

# INTERNATIONAL STANDARD

---

**Electromechanical equipment guidance for small hydroelectric installations**



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2025 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Secretariat  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

**About the IEC**

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

**About IEC publications**

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

**IEC publications search -**  
[webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

**IEC Just Published -** [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

**IEC Customer Service Centre -** [webstore.iec.ch/csc](http://webstore.iec.ch/csc)

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

**IEC Products & Services Portal -** [products.iec.ch](http://products.iec.ch)

Discover our powerful search engine and read freely all the publications previews, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

**Electropedia -** [www.electropedia.org](http://www.electropedia.org)

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

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

## CONTENTS

FOREWORD .....	4
1 Scope .....	6
2 Normative references .....	6
3 Terms, definitions and units .....	7
3.1 General .....	7
3.2 Terms and definitions .....	7
3.3 Units .....	9
4 Methodology .....	9
5 Description of installation and operating conditions of power station .....	11
5.1 General .....	11
5.2 Site conditions .....	11
5.3 Hydraulic conditions for plant and design criteria for the units .....	16
5.4 Electrical conditions for plant operation .....	18
5.4.1 General .....	18
5.4.2 The plant is intended to operate in an isolated grid .....	18
5.4.3 The plant is intended to operate in parallel with a grid which imposes the frequency .....	19
5.4.4 Energy transport and distribution .....	19
5.5 Types of regulation and modes of operation (reference can be made to IEC 61362 and IEC 60308) .....	20
5.5.1 Frequency regulation .....	20
5.5.2 Power regulation .....	20
5.5.3 Level control .....	20
5.5.4 Flow regulation .....	20
5.5.5 Simplified governing .....	20
5.6 Automation, telemetry, remote control, alarms .....	20
6 Equipment specifications .....	21
6.1 General .....	21
6.2 Technical requirements .....	21
6.3 Limits of the supply .....	21
6.3.1 General .....	21
6.3.2 For the hydraulic system .....	21
6.3.3 For the electric system .....	21
6.3.4 For the auxiliary equipment system .....	21
6.3.5 Elements not normally included in the supply .....	21
6.4 Specifications of the elements of the plant .....	22
6.4.1 General .....	22
6.4.2 Trashrack and rack cleaner .....	22
6.4.3 Water-level control .....	22
6.4.4 Discharge closure devices (see Figure 5) .....	22
6.4.5 Penstock .....	24
6.4.6 Turbine (see Figure 6) .....	25
6.4.7 Generator .....	29
6.4.8 Automatic control system .....	31
6.4.9 Main transformers (reference can be made to IEC 60076-1) .....	33
6.4.10 Auxiliary equipment .....	34
6.4.11 Spare parts and special tools .....	35

6.4.12	Mechanical handling.....	35
6.4.13	Corrosion protection.....	36
6.5	Guarantees.....	36
6.5.1	General.....	36
6.5.2	Discharge closure devices.....	37
6.5.3	Turbine.....	37
6.5.4	Generator.....	37
6.5.5	Governor.....	38
6.5.6	Speed increaser.....	38
6.5.7	Excitation equipment.....	38
6.5.8	Comments concerning the complete generating set.....	38
6.5.9	Main transformer.....	39
6.6	General conditions for tender enquiries and comparison of tenders.....	39
6.6.1	General.....	39
6.6.2	Instructions to tenderers.....	39
6.6.3	General conditions of contract.....	39
6.6.4	Technical comparison of tenders.....	39
7	Inspection, delivery, operation and maintenance.....	41
7.1	General.....	41
7.2	Approval of the design and inspection of the work.....	42
7.2.1	Approval of design documents.....	42
7.2.2	Inspection of materials and sub-assemblies.....	42
7.2.3	Inspection at manufacturer's works.....	42
7.2.4	Delivery.....	43
7.2.5	Assembly at site.....	43
7.3	Commissioning.....	44
7.3.1	General.....	44
7.3.2	Preliminary checks before watering-up.....	44
7.3.3	Watering-up.....	44
7.3.4	Unit rotation.....	45
7.3.5	Preliminary checks and electrical load tests.....	46
7.4	Operation.....	46
7.4.1	Trial operation.....	46
7.4.2	Guarantee period.....	46
7.4.3	Normal operation.....	48
7.5	Training of personnel.....	49
7.6	Checking and maintenance.....	49
	Bibliography.....	52
	Figure 1 – Example of sequence of events.....	10
	Figure 2 – Power station arrangements.....	14
	Figure 3 – Run-of-river power station arrangements.....	16
	Figure 4 – Flow duration curve (showing river flow and plant flow).....	17
	Figure 5 – Hydraulic closure devices (examples).....	23
	Figure 6 – Schematic representation of a hydraulic machine.....	25
	Figure 7 – Electrical single-line diagram.....	33

Table 1 – Energy utilization for passive and active loads .....	19
Table 2 – Elements of bid evaluation .....	40
Table 3 – Examples of checks during normal operation .....	51

This document is a preview generated by EVS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

---

**Electromechanical equipment guidance for  
small hydroelectric installations**

**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 61116 has been prepared by IEC technical committee 4: Hydraulic turbines. It is an International Standard.

This second edition cancels and replaces the first edition published in 1992. This edition constitutes a technical revision.

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

- a) harmonization of scope with IEC 62006;
- b) introduction of new technical aspects;
- c) overall editorial revision.

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

Draft	Report on voting
4/510/CDV	4/521A/RVC

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 [www.iec.ch/members\\_experts/refdocs](http://www.iec.ch/members_experts/refdocs). The main document types developed by IEC are described in greater detail at [www.iec.ch/publications](http://www.iec.ch/publications).

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](http://webstore.iec.ch) in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

## 1 Scope

This document is used as a guidance that applies to hydroelectric installations containing impulse or reaction turbines with unit power up to about 15 MW and reference diameter of about 3 m. These figures do not represent absolute limits.

This document deals only with the direct relations between the purchaser or the consulting engineer and the supplier. It does not deal with civil works, administrative conditions or commercial conditions.

This document is intended to be used by all concerned in the installation of electromechanical equipment for small hydroelectric plants.

This document, based essentially on practical information, aims specifically at supplying the purchaser of the equipment with information which will assist him with the following:

- preparation of the call for tenders;
- evaluation of the tenders;
- contact with the supplier during the design and manufacture of the equipment;
- quality control during the manufacture and shop-testing;
- follow-up of site erection;
- commissioning;
- acceptance tests;
- operation and maintenance.

The document comprises the following:

- a) general requirements for the electromechanical equipment of small hydroelectric installations;
- b) technical specifications for the electromechanical equipment, excluding its dimensioning and standardization;
- c) requirements for acceptance, operation and maintenance.

Bearing in mind the type of installation considered, the relevant documents are intended to be as simple as possible but to satisfactorily define the particular operation conditions. Over-specification is harmful to the economy of the project.

This document does not cover the initial stage of investigations, that is to say the preliminary study and feasibility study. Neither does it deal with the economic study concerning the supply and demand of energy.

To conclude, the document does not replace the applicable engineering studies for the selection, design, manufacture, installation and testing of the equipment. It is intended only to make the purchaser aware of the important points and data to be furnished, specified and kept in due consideration in the construction of small hydroelectric plants.

## 2 Normative references

There are no normative references in this document.