PETERBOROUGH CATHEDRAL

ENVIRONMENTAL MONITORING

1st FEBUARY TO 26th JUNE 1996.

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This report covers 5 months bridging winter/spring/summer. An analysis of temperatures across the painted ceiling has been included to assess the effects of solar gains in the roof space. The mid level temperature and humidity sensor had been disturbed around April 8th and humidity readings from that sensor are unreliable.

EXTERNAL READINGS

Relative humidities remained high for the entire period, temperatures reached a low in December and showed a steady rise towards the end of June. External readings can be seen in graphs 1 - 5.

INTERNAL READINGS
MAIN BODY OF CATHEDRAL

Internal conditions can be seen in graphs 1 - 5, as in previous periods there is virtually no temperature gradient whilst the heating is in operation. Once the heating was turned off (April 8/9th?), there was a very small gradient of around 2°C. The relative humidity was fairly constant at around 60%, with occasional dips coinciding with changes in external conditions.

PAINTED CEILING

Temperatures either side of the ceiling are shown in graphs 23 to 27. When the heating is operating, the underside of the ceiling is generally warmer than the topside. After April the 8th/9th (graph 25), when the heating had been turned off, it can be seen that the temperature of the topside is generally higher than the underside. This action is caused by solar gains in the roof space. As the temperature is fluctuating across the ceiling it is more likely that movement of the timber will occur in the summer than the winter. Graphs 25 - 27 show the effects on the ceiling of a heated and unheated cathedral.

Dewpoint temperatures for the ceiling are shown in graphs 6 to 10, there were no occasions when the surface temperature dropped below the dewpoint. It is therefore safe to assume that the ceiling will remain condensation free for the whole year.

In February moisture movement was predominantly from the cathedral to the roof space, for the remainder of the period moisture moved either way on a fairly even basis.

ROOF SPACE TEMPERATURES

Comparisons of "black ball", external temperature and inside roof timber temperatures are shown in graphs 21 - 22. Graph 21 shows the roof space temperature (black line) as fairly constant at around 12°C with the heating in operation in February. Graph 22 shows the roof space temperature in May with no heating. It can be seen that the internal temperature is being

influenced directly by the external conditions.

RESULTS AND CONCLUSIONS.

The heating season appears to offer the most stable environment for the painted ceiling. Once the heating is turned off the ceiling is subject to the variations of the external conditions, although the extremes are buffered by the building fabric.

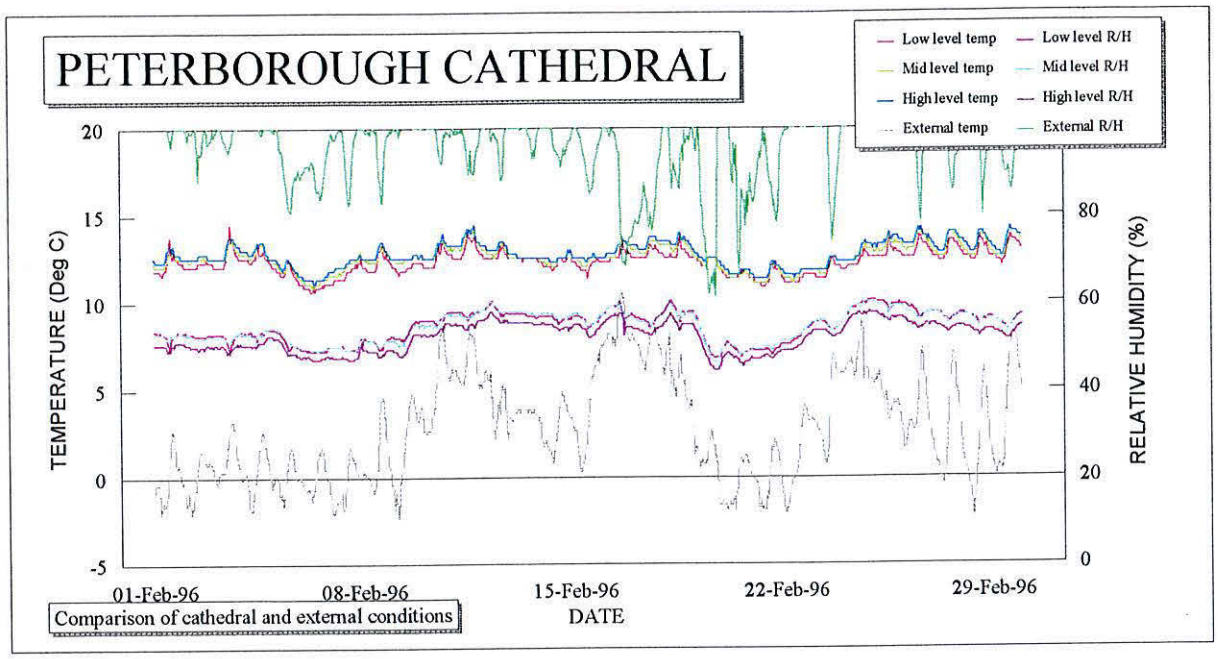
As already mentioned in previous reports, the ceiling does not appear to be in any immediate danger. Any deterioration (as indicated by loose nails etc) is likely to have coincided with the previous upgrade of the heating system. For the next heating season, the temperature should be kept as low as possible. The settings used for 1995/96 gave good results, by limiting the temperature the relative is kept to reasonable figures. If the temperature is too high the tendancy is for the relative humidity to fall. This will create unacceptable differences of both temperature and vapour pressure on either side of the ceiling.

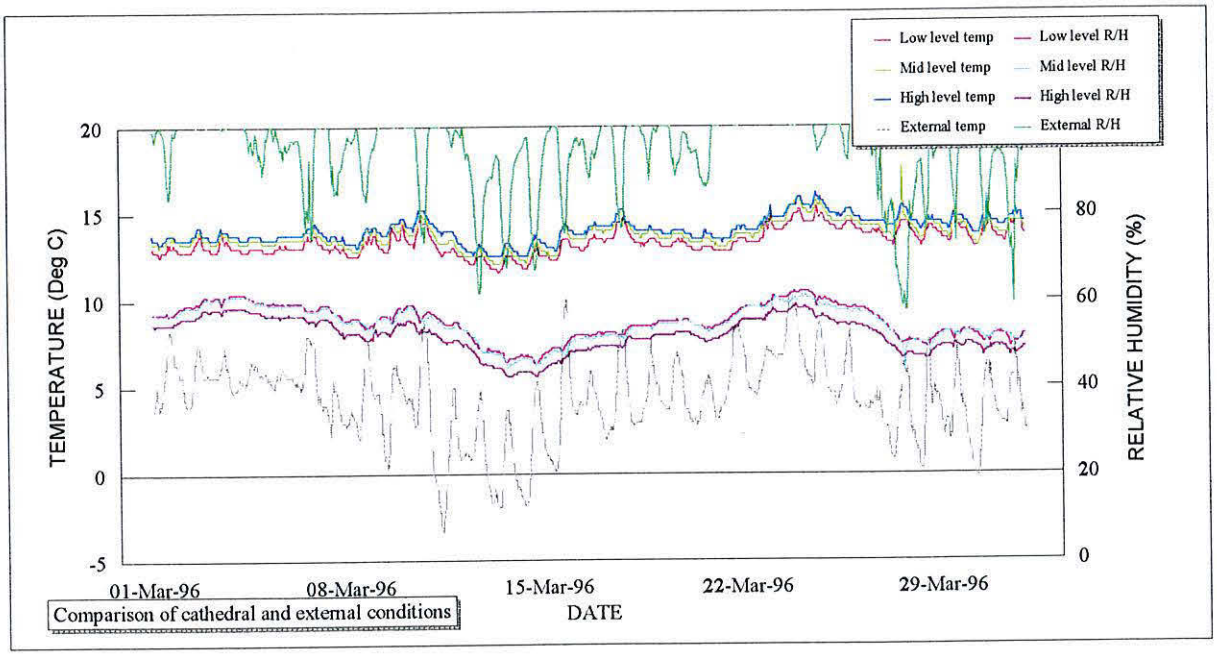
K Waterman. July 1996

The advice which this report contains is of a preliminary nature given that so far as we are aware no firm commitment to carry out the work has yet been made. As and when you do decide to carry out the work then we are under an obligation to comply with the Construction (Design and Management) Regulations 1994 in respect of any element of the advice given which relates to the design of the work. We therefore need to be notified if you decide to proceed and will need details of the planning supervisor, principal contractor and any other designers appointed by you in connection with the project to enable us to comply with the duties imposed by the Regulations on designers.

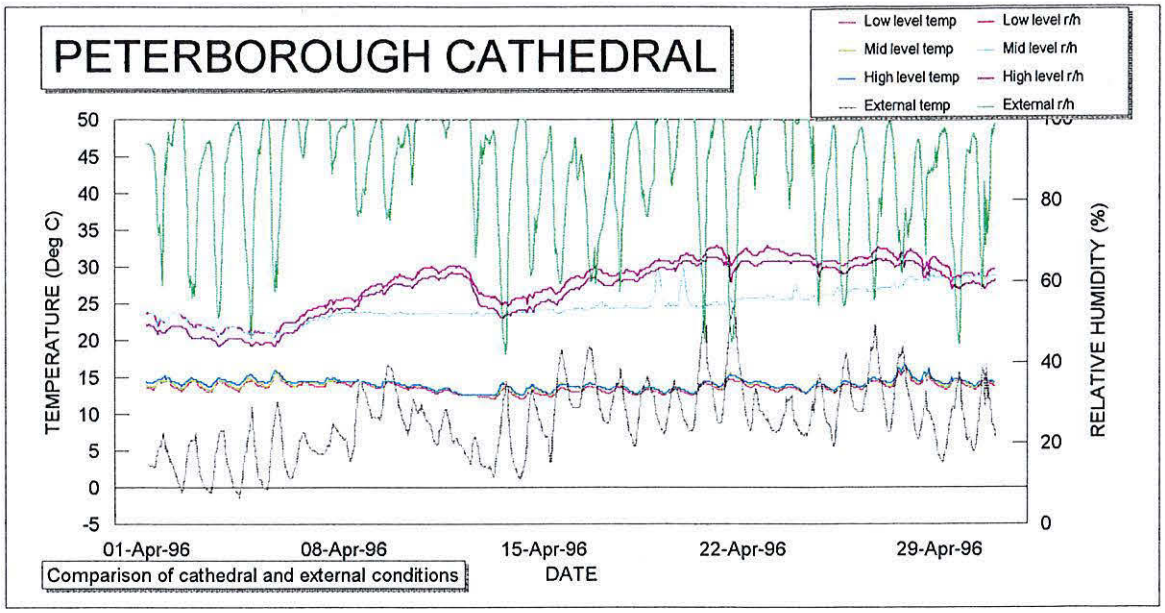
The execution of any works suggested in this report must be supervised by a competent person.

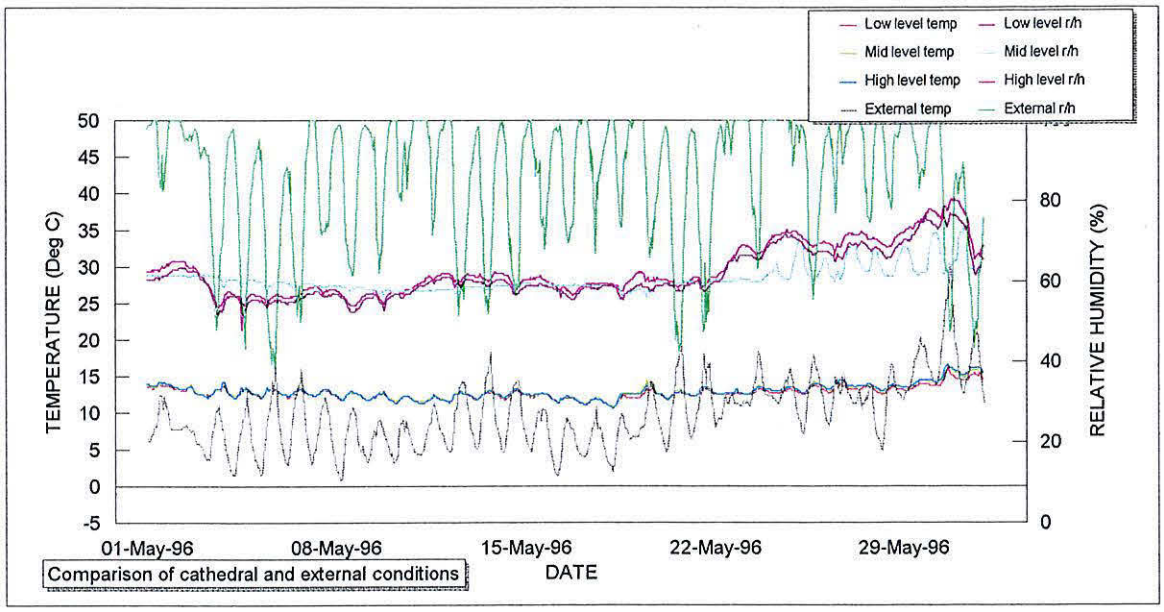
This report/letter refers only to those parts of the building/structure inspected and unless specifically stated, it does not refer to inaccessible parts of the structure. The report is on the current condition of the installation and due care and attention to inspection and maintenance is vital to avoid further deterioration.

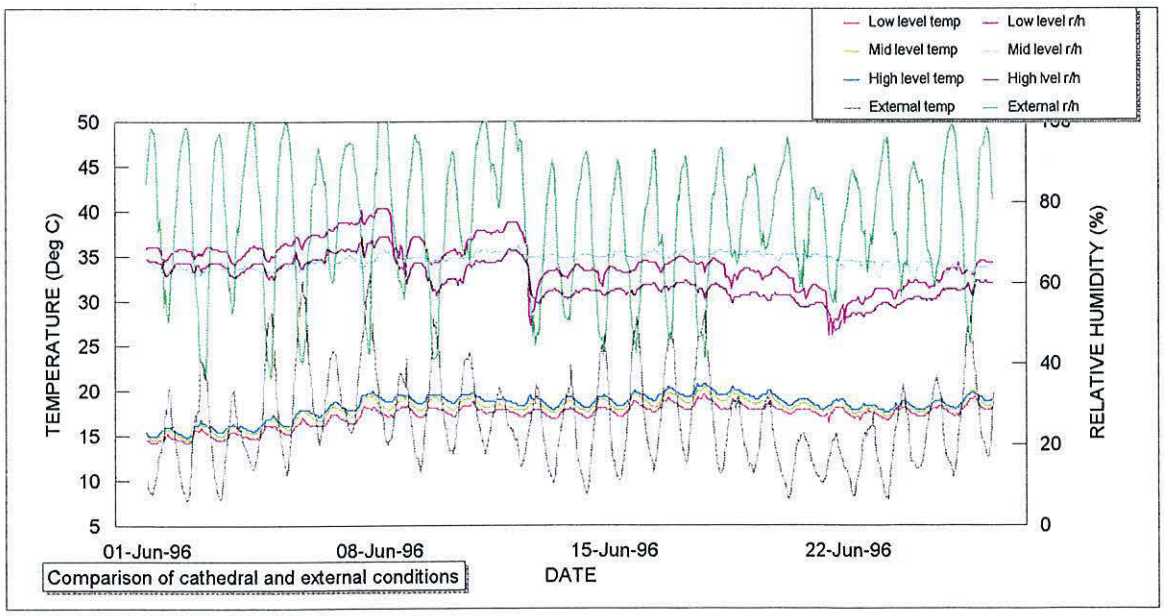

PETERBOROUGH CATHEDRAL
Low level temp
Mid level temp
High level temp
External temp
Low level R/H
Mid level R/H
High level R/H
External R/H
TEMPERATURE (Deg C)
RELATIVE HUMIDITY (%)
20
15
10
5
0
-5
80
60
40
20
0
01-Feb-96
08-Feb-96
15-Feb-96
22-Feb-96
29-Feb-96
DATE
Comparison of cathedral and external conditions


Low level temp
Mid level temp
High level temp
External temp
Low level R/H
Mid level R/H
High level R/H
External R/H
TEMPERATURE (Deg C)
RELATIVE HUMIDITY (%)
20
15
10
5
0
-5
80
60
40
20
0
01-Mar-96
08-Mar-96
15-Mar-96
22-Mar-96
29-Mar-96
DATE
Comparison of cathedral and external conditions

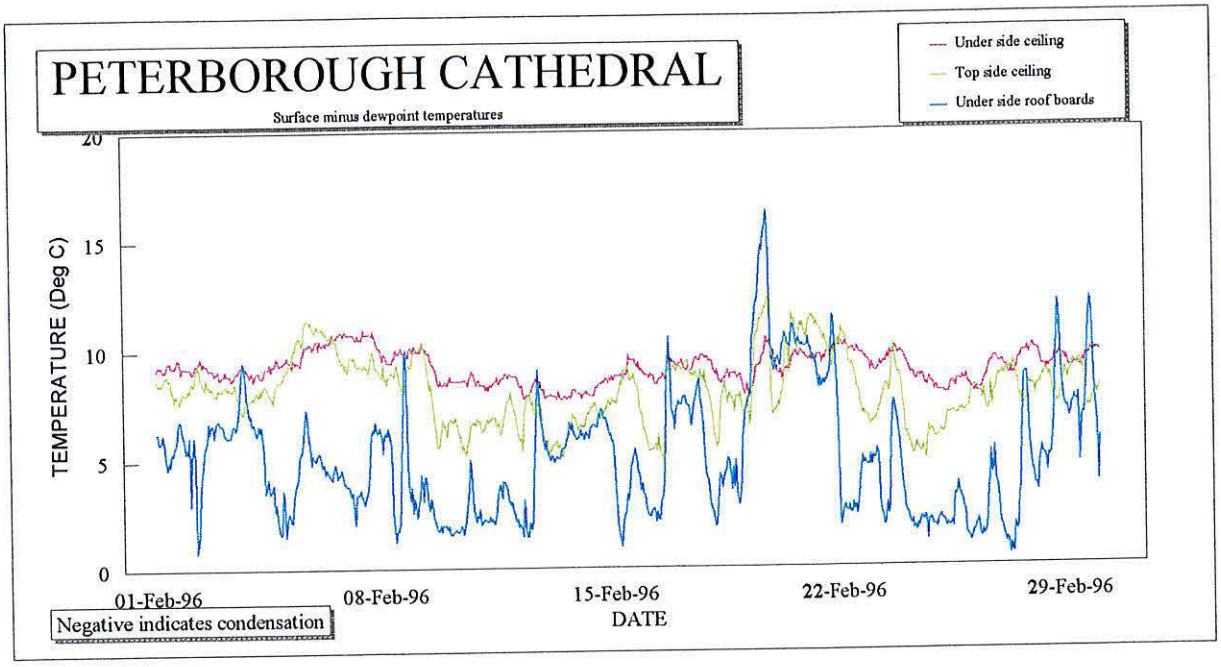
GRAPHS 1 - 2

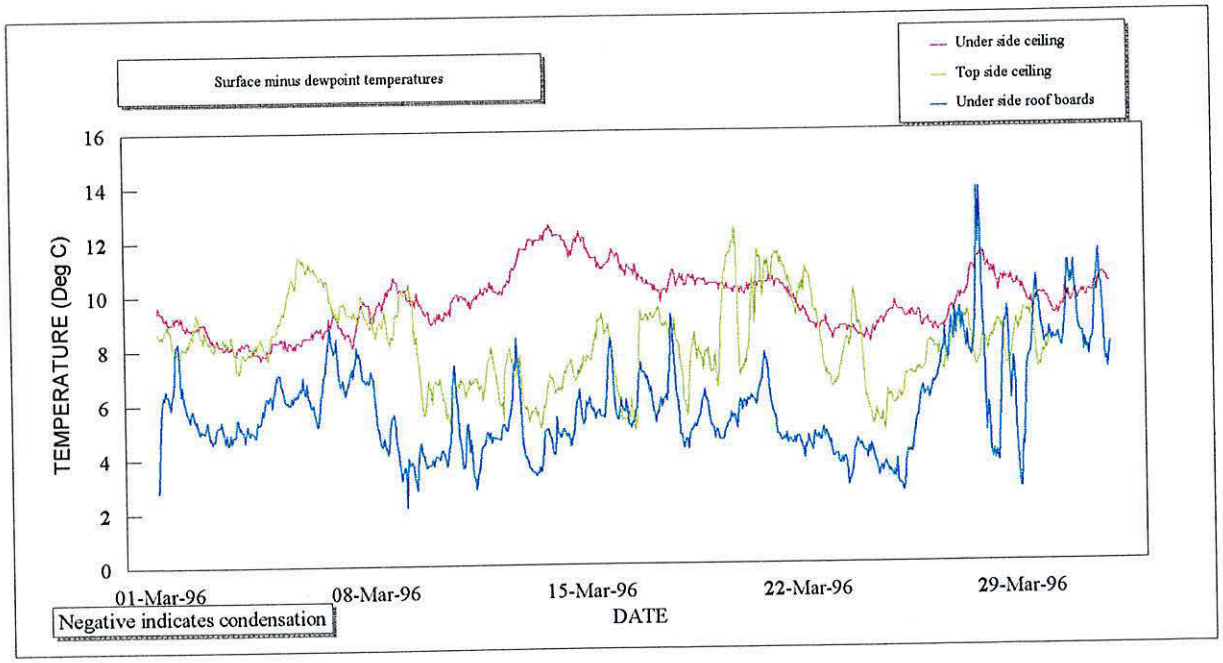

PETERBOROUGH CATHEDRAL
Low level temp
Low level r/h
Mid level temp
Mid level r/h
High level temp
High level r/h
External temp
External r/h
TEMPERATURE (Deg C)
RELATIVE HUMIDITY (%)
50
45
40
35
30
25
20
15
10
5
0
-5
80
60
40
20
0
01-Apr-96
08-Apr-96
15-Apr-96
22-Apr-96
29-Apr-96
DATE
Comparison of cathedral and external conditions


Low level temp
Low level r/h
Mid level temp
Mid level r/h
High level temp
High level r/h
External temp
External r/h
TEMPERATURE (Deg C)
RELATIVE HUMIDITY (%)
50
45
40
35
30
25
20
15
10
5
0
-5
80
60
40
20
0
01-May-96
08-May-96
15-May-96
22-May-96
29-May-96
DATE
Comparison of cathedral and external conditions

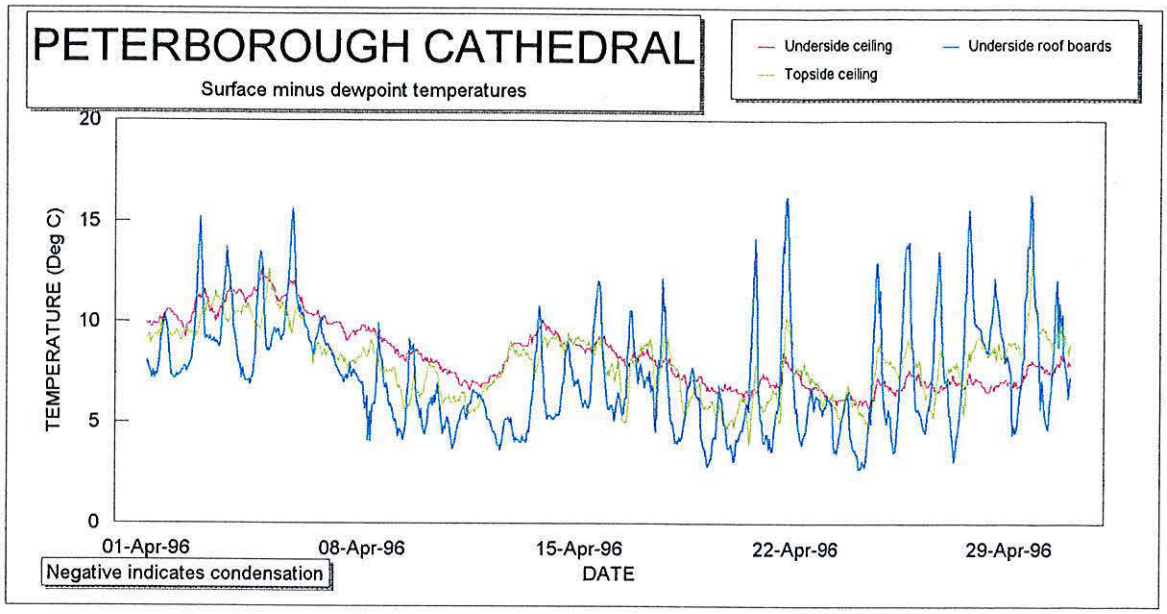

Low level temp
Low level r/h
Mid level temp
Mid level r/h
High level temp
High lvel r/h
External temp
External r/h
TEMPERATURE (Deg C)
RELATIVE HUMIDITY (%)
50
45
40
35
30
25
20
15
10
5
80
60
40
20
0
01-Jun-96
08-Jun-96
15-Jun-96
22-Jun-96
DATE
Comparison of cathedral and external conditions

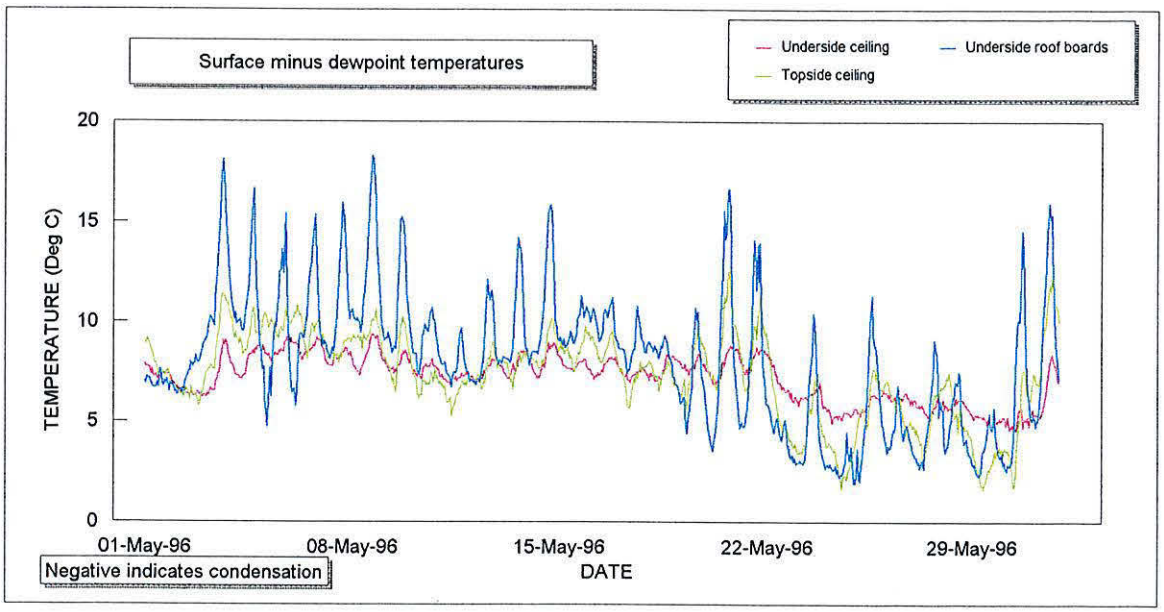
GRAPHS 3 - 5

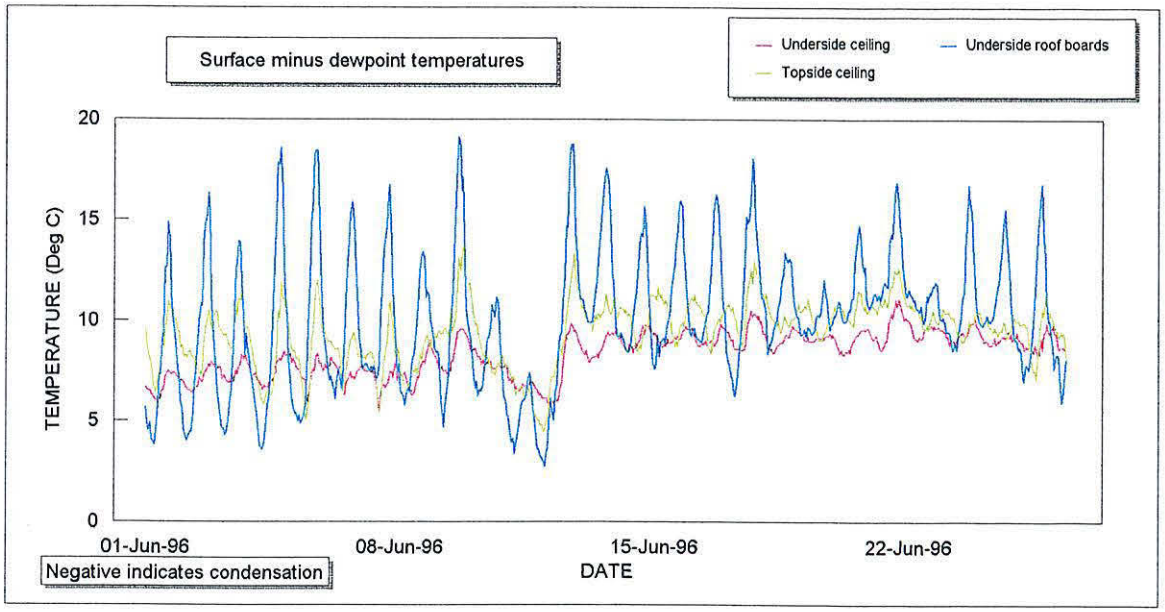

PETERBOROUGH CATHEDRAL
Surface minus dewpoint temperatures
Under side ceiling
Top side ceiling
Under side roof boards
TEMPERATURE (Deg C)
20
15
10
5
0
01-Feb-96
08-Feb-96
15-Feb-96
22-Feb-96
29-Feb-96
DATE
Negative indicates condensation


Surface minus dewpoint temperatures
Under side ceiling
Top side ceiling
Under side roof boards
TEMPERATURE (Deg C)
16
14
12
10
8
6
4
2
0
01-Mar-96
08-Mar-96
15-Mar-96
22-Mar-96
29-Mar-96
DATE
Negative indicates condensation

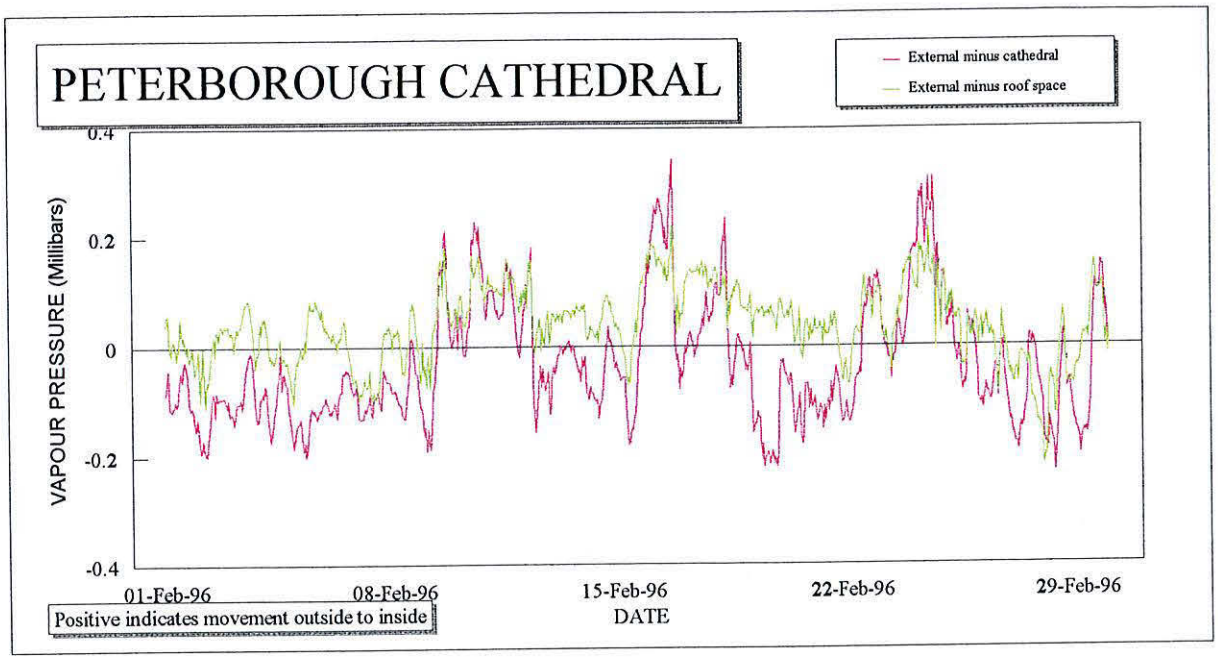
GRAPHS 6 - 7

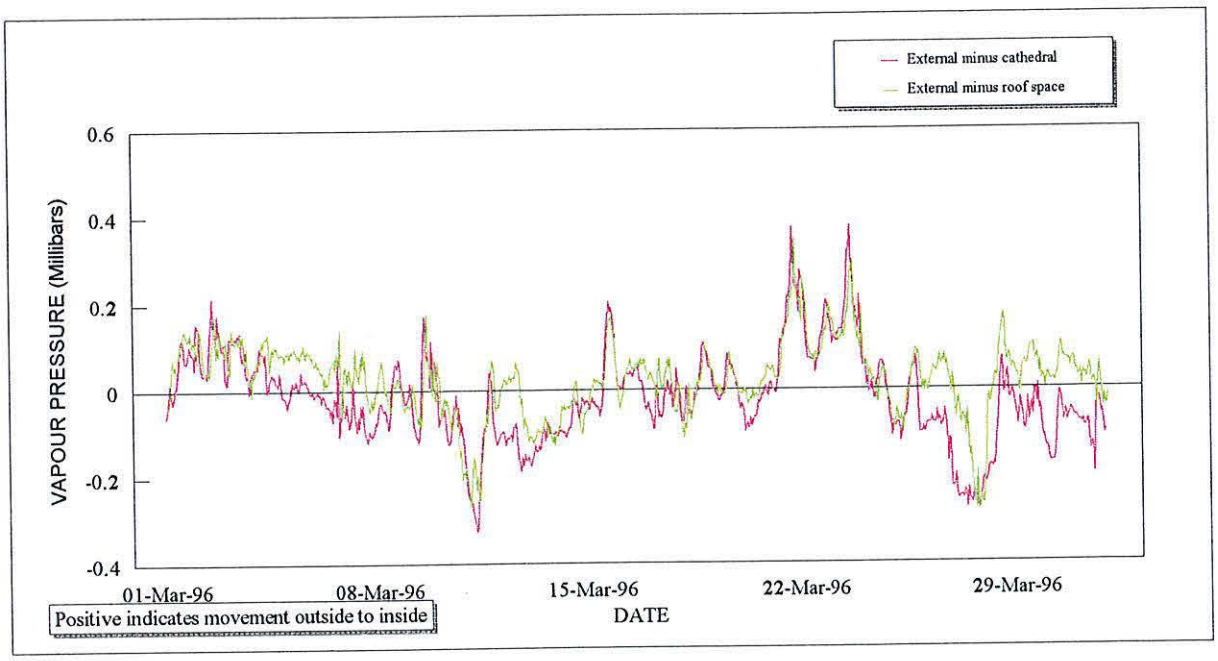

PETERBOROUGH CATHEDRAL
Surface minus dewpoint temperatures
Underside ceiling
Underside roof boards
Topside ceiling
TEMPERATURE (Deg C)
20
15
10
5
0
01-Apr-96
08-Apr-96
15-Apr-96
22-Apr-96
29-Apr-96
DATE
Negative indicates condensation


Surface minus dewpoint temperatures
Underside ceiling
Underside roof boards
Topside ceiling
TEMPERATURE (Deg C)
20
15
10
5
0
01-May-96
08-May-96
15-May-96
22-May-96
29-May-96
DATE
Negative indicates condensation

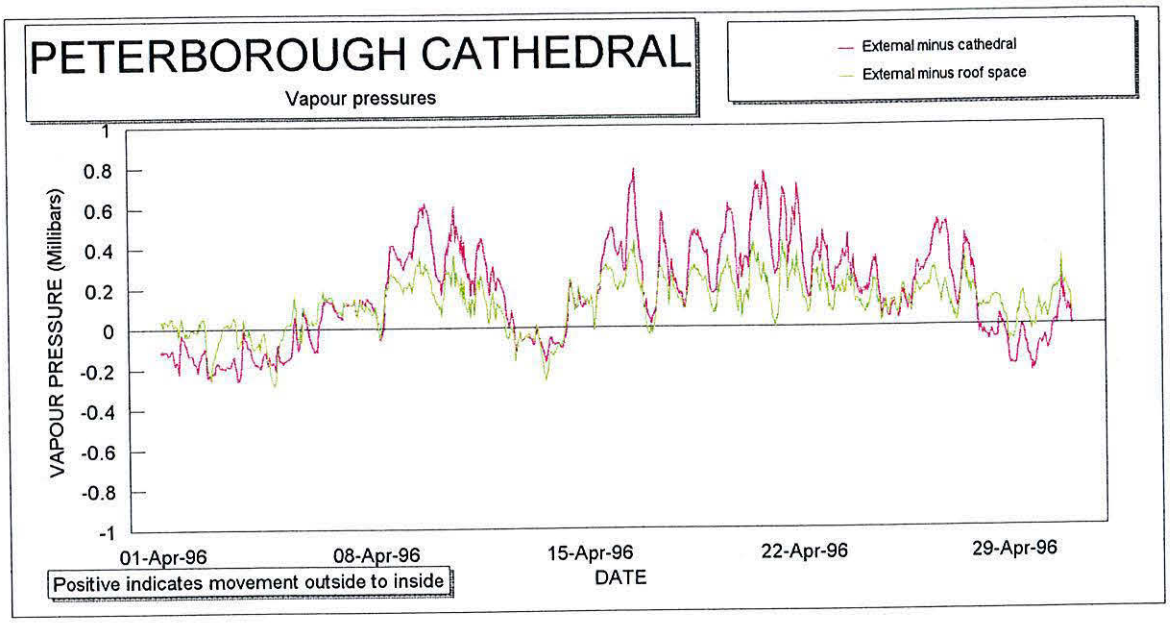

Surface minus dewpoint temperatures
Underside ceiling
Underside roof boards
Topside ceiling
TEMPERATURE (Deg C)
20
15
10
5
0
01-Jun-96
08-Jun-96
15-Jun-96
22-Jun-96
DATE
Negative indicates condensation

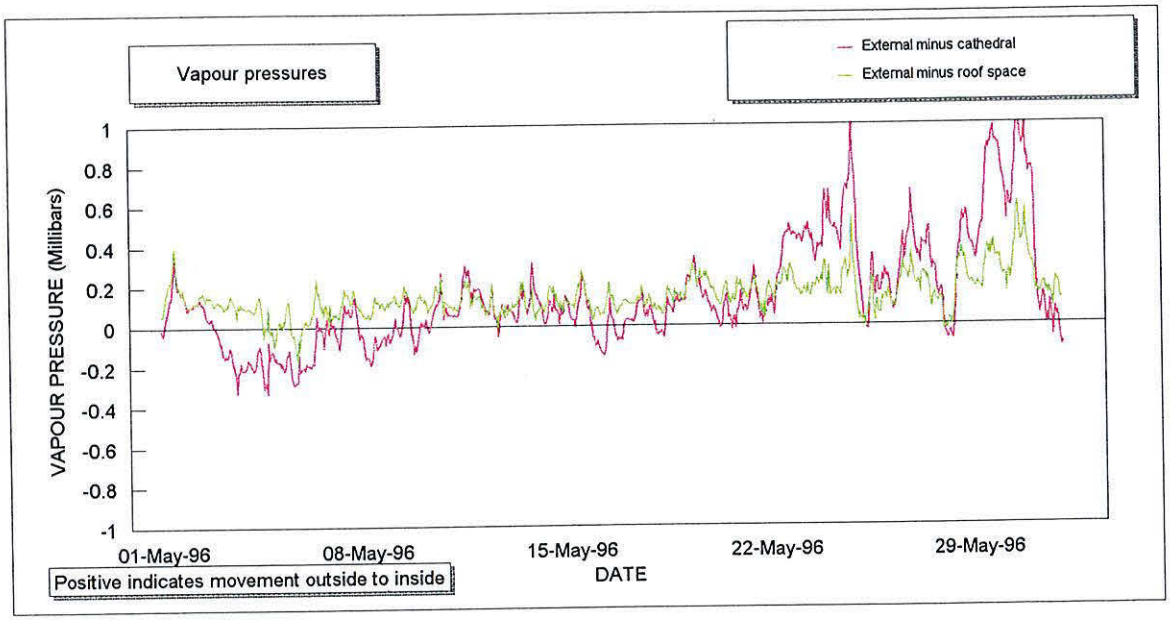
GRAPHS 8 - 10

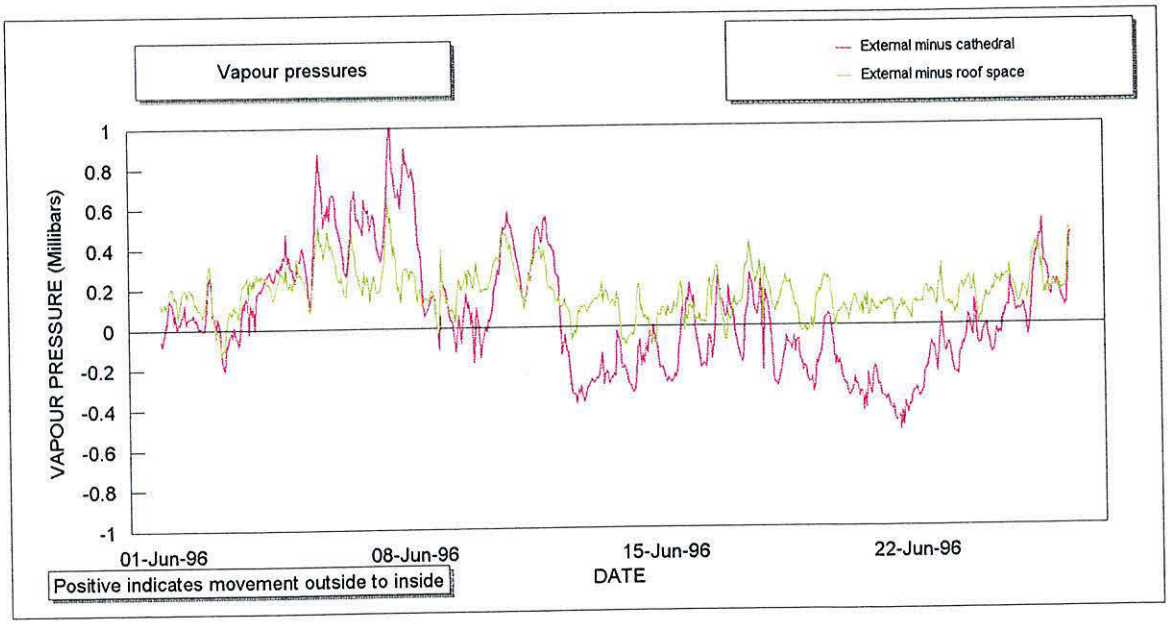

PETERBOROUGH CATHEDRAL
External minus cathedral
External minus roof space
VAPOUR PRESSURE (Millibars)
0.4
0.2
0
-0.2
-0.4
01-Feb-96
08-Feb-96
15-Feb-96
22-Feb-96
29-Feb-96
DATE
Positive indicates movement outside to inside


External minus cathedral
External minus roof space
VAPOUR PRESSURE (Millibars)
0.6
0.4
0.2
0
-0.2
-0.4
01-Mar-96
08-Mar-96
15-Mar-96
22-Mar-96
29-Mar-96
DATE
Positive indicates movement outside to inside

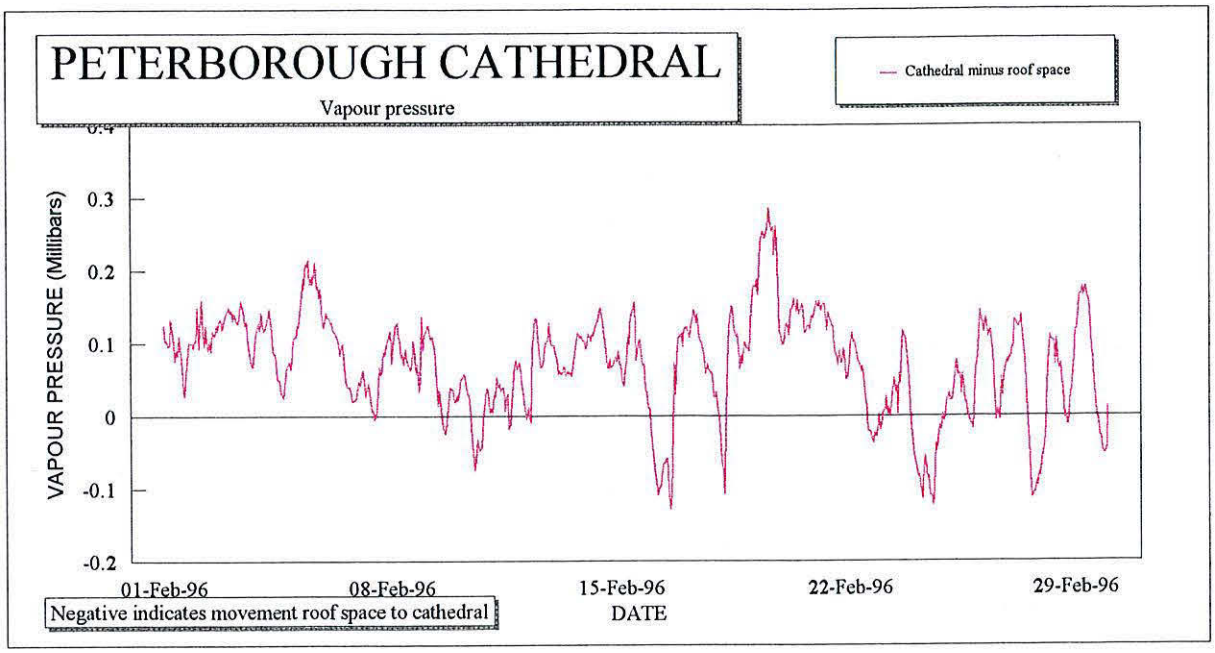
GRAPHS 11 - 12

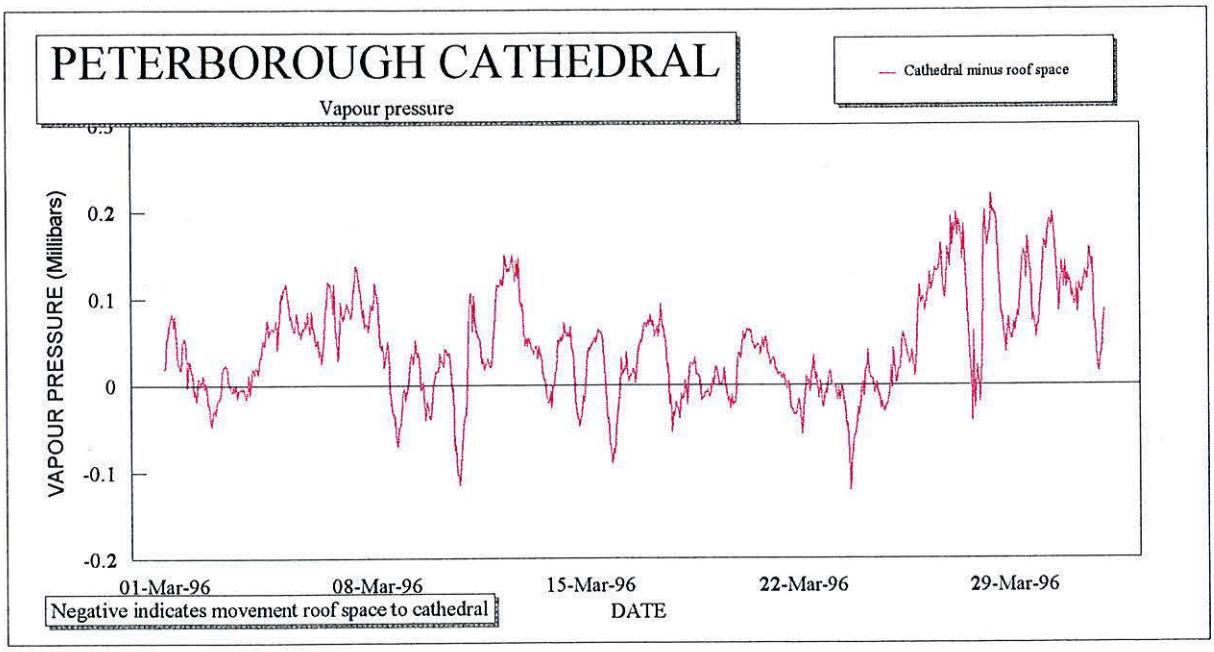

PETERBOROUGH CATHEDRAL
Vapour pressures
External minus cathedral
External minus roof space
VAPOUR PRESSURE (Millibars)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
01-Apr-96
08-Apr-96
15-Apr-96
22-Apr-96
29-Apr-96
DATE
Positive indicates movement outside to inside

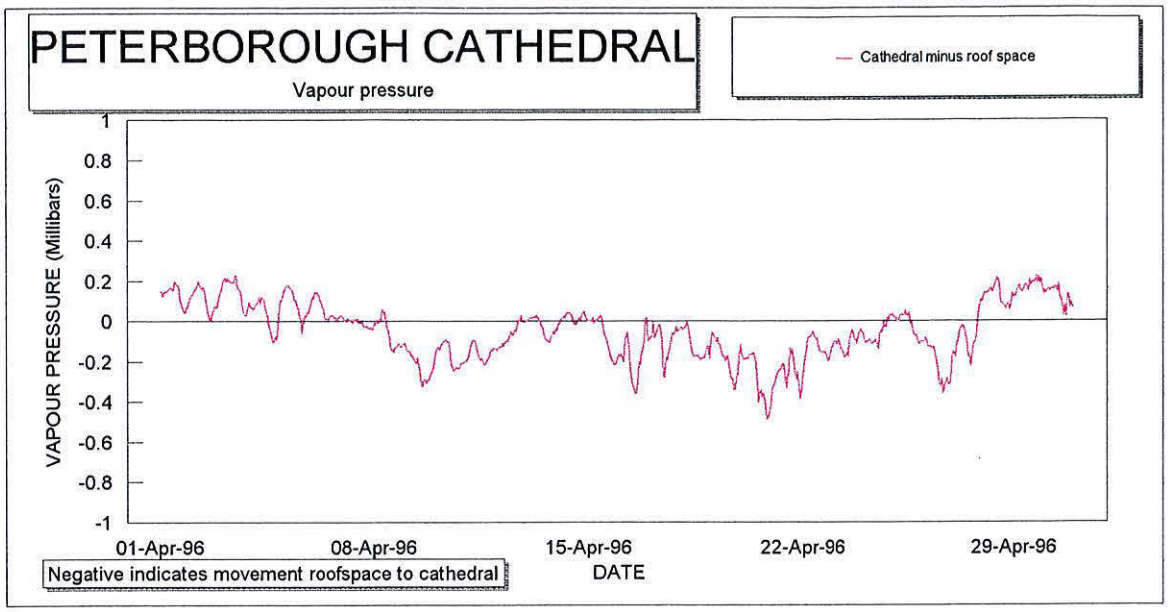

Vapour pressures
External minus cathedral
External minus roof space
VAPOUR PRESSURE (Millibars)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
01-May-96
08-May-96
15-May-96
22-May-96
29-May-96
DATE
Positive indicates movement outside to inside

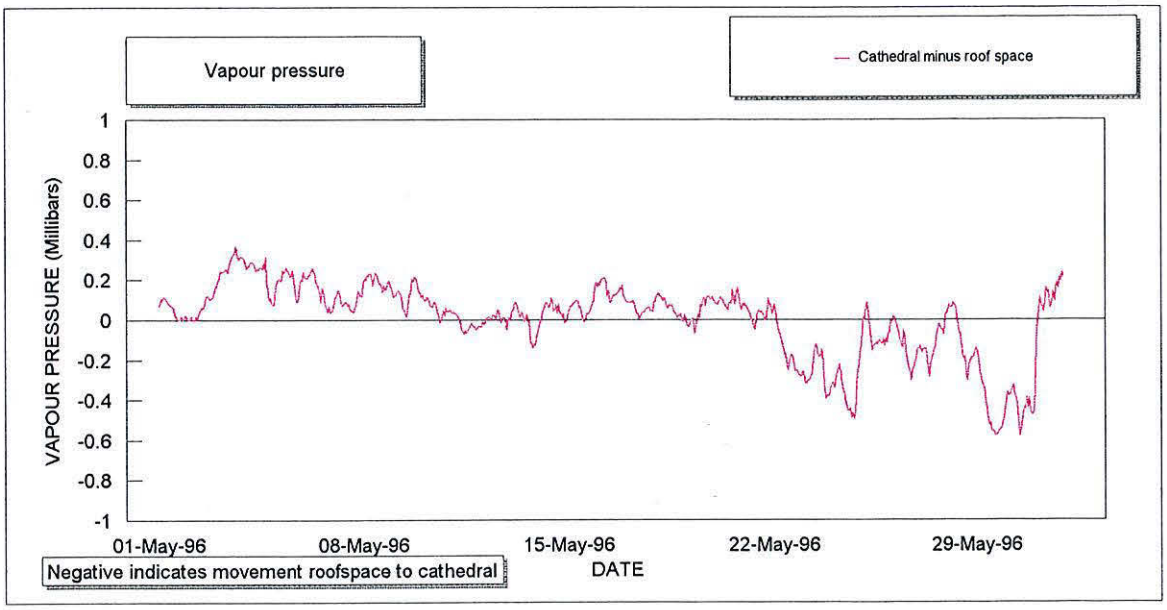

Vapour pressures
External minus cathedral
External minus roof space
VAPOUR PRESSURE (Millibars)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
01-Jun-96
08-Jun-96
15-Jun-96
22-Jun-96
DATE
Positive indicates movement outside to inside

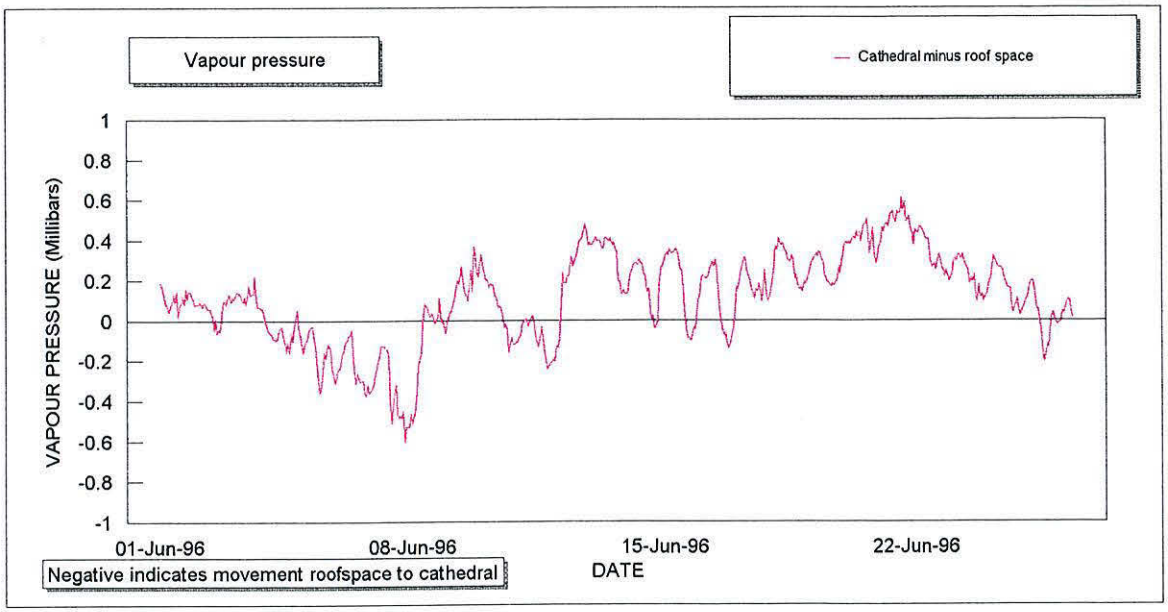
GRAPHS 13 - 15


PETERBOROUGH CATHEDRAL
Vapour pressure
Cathedral minus roof space
VAPOUR PRESSURE (Millibars)
0.3
0.2
0.1
0
-0.1
-0.2
01-Feb-96
08-Feb-96
15-Feb-96
22-Feb-96
29-Feb-96
DATE
Negative indicates movement roof space to cathedral

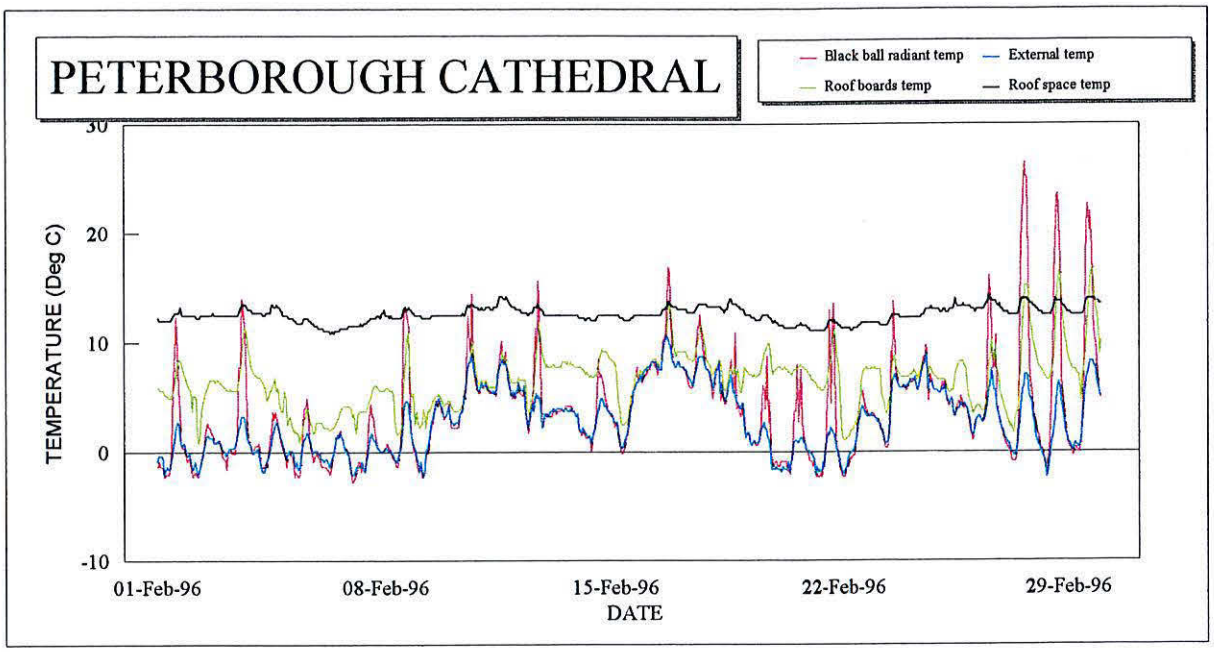

PETERBOROUGH CATHEDRAL
Vapour pressure
Cathedral minus roof space
VAPOUR PRESSURE (Millibars)
0.2
0.1
0
-0.1
-0.2
01-Mar-96
08-Mar-96
15-Mar-96
22-Mar-96
29-Mar-96
DATE
Negative indicates movement roof space to cathedral

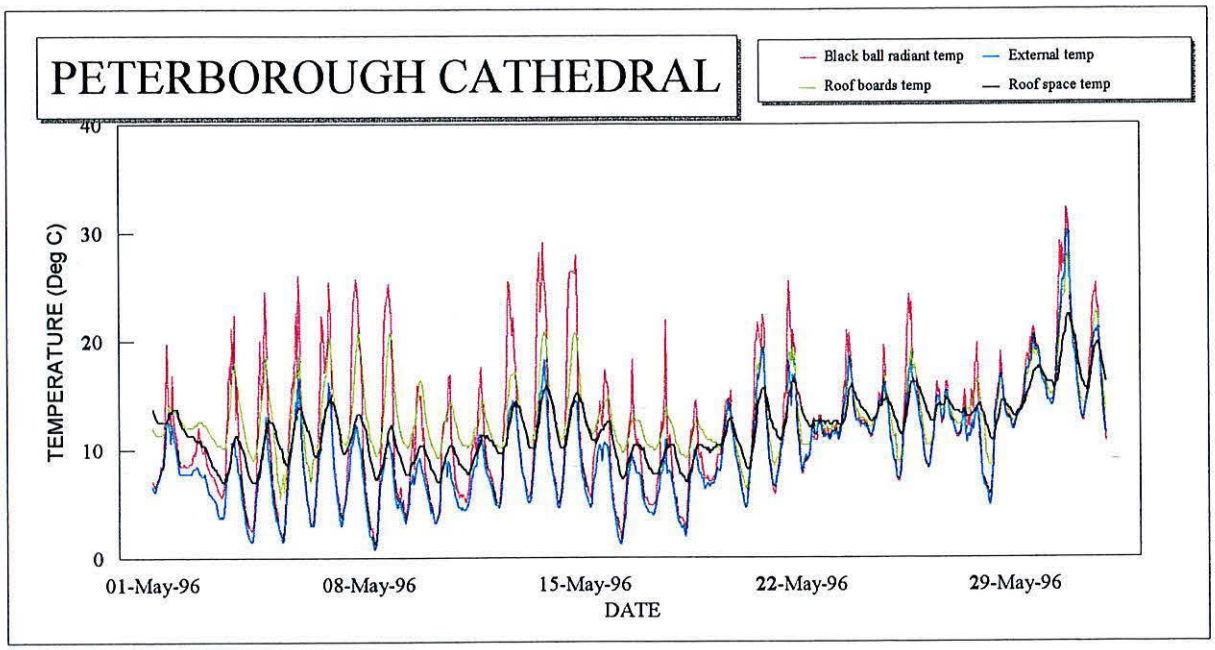

PETERBOROUGH CATHEDRAL
Vapour pressure
Cathedral minus roof space
VAPOUR PRESSURE (Millibars)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
01-Apr-96
08-Apr-96
15-Apr-96
22-Apr-96
29-Apr-96
DATE
Negative indicates movement roofspace to cathedral


Vapour pressure
Cathedral minus roof space
VAPOUR PRESSURE (Millibars)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
01-May-96
08-May-96
15-May-96
22-May-96
29-May-96
DATE
Negative indicates movement roofspace to cathedral

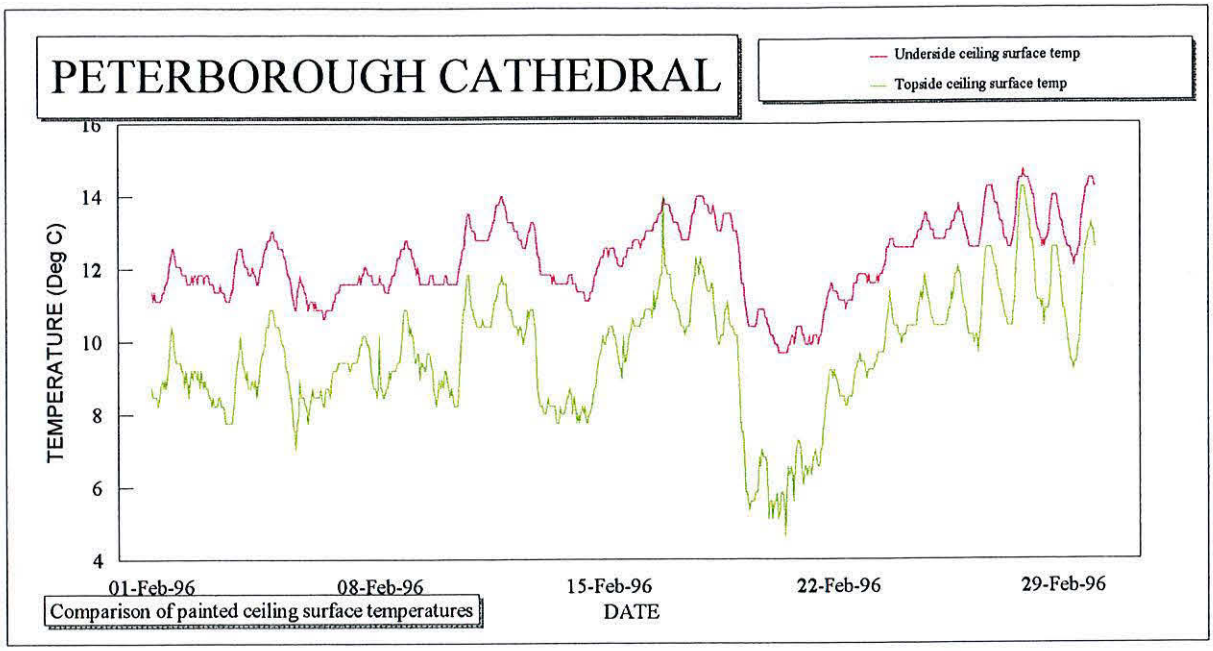

Vapour pressure
Cathedral minus roof space
VAPOUR PRESSURE (Millibars)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
01-Jun-96
08-Jun-96
15-Jun-96
22-Jun-96
DATE
Negative indicates movement roofspace to cathedral

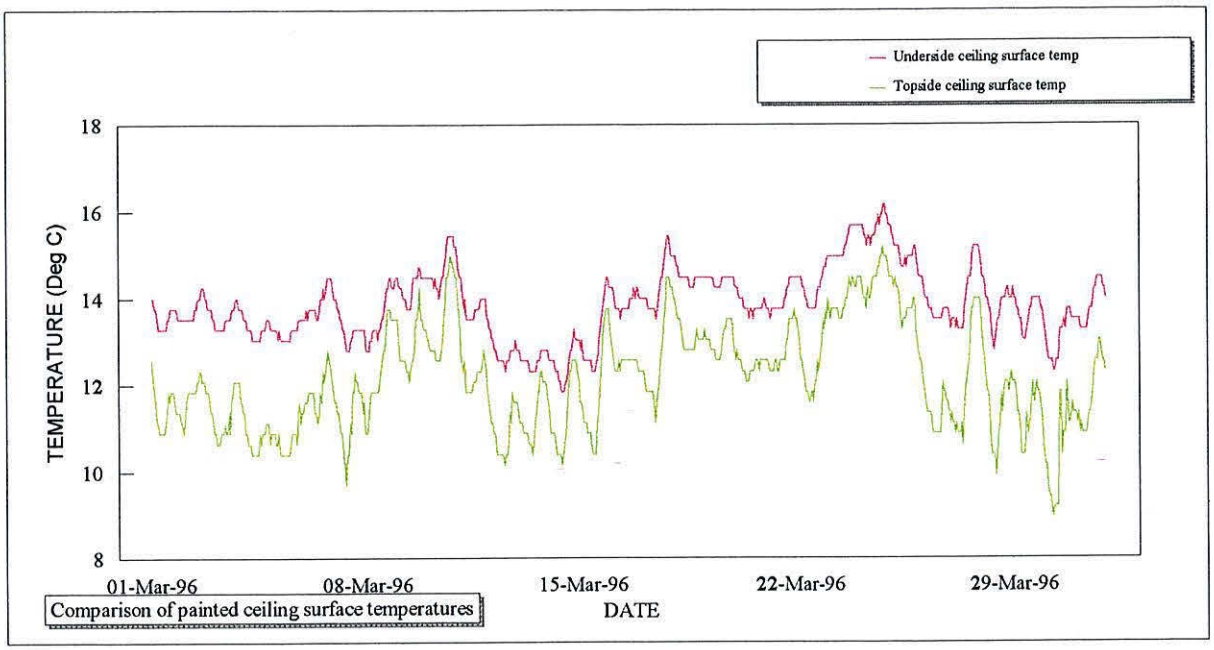
GRAPHS 18 - 20

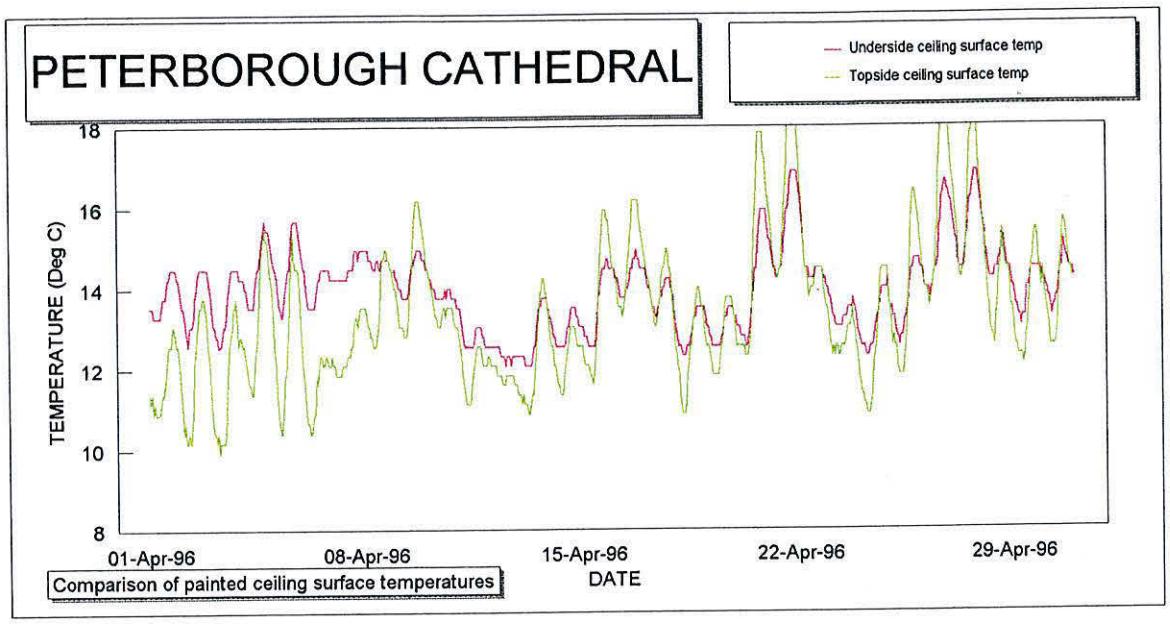


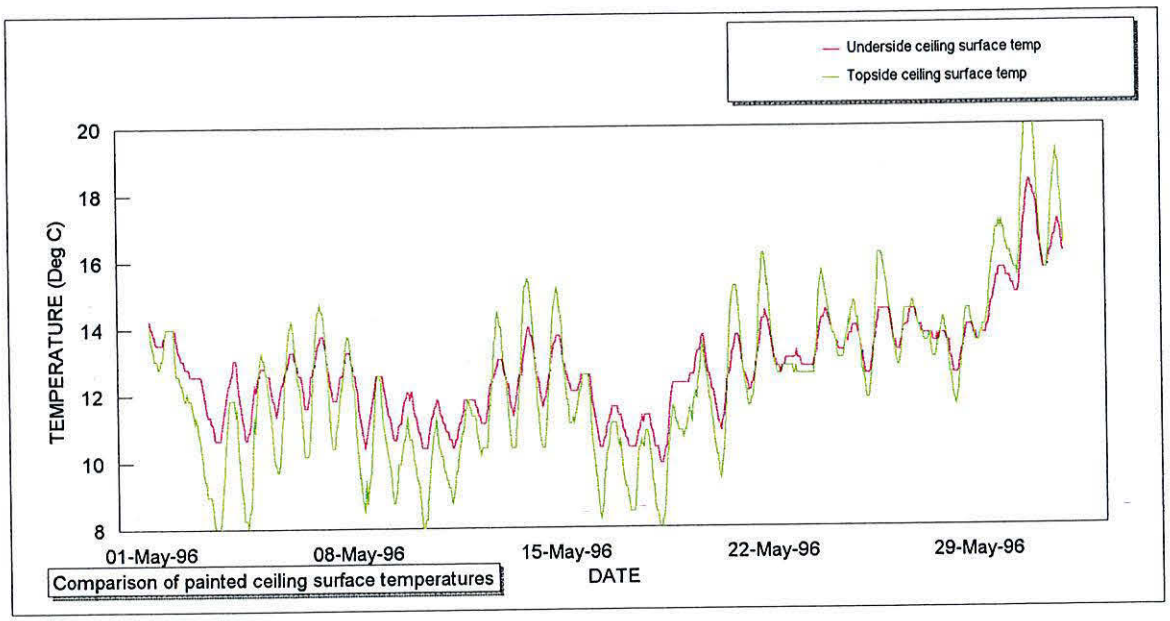


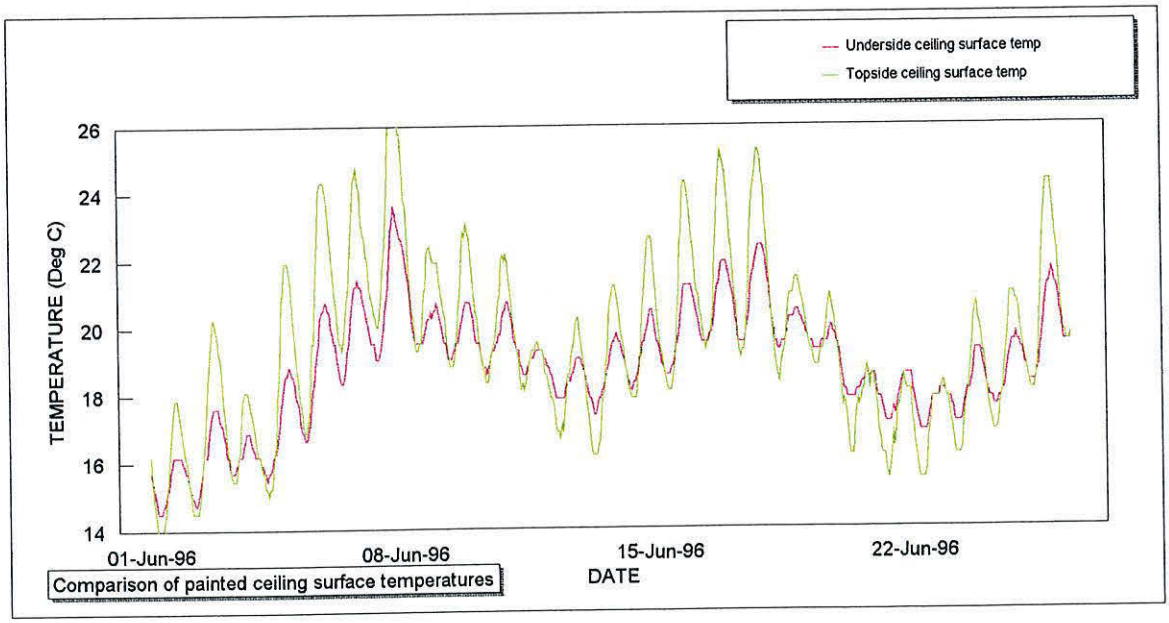
GRAPHS 21 - 22 SHOWING EFFECT OF HEATING ON ROOF SPACE TEMP


PETERBOROUGH CATHEDRAL
Underside ceiling surface temp
Topside ceiling surface temp
TEMPERATURE (Deg C)
16
14
12
10
8
6
4
01-Feb-96
08-Feb-96
15-Feb-96
22-Feb-96
29-Feb-96
DATE
Comparison of painted ceiling surface temperatures


Underside ceiling surface temp
Topside ceiling surface temp
TEMPERATURE (Deg C)
18
16
14
12
10
8
01-Mar-96
08-Mar-96
15-Mar-96
22-Mar-96
29-Mar-96
DATE
Comparison of painted ceiling surface temperatures


PETERBOROUGH CATHEDRAL
Underside ceiling surface temp
Topside ceiling surface temp
TEMPERATURE (Deg C)
18
16
14
12
10
8
01-Apr-96
08-Apr-96
15-Apr-96
22-Apr-96
29-Apr-96
DATE
Comparison of painted ceiling surface temperatures


Underside ceiling surface temp
Topside ceiling surface temp
TEMPERATURE (Deg C)
20
18
16
14
12
10
8
01-May-96
08-May-96
15-May-96
22-May-96
29-May-96
DATE
Comparison of painted ceiling surface temperatures


Underside ceiling surface temp
Topside ceiling surface temp
TEMPERATURE (Deg C)
26
24
22
20
18
16
14
01-Jun-96
08-Jun-96
15-Jun-96
22-Jun-96
DATE
Comparison of painted ceiling surface temperatures

GRAPHS 25 - 27