

TECHNICAL STANDARD

THE DESIGN, SUPPLY AND INSTALLATION
OF
A SOLAR POWER SUPPLY SYSTEM



Issued by: Manager Engineering

Issue Date: 4 August 2008

TS 80

The Design, Supply and Installation

Of

A Solar Power Supply System

© SA WATER DISCLAIMER 2007

This is an intellectual property of the South Australian Water Corporation. This document is copyright and all rights are reserved by SA Water. No part may be reproduced, copied or transmitted in any form or by any means without the express written permission of SA Water.

The information contained in these Standards is strictly for the private use of the intended recipient in relation to works or projects of SA Water.

These Standards have been prepared for SA Water's own internal use and SA Water makes no representation as to the quality, accuracy or suitability of the information for any other purpose.

It is the responsibility of the users of these Standards to ensure that the application of information is appropriate and that any designs based on these Standards are fit for SA Water's purposes and comply with all relevant Australian Standards, Acts and regulations. Users of these Standards accept sole responsibility for interpretation and use of the information contained in these Standards.

SA Water and its officers accept no liability for any loss or damage caused by reliance on these Standards whether caused by error, omission, misdirection, misstatement, misinterpretation or negligence of SA Water.

Users should independently verify the accuracy, fitness for purpose and application of information contained in these Standards.

The currency of these Standards should be checked prior to use.

APPROVAL TO DEVIATE FROM THIS STANDARD

Approval may be granted by the Asset Owner to deviate from the requirements as stipulated in this Standard if the functional requirements (e.g. Asset Life) for the asset differs from those stated in the Standard, but is assessed as still being acceptable by the Asset Owner's nominated representative.

Any approval to deviate from the stated requirements of this Standard will not be seen as creating a precedent for future like project. Any request to deviate from this Standard must be carried out on a project by project basis where each alternate proposal will be individually assessed on its own merit.

CONTENTS

© SA WATER DISCLAIMER 2007	3
APPROVAL TO DEVIATE FROM THIS STANDARD.....	3
CONTENTS.....	4
1. GENERAL	6
1.1 SCOPE	6
1.2 ENVIRONMENT	6
1.3 STANDARDS AND CODES.....	6
2. SOLAR POWER SUPPLY SYSTEM	8
2.1 GENERAL ARRANGEMENT.....	8
3. SOLAR POWER SUPPLY EQUIPMENT	9
3.1 SUPPORT STRUCTURE	9
3.1.1 Concrete Footing	9
3.1.2 Pole Support Structure	9
3.1.3 Pole Tilt Mechanism	9
3.1.4 Antenna Support Bracket	9
3.2 CUBICLES	10
3.2.1 General	10
3.2.2 Control Cubicle	10
3.2.3 Battery Cubicle	11
3.3 ELECTRICAL EQUIPMENT.....	11
3.3.1 General	11
3.3.2 Electrical Capacity	11
3.3.3 Photovoltaic Array.....	11
3.3.4 Regulator	12
3.3.5 Batteries.....	12
3.3.6 Converter	13
3.3.7 Inverter.....	13
3.3.8 Indications.....	13
3.3.9 Output Signals	13
3.3.10 Lighting	14
3.3.11 Circuit Breakers	14
3.3.12 Isolation Switches	14
4. INSTALLATION	15
4.1 GENERAL	15
4.2 SUPPORT STRUCTURE	15
4.3 CUBICLES	15
4.4 ELECTRICAL EQUIPMENT.....	15
4.4.1 Photovoltaic Array.....	15
4.4.2 Battery Bank	16
4.4.3 Cabling.....	16
4.5 LABELLING AND SIGNS	16

5.	INSPECTION, TESTING AND WARRANTY	17
5.1	GENERAL	17
5.2	INSPECTION.....	17
5.3	TESTING	17
5.4	WARRANTY.....	17
6.	TECHNICAL INFORMATION TO BE PROVIDED	18
6.1	WITH THE OFFER	18
6.2	PRACTICAL COMPLETION	18
7.	DIAGRAMS	19
8.	SITE SCHEDULE.....	22

1. GENERAL

1.1 SCOPE

This Standard Specification covers the design, supply and installation of A Solar Power Supply System for low and extra low voltage equipment.

Where this work is part of another contract then the requirements of this Standard Specification shall apply unless they are specifically deleted or amended in the project specification or drawings which shall then take precedence.

1.2 ENVIRONMENT

Equipment shall be rated for operation in the following ambient temperature range:

Outdoors: -5°C to 60°C

Indoors: 0°C to 45°C

1.3 STANDARDS AND CODES

Any Standard referred to in this Specification shall be of the latest edition (including amendments) of that Standard at the date of calling of tenders.

The following Standards and codes are referred to in this Specification:

Standards Association of Australia

AS (Australian Standards)

1768	Lightning Protection
2700	Colour standards for general purposes
3600	Concrete structures
4086	Secondary batteries for use with stand-alone power systems
4086.1	Part 1: General Requirements
4086.2	Part 2: Installation and maintenance
4100	Steel structures
4509	Stand-alone power systems
4509.1	Part 1: Safety requirements
4509.2	Part 2: System design guidelines
4509.3	Part 3: Installation and maintenance
60529	Degrees of protection provided by enclosures (IP Code)

AS/NZS (Australian Standards / New Zealand Standards)

1164	Aluminium structures
1170	Structural design actions
1170.1	Part 1: Permanent, imposed and other actions
1170.2	Part 2: Wind actions
3000	Wiring Rules
3008	Electrical installations – Selection of cables
3008.1.1	Part 1.1 Cables for alternating voltages up to and including 0.6/1 kV – Typical Australian installation conditions
3133	Approval and test specification – Air break switches
5033	Installation of Photovoltaic (PV) arrays

Australian and New Zealand Solar Energy Society Radiation Specification

Australian and New Zealand Solar Energy Society

Australian Solar Radiation Data Handbook (ASRDH)

2. SOLAR POWER SUPPLY SYSTEM

2.1 GENERAL ARRANGEMENT

The solar power supply system shall consist of the following:

- (1) Concrete footing.
- (2) Pole support structure mounted on the concrete footing.
- (3) Photovoltaic array mounted at the top of the pole support structure.
- (4) Control cubicle bolted to the pole support structure (unless specified to be located indoors) accommodating the electrical equipment referred to in this specification including space for any specified SA Water equipment.
- (5) Battery cubicle bolted to the pole support structure (unless specified to be located indoors) accommodating the batteries.
- (6) Sunshield (unless cubicles located indoors).
- (7) If specified, an antenna support bracket for the mounting of a radio antenna(s) by others.

Note: Variations of this solar power supply system shall be submitted to S.A. Water for approval.

3. SOLAR POWER SUPPLY EQUIPMENT

3.1 SUPPORT STRUCTURE

3.1.1 Concrete Footing

The concrete footing shall support the pole support structure and shall be designed to take into account the appropriate terrain category (for wind loading) and foundation (geotechnical) conditions at the site in accordance with but not limited to AS 3600 and AS 1170.

3.1.2 Pole Support Structure

The pole structure shall be designed in accordance with, but not limited to AS 4509.1, AS 1170.2, and the following:

- (1) The pole structure shall be at least 5m in height to minimise the possibility of vandalism.
- (2) The pole structure shall be constructed from hot dipped galvanised steel or aluminium in accordance with AS 1164.
- (3) The pole structure shall be capable of supporting the weight and wind loading forces of the photovoltaic array mounted at the top of the pole and cubicles bolted to the bottom of the pole.
- (4) The photovoltaic array shall be fixed to the structure with a mechanism to adjust the tilt angle for seasonal variations if required (Refer to AS 4509.3 Clause 3.2) and the angular direction. The photovoltaic modules shall be mounted in such a way as to minimise the potential for theft of or vandalism to the modules.

3.1.3 Pole Tilt Mechanism

The pole shall have the ability to be tilted down above the cubicles to facilitate maintenance of equipment at the top of the pole. The tilting shall be by means of a central pivot as shown in the diagram in section 7. Equipment to provide lowering and raising of the pole (eg rope and pulley) shall form an integral part of the pole support structure. A means of fixing the pole at any angle while lowering shall be provided. Access to this facility shall be restricted to prevent vandals from damaging equipment.

If needed, the pole shall be provided with a weight fixed at the bottom to counterbalance the weight of the solar panels so that the weight imbalance is between 5 and 10 kg heavier at the top of the pole.

3.1.4 Antenna Support Bracket

Where required by the Site Schedule the pole structure shall be provided with a support bracket mounted at the top of the pole for others to install a radio antenna(s) and feeder cable(s).

The bracket shall be made of a square channel of hot dipped galvanised steel or aluminium in accordance with AS 1164 and shall be of a length sufficient to clear the PV panel in any direction by 250mm. The bracket shall be capable of supporting a load of 10kg at the end and sufficiently rigid to prevent distortion due to wind loading on the antenna(s). The bracket shall be adjustable in height and rotation around the pole.

3.2 CUBICLES

3.2.1 General

Cubicles shall be in accordance with AS 60529 and the following:

3.2.1.1 Indoor Cubicles

Indoor cubicles shall be painted Zincseal sheet steel construction of minimum thickness 1.5mm, rated at not less than IP54 with controls and indications mounted on hinged lockable doors. Locks shall be coded to Lenlock key code 320. Paint colour shall be in accordance with manufacturer's standard with colour being grey, white or cream unless otherwise approved.

Cubicles shall be provided with multiple knockouts along the bottom to facilitate the installation of conduits and wiring.

3.2.1.2 Outdoor Cubicles and Sunshield

Outdoor cubicles shall be constructed from 316L stainless steel of minimum thickness 2mm and shall be rated at not less than IP56.

Outdoor cubicles shall be fitted with a 316L stainless steel sun shield to protect the cabinets from the direct rays of the sun. There shall be at least 50mm clearance between the sides of the cubicles and the sunshield to allow the installation of conduits.

Cubicles shall be provided with multiple knockouts along the bottom to facilitate the installation of conduits and wiring.

Cubicles and sun shield shall be painted white (N14) in accordance with AS 2700 unless otherwise approved by S.A. Water.

Cubicles shall be designed to be vandal resistant and include the following:

- (1) No controls or indicators on the front door
- (2) Provided with ventilation inlets to protect equipment against the effects of excessive temperature. Ventilation inlets shall incorporate air filters
- (3) Concealed or vandal resistant hinges
- (4) Designed to avoid leverage points which would allow doors to be forced open
- (5) Doors to be provided with high security swing type handles (Emka 1107SBC01 or approved equivalent) with locking facility for SA Water approved padlocks.
- (6) Fixing bolts, screws etc concealed to prevent unauthorised removal.

3.2.2 Control Cubicle

The control cubicle shall contain all the electrical equipment supplied under this specification with the exception of the battery bank. This includes regulators, converters, inverters, distribution boards, meters, lighting, protective equipment, terminal strips, conduits and cabling.

The cubicle shall have sufficient space for the mounting of SA Water equipment if required in the attached Schedule.

3.2.3 Battery Cubicle

The battery cubicle shall contain only the batteries for the battery bank and shall be in accordance with AS 4086.2 Clause 2, AS 4509.1 Clause 3.5, and AS 4509.2 Clause 4.6.

3.3 ELECTRICAL EQUIPMENT

3.3.1 General

All electrical equipment shall comply with relevant Australian and International Standards.

3.3.2 Electrical Capacity

The contractor shall design and size the electrical capacity of the solar power supply system, including all components, for the specified loads. All electrical equipment shall be rated for a capacity increase of 20% above the loads specified in the attached Schedule.

The battery cubicle shall be provided with sufficient spare space and facilities to add a minimum of 20% more battery capacity or one more battery whichever is greater.

3.3.3 Photovoltaic Array

The photovoltaic (PV) array for the renewable supply of power shall be designed in accordance with AS 4509.2, AS 4509.3, AS/NZS 5033, the Australian and New Zealand Solar Energy Society – Australian Solar Radiation Data Handbook (ASRDH), and the following:

3.3.3.1 PV Modules

The PV modules used shall be in accordance with the following:

- (1) Crystalline cell type modules
- (2) Nominal output voltage of 12V d.c.
- (3) Efficiency energy conversion ratio greater than 12%.
- (4) Capable of operating at the installation location considering ambient temperatures and extreme weather conditions (for example hail).
- (5) Warranted power output of not less than 90% of nominal for at least 10 years.

3.3.3.2 PV Array

The PV array shall be in accordance with the following:

- (1) The PV modules used for the creation of the PV array shall all be of the same model, type and characteristics.
- (2) An equal number of PV modules shall be used within each parallel string.
- (3) Capable of supplying the required load (including the capacity increase of 20%).
- (4) Sized to account for seasonal variations and where necessary for local geographic features at the site.
- (5) Sized to account for the used regulator type (Switched/PWM or MPPT) in accordance with AS 4509.2.

- (6) Adequately de-rated considering component efficiencies, tolerances and system losses in accordance with AS 4509.2.
- (7) Provided with bypass diodes used in parallel with each module (preferably in parallel with each sub-section of module cells) to prevent the modules from becoming reversed biased and causing photovoltaic hot spots. The bypass diodes used shall minimise any loss in efficiency of the modules and shall be rated in accordance with AS/NZS 5033 Clause 2.2.

3.3.4 Regulator

The regulator shall be in accordance with the following:

- (1) Capable of supplying the required load (including the capacity increase of 20%).
- (2) Capable of accepting the maximum voltage from the PV array.
- (3) Capable of controlling the battery charging and compatible with the chosen battery type. Capable of staged battery charging (Boost, Absorption, Float, and Equalisation) and shall ensure that the battery does not become overcharged.
- (4) Capable of altering the maximum charge voltage to account for the temperature of the electrolyte.
- (5) Prevent reverse current from flowing from the batteries to the photovoltaic array otherwise blocking diodes will be required in accordance with AS/NZS 5033 Clause 2.3.
- (6) For Maximum Power Point Tracking (MPPT) regulators the Power conversion efficiency shall be a minimum of 95% and the PV array power shall not exceed the rated power of the MPPT.

3.3.5 Batteries

3.3.5.1 General

Batteries for the storage and supply of power shall be in accordance with AS 4509.2, AS 4086.2 and the following:

- (1) Suitable for photovoltaic applications
- (2) Life expectancy of not less than 10 years.
- (3) Low Maintenance.
- (4) Heavy Duty Terminals.
- (5) Explosion resistant.
- (6) Low self-discharge rate not greater than 0.5 – 1.0% per week.
- (7) Operational at low internal pressures.
- (8) Capable of supplying the surge demand of the installation.
- (9) Compatible with the specified regulator.
- (10) Deep cycle capability.

3.3.5.2 Battery Bank

The battery bank shall comply with the following:

- (1) All batteries shall be of the same model type and characteristics.

- (2) The battery bank shall be sized to enable the solar power supply system to operate with no charging current from the PV array for a minimum of 5 days to allow for extended overcast conditions). Note that in some locations such as at Williamstown in the Adelaide Hills it has been found necessary to allow for 3 weeks of overcast conditions. The capacity of the battery bank shall take into account the local weather conditions.

3.3.6 Converter

If a converter is required by the schedule then the converter shall comply with the following:

- (1) Capable of accepting an input voltage of 12V d.c. and supplying an output voltage of 24V d.c.
- (2) Shall have conversion efficiency at full load of no less than 85%.
- (3) Capable of supplying the required load current plus a future load capacity increase of 20%.

3.3.7 Inverter

If an inverter is required by the schedule then the inverter shall comply with the following:

- (1) Capable of accepting an input voltage of 12V d.c.
- (2) Capable of supplying a 240V a.c. sine wave output.
- (3) The level of harmonic distortion shall not exceed the levels that would normally exist in a mains supply from the Supply Authority (ETSA) in South Australia.
- (4) Capable of supplying the required load current plus a future load capacity increase of 20%.

3.3.8 Indications

Indications shall be provided for the following parameters as a minimum:

- (1) PV array voltage
- (2) PV array current
- (3) Regulator output voltage
- (4) Regulator output current

These indications shall preferably be provided by a display built into the regulator or otherwise by separate indicators.

3.3.9 Output Signals

The following signals shall be provided at a terminal strip within the control cubicle for input to equipment provided by SA Water:

- (1) Battery Voltage (actual voltage from a fused circuit)
- (2) Low Battery Voltage alarm (digital – voltage free contact rated at 12V, 1A which opens on low battery voltage)
- (3) Solar Power Supply System fault (digital – voltage free contact rated at 12V, 1A which opens on fault)

3.3.10 Lighting

A low wattage fluorescent lamp with adjacent On/Off switch shall be mounted in the Control Cubicle.

3.3.11 Circuit Breakers

Circuit breakers located in the control cubicle for power distribution shall comply with the following:

- (1) Circuit breakers shall be in accordance with AS 4509.1, AS 4509.2, AS/NZS 5033
- (2) Lockable in the off (open) position
- (3) Shall be installed on the PV array cable outputs in accordance with AS/NZS 5033 Clause 2.4.5.
- (4) Shall be installed on the battery charger output. Refer to AS 4509.3 Clause 9.2.
- (5) Shall be installed at the battery bank output in accordance with AS 4509.2 Clause 3.6.6.
- (6) Shall be installed for each piece of equipment within the d.c. and a.c. distribution boards.
- (7) Shall be appropriately labelled to indicate the circuit protected by the device. Refer to AS 4509.2 clause 3.6.4.
- (8) Can be used for isolation devices if the component is rated as an isolation device. Refer to AS/NZS 5033 Clause 2.5.2, and 4.3.3.

3.3.12 Isolation Switches

Isolation switches shall be in accordance with AS/NZS 3133 and shall provide electrical isolation from all power supplies at the solar site including the photovoltaic array and batteries and shall be in accordance with the following:

- (1) Rated for the full load current for the d.c. and a.c. circuits.
- (2) Lockable in the open position.
- (3) As per the electrical schematic.
- (4) Shall be installed on each PV series string, and on the PV array power supply outputs to enable each string and/or the entire array to be isolated.

4. INSTALLATION

4.1 GENERAL

All electrical work shall be in accordance with AS/NZS 3000 and this Specification.

4.2 SUPPORT STRUCTURE

The location of the pole support structure shall be as approved by the Superintendent's Representative. Care shall be taken in locating the final position of the pole to avoid problems such as future shadows from growing trees.

The pole support structure shall be appropriately fastened to the concrete footing.

4.3 CUBICLES

The installation of cubicles shall be in accordance with the following:

- (1) The cubicles shall be installed in accordance with the Diagram in section 7 and as per the Site Schedule (either outdoors attached to the pole support structure or indoors in an approved location).
- (2) For outdoor cubicle installations a suitable air gap shall be provided between the rear of the cubicles and the sun shield and there shall be at least 100mm free space below the control cubicle to allow for installation of conduits. The bottom of the sunshield and the battery cubicle shall both be at least 50mm above the concrete base to facilitate the installation of conduits.
- (3) Where stainless steel cubicles are fixed to a hot dipped galvanised or aluminium structure then stainless steel bolts, nuts and washers shall be used, and plastic washers shall be used to prevent contact between the dissimilar materials, i.e. stainless steel and hot dipped galvanised or aluminium materials.
- (4) Signage for the battery cubicle shall be provided in accordance with AS 4086.2

4.4 ELECTRICAL EQUIPMENT

4.4.1 Photovoltaic Array

The photovoltaic array shall be installed in accordance with AS 4509.3, AS/NZS 5033 and the following:

- (1) The array shall be positioned, orientated and installed to maximise power output whilst considering geographic features and the elimination of shading. Refer to AS 4509.3 Section 3.
- (2) The array shall be mounted to prevent molten metal originating from the PV modules from creating a hazard. Refer to AS/NZS 5033 Clause 2.4.3.
- (3) The array shall be mounted to avoid contact between metals that could produce electrolysis. Refer to AS 4509.3 Clause 3.3.4.

4.4.2 Battery Bank

The battery bank shall be installed in accordance with AS 4086.2, and AS 4509.3 Section 6.

4.4.3 Cabling

Cabling shall be installed in accordance with the following:

- (1) Cabling shall be in accordance with AS/NZS 5033 Section 3.
- (2) All underground cables shall be installed in Category A heavy duty underground UPVC conduits. Conduits exposed to sunlight shall be protected from UV by painting. Cable route markers shall be provided for underground cables.

4.5 LABELLING AND SIGNS

Labelling and signs shall be in accordance with AS 4509.1, AS 4509.3, and AS/NZS 5033.

5. INSPECTION, TESTING AND WARRANTY

5.1 GENERAL

Where SA Water has contracted directly for the design, supply and installation of the solar power supply system then the following inspection, testing and warranty requirements shall apply.

Where the design, supply and installation of the solar power supply system is part of another contract then the terms and conditions of that contract shall also apply.

5.2 INSPECTION

SA Water, or its representative, reserves the right to inspect the installation and be present at any testing carried out.

5.3 TESTING

The installation shall be tested in accordance with AS 4509.3 Clause 10 and AS/NZS 5033 Clause 8.

The results of all tests carried out on the electrical equipment shall be recorded on approved test sheets.

5.4 WARRANTY

All equipment shall be covered by a 12 month warranty from the date of Practical Completion.

6. TECHNICAL INFORMATION TO BE PROVIDED

6.1 WITH THE OFFER

The contractor shall provide the following information as a minimum

- (1) Calculations supporting determination of panel array and battery capacity.
- (2) Details of all equipment offered (manufacturer, model, ratings etc)
- (3) Details of method of pole lowering/raising
- (4) Details of the antenna support bracket (if specified)
- (5) Details of construction relating to vandal-proofing

6.2 PRACTICAL COMPLETION

The contractor shall provide an Operation and Maintenance Manual which shall include the following information as a minimum:

- (1) Operating instructions.
- (2) Maintenance instructions.
- (3) Electrical Schematic.
- (4) Supplier details for all major components of the system (company name, address, phone number etc).

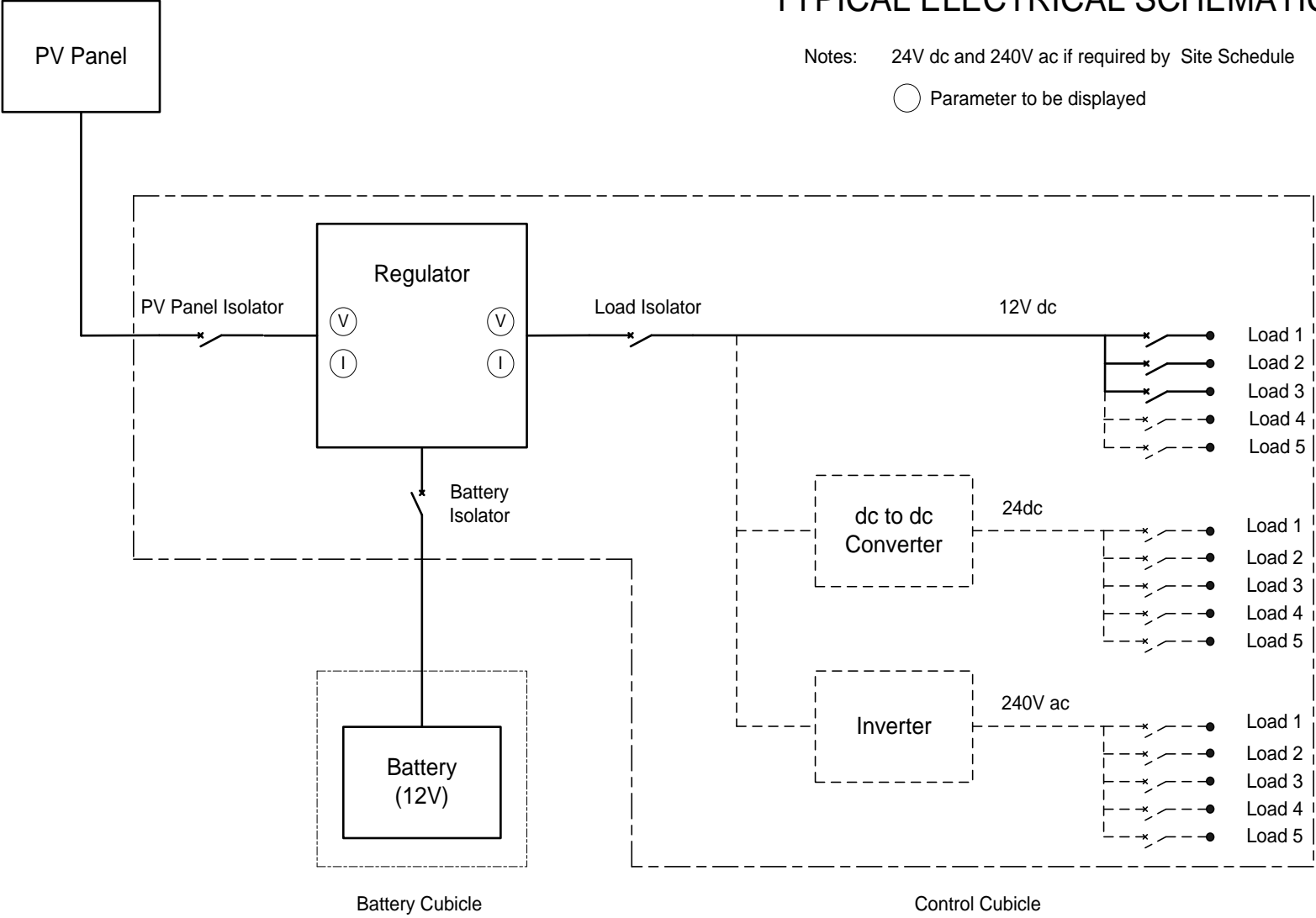
7. DIAGRAMS

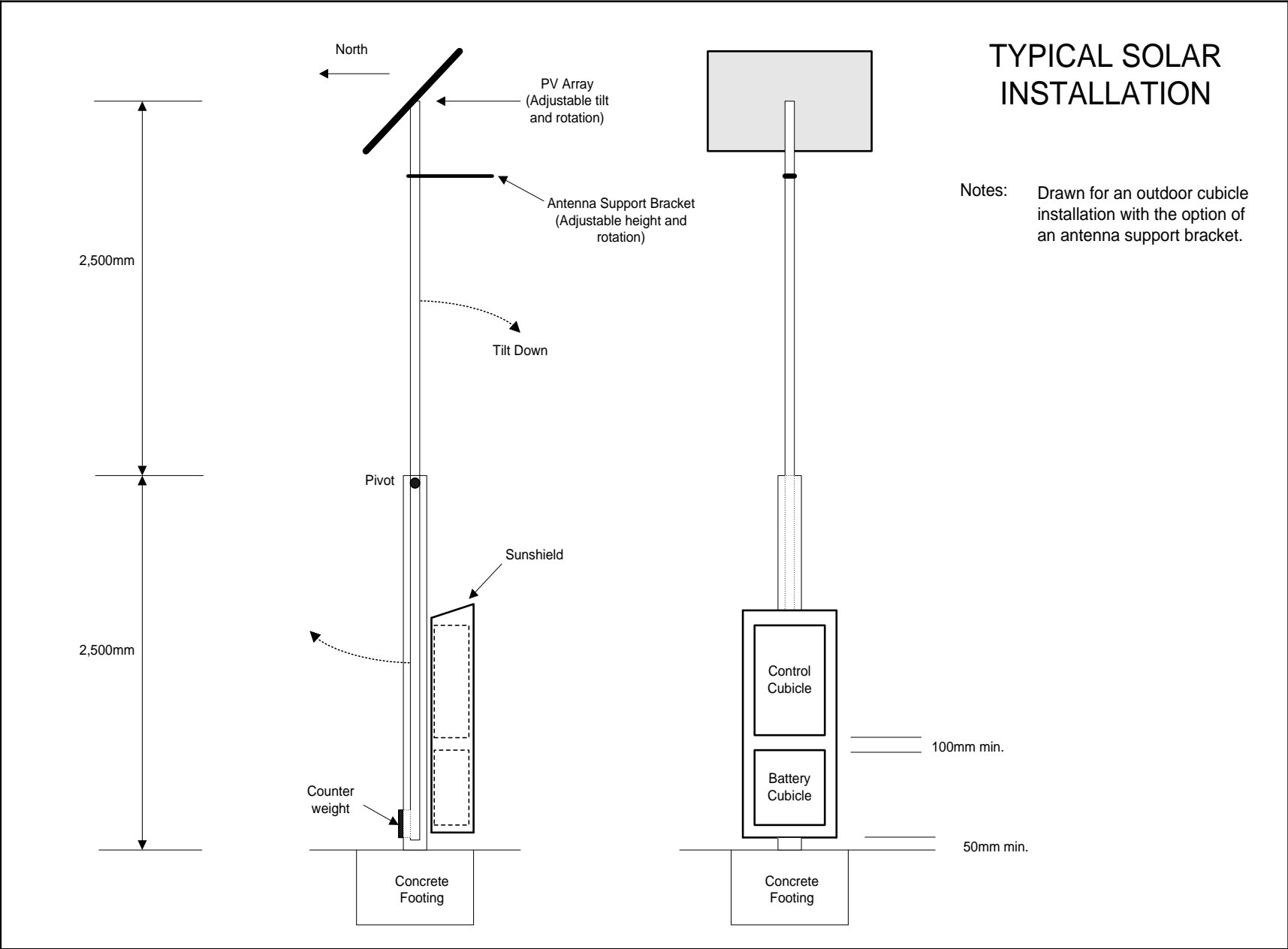
The design, supply and installation of the Solar Power Supply System shall comply with the following.

TYPICAL ELECTRICAL SCHEMATIC

Notes: 24V dc and 240V ac if required by Site Schedule

○ Parameter to be displayed





8. SITE SCHEDULE

A copy of the following schedule shall be completed for each site for which a solar power supply system is required.

Responsibility for completing the Schedule(s) is as follows:

1. Where the solar power supply system(s) is being purchased by SA Water directly then SA Water will complete the schedule(s).
2. Where the provision of the solar power supply systems is part of a larger contract then that contractor shall complete the schedule(s). In those cases information shall be sought by that contractor from SA Water as to the loads that are to be supplied.

SOLAR POWER SUPPLY SYSTEM SITE SCHEDULE

SITE DETAILS			
Site Name			
Site Location Details			
Cubicle Location (Indoor/Outdoor) (If indoors detail the location)			
Any Specific Installation Requirements			
LOAD DETAILS	Load Name	Load I (mA)	Duty (% of time)
12V dc			
Load 1			
Load 2			
Load 3			
Load 4			
Load 5			
24V dc			
Load 1			
Load 2			
Load 3			
Load 4			
Load 5			
240V ac			
Load 1			
Load 2			
Load 3			
Load 4			
Load 5			
SA WATER EQUIPMENT DETAILS			
Space Required in Control Cubicle W H D (mm)		
Antenna Support Required (Y/N)			

EXAMPLE

SOLAR POWER SUPPLY SYSTEM SITE SCHEDULE

SITE DETAILS			
Site Name	Belalie North Tank		
Site Location Details			
Cubicle Location (Indoor/Outdoor) (If indoors detail the location)	Outdoors		
Any Specific Installation Requirements	None		
LOAD DETAILS	Load Name	Load (mA)	Duty (% of time)
12V dc			
Load 1	Kingfisher LP1 RTU	25	100
Load 2	Trio 1W Remote Radio Tx Trio 1W Remote Radio Rx	750 150	10 90
Load 3	Cabinet Light (15W)	1250	Negligible
Load 4	Security	1500	100
Load 5			
24V dc			
Load 1	Ultrasonic Level Sensor	24	100
Load 2	Instrumentation Loops	40	100
Load 3			
Load 4			
Load 5			
240V ac			
Load 1			
Load 2			
Load 3			
Load 4			
Load 5			
SA WATER EQUIPMENT DETAILS			
Space Required in Control Cubicle	400 W	300 H	200 D (mm)
Antenna Bracket Required (Y/N)	Yes		