SLOVENSKI STANDARD
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Vodilo za določanje krmilnih sistemov vodnih turbin (IEC 61362:1998)

Guide to specification of hydraulic turbine control systems

Leitfaden zur Spezifikation der Regelungssysteme für hydraulische Turbinen

Guide pour la spécification des régulateurs des turbines hydrauliques

Ta slovenski standard je istoveten z: **EN 61362:1998**

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Guide to specification of hydraulic turbine control systems
(IEC 61362:1998)

Guide pour la spécification des régulateurs des turbines hydrauliques
(CEI 61362:1998)

Leitfaden zur Spezifikation der Regelungssysteme für hydraulische Turbinen
(IEC 61362:1998)

CENELEC

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

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Foreword

The text of document 4/119/FDIS, future edition 1 of IEC 61362, prepared by IEC TC 4, Hydraulic turbines, was submitted to the IEC-CENELEC parallel vote and was approved by CENELEC as EN 61362 on 1998-01-01.

The following dates were fixed:

- latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1998-12-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1998-12-01

Annexes designated "normative" are part of the body of the standard.
In this standard, annexes A and ZA are normative.
Annex ZA has been added by CENELEC.

Endorsement notice

The text of the International Standard IEC 61362:1998 was approved by CENELEC as a European Standard without any modification.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE: When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60068-2-6 + corr. March	1995 1995	Environmental testing Part 2: Tests - Test Fc: Vibration (sinusoidal)	EN 60068-2-6	1995
IEC 60308	1970	International code for testing of speed governing systems for hydraulic turbines	-	-
IEC 61000-3-2	1995	Electromagnetic compatibility (EMC) Part 3: Limits Section 2: Limits for harmonic current emissions (equipment input current up to and including 16 A per phase)	EN 61000-3-2 + corr. July	1995 1997
IEC 61000-3-3	1994	Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current up to and including 16 A	EN 61000-3-3 + corr. July	1995 1997
IEC 61000-4-1	1992	Part 4: Testing and measurement techniques Section 1: Overview of immunity tests	EN 61000-4-1	1994
CISPR 11 (mod)	1990	Limits and methods of measurement of radio disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment	EN 55011	1991
ISO 3448	1992	Industrial liquid lubricants ISO viscosity classification	-	-

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Guide to specification of hydraulic turbine control systems

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

GUIDE TO SPECIFICATION OF HYDRAULIC TURBINE CONTROL SYSTEMS

FOREWORD

1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the 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, the IEC publishes International Standards. 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. The 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 the 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 National Committees.

3) The documents produced have the form of recommendations for international use and are published in the form of standards, technical reports or guides and they are accepted by the National Committees in that sense.

4) In order to promote international unification, IEC National Committees undertake to apply IEC International Standards transparently to the maximum extent possible in their national and regional standards. Any divergence between the IEC Standard and the corresponding national or regional standard shall be clearly indicated in the latter.

5) The IEC provides no marking procedure to indicate its approval and cannot be rendered responsible for any equipment declared to be in conformity with one of its standards.

6) Attention is drawn to the possibility that some of the elements of this International Standard may be the subject of patent rights. The IEC shall not be held responsible for identifying any or all such patent rights.

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

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

FDIS	Report on voting
4/119/FDIS	4/142/RVD

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

Annex A forms an integral part of this standard.

The contents of the corrigendum of March 2000 have been included in this copy.

INTRODUCTION

Recent developments have led to more stringent control system requirements with respect to power frequency regulation and to isolated network operation. These requirements essentially concern the primary control, which due to the use of modern, mostly electronic components, can be tasked with some additional control functions. Also the primary control responds to a superimposed large network control system (secondary control).

This guide mainly deals with primary control specifications; additional tasks are covered but the guide does not elaborate on specific details.

Specifically the primary control can include some or all of the following functions:

– unit start-up and shut-down;
– idling before synchronizing and after separation from the network and synchronizing;
– isolated network operation;
– parallel operation on large networks in speed control and power output control mode;
– head water level and/or flow control;
– operating mode transitions;
– monitoring and safety functions.

The guide also deals with aspects of the actuating energy supply.

The controlled system in a hydroturbine control loop, i.e., the respective transfer function, is characterized by:

– the unit(s), i.e. turbine(s) and generator(s);
– the water passage system;
– the network to which the unit(s) is (are) connected;
– the modes of operation as mentioned above.

The parameters of the primary control system (speed governor, power output governor, etc.) are to be carefully matched to the prevailing system conditions in order to:

– achieve adequate stability;
– satisfy performance requirements with respect to damping, response and accuracy;
– provide safety with respect to limitations in hydraulic transients, etc.

To achieve the above, in many cases modeling and simulations are valuable. The guide refers to some important aspects in this respect.

Since the governors have to be able to cope with a range of conditions, it is suitable practice to specify that a certain range for the setting of parameters is available in the governors. The guide follows this practice in the relevant part.

Specifically, in this guide, the performance-relevant definitions refer to the PID-controller, which can be implemented by analog or digital means. With appropriate microcomputer technology, higher control algorithms also can be implemented. Although it is deemed difficult to set up specific rules at the time of the issue of this guide, the general criteria for the adequate performance of a control system are essentially independent of the control strategy used. This means that they remain applicable as described in this guide and that the PID-controller can be regarded and used as a reference governor to gauge the control performance of a system.

The guide makes reference to IEC 60308 on hydraulic turbine control systems. It relies on it for the methods of system identification and verification of performance, etc. It is the intention of this guide to supplement IEC 60308 by recommending performance criteria and ranges for the setting of parameters.

To facilitate the setting up of specifications, this guide also includes data sheets, which are to be filled out by the customer and the vendor in the various stages of the project and the contract.

GUIDE TO SPECIFICATION OF HYDRAULIC TURBINE CONTROL SYSTEMS

1 General

1.1 Scope and object

This guide includes relevant technical data necessary to describe hydraulic turbine control systems and define their performance. It is aimed at unifying and thus facilitating the bidding specifications and technical bids. It will also serve as a basis for setting up technical guarantees.

In case of separate vendors for different segments of a system, the interface between them is especially important.

The guide is not confined to the control loop functions proper but includes all important functions of a control system, i.e., it also treats sequencing functions, etc. Hydraulic turbine control is thus understood to include:

– speed, power, water level and discharge control for reaction and impulse-type turbines including double regulated machines;
– means of providing actuating energy;
– safety devices for emergency shut-down, etc;
– environmental performance criteria.

The guide aids the selection of some important parameters to be specified and checked in relation to the different types of installations.

Excluded topics are acceptance tests, specific test procedures and guarantees.

1.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreement based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60068-2-6:1995, *Environmental testing – Part 2: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60308:1970, *International code for testing of speed governing systems for hydraulic turbines*

IEC 61000-3-2:1995, *Electromagnetic compatibility (EMC) – Part 3: Limits – Section 2: Limits for harmonic current emissions (equipment input current ≤16 A per phase)*

IEC 61000-3-3:1994, *Electromagnetic compatibility (EMC) – Part 3: Limits – Section 3: Limitation of voltage fluctuations and flicker in low-voltage supply systems for equipment with rated current ≤16 A*

IEC 61000-4-1:1992, *Electromagnetic compatibility (EMC) – Part 4: Testing and measurement techniques – Section 1: Overview of immunity tests*

CISPR 11:1990, *Limits and methods of measurement of electromagnetic disturbance characteristics of industrial, scientific and medical (ISM) radio-frequency equipment*

ISO 3448:1992, *Industrial liquid lubricants – ISO viscosity classification*

2 Terms, definitions, symbols and units

2.1 General definitions

This guide uses as far as possible the terms and definitions of IEC 60308. For clarification, the simplified differential equation of the idealized PID-governor as used in this guide in comparison with that of an idealized PI-governor used in IEC 60308 is given in annex A.

For the purpose of this International Standard the following definitions, as well as the definitions given in IEC 60308, apply.

2.1.1
differential equation
equation describing the dynamic system behavior in the time-domain, as shown in annex A.

2.1.2
transient response
system response (output) to a step change of the input.

2.1.3
frequency response
dynamic response of the linearized system to a sinusoidal change of the input signal derived from the differential equation by applying the Fourier transformation.

2.1.4
transfer function
dynamic response of the linearized system to an arbitrary variation of the input signal derived from the differential equation by applying the Laplace transformation.

2.2 List of terms, definitions, symbols and units

Sub-clause	Term	Definition	Symbol	Unit
2.2.1	**Rated**	Subscript indicating the rated operation point of the system.	r	–
2.2.2	**Maximum** **Minimum**	Subscript indicating maximum or minimum values of any term.	max. min.	–
2.2.3	**Deviation**	Deviation of any term from a steady-state value	Δ	–
2.2.4	**Guide vanes**	Subscript associating a quantity to wicket gate	ga	–
2.2.5	**Runner**	Subscript associating a quantity to runner	ru	–
2.2.6	**Nozzle**	Subscript associating a quantity to nozzle	nz	–
2.2.7	**Deflector**	Subscript associating a quantity to deflector	de	–

2.3 Terms relating to the plant and the machines

Sub-clause	Term	Definition	Symbol	Unit
2.3.1	**Specific energy of machine**	Specific energy of hydraulic water available between the high- and low-pressure side sections of the machine	E	$J \cdot kg^{-1}$
2.3.2	**Turbine head**	$H = E/g$ definition of E, see 2.3.1 g = acceleration due to gravity. = 9,81 $m \cdot s^{-2}$ (at sea level)	H	m
2.3.3	**Discharge**	Volume of water per unit time flowing through any section in the system	Q	$m^3 \cdot s^{-1}$
2.3.4	**Rotational speed**	Number of revolutions per unit time	n	$t \cdot min^{-1}$
2.3.5	**Frequency**	Cycles per second	f	Hz
2.3.6	**Generator output**	Generator power measured at generator terminals	P_G	W
2.3.7	**Moment of inertia of mass**	Moment of inertia for calculation of fly-wheel effect. $I = M\ D^2/4 = MR^2$ (M = mass, D = diameter of gyration, R = radius of gyration)	I	$kg \cdot m^2$

2.4 Terms relating to the control system

Sub-clause	Term	Definition	Symbol	Unit
2.4.1	**Controlled variable**	Variable which has to be controlled as speed n, output P_G, water level h:		
		– absolute, dimensional value	X	var.
		– relative deviation from a steady-state value, $x = \Delta X/X_r$	x	–
		Rotational speed	x_n	–
		Output	x_p	–
		Water level	x_h	–
2.4.2	**Command signal**	A signal which can be set by an external adjustment:		
		– absolute, dimensional value	C	var.
		– relative deviation from a steady-state value, $c = \Delta C/C_r$	c	–
		Rotational speed	c_n	–
		Output	c_p	–
		Water level	c_h	–
2.4.3	**Servomotor stroke**	Stroke of the main servomotor which moves the gate/runner blades/nozzles/deflectors		
		– absolute value	Y	m
		– relative deviation from a steady-state value, $y = \Delta Y/Y_{max}$	y	–
2.4.4	**Controlled variable range**	Adjusting range for the setting of the controlled variable with an average setting of the permanent droop:		
		– maximum value of the controlled variable for $Y/Y_{max} = 0$	X_{max}	–
		– minimum value of the controlled variable for $Y/Y_{min} = 1,0$ (see figure 1)	X_{min}	–

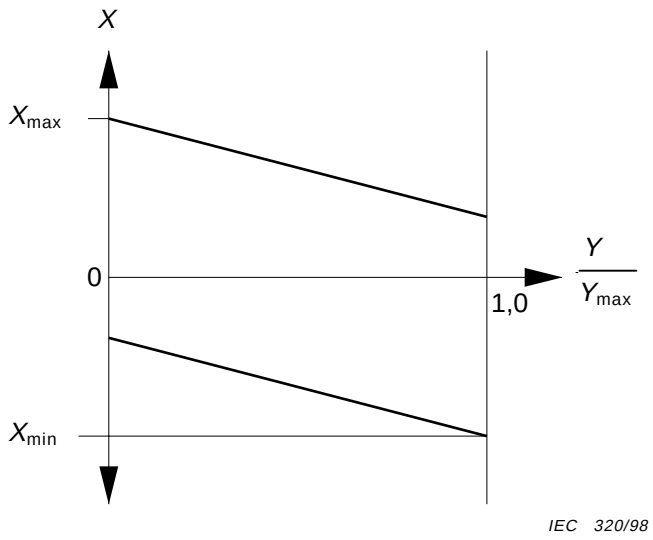

Figure 1 – Controlled variable range