2.46	370	1.4
391	27-Jan-87	2.48	370	1.4
392	28-Jan-87	2.47	340	1.28
393	29-Jan-87	2.46	370	1.4
394	30-Jan-87	2.46	350	1.3
395	31-Jan-87	2.48	320	1.2
396	01-Feb-87	2.47	340	1.3
397	02-Feb-87	2.48	330	1.25
398	03-Feb-87	2.46	330	1.2
399	04-Feb-87	2.47	350	1.4
400	05-Feb-87	2.47	370	1.4
401	06-Feb-87	2.48	350	1.4
402	07-Feb-87	2.5	330	1.2
403	08-Feb-87	2.48	340	1.3
404	09-Feb-87	2.5	380	1.47
405	10-Feb-87	2.5	350	1.3
406	11-Feb-87	2.5	340	1.35
407	12-Feb-87	2.5	270	1.1
408	13-Feb-87	2.5	340	1.3
409	14-Feb-87	2.5	340	1.35
410	15-Feb-87	2.5	360	1.3
411	16-Feb-87	2.46	380	1.6
412	17-Feb-87	2.47	400	1.5
413	18-Feb-87	2.47	350	1.35
414	19-Feb-87	2.45	350	1.4
415	20-Feb-87	2.47	330	1.2
416	21-Feb-87	2.47	300	1.12
417	22-Feb-87	2.49	320	1.2
418	23-Feb-87	2.46	340	1.25
419	24-Feb-87	2.45	320	1.2
420	25-Feb-87	2.45	340	1.25
421	26-Feb-87	2.45	330	1.25
422	27-Feb-87	2.45	340	1.3
423	28-Feb-87	2.48	310	1.15
424	01-Mar-87	2.48	310	1.2
425	02-Mar-87	2.42	340	1.85
426	03-Mar-87	2.42	410	1.6
427	04-Mar-87	2.41	500	2
428	05-Mar-87	2.42	510	2
429	06-Mar-87	2.42	500	2
430	07-Mar-87	2.45	480	1.8
431	08-Mar-87	2.45	480	1.8
432	09-Mar-87	2.42	500	1.9
433	10-Mar-87	2.42	510	2
434	11-Mar-87	2.42	510	2
435	12-Mar-87	2.4	520	2
436	13-Mar-87	2.43	520	2
437	14-Mar-87	2.43	520	2.05
438	15-Mar-87	2.45	500	1.95
439	16-Mar-87	2.43	490	1.9
440	17-Mar-87	2.43	460	1.8
441	18-Mar-87	2.43	500	1.95
442	19-Mar-87	2.41	510	2
443	20-Mar-87	2.42	500	1.95
444	21-Mar-87	2.43	490	1.9
445	22-Mar-87	2.43	480	1.9

446	23-Mar-87	2.4	470	1.9
447	24-Mar-87	2.4	500	1.9
448	25-Mar-87	2.42	470	2
449	26-Mar-87	2.45	520	2
450	27-Mar-87	2.45	500	1.9
451	28-Mar-87	2.45	480	1.7
452	29-Mar-87	2.45	320	1.3
453	30-Mar-87	2.45	320	1.3
454	31-Mar-87	2.42	480	1.9
455	01-Apr-87	2.4	490	1.9
456	02-Apr-87	2.42	510	2
457	03-Apr-87	2.42	500	1.9
458	20-May-87	2.4	490	1.8
459	21-May-87	2.41	650	2.4
460	22-May-87	2.4	460	1.75
461	21-Jun-87	2.4	510	1.85
462	22-Jun-87	2.4	520	1.9
463	23-Jun-87	2.4	510	1.9
464	24-Jun-87	2.4	500	1.85
465	25-Jun-87	2.38	530	2
466	10-Jul-87	2.42	815	3.1
467	11-Jul-87	2.4	530	1.9
468	12-Jul-87	2.4	545	2
469	13-Jul-87	2.42	700	2.6
470	14-Jul-87	2.4	800	2.95
471	15-Jul-87	2.48	440	1.7
472	16-Jul-87	2.5	350	1.2
473	17-Jul-87	2.46	355	1.2
474	18-Jul-87	2.45	370	1.22
475	19-Jul-87	2.45	370	1.3
476	20-Jul-87	2.43	390	1.3
477	21-Jul-87	2.4	365	1.3
478	22-Jul-87	2.4	420	1.45
479	23-Jul-87	2.4	520	2
480	24-Jul-87	2.38	530	1.95
481	25-Jul-87	2.37	550	1.95
482	17-Aug-87	2.38	800	3
483	18-Aug-87	2.4	520	1.9
484	23-Aug-87	2.42	810	3
485	24-Aug-87	2.42	475	1.8
486	25-Aug-87	2.45	500	1.8
487	22-Sep-87	2.4	640	2.4
488	23-Sep-87	2.4	500	1.9
489	01-Oct-87	2.4	520	3
490	02-Oct-87	2.4	540	2
491	03-Oct-87	2.47	435	1.7
492	04-Oct-87	2.45	310	1.15
493	05-Oct-87	2.42	310	1.1
494	06-Oct-87	2.43	310	1.45
495	07-Oct-87	2.42	310	1.2
496	08-Oct-87	2.42	330	1.3
497	09-Oct-87	2.43	285	1.02
498	10-Oct-87	2.43	340	1.35
499	11-Oct-87	2.45	370	1.35
500	12-Oct-87	2.45	380	1.35
501	13-Oct-87	2.47	370	1.4

502	14-Oct-87	2.45	335	1.3
503	15-Oct-87	2.45	340	1.3
504	16-Oct-87	2.45	330	1.15
505	17-Oct-87	2.45	340	1.25
506	18-Oct-87	2.47	330	1.2
507	19-Oct-87	2.45	370	1.3
508	20-Oct-87	2.45	340	1.3
509	21-Oct-87	2.45	400	1.55
510	22-Oct-87	2.45	320	1.25
511	23-Oct-87	2.45	340	1.3
512	24-Oct-87	2.45	360	1.38
513	25-Oct-87	2.45	400	1.5
514	26-Oct-87	2.45	340	1.3
515	27-Oct-87	2.46	330	1.3
516	28-Oct-87	2.45	320	1.3
517	29-Oct-87	2.45	380	1.4
518	30-Oct-87	2.46	350	1.35
519	31-Oct-87	2.47	320	1.2
520	01-Nov-87	2.47	380	1.2
521	02-Nov-87	2.46	300	1.2
522	03-Nov-87	2.47	340	1.3
523	04-Nov-87	2.47	290	1.1
524	05-Nov-87	2.45	350	1.3
525	06-Nov-87	2.43	360	1.35
526	07-Nov-87	2.42	370	1.7
527	08-Nov-87	2.42	480	1.9
528	09-Nov-87	2.4	510	2
529	10-Nov-87	2.4	540	2.1
530	11-Nov-87	2.4	535	2.1
531	12-Nov-87	2.4	540	2.1
532	05-Dec-87	2.4	520	2
533	06-Dec-87	2.4	430	1.6
534	07-Dec-87	2.4	400	1.5
535	08-Dec-87	2.4	390	1.5
536	09-Dec-87	2.42	365	1.4
537	10-Dec-87	2.42	370	1.4
538	11-Dec-87	2.43	400	1.63
539	12-Dec-87	2.42	390	1.5
540	13-Dec-87	2.42	400	1.6
541	14-Dec-87	2.42	390	1.55
542	15-Dec-87	2.42	400	1.55
543	16-Dec-87	2.42	420	1.55
544	17-Dec-87	2.41	410	1.7
545	18-Dec-87	2.5	390	1.5
546	19-Dec-87	2.46	320	1.3
547	20-Dec-87	2.47	310	1.25
548	21-Dec-87	2.46	330	1.3
549	22-Dec-87	2.45	310	1.25
550	23-Dec-87	2.45	325	1.3
551	24-Dec-87	2.48	320	1.3
552	25-Dec-87	2.48	300	1.2
553	26-Dec-87	2.47	300	1.2
554	27-Dec-87	2.47	310	1.3
555	28-Dec-87	2.46	340	1.4
556	29-Dec-87	2.45	315	1.35
557	30-Dec-87	2.46	360	1.5

558	31-Dec-87	2.5	330	1.3
559	01-Jan-88	2.5	380	1.45
560	02-Jan-88	2.45	370	1.45
561	03-Jan-88	2.47	350	1.45
562	04-Jan-88	2.45	390	1.6
563	05-Jan-88	2.46	400	1.6
564	06-Jan-88	2.5	400	1.7
565	07-Jan-88	2.47	400	1.5
566	08-Jan-88	2.47	370	1.5
567	09-Jan-88	2.45	350	1.4
568	10-Jan-88	2.45	360	1.4
569	11-Jan-88	2.45	370	1.5
570	12-Jan-88	2.46	300	1.2
571	13-Jan-88	2.47	250	1.05
572	14-Jan-88	2.47	410	1.6
573	15-Jan-88	2.46	460	1.75
574	16-Jan-88	2.45	340	1.35
575	17-Jan-88	2.45	320	1.2
576	18-Jan-88	2.45	340	1.3
577	19-Jan-88	2.45	360	1.4
578	20-Jan-88	2.42	410	1.6
579	21-Jan-88	2.4	420	1.6
580	22-Jan-88	2.4	450	1.52
581	23-Jan-88	2.4	500	2
582	24-Jan-88	2.4	510	2.1
583	25-Jan-88	2.4	570	2.2
584	26-Jan-88	2.4	510	2.1
585	27-Jan-88	2.4	550	2.18
	MAX VALUE	2.7	815	3.1

Attachment B

FIECAG
Cable Ampacity Computer Program

Section I

Computer Program Description

Canadian Electrical Association
Association canadienne de l'électricité

Wallace S. Read
President,
Suite 500, 1 Westmount Square,
Montréal, P.Q. H3Z 2P9
Tel. (514) 937-6181
Telex: 05-267401

Representing Canada's Electric Utilities.
Porte-parole des services publics d'électricité au Canada.

RESEARCH & DEVELOPMENT

April 29, 1988

B. Meredith
CONSUMERS POWER PALISADES PLT
27780 Blue Star
Covert, MI
49043

Dear Mr. Meredith,

Your name has been submitted to us by the publishers of Transmission & Distribution magazine. They noted that you are interested in knowing more about FETA, the cable ampacity calculation program developed for CEA by Ontario Hydro.

In response to your interest, I am sending you a booklet which will inform you of some of the capabilities of the program.

FETA is a new program on the market and compliments another program called FIECAG, also developed by Ontario Hydro for CEA.

The latter program has been on the market for almost 2 years and has been acquired by electric utilities, cable manufacturers and consulting engineering firms in Canada, the United States and Europe.

A booklet describing FIECAG is also enclosed and a demonstration diskette is available for $15.00 U.S. The diskette may be obtained from the software company to whom we have licensed the program's marketing rights. Other pertinent details are available from:

Mr. Bert Evangelista
Marketing Engineer
CYME INTERNATIONAL INC.
1485 Roberval
Suite 204
St-Bruno, Québec
J3V 3P8
(514) 461-3655

...2/

The cost of FIECAG is $6,000 U.S.; that of FETA is $7,500.00 U.S. Please note, however, that very attractive discounts apply for the purchase of both programs simultaneously or multiple copies of either program.

The differences between the two programs are explained in the enclosed booklets. In short, FIECAG is based on the Neher-McGrath/IEC Standard Publication 287 techniques, whereas FETA uses the finite element analysis technique and can be used to perform steady state as well as transient analysis.

Yours truly,

CANADIAN ELECTRICAL ASSOCIATION

S. Morielli

S. Morielli
Program Manager
Technology Implementation
Research & Development

SM/cs
Enclosures

c.c. B. Evangelista (no enclosures)

Section II

Program Assumptions and Data Input Screens

ASSUMPTIONS FOR STUDY

1. 40 C Ambient
2. Unshaded conduit or tray
3. Solar radiation is 700 W/M2
4. Cable surface absorption coefficient is .40
5. No external heat source
6. Metallic conduit with three conductors touching
7. 2500 Volts phase to phase
8. Conduit is 4 inch steel pipe
9. All cables are 500 MCM unshielded
10. Load factor is 100%
11. Neher-McGrath method is used

WPWaudby
5/17/88
hoot

STUDY NO. 9 CABLES IN AIR
EXECUTION NO. 2 HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 80 C

DATAMENU

1. EXAMINE/MODIFY GENERAL DATA
2. EXAMINE/MODIFY CABLE INSTALLATION DATA
3. EXAMINE/MODIFY EXECUTION TITLE
4. EXAMINE/MODIFY CABLE DESIGN DATA
0. PREVIOUS MENU

PLEASE SELECT

STUDY NO. 9 CABLES IN AIR
EXECUTION NO. 2 HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 80 C

GENERAL DATA

1. GENERAL INPUT DATA
2. DEFAULT DATA
3. CABLE IN AIR SETUP
4. CABLE IN AIR DETAILS
5. EXTERNAL HEAT SOURCE DATA
0. PREVIOUS MENU

PLEASE SELECT

DY NO. 9 CABLES IN AIR
CUTION NO. 2 HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 80 C

GENERAL INPUT DATA

1. enter 1 to calculate ampacity of equally loaded, similar cables, enter 2 to calculate ampacity of unequally loaded and/or dissimilar cables, enter 3 to calculate conductor temperature	1
2. number of cables in study	2
3. number of cable design types in study	1
4. ambient temperature, deg. C	40.0
5. native soil thermal resistivity, C-M/W	0.000
6. reference cable for calculating ampacities of unequally loaded cables	2

BACKFILL/DUCT BANK DATA (ENTER 0.0 IF NO BACKFILL OR DUCT BANK)

7. height, M	0.000
8. width, M	0.000
9. X and Y of horizontal centre of	0.000
backfill/duct bank, M	0.000
10. backfill/duct bank thermal resistivity, C-M/W	0.000
11. are the cables in air/duct in air - Y or N	y
12. is there an external heat source - Y or N	n

THREE SINGLE PHASE CABLES IN ONE DUCT ARE COUNTED AS ONE CABLE

STUDY NO. 9 CABLES IN AIR
EXECUTION NO. 2 HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 80 C

GENERAL DEFAULT VARIABLES

13.	convergence tolerance for sheath/shield, armour temperatures, C	0.10
14.	convergence tolerance for ampacity, A	1.00
15.	maximum number of iterations	100
16.	fraction of conductor current returning through sheath for single phase cables	0.000
17.	system frequency, HZ	60.0
18.	input data display flag,0-none,1-some,2-all	0
19.	output results display flag - see manual	1
20.	external thermal resistance calculating method flag: 1=NEHER-MCGRATH, 2=IEC-287	1

SEE USER MANUAL FOR FURTHER DETAILS

CABLE IN AIR DATA

FOR 1. THROUGH 8. - IT IS ASSUMED THAT CABLES ARE IN FREE AIR, INSTALLED ON NON-CONTINUOUS BRACKETS, LADDER TRAYS OR CLEATS, CABLE DIAMETERS LESS THAN 0.15 M

1. single cable, or group of cables spaced horizontally, spacing between cables greater than 0.75 times cable diameter, cable spacing from vertical face 0.3 times cable diameter

FOR 2. THROUGH 8. - CABLE SPACING FROM VERTICAL FACE IS 0.5 TIMES CABLE DIAMETER

2. two cables touching, horizontal arrangement
3. three cables touching, triangular arrangement
4. three cables touching, horizontal arrangement
5. two cables touching, vertical arrangement
6. two cables, spaced one cable diameter, vertical arrangement
7. three cables touching, vertical arrangement
8. three cables, spaced one cable diameter, vertical arrangement

FOR 9. AND 10. - IT IS ASSUMED THAT CABLES ARE CLIPPED TO A VERTICAL WALL AND THAT CABLE DIAMETERS ARE LESS THAN 0.08 M

9. single cable
10. three cables triangular arrangement

THE CURRENT CHOICE IS 3

DY NO. 9 CABLES IN AIR
CUTION NO. 2 HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 80 C

MORE CABLE IN AIR DATA

22. enter 1 for shaded cables, 2 for unshaded 2

23. intensity of solar radiation 700.000

24. cable suface absorption coefficient , SUNABSO
SUNABSO = 0.8 for compounded jute/fibrous materials
SUNABSO = 0.8 for polychloroprene
SUNABSO = 0.6 for polyvinylchloride
SUNABSO = 0.4 for polyethylene
SUNABSO = 0.6 for lead or armour
enter one of the above or a user defined value 0.40

CITY CALCULATION FOR EQUALLY LOADED, SIMILAR CABLES Study 9 Exec. 2

Cable No.	Circuit No.	Cable Design Type	Number	Location XL(m)	YL(m)	Conductor Temperature	Daily Load Factor
1	1	50		0.000	0.000	80.00	1.00
2	2	50		0.254	0.000	80.00	1.00
3	0	0		0.000	0.000	0.00	0.00
4	0	0		0.000	0.000	0.00	0.00
5	0	0		0.000	0.000	0.00	0.00
6	0	0		0.000	0.000	0.00	0.00
7	0	0		0.000	0.000	0.00	0.00
8	0	0		0.000	0.000	0.00	0.00
9	0	0		0.000	0.000	0.00	0.00
10	0	0		0.000	0.000	0.00	0.00
11	0	0		0.000	0.000	0.00	0.00
12	0	0		0.000	0.000	0.00	0.00
13	0	0		0.000	0.000	0.00	0.00
14	0	0		0.000	0.000	0.00	0.00
15	0	0		0.000	0.000	0.00	0.00

ENTER ONE CABLE ONLY FOR A GROUP OF THREE SINGLE CORE CABLES IN ONE DUCT

CABLE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

C A B L E T Y P E L I B R A R Y

1. Cable Design Materials
2. Cable Design Dimensions
R. Save Changes and Return
Q. Ignore Changes and Return

Please select

CABLE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

C A B L E D E S I G N M A T E R I A L S

1. Installation
2. Conductor Material
3. Conductor Construction
4. Dry and Impregnated
5. Skin,proximity effect loss factors
6. Insulation Type
7. Dielectric Constant Loss Factor
8. Number of Conductors in Cable
9. Skid Wire / Concentric Neutral
10. Sheath Material
11. Sheath/Shield Bonding
12. Loss Factor Constant
13. Jacket or Pipe Coating Material
14. Armour/Reinforcement Tape
18. Insulation Shielding
19. Sheath Reinforcing Material
23. Duct Bank Construction
26. Cable Type Title

Q. Previous menu

PLEASE SELECT

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

INDENTIFY CABLE INSTALLATION

1. self contained cables in air/Duct in air
2. self contained cables directly buried
3. self contained cables in thermal backfill
4. self contained cables in duct/ductbank
5. pipe type cables directly buried
6. pipe type cables in thermal backfill
7. pipe type cables in air

THE CURRENT CHOICE IS 1

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

IDENTIFY CONDUCTOR MATERIAL

-1. user supplies RHC (conductor resistivity at 20 C in ohm-m) and ALFA (temperature coefficient of resistance in 1/(dég C) .)
1. copper conductor,RHC=1.7241E-8,ALFA=0.00393
2. aluminum conductor,RHC=2.8264E-8,ALFA=0.00403

THE CURRENT CHOICE IS 1

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS
IDENTIFY THE CONDUCTOR CONSTRUCTION

1. round, stranded
2. round, compact or compressed
3. type m, round segmental type m, 4 segment hollow core
4. hollow core (not type m)
5. type m, six segment hollow core
6. sector shaped
7. oval
8. solid

THE CURRENT CHOICE IS 1

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

INDICATE WHETHER OR NOT CABLE HAS BEEN DRIED AND IMPREGNATED

1. cable dried and impregnated
2. cable not dried and impregnated or not applicable

THE CURRENT CHOICE IS 1

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

INDICATE WHETHER OR NOT CABLE HAS BEEN DRIED AND IMPREGNATED

1. cable dried and impregnated
2. cable not dried and impregnated or not applicable

THE CURRENT CHOICE IS 1

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

IDENTIFY SOURCE OF COEFFICIENTS USED IN CALCULATING CONDUCTOR LOSSES

-1. user enters KS and KP (see IEC 287 for definitions)
0. values are set by the program (see manual for details)

THE CURRENT CHOICE IS 0

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

IDENTIFY INSULATION TYPE

-1. user supplies RHI (insulation thermal resistivity in C-M/W)
 1. solid type or mass impregnated, non draining cable,RHI=6.
 2. LPOF self contained cable,RHI=5.0
 3. HPOF self contained cable,RHI=5.0
 4. HPOF pipe type cable,RHI=5.0
 5. external gas pressure cable,RHI=5.5
 6. internal gas pressure, preimpregnated cable,RHI=6.5
 7. internal gas pressure mass impregnated cable,RHI=6.0
 8. butyl rubber,RHI=5.0
 9. EPR,RHI=5.0
10. PVC,RHI=6.0
11. polyethylene,RHI=3.5
12. cross linked polyethylene,RHI=3.5

THE CURRENT CHOICE IS 8

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

INDICATE SOURCE OF DIELECTRIC LOSS FACTOR AND DIELECTRIC CONSTANT

-3. user supplies COSPHI (dielectric loss factor)
and EPSILN (dielectric constant)
-2. user supplies EPSILN
-1. user supplies COSPHI
0. program selects coefficients (see manual for details)

THE CURRENT CHOICE IS -3

ENTER COSPHI 4.5000
ENTER EPSILN 0.03

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

INDICATE NUMBER OF CONDUCTORS

1. single conductor cable
2. three conductor cable
3. single conductor cables touching

THE CURRENT CHOICE IS 3

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

IDENTIFY MATERIAL OF SKID WIRE/CONCENTRIC NEUTRAL

-1. user supplies RHK (skid wire/concentric neutral resistivity at 20 C) and ALFAK (temperature coefficient of resistance)
 0. no skid wire/concentric neutral
 1. copper,RHK=1.7241E-8,ALFAK=0.00393
 2. brass/bronze,RHK=3.5E-8,ALFAK=0.003
 3. zinc,RHK=6.11E-8,ALFAK=0.004
 4. stainless steel,RHK=70.E-8,ALFAK=0.000

THE CURRENT CHOICE IS 0

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

IDENTIFY SHEATH MATERIAL

-1. user supplies RHS (sheath resistivity in ohm-m at 20 C)
    and ALFAS (temperature coefficient of resistance)
 0. no sheath
 1. aluminum, RHS=2.84E-8,ALFAS=0.00403
 2. lead, RHT=21.4E-8,ALFAS=0.004
 3. lead sheath with reinforcing tape,RHS=21.4E-8,ALFAS=0.004

THE CURRENT CHOICE IS 0

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

IDENTIFY SHEATH/SHIELD/NEUTRAL BONDING ARRANGEMENT
sheath means sheath/shield/neutral

1. single conductor cables, sheaths bonded both ends, triangular config.
2. single conductor cables, sheaths bonded both ends, flat configuration
3. single conductor cables, sheaths single point bonded, triangular con.
4. single conductor cables, sheaths single point bonded, flat config.
5. single conductor cables, sheaths cross bonded, triangular config.
6. single conductor cables, sheaths cross bonded, flat configuration
7. three conductor cable in common sheath
8. three conductor cable with steel tape armour
9. single conductor cables with no bonding

THE CURRENT CHOICE IS 9

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

IDENTIFY THE LOSS FACTOR CONSTANT

-1. user supplies ALOS for LOSS FACTOR = ALOS*DLF+(1.-ALOS)*DLF**2
 1. ALOS = 0.3 (see manual for details)

THE CURRENT CHOICE IS 1

BLE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

IDENTIFY ARMOUR OR REINFORCEMENT TAPE OR MATERIAL

-4. user supplies RHA (armour resistivity in ohm-m at 20c) and ALFAA (temperature coefficient of resistance) for non-magnetic reinforcement tape
-3. user supplies RHA and ALFAA for magnetic armour wires
-2. user supplies RHA and ALFAA for magnetic reinforcement tape
-1. user supplies RHA and ALFAA for non-magnetic reinforcement wires
0. no armour or tape reinforcement
1. steel wire armour, wires touching, RHA=13.8E-8,ALFAA=0.0045
2. steel wire armour, wires not touching, RHA=13.8E-8,ALFAA=0.0045
3. steel tape reinforcement,RHA=13.8E-8,ALFAA=0.0045
4. copper armour wires,RHA=1.721E-8,ALFAA=0.00393
5. stainless steel armour wires,RHA=70.E-8,ALFAA=0.0
6. TECK armour (aluminum interlocking tape, RHA=2.84E-8,ALFAA =.00403

THE CURRENT CHOICE IS 0

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

IDENTIFY JACKET MATERIAL OR PIPE COATING FOR PIPE TYPE CABLES

-1. user supplies RHJ (jacket thermal resistivity in c-m/w)
0. no jacket
1. compounded jute and fibrous material,RHJ=6.0
2. rubber sandwich protection,RHJ=6.0
3. polychloroprene,RHJ=5.5
4. polyethylene,RHJ=3.5
5. PVC,for E<=35kV,RHJ=5.0;for E>35kV,RHJ=6.0
6. ethylene-propylene rubber,RHJ=5.0
7. butyl rubber,RHJ=5.0
8. coal tar wrapping,RHJ=4.5

THE CURRENT CHOICE IS 5

C[redacted]E TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN DIMENSIONS

CABLE OUTER DIAMETER, PIPE/DUCT DIAMETERS

40.	overall cable diameter,	m	0.03366
41.	inside diameter of duct or cable pipe,	m	0.10226
42.	outside diameter of duct or cable pipe,	m	0.11430

CABLE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN DIMENSIONS

CABLE JACKET, ARMOUR BEDDING AND ARMOUR SERVING DATA

26. diameter over cable jacket,	m	0.03366
27. thickness of cable jacket,	m	0.00229

CABLE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN DIMENSIONS

CABLE CONDUCTOR DATA:

1. Number of conductors in the cable	1
2. Conductor cross sectional area, m2	0.00025315
3. Diameter or geometric mean diameter of the conductor, m	0.02065
4. Diameter over the conductor shield, m	0.02111

CABLE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

C A B L E D E S I G N D I M E N S I O N S

1. Cable Conductor Data
2. Cable Insulation Data
3. Sheath and non-magnetic reinforcing tape or metalic binder data
4. Cable jacket, armour bedding and armour serving data
5. Skid wires/concentric neutral wires or wire armour or magnetic reinforcement tape
6. Cable outer diameter, pipe/duct diameters

Q. Previous menu

Please select

LE NO. 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS
IDENTIFY DUCT/DUCTBANK CONSTRUCTION

-K. user supplies RHD (duct material thermal resistivity C.W/m)
K denotes one of the 12 types of duct construction listed below

0.	cables not in ducts	
1.	metallic conduit	RHD=0.0
2.	fibre duct in air	RHD=4.8
3.	fibre duct in concrete	RHD=4.8
4.	asbestos duct in air	RHD=2.0
5.	asbestos duct in concrete	RHD=2.0
6.	PVC duct in air	RHD=7.0
7.	PVC duct in concrete	RHD=7.0
8.	polyethylene duct in air	RHD=3.5
9.	polyethylene duct in concrete	RHD=3.5
10.	earthenware duct	RHD=1.2
11.	high pressure gas filled pipe type	RHD=0.0
12.	high pressure oil filled pipe type	RHD=0.0

THE CURRENT CHOICE IS 1

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

IDENTIFY MATERIAL OF SHEATH REINFORCING TAPE OR METAL TAPE IN PIPE TYPE CABLE BINDER

-1. user supplies RHT (reinforcing tape resistivity in ohm-m) and ALFAT (temperature coefficient of resistance in 1/deg c)
0. no reinforcing tape
1. copper,RHT=1.7241E-8,ALFAT=0.00393
2. brass/bronze,RHT=3.5E-8,ALFAT=0.003
3. zinc,RHT=6.11E-8,ALFAT=0.004
4. stainless steel,RHT=70.E-8,ALFAT=0.000
5. steel,RHT=13.8E-8,ALFAT=0.0045

THE CURRENT CHOICE IS 0

LE TYPE 50 5 KV 500 MCM Cu 1/C non-shielded 90 C Butyl Rubber (EPR) w/j

CABLE DESIGN MATERIALS

IDENTIFY INSULATION SHIELDING

0. belted cable or no insulation shielding
1. copper metallized paper
2. aluminum metallized paper
3. copper tape
4. aluminum tape

THE CURRENT CHOICE IS 0

Section III

Program Results

CABLES IN CONDUIT, IN AIR
HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 80 C

SOLUTION CONVERGED AFTER 3 ITERATIONS

CABLE NO	X LOCATION (M)	Y LOCATION (M)	COND. TEMP. (DEG.C)	AMPACITY (AMPS)
1	.00	.00	80.	420.
2	.25	.00	80.	420.

To continue output display press <return> key

CABLES IN CONDUIT, IN AIR
HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 1010A

SOLUTION CONVERGED AFTER 5 ITERATIONS

CABLE NO	X LOCATION (M)	Y LOCATION (M)	AMPACITY (AMPS)	COND. TEMP. (DEG.C)
1	.00	.00	505.	90.
2	.25	.00	505.	90.

To continue output display press <return> key

Stop - Program terminated.

C:\FIECAG>

CABLES IN CONDUIT, IN AIR
HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 1020A

SOLUTION CONVERGED AFTER 5 ITERATIONS

CABLE NO	X LOCATION (M)	Y LOCATION (M)	AMPACITY (AMPS)	COND. TEMP. (DEG.C)
1	.00	.00	510.	91.
2	.25	.00	510.	91.

To continue output display press <return> key

CABLES IN CONDUIT, IN AIR
HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 1030A

SOLUTION CONVERGED AFTER 5 ITERATIONS

CABLE NO	X LOCATION (M)	Y LOCATION (M)	AMPACITY (AMPS)	COND. TEMP. (DEG.C)
1	.00	.00	515.	92.
2	.25	.00	515.	92.

To continue output display press <return> key

CABLES IN CONDUIT, IN AIR
HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 1040A

SOLUTION CONVERGED AFTER 5 ITERATIONS

CABLE NO	X LOCATION (M)	Y LOCATION (M)	AMPACITY (AMPS)	COND. TEMP. (DEG.C)
1	.00	.00	520.	93.
2	.25	.00	520.	93.

To continue output display press <return> key

Stop - Program terminated.

C:\FIECAG>

CABLES IN CONDUIT, IN AIR
HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 1050A

SOLUTION CONVERGED AFTER 5 ITERATIONS

CABLE NO	X LOCATION (M)	Y LOCATION (M)	AMPACITY (AMPS)	COND. TEMP. (DEG.C)
1	.00	.00	525.	93.
2	.25	.00	525.	93.

To continue output display press <return> key

CABLES IN CONDUIT, IN AIR
HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 1060A

SOLUTION CONVERGED AFTER 5 ITERATIONS

CABLE NO	X LOCATION (M)	Y LOCATION (M)	AMPACITY (AMPS)	COND. TEMP. (DEG.C)
1	.00	.00	530.	94.
2	.25	.00	530.	94.

To continue output display press <return> key

CABLES IN CONDUIT, IN AIR
HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 1070A

SOLUTION CONVERGED AFTER 5 ITERATIONS

CABLE NO	X LOCATION (M)	Y LOCATION (M)	AMPACITY (AMPS)	COND. TEMP. (DEG.C)
1	.00	.00	535.	95.
2	.25	.00	535.	95.

To continue output display press <return> key

CABLES IN CONDUIT, IN AIR
HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 1080A

SOLUTION CONVERGED AFTER 5 ITERATIONS

CABLE NO	X LOCATION (M)	Y LOCATION (M)	AMPACITY (AMPS)	COND. TEMP. (DEG.C)
1	.00	.00	540.	95.
2	.25	.00	540.	95.

To continue output display press <return> key

CABLES IN CONDUIT, IN AIR
HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 1090A

SOLUTION CONVERGED AFTER 4 ITERATIONS

CABLE NO	X LOCATION (M)	Y LOCATION (M)	AMPACITY (AMPS)	COND. TEMP. (DEG.C)
1	.00	.00	545.	96.
2	.25	.00	545.	96.

To continue output display press <return> key

To activate the printer (if one is connected)
press simultaneously Ctrl and P keys and then ....

Strike a key when ready . . .

CABLES IN CONDUIT, IN AIR
HORIZONAL CONDUIT SPT 1-2 TO BUS IE DATA/B. MEREDITH 1100A

SOLUTION CONVERGED AFTER 4 ITERATIONS

CABLE NO	X LOCATION (M)	Y LOCATION (M)	AMPACITY (AMPS)	COND. TEMP. (DEG.C)
1	.00	.00	550.	97.
2	.25	.00	550.	97.

To continue output display press <return> key

Section IV

Phillips Cable
Test Report

Phillips Cables LIMITED

Power Products Division
Engineering Department
King Street West
Brockville, Ontario K6V 5W4

Area Code 613, 345-5666
Telex 066-38512

ENGINEERING REPORT NO. 87-30

FIECAG AMPACITY PROGRAM

EVALUATION PHASE I

DECEMBER, 1987

SUMMARY:

In January 1987, Phillips Engineering Department purchased from the Canadian Electrical Association (CEA) a copy of the FIECAG Ampacity Program developed by Ontario Hydro. Due to the complexity of the program with respect to input data options, an evaluation program was set up to establish a "confidence level" for various cable types and installation conditions. This report tabulates results of ampacity ratings obtained using FIECAG, Phillips Program, ICEA/IEEE Tables and Catalogue values.

PREPARED BY: J.D. Moncrieff
J. D. Moncrieff, P.Eng.

APPROVED BY: N.R. Plant
N. R. Plant, CET

DATE: 1987-12-17 DATE: 1987-12-17

DISTRIBUTION: JH, NRP, JV, TS, TGM

FILE REF.: Project 27.2

1. Background

After receiving the FIECAG Ampacity Program, a limited number of ampacity calculations were performed with great difficulty. This was due mainly to the complexity of the program with respect to input data options.

In April 1987, a meeting was held to discuss an evaluation routine addressing a number of the capabilities of the FIECAG Ampacity Program. The persons involved at Phillips are as follows:

N. R. Plant
J. S. Tennant
J. D. Moncrieff
J. Visser
T. Singh
T. G. MacMillan

An action plan (Phase 1) was designed to allow us to establish a "confidence level" with the program.

2. Evaluation - Phase 1

Phase 1 of the evaluation concentrated on medium voltage power cable used by Utilities, specifically Shielded Power and Concentric Neutral Cable.

Eleven different installation configurations were evaluated (ie. for cable(s) in air, directly buried, in ductbank, and in conduit in air). Details on cable types and installation conditions are outlined in Appendix I.

Ampacity ratings were obtained using FIECAG, Phillips ampacity programs, ICEA/IEEE tables and catalogue values for the above cable types and installation conditions. For comparison purposes, results have been tabulated for each cable type and listed in Appendix II.

In addition to the above comparison, we performed actual load cycle tests on various cables in our High Voltage Laboratory and simulated the same test conditions using FIECAG. The test results are shown in Appendix III.

5. Interpretation of the various screens requires a thorough understanding of the IEC Standard Publication 287, "Calculation of the Continuous Current Rating of Cables (100% load factor)".

   For example, when identifying the sheath/shield /neutral bonding arrangement, there are nine options for various single and three conductor arrangements.

6. Lack of safety checks for possible errors made in the program input; eg. changing installation condition from "in air" to "direct burial" requires that all screens must be reviewed to insure all direct burial input data has been entered. No safety check to highlight these screens.

7. Actual ampacity values obtained in laboratory tests compared very closely to the values obtained using the FIECAG program.

5. Conclusion:

It is our opinion that the FIECAG program is a very powerful tool for calculating power cable ampacities under various installation conditions. However in the present format, FIECAG requires that the user be knowledgeable with regard to cable design and installation in order to use it effectively.

As discussed in our meeting with Dr. Anders, an amendment to the program to make it more "user-friendly" with more safety checks, and designed for typical American cable designs (ie. shielded power cable, concentric neutral cable, interlocked armoured cable, etc.), will make this program an even more powerful tool for cable manufacturers and electrical utilities.

APPENDIX I

Phase 1 of the evaluation concentrated on the following cable types and installation conditions:

A) Cable Types:

i) 1C & 3C 1/0 AWG Copper, XLPE, 15 kV Shielded Power Cable

ii) 1C & 3C 500 kcmil Copper, XLPE, 15 kV Shielded Power Cable

iii) 1C 1/0 AWG Copper, XLPE, 15 kV (1/3 & Full) Concentric Neutral Power Cable

iv) 1C 500 kcmil Copper, XLPE, 15 kV 1/3 Concentric Neutral Cable

B) Installation Conditions/Assumptions:

1. Conductor normal operating temperature = 90°C

2. Ambient temperature:
   a) Direct burial = 20°C
   b) Buried duct bank = 20°C
   c) In air = 40°C
   d) Conduit (non-metallic) in air = 40°C

3. Load factor = 100%

4. Shield operation:
   a) Single and triplexed cables: open-circuit for shielded power cables and short -circuit for conentric neutral cables.
   b) 3 conductor cables: Short-circuit

5. Installation:
   a) Direct burial
      i) Depth of burial = 36 in.
      ii) Horizontal separation between duct centres (single conductor cables) = 7.5 in.

APPENDIX I (Cont'd)

b) Buried duct bank
   i) Depth to top of duct bank = 30 in.
   ii) Duct diameter = 5 in.
   iii) Horizontal separation between duct centres (single conductor cables) = 7.5 in.
   iv) One single conductor cable per duct in a three (3) duct bank; one 3 conductor cable or one triplexed cable in a one (1) duct bank.

c) In air:
   i) Minimum separation between adjacent single conductor cables = 1 cable diameter

d) Conduit (non-metallic) in air:
   i) Conduits touching (single conductor cables)
   ii) Conduit diameter: 5 in.

6. Thermal resistivities of:

   a) Soil: = 90°C-cm/watt

   b) Concrete: = 85°C-cm/watt

   c) Duct: = 480°C-cm/watt

7. Temperature of metallic shield or concentric neutral wires = 80°C

APPENDIX II

Tables 1 through 4 list ampacity results for the cable types listed below based on FIECAG, Phillips computer program, ICEA, Phillips' catalogues, and competitors' catalogues.:

Table No.	Cable Type
1	#1/0 AWG Compact Copper, XLPE Insulated, PVC Jacketed, 15 kV Shielded Power Cable.
2	500 kcmil Compact Copper, XLPE Insulated, PVC Jacketed, 15 kV Shielded Power Cable.
3	#1/0 AWG Compact Copper, XLPE Insulated, PVC Jacketed, 15 kV (1/3 and Full) C/N Power Cable.
4	500 kcmil Compact Copper, XLPE Insulated, PVC Jacketed, 15 kV (1/3) C/N Power Cable.

TABLE 1

CABLE DESCRIPTION: #1/0 AWG, Compact Copper, XLPE, PVC 15 kV Shielded Power Cable

		AMPACITY RATINGS (Amperes)				
CABLE TYPE	INSTALLATION	FIECAG PROGRAM	PHILLIPS PROGRAM	ICEA TABLE	PHILLIPS CATALOGUE	COMPETITOR CATALOGUE
1/C	AIR	280	277	259	272	281
1/C	BURIED	290	294	274	282	288
1/C	DUCT	243	243	232	247	246
3/C	AIR	219	224	215	230	236
3/C	BURIED	245	249	238	248	253
3/C	DUCT	196	194	194	205	213
3/C	CICIA	172	-	194	-	209
TRIPLEX	AIR	235	239	229	238	249
TRIPLEX	BURIED	256	256	244	251	263
TRIPLEX	DUCT	209	201	201	209	216
TRIPLEX	CICIA	205	-	195	-	212

CICIA - Cable in Conduit in Air

TABLE 2

CABLE DESCRIPTION: 500 kcmil Compact Copper, XLPE, PVC, 15 kV Shielded Power Cable

		AMPACITY RATINGS (Amperes)				
CABLE TYPE	INSTALLATION	FIECAG PROGRAM	PHILLIPS PROGRAM	ICEA TABLE	PHILLIPS CATALOGUE	COMPETITOR CATALOGUE
1/C	AIR	727	708	678	706	740
1/C	BURIED	679	678	649	666	680
1/C	DUCT	584	570	557	591	593
3/C	AIR	548	550	536	596	608
3/C	BURIED	565	552	549	587	597
3/C	DUCT	468	441	449	492	508
3/C	CICIA	438	-	473	-	527
TRIPLEX	AIR	604	582	583	613	646
TRIPLEX	BURIED	606	569	564	594	620
TRIPLEX	DUCT	501	453	465	500	513
TRIPLEX	CICIA	601	-	481	-	535

CICIA - Cable in Conduit In Air

TABLE 3

CABLE DESCRIPTION: #1/0 AWG COMPACT COPPER, XLPE, PVC, 15 kV (1/3 and Full) C/N Cable

		AMPACITY RATINGS (Amperes)				
CABLE TYPE	INSTALLATION	FIECAG PROGRAM	PHILLIPS PROGRAM	ICEA TABLE	PHILLIPS CATALOGUE	COMPETITOR CATALOGUE
1/C (1/3)	AIR	280	274	-	-	-
1/C (1/3)	BURIED	273	290	-	274	-
1/C (1/3)	DUCT	231	241	-	-	-
1/C Full	AIR	224	-	208	-	208
1/C Full	BURIED	279	-	273	273	272
1/C Full	DUCT	210	-	194	194	194
1/C Full	CICIA	179	-	169	-	169
TRIPLEX 1/3	AIR	238	237	229	-	-
TRIPLEX 1/3	BURIED	260	252	244	-	-
TRIPLEX 1/3	DUCT	212	200	201	201	-
TRIPLEX 1/3	CICIA	228	-	195	-	-

CICIA - Cable in Conduit In Air

TABLE 4

CABLE DESCRIPTION: 500 kcmil Compact Copper, XLPE, PVC, 15 kV (1/3) C/N Cable

		AMPACITY RATINGS (Amperes)				
CABLE TYPE	INSTALLATION	FIECAG PROGRAM	PHILLIPS PROGRAM	ICEA TABLE	PHILLIPS CATALOGUE	COMPETITOR CATALOGUE
1/C	AIR	570	-	-	-	-
1/C	BURIED	430	-	499	518	522
1/C	DUCT	364	-	406	-	454
TRIPLEX	AIR	578	560	-	-	-
TRIPLEX	BURIED	564	533	556	472	591
TRIPLEX	DUCT	465	426	455	-	466
TRIPLEX	CICIA	567	-	-	-	-

CICIA - Cable in Conduit in Air

APPENDIX III

Test #1

Cable: Single 1000 kcmil aluminum conductor, XLPE insulated, copper wire shield, 35 kV (100% insulation level) Power Cable.

Installation Conditions:

1) Cable in fibre duct in air.
2) Ambient temperature = 20.0°C
3) Duct O.D. = 4.5 inches
4) Duct I.D. = 4.0 inches
5) Thermal resistivity of the duct material = 480°C·cm/watt
6) Shield operation = Open Circuit

Results:

Conductor Temperature (°C)	Shield Temperature (°C)		Ampacity (amperes)	
	Actual	FIECAG	Actual	FIECAG
90.0	76.0	73.6	810	817
130.0	102.0	102.6	1005	1004

Test #2

Cable: Single 500 kcmil aluminum, XLPE insulated, copper wire neutral, 35 kV (100% insulation level) C/N (1/3) Power Cable.

Installation Conditions:

1) Cable in fibre duct in air.
2) Ambient temperature = 20.0°C
3) Duct O.D. = 4.5 inches
4) Duct I.D. = 4.0 inches
5) Thermal resistivity of the duct material = 480°C·cm/watt
6) Shield operation = Open Circuit

Results:

Conductor Temperature (°C)	Neutral Temperature (°C)		Ampacity (amperes)	
	Actual	FIECAG	Actual	FIECAG
88.0	68.0	70.2	540	543

APPENDIX IV

1. Letter from Dr. Anders, Ontario Hydro, dated February 24, 1987, regarding the correction of an error in evaluating ampacities for cables in air, not in ducts.

   Revised diskette No. 3 of the CEA Cable Ampacity Program.

2. Letter from J. A. Roiz, CEA, dated February 27, 1987, regarding the above revision of diskette No. 3, of FIECAG Version 1.2.

3. Letter from Dr. Anders, Ontario Hydro, dated June 12, 1987, regarding additional changes to diskette No. 3 of the CEA Cable Ampacity Program.

4. Letter from J. A. Roiz, CEA, dated Aug. 3, 1987, regarding additional changes in diskettes Nos. 1 and 3, Version 1.3. These changes were a direct result of our July meeting with Dr. Anders.

APPENDIX V

1. Statement: When entering input data for a particular type of installation (ie. direct buried), only the data options/screens relating to that installation should be accessible.

   Response: This will be modified.

2. Statement: The program does not include an input option for copper tape shields on polymeric cable designs, only for PILC cables.

   Response: This will be modified.

3. Statement: Single conductor cables with SWA acting as a neutral (Ontario Hydro design) should be modelled as a concentric neutral, but no option exists for input of permeability to account for eddy currents/hysteresis effects.

   Response: This will be looked into.

4. Question: Does the program take into account the effects of load sharing for single conductor cables in parallel?

   Response: This subject has been raised before and it was beyond the scope of the program.

5. Question: Can the program be modified to handle parallel cables ie. USEI90?

   Response: This will be included in the second version.

6. Statement: Concentric neutral wire area was calculated as if it were a "D" shaped skid wire. This resulted in double the resistance for the concentric neutral and a pessimistic ampacity value for single phase cables.

   Response: This has been changed and is included in revision 1.3.

7. Statement: Presently there is no option available for the bonding arrangement for single phase cables.

Response: This will be looked into.

8. Statement: The FIECAG program was not designed to accommodate a TECK cable design which incorporates an inner jacket, interlocked armour and an overall jacket.

Response: This is a common concern and it will be modified.

Attachment C

General Electric
Butyl Rubber Insulation
Data

Super Coronol* Power Cable
Unshielded—Flamenol* Jacketed
SI-58243

Single-conductor **5 kV Gnd Neutral**

APPLICATION: Power circuits in wet or dry locations installed in conduit, ducts, open air or directly buried. IPCEA specifications call for shielded cable for applications over 2001 volts.

FEATURES: A flexible, ozone-resistant cable with a protective jacket that is acid, alkali, oil, and sunlight resistant.

CONSTRUCTION: Solid or stranded coated-copper conductor, semiconducting tape (stranded only), Super Coronol insulation, Flamenol jacket.

Meets IPCEA Specifications **CONDUCTOR TEMPERATURE 90°C**

Conductor		Thickness in Mils		Approx OD in Inches	Ampacity† 40°C Ambient	Conduit Size Inches (3 Insulated Conductors per Conduit)	Minimum‡ Ordering Quantity in Feet	Approx Ship. Wt in Lb per M Ft Net Weight 1 & Less
Size AWG or MCM	No. of Strands	Insulation	Jacket					
GROUNDED NEUTRAL (INSULATION LEVEL 100%)								
8	1	155	45	0.55	55	1½	5000	257
8	7	155	45	0.59	55	2	5000	263
6	1	155	45	0.59	75	2	5000	297
6	7	155	45	0.63	75	2	5000	305
4	7	155	45	0.68	97	2	2000	434
2	7	155	45	0.74	130	2	2000	538
1	19	155	45	0.78	156	2½	2000	610
0	19	155	65	0.86	179	2½	1500	736
00	19	155	65	0.91	204	2½	1500	846
000	19	155	65	0.96	242	3	1500	974
0000	19	155	65	1.02	278	3	1500	1167
250	37	170	65	1.10	317	3	1000	1441
300	37	170	65	1.15	351	3	1000	1624
350	37	170	65	1.21	384	3½	1000	1849
400	37	170	65	1.26	415	3½	1000	2035
500	37	170	65	1.35	477	4	1000	2400
600	61	170	65	1.43	525	4	1000	2982
750	61	170	65	1.54	598	5	1000	3511
1000	61	170	95	1.77	689	5	1000	4431

FACTORY: Bridgeport.

CABLE IDENTIFICATION: Surface printing, giving size, voltage, manufacturer's name and SI number. Sizes No. 4 AWG and larger have center strand stamped with GE and year of manufacture.

SPLICING MATERIALS: Uni-Kits, Cable Accessory Products, etc., refer to WCD-190, pages 1 and 2.

EXPLANATION OF SYMBOLS

‡ Based on cables with black jacket. Colored jackets are special. Refer to the nearest General Electric Company Wire and Cable Products Department Sales District Headquarters for prices and minimum quantities.

† Based on three insulated conductors in single enclosed or exposed conduit. IPCEA methods used for ratings.

* Reg. Trademark of General Electric Company.

DATA SUBJECT TO CHANGE WITHOUT NOTICE.

Authorized stock items removed since last issue.

For prices refer to WCP-129, page 7

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONN
Wire and Cable Products Department

Comparison Data on Insulations

Effective July 19, 1965
Supersedes issue dated Mar. 30, 1964

POWER CABLE INSULATION COMPARISON DATA—TYPICAL VALUES—NOT FOR SPECIFICATION USE

	Test Method	Units	Vulkene® (e)	Silicone Rubber(g)	Versatol®	Super Coronal®	Polytetra-fluoro-ethylene	Flamenol®	Poly-ethylene	Varnished Dacron Glass
APPLICATION LIMITS										
Voltage			0–35000	0–5000	0–2000	0–15000	0–1000	0–600(h)	0–600	0–28000
Normal Temp		C	90	125(k)	75	85–90	200–250	60–75(k)	75	80–85
Emergency Overload Temp.		C	130	150	95	105–125		85	95	
Short Circuit Temp.		C	250	250	200	200		150	150	
Minimum Installation Temp.		C	−30(d)	−30	−20(d)	−30(d)	−30	−10	−30(d)	−10
PHYSICAL PROPERTIES										
Tensile	ASTM D-412	Lb/sq. in.	2300	1200	900	800	2000	2400	2100	
Elongation	ASTM D-412	%	400	400	500	550	150	300	400	
THERMAL PROPERTIES										
Heat Aging			Tens. Elong.	Tens. Elong.	Tens. Elong.	Tens. Elong.	Tens. Elong.	Tens. Elong.	Tens. Elong.	
40 Hours@127 C, Air Bomb	ASTM D-572	% Retention	95 95			95 80			Melts Melts	
2 Days@100 C, Air Oven	ASTM D-573	% Retention							95 109	
7 Days@80 C, Oxygen Bomb	ASTM D-454	% Retention			85 75					
7 Days@100 C, Air Oven	ASTM D-573	% Retention	95 95			85 85		90 95		
7 Days@150 C, Air Oven	ASTM D-573	% Retention	85 80		Fails Fails	45 40		Fails Fails	Melts Melts	
5 Days@200 C, Air Oven	ASTM D-573	% Retention		75 60	Fails Fails	Fails Fails	85 75	Fails Fails	Melts Melts	
ELECTRICAL PROPERTIES										
Insulation Resistance	ASTM D-470	Megohm Constant	50000	30000	10000	50000	> 50000	10000	> 50000	20000
Power Factor At Room Temp.	ASTM D-150	%	0.5	.1	4.5	2.5	> 0.1	5–8	<1.0	30 C 2.3 80 C 3.5 100 C 6.7
Dielectric Constant At Room Temp.	ASTM D-150	Dimensionless	2.9	3.0	6.0	4.5	2.1	5–8	2.3	
Impulse Strength	GE	Volts/Mil	1375			700			1200	
Track Resistance	GE CW-1415	Kilovolts	2.7			1.5		1.4	1.2	
MOISTURE RESISTANCE										
Mechanical Moisture Absorption	IPCEA 6.9.3	Mg/sq. in.	1.0	10	9	3	0.5	8–10	<1.0	(b)
Electrical— % Change in 75 C Water SIC										
1–14 Days	IPCEA 6.9.2	%	1.0	1.0	4	2.5			1.0	
7–14 Days	IPCEA 6.9.2	%	1.0	0	2	1.0			1.0	
ENVIRONMENTAL PROPERTIES										
Cold Bend	ASTM D-1351	C	−65	−54	−40	−54	−55	−40	−90	(b)
Ozone Resistance .03% Concentration Room Temp.	ASTM D-470	Days	> 25	> 25		> 25		> 25	> 25	
.0005% Concentration 125 F	GE	Days	> 45			< 23		> 45	> 45	
Radiation Resistance	GE	25% Damage Level of Gamma Photons	2×10^7	5×10^6	10^7	4×10^8	4×10^6	10^8	10^8	Fair-Good
Deformation										
@100 C	ASTM D-2220	% Deformation	0		0	0		15	5	
@125 C	ASTM D-2220	% Deformation	5		20	20		30	Melts	
@150 C	ASTM D-2220	% Deformation	8		20	20		70	Melts	
Chemical Resistance	ASTM D-543		Excellent	Good	Poor (a)	Poor (a)	Excellent	Good	Fair	
Crush Resistance	GE		Excellent		Good	Good		Fair	Good	
Impact Resistance	GE	3 Foot-Lb	Excellent		Good	Good		Fair	Good	
Flame	IPCEA Horizontal	*	Passes	Burns to non-conducting ash	Poor (a)	Poor (a)	Self-extinguishing	Passes	Poor	
Weathering	ASTM D-750		Excellent	Excellent	Poor (a)	Excellent	Excellent	Excellent	Must be pigmented	(b)

(a) This characteristic is partially offset by Geoprene® jacket.
(b) Not applicable to laminated insulations.
(d) Minimum installation temp is −10 C when Flamenol jackets are used and −20 C when Geoprene® jackets are used.
(e) Values do not necessarily apply for Vulkene® Type RHH-RHW.
(g) The values shown are for extruded silicone rubber.
The taped insulation is available up to 35,000 volts.
(h) Flamenol is available up to 5000 volts for street lighting circuits.
(k) For appliance wiring, silicone rubber may be rated up to 200 C and Flamenol up to 105 C.

General revision since last issue.

GENERAL ELECTRIC

GENERAL ELECTRIC COMPANY, BRIDGEPORT, CONN.
Wire and Cable Department

Thermosetting Insulations

SUPER CORONOL*

Super Coronol (butyl rubber) is the result of the proper blending of polyisoprene and polyisobutylene with just enough polyisoprene added to effect vulcanization. Unlike natural rubber, after vulcanization little or no chemically active atoms remain, making the finished product appreciably less vulnerable to ozone, oxidizing agents, sunlight and aging.

A high-voltage rubber insulation, Super Coronol's outstanding features are its heat, moisture and ozone resistance. It may be used at temperatures up to 90 C continuously, and even higher for emergency and short-circuit conditions. Also, its flexibility and toughness make it an excellent choice for high-voltage portable cables in mining and allied industries.

Super Coronol is suitable for installations in air, conduit, ducts, direct burial, submarine and portable cable applications at voltages up to 15 KV.

Super Coronol* Power Cable

	Guaranteed Values	IPCEA S-19-81, Par. 3.15 Requirements for Butyl Rubber
Physical Properties		
Original		
Tensile—psi	750△	700
Elongation—%	500△	300
Set in 2-in. test piece, in., max	5/16	1/2
Aged—Air Oven Test—7 Days at 100 C		
% retention of original		
Tensile	80△	60
Elongation	75△	60
Aged—Oxygen Pressure Test—168 Hr at 80 C		
% retention of original		
Tensile	80△	
Elongation	75△	
Aged—Air Pressure Test—80 Psi, 40 Hr, 127 C		
% retention of original		
Tensile	70△	50
Elongation	65	50
Electrical Properties		
AC Test Voltages—See CM-646:12, Table 1		
Insulation resistance constant	25,000	20,000
SIC at room temperature	4.5	4.5
Power Factor at room temperature—%	3.0	3.5
Moisture Resistance		
Mechanical moisture absorption—mg/sq inch	10.0	15.0
Max % change in SIC—75 C water		
1–14 days	5	5
7–14 days	3	3
Ozone Resistance		
.030% concentration—room temperature	No cracks after 24 hr exposure	
Cold bend and long time dielectric strength tests per paragraph 6.6 of IPCEA-NEMA Standard		
Temp C	Minus 10	
U-Bend—100 Volts/Mil	No failure after 6 hr	
Corona Level—5 kv and above	Cable Meets IPCEA requirement	

△Changed since last issue.

Data subject to change without notice
**Reg. Trade-mark of General Electric Company*

Attachment D

Ampacity Calculations of Single Conductor 500MCM 5 KV GE Super Coronol Flamenol SI-58243 Cable

Consumers Power Company

NUCLEAR OPERATIONS DEPARTMENT
Engineering Analysis Work Sheet

Title: Ampacity Calculations of Single Conductor 500 MCM 5000V GE Super Coronol Flamenol SI-58243 Cable

Performed by: [illegible] Date: 8/8/86

Review Method by: [illegible]
☐ Alternate Calculations
☑ Detailed Review
☐ Qualification Test

Technical Review by: [illegible] Date: 8/8/86

References:
1. GE Wire and Cable Application Data
2. National Electric Code
3. KEY Ltr to KAT PAL-20-29 of 8/5/86
5. RLS Telecon with RAL of 8/8/86

1. Objective: This EA will calculate the ampacity for the cables (based on their routing) which supply 1C, 1D, and 1E Swgr from the Station and S/U transformers. It will show that all the cables are properly loaded with the exception of the feeder from the Station transformer to 1E swgr, and the feeder to 1D switchgear from the S/U transformer.

2. Analysis Input: This analysis is based largely on the National Electric Code Articles 310 Conductors for General Wiring, 318 Cable Trays and on GE Wire and Cable Application data. The loading on busses 1C, 1D and 1E are based on KEY/RLS Ltr to KAT and a prior Telecon. KEY's figures were obtained from operators' log readings.

3. Assumptions:

a. The grouping of three single conductors in a conduit or tray may be considered as "Triplexed Cable". This is an acceptable assumption since Triplexed cable is defined as "three single conductor cables twisted together". The contact between the conductors will be the same whether twisted or left untwisted.

Form 3119 3-83

4. Analysis:

a. A summary of the cable routing methods and the maximum observed / calculated loading for these routings is presented in Attachment 1. The [illegible] information is from plant dwgs E-33 – E-37. Attachment Two provides detailed conduit and cable tray routing data.

The loading data is based on KE/Leader of Power Resources + System Planning observations / calculations. These are presented in Attachments 3 and 4.

Attachment 1 shows five types of routing (1) in conduit (2) in buried duct bank (3) in [illegible] bottom cable tray (4) in covered cable tray and (5) [illegible] + exposed to Sunlight.

These five [illegible] are analyzed in paragraphs [illegible] and summarized in [illegible]

Cable Rating: 5000 V [illegible] 60°C Amb
(Present [illegible] used 20°C Amb)
based on data from Reference 1

Routing: Each [illegible] of a single conductors [illegible] two [illegible] phase. One conductor per phase are grouped and routed through conduits and duct banks independent of the other conductor per phase. In the cable trays all 6 conductors are together.

4 Analysis (Cont'd)

b. Ampacity of Three Single Conductor Copper Cables in Isolated Conduit in Air

(1) From table 310-73 of reference 2 this is read directly as

| 475 A |

(2) From table [illegible] of reference [illegible] this is read directly as

| 4[illegible] A |

c. Ampacity [illegible] Single Conductor Copper Cables [illegible] Raceways:

(1) From table [illegible] of reference 2 this [illegible] read directly as

| 4[illegible] A |

(2) From [illegible]

| 4[illegible] A |

d. Ampacity [illegible] Single Conductor Copper Cables [illegible] in Cable Trays

(1) Reference 2 [illegible] states that [illegible] ampacity [illegible] 75% of [illegible] allowable ampacity [illegible] table 310-[illegible] (A Single Conductor in Air)

[illegible] | [illegible]21.25 A |

4. Analyses - Cont.

d.(2) Reference 1 directs the ampacity of cables in solid metal trays be determined in conflicting manners

i. One method directs the use of the cable ampacity in air be corrected by a factor for not uniformly spacing the conductors.

Table 68 provides the ampacity of a single conductor in AIR of 660 A. Table 4 Provides A - Correction factor of .80 for 4-6 conductors without spacing.

660 A x .80 = **528 A**

ii The alternate method directs for these conductor cable to use the ampacity for identical cable in isolated conduit in AIR and to correct it for not maintaining uniform spacing.

Table 67 provides the Ampacity of these conductor, TRIAD/XLPE cable at 477 A. Table 4 provides A Correction factor of .80 for 4-6 conductors without spacing.

477 A x .80 = 381.6 A

Method ii above is not conservative value since it is based on solid metal tray and the installed system is open top. Method i is correct.

7505 1110

4. Analysis (Cont'd)
d (2) (Cont'd)

e. Ampacity of six single conductor copper cables in covered cable tray.

(1) Reference : Section 310-12.6.1 directs that the allowable ampacity is 70% of the allowable ampacity of TABLE 310-69 (1 Single conductor in AIR)

695A x .70 = 486.5 A

(2) Reference : makes no differentiation between solid metal trays and covered trays. The discussion of the Methods used in d(2) above is Applicable yet must be further Analyzed. Method 1 assumes zero Movement of heat energy and is thus is not conservative for the case of a covered tray (with open bottom). At the same time Method ii is still overly conservative since it ignores the heat removal improvement of an open bottom tray over that of a Solid metal tray. Based on this discussion Neither of the two values calculated above is Appropriate.

4. Analysis (cont'd)

f. Ampacity of three Single conductor Copper cables in conduit in Air exposed to sunlight.

(1) The NEC Reference does not address this other than all states in b(2) above.

(2) Per Attachment 5, A record of telecon documenting RA Lasky's conversation with General Electric

The Ambient temperature of Cable in conduit exposed to sunlight must be raised to 50°C resulting in a 10% Reduction in Ampacity. This is the table 67 Reference value of 477 Amps Multiplied by 90%

477 A x .90 = **429.3 A**

4. Analysis (cont'd)

g. Summary of Ampacities

Routing	Ampacity (in Amps) NEC	IEE
Conduit	475	477
Duct Bank	470	471
Tray (Solid Bottom)	521	528
Tray (Covered)	486	—
Conduit in Sunlight	—	429.3

The NEC values will be utilized as they are the more conservative. Each Ampacity is considered to be for a given conductor, since there are two conductors per phase - the NEC values are doubled and summarized below.

Routing	Ampacity/Phase (in Amps)	
Conduit	950	
Duct Bank	940	1042
Tray (Solid Bottom)	~~954~~	
Tray (Covered)	972	
Conduit in Sunlight	859	

5. Conclusion

Attachment 1 shows the routing method for each cable supplying the 1C, 1D and 1E swgr from the STATION and the terminations listed below each routing is that methods Allowable Ampacity. Also listed are the maximum observed normal and cold shutdown loadings* for the three busses. It is noted that the cold s/d loadings could be placed on either the s/u or the STATION transformer

5. Conclusion (Cont'd)

by backfeeding from the main transformer.

The only cables which have been overloaded are the station transformer feed to 1E swgr. (From Attachment 3 graph of normal station power it is observed that this occurred on only 3 days out of 625 days reported in the 42 month period analyzed. This is approximately 0.5% of the days reported.)

Also overloaded is the s/u transformer feeder to 1D switchgear in the LOCA condition of cold shutdown. It is noted that this is based on the observed cold shutdown loading and observed power requirements for the maximum LOCA loads.

1104 1501

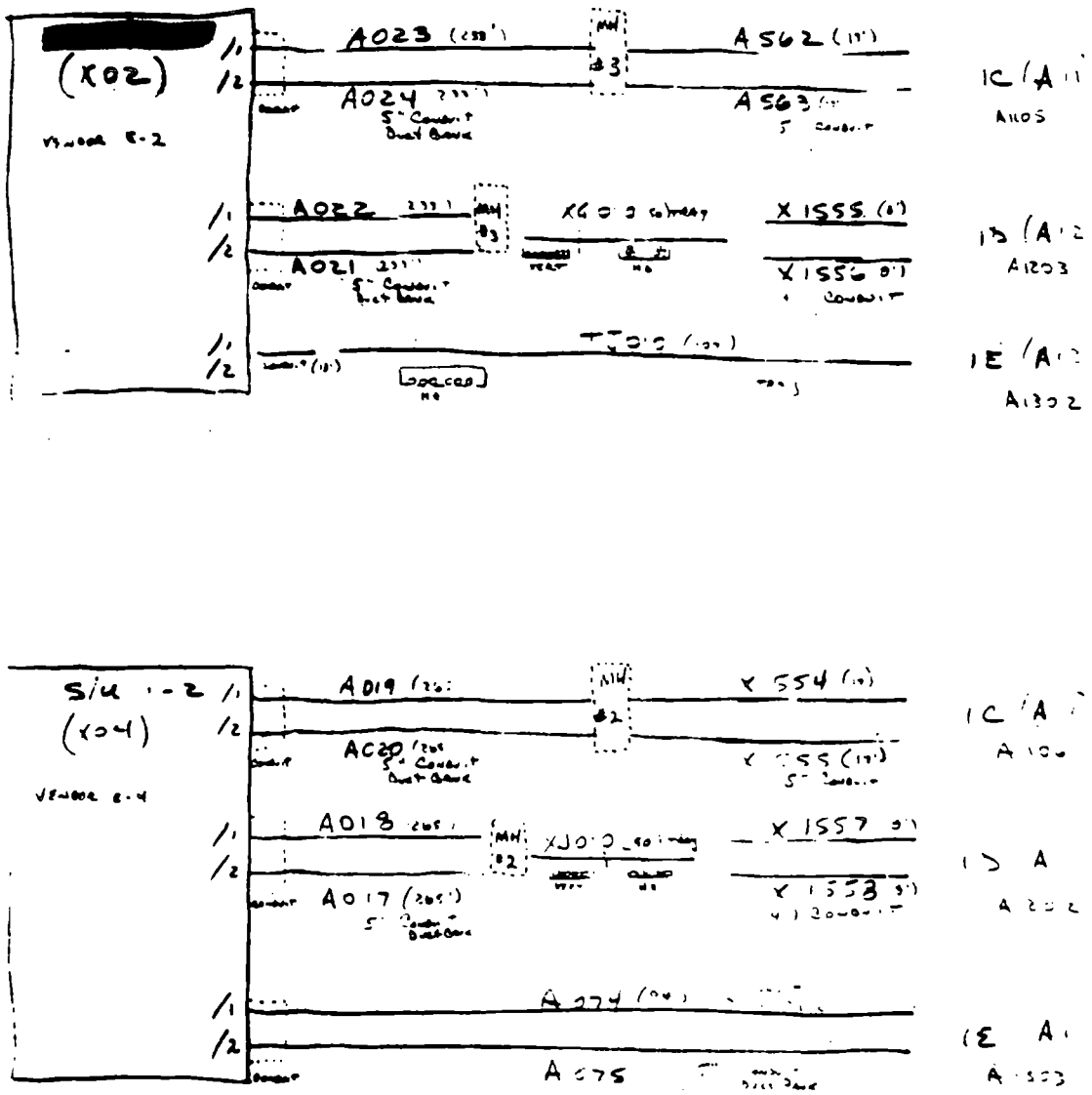
Summary of Cable Routing and Ch[illegible] Loading

	Routing Method (Ampacity)				SWG	Max Loading: Normal	Max Loading: Cold S/D	Max Loading: LOCA
STA 1-2 (X-02)	Conduit in Soil (859)	Duct Bank (940)	Conduit (950)		1C	630 A	630A	-
	Conduit in Soil (859)	Duct Bank (940)	Solid Bottom Uncovered Tray (1042)	Conduit (950)	1D	500 A	510A	-
	Conduit in Soil (859) allowed	Covered Tray (972)			1E	990A actual	580A	-
S/U 1-2 (X-04)	Conduit in Soil (859)	Duct Bank (940)	Conduit (950)		1C	—	630 A	766A
	Conduit in Soil (859)	Duct Bank (940)	Solid Bottom Uncovered Tray (1042)	Conduit (950)	1D	—	510A	919A
	Conduit in Soil (859)	Duct Bank (940)			1E	—	580A	380A

7 5 0 … 1 1 5

Attachment 1

Detector Cable Routing



CABLE TYPE: 500 MCM 5000V GENERAL ELECTRIC SUPER VOROND FLAMENOL SI-58243

Attachment 2

To KAToner, Palisades

From KEYeager, P-24-131, Jackson

Date August 5, 1986

Subject PALISADES 2400V LOADS FOR EVALUATING POWER CABLE LOADINGS

CC RALarkin, P-13-421
File: PAC-20-29

CONSUMERS POWER COMPANY

Internal Correspondence

Per our conversation, attached are operating load profiles for 2400V Buses 1C, 1D and 1E for the period 1983 through the first half of 1986. Note that the designations "Normal Station Power" and "Cold Shutdown" also include loads during unit start-up or shutdown when fed from Station Power Transformer 1-2 or Start-up Transformer 1-2. Loads during LOCA conditions are:

Bus	Load (Amps)	Load (Amps) With Aux Feed Pump
1C	653	766 (with P8A)
1D	819	919 *(with P8C)
1E	320	320

If you need further information or assistance, do not hesitate to call.

*Assumes P8A fails to start.

A Hachmeister -

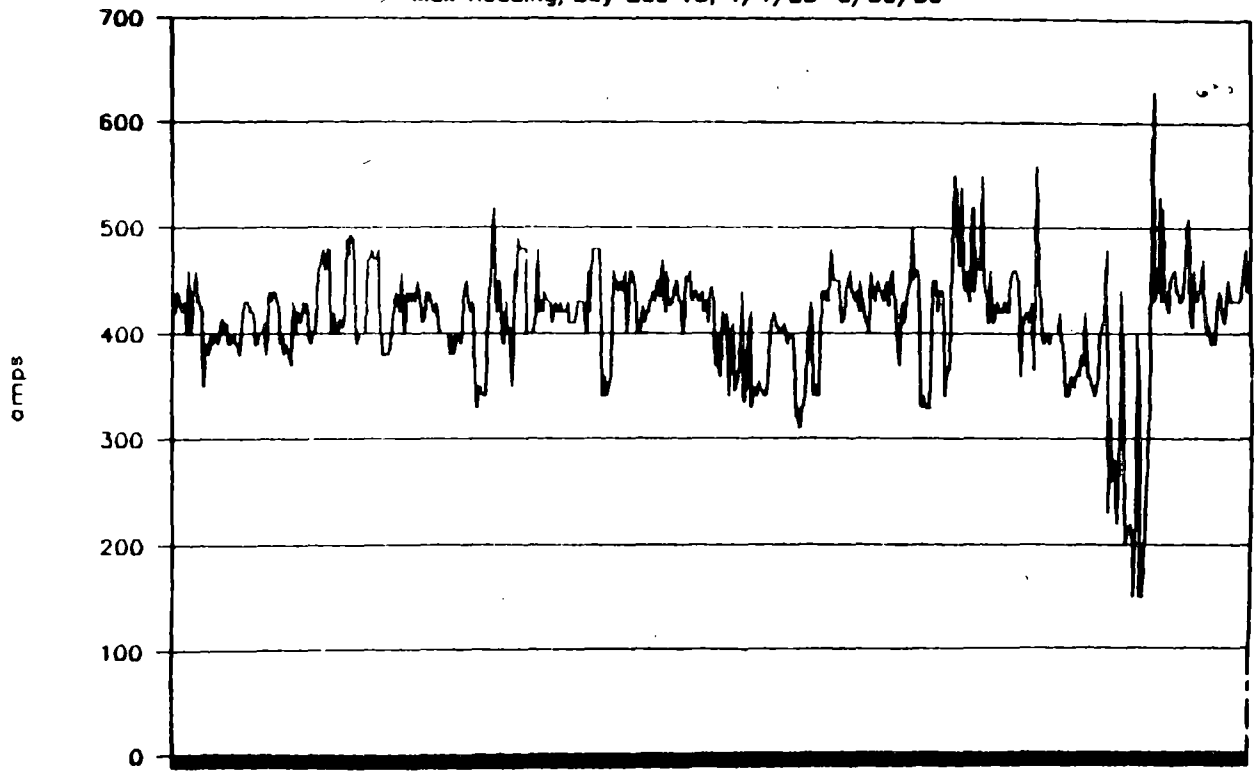
Note:

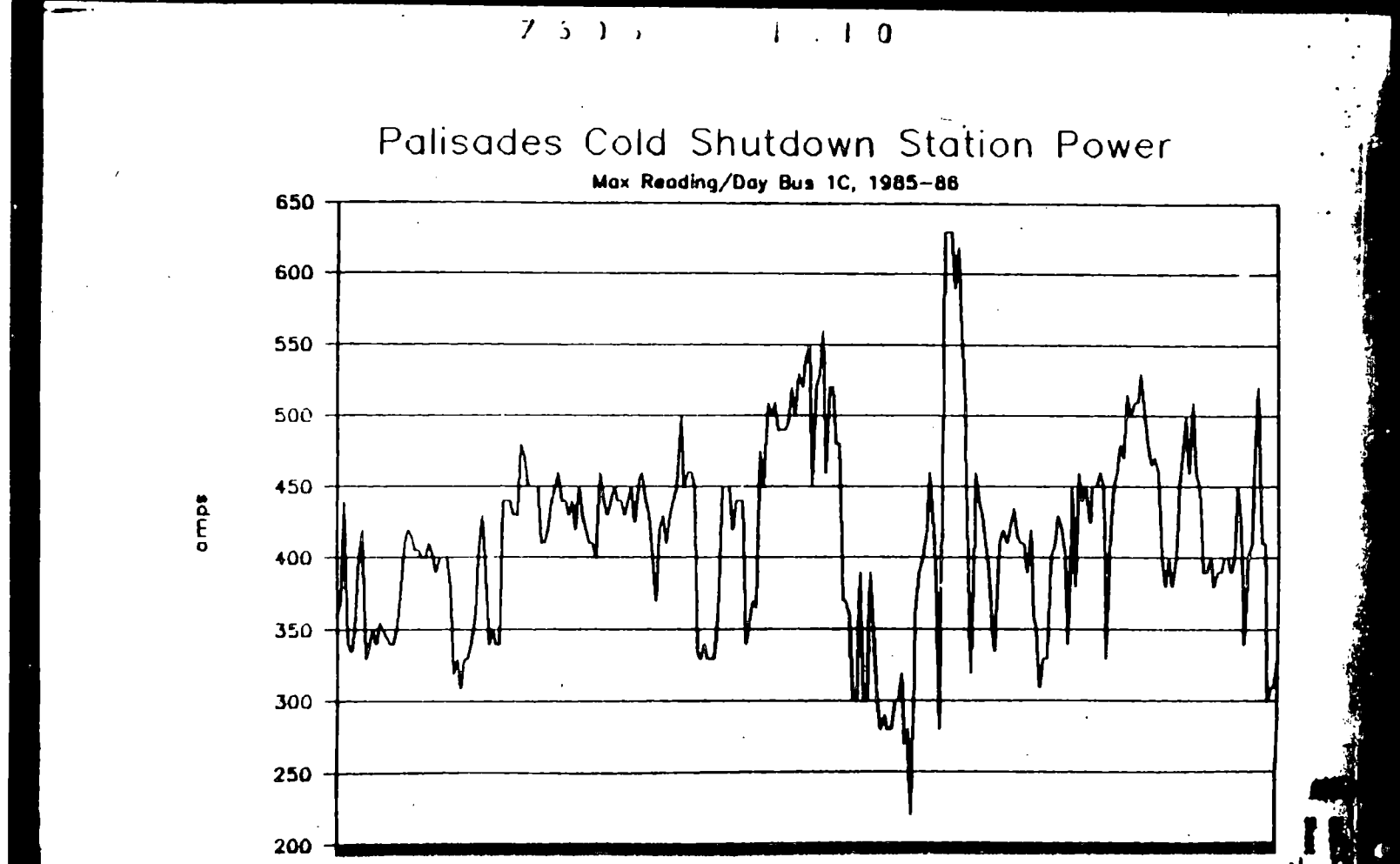
The following graphs represent the maximum current reading each day using the readings from the Station Power Log Book/3 shifts per day. Therefore, each reading is assumed valid for 8 hours (until the next shift reading is taken). Lower readings during normal running conditions are due to unit start-up or shutdown when fed via the station power transformer. The following tables summarize the number of readings for the attached graphs.

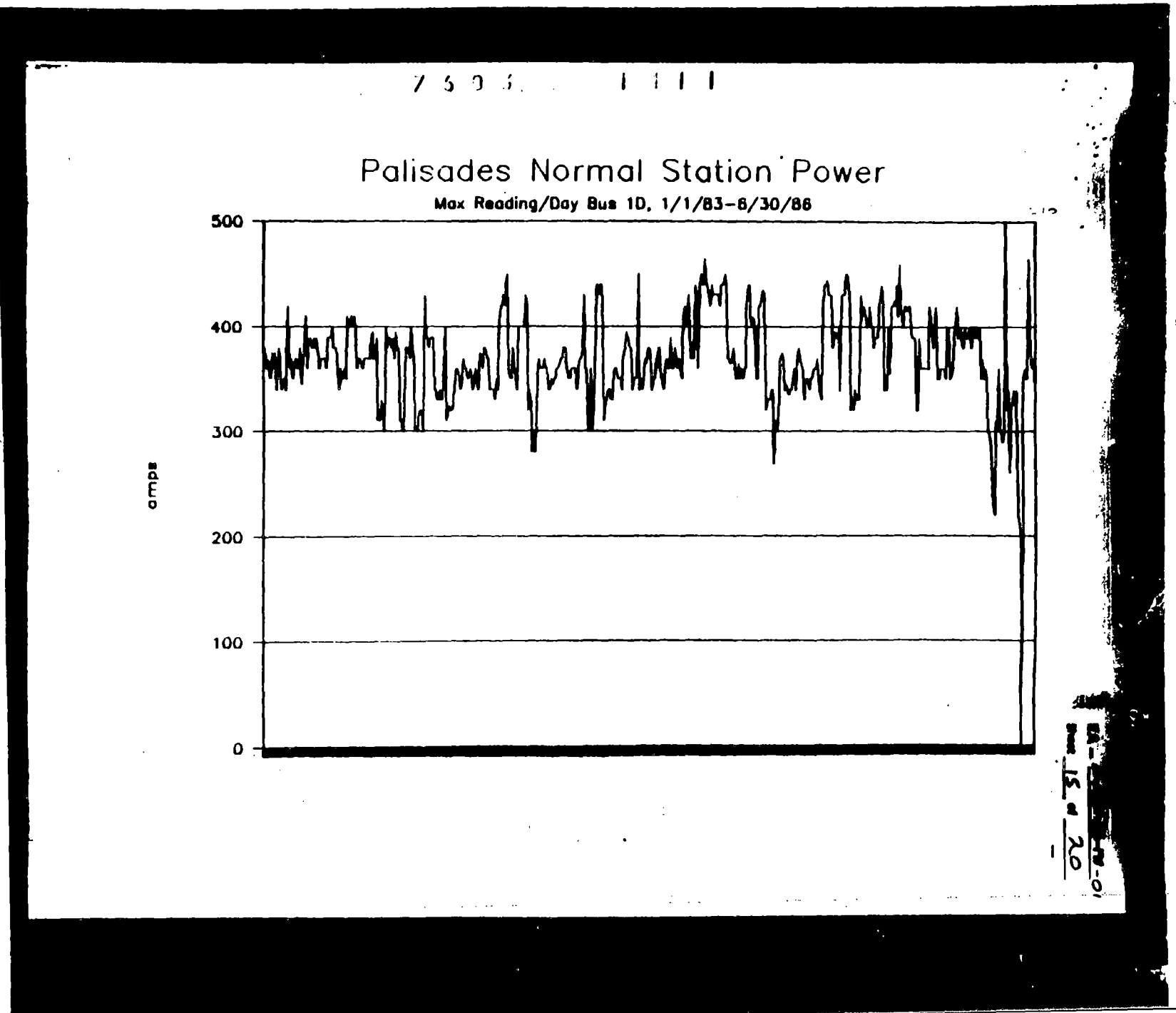
	Number of Days	
Year	Normal	Cold Shutdown
1983	181	NA
1984	40	NA
1985	331	34
1986	73	108
	625	142

Palisades Normal Station Power

Max Reading/Day Bus 1C, 1/1/83- o/30/86

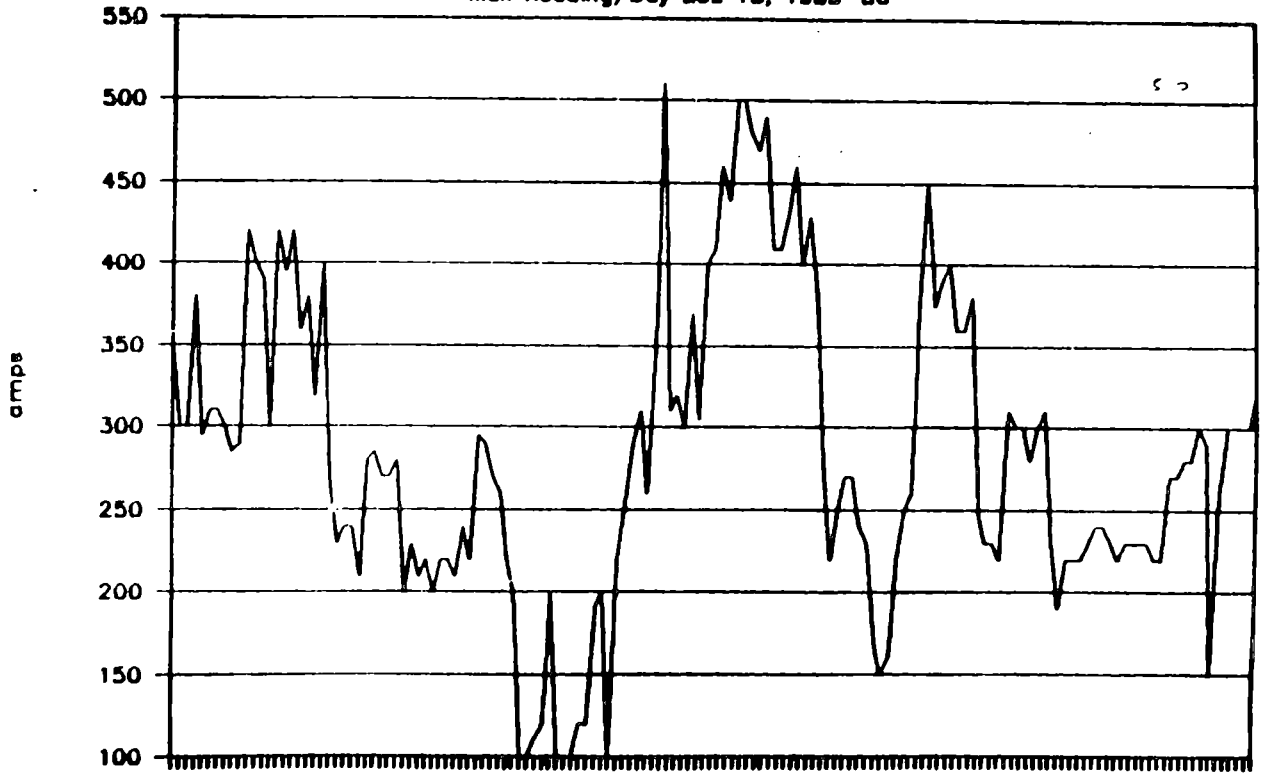


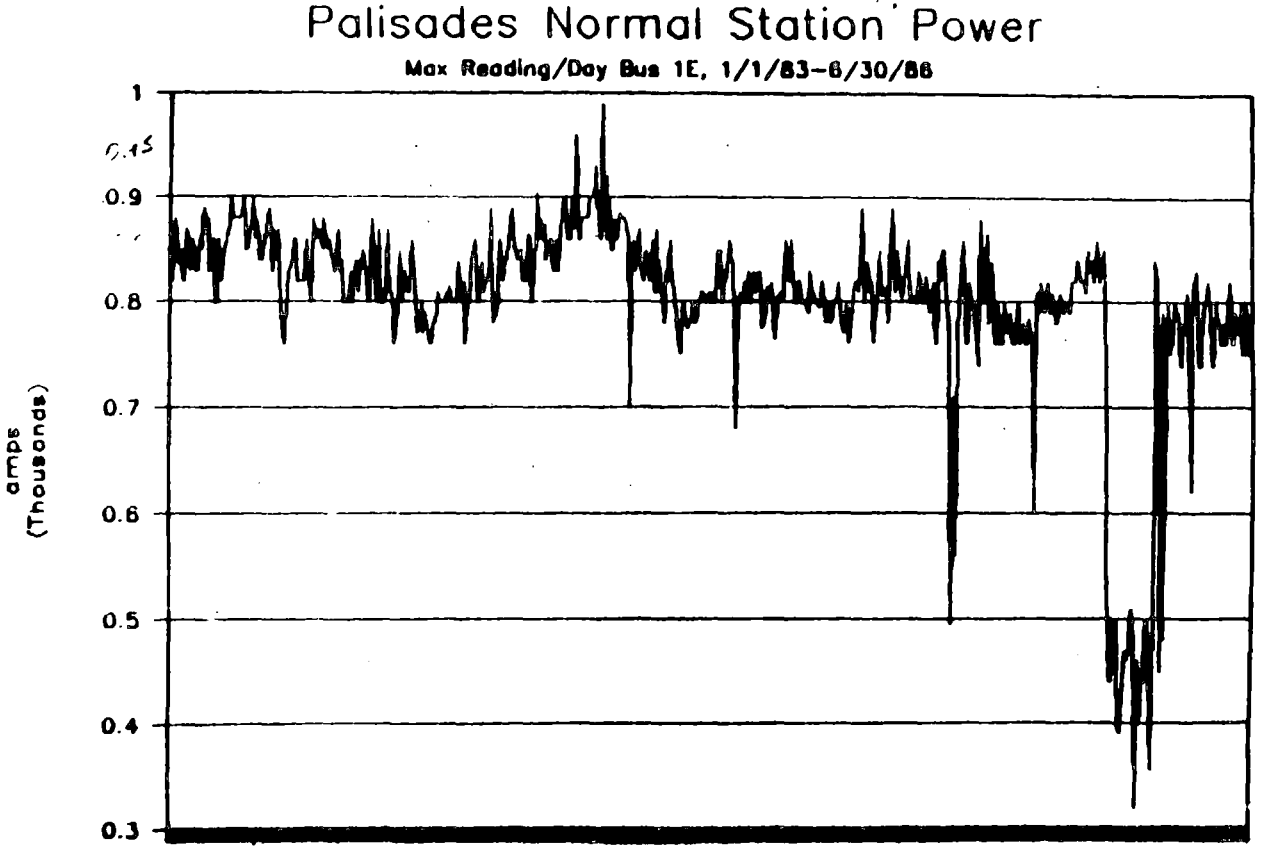

Palisades Cold Shutdown Station Power
Max Reading/Day Bus 1C, 1985-86
650
600
550
500
450
400
350
300
250
200
amps


Palisades Normal Station Power
Max Reading/Day Bus 1D, 1/1/83-6/30/86
amps
500
400
300
200
100
0

Palisades Cold Shutdown Station Power

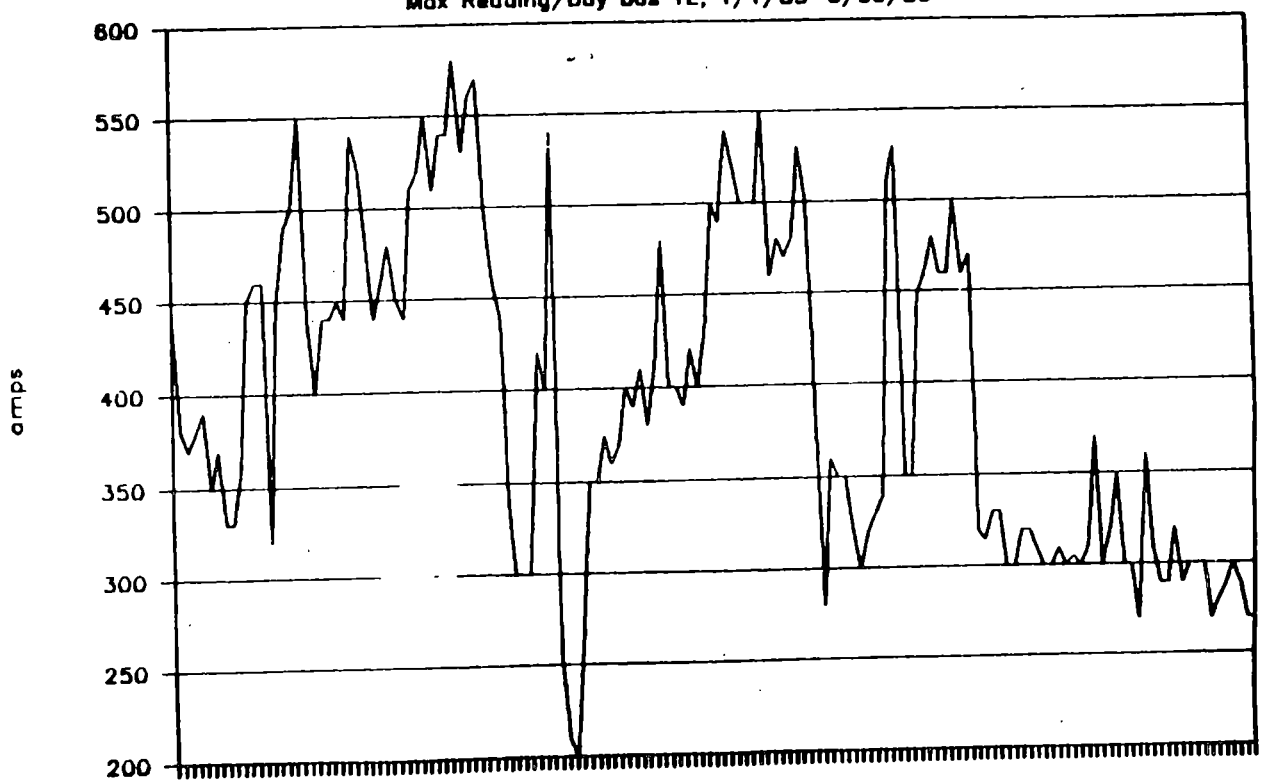
Max Reading/Day Bus 1D, 1985-86




Palisades Normal Station Power
Max Reading/Day Bus 1E, 1/1/83-6/30/86
amps (Thousands)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3

Palisades Cold Shutdown Station Power

Max Reading/Day Bus 1E, 1/1/83-6/30/86



1C, 1D & 1E Bus Feeder Loads

Data Provided By: RA Larkin (Ext 324/92) @ 1030 hrs, 8/5/86
KE Yeager (Ext 8739)

Feeder Description: Two (2) 500 MCM cables per ϕ each 90°C rated at 380A
∴ Total feeder capacity = 2(380A) = 760A

Feeder Loading:

Note: Values in table below are peak values from plant log books and may represent only eight (8) hours in duration. Aux Recs & Sys Rel is averaging recs over longer time period for a more accurate long term cable impact.

Bus Feeder*	Normal Op.	Cold S/D	LOCA (worst case)
1C	630A	630A	746A
1D	500A	510A	819A ●
1E	990A ●	580A	320A

* Includes feeder cable from both station power xfmr and startup xfmr to bus incoming breakers (see attached dwg).

● Overload (>760A)

Feeder Protection: ϕ O/C @ set @ 1440A (see dwg, 151a)

Cause of Overload: Long term load growth:
- Support Bldg
- Ware House
- Station Power Bank 200
- Station Power Bank 90
- Station Power Bank 91

Even in Apr 1981 1E normal was 830A (>760A) as recorded in plant shift log book

Attachment 4

RECORD OF TELECON

Date: 8/8/86 Time: 1400 By: RL Scudder

Who Talked To: RA Larkin His/Her Dept: PE&C

Company: CPCo Phone: AC — No 82482

Ext —

Subject: RAL's Telecon with General Electric, Vendor of Feeder Cables to 1C, 1D and 1E Switch Gear.

Topics Discussed:

GE Vendor States the following to RAL.

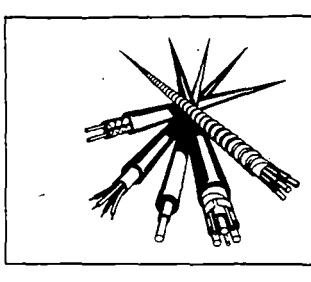
1. Cable is Rated for a Maximum of 477 Amps at 90°C Conductor Temp. 40°C Amb.
2. A Conduit Exposed to Sunlight Raises the Ambient to 50°C Results in a 10% Derate or 477 x .90 = 429.3 Amp
3. He is not Concerned with the fact that the outside Portion of TJ010 Tray is Covered the 477A limit Adequately Protects Cable.
4. The Table No 5 Proximity of other Conduits Does not Affect the 477 Amp Limit
5. Cable has a Short Circuit Temp Limit of 200°C and an Emergency Overload Limit of 125°C.

TELECON-0506

Attachments

Attachment E

General Electric
Application Data
Butyl Rubber
Arrhenius Plot



APPLICATION DATA

Determination of Conductor Size

INTRODUCTION

All insulation temperature ratings are based on the heat aging properties of the material used. The useful life of a cable is generally determined by extrapolating laboratory heat-aging data taken at various temperatures on a curve called an "Arrhenius Plot" (see Fig. 3). From this figure, the expected life of the insulation at any temperature can be determined. Generally, a good rule-of-thumb is that cable life is halved for every 8 C rise in temperature.

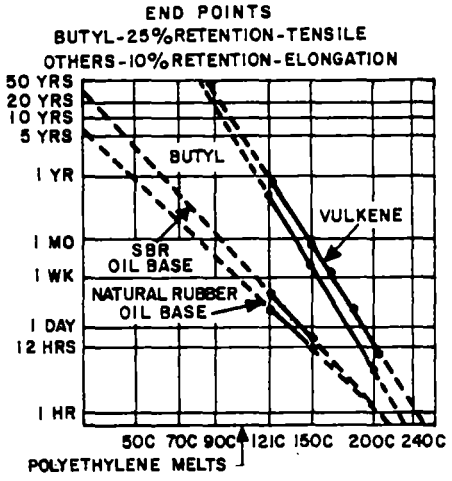


Fig. 3. Arrhenius Plot

Determining cable ampacities involves the application of complex electrical and thermal concepts too lengthy to explain here. It would be advisable, however, to review the basic fundamentals involved in computing cable current ratings.

Basically the thermal circuit involved in the calculation of current ratings is analogous to a simple electric circuit, as shown in Fig. 4.

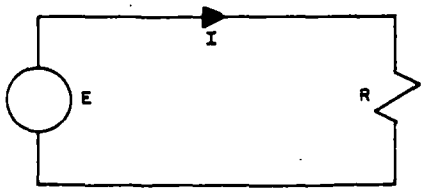


Fig. 4

Ohm's law of electricity states that:

$$E = IR$$

A similar relationship can be derived for the thermal circuit, Fig. 5.

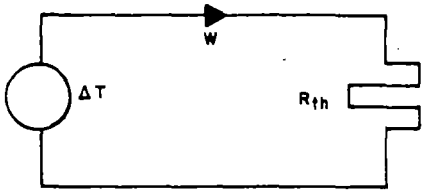


Fig. 5

$$\Delta T = WR_{th}$$

but: $\Delta T = T_c - T_a$ and $W = I^2R_c$

so: $T_c - T_a = I^2R_cR_{th}$

And: $I = \sqrt{\dfrac{T_c - T_a}{R_cR_{th}}}$

ΔT = temperature rise of conductor

T_a = ambient temperature

T_c = conductor operating temperature

R_c = Conductor resistance, at operating frequency, per foot of cable, at operating temperature

R_{th} = Thermal Resistance

I = current

W = watts loss from conductor

E = voltage

It should be remembered that this is a naive approach to current capacity determination and many other variables enter into the actual calculations: losses in conductors and sheaths, losses in the dielectric, whether the cable is buried or in duct or air, the number and proximity of other cables, and the effects of extraneous heat sources all affect current capacity.

To illustrate this point, let us attempt to determine the current carrying capacity of one particular cable, under various conditions. The illustrated cable is 1/C Vulkene, 5 kV, Shielded, 500 MCM copper.

In Condition A, the cable will be in an underground duct at an operating temperature of 90 C.

In Condition B, the cable will be buried in an ambient temperature of 30 C.

Condition A

1. One cable per duct, one circuit, 100 percent load factor.
   I = 561 amperes at 20 C ambient
   0.93 is the correction factor for 30 C ambient, thus
   I at 30 C ambient = 561 x 0.93 = 522 amperes
2. One triplexed cable per duct, one circuit, 100 percent load factor.
   I = 465 amperes at 20 C ambient
   0.93 is the correction factor for 30 C ambient, thus
   I at 30 C ambient = 465 x 0.93 = 432 amperes

Condition B

1. Single Conductor, one circuit, 100 percent load factor.
   I = 669 amperes at 20 C ambient
   0.93 is the correction factor for 30 C ambient, thus
   I at 30 C ambient = 669 x 0.93 = 622 amperes
2. One triplexed cable, 100 percent load factor.
   I = 572 amperes at 20 C ambient
   0.93 is the correction for 30 C ambient, thus
   I at 30 C ambient = 572 x 0.93 = 532 amperes

Because the same cable used in different installations can have a range of almost 200 amperes in current carrying capacity, extreme care should be exercised when selecting a cable to carry a given load. All conditions pertinent to the installation must be known before an ampacity can be given to a cable.