The Certification Mark for Onsite Sustainable Energy Technologies

MCS 016

Product Certification Scheme Requirements: Micro Hydro Turbines

Issue 1.0

This standard has been approved by the Management Panel of the Microgeneration Certification Scheme.

This standard was prepared by the Microgeneration Certification Scheme Working Group 5 'Micro-Hydro Turbines'.

REVISION OF MICROGENERATION PRODUCT SCHEME DOCUMENT

Microgeneration product scheme documents will be revised by issue of revised editions or amendments. Details will be posted on the website at www.microgenerationcertification.org

Technical or other changes which affect the requirements for the approval or certification of the product or service will result in a new issue. Minor or administrative changes (e.g. corrections of spelling and typographical errors, changes to address and copyright details, the addition of notes for clarification etc.) may be made as amendments.

The issue number will be given in decimal format with the integer part giving the issue number and the fractional part giving the number of amendments (e.g. Issue 3.2 indicates that the document is at Issue 3 with 2 amendments).

Users of this scheme document should ensure that they possess the latest issue and all amendments.

TABLE OF CONTENTS

1. INTRODUCTION 4
2. SCOPE 5
3. APPLICATIONS TO JOIN THE SCHEME 5
4. MANAGEMENT SYSTEMS CERTIFICATION 6
5. CERTIFICATION AND APPROVAL 6
6. TECHNICAL DOCUMENTATION 7
7. PERFORMANCE CRITERIA 9
   - 7.1 Factory audits 9
   - 7.2 Product audits 9
   - 7.3 On-site testing of hydro turbines 9
   - 7.4 Methodology 11
8. MAINTENANCE OF CERTIFICATION AND LISTING 14
9. REVISION OF MICROGENERATION CERTIFICATION SCHEME REQUIREMENTS 15

AMENDMENTS ISSUES SINCE PUBLICATION 15

1. INTRODUCTION

This document identifies the evaluation and assessment requirements and practices for the purposes of certification and listing of Micro Hydropower products.

Certification, listing and approval of products is based on evidence acceptable to the certification body:

- that the product meets this standard;
- that the manufacturer has staff, processes and systems in place to ensure that the product delivered meets this standard.

and on:

- periodic audits of the manufacturer including testing as appropriate;
- compliance with the contract with the certification body for listing and approval including agreement to rectify faults as appropriate.

2. SCOPE

This scheme provides ongoing independent, third party assessment and approval of companies who wish to demonstrate that their micro hydro turbines, with power output not exceeding 50kW, meet the required performance and safety standards

Definitions:

Hydro Turbine – A device that converts the energy from the movement of water into mechanical energy.

Supplier – The company that provides the MCS Certificated product to the MCS Installation Company and or customer.

3. APPLICATIONS TO JOIN THE SCHEME

Applications should be made to an accredited certification body operating this scheme, who will provide the appropriate application form and details of the applicable fees.

4. MANAGEMENT SYSTEMS CERTIFICATION

Manufacturers shall operate a certified documented manufacturing quality control system, in accordance with the requirements of MCS 010 “Generic Factory Production Control Requirements.”

5. CERTIFICATION AND APPROVAL

Certification and approval is based on the following:

a) Evidence of compliance with the requirements of this document and BSEN61116 Electromechanical equipment guide for small hydroelectric installations.

Evidence of compliance is accepted in accordance with MCS 011 ‘Testing acceptance criteria’.

b) Verification of the establishment and maintenance of the manufacturing company’s quality management system in accordance with the MCS 010 Factory Production Control requirements (FPC).

Product Family – Applications for certification of product families will be dealt with on a case by case basis at the discretion of the Certification Body, where for the purposes of this standard product families are products which retain the same hydraulic characteristics as the assessed product, however, have variations in parameters for example, in head, flow, kW rating. A product family can be certified by testing selected example(s) providing the necessary extrapolation of parameters can be demonstrated and justified by the supplier.

A certificate is awarded following demonstration of satisfactory compliance with this standard and this scheme document, taking into account any limitations imposed by this standard and other appropriate guidelines and satisfactory verification/assessment of the manufacturer's Factory Production Control and technical documentation.

Certificates contain the name and address of the manufacturer, model and reference number of the Micro Hydro product, this test standard, a unique certificate reference number and the issue number and date.

Certificates are valid from the date of issue and are maintained and held in force subject to satisfactory completion of the requirements for maintenance of certification (see item 7); but remain the property of the issuing certification body.

Details of the manufacturer and the certificated product(s) are listed on the website at www.microgenerationcertification.org

6. TECHNICAL DOCUMENTATION

A full set of documentation for the product shall be provided, as described in accordance with relevant sections of BS EN 61116 Electromechanical equipment guide for small hydroelectric installations

This documentation shall be presented in English and shall be such that it can be assured that the products submitted for test are equivalent to those that are to be manufactured for normal production.

Where relevant the following product specification information shall be provided:

- Generic type or description of the turbine, including its layout (vertical, horizontal, angled shaft; cased, pit, bulb etc.)
- Manufacturer's type number, product name or any other descriptive information
- Outline drawing giving main dimensions and locations of output shaft and fixing points
- For integral generator, the electrical connections and nominal voltage, current, frequency and phase
- Method of control of flow of water through the turbine
- Design (rated) head in metres and flow in litres/second
- Head and flow operational range
- Efficiency over operational range of flow
- Output at design head and flow (kW shaft, or electrical if integral generator)
- Design rotational speed and direction of rotation

- Runaway speed at design head
- Operational environmental limitations
- Materials and grades used in the construction of casings, shafts, fastenings and pipe work together with details of finishes
- Bearing types and design life
- Maintenance requirements

In addition to the product specification, the following procedural factors should be considered to enable the design and manufacture of hydro turbines that will operate satisfactorily and safely in accordance with the specification.

- The manufacturer shall be able to demonstrate that they have suitable competence to manufacture products of satisfactory quality and performance.
- A justifiable method of inspection shall be used
- The complete turbine and, if appropriate, runner assembly should be provided with a unique identification number that relates to the original specification, manufacturer or supplier and that can be used for the purposes of replacement or provision of components for its maintenance. This should be permanently fixed and visible on the hydro turbine.

7. PERFORMANCE CRITERIA

Certificates and listing are maintained and held in force subject to satisfactory completion of the following requirements for maintenance of certification:

7.1 Factory audits

Certification is maintained through surveillance FPC quality system audits, which shall include a detailed check that the product being manufactured is to the same specification as the product tested.

7.2 Product audits

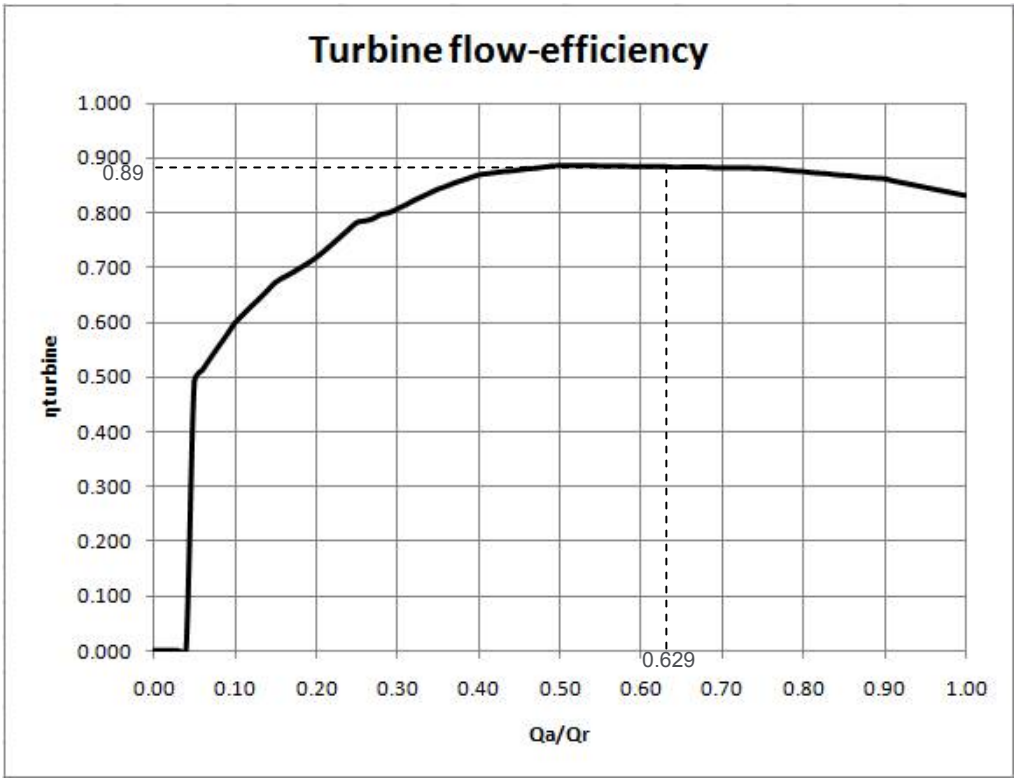
Product audits will be conducted as follows:

- Review of the product technical data files including materials.
- Review of end of line tests in accordance with the manufacturer's quality plan.
- Repeat testing of elements from the product standard as appropriate to confirm that the product continues to meet the requirements for certification and listing.

7.3 On-site testing of hydro turbines

The following methodology shall be used to validate the normalised turbine efficiency curve submitted by the product manufacturer.

A typical normalised efficiency curve is shown below.



η = efficiency of turbine, Qa = actual (measured) flow, Qr = rated flow

(dashed line represents example given in 7.4.3)

The aim of on-site testing is not to measure the efficiency across the whole operating flow range, but simply to measure it at the flow rate on the day the turbine is tested and compare this with a point on the manufacturer's efficiency curve. Provided the measured efficiency agrees with the submitted efficiency curve within the required tolerance (+/- 10%), this will be accepted as proof that the turbine meets the manufacturers claimed performance specification.

To avoid the possibility of significant errors due to testing the turbine during very low flows / low powers the turbine should only be tested between 100% and 50% of its maximum flow rate.

7.4 Methodology

7.4.1 Measure the flow rate through the turbine

The measurement can be done on the turbine intake or discharge side, whichever is most convenient provided only the flow that passes through the turbine is contained in the channel.

The flow rate shall be measured in accordance with BS EN ISO 748, or equivalent standard for the measurement of liquid flows.

7.4.2 Normalise the test flow rate

The turbine efficiency curve submitted by the manufacturer as part of the product registration shall be normalised, which means that the axes are re-scaled from 0 to 100% rather than for specific values so that the same curve can be used on any site and for turbines from the same product range, but with different rated (i.e. maximum) flow rates.

The flow measured in step 1 shall be normalised using:

$Q_{normalised} = Q_{actual} / Q_{rated}$

7.4.3 Determine the claimed efficiency at the test flow rate

Determine the expected turbine efficiency, η, from the manufacturer's efficiency curve.
For example, assuming a turbine with a rated flow (Q_{rated}) of 2000 litres/second and the flow through the turbine on the day of the test was measured to be 1,258 litres/second, then $Q_{normalised}$ would be:

$Q_{normalised} = Q_{actual} / Q_{rated}$
$= 1,258 / 2,000$
$= 0.629$

Using the efficiency curve in 7.3 the expected turbine efficiency can then be read off, which, in this example, is 89%.

7.4.4 Determine the net operating head of the turbine

Measure the gross head using calibrated survey equipment.

Present a set of calculations showing how the net head (H_{net}) has been calculated from the measured gross head by calculating the head losses throughout the system. *Note: This should be completed by a suitably competent person with reference to a recognised method, or by using proprietary fluid dynamic software*.

7.4.5 Measure the electrical power output from the turbine generator

This shall be performed using a calibrated power meter to measure the true RMS output voltage, current and power factor to calculate the power in single or three-phase systems.
If the installation includes a non-reactive dump load that is capable of dissipating the turbine output during the period of measurement, this should be used in preference.

7.4.6 Apply factors to add-back the power lost in the hydro system generator and transmission and calculate the actual turbine power output

The generator manufacturer's efficiency curve for the generator shall be used to justify the generator efficiency used in the calculation below.

If the generator is a motor operating as a generator it is acceptable to provide the motor efficiency curve with a similar justification of the generator efficiency used in the calculation below.

In a similar way, provide evidence to support claimed efficiencies for any couplings / drive systems used to transmit the power between the turbine and the generator.

Calculate the overall generator / drive system efficiency by multiplying the generator and coupling and/or drive efficiencies together.

Calculate the actual turbine mechanical power output by dividing the measured electrical power output by the overall generator / drive system efficiency.

7.4.7 Calculate the actual turbine efficiency

$$\text{Actual turbine efficiency} = \frac{\text{actual turbine power output}}{\text{theoretical gross turbine power output}}$$

$$= \frac{\text{actual turbine power output from 7.4.6}}{m \times g \times H_{net}}$$

Where m = mass flow rate in kg/s (same numerically as the flow rate in l/s measured in 7.4.1)

g = gravitational constant (9.81 m/s^2)

H_{net} = the net head calculated in 7.4.4

7.4.8 Compare actual turbine efficiency to claimed efficiency

Compare the actual turbine efficiency calculated in 7.4.7 with the claimed efficiency from 7.4.3. The claimed efficiency should not deviate from the actual by more than +/- 10% to pass the on-site test.

8. MAINTENANCE OF CERTIFICATION AND LISTING

All approved products listed under this scheme shall be traceable to identify that they have been tested and certificated in accordance with the requirements of the test standard. See below for details.

The Supplier shall use Certification Mark(s) in accordance with the Certification Bodies' instructions.
An example of the certification mark that can be used for this scheme is as follows:

Certificate Number MCS "XXX"

"Description of the Technology certificated"

Where 'XXX' is the certificate number and the logo of the certification body issuing the certification would sit in the right hand box.
Companies may only use the mark while the certification is maintained.

9. REVISION OF MICROGENERATION CERTIFICATION SCHEME REQUIREMENTS

AMENDMENTS ISSUES SINCE PUBLICATION

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