



# **VEHICLE CABIN TEMPERATURES SURVEY**

Compiled By:

TRAFFIC AND SAFETY DEPARTMENT

1995

## EXECUTIVE SUMMARY

The cabin temperature of closed stationary vehicles in direct sunlight can quickly rise to a level that may damage property or harm children or animals left in the vehicle. There have been documented cases of child fatalities resulting from heat stress in vehicles. To determine the rate of temperature change and the maximum temperatures reached, tests were conducted on a series of modern light and dark coloured vehicles of varying sizes. The tests were conducted in Brisbane during typical summer and winter conditions.

The dark coloured vehicles reached higher temperature than the light coloured vehicles. During typical winter day conditions, the differences in maximum temperature between the light and dark vehicles varied in the range 3.6 to 5.1°C. During typical summer day conditions, the differences in maximum temperature between the light and dark vehicles varied in the range 5.1 to 8.3°C.

The results indicate that vehicle size has very little effect on cabin temperature. Vehicles of different size but of the same colour generally had similar heating characteristics. However, the results indicate that vehicles with larger glass surface areas, such as hatch-backs, heat up faster and obtain a higher maximum temperature than similar sized sedans.

The highest average maximum temperature reached for winter conditions was 48.1°C in the cabin of a dark blue Laser sedan. In summer, the highest average maximum temperature reached was 73.0°C in the cabin of a dark green Telstar sedan.

The results show that, on average, at least 50% of the temperature change occurred within the first five minutes and at least 80% of the temperature change occurred within the first fifteen minutes of closing the vehicle.

The rate of temperature increase was generally proportional to the upper stabilised temperature for all vehicles in both summer and winter.

In summer after 5 minutes the peak average temperature change was as high as 61% and this was recorded in both light and dark coloured Falcons as well as the light coloured Telstar.

## ROYAL AUTOMOBILE CLUB OF QUEENSLAND

---

In summer after 15 minutes the peak average temperature change was as high as 87% recorded in the dark Falcon.

In winter after 5 minutes the peak average temperature change was as high as 59% in the light coloured Falcon station wagon.

In winter after 15 minutes the peak average temperature change was as high as 89% recorded in the light coloured Telstar.

The rate of temperature increase and maximum temperatures recorded reinforce the dangers of leaving children, animals and objects sensitive to heat in parked vehicles, even for a short period of time.



**CONTENTS**

1.0 AIM ..... Page: 1

2.0 MATERIALS ..... Page: 1

3.0 PROCEDURE ..... Page: 2

4.0 RESULTS ..... Page: 3

5.0 DISCUSSION ..... Page: 8

    5.1 VEHICLE SIZE ..... Page: 8

    5.2 VEHICLE COLOUR ..... Page: 9

    5.3 TEMPERATURE CHANGE VERSUS TIME .....Page: 10

    5.4 COMPARISON WITH PREVIOUS TESTS BY  
        KING AND NEGUS ..... Page: 11

6.0 CONCLUSIONS ..... Page: 12

REFERENCE ..... Page: 14

## **VEHICLE CABIN TEMPERATURE TESTS**

### 1.0 AIM

The RACQ receives many inquiries regarding temperatures in modern vehicles. The inquiries may be for a number of reasons including the purchase of a new car, destruction of various materials in the vehicle and safety of occupants left in the stationary vehicle.

The safety of occupants left in parked vehicles is of particular concern. Despite press releases and public education campaigns this practice still occurs.

A previous study by King and Negus (1982) investigated the heating characteristics and variables of a number of vehicles. However, advances in vehicle design have resulted in radically different body shapes and use of glass than those used in the tests undertaken by King and Negus (1982).

These tests aim to determine the heating characteristics of a cross section of modern cars under typical winter and summer conditions in Brisbane.

### 2.0 MATERIALS

Test vehicles were made available by Metro-Ford, Spring Hill, and tests were conducted on site with vehicles positioned on a concrete roof-top carpark free of shade.

The test vehicles included:

- o Falcon sedan – white and Polynesian green (dark green)
- o Laser sedan – white and dark blue (the dark colour in winter only)
- o Laser hatch – white and red (both available for summer only)
- o Telstar sedan – off white and dark grey
- o Falcon station wagon - white

The darkest colours available were used depending on availability. The same vehicles were used throughout the tests where possible, however when this was not possible they were replaced by vehicles with the same colour paint and quality of interior trim. The interior trim in the test vehicles was either cloth or velour.

## ROYAL AUTOMOBILE CLUB OF QUEENSLAND

---

The equipment used to monitor cabin temperatures in the test vehicles included:

- o CIE305 hand held digital thermometer
- o 10 x type K industry standard thermocouple probes
- o stopwatch

### 3.0 PROCEDURE

The following procedure was used to monitor cabin temperatures within the test vehicles:

1. The supplied cars were positioned to face south and in close proximity to each other on a concrete surface such that shade did not extend onto the vehicles.
2. All doors were then opened to allow the cabin temperatures to equalise with ambient levels.
3. Each vehicle was fitted with a single thermo-couple (type K probes) 100mm below the centre of the roof (i.e. below the interior light). A single vehicle was fitted with a thermo-couple below the rear bumper bar, in the shade, to measure the ambient temperature.
4. When the cabin temperature had stabilised close to the ambient temperature all doors were closed and cabin temperatures monitored, with a CIE305 hand held digital thermometer, at 5 minute intervals for the first 30 minutes and then at 15 minute intervals for the remaining 60 minutes.
5. All doors were then opened and cabin temperatures again monitored for 5 minute intervals until temperatures approached ambient conditions.

**Note:** Preliminary testing found that one centrally located probe was adequate per vehicle and vehicle orientation had little effect on internal cabin temperatures between 11am and 2pm (King and Negus, 1982). The vehicles were aligned in a north-south orientation during testing for consistency between winter and summer testing periods.



---

## ROYAL AUTOMOBILE CLUB OF QUEENSLAND

---

### 4.0 RESULTS

The testing was undertaken between July 12 and 21, 1994 to be representative of an “average” winter’s day and between January 24 and February 6, 1995 for a representative “average” summer’s day. Varying degrees of cloud cover and solar heat loading were evident over the test period.

Table 1 shows the maximum temperature reached for various vehicles on any one of the particular days during the summer and winter testing periods. The hottest temperature reading during the winter testing was 48.1°C which was recorded in the cabin of the dark blue Laser sedan. The hottest temperature reading during the summer testing was 73.0°C which was recorded in the cabin of the dark green Telstar sedan.

VEHICLE TYPE	MAXIMUM TEMPERATURES (AMBIENT IN BRACKETS)	
	WINTER (°C)	SUMMER (°C)
FALCON SEDAN WHITE	43.4 (19.3)	63.6 (33.7)
FALCON SEDAN DARK GREEN	47.9 (19.3)	71.2 (37.2)
FALCON STATION WAGON WHITE	39.1 (21.5)	56.6 (37.2)
TELSTAR SEDAN OFF-WHITE	43.7 (21.3)	66.6 (33.7)
TELSTAR SEDAN DARK GREEN	47.6 (19.3)	73 (37.2)
LASER SEDAN WHITE	41.3 (21.4)	63 (37.2)
LASER SEDAN BLUE	48.1 (21.4)	N.A.
LASER HATCH WHITE	N.A.	64 (37.2)
LASER HATCH RED	N.A.	70.5 (37.2)

**TABLE 1**

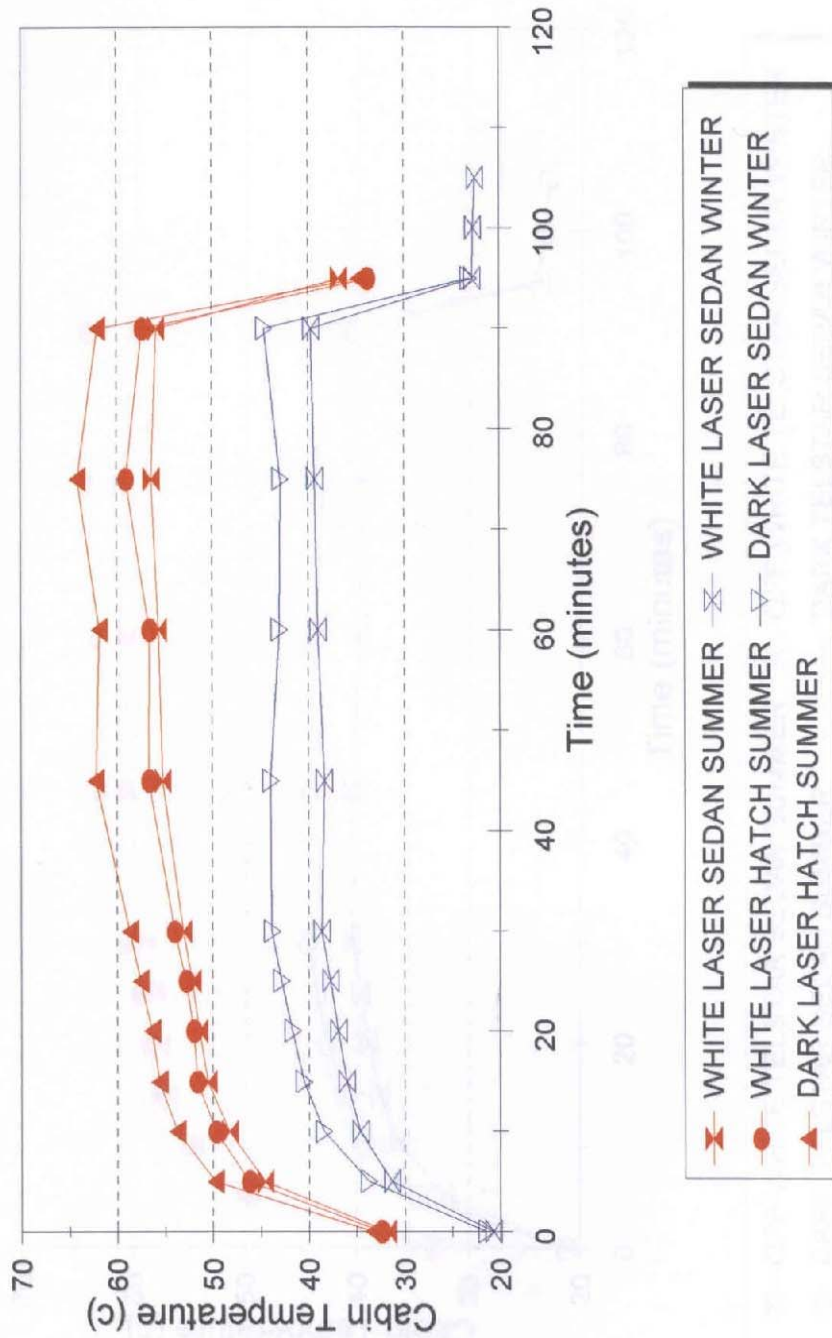


## ROYAL AUTOMOBILE CLUB OF QUEENSLAND

---

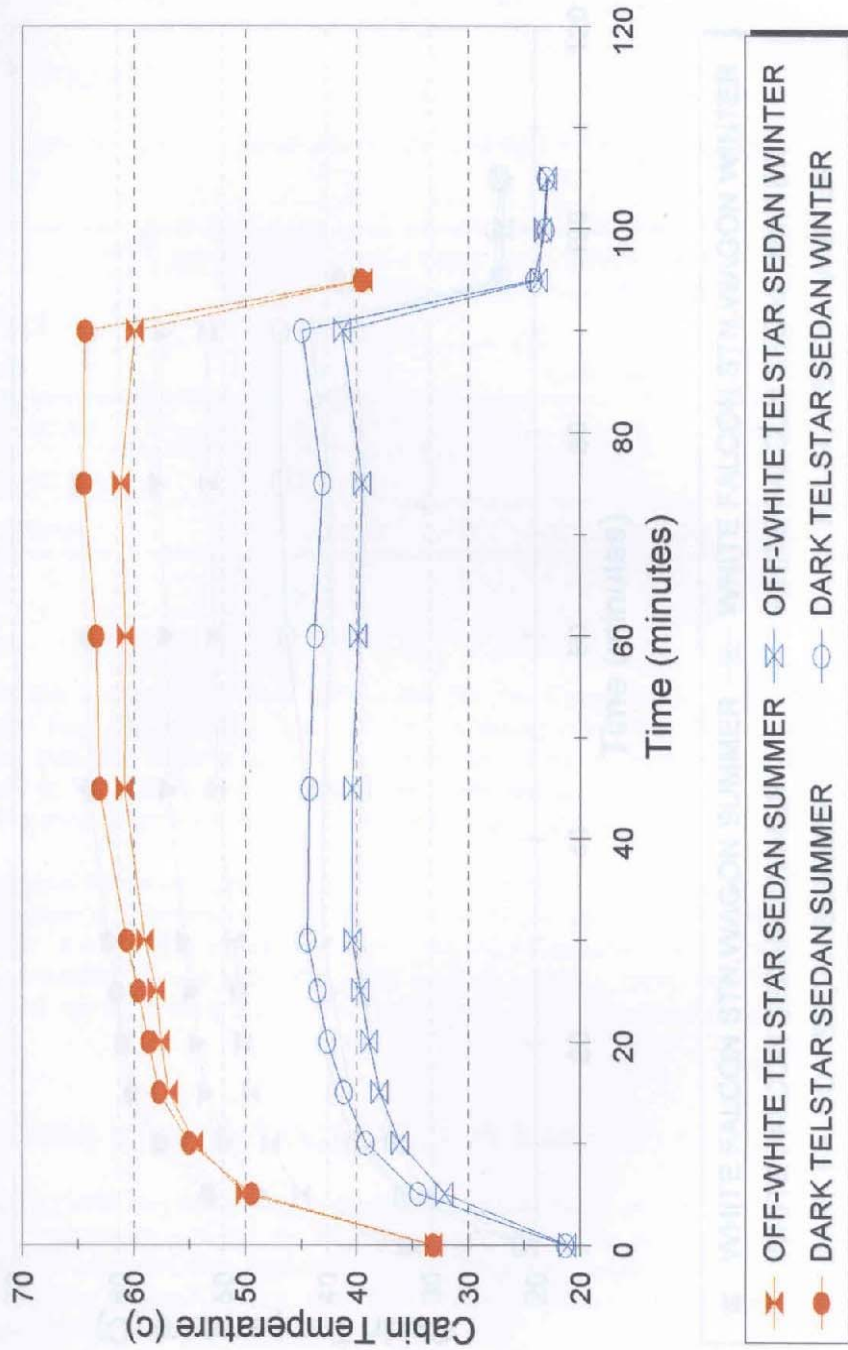
A plot of cabin temperature versus time is shown in Figures 1, 2 and 3 for all the vehicles tested. The temperatures displayed are an average of the test temperatures over the duration of testing. The average ambient temperatures over the winter and summer test periods were 20.3°C and 32.5°C respectively.

**RACQ Cabin Temperature Tests**  
**Ford Laser**



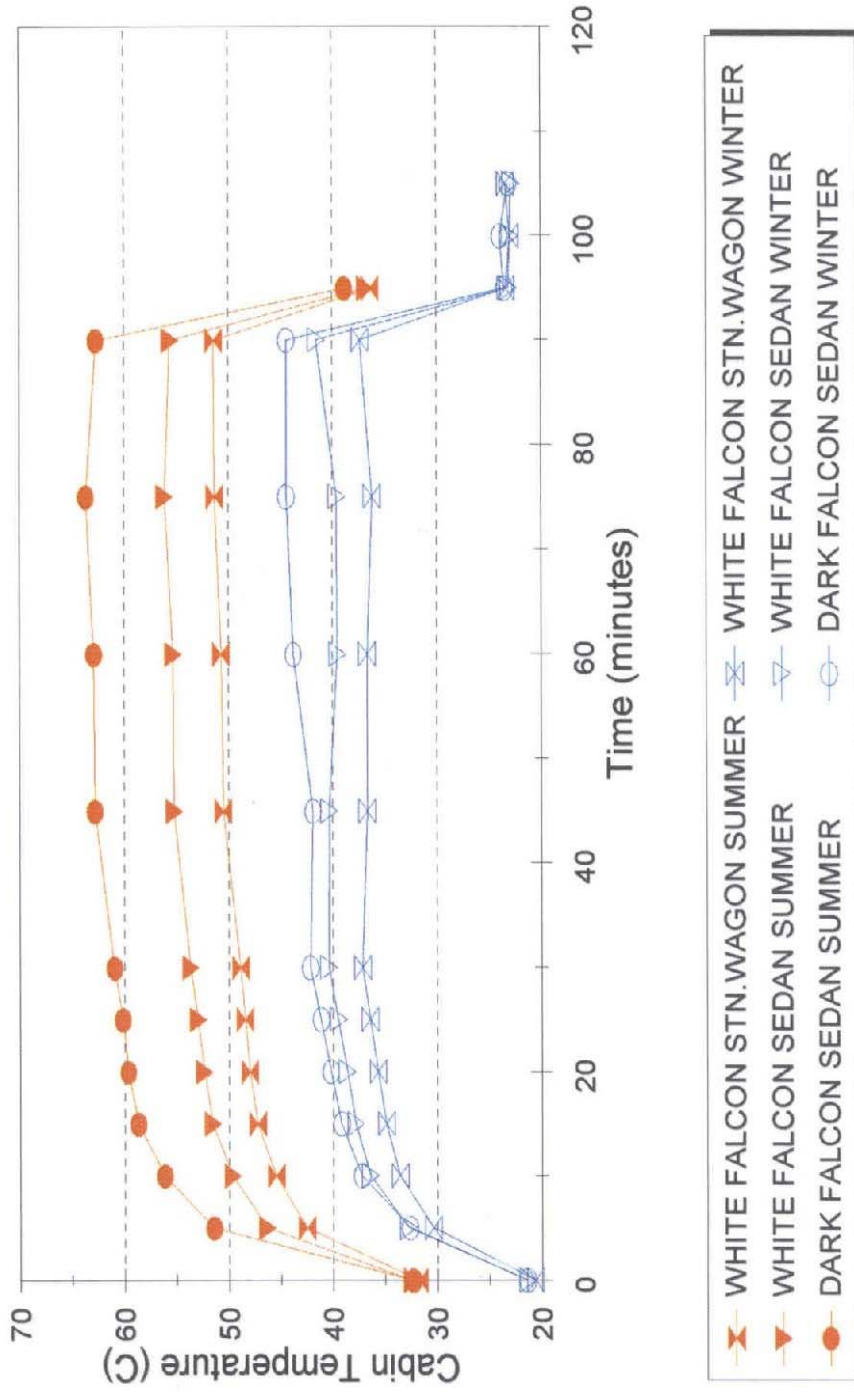
**FIGURE: 1**

## RACQ Cabin Temperature Tests Ford Telstar



**FIGURE: 2**

**RACQ Cabin Temperature Tests**  
**Ford Falcon**



**FIGURE: 3**

## 5.0 DISCUSSION

### 5.1 VEHICLE SIZE

For the average winter's day, all dark vehicles reached an average maximum in the range of 45°C (i.e. Falcon – 44.4, Telstar – 44.9 and Laser – 44.6) while the light coloured sedans reached an average maximum between 40°C and 42°C (Falcon – 41.6, Telstar – 41.3 and Laser – 39.7). In comparison, the white Falcon station wagon reached an average maximum of only 37.4°C.

For the average summer's day the dark Falcon sedan, dark Telstar sedan and dark Laser Hatch reached an average maximum temperature of approximately 64°C (Falcon – 63.7, Telstar – 64.5 and Laser 64.1). While the light coloured Falcon, Telstar, Laser sedan and Laser hatch reached temperatures of 56.1°C, 61.2°C, 56.4°C and 59.0°C respectively.

It is suggested that the Laser hatch reached a similar temperature to the larger sedans during the summer testing due to the greater plan area of glass for a hatch body type (discussed by King and Negus, 1982). This hypothesis is supported by a comparison of average maximum summer temperatures for the white laser sedan and hatch, which has a larger plan area of glass. The white laser sedan reached only 56.4°C while the hatch body type reached 59.0°C

In broad terms this experiment has shown that vehicle size is not a good indicator of heat absorption. This hypothesis is due to the similarity of temperature readings between vehicles of the same colour but different body sizes.

## 5.2 VEHICLE COLOUR

The difference between cabin temperatures in light and dark coloured vehicles is shown in Table 2.

VEHICLE TYPE	AV. MAX. TEMPERATURE DIFFERENCE BETWEEN LIGHT AND DARK COLOURED VEHICLES	
	WINTER (°C)	SUMMER (°C)
FALCON SEDAN	3.7	8.3
TELSTAR SEDAN	3.6	5.1
LASER SEDAN	5.1 (SEDAN)	7.2 (HATCH)

**Table 2**

Table 2 shows the average maximum differences for the three hottest winter and summer test days between the light and dark coloured vehicles. The test results indicate that the difference between light and dark coloured vehicle cabin temperatures for summer conditions ranged between 5.1 and 8.3°C. In winter, this difference was approximately 3.5°C for Falcons and Telstars.

The large difference between light and dark coloured Lasers (refer Table 2) for winter was surprising considering the differences displayed for the larger vehicles. Also, the heating curves for light and dark coloured lasers and Falcons were essentially parallel after the initial heating period. However, this was not the case for the Telstar model during summer (refer Figures 1, 2 and 3).

### 5.3 TEMPERATURE CHANGE VERSUS TIME

The upper stabilised cabin temperature was calculated by averaging the last four temperature readings of each closed vehicle. The temperature change for each vehicle was taken as the difference between the upper stabilised cabin temperature and initial cabin temperature obtained before the vehicle was closed.

The results show that, on average, at least 50% of the temperature change occurred within the first five minutes and at least 80% of the temperature change occurred within the first fifteen minutes of closing the vehicle.

The rate of temperature increase was generally proportional to the upper stabilised temperature for all vehicles in both summer and winter.

In summer after 5 minutes the peak average temperature change was as high as 61% and this was recorded in both light and dark coloured Falcons as well as the light coloured Telstar.

In summer after 15 minutes the peak average temperature change was as high as 87% recorded in the dark Falcon.

In winter after 5 minutes the peak average temperature change was as high as 59% in the light coloured Falcon station wagon.

In winter after 15 minutes the peak average temperature change was as high as 89% recorded in the light coloured Telstar.

5.4 COMPARISON WITH PREVIOUS TESTS BY KING AND NEGUS

King and Negus (1982) concluded, “cabin temperatures increased to well above ambient”. This correlates with results for modern vehicles. An estimate was made of the stabilised cabin temperatures used by King and Negus in order to compare the heating characteristics of older vehicles and modern vehicles. These estimates are shown on Table 3.

VEHICLE SIZE / TYPE	ESTIMATED SUMMER STABILISED CABIN TEMPERATURES	
	OLDER MODELS (°C)	MODERN (°C)
LARGE LIGHT	59	56
LARGE DARK	67	63
SMALL LIGHT	54	57 (57)
SMALL DARK	62	N.A. (63)

*N.B. the temperatures in brackets represent the estimated stabilised temperatures for small hatches, i.e. Lasers*

**Table 3**

The comparison tends to suggest modern large sedans are cooler than older equivalent models. Factory glass tint would be one of the major reasons for this temperature reduction.

Although equivalent test vehicles were not available for comparison, it appears that smaller vehicles may generate similar vehicle cabin temperatures for both older and modern models.

King and Negus (1982) also discuss the effect of ventilation and generated the following results:

<i>Window closed</i>	66.4°C
<i>Window open 50mm</i>	50.5°C
<i>Window open 200mm (half open)</i>	40.9°C

This test was not replicated and hence a comparison can not be made. However, it would be expected that the effect of ventilation on modern vehicles would be similar to that on older models, as body shape would not be expected to be an important factor.

King and Negus (1982) also concluded that interior trim colour had no effect on vehicle cabin temperatures. The effect of interior trim was not replicated in this test.

It was interesting to note that a sample of surface temperature taken on the dashboard produced a reading in excess of 100°C. However, the validity of using a thermo-couple probe for a surface reading is questionable.

## 6.0 CONCLUSIONS

The vehicle cabin temperature tests confirmed the fact that the cabin temperature of vehicles left stationary in direct sunlight increases substantially above ambient temperature. The temperatures recorded for both winter and summer reinforce the dangers of leaving children, animals and objects sensitive to heat in parked vehicles, even for short periods of time during winter.

## ROYAL AUTOMOBILE CLUB OF QUEENSLAND

---

The results show that, on average, at least 50% of the temperature change occurred within the first five minutes and at least 80% of the temperature change occurred within the first fifteen minutes of closing the vehicle.

The rate of temperature increase was generally proportional to the upper stabilised temperature for all vehicles in both summer and winter.

The tests showed a consistent difference between temperatures in light coloured vehicles and dark coloured vehicles.

When comparing large and small vehicles, size did not appear to be an important indicator of the heat absorption of the vehicle. However, body types within any particular size of vehicle appear to affect cabin temperatures. The falcon station wagon was consistently cooler than the equivalent sedan, while the Laser hatch was consistently hotter than the Laser sedan. This tended to support the hypothesis put forward by King and Negus (1982) that heat absorption is related to the plan area of glass for a particular model.

The tests tended to suggest that the large modern vehicles tested were slightly cooler than the older models tested by King and Negus in 1982.

The highest temperature reached was 73°C achieved in a dark green Telstar sedan in summer with an ambient temperature of 36°C.

REFERENCE

King and Negus (1982). The Prevention of Childhood Accidents – Design, Education and Legislation – Chapter 5 Heat Stress in Cars. The Child Accident Prevention Foundation of Australia, Australasian Medical Pub. Co. Ltd., Sydney 1982.