Dynamic Thermal Modelling of Overheating Risk (Part O)

For the development at

Ransoms, Swan Corner, Station Road, Pulborough, West Sussex, RH20 1AH

Prepared by

BBL Consultants Ltd

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1 Executive Summary

1. The proposed development involves the construction of eight new flats at Ransoms, Swan Corner, Station Road, Pulborough, West Sussex, RH20 1AH .
2. Dynamic thermal modelling, in line with the guidance in Part O and CIBSE TM59, is carried out to assess the overheating risk for the proposed development. The government-approved dynamic simulation software, DesignBuilder (v7.2.0.32) , is used for this purpose.
3. A range of passive and active cooling measures are to be incorporated in order to reduce the risk of overheating.

<table>
<tr><th>Building Elements</th><th>Design Parameters</th><th>Measures/notes</th></tr>
<tr><td>G-Value for glazing (solar transmittance value)</td><td>0.45</td><td>For all windows and patio doors</td></tr>
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<tr><td>flat 7 livkitchen</td><td>90</td></tr>
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All top-hung windows open inwards to maximize the opening angle
Fixed or lockable grills/louvred shutters to be installed on windows and patio doors in the ground floor bedrooms to ensure the secure opening during hot nights. Their use must not obstruct the opening of windows or patio door</td></tr>
</table>

Table 1: Key measures for minimising overheating risk

4. Although an exhaustive list of passive cooling measures is to be incorporated into the proposed scheme, an active cooling strategy, such as air conditioning equipment utilizing the air source heat pumps, needs to be adopted for the scheme. Other rooms meet the minimum requirements using a single DSY1 weather profile, and therefore comply with Part O of the Building Regulations in relation to overheating.

2 Introduction

2.1 Proposed development

The proposed development involves the construction of eight new flats at Ransoms, Swan Corner, Station Road, Pulborough, West Sussex, RH20 1AH .

3 Part O Dynamic Thermal Modelling Methodology

3.1 Part O assessment methodology – CIBSE TM59

Part O of the Building Regulation stipulates that to demonstrate compliance using the dynamic thermal modelling method, all of the following guidance should be followed.

- CIBSE's TM59 methodology for predicting overheating risk. CIBSE TM59:2017 (Design methodology for the assessment of overheating risk in homes) defines a standardised approach to predicting overheating risk for residential buildings (new-build or major refurbishment) using dynamic thermal analysis.
- The limits on the use of CIBSE's TM59 methodology set out in paragraphs 2.5 and 2.6.
- The acceptable strategies for reducing overheating risk in paragraphs 2.7 to 2.11.
- The building control body should be provided with a report that demonstrates that the residential building passes CIBSE's TM59 assessment of overheating. This report should contain the details in CIBSE's TM59, section 2.3.

3.2 TM59 compliance criteria

3.2.1 Compliance criteria for homes predominantly naturally ventilated

Compliance is based on passing both of the following two criteria (Table 2):

Item	Rooms Applied	Compliance Standards
Criterion 1	Living rooms Kitchens Bedrooms	the number of hours during which ΔT is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 per cent of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance).
Criterion 2	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 °C for more than 1% of annual hours. (Note: 1% of the annual hours between 22:00 and 07:00 for bedrooms is 32 hours, so 33 or more hours above 26 °C will be recorded as a fail).

Table 2: Compliance criteria for homes predominantly naturally ventilated

3.2.2 Compliance criteria for homes predominantly mechanically ventilated

For homes with restricted window openings, the CIBSE fixed temperature test must be followed, i.e. all occupied rooms should not exceed an operative temperature of 26 ˚C for more than 3% of the annual occupied hours (CIBSE Guide A (2015a)).

3.2.3 Compliance criteria for communal corridors

The inclusion of corridors in the overheating analysis is mandatory where community heating pipework runs through them. The overheating test for corridors should be based on the number of annual hours for which an operative temperature of 28 °C is exceeded. Whilst there is no mandatory target to meet, if an operative temperature of 28 °C is exceeded for more than 3% of the total annual hours, then this should be identified as a significant risk within the report.

3.3 Dynamic simulation modelling software

The government approved Dynamic Simulation Software, DesignBuilder (v7.2.0.32) , is used for the modelling purpose.

4 Dynamic Thermal Modelling Data Input

4.1 Site location and orientation

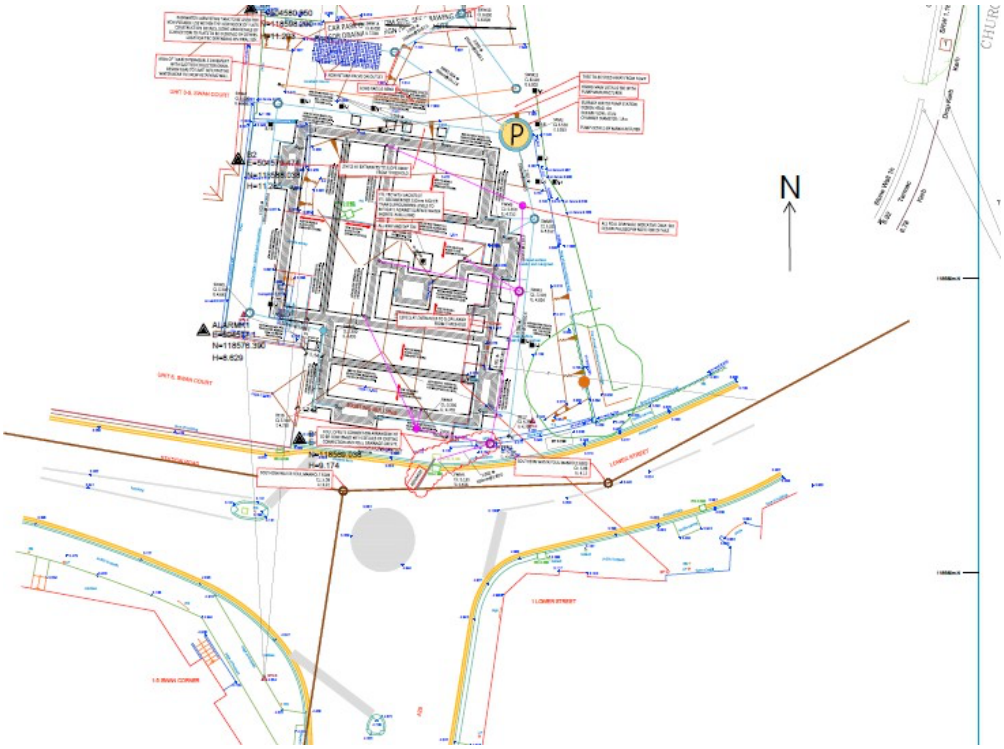


Figure 1: Site location plan, North as indicated (Source: architect's plan)

4.2 Weather files

Developments are required to pass using the DSY1 weather file most appropriate to the site location, for the 2020s, high emissions, 50% percentile scenario.

The proposed development is located at Ransoms, Swan Corner, Station Road, Pulborough, West Sussex, RH20 1AH. In accordance with CIBSE TM59 and CIBSE TM49 Design Summer Years for London , the weather profiles detailed in Table 3 are used for this assessment.

Weather files	Description
London_GTW_DSY1_2020High50.epw	CIBSE DSY London Gatwick weather files for the 2020s, high emissions, 50% percentile scenario, featuring moderately warm summer

Table 3: Weather files used for the development

4.3 Thermal comfort category

The proposed development is a new residential building which is not catered for vulnerable residents. Therefore it belongs to category II which reflects normal expectation of thermal comfort (refer to CIBSE TM52 (2013) for more detailed explanations).

Building Category	Expected Thermal Comfort Description
I	High level of expectation only used for spaces occupied by very sensitive and fragile persons
II	Normal expectation (for new buildings and renovations)
III	A moderate expectation (used for existing buildings)
IV	Values outside the criteria for the above categories (only acceptable for a limited periods)

Table 4: Thermal comfort category (CIBSE TM52 2013)

4.4 Occupancy and equipment heat gain profiles

CIBSE TM59 (2017) stipulates occupancy and heat gain profiles which should be used for dynamic overheating analysis (see Appendix A)

4.5 Sample units and building geometry

All units are assessed in the software.

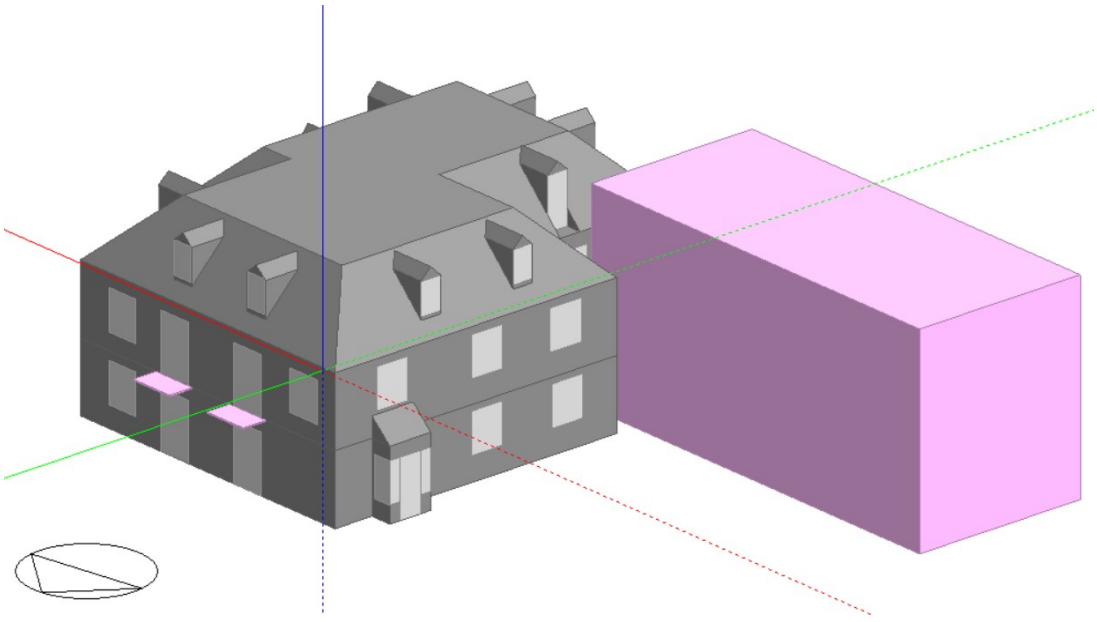


Figure 2: Building geometry

4.6 The internal layouts for the sample units

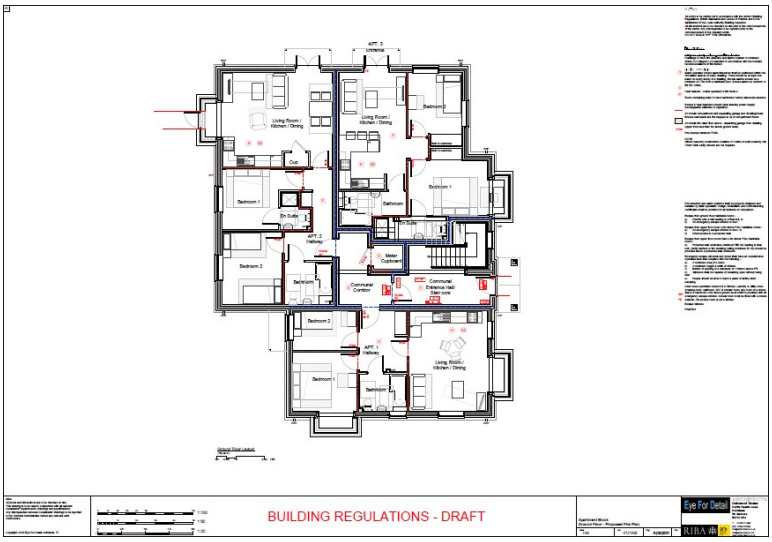


Figure 3: Ground floor (Source: architect's plan)

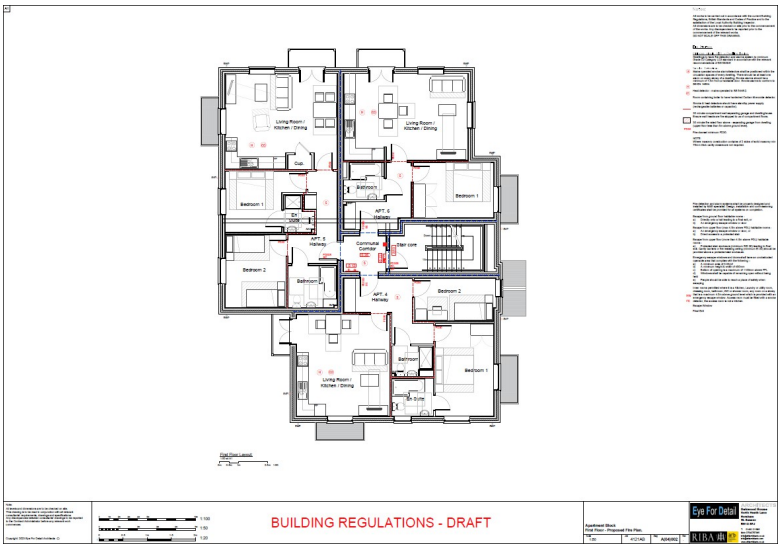


Figure 4: First floor (Source: architect's plan)

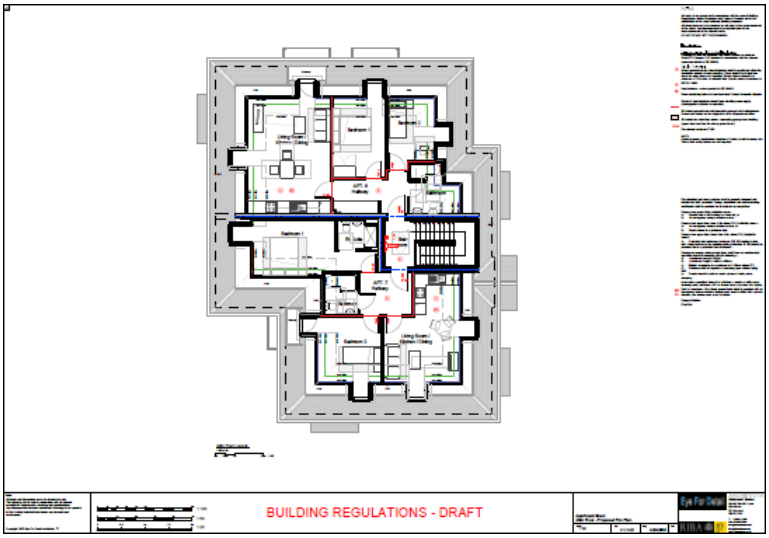


Figure 5: Second floor (Source: architect's plan)

4.7 Communal corridors

The inclusion of corridors in the overheating analysis is mandatory where community heating pipework runs through them. The overheating test for corridors should be based on the number of annual hours for which an operative temperature of 28 °C is exceeded.

Because communal heating is not proposed for this development, overheating analysis is not carried out for communal corridors.

4.8 Key building specifications

Table 5 details performance of key building elements for the proposed development.

Building Elements	Design Parameters
Ground Floor U-Value (W/m²k)	0.11
External Wall U-Value (W/m²k)	0.16
Pitched Roof U-Value (W/m²k) - insulated slope	0.09
Flat Roof U-Value (W/m²k)	0.09
Thermal Mass	Calculated in Design Builder based on construction details
Windows U-Value (W/m²k)	0.9
Doors U-Value (W/m²k)	1
Thermal Bridging	RCD
Air Leakage Rate (m*/m²/hr@50Pa)	3
Energy Efficiency Lighting	LED
Heating System	Air source heat pump
Hot Water System	Air source heat pump

Table 5: Performance of key building fabrics and services

4.9 Window free areas

Please see Table 6 below for ventilation free areas calculated for each openings:

ID	Window W, m	Window H, m	Opening W, m	Opening H, m	Opening angle	Window area, m²	Free area, m²	Free area as % of window area
w001	0.91	1.585	0.82	0.86	80°	1.44	0.65	45.4%
w002	2.214	1.585	0.82	2.06	80°	3.51	1.66	47.2%
w003.1	0.774	1.585	0.82	0.73	80°	1.23	0.52	42.5%
w003.2	0.774	1.585	0.82	0.73	80°	1.23	0.52	42.5%
w004	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w005	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w006.1	0.774	1.585	0.82	0.73	80°	1.23	0.52	42.5%
w006.2	0.774	1.585	0.82	0.73	80°	1.23	0.52	42.5%
w007.1	0.65	1.585	0.82	0.6	80°	1.03	0.43	41.6%
w007.2	0.65	1.585	0.82	0.6	80°	1.03	0.43	41.6%
w008	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%

ID	Window W, m	Window H, m	Opening W, m	Opening H, m	Opening angle	Window area, m²	Free area, m²	Free area as % of window area
w009	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w010	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w011	2.214	1.585	0	0	0°	3.51	0.00	0%
w012.1	0.774	1.585	0	0	0°	1.23	0.00	0%
w012.2	0.774	1.585	0	0	0°	1.23	0.00	0%
w013	0.91	1.585	0	0	0°	1.44	0.00	0%
w014	1.36	1.585	0	0	0°	2.16	0.00	0%
w015	2.214	1.585	0.82	2.06	80°	3.51	1.66	47.2%
w016.1	0.774	1.585	0.82	0.73	80°	1.23	0.52	42.5%
w016.2	0.774	1.585	0.82	0.73	80°	1.23	0.52	42.5%
w017	0.91	1.585	0.82	0.86	80°	1.44	0.65	45.4%
ed002	1.36	2.26	1.31	1.92	90°	3.07	2.36	76.6%
ed003	1.36	2.26	1.31	1.92	90°	3.07	2.36	76.6%
ed004	0.91	2.26	0.86	1.92	90°	2.06	1.62	79%
w101	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w102	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w103	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w104	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w105	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w106	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w107	0.91	1.585	0.82	0.86	80°	1.44	0.65	45.4%
w108	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w109	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
w110	0.91	1.585	0.82	0.86	80°	1.44	0.65	45.4%
w111	1.36	1.585	0.82	1.31	80°	2.16	1.00	46.3%
ed101	1.36	2.26	1.31	1.92	90°	3.07	2.36	76.6%
ed102	1.36	2.26	1.31	1.92	90°	3.07	2.36	76.6%
ed103	1.36	2.26	1.31	1.92	90°	3.07	2.36	76.6%
w201	0.91	1.268	0.86	1.16	90°	1.15	0.93	81%
w202	0.91	1.268	0.86	1.16	90°	1.15	0.93	81%
w203	0.91	1.268	0.86	1.16	90°	1.15	0.93	81%
w204	0.91	1.268	0.86	1.16	90°	1.15	0.93	81%

ID	Window W, m	Window H, m	Opening W, m	Opening H, m	Opening angle	Window area, m²	Free area, m²	Free area as % of window area
w205	0.91	1.268	0.86	1.16	90°	1.15	0.93	81%
w206	0.91	1.268	0.86	1.16	90°	1.15	0.93	81%
w207	0.91	1.268	0.86	1.16	90°	1.15	0.93	81%
ed201	0.91	2.26	0.86	1.92	90°	2.06	1.62	79%
ed202	0.91	2.26	0.86	1.92	90°	2.06	1.62	79%

Table 6: Opening free areas

4.10 Key passive cooling measures to minimise overheating risk

A variety of passive cooling measures including shading, solar control glazing and mechanical ventilation, are modelled for the proposed scheme.

Table 7 details key passive cooling measures for minimising overheating risk for the proposed development.

<table>
<tr><th>Building Elements</th><th>Design Parameters</th><th>Measures/notes</th></tr>
<tr><td>G-Value for glazing (solar transmittance value)</td><td>0.45</td><td>For all windows and patio doors</td></tr>
<tr><td>Supplementary ventilation strategy</td><td>Natural ventilation</td><td>Fixed panes are minimised in order to maximise ventilation areas
w201-w207: change to casement windows with an opening angle of 90 degree
All top-hung windows open inwards to maximize the opening angle
Fixed or lockable grills/louvred shutters to be installed on windows and patio doors in the ground floor bedrooms to ensure the secure opening during hot nights. Their use must not obstruct the opening of windows or patio doors.</td></tr>
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</table>

Table 7: Key measures for minimising overheating risk

5 Modelling Results using weather file DSY1

5.1 Model results for living rooms, kitchens and bedrooms

Refer to Figure 6 for model results.

6 Conclusions

Although an exhaustive list of passive cooling measures is to be incorporated into the proposed scheme, the main ventilation strategy has been specified as mechanical ventilation due to acoustic requirements. The mechanical ventilation with heating recovery (MVHR) system is connected to the air source heat pump which supplies cool air, and therefore comply with Part O of the Building Regulations in relation to overheating.

Figure 1 Heat gain profile

Number of people	Description	Peak load (W) Sensible	Latent	Period 00–01	01–02	02–03	03–04	04–05	05–06	06–07	07–08	08–09	09–10	10–11	11–12	12–13	13–14	14–15	15–16	16–17	17–18	18–19	19–20	20–21	21–22	22–23	23–24
				Hour ending 1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00	10.00	11.00	12.00	13.00	14.00	15.00	16.00	17.00	18.00	19.00	20.00	21.00	22.00	23.00	24.00
1	Single bedroom occupancy	75	55	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.7
2	Double bedroom cccupancy	150	110	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1	0.7
2	Studio occupancy	150	110	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.7
1	1–bedroom living/kitchen occupancy	75	55	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
1	1–bedroom living occupancy	75	55	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
1	1–bedroom kitchen occupancy	75	55	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
2	2–bedroom living/kitchen occupancy	150	110	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
2	2–bedroom living occupancy	150	110	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
2	2–bedroom kitchen occupancy	150	110	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
3	3–bedroom living/kitchen occupancy	225	165	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0
3	3–bedroom living occupancy	225	165	0	0	0	0	0	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0	0
3	3–bedroom kitchen occupancy	225	165	0	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0	0
	Single bedroom equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Double bedroom equipment	80		0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0.13
	Studio equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living/litchen equipment	450		0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.19	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	1	1	0.44	0.44	0.24	0.24
	Living equipment	150		0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	1	1	1	1	0.4	0.4
	Kitchen equipment	300		0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	1	1	0.17	0.17	0.17	0.17
	Lighting profile	2 (W/m2)		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0

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