MSC Guidelines for Short-Circuit Analysis

Procedure Number: E2-19 Revision Date: 10/28/2014

S. T. Brady , CDR, Chief of Engineering Division

Purpose:

This document outlines acceptable methods for performing a short-circuit analysis to ensure that electrical system components are properly rated for the maximum fault current they may be subjected to in service.

References:

a) 46 CFR 111.52 – Calculations of Short-Circuit Currents
b) MSC Plan Review Guidelines (PRGs): E2-04 Circuit Breaker Coordination Study; E2-06 Electrical Load Analysis; E2-07 Electrical One-Line Diagram; E2-21 Ship Service Generator Switchboard
c) IEEE Standard 141-1993, "IEEE Recommended Practice for Electric Power Distribution for Industrial Plants"
d) Navigation and Vessel Inspection Circular (NVIC) 2-89, "Guide for Electrical Installations on Merchant Vessels and Mobile Offshore Drilling Units," http://www.uscg.mil/hq/cg5/nvic/pdf/1989/n2-89.pdf
e) ABS "Rules for Building and Classing Steel Vessels 2003, Part 4"
f) Naval Sea Systems Command (NAVSEA) Design Data Sheet DDS 300-2, "A.C. Fault Current Calculations," 1988
g) IEC 61363-1, "Procedures for Calculating Short-Circuit Currents in Three-Phase AC"

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 E2-19.

Email: MSC@uscg.mil
Phone: 703-872-6729
Website: http://homeport.uscg.mil/msc

Responsibilities:

The submitter shall provide sufficient documentation and plans to indicate compliance with the applicable requirements outlined in references (a) through (g). 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.

MSC Guidelines for Short-Circuit Analysis

Procedure Number: E2-19 Revision Date: 10/28/2014

Background:

Fault current calculations are necessary to properly select the type, interrupting rating, and tripping characteristics of power and lighting system circuit breakers and fuses. Results of the fault current calculations are also used to determine the required short-circuit ratings of power distribution system components including bus transfer switches, variable speed drives, switchboards, load centers, and panelboards. In calculating the maximum fault current, it is necessary to determine the total contribution from all generators that may be paralleled and the motor contribution from induction and synchronous motors.

General Guidance:

- Review reference (b) [E2-07] to validate that all of the information necessary to conduct the short circuit analysis review has been provided, including proper equipment selection.

- Fault current calculations must be performed using the total contribution from all generators capable of operating in parallel. Fault current calculations must also include the motor contribution from the largest probably motor load. Fault current calculations must include faults on the load side terminals of each distribution system protective device, as per 46 CFR 111.52-1.

- If the vessel total generator capacity is below 1500kW, the following simplified calculations may be used, as per 46 CFR 111.52-3:
  a) For DC systems, the maximum short-circuit current is assumed to be 10 times the aggregate normal rated generator currents plus 6 times the aggregate normal rated currents of all motors that may be operating. DC protective devices should be rated above this short-circuit current, as per 46 CFR 111.52-3(a).
  b) For AC systems, the maximum asymmetrical system short-circuit current is assumed to be 10 times the aggregate normal rated generator currents plus 4 times the normal rated currents of all motors that may be operating. AC protective devices should be rated above this short-circuit current, as per 46 CFR 111.52-3(b).
  c) For AC systems, the average asymmetrical system short-circuit current is assumed to be 8½ times the aggregate normal rated generator currents plus 3½ times the aggregate normal rating currents of all the motors that may be operating. AC protective devices should be rated above this short circuit current, as per 46 CFR 111.52-3(c).

- For vessels with aggregate generator capacity of 1500kW and above, detailed fault current calculations must be submitted, as per 46 CFR 111.52-5. The submittal should include a summary of maximum short-circuit currents.
  a) The summary should address a three-phase bolted fault on the load side of each protective device with all generators operating in parallel and powering the largest probable motor load.
  b) The summary should include adequate data to validate fault current calculations. This data should include, but not be limited to, the following:
     1. generator resistance and reactance data,
     2. motor rating and reactance-to-resistance (X/R) ratio,
     3. transformer per-unit impedance, and
     4. cable type, length, and impedance.
  c) The summary should validate that the maximum fault current calculated at each fault location does not exceed the associated component rating. Reference the electrical one-line and switchboard diagrams as applicable.
  d) Acceptable short-circuit calculation methods, as per 46 CFR 111.52-5, include:
     1. Exact calculations using actual impedance and reactance values of system components.
     2. Estimated calculations using reference (f).
     3. Estimated calculations using reference (g).
     4. Estimated calculations using a commercially-established power system analysis software. All input data used in the analysis is to be provided for review.

- Verify that the following equipment and systems can withstand the calculated fault currents with a reasonable margin:
  a) main, emergency, and auxiliary switchboard bus bracing and circuit breakers,
  b) load centers, distribution panels, and circuit breakers,
  c) motor control centers (MCCs) and circuit breakers,
  d) automatic and manual bus transfer switches (ABTs and MBTs),
  e) electrical propulsion system protective devices, and
  f) variable speed drives.

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.