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IEEE Guide for Wind Power Plant Grounding System Design for Personnel Safety

IEEE Power and Energy Society

Developed by the
Energy Development and Power Generation Committee

IEEE Std 2.60™-2020

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IEEE Guide for Wind Power Plant Grounding System Design for Personnel Safety

Energy Development and Power Generation Committee
of the
IEEE Power and Energy Society

Approved 24 September 2020

IEEE SA Standards Board

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Abstract: The collector system grounding for wind power plants (WPPs) is the primary concern of this guide. This guide is not intended for the WPP substation; however, since the substation is typically interconnected with the collector system, its design might affect or be affected by the collector system. With proper consideration, the methods described herein could be used in determining the impact of the collector system on substation safety and vice versa.

Quantitative analysis of the effects of lightning surges is beyond the scope of this document. Similarly, this guide does not cover offshore wind power plants, battery energy storage facilities, solar power plants, or substation grounding.

Keywords: collector system, grounding, IEEE 2760™, safety, wind power plant

The Institute of Electrical and Electronics Engineers, Inc.
3 Park Avenue, New York, NY 10016-5997, USA

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PDF: ISBN 978-1-5044-7106-0 STD24433
Print: ISBN 978-1-5044-7107-7 STDPD24433

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Introduction

This introduction is not part of 2760-2020, Guide for Wind Power Plant Grounding System Design for Personnel Safety.

Wind Power Plants (WPPs) present unique grounding challenges when compared to other generation facilities. This is primarily due to their large interconnected nature—often over several square kilometers—and the fact that the plant is not fenced from the public. This guide addresses those aspects and provides guidance on the design and analysis of grounding systems for these large facilities.

The inaugural version of this document has been prepared by the Wind and Solar Plant Collector Design Working Group and the associated task force on grounding for personnel protection over the last several years.

This document assumes the user is designing using a grounded-wye secondary on the main power transformer. While this grounded-wye arrangement is by far the most common electrical collector system used in WPPs across the United States (US) and most countries in the Americas, many other countries commonly use an ungrounded delta connection. The guidance in this document may not apply to countries that are not using a wye-grounded collector system.

In the US, the most common main power transformer design used in WPPs is a three-winding transformer, as many utilities require a wye grounded high voltage (HV) primary and the WPP desires a wye-grounded medium voltage (MV) secondary. A third delta connected winding (to suppress third phase harmonics) is often added into one transformer case. Occasionally a utility will accept a delta connected HV winding; therefore, a two-winding transformer is used with a delta HV connection and wye grounded MV connection. In some locations around the world, the three winding transformer is built as two separate transformers; a two-winding transformer with a wye-connected HV side and a delta-connected MV side, and then a separate grounding or ground reference transformer (often of a zig-zag design) is added to create the system ground, or effective ground, on the MV side. Regardless of whether a single transformer or two separate transformers are used, the result is that ground faults on these systems will flow through multiple ground paths back to the wye-ground. In systems that utilize a grounded-wye collection system, the guidance found in this document will apply.

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IEEE Guide for Wind Power Plant Grounding System Design for Personnel Safety

1. Overview

1.1 Scope

This guide is primarily concerned with the collector system grounding for onshore wind power plants (WPPs). This guide is not intended for the WPP substation; however, since the substation is typically interconnected with the collector system, its design might affect or be affected by the collector system. With proper consideration, the methods described herein could be used in determining the impact of the collector system on substation safety and vice versa.

Quantitative analysis of the effects of overvoltage transients (switching and lightning) is beyond the scope of this document. Similarly, this guide does not cover offshore WPPs, battery energy storage facilities, solar power plants, or substation grounding.

1.2 Purpose

The intent of this guide is to provide guidance and information pertinent to the grounding practices in WPP collector system for personal safety.

The specific purpose of this guide is as follows:

- Identify differences between substation grounding (covered under IEEE Std 80™) and WPP collector system grounding.
- Establish, as a basis for design, safety limits of potential differences that can exist in a WPP collection system under fault conditions between points that can be contacted by the human body.
- Review WPP grounding practices with reference to safety criteria for the design, and provide a procedure for the design of practical grounding systems based on these criteria.
- Develop analytical methods as an aid in the understanding and solution of typical voltage gradient problems within a WPP.

This guide is primarily concerned with grounding practices within WPPs for 50 Hz or 60 Hz systems. DC systems are beyond the scope of this guide. A grounding system designed as described herein does, nonetheless, provide some degree of protection against steep wave front surges (such as lightning) entering the wind turbine generator (WTG) and passing to earth through its grounding system electrodes.

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