

## Design Note

Project Back of Ancoats – Plot B  
Subject Overheating and Performance Review  
Project no 0047020  
Date 14 July 2022

| Revision | Description            | Issued by | Date     | Approved (signature) |
|----------|------------------------|-----------|----------|----------------------|
| 00       | Issued for information | LJ/JW     | 16/07/21 | MR                   |
| 01       | Issued for information | LJ/JW     | 18/05/22 | MR                   |
| 02       | Issued for information | LJ/JW     | 13/06/22 | MR                   |
| 03       | Issued for information | JW        | 14/07/22 | MR                   |

## 1 Executive Summary

An overheating analysis has been carried out using IES Virtual Environments (VE) for the residential spaces at Eliza Yard, in accordance with methodology defined in Approved Document O. The overheating assessment was carried out for the following scenario:

- Natural ventilation provided via openable windows and standard mechanical ventilation (MVHR) provided for background ventilation throughout a day.

The results for this scenario are included within section 5 of this report, identifying that this scenario can meet the Approved Document O criteria and therefore overheating risk is at a minimum. The following is a summary of the design measures that help mitigate the overheating risks:

- Window openings, designed to meet Part F purge ventilation. Attention has been made to ensure effective opening areas to be achieved;
- Mechanical ventilation based on MVHR to provide background ventilation;
- Window /glazing size has been discussed extensively during the design stage, driven by minimising heat loss to meet and exceed Manchester City Council's Core Strategy Policy EN6, i.e. a 15% improvement over Part L 2010 building regulations standard.

## 2 Introduction

Thermal comfort assessments have been undertaken for the residential spaces of the Eliza Yard development. This is necessary to evaluate the comfort level in the habitable rooms, and to future-proof the development against the risks of increased temperatures due to climate change.

Thermal comfort has been assessed in accordance with the new Approved Document O. The document is the government's first formal consideration of overheating within buildings and aims to mitigate overheating risk in new buildings. This report has been prepared for the sole benefit, use and information of Manchester Life Development Company 2 Limited and Loom Holding 2 Limited for the purposes set out in the Design note or instructions commissioning it. The liability of Buro Happold in respect of the information contained in the report will not extend to any third party. All concepts and proposals are copyright © 1976 – 2022 Buro Happold. All rights reserved. Issued in commercial confidence.

residential buildings only. The document calls for compliance with requirement O1 (overheating mitigation), which states reasonable provision must be made to encourage the design/construction of buildings which:

1. Limit unwanted solar gains in summer
2. Provide an adequate means to remove heat from the indoor environment.

The analysis was done on a sample basis, by selecting apartments with the highest risk of overheating and at the same time including as many apartments typologies as possible. The habitable spaces (i.e. living/kitchen areas and bedrooms) of each apartment are analysed within the overheating calculations.

The residential spaces do not have mechanical cooling proposed and so were assessed against the CIBSE TM59 adaptive thermal comfort criteria, which allows for tolerance of occupants in naturally ventilated environments.

### 3 Methodology

Compliance with requirement O1 was achieved by following the design methodology for the assessment of overheating risk in homes within CIBSE's Technical Memorandum (TM59) document. TM59 provides separate compliance criteria for dwellings, while it also refers to TM52 for adaptive thermal comfort. TM59 differs to TM52 in that only 2 criteria are assessed, however both must be adhered to. Additionally, the criterion set out in TM59 are specific to residential areas. TM52 and TM59 share the same first criterion. The second TM59 criterion varies depending on whether the home is predominantly naturally or mechanically ventilated.

#### TM59 Criteria:

- 1 For living rooms, kitchens and bedrooms: the number of hours during which  $\Delta T$  is greater than or equal to  $1^{\circ}\text{C}$  during the period May to September inclusive shall not be more than 3 per cent of occupied hours.

Appendix A  $\Delta T = T_{op} - T_{max}$ , where:

$T_{op}$  – actual operative room temperature

$T_{max}$  – the limiting maximum acceptable temperature (func. of outdoor temp)

- 2 For bedrooms only: to guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10 pm to 7 am shall not exceed  $26^{\circ}\text{C}$  for more than 1% of annual hours (>32 hours per year).

Dynamic thermal simulation has been carried out and results shown in the following sections are reported against TM59 criteria.

### 4 Modelling Inputs & Assumptions

#### 4.1 Building geometry and fabric

Building heights and internal layouts were taken from the latest architectural information received on 06/06/21. A selection of apartments at highest risk of overheating due to their orientation and geometry were modelled; these include apartments on higher floors, with large areas of south-facing glazing, and inline apartments with only one external wall. Table 4-1 highlights the fabric assumptions for the site.

**Table 4.1 – Building fabric assumptions**

| Element       | Parameter | Value                   |
|---------------|-----------|-------------------------|
| External wall | U value   | 0.14 W/m <sup>2</sup> K |
| Roof          | U value   | 0.1 W/m <sup>2</sup> K  |

|                  |         |                        |
|------------------|---------|------------------------|
| External glazing | U value | 1.3 W/m <sup>2</sup> K |
|                  | g value | 0.53                   |

The surrounding buildings have been deemed to have negligible impact on overheating; they are not tall enough to affect the solar gain of the site and have thus not been modelled. Additionally, future adjacent developments have not been factored into the calculations.

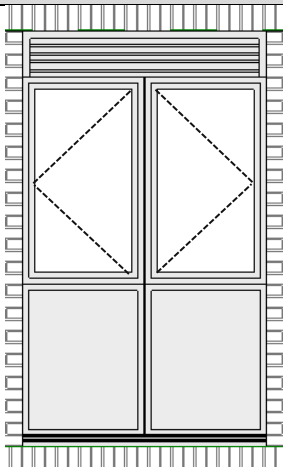
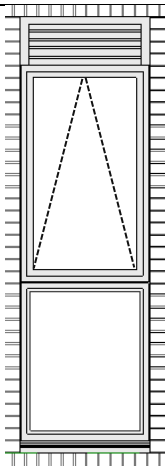
## 4.2 Internal Gains

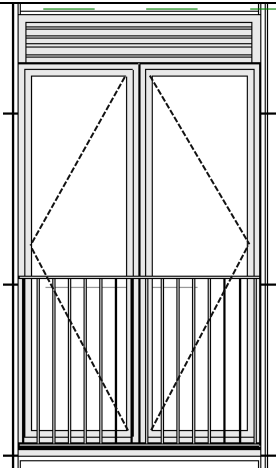
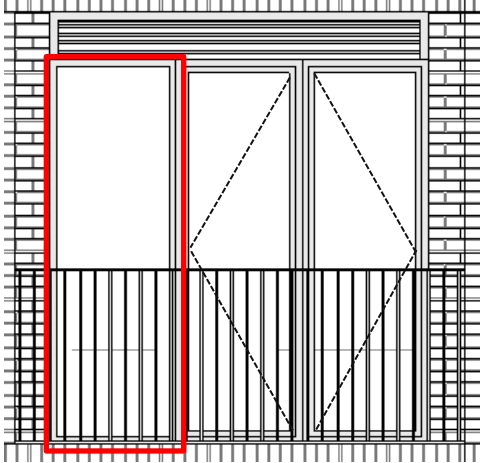
The internal gain levels and profiles were taken directly from the IES VE TM59 Template and can be found in Appendix 1.

## 4.3 Window Openings

Four types of windows have been modelled; their parameters are shown in the table below. When using windows as a means of natural ventilation to mitigate overheating, compliance with Building Regulations Part F1 (Means of Ventilation) was ensured, such that any hinged or pivot window that opened between 15 and 30 degrees has an opening area at least 1/10<sup>th</sup> of the total room floor area.

Table 4.2

| Window Name      | Example of window type                                                              | Length/Height ratio of opening | Hanging Type | Openable Area | Max angle open | Equivalent orifice area |
|------------------|-------------------------------------------------------------------------------------|--------------------------------|--------------|---------------|----------------|-------------------------|
| Bedroom window 1 |  | 0.47                           | Side-hung    | 90%           | 15°            | 23.2% of gross          |
| Bedroom window 2 |  | 0.43                           | Top-hung     | 90%           | 15°            | 23.2% of gross          |

|              |                                                                                    |      |           |     |     |                |
|--------------|------------------------------------------------------------------------------------|------|-----------|-----|-----|----------------|
| Balcony door |   | 0.29 | Side-hung | 90% | 90° | 92.9% of gross |
| Fixed door   |  | 0.23 | -         | 0%  | 0°  | -              |

The window opening modulating profile is such that the window is modelled as open if the internal temperature exceeds 22°C, as per CIBSE TM59 guidelines.

#### 4.4 Shading

In some cases, external shading was provided from balconies, which are vertically stacked. There are no other tall structures near the site.

#### 4.5 Weather

In accordance with CIBSE TM59, the DSY1 weather file for Manchester location was used, specific to the 2020s with high emissions (50<sup>th</sup> percentile scenario). For context, TM49 demonstrates the probability of a summer being as warm as or warmer than DSY1 is 1 in 9, for DSY2 this decreases to 1 in 19 and 1 in 27 for DSY 2 and 3 respectively (based on weighted cooling degree hours metric). Passing DSY1 for the 2020s, high emissions, 50% percentile scenario is mandatory for TM59 compliance and for this reason is the only weather file that has been modelled.

#### 4.6 Cooling

No cooling system has been proposed for the residential spaces.

## 5 Results

The below table summarises the results of the overheating assessment for the case of openable windows (as per section 4.3) and no mechanical ventilation.

**Table 5.1 TM59 Criteria 1 and 2 results for all rooms, with openable windows and no mechanical ventilation**

| Room ID                                      | TM59 Criteria 1 (living areas and bedrooms)     |       | TM59 Criteria 2 (bedrooms only)              |                |
|----------------------------------------------|-------------------------------------------------|-------|----------------------------------------------|----------------|
|                                              | % Hours $T_{op}-T_{max} \geq 1^{\circ}\text{C}$ | Pass? | Hours between 10pm-7am $>26^{\circ}\text{C}$ | Pass? (<32hrs) |
| 01 - 1 bed corner NE bedroom 1st-5th floor   | 0                                               | Pass  | 0                                            | Pass           |
| 01 - 1 bed corner NE living 1st-5th floor    | 0                                               | Pass  | 0                                            | Pass           |
| 01 - 1 bed inline NE bedroom 1st-5th floor   | 0.1                                             | Pass  | 0                                            | Pass           |
| 01 - 1 bed inline NE living 1st-5th floor    | 0                                               | Pass  | 0                                            | Pass           |
| 01 - 1 bed inline SW bedroom 1st-5th floor   | 0                                               | Pass  | 0                                            | Pass           |
| 01 - 1 bed inline SW living 1st-5th floor    | 0                                               | Pass  | 0                                            | Pass           |
| 01 - 2 bed corner NE bedroom 1 1st-5th floor | 0.1                                             | Pass  | 0                                            | Pass           |
| 01 - 2 bed corner NE bedroom 2 1st-5th floor | 0.4                                             | Pass  | 6                                            | Pass           |
| 01 - 2 bed corner NE living 1st-5th floor    | 0.2                                             | Pass  | 0                                            | Pass           |
| 01 - 2 bed corner SW bedroom 1 1st-5th floor | 0                                               | Pass  | 0                                            | Pass           |
| 01 - 2 bed corner SW bedroom 2 1st-5th floor | 0                                               | Pass  | 7                                            | Pass           |
| 01 - 2 bed corner SW living 1st-5th floor    | 0                                               | Pass  | 0                                            | Pass           |
| 01 - 2 bed inline NW bedroom 1 1st-5th floor | 0                                               | Pass  | 0                                            | Pass           |
| 01 - 2 bed inline NW bedroom 2 1st-5th floor | 0                                               | Pass  | 5                                            | Pass           |
| 01 - 2 bed inline NW living 1st-5th floor    | 0                                               | Pass  | 0                                            | Pass           |
| 01 - 2 bed inline SE bedroom 1 1st-5th floor | 0                                               | Pass  | 0                                            | Pass           |
| 01 - 2 bed inline SE bedroom 2 1st-5th floor | 0                                               | Pass  | 0                                            | Pass           |
| 01 - 2 bed inline SE living 1st-5th floor    | 0                                               | Pass  | 0                                            | Pass           |
| 02 - 1 bed corner NE bedroom 1st-5th floor   | 0                                               | Pass  | 0                                            | Pass           |
| 02 - 1 bed corner NE living 1st-5th floor    | 0                                               | Pass  | 0                                            | Pass           |
| 02 - 1 bed inline NE bedroom 1st-5th floor   | 0.1                                             | Pass  | 1                                            | Pass           |
| 02 - 1 bed inline NE living 1st-5th floor    | 0.1                                             | Pass  | 0                                            | Pass           |
| 02 - 1 bed inline SW bedroom 1st-5th floor   | 0                                               | Pass  | 0                                            | Pass           |
| 02 - 1 bed inline SW living 1st-5th floor    | 0                                               | Pass  | 0                                            | Pass           |
| 02 - 2 bed corner NE bedroom 1 1st-5th floor | 0.2                                             | Pass  | 2                                            | Pass           |
| 02 - 2 bed corner NE bedroom 2 1st-5th floor | 0.5                                             | Pass  | 10                                           | Pass           |
| 02 - 2 bed corner NE living 1st-5th floor    | 0.4                                             | Pass  | 0                                            | Pass           |
| 02 - 2 bed corner SW bedroom 1 1st-5th floor | 0                                               | Pass  | 1                                            | Pass           |
| 02 - 2 bed corner SW bedroom 2 1st-5th floor | 0                                               | Pass  | 7                                            | Pass           |
| 02 - 2 bed corner SW living 1st-5th floor    | 0                                               | Pass  | 0                                            | Pass           |
| 02 - 2 bed inline NW bedroom 1 1st-5th floor | 0                                               | Pass  | 1                                            | Pass           |
| 02 - 2 bed inline NW bedroom 2 1st-5th floor | 0                                               | Pass  | 5                                            | Pass           |
| 02 - 2 bed inline NW living 1st-5th floor    | 0                                               | Pass  | 0                                            | Pass           |
| 02 - 2 bed inline SE bedroom 1 1st-5th floor | 0                                               | Pass  | 0                                            | Pass           |
| 02 - 2 bed inline SE bedroom 2 1st-5th floor | 0                                               | Pass  | 3                                            | Pass           |
| 02 - 2 bed inline SE living 1st-5th floor    | 0                                               | Pass  | 0                                            | Pass           |
| 03 - 1 bed corner NE bedroom 1st-5th floor   | 0                                               | Pass  | 0                                            | Pass           |

|                                              |     |      |    |      |
|----------------------------------------------|-----|------|----|------|
| 03 - 1 bed corner NE living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 03 - 1 bed inline NE bedroom 1st-5th floor   | 0.2 | Pass | 1  | Pass |
| 03 - 1 bed inline NE living 1st-5th floor    | 0.1 | Pass | 0  | Pass |
| 03 - 1 bed inline SW bedroom 1st-5th floor   | 0   | Pass | 0  | Pass |
| 03 - 1 bed inline SW living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 03 - 2 bed corner NE bedroom 1 1st-5th floor | 0.2 | Pass | 2  | Pass |
| 03 - 2 bed corner NE bedroom 2 1st-5th floor | 0.5 | Pass | 10 | Pass |
| 03 - 2 bed corner NE living 1st-5th floor    | 0.4 | Pass | 0  | Pass |
| 03 - 2 bed corner SW bedroom 1 1st-5th floor | 0   | Pass | 1  | Pass |
| 03 - 2 bed corner SW bedroom 2 1st-5th floor | 0   | Pass | 6  | Pass |
| 03 - 2 bed corner SW living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 03 - 2 bed inline NW bedroom 1 1st-5th floor | 0   | Pass | 1  | Pass |
| 03 - 2 bed inline NW bedroom 2 1st-5th floor | 0   | Pass | 6  | Pass |
| 03 - 2 bed inline NW living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 03 - 2 bed inline SE bedroom 1 1st-5th floor | 0   | Pass | 0  | Pass |
| 03 - 2 bed inline SE bedroom 2 1st-5th floor | 0   | Pass | 4  | Pass |
| 03 - 2 bed inline SE living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 04 - 1 bed corner NE bedroom 1st-5th floor   | 0   | Pass | 0  | Pass |
| 04 - 1 bed corner NE living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 04 - 1 bed inline NE bedroom 1st-5th floor   | 0.2 | Pass | 1  | Pass |
| 04 - 1 bed inline NE living 1st-5th floor    | 0.1 | Pass | 0  | Pass |
| 04 - 1 bed inline SW bedroom 1st-5th floor   | 0   | Pass | 0  | Pass |
| 04 - 1 bed inline SW living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 04 - 2 bed corner NE bedroom 1 1st-5th floor | 0.2 | Pass | 2  | Pass |
| 04 - 2 bed corner NE bedroom 2 1st-5th floor | 0.5 | Pass | 10 | Pass |
| 04 - 2 bed corner NE living 1st-5th floor    | 0.4 | Pass | 0  | Pass |
| 04 - 2 bed corner SW bedroom 1 1st-5th floor | 0   | Pass | 1  | Pass |
| 04 - 2 bed corner SW bedroom 2 1st-5th floor | 0   | Pass | 7  | Pass |
| 04 - 2 bed corner SW living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 04 - 2 bed inline NW bedroom 1 1st-5th floor | 0   | Pass | 1  | Pass |
| 04 - 2 bed inline NW bedroom 2 1st-5th floor | 0   | Pass | 6  | Pass |
| 04 - 2 bed inline NW living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 04 - 2 bed inline SE bedroom 1 1st-5th floor | 0   | Pass | 0  | Pass |
| 04 - 2 bed inline SE bedroom 2 1st-5th floor | 0   | Pass | 4  | Pass |
| 04 - 2 bed inline SE living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 05 - 1 bed corner NE bedroom 1st-5th floor   | 0   | Pass | 0  | Pass |
| 05 - 1 bed corner NE living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 05 - 1 bed inline NE bedroom 1st-5th floor   | 0.2 | Pass | 1  | Pass |
| 05 - 1 bed inline NE living 1st-5th floor    | 0.1 | Pass | 0  | Pass |
| 05 - 1 bed inline SW bedroom 1st-5th floor   | 0   | Pass | 0  | Pass |
| 05 - 1 bed inline SW living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 05 - 2 bed corner NE bedroom 1 1st-5th floor | 0.2 | Pass | 2  | Pass |
| 05 - 2 bed corner NE bedroom 2 1st-5th floor | 0.5 | Pass | 10 | Pass |
| 05 - 2 bed corner NE living 1st-5th floor    | 0.4 | Pass | 0  | Pass |
| 05 - 2 bed corner SW bedroom 1 1st-5th floor | 0   | Pass | 1  | Pass |
| 05 - 2 bed corner SW bedroom 2 1st-5th floor | 0   | Pass | 6  | Pass |

|                                              |     |      |    |      |
|----------------------------------------------|-----|------|----|------|
| 05 - 2 bed corner SW living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 05 - 2 bed inline NW bedroom 1 1st-5th floor | 0   | Pass | 1  | Pass |
| 05 - 2 bed inline NW bedroom 2 1st-5th floor | 0   | Pass | 6  | Pass |
| 05 - 2 bed inline NW living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 05 - 2 bed inline SE bedroom 1 1st-5th floor | 0   | Pass | 0  | Pass |
| 05 - 2 bed inline SE bedroom 2 1st-5th floor | 0   | Pass | 1  | Pass |
| 05 - 2 bed inline SE living 1st-5th floor    | 0   | Pass | 0  | Pass |
| 06 - 1 bed corner NE bedroom 6th floor       | 0   | Pass | 0  | Pass |
| 06 - 1 bed corner NE living 6th floor        | 0   | Pass | 0  | Pass |
| 06 - 1 bed inline NE bedroom 6th floor       | 0.2 | Pass | 1  | Pass |
| 06 - 1 bed inline NE living 6th floor        | 0.1 | Pass | 0  | Pass |
| 06 - 1 bed inline SW bedroom 6th floor       | 0   | Pass | 0  | Pass |
| 06 - 1 bed inline SW living 6th floor        | 0   | Pass | 0  | Pass |
| 06 - 2 bed corner NE bedroom 1 6th floor     | 0   | Pass | 1  | Pass |
| 06 - 2 bed corner NE bedroom 2 6th floor     | 0   | Pass | 6  | Pass |
| 06 - 2 bed corner NE living 6th floor        | 0   | Pass | 0  | Pass |
| 06 - 2 bed corner SW bedroom 1 6th floor     | 0   | Pass | 0  | Pass |
| 06 - 2 bed corner SW bedroom 2 6th floor     | 0.5 | Pass | 4  | Pass |
| 06 - 2 bed corner SW living 6th floor        | 0.5 | Pass | 10 | Pass |
| 06 - 3 bed duplex NW bedroom 1 6th floor     | 0.3 | Pass | 0  | Pass |
| 06 - 3 bed duplex NW bedroom 2 6th floor     | 0   | Pass | 0  | Pass |
| 06 - 3 bed duplex NW bedroom 3 6th floor     | 0   | Pass | 10 | Pass |
| 07 - 1 bed corner NE living 7th floor        | 0   | Pass | 6  | Pass |
| 07 - 1 bed inline NE bedroom 7th floor       | 0   | Pass | 0  | Pass |
| 07 - 1 bed inline NE living 7th floor        | 0.1 | Pass | 1  | Pass |
| 07 - 1 bed inline SW bedroom 7th floor       | 0.1 | Pass | 0  | Pass |
| 07 - 1 bed inline SW living 7th floor        | 0   | Pass | 0  | Pass |
| 07 - 3 bed corner 1 SE bedroom 1 7th floor   | 0   | Pass | 0  | Pass |
| 07 - 3 bed corner 1 SE bedroom 2 7th floor   | 0   | Pass | 1  | Pass |
| 07 - 3 bed corner 1 SE bedroom 3 7th floor   | 0   | Pass | 5  | Pass |
| 07 - 3 bed corner 1 SE living 7th floor      | 0   | Pass | 0  | Pass |
| 07 - 3 bed corner 2 SE bedroom 1 7th floor   | 0.1 | Pass | 1  | Pass |
| 07 - 3 bed corner 2 SE bedroom 2 7th floor   | 0.4 | Pass | 4  | Pass |
| 07 - 3 bed corner 2 SE bedroom 3 7th floor   | 0.5 | Pass | 8  | Pass |
| 07 - 3 bed corner 2 SE living 7th floor      | 0.2 | Pass | 0  | Pass |
| 07 - 3 bed duplex NW top floor 7th floor     | 0.8 | Pass | 4  | Pass |

## 6 Conclusions of overheating assessment

The results show that, with the assumptions outlined in Section 4, overheating has been mitigated in all bedrooms and living rooms – fulfilling requirements stated in Approved Document O through the use of natural ventilation via openable windows. The following is a summary of the design measures that help mitigate the overheating risks adopted by the proposed buildings:

- Window openings, designed to meet Part F purge ventilation. Attention has been made to ensure effective opening areas to be achieved;
- Mechanical ventilation based on MVHR to provide background ventilation;
- Window/glazing size has been discussed extensively during the design stage, driven by minimising heat loss, to meet and exceed Manchester City Council's Core Strategy Policy EN6, i.e. a 15% improvement over Part L 2010 building regulations standard.
- Solar gain reduction by using windows with low g value, whilst still maintaining light transmittance of no less than 60% and allowing homes to benefit from the winter solar gains to reduce energy cost.

## 7 Appendices

### 7.1 Appendix 1: TM59 Internal Gains

| Room type                       | Gain type         | Peak value                               | Modulating profile                                                                                                                          |
|---------------------------------|-------------------|------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Double bedroom                  | People            | 2 people (75W sensible, 55W latent each) | 08:00-09:00 fully occupied<br>09:00-22:00 50% occupied<br>22:00-23:00 fully occupied<br>23:00-08:00 70% of maximum (sleeping)               |
|                                 | Equipment         | 80W                                      | 09:00-23:00 maximum<br>23:00-09:00 13% of maximum                                                                                           |
|                                 | Lighting          | 2W/m <sup>2</sup>                        | 18:00-23:00 on<br>23:00-18:00 off                                                                                                           |
| Single bedroom                  | People            | 1 person (75W sensible, 55W latent)      | 08:00-23:00 occupied<br>23:00-08:00 70% of maximum (sleeping)                                                                               |
|                                 | Equipment         | 80W                                      | 09:00-23:00 maximum<br>23:00-09:00 13% of maximum                                                                                           |
|                                 | Lighting          | 2W/m <sup>2</sup>                        | 18:00-23:00 on<br>23:00-18:00 off                                                                                                           |
| Studio                          | People            | 2 people (75W sensible, 55W latent each) | 00:00-24:00 fully occupied                                                                                                                  |
|                                 | Equipment         | 450W                                     | 09:00-18:00 24% of maximum<br>18:00-20:00 maximum<br>20:00-22:00 44% of maximum<br>22:00-24:00 24% of maximum<br>24:00-00:00 19% of maximum |
|                                 | Lighting          | 2W/m <sup>2</sup>                        | 18:00-23:00 on<br>23:00-18:00 off                                                                                                           |
| 1 Double bedroom kitchen/living | People            | 2 person (75W sensible, 55W latent)      | 09:00-22:00 fully occupied<br>22:00-09:00 unoccupied                                                                                        |
|                                 | Cooking/equipment | 450W                                     | 09:00-18:00 24% of maximum<br>18:00-20:00 maximum<br>20:00-22:00 44% of maximum<br>22:00-24:00 24% of maximum<br>24:00-09:00 19% of maximum |
|                                 | Lighting          | 2W/m <sup>2</sup>                        | 18:00-23:00 on<br>23:00-18:00 off                                                                                                           |

|                                                         |                   |                                     |                                                                                                                                             |
|---------------------------------------------------------|-------------------|-------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| 2 Double bedroom<br>kitchen/living                      | People            | 4 person (75W sensible, 55W latent) | 09:00-22:00 fully occupied<br>22:00-09:00 unoccupied                                                                                        |
|                                                         | Cooking/equipment | 450W                                | 09:00-18:00 24% of maximum<br>18:00-20:00 maximum<br>20:00-22:00 44% of maximum<br>22:00-24:00 24% of maximum<br>24:00-09:00 19% of maximum |
|                                                         | Lighting          | 2W/m <sup>2</sup>                   | 18:00-23:00 on<br>23:00-18:00 off                                                                                                           |
| 1 Double bedroom and 1<br>Single bedroom kitchen/living | People            | 3 person (75W sensible, 55W latent) | 09:00-22:00 fully occupied<br>22:00-09:00 unoccupied                                                                                        |
|                                                         | Cooking/equipment | 450W                                | 09:00-18:00 24% of maximum<br>18:00-20:00 maximum<br>20:00-22:00 44% of maximum<br>22:00-24:00 24% of maximum<br>24:00-09:00 19% of maximum |
|                                                         | Lighting          | 2W/m <sup>2</sup>                   | 18:00-23:00 on<br>23:00-18:00 off                                                                                                           |
| 2 Double bedroom and 1<br>Single bedroom kitchen/living | People            | 5 person (75W sensible, 55W latent) | 09:00-22:00 fully occupied<br>22:00-09:00 unoccupied                                                                                        |
|                                                         | Cooking/equipment | 450W                                | 09:00-18:00 24% of maximum<br>18:00-20:00 maximum<br>20:00-22:00 44% of maximum<br>22:00-24:00 24% of maximum<br>24:00-09:00 19% of maximum |
|                                                         | Lighting          | 2W/m <sup>2</sup>                   | 18:00-23:00 on<br>23:00-18:00 off                                                                                                           |