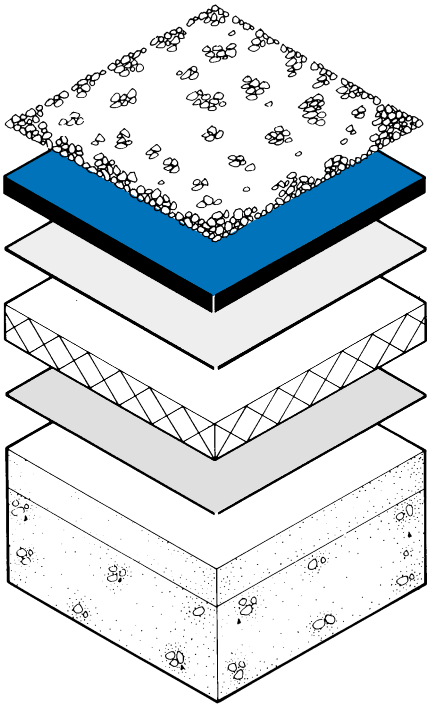
Appendix A

A1 U-VALUE CALCULATION EXAMPLES

EXAMPLE 1
Calculation of the U-value of a roof construction of the following specification:



Calculate the thermal resistance of each component from t/λ, or taking standard values from table A1.

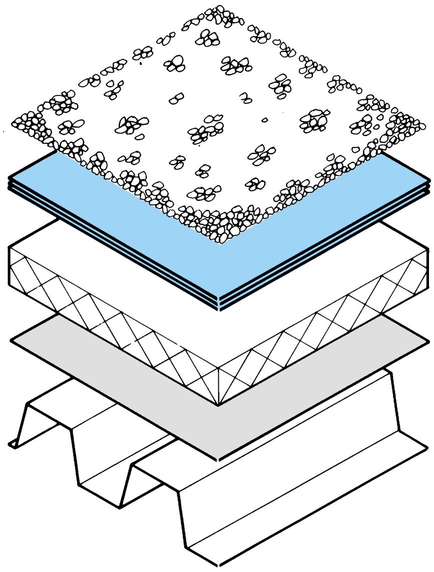
Roof element	Thickness t (m)	λ value (W/mK)	Thermal resistance t/λ (m^2K/W)
External surface resistance			0.040
Asphalt waterproofing			0.060
Rigid urethane foam	0.050	0.023	2.174
Vapour control layer			0.020
Sand and cement screed	0.050	1.400	0.036
Concrete slab	0.125	1.400	0.089
Internal surface resistance			0.100
		Total resistance R =	2.519

Overall U-value 1/R = 0.40 W/m^2K

EXAMPLE 2

Details of construction are known, and a specific U-value is required. What thickness of insulation is necessary? The required R-value of the insulation component can be calculated and then multiplied by the λ-value of insulation materials to find the thickness required.

Calculation of the thickness of insulation required to achieve an overall U-value of 0.45 W/m^2K in a roof constructed to the following specification:



Roof element	Thermal resistance ($m^2°K/W$)
External surface resistance	0.040
Built-up roofing	0.060
Vapour control layer	0.020
Metal trough decking	0.000
Deck cavities	0.090
Internal surface resistance	0.100
Total thermal resistance without insulation:	0.310

U-value required is 0.45 W/m^2K.

Therefore total thermal resistance (R) required is:

$$\frac{1}{0.45} = 2.22$$

Subtracting the thermal resistance of the above elements 0.31 leaves a thermal resistance to be provided by the insulation of 1.912.

Thickness = λ-value x resistance R

The minimum thickness required for cork insulation board would therefore be:

λ x R = 0.042 x 1.912 = 80mm

Similarly, the minimum thickness for polyurethane insulation board would therefore be:

0.023 x 1.912 = 44mm
(nearest commercially available thickness 45mm).

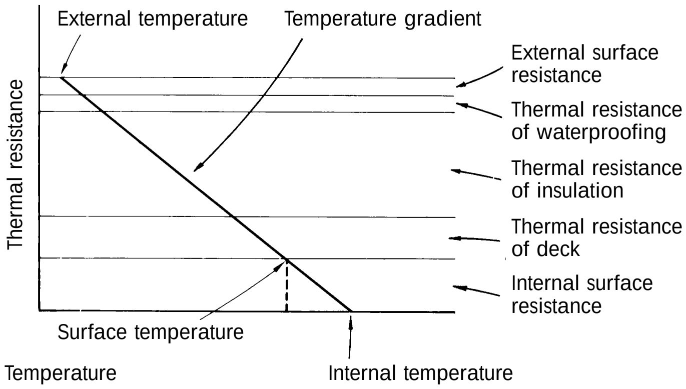
SURFACE CONDENSATION STEADY STATE CALCULATION

In the steady state calculation, the possibility of condensation is checked in the following stages to allow a comparison between the actual temperature at any point in a specification and the dew point temperature of the internal condition.

If the actual temperature at that point is lower than the dew point temperature, condensation will occur.

1. The external temperature normally used in the UK is -5°C.
The internal temperature and relative humidity used are the maximum conditions that are likely to occur for an appreciable period of time.

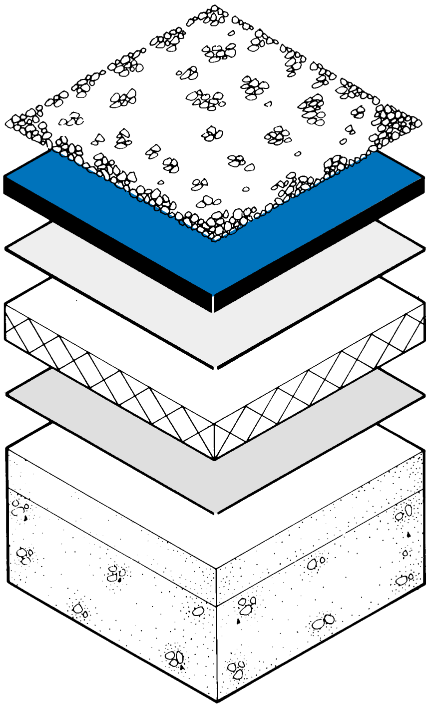
2. The temperature gradient within the system must be calculated, either from the equation given in step 2 of moisture gain analysis below or by reading from a graph plotting temperature against the thermal resistance of the components of the roof structure.
The relationship between temperature drop and thermal resistance is a straight line and the internal and external temperatures give the two points from which the straight line graph is established.



3. Calculate the dew point temperature for the internal conditions, using a psychrometric chart, or by reference to table A2. If the temperature at any point is lower than the dew point temperature, then condensation will occur at that position.
This calculation method is suitable for predicting surface condensation, including surface condensation in ceiling spaces.

The formation of interstitial condensation within the materials of constructions, in particular the insulation layer, is generally slow as the passage of water vapour is by diffusion only. In this case the steady state calculation is of little value and reference should be made to the moisture gain analysis calculation which takes account of the rate of moisture movement and the quantity of interstitial condensation which would be formed.

EXAMPLE 1
Check if surface condensation will occur for the specification illustrated with internal conditions of 20°C and 45% RH.



1 Calculate the thermal resistance of the specification

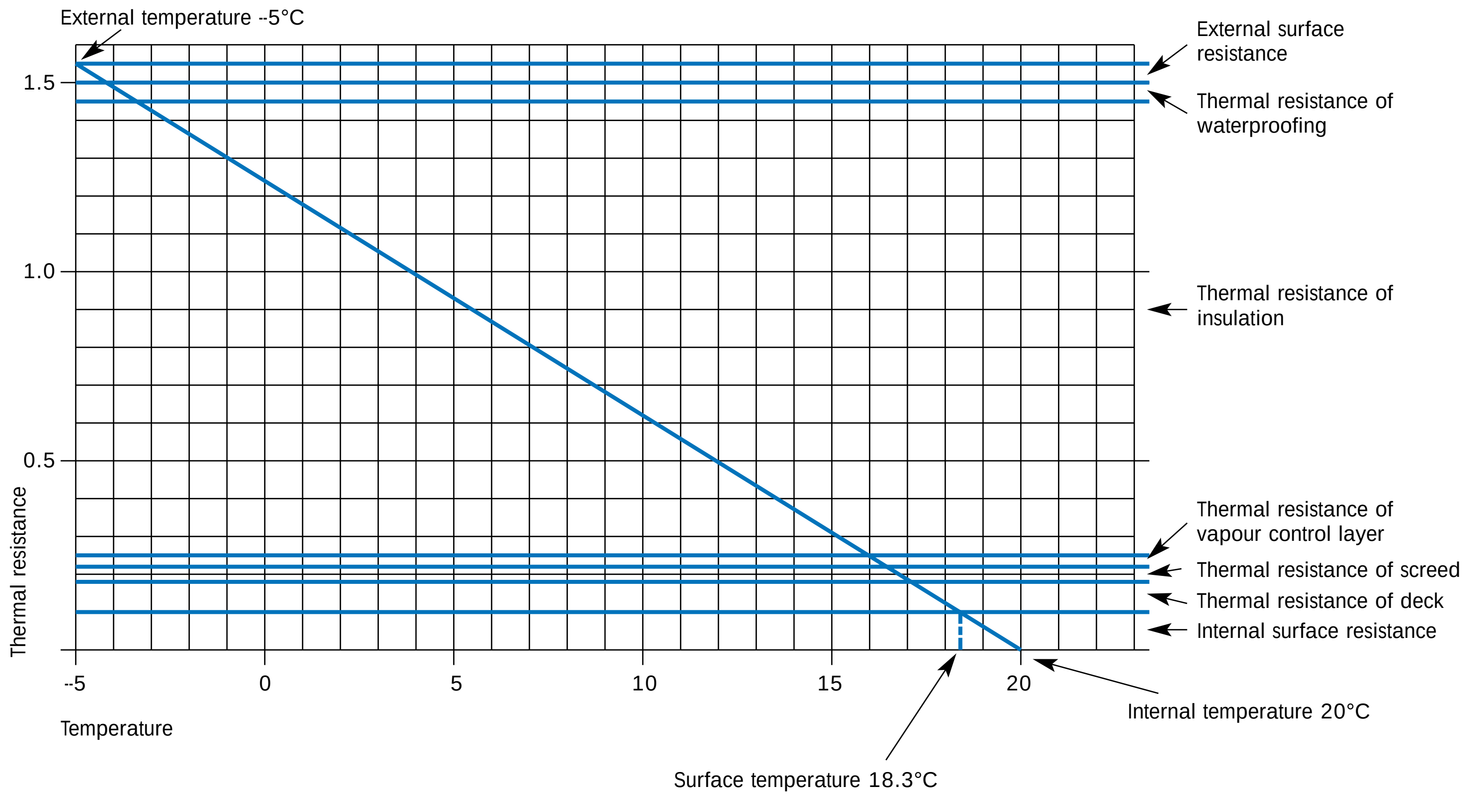
Roof element	Thickness t (m)	λ value (W/mK)	Thermal resistance t/λ (m^2K/W)
External surface resistance			0.040
Asphalt waterproofing			0.060
Cork insulation board	0.050	0.042	1.190
Vapour control layer			0.020
Sand and cement screed	0.050	1.400	0.036
Concrete slab	0.125	1.400	0.089
Internal surface resistance			0.100
	Total resistance R =		1.535

2 From the straight line graph 1, plotted to show temperature against thermal resistance, a surface temperature of 18.3°C is indicated.

3 From table A2 the dew point temperature at 20°C and 45% relative humidity is 7.7°C.

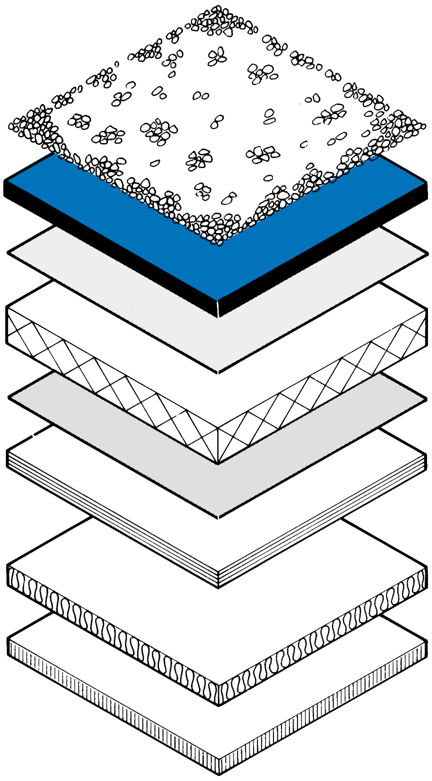
4 The surface temperature is therefore above the dew point temperature, and surface condensation will not occur.

GRAPH 1



EXAMPLE 2

Check if surface condensation will occur in the ceiling void for the specification illustrated below, with internal conditions of 20°C and 60% RH.



1 Calculate the thermal resistance of the specification

Roof element	Thickness t (m)	λ value (W/mK)	Thermal resistance t/λ (m^2K/W)
External surface resistance			0.040
Asphalt waterproofing			0.060
Cork insulation board	0.050	0.042	1.190
Vapour control layer			0.020
Plywood	0.019	0.14	0.130
Air space			0.170
Glass fibre insulation	0.025	0.04	0.620
Fibreboard ceiling	0.012	0.05	0.240
Internal surface resistance			0.100
		Total resistance R =	2.570

2 From the straight line graph 2, plotted to show temperature against thermal resistance, a surface temperature of 9°C is indicated at the deck soffit.

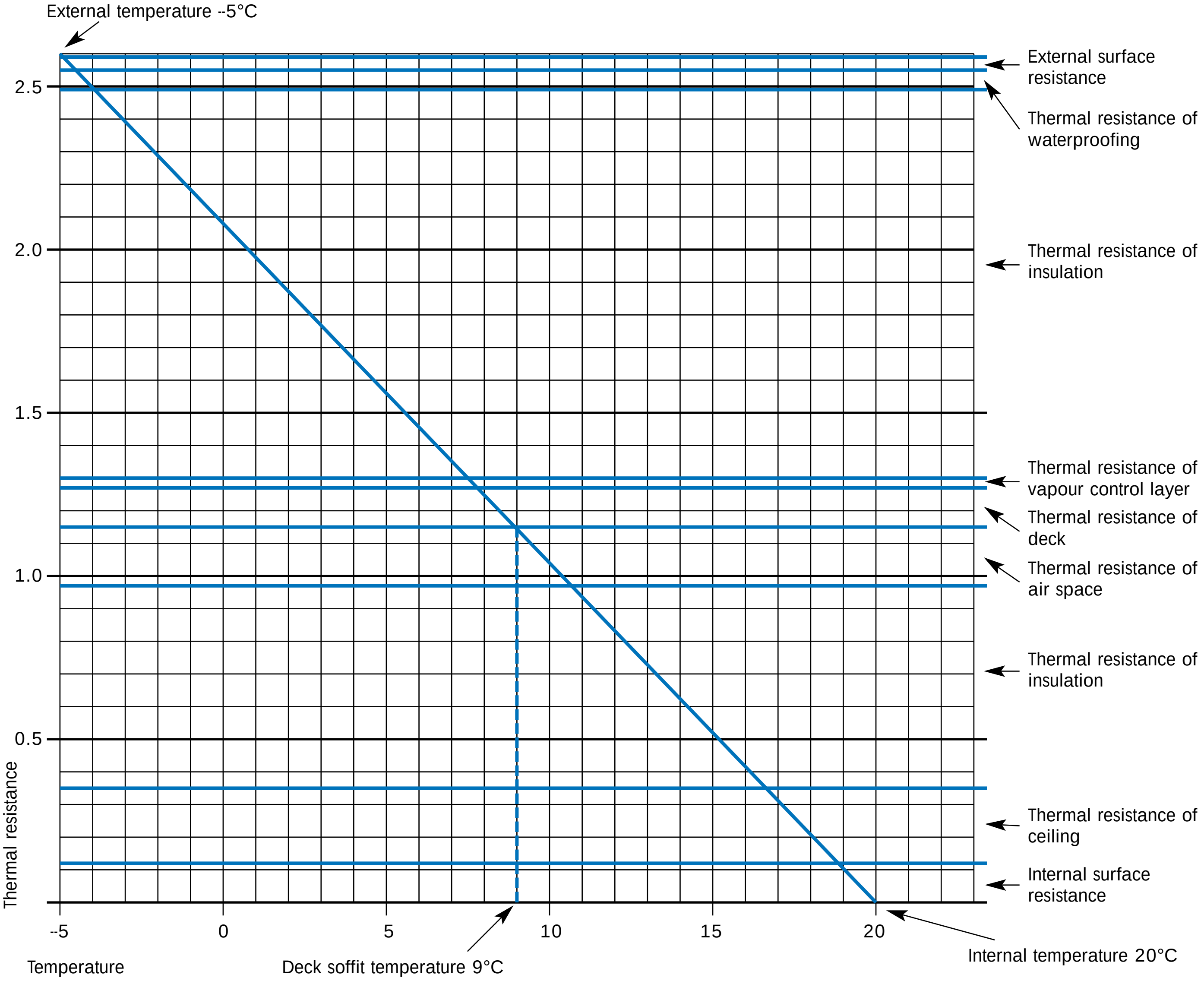
3 From table A2 the dew point temperature at 20°C and 60% relative humidity is 12°C.

4 The deck soffit temperature is below the dew point temperature and condensation will therefore occur in the ceiling void. To stop condensation, the insulation above the deck should be increased.

The balance of insulation table A3 shows the required minimum ratio between thermal resistance above the deck soffit and thermal resistance below the deck to avoid condensation.

In this example at 20°C and 60% relative humidity, the ratio is 2:1. The thermal resistance below the deck is 1.13m^2K/W so the total thermal resistance required to prevent condensation in the ceiling void is 3.50 or a U-value of 0.28$W/m^2°K$. The thickness of insulation required can be calculated as described in example 2 of the U-value calculation method.

GRAPH 2



External temperature -5°C
2.5
2.0
1.5
1.0
0.5
Thermal resistance
-5
0
5
10
15
20
Temperature
Deck soffit temperature 9°C
Internal temperature 20°C
External surface resistance
Thermal resistance of waterproofing
Thermal resistance of insulation
Thermal resistance of vapour control layer
Thermal resistance of deck
Thermal resistance of air space
Thermal resistance of insulation
Thermal resistance of ceiling
Internal surface resistance

INTERSTITIAL CONDENSATION MOISTURE GAIN ANALYSIS

The calculation of moisture gain is valid for warm roof constructions when the moisture vapour movement is by diffusion. In the calculation method below, the waterproofing is assumed to be impermeable to vapour and the theoretical vapour pressure within the roof system may be taken as the vapour pressure within the building, with no significant loss of accuracy.

To determine the position of the condensation zone, the saturated vapour pressure at any point in the roof system is compared with the theoretical vapour pressure at the same point. Condensation will occur when the saturated vapour pressure is less than the theoretical vapour pressure.

The amount of condensation is calculated by assessing the rate at which moisture vapour arrives at this position.

The results of moisture gain analysis for typical warm roof specifications are given in table 1.10 section 1.3. For specifications not covered by this table the analysis may be carried out in the following stages:

1. PSYCHROMETRIC CONDITIONS

External conditions

The outdoor notional conditions given below are assumed to apply anywhere in the United Kingdom.

	Temperature °C	Length of season (days)
Winter	-5	60
Summer	18	60

Internal conditions

In the absence of specific data for the building under consideration, the following indoor conditions may be assumed.

Type of building	Temperature °C	Relative humidity %
Houses and flats	20	55
Offices	20	40
Schools	20	50
Factories and heated warehouses	15	35
Textile factories	20	70
Swimming pool halls	25	70

These conditions are representative of temperature and relative humidity for a 60 day period.

2 Calculate the temperature at each interface between different materials in a roof system using the equation

$$t_\chi = t_i - (t_i - t_e) \times R_\chi U$$

where
t_χ = temperature at interface χ
t_i = internal temperature
t_e = external temperature
R_χ = thermal resistance from inside to interface χ
U = U-value

3 Calculate the internal vapour pressure and the saturated vapour pressure at each interface using table A5 or from a standard psychrometric chart.

4 If the internal vapour pressure is shown to be above the saturated vapour pressure at any interface (although of course, this is not possible in practice) then condensation will occur at that interface.

5 The amount of condensation or evaporation may be calculated from the equation

$$q = S \times \frac{(VP_i - SVP_\chi)}{VR_\chi}$$

where
VP_i = internal vapour pressure
VR_χ = vapour resistance from inside to interface χ
S = length of season (normally 60 days)
SVP_χ = saturated vapour pressure at interface χ

If the vapour resistance is in MNs/g, the vapour pressures in kilopascal (kPa), and the length of season in seconds, then the equation becomes

$$q = S \times 10^{-6} \times \frac{(VP_i - SVP_\chi)}{VR_\chi} \text{ kg/m}^2$$

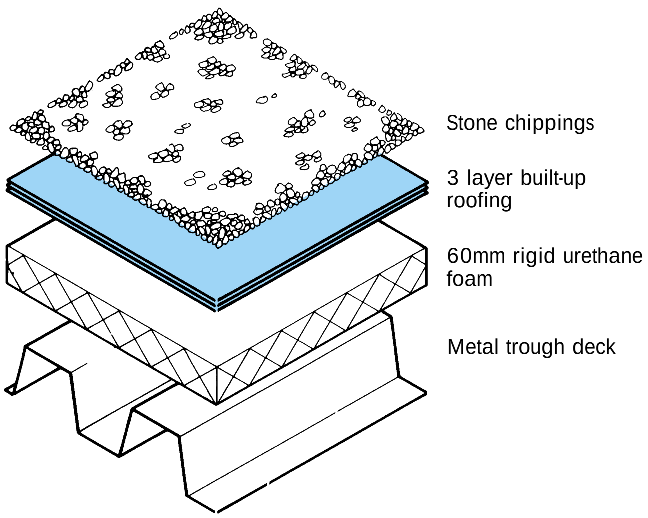
6 *Acceptable levels of condensate*

For non-fibrous insulation materials, a maximum winter condensate of 0.5kg/m², and for fibrous insulation materials a maximum of 0.35kg/m² is accepted.

Although there should be full drying out of the condensate over the summer season, a calculated annual net retention of 5% of the maximum permissible winter condensate is allowable.

EXAMPLE 3

Determine if a vapour barrier or vapour check is required for the specification below, over a heated warehouse.



From the table of internal conditions, step 1 on the previous page, the design conditions are taken as 15°C and 35%RH.

Calculation stages 2-5 must be completed. Detailed calculations are not shown, but the results of stages 2-3 for the given set of circumstances are shown in the table below.

From the table it can be seen that condensation will take place at the interface between the insulation and the waterproofing. From step 5 the amount of condensate over a 60 day winter period is shown to be 0.014kg/m^2 and the amount of evaporation over a 60 day summer period is 0.116kg/m^2. Therefore the condensate completely dries out over the summer period, and a vapour control layer is not required.

Internal temperature 15°C 35% RH

	Thermal resistance m^{2}K/W	Vapour resistance MNs/g	WINTER Temp. °C	Saturated vapour pressure (kPa)	Vapour pressure (kPa)	SUMMER Temp. °C	Saturated vapour pressure (kPa)	Vapour pressure (kPa)
			--5.0	0.40		18.0	2.06	
External surface	0.04							
			--4.72	0.41		17.96	2.06	
Built-up roofing	0.06	Infinite						
			--4.31	0.43	0.60	17.90	2.05	0.60
60mm Rigid urethane foam	2.61	55						
			13.69	1.56	0.60	15.20	1.72	0.60
Deck cavities	0.09	0						
			14.31	1.63	0.60	15.10	1.71	0.60
Metal deck	0	10						
			14.31	1.63	0.60	15.10	1.71	0.60
Internal surface	0.10	0						
			15.0	1.70	0.60	15.0	1.70	0.60

If the building use had been as a textile factory with conditions of 20°C and 70%RH internally, the results of the calculation would be as the table below. This shows that there would be 0.096kg/m^2 of condensate over the winter period and only 0.035kg/m^2 drying out during the summer period. This would not be acceptable and further calculations will be needed, first including a vapour check in the specification and then, if that proves insufficient, a vapour barrier.

Internal temperature 20°C 70% RH

	Thermal resistance m^{2}K/W	Vapour resistance MNs/g	WINTER Temp. °C	Saturated vapour pressure (kPa)	Vapour pressure (kPa)	SUMMER Temp. °C	Saturated vapour pressure (kPa)	Vapour pressure (kPa)
			--5.0	0.40		18.0	2.06	
External surface	0.04							
			--4.66	0.41		18.03	2.07	
Built-up roofing	0.06	Infinite						
			--4.14	0.43	1.64	18.07	2.07	1.64
60mm Rigid urethane foam	2.61	55						
			18.36	2.11	1.64	19.87	2.32	1.64
Deck cavities	0.09	0						
			19.14	2.21	1.64	19.93	2.33	1.64
Metal deck	0	10						
			19.14	2.21	1.64	19.93	2.33	1.64
Internal surface	0.10	0						
			20.0	2.34	1.64	20.0	2.34	1.64

TABLE A1

THERMAL AND VAPOUR PROPERTIES

	Thermal conductivity (λ-value) W/mK	Thermal resistance (R-value) m^2K/W	Vapour resistivity MNs/gm	Vapour resistance MNs/g
AIR SURFACES				
Internal		0.10		0
External		0.04		0
AIR CAVITIES (unventilated)				
Low surface emissivity		0.35	5.2	
High surface emissivity		0.17	5.2	
Intermittant cavity *(between metal deck and roofing space)*		0.09		0
DECKS				
Dense concrete	1.4		210	
Lightweight aerated concrete	0.16		60	
Plywood and chipboard	0.14		520	
Timber boarded deck	0.14		210	
Woodwool (pre-screeded)*	0.093		15-40	
Metal decking	0			10
VAPOUR CHECK				
Single layer bitumen felt on metal deck		0.02		100
Single layer bitumen felt fully supported		0.02		300
VAPOUR BARRIER				
Two layer built-up felt		0.04		500
Metal lined felt		0.02		500
INSULATIONS				
Cellular glass slab	0.044		Infinite	
Cork board	0.042		50	
Expanded polystyrene (bead board)	0.034		200	
Extruded polystyrene	0.028		1125	
Mineral wool slab	0.036		7	
Perlite board	0.05		27	
Perlite bitumen screed	0.076		10	
Rigid urethane foam	0.023			55
Phenolic foam	0.02			55
Wood fibreboard	0.05		26	
WATERPROOFING				
Mastic asphalt		0.06		May be taken as impermeable
Built-up bitumen felt		0.06		

*For pre-felted woodwool, the combined properties of pre-screeded woodwool and single layer bitumen felt fully supported may be used, provided that the slab joints are taped.

A single layer of felt used as a vapour check on metal deck is likely to be damaged or perforated. The vapour resistance of this layer is taken as one third that of a fully supported layer on concrete. The vapour resistance of a two layer vapour barrier also takes into account that normally the vapour barrier would be partially bonded. The vapour resistance of the waterproofing is so large compared with the resistance of the other components in the system, that its magnitude has very little effect on the calculation of the amount of condensate and the waterproofing may be taken as impermeable.

Dew point temperatures

TABLE A2

%RH	Temperature °C															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
30	-2.1	-1.4	-0.6	0.2	1.0	1.9	2.8	3.6	4.5	5.4	6.2	7.1	8.0	8.8	9.7	10.5
35	-0.3	0.6	1.4	2.3	3.2	4.1	5.0	5.9	6.7	7.6	8.5	9.4	10.2	11.1	12.0	12.9
40	1.5	2.4	3.3	4.2	5.1	6.0	6.9	7.8	8.7	9.6	10.5	11.4	12.3	13.2	14.0	14.9
45	3.2	4.1	5.0	5.9	6.8	7.7	8.6	9.5	10.4	11.3	12.3	13.2	14.1	15.0	15.9	16.8
50	4.7	5.6	6.5	7.4	8.4	9.3	10.2	11.1	12.0	12.9	13.9	14.8	15.7	16.6	17.5	18.4
55	6.0	7.0	7.9	8.8	9.8	10.7	11.6	12.6	13.5	14.4	15.3	16.3	17.2	18.1	19.0	20.0
60	7.3	8.2	9.2	10.1	11.1	12.0	12.9	13.9	14.8	15.8	16.7	17.6	18.6	19.5	20.4	21.4
65	8.5	9.4	10.4	11.3	12.3	13.2	14.2	15.1	16.1	17.0	18.0	18.9	19.9	20.8	21.8	22.7
70	9.6	10.5	11.5	12.5	13.4	14.4	15.3	16.3	17.2	18.2	19.1	20.1	21.1	22.0	23.0	23.9
75	10.6	11.6	12.5	13.5	14.5	15.4	16.4	17.4	18.3	19.3	20.3	21.2	22.2	23.2	24.1	25.1
80	11.6	12.6	13.5	14.5	15.5	16.4	17.4	18.4	19.4	20.3	21.3	22.3	23.3	24.2	25.2	26.2
85	12.5	13.5	14.5	15.4	16.4	17.4	18.4	19.4	20.3	21.3	22.3	23.3	24.3	25.2	26.2	27.2
90	13.4	14.4	15.3	16.3	17.3	18.3	19.3	20.3	21.3	22.3	23.2	24.2	25.2	26.2	27.2	28.2

Balance of Insulation

TABLE A3 External Temperature -5°C

%RH	Internal Temperature °C															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
30	0.2	0.2	0.2	0.3	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.7	0.7	0.8	0.8
35	0.3	0.4	0.4	0.5	0.5	0.6	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.0
40	0.5	0.5	0.6	0.7	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3
45	0.7	0.8	0.8	0.9	1.0	1.0	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.5	1.6	1.6
50	0.9	1.0	1.1	1.2	1.3	1.3	1.4	1.5	1.6	1.6	1.7	1.8	1.8	1.9	2.0	2.0
55	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.2	2.3	2.3	2.4	2.5
60	1.6	1.7	1.8	1.9	2.0	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.0	3.1
65	2.1	2.2	2.3	2.4	2.6	2.7	2.8	2.9	3.0	3.2	3.3	3.4	3.5	3.6	3.7	3.8
70	2.7	2.8	3.0	3.1	3.3	3.4	3.6	3.7	3.9	4.0	4.1	4.3	4.4	4.5	4.6	4.8
75	3.6	3.7	3.9	4.1	4.3	4.5	4.7	4.8	5.0	5.2	5.3	5.5	5.6	5.8	6.0	6.1
80	4.9	5.1	5.3	5.6	5.8	6.0	6.3	6.5	6.7	6.9	7.1	7.3	7.5	7.7	7.9	8.1
85	7.0	7.3	7.7	8.0	8.3	8.6	8.9	9.2	9.5	9.8	10.1	10.4	10.7	10.9	11.2	11.5
90	11.3	11.8	12.3	12.8	13.3	13.8	14.3	14.7	15.2	15.6	16.1	16.5	17.0	17.4	17.8	18.2
95	24.2	25.2	26.3	27.3	28.3	29.3	30.3	31.2	32.1	33.1	34.0	34.9	35.7	36.6	37.5	38.3

TABLE A4 External Temperature -10°C

%RH	Internal Temperature °C															
	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
30	0.5	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.1
35	0.6	0.7	0.7	0.8	0.8	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.3
40	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.4	1.5	1.5	1.6	1.6	1.7
45	1.1	1.2	1.2	1.3	1.4	1.4	1.5	1.6	1.6	1.7	1.7	1.8	1.9	1.9	2.0	2.0
50	1.4	1.5	1.6	1.6	1.7	1.8	1.9	1.9	2.0	2.1	2.1	2.2	2.3	2.3	2.4	2.5
55	1.8	1.9	2.0	2.1	2.1	2.2	2.3	2.4	2.5	2.5	2.6	2.7	2.8	2.8	2.9	3.0
60	2.2	2.4	2.5	2.6	2.7	2.8	2.8	2.9	3.0	3.1	3.2	3.3	3.4	3.5	3.6	3.6
65	2.8	3.0	3.1	3.2	3.3	3.4	3.5	3.7	3.8	3.9	4.0	4.1	4.2	4.3	4.4	4.5
70	3.6	3.8	3.9	4.0	4.2	4.3	4.5	4.6	4.7	4.9	5.0	5.1	5.2	5.4	5.5	5.6
75	4.7	4.9	5.1	5.2	5.4	5.6	5.7	5.9	6.1	6.2	6.4	6.5	6.7	6.8	7.0	7.1
80	6.3	6.5	6.8	7.0	7.2	7.4	7.7	7.9	8.1	8.3	8.5	8.7	8.9	9.1	9.3	9.4
85	9.0	9.3	9.6	9.9	10.2	10.5	10.8	11.1	11.4	11.7	12.0	12.2	12.5	12.8	13.0	13.3
90	14.4	14.9	15.4	15.8	16.3	16.8	17.2	17.6	18.1	18.5	18.9	19.3	19.8	20.2	20.6	20.9
95	30.5	31.5	32.5	33.4	34.4	35.3	36.3	37.2	38.1	38.9	39.8	40.7	41.5	42.3	43.1	43.9

Vapour pressures (kPa)

TABLE A5

%RH	Temperature °C																	
	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11	12
30	0.12	0.13	0.14	0.16	0.17	0.18	0.20	0.21	0.23	0.24	0.26	0.28	0.30	0.32	0.34	0.37	0.39	0.42
35	0.14	0.15	0.17	0.18	0.20	0.21	0.23	0.25	0.27	0.28	0.30	0.33	0.35	0.37	0.40	0.43	0.46	0.49
40	0.16	0.17	0.19	0.21	0.22	0.24	0.26	0.28	0.30	0.32	0.35	0.37	0.40	0.43	0.46	0.49	0.52	0.56
45	0.18	0.20	0.21	0.23	0.25	0.27	0.30	0.32	0.34	0.37	0.39	0.42	0.45	0.48	0.52	0.55	0.59	0.63
50	0.20	0.22	0.24	0.26	0.28	0.31	0.33	0.35	0.38	0.41	0.44	0.47	0.50	0.54	0.57	0.61	0.66	0.70
55	0.22	0.24	0.26	0.28	0.31	0.34	0.36	0.39	0.42	0.45	0.48	0.51	0.55	0.59	0.63	0.67	0.72	0.77
60	0.24	0.26	0.29	0.31	0.34	0.37	0.39	0.42	0.45	0.49	0.52	0.56	0.60	0.64	0.69	0.74	0.79	0.84
65	0.26	0.28	0.31	0.34	0.37	0.40	0.43	0.46	0.49	0.53	0.57	0.61	0.65	0.70	0.75	0.80	0.85	0.91
70	0.28	0.31	0.33	0.36	0.39	0.43	0.46	0.49	0.53	0.57	0.61	0.65	0.70	0.75	0.80	0.86	0.92	0.98
75	0.30	0.33	0.36	0.39	0.42	0.46	0.49	0.53	0.57	0.61	0.65	0.70	0.75	0.80	0.86	0.92	0.98	1.05
80	0.32	0.35	0.38	0.41	0.45	0.49	0.52	0.56	0.61	0.65	0.70	0.75	0.80	0.86	0.92	0.98	1.05	1.12
85	0.34	0.37	0.40	0.44	0.48	0.52	0.56	0.60	0.64	0.69	0.74	0.79	0.85	0.91	0.97	1.04	1.11	1.19
90	0.36	0.39	0.43	0.47	0.51	0.55	0.59	0.63	0.68	0.73	0.78	0.84	0.90	0.96	1.03	1.10	1.18	1.26
95	0.38	0.42	0.45	0.49	0.53	0.58	0.62	0.67	0.72	0.77	0.83	0.89	0.95	1.02	1.09	1.17	1.25	1.33
100*	0.40	0.44	0.48	0.52	0.56	0.61	0.66	0.70	0.76	0.81	0.87	0.93	1.00	1.07	1.15	1.23	1.31	1.40

TABLE A5 Continued

%RH	Temperature °C																	
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
30	0.45	0.48	0.51	0.54	0.58	0.62	0.66	0.70	0.75	0.79	0.84	0.89	0.95	1.01	1.07	1.13	1.20	1.27
35	0.52	0.56	0.60	0.64	0.68	0.72	0.77	0.82	0.87	0.92	0.98	1.04	1.11	1.18	1.25	1.32	1.40	1.48
40	0.60	0.64	0.68	0.73	0.77	0.82	0.88	0.93	0.99	1.06	1.12	1.19	1.27	1.34	1.42	1.51	1.60	1.70
45	0.67	0.72	0.77	0.82	0.87	0.93	0.99	1.05	1.12	1.19	1.26	1.34	1.42	1.51	1.60	1.70	1.80	1.91
50	0.75	0.80	0.85	0.91	0.97	1.03	1.10	1.17	1.24	1.32	1.40	1.49	1.58	1.68	1.78	1.89	2.00	2.12
55	0.82	0.88	0.94	1.00	1.06	1.13	1.21	1.28	1.37	1.45	1.54	1.64	1.74	1.85	1.96	2.08	2.20	2.33
60	0.90	0.96	1.02	1.09	1.16	1.24	1.32	1.40	1.49	1.58	1.68	1.79	1.90	2.01	2.14	2.27	2.40	2.54
65	0.97	1.04	1.11	1.18	1.26	1.34	1.43	1.52	1.61	1.72	1.82	1.94	2.06	2.18	2.32	2.45	2.60	2.76
70	1.05	1.12	1.19	1.27	1.35	1.44	1.54	1.63	1.74	1.85	1.96	2.09	2.22	2.35	2.49	2.64	2.80	2.97
75	1.12	1.20	1.28	1.36	1.45	1.55	1.65	1.75	1.86	1.98	2.10	2.24	2.37	2.52	2.67	2.83	3.00	3.18
80	1.20	1.28	1.36	1.45	1.55	1.65	1.76	1.87	1.99	2.11	2.25	2.38	2.53	2.69	2.85	3.02	3.20	3.39
85	1.27	1.36	1.45	1.54	1.64	1.75	1.87	1.99	2.11	2.24	2.39	2.53	2.69	2.85	3.03	3.21	3.40	3.61
90	1.35	1.44	1.53	1.63	1.74	1.86	1.98	2.10	2.24	2.38	2.53	2.68	2.85	3.02	3.21	3.40	3.60	3.82
95	1.42	1.52	1.62	1.73	1.84	1.96	2.08	2.22	2.36	2.51	2.67	2.83	3.01	3.19	3.38	3.59	3.80	4.03
100*	1.50	1.60	1.70	1.82	1.94	2.06	2.19	2.34	2.48	2.64	2.81	2.98	3.16	3.36	3.56	3.78	4.00	4.24

*100%RH = saturated vapour pressure