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INDUSTRIAL DEVELOPMENT ORGANIZATION



Technical Guidelines for the
Development of Small Hydropower Plants
MANAGEMENT

Part 4: Acceptance of Projects

SHP/TG 005-4: 2019



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Further recommendations and suggestions for application for the update would be highly welcome.

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Foreword

The United Nations Industrial Development Organization (UNIDO) is a specialized agency under the United Nations system to promote globally inclusive and sustainable industrial development (ISID). The relevance of ISID as an integrated approach to all three pillars of sustainable development is recognized by the 2030 Agenda for Sustainable Development and the related Sustainable Development Goals (SDGs), which will frame United Nations and country efforts towards sustainable development in the next fifteen years. UNIDO's mandate for ISID covers the need to support the creation of sustainable energy systems as energy is essential to economic and social development and to improving quality of life. International concern and debate over energy have grown increasingly over the past two decades, with the issues of poverty alleviation, environmental risks and climate change now taking centre stage.

INSHP (International Network on Small Hydro Power) is an international coordinating and promoting organization for the global development of small hydropower (SHP), which is established on the basis of voluntary participation of regional, subregional and national focal points, relevant institutions, utilities and companies, and has social benefit as its major objective. INSHP aims at the promotion of global SHP development through triangle technical and economic cooperation among developing countries, developed countries and international organizations, in order to supply rural areas in developing countries with environmentally sound, affordable and adequate energy, which will lead to the increase of employment opportunities, improvement of ecological environments, poverty alleviation, improvement of local living and cultural standards and economic development.

UNIDO and INSHP have been cooperating on the World Small Hydropower Development Report since year 2010. From the reports, SHP demand and development worldwide were not matched. One of the development barriers in most countries is lack of technologies. UNIDO, in cooperation with INSHP, through global expert cooperation, and based on successful development experiences, decided to develop the SHP TGs to meet demand from Member States.

These TGs were drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of these TGs may be subject to patent rights. UNIDO and INSHP shall not be held responsible for identifying any such patent rights.

Introduction

Small Hydropower (SHP) is increasingly recognized as an important renewable energy solution to the challenge of electrifying remote rural areas. However, while most countries in Europe, North and South America, and China 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 globally agreed good practices or standards for SHP development.

These Technical Guidelines for the Development of Small Hydropower Plants (TGs) will 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 these agreed upon Guidelines to support their current policy, technology and ecosystems. Countries that have limited institutional and technical capacities, will be able to enhance their knowledge base in developing SHP plants, thereby attracting more investment in SHP projects, encouraging favourable policies and subsequently assisting in economic development at a national level. These TGs will be valuable for all countries, but especially allow for the sharing of experience and best practices between countries that have limited technical know-how.

The TGs can be used as the principles and basis for the planning, design, construction and management of SHP plants up to 30 MW.

- The Terms and Definitions in the TGs specify the professional technical terms and definitions commonly used for SHP Plants.
- The Design Guidelines provide guidelines for basic requirements, methodology and procedure in terms of site selection, hydrology, geology, project layout, configurations, energy calculations, hydraulics, electromechanical equipment selection, construction, project cost estimates, economic appraisal, financing, social and environmental assessments—with the ultimate goal of achieving the best design solutions.
- The Units Guidelines specify the technical requirements on SHP turbines, generators, hydro turbine governing systems, excitation systems, main valves as well as monitoring, control, protection and DC power supply systems.
- The Construction Guidelines can be used as the guiding technical documents for the construction of SHP projects.
- The Management Guidelines provide technical guidance for the management, operation and maintenance, technical renovation and project acceptance of SHP projects.

Technical Guidelines for the Development of Small Hydropower Plants-Management

Part 4: Acceptance of Projects

1 Scope

This part of the Management Guidelines stipulates acceptance conditions and the main content of small hydropower (SHP) key acceptance work, including acceptance before river diversion (closure) of the project, acceptance of reservoir (barrage) impoundment, acceptance of unit start-up and acceptance of project completion. The acceptance organization, specifications, procedures and methods, as well as project handover and resolution of outstanding issues, shall be handled according to the provisions of project contract documents.

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.

SHP/TG 001, *Technical guidelines for the development of small hydropower plants—Terms and definitions*.

3 Terms and definitions

For the purposes of this document, the terms and definitions given in SHP/TG 001 apply.

4 Acceptance before river diversion (closure) of project

4.1 Acceptance of river diversion (closure) of the project shall meet the following conditions:

- a) The river diversion project has been essentially completed and has met flow pass conditions, and will have no influence on other follow-up construction after being put into use.
- b) The underwater concealed works, related to river closure in the main work, have been completed and their quality meets the standards stipulated in the contract documents.

- c) The river closure plan has been prepared and all the preparations are in place.
- d) The flood control plan of the project has been approved and relevant measures have been prepared.
- e) The rehabilitation and resettlement of residents below the banked-up water level after river closure and the cleaning at the reservoir bottom has been completed and passed the acceptance tests.
- f) Any navigation obstruction problems of the river course in relation to shipping functions, have been solved.

4.2 The acceptance of river diversion (closure) shall include the following main contents:

- a) Inspection and verification of whether underwater works, concealed works, and river diversion (closure) works, meet the requirements of the river diversion (closure).
- b) Inspection and verification of the completion of the construction land acquisition, the rehabilitation and resettlement of residents, and the cleaning at the reservoir bottom.
- c) Review of the river closure plan, and inspection and verification of the implementation of river diversion (closure) measures and preparations.
- d) Inspection and verification of the implementation of engineering measures taken to solve problems such as navigation obstruction.
- e) Identify construction quality of the completed works related to the river closure.
- f) Comments on resolutions of the problems discovered during the acceptance process.
- g) Discussion and approval of the intermediate acceptance statement.

4.3 When the river diversion (closure) is implemented in stages, it is advisable to also perform river diversion (closure) acceptance in stages.

5 Acceptance of reservoir (barrage) impoundment

5.1 The impoundment acceptance shall meet the following conditions:

- a) The construction completion status of water-retaining structures meets the requirements of the impounded level.

- b) The rehabilitation and resettlement of residents, within the area inundated by impoundment, and the cleaning at the reservoir bottom, has been completed and passed the acceptance.
- c) The ecological flow discharge facilities to be used after impoundment have been completed and met flow pass conditions. Relevant ecological compensation measures have been implemented.
- d) The sluicing structures and gate control facilities to be used after impoundment have been completed and met flow pass conditions.
- e) Relevant observation instruments and equipment have been installed and adjusted according to the design requirements, and the initial values and observed values in the construction period have been measured.
- f) Construction plans for the unfinished works after impoundment have been prepared.
- g) The problems that may affect safe operation of the project after impoundment have been resolved, and conclusions have been reached on major technical issues.
- h) The impoundment plan and diversion orifice (tunnel) blocking plan has been prepared and approved, and all preparations are ready.
- i) The annual flood control plan (including flood release and utilization plans) has been approved as required and relevant measures have been implemented.
- j) Other requirements specified by the country have been satisfied.

5.2 The acceptance of impoundment shall include the following main contents:

- a) Inspection and verification of whether the finished works meet the impoundment requirements.
- b) Inspection and verification of the completion of land acquisition, the rehabilitation and resettlement of residents, and the cleaning of the reservoir area.
- c) Inspection and verification of the treatment of the reservoir bank near the dam.
- d) Inspection and verification of the implementation of the impoundment preparation works.
- e) Quality of finished works related to impoundment.
- f) Comments on resolutions of problems discovered during acceptance.

5.3 When the project is impounded in stages, it is advisable to also perform impoundment acceptance in stages.

6 Acceptance of unit start-up

6.1 The acceptance of unit start-up shall meet the following conditions:

- a) The structures related to start-up of the unit have been basically completed and met the requirements for start-up of the unit.
- b) The water level of the reservoir (head works) has exceeded the minimum power generation level, and the available discharge for generation meets the minimum required for start-up of the unit.
- c) The hydro mechanical structures and hoisting equipment related to start-up of the unit have been completed, and adjusted to meet the requirements for start-up of the unit.
- d) The hydro turbine generator unit, accessory equipment and auxiliary equipment for oil, air and water have been installed, adjusted to be qualified, tested by sections and meet the requirements for start-up of the unit.
- e) The relevant electrical equipment or appliances have been installed, tested according to relevant regulations, and meets the requirements for start-up of the unit.
- f) The transmission and transformation equipment and facilities have been constructed, installed and adjusted, and have passed safety evaluation or acceptance by relevant departments. The power transmission work has been made ready and has met the requirements for unit start-up.
- g) The electrical equipment for measurement, monitoring, control and protection for start-up of the unit have been installed and adjusted to be qualified.
- h) The operation management organization has been established, and the operation management personnel have been allocated to meet the requirements for start-up of the unit.
- i) Protective measures for safety and fire protection for start-up of the unit are in place.
- j) Rules and regulations such as safety work procedures and operational procedures on the site have been formulated.

6.2 Before the unit start-up acceptance, the test documents for unit start-up and commissioning, including unit start-up acceptance outline and test run plan, shall be prepared, and the acceptance work plan and the preparation requirements shall be put forward.

6.3 Start-up commissioning of the unit shall include start-up tests of the unit and a 72-hour continuous commissioning of the unit with rated load or the maximum load under the relevant head.

- a) Start-up tests of the unit, and start-up test procedures of the unit shall include:
 - 1) Inspection, test and evaluation of the water diversion system, the unit body, the accessory equipment of the unit, the utility systems of oil, air and water related to the tested unit, the electrical equipment, and the control and protection equipment;
 - 2) Inspection and testing of the water diversion facilities and equipment during water filling and after water filling;
 - 3) Inspection and testing of the unit during the first start-up and no-load operation;
 - 4) Inspection and testing of the unit when it is put into the system and operates with load;
 - 5) Load rejection testing of the unit.
- b) The unit shall go through a 72-hour continuous commissioning with rated load. If the unit cannot achieve the rated output due to insufficient load or special reasons, the maximum test load applicable to the unit may be determined according to the specific conditions.
- c) Start-up commissioning of the unit is completed if it functions normally after a 72-hour continuous operation with load. The start-up commissioning report of the unit shall be presented.

6.4 During the start-up commissioning of the unit, inspection and test records and commissioning records of the unit shall be well documented. All these records shall form part of the technical data handed over to the operation management organization.

6.5 Problems such as equipment defects and faults discovered during the commissioning shall be handled by the responsible party in a timely manner. The unit cannot be transferred for trial operation unless these problems are resolved.

6.6 After the unit start-up acceptance is approved, an acceptance report shall be provided and hand-over procedures shall be provided for commercial operation.

7 Completion acceptance

7.1 Completion acceptance shall meet the following conditions:

- a) The project has been completed in accordance with the approved design scales and design standards, and the project quality is qualified.
- b) The power station has been properly operated for at least one year, and all units can operate with rated output.

- c) The new hydropower project has stood the tests of at least one flood period and/or one freezing period. The multi-year regulating reservoirs shall stand the tests of at least two flood periods. During the flood periods, the highest reservoir water level has reached, or largely reached, the normal pool water level.
- d) Other requirements specified by the country have been satisfied.

7.2 Main tasks of acceptance shall include:

- a) Inspect and verify the basic construction of the project according to the approved design documents, including engineering construction completion status, the achievement of engineering parameters and functions, the impact of major design changes on the project, the implementation of environmental protection measures as well as work quantities and project cost.
- b) Inspect and evaluate the safety of water-retaining structures, based on the analysis and results of monitoring data during operation of water-retaining structures after impoundment, the results of stability and structural safety reviews and the solution of any problems discovered.
- c) Inspect functions of flood discharge and energy dissipation facilities, and evaluate safety and reliability of flood control of the project according to the operation of the flood discharge and energy dissipation structures during the operation after impoundment and the resolution of any problems discovered. Inspect whether the project has any major potential quality issues or problems that may impact safe operation.
- d) Inspect and evaluate functions and safety of the structures of the diversion and power generation system according to their operational status, the analysis and the results of safety monitoring data during the operation, and the resolution of problems discovered during the seepage discharge inspection.
- e) Inspect and evaluate the stability of the permanent slopes of the pivot structures and slope treatment works for the reservoir bank near the dam according to the analysis of safety monitoring data during the operation after the impoundment, the results of the stability review, and the resolution of the problems discovered.
- f) Inspect and evaluate effective operation of the safety monitoring system for the project (operation and maintenance) during operation after impoundment, the status of the instruments and equipment, and the status of the processing and analysis of monitoring data.
- g) Inspect and evaluate functions and reliability of the unit operation according to commissioning, load tests and overhaul results of the unit in the power station.

- h) Inspect construction quality of the project in terms of civil construction, equipment manufacturing and installation, and the resolution of quality defects exposed during the operation after impoundment, and evaluate the overall quality of the project.
 - i) Bring forth comments on resolution and requirements for the outstanding issues of the project.
-