REVIEW OF ELECTRICAL ONE-LINE DIAGRAMS

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Purpose

This Plan Review Guideline (PRG) provides guidance relating to applicable Code of Federal Regulations (CFR) to aid in creation of a submission package to the Marine Safety Center (MSC) for review of the electrical plans for U.S. flag inspected vessels that fall under the applicable subchapters. To facilitate plan review and project management, all plans and information specified in this guideline should be submitted as one complete package through a single point of contact for the project.

Contact Information

If you have any questions or comments concerning this document, please contact the Marine Safety Center (MSC) by e-mail or phone.

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1. Applicability

This Plan Review Guideline (PRG) is applicable for vessels inspected under subchapters D, H, I, I–A, L, R, U and vessels meeting the requirements of SOLAS. For guidance on electrical systems of small passenger vessels inspected to subchapters K and T please refer to PRG E2-23. Guidelines for other portions of applicable sections of a full electrical system submission are outlined in the following references:

a. General Emergency Alarm and Public Address Systems (PRG E2-02)
b. Coordination Study (PRG E2-04)
c. Design Verification Test Procedures (PRG E2-05)
d. Electrical Load Analysis (PRG E2-06)
e. Emergency Generators and Switchboards (PRG E2-08)
f. Fire Detection Systems (PRG E2-09)
g. Lighting Systems and Components (PRG E2-14)
h. Motor Circuits, Controllers, and Protection (PRG E2-15)
i. Periodic Safety Test Procedures (PRG E2-17)
j. Qualitative Failure Analysis (PRG E2-18)
k. Short-circuit Analysis (PRG E2-19)
l. Steering-gear Electrical Systems (PRG E2-20)
m. Ship Service Switchboard and Generator Drawing (PRG E2-21)
n. Lithium-Ion Batteries (PRG E2-29)

2. Background

The purpose of an electrical one-line diagram is to provide an elementary schematic outlining connections from power sources (generators, shore power, battery banks) through a distribution system (switchboard, busbars, cables, feeders, and panels) to supply various power consuming loads. In the same document, or in supporting documentation, all necessary information required to verify compliance with all sections of applicable regulations should include plans and information required by 46 CFR 110.25-1.

3. References

a. 46 CFR Subchapter J
b. NEC 2002 (NFPS 70) – National Electric Code Handbook, Ninth Edition, 2002
c. IEEE Standard 45-2002, "Recommended Practice for Electric Installations on Shipboard"
d. ABS "Rules for Building and Classing Steel Vessels, 2003"
e. ABS "Rules for Building and Classing Mobile Offshore Drilling Units, 2001"
f. SOLAS (Consolidated Edition 2009)
g. Navigation and Vessel Inspection Circular (NVIC) 2-89, "Guide for Electrical Installation on Merchant Vessels and Mobile Offshore Drilling Units"
h. IEC/ISO/IEEE 80005-1-2012, "Utility Connections in Port – Part 1 High Voltage Shore Connection (HVSC) Systems – General Requirements"

4. Definition

Independent laboratory. An organization which meets the standards for acceptance in 46 CFR 159.010-3, and is accepted by the Coast Guard for performing certain tests and inspections. In addition to commercial testing laboratories, the Commandant may also accept classification societies and agencies of governments that are involved in the inspection and testing of marine safety equipment that meet the requirements of 46 CFR 159.010-3. (46 CFR 110.15-1; 46 CFR 159.001-3)

5. Plan Submission

The submitter shall provide documentation and plans sufficient to demonstrate compliance with applicable USCG regulations. For a typical electrical one-line diagram, plans include: detailed one line diagram of power system, panel board summaries, motor control diagrams, remote shutdowns diagram, load analysis, short circuit analysis, breaker coordination study, switchboard details and generator details. To facilitate efficient review, required plans and information should be submitted as a package from a single point of contact; any revisions to plans and resubmissions made should include all plans the submitter wishes to receive review and approval for in the electronic submission. Submissions shall be made electronically to msc@uscg.mil, or, by mail, and in triplicate, to the MSC's postal address found here.

6. General Guidance General requirements for electrical systems may be found in 46 CFR 111.01-108.

a. Generator and Overcurrent Protection

(1) Each vessel must have two generating sources, as per 46 CFR 111.10-3. (Self-propelled vessels only, barges with a single power source are permitted)

(2) As per 46 CFR 111.12-11(d) and (g), generator circuit breakers must be located in the generator switchboard and longtime overcurrent trip set at a value *not higher than 115%* of:

(i) The continuous generator rating; or
(ii) The overload for a machine with a 2 hour or greater overload rating.
Note: If 115% of the full load amperage does not correspond to a standard size, rounding up to the next largest standard size is not permitted.

(3) As per 46 CFR 111.12-9(a), generator cables must be rated for *at least 115%* of:

(i) The continuous generator rating; or
(ii) The overload for a machine with a 2 hour or greater overload rating.

b. Other Special Ship Industrial Generators

Generators installed for industrial loads only and **not** ship service loads are **partially exempt** from 46 CFR 111.12 (Generator Construction and Circuits) and 46 CFR 111.30 (Switchboards). Instead, 46 CFR 111.107 outlines the specific requirements for these

generators. Generator longtime overcurrent trip must still be set *not higher than 115%* of the continuous generator setting.

c. Transformers

(1) As per 46 CFR 111.20-15, transformers must have overcurrent protection that meets NEC Article 450 or IEC 60092-303. Transformers may have primary only, or both primary and secondary overcurrent protection. NEC Table 450.3(b) is provided below for reference.

Table 450.3(B) Maximum Rating or Setting of Overcurrent Protection for Transformers 600 Volts and Less (as a Percentage of Transformer-Rated Current)

	Primary Protection			Secondary Protection (See Note 2.)	
Protection Method	Currents of 9 Amperes or More	Currents Less Than 9 Amperes	Currents Less Than 2 Amperes	Currents of 9 Amperes or More	Currents Less Than 9 Amperes
Primary only protection	125% (See Note 1.)	167%	300%	Not required	Not required
Primary and secondary protection	250% (See Note 3.)	250% (See Note 3.)	250% (See Note 3.)	125% (See Note 1.)	167%

Notes:
1. Where 125 percent of this current does not correspond to a standard rating of a fuse or nonadjustable circuit breaker, a higher rating that does not exceed the next higher standard rating shall be permitted.
2. Where secondary overcurrent protection is required, the secondary overcurrent device shall be permitted to consist of not more than six circuit breakers or six sets of fuses grouped in one location. Where multiple overcurrent devices are utilized, the total of all the device ratings shall not exceed the allowed value of a single overcurrent device. If both breakers and fuses are utilized as the overcurrent device, the total of the device ratings shall not exceed that allowed for fuses.
3. A transformer equipped with coordinated thermal overload protection by the manufacturer and arranged to interrupt the primary current shall be permitted to have primary overcurrent protection rated or set at a current value that is not more than six times the rated current of the transformer for transformers having not more than 6 percent impedance and not more than four times the rated current of the transformer for transformers having more than 6 percent but not more than 10 percent impedance.

(2) As per 46 CFR 111.50-5(a)(4), overcurrent protection on the secondary side is not required if the fuse or breaker on the primary side adequately protects the secondary conductor, as determined by multiplying the secondary conductor capacity by the ratio of secondary-to-primary transformer voltages. For example, a 240/120V transformer with a 25A primary breaker and secondary side cable current capacity of 50A does not require secondary protection.

(3) Transformers used to supply the ship's service distribution system have two special requirements, as indicated in 46 CFR 111.10-9 (Ex: If transformers are used to supply a low-voltage (<600V) switchboard from a medium- or high-voltage (≥600V) switchboard)

(i) There must be two installed, independent power transformers.
(ii) With the largest transformer out of service, the capacity of the remaining units must be sufficient to supply the ship service loads.
Note: This regulation does not apply to smaller transformers within the ship's service distribution system, such as a transformer from the main service 480V switchboard to a 208V distribution panel for smaller ship's loads.

(4) Verify that overcurrent protection on transformers are not sized larger than the maximum current rating of the connected distribution panels downstream. (Ex: The primary overcurrent protection device of 100A on a 2:1 voltage transformer results in a doubling of current on the secondary side, 200A. Ensure that the distribution panels downstream are rated for at least 200A, per 46 CFR 111.40-13.)

d. Switchboards

(1) A detailed switchboard internal schematic is required to be provided for review. See PRG E2-21 for details. The circuit breaker trip setting and frame sizes shown on the switchboard plans should be compared with the one-line to confirm there are no conflicts between the plans.

(2) Each ship's service switchboard must have an appropriately-sized circuit breaker or fused switch for each shore power connection, as per 46 CFR 111.30-25(f) and 30.27-(f).

(3) If the cumulative generator capacity exceeds 3000kW, the switchboard must have at least two sections of the main bus connected by a non-automatic circuit breaker, disconnect switch, or removable links, as per 46 CFR 111.30-24(a).

(4) Voluntary compliance to reference (h) for high voltage shore connections, per MI Notice # 02-11, dated May 06, 2011 is authorized. Until this standard is incorporated by reference into 46 CFR Subchapter J, a comment may be noted on the response letter of the voluntary compliance to this standard.

(5) Refer to PRG E2-08 for emergency generator, emergency switchboard, and emergency systems requirements, as applicable. The design of the electrical distribution system changes significantly when emergency power sources are required and added.
Note: With limited exceptions, conductor ampacity, overcurrent protection, transformer protection are the same for ship service systems and should be verified.

e. Distribution Conductors

(1) All cables must meet one of the following construction standards for compliance with 46 CFR 111.60-1:

(i) IEEE 1580
(ii) UL 1309
(iii)IEC 60092-353, and flammability requirements of Category A of IEC 60332-3-22
(iv)NPFC MIL-C-24640A
(v) NPFC MIL-C-24643A
Note: Additional information on cable types and identifiers are shown in Enclosure 1

Additional requirements:
(i) Cables rated above 5,000 volts must meet IEEE 1580 and UL 1072.

Note: High Voltage (1kV – 15kV) cable ratings are affected by the method of grounding. Systems without automatic disconnection upon detection of a Ground fault (e.g., high resistance or impedance ground) need to be rated higher than systems that will automatically disconnect (e.g., low resistance or impedance ground). Per 46 CFR 110.30-1(b), the rated phase to ground voltage (U_o) of high voltage cables shall not be less than the values shown in the table provided in ABS MVRs(2019), 4-8-5/3.9.6.

(ii) Type T/N (Polyvinyl-chloride insulation with a nylon jacket) must meet either UL 1309, IEEE 1580, or IEEE 45-2002 Section 8.

(2) As per 46 CFR 111.50-3(b), each conductor must be protected in accordance with its current-carrying capacity by an overcurrent protection device (fuse or circuit breaker). The current carrying capacity can be verified by:

(i) Table 25 of reference (c). This table is provided for reference in Enclosure 2.
(ii) Manufacturer provided datasheets with the stated ampacity
Note: There are exceptions to this general rule. Certain conductors must be oversized or are allowed to be undersized in Table 111.60-7 (See paragraph 3 below). Minimum conductor sizes for lighting, instrumentation, and other circuits is described in 46 CFR 111.60-4 when conductor capacity does not correspond to a standard fuse or breaker rating, refer to 46 CFR 11.50-3 (c) for compliance.

(3) A summary table of conductor sizes is provided by 46 CFR Table 111.60-7. Note that this table combines and summarizes multiple regulations regarding the minimum conductor size of various circuit types.

TABLE 111.60–7—DEMAND LOADS

Type of circuit	Demand load
Generator cables	115 percent of continuous generator rating.
Switchboard bus-tie, except ship's service to emergency switchboard bus-tie.	75 percent of generating capacity of the larger switchboard.
Emergency switchboard bus-tie	115 percent of continuous rating of emergency generator.
Motor feeders	Article 430, NFPA NEC 2002 (incorporated by reference; see 46 CFR 110.10–1).
Galley equipment feeder	100 percent of either the first 50 KW or one-half the connected load, whichever is the larger, plus 65 percent of the remaining connected load, plus 50 percent of the rating of the spare switches or circuit breakers on the distribution panel.
Lighting feeder	100 percent of the connected load plus the average active circuit load for the spare switches or circuit breakers on the distribution panels.
Grounded neutral of a dual voltage feeder	100 percent of the capacity of the ungrounded conductors when grounded neutral is not protected by a circuit breaker overcurrent trip, or not less than 50 percent of the capacity of the ungrounded conductors when the grounded neutral is protected by a circuit breaker overcurrent trip or overcurrent alarm.

(4) 46 CFR 111.60-4 identifies minimum cable conductor sizes:

(i) 14 AWG for power and lighting cables.
(ii) 22 AWG for thermocouple, pyrometer, or instrumentation cables. Control signal cable is considered instrumentation cable.
(iii)18 AWG for all other cables.

f. Overcurrent Protection

(1) For over current protection of conductors refer to 46 CFR 111.50-3(c).

(2) As per 46 CFR 111.53-1, each fuse must:

(i) Meet Article 240 of NEC 2002 or IEC 60092-202.
(ii) Have an interrupting rating sufficient to interrupt the asymmetrical RMS short-circuit current at the point of application.
(iii) Be listed by an independent laboratory.
(iv) Renewable link cartridge-type fuses must not be used.

(3) As per 46 CFR 111.54-1, each circuit breaker must:

(i) Meet Article 240 of NEC 2002 or IEC 60092-202.
(ii) Have an interrupting rating sufficient to interrupt the asymmetrical RMS short-circuit current at the point of application.
(iii) Meet switching requirements of 46 CFR 111.55.
(iv) Not be dependent upon mechanical cooling to operate within its rating
(v) Not have a long-time-delay trip element set above the continuous current rating of the trip element or the circuit breaker frame.
(vi) Remotely controlled circuit breakers must have a local manual means of operation.

(4) Construction standards for circuit breakers are as follows:

(i) Alternating systems above 600 volts (greater than 1,000 volts for IEC standard circuit breakers) must meet either:
   a. IEEE C37.04, IEEE C37.10, and ANSI/IEEE C37.12 (all three); or
   b. IEC 62271-100
(ii) Alternating systems of 600 volts or below (1,000 volts or less for IEC standard circuit breakers) must meet either:
   a. IEEE C37.13
   b. ANSI/IEEE C37.27; or
   c. IEC 60947-2
   d. Molded-case circuit breakers must meet UL 489 and UL489A (Marine supplement)
(iii) Direct-current system of 3,000 volts or less must meet IEEE C37.14.

(5) As per 46 CFR 111.77-1, the overcurrent protection device for a branch circuit supplying only one appliance must not be more than 150% of the rating of the appliance or 15A, whichever is greater.

(6) As per 46 CFR 111.50-3(d), overcurrent protective devices must not be connected in parallel.

(7) As per 46 CFR 111.50-3(g), an overcurrent device in a permanently grounded conductor (e.g., neutral) must:
   (i) Simultaneously open all conductors of the circuit
   (ii) Never be installed in the bus-tie feeder connecting the emergency and main switchboards.

(8) As per 46 CFR 111.60-9(a), a branch circuit that supplies equipment vital to the propulsion, control, or safety of the vessel must not supply any other equipment.

g. Batteries

(1) For Li-ion battery installations, see PRG E2-29 for additional requirements to be verified on the One-Line Diagram (e.g., ESS emergency shutdowns, required redundant power sources, etc.).

(2) 46 CFR 111.15-25(a) requires an overload protective device in each battery conductor, except conductors of engine cranking batteries, and batteries of 6V or less.

(3) 46 CFR 111.15-5 and 111.15-10 provide requirements for battery installation and ventilation. Compliance with battery installation requirements will be verified locally by the OCMI. Requirements to be verified based on the battery category:

   (i) Large (chargers > 2kW): Batteries must be installed in a room designated only for batteries or in a box on deck. This room is considered hazardous and must have a power ventilation system. The battery power ventilation system must have an explosion-proof motor or locate the motor outside the hazardous space and be interlocked with the battery charger so that the charger cannot operate without ventilation.
   (ii) Moderate (.2 kW < chargers < 2 kW): Batteries must be in a room, locker, or box in a naturally ventilated compartment protected from falling objects.
   (iii) Small (chargers < .2 kW): Batteries must not be installed in closets or living spaces.

h. Motor Circuits

(1) Compliance to the motor circuit requirements can be shown either on the One-Line distribution drawing or in a separate motor controller drawing. See PRG E2-15 for guidelines on motor circuits, controllers, and protections review. A summary of motor overcurrent protection, LVR/LVP, and remote ventilation requirements are listed for reference below.
Note: Steering gear motors have specific requirements listed in PRG E2-20.

(2) Motor Cable Sizes: As per 46 CFR Table 111.60-7, motor feeder cables must have the following current-carrying capacities:

   (i) For a single motor, at least 125% of the motor's full-load-amps (FLA), as per reference (b), Article 430.22.

(ii) For multiple motors (not permitted for vital systems), at least 125% of the highest-rated motor's FLA plus the sum of the FLA ratings of all the other motors, as per reference (b), Article 430.24.

(3) Motor Overcurrent Protection: ABS SVR 2003 4-8-2/9.17.1, incorporated by 46 CFR 111.70-1(a), states that motor circuit overcurrent protection device trip settings must not exceed the values shown in the table below.

Type of motor	*Rating or setting, % motor full-load current*
Squirrel-cage and synchronous full-voltage, reactor- or resistor-starting	250
Autotransformer starting	200
Wound rotor	150

(4) Low Voltage Release (LVR): The motor is disconnected when voltage is abnormally low (i.e., motor contactor opens and stops motor when coil voltage drops below ~85%). The motor will automatically restart upon resumption of normal voltage. This may be done using a selector switch (vice Low Voltage Protection, push-button), latching relays, or the automation system providing LVR control. LVR is used where automatic restart of a motor is necessary for the safety when power is restored following a blackout. As per 46 CFR 111.70-3(b), the following motor controllers must have LVR:

(i) Fire Pump
(ii) Steering Gear
(iii) Elevator Motors
(iv) Any auxiliary vital to vessel's propulsion, unless it can be restarted from a central control station
Note: If a bilge pump is cross-connected to the fire main to fulfill the requirement for a second fire pump, it will need LVR even if it is listed on the plan as "Bilge Pump."

(5) Low Voltage Protection (LVP): When an abnormally low voltage is detected, the motor is disconnected from the power source. The motor *will not* automatically restart upon resumption of normal voltage and must be manually restarted. As per 46 CFR 111.70-3(c), all motor controller must have LVP unless the motor has LVR, or the motor is less than 2 horsepower.

(6) Remote Stopping Systems: The requirements of 46 CFR 111.103 are usually verified either on the One-Line or a separate shutdown system plan. Remote stops can be verified by the motor notation. The following motors/pumps require emergency stops:

(i) All power ventilation fans
(ii) All machinery space ventilation
(iii) Forced draft fans
(iv) Induced draft fans
(v) Blowers of inert gas systems
(vi) Fuel oil transfer pumps
(vii) Fuel oil units
(viii) Fuel oil service pumps
(ix) Any other fuel oil pumps

(7) These systems noted above must automatically stop upon damage to the switch or cable as per 46 CFR 111.103-7 and 111.103-9.

i. Lighting Circuits

(1) The regulations detail specific design, arrangement, distribution, and overcurrent protection requirements for lighting circuits. Lighting overcurrent requirements are usually verified on the one-line, however a lighting arrangements drawing and other details, will normally be separately provided from the one-line. See PRG E2-14 for a full lighting systems and components review.

(2) Navigation Light Feeder Requirement. On vessels required to have a final emergency power source by 46 CFR 112.05-5(a), each navigation light panel must be supplied by a feeder from the emergency switchboard (see 112.43-13) or a through feed, without switch or overcurrent protection from the navigating bridge emergency lighting panel. The feeder must be protected by overcurrent devices rated or set at a value of at least twice that of the navigation light panel main fuses. (46 CFR 111.75-17(a)).

j. Steering Gear Circuits

(1) Steering gear circuit details are usually provided in a separate submission. Steering gear electrical systems are distinguished by two separate parts (power motor circuits and control system circuits). Overcurrent protection for these circuits may be found and verified on the One-Line diagram. See PRG E2-20 for full detailed requirements.

(2) As per 46 CFR 58.25-55(a)-(c), steering gear feeder (power) circuit breakers must provide instantaneous trip protection set at;
(i) DC Motors - Between 300% and 375% of the rated full-load current
(ii) AC Motors - Between 175% and 200% of the locked-rotor current
(iii) Additional steering-gear feeder overcurrent protection is not allowed. Overload relays provided in steering gear motor starters must be wired to provide the steering motor overload alarm required by 46 CFR 58.25-25(e)(2) and NOT wired to provide overload protection for the motor (i.e., not wired to open the coil circuit for the motor contactor on overload).

(3) As per 46 CFR 58.25-55(d), steering control circuits (control) may have instantaneous trip protection set at 400% to 500% of either the current carrying conductor or the normal load of the system.

k. General Alarm and Public Address Systems

Requirements for the GA and PA systems are separately detailed in PRG E2-02. See this PRG for guidance. These systems will be noted on the one-line with a corresponding circuit, but are usually reviewed in a separate submission with additional system details provided. GA and PA systems are required as per 46 CFR 113.25-1(a) and 113.50-1 applicability;

(i) All manned vessels over 100 gross tons, except barges, scows, and similar vessels
(ii) Manned and coastwise barges over 100 gross tons if the crew is divided into watches for the purpose of steering
(iii) Barges of 300 gross tons or more with sleeping accommodations for more than 6 persons

l. Coordination Study

As required by 46 CFR 110.25-1(a)(7), an overcurrent protection device coordination analysis is required for each generator distribution system of 1500 kilowatts or above that includes selectivity and shows that each overcurrent device has an interrupting capacity sufficient to interrupt the maximum asymmetrical short-circuit current available at the point of application. See PRG E2-04 for guidance.

m. Short Circuit Analysis

As required by 46 CFR 110.25-1(a)(6) and 111.52-2, short circuit calculations must be submitted for systems with an aggregate generating capacity of 1500 kilowatts or more. See PRG E2-19 for Guidance.

7. Disclaimer

This guidance is not a substitute for applicable legal requirements, nor is it itself a rule. It is not intended to nor does it impose legally-binding requirements on any party. It represents the Coast Guard's current thinking on this topic and may assist industry, mariners, the general public, and the Coast Guard, as well as other federal and state regulators, in applying statutory and regulatory requirements. You can use an alternative approach for complying with these requirements if the approach satisfies the requirements of the applicable statutes and regulations. If you want to discuss an alternative, you may contact MSC, the unit responsible for implementing this guidance.

8. Enclosures

a. Enclosure 1 – Cable Type and Identifying Marks

The exact cable type, designation, and marks are critical for appropriate ampacity calculations and minimum construction standards required by 46 CFR 111.60. As noted in 46 CFR 111.60-1(e), IEEE Std 1580 Section 5.19 demonstrates appropriate minimum cable designation marks.

5.19 Cable designations

5.19.1 Cable types T, T/N, E, P, X, LSE, LSX, and S

The following cable designations should be used in connection with the cables described in 5.18.1 to 5.18.5 inclusive. The designations are made up of letters and numbers signifying, to the extent shown below, the service, number of conductors, types of insulation, jacket, armor, and conductor size comprised of the components listed in 5.19.1.1–5.19.1.7:

5.19.1.1 Cable type (service symbol)

"S"	Single conductor distribution
"D"	Two conductor distribution
"T"	Three conductor distribution
"F"	Four conductor distribution
"Q"	Five conductor distribution
"C"	Control cable (1)
"TP"	Twisted pair (1)
"TT"	Twisted triad (1)

(1) = Insert AWG size of conductors following service symbol for C, TP, and TT.

5.19.1.2 Shielding

No marking	Unshielded
"OS"	Overall shield
"IS"	Individual shield
"IS-OS"	Individual and overall shield
"OBS"	Overall braid shield

5.19.1.3 Insulation type (2)

"E"	Ethylene propylene rubber
"X"	Crosslinked polyethylene
"P"	Crosslinked polyolefin
"S"	Silicone rubber
"LSX"	Low smoke, halogen-free crosslinked polyolefin
"LSE"	Low smoke, halogen-free ethylene propylene rubber
"T"	Polyvinyl chloride
"T/N"	Polyvinyl chloride/nylon

(2) = For insulation types E, X, T, T/N, and S where the VW-1 is the option, the letter "V" is added after the insulation type to indicate compliance with this optional requirement.

5.19.1.4 Jacket type

"T"	Polyvinyl chloride
"CP"	Chlorosulfonated polyethylene
"N"	Polychloroprene (neoprene)
"L"	Low smoke, zero halogen crosslinked polyolefin
"TPO"	Low smoke, zero halogen thermoplastic polyolefin
"CPE"	Thermoset chlorinated polyethylene

5.19.1.5 Armor

No marking	Unarmored
"A"	Aluminum armor
"B"	Bronze armor
"T"	Tinned copper armor
"_S"	Armor and sheath (3)
"CWCMC"	Continuously corrugated metal armor

5.19.1.6 Size

The wire size is designated for distribution cable by adding a dash (-), followed by the conductor size in kcmil.

5.19.1.7 Voltage rating

The rated distribution cable voltage is added to the symbol following a dash (-), as follows:

2 000 V	2 kV
5 000 V	5 kV
8 000 V	8 kV
15 000 V	15 kV
25 000 V	25 kV
28 000 V	28 kV
35 000 V	35 kV

The complete type designation should include the following parts:

- Cable type (S, D, T, F, Q, C, TP, TT)
- Shielding designation, if applicable
- Insulation type
- Jacket type
- Armor, if applicable
- "S" if jacket over armor

For Types S, D, T, F, and Q, distribution cables.

Following a dash (-), the conductor size in kcmil.

- DTTB-4 = AWG 14 (4.11 kcmil), two-conductor, polyvinylchloride-insulated, thermoplastic polyvinyl chloride jacketed, and bronze armored
- SXNA-250 = 250 kcmil, single conductor, cross-linked polyethylene insulated, thermosetting neoprene jacketed, and aluminum armor
- TPNBS-313 = 3 conductor, 313 kcmil, polyolefin insulation with neoprene jacket, bronze armor, and overall sheath

Following a second dash (-), the voltage rating:

- TPNBS-313-5KV = 3 conductors, 313 kcmil, polyolefin insulation with neoprene jacket, bronze armor, and overall sheath, 5 kV.

For Types C, TP, and TT, the number of conductors, pairs or triads, as applicable; the number of conductors of control, and the number of conductor pairs/triads of signal cable, is added to the cable designation, as follows:

- C14TCPB-20 = 20 conductor control cable, 14 AWG, thermoplastic-insulated, thermosetting chlorosulfonated polyethylene jacketed, and bronze armor
- TP18TNA-10 = 10 twisted pair signal cable, 18 AWG, thermoplastic-insulated, thermosetting neoprene jacketed, and aluminum armor
- C14PCP-3 = 3 conductor, 14 AWG, polyolefin insulated, and chlorosulfonated polyethylene jacketed
- TP (OS) 18PNBS-2 = 2 twisted pairs, 18 AWG with polyolefin insulation, overall tape shield and drain wire, neoprene jacketed, with bronze armor and overall outer sheath

b. Enclosure 2 – Cable Ampacity

Ampacity can be found with the correct size (AWG or Circular Mils) and the number of conductors.

Table 25—Distribution, control, and signal cables—single-banked, maximum current-carrying capacity (types T, T/N, E, X, S, LSE, LSX, and P @ 45 °C ambient)

AWG/ kcmil	Cross sectional		Single conductor			Two conductor			Three conductor		
	mm^2	Circular Mils	T	LSE LSX T/N E, X	S, P	T	LSE LSX T/N E, X	S,P	T	LSE LSX T/N E, X	S, P
			75 °C	90 °C	100 °C	75 °C	90 °C	100 °C	75 °C	90 °C	100 °C
20	0.517	1020	9	11	12	8	9	10	6	8	9
18	0.821	1620	13	15	16	11	13	14	9	11	12
16	1.31	2580	18	21	23	15	18	19	13	15	16
-	1.5	2960	20	24	26	17	20	22	14	17	18
15	1.65	3157	21	26	28	18	22	23	15	18	19
14	2.08	4110	28	34	37	24	27	31	20	24	25
12	3.31	6530	35	43	45	31	36	40	24	29	31
10	5.26	10 400	45	54	58	38	46	49	32	38	41
8	8.37	16 500	56	68	72	49	60	64	41	48	52
7	10.5	20 800	65	77	84	59	72	78	48	59	63
6	13.3	26 300	73	88	96	66	79	85	54	65	70
5	16.8	33 100	84	100	109	78	92	101	64	75	82
4	21.2	41 700	97	118	128	84	101	110	70	83	92
3	26.7	52 600	112	134	146	102	121	132	83	99	108
2	33.6	66 400	129	156	169	115	137	149	93	111	122
1	42.4	83 700	150	180	194	134	161	174	110	131	143
1/0	53.5	10 600	174	207	227	153	183	199	126	150	164
2/0	67.4	133 000	202	240	262	187	233	242	145	173	188

Table 25—Distribution, control, and signal cables—single-banked, maximum current-carrying capacity (types T, T/N, E, X, S, LSE, LSX, and P @ 45 °C ambient) *(continued)*

AWG/ kcmil	Cross sectional		Single conductor			Two conductor			Three conductor		
	mm^2	Circular Mils	T	LSE LSX T/N E, X	S, P	T	LSE LSX T/N E, X	S,P	T	LSE LSX T/N E, X	S, P
			75 °C	90 °C	100 °C	75 °C	90 °C	100 °C	75 °C	90 °C	100 °C
3/0	85.0	168 000	231	278	300	205	245	265	168	201	218
4/0	107.2	212 000	271	324	351	237	284	307	194	232	252
250 kcmil	126.7	250 000	300	359	389	264	316	344	217	259	282
262 kcmil	133.1	262 600	314	378	407	278	333	358	228	273	294
300 kcmil	152	300 000	345	412	449	296	354	385	242	290	316
313 kcmil	158.7	313 100	351	423	455	303	363	391	249	298	321
350 kcmil	177.3	350 000	372	446	485	324	387	421	265	317	344
373 kcmil	189.4	373 700	393	474	516	339	406	442	277	332	361
400 kcmil	203	400 000	410	489	533	351	419	455	286	342	371
444 kcmil	225.2	444 400	453	546	588	391	468	504	319	382	411
500 kcmil	253.3	500 000	469	560	609	401	479	520	329	393	428
535 kcmil	271.3	535 000	485	579	630	415	496	538	340	407	443
600 kcmil	304	600 000	521	623	678	450	539	585	368	440	478
646 kcmil	327.6	646 000	557	671	731	485	581	632	396	474	516
750 kcmil	380	750 000	605	723	786	503	602	656	413	494	537
777 kcmil	394.2	777 000	627	755	822	525	629	684	431	516	562
1000 kcmil	506.7	100 0000	723	867	939	601	721	834	493	592	641
1111 kcmil	563.1	1 11 1000	767	942	1025	637	784	854	523	644	701
1250 kcmil	635	1 250 000	824	990	1072	—	—	—	—	—	—