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Condition monitoring and diagnostics of machines — Hydroelectric generating units

Surveillance et diagnostic d'état des machines — Groupes de production hydroélectrique

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 108, *Mechanical vibration, shock and condition monitoring*, Subcommittee SC 5, *Condition monitoring and diagnostics of machine systems*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Traditionally, hydroelectric generating units (or simply hydro units) have been overdesigned, well-staffed for maintenance and often continuously operated at only baseload conditions over a period of many years. As a result of this, there were few maintenance issues, shutdowns could be planned at fixed intervals, and therefore there was little need for condition monitoring of the units. Simple machine protection systems sufficed, if used at all.

Nowadays, there are more stringent requirements for operational regimes, availability and reliability. Disruption to consumers' needs should be minimized and cash generation for the utilities maximized. The operating regimes for many hydro units have been extended to include synchronous compensation, load-following and peaking, which means there are many starts and stops and partial load operation, sometimes in the rough zones. Many applications are based on pump storage. Moreover, new units are designed more streamlined to the application, less robust, and older units are often refurbished to extend life or to increase rating. This means that machines are more stressed, which can lead to premature or unpredictable failure of the components, and even some new failure modes. At the same time, there is a trend towards fewer maintenance staff and specialists to look after the machines.

Therefore, there is a significantly greater need for an effective condition monitoring strategy, not just a protection system. Moreover, the condition monitoring solution of these machines should be more than just basic vibration monitoring. Due to the complex nature of the hydro unit components, a number of potential failure modes now become apparent under the current stressful conditions, which require a number of different, specialized monitoring techniques and diagnostic expertise. There are few standards for monitoring the hydro units and a general lack of understanding of the monitoring techniques. Even for hydropower stations that have a legacy condition monitoring system installed, the existing condition monitoring requirements for the hydro units are sometimes no longer valid as a result of changing operating conditions or refurbishment of the units.

Condition monitoring and diagnostics of machines — Hydroelectric generating units

1 Scope

This document focuses on recommended condition monitoring techniques for detecting and diagnosing developing machine faults associated with the most common potential failure modes for hydro unit components. It is intended to improve the reliability of implementing an effective condition monitoring approach for hydroelectric generating units (hydro units). It is also intended to help create a mutual understanding of the criteria for successful hydro unit condition monitoring and to foster cooperation between the various hydropower stakeholders.

This document is intended for end-users, contractors, consultants, service providers, machine manufacturers and instrument suppliers.

This document is machine-specific and is focused on the generator, shaft/bearing assembly, runner (and impeller for pumped storage applications), penstock (including the main inlet valve), spiral case and the upper draft tube of hydro units. It is primarily intended for medium to large sized hydro units with more than 50 MVA installed capacity, but it is equally valid for smaller units in many cases. It is applicable to various types of turbines such as Francis, Kaplan, Pelton, Bulb and other types. Generic auxiliary systems such as for lubrication and cooling are outside the scope, with the exception of some monitoring techniques that are related to condition monitoring of major systems covered by this document, such as oil analysis. Transmission systems, civil works and the foundation are outside the scope.

This document covers online (permanently installed) and portable instrument condition monitoring and diagnostic techniques for operational hydro units. Offline machine testing, i.e. that which is only done during shutdown, although very important, is not part of the scope of this document. Nor is one-time acceptance and performance testing within the scope. The condition monitoring techniques presented in this document cover a wide range of continuous and interval-based monitoring techniques under generalized conditions for a wide range of applications. Therefore, the actual monitoring approach required for a specific application can be different than that which is recommended in this generalized document.

2 Normative references

There are no normative references in this document.

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at http://www.electropedia.org/

3.1
hydro unit
entire hydro-generating unit, consisting of the generator, shaft, turbine, and including the immediate intake and discharge components, e.g. the penstock, main inlet valve, spiral case and the upper portion of the draft tube