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IEEE Recommended Practice for Overvoltage and Insulation Coordination of Transmission Systems at 1000 kV AC and Above

IEEE-SA Board of Governors and IEEE Power and Energy Society

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Abstract: The procedure for selection of insulation levels of UHV ac transmission lines and substations are specified. Also specified are reliability criterion under switching overvoltage and lightning overvoltage. Calculation methods of insulation coordination design are suggested. According to the characteristics of UHV ac systems, overvoltage mitigation measures are recommended. Some examples of insulation coordination are presented.

Keywords: atmospheric correction factor, basic lightning impulse insulation level (BIL), basic switching impulse insulation level (BSL), clearance, crest value, ground fault factor, IEEE 1862™, insulation coordination, insulation design, overvoltage, phase-to-ground insulation configuration, phase-to-phase insulation configuration, protective margin, protective ratio, shielding failures, standard withstand voltages, ultra-high voltage (UHV), voltage stresses

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Introduction

This introduction is not part of IEEE Std 1862-2014, IEEE Recommended Practice for Overvoltage and Insulation Coordination of Transmission Systems at 1000 kV AC and Above.

In order to resolve the prominent problem of the inverse distribution between energy resources and power demands, the ultra-high voltage (UHV) ac transmission, which is advantaged over long distance and large capacity, is required.

There are specifics on overvoltage and insulation coordination of UHV ac systems, such as switching overvoltages (SOV), very fast front overvoltage (VFFO), lightning overvoltage, etc. Time-to-crest of SOV on UHV lines is much longer than that of standard switching impulse (SI). For air clearance of UHV transmission lines, the switching impulse flashover voltage is non-linearly related to the distance of the clearance. Flashover voltage presents its saturation feature as clearance increase. In order to improve the economy of an UHV transmission line, air clearance test data of longer time-to-crest SI can be used for insulation coordination. In UHV ac systems, the ratio of the basic lightning impulse insulation level (BIL) to the system voltage is lower than that of EHV system, so VFFO may become the main dielectric stress to be limited. Since UHV towers are higher than EHV ones, lightning overvoltage in UHV systems needs special attention.

Contents

IEEE Recommended Practice for Overvoltage and Insulation Coordination of Transmission Systems at 1000 kV AC and Above

1. Overview

1.1 Scope

This recommended practice applies to transmission system at 1000 kV ac and above. It defines standard insulation levels and specifies procedures for selecting insulation levels of ac transmission lines and substations. It also specifies reliability criteria under switching and lightning overvoltages. Suggestions on insulation coordination design are described. Overvoltage mitigation measures are recommended according to the characteristics of such ac systems. Some examples of insulation coordination are also presented.

1.2 Purpose

Ultra-high voltage (UHV) ac power transmission system is an effective approach to achieve efficient allocation of energy resources utilizing the advantages of large capacity with long distance, and low loss. Some countries have already carried out research on UHV technologies, and several UHV ac projects have been constructed and put into operation. This recommended practice is formulated specifically for the design and application of insulation coordination for transmission systems at 1000 kV ac and above.