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Hydraulic machines – Francis turbine pressure fluctuation transposition

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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HYDRAULIC MACHINES – FRANCIS TURBINE PRESSURE FLUCTUATION TRANSPOSITION

FOREWORD

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Technical specifications are subject to review within three years of publication to decide whether they can be transformed into International Standards.

IEC TS 62882, which is a Technical Specification, has been prepared IEC technical committee 4: Hydraulic turbines.

The text of this Technical Specification is based on the following documents:

Enquiry draft	Report on voting
4/375/DTS	4/398/RVDTS

Full information on the voting for the approval of this technical specification can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
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- replaced by a revised edition, or
- amended.

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INTRODUCTION

With the increased amount of renewable energy that is being added to the electrical grid in the form of wind and solar, in addition to new energy in the form of nuclear, the grid needs to integrate more hydropower generation with flexible operation to balance loads. To meet this challenge, the hydraulic stability of the machine has become more and more important.

The current document provides a technical specification for Francis turbine pressure fluctuations. This document aims to describe pressure fluctuations, their phenomena and related problems, to define the relationship between model and prototype fluctuations, to identify methods to predict pressure fluctuations in prototypes through transposition of model measurements, and to suggest potential mitigations.

In this document, the term "turbine" refers to Francis turbines and pump-turbine operating as a turbine.

This document excludes all matters of purely commercial interest, except those inextricably bound within the conduct of the tests.

HYDRAULIC MACHINES – FRANCIS TURBINE PRESSURE FLUCTUATION TRANSPOSITION

1 Scope

IEC 62882, which is a Technical Specification, provides pressure fluctuation transposition methods for Francis turbines and pump-turbines operating as turbines, including:

– description of pressure fluctuations, the phenomena causing them and the related problems;
– characterization of the phenomena covered by this document, including but not limited to inter-blade vortices, draft tube vortices rope and rotor-stator interaction;
– demonstration that both operating conditions and Thoma numbers (cavitation conditions) are primary parameters influencing pressure fluctuations;
– recommendation of ways to measure and analyse pressure fluctuations;
– identification of potential resonances in test rigs and prototypes;
– identification of methods, to transpose the measurement results from model to prototype or provide ways to predict pressure fluctuations in prototypes based on statistics or experience;
– recommendation of a data acquisition system, including the type and mounting position of model and prototype transducers and to define the similitude condition between model and prototype;
– presentation of pressure fluctuation measurements comparing the model turbine and the corresponding prototype;
– discussion of parameters used for the transposition from model to prototype, for example, the peak to peak value at 97 % confidence interval, the RMS value or the standard deviation in the time domain and the relation of main frequency and the rotational frequency in the frequency domain obtained by FFT;
– discussion of the uncertainty of the pressure fluctuation transposition from model to prototype;
– discussion of factors which influence the transposition, including those which cannot be simulated on the model test rig such as waterway system and mechanical system;
– establishment of the transposition methods for different types of pressure fluctuations;
– suggestion of possible methods for mitigating pressure fluctuation;
– definition of the limitations of the specification.

This document is limited to normal operation conditions. Hydraulic stability phenomena related to von Karman vortices, transients, runaway speed and speed no load are excluded from this document.

This document provides means to identify potential resonances in model test rigs and prototype turbines. Scaling-up resonance conditions are not treated in this document. When resonance exists, the transposition methods identified in this document do not apply. Under these conditions, the relationship between model and prototype pressure fluctuations cannot be determined.

This document is concerned neither with the structural details of the machines nor the mechanical properties of their components, so long as these characteristics do not affect model pressure fluctuations or the relationship between model and prototype pressure fluctuations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60193:2019, *Hydraulic turbines, storage pumps and pump-turbines – Model acceptance tests*