

Specification  
For  
**Solar Power Supply and  
Installation at Unitywater  
Sites**

Pr9914



Unitywater



# Pr9914 - Specification for Solar Power Supply and Installation at Unitywater Sites

## Documents Details

This document is only valid on the day it was printed.

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## 1. Purpose

- 1.0.1 The purpose of this Specification is to define Unitywater requirements for design, supply, installation, testing and commissioning of Solar Power Supplies at Unitywater sites.
- 1.0.2 This Specification defines quality, performance, reliability, durability, safety and appearance requirements for these units. Particular emphasis is placed on Photovoltaic (PV) solar powered systems.

## 2. Scope

- 2.0.1 This Specification applies to the PV design, supply, installation, testing and commissioning work at all Unitywater sites; however, some requirements may be sewage treatment plant specific.
- 2.0.2 The PV system is required to connect to the Power Supply Authority distribution network to offset daytime power consumption and assist with peak demand lopping. It shall be ground mounted with a capacity to be determined by the Contractor and approved by Unitywater.
- 2.0.3 The scope includes, but is not limited to, the provision of the following items associated with the design, supply, installation, testing and commissioning of the PV array:
  - Appropriate site selection of the array;
  - Outdoor, ground mounted PV array;
  - PV modules;
  - Inverters and Mains power synchronisation controls;
  - Lightning Protection, Earthing system and protection;
  - Design and documentation, preparation of workshop drawings, such as constructed drawings, inspection and test plans, operation and maintenance manuals, etc.;
  - Supply, installation, testing and commissioning of all equipment including test and performance results;
  - Obtain all relevant certificates as required by legislation;
  - Maintenance support during defects liability period.

## 3. References

### 3.1. General

- 3.1.1 All design, equipment and workmanship shall conform to the most recent requirements of relevant statutory local, state and Commonwealth requirements and applicable, current Australian Standards.

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- 3.1.2 Where no Australian Standard exists, work shall conform to the most applicable, current IEC Standard.
- 3.1.3 If the requirements of this Specification do not articulate the minimum requirements of the statutory regulations and standards, the regulatory requirements are taken to apply. If the requirements of this Specification are more exacting than the minimum requirements of the statutory regulations and standards, the former shall apply.
- 3.1.4 All Materials, fittings, accessories and equipment supplied by the Contractor shall be new and the best obtainable of their kind and shall comply in all respects with the requirements of the relevant Standards Australia specifications.

### 3.2. Applicable Legislation and Regulation

- 3.4.1 The following primary legislation and regulations apply in relation to this Specification:
- a. *Electricity Act 1994* (Qld);
  - b. *Electrical Safety Act 2002* (Qld);
  - c. *Electrical Safety Regulation 2013* (Qld);
  - d. *Electricity Regulations 2006* (Qld);
  - e. *Work Health and Safety Act 2011* (Qld); and
  - f. *Work Health and Safety Regulations 2011* (Qld);
  - g. *Renewable Energy (Electricity) Act 2000* (Cth); and
  - h. *Queensland Electricity Connection and Metering Manual – Service and Installation Rules EE NA000403R328 V10* (QECMM).

### 3.3. Codes of Practice

- Clean Energy Council (CEC) Guidelines:
  - Grid-Connected Solar PV Systems: Install and Supervise Guidelines for Accredited Installers – February 2013; and
  - Grid-Connected Solar PV Systems: No Battery Storage, Design Guidelines for Accredited Installers – February 2013.

### 3.4. Australian and International Standards

- 3.4.1 All designs and equipment shall comply with the current edition of the following standards:

Standard	Title
AS ISO 1000	The international system of units (SI) and its application
AS 1074	Steel tubes and tubulars for ordinary service
AS 1101	Graphic symbols for general engineering
AS/NZS 1102	Graphical symbols for electrotechnical documentation
AS/NZS 1170 series	Structural design actions

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Standard	Title
AS 1627	Metal finishing – Preparation and pre-treatment of surfaces
AS 1657	Fixed platforms, walkways, stairways and ladders - Design, construction and installation
AS/NZS 1664 series	Aluminium structures
AS 1665	Welding of aluminium structures
AS/NZS 1768	Lightning protection
AS/NZS 1866	Aluminium and aluminium alloys – Extruded rod, bar, solid and hollow shapes
AS/NZS 2053	Conduits and fittings for electrical installations – General requirements
AS/NZS 2373	Electric cables – Twisted pair for control and protection circuits
AS/NZS 3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS/NZS 3008.1.1	Electrical installations – Selection of cables – Cables for alternating voltages up to 0.6/1 kV – Typical Australian installation conditions
AS/NZS 3013	Electrical installations – Classification of the fire and mechanical performance of wiring system elements
AS/NZS 3017	Electrical installations - Verification guidelines
AS/NZS 3100	Approval and test specification - General requirements for electrical equipment
AS/NZS 3439.1	Low-voltage switchgear and control gear assemblies – Type-tested and partially type-tested assemblies
AS/NZS 4509	Stand-alone power systems
AS 4777 series	Grid connection of energy systems via inverters
AS/NZS 5000.1	Electric cables – Polymeric insulated – For working voltages up to and including 0.6/1 kV
AS/NZS 5033	Installation and safety requirements for photovoltaic (PV) arrays
AS 60044.1	Instrument transformers – Current transformers
AS 60529	Degree of protection provided by enclosures (IP code)
AS/NZS IEC 60947	Low-voltage switchgear and control gear
IEC 60364	Low-voltage electrical installations
TR IEC 61000.3.6	Electromagnetic compatibility (EMC) Part 3.6: Limits—Assessment of emission limits for the connection of distorting installations to MV, HV and EHV power systems
IEC 61215	Crystalline silicon terrestrial photovoltaic (PV) modules – Design qualification and type approval

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Standard	Title
IEC 61646	Thin-film terrestrial photovoltaic (PV) modules – Design qualification and type approval
IEC 61724	Photovoltaic system performance monitoring – Guidelines for measurement, data exchange and analysis
IEC 61730 series	Photovoltaic (PV) module safety qualification
IEEE 519	IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems

### 4. Definitions/Abbreviations

Term	Meaning
AC or ac	Alternating current
CB	Circuit Breaker
CCA	Copper Chromate Arsenate
CEC	Clean Energy Council
CT	Current Transformer
DC or dc	Direct current
DNSP	Distribution Network Service Provider
ELV	Extra Low Voltage
EMC	Electromagnetic Compatibility
IEC	International Electrotechnical Commission
IEEE	International Electrical and Electronics Engineers
LV	Low Voltage
PCB	Polychlorinated Biphenyls
PV	Photovoltaic
PVC	Polyvinyl Chloride
RPEQ	Registered Professional Engineer of Queensland
SCADA	Supervisory Control and Data Acquisition
STC	Standard Test Condition
STP	Sewage Treatment Plant
UV	Ultra-Violet
WS	Wiring System
XLPE	Cross-Linked Polyethylene



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## 5. General Requirements

### 5.1. Safety in Design

- 5.1.1 Systems shall be designed and constructed as far as practicable to protect against foreseeable misuse and damage to the facilities and equipment and to extend the safe operation and maintenance of the installations over the duration of the nominated asset life without need of rehabilitation.
- 5.1.2 Due consideration shall be made in the design of the equipment to simplify installation and termination of field cables.
- 5.1.3 All necessary safety facilities and mechanisms shall be installed to assure that there are no exposed live conductors when any switchboard door is open.
- This is to prevent accidental contact with otherwise exposed live circuits behind doors or hinged panels that may be opened without special tools and also when specifically directed within the Scope of Work or the Principal's Project Requirements or any other overarching document that details the specific requirements for the work.
- 5.1.4 The design shall be in accordance with good modern practice and shall be such as will facilitate operation, inspection, cleaning, and repair to ensure long life and satisfactory operation under all service conditions.

### 5.2. Design Review and Verification

- 5.2.1 Unitywater will carry out a design review for general compliance with this specification and relevant Australian Standards.
- 5.2.2 All items which are designed shall be design checked or verified. The design check or verification shall be undertaken by a Registered Professional Engineer of Queensland (RPEQ) from the Board of Professional Engineers Queensland, in the category appropriate to the item being design checked or verified.

### 5.3. Materials and Workmanship

- 5.3.1 Materials shall comply with the relevant Australian standards stated in this Specification. Materials incorporated in the works shall be new and first class quality, free from imperfections and selected for long life, minimum maintenance and shall be suitable for the intended purpose.
- 5.3.2 Workmanship shall comply with good trade practices and with the relevant Australian standards stated in this Specification.

### 5.4. Hazardous Materials

- 5.4.1 The following hazardous materials are prohibited and shall not be used in any equipment or packaging:
- Asbestos;
  - Cadmium or Cadmium Plating;
  - Copper Chrome Arsenate (CCA) Treated Timber; and

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- Polychlorinated Biphenyls (PCB).
- 5.4.2 Approved alternatives to cadmium plating are zinc plating (chromate converted) and stainless steel.
- 5.4.3 Any other hazardous materials used in the design and construction of equipment shall be submitted to Unitywater for approval prior to the items being used.

### 5.5. Power System

- 5.5.1 **Table 1** lists the details of the mains power system.

**Table 1 – Power System Details**

Electrical Supply Aspect	Requirement
System Voltage	400/415 V +10, -6% (*)
Phases	3-phase and neutral (4 wire)
Frequency	50 Hz $\pm$ 1%
A-Phase	Red
B-Phase	White
C-Phase	Blue
Neutral	Black
Earth	Green/Yellow

\* - The system voltage is dependent upon site supply. The Contractor shall ensure the new system integrates with the site's regulated distribution voltage.

### 5.6. Grid Connection Approval

- 5.6.1 For the case that a grid connection agreement is required the Contractor will work the Unitywater engineering personnel to determine requirements. The scope of work document for the project shall outline responsibilities for costs associated with obtaining connection agreement from the relevant DNSP, including (but not limited to) enquiries, preparation of applications, submission of applications, preparation of any power system studies and payment of all fees.
- 5.6.2 The system shall be designed to connect to the sites power network. The design shall include metering and all documentation to the requirement of the DNSP.
- 5.6.3 The grid connection point shall be discussed and agreed with the Unitywater.

### 5.7. Engineering and Design

- 5.7.1 The design documents shall include but not be limited to:
- Design Basis Document, clearly stating main assumptions and justifications; the site latitude and longitude values shall be recorded and used as a key design input for the selected site;

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- Energy yield estimation using commercial simulation tool such as PVSyst, SAM or similar taking in to account any shading from surrounding buildings and infrastructure;
  - Minimum solar system capacity shall be defined in terms of instantaneous peak power, energy yield and specific yield;
  - Site layout drawings including panel layout and mounting systems overlaid over provided site layout drawings;
    - Single line diagram of the PV systems;
    - Wiring diagrams of all electrical works including grid connection;
    - PV modules and mounting system engineering compliance;
    - Array mounting structural certification and drawings;
    - Monitoring, control and communications drawings;
    - Testing and commissioning plan.
- 5.7.2 The systems shall be designed, installed and signed off by suitably qualified RPEQ and CEC accredited personnel. The Contractor shall also obtain Small Scale Technology Certificates as required by the Renewable Energy (Electricity) Act.
- 5.7.3 Suitable irradiance, climatic and environmental data shall be used in the design of the PV array.
- 5.7.4 All materials used shall be able to withstand the below environmental conditions:
- 30 °C to 60 °C operating range;
  - 95% humidity, non-condensing 30 °C to 60 °C.

## 6. Technical Requirements

### 6.1. General

- 6.1.1 The system shall include PV modules, inverters, mounting systems, PV array junction boxes, array string protection, disconnect switches, lightning protection, metering and system monitoring.
- 6.1.2 The system shall be designed and sized by the Contractor, based on, but not limited to, the following constraints:
- Withstand the local climatic conditions for a minimum design life of 25 years;
  - Maximise the total energy generation over 25 years;
  - Placement of the system shall take into consideration the potential use of any remaining land area for future systems both PV and general plant and aim to make any future process and access as easy as possible;
  - Optimised for maximum annual energy production, taking into account the tilt, shading and placement of arrays of modules;

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- Optimised to minimise maintenance requirements and maximise lifetime performance;
- Protection against impacts, of dust, vermin, insects, and birds; the ground surface within the perimeter of the panel installation shall be covered with stones and/or incorporate weed mat to prevent the growth of vegetation.

6.1.3 The Contractor shall consider potential safety risks during the design process, such that:

- The systems shall be installed, operated, maintained and decommissioned in the safest possible way; this shall include allowing sufficient clearances between the system and the edge of building rooves or tops of hills and structures to minimise the future risk to Contractor or Principal personnel. Suitable access for regular cleaning and maintenance activities shall also be provided;
- The systems installed on the buildings must be traversable and each panel must be accessible for maintenance and compliant with AS 1657; access for future maintenance must be considered and provided by the contractor with suitable recommendations provided on how access for maintenance may be achieved;
- The systems shall be designed to wind loads in accordance with the requirements of AS/NZS 1170.2.

### 6.2. Components

#### 6.2.1 PV Modules

6.2.1.1 Modules shall be high-efficiency modules from a leading global manufacturer with:

- Crystalline modules: A minimum module efficiency 15% and a temperature coefficient no more than  $-0.47 \text{ \%}/^{\circ}\text{C}$ ;
- Thin-film modules: A minimum module efficiency 13% and a temperature coefficient no more than  $-0.3 \text{ \%}/^{\circ}\text{C}$ .

6.2.1.2 PV modules shall be certified as being type-tested as specified in relevant IEC Standards and be listed on Clean Energy Council database for approved modules.

6.2.1.3 PV modules can operate and withstand the environmental conditions present on site.

6.2.1.4 The performance of PV modules shall be type tested under Standard Test Condition (STC), i.e., an irradiance of  $1000 \text{ W}/\text{m}^2$  at air mass 1.5 and at a cell temperature of  $25 \text{ }^{\circ}\text{C}$ .

6.2.1.5 The rated power output of PV modules after 10 years shall not be less than 90% and after 25 years shall not be less than 80% of that of the original rated output.

6.2.1.6 The specific locations shall be proposed by the Contractor and approved by the Principal.

6.2.1.7 The arrays shall be designed and installed to face north or as close to north as possible.

6.2.1.8 The arrays will be designed in accordance with AS/NZS 1170.2 Regional Wind Speed Zone B and connected to the mounting system to ensure adequate lightning protection to AS/NZS 1768.

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### 6.2.2 Inverters

- 6.2.2.1 Inverters shall be high efficiency from a leading global manufacturer with European weighted efficiency of no less than 94%.
- 6.2.2.2 Inverters shall be of the passive cooling type and fanless to prevent corrosion.
- 6.2.2.3 Inverters shall be Australia's Clean Energy Council approved and must be tested and in accordance with AS 4777.
- 6.2.2.4 Inverters shall be self-commutation modules which automatically synchronise the inverter supply frequency and phase angle to the low voltage network or other embedded generating system.
- 6.2.2.5 Inverters must be capable of aggregated system control with the capability to control real and reactive power across all inverters through internal control or through a separate proprietary control module.
- 6.2.2.6 Inverters shall have three phase output regulating the voltage as listed in Table 1 or be capable of being teamed together in such a way to achieve the same output.
- 6.2.2.7 The exact locations of the inverters and grid connections shall be proposed by the Constructor and approved by the Principal and the relevant authorities.

### 6.3. Mounting Systems

- 6.3.1 The PV array mounting system may be fabricated from 316 stainless steel or anodised aluminium. The material selected shall adhere to the applicable Australian Standard and be able to withstand environmental conditions of an STP.
- 6.3.2 Aluminium alloys should be marine grade, e.g. the 6000 series alloys.
- 6.3.3 Aluminium sections shall be in accordance with AS 1866.
- 6.3.4 Aluminium welds shall be in accordance with AS 1665, category B. Care shall be taken during installation to prevent galvanic corrosion.
- 6.3.5 Aluminium shall not be placed in direct contact with, or be fastened to, steel members or other dissimilar materials.

When such contacts cannot be avoided, an insulating barrier between the aluminium and the dissimilar materials shall be installed. To avoid this problem the following isolation kits should be considered at bolt connections:

- Isolated Sleeve for bolts connection:
  - Materials: Mylar (Polyester film/plastic sheet) or equivalent;
  - Required thickness: different thickness depends on the space allowance;
- Isolated Washers:
  - Materials: GRE or Silicone or equivalent;
  - Required thickness: Minimum 3 mm.
- 6.3.6 All bolts, nuts and washers shall be aluminium alloys. Nuts for 6.4 mm bolt and smaller shall be 2024-T4. Nuts for larger diameter bolts shall be alloy 6061-T6 or 6262-T9. Spring lock washers shall be alloy 7075-T6. A minimum 0.005 mm thick anodic coating shall be applied to alloy 2024 bolts for additional corrosion resistance.

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- 6.3.7 Sufficient ventilation shall be allowed between PV modules and the ground to reduce temperature effects on the PV systems.
- 6.3.8 Array arrangements shall be free standing structures whose arrangement takes into account safe access for maintenance procedures and vehicular access.
- 6.3.9 The array mounting structures must have a minimum expected lifetime of 25 years and comply with the requirements of the modules as nominated by the Contractor.

### 6.4. Metering and Monitoring System

- 6.4.1 The PV array shall be incorporated into the plant SCADA system allowing measuring, recording and output of the system performance and important system parameters:
- Instantaneous electrical energy generation of array (kW/kWp);
  - Instantaneous building electrical energy consumption (kW);
  - Current daily energy generation total (kWh);
  - Rolling weekly energy generation profile (chart) including total (kWh);
  - Outside ambient air temperature (°C);
  - Time period / date for energy generated;
  - Instantaneous voltage of PV system (V);
  - Instantaneous current of PV system (A).
- 6.4.2 The monitoring system shall be designed and installed in compliance with IEC 61724.
- 6.4.3 The monitoring system must be capable of monitoring multiple inverters (or PV systems) at once and must be able to record individual inverter performance and operation parameters of the PV strings, such as DC voltage and current, and AC voltage, current and frequency.
- 6.4.4 The Contractor shall be responsible for monitoring, control and communications Interfaces for the PV systems.
- 6.4.5 Appropriate IP levels shall be used for the various components of the monitoring system. For the components located outdoors, the enclosures shall be weatherproof, UV rated with a minimum IP rating of IP56 in accordance with AS 60529.
- 6.4.6 Sufficient and appropriate lightning protection and earthing shall be provided in all parts of the monitoring system when necessary.
- 6.4.7 The monitoring system shall be designed in an approach of modular concept design with adequate allowance for future system expansion and modification.
- 6.4.8 The Contractor shall submit the design of the monitoring system to the Principal for approval.

### 6.5. Solar System Electrical works

- 6.5.1 All electrical equipment supplied and installed shall be in accordance with the Electrical Installation at Sewage Treatment Plants Specification (Pr9835).

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### 6.6. Earthing

- 6.6.1 All earthing shall be installed in accordance with AS/NZS 3000, related and referenced standards and the Unitywater standard specification Pr9835.
- 6.6.2 Each PV array shall be fitted with a copper earth bar of not less than 120 mm<sup>2</sup> section to which shall be effectively connected all metal parts not intended to be live.
- 6.6.3 The secondary circuit of each CT shall be earthed at one point only. Provision shall be made for these Earth connections to be disconnected at a readily accessible position for testing.
- 6.6.4 M10 earthing connection studs are required.

## 7. Testing, Commissioning and Documentation

### 7.1. Testing and Commissioning

- 7.1.1 The Contractor shall undertake commissioning tests in accordance with AS/NZS 3000, AS/NZS 5033, AS 4777, CEC Guidelines and the requirements of the DNSP as a minimum and the Testing and Commissioning Plan approved by the Principal.
- 7.1.2 The following testing activities shall be undertaken, but not be limited to:
  - Detailed electrical inspection;
  - Continuity of all strings, sub-array and array wiring;
  - Continuity of all Earth connections, including module frame earth connections;
  - Voltage and polarity of all strings, sub-arrays and arrays;
  - Open circuit voltage, short circuit current, operating current, and I-V curve measurement;
  - Insulation resistance of array and inverter wiring;
  - Check operation of array under load conditions;
  - Record operation voltage and current of the PV array;
  - Check operational string currents in a multi string array;
  - Operate the PV array isolators under load to ensure safe isolation of the inverters from the array;
  - Verification of correct labelling;
  - Functional testing of all control, indication, measurement and protection circuits;
  - Functional testing of all interfaces to the controller for remote monitoring;
  - Performance testing to demonstrate the equipment meets the specified performance requirements;
  - Infrared scan to detect areas of non-uniform temperature;
  - For inverters: Perform as a minimum the manufacturer's specified commissioning schedule;

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- Earth Fault Protection test (only relevant for earthed arrays);
- Review of manufacturing inspection and test documentation and records;
- Review of manufacturing defect lists/punchlists;
- Any other testing and commissioning activities as required by the DNSP.

7.1.3 The commissioning time shall be selected on the basis of sunlight availability.

7.1.4 Instruments calibrated by authorities accredited by National Association of Testing Authorities (NATA) of Australia must be used for the testing activities.

7.1.5 The Contractor shall give the Principal five (5) days' notice for inspection to be made of the commissioning of the installation. The results of all site tests shall be available for review during the tests.

7.1.6 A comprehensive Site Test Report shall be submitted to the Principal for approval within 5 working days of completion of the respective site tests (or handover to the Principal, whichever is the earlier). The Site Test Report shall include:

- Results of all tests;
- Copies of any test oscillograms, graphs, printouts, etc.;
- Copies of site defect lists / punchlists;
- Copy of the completed Site ITP;
- Statement confirming compliance with all specified and legislated requirements.

### 7.2. Warranties

7.2.0 Major components shall have warranties in accordance with industry standard.

#### 7.2.1 Solar Modules

7.2.1.1 Solar modules shall be covered by the following warranties as a minimum:

- Ten (10) years manufacturer workmanship;
- Ten (10) year 90% and twenty five (25) year 80% performance power output warranty.

#### 7.2.2 Inverters

7.2.2.1 Inverter units shall be covered by the following warranties as a minimum:

- Ten (10) years manufacturer workmanship warranty.
- Five (5) years manufacturer workmanship with the option of purchasing an extended warranty period from the manufacturer.

7.2.2.2 Each components warranty compliance and registration shall be undertaken by the Contractor prior to Completion.



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## 7.3. Quality Assurance and ITPs

### 7.3.1 Quality Assurance

- 7.3.1.1 The Supplier shall implement a quality system that complies with the requirements of AS ISO 9001 for all work on the PV arrays and inverters.
- 7.3.1.2 Quality records shall be provided by the Supplier in accordance with Documentation and Deliverables Section 7.4 of this Specification.

### 7.3.2 Inspection and Test Plans

- 7.3.2.1 The Supplier shall submit to the Principal for approval 2 project-specific Inspection and Test Plans (ITPs) for the PV arrays:
- FAT ITP - Covering all off-site activities, i.e. engineering, design, supply, manufacture, factory assembly, factory testing, resolution of factory defects/punchlists, release for delivery, preparation for transport, etc.;
  - SAT ITP - Covering all on-site testing, resolution of site defects/punchlists, handover, etc.
- 7.3.2.2 The ITPs shall identify the standards and/or procedures as well as the acceptance criteria that shall apply for each stage in the ITPs. Unless approved otherwise by the Principal all standards, procedures and acceptance criteria included in the ITPs shall comply with the requirements defined in this Specification.
- 7.3.2.3 The Supplier shall perform all work on the PV arrays in accordance with the approved ITPs.
- 7.3.2.4 The Principal may apply witness points and/or hold points on various stages of the ITPs.
- 7.3.2.5 The Principal may elect to appoint third party inspector(s) to witness inspections and tests.

## 7.4. Documentation and Deliverables

### 7.4.1 General

- 7.4.1.1 The Supplier shall provide documentation for the PV arrays in accordance with the tender documents. Unless approved otherwise by the Principal, all drawings shall comply with AS 1101 and AS/NZS 1102 Parts 101-111.
- 7.4.1.2 Two (2) hardcopies of all documents shall be submitted to the Principal. All documentation shall be submitted electronically in the following file formats:
- Drawings AutoCAD (dwg) and Adobe Acrobat (pdf);
  - Spreadsheets Microsoft Office Excel (xls);
  - Specifications, procedures, etc. Microsoft Office Word (doc);
  - Training presentations Microsoft Office PowerPoint (ppt);
  - Supplier datasheets, etc. Adobe Acrobat (pdf) and native format (.xls/.doc)
  - Other types To be approved by the Principal.

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- 7.4.1.3 Standard drawing sizes are A4, A3 and A1. The preferred size for drawings is A3.
- 7.4.1.4 All documentation other than drawings shall be sized A4.
- 7.4.1.5 A complete, detailed and fully customised set of drawings shall be provided for each system.

### **7.5. Spare Parts and Tools**

#### **7.5.1 Operating Tools**

- 7.5.1.1 The Supplier shall supply 1 complete set of operating tools.

#### **7.5.2 Spare Parts and/or Tools**

- 7.5.2.1 The Supplier shall provide a priced list of all spare parts and/or tools for routine and scheduled maintenance up to end of the defects liability period. Prices shall include delivery to site and packing suitable for long-term storage.
- 7.5.2.1 The Principal will confirm whether he/they wishes to purchase some (or all) of these spare parts and/or tools for possible use during the defects liability period.
- 7.5.2.2 The Supplier shall provide a priced list of optional spare parts and/or tools for consideration by the Principal. Prices shall include delivery to site and packing suitable for long-term storage.
- 7.5.2.3 The Principal will confirm if it wishes to purchase some (or all) of these optional spare parts and/or tools.