Structural Report on Installation of Roof PV Array at Congleton Town Hall, High Street, Congleton CW12 1BN

September 2024

PEARSON DESIGN & PROJECT MANAGEMENT LTD

Authored by: Allan Parsonage MEng (Hons) CEng MIStructE

PEARSON
DESIGN & PROJECT MANAGEMENT

Table of Contents

1. Introduction 3
2. Survey Commentary 4
3. Assumptions and Limitations 5
4. Structural Appraisal 6
5. Conclusion and Recommendations 8
APPENDIX A – SURVEY PHOTOGRAPHS 9
APPENDIX B – PROPOSED PV SYSTEM DATA 12
APPENDIX C – MUSEUM ROOF SNOW DRIFT CALCULATION 13

1. Introduction

1.1 In accordance with the instructions received from Congleton Town Council, Pearson Design and Project Management (Pearson DPM) were asked to undertake a structural appraisal and assessment of the existing roofs at Congleton Town Hall, located at High Street, Congleton CW12 1BN. The assessment is intended to support the installation of proposed PV panels as an additional feature to one of two existing pitched roofs of the building, with the exact decision on which of the two locations still to be decided. The figure below illustrates the plan view of the roof, indicating the two potential proposed locations; Location 1 on the main upper roof of the building over the Grand Hall, and Location 2 on the lower annexe roof of the Museum at the rear.

1.2 An inspection of the building and the existing roof structure was undertaken on the afternoon of 12th July 2024. Access was facilitated on the day by the Client.

1.3 This report, and the assessment it relates to, is based on the proposed PV system specification as detailed in Pearson DPM Drawing 2402-E002-T1 and PV Performance Specification (Rev T1) dated August 2024, as well as the S-Flex Mounting System Datasheet (Refer to Appendix B).

2. Survey Commentary

2.1 The survey was conducted by Allan Parsonage (MIStructE) on July 12th, 2024.

2.2 During the survey inspection, it was clearly observed that the roof of the building comprised traditional cut timber pitched rafters, supported on timber purlins back to either timber and steel ornate trusses (Grand Hall) or load-bearing masonry walls (Museum).

2.3 No detailed construction record drawings were available for the existing building.

2.4 The survey included a general examination of the roof structure and its overall condition, limited only to accessible areas where either the structure was exposed and clearly visible (Grand Hall) or where a head and shoulders view into the roof space above the suspended grid ceiling could be safely undertaken (Museum). No access up into the ceiling void was undertaken, nor any detailed close-up inspection at height of any structure.

2.5 In the Grand Hall, the visible elements of the existing roof structure (timber rafters, timber purlins and timber/steel trusses) were seen to be in good overall condition for their age, showing no obvious signs of significant structural deterioration or damage, and also of a generally robust and sizeable nature.

2.6 In the Museum, the visible elements of the existing roof structure above the ceiling were seen to be in a more varied condition overall, with a number of steel beams in place where walls and or chimney breasts appear to have been historically modified or removed within the building, and the timbers were seen to be generally of a smaller and less robust size and section.

2.7 No samples of materials were removed from site for testing or analysis as part of this survey.

2.8 A number of photographs taken during the survey are provided in Appendix A for information.

3. Assumptions and Limitations

3.1 The opinions expressed in this report are based solely on the findings of the survey and the relevant existing information made available at the time.

3.2 The structural assessment of the existing roof was conducted using Eurocode 1 typical roof loading criteria, considering access for maintenance purposes only (BS EN 1991-1-1:2002 Table NA.7).

3.3 The roof pitches were not easy to ascertain during the survey, but in both cases were reasonably deemed to be in excess of 30 degrees in both locations.

3.4 Drainage of the roofs is assumed to be in adequate condition, with no likelihood of water ponding on the roofs.

4. Structural Appraisal

4.1 PV System Weight

Based on the information provided on drawing 2402-E002-T1 for the proposed 'Longi 430W LR5-54HTH-440M Explorer' PV panels (Refer to Appendix B): -

Weight of a Single Panel	=	20.8kg (0.20kN)		
Plan Area of a Single Panel	=	1.722m x 1.134m	=	1.95m^2
UDL Weight Per Panel	=	0.20kN / 1.95m^2	=	0.10kN/m^2

Allowing a further conservative 0.02kN/m^2 (2kg/m^2) for the lightweight S-Flex framing support system and cabling/trunking: -

Total System UDL on the Roof = 0.12kN/m^2

4.2 Existing Roof Imposed Loading

The 'maintenance access-only' existing pitched roofs can reasonably be argued to have a minimum allowable imposed loading of 0.6kN/m^2 in accordance with historic Codes of Practice, making wind loading less critical in determining roof imposed loading.

Considering the new PV loading as appraised above, which will replace the typical roof imposed roof loading as the roof area will not be walkable in the footprint where the PV panels are located: -

Load of PV System < Maintenance Access Only Imposed Loading Allowance

Thus, the installation of the proposed PV panels on either roof is considered feasible in terms of the existing roof imposed loading allowance alone.

There is however some concern structurally regarding the Museum roof given the generally less robust construction, and the less favourable overall condition and structural alterations noted during the survey.

4.3 Existing Roof Snow Loading

The upper duo-pitched roof above the Grand Hall would not be subject to any potential snow drift loading as it is higher than all adjoining roofs, and therefore only the general blanket snow loading needs to be considered.

In accordance with EN1991-1-3 for the persistent/transient design situation (non-drift), and for a roof with a pitch of 30 degrees (conservative): -

Snow Load on the Roof = 0.8 (μ_1) x 1.0 (C_e) x 1.0 (C_t) x 0.3kN/m^2 (s_k) = 0.24kN/m^2

Assuming snow in addition to the proposed PV system weight therefore: -

Total Load on the Roof = 0.12kN/m^2 + 0.24kN/m^2 = 0.36kN/m^2

Load of PV System + Snow < Maintenance Access Only Imposed Loading Allowance

Thus, the installation of the proposed PV panels on the upper Grand Hall roof is considered feasible in terms of the existing roof imposed loading allowance even when anticipated snow loading is factored in addition.

The lower hipped duo-pitched roof above the Museum however would be subject to snow drift against the adjoining wall of the higher Grand Hall, and therefore this increased snow drift loading needs to be considered.

Referencing the detailed snow drift loading calculations in Appendix C:-

Max. Snow Drift Load on the Roof = 0.98kN/m^2

Assuming snow in addition to the proposed PV system weight therefore: -

Total Load on the Roof = 0.12kN/m^2 + 0.98kN/m^2 = 1.10kN/m^2

> Load of PV System + Snow Drift > Maintenance Access Only Imposed Loading Allowance

Thus, the installation of the proposed PV panels on the Museum roof is considered not feasible in terms of the existing roof imposed loading allowance when anticipated snow drift loading is factored in addition. The existing roof dead load would therefore need to be reduced instead, to free up loading allowance which would offset the additional PV system loading.

5. Conclusion and Recommendations

5.1 Based upon the structural survey and review of the PV loading, Pearson DPM confirm that it is feasible to install the proposed PV units on the existing upper roof above the Grand Hall, subject to compliance with the following considerations: -

- The additional loads from the proposed PV system are as per that detailed on the Pearson DPM drawing 2402-E002-T1 and on the S-Flex mounting system data sheet. Any change to the proposed system is to be notified to Pearson DPM immediately for further reassessment of the loadings.
- The installer is to provide sufficient connections to safely support the PV units and mounting system to the roof. The connection details are outside of this appraisal.
- The installer is to ensure no impact is made on the existing roof drainage systems and to ensure that the existing waterproofing system is not compromised in any way.

On the lower roof above the Museum however, Pearson DPM confirm that it is only feasible to install the proposed PV units, subject to the following additional measure, as well as compliance with the same points above: -

- The removal of the existing heavy slates covering the roof, and replacement with new lightweight fibre cement artificial slates. This will reduce the existing roof dead load by a sufficient amount to offset the additional weight of the proposed PV system, and thus leave the full roof imposed loading allowance available for both maintenance access and also potential snow drift loading.

APPENDIX A – SURVEY PHOTOGRAPHS

APPENDIX B – PROPOSED PV SYSTEM DATA

NOTES:

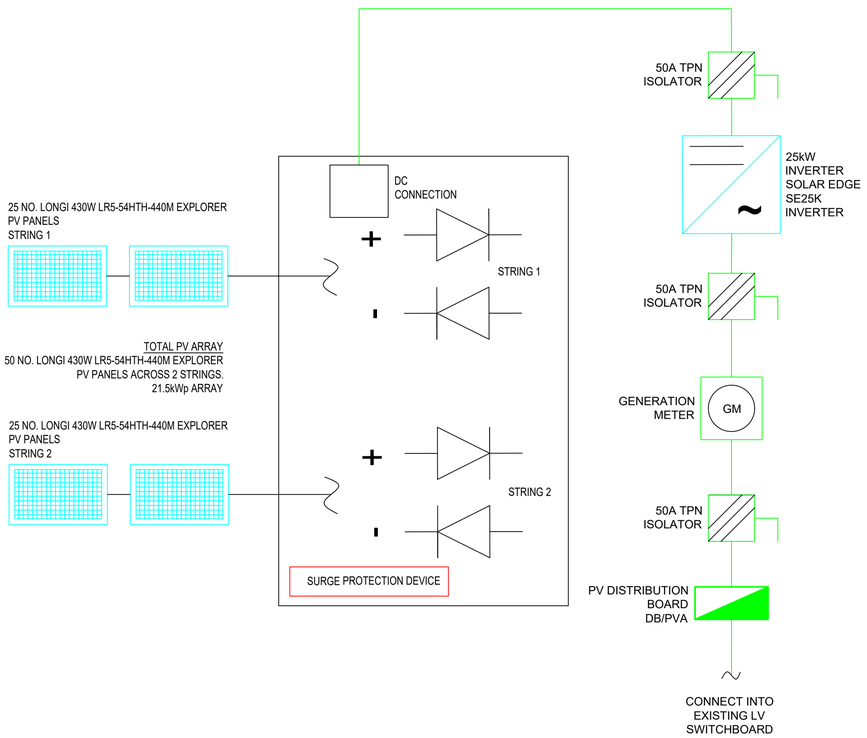
1. DO NOT SCALE OFF THIS DRAWING.
2. ALL DRAWINGS TO BE READ IN CONJUNCTION WITH THE RELEVANT MECHANICAL AND / OR ELECTRICAL SPECIFICATION(S).
3. ALL DIMENSIONS SHOWN ARE IN mm UNLESS SHOWN OTHERWISE.
4. THE PV SYSTEM DESIGN SHALL BE BASED UPON SOLAR EDGE AS DETAILED.
5. THE CONTRACTOR SHALL ENSURE THE PV PANELS COMPLY WITH THE DEFRA SOLAR PANEL PROCUREMENT AND FORCED LABOR RISK MITIGATION GUIDANCE.
6. ALL ROOF MOUNTED CABLE TRAY SHALL BE GALVANISED WITH GALVANISED COVERS.
7. ALL PHOTOVOLTAIC PANELS SHALL BE WIRED & INTERCONNECTED USING ELAND CABLES H1Z2Z2-4 CABLE OR EQUIVALENT, SIZE 4mm² SSA, TO COMPLY WITH BS EN 50618 OR EQUAL AND APPROVED.
8. A SPECIALIST CONTRACTOR SHALL BE EMPLOYED FOR THE DESIGN, SUPPLY, INSTALLATION AND COMMISSION OF THE NEW PHOTOVOLTAIC SYSTEM.
9. PV STRING GENERATOR JUNCTION BOX WHERE APPLICABLE IN THE DESIGN SHALL CONTAIN BLOCKING DIODES AND SURGE PROTECTION DEVICE.
10. ALL NEW PHOTOVOLTAIC FRAME SUPPORT SHALL BE BONDED TO THE EXISTING LIGHTNING PROTECTION NETWORK (ROOF).
11. THE CONTRACTOR SHALL ALLOW FOR ISSUING FULL DETAILS OF WEIGHTS AND SIZES TO THE STRUCTURAL ENGINEER PRIOR TO INSTALL ETC TO ENABLE ANY ROOF SUPPORT OR REINFORCEMENTS TO BE DESIGNED IN IF REQUIRED TO SUPPORT THE NEW SYSTEMS.
12. THE CONTRACTOR SHALL ALSO ADVISE OF ALL THE PROCUREMENT DETAILS AND LEAD IN TIMES FOR ALL ASSOCIATED PV PANELS AND EQUIPMENT.
13. THE CONTRACTOR SHALL ALLOW FOR FULL LIAISON WITH THE END USER TO AGREE INSTALLATION DATES AND ANY DOWNTIME REQUIRED FOR CONNECTION BACK INTO EACH BLOCKS ELECTRICAL SWITCHGEAR.
14. THE SPECIALIST PV CONTRACTOR EMPLOYED BY THE CONTRACTOR SHALL MAKE ALL NECESSARY G99 STATUTORY METER APPLICATIONS UPON APPOINTMENT.

Longi 430W LR5-54HTH-440M Explorer	
25-Year warranty for materials and processing. 25-Year warranty for extra linear power output – Panel efficiency: 22.5% – Dimensions: 1722 x 1134 x 30mm – Weight: 20.8kg	

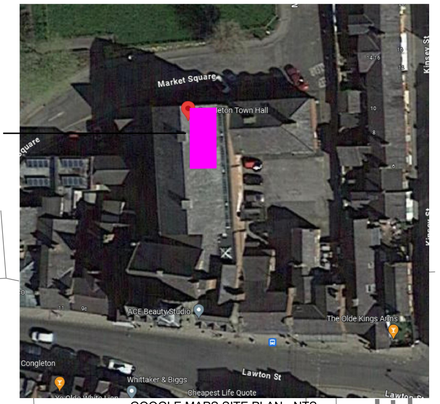
Solaredge SE25K Inverter	
12 year (can be extended to 20) manufacturer's parts and replacement warranty for inverter – 98% efficiency – G98 approved single-phase inverter for use on UK grid – Installed local to mains incomer	

Solaredge Power Optimisers	
25 years manufacturer's parts and replacement warranty for Power Optimisers – Maximises power output and enables monitoring of individual PV panels – Located beneath PV panels on roof	

Total Generation Meter	
MID approved 3-phase generation meter to measure kWh of solar energy generated. – Modbus comms enable remote metering via Solaredge monitoring portal – Located between inverter and AC connection	



PROPOSED PHOTOVOLTAIC SCHEMATIC - NTS



GOOGLE MAPS SITE PLAN - NTS

PROPOSED PHOTOVOLTAIC LAYOUT
SCALE - 1:100

PROPOSED VACANT WALL SPACE ADJACENT TO ELECTRICAL SWITCHGEAR IS TO HOUSE NEW PV INVERTER

Rev	Date	Description
T1	15.08.2024	TENDER ISSUE

Client & Site: CONGLETON TOWN HALL
CONGLETON TOWN COUNCIL
7 HIGH STREET, CONGLETON
CW12 1BN

Title: PROPOSED PHOTOVOLTAIC LAYOUT

PEARSON
DESIGN & PROJECT MANAGEMENT

Date: JULY 24 Scale: 1:100 Size: A0 Drawn: AW Chkd: CP

Drawing No. 2402–E002 Rev: T1

STAGE 4

PEARSON
DESIGN & PROJECT MANAGEMENT

Congleton Town Hall
High Street, Congleton, CW12 1BN

PSDS – PV Performance Specification – T1

August 2024

Congleton
Town Council

info@pearsonsurveyors.co.uk
Liverpool / Cheshire **0800 3029 995**

Revision Record

Date	Reference	Revision	Prepared By	Checked By
15/08/2024	2402	T1	AW	CP

Contents

1.0 SCOPE OF WORKS 4
General 4
Drawings & Design Information 5
Submissions with Tender 6
Site Visits 7
Working Conditions 7
Responsibility 8
Builderswork 8
Asbestos 8
Structural 9
Electrical Compliance 9
2.0 MAINS AND SUB-MAIN DISTRIBUTION 10
Main Distribution & Supply 10
Distribution Boards 10
Sub-Main Cabling 11
Distribution Cable Tray Systems 12
Distribution Cable Trunking Systems 12
System Earthing and Bonding 13
3.0 GENERAL EQUIPMENT 14
Conduit 14
Conduit Boxes 14
PVC Conduit 14
PVC Conduit Boxes 15
Uni-Channel 15
Cabling 15
Flexible Conduit 16
Equipment Safety 16
Schedule of General Accessories 16
4.0 PHOTOVOLTAICS 18
Site & Locations 19
Building 19
Existing Systems 19
Proposed Systems 20
Access & Scaffolding 20
Testing and Commissioning 21
Maintenance 21

1.0 SCOPE OF WORKS

General

This project involves the installation of a photovoltaic system on the roof of the Congleton Town Council Building in Congleton Town Centre, CW12 1BN.

It should be noted that this site will remain live throughout the works. The installation is to take place in line with the project programme and care shall be taken in respect of working on a live site with the building being occupied 7 days a week.

It is anticipated that this work shall start June 2025.

As this work forms part of a wider Public Sector Decarbonisation Scheme, this particular site will also have major works being carried out during the same period of time and all contractors will need to engage, programme and "buy into" the overall master programme of works. For clarity, the following works will be carried out: -

1. Photovoltaic Array / Installation Works
2. Air Source Heat Pump / Heating Upgrade Works
3. LED lighting upgrades
4. Building fabric upgrades

The Principle (PV) Contractor shall be made aware that all works carried out must be carried out whilst the building/site is potentially live albeit at reduced capacity. The works to be undertaken shall be carried out to ensure the minimum amount of disruption is caused to the day to operations.

Generally, the photovoltaic systems shall comprise of roof mounted photovoltaic panels connected to DC/AC inverters installed within the roof space or plant areas as identified on the drawings. A new distribution board and sub-main cable shall be installed to facilitate power distribution to/from the system. The installation of a generation export meter will be required to determine the amount of electricity produced by the system and subsequently exported back to the grid. A public display meter shall be installed within the main entrance to demonstrate to visitors the amount of renewable energy being produced by the system/building.

Note, G99 applications will be made on the Clients behalf during design development stage.

The Principle (PV) Contractor shall be considered as the main contractor under this contract. The Principle (PV) Contractor is to tender for the design, supply, installation and commissioning of the complete photovoltaic installation to be installed on each building. The Principle (PV) Contractor will responsible for the delivery of the contract on a 'turnkey' basis. The Principle (PV) Contractor will be entirely responsible for all aspects of design, installation and commissioning, including fulfilling all administrative requirements (i.e. completing applications to planning if required) and completing all health and safety documentation and reporting back to the Consulting Engineer and Client on a regular basis.

The Consulting Engineer has provided the Principle (PV) Contractor with this performance specification and the attached electrical services drawings which shall be used by the Principle (PV) Contractor as guidance only. The purpose of this information is to assist the Principle (PV) Contractor in developing their own designs.

The Principle (PV) Contractor is to ensure that they make full allowance within their contract sum analysis for all builders work requirements in connection with the electrical installation.

Note – This spec shall be read in conjunction with the following information being:-

- PSDS feasibility documentation
- The accompanying indicative PV drawing
- Asbestos register
- Congleton Town Council standard specifications (available on request)

It should be noted that the extent of this specification is performance details only and has been prepared to translate the client's requirements into a document that enables the principle (PV) contractor to prepare comparable competitive designs and quotations. The design will remain the full responsibility of the principle (PV) contractor who will be expected to enter in to a design warranty.

The principle (PV) contractor is to ensure that they and any sub-contractors familiarise themselves fully, with the plans and details. No claim will be entertained based on a lack of knowledge of the site and the constraints within it. This is a design and build contract will full contractor design responsibility and fully inclusive.

The installation is to be strictly carried out in accordance with the relevant British Standards codes of practice, local authority requirements and the recommendations of CIBSE and Mersey Cares unique site requirements.

Upon completion of each installation, each system shall be tested, commissioned and left in full working order allowing immediate use following handover.

Drawings & Design Information

The drawings accompanying this performance specification are as follows:-

	Congleton Town Hall	
2402-E002	Proposed Photovoltaic Layout	T1

It must be clearly understood by the M&E Contractor that Tender Drawings show indicative design intent only in regard to system selections, service routes and locations of items of equipment.

Within an agreed time period following appointment, the principle (PV) contractor is to provide at their own expense, full detailed working drawings and design data indicating the design, layout of services and schematics for each installation, included in the tender.

The extent of the drawing requirement shall include the following:

a. Scaled floor plans of all services including roof pans.

b. Sufficient sections to show all riser details, trunking suspensions and bracketry details.

c. Sub-main wiring schematic with wiring diagrams showing cable types, sizes, etc., other schematics.

d. Dynamic modelling using recognised software

e. Basic asbestos R&D report focussed on the work areas

f. Structural survey report

g. Electrical periodic certificate

The extent of the design data shall include the following:

a. Full sub-main and sub-circuit cable calculations to BS7671,17th edition of the IEE wiring regulations.

b. Full CPC sizing calculations, with EFFL and fault current determination along with discrimination verifications.

c. AC cabling/ DCs string cabling calculations.

d. PV array sizing/output calculations – using CIBSE weather files for the specific area/address given for each site.

e. Inverter loading/sizing calculations.

d. Builders work drawings.

Following completion of the drawings, they shall be submitted to the Client for comments. Should the drawings require amendment, they shall be suitably revised within a two week period and re-issued for comments. Following comments the drawings will be declared 'Issued for Construction' and issued to all parties.

Should variations occur then all drawings shall be kept up to date and re-issued with the appropriate amendment reference.

Submissions with Tender

The principle (PV) contractor shall ensure that they submit with the contract analysis sum the following information:

a) The completed tender breakdown clauses 2.1 with clauses 2.2, 2.3 and 2.4. It should be noted that there is strict control on the funding of this project and it is extremely important that the cost breakdowns indicated in the tender are adhered to.

b) A covering letter with any discrepancies and exclusions.

c) Notification of any variations to this performance specification and any reasons why.

d) Notification of any extended delivery periods, i.e. any items of equipment over six weeks.

e) All sub-contractors proposed for the project shall be declared within the tender package.

f) A list of selected manufacturers for all main plant and equipment.

g) Contract risk assessments

All of the above information shall be submitted with the tender to the Consulting Engineer within the specified date and time. Failure to comply with this requirement may disqualify the tender and shall be strongly adhered to.

Site Visits

A site visit may be made to the premises with arrangements made through Congleton Town Council. Forty-eight hours notice must be given to allow the necessary arrangements to be made.

The principle (PV) contractor is **strongly** recommended to visit each building as no claim will be accepted by the Consulting Engineer with respect to the lack of knowledge of the building and the constraints within it as well as the extent of existing services.

It is imperative the principle (PV) contractor visits site to view all areas of proposed work.

Without this visit the contractor will not be able to provide a tender bid that provides a true reflection of the works required.

Working Conditions

The principle (PV) contractor shall make due allowance and the necessary provisions for carrying out the works on a building that is potentially partially occupied.

Each site has different requirements and so the principle (PV) contractor will be required to provide a schedule of work in advance to the project manager so that sufficient resources can be allocated to complete the works on schedule. It may be necessary for the principle (PV) contractor to reschedule the works at the request of the client, at any time, depending on the availability of resources and activities. **The principle (PV) contractor shall make adequate provision for dealing with elements of work to be carried out during 'out of hours'.**

All possible care shall be taken in the execution of the works to ensure that there is the minimum of disruption and nuisance to the normal activities of the premises and surroundings. This will entail close liaison and co-operation with the caretaker / building manager.

Where applicable the principle (PV) contractor shall be responsible for maintaining the existing building fabric and all furnishings in good order throughout the contract and shall provide all necessary protection required e.g., dustsheets.

The contractor shall be entirely responsible for the removal and replacement of all furniture and equipment as required for the purpose of carrying out the works detailed in this specification.

The contractor shall provide and erect purpose built barriers with prominent warning notices to guard against hazard. The contractor must be alert to the fact that the premises are occupied and great care must be exercised at all times to ensure that all corridors and circulation areas are kept free from all tools, trailing leads, materials or other obstructions, other than barriers and rails specifically placed to protect the occupants and employees of the premises.

The contractor shall include within their tender for regular and coordinated site meetings (each Monday morning) with the other specialists carrying out work during this period.

Responsibility

The appointed contractor shall take full responsibility for the design and installation of the services installation and shall ensure full operation in all respects as detailed in the specification.

Upon acceptance of the tender figure the contractor shall submit his design drawings to the Consulting Engineer for comments. Comments will be given in principle only and the responsibility for the design will still be that of the contractor.

Builderswork

Builderswork shall be the responsibility of the principle (PV) contractor. Note, the PV specialist shall act as principle contractor although not principle designer. CDM requirements will be included, implemented, managed and executed by the Client.

Holes through walls/floors, chases for cable and drops shall generally be marked on site. However, if any part of the works requires a more detailed builderswork provision, builderswork drawings shall be issued as necessary.

All builderswork shall be submitted to satisfy the programme of works.

Should it not be possible to exactly define a builderswork requirement for any reason within the agreed programme this must clearly be stated to the Client within good time to enable suitable action to be taken.

Prior to cutting any large holes or cutting out major builderworks apertures, the Principle (PV) Contractorwill notify the Mersey Care project manager and care centre manager so that arrangements can be made to minimise the level of disruption caused to the operation of the facility and to the service users.

Asbestos

The principle (PV) contractor shall, at their own expense, include and have carried out a basic R&D asbestos survey of the areas being worked in, holes being cored and general areas inc switchrooms to ensure that the work can be carried out without any asbestos risk.

The principle (PV) contractor shall also see sight of the building asbestos register for clarity and guidance.

Note – as this work is carried out during a strict timeframe on a grant drawdown facility, the Client cannot afford for any delays, downtime etc and as such, the principle (PV) contractor will be deemed to have included for all things necessary to facilitate this.

Structural

The principle (PV) contractor shall include within their tender for the survey and confirmation (in basic report format), that the photovoltaic panels / array can be accommodated on the existing roof.

The sites includes flat roof areas only. The principle (PV) Contractor shall provide the most suitable means of installation methods i.e. A frames, weighted ballasts etc..

This confirmation document shall be issued to the client before any works commence.

Although the principle (PV) specialist can nominate their own specialist, we would recommend using:-

Pearson Surveyors Ltd
7, 4 St Pauls Square
Liverpool
L3 9SJ

Chris Pearson – 07876-443-520

Electrical Compliance

Prior to works commencing, the principle (PV) specialist shall appoint an approved Principle (PV) Contractor to carry out a periodic inspection of the installation but specifically to review the existing switchgear, distribution boards etc.

The intention is to clarify that the PV system, AC/DC string lines and inverters can all be installed and accommodated onto the system whilst maintaining compliance with the IEE wiring regulations and 18th edition documentation.

Although the principle (PV) specialist can nominate their own specialist, we would recommend using:-

KDE Ltd
Greenfields
Chester Road
Sutton Weaver
Cheshire
WA7 3EG

Tel – 01928-711-444

2.0 MAINS AND SUB-MAIN DISTRIBUTION

Main Distribution & Supply

The principle (PV) contractor will be responsible for making alterations to the existing LV distribution system to accommodate a new distribution board that will serve the new photovoltaic installation that is to be installed.

The new proposed distribution boards DB/PV will be supplied from the main panel or a sub distribution board depending on further site survey work. The principle (PV) contractor is required to visit site to determine the type of existing panel/board and the breaker technology that it uses.

The contractor is required to install a new fuse or MCCB, or similar in a spare single or three phase outgoing way (depending on building load) within the panel/board to facilitate the supply to the new distribution board. The size and type of the device shall be determined by the contractor, the type of device shall be kept to be the same as the existing.

The principle (PV) contractor will be responsible for ensuring the new device operates and discriminates correctly with the other upstream and downstream devices forming part of the electrical distribution system. From the main panel the contractor will install new sub mains cabling to serve the new distribution board, details of which are given elsewhere in this document.

Distribution Boards

The principle (PV) contractor shall install supply and install a new distribution board as part of the photovoltaic installation. This distribution board will act as a connection point to enable the generated electricity to supply the building and excessive generated electricity to be exported back onto the grid via G99. The contractor will be responsible for sizing the new distribution board and associated breakers to ensure that all inverters and other ancillary equipment are can be supplied and accommodated as part of the system.

The new distribution board shall take the form of metal clad surface mounted MCB boards with integral main isolator and hinged lockable, front cover. As a minimum the contractor will be required to provide, a 100A rated, three phase distribution board with a minimum of 4 TP&N outgoing ways. All distribution boards shall be manufactured by:

Schneider Electric Ltd
Merlin Gerin Low Voltage Devices
Fordhouse Road
Wolverhampton
WV10 9ED
T: 01952 290029
F: 01902 303366

Or Equivalent & Approved

The principle (PV) contractor shall include for miniature circuit breakers (MCB's) to supply the inverters and Combined MCB/RCD's where supplies to equipment (such as the public display meter) are to be installed in 'non-instructed' areas.

The breakers shall be shall be of the single module type to minimize the space taken within the distribution boards. All devices shall be of the minimum 10KA rating and shall generally of the type ‘B’ for general power circuits.

Connection and dressing of the cabling within the distribution boards shall be in a neat and unobstructive manner so as to facilitate future installations, cable marked to identify each leg of each circuit.

On each of the distribution boards, provision is to be made on the inside of the doors for numbering and describing the various outgoing circuits. This is to be completed at the termination of the contract in clear type black printing ink or similar permanent marking on white card.

Identity labelling shall be on the external front face of each distribution board as per that detailed for the main distribution panel identifying source and description.

The distribution boards and consumer units are to be positioned and fed as indicated upon the accompanying drawings at a height of a minimum 1200mm above finished floor level to the bottom of the unit.

Trunking connecting to the distribution boards and consumer units shall be run to the top and bottom of the distribution for the entirety of their width. It shall be slotted as per the distribution board to accept incoming and outgoing cabling, and correctly insulated and grommeted to prevent damage to the cables.

Sub-Main Cabling

The principle (PV) contractor shall supply and install, XLPE/SWA/LSF sub-main cable between the main panels and the new distribution boards. The size of this cable shall be as required and determined by the contractor for the building. The cable shall be routed upon the medium duty return flanged galvanised steel tray or cleated directly to the building structure.

These cables are to have shaped copper conductors; XLPE compound insulated taped steel wire armouring and LSF compound over sheath. They shall be suitable for 600/1000 volt grade and complete with manufacturers recommended and approved indoor type cable terminations to be manufactured in accordance with BS6346. Earth type rings shall be installed with each termination and bolted to the panel accordingly accepting and extending the same size earth cable to the local earth bar within the distribution panel/board as per that running with the boards supply cable.

The pre-construction electrical periodic test results should highlight any issues prior to works commencing.

Means of fixing to the cable tray will be via heavy duty UPVC cable ties suitably sized to accommodate the cabling. They should be spaced at a maximum of 500mm with cabling of diameter of 25mm or over being individually tied.

Where cabling is not installed upon traywork, one piece heavy duty non-corrosive cleats of high impact plastic, system grouped as required and of a size and pattern recommended by the manufacturer are to be used.

Manufacturer: BICC Cables Limited or AEI Cables Limited

Distribution Cable Tray Systems

The principle contractor shall install a cable tray system upon which the sub-mains cabling will be installed. The size of the tray shall be determined by the contractor and sized in accordance with the requirements of the latest version of BS7671.

The Mains & sub-mains tray will be of perforated hot dipped galvanised sheet steel to BS EN 10143 (latest version), self colour galvanised finished complete with steel angle supports, brackets and external earth bonding straps as recommended by the manufacturer.

Heavy duty return flanged type cable tray is to be used for the distribution system for trays of sizes of 225mm and above, but below this size, medium duty return flanged cable tray is to be used. Separate systems shall be installed for power, data, Fire Alarm and ELV services to maintain segregation.

On heavy duty tray the return flange shall be of a minimum height of 50mm and to the medium duty tray it shall be of minimum height of 25mm.

Bracketry supporting the tray work systems within the ceiling voids shall be purpose made utilising 41 x 41 Steel channel and associated accessories complete with 10mm stud iron and specialist manufacturers steel framework fixings, e.g., Erco, Furse, Unistrut etc. Within any risers 21x41mm Unistrut may be used due to the minimal space available within these areas.

Spacing of bracketry shall be as per manufacturers recommendations to provide a minimum deflection of 2mm. Prior to installation, design proposals with respect to the positioning and forming of all bracketry shall be submitted to the Client for approval. The tray work shall be securely fixed down to each of the brackets.

Distribution Cable Trunking Systems

The principle (PV) contractor shall design, supply and install a distribution cable trunking system to accommodate sub-mains cabling and the specialist PV power cabling. The trunking shall be configured as a ‘header trunking arrangement’ spanning the length of the distribution board and inverters to facilitate the termination of cabling in to isolators and each item of equipment. The size of the trunking shall be determined by the Principle (PV) Contractorand sized in accordance with the requirements of BS7671 18th edition.

The trunking will be of standard section, in accordance with drawing or as elsewhere specified. It will be manufactured from heavy gauge hot dipped galvanised sheet steel to BS EN 10142 (latest version)and will be of the surface mounting pattern type with snap fit or MS overlapping cover plates secured by counter-sunk screws at regular intervals. Finish to be self-coloured galvanised.

All elbow, offsets, tees and other accessories etc., to be as recommended and supplied by the manufacturer and each connection complete with external earth bonding straps (for equipotential bonding). The contractor shall also include for manufacturers recommended fire barrier protection where trunking passes through fire barrier protection walls, floors or ceiling void fire curtains.

Where trunking drops to the distribution board position, the contractor shall ensure that enough cable capacity is provided within the trunking so as not to exceed the cable grouping factors. The trunking shall be configured so that it runs along the whole top and bottom edges of the distribution boards slotted and insulated accordingly.

System Earthing and Bonding

The electrical installation is to be earthed in accordance with the 18th Edition of the IEE Regulations for Electrical Installations.

The effectiveness of each of the earthing systems shall be tested and the results recorded on a Test Certificate particular to the building to which it is installed.

3.0 GENERAL EQUIPMENT

Conduit

Shall comply in all respects with BS4568 Parts 1 and 2. To be heavy gauge welded screwed galvanised steel type. All conduits to be free from internal burrs.

The ends of all conduit lengths are to be reamed to a smooth finish.

No conduit of a smaller diameter overall than 20mm to be used.

All surface installed conduits are to be securely fixed by means of 'Hospital' type distance saddles.

Manufacturer : Walsall Conduits Limited, Barton Conduits or equivalent and approved.

Conduit Boxes

All boxes to be galvanised. Unless used in association with direct fixed equipment, all boxes are to be fitted with a steel cover lid fixed with brass screws and, where there is a possibility of moisture entering the boxes, they shall be provided with suitable water tight gaskets.

Standard circular conduit boxes shall be of malleable iron for all surface work or pressed steel where concealed in the building fabric. Male brass bushes and couplings shall be used for all adaptable or switch box entries.

Manufacturer : Walsall Conduits Limited, Barton Conduits or equivalent and approved.

PVC Conduit

Shall be manufactured in accordance with BS4607 and BS6099. To be high impact, heavy gauge UPVC type.

The ends of all conduits are to be reamed to a smooth finish.

No conduit of a smaller diameter overall than 20mm to be used. Appropriate vinyl solvent of the water resistant type to be used on all connections.

All surface installed conduits are to be securely fixed by means of spacer bar type saddle.

Bends shall be formed on site. No inspection junctions will be acceptable.

Manufacturer:

Caradon MK Limited - Type/Range - HIP
Mita Trunkings Ltd
Marshall Tufflex Ltd

PVC Conduit Boxes

To be of the standard UPVC circular box. Unless used in association with direct fixed equipment, all boxes are to be fitted with a UPVC circular lid fixed with brass screws, and where there is a possibility of moisture entering the boxes they shall be provided with suitable water tight gaskets.

Female thread bush adapters are to be used for all switch box entries.

Appropriate vinyl solvent or the water resistant type to be used on all connections.

Manufacturer: Caradon MK Ltd, Mita Trunkings Ltd, Marshall Tufflex Ltd

Uni-Channel

Shall comply to BS6949. pre-galvanised finished in standard lengths of 3 metre or 6 metre. Channel sizes to be either 41mm x 41mm or 21mm x 21mm section.

All fixings and accessories to be as per manufacturers recommendations.

Manufacturer: Unistrut Ltd or equivalent and approved.

Cabling

A LSF Insulated, Non Sheathed (Mains and Final Circuit wiring)

Single core LSF insulated only 450/750-volt grade cables having copper conductors of cross section as indicated on the drawings.

Ref: 6491B manufactured to BS6004 (New harmonised coloured conductors) Manufacturer: BICC Limited or AEI Limited

B Surface Wiring Cabling (General Services Final circuit Wiring)

XLPE insulated and sheathed flat cables with bare circuit protective conductor (CPC) and LSF outer sheath to BS7211, minimum sized to be utilised 1.5mm^2.

Ref: 6181B - Single core and earth
6242B - Flat twin core and earth
6243B - Flat three core and earth

Manufacturer: Draka Cables or AEI cables Ltd

C XPLE/SWA/LSF Steel Wire Armoured

These cables are to have shaped copper conductors; PVC compound insulated taped steel wire armouring and LSF compound over sheath. They shall be suitable for 600/1000-Volt grade and c/w manufacturers recommended and approved outdoor type cable terminations to be manufactured in accordance with BS6346. Earth type rings shall be installed with each termination and bolted to the termination point accordingly accepting and extending the same size earth cable to the earth connection point within the equipment.

Manufacturer: Prysmain cables Ltd or AEI cables Ltd to BS6724. (New harmonised coloured conductors)

E Flexible cabling

To be 3 core, heat resisting LSOH sheathed, 300/500 volt grade to be BS6500 having copper conductors as specified separately.

Ref: 3183B (New harmonised coloured conductors)

Note: *Where the luminaire's thermal temperature exceeds cable 85°C, silicon runner glass braided flexibles ref: 2793D to BS 6500 shall be used.*

Manufacturer: Prysmain cables Ltd or AEI Limited

Flexible Conduit

Galvanised steel flexible, liquid tight type tubing, having low acid, LSOH covering overall, complete with externally threaded clamp pattern brass adapters.

Manufacturer: Kopex type LT-T-LFH or equivalent and approved.

Equipment Safety

In order to comply with the IEE Regulations, any equipment providing the source of supply to any sub-main or sub-circuit, if not already provided with a means of 'locked' isolation as standard, is to have this facility added by the electrical sub contractor. Simple brackets of appropriate design and quality which, when required, will allow the fixing of a padlock by authorised persons, for the duration that the circuit(s) require isolation are considered suitable.

Schedule of General Accessories

Accessory Catalogue Numbers
Manufacturer MK Ltd (or equivalent and approved)

Item	WHI Logic Plus	Metal Clad
1 gang switched socket outlet	K2757WHI	K2977ALM
2 gang switched socket outlets	K2657WHI	K2945ALM
1 gang lockable socket outlet	K14355WHI W	
20A DP switch	K5105WHI	
13A switched fused spur	K370WHI	K972ALM
Shaver Outlets	K701WHI	
Cooker connection unit	K5045WHI	
45A double pole switch	K5215WHI	
6A ceiling mounted pull cord switch	K3192WHI	
1 gang grid switch plate	K3631WHI	K3491ALM
2 gang grid switch plate	K3632WHI	K3492ALM
3 gang grid switch plate	K3633WHI	K3493ALM
4 gang grid switch plate	K3634WHI	K3494ALM

6 gang grid switch plate	K3636WHI	K3496ALM
1 gang grid	K3701	
2 gang grid	K3702	
3 gang grid	K3703	
4 gang grid	K3704	
6 gang grid	2XK3703	
1 way switch - 20A	K4891WHI	
2 way switch - 20A	K4892WHI	
Intermediate switch 20A	K4893WHI	
Key Switch	K4898ELWHI	
Neon Indicator	K4889RED	
Blank Plates	K4880WHI	
20A SP retractive 2 way + off	K4900WHI	
TV Co-Axial Outlets	K4520WHI	
1gang-1way plate switch	K4870WHI	
1gang-2way plate switch	K4871WHI	
2gang-2 way plate switch	K4872WHI	
1gang-intermediate plate switch	K4875WHI	
3 gang – 2 way plate switch	K4873WHI	
4 gang – 2 way plate switch	K4879WHI	

Accessories within plant areas shall be of the surface mounted metalclad range.

Isolator Units

Shall be of IP54 weatherproof type isolators: Shall be of a thermoplastic enclosure to IP54 and comply to BS5419 with a lockable handle.

Manufacturer MEM Limited

List No. 20A 4 Pole 204 RDMP
40A 4 Pole 404 RDMP
63A 4 Pole 634 RDMP

Or equivalent and approved.

4.0 PHOTOVOLTAICS

The photovoltaic system to be installed shall generally consist of the following items of equipment and components:

- **Photovoltaic Panels** – these shall generally be of the monocrystalline type to provide maximum output and system efficiency.

  The PV panels shall be linked together to create a PV array. The array shall be sized by the principle (PV) contractor to provide maximum output within the given space constraints in line with the outputs detailed on the accompanying photovoltaic drawing.

- **DC string cabling** – DC string cabling sizes to be determined by the electrical contractor.

- **DC isolators** – these shall be rated to match the DC output from the PV array and shall act as means of isolating the DC side of the inverter.

- **DC/AC inverters** – these shall be sized by the contractor to match the output of the PV arrays. The inverters shall be of the indoor type and shall be installed complete with ancillary items necessary to provide an output to a public display meter, such as com cards, modems etc.

- **AC isolators** – these shall be rated to match the AC output from the each PV array and shall act as means of isolating the AC side of the inverter.

- **AC Cabling** – cabling sizes to be determined by the contractor.

- **Generation Export Meter** – The principle (PV) contractor shall provide an export meter to facilitate the 'sale' of electricity to the main grid.

- **Labelling** – The contractor shall provide and erect all warning labels to comply with the required regulations.

- **Public Display Meter** – The contractor will install a public display meter in a part of the building, typically the entrance, so that the output from the PV system can be seen by all visitors to the building.

The above list is not exhaustive and the PV Contractor shall be expected to include all necessary ancillary items as required to provide a fully comprehensive installation.

Site & Locations

The principle (PV) contractor is **strongly** recommended to visit site as no claim will be accepted by the Consulting Engineer or Client with respect to the lack of knowledge of the building and the constraints within it as well as the extent of any existing services.

The layout drawings accompanying this specification are for guidance only. The contractor is fully responsible for the design of the PV system.

The drawings are to assist the principle (PV) contractor with complying with the Client's requirements and provide an indication for what is to be provided and give the contractor an idea of the installation constraints and where supplies can be obtained and where equipment could possibly be positioned.

The contractor will be responsible for all aspects of the design including the co-ordination and the final positioning of all plant and equipment and ensuring that it can be comfortably located within the given space constraints.

Below is a brief description of the site, detailing the address and a brief outline of the installation parameters.

Site location:-

Congleton Town Hall
High Street
Congleton, Cheshire
CW12 1BN

Building

The Congleton Town Hall building is a grade II listed building located in Congleton town centre, the main building spans over two stories with a tower that routes up a further two stories.

The town hall comprised of the main grand hall space, a bar area, bistro, commercial kitchen, meeting rooms, offices, store rooms and toilet facilities. The plantroom for the building is located at lower ground floor level, the incoming electrical supply is located within a separate plantroom area at ground floor level.

Existing Systems

The incoming electrical supply to the Congleton Town Hall is located within the ground floor switchroom, off the main circulation area.

The LV switch panel is located within the plantroom and is a TP&N supply rated at 250A. The main board subsiquently feeds various distribution boards around the building.

There is no existing photovoltaic system on the site.

Proposed Systems

Upon initial site investigations, there are areas of the pitched roof that can provide a suitable location for the installation of a PV array with a South East orientation. We would target a 50-panel array yielding circa 21.5kWe.

Installed on the pitched roof of the building shall be ***typically*** 50 panels facing south-east and equivalent to approx. 100m2. The system shall be split into multiple arrays and to maximise both installation time and operational efficiency (subject to detailed design). Final quantity and output to be developed and designed by the contractor.

Battery storage shall also be included within the photovoltaic package for consideration. The storage capacity of the battery system shall be sized by the Contractor and shall be determined based on the photovoltaic output in relation to the buildings electrical consumption.

The contractor shall design/size each array to provide maximum output to achieve the target values.

The DC string cabling shall be routed from the arrays down into the loft space where the existing photovoltaic system is installed. At this point the contractor shall install inverters (sized to match the output from the PV system / arrays) and all associated AC and DC isolators as well as the generation export meter within the main switchroom.

The contractor should also install the new distribution board in this location. The distribution board will be supplied from the main panel in the ground floor switchroom.

The supply cabling for the distribution board will be installed in the roof space and clipped direct to the building fabric. An alternative neat and safe external route shall be considered if absolutely necessary.

A data cable shall be installed in conduit, generally routed through the roof space, linking the inverters to the public display meter which is to be installed within the main entrance at ground floor.

The public display panel shall require a new supply from a 13A fused connection unit installed within the ceiling void. The fused connection unit could be spurred from an existing nearby socket and included by the principle (PV) contractor.

Access & Scaffolding

The principle (PV) contractor will be responsible for all access plant and scaffolding required to undertake the proposed works. The responsibility will include ensuring all safe erection and dismantling of all scaffolding and the delivery and offloading of any other access plant to each site. Where necessary the contractor will be responsible for the erection of purpose built safety barriers and safety signage and should if necessary create temporary pedestrian walkways ensure safe access and egress to and from the building as required.

The site may have their own preference regarding the use of scaffold and access plant depending on the level of site security and also space limitations around each building.

The contractor will inform the project manager of their proposals for access, this will include a sketch or marked up plant to demonstrate where any scaffolding maybe erected or where any other obstructions may be created. The project manager may request that the principle (PV) contractor provide alternative means of access to that proposed originally.

Testing and Commissioning

The principle (PV) contractor shall include for the testing and commissioning of all works in line with the following documents:

BS 7671 IEE 18th Edition Wiring Regulations

Commissioning with respect to all systems shall be carried out to the approved configurations identifying correct operation of each programmed function.

The contractor shall give the Client 7 days notice with respect to final witness testing and shall provide all necessary access equipment throughout the contract to enable all works to be inspected by the Client.

Final commissioning data shall include all programmed functions and results and shall be included along with the relevant NICEIC Certificates in fourfold to the Operating and Maintenance Manuals.

In addition to the above the contractor shall make allowance for the commissioning of all systems to be verified by the Client / third party. This should be done after complete systems have been commissioned by the relevant specialist and prior to handover.

Please note that handover of the building will not be accepted until all systems have been witnessed by the Client / third party and deemed acceptable.

Maintenance

The contractor shall provide a separate cost for carrying out a maintenance programme in relation to the above-specified works during the twelve months defects liability period.

Maintenance shall include four visits at three monthly intervals (4 visits in total) where the following are checked:

Main and sub main distribution switchgear - general switchgear, MCCB's, MCB's, fuses and RCD units etc, roof mounted photovoltaic panels, all AC and DC cabling and all DC/AC inverters and all other ancillary equipment forming part of the installation.

The contractor shall include for all labour and materials associated with these works bearing in mind that all items remain under guarantee for the first twelve-month period.

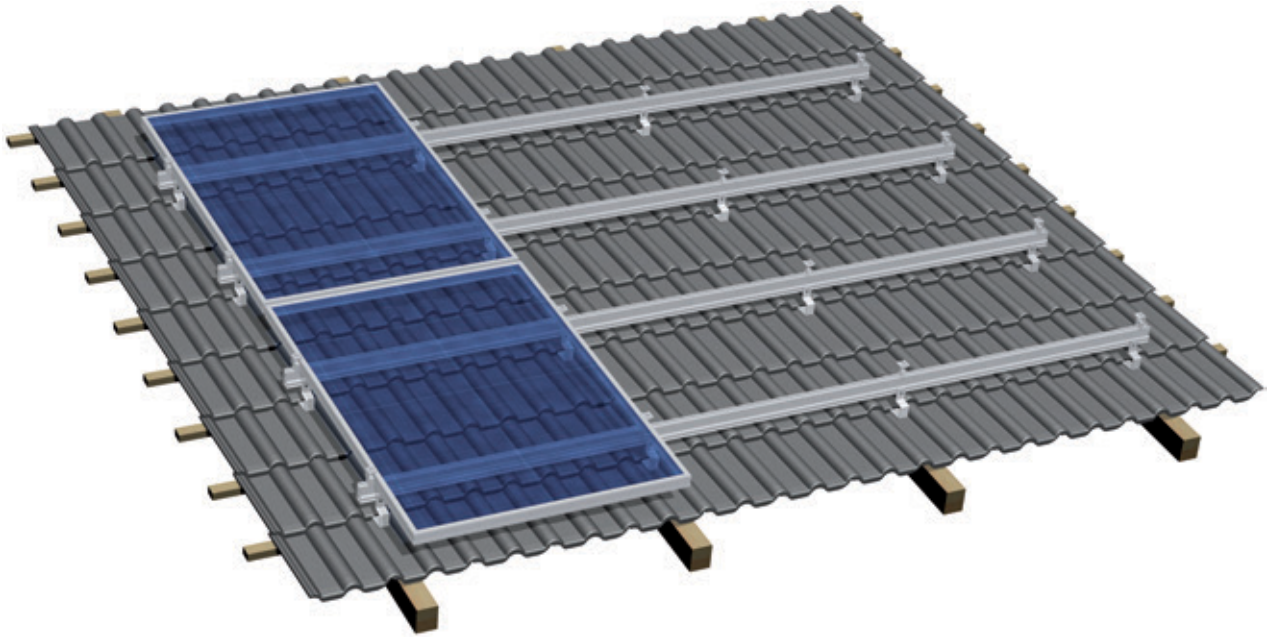
All test certificates and reports shall be sent to the Client / third party consultant for inspection within seven days of carrying out the works.

S:FLEX

Technical Data

PITCHED ROOF STRUCTURES

for tiled roofs



Flexible Application

The S:FLEX pitched roof system allows for easy installation of framed and frameless photovoltaic modules on old and new buildings with all common kinds of roofing (tiles, plain tiles, slate).

Quick Assembly

The S:FLEX pitched roof mounting structure has numerous pre-assembled parts. The click technology further reduces assembly time. Spanners of two different sizes are the only required tools on the roof, and the detailed assembly instructions ensure an easy installation.

Excellent Adaptability

Roof hooks are suitable for all kinds of tiles. They can be adjusted laterally and in height. Variable system height capability enables level PV arrays on uneven roof surfaces.

Extensive Module Compatibility

Height-adjustable module clamps and end clamps allow for maximum flexibility when mounting framed modules from 30 to 50 mm thick. We can also provide certified laminate clamps for frameless modules.

Maximum Security

If required, S:FLEX can provide structural design services for the mounting structure in compliance with the 2006 International Building Code.

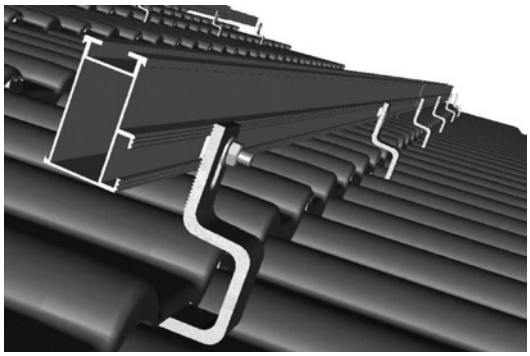
Long Service Lifetime

All major components are made of aluminum and stainless steel. High corrosion resistance ensures a maximum service life, and all components are recyclable.

PITCHED ROOF STRUCTURES

for tiled roofs

Technical Data



Tiled roof installation with roof hooks

Application	Pitched roof
Roofing type	Suitable for all kinds of roofing
Roof pitch	Up to 60 degrees
Building height	25 m max.
Wind load	Up to 2.4 kN/m²
Snow load	Up to 5.4 kN/m²
Module type	Framed and frameless
Layers of rails	Single or double layer
Module orientation	Portrait / landscape
Module field size	Up to 12 modules in a row portrait orientation / Up to 12 modules in a row landscape orientation
Height adjustment	Up to 92 mm (dependent on system)
Standards	DIN EN 1991-1-3:2010-12 (Snow), DIN EN 1991-1-4:2010-12 (Wind) – Statics on request / DIN EN 1999-1-1/ NA:2018-03 — Dimensioning and design of aluminium frameworks
Roof hooks	Aluminium standard: EN-AW-6063 T6 Plain tile and slate: Stainless steel A2 1.4301
Mounting rails	Extruded aluminum EN-AW-6063 T6
Small parts	Stainless steel X5CrNi18-10 A2-70
Lightning protection	Optional
Colour	Natural aluminium
Warranty	10 years on durability of materials

S:FLEX GmbH Germany • Reinbeker Weg 9 21029 Hamburg Phone +49-(0)40-688 93 17-0 Fax +49-(0)40-688 93 17-99 info@sflex.com www.sflex.com

APPENDIX C – MUSEUM ROOF SNOW DRIFT CALCULATION

SNOW LOADING

In accordance with EN1991-1-3:2003+A1:2015 incorporating corrigenda dated December 2004 and March 2009 and the UK national annex NA+A1:2015 to BS EN 1991-1-3:2003+A1:2015 incorporating Corrigendum No.1

Tedds calculation version 1.0.14

Characteristic ground snow load

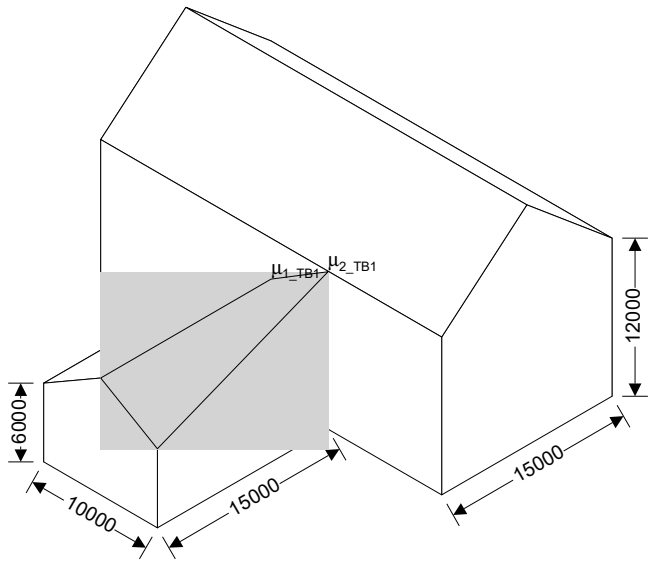
Location	Stoke
Site altitude above sea level (user modified value)	A = **95** m
Zone number	Z = **3.0**
Density of snow	γ = **2.00** kN/m^3
Characteristic ground snow load	$s_k = ((0.15 + (0.1 \times Z + 0.05)) + ((A - 100m) / 525m)) \times 1kN/m^2$ = **0.49** kN/m^2
Exposure coefficient (Normal)	C_e = **1.0**
Thermal coefficient	C_t = **1.0**
Snow fence	Not present

Building details

Roof type	Abutting
Width of lower roof	b_1 = **15.00** m
Width of upper roof	b_2 = **15.00** m
Height difference to eaves	h_{diff} = **6.00** m
Angle of lower roof	α_1 = **30.00** deg
Angle of upper roof	α_2 = **40.00** deg
Width of lower building	L_1 = **10.00** m
Width of upper building	L = **30.00** m

Shape coefficients

Shape coefficient roof (Cl.5.3.6)	$\mu_{1\_T5.2}$ = **0.80**
Shape coefficient roof (Table B.1)	$\mu_3 = \min(2kN/m^3 \times h_{diff} / s_k, 2 \times \max(b_1, b_2) / l_s, 8)$ = **2.00**
Drift length (Cl.5.3.6)	$l_s = \min(5 \times h_{diff}, b_1, 15m)$ = **15.00** m
Shape coefficient roof (Table B.1)	$\mu_{1\_TB1} = \mu_3 \times (30deg - \alpha) / 15deg$ = **0.00**
Shape coefficient roof (Table B.1)	$\mu_{2\_TB1} = \mu_3$ = **2.00**



Shape coef	Coef	Loading (kN/m^2)
$\mu_{1\_T5.2}$	0.800	0.39
μ_{1_TB1}	0.000	0.00
μ_{2_TB1}	2.000	0.98

Loadcase 1 Table 5.2

Loading to roof 1 $s_{1\_1} = \mu_{1\_T5.2} \times C_e \times C_t \times s_k =$ **0.39** kN/m^2

Loadcase 2 Table 5.2

Loading to roof 1 $s_{1\_2} = \mu_{1\_TB1} \times s_k =$ **0.00** kN/m^2

Loading to roof 1 $s_{2\_2} = \mu_{2\_TB1} \times s_k =$ **0.98** kN/m^2