MSC Guidelines for Electrical One-Line Diagram

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References:

a. 46 CFR Subchapter J, 1996 with amendments effective Sept. 25, 2009
b. National Electric Code, 2002 edition
c. American Bureau of Shipping; *Rules for Building and Classing Steel Vessels*, 2003 (SVR)
d. American Bureau of Shipping; *Rules for Building and Classing Mobile Offshore Drilling Units*, 2001 (MODU)
e. SOLAS, 1974 with amendments to date
f. Navigation and Inspection Circular (NVIC) 2-89, "Guide for Electrical Installations on Merchant Vessels and Mobile Offshore Drilling Units", can be found at: **www.uscg.mil/hq/cg5/nvic/pdf/1989/n2-89.pdf**
g. IEEE Standard 45, 1998 or 2002 edition, as incorporated

Contact Information:

If you have any questions or comments concerning this document, please contact the Marine Safety Center by e-mail or phone, referring to Procedure Number: **E2-07**

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Responsibilities:

Using applicable portions of references (a) through (g), the submitter shall provide sufficient documentation and plans to support electrical plant design review. For a typical electrical one-line diagram, plans include: detailed one line diagram of power system, panel board summaries, load analysis, short circuit analysis, breaker coordination study, switchboard details and generator details. The submission shall be made in triplicate. To facilitate plan review and project management, all plans and information specified in this guideline should be submitted as one complete package through a single point of contact for the project.

General Guidance:

System	**Ref. (46 CFR)**
1. Generators	
❑ At least two ship service generators	111.10-3
❑ Parallel operation	111.12-7
❑ Protection	111.12-11(c)(2)&(f)
These sections of reference (c) are incorporated by reference (110.10-1), see for compliance:	4-2-3/7.5.2, 4-2-4/7.5.2, 4-8-3/3.13.2, 4-8-3/3.13.3

General Guidance (continued):

1. Generators (continued)

These sections of reference (d) are incorporated by reference (110.10-1), see for compliance:	4-3-4/3.21.2, 4/3.21.3, 4/3.23.2 & 4/3.23.3
❑ With any Ship Service Generator down, the remaining set/sets must carry the load	111.10-4(a)(b)(c)
❑ The emergency generator must be capable of carrying its full rated load within 45 seconds	112.50-1(d)
❑ Continuous and uninterrupted source	111.10-4(d)
❑ Low voltage switchboards must meet the section 8.3 of IEEE 45-2002 or IEC 60092-302	111.30-5(a)(1)&(b)
❑ Medium voltage switchboards must meet the section 8.4 of IEEE 45-2002 or IEC 92-503	111.30-5(a)(2)&(b)

2. Generator Cable Size

❑ At least 115% of the continuous rating or overload rating of generator	111.12-9

3. Generator Circuit Breakers

❑ Must be less than 115% of the generator rating for a continuous rated machine or 115% of the overload rating for a machine with a 2-hour or greater overload rating	111.12-11(d)
❑ Located on S.S. Gen switchboard	111.12-11(g)
❑ Shore power connection	111.30-25(f) or -27(f)
❑ If instantaneous trip - must be set as close as practicable, above max asymmetrical short circuit	111.12-11(e)

4. Buses

❑ General requirements, must meet section 7.10 of IEEE 45-1998 or IEC 60092-302	111.30-19
❑ Requirements outlined for A.C or D.C switchboards	111.30-25 or -27
❑ Each generator switchboard must have a disconnect switch, link or circuit breaker that disconnects each generator conductor. If there is a switch in the neutral, there must also be some type of disconnect for each ungrounded conductor	111.30-25
❑ If more than 3000 KW of ship service power, the switchboard must have at least two sections of the main bus connected by a disconnect switch, removable link or non-automatic circuit breaker	111.30-24

General Guidance (continued):

5. Cable Sizing
   - ❑ Meet construction and testing requirements 111.60-1
   - ❑ Size for demand loads 111.60-7
   - ❑ Minimum cable conductor size 111.60-4
     - Power & Lighting - 14AWG or larger
     - Thermocouple or pyrometer cable - 22AWG or larger
     - Otherwise - 18AWG or larger

6. Cable Protection (Fuse or Circuit Breaker)
   - ❑ In general, sized to the allowable current carrying capacity of the conductor 111.50-3(b)
   - ❑ If not standard size, the next larger size may be used but must not be larger than 150%; standard sizes are in section 240.6 of the NEC 111.50-3(c)

7. Segregation of Vital Circuits
   - ❑ Circuits supplying equipment vital to the propulsion, control or safety of the vessel must not supply other equipment 111.60-9

8. Steering Gear System
   - ❑ Instantaneous circuit breaker set at 175% to 200% of locked-rotor current 58.25-55(a)(2)
   - ❑ Low voltage release required 111.70-3(b)
   - ❑ Feeder circuits must have two sources of power one being the ship service switchboard, the other can be the emergency switchboard 58.25-65(a)
   - ❑ Feeder circuits required - at least two - must have a current carrying capacity of 125% of full load rating of motor 58.25-65(d)(1)
   - ❑ Alarms 58.25-25(c)(d) & (e)
   - ❑ A vessel 1600 GT and over must have a steering failure alarm system fed from a final emergency power source. It must have no overcurrent protection except a circuit breaker set at 400 to 500% of the smallest alarm interconnecting conductor 113.43-5

9. Fire and Bilge Pumps
   - ❑ May be required on certain vessels to be powered by the emergency power source. 112.15-5(d)&(e)
   - ❑ Low voltage release required for fire pump, elevator and steering gear or auxiliary that is vital to the vessel's propulsion system 111.70-3 (b)

General Guidance (continued):

10. Motors

❑ Large motors starting current shall not produce a voltage dip in excess of 18% at generator switchboard	IEEE STD 45
❑ Branch-circuit conductors supplying a single motor shall have an ampacity not less than 125% of the motor full-load current rating	111.60-7 and NEC 430-22
❑ If more than one motor on a branch-circuit see ref.	NEC 430-24
❑ Circuit Breakers	111.60-7 ref.
• For A.C. see reference	NEC 430-32
• ABS Rules as referenced by	111.70-l(a)
❑ Disconnects located in sight of motor and externally operable	111.70-l(c)
❑ Low voltage release required for all vital loads which include: fire pump, elevator and steering gear or auxiliary that is vital to the vessel's propulsion system	111.70-3 (b)
❑ Motor starting current and short-time sustained current of additional low voltage release loads must be within the capacity of one generator	111.70-3 (b)
❑ Low voltage protection is required if motor is 2 HP (1.5KW) or more	111.70-3 (c)

11. Grounded Systems

❑ Neutral Grounding - If there is a neutral bus or conductor it must be grounded	111.05-15
❑ If tank vessel, less than 1000 volts Line-to-line, it must not have a grounded distribution system. This also means no 4 conductor cable	111.05-19
❑ Must have only one point of connection to ground	111.05-13
❑ Distribution system grounding	111.05-17
• Must be provided at generator switchboard	
• Can't be grounded directly at emergency switchboard	
• If it has a neutral bus it must be permanently connected to the bus on the main switchboard	
• Must not have a switch, circuit breaker, or fuse in the neutral conductor of the bus-tie connecting the emergency to main switchboard	
❑ Medium voltage, high resistance grounding, see ref.	IEEE STD 45, 1998, 11.39.1

12. Ground Detection

❑ At ship's service switchboard, except for propulsion system which will be at propulsion switchboard	111.05-23
❑ There must be ground detection for:	111.05-21

General Guidance (continued):

- Electric propulsion systems
- Ship's Service power
- Lighting Systems
- Power or lighting that is isolated from ship's
- Service power by transformer or motor generator

❑ If neutral grounded, an ammeter must be installed which can indicate current in the ground connection, and be available to withstand the maximum available fault current	111.05-27
❑ Dual voltage system - must have a range of at least 150% of the neutral current rating and indicate the polarity of the fault	111.05-29
❑ Ungrounded system - must be located at the switchboard and provide continuous indication of circuit status to ground	111.05-25

13. Emergency Power

❑ General requirements	112.05
❑ Required emergency loads	112.15-5
❑ Sized to supply all connected load with unity service factor.	112.05-1(c)
❑ Final emergency power source must support all connected loads in no more than 45 seconds	112.25-10

14. Bus-tie between main and emergency switchboard

❑ Must disconnect automatically upon loss of potential at the emergency switchboard	112.05-3(a)
❑ Be arranged to prevent parallel operation of an emergency source with any other source	112.05-3(c)(2)
❑ If arranged for feedback operation, it must open automatically upon overload of emergency power source. (Exception – Vital loads approved by MSC)	112.05-3(c)

15. Transformers

❑ Overcurrent protection requirements	111.20-15 ref. NEC 450.3(a) or (b)
❑ High or Medium voltage supply requires two transformers	111.10-9
❑ If current is less than 9 amps see exceptions in NEC 450-3(b). Also, if protection on primary and secondary see NEC 450-3(b)(2). Ratings for primary (250%) and secondary (125%).	111.20-15

General Guidance (continued):

16. Batteries

- ❑ Battery installation properly classed: 111.15-3
  - Large >2 kW
  - Moderate 0.2-2.0 kW
  - Small <0.2 kW
- ❑ Proper ventilation for battery category 111.15-10
- ❑ Overload protection device 111.15-25(a)

17. Lighting

- ❑ Cable for a 15 ampere circuit or less shall be14 AWG or larger. Cable for a 20 ampere circuit shall be 12 AWG or larger 111.75-5
- ❑ Lighting branch circuits must be protected by overcurrent protection rated at 20 amperes or less. 111.75-5(d)
- ❑ Navigation light feeders shall be of suitable size, type and protected by overcurrent protection rated at twice that of the navigation light panel's main fuse. The navigation light panel shall be supplied from the emergency switchboard 111.75-17(a) & 112.43-13
- ❑ Two lighting circuits for machinery spaces 111.75-15(b)
- ❑ Self-propelled vessels must have dual light sources for side, masthead, stern and range lights. Not applicable for offshore supply vessels 111.75-17(c)
- ❑ 25 or 30 ampere lighting branch circuits shall be only non-switched lighting fixtures for cargo holds or deck lighting. Cable shall be 10 AWG or larger and of a suitable type 111.75-5(e)
- ❑ Verify lifeboat and or liferaft flood lights are provided with proper cable and overcurrent protection. These lights shall be off the emergency power circuit 111.75-16, 112.43-11 & 112.43-7
- ❑ A signal light is required on vessels over 150 gross tons on international voyages. The signal light shall not be solely dependent upon the vessel's main source of electrical power. A suitable type light would be left for approval to the OCMI 111.75-18

18. Remote stops

- ❑ Two remote stops provided for power ventilation 111.103-1
- ❑ Machinery remote stop shall be provided for each forced or induced draft for, fuel oil pump, etc. 111.103-9
- ❑ Shall be wired so that damage to switch or cable will 111.103-7

automatically stop controlled equipment

19. Miscellaneous

- Appliances and Appliance Circuits shall have overcurrent protection rated at not more than 150% of the rating of the appliance or 15 amperes, whichever is higher. 111.77-1

General Guidance (continued):

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.