SOUTH CAROLINA ELECTRIC & GAS COMPANY
POST OFFICE 764
COLUMBIA, SOUTH CAROLINA 29218

O. W. DIXON, JR.
VICE PRESIDENT
NUCLEAR OPERATIONS

February 6, 1985

Mr. Harold R. Denton, Director
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Virgil C. Summer Nuclear Station
Docket No. 50/395
Operating License No. NPF-12
Request for Additional
Information - Cable Separation

Dear Mr. Denton:

In a letter to you dated November 29, 1984, South Carolina Electric and Gas Company responded to a condition of the Operating License on cable separation (Item 2.C.16). Included in this letter was a request for Technical Specification revision. In a letter from the Staff dated January 8, 1985, additional information was requested on protection of the cable for I^2t rating. The attached information is in response to that request.

If you have any further questions, please advise.

Very truly yours,

O. W. Dixon, Jr.

JAW/OWD/gj
Attachment:

cc: V. C. Summer
T. C. Nichols, Jr./O. W. Dixon, Jr.
E. H. Crews, Jr.
E. C. Roberts
W. A. Williams, Jr.
D. A. Nauman
J. P. O'Reilly
Group Managers
O. S. Bradham
C. A. Price
C. L. Ligon (NSRC)
K. E. Nodland
R. A. Stough
G. Percival
C. W. Hehl
J. B. Knotts, Jr.
NPCF
File

A001
1/1

QUESTIONS

1. Your letter of November 29, 1984 does not demonstrate that the associated cable protective device will clear the imposed fault condition without exceeding the I^2t rating of the cable (before the ignition temperature of the cable insulation is reached). Therefore, provide for Staff review some typical protection device curves for the subject circuits plotted against the I^2t curve of the cable which it protects.

2. For all of the subject circuit cables protected by overcurrent protective devices, are those cables protected equal to or better than their I^2t curves?

RESPONSE

The Virgil C. Summer Nuclear Station cable sizing is designed in accordance with industry standards, and the circuit breakers are also designed and sized in accordance with industry standards. The circuit breaker's function is to protect the circuit, i.e., cable and equipment, in the event of a malfunction of the cable or equipment.

The Virgil C. Summer Nuclear Station cable sizing is governed by the Project Design Criteria Manual, Chapter 4, section 4.7. This design criteria was developed by Gilbert/Commonwealth, Inc. for use in designing Virgil C. Summer Nuclear Station. The criteria is based on cable industry standards. A conservative margin is factored into the plant design via this design criteria. The applicable section is attached as Reference #4.

The size of a given cable for a load is also increased based on a derating factor if installed in cable trays. This derating adds to the conservatism of cable selection and increases the I^2t capability of a given cable.

Examples of typical protection device curves plotted against the I^2t curve of the cable it protects are attached:

1. A typical 600V air circuit breaker for the Virgil C. Summer Station is a Brown Boveri (ITE) 600 Ampere, K-600, circuit breaker. From Reference #4, table 4.18, the maximum allowable ampacity for 750 MCM copper cable is 492 amperes, random lay. Therefore the long-time setting on the circuit breaker would be 0.8 or 480 Amperes.

   From Reference #1, the short circuit allowable amperes for various times for 750 MCM cable were determined. Reference #1 is an Allowable Short Circuit Current table taken from a cable design handbook. These values of allowable short circuit amperes for the cable were then plotted on the Time-Current Characteristics curves for the breaker; Reference #2. From this plot it is evident that the breaker will trip before the I^2t of the cable is reached.

2. A typical 600V Molded case circuit breaker for the Virgil C. Summer Station is a Square D 100 Ampere, FA circuit breaker. From Reference #4, table 4.12, the maximum allowable ampacity for 1/0 copper cable is 130 Amperes. Therefore the 100 Ampere breaker would protect the cable. If the cable was routed through a random lay cable tray, a derating factor would be applied, and the ampacity would be taken from Reference #4, table 4.18. The ampacity would then be reduced to 86 amperes and an 80 ampere breaker would be used to protect the cable.

From Reference #1, the short circuit allowable amperes for various times for 1/0 cable were determined. These values of allowable short circuit amperes for the cable were then plotted on the Characteristic Tripping Curve for the FA 100 Ampere breaker; Reference #3. From this plot it is evident that the breaker will trip before the I^2t of the cable is reached.

Circuits for the Virgil C. Summer Nuclear Station are designed in accordance with the Project Design Criteria Manual which factors in a conservative margin to assure that the circuit breakers function to protect cable and equipment. The cable design criteria used for sizing the cable feeds from a breaker gives consideration to the I^2t capability of the breaker to protect the cable. Therefore it can be concluded that if the breakers are demonstrated to function then the integrity of the cable is insured and the I^2t of the cable is not exceeded.

REFERENCE #1

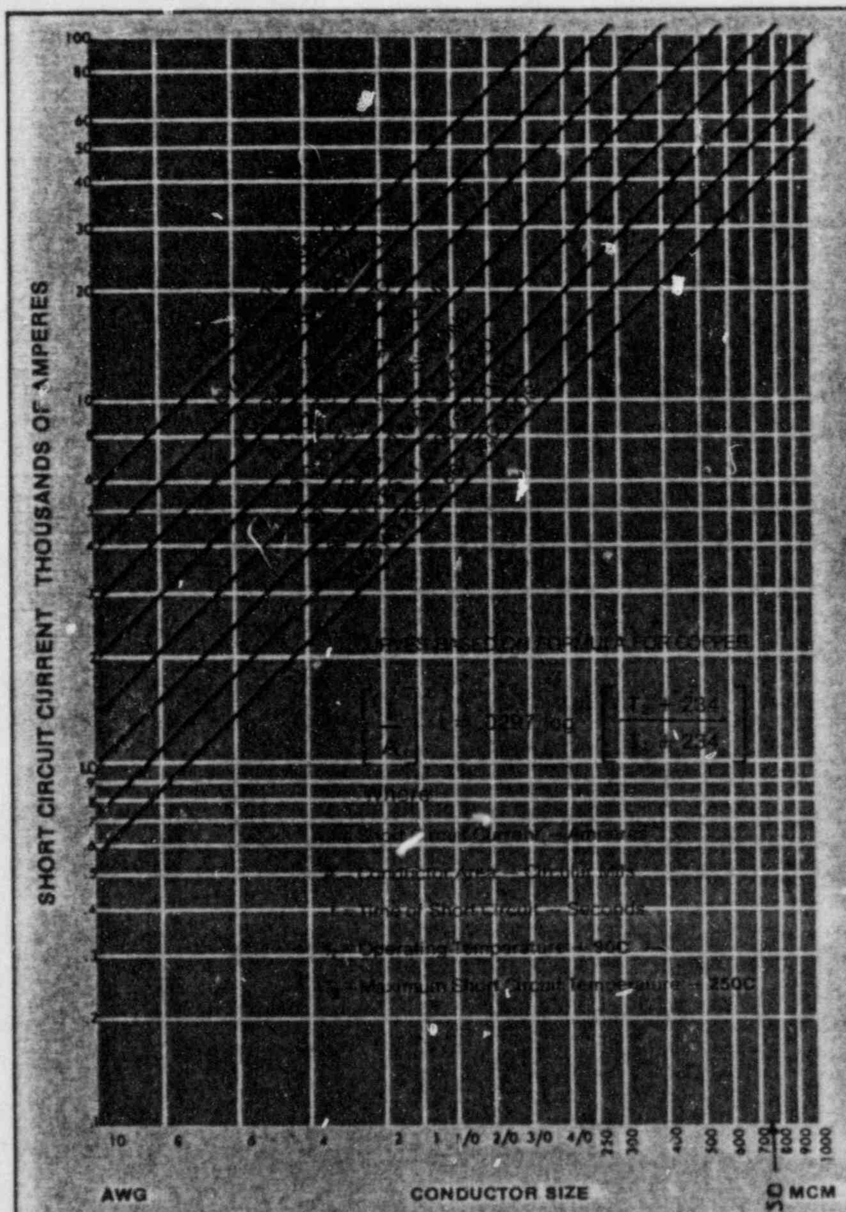
Short Circuit Currents

With the ever-increasing kva capacity of power systems, the possible short circuit currents are becoming so high that it is frequently necessary to consider the effect of these short circuits on the heating of the cables. The conductor size must be large enough to carry the short circuit current for a sufficient length of time to permit the circuit breakers to open before the conductor is heated to the point where it damages the insulation.

The chart at right shows the maximum currents to which various size copper conductors can be subjected for various times without injuring the insulation. It is based on a 90C conductor operating temperature. The maximum current for short curcuit ratings for 75C conductor temperatures and for other than 250C may be obtained by multiplying the value obtained for T_1 = 90C and T_2 = 250C from chart by appropriate correction factor for other values of T_1 and T_2.

Allowable short circuit currents for insulated copper conductors*

Table 4-1



*For Aluminum Conductors Multiply Value Obtained from Chart by 0.65.

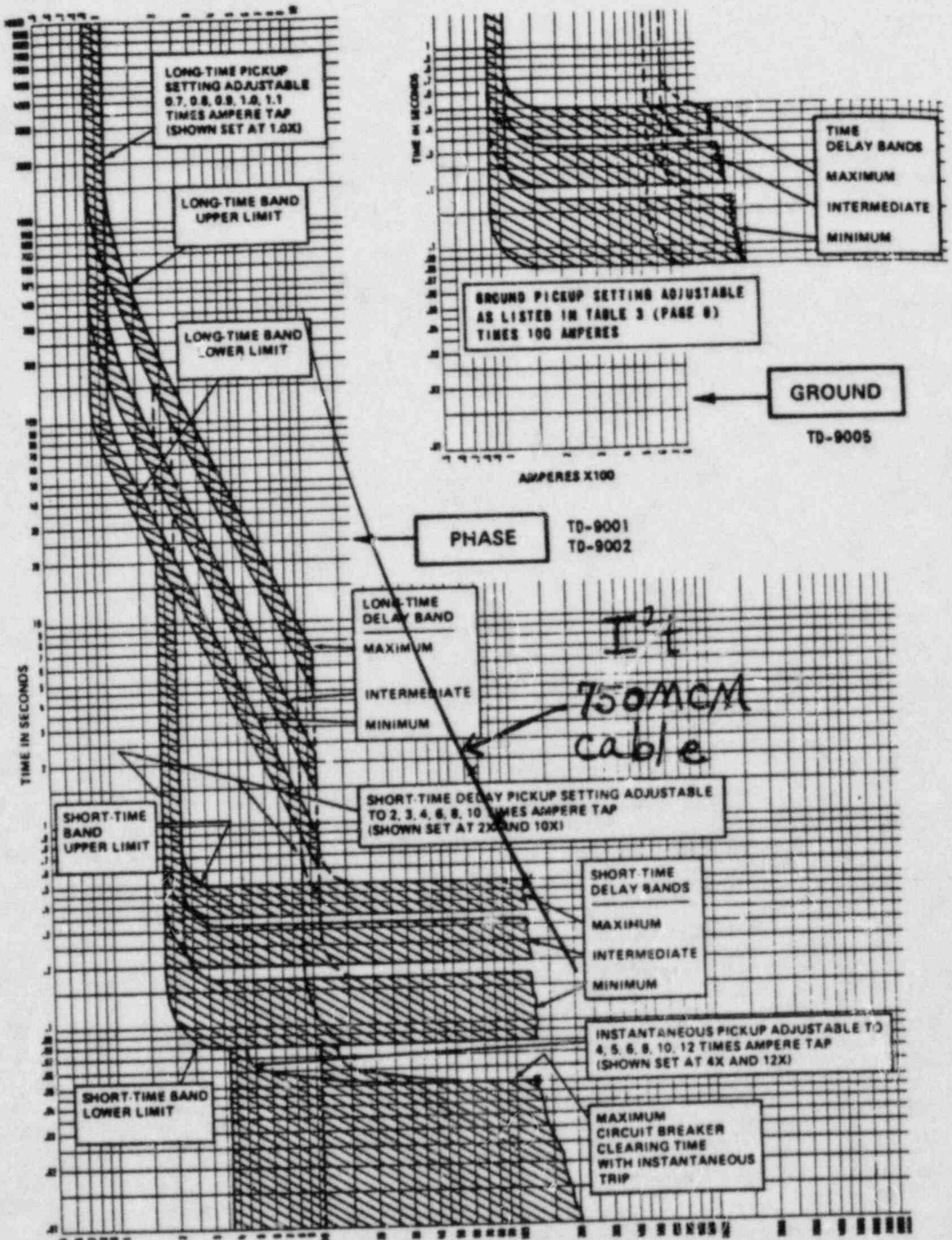
COPPER & ALUMINUM CORRECTION FACTORS FOR VARIOUS SHORT CIRCUIT TEMPERATURES

Short Circuit Temp. (T_2)

	175C	200C	225C	250C
T_1 = 75C	.84	.92	.99	1.06
T_1 = 90C	.76	.85	.93	1.00

REFERENCE #2

POWER SHIELD TIME-CURRENT CHARACTERISTICS



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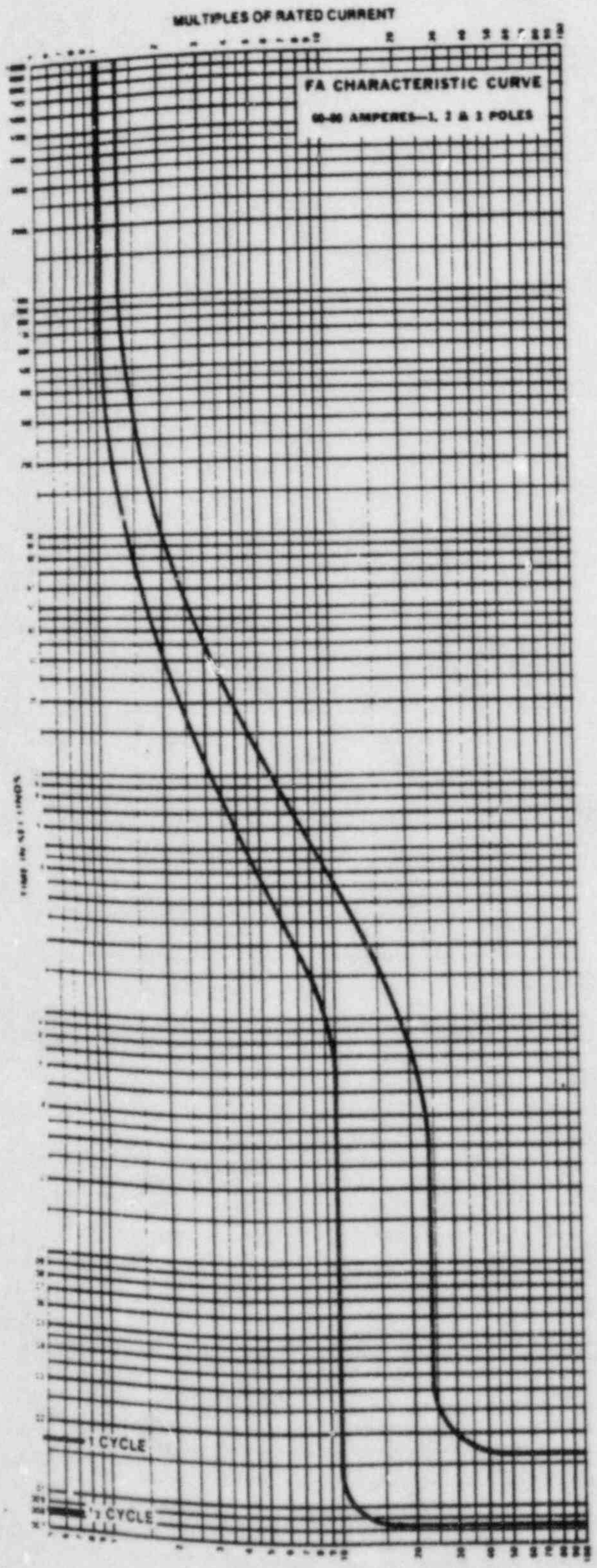
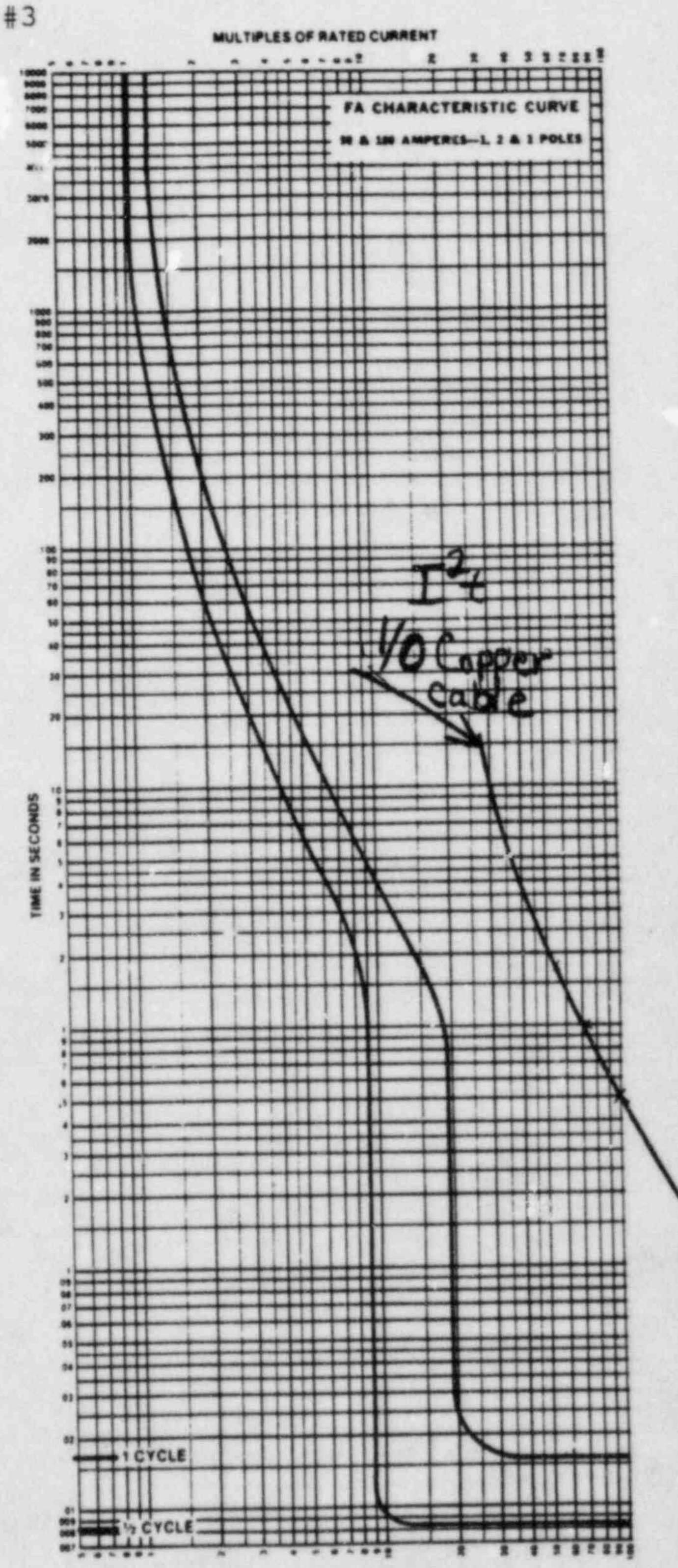
FA
MOLDED CASE CIRCUIT BREAKERS
CHARACTERISTIC TRIPPING CURVE

REFERENCE #3





ATTACHMENT 6 of 9

All curves available on tissue stock as a set for coordination studies

4.7 CABLE RATING CRITERIA

Motor feeders, power panel feeds, and small lighting and receptacle panel transformer feeds will be sized for 125% of full load current. Large power transformer feeders will be sized for 140% of full load current at maximum rating. Motor control center feeders will be sized for 140% of the calculated normal diversified load current, and feeders to resistive loads will be sized on the basis of 110% of rated current at rated voltage.

In selecting IPCEA ampacity tables, a load factor of 100% shall be assumed.

Ampacities of 7.2 kV power cables will be in accordance with IPCEA in air ratings derated by a factor of 0.70 in 40° C areas and 0.63 in 50° C areas.

Ampacities of 480 volt cables or large DC cables in single layer power trays will be in accordance with IPCEA in air ratings and derated by a factor of 0.70 in 40° C areas and 0.63 in 50° C areas.

Ampacities of 480 volt cables or DC cables in a random lay power tray shall be in accordance with IPCEA - NEMA Standard Pub. P-54-440. The derating factors for 3-inch depth shall be used.

Ampacities of 480 volt cables or DC cables #10 and smaller, when run in the control tray, will be in accordance with the IPCEA in air ratings derated by a factor of 0.50.

Control cables and instrument cables will have no ampacity derating factors applied.

All ampacities are on the basis of 90° C tables at 40° C ambient in all interior areas except containment. Containment or ESF motors in areas requiring forced ventilation of the motor shall be on the basis of 50° C ambient.

Pressurizer heater cables will be sized by special ratings.

The Reactor Building recirculation fan motor power cables require special consideration, since these motors must operate in the post-accident containment environment. These cables will be sized to carry the required current, during the post-accident temperature and pressure transient, without exceeding the recommended emergency operating temperature rating for the cable and continue to operate for a minimum time of six months post-accident.

Ampacities for 7.2 kV and 480 volt three conductor cables in conduit wrapped in Kaowool at 40° C ambient temperature are calculated to ensure that the maximum copper surface temperature of 90° C is not exceeded.

4.18

480 V 3Ø PWR. CABLE RANDOM LAY

KVA vs CABLE SIZE - 40° C AMBIENT

(FOR NON-MOTOR LOADS)

OVERLOAD FACTORS

Cond. Size	Ampacity	MAXIMUM CURRENT FOR 110% Overload	MAXIMUM CURRENT FOR 125% Overload	MAXIMUM CURRENT FOR 140% Overload	MAXIMUM KVA FOR 110% Overload	MAXIMUM KVA FOR 125% Overload	MAXIMUM KVA FOR 140% Overload
10 AWG	12	10.9	9.6	8.55	8.7	7.6	6.8
8	17	15.4	13.6	12.14	12.2	10.8	9.6
6	28	25.4	22.4	20.00	20.2	17.8	15.9
4	39	35.4	31.2	27.86	28.2	24.8	22.2
2	55	50.0	44.0	39.29	39.8	35.0	31.3
1	72	65.5	57.5	51.43	52.1	45.8	40.9
1/0	86	78.0	68.8	61.43	62.1	54.8	48.9
2/0	103	93.5	82.5	73.57	74.5	65.7	58.6
3/0	124	112.0	99.0	88.57	89.2	78.8	70.5
4/0	156	142.0	124.0	111.43	113.1	98.8	88.7
250 MCM	190	172.0	152.0	135.7	137.0	121.0	108.1
350 MCM	250	226.0	200.0	178.57	180.0	159.3	142.3
500 MCM	338	306.0	270.0	241.43	243.8	215.1	192.3
750 MCM	492	445.0	393.0	351.43	354.5	313.1	279.9

Gilbert/Commonwealth

4.12
277 V 1Ø PWR. CABLE SINGLE LAY
KVA vs CABLE SIZE - 40° C AMBIENT
(FOR NON-MOTOR LOADS)
OVERLOAD FACTORS

Cond. Size	Ampacity	MAXIMUM CURRENT FOR 110% Overload	MAXIMUM CURRENT FOR 125% Overload	MAXIMUM CURRENT FOR 140% Overload	MAXIMUM KVA FOR 110% Overload	MAXIMUM KVA FOR 125% Overload	MAXIMUM KVA FOR 140% Overload
10 AWG	28	25.4	22.4	20.0	7.0	6.2	5.54
8	41	37.2	32.8	29.3	10.3	9.1	8.12
6	55	50.0	44.0	39.3	13.8	12.2	10.89
4	72	65.4	57.6	51.4	18.1	15.9	14.24
2	96	87.2	76.8	68.5	24.1	21.2	18.97
1	112	101.8	89.6	80.0	28.2	24.8	22.16
→ 1/0	130	118.2	104.0	92.86	32.7	28.8	25.72
2/0	150	136.3	120.0	107.1	37.7	33.2	29.67
3/0	174	158.2	139.2	124.3	43.8	38.5	34.43
4/0	200	181.8	160.0	142.86	50.36	44.3	39.57
250 MCM	224	203.6	179.2	160.0	56.4	49.64	44.32
350	275	250.0	220.0	196.43	69.25	61.0	54.41
500	340	309.0	272.0	242.86	85.59	75.34	67.27
750	430	391.0	344.0	307.14	108.31	95.29	85.08