



SLOVENSKI STANDARD
oSIST prEN IEC 60308:2023
01-september-2023

Hidravlične turbine - Preskušanje krmilnih sistemov

Hydraulic turbines - Testing of governing systems

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Ta slovenski standard je istoveten z: prEN IEC 60308:2023

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ICS:

27.140

Vodna energija

Hydraulic energy engineering

oSIST prEN IEC 60308:2023

en



4/470/CDV

COMMITTEE DRAFT FOR VOTE (CDV)

PROJECT NUMBER:

IEC 60308 ED3

DATE OF CIRCULATION:

2023-06-16

CLOSING DATE FOR VOTING:

2023-09-08

SUPERSEDES DOCUMENTS:

4/428/CD, 4/467/CC

IEC TC 4 : HYDRAULIC TURBINES	
SECRETARIAT: Canada	SECRETARY: Mrs Christine Geraghty
OF INTEREST TO THE FOLLOWING COMMITTEES:	PROPOSED HORIZONTAL STANDARD: <input type="checkbox"/> Other TC/SCs are requested to indicate their interest, if any, in this CDV to the secretary.
FUNCTIONS CONCERNED: <input type="checkbox"/> EMC <input type="checkbox"/> ENVIRONMENT <input type="checkbox"/> QUALITY ASSURANCE <input type="checkbox"/> SAFETY	
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TITLE:

Hydraulic turbines - Testing of governing systems

PROPOSED STABILITY DATE: 2026

NOTE FROM TC/SC OFFICERS:

1 CONTENTS

2		
3	FOREWORD	6
4	INTRODUCTION	8
5	1 Scope	9
6	2 Normative references	9
7	3 Terms and definitions	9
8	4 Recommendations on tests	10
9	4.1 General	10
10	4.2 Recommendations on workshop tests	10
11	4.3 Recommendations on field tests	11
12	4.3.1 New governing systems	11
13	4.3.2 Existing governing systems	11
14	5 Governing system tests	12
15	5.1 Test conditions to be fulfilled	12
16	5.1.1 General	12
17	5.1.2 Turbine operation conditions	12
18	5.1.3 Hydraulic pressure unit condition	13
19	5.1.4 Deviation of values from specified operating conditions	13
20	5.1.5 Provisions for instruments	13
21	5.1.6 Calibration of instruments	13
22	5.2 Electrical checks	14
23	5.2.1 General	14
24	5.2.2 Selection of test center	14
25	5.2.3 Power supply	14
26	5.2.4 Overvoltage protection and suppression of interference voltage	14
27	5.3 Test of the process interface system	15
28	5.4 Test of converters, amplifiers and actuators	15
29	5.4.1 Electrohydraulic and electromechanical converters	15
30	5.4.2 Servomotors	20
31	5.4.3 Dead time, insensitivity	20
32	5.4.4 Provision of actuating energy	21
33	5.4.5 Oil leakage	22
34	5.4.6 Test of the positioning loop	22
35	5.5 Tests of governor characteristics	22
36	5.5.1 General	22
37	5.5.2 Test of the governing system	22
38	5.5.3 Determination of governing system's parameters	23
39	5.5.4 Test of main control loops	25
40	5.5.5 Considerations for Island grid field tests	27
41	5.6 Servomotor pressure indication test	30
42	5.7 Safety tests	30
43	5.7.1 General	30
44	5.7.2 Test strategy	31
45	5.7.3 Test plan	31

46	6	Inaccuracies in tests of governing systems	32
47	7	Simulation of governing and control operations	34
48	8	Organizational aspects of test management	34
49		Annex A (informative) Test procedures	36
50	A.1	Insensitivity test procedure	36
51	A.2	Dead time test procedure	36
52	A.3	Test procedure for the servomotor pressure indication	37
53	A.4	Procedure for the measurement of the pressure and flow characteristics of	
54		control valves	37
55		Annex B (informative) Recommendation for testing of turbine governing systems	39
56	B.1	General	39
57	B.1.1	Workshop tests	40
58	B.2	Level II – Units for base load operation	44
59	B.2.1	Workshop tests	44
60		Field tests 46	
61	B.3	Level III – Other units without special requirements	48
62	B.3.1	Workshop tests	48
63	B.3.2	Field tests	49
64		Annex C (informative) Field test of governing systems	50
65	C.1	Data on operating conditions	50
66	C.2	Pre-start tests prior to filling waterways	50
67	C.3	Test after filling waterways	51
68	C.4	Initial run	51
69	C.5	No-load tests	51
70	C.6	Load and load rejection tests	51
71	C.7	Measurement and recordings	51
72		Annex D (informative) Governing system test examples	53
73	D.1	Insensitivity test under speed control with X-Y recording (example referring	
74		to 5.5.3.3.2 and Annex A 1b)	53
75	D.2	Insensitivity test under opening control with frequency-opening-droop and	
76		time characteristics (example referring to 5.5.3.3.3 and Annex A 1a)	55
77	D.3	Insensitivity test under power control with time characteristics (example	
78		referring to 5.5.3.3.3 and Annex A 1a)	57
79	D.4	Synchronism test of 2 controlled quantities with X-Y recording (example	
80		referring to 5.5.3.4)	59
81	D.5	Measurement of a unit step response with PID speed controller (example	
82		referring 5.5.4.2 and 5.5.3.1)	61
83	D.6	Measurement of a unit step response with speed control for determination of	
84		PID controller parameters (example referring to 5.5.4.2; 5.5.3.1)	63
85	D.7	Measurement of a unit step response with speed control for determination of	
86		PID controller parameters (example referring to 5.5.4.2; 5.5.5)	65
87	D.8	Measurement of a unit step response in island operation (example referring	
88		to 5.5.5.3)	67
89	D.9	Measurement of unit step responses with power control (example referring	
90		to 5.5.4.3 and 5.5.4.6)	69
91	D.10	Measurement of unit step responses with power control (example referring	
92		to 5.5.4.3 and 5.5.4.6)	71
93	D.11	Measurement of a unit step response with power control for determination of	
94		PI-controller parameters (example referring to 5.5.4.3)	73

95	D.12	Measurement of a unit step response with headwater level control (example referring to 5.5.4.4)	75
96			
97	D.13	Measurement of the unit step responses with headwater level control, in multi-unit operations (example referring to 5.5.4.4).....	77
98			
99	D.14	Measurement of a load rejection with transition into no-load operation (example referring to 5.5.4.2)	79
100			
101	D.15	Measurement of a load rejection with limit control of surge and suction waves and with transition into no-load operation (example referring to 5.5.4.2)	81
102			
103			
104	D.16	Measurement of a start-up process and loading (example referring to 5.5.4)	83
105	D.17	Measurement of changeover from full turbine load to synchronous condenser operation (example referring to 5.5.4).....	85
106			
107	D.18	Measurement of a power step-response in on-line simulated island operation test (example referring to 5.5.4, 5.5.5).....	87
108			
109	Bibliography		89
110			
111	Figure 1	– Oil flow Q function of input current I and pressure drop Δp	15
112	Figure 2	– Two stage Electro hydraulic control with pilot servomotor	17
113	Figure 3	– Output stroke Δs of a converter versus input current I	17
114	Figure 4	– Performance curves of control valves	19
115	Figure 5	– Example of on-line simulated island grid test.....	29
116			
117	Figure D.1	– Insensitivity test under speed control with X-Y recording.....	54
118	Figure D.2	– Insensitivity test under opening control with time characteristics	56
119	Figure D.3	– Insensitivity test under power control with time characteristics	58
120	Figure D.4	– Synchronism test of 2 controlled quantities with X-Y recording.....	60
121	Figure D.5	– Measurement of a unit step response with PID speed controller.....	62
122	Figure D.6	– Measurement of a unit step response with speed control for determination of PID controller parameters	64
123			
124	Figure D.7	– Measurement of a unit step response with speed control for determination of PID controller parameters	66
125			
126	Figure D.8	– Measurement of unit step response in island operation	68
127	Figure D.9	– Measurement of a unit step responses with power control (Pelton turbine).....	70
128	Figure D.10	– Measurement of unit step responses with power control (pump turbine)	72
129	Figure D.11	– Measurement of a unit step response with power control for determination of PI-controller parameters.....	74
130			
131	Figure D.12	– Measurement of a unit step response with headwater level control.....	76
132	Figure D.13	– Measurement of the unit step responses with headwater level control in multi-unit operations.....	78
133			
134	Figure D.14	– Measurement of a load rejection with transition into no-load operation	80
135	Figure D.15	– Measurement of a load rejection with limit control of surge and suction waves and with transition into no-load operation	82
136			
137	Figure D.16	– Measurement of a start-up process under load.....	84
138	Figure D.17	– Measurement of changeover from full turbine load to synchronous condenser operation.....	86
139			
140	Figure D.18	– Measurement of a power step response in on-line simulated isolation test	88
141			

142		
143	Table 6.1 – Admissible measuring instrument inaccuracies	33
144	Table B. 1 – Normal test plan	40
145	Table B. 2 – Comprehensive test plan	41
146	Table B. 3 – Normal test plan	42
147	Table B. 4 – Comprehensive test plan	43
148	Table B. 5 – Normal test plan	44
149	Table B. 6 – Comprehensive test plan	45
150	Table B. 7 – Normal test plan	46
151	Table B. 8 – Comprehensive test plan	47
152	Table B. 9 – Normal test plan	48
153	Table B.10 – Comprehensive test plan	48
154	Table B. 10 – Normal test plan	49
155	Table B. 11 – Comprehensive test plan	49

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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**HYDRAULIC TURBINES –
TESTING OF GOVERNING SYSTEMS****FOREWORD**

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IEC 60308 has been prepared by subcommittee WG 14: Hydroelectric Power Plant Automation and Turbine Governing Systems, of IEC technical committee TC 4: Hydraulic turbines. It is an International Standard.

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This third edition cancels and replaces the second edition published in 2005. This edition constitutes a technical revision.

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The main objective of this edition is the harmonization with the parallel developed new edition of IEC 61362. This edition includes the following technical changes with respect to the previous edition:

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a) Adoption of parts of IEC 61362 second edition published 2012 which deal with test matters;

b) Introduction of new technical aspects;

c) Overall editorial revision.

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210

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

Draft	Report on voting
XX/XX/FDIS	XX/XX/RVD

212

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

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

216 This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in
217 accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available
218 at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are
219 described in greater detail at <http://www.iec.ch/standardsdev/publications>.

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

- 223 • reconfirmed,
- 224 • withdrawn,
- 225 • replaced by a revised edition, or
- 226 • amended.

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INTRODUCTION

229 The first and second editions of this standard were developed to have a comprehensive
230 description for the test of hydraulic turbine governing systems according to the corresponding
231 state of the art. They were published independently of the guide to specification of hydraulic
232 turbine governing systems (IEC 61362). This third edition was developed together with IEC
233 61362 in order to harmonize their contents and their publishing dates. Furthermore, the
234 standards are kept open for state of the art by introducing new topics and harmonizing the
235 structure as well as the terms and definitions for both standards.

236 The definitions of all specific terms used in this standard are included in the standard IEC
237 61362.

238 The International Electrotechnical Commission (IEC) draws attention to the fact that it is claimed
239 that compliance with this document may involve the use of a patent. IEC takes no position
240 concerning the evidence, validity, and scope of this patent right.

241 The holder of this patent right has assured IEC that s/he is willing to negotiate licences under
242 reasonable and non-discriminatory terms and conditions with applicants throughout the world.
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HYDRAULIC TURBINES – TESTING OF GOVERNING SYSTEMS

254 1 Scope

255 This International Standard covers acceptance tests and the related specific test procedures
256 for hydraulic turbine governing systems. It can be used to fulfil following tasks:

- 257 – verification of system characteristics as per specification;
- 258 – verification of technical guarantees;
- 259 – verification of general proper functioning in the workshop and/or on site;
- 260 – assessment of the actual state of an existing governing system.

261 This standard covers the tests for systems and devices described in IEC 61362.

262 2 Normative references

263 The following documents are referred to in the text in such a way that some or all of their content
264 constitutes requirements of this document. For dated references, only the edition cited applies.
265 For undated references, the latest edition of the referenced document (including any
266 amendments) applies.

267 IEC 61362, *Guide to specification of hydraulic turbine control systems*

268 IEC 60041, *Field acceptance tests to determine the hydraulic performance of hydraulic turbines,*
269 *storage pumps and pump-turbines*

270 IEC 60545, *Guide for commissioning, operation and maintenance of hydraulic turbines*

271 ISO 4406, *Hydraulic fluid power – Fluids – Method for coding the level of contamination by solid*
272 *particles*

273

274 3 Terms and definitions

275 No terms and definitions are listed in this standard.

276 The definitions of all specific terms used in this standard are included in the standard IEC
277 61362.

278 ISO and IEC maintain terminological databases for use in standardization at the following
279 addresses:

- 280 • IEC Electropedia: available at <http://www.electropedia.org/>
- 281 • ISO Online browsing platform: available at <http://www.iso.org/obp>

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284 **4 Recommendations on tests**

285 **4.1 General**

286 In order to keep the commissioning period as short as possible, it is recommended that the
287 largest part possible of the required contractual tests be carried out in the manufacturer's works
288 (workshop tests). On site tests should be limited to the verification of such characteristics,
289 which:

- 290 – are indispensable for the safety, and
- 291 – cannot be carried out without the generating unit and the pressure supply system.

292 In the following subclauses, some basic aspects are summarised.

293 **4.2 Recommendations on workshop tests**

294 The scope of the tests, the best set up and the extent of the test documentation should be
295 stipulated in the contract in accordance with the requirements.

296 In case of type tests including EMC (Electro Magnetic Compatibility) type tests already
297 performed by the manufacturer of the equipment or assembly, the corresponding certificates
298 shall be accepted in order to reduce the tests efforts to a reasonable level.

299 It should be early and clear enough stipulated, who will witness the tests.

300 For workshop tests, it is not necessary to set up all components of the governing system in a
301 complete loop, the electronic governor and the oil hydraulic governor can rather be tested
302 separately. During these independent tests, signals at interfaces between the electronic
303 governor and the oil hydraulic governor shall be clearly defined and measurable.

304 Only if it is explicitly required in the contract the complete governing system, including the
305 electronic and the oil hydraulic governor should be assembled in the workshop. In this case the
306 individual testing of the systems may not be needed.

307 In exceptional technically challenging situations, it can be an advantage to employ a plant
308 simulator for the workshop test of the digital governor (see also chapter 7). The use of a plant
309 simulator in the workshop test has to be clearly stipulated in the contract.

310

311

312

313 **4.3 Recommendations on field tests**

314 **4.3.1 New governing systems**

315 For governing systems, the following measures and steps apply.

- 316 – Safety devices, displays, alarms and trip settings shall be verified prior to conducting the
317 field tests.
- 318 – Commissioning of the complete generating unit must be performed including load rejection
319 tests as per IEC 60041. The testing of governing systems shall be coordinated with the
320 overall commissioning of the hydro generating equipment, refer to IEC 60545.

321 For the actual governing system tests:

- 322 – The relevant control mode and operational mode to be checked is set, e.g. speed control in
323 island operation; subsequently defined test signals are superimposed and resulting changes
324 for the specified values through the entire operating range are observed and/or recorded,
325 whereby control settings can be optimised during the process. The results of such tests can
326 be used as baseline values in order to be compared with the results of verification tests
327 which are carried out during the lifetime of the equipment.
- 328 – The test of the insensitivity of the governing system is only needed if the power station will
329 be participating in primary regulation of network frequency, especially in peak load power
330 stations and in power stations with special requirements for high control accuracy (for
331 recommended insensitivities, see IEC 61362, acceptable measuring uncertainties are given
332 in chapter 6).
- 333 – In some cases, the parameters of the governing system can be determined based on
334 physical measurements. If the expected behaviour is not achieved and the reason for this
335 has to be identified, then other factors influencing the governing system behaviour shall be
336 examined. These factors may include: inertias, generator-load characteristics and the
337 influence of hydraulic forces on actuating times. The determination of the governing
338 system's parameters and of the turbine transfer function may be used to provide models of
339 the power plant, in order to carry out studies of the power system's dynamic behaviour
- 340 – Special attention shall be given to the test of pump turbines because of their complex
341 turbine characteristics (e.g. S-shape characteristic).

342 **4.3.2 Existing governing systems**

343 **4.3.2.1 Motivation for a field test in an existing governing system**

344 Existing governing systems may have deficiencies causing one or more of the following effects,
345 which can lead to the decision to conduct a field test.

- 346 – long settling times of the controlled variable;
- 347 – long synchronisation times
- 348 – drifting operating points;
- 349 – changes in actuator speeds;
- 350 – unusual oscillations (e. g. in no-load and/or island operation);
- 351 – excessive insensitivities and/or hysteresis effects;
- 352 – excessive leakages (long pumping periods, high oil temperature, etc.);
- 353 – general inconsistent governor performance

354

355 **4.3.2.2 Identification of deficiencies**

356 Depending on the observed effects the following checks can be made:

- 357 – measurement of the insensitivity and dead time, see Annexes A.1 and A.2;
- 358 – recording of step responses/transient functions (unit step responses) by applying defined
359 signals at the input (command signal, controlled variable, frequency, etc.), e.g. see Annexes
360 D.5 to D.13;
- 361 – indexing the servomotors, see Annex A.3;
- 362 – checking the runner/guide vane relationship in Kaplan turbines;
- 363 – checking the deflector/nozzle relationship in Pelton turbines;
- 364 – identifying possible resonances (with oscillations in the draft tube, surge tank, waterways:
365 penstock and/or channel system, the generator, the grid, etc.);
- 366 – measurements of the parameters of the governing system and comparison to the original
367 values recorded during the first commissioning, e.g. see Annexes D.6 and D.7;
- 368 – checking of the overall functionality of the oil hydraulic system, e.g. see Annex A.4.

369 **4.3.2.3 Deciding whether to replace or to repair existing governing systems**

370 The above-mentioned checks give information about the possible causes of the deficiencies,
371 allowing to decide on the measures to be taken, such as for instance:

- 372 – overhauling of individual components;
- 373 – replacement of components or of complete governing systems;
- 374 – changes in the configuration;

375 Besides the above-mentioned points, the following facts may also influence the decision to
376 replace or repair existing elements or systems:

- 377 – the assessment of operating costs;
- 378 – the assessment of repair costs;
- 379 – the potential for operating and efficiency improvement of replacement versus repair;
- 380 – general safety and any other demands required by authorities.

381 **5 Governing system tests**

382 **5.1 Test conditions to be fulfilled**

383 **5.1.1 General**

384 The following test conditions apply, unless there is an explicit exception made in this guide.
385 They can be modified by mutual agreement.

386 **5.1.2 Turbine operation conditions**

- 387 – Operating head on the turbine shall be within the limits specified in the turbine contract,
388 otherwise the method of correction should be agreed upon.
- 389 – Tailwater elevation and power output of the turbine shall be such that the net positive suction
390 head NPSH, see IEC 60041, is not less than the lower limit of the turbine manufacturer's
391 guarantee or recommendation.
- 392 – Steady-state power output of the turbine for constant position of the regulating devices (e.g.
393 wicket gate, runner, needle, deflector) shall not deviate from the specified value by more
394 than $\pm 1,5$ % of rated output.

395 **5.1.3 Hydraulic pressure unit condition**

396 Tests should be performed under approximately constant oil pressure. The fluctuations of the
397 supply oil pressure shall not exceed $\pm 10\%$ of average oil pressure.

398 **5.1.4 Deviation of values from specified operating conditions**

399 **5.1.4.1 General**

400 It is important that specified values stated in the contract, upon which stated guarantees are
401 based, be adhered to as closely as possible. The relative deviations from specified values under
402 which it is permissible to make a governing system acceptance test are specified in the following
403 subclauses.

404 **5.1.4.2 Speed**

405 If acceptance tests cannot be performed at the specified speed, the permissible deviation from
406 the specified speed and its effect on the acceptance test results shall be agreed upon prior to
407 tests.

408 **5.1.4.3 Oil hydraulic system**

409 The acceptance tests of oil hydraulic systems pertain to the following parameters:

410 a) Pressure

411 Acceptance tests, performed on a governing system installed on site with the turbine running
412 or at standstill, shall be performed with the oil pressure as specified in the contract; for tests
413 performed in the workshop of the governing system manufacturer, because of the absence
414 of regulating force required by the turbine, the oil pressure of the last amplification stage of
415 the controller system may be reduced correspondingly after demonstrating satisfactory
416 operation at the specified pressure. This reduction in oil pressure shall be mutually agreed
417 upon prior to performing the tests.

418 b) Oil quality and temperature

419 Acceptance tests shall be performed with the oil quality specified in the contract. Otherwise
420 the oil quality should be agreed upon.

421 The prescriptions of the manufacturers of components regarding oil purity and absence of
422 foam in the oil shall be strictly observed.

423 Oil temperatures during the tests shall correspond to normal sustained operating conditions
424 and lie within the range indicated by the manufacturers of components.

425

426 **5.1.5 Provisions for instruments**

427 The final report shall state the manufacturer and manufacturer's serial number of the
428 instruments and completely describe special devices or modifications to standard instruments
429 used in connection with the acceptance test.

430 **5.1.6 Calibration of instruments**

431 All instruments shall carry calibration certificates, valid on the date of the tests, issued by an
432 institution which is acceptable to both parties. The provision of calibration certificates shall be
433 the responsibility of the party providing the test instruments.

434