

#### SLOVENSKI STANDARD SIST EN IEC 61362:2024

01-december-2024

### Smernice za specifikacijo sistemov za krmiljenje hidravličnih turbin (IEC 61362:2024)

Guidelines to specification of hydraulic turbine governing systems (IEC 61362:2024)

Leitfaden zur Spezifikation der Regeleinrichtung von Wasserturbinen (IEC 61362:2024)

Lignes directrices pour la spécification des systèmes de régulation des turbines hydrauliques (IEC 61362:2024)

Ta slovenski standard je istoveten z: EN IEC 61362:2024

<u>SIST EN IEC 61362:2024</u>

ICS:

27.140 Vodna energija

Hydraulic energy engineering

**SIST EN IEC 61362:2024** 

en

### iTeh Standards (https://standards.iteh.ai) Document Preview

SIST EN IEC 61362:2024

#### EUROPEAN STANDARD NORME EUROPÉENNE EUROPÄISCHE NORM

**EN IEC 61362** 

October 2024

ICS 27.140

Supersedes EN 61362:2012

#### **English Version**

# Guidelines to specification of hydraulic turbine governing systems (IEC 61362:2024)

Lignes directrices pour la spécification des systèmes de régulation des turbines hydrauliques (IEC 61362:2024) Leitfaden zur Spezifikation der Regeleinrichtung von Wasserturbinen (IEC 61362:2024)

This European Standard was approved by CENELEC on 2024-10-22. 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, Türkiye and the United Kingdom.

SIST EN IEC 61362:2024

https://standards.iteh.ai/catalog/standards/sist/72e3e570-2745-444a-9809-791c7feb6ced/sist-en-jec-61362-2024



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

#### EN IEC 61362:2024 (E)

#### **European foreword**

The text of document 4/500/FDIS, future edition 3 of IEC 61362, prepared by TC 4 "Hydraulic turbines" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 61362:2024.

The following dates are fixed:

- latest date by which the document has to be implemented at national (dop) 2025-10-31 level by publication of an identical national standard or by endorsement
- latest date by which the national standards conflicting with the (dow) 2027-10-31 document have to be withdrawn

This document supersedes EN 61362:2012 and all of its amendments and corrigenda (if any).

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.

Any feedback and questions on this document should be directed to the users' national committee. A complete listing of these bodies can be found on the CENELEC website.

Endorsement notice ttps://standards.iteh.ai

The text of the International Standard IEC 61362:2024 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60193 NOTE Approved as EN IEC 60193

EN IEC 61362:2024 (E)

### 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.cencenelec.eu.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	EN/HD	<u>Year</u>
IEC 60308	-	Hydraulic turbines - Testing of governing systems	EN IEC 60308	-
IEC 61131-2	-	Industrial-process measurement and control - Programmable controllers - Part 2 Equipment requirements and tests	EN 61131-2 2:	-

(https://standards.iteh.ai)
Document Preview

SIST EN IEC 61362:2024

### iTeh Standards (https://standards.iteh.ai) Document Preview

SIST EN IEC 61362:2024



IEC 61362

Edition 3.0 2024-09

### INTERNATIONAL STANDARD

# NORME INTERNATIONALE



#### Guidelines to specification of hydraulic turbine governing systems

Lignes directrices pour la spécification des systèmes de régulation des turbines hydrauliques

SIST EN IEC 61362:2024

https://standards.iteh.ai/catalog/standards/sist/72e3e570-2745-444a-9809-791c7feb6ced/sist-en-jec-61362-2024

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION ELECTROTECHNIQUE INTERNATIONALE

ICS 27.140 ISBN 978-2-8322-9577-9

Warning! Make sure that you obtained this publication from an authorized distributor.

Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

#### CONTENTS

F	OREWO	PRD	7
IN	NTRODU	JCTION	9
1	Scop	e	10
2	Norm	native references	10
3	Term	ns and definitions	10
	3.1	General terms and definitions	11
	3.2	Terms and definitions related to control levels, control modes and	
	-	operational modes	11
	3.3	Terms and definitions from control theory	12
	3.4	Subscripts and prefixes	13
	3.5	Terms and definitions related to the plant and the units	13
	3.6	Terms and definitions related to the governing system	
4	Gove	erning system structure	23
	4.1	General	23
	4.2	Main control functions	24
	4.2.1	General	24
	4.2.2	Speed control	24
	4.2.3	Power output control	24
	4.2.4	Opening control	24
	4.2.5	Water level control	25
	4.2.6	Flow control	25
	4.3	Configurations of combined controllers	25
	4.3.1	General	25
	4.3.2	Parallel structure	25
	4.3.3		
	4.4 s.i	Special control functions 1/72e3e570-2745-444a-9809-791c7feb6ced/six	t-en-iec-626
	4.4.1	Feed forward control	26
	4.4.2	Surge tank level or pressure feedback	27
	4.5	Pump-turbine control	28
	4.5.1	General	28
	4.5.2	Conventional pump-turbine control	28
	4.5.3	Variable speed pump-turbine control	28
	4.6	Manual control	30
	4.7	Linearization	30
	4.8	Limitation functions	30
	4.9	Bumpless control modes transition	31
	4.10	Optimization control	31
5	Fund	tional performance	31
	5.1	General	31
	5.2	Modelling and digital simulation	32
	5.2.1	General	32
	5.2.2	Water passages	33
	5.2.3	Turbine, generator, electrical grid	33
	5.2.4	Control concept	33
	5.2.5	Hardware-in-the-loop simulation	34
	5.2.6	Personnel training	34
	5.2.7	Inaccuracy of plant simulators	34

	5.3	Characteristic parameters for PID-controllers	35
	5.3.1	General	35
	5.3.2	Permanent droop	35
	5.3.3	Proportional action coefficient $K_{P}$ , integral action time $T_{I}$ , and derivative action time $T_{D}$	35
	5.3.4		
	5.4	Other parameters of the governing systems	
	5.4.1	Command signal adjustments for controlled variables (speed, power output, etc.) and load limiter	
	5.4.2	Governor insensitivity i <sub>X</sub> /2	37
	5.4.3	Dynamic characteristics of servo-positioner	37
	5.4.4	·	
	5.4.5	Servo-positioner non-linearity by kinematics	40
6	Servo	positioner configurations	40
	6.1	Servo-positioners	40
	6.2	Configurations of servo-positioners	41
	6.3	Multiple actuator control	41
	6.3.1	General	41
	6.3.2	Parallel structure	42
	6.3.3	Series structure	42
	6.3.4	Individual control	42
	6.4	Dual regulation of turbines with controllable guide vane and runner blade angles	43
	6.5	Dual control of turbines with needles and deflectors	43
	6.6	Other relationships	43
7	Instru	umentation	
	7.1	General SIST FN JEC 61362:2024	
	7.21s.it	Rotational speed and sest / 72-3-570-2745-444a-9809-791-7feb6ced/sist-en-icc	44
	7.3	Power output	44
	7.4	Water level	44
	7.5	Actuator position (stroke)	44
	7.6	Signal transmission from electronic transmitters	44
8	Safet	y functions and devices	44
	8.1	General	44
	8.2	Quick shutdown and emergency shutdown	44
	8.2.1	General	44
	8.2.2	Tripping actions	45
	8.2.3	Servomotor shutdown initiating devices	45
	8.2.4		
	8.2.5	Tripping strategies	45
	8.3	Overspeed protection device	
	8.4	Interlocks	
9	Provi	sion of actuating energy	46
	9.1	General	46
	9.2	System with an accumulator	
	9.2.1	Pressure tank (air-oil accumulator)	
	9.2.2		
	9.2.3	Bladder accumulators	48

9.2.4	Other systems	48
9.2.5	Pumps for accumulator systems	48
9.2.6	Oil sump tanks	49
9.2.7	Auxiliary equipment	49
9.2.8	Provision of pressurized gas	49
9.3	Systems without accumulator	
9.3.	•	
9.3.2	•	
9.4	Direct electric positioner	
9.5	Recommendation for hydraulic fluid selection	
	rational transitions	
10.1	Start-up and synchronization	
10.1	Normal shutdown	
10.2	Sudden load rejection	
	,	
10.4	Other operational transitions	
	plementary equipment	
11.1	Measures to reduce pressure variations	
11.2	Surge control	
11.3	Equipment and measures to lower the speed rise	
11.4	Joint control	
11.5	Braking	
11.6	Synchronous condenser mode of operation	
12 Cons	siderations for the electronic governor	55
12.1	Equipment requirements	55
12.2	Power supply recommendations	55
13 How	to apply the recommendations	55
Annex A	(normative) Simplified differential equations and transfer functions of	
idealized	PID-control functions \$\sist\/72e3e570-2745-444a-9809-791e7feb6ced/sist-en	100-06862
Annex B	(informative) Grid frequency control	70
B.1	General	70
B.2	Power equilibrium and grid frequency	70
B.2.		
B.2.	Grid frequency	70
B.3	Primary frequency control	
B.3.		
B.3.2		
B.4	Secondary frequency control	
Annex C	(informative) Role of governing systems for stability in interconnected grid	
		73
C.1	General	73
C.2	Stability of the unit with respect to the water hydraulic system	73
C.3	Stability of the unit with respect to the electrical power system	
C.3.		
C.3.		
C.3.	, ,	
C.3.	· · · · · · · · · · · · · · · · · · ·	
	(informative) Quick shutdown and emergency shutdown	
	General	76

D.2 Alternative example I	76
D.2.1 General	76
D.2.2 Quick shutdown	76
D.2.3 Emergency shutdown	77
D.2.4 Summary table and combined tripping cases	
D.3 Alternative example II	
Bibliography	80
Figure 1 – Turbine control transmission ratio	
Figure 2 – Controlled system self-regulation factor	
Figure 3 – Controlled variable range	17
Figure 4 – Permanent droop	17
Figure 5 – Proportional action coefficient and integral action time	
Figure 6 – Derivative time constant	19
Figure 7 – Dead band	20
Figure 8 – Minimum servomotor opening/closing time	20
Figure 9 – Time constants of the servomotor/servo-valve combination	21
Figure 10 – Servo-positioner inaccuracy	22
Figure 11 – Governing system dead time	23
Figure 12 – Governing system with speed and power output control functions in parallel	26
Figure 13 – Governing system with speed control function and water level control function in parallel	26
Figure 14 – Governing system with power output and speed control functions in serie	es26
Figure 15 – Schematic diagram of a turbine governing system with feed forward	27
Figure 16 – Schematic diagram of a turbine governing system with an additional pressure feedback compensation control function	en-iec-61362-2024 28
Figure 17 – Governor function in conventional pump mode	28
Figure 18 – Governor function of variable speed pumped storage systems in pump mode	29
Figure 19 – Governor function of variable speed pumped storage systems in turbine mode with power output based control	29
Figure 20 – Governor function of variable speed pumped storage systems in turbine mode with rotating speed based control	29
Figure 21 – Servo-positioner control loop – simplified dynamic model with P-controlle	ers38
Figure 22 – Servo-positioner control loop – simplified dynamic model	38
Figure 23 – Time step response and frequency response of the output of the servo-positioner	39
Figure 24 – Servo-positioner block diagram	41
Figure 25 – Parallel structure with defined functional relation and an additional signa superimposition	
Figure 26 – Series structure with defined functional relation and additional signal superimposition	
Figure 27 – Structure with different set-points for each servo-positioner	42
Figure 28 – Pressure tank content and pressure ranges	
Figure 29 – Open-circuit system	

Figure 31 – Load rejection	53
Figure A.1 – Idealized PID in pure parallel structure	68
Figure A.2 – Idealized PID alternative representation	68
Figure B.1 – Example of principle schematic functional diagram of a unit with a turbine governing system using an idealized PID control function with a frequency-power droop	71
Figure B.2 – Behaviour of two units with different governor permanent droop values	72
Table 1 – Unit and plant categories	55
Table D.1 – Alternative I – Summary of cases for quick shut-down and emergency shut-down	78
Table D.2 – Alternative II – Summary of cases for quick shut-down and emergency	70

### iTeh Standards (https://standards.iteh.ai) Document Preview

SIST EN IEC 61362:2024

#### INTERNATIONAL ELECTROTECHNICAL COMMISSION

### GUIDELINES TO SPECIFICATION OF HYDRAULIC TURBINE GOVERNING SYSTEMS

#### **FOREWORD**

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at https://patents.iec.ch. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 61362 has been prepared by IEC technical committee 4: Hydraulic turbines. It is an International Standard.

This third edition cancels and replaces the second edition published in 2012. This edition constitutes a technical revision.

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

- a) adoption of parts of IEC 60308:2005 which deal with specification matters;
- b) introduction of several new technical topics;
- c) overall editorial revision.

- 8 -

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

Draft	Report on voting
4/500/FDIS	4/509/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at <a href="https://www.iec.ch/members\_experts/refdocs">www.iec.ch/members\_experts/refdocs</a>. The main document types developed by IEC are described in greater detail at <a href="https://www.iec.ch/publications">www.iec.ch/publications</a>.

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

- reconfirmed,
- withdrawn, or
- revised.

#### iTeh Standards

IMPORTANT – The "colour inside" logo on the cover page of this document indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

SIST EN IEC 61362:2024