## *E-11 AC and DC ELECTRICAL SYSTEMS ON BOATS* *Based on ABYC's assessment of the existing technology, and the problems associated with achieving the goals of this standard, ABYC recommends compliance with this standard for all systems and associated equipment manufactured and/or installed after July 31,* 2009**.**



### 11.4 *DEFINITIONS*

11.4.3 Battery cold cranking performance rating 0°F (-17.8°C) - The discharge load in amperes that a battery at 0°F (-17.8°C) can deliver for 30 seconds, and maintain a voltage of 1.2 volts per cell or higher, e.g., 7.2 volts for a 12 volt battery.

11.4.10 Equipment Leakage Circuit Interrupter (ELCI) - A residual current device which detects equipment ground fault leakage current and disconnects all ungrounded (110 V & 240V) and grounded (110 V neutral) current carrying conductors from the supply source at a preset trip threshold.

11.4.15 Ignition protection - The design and construction of a device such that under design operating conditions:

a. it will not ignite a flammable hydrocarbon mixture surrounding the device when an ignition source causes an internal explosion, or

b. it is incapable of releasing sufficient electrical or thermal energy to ignite a hydrocarbon mixture, or

c. the source of ignition is hermetically sealed.

***NOTES:***

***1. A flammable hydrocarbon mixture is a mixture of gasoline and air, CNG and air, or propane (LPG) and air between the lower explosive limit (LEL) and upper explosive limit (UEL).***

***2. It is not intended to require such devices to be "explosion proof" as that term is defined in the National Electrical Code of the NFPA pertaining to shore systems.***

***3. It is intended that the protection provided be generally equivalent to that of wiring permitted by this standard wherein a definite short or break would be necessary to produce an open spark.***

***4. Devices that are "explosion proof" are considered to be ignition protected when installed with the appropriate fittings to maintain their "explosion proof" integrity.***

***5. It is not intended to require such devices to be "intrinsically safe" per Article 504 of the National Electrical Code of the NFPA.***

***6. Devices that are "intrinsically safe" are considered to be ignition protected.***

***7. Test standards to determine ignition protection include SAE J1171, External Ignition Protection of Marine Electrical Devices, and UL 1500, Ignition Protection Test For Marine Products, and the electrical system requirements for boats in Title 33 CFR 183.410(a).***

11.4.20 Polarized system AC - A system in which the grounded and ungrounded conductors are connected in the same relation to terminals or leads on devices in the circuit.

11.4.21 Polarized system DC - A system in which the grounded (negative) and ungrounded (positive) conductors are connected in the same relation to terminals or leads on devices in the circuit.

11.4.32 Weatherproof - Constructed or protected so that exposure to the weather will not interfere with successful operation under the test conditions specified in NEMA Standard 250, Type 3 or IEC Standard 60529 Type IP 54.

11.5.2.1 Marking of Controls - All switches and electrical controls shall be marked to indicate their usage.

***EXCEPTION: A switch or electrical control whose purpose is obvious and whose mistaken operation will not cause a hazardous condition.***

11.5.2.2 Marking of Equipment - Electrical equipment, except a part of an identified assembly, such as an engine, shall be marked or identified by the manufacturer to indicate:

11.5.2.2.7 Phase and frequency, if applicable, and

11.5.2.2.8 "Ignition Protected," if applicable. This shall be identified by a marking such as "SAE J1171 Marine," "UL Marine-Ignition Protected," or "Ignition Protected."

11.5.3.1 Potential electrical sources of ignition located in spaces containing gasoline powered machinery, or gasoline fuel tank(s), or joint fitting(s), or other connection(s) between components of a gasoline system, shall be ignition protected, unless the component is isolated from a gasoline fuel source as described in E-11.5.3.3 (See FIGURE 1, FIGURE 2, FIGURE 3, FIGURE 4, FIGURE 5, FIGURE 6, FIGURE 7, and FIGURE 8)

***EXCEPTION:***

***1. Boats using diesel fuel as the only fuel source.***

***2. Outboard engines mounted externally or in compartments open to the atmosphere in accordance with the requirements of ABYC H-2, Ventilation of Boats Using Gasoline.***

11.5.5.1 The system shall be polarized as defined in E-11.4

11.5.5.2 Grounded Neutral - A grounded neutral system is required. The neutral for AC power sources shall be grounded only at the following points:

11.5.5.2.3 The generator neutral shall be grounded at the generator. (See DIAGRAM 2 or DIAGRAM 4.)

11.5.5.6.1 Transfer of Power - The transfer of power to a circuit from one source to another shall be made by a means that opens all current-carrying conductors, including neutrals, before closing the alternate source circuit, to maintain isolation of power sources.

11.5.5.7 Power Source Disconnecting Means - A means for disconnecting all power sources from the load shall be provided at the same location.

11.6.1.1.1 The battery, or battery bank, shall have at least the cold cranking amperage required by the engine manufacturer.

11.6.3.1.1 Power Inlet - The receptacle, or receptacles, installed to receive a connecting cable to carry AC shore power aboard shall be a male type connector.

11.6.3.1.1.1 Power inlets installed in locations subject to rain, spray, or splash shall be weatherproof whether or not in use.

11.6.3.1.1.2 Power inlets installed in areas subject to flooding or momentary submersion shall be watertight whether or not in use.

11.6.3.1.1.3 Metallic power inlets installed on metallic or carbon fiber reinforced boats using an isolation transformer or a galvanic isolator shall be insulated from metallic structure and components. On non-metallic boats using an isolation transformer or a galvanic isolator the power inlet shall be insulated from metallic components connected to the boat's ground.

11.6.3.1.2 Shore Power Cable – On each boat equipped with an AC shore power system, a shore power cable that contains the conductors for the power circuit and a grounding (green) conductor shall be provided.

11.6.3.1.2.1 Except where the shore power cable is permanently connected to the boat, the boat end of this cable shall be terminated with a locking and grounding female type connector to match the boat power inlet. (See FIGURE 13 and FIGURE 14)

11.6.3.1.2.2 The shore power cable shall be flexible cord with the minimum properties of Type SOW, STW, STOW, SEOW, or STOOW, and shall be suitable for outdoor use. The shore connection end of this cable shall be fitted with a locking and grounding type plug with the required number of poles and shall comply with Article 555 of the National Electrical Code. (See FIGURE 13 and Table VII-A)

***EXCEPTION: Pin and sleeve devices in accordance with FIGURE 14.***

11.6.3.2 Shore Power Inlet Warning

11.6.3.2.1 Labels and warnings shall comply with *A*BYC T-5, *Safety Signs and Labels*.

11.6.3.2.2 Labels shall include the following informational elements:

11.6.3.2.2.1 the signal word for the level of hazard intensity;

11.6.3.2.2.2 nature of the hazard;

11.6.3.2.2.3 consequences that can result if the instructions to avoid the hazard are not followed; and

11.6.3.2.2.4 instructions on how to avoid the hazard.

11.6.3.2.3 A permanently mounted waterproof warning label shall be located at each shore power inlet location on the boat.

***NOTE: An example of such a label follows:***

**WARNING**

Electrical shock and fire hazard.
Failure to follow these instructions
may result in injury or death.

(1) Turn off the boat's shore power connection switch before connecting or disconnecting the shore power cable.

(2) Connect shore power cable at the boat first.

(3) If polarity-warning indicator is activated, immediately disconnect cable.

(4) Disconnect shore power cable at shore outlet first.

(5) Close shore power inlet cover tightly.

DO NOT ALTER SHORE POWER CABLE CONNECTORS

***EXCEPTIONS:***

***1. Item 3 is not required if a polarity indicator is not installed. (See E-11.6.3.3)***

***2. Items 2 and 4 are not required for permanently connected shore power cables.***

11.6.3.3.1 Reverse polarity indicating devices providing a continuous visible or audible signal shall be installed in 120 V AC shore power systems and must respond to the reversal of the ungrounded (black) and the grounded (white) conductors (See E-11.17.1, DIAGRAM 3), if

11.7.1 Isolation Transformers – If used, an isolation transformer shall be of the encapsulated type and shall meet the requirements of UL 1561, *Dry Type General Purpose and Power Transformers* and the following additional requirements: (See E-11.17, DIAGRAM 6 and DIAGRAM 7.)

## 11.8 *LOAD CALCULATIONS*

### 11.8.1 FOR DC SYSTEMS

11.8.1.1 The following method shall be used for calculating the total electrical load requirements for determining the minimum size of each panelboard, switchboard, and their main conductors. Additionally this information may be used to size the alternator, or other charging means, and the battery. (See E-11.6.1.1 and ABYC E-10, *Storage Batteries*)

11.8.1.1.1 In column A of TABLE II, Electrical Load Requirement Worksheet, list the current rating (amps) of the loads that must be available for use on a continuous duty basis for normal operations;

11.8.1.1.2 In column B of TABLE II, list the current rating (amps) of the remaining loads that are intermittent, and total these loads. Take 10% of the total load in column B, or the current draw of the largest item, whichever is greater, and add this value to the total from column A to establish the total electrical load.

***NOTE: Calculations are based on the actual operating amperage for each load, and not on the rating of the circuit breaker or fuse protecting that branch circuit.***

**TABLE II - ELECTRICAL LOAD REQUIREMENT WORKSHEET**

| A | | B | |
|---|---|---|---|
| | AMPERES | | AMPERES |
| Navigation Lights | | Cigarette Lighter | |
| Bilge Blower(s) | | Cabin Lighting | |
| Bilge Pump(s) | | Horn | |
| Wiper(s) | | Additional Electronic Equipment | |
| Largest Radio (Transmit Mode) | | Trim Tabs | |
| Depth Sounder | | Power Trim | |
| Radar | | Toilets | |
| Searchlight | | Anchor Windlass | |
| Instrument(s) | | Winches | |
| Alarm System (standby mode) | | Fresh Water Pump(s) | |
| Refrigerator | | | |
| Engine Electronics | | | |
| | | | |
| Total Column A | | Total Column B | |
| | | 10% Column B | |
| | | Largest Item in Column B | |

Total Load Required
Total Column A _____
Total Column B _____ (The larger of 10% of Column B or the largest item)
Total Load _____

11.8.2 FOR AC SYSTEMS

11.8.2.1 Power Source Options – The method shown in E-11.8.2.2 shall be used for calculating the total electrical load requirements for determining the size of panelboards and their feeder conductors along with generator, inverter, and shore power capacities. The total power required shall be supplied by one of the following means:

11.8.2.1.1 Single Shore Power Cable - A shore power cable, power inlet, wiring, and components with a minimum capacity to supply the total load as calculated, complying with E-11.6.3.1.

11.8.2.1.2 Multiple Shore Power Cables - Multiple shore power cables, power inlets, wiring, and components shall have a minimum total capacity to supply the total load as calculated complying with E-

11.6.3.1. All sources need not be of equal capacity, but each power inlet shall be clearly marked to indicate voltage, ampacity, phase (if a three phase system is incorporated), and the load or selector switch that it serves.

11.8.2.1.3 On Board AC Generator(s) or Inverter(s) - On board AC generator(s) or inverter(s) to supply the total load as calculated. Total minimum installed Kva (kilovolt amperes) for a single phase system is as follows:

$$kVA = \frac{\text{Maximum Total Leg Amps. X System Voltage}}{1000}$$

11.8.2.1.4 Combination of Shore Power Cable(s), On-board Generator(s) and Inverter(s) -
A combination of power sources, used simultaneously if the boat circuitry is arranged such that the load connected to each source is isolated from the other in accordance with E-11.5.5.6. Shore power cable(s) plus on-board generator(s) and inverter(s) capacity shall be at least as large as the total electrical load requirements calculated as per E-11.8.2.2 for each load group. Generator(s) and inverters(s) installation and switching shall be as required in E-11.6.4.

11.8.2.2 Load Calculations

11.8.2.2.1 The following is the method for load calculation to determine the minimum size of panelboards and their main feeder conductors as well as the size of the power source(s) supplying these devices. (See E-11.8.2.1.)

11.8.2.2.1.1 Lighting Fixtures and Receptacles - Length times width of living space (excludes spaces exclusively for machinery and open deck areas) times 2 watts per square foot (20 watts per square meter).

Formula:

Length (feet) x width (feet) x 2 = _____ lighting watts, or

Length (meters) x width (meters) x 20 = _____ lighting watts.

11.8.2.2.1.2 Small Appliances - Galley and Dinette Areas - Number of circuits times 1,500 watts for each 20 ampere appliance circuits.

Formula:

Number of circuits x 1,500 = _____ small appliance watts.

11.8.2.2.1.3 Total Load

Formula:

Lighting watts plus small appliance watts = _____ total watts.

11.8.2.2.1.4 Load Factor

Formula:

First 2,000 total watts at 100% = _____.

Remaining total watts x 35% = _____.

Total watts divided by system voltage = _____amperes.

11.8.2.2.2 If a shore power system is to operate on 240 volts, split and balance loads into Leg A and Leg B. If a shore power system is to operate on 120 volts, use Leg A only.

11.8.2.2.3 Add nameplate amperes for motor and heater loads:

| LEG A | LEG B | |
|---|---|---|
| | | Total Amperes |
| | | Exhaust and supply fans |
| | | Air conditioners*,** |
| | | Electric, gas or oil heaters* |
| | | 25% of largest motor in above items |
| | | Sub-total |

***NOTES:***
**** Omit smaller of these two, except include any motor common to both functions***
***** If system consists of three or more independent units adjust the total by multiplying by the 75% diversity factor***

11.8.2.2.4 Add nameplate amperes at indicated use factor percentage for fixed loads:

| LEG A | LEG B | |
|---|---|---|
| | | Disposal -10% |
| | | Water Heater - 100% |
| | | Wall Mounted Ovens – 75% |
| | | Cooking Units - 75% |
| | | Refrigerator -100% |
| | | Freezer – 100% |
| | | Ice Maker - 50% |
| | | Dishwasher - 25% |
| | | Washing Machine – 25% |
| | | Dryer - 25% |
| | | Trash Compactor – 10% |
| | | Air Compressor - 10% |
| | | Battery Chargers – 100% |
| | | Vacuum System - 10% |
| | | Other Fixed Appliances |
| | | Sub-Total |
| | | **Adjusted Sub-Total |

***NOTE: **If four or more appliances are installed on a leg, adjust the sub-total of that leg by multiplying by 60% diversity factor.***

11.8.2.2.5 Determine Total Loads

| LEG A | LEG B | |
|---|---|---|
| | | Lighting, receptacles, and small appliances (from E-11.8.2.2.1.1, E-11.8.2.2.1.2) |
| | | Motors and heater loads (from E-11.8.2.2.3) |
| | | Fixed appliances (from E-11.8.2.2.4) |
| | | Free standing range (See NOTE 1) |
| | | Calculated total amperes (load) |

***NOTES:***

***1. Add amperes for free standing range as distinguished from separate oven and cooking units. Derive by dividing watts from TABLE III by the supply voltage, e.g., 120 volts or 240 volts.***

***2. If the total for Legs A and B are unequal, use the larger value to determine the total power required***

11.10 ***OVERCURRENT PROTECTION***

11.10.1 LOCATION OF OVERCURRENT PROTECTION – DC CIRCUITS

11.10.1.1.1 Overcurrent Protection Device Location - Ungrounded conductors shall be provided with overcurrent protection within a distance of seven inches (175mm) of the point at which the conductor is connected to the source of power measured along the conductor. (See FIGURE 15.)

***EXCEPTIONS:***

***1. Cranking motor conductors.***

***2. If the conductor is connected directly to the battery terminal and is contained throughout its entire distance in a sheath or enclosure such as a conduit, junction box, control box or enclosed panel, the overcurrent protection shall be placed as close as practicable to the battery, but not to exceed 72 inches (1.83m).***

***3. If the conductor is connected to a source of power other than a battery terminal and is contained throughout its entire distance in a sheath or enclosure such as a conduit, junction box, control box or enclosed panel, the overcurrent protection shall be placed as close as practicable to the point of connection to the source of power, but not to exceed 40 inches (1.02m).***

***4. Overcurrent protection is not required in conductors from self-limiting alternators with integral regulators if the conductor is less than 40 inches (1.02m), is connected to a source of power other than the battery, and is contained throughout its entire distance in a sheath or enclosure.***

***5. Pigtails less than 7 inches (175mm) in length are exempt from overcurrent protection requirements.***

11.10.1.5 Circuit Breakers

11.10.1.5.1 Circuit breakers installed in spaces requiring ignition protection shall comply with SAE J1171, *External Ignition Protection of Marine Devices*, or UL 1500, *Ignition Protection Test for Marine Products*. If internal explosion tests are required, the ignition of the test gas shall be created at four times the current rating of the device being tested.

11.10.1.5.2 Circuit breakers shall

11.10.1.5.3 have a DC voltage rating of not less than the nominal system voltage, and

11.10.1.5.4 be of the trip-free type, and

11.10.1.5.5 be capable of an interrupting capacity according to TABLE IV-A, and remain operable after the fault, and

***EXCEPTION: Integral overcurrent protection in electrical devices.***

***NOTES:***

***1. A fuse in series with, and ahead of the circuit breaker, may be used to comply with TABLE IV-A.***

***2. Consult the circuit breaker manufacturer to determine the fuse size and the type of fuse.***

11.10.1.5.6 be of the manual reset type except as provided in E-11.10.1.7.

## 11.10.2 FOR AC SYSTEMS

1.10.2.1 Circuit breakers shall meet the requirements of UL 489, *Molded Case Circuit Protectors For Circuit Breaker Enclosures*, or UL 1077, *Supplementary Protectors For Use In Electrical Equipment*, and

11.10.2.1.1 shall be of the manually reset trip-free type, and-

11.10.2.1.2 shall be capable of an interrupting capacity in accordance with TABLE IV -B.

***EXCEPTION: Integral overcurrent protection in electrical devices.***

11.10.2.2 Rating of Overcurrent Protection Devices - Overcurrent protection devices shall have a temperature rating and demand load characteristics consistent with the protected circuit and their location in the boat, i.e. machinery space or other space. (See E-11.5.1.)

11.10.2.3 The current rating of the overcurrent protection device shall not exceed the maximum current carrying capacity of the conductor being protected. (See TABLE VI A-E )

***EXCEPTION: If there is not a standard current rating of the overcurrent protection device equal to 100 percent of the allowable current for the conductor in TABLE IV-B, the next larger standard current rating may be used, provided it does not exceed 150 percent of the current allowed by TABLE VI or TABLE XII.***

11.10.2.4 The AC voltage rating of the overcurrent protection device shall not be less than the nominal voltage of the supply circuit.

11.10.2.7.1 Generator circuit breaker ampere interrupting capacity (rms) shall be selected considering available transient short circuit current (first half cycle).

11.10.2.8.1 Each ungrounded current carrying conductor shall be protected by a circuit breaker or fuse.

11.10.2.8.3 Additional Overcurrent Protection - If the location of the main shore power disconnect circuit breaker is in excess of 10 feet (three meters) from the shore power inlet or the electrical attachment point of a permanently installed shore power cord, additional fuses or circuit breakers shall be provided within 10 feet (three meters) of the inlet or attachment point to the electrical system of the boat. Measurement is made along the conductors.

11.10.2.8.3.1 If fuses are used in addition to the main shore power disconnect circuit breaker, their rating

shall be such that the circuit breakers trip before the fuses open the circuit, in the event of overload. The ampere rating of the additional fuses or circuit breaker shall not be greater than 125% of the rating of the main shore power disconnect circuit breaker. For 120-volt service, both the grounded and ungrounded current carrying conductors shall be provided with this additional overcurrent protection.

11.10.2.8.4 If required, overcurrent protection for power-feeder conductors from AC generators and inverters, shall be within seven inches (180 mm) of the output connections or may be within 40 inches (1.0 meter) of the output connections if the unprotected insulated conductors are contained throughout their entire distance in a sheath or enclosure such as a conduit, junction box or enclosed panel.

11.11.1.1 This device shall meet the requirements of UL 1053 and the requirements of UL 943 with the exception of trip level and trip time. Trip level shall be set at a maximum of 30mA. The trip time shall be set at a maximum of 100ms.

***NOTE: Trip levels of less than 30ma and times of less than 100ms may result in nuisance trips in certain environments.***

11.14.1.1 Minimum surface marking of the individual conductors and their jackets shall include:

11.14.1.1.1 type/style,

11.14.1.1.2 voltage,

11.14.1.1.3 wire size, and

11.14.1.1.4 temperature rating, dry.

***EXCEPTION: Flexible cords in Table VII-A and B***

11.14.1.2 Conductors shall be at least 16 AWG.

11.14.1.3 In engine spaces the conductor insulation shall be oil resistant and have a temperature rating of at least 167$^{0}$F (75°C) dry.

11.14.2.1 Conductors and flexible cords shall have a minimum rating of 50 volts.

11.14.2.1.1 The construction of insulated cables and conductors shall conform with the requirements of:

11.14.2.1.1.1 UL 1426, *Cables for Boats*, or

11.14.2.1.1.2 the insulating material temperature rating requirements of:

11.14.2.1.1.3 SAE J378, *Marine Engine Wiring*, and

11.14.2.1.1.4 SAE J1127, *Battery Cable*, or SAE J1128, *Low-Tension Primary Cable*.

11.14.2.2 Conductors may be selected from the types listed in TABLE V, Table VII and TABLE VIII. The temperature ratings shown contemplate the routing of wires above bilge water in locations protected from dripping, exposures to weather, spray, and oil.

11.14.2.3 Flexible cords shall conform with the National Electrical Code, and shall be selected from the types listed in TABLE VII.

11.14.2.4 Conductors and flexible cords shall be stranded copper according to TABLE XI.

11.14.2.5 Conductors used for panelboard or switchboard main feeders shall have ampacities as determined in E-11.8.1.1. Conductors used for branch circuits or in electrical systems that do not use a panelboard or switchboard shall have their ampacities determined by their loads (See TABLE II)

11.14.2.6 Voltage Drop - Conductors used for panelboard or switchboard main feeders, bilge blowers, electronic equipment, navigation lights, and other circuits where voltage drop must be kept to a minimum, shall be sized for a voltage drop not to exceed three percent. Conductors used for lighting, other than navigation lights, and other circuits where voltage drop is not critical, shall be sized for a voltage drop not to exceed 10 percent.

11.14.2.7 Conductor Size - To determine conductor size and insulation temperature rating, use the ampacity as specified in E11.14.2.5 in conjunction with TABLE VI. Then use TABLE IX or TABLE X to check the conductor size for compliance with the maximum allowable voltage drop specified in E-11.14.2.6. In the event of a conflict between the ampacity table and the voltage drop tables, the larger conductor size shall be used.

11.14.2.7.1 To use TABLE IX and TABLE X , measure the length of the conductor from the positive power source connection to the electrical device and back to the negative power source connection. Use the conductor length, the system voltage, and the ampacity as specified in E-11.14.2.5, in conjunction with the appropriate volt drop table, i.e., three percent or 10 percent – TABLE IX or TABLE X, to determine conductor size.

***NOTES:***

***1. The power source connection may be the battery, or a panelboard or switchboard, if used.***

***2. If the ampacity as specified in E-11.14.2.5 exceeds the ampacities in TABLE IX and TABLE X, the conductor size necessary to keep voltage drop below the maximum permitted level may be calculated by means of the following formula:***

$$CM = \frac{K \times I \times L}{E}$$

***Where:***

***CM = Circular mil area of conductor.***
***K = 10.75 (constant representing the resistivity of copper)***
***I = Load current in amperes***
***L = Length of conductor from the positive power source connection to the electrical device and back to the negative power source connection, measured in feet.***
***E = Maximum allowable voltage drop at load in volts (e.g., for a three percent voltage drop at nominal 12V, E= 0.03 x 12 = 0.36; for a 10 percent voltage drop at nominal 12V, E = 1.2).***

***3. Use TABLE XI or TABLE XII to convert circular mils (cm) to conductor gauge. If the cm area falls between two gauge sizes, the larger conductor shall be used.***

11.14.3.1 Conductors shall have a minimum rating of 600 volts.

11.14.3.2 Flexible cords shall have a minimum rating of 300 volts.

11.14.3.3 The temperature rating of conductors and flexible cords shall be at least 140$^{o}$F (60$^{o}$C) dry.

11.14.3.4 All conductors and flexible cords shall meet the flame retardant and moisture resistant requirements of UL 83, *Thermoplastic-Insulated Wires and Cables*.

11.14.3.5 All conductors and flexible cords shall meet the requirements of the applicable standards of Underwriters Laboratories Inc.

11.14.3.6 Conductors and flexible cords shall be stranded copper according to TABLE XI.

***NOTE: Some currently available wire types that meet all of the above requirements are listed in Table VIII.***

11.14.3.7 Conductors and flexible cords shall be of size according to TABLE VI and TABLE XII

11.14.3.7.1 Where single conductors or multi-conductor cables are bundled for a distance greater than 24 inches (610 mm), the allowable ampacity of each conductor shall be reduced as shown in TABLE VI and TABLE XII.

***NOTE: When determining the allowable amperage of bundled conductors using TABLE VI and TABLE XIII, the AC grounding conductor and a neutral conductor that carries only the unbalanced current from other conductors are not considered to be current carrying conductors.***

11.14.3.7.2 The AC grounding conductor shall be permitted to be one size smaller than the current carrying conductors on circuits rated greater than 30 amperes.

11.17.4 Isolation Transformer System with a Single Phase 120-Volt Input, 120-Volt Output with Boat Grounded Secondary. Transformer Shield Grounded On the Shore. Transformer Metal Case Grounded on the Boat. (See DIAGRAM 6.)

11.17.4.1 The shore grounded (white) and ungrounded shore current carrying conductors are connected from the shore power inlet to the primary winding of the isolation transformer through an overcurrent protection device that simultaneously opens both current carrying shore conductors. Fuses shall not be used instead of the simultaneous trip devices. (See E-11.10.2.8.2.)

11.17.4.1.1 The shore grounding (green) conductor is connected, without interposing switches or overcurrent protection devices (See E-11.5.5.5), from the shore power inlet to the isolation transformer shield.

11.17.4.2 The shell of a metallic shore power inlet shall be electrically insulated from the boat.

11.17.4.3 The secondary of the isolation transformer is grounded (polarized) on the boat. (See E-11.5.5.2.2 and (E-11.5.5.2.3 **EXCEPTION.)**

11.17.4.4 The boat grounding (green) conductor is connected, without interposing switches or overcurrent protection devices (See E-11.5.5.5), from

11.17.4.4.1 the transformer grounded secondary terminal,

11.17.4.4.2 the transformer metal case, and

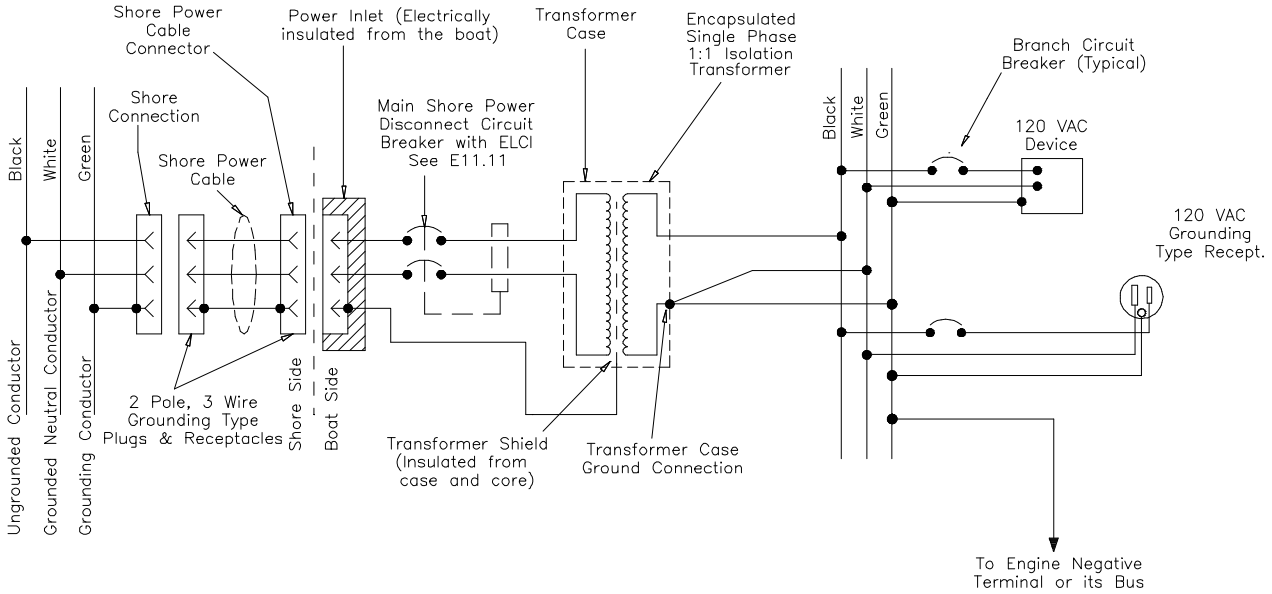
11.17.4.4.3 to all non-current-carrying parts of the boat's AC electrical system, including

11.17.4.4.4 the engine negative terminal or its bus.

11.17.4.5 If the boat's AC electrical system includes branch circuit breakers, the branch circuit breakers shall simultaneously open both current carrying conductors unless a polarity indicating device is provided. (See E-11.10.2.6.1 ***EXCEPTION***.)

11.17.4.6 Polarization of conductors must be observed in all circuits.

**DIAGRAM 6 – (See E-11.17.4.)**
*Isolation Transformer System with a Single Phase 120-Volt Input, 120-Volt Output with Boat Grounded Secondary. Transformer Shield Grounded On the Shore. Transformer Metal Case Grounded on the Boat.*
***Note: This diagram does not illustrate a complete system. Refer to appropriate text.***




11.17.5 Isolation Transformer System with Single Phase 240 Volt Input, 120/240-Volt Output with Boat Grounded Secondary. Transformer Shield Grounded on the Shore. Transformer Metal Case Grounded on the Boat. (See DIAGRAM 7.)

11.17.5.1 Each ungrounded shore current carrying conductor is connected from the shore power inlet to the primary winding of the isolation transformer through an overcurrent protection device that simultaneously opens both current carrying shore conductors. Fuses shall not be used instead of simultaneous trip devices. (See E-11.10.2.8.2.)

11.17.5.2 The shore grounded (white) terminal of the shore power inlet is not connected on the boat.

11.17.5.3 The shore grounding (green) conductor is connected, without interposing switches or overcurrent protection devices (See E-5.5.5), from the shore power inlet to the transformer shield.

11.17.5.4 The shell of a metallic shore power inlet shall be electrically insulated from the boat.

11.17.5.5 The secondary of the isolation transformer is grounded (polarized) on the boat. (See E-11.5.5.2.2 and E-11.5.5.2.3 **EXCEPTION.)**

11.17.5.6 The boat grounding (green) conductor is connected, without interposing switches or overcurrent protection devices (See E-11.5.5.5), from

11.17.5.6.1 the transformer grounded secondary terminal,

11.17.5.6.2 the transformer metal case, and

11.17.5.6.3 to all non-current carrying parts of the boat's AC electrical system, including

11.17.5.6.4 the engine negative terminal or its bus.

11.17.5.7 If the boat's AC electrical system includes branch circuit breakers, the branch circuit breakers shall simultaneously open both current carrying conductors unless a polarity indicating device is provided. (See E-11.10.2.6.1 ***EXCEPTION.)***

11.17.5.8 240-volt branch circuit breakers shall simultaneously open all current-carrying conductors. (See E-11.10.2.6.2)

11.17.5.9 Polarization of conductors must be observed in all circuits.

**DIAGRAM 7 – (See E-11.17.5.)**
*Isolation Transformer System with Single Phase 240 Volt Input, 120/240-Volt Output with Boat Grounded Secondary. Transformer Shield Grounded on the Shore. Transformer Metal Case Grounded on the Boat.*
***Note: This diagram does not illustrate a complete system. Refer to appropriate text.***

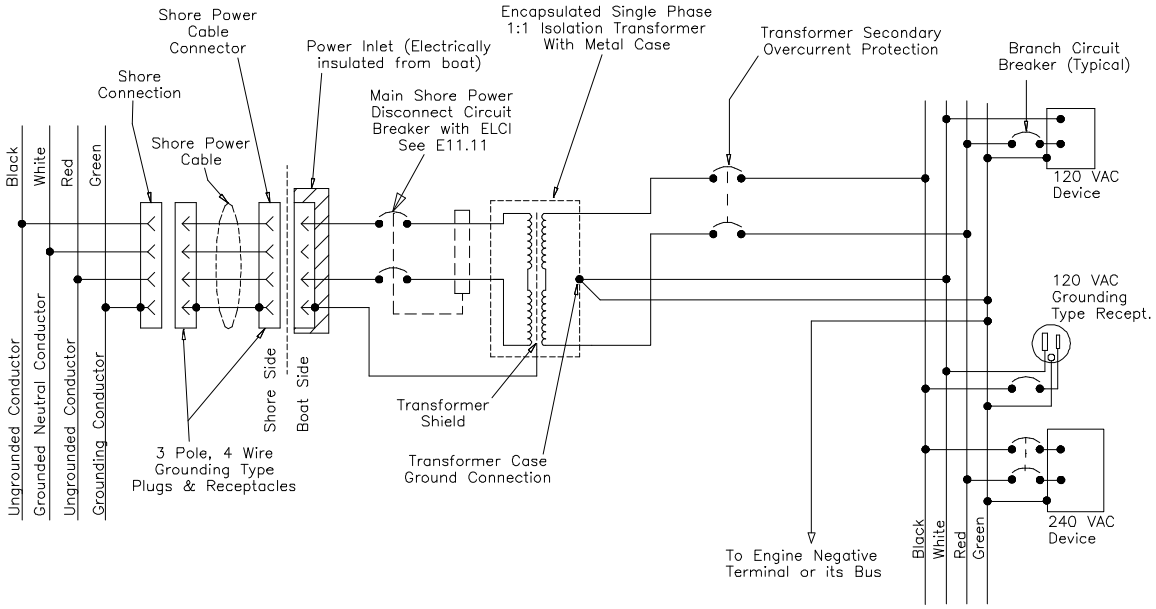


**FIGURE 15 – BATTERY SUPPLY CIRCUITS – LOCATION OF OVERCURRENT DEVICES**

***NOTE: Up to 40 inches (1.02m) is allowed if the conductor throughout this distance is contained in a sheath or enclosure, such as a junction box, control box, or enclosed panel.***

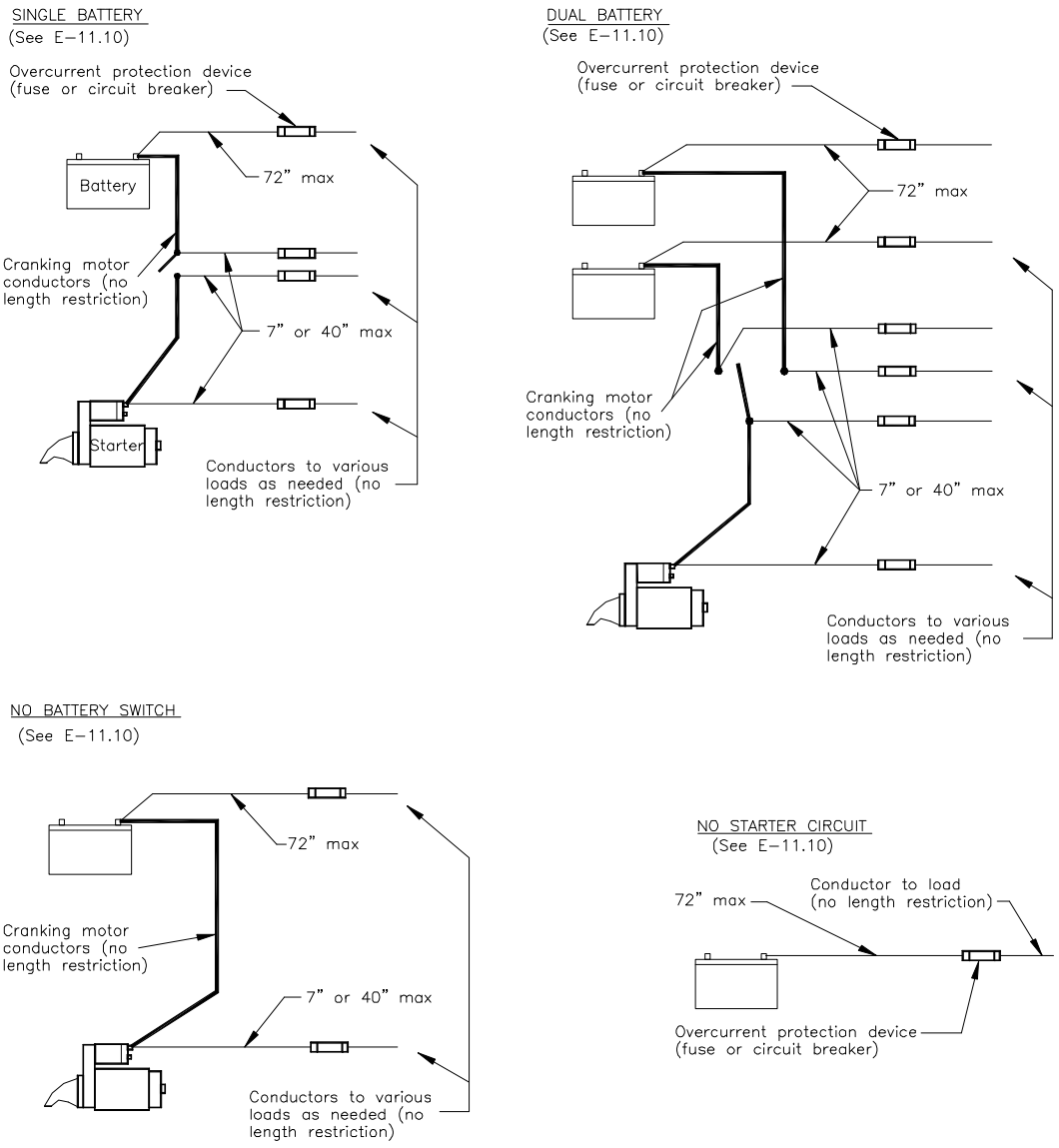


**TABLE III – FREE STANDING RANGE RATINGS**

| NAMEPLATE RATING (WATTS) | USE (WATTS) |
|---|---|
| | |
| 10,000 or less | 80% of rating |
| 10,001 – 12,500 | 8,000 |
| 12,501 – 13,500 | 8,400 |
| 13,501 – 14,500 | 8,800 |
| 14,501 – 15,500 | 9,200 |
| 15,501 – 16,500 | 9,600 |
| 16,501 – 17,500 | 10,000 |

***NOTE: Ratings are for free standing ranges as distinguished from separate oven and cooking units.***

**TABLE IV - A – CIRCUIT BREAKER MINIMUM AMPERE INTERRUPTING CAPACITY FOR SYSTEMS UNDER 50 VOLTS**

| | | Ampere Interrupting Capacity (AIC) (amperage available at circuit breaker terminals) | |
|---|---|---|---|
| | Total Connected Battery (Cold Cranking Amperes) | Main Circuit Breaker (Amperes) *See Note | Branch Circuit Breaker (Amperes) *See Note |
| 12 Volts and 24 Volts | 650 or less | 1500 | 750 |
| | 651-1100 | 3000 | 1500 |
| | over 1100 | 5000 | 2500 |
| 32 Volts | 1250 or less | 3000 | 1500 |
| | over 1250 | 5000 | 2500 |

****NOTE: The main circuit breaker(s) shall be considered to be the first breaker(s) in a circuit connected in series with the battery. All subsequent breakers, including sub-main breakers, connected in series with a main circuit breaker shall be considered to be "branch circuit breakers." (See FIGURE 16.)***

**TABLE IV - B – CIRCUIT BREAKER INTERRUPTING CAPACITY FOR SYSTEM OVER 50 VOLT**

| SHORE POWER SOURCE | MAIN SHORE POWER DISCONNECT CIRCUIT BREAKER | BRANCH BREAKER |
|---|---|---|
| 120V – 30A | 3000 | 3000 |
| 120V – 50A | 3000 | 3000 |
| 120/240V – 50A | 5000 | 3000 |
| 240V – 50A | 5000 | 3000 |
| 120/208V – 3 phase/WYE – 30A | 5000 | 3000 |
| 120/240V – 100A | 5000 | 3000 |
| 120/208V – 3 phase/WYE – 100A | 5000 | 3000 |

***NOTES:***

***1. The main circuit breaker shall be considered to be the first circuit breaker connected to a source of AC power. All subsequent breakers, including sub-main breakers connected in series with a main circuit breaker, shall be considered to be branch circuit breakers.***

***2. A fuse in series with, and ahead of, a circuit breaker may be required by the circuit breaker manufacturer to achieve the interrupting capacity in*** TABLE IV - A ***and*** TABLE IV – B.

**TABLE V – SAE CONDUCTORS**

| SAE CONDUCTORS | | |
|---|---|---|
| TYPE | DESCRIPTION | AVAILABLE INSULATION TEMPERATURE RATING PER SAE J378 |
| | | |
| GPT | Thermoplastic Insulation, Braidless | 60° C (140° F), 90° C (194° F), 105° C (221° F) |
| HDT | Thermoplastic Insulation, Braidless | 60° C (140° F), 90° C (194° F), 105° C (221° F) |
| SGT | Thermoplastic Insulation, Braidless | 60° C (140° F), 90° C (194° F), 105° C (221° F) |
| STS | Thermosetting Synthetic Rubber Insulation, Braidless | 85° C (185° F), 90° C (194 ° F) |
| HTS | Thermosetting Synthetic Rubber Insulation, Braidless | 85° C (185° F), 90° C (194° F) |
| SXL | Thermosetting Cross Linked Polyethylene Insulation, Braidless | 125° C (257° F) |

**TABLE VI – A - AC & DC CIRCUITS– ALLOWABLE AMPERAGE OF SINGLE CONDUCTORS NOT BUNDLED, SHEATHED, OR IN CONDUIT**

| CONDUCTOR SIZE (AWG) | TEMPERATURE RATING OF CONDUCTOR INSULATION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60°C (140°F) | | 75°C (167°F) | | 80°C (176°F) | | 90°C (194°F) | | 105°C (221°F) | | 125°C (257°F) | | 200°C (392°F) |
| | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE OR INSIDE ENGINE SPACES |
| 18 | 10 | NOT PERMITTED | 10 | 7.5 | 15 | 11.7 | 20 | 16.4 | 20 | 17.0 | 25 | 22.3 | 25 |
| 16 | 15 | | 15 | 11.3 | 20 | 15.6 | 25 | 20.5 | 25 | 21.3 | 30 | 26.7 | 35 |
| 14 | 20 | | 20 | 15.0 | 25 | 19.5 | 30 | 24.6 | 35 | 29.8 | 40 | 35.6 | 45 |
| 12 | 25 | | 25 | 18.8 | 35 | 27.3 | 40 | 32.8 | 45 | 38.3 | 50 | 44.5 | 55 |
| 10 | 40 | | 40 | 30.0 | 50 | 39.0 | 55 | 45.1 | 60 | 51.0 | 70 | 62.3 | 70 |
| 8 | 55 | | 65 | 48.8 | 70 | 54.6 | 70 | 57.4 | 80 | 68.0 | 90 | 80.1 | 100 |
| 6 | 80 | | 95 | 71.3 | 100 | 78.0 | 100 | 82.0 | 120 | 102.0 | 125 | 111.3 | 135 |
| 4 | 105 | | 125 | 93.8 | 130 | 101.4 | 135 | 110.7 | 160 | 136.0 | 170 | 151.3 | 180 |
| 3 | 120 | | 145 | 108.8 | 150 | 117.0 | 155 | 127.1 | 180 | 153.0 | 195 | 173.6 | 210 |
| 2 | 140 | | 170 | 127.5 | 175 | 136.5 | 180 | 147.6 | 210 | 178.5 | 225 | 200.3 | 240 |
| 1 | 165 | | 195 | 146.3 | 210 | 163.8 | 210 | 172.2 | 245 | 208.3 | 265 | 235.9 | 280 |
| 0 | 195 | | 230 | 172.5 | 245 | 191.1 | 245 | 200.9 | 285 | 242.3 | 305 | 271.5 | 325 |
| 00 | 225 | | 265 | 198.8 | 285 | 222.3 | 285 | 233.7 | 330 | 280.5 | 355 | 316.0 | 370 |
| 000 | 260 | | 310 | 232.5 | 330 | 257.4 | 330 | 270.6 | 385 | 327.3 | 410 | 364.9 | 430 |
| 0000 | 300 | | 360 | 270.0 | 385 | 300.3 | 385 | 315.7 | 445 | 378.3 | 475 | 422.8 | 510 |

***NOTE: For DC, cross reference with voltage drop tables and formula in E-Error! Reference source not found., Note 2.***

**TABLE VI – B - AC & DC CIRCUITS – ALLOWABLE AMPERAGE OF CONDUCTORS WHEN UP TO THREE CURRENT CARRYING CONDUCTORS ARE BUNDLED, SHEATHED OR IN CONDUIT**

| SIZE CONDUCTOR (AWG) | TEMPERATURE RATING OF CONDUCTOR INSULATION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60°C (140°F) | | 75°C (167°F) | | 80°C (176°F) | | 90°C (194°F) | | 105°C (221°F) | | 125°C (257°F) | | 200°C (392°F) |
| | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE OR INSIDE ENGINE SPACES |
| 18 | 7.0 | NOT PERMITTED | 7.0 | 5.3 | 10.5 | 8.2 | 14.0 | 11.5 | 14.0 | 11.9 | 17.5 | 15.6 | 17.5 |
| 16 | 10.5 | | 10.5 | 7.9 | 14.0 | 10.9 | 17.5 | 14.4 | 17.5 | 14.9 | 21.0 | 18.7 | 24.5 |
| 14 | 14.0 | | 14.0 | 10.5 | 17.5 | 13.7 | 21.0 | 17.2 | 24.5 | 20.8 | 28.0 | 24.9 | 31.5 |
| 12 | 17.5 | | 17.5 | 13.1 | 24.5 | 19.1 | 28.0 | 23.0 | 31.5 | 26.8 | 35.0 | 31.2 | 38.5 |
| 10 | 28.0 | | 28.0 | 21.0 | 35.0 | 27.3 | 38.5 | 31.6 | 42.0 | 35.7 | 49.0 | 43.6 | 49.0 |
| 8 | 38.5 | | 45.5 | 34.1 | 49.0 | 38.2 | 49.0 | 40.2 | 56.0 | 47.6 | 63.0 | 56.1 | 70.0 |
| 6 | 56.0 | | 66.5 | 49.9 | 70.0 | 54.6 | 70.0 | 57.4 | 84.0 | 71.4 | 87.5 | 77.9 | 94.5 |
| 4 | 73.5 | | 87.5 | 65.6 | 91.0 | 71.0 | 94.5 | 77.5 | 112.0 | 95.2 | 119.0 | 105.9 | 126.0 |
| 3 | 84.0 | | 101.5 | 76.1 | 105.0 | 81.9 | 108.5 | 89.0 | 126.0 | 107.1 | 136.5 | 121.5 | 147.0 |
| 2 | 98.0 | | 119.0 | 89.3 | 122.5 | 95.6 | 126.0 | 103.3 | 147.0 | 125.0 | 157.5 | 140.2 | 168.0 |
| 1 | 115.5 | | 136.5 | 102.4 | 147.0 | 114.7 | 147.0 | 120.5 | 171.5 | 145.8 | 185.5 | 165.1 | 196.0 |
| 0 | 136.5 | | 161.0 | 120.8 | 171.5 | 133.8 | 171.5 | 140.6 | 199.5 | 169.6 | 213.5 | 190.0 | 227.5 |
| 00 | 157.5 | | 185.5 | 139.1 | 199.5 | 155.6 | 199.5 | 163.6 | 231.0 | 196.4 | 248.5 | 221.2 | 259.0 |
| 000 | 182.0 | | 217.0 | 162.8 | 231.0 | 180.2 | 231.0 | 189.4 | 269.5 | 229.1 | 287.0 | 255.4 | 301.0 |
| 0000 | 210.0 | | 252.0 | 189.0 | 269.5 | 210.2 | 269.5 | 221.0 | 311.5 | 264.8 | 332.5 | 295.9 | 357.0 |

**TABLE VI – C - AC CIRCUITS – ALLOWABLE AMPERAGE OF CONDUCTORS WHEN FOUR TO SIX CURRENT CARRYING CONDUCTORS ARE BUNDLED**

| CONDUCTOR SIZE (AWG) | TEMPERATURE RATING OF CONDUCTOR INSULATION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60°C (140°F) | | 75°C (167°F) | | 80°C (176°F) | | 90°C (194°F) | | 105°C (221°F) | | 125°C (257°F) | | 200°C (392°F) |
| | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE OR INSIDE ENGINE SPACES |
| 18 | 6.0 | NOT PERMITTED | 6.0 | 4.5 | 9.0 | 7.0 | 12.0 | 9.8 | 12.0 | 10.2 | 15.0 | 13.4 | 15.0 |
| 16 | 9.0 | | 9.0 | 6.8 | 12.0 | 9.4 | 15.0 | 12.3 | 15.0 | 12.8 | 18.0 | 16.0 | 21.0 |
| 14 | 12.0 | | 12.0 | 9.0 | 15.0 | 11.7 | 18.0 | 14.8 | 21.0 | 17.9 | 24.0 | 21.4 | 27.0 |
| 12 | 15.0 | | 15.0 | 11.3 | 21.0 | 16.4 | 24.0 | 19.7 | 27.0 | 23.0 | 30.0 | 26.7 | 33.0 |
| 10 | 24.0 | | 24.0 | 18.0 | 30.0 | 23.4 | 33.0 | 27.1 | 36.0 | 30.6 | 42.0 | 37.4 | 42.0 |
| 8 | 33.0 | | 39.0 | 29.3 | 42.0 | 32.8 | 42.0 | 34.4 | 48.0 | 40.8 | 54.0 | 48.1 | 60.0 |
| 6 | 48.0 | | 57.0 | 42.8 | 60.0 | 46.8 | 60.0 | 49.2 | 72.0 | 61.2 | 75.0 | 66.8 | 81.0 |
| 4 | 63.0 | | 75.0 | 56.3 | 78.0 | 60.8 | 81.0 | 66.4 | 96.0 | 81.6 | 102.0 | 90.8 | 108.0 |
| 3 | 72.0 | | 87.0 | 65.3 | 90.0 | 70.2 | 93.0 | 76.3 | 108.0 | 91.8 | 117.0 | 104.1 | 126.0 |
| 2 | 84.0 | | 102.0 | 76.5 | 105.0 | 81.9 | 108.0 | 88.6 | 126.0 | 107.1 | 135.0 | 120.2 | 144.0 |
| 1 | 99.0 | | 117.0 | 87.8 | 126.0 | 98.3 | 126.0 | 103.3 | 147.0 | 125.0 | 159.0 | 141.5 | 168.0 |
| 0 | 117.0 | | 138.0 | 103.5 | 147.0 | 114.7 | 147.0 | 120.5 | 171.0 | 145.4 | 183.0 | 162.9 | 195.0 |
| 00 | 135.0 | | 159.0 | 119.3 | 171.0 | 133.4 | 171.0 | 140.2 | 198.0 | 168.3 | 213.0 | 189.6 | 222.0 |
| 000 | 156.0 | | 186.0 | 139.5 | 198.0 | 154.4 | 198.0 | 162.4 | 231.0 | 196.4 | 246.0 | 218.9 | 258.0 |
| 0000 | 180.0 | | 216.0 | 162.0 | 231.0 | 180.2 | 231.0 | 189.4 | 267.0 | 227.0 | 285.0 | 253.7 | 306.0 |

**TABLE VI – D - AC CIRCUITS – ALLOWABLE AMPERAGE OF CONDUCTORS WHEN 7 TO 24 CURRENT CARRYING CONDUCTORS ARE BUNDLED**

| CONDUCTOR SIZE (AWG) | TEMPERATURE RATING OF CONDUCTOR INSULATION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60°C (140°F) | | 75°C (167°F) | | 80°C (176°F) | | 90°C (194°F) | | 105°C (221°F) | | 125°C (257°F) | | 200°C (392°F) |
| | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE OR INSIDE ENGINE SPACES |
| 18 | 5.0 | NOT PERMITTED | 5.0 | 3.8 | 7.5 | 5.9 | 10.0 | 8.2 | 10.0 | 8.5 | 12.5 | 11.1 | 12.5 |
| 16 | 7.5 | | 7.5 | 5.6 | 10.0 | 7.8 | 12.5 | 10.3 | 12.5 | 10.6 | 15.0 | 13.4 | 17.5 |
| 14 | 10.0 | | 10.0 | 7.5 | 12.5 | 9.8 | 15.0 | 12.3 | 17.5 | 14.9 | 20.0 | 17.8 | 22.5 |
| 12 | 12.5 | | 12.5 | 9.4 | 17.5 | 13.7 | 20.0 | 16.4 | 22.5 | 19.1 | 25.0 | 22.3 | 27.5 |
| 10 | 20.0 | | 20.0 | 15.0 | 25.0 | 19.5 | 27.5 | 22.6 | 30.0 | 25.5 | 35.0 | 31.2 | 35.0 |
| 8 | 27.5 | | 32.5 | 24.4 | 35.0 | 27.3 | 35.0 | 28.7 | 40.0 | 34.0 | 45.0 | 40.1 | 50.0 |
| 6 | 40.0 | | 47.5 | 35.6 | 50.0 | 39.0 | 50.0 | 41.0 | 60.0 | 51.0 | 62.5 | 55.6 | 67.5 |
| 4 | 52.5 | | 62.5 | 46.9 | 65.0 | 50.7 | 67.5 | 55.4 | 80.0 | 68.0 | 85.0 | 75.7 | 90.0 |
| 3 | 60.0 | | 72.5 | 54.4 | 75.0 | 58.5 | 77.5 | 63.6 | 90.0 | 76.5 | 97.5 | 86.8 | 105.0 |
| 2 | 70.0 | | 85.0 | 63.8 | 87.5 | 68.3 | 90.0 | 73.8 | 105.0 | 89.3 | 112.5 | 100.1 | 120.0 |
| 1 | 82.5 | | 97.5 | 73.1 | 105.0 | 81.9 | 105.0 | 86.1 | 122.5 | 104.1 | 132.5 | 117.9 | 140.0 |
| 0 | 97.5 | | 115.0 | 86.3 | 122.5 | 95.6 | 122.5 | 100.5 | 142.5 | 121.1 | 152.5 | 135.7 | 162.5 |
| 00 | 112.5 | | 132.5 | 99.4 | 142.5 | 111.2 | 142.5 | 116.9 | 165.0 | 140.3 | 177.5 | 158.0 | 185.0 |
| 000 | 130.0 | | 155.0 | 116.3 | 165.0 | 128.7 | 165.0 | 135.3 | 192.5 | 163.6 | 205.0 | 182.5 | 215.0 |
| 0000 | 150.0 | | 180.0 | 135.0 | 192.5 | 150.2 | 192.5 | 157.9 | 222.5 | 189.1 | 237.5 | 211.4 | 255.0 |

**TABLE VI – E - AC CIRCUITS - ALLOWABLE AMPERAGE OF CONDUCTORS WHEN 25 OR MORE CURRENT CARRYING CONDUCTORS ARE BUNDLED**

| CONDUCTOR SIZE (AWG) | TEMPERATURE RATING OF CONDUCTOR INSULATION | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 60°C (140°F) | | 75°C (167°F) | | 80°C (176°F) | | 90°C (194°F) | | 105°C (221°F) | | 125°C (257°F) | | 200°C (392°F) |
| | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE ENGINE SPACES | INSIDE ENGINE SPACES | OUTSIDE OR INSIDE ENGINE SPACES |
| 18 | 4.0 | NOT PERMITTED | 4.0 | 3.0 | 6.0 | 4.7 | 8.0 | 6.6 | 8.0 | 6.8 | 10.0 | 8.9 | 10.0 |
| 16 | 6.0 | | 6.0 | 4.5 | 8.0 | 6.2 | 10.0 | 8.2 | 10.0 | 8.5 | 12.0 | 10.7 | 14.0 |
| 14 | 8.0 | | 8.0 | 6.0 | 10.0 | 7.8 | 12.0 | 9.8 | 14.0 | 11.9 | 16.0 | 14.2 | 18.0 |
| 12 | 10.0 | | 10.0 | 7.5 | 14.0 | 10.9 | 16.0 | 13.1 | 18.0 | 15.3 | 20.0 | 17.8 | 22.0 |
| 10 | 16.0 | | 16.0 | 12.0 | 20.0 | 15.6 | 22.0 | 18.0 | 24.0 | 20.4 | 28.0 | 24.9 | 28.0 |
| 8 | 22.0 | | 26.0 | 19.5 | 28.0 | 21.8 | 28.0 | 23.0 | 32.0 | 27.2 | 36.0 | 32.0 | 40.0 |
| 6 | 32.0 | | 38.0 | 28.5 | 40.0 | 31.2 | 40.0 | 32.8 | 48.0 | 40.8 | 50.0 | 44.5 | 54.0 |
| 4 | 42.0 | | 50.0 | 37.5 | 52.0 | 40.6 | 54.0 | 44.3 | 64.0 | 54.4 | 68.0 | 60.5 | 72.0 |
| 3 | 48.0 | | 58.0 | 43.5 | 60.0 | 46.8 | 62.0 | 50.8 | 72.0 | 61.2 | 78.0 | 69.4 | 84.0 |
| 2 | 56.0 | | 68.0 | 51.0 | 70.0 | 54.6 | 72.0 | 59.0 | 84.0 | 71.4 | 90.0 | 80.1 | 96.0 |
| 1 | 66.0 | | 78.0 | 58.5 | 84.0 | 65.5 | 84.0 | 68.9 | 98.0 | 83.3 | 106.0 | 94.3 | 112.0 |
| 0 | 78.0 | | 92.0 | 69.0 | 98.0 | 76.4 | 98.0 | 80.4 | 114.0 | 96.9 | 122.0 | 108.6 | 130.0 |
| 00 | 90.0 | | 106.0 | 79.5 | 114.0 | 88.9 | 114.0 | 93.5 | 132.0 | 112.2 | 142.0 | 126.4 | 148.0 |
| 000 | 104.0 | | 124.0 | 93.0 | 132.0 | 103.0 | 132.0 | 108.2 | 154.0 | 130.9 | 164.0 | 146.0 | 172.0 |
| 0000 | 120.0 | | 144.0 | 108.0 | 154.0 | 120.1 | 154.0 | 126.3 | 178.0 | 151.3 | 190.0 | 169.1 | 204.0 |

**TABLE VII - FLEXIBLE CORDS**

**Table VII-A**

| FLEXIBLE CORDS | | |
|---|---|---|
| TYPE | DESCRIPTION | AVAILABLE INSULATION TEMPERATURE RATING |
| SO, SOW | Hard Service Cord, Oil Resistant Compound | 60°C (140° F), 75°C (167°F) & higher |
| ST, STW | Hard Service Cord, Thermoplastic | 60°C (140° F), 75°C (167°F) & higher |
| STO, STOW, SEO, SEOW | Hard Service Cord, Oil Resistant Thermoplastic | 60°C (140° F), 75°C (167°F) & higher |
| SJO, SJOW | Junior Hard Service Cord, Oil Resistant Compound | 60°C (140°F), 75°C (167°F) & higher |
| SJT, SJTW | Junior Hard Service Cord, Thermoplastic | 60°C (140°F), 75°C (167°F) & higher |
| SJTO, SJTOW | Junior Hard Service Cord, Oil Resistant Thermoplastic | 60°C (140°F), 75°C (167°F) & higher |

**TABLE IX – CONDUCTORS SIZED FOR 3 PERCENT DROP IN VOLTAGE**

***NOTE: In the event of a conflict between the voltage drop table and the ampacity table, use the larger wire size.***

Length of Conductor from Source of Current to Device and Back to Source - Feet

| TOTAL CURRENT ON CIRCUIT IN AMPS | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 Volts - 3% Drop Wire Sizes (gauge) - Based on Minimum CM Area | | | | | | | | | | | | | | | | | | | |
| 5 | 18 | 16 | 14 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| 10 | 14 | 12 | 10 | 10 | 10 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 |
| 15 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 20 | 10 | 10 | 8 | 6 | 6 | 6 | 4 | 4 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 2/0 |
| 25 | 10 | 8 | 6 | 6 | 6 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 2/0 | 2/0 | 2/0 | 3/0 |
| 30 | 10 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 2/0 | 2/0 | 3/0 | 3/0 | 3/0 | 3/0 |
| 40 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 1 | 0 | 0 | 2/0 | 2/0 | 3/0 | 3/0 | 3/0 | 4/0 | 4/0 | 4/0 | 4/0 |
| 50 | 6 | 6 | 4 | 4 | 2 | 2 | 1 | 0 | 2/0 | 2/0 | 3/0 | 3/0 | 4/0 | 4/0 | 4/0 | | | | |
| 60 | 6 | 4 | 4 | 2 | 2 | 1 | 0 | 2/0 | 3/0 | 3/0 | 4/0 | 4/0 | 4/0 | | | | | | |
| 70 | 6 | 4 | 2 | 2 | 1 | 0 | 2/0 | 3/0 | 3/0 | 4/0 | 4/0 | | | | | | | | |
| 80 | 6 | 4 | 2 | 2 | 1 | 0 | 3/0 | 3/0 | 4/0 | 4/0 | | | | | | | | | |
| 90 | 4 | 2 | 2 | 1 | 0 | 2/0 | 3/0 | 4/0 | 4/0 | | | | | | | | | | |
| 100 | 4 | 2 | 2 | 1 | 0 | 2/0 | 3/0 | 4/0 | | | | | | | | | | | |
| 24 Volts - 3% Drop Wire Sizes (gauge) - Based on Minimum CM Area | | | | | | | | | | | | | | | | | | | |
| 5 | 18 | 18 | 18 | 16 | 16 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 |
| 10 | 18 | 16 | 14 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 6 |
| 15 | 16 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 4 | 2 |
| 20 | 14 | 12 | 10 | 10 | 10 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 |
| 25 | 12 | 12 | 10 | 10 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 1 |
| 30 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 40 | 10 | 10 | 8 | 6 | 6 | 6 | 4 | 4 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 2/0 |
| 50 | 10 | 8 | 6 | 6 | 6 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 2/0 | 2/0 | 2/0 | 3/0 |
| 60 | 10 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 2/0 | 2/0 | 3/0 | 3/0 | 3/0 | 3/0 |
| 70 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 2/0 | 2/0 | 3/0 | 3/0 | 3/0 | 3/0 | 4/0 | 4/0 |
| 80 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 1 | 0 | 0 | 2/0 | 2/0 | 3/0 | 3/0 | 3/0 | 4/0 | 4/0 | 4/0 | 4/0 |
| 90 | 8 | 6 | 4 | 4 | 2 | 2 | 1 | 0 | 0 | 2/0 | 2/0 | 3/0 | 3/0 | 4/0 | 4/0 | 4/0 | 4/0 | 4/0 | |
| 100 | 6 | 6 | 4 | 4 | 2 | 2 | 1 | 0 | 2/0 | 2/0 | 3/0 | 3/0 | 4/0 | 4/0 | 4/0 | | | | |

Length of Conductor from Source of Current to Device and Back to Source - Feet

| TOTAL CURRENT ON IN CIRCUIT AMPS | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 32 Volts - 3% Drop Wire Sizes (gauge) - Based on Minimum CM Area | | | | | | | | | | | | | | | | | | |
| 5 | 18 | 18 | 18 | 18 | 16 | 16 | 14 | 14 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 10 | 8 |
| 10 | 18 | 16 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 6 | 6 | 6 | 6 |
| 15 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 4 | 4 |
| 20 | 16 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 4 | 2 |
| 25 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 |
| 30 | 14 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 1 |
| 40 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 50 | 12 | 10 | 8 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 0 |
| 60 | 10 | 8 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 2/0 | 2/0 | 2/0 |
| 70 | 10 | 8 | 6 | 6 | 6 | 4 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 2/0 | 2/0 | 2/0 | 3/0 | 3/0 |
| 80 | 10 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 2/0 | 2/0 | 3/0 | 3/0 | 3/0 | 3/0 |
| 90 | 8 | 6 | 6 | 6 | 4 | 2 | 2 | 2 | 1 | 0 | 0 | 2/0 | 2/0 | 2/0 | 3/0 | 3/0 | 3/0 | 4/0 | 4/0 |
| 100 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 1 | 0 | 0 | 2/0 | 2/0 | 2/0 | 3/0 | 3/0 | 3/0 | 4/0 | 4/0 | 4/0 |

**TABLE X - CONDUCTORS SIZES FOR 10 PERCENT VOLTAGE DROP**

***NOTE: In the event of a conflict between the voltage drop table and the ampacity table, use the larger wire size.***

Length of Conductor from Source of Current to Device and Back to Source - Feet

| TOTAL CURRENT ON CIRCUIT IN AMPS | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 Volts - 10% Drop Wire Sizes (gauge) - Based on Minimum CM Area | | | | | | | | | | | | | | | | | | | |
| 5 | 18 | 18 | 18 | 18 | 18 | 16 | 16 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 10 |
| 10 | 18 | 18 | 16 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 8 | 6 |
| 15 | 18 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 |
| 20 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 4 | 4 | 4 |
| 25 | 16 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 4 | 2 |
| 30 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 |
| 40 | 14 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 50 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |
| 60 | 12 | 10 | 8 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 |
| 70 | 10 | 8 | 8 | 6 | 6 | 6 | 4 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 0 | 0 | 2/0 | 2/0 |
| 80 | 10 | 8 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 2/0 | 2/0 | 2/0 | 2/0 |
| 90 | 10 | 8 | 6 | 6 | 6 | 4 | 2 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 2/0 | 2/0 | 2/0 | 3/0 | 3/0 |
| 100 | 10 | 8 | 6 | 6 | 4 | 4 | 2 | 2 | 1 | 1 | 0 | 0 | 0 | 2/0 | 2/0 | 2/0 | 3/0 | 3/0 | 3/0 |
| 24 Volts - 10% Drop Wire Sizes (gauge) - Based on Minimum CM Area | | | | | | | | | | | | | | | | | | | |
| 5 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 16 | 16 | 16 | 16 | 14 | 14 | 14 | 14 | 14 | 14 | 12 |
| 0 | 18 | 18 | 18 | 18 | 18 | 16 | 16 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 10 |
| 15 | 18 | 18 | 18 | 16 | 16 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 |
| 20 | 18 | 18 | 16 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 8 | 6 |
| 25 | 18 | 16 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 6 | 6 | 6 | 6 |
| 30 | 18 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 |
| 40 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 4 | 4 | 4 |
| 50 | 16 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 4 | 2 |
| 60 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 |
| 70 | 14 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 |
| 80 | 14 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| 90 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 | 1 | 1 |
| 100 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 |

Length of Conductor from Source of Current to Device and Back to Source - Feet

| TOTAL CURRENT ON CIRCUIT IN AMPS | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 32 Volts - 10% Drop Wire Sizes (gauge) - Based on Minimum CM Area | | | | | | | | | | | | | | | | | | |
| 5 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 18 | 16 | 16 | 16 | 16 | 14 | 14 | 14 | 14 |
| 10 | 18 | 18 | 18 | 18 | 18 | 18 | 16 | 16 | 14 | 14 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 12 | 12 |
| 15 | 18 | 18 | 18 | 18 | 18 | 16 | 14 | 14 | 14 | 12 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 10 |
| 20 | 18 | 18 | 18 | 16 | 16 | 14 | 14 | 12 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 |
| 25 | 18 | 18 | 16 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 8 |
| 30 | 18 | 18 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 6 | 6 | 6 |
| 40 | 18 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 |
| 50 | 16 | 14 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 6 | 4 | 4 |
| 60 | 16 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 |
| 70 | 14 | 14 | 12 | 10 | 10 | 8 | 8 | 8 | 6 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 |
| 80 | 14 | 12 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 |
| 90 | 14 | 12 | 10 | 10 | 10 | 8 | 6 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 |
| 100 | 14 | 12 | 10 | 10 | 8 | 8 | 6 | 6 | 6 | 4 | 4 | 4 | 4 | 2 | 2 | 2 | 2 | 2 | 2 |

**TABLE XI - CONDUCTOR CIRCULAR MIL (CM) AREA AND STRANDING**

| CONDUCTOR GAUGE | NOMINAL ACCEPTABLE CM AREA AWG | NOMINAL ACCEPTABLE CM AREA SAE | NOMINAL NUMBER OF STRANDS | | |
|---|---|---|---|---|---|
| | | | TYPE 1* | TYPE 2** | TYPE 3*** |
| 18 | 1,620 | 1,537 | - | 16 | - |
| 16 | 2,580 | 2,336 | - | 19 | 26 |
| 14 | 4,110 | 3,702 | - | 19 | 41 |
| 12 | 6,530 | 5,833 | - | 19 | 65 |
| 10 | 10,380 | 9,343 | - | 19 | 105 |
| 8 | 16,510 | 14,810 | - | 19 | 168 |
| 6 | 26,240 | 24,538 | - | 37 | 266 |
| 4 | 41,740 | 37,360 | - | 49 | 420 |
| 2 | 66,360 | 62,450 | - | 127 | 665 |
| 1 | 83,690 | 77,790 | - | 127 | 836 |
| 0 | 105,600 | 98,980 | - | 127 | 1064 |
| 00 | 133,100 | 125,100 | - | 127 | 1323 |
| 000 | 167,800 | 158,600 | - | 259 | 1666 |
| 0000 | 211,600 | 205,500 | - | 418 | 2107 |

***Type 1 - Solid conductor and stranding less than that indicated under Type 2 shall not be used.***

****Type 2 - Conductors with at least Type 2 stranding shall be used for general purpose boat wiring.***

*****Type 3 - Conductors with Type 3 stranding shall be used for any wiring where frequent flexing is involved in normal use.***

***NOTE:***
***1. Metric wire sizes may be used if of equivalent circular mil area. If the circular mil area of the metric conductor is less than that listed, the wire ampacity shall be corrected based on the ratio of the circular mil areas. For comparison of conductor cross sections (AWG and ISO) see AP TABLE 2.***

***2. The circular mil area given is equal to the mathematical square of the diameter of the AWG standard solid copper conductor measured in one thousandths of an inch.***

***The area in square inches =*** $\dfrac{pi(circular\ mils)}{4(1{,}000{,}000)}$

***The circular mil area of the stranded conductors may differ from the tabulated values and is the sum of the circular mil areas of the wires (strands) in the conductor.***

**TABLE XIV – ENGINE AND ACCESSORY WIRING COLOR CODE**

| COLOR | ITEM | USE |
|---|---|---|
| | | |
| Yellow w/Red Stripe (YR) | Starting Circuit | Starting switch to solenoid |
| | | |
| Brown/Yellow Stripe (BY) or Yellow (Y) - see note | Bilge Blowers | Fuse or switch to blowers |
| | | |
| Dark Gray (Gy) | Navigation Lights<br>Tachometer | Fuse or switch to lights<br>Tachometer sender to gauge |
| | | |
| Brown (Br) | Generator Armature<br>Alternator Charge Light<br><br><br>Pumps | Generator armature to regulator<br>Generator<br>Terminal/alternator<br>Auxiliary terminal to light to regulator<br>Fuse or switch to pumps |
| | | |
| Orange (O) | Accessory Feed | Ammeter to alternator or generator output and accessory fuses or switches.<br>Distribution panel to accessory switch |
| | | |
| Purple (Pu) | Ignition<br><br>Instrument Feed | Ignition switch to coil and electrical instruments.<br>Distribution panel to electric instruments |
| | | |
| Dark Blue (Dk Bl) | Cabin and Instrument Lights | Fuse or switch to lights |
| | | |
| Light Blue (Lt Bl) | Oil Pressure | Oil pressure sender to gauge |
| | | |
| Tan (Tn) | Water Temperature | Water temperature sender to gauge |
| | | |
| Pink (Pk) | Fuel Gauge | Fuel gauge sender to gauge |
| | | |
| Green/Stripe (G/x) (Except G/Y) | Tilt down and/or Trim in | Tilt and/or trim circuits |
| | | |
| Blue/Stripe (Bl/x) | Tilt up and/or Trim out | Tilt and/or trim circuits |

***NOTE: If yellow is used for DC negative, blower must be brown with yellow stripe.***

**AP TABLE 1 – CONDUCTORS**

| AWG | INSULATION TYPE | NOMINAL WALL THICKNESS (MILS) | MAXIMUM OPERATING TEMP. DRY (°C) | MAXIMUM OPERATING TEMP. WET (°C) | BREAK DOWN VOLTAGE (V) | OIL RESISTANT TEMP. (°C) | COMMENTS |
|---|---|---|---|---|---|---|---|
| 14-10 | THW | 45 | 75 | 75 | 600 | | Thermoplastic |
| 8-2 | THW | 60 | | | | | |
| 1-4/0 | THW | 80 | | | | | |
| 14-10 | TW | 30 | 75 | 60 | 600 | | Thermoplastic |
| 8 | TW | 45 | | | | | |
| 14-12 | THWN | 19 | 105 | 75 | 600 | 60 | PVC/Nylon |
| 10 | THWN | 20 | | | | | |
| 14-12 | XHHW | 30 | 90 | 75 | 600 | | X-linked |
| 10 | | | | | | | |
| 8-2 | | 45 | | | | | |
| 1-4/0 | | 55 | | | | | |
| 18-10 | MTW | 45 | 90 | 60 | 600 | | Heavy Wall PVC |
| 8 | MTW | 45 | | | | | |
| 6 | MTW | 60 | | | | | |
| 18-8 | TW | 30 | 90 | 60 | 600 | | Light Wall PVC |
| 18-10 | AWM Style #1230 PVC | 30 | 105 | 60 | 600 | 60 | |
| 18-8 | AWM Style #1231 PVC | 45 | 105 | 60 | 600 | 60 | |
| 8-2 | AWM Style #1232 PVC | 60 | 105 | 60 | 600 | 60 | |
| 1-4/0 | AWM Style #1232 PVC | 80 | 105 | 60 | 600 | 60 | |
| 18-10 | AWM Style #1275 PVC | 60 | 105 | 60 | 600 | 60 | |
| 18-10 | AWM Style #1345 PVC | 30 | 105 | 75 | 600 | 60 | |
| 8-2 | AWM Style #1346 PVC | 60 | 105 | 75 | 600 | 60 | |
| 18-10 | UL 1426 *Boat Cable* | 30 | 105 | 75 | 600 | 60 | |
| 8 | Boat Cable | 45 | 105 | 75 | 600 | 60 | |
| 6-2 | Boat Cable | 60 | 105 | 75 | 600 | 60 | |
| 1-4/0 | Boat Cable | 80 | 105 | 75 | 600 | 60 | |

***NOTES:***
***1. AWM must be accompanied by a style number.***

***2. Some of the listed types are not commonly available in standard construction for sizes smaller than 8 AWG. However, these types are acceptable if obtainable.***

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