PHILIPPINE NATIONAL STANDARD

PNS/BAFS 325:2021

Solar Powered Irrigation System – Methods of Test

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Foreword

The Bureau of Agriculture and Fisheries Standards (BAFS) was directed to prioritize the development of the Philippine National Standards (PNS) on Solar Powered Irrigation System (SPIS) pursuant to a Memorandum signed by the Department of Agriculture Secretary dated July 30, 2018, entitled “Preparation of Philippine Agricultural Engineering Standards for SPIS”. A Technical Working Group (TWG) was created to develop the PNS under Special Order No. 817, series of 2021 (Addendum to Special Order No. 81 series of 2021 entitled, “Creation of TWG for the Development of PNS for Agriculture and Fishery Products, Machinery, and Equipment”), which is composed of representatives from relevant government agencies, academe, research institution, civil society organizations, and private sector. The draft PNS underwent a series of TWG meetings and stakeholder consultations conducted via online platforms before their endorsement to the Secretary for approval.

This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2.

Contents

1 Scope

This standard specifies the method for the conduct of system test for the completely installed Solar Powered Irrigation System (SPIS). Specifically, it shall be used to:

1.1 validate the specifications of the solar modules, pump, inverter/controller, and other components submitted by the test applicant;

1.2 determine the performance of the solar array, controller, pump, and SPIS system as a whole (excluding field conveyance efficiency); and

1.3 report the results of the test.

2 Normative References

The following documents are referred to in the text in such a way that some or all of their contents constitute the 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.

Bureau of Agriculture and Fisheries Standards (BAFS) – Department of Agriculture (DA). (2021). Solar Powered Irrigation System – Specifications (PNS/BAFS 324: 2021).

3 Terms and Definitions

For the purpose of this standard the following terms and definitions shall apply:

3.1
controller
link between motor pump and solar generator that regulates the operation of PV array to pump and is classified into two types: inverter (directly connected to pump set) and charge controller (with batteries)

3.1.1
charge controller
monitors the charging and discharging of the battery connected to the PV array

3.1.2
inverter
converts DC current from PV module to AC

3.2
photovoltaic (PV) array
composed of PV modules connected in combination of series and parallel connections, which convert energy from the sun into electrical energy

3.3
pump
agricultural machinery that is used to lift or transfer water from one source to another

3.3.1
submersible pump
pump designed to operate fully submerged in the water source

3.3.2
surface pump
pump designed to operate above water surface

3.4
PV module
solar panel
assembly of photovoltaic cells mounted in a frame that uses sunlight as a source of energy to generate a DC electricity

3.5
Solar Powered Irrigation System (SPIS)
irrigation system powered by solar energy, using photovoltaic (PV) technology, which converts solar energy into electrical energy to run a direct current (DC) or alternating current (AC) motor-based water pump. It consists of solar panels, pumpset, electronic controls to operate the pumpset, the required hardware and in some cases other components like inverters and batteries

3.6
suction lift
the vertical distance from the free suction water level to the center line of the pump suction

3.7
system efficiency
ratio of the output water power from the pumpset discharge rate with the total available solar power that can be harvested by the PV modules

3.8
system testing
testing undertaken by a recognized testing authority to verify the performance of the installed system in terms of compliance to set specifications of the PV module, inverter/controller, pumpset and any other accessories

3.9
total dynamic head
total head
measure of energy increase imparted to the water by the pump and expressed by the algebraic difference between the total discharge head and total suction head, expressed in meters (m)

4 General Conditions for Test

4.1 Role of the Test Applicant

The test applicant shall submit specifications, signed brochure, detailed design and as-built plans of the SPIS, and other relevant information (i.e., PV module, controller, pump set). They shall abide with the terms and conditions set forth by the recognized testing authority.

4.2 Role of the Test Representative of the Manufacturer/Supplier/Dealer

The test applicant likewise may designate an official representative to operate, demonstrate, adjust, and witness the actual testing. It shall be the duty of the representative to make all decisions on matters of adjustment and preparation of the system for testing.

4.3 General Test Conditions

The following conditions shall be ensured prior to the conduct of the system test:

4.3.1 The test shall be conducted to a completely installed system.

4.3.2 There shall be provision for workspace that is suitable for normal working condition.

4.3.3 There shall be ample supply of water in the water source.

4.3.4 The tank shall be emptied prior to the test.

4.3.5 The system shall be observed and tested for a total of eight hours continuous operation. No system breakdown shall be observed during this period.

4.3.6 The total discharge requirement (m^3/day) shall be attained during the six-hour data collection time period.

4.4 Role of Test Engineer

The certified test engineer shall lead the conduct of the performance testing in accordance with the provisions of this standard. Furthermore, the test engineer shall oversee other relevant activities prior to and subsequent to the conduct of the testing.

4.5 Suspension of Test

In case of any major component breakdown or malfunction that could affect the collection of data and subsequently the test result during the eight hour observation and test period, a maximum of 30 minutes shall be allowed for troubleshooting. Otherwise, the test shall be suspended.

In case the system stops due to sudden change in weather, insufficient discharge or clogging of suction, the test may be suspended with the concurrence of the recognized testing authority and the representative of the test applicant.

5 Preliminary Testing Preparation

5.1 Preparation and Verification of the SPIS Specifications

The specifications submitted by the test applicant and the specifications given in Annex A (Specifications of SPIS) shall be verified by the recognized testing authority.

5.2 Test Instruments and other Materials

The suggested list of minimum field test equipment needed to carry out the SPIS system test is shown in Annex B (List of minimum field test equipment and materials). The test instruments shall be calibrated regularly. It shall be physically checked and cleaned for operation before and after each test. A checklist of instruments and materials to be used shall be prepared by the recognized testing authority before departure to and from the site.

5.3 Running-in and Preliminary Adjustments

The SPIS shall undergo a running-in period before starting the test. During the running-in period, the various adjustments of the SPIS shall be made according to the recommendation of the test applicant/representative.

6 Performance Test

6.1 Operation of the SPIS

The SPIS shall be operated at the recommended setting of the test applicant. The recognized testing authority shall make all measurements, which form part of the test.

6.2 Data Collection

All data measurements shall be simultaneously gathered within one minute for every 30-minute time period.

6.2.1 Solar Irradiance

Solar irradiance shall be measured in W/m^2 by an appropriate measuring device available.

6.2.2 Panel Temperature

Thermometer or thermocouple sensor, or any appropriate measuring device, shall be used to determine the PV temperature (°C).

6.2.3 Ambient Conditions

Ambient temperature (°C) and relative humidity (%) in the area shall be measured using an appropriate measuring device.

6.2.4 Power Requirement

The power requirements of the system shall be measured using an appropriate measuring device.

6.2.4.1 Input to the Controller

The current and voltage supplied by the solar array shall be measured using an appropriate measuring device.

6.2.4.2 Output of the Controller

The current and voltage inputs to the pump shall be measured using an appropriate measuring device.

6.2.5 Total Dynamic Head

The total dynamic head shall be determined using the total static head, including the friction losses in the pipe.

6.2.6 Pump Discharge

Pump discharge shall be measured on the outlet closing off all laterals, if there are any.

6.2.6.1 SPIS with Reservoir

The discharge of the system shall be measured using the appropriate measuring device available, measured at the tank inlet pipe. Provision of material to properly gather the discharge to minimize losses is recommended. The tank outlet shall be fully open to drain the water inside the tank to facilitate data gathering.

6.2.6.2 SPIS without Reservoir

The discharge shall be measured at the pump discharge outlet using an appropriate measuring device.

NOTE All output valves will be fully open during testing.

6.3 Data Recording and Observations

Record sheet for all data and information during the test is given in Annex C (Performance test data sheet). Observations to be taken during the performance test shall be recorded in this sheet.

7 Data Analysis

7.1 Presentation of Results

System specifications and the results of the test shall be presented in tabular form. A schematic diagram of the system layout shall also be included. Observations made on the system while in operation shall be supported with photographs.

8 Formula

The formulas to be used during calculations and testing are given in Annex D (Formula used during calculation and testing).

9 Test Report

The test report shall include the following information in the order given:

9.1 Title;

9.2 Summary of Results (including the performance compared with the criteria);

9.3 Purpose and Scope of Test;

9.4 Description of the System;

9.5 Results and Discussions;

9.6 Schematic Diagram;

9.7 Observations (include pictures); and

9.8 Names and Signature of Test Engineer/s.

Annex A
(Normative)

Specifications of SPIS

Item[1]	Manufacturer's Specification	Verification by the Testing Authority
A.1 Reservoir		
A.1.1 Overall dimensions (m)		
A1.1.1 Length		
A.1.1.2 Width		
A.1.1.3 Height		
A.1.1.4 Height from the discharge outlet of the tank to the distribution channel (m)		
A.1.1.5 Thickness (m)		
A.2 Pumpset		
A.2.1 Pump		
A.2.1.1 Brand		
A.2.1.2 Model		
A.2.1.3 Serial Number		
A.2.1.4 Type		
A.2.1.5 Size (mm)		
A.2.1.6 Maximum discharge		
A.2.1.7 Maximum total head (m)		
A.2.1.8 Manufacturer		
A.2.1.9 Country of Manufacture		
A.2.2 Electric Motor		
A.2.2.1 Brand		
A.2.2.2 Model		
A.2.2.3 Type		
A.2.3 Rated power (kW)		
A.2.4 Rated Voltage (V)		
A.2.5 Rated Current (A)		
A.2.6 Frequency (Hz)		
A.2.7 Rated Maximum Discharge (m^3/h)		
A.2.8 Rated Maximum Total Head (m)		
A.3 Controller/Inverter		
A.3.1 Brand		
A.3.2 Model		
A.3.3 Enclosure Class		
A.3.4 Input		
A.3.4.1 Maximum Power (kW)		

[1] The parameter will be checked upon availability

A.3.4.2 Maximum Input Voltage (V)		
A.3.4.3 Maximum Motor Current (A)		
A.3.5 Output		
A.3.5.1 Maximum Power (kW)		
A.3.5.2 Maximum Input Voltage (V)		
A.3.5.3 Maximum Motor Current (A)		
A.4 Solar Module		
A.4.1 Brand		
A.4.2 Model		
A.4.3 Manufacturer		
A.4.4 Country of manufacture		
A.4.5 Cell type		
A.4.6 Cell Size (mm)		
A.4.7 Cell Configuration		
A.4.8 PV Module Dimension		
A.4.8.1 Length		
A.4.8.2 Width		
A.4.9 Total No. of Solar Modules		
A.4.9.1 No. of Solar Modules/string		
A.4.9.2 No. of strings		
A.4.10 Nominal Power (Wp)		
A.4.11 Short circuit current, I_{sc} (A)		
A.4.12 Open circuit voltage, V_{oc} (V)		
A.4.13 Maximum operating Current, Imp (A)		
A.4.14 Maximum operating Voltage, V_{mp} (V)		
A.4.15 Reference Standard Temperature condition, T_{STC}		
A.4.16 Orientation		
A.4.17 Angle of Inclination		
A.5 Safety devices		
A.6 Special features		

A.7 System Layout

Annex B
(Informative)

List of minimum field test equipment and materials

Equipment/material	Quantity
Recognized Testing Authority	
B.1 Pyranometer (resol)	1
B.2 Stop Watch Resolution: 0.1 second	1
B.3 Measuring Tape	1
B.4 Temperature Humidity meter	2
B.5 Thermometer/Temperature Sensor/Thermocouple	3
B.6 Clamp-on AC/DC Volt/Ammeter 1000 V, 2000 A TRMS	4
B.7 Range finder (measuring tape for head, total station is an alternative)	1
B.8 Camera	1
B.9 Flow meter	1
B.10 Clinometer/Inclinometer	1
Test Applicant	
B.11 200-L drum/measuring container	1

Annex C
(Informative)

Performance test data sheet

Test Applicant:

_____

Location:

_____

SOLAR MODULE

Brand: _____ Rated Power: _____

No. of strings: _____ No. of Module/string: _____

CONTROLLER Max. kW: _____

Type: _____

Others:

_____

SYSTEM

Static Head: _____ Discharge head: _____ Total length of pipe: _____

Pipe Material: _____ Total no. of bends: _____

Others: _____

Time of the day	Ambient Conditions		Solar Radiation (W/m^2)	PV Temperature ($^{\circ}C$)	Solar Array output (input to the controller)		Input to the pump (output of the controller)		Discharge capacity (Q) (L/h)
	Temp (°C)	RH (%)			Voltage	Current	Voltage	Current	

C.1 Other observations

C.1.1 Ease of cleaning the solar panels

_____
_____
_____
_____

C.1.2 Ease of adjusting and repairing of parts

_____
_____
_____
_____

C.1.3 Safety

_____
_____
_____
_____

C.1.4 Failure or abnormalities that may be observed on the system during and after the operation.

_____
_____
_____
_____

C.1.5 Others

_____
_____
_____
_____

Annex D
(Informative)

Formula used during calculation and testing

D.1 Total Head (H)

$$H = H_d + H_s$$

$$H_d = h_d + h_f$$

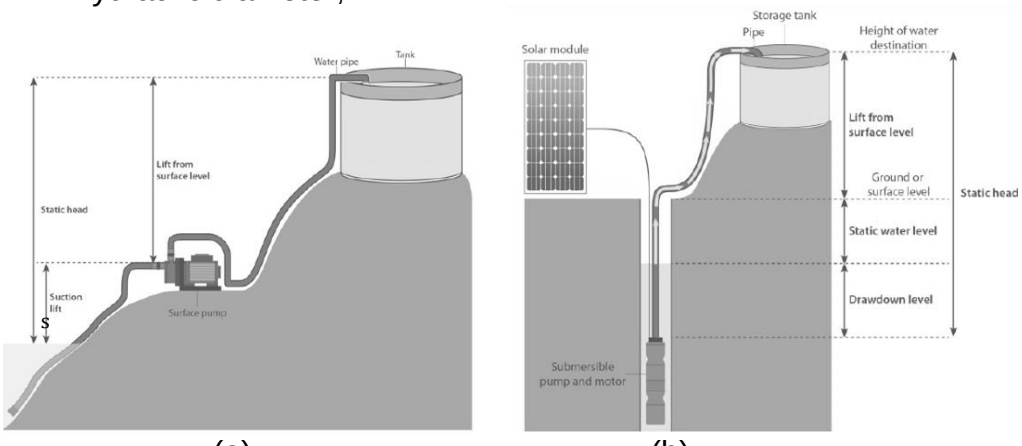
$$h_f = f\frac{L}{D}x\frac{v^2}{2g}$$

$$H_s = h_s + h_f$$

$$\frac{1}{f^{0.5}} = -2\log\left[\frac{2.51}{Ref^{0.5}} + \frac{\frac{k}{d_h}}{3.72}\right]$$

where:

H = total head, m
H_d = dynamic head, m
h_d = discharge head, m
h_f = head loss, m
f = coefficient of friction
L = pipe length, mm
D = pipe diameter, mm
v = fluid flow velocity
g = acceleration due to gravity, m/s^2
H_s = static head, m
h_s = static suction lift, m
Re = Reynold's Number
k = rougness coefficient
d_h = hydraulic diameter, mm



(a) (b)

Figure D.1. Visual representation for determining total head (H) for surface pump (a) and submersible pump (b)

D.2 Efficiencies

D.2.1 Pumpset Efficiency

$$Eff_{ps} = \frac{\gamma QH}{V_2 I_2}$$

where:

Eff_{ps} = Pumpset efficiency, %
γ = Specific weight, N/m^3
Q = Discharge, m^3/s
H = Head, m
V_2 = Voltage supplied to the pump, V
I_2 = Current supplied to the pump, A

D.2.2 System Efficiency

$$Eff_{sys} = \frac{\gamma QH}{IA}$$

where:

Eff_{sys} = System efficiency, %
I = Solar irradiance, W/m^2
A = Total surface area of solar array, m^2

Bibliography

Bureau of Agriculture and Fisheries Standards (BAFS) – Department of Agriculture (DA). (2016). Guidelines on after-sales service (PNS/BAFS/PAES 192:2016). http://amtec.ceat.uplb.edu.ph/wp-content/uploads/2020/06/PNS-BAFS-192.2016-Guidelines-on-After-sales-services.pdf

Bureau of Agriculture and Fisheries Standards (BAFS) – Department of Agriculture (DA). (2021). Solar Powered Irrigation System – Specifications (PNS/BAFS 324: 2021).

Philippine Agricultural Engineering Standards (PAES) Task Force. (2000). Centrifugal, mixed flow and axial flow water pumps – Methods of test (PAES 115:2000). https://amtec.ceat.uplb.edu.ph/wp-content/uploads/2019/07/PAES-115-2000.pdf

Philippine Agricultural Engineering Standards Task Force. (2000). Centrifugal, mixed flow and axial flow water pumps – Specifications (PAES 114:2000). https://amtec.ceat.uplb.edu.ph/wp-content/uploads/2019/07/PAES-114-2000.pdf

Philippine Agricultural Engineering Standards Task Force. (2000). Operator's manual content and presentation (PAES 102:2000). https://amtec.ceat.uplb.edu.ph/wp-content/uploads/2019/ 07/ PAES-102-Operators-Manual-Content-and-Presentation.pdf

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