PQS Quality Assurance protocol

WHO/PQS/PVDC-VP2.0
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TITLE: Solar power system for low electrical requirements – on-site checklists for completed installations.

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Contents

1. Scope

This document sets out the requirements for the procurement, installation and commissioning of solar powered crucial cold chain devices with low power requirements, including equipment monitoring systems (EMS) such as remote temperature monitoring devices (RTMD) and other necessary peripherals.

The **WHO PQS E006/PVDC 01** specification sets out the requirements for solar power systems that are appropriate for present day EMS and for other load devices with similar

power requirements of less than 400 Wh/day. This specification also details the requirements for a generic low voltage direct current (DC) standalone solar power system with a photovoltaic solar module or array of solar modules powering an EMS, such as an RTMD that complies with **WHO PQS E006/TR03** specifications. These requirements may also be applicable to other load devices that require low voltage low power DC input. Note: the current specification document does NOT apply when using solar direct drive energy harvesting to power an RTMD or similar device (see **WHO PQS E007/EHC01** specifications and verification protocols for requirements).

The procurement agency should complete Annex 1 and issue the document together with a copy of specification **E006/PVDC 01**to one or more legal manufacturer or reseller as the basis for obtaining tender offers. A copy of the Annex 2 checklist should subsequently be completed by the installer at the time of commissioning and handover and a copy of the Annex 3 checklist should be completed by the user at the end of the first 30 days of operation.

It is intended that the partly completed **E006/PVDC VP2.0** and any other supporting documents that the procurement agency considers necessary, together with the successful tenderer's priced offer, should form the basis for a contractual agreement between the parties for the supply, installation and commissioning of one or more installation(s).

2. Terms and definitions

Alternating current (AC): an electric current that reverses its direction at regularly recurring intervals the value of which varies as a sine wave.
Autonomy: time in hours that a solar power system can maintain the load under low solar radiation conditions (e.g. rain). Autonomy is determined as described in **E006/PVDC 01** Clause 4.2.3: Battery set sizing.
Design day: the day that is selected to size the solar power system to meet all EMS electrical load requirements (the "design day") must be largest of the following three options 1) based on the lowest monthly solar radiation reference period; 2) based on the highest average daily electrical load requirement for a given month; or 3) both if occurring simultaneously.
Direct current (DC): an electric current flowing in one direction.
Employer: the organization that contracts with the legal manufacturer or reseller who will supply the system components and the installation and maintenance advisory services described in this specification. The employer will typically contract with an installer who will install, commission and maintain the installation.
Equipment monitoring system (EMS): measurement and recording device intended to monitor cold chain temperature, performance, events and alarms in walk-in cold rooms and freezer rooms (PQS E001) and refrigeration appliances (PQS E003).
In writing: communication by letter, fax or email.
Installation: the complete solar power system installation described in **E006/PVDC 01** equipment specification and in the companion **E006/PVDC-VP1.0** document, together with any other employer's requirements documentation issued for a specific installation or installations.
Installer: a person or organization who has been appointed by the employer to carry out the installation of the system.
Legal manufacturer: the natural or legal person with responsibility for the design, manufacture or integration of components, packaging and labelling of a product or device

before it is placed on the market under the person's own name, regardless of whether these operations are carried out by that person or on that person's behalf by a third party.
Load: any end-use device in an electrical circuit that can consume power when the electrical circuit is energized.
Maximum power point tracking (MPPT) control: a type of photovoltaic (PV) to battery charge control that optimizes solar array output by operating as a DC-to-DC converter. It uses the DC input from the PV array and converts it back to a different DC voltage and current so that the PV module is correctly matched to the battery. This allows a solar array to be wired at optimal voltage to overcome long cable distances that otherwise would result in excessive voltage drop or unacceptably large cable diameter.
Montreal Protocol: the Montreal Protocol, finalized in 1987, is a global agreement to protect the stratospheric ozone layer by phasing out the production and consumption of ozone depleting substances (ODS).
QA assessor: the person or entity appointed by the employer to assess the quality and suitability of manufacturing sites and/or candidate approved installers.
QA: Quality Assurance.
Remote temperature monitoring device (RTMD): a system including programmable temperature and event monitor and peripheral devices in compliance with **WHO PQS E006/TR03**.
Reseller: a commercial entity, licensed to act on behalf of a legal manufacturer and which carries product liability and warranty responsibilities no less onerous than those carried by the legal manufacturer.
Solar radiation reference period: the minimum average daily solar radiation on the plane of the solar array that is required to properly power the EMS, expressed in kWh/m²/day.
Standalone: solar power system capable of independently powering 100% of all connected electrical loads.
User: the person responsible for the day-to-day operation of the cold chain equipment and/or solar power system.

3. Normative references

(Use most current version)

EMAS: European Union Eco-Management and Audit Scheme.
IEC 60335-1: 2006 Household and similar electrical appliances - Safety - Part 1: General requirements.
IEC 60364-1: 2005 Low-voltage electrical installations - Part 1: Fundamental principles, assessment of general characteristics, definitions.
IEC 61000-6-1 edition 2.0: 2005 Electromagnetic compatibility (EMC) Generic standards - Immunity for residential, commercial and light-industrial environments.
IEC 61000-6-3 edition 2.1: 2011 Electromagnetic compatibility (EMC) Generic standards - Emission standard for residential, commercial and light-industrial environments.
IEC 61194: 1992 Characteristic parameters of stand-alone photovoltaic (PV) systems.
IEC 61215: 2005 Crystalline silicon terrestrial photovoltaic (PV) modules - Design qualification and type approval.
IEC 61646: 2008 Thin film terrestrial photovoltaic (PV) modules – Design qualification and type approval.
IEEE 1562: 2007 Guide for Array and Battery Sizing in Stand-Alone Photovoltaic (PV) Systems.
ISO 1461: 2009 Hot dip galvanized coatings on iron and steel articles - specifications and test methods.

ISO 9001: Quality Management Systems – Requirements.
ISO 14001: 2004 Environmental management systems - Requirements with guidance for use.
ISO 20282-1: 2006 Ease of operation of everyday products - Part 1: Context of use and user characteristics.
Solar Autonomy Calculation Tool, H.Toma and T. Markvart, University of Southampton, UK 2009.
UL2054: Second edition, 2009 Household and Commercial Batteries.
UL1642: First edition, 2012 Standard for Safety, Lithium Batteries.
WHO PQS E006/PVDC 01: Solar power system for low electrical requirements.
WHO PQS E006/PVDC-VP1.0: PQS Independent type examination.
WHO PQS E006/TR03.2: Programmable remote temperature and event monitoring systems.
WHO PQS E007/EHC01.1: Solar direct drive surplus energy harvest control.

4. Applicability

The Annex 1 specification checklist will be completed by the employer. The Annex 2 QA assessment will be completed by the installer. The Annex 3 checklist will be completed by the user.

5. Specification checklist

5.1 Specification requirements

Annex 1 lists the required installation(s) and their location(s). Each complete installation (including solar power system and compatible load equipment) is to be designed and supplied using component elements already prequalified by WHO in accordance with PQS specifications **E006/PVDC01** and if applicable, PQS load specifications (e.g. PQS E006 specifications for EMS, RTMD and their peripherals). Legal manufacturers and resellers should consider environmental conditions at the installation site(s) when selecting a suitable component - for example, in dusty conditions, avoid using components requiring frequent cleaning maintenance.

Equipment for known locations is to be designed for climatic conditions at, or as close as possible to, the named site. Equipment for unknown locations is to be designed on the basis of the best available climatic information for the country, region, province or district specified in Annex 1, Part 1, line 1.1.

5.2 Criteria for qualification

An individual installation will be accepted by the employer when:

- the completed Annex 2 handover checklist shows that all components are correctly installed and are operating satisfactorily.
- a completed Annex 3 user checklist has been received, showing no faults and correct operation throughout the first 30 days of operation.

6. Quality control checklist

6.1 Quality control standards

All installation work must be carried out in accordance with the legal manufacturer's installation instructions. All on-site electrical installation work must comply with **IEC 60364-1.**

6.2 Manufacturing quality control checklist

On-site inspection of the production facility is not required.

6.3 Site work quality control checklist

The installer will carry out an inspection of each completed installation and complete a copy of the Annex 2 checklist. If the installation is satisfactory it will be handed over to the user who will complete a copy of the Annex 3 checklist after the first 30 days of operation. The employer will only accept the installation when both checklists are satisfactory.

6.3.1 Training

User training is optional. If offered, the syllabus should cover the following topics:

- operations,
- daily, weekly and monthly maintenance tasks,
- health and safety guidance.

6.4 Handover dossier

The handover dossier must be issued to the employer after the installation has been completed. The dossier must be presented in a lever arch folder with clearly marked subject dividers and must contain the following:

- completed, signed, installation checklist,
- user manual, technician's manual and installation manual for the solar power system containing the material listed in specification **E006/PVDC**,
- completed, signed, 30-day test checklist.

One copy of the user manual is also to be handed to the responsible person at the installation site.

7. Customer reference checklist

Not applicable.

8. Prequalification evaluation

Not applicable.

9. Modified products

Not applicable.

Annex 1 – Specification checklist[1]

Note: The employer should complete one checklist for each **known** site. For **unknown** sites, complete one schedule (Part 4) for each type and size of PVDC system.

Solar power system specification checklist		**Date:**	
Country:			
Procurement agency: Contact name: Address 1: Address 2: Address 3: Address 4: Tel: Fax: Email:			
All system components must comply with applicable PQS specifications. EMS and/or RTMD must be prequalified to applicable PQS E006 specification. Solar power systems must comply with PQS specification **E006/PVDC 01.**			
PART 1: Site information			
1.1	**Site location and quantity** *The solar power system for equipment on unknown sites will be a generic design.*	**Known** (complete Part 2 and Part 3 only) **Qty =** **Unknown** (complete Part 2 and Part 4 only) **Qty =**	
PART 2: Load details			
2.1	**Load quantity**	Number of units required:	
2.2	**Load type(s)** At least one load required.	**Load 1**: **Load 2**:	
2.3	**Temperature zone** *Choose the appropriate temperature zone. If winter temperatures are low and site heating is unreliable, battery capacity may be reduced.*	Hot zone (+43°C): Temperate zone (+32°C): Moderate zone (+27°C): Cold climate: If YES, specify the lowest winter temperature that the load/battery will be exposed to[2]:	 Yes No °C
2.4	**Load model** *Check PQS data sheets for load details for named load model.*	Load manufacturer: Model number: Load voltage Load watts	 Vdc Watts
PART 3: Known sites			
3.1	**Known site location details** *Fields marked * are mandatory. The more precise the other data, the easier it will be to design the solar power system to suit the specific site.*	* Country: * Longitude: * Latitude: Nearest city/town: Village or suburb: Site name: Altitude in metres above sea level:	

[1] This is a Word 'Form' document. It needs to be copied before it can be used for data entry. Then activate View/Toolbars/Forms and click the 'lock' icon on the Forms toolbar. See also Word Help.

[2] This is the lowest temperature in the room housing the load battery, NOT the lowest outside air temperature. In cold climates, temperatures down to -10°C may occur in health facilities that are left unattended and unheated for long periods.

Solar power system specification checklist		Date:	
Country:			
3.2	**Array support details** *The chosen array position must face as close as possible to South (northern hemisphere) or North (southern hemisphere) and must be completely shade free (including overhead cables) from at least 9:00am to 3:00pm throughout the year. Give orientation in Northern hemisphere as: SE, SSE, S, SSW, SW or in Southern hemisphere as: NE, NNE, N, NNW or NW.*	**Pitched roof mounting?**	Yes No
		If YES, give roof pitch in degrees:	
		If YES give roof slope orientation:	
		If YES, state roof finish material:	
		If YES, height of building to eaves:	m
		Flat roof mounting?	Yes No
		If YES, height of building to roof:	m
		If YES, state roof finish material:	
		Wall mounting?	Yes No
		If YES, give wall orientation:	
		If YES, give mounting height:	m
		Ground mounting?	Yes No
		Pole mounting:	Yes No
		If YES, give height of pole:	m
		If YES, choose top or side mount:	Top Side
3.3	**Array cable** *Measure the true distance[3] from the array to the load or battery set position as accurately as possible.*	Length of array cable required:	m
		Measured cable length including all bends, and vertical and horizontal lengths, plus 10%.	m
PART 4: Unknown sites			
4.1	**Unknown site location details** *Field marked * is mandatory. Give as much additional detail as possible.*	* Country:	
		Region(s) or Province(s) (if known):	
		District(s) (if known):	
4.2	**Solar power system quantity**	Solar power units required:	
4.3	**Array support details**	No. of roof/ground mounting kits:	
		No. of pitched roof mounting kits:	
		No. of pole mounting kits:	
		No. of wall mounting kits:	
		No. of ground mounting kits:	
4.4	**Array cables** *Agree realistic lengths with the Legal manufacturer or reseller.*	Typical length of array cable:	m

[3] True distance is measured along the actual route the cable will follow. Measure vertically, horizontally and with all changes in direction at 90 degrees.

Annex 2 – Installation checklist

Note: The installer must fill in this checklist for each completed installation.

Solar power system installation checklist			**Date:**
Country:	**City/town:**	**Site name:**	
Installation technician: Installation company: Address 1: Address 2: Address 3: Address 4: Tel: Fax: Email:			
Note: All checks must be satisfactory before the installation is handed over to the user.			
CHECK 1 – System description			
1.1	Supplier- legal manufacturer or reseller:	Name:	
1.2	Solar module:	Mfc./Model:	Qty:
1.3	Solar array structure:	Type of support structure (describe):	
1.4	Load:	Mfc/Model.:	Qty:
1.5	Battery system:	Battery-integrated in load	Battery-standalone
		→ *If "battery-integrated" go to* ***CHECK 2***	
1.6	Battery- standalone:	Mfc/Model:	Qty:
	Battery type (e.g Li, Lead)		Sealed Flooded
	Charge regulator (type):	Mfc/Model:	Enclosure:
CHECK 2 – Shipment details			
2.1	Was the shipment damaged?		Yes No
	If YES, describe damage:		
2.2	Were any components missing?		Yes No
	If YES, list missing parts:		
2.3	Were any components under-supplied?		Yes No
	If YES, list under-supplied parts:		
2.4	Were any spare parts missing?		Yes No
	If YES, list missing parts:		
2.5	Were any spare parts under-supplied?		Yes No
	If YES, list under-supplied parts:		
2.6	Have damaged/missing/under-supplied parts been replaced?	Not applicable	Yes No
	If NO, describe action taken to complete the installation:		
	Comments:		

Solar power system installation checklist			**Date:**
Country:	**City/town:**	**Site name:**	

CHECK 3 – Solar module/array installation			
3.1	Solar array orientation:		
3.2	Solar array slope (measure angle relative to the horizontal):		degrees
3.3	Do shadows fall on the solar array between 9:00am and 3:00pm?		Yes No
	→ *If YES, the system may fail and the array may need to be moved.*		
3.4	Array support structure:	Anodized aluminium:	Yes No
		Stainless steel:	Yes No
	Galvanized steel (painted or unpainted):		Yes No
	Other (material (describe):		
	→ *If 'other material', the structure does not comply and must be replaced.*		
	Are foundation pads or roof fixings in place and are they adequate?		Yes No
	Have theft-deterrent fasteners been used for all accessible fasteners?		Yes No
	→ *If no, fasteners do not comply and must be replaced.*		
3.5	Lightning protection:		
	Has the lightning protection circuit been correctly fitted?		Yes No
	Has the earth electrode been correctly fitted?		Yes No
	Has lightning protection system been tested for electrical continuity?		Yes No
3.6	Array cable:		
	Is the solar array cable type correct for external use?		Yes No
	Is the solar array cable protected against mechanical damage?		Yes No
	Is the solar array cable protected against rodent attack?		Yes No
	Comments:		
CHECK 4 – Battery installation (where applicable)			
4.1	Battery set and battery set housing:	Battery-standalone "Battery-integrated" in load (go to Check 5)	
	Accessible for maintenance?		Yes No
	Protected against the weather?		Yes No
	Safely located to prevent accidental damage?		Yes No
	Secured against theft?		Yes No
	Have battery safety and maintenance instructions been provided?		Yes No
	Is there a switch or other means to disconnect the battery?		Yes No
4.2	Flooded batteries (where fitted):	Applicable Not applicable (go to 4.3)	
	Are battery casings transparent?		Yes No
	Was the electrolyte (acid) supplied in a separate sealed container?		Yes No
	Has the battery safety equipment kit been supplied?		Yes No
4.3	Battery charge regulator:		
	Is the regulator specified for the battery type (e.g. Li, lead acid)?		Yes No
	Was the regulator pre-set in the factory?		Yes No
	Does the regulator have a battery capacity indicator?		Yes No
	Does the regulator have automatic temperature compensation?		Yes No
	Does the regulator have an optional acoustic alarm?		Yes No
4.4	Fuses: 10 no. spare fuses in polythene bag fixed next to fuse box?		Yes No
	Comments:		

Solar power system installation checklist			Date:
Country:	**City/town:**	**Site name:**	

CHECK 5 – Loads		
5.1	List load type(s):	
	Do load(s) have a WHO PQS prequalification code number?	Yes No
	List all load(s) if applicable add the WHO PQS code number.	
	Comments:	
CHECK 6 – Wiring installation		
6.1	Wiring:	
	Has the system been wired in accordance wit the legal manufacturer or reseller's wiring diagram?	Yes No
	Are all electrical connections concealed and properly protected?	Yes No
	Was site installed electrical wiring tested for safety and function?	Yes No
	Comments:	
CHECK 7 – Commissioning tests		
7.1	Commissioning: have all tests been carried out in accordance with the legal manufacturer or reseller's instructions?	Yes No
	If YES, describe tests:	
	If NO, explain why tests have not been carried out:	
7.2	Are all solar power system components and all loads functioning properly?	Yes No
	Comments:	
CHECK 8 – Documentation		
8.1	Documentation check:	
	Has a user manual been supplied for all system components?	Yes No
	Are user manuals in the correct language?	Yes No
	Has a technician's manual been supplied for all system components?	Yes No
	Are technician's manuals in the correct language?	Yes No
	Has an installation manual been supplied?	Yes No
	Is the installation manual in the correct language?	Yes No
	Has one complete set of documentation been given to the employer?	Yes No
CHECK 9 – Overall conclusions and recommendations		
9.1	Recommendation:	Pass Fail
	If FAIL, list outstanding work still required:	
	If PASS, the installation can be handed over to the user.	

Installation technician's signature: ……..

Date: ……

Annex 3 – 30-day test checklist

Note: The -user must complete this checklist for each installation after the first 30 days of operation.

Solar power system 30-day test checklist		**Date:**
Country:	**City/town:**	**Site name:**
Instructions for completing this form: Complete the form 30 days after the solar power system was handed over to you. Send a copy of the form back to **<name of recipient>.**		
Name: Position: Tel: e-mail:		
Have you received training in the use of the system?		Yes No
Do you have a copy of the *user manual* for the solar power system, battery set and load devices (e.g. monitoring system)?		Yes No
Is the system working correctly?		Yes No
Is there a battery capacity indicator and does it work correctly?		Yes No
If YES, how is battery capacity indicated?		
Note: Tick NA to the next two questions if the batteries are not transparent.		
Can you see the liquid level in the batteries without using tools?		NA Yes No
Do you know how to top up the batteries with electrolyte (acid)?		NA Yes No
Were battery maintenance tools and supplies provided?		NA Yes No
Have the loads worked properly throughout the last 30 days?		Yes No
If you have any comments or questions, please write them here:		
User's signature: ……. Date: ……		

Revision history			
Date	Change summary	Reason for change	Approved