



Apache-Tables User Guide

IES Virtual Environment 6.4

Apache

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Table 1 Ground Reflectance

General Situation	Typical Kr
Temperate localities	0.2
Tropical localities (humid)	0.2
Tropical localities (arid)	0.5

Source: CIBSE Guide

Environment	Typical Kr
Snow (fresh)	0.8 - 0.9
Snow (old)	0.45 - 0.7
Water	0.1 - 0.2
Ice	0.7
Grass	0.25
Crops & woodland	0.2
Concrete	0.3
Brick	0.2 - 0.4
Asphalt	0.15

Source: Climate in the UK by Page & Lebens.

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Table 2 Precipitable Water Vapour Depth (In Metres)

Altitude	Latitude				
(air pressure)	0	30	45	60	70
Warm or wet season					
1000 mb mean	0.05	0.04	0.025	0.02	0.018
min.	0.02	0.02	0.01	0.007	0.007
max.	0.1	0.07	0.04	0.04	0.04
900 mb mean	0.03	0.019	0.016	0.012	0.011
				5	
min.	0.01	0.007	0.007	0.004	0.004
max.	0.07	0.04	0.04	0.02	0.02
800 mb mean	0.02	0.015	0.01	0.008	0.007
min.	0.01	0.007	0.004	0.004	0.002
max.	0.04	0.04	0.02	0.02	0.02
700 mb mean	0.01	0.008	0.005	0.004	0.003
					5
min.	0.004	0.004	0.002	0.002	0.001
max.	0.02	0.02	0.01	0.01	0.01
Cold or dry season					
1000 mb mean	0.03	0.015	0.008	0.005	0.003
min.	0.01	0.004	0.004	0.002	0.001
max.	0.07	0.04	0.02	0.01	0.01
900 mb mean	0.02	0.01	0.005	0.003	0.002
				5	
min.	0.007	0.004	0.002	0.002	0.001
max.	0.04	0.02	0.01	0.01	0.007

800 mb mean	0.01	0.006	0.003	0.002	0.001
min.	0.004	0.002	0.001	0.001	0.000 5
max.	0.02	0.02	0.01	0.007	0.002
700 mb mean	0.006	0.003	0.001 5	0.001	0.000 5
min.	0.002	0.001	0.001	0.000 5	0.000 2
max.	0.01	0.01	0.004	0.002	0.001

From 'Solar Radiation', ed. by N. Robinson. Maps from Engineering Data Unit.

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Table 3 Dry-Bulb Temperatures

See CIBSE Guide A Table A2.28.

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Table 4 World Weather Data

See CIBSE Guide A Table A2.19.

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Table 5 U-Values for Glazing

Without Frames

Construction	Shelt ered	No rm al	Se ver e
Single window glazing	5	5.6	6.7
Double window glazing with airspace			
25 mm or more	2.8	2.9	3.2
12 mm	2.8	3	3.3
6 mm	3.2	3.4	3.8
3 mm	3.6	4	4.4
Triple window glazing with airspace			
25 mm or more	1.9	2	2.1
12 mm	2	2.1	2.2
6 mm	2.3	2.5	2.6
3 mm	2.8	3	3.3
Roof glazing skylight	5.7	6.6	7.9
Horizontal laylight with skylight or lantern light over ventilated unventilated	3.5 2.8	3.8 3	4.2 3.3

With Frames

Window type	Fraction of area occupied by frame	Sheltered	Normal	Severe
SINGLE GLAZING				
Wood frame	10%	4.7	5.3	6.3
	20%	4.5	5	5.9
	30%	4.2	4.7	5.5
Aluminium frame (no thermal break)	10%	5.3	6	7.1
	20%	5.6	6.4	7.5
	30%	5.9	6.7	7.9
(with thermal break)	10%	5.1	5.7	6.7
	20%	5.2	5.8	6.8
	30%	5.2	5.8	6.8
DOUBLE GLAZING				
Wood frame	10%	2.8	3	3.2
	20%	2.7	2.9	3.2
	30%	2.7	2.9	3.1
Aluminium frame (no thermal break)	10%	3.3	3.6	4.1
	20%	3.9	4.3	4.8

	30%	4.4	4.9	5.6
Aluminium frame				
(with thermal break)	10%	3.1	3.3	3.7
	20%	3.4	3.7	4
	30%	3.7	4	4.4

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Table 6 Thermal Conductivity, Specific Heat Capacity and Density

System Material Database

Material Description	Conductivity (W/mK)	Sp. Heat Capacity (J/kgK)	Density (kg/m3)
Asphalts & Other Roofing Finishes			
Asbestos Cement Decking	0.360	1050	1500
Asbestos Cement Sheet	0.360	1050	700
Asphalt	0.500	1000	1700
Felt/Bitumen Layers	0.500	1000	1700
Asphalt/Asbestos Tiles	0.550	837	1900
Roofing Felt	0.190	837	960
Asphalt Mastic Roofing	1.150	837	2325
Built-Up Roof – BR01	0.162	1464	1121
Roof Gravel/Slag – RG01	1.442	881	1674

Boards, Sheets & Deckings

Asbestos Cement Decking	0.360	1050	1500
Asbestos Cement Sheet	0.360	1050	700
Fibreboard	0.060	1000	300
Gypsum Plasterboard	0.160	840	950
Polyurethane Board	0.025	1400	30
Hardboard (Medium)	0.080	2000	600
Hardboard (Standard)	0.130	2000	900
Cork Board	0.040	1888	160
Chipboard	0.150	2093	800
Weatherboard	0.140	2000	650
Perlite Plasterboard	0.180	837	800

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Cratherm Board	0.050	837	176
Anti-Sun Glass Cladding	1.050	750	2500
Plate-Glass Cladding	0.760	837	2710
4mm Clear Float Cladding	1.050	750	2500
Lightweight Metallic Cladding	0.290	1000	1250
Asbestos-Cement Board	0.580	1000	1900
Fibreboard – Tile & Lay-In Panel	0.058	600	290
Paperboard – Laminated	0.072	1400	480
Hardboard – Medium Density	0.105	1300	800
Paperboard – Homogeneous From Repulped Paper	0.072	1200	480
Hardboard – High Density	0.820	1300	880
Hardboard – Standard Tempered Grade	0.144	1300	1010
Particleboard – Low Density	0.102	1300	590
Particleboard – Medium Density	0.135	1300	800
Particleboard – High Density	0.170	1300	1000
Asbestos-Cement Board – AB01	0.597	837	1922
Cement Mortar – CM01	0.721	837	1858
Particle Board Underlay – PB04	0.311	1213	1202
Hard Board Medium Density Siding – HB01	0.094	1171	641
Hard Board Medium Density Others – HB02	0.105	1297	801
Hard Board High Density – HB03	0.118	1381	881
Hard Board High Density Standard Service Tempered – HB04	0.144	1381	1009
Brick & Block Work			
Brickwork (Outer Leaf)	0.840	800	1700
Brickwork (Inner Leaf)	0.620	800	1700
Concrete Block (Heavyweight)	1.630	1000	2300
Concrete Block (Medium)	0.510	1000	1400

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Concrete Block (Lightweight)	0.190	1000	600
Concrete Paviour	0.960	840	2000
Foam Slag	0.250	960	1040
Vermiculite Insulating Brick	0.270	837	700
Aerated Concrete Block	0.240	1000	750
Thermalite - High Strength	0.190	1050	760
Thermalite 'Turbo'	0.110	1050	480
Thermalite 'Shield'/'Smooth Face'	0.170	1050	650
Glass Block	0.700	837	2500
Common Brick – BK01	0.721	837	1922
Face Brick – BK04	1.310	921	2083
Face Brick – HF-A2	1.331	921	2083
Face Brick – HF-A7	1.331	921	2003
Common Brick – HF-C4	0.727	837	1922

Carpet

Wilton Carpet	0.060	1360	186
Simulated Sheeps Wool	0.060	1360	198
Wool Felt Underlay	0.040	1360	160
Cellular Rubber Underlay	0.100	1360	400
Synthetic Carpet	0.060	2500	160

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Concrete

Aerated Concrete Slab	0.160	840	500
Cast Concrete (Dense)	1.400	840	2100
Cast Concrete (Lightweight)	0.380	1000	1200
Cast Concrete	1.130	1000	2000
Concrete Block (Heavyweight)	1.630	1000	2300
Concrete Block (Medium)	0.510	1000	1400
Concrete Block (Lightweight)	0.190	1000	600
Concrete Paviour	0.960	840	2000
Foam Slag	0.250	960	1040
Aerated Concrete Block	0.240	1000	750
Refractory Insulating Concrete	0.250	837	1050
Vermiculite Aggregate	0.170	837	450
Concrete Tiles	1.100	837	2100
Heavyweight Concrete Dried Aggregate – CC01	1.310	837	2243
Heavyweight Concrete Undried Aggregate – CC11	1.802	837	2243
Heavyweight Concrete Undried Aggregate – HF-C12	1.730	837	2243
Lightweight Concrete – 80 Lbs – CC21	0.36	837	1282
Lightweight Concrete – 30 Lbs – CC31	0.130	837	481
Lightweight Concrete – 40 Lbs – HF-C14	0.173	837	641
Lightweight Concrete – HF-C2	0.380	837	609
Heavyweight Concrete Block - Hollow – CB01	0.812	837	1618
Heavyweight Concrete Block - Concrete-Filled – CB02	1.310	837	2234
Heavyweight Concrete Block - Perlite-Filled – CB03	0.384	837	1650
Heavyweight Concrete Block – Part-Filled Concrete – CB04	1.011	837	1826
Heavyweight Concrete Block –	0.825	837	1842

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Concrete and Perlite-Filled – CB05			
Mediumweight Concrete Block - Hollow – CB21	0.519	837	1218
Mediumweight Concrete Block - Concrete-Filled – CB22	0.771	837	1842
Mediumweight Concrete Block - Perlite-Filled – CB23	0.262	837	1250
Mediumweight Concrete Block – Part-Filled Concrete – CB24	0.572	837	1426
Mediumweight Concrete Block – Concrete and Perlite-Filled – CB25	0.431	837	1442
Lightweight Concrete Block - Hollow – CB41	0.384	837	1041
Lightweight Concrete Block - Concrete-Filled – CB42	0.639	837	1666
Lightweight Concrete Block - Perlite-Filled – CB43	0.220	837	1073
Lightweight Concrete Block – Part- Filled Concrete – CB44	0.486	837	1250
Lightweight Concrete Block – Concrete and Perlite-Filled – CB45	0.360	837	1266

Gravels, Beddings Etc.

Stone Chippings	0.960	1000	1800
Gravel	0.360	840	1840
Gravel-Based Soil	0.520	184	2050
Tile Bedding	1.400	650	2100

Insulating Materials

Eps Slab	0.035	1400	25
Silicon	0.180	1004	700
Glass-Fibre Quilt	0.040	840	12
Glass-Fibre Slab	0.035	1000	25
Mineral Fibre Slab	0.035	1000	30

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Phenolic Foam	0.040	1400	30
Polyurethane Board	0.025	1400	30
Uf Foam	0.040	1400	10
Wood Wool Slab	0.100	1000	500
Vermiculite Insulating Brick	0.270	837	700
Refractory Insulating Concrete	0.250	837	1050
Glasswool	0.040	670	200
Thermalite - High Strength	0.190	1050	760
Thermalite 'Turbo'	0.110	1050	480
Thermalite 'Shield'/'Smooth Face'	0.170	1050	650
Siporex	0.120	1004	550
P.V.C	0.160	1004	1379
Polystyrene	0.030	1380	25
Hard Rubber	0.150	1000	1200
Cratherm Board	0.050	837	176
Uf Foam Two	0.030	1764	30
Uf Foam Two	0.030	1764	30
Lightweight Metallic Cladding	0.290	1000	1250
Dense Eps Slab Insulation (styrofoam)	0.025	1400	30
Cellular Glass	0.050	800	136
Glass-Fibre – Organic Bonded	0.036	1000	100
Expanded Perlite – Organic Bonded	0.052	1300	16
Expanded Rubber - Rigid	0.032	1700	72
Cellular Polyurethane	0.023	1600	24
Cellular Polyisocyanurate	0.023	900	32
Cellular Phenolic – Mineral Fibre With Resin Binder	0.042	700	240
Cement Fibre Slab – Shredded Wood With Magnesia Oxysulfide Cement Binder	0.082	1300	350
Vermiculite - Exfoliated	0.068	1300	120
Felt & Membrane – Felt – HF-E3	0.190	1674	1121

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Felt & Membrane – Finish – HF-A6	0.415	1088	1249
Mineral Wool/Fibre – Batt – IN01	0.043	837	10
Mineral Wool/Fibre – Fill – IN11	0.046	837	10
Mineral Wool/Fibre – Fill – IN12	0.046	837	11
Cellulose Fill – IN13	0.039	1381	48
Insulation Board – HF-B2	0.043	1381	48
Insulation Board – HF-B5	0.043	837	32
Preformed Mineral Board – IN21	0.042	711	240
Expanded Polystyrene – IN31	0.035	1213	29
Expanded Polyurethane – IN41	0.023	1590	24
Urea Formaldehyde – IN51	0.035	1255	11
Insulation Board Sheathing – IN61	0.055	1297	288
Insulation Board Shingle Backer – IN63	0.058	1297	288
Insulation Board Nail Base Sheathing – IN64	0.064	1297	400
Preformed Roof Insulation – IN71	0.052	837	256

Metal

Steel	50.000	480	7800
Copper	200.000	418	8900
Aluminium	160.000	896	2800
Lightweight Metallic Cladding	0.290	1000	1250
Steel Siding – HF-A3	44.970	418	7690

Plaster

Plaster (Dense)	0.500	1000	1300
Plaster (Lightweight)	0.160	1000	600
Gypsum Plasterboard	0.160	840	950
Perlite Plasterboard	0.180	837	800
Gypsum Plastering	0.420	837	1200

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Perlite Plastering	0.080	837	400
Vermiculite Plastering	0.200	837	720
Plaster Ceiling Tiles	0.380	840	1120
Cement Plaster	0.720	800	1860
Perlite Plaster	0.220	1300	720
Perlite Plaster – Sand Aggregate	0.810	800	1680
Cement Plaster – With Sand Aggregate – CM03	0.721	837	1858
Gypsum/ Plaster Board – HF-E1	0.160	837	801
Gypsum Plaster Lightweight Aggregate– GP04	0.230	837	721
Gypsum Plaster – Sand Aggregate– GP06	0.819	837	1682

Screeds And Renders

External Rendering	0.500	1000	1300
Screed	0.410	840	1200
Granolithic Render/Screed	0.870	837	2085
Stucco – HF-A1	0.721	837	2659

Sands, Stones And Soils

Stone Chippings	0.960	1000	1800
Gravel	0.360	840	1840
Gravel-Based Soil	0.520	184	2050
Sandstone	1.830	712	2200
Granite (Red)	2.900	900	2650
Marble (White)	2.770	802	2600
Cultivated Sandy Soil 12.5%D.W. Moisture	1.790	1190	1800
Cultivated Sandy Soil 25.0%D.W. Moisture	2.220	1480	2000
Cultivated Clay Soil 12.5%D.W. Moisture	1.180	1250	1800

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Cultivated Clay Soil 25.0%D.W. Moisture	1.590	1550	2000
Cultivated Peat Soil 133%D.W. Moisture	0.290	3300	700
Cultivated Peat Soil 366%D.W. Moisture	0.500	3650	1100
Dry Limestone Sub-Soil	1.490	840	2180
London Clay	1.410	1000	1900
Soil	1.729	837	1842
Stone – ST01	1.802	837	2243
Stone – HF-A3	1.435	1674	881
Terrazzo – TZ01	1.802	837	2243

Tiles

Clay Tile	0.840	800	1900
Concrete Tiles	1.100	837	2100
Slate Tiles	2.000	753	2700
Plastic Tiles	0.500	837	1950
Rubber Tiles	0.300	2000	1600
Cork Tiles	0.080	1800	530
Asphalt/Asbestos Tiles	0.550	837	1900
P.V.C./Asbestos Tiles	0.850	837	2000
Ceiling Tiles	0.056	1000	380
Plaster Ceiling Tiles	0.380	840	1120
Lightweight Metallic Cladding	0.290	1000	1250
Acoustical Tile – Mineral Fibreboard	0.050	800	290
Acoustic Tile - AC01	0.057	1339	288
Acoustic Tile – HF-E5	0.061	2142	480
Hollow Clay Tile – 1 Cell – CT01	0.498	837	1121
Hollow Clay Tile – 2 Cells – CT03	0.571	837	1121
Hollow Clay Tile – 3 Cells – CT06	0.692	837	1121
Clay Tile – HF-C1	0.571	837	1121

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Paver – Clay Tile – CT11	1.802	837	1922
Slate – SL01	1.442	1464	1602

Timber

Timber Flooring	0.140	1200	650
Plywood (Lightweight)	0.150	2500	560
Plywood (Heavyweight)	0.150	1420	700
Wood Blocks	0.140	1200	650
Wood Wool Slab	0.100	1000	500
Hardboard (Medium)	0.080	2000	600
Hardboard (Standard)	0.130	2000	900
Pine (20% Moist)	0.140	2720	419
Cork Board	0.040	1888	160
Chipboard	0.150	2093	800
Weatherboard	0.140	2000	650
Oak (Radial)	0.190	2390	700
Cork Tiles	0.080	1800	530
Plywood – PW01	0.115	1213	545
Soft Wood – WD01	0.115	1381	513
Hard Wood – WD11	0.158	1255	721
Wood – HF-B7	0.121	837	593
Plywood – Douglas Fir	0.120	1200	540
Shingle Wood – WS01	0.115	1255	513

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Table 7 Reflectance, Absorbance and Transmittance of Glazing Materials

Description	Refl	Absorp	Trans	Refr
Clear Float 4mm	0.07	0.11	0.82	1.526
Clear Float 6mm	0.07	0.15	0.78	1.526
Clear Float 10mm	0.07	0.23	0.7	1.526
Clear Float 12mm	0.06	0.27	0.67	1.526
'Spectrafloat' 6mm 51/65 (Bronze)	0.1	0.36	0.54	1.526
'Antisun' Float 6mm 72/62 (Green)	0.05	0.49	0.46	1.526
'Antisun' Float 4mm 55/68 (Grey)	0.05	0.4	0.55	1.526
'Antisun' Float 6mm 42/60 (Grey)	0.05	0.53	0.42	1.526
'Antisun' Float 10mm 25/49 (Grey)	0.04	0.71	0.25	1.526
'Antisun' Float 12mm 19/45 (Grey)	0.04	0.77	0.19	1.526
'Antisun' Float 4mm 61/70 (Bronze)	0.06	0.36	0.58	1.526
'Antisun' Float 6mm 50/62 (Bronze)	0.05	0.49	0.46	1.526
'Antisun' Float 10mm 33/51 (Bronze)	0.04	0.67	0.29	1.526
'Antisun' Float 12mm 27/47 (Bronze)	0.04	0.73	0.23	1.526
'Antisun' Float 6mm 54/62 (Blue)	0.05	0.49	0.46	1.526
Reflectafloat 6mm 35/53 (Silver)	0.28	0.29	0.43	1.526
'Suncool' Classic 6mm 20/33 (Blue)	0.21	0.64	0.15	1.526
'Suncool' Classic 6mm 30/39 (Blue)	0.18	0.61	0.21	1.526
'Suncool' Classic 6mm 40/50 (Blue)	0.1	0.58	0.32	1.526
'Suncool' Classic 6mm 10/24 (Bronze)	0.21	0.73	0.06	1.526
'Suncool' Classic 6mm 10/23 (Silver)	0.32	0.6	0.08	1.526
'Suncool' Classic 6mm 20/34 (Silver)	0.18	0.66	0.16	1.526
'Suncool' Classic 10mm 10/33 (Blue)	0.19	0.66	0.15	1.526
'Suncool' Classic 10mm 30/38 (Blue)	0.17	0.63	0.2	1.526
'Suncool' Classic 10mm 40/49 (Blue)	0.09	0.6	0.31	1.526
'Suncool' Classic 10mm 10/24 (Bronze)	0.19	0.76	0.05	1.526
'Suncool' Classic 10mm 10/23 (Silver)	0.3	0.62	0.08	1.526
'Suncool' Classic 10mm 20/34 (Silver)	0.16	0.69	0.15	1.526
'Suncool' Classic 6mm 20/34 (Silver)	0.18	0.66	0.16	1.526
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'Suncool' Classic 10mm 20/33 (Blue)	0.19	0.66	0.15	1.526
Stopsol 4mm (Clear)	0.25	0.22	0.53	1.526
Stopsol 5mm (Clear)	0.25	0.24	0.51	1.526
Stopsol 6mm (Clear)	0.25	0.25	0.5	1.526
Stopsol 8mm (Clear)	0.25	0.28	0.47	1.526
Stopsol 10mm (Clear)	0.24	0.31	0.45	1.526
Stopsol 4mm (Bronze)	0.27	0.38	0.35	1.526
Stopsol 5mm (Bronze)	0.27	0.41	0.32	1.526
Stopsol 6mm (Bronze)	0.26	0.45	0.29	1.526
Stopsol 8mm (Bronze)	0.26	0.51	0.23	1.526
Stopsol 10mm (Bronze)	0.26	0.56	0.18	1.526
Stopsol 6mm (Silver)	0.2	0.37	0.43	1.526
Kappafloat 4mm (Champagne)	0.17	0.22	0.61	1.526
Kappafloat 4mm (Neutral)	0.2	0.14	0.66	1.526
Kappafloat 6mm (Champagne)	0.16	0.26	0.58	1.526
Kappafloat 6mm (Neutral)	0.2	0.17	0.63	1.526
Saflex Blue-Green (Light) 5.4mm	0.07	0.19	0.74	1.526
Saflex Blue-Grey (Light) 5.4mm	0.06	0.4	0.54	1.526
Saflex Blue-Grey (Medium) 6.2mm	0.05	0.59	0.36	1.526
Saflex Bronze 5.4mm	0.06	0.41	0.53	1.526
Saflex Bronze (Light) 5.4mm	0.06	0.37	0.57	1.526
Saflex Bronze (Medium) 5.7mm	0.05	0.56	0.39	1.526
Saflex Green-Blue (Light) 5.3mm	0.07	0.18	0.75	1.526
Saflex Grey 5.4mm	0.05	0.51	0.44	1.526
Saflex Grey-Green (Light) 5.4mm	0.06	0.42	0.52	1.526
Saflex Marine Blue (Light) 5.3mm	0.06	0.35	0.59	1.526
Saflex Marine Blue (Medium) 5.3mm	0.05	0.56	0.39	1.526
Saflex Pink (Light) 6.3mm	0.06	0.31	0.63	1.526
Saflex Translucent White 6.1mm	0.06	0.37	0.57	1.526
Saflex Shadowlite Smoke Brown (L) 5.4mm	0.06	0.39	0.55	1.526
Saflex Shadowlite Smoke Brown (M) 5.3mm	0.05	0.67	0.28	1.526

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6.3		2

Saflex Shadowlite Smoke Brown (D) 6.3mm	0.04	0.86	0.1	1.526
Polycarbonate 3mm Clear	0.09	0.09	0.82	1.6
Acrylic 3mm Clear	0.09	0.06	0.85	1.49
Luxguard 6mm (Bright Silver) Cs-14	0.27	0.61	0.12	1.526
Luxguard 6mm (Bright Silver) Cs-20	0.22	0.61	0.17	1.526
Luxguard 6mm (Bright Silver) Cs-35	0.14	0.54	0.32	1.526
Luxguard 6mm (Pewter) Cp-14	0.2	0.66	0.14	1.526
Luxguard 6mm (Pewter) Cp-20	0.16	0.65	0.19	1.526
Luxguard 6mm (Pewter) Cp-35	0.09	0.58	0.33	1.526
Luxguard 6mm (Bronze) Cb-14	0.18	0.69	0.13	1.526
Luxguard 6mm (Bronze) Cb-20	0.13	0.68	0.19	1.526
Luxguard 6mm (Bronze) Cb-35	0.08	0.6	0.32	1.526
Luxguard 6mm (Royal Blue) Cr-14	0.17	0.7	0.13	1.526
Luxguard 6mm (Royal Blue) Cr-20	0.12	0.69	0.19	1.526
Luxguard 6mm (Royal Blue) Cr-35	0.07	0.61	0.32	1.526
Thermoclear 8mm Polycarbonate Sheeting	0.05	0.8	0.15	1.59
Thermoclear 16mm Polycarbonate Sheeting	0.08	0.7	0.22	1.59
Perfectly Clear Glazing Material	0	0	1	1

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Note:

The figures for Kappafloat are for viewing the glass from the coated side, i.e. when the Kappafloat is the inside pane. If the Kappafloat is used as the outside pane then values should be obtained from another source.

The Saflex and Saflex Shadowlite glasses are laminated glass with a 0.38mm interlayer

The refractive index for the plastic materials listed (GRP, PC) will NOT be the same as for glass.

Sources of above data:

Pilkington, Transmission Properties of Windows July 85 Glaverbel, Reflective Glazing Monsanto, Solar Control J.Page and R.Lebens, Climate in the United Kingdom.

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Table 8 Shading Coefficient and Short-wave Radiant Fraction for Blinds and Curtains

Shading device	Shading Coefficient	Short-wave Radiant Fraction
Dark green open-weave plastic blind	0.81	0.5
Venetian blind	0.61	0.3
White cotton curtain	0.54	0.3
Cream Holland linen blind	0.40	0.3
Mid-pane Venetian blind	0.44	0.4
<i>(From BRE data)</i>		
Net curtain (fine)	0.76	
Net curtain (open weave)	0.85	
Venetian blind (open)	0.83	
Venetian blind (closed)	0.56	
Light curtain (closed)	0.49	
<i>(From ETSU data for white room 1987)</i>		

Note: A shading coefficient of 0 means full shading, and a coefficient of 1 means no shading.

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Table 9 Transmission Factors for External Miniature Louvres

Vertical Shadow Angle (°)	Transmission	
	Standard Koolshade	Low-Sun Angle KoolShade
0	0.65	0.5
15	0.4	0.2
30	0.2	0
45	0	0
60	0	0
75	0	0
90	0	0

From Colt KoolShade leaflet.

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Table 10 Sensible and Latent Gains from People

Sensible (S) and latent (L) heat emissions (in Watts) from an adult human male with a body surface area of 2m². Further information on people gains can be found in Section 1.4 of CIBSE Guide A.

Degree of Activity	20°C		22°C	
	Sensible	Latent	Sensible	Latent
Seated at rest	90	25	80	35
Light work	100	40	90	50
Walking slowly	110	50	100	60
Light bench work	130	105	115	120
Medium work	140	125	125	140
Heavy work	190	250	165	275

Sensible and latent gains from machinery etc. can be found in Section 6 of CIBSE Guide A.

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Table 11 Radiant Fraction for Casual Gains

Source	r.f.
fluorescent light	0.45
tungsten light	0.85
high-pressure discharge lamp	0.62
people	0.20
computer equipment	0.22

Radiant fractions for plane surfaces in a room at 20°C.

Surfaces are assumed to have emissivity of 0.9.

Surface Temperature (°C)	Vertical surface	Horizontal Surface looking down	Horizontal Surface looking up
5	0.58	0.53	0.79
30	0.64	0.83	0.6
50	0.58	0.8	0.53
70	0.56	0.8	0.52
100	0.56	0.8	0.51
200	0.6	0.84	0.56
300	0.67	0.87	0.62
400	0.73	0.9	0.69

Table 12 Winter Design Temperatures and Air Changes

Type of building	Temperature (°C)	Air changes (/h)
Art galleries and museums	20	1
Assembly halls, lecture halls	18	0.5
Banking halls:		
large (height over 4 m)	20	1
small (height less than 4 m)	20	1.5
Bars	18	1
Canteens and dining rooms	20	1
Churches and chapels:		
up to 7000 m ²	18	0.5
over 7000 m ²	18	0.25
vestries	20	1
Dining and banqueting halls	21	0.5
Exhibition halls:		
large (height over 4 m)	18	0.25
small (height less than 4 m)	18	0.5
Factories: sedentary work	19	see note
light work	16	below
heavy work	13	

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Fire stations, ambulance
stations:

appliance rooms	15	0.5
watch rooms	20	0.5
recreation rooms	18	1

Flats, residences and hostels:

living rooms	21	1
bedrooms	18	0.5
Bed sitting rooms	21	1
bathrooms	22	2
lavatories and cloakrooms	18	1.5
service rooms	16	0.5
staircases and corridors	16	1.5
entrance halls and foyers	16	1.5
public rooms	21	1

Gymnasiums	16	0.75
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Hospitals:

corridors	16	1
offices	20	1
operating theatre suite	18-21	0.5
stores	15	0.5
wards and patient areas	18	2
waiting rooms	18	1

Hotels:

bedrooms (standard)	22	1
bedrooms (luxury)	24	1
public rooms	21	1
staircases and corridors	18	1.5

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entrance halls and foyers	18	1.5
Laboratories	20	1
Law Courts	20	1
Libraries:		
reading rooms (height over 4 m)	20	0.5
reading rooms (height below 4 m)	20	0.75
stack rooms	18	0.5
store rooms	15	0.25
Offices: general	20	1
private	20	1
stores	15	0.5
Police stations: cells	18	5
Restaurants and tea shops	18	1
Schools and colleges:		
classrooms	18	2
lecture rooms	18	1
studios	18	1
Shops and showrooms:		
small	18	1
large	18	0.5
department store	18	0.25
fitting rooms	21	1.5
store rooms	15	0.5

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Sports pavilions: dressing rooms	21	1
Swimming baths:		
changing rooms	22	0.5
bath halls	26	0.5
Warehouses:		
working and packing spaces	16	0.5
storage spaces	13	0.25

For infiltration rates in factories see CIBSE Guide A4, page A4_9 and Table A4.9.

The tabulated infiltration rates are based on normal exposure and on an average ratio (25%) of openable areas (windows and doors) to external wall area. If the ratio much exceeds 25% in one external wall only, increase the infiltration by one quarter; if it is the case for two or more walls, an increase of one half should be allowed. On severely exposed sites, a 50% increase should be allowed, and on sheltered sites the infiltration rate may be reduced by one third. During periods when the building is unoccupied the infiltration rate can be taken as half that obtained in normal use.

The air-change rate in rooms in tall buildings may be increased above the values given by the direct action of the wind, and by stack effect. The design of tall buildings should include barriers against vertical air movement through stairwells and shafts to minimize stack effect. If this is not done, the balance of internal temperatures can be seriously upset.

Where warm air is supplied mechanically for ventilation, rates of infiltration applicable to a closed building (i.e. half the tabulated values) should be used for calculating the room heat requirements, so that room temperatures can be maintained, if required, when the mechanical ventilation is not operating. Heat for the warm air requirements must, however, be included in the total load on the central plant.

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Table 13 Heat Emitter Radiant Fraction

Heat emitter	Radiant fraction
Forced warm air heaters	0
Natural convectors and convector radiators	0.1
Multicolumn radiators	0.2
Double and triple panel radiators and double column radiators	0.3
Single column radiators, floor warming systems, block storage heaters	0.5
Vertical and ceiling panel heaters	0.67
High temperature radiant systems	0.9

Note that if the heater is obstructed by furniture or a floor warming system is impeded by carpet on the floor, allowance must be made when calculating the heating load. For example, a radiant heater obstructed by furniture will behave more like a natural convector.

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Table 14 Solar Absorptivity

Material	Absorption
Bricks	
White glazed	0.25
Fletton light	0.4
Fletton dark	0.65
Stafford blue	0.9
White sand lime	0.4-0.5
Red sand lime	0.55-0.7
Stone	
Limestone	0.3-0.5
White marble	0.45
Red granite	0.55
Roofs	
Concrete tiles	0.65
Asphalt	0.9
Grey slates	0.8-0.9
Red tiles	0.4-0.8
Asbestos sheets, natural colour	0.6
Galvanised iron	0.65
Lead sheeting	0.8
Mortar screed	0.8
Aluminium	0.2
Copper (tarnished)	0.65
Whitewashed roof or white tile	0.3-0.5
Water	
1 m thick	0.56

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2 m thick	0.61
3 m thick	0.64
Dirty surfaces	
Light when clean	0.5
Medium when clean	0.8
Dark when clean	0.9

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Table 15 Thermal Resistances of Air Gaps

Unventilated air gaps				
Thickness	Surface emissivity	Thermal resistance (m ² K/W) for		
		Horizontal heat flow	Upward heat flow	Downward heat flow
5 mm	High	0.1	0.1	0.1
	Low	0.18	0.18	0.18
25mm or over	High	0.18	0.17	0.22
	Low	0.35	0.35	1.06
High emissivity plane and corrugated sheets in contact	High	0.09	0.09	0.11
Low emissivity multiple foil insulation with air gap on one side	Low	0.62	0.62	1.76

Ventilated air gaps

Type	Thermal resistance
Gap between asbestos cement or black metal cladding with unsealed joints and high emissivity lining	0.16
Gap between asbestos cement or black metal cladding with unsealed joints, and low emissivity surface facing gap	0.3

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Loft space between flat ceiling and
unsealed asbestos cement sheets
or
black metal cladding pitched roof 0.14

Loft space between flat ceiling and
pitched roof with aluminium
cladding
instead of black metal or low
emissivity upper surface on ceiling 0.25

Loft space between flat ceiling and
pitched roof lined with felt or
building paper 0.18

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Gap between tiles and roofing felt
or building paper 0.12

Gap between tiles on tile hung wall
(includes resistance of tile) 0.12

Gap in cavity wall construction 0.18

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Table 16 Diffusion Resistance Factors

Material	Diffusion Factor	Resistance
Brick (common)		6.7 - 10
Brick (sand lime)		8.6 - 71
Cement mortar		37.5 - 50
Concrete (pumice)		5.8 - 30
Concrete (gas)		5.1 - 11.9
Cork slab		2.5 - 15
Hardboard		80 - 200
Insulating board		2.4 - 6
Lime mortar		8.6 - 9.8
Mineral wool (bituminised)		1.55 - 1.75
Plaster		7.0 - 12
Plywood		210 - 670
Wood-wool slab		2.5 - 5.1

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Table 17 Permeances

Material	Permeance (kg / Ns) x 1E-11
Aluminium - foil	0.01 - 0.57
- foil backing plasterboard	0.025 - 0.50
Asphalt (1.1 kg/m ²)	0.6
Breather Membrane	20
Building Paper (bitumen impregnated)	10
Felt - felt laid in bitumen	0.1
Kraft Paper - single	454
double	281
three-ply	200
four-ply	174
five ply	160
Paints - emulsion	200
- gloss	2.5 - 12.5
- vapour resistant	4
Polythene Film (0.06mm)	0.4
Polyethylene - 500 gauge (0.12mm)	0.286 - 0.500
- 1000 gauge (0.25mm)	0.167 -

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0.250

Vinyl Wallpaper

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Sources of data:

BSI 5250

J.Page and R.Lebens, Climate in the United Kingdom.

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Table 18 Vapour Resistivities

Material	Resistivity	
	Typical (GN s/kg m)	Range (GN s/kg m)
Asbestos Cement Sheeting and Substitutes:	300	200 - 1000
Blockwork and Brickwork:		
Lightweight / aerated blocks	30	20 - 50
Medium weight blocks	50	30 - 80
Dense / clinker blocks	100	60 - 150
Common / facing brick	50	25 - 100
Sandlime / engineering brick	100	80 - 250
Boards etc.:		
Cork board	100	50 - 200
Chipboard	500	
Fibreboard - Plain or tile	40	15 - 60
Hardboard	600	450 - 1000
Carpeting:		
Normal backing	10	7.0 - 20.0
Foam backed or with underlay	200	100 - 300
Concrete (cast):		
Lightweight / aerated	40	30 - 80
Medium weight	100	60 - 150

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Dense	200		
No fines	20		
Insulating Materials:			
Polystyrene - expanded bead	300	100 600	-
- expanded extruded	1000	600 1300	-
Polyurethane foam (closed cell)	600	500 1000	-
Glass fibre	7		
Expanded or foamed glass	10000		
Urea formaldehyde	15	10.0 30.0	-
Vermiculite	15		
PVC sheet or tile	1000	800 1300	-
Plaster:			
Plaster	60		
Plasterboard	60		
Screeds and Renders:			
Rendering	100		
Screed	100		
Stonework:			
Granite, slate and marble	300	150 450	-
Limestone and sandstone	200	150 450	-
Tiles:			
Roofing tile or slating	250	50 300	-

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Ceramic tiling	2000	500 - 5000
Timber:		
General	60	40 - 70
Pine	500	
Plywood	1000	150 - 6000
Woodwool slabs	20	15 - 40

Source of data: BSI 5250

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Table 21 Inside Surface Resistance (Table A3.5 CIBSE Guide)

Building element	Heat flow	Surface resistance (m ² K/W)	
		High emissivity factor	Low emissivity factor
Walls	Horizontal	0.12	0.3
Ceilings or roofs, flat or pitched floors	Upward	0.1	0.22
Ceilings and floors	Downward	0.14	0.55

Notes:

1. High emissivity factor assumes $\epsilon_1 = \epsilon_2 = 0.90$ (most building materials),
Low emissivity factor assumes $\epsilon_1 = 0.90, \epsilon_2 = 0.05$,
2. Surface temperatures are 20°C
3. Air speed at the surface is assumed to be less than or equal to 0.1 m/s

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Table 22 Outside Surface Resistance (Table A3.6 CIBSE Guide)

Surface resistance for stated exposure				
Building element	Emissivity of surface	(m ² K/W)		
		Sheltered	Normal	Severe
Wall	High	0.08	0.06	0.03
	Low	0.11	0.07	0.03
Roof	High	0.07	0.04	0.02
	Low	0.09	0.05	0.02

Notes:

- 1 Form (shape) factor for radiative heat transfer is taken to be unity
- 2 High emissivity is taken as 0.9, low emissivity is taken as 0.05.

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Table 23 Emissivities of Various Materials (Table C3.7 CIBSE Guide)

Material	Surface	Emissivity
Aluminium	polished	0.04
	unoxidised	0.03
	oxidised	0.1
	anodised	0.72
Brick		0.93
Chromium	polished	0.06
	unoxidised	0.08
Clay		0.91
Copper	polished	0.02
	oxidised	0.6
Enamel		0.9
Glass		0.88
Lead	grey oxidised	0.28
	grey unoxidised	0.05
	red	0.93
Mortar		0.93
Paint		0.95
Paper		0.92
Steel	polished	0.08
	oxidised	0.79
	rolled sheet	0.6
	rough plate	0.9
Wood	beech	0.94
Zinc	galvanising	0.23

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Note emissivities quoted are normal to the surface. The hemispherical values may be obtained from the tabulated values by multiplying by the following factors:

Bright metal:	1.2
Other, smooth:	0.95
Other, rough:	0.98

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