

SPECIFICATION

MARCH 2023

GPA NET ZERO PROGRAMME DWP PHOTOVOLTAICS

RIBA STAGE 4 PV SPECIFICATION

ADELPHI HOUSE – DEPARTMENT FOR WORK & PENSION
(MITIE FM)

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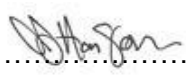
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AUTHORISATION

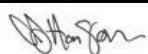
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Issue Record Sheet

Issue/revision	Issue 0	Revision 1	Revision 2	Revision 3
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Prepared by	Andrew Hanson			
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1.0 INTRODUCTION

This specification has been prepared on behalf of Mitie in response to their instruction to RLB to develop a RIBA Stage 4 design for the photovoltaic installation at Adelphi House, Reading.

The purpose of this document is to summarise the services requirements and capture the employers requirements to provide a level of information which will allow the contractors to tender the project and develop the design further where required and undertake the subsequent construction, installation and commissioning activities.

1.1 PRELUDE

The RIBA Stage 4 design for the PV installation at Adelphi House contained within this specification and associated design drawings, has been based on the feasibility recommendations of Faithful & Gould's Net Zero Programme Report Appendix D 5208777/14/NZSOW4 dated 18 March 2022.

The Faithful & Gould report provided a proposed location for the PV array and indicative peak power to be achieved.

There are a number of obstructions on the roof identified by Faithful & Gould, including roof cowls and vents. These will affect the total useable area of the roof and the anticipated peak PV generation output. The Stage 4 design detailed within this specification and on the design drawings takes account of these obstructions and adjusts the peak PV generation output accordingly.

1.2 KEY RISKS / ISSUES / OUTSTANDING INFORMATION

Through our engagement on the project, we have established the following key risks / issues and outstanding information for consideration and development by the contractor as part of the works:

- The contractor will be responsible for seeking planning approval.
- The contractor will be responsible for liaison with the DNO / utility provider.
- The contractor will be responsible for obtaining a structural assessment and wind loading assessment for the proposed PV array.
- The contractor will be responsible for any applicable grant / funding applications.

2.0 PREAMBLES

2.1 PROJECT PARTICULARS

The preamble is an introduction to the specification for the building engineering services, which sets out additional requirements the contractor is obliged to fulfil. The preamble will be read in conjunction with all contract documents.

The specification and related documentation provides detail of the required performance, workmanship, materials standards, and design intent of the engineering services.

The specification refers to a single Contractor only. Therefore, should the Contractor split the specified works into separate packages and employ the services of Sub-Contractors, the Contractor is responsible for explicitly defining the role of each of the Sub-Contractors and coordinating their works accordingly.

The Contractor will confirm if they do not understand any aspects of the specification, or if they believe discrepancies exist within.

2.2 THE ROLE OF THE EMPLOYER'S CONSULTANT

An Employer's Consultant will be appointed, who will undertake a monitoring role on behalf of the Employer, to see that the Contractor's design and installation works are in accordance with the Employer's Requirements.

The Employer's Consultant will advise the Client throughout the design and installation phases of the project. The Employer's Consultant does not carry out a design co-ordination role, nor does it 'approve' or otherwise endorse any specific course of action put to it in anyway by the Contractor. Its role is to advise the Employer only of the adequacy of the Contractor's works against the Employer's Requirements.

Prior to the commencement of installation works on site, the role of the Employer's Consultant will be to review all Contractor proposals and report its findings to the Employer only. Once installation works begin on site, the role of the Employer's Consultant will be to inspect installations for good workmanship and compliance with the specification, and to witness the commissioned engineering services, all on behalf of the Client.

If at any stage during the project the Employer's Consultant identifies that the Contractor's proposals or installations deviate away from the specification, it will be reported to the Client. Under such circumstances, the Contractor will be required to respond to the report and undertake all necessary changes and provide compliant systems entirely at their own cost, whilst not causing delay to the construction programme.

The Employer's Consultant will not authorise any changes to the specification unless instructed to do so by the Employer. Should the Contractor wish to vary the requirements of the specification or any

other Contract documents, a Request for Change or Variation Request must be submitted for consideration by the Employer's Consultant.

When the Employer's Consultant is called to site by the Contractor to undertake inspection of the works, or to witness the commissioned engineering services, all offered works must be 100% complete, of good quality and fully compliant with the Employer's Requirements. If the works are not found to be satisfactory and the inspection visit must be repeated, the Employer's Consultant will recover all costs incurred for the additional time spent from the Contractor via the Employer through the contract.

Similarly, if the works are delayed through the actions of the Contractor, the Employer's Consultant will recover all costs incurred for the additional time spent from the Contractor via the Employer through the contract.

No approvals, comments, instructions, consents or advice or indication of satisfaction given by or from Employer's Consultant, nor any enquiry or inspection which Employer's Consultant may make or have carried out for its benefit or on its behalf will operate to reduce, extinguish, exclude, limit or modify the Contractor's obligation to fulfil its duties and obligations under the Contract. Any amendment to the Contract will be issued by the Employer's Representative in accordance with the terms of the Contract.

2.3 DEFINITIONS; ROLES

Commissioning	The setting to work of engineering services to operate within the specified parameters using the least amount of energy possible.
Contract Administrator	The Employer's elected representative.
Employer's Consultant	The Employer's representative concerned with all systems described in the specification.
Contractors Proposals	Drawings/calculations/technical data sheets showing details of Contractor or Sub-Contractors proposals for execution of the specified works, provided in enough detail to enable installation works.
Record/as-fitted drawing	Accurate record drawings detailing installed engineering services in a similar level of detail as the installation drawings.
Systems/engineering services	Mechanical and electrical systems described within the specification comprising all plant, materials, equipment, controls, and ancillaries. Including their design, supply, installation, setting to work and commissioning.

Commissioning	The setting to work of engineering services to operate within the specified parameters using the least amount of energy possible.
Tenant/End-User	Building occupant(s) post practical completion.
The specification	The Employer's requirements detailed in the specification which states the required systems, their performance, workmanship, and quality. Including design intent drawings listed in Section Two and Three of the specification.
Works	The specified and/or contracted scope of works.

2.4 THE SPECIFICATION

The specification requires compliance with Statutory legislation and recognised UK standards, such as British Standards, CIBSE, IET, BSRIA, BESA and Approved Documents for Building Regulations, including all 'tiered' documents referred to within these standards and guides. The Contractor is to utilise these standards on which to base the development of the design.

The specification describes the design philosophy/servicing strategy for the engineering services. These are the minimum provisions required. The Contractor is not permitted to deviate away from the design philosophy/servicing strategy under any circumstances, however, it is accepted that minor deviations may occur due to final site coordination, or changes to the building design approved by the Employer. All minor deviations must be reported.

Plant and equipment sizes/loads provided in the specification and/or design intent drawings are for information only to assist during the tender stage and may comprise approximations and estimates of such. The Contractor is required to undertake its own detailed design calculations as described in the specification.

When the specification does not provide a specific requirement, or the design or installation requirements are not covered by any of the quoted standards, the Contractor will contact the Employer's Consultant to agree a solution.

To provide the Contractor with design flexibility, more than one type of material may have been permitted for use. However, only one material should be utilised for each element of any given system, a mixture of materials in the same system is not acceptable.

2.5 STANDARDS, CODES, REGULATIONS & GUIDES

The Contractor is required to provide all materials and works in accordance with appropriate British Standards or Codes of Practice, and must comply with all Statutory Instruments and Regulations, planning conditions and Local Byelaws relating to the area of the site current at the date of tender.

The Contractor is also required to comply with the requirements of the Local Authority Building Inspector and all relevant requirements included in the Main Contract Preliminaries including notification to all Authorities in accordance with their Regulations, obtaining all required approvals for the installation.

The Contractor will report all queries over the specification as soon as they become apparent.

The Contractor will ensure all equipment and systems are designed and installed in accordance with the relevant Standards and that operational compatibility exists between the systems and any other system installed at the same location. The Contractor will supply plant and equipment to achieve the specified design conditions and to provide stable control.

Systems and equipment selected by the Contractor will have a successful proven performance of not less than three years under equivalent conditions to those required by the specification. Systems and equipment that do not comply with the foregoing proven performance period may be considered, provided that full technical details and evidence of suitability are given at the time of tendering.

All systems, plant and equipment will be installed in accordance with Manufacturer's instructions and recommendations.

2.6 HEALTH & SAFETY

The Contractor will comply with all relevant Health and Safety Legislation and Codes of Practice. The Contractor is responsible for all matters regarding the Construction Design & Management Regulations during design, installation, commissioning and consideration for future demolition, adaptation, and extensions. The Contractor will comply with the requirements of the CDM Regulations by:

- Compiling risk assessments for all works
- Providing information on the works which might affect the health or safety of any person
- Providing appropriate input to the Pre-Construction Information, Construction Phase Plan, and health and safety file for the works
- Providing all safe methods of working prior to commencing work and for working to those methods
- Reporting accidents, injuries, or dangerous occurrences
- Providing appropriate input to the health and safety plan, including risk assessments, and to the health and safety file.

The accuracy and sufficiency of this information is not guaranteed by the Employer or the Contract Administrator. The Contractor must ascertain any information they may require ensuring the safety of all persons and the Works.

The Contractor will ascertain the nature of the site and all local conditions and restrictions likely to affect the execution of the Works. Before commencing work, the Contractor is required to carry out a survey and examination of buildings, structure and engineering services affected by the works and will examine all available drawings of the engineering services and report any discrepancies to the Contract Administrator.

The Contractor is required to submit a statement within their tender submission which describes their organisation and available resources which will be adopted during the works to safeguard the health and safety of operatives, and of any person who may be affected by the Works, including:

- A copy of their health and safety policy document, including risk assessment procedures
- Records of previous Health and Safety Executive enforcement action
- Records of training and training policy
- The number and type of staff responsible for health and safety on this project with details of their qualifications and duties.

Residual risks are to be managed through the remaining design process by the Contractor.

2.7 UNACCEPTABLE MATERIALS

The following will not be used in any of the specified works:

Any of the materials identified as potentially hazardous in the British Property Federation/British Council for Office report Good Practice in the selection of construction materials (current edition) other than in accordance with the recommendations as to good practice contained in section 2 of that report.

Any other material which does not comply with relevant British Standard Specifications (or their European Union equivalent) or Codes of Practice.

The Contractor will select plant, equipment, and materials from the schedules of permitted materials within each work section (where given) and any nominated Manufacturer.

2.8 TENDER SUBMISSION

The Contractor is required to submit their tender proposal for all works described within the specification, meeting all performance requirements including integration with the works generally.

Before tendering, the Contractor is required to ascertain the nature of the site, access thereto and all local conditions and restrictions likely to affect the execution of the works. All conditions affecting the scope or execution of the works, provision of facilities, attendances or the like must be identified at tender return stage. The Contractor will have no claim due to a lack of knowledge in any respect.

Where Manufacturers, Suppliers or Installers of products are identified by name(s) in the specification they will be used exclusively. Alternative plant and equipment manufacturers will not be considered by the Employer during tender, however, post tender, the Contractor may offer alternative plant and equipment manufacturers to the Employer, via the Employer's Consultant for consideration. The alternatives may only be used after instruction.

The Contractor will ensure that all named products are selected. If alternative are proposed post tender, the Employer's Consultant will be provided with sufficient time to make comments prior to order.

The specification forms an Employer's Requirements. The Consultant does not have authority to approve changes. Changes will be dealt with formally with sufficient time provided. A claim for time may be made, at the discretion of the Consultant.

No alternatives will be accepted due to the Contractor's failure to order the specified goods in sufficient time. The Employer, at their discretion, may only accept alternative products when they offer improved standard, performance, or lifespan over those which are specified.

If the Employer's Consultant deems that the proposed alternative is beneficial to the Employer, the alternative will be offered to the Employer for consideration. Only if the Employer accepts the alternative proposal will the Contractor be permitted to deviate away from the specification. If a particular Manufacturer is not listed in the specification, the Contractor will offer a proposal to the Employer's Consultant for review prior to ordering and in sufficient time for an alternative to be procured should any proposal be unacceptable.

Information provided within the specification does not comprise a completed design. The Contractor is therefore required to undertake their own design for the purpose of submitting tender costs. The successful Contractor will then be obliged to develop their design further and produce detailed design calculations and installation drawings in accordance with the specification.

The defects liability period for the engineering services installations will be twelve months from the date of practical completion, or as given in the main contract. Where extended warranties are available from Manufacturers, for instance, through the use of approved installers, these will always be obtained.

Unless otherwise indicated within specification, all equipment and materials will be new and have full UK warranties/guarantees and servicing.

Upon request post tender, the successful Contractor may be required to provide the Employer with samples for review of proposed terminal equipment.

2.9 MANAGEMENT

INSTALLATION WORKS

The Contractor is required to:

- Produce detailed design and installation drawings as described in the specification, including any required information to demonstrate compliance with the specification
- Co-operate with the Project Team, Suppliers, Local Authorities, and statutory undertakings in the execution of their work
- Attend coordination meetings as deemed necessary
- Produce builder's work details
- Set-to-work, test, and commission the services, to the satisfaction of the Employer's Consultant, that the dynamic performance meets the requirements of the specification
- Handover the commissioned installation to the Employer with an Operating and Maintenance Manual update
- Provide comprehensive training to the building Tenant/End User in the operation and maintenance of all installations
- Make good any defects that occur during the defect liability period.

The Contractor will appoint a dedicated Foreman-in-charge and/or Site Consultant/Project Manager to ensure constant management and supervision of the Works.

All works will be handed over at practical completion in a dust-free clean condition, clear of any damage and with as few running hours incurred as are necessary to undertake commissioning only. The Contractor will provide adequate and safe protection for all materials and products during transport to site. All ductwork, tubes, conduit, trunking, and associated equipment with open ends will be effectively plugged, capped, or sealed during delivery and storage up to and including installation. Offload and transport all plant, equipment and materials as recommended by manufacturers.

The Contractor will store all plant, equipment and materials as recommended by manufacturers. The Contractor will provide sufficient, safe and secure storage for all materials and products, provide racks to prevent distortion for storage of conduits, pipes and similar materials, and store all fittings, accessories and sundry items in clean bins or bagged and stowed in racks and maintained under suitable weather proof cover.

The Contractor will protect all installed works against dust, dirt and damage and will regularly check post installation to ensure that the protection remains in place. All items such as lighting fittings, switches, accessories etc. will be installed as close to practical completion as possible.

The Contractor will leave plant and equipment in a ready to paint condition where specified as part of the works or to be carried out by others. Parts liable to corrosion immediately after removal of any temporary protection will be immediately treated/painted. The Contractor will replace material, plant, or equipment where deterioration or damage has occurred prior to handover.

PROGRAMME

The Contractor is required to provide detailed programmes for design, procurement, installation, and commissioning. The proposed programmes, or a summary thereof, showing the sequence and timing of the principal parts of the works, periods for planning and design, and itemising any work which is excluded must be submitted. Due allowance will be made in the programme for the works for, but not limited to, the following:

- Design period
- Ordering and installation periods
- The completion of drawings, including a minimum ten working day period for review by the Employer's Consultant
- Work resulting from instructions issued in respect to the expenditure of provisional sums
- Concurrent work by other trades
- Any temporary works necessary
- Pre-commissioning, commissioning, and performance testing of the services
- Preparation and provision of Record Drawings and Operating and Maintenance Manuals, including a minimum ten working day period for review by the Employer's Consultant
- Review of all Contractor documents by the Employer's Consultant, offering a minimum ten working day period
- Witnessing of commissioned systems by the Employer's Consultant.

The Contractor will provide programme information as a simple bar chart type including critical path networks making do allowance for:

- Commissioning, demonstration, and instruction procedures
- Provision of written notice before each (or series of) test, inspection, commissioning, or demonstration procedures are to be carried out, not less than
- Demonstration to the Employer's Consultant that test instruments and equipment are accurate

The Contractor will ensure procurement details of materials are incorporated in the programme, order all plant, materials, and equipment necessary for the completion of the works immediately after review of the Employer's Consultant. No delay to practical completion or completion of any part thereof caused by delays in ordering will be accepted.

The Contractor will make provision in their programme to allow for circumstances when their documents and installation works may be rejected by the Employer's Consultant on the grounds of poor practice, poor workmanship, or non-compliance with the specification. The Employer's Consultant will not be held accountable for any delays to the programme in any such circumstances.

2.10 DESIGN & QUALITY

The principles of best practice will be applied during design and installation, to provide the Employer with a building that balances performance with low operating costs. Best practice utilises known technologies and modern design and process management techniques to produce systems that operate within sensible parameters, without excessive margins that result in over-design and poor performance.

The design of the engineering services will use the guidance published by the Standards and Guidance listed in the specification and will deliver the performance stated. Where parameters are not stated, the Contractor will state all assumptions made in their tender return and design calculations.

The Contractor will ensure all equipment can be installed in the allotted spaces and will maintain adequate access for future maintenance and replacement. All equipment will be installed in accordance with the Manufacturer's written instructions and technical bulletins up to the date of practical completion.

The Contractor will provide Manufacturer guarantees and warranties for all specified and installed plant, equipment, and ancillaries for a period of twelve months commencing from practical completion. The Contractor will only procure plant, equipment and ancillaries which have an availability of spares for ten years commencing from practical completion.

The Contractor will employ only operatives who are skilled and appropriately qualified for the undertaking of the works in which they will carry out.

2.11 CONTRACTORS DOCUMENTS

The Contractor is required to undertake the design and detailing of all works described in the specification and to provide complete information including detailed design calculations and installation drawings. The Contractor will liaise with all other trades, the Contract Administrator, the CDM Coordinator and all others as necessary to ensure good co-ordination of all works, building elements, and services.

CALCULATIONS

The Contractor is required to undertake detailed design calculations for the purpose of sizing and selecting plant, equipment, and ancillaries which deliver the requirements of the specification in a cost effective and energy efficient manner. The design calculations will satisfy the specification in its entirety and the strategy shown on the design intent drawings.

All calculations will be typewritten and laid out in accordance with the standards applicable to each Service. Calculation formats and checking/audit procedures are provided in various BSRIA publications, handwritten calculations are not acceptable and will be rejected.

Practical hand calculations and supplier specific sizing tools will be accepted as design evidence in some instances.

DRAWINGS

Following completion of detailed design calculations, the Contractor will adopt the design intent drawings and develop them into installation drawings for review by the Employer's Consultant. All drawings will be submitted to the Employer's Consultant for review prior to the commencement of installation works on-site, all-in accordance with BSRIA '*A Design Framework for Building Services*'. Drawings will not be reviewed until such time that all design calculations have been reviewed by the Employer's Consultant.

All installation drawings will be fully detailed to allow the Employer's Consultant to review the proposals for practicality, coordination with the building and other services and compliance with the specification. Where necessary, or at the request of the Employer's Consultant, the drawings will be supported with schedules and further design calculations. Installation works on site will not be permitted until all drawings have been received, reviewed and any necessary alterations incorporated.

Installation drawings will be provided to members of the design and construction team prior to installation works commencing on site. Sufficient time, as agreed with the Contract Administrator, will allow for comments/suggestions to be offered prior to final issue.

Builder's work drawings will be produced by the Contractor prior to the commencement of installation works. The builders work drawings will detail work which forms part of the building construction and will include as a minimum concrete bases, holes through the building fabric, foundation bolts and metal inserts, making chases and cutting away and making good. The drawings will accurately

indicate the sizes and locations of all items of builders' work required. The Contractor may be required to mark out builder's work requirements on site.

Builder's work requirements which impose on the structural engineering design will be checked by the Structural Engineer to ensure that there is no detrimental effect. Requirements for pre-cast chases within building structure will be clearly identified in terms of location and extent. Approval will be required for all fixings into concrete walls, floors, ceilings, or roofs. Fixings to steelwork will be of the clamp types. No steelwork will be cut, drilled, or welded without authorisation from the Architect/Structural Engineer. Sketch drawings will be submitted. Provision will be made for all access equipment such as ladders and scaffolding.

The Contractor will advise the weights of all plant, equipment, and ancillaries to the Structural Engineer in the form of drawings and schedules for approval prior to the commencement of installation works on site.

All drawings will be created in a CAD format, in particular Autodesk Revit or the current version of Autodesk AutoCAD and subsequently published in Portable Document Format (PDF) and AutoCAD Drawing Interchange Format (DXF) for issue to the Employer's Consultant and Contract Administrator. All electronic drawings will be included in the electronic version of the operating and maintenance manual.

TECHNICAL SUBMITTALS

The Contractor will provide comprehensive technical details of all proposed plant, equipment, and ancillaries to the Employer's Consultant for review prior to order and delivery to site. The technical submittals will be forwarded in a format agreed with the Employer's Consultant including the following information as a minimum:

- Plant item description, reference identification and serial number
- Electrical input rating – kVA, Volts, Phase
- Description of controls
- Performance characteristics
- Capacities and duties
- Nominal and seasonal efficiency
- Noise level
- Weight etc.

The Contractor will obtain on behalf of the Client all appropriate licences, permissions, copyright waivers, rights of use and the like from the owners of software rights. The Contractor will ensure that the Client is properly registered with the software supplier for support and appropriate updating.

2.12 EMPLOYER'S CONSULTANT DOCUMENT REVIEWS

All Contractor documents will be submitted to the Employer's Consultant for review prior to the commencement of installation works on site. A minimum period of ten working days per document issue will be given to the Employer's Consultant.

The role of the Employer's Consultant, when reviewing contractor documents, is to identify circumstances in which they believe the requirements of the specification have not been met or delivered and to advise the Employer accordingly. It remains entirely the responsibility of the Contractor to ensure that all their proposals are fully in accordance with the specification. Document reviews and comments issued thereafter will not relieve the Contractor of its responsibilities and obligations described in the specification and contract.

The Employer's Consultant will not approve the Contractor's information, it will review on behalf of the Employer. If the Contractor's proposals are deemed not to comply with the specification, notice may be issued to the Contractor. The Contractor will be required to make the necessary changes and ensure that compliant systems are provided. Should the Contractor proceed with installation works on site having not first offered all documents to the Employer's Consultant for review, they do so at risk.

No approvals, comments, instructions, consents or advice or indication of satisfaction or otherwise given by or from RLB UK, nor any enquiry or inspection which RLB UK may make or have carried out for its benefit or on its behalf will operate to reduce, extinguish, exclude, limit or modify the Contractor's obligation to fulfil its duties and obligations under the Contract. Any amendment to the Contract will be issued by the Employer's Representative in accordance with the terms of the Contract.

2.13 INSPECTIONS OF COMPLETED WORKS

The Employer's Consultant will undertake periodic inspections of completed installation works to assess for good workmanship and compliance with the specification. Poor workmanship and deviations from the specification will be reported by the Employer's Consultant to the Employer and the Contractor will be required to rectify all identified issues at their own cost, whilst not affecting the programme.

Prior to the concealment of installations, the Contractor will undertake their own inspections to ensure good workmanship and compliance with the specification. Only once the Contractor has completed their inspection and corrected any discrepancies, will they offer the installations to the Employer's Consultant ahead of concealment. The programme should include the required periods ahead of concealment for inspection by the Employer's Consultant, including a notice period of two working days and one working day for inspection.

Failure to offer areas for inspection ahead of concealment may result in works being uncovered and later reinstated at the cost of the Contractor. The Employer's Consultant reserves the right to forgo inspections.

2.14 COMMISSIONING

The Contractor will carry out commissioning of all installations in accordance with the Building Regulations and procedures, checks and tolerances given in the BSRIA Application Guides for water systems and air systems to achieve the standards set in the CIBSE Commissioning Codes.

The Contractor will undertake comprehensive setting to work, testing and commissioning of the services prior to handover at practical completion. The Contractor will provide method statements, Commissioning data and programmes for testing and commissioning at least four weeks prior to the commencement of testing and commissioning for Employer's Consultant to review.

The Contractor will ensure all equipment is installed in accordance with Manufacturer's recommendations and commissioned by the relevant Manufacturers.

The Contractor will submit all commissioning results to the Employer's Consultant for comment five days before witnessing is carried out. All test certificates will be type written and signed by the Specialist undertaking the work and copies included within the Operation and Maintenance Manual.

The Contractor will employ the services of a specialist Commissioning Manager, if deemed necessary, for complex systems such as heating, cooling, mechanical ventilation, and automatic controls. The appointed Commissioning Manager will review the design of the system and will undertake the following checks:

- Design input: design reviews to see systems can be adequately commissioned
- Commissioning management input to construction programming
- Commissioning management input during installation stages
- Management of commissioning, performance testing and handover/post-handover stages.

A schedule of commissioning and testing that identifies and includes a suitable timescale for commissioning and re-commissioning of all complex and non-complex building services and control systems will be provided at least 4 weeks prior to the commissioning and testing commencing.

The schedule will identify the appropriate standards that all commissioning activities will be conducted in accordance with, such as current Building Regulations, BSRIA and CIBSE guidelines and/or other appropriate standards, where applicable.

WITNESSING OF COMMISSIONING

The Contractor will demonstrate the specified works to the Employer's Consultant in a fully completed, operational and commissioned state. The Contractor will accommodate the Employer's Consultant in undertaking their role to witness commissioning on behalf of the Employer. The

Contractor will undertake the commissioning and witness as satisfactory before inviting the Employer's Consultant to site having first provided at least five working days' notice.

The Employer's Consultant will attend site on designated and agreed days to witness a proportion of the recorded testing and commissioning results measurements and operation of systems.

Should witnessing not be satisfactory due to the witnessed test results being in excess of 10% of the results previously recorded by the Contractor, at the discretion of the Employer's Consultant, the Contractor may be required to completely re-test and re-commission the entire system at their expense within the timeframe of the construction programme.

All test instruments and labour required to demonstrate the satisfactory performance of the installation will be supplied by the Contractor and included for within the tender sum. Calibration of all test instruments will have been carried out within the previous six months by an accepted authority, and those used for witnessing will be those used for the previously recorded results.

The Contractor will allow to provide training to the Employer/End user of all new services installations.

2.15 OPERATING AND MAINTENANCE MANUAL

The Contractor / Sub-Contractors will provide a comprehensive operating and maintenance manual which addresses all installations undertaken, mechanical and electrical.

The Contractor will employ the professional service of an organisation which specialises in the collation and production of operating and maintenance manuals, if deemed necessary.

The operating and maintenance manual will be provided strictly in accordance with BSRIA '*Handover, O&M Guides and Project Feedback*' and '*Building Manuals and Building User Guides*'. The manual will provide purpose and planning information, technical documentation including record drawings, full operating instructions for each system, detailed maintenance instructions and schedules, parts lists, modification instructions, disposal instructions, and procedures and results of all tests undertaken during the commissioning process.

The Contractor will encase the operating and maintenance manual in A4 size, plastic-covered, loose leaf, four ring binders with hard covers, each indexed, divided and appropriately cover- titled. Drawings larger than A4 will be folded and included in the binder so they may be unfolded without being detached from the rings.

Prior to the issue of the first manual draft, the Contractor will provide a draft manual layout which demonstrates proposed content and formatting for approval.

The Contractor is required to provide one paper manual and two compact disks containing electronic manuals. Electronic manuals will be fully indexed and published in Portable Document Format (PDF), including all electronic drawings previously described.

At commencement of commissioning to enable the Employer to familiarise themselves with the installations, the Contractor will prepare a draft Operation & Maintenance Manual with provisional

record drawings and preliminary performance data. These should be of the same format as the final manuals with temporary insertions for items which cannot be finalised until the installations are commissioned and performance tested.

2.16 HANDOVER

The Contractor will provide information to the Employer in accordance with BSRIA '*Handover, O and M Manuals and Project Feedback*'.

The Contractor will provide comprehensive training in the operation of the installed works to the Employer/Tenant/End-user in accordance with BSRIA '*Handover, O and M Manuals and Project Feedback*'. The Contractor will state such allowances in tender submissions.

By means of photographs, the Contractor will record meter readings of all electricity and energy meters immediately upon completion of the installation works and forward to the Employer.

3.0 PHOTOVOLTAICS

The works detailed within this specification and on the design drawings cover the supply and installation of a complete solar photovoltaic installation at Adelphi House, Reading.

The Contractor will fully co-ordinate all the works to ensure a fully complete and operational system.

3.1.1 PV DESIGN STANDARDS

The system will be selected, installed, tested and commissioned in accordance with the requirements and/or recommendations of the following industry standards and good practice guidelines, the below list is not exhaustive:

- British Standards, Codes of Practice and Building Regulations
- Construction (Design and Management) Regulations 2015
- Local and Statutory Authority Requirements
- IET Wiring Regulations (BS 7671)
- Health and Safety at Works Act 1974
- Electricity at Work Regulations
- Health and Safety at Work Act
- Manufacturer's Literature
- Photovoltaics in Buildings – Guide to the Installation of PV Systems. 2nd Edition 2006
- Building Regulations Approved Document P – Electrical Safety
- Engineering Recommendation G99
- MIS 3002, Solar Photovoltaic Standard
- BS 6399 'Loading for buildings – Code of practice'
- BS 60947 'Specification for low-voltage switchgear and control gear'

3.2 SCOPE OF WORKS

The specialist contractor carrying out the installation will include for, but not be limited to, the following:

1. The supply and installation of the PV support structure for the modules on the roof.
2. The supply, installation and interconnecting of all PV panels as detailed within the design specification and on the drawings.
3. The supply, installation and connection of all inverters.
4. The supply and installation of all DC & AC isolators.
5. The supply and installation of distribution boards (if required).
6. The supply and installation of surge protection devices.
7. The supply and installation of all associated cabling.
8. The supply and installation of all necessary cable containment.
9. The supply and installation of PV Ofgem approved generation meter (kWh).
10. The supply, installation and connection of all G99 protective relays.
11. The supply and installation of all necessary warning signs and labels.
12. The supply and installation of all necessary fire alarm interface / fireman's override switching.
13. Liaison with the Distribution Network Operator (DNO) in order to seek approval for grid connection of the PV system.
14. Modification of existing building low voltage switchgear as required for the integration of the PV system.
15. Modification of existing lightning protection system installation.
16. Modification of existing earthing and bonding installation.
17. Builders work in connection with the complete PV installation.
18. Testing and commissioning of the complete system.
19. Providing detailed operation and maintenance documentation including as fitted drawings.
20. Demonstration of the complete system to the client and engineers.

3.3 PHOTOVOLTAIC PANELS

In the positions indicated on the design drawing, supply, install and put into operation the following PV panels:

Photovoltaic Panels	
Manufacturer	SunPower Maxeon Solar Technologies
Model	Maxeon 3 SPR-MAX3-400-COM
Nominal output per panel	400 W
Panel dimensions	1690mm(L) x 1046mm(W) x40mm(D)
Total number of panels	30No.
Incline	30°
Total nominal system output	12 kWp
Energy Generation	11,411 kWh/year

The RIBA Stage 4 design has been based on the above photovoltaic panels, should an alternative manufacturer be proposed by the specialist PV contractor, it will be of an equal quality and performance and be approved by the engineer / client's representative prior to procurement.

All associated cabling will be contained within the support framing or on appropriate cable containment, i.e. cable tray.

3.4 AC / DC INVERTERS

In the positions agreed on site, supply, install and put into operation the following AC/DC Inverters:

Inverters	
Manufacturer	SMA Solar UK
Model	Sunny Tripower X 12
No. of Inverters	1No.
No. of MPP Trackers	3No.
Panel Configuration per MPP Tracker	3 strings of 10 panels each (see schematic)
Total connected panels	30No.

Inverter equipment and associated DC switchgear will be suitably located and protected within the switch room / internal plant room. Alternatively, if there is limited space within the plant room, inverters will be located externally within an IP67 rated weatherproof enclosure.

The RIBA Stage 4 design has been based on the above inverters, should an alternative manufacturer be proposed by the specialist PV contractor, it will be of an equal quality and performance and be approved by the engineer / client's representative prior to procurement.

3.5 G99 PROTECTIVE RELAY

The PV system will be provided with a G99 protective relay. The G99 relay package will trip the AC supply to the inverters if the AC output from the PV system or the grid itself strays outside of the voltage of frequency limits set by the DNO. The relay will also disconnect the PV system in the event of phase failure or a grid failure, removing any danger of the building's network remaining live despite the loss of the main distribution network.

3.6 METERING

An OFGEM approved meter will be provided at or adjacent to the main LV switchboard. The meter will display and record the following:

- Instantaneous power output (kW)
- Energy generated by the PV system (kWh)

The generation meter will have the facility be interfaced with the buildings BMS.

3.7 CABLE SIZING

Cable sizes have been provided on the schematic for tender, should the contractor change any aspect of the photovoltaic system, cable sizes should be re-calculated accordingly.

Cable distribution and containment at system level is required for connection between PV modules, inverter equipment and for routing and termination into the main LV distribution board. The system should be able to demonstrate compliance and approval by the DNO. The final testing and commissioning can be undertaken with the DNO as witness if required. All results should be recorded in newly produced operating and maintenance manuals for the installation.

3.8 ROOF MOUNTING SYSTEM / SUPPORT

Suitable framing systems will be employed to allow mounting and securing in accordance with the PV panel manufacturer's requirements.

The PV array mounting system will comprise of and not limited to mounting frames, frame rails, frame components, fixings, and support ballasts.

The selection of the roof mounting / support system will be the responsibility of the specialist PV contractor to suit the existing roof structure. This could be a fixed or ballasted system. Prior to procurement and installation, a structural assessment and wind loading assessment will be carried out by a structural engineer.

The roof mounting system will allow the panels to be mounted at the optimum angle of 30°.

The mounting system will be spaced so that the panels do not cast a shade on each other.

3.9 EARTHING AND BONDING

Earthing for the entire PV installation shall comply with BS 7430, BS EN 62305(All) and BS 7671. All exposed conductive parts of the PV installation shall be connected to earth in accordance with BS 7671 and BS 7430.

3.10 TESTING AND COMMISSIONING

Testing and commissioning will be carried out in accordance with all relevant standards and regulations.

The PV Specialist will allow for testing and commissioning the following:

- The PV array will be tested and inspected to ensure all panels are securely mounted and will tolerate expected wind loadings.
- The PV array will be inspected to ensure all panels are operating at manufacturer's specified efficiency and all connections are suitably and robustly terminated to cope with external environments.
- The inverters will be verified to ensure they are in optimum working order without faults.
- DC side testing and commissioning.
- AC side testing and commissioning.
- G99 witness testing.

3.11 LIGHTNING PROTECTION

The PV system must be protected against a direct lightning strike in accordance with BS EN 62305.

The existing lightning protection installation shall be modified to ensure the PV system is incorporated into the protective zone of the existing air termination system and protected against direct lightning strikes.

The PV support framework will be bonded at suitable points into the building's lightning protection system.

The design of this system will be carried out by a specialist lightning protection engineer employed by the PV contractor.

3.12 STRUCTURAL INVESTIGATIONS

An assessment will be undertaken by a structural engineer to ensure that the existing roof structure can support the weight of the new PV system / any associated ballast.

Where it is confirmed that the existing roof structure is inadequate for the proposed additional loads, structural works associated with strengthen existing roof to increase its load carrying capacity shall be undertaken.

Structural investigations / works will be undertaken by others and do not form part of this tender document.

3.13 BUILDERSWORK OPENINGS

New builders work openings will be provided from roof level to the floor below and as required across the floors. Openings made at roof level shall be weather sealed.

3.14 FIRE STOPPING

Where cables pass through fire compartment walls and floors via new penetrations, suitable fire stopping will be provided.

3.15 DESIGN AND INSTALLATION NOTES

The DC Side

Installers are obliged to liaise with the relevant Distribution Network Operator (DNO) in the following manner: Written approval from DNO to be gained prior to works and undertake commissioning in conjunction with DNO engineer, or as required by DNO.

PV Modules must comply with the international standards: IEC 61215 / IEC 61730.

The use of Class II modules is generally recommended, and strongly recommended for array open-circuit voltages of greater than 120 V.

The international standard IEC61730: 2016 'Photovoltaic (PV) module safety qualification – Part 2 – Requirements for testing' should be considered during installation as they refer to safe electrical and mechanical operation during the PV modules' expected lifetime. It also addresses the prevention of electrical shock, fire hazards, and personal injury due to mechanical and environmental stresses and is to be used in conjunction with IEC 61215.

Double insulation (insulation comprising both basic & supplementary insulation, International Electro-technical Vocabulary IEC 60050-101-08), appropriate barriers and separation of parts must be applied to all systems with an open-circuit voltage of $>120 V_{DC}$. Class II insulation on the DC part of the PV system, even if less than $120 V_{DC}$, is strongly recommended.

External cables should be UV stable, water resistant, and it is recommended that they be flexible (multi-stranded) to allow for thermal/wind movement of arrays/modules.

To minimise the risk of faults, cable runs should be kept as short as practicable. Where long cable runs are required, it is good practice to label along the DC cables as follows: "Danger solar PV array cable – high voltage DC – live during daylight". This is to inform personnel involved in maintenance or alterations to a building at a later date.

Connectors must be DC rated. They must have the same or greater voltage and current ratings as the string/DC main cable to which they are fitted. A sign, 'Do not disconnect DC plugs and sockets under load – turn off AC supply first' must be fixed next to connectors, except those that are inaccessible to anyone except trained personnel in the course of PV maintenance or fault finding.

The DC junction box must be labelled as 'PV array DC junction box', and also labelled with 'Danger – contains live parts during daylight'. All labels must be clear, legible, located so as to be easily visible, and durably constructed and affixed to last.

A PV system cannot be turned off – terminals will remain live at all times during daylight hours. It is important to ensure that anyone opening an enclosure is fully aware of this. A readily accessible disconnection device will be provided to isolate individual strings. Isolation will be provided in both positive and negative string cables.

The installation of string fuses can provide protection against fault currents in all other cases. While some fault combinations are less likely than others, in order to provide full protection of all cables and modules – string fuses are required in both the positive and negative legs of the string cabling.

The DC switch provides a means of manually electrically isolating the entire PV array. Such electrical isolation is required during system installation and subsequent system maintenance or repair work. It should be located adjacent to, or integrated into the inverter.

The DC switch must be double pole – to effectively electrically isolate both PV array positive and PV array negative. It must be rated for DC operation and should be load-break rated.

The DC switch (or switches) must be labelled as ‘PV array DC isolator’, with the ON and OFF positions clearly marked. Switch enclosures must also be labelled with ‘Danger - contains live parts during daylight’. All labels must be clear, easily visible, constructed and affixed to last and remain legible for as long as the enclosure.

The bonding to earth of any of the current carrying DC conductors is not recommended. However, earthing of one of the live conductors of the DC side is permitted, if there is at least simple separation between the AC side and the DC side, including in the inverter. The inverter must be treated as standard electrical apparatus and earthed as per BS 7671 if Class 1.

All DC cables should be installed to provide as short runs as possible, and positive and negative cables of the same string or main DC supply should be bundled together, avoiding the creation of loops in the system. This requirement for short runs and bundling includes any associated earth/bonding conductors. Long cables (e.g. PV main DC cables over 50 m) should be installed in earthed metal conduit or trunking, or be screened cables such as mineral insulated or armoured. Most grid connect inverters have some form of in-built surge suppression however discrete devices may also be required.

The AC Side

An inverter supplied from a PV array must preferably be installed in a dedicated circuit in which:

- No current-using equipment is connected, and
- No provision is made for the connection of current-using equipment
- No socket-outlets are permitted.

An inverter must not be connected by means of a plug with contacts which may be live when exposed.

Where an electrical installation includes a PV power supply system without at least simple separation between the AC side and the DC side, an RCD installed to provide fault protection by automatic disconnection of supply must be type B RCD according to BS EN 60898 (IEC 60755).

AC cables are to be specified and installed in accordance with BS 7671.

A manual AC switch-disconnector must be provided located in an accessible position within the customer's installation which is:

- In accordance with BS 60947-3
- Must switch all live and neutral conductors.
- Must be securable in the OFF position only. It must be simple to secure using a standard padlock - devices that require a separate removable adaptor or special key to enable them to be secured are not acceptable.
- Must clearly show the ON and OFF positions and be labelled as 'PV system – main AC isolator'.

If the AC switch-disconnector and the inverter(s) are not in the same room a local isolator should be installed adjacent to the inverter(s). This is to facilitate maintenance of the AC cable run and inverter(s).

It is recommended that Inverters carry a sign 'Inverter - isolate AC and DC before carrying out work'.

Short-circuit protection for the dedicated feeder cable from the inverter(s) must be provided at the consumer unit. This electrical protection is to be specified and installed in accordance with the requirements of BS 7671.

The inverter output meter should be located where the consumer can readily observe it. In order to enable payment on exported electricity the Building Export meter, although not directly part of the PV system, should show kWh export meter and be approved by OFGEM with appropriate meter reading. The appropriate electricity supplier should be contacted to find out any particular requirements and to arrange for its fitting.

Installation/Site Work

All persons working on the live DC cabling of a Photovoltaic (PV) system must be experienced or trained in working with such systems and familiar with the voltages present on that system in particular.

All DC wiring should if possible be completed prior to installing a PV array. This will allow effective electrical isolation of the DC system (via the DC switch-disconnector and PV module cable connectors) while the array is installed; and effective electrical isolation of the PV array while the inverter is installed. This should be carried out in such a way that it should never be necessary for an installer to work in any enclosure or situation featuring simultaneously accessible live PV string positive and negative parts.

Cables are to be well supported, especially those cables exposed to the wind. Cables must be routed in prescribed zones or within mechanical protection. They must also be protected from sharp edges.

If it is unavoidable to work in any enclosure or situation featuring simultaneously accessible live PV string positive and negative parts, this must be performed either by utilising insulating gloves, tools, insulating materials for shrouding purposes and appropriate personal protective equipment (HSE HSG 85; BS EN 60903; BS EN 60900) or by covering the PV array; or by working at night (with

appropriate task lighting). When covering PV panels during installation, the covering must be opaque, cover the whole array and be well secured. A temporary warning sign and barrier must be posted for any period while live PV array cables or other DC cables are being installed.

Always test for the presence of voltage of parts before touching any part of the system. Where a residual electric shock hazard is encountered, live working practices must be adopted.

An electric shock may be experienced due to the PV array developing a ground leakage path. Good wiring practice, double insulation and modules of Class II construction can significantly reduce this problem, but in any installed systems, leakage paths may still occur. Any person working on a PV system must be aware of this and take the necessary precautions.

Inspection and testing of the completed system to the requirements of BS 7671 must be carried out and documented. Provision of this documentation is a requirement of the Building Regulations Approved Document P. The inspection and testing of AC circuits is comprehensively covered within BS 7671 and supporting technical guides. Inspection and testing documentation typically comprises 3 forms – an installation certificate, which includes a schedule of items inspected and a schedule of test results.

PV array/string performance tests are recommended to verify performance as a check for faulty modules. These will entail additional tests over and above those set out in BS 7671 and the associated guidance. This may require a means of measuring solar radiation for larger installations if radiation levels are changing during testing.

Inverters should be programmed such that the automatic protection system operates at:

- Operating voltage greater than 264 V phase to neutral
- Operating voltage less than 207 V phase to neutral
- Operating frequency greater than 50.5 Hz
- Operating frequency less than 47 Hz

Dual supply labelling should be provided at the service termination, meter position and all points of isolation to indicate the presence of on-site generation and indicating the position of the main AC switch disconnector.

At the point of interconnection, the following information is to be displayed (typically all displayed on the circuit diagram):

- Circuit diagram showing the relationship between the inverter equipment and supply.
- A summary of the protection settings incorporated within the equipment.
- A contact telephone number for the supplier/installer/maintainer of the equipment.

The requirements for larger systems connected under G99- including commissioning tests (which may need to be witnessed) are to be confirmed with the relevant DNO engineer as part of the connection application process.

All labels must be clear, easily visible, constructed and affixed to last and remain legible for the lifetime of the system.

4.0 EXISTING LV DISTRIBUTION SYSTEM

This following section of the specification document provides a detailed summary of the existing LV distribution system within the building and aims to provide a snapshot of the systems during the initial site survey.

4.1 INCOMING CONNECTION & MAIN LV PANEL

The electrical infrastructure to the building consists of a single incoming supply via a 3no. 4C 70mm² XLPE/SWA cables, installed in parallel, feeding a 1000A Form 4 Type 2 (50kA rated) switch panel.

The DNO cut-out/metering cubicle is located in the basement car park, from here the supply cables to the main LV panel board emanate and are routed to the roof. The supply cables enter the panel top entry with all outgoing ways exiting the panel at the top. The main panel is located within the externally accessed plant room on the roof. The main LV panel does not appear to have surge protection.

The incoming connection is metered at the incomer with an Elstar A1700 CT Meter (200:5). Further, none of the outgoing circuits from the LV switchgear are sub-metered. None of the existing distribution boards have any sub-meters installed either.

The main panel consists of 13No. outgoing ways serving distribution boards / equipment throughout the building. This leaves 1No. Spare outgoing way remaining. Spare outgoing ways will be required in order to ensure the new PV system can be interfaced to the existing LV distribution system.

The panel appears to have been manufactured utilising Merlin Gerin MCCB's. There are no sub meters installed within the panel or local to DB's.

During our initial site survey it was noted that the main meter within the main LV panel provided a live demand figure of 390kW.

4.2 EARTHING & BONDING

The existing earthing & bonding arrangement consists of a main copper earthing bar with earth connection for the incoming arrangement, main LV panel, incoming main pipework systems (water & gas) and lightning protection system.

4.3 SURGE PROTECTION

No surge protection has been installed within the main LV panel.

4.4 CONTAINMENT

The existing containment system comprises of medium duty cable tray and cable basket. Heavy duty tray has been installed for sub-main cabling emanating from the main LV panel.

There is an existing route to proposed PV distribution board location, the contractor will verify this on site during their site survey.

5.0 PARTICULAR REQUIREMENTS

5.1 SCOPE OF WORKS

The Contractor shall read and understand the specification and contract documentation provided for the project.

This section details the requirements for modifications to the existing LV distribution system to facilitate the installation of the new PV system and associated switchgear, equipment and cabling. This section shall be read in conjunction with all other sections of this specification and Stage 4 design & installation documents.

The new systems shall be installed, tested, and commissioned in strict accordance with manufacturer's recommendations and the standards detailed within this specification and contract documents.

The works are planned to commence outside of standard operating hours. (6pm onwards and during weekend periods) These works will need to be programmed carefully with each building operator and the client.

The Contractor will complete an asset management change control form detailing the installation of new upgraded equipment.

The proposed works shall comprise of, but not be limited to, the following:

- Enabling works / preambles
- Electrical enabling works – EICR Intrusive survey and identification of existing circuits.
- Installation of surge suppression unit to the main LV panel.
- Installation of a new high efficiency PV Panels and associated equipment (Inverters, AC/DC isolators).
- Installation of a new PV Distribution Board, sub-main, local surge suppression and MCCB to interface the existing LV installation to the new PV systems.
- Installation of energy meter.
- Installation of new containment for all new cabling.
- Installation of new fire alarm interfaces for PV inverters.
- Testing, certification, and commissioning
- Handover documentation
- 12-month defect period

5.2 ENABLING WORKS

To facilitate the PV system installation the existing LV distribution systems will need to be modified as required. The extent of the works will include the following;

- Safely isolate all circuits to allow for installation of new PV distribution board, sub-main & MCCB (once identified by EICR/intrusive survey).
- Installation of new surge suppression to main LV panel.

- Installation of new sub-main containment.
- Installation of new MCCB into exiting LV main panel.
- Installation of new sub-main for PV distribution board.
- Installation of new PV distribution board.
- Installation of energy meter & fire alarm interfaces for PV inverters.
- The contractor will confirm the location of any skips/disposal locations to the client, employer's consultant and building operators prior to commencement of site clearance works.

5.2.1 SURVEY

Prior to submitting tender returns, the contractor shall undertake a detailed-on site survey of the area of works to accurately ascertain the full extent of the works and advise of any issues or disruption that may arise from the works. Such visits are to be by prior appointment only.

5.2.2 REDUNDANT MATERIALS

Include for the safe removal of all redundant materials from site once these materials have been offered to the Client. Materials shall be periodically removed, items awaiting removal should be assembled in a safe manner and in an agreed location so as not to affect the functioning of the rest of the building or progress of work on site.

5.3 ELECTRICAL STANDARD APPLICABLE

Electrical works shall be completed in accordance with all applicable industry standards. Some of the most relevant standards associated with this section are scheduled below: -

Standards	
BS 7671	IET Wiring Regulations – Requirements for Electrical Installations
IET On-Site Guide – BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations	
All IET Guidance Notes – BS 7671 – IET Wiring Regulations – Requirements for Electrical Installations	
BS EN 61439-1	Low Voltage Switchgear and Control Gear Assemblies – General Rules
BS EN 61439-2	Low Voltage Switchgear and Control Gear Assemblies – Power switchgear and controlgear assemblies
BS EN 61439-3	Low Voltage Switchgear and Control Gear Assemblies – Distribution Boards intended to be operated by ordinary persons
BS EN 61439-6	Low Voltage Switchgear and Control Gear Assemblies – Bus bar trunking systems
BS EN 60898-1	Circuit breakers for overcurrent protection for household and similar installations AC operation

Standards	
BS EN 60898-2	Circuit breakers for overcurrent protection for household and similar installations AC and DC operation
BS EN 60947-2	Circuit breakers for industrial applications
BS EN 60947-3	Switches, disconnectors, switch-disconnectors and fuse combination units
BS EN 61009	Residual current operated circuit breakers
BS EN 60831	Power Capacitors
BS EN 61558	Safety of Power Transformers
BS EN 60529	Degrees of protection provided by enclosures
BS EN 62040	Uninterruptable Power Supplies
BS EN 62053	Electricity Metering Equipment (a.c.)
BS EN 62305	Protection against Lightning
BS IEC 61000	Electromagnetic Compatibility Limits
IEEE-519	Harmonic Limits
BS EN 60529	Degrees of Protection provided by enclosures
The Building Regulations – Approved Document L	
The Building Regulations – Approved Document M	
The Building Regulations – Non-Domestic and Domestic Building Services Compliance Guides	
All current and relevant Building Bulletin's by the DWP (Department for Work & Pensions) and other government agencies	
All current and relevant BRE (Building Research Establishment), EFA (Education Funding Agency), ICEL (The industry Committee for Emergency Lighting), ILP (Institution of Lighting Professionals) and SBD (Secured by Design) publications	
All standards, guidance and statutory regulations detailed throughout this specification.	

Where the above standards refer to supporting documentation and standards these shall be fully complied with in all respects.

Any discrepancies between this specification and the relevant standards shall be referred to Engineer via the Contract Administrator for clarification prior to submission of the tender and in the absence of this clarification the Contractor shall include the most onerous requirements.

5.4 SUB-MAIN SCHEDULE

The contractor shall adhere to the following sub-main schedule for the installation of the new sub-main.

Spare Way	Ref:/Description	Circuit Type	Cable Type	Cable Size/CPC	MCCB
RYB4	SUB1 - Sub-main for PV Distribution Board	Radial - TNS	4C SWA	1x25mm/Separate 1x16mm	Eaton NZMC1-A100 – 4 Pole 100A (BS 60947-2)

5.5 SWITCHGEAR SCHEDULE

The contractor shall adhere to the following distribution board schedule for the installation of the new distribution board.

Ref:/Description	Rating	Size	Manufacturer	Metering
DB/PV - PV Distribution Board	125A	6 - Way	Eaton – TPN Mem 3 / Type B	MID Compliant meter installed within LV panel.

5.6 CONTAINMENT SCHEDULE

The contractor shall adhere to the following distribution board schedule for the installation of the new distribution board.

Ref:/Description	Size (WxH)	Manufacturer	Support
C1 – Sub – main LV cable tray.	100x50mm	Legrand	Unistrut arm support from building fabric.
C2 – PV circuits LV cable tray.	100x50mm	Legrand	Unistrut arm support from building fabric.

5.7 PV INVERTER SCHEDULE

The contractor shall adhere to the following distribution board schedule for the installation of the new distribution board.

Ref:/Description	Manufacturer/Model	No. of Strings
INV1 - PV Inverter 1	SMA Sunny – Tripower X12	3 Strings

5.8 FIRE ALARM INTERFACE SCHEDULE

The contractor shall adhere to the following distribution board schedule for the installation of the new distribution board.

Ref:/Description	Serving	Manufacturer
FAI1 – Fire Alarm Interface	INV1 – PV Inverter 1	As incumbent system

5.9 GENERAL LV DISTRIBUTION REQUIREMENTS

5.9.1 DISTRIBUTION REQUIREMENTS

The contractor shall install test and commission low voltage distributions so that the Volt drop at each panel will be limited to 3%, thus allowing the further 2% for the field wiring. All necessary equipment and accessories for the complete and working installation shall be provided. This may include equipment and accessories not detailed within this Specification but are usually used in the course of construction and good workmanship practice.

TRANSIENT SURGE PROTECTION

The LV distribution panel, PV distribution board, or any other distribution board or services that supply external services, shall incorporate integral surge protection equipment.

The equipment shall provide protection of surge currents in excess of 10kA.

Surge protection and power factor correction shall also be incorporated into the LV system, within the main/ sub main switch panel.

Where a lightning protection system is installed to the building, surge protection shall be provided as detailed within BS62305-2.

Where no lightning protection system is installed, surge suppression shall comply with BS7671:2018

LOAD BALANCING

It is the contractor's responsibility to ensure that load balancing is achieved through all stages of the project, including alterations when commissioning, that may be required to improve or maintain the calculated load balance, or for any modifications that may be undertaken to the design during construction.

WIRING

Wiring of the LV Distribution system shall be carried out utilising XPLE/AWA/LSOH and XPLE/SWA/LSOH cables installed direct to the building fabric or fixed to a suitable rack/tray system. The containment system shall be routed down the main services routes. Cable baskets will not be considered or permitted for LV distribution system wiring.

All submains cabling shall be fixed via suitable fixings at distances recommended by the manufacturer.

All wiring, containment, glands, lugs, fixings etc... shall be provided as part of the LV Distribution system. All sub main cables shall be suitably rated for the application.

Terminations shall be carried out using approved type brass compression glands with earthing tags and LSOH shrouds. Earthing rings shall be secured to the item of equipment utilising a minimum of a M6 brass nut and pin. A CPC of suitable size shall be installed between the brass pin and nut to the earthing bar on each item of equipment.

Cable terminations into the Distribution Panel shall be such that they do not impede the future installation of outgoing supplies.

All cables shall be installed in accordance with the manufacturer's recommendations. All cables shall be fixed, at intervals recommended by the manufacturers.

All final circuit cable terminations into terminals within the distribution boards and panels shall be identified with Z-type slide on cable identification markers. The markers shall indicate the unique circuit references.

Where cables pass through fire compartments, a suitable fire barrier, or fire-retardant material shall be installed to ensure the integrity of the fire compartment is maintained.

Where cables pass through acoustic barriers, a suitable barrier or material shall be installed to ensure the integrity of the acoustic barrier is maintained.

Only mechanical fixings will be permitted. Adhesive fixed cable supports and fixings will not be allowed.

All cables terminating into enclosures external to the building shall be via a bottom entry arrangement.

All cables shall be LSOH and be BASEC approved and fully compliant with the Construction Products Regulation.

G99/98 CONNECTION OF GENERATION EQUIPMENT

The PV system shall be connected in parallel with the DNO network and will need to be provided with the relevant connection agreement. A relay shall be provided to disconnect the supply to the inverters if the AC output from the PV system or the AC output from the grid itself strays outside of the voltage parameters set by the Distribution Network Operator.

The relay shall also disconnect the PV system in the event of a phase failure or a grid failure, removing any danger of the buildings network remaining live despite the loss of the main distribution network.

The contractor shall be completely responsible for acquisition of the G98/99 relay agreement from the DNO.

MCS / CERTIFICATE OF COMPLIANCE

Upon completion of the installation a valid Microgeneration Certification Scheme Certificate shall be issued. The contractor and their accredited Specialist Contractor shall be completely responsible for successfully registering the installation with the scheme.

Alternatively, where systems are in excess of 50kw, the Specialist Contractor shall provide a Certificate of Compliance including all supporting calculations to validate the system and demonstrate that it meets the required criteria.

5.9.2 DISTRIBUTION BOARD REQUIREMENTS

The contractor shall install suitable metallic final distribution boards and associated supplies to serve all items of equipment, as necessary. New distribution boards shall be compatible with the existing Main LV Distribution Panel.

The new distribution board shall be supplied from the Main LV Distribution Panel. Final distribution boards shall not be supplied from other final distribution boards, nor shall more than one distribution board be supplied from a single sub-main supply.

The distribution boards shall be designed as a minimum to conform with BS EN 61439-2: 2011. The distribution boards shall be provided with suitably rated incomers.

The Distribution Boards shall be suitable for the intended incoming supply characteristics, and location into which they are to be installed.

All distribution boards will be provided with MCB/CB's for circuit protection. Distribution boards will be provided and will be capable of providing single or three phase power. All distribution will be sized with a minimum spare capacity of 25%.

Each distribution board/panel shall be complete with hinged cover and factory fitted locks, each of which shall be provided with 2No. keys.

Every distribution board and distribution panel shall be clearly labelled with a unique reference number mounted on the hinged door. Comprehensive typed circuit charts shall be located within each distribution board/panel, and shall provide the following details: -

- Circuit reference and phase
- Device type
- Device rating (the minimum rating of a CB/MCCB device shall be not less than 10A)
- Circuit description

- Cable type
- Cable size
- CPC size
- Circuit load

a)

The heading of each distribution board schedule shall detail the following:

- Project reference
- Incoming supply main switch size
- Location
- Distribution board type and size
- Distribution board reference
- Fault level
- Earth loop impedance
- Incoming cable size and type and supply origin

All distribution boards and circuit protective devices shall be of the same manufacturer and be provided in the manufacturer's standard colour. All circuit protective devices shall only take-up one way in a distribution board. Devices that utilise two or more ways in a distribution board will not be permitted. Each distribution board shall be provided with voltage warning notices and identification labels. All distribution boards shall be metallic and finished in the manufacturers' standard finish.

Where appropriate each distribution board shall be provided with voltage warning notices, RCD labels, high integrity earthing labels, next inspection date labels, and identification labels. All distribution boards shall be metallic and finished in the manufacturers' standard finish. All items of switchgear shall be complete with labels, operating instructions, padlocks etc.

The meters shall not be connected directly to the incoming supply and shall be powered via suitably rated current transformers located in a dedicated compartment of the switchboard. The meters shall be correctly calibrated and manufacturers test certificates shall be submitted within the O&M Manual.

Where header trunkings are fitted to distribution boards, the minimum size of the header trunking shall be 150mm x 150mm. Header trunkings shall be fixed to distribution boards with a slotted board arrangement to protect cabling, bushes shall not be used to connect the header trunkings to any distribution board.

Submains serving distribution boards shall not be routed through the distribution board via a top entry arrangement. All submains/supply cabling shall be bottom entry. All final circuits shall exit the distribution board at the top through a slotted board arrangement to protect cabling, bushes shall not be used to connect the header trunkings to any distribution board.

Sheathed type cables shall not be glanded directly into the top of distribution boards. Every distribution board shall be provided with minimum 150mm x 150mm header trunking

ENERGY METERING

The Electrical Contractor shall supply, install and commission accessible electricity energy meters within the installation, and as required in contract documents and relevant standards/regulations, in particular the Building Regulations Part L2. This shall include electricity energy meters for all electricity supplies to all distribution boards, items of plant and equipment.

All items of switchgear shall be complete with metering arrangement monitoring the incoming supply. This shall comprise a multi-function digital meter having the facility to indicate as a minimum the following via push button selectors:

- Accumulative kVA demand
- kVA maximum demand
- kW maximum demand
- Instantaneous power factor
- Instantaneous current for each phase
- Instantaneous voltage for each phase

The electricity meters shall each be provided with a pulse output ability, suitable for remote monitoring by a building management system (BMS), with connection made by either RS232 or RS485 connection, as required.

The meters shall be installed at within the body of the Main LV Distribution Panel, providing suitable cableway/side extension panels for the housing of the meters, where used for monitoring single loads

5.9.3 MCCB'S/CONTROL REQUIREMENTS

The contractor shall install the new modifications to the LV distribution system to provide suitable means of control. Isolation of outgoing circuits from the main LV panel & distribution boards shall be by means of disconnection by the circuit protective device. This shall include;

- Isolation devices
- Circuit protective devices
- Switching devices

5.9.4 EARTHING/BONDING REQUIREMENTS

The contractor shall provide new earthing and bonding, as required, throughout all areas of the building to incorporate the new switchgear, sub-mains and associated equipment into the existing earthing and bonding system.

Exposed conductive parts and extraneous metal work to be bonded with supplementary bonding conductors shall comprise: (not exhaustive)

- External plant and equipment
- Metal frame supports for PV Panels.

b)

The contractor shall install conductors of appropriate cross-sectional area (CSA) for the installations.

Each main bond terminating onto the main earthing bar shall be clearly labelled to identify its purpose. All other earthing terminations shall also be clearly labelled

"SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE"

Where cables pass through fire compartments, a suitable fire barrier, or fire-retardant material shall be installed to ensure the integrity of the fire compartment is maintained.

Where cables pass through acoustic barriers, a suitable barrier or material shall be installed to ensure the integrity of the acoustic barrier is maintained.

All cables shall be LSOH and be BASEC approved and fully compliant with the Construction Products Regulation.

5.9.5 CONTAINMENT REQUIREMENTS

The contractor shall supply and install a containment system to distribute the new electrical services.

The containment systems shall be supported by and fixed to proprietary pre-manufactured brackets and supports and/or strut support systems. Threaded rod droppers and supports shall be used as appropriate. Plastic end caps shall be inserted into ends of all strut supports and to the ends of all threaded rods. Where possible, the containment systems shall share the same support systems of other cable containment systems and mechanical services.

All joints, bends, cross sections, T-pieces etc. shall be made utilising proprietary manufactured sections. Site manufactured sections will not be permitted. Zinc based oxide inhibiting paint shall be applied to all edges where the containment systems are cut or drilled.

Externally mounted cable tray and or ladder systems shall be complete with proprietary lidded sections along its entire length.

All external containment systems including bracketry shall be of a steel construction and have a hot dipped galvanised finish. The galvanising process must be applied as part of the final manufacturing process after slots have been punched out to ensure all surfaces are fully protected.

The containment systems shall be routed parallel and perpendicular to the building fabric and structural elements. The routes of the containment systems shall be fully coordinated with other trades and building elements.

Consideration must be taken to ensure all parts of the containment systems are installed within readily accessible locations for future cable installation. Generally, this should be no more than 500mm above the ceiling level.

6.0 TENDER SUMMARY

engineering services works tender summary:

1.	Services Preambles	£
2.	PV Equipment & Installation	£
3.	Roof Mounting System	£
4.	Lightning Protection works	£
5.	Associated Electrical Works	£
6.	Builderswork	£
7.	Testing, Commissioning, Witnessing & Training	£
8.	O&M Manuals & As Fitted Information	£
	Sub Total	£
	Contractor's items:	
1.		£
2.		£
3.		£
	Total for Engineering Services	£

Signed:

Date:

For and on behalf of:

RLB.com

AFRICA | AMERICAS | ASIA | EUROPE | MIDDLE EAST | OCEANIA

