REVIEW OF SMALL PASSENGER VESSELS

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Purpose

This Plan Review Guideline (PRG) provides guidance regarding the information required to be submitted to the Marine Safety Center (MSC) for review of the electrical plans for small passenger vessels on U.S. flag inspected vessels.

Contact Information

If you have any questions or comments concerning this document, please contact the Marine Safety Center (MSC) by e-mail or phone. Please refer to Procedure Number E2-23.

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1. Applicability

This Plan Review Guideline (PRG) is applicable to the electrical systems on small passenger vessels regulated under either subchapter T (46 CFR 183) or subchapter K (46 CFR 120). If your vessel does not fall under either of those subchapters, see the Marine Safety Center's page on plan review guides to determine which guide applies to your vessel.

2. References

(a) IEEE Standard 45 (2002), "Recommended Practice for Electrical Installations on Shipboard"
(b) American Boat and Yacht Council (ABYC), July 2008: E-11 AC and DC Electrical System on Boats; A-16 Electrical Navigation Lights
(c) Navigation and Vessel Inspection Circular (NVIC) 2-89, "Guide for Electrical Installations on Merchant Vessels and Mobile Offshore Drilling Units"
(d) MTN 01-03, CH 2, "Guidance on Submitting T-Boat Plans to the Marine Safety Center"
(e) MTN 01-11, CH-1 "Plan Approval Extension Procedures"
(f) MTN 02-11, "Review of Vital System Automation and Dynamic Positioning System Plans"
(g) CG-CVC Policy Letter 17-07, "Required Plan Review and Design Verification Testing on Small Passenger Vessels," dated October 19, 2017
(h) CG-ENG Memo, "Microprocessor and Computer Based Propulsion Engine Control Systems on Subchapter K and Subchapter T Boats," dated June 7, 2017
(i) CGMIX
(j) CH-2 to Coast Guard Marine Safety Manual Volume II: Materiel Inspection, COMDTINST 16000.7B

3. General Guidance

a. Subchapters K and T generally have the same paragraph arrangement. Citations are given in this Work Instruction in the format ***XXX/YYY.ZZZ***; that is, *XXX.ZZZ* is the applicable paragraph for Subchapter K vessels and *YYY.ZZZ* is the applicable paragraph for Subchapter T vessels unless otherwise noted when the requirements differ between the subchapters.

b. [*Subchapter T vessels only*]: See enclosure (1) of reference (d) for guidance on what plans to submit to the MSC for review.

c. Reference (e) and 46 CFR 116/177.210 provide information relevant to "sister vessel" submittals.

d. "Novel" design, as used in 46 CFR 121/184.100(b), is to be interpreted in light of technology and industry standards at the time the regulation was written, typically 1996.

e. Per 46 CFR 116.202(b)(6)/177.202(b)(4), documents/information to be submitted include, but are not necessarily limited to:

(1) Elementary one-line diagram
(2) Cable lists
(3) Bills of materials
(4) Type and size of generators and prime movers
(5) Type and size of generator cables, bus-tie cables, feeders, and branch circuit cables
(6) Power, lighting, and interior communication panelboards
(7) Type and capacity of storage batteries
(8) Rating of circuit breakers and switches, interrupting capacity of circuit breakers, and rating and setting of overcurrent devices
(9) Load analysis
(10) Fire and smoke detection system
(11) [*Subchapter K vessels only*]: Overcurrent protective device coordination analysis for a vessel of more than 65 feet in length with overnight accommodations for more than 49 passengers, if the information in the other required plans is not adequate to review the coordination of the vessel's overcurrent protection devices

4. Plan Requirements

a. All small passenger electrical plan submissions to MSC should meet these minimum requirements in order to receive a full technical review and response. If the following requirements are not met, MSC may not be able to review the submission.

b. Emails sent to msc@uscg.mil should include:

(1) Submitter's name and contact information
(2) Address
(3) MSC project number (if assigned)

(4) Vessel name(s)
(5) Shipyard(s)
(6) Hull number(s)
(7) Official Number(s) (O.N.), CG Number(s), or IMO number(s).
(8) Desired scope of review
(9) List of submitted plans

c. Plans must include a title block with enough identifying information that the plans can be unambiguously referenced in our correspondence. Ideally, we would like all of the below information.

(1) Drawing number
(2) Title
(3) Revision number or letter
(4) Date
(5) Sheet number of each sheet
(6) Total number of sheets

d. Plans must include enough information about the installed equipment to determine if it is compliant with the applicable subchapter. Ideally, we would like a Bill of Materials which identifies each installed electrical component identified by:

(1) Numbered items that can easily be correlated with the electrical one line diagram or associated drawing.
(2) Manufacturer make and model number
(3) All appropriate certifications/ratings.

e. All cables and conductors must be identified on the electrical one-line drawing or in a separate cable list. All cable identifications should include:

(1) Wire Size in AWG (4/0 AWG), mm^2 (2.5 mm), or circular mils
(2) Number of conductors (1C for one conductor, 3C for three conductors, etc.)
(3) Length of DC system cable in number of feet in one-way distance. If round trip distance is used please clearly identify lengths as being round trip.
(4) Ampacity and temperature rating. (232A @90℃ means the cable is rated for 232 Amps at 90 degrees Celsius)
(5) Preferred formats for identification include:
    i. XX AWG, X C, X FT, XX A @XX ℃
    ii. XX C x XX mm x X FT with a general note for cable ratings

f. The bill of materials shall include all fuses, labeled with their current rating, and should show the following information:

(1) Manufacturer and model number
(2) Fuse Class (ATC and other blade type fuses do not meet the regulation)
(3) Verification of UL listing

g. The bill of materials shall include all circuit breakers, labeled with trip rating, and should show the following information:

(1) Manufacturer and model number
(2) Verification of UL listing as appropriate

i. Blanket statements such as "All circuit breakers will meet UL-489" do not satisfy this requirement.

ii. It is common that a vessel will be in a design phase where electrical hardware is not installed yet. Submitters should still include the piece of equipment they plan on purchasing as an item in the bill of materials submitted. Including "as equivalent" is acceptable in the description (i.e. "Eaton Square D UL-489 certified breaker or equiv.") only if the information preceding "as equivalent" is adequate.

h. A load analysis should show all connected loads during various applicable operating conditions, such as underway, pier-side, summer, winter, DP operations, and emergency. Emergency conditions must be shown for all vessels. The sufficiency of two sources of power for all vital loads, per 46 CFR 120/183.310, should be shown, so engine alternator sizes should be provided in addition to generator ratings if necessary. To adequately address worst-case scenarios, all vital loads shall be included at a unity load factor (1.0 or 100%) in emergency conditions.

5. Power Generation and Distribution

a. [*Subchapter K vessels only*]: Per 46 CFR 120.312, vessels more than 65 feet in length carrying more than 600 passengers or with overnight accommodations for more than 49 passengers must have:

(1) Two generating sets that satisfy 46 CFR 111.10-4, -5, and -9, and
(2) A final emergency power source satisfying 46 CFR 112.01-20, with the capacity to power the loads listed in 46 CFR 112.15-5 for three hours, located outside the machinery space.
Note: Historically, this requirement has been a source of contention when a vessel previously regulated under Old T, carrying more than 600 passengers, is modified. It is easy to assume that such a vessel would need to install emergency power sources, but that has not always been the case. If a major conversion determination has been completed, then the outcome of that process should be used by the OCMI to decide whether new regulations or old regulations should apply. If new regulations apply, meaning those that came into force in March 1996, then an emergency generator needs to be installed.
Note: Per 46 CFR 112.15-5(e), the fire pump does not necessarily need to be on the emergency panel if it can be powered in a manner that meets the fire pump requirements of Subchapter K.

b. [*AC only*]: For vessels with two or more generators, 46 CFR 120/183.322(b) requires that:

(1) If two or more generators are NOT configured for parallel operation, they shall be interlocked to prevent parallel operation. The interlock may be mechanical or electrical.

(2) If two or more generators may be paralleled, the requirements of 46 CFR 111.12-11(f) and 111.30-25(d) must be met.

c. Per 46 CFR 120.330(k)/183.330(j), switchboards and distribution panels must be sized in accordance with:

(1) Section 7.10 of IEEE 45-1998 or IEC 60092-302 (clause 7) as required by 46 CFR 111.30-19(a); and
(2) [*Subchapter K vessels only*]: Instrumentation and control wiring must meet the requirements listed in 46 CFR 111.30-19(b).

d. [*Subchapter T vessels only*]: Per 46 CFR 183.330(j), switchboards and distribution panels must be sized in accordance with Section 7.10 of IEEE 45-1998 or IEC 60092-302 (clause 7) as required by 46 CFR 111.30-19(a).

e. For shore power receptacles of more than 50 volts:
(1) A circuit breaker must be installed in the switchboard or main distribution panel and must be interlocked to prevent parallel operation with the generator(s) onboard the vessel, per 46 CFR 120/183.390(c) and (d). A mechanical interlock must be provided on the switchboard or power panel to ensure that only one AC power source can be selected and online.
(2) Per 46 CFR 183.376(a), there must only be a single neutral connection to ground in a grounded distribution system, regardless of the number of power sources. When the power source is onboard the vessel, this ground connection must be at the switchboard. When connected to shore power the vessel neutral to ground bond must be severed because the shore power neutral to ground to neutral connection is made at the service entrance panel on shore. There are a number of methods to accomplish this, including but not limited to: (1) an isolation transformer (1:1 windings); and (2) a disconnect switch in the ground to neutral connection at the switchboard. If a switch is used to open the ground to neutral connection at the vessel's switchboard there must be some method of ensuring the ground to neutral connection is open prior to connecting to shore power and a means to ensure the connection is restored after disconnecting from shore power. See Enclosure (2) for a visual explanation of the single neutral to ground requirement.
(3) A galvanic isolator is permitted but not required. Its purpose is to block low-voltage DC current while permitting the passage of AC current, which provides protection against galvanic corrosion. It does not provide the same grounding isolation as an isolation transformer, nor does it solve the issue described in (b) above.

f. Dual-voltage distribution systems (e.g. 208/120V) must have the neutral grounded and be provided with a ground detection system.

(1) Each grounded distribution system shall include:
   i. A ground detection system meeting 46 CFR 111.05-27 (AC systems) or -29 (DC Systems), as required by 46 CFR 120/183.324; and
   ii. A single neutral connection to ground, regardless of the number of power sources, per 46 CFR 120/183.376(a). Multiple generators would

constitute multiple power sources, as would shore power. Dual voltage (and single phase 120V) shore connections will connect to a neutral to ground connection ashore, so the shipboard neutral to ground connection must be disconnected while connected to shore power– see Enclosure (2).

(2) Ungrounded distribution systems shall include ground detection at the switchboard that continuously indicates the circuit's status to ground, per 46 CFR 120/183.378. Ungrounded systems typically have either generator(s) without neutral connections (single voltage output), or are distribution systems fed from 3-phase delta-delta transformer banks, or are single-phase single connected to provide a single secondary voltage (e.g. 120V or 240V).

g. The grounded conductor (neutral) in a circuit must not be disconnected by a switch, circuit breaker, or other device unless the device simultaneously disconnects all ungrounded (hot) conductors per 46 CFR 120/183.380(b).

h. [*DC only*]: Battery chargers must have an ammeter connected in the charging circuit per 46 CFR 120/183.350(f). Some battery chargers come prebuilt with ammeters. Please include information to determine if one is installed or not via a description or illustration on the diagram itself, attached datasheet in submission, or adequate manufacturer information so we can search and find the equipment specifications.

i. [*DC only*]: If the batteries are not adjacent (typically <6ft) to a distribution panel or switchboard, the battery leads must have a fuse in series as close as practicable to the battery, per 46 CFR 120/183.350(g).

j. [*DC only*]: Batteries used for engine starting are to be located as close as possible to the engine or engines served, per 46 CFR 120/183.350(h).

k. [*DC only*]: An emergency switch must be provided in the normally ungrounded main supply conductor located as close to the battery as practicable, per 46 CFR 120/183.380(i). This can serve as the means of disconnect required by 46 CFR 120/183.380(j).

l. [*Lithium Ion Batteries*]: Refer to PRG E2-29 for guidance on the requirements for propulsion systems based on lithium ion batteries.

6. Cable and Wiring

a. Per 46 CFR 183.340(c):

(1) Power and lighting conductors must be 14 AWG or larger.
(2) Conductors in control and indicator circuits must be 22 AWG or larger.
(3) Any arrangement that cannot comply with these requirements (i.e. LED bulb connectors too small for 14 AWG wiring) can be approved if the OCMI uses special consideration via 46 CFR 175.550. Equivalency can be requested under 46 CFR 175.540(a), but will not typically be granted; the 14 AWG minimum creates a robustness standard separate from the size requirements of 46 CFR 183.380(d), and 16 AWG is not as robust as 14 AWG.
Note: Subchapter T contains no authority for waivers.

b. Each conductor shall be protected from overcurrent by fuses or circuit breakers set at or below its current-carrying capacity. Where conductor ampacity does not correspond to standard ratings for fuses or circuit breakers, the next higher standard size fuse or circuit breaker may be used, up to 150% of the current-carrying capacity of the conductor, per 46 CFR 120/183.380(d).

c. Ampacities of wires (a wire being a stranded copper conductor provided with electrical insulation, which is different from a cable which has one or more wires provided with a protective cable jacket) must meet Section 310-15 of NEC (NFPA 70) or other standard specified by the Commandant. Ampacities of cable must meet table A6 of IEEE 45 per 46 CFR 120/183.340(o). Panelboard circuit breakers, used extensively on SPVs, have a wire termination temperature rating of 75°C. Cable or wire connecting to panelboard circuit breakers should not exceed 75°C at full load or premature tripping of the circuit breaker will occur due to heating. This can be verified by comparing the full load current to the 75°C rating of the wire or cable. Circuit breaker trip settings are based on the cable ampacity at rated temperature (e.g. 75°C, 90°C, or 100°C). **Ideally, provide the wire or cable temperature ratings in a general note, or the cable manufacturer's datasheets, so we can verify proper ampacity**.

d. NOTE: [*Subchapter T vessels only*]: 46 CFR 183.130(b) allows the requirements of 33 CFR 183.430 OR ABYC rules to be applied under certain conditions. We will not review to these standards unless the submitter has explicitly stated that they used this provision to design their vessel. When allowed, 33 CFR 183.430 allows conductors to be rated to SAE Standard, J378, J1127 or SAE Standard J1128. These SAE standards are for boat cable.

7. Bonding and Grounding

a. A vessel's hull must not carry current as a conductor except for the following systems per 46 CFR 120/183.370(a):

(1) Impressed current cathodic protection systems; or

(2) Battery systems for engine starting.

Note: Anything more than one ground to hull connection creates current flow in the hull. When it is not clear from a drawing if the vessel has multiple connections from its ground network to the vessel hull, the plan may be returned for revision. Having multiple ground symbols throughout diagram without tying them together is acceptable as long as a note is included stating that all grounds are tied together to a common ground and (for a metal hull) connected to the hull in one location.

b. A grounded alternating current system must be grounded to the hull of a metallic vessel or, on a nonmetallic vessel, the neutral must be connected to the common ground, except that aluminum ground conductors must not be used, per 46 CFR 120/183.376(d). See Enclosure (2) for additional information on grounding.

8. Circuit Breakers and Fuses

a. Per 46 CFR 120/183.380(m). all circuit breakers shall be:

(1) Of the trip-free manual reset type per UL 489-1995;
(2) Designed for inverse time delay (thermal);
(3) Provide instantaneous short circuit protection (magnetic); and
(4) Rated for switching duty if used as a switch.
Note: An old G-MOC Policy Letter authorized the use of circuit breakers meeting UL 1077 under certain conditions. That letter has been cancelled by the Office of Commercial Vessel Compliance. However, reference (j) now addresses miniature thermal overcurrent circuit breakers on small passenger vessels and allows the following for ***low voltage DC circuits less than 50 volts****:*

i. circuit breakers may meet UL 489; or
ii. UL 1077 if:

a. Verified by an NRTL as meeting UL 1077;
b. Installed in a panelboard; and
c. There is at least one UL-listed fuse or UL 489 certified breaker protecting the main feeder to the panelboard to provide primary branch circuit protection.

b. All generators must be protected by an overcurrent device set at no more than 115% of the generator full load rating, per 46 CFR 120/183.320(f).
Note: While circuit breakers are typically seen, fuses can be used as long as they are properly rated and have the necessary disconnect switch on the supply side, as required by 46 CFR 120/183.380(j).

c. Motor overcurrent protective devices must be sized to support motor starting currents and installed to protect motors, motor conductors, and control devices, per 46 CFR 120/183.380(h). Refer to NEC 2008 Table 430.52 as required by 46 CFR 111.70-1, incorporated by 46 CFR 120/183.380(h)(2).

(1) Overcurrent trip settings, must be not more than 250% of FLA.
(2) For more information, see PRG E2-15.

d. A disconnect must be provided on the supply side of, and adjacent to, fuses per 46 CFR 120/183.380(j).

9. Steering Gear

a. Steering gear systems for Subchapter K vessels must meet Subchapters F and J, as required by 46 CFR 119.600. Further guidance can be found in PRG E2-20.

b. Steering gear systems for Subchapter T vessels must meet 46 CFR 182.600, 182.610, and 182.620.

(1) Control of the main steering gear, including associated devices, must be provided from the operating station, per 46 CFR 182.610(b).
(2) Vessels with a power driven main steering gear must be provided with the following:

i. A disconnect switch (for both power and control circuits) located in the steering compartment, per 46 CFR 182.610(e)(1).
ii. Per 46 CFR 183.380(f), each steering gear feeder circuit must be protected by a circuit breaker that meets the requirements of 46 CFR 58.25-55.

iii. An arrangement that automatically resumes operation, without reset, when power is restored after a power failure (labeled as **low-voltage release** or **"LVR"** on the diagram), per 46 CFR 182.610(f)(3).

(3) Each feeder circuit for steering must be protected by a circuit breaker on the switchboard that supplies it and must have an instantaneous trip (magnetic only; no overload/thermal/long time) set at a current of at least 300-375% of the full-load current of one steering-gear motor for a DC motor, or 175-200% of the locked-rotor current of one steering-gear motor for an AC motor

Note: full-load current for DC motors should be included in the submission. Locked-rotor current should be included with steering gear systems. If it is not known, it can be calculated based off the horsepower, voltage, and the upper end of the NEMA code letter (A-V) range of the motor using the below table and equations.

Locked-Rotor Current Code Letters

Letter Designation	KVA per Hp*
A	0 - 3.15
B	3.15 - 3.55
C	3.55 - 4.0
D	4.0 - 4.5
E	4.5 - 5.0
F	5.0 - 5.6
G	5.6 - 6.3
H	6.3 - 7.1
J	7.1 - 8.0
K	8.0 - 9.0
L	9.0 - 10.0
M	10.0 - 11.2
N	11.2 - 12.5
P	12.5 - 14.0
R	14.0 - 16.0
S	16.0 - 18.0
T	18.0 - 20.0
U	20.0 - 22.4
V	22.4 and up

Locked Rotor Current (LRC)

$$LRC_{\text{single phase}} = \frac{HP \times KVA_{hp} \times 1000}{E}$$

$$LRC_{3\text{ phase}} = \frac{HP \times KVA_{hp} \times 1000}{E \times 1.73}$$

(4) No control circuit of a motor controller, steering-gear control system, or indicating or alarm system may have overcurrent protection except **short circuit protection that is instantaneous and rated at 400-500%** of the current-carrying capacity of the conductor; or the normal load of the system.

Note: A steering control system that is fed from the main feeder circuit for the steering pump, and stepped down to the appropriate voltage for control power, with an instantaneous trip circuit breaker upstream satisfies the short circuit protection necessary to comply with this section of subchapter T. Low DC voltage instantaneous trip only circuit breakers are larger and bulkier than the miniature circuit breakers most commonly used on T boats, but they are commercially available.

10. Lighting

a. Standards:

(1) UL no longer reviews to UL 595 and UL 1570-1574, which are referenced in 46 CFR 120/183.410(d). 46 CFR 111.75-20 was revised after UL updated their standards, and should be used in lieu of these out-of-date sections.

(2) Lighting fixtures over 50V meeting UL 1598A or IEC 60092-306 will be accepted as providing an equivalent level of safety.

(3) Lighting fixtures under 36V meeting UL 1149 or IEC 60092-306 will be accepted as providing an equivalent level of safety. (There are no UL standards for fixtures between 36 and 50V.)
(4) Emergency lighting must meet UL 1598A and be wired so as to meet the CFR requirements for emergency lighting in 46 CFR 120/183.432.
(5) LEDs must meet UL 1598A.
(6) Lighting fixtures in hazardous areas must meet UL 844.
(7) Navigation lights on vessels over 65 feet must meet UL 1104, per 46 CFR 120/183.420. See MTN 01-18 for guidance on the use of LED navigation lights on such vessels. Vessels less than 65 feet in length need only comply with the International and Inland Navigation Rules.

b. Emergency lighting installations are not reviewed by the MSC and will be forwarded to the OCMI for approval.

c. [*Subchapter K vessels only:*] Vessels over 65 feet in length carrying more than 600 passengers or with overnight accommodations for more than 49 passengers must also meet the requirements of 46 CFR 112, per 46 CFR 120.432(c).

11. Load Analysis

a. The load analysis should include connected loads as well as the loads during various operating conditions such as underway, pier-side, DP operations, and emergency.
(1) Guidance on demand factors that may be appropriate for Subchapter T vessels under 65 feet can be found in reference (b).
(2) Guidance on demand factors for all other vessels can be found in Appendix 2 of reference (c).
(3) Vital loads must have a load factor of (1.0) during the emergency operating condition to be as conservative as possible.

b. The loads listed on the load analysis must correspond to those shown on the one-line diagram. The calculated loads must not exceed the corresponding breaker sizes for vital loads, per 46 CFR 120/183.220(b). MSC will not return the plan for revision if non-vital loads will be susceptible to nuisance tripping, but may point this out if the problem is noticed during our review.

c. Verify that power supply, protection, and wiring is sufficient to simultaneously power all vital loads, as listed in 46 CFR 120/183.310(a)(1)(i) through (iv).

d. Vital systems listed in 46 CFR 119/182.710(a)—interior lighting; communication systems, and navigation equipment (including GPS) and lights—must have two sources of power per 46 CFR 120/183.310(a)(1)(i) through (iv).
(1) A source of power may be a generator, alternator, or battery bank with adequate capacity. A battery charger is not considered a source of power unless rated for duty as a continuous supply per 46 CFR 120/183.220(b).
(2) One source of power (but not both, except in some novel designs) may be a battery bank with at least a capacity to provide power to all vital loads for at least 3 hours.

e. [*DC only:*] Battery banks being used as a second power source for vital loads must be sized to provide at least 3 hours of power at full load, per 46 CFR 120/183.310(a)(2). Note that many "reserve capacity" values given in specification sheets are the number of minutes a battery can provide power at 25A, but the vessel may have a very different current draw.

f. [*DC only:*] Battery capacity should be listed in amp-hours and the Full Load Amps (FLA) rating should be given for alternators and battery chargers.
Note: Calculations that assume hours of operation change proportionally as the amperage draw changes are acceptable. Although this is not a perfectly accurate representation of the battery's expected behavior, load analyses are approximate to begin with, so requiring this level of precision is not appropriate. We will not return a load analysis for revision due solely to insufficient battery power on the grounds of Peukert's law calculations.

g. [*DC only:*] Conductors must be sized such that the voltage drop at the load terminals does not exceed 10%, per 46 CFR 120/183.340(p). See 46 CFR Table 120/183.340(p).

Example
Determine necessary conductor size based off conductor length, amperage, and voltage for a 50ft cable run, using a two conductor cable, at 5A at 12VDC.

$$K = 10.75 \frac{\Omega}{mil - ft} x \frac{1\,mil - ft}{12\,mil - inch} = .8933 \frac{\Omega}{mil - ft}$$

$$L = 50\,ft\,x \frac{12\,inches}{1\,ft} = 600\,inches$$

$$E = 12V\,x\,0.10 = 1.2V\ (10\%\ voltage\ drop\ of\ a\ 12V\ system)$$

$$Circular\ Mills\ (CM) = \frac{K\,x\,I\,x\,L\,x\,2\,wires}{E} = \frac{0.8933\,x\,5\,x\,600\,x\,2}{1.2} = 4466.5\ CM\ minimum$$

$$\boldsymbol{Minium\ Wire\ Gauge: 12\ AWG = 6530\ CM}$$

For a 50ft cable run at 5A, a cable must be more than 4466.5 CM, so that the voltage drop is less than 10%. This would mean that 14 AWG, which is only 4110 CM, would not be acceptable, but 12 AWG, which is 6530 CM, would be acceptable. See table 183.340(p) for conductors necessary for various current and length combinations.

TABLE 183.340(p)—CONDUCTOR SIZES FOR AMPERES—LENGTHS

Total current on circuit, amperes	Length of conductor in meters (feet) from source of current to most distant fixture										
	3.1(10)	4.5(15)	6.1(20)	7.6(25)	9.2(30)	10.7(35)	12.2(40)	13.7(45)	15.2(50)	16.8(55)	18.3(60)
	12-volts, 2 wire—10 percent drop wire sizes (A.W.G.)										
5	14	14	14	14	14	14	14	14	12	12	12
10	14	14	14	12	12	12	10	10	10	10	8
15	14	14	12	10	10	10	8	8	8	8	8
20	12	12	10	10	8	8	8	8	6	6	6
25	10	10	10	8	8	8	6	6	6	6	4

h. Bilge Pumps

(1) The primary bilge pump should have a 1.0 demand factor.

(2) A secondary bilge pump can have a zero demand factor, as it is not expected to be used, even in an emergency, while the primary is operating.

(3) Vessels which require two fixed power pumps may use the fire pump as one of their two required bilge pumps. For the load analysis, you would only need to have a 1.0 demand factor for the fire pump. You would not need a 1.0 demand factor for the second bilge pump, as it would be considered the secondary.

(4) Vessels with individual submersible bilge pumps should all have 1.0 demand factors, as all are needed to have complete coverage of the vessel's bilge pumping capabilities.

12. Fire and Smoke Detection

a. Per 46 CFR 118.400(c)/181.405(a), the following spaces are required to have fire detection systems, unless an automatic discharge system ("pre-engineered fixed gas extinguishing system") is installed:

(1) Propulsion machinery spaces;

(2) Spaces containing engines >50hp;

(3) Spaces containing an oil-fired boiler;

(4) [*Subchapter T vessels only:*] Spaces containing machinery powered by, or a tank containing, gasoline or a fuel with a flash point of 110°F or lower.

b. [*Subchapter K vessels only:*] Per 46 CFR 118.405(c), each accommodation, control, and service space must be fitted with a CG-approved smoke-actuated fire detecting system and a manual alarm station unless continuously manned. The following spaces must have manual pull stations, per 46 CFR 76.35-10:

(1) Passageways,

(2) Stairways,

(3) Enclosed public spaces, and

(4) Other readily available public locations.

c. [*Subchapter T vessels only:*] Fiber reinforced plastic (FRP) vessels constructed with general purpose (non-fire-retardant) resins must be fitted with an approved type smoke-activated fire detection system installed in accordance with 46 CFR 76.27, per 46 CFR 177.410(c)(3)(ii). See H1 for any FRP boats to determine resin type.

d. The fire detection system must be listed in reference (i) under “USCG Approved Equipment” > “161.002 – FIRE DETECTION SYSTEMS.” Ensure that all fire detection system components being installed have manufacturer’s part numbers that match those listed. Please note that existing systems are acceptable if they are listed as “Former – May Use,” but not if listed as “Former – Do Not Use.” New systems must be listed as “Approved.”

e. Pre-engineered fixed gas extinguishing systems are permitted for the engine room under 46 CFR 118/181.420(a)(1) through (4). The system must be listed as an approved type.

13. Electronic Propulsion Control Systems

a. Per 46 CFR 121/184.100(b), the OCMI may determine that a vessel’s novel design and/or operating conditions warrant additional review of control systems. Examples of novel design or operation include diesel-electric propulsion or operation. For vessels not covered by existing MSC guidance like PRG E2-29, those situations should be discussed with the Marine Safety Center and handled on a case-by-case basis. Typically, vessels will have to meet all of the requirements of 46 CFR Part 62, including a Failure Mode and Effects Analysis (FMEA) or Qualitative Failure Analysis (QFA), a Design Verification Test Procedure (DVTP), and a Periodic Safety Test Procedure (PSTP).

b. For steam, electric or diesel-electric propulsion systems, and other novel systems that are required to meet 46 CFR Subchapters F and J, per 46 CFR 119.220(a)/ 182.220(b), the following references should be used when submitting automation documentation: PRG E2-05, PRG E2-17, and PRG E2-18.

c. Propulsion control systems (electronic and mechanical) must have two independent means of controlling each engine unless there are multiple engines and each has an independent control system, per 46 CFR 121/184.620(a).

d. The pilothouse control station must have reliable means of shutting down a propulsion engine independent of the engine’s speed control, per 46 CFR 121/184.620(b). This shutdown may not use the control processor in any way; however, it may secure power to the engine-mounted control system (ECU) to shut the engine down.

e. [*Subchapter T vessels only*]: Electronic propulsion control systems must be designed so that a loss of power to the control system does not result in increased shaft speed or propeller pitch, per 46 CFR 184.620(c). A propulsion control system drawing should be submitted along with a ‘Test Protocol’ to verify this, in accordance with reference (h), implemented by reference (g). The Test Protocol should consist of a limited QFA and DVTP, only including analysis of the loss of power to the control system.

f. [*Subchapter K vessels only*]: Per 46 CFR 121.620(d), the vessel must meet the requirements of 46 CFR 62 in addition to 46 CFR 121.620(a) through (c). A propulsion control system drawing should be submitted in addition to documentation meeting the below criteria from part 62, as discussed in reference (h), implemented by reference (g).

(1) 46 CFR 62.20-3(b)(2). Submit a QFA.
(2) 46 CFR 62.20-5. System must be suitable for intended service.

(3) 46 CFR 61.40-3. Submit a DVTP based on the QFA.

g. In addition to loss of power to the control system, any inputs that affect the propulsion system default settings should be included in the QFA/DVTP. Examples of additional inputs include:

(1) Loss of power to components
(2) Loss of signal to the reduction gear
(3) Loss of communication between processors
(4) Control head failure
(5) Transfer control failure between stations

h. A sample format of a QFA and DVTP are enclosed in Enclosure 1. This only shows one type of component failure. The configuration of the system will determine the number of failure modes and component failures which need to be evaluated. See reference (g) for more details.

14. Dynamic Positioning (DP) Systems

(1) See reference (f) for requirements if the vessel has a DP system.

15. 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.

Sample Formatting for QFA and DVTP

Qualitative Failure Analysis (QFA)

Vessel Name:

Item No.	**Component Failed**	**Assumptions or Results**	**Notification to the Crew**	**Alternatives Available**
1	Loss of power supply to port processor	throttle solenoid returns to neutral	audible and visual alarm in the pilothouse	Vessel maintains control on stbd processor and engine

Please note that this is to provide a general formatting guidance only and that each QFA should be tailored to the vessel specific components.

Design Verification Test Procedures (DVTP)

Vessel Name:

Item No.	**Initial Conditions**	**Component Tested**	**Test Procedures**	**Results/Alarms (w/location)**	**Signature, Date**
1	Port engine running and processor on, take command at control station 1	port processor	Secure breaker 10A to port processor in engine room panel	"Port Processor Fail" on display, audible alarm in pilothouse. Port control handle has no effect on the engine, verify stbd controls still has control	

Please note that this is to provide a general formatting guidance only and that each DVTP should be tailored to the vessel specific components.

Note: As per reference (h), implemented by reference (g), a ***propulsion control drawing*** *should be submitted along with the installation/operation test protocol.*

Neutral to Ground Bonding

Ground conductors provide a low impedance path for fault current in grounded power distribution systems to trip overcurrent protective devices upon a single short to ground. There must be only one connection provided between the grounded distribution system neutral and ground. This creates a safety issue with shore power connections for vessels with grounded distribution systems. The shore power grounded distribution system neutral is bonded to the ground at the shoreside power panel to comply with NEC requirements. When a vessel with a grounded distribution system connects to shore power, the neutral to ground bond, required per 46 CFR 183.376(a), must be broken. If this neutral to ground bond is not broken, the neutral to ground bond onboard the vessel will create a parallel circuit and neutral current will flow on both the shore power neutral and the shore power safety ground. This presents an electric shock hazard, posing a threat to passengers and crew, and also may create stray currents that endanger any swimmers or divers in close proximity to the SPV. A search for "Electric Shock Drownings" will show you how real this issue can be when not properly addressed.

Figure (1) below is one example illustrating a properly connected shore power connection to a single phase dual voltage (240/120) grounded power distribution system. The transfer switch allows the neutral to ground bond (at the generator in this case) to be removed upon switching to shore power. This is one solution of the many possible solutions to resolve this issue. Another solution is to install an isolation transformer as shown in figure (2). These images from ABYC E-11 for AC and DC Electrical systems are for illustration purposes only and are not meant to serve as templates for submitters.

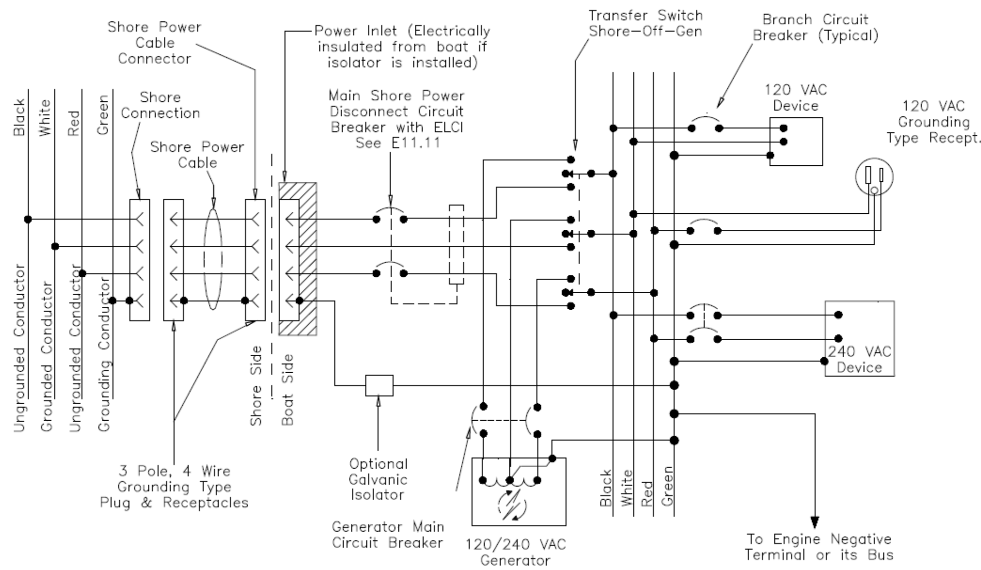

Figure 1 Single Phase 120/240 Volt System With Shore Grounded (White) Neutral Conductor And Grounding (Green)

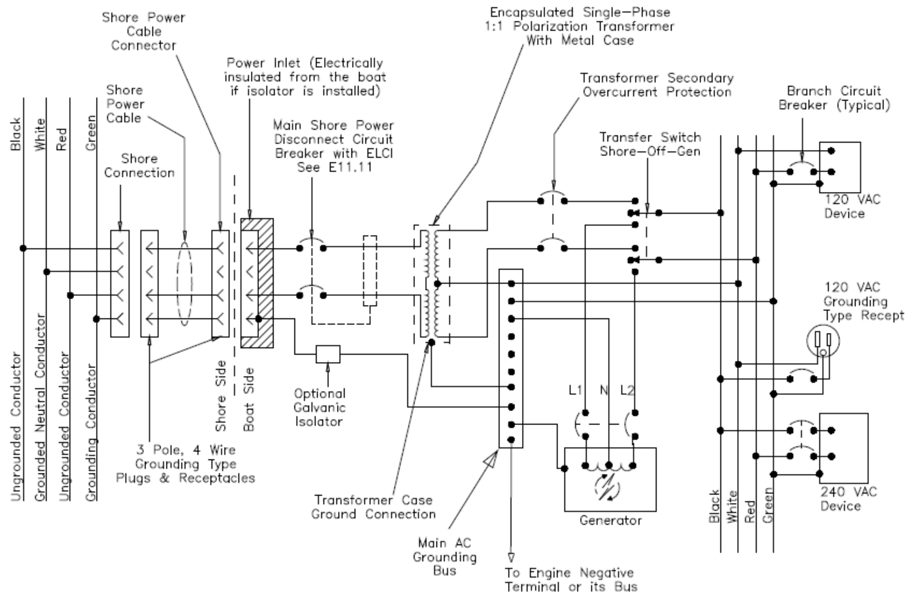

Figure 2 Polarization Transformer System with A Single Phase 240 Volt Input and a 120/240-Volt Output