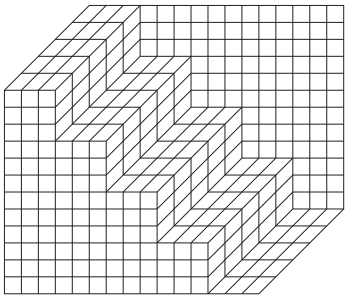

Buro Happold

025901 South Camden Community School

Sustainability and Alternative Technologies

SCCS_SP_0002 Photovoltaic Installation
Section B: Performance Specification
Section C: Materials and Workmanship

Job no [025901]
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01

Buro Happold

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00	Draft for comment	IPEGG	20/09/10	AYoung
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approval Alasdair Young

signature 

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Contents

1 Executive Summary

This performance specification sets out Employer's Requirements for the design and build of a complete photovoltaic installation.

For clarity the works to be costed shall be described as duties of the 'specialist contractor'. Duties falling outside of the scope, but required for the installation are described as duties of the 'main contractor'.

The specialist Contractor shall design, supply, install, test and fully commission the photovoltaic systems as a turnkey package in line with the requirements of this Performance Specification.

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2 Project Particulars

Refer to the Main Contract Preliminaries for details of Project, Employer, Design Team, Contract Administrator.

The Photovoltaic System specification is split as follows:

Section A: Technical Preliminaries

Section B: Performance Specification

This Performance Specification shall be read in conjunction with Section A of the Specification as well as the Main Contract Preliminaries and all work shall comply with the Main Contract Preliminaries. The Main Contract shall take precedence in the event of any conflict between this Performance Specification and the Main Contract.

3 Scope of Works

3.1 Introduction

The scope of works for the photovoltaic system is to design, supply, install, test and fully commission a photovoltaic installation, including polycrystalline cells, all electrical wiring and containment, isolators, inverters, meters and grid protection devices.

The photovoltaic systems described within this performance specification are to be located on the roof of the school building with inverters and isolators located in local rooftop plant cupboards and all other associated electrical plant and controls located in the main plantroom. The panel arrays will be grouped in locations as shown on the drawings SCCS_M_4000_1 and SCCS_M_4000_2.

This specification should be read in conjunction with the Architect's site plan drawings, Planning Permission drawings and general arrangement drawings. The specification shall be subject to the terms and conditions as specified by the Contract Administrator.

Design warranties shall also be required from the specialist Contractor. Collateral design warranties shall be part of the contract between the Contractor and the Client.

The specialist Contractor shall be responsible for the detailed design, supply, installation, co-ordination and setting out of all electrical systems as described within the Contract Documents.

The specialist Contractor must survey the existing site prior to commencing the production of working installation and builderswork drawings. The specialist contractor must assess any shading on-site affecting the installation output.

The specialist contractor shall ensure that the proposed installation complies with all current CDM regulations, particularly where working at height. The system shall be installed to require minimum cleaning and maintenance where the array is located on roof areas which are not flat.

The specialist Contractor shall interface with all trade packages to ensure the satisfactory integration of the works with the architectural scheme and all other trade packages. These interfaces shall be detailed on all installation drawings and submitted to the Contract Administrator (hereafter referred to as the CA) and the Architect for approval.

The specialist contractor shall be fully responsible for satisfying that the utilities companies' requirements are met, and shall liaise with the DNO and electricity supplier, and complete all necessary paperwork and bear all associated costs, including the application for grid connection. Where the array is in excess of 16A/phase, the specialist contractor shall liaise with the DNO in accordance with Engineering Recommendation G59/1.

The specialist Contractor shall be responsible for all liaisons and submitting all drawings and documentations as required to the Building Control/District Surveyor for their approval/sign off. This process shall be co-ordinated with other approvals required by the Architect and Structural Engineer.

The specialist Contractor shall be responsible for the coordination of access requirements and shall liaise with all trade contractors to ensure adequate access provisions to all components and ensure compliance with all CDM regulations.

The specialist contractor shall advise the client on opportunities to make best value of the generated electricity and determine a strategy for claiming and selling Renewable Obligations Certificates (ROCs) or feed in tariffs. The system will include a connection to the main electricity grid via an import/ export meter.

The specialist Contractor shall be responsible for programming the works within the main construction works and fit out.

The specialist Contractor shall provide a sample of every item of equipment that shall be visible to the building users, for review by the Contract Administrator for approval.

The main Contractor is responsible for providing a suitable cable route from the photo-voltaic panels to the low-voltage plant room. The main contractor is responsible for trenching, below-ground works or any other access to enable the required electrical connections. The specialist contractor is responsible for installing the

cables. The main contractor is responsible for providing and trenches and providing builders work to enable cable routes. The specialist contractor will also make good any works.

The specialist contractor shall design a suitable Earthing strategy, in particular where the system is designed to operate during grid failure.

The specialist Contractor shall identify any opportunities for value engineering in writing to the Contract Administrator including any impact these might have on the level of service provided by the installation.

3.2 SCOPE OF WORKS

The specialist Contractor shall design, supply and install, test and fully commission a photovoltaic system. The photovoltaic panels shall be provided in the locations shown in drawing SCCS_E_4707.

This includes:

- Roof mounted photovoltaics (polycrystalline) with associated framing and structural supports.
- Approximately 265sqm of panels.
- DC cables, junction boxes, isolators, earthing and containment;
- Inverters;
- Electrical panel;
- Meter;
- Display panel for educational purposes;
- 'As Installed' record drawings, operating and maintenance manual and cleaning schedule.

The specialist Contractor shall be responsible for surveying the existing site prior to commencing the production of working installation and builders work drawings. The specialist contractor shall model the site conditions to assess any shading or obstruction that could affect array performance.

All design information, production drawings and buildersworks details shall be provided in good time to enable co-ordination and final detailing to comply with the requirements of the construction works programme.

3.3 SYSTEM DESCRIPTION

3.3.1 System Performance Requirements

The photovoltaic installation shall provide in excess of 31,000 kWh per annum,

This annual generation should be measured after all losses are accounted at the 'ROC' meter, including but not limited to:

- Cable distribution losses
- Losses from overshadowing
- Inverter losses

The generation shall be metered immediately prior to connection to the LV panel.

3.3.2 Panels

The photovoltaic panels have the following functions:

- Energy generation

The panels will use laminated polycrystalline cells.

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3.4 DESIGN PARAMETERS

The specialist contractor shall list all the equipment necessary to complete the system installation. The specialist contractor shall design, configure, procure and provide the equipment, hardware, documentation, labour and supervision required for the installation of the photovoltaic (PV) systems.

The specialist contractor shall provide documentation on the design, configuration, installation, operation and maintenance of the actual system installed including a maintenance manual.

All systems should be designed for outdoor installation in the Borough of Camden, taking into account the prevailing weather conditions for this location (e.g. hours of sunlight, rainfall, wind speeds). Supplied equipment must be rated and warranted to withstand and operate under these conditions.

3.5 PV module and array specification

Photovoltaic Panels

The scheme is based on roof mounted polycrystalline photovoltaic arrays.

The specified PV modules shall meet the following performance criteria as a minimum:

Module Parameter	**Minimum performance** (per module)
Rated Power	**185W**
Power Tolerance	**-0/+2.5%**
Module Efficiency	**14.0%**

As the PV circuit will produce a voltage equal to that of the worst performing cell, the specialist contractor shall take care when connecting the array to ensure that any cells in areas of shade are not connected to any other cells.

Each PV system will be installed at site. The specialist Contractor shall provide any roof mounting or necessary materials related to the direct installation of the PVs. The array mounting arrangement shall be subject to approval by the contract administrator.

Each PV module shall include bypass diodes installed in the module junction box.

Costs for the PV system are to be included in the returned documents.

The products used and installer shall be accredited by the Micro-generation Compliance Scheme.

3.6 Other components specification

An allowance should be made for the associated switches, cables, isolators and inverters required for each system and a data system that can be used as an educational tool by teachers and students related to the production of electricity by the PVs.

The power conditioning systems (PCS) for the system must use multiple inverter(s), designed specifically for utility grid interconnection of PV arrays and be capable of automatic, continuous, and stable operation over the range of voltages, currents, and power levels expected for the size and type of array used.

The PCS must have an automatic visual indicator showing whether the system is on-line or not.

The PCS must have at least a two-year repair or replacement warranty from the manufacturer covering parts and labour.

The PCS, AC and DC disconnects, and any other required electronics shall be installed near the array, where they may be exposed to weather and possible vandalism. The main contractor will provide a suitable pad-mountable, lockable enclosure for housing these components. This enclosure shall provide any venting and weather sealing required by the electronics enclosed. All external electrical enclosures shall be rated as IP65 and have superior strength and corrosion resistance properties. The specialist contractor shall provide the main contractor with their requirements for these inverter cupboards.

Performance and reliability of the inverters is a factor as a PV system is vulnerable to a single-point failure where the power generated from the PV array must be transformed and synchronised through an inverter from DC to AC. The specialist contractor shall specify the number and type of inverter(s) that shall be used e.g. single inverters, master-slave inverter configurations, modular inverters and parallel independent (string) inverters etc.

For each type of inverter selected the specialist contractor shall indicate the lifetime of the inverter, the PV system maintenance procedures and the normal fault finding process if there is a system failure.

3.7 PV System Electrical Design

The PV array shall be designed to operate in parallel with the grid connection to the building.

All electrical components, including overcurrent protection, disconnect, surge suppression devices, conduit, wiring and terminals must be approved for use under the IEE wiring regulations and have appropriate voltage, current and temperature ratings for the application. Special attention should be given to appropriate ratings for components used in DC circuits.

All wiring shall be listed for a minimum operation of 600 volts and temperature rating of 90° C in wet locations. All current carrying conductors must be enclosed in conduit, including module interconnections.

Ampacity calculations must take into account appropriate de-ratings as required. Appropriate temperature de-ratings for conductors used in module junction boxes must be considered for peak module operating temperatures, as well as de-ratings for instances where more than three current-carrying conductors are enclosed in a conduit.

Voltage drop in array DC source circuits should be limited to no more than five percent (5%), including losses in conductors and through all fuses blocking diodes and termination points. Note the minimum energy generation shall be achieved after losses. This shall be measured in-use to establish compliance with the specification.

All overcurrent devices shall have trip ratings no greater than the de-rated ampacity of the conductors that it protects.

All series connected strings of modules must include a series fuse as required by the IEE to prevent wiring to other system components. Parallel connections of modules in individual source circuits are not permitted.

Parallel-connected cells within individual modules are allowable as long as the module listing allows for the series fuse required for this configuration.

All series connected strings of modules may also include a blocking diode to prevent reverse currents. These diodes should have low voltage drop to meet the requirements above, and have a voltage and current ratings (at temperature) at least twice the open-circuit voltage and short-circuit ratings of the source circuits.

As array ground-fault protection devices should be included as part of the PCS as required by the IEE. These devices must be capable of detecting array ground faults, shunting the fault current to ground, and disabling the array until the fault has been cleared.

All terminations must use listed box terminal or compression type connections. Twist on wire splices, crimped, soldered or taped connections are not permitted for the required field installed wiring. Proper torque specifications should be provided for all of the required field connections.

All module frames, panel/array support structures, metal enclosures, distribution boards and the PCS cabinet should be provided with connections for bonding to a common grounding conductor and terminating at the ground rod at the utility service entrance point. In addition, provisions for grounding the neutral of the PCS output shall be provided.

The DC negative circuit may be common to the AC neutral in the PCS design and under no circumstances should multiple connections to ground be specified for current carrying conductors in the system.

Loss of Line: The PCS shall not operate without the line voltage present. The PCS shall sense a "loss of line" (utility) condition and shall automatically disconnect from the line. In the event of multiple PCSs and/or balanced load on a common line, the PCS shall contain circuits (such as Sandia Voltage Shift and Sandia Frequency Shift) that will cause the PCS voltage or frequency to drift downwards under loss of line conditions and cause it to cease energizing the grid within two seconds after loss of line. The PCS restart shall occur automatically after restoration of line voltage and frequency for at least five minutes.

The specialist contractor shall also advise on the technical issues related to a PV system installation in relation to lightning strikes, ground faults, transient overvoltages and power line surges that can cause high voltage in otherwise low voltage PV systems. This is of particular importance where modifications or additions are required in other electrical systems or equipment e.g. surge suppression.

The PV frame and mounting structure shall be earthed and bonded to building structure (not the case if class 2 DC equipment is used).

The PV arrays and associated equipment shall be protected by air termination rods against lightning strikes.

Care should be taken to prevent the lightning rods from creating shadows on the modules. The safety distance between the PV generator and the lighting rod shall be at least 1m to avoid flashovers to the generator.

In addition to the internal overvoltage protection in the inverter, appropriate surge arrestors of class 1 shall be connected on both AC and DC side of each inverter to protect the equipment against lighting and surge currents.

3.8 PV array mechanical design

The specialist Contractor shall provide any structural system and/or supports required for mounting the photovoltaic arrays. The specialist Contractor shall provide all other materials required for assembling the photovoltaic modules and structurally attaching or integrating them to the roof.

The PV array, including modules, hardware and attachments shall be designed to withstand wind loads of 16m/*s* or more and comply with all existing local and national codes.

Array mounting hardware supplied shall be compatible with the site considerations and environment.

Special attention should be paid to minimising the risk from exposed fasteners, sharp edges, and potential damage to the PV modules or any support structure provided. Corrosion resistance and durability of the mechanical hardware should be emphasised – the use of stainless steel fasteners and an aluminium support structure is preferred. The use of ferrous metals, wood or plastic components are strongly discouraged. Galvanic corrosion should be avoided.

As the installation shall be visible the aesthetics of the overall installation is extremely important. As much as possible, all mechanical hardware, conduit, junction boxes and other equipment should be concealed.

The array layout should be consistent with the ordering (and labelling) of source circuits in the array combiner boxes. Ease of access for array troubleshooting and maintenance is desired by allowing access for module junction box servicing, and removal/replacement of individual source circuits (panels) and modules if necessary.

As there are a number of different roof finishes on the school, the mechanical hardware used should be suitable for each particular type of roof finish and structure.

3.9 Control Requirements

Metering will be provided by the photovoltaic specialist contractor but must be acceptable and approved for use with the standard Core Utility Solutions metering procedures.

3.10 Grid Protection

The specialist contractor shall ensure that the installation is compatible with the recommendations from the energy networks association set out in G83/1 for installation of less than 16 Amps per phase, and G59/1 for installations greater than 16A per phase. The specialist contractor shall liase with the DNO to ensure compliance with their requirements and formal approval of the system.

The specialist contractor shall initiate discussions with the DNO in a timely manner in order to ensure that the project is not subject to delays.

3.11 Metering

The specialist contractor shall ensure that adequate metering is provided to enable the output of the PV array to be recorded. The meters shall be of the MBUS (in conjunction with EN 13757-2) type and shall interface with the schools energy monitoring system and link to the physical display meter.

The physical display meter shall be located in a prominent position in the Hall/Library space. The panel will display the following information:

- Energy generated – overall and per day;

- Instantaneous power generation
- Carbon saved overall
- Intuitive carbon conversion (i.e. equivalent miles travelled in a car)

The meter shall be acceptable to ensure that generated electricity can be sold to utility suppliers. A meter shall be provided to measure the exported electricity from the site. The meter shall be fitted with a pulsed output to enable consumption data to be collected by a building management system, or educational display.

Metering at the inverter output shall be installed to display and record energy delivered by the PV system (kWh) and instantaneous power output (kW).

A kWh building export meter approved by OFGEM with appropriate reading shall be provided. The specialist Contractor shall contact the Electricity supplier and to arrange for its fitting.

3.12 Testing and Commissioning Procedures

Sufficient time shall be allowed in the construction schedule for testing and commissioning to be adequately carried out and to ensure that any faults and equipment defects are identified and rectified. Testing cannot be properly carried out under low levels so extra time should be allowed for testing during rainy seasons.

When carrying out visual checks, special attention shall be paid for:

- Cracked or broken cells
- Signs of delamination or water infiltration
- Broken, damaged or discoloured cells
- Loose electrical connections to the junction boxes and leads

Electrical test shall be carried out in line with IEE Wiring Regulations 17th edition and shall include (but not limit) the following:

- Continuity of circuit, protective conductors, equipotential bonding
- Earth electrode impedance
- Insulation resistance
- Polarity
- Earth loop impedance
- Functions of protective devices

For a sensible recording of the PV performance, the array commissioning tests should be carried out under a reasonable sunlight condition of global irradiance of higher than 400W/m2 onto the plane of PV panels. The tests shall be checked against the system specification and detail design taking into account any change made during installation as follow:

- String open circuit voltage
- String short circuit current
- String maximum power point voltage
- String maximum power point current

- Array open circuit voltage
- Array short circuit current
- Array maximum power point voltage
- Array maximum power point current
- Array rated power
- Physical installation including mounting details, orientation and tilt angle.

A series of power conversion unit functional test shall be carried out:

- Anti-islanding tests
- Disconnection capability for voltage and frequency disturbances
- THD and individual harmonics measurement
- Isolation between dc and ac side
- Power factor recording
- EMI measurement
- Acoustic noise recording
- Visual check on markings

Commissioning tests of IV curve measuring, details detailed tests of inverter performance and data acquisition and monitoring systems shall be carried out to confirm guarantied system performance and to deliver a specified number of kWh over a given period.

All testing and commissioning shall be done in line wit requirements of:

- G83
- G59/1
- BS7671
- DTI document 'Photovoltaics in Buidlings: Testings, Commissioning and monitoring Guide"

3.13 Manufacturers

All manufacturers or suppliers listed below are on an EQUAL OR APPROVED basis, the specialist contractor will include the costs associated with these specified manufacturers within their tender return.

Solar PV systems:

Viessmann Limited
Hortonwood 30
Telford TF1 7YP

Solar Century
91-94 Lower Marsh Road
London, SE1 7AB

4 Summary of Design Brief Documents

The specialist contractor shall install the photovoltaic system in line with all relevant standards and legislation.

A number of British Standards have been listed below for information.

It should be noted that the British Standards listed below are not an exhaustive or all-inclusive list and does not relieve the specialist contractor of his duties to comply with all relevant standards and legislation under the contract.

The principle design parameter shall be in line with the following standards, regulations, guidelines and codes of practice:

- Electricity at Work Regulations 1989
- Building Regulations
- Health and Safety at Work etc Act 1974
- Control of Substances Hazardous to Health Regulations 1988
- Engineering recommendations G77/1, G59/1, G83
- Department of Trade and Industry guidelines *'Photovoltaics in Buildings:Guide to the installation of PV systems'* and *'Photovoltaics in Buildings:Testing, Commissioning and Monitoring Guide'*
- BS 7671: Requirements for electrical installations, IEE Wiring Regulations 17th Edition.
- HSE Guide GS38 Electrical test equipment for use by electricians.
- Construction Design and Management Regulations 2007
- Fire Precautions Act
- Disabilities Discrimination Act 1995
- Electromagnetic Compatibility regulations 1992

Main Photovoltaic Related Documents	
Standard	**Description**
CIBSE	Code for interior lighting: 2002
CIBSE Guide A	Design data
CIBSE Guide B	Installation and equipment data
CIBSE Guide C	Reference data
ENA Engineering Recommendation G83/1	Recommendations for the connection of small scale embedded generators (up to 16A per phase) in parallel with public low-voltage distribution networks
CIBSE TM25	Understanding Building Integrated Photovoltaics
BS EN 60904	BS EN 60904 parts 1 to 10: Photovoltaic Devices
BS EN 61173	BS EN 61173: Overvoltage protection for PV Power Generating Systems
BS EN 61194	BS EN 61194: Characteristic Parameters of Stand Alone PV Systems
BS EN 61277	BS EN 61277: Terrestial PV power generating systems
BS EN 61427	BS EN 61427: Secondary Cells and Batteries for solar PV energy systems.
BS EN 61724	BS EN 61724: PV System performance monitoring
BS EN 61727	BS EN 61727: PV systems. Characteristics of the Utility Interfaces
British Standards	Various standards referred to throughout the document

5 Summary of Tender Return Requirements

The technical details within this specification represent the minimum standards, quality and performance which are acceptable. However, it is not intended for this document to limit competition, prevent product improvement or exclude manufacturers from supplying above standard products. Where standard products are offered the manufacturer shall demonstrate them to be equal or better than the performance requirements contained within this specification.

Bids shall list all the equipment necessary to complete system installations. In addition, documentation on the design, configuration, installation, operation and maintenance of the complete system shall be included.

The tender shall include the total bid price.

The tender shall include the required lead-time in delivery of equipment.

The tender shall include following performance information:

- Peak kWe output of the system
- Annual metered kWh output of the system under average climatic conditions, measured after losses from inverters and cables are taken into account
- Peak amps on each electrical way

The tender shall include the required documentation package:

A price list for all replacement components, including individual modules and PCS unit shall be included. These prices are to remain in effect for one year after the date of acceptance.

- Overview of major system components and principles of operation.
- Complete parts lists, including all electrical components, mechanical fixings and other equipment required for installing the systems (must include description and make for all the equipment provided, model/part number and source are also required for the PV modules and the inverter).
- Diagram indicating proposed layout of entire system, including PV array, and location PCS and other necessary equipment with respect to the array.
- Electrical schematics and diagrams showing all major components and devices, including conductor types and sizes, connections of individual modules and array source circuits, terminations at junction boxes, connection to surge suppression devices and the PCS, and the PCS interface with the utility grid.
- Mechanical drawings showing details of module/array mechanical support.
- Warranty information on individual components as required in this bid document.

- Proof of solar or electrical contractors license, with license number, type of license and expiration date.
- All equipment manufacturer's specifications and operations manuals, including those for PV modules, PCS, overcurrent devices, switches and optional equipment.
- Procedure for commissioning, operating, disconnecting, servicing and maintaining complete system and individual components.

The specialist contractor shall provide cost options for:

- 12 months maintenance contract with a 24 hour call out period
- 3 year maintenance contract with a 24 hour call out period
- 5 year maintenance contract with a 24 hour call out period.

Routine maintenance is defined as the act of making sure the PV system operates properly. This includes changing blown fuses, diodes, or other minor equipment. This does not extend the warranties of factory-warrantied components such as the modules or inverters, but includes any labour required to change out these or other components that fail during the maintenance contract.

Designs will be reviewed as part of the tender review process. The drawings and other technical information will be checked for completeness and accuracy. Contactors with insufficient design information may be requested for additional supporting material.

5.1 Information to Be Provided by Approved Selected Specialist Contractor Before Installation and Project Completion

Installation diagrams indicating overall layout of entire system, including PV array, and location of PCS and other equipment with respect to the array, complete assembly and installation instructions for mounting array, junction boxes and enclosures, routing conduit, wiring arrays, and terminating conductors at array, combiner boxes and PCS.

A site survey of the intended array location should be completed before the installation begins. This will help the specialist Contractor determine appropriate equipment locations and give all parties a better idea of the expected performance of the PV system.

An independent testing organisation must test the PV modules used in this project before the system is to be installed.

An acceptance test must be performed on the system once the installation is complete. This includes measuring the short circuit currents and open-circuit voltages on all source circuits while measuring irradiance

and module temperature. This also includes measuring the instantaneous DC input and AC output of the system to determine its efficiency..

A copy of the permit obtained from the appropriate legal authority for system installation.

The specialist Contractor is responsible for providing two complete copies of all installation, operations and maintenance manuals.

These will description of the design, materials, installation, and permitting price information. The materials information will be broken down into four categories: modules, PCS, batteries, and other. These costs should be the costs to the Client, and not wholesale or distributor costs, and should be similar or identical to those on the parts list mentioned above. In the case of packaged PV systems (e.g. Siemens Earthsafe, AstroPower SunLINE, BP Solar PV Plus, etc.), the materials cost breakdown may not be possible, so the replacement cost of each component should be listed, along with the cost of any miscellaneous materials (e.g. wire, junction boxes, etc.). This information will not be shared with utilities/research organisations.

A copy of the interconnection agreement between the owner and the utility must be provided.

A copy of the minimum two-year system warranty including parts and labour.

6 Section C. Equipment, Materials and Workmanship

V14 PHOTOVOLTAIC ELECTRICITY GENERATION PLANT

Contents

V14.1 General

A This section of the specification relates to the design, manufacture, delivery to site and installation of private photovoltaic electricity generating systems (including electricity exported to the public network).

B Supply, install, test and commission the complete generation system or systems.

C The generation systems shall meet the criteria as detailed in the schedules and drawings.

V14.1.1 Service Conditions

A All components and systems shall be designed for outdoor installation. Supplied equipment must be rated and warranted to withstand and operate under the local weather conditions.

V14.2 Quality Assurance

A Ensure that the design, construction, materials and finishes of all equipment are suitable for the location, climatic and operating conditions to which the installation shall be exposed.

B Ensure that the whole installation complies with the relevant standards, including the following:

- BS 6133:1995 Code of practice for safe operation of lead-acid stationary batteries
- BS 6290-2:1999 Lead-acid stationary cells and batteries. Specification for the high-performance Plante positive type
- BS 6290-3:1999 Lead-acid stationary cells and batteries. Specification for the flat positive plate type
- BS 6290-4:1997 Lead-acid stationary cells and batteries. Specification for classifying valve
- BS 6651:1999 Code of practice for protection of structures against lightning (to be superseded by BS EN 62305)
- BS 7430:1998 Code of practice for earthing
- BS 7671:2008 Requirements for electrical installations. IET Wiring Regulations. Seventeenth edition
- BS 7697:1993 Nominal voltages for low voltage public electricity supply systems
- BS EN 50160:2007 Voltage characteristics of electricity supplied by public distribution networks
- BS EN 61000-6-1:2001 Electromagnetic compatibility (EMC). Generic standards. Immunity for residential, commercial and light-industrial environments
- BS EN 61000-6-2:1999, IEC 61000-6-2:1999 Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments. Generic immunity standard for industrial environments
- BS EN 61000-6-3:2001 Electromagnetic compatibility (EMC). Generic standards. Emission standard for residential, commercial and light-industrial environments
- BS EN 61000-6-4:2001 Electromagnetic compatibility (EMC). Generic standards. Emission standard for industrial environments
- BS EN 60086-1:2001 Primary batteries. General
- BS EN 60086-2:2001 Primary batteries. Physical and electrical specifications
- BS EN 60086-5:2005 Primary batteries. Safety of batteries with aqueous electrolyte

- BS EN 60439-2:2000, IEC 60439-2:2000 Low voltage switchgear and controlgear assemblies. Particular requirements for busbar trunking systems (busways)
- BS EN 60439-5:2006 Low-voltage switchgear and controlgear assemblies. Particular requirements for assemblies for power distribution in public networks
- BS EN 60439-4:1991 Specification for low-voltage switchgear and controlgear assemblies. Particular requirements for assemblies for construction sites (ACS)
- BS EN 60439-4:2004 Low-voltage switchgear and controlgear assemblies. Particular requirements for assemblies for construction sites (ACS)
- BS EN 60439-1:1999, IEC 60439-1:1999 Low-voltage switchgear and controlgear assemblies. Type-tested and partially type-tested assemblies
- BS EN 60439-3:1991 Specification for low-voltage switchgear and controlgear assemblies. Particular requirements for low-voltage switchgear and controlgear assemblies intended to be installed in places where unskilled persons have access to their use. Distribution boards
- BS EN 60529:1992 Specification for degrees of protection provided by enclosures (IP code)
- BS EN 60896-11:2003 Stationary lead-acid batteries. General requirements and methods of test. Vented types. General requirements and methods of tests
- BS EN 60896-21:2004 Stationary lead-acid batteries. Valve regulated types. Methods of test
- BS EN 60896-22:2004 Stationary lead-acid batteries. Valve regulated types. Requirements
- BS EN 60904 Parts 1-10: Photovoltaic Devices
- BS EN 61194:1996 Characteristic parameters of stand-alone photovoltaic (PV) systems
- BS EN 61173:1995, IEC 61173:1992 Overvoltage protection for photovoltaic (PV) power generating systems. Guide
- BS EN 61215:2005 Crystalline silicon terrestrial photovoltaic (PV) modules. Design qualification and type approval
- BS EN 61277:1998, IEC 61277:1995 Terrestrial photovoltaic (PV) power generating systems. General and guide
- BS EN 61427:2005 Secondary cells and batteries for photovoltaic energy systems (PVES). General requirements and methods of test
- BS EN 61724:1998, IEC 61724:1998 Photovoltaic system performance monitoring. Guidelines for measurement, data exchange and analysis
- BS EN 61727:1996, IEC 61727:1995 Photovoltaic (PV) systems. Characteristics of the utility interface
- BS EN 62305-1:2006 Protection against lightning. General requirements
- BS EN 62305-2:2006 Protection against lightning. Risk management
- BS EN 62305-3:2006 Protection against lightning. Physical damage to structures and life hazard
- BS EN 62305-4:2006 Protection against lightning. Electrical and electronic systems within structures
- Engineering Recommendation ER G5/4-1 Planning Levels for harmonic Voltage Distortion and the Connection of Non-Linear Equipment to Transmission Systems and Distribution Networks in the United Kingdom
- Engineering Recommendation ER G59/1 'Recommendations for the connection of embedded generating plant to the Public Electricity Suppliers distribution systems' (Energy Networks Association 1991)
- Engineering Recommendation ER G75/1 Recommendations for the connection of embedded generating plant to Public distribution systems above 20kV or with outputs over 5MW (Energy Networks Association)
- Engineering Recommendation ER G83/1 'Recommendations for the connection of small-scale embedded generators (up to 16A per phase) in parallel with public low-voltage distribution networks' (Energy Networks Association 2003)

V14.3 Submittals

A Refer to Section B of this specification.

V14.4 Operation in parallel with the DNO

A Where AC output from the PV array/inverter is to be used in parallel operation with the District Network Operator's (DNO's) network fully automated synchronisation equipment is to be provided in accordance with G5/4-1, G59/1, G75/1, (or G83/1) and the DNO requirements.

V14.5 Photovoltaics (PVs)

A The PV specialist contractor will provide, install, test, commission, demonstrate and generally set to work the PV Electrical Generation Equipment as described previously and detailed in the electrical equipment schedules.

B Solar PV modules shall be connected in series and parallel as per the instructions provided by the manufacturers in order to best match the input characteristics of the inverters. When converting from DC to AC a fully electronic sinewave inverter unit shall be utilised.

C When used, batteries should be to BS EN 61427 and any other relevant standards and installed in series and parallel as per the manufacturer's instructions.

D All DC electrical connections, both for series and parallel connections, including those between PV laminates shall be made using Multi-Contact cables and connectors using the shortest practical cable lengths possible and supported using suitable containment.

E When connected to the mains inverter/s must condition the solar generated DC electricity, from the PVs, into a suitable AC waveform to provide a low voltage electrical supply at 230V for feeding directly into the electricity mains supply. The inverter/s shall be located as close to the solar PV array as practically possible in order to minimise the lengths of DC cables required. Or where the PV DC output is used directly serve DC items of plant or equipment use the shortest possible cable runs.

F Inverters shall be mounted as per the manufacturer's instructions along with both the DC and AC electrical disconnects, junction boxes and other safety equipment. All brackets and supports are to be included. The inverter locations shall be such that access can be easily made in order to reset the units after periods of mains failure and for maintenance.

G The solar PV elements shall meet the requirements as scheduled and shall be incorporated into or onto the building or surrounds under the instruction of the PV specialist contractor. Photovoltaic panels shall be mounted to the satisfaction of the structural engineer and architect. Details of

frames, and mounting arrangement to be supplied to architect, CA and structural engineer prior to installation for confirmation.

H AC outputs from each inverter shall be connected together in a suitable manner and fed to the main distribution board, leaving sufficient cable length for the grid connection to be made to the distribution board. Cables shall be XLPE/ SWA/ LSF or PVC sheathed as detailed on the main electrical schematic

I All calculations, design information etc to be provided by PV specialists to engineer prior to installation for confirmation of performance of installation.

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