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Hydraulic machines – Francis turbine pressure fluctuation transposition

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CONTENTS

FOREWORD.....	9
INTRODUCTION.....	11
1 Scope.....	12
2 Normative references	13
3 Terms, definitions, symbols and units	13
3.1 General terms and definitions	13
3.2 Units.....	13
3.3 Overview of the terms, definitions, symbols and units used in this document	14
3.3.1 Subscripts and symbols	15
3.3.2 Geometric terms and definitions	16
3.3.3 Physical quantities and properties terms and definitions	17
3.3.4 Discharge, velocity and speed terms and definitions.....	17
3.3.5 Pressure terms and definitions	18
3.3.6 Specific energy terms and definitions.....	18
3.3.7 Height and head terms and definitions.....	19
3.3.8 Power and torque terms and definitions	20
3.3.9 Efficiency terms and definitions	21
3.3.10 General terms and definitions relating to fluctuating quantities	21
3.3.11 Fluid dynamic and scaling terms and definitions	24
3.3.12 Dimensionless terms and definitions.....	24
4 Description of pressure fluctuation phenomena.....	25
4.1 General.....	25
4.2 Pressure fluctuations overview.....	30
4.3 General description of draft tube flow in Francis turbines	32
4.4 Detailed description of pressure fluctuation phenomena.....	34
4.4.1 Mode 1: Pressure fluctuation in high load	34
4.4.2 Mode 2: Pressure fluctuation in best operation range.....	35
4.4.3 Mode 3: Pressure fluctuation in upper part load	35
4.4.4 Mode 4: Pressure fluctuation in part load.....	36
4.4.5 Mode 5: Pressure fluctuation in deep part load	38
4.4.6 Modes 6.a and 6.b: Rotor-stator interaction (RSI) pressure fluctuation.....	39
5 Specifications of pressure fluctuation measurement and analysis	41
5.1 General.....	41
5.1.1 Overview	41
5.1.2 Purpose of the measurements	41
5.1.3 Procedures and parameters to record.....	42
5.1.4 Locations of pressure fluctuation test transducers	43
5.1.5 Data acquisition for pressure fluctuation measurements	44
5.1.6 Transducers and calibration.....	45
5.2 Pressure fluctuation on a model turbine	45
5.2.1 General	45
5.2.2 Homology and limitations.....	46
5.2.3 Detailed procedures.....	46
5.3 Special requirements and information for a prototype turbine.....	48
5.3.1 General	48
5.3.2 Source of information	48

5.3.3	Important aspects	48
5.4	Analysis, presentation and interpretation of results	49
5.4.1	General	49
5.4.2	Time-domain analysis	49
5.4.3	Frequency-domain analysis	50
5.4.4	Non-dimensional frequency and pressure	50
5.4.5	Presentation and interpretation of pressure fluctuations.....	50
6	Identification of potential resonances in test rig and prototype	51
6.1	General.....	51
6.2	Identify resonance in test rig	53
6.3	Possible resonance and self-excited pressure fluctuation in prototype	53
6.3.1	General	53
6.3.2	Draft tube vortex related resonances and self-excited pressure fluctuation in prototype	53
6.3.3	Rotor-stator interaction (RSI) related resonance	55
6.3.4	Resonance with fluctuation modes not treated in this document.....	55
7	Transposition method and procedure	56
7.1	General.....	56
7.2	Parameters influencing transposition	56
7.2.1	Model test head	56
7.2.2	Thoma number	56
7.2.3	Froude number	57
7.3	Relevant quantities for transposition	57
7.3.1	Fluctuation frequency	57
7.3.2	Fluctuation amplitude	57
7.4	Transposable types of fluctuations	57
7.5	Statistical analysis of model and prototype transposition accuracy	58
8	Mitigations	59
8.1	Draft tube vortex phenomena	59
8.1.1	General	59
8.1.2	Draft tube fins.....	59
8.1.3	Draft tube with a central column	60
8.1.4	Air admission.....	61
8.1.5	AVR or PSS parameter tuning	62
8.2	Runner inter-blade vortex.....	63
8.3	Blade interaction.....	63
8.4	Operation restriction	63
Annex A (informative)	Example of pressure fluctuation records	64
Annex B (informative)	Typical pressure fluctuation transducers parameters for model test.....	83
Annex C (informative)	Pressure transducer dynamic calibration	84
C.1	Fast valve opening method	84
C.2	Rotating valve method	84
C.3	Electrical spark method.....	85
Annex D (informative)	Proposed remote pressure measurement fluctuation correction.....	86
D.1	General.....	86
D.2	Correction method theory.....	86
D.3	Measuring and estimating tube frequency response	87

D.4	Pressure fluctuation correction.....	89
D.5	Limitations	92
Annex E (informative) Forced response analysis for Francis turbines operating in part load conditions.....		93
E.1	General.....	93
E.2	Systematic methodology based on detailed modelling of hydroelectric power plant	93
E.2.1	Description of the test case	93
E.2.2	Modelling of the hydraulic power plant.....	94
E.2.3	Forced response analysis of the test case	97
E.3	Simplified approach based on the hydroacoustic properties of the hydraulic system	100
E.3.1	General	100
E.3.2	Cavitating draft tube first natural frequency	100
E.3.3	Hydraulic circuit natural frequencies	101
E.3.4	Example of applications.....	102
E.3.5	Limitations of the methodology	107
Annex F (informative) Influence of Thoma number on pressure fluctuation.....		108
Annex G (informative) Transposition of synchronous pressure fluctuations from model to prototype for Francis turbines operating at off-design conditions.....		110
G.1	General.....	110
G.1.1	Overview	110
G.1.2	Step 1: 1-D numerical modelling of both the test rig at the model scale and the corresponding hydropower unit operating in off-design conditions	110
G.1.3	Step 2: Experimental identification of the parameters of interest on the reduced scale model.....	112
G.1.4	Step 3: Transposition of the hydroacoustic parameters from model to prototype	115
G.1.5	Step 4: Prediction of the precession frequency and eigenfrequencies at the prototype scale	116
G.1.6	Step 5: Prediction of pressure fluctuations at the prototype scale	116
G.2	Concluding remark: use of the local cavitation coefficient for transposition from model to prototype	116
Annex H (informative) Statistical analysis of pressure fluctuation data		119
H.1	Normalizing step for the comparison of data	119
H.2	Collected data.....	121
H.3	Draft tube zone phenomena	121
H.4	Vaneless zone phenomena	126
H.5	Spiral case phenomena.....	130
Annex J (informative) Gathering worldwide pressure fluctuation data		134
J.1	Chinese test cases.....	134
J.2	France test case	135
J.3	Norway test case	137
Bibliography.....		138
Figure 1 – Reference diameter of Francis turbine.....		16
Figure 2 – Reference level of the Francis turbine		19
Figure 3 – Flux diagram for power and discharge.....		20
Figure 4 – Illustration of some definitions related to fluctuating quantities		23

Figure 5 – Discharge range for the various fluctuation modes	30
Figure 6 – Efficiency hill chart with pictures of swirling flow	31
Figure 7 – Example of a waterfall diagram of pressure amplitudes measured in the draft tube cone.....	32
Figure 8 – Velocity triangles at inlet and outlet of the runner blade	33
Figure 9 – Influence of the discharge on the circumferential component of the absolute velocity	34
Figure 10 – Elliptical vortex rope precessing in the draft tube cone at upper part load	36
Figure 11 – Decomposition between the synchronous and asynchronous component of part load draft tube pressure fluctuations	37
Figure 12 – Example of inter-blade vortex.....	38
Figure 13 – Modulation process between runner blade flow field and guide vanes flow field	39
Figure 14 – Diametrical modes shapes representation according to k values	40
Figure 15 – Suggested locations of pressure transducers	43
Figure 16 – Turbine hill-chart with exploration paths	45
Figure 17 – Schematic of the axial aeration device	47
Figure 18 – Schematic arrangement for pressure fluctuation transducers.....	49
Figure 19 – Typical plot showing pressure fluctuation coefficient versus relative discharge.....	51
Figure 20 – Elementary hydroacoustic oscillator	52
Figure 21 – Part load vortex rope in the draft tube and its fluctuation frequency range and corresponding risk of resonance with the generator local mode of oscillation valid for both $F_{grid} = 50$ Hz and $F_{grid} = 60$ Hz	54
Figure 22 – Waterfall diagram of the pressure fluctuations as function of the frequency and Froude number for a given Thoma number.....	57
Figure 23 – Example of fins in the draft tube and influence on the pressure fluctuations	60
Figure 24 – Example of the draft tube with central column extension	61
Figure 25 – Typical runner cone extensions used for reducing draft tube pressure fluctuations	61
Figure 26 – Central and peripheral air admission locations for draft tube pressure fluctuations on a radial flow turbine.....	62
Figure 27 – Central air admission	62
Figure A.1 – Example 1: a case corresponding to mode 1 (a limited high load)	66
Figure A.2 – Example 2: a case corresponding to mode 1 (a large overload)	68
Figure A.3 – Example 3: a case corresponding to mode 2.....	70
Figure A.4 – Example 4 : a case corresponding to mode 3.....	72
Figure A.5 – Example 5 : a case corresponding to mode 4.a and 4.b	74
Figure A.6 – Example 6: a case corresponding to mode 4.a and 4.b	76
Figure A.7 – Example 7: a case corresponding to mode 4.c	78
Figure A.8 – Example 8: a case corresponding to mode 5.b.....	80
Figure A.9 – Example 9: a case corresponding to mode 6.a.....	82
Figure C.1 – Pressure transducer dynamic calibration schematic diagram with fast open valve method.....	84
Figure C.2 – Pressure transducer dynamic calibration with rotating valve method.....	85

Figure C.3 – Spark plug used as to generate an impulse excitation in water for pressure transducer dynamic calibration	85
Figure D.1 – Typical results obtained by shutting off drainage valve	88
Figure D.2 – Signal and spectrum of four remote sensors and one local sensor	90
Figure D.3 – Signal and spectrum of four remote sensors (corrected) and one local sensor	91
Figure E.1 – SIMSEN model of the test case.....	94
Figure E.2 – Performance hill chart of the Francis turbine for different guide vane openings.....	94
Figure E.3 – Elementary hydraulic pipe of length dx and its equivalent circuit	96
Figure E.4 – Forced response for $a = 50$ m/s (left) and $a = 60$ m/s (right)	97
Figure E.5 – Forced response for $a = 70$ m/s (left) and $a = 80$ m/s (right)	98
Figure E.6 – Forced response for $a = 90$ m/s (left) and $a = 100$ m/s (right)	98
Figure E.7 – Damping and eigenfrequency for $a = 50$ m/s (left) and $a = 60$ m/s (right).....	98
Figure E.8 – Damping and eigenfrequency for $a = 70$ m/s (left) and $a = 80$ m/s (right).....	98
Figure E.9 – Damping and eigenfrequency for $a = 90$ m/s (left) and $a = 100$ m/s (right).....	99
Figure E.10 – Eigenmode for $a = 50$ m/s and eigenfrequency $f = 4,18$ Hz.....	99
Figure E.11 – Eigenmode for $a = 50$ m/s and eigenfrequency $f = 3,67$ Hz.....	99
Figure E.12 – Eigenmode for $a = 100$ m/s and eigenfrequency $f = 2,61$ Hz.....	99
Figure E.13 – Draft tube modelled with cavitation compliance and draft tube inductance	100
Figure E.14 – Simplified model of a cavitation draft tube connected to a tailrace pipe composed by cavitation compliance of the draft tube and downstream inductance of the tailrace pipe	101
Figure E.15 – Hydraulic system modelled by an equivalent pipe and corresponding modes shapes for the first and second natural frequencies	102
Figure E.16 – Hydraulic systems 1, 2 and 3	103
Figure F.1 – Influence of Thoma number on pressure fluctuation	108
Figure F.2 – Example of waterfall diagram of the pressure fluctuations as function of the frequency and Thoma number.....	109
Figure G.1 – Peak-to-peak value of pressure fluctuations as a function of the discharge factor measured on the model and the corresponding prototype	110
Figure G.2 – Layout of EPFL test rig PF3 1-D hydroacoustic model	111
Figure G.3 – Electrical T-shaped representation of the cavitation vortex rope developing in Francis turbine draft tube in part load conditions	111
Figure G.4 – Excitation system and 3D cut-view of the rotating valve.....	113
Figure G.5 – Strouhal number of the precession frequency as a function of the swirl number computed with Formula (G.6)	114
Figure G.6 – Strouhal number of the first eigenfrequency of the test rig as a function of swirl number (a), the wave speed in the draft tube determined in the 1-D model (b).....	115
Figure G.7 – Predicted values of precession frequency and first eigenfrequency at the prototype scale as a function of the output power of the generating unit	116
Figure G.8 – Comparison between observed and predicted values of the precession frequency f_{rope} and the first eigenfrequency f_0 of a 444 MW hydropower unit (HYPERBOLE project test case)	117
Figure G.9 – Hill chart comparing the measured and the predicted resonance conditions assuming a constant pressure value in the draft tube cone of the prototype	118
Figure H.1 – Pressure fluctuations versus discharge factor	120

Figure H.2 – Normalized discharge of pressure fluctuations	120
Figure H.3 – Normalized pressure amplitude of pressure fluctuations	120
Figure H.4 – Comparison of pressure fluctuations of model and prototype	120
Figure H.5 – Set of pressure fluctuation of models and prototypes for draft tube analysis	121
Figure H.6 – Difference between pressure fluctuations between the model and the prototype	122
Figure H.7 – Standard deviation of difference of pressure fluctuation.....	122
Figure H.8 – Transposition accuracy for draft tube cone	123
Figure H.9 – Transposition of each power plant test case for the draft tube cone	126
Figure H.10 – Set of pressure fluctuation of models and prototypes for vaneless zone analysis	127
Figure H.11 – Difference between pressure fluctuations between the model and the prototype	127
Figure H.12 – Standard deviation of difference of pressure fluctuation.....	128
Figure H.13 – Transposition accuracy for vaneless zone.....	128
Figure H.14 – Transposition of each power plant test case for vaneless zone	129
Figure H.15 – Set of pressure fluctuation of models and prototypes for spiral case analysis	130
Figure H.16 – Difference between pressure fluctuations between the model and the prototype	131
Figure H.17 – Standard deviation of difference of pressure fluctuation.....	131
Figure H.18 – Transposition accuracy for spiral case	132
Figure H.19 – Transposition of each power plant test cases for spiral case.....	133
Figure J.1 – Comparison of pressure fluctuations on the draft tube for 10 Chinese model and prototype references.....	135
Figure J.2 – Comparison of pressure fluctuations on the draft tube for one France model and prototype reference	136
Figure J.3 – Comparison of pressure fluctuations on the spiral case for one France model and prototype reference	136
Figure J.4 – Comparison of pressure fluctuations on the draft tube for one Norway model and prototype reference	137
Table 1 – Pressure fluctuation overview matrix	27
Table 2 – Locations of pressure fluctuations transducers	44
Table 3 – Accuracy for transposition of fluctuation amplitude in draft tube cone	58
Table 4 – Accuracy for transposition of fluctuation amplitude in vaneless zone	58
Table 5 – Accuracy for transposition of fluctuation amplitude in spiral case.....	59
Table D.1 – $f_{1/4}$ and dec calculated for p_1 to p_4	88
Table D.2 – Estimated frequencies based on tubing mechanical characteristics.....	89
Table D.3 – Peak-to-peak value on the raw signals.....	90
Table D.4 – Wave speed and damping ratio.....	90
Table D.5 – Peak-to-peak value on the corrected signals.....	92
Table E.1 – Francis turbine parameters	94
Table E.2 – Parameters of the hydraulic systems 1, 2 and 3	103
Table E.3 – Parameters of the equivalent pipe of the hydraulic system 1	104

Table E.4 – Estimation of the natural frequencies f_0 to f_6 of the hydraulic system 1 based on Formulae (E.9) and (E.11) and comparison with results obtained with eigenvalue calculation and corresponding errors..... 105

Table E.5 – Parameters of the equivalent pipe of the hydraulic system 2 105

Table E.6 – Estimation of the natural frequencies f_0 to f_6 of the hydraulic system 2 based on Formulae (E.10) and (E.11) and comparison with results obtained with eigenvalue calculation and corresponding errors..... 105

Table E.7 – Parameters of the equivalent pipe of the hydraulic system 3 106

Table E.8 – Estimation of the natural frequencies f_0 to f_6 of the hydraulic system 3 based on Formulae (E.10) and (E.11) and comparison with results obtained with eigenvalue calculation and corresponding errors..... 107

Table E.9 – Pressure mode shape obtained by eigenvalue and eigenvector calculation for the three first natural frequencies f_1, f_2 and f_3 of the hydraulic systems 1 and 2..... 107

Table H.1 – World hydropower plant references 121

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**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,
- withdrawn,
- 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*