# 1. General Principles of Control of Overall Thermal Transfer Value

1.1 For the design and planning of energy - efficient buildings, Government is developing a comprehensive energy code to cover inter alia lighting and air-conditioning. Overall thermal transfer value (OTTV) is one aspect of energy conservation.

## General approach

1.2 An OTTV is a measure of the energy consumption of a building envelope. Its formulation allows authorized persons, registered structural engineers and other persons responsible for the design and construction of buildings freedom to innovate and 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. Any measure to improve energy efficiency or to save energy should be considered in planning a building.

1.3 Siting a building to avoid extensive glazed facades with a southerly aspect or introducing shades to window areas can reduce solar heat gain. Appropriate choice of windows with a low thermal transmittance characteristic will also minimize solar heat transmission.

1.4 Artificial lighting consumes electricity and creates heat. This increases the cooling load of a building and in turn increases energy consumption. Consequently, when determining the size and location of windows as well as choice of glass in the envelope of a building, efforts should be made to provide as much natural lighting into the building as possible. For example, with glazing, the visible lighting transmittance should be acknowledged in addition to its thermal transmittance properties; daylight can supplement artificial lighting and consequently reduce the cooling load.

1.5 Other measures include more extensive use of energy-efficient building services equipment and appliances, e.g. energy-saving lamps, low-loss luminaries and high-efficiency air-conditioning and more sophisticated building services control systems.

**Scope**

1.6 The provisions in this Code apply to all hotels and commercial buildings as defined in the Building (Energy Efficiency) Regulation. They aim at reducing heat transfer through the building envelope and thus the electricity required for air-conditioning.

1.7 The concept of OTTV is based on the assumption that the envelope of a building is completely enclosed.

1.8 In the OTTV formulation, the following factors are not addressed or allowed for :

(a) Internal shading devices, such as draperies and blinds.

(b) Solar reflection or shading from adjacent buildings.

## 2. Definitions

In this Code, unless otherwise stated, words and expressions have the meaning attributed to them by the Building (Energy Efficiency) Regulation. It should also be noted that :

"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 as 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 for 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.

## 3. Suitable OTTV

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

(a) in the case of a building tower; the OTTV should not exceed 35 W/m$^2$; and

(b) in the case of a podium; the OTTV should not exceed 80 W/m$^2$.

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

3.3 The OTTV of the external walls and roofs of a building tower or podium should be assessed in accordance with methods set out in this Code. A sample of OTTV calculations for a typical commercial building is set out in Appendix for illustration.

## 4. Principles of OTTV Calculations

### External walls and roofs not included in OTTV calculations

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

(a) an external wall of a refuge floor;

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

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

(d) any wall on any roof.

### Party wall

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

## 5. OTTV of External Walls

The OTTV of the external walls of a building tower or a podium, $OTTV_w$, should 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, $m^2$ |
| $U$ | = | Thermal transmittance of opaque wall, $W/m^2 {}^\circ C$ (See para 7.1) |
| $\alpha$ | = | 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 7.5) |
| 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, i.e. $A_w + Af_w$, $m^2$ |

## 6. OTTV of Roofs

The OTTV of the roofs of a building tower or a podium, $OTTV_r$, should 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, $m^2$ |
| $U$ | = | Thermal transmittance of opaque roof, $W/m^2 {}^\circ C$ (See para 7.1) |
| $\alpha$ | = | 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 7.5) |
| SF | = | Solar factor for horizontal surface, $W/m^2$ (Table 8) |
| $Ao_r$ | = | Gross area of roof, i.e. $Ar + Af_r$, $m^2$ |

## 7. Calculation of Component Coefficients and Parameters of OTTV

### Thermal transmittance of opaque construction (U)

7.1 Opaque walls and roofs usually involve a composite of materials. The thermal transmittance of an opaque wall or roof should 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, m²°C/W (Table 2)

$R_o$ = Surface film resistance of external surface of the wall or roof, m²°C/W (Table 2)

$R_a$ = Air space resistance, m²°C/W (Table 3)

### Component coefficients and parameters of thermal transmittance

7.2 The component coefficients and parameters used in calculating the thermal transmittance of opaque construction should be assessed as follows :

(a) Thermal conductivity of building materials (k)

The thermal conductivity of the building materials of walls and roofs should be obtained from Table 1.

**Table 1 Thermal Conductivity of Building Materials**

| Material | Density kg/m$^3$ | Thermal Conductivity (k) 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 thermal conductivity values should be subject to the acceptance of the Building Authority and the source of the information from which the thermal conductivity values are obtained should be submitted for his consideration for this purpose.

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

The surface film resistance for walls and roofs should be obtained from Table 2.

**Table 2 Surface Film Resistance 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 |

(c) Air space resistance for walls and roofs ($R_a$)

The air space resistance for walls and roofs should be obtained from Table 3.

**Table 3 Air Space Resistance for Walls and Roofs**

| Type of air space | Air space resistance ($R_a$) $m^2 {}^\circ C/W$ | | | | | |
|---|---|---|---|---|---|---|
| | 5 mm | 10 mm | 20 mm | 50 mm | 75 mm | 100 mm |
| **Air space resistance 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 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 |

**Absorptivity ($\alpha$)**

7.3 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 should be included in the heat gain calculation as a multiplication constant to the equivalent temperature difference. The absorptivity for wall and roof surfaces should be obtained from Table 4.

**Table 4 Absorptivity for wall and roof surfaces**

| Material | Absorptivity $\alpha$ | Paint | Absorptivity $\alpha$ |
|---|---|---|---|
| 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 should be subject to the acceptance of the Building Authority and the source of the information from which the absorptivity values are obtained should be submitted for his consideration.

**Equivalent temperature difference for walls ($TD_{EQW}$)**

7.4 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 should 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 should be obtained from Table 5.

**Table 5 Equivalent Temperature Difference for Walls**

| 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 |

**Shading coefficient of fenestration (SC)**

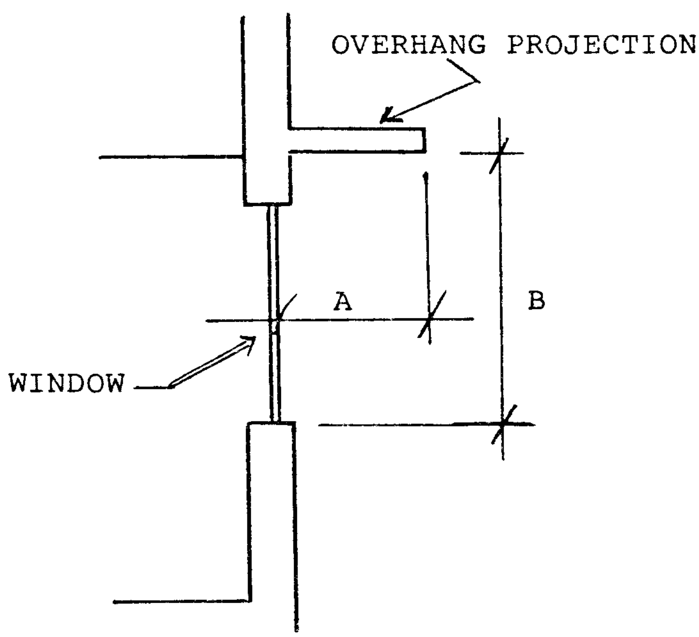
7.5 The shading coefficient of fenestration is the ratio of the solar heat gain through a particular type of glass under a specific set of conditions to the solar heat gain through double strength sheet clear glass under the same conditions. Allowances for Hong Kong's latitude and solar effects have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

**External shading multiplier (ESM)**

7.6 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 calculations this shading effect is taken into account as an external shading multiplier which should be assessed as follows :

(a) Overhang projections to windows

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




$$OPF = \frac{A}{B}$$

**Table 6 External Shading Multiplier 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 :

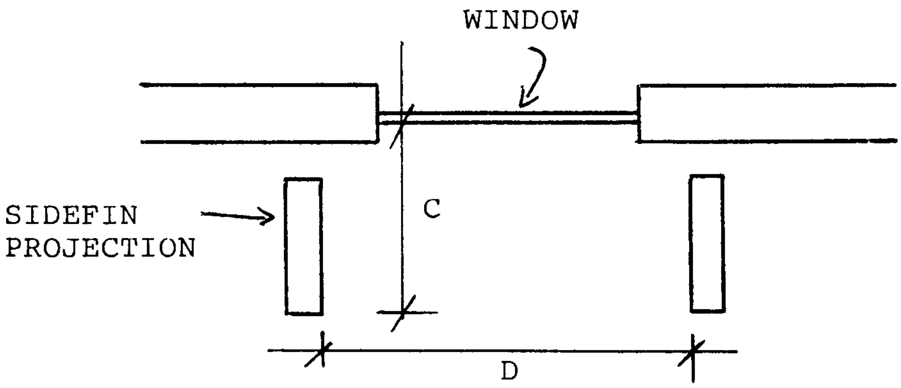
(i) Should the OPF value fall in between increments, adopt the multiplier related to the next larger OPF value.

(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.

(b) Sidefin projections to windows

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




$$SPF = \frac{C}{D}$$

**Table 7 External Shading Multiplier 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 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.

(c) Combination of overhang and sidefin projections

For windows with both overhang and sidefin projections each external shading multiplier should be calculated separately as described in (a) and (b) and the smaller of the two values obtained should be used as the external shading multiplier in the OTTV calculations.

**Solar factor (SF)**

7.7 The solar factor for vertical surfaces at various orientations and that for horizontal surfaces should 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 | | | | | | | |

**Equivalent temperature difference for roofs ($TD_{EQr}$)**

7.8 The equivalent temperature difference for roofs should take into account the roof mass and density and should be obtained from Table 9.

**Table 9 Equivalent Temperature Difference for Roofs**

| 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 |

8. **Windows and doors**

Buildings should 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 should be employed. Careful attention should also be paid to the sealing of windows to guard against leakage during service.

9. **Submission of Information**

9.1 Information and calculations required by the Building Authority are specified in the Building (Energy Efficiency) Regulation. Simplified version of OTTV calculations can be included in the first submission of building plans, provided that detailed calculations have to be submitted before consent to commence works will be granted. The following information and calculations should be submitted on the standard forms set out in the schedule to this Code :

(a) Calculation of 'U' value of composite wall and roof and details of other component coefficients and parameters of OTTV 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 should be made to two places of decimals.