
Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 1
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 2
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Building Summary

		Orient	Area m ²		U-value	Total heat loss W/K
			Gross	Open		
Wall	1: West Wall 01	W	20.10	9.68	1.11	54.22
	2: West Wall 02	W	63.00	62.88	1.11	292.02
	3: North West Wall	NW	57.50	16.97	1.11	123.77
	4: North Wall 01	N	41.80	16.97	1.11	106.35
	5: North Wall 02	N	14.61	0.00	1.11	16.22
	6: East Wall 01	E	45.45	2.10	1.11	54.42
	7: East Wall 02	E	63.00	62.88	1.11	292.02
	8: South Wall 01 (sx)	S	57.50	16.97	1.11	123.77
	9: South East Wall (sx)	SE	41.80	16.97	1.11	106.35
	10: South Wall 02	S	14.61	0.00	1.11	16.22
GdFlr	1: Ground Floor (Slab)	N/A	493.50	0.00	0.40	197.56
Roof	1: West - Flat Roof	W	48.50	0.00	3.14	152.29
	2: East - Flat Roof	E	63.71	2.00	3.14	202.24
	3: South - Hyperbolic Roof	S	222.50	0.00	2.48	551.80
	4: North - Hyperbolic Roof	N	222.50	0.00	2.48	551.80

Total: 2,841.05

Breakdown by element type:

		Area		
Wall	User-entered U-value	213.93	1.11	237.46
Gd floor	U-value based on shape factor	493.50	0.40	197.56
Roof	User-entered U-value	110.21	3.14	346.06
Roof	User-entered U-value	445.00	2.48	1103.60
Rooflight	Single-glazed PVC frame	2.00	4.24	8.48
Window	Single-glazed metal frame	193.67	4.64	898.62
Door	Solid wood	2.10	3.00	6.30
Window	Single-glazed wood frame	4.90	4.03	19.75
Door	Single-glazed wood half-glazed	4.78	4.80	22.92

Window U-values include curtain factor adjustment (SAP-2005 §3.2)

Average/maximum U-values: Walls: 1.11/1.11 **FAIL**; Floors: 0.40/0.40 **FAIL**
 Roofs: 2.61/3.14 **FAIL**; Openings: 5.62/5.70 **FAIL**

Floor area: 489.00m² Living area fraction: 0.78 Internal volume: 2695m³

Front faces: W

Storeys: 1 Chimneys: 0 Flues: 0 Fans: 0 Flueless gas heaters: 0 Sheltered sides: 1

Pressure test: None - default infiltration used:

Masonry construction; draught lobby; 0% draught stripping:

Natural ventilation with intermittent extract fans

Low energy lighting: 0% of fixed lighting points (30% assumed for DER/TER calculations)

Primary heating system: Electricaire system
 No thermostatic control
 Fuel: Electricity (standard tariff)

Secondary heating system: Electric convector or radiant panel heaters
 Fuel: Electricity (standard tariff)

Domestic hot water supply: Point of use
 Electricity (standard tariff)

SAP 2005 Rating 1 Band G
EI Rating 1 Band G

Total CO₂ emissions = 82.55 tonnes/year

These calculations should not be accepted without first checking the input data

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 3
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Important design features (*L1A Appendix B*)
None

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln

Job: Energy Audit

Job number: P336

Made by AG

Page 4

File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Elements of construction used in building

Ground floor

U-value has been calculated using BS EN 13370:1998

Location: Ground Floor (Slab)

Solid ground floor: exposed perimeter = 92.80m Area = 517.20m²

$B = 517.20 / (0.5 \times 92.80) = 11.147$

Subsoil type: Sand/gravel $\lambda = 2.0$ External wall thickness: 300mm

O/A insulation: 150mm Sand/cement screed

Thermal resistance of insulation, $R_f = 150 \times 1 / 1.15 \times 1000 = 0.130$

$d_f = 0.981\text{m}$.

U-value of insulated floor = 0.40

Doors, windows and rooflights

	<i>U-value</i>	<i>Solar Transmittance</i>	<i>Frame Factor</i>
Single-glazed wood frame window	4.80	0.85	0.70
Single-glazed metal frame window	5.70	0.85	0.80
Solid wood door	3.00	0.00	0.70
Single-glazed wood half-glazed door	4.80	0.00	0.70
Single-glazed PVC frame rooflight	5.10	0.85	0.70

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 5
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Building heat loss calculations

Building use: Existing dwelling

Walls

Location: **West Wall 01** Orientation: W
User-entered U-value : 1.110
Areas (m²) :- Gross: 20.10 Opening(s): 9.68 Net: 10.43

	Area x U-value	W/K
Heat loss through solid area	10.43 x 1.11 =	11.57
Heat loss through openings:		
1: Single-glazed wood frame window	2x0.98x2.5=4.90 x 4.027 (4.8)=	19.73
2: Single-glazed wood half-glazed door	1.91x2.5=4.78 x 4.8 =	22.92
	Total heat loss =	54.22

Location: **West Wall 02** Orientation: W
User-entered U-value : 1.110
Areas (m²) :- Gross: 63.00 Opening(s): 62.88 Net: 0.12

	Area x U-value	W/K
Heat loss through solid area	0.12 x 1.11 =	0.13
Heat loss through openings:		
1: Single-glazed metal frame window	7.93x7.93=62.88 x 4.642 (5.7)=	291.89
	Total heat loss =	292.02

Location: **North West Wall** Orientation: NW
User-entered U-value : 1.110
Areas (m²) :- Gross: 57.50 Opening(s): 16.97 Net: 40.53

	Area x U-value	W/K
Heat loss through solid area	40.53 x 1.11 =	44.98
Heat loss through openings:		
1: Single-glazed metal frame window	4.12x4.12=16.97 x 4.642 (5.7)=	78.79
	Total heat loss =	123.77

Location: **North Wall 01** Orientation: N
User-entered U-value : 1.110
Areas (m²) :- Gross: 41.80 Opening(s): 16.97 Net: 24.83

	Area x U-value	W/K
Heat loss through solid area	24.83 x 1.11 =	27.56
Heat loss through openings:		
1: Single-glazed metal frame window	4.12x4.12=16.97 x 4.642 (5.7)=	78.79
	Total heat loss =	106.35

Location: **North Wall 02** Orientation: N
User-entered U-value : 1.110
Area = 14.61 m²

	Heat loss = 14.61 x 1.11 =	16.22 W/K
--	-----------------------------------	------------------

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 6
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Location: **East Wall 01**

Orientation: E

User-entered U-value : 1.110

Areas (m²) :- Gross: 45.45 Opening(s): 2.10 Net: 43.35

Area x U-value W/K
43.35 x 1.11 = 48.12

Heat loss through solid area

Heat loss through openings:

1: Solid wood door

1.0x2.1=2.10 x 3.0 = 6.30

Total heat loss = 54.42

Location: **East Wall 02**

Orientation: E

User-entered U-value : 1.110

Areas (m²) :- Gross: 63.00 Opening(s): 62.88 Net: 0.12

Area x U-value W/K
0.12 x 1.11 = 0.13

Heat loss through solid area

Heat loss through openings:

1: Single-glazed metal frame window

7.93x7.93=62.88 x 4.642 (5.7)= 291.89

Total heat loss = 292.02

Location: **South Wall 01**

Orientation: S

User-entered U-value : 1.110

Areas (m²) :- Gross: 57.50 Opening(s): 16.97 Net: 40.53

Area x U-value W/K
40.53 x 1.11 = 44.98

Heat loss through solid area

Heat loss through openings:

1: Single-glazed metal frame window

4.12x4.12=16.97 x 4.642 (5.7)= 78.79

Total heat loss = 123.77

Location: **South East Wall**

Orientation: SE

User-entered U-value : 1.110

Areas (m²) :- Gross: 41.80 Opening(s): 16.97 Net: 24.83

Area x U-value W/K
24.83 x 1.11 = 27.56

Heat loss through solid area

Heat loss through openings:

1: Single-glazed metal frame window

4.12x4.12=16.97 x 4.642 (5.7)= 78.79

Total heat loss = 106.35

Location: **South Wall 02**

Orientation: S

User-entered U-value : 1.110

Area = 14.61 m²

Heat loss = 14.61 x 1.11 = 16.22 W/K

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 7
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Ground Floor

Location: **Ground Floor (Slab)**

Floor type: Solid ground floor: exposed perimeter = 92.80m Area = 517.20m²

O/A insulation: 150mm Sand/cement screed

U-value of insulated floor = 0.40

Area = 493.50 m²

Heat loss = 493.50 x 0.40 = 197.56 W/K

Roofs

Location: **West - Flat Roof**

Orientation: W

User-entered U-value : 3.140

Area = 48.50 m²

Heat loss = 48.50 x 3.14 = 152.29 W/K

Location: **East - Flat Roof**

Orientation: E

User-entered U-value : 3.140

Areas (m²) :- Gross: 63.71 Opening(s): 2.00 Net: 61.71

Heat loss through solid area

Area x U-value W/K
61.71 x 3.14 = 193.77

Heat loss through openings:

1: Single-glazed PVC frame rooflight

5x0.4x1.0=2.00 x 4.236 (5.1)= 8.47

Total heat loss = 202.24

Location: **South - Hyperbolic Roof**

Orientation: S

User-entered U-value : 2.480

Area = 222.50 m²

Heat loss = 222.50 x 2.48 = 551.80 W/K

Location: **North - Hyperbolic Roof**

Orientation: N

User-entered U-value : 2.480

Area = 222.50 m²

Heat loss = 222.50 x 2.48 = 551.80 W/K

Total building heat loss = 2841.05 W/K C/F to SAP/DER worksheets [33]

Thermal bridges: Use default loss of 0.08 x ΣA_{exp} (Accredited Construction Details) = 0.08 x 1470.08 = **117.61 W/K**

C/F to SAP/DER worksheets [34]

Window U-values include curtain factor adjustment; unadjusted U-value shown in brackets (# denotes user-entered U-value)

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
 Job: Energy Audit
 Job number: P336

Made by AG
 Page 8
 File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Solar-related calculations
Solar gains through openings during heating season

#	Opening	Orientation	0.9 x Area x Flux x Trans x FF x SAF	Gain (W)
West Wall 01		Orientation: W (E/W)		
1	Single-glazed window		$0.9 \times 4.90 \times 48 \times 0.85 \times 0.7 \times 1.00 =$	126
West Wall 02		Orientation: W (E/W)		
1	Single-glazed window		$0.9 \times 62.88 \times 48 \times 0.85 \times 0.8 \times 1.00 =$	1847
North West Wall		Orientation: NW (NE/NW)		
1	Single-glazed window		$0.9 \times 16.97 \times 34 \times 0.85 \times 0.8 \times 0.54 =$	191
North Wall 01		Orientation: N (North $\pm 30^\circ$)		
1	Single-glazed window		$0.9 \times 16.97 \times 29 \times 0.85 \times 0.8 \times 0.54 =$	163
East Wall 01		Orientation: E (E/W)		
East Wall 02		Orientation: E (E/W)		
1	Single-glazed window		$0.9 \times 62.88 \times 48 \times 0.85 \times 0.8 \times 1.00 =$	1847
South Wall 01		Orientation: S (South $\pm 30^\circ$)		
1	Single-glazed window		$0.9 \times 16.97 \times 72 \times 0.85 \times 0.8 \times 0.77 =$	576
South East Wall		Orientation: SE (SE/SW)		
1	Single-glazed window		$0.9 \times 16.97 \times 64 \times 0.85 \times 0.8 \times 0.77 =$	512
East - Flat Roof		Orientation: E (E/W)		
1	Single-glazed rooflight		$0.9 \times 2.00 \times 75 \times 0.85 \times 0.7 \times 1.00 =$	80
Total Solar Gain			<i>C/F to SAP/DER worksheets [65]</i>	5342W

Lighting

Light transmission through windows and rooflights

West Wall 01		Orientation: W (E/W)		
1	Single-glazed wood frame window		$0.9 \times 4.90 \times 0.7 \times 0.90 \times 1.00 =$	2.78
2	Single-glazed wood half-glazed door			0.00
West Wall 02		Orientation: W (E/W)		
1	Single-glazed metal frame window		$0.9 \times 62.88 \times 0.8 \times 0.90 \times 1.00 =$	40.75
North West Wall		Orientation: NW (NE/NW)		
1	Single-glazed metal frame window		$0.9 \times 16.97 \times 0.8 \times 0.90 \times 0.67 =$	7.37
North Wall 01		Orientation: N (North $\pm 30^\circ$)		
1	Single-glazed metal frame window		$0.9 \times 16.97 \times 0.8 \times 0.90 \times 0.67 =$	7.37
East Wall 01		Orientation: E (E/W)		
1	Solid wood door			0.00
East Wall 02		Orientation: E (E/W)		
1	Single-glazed metal frame window		$0.9 \times 62.88 \times 0.8 \times 0.90 \times 1.00 =$	40.75
South Wall 01		Orientation: S (South $\pm 30^\circ$)		
1	Single-glazed metal frame window		$0.9 \times 16.97 \times 0.8 \times 0.90 \times 0.83 =$	9.13
South East Wall		Orientation: SE (SE/SW)		
1	Single-glazed metal frame window		$0.9 \times 16.97 \times 0.8 \times 0.90 \times 0.83 =$	9.13
East - Flat Roof		Orientation: E (E/W)		
1	Single-glazed PVC frame rooflight		$0.9 \times 2.00 \times 0.7 \times 0.90 \times 1.00 =$	1.13
Total light input				118.41

$G_L = 118.41/489.00 = 0.242 \quad C_2 = 0.96$

Low energy lighting fixed outlets: 0% $C_1 = 1 - 0.50 \times 0/100 = 1$

Electricity used for lighting, $E_L = E_B \cdot TFA \cdot C_1 \cdot C_2 = 9.3 \times 489.0 \times 1 \times 0.96 = 4366$ C/F to SAP worksheet [93]

DER calculation assumes 30% low energy lighting fixed outlets $C_1 = 1 - 0.50 \times 30/100 = 0.85$

Electricity used for lighting, $E_L = E_B \cdot TFA \cdot C_1 \cdot C_2 = 9.3 \times 489.0 \times 0.85 \times 0.96 = 3711$ C/F to DER worksheet [109]

Reduction in energy use due to low energy lights, $\Delta_{EL} = E_B \cdot TFA \cdot (1 - C_1) \cdot C_2 = 9.3 \times 489.0 \times (1 - 0.85) \times 0.96 = 655$

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 9
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Reduction in gains, $\Delta_{\text{gains}} = 0.15\Delta E_L = 0.15 \times 655 = 98$ C/F to DER worksheet [53a]

Solar Panel: none

Solar gains through openings during summer

No daytime shading assumed

Ventilation: trickle vents only Single storey Cross-ventilation possible: Y

Ventilation rate in hot weather = 0.1 ACH

Summer ventilation heat loss = $0.33 \times 0.1 \times 2695.0$ [6] = 89

Total summer heat loss = 2977 [35] + 89 = 3066W/K

# Opening		0.9 x Area x Flux x Trans x FF x SAF	Gain (W)
West Wall 01	Orientation: W (E/W)		
1 Single-glazed window		Little: $0.9 \times 4.90 \times 109 \times 0.85 \times 0.7 \times 1.00 =$	286
2 Half-glazed door			0
West Wall 02	Orientation: W (E/W)		
1 Single-glazed window		Little: $0.9 \times 62.88 \times 109 \times 0.85 \times 0.8 \times 1.00 =$	4195
North West Wall	Orientation: NW (NE/NW)		
1 Single-glazed window		More: $0.9 \times 16.97 \times 89 \times 0.85 \times 0.8 \times 0.70 =$	647
North Wall 01	Orientation: N (North $\pm 30^\circ$)		
1 Single-glazed window		More: $0.9 \times 16.97 \times 75 \times 0.85 \times 0.8 \times 0.70 =$	545
East Wall 01	Orientation: E (E/W)		
1 Solid door			0
East Wall 02	Orientation: E (E/W)		
1 Single-glazed window		Little: $0.9 \times 62.88 \times 109 \times 0.85 \times 0.8 \times 1.00 =$	4195
South Wall 01	Orientation: S (South $\pm 30^\circ$)		
1 Single-glazed window		Average: $0.9 \times 16.97 \times 107 \times 0.85 \times 0.8 \times 0.90 =$	1000
South East Wall	Orientation: SE (SE/SW)		
1 Single-glazed window		Average: $0.9 \times 16.97 \times 112 \times 0.85 \times 0.8 \times 0.90 =$	1047
East - Flat Roof	Orientation: E (E/W)		
1 Single-glazed PVC frame rooflight		Little: $0.9 \times 2.00 \times 187 \times 0.85 \times 0.7 \times 0.87 =$	173
Total Solar Gain			<u>12089W</u>

Total summer gains, $G = 12089 + 1713$ [55] = 13802

Summer Gain/Loss ratio = $13802/3066 = 4.50$

Region: Midlands Mean summer air temperature = 15.5°C

Thermal mass parameter, TMP = 6 (user-entered value)

$\Delta T_{\text{mass}} = 0.8$

$T_{\text{threshold}} = 15.50 + 4.50 + 0.8 = 20.80^\circ\text{C}$

Likelihood of high internal temperatures during summer weather: **Slight**

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 10
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

SAP Worksheet (Version 9.80)

Calculation of Energy Rating

Overall Dwelling Dimensions

	Area m ²	Avg ht m.	Vol. m ³	
Ground/entrance level:	489.00	5.51	2695.00	[1]
Total floor area:	489.00 [5]	Volume:	2695.00	[6]

Ventilation Rate

Infiltration due to chimneys, flues and fans:		ACH	0.00	[10]
Number of storeys: 1				[1])
Structural infiltration (masonry):		0.35		[13]
0% of windows and doors are draught stripped:				[16]
Resulting infiltration:		$0.25 - (0.2 \times 0/100) = 0.25$		[17]
Infiltration rate:		0.60		[19]
1 sheltered side: shelter factor = 0.925				[21]
Adjusted infiltration rate = 0.60×0.93		0.56		[22]
Natural ventilation:				
Effective air change rate		0.65		[24]
		0.65		[25]

Heat Loss Summary

Heat loss through structure (b/f from building summary):		W/K	2841.05	[33]
Thermal bridges 0.08×1470.08 :			117.61	[34]
Total fabric heat loss:			2958.65	[35]
Ventilation heat loss:	$0.65 [25] \times 0.33 \times 2695.00 [6]$		= 581.65	[36]
Specific heat loss:			3540.30	[37]
Heat loss parameter:			$3540.30/489.0 = 7.24$	[38]

Water Heating Energy Requirements

Source: Point of use				
Fuel: Electricity (standard tariff)				
Energy content of heated water (Table 1a N=8.000):			4319	[39]
Primary circuit loss :			0	[48]
Solar input:			0	[50]
Required output from water heater:			4319	[51]
Heat gains from water heating:		$0.25 \times 4319 + 0.8 \times 0 = 1080$		[52]

Gains

Lighting, appliance & metabolic gains (Table 5 N=8.000):		Watts	1,428	[53]
Heating system fan: 161.7				
Total additional gains			162	[53b]
Water heating:		$1080/8.72 = 123$		[54]
Total internal gains:		1,713		[55]
Total solar gains (B/F from solar-related report):		5,342		[65]
Total gains		7,055		[66]
Gains/Loss ratio (GLR) = $7055/3540.3 [37] = 1.993$				[67]
Utilisation factor (Table 7): 1.00				[68]
Useful gains:		$7055 \times 1.00 = 7,054$		[69]

Mean internal temperature

Living area mean temperature: Table 8 col.2; HLP [38] = 7.24		°C	18.44	[70]
Control adjustment (Table 4e)			0.00	[71]
Heating system responsiveness (R) = 0.75 (Table 4a)				
Adjustment for gains:		$0.2 \times R \times ((7054 [69]/3540.3 [37]) - 4.0) = -0.30$		[72]
Adjusted living room temperature:		18.14		[73]
Temperature difference between zones : (Table 9 col 1)		2.00		[74]
Living area fraction: 0.78				[75]
Rest-of-house fraction: 0.22				[76]

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 11
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Mean internal temperature: 18.14 - (2.00 x 0.22) = 17.71 [77]

Degree Days

Temperature rise from gains: 7054 [69]/3540.3 [37] = 1.99 [78]

Base temperature: 17.71 - 1.99 = 15.71 [79]

Degree days (Table 10): 2181 [80]

Space heating requirements

kWh/year

Energy requirement (useful): 0.024 x 2181 x 3540.3 [37] = 185319 [81]

Heat from secondary system: 10% (Table 11) [82]

Primary system: Electricaire system
 Controls: No thermostatic control
 Fuel: Electricity (standard tariff)
 Efficiency: 100% (Table 4a) [83]
 Fuel required: 185319 x 0.90 x 100/100 = 166787 [85]

Secondary system: Electric convector or radiant panel heaters
 Fuel: Electricity (standard tariff)
 Efficiency: 100% (Table 4a) [84]
 Fuel required: 185319 x 0.10 x 100/100 = 18532 [85a]

Water heating energy requirement (net): 4319 kW [51]

Source: Point of use
 Efficiency : 100% [86]

Energy required: 4319 [51] x 100/100 = 4319 [86a]

Electricity for pumps & fans: 1617 [87]

Electricity for lighting (B/F from Solar report) 4366

Fuel Costs £/year

Space heating: Primary system: 166787 x 7.12p = 11875.25 [88]

Secondary system: 18532 x 7.12p = 1319.47 [89]

Water heating: 4319 x 7.12p = 307.49 [91b]

Pump/fan energy cost: 1617 x 7.12p = 115.13 [92]

Lighting energy cost: 4366 x 7.12p = 310.84 [93]

Total heating cost: 13928.19 [97]

SAP Rating

Energy cost deflator (Table 12, footnote 2): 0.91 [98]

Energy cost factor (ECF) £/m²: (13928.19 x 0.91 - 30)/(489.00 + 45.0) = 23.68 [99]

SAP value = -40.1802 [100]

SAP Rating = 1 Band G

CO₂ Emissions kg/year

Primary heating system (electricity) 166787 [85] x 0.422 = 70,384 [101]

Secondary heating system (electricity) 18532 [85a] x 0.422 = 7,820 [102]

Water heating (electricity) 4319 [86a] x 0.422 = 1822 [103]

Total for space and water heating 80027 [107]

Electricity for pumps and fans 1617 [87] x 0.422 = 682 [108]

Electricity for lighting, C_L 4366 x 0.422 = 1842 [109]

New technology: None:

Total: 82,552 [112]

Carbon Factor, CF = 82552/(489.00 + 45) = 154.59 EI = 1.00

EI Rating = 1 Band G

Primary energy	Energy kWh/Yr	Primary Factor	P.Energy kWh/yr	
Space heating	166787	2.80	467004	[101]
Secondary heating	18532	2.80	51889	[102]
Water heating	4319	2.80	12092	[103]
Electricity for pumps and fans	1617	2.80	4528	[108]

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 12
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Electricity for lighting	4366	2.80	12224	[109]
New Technology: Energy saved	0	0.00	0	[110]
New Technology: Energy used	0	0.00	0	[111]
			<u>547,738</u>	[112]
			1,120	[113]

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 13
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

SAP Worksheet (Version 9.80)

Dwelling Carbon Dioxide Emission Rate (DER) Calculation

Overall Dwelling Dimensions

	Area m ²	Avg ht m.	Vol. m ³	
Ground/entrance level:	489.00	5.51	2695.00	[1]
Total floor area:	489.00 [5]	Volume:	2695.00	[6]

Ventilation Rate

Infiltration due to chimneys, flues and fans:	ACH	0.00	[10]
Number of storeys: 1		[1]	[11]
Structural infiltration (masonry):	0.35		[13]
0% of windows and doors are draught stripped:			[16]
Resulting infiltration:	$0.25 - (0.2 \times 0/100) = 0.25$		[17]
Infiltration rate:	0.60		[19]
1 sheltered side: shelter factor = 0.925			[21]
Adjusted infiltration rate = 0.60 x 0.93		0.56	[22]
Natural ventilation:			
Effective air change rate		0.65	[24]
		0.65	[25]

Heat Loss Summary

Heat loss through structure (b/f from building summary):	W/K	2841.05	[33]
Thermal bridges 0.08 x 1470.08:		117.61	[34]
Total fabric heat loss:		2958.65	[35]
Ventilation heat loss:	$0.65 [25] \times 0.33 \times 2695.00 [6] = 581.65$		[36]
Specific heat loss:		3540.30	[37]
Heat loss parameter:		$3540.30/489.0 = 7.24$	[38]

Water Heating Energy Requirements

Source: Point of use			
Fuel: Electricity (standard tariff)			
Energy content of heated water (Table 1a N=8.000):		4319	[39]
Primary circuit loss :		0	[48]
Solar input:		0	[50]
Required output from water heater:		4319	[51]
Heat gains from water heating:	$0.25 \times 4319 + 0.8 \times 0 = 1080$		[52]

Gains

Lighting, appliance & metabolic gains (Table 5 N=8.000):	Watts	1,428	[53]
Reduction due to low energy lighting (30% assumed):		-98	[53a]
Heating system fan: 161.7			
Total additional gains		162	[53b]
Water heating:	$1080/8.72 = 123$		[54]
Total internal gains:		1,615	[55]
Total solar gains (B/F from solar-related report):		5,342	[65]
Total gains		6,957	[66]
Gains/Loss ratio (GLR) = 6957/3540.3 [37] = 1.965			[67]
Utilisation factor (Table 7): 1.00			[68]
Useful gains:	$6957 \times 1.00 = 6,956$		[69]

Mean internal temperature

Living area mean temperature: Table 8 col.2; HLP [38] = 7.24	°C	18.44	[70]
Control adjustment (Table 4e)		0.00	[71]
Heating system responsiveness (R) = 0.75 (Table 4a)			
Adjustment for gains:	$0.2 \times R \times ((6956 [69]/3540.3 [37]) - 4.0) = -0.31$		[72]
Adjusted living room temperature:		18.13	[73]
Temperature difference between zones : (Table 9 col 1)		2.00	[74]
Living area fraction: 0.78			[75]

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 14
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Rest-of-house fraction: 0.22 [76]
Mean internal temperature: 18.13 - (2.00 x 0.22) = 17.70 [77]

Degree Days

Temperature rise from gains: 6956 [69]/3540.3 [37] = 1.96 [78]
Base temperature: 17.70 - 1.96 = 15.74 [79]
Degree days (Table 10): 2187 [80]

Space heating requirements

kWh/year

Energy requirement (useful): 0.024 x 2187 x 3540.3 [37] = 185800 [81]
Heat from secondary system: 10% (Table 11) [82]

Primary system: Electricaire system
Controls: No thermostatic control
Fuel: Electricity (standard tariff)
Efficiency: 100% (Table 4a) [83]
Fuel required: 185800 x 0.90 x 100/100 = 167220 [85]

Secondary system: Electric convector or radiant panel heaters
Fuel: Electricity (standard tariff)
Efficiency: 100% (Table 4a) [84]
Fuel required: 185800 x 0.10 x 100/100 = 18580 [85a]

Water heating energy requirement (net): 4319 kW [51]

Source: Point of use
Efficiency : 100% [86]
Energy required: 4319 [51] x 100/100 = 4319 [86a]

Electricity for pumps & fans: 1617 [87]
Electricity for lighting (B/F from Solar report) 3711

CO₂ Emissions

kg/year

Primary heating system (electricity) 167220 [85] x 0.422 = 70,567 [101]
Secondary heating system (electricity) 18580 [85a] x 0.422 = 7,841 [102]
Water heating (electricity) 4319 [86a] x 0.422 = 1822 [103]
Total for space and water heating 80230 [107]
Electricity for pumps and fans 1617 [87] x 0.422 = 682 [108]
Electricity for lighting, C_L 3711 x 0.422 = 1566 [109]
New technology: None:

Total: 82,478 [112]

Dwelling Carbon Dioxide Emission Rate (DER) = 168.67

(82,478/489.00)

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 15
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

SAP Worksheet (Version 9.80)

Target Carbon Dioxide Emission Rate (TER) Calculation

	Area	U-Value	Heat Loss W/K
Walls (net)	297.12	0.35	103.99
DG wood frame window 16mm gap low-E glass (en=0.2)	120.40	2.00	222.96
Solid wood door	1.85	2.00	3.70
Floors	493.50	0.25	123.38
Roofs	557.21	0.16	89.15
Total heat loss (C/F to [33])			543.18

Overall Dwelling Dimensions

	Area m ²	Avg ht m.	Vol. m ³	
Ground/entrance level:	489.00	5.51	2695.00	[1]
Total floor area:	489.00 [5]	Volume:	2695.00	[6]

Ventilation Rate

Fans and passive vents:		3 x 10/2695.00 = 0.01	[9]
Infiltration due to chimneys, flues and fans:		0.01	[10]
Default q ₅₀ value = 10.00		10.00/20 = 0.50	
Infiltration rate:		0.51	[19]
2 sheltered sides: shelter factor = 0.85			[21]
Adjusted infiltration rate = 0.51 x 0.85		0.43	[22]
Natural ventilation:			
Effective air change rate		0.59	[24]
		0.59	[25]

Heat Loss Summary

Heat loss through structure (from above):		543.18	[33]
Thermal bridges 0.11 x 1470.08:		161.71	[34]
Total fabric heat loss:		704.89	[35]
Ventilation heat loss:	0.59 [25] x 0.33 x 2695.00 [6] =	528.61	[36]
Specific heat loss:		1233.50	[37]
Heat loss parameter:		1233.50/489.0 = 2.52	[38]

Water Heating Energy Requirements

Source: Primary heating system (Gas boiler, automatic ignition, 1998 or later)			
Fuel: Mains Gas			
Energy content of heated water (Table 1a N=8.000):		4319	[39]
Distribution loss (Table 1b):		762	[40]
Cylinder volume = 150 litres			[43]
Cylinder loss factor: 0.0191 (Table 2)			[44]
Volume factor: 0.9283 (Table 2a)			[44a]
Temperature factor: 0.54 (Table 2b)			[44b]
Energy lost from store:	150 x 0.0191 x 0.9283 x 0.54 x 365 =	524	[47]
Primary circuit loss :		610	[48]
Solar input:		0	[50]
Required output from water heater:		6215	[51]
Heat gains from water heating:	0.25 x 4319 + 0.8 x (762+524+610) =	2597	[52]

Gains

Lighting, appliance & metabolic gains (Table 5 N=8.000):		1,428	[53]
Reduction due to low energy lighting (30% assumed):		-98	[53a]
Central heating pump: 10.0			
Total additional gains		10	[53b]
Water heating:		2597/8.72 =	296 [54]
Total internal gains:		1,636	[55]

Place : Architecture
26 Westgate Lincoln LN1 3BD

Site: St John's Church, Ermine, Lincoln
Job: Energy Audit
Job number: P336

Made by AG
Page 16
File copy

SuperHeat 6.20k 600105

P336- 3.2-Supaheat6-calcs-existing fabric

Printed 24 Oct 2007 15:32

Total solar gains (B/F from solar-related report):		2,019	[65]
Total gains		3,655	[66]
Gains/Loss ratio (GLR) = 3655/1233.5 [37] = 2.963			[67]
Utilisation factor (Table 7): 1.00			[68]
Useful gains:	3655 x 1.00 = 3,646		[69]
Mean internal temperature		°C	
Living area mean temperature: Table 8 col.1; HLP [38] = 2.52		18.81	[70]
Control adjustment (Table 4e)		0.00	[71]
Heating system responsiveness (R) = 1.00 (Table 4d)			
Adjustment for gains:	$0.2 \times R \times ((3646 [69]/1233.5 [37]) - 4.0) = -0.21$		[72]
Adjusted living room temperature:		18.60	[73]
Temperature difference between zones : (Table 9 col 2)		1.65	[74]
Living area fraction: 0.78			[75]
Rest-of-house fraction: 0.22			[76]
Mean internal temperature:	$18.60 - (1.65 \times 0.22) = 18.24$		[77]
Degree Days			
Temperature rise from gains:	$3646 [69]/1233.5 [37] = 2.96$		[78]
Base temperature:	$18.24 - 2.96 = 15.28$		[79]
Degree days (Table 10):		2080	[80]
Space heating requirements		kWh/year	
Energy requirement (useful):	$0.024 \times 2080 \times 1233.5 [37] = 61584$		[81]
Heat from secondary system: 10% (Table 11)			[82]
Primary system:	Gas boiler, automatic ignition, 1998 or later Controls: Programmer + roomstat + TRV's Fuel: Mains Gas Notional efficiency: 78%		
Fuel required:	$61584 \times 0.90 \times 100/78 = 71058$		[83] [85]
Secondary system:	Portable electric heaters Fuel: Electricity (standard tariff) Efficiency: 100% (Table 4a)		
Fuel required:	$61584 \times 0.10 \times 100/100 = 6158$		[84] [85a]
Water heating energy requirement (net): 6215 kW [51]			
Source: Primary heating system			
Efficiency : 78% (Manufacturer's declared value)			[86]
Energy required:	$6215 [51] \times 100/78 = 7968$		[86a]
Electricity for pumps & fans:		175	[87]
Electricity for lighting (B/F from Solar report)		3711	
CO₂ Emissions			kg/year
Primary heating system (mains gas)	$71058 [85] \times 0.194 = 13,785$		[101]
Secondary heating system (electricity)	$6158 [85a] \times 0.422 = 2,599$		[102]
Water heating (mains gas)	$7968 [86a] \times 0.194 = 1546$		[103]
Total for space and water heating		17930	[107]
Electricity for pumps and fans	$175 [87] \times 0.422 = 74$		[108]
Electricity for lighting, C _L	$3711 \times 0.422 = 1566$		[109]
New technology: None			
		Total: 19,570	[112]

$$C_H = (17930 + 74)/489.00 = 36.82 \quad C_L = 1566/489.00 = 3.20$$

Fuel: Electricity (standard tariff) : Fuel Factor = 1.47 Improvement Factor = 0.20

$$\text{Target CO}_2 \text{ Emission Rate (TER)} = (C_H \times \text{Fuel Factor} + C_L) \times (1 - \text{imp factor}) \\ = (36.82 \times 1.47 + 3.20) \times (1 - 0.20) = \mathbf{45.86}$$