

# INTERNATIONAL WORKSHOP AGREEMENT

**IWA  
33-3**

First edition  
2021-03

---

---

## **Technical guidelines for the development of small hydropower plants —**

### **Part 3: Design principles and requirements**



Reference number  
IWA 33-3:2021(E)

© ISO 2021

This document is a preview generated by EKO



**COPYRIGHT PROTECTED DOCUMENT**

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office  
CP 401 • Ch. de Blandonnet 8  
CH-1214 Vernier, Geneva  
Phone: +41 22 749 01 11  
Email: [copyright@iso.org](mailto:copyright@iso.org)  
Website: [www.iso.org](http://www.iso.org)

Published in Switzerland

# Contents

Page

<b>Foreword</b>	<b>vi</b>
<b>Introduction</b>	<b>vii</b>
<b>1 Scope</b>	<b>1</b>
<b>2 Normative references</b>	<b>1</b>
<b>3 Terms and definitions</b>	<b>1</b>
<b>4 Hydrology</b>	<b>1</b>
4.1 Basic data	1
4.2 Runoff (discharge)	2
4.3 Flood	3
4.4 Stage-discharge relation curve	4
4.5 Sediment, evaporation, ice regime and others	5
4.6 Rationality check of the outcomes	5
<b>5 Engineering geology</b>	<b>6</b>
5.1 General provisions	6
5.2 Regional geology	7
5.3 Engineering geology of the reservoir area	7
5.4 Engineering geology of hydraulic structures	8
5.5 Natural construction material	10
<b>6 Hydraulic engineering and energy calculation</b>	<b>11</b>
6.1 General provisions	11
6.2 Computation of runoff regulation	11
6.3 Hydraulic energy calculation	12
6.4 Load forecast and electric power and energy balance	13
6.5 Selection of flood regulation and characteristic flood-control level	13
6.6 Selection of normal water level and dead storage water level	13
6.7 Selection of installed capacity and type of unit	14
6.8 Selection of dimensions of headrace and volume of daily regulation pool	14
6.9 Analysis of the reservoir sediment deposition and calculation of the backwater	14
6.10 Reservoir operation mode and operational characteristics	15
<b>7 Engineering layout and hydraulic structure</b>	<b>15</b>
7.1 General provisions	15
7.2 General engineering layout	16
7.3 Water retaining structure	18
7.4 Water release structure	20
7.5 Water diversion structure	23
7.6 Powerhouse structure	26
7.7 Engineering safety monitoring	31
7.8 Concrete strength and durability	32
<b>8 Hydraulic machinery, fire protection, heating and ventilation</b>	<b>33</b>
8.1 General requirements for selection of turbine and generator	33
8.2 Selection of turbine rated head	34
8.3 Selection of turbine type	35
8.4 Selection of basic parameters of the reaction turbine	36
8.5 Selection of basic parameters of the impulse turbine	38
8.6 Unit transient performance analysis	39
8.7 Turbine governing system	40
8.8 Turbine main inlet valve	40
8.9 Cooling water and drainage system	41
8.10 Oil system	42
8.11 Compressed air system	42
8.12 Hydraulic monitoring system	43

8.13	Selection of lifting equipment.....	43
8.14	Fire protection.....	44
8.15	Heating and ventilation.....	44
8.16	Repair and maintenance equipment.....	45
8.17	Arrangement of hydraulic machinery equipment.....	45
<b>9</b>	<b>Electrical system.....</b>	<b>46</b>
9.1	Connection of the hydropower plant to the power system.....	46
9.2	Main electrical connection wiring.....	46
9.3	Selection of the main transformer.....	48
9.4	Selection of high-voltage electrical equipment.....	49
9.5	Overvoltage protection and earthing system.....	54
9.6	Lighting system.....	55
9.7	Layout of main electrical equipment inside and outside the power plant.....	55
9.8	Relaying protection and security automatic equipment.....	55
9.9	Excitation system.....	57
9.10	Automatic monitoring system.....	57
9.11	Plant service power supply and dam area power supply.....	58
9.12	DC operating power supply.....	58
9.13	Video monitoring system.....	58
9.14	Communication.....	58
<b>10</b>	<b>Hydro mechanical structure.....</b>	<b>59</b>
10.1	General provisions.....	59
10.2	Arrangement of hydro mechanical structure.....	59
10.3	Hoist selection for gates.....	61
10.4	Gate structure design.....	61
10.5	Anti-corrosion of hydro mechanical structures.....	61
<b>11</b>	<b>Guidelines for construction planning.....</b>	<b>62</b>
11.1	Construction diversion.....	62
11.2	Selection, planning and exploitation of the borrow area.....	64
11.3	Construction of the main works.....	64
11.4	Construction planning of roads and transportation.....	65
11.5	Construction plant facilities.....	65
11.6	Construction general layout.....	66
11.7	Overall construction programme.....	67
11.8	Construction safety.....	67
<b>12</b>	<b>Social and environmental impact assessment.....</b>	<b>67</b>
12.1	General provisions.....	67
12.2	Environmental impact assessment.....	68
12.3	Land acquisition and resettlement.....	69
12.4	Soil and water conservation.....	70
12.5	Social impact assessment.....	70
12.6	Conclusion of assessment and advice.....	71
<b>13</b>	<b>Project cost estimates.....</b>	<b>71</b>
13.1	General provisions.....	71
13.2	Project division.....	72
13.3	Costs and unit price.....	73
13.4	Engineering budget preparation.....	74
13.5	Composition of cost estimate documents.....	75
<b>14</b>	<b>Economic appraisal.....</b>	<b>76</b>
14.1	General provisions.....	76
14.2	Cost calculation.....	76
14.3	Benefits calculation.....	76
14.4	Economic cost benefit evaluation.....	77
14.5	Financial evaluation.....	77
14.6	Uncertainty analysis.....	78

14.7	Methods of scheme comparison .....	78
<b>Annex A</b>	<b>(informative) Workshop contributors .....</b>	<b>79</b>

This document is a preview generated by EVS

## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see [www.iso.org/directives](http://www.iso.org/directives)).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see [www.iso.org/patents](http://www.iso.org/patents)).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see [www.iso.org/iso/foreword.html](http://www.iso.org/iso/foreword.html).

International Workshop Agreement IWA 33 was approved at a workshop hosted by the Standardization Administration of China (SAC) and Austrian Standards International (ASI), in association with the International Center on Small Hydro Power (ICSHP), held virtually from 19<sup>th</sup> to 23<sup>rd</sup> October, 2020.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at [www.iso.org/members.html](http://www.iso.org/members.html).

A list of all parts in the IWA 33 series can be found on the ISO website.

## Introduction

Small hydropower (SHP) is well recognized as an important renewable energy solution to the challenge of increasing access to electricity in remote rural areas. However, while most countries in Europe, North and South America, China and India have high degrees of installed capacity, the potential of SHP in many developing countries remains untapped and is hindered by a number of factors, including the lack of best practices or standards for SHP development.

The technical guidelines for the development of small hydropower plants contained in this document address the current limitations of the regulations applied to technical guidelines for SHP plants by applying the expertise and best practices that exist across the globe. It is intended for countries to utilize this document to support their current policy, technology and legislation. Countries that have limited institutional and technical capacities will be able to enhance their knowledge base in developing SHP plants on rivers/streams and existing water resource structures outlets such as dams, barrages, navigation lock, canal falls, outfalls and flowing water (kinetic flow), including renovating/upgrading the old SHP plants, thereby attracting more investment in SHP projects, encouraging favourable policies and subsequently assisting in economic development at a national level. This document will be valuable for all countries, but also allow for the sharing of experience and best practices between countries.

This document is the result of a collaborative effort between the United Nations Industrial Development Organization (UNIDO) and the International Network on Small Hydro Power (INSHP). About 80 international experts and 40 international agencies were involved in this document's preparation and peer review. This document can be used as the principles and basis for the planning, design, construction and management of SHP plants up to 30 MWe.





# Technical guidelines for the development of small hydropower plants —

## Part 3: Design principles and requirements

### 1 Scope

This document specifies the general principles and basic requirements of design for small hydropower (SHP) projects up to 30 MWe, mainly including hydrology, geology, energy calculations, project layout, hydraulics, electromechanical equipment selection, construction planning, project cost estimates, economic appraisal, social and environmental assessments.

Application of this document is intended to be site specific, with the principles and requirements of design applied in accordance with the needs of proposed hydropower plant.

### 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.

IWA 33-1, *Technical guidelines for the development of small hydropower plants — Part 1: Vocabulary*

### 3 Terms and definitions

For the purposes of this document, the terms and definitions given in IWA 33-1 apply.

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

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

### 4 Hydrology

#### 4.1 Basic data

**4.1.1** The basic data include hydrometeorological data, river basin physiographic characteristics data, information about the human activities impact, hydrological computation results of the basin and nearby areas and the other relevant data. The changes in water resources management that occur upstream of a hydropower plant during its long lifespan will alter the runoff regime. Thus, the present and foreseeable needs of the population living on both sides of the river shall be taken into account for water supply, irrigation, industrial, ecology and recreation purposes.

**4.1.2** The data series upon which hydrological computation is based shall be checked for reliability, consistency and representativeness.

**4.1.3** The investigation of historical floods and dry seasons shall be carried out for the regions with insufficient or no data; if the conditions permit, observation and survey of water level, flow and sediment