Integrating Medium Voltage Switchgear Breakers into a Safety Instrumented Function

David J. Grattan, P.E., CFSE and Sam Nicholson, P.E.  
(S&B Engineers & Constructors, Ltd.)  
djgrattan@sbec.com

Abstract

For some incident outcome scenarios, a risk assessment study has determined the need to include the shutdown of a large electric motor, as part of a safety instrumented function (SIF). In the process industries, it is common practice to control and protect large horsepower motors (typically 2,000 HP and above), with medium voltage switchgear breakers. Safety instrumented functions that include electric motors utilizing medium voltage switchgear for tripping, have unique final element subsystems, which require specialized knowledge in order to implement correctly. This paper will discuss the design considerations for integrating medium voltage switchgear used for shutdown of an electric motor, into a safety instrumented function. First, an overview of typical low and medium voltage electrical equipment used for controlling and protecting electric motors will be discussed. Next, a review of generic sourced failure data for medium voltage switchgear breakers will be presented. Focus will be on the taxonomy used to classify different breaker types, and the relevant failure modes and effects, used for quantifying performance. Next, specific SIF design details for tripping medium voltage switchgear breakers will be analyzed, in the context of achieving a certain integrity level. Parameters to be considered include hardware fault tolerance requirements, voting, available diagnostics, proof-test interval, energize v. de-energize to trip shutdown circuits, certified equipment v. proven-in-use, and alternate means of shutdown (including manual intervention and protective relaying). Often times, in a risk assessment study such as a layer of protection analysis (LOPA), multiple actions will be credited for shutdown of a motor, for the same consequence scenario. This paper will analyze the common electrical equipment shared among the multiple actions, and determine how much credit can be taken considering common cause failure. Next, on-line and off-line proof-testing techniques of the safety instrumented function will be explored. Inspection, test, and preventive maintenance (ITPM) of medium voltage switchgear will be discussed, as a means for maintaining the electrical equipment in the “as good as new” condition. Finally, a consideration of reliability will be made by analyzing how the safety instrumented function (including proof-testing) will impact the machine uptime.