2nd DRAFT

CODE OF PRACTICE

FOR

OVERALL THERMAL TRANSFER VALUE

IN BUILDINGS

1994

BUILDING AUTHORITY

HONG KONG

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CONTENTS

Foreword

This code sets out technical details for the guidance of authorized persons, registered structural engineers and other parties concerned in the design and construction of buildings. Compliance with the provisions in this code will satisfy the requirements for a suitable overall thermal transfer value of a building under the Building (Energy Efficiency) Regulations. Alternatives may, however, also be acceptable if they fulfil equivalent performance.

1. General principles of control of Overall Thermal Transfer Value (OTTV)

1.1 General approach

1.1.1 OTTV is a measure of the energy consumption of the building envelope. Its formulation allows the authorized person, registered structural engineer and other persons concerned in the design and construction of buildings freedom to vary important envelope components such as type of glazing, window size, external shading to windows, wall colour, and wall type to meet the maximum OTTV criteria. Siting of the building to avoid extensive glazed facades with a southerly aspect or introducing canopies or overhangs to shade windows are simple means of reducing solar heat gain. Appropriate choice of reflective or tinted glass to windows will also minimize solar heat transmission. In fact the shading of windows and the area of windows in relation to the overall area of the wall are of paramount importance in reducing the solar heat gain of the building to a level which will comply with the OTTV control.

1.1.2 For the purpose of designing energy efficient buildings, a comprehensive energy code for buildings in Hong Kong is being developed which will include also codes for lighting and air conditioning. Meanwhile, it should be borne in mind that OTTV is only one aspect of energy conservation that should be considered during the planning of a building.

1.1.3 Artificial lighting consumes a significant amount of electricity and creates heat which adds to the cooling load of the building. The increase in cooling load will further increase the energy consumption of the building. Consequently, when determining the size and location of windows in the envelope of the building, consideration should be given to provide as much natural lighting into the building as is possible. The visible lighting transmittance of glazing should be taken into consideration in addition to their thermal transmittance properties, so that daylight can be used to reduce artificial lighting without unduly increasing the cooling load of the building.

1.1.4 Other measures to improve energy efficiency and save energy should also be considered whilst planning the building. These measures may include the extensive use of energy efficient building services equipment such as energy saving lamps, low-loss luminaries and high efficiency air-conditioning equipment and the use of more sophisticated building services control systems.

1.2. **Scope**

1.2.1 The OTTV requirements will apply to all hotels and commercial buildings as defined in the Building (Energy Efficiency) Regulations and are aimed at reducing the amount of heat transfer through the building envelope and therefore reducing the amount of electricity required to cool the building by airconditioning. Lighting levels and heat generated by them, and their effect on electricity consumption and increased airconditioning load, are not addressed in this OTTV formulation.

1.2.2 Solar reflection or shading from adjacent buildings is not allowed for in the OTTV formulation. Such effects cannot be considered in a generalized manner, as each building has to be examined individually. In addition when adjoining buildings are demolished and new buildings take their place the effects of shading and reflection changes cannot be accommodated within the formulation.

2. **Definitions**

In this code, unless otherwise stated, words and expressions have the meaning attributed to them by the Building (Energy Efficiency) Regulations, and -

"airconditioned space" includes all usable activity space which could be airconditioned, even if not served by a central airconditioning plant and not provided with airconditioning by individual window or other types of cooling apparatus at the time of completion of the building;

"buffer area" means a space against an external wall or under a roof which forms a buffer to air-conditioned space and includes lift shafts, required staircases and other staircases which are enclosed, toilets (even if air-conditioned), air handling unit rooms, plant rooms and areas directly below a roof-top tank;

"building tower" means that part of a building above the podium of the building;

"fenestration" means any glazed aperture in the building envelope;

"lightwell" means a vertical shaft of open air enclosed on all sides by parts of a building;

"opaque" wall or roof means that solid part of the wall or roof which is not part of the fenestration;

"podium" means that part of a building which,

(a) if having a site coverage exceeding the permitted percentage site coverage, is -

(i) within 15 m above ground level as permitted under Building (Planning) Regulation 20(3); or

(ii) within such height which is permitted by the Building Authority by way of a modification of that regulation granted under section 42 of the Buildings Ordinance; and

(b) if having a site coverage within the permitted percentage site coverage, is within 15 m above ground level.

"refuge floor" has the meaning assigned to it in the Code of Practice on Means of Escape and means a protected floor that serves as a refuge for the occupants of the building to assemble in case of fire.

"required staircase" means an access staircase in a firefighting and rescue stairway or a staircase required as means of escape in case of fire.

3. **Suitable OTTV**

3.1 The external walls and roofs of a building to which the Building (Energy Efficiency) Regulations apply shall be designed and constructed to have the following OTTV :

(a) The OTTV of the external walls or roofs of a building tower shall not exceed 35 W/m^2.

(b) The OTTV of the external walls or roofs, if any, of a podium shall not exceed 80 W/m^2.

3.2 The maximum OTTV specified in paragraph 3.1 shall apply to the overall building envelope, i.e. all the external walls or roofs, as the case may be, in average and not to the individual wall or roof.

3.3 The OTTV of the external walls or roofs of a building tower or podium shall be assessed in accordance with methods set out in this code (a sample of OTTV calculation for a typical commercial building is set out in Appendix A for illustration).

4. Principles of OTTV calculations

4.1 External walls and roofs not included in OTTV calculations

All external walls and roofs of a building shall be included in OTTV calculations except -

(a) a roof which is not exposed to the sky;

(b) an external wall of a refuge floor;

(c) an external wall or roof of a carparking floor;

(d) an external wall of a lightwell having an area on plan not exceeding 21 m^2;

(e) an external wall of a service duct;

(f) an external wall or roof of a buffer area.

4.2 Party wall

An external wall of a building which is a party wall shall be included in OTTV calculations whether an adjoining building exists or not. Shading to the party wall from adjoining buildings shall not be considered in calculating the OTTV.

4.3 Internal shading

Internal shading devices such as draperies and blinds shall not be considered in calculating the OTTV.

5. OTTV of external walls

5.1 The OTTV of the external walls of a building tower or a podium, $OTTV_w$, shall be calculated using the following formula -

$$OTTV_w = \frac{(A_w \times U \times \alpha \times TD_{EQw}) + (Af_w \times SC \times ESM \times SF)}{Ao_w}$$

where

A_w = Area of opaque wall enclosing airconditioned space, m^2

U = Thermal transmittance of opaque wall, $W/m^2°C$ (See para 5.2)

α = Absorptivity of the opaque wall (Table 4)

TD_{EQw} = Equivalent temperature difference for wall, °C (Table 5)

Af_w = Area of fenestration in wall, m^2

SC = Shading coefficient of fenestration in wall (See para 5.5)

ESM = External shading multiplier (Table 6 and 7)

SF = Solar factor for the vertical surface, W/m^2 (Table 8)

Ao_w = Gross area of external walls enclosing airconditioned space, m^2

5.2 Thermal transmittance of opaque construction (U)

Opaque walls and roofs usually involve a composite of materials. The thermal transmittance of an opaque wall or roof shall be derived by the following formula -

$$U = \frac{1}{R_i + \frac{x_1}{k_1} + \frac{x_2}{k_2} + \ldots\ldots\frac{x_n}{k_n} + R_a + R_o}$$

x = Thickness of building material of the wall or roof or part thereof, m

k = Thermal conductivity of the building material, $W/m°C$ (Table 1)

R_i = Surface film resistance of internal surface of the wall or roof, $m^2°C/W$ (Table 2)

R_o = Surface film resistance of external surface of the wall or roof, $m^2°C/W$ (Table 2)

R_a = Air space resistance, $m^2°C/W$ (Table 1)

5.2.1 Thermal conductivity of building materials (k)

The thermal conductivity (K-value) of the building materials of walls and roofs shall be obtained from Table 1.

Table 1 Thermal Conductivity (K-value) of Building Materials

Material	Density kg/m^3	k-value $W/m°C$
Asphalt, mastic with 20% grit	2350	1.15
Boards		
a) cork	145	0.042
b) hardboard high density	1010	0.144
c) mineral fibre	265	0.053
d) plasterboard	950	0.16
Brick (common)	1900	0.95
Concrete		
a) normal weight aggregate	2400	2.16
b) lightweight aggregate	1300	0.44
c) flat roof tiles or slabs	2100	1.10
Glass	2500	1.05
Mosaic tile cladding	2500	1.50
Insulating materials		
a) glass fibre mat or quilt	32	0.035
b) mineral wool felt	50	0.039
c) polystyrene expanded	25	0.034
d) polyurethane foam	30	0.026
Metals		
a) aluminium alloy typical	2800	160
b) copper commercial	8900	200
c) steel, carbon	7800	50
Plaster/render		
a) gypsum	1120	0.38
b) gypsum, sand aggregate	1570	0.53
c) cement/sand	1860	0.72
Screeding		
a) cement sand	1860	0.72
b) terrazzo	2435	1.59
Stone		
a) granite	2650	2.9
b) marble	2500	2.0

Note : If other materials are used the K-values shall be subject to the acceptance of the Building Authority and the source of the information from which the K-values are obtained shall be submitted for his consideration for this purpose.

5.2.2 Surface film resistance for walls and roofs (R_i, R_o)

The surface film resistance (R_i or R_o) for walls and roofs shall be obtained from Table 2.

Table 2 Surface Film Resistance (R_i, R_o) for Walls and Roofs

Type of surface	Surface film resistance $m^2°C/W$
Surface film resistance for walls	
1. Internal surface (R_i)	
(a) Absorptivity (0.5 and above)	0.120
(b) Absorptivity (below 0.5)	0.299
2. External surface (R_o)	0.044
Surface film resistance for roofs	
1. Internal surface (R_i)	
(a) Absorptivity (0.5 and above)	
(i) Flat roof	0.162
(ii) Sloped roof 22½°	0.148
(iii) Sloped roof 45°	0.133
(b) Absorptivity (below 0.5)	
(i) Flat roof	0.801
(ii) Sloped roof 22½°	0.595
(iii) Sloped roof 45°	0.391
2. External surface (R_o)	0.055

5.2.3 Air space resistance for walls and roofs (R_a)

The air space resistance (R_a) for walls and roofs shall be obtained from Table 3.

Table 3 Air Space Resistance (R_a) for Walls and Roofs

Type of air space	Air space resistance m²°C/W					
	5 mm	10 mm	20 mm	50 mm	75 mm	100 mm
Air space resistance (R_a) for walls						
Vertical air space (heat flows horizontally)						
(a) Absorptivity (0.5 and above)	0.110	0.123	0.148	0.153	0.156	0.160
(b) Absorptivity (below 0.5)	0.250	0.359	0.578	0.589	0.597	0.606
Air space resistance (R_a) for roofs						
Horizontal or sloping air space (heat flows downward)						
(a) Absorptivity (0.5 and above)						
(i) horizontal air space	0.110	0.123	0.148	0.158	0.166	0.174
(ii) sloped air space 22½°	0.110	0.123	0.148	0.154	0.160	0.165
(iii) sloped air space 45°	0.110	0.123	0.148	0.152	0.155	0.158
(b) Absorptivity (below 0.5)						
(i) horizontal air space	0.250	0.357	0.572	0.891	1.157	1.423
(ii) sloped air space 22½°	0.250	0.357	0.571	0.768	0.931	1.095
(iii) sloped air space 45°	0.250	0.357	0.570	0.644	0.706	0.768

5.3 Absorptivity (α)

Energy simulation studies for Hong Kong have shown that the external surface and colour of walls and roofs and therefore their absorptivity have a significant effect on chiller energy used. This shall be included in the heat gain calculation as a multiplication constant to the equivalent temperature difference. The absorptivity (α) for wall and roof surfaces shall be obtained from Table 4.

Table 4 Absorptivity (α) for wall and roof surfaces

Material	Absorptivity α	Paint	Absorptivity α
Black glass	1.0	Optical flat black paint	0.98
Black concrete	0.91	Flat black paint	0.95
Stafford blue brick	0.89	Black lacquer	0.92
Red brick	0.88	Dark grey paint	0.91
Bituminous felt	0.88	Dark blue lacquer	0.91
Blue grey slate	0.87	Black oil paint	0.90
Roofing, green	0.86	Dark olive drab paint	0.89
Brown concrete	0:85	Azure blue or dark green lacquer	0.88
Asphalt pavement, weathered	0.82	Dark brown paint	0.88
Wood, smooth	0.78	Dark blue-grey paint	0.88
Uncoloured concrete	0.65	Medium brown paint	0.84
White marble	0.58	Medium light brown paint	0.80
White mosaic tiles	0.58	Brown or green lacquer	0.79
Light buff brick	0.55	Medium rust paint	0.78
Built-up roof, white	0.50	Light grey oil paint	0.75
Bituminous felt, aluminized	0.40	Red oil paint	0.74
Gravel	0.29	Medium dull green paint	0.59
White on galvanized iron	0.26	Medium orange paint	0.58
White glazed brick	0.25	Medium yellow paint	0.57
Polished aluminium reflector sheet	0.12	Medium blue paint	0.51
Aluminized mylar film	0.10	Medium kelly green paint	0.51
Tinned surface	0.05	Light green paint	0.47
		Aluminium paint	0.40
		White semi-gloss paint	0.30
		White gloss paint	0.25
		Silver paint	0.25
		White lacquer	0.21
		Laboratory vapour deposited coatings	0.02

Note : Absorptivity for other materials or surfaces shall be subject to the acceptance of the Building Authority and the source of the information from which the absorptivity values are obtained shall be submitted for his consideration.

5.4 Equivalent temperature difference for walls (TD_{EQw})

Energy simulation studies for Hong Kong have indicated that thermal mass affects the total heat flow through walls sufficiently to warrant its inclusion in the formulation of an OTTV. The equivalent temperature difference for walls shall take into account the wall mass, density and orientation. Heavyweight construction gives a better performance than lightweight construction because it resists the passage of heat. The equivalent temperature difference for walls (TD_{EQw}) shall be obtained from Table 5.

Table 5 Equivalent Temperature Difference for Walls (TD_{EQw})

Orientation	Density of wall construction				
	less than 22 kg/m²	23-199 kg/m²	200-379 kg/m²	380-569 kg/m²	570 kg/m² or greater
N	3.70	3.38	2.72	2.05	1.70
NNE	4.65	4.21	3.30	2.36	1.88
NE	5.60	5.03	3.86	2.67	2.05
ENE	6.55	5.86	4.44	2.98	2.23
E	7.50	6.68	5.01	3.28	2.40
ESE	7.05	6.26	4.65	3.00	2.15
SE	6.60	5.85	4.30	2.71	1.90
SSE	6.15	5.43	3.95	2.43	1.65
S	5.70	5.01	3.60	2.15	1.40
SSW	6.15	5.42	3.92	2.37	1.58
SW	6.60	5.82	4.23	2.59	1.75
WSW	6.55	5.81	4.29	2.73	1.93
W	6.50	5.79	4.35	2.86	2.10
WNW	5.80	5.19	3.94	2.66	2.00
NW	5.10	4.59	3.54	2.45	1.90
NNW	4.40	3.98	3.13	2.25	1.80

5.5 Shading coefficient of fenestration (SC)

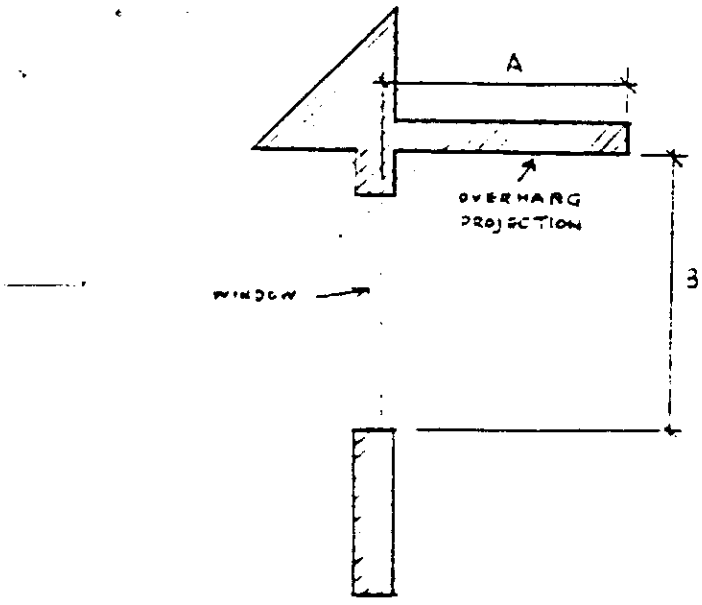
The shading coefficient (SC) of fenestration is the ratio of the solar heat gain through a particular type of glass under a specific set of conditions to the solar heat gain through double strength sheet clear glass under the same conditions. Allowances for Hong Kong's latitude and solar effects have been taken into account in the solar factor (SF) and therefore the SC of glass published by glass manufacturers either in Hong Kong or overseas can be used without modification provided that the calculations have been based on a normal angle of incidence.

5.6 External shading multiplier (ESM)

Shading of windows is of paramount importance in reducing solar heat gain to the building. This shading can be provided by projections over the window, at the side of the window, or a combination of both. For the purpose of simplicity in OTTV calculation this shading effect is taken into account as an external shading multiplier (ESM).

5.6.1 Overhang projections to windows

The external shading multiplier (ESM) for overhang projections to windows shall be obtained from Table 6 according to the overhang projection factor (OPF) and the orientation of the window. The OPF shall be calculated as follows :



$$\text{OPF} = \text{Overhang projection factor} = \frac{A}{B}$$

Table 6 External Shading Multiplier (ESM) for Overhang Projections to Windows

OPF	ESM			
	N	NE/NW	S/E/W	SE/SW
0.00	1.000	1.000	1.000	1.000
0.05	0.975	0.969	0.962	0.962
0.10	0.951	0.939	0.926	0.926
0.15	0.928	0.909	0.890	0.890
0.20	0.905	0.880	0.856	0.856
0.25	0.883	0.853	0.823	0.823
0.30	0.861	0.826	0.790	0.790
0.35	0.840	0.800	0.759	0.759
0.40	0.820	0.774	0.729	0.729
0.45	0.800	0.750	0.700	0.700
0.50	0.781	0.726	0.672	0.672
0.55	0.762	0.704	0.645	0.645
0.60	0.744	0.682	0.620	0.620
0.65	0.726	0.661	0.595	0.595
0.70	0.710	0.641	0.572	0.572
0.75	0.693	0.621	0.549	0.549
0.80	0.678	0.603	0.528	0.528
0.85	0.663	0.585	0.507	0.507
0.90	0.648	0.568	0.488	0.488
0.95	0.634	0.552	0.470	0.470
1.00	0.621	0.537	0.453	0.453

Notes :

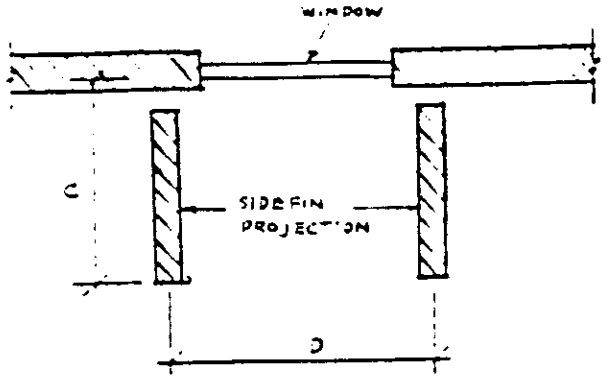
(i) Should the OPF value fall in between increments, adopt the multiplier related to the next larger OPF value.

(ii) OPF values above 1.0 are considered to produce too great an error in estimation.

(iii) ESM for South, East and West orientations are combined since the figures are very similar.

5.6.2 Sidefin projection to windows

The external shading multiplier (ESM) for sidefin projections to windows shall be obtained from Table 7 according to the sidefin projection factor (SPF) and the orientation of the window. The SPF shall be calculated as follows :



SPF = Sidefin projection factor = $\frac{C}{D}$

Table 7 **External Shading Multiplier (ESM) for Sidefin Projections to Windows**

SPF	ESM							
	N	NE	E	SE	S	SW	W	NW
0.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0.05	0.955	0.964	0.974	0.968	0.962	0.968	0.968	0.964
0.10	0.911	0.929	0.948	0.937	0.925	0.936	0.947	0.929
0.15	0.869	0.896	0.923	0.906	0.890	0.906	0.922	0.895
0.20	0.828	0.863	0.898	0.877	0.855	0.876	0.897	0.863
0.25	0.789	0.832	0.875	0.848	0.822	0.848	0.873	0.831
0.30	0.751	0.801	0.852	0.821	0.790	0.820	0.850	0.800
0.35	0.714	0.772	0.829	0.794	0.759	0.793	0.828	0.771

(Cont'd)

Table 7 External Shading Multiplier (ESM) for Sidefin Projections to Windows (Cont'd)

SPF	ESM							
	N	NE	E	SE	S	SW	W	NW
0.40	0.679	0.743	0.807	0.768	0.729	0.767	0.806	0.742
0.45	0.645	0.716	0.786	0.743	0.700	0.743	0.785	0.715
0.50	0.613	0.690	0.766	0.719	0.673	0.719	0.765	0.689
0.55	0.582	0.664	0.746	0.696	0.646	0.696	0.746	0.664
0.60	0.553	0.640	0.727	0.674	0.621	0.674	0.727	0.640
0.65	0.525	0.617	0.709	0.653	0.596	0.653	0.709	0.617
0.70	0.499	0.595	0.691	0.632	0.573	0.633	0.692	0.595
0.75	0.473	0.574	0.674	0.613	0.551	0.613	0.675	0.574
0.80	0.450	0.554	0.658	0.594	0.531	0.595	0.660	0.555
0.85	0.428	0.535	0.642	0.577	0.511	0.578	0.645	0.536
0.90	0.407	0.517	0.627	0.560	0.493	0.561	0.630	0.519
0.95	0.388	0.500	0.613	0.544	0.475	0.546	0.617	0.502
1.00	0.370	0.484	0.599	0.529	0.459	0.531	0.604	0.487
1.05	0.354	0.470	0.586	0.515	0.444	0.518	0.592	0.473
1.10	0.339	0.456	0.574	0.502	0.430	0.505	0.581	0.460
1.15	0.325	0.444	0.562	0.490	0.417	0.494	0.570	0.448
1.20	0.313	0.432	0.551	0.478	0.406	0.483	0.560	0.437
1.25	0.302	0.422	0.541	0.468	0.395	0.473	0.551	0.427
1.30	0.293	0.412	0.531	0.458	0.386	0.464	0.543	0.418
1.35	0.286	0.404	0.522	0.450	0.377	0.456	0.535	0.410
1.40	0.279	0.396	0.514	0.442	0.370	0.449	0.528	0.404
1.45	0.274	0.390	0.506	0.435	0.364	0.443	0.522	0.398
1.50	0.271	0.385	0.499	0.429	0.359	0.438	0.517	0.394

Notes :

(i) SPF values above 1.5 are considered to produce too great an error in estimation.

(ii) Should the SPF value fall in between increments, adopt the multiplier related to the next larger SPF value.

5.6.3 For windows with both overhang and sidefin projections each external shading multiplier shall be calculated separately as described in 5.6.1 and 5.6.2 and the smaller of the two values obtained shall be used as the external shading multiplier in the OTTV calculation.

5.7 Solar factor (SF)

The solar factor (SF) for vertical surfaces at various orientations and that for horizontal surfaces shall be obtained from Table 8. The solar factors have been calculated for the Hong Kong climate. Any sloping or angled wall or roof can be resolved into vertical and horizontal components. The vertical components of the sloping or angled wall or roof can be treated as a vertical surface with a solar factor at that respective orientation; whereas the horizontal component can be treated as a horizontal surface.

Table 8 Solar Factor

orientation	N	NE	E	SE	S	SW	W	NW
SF for vertical surface	104	138	168	197	191	202	175	138
orientation	NNE	ENE	ESE	SSE	SSW	WSW	WNW	NNW
SF for vertical surface	121	153	183	194	197	189	157	121
SF for horizontal surface	264							

6. OTTV of roofs

6.1 The OTTV of the roofs of a building tower or a podium, $OTTV_r$, shall be calculated using the following formula :-

$$OTTV_r = \frac{(A_r \times U \times \alpha \times TD_{EQr}) + (Af_r \times SC \times SF)}{Ao_r}$$

Where

A_r = Area of opaque roof over airconditioned space, m^2

U = Thermal transmittance of opaque roof, $W/m^2°C$ (See para 5.2)

α = Absorptivity of the opaque roof (Table 4)

TD_{EQr} = Equivalent temperature difference for roof, °C (Table 9)

Af_r = Area of fenestration in roof, m^2

SC = Shading coefficient of fenestration in roof (See para 5.5)

SF = Solar factor for horizontal surface, W/m^2 (Table 8)

Ao_r = Gross area of roof over airconditioned space, m^2

6.2 Equivalent temperature difference for roofs (TD_{EQr})

The equivalent temperature difference for roofs (TD_{EQr}) shall take into account the roof mass and density and shall be obtained from Table 9.

Table 9 Equivalent Temperature Difference for Roofs (TD_{EQr})

Density of roof construction	less than 22 kg/m²	23-199 kg/m²	200-379 kg/m²	380-569 kg/m²	570 kg/m² or above
TD_{EQr}	18.60	16.88	13.37	9.75	7.90

7. **Windows and doors**

The concept of OTTV is based on the assumption that the envelope of the building is completely enclosed. Consequently, as a basic requirement, buildings shall not have unenclosed doorways and entrances. For commercial buildings where heavy traffic of people is anticipated, self closing doors without restrainers, revolving doors or other similar means of minimizing heat gain shall be employed. Also careful attention shall be paid to the sealing of windows to guard against leakage during service.

8. **Buffer areas**

All buffer areas shall be adequately ventilated to avoid heat build up within that area.

9. **Submission of information**

9.1 The following information shall be submitted on standard forms set out in the schedule to this code to facilitate checking by the Building Authority :

(a) Calculation of 'U' value of composite wall and roof and details of other values on Form OTTV 1.

(b) Window and rooflight schedule on Form OTTV 2.

(c) OTTV calculations on Form OTTV 3 and Form OTTV 4.

9.2 OTTV calculations shall be made to two places of decimals.

Schedule of Standard Forms

Form OTTV 1

Form OTTV 2

Form OTTV 3

Form OTTV 4

Building (Energy Efficiency) Regulation

Form OITV 1

Calculation of 'U' Value of Composite *Wall/Roof and Details of Other Values

[redacted]

Building address _____

Physical data of Opaque *Wall/Roof

Facade Orientation facing _____ Solar Factor (SF) is _____

*Wall/Roof Code No.	$*W_1/R_1$	$*W_2/R_2$	$*W_3/R_3$	$*W_4/R_4$
Location of Wall/Roof				
External Finish Material				
Conductivity W/m°C				
Density kg/m^3				
Thickness m				
Absorptivity (α)				
Intermediate component				
Conductivity W/m°C				
Density kg/m^3				
Thickness m				
Intermediate component				
Conductivity W/m°C				
Density kg/m^3				
Thickness m				
Intermediate component				
Conductivity W/m°C				
Density kg/m^3				
Thickness m				
Intermediate component				
Conductivity W/m°C				
Density kg/m^3				
Thickness m				
Internal Finish Material				
Conductivity W/m°C				
Density kg/m^3				
Thickness m				
Absorptivity α				
'U' value of composite *Wall/Roof				
Area of *Wall/Roof m^2				
Density of composite *Wall/Roof kg/m^3				
Equivalent temperature difference (TD_{EQ})				

*Delete as appropriate

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Building (Energy Efficiency) Regulation
Form BEE 2

Window/Rooflight Schedule

Sheet No. B _____ BD Ref 2/___/___/___

Building address _____

Physical data on *window/rooflight

Facade Orientation facing _____ Solar Factor (SF) is _____

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight				
Glazing type				
Thickness mm				
Shading Coefficient (SC)				
Type of shading device				
External Shading Multiplier (ESM)				
Area of glazing m^2				

Physical data on *window/rooflight

Facade Orientation facing _____ Solar Factor is _____

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight				
Glazing type				
Thickness mm				
Shading Coefficient (SC)				
Type of shading device				
External Shading Multiplier (ESM)				
Area of glazing m^2				

* Delete as appropriate

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Building (Energy Efficiency) Regulation

Form OTTV 3

Calculation of OTTV of Individual Facade in Building Envelope

Sheet No. C _____ BD Ref 2/___/___/___

Building address _____

Facade Orientation facing _____.

Opaque *Walls/Roofs

Code No.	Description	$*A_w/A_r$	U	α	TD_{EQ}	Sum
	Subtotals		(A)		Heat Gain	(C)

Fenestration

Code No.	Description	$*Af_w/Af_r$	SC	ESM	SF	Sum
	Subtotals		(B)		Heat Gain	(D)

Gross Heat Gain (C + D) _____

Gross Area (A + B) _____

$$OTTV = \frac{C + D}{A + B} = \_\_\_\_\_ W/m^2$$

* Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 4

Summary of OTTV of Building Envelope

Sheet No. D _____ BD Ref. 2/____/____/____

Building address _____

Total Envelope Heat Gain (* Tower/Podium)

Facade Orientation	Gross Area from Form OTTV 3	Gross Heat Gain from Form OTTV3
a. b. c. d. e. f.		
Subtotal	(E)	(G)
Roof		
a. b.		
Subtotal	(F)	(H)

* Tower/Podium Walls OTTV = $\frac{G}{E}$ = _____ W/m²

* Tower/Podium Roofs OTTV = $\frac{H}{F}$ = _____ W/m²

* Delete as appropriate

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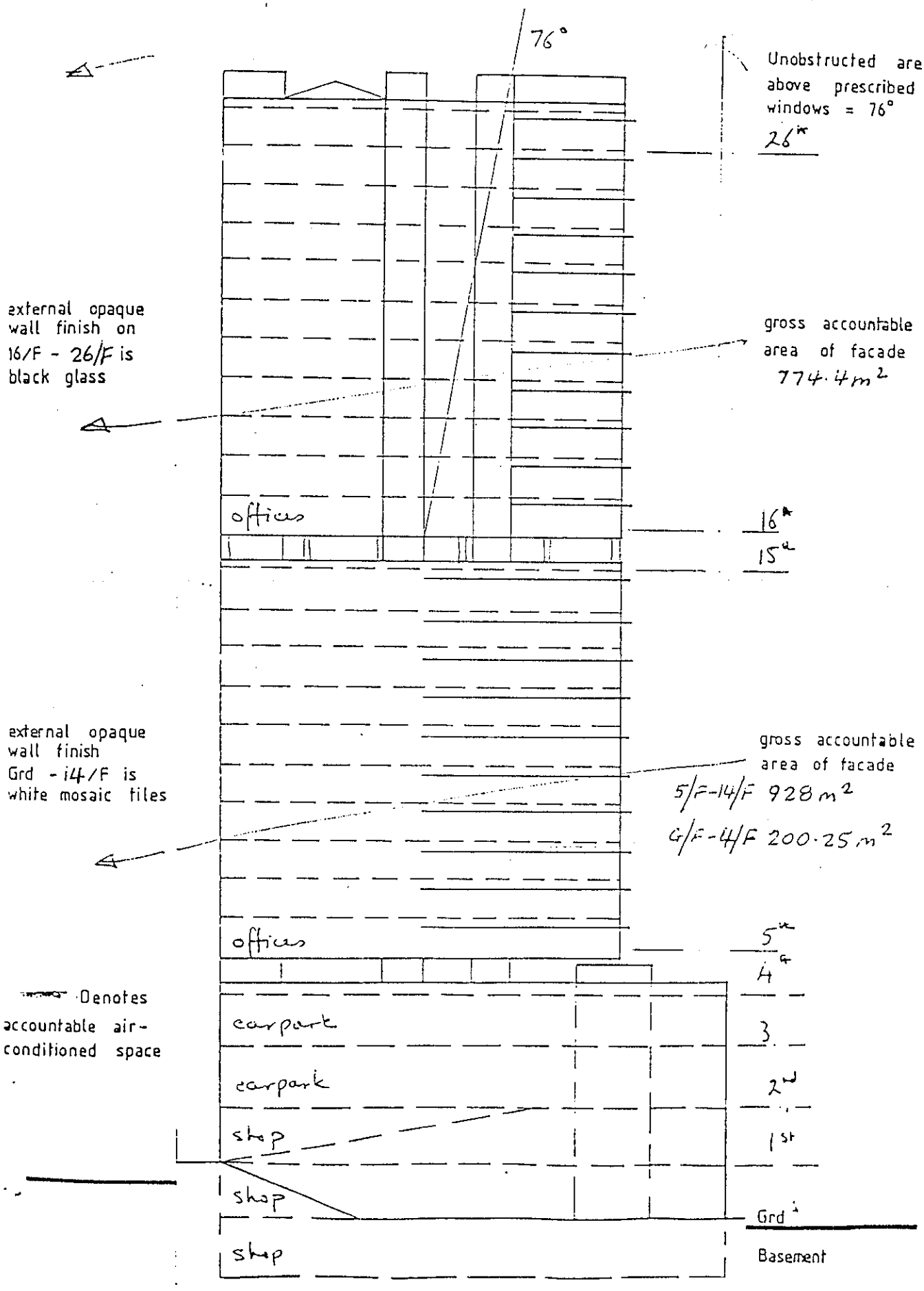
Appendix A

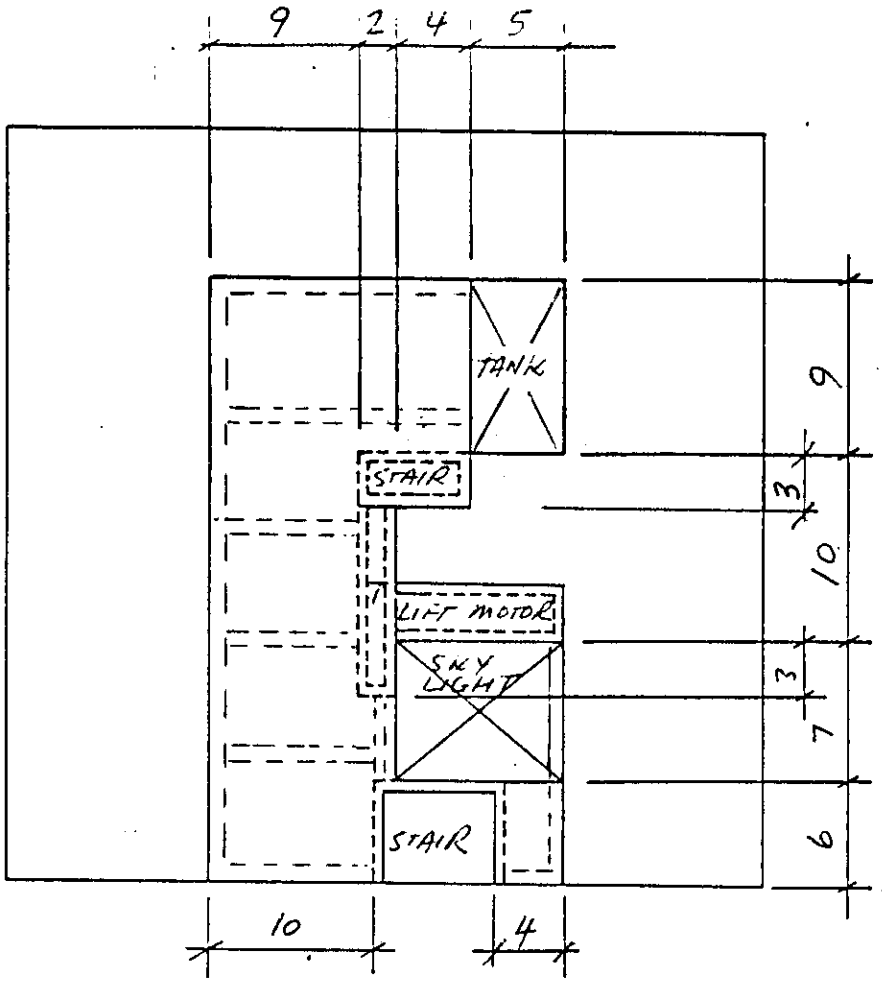
A sample of OTTV calculation for a typical commercial building

Plans and Elevation of A Typical Commercial Building

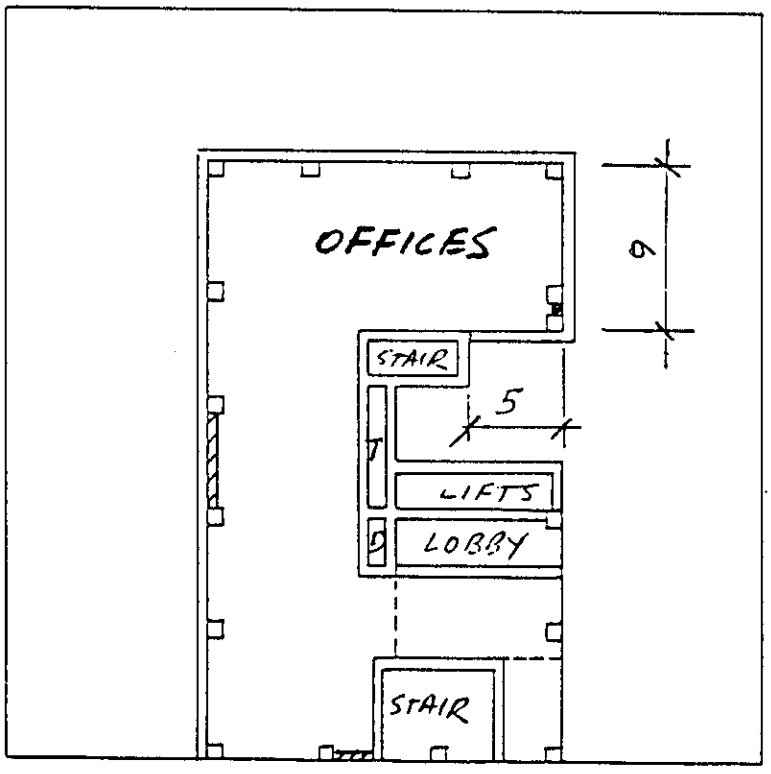


East Elevation

A 2

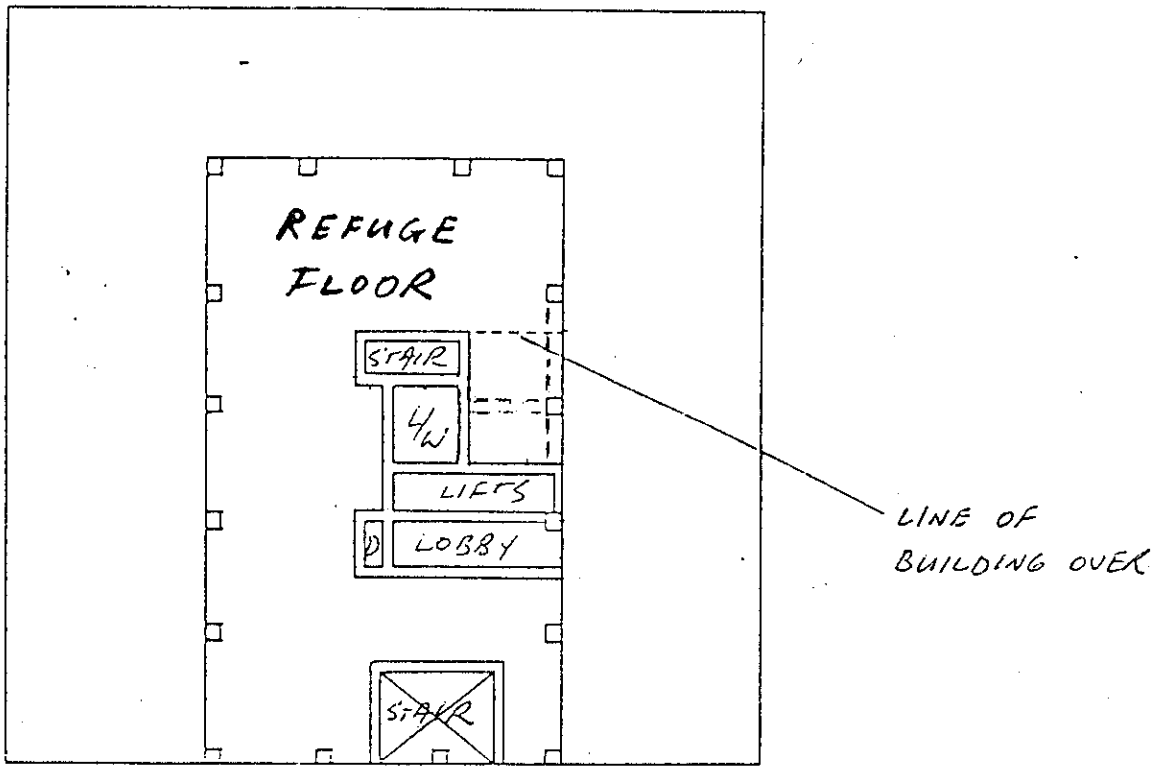


ROOF

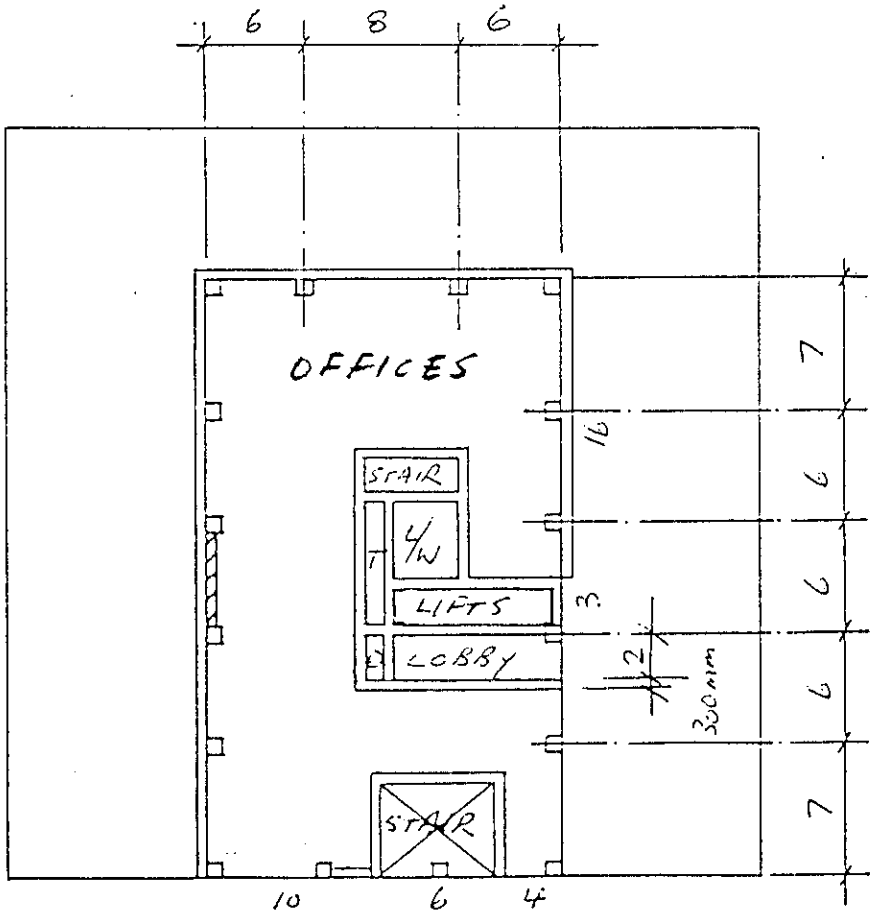


16TH – 26TH FLOOR

A3

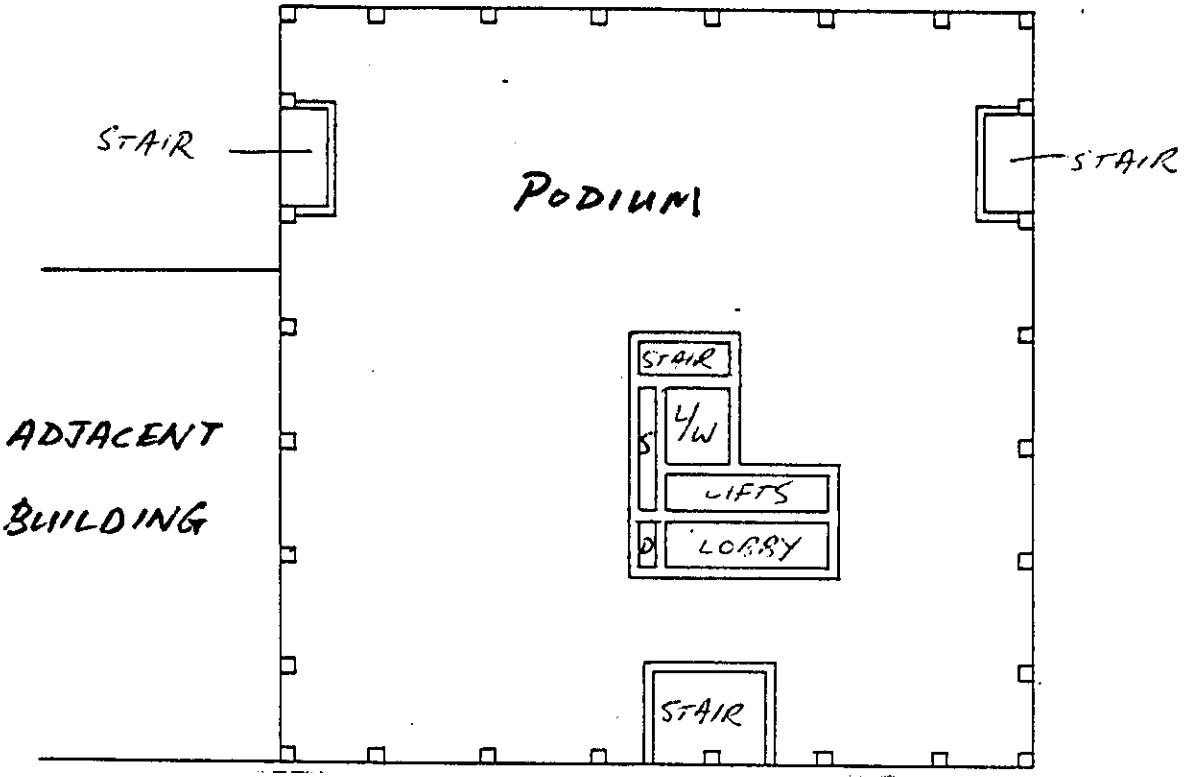


15TH FLOOR

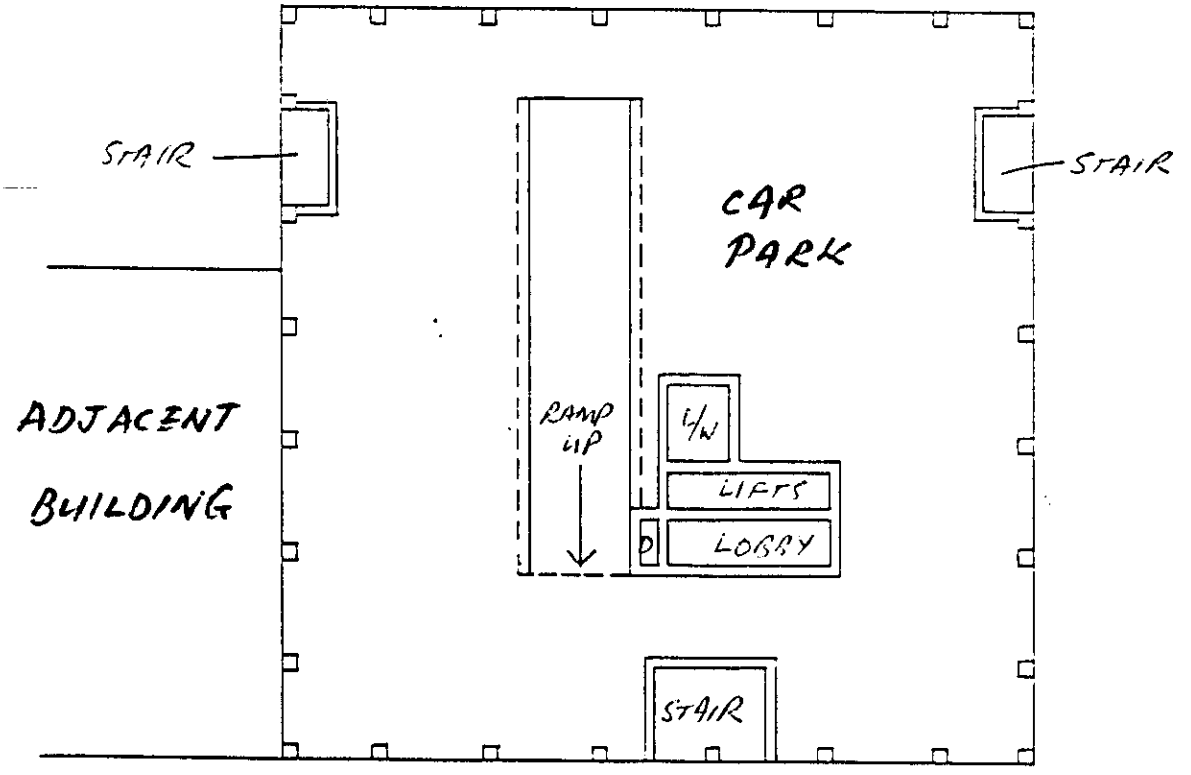


5TH – 14TH FLOOR

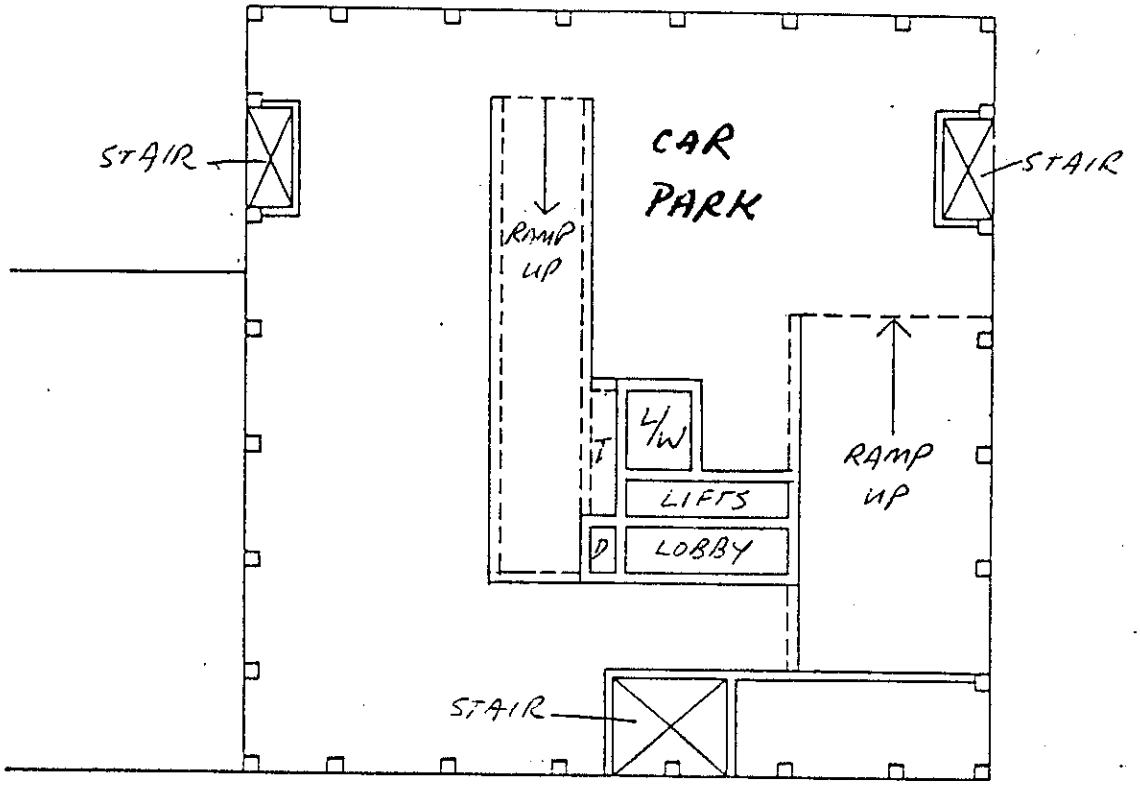
A 4



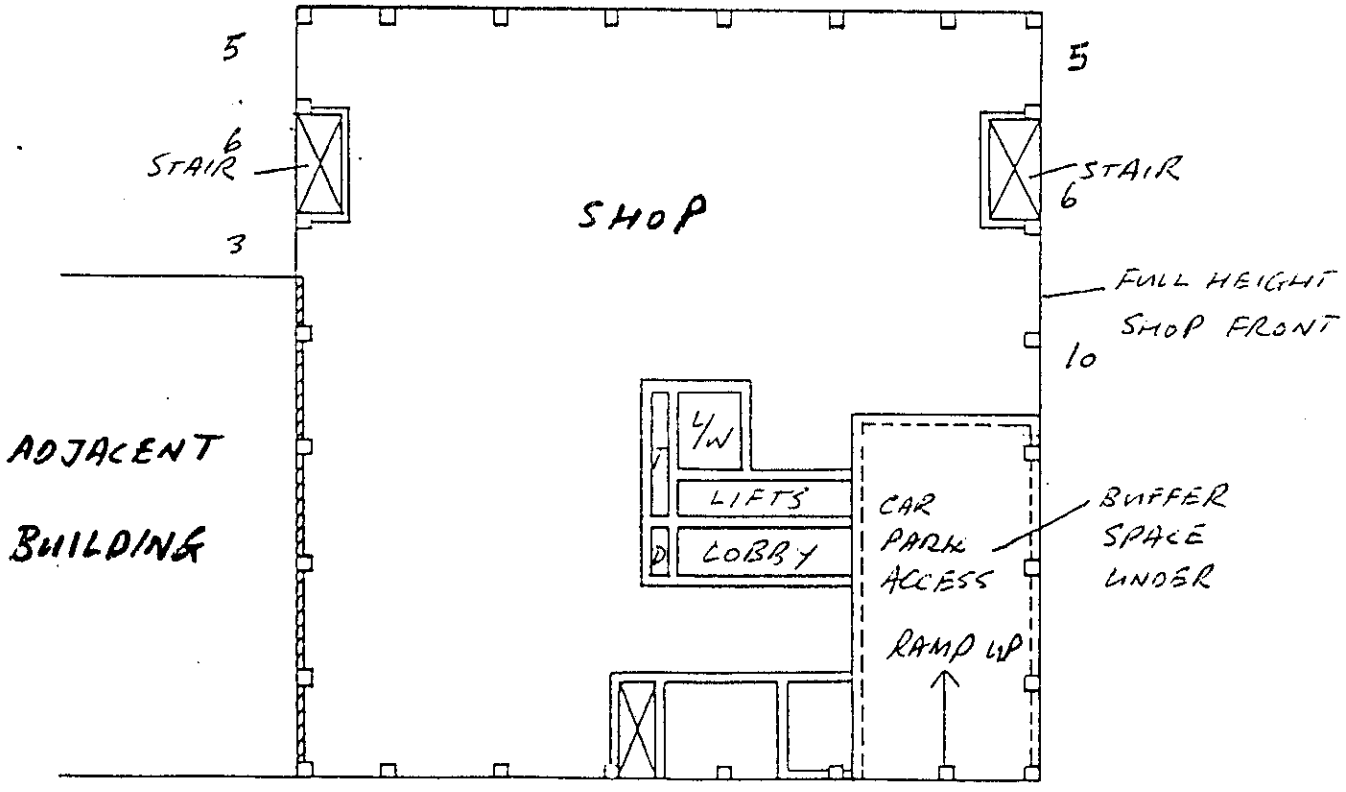
4TH FLOOR



3RD FLOOR

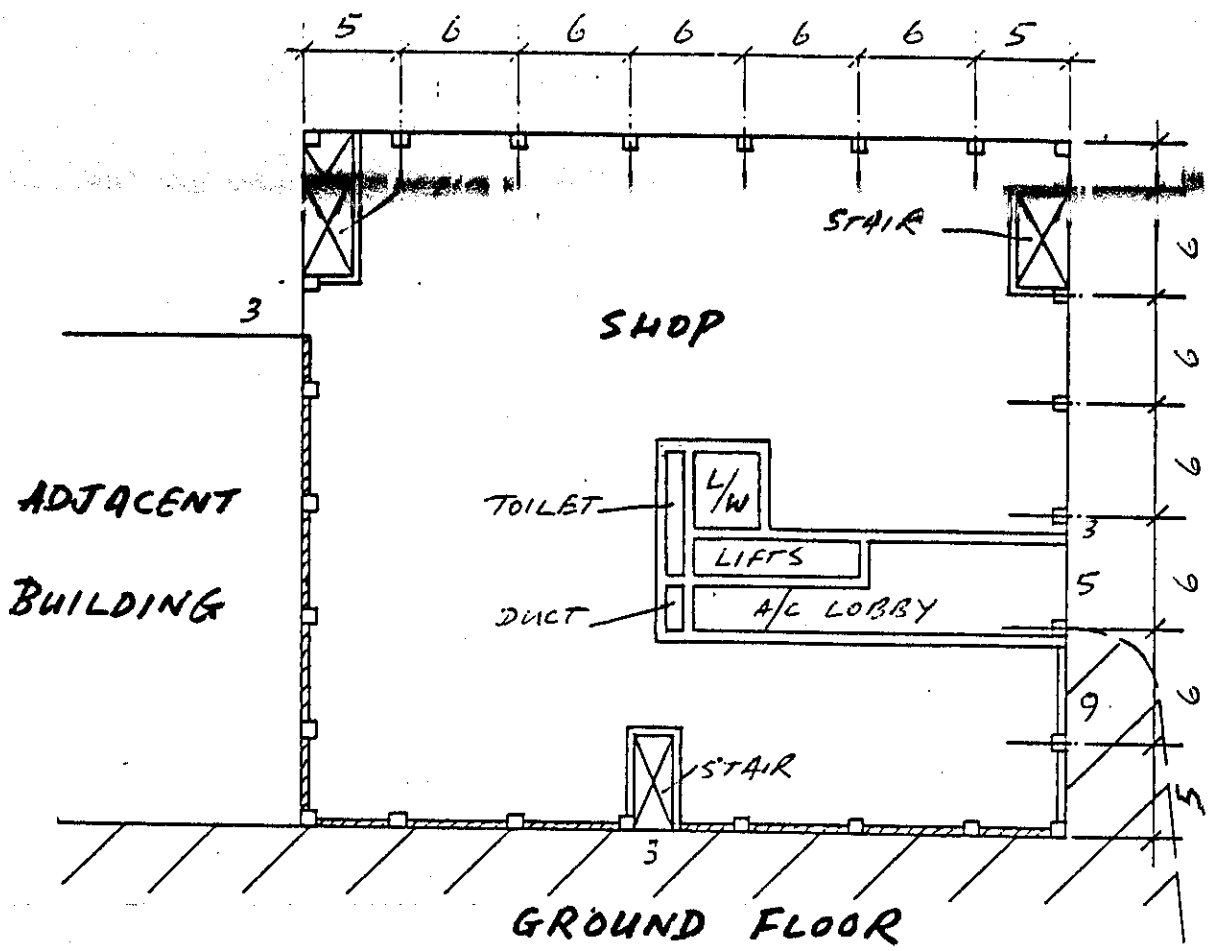


2ND FLOOR

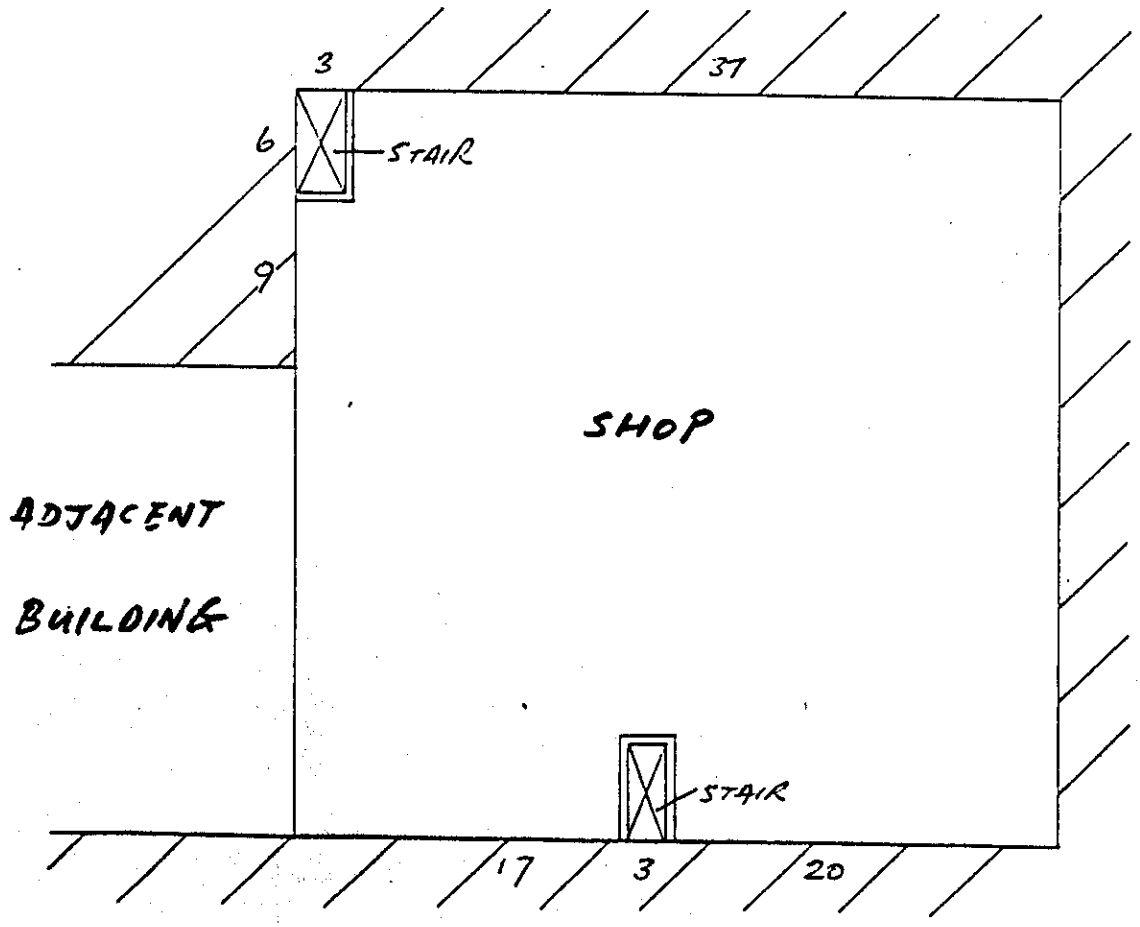


1ST FLOOR

A6

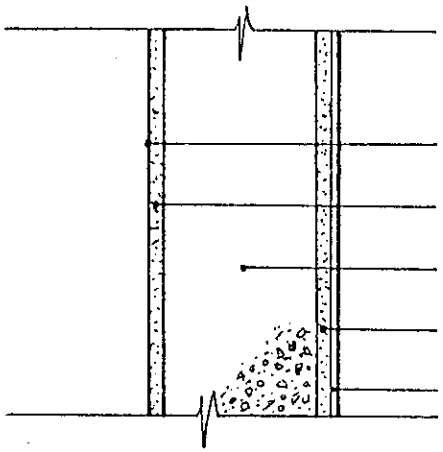


GROUND FLOOR

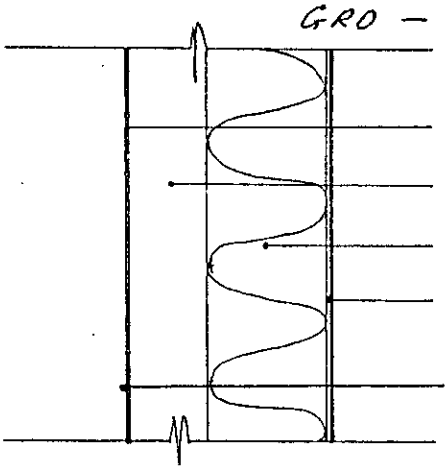


BASEMENT

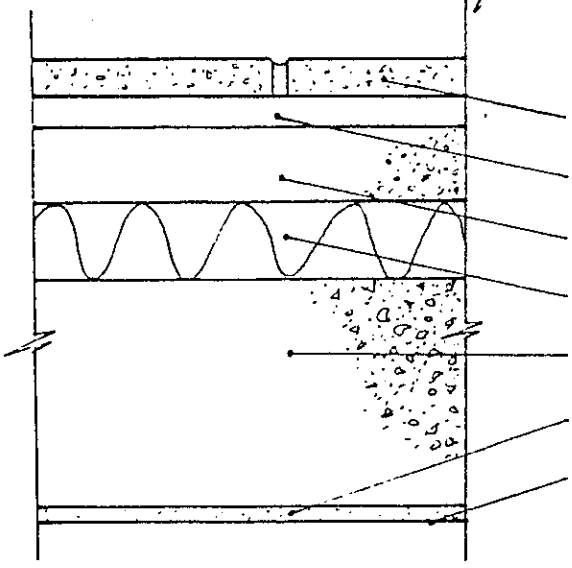
CONSTRUCTION OF WALLS AND ROOF



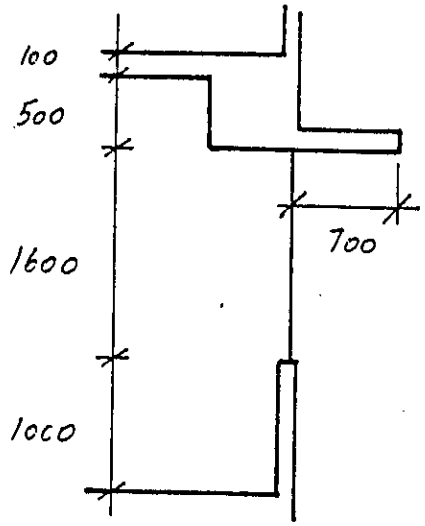
PANEL WALLS
GRO – 15/F.



CURTAIN WALL
16/F – 26/F



ROOF.



TYPICAL SECTION
5TH FLOOR - 26TH FLOOR.

Gross Wall Area Calculations of accountable space

Storey heights : Podium floors are 4.5 m, Tower floors are 3.2 m

All columns 600 x 600 mm All beams 600 x 600 mm

East Elevation

	G/F	9 x 4.5 ÷ 2 + (20 + 5) x 4.5	=	132.75 m²	
P	1/F	(10 + 5) x 4.5	=	67.50 m²	
	2/F - 4/F	Nil	=	-	200.25 m²
	5/F - 14/F	(13 + 16) x 3.2 x 10	=	928.00 m²	
T	15/F	Nil	=	-	
	16/F - 26/F	(13 + 9) x 3.2 x 11	=	774.40 m²	1,702.40 m²

North Elevation

	G/F	37 x 4.5	=	166.50 m²	
P	1/F	40 x 4.5	=	180.00 m²	
	2/F - 4/F	Nil	=	-	346.50 m²
	5/F - 14/F	20 x 3.2 x 10	=	640.00 m²	
T	15/F	Nil	=	-	
	16/F - 26/F	20 x 3.2 x 11	=	704.00 m²	1,344.00 m²

West Elevation

	G/F	29 x 4.5	=	130.50 m²	
P	1/F	(29 + 5) x 4.5	=	153.00 m²	
	2/F - 4/F	Nil	=	-	283.50 m²
	5/F - 14/F	32 x 3.2 x 10	=	1,024.00 m²	
T	15/F	Nil	=	-	
	16/F - 26/F	32 x 3.2 x 11	=	1,126.40 m²	2,150.40 m³

South Elevation

	G/F	Nil	=	-	
P	1/F	17 x 4.5	=	76.50 m²	
	2/F - 4/F	Nil	=	-	76.50 m³
	5/F - 14/F	(10 + 4) x 3.2 x 10	=	448.00 m²	
T	15/F	Nil	=	-	
	16/F - 26/F	(10 + 4) x 3.2 x 11 + 5 x 3.2 x 11	=	668.80 m²	1,116.80 m²

Window Schedule

Building Address Typical Commercial Building

Orientation of Facade	Floor	Glass Thickness m	Type	Sizes and no./floor m	Total area per floor m^2
East	G/F	0.012	plain	(1.7 + 3x5.4 + 4.1) x 3.9	85.80
	1/F	0.012	plain	(3.7 + 5.4 + 4.1) x 3.9	51.48
	2-4/F	Nil	Nil	-	-
	5-14/F	0.008	tinted	(6.1+3.4+1.7+2.7+5.4+6.1) x1.6	40.64
	15/F	Nil	Nil	-	-
	16-26/F	0.008	tinted	(6.1+3.4+1.7+6.1) x 1.6	27.68
North	G/F	0.012	plain	(1.7 + 5x5.4 + 4.1) x 3.9	127.92
	1/F	0.012	plain	(4.1 + 5x5.4 + 4.1) x 3.9	137.28
	2-4/F	Nil	Nil	-	-
	5-14/F	0.008	tinted	(5.1 + 7.4 + 5.1) x 1.6	28.16
	15/F	Nil	Nil	-	-
	16-26/F	0.008	tinted	(5.1 + 7.4 + 5.1) x 1.6	28.16
West	G/F	0.012	plain	2.7 x 3.9	10.53
	1/F	0.012	plain	(2.7 + 4.1) x 3.9	26.52
	2-4/F	Nil	Nil	-	-
	5-14/F	0.008	tinted	(6.1 + 5.4) x 2 x 1.6	36.80
	15/F	Nil	Nil	-	-
	16-26/F	0.008	tinted	(6.1 + 5.1) x 2 x 1.6	36.80
South	G/F	Nil	Nil	-	-
	1/F	0.012	plain	(4.1 + 2 x 5.4) x 3.9	58.11
	2-4/F	Nil	Nil	-	-
	5-14/F	0.008	tinted	(5.1 + 3.4) x 1.6	13.60
	15/F	Nil	Nil	-	-
	16-26/F	0.008	tinted	(5.1+3.4+4.1) x 1.6	20.64

East Elevation (Tower) Gross Wall Area 1,702.40 m²

Wall composite areas

Beams and Column Areas

5/F - 14/F	[0.6 x (10.7 + 2 + 16) + 0.6 (5 x 2.6 + 1 x 2.6 x 0.5*)] 10	=	258.00 m²	
Lift Lobby Wall	0.3 x 3.2 x 10	=	9.60 m²	267.60 m²
15/F	Nil			
16/F - 26/F	[0.6 x (10.7 + 2 + 9) + 0.6 (5 x 2.6 + 1 x 2.6 x 0.5*)] 11	=	237.60 m²	
Lift Lobby wall	0.3 x 3.2 x 11	=	10.56 m²	248.16 m²

Glazing Areas from Window Schedule

5/F - 14/F	40.64 x 10	=	406.40 m²	
15/F	Nil			
16/F - 26/F	27.68 x 11	=	304.48 m²	710.88 m²

Wall Panel Areas

5/F - 14/F	928.00 - (267.60 + 406.40)	=	254.00 m²	
15/F	Nil			
16/F - 26/F	774.40 - (248.16 + 301.48)	=	221.76 m²	475.76 m²

Fenestration between 5/F - 14/F

Total Glazing	=	406.40	
(6.1 + 3.4 + 1.7) x 1.6 x 10	=	179.20	unshaded
		227.20	shaded

Fenestration between 16/F - 26/F

Total Glazing	=	304.48	
(6.1 + 3.4 + 1.7) x 1.6 x 11	=	197.12	unshaded
		107.36	shaded

'U' value of composite columns and beams :-
16/F - 26/F

W_2 for beam and column		Weight
External surface film	Ro = 0.044	
8 mm black glass	$\frac{0.008}{1.05}$ = 0.0076	0.008 x 2500 = 20.00
50 mm Air space resistance (emissivity above 0.5)	Ra = 0.153	
600 mm concrete beam and column	$\frac{0.60}{2.16}$ = 0.278	0.6 x 2400 = 1440.00
10 mm gypsum plaster	$\frac{0.01}{0.38}$ = 0.026	0.01 x 1120 = 11.20
Internal surface film	Ri = 0.299	
Totals	0.808	1471.20 kg/m²

$$U_W = \frac{1}{0.308} = 1.24 \text{ W/m}^2\text{°C}$$

'U' value of composite curtain wall panels :-
16/F - 26/F

W_4 for panel wall		Weight
External surface film	Ro = 0.044	
8 mm black glass	$\frac{0.008}{1.05}$ = 0.0076	0.008 x 2500 = 20.00
75 mm mineral wool felt insulation	$\frac{0.075}{0.039}$ = 1.923	0.075 x 50 = 3.75
50 mm Air space resistance (emissivity above 0.5)	Ra = 0.153	-
2 mm pressed steel panel	$\frac{0.002}{50}$ = 0.00004	0.002 x 7800 = 15.60
Internal surface film	Ri = 0.299	
Totals	2.427	39.35 kg/m²

$$U_W = \frac{1}{2.427} = 0.41 \text{ W/m}^2\text{°C}$$

'U' value of Lift Lobby wall :-
5/F - 14/F

W_5 for beam and column			Weight
External surface film	Ro	= 0.044	
5 mm white mosaic tiles		= 0.003	0.005 x 2500 = 12.50
10 mm cement/sand render		= 0.014	0.01 x 1860 = 18.60
*3.0 m concrete lobby wall	$\frac{3.00}{2.16}$	= 1.389	3.00 x 2440 = 7320.00
Totals		1.450	7351.10 kg/m²

$$U_w = \frac{1}{1.45} = 0.69 \text{ W/m}^2\text{°C}$$

* 3.0 m length assumed for simplicity

'U' value of Lift Lobby wall :-
16/F - 26/F

W_6 for beam and column			Weight
External surface film	Ro	= 0.044	
8 mm black glass		= 0.0076	0.008 x 2500 = 20.00
50 mm Air space resistance (emissivity above 0.5)	Ra	= 0.153	
*3.0 m concrete lobby wall		= 1.389	3.00 x 2440 = 7320.00
Totals		= 1.594	7430.00 kg/m²

$$U_w = \frac{1}{1.594} = 0.63 \text{ W/m}^2\text{°C}$$

Building (Energy Efficiency) Regulation
Form OTTV 1

Calculation of 'U' Value of Composite Wall/Roof
and Details of Other Values

Sheet No. A 1 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data of Opaque *Wall/Roof From table 8

Facade Orientation facing East (Tower) Solar Factor (SF) is 168

*Wall/Roof Code No.		$*W_1/R_1$	$*W_2/R_2$	$*W_3/R_3$	$*W_4/R_4$
Location of Wall/Root		beams & cols E/F-14/F	beams & cols E/F-16/F	Panel walls E/F-14/F	Curtain wall panel E/F-16/F
External Finish Material		white mos. tiles	black glass	white mos. tiles	black glass
Conductivity	W/m°C	1.50	1.05	1.50	1.05
Density	kg/m³	2500	2500	2500	2500
Thickness	m	0.005	0.008	0.005	0.008
Absorptivity	(α)	0.58	1.00	0.58	1.00
Intermediate component		cement render	air gap	cement render	mineral wool
Conductivity	W/m°C	0.72		0.72	0.039
Density	kg/m³	1860		1860	50
Thickness	m	0.01	0.05	0.01	0.075
Intermediate component		r. concrete	r. concrete	r. concrete	air gap
Conductivity	W/m°C	2.16	2.16	2.16	
Density	kg/m³	2400	2400	2400	
Thickness	m	0.60	0.60	0.10	0.05
Intermediate component					
Conductivity	W/m°C				
Density	kg/m³				
Thickness	m				
Intermediate component					
Conductivity	W/m°C				
Density	kg/m³				
Thickness	m	white semi gloss paint			white semi gloss paint
Internal Finish Material			on gypsum plaster		steel panel
Conductivity	W/m°C	0.38	0.38	0.38	50
Density	kg/m³	1120	1120	1120	7800
Thickness	m	0.01	0.01	0.01	0.002
Absorptivity	α	0.30	0.30	0.30	0.30
'U' value of composite *Wall/Root		1.51	1.24	2.32	0.11
Area of *Wall/Root	m²	258.30	237.60	254.00	221.76
Density of composite *Wall/Root	kg/m²	1482	1471	281	39
Equivalent temperature difference	(TD_{EQ})	2.40	2.40	5.01	5.68

*Delete as appropriate

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Building (Energy Efficiency) Regulation
Form BEE 1

Calculation of 'U' Value of Composite Wall/Roof and Details of Other Values

Sheet No. A 1(A) BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data of Opaque *Wall/Roof From table 8

Facade Orientation facing East (Tower) Solar Factor (SF) is 168

*Wall/Root Code No.		$*W_5/R_5$	$*W_6/R_6$	$*W_7/R_7$	$*W_8/R_8$
Location of Wall/Root		[illegible]	[illegible]		
External Finish Material		White mosaic tiles	Black glass		
Conductivity	W/m°C	1.50	1.05		
Density	kg/m^3	2500	2500		
Thickness	m	0.005	0.008		
Absorptivity	(α)	0.58	1.00		
Intermediate component		cement render	air gap		
Conductivity	W/m°C	0.72			
Density	kg/m^3	1860			
Thickness	m	0.01	0.05		
Intermediate component		r. concrete	r. concrete		
Conductivity	W/m°C	2.16	2.16		
Density	kg/m^3	2400	2400		
Thickness	m	3.00	3.00		
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m				
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m				
Internal Finish Material					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m				
[illegible]	α				
'U' value of composite *Wall/Root		0.69	0.51		
Area of *Wall/Root	m^2	4.50	10.26		
Density of composite *Wall/Root	kg/m^2	7351	7340		
Equivalent temperature difference	(TD_{EQ})	2.40	2.40		

*Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 2

Window/Rooflight Schedule

Sheet No. 1 OP Not 1/ ___/___/___

Building address Typical Commercial Building

Physical data on *window/rooflight

Facade Orientation facing East (Tower) Solar Factor (SF) is 168

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight	5/F-14/F shaded	5/F-14/F unshaded	16/F-26/F shaded	16/F-26/F unshaded
Glazing type	tinted	tinted	tinted	tinted
Thickness m	0.008	0.008	0.008	0.008
Shading Coefficient (SC)	0.70	0.70	0.70	0.70
Type of shading device	solid overhang	-	aluminium foils	-
External Shading Multiplier (ESM)	0.7	-	0.7	-
Area of glazing m^2	227.20	179.20	107.36	197.12

Physical data on *window/rooflight

Facade Orientation facing _____ Solar Factor is _____

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight				
Glazing type				
Thickness m				
Shading Coefficient (SC)				
Type of shading device				
External Shading Multiplier (ESM)				
Area of glazing m^2				

* Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 3

Calculation of OTTV of Individual Facade in Building Envelope

Sheet No. C 1 BD Ref 2/___/___/___

Building address Typical Commercial Building

Facade Orientation facing East (Tower) .

Opaque *Walls/Roofs

Code No.	Description	$*A_w/A_r$	U	α	TD_{EQ}	Sum
W1	Beams & Cols 5/F-14/F	258.00	1.51	0.58	2.40	542.30
W2	Beams & Cols 16/F-26/F	237.60	1.24	1.00	2.40	707.10
W3	Panels Walls 5/F-14/F	254.00	2.32	0.58	5.01	1,712.33
W4	Panels Walls 16/F-26/F	221.76	0.41	1.00	6.68	607.36
W5	Lobby Wall 5/F-14/F	9.60	0.69	0.58	2.40	9.22
W6	Lobby Wall 16/F-26/F	10.56	0.63	1.00	2.40	15.97
	Subtotals	991.52	(A)		Heat Gain	3,594.28 (C)

Fenestration

Code No.	Description	$*At_w/At_r$	SC	ESM	SF	Sum
F1	5/F - 14/F shaded	227.20	0.70	0.7	168	18,703.10
F2	5/F - 14/F unshaded	179.20	0.70	-	168	21,073.92
F3	16/F - 26/F shaded	107.36	0.70	0.7	168	8,837.88
F4	16/F - 26/F unshaded	197.12	0.70	-	168	23,181.31
	Subtotals	710.88	(B)		Heat Gain	71,796.21 (D)

Gross Heat Gain (C + D) 75,390.49

Gross Area (A + B) 1,702.10

$$OTTV = \frac{C + D}{A + B} = 44.28 \text{ W/m}^2$$

* Delete as appropriate

First issue 1994

North Elevation (Tower) Gross Wall Area 1,344.00 m²

Wall composite areas

Beams and Column Areas

5/F - 14/F	(0.6 x 20 + 0.6 x 4 x 2.6) 10	=	182.40 m²	
15/F	Nil	=	-	
16/F - 26/F	(0.6 x 20 + 0.6 x 4 x 2.6) 11	=	200.64 m²	383.04 m²

Glazing Areas

5/F - 14/F	28.16 x 10	=	281.60 m²	
15/F	Nil	=	-	
16/F - 26/F	28.16 x 11	=	309.76 m²	591.36 m²

Wall Panel Areas

5/F - 14/F	640.00 - (182.40 + 281.60)	=	176.00 m²	
15/F	Nil	=	-	
16/F - 26/F	704.00 - (200.64 + 309.76)	=	193.60 m²	369.60 m²

Building (Energy Efficiency) Regulation
Form OTTV 1

Calculation of 'U' Value of Composite Wall/Root
and Details of Other Values

Sheet No. A 2 BD Ref 2/ / /

Building address Typical Commercial Building

Physical data of Opaque *Wall/Roof From table 8

Facade Orientation facing North (Tower) Solar Factor (SE) is 104

*Wall/Root Code No.		$*W_1/R_1$	$*W_2/R_2$	$*W_3/R_3$	$*W_4/R_4$
Location of Wall/Roof		Beams & Cols 5/F-14/F	Beams & Cols 16/F-26/F	Panel Walls 5/F-14/F	Curtain Wall panel 16/F-26/F
External Finish Material		White mosaic tiles	black glass	White mosaic tiles	black glass
Conductivity	W/m°C	1.50	1.05	1.50	1.05
Density	kg/m^3	2500	2500	2500	2500
Thickness	m	0.005	0.008	0.005	0.008
Absorptivity	(α)	0.58	1.00	0.58	1.00
Intermediate component		cement render	air gap	cement render	mineral felt
Conductivity	W/m°C	0.72		0.72	0.039
Density	kg/m^3	1860		1860	50
Thickness	m	0.01	0.05	0.01	0.075
Intermediate component		r. concrete	r. concrete	r. concrete	air gap
Conductivity	W/m°C	2.16	2.16	2.16	
Density	kg/m^3	2400	2400	2400	
Thickness	m	0.60	0.60	0.10	0.05
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m				
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m	white semi gloss paint on			white semi gloss paint on
Internal Finish Material			gypsum plaster		steel panel
Conductivity	W/m°C	0.38	0.38	0.38	50
Density	kg/m^3	1120	1120	1120	7800
Thickness	m	0.01	0.01	0.01	0.002
Absorptivity	α	0.30	0.30	0.30	0.30
'U' value of composite *Wall/Root		1.51	1.24	2.32	0.41
Area of *Wall/Root	m^2	182.40	200.64	176.00	193.60
Density of composite *Wall/Root	kg/m^3	1182	1171	281	39
Equivalent temperature difference	(TD_{EQ})	1.70	1.70	2.72	3.38

*Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 2

Window/Rooflight Schedule

Sheet No. B 3 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data on *window/rooflight

Facade Orientation facing North (Tower) Solar Factor (SF) is 104

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight	5/F-14/F	16/F-26/F		
Glazing type	tinted	tinted		
Thickness m	0.008	0.008		
Shading Coefficient (SC)	0.70	0.70		
Type of shading device	solid overhang	aluminium foils		
External Shading Multiplier (ESM)	0.80	0.80		
Area of glazing m^2	281.60	309.76		

Physical data on *window/rooflight

Facade Orientation facing _____ Solar Factor is _____

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight				
Glazing type				
Thickness m				
Shading Coefficient (SC)				
Type of shading device				
External Shading Multiplier (ESM)				
Area of glazing m^2				

* Delete as appropriate

Building (Energy Efficiency) Regulation
Form OTTV 3

Calculation of OTTV of Individual Facade in Building Envelope

Sheet No. C 2 BD Ref 2/___/___/___

Building address Typical Commercial Building

Facade Orientation facing North (Tower).

Opaque *Walls/Roofs

Code No.	Description	$*A_w/A_r$	U	α	TD_{EQ}	Sum
W1	Beams & Col. 5/F-14/F	182.40	1.51	0.58	1.70	271.57
W2	Beams & Col. 16/F-26/F	200.64	1.24	1.00	1.70	422.95
W3	Panels Walls 5/F-14/F	176.00	2.32	0.58	2.72	644.17
W4	Panels Walls 16/F-26/F	193.60	0.41	1.00	3.38	268,29
	Subtotals	752.64	(A)		Heat Gain	1,606.98 (C)

Fenestration

Code No.	Description	$*Af_w/At_r$	SC	ESM	SF	Sum
F1	5/F - 14/F	281.60	0.70	0.80	104	16,400.38
F2	16/F - 26/F	309.76	0.70	0.80	104	18,040.42
	Subtotals	591.36	(B)		Heat Gain	34,440.80 (D)

Gross Heat Gain (C + D) 36,047.78

Gross Area (A + B) 1,344.00

$$OTTV = \frac{C + D}{A + B} = 26.82 \text{ W/m}^2$$

* Delete as appropriate

First issue 1994

West Elevation (Tower)	Gross Wall Area			2,150.40 m²
Wall composite areas				
Beams and Column Areas				
5/F - 14/F	(0.6 x 32 + 0.6 x 6 x 2.6) 10	=	285.60 m²	
15/F	Nil	=	-	
16/F - 26/F	(0.6 x 32 + 0.6 x 6 x 2.6) 11	=	314.16 m²	599.76 m²
Glazing Areas				
5/F - 14/F	36.80 x 10	=	368.00 m²	
15/F	Nil	=	-	
16/F - 26/F	36.80 x 11	=	404.80 m²	772.80 m²
Wall Panel Areas				
5/F - 14/F	1,024.00 - (285.60 + 368.00)	=	370.40 m²	
15/F	Nil	=	-	
16/F - 26/F	1,126.40 - (314.16 + 404.80)	=	407.44 m²	777.84 m²

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Building (Energy Efficiency) Regulation
Form OITV 1

Calculation of 'U' Value of Composite Wall/Roof
and Details of Other Values

Sheet No. A 3 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data of Opaque *Wall/Roof From table 8

Facade Orientation facing West (Tower) Solar Factor (SF) is 175

*Wall/Root Code No.		*W_1/R_1	*W_2/R_2	*W_3/R_3	*W_4/R_4
Location of Wall/Roof		Beams & Cols 5/F-14/F	Beams & Cols 16/F-26/F	Panel Walls 5/F-14/F	Curtain Wall panel 16/F-26/F
External Finish Material		White mosaic tiles	black glass	White mosaic tiles	black glass
Conductivity	W/m°C	1.50	1.05	1.50	1.05
Density	kg/m^3	2500	2500	2500	2500
Thickness	m	0.005	0.008	0.005	0.008
Absorptivity	(α)	0.58	1.00	0.58	1.00
Intermediate component		cement render	air gap	cement render	mineral felt
Conductivity	W/m°C	0.72		0.72	0.039
Density	kg/m^3	1860		1860	50
Thickness	m	0.01	0.05	0.01	0.075
Intermediate component		r. concrete	r. concrete	r. concrete	air gap
Conductivity	W/m°C	2.16	2.16	2.16	
Density	kg/m^3	2400	2400	2400	
Thickness	m	0.60	0.60	0.10	0.05
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m				
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m	white semi gloss paint on			white semi gloss paint on
Internal Finish Material		gypsum plaster			steel panel
Conductivity	W/m°C	0.38	0.38	0.38	50
Density	kg/m^3	1120	1120	1120	7800
Thickness	m	0.01	0.01	0.01	0.002
Absorptivity	α	0.30	0.30	0.30	0.30
'U' value of composite *Wall/Root		1.51	1.24	2.32	0.11
Area of *Wall/Root	m^2	285.60	314.16	370.40	107.44
Density of composite *Wall/Root	kg/m^2	1482	1471	281	39
Equivalent temperature difference	(TD_{EQ})	2.10	2.10	4.35	5.79

*Delete as appropriate

First issue 1994

Building (Energy Efficiency) Regulation
Form OITV 2

Window/Rooflights Schedule

Sheet No. B 3 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data on *window/rooflight

Facade Orientation facing West (Tower) Solar Factor (SF) is 175

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight	5/F-14/F	16/F-26/F		
Glazing type	tinted	tinted		
Thickness m	0.008	0.008		
Shading Coefficient (SC)	0.70	0.70		
Type of shading device	solid overhang	aluminium foils		
External Shading Multiplier (ESM)	0.70	0.70		
Area of glazing m^2	368.00	404.80		

Physical data on *window/rooflight

Facade Orientation facing _____ Solar Factor is _____

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight				
Glazing type				
Thickness m				
Shading Coefficient (SC)				
Type of shading device				
External Shading Multiplier (ESM)				
Area of glazing m^2				

* Delete as appropriate

Building (Energy Efficiency) Regulation
Form OTTV 3

Calculation of OTTV of Individual Facade in Building Envelope

Sheet No. C 3 BD Ref 2/___/___/___

Building address Typical Commercial Building

Facade Orientation facing West (Tower).

Opaque *Walls/Roofs

Code No.	Description	$*A_w/A_r$	U	α	TD_{EQ}	Sum
W1	Beams & Col. 5/F-14/F	285.60	1.51	0.58	2.10	525.27
W2	Beams & Col. 16/F-26/F	314.16	1.24	1.00	2.10	818.07
W3	Panels Walls 5/F-14/F	370.40	2.32	0.58	4.35	2,168.08
W4	Panels Walls 16/F-26/F	407.44	0.41	1.00	5.79	967.22
	Subtotals	1,377.60	(A)		Heat Gain	4,478.64 (C)

Fenestration

Code No.	Description	$*Af_w/Af_r$	SC	ESM	SF	Sum
F1	5/F - 14/F	368.00	0.70	0.70	175	31,556.00
F2	16/F - 26/F	404.80	0.70	0.70	175	34,711.60
	Subtotals	772.80	(B)		Heat Gain	66,267.60 (D)

Gross Heat Gain (C + D) 70,746.24

Gross Area (A + B) 2,150.40

$$OTTV = \frac{C + D}{A + B} = 32.90 \text{ W/m}^2$$

* Delete as appropriate

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South Elevation (Tower) Gross Wall Area 1,116.80 m²

Wall composite areas

Beams and Column Areas

5/F - 14/F	(0.6 x (10+4) + 0.6 x 3 x 2.6) 10	=	130.80 m²	
15/F	Nil			
16/F - 26/F	(0.6 x (10+4) + 0.6 x 3 x 2.6) 11 + (0.6 x 5 + 0.6 x 1 x 2.6) 11	=	194.04 m²	324.84 m²

Glazing Areas

5/F - 14/F	13.60 x 10	=	136.00 m²	
15/F	Nil			
16/F - 26/F	20.64 x 11	=	227.04 m²	363.04 m²

Wall Panel Areas

5/F - 14/F	448.00 - (130.80 + 136.00)	=	181.20 m²	
15/F	Nil			
16/F - 26/F	668.80 - (194.04 + 227.04)	=	247.72 m²	428.92 m²

Fenestration between 16/F - 26/F

Total Glazing =	227.04 m²	
(5.1 + 3.4) x 1.6 x 11 =	149.60 m²	Unshaded
	77.44 m²	Shaded

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Building (Energy Efficiency) Regulation
Form OTTV 1

Calculation of 'U' Value of Composite Wall/Roof
and Details of Other Values

Sheet No. A 4 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data of Opaque *Wall/Roof From table 8 .

Facade Orientation facing South (Tower) Solar Factor (SF) is 191

*Wall/Roof Code No.		$*W_1/R_1$	$*W_2/R_2$	$*W_3/R_3$	$*W_4/R_4$
Location of Wall/Roof		Beams & Cols 5/F-14/F	Beams & Cols 16/F-26/F	Panel Walls 5/F-14/F	Curtain Wall panel 16/F-26/F
External Finish Material		white mosaic tiles	black glass	white mosaic tiles	black glass
Conductivity	W/m°C	1.50	1.05	1.50	1.05
Density	kg/m^3	2500	2500	2500	2500
Thickness	m	0.005	0.008	0.005	0.008
Absorptivity	(α)	0.58	1.00	0.58	1.00
Intermediate component		cement render	air gap	cement render	mineral felt
Conductivity	W/m°C	0.72		0.72	0.039
Density	kg/m^3	1860		1860	50
Thickness	m	0.01	0.05	0.01	0.075
Intermediate component		r. concrete	r. concrete	r. concrete	air gap
Conductivity	W/m°C	2.16	2.16	2.16	
Density	kg/m^3	2400	2400	2400	
Thickness	m	0.60	0.60	0.10	0.05
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m				
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m	white semi gloss paint on			white semi gloss paint on
Internal Finish Material		gypsum plaster			steel panel
Conductivity	W/m°C	0.38	0.38	0.38	50
Density	kg/m^3	1120	1120	1120	7800
Thickness	m	0.01	0.01	0.01	0.002
Absorptivity	α	0.30	0.30	0.30	0.30
'U' value of composite *Wall/Roof		1.51	1.24	2.32	0.41
Area of *Wall/Roof	m^2	130.30	194.04	181.20	247.72
Density of composite *Wall/Roof	kg/m^2	1482	1471	281	39
Equivalent temperature difference	(TD_{EQ})	1.40	1.40	3.60	5.01

*Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 2

Window/Rooflight Schedule

Sheet No. B 4 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data on *window/rooflight

Facade Orientation facing South (Tower) Solar Factor (SF) is 191

Window/Rooflight Code No.	*F_1/RL_1	*F_2/RL_2	*F_3/RL_3	*F_4/RL_4
Location of *Window/ Rooflight	5/F-14/F	16/F-26/F	16/F-26/F	
Glazing type	tinted	reflective	tinted	
Thickness m	0.008	0.006	0.008	
Shading Coefficient (SC)	0.70	0.40	0.70	
Type of shading device			aluminium foils	
External Shading Multiplier (ESM)			0.70	
Area of glazing m^2	136.00	149.60	77.44	

Physical data on *window/rooflight

Facade Orientation facing _____ Solar Factor is _____

Window/Rooflight Code No.	*F_1/RL_1	*F_2/RL_2	*F_3/RL_3	*F_4/RL_4
Location of *Window/ Rooflight				
Glazing type				
Thickness m				
Shading Coefficient (SC)				
Type of shading device				
External Shading Multiplier (ESM)				
Area of glazing m^2				

* Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 3

Calculation of OTTV of Individual Facade in Building Envelope

Sheet No. C 4 BD Ref 2/___/___/___

Building address Typical Commercial Building

Facade Orientation facing South (Tower) .

Opaque *Walls/Roofs

Code No.	Description	$*A_w/A_r$	U	α	TD_{EQ}	Sum
W1	Beams & Col. 5/F-14/F	130.80	1.51	0.58	1.40	160.38
W2	Beams & Col. 16/F-26/F	194.04	1.24	1.00	1.40	336.85
W3	Panels Walls 5/F-14/F	181.20	2.32	0.58	3.60	877.76
W4	Panels Walls 16/F-26/F	247.72	0.41	1.00	5.01	508.84
	Subtotals	753.76	(A)		Heat Gain	1,883.83 (C)

Fenestration

Code No.	Description	$*Af_w/Af_r$	SC	ESM	SF	Sum
F1	5/F - 14/F unshaded	136.00	0.70		191	18,183.20
F2	16/F - 26/F unshaded	149.60	0.40		191	11,429.44
F3	16/F - 26/F shaded	77.44	0.70	0.70	191	7,247.61
	Subtotals	363.04	(B)		Heat Gain	36,860.25 (D)

Gross Heat Gain (C + D) 38,744.08

Gross Area (A + B) 1,116.80

$$OTTV = \frac{C + D}{A + B} = 34.69 \text{ W/m}^2$$

* Delete as appropriate

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Accountable Roof Areas

Roof

Gross Area = 15 x 9 + 9 x 13 + 11 x 4 + 10 x 6 + 4 x 6 + 7 x 9 = 443.00 m²

Glazed area = 7 x 8.4 = 58.80 m²

Beam area = 0.6 (32 + 14.4 + 14.4 + 8.4 + 8.4 + 9.4 + 9.4 + 4.0 + 13 + 3.4) = 70.08 m²

Panel area = 443.00 - (70.08 + 58.80) = 314.12 m²

15/F

Gross Area = 5 x 7 = 35.00 m²

Glazed area = Nil

Beam area = 0.6 (7 + 4.4) = 6.84 m²

Panel area = 35.00 - 6.84 = 28.16 m²

'U' value of composite roof beams (and panels) :-
15/F and Roof

R_1 (R_2) for beams (panels)	r	Weight
External surface film	Ro = 0.055	
25 mm concrete tiles	$\frac{0.025}{1.10}$ = 0.023	0.025 x 2100 = 52.50
20 mm asphalt	$\frac{0.02}{1.15}$ = 0.017	0.02 x 2350 = 47.00
50 mm cement/sand screed	$\frac{0.05}{0.72}$ = 0.069	0.05 x 1860 = 93.00
50 mm polystyrene insulation	$\frac{0.05}{0.034}$ = 1.471	0.05 x 25 = 1.25
600 mm r. concrete	= 0.278	0.6 x 2400 = 1440.00
10 mm gypsum plaster	= 0.026	0.01 x 1120 = 11.20
Internal surface film	Ri = 0.801	
Totals	2.740	1644.95 kg/m

$$U_R = \frac{1}{2.740} = 0.37 \quad W/m^2°C$$

for 150 mm slab 'U' value is 0.40 $W/m^2°C$ and weight = 564.95 kg/m

Building (Energy Efficiency) Regulation
Form OTTV 1

Calculation of 'U' Value of Composite Wall/Roof
and Details of Other Values

Sheet No. A 5 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data of Opaque *Wall/Roof From table 8

Facade Orientation facing Roof (Tower) Solar Factor (SF) is 264

*Wall/Roof Code No.		$*W_1/R_1$	$*W_2/R_2$	$*W_3/R_3$	$*W_4/R_4$
Location of Wall/Roof		Tower Roof Beams	Tower Roof Panels	15/F Beams	15/F Panels
External Finish Material		concrete tiles	concrete tiles	concrete tiles	concrete tiles
Conductivity	W/m°C	1.10	1.10	1.10	1.10
Density	kg/m^3	2100	2100	2100	2100
Thickness	m	0.025	0.025	0.025	0.025
Absorptivity	(α)	0.65	0.65	0.65	0.65
Intermediate component		asphalt	asphalt	asphalt	asphalt
Conductivity	W/m°C	1.15	1.15	1.15	1.15
Density	kg/m^3	2350	2350	2350	2350
Thickness	m	0.02	0.02	0.02	0.02
Intermediate component		cement/sand screed			
Conductivity	W/m°C	0.72	0.72	0.72	0.72
Density	kg/m^3	1860	1860	1860	1860
Thickness	m	0.05	0.05	0.05	0.05
Intermediate component		expanded polystyrene			
Conductivity	W/m°C	0.034	0.034	0.034	0.034
Density	kg/m^3	25	25	25	25
Thickness	m	0.05	0.05	0.05	0.05
Intermediate component		r. concrete	r. concrete	r. concrete	r. concrete
Conductivity	W/m°C	2.16	2.16	2.16	2.16
Density	kg/m^3	2400	2400	2400	2400
Thickness	m	0.60	0.15	0.60	0.15
Internal Finish Material		white semi gloss paint on gypsum plaster			
Conductivity	W/m°C	0.38	0.38	0.38	0.38
Density	kg/m^3	1120	1120	1120	1120
Thickness	m	0.01	0.01	0.01	0.01
Absorptivity	α	0.30	0.30	0.30	0.30
'U' value of composite *Wall/Roof		0.37	0.40	0.37	0.40
Area of *Wall/Roof	m^2	70.08	314.12	6.34	28.16
Density of composite *Wall/Roof	kg/m^2	1645	565	1645	565
Equivalent temperature difference	(TD_{EQ})	7.90	9.75	7.90	9.75

*Delete as appropriate

Building (Energy Efficiency) Regulation
Form OTTV 2

Window/Rooflight Schedule

Sheet No. B 5 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data on *window/rooflight

Facade Orientation facing Roof (Tower) Solar Factor (SF) is 264

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight	Roof			
Glazing type	tinted			
Thickness m	0.006			
Shading Coefficient (SC)	0.70			
Type of shading device	-			
External Shading Multiplier (ESM)				
Area of glazing m^2	58.80			

Physical data on *window/rooflight

Facade Orientation facing _____ Solar Factor is _____

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight				
Glazing type				
Thickness m				
Shading Coefficient (SC)				
Type of shading device				
External Shading Multiplier (ESM)				
Area of glazing m^2				

* Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 3

Calculation of OTTV of Individual Facade in Building Envelope

Sheet No. C 5 BD Ref 2/___/___/___

Building address Typical Commercial Building

Facade Orientation facing Roof (Tower) .

Opaque *Walls/Roofs

Code No.	Description	$*A_w/A_r$	U	α	TD_{EQ}	Sum
R_1	Tower Roof Beams	70.08	0.37	0.65	7.90	133.15
R_2	Tower Roof Panels	314.12	0.40	0.65	9.75	796.29
	Subtotals	384.20	(A)		Heat Gain	929.44 (C)

Fenestration

Code No.	Description	$*Af_w/Af_r$	SC	ESM	SF	Sum
RL_1	Rooflight	58.80	0.70	-	264	10,866.24
	Subtotals	58.80	(B)		Heat Gain	10,866.24 (D)

Gross Heat Gain (C + D) 11,795.68

Gross Area (A + B) 443.00

$$OTTV = \frac{C + D}{A + B} = 26.63 \text{ W/m}^2$$

* Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 3

Calculation of OTTV of Individual Facade in Building Envelope

Sheet No. C 5 (A) BD Ref 2/___/___/___

Building address Typical Commercial Building

Facade Orientation facing Roof (15/F).

Opaque *Walls/Roofs

Code No.	Description	$*A_w/A_r$	U	α	TD_{EQ}	Sum
R_3	15/F Beams	6.84	0.37	0.65	7.90	13.00
R_4	15/F Panels	28.16	0.40	0.65	9.75	71.39
	Subtotals	35.00	(A)		Heat Gain	84.39 (C)

Fenestration

Code No.	Description	$*Af_w/Af_r$	SC	ESM	SF	Sum
	Subtotals		(B)		Heat Gain	(D)

Gross Heat Gain (C + D) 84.39

Gross Area (A + B) 35.00

$$OTTV = \frac{C + D}{A + B} = 2.41 \text{ W/m}^2$$

* Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 4

Summary of OTTV of Building Envelope

Sheet No. D 1 BD Ref. 2/___/___/___

Building address Typical Commercial Building

Total Envelope Heat Gain (* Tower/~~Podium~~)

Facade Orientation	Gross Area from Form OTTV 3	Gross Heat Gain from Form OTTV3
a. East	1,702.00	75,389.98
b. North	1,344.00	36,047.78
c. West	2,150.00	70,746.24
d. South	1,116.00	38,744.08
e.		
f.		
Subtotal	6,313.20 (E)	220,928.08 (G)
Roof		
a. Main	443.00	11,795.68
b. 15/F	35.00	84.39
Subtotal	(F)	(H)

* Tower/~~Podium~~ Walls OTTV = $\frac{G}{E}$ = 34.99 W/m²

* Tower/~~Podium~~ Roofs OTTV = $\frac{H}{F}$ = 26.63 W/m² (main roof)

2.41 W/m² (15/F roof)

* Delete as appropriate

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East Elevation (Podium) Gross Wall Area 200.25 m²

Wall Composite Areas

Beam and Column Areas

G/F	0.6 (29+5) + 0.6 (4x3.9 + 3 x 3.9 x 0.5*)	= 33.27 m²	
1/F	0.6 (10+5) + 0.6 (2x3.9 + 2 x 3.9 x 0.5*)	= 16.02 m²	
2/F - 4/F	Nil	= -	49.29 m²

Glazing Areas

G/F	85.50 m²	= 85.80 m²	
1/F	51.48 m²	= 51.48 m²	
2/F - 4/F	Nil	= -	137.28 m²

Panel Areas

G/F	132.75 - (33.27 + 85.80)	= 13.68 m²	
1/F	67.50 - (16.02 + 51.48)	= -	13.68 m²

* Only half column considered to contribute

'U' value of composite wall of columns and beams :-

G/F & 1/F

W_1 for beam and column		Weight
external surface film	Ro = 0.044	
5 mm white mosaic tiles	$\frac{0.005}{1.5}$ = 0.003	0.005 x 2500 = 12.50
10 mm cement/sand render	$\frac{0.01}{0.72}$ = 0.014	0.01 x 1860 = 18.60
600 mm concrete beam & column	$\frac{0.60}{2.16}$ = 0.278	0.60 x 2400 = 1440.00
10 mm gypsum plaster	$\frac{0.01}{0.38}$ = 0.026	0.01 x 1120 = 11.20
Internal surface film (emissivity below 0.5)	Ri = 0.299	
Totals	0.66	1482.30 kg/m²

$U_W = \frac{1}{0.66} = 1.51$ W/m²°C

(for west podium wall without tiles or render 'U' value is 1.54 W/m²°C)

'U' value of composite wall panels :-

G/F & 1/F

W_2 for wall panel		Weight
external surface film	Ro = 0.044	
5 mm white mosaic tiles	= 0.003	0.005 x 2500 = 12.50
10 mm cement/sand render	= 0.014	0.01 x 1860 = 18.60
100 mm concrete panel	$\frac{0.1}{2.16}$ = 0.046	0.10 x 2400 = 240.00
10 mm gypsum plaster	= 0.026	0.01 x 1120 = 11.20
Internal surface film	Ri = 0.299	
Totals	0.432	281.04 kg/m²

$U_W = \frac{1}{0.432} = 2.32$ W/m²°C

(for west podium wall without tiles and render 'U' value is 2.41 W/m²°C)

Building (Energy Efficiency) Regulation
Form OTTV 1

Calculation of 'U' Value of Composite Wall/Roof
and Details of Other Values

Sheet No. A 6 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data of Opaque *Wall/Roof From table 8

Facade Orientation facing East (Podium) Solar Factor (SF) is 168

*Wall/Roof Code No.		*W_1/R_1	*W_2/R_2	*W_3/R_3	*W_4/R_4
Location of Wall/Roof		Beams & Cols. G/F & 1/F	Panels G/F & 1/F		
External Finish Material		white mosaic tiles			
Conductivity	W/m°C	1.50	1.50		
Density	kg/m^3	2500	2500		
Thickness	m	0.005	0.005		
Absorptivity	(α)	0.58	0.58		
Intermediate component		cement render			
Conductivity	W/m°C	0.72	0.72		
Density	kg/m^3	1860	1860		
Thickness	m	0.01	0.01		
Intermediate component		Reinforced concrete			
Conductivity	W/m°C	2.16	2.16		
Density	kg/m^3	2400	2400		
Thickness	m	0.60	0.10		
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m				
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m	white semi gloss paint			
Internal Finish Material		on gypsum plaster			
Conductivity	W/m°C	0.38	0.38		
Density	kg/m^3	1120	1120		
Thickness	m	0.01	0.01		
Absorptivity	α	0.30	0.30		
'U' value of composite *Wall/Roof		1.51	2.32		
Area of *Wall/Roof	m^2	19.29	13.68		
Density of composite *Wall/Roof	kg/m^2	1482	281		
Equivalent temperature difference	(TD_{EQ})	2.40	5.01		

*Delete as appropriate

Building (Energy Efficiency) Regulation
Form OTTV 2

Window/Rooflight Schedule

Sheet No. B 6 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data on *window/rooflight

Facade Orientation facing East (Podium) Solar Factor (SF) is 168

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight	G/F&1/F			
Glazing type	plain			
Thickness m	0.012			
Shading Coefficient (SC)	0.90			
Type of shading device	-			
External Shading Multiplier (ESM)	-			
Area of glazing m^2	137.28			

Physical data on *window/rooflight

Facade Orientation facing _____ Solar Factor is _____

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight				
Glazing type				
Thickness m				
Shading Coefficient (SC)				
Type of shading device				
External Shading Multiplier (ESM)				
Area of glazing m^2				

* Delete as appropriate

Building (Energy Efficiency) Regulation
Form OTTV 3

Calculation of OTTV of Individual Facade in Building Envelope

Sheet No. C 6 BD Ref 2/___/___/___

Building address Typical Commercial Building

Facade Orientation facing East (Podium) .

Opaque *Walls/Roofs

Code No.	Description	$*A_w/A_r$	U	α	TD_{EQ}	Sum
W1	Beams & Col. G/F&1/F	49.29	1.51	0.58	2.40	103.60
W2	Panel G/F&1/F	13.68	2.32	0.58	5.01	92.22
	Subtotals	**62.97**	**(A)**		**Heat Gain**	**195.82** **(C)**

Fenestration

Code No.	Description	$*Af_w/Af_r$	SC	ESM	SF	Sum
F1	G/F & 1/F	137.28	0.90	-	168	20,756.74
	Subtotals	137.28	(B)		Heat Gain	20,756.74 (D)

Gross Heat Gain (C + D) 20,952.56

Gross Area (A + B) 200.25

$$OTTV = \frac{C + D}{A + B} = 104.63 \text{ W/m}^2$$

* Delete as appropriate

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North Elevation (Podium)	Gross Wall Area			346.50 m²
Wall Composite Areas				
Beams and Column Areas				
G/F	0.6 x 37 + 0.6 x 7 x 3.9	=	38.58 m²	
1/F	0.6 x 40 + 0.6 x 8 x 3.9	=	42.72 m²	81.30 m²
Glazing Areas				
G/F	127.92	=	127.92 m²	
1/F	137.28	=	137.28 m²	265.20 m²
Panel Areas				
G/F	166.50 - (38.58 + 127.92)	=	0	
1/F	180.00 - (42.72 + 137.28)	=	0	0

Building (Energy Efficiency) Regulation
Form OTTV 1

Calculation of 'U' Value of Composite Wall/Roof and Details of Other Values

Sheet No. A 7 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data of Opaque *Wall/Roof From table 8

Facade Orientation facing North (Podium) Solar Factor (SF) is 104

*Wall/Roof Code No.		*W_1/R_1	*W_2/R_2	*W_3/R_3	*W_4/R_4
Location of Wall/Roof		Beams & Cols G/F & 1/F			
External Finish Material		white mosaic tiles			
Conductivity	W/m°C	1.50			
Density	kg/m^3	2500			
Thickness	m	0.005			
Absorptivity	(α)	0.58			
Intermediate component		cement render			
Conductivity	W/m°C	0.72			
Density	kg/m^3	1860			
Thickness	m	0.01			
Intermediate component		Reinforced concrete			
Conductivity	W/m°C	2.16			
Density	kg/m^3	2400			
Thickness	m	0.60			
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m				
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m	white semi gloss paint			
Internal Finish Material		on gypsum plaster			
Conductivity	W/m°C	0.38			
Density	kg/m^3	1120			
Thickness	m	0.01			
Absorptivity	α	0.30			
'U' value of composite *Wall/Roof		1.51			
Area of *Wall/Roof	m^2	81.30			
Density of composite *Wall/Roof	kg/m^2	1482			
Equivalent temperature difference	(TD_{EQ})	1.70			

*Delete as appropriate

Building (Energy Efficiency) Regulation
Form OTTV 2

Window/Rooflight Schedule

Sheet No. B 7 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data on *window/rooflight

Facade Orientation facing North (Podium) Solar Factor (SF) is 104

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight	G/F&1/F			
Glazing type	plain			
Thickness m	0.012			
Shading Coefficient (SC)	0.90			
Type of shading device	-			
External Shading Multiplier (ESM)	-			
Area of glazing m^2	265.20			

Physical data on *window/rooflight

Facade Orientation facing _____ Solar Factor is _____

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight				
Glazing type				
Thickness m				
Shading Coefficient (SC)				
Type of shading device				
External Shading Multiplier (ESM)				
Area of glazing m^2				

* Delete as appropriate

Building (Energy Efficiency) Regulation
Form OTTV 3

Calculation of OTTV of Individual Facade in Building Envelope

Sheet No. C 7 BD Ref 2/___/___/___

Building address Typical Commercial Building

Facade Orientation facing North (Podium) .

Opaque *Walls/Roofs

Code No.	Description	$*A_w/A_r$	U	α	TD_{EQ}	Sum
W1	Beams & Cols. G/F&1/F	81.30	1.51	0.58	1.70	121.04
	Subtotals	81.30	(A)		Heat Gain	121.04 (C)

Fenestration

Code No.	Description	$*Af_w/Af_r$	SC	ESM	SF	Sum
F1	G/F & 1/F	265.20	0.90	-	104	24,822.72
	Subtotals	265.20	(B)		Heat Gain	24,822.72 (D)

Gross Heat Gain (C + D) 24,943.76

Gross Area (A + B) 346.50

$$OTTV = \frac{C + D}{A + B} = 71.99 \ W/m^2$$

* Delete as appropriate

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West Elevation (Podium)	Gross Wall Area			283.50 m²

Wall Composite Areas

Beams and Column Areas

G/F	0.6 x 29 + 0.6 (5 x 3.9 + 1 x 3.9 x 0.5*)	=	30.27 m²	
1/F	0.6 (29 + 5) + 0.6 (6 x 3.9 + 2 x 3.9 x 0.5*)	=	36.78 m²	67.05 m²

Glazing Areas

G/F	10.53	=	10.53 m²	
1/F	26.52	=	26.52 m²	37.05 m²

Panel Areas

G/F	130.50 - (30.27 + 10.53)	=	89.70 m²	
1/F	153.00 - (36.78 + 26.52)	=	89.70 m²	179.40 m²

* Only half column considered to contribute

Beam and Column Areas

G/F	Total Area	=	30.27 m²
With mosaic tiles	0.6 x 3 + 0.6 (0.5 x 3.9)	=	2.97 m²
Area without mosaic tiles		=	27.30 m²

1/F	Total Area	=	36.78 m²
With mosaic tiles	0.6 x 8 + 0.6 (2 x 3.9)	=	9.48 m²
Area without mosaic tiles		=	27.30 m²

All Panel Areas are without mosaic tiles

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Building (Energy Efficiency) Regulation
Form OTTV 1

Calculation of 'U' Value of Composite Wall/Roof
and Details of Other Values

Sheet No. A 8 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data of Opaque *Wall/Roof From table 8

Facade Orientation facing West (Podium) Solar Factor (SF) is 175

*Wall/Roof Code No.		*W_1/R_1	*W_2/R_2	*W_3/R_3	*W_4/R_4
Location of Wall/Roof		Beams & Cols G/F & 1/F	Beams & Cols G/F & 1/F	Panels G/F & 1/F	
External Finish Material		white mosaic tiles	Reinforced Concrete		
Conductivity	W/m°C	1.50	2.16	2.16	
Density	kg/m^3	2500	2400	2400	
Thickness	m	0.005	0.60	0.10	
Absorptivity	(α)	0.58	0.65	0.65	
Intermediate component		cement render			
Conductivity	W/m°C	0.72			
Density	kg/m^3	1860			
Thickness	m	0.01			
Intermediate component		Reinforced concrete			
Conductivity	W/m°C	2.16			
Density	kg/m^3	2400			
Thickness	m	0.60			
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m				
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m	white semi gloss paint			
Internal Finish Material		on gypsum plaster			
Conductivity	W/m°C	0.38	0.38	0.38	
Density	kg/m^3	1120	1120	1120	
Thickness	m	0.01	0.01	0.01	
Absorptivity	α	0.30	0.30	0.30	
'U' value of composite *Wall/Roof		1.51	1.54	2.41	
Area of *Wall/Roof	m^2	12.45	54.60	179.40	
Density of composite *Wall/Roof	kg/m^2	1482	1451	281	
Equivalent temperature difference	(TD_{EQ})	2.10	2.10	4.35	

*Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 2

Window/Rooflight Schedule

Sheet No. B 8 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data on *window/rooflight

Facade Orientation facing West (Podium) Solar Factor (SF) is 175

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight	G/F&1/F			
Glazing type	plain			
Thickness m	0.012			
Shading Coefficient (SC)	0.90			
Type of shading device	-			
External Shading Multiplier (ESM)	-			
Area of glazing m^2	37.05			

Physical data on *window/rooflight

Facade Orientation facing _____ Solar Factor is _____

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight				
Glazing type				
Thickness m				
Shading Coefficient (SC)				
Type of shading device				
External Shading Multiplier (ESM)				
Area of glazing m^2				

* Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 3

Calculation of OTTV of Individual Facade in Building Envelope

Sheet No. C 8 BD Ref 2/___/___/___

Building address Typical Commercial Building

Facade Orientation facing West (Podium) .

Opaque *Walls/Roofs

Code No.	Description	$*A_w/A_r$	U	α	TD_{EQ}	Sum
W1	Beams & Cols. G/F&1/F	12.45	1.51	0.58	2.10	22.90
W2	Beams & Cols. G/F&1/F	54.60	1.54	0.65	2.10	114.77
W3	Panel G/F&1/F	179.40	2.41	0.65	4.35	1,222.48
	Subtotals	246.45	(A)		Heat Gain	1,360.15 (C)

Fenestration

Code No.	Description	$*Af_w/Af_r$	SC	ESM	SF	Sum
F1	G/F & 1/F	37.05	0.90	-	175	5,835.38
	Subtotals	37.05	(B)		Heat Gain	5,835.38 (D)

Gross Heat Gain (C + D) 7,195.53

Gross Area (A + B) 283.50

$$OTTV = \frac{C + D}{A + B} = 25.38 \text{ W/m}^2$$

* Delete as appropriate

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South Elevation (Podium)	Gross Wall Area			76.50 m²
Wall Composite Areas				
Beams and Column Areas				
G/F	-	=	-	
1/F	0.6 x 17 + 0.6 (3 x 3.9 + 1 x 3.9 x 0.5*)	=	18.39 m²	18.39 m²
Glazing Areas				
G/F	-	=	-	
1/F	58.11	=	58.11 m²	58.11 m²
Panel Areas				
G/F	-	=	-	
1/F	76.50 - (18.39 + 58.11)	=	0	0

* Only half column considered to contribute

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Building (Energy Efficiency) Regulation
Form OTTV 1

Calculation of 'U' Value of Composite Wall/Roof
and Details of Other Values

Sheet No. A 9 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data of Opaque *Wall/Roof From table 8

Facade Orientation facing South (Podium) Solar Factor (SF) is 191

*Wall/Roof Code No.		*W_1/R_1	*W_2/R_2	*W_3/R_3	*W_4/R_4
Location of Wall/Roof		Beams & Cols G/F & 1/F			
External Finish Material		white mosaic tiles			
Conductivity	W/m°C	1.50			
Density	kg/m^3	2500			
Thickness	m	0.005			
Absorptivity	(α)	0.58			
Intermediate component		cement render			
Conductivity	W/m°C	0.72			
Density	kg/m^3	1860			
Thickness	m	0.01			
Intermediate component		Reinforced concrete			
Conductivity	W/m°C	2.16			
Density	kg/m^3	2400			
Thickness	m	0.60			
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m				
Intermediate component					
Conductivity	W/m°C				
Density	kg/m^3				
Thickness	m	white semi gloss paint			
Internal Finish Material		on gypsum plaster			
Conductivity	W/m°C	0.38			
Density	kg/m^3	1120			
Thickness	m	0.01			
Absorptivity	α	0.30			
'U' value of composite *Wall/Roof		1.51			
Area of *Wall/Roof	m^2	18.39			
Density of composite *Wall/Roof	kg/m^2	1482			
Equivalent temperature ditterence	(TD_{EQ})	1.40			

*Delete as appropriate

Building (Energy Efficiency) Regulation
Form OTTV 2

Window/Rooflight Schedule

Sheet No. B 9 BD Ref 2/___/___/___

Building address Typical Commercial Building

Physical data on *window/rooflight

Facade Orientation facing South (Podium) Solar Factor (SF) is 191

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight	1/F			
Glazing type	plain			
Thickness m	0.012			
Shading Coefficient (SC)	0.90			
Type of shading device	-			
External Shading Multiplier (ESM)	-			
Area of glazing m^2	58.11			

Physical data on *window/rooflight

Facade Orientation facing _____ Solar Factor is _____

Window/Rooflight Code No.	$*F_1/RL_1$	$*F_2/RL_2$	$*F_3/RL_3$	$*F_4/RL_4$
Location of *Window/ Rooflight				
Glazing type				
Thickness m				
Shading Coefficient (SC)				
Type of shading device				
External Shading Multiplier (ESM)				
Area of glazing m^2				

* Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 3

Calculation of OTTV of Individual Facade in Building Envelope

Sheet No. C 9 BD Ref 2/___/___/___

Building address Typical Commercial Building

Facade Orientation facing South (Podium) .

Opaque *Walls/Roofs

Code No.	Description	*A_w/A_r	U	α	TD_{EQ}	Sum
W1	Beams and Cols G/F&1/F	18.39	1.51	0.58	1.40	22.55
	Subtotals	18.39	(A)		Heat Gain	22.55 (C)

Fenestration

Code No.	Description	*Af_w/Af_r	SC	ESM	SF	Sum
F1	1/F	58.11	0.90	-	191	9,989.11
	Subtotals	58.11	(B)		Heat Gain	9,989.11 (D)

Gross Heat Gain (C + D) 10,011.66

Gross Area (A + B) 76.50

$$OTTV = \frac{C + D}{A + B} = 130.87 \text{ W/m}^2$$

* Delete as appropriate

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Building (Energy Efficiency) Regulation
Form OTTV 4

Summary of OTTV of Building Envelope

Sheet No. D 2 BD Ref. 2/___/___/___

Building address Typical Commercial Building

Total Envelope Heat Gain (* ~~Tower~~/Podium)

Facade Orientation	Gross Area from Form OTTV 3	Gross Heat Gain from Form OTTV3
a. East	200.25	20,952.56
b. North	346.50	24,943.76
c. West	283.50	7,195.53
d. South	76.50	10,011.66
e.		
f.		
Subtotal	906.75 (E)	63,103.51 (G)
Roof	Carpark under - non accountable	
a.		
b.		
Subtotal	(F)	(H)

* ~~Tower~~/Podium Walls OTTV = $\frac{G}{E}$ = 69.59 W/m²

* Tower/Podium Roofs OTTV = $\frac{H}{F}$ = _____ W/m²

* Delete as appropriate

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