Ship's Service Generator/Switchboard

Procedure Number: E2-21 Revision Date: 03/09/99

References:

a. Title 46 CFR 111.

b. International Electrotechnical Commission (IEC) 92-302, "Electrical Installations on Ships"

c. IEEE Std 45-1998, "Recommended Practice for Electrical Installations on Shipboard"

d. Navigation and Inspection Circular (NVIC) 2-89, "Guide for Electrical Installations on Merchant Vessels and Mobile Offshore Drilling Units" (See http://www.uscg.mil/hq/g-m/nvic/index.htm)

e. Safety Of Life at Sea (SOLAS), Consolidated Editions, 1997, Chapter II-1, Part D

f. American Bureau of Shipping (ABS), "Rules for Building and Classing Vessels under 90 Meters in Length", 1996

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These guidelines were developed by the Marine Safety Center staff as an aid in the preparation and review of vessel plans and submissions. They were developed to supplement existing guidance. They are not intended to substitute or replace laws, regulations, or other official Coast Guard policy documents. The responsibility to demonstrate compliance with all applicable laws and regulations still rests with the plan submitter. The Coast Guard and the U. S. Department of Transportation expressly disclaim liability resulting from the use of this document.

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E2-21

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General Review Guidance

- Each self-propelled vessel must have at least two electric generating sources which are capable of providing continuous and uninterrupted power. This shall be verified using the load analysis, additionally the aggregate capacity of the generators must be sufficient for the ship's service loads. (111.10-3)

- The generator and its switchboard shall be located in the same space; a control room inside the machinery casing is considered the same space. (111.12-11(g))

- The switchboard shall be located in a dry location and shall be accessible from the front and rear. Ample space shall be provided in front of the board for maintenance. An insulating mat shall be provided in the front and rear of the board. (111.30-1)

- The capacity of the ship's service generators, excluding the generator with the largest capacity, shall be sufficient to supply those services necessary for normal operational conditions and comfortable conditions of habitability. (111.10-4(b)).

- The generator shall be rated for 50^0 C ambient temperature, otherwise the generator shall be derated. (111.01-15(e))

- Prime movers shall conform to design requirements of the following section of reference (f) as applicable: 4/5C2.15 (gas turbines), 4/5C2.17 (diesel engines) or 4/3.21 (MODUs). (111.12-1(a))

- If the generator is directly coupled to the prime mover, the prime mover must automatically shutdown in the event of loss of lube oil pressure to the generator bearing. (111.12-1(c))

- Switchboards for a 600 volt or less distribution system shall meet the following construction guidelines: (111.30-5, 111.30-15)
  - Dead front type
  - Front panel sections shall be hinged unless rear access is available
  - Hinged panels > 45" height or 24" width have panel positioners
  - Drip proof covers
  - Nonconducting handrail attached to board front and backs
  - Sheet metal end covers with ventilation louvers/grilles
  - Each device must have a nameplate indicating the device function
  - Each breaker must have a nameplate indicting connected load and breaker setting.

- Each switchboard must be equipped with the following components for each connected generator: (111.30-25(b) & (g))
  - Neutral disconnect link or switch (as applicable)
  - Generator power pilot lamp
  - Ammeter/switch capable of indicating the separate phase currents
  - Voltmeter capable of indicating phase, bus and shore power voltages
  - A voltage regulator and voltage regulator cutout switch
  - Ground detection (If neutral grounded system, a meter is required)
  - Frequency meter
  - Exciter field rheostat
  - Shore power breaker or fused switch (1)
  - Shore power pilot light (1)

- Each generator shall be protected by an individual trip-free circuit breaker, located on the switchboard, with a longtime overcurrent trip set at 115% (maximum) of the continuous generator rating or 115% of the overload for a unit with a 2 hour or greater overload rating. (111.12-11(b) & (d))

- The generator circuit breaker must have poles for each generator lead with the exception of the neutral lead. (111.12-11(h))

- The generator circuit breaker shall not automatically close after tripping. (111.12-11(j))

- Instantaneous trip protection shall be provided if three or more generators can be paralleled. The trip shall be set as close to the maximum asymmetrical short circuit current available from any one generator. (111.12-11(c) & (e))

- Reverse power or reverse current relays shall be provided for each generator that is arranged for parallel operation. (111.12-11(f))

- For generators capable of parallel operation, the switchboard shall be equipped with the following components: (111.30-25(d))
  - Speed control for each generator prime mover
  - Wattmeter for each generator
  - Synchroscope, synchronizing lamps and switch arrangement.

- The current carrying capacity of the generator cables must not be less than 115% of the continuous generator rating or 115% of the overload for a unit with a 2 hour or greater overload rating. (111.12-9)

- The neutral conductor of a dual voltage system must be solidly grounded at the generator switchboard. (111.05-15)

- The neutral grounding conductor shall be sized in accordance with 46 CFR, Table 111.05-31(b).

- Generator excitation shall be in accordance with section 4/5C2.19.1 of reference (f). A static exciter is not acceptable unless provided with a permanent or residual magnetism type exciter capable of voltage buildup after two months of no operation. (111.12-3)

- Voltage regulation and parallel operation shall conform to sections 4/5C2.19.2, 4/5C2.19.3, 4/5C2.21.2 and 4/5C2.21.3 of reference (f).

- Bus bars shall be sized to limit the bus bar temperature to 50^0C at rated current. Refer to reference (c), section 17.11 and table A27 for proper sizing. (111.30-19)

- The switchboard/breakers shall have an interrupting rating greater than the maximum asymmetrical short circuit current. This shall be verified by the short circuit analysis. (111.52)

- Switchboard instrument circuits, except the voltage regulator, circuit breaker tripping control devices and any device that creates vessel hazard if tripped, must have overcurrent protection (111-30-17(b))

- Current transformer secondary circuits shall not be fused. (111.30-17(d))

- The switchboard circuit breakers shall comply with article 240 and 380 of the NEC or IEC 92-302, as applicable. The breakers shall have an interrupting rating sufficient to withstand the maximum asymmetrical short circuit current available.

- Molded circuit breakers conforming to UL 489/489SA or IEC 947-2 are acceptable for voltages of 600 volts or less. Breakers for voltages greater than 600 volts shall conform to IEEE C37.13, IEEE Std 331 or IEC 947-2, part 2. (Title 46 CFR 111.54-1(c)). The generator shall be rated for 50^0 C ambient temperature, otherwise the generator shall be derated. (Title 46 CFR 111.01-15(e))

- The switchboard circuit breakers must be mounted or arranged to allow removal from the front of the switchboard without unbolting bus or cable connections or de-energizing the supply unless the switchboard is divided into sections capable of providing power to the vessel. (111.30-4)

- Switchboard components and busbar connections must be accessible from the rear of the switchboard or be located within 20 inches of the switchboard front. (111.30-3)

- Switchboard wiring shall not be less than AWG #14, rated at 90^0 C or higher, stranded, UL 1581 flame test. (111.30-19(b))

General Notes

Attachments:

- Switchboard diagrams make use of "American Standard Device Function Numbers". Other standards (e.g. European) are used, but the ASDFN are most prevalent in the U.S. These numbers are shorthand for common device functions that appear next to the device. For example, the marking "12" means "over speed device" and the marking "52" means "AC circuit breaker". These codes often have prefixes and suffixes. A prefix typically differentiates between multiple generators, e.g. "152" means "#1 ship's service generator breaker" and "E52" means "Emergency generator breaker". A suffix usually denotes an auxiliary function, e.g. "E52Y" may stand for an auxiliary contact in the emergency generator that activates the "breaker closed" light.
- Switchboard diagrams are typically zoned (similar to a road map). These zones are a necessity because of the numerous relays found in the circuits. A relay coil and it's associated contact are mapped to each other using these zones; e.g. the number "F25" above a relay coil is the location of the contact closed by that coil.
- In addition to the "American Standard Device Function Numbers", switchboard diagrams often employ other shorthand notation. For example "CBTD" may stand for "circuit breaker close time delay" and "MCT" may stand for "metering current transformer". Such shorthand notation is not standard and a legend should be included in the submission. Sometimes revisions of submittals do not include legends such as these-- they only include the revised pages. In this case the legend may be found in prior revisions, or else must be requested from the submitter.

- While relays are usually taught and more easily understood as DC devices, in practice AC relays are commonly used. These relays typically employ shaded poles, similar to the shaded pole induction motor. A shaded pole is a coil loop which is not separately excited by the relay source; it is excited by the flux on the main relay coil. This coil then produces an opposing current, flux and voltage (Faraday's and Lenz's law) which holds the contact during zero voltage intervals on the main coil. Failure of the shaded pole leads to "relay chatter"— a 120 Hz clicking that occurs every time the main relay voltage crosses the zero point.
- Opening of the circuit breaker upon shutting down of the prime mover (required by 111.12-11), is typically accomplished with an undervoltage relay.