TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401
400 Chestnut Street Tower II

August 30, 1985

Director of Nuclear Reactor Regulation
Attention: Ms. E. Adensam, Chief
Licensing Branch No. 4
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Adensam:

In the Matter of the Application of	)	Docket Nos. 50-390
Tennessee Valley Authority	)	50-391

My letter to you dated August 15, 1985 transmitted the information Tom Kenyon (NRC-NRR) requested to be submitted regarding TVA's utilization of the Black and Veatch (B&V) Independent Design Verification Program (IDVP) at Watts Bar. The information consisted of our responses to your July 9, 1985 letter and the NRC's B&V dedicated review team's July 18, 1985 request for additional documentation for Category 35.

Enclosed is the following additional information requested by Paul Gill (NRC-NRR) on Category 35 relating to circuit breakers and cable protection.

a. J. C. Standifer's memorandum to R. A. Costner dated July 18, 1984.

b. Pages C-3, D-14, and E-12 from UL 489.

c. A document (one page) entitled "The Cable Protector Story."

d. A chart entitled, "Maximum Peak Let-Through Current Data. . . ."

e. Pages 1 and 2 of Electrical Design Standard DS-E12.1.1.

B001
1/1

Director of Nuclear Reactor Regulation August 30, 1985

If there are any questions, please get in touch with D. L. Terrill at FTS 858-7840.

Very truly yours,

TENNESSEE VALLEY AUTHORITY

J. A. Domer

J. A. Domer, Chief
Nuclear Licensing Branch

Sworn to and subscribed before me
this 30th day of August 1985

Bryant M. Lowery
Notary Public
My Commission Expires 4/8/86

Enclosure

cc: U.S. Nuclear Regulatory Commission (Enclosure)
Region II
Attention: Dr. J. Nelson Grace, Regional Administrator
101 Marietta Street, NW, Suite 2900
Atlanta, Georgia 30323

TVA 64 (OS-9-65)

UNITED STATES GOVERNMENT

Memorandum

E. Whitley

TENNESSEE VALLEY AUTHORITY

WBP '84 0718 076

TO : R. A. Costner, Chief, Design Quality Assurance Branch, 362 SPB-K

FROM : J. C. Standifer, Project Manager, Watts Bar Design Project, 204 GB-K

DATE : JUL 18 1984

SUBJECT: WATTS BAR NUCLEAR PLANT - APRIL 1984 SURVEILLANCE REPORT SUMMARY

Reference: Your memo to me dated May 4, 1984 (OQA 840504 508)

We have the following comments regarding your five concerns identified in section 2.1 of the referenced memorandum:

(Concern 1a)

Since DS-E9.2.1 is superseded, this concern is no longer pertinent. 10B75

(Concern 1b)

Design Standard DS-E2.3.2, section 3.1.4 R0 issued December 9, 1982, references Design Standard DS-9.2.1 as follows:

"Molded case circuit breakers should be selected in accordance with DS-E9.2.1."

Design Standard DS-E2.3.2 was not revised to replace "DS-E9.2.1" with "DG-E2.3.5" in the above statement when DS-E9.2.1 was superseded. Presently, DS-E2.3.2 is being revised for other reasons and this change will also be incorporated. DS-E2.3.2 will be revised and issued by July 31, 1984. The reference to DG-E2.3.5 in DS-E2.3.2 will ensure future compliance with design requirements for moded case circuit breaker instantaneous trip settings.

(Concern 1c)

Although Design Guide DG-E2.3.5 does not specifically address motors rated less than 1/2 hp for application of molded case circuit breaker instantaneous trip settings, it does address such settings generically as follows:

Section 2.0, paragraphs 2 and 3, states:

"Table 1 should be used as a guide only. In that context it applies to the majority of power plant applications. It is mandatory to verify for each application the ratings given in the table by using actual motor full-load current value obtained from the nameplate or test report and considering both the drive application and the manufacturer's recommendations for protective devices furnished.

Trip settings for instantaneous trip circuit breakers are not given. To obtain optimal settings, they should be established for each motor in accordance with vendor instructions."

(Concern 1c) (Continued)

The above statements, in conjunction with vendor instructions, are adequate to select molded case circuit breaker instantaneous trip settings for all applicable motors, including motors less than 1/2 hp.

(Concern 2)

Concern No. 2 references the 59 breakers that provide protection for motors of less than 1/2 hp. The 59 breakers are the smallest of the types used and are adjusted to the lowest setting, which is 7 amps. Following the Black and Veatch Task Force Category 35 report, a safety analysis (NEB 840207 222) by NEB determined that a safety problem did not exist. On the basis of the safety analysis, no design action is required and we have met the safety requirements. Subsequent to the evaluation of the Task Force Category 35 finding, Design Standard DSE9.2.1 was replaced by DGE-2.3.5. This occurred on November 10, 1983, and negates the requirement to comply with the National Electrical Code. Design Guide DGE-2.3.5 references the National Electrical Code but the final decision on complying with the National Electrical Code is left up to the discretion of the designer per the definition of design guides. FSAR Section 8.3.1.1 describes the methods used for protection of motor circuits.

The motor protection is selected to protect the motor and its cable. Motor overload heaters are selected to provide overload protection of the motor. The circuit breakers are adjusted to 7 amps on all motor circuits of less than 1/2 horsepower as recommended by Black and Veatch Finding F-137.

The vendors supplying the breaker types do not make breakers that can be adjusted below 7 amps. This value exceeds the 13X value recommended by the NEC. The UL tests only go up to 13X the rating of the overload heaters. There is a probability that a current exceeding the 13X full load amps of the motor would cause the motor overload heater to fail. This would occur after the motor has already failed due to internal windings of the motor shorting out and causing a current in excess of locked rotor current for 8 seconds or less. The operating time of the overload heaters at 13X rated current is approximately 8 seconds and with the current exceeding 1300 percent of full load the relay operating time or failure time of the overload heater would be less than 8 seconds. The configuration of the motor overload heater will limit the failure to the one motor circuit involved and this would only be an additional failure in the same circuit. The overload heater would require replacement along with the motor in the unlikely event that the motor failed in the manner described.

(Concern 2) (Continued)

The overload heater is a wirewound heater, insulated from the metal support by mica insulation which has an extremely high temperature rating. The heater is installed in a bakelite case and no part of the heater winding makes contact with the bakelite. The heat to the thermal element is transmitted through the metal mount and through convection internal to the assembly. Bakelite is a high temperature material, self extinguishing, and is used extensively in cookware such as frying pan handles. It is unreasonable to assume that fire or smoke could occur, and that any other circuit would be affected by a failure of this type in less than 8 seconds with the current never in excess of 7 amps. In all cases the cables are rated for greater than 7 amps. In actuality the cables are better protected on motor circuits of less than 1/2 hp than on larger motors since the instantaneous setting of the breaker is less than the continuous rating of the cable.

Since the evaluation sheets for the Black and Veatch category finding already indicates that no safety problem exists, the only remaining concern apparently was that EN DES criteria and vendor recommendations were not applied in setting the circuit breakers. This condition no longer exists since the design standard requiring compliance with the National Electrical Code was superseded with DG-E2.3.5. The category 35 evaluation sheets will be revised by July 31, 1984 to delete the reference in 3.B to the National Electrical Code.

(Concern 3)

Concern No. 3 is that MEDS No. EEB 830908 926 referenced in evaluation sheet, item 7A.b should be EEB 830907 918. We concur with this concern and the revised sheet will be submitted by July 31, 1984.

(Concern 4)

a. The 385 number is an approximation and is stated as approximate in the ECN cover sheet. Thirteen (13) breakers were replaced to allow the lowest possible adjustment of 7 amps on motor of less than 1/2 hp.

b. The breakers are not in noncompliance as stated in the concern. DG-E2.3.5 does not specify the trip setting to be used for the loads, but are established for each motor in accordance with vendor instructions.

c. The breakers are not in noncompliance. The setting value is not specified in the Design Guide.

R. A. Costner
JUL 18 1984

WATTS BAR NUCLEAR PLANT - APRIL 1984 SURVEILLANCE REPORT SUMMARY

(Concern 5)

Evaluation sheet, item 11A.B references the wrong document. NEB 830127 015 should be SWP 830127 015. We agree with this concern and a revised sheet will be supplied by July 31, 1984.

J. C. Standifer

ERW:LB
cc: F. W. Chandler, W8C126 C-K
MEDS, W5B63 C-K
E. G. Beasley, W12B21 C-K
H. L. Jones, W10A17 C-K
R. M. Pierce, 104 ESTA-K

Principally Prepared By: E. R. Whitley, Extension 3085

(1)

DS
E12.1.1

TABLE 8.1
TERMINAL CURRENT AND CONDUCTOR SIZE

Terminal Current in Amperes[a]	Copper Conductor			Aluminum or Copper-Clad Aluminum Conductor		
	Paralleled	Size		Paralleled	Size	
		60°C	75°C		60°C	75°C
15 or less	–	14 AWG	14 AWG	–	12 AWG	12 AWG
20	–	12	12	–	10	10
25	–	10	10	–	10	10
30	–	10	10	–	8	8
40	–	8	8	–	6	8
50	–	6	6	–	4	6
60	–	4	6	–	3	4
70	–	4	4	–	2	3
80	–	3	4	–	1	2
90	–	2	3	–	1/0	2
100	–	1	3	–	1/0	1
110	–	1	2	–		1/0
125	–	1/0	1	–		2/0
150	–		1/0	–		3/0
175	–		2/0	–		4/0
200	–		3/0	–		250 MCM
225	–		4/0	–		300
250	–		250 MCM	–		350
275	–		300	–		500
300	–		350	–		500
325	–		400	two		1/0 AWG
350	–		500	two		4/0
400	two		3/0 AWG	two		250 MCM
450	two		4/0	two		300
500	two		250 MCM	two		350
550	two		300	two		500
600	two		350	two		500
700	two		500	three		350
800	three		300	three		400
1000	three		400	four or three		350 or 600
1200	four three		350 or 600	four		600
1400	four		500	five		500
1600	five four		400 or 600	five		600
2000	six five		400 or 600	six		600
2500	eight seven six		400 MCM, 500, or 600	eight seven nine		600 MCM, 750, or 500
3000	nine eight seven		400, 500, or 600	ten nine eight		500, 600, or 750
4000	twelve eleven ten		400, 500, or 600	thirteen twelve eleven		500, 600, or 750
5000[b]	fifteen thirteen twelve		400, 500, or 600	sixteen fifteen thirteen		500, 600, or 750
6000[b]	eighteen sixteen fifteen		400, 500, or 600	nineteen eighteen sixteen		500, 600, or 750

[a] For a terminal current other than indicated, the next higher rating is to be used – for example, if rated 35 A, enter at 40 A.

[b] Circuit breakers rated at more than 4000 A are to be considered as being bus- or cable-connected unless indicated otherwise in marking.

Table 8.1 effective November 1, 1982

19.3 To determine if a circuit breaker complies with the requirements of paragraph 19.1 and Table 19.1, the device is to be mounted, connected, and operated as described in paragraphs 12.15 and 12.16, and paragraphs 16.3–16.13 under "Overload", except that the power factor for an ac test is to be 0.75–0.80 lagging. A 2-pole circuit breaker that has independent trip operation of each pole, such as described in paragraph 16.10, is to be tested with both poles operating simultaneously. In each cycle of operation of the endurance test with load, the breaker is t be closed and then opened immediately unless a longer "on" period is agreeable to those concerned.

19.4 The current capacity of the supply circuit may be determined with rated current flowing (instead of 600 percent of rated current, as required in paragraph 16.3), in which case the voltage across the circuit breaker and load is to be not less than 97-1/2 percent of rated voltage of the circuit breaker except that the capacity of the supply circuit need not be greater than that of a circuit which is considered to be acceptable for the interrupting ability test as described in Table 21.3.

19.5 Typical wiring diagrams illustrating the test of circuit breakers under endurance conditions are indicated in Figure 19.1. Reference should be made to the explanation of test methods and circuit characteristics given in paragraphs 19.1–19.4.

20. Calibration – Repeated

20.1 The 200 percent calibration test and the 125 and/or 135 percent calibration tests shall be repeated following the endurance test.

20.2 The repeated 125-percent calibration test of a compensated thermal circuit breaker at 40°C (104°F) is to be made with the circuit breaker at ambient temperature, without preheating by carrying rated current. The repeated 125-percent calibration test of a compensated thermal breaker at 40°C (104°F) may be omitted if the compensation of the circuit breaker is not considered to be affected by the overload and endurance tests.

21. Interrupting Ability

21.1 A circuit breaker shall perform successfully when operated under conditions as described in paragraphs 21.2 and 21.3. There shall be no electrical or mechanical breakdown of the device, and the fuse that is indicated in paragraph 12.16 shall not have cleared. Cotton indicators as described in paragraphs 21.4 and 21.6 shall not be ignited. There shall be no damage to the insulation on conductors used to wire the device. After the final operation, the circuit breaker shall have continuity in the closed position at rated voltage.

Exception: The cotton indicator mentioned in paragraph 21.4 may be omitted, if, with the handle in any position, there is no opening around the handle through which a music wire 0.010 inch (0.26 mm) in diameter can be inserted into the internal arcing area.

21.2 A circuit breaker shall be subjected to the number and type of operations indicated in Table 21.1 when connected as shown in Figure 21.1 and shall interrupt the current indicated in Table 21.3. Successive operations shall be conducted by alternating closing the circuit on the circuit breaker ("O" operation) by means of any appropriate switching device, using random closing, and closing the circuit breaker on the circuit ("CO" operation). At the option of the manufacturer the common or 3-phase operation may be conducted first, provided that "O" – "CO" – "O" alternate operations are maintained.

21.3 The time interval between the interrupting operations of a circuit breaker shall be 2 minutes, except that the time interval may be extended to whatever is necessary to allow the circuit breaker to be reset, but not more than 1 hour.

28.7 A circuit breaker is to be tested in the smallest enclosure (box and cover) in which it is intended to be used. Openings may be provided in the enclosure if the combined area of all openings does not exceed 10 percent of the total external enclosure area and if no opening is directly opposite a vent in the circuit breaker case.

28.8 The test leads are to be as indicated in Table 28.1. The line terminal connections are to be not over 4 feet (1.2 m) in length except that a greater length may be used, if the excess over 4 ft (1.2 m) per terminal is in the circuit during the test circuit calibration.

28.9 In both the single-phase (multipole, including single-pole circuit breakers tested in pairs) and 3-phase tests, the load terminals of the circuit breaker are to be connected together with 10-inch (254-mm) test leads (per pole) brought to a common point, or brought to a shorting bar of adequate current-carrying capacity.

28.10 When testing a single-pole circuit breaker the load side test lead is to be not more than 4 feet (1.2 m) long except that if the circuit breaker rating is less than 100 A and is the maximum of the frame or test group within the frame, the rated size wire is to be 10 inches (254 mm) long and shall be connected to the load supply terminal by 4 feet (1.2 m) of No. 1 AWG copper wire.

28.11 A circuit breaker that is the maximum rating for the frame or group represented and that is rated less than 100 A is to be tested under "bus bar conditions." The line terminals of single and multipole circuit breakers, and the load terminals of single pole circuit breakers shall be connected with a 10-inch (254-mm) long lead of rated wire size. To the ends of each of these leads, No. 1 AWG leads, each 4 feet (1.2 m) long, are to be joined for connection to the test terminals.

TABLE 28.1
TEST LEADS

Manner Tested	Frame or Group Within Frame	Ampere Rating Relative to Frame or Group Within Frame	Size of Copper Test Leads [a,b]	
			Line	Load [c]
Tested	100 A and above	Maximum	Rated Wire	Rated Wire
		Minimum	Rated Wire	Rated Wire
with Leads	Less than 100 A	Maximum	Rated Wire	Rated Wire [d]
		Minimum	Rated Wire [e]	Rated Wire [e]
Tested under "Busbar Conditions"	Less than 100 A	Maximum	No. 1 AWG [f]	Rated Wire (2 and 3 pole) No. 1 AWG (1-pole) [f]

[a] "Rated Wire" refers to size as specified in Table 8.1. For a circuit breaker rated 125 A or less the 60°C (140°F) wire is to be used.

[b] Circuit breakers of frame sizes rated 1600 A or more may be tested with bus bars of a size shown in Table 18.2.

[c] A copper bus bar may be substituted for the load leads if the ampacity is equal to or greater than the required lead ampacity.

[d] See paragraphs 28.9 and 28.10.

[e] For circuit breakers rated 15 A, at 480 or 600 V, No. 12 AWG wire may be used instead of No. 14 AWG wire.

[f] See paragraph 28.11.

THE CABLE PROTECTOR STORY

HISTORY

Amp-trap Cable Protectors were introduced in 1954. Prior to this, the only low voltage cable fuses or limiters available were those used on 120/208 volt secondary networks. These limiters were made from copper tubing. The two ends were crimped onto cable ends and the center portion was flattened and trimmed to various widths to give a range of melting time-current characteristics. These were sometimes enclosed in asbestos covers inside rubber sleeves. These satisfied the simplest definition of a fuse, namely, "the weakest link in the system," but were hardly current limiting as we understand that concept today.

Amp-trap Cable Protectors offered three new dimensions to cable protection:

1. True current-limiting action.
2. Interruption without noise, flame or smoke.
3. 600 volt ratings which made them suitable for 277/480 volt secondary network systems.

The original Amp-trap Cable Protectors were designated CP6. They isolated cables on overloads slightly over maximum cable ratings so that cables were not damaged and could remain in use after the CP6 Cable Protectors were replaced. This type also operated fast on short-circuit faults, again protecting cables, while providing current-limiting protection for the system.

Some applications, especially heavy network systems using multiple conductors on each phase, cannot tolerate outages and only require cable protectors which isolate individual faulted cables. For these applications, a heavier less current-limiting type Cable Protector was developed and designated CP6A.

CP6A Cable Protectors were for systems which experience long duration overloads (contingency conditions) when cables must not be isolated quickly. This type featured a long "float" time during which cables could be damaged, but which allowed enough time for repairs to that part of the system in trouble. There was less chance of nuisance opening with the CP6A type than with the CP6 type but high fault currents were still limited to a quarter cycle or less.

1/4 cycle = .0042 sec

CP6 and CP6A Cable Protectors were furnished and installed for over 25 years. They were available for copper and aluminum cables from #4 to 1000MCM. Catalog numbers included suffixes which referred to specific cable sizes in a wide variety of mounting configurations. Nearly 400 possible variations were cataloged!

THE NEW GENERATION

With 400 variations of Cable Protectors, it became impractical to stock all of them. A new approach had to be taken.

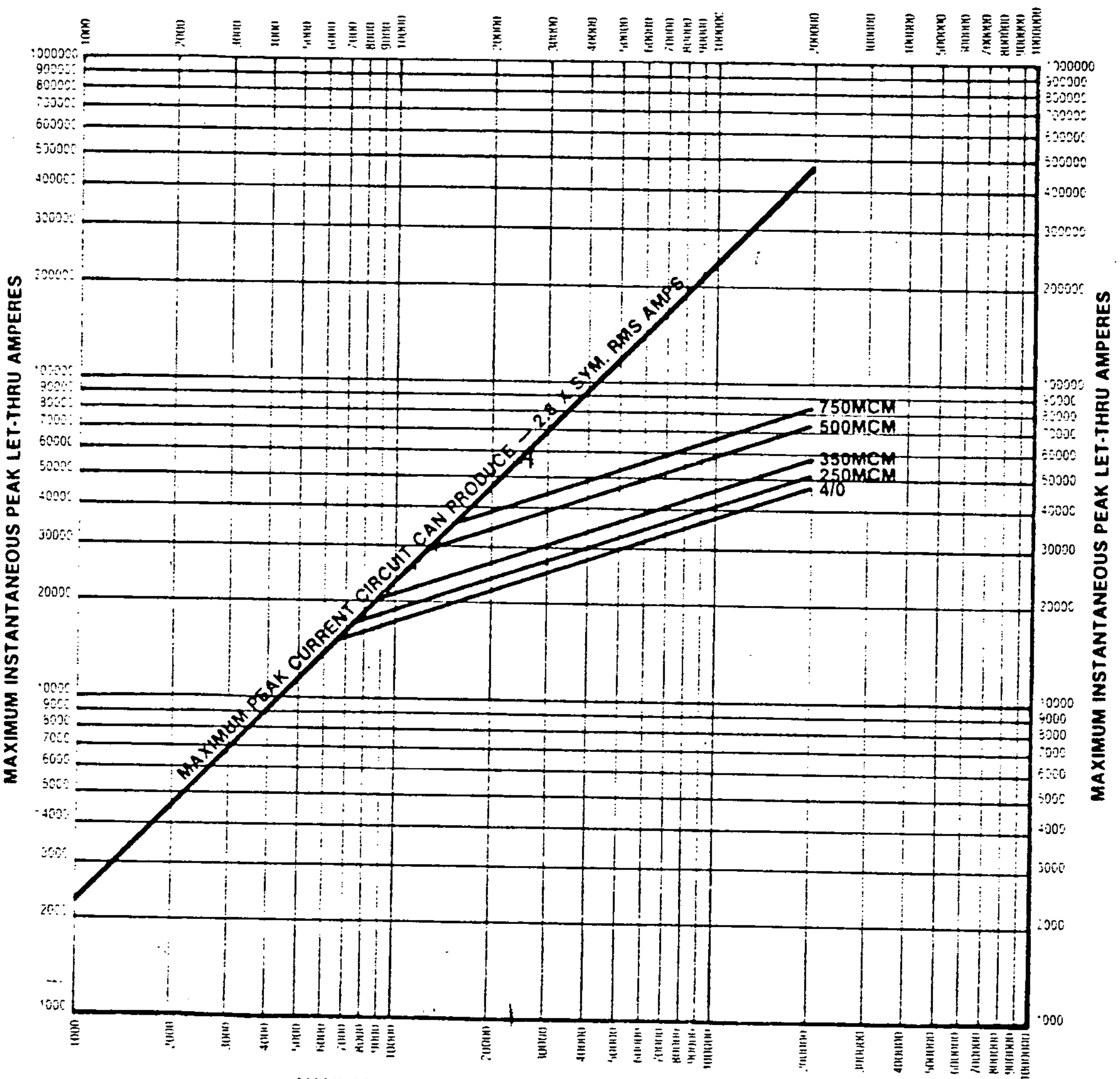
Twenty Five years of experience taught that most small cables #4 thru 3/0, can be adequately protected by current-limiting Class J fuses 125 through 400 amperes. These fuses have blade terminals with bolt holes, which make them a natural for bolting directly to cable lugs or bus bars. Therefore, standard readily available and nationally stocked Amp-trap Class J fuses are now recommended for all cables smaller than 4/0. (See page 7)

Experience also taught that five basic types of cable protectors can satisfy nearly all requirements, and that today's most popular copper and aluminum cable sizes are 4/0, 250MCM, 350MCM, 500 MCM and 750MCM. (See page 3)

Furthermore, experience taught that these applications could be satisfied by a cable protector somewhat less current limiting than the CP6 and more current limiting than the CP6A. This lead to the development of the new standard CP Cable Protector which is described in this bulletin.

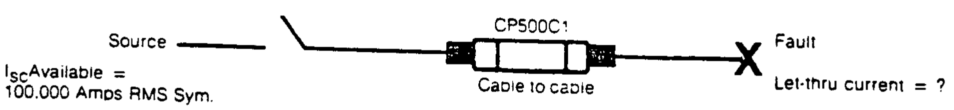
A new "heavy" Cable Protector CPH is available for replacement of old CP6A Cable Protectors and for new applications on very large fully engineered systems. All information for CPH Cable Protectors (for copper cables only) must be requested from the factory.

MAXIMUM PEAK LET-THRU CURRENT DATA
STANDARD CP CABLE PROTECTOR
FOR COPPER AND ALUMINUM CABLE
4/0, 250MCM, 350MCM, 500MCM, 750MCM
600VOLTS
084111A



HOW TO READ LET-THRU CHARTS

EXAMPLE:



At the source, assume the available short-circuit current is I_{SC} = 100,000 amperes RMS. An AMP-TRAP CP500C1 cable protector is used for short-circuit protection. To find the let-thru current of the cable protector:

First — Enter the chart at 100,000 amperes on the bottom Available Current scale and proceed up to the 500MCM curve.

Second — From this intersection, proceed directly to the left to the intersection with the MAXIMUM PEAK CURRENT line.

Third — Proceed directly down to the horizontal scale and read value of RMS short-circuit current let thru by the CP500 cable protector (25,000 amperes).

This value of short-circuit current is what will actually flow to fault point X during a short-circuit fault.

Caution: Where parallel (per phase) cable protectors are used, the clearing of one will not necessarily open the others and thus the current to the service equipment is not limited.

1.0 GENERAL

1.1 Ratings in this design standard[1] table are based on IPCEA ampacities and: (a) load factor of 100 percent which is continuous loading for a period of 8 hours or longer; (b) maximum copper temperature of 75° C with ambient temperature of 40° C; (c) 60 Hertz ac; (d) skin and proximity effect included; (e) single-conductor cable nonleaded or with open-circuited sheath.

1.2 For motor circuits use cables with ratings 125 percent of motor ratings.

1.3 For cable sizes larger than 500 MCM consult technical supervisor.

1.4 Cable sizes shown above are determined by current carrying capacity only and should be increased where necessary for short circuit handling capability (see DG-E12.6.2), and to maintain suitable voltage regulation.

1.5 Control cables made up of No. 14, No. 12, or No. 10 wire are not ordinarily subject to temperature rise limitations.

1.6 Short circuit calculations are to include cable impedence to nearest probable short circuit point, such as a cable splice or terminal connection point.

2.0 CORRECTION FACTORS FOR AMBIENT TEMPERATURES

For 20° C multiply table values by 1.25
For 30° C multiply table values by 1.13
For 50° C multiply table values by 0.85

[1] This design standard supersedes Electrical Standard Drawing 30A1020.

ORIGINAL ISSUE:	9/28/76
REVISION NO:	RO
DATE REVISED:	

PREP'D / SPON'D / SUBM'D / APPR'D: [illegible signatures]

SINGLE-CONDUCTOR DATA AND CURRENT CARRYING CAPACITY POLYETHYLENE-INSULATED CABLE*
(75^oC MAXIMUM COPPER TEMPERATURE)
100 PERCENT LOAD FACTOR - 40^oC AMBIENT AIR

CONDUCTOR SIZE AWG OR MCM	VOLTAGE RANGE								NOMINAL O.D.			IPCE PUB 32-382
	0-5000			5001-8000			0-5000	5001-8000				
	NUMBER OF CABLES IN ONE CONDUIT						SINGLE CONDUCTOR IN STILL AIR*					
	1	2	3	1	2	3			600V	5000V	8000V	I^2t
14			19			23	26		.137			47×10^3
12			24			28	33		.156			12×10^4
10			33			37	44		.187			30×10^4
8			43			46	61		.34			76×10^4
6			57			65	83		.378			19×10^5
4			76			85	110		.43			48×10^5
2			101			111	150		.485			12×10^6
1			115			127	172		.58			19×10^6
1/0	167	146	133	179	161	145	202	214	.62	.870	1.05	31×10^6
2/0	194	169	152	205	185	165	235	245	.66	.915	1.122	49×10^6
3/0	222	194	175	235	212	187	273	284	.70	.985	1.17	78×10^6
4/0	256	222	203	270	240	213	315	329	.77	1.04	1.23	12×10^7
250	285	247	225	298	264	235	352	362	.88			19×10^7
300	323	279	251	333	294	263	393	403	.94	1.145	1.35	25×10^7
350	352	304	274	367	322	288	443	445	.99			34×10^7
400	380	327	296	398	348	312	481	486	1.03	1.23	1.43	44×10^7
500	432	374	336	453	395	352	546	554	1.13	1.30	1.60	69×10^7
750	546	467	418	569	487	432	691	716	1.42	1.50	1.73	15×10^8
1000	640	532	478	670			824	852	1.58			27×10^8
1250	728			765			938	980	1.75			43×10^8
1500	808			848			1032	1084				62×10^8
1750	880			922			1130	1187				85×10^8
2000	950			987			1220	1290				11×10^9

*Do not use this cable on power cable trays without permission from technical supervisor.

TABLE 1