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IEEE Guide for Electrical and Control Design of Hydroelectric Water Conveyance Facilities

IEEE Power and Energy Society

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Energy Development and Power Generation Committee

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Abstract: Electrical and control design of water conveyance facilities associated with hydroelectric projects including associated penstocks, valves, and gates are described in this guide. Guidance to plan and prepare designs is included. Installation, operation, or maintenance guideline and methodologies are not included. Design of new facilities and rehabilitation or replacement of existing facilities is covered. Comprehensive considerations for design, monitoring, control, protection, and operation of water conveyance facilities associated with hydroelectric projects is provided. Guidance in electrical and instrumentation work unique to water conveyance systems is provided. Guidance for the safe control of water release systems, bypass systems, and failure modes are provided. Reliability measures such as redundancy and power source considerations are provided. Gate and valve types and associated operating mechanisms are introduced. Power and non-power water conduits including penstocks, tunnels, and canals are covered.

Keywords: control, conveyance, design, electrical, gate, hydroelectric, IEEE 1827™, monitoring, penstock, protection, valve, water

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Introduction

This introduction is not part of IEEE Std 1827™-2016 IEEE Guide for Electrical and Control Design of Hydroelectric Water Conveyance Facilities.

This Guide has been developed to provide guidance to the practicing engineer for design elements specific to water conveyance facilities associated with hydroelectric projects. Hydroelectric project water conveyance facilities are critical for emergency operation, regulating flow, and maintenance functions. The failure of water conveyance facilities has potential public safety, regulatory, equipment damage, environmental, and loss of human life consequences.

Project owners, operators, and stakeholders can use the guidance provided to plan and prepare electrical designs that monitor, control, and protect the water conveyance facilities. Gate and valve design involves civil, environmental, electrical, mechanical, and structural engineering challenges and coordination. This Guide focuses on the electrical and control design challenges. An overview of the gate types and gate operating mechanism types is provided. Discussion of multi-discipline (i.e., civil or mechanical engineering) application and gate type specific design are not included due to the unique system design and application specific criteria. Annex B contains Table B.1—Gate Types and Functions, which provides a comprehensive reference for specific applications. This Guide's most valuable addition to the hydroelectric industry is found in the gate control, monitoring, and protection guidance.

Contents

IEEE Guide for Electrical and Control Design of Hydroelectric Water Conveyance Facilities

1. Overview

1.1 Scope

This guide describes the electrical and control design of water conveyance facilities associated with hydroelectric projects including associated penstocks, valves, and gates. The guide includes guidance to plan and prepare designs; however, it does not include details of installation, operation, or maintenance guidelines and methodologies. This guide is applicable to design of new facilities and rehabilitation or replacement of existing facilities.

1.2 Purpose

This guide provides a description of the terminology, as well as the design practices and principles used in modern electrical and control design of water conveyance facilities associated with hydroelectric projects. The practices and principles are not covered by other guides associated with hydroelectric facilities. This guide is for use by practicing engineers and provides guidance for facility owners and operators. The guide does not cover every possible variation that can be encountered, but it provides a working familiarity with the terminology and principles involved.

1.3 Use of this guide

This guide is intended for the practicing engineer who has some familiarity with electrical and control system design. This guide provides a control hierarchy capable of standalone operation or interfacing with other systems. This guide provides comprehensive considerations for design, monitoring, control, protection, and operation of water conveyance facilities associated with hydroelectric projects. It provides guidance in electrical and instrumentation work unique to water conveyance systems. It provides guidance for the safe control of water release systems, bypass systems, and failure modes. It provides reliability measures such as redundancy and power source considerations. It introduces the gate and valve types and associated operating mechanisms. This guide covers power and non-power water conduits including penstocks, tunnels, and canals. It does not include hydraulic turbines or their flow control devices (wicket gates, nozzles, etc.).

This guide does not cover:

— Cascade river control systems or waterway navigation locks