

**Ambient sulphur dioxide monitoring at Cairnryan  
village hall, Dumfries and Galloway.  
January 2004 to December 2004.**

**by J Green, D Gardiner and I S McCrae**

**UPR SE/013/04  
Clients Project Reference Number**

**UNPUBLISHED PROJECT REPORT**



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**AMBIENT SULPHUR DIOXIDE MONITORING AT  
CAIRNRYPAN VILLAGE HALL, DUMFRIES AND  
GALLOWAY.  
JANUARY 2004 TO DECEMBER 2004.**

Version:: 1 March 2005

by J Green, D Gardiner and I S McCrae

**Prepared for: Project Record:**      **Monitoring of ambient sulphur dioxide concentrations at Cairnryan Village Hall.**  
**Client:**                                      **Environmental Health Department, Dumfries and Galloway Council (Mr J Coltart)**

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## **Executive summary**

In 2003, a sulphur dioxide (SO<sub>2</sub>) monitoring project was commissioned by Dumfries and Galloway Council. The objective of the study was to investigate the contribution of the local port activities in the Port of Cairnryan, on local ambient ground level SO<sub>2</sub> concentrations. This report presents those data collected over the twelve-month period between 1<sup>st</sup> January 2004 and 31<sup>st</sup> December 2004.

Over this period, the 1-hour and 24-hour SO<sub>2</sub> objectives specified in the UK Air Quality Strategy, to be achieved by 31 December 2004, were not exceeded. The maximum hourly mean and 24-hour mean were 44.6 ppb and 11.7 ppb respectively which were well within the corresponding limits of 132 ppb and 47 ppb. The 15-minute objective of 100 ppb, which is to be achieved by 31<sup>st</sup> December 2005, was exceeded on two occasions with a maximum 15-minute mean value of 123.7 ppb recorded on 8<sup>th</sup> June and of 107.6 ppb on 27<sup>th</sup> June. Additional high concentration peaks were recorded in the 15-minute data which suggest a local source of SO<sub>2</sub> emissions. Subsequent analysis of these SO<sub>2</sub> peaks, in conjunction with meteorological data, confirms the port facility as a significant local source of SO<sub>2</sub>.

## 1 Introduction

An air quality monitoring system, supplied and installed by TRL Environment, has been used to obtain ambient ground level concentrations of sulphur dioxide (SO<sub>2</sub>) at Cairnryan Village Hall, on behalf of Dumfries and Galloway Council.

The objective of the study was to investigate the contribution to ambient ground level SO<sub>2</sub> concentrations associated with the local port operation and ship activity at the port of Cairnryan. The port of Cairnryan is a major roll-on roll-off (RORO) terminus, providing regular services to Larne. In comparison to road transport where fuel sulphur content has been gradually reduced, high sulphur fuels remain in general use in marine and coastal shipping. Emissions from their activity, therefore, could result in significant contributions to ambient ground level SO<sub>2</sub> concentrations in the vicinity of the port.

The measurements obtained during the survey comprise emissions from all sources during the period of study and are also influenced by the prevailing meteorology which affects the manner in which those emissions are dispersed and mixed to ground level.

This report covers the twelve-month monitoring period from 1<sup>st</sup> January to 31<sup>st</sup> December 2004 and updates the previous interim reports.

## 2 Background

### 2.1 Air quality standards

Air quality in the European Union is required to comply with various directives which essentially specify the establishment of ambient air quality standards and objectives, the assessment of air quality, the provision of information to the public and the development of plans to bring air quality within the desired limits. New provisions for air quality were brought into UK legislation through Part IV of the 1995 Environment Act, which required local authorities to review and assess air quality in their areas against standards and objectives set out in the Air Quality (Scotland) Regulations 2000 (as amended 2002) and the Air Quality Strategy (AQS) (DETR 2000 and Defra 2003). The limits contained within the AQS are based upon concentrations over a given time period that are considered to be acceptable, judged on the basis of the most recent information on the effects of each pollutant on human health and the environment. The objectives for sulphur dioxide are listed in Table 2.1.

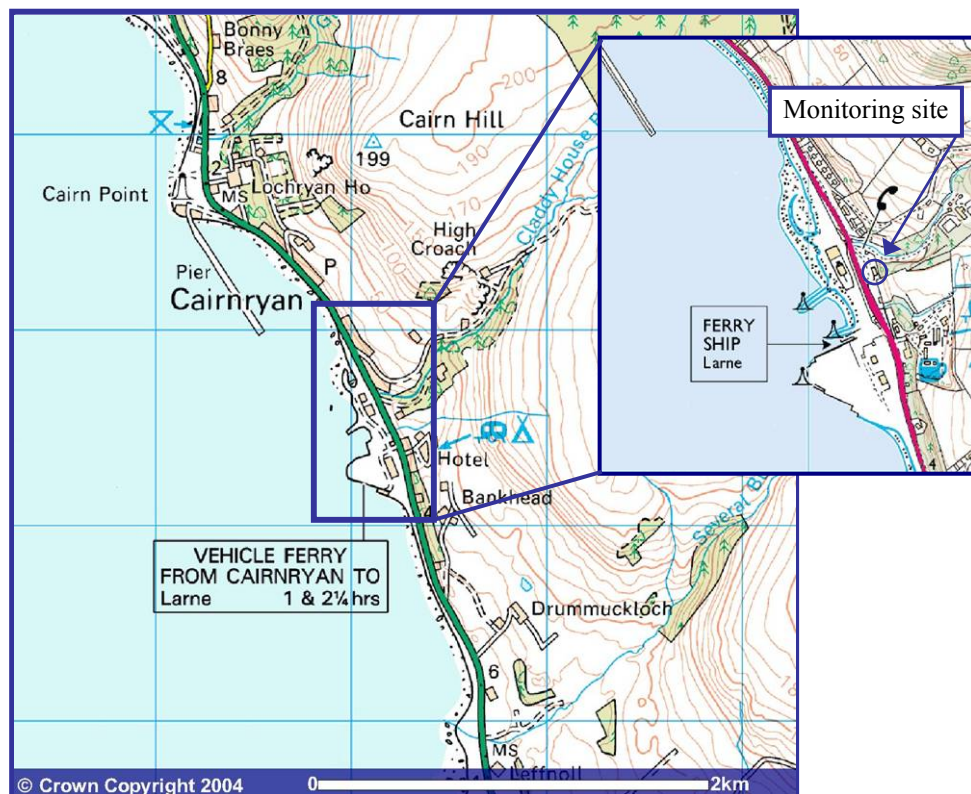
**Table 2.1: Objectives of the UK Air Quality Strategy for sulphur dioxide**

| Objective   | Compliance date  |
|---|------------------|
| <b>UK objectives for SO<sub>2</sub> set in regulations</b>  |                  |
| Hourly average concentration of 132 ppb (350 µg/m <sup>3</sup> ) not to be exceeded more than 24 times a year.  | 31 December 2004 |
| 24-hour average of 47 ppb (125 µg/m <sup>3</sup> ) not to be exceeded more than 3 times a year.   | 31 December 2004 |
| 15-minute mean of 100 ppb (266 µg/m <sup>3</sup> ) not to be exceeded more than 35 times a year.  | 31 December 2005 |
| <b>UK objectives for SO<sub>2</sub> not set in regulations (vegetation based directives; targets met)</b>   |                  |
| Annual average concentration of 20 µg/m <sup>3</sup> (8 ppb).<br>Winter average concentration (1 October to 31 March) of 20 µg/m <sup>3</sup> (8 ppb) | 31 December 2000 |

## 2.2 Site Details

The coastal town of Cairnryan is located near the southern uplands, in south-west Scotland. The air quality monitoring equipment was installed at the village hall, to the east side of the A77. This position was agreed prior to installation with the Scottish Environmental Protection Agency (SEPA). The A77 links Stranraer to the south with Girvan to the north, and runs along the eastern edge of Loch Ryan. The monitoring station is situated across the road from the ferry terminal (Figure 2.1).

The station was equipped with a Monitor Labs 9850B sulphur dioxide analyser, operating under the standard principle of ultra-violet fluorescence. A meteorological mast was also installed at the monitoring station approximately 5.5m above ground level, to measure wind speed and wind direction. A Campbell 21x data logger configured to record 15-min average concentrations was used to record sulphur dioxide concentrations, wind speed and wind direction. The equipment was positioned in the northern end of the hall, as pictured in Figure 2.2.



**Figure 2.1: Map showing the location of the monitoring site at Cairnryan.**



**Figure 2.2: Building in which the monitoring equipment was housed. The equipment was located in the left hand portion of the building.**

### 2.3 Monitoring Procedures

A continuous sample of air was drawn into the analyser through a 6mm PTFE sample tube. The sample line was fitted with a rain protector to limit the ingress of water into the analyser. In order to attempt to ensure that the gas sample reaching the analyser remained unchanged from that entering the sampling system, all wetted surfaces comprised of PTFE and the sample residence times were kept to a minimum by keeping sample line lengths to a minimum. The sample inlet was located approximately 2.5 m above ground level as indicated on Figure 2.2. A bracket was installed to support the sample inlet line and distanced the inlet head approximately 0.5 m from the external wall of the building.

Standard calibration procedures are applied to this monitoring facility. These procedures provide a check of the instruments zero and span responses, as compared against certified gas standards. Routine instrument calibrations were conducted approximately once a fortnight. The sulphur dioxide analyser was checked for span calibration by using a certified BOC Spectraseal gas standard, traceable to NPL primary standards. The analyser zero was checked using zero air, derived using a conventional scrubber column containing activated charcoal.

Environmental Health Staff based at Stranraer were trained by TRL staff to conduct the fortnightly analyser calibrations. This procedure included a pre- and post-calibration inspection, and written record of the gas analyser diagnostics followed by a zero and span calibration. A general visual inspection of all equipment was also recorded. The operating procedure is detailed in Appendix A and an example site visit calibration record sheet, is detailed in Appendix B.

Data from the monitoring station were retrieved and stored on a Campbell 21x data logger as 15-minute average data. The data were retrieved from the logger remotely by ENVIEW 2000 at TRL at 12-hour intervals. The data were checked each working day to ensure that the analyser was working correctly. These 15-minute data were corrected for zero and span drifts, through reference to the results of the periodic calibrations. On completion of this data correction procedure, these data are converted to hourly averages.



### 3 Data Analysis

This section provides a summary of the measurement data from the Cairnryan site collected between the 1<sup>st</sup> January 2004 and the 31<sup>st</sup> December 2004. These data are presented graphically and summarised statistically, with pollutant concentrations compared to the air quality objectives. In addition, pollution roses are presented to assist in the determination of the source apportionment of the SO<sub>2</sub> emissions.

#### 3.1 Presentation of the data

Figure 3.1 and Figure 3.2 show the 15-minute concentrations of sulphur dioxide over the monitoring period. Figure 3.1 shows these data for the first six months of the year and Figure 3.2 shows the data for the second half of the year. Figure 3.3 shows the hourly average SO<sub>2</sub> concentrations over the 12-month monitoring period. Table 3.1 presents the summary statistics for the 15-minute, 1-hour and 24-hour data.

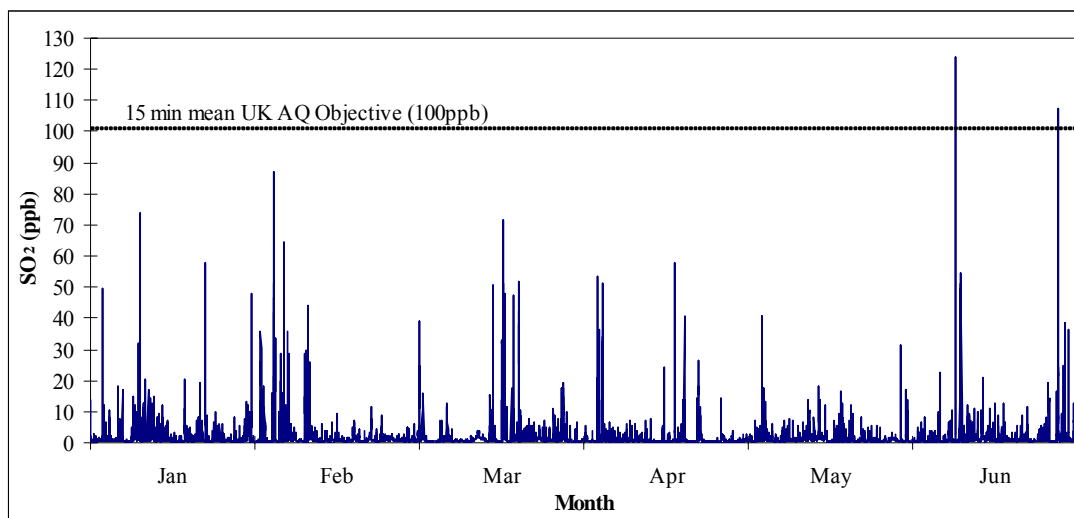


Figure 3.1: 15-minute average time series plot January to June.

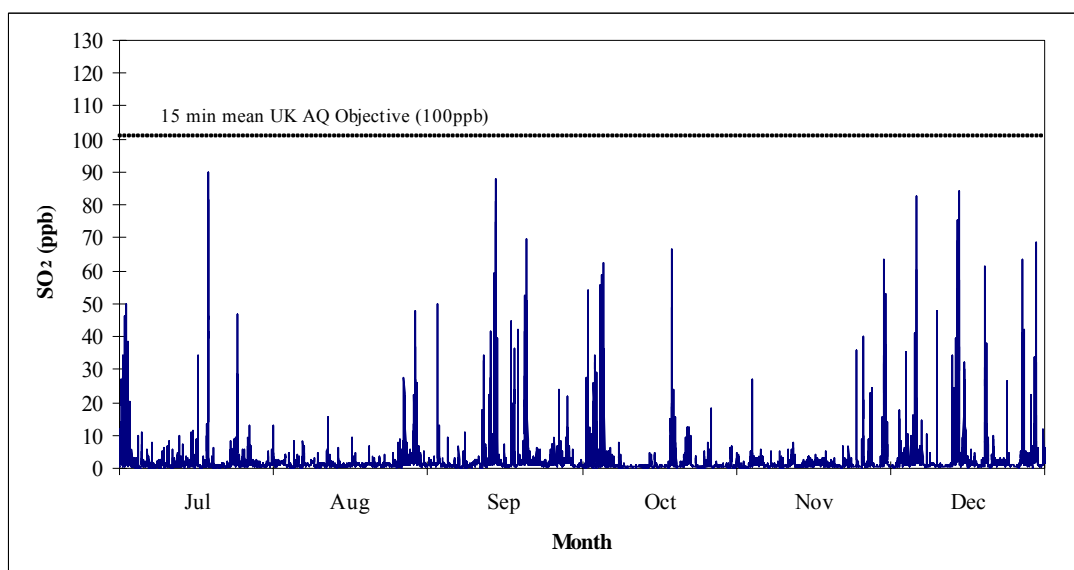
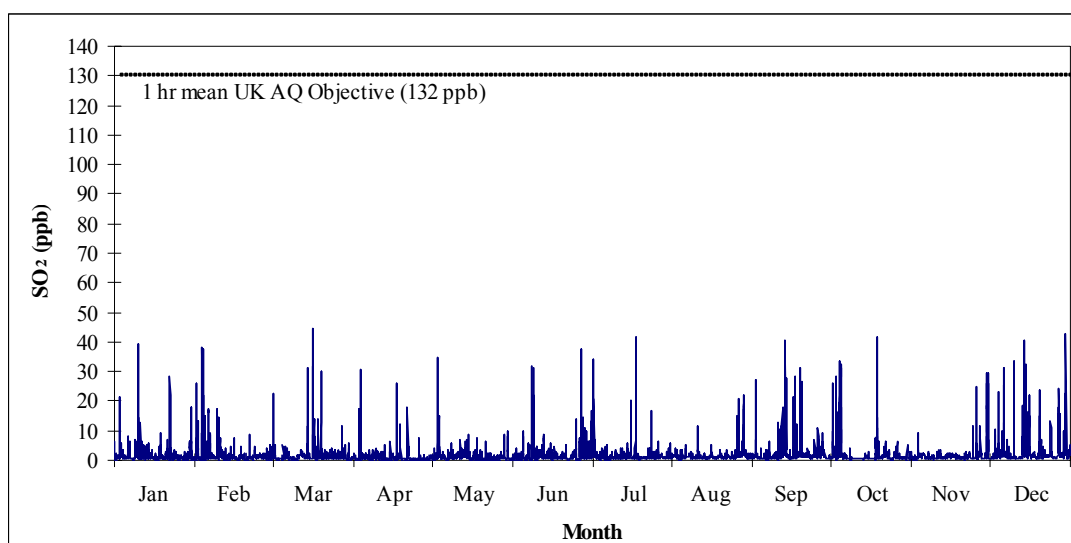


Figure 3.2: 15-minute average time series plot July to December.



**Figure 3.3: Hourly average time series plot.**

Figure 3.1, Figure 3.2, Figure 3.3 and Table 3.1 show that the UK Air Quality Strategy limits for hourly and 24-hour  $\text{SO}_2$  measurements were not exceeded. The maximum hourly mean and 24-hour mean were 44.6 ppb and 11.7 ppb respectively which were well within the corresponding objectives of 132 ppb and 47 ppb. There were, however, two exceedences of the 15-minute mean objective. One, which was previously reported in the 6-month report, occurred on 8<sup>th</sup> June at 12:45 with a 15-minute mean concentration of 123.7 ppb. A second, which was reported in the 9-month report, occurred on 27<sup>th</sup> June at 12:30 with a mean 15-minute concentration of 107.6 ppb. No subsequent exceedences occurred.

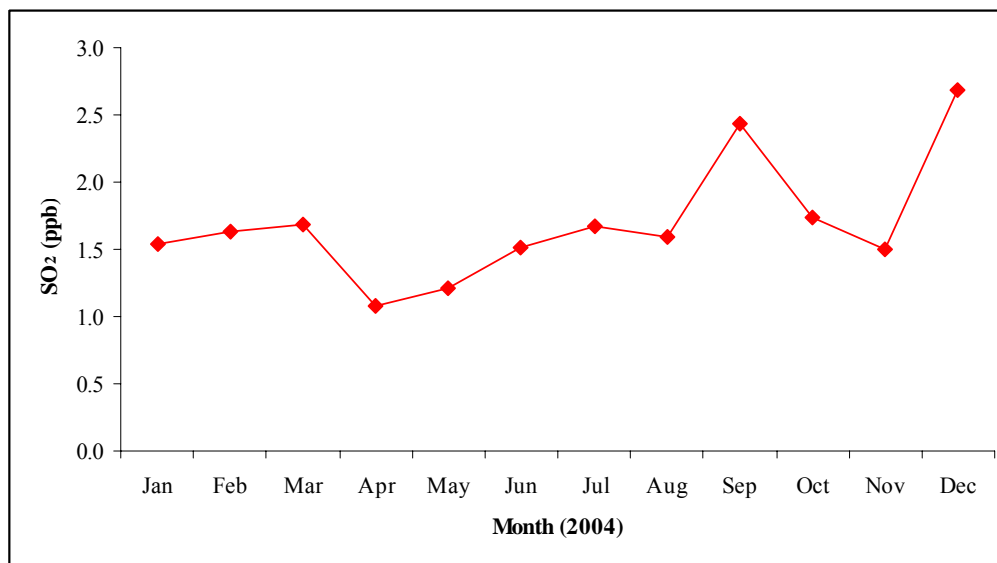
**Table 3.1: Summary statistics of sulphur dioxide concentrations for the monitoring period**

| Statistics for monitoring period | 15-minute average | Hourly average | 24-hr average |
|----------------------------------|-------------------|----------------|---------------|
| Minimum (ppb)                    | 0.0               | 0.0            | 0.2           |
| Average (ppb)                    | 1.7               | 1.7            | 1.7           |
| Standard deviation (ppb)         | 4.2               | 3.3            | 1.5           |
| Median (ppb)                     | 0.9               | 0.9            | 1.2           |
| Maximum (ppb)                    | 123.7             | 44.6           | 11.7          |
| Data capture (%)                 |                   | 99.7           |               |

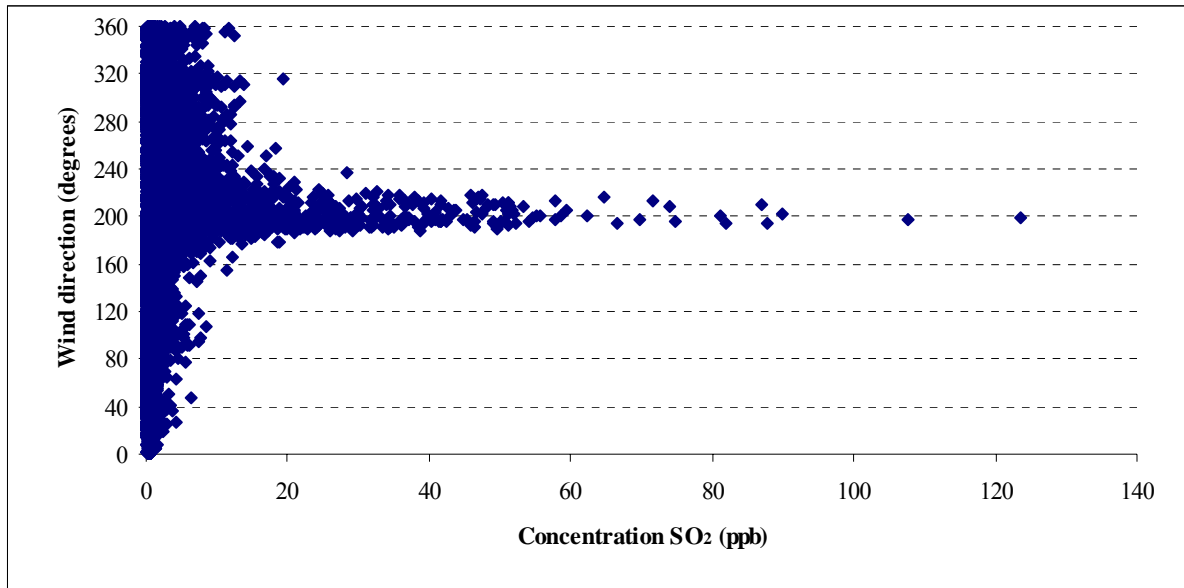
The full annual data set was used to calculate concentrations for summer and winter and also average monthly  $\text{SO}_2$  concentrations. This was to determine if summer ferry movements during the summer resulted in higher average  $\text{SO}_2$  concentrations. The summer period was taken as the six months from April to September and the winter period the remaining six months and the summary statistics are shown in Table 3.2. There was little difference between the average concentrations for the two seasons but the summer months saw the highest maximum concentration. Figure 3.4 shows that September and December had the highest average concentrations with the summer months of June, July and August showing no significant difference from the average concentrations recorded during the majority of the winter months.

**Table 3.2: Seasonal statistics of 15-minute average sulphur dioxide concentrations.**

|                          | Winter | Summer |
|--------------------------|--------|--------|
| Minimum (ppb)            | 0.0    | 0.0    |
| Average (ppb)            | 1.8    | 1.6    |
| Standard deviation (ppb) | 4.5    | 3.8    |
| Median (ppb)             | 0.9    | 0.9    |
| Maximum (ppb)            | 87.1   | 123.7  |

**Figure 3.4: Monthly average sulphur dioxide concentrations**

In addition to the exceedences of the 15-min limit, several other relatively high 15-min SO<sub>2</sub> peaks were observed during the monitoring period. The highest peaks are discussed further in Section 3.2. Estimated background concentrations in Dumfries and Galloway are typically below 2 ppb<sup>1</sup> and thus all peaks imply a local source of SO<sub>2</sub> emissions. In order to identify any significant sources of SO<sub>2</sub> in the area throughout the monitoring period, the 15-min mean concentrations were plotted against wind direction (Figure 3.5). The peaks of SO<sub>2</sub> which occurred over the period indicated a major source of the SO<sub>2</sub> from approximately 180 to 240 degrees (south to south-west of the monitoring site) with the highest concentrations recorded when the wind is blowing from 200 to 220 degrees. These data are also illustrated as pollution roses in Figure 3.6 and Figure 3.7.



**Figure 3.5: 15-minute mean SO<sub>2</sub> concentrations plotted against wind direction.**

<sup>1</sup> Background SO<sub>2</sub> (estimated for 2001) obtained from the Netcen national background concentration maps, available at: <http://www.airquality.co.uk/archive/laqm/tools.php?tool=background>

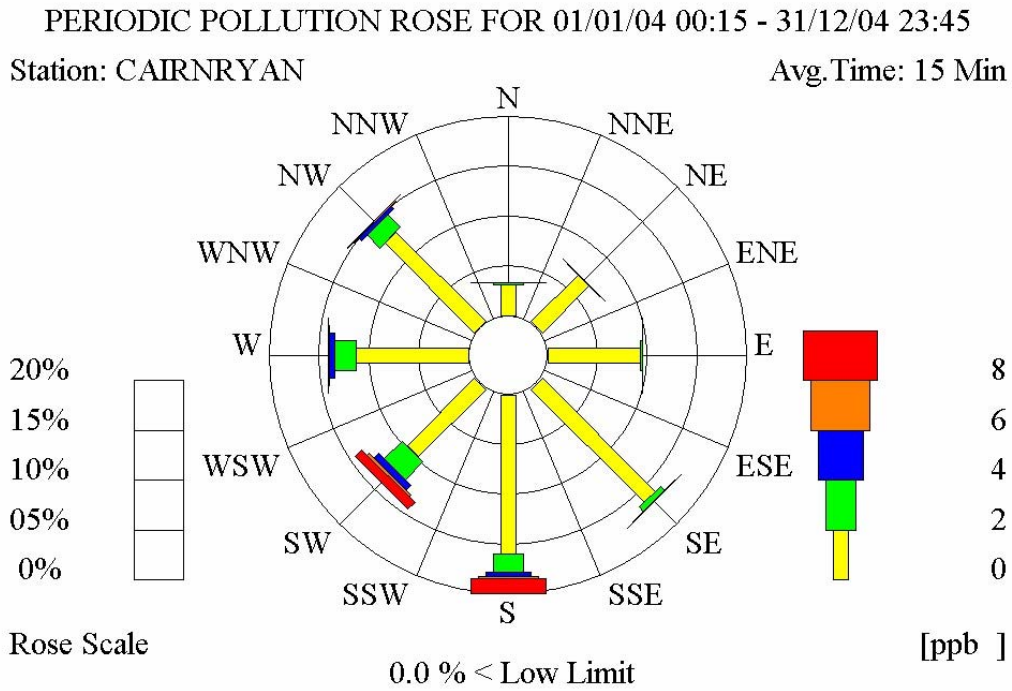


Figure 3.6: Pollution rose for SO<sub>2</sub> demonstrating the frequency of all concentrations above background levels.

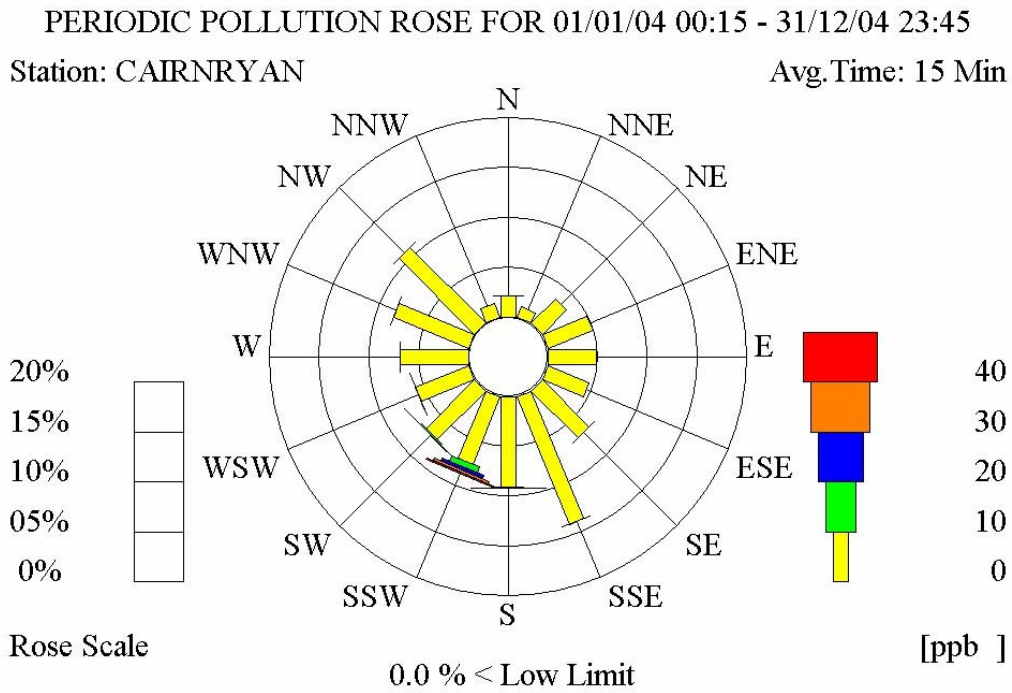


Figure 3.7: Pollution rose for SO<sub>2</sub> demonstrating the frequency of higher concentrations.

Figure 3.6 and Figure 3.7 display the percentage of time that the wind was blowing from a given direction and the corresponding frequency of SO<sub>2</sub> concentrations. The concentrations of SO<sub>2</sub> are grouped in intervals as indicated by the scale on the right-hand side of the rose with the final grouping being all measurements of that concentration and greater. The rose scale on the left of the figure corresponds to the circles within the rose.

To assist in the interpretation of the pollution rose diagrams, an example is explained here. Figure 3.6 shows the elevation of SO<sub>2</sub> concentrations above the background level (2ppb). On the right hand side the scale of concentration is given from yellow, representing the pollution band from 0 to 2ppb, to red representing concentrations of 8ppb and above. The bars coming out from the centre represent the concentration of SO<sub>2</sub> from each direction. Each of the circles coming out from the centre represents 5%, so for example the wind was blowing from the south for a total of 20% of the monitoring duration. For about 15% of the period the SO<sub>2</sub> concentration from the south was within the low band of 0 to 2ppb shown by the yellow line coming out just beyond the 15% line in the southerly direction. The green line represents about 2% of the total monitoring time so the SO<sub>2</sub> concentration was measured between 2 and 4ppb from the southerly direction for about 2% of the period. The orange and blue lines represent only a very small percentage of the time and the red line represents the SO<sub>2</sub> concentration above 8ppb, accounting for about 3% of the period. The pollution rose shows the elevation of SO<sub>2</sub> concentrations above background level (2 ppb) without detailing the extent of any episodes. The pollution rose demonstrates that background levels of SO<sub>2</sub> were recorded from all directions for the majority of the period. Concentrations were also recorded above background levels from all directions with the majority of concentrations above 2 ppb from a south-westerly direction. The wind was blowing from this direction for just under 15% of the time and for just under one third of this time the pollution levels were raised above the background level. Westerly winds resulted in the second-highest proportion of occurrences when concentrations were above background level whilst the southerly winds resulted in the second-highest proportion of occurrences of 8 ppb or over.

The pollution rose presented in Figure 3.7 focuses on the concentration peaks measured at the Cairnryan site. This pollution rose was split further into 16 segments to provide more detailed information as to the direction of the source of the episodes. Again this pollution rose indicates that for the majority of the time, and from all directions, the concentrations of SO<sub>2</sub> were relatively low (between 0 and 10 ppb). The sixteen-arm pollution rose highlights that elevated concentrations were seen predominantly from the south-south-west direction.

### 3.2 Pollution episodes

To investigate further the episodes mentioned in Section 3.1, those data for the three highest recorded 15-minute averages over the year are plotted in Figure 3.8 to Figure 3.10. Figure 3.8 shows in more detail the one exceedence of the 15-minute limit recorded on 27<sup>th</sup> June. As with all previous peaks, this exceedence coincides with a wind direction from the south-west, with the average wind direction during the 15-minute peak concentration at 197 degrees from north. The other two periods of high concentrations discussed in Section 3.1 consisted of multiple concentration peaks as opposed to a single 15-minute episode. The episode recorded on 18<sup>th</sup> July is plotted in Figure 3.9. This shows that two peaks occurred at 17:45 and 19:30 and during this period there was a constant wind direction of between 195 and 202 degrees. On plotting the next highest peak concentration (Figure 3.10) it can be seen that the period consisted of a number of high concentration peaks. As with the episode on 18<sup>th</sup> July, these coincided with a period during which the wind speed was steadily from the south-west, ranging from 192 to 211 degrees.

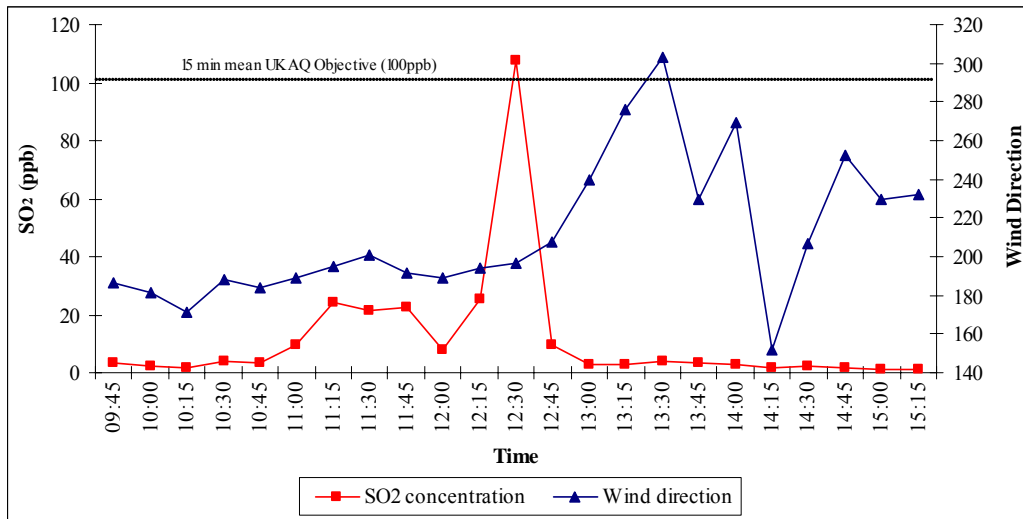


Figure 3.8: SO<sub>2</sub> episode recorded on 27<sup>th</sup> June 2004.

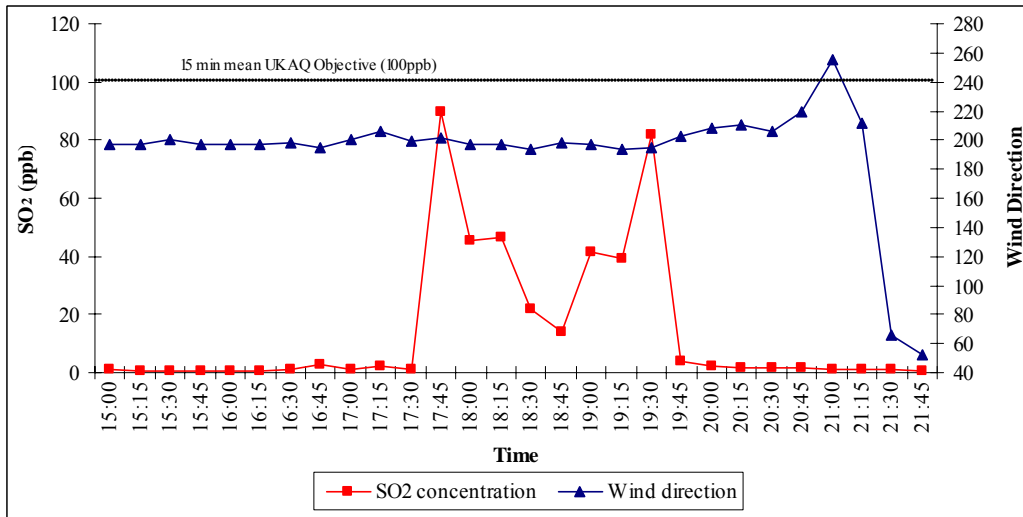


Figure 3.9: SO<sub>2</sub> episode recorded on 18<sup>th</sup> July 2004.

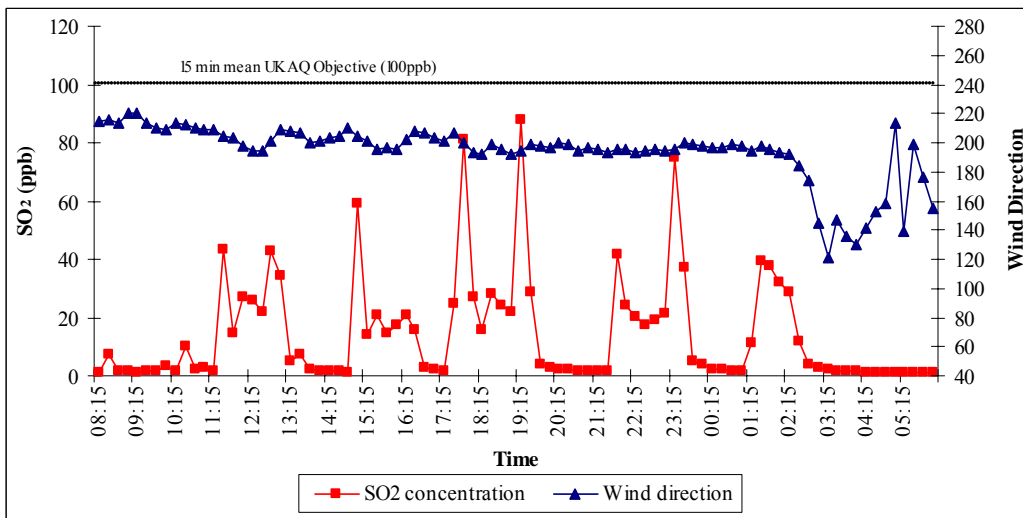


Figure 3.10: SO<sub>2</sub> episode recorded on 13<sup>th</sup> September 2004.

## 4 Summary

This report presents SO<sub>2</sub> data recorded over a 12-month monitoring period from January to December 2004 in Cairnryan. This has enabled these data to be directly compared to the air quality objectives and seasonal comparisons to be undertaken. The concentrations of SO<sub>2</sub> during this period were well within the 1-hour mean and 24-hour mean limits contained within the AQS. The 15-minute mean objective of 100 ppb, however, was exceeded on two occasions with a maximum value of 123 ppb occurring on 8<sup>th</sup> June. Although there were only two exceedences of the 15-minute mean objective, 15-minute mean concentrations frequently peaked above 40 ppb. The analysis of these SO<sub>2</sub> data with respect to wind direction concludes that the main source of the highest concentration peaks were to be found to the south-west of the monitoring station, in the direction of the RORO port facility. An analysis of seasonal differences did not conclude that there was a significant difference in SO<sub>2</sub> concentrations between the summer and winter periods. The main driving force behind SO<sub>2</sub> emissions being detected in the local area therefore seems to be wind direction rather than volume of ferry traffic. With an increase in ferry traffic, however, there would be an increase in the probability that south-westerly winds would coincide with periods when the ferries were berthed in port.

The following recommendations made in the interim reports remain applicable:

1. The collection of port activity data to allow the analysis of SO<sub>2</sub> concentrations in relation to meteorology and ferry movements.
2. The sourcing of traffic flow data for the A77 to determine the potential impact of vehicle emissions on local SO<sub>2</sub> concentrations.



## **Acknowledgements**

The work described in this report was carried out in the Environment Group of TRL Limited. The authors are grateful to Dr Ian McCrae who carried out the quality review and auditing of this report. They would also like to thank Jim Coltart, Linda and Rhona who undertook the local site operator duties for the duration of this project.

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Defra (2003). The air quality strategy for England, Scotland, Wales and Northern Ireland: Addendum. Publication PB7874. Department of the Environment, Food and Rural Affairs in partnership with the Scottish Executive, The National Assembly for Wales and the Department of the Environment in Northern Ireland. Defra, London.

DETR (2000). The air quality strategy for England, Scotland, Wales and Northern Ireland. Cm 4548. Department of the Environment, Food and Rural Affairs in partnership with the Scottish Executive, The National Assembly for Wales and the Department of the Environment in Northern Ireland. DETR, London.

## Appendix A – Site and Calibration Operating Procedures

### Cairnryan SO<sub>2</sub> (ML9850B) site visit and calibration procedure

On arrival at analyser location the following procedure should be followed:

#### Initial observations

- Make a written note on the calibration sheet of observations listed.

#### Analyser:

1. SO<sub>2</sub> real time concentration (top value on screen)
2. SO<sub>2</sub> average concentration (low value)
3. Alarms or faults listed on front screen (*i.e.* flow, temp *etc*)

#### Analyser status.

1. MENU symbol will be flashing on front screen bottom right corner.
2. Press SELECT (3<sup>rd</sup> button from left). This enters the MENU table
3. Scroll down to INSTRUMENT STATUS and press SELECT.
4. Record values on cal sheet.
5. Press EXIT button to return to main screen

#### Analyser vacuum pump.

1. Record any unusual noises *etc.*
2. Check pump is connected to analyser EXHAUST port (rear of analyser)

#### Data logger & GSM

1. Check logger is displaying in LCD window.
2. Check Red LED is lit at side of logger.
3. Check green LED on front of GSM is on.

#### Sample line

1. Check sample line is located correctly and connected to external analyser inlet filter.
2. Check inlet filter is connected to analyser inlet (rear of analyser).

#### Met station

1. Check visual physical condition and location of met mast.

### Calibration Procedure

#### • Data logger

Set data logger from 15-min averages to 1-min averages:

Using the keypad on the Campbell data logger.

1. Press \***1** to access the programme.
2. Press **A** repeatedly to advance through the programme line by line until the line **P92** is displayed.  
Use the **B** button to step back through the programme if required.
3. Press **A** once. Display will show **01:0000** (this is line 01 of this procedure)
4. Press **A** again. Display will show **02:0015** (this is line 02, the 15-min logging period).
5. Enter the value **1** using the keypad. (this represents 1-min averages)
6. Press **A**. (this acts as an enter command, and steps down a line)
7. Press **B** to go back a line to check that the line shows **02:0001** (1-min logging period) has been accepted.
8. Logger is now in 1-min averaging mode.

#### Returning to 1-min averaging

9. At the end of the analyser calibration, this procedure must be repeated and the averaging period value returned to 15-min. Repeat the above procedure to number 5 above and enter the value **15** using the keypad, followed by **A**.
10. Check as in line 8 by stepping back one line using the **B** button.
11. The line should indicate now **02:0015**

#### Logger channel display

12. Press **\*6** to access the channel display.
13. Press **A & B** to scroll up and down the channels
  - **01:** SO<sub>2</sub> value in ppb.
  - **05:** room temp in degree C
  - **06:** Wind Speed in m/s
  - **07:** Wind Direction in degrees from north

**If at any time you get lost. Press \*0 and start again.**

#### Key strokes:

- \*1** accesses the logger programme
- \*6** Channel display
- \*0** will display :Log1 (blinking ':' indicates the logger is logging)
- A** Advance line on screen
- B** Step back line on screen

#### Analyser Calibration

##### ZERO

1. Disconnect sample inlet tube to filter, at rear of analyser.
2. Connect the Carbon/Purafil zero scrubber to the filter inlet.
3. Allow analyser display concentration to stabilise (approx 15-mins)
4. Record 3 off 1-min readings from analyser screen.
5. Remove zero scrubber.

##### SPAN

6. Turn on SO<sub>2</sub> span bottle main valve.
7. Without connecting to analyser adjust the outlet needle valve to give a small positive bypass flow of approx 150 cc/min on the flow meter.
8. Connect span gas to the analyser inlet filter. (gas must go through the filter).
9. Adjust bypass flow using needle valve to give approx 150 cc/min.
10. The analyser concentration should increase quickly towards the cal value indicated on the bottle. It can take approx 20-mins for the analyser to fully stabilise. This can be observed by the difference in the real and average concentrations displayed on the analyser screen.
11. Once readings are steady. Record 3 off 1-min readings.
12. Remove the span gas tube and close the span gas bottle isolator valve.
13. Reconnect the sample inlet tube to the inlet filter.

#### Changing Analyser Inlet Filter

1. Disconnect tube connecting filter housing to the analyser (prevents filter paper getting sucked down)
2. Open housing
3. Replace filter as required.
4. Reconnect filter housing to analyser.

**Data Logger**

1. Ensure data logger is returned to 15-min averaging period. (see procedure above).
2. Press \*0 to leave logger displaying **:Log1**

**Post Calibration Checks**

1. Check analyser is displaying sensible concentrations.
2. Complete post cal checks on sheet.

## Appendix B – Record of Site Calibration Visit

### Summary of Site Visit

|                       |                     |                           |
|-----------------------|---------------------|---------------------------|
| <b>To</b>             | TRL Ltd             |                           |
| <b>Email</b>          | dgardiner@trl.co.uk |                           |
| <b>FAO</b>            | David Gardiner      | Mobile: 07887 991390      |
| <b>Office fax no.</b> | 01344 770918        | Office: 01344 770661      |
| <b>From</b>           | Jim Coltart         | Direct dial: 01557 332540 |

**Site name:** CAIRNRYAN

**Name of LSO/ESU:**

**Date of visit:** 9/1/04

**Reason for visit** (please check/tick )

|                         |     |
|-------------------------|-----|
| LSO routine calibration | Yes |
| LSO call-out            |     |
| Service                 |     |
| Other                   |     |

Other (please specify)

**Equipment attended to:** (please check/tick )

|                                | <b>Fault on arrival</b> | <b>Attended</b> | <b>Fault on leaving</b> |
|--------------------------------|-------------------------|-----------------|-------------------------|
| <b>SO<sub>2</sub> analyser</b> | No                      |                 |                         |
| <b>Met station</b>             | No                      |                 |                         |
| <b>Data logger</b>             | No                      |                 |                         |
| <b>Other</b>                   |                         |                 |                         |

Other (please specify)

| <b>PRECALIBRATION CHECKLIST</b>   |        |         |              |
|---|--------|---------|--------------|
| Site: <u>Cairnryan</u> Date: _____ Operators <u>Jim Coltart Linda K Rhona M</u>   |        |         |              |
| Start time _____ GMT. Pollution episode in progress YES/NO  |        |         |              |
| Tick boxes or note the test values obtained in the spaces provided. If any checks are not correct, inform TRL after completing all of the Checklist and before proceeding with the calibration. |        |         |              |
| <b><u>SO<sub>2</sub> analyser</u></b>   |        |         |              |
| SO <sub>2</sub> concentration:  | 0.001  | (ppm)   | as on screen |
| Avg SO <sub>2</sub> concentration:  | 0.001  | (ppm)   |              |
| Analyser time   | 1016   |         |              |
| Analyser fault messages/alarms displayed? YES/NO  |        |         |              |
| If yes list: _____  |        |         |              |
| <b><u>Analyser parameters:</u></b>  |        |         |              |
| GAS FLOW:   | 0.60   | (SLPM)  |              |
| GAS PRESSURE:   | 706.8  | (TORR)  |              |
| REF VOLTAGE:  | 2.595  | (VOLTS) |              |
| CONC. VOLTAGE:  | 1.432  | (VOLTS) |              |
| ANALOG SUPPLY:  | 12.063 | (VOLTS) |              |
| DIGITAL SUPPLY:   | 4.977  | (VOLTS) |              |
| GROUND OFFSET   | 308    |         |              |
| HIGH VOLTAGE  | 705    | (VOLTS) |              |
| LAMP CURRENT  | 35.165 | (mA)    |              |
| <b><u>Data logger/GSM</u></b>   |        |         |              |
| DATA LOGGER Supply OK   | YES    |         |              |
| DATA LOGGER LCD indicating  | YES    |         |              |
| GSM LED lit   | YES    |         |              |
| <b><u>Met station</u></b>   |        |         |              |
| MET STATION visual check OK   | YES    |         |              |
| <b><u>Analyser sample pump</u></b>  |        |         |              |
| PUMP OPERATING OK   | YES    |         |              |
| <b>Comments</b>   |        |         |              |

| <b>CALIBRATION RECORD SHEET</b>                      |                                     |                 |  |   |
|--|-------------------------------------|-----------------|--|---|
| <b>SO<sub>2</sub> analyser</b>                       |                                     |                 |  |   |
| Inst   | Routine                             | gas             | Logger (mV) Channel 1<br>(3 x 1min readings) | Inst (ppm) front panel<br>(3 x 1min readings) |
| Inst No<br>ML 9850B                                  | ZERO<br>CAL<br>(scrubber)           | SO <sub>2</sub> | 1. -2.430<br>2. -1.041<br>3. -0.694          | 1. 0.000<br>2. 0.000<br>3. 0.000              |
| Range<br>0 -1000ppb                                  | SO <sub>2</sub><br>CAL<br>(cal gas) | SO <sub>2</sub> | 1. 495.60<br>2. 493.75<br>3. 493.40          | 1. 0.496<br>2. 0.496<br>3. 0.496              |
| SO <sub>2</sub> analyser sample inlet filter changed |                                     |                 | YES  |   |

**POST CALIBRATION CHECKLIST**SO<sub>2</sub> concentration: 0.008 (ppm) as on screenAvg SO<sub>2</sub> concentration: 0.011 (ppm)

Analyser time \_\_\_ 1133 \_\_\_

Analyser fault messages/alarms displayed? /NO

If yes list: \_\_\_\_\_

**Analyser parameters:**

GAS FLOW: \_\_\_\_\_ 0.61 (SLPM)

GAS PRESSURE: \_\_\_\_\_ 709.0 (TORR)

REF VOLTAGE: \_ 2.596 (VOLTS)

CONC. VOLTAGE: \_\_\_ 0.848 (VOLTS)

ANALOG SUPPLY: \_\_\_ 12.048 (VOLTS)

DIGITAL SUPPLY: \_\_\_ 4.979 (VOLTS)

GROUND OFFSET 306

HIGH VOLTAGE \_\_\_\_\_ 705 (VOLTS)

LAMP CURRENT \_\_\_ 35.018 (mA)

**Data logger/GSM**

DATA LOGGER Supply OK YES

DATA LOGGER LCD indicating :Log1 YES

GSM LED lit YES

**Analyser sample pump**

PUMP OPERATING OK YES

COMMENTS:



**Final checks****Calibration end time** 1134 **GMT/BST**Safety and security check of site;  OKCheck sample inlet filter changed  OKInlet tube/manifold OK (inverted funnel in place)  OKCalibration cylinders turned off and secure  OKPump operating OK  OKLogger/GSM operating OK  OKSite clean and tidy  OK**Fax or email check and calibration sheets ASAP to TRL****Record of cylinder pressures**

| <b>Gas</b>            | <b>Cylinder number</b> | <b>Cylinder pressure (psi)</b> |
|-----------------------|------------------------|--------------------------------|
| <b>SO<sub>2</sub></b> | 158598                 | 1900                           |

**ADDITIONAL COMMENTS**