SLOVENSKI STANDARD
SIST IEC 60041:1999

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Field acceptance tests to determine the hydraulic performance of hydraulic turbines, storage pumps and pump turbines

Field acceptance tests to determine the hydraulic performance of hydraulic turbines, storage pumps and pump-turbines

Essais de réception sur place des turbines hydrauliques, pompes d'accumulation et pompes-turbines, en vue de la détermination de leurs performances hydrauliques

Ta slovenski standard je istoveten z: IEC 60041

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Essais de réception sur place des turbines hydrauliques, pompes d'accumulation et pompes-turbines, en vue de la détermination de leurs performances hydrauliques

Field acceptance tests to determine the hydraulic performance of hydraulic turbines, storage pumps and pump-turbines

Bureau Central de la Commission Electrotechnique Internationale 3, rue de Varembé Genève, Suisse

Commission Electrotechnique Internationale
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CORRIGENDUM 1

Correction dans le texte anglais uniquement

Page 3

CONTENTS

In the title of subclause 4.1, instead of

. . . provision for the test . . .

read

. . . provision for test . . .

Page 13

Correction dans le texte anglais uniquement

In clause 1, **Scope and object**, *change the numeration in order to obtain (as on page 12):*

1 **Scope and object**

1.1 *Scope*

1.1.1 This International Standard . . .

1.1.2 Model tests, when used . . .

1.1.3 Tests of speed . . .

1.2 *Object*

1.3 *Types of machines*

Page 16

Dans le tableau, au paragraphe 2.3.1.7 (Limites), remplacer les signes repr sentatifs existants par les nouveaux signes suivants:

. . . ne pas d passer ▨

. . . atteindre ○ ou ▨

Page 17

In the table, subclause 2.3.1.7 (Limits), replace the existing symbols by the following new symbols:

. . . not to be exceeded ▨

. . . to be reached ○ or ▨

Correction dans le texte anglais uniquement

Page 29

In the table, subclause 2.3.6.4, third column, in the sixth line, instead of

$$\ldots \text{ and } \bar{g} = -\frac{g_3+g_4}{2}$$

read

$$\ldots \text{ and } \bar{g} = \frac{g_3+g_4}{2}$$

Page 30

Dans le tableau, au paragraphe 2.3.6.5, sous «Terme» *(deuxi me colonne), au lieu de*

. . . . pompe d bit

lire

. . . . pompe d bit nul

Correction in the French text only.

Page 34, figure 5b

Dans la partie sup rieure du sch ma, d placer les deux quations existantes afin de les situer ensemble droite, au-dessus du sch ma d crivant un «Groupe axe horizontal», comme suit:

$$Z_1 = z_{1'} - z_1$$
$$Z_2 = z_{2'} - z_2$$

Page 35, figure 5b

In the upper part of the diagram, rearrange the two existing equations so as to place them together, on the right-hand side, above the diagram describing a "Horizontal shaft unit as follows:

$$Z_1 = z_{1'} - z_1$$
$$Z_2 = z_{2'} - z_2$$

Page 36, figure 5c

Dans la bordure de droite du sch ma, la hauteur de la pointe de fl che, ajouter l' quation suivante:

$$z_1 = z_2$$

Page 37, figure 5c

Add, at the right-hand side of the diagram, level with the arrowhead, the following equation:

$$z_1 = z_2$$

Page 84, figure 14

Dans le sch ma, au lieu de «constant», *lire partout* «constante».

Correction in the French text only

Page 86

6.2.3.2 Erreurs al atoires

Dans l'avant-derni re ligne de la page, au lieu de

. . . d pend de la combinaison des lectures et de la combinaison de l'erreur al atoire . . .

lire

. . . d pend de la combinaison de l'erreur al atoire . . .

Correction in the French text only

Page 128

10.2.3.2 Prescriptions compl mentaires

Au cinqui me alin a, au lieu de

Annexes F et G de l'ISO 3354:

lire

Annexes H et J de l'ISO 3354:

Correction dans le texte anglais uniquement

Page 129

10.2.3.2 Additional requirements

In the fifth paragraph, instead of

Annexes F and G of ISO 3354:

read

Annexes H and J of ISO 3354:

Page 141

10.2.5.6 Computation of discharge

In the eighth line of text, instead of

m is the coefficient . . .

read

m is a coefficient . . .

Correction dans le texte anglais uniquement

Page 195, figure 34b

In the legends below the diagram, on the right-hand side; in the first line, instead of

. . . (geodesic . . .

read

. . . (geodetic . . .

third line, instead of

$$z_B' = z_B' - z_B \ldots$$

read

$$Z_B' = z_B' - z_B \ldots$$

Page 204, figure 37

M me correction qu'en page 34 (voir ci-dessus)

Page 205, figure 37

Same correction as on page 35 (see above)

Page 206, figure 38

M me correction qu'en page 36 (voir ci-dessus)

Page 207, figure 38

Same correction as on page 37 (see above)

Page 212

Dans l' quation encadr e au haut de la page, apr s le H, ajouter un signe gal (=); au lieu de

Page 213

In the framed equation at the top of the page, after the H add an equal sign (=); instead of

$$\boxed{E = \bar{g} \cdot H \frac{(p_{\mathrm{abs}_1} - p_{\mathrm{abs}_2})}{} + \frac{(v_1^2 - v_2^2)}{2} + \bar{g} \cdot (z_1 - z_2)}$$

lire

read

$$\boxed{E = \bar{g} \cdot H = \frac{(p_{\mathrm{abs}_1} - p_{\mathrm{abs}_2})}{} + \frac{(v_1^2 - v_2^2)}{2} + \bar{g} \cdot (z_1 - z_2)}$$

Page 214

Dans l' quation situ e juste au-dessous de la figure 41 au lieu de

Page 215

In the equation following figure 41, instead of

$$\boxed{NPSE = g_2 \cdot NPSH = \frac{(p_{\mathrm{abs}_2} - p_{\mathrm{va}})}{\rho_2} + \frac{v_2^2}{2} + g_2 \cdot (z_{\mathrm{r}} - z_2)}$$

lire

read

$$\boxed{NPSE = g_2 \cdot NPSH = \frac{(p_{\mathrm{abs}_2} - p_{\mathrm{va}})}{\rho_2} + \frac{v_2^2}{2} - g_2 \cdot (z_{\mathrm{r}} - z_2)}$$

Correction dans le texte anglais uniquement

Page 219, figure 42

In the legends under the diagram, instead of

d = 3 mm 6 mm

read

d = 3 mm to 6 mm

Page 228, figure 45a

Sous le sch ma, dans la formule pour p_M enlever un Δ afin de lire:

Page 229, figure 45a

In the third line of the legends half-way up the diagram, instead of

Δp = differential-pressure

read

Δp = differential pressure

Under the diagram, in the formula for p_M, delete one Δ in order to read:

$$p_M = p_1 + \rho \cdot g \cdot h_1 = p + \rho_{oil} \cdot g \cdot (h_2 - h_1) + \rho \cdot g \cdot h_1 + \Delta p$$

Page 256

Sous l' quation (4), dans la derni re formule de la page, aligner les indices; au lieu de

$$\cos \varphi_s = \frac{P_{as}(2w)}{\sqrt{3} \cdot U_s \cdot I_s}$$

lire

$$\cos \varphi_s = \frac{P_{as(2w)}}{\sqrt{3} \cdot U_s \cdot I_s}$$

Page 257

Under equation (4), in the last formula on the page, align indices; instead of

$$\cos \varphi_s = \frac{P_{as}(2w)}{\sqrt{3} \cdot U_s \cdot I_s}$$

read

$$\cos \varphi_s = \frac{P_{as(2w)}}{\sqrt{3} \cdot U_s \cdot I_s}$$

Page 280

Dans la l gende de la figure 58, au lieu de

– Dimension du b ti . . .

lire

– Dimensions du b ti . . .

Correction dans le texte anglais uniquement

Correction in the French text only

Page 303

In the penultimate line of the page:

instead of "ou , *read* "or .

Correction in the French text only

Page 308

14.4.2 Mesures auxiliaires

Dans la premi re ligne, au lieu de

. . . ±5 % pr s, . . .

lire

. . . ±5 % pr s environ, . . .

Page 322

Paragraphe 15.2.1.1, deuxi me alin a, derni re ligne, au lieu de

. . . *n*, th oriquement gale . . .

lire

. . . *n* est th oriquement gal . . .

Page 323

Subclause 15.2.1.1, second paragraph, last line, instead of

. . . *n* theoretically equal to . . .

read

. . . *n* is theoretically equal to . . .

Page 356

Dans les premi re et troisi me lignes du texte juste au-dessous du tableau C1, au lieu de « $\overline{Y}$ *» et «* $\overline{Y}_r$ *» lire* Y_r

Page 357

In the first line and third line of text, just below table C.1, instead of "$\overline{Y}$*" and "*$\overline{Y}_r$*" read* Y_r

Page 398

Annexe H

Dans le titre, la deuxi me ligne, au lieu de

. . . DE L' NERGIE M CANIQUE

lire

. . . DE L' NERGIE M CANIQUE MASSIQUE

Correction in the French text only

CONTENTS

SECTION FOUR – METHODS OF MEASUREMENT

INTERNATIONAL ELECTROTECHNICAL COMMISSION

FIELD ACCEPTANCE TESTS TO DETERMINE THE HYDRAULIC PERFORMANCE OF HYDRAULIC TURBINES, STORAGE PUMPS AND PUMP-TURBINES

FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This International Standard has been prepared by IEC Technical Committee No. 4: Hydraulic turbines.

It replaces the second edition of IEC 41, the first edition of IEC 198 and the first edition of IEC 607.

The text of this standard is based on the following documents:

Six Months' Rule	Report on Voting
4 (CO) 48	4 (CO) 52

Full information on the voting for the approval of this standard can be found in the Voting Report indicated in the above table.

The following IEC publications are quoted in this standard:

Publications Nos. 34–2	(1972):	Rotating electrical machines. Part 2: Methods for determining losses and efficiency of rotating electrical machinery from tests (excluding machines for traction vehicles).
34–2A	(1974):	First supplement: Measurement of losses by the calorimetric method.
185	(1987):	Current transformers.
186	(1987):	Voltage transformers. Amendment No.1 (1988).
193	(1965):	International code for model acceptance tests of hydraulic turbines. Amendment No.1 (1977).
193A	(1972):	First supplement.
308	(1970):	International code for testing of speed governing systems for hydraulic turbines.
497	(1976):	International code for model acceptance tests of storage pumps.
545	(1976):	Guide for commissioning, operation and maintenance of hydraulic turbines.
609	(1978):	Cavitation pitting evaluation in hydraulic turbines, storage pumps and pump-turbines.
805	(1985):	Guide for commissioning, operation and maintenance of storage pumps and of pump-turbines operating as pumps.

ISO standards quoted:

Publications Nos.	31 – 3	(1978):	Quantities and units of mechanics. Amendment 01 – 1985.
	748	(1979):	Liquid flow measurements in open channels – Velocity-area methods.
	1438 – 1	(1980):	Water flow measurement in open channels using weirs and Venturi flumes-Part 1: Thin-plate weirs.
	2186	(1973):	Fluid flow in closed conduits – Connections for pressure signal transmissions between primary and secondary elements.
	2533	(1975):	Standard Atmosphere. Addendum 01 – 1985.
	2537	(1988):	Liquid flow measurement in open channels – Rotating element current-meters.
	2975:		Measurement of water flow in closed conduits – Tracer methods.
	2975 – 1	(1974):	Part I: General.
	2975 – 2	(1975):	Part II: Constant rate injection method using non-radioactive tracers.
	2975 – 3	(1976):	Part III: Constant rate injection method using radioactive tracers.
	2975 – 6	(1977):	Part VI: Transit time method using non-radioactive tracers.
	2975 – 7	(1977):	Part VII: Transit time method using radioactive tracers.
	3354	(1988):	Measurement of clean water flow in closed conduits – Velocity area method using current-meters in full conduits and under regular flow conditions.
	3455	(1976):	Liquid flow measurement in open channels – Calibration of rotating-element current-meters in straight open tanks.
	3966	(1977):	Measurement of fluid flow in closed conduits – Velocity area method using Pitot static tubes.
	4373	(1979):	Measurement of liquid flow in open channels – Water level measuring devices.
	5167	(1980):	Measurement of fluid flow by means of orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full.
	5168	(1978):	Measurement of fluid flow – Estimation of uncertainty of a flow-rate measurement.
	7066:		Assessment of uncertainty in the calibration and use of flow measurement devices.
	7066 – 1	(1989):	Part 1: Linear calibration relationships.
	7066 – 2	(1988):	Part 2: Non-linear calibration relationships.

FIELD ACCEPTANCE TESTS TO DETERMINE THE HYDRAULIC PERFORMANCE OF HYDRAULIC TURBINES, STORAGE PUMPS AND PUMP-TURBINES

SECTION ONE – GENERAL RULES

Scope and object

1 *Scope*

1.1 This International Standard covers the arrangements for tests at the site to determine the extent to which the main contract guarantees (see 3.2) have been satisfied. It contains the rules governing their conduct and prescribes measures to be taken if any phase of the tests is disputed. It deals with methods of computation of the results as well as the extent, content and style of the final report.

1.2 Model tests, when used for acceptance purposes, are dealt with in IEC 193 with Amendment No. 1, first supplement 193 A, and in IEC 497.

1.3 Tests of speed governing systems are dealt with in IEC 308.

2 *Object*

The purpose of this standard for field acceptance tests of hydraulic turbines, storage pumps or pump-turbines, also called the machine, is:

- to define the terms and quantities which are used;
- to specify methods of testing and ways of measuring the quantities involved in order to ascertain the hydraulic performance of the machine;
- to determine if the contract guarantees which fall within the scope of this standard have been fulfilled.

The decision to perform field acceptance tests including the definition of their scope is the subject of an agreement between the purchaser and the supplier of the machine. For this, it has to be examined in each case, whether the measuring conditions recommended in this standard can be realized. The influence on the measuring uncertainties, due to hydraulic and civil conditions has to be taken into account.

If the actual conditions for field acceptance tests do not allow compliance with the guarantees to be proved, it is recommended that acceptance tests be performed on models (see 1.1.2).

3 *Types of machines*

In general, this standard applies to any size and type of impulse or reaction turbine, storage pump or pump-turbine. In particular, it applies to machines coupled to electric generators, motors or motor-generators.

For the purpose of this standard the term turbine includes a pump-turbine functioning as a turbine and the term pump includes a pump-turbine functioning as a pump. The term generator includes a motor-generator functioning as a generator and the term motor includes a motor-generator functioning as a motor.