SAP 2009 Worksheet
Design - Draft

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 Andrew Hart	Assessor number	2311
Client		Last modified	14/11/2013
Address	Plot 2 to rear of 1 (Code 4 with basement) Frognal,, Hampstead, London, NW3 6AL		

1. Overall dwelling dimensions

		Area (m²)		Average storey height (m)		Volume (m³)	
Lowest occupied		33.65	(1a) x	2.35	(2a) =	79.08	(3a)
+1		33.65	(1b) x	2.60	(2b) =	87.49	(3b)
+2		32.87	(1c) x	2.80	(2c) =	92.04	(3c)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	100.17	(4)				
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =	258.60	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	3	x 10 =	30	(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) =	30	÷ (5) =	0.12 (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	9.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.57	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered	2	(19)
Shelter factor	1 - [0.075 x (19)] = 0.85	(20)
Adjusted infiltration rate	(18) x (20) = 0.48	(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 7													
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10	

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27	

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

(22b)m	0.65	0.61	0.61	0.54	0.49	0.47	0.45	0.45	0.51	0.54	0.58	0.61	

∑(22b)1...12 = 6.51 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system | N/A | (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a) | N/A | (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = | N/A | (23c)

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

if (22b)m ≥ 1, then (24d)m = (22b)m; otherwise (24d)m = 0.5 + [(22b)m2 x 0.5]

(24d)m	0.71	0.69	0.69	0.65	0.62	0.61	0.60	0.60	0.63	0.65	0.67	0.69	(24d)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

(25)m	0.71	0.69	0.69	0.65	0.62	0.61	0.60	0.60	0.63	0.65	0.67	0.69	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

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*			29.04	x	1.50	=	43.66	N/A	N/A	(27)
Roof window*			3.04	x	1.33	=	4.02	N/A	N/A	(27a)
Doors			2.10	x	1.80	=	3.78	N/A	N/A	(26)
Ground floor			33.56	x	0.25	=	8.39	N/A	N/A	(28a)
Exposed floor			3.22	x	0.25	=	0.80	N/A	N/A	(28b)
Basement wall			79.60	x	0.13	=	10.35	N/A	N/A	(29)
External wall			52.72	x	0.13	=	6.85	N/A	N/A	(29a)
Party Wall			33.54	x	0.00	=	0.00	N/A	N/A	(32)
Roof			35.75	x	0.18	=	6.44	N/A	N/A	(30)

Total area of external elements ∑A, m² | 239.02 | (31)

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 84.30 | (33)

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

Thermal mass parameter (TMP) in kJ/m²K | Calculated separately = | 450.00 | (35)

Thermal bridges: ∑(L x Ψ) calculated using Appendix K | 15.53 | (36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss | (33) + (36) = | 99.83 | (37)

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

(38)m	60.67	58.72	58.72	55.17	53.05	52.06	51.12	51.12	53.56	55.17	56.89	58.72	(38)

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

(39)m	160.50	158.55	158.55	155.00	152.87	151.89	150.95	150.95	153.39	155.00	156.72	158.55	

Average = ∑(39)1...12/12 = | 155.24 | (39)

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

(40)m	1.60	1.58	1.58	1.55	1.53	1.52	1.51	1.51	1.53	1.55	1.56	1.58	

Average = ∑(40)1...12/12 = | 1.55 | (40)

4. Water heating energy requirement

kWh/year

Assumed occupancy, N | 2.74 | (42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 99.30 | (43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												

(44)m	109.23	105.26	101.29	97.31	93.34	89.37	89.37	93.34	97.31	101.29	105.26	109.23

∑(44)1...12 = 1191.61 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

(45)m	162.37	142.01	146.55	127.76	122.59	105.79	98.03	112.49	113.83	132.66	144.81	157.25

∑(45)1...12 = 1566.13 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

Distribution loss 0.15 x (45)m

(46)m	24.36	21.30	21.98	19.16	18.39	15.87	14.70	16.87	17.07	19.90	21.72	23.59

(46)

Water storage loss:

Cylinder volume (litres) including any solar storage within same cylinder 0 (50)

Energy lost from water storage, kWh/day (50) x (51) x (52) x (53) 0.00 (54)

Enter (49) or (54) in (55) 0.00 (55)

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

(56)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(56)

If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H

(57)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(57)

Primary circuit loss (annual) from Table 3 0.00 (58)

Primary circuit loss for each month (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

(59)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

(59)

Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)

(61)m	50.96	46.03	50.96	47.99	47.57	44.07	45.54	47.57	47.99	50.96	49.32	50.96

(61)

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

(62)m	213.33	188.04	197.50	175.75	170.16	149.86	143.57	160.05	161.82	183.62	194.12	208.21

(62)

Solar DHW input calculated using Appendix H (negative quantity) ('0' entered if no solar contribution to water heating)

(63)m	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)1...12 = 0.00 (63)

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

(64)m	213.33	188.04	197.50	175.75	170.16	149.86	143.57	160.05	161.82	183.62	194.12	208.21

∑(64)1...12 = 2146.04 (64)

if (64)m < 0 then set to 0

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

(65)m	66.73	58.73	61.47	54.48	52.65	46.19	43.98	49.29	49.85	56.85	60.48	65.03

(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metabolic gains (Table 5), Watts												
(66)m	164.47	164.47	164.47	164.47	164.47	164.47	164.47	164.47	164.47	164.47	164.47	164.47
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5												
(67)m	71.49	63.50	51.64	39.09	29.22	24.67	26.66	34.65	46.51	59.05	68.92	73.48
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5												
(68)m	382.99	386.96	376.95	355.63	328.71	303.42	286.52	282.55	292.56	313.88	340.80	366.09
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5												
(69)m	54.19	54.19	54.19	54.19	54.19	54.19	54.19	54.19	54.19	54.19	54.19	54.19
Pumps and fans gains (Table 5a)												
(70)m	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00	10.00
Losses e.g. evaporation (negative values) (Table 5)												
(71)m	-109.64	-109.64	-109.64	-109.64	-109.64	-109.64	-109.64	-109.64	-109.64	-109.64	-109.64	-109.64
Water heating gains (Table 5)												

(72)m	89.69	87.39	82.62	75.66	70.77	64.16	59.11	66.25	69.23	76.41	84.00	87.40	(72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

(73)m	663.18	656.86	630.21	589.39	547.72	511.26	491.30	502.46	527.31	568.35	612.72	645.97	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
Southwest	0.77	x	8.22	x	37.39	x	0.63	x	1.00	=	149.17	(79)
Rooflights	1.00	x	3.04	x	26.00	x	0.63	x	1.00	=	49.71	(82)
Southeast	0.77	x	20.81	x	37.39	x	0.63	x	1.00	=	377.43	(77)

Solar gains in watts, calculated for each month ∑(74)m...(82)m

(83)m	576.32	1000.96	1365.91	1744.45	1959.63	2004.72	1959.60	1797.30	1530.25	1149.25	694.46	490.16	(83)

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

(84)m	1239.49	1657.82	1996.12	2333.84	2507.35	2515.97	2450.90	2299.76	2057.56	1717.60	1307.18	1136.14	(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, η1,m (see Table 9a)													
(86)m	1.00	0.97	0.91	0.76	0.56	0.39	0.25	0.27	0.50	0.83	0.98	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	20.68	20.74	20.81	20.86	20.87	20.87	20.87	20.87	20.87	20.85	20.75	20.68	(87)
Temperature during heating periods in the living area from Table 9, Th2(˚C)													
(88)m	19.62	19.63	19.63	19.66	19.67	19.68	19.69	19.69	19.67	19.66	19.64	19.63	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.99	0.96	0.87	0.70	0.48	0.31	0.17	0.18	0.40	0.75	0.97	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	19.18	19.29	19.38	19.46	19.49	19.49	19.50	19.50	19.48	19.45	19.31	19.20	(90)

Living area fraction fLA 20.48 ÷ (4) = 0.20 (91)

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

(92)m	19.49	19.59	19.67	19.74	19.77	19.78	19.78	19.78	19.77	19.74	19.61	19.50	(92)

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

(93)m	19.49	19.59	19.67	19.74	19.77	19.78	19.78	19.78	19.77	19.74	19.61	19.50	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

Utilisation factor for gains, ηm

(94)m	0.99	0.96	0.87	0.70	0.49	0.31	0.18	0.19	0.41	0.76	0.97	0.99	(94)

Useful gains, ηmGm, W = (94)m x (84)m

(95)m	1229.57	1593.87	1740.07	1641.35	1227.07	786.02	435.24	435.24	836.93	1300.02	1273.09	1129.40	(95)

Monthly average external temperature from Table 8

(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)

Heat loss rate for mean internal temperature, Lm, W

(97)m	2405.62	2313.32	2040.90	1711.41	1233.51	786.30	435.25	435.25	838.46	1385.39	1975.51	2314.79	(97)

Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m

(98)m	874.99	483.46	223.81	50.44	4.79	0.00	0.00	0.00	0.00	63.51	505.74	881.93	

Total per year (kWh/year) = ∑(98)1...5, 10...12 = 3088.68 (98)

Space heating requirement in kWh/m²/year (98) ÷ (4) = 30.83 (99)

9a. Energy Requirements - Individual heating systems including micro-CHP

Space heating:

Fraction of space heating from secondary/supplementary system (Table 11)	0.00	(201)
Fraction of space heating from main system(s) 1 - (201)	1.00	(202)
Fraction of space heating from main system 2	0.00	(203)
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 space heating system 1 (%)	89.80	(206)

(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating requirement, kWh/month (as calculated above)												
(98)m	874.99	483.46	223.81	50.44	4.79	0.00	0.00	0.00	0.00	63.51	505.74	881.93
Space heating fuel (main heating system 1), kWh/month = (98)m x (204) x 100 ÷ (206)												
(211)m	974.37	538.38	249.24	56.17	5.34	0.00	0.00	0.00	0.00	70.73	563.19	982.10

Total per year (kWh/year) = ∑(211)1...5, 10...12 = 3439.51 (211)

Water heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Output from water heater, kWh/month (calculated above)												
(64)m	213.33	188.04	197.50	175.75	170.16	149.86	143.57	160.05	161.82	183.62	194.12	208.21

∑(64)1...12 = 2146.04 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Efficiency of water heater per month												
(217)m	87.81	86.99	85.19	82.40	80.73	80.50	80.50	80.50	80.50	82.70	87.01	87.86
Fuel for water heating, kWh/month = (64)m x 100 ÷ (217)m												
(219)m	242.94	216.17	231.85	213.28	210.78	186.16	178.35	198.82	201.02	222.02	223.10	236.98

Total per year (kWh/year) = ∑(219)1...12 = 2561.48 (219)

Annual Totals Summary:	**kWh/year**	**kWh/year**	
Space heating fuel used, main system 1		3439.51	(211)
Water heating fuel used		2561.48	(219)
Electricity for pumps, fans and electric keep-hot (Table 4f):			
mechanical ventilation fans - balanced, extract or positive input from outside	0.00		(230a)
warm air heating system fans	0.00		(230b)
central heating pump	130.00		(230c)
oil boiler pump	0.00		(230d)
boiler flue fan	45.00		(230e)
maintaining electric keep-hot facility for gas combi boiler	0.00		(230f)
pump for solar water heating	0.00		(230g)
Total electricity for the above	∑(230a)...(230g)	175.00	(231)
Electricity for lighting (calculated in Appendix L):		505.00	(232)
Energy saving/generation technologies (Appendices M, N and Q):			
Electricity generated by PVs (Appendix M) (negative quantity)		-657.28	(233)

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

	Fuel kWh/year		Fuel price (Table 12)		Fuel cost £/year	
Space heating - main system 1	3439.51	x	3.10	x 0.01 =	106.62	(240)
Water heating cost (other fuel)	2561.48	x	3.10	x 0.01 =	79.41	(247)
Pumps, fans and electric keep-hot	175.00	x	11.46	x 0.01 =	20.06	(249)
Energy for lighting	505.00	x	11.46	x 0.01 =	57.87	(250)
Additional standing charges (Table 12)					106.00	(251)

Energy saving/generation technologies (Appendices M, N and Q):

PV savings (negative quantity)	-657.28	x	11.46	x 0.01 =	-75.32	(252)
Total energy cost			(240)...(242) + (245)...(254)		294.63	(255)

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

Energy cost deflator (Table 12)		0.47	(256)
Energy cost factor (ECF)	[(255) x (256)] ÷ [(4) + 45.0] =	0.95	(257)
SAP value		86.69	
SAP rating		87	(258)
SAP band		B	

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year		Emissions Factor		Emissions (kgCO2/year)	
Space heating - main system 1	3439.51	x	0.198	=	681.02	(261)
Water heating	2561.48	x	0.198	=	507.17	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1188.20	(265)
Pumps, fans and electric keep-hot	175.00	x	0.517	=	90.48	(267)
Lighting	505.00	x	0.517	=	261.09	(268)
Energy saving/generation technologies:						
PV emission savings (negative quantity)	-657.28	x	0.529	=	-347.70	(269)
Total carbon dioxide emissions				∑(261)...(271) =	1192.06	(272)
Dwelling carbon dioxide emissions rate				(272) ÷ (4) =	11.90	(273)
EI value					89.00	
EI rating (see section 14)					89	(274)
EI band					B	

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

	Energy kWh/year		Primary Energy Factor		Primary Energy	
Space heating - main system 1	3439.51	x	1.02	=	3508.30	(261*)
Water heating	2561.48	x	1.02	=	2612.70	(264*)
Space and water heating			(261*) + (262*) + (263*) + (264*) =		6121.01	(265*)
Pumps, fans and electric keep-hot	175.00	x	2.92	=	511.00	(267*)
Lighting	505.00	x	2.92	=	1474.61	(268*)
Energy saving/generation technologies:						
PV primary energy savings (negative quantity)	-657.28	x	2.92	=	-1919.26	(269*)
Total primary energy kWh/year				∑(261*)...(271*) =	6187.36	(272*)
Primary energy kWh/m2/year				(272*) ÷ (4) =	61.77	(273*)