PHILIPPINE NATIONAL STANDARD

PNS/BAFS 325:2022
ICS 65.060.35

Solar Powered Irrigation System — Methods of Test

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Foreword

In 2021, the Bureau of Agriculture and Fisheries Standards (BAFS)-Department of Agriculture (DA) developed the PNS SPIS - Specifications (PNS/BAFS 324:2021) and Methods of Test (PNS/BAFS 325:2021) pursuant to a Memorandum signed by the Department of Agriculture Secretary dated 30 July 2018, entitled "Preparation of Philippine Agricultural Engineering Standards for SPIS". In 2022, during the 8th Review Committee (RC) Meeting of the Bureau of Agricultural and Fisheries Engineering (BAFE)-DA, the Agricultural Machinery Testing and Evaluation Center (AMTEC)-University of the Philippines Los Baños (UPLB) raised concerns on the lack of discharge requirement specified in sub clause 4.3.6 under General test condition section of the PNS/BAFS 325:2021, which is important during the testing of the SPIS.

In response, the BAFS reconvened the Technical Working Group (TWG) created 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") to amend the PNS. The TWG is composed of representatives from relevant government agencies, academe, research institution, Civil Society Organizations (CSO), and private sector. The proposed amended draft PNS underwent a series of TWG meetings and a final Stakeholder Consultation conducted via online platforms before their endorsement to the Department of Agriculture Secretary for approval.

The amendment includes the following significant changes compared to the previous version of this Standard:

a) During testing, the system shall be observed the whole day, instead of eight hours; and
b) Discharge requirement provision is transferred from the Methods of Test to the Performance Requirements in the Specifications.

This Standard cancels and replaces PNS/BAFS 325:2021 which has been technically amended. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2.

Table of 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:

a) Validate the specifications of the solar modules, pump, inverter/controller, and other components submitted by the test applicant;
b) Determine the performance of the solar array, controller, pump, and SPIS system as a whole (excluding field conveyance efficiency); and
c) 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 their contents constitute the requirements of this document. The latest edition of the referenced documents (including any amendments) applies.

Bureau of Agriculture and Fisheries Standards (BAFS)-Department of Agriculture (DA). (2022). Solar Powered Irrigation System (SPIS) — Specifications (PNS/BAFS 324: 2022).

3 Terms and Definitions

For the purpose of this Standard, the definitions given in PNS/BAFS 324:2022 (SPIS – Specifications) shall apply.

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., photovoltaic [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 and during 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 for the whole day as long as the system operates. No system breakdown shall be observed during the testing 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

4.5.1 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.

4.5.2 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 (Minimum list of 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 are fully opened 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 (Formulas used during calculation and testing).

9 Test Report

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

a) Title;
b) Summary of results (including the performance compared with the criteria);
c) Purpose and scope of test;
d) Description of the system;
e) Results and discussions;
f) Schematic diagram;
g) Observations (include pictures); and
h) Names and signature of test engineer/s.

Annex A
(Normative)

Specifications of SPIS

No.	Item[1]	Manufacturer's specification	Verification by the testing authority
1	Reservoir		
1.1	Overall dimensions, m		
1.1.1	Length		
1.1.2	Width		
1.1.3	Height		
1.1.4	Height from the discharge outlet of the tank to the distribution channel		
1.1.5	Thickness		
2	Pumpset		
2.1	Pump		
2.1.1	Brand		
2.1.2	Model		
2.1.3	Serial number		
2.1.4	Type		
2.1.5	Size, mm		
2.1.6	Maximum discharge		
2.1.7	Maximum total head, m		
2.1.8	Manufacturer		
2.1.9	Country of manufacture		
2.2	Electric motor		
2.2.1	Brand		
2.2.2	Model		
2.2.3	Type		
2.3	Rated power, kW		
2.4	Rated voltage, V		
2.5	Rated current, A		
2.6	Frequency, Hz		
2.7	Rated maximum discharge, m^3/h		
2.8	Rated maximum total head, m		
3	Controller/Inverter		
3.1	Brand		
3.2	Model		
3.3	Enclosure class		
3.4	Input		
3.4.1	Maximum power, kW		
3.4.2	Maximum input voltage, V		
3.4.3	Maximum motor current, A		

No.	Item[1]	Manufacturer's specification	Verification by the testing authority
3.5	Output		
3.5.1	Maximum power, kW		
3.5.2	Maximum input voltage, V		
3.5.3	Maximum motor current, A		
4	Solar Module		
4.1	Brand		
4.2	Model		
4.3	Manufacturer		
4.4	Country of manufacture		
4.5	Cell type		
4.6	Cell size (mm)		
4.7	Cell configuration		
4.8	PV module dimension		
4.8.1	Length		
4.8.2	Width		
4.9	Total no. of solar modules		
4.9.1	No. of solar modules/string		
4.9.2	No. of strings		
4.10	Nominal power, Wp		
4.11	Short circuit current (I_{sc}), A		
4.12	Open circuit voltage (V_{oc}), V		
4.13	Maximum operating current (I_{mp}), A		
4.14	Maximum operating voltage, (V_{mp}), V		
4.15	Reference standard temperature condition (T_{STC})		
4.16	Orientation		
4.17	Angle of inclination, °		
5	Safety devices		
6	Special features		

[1] The parameter will be checked upon availability

7 System Layout

Annex B
(Informative)

Minimum list of field test equipment and materials

Equipment/material	Quantity
Provided by the recognized testing authority	
B.1 Pyranometer (resol)	1
B2 Stopwatch 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
Provided by the 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 Temp, °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, V	Current, A	Voltage, V	Current, A	

1 Other observations

1.1 Ease of cleaning the solar panels

1.2 Ease of adjusting and repairing of parts

1.3 Safety

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

1.5 Others

Annex D
(Informative)

Formula used during calculation and testing

D.1 Total head (H)

$$H = H_d + H_s$$

$$H_d = h_d + h_f$$

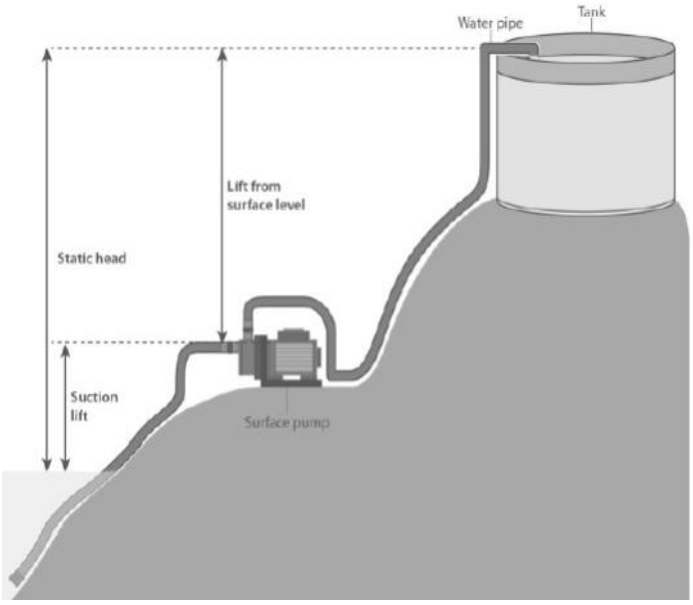
$$h_f = f\frac{L}{D}x\frac{v^2}{2g}$$

$$H_s = h_s + h_f$$

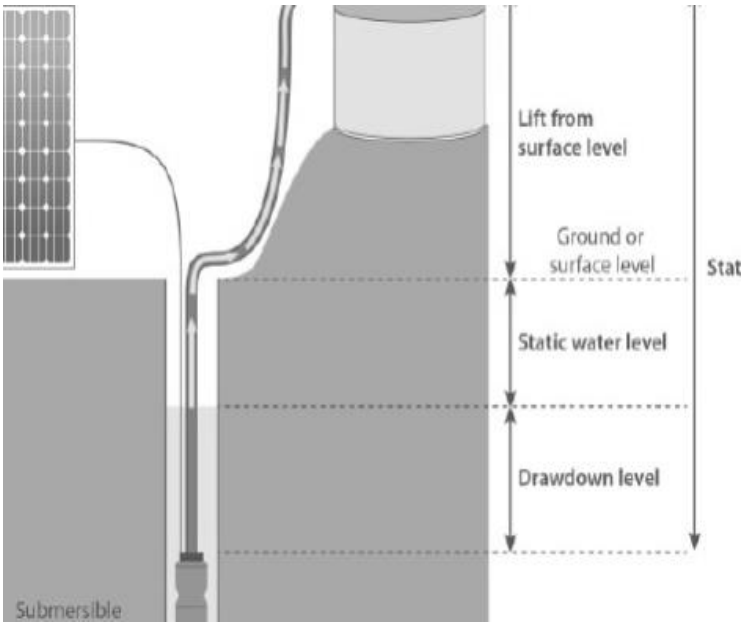
$$\frac{1}{f^{0.5}} = -2\log\left[\frac{2.51}{Ref^{0.5}} + \frac{\frac{k}{d_h}}{3.72}\right]$$

where:

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



(a)



(b)

Figure D.1. Visual representation for determining total head [H] for surface pump (a) and submersible pump (b) (BAFE-DA, n.d.)

D.2 Efficiencies

D.2.1 Pumpset efficiency

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

where:

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

D.2.2 System efficiency

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

where:

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

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