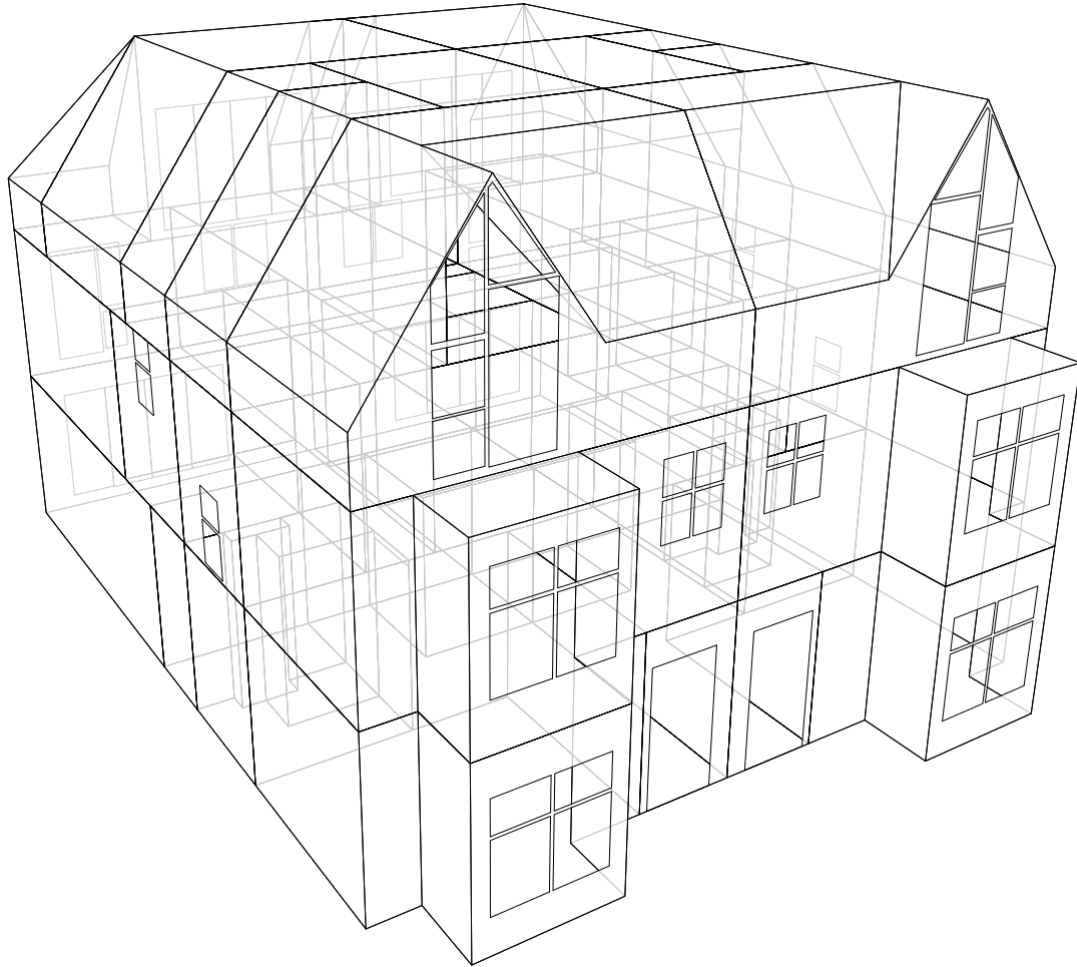


TM59 Thermal Comfort Summary Report

27-29 TRENCHARD DRIVE, WYTHENSHAW, M22 5LZ

OUR REF: 211018

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1.0 INTRODUCTION

Hurstwood has been appointed to provide a HEA04 Summary Report for the proposed pair of semi-detached dwellings at 27-29 Trenchard Drive, Wythenshaw, Manchester, M22 5LZ.

The purpose of this report is to clearly confirm that:

1. Thermal modelling has been carried out using software in accordance with CIBSE AM11 Building Energy and Environmental Modelling.

The modelling demonstrates that the building design and services strategy can deliver thermal comfort levels in occupied spaces in accordance with the criteria set out in CIBSE Guide A Environmental Design; or other appropriate industry standard (where this sets a higher or more appropriate requirement/level for the building type) to a **warmer than average climate** as per guidance in *CIBSE TM48: Use of climate change data in building simulation*.

2. The software used to carry out the simulation at the detailed design stage provides full dynamic thermal analysis.
3. The results of the dynamic thermal analysis show the building cooling load required to ensure:
 - a. The occupied areas of the building comply with any requirement, in terms of “time out of range” (TOR) metric, from the appropriate industry standard (as above) OR where there is no appropriate industry standard available or TOR recommendation made, the building services engineer confirms that the TOR is acceptable for the purpose and function of the building.
 - b. The occupied areas of the building comply with any requirement, in terms of “Predicted Mean Vote” (PMV) metric, from the appropriate industry standard (as above).
 - c. The occupied areas of the building comply with any requirement, in terms of “Percentage of People Dissatisfied” (PPD) metric, from the appropriate industry standard (as above).

2.0 DECLARATION OF COMPLIANCE WITH CIBSE AM11

CIBSE Applications Manual AM11: 1998, Building Energy and Environmental Modelling has been written to help in the selection and application of BEEM software in practice.

The manual covers:

- a) *Applicability*: BEEM software is normally a complex package of various calculation procedures; it should only be used when it is appropriate to do so.
- b) *Selection*: a large number of BEEM software tools exist; choosing the right tool for the job is the first important task in modelling.
- c) *Quality*: there is always the possibility of errors within software, mistakes in implementation and/ or the misapplication of software. Consideration should be given to validation of software and procedures for their use.
- d) *User skills*: the effect of user errors and assumptions on the results obtained can far outweigh the accuracy of BEEM software. Appropriate training, together with the establishment and use of quality assurance procedures, is an important part of developing a modelling capability.
- e) *Input data*: access to guidance and sources of information for deriving appropriate input data is pertinent to good modelling.

The guidance given in AM11: 1998 has been followed in the production of this report.

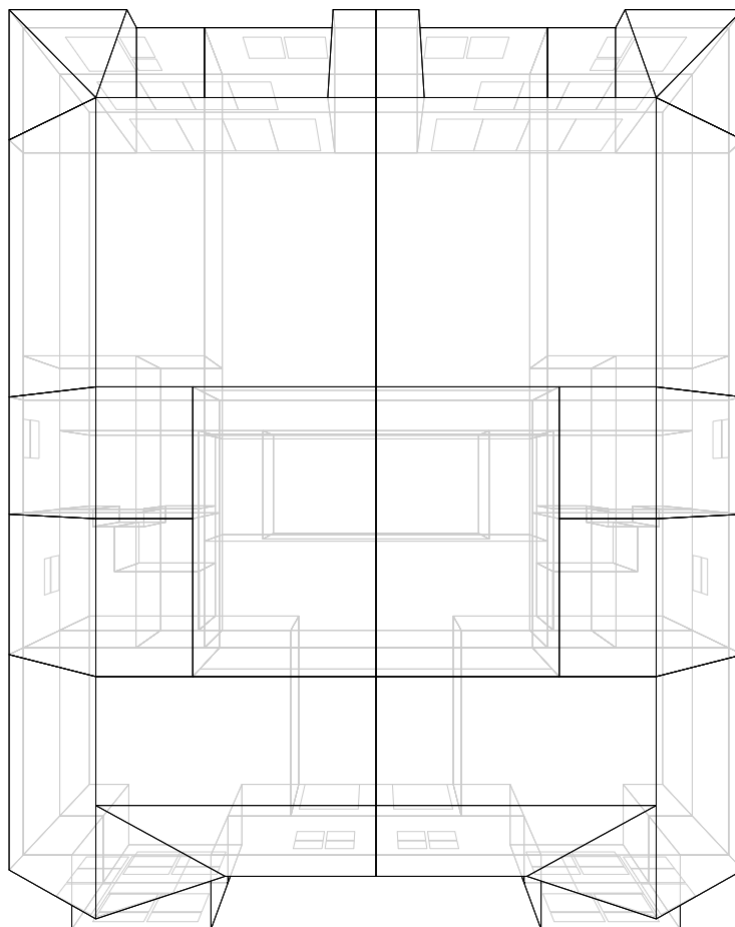


Figure 1. Top view of the proposed dwellings from IES Thermal Model

3.0 SOFTWARE USED FOR DYNAMIC THERMAL SIMULATION

The simulation tool used for this investigation is IES Virtual Environment, Version 2021.3.0.0.

The calculation methodology adopted was full Dynamic Thermal Simulation over a period of 365 days with a 20 day pre-conditioning period.

The ApacheSim calculation engine was used and a full SunCast solar shading analysis was performed to ensure the local shading devices and overhangs were accurately reflected in the simulation.

ApacheSim is comprised of the following tools:

- Apache
- ApacheEngine
- Vista & VistaPro
- ApacheView
- ApachePro
- ApacheLocate
- Constructions Database



Calculations are based on first-principles models of heat transfer process and are driven by real weather data.

Data Entry Options

- Extensive database of global weather
- Data detailing layer-by-layer thermo-physical properties of building elements
- Comprehensive data on glazing systems including angle-dependent transmissivity and absorptivity
- Sensible and latent gains from lights, equipment and occupants
- Natural ventilation, mechanical ventilation and infiltration
- Plant operation profiles
- Plant efficiency and fuel characteristics
- Powerful facilities for assigning and editing time-varying room data such as plant, casual gains and air exchanges
- Database of constructions
- Time-series profiles
- Tabular Edit feature for Building Template Manager & NCM (for UK Part L)
- Tabular Edit interface for entering properties of thermal templates, room thermal properties, HVAC systems and constructions. Gives ability to quickly enter data, review inputs and includes option to export and import *.csv files (e.g. Excel)
- Faster project setup using Master Template and Design Options features. The Master Templates feature delivers bulk data copying & rapid automatic seeding of data in to a project while the Design Option feature provides a means to make specific and targeted changes to specified data in a project

Analysis options

- User-controlled time steps down to 1 minute
- Idealised or detailed HVAC plant modeling
- Options for natural and mechanical ventilation; specify flows in advance or calculate using MacroFlo and ApacheHVAC

- Choice of models for internal and external convection

RadianceIES – Day Lighting and Electric Lighting Simulation

RADIANCE is a computer software package developed by the Lighting Systems Research Group at Lawrence Berkley Laboratory in California, USA. It was developed as a research tool to accurately calculate and predict the visible radiation within a space. Radiance is internationally recognised as one of the leading lighting simulation tools available. Using a 3-dimensional geometrical model of the physical environment Radiance produces a map of spectral radiance values in a photo-realistic image.

Radiance can be categorised as a “ray-tracing” algorithm, which tracks rays of light backwards from the “eye” to the “focus” of the scene. This contrasts with the “radiosity” technique where the exchange of energy between surface matches is matched.

SunCast – Solar Shading Analysis

SunCast is used to perform shading and solar insolation studies. It can be used to investigate:

- External obstruction and self-shading of a building.
- Solar mapping through windows and openings.
- The effects of changing orientation of building.

SunCast generates shadows and internal solar insolation from any sun position defined by date, time, orientation, site latitude and longitude. This shadow information can be stored for subsequent analysis by:

- Viewing shadows from any eye position.
- Animating the solar analyses by generating a sequence of images and creating an *.avi movie.
- Making opaque surfaces “transparent” to permit the user to better view the solar insolation on internal surfaces e.g. “removing” roofs or surfaces to identify internal solar insolation paths.
- Displaying solar surface shading/insolation statistics.
- Output data for thermal simulation.

SunCast can be used in a variety of studies including passive solar design and is essential at the planning stage to visualize the effect of the building on surrounding buildings. SunCast has also been used to study problems such as grass growth in sports stadia and ‘right of light’ issues.

MacroFlo – Multi Zone Air Movement

MacroFlo uses a multi-zone thermo-fluid solver to simulate bulk air flow driven by wind pressure and buoyancy forces. It allows analysis of problems involving infiltration, natural ventilation and mechanical ventilation. Typical applications include:

- Evaluation of natural ventilation solutions (including Advanced Natural Ventilation and Mixed-mode systems).
- Evaluation of ventilation control strategies.
- An understanding of the performance of double-skin façades.
- Analysis of room temperature statistics in naturally ventilated buildings (simulation of overheating risk).
- Predictions of air velocities through openings.
- Analysis of HVAC systems where the building is used as a return air pathway.

4.0 RELEVANT THERMAL COMFORT CRITERIA

An appropriate industry standard for the proposed development is given in CIBSE Guide A.

Table 1.5 of CIBSE Guide A also recommends summer and winter comfort criteria for building spaces which can be used to determine and report the percentage time out of range (TOR) metric (criterion 5).

Building/room type	Winter operative temp. range for stated activity and clothing levels			Summer operative temp. range (air conditioned buildings [†]) for stated activity and clothing levels		
	Temp. /°C	Activity /met	Clothing /clo	Temp. /°C	Activity /met	Clothing /clo
<i>Dwellings:</i>						
— <i>bathrooms</i>	20-22	-	-	23-25	-	-
— <i>bedrooms</i>	17-19	0.9	2.5	23-25	0.9	1.2
— <i>halls/stairs/landings</i>	19-24	-	-	21-25	-	-
— <i>kitchens</i>	17-19	1.6	1.0	21-25	1.5	0.5
— <i>living rooms</i>	22-23	1.1	1.0	21-25	1.1	0.6
— <i>toilets</i>	19-21	-	-	21-25	1.1	0.6

The temperature ranges given in Table 1.5 of CIBSE Guide A (shown above) can be adjusted to account for the circumstance that the clothing and activity differ from those assumed in Table 1.5. The temperature ranges may be widened by approximately 1°C at each end if a predicted mean vote of ± 0.5 of the operative temperature (i.e. percentage of people dissatisfied of 10%) is acceptable.

† The summer comfort temperatures given in Table 1.5 apply to air-conditioned buildings. Higher temperatures may be acceptable if full air conditioning is not present, and guidance on this can be found in section 1.4.2 of CIBSE Guide A, with a detailed discussion of the adaptive approach in section 1.6 of the same.

The Adaptive Thermal Comfort assessment method outlined in CIBSE TM 59 has been used to assess the overheating propensity. The development will be considered 'at risk' if any of the following criteria are exceeded.

TM59, 4.2(a) Criterion 1 - Hours of Exceedence (H_e): For living rooms, kitchens and bedrooms: The number of hours the ΔT is greater than or equal to one degree (K) during the period May to September inclusive must not exceed 3% of total annual occupied hours.

TM59, 4.2(b) Criterion 2 - Hours of Exceedence (H_e): For bedrooms only: The number of hours the predicted operative temperature exceeds 26°C (θ_{max}) by 1K or more between 10pm and 7am, should not exceed 1% of total annual occupied hours during the period May to September inclusive (32 hours).

TM59, 4.3 Criteria for homes predominantly mechanically ventilated - Hours of Exceedence (H_e): The number of hours the predicted operative temperature in each room exceeds 26°C (θ_{max}) by 1K, or more, should not exceed 3% of total annual occupied hours.

5.0 RELEVANT SIMULATION DATA

Weather Data

To demonstrate adaptability to a current climate scenario the Manchester_DSY01 has been applied as per guidance in *CIBSE TM48: Use of climate change data in building simulation*. This represents a current warmer than average summer based in historic measured data for the region.

General Performance Criteria

<i>External Wall Area Weighted U-Value</i>	0.18	W/m ² .K
<i>Roof Area Weighted U-Value</i>	0.08	W/m ² .K
<i>Ground Floor Area Weighted U-Value</i>	0.10	W/m ² .K
<i>Windows Area Weighted U-Value</i>	1.40	W/m ² .K
<i>Windows Total Solar Transmission (G-Value)</i>	40	%
<i>Glazing (Incl. Roof Light) Visible Light Transmission (VLT)</i>	70	%

General Infiltration

This ventilation profile is considered to run continuously as it is governed by the air permeability of the building fabric which at this stage is assumed. The assumed ventilation rate is 0.15 air changes per hour. The condition of the supply air is External.

Natural Ventilation

Each dwelling benefits from openable windows. However, due to excessive external noise pollution the opening windows cannot be relied upon for purge ventilation. All windows are considered to be permanently closed for the purpose of this simulation.

Mechanical ventilation

Each dwelling benefits from a whole house Mechanical Ventilation with Heat Recovery (MVHR) unit. The following flow rates are applied to the relevant zones:

<i>Zone</i>	<i>K/L/Dining</i>	<i>Bedroom</i>	<i>Bathroom</i>	<i>Ensuite</i>
<i>Flow Rate</i>	13 l/s	8 l/s	8 l/s	8 l/s

The MVHR unit in each dwelling will be sized to provide purge ventilation by way of mechanical extract at 4ACH. The purge ventilation will be manually controlled.

Internal Shading Devices

Internal shading devices have not been included in the simulation.

Internal Gains

Figure 1 of CIBSE TM59 provides guidance on the typical peak equipment gains which can be expected in modern dwellings.

Zone	Watts
Double bedroom	80
Living/Kitchen/Dining	450
Sitting Room	150

All internal gains are controlled by specific modulating profiles which are used to better represent the equipment heat gain into the space as it varies throughout the day. These profiles are taken directly from Figure 1 of CIBSE TM59.

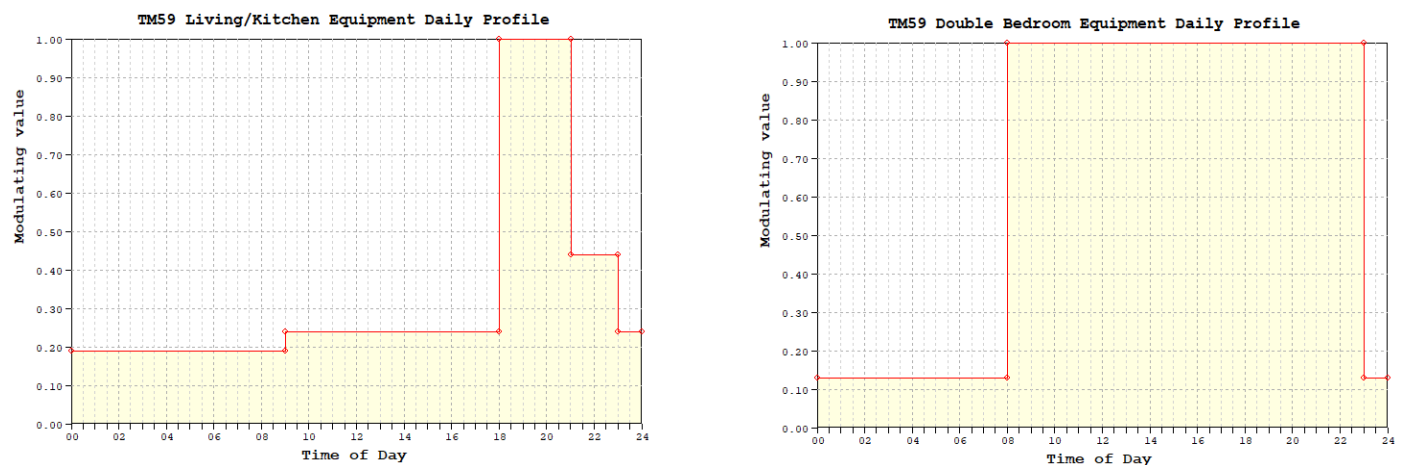


Figure 2. Kitchen/Living/Dining and Double Bedroom Modulating Profile for Equipment Gains

The internal lighting gain is based on figures provided and is as follows:

Zone	W/m ²
All Zones	2.0

The occupancy gain is based on the CIBSE figures above with the following occupancy density in each space:

Zone	K/L/D	Bedroom	Bathroom	Ensuite
No. of occupants	4	2	0	0

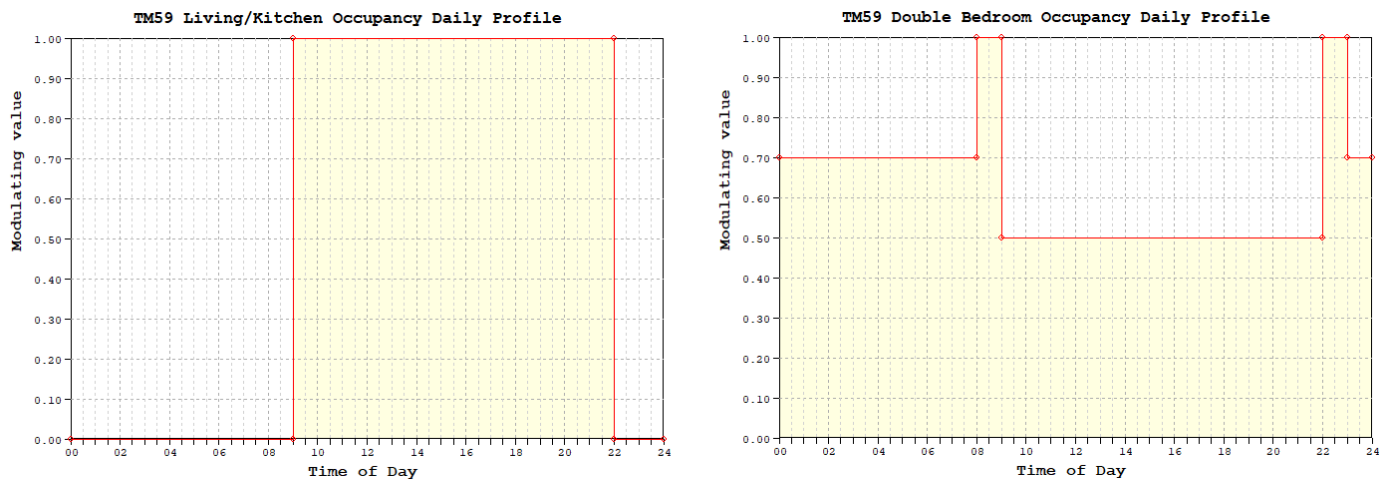


Figure 3. Kitchen/Living/Dining and Double Bedroom Modulating Profile for Occupant Gains

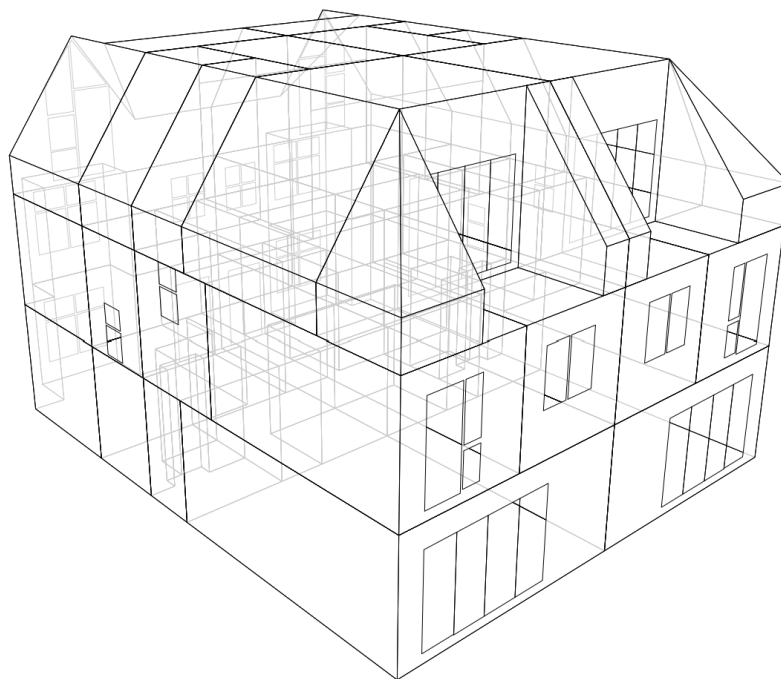


Figure 4. Axonometric View of the dwellings from IES Thermal Model



6.0 RESULTS FROM DYNAMIC THERMAL SIMULATION

The following table shows the predicted percentage of occupied hours the internal temperature exceeds 26°C in all occupied areas based on the mechanical purge ventilation rate of 4ACH.

<i>ROOM NAME</i>	<i>CRITERIA 1 % Hrs TOP- TMAX>=1K</i>	<i>PASS/ FAIL</i>
A_00_HALL	0.3	PASS
A_00_KITCHEN/LIVING/DINER	0.8	PASS
A_00_SITTING ROOM	0	PASS
A_00_WC	0	PASS
A_01_BATHROOM	0.1	PASS
A_01_BEDROOM 2	0.6	PASS
A_01_BEDROOM 3	0.4	PASS
A_01_BEDROOM 4	0.3	PASS
A_01_EN-SUITE [2]	0.1	PASS
A_01_EN-SUITE [3]	0	PASS
A_01_LANDING	0	PASS
A_02_EN-SUITE [MASTER]	0	PASS
A_02_MASTER BEDROOM	0.4	PASS
A_02_MASTER CIRCULATION	0	PASS
A_02_MASTER LOUNGE	3.0	PASS
B_00_HALL	0.2	PASS
B_00_KITCHEN/LIVING/DINER	0.8	PASS
B_00_SITTING ROOM	0	PASS
B_00_WC	0	PASS
B_01_BATHROOM	0	PASS
B_01_BEDROOM 2	0.6	PASS
B_01_BEDROOM 3	0.4	PASS
B_01_BEDROOM 4	0.3	PASS
B_01_EN-SUITE [2]	0	PASS
B_01_EN-SUITE [3]	0	PASS
B_01_LANDING	0	PASS
B_02_EN-SUITE [MASTER]	0	PASS
B_02_MASTER BEDROOM	0.4	PASS
B_02_MASTER CIRCULATION	0	PASS
B_02_MASTER LOUNGE	3.0	PASS

-END-