SVENSK STANDARD SS-EN IEC 60193

Fastställd	Utgåva	Sida	Ansvarig kommitté
2019-11-13	2	1 (1+313)	SEK TK 4

Vattenturbiner, magasineringspumpar och pumpturbiner – Hydrauliska egenskaper – Leveransprovning i modell

Hydraulic turbines, storage pumps and pump-turbines –
Model acceptance tests

Som svensk standard gäller europastandarden EN IEC 60193:2019. Den svenska standarden innehåller den officiella engelska språkversionen av EN IEC 60193:2019.

Nationellt förord

Europastandarden EN IEC 60193:2019

består av:

– **europastandardens ikraftsättningsdokument,** utarbetat inom CENELEC
– **IEC 60193, Third edition, 2019 - Hydraulic turbines, storage pumps and pump-turbines - Model acceptance tests**

utarbetad inom International Electrotechnical Commission, IEC.

Tidigare fastställd svensk standard SS-EN 60193, utgåva 1, 2000, gäller ej fr o m 2022-05-30.

ICS 27.140.00

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Det finns många fördelar med att ha gemensamma tekniska regler för bl a mätning, säkerhet och provning och för utförande, skötsel och dokumentation av elprodukter och elanläggningar.

Genom att utforma sådana standarder blir säkerhetsfordringar tydliga och utvecklingskostnaderna rimliga samtidigt som marknadens acceptans för produkten eller tjänsten ökar.

Många standarder inom elområdet beskriver tekniska lösningar och metoder som åstadkommer den elsäkerhet som föreskrivs av svenska myndigheter och av EU.

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Stora delar av arbetet sker internationellt

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Arbetet i de tekniska kommittéerna är öppet för alla svenska organisationer, företag, institutioner, myndigheter och statliga verk. Den årliga avgiften för deltagandet och intäkter från försäljning finansierar SEKs standardiseringsverksamhet och medlemsavgift till IEC och CENELEC.

Var med och påverka!

Den som deltar i SEKs tekniska kommittéarbete har möjlighet att påverka framtida standarder och får tidig tillgång till information och dokumentation om utvecklingen inom sitt teknikområde. Arbetet och kontakterna med kollegor, kunder och konkurrenter kan gynnsamt påverka enskilda företags affärsutveckling och bidrar till deltagarnas egen kompetensutveckling.

Du som vill dra nytta av dessa möjligheter är välkommen att kontakta SEKs kansli för mer information.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 60193

June 2019

ICS 27.140

Supersedes EN 60193:1999

English Version

Hydraulic turbines, storage pumps and pump-turbines - Model acceptance tests (IEC 60193:2019)

Turbines hydrauliques, pompes d'accumulation et pompes-turbines - Essais de réception sur modèle (IEC 60193:2019)

Hydraulische Turbinen, Speicherpumpen und Pumpturbinen - Modellabnahmeprüfungen (IEC 60193:2019)

This European Standard was approved by CENELEC on 2019-05-30. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. EN IEC 60193 E

European foreword

The text of document 4/371/FDIS, future edition 3 of IEC 60193, prepared by IEC/TC 4 "Hydraulic turbines" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 60193.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2020-02-29
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2022-05-30

This document supersedes EN 60193:1999.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60193:2019 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60041:1991	NOTE	Harmonized as EN 60041:1994
IEC 60609-1:2004	NOTE	Harmonized as EN 60609-1:2005 (not modified)
IEC 60609-2:1997	NOTE	Harmonized as EN 60609-2:1999 (not modified)
IEC 60994:1991	NOTE	Harmonized as EN 60994:1992 (not modified)
ISO 4006:1991	NOTE	Harmonized as EN 24006:1993 (not modified)
ISO 4373:2008	NOTE	Harmonized as EN ISO 4373:2008 (not modified)
ISO 5167-1:2003	NOTE	Harmonized as EN ISO 5167-1:2003 (not modified)
ISO 20456:2017	NOTE	Harmonized as EN ISO 20456 (not modified)[1]

[1] Under preparation. Stage at the time of publication: prEN ISO 20456.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 62097	2009	Hydraulic machines, radial and axial - Performance conversion method from model to prototype	EN 62097	2009
ISO 2186	2007	Fluid flow in closed conduits - Connections for pressure signal transmissions between primary and secondary elements	-	-
ISO 2533	1975	Standard Atmosphere	-	-
ISO 4185	-	Measurement of liquid flow in closed conduits - Weighing method	EN 24185	1993
-	-		+ AC	1993
ISO 4287	1997	Geometrical Product Specifications (GPS) - Surface texture: Profile method - Terms, definitions and surface texture parameters	EN ISO 4287	1998
ISO 8316	-	Measurement of liquid flow in closed conduits - Method by collection of the liquid in a volumetric tank	EN ISO 8316	1995

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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HYDRAULIC TURBINES, STORAGE PUMPS AND PUMP-TURBINES – MODEL ACCEPTANCE TESTS

FOREWORD

International Standard IEC 60193 has been prepared by IEC technical committee 4: Hydraulic turbines.

This third edition cancels and replaces the second edition published in 1999. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) update to methods/measuring tools currently used for checking dimensions on both model and prototype;

b) update to requirements of accuracy in the dimensional check procedure as a result of new technology;

c) merging of tables/sections with redundant information in dimension check in 5.2;
d) update to methods of measuring discharge;
e) update to pressure fluctuation methods and terminology;
f) specification of measuring times for accurate pressure fluctuation analyses in the model;
g) redefine definition for the transposition of pressure fluctuations to prototype;
h) update to surface waviness requirements in prototype;
i) redefining methods/references in clause on cavitation nuclei content (5.7.3.2.2);
j) update to 7.3 and review of methods on radial thrust measurements;
k) update to 7.4 (Hydraulic loads on control components);
l) update and develop methodology in 7.5 for testing in the extended operating range;
m) update to 7.6 concerning index testing;
n) update to methods for measuring roughness;
o) updates to references;
p) updates to figures;
q) revision of sigma definition;
r) reference to new method of transposition in accordance with IEC 62097.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
4/371/FDIS	4/373/RVD

Full information on the voting for the approval of this International Standard 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.

HYDRAULIC TURBINES, STORAGE PUMPS AND PUMP-TURBINES – MODEL ACCEPTANCE TESTS

1 Scope

This document applies to laboratory models of any type of impulse or reaction hydraulic turbine, storage pump or pump-turbine.

This document applies to models of prototype machines either with unit power greater than 5 MW or with reference diameter greater than 3 m. Full application of the procedures herein prescribed is not generally justified for machines with smaller power and size. Nevertheless, this document may be used for such machines by agreement between the purchaser and the supplier.

In this document, the term "turbine" includes a pump-turbine operating as a turbine and the term "pump" includes a pump-turbine operating as a pump.

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

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

This document covers the arrangements for model acceptance tests to be performed on hydraulic turbines, storage pumps and pump-turbines to determine if the main hydraulic performance contract guarantees (see 4.2) have been satisfied.

It contains the rules governing test conduct and prescribes measures to be taken if any phase of the tests is disputed.

The main objectives of this document are:

– to define the terms and quantities used;
– to specify methods of testing and of measuring the quantities involved, in order to ascertain the hydraulic performance of the model;
– to specify the methods of computation of results and of comparison with guarantees;
– to determine if the contract guarantees that fall within the scope of this document have been fulfilled;
– to define the extent, content and structure of the final report.

The guarantees can be given in one of the following ways:

– guarantees for prototype hydraulic performance, computed from model test results considering scale effects;
– guarantees for model hydraulic performance.

Moreover, additional performance data (see 4.4) can be needed for the design or the operation of the prototype of the hydraulic machine. Contrary to the requirements of Clauses 4 to 6 related to main hydraulic performance, the information of these additional data given in Clause 7 is considered only as recommendation or guidance to the user (see 7.1).

It is particularly recommended that model acceptance tests be performed if the expected field conditions for acceptance tests (see IEC 60041:1991) would not allow the verification of guarantees given for the prototype machine.

A transposition method taking into account the model and prototype wall surface roughness for the performance conversion on pump-turbines, Francis turbines, and axial machines is described in IEC 62097. This method requires model and prototype surface roughness data and is takes into account the shift in n_{ED}, Q_{ED} and P_{ED} factors for determining the transposition of efficiency between model and prototype. However, in the case of Francis machines with semi-spiral casing and axial machines, the transposition method has not been fully validated due to a lack of data. In addition, IEC 62097 does not apply to storage pumps, Pelton turbines, and Dériaz. Therefore, for these and otherwise specifically agreed upon cases where hydraulically smooth flow conditions are assumed on the model and the prototype, the transposition formula and procedure given in Annex D and Annex I can be applied. Applications and limitations of both this document and IEC 62097 transposition methods are discussed in Annex E.

The method for performance conversion from model to prototype needs to be clearly defined in the main hydraulic performance contract.

This document may also be applied to model tests for other purposes, i.e. comparative tests and research and development work.

If model acceptance tests have been performed, field tests can be limited to index tests (see IEC 60041:1991).

If a contradiction is found between this document and any other document, this document prevails.

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 62097:2009, *Hydraulic machines, radial and axial – Performance conversion method from model to prototype*

ISO 2186:2007, *Fluid flow in closed conduits – Connections for pressure signal transmissions between primary and secondary elements*

ISO 2533:1975, *Standard atmosphere*

ISO 4185:1980, *Measurement of liquid flow in closed conduits – Weighing method*

ISO 4287:1997, *Geometrical Product Specifications (GPS) – Surface texture: Profile method – terms, definitions and surface texture parameters*

ISO 8316:1987, *Measurement of liquid flow in closed conduits – Method by collection of the liquid in a volumetric tank*