Efficiency Matrix Pty Ltd

Efficiency Matrix – Halogen Light Mitt 2x2m System

Calculation of System R-Value and Energy Loss

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Vipac Engineers & Scientists Ltd

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EXECUTIVE SUMMARY

Vipac Engineers & Scientists Ltd (VIPAC) has been commissioned by Efficiency Matrix Pty Ltd to calculate the system R-value, in accordance with AS/NZS 4859.1:2002, for a 2m x 2m cross-section of a standard room with one gimble down light exposed following the standards of AS/NZS 3000:2007 with 200mm clearance, and the Halogen Mitt installed with standard R3.5 insulation cut to the footprint (cylindrical hole) of the Halogen Mitt. These calculations are not experimental tests, but rather engineering calculations based on AS/NZS 4859.1:2002, typical heat transfer equations, and the measured thermal conductivity of the material from which the thermal mitt is made.

All of the calculations were carried out for the passive situation, where the light is turned off and therefore does not provide a source of energy flow or an elevated surface temperature.

The difference in heating/cooling loss will then be determined for each season (Summer, Autumn, Winter and Spring) based on typical weather and housing conditions (as defined by AIRAH handbook, standard weather data, BCA and/or AS/NZS 4859.1:2002), as well as an additional calculation for an elevated attic temperature.

The resulting System-R value for a 2m x 2m cross-section of a standard room with one gimble down light and a Halogen Light Mitt is 3.8 m^2K/W for upwards energy flow (heating/winter) and 3.9 m^2K/W for downwards energy flow (cooling/summer), as compared with 2.8 and 3.1 m^2K/W respectively for a 2m x 2m cross-section of a standard room with one gimble down light, without the Halogen Light Mitt. This results in a range of energy savings depending on the indoor and temperature conditions. For average winter conditions, the energy saving is 1.7 kWh/month while for average summer conditions, the energy saving is 1.1 kWh/month.

When raised attic temperatures occur, the Halogen Light Mitt can provide significant thermal protection, and is predicted to reduce an attic air temperature of 71°C, to an air temperature within the halogen light mitt of about 48°C (when the light is turned off).

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1. INTRODUCTION

Vipac Engineers & Scientists Ltd (VIPAC) has been commissioned by Efficiency Matrix Pty Ltd to calculate the system R-value for a 2m x 2m cross-section of a standard room with one gimble down light exposed with 200mm clearance, and the Halogen Light Mitt installed with standard R3.5 insulation cut to the footprint (cylindrical hole) of the Halogen Mitt. The difference in heating/cooling loss will then be determined for a range of temperature conditions.

2. SCOPE OF WORK

To calculate the system R-value, in accordance with AS/NZS 4859.1:2002 [3], for a 2m x 2m cross-section of a standard room with one gimble down light exposed following the standards of AS/NZS 3000:2007 [4] with 200mm clearance, and the Halogen Light Mitt installed with standard R3.5 insulation cut to the footprint (cylindrical hole) of the Halogen Mitt as shown in Figure 3.2.

The difference in heating/cooling loss will then be determined for each season (Summer, Autumn, Winter and Spring) based on typical weather and housing conditions (as defined by AIRAH handbook [5], standard weather data, BCA and/or AS/NZS 4859.1:2002 [3]), as well as an additional calculation for an elevated attic temperature.

3. ASSESSMENT

3.1. HALOGEN LIGHT MITT SYSTEM

Customer supplied data defined the geometry of the Halogen Light Mitt, as shown in Figure 3.1.

Base: 230mm outer diameter
Height: 220mm
Thickness: 22mm at base, 10mm near tip

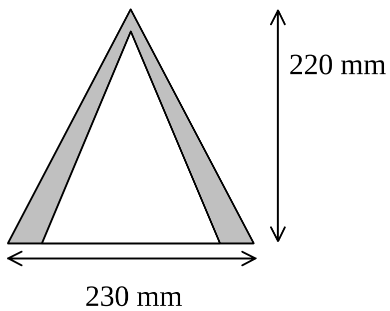

Figure 3.1: Halogen Light Mitt

The thermal conductivity of the Halogen Light Mitt material is k = 0.035 ± 0.003 mK/W [1]. The material R-value for the Halogen Light Mitt was previously calculated, in accordance with

AS 4859.1:2002 [3], to be R_m = 0.514 m^2K/W based on an area of 0.0897 m^2, which projected onto the circular area covered by the base of the cone results in an equivalent material R-value of $R_{m, eq}$ = 0.238 m^2 K/W based on an area of 0.0416m^2 [2].

For the purpose of calculating the system R-Value of the Halogen Light Mitt System, it is assumed that:

- the Halogen Light Mitt will typically be used in conjunction with a plasterboard ceiling of 10mm thickness (R = 0.059 m^2K/W) as stipulated by the default ceiling construction AS/NZS 4859.1:2002 [3], and shown in Figure 3.2, and that the variation in the ceiling R-Value due to the presence of the gimble down light is negligible;
- the gimble down light is turned off (no energy source or elevated temperature);
- standard R3.5 insulation is placed around the Halogen Light Mitt, with a cylindrical hole cut to achieve a close fit around the Halogen Light Mitt, as shown in Figure 3.2;
- the Halogen Light Mitt and gimble down light are located in the centre of a 2m x 2m cross-section, as shown in Figure 3.3;
- the roof is a pitched tiled roof, as outlined in AS/NZS 4859.1:2002 K8 Default Construction Types [3], with a pitch of 22.5° and an R-value of 0.023 m^2K/W;
- the attic space is assumed to be non-vented [3]; and
- the thermal resistance of the air film on the outdoor surface is assumed to be 0.04 m^2K/W.

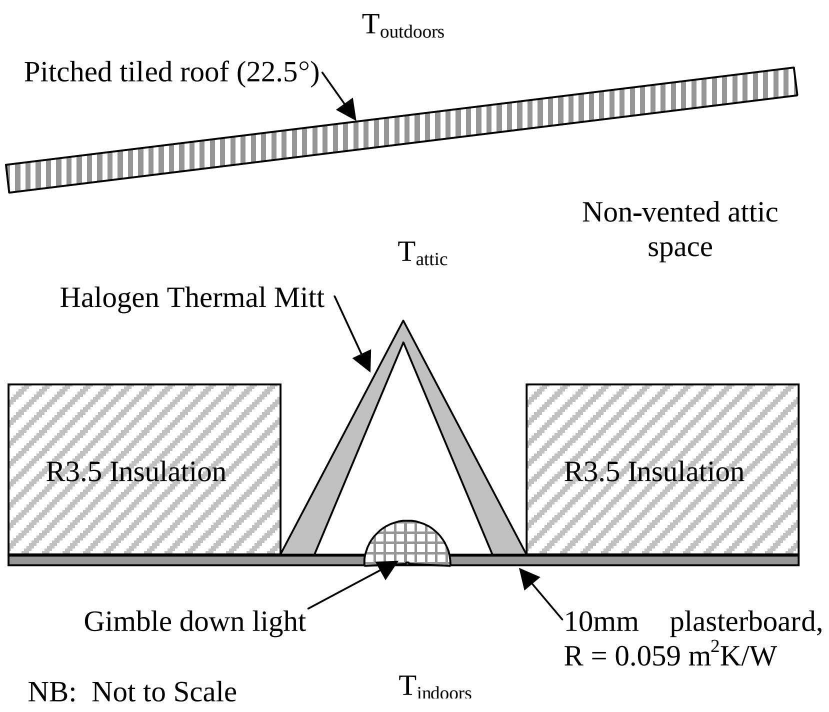

Figure 3.2: Side View of Halogen Light Mitt System

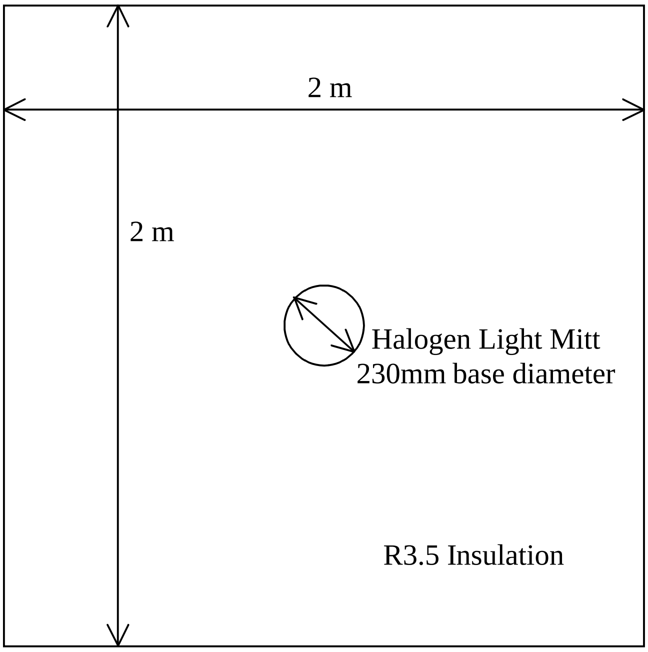

Figure 3.3: Plan View of Halogen Light Mitt System

3.2. STANDARD DOWN LIGHT SYSTEM

For the purpose of calculating the system R-Value for the Standard Down Light System, it is assumed that:

- a standard down light will typically be used in conjunction with a plasterboard ceiling of 10mm thickness (R = 0.059 m^2K/W) as stipulated by the default ceiling construction AS/NZS 4859.1:2002 [3], and shown in Figure 3.4, and that the variation in the ceiling R-Value due to the presence of the gimble down light is negligible;
- the gimble down light is turned off (no energy source or elevated temperature);
- standard R3.5 insulation is placed around the gimble down light following the standards of AS/NZS 3000:2007 [4] with 200mm clearance, as shown in Figure 3.4;
- the gimble down light is located in the centre of a 2m x 2m cross-section, as shown in Figure 3.5;
- the roof is a pitched tiled roof, as outlined in AS/NZS 4859.1:2002 K8 Default Construction Types [3], with a pitch of 22.5° and an R-value of 0.023 m^2K/W;
- the attic space is assumed to be non-vented [3]; and

- the thermal resistance of the air film on the outdoor surface is assumed to be 0.04 m²K/W.

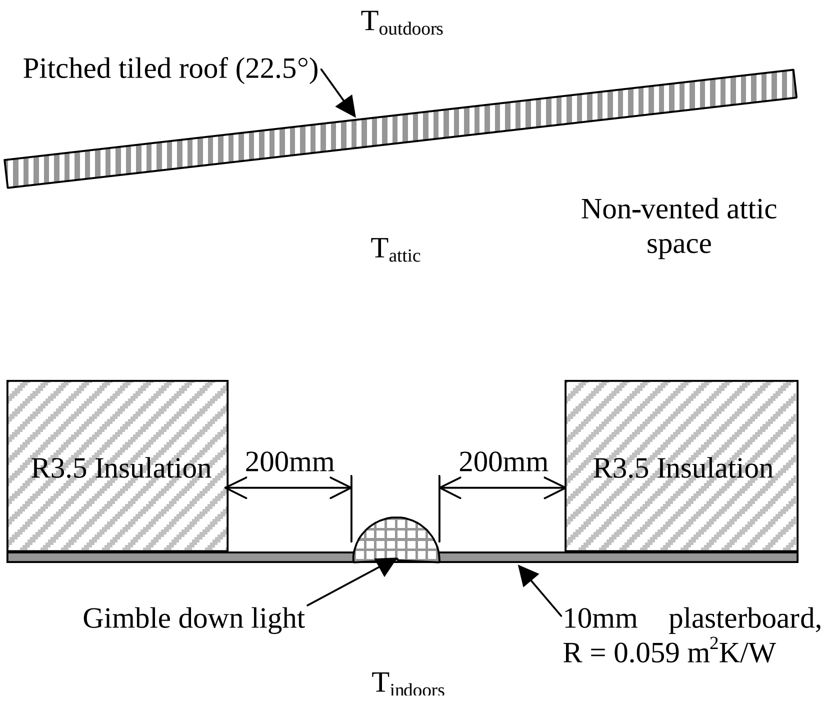

Figure 3.4: Side View of Standard Down Light System

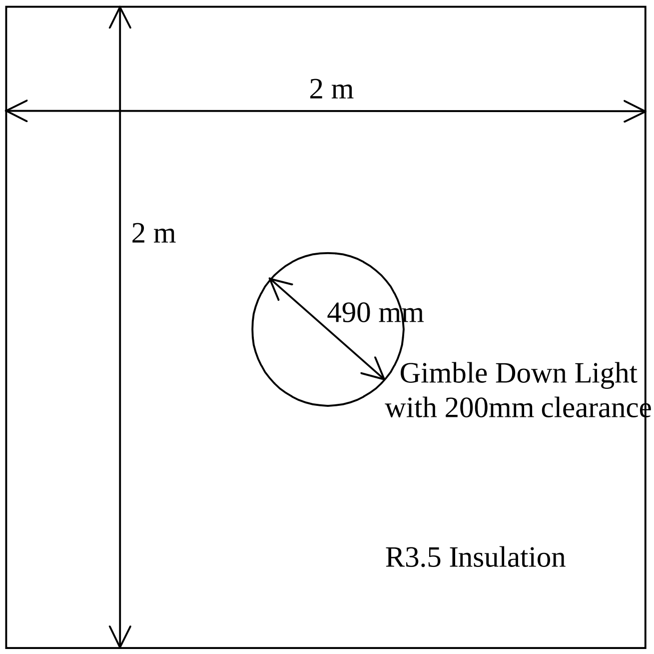

Figure 3.5: Plan View of Halogen Light Mitt System

3.3. TEMPERATURE CONDITIONS

The thermal resistance of the air films above and below the combined system are dependent on the direction of energy flow. AS/NZS 4859.1:2002 [3] requires the following temperatures, temperature differences and mean temperatures to be used in determining total thermal resistances:

- Heat flow out: Indoors 18°C, outdoors 12°C (6 K difference), mean 15 °C.
- Heat flow in: Indoors 24°C, outdoors 36°C (12 K difference), mean 30 °C.

In order to demonstrate the full range of energy flows through the ceiling, additional indoor and outdoor temperatures have been added to this analysis. These additional temperatures are based on the AIRAH Handbook [5], which specifies the summer and winter temperatures for comfort assessment to be 34.3 and 3.5 respectively, and Climate statistics for Melbourne, obtained from the Bureau of Meteorology [6] and included in Appendix A1.

An additional temperature condition, simulating high attic temperatures, was also calculated. A raised attic temperature of 71°C was achieved by setting the outdoor air temperature to 85°C, in order to simulate high solar radiation loads on the roof, and a resulting increase in roof temperature and attic temperature.

The full set of indoor and outdoor temperatures calculated are shown in Table 3.1.

Condition	Indoor Temperature (°C)	Outdoor Temperature (°C)
1. Extreme Winter	18	-2.0
2. Cold Winter	18	3.5
3. Average Winter	18	12
4. Spring/Autumn	20	15
5. Average Summer	20	26
6. Warm Summer	24	36
7. Extreme Summer	24	45
8. Raised Attic Temperature	24	Attic Temperature = 71°C

Table 3.1: Indoor and Outdoor Temperature Conditions

3.4. AIR FILM AND AIR SPACE RESISTANCES

In the absence of other documented values, and given the likely collection of dust on the indoor surfaces, it is assumed that all surfaces are high emittance surfaces, with ε = 0.9.

The air film resistances are therefore determined as per AS/NZS 4859.1:2002 [3], and the resulting values are shown in Table 3.2.

Surface	Direction of heat flow	Air Film Resistance	Equivalent Resistance, based on Projected Horizontal Area.
Horizontal indoor surfaces, (plasterboard, R3.5 insulation).	Up Down	0.11 m^2K/W 0.16 m^2K/W	0.11 m^2K/W 0.16 m^2K/W
22.5° slope outdoor surfaces, (outer surface of roof).	-	0.04 m^2K/W	0.037 m^2K/W

Table 3.2: Air Film Thermal Resistances

The attic thermal resistance, for a non-ventilated attic space, and high emittance surfaces is provided in AS/NZS 4859.1:2002 [3], and included in Table 3.3. These values are used for the attic space above the R3.5 insulation, and above the un-insulated down light. The thermal resistance of the attic space above the halogen light mitt, however, was calculated as described below, due to the significant increase in surface area, and change in surface orientation, with the presence of the halogen light mitt.

Roof Space Type	Direction of heat flow	Resistance
Non-ventilated	Up (winter) Down (summer)	0.18 m^2K/W 0.28 m^2K/W

Table 3.3: Attic Space Thermal Resistances

The thermal resistance of the enclosed air spaces between the plasterboard ceiling and the Halogen Light Mitt, and the Halogen Light Mitt and the roof, were then determined by:

- Assuming the temperature of the air above the roof is at the Outdoor temperatures stated above, and the temperature of the air below the ceiling is at the Indoor temperatures stated above.
- Combining the thermal resistances for each system component into a thermal circuit.

- Using natural convection correlations and radiation laws to determine the thermal resistance provided by the air space enclosed between the plasterboard ceiling and the Halogen Light Mitt, and the Halogen Light Mitt and the roof, based on iteratively obtained surface temperatures for the upper surface of the plasterboard, the lower surface of the thermal mitt, the upper surface of the thermal mitt and the lower surface of the roof.

- Assuming that the surfaces are isothermal, and neglecting thermal bridging at their area of contact.

- Neglecting the effect of any air gaps in the plasterboard, gimble downlight, thermal mitt or roof.

The thermal resistance of the enclosed air spaces between the plasterboard ceiling and the Halogen Light Mitt, and the Halogen Light Mitt and the roof, are sensitive to temperature, and therefore must be calculated separately for each temperature condition.

4. RESULTS

The System R-values, R, and corresponding rates of energy loss, Q, for both the Halogen Light Mitt System, and the Standard Down Light System, for each temperature condition, are summarised in Table 4.1: System R-Values and Rates of Energy Loss.

Condition	Indoor Temp. (°C)	Outdoor Temp. (°C)	Halogen Light Mitt 2x2m System		Standard Down Light 2x2m System	
			R (m^2K/W)	Q (W)	R (m^2K/W)	Q (W)
1. Extreme Winter	18	-2.0	3.8	21.3	2.8	28.8
2. Cold Winter	18	3.5	3.8	15.4	2.8	20.9
3. Average Winter	18	12	3.8	6.4	2.8	8.6
4. Spring/Autumn	20	15	3.8	5.3	2.8	7.2
5. Average Summer	20	26	3.9	6.1	3.1	7.7
6. Warm Summer	24	36	3.9	12.3	3.1	15.3
7. Extreme Summer	24	45	3.9	21.5	3.1	26.8
8. Raised Attic Temperature	24	Tattic = 71°C	3.9	62.7	3.1	78.0

Table 4.1: System R-Values and Rates of Energy Loss

The resulting energy savings provided by the use of the Halogen Light Mitt, based on a 2x2m system, are presented in Table 4.2: Energy Savings with the Halogen Light Mitt.

Condition	Indoor Temp. (°C)	Outdoor Temp. (°C)	Energy Savings with Halogen Light Mitt, based on a 2x2m System		
			Change in Energy Loss, ΔQ (W)	Energy Savings per Day (kWh/day)	Energy Savings per month (kWh/month)
1. Extreme Winter	18	-2.0	7.5	0.18	5.5
2. Cold Winter	18	3.5	5.5	0.13	4.0
3. Average Winter	18	12	2.3	0.054	1.7
4. Spring/Autumn	20	15	1.9	0.045	1.4
5. Average Summer	20	26	1.5	0.037	1.1
6. Warm Summer	24	36	3.1	0.073	2.2
7. Extreme Summer	24	45	5.3	0.13	3.9
8. Raised Attic Temperature	24	Tattic = 71°C	15.2	0.36	11

Table 4.2: Energy Savings with the Halogen Light Mitt

For temperature condition 8, with the raised attic temperature, the Halogen Light Mitt provides thermal protection from the high attic temperatures, reducing the air temperature around the down light from an attic air temperature of 71°C, to an air temperature within the halogen light mitt of about 48°C (with the light turned off).

5. REFERENCES

1. Test Report, Curtin University of Technology, Division of Science and Engineering.

2. Halogen Light Mitt – Thermal Efficiency Analysis, Report No. 30B-09-0338-TRP-445314-0, Vipac Engineers and Scientists, 11/11/2009.

3. AS/NZS 4859.1:2002 Materials for the thermal insulation of buildings. Part 1: General criteria and technical provisions, Standards Australia/Standards New Zealand.

4. AS/NZS 3000:2007 Electrical installations (known as the Australian/New Zealand Wiring Rules), Standards Australia/Standards New Zealand.

5. AIRAH Technical Handbook, Edition 4, 2007

6. Bureau of Meteorology, Climate Statistics for Melbourne. Obtained from http://www.bom.gov.au/climate/averages/tables/cw_086282_All.shtml on 1/4/2010, and included in Appendix 1.

A1 : CLIMATE STATISTICS FOR MELBOURNE

Climate statistics for Australian locations

Monthly climate statistics

All years of record

Site name: MELBOURNE AIRPORT **Site number:** 086282 **Commenced:** 1970 Map

Latitude: 37.67°S **Longitude:** 144.83°E **Elevation:** 113 m **Operational status:** Open

View: Main statistics / All available   Period: Use all years of data   Text size: Normal / Large

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Temperature															
Maximum temperature															
Mean maximum temperature (°C)	26.3	26.5	24.0	20.2	16.6	13.6	13.0	14.4	16.6	19.2	21.9	24.4	19.7	40	1970 2010
Highest temperature (°C)	44.6	46.8	40.8	34.5	27.0	21.8	22.7	25.6	30.2	36.0	39.6	43.8	46.8	40	1970 2010
Date	25 Jan 2003	07 Feb 2009	08 Mar 1991	10 Apr 2005	07 May 2002	08 Jun 2005	30 Jul 1975	29 Aug 1982	12 Sep 2009	12 Oct 2006	24 Nov 1982	31 Dec 2005	07 Feb 2009		
Lowest maximum temperature (°C)	13.9	13.5	12.7	11.7	8.0	6.2	5.7	6.5	8.2	10.4	11.6	13.0	5.7	40	1970 2010
Date	05 Jan 1991	02 Feb 2005	29 Mar 1973	07 Apr 1995	31 May 1977	19 Jun 1975	03 Jul 1984	16 Aug 1970	05 Sep 1995	16 Oct 1974	15 Nov 2006	04 Dec 1995	03 Jul 1984		
Decile 1 maximum temperature (°C)	19.6	19.8	18.1	15.4	13.3	11.1	10.5	11.5	12.7	14.3	15.9	18.1		40	1970 2010
Decile 9 maximum temperature(°C)	35.6	34.8	31.6	26.1	20.8	16.3	15.5	17.8	21.1	25.3	29.6	32.7		40	1970 2010
Mean number of days ≥ 30 °C	8.1	8.5	4.9	0.3	0.0	0.0	0.0	0.0	0.0	0.9	2.7	6.1	31.5	40	1970 2010
Mean number of days ≥ 35 °C	3.7	2.7	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6	1.8	9.7	40	1970 2010
Mean number of days ≥ 40 °C	0.6	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	1.2	40	1970 2010
Minimum temperature															
Mean minimum temperature (°C)	13.6	14.1	12.6	10.1	8.3	6.2	5.3	5.9	7.0	8.4	10.3	12.0	9.5	40	1970 2010
Lowest temperature (°C)	6.0	4.8	3.7	1.2	0.6	-0.9	-2.5	-2.5	-1.1	1.3	0.9	4.1	-2.5	40	1970 2010
Date	27 Jan 1980	10 Feb 1980	26 Mar 2005	30 Apr 2009	19 May 1981	15 Jun 1972	21 Jul 1982	11 Aug 1986	20 Sep 1970	22 Oct 2006	04 Nov 1980	15 Dec 1986	11 Aug 1986		
Highest minimum temperature (°C)	30.5	26.9	24.3	21.7	16.5	14.1	12.7	13.3	18.5	21.8	23.6	26.3	30.5	40	1970 2010
Date	29 Jan 2009	20 Feb 1997	18 Mar 2008	03 Apr 2009	02 May 1997	09 Jun 1995	28 Jul 1975	31 Aug 2007	24 Sep 2001	13 Oct 1977	02 Nov 1987	12 Dec 1998	29 Jan 2009		
Decile 1 minimum temperature (°C)	9.5	10.0	8.6	6.2	4.5	2.5	2.0	2.8	3.4	4.4	6.3	8.1		40	1970 2010
Decile 9 minimum temperature (°C)	17.9	18.5	16.8	14.2	12.0	9.4	8.3	9.0	11.0	12.8	14.9	16.3		40	1970 2010
Mean number of days ≤ 2 °C	0.0	0.0	0.0	0.1	0.2	2.2	3.2	1.9	1.1	0.3	0.1	0.0	9.1	40	1970 2010
Mean number of days ≤ 0 °C	0.0	0.0	0.0	0.0	0.0	0.3	0.6	0.2	0.1	0.0	0.0	0.0	1.2	40	1970 2010
Ground surface temperature															
Mean daily ground minimum temperature (°C)	12.5	13.2	11.0	8.4	6.4	5.0	4.1	4.6	5.5	6.6	9.5	10.6	8.1	11	1999 2010
Lowest ground temperature (°C)	3.2	3.4	0.0	-0.4	-0.4	-2.2	-2.2	-2.2	-2.9	-1.4	1.7	4.0	-2.9	11	1999 2010
Date	03 Jan 2009	13 Feb 2009	26 Mar 2005	30 Apr 2009	30 May 2006	25 Jun 2005	21 Jul 2006	10 Aug 2003	05 Sep 2007	16 Oct 2006	02 Nov 1999	03 Dec 2004	05 Sep 2007		
Mean number of days ground min. temp. ≤ -1 °C	0.0	0.0	0.0	0.0	0.0	0.7	1.0	1.3	0.3	0.2	0.0	0.0	3.5	11	1999 2010
Statistics	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**	**Years**	
Rainfall															
Mean rainfall (mm)	41.2	42.2	37.3	44.5	40.2	37.5	36.0	46.4	46.3	53.1	61.1	48.4	533.9	40	1970 2010
Highest rainfall (mm)	101.6	200.6	142.2	141.6	155.5	105.4	94.4	97.1	127.0	143.8	158.0	139.0	820.8	40	1970 2010
Date	1991	2005	2001	1977	1974	1991	1987	1975	1993	1975	1988	1999	1978		
Lowest rainfall (mm)	1.6	1.0	4.4	4.8	8.0	10.4	7.0	16.4	8.2	5.6	18.2	1.6	310.2	40	1970 2010
Date	2009	1991	1998	1981	2005	2006	1994	1987	2007	2007	2002	1972	1997		
Decile 1 rainfall (mm)	13.9	6.4	12.8	13.9	11.8	13.1	12.1	22.3	21.3	20.0	25.3	11.8	384.4	40	1970 2010
Decile 5 (median) rainfall (mm)	40.0	25.6	34.2	39.6	38.8	34.8	35.5	42.1	40.2	48.9	52.8	44.5	554.6	40	1970 2010
Decile 9 rainfall (mm)	71.7	99.4	63.7	83.8	65.0	56.4	60.8	69.6	77.0	92.0	113.4	86.7	659.8	40	1970 2010
Highest daily rainfall (mm)	50.6	138.8	98.2	132.4	52.4	28.2	44.6	37.0	38.0	70.8	80.8	76.4	138.8	40	1970 2010
Date	06 Jan 1995	03 Feb 2005	23 Mar 2001	08 Apr 1977	16 May 1974	08 Jun 1991	30 Jul 1987	07 Aug 1978	15 Sep 1993	16 Oct 1983	19 Nov 1978	27 Dec 1999	03 Feb 2005		
Mean number of days of rain	8.5	6.9	8.9	10.1	12.4	13.5	14.1	15.5	14.2	13.5	11.6	9.4	138.6	40	1970 2010
Mean number of days of rain ≥ 1 mm	5.2	4.5	5.7	6.3	7.4	8.2	8.1	10.0	9.2	8.8	7.8	6.0	87.2	40	1970 2010
Mean number of days of rain ≥ 10 mm	1.3	1.1	1.0	1.1	0.8	0.7	0.5	0.9	1.0	1.4	1.7	1.5	13.0	40	1970 2010
Mean number of days of rain ≥ 25 mm	0.3	0.3	0.3	0.3	0.1	0.1	0.1	0.1	0.1	0.2	0.3	0.3	2.5	40	1970 2010
Statistics	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**	**Years**	
Other daily elements															
Mean daily wind run (km)	454	437	425	391	405	470	475	492	502	460	438	456	450	12	1997 2010
Maximum wind gust speed (km/h)	137	115	113	107	108	102	108	124	115	122	139	113	139	39	1970 2010
Date	03 Jan 1981	26 Feb 1998	26 Mar 1984	02 Apr 2008	21 May 1989	28 Jun 1991	30 Jul 1993	10 Aug 1992	02 Sep 2002	03 Oct 1971	15 Nov 1982	21 Dec 1973	15 Nov 1982		

Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Mean daily sunshine (hours)	8.7	8.1	7.5	6.4	4.8	4.0	4.5	5.5	6.2	7.3	7.6	8.4	6.6	11	1999 2010
Mean daily solar exposure (MJ/m²)	24.7	21.7	17.4	11.8	8.0	6.3	7.1	10.3	13.8	18.4	22.2	24.2	15.5	20	1990 2010
Mean number of clear days	5.1	5.4	5.5	4.8	3.1	2.9	2.8	2.6	3.0	3.3	3.3	4.1	45.9	39	1970 2010
Mean number of cloudy days	13.1	10.3	13.6	14.6	17.5	16.9	16.7	15.6	15.6	16.6	15.5	14.8	180.8	39	1970 2010
Mean daily evaporation (mm)	8.1	7.2	5.9	3.9	2.5	1.9	2.0	2.8	4.2	5.2	6.0	7.4	4.8	12	1998 2010

Statistics 9 am conditions	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Mean 9am temperature (℃)	18.1	18.0	16.6	14.1	11.3	8.7	7.9	9.1	11.3	13.6	15.0	16.8	13.4	39	1970 2010
Mean 9am wet-bulb temperature (℃)	14.2	14.5	13.4	11.5	9.6	7.4	6.6	7.3	8.9	10.5	11.7	13.0	10.7	39	1970 2010
Mean 9am dew-point temperature (℃)	10.7	11.6	10.5	8.8	7.7	5.9	4.9	5.1	6.1	7.0	8.5	9.3	8.0	39	1970 2010
Mean 9am relative humidity (%)	65	69	70	72	79	83	82	77	72	66	67	64	72	39	1970 2010
Mean 9am cloud cover (oktas)	5.2	4.8	4.9	5.1	5.4	5.4	5.2	5.1	5.2	5.4	5.3	5.3	5.2	39	1970 2010
Mean 9am wind speed (km/h)	18.5	17.0	16.9	16.6	17.3	18.3	20.3	21.6	22.1	21.8	19.0	18.7	19.0	39	1970 2010

Statistics 3 pm conditions	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years	
Mean 3pm temperature (℃)	24.3	24.8	22.5	19.0	15.6	12.6	12.0	13.3	15.3	17.6	20.2	22.4	18.3	39	1970 2010
Mean 3pm wet-bulb temperature (℃)	16.4	16.9	15.5	13.3	11.6	9.7	8.9	9.5	10.8	12.2	13.9	15.1	12.8	39	1970 2010
Mean 3pm dew-point temperature (℃)	9.8	10.4	9.4	7.9	7.5	6.3	5.2	5.1	5.8	6.6	8.0	8.5	7.5	39	1970 2010
Mean 3pm relative humidity (%)	44	44	47	52	60	67	65	59	56	52	49	45	53	39	1970 2010
Mean 3pm cloud cover (oktas)	4.4	4.5	4.8	5.2	5.7	5.7	5.7	5.7	5.6	5.5	5.2	5.0	5.3	39	1970 2010
Mean 3pm wind speed (km/h)	22.3	21.2	20.6	19.8	19.7	20.8	22.8	23.9	24.4	23.5	22.4	22.7	22.0	39	1970 2010

red = highest value blue = lowest value

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Monthly statistics are only included if there are more than 10 years of data. The number of years (provided in the 2nd last column of the table) may differ between elements if the observing program at the site changed. More detailed data for individual sites can be obtained by contacting the Bureau.

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