QODA

Isles of Scilly Museum

Sustainable Deliverables

2877.R05

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Revision Summary

Issue	Document prepared			Document checked		
	Name	Signature	Date	Name	Signature	Date
First Issue	G. Sigalas	[redacted]	29.03.2022	T. Walkley	[redacted]	29.03.2022
P1	G. Sigalas		25.04.2022	T. Walkley		25.04.2022
P2	M. Tobin		06.07.2023	T. Walkley		06.07.2023

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1 Executive Summary

QODA Consulting have been appointed as part of the design team for the refurbishment and extension of the Isles of Scilly Town Hall building in Isles of Scilly.

The proposed works aim to improve the energy and sustainability performance, eliminate the use of fossil fuels, and significantly reduce the carbon footprint of the building. The works will include the following:

- Upgrade of the existing and retained main building, which includes the main hall, exhibition areas and administration offices.
- Demolishing the 1970s west wing and replacing it with a new build extension that will accommodate exhibition and archive spaces, reading areas, a new shop, and ancillary spaces.
- New build extension on the east side of the building that will include a café/bar and a gig area.

In order to demonstrate a quantitative improvement and decarbonisation of the town hall, QODA Consulting have built a baseline energy model with existing fabric and servicing arrangements, and a proposed model complete with the proposed fabric and services upgrades. From this exercise we are then able to compare the regulated carbon emissions using the Building Regulations Part L methodology.

2 Sustainable Building Services

2.1 Town Hall

In the town hall, heating, ventilation, and active cooling will all be provided by a central Air Handling Unit (AHU) located on a concealed flat roof plant area. The AHU will incorporate a reversible heat pump, heat recovery thermal wheel and a recirculation damper.

The system will provide tempered air at a rate equivalent to 6 air changes per hour (2.5 m3/s) through low velocity openings formed at low level. Air will be extracted from a single point at high level. This is commonly referred to as displacement ventilation.

This strategy works in tandem with the natural tendency of warm, stale air to rise to high level, where it can be extracted, while providing fresh air to seated occupants from below in a manner which is less likely to transit via other occupants and pick up contaminants. This system is pertinent to the space due to the extended period where occupants are expected to be seated together.

The high air change rate means that the system can quickly adapt to an influx of occupants and provide plentiful fresh air for well-attended events.

The system will be variable volume and capable of recirculating air. This will be managed via CO2 and occupancy sensing such that when the space is not occupied but requires heating or cooling (for instance, prior to a performance), the system can temper recirculated air which will greatly reduce the energy demand. The volume of air being delivered will be modulated based on measured CO2 within the space, which is indicative of general air quality.

2.2 Rebuilt 1970s wing and new extension

A 60 kW air-to-water Air Source Heat Pump (ASHP) system common to the rebuilt 1970s building, refurbished town hall exhibition spaces and the new build gig display area will be located on the concealed flat roof plant area.

The system will service underfloor heating throughout which will be linked to local manifolds allowing room-by-room control, thereby minimising instances of heating unoccupied spaces.

Ventilation will be provided via soffit-mounted MVHR units, concealed by suspended ceilings, which will duct supply air and extract air to and from all occupied spaces at high level. Due to the use of heat recovery, this system will ensure appropriate ventilation rates in all seasons without placing excessive load on the heating system.

Cooling in the summer months will be provided by operating ventilation units in “summer bypass” mode, along with natural openings utilised to provide free cooling.

Consideration will be made to provisioning a specialist archive space for delicate items, which would comprise of local climate control via a split DX heating and cooling unit and an inert gas fire suppression system.

2.3 Photovoltaics (PV)

There is precedence for PV in the area, and the orientation of the building lends itself to a possible East-West array comprising of ~150 m^2 panels. This represents an array of around 30 kWp but it must be stressed that this is pending further design. An east-west array is considered beneficial as the output is flattened across a longer period when compared to the shorter, sharper peak from a due south array. This is likely better suited to the usage profile of the building and will directly offset energy used by the building from the grid, inclusive of heating and ventilation demands.

Consideration will need to be made as to how panels are incorporated and securely fixed to the roof structure without compromising thermal lines, waterproofing or other systems. This will be significantly easier if completed in tandem with other roof works than if it was to be retrofitted.

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3 Compliance with Building Regulations Approved Document L

3.1 Compliance with Approved Document L2B – Existing Building

The proposed refurbishment works in the existing building must comply with Part L2B 2013 of the UK Building Regulations, which sets targets for the thermal properties of upgraded fabric elements and building services efficiencies in refurbished buildings.

The following paragraphs summarise the fabric requirements of Part L2B 2013 and the energy efficiency 'triggers' as a result of the proposed works. All mechanical and electrical systems installed within the extension and refurbishment builds will be designed in accordance with the requirements of the Non-Domestic Building Services Compliance Guide 2013.

3.2 Compliance with Approved Document L2A –Extensions

The works include the provision of extensions which will provide additional facilities to the building.

Approved document L2B specifies that extensions that are both:

a. Greater than 100 m^2, and
b. Greater than 25% of the total useful floor area of the existing building,

Must be regarded as large extensions and assessed under Approved document L2A (new constructions). In the case of the Isles of Scilly Museum, the two extensions cover more than 25% of the existing floor area, so they need to be assessed under Approved Document L2A: Conservation of fuel and power in new buildings other than dwellings.

Table 1: Breakdown of the floor areas for existing and extension builds.

Existing Building Floor Area (m^2)	480
New Build (Extension) Floor Area (m^2)	590
Extension % of existing building	**123%**

4 Building Specification

4.1 Fabric

4.1.1 Extension Fabric

New thermal elements used in the construction of the extension will meet and exceed the minimum U-Value standards identified in Approved Document L2A.

Table 2: Proposed New Fabric Standards for the Extensions.

	Fabric Element	L2A Requirement	Proposed Specification	Improvement Over L2A
New Thermal Elements - Extensions	Roof U-value	0.25 W/m².K	0.12 W/m².K	52%
	Ground Floor U-Value	0.25 W/m².K	0.14 W/m².K	44%
	External Walls U-Value	0.35 W/m².K	0.18 W/m².K	48%
	Windows, Rooflights and Pedestrian Doors U-Value (whole unit)	2.20 W/m².K	1.20 W/m².K	45%
	Air Permeability Target	10 m³/(h.m²) @50Pa	7 m³/(h.m²) @50Pa	30%

4.1.2 Existing Building Fabric

New and upgraded fabric elements in the retained building must comply with the fabric efficiency requirement detailed in Approved Document L2B.

The proposed works include the upgrade of the retained uninsulated roof, as well as provision of new rooflights above the gallery area. The upgrade of the roof is the one with the highest cost benefit for the following reasons:

- Due to the buildings form factor, most of the heat losses will be through the roof, if left uninsulated.
- The roof upgrade is the most practical and technically feasible. Internal wall insulation will have a high risk of condensation if it is to be insulated to the same standard.
- Internal wall insulation will reduce the net floor area of the building.
- Maintaining the existing windows will preserve the heritage of the building.

For these reasons, upgrading the roof has been prioritised. For the purposes of this exercise, the rest of the fabric elements (external walls, ground floor) have been considered uninsulated and the existing windows single glazed based on the buildings age.

Table 3: Proposed fabric upgrades against L2B minimum requirements for the existing building.

	Fabric Element	Existing U-value assumption	L2B Requirement	Proposed Specification	Improvement Over L2B
Upgraded Fabric Elements – Existing Building	Upgraded Roof U-value	1.4 W/m².K (uninsulated roof)	0.18 W/m².K	0.16 W/m².K	11%
	New Rooflights U-value	-	1.80 W/m².K	1.20 W/m².K	33%

4.2 Mechanical & Electrical Services Design Standards

All mechanical and electrical systems installed within the extension and refurbishment will be designed in accordance with the requirements of the Non-Domestic Building Services Compliance Guide 2013. Evidence of the design standards will be documented via technical drawings, specifications and schedules and will be provided to the Building Control officer as evidence.

4.2.1 Extension Mechanical and Electrical Services Specification

Table 4: Proposed M&E services specification for the new extensions.

HVAC Strategy	Proposed Design
Gallery & Exhibition Spaces, Meeting & Reading Rooms, Kitchen, Bar/Café area, Shop	Underfloor Heating via ASHP and balanced mechanical ventilation with heat recovery
WC	Underfloor Heating via ASHP and zonal mechanical extract
Stair cores	Underfloor Heating via ASHP, natural ventilation

Heating & Cooling System Specification	Proposed Design
System 1 - Underfloor Heating via ASHP	
Seasonal Coefficient of Performance	3.3

Ventilation	Proposed Design
System 1 - Central Balanced Mechanical Ventilation	
Heat Recovery Efficiency (Plate Heat Exchanger)	81%
Specific fan power	1.99 W/l/s
System 2 - WC Zonal Extract	
Specific fan power (Zonal Extract)	0.5 W/l/s

Domestic Hot Water	Proposed Design
Bar & Café Areas Generator Type	**Air Source Heat Pump**
Seasonal Coefficient of Performance	3.3
Storage Volume (l)	150L
All other areas Hot Water System	**Instantaneous Electric Water Heaters**
Total Storage Volume - All heaters (L)	150L

Luminaire Efficacy	Proposed Design
Luminaire Efficacy Target - All Areas Average	90 lm/W

Lux Level Target	Proposed Design
Kitchen	500 Lux
Office, Activity Space, Meeting Rooms, Reading Room	400 Lux
Exhibition space, WC, Circulation, Archive, Shop	200 Lux
Stairs	150 Lux
Store rooms	100 Lux

Lighting Controls	Proposed Design
Activity Space, Meeting Space	Absence Detection and Daylight Dimming
Reading Room	Absence Detection
WC, Archive, Circulation	Presence Detection
Exhibition Space	Manual Switching, dimmable to reduced output via PIR sensor
Kitchen, Bar/Café, Shop	Manual Switching

Renewables (PV)	Proposed Design
Total PV Area	150 m^2

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4.2.2 Existing Building Mechanical and Electrical Services Specification

Table 5: Proposed M&E services specification upgrade for the existing building.

Heating & Cooling System Specification	
Existing System	**Proposed Upgrade**
Oil-fired Boiler	**VAV system served from Air Source Heat Pump (Main Hall)**
Seasonal Efficiency 81%	Seasonal Coefficient of Performance 3.3
	Seasonal Energy Efficiency Rate 5
	Underfloor Heating via Air Source Heat Pump
	Seasonal Coefficient of Performance 3.3

Ventilation System Specification	
Existing System	**Proposed Upgrade**
Naturally Ventilated	**Central Balanced Mechanical Ventilation with Heat Recovery**
	Heat Recovery Efficiency 81.2%
`	Specific Fan Power 1.99 W/l/s
	Zonal Extract Ventilation (WC only)
	Specific Fan Power 0.50 W/l/s

Lighting Specification	
Existing Lighting Average Efficacy	**Proposed Lighting Average Efficacy**
60 lm/W, assumed based on Approved Document L Typical Value	90 lm/W

Existing Lighting Controls	Proposed Lighting Controls
WC Areas: Presence Detection	Offices: Absence Detection
All other areas: Manual Switching	WC/Circulation Areas: Presence Detection
	Main Hall/Exhibition Areas: Manual Switching, dimmable to reduced output via PIR sensor
	Kitchen / Bar/Café/Shop: Manual Switching

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5 Carbon Emission Calculation

5.1 Calculation Methodology

The building specification, as detailed in chapter two of this report, has been included in a thermal modelling simulation to quantify the carbon emissions of the proposed development.

The thermal model has been prepared in the dynamic simulation modelling software IES Virtual Environment which includes the thermal templates of the National Calculation Methodology for Part L assessments.

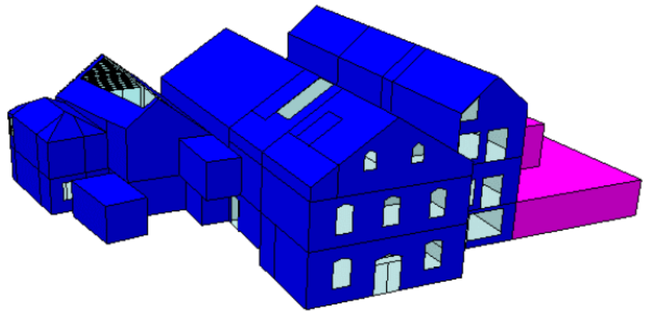

Figure 1: 3D view of the IES thermal model.

The model replicates the geometry of the proposed building and parameters including U-value fabric standards and M&E services specification as detailed in chapter two. CIBSE Test Reference Year weather data for Plymouth (the nearest TRY dataset) was used, following the NCM methodology guidance on weather data sets.

Thermal Model Location: Isles of Scilly

Simulation Weather File: Plymouth_TRY05

5.2 Carbon Reduction Results

5.2.1 New Extension

With the specification detailed in tables 2 & 4, the extension build achieves 8% reduction in carbon emissions from Approved Document L2A baseline.

Carbon Emission Results	New Extensions
L2A Target Emission rate ($kgCO_2/m^2/yr$)	30.5
Building Emission rate ($kgCO_2/m^2/yr$)	28.1
CO_2 emission reduction	7.9%

5.2.2 Existing Building Refurbishment

With the energy efficiency measures detailed in tables 3 & 5, the existing building achieves 61% reduction in carbon emissions compared to the existing specification.

Carbon Emission Results	New Extensions
Existing Carbon Emission rate ($kgCO_2/m^2/yr$)	103
Carbon Emission rate after proposed works ($kgCO_2/m^2/yr$)	39.9
CO_2 emission reduction	61%

6 Conclusion

The building achieves significant carbon savings compared to the baselines, both for the new extensions and the existing building. These savings are driven by the following design details:

- An excellent insulated fabric, with properties improving upon the Approved Document L2A & L2B minimum standards.
- Use of an energy efficient air source heat pump, both for space heating and hot water preparation. This will replace the existing oil-fired boiler and eliminate the reliance on fossil fuels.
- Energy efficient lighting, equipped with occupancy sensors.
- A 150 m^2 PV installation located on the roof.

Appendix A– Extension Building BRUKL

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Isles of Scilly New Extension — As designed

Date: Mon Mar 28 22:41:37 2022

Administrative information

Building Details

Address: Address 1, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.13

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.13

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	30.5
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	30.5
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	28.1
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	00000000:Surf[1]
Floor	0.25	0.14	0.14	RM000010:Surf[0]
Roof	0.25	0.12	0.12	RM000013:Surf[4]
Windows***, roof windows, and rooflights	2.2	1.16	1.22	RM00000B:Surf[1]
Personnel doors	2.2	1.21	1.21	00000000:Surf[0]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
m³/(h.m²) at 50 Pa	10	7

Appendix B– Upgraded BRUKL

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Isles of Scilly Museum — As designed

Date: Wed Jul 05 14:09:48 2023

Administrative information

Building Details

Address: Address 1, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.20

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.20

BRUKL compliance check version: v5.6.b.0

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Criterion 1: The calculated CO_2 emission rate for the building must not exceed the target

The building does not comply with England Building Regulations Part L 2013

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	23.5
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	23.5
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	39.9
Are emissions from the building less than or equal to the target?	BER > TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	1.31	1.43	RM000005:Surf[2]
Floor	0.25	0.67	0.71	RM000005:Surf[0]
Roof	0.25	0.16	0.16	01000006:Surf[2]
Windows***, roof windows, and rooflights	2.2	3.37	5.56	RM000002:Surf[1]
Personnel doors	2.2	2.2	2.2	00000008:Surf[4]
Vehicle access & similar large doors	1.5	-	-	No vehicle access doors in building
High usage entrance doors	3.5	-	-	No high usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [$W/(m^2K)$]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	7

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