

MSC Guidelines for Electrical Plans – Small Passenger Vessels

Procedure Number: E2-23

Revision Date: 26Jul17

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Purpose:

This document outlines basic guidance for submitting the proper electrical plans for small passenger vessels to meet the requirements of 46 CFR Subchapters K & T.

References:

- a) 46 CFR 118/181 – Fire Protection Equipment
 - b) 46 CFR 119/182 – Machinery Installation
 - c) 46 CFR 120/183 – Electrical Installation
 - d) 46 CFR Subchapter J – Electrical Engineering
 - e) IEEE Standard 45 (2002): Recommended Practice for Electrical Installations on Shipboard
 - f) American Boat and Yacht Council (ABYC), July 2008: E-11 AC and DC Electrical Systems on Boats; A-16 Electrical Navigation Lights
 - g) Navigation and Vessel Inspection Circular (NVIC) 2-89, “Guide for Electrical Installations on Merchant Vessels and Mobile Offshore Drilling Units”
 - h) MTN 01-03, CH 1, “Guidance on Submitting T-Boat Plans to the Marine Safety Center”
 - i) MTN 01-11, “Plan Approval Extension Procedures”
 - j) MTN 02-11, “Vital System Automation & Dynamic Positioning System”
 - k) G-MOC Policy Ltr No. 11-97, “Use of Miniature Thermal Overcurrent Circuit Breakers on Small Vessels”
 - l) CGMIX, <http://www.cgmix.uscg.mil/Default.aspx>
 - m) COMDT CG-ENG -3 Memorandum 07Jun17 “Microprocessor and Computer Based Propulsion Engine Control Systems on Subchapter K and Subchapter T Boats”
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Contact Information:

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

Email: MSC@uscg.mil

Phone: 202-795-6729

Website: <http://homeport.uscg.mil/msc>

Responsibilities:

The submitter shall provide sufficient documentation and plans to indicate compliance with the requirements outlined in references (a) through (j), as

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applicable to the particular vessel. The submission shall be made electronically to the above email address or, if paper, in triplicate to the MSC's address found on the above website. To facilitate plan review, all plans and information specified in these guidelines should be submitted as one complete package through a single point of contact for the project.

Applicability:

This document contains guidance on all aspects of electrical plan review for vessels being inspected under Subchapters K & T. Other Plan Review Guidelines should not be used unless specifically referenced in this document.

General Guidance:

- Subchapters K and T generally have the same paragraph arrangement. References used in these Guidelines are of 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.
- [*Subchapter T vessels only*]: See enclosure (1) of reference (h) for guidance on what plans to submit to the MSC for review.
- Reference (i) and 46 CFR 116/177.210 provide information relevant to “sister vessel” submittals.
- As per 116/177.202(b)(4), documents/information to be submitted include:
 - a) Elementary one-line diagram;
 - b) Cable lists;
 - c) Bills of materials;
 - d) Type and size of generators and prime movers;
 - e) Power, lighting, and interior communication panelboards;
 - f) Type and capacity of storage batteries;
 - g) Rating of circuit breakers and switches; and
 - h) Load analysis.

Power Generation & Distribution:

- [*Subchapter K vessels only*]: As 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 the following:
 - a) Two generating sets that satisfy 46 CFR 111.10-4, -5, & -9.
 - b) A final emergency power source satisfying 46 CFR 112.01-20, located outside the machinery space.

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- [AC only]: As per 46 CFR 120/183.322(b), for vessels with two or more generators,
 - a) If they are NOT configured for parallel operation, they must have interlocked circuit breakers to prevent this.
 - b) If they can be paralleled, they must comply with 46 CFR 111.12-11(f) and 111.30-25(d).
- As per 46 CFR 120.330(k)/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).
- [AC only]: For shore power receptacles,
 - a) 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, as per 46 CFR 120/183.390(c)&(d).
 - b) The neutral wire should connect to the shore tie.
 - c) A galvanic isolator is permitted but not required.
- [AC only]: Dual-voltage distribution systems should be grounded.
 - a) If the system is grounded, it must be provided with a ground detection system that meets 46 CFR 111.05-27 or -29, as per 120/183.324, and there must only be one connection to ground, regardless of the number of power sources, as per 120/183.376(a).
 - b) If the system is ungrounded, there must be ground detection at the switchboard that continuously indicates the circuit's status to ground, as per 120/183.378.
 - c) It is recommended for safe operation of the vessel, that the ground conductor complies with Table 111.05-31(b).
- 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, as per 120/183.380(b).
- 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, as per 120/183.310(a)(1).
 - a) One of these sources (but not both) may be a battery bank with at least a 3-hour capacity.
 - b) Battery chargers used a power source must be suitable for that purpose.

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- c) If a battery bank is being used as a second power source for vital loads or as a final emergency power source, and is connected to a battery charger having an output of more than 2kW,
 1. it must be located in a dedicated locker, room, or enclosed box and electrical equipment inside must be rated for use in Class I, Div 1, Group B hazardous locations, and meet 111.105 in Subchapter J.
 2. It must be provided with a power exhaust ventilation system in accordance with 46 CFR 111.15-10. Verify that there is a power exhaust ventilation system on the one-line diagram, and that there is a comment to the effect that proper ventilation will be provided.
 - d) If transformers are used to supply a low-voltage switchboard from a medium- or high-voltage switchboard, there must be at least two independent transformers of sufficient size to individually power all of the loads, as per 46 CFR 111.10-9.
 - e) As per 120/183.310(a)(1), power supply, protection, and wiring must be sized to power all vital loads simultaneously.
- [*DC only*]: If the batteries are not adjacent to a distribution panel or switchboard, the following requirements apply:
 - a) The battery lead must have a fuse in series as close as practicable to the battery, as per 46 CFR 120/183.350(g).
 - An emergency switch must be provided in the normally ungrounded main supply conductor located as close to the battery as practicable, as per 183.380(i). This can serve as the means of disconnect required by 120/183.380(j).
 - As per 46 CFR 120.530(a)/182.410(a), electrical equipment located in spaces containing gasoline tanks (or any fuel with a flashpoint under 110°F) or paint lockers must be explosion-proof or ignition-proof or part of an intrinsically-safe system, as required by 111.105.

Circuit Breakers & Fuses:

- Conductors must be protected by fuses or circuit breakers set at or below their current-carrying capacities. Where conductor capacity does not correspond to standard ratings for fuse and circuit breakers, the next higher standard fuse or circuit breaker size available may be used, up to 150% of the current-carrying capacity of the conductor, as per 46 CFR 120/183.380(d).
- Ampacities of wires must meet section 310-15 of NFPA 70 or other standard specified by the Commandant. Ampacities of cable must meet

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table A6 of IEEE 45-1977 (Incorporated by reference) per 46 CFR 183.340(o). Conductors are normally sized based on their rating at 90°C. However, conductors connected to panelboards or miniature circuit breakers should be sized based on their rating at 75°C to prevent exceeding the temperature rating of the circuit breaker.

NOTE: [Subchapter T vessels only]: When meeting ABYC rules as allowed by 46 CFR 183.130, electric navigation lights can have a switch to display the complete navigation light configuration as required for the vessel while underway and the other switch position for the anchor light only ABYC A-16.6.5.

- The following requirements apply to circuit breakers:
 - a) They shall be of the trip-free manual reset type per UL 489-1995 (incorporated by reference). Meaning the contacts cannot be held in the closed position by the means of operation during trip command conditions.
 - b) They must be capable of repeatedly opening the circuit in which it is to be used without damage to the circuit breaker.
 - c) They must be designed for inverse time delay, provide instantaneous short circuit protection, and be rated for switching duty if used as a switch, as per 46 CFR 120/183.380(m).
 - d) They must be certified by a nationally-recognized testing laboratory (NRTL).
 - e) For DC systems over 50V and AC systems of any voltage, circuit breakers must conform to the requirements of Underwriters Laboratory (UL) 489, Molded-Case Circuit Breaker.
 - f) For DC systems under 50V,
 1. circuit breakers may meet UL 489; or
 2. per reference (k), circuit breakers may meet UL 1077, Supplementary Protectors for Use in Electrical Equipment, if;
 - i. an NRTL has verified that they meet UL 1077;
 - ii. they are installed in a panel board; and
 - iii. there is at least one UL listed fuse or UL 489 certified breaker protecting the main feeder to the panel board to provide primary branch circuit protection.

NOTE: While ABYC has broader and generally less stringent standards for overcurrent breaker design such as UL 1077, there is additional analysis applied to the specific application. ABYC incorporates a stepped Ampere Interrupting Capacity (AIC) rating that overcurrent breakers must meet, based on assumed short circuit current of the battery installation. Although

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it is possible for overcurrent breakers meeting this alternate standard to comply with the 'Main Circuit Breaker' requirements in ABYC, it is common for the system to incorporate a fuse in series with the battery lead per 46 CFR 183.350; making the fused overcurrent breaker a 'Branch Circuit Breaker' subject to the lower AIC rating in ABYC E-9.11 Table II. This configuration is typically within range of most available 1077 breakers, and found in existing vessels.

- [AC only]: All generators must be protected by an overcurrent device set at no more than 115% of the generator full load rating, as per 120/183.320(f).

NOTE: AC systems can use fuses as long as they are properly rated and have the necessary disconnect switch on the supply side as required by 120/183.380(j).

- 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).
 - a) Overcurrent trip settings must be not more than 250% of FLA.
- A disconnect must be provided on the supply side of, and adjacent to, fuses as per 46 CFR 120/183.380(j).

Steering Gear:

- Steering gear requirements for Subchapter K vessels can be found in PRG E2-20 Steering-Gear Electrical Systems.
- Steering gear requirements for Subchapter T vessels can be found in 46 CFR 182, Subpart F-Steering Systems
 - a) Control of the main steering gear, including associated devices, must be provided from the operating station.
 - b) Vessels with a power driven main steering gear must be provided with the following:
 1. A disconnect switch (for both power and control circuits) located in the steering compartment.
 2. 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. In accordance with 46 CFR 58.25-55(c), the motor must have a device that activates an audible and visible at the main machinery-control station if an overload condition exists
 3. An independent rudder angle indicator at the operating station.
 4. An arrangement that automatically resumes operation, without reset, when power is restored after a power failure.

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5. A limit switch to stop the steering gear before it reaches the rudder stops.
6. Vessels more than 65 feet in length must be provided with a visual means, at the operating station, to indicate operation of the power units.
- c) Per 46 CFR 182.620 (b) & (c), auxiliary steering gear is not required if:
 1. A suitable hand tiller is installed and acceptable to the OCMI.
 2. There is a duplicate main steering gear and controls.
 3. There are multiple screws with independent pilothouse control for each screw.
 4. There is no regular rudder, and steering is obtained by a change of setting of the propelling unit.
 5. The main steering gear is a rudder and hand tiller.

Lighting:

- Standards:
 - a) UL no longer reviews to UL 595 and UL1570-1574, which are called out in 46 CFR 120/183.410(d).
 - b) Lighting fixtures over 50V meeting UL 1598A or IEC 92-306 will be accepted as providing an equivalent level of safety.
 - c) Lighting fixtures under 36V meeting UL 1149 or IEC 92-306 will be accepted as providing an equivalent level of safety.
 - d) Emergency lighting must meet UL 1598A and be wired so as to meet the CFR requirements for emergency lighting in 183.432
 - e) Lighting fixtures in hazardous areas must meet UL 844.
 - f) Navigation lights must meet UL 1104, as per 120/183.420. Vessels less than 65 feet in length inspected under Subchapter T need only comply with the International and Inland Navigation Rules.
- Emergency lights must actuate automatically upon loss of the main lighting system. Battery banks for emergency lights must have sufficient capacity to provide continuous operation for a minimum of 2 hours, as per 46 CFR 120/183.432(b).
- [*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, as per 120.432(c).

Miscellaneous Components:

- Bilge pumps must be provided on a vessel in accordance with Table 120/182.520(a). A second power pump is an acceptable alternative to a

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hand pump if it is supplied by a source of power independent of the first power bilge pump.

- A catamaran vessel must be equipped with bilge pumps for each hull, as per 46 CFR 119/182.520(j).
- As per 46 CFR 119/182.530(a), bilge high-level visual and audible alarms are required on vessels 26 feet or longer.

Load Analysis:

- 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.
 - a) Guidance on demand factors for Subchapter T vessels under 65 feet can be found in reference (f).
 - b) Guidance on demand factors for all other vessels can be found in Appendix 2 of reference (g).
- [*DC only*]: Battery banks being used as a second source of power for vital loads must be sized to provide at least 3 hours of power at full load, as per 46 CFR 120/183.310(a)(2).
- [*DC only*]: Battery capacity should be listed in amp-hours and the Full Load Amp (FLA) or output rating should be given for alternators and battery chargers.
- [*DC only*]: Conductors must be sized such that the voltage drop at the load terminals does not exceed 10%, as per 46 CFR 120/183.340(p).

Fire & Smoke Detection Systems:

- As per 46 CFR 118/181.400(c), the following spaces are required to have fire detection systems, unless an automatic discharge system (“pre-engineered fixed gas extinguishing system”) is installed:
 - a) Propulsion machinery spaces;
 - b) Spaces containing engines >50hp;
 - c) Spaces containing an oil-fired boiler;
 - d) [*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.
- [*Subchapter K vessels only*]: As per 46 CFR 118.400(e), each accommodation, control, and service space must be fitted with a CG-

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approved smoke-actuated fire detecting system and a manual alarm station unless continuously manned. The following spaces must have manual pull stations, as per 76.35-10:

- a) Passageways;
- b) Stairways;
- c) Enclosed public spaces; and
- d) Other readily available public locations.

- [Subchapter T vessels only]: As per 46 CFR 181.400(e), overnight accommodation spaces must be fitted with an independent modular smoke detection unit meeting the requirements of 181.450.
- [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, as per 177.410(c)(3).
- The fire detection system must be listed in reference (I) under “USCG Approved Equipment” > “161.002 – FIRE PROTECTIVE SYSTEM.” 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.”
- Pre-engineered fixed gas extinguishing systems are permitted for the engine room under 46 CFR 118/181.420(a). The system must be listed in reference (I) as an approved type.

Electronic Propulsion Control Systems:

- Steam, electric or diesel-electric propulsion systems, and other novel systems that are required to meet 46 CFR Subchapters F & J, as per 119/182.220(b), may use the following references to develop full-ship testing documents:
 - a) PRG E2-05 DVTP “Design Verification Test Procedure”
 - b) PRG E2-17 PSTP “Periodic Safety Testing Procedure”
 - c) PRG E2-18 QFA “Qualitative Failure Analysis”
- 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, as per 46 CFR 121/184.620(a).

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- The pilothouse control station must have reliable means of shutting down a propulsion engine independent of the engine's speed control, as per 46 CFR 121/184.620(b).
- [*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, as per 184.620(c). A propulsion control system drawing should be submitted along with a 'Test Protocol' to verify this, in accordance with reference (m). The Test Protocol should consist of a limited QFA and DVTP, only including analysis of the loss of power to the control system.
- [*Subchapter K vessels only*]: As per 46 CFR 121.620(d), the vessel must meet the requirements of part 62 in addition to 46 CFR 121(a) through (c). A propulsion control system drawing should be submitted in addition to documentation meeting the below criteria from part 62, as modified in reference (m).
 - a) 46 CFR 62.20-3(b)(2). Submit a QFA.
 - b) 46 CFR 62.20-5. System must be suitable for intended service.
 - c) 46 CFR 61.40-3. Submit a DVTP based on the QFA.

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

A sample format of a QFA and DVTP are enclosed in Appendix 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.

Dynamic Positioning Systems:

- See reference (j) for requirements if the vessel has a DP system.
- The following documents must be submitted for review:
 - a) DP Operations Manual
 - b) DP FMEA
 - c) DP Proving Trials

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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 the Marine Safety Center (MSC), the unit responsible for implementing this guidance.

Appendix 1:

Sample Formatting for Qualitative Failure Analysis (QFA) and Design Verification Test Procedures (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
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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	
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Please note that this is to provide a general formatting guidance only and that each DVTP should be tailored to the vessel specific components