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Short-Circuit Current Calculation Application for A.C 3 Phase on Marine and Mobile Offshore Installations Based on IEC-61363 Standard

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Abstract

As part of increasing marine vessel and mobile offshore installation safety, The Safety of Life at Sea (SOLAS), an International Maritime Organization (IMO) publication required that electrical installations in ships shall be protected against short circuit. The short circuit calculation shall be performed properly to obtain the appropriate protection device. Since the methods of calculation used by designer are mostly varied, the amount of time needed for verification by Classification Society reviewer will be increased if both of parties used different techniques. Moreover, the manual calculation data (by using Microsoft Excel, etc.) will not be saved in appropriate order, according to ship's name where such historical technical data might be needed in case of another modification or electrical equipment replacement in the future. Therefore, this research is aimed at creating a short circuit calculation software, in which the calculation data will be saved as historical record in an IMO number group and the method of calculation will be technically uniform.The calculation is intended to obtain the short circuit current of a.c three phase based on IEC 61363 standard. The calculated short circuit current comprises of three components, a.c component (I_{ac}), d.c component (I_{dc}) and peak current (I_p). The output of calculation can also be used as the way to determine the breaking and making capacity current in selection of protection device.

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Keywords: Short-circuit current;SOLAS;IMO; Making capacity;Breaking capacity; Protecting device

1. Introduction

To prevent short circuit currents occurring on marine and offshore installations, electrical system must be designed in such a way to diminish short circuit event by ensuring all possible precautions have been taken. The calculation result will be taken as minimum capability for electrical system and its component to withstand the effect of any possible short circuit event and hence limit occurring damage to a minimum. In practical, short circuit current protection normally consists of some arrangements of fuses and circuit breakers. Therefore, this calculation can also provide suitable information for any user to select ratings and capability of short circuit current protection component in order to provide such necessary protection for their system[1].

As Classification Society, Biro Klasifikasi Indonesia are demanded to evaluate the safety precaution of all electrical components, including verification of electrical component's ability in concern to withstand short circuit current.

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However, the calculation is still performed manually by the user which takes long time and risk of calculation mistakes due to many complicate calculation formulas. Thus, the calculation software is developed which is based on IEC publication 61363 which has been used for years as a fundamental reference related with short circuit calculation suited for application on ships and offshore installations. This software will be used as complement tools for the rules of Electrical Installations published by Biro Klasifikasi Indonesia were as required by the rules that the electrical power source with the total output of greater than 500 kVA should be supplemented with short circuit calculation [4]. This software is expected to reduce the time needs for calculation and also reduce the calculation error.

The output of this calculation software will be used to determine the value of breaking and making capacity for selection of appropriate circuit breaker. The calculation is performed by using the simplified one-line diagram as basis.The system is divided into its active and non-active components. The active components are sources of short-circuit current, the non-active components transmit or transform the short-circuit current to distribute it from the source to the fault point. Each component is represented by a mathematical model formulated from its characteristic parameters.

The result of this calculation software will be validated using commercial software. The difference between value produced by designed calculation software and validating software as proof of its reliability, shall not to be more than 1%.

2. Short-circuit Current Calculation

The electrical power system in the shipping and offshore industry should be designed to serve the load with a safe and reliable manner. One of the key considerations in planning the power system is a good control against short circuit. Uncontrolled short circuit can cause service outages, which in turn will cause stoppage of the production, termination of essential facilities or vital services, or fatal accidents to personnel and possible fire risk.

The electrical power system is designed to be free from the possibility of a short circuit through the design and equipment selection, careful installation and adequate care. But even with those precautions, short circuit may still occur.Some of the causes include rodents, breakage of connection, voltage spikes, degrade insulation material, accumulation of dust, moisture and other contaminants, the inclusion of metal or conductive object and other phenomena that can-not be determined.

Short-circuit current event is occurred when there is contact between a phase conductor with the earthing (ground), phase conductors with each other or phase conductor with neutral conductor. The current induced by the short circuit event has a high magnitude. Protective device must be able to withstand the current and disconnect the circuit within the specified time. It is necessary for rating and selecting the appropriate protective device settings. Calculation of short circuit current is intended to determine the value of short-circuit current that occurs on a system in regard to the components that are involved. There is some effect when a short circuit occurs in a system:

- At the location of the short circuit, a fire and electric arc can occur
- The short circuit current flows from the source to the location of the short circuit
- All components energized by short circuit current will experience mechanical and thermal stress. Stress varies as a function of the current squared (I^2) and duration of the flowing current.
- The system voltage will decay following the proportion of short-circuit current. The maximum voltage drop occurs at the location of the short circuit (to zero), but all parts of the power system will be affected by the voltage drop.

The short-circuit current must be immediately removed from the power system and that is the task of a protective device which in this case is the circuit breaker and fuse. To carry out their duties properly, an appropriate protective device must be selected proportional to maximum short circuit current flowing to the location of the short circuit. The maximum value of the short-circuit current is often referred to as 'available' short-circuit current. When determining the value of the magnitude of the short circuit current, it is important to consider all sources of short circuit and characteristic impedance.

In calculating the short-circuit current, only the highest values of the current are considered. Such value refers to maximum or peak current (i_k) as shown in figure 1. The highest values vary as a function of time along the upper