Torbay Council

Paignton Academy SEND Block, Borough Rd, Paignton

TQ4 7DH

Building Physics and Part L Compliance Report

Job Number:	35432
Latest Revision:	P01
Issue Date:	26/02/24
Status:	S3
Purpose of Issue:	For Information
Reference:	PNASD-BPC-XX-XX-RP-M-0001

Document Revision History

Revision	Date	Issue / Revision Details	Prepared By	Checked By	Approved By
P01	26/02/24	For Information	DJ	SM	-
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Document Validation (Latest Issue)

Revision	Date		Prepared By	Checked By	Approved By
P01	26/02/24	Name	DJ	SM	-
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Table of Contents

1. Executive Summary

The following report details the results of the overheating & Part L compliance assessment undertaken for the proposed new SEND block at Paignton Academy.

All assessments have been carried out to verify the following:

- Compliance with the overheating criteria as defined by the EFSA guidance document BB101: Ventilation, Thermal Comfort, and Indoor Air Quality 2018
- Reduction of carbon emissions in compliance with Building Regulations Approved Document Part L2 2021.

The model geometry was defined as per the architectural layouts as produced by MTA

Overheating Assessment

The overheating calculations have been calculated in accordance with the maximum summertime temperature requirements set out in BB101 (2018).

The results of the calculations and analysis indicate that all of the occupied spaces are passing the minimum requirement for overheating with the current strategy.

Therefore, the new SEND Block is meeting the requirements of BB101 and is not identified as having a risk of overheating.

Part L Compliance Assessment

A Part L compliance assessment was carried out and illustrated; the achieved baseline preliminary buildings emissions rate (BER) and Building Primary Energy Rate (BPER) were less than the notional target emissions rate (TER) & target primary energy rate (TPER), therefore, provided that the design criteria stated in this report are followed, our as-designed assessment indicates that the building complies with Approved Document Part L Volume 2 for Buildings other than Dwellings.

2. Overheating Assessment

2.1. Introduction

This report details the methodology, input variables and results of the overheating assessment undertaken for the new SEND block at Paignton Academy.

The natural ventilation and overheating assessment assesses compliance with the overheating criteria as defined by the Education & Skills Funding Agency (EFSA) guidance document BB101: Ventilation, thermal comfort, and Indoor Air Quality 2018.

2.2. Software & Climate Data

The overheating assessment and dynamic thermal modelling were carried out using IES Virtual Environment Modelling Software Version 2023.3.1.0

The climate data used for the overheating assessment was the CIBSE DSY1 (Design Summer Year) 2020 (50th Percentile Range) in line with BB101 (2018). The weather file location used was Plymouth.

2.3. Benchmarks

2.3.1. Naturally/Mechanically Ventilated Spaces – BB101 (2018)

The overheating criteria defined by BB101 (2018) relates the adaptive thermal comfort method from BS EN 15251 and the guidance in CIBSE TM52' The Limits of Thermal Comfort'. The adaptive comfort criteria only apply to 'free-running' buildings.

This approach follows the recommendations of BS EN 15251 to determine whether a building will overheat based on a variable temperature threshold related to the outside running-mean dry-bulb temperature (T_{rm}).

The assessment is based on three criteria for overheating, which are defined in terms of ΔT, the difference between the actual operative temperature in the room at any time (T_{op}) and (T_{max}), the limiting maximum acceptable temperature. The values for the maximum acceptable temperature are calculated from the running mean of the outdoor temperature, and the suggested acceptable range (shown in Table 1).

$$T_{COMF} = 0.33 \cdot T_{RM} + 18.8 \ and \ T_{MAX} \ + \ (acceptable\ range\ °C)$$

Table 1 – Categories for Overheating Risk Assessment		
Category	Explanation	Suggested Acceptable Range (°C)
I	High level of expectation. Also recommended for spaces occupied by very sensitive and fragile persons with special requirements like some disabilities, sick, very young children and elderly persons, to increase accessibility.	+ 2°C / -3 °C
II	Normal expectation	+ 3°C / -4 °C
III	An acceptable moderate level of expectation	+4°C / -5 °C
IV	Low level of expectation. This category should only be accepted for a limited part of the year	>+4°C / < -5°C

Table 2 – Adaptive Thermal Comfort Category to Apply		
Type of Space or activity	New Build	Refurbishment
Teaching and learning, drama, dance, exams, multi-purpose halls	II	III/IV
Practical activities such as cooking	N/A	N/A
Sports Halls not used for exams	III	IV
Working areas, e.g kitchens	N/A	N/A
Offices	II	III/IV
Atria, circulation, reception and corridors - not continuously occupied	III	IV
Areas for pupils with complex health needs	I	I

The thermal comfort criteria are based on categories of spaces and activities as defined in BS EN 15251. For the purpose of this assessment, all areas and spaces are defined as Category I (an acceptable High Level of expectation), as this report is focused upon the occupiable space within the SEND block.

The three criteria for overheating are detailed below. In accordance with Building Bulletin 101 (2018), Criterion 1 defines a minimum requirement for assessing the risk of overheating and any room or building that does not meet this requirement is deemed to have failed. Criterion 2 and Criterion 3 are, primarily, measurements of short-term discomfort and should be reported for information only. Where a design fails to meet Criterion 2 and Criterion 3, designers should consider potential overheating mitigation measures and indicate which are viable for the project.

Criterion 1 - Hours of Exceedance (H_e)

The number of hours (H_e) that ΔT is greater than or equal to one degree (K) during the period 1st May to 30th September for the defined hours inclusive shall not be more than 40 hours.

An understanding of how often a building in any given location is likely to exceed its comfort range during the summer months (1st May- 30th September) can provide useful information about the building's thermal characteristics and potential risk of overheating over the range of weather conditions to which it will be subjected.

Criterion 2 - Daily Weighted Exceedance (W_e)

To allow for the severity of overheating the weighted Exceedance (W_e) shall be less than or equal to 6 in any one day.

Where: $\sum h_e \times w_f = (h_{e0} \times 0) + (h_{e1} \times 1) + (h_{e2} \times 2) + ... + (h_{en} \times)$

Where the weighting factor wf = 0 if ΔT ≤ 0, otherwise wf = ΔT and h_{ey} = time in hours when wf = y.

This Criterion sets an acceptable level for the severity of overheating, which is arguably more important than its frequency. It sets a daily limit of acceptability and is based on Method B – 'Degree hours criteria' in BS EN 15251: 2007. It is the time (hours and part hours) during which the operative temperature exceeds the specified range during the occupied hours, weighted by a factor. The weighting factor is a function depending on how many degrees the range has been exceeded. The value of the weighting factor is based on the observed increase in the percentage of occupants voting 'warm' or 'hot' on the ASHRAE scale (overheating risk) with each degree increase in ΔT, the temperature above the comfort threshold temperature.

Criterion 3 - Upper Limit Temperature (T_{upp})

To set an absolute maximum value for the indoor operative temperature the value of ΔT shall not exceed 4K.

Criterion 3, the threshold or upper limit temperature sets a limit beyond which normal adaptive actions will be insufficient to restore personal comfort and the vast majority of occupants will complain of being 'too hot'. This Criterion covers the extremes of hot weather conditions and future climate scenarios.

2.4. Thermal Elements

2.4.1. Building Fabric Performance

Under the requirements of Approved Document Part L Volume 2 (2021), the new SEND block is considered a standalone building and therefore shall meet the requirements of Section 4 with regards to limiting standards for new thermal elements.

The performance of the thermal elements used within the model is as defined in the table below in accordance with the architect's proposed U-values.

Table 3 – Thermal Elements & Calculated U-Values	
Thermal Element	U-Value (W/m²K)
External Walls	0.23
Ground Floor	0.18
Roof - Pitched	0.12
Standard Windows / Glazed Personnel Doors	1.4 (0.4 G-Value & 0.76 Light Transmittance)
Personnel Doors	1.4

All associated U-Values (W/m²K) in preceding tables were calculated using IES Virtual Environment in accordance with EN ISO standards.

2.4.2. Thermal Mass

Thermal mass allows for the latent heat in the building to be absorbed during the day (primarily during the summer months), which is gradually released back into space when the temperature decreases, which in turn is purged via appropriate nighttime ventilation.

The new SEND block is generally of lightweight construction, utilising an SFS with internal lining and external brickwork/block construction which could create issues when it comes to providing sufficient thermal mass.

2.5. Building Services Strategy

2.5.1. Heating & Cooling Set Points

All heating systems were set to 'off continuously' for the duration of the assessment period.

The assessment is based on a 'free running building' so no allowance has been made for mechanical cooling or space conditioning to the naturally ventilated spaces.

2.5.2. Hours of Occupation

A summary of the occupancy levels utilised are shown in Section 2.5.1.

BB101 (2018)

This generally assumes 100% occupation outside of the heating season for the hours of 09:00 to 16:00, Monday to Friday from 1st May to 30th September, including the summer holiday period as if the school was occupied normally throughout the summer. A lunch break from 12:00pm to 1:00pm with no internal heat gains during this period has been included for all occupied areas.

2.5.3. Air Permeability

We have assumed that the external envelope of the building will achieve an air permeability of at least 3.0 m³/(h·m²) at 50 Pa, which corresponds to a natural infiltration rate of 0.15 air changes per hour (ACH). This is an average value in line with the empirical values for air infiltration rates for school buildings as defined in CIBSE Guide A.

Table 4.21 Empirical values for air infiltration rate due to air infiltration for rooms in buildings on normally exposed sites in winter: schools; partial exposure

Air permeability / ($m^3 \cdot h^{-1}/m^2$ at 50 Pa)	Infiltration rate (ACH) for given building size / h^{-1}							
	1 storey; 500 m^2 (25 m × 20 m × 4 m)*		1 storey; 1000 m^2 (40 m × 25 m × 4 m)*		2 storeys; 1000 m^2/floor (40 m × 25 m × 4 m)*		3 storeys; 1000 m^2/floor (40 m × 25 m × 4 m)*	
	Peak	Average	Peak	Average	Peak	Average	Peak	Average
20.0 (leaky)	1.05	0.70	0.90	0.65	0.65	0.5	0.65	0.45
10.0 (Part L (2002))	0.55	0.35	0.45	0.35	0.35	0.25	0.35	0.25
7.0 (Part L (2005))	0.40	0.25	0.35	0.25	0.25	0.20	0.25	0.20
5.0	0.30	0.20	0.25	0.20	0.20	0.15	0.20	0.15
3.0	0.15	0.10	0.15	0.10	0.10	0.10	0.10	0.10
Air change rate at 50 Pa (/ h^{-1})		6.80		6.30		3.80		3.00
ACR_{50} divisor		20.0		19.7		15.2		13.5

* (length × width × height) for each storey; each storey is nominally isolated by structural design and fire doors etc.

CIBSE Guide A Table 4.21 – Empirical values for air infiltration rates

2.5.4. Natural Ventilation

For the purposes of modelling summertime overheating to determine the required size of summertime natural ventilation openings to prevent summertime overheating, the maximum average air speed through the vent should be assumed to be less than 0.8 m/s.

The behaviour of all opening natural ventilation devices during occupied hours is controlled by a formula employed within the daily profile, that will open the devices when the internal temperature exceeds 20°C, or the internal carbon dioxide concentration exceeds 1000PPM.

Formula: gt(t_a,20,2) | gt (CO_2,1000,50)

2.5.5. Opening Characteristics

There are several types of opening natural ventilation devices, some of which are defined below. Several profiles have been set up to represent the variety of window sizes that have been proposed; parameters that vary include the openable area of the window, the proportions of the window, and the maximum angle the window can open.

Window Opening Types				
Opening Type	Openable Area (%)	Max Angle Open (°)	Proportions	Equivalent Orifice Area (%)
Type 1 – Fixed Glazing/Doors	0%	-	-	0.0%
Type 2 - Restricted Window	90%	15°	1 ≤ Length/Height < 2	34%
Type 3 - Un-restricted Window	90%	25°	1 ≤ Length/Height <2	49%

2.5.6. Mechanical Ventilation

The toilets have been designed at 7.5l/s/m^2 in line with BB101, but these have been modelled with an auxiliary ventilation rate of 2 air changes per hour (ACH), to represent intermittent extract ventilation systems.

These rates are calculated within IES based on room volumes.

2.6. Internal Gains

Internal gains within the overheating model have been defined based on the recommendations of BB101 (2018).

2.6.1. Occupancy Gains

Occupancy rates vary depending on the activity present in the room. For the main halls and general spaces, occupants have been assumed with each having a sensible heat gain of 75 W and a latent heat gain of 50 W.

Occupancy level: 16 in the main classroom, 8 within the HLTA classroom and 2 to 3 in each of the office areas.

Occupied hours: 9:00 – 16:00 (Monday to Friday) with a lunch break from 12pm to 1pm

2.6.2. Internal Artificial Lighting Gains

For the purpose of this assessment the following assumptions have been made:

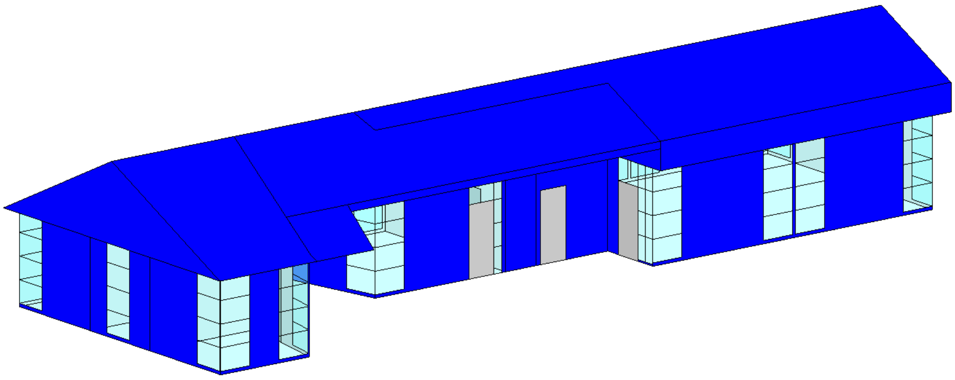
- Internal lighting throughout the building will be via highly efficient LED fittings with an assumed installed power density of <2.4 W/ m^2/100 lux.
- The main hall will have a maintained illuminance of 300 lux resulting in a lighting gain of 7.2 W/m^2, and the food preparation area and office will have a maintained illuminance of 500 lux resulting in a lighting gain of 12 W/m^2. (BB101 states 7.2 W/m^2 unless calculated otherwise) No additional allowance has been made for parasitic gains from dimmers and ballasts.
- All toilets, circulation spaces and stores will have a maintained illuminance of 200 lux resulting in a lighting gain of 4.8 W/m^2. No additional allowance has been made for parasitic gains from dimmers and ballasts.
- All office, circulation spaces and stores will have a maintained illuminance of 500 lux resulting in a lighting gain of 12.0 W/m^2. No additional allowance has been made for parasitic gains from dimmers and ballasts.
- All internal lighting has been modelled as permanently on during all occupied hours (as defined in the criteria for the overheating assessment).

2.6.3. Summary of Internal Gains

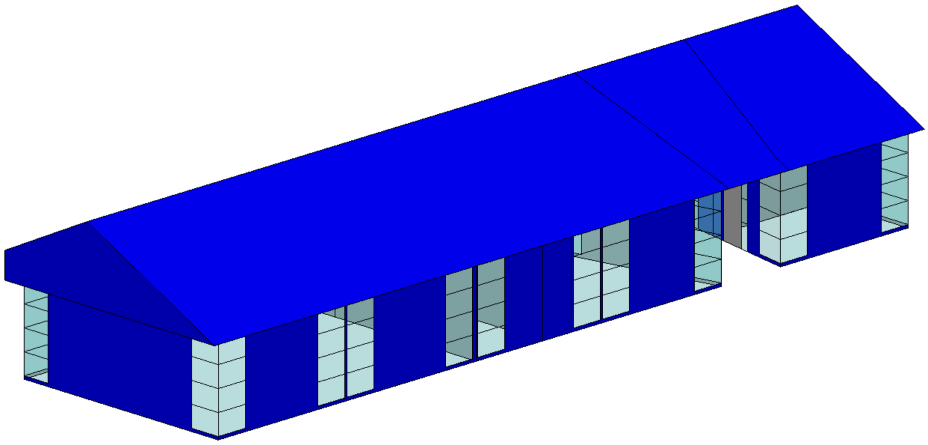
For Overheating compliance checks, only occupied spaces are included for. All items which give off heat must be identified by the Engineers to ensure that they are accounted for within the assessments.

Internal Gains										
Room	Room Area (m^2)	Occupancy			Lighting			Equipment		Total Internal Gains (W)
		Max	Sensible Gain (W/P)	Total (W)	Heat Gain (W/m^2/ 100 lux)	Illumina-nce (lux)	Total (W)	Heat Gain (W/m^2)	Total (W)	
SEND Classroom	77.8	16	70	880	2.4	300	559.9	10	778	2217.9
HLTA Classroom	29.7	8	70	440	2.4	300	213	10	297	950
Sensor Room	10.4	4	70	220	2.4	300	74.8	0	0	294.8
Office 1	15.5	3	70	216.4	2.4	500	185	10	155	556.4
Office 2	11.5	2	70	161	2.4	500	138	10	115	414
Office 3	11.6	2	70	161	2.4	500	138	10	116	415

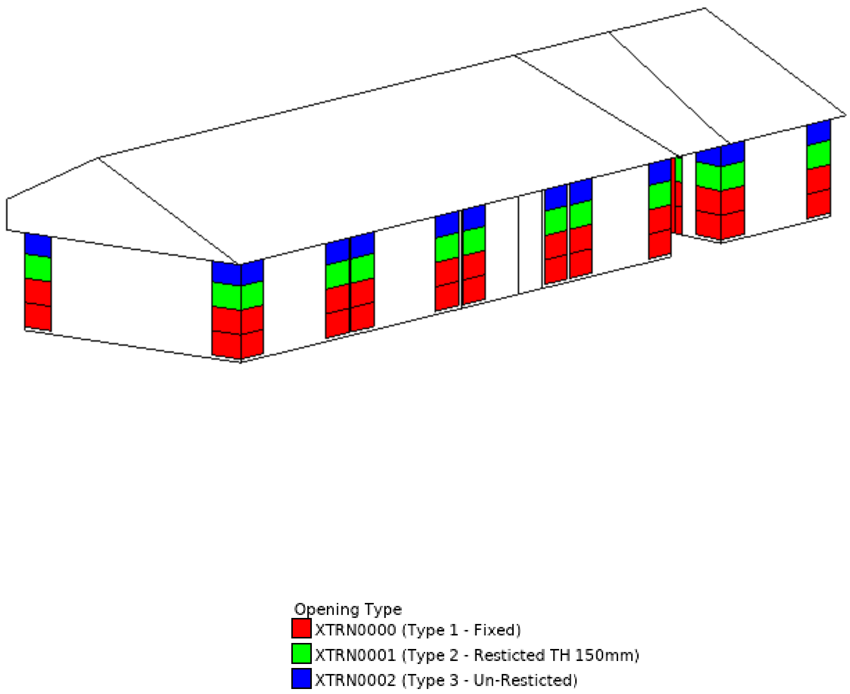
2.7. Model Geometry Visualisations - Baseline Assessment



IES-VE Geometry - Construction Building - South-West Elevation



IES-VE Geometry - Construction Building -North-East -Elevation



IES-VE Geometry - Construction Building - Window Opening - South-East Elevation

2.8 Results

2.8.1 Baseline Assessment

The baseline option for natural/passive ventilation to serve the SEND Block is based on the current architectural drawings, with an allowance for top-hung opening windows for cross-flow ventilation.

Based on the original architectural drawings, an overheating assessment was carried out against natural ventilation only, with the following assumptions:

- Constructions (buildup and thermal properties), as detailed previously in the report in Section 2.4
- Occupancies and internal gains, as previously detailed in this report in Section 2.6
- A mixture of openable restricted & unrestricted windows
- Assuming natural ventilation throughout just from windows opening
- Standard glazing throughout
- Category 1 assessment
- CIBSE DSY1 2020 (50th Percentile Range) - Plymouth.

BB101 (2018) & ESFA Overheating Assessment - Baseline									
Ref	Room Name	Occupied Hours (during Summer)	Crit. 1	Crit. 2	Crit 3	Criteria Failing			Result
1	Classroom	69.9%	4	0	1	-	-	-	PASS
2	Sensory Room	69.9%	3	0	1	-	-	-	PASS
3	Classroom	69.9%	2	0	1	-	-	-	PASS
4	Office 1	69.9%	4	0	1	-	-	-	PASS
5	Office 3	69.9%	5	1	2	-	-	-	PASS
6	Office 2	69.9%	4	0	1	-	-	-	PASS

All spaces pass the first overheating criteria and are therefore compliant with the minimum requirement for assessing the risk of overheating in schools, as set out in BB101 (2018). As mentioned earlier in this report, the assessment was conducted in accordance with category 1, which is a SEND requirement under the BB101 guidelines.

Natural ventilation methods in isolation can introduce a risk of cold draughts in colder weather. Standardised tools can be used to optimise the façade and minimise this; however, the results don't always guarantee draught-free conditions. If draught-free conditions are desired in all weather conditions, then alternative ventilation solutions should be considered.

CIBSE AM10 recommends that the width of a room for cross-flow ventilation should not exceed 5 times the height of the space, which the SEND block fully complies with.

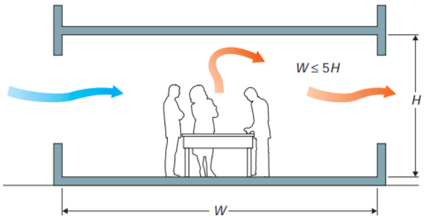


Figure 2.20 Cross ventilation

CIBSE AM10 - Cross Flow Natural Ventilation Limitations

2.8.2. CO_2 Concentration Compliance

The building should comply with BB101 guidance for ventilation provision in teaching and learning areas. The guidance states the following:

- Where mechanical ventilation is used, or when hybrid systems are operating in mechanical mode (in general teaching and learning spaces), sufficient outdoor air should be provided to achieve a daily average concentration of carbon dioxide (CO2) of less than 1000 ppm during the occupied period. This shall occur when the number of room occupants is equal to, or less than, the design occupancy.
- Where natural ventilation is used, or when hybrid systems are operating in natural mode (in general teaching and learning spaces), the following standards apply:
- Sufficient outdoor air should be provided to achieve a daily average concentration of CO2 of less than 1500 ppm, during the occupied period, when the number of room occupants is equal to, or less than the design occupancy.
- The maximum concentration should also not exceed 2000 ppm for more than 20 consecutive minutes each day when the number of room occupants is equal to, or less than the design occupancy.
- The system should be designed to achieve a carbon dioxide level for the majority of the time of less than:
- 1200 ppm for a new building (800 ppm above the outside carbon dioxide level, taken as 400ppm) for the majority of the occupied time during the year - this is the criterion for a category II building
- 1750ppm for a refurbished building (1350ppm above outside air level) for the majority of the occupied time during the year - this is the level for a category III building.

The building will be naturally ventilated; therefore, compliance can only be achieved by using sufficient external wall openings that will allow for air circulation and reduce the indoor CO_2 concentrations. The high openable area though, will result in the movement of large volumes of external cold air. This can create significant discomfort to the students during the winter period and increase the heating energy consumption significantly. The goal is to find a balanced solution that will comply with the CO_2 concentration limits but will also not compromise the building's indoor thermal comfort and energy consumption.

Carbon Dioxide Level Assessment (BB101 2018)					
Ref	Room Name	Ventilation Type	Average Internal CO2 Level (ppm)	Maximum Internal CO2 Level (ppm)	Result
1	Classroom	Natural	801	852	PASS
2	Sensory Room	Natural	994	1028	PASS
3	Classroom	Natural	868	927	PASS
4	Office 1	Natural	661	742	PASS
5	Office 3	Natural	615	687	PASS
6	Office 2	Natural	858	886	PASS

The table above illustrates that the daily average CO_2 concentration for all of the occupied spaces during teaching hours does not exceed the 1500 ppm limit for natural ventilation in any of the occupied spaces, for any of the days throughout the summer period.

2.9. Conclusion

The preceding detailed overheating calculations have been calculated in accordance with the maximum summertime temperature requirements set out in BB101 (2018)

When assuming just natural ventilation through the use of openable windows in all occupied spaces the new SEND block does comply with the minimum requirements set within BB101 guidelines. This is due to the use of cross-flow ventilation and also due to the building being mostly sheltered from significant solar heat build-up during the course of the day with the summer timer period.

The results of the calculations and analysis indicate that provided the assumptions detailed in the preceding sections of this report are followed, then all of the occupied spaces pass the minimum requirement for overheating set out within BB101 (2018) guidelines.

Therefore, the new SEND at Paignton Academy is deemed as meeting the thermal comfort requirements of BB101 and is not identified as being at risk of overheating

3. Part L Compliance

3.1. Introduction

This report details the methodology, input variables and results of the Part L compliance assessment undertaken for the new new SEND block at Paignton Academy.

The results contained within this report have been produced using IES Virtual Environment Modelling Software Version 2023.3.1.0, within the module VE Compliance (UK & Ireland) Version 7.0.24.0.

The building has been assessed against Part L2 (2021) – England, using the ApacheSim compliance analysis tool. The site location was modelled as Plymouth, and the stage of analysis is ‘As Designed’.

Regulation 26 of the Building Regulations states that: “Where a building is erected, it shall not exceed the target CO_2 emission rate for the building...”

The target CO_2 emission rate (TER) sets a minimum value for the energy performance of a building and is defined by the annual emissions of a “notional building” of the same type, size and shape to the designed (actual) building. The TER is expressed in kgs of CO_2 per metre squared.

Weather file

- Plymouth TRY05.fwt

Model Links

- Suncast link - Yes

Simulation

- Time step: 2 minutes
- Reporting interval: 60 minutes
- Preconditioning period: 10 days

3.2 Policy and Legislation

The following policies have been considered when developing the energy strategy for the scheme.

3.2.1 Building Regulation Approved Document Part L2 (2021)

Part L2 gives guidance on how to comply with Part L of Schedule 1 to the Building Regulations and the minimum energy efficiency requirements for the conservation of fuel and power for buildings other than dwellings.

3.2.1.1. Achieving the TER and Target Primary Energy Rate

To demonstrate that the requirements in Regulations 24, 25, 25B, 26, 26C, 27 and 27C have been met, a new building must be built to a minimum standard of total energy performance. This is evaluated by comparing calculations of the performance of the ‘actual building’ against calculations of the performance of a theoretical building, called the ‘notional building’. This must be carried out both at the design stage and when work is complete.

The energy performance of the notional building is described using the following metrics.

1. The target primary energy rate (TPER), in kWh_{PE}/m^2 per year.
2. The target emission rate (TER), in $kgCO_2/m^2$ per year.

The building primary energy rate and building emission rate must not exceed the target primary energy rate and the target emission rate, respectively

3.2.1.2. Limiting Heat Gains and Losses

Reasonable provision shall be made for the conservation of fuel and power in buildings by:

1. limiting heat gains and losses
    a. through thermal elements and other parts of the building fabric; and
    b. from pipes, ducts and vessels used for space heating, space cooling and hot water services;
2. providing fixed building services which
    a. are energy efficient to a reasonable standard;
    b. have effective controls; and
    c. are commissioned by testing and adjusting as necessary to ensure they use no more fuel and power than is reasonable in the circumstances.

3.2.1.3 Limiting the Effects of Solar Gains in Summer

The intention is that the building should demonstrate appropriate passive control measures to limit solar gains during the summer period in order to either:

1. reduce the need for air-conditioning
2. reduce the capacity of any air-conditioning system that is installed.

3.3. Constructions

3.3.1. U-values

A ‘fabric-first’ approach to the building design has been undertaken in order to maximise the performance of the components and materials that make up the building fabric before consideration is given to mechanical or electrical building services installations. This means prioritising insulation and air-tightness and adhering to accredited construction details to minimise the effect of thermal bridging through the fabric.

The performances of the building thermal elements shall improve on both the limiting values of Approved Document Part L Volume 2 as a minimum, as well as the NCM notional building U-values.

Constructions U-values have been modelled for the Part L calculation as per those detailed in section 2.4.

3.3.2 Glazing Design

Solar gains can be beneficial during winter months to reduce the heating demand but can be detrimental during the summer months, resulting in uncomfortably high internal temperatures.

The glazing specification shall balance solar energy transmittance (g-value) and light transmittance (LT value) to control solar gains and maximise natural daylight.

With the proposed development, we recommend the following solar performance criteria be targeted.

<table>
<tr><th colspan="6">Glazing Solar Performance</th></tr>
<tr><th rowspan="2">Thermal Element</th><th rowspan="2">Part L2 Limiting Values (W/m²K)</th><th colspan="2">Notional Building</th><th rowspan="2">Targeted G-Value</th><th rowspan="2">Targeted LT Value</th></tr>
<tr><th>Side-lit and Unlit</th><th>Top-lit</th></tr>
<tr><td>Windows, Roof Windows, Curtain Walling</td><td>g-value = 48%</td><td>g-value = 28%
Light transmittance = 60%</td><td>-</td><td>40%</td><td>70%</td></tr>
</table>

Final specification of all glazing systems shall be confirmed by the architect during the detailed design stage.

3.3.2 Air Permeability

The latest Building Regulations require a minimum air permeability of 8.0 $m^3/h.m^2$ @50Pa, whereas the notional building is modelled with 3.0 $m^3/h.m^2$ @50Pa for side-lit/unlit activities, and 5.0 $m^3/h.m^2$ @50Pa for top-lit activities. We propose a figure of 3 $m^3/h.m^2$ @50Pa, which sufficiently promotes a reduction in energy when compared to the Building Regulations.

3.3.3. Internal Conditions

All internal operating conditions are as provided by the NCM criteria; the following are fixed and cannot be manipulated within the software:

- Occupancy – Levels and periods
- Heating and cooling set-points
- Plant operation times

3.4 Systems

The NCM building type was defined as 'D1:Primary or Secondary School (Secondary)', and each room has the closest appropriate NCM activity assigned to it.

Room Templates			
Room Type	Room Name	NCM Building Type	NCM Activity
Heated or Occupied Room	SEND Classroom	D1:Primary or Secondary School	NCM D1EDuS: Teaching area
Heated or Occupied Room	HLTA Classroom	D1:Primary or Secondary School	NCM D1EDuS: Teaching area
Heated or Occupied Room	Sensor Room	D1:Primary or Secondary School	NCM D1EDuS: Teaching area:
Heated or Occupied Room	Offices	D1:Primary or Secondary School	NCM D1EDuS: Office (Common)

Room Templates			
Room Type	Room Name	NCM Building Type	NCM Activity
Heated or Occupied Room	AWC	D1:Primary or Secondary School	NCM D1EDuS: Toilets
Heated or Occupied Room	Store/Plant room	D1:Primary or Secondary School	NCM D1EDuS: Light Plant Spaces
Void	Roof	-	-

The following design criteria were assumed and provided within the calculation software:

- Project complexity: Level 5
- Fabric build-ups as stated previously, improving on the limiting values of approved document Part L Volume 2.
- Space heating to office, classroom and group rooms, is assumed to be provided by high-efficiency air to water R32 air source heat pumps, providing heating to the central underfloor heating system as per Toshiba R32 NXHM 012 (at W55°C
    - Heat Source: Heat pump (electric): air source
        - Meter: Electricity
        - COP/SCOP: 3.05/3.45
- Heating to the sanitary areas is to be assumed at this stage to be done via electric wall mounted panel heaters
    - UK NCM Type: Other local room heater unfanned.
    - Heat Source: Direct or storage electric heater
    - Seasonal Efficiency: 1
    - Has the ductwork been leakage tested? No, use default leakage
    - Does the AHU meet CEN leakage standards? No, use default leakage
    - Does the system have provision for metering? Yes, it does
    - Does the metering warn “out of range” values? No, as per default
    - Spaces assigned to this system have a heating plant radiant fraction of 0.67 (From IES-VE reference data Table 13 for vertical and ceiling panel heaters)
- Domestic hot water generation is assumed to be provided by local semi-instantaneous electric water storage heaters as per Andris Lux 6 litre.
    - Storage volume: 6 litres
    - Storage losses: 0.42 kWh

- Total storage losses: 0.042kWh/litre/day
- Secondary Circulation? None

- Domestic hot water generation for the proposed shower is via an electric point of use system
  - No Water Storage.
- Lighting assumed to be high efficiency LED type
  - Average lighting luminaire efficacy of 123 lm/W, with a Light Output Ratio of 1.0.
- Lighting occupancy controls
  - MAN ON/ AUTO off occupancy detection generally in office and classrooms spaces
  - AUTO ON/ OFF occupancy detection in the WC
  - Occupancy parasitic power of 0.3W/m² assigned to all spaces with occupancy controls
  - Occupancy sensing time-switch assigned to all spaces with occupancy controls
- Lighting photoelectric controls
  - Photoelectric options provided to all perimeter office spaces only
  - Photoelectric sensor type: standalone
  - Photoelectric control type: dimming
  - Different sensor to control back half of room: yes
  - Automatic daylight zoning
  - Photoelectric parasitic power of 0.3W/m² assigned to all spaces with photoelectric controls
  - Photoelectric sensing time-switch assigned to all spaces with photoelectric controls
- Ventilation strategies detailed as following:
  - Mechanical ventilation with heat recovery to AWC
    - SFP: 0.5W/l/s
    - Heat Recovery Type: Plate Heat Exchanger
    - Heat Recovery Efficiency:90%
    - DCV Type: No demand controlled ventilation
    - Ductwork Leakage Standards: Class A
    - AHU Leakage Standards: Class L2
- Power factor correction unit not provided; 0.9-0.95
- Does the lighting system have provision for metering? Yes, it does
- Does the lighting metering warn “out of range” values? No, it doesn’t

3.5. Results

3.5.1. Baseline Emissions

The baseline emissions for the SEND block is equivalent to the following target emissions rate (TER) of **7.3 kg·CO_2·m² per annum**.

3.5.2 Be Lean

The results below indicate the baseline results without using renewable or low-zero-carbon technologies.

These simulations incorporate 'lean' measures such as energy-conscious design, energy-efficient plants, and effective control strategies for mechanical and electrical building services.

Carbon Dioxide Emissions Rate – Be Lean Assessment (Part L 2021)				
Building	Target Emission Rate, TER (kg.CO_2/m^2/yr)	Building Emission Rate, BER (kg.CO_2/m^2/yr)	Percentage Difference	Result
SEND block	7.3	7.0	-4.1%	PASS

Primary Energy Rate – Be Lean Assessment (Part L 2021)				
Building	Target Primary Energy Rate, TPER (kWh/m²)	Building Primary Energy Rate, BPER (kWh/m²)	Percentage Difference	Result
SEND block	76.1	73	-4.1%	PASS

The assessment is just passing the minimum requirements of Part L Volume 2 with regards to both the TER and TPER. However, it is anticipated that as the notional building includes a measure of solar photovoltaics in the assessment (generating circa 29.88 kWh/annum), roof-mounted PV will be required to offset the carbon emissions and meet the minimum targets.

3.5.3. Be Clean

No further improvements can be made to the assessment using ‘clean’ measures, beyond that which are already incorporated into the design.

3.5.4.Be Green

Assuming the use of a high-efficiency solar panel, as per Sharp NUJC410H 415W type, proposals consist of a roof-mounted mono-crystalline silicon photovoltaic array with 21% nominal efficiency, orientated towards the **Southeast** and mounted on the roof at an angle of 25degrees inline with the roof pitch.

Photovoltaic Assumptions

- Manufacturer: Sharp
- Panel Type: 410Wp / NUJC410B
- Panel Size: 1,134 x 1,722mm
- Technology: Mono-crystalline silicon
- Module nominal efficiency: 21.0%
- Nominal Cell Temperature (NOCT): 42.5°C
- Reference Irradiance for NOCT: 800W/m²
- Temperature Coefficient for Module Efficiency, Pmax: -0.341%/°C
- Degradation Factor: 0.99
- Electrical Conversion Efficiency: 0.96

3.5.4.1 Maximum Provision of PV

- Allowance for 50 m² mono-crystalline PV array (20.4kWp)

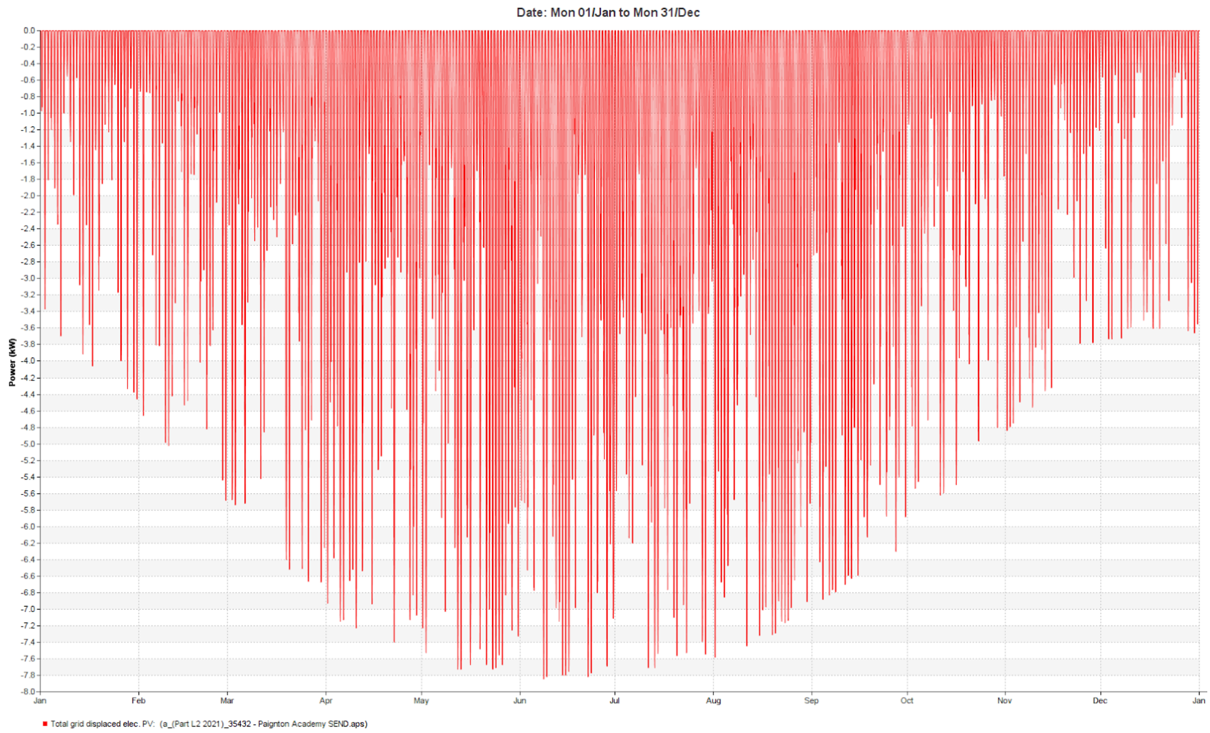
Carbon Dioxide Emissions Rate – Be Green Assessment (Part L 2021)				
Building	Target Emission Rate, TER (kg.CO_2/m^2/yr)	Building Emission Rate, BER (kg.CO_2/m^2/yr)	Percentage Difference	Result
SEND Block	7.3	-0.7	-109.58%	PASS

Primary Energy Rate – Be Green Assessment (Part L 2021)				
Building	Target Primary Energy Rate, TPER (kWh/m²)	Building Primary Energy Rate, BPER (kWh/m²)	Percentage Difference	Result
SEND block	76.1	-14.7	-119.31%	PASS

Based on provision of circa 50m² roof-mounted PV panels which is the theoretical maximum allowance, the SEND block demonstrates full compliance and a substantial improvement on the minimum requirements of Part L Volume 2 with regards to carbon emissions and energy efficiency.

The predicted annual output for the solar photovoltaic system is circa 9.94MWh/annum.

Solar PV Generation												
Date	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Energy Generated (kWh)	0320	429	688	1007	1301	1418	1294	1265	0966	0523	0413	0295



Paignton SEND Block - Estimated PV Generation - Maximum Provision

However, yield is not limited to this amount, which shall be confirmed at a later stage by the solar design specialist. The annual yield will need to consider the final orientation, panel inclination, shading factor and degradation due to the proximity of the local trees.

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3.6. Conclusions

For the new SEND block at Paignton Academy, the achieved baseline preliminary buildings emissions rate (BER) and Building Primary Energy Rate (BPER) were less than the notional target emissions rate (TER) & target primary energy rate (TPER), which demonstrated compliance with the requirements of Approved Document Part L Volume 2 for Buildings other than Dwellings.

The provision of a mono-crystalline silicon solar PV array, orientated to the South East with a 25° azimuth from horizontal (mounted to roof pitch), has been shown to allow for the demonstration that by maximising the provision of photovoltaics on the available roof space (total area of 50m² @ 21% efficiency), a total decrease in carbon emissions of 100% can be achieved, which demonstrates that the development can achieve net zero carbon based on the compliance calculations.