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IEEE Guide for Breaker Failure Protection of Power Circuit Breakers

IEEE Power and Energy Society

Sponsored by the
Power System Relaying Committee

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USA

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(Revision of IEEE Std C37.119-2005)

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Abstract: Methods to protect a power system from faults that are not cleared because of failure of a power circuit breaker to operate or interrupt when called upon by a protective relay are described in this guide. The intent is to give the reader a guide in how to detect that a breaker has failed to clear a fault, and how to electrically isolate the fault after the breaker has failed to clear the fault. Additionally, schemes that provide primary protection of the power system from performance failures of the power circuit breaker other than fault clearing failures such as failure to operate, either tripping or closing, manual or automatic, are also described. Such schemes, when applied, are typically integrated as a part of the overall breaker failure protection scheme. Also covered are recent practices that take advantage of new technologies.

Keywords: BFP, breaker failure, breaker failure protection, circuit breaker, fault, IEEE C37.119™, power system

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Introduction

This introduction is not part of IEEE Std C37.119-2016, IEEE Guide for Breaker Failure Protection of Power Circuit Breakers.

This guide is a revision to IEEE Std C37.119-2005. Corrections to timing diagrams describing particular schemes have been made to improve clarity and accuracy. Precautionary statements have been added to provide guidance based upon occurrence of recent power system events.

The definition and scope of breaker failure protection has been broadened to provide a more comprehensive description of breaker failure protection, not only for power circuit breakers applied to transmission lines but also for generator unit breakers. In addition to breaker failure initiation for fault conditions, initiation from automatic or manual tripping and closing devices that detect potentially damaging non-fault conditions is now included.

In addition to the breaker failure logic schemes previously provided by the guide, examples of best practices of how to interconnect control power to redundant protective relay systems while providing breaker failure functionality is provided. These methods increase the independence of the primary protection from the local backup protection and thereby decrease the impact of single points of failure within the overall protection scheme. Practical considerations are now included that describe application of breaker failure protection to legacy equipment and modern microprocessor relays, and that describe the interaction of the breaker failure protection scheme with local and remote controls including automatic reclosing, lockout, and restoration functions.

Other additions to the guide include descriptions for column ground fault protection, breaker differential protection, and tandem breaker protection. These protection functions are typically applied as a part of the overall breaker failure protection scheme.

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IEEE Guide for Breaker Failure Protection of Power Circuit Breakers

1. Overview

1.1 General

Breaker failure protection (BFP) is a backup protection for the power system that is needed when a power circuit breaker fails to clear a fault when called upon to do so by a protective relay. The BFP scheme acts to isolate the fault from the protected power system by removing from service power circuit elements located electrically adjacent to the failed power circuit breaker.

In general, backup relay protection has been used on power systems for many years. Typically, all parts of the protection system including the relays, voltage and current transformers, circuit breakers, and control power source are vulnerable to failure. All of these components are needed to work properly to effectively clear a fault. To improve protection system reliability, components such as protective relays, power sources, and instrument transformers are often duplicated. Duplicate systems are designed to operate independently to ensure complete protection system functionality during failures. Because it is usually too costly to duplicate the breaker, breaker failure schemes are specifically employed to provide backup protection in the event that a circuit breaker fails to operate properly during fault clearing.

Primary protection of the power system from performance failures of the power circuit breaker other than fault clearing failures is sometimes added to breaker failure schemes. These include failure to operate, either tripping or closing, manual or automatic. Where applied, this protection typically exists as an addition to, and as a part of, the same overall scheme as the breaker failure backup protection.

The choice and successful application of any BFP scheme depends upon factors such as the local breaker arrangement and also the relative criticality of protected power circuit elements. There is a delicate balance

between the risk of damage to unprotected equipment versus the impact of removing adjacent power circuit elements when the scheme operates.

This guide reviews generally accepted breaker failure schemes used on utility transmission and generation systems. Many of the characteristics of these schemes also apply to the use of breaker failure on utility distribution systems. Schemes are carefully examined so that advantages as well as disadvantages can be compared. Application examples and testing practices are also included.

The guide is written for engineers who have a working knowledge of power system protection but require a better understanding of breaker failure applications. It can also be used as an evaluation tool when comparing alternative breaker failure options.

1.2 Scope

This guide describes methods to protect a power system from faults that are not cleared because of failure of a power circuit breaker to operate or interrupt when called upon by a protective relay. The intent is to give the reader a guide in how to detect that a breaker has failed to clear a fault, and how to electrically isolate the fault after the breaker has failed to clear the fault. Additionally, schemes that provide primary protection of the power system from performance failures of the power circuit breaker other than fault clearing failures such as failure to operate, either tripping or closing, manual or automatic, are also described. Such schemes, when applied, are typically integrated as a part of the overall BFP scheme. Also covered are recent practices that take advantage of new technologies.

1.3 Purpose

This guide is intended to help the relay engineer understand the application considerations when applying BFP to power circuit breakers.

2. Normative references

The following referenced documents are indispensable for the application of this document (i.e., they must be understood and used, so each referenced document is cited in text and its relationship to this document is explained). For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments or corrigenda) applies.

IEEE Std C37.102™, IEEE Guide for AC Generator Protection.[1, 2]

IEEE Std C37.113™, IEEE Guide for Protective Relay Applications to Transmission Lines.

3. Definitions, acronyms, and abbreviations

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