Total electricity for the above, kWh/year		266.25	(331)
Electricity for lighting (Appendix L)		451.41	(332)
Total delivered energy for all uses	(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =	7294.72	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from boilers	4173.88	x	4.24	x 0.01 =	176.97	(340a)
Water heating from boilers	2403.18	x	4.24	x 0.01 =	101.89	(342a)
Pumps and fans	266.25	x	13.19	x 0.01 =	35.12	(349)
Electricity for lighting	451.41	x	13.19	x 0.01 =	59.54	(350)
Additional standing charges					120.00	(351)
Total energy cost				(340a)...(342e) + (345)...(354) =	493.53	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.25	(357)
SAP value	82.60	
SAP rating (section 13)	83	(358)
SAP band	B	

12b. CO_2 emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of boilers	89.50					(367a)
CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) =	7348.67	x	0.216	=	1587.31	(367)
Electrical energy for community heat distribution	65.77	x	0.519	=	34.13	(372)
Total CO2 associated with community systems					1621.45	(373)
Total CO2 associated with space and water heating					1621.45	(376)
Pumps and fans	266.25	x	0.519	=	138.18	(378)
Electricity for lighting	451.41	x	0.519	=	234.28	(379)
Total CO_2, kg/year				(376)..(382) =	1993.92	(383)
Dwelling CO_2 emission rate				(383) ÷ (4) =	16.46	(384)
EI value					83.92	
EI rating (section 14)					84	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)	
Primary energy from other sources (space heating)						
Efficiency of boilers	89.50					(367a)
Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) =	7348.67	x	1.22	=	8965.37	(367)
Electrical energy for community heat distribution	65.77	x	3.07	=	201.92	(372)
Total primary energy associated with community systems					9167.29	(373)
Total primary energy associated with space and water heating					9167.29	(376)
Pumps and fans	266.25	x	3.07	=	817.39	(378)
Electricity for lighting	451.41	x	3.07	=	1385.84	(379)
Primary energy kWh/year					11370.52	(383)

Dwelling primary energy rate kWh/m2/year	93.85	(384)

TER Worksheet
Design - Draft

NHER

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr AECOM Planner	Assessor number	101
Client	Default Client	Last modified	30/08/2018
Address	5.8 redYellow 42, London		

1. Overall dwelling dimensions

		Area (m^2)		Average storey height (m)		Volume (m^3)	
Lowest occupied		121.16	(1a) x	2.62	(2a) =	317.44	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	121.16	(4)				
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =	317.44	(5)

2. Ventilation rate

			m^3 per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	4	x 10 =	40	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 40	÷ (5) =	0.13	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		5.00 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.38 (18)
Number of sides on which the dwelling is sheltered		2 (19)
Shelter factor	1 - [0.075 x (19)] =	0.85 (20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.32 (21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.41	0.40	0.39	0.35	0.34	0.30	0.30	0.30	0.32	0.34	0.36	0.38	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

d) natural ventilation or whole house positive input ventilation from loft

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57	(24d)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			30.29	x	1.33	=	40.16			(27)
External wall			46.95	x	0.18	=	8.45			(29a)
Party wall			75.31	x	0.00	=	0.00			(32)
Roof			121.16	x	0.13	=	15.75			(30)
Total area of external elements ∑A, m²			198.40							(31)

Fabric heat loss, W/K = ∑(A × U) (26)...(30) + (32) = 64.36 (33)

Heat capacity Cm = ∑(A x κ) (28)...(30) + (32) + (32a)...(32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K 250.00 (35)

Thermal bridges: ∑(L x Ψ) calculated using Appendix K 9.92 (36)

Total fabric heat loss (33) + (36) = 74.28 (37)

Ventilation heat loss calculated monthly 0.33 x (25)m x (5)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
61.08	60.74	60.41	58.85	58.56	57.21	57.21	56.96	57.73	58.56	59.15	59.76	(38)

Heat transfer coefficient, W/K (37)m + (38)m

135.35	135.02	134.69	133.13	132.84	131.49	131.49	131.23	132.01	132.84	133.43	134.04	

Average = ∑(39)1...12/12 = 133.13 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

1.12	1.11	1.11	1.10	1.10	1.09	1.09	1.08	1.09	1.10	1.10	1.11	

Average = ∑(40)1...12/12 = 1.10 (40)

Number of days in month (Table 1a)

31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N 2.87 (42)

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 102.31 (43)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
112.54	108.45	104.35	100.26	96.17	92.08	92.08	96.17	100.26	104.35	108.45	112.54	

∑(44)1...12 = 1227.69 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

166.89	145.96	150.62	131.32	126.00	108.73	100.75	115.62	117.00	136.35	148.83	161.63	

∑(45)1...12 = 1609.70 (45)

Distribution loss 0.15 x (45)m

25.03	21.89	22.59	19.70	18.90	16.31	15.11	17.34	17.55	20.45	22.33	24.24	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel 180.00 (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day) 1.55 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage (kWh/day) (48) x (49) 0.84 (50)

Enter (50) or (54) in (55) 0.84 (55)

Water storage loss calculated for each month (55) x (41)m

25.98	23.47	25.98	25.14	25.98	25.14	25.98	25.98	25.14	25.98	25.14	25.98	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

25.98	23.47	25.98	25.14	25.98	25.14	25.98	25.98	25.14	25.98	25.14	25.98	(57)

Primary circuit loss for each month from Table 3

23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)

Combi loss for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

216.13	190.44	199.86	178.97	175.24	156.38	150.00	164.86	164.65	185.59	196.49	210.87	(62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)

Output from water heater for each month (kWh/month) (62)m + (63)m

216.13	190.44	199.86	178.97	175.24	156.38	150.00	164.86	164.65	185.59	196.49	210.87

∑(64)1...12 = 2189.49 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

94.89	84.11	89.48	81.79	81.29	74.28	72.89	77.84	77.02	84.73	87.61	93.13	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	143.38	143.38	143.38	143.38	143.38	143.38	143.38	143.38	143.38	143.38	143.38	143.38	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	25.56	22.70	18.46	13.98	10.45	8.82	9.53	12.39	16.63	21.11	24.64	26.27	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	286.72	289.69	282.19	266.23	246.08	227.15	214.50	211.52	219.02	234.98	255.13	274.07	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.34	37.34	37.34	37.34	37.34	37.34	37.34	37.34	37.34	37.34	37.34	37.34	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-114.71	-114.71	-114.71	-114.71	-114.71	-114.71	-114.71	-114.71	-114.71	-114.71	-114.71	-114.71	(71)
Water heating gains (Table 5)	127.53	125.17	120.26	113.59	109.26	103.16	97.98	104.62	106.98	113.88	121.68	125.18	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	508.83	506.58	489.94	462.82	434.81	408.15	391.02	397.55	411.64	438.99	470.47	494.53	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
South	0.77	x	24.43	x	46.75	x 0.9 x	0.63	x	0.70	=	349.06	(78)
West	0.77	x	5.86	x	19.64	x 0.9 x	0.63	x	0.70	=	35.17	(80)

Solar gains in watts ∑(74)m...(82)m

384.23	640.47	841.52	988.29	1060.18	1032.70	1003.82	952.71	892.48	698.24	457.61	330.54	(83)

Total gains - internal and solar (73)m + (83)m

893.06	1147.05	1331.45	1451.10	1494.99	1440.84	1394.84	1350.26	1304.12	1137.23	928.08	825.07	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C) 21.00 (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)	0.99	0.98	0.95	0.88	0.75	0.57	0.41	0.44	0.66	0.91	0.99	1.00	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.93	20.18	20.46	20.74	20.91	20.98	21.00	21.00	20.96	20.73	20.27	19.88

(87)

Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

19.99	19.99	19.99	20.00	20.00	20.01	20.01	20.01	20.01	20.00	20.00	20.00

(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.98	0.94	0.85	0.69	0.49	0.32	0.35	0.58	0.88	0.98	1.00

(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

18.57	18.94	19.34	19.72	19.92	20.00	20.01	20.01	19.98	19.71	19.07	18.51

(90)

Living area fraction — Living area ÷ (4) = 0.53 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

19.29	19.60	19.93	20.26	20.45	20.52	20.53	20.53	20.50	20.25	19.70	19.24

(92)

Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.29	19.60	19.93	20.26	20.45	20.52	20.53	20.53	20.50	20.25	19.70	19.24

(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation factor for gains, ηm	0.99	0.97	0.94	0.86	0.72	0.53	0.37	0.40	0.62	0.89	0.98	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	885.67	1117.33	1246.48	1241.78	1074.10	764.19	515.32	539.67	812.36	1006.49	908.72	820.31	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	2029.06	1984.36	1809.38	1511.82	1161.71	778.48	517.07	542.32	845.03	1281.80	1681.45	2015.52	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	850.68	582.64	418.79	194.43	65.18	0.00	0.00	0.00	0.00	204.84	556.37	889.24	

∑(98)1...5, 10...12 = 3762.17 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 31.05 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11) — 0.00 (201)

Fraction of space heat from main system(s) — 1 - (201) = 1.00 (202)

Fraction of space heat from main system 2 — 0.00 (202)

Fraction of total space heat from main system 1 — (202) x [1- (203)] = 1.00 (204)

Fraction of total space heat from main system 2 — (202) x (203) = 0.00 (205)

Efficiency of main system 1 (%) — 93.50 (206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	909.82	623.15	447.91	207.95	69.71	0.00	0.00	0.00	0.00	219.08	595.04	951.06

∑(211)1...5, 10...12 = 4023.71 (211)

Water heating

Efficiency of water heater

	88.11	87.61	86.74	85.04	82.44	79.80	79.80	79.80	79.80	85.08	87.44	88.23

(217)

Water heating fuel, kWh/month

	245.31	217.38	230.41	210.47	212.56	195.97	187.96	206.59	206.33	218.14	224.71	238.99

∑(219a)1...12 = 2594.83 (219)

Annual totals

Space heating fuel - main system 1 — 4023.71

Water heating fuel		2594.83	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
central heating pump or water pump within warm air heating unit	30.00		(230c)
boiler flue fan	45.00		(230e)
Total electricity for the above, kWh/year		75.00	(231)
Electricity for lighting (Appendix L)		451.41	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	7144.96	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4023.71	x	3.48	x 0.01 =	140.03	(240)
Water heating	2594.83	x	3.48	x 0.01 =	90.30	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	451.41	x	13.19	x 0.01 =	59.54	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	419.76	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.06	(257)
SAP value	85.20	
SAP rating (section 13)	85	(258)
SAP band	B	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	4023.71	x	0.216	=	869.12	(261)
Water heating	2594.83	x	0.216	=	560.48	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1429.61	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	451.41	x	0.519	=	234.28	(268)
Total CO_2, kg/year			(265)...(271) =		1702.82	(272)
Dwelling CO_2 emission rate			(272) ÷ (4) =		14.05	(273)
EI value					86.27	
EI rating (section 14)					86	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	4023.71	x	1.22	=	4908.93	(261)
Water heating	2594.83	x	1.22	=	3165.70	(264)
Space and water heating			(261) + (262) + (263) + (264) =		8074.63	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	451.41	x	3.07	=	1385.84	(268)
Primary energy kWh/year					9690.72	(272)
Dwelling primary energy rate kWh/m2/year					79.98	(273)

Appendix D Non-Domestic Energy Calculations

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Untitled

As designed

Date: Tue Aug 28 16:46:24 2018

Administrative information

Building Details

Address: Address 1, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.9

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.9

BRUKL compliance check version: v5.4.a.1

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	26
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	26
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	18.8
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	F0000000:Surf[2]
Floor	0.25	0.12	0.12	F0000000:Surf[0]
Roof	0.25	0.13	0.13	F0000000:Surf[1]
Windows***, roof windows, and rooflights	2.2	1.4	1.4	F0000001:Surf[2]
Personnel doors	2.2	2.2	2.2	F0000005:Surf[3]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

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

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

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

* There might be more than one surface where the maximum U-value occurs.

** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.

*** Display windows and similar glazing are excluded from the U-value check.

N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	5

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- rads_HP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.73	-	0.2	0	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

2- FCU_1p5_HP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.73	3.13	0	1.5	0.75
Standard value	2.5*	2.55	N/A	1.6^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

3- FCU_HP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.73	3.13	0	1.7	0.75
Standard value	2.5*	2.55	N/A	1.6^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

4- CV_HP

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	2.73	3.13	0	1.7	0.75
Standard value	2.5*	2.55	N/A	1.6^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

"No HWS in project, or hot water is provided by HVAC system"

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
F00 Cinema/Activity	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 ElectricalCB/DistBoard	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Generator	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 HairSalon	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 ICT	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Kitchen	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 LibraryLounge	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 LibraryLoungePer	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Medicalcentre01	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Medicalcentre01Perimeter	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 MedicalConsultingRoom01	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 MedicalConsultingRoom02	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 MedicalNursesRoom	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 MSR	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Office01	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Office02	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Plant01	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Plant02	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Plant03	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Rehab+Exercise	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 RestaurantCafe	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 RestaurantCafePerimeter	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 ShowersFemale	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 ShowersMale	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Staff	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 StaffChange(Dry)	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 StaffWC	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Therapy01	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Therapy02	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Therapy03	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Therapy04	-	-	-	-	-	-	-	0.3	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
F00 WC	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WC02	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WC03	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WC04	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WC05	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WC06	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WCCycle	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WCsF	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WCsM	-	-	0.5	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
F00 BinCollection	90	-	-	118
F00 ChefOffice	-	90	60	129
F00 Cinema/Activity	-	90	-	374
F00 Circ	-	90	-	76
F00 Circ01	-	90	-	167
F00 Circ02	-	90	-	187
F00 CL	90	-	-	34
F00 ColdRoom	90	-	-	37
F00 Cyclestorage	90	-	-	73
F00 DryChange	90	-	-	29
F00 DryStore	90	-	-	35
F00 ElectricalCB/DistBoard	90	-	-	44
F00 Freezer	90	-	-	27
F00 Generator	90	-	-	183
F00 HairSalon	-	90	60	278
F00 HeatingPlant	90	-	-	287
F00 ICT	90	-	-	51
F00 Kitchen	-	90	-	394
F00 LibraryLounge	-	90	60	471
F00 LibraryLoungePer	-	90	60	586
F00 LinenStore	90	-	-	55
F00 LoadingZone	90	-	-	267
F00 Mail	90	-	-	52
F00 Medicalcentre01	90	-	-	100
F00 Medicalcentre01Perimeter	90	-	-	333
F00 MedicalConsultingRoom01	90	-	-	102
F00 MedicalConsultingRoom02	90	-	-	193
F00 MedicalNursesRoom	90	-	-	102
F00 MedicalStore	90	-	-	25
F00 MSR	90	-	-	111

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
F00 Office01	90	-	-	160
F00 Office02	90	-	-	100
F00 Plant01	90	-	-	49
F00 Plant02	90	-	-	244
F00 Plant03	90	-	-	94
F00 Pool	-	90	-	299
F00 Poolside	-	90	-	393
F00 Poolside	-	90	-	283
F00 Reception/Lobby	-	90	60	754
F00 ReceptionEntrance01	-	90	60	176
F00 ReceptionEntrance02	-	90	60	181
F00 Refuse/IncomingService	90	-	-	33
F00 Rehab+Exercise	-	90	-	141
F00 RestaurantCafe	-	90	-	189
F00 RestaurantCafePerimeter	-	90	-	286
F00 Scooterstorage	90	-	-	121
F00 ShowersFemale	-	90	-	20
F00 ShowersMale	-	90	-	20
F00 Staff	90	-	-	466
F00 StaffChange(Dry)	90	-	-	123
F00 StaffWC	-	90	-	40
F00 Stairs01	-	90	-	55
F00 Stairs02	-	90	-	51
F00 Store	90	-	-	25
F00 Store	90	-	-	13
F00 Store	90	-	-	49
F00 Store	90	-	-	40
F00 Store	90	-	-	32
F00 Store	90	-	-	34
F00 Store	90	-	-	53
F00 Therapy01	-	90	-	137
F00 Therapy02	-	90	-	38
F00 Therapy03	-	90	-	37
F00 Therapy04	-	90	-	46
F00 Transformer	90	-	-	87
F00 VentPlant	90	-	-	117
F00 WC	-	90	-	35
F00 WC02	-	90	-	56
F00 WC03	-	90	-	49
F00 WC04	-	90	-	26
F00 WC05	-	90	-	45
F00 WC06	-	90	-	29
F00 WCCycle	-	90	-	26

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
F00 WCsF	-	90	-	68
F00 WCsM	-	90	-	68
F01 Corridor	-	90	-	170
F01 Corridor	-	90	-	178
F01 Corridor	-	90	-	227
F02 Corridor	-	90	-	170
F02 Corridor	-	90	-	227
F02 Corridor	-	90	-	178
F03 Corridor	-	90	-	185
F03 Corridor	-	90	-	238
F03 Corridor	-	90	-	177
F04 Corridor	-	90	-	168
F04 Corridor01	-	90	-	240
F04 Corridor02	-	90	-	151
F05 Corridor	-	90	-	216
F05 Corridor	-	90	-	133

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
F00 ChefOffice	NO (-62.6%)	NO
F00 Cinema/Activity	NO (-23.7%)	NO
F00 HairSalon	NO (-32.3%)	NO
F00 ICT	NO (-100%)	NO
F00 LibraryLounge	NO (-76.4%)	NO
F00 LibraryLoungePer	NO (-65.9%)	NO
F00 Medicalcentre01	YES (+9.8%)	NO
F00 Medicalcentre01Perimeter	YES (+6.6%)	NO
F00 MedicalConsultingRoom01	NO (-51.9%)	NO
F00 MedicalConsultingRoom02	NO (-68.9%)	NO
F00 MedicalNursesRoom	NO (-11.2%)	NO
F00 Office01	YES (+5.4%)	NO
F00 Office02	NO (-2%)	NO
F00 Pool	N/A	N/A
F00 Poolside	YES (+69.4%)	NO
F00 Poolside	NO (-59%)	NO
F00 Reception/Lobby	NO (-92.7%)	NO
F00 ReceptionEntrance01	YES (+33.3%)	NO
F00 ReceptionEntrance02	YES (+16.3%)	NO
F00 Rehab+Exercise	NO (-26.7%)	NO
F00 RestaurantCafe	NO (-35.3%)	NO
F00 RestaurantCafePerimeter	NO (-32.1%)	NO
F00 ShowersFemale	N/A	N/A
F00 ShowersMale	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
F00 Staff	NO (-49.3%)	NO
F00 StaffChange(Dry)	N/A	N/A
F00 Therapy01	NO (-42.9%)	NO
F00 Therapy02	N/A	N/A
F00 Therapy03	N/A	N/A
F00 Therapy04	YES (+1.6%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	3421.8	3421.8
External area [m²]	3811.5	3811.5
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	5	3
Average conductance [W/K]	1116.75	1386.91
Average U-value [W/m²K]	0.29	0.36
Alpha value* [%]	10.05	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
1	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
94	**C2 Residential Institutions: Hospitals and Care Homes**
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
6	**D2 General Assembly and Leisure, Night Clubs, and Theatres**
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	4.12	4.83
Cooling	6.89	5.95
Auxiliary	17.8	12.79
Lighting	15.96	23.79
Hot water	5.12	4.09
Equipment*	128.71	128.71
TOTAL**	**49.9**	**51.46**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	12.45	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	140.11	125.63
Primary energy* [kWh/m²]	177.02	180.73
Total emissions [kg/m²]	18.8	26

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Fan coil systems, [HS] Heat pump (electric): ground or water source, [HFT] Electricity, [CFT] Electricity										
	Actual	1.9	638.2	0.2	43.2	52.8	2.59	4.1	2.73	4.6
	Notional	0	0	0	0	0	0	0	---	---
[ST] Single-duct VAV, [HS] Heat pump (electric): ground or water source, [HFT] Electricity, [CFT] Electricity										
	Actual	128.8	81.1	13.8	5.5	47	2.59	4.1	2.73	4.6
	Notional	4.6	512.1	0.5	37.5	39.6	2.56	3.79	---	---
[ST] Central heating using water: radiators, [HS] Heat pump (electric): ground or water source, [HFT] Electricity, [CFT] Electri										
	Actual	50.8	0	5.4	0	7.7	2.59	0	2.73	0
	Notional	164.2	58.9	17.9	4.3	17.9	2.56	3.79	---	---
[ST] Fan coil systems, [HS] Heat pump (electric): ground or water source, [HFT] Electricity, [CFT] Electricity										
	Actual	9.1	167	1	11.3	42.9	2.59	4.1	2.73	4.6
	Notional	57.1	0	6.2	0	6	2.56	0	---	---
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	11.8	132.4	1.3	9.7	32.8	2.56	3.79	---	---

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.18	F0000000:Surf[2]
Floor	0.2	0.12	F0000000:Surf[0]
Roof	0.15	0.13	F0000000:Surf[1]
Windows, roof windows, and rooflights	1.5	1.4	F0000001:Surf[2]
Personnel doors	1.5	2.2	F0000005:Surf[3]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	5

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Untitled

As designed

Date: Tue Aug 28 16:30:28 2018

Administrative information

Building Details

Address: Address 1, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.9

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.9

BRUKL compliance check version: v5.4.a.1

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

CO_2 emission rate from the notional building, $kgCO_2/m^2.annum$	27.2
Target CO_2 emission rate (TER), $kgCO_2/m^2.annum$	27.2
Building CO_2 emission rate (BER), $kgCO_2/m^2.annum$	25.7
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.18	0.18	F0000000:Surf[2]
Floor	0.25	0.12	0.12	F0000000:Surf[0]
Roof	0.25	0.13	0.13	F0000000:Surf[1]
Windows***, roof windows, and rooflights	2.2	1.4	1.4	F0000001:Surf[2]
Personnel doors	2.2	2.2	2.2	F0000005:Surf[3]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

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

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

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	5

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	>0.95

1- rads

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	-	0.2	0	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

2- FCU_1p5

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	3.13	0	1.5	0.75
Standard value	0.91*	2.55	N/A	1.6^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

3- FCU

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	3.13	0	1.7	0.75
Standard value	0.91*	2.55	N/A	1.6^	0.5
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

4- CV

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.96	3.13	0	1.7	0.75
Standard value	0.91*	2.55	N/A	1.6^	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

^ Limiting SFP may be extended by the amounts specified in the Non-Domestic Building Services Compliance Guide if the system includes additional components as listed in the Guide.

"No HWS in project, or hot water is provided by HVAC system"

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
F00 Cinema/Activity	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 ElectricalCB/DistBoard	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Generator	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 HairSalon	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 ICT	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Kitchen	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 LibraryLounge	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 LibraryLoungePer	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Medicalcentre01	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Medicalcentre01Perimeter	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 MedicalConsultingRoom01	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 MedicalConsultingRoom02	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 MedicalNursesRoom	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 MSR	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Office01	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Office02	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Plant01	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Plant02	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Plant03	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Rehab+Exercise	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 RestaurantCafe	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 RestaurantCafePerimeter	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 ShowersFemale	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 ShowersMale	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Staff	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 StaffChange(Dry)	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 StaffWC	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 Therapy01	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Therapy02	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Therapy03	-	-	-	-	-	-	-	0.3	-	-	N/A
F00 Therapy04	-	-	-	-	-	-	-	0.3	-	-	N/A

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
F00 WC	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WC02	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WC03	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WC04	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WC05	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WC06	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WCCycle	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WCsF	-	-	0.5	-	-	-	-	-	-	-	N/A
F00 WCsM	-	-	0.5	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
F00 BinCollection	90	-	-	118
F00 ChefOffice	-	90	60	129
F00 Cinema/Activity	-	90	-	374
F00 Circ	-	90	-	76
F00 Circ01	-	90	-	167
F00 Circ02	-	90	-	187
F00 CL	90	-	-	34
F00 ColdRoom	90	-	-	37
F00 Cyclestorage	90	-	-	73
F00 DryChange	90	-	-	29
F00 DryStore	90	-	-	35
F00 ElectricalCB/DistBoard	90	-	-	44
F00 Freezer	90	-	-	27
F00 Generator	90	-	-	183
F00 HairSalon	-	90	60	278
F00 HeatingPlant	90	-	-	287
F00 ICT	90	-	-	51
F00 Kitchen	-	90	-	394
F00 LibraryLounge	-	90	60	471
F00 LibraryLoungePer	-	90	60	586
F00 LinenStore	90	-	-	55
F00 LoadingZone	90	-	-	267
F00 Mail	90	-	-	52
F00 Medicalcentre01	90	-	-	100
F00 Medicalcentre01Perimeter	90	-	-	333
F00 MedicalConsultingRoom01	90	-	-	102
F00 MedicalConsultingRoom02	90	-	-	193
F00 MedicalNursesRoom	90	-	-	102
F00 MedicalStore	90	-	-	25
F00 MSR	90	-	-	111

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
F00 Office01	90	-	-	160
F00 Office02	90	-	-	100
F00 Plant01	90	-	-	49
F00 Plant02	90	-	-	244
F00 Plant03	90	-	-	94
F00 Pool	-	90	-	299
F00 Poolside	-	90	-	393
F00 Poolside	-	90	-	283
F00 Reception/Lobby	-	90	60	754
F00 ReceptionEntrance01	-	90	60	176
F00 ReceptionEntrance02	-	90	60	181
F00 Refuse/IncomingService	90	-	-	33
F00 Rehab+Exercise	-	90	-	141
F00 RestaurantCafe	-	90	-	189
F00 RestaurantCafePerimeter	-	90	-	286
F00 Scooterstorage	90	-	-	121
F00 ShowersFemale	-	90	-	20
F00 ShowersMale	-	90	-	20
F00 Staff	90	-	-	466
F00 StaffChange(Dry)	90	-	-	123
F00 StaffWC	-	90	-	40
F00 Stairs01	-	90	-	55
F00 Stairs02	-	90	-	51
F00 Store	90	-	-	25
F00 Store	90	-	-	13
F00 Store	90	-	-	49
F00 Store	90	-	-	40
F00 Store	90	-	-	32
F00 Store	90	-	-	34
F00 Store	90	-	-	53
F00 Therapy01	-	90	-	137
F00 Therapy02	-	90	-	38
F00 Therapy03	-	90	-	37
F00 Therapy04	-	90	-	46
F00 Transformer	90	-	-	87
F00 VentPlant	90	-	-	117
F00 WC	-	90	-	35
F00 WC02	-	90	-	56
F00 WC03	-	90	-	49
F00 WC04	-	90	-	26
F00 WC05	-	90	-	45
F00 WC06	-	90	-	29
F00 WCCycle	-	90	-	26

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
F00 WCsF	-	90	-	68
F00 WCsM	-	90	-	68
F01 Corridor	-	90	-	170
F01 Corridor	-	90	-	178
F01 Corridor	-	90	-	227
F02 Corridor	-	90	-	170
F02 Corridor	-	90	-	227
F02 Corridor	-	90	-	178
F03 Corridor	-	90	-	185
F03 Corridor	-	90	-	238
F03 Corridor	-	90	-	177
F04 Corridor	-	90	-	168
F04 Corridor01	-	90	-	240
F04 Corridor02	-	90	-	151
F05 Corridor	-	90	-	216
F05 Corridor	-	90	-	133

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
F00 ChefOffice	NO (-62.6%)	NO
F00 Cinema/Activity	NO (-23.7%)	NO
F00 HairSalon	NO (-32.3%)	NO
F00 ICT	NO (-100%)	NO
F00 LibraryLounge	NO (-76.4%)	NO
F00 LibraryLoungePer	NO (-65.9%)	NO
F00 Medicalcentre01	YES (+9.8%)	NO
F00 Medicalcentre01Perimeter	YES (+6.6%)	NO
F00 MedicalConsultingRoom01	NO (-51.9%)	NO
F00 MedicalConsultingRoom02	NO (-68.9%)	NO
F00 MedicalNursesRoom	NO (-11.2%)	NO
F00 Office01	YES (+5.4%)	NO
F00 Office02	NO (-2%)	NO
F00 Pool	N/A	N/A
F00 Poolside	YES (+69.4%)	NO
F00 Poolside	NO (-59%)	NO
F00 Reception/Lobby	NO (-92.7%)	NO
F00 ReceptionEntrance01	YES (+33.3%)	NO
F00 ReceptionEntrance02	YES (+16.3%)	NO
F00 Rehab+Exercise	NO (-26.7%)	NO
F00 RestaurantCafe	NO (-35.3%)	NO
F00 RestaurantCafePerimeter	NO (-32.1%)	NO
F00 ShowersFemale	N/A	N/A
F00 ShowersMale	N/A	N/A

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
F00 Staff	NO (-49.3%)	NO
F00 StaffChange(Dry)	N/A	N/A
F00 Therapy01	NO (-42.9%)	NO
F00 Therapy02	N/A	N/A
F00 Therapy03	N/A	N/A
F00 Therapy04	YES (+1.6%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	YES
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	3421.8	3421.8
External area [m²]	3811.5	3811.5
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	5	3
Average conductance [W/K]	1116.75	1386.91
Average U-value [W/m²K]	0.29	0.36
Alpha value* [%]	10.05	10

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
1	**A1/A2 Retail/Financial and Professional services**
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
94	**C2 Residential Institutions: Hospitals and Care Homes**
	C2 Residential Institutions: Residential schools
	C2 Residential Institutions: Universities and colleges
	C2A Secure Residential Institutions
	Residential spaces
	D1 Non-residential Institutions: Community/Day Centre
	D1 Non-residential Institutions: Libraries, Museums, and Galleries
	D1 Non-residential Institutions: Education
	D1 Non-residential Institutions: Primary Health Care Building
	D1 Non-residential Institutions: Crown and County Courts
6	**D2 General Assembly and Leisure, Night Clubs, and Theatres**
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others: Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	11.72	14.32
Cooling	6.89	5.95
Auxiliary	17.8	12.79
Lighting	15.96	23.79
Hot water	12.14	12.14
Equipment*	128.71	128.71
TOTAL**	**64.52**	**69**

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	0	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	140.11	125.63
Primary energy* [kWh/m²]	150.8	159.61
Total emissions [kg/m²]	25.7	27.2

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	50.8	0	15.5	0	7.7	0.91	0	0.96	0
	Notional	0	0	0	0	0	0	0	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	1.9	638.2	0.6	43.2	52.8	0.91	4.1	0.96	4.6
	Notional	57.1	0	18.4	0	6	0.86	0	----	----
[ST] Single-duct VAV, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	128.8	81.1	39.4	5.5	47	0.91	4.1	0.96	4.6
	Notional	4.6	512.1	1.5	37.5	39.6	0.86	3.79	----	----
[ST] Fan coil systems, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	9.1	167	2.8	11.3	42.9	0.91	4.1	0.96	4.6
	Notional	164.2	58.9	53	4.3	17.9	0.86	3.79	----	----
[ST] No Heating or Cooling										
	Actual	0	0	0	0	0	0	0	0	0
	Notional	11.8	132.4	3.8	9.7	32.8	0.86	3.79	----	----

Key to terms

Heat dem [MJ/m2] = Heating energy demand
Cool dem [MJ/m2] = Cooling energy demand
Heat con [kWh/m2] = Heating energy consumption
Cool con [kWh/m2] = Cooling energy consumption
Aux con [kWh/m2] = Auxiliary energy consumption
Heat SSEFF = Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER = Cooling system seasonal energy efficiency ratio
Heat gen SSEFF = Heating generator seasonal efficiency
Cool gen SSEER = Cooling generator seasonal energy efficiency ratio
ST = System type
HS = Heat source
HFT = Heating fuel type
CFT = Cooling fuel type

Key Features

The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.

Building fabric

Element	$U_{l\text{-}Typ}$	$U_{l\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.18	F0000000:Surf[2]
Floor	0.2	0.12	F0000000:Surf[0]
Roof	0.15	0.13	F0000000:Surf[1]
Windows, roof windows, and rooflights	1.5	1.4	F0000001:Surf[2]
Personnel doors	1.5	2.2	F0000005:Surf[3]
Vehicle access & similar large doors	1.5	-	No Vehicle access doors in building
High usage entrance doors	1.5	-	No High usage entrance doors in building

$U_{l\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{l\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
m³/(h.m²) at 50 Pa	5	5

Appendix E Overheating Calculation

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Figures

Tables

1. Executive Summary

For London domestic developments the GLA requires the use of CIBSE TM59 to mitigate the risk of overheating. 9 out of 89 units have been selected from the development as sample units for the overheating assessment for the Kew Red and Yellow project. Six (A-F) options have been tested to demonstrate the improvements made to mitigate the risk of overheating within the sample units.

Table 1 summarises the results for the Base case and the remaining options undertaken to mitigate the risk of overheating.

Table 7. Summary of results for Base case and each option

Room name			Base case (Opt A)	Opt B	Opt C	Opt D	Opt E	Opt F
			Base case	Curtains applied to closed glazing	Reasonable openings	Reduce g-value	Mechanical ventilation	External Overhang
	F2 01	F04 01Livingroom	X	X	X	✓	✓	✓
		F02 01Bed01	X	X	✓	✓	✓	✓
		F02 01Bed02	X	X	✓	✓	✓	✓
	F2 05	F02 05Livingroom	X	X	✓	✓	✓	✓
		F02 05Bed01	X	X	✓	✓	✓	✓
		F02 05Bed02	X	X	✓	✓	✓	✓
	F2 09	F02 09Livingroom	X	X	✓	✓	✓	✓
		F02 09Bed01	X	X	✓	✓	✓	✓
		F02 09Bed02	X	X	✓	✓	✓	✓
	F2 13	F02 13Livingroom	X	X	✓	✓	✓	✓
		F02 13Bed01	X	X	✓	✓	✓	✓
		F02 13Bed02	X	X	✓	✓	✓	✓
	F2 15	F02 15Livingroom	X	X	X	✓	✓	✓
		F02 15Bed01	X	X	X	✓	✓	✓
		F02 15Bed02	X	X	✓	✓	✓	✓
	F2 19	F02 19Livingroom	X	X	X	X	X	✓
		F02 19Bed01	X	X	X	✓	✓	✓
	F4 01	F04 01Livingroom	X	X	X	X	X	✓
		F04 01Bed01	X	X	✓	✓	✓	✓
		F04 01Bed02	X	X	✓	✓	✓	✓
	F5 03	F05 03	X	X	X	✓	✓	✓
		-	X	X	✓	✓	✓	✓
		-	X	X	✓	✓	✓	✓
	F5 08	F05 08	X	X	X	X	X	✓
		-	X	X	✓	✓	✓	✓
		-	X	X	✓	✓	✓	✓
Rooms passed			0/27	0/27	19/27	24/27	24/27	0/27

Units passed	0/9	0/9	3/9	6/9	6/9	0/9

Overall, to mitigate the risk of overheating according to TM 59,

- External windows have been reduced from a g-value of 0.55 to 0.45;
- Cream Holland linen curtains have been applied to the glazing locations; these have been applied to glazing locations that do not open and in such a way that they do not block the openable glazing areas;
- The sample assessment has shown that some units benefit from the increased air changes provided by the MVHR;
- and that overhanging local shades area beneficial on some critical south facing rooms.

2. Introduction

For London domestic developments the GLA requires an analysis using CIBSE TM59 to mitigate the risk of overheating. CIBSE TM59 uses the following design comfort criteria:

- CIBSE TM52: Limits of thermal comfort: avoiding overheating in European buildings (2013) provides the principles of thermal comfort and should be the main reference for any additional detail. TM52 is based on the concept of adaptive thermal comfort. Instead of there being an absolute summertime limit, the limiting threshold is a dynamic number varying according to external weighted mean temperatures. This recognises that occupant comfort varies with external conditions.

- CIBSE Guide A: Environmental design (2015a) includes advice regarding sleep quality (that may be compromise at temperatures above 24°C), and recommends peak bedroom temperatures should not exceed an absolute threshold of 26°C.

CIBSE TM59 states two criteria to assess if a predominantly naturally ventilated flat is overheating:

A. *For living rooms, kitchen and bedrooms:* the number of hours during which the temperature difference between the temperature threshold and the internal operative temperature is greater than or equal to one degree (K) during the period May to September inclusive shall not be more than 3 percent of occupied hours. (CIBSE TM52 Criterion 1: Hours of exceedance).

B. *For bedrooms only:* 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 sleeping hours.

Criteria 2 and 3 of CIBSE TM52 may fail to be met, but both (A) and (B) above must be passed for all relevant rooms.

The bedrooms and living/kitchen rooms were assessed under ‘category I’ which is required for young and infirm occupants.

9 out of 89 units have been selected from the development as sample units for the overheating assessment. Figure 2, 2 and 3 shows the sample units highlighted in red for this assessment. These have been selected to be appropriate to represent the development.

IES software version 2017.4.0.0 has been used to carry out the overheating analysis.

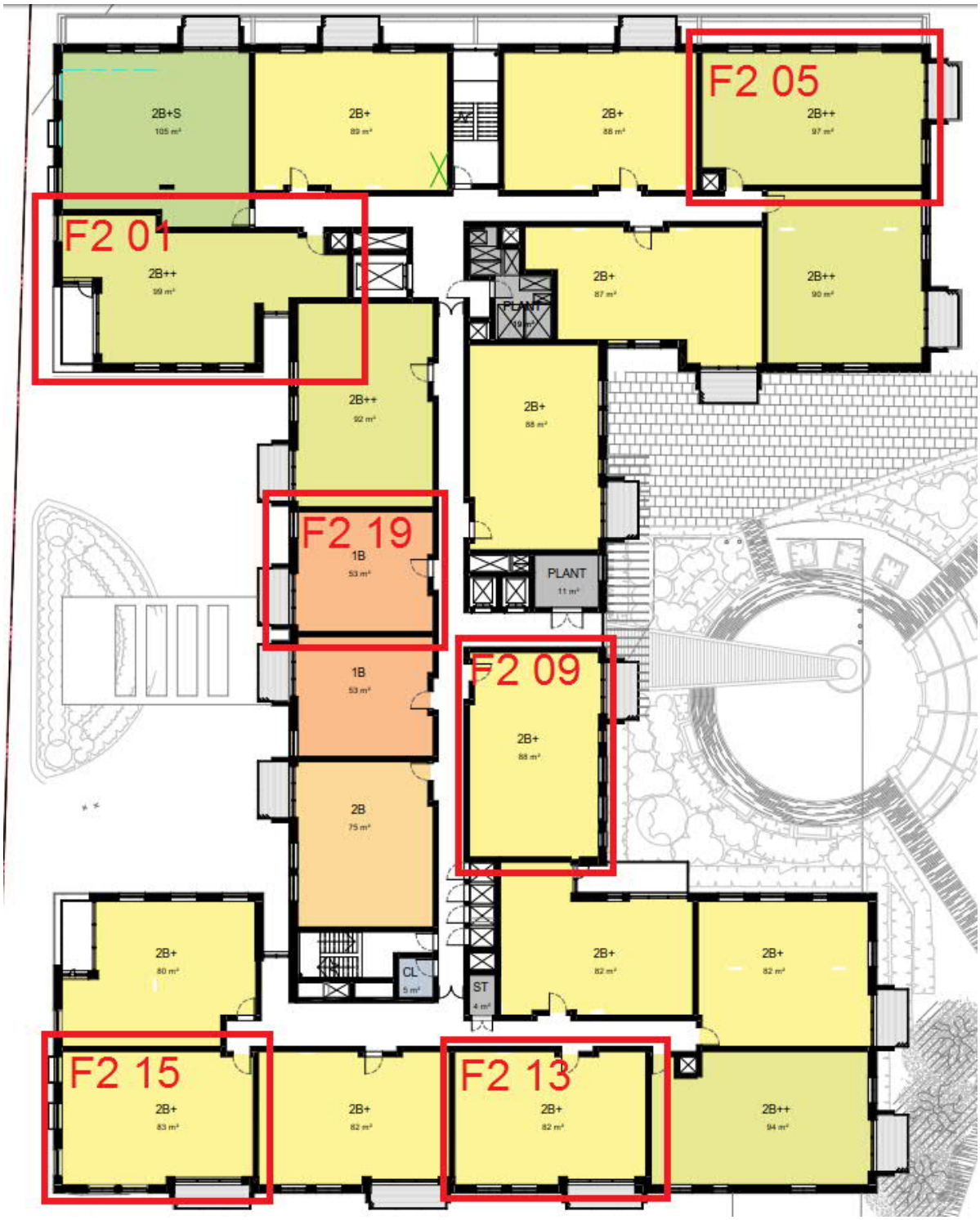

Figure 2. Sample units on 2nd floor to represent the development

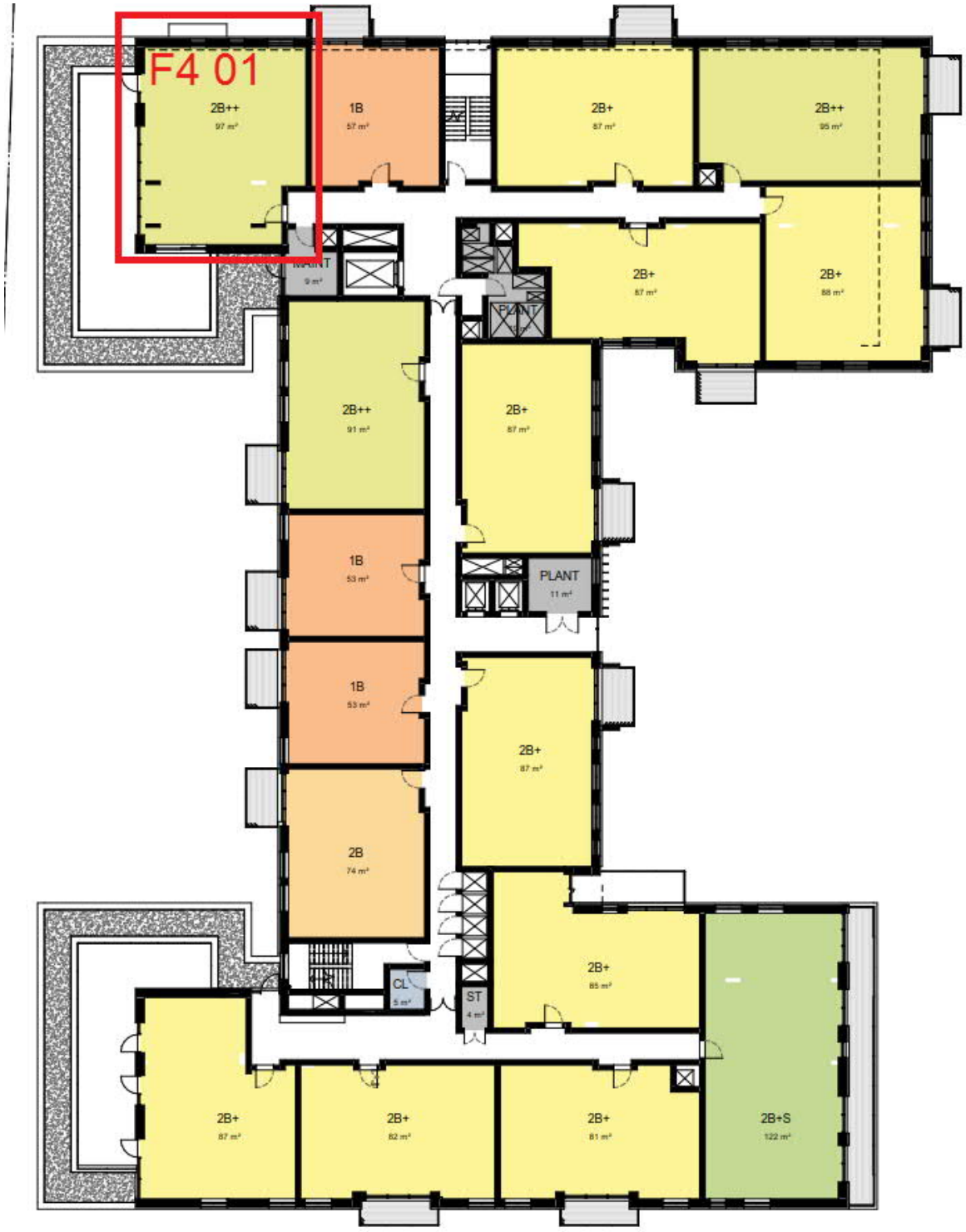

Figure 3. Sample units on 4th floor to represent the development

Figure 4. Sample units on 5th floor to represent the development

3. Model Geometry

The drawings below were used to build the geometry.

Table 8. Drawings used to build the model

Drawing type	File Name	Date	Revision	Description
Floor plans	17093 - KEW_ARC-Plano - PA2-01 - OVERVIEW PLAN LEVEL GROUND.dwg	2018-08-06	G	Overview Plan Ground
	17093 - KEW_ARC-Plano - PA2-02 - OVERVIEW PLAN TYPICAL LEVEL 1 - 3.dwg	2018-08-06	G	Overview Level 1 - 3
	17093 - KEW_ARC-Plano - PA2-03 - OVERVIEW PLAN LEVEL 4.dwg	2018-08-06	G	Overview Level 1 - 3
	17093 - KEW_ARC-Plano - PA2-04 - OVERVIEW PLAN LEVEL 5.dwg	2018-08-06	G	Overview Level 1 - 3
	17093 - KEW_ARC-Plano - PA2-05 - OVERVIEW PLAN LEVEL ROOF.dwg	2018-08-06	F	Overview Level Roof
	17093 - KEW_ARC-Plano - PA2-10 - GENERAL ARRANGEMENT- LEVEL GROUND NORTH.dwg	2018-08-06	D	North half of Ground Floor
	17093 - KEW_ARC-Plano - PA2-11 - GENERAL ARRANGEMENT- LEVEL GROUND SOUTH.dwg	2018-08-06	D	South half of Ground Floor
	17093 - KEW_ARC-Plano - PA2-12 - GENERAL ARRANGEMENT- LEVEL 1 NORTH.dwg	2018-08-06	C	North half of Level 1
	17093 - KEW_ARC-Plano - PA2-13 - GENERAL ARRANGEMENT- LEVEL 2-3 NORTH.dwg	2018-08-06	D	North half of Level 2-3
	17093 - KEW_ARC-Plano - PA2-14 - GENERAL ARRANGEMENT- LEVEL 2-3 SOUTH.dwg	2018-08-06	D	South half of Level 2-3
	17093 - KEW_ARC-Plano - PA2-15 - GENERAL ARRANGEMENT - LEVEL 4 NORTH.dwg	2018-08-06	D	North half of Level 4
	17093 - KEW_ARC-Plano - PA2-16 - GENERAL ARRANGEMENT- LEVEL 4 SOUTH.dwg	2018-08-06	D	South half of Level 4
	17093 - KEW_ARC-Plano - PA2-17 - GENERAL ARRANGEMENT- LEVEL 5 NORTH.dwg	2018-08-06	D	North half of Level 5
	17093 - KEW_ARC-Plano - PA2-18 - GENERAL ARRANGEMENT- LEVEL 5 SOUTH.dwg	2018-08-06	D	South half of Level 5
Elevations	17093 - KEW_ARC-Plano - PA3-03 - PROPOSE ELEVATIONS - MELLIS AVE (WEST).dwg	2018-08-06	D	West Elevation
	17093 - KEW_ARC-Plano - PA3-04 - PROPOSE ELEVATIONS - SOUTH.dwg	2018-08-06	D	South Elevation
	17093 - KEW_ARC-Plano - PA3-05 - PROPOSE ELEVATIONS - RIVER THAMES (EAST).dwg	2018-08-06	B	East Elevation

	17093 - KEW_ARC-Plano - PA3-06 - PROPOSE ELEVATIONS - NORTH.dwg	2018-08-06	B	North Elevation
Sections	17093 - KEW_ARC-Plano - PA4-02 - PROPOSE SECTION - A+ B.dwg	2018-08-06	D	Sections
Summary	180806 KEW DRAWINGS.pdf	NA	NA	Summary document with plans, elevations and sections in pdf.
Site Plan	17093 - KEW_ARC-Plano - PA1-04 - SITE PLAN.dwg	NA	NA	Site Plan

3.1 Model image

Figure 5, is a screenshot taken from the IES thermal model of Option F.

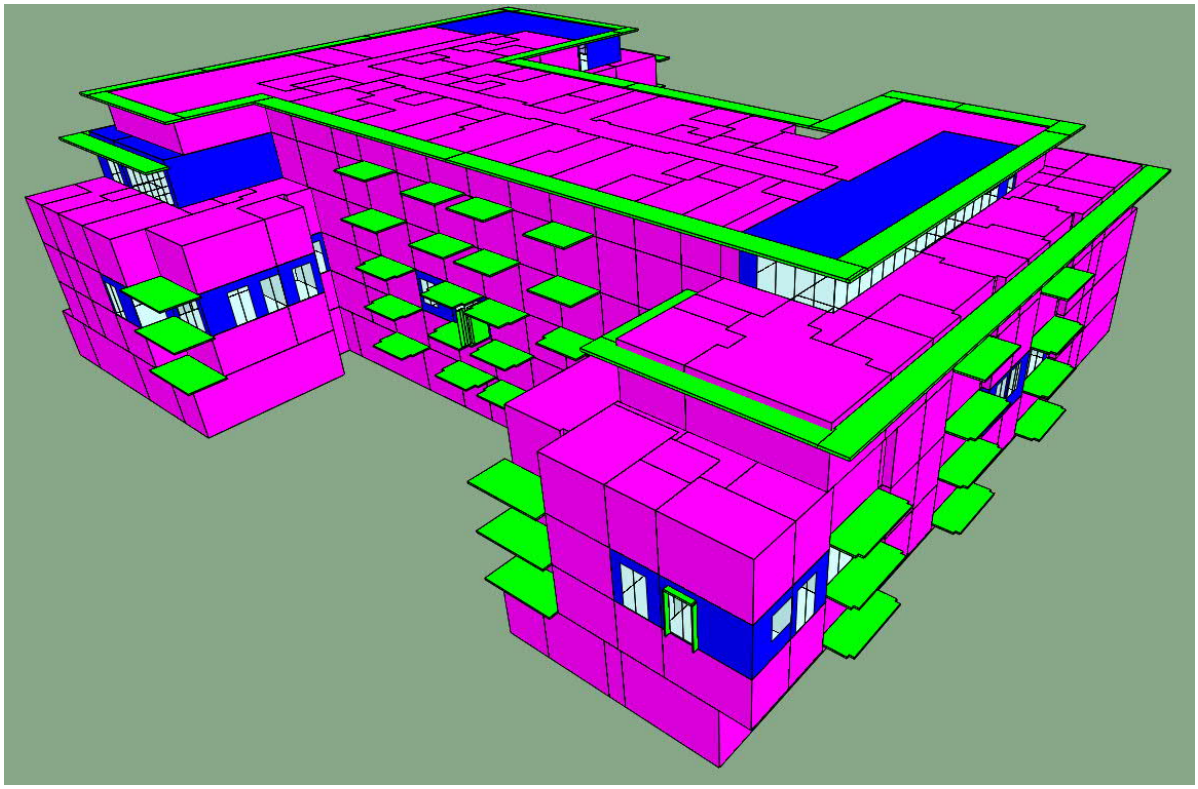

Figure 5. South view of the model after Option F

4. Key input data

4.1 Building Fabric

The thermal performance and the build-up of the building fabric are summarised in Table 9.

Table 9. Opaque fabric elements used in model

Element	Description	Average overall U-value including thermal bridging (W/m²K)
Ground Floor	Ground and exposed floors	0.12
Internal floor/ceiling	Uninsulated concrete floor slab	1.06
Internal partitions	Timber with air cavity and plasterboard	1.78
Roof	Used in samples exposed to the roof	0.13

Element	Description	Average overall U-value including thermal bridging (W/m²K)
External Wall	Used for all walls that face the external	0.18

Table 10. Glazed fabric elements used in model

Glazing type	U-value including frame (W/m²K)	g-value (EN 410)	Light transmittance	Frame factor (%)
External window (double glazed)	1.4	0.45 (0.55*)	0.60	20

*Note:

0.55 was used in the base case run (option A) and Options B and C,

0.45 was used in Option D, Option E and Option F.

4.2 Thermal templates

4.2.1 Room conditions

As recommended in CIBSE TM 52, the sample dwellings are assessed as “free-running”; therefore, there are no heating or cooling set points in the model.

4.2.2 Internal gains and mechanical ventilation

Internal gains were input based on the guidance provided by CIBSE TM 59; this provides a set of profiles that represent reasonable usage patterns for a dwelling suitable for evaluating overheating risk.

The mechanical ventilation rate of 0.6 L/s/m² is based on the boost ventilation provision provided by the MVHR units proposed in the specification.

The table below describes the model inputs used for the rooms types tested in this overheating assessment.

Bedroom (single)

Table 11. Bedroom (double) internal gains and mechanical ventilation

Input/Gain	Model input	Weekly profile
Lighting	2 W/m²	100% on 1800-2300 off on other times
Occupancy	1 person @ 75 W/person sensible/ 55 W/person latent	70% on 2300-0800 100% on 0800-0900 and 2200-2300 50% on 0900-2200
Equipment	80 W	100% on 0800-2300 12.5% on 2300-0800 (background gain)
Mechanical ventilation	0.6 l/s/m²	On continuously

Bedroom (double)

Table 12. Bedroom (double) internal gains and mechanical ventilation

Input/Gain	Model input	Weekly profile
Lighting	2 W/m²	100% on 1800-2300 off on other times
Occupancy	2 people @ 75 W/person sensible/ 55 W/person latent	70% on 2300-0800 100% on 0800-0900 and 2200-2300 50% on 0900-2200
Equipment	80 W	100% on 0800-2300 12.5% on 2300-0800 (background gain)
Mechanical ventilation	0.6 l/s/m²	On continuously

Living/Kitchen (1 bedroom)

Table 13. Living/Kitchen internal gains mechanical ventilation

Input/Gain	Model input	Weekly profile
Lighting	2 W/m²	100% on 1800-2200 off on other times
Occupancy	1 person @ 75 W/person sensible/ 55 W/person latent	100% on 0900-2200 off on other times
Equipment	450 W	100% on 1800-2000 44% on 2000-2200 24% on 0900-1800 and 2200-2400 19% on 0000-0900
Mechanical ventilation	0.6 l/s/m²	On continuously

Living/Kitchen (2 bedrooms)

Table 14. Living/Kitchen internal gains mechanical ventilation

Input/Gain	Model input	Weekly profile
Lighting	2 W/m²	100% on 1800-2200 off on other times
Occupancy	2 people @ 75 W/person sensible/ 55 W/person latent	100% on 0900-2200 off on other times
Equipment	450 W	100% on 1800-2000 44% on 2000-2200 24% on 0900-1800 and 2200-2400 19% on 0000-0900
Mechanical ventilation	0.6 l/s/m²	On continuously

Living/Kitchen (3 bedrooms)

Table 15. Living/Kitchen internal gains mechanical ventilation

Input/Gain	Model input	Weekly profile
Lighting	2 W/m²	100% on 1800-2200 off on other times
Occupancy	3 people @ 75 W/person sensible/ 55 W/person latent	100% on 0900-2200 off on other times

Input/Gain	Model input	Weekly profile
Equipment	450 W	100% on 1800-2000 44% on 2000-2200 24% on 0900-1800 and 2200-2400 19% on 0000-0900
Mechanical ventilation	0.6 l/s/m²	On continuously

Unoccupied areas (Apartment hall, bathroom, riser/void and store)

There are no internal gains or mechanical ventilation applied in the unoccupied areas as these rooms are not assessed for their comfort performance but included within the thermal model in order to provide suitable adjacent conditions for the assessed rooms.

4.3 Infiltration rate

The infiltration rate of 0.034 Ac/hr was converted from the design air permeability of 3 m³/hr/m² using the TM 23 method. The infiltration rate is applied to all zones.

4.4 Internal shading device

No internal shading device has been applied in the base case model. Cream Holland linen curtains were introduced in Option B. These curtains have a shading coefficient of 0.4 and short-wave radiant fraction of 0.3 and are modelled as drawn across the closed area of windows. The open area of the windows is left without curtains to allow air to freely circulate between the room and the outside environment.

4.5 Openings

Natural ventilation is accounted for using MacroFlo and openable windows. MacroFlo analyses the infiltration and natural ventilation in buildings by using a zonal airflow model to calculate bulk air movement in and through the building driven by wind and buoyancy induced pressures. MacroFlo simulates air flow driven by wind pressure, and buoyancy forces. It models large air volumes and can simulate air flow through building elements based on the opening size, type and location.

Internal doors in the living/kitchen rooms are open when occupied while the bedroom internal doors are only open when the occupants are awake. It is assumed that the internal bathroom doors are opened when the living/kitchen rooms are occupied.

The opening strategy for living rooms and bedrooms are different. For the Living rooms, the opening strategy is based on a 25% vertical strip of window that can slide or tilt open. The remaining 75% has the aforementioned blind behind the window.

Table 16 summarises the openings in the model.

Table 16. Openings in model

Opening type	Opening category	Openable area of window in model (%)	Max angle of openable pane (°)	Application
Opening bedroom full height window	Side hung	90%	90	Full height windows found in the bedrooms

Opening type	Opening category	Openable area of window in model (%)	Max angle of openable pane (°)	Application
Opening living room full height window	Side hung	25%	90	Full height windows found in the living rooms that are defined as openable.
Remaining openings	Closed openings	0%	0	Sealed openings (e.g. bathroom windows, windows in corridors, windows not openable in the living room, etc.)

4.6 Weather file

The weather file "London_LWC_DSY1_2020High50.epw" has been used in accordance with CIBSE TM59 methodology. The following wording found in TM 49 decided the use of the London LWC weather file, *"The relative sparsity of temperature observations stations in the London area makes precise definitions of these boundaries difficult and where there is any doubt conservative choices should be made, i.e. to use the next warmest more central weather station."*

4.7 Summer elevated air speed

CIBSE TM59 states that the summer elevated air speed must be set to 0.1 m/s unless there is a ceiling fan or other means of reliable generating air movement. This overheating assessment assumed 0.1 m/s air speed.

4.8 Corridors and circulation spaces

Corridors have not been modelled because of the proposed system for the development is a heat pump. The heat pump uses an ambient temperature loop; the heat transfer medium is then compressed to the relevant higher temperature within the dwelling.

5. Overheating Results and Mitigation

Table 17 summarises the results for the Base case and the remaining options undertaken to mitigate the risk of overheating.

Table 17. Summary of results for Base case and each option

Room name			Base case (Opt A)	Opt B	Opt C	Opt D	Opt E	Opt F
			Base case	Curtains applied to closed glazing	Reasonable openings	Reduce g-value	Mechanical ventilation	External Overhang
'	F2 01	F04 01Livingroom	X	X	X	✓	✓	✓
		F02 01Bed01	X	X	✓	✓	✓	✓
		F02 01Bed02	X	X	✓	✓	✓	✓
	F2 05	F02 05Livingroom	X	X	✓	✓	✓	✓
		F02 05Bed01	X	X	✓	✓	✓	✓
		F02 05Bed02	X	X	✓	✓	✓	✓
	F2 09	F02 09Livingroom	X	X	✓	✓	✓	✓
		F02 09Bed01	X	X	✓	✓	✓	✓
		F02 09Bed02	X	X	✓	✓	✓	✓
	F2 13	F02 13Livingroom	X	X	✓	✓	✓	✓

		F02 13Bed01	x	x	✓	✓	✓	✓
		F02 13Bed02	x	x	✓	✓	✓	✓
	F2 15	F02 15Livingroom	x	x	x	✓	✓	✓
		F02 15Bed01	x	x	x	✓	✓	✓
		F02 15Bed02	x	x	✓	✓	✓	✓
	F2 19	F02 19Livingroom	x	x	x	x	x	✓
		F02 19Bed01	x	x	x	✓	✓	✓
	F4 01	F04 01Livingroom	x	x	x	x	x	✓
		F04 01Bed01	x	x	✓	✓	✓	✓
		F04 01Bed02	x	x	✓	✓	✓	✓
	F5 03	F05 03	x	x	x	✓	✓	✓
		-	x	x	✓	✓	✓	✓
		-	x	x	✓	✓	✓	✓
	F5 08	F05 08	x	x	x	x	x	✓
		-	x	x	✓	✓	✓	✓
		-	x	x	✓	✓	✓	✓
Rooms passed			0/27	0/27	19/27	24/27	24/27	0/27
Units passed			0/9	0/9	3/9	6/9	6/9	0/9

Detailed results can be found in Appendix F.

9 units out of 89 units in the development have been selected as sample units for the overheating assessment. A unit is considered at risk of overheating if it fails in any of the TM59 criteria. Six (A-F) options have been tested to demonstrate the improvements made to mitigate the risk of overheating within the sample units.

Following the methodology laid out in CIBSE TM59 and using the drawings provided with the key inputs listed in the previous sections, a specification was developed for the base case option. The base case has a higher g-value than stated in the previous section. The Base case assumes that in each living room, 25% of each window's glazing area is openable. The Base case (Option A) and Option B show that all flats fail the assessment. Options C improve the development and many more of the rooms pass the assessment but only a third of the units pass overall. Option D shows that mechanical ventilation almost passes all the assessed rooms and units, and Appendix F shows that the assessment gets closer to passing when using increased mechanical ventilation in Option E. Finally, external shades are required to pass all the assessed rooms and units.

Descriptions of the different solutions that have been tested to mitigate the overheating are as follows:

- Option B applies the internal Cream Holland linen curtains to all the closed glazing areas in all the sample assessments. The internal Cream Holland linen curtains should be applied on all the glazing locations; it must be applied to glazing locations that do not open and in such a way that they do not block the openable glazing areas. For living rooms it assumes that the remaining 75% that is not openable is covered by the curtains. The curtains have a shading coefficient of 0.4 and short-wave radiant fraction of 0.3 and are

assumed to be down or “on” all the time in the model. This option is built upon the model developed for the base case (Option A).

- Option C makes reasonable assumptions on further openings on the façade to all the sample assessments, for this option, the bedroom windows have been made fully openable. In Option B, all bedroom windows were closed with curtains on them. In this option, all the bedroom windows are only closed with curtains on them between 08:00-19:00. Outside these hours there are no curtains and the windows are fully openable. It is assumed they open inwards or slide and that there is a Juliette balcony for safety. This option includes all the improvements made in Option B.
- Option D reduces the g-value of the glazed elements from 0.55 to 0.45. This option includes all the improvements made in Option C.
- Option E introduces an extract of 0.6l/s/m^2 to all the occupied spaces on all the sample assessments. This represents a MVHR boost bypass system that should meet this flowrate requirement. This option includes all the improvements made in Option D.

All the tested solutions were not sufficient to mitigate the risk of overheating for the sample units and further solutions had to be explored.

The below solution has been further explored to try to mitigate the risk of overheating:

- Option F, to pass the final few rooms failing the assessment. A overhang was applied strategically as shown below in Figure 5, on the samples still failing the assessment. The overhang must protrude 1.6 meters from the glass pane to ensure a pass. These overhangs were required to pass the final failing rooms against the TM 59 criteria. Alternative solar shading options that provide an equivalent amount of shading can be reviewed at later stages to provide similar protection from adverse solar gains.

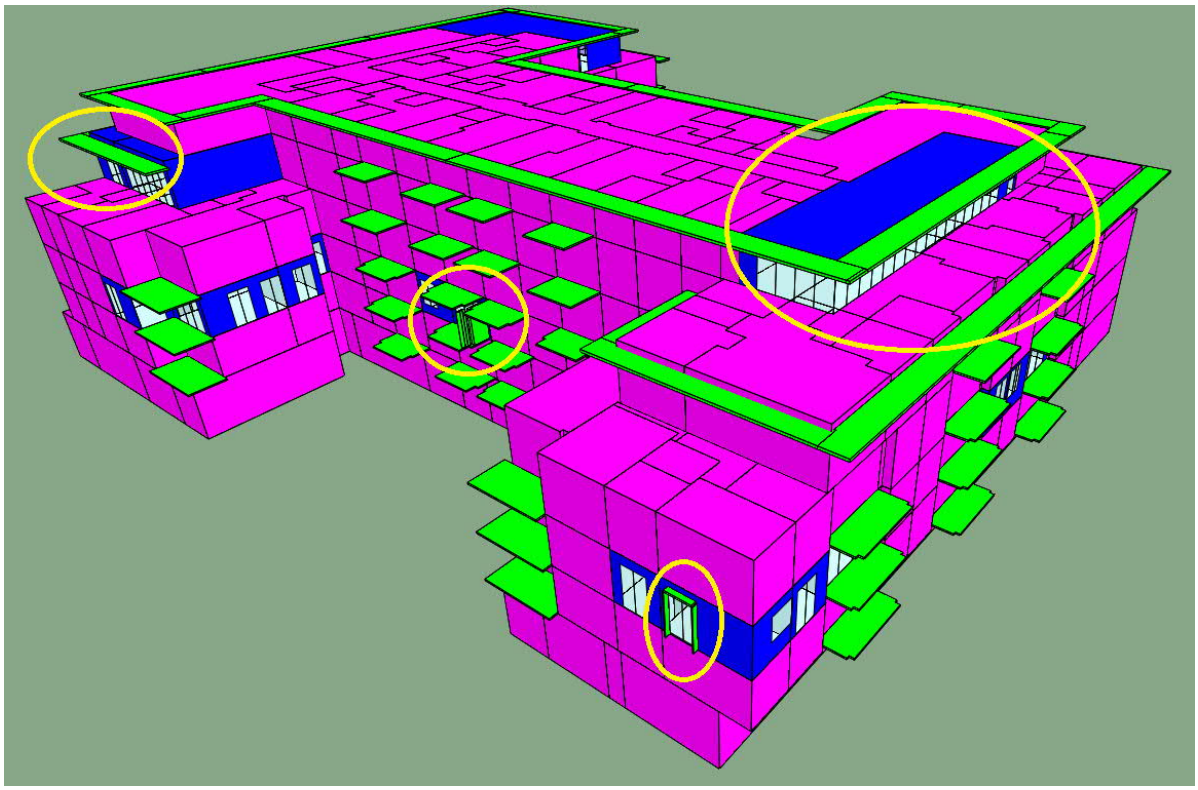

Figure 6. South view of the model with yellow circles around the overhangs included in option F.

6. Conclusion and Recommendations

To mitigate the risk of overheating according to TM 59, the glass used on the thermal line of the building has been reduced from a g-value of 0.55 to 0.45; the internal Cream Holland linen curtains should be applied on all the glazing locations, it must be applied to glazing locations that do not open and in such a way that they do not block the openable glazing areas. The sample assessment has shown that some units benefit from the increased air changes provided by the MVHR and that overhanging local shades need to be applied to some critical south facing rooms.

Appendix F shows that with all the mitigation options presented above Option F will ensure that the modelled development will pass the TM 59 assessment. It should be highlighted that Option F includes all the improvements from the previous options. Juliette balconies are assumed in the bedrooms that allows for the floor to ceiling height windows to be fully openable. Furthermore, Cream Holland linen curtains are assumed in this model to stop the solar gains during daylight hours. Finally the overhang that has been proposed must be 1.6m from the glass pane on the façade. This must be in place especially at the south facing facade to ensure the final sample rooms pass the TM 59 assessment.

Appendix F TM59 Results

Option C

Table 18. Criterion A Option C

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	TM 59 Pass/ Fail
F02 05Livingroom	2.6	30	4	2	Pass
F02 09Livingroom	2.7	22	3	2	Pass
F02 13Livingroom	2.6	24	3	2	Pass
F04 01Livingroom	5.4	30	4	1 & 2	Fail
F05 03	3.4	34	4	1 & 2	Fail
F05 08	5.9	43	5	1 & 2 & 3	Fail
F02 15Livingroom	3	28	4	1 & 2	Fail
F02 19Livingroom	4.4	28	4	1 & 2	Fail
F02 01Livingroom	3.1	27	4	1 & 2	Fail

Table 19. Criterion B Option C

Room name	Total hours over 26°C	Criteria 1 (%Hrs Top-Tmax>=1K)	Pass/fail
F02 01Bed01	14	1	Pass
F02 01Bed02	27	1.7	Pass
F02 05Bed01	28	1	Pass
F02 05Bed02	28	1.4	Pass
F02 09Bed01	26	1	Pass
F02 09Bed02	31	2	Pass
F02 13Bed01	32	1.1	Pass
F02 13Bed02	32	1.7	Pass
F02 15Bed01	16	4.1	Fail
F02 15Bed02	27	2.9	Pass
F04 01Bed01	17	2.6	Pass
F04 01Bed02	32	1.6	Pass
F02 19Bed01	34	1.7	Fail

Option D

Table 20. Criterion A Option D

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	TM 59 Pass/ Fail
F02 05Livingroom	2.3	28	4	2	Pass
F02 09Livingroom	2.2	20	3	2	Pass
F02 13Livingroom	2.4	24	3	2	Pass
F04 01Livingroom	3.9	27	4	1 & 2	Fail
F05 03	2.8	33	4	2	Pass
F05 08	4.7	37	4	1 & 2	Fail
F02 15Livingroom	2.7	26	3	2	Pass
F02 19Livingroom	3.2	27	4	1 & 2	Fail
F02 01Livingroom	2.9	25	3	2	Pass

Table 21. Criterion B Option D

Room name	Total hours over 26°C	Criteria 1 (%Hrs Top-Tmax>=1K)	Pass/fail
F02 01Bed01	13	0.8	Pass
F02 01Bed02	26	1.5	Pass
F02 05Bed01	28	0.9	Pass
F02 05Bed02	28	1.2	Pass
F02 09Bed01	26	0.9	Pass
F02 09Bed02	30	1.7	Pass
F02 13Bed01	32	1	Pass
F02 13Bed02	32	1.4	Pass
F02 15Bed01	16	2.9	Pass
F02 15Bed02	26	1.9	Pass
F04 01Bed01	16	1.7	Pass
F04 01Bed02	31	1.1	Pass
F02 19Bed01	33	1.3	Fail

Option E

Table 22. Criterion A Option E

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	TM 59 Pass/ Fail
F02 05Livingroom	2.2	26	4	2	Pass
F02 09Livingroom	1.9	20	3	2	Pass
F02 13Livingroom	2.3	24	3	2	Pass
F04 01Livingroom	3.6	27	4	1 & 2	Fail
F05 03	2.7	32	4	2	Pass
F05 08	4.4	37	4	1 & 2	Fail
F02 15Livingroom	2.6	25	3	2	Pass
F02 19Livingroom	3	25	4	1 & 2	Fail
F02 01Livingroom	2.7	25	3	2	Pass

Table 23. Criterion B Option E

Room name	Total hours over 26°C	Criteria 1 (%Hrs Top-Tmax>=1K)	Pass/fail
F02 01Bed01	13	0.8	Pass
F02 01Bed02	26	1.4	Pass
F02 05Bed01	27	0.9	Pass
F02 05Bed02	28	1.2	Pass
F02 09Bed01	23	0.8	Pass
F02 09Bed02	30	1.3	Pass
F02 13Bed01	32	0.9	Pass
F02 13Bed02	30	1.4	Pass
F02 15Bed01	16	2.5	Pass
F02 15Bed02	23	1.7	Pass
F04 01Bed01	15	1.6	Pass
F04 01Bed02	30	1.1	Pass
F02 19Bed01	32	1.1	Pass

Option F

Table 24. Criterion A Option F

Room Name	Criteria 1 (%Hrs Top-Tmax>=1K)	Criteria 2 (Max. Daily Deg.Hrs)	Criteria 3 (Max. DeltaT)	Criteria failing	TM 59 Pass/ Fail
F02 05Livingroom	2.2	26	4	2	Pass
F02 09Livingroom	1.9	19	3	2	Pass
F02 13Livingroom	2.3	24	3	2	Pass
F04 01Livingroom	2.5	22	4	2	Pass
F05 03	2.5	32	4	2	Pass
F05 08	2.7	31	4	2	Pass
F02 15Livingroom	2.6	25	3	2	Pass
F02 19Livingroom	2.9	24	4	2	Pass
F02 01Livingroom	2.6	25	3	2	Pass

Table 25. Criterion B Option F

Room name	Total hours over 26°C	Criteria 1 (%Hrs Top-Tmax>=1K)	Pass/fail
F02 01Bed01	13	0.8	Pass
F02 01Bed02	26	1.4	Pass
F02 05Bed01	27	0.9	Pass
F02 05Bed02	28	1.2	Pass
F02 09Bed01	23	0.7	Pass
F02 09Bed02	30	1.3	Pass
F02 13Bed01	32	0.9	Pass
F02 13Bed02	30	1.4	Pass
F02 15Bed01	16	2.4	Pass
F02 15Bed02	23	1.7	Pass
F04 01Bed01	14	1	Pass
F04 01Bed02	29	0.9	Pass
F02 19Bed01	32	1.1	Pass

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