PHILIPPINE NATIONAL STANDARD

PNS/BAFS 324:2022
ICS 65.060.35

Solar Powered Irrigation System — Specifications

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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 subclause 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) Discharge requirement provision is transferred from the Methods of Test to the Performance Requirements in the Specifications; and
b) PV performance ratio consideration changed to type of PV instead of PV-pump combination;

This Standard cancels and replaces PNS/BAFS 324:2021 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 minimum specification and construction and performance requirements for Solar Powered Irrigation System (SPIS).

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.

Agricultural Machinery Testing and Evaluation Center (AMTEC)-University of the Philippines Los Baños (UPLB). (2000c). 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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3 Terms and Definitions

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

3.1
angle of inclination
the tilt of the PV module with respect to the horizontal plane

3.2
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)

3.2.1
charge controller
monitors the charging and discharging of the battery connected to the PV array (Khamisani, 2018, *modified*)

3.2.2
inverter
converts direct current (DC) from PV module to alternating current (AC) (Morales, 2017, *modified*)

3.3
photovoltaic (PV) array
composed of PV modules connected in combination of series and parallel connections, which convert energy from the sun into electrical energy (Morales, 2010, *modified*)

3.4
pump
agricultural machinery that is used to lift or transfer water from one source to another (AMTEC-UPLB, 2000b, *modified*)

3.4.1
submersible pump
pump designed to operate fully submerged in the water source

3.4.2
surface pump
pump designed to operate above water surface

3.5
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 (Morales, 2010, *modified*)

3.6
PV performance ratio
ratio of the input solar power to the PV module and the output power of the inverter/controller

3.7
ray of incidence
the angle with which a ray of sunlight strikes the surface of the PV module, measured with respect to a line perpendicular to said surface (Page, 2012, *modified*)

3.8
reservoir
temporary water storage that adds kinetic energy to facilitate water distribution. This is also known as a water tank

3.9
solar irradiance
amount of solar energy received by or projected onto a surface, expressed in Watts per square meter (W/m^2) (Morales, 2010, *modified*)

3.10
Solar Powered Irrigation System (SPIS)
irrigation system powered by solar energy, using PV technology, which converts solar energy into electrical energy to run a DC or AC motor-based water pump. It consists of solar PV modules, pump set, electronic controls to operate the pump, the required hardware, and in some cases other items like inverters and batteries (BAFE, n.d., *modified*)

3.11
suction lift
the vertical distance from the free suction water level to the center line of the pump suction (AMTEC-UPLB, 2000a, *modified*)

3.12
system efficiency
ratio of the output power of the pump set and the total solar input power (BAFE, n.d., *modified*)

3.13
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) (AMTEC-UPLB, 2000a, *modified*)

4 Classification

4.1 SPIS Configuration

The following are the typical configurations for an SPIS as shown in Figures 1-4:

4.1.1 Surface Water Source with Reservoir

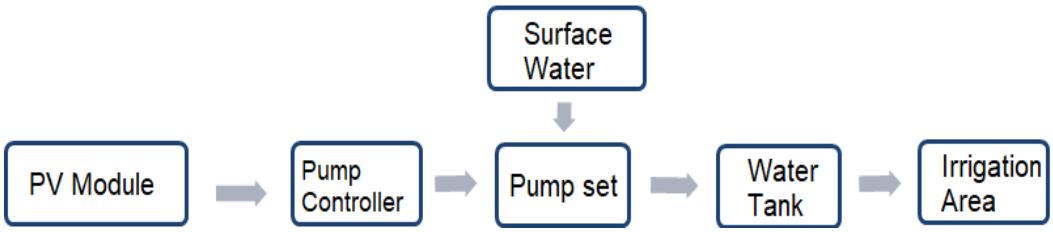


Figure 1. Configuration setup for a surface water source with reservoir

4.1.2 Surface Water Source without Reservoir

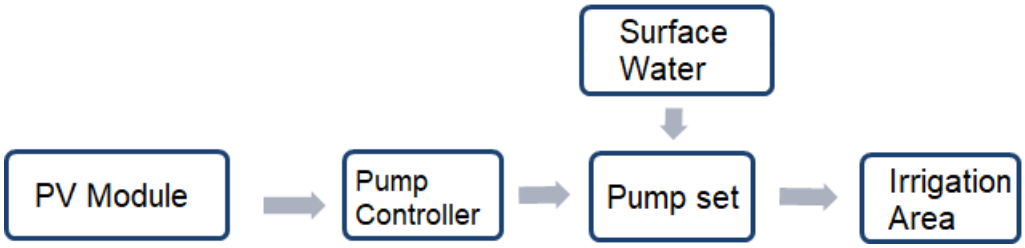


Figure 2. Configuration setup for a surface water source without reservoir

4.1.3 Groundwater Source with Reservoir

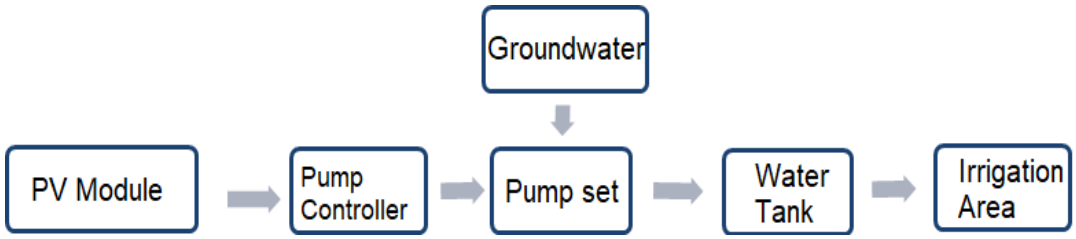


Figure 3. Configuration setup for a groundwater source with reservoir

4.1.4 Groundwater Source without Reservoir

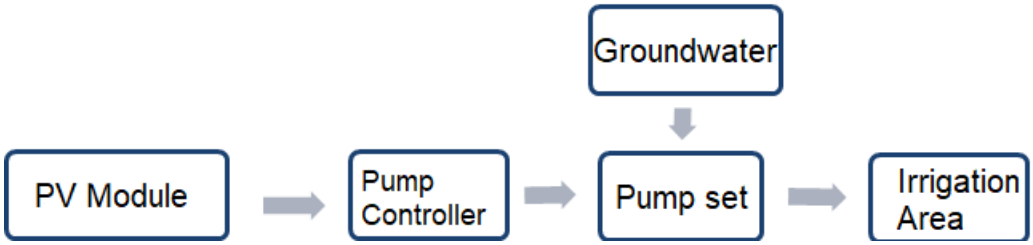


Figure 4. Configuration setup for a groundwater source without reservoir

4.2 Pumpset

There are two types of pumps that could be used for the irrigation system, depending on the location of installation namely, surface and submersible pumpsets.

4.2.1 Surface Pumpset

Pumpsets in which suction inlets are not submerged in water.

4.2.2 Submersible Pumpset

Pumpsets installed below water level.

4.3 Controller

The two types of controller are indicated in 4.3.1 and 4.3.2.

4.3.1 Inverter

a) converts DC power to AC power
b) converts DC power to DC power (voltage conversion)

4.3.2 Charge Controller

a) Maximum Power Point Tracking (MPPT)
b) Pulse Width Modulation (PWM)

4.4 Irrigation Method

4.4.1 Open Channel

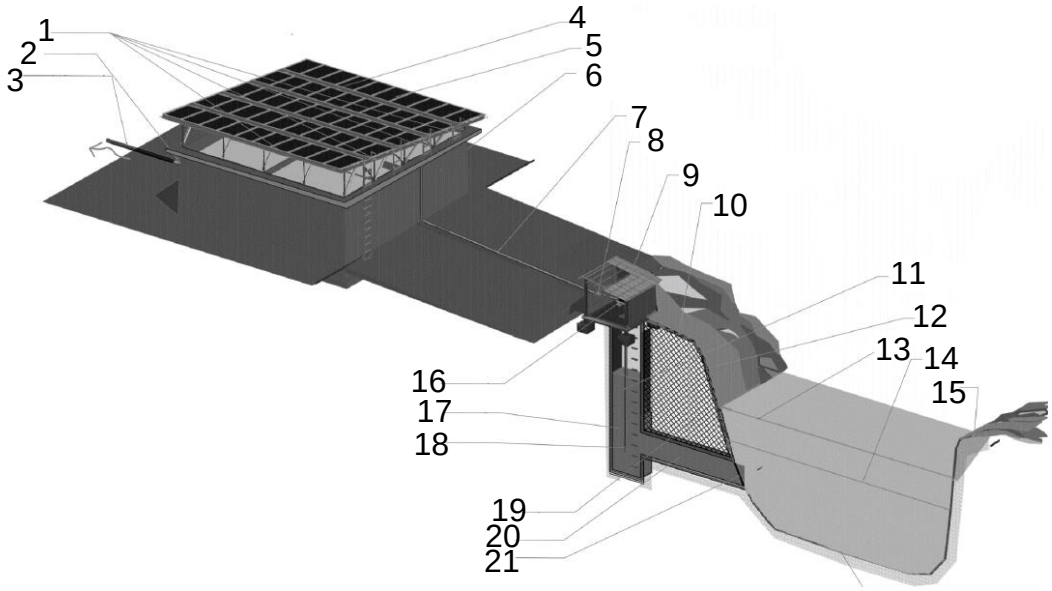
Flow of water affected by atmospheric and surface conditions.

4.4.2 Closed Channel

The flow of water in completely filled conduits, where no free water surface exists or where surface conditions, is insignificant.

5 Construction and Structural Requirements

Figure 5 illustrates an example of SPIS. The major components of SPIS are the PV modules, pumpset, and controller.



Key:

1	Steel Ladder	12	Grouted Riprap
2	Gate Valve (150 mm)	13	Max Flood Flow
3	GI Pipe (150 mm)	14	Min River Flow
4	Pathways	15	River Bank
5	Variable	16	Surface Pump
6	Concrete Tank	17	Pump Sump
7	GI Pipe (100 mm)	18	Foot Valve
8	Gate Valve (100 mm)	19	Compacted Backfill
9	Pump House	20	Intake Box
10	NGL	21	Trashrack
11	GI Pipe (150 mm)		

Figure 5. Example of an SPIS (Water Resource Management Division-Bureau of Soils and Water Management [WRMD-BSWM], n.d.)

5.1 PV Array

5.1.1 Mounting Rails of PV Array

The panels in the PV array should be installed with a rigid alloy rail made of non-corrosive material.

5.1.2 Mounting Frame Material

The mounting frame structure should be made from Galvanized Iron (GI) pipes or angular bars that are either primed, hot dipped galvanized with minimum of 5 mils or double coated with non-corrosive paint.

5.1.3 Type of PV Module

A uniform type and specifications of PV modules, either monocrystalline or polycrystalline, shall be used for the whole array.

5.1.4 Gustiness, Uplift, and Degradation

The PV modules shall be able to withstand a minimum gustiness and uplift of 180 kph. The standard degradation should be a minimum of 0.5% annually as per IEC 61215-1:2021 (Terrestrial photovoltaic (PV) modules – Design qualification and type approval – Part 1: Test requirements).

5.1.5 Orientation

The orientation of the PV array shall be as per site assessment. It is recommended that the PV array should be facing the south based on efficiency and performance.

5.1.6 Angle of Inclination

The angle of inclination in degrees for the PV array shall be dependent on latitude of the location maximizing solar energy to be harvested.

5.1.7 Location

Placement of the PV array shall be away from any source of shades any time of the year. If applicable, the site of installation shall be cleared of any trees and other obstructions.

5.1.8 Spatial Requirements

The spatial distance between each PV modules should be at least 20 mm.

5.2 Pumpset

5.2.1 Requirements

The type, capacity of pump, suction and discharge pipe material, and other basic components shall be dependent on the design of the SPIS.

5.2.2 Protection

Dry running, overheating, overloading, voltage transient, and low/high voltage input protection shall be provided for the pumpset.

5.2.3 Pump Intake

A trash rack, made of non-corrosive material or painted with protective coating, shall be installed along with the pump intake. The orientation of the pump shall be dependent on the system design (e.g. submersible or surface).

5.2.4 Pumpset Installation Based on Water Source

The pumpset to be used shall be dependent on the water source and total head. Casings for groundwater sources shall be provided.

5.2.5 Pump Discharge

A discharge measuring device, such as flow meter or water meter, should be included with the pumpset.

5.3 Solar Panel Controller

5.3.1 Protection

The pumpset controller and the PV array controller shall be insect-proofed and weather-proofed by using double-proof box and sealants.

5.3.2 Ingress Protection (IP) Ratings Used

A minimum of IP58 (splash proof) rating shall be used as per IEC 60529:2019 (Degrees of protection provided by enclosures [IP Code]).

5.3.3 Circuit Breaker Housing

The solar panel controller should be encased with a combiner box.

5.3.4 Size of Controller

The capacity of inverter shall be at least 25% higher than pumpset input power requirement.

5.3.5 Controller

The controller shall be fully automated based on manufacturers' specifications.

5.4 Cables and Wires

Cables and wirings used for the SPIS shall be in accordance with the Philippine Electrical Code (PEC), using PV cables specific for PV modules. Wiring installations shall be properly protected for weather conditions and other external factors.

5.5 Reservoir (optional)

If installed, the design of the reservoir should indicate that the intake be at least equal to the outflow during operation. The reservoir shall be able to withstand the design load. The water storage should also include a ladder, drain and overflow sensor, a freeboard, and an intake and outflow valves. Construction shall be in accordance with the PD 1096 (Adopting a NBCP thereby revising RA No. 6541).

6 Performance Requirements

6.1 The performance of SPIS shall be in accordance with the criteria specified in Table 1.

Table 1. Performance criteria for SPIS (AMTEC-UPLB, n.d.)

Criteria	Performance data
Maximum PV performance ratio (monocrystalline)	18
Maximum PV performance ratio (polycrystalline)	19

6.2 The pump set shall have a test report with pump/performance curve prior to installation.

6.3 The required total volume (m^3) discharged by the system based on the design during the whole day operation shall be attained.

7 Safety Requirements

7.1 A Rapid Shutdown Device (RSD) shall be installed for roof-mounted panels.

7.2 Lightning arrester shall be installed in accordance with Article 2.80 (Surge Arresters) of the National Electrical Code (NEC).

7.3 Warning signs shall be installed for electrical components on-site.

7.4 Surge Protection Devices (SPD) shall be installed along with the PV module.

7.5 Personal Protective Equipment (PPE) shall be provided for each operator on site.

8 Equipment and Accessories

8.1 Communication devices should be provided on site.

8.2 Multi-testers should be provided on site.

9 Warranties for Construction

9.1 Warranty shall be provided for parts and services except for normal wear and tear of the following components:

9.1.1 Pumps shall have at least a one-year warranty.

9.1.2 Workmanship warranty shall be at least one year.

9.1.3 PV modules shall have at least 10 years for material warranty and 25 years performance warranty.

9.1.4 Inverters shall have at least a one-year warranty.

9.2 Warranty shall cover those specified under PNS/BAFS 192:2016 (Guidelines on after-sales service). In addition, pest infestation is not covered in the warranty.

10 Maintenance

10.1 Each unit shall be provided with the following basic hand tools including, but not limited to, one set of each of the following: adjustable wrench, pipe wrench, box and open wrenches, Philips, and flat screw-driver.

10.2 The grease points for lubrication of mechanical parts should be provided.

10.3 Solar panels shall be cleaned using the proper tools and procedures based on manufacturer's manual.

10.4 Cleaning of the solar panels should be performed as the need arises.

10.5 Weeds and grass should be cut when nearing or going above the height of the solar panel array.

10.6 Maintenance of components shall be performed with proper tools and equipment.

11 Operation

11.1 Operators shall wear appropriate clothing, along with the provided PPE during operating hours at all times.

11.2 The operators' manual based on the PAES 102:2000 (Agricultural machinery – Operators manual – Content and presentation), maintenance schedule, and a list of warrantable parts of the SPIS shall be provided.

11.3 Readout of voltage and current of running motor, along with other necessary warnings shall be provided on-site.

12 Testing

The SPIS shall be tested in accordance with PNS/BAFS 325:2022 (SPIS – Methods of test).

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