

System wiring –AC- Continued

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

11.16.1.3.8. Conductors and flexible cords shall be of size according to TABLE VII and TABLE XIII.

11.16.1.3.8.1. 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 VII and TABLE XIII.

NOTE: When determining the allowable ampereage of bundled conductors using TABLE VII 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.

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

11.16.2. WIRING IDENTIFICATION

11.16.2.1. FOR DC SYSTEMS

11.16.2.1.1. Each electrical conductor that is part of the boat's electrical system shall have a means to identify its function in the system.

EXCEPTION: Pigtails less than seven inches (175mm) in length.

11.16.2.1.2. Insulated grounding conductors shall be identified by the color green or green with yellow stripe(s).

11.16.2.1.3. The color code shown in TABLE XIV identifies colors for DC conductors used for general wiring purposes on boats.

11.16.2.1.4. The color code shown in Table XV identifies one selection of colors for use as an engine accessory wiring color code. Other means of identification may be used providing a wiring diagram of the system indicating the method of identification is provided with each boat.

11.16.2.1.4.1. Color-coding may be accomplished by colored sleeving or color application to wiring at termination points.

11.16.2.1.4.2. If tape is used to mark a wire, the tape shall be at least 3/16 inch (5mm) in width, and

shall have sufficient length to make at least two complete turns around the conductor to be marked. The tape shall be applied to be visible near each terminal.

11.16.2.2. FOR AC SYSTEMS

11.16.2.2.1. Conductors shall be identified to indicate circuit polarity as follows:

ungrounded conductor	black or brown
grounded neutral conductor	white, or light blue
grounding conductor	green, green w/yellow stripe
additional ungrounded conductors	red, orange, blue
additional colors for ungrounded conductors (black)	Black w/red stripe Black w/ blue stripe Black w/ orange stripe

11.16.3. WIRING TERMINALS

11.16.3.1. Wiring connections shall be designed and installed to make mechanical and electrical joints without damage to the conductors.

11.16.3.2. Metals used for the terminal studs, nuts, and washers shall be corrosion resistant and galvanically compatible with the conductor and terminal lug. Aluminum and unplated steel shall not be used for studs, nuts, and washers.

11.16.3.3. Each conductor-splice joining conductor to conductor, conductor to connectors, and conductor to terminals must be able to withstand a tensile force equal to at least the value shown in Table XVI for the smallest conductor size used in the splice for a one minute duration, and not break.

11.16.3.4. Terminal connectors shall be the ring or captive spade types. (See FIGURE 17.)

EXCEPTION: Friction type connectors may be used on components if

1. the circuit is rated not more than 20 amperes or the manufacturer's rating for a terminal designed to meet the requirements of UL 310, "Electrical Quick-Connect Terminals", or UL 1059, "Terminal Block"s, and

2. the voltage drop from terminal to terminal does not exceed 50 millivolts for a 20 amp current flow, and

3. the connection does not separate if subjected for one minute to a six pound (27 Newton) tensile force along the axial direction of the connector, on the first withdrawal.

Wiring Terminals-Continued

11.16.3.5. Connections may be made using a set-screw pressure type conductor connector, providing a means is used to prevent the set-screw from bearing directly on the conductor strands.

11.16.3.6. Twist on connectors, i.e., wire nuts, shall not be used.

11.16.3.7. Solder shall not be the sole means of mechanical connection in any circuit. If soldered, the connection shall be so located or supported as to minimize flexing of the conductor where the solder changes the flexible conductor into a solid conductor.

EXCEPTION: Battery lugs with a solder contact length of not less than 1.5 times the diameter of the conductor.

NOTE: When a stranded conductor is soldered, the soldered portion of the conductor becomes a solid strand conductor, and flexing can cause the conductor to break at the end of the solder joint unless adequate additional support is provided.

11.16.3.8. Solderless crimp on connectors shall be attached with the type of crimping tools designed for the connector used, and that will produce a connection meeting the requirements of E-11.16.3.3.

11.16.3.9. The shanks of terminals shall be protected against accidental shorting by the use of insulation barriers or sleeves, except for those used in grounding systems.

11.16.4. INSTALLATION

11.16.4.1. GENERAL

11.16.4.1.1. Junction boxes, cabinets, and other enclosures in which electrical connections are made shall be weatherproof, or installed in a protected location, to minimize the entrance or accumulation of moisture or water within the boxes, cabinets, or enclosures.

11.16.4.1.2. In wet locations, metallic boxes, cabinets, or enclosures shall be mounted to minimize the entrapment of moisture between the box, cabinet, or enclosure, and the adjacent structure. If air spacing is used to accomplish this, the minimum shall be 1/4 inch (7.0 mm).

11.16.4.1.3. Unused openings in boxes, cabinets, and weatherproof enclosures shall be closed.

11.16.4.1.4. All conductors shall be supported and/or clamped to relieve strain on connections.

11.16.4.1.5. When AC and DC conductors are run together, the AC conductors shall be sheathed,

bundled, or otherwise kept separate from the DC conductors.

11.16.4.1.6. Current-carrying conductors shall be routed as high as practicable above the bilge water level and other areas where water may accumulate. If conductors must be routed in the bilge or other areas where water may accumulate, the connections shall be watertight.

11.16.4.1.7. Conductors shall be routed as far away as practicable from exhaust pipes and other heat sources. Unless an equivalent thermal barrier is provided, a clearance of at least two inches (51 mm) between conductors and water cooled exhaust components, and a clearance of at least nine inches (230 mm) between conductors and dry exhaust components, shall be maintained. Conductors shall not be routed directly above a dry exhaust.

EXCEPTIONS: 1. Wiring on engines.

2. Exhaust temperature sensor wiring.

11.16.4.1.8. Conductors that may be exposed to physical damage shall be protected by self-draining; loom, conduit, tape, raceways, or other equivalent protection. Conductors passing through bulkheads or structural members shall be protected to minimize insulation damage such as chafing or pressure displacement. Conductors shall also be routed clear of sources of chafing such as steering cable and linkages, engine shafts, and control connections.

11.16.4.1.9. Loom used to cover conductors shall be self-extinguishing. The base product (or resin) shall be classified as V-2 or better, in accordance with UL 94, *Tests For Flammability Of Plastic Materials*.

11.16.4.1.10. Conductors shall be supported throughout their length or shall be secured at least every 18 inches (455mm) by one of the following methods:

11.16.4.1.10.1. By means of non-metallic clamps sized to hold the conductors firmly in place. Non-metallic straps or clamps shall not be used over engine(s), moving shafts, other machinery or passageways, if failure would result in a hazardous condition. The material shall be resistant to oil, gasoline, and water and shall not break or crack within a temperature range of -34°C (-30°F) to 121°C (250°F);

11.16.4.1.10.2. By means of metal straps or clamps with smooth, rounded edges to hold the conductors firmly in place without damage to the conductors or insulation. That section of the conductor or cable directly under the strap or clamp shall be protected by means of loom, tape or other suitable wrapping to prevent injury to the conductor;

Installation - General -Continued

11.16.4.1.10.3. By means of metal clamps lined with an insulating material resistant to the effects of oil, gasoline, and water.

EXCEPTIONS: Exception to E-11.16.4.1.10:

1. Battery cables within 36 inches (910mm) of a battery terminal.

2. Cables attached to outboard motors.

11.16.4.1.11. No more than four conductors shall be secured to any one terminal stud. If additional connections are necessary, two or more terminal studs shall be connected together by means of jumpers or copper straps.

11.16.4.1.12. Ring and captive spade type terminal connectors shall be the same nominal size as the stud.

11.16.4.1.13. Conductors terminating at panelboards in junction boxes or fixtures shall be arranged to provide a length of conductor to relieve tension, to allow for repairs and to permit multiple conductors to be fanned at terminal studs.

11.16.4.2. DC SYSTEMS

11.16.4.2.1. Wiring shall be installed in a manner that will avoid magnetic loops in the area of the compass and magnetically sensitive devices. Direct current wires that may create magnetic fields in this area shall run in twisted pairs.

11.16.4.2.2. Battery cables without overcurrent protection shall comply with the following:

11.16.4.2.2.1. Battery cables shall be routed above normal bilge water levels throughout their length;

11.16.4.2.2.2. Battery cables shall be routed to avoid contact with metallic fuel system components;

11.16.4.2.2.3. The ungrounded battery cable shall be routed to avoid contact with any part of the engine or drive train.

11.16.4.3. FOR AC SYSTEMS

11.16.4.3.1. All connections normally carrying current shall be made in enclosures to protect against shock hazards.

11.16.4.3.2. Nonmetallic outlet boxes, flush device boxes and covers shall meet the requirements of UL 514C, *Non-metallic Outlet Boxes, Flush Device Boxes and Covers*.

11.17. **APPLIANCES AND EQUIPMENT**

11.17.1. GENERAL

11.17.1.1. All electrical appliances and equipment designed for permanent installation shall be securely mounted to the boat's structure.

11.17.2. FOR DC SYSTEMS

11.17.2.1. Appliances and fixed DC electrical equipment shall be designed so that the current carrying parts of the device are insulated from all exposed electrically conductive parts.

EXCEPTIONS: 1. 12-volt equipment not located in machinery spaces, not in contact with bilge, and not in contact with a fuel line.

2. Communications and audio equipment

3. Electric navigation equipment

4. Instruments and instrument clusters

5. Liquid level gauge transmitters. For installation of fuel tank transmitters on conductive surfaces. (See E-11.17.2.4.)

6. Navigation lights operating at nominal 12 volts. See [ABYC A-16, "Electric Navigation Lights."](#)

7. Auxiliary generator sets

8. Engine mounted equipment. (See E-11.5.2.1.)

11.17.2.2. Devices subject to exceptions 1 through 8 in E-11.17.2.1 shall be installed with the case negative, and the positive connection shall be identified.

11.17.2.3. All exposed electrically conductive non-current carrying parts of fixed DC electrical equipment, and appliances that may normally be in contact with bilge water or seawater, shall be connected to the DC grounding system.

EXCEPTIONS: 1. Boats not equipped with a DC grounding system.

2. Equipment with an effective double insulation system.

3. Metal parts isolated in non-conductive material

4. Electric trolling motors

11.17.2.4. Grounded Liquid Level Gauge Transmitters (senders) - Grounded liquid level gauge