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PAM CPD . PAM Centre. Kuala Lumpur

7 October 2017

Ar Chan Seong Aun

Past President PAM
Past Chairman GBI Accreditation Panel
M. Arch. B. Arch (NZ), P. Arch, APAM

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ROOF INSULATION U-VALUES

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ROOF THERMAL RESISTANCE

Roof thermal resistance RESIDENTIAL

SSTH
75%

DSTH
50%

5S Flat
40%

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THERMAL RESISTANCE

Solar Heat Gain in typical Malaysian homes

	Single Storey Terrace	Double Storey Terrace	Five Storey Flats	Eight Storey Apartments
Gross Floor Area	880	1,408	60,500	81,680
Roof over Envelope Area	68%	45%	30%	18%
Wall over Envelope Area	32%	55%	70%	82%
North-South Facing				
Roof Solar Heat Gain in kWh/day	30	24	363	306
Total Solar Heat Gain in kWh/day	35	33	726	908
Roof over Total Solar Heat Gain	**86%**	**73%**	**50%**	**34%**
East-West Facing				
Roof Solar Heat Gain in kWh/day	30	24	363	306
Total Solar Heat Gain in kWh/day	40	43	842	1,141
Roof over Total Solar Heat Gain	**75%**	**55%**	**40%**	**27%**

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ROOF THERMAL RESISTANCE

Roof thermal resistance NON-RESIDENTIAL

FACTORIES

75%

LOW RISE

40%

HIGH RISE

20%

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Roof U-Value

MS1525 Clause 5.5

The calculation of OTTV does not include the roof plane, but the thermal transmittance (Roof U-value) of the roof construction is important.

U-values are worked out from the Thermal Resistance of the respective materials making up the Roof, similar to that for Walls.

ie, $U = 1 / R_{total}$

The higher the R, the lower the U, the better.

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MS1525 Clause 5.5.1

Roof Weight Group	Maximum U-Value (W/m^2K)
Light (Under 50 kg/m^2)	0.4
Heavy (Above 50 kg/m^2)	0.6

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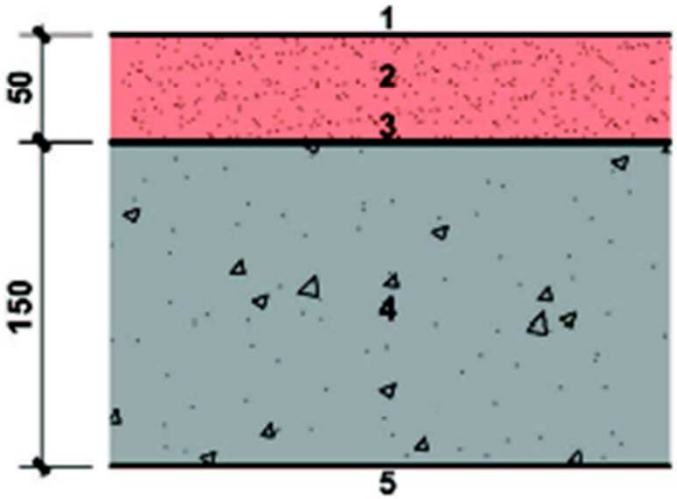
R.C. Roof without insulation



		THERMAL CONDUCTIVITY (W/mk)	R THERMAL RESISTANCE (m^2k/W)
1	External surface	-	0.040
2	Cement screed, 50mm thk	0.41	0.122
3	Waterproof membrane	0.23	0.004
4	R.C Slab, 150mm thk	2.30	0.065
5	Internal surface	-	0.130
		Total R	0.362

$$\text{U-Value} = \frac{1}{R}$$

$$= \frac{1}{0.362}$$

$$= 2.762\ W/m^2k$$

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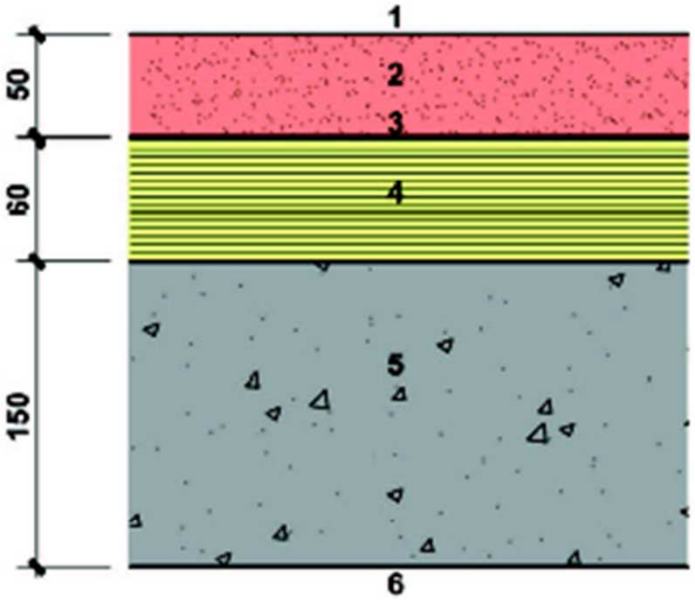
R.C. Roof with insulation



		THERMAL CONDUCTIVITY (W/mk)	R THERMAL RESISTANCE (m^2 k/W)
1	External surface	-	0.040
2	Cement screed, 50mm thk	0.41	0.122
3	Waterproof membrane	0.23	0.004
4	Expanded polystrene, 60mm thk	0.04	1.500
5	R.C Slab, 150mm thk	2.30	0.065
6	Internal surface	-	0.130
		Total R	1.860

$$\text{U-Value} = \frac{1}{R}$$

$$= \frac{1}{1.861}$$

$$= 0.537 \text{ W/m}^2\text{k}$$

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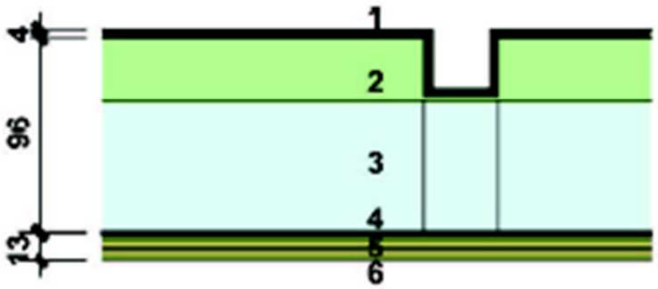
Metal Deck Roof without insulation



		THERMAL CONDUCTIVITY (W/mk)	R THERMAL RESISTANCE (m^2k/W)
1	External surface	-	0.040
2	Steel decking	50.0	0.00008
3	Cavity	-	0.090
4	Sisalation		-
5	Plasterboard liner, 13mm thk	0.25	0.052
6	Internal surface	-	0.130
		Total R	0.312

$$\text{U-Value} = \frac{1}{R}$$

$$= \frac{1}{0.312}$$

$$= 3.205\ W/m^2k$$

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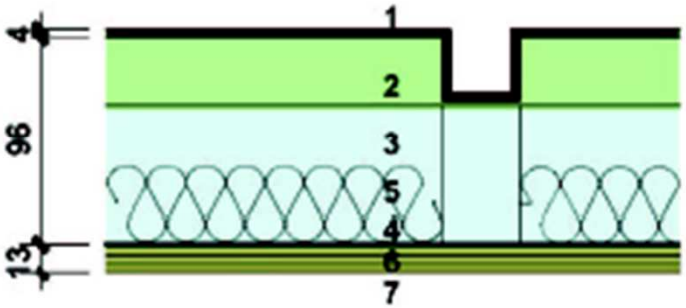
Metal Deck Roof with insulation



		THERMAL CONDUCTIVITY (W/mk)	R THERMAL RESISTANCE (m^2k/W)
1	External surface	-	0.040
2	Steel decking & structure	50.0	0.00008
3	Cavity	-	0.090
4	Sisalation		-
5	Mineral wool batt, 150mm thk	0.038	3.947
6	Plasterboard liner, 13mm thk	0.25	0.052
7	Internal surface	-	0.130
		Total R	4.259

$$\text{U-Value} = \frac{1}{R}$$

$$= \frac{1}{4.259}$$

$$= 0.235\ W/m^2k$$

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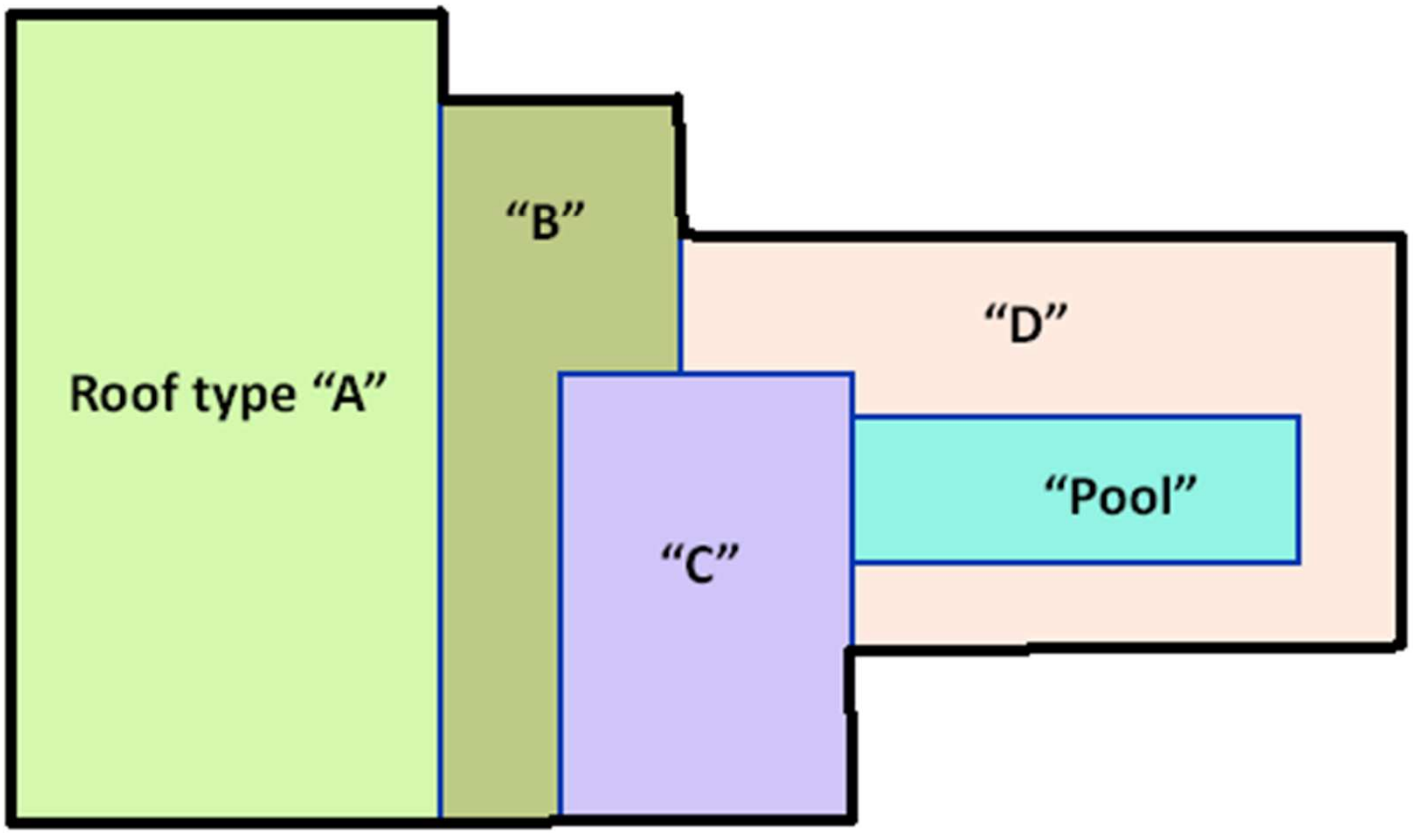
Multiple Roof Types : Worst case applies



Plan View

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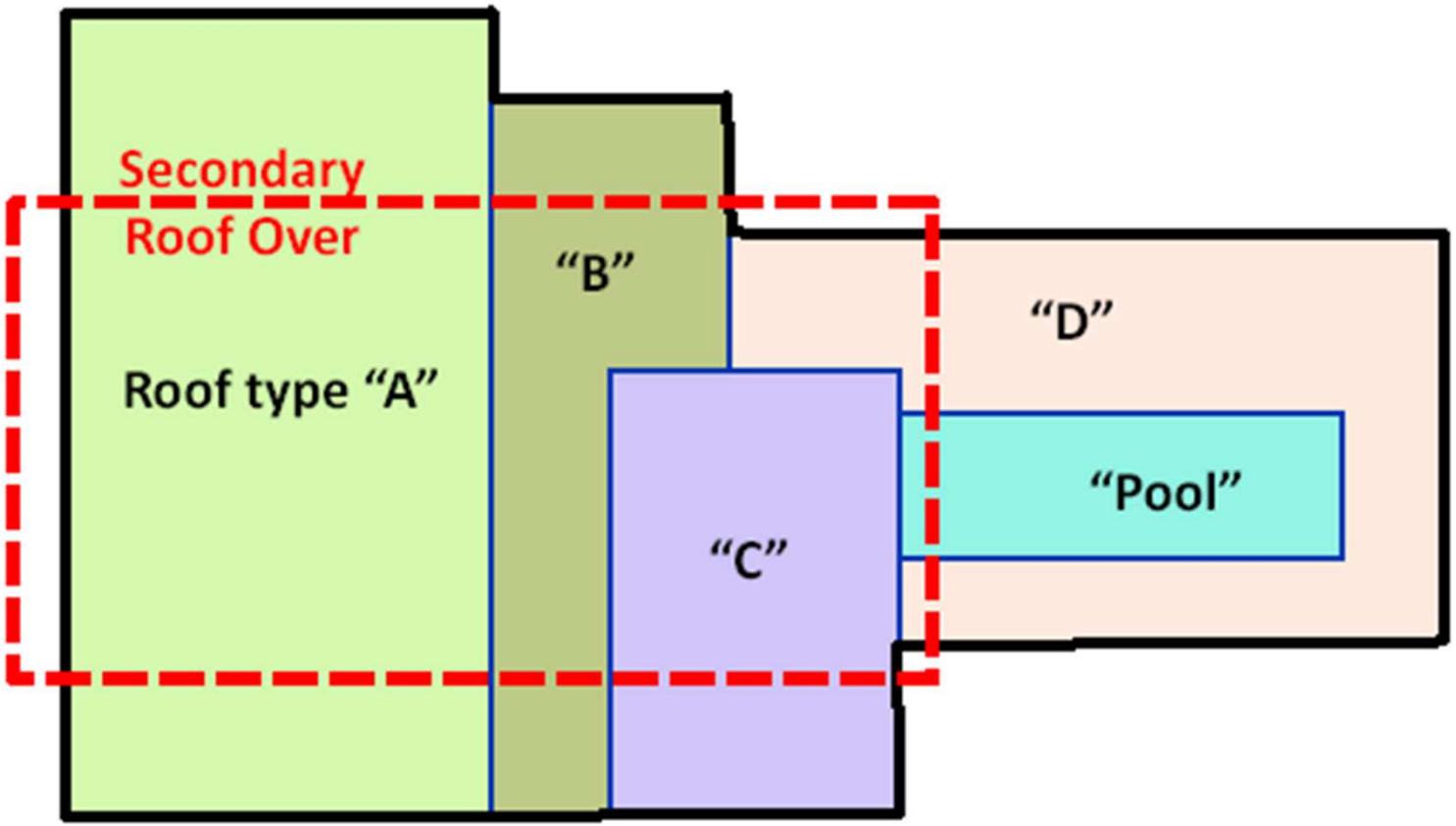
Secondary Roof



Plan View

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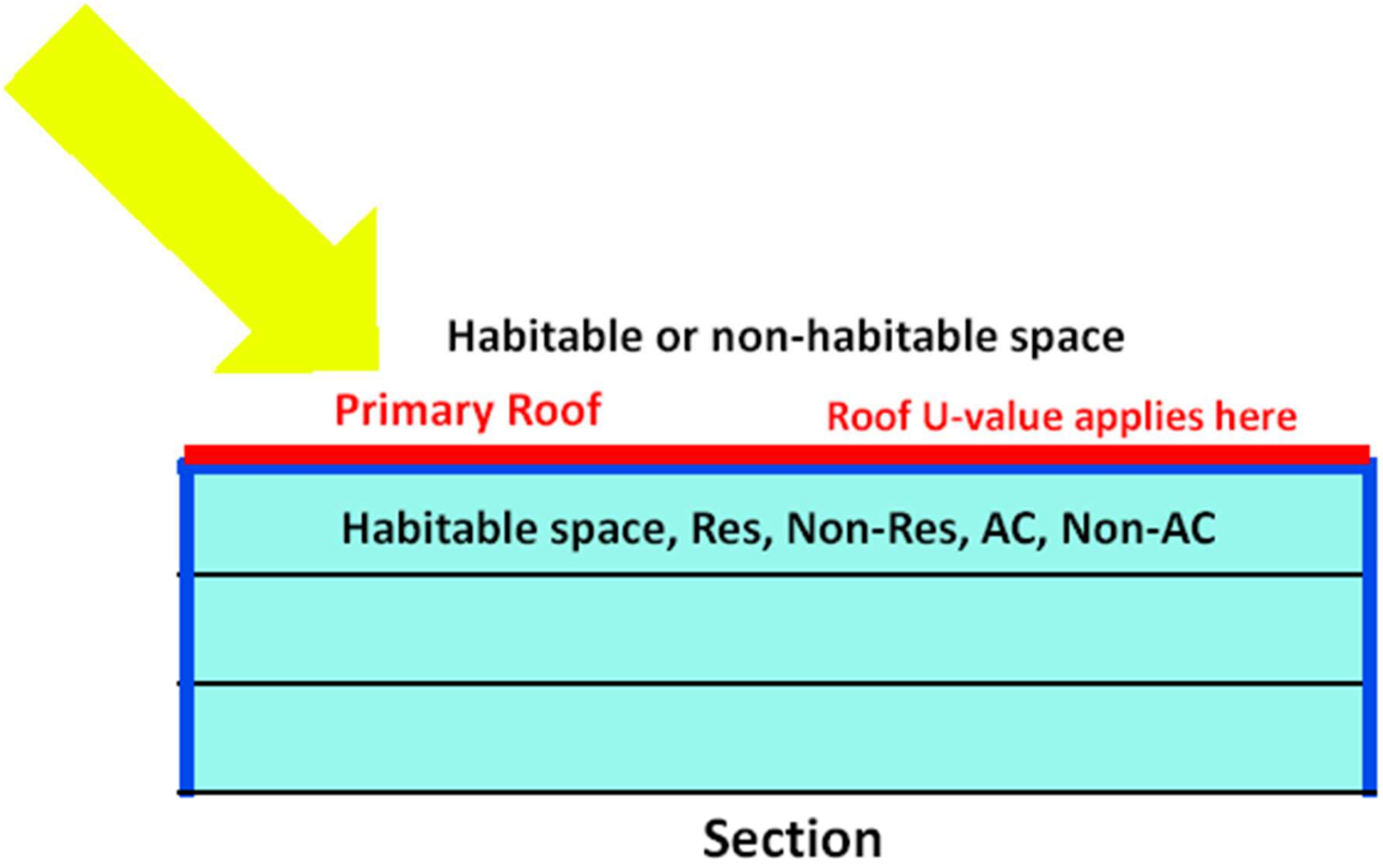
Secondary Roofs



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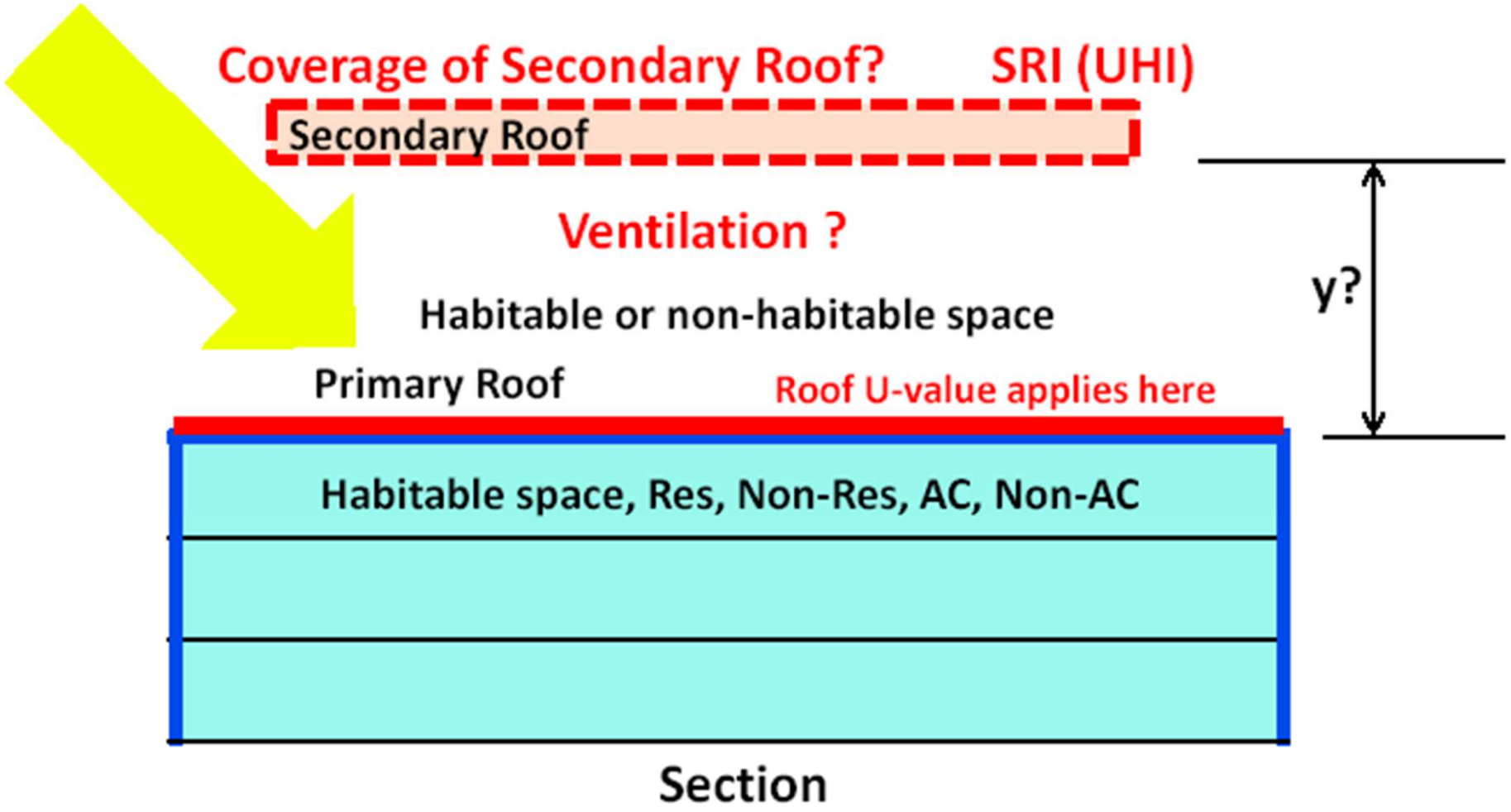
Secondary Roofs



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Secondary Roofs

Q1 : Ventilation ?

Can be natural or forced.

Rate of ventilation (ACH) is important

Q2 : Height of secondary roof ?

Affects ACH

Q3 : Coverage of secondary roof ?

Uncovered Primary Roof requires insulation

Q4 : SRI ?

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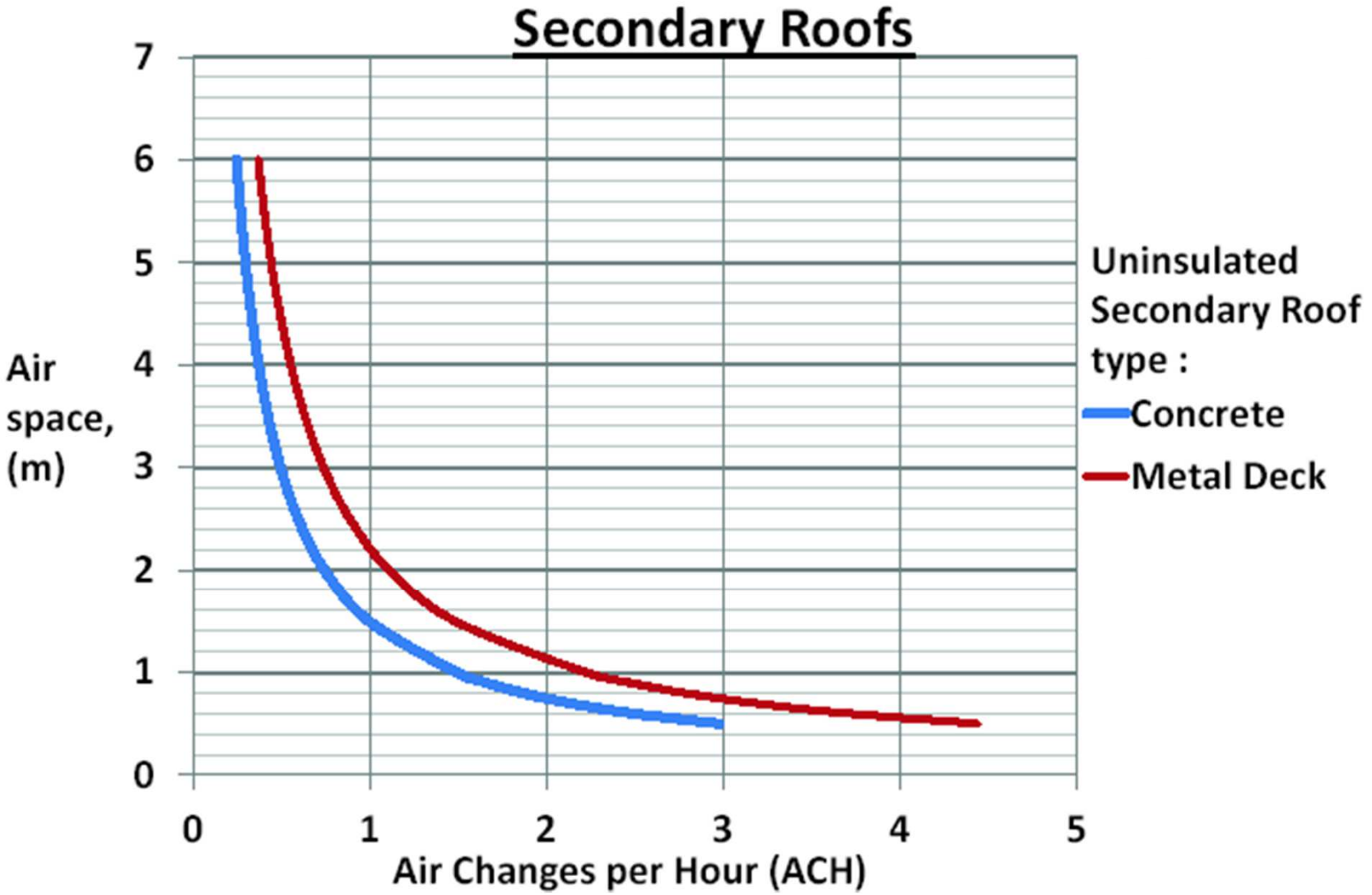

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Secondary Roofs

Horizontal pergolas
or vertical screens

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Secondary Roofs

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Difference in concept between Roof U-value and UHI

Roof U-value measures heat
conducted through the composite Primary Roof construction
AND
Applies where habitable or living spaces are found directly below it.
Habitable spaces below Primary Roof need not be fully enclosed or aircond, and includes outdoor dining etc

UHI is about reflecting away solar radiation
to achieve a cooler micro-climate.

Once heat comes in, it takes a lot of energy to get it out,
regardless whether the spaces below are occupied or not.

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Difference in concept between Roof U-value and UHI

Can secondary roofs eg horizontal pergolas or screens be used to calculate as part of the Primary Roof's composite Roof U-value?

No, because they are not part of the composite roof construction.

But they can be used to be a part of the calculation to reduce UHI

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Can PV be used in calculating Roof U-value?

Similar to pergolas.

It will count only if it is BIPV, ie it forms part of the roof construction.

What is the SRI of PV surfaces?

SRI is about 40%

New technologies create PV with less SRI.

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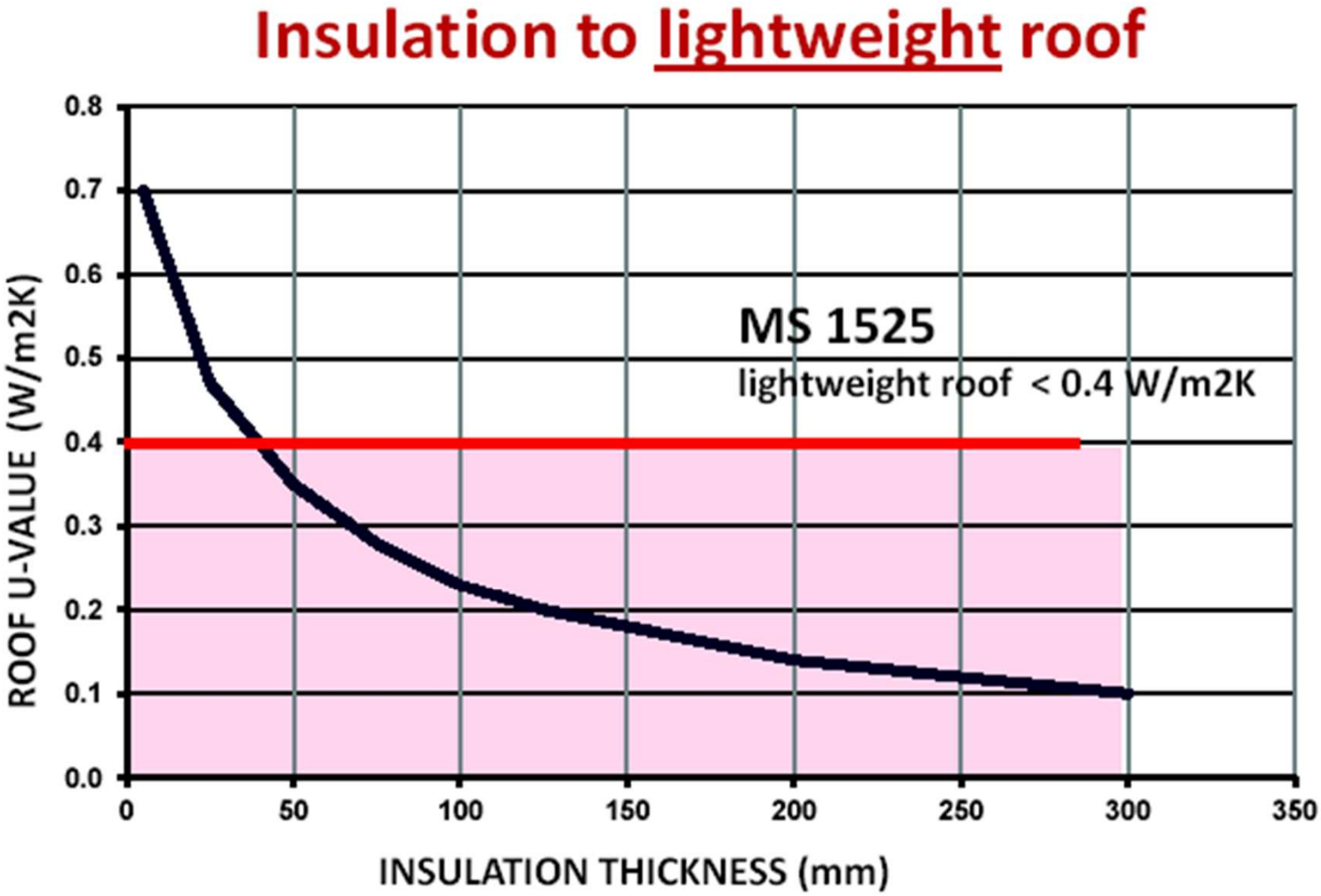

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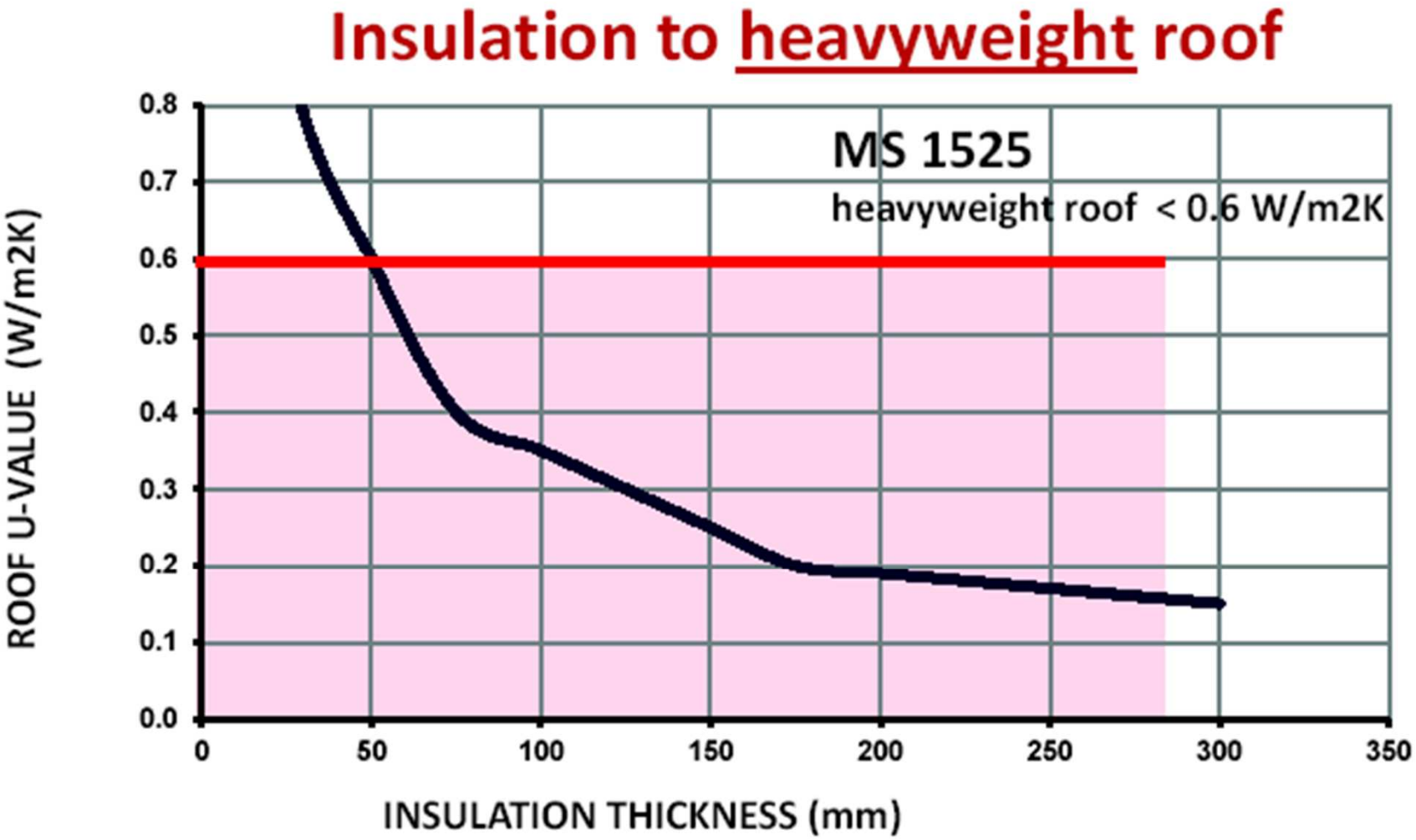

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RTTV

MS1525:2007 Clause 5.6

Clause 5.6.1

The concept of RTTV applies if the roof is provided with skylight, and the entire enclosure below is fully air-conditioned.

Clause 5.6.2

The maximum recommended RTTV is 25 W/m^2.

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KEY CONCEPTS

- Low rise building such as Factories and Terraced Housing have a high ratio of roof to envelope. Most of the heat therefore ebters through the roof. ROOF INSULATION is critical to keeping cool
- A combination of reflective foil and high thermal resistance insulation if more effective than a single insulation type for light weight roofs

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SUMMARY

Clause 5.2

OTTV applies to building envelope, where

OTTV $\leq$ 50 W/m^2

Clause 5.5

Roof U-value refers to the thermal transmittance of the roof, where

Roof U-value $\leq$ 0.4 - 0.6 W/m^{2}K

Clause 5.6

RTTV applies to roof with skylights, where

RTTV $\leq$ 25 W/m^2

THANK YOU

Ar Chan Seong Aun

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