

Annual Review of Air Quality Strategy Management Plan for Aberthaw Power Station

2014

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Annual Review of AQS Management Plan for Aberthaw Power Station, Calendar Year 2014

1 Introduction

The AQS Management Plan for Aberthaw Power Station was submitted to the Environment Agency of England & Wales (EA) in June 2001 (Note: regulatory responsibility for the station passed to Natural Resources Wales (NRW) in April 2013). NRW now regulate the air quality management obligations of the station.

The aims of the Management Plan are to:

- Ensure that the Air Quality Strategy (AQS) objectives for sulphur dioxide, oxides of nitrogen and particulate matter are met by, and after, the due dates.
- Review recent air quality around the power station compared to the AQS objectives using dispersion modelling and local ambient monitoring data, as appropriate.
- Assess the likely air quality around the station in future years, including impacts due to emissions from the station, against the AQS objectives.
- Review the ambient air quality monitoring plan for the station.
- If appropriate, outline any actions required by the station to ensure future compliance with the AQS objectives.

The Management Plan is reviewed annually and this is the Review for calendar year 2014. It assesses the prospective effectiveness of the Management Plan and fulfils the requirements of the agreed implementation of Section 3.8 of Environmental Permit RP3133LD issued by the Environment Agency and now regulated by NRW.

2 Changes to the Management Plan since the last review

The current issue status of each AQS Management Plan methodology is as follows:

- (i) Methodology for the Use and Interpretation of Monitoring and Modelling for AQS Management Plans (Issue 5, January 2002)
- (ii) Technical Methodology for Dispersion Modelling Related to Power Station AQS Management Plans (Issue 5, November 2010)
- (iii) Monitoring To Assess Power Station Compliance With AQS Objectives Technical Methodology (Issue 6, March 2003)
- (iv) Generic Methodology for Compiling Station Hourly Emission Datasets from Generation Data (Issue 5, January 2003)

It was previously agreed with the EA/NRW that since FGD has mitigated air quality risk the annual AQMP report would not consider or model future operational scenarios.

Seawater process FGD has been fully operational at Aberthaw throughout 2014, and emission parameters reflect the FGD characteristics.

ADMS v5 has been used to produce the dispersion modelling results in this report.

There have been no other specific changes applicable to Aberthaw Power Station during 2014 incorporated into this Review.

3 Air Quality Strategy Objectives

The Revised AQS (Defra, 2007) objectives for sulphur dioxide, nitrogen dioxide and particles (PM₁₀) which have superseded those referred to in the original Management Plan are summarised in Table 3.1. The PM_{2.5} objectives are EU limit values taken from The Air Quality Standards Regulations, 2010.

Pollutant	Objective		To be achieved by
	Concentration	Measured as	
Sulphur dioxide	266 $\mu\text{g m}^{-3}$ (100 ppb) not to be exceeded more than 35 times a year	15 minute mean	31 Dec 2005
	350 $\mu\text{g m}^{-3}$ (132 ppb) not to be exceeded more than 24 times a year	1 hour mean	31 Dec 2004
	125 $\mu\text{g m}^{-3}$ (47 ppb) not to be exceeded more than 3 times a year	24 hour mean	31 Dec 2004
Nitrogen dioxide	200 $\mu\text{g m}^{-3}$ (105 ppb) not to be exceeded more than 18 times a year	1 hour mean	31 Dec 2005
	40 $\mu\text{g m}^{-3}$ (21 ppb)	Annual mean	31 Dec 2005
PM ₁₀	50 $\mu\text{g m}^{-3}$ not to be exceeded more than 35 times a year	24 hour mean	31 Dec 2004
	40 $\mu\text{g m}^{-3}$	Annual mean	31 Dec 2004
PM _{2.5}	25 $\mu\text{g m}^{-3}$	Annual mean	1 st January 2015
	10% or 15% reduction from 2010 values at urban background locations	Annual mean	2020

Table 3.1 Air Quality Objectives

4 Station operation during the review period

Over the review period, 01/01/2014 to 31/12/2014, Aberthaw Power Station has operated with an average load factor of 51% and burnt coal with an average S content of approximately 0.85%. Monthly generation and SO₂ emissions are shown in Figures 4.1 and 4.2. The SO₂ A limit for 2014 is defined in the station Environmental Permit as 39 kilotonnes and the station emitted ~5.65 kilotonnes.

Nitrogen oxide emissions are assumed to be directly proportional to the coal burnt and, therefore, to the energy generated, and following the AQS management plan methodology are calculated using an appropriate NO_x emission factor previously agreed with the Environment Agency. Using this method, the total NO_x emission during the review period was 22.9 kilotonnes (as NO₂ equivalent mass) with the monthly variation following the same relative pattern as the generation (Figure 4.1).

This is slightly different to the figure in other emission reporting due to use of different methodologies.

For the purposes of this Review, the dust emission has been assumed to be constant at the authorised limit for FGD units of 25 mg Nm⁻³ (dry, 6% O₂). In practice, the emission will frequently be lower than this limit (by approximately 45% based on monitoring data) and the assumption of constant emissions will lead to higher emissions than will actually have been the case. Estimates of impacts of dust emissions discussed in this Review will, therefore, generally be greater than those which will have actually occurred. The total dust emission over the review period, estimated as described above, was ~0.6 kilotonnes, with the monthly variation following the same relative pattern as the generation (Figure 4.1).

5 Ambient air quality monitoring

Site	Location	Comment
Aberthaw - West	Seaview Farm ST002673 2.5 km WNW (105°)	SO ₂ and NO _x . Operational until September 15 th 2011.
Aberthaw - East	Font-y-Gary Pumping Station ST053661 2.9 km E (274°)*	SO ₂ , NO _x and O ₃ . Operational throughout the review period.
Supplementary site, Vale of Glamorgan	Highwayman Inn, Fonmon ST058673 3.5 km ENE (253°)*	SO ₂ , NO _x and O ₃ . Operational until closure on 27 th May 2014. Not formal part of Monitoring Plan.

Table 5.1 Ambient air quality Monitoring Plan and supplementary site details

Notes: * Wind direction for the measurement site to be downwind of the station.

The Monitoring Plan has been developed using the current Technical Monitoring Methodology described in Appendix C to the Management Plan. Following this methodology, the monitoring sites described in Table 5.1 have been identified as appropriate and agreed with the Environment Agency/NRW. The locations of the monitoring sites and the power station are shown in Figure 5.1. There is a cement works which emits SO₂, NO_x and particulate matter approximately 1.6 km NE of the power station.

The downwind Monitoring Plan monitoring site at Font-y-Gary has been in operation throughout the current review period, whilst the upwind site at Seaview Farm was closed on 15th September 2011. The Vale of Glamorgan Council has operated a temporary site at the Highwayman Inn, Fonmon, since 2001 and this closed on March 27th 2014. Summary data from this site have been downloaded from the Welsh Air Quality Forum web-site.

(www.welshairquality.co.uk/data_and_statistics.php).

Detailed presentation of the ambient air quality measurements is included in the Appendix to this Review and only key points are reproduced below. The measured concentrations with respect to relevant AQS compliance targets are listed in Table 5.2. Measured compliances with other air quality targets (e.g. ecosystem standards) which are not directly relevant to the AQS are included in the Appendix.

The data in Table 5.2 indicate that good data coverage was achieved from the SO₂ and NO_x instruments at Font-y-Gary during 2014, although there was a period in April when data loss occurred due to problems with the data logger.

	AQS compliance value	Font-y-Gary	Highwayman Inn (VoG)
SO₂ STATISTICS			
Period Mean (µg m ⁻³)		4.3	3.0
99.18%ile daily value (µg m ⁻³)	125	14	18
99.73%ile hourly value (µg m ⁻³)	350	32	57
99.90%ile 15-min value (µg m ⁻³)	266	43	85
Number of Readings Greater than:			
AQS Daily Threshold	≤3 pa >125 µg m ⁻³	0	0
AQS Hourly Threshold	≤24 pa >350 µg m ⁻³	0	0
AQS 15-minute Threshold	≤35 pa >266 µg m ⁻³	0	0
NO₂ STATISTICS			
Period Mean (µg m ⁻³)	40	10.3	9.4
99.80%ile Hourly Value (µg m ⁻³)	200	66	63
Number of Readings Greater than:			
AQS hourly Threshold	≤18 pa >200 µg m ⁻³	0	0
ANNUAL DATA COVERAGE:			
SO ₂ 15-min		89.9	39.4
SO ₂ 1-hour		91.4	40
NO ₂ 1-hour		89.5	38.9

Table 5.2 Summary of measured concentration statistics for calendar year 2014.

Notes: The percentile values are the actual percentiles over the collected data. The numbers of exceedences are the actual number of measured exceedences and are not adjusted for data coverage.

Data for the Vale of Glamorgan's Highwayman Inn site downloaded from the Welsh Air Quality Forum web-site: www.welshairquality.co.uk/data_and_statistics.php

All data deletions were made by the site operating contractors (Bureau Veritas HS&E Ltd. for the RWE Generation site at Font-y-Gary) as a result of their professional judgement of when data were invalid or insufficiently reliable. The data coverage target of ≥90% was achieved at Font-y-Gary with 91.4% for 1-hour sulphur dioxide and 89.5% for nitrogen oxides.

The measured concentrations (Table 5.2) indicate that there were no exceedences of the 15-min SO₂ AQS threshold or of the hourly or daily SO₂ thresholds at either monitoring station. There were also no exceedences of the NO₂ AQS hourly threshold. The percentile concentrations listed in the Table, which allow for the actual period of measurement, are those which correspond to the AQS targets (Table 3.1). All values were significantly lower than the AQS targets.

The measured concentrations indicate that the area around Aberthaw Power Station was in compliance with all relevant AQS targets during calendar year 2014.

6 Dispersion modelling of review period operation

6.1 Dispersion modelling methodology

The dispersion modelling described below has been carried out following the current Technical Modelling Methodology discussed by the Environment Agency/JEP Air Quality Working Group and agreed with the Environment Agency/NRW. The methodology was reproduced as Appendix A to the Management Plan. The model used was ADMS 5. The station-specific input parameters used in the modelling are those given in the current Modelling Methodology listed in Table 6.1.

Stack height (m)	152
No. of flues	3
Flue diameter (m)	6.86
Full load volume flux (Am^3s^{-1}) (with FGD)	1793 (at 1470 MW)
Exit temperature ($^{\circ}\text{C}$) (with FGD)	50
Specific heat capacity at constant pressure ($\text{J kg}^{-1} \text{K}^{-1}$)	1052.8
Mean molecular weight	29.9
Met. Data	St Athan
Source of met. Data	The Met. Office
Roughness length	0.1

Table 6.1 Model input parameters for Aberthaw Power Station

Hourly varying volume flux and SO_2 , NO_x and PM emissions for Aberthaw during calendar year 2014, estimated according to the procedure described in the current version of Appendix D to the Management Plan, have been used for the modelling study. The hourly volume flux was derived from the generation level for that hour; the hourly SO_2 emissions were determined from the monthly emission figures per MW; the NO_x emissions using the emissions per tonne of fuel figure previously agreed with the Environment Agency/NRW; and the PM emissions were assumed to be 25 mg Nm^{-3} (dry, 6% O_2), the permit limit for FGD units. Coincident hourly sequential meteorological data from St Athan were used. A copy of the hourly varying emissions file has been provided to NRW.

6.2 Background concentrations

For sulphur dioxide, a background concentration of $4 \mu\text{g m}^{-3}$ (1.5 ppb) has been assumed. This value is based on diffusion tube measurements around Aberthaw Power Station between September 1998 and May 2000 and continuous measurements at Font-y-Gary between 1st February 2002 and 31st December 2003 (Webb, 2004). These values have been agreed as appropriate with the Environment Agency/NRW.

The quantity of NO_x in the NO_2 form is largely determined by the concentration of O_3 in the background air. At low NO_x concentrations, most will be in the NO_2 form while, at high NO_x concentrations, the NO_2 concentration is limited by the availability of ozone. For this latter reason, at high power-station plume concentrations of NO_x , simultaneously high background NO_x concentrations would make only a small difference to the concentration of NO_2 . Furthermore, at times of significant power station plume impacts, background concentrations of NO_x are usually low. For these

two reasons, the prevailing background NO_x concentration generally makes a negligible difference to higher plume NO_2 concentrations (Webb, 2008) and background NO_x will not, therefore, be included in the assessment of power station influence on attainment of the short-term AQS objective. The situation with the annual mean NO_2 concentration is not as straightforward, as the annual mean contribution from the power station comprises a mixture of different magnitude impacts which will have varying NO_2/NO_x ratios and different background concentrations. An explicit NO_2 background concentration will not be added to the modelled NO_x concentration but the modelled value will be compared with the long-term AQS target.

These procedures are in accordance with the current version of the Interpretation Methodology (Appendix B to the Management Plan) agreed with the Environment Agency/NRW.

Since the station makes a very small contribution to local ambient PM_{10} concentrations compared to pre-existing background concentrations, an explicit background will not be added to the modelled PM_{10} concentration but the modelled value will be compared with the AQS targets. Station $\text{PM}_{2.5}$ emissions are approximately 90% of those for PM_{10} and modelled $\text{PM}_{2.5}$ impacts are assumed to be 90% of those for PM_{10} .

6.3 Dispersion modelling results

Modelled concentrations at the point of maximum impact are presented in Table 6.2 for SO_2 , NO_x and PM_{10} . The appropriate AQS compliance target is also given in the Table. Figures 6.1 and 6.2 show the contour plots for the distribution of the most demanding short-term AQS SO_2 standard (i.e. the 99.9thile of 15-minute means) and the annual average SO_2 concentrations around Aberthaw Power Station. The power station location is shown by a square and the monitoring site locations by triangles. Contour plots of NO_x and PM_{10} concentrations are not presented since the impacts from the station are less significant with respect to AQS objectives (the short term NO_x figure is quite high, but the corresponding NO_2 figure will be substantially less, see Table 6.2 and discussion below).

The dispersion modelling study indicates that, for calendar year 2014, the impact of the station was modelled to be below all relevant AQS objectives at all locations.

The sulphur dioxide impact was below the AQS short-term 15-minute mean objective, with no modelled exceedences of the $266 \mu\text{g m}^{-3}$ threshold, including a $4 \mu\text{g m}^{-3}$ background concentration, predicted at the maximum impact location. The modelled maximum 99.9th percentile was $66 \mu\text{g m}^{-3}$, equivalent to $70 \mu\text{g m}^{-3}$ including background. The concentrations corresponding to the other AQS SO_2 objectives were also less than the Strategy values.

For nitrogen oxides, even if it is assumed that all NO_x is in the form of NO_2 , the predicted maximum annual mean NO_2 was ~16% of the long-term objective. Application of the methodology for estimating the proportion of power station NO_x in the NO_2 form described in the current Interpretation Methodology (Appendix B to the Management Plan) would result in a smaller contribution to ambient NO_2 concentrations. The short-term total NO_x concentration was lower than the AQS objective for NO_2 , indicating compliance. This is supported by the fact that actual concentrations measured at Font-y-Gary and the Highwayman Inn were well below the AQS objective concentrations (Table 5.2). Thus, nitrogen oxides impacts from

the power-station emissions did not have a significant impact on ambient concentrations with respect to AQS objectives.

	AQS compliance value	Result at maximum impact point, concentrations in $\mu\text{g m}^{-3}$
SO₂ STATISTICS		
Annual mean		1.5
99.18 th %ile daily value	125 $\mu\text{g m}^{-3}$	26
99.73 th %ile hourly value	350 $\mu\text{g m}^{-3}$	48
99.9 th %ile 15-min value	266 $\mu\text{g m}^{-3}$	66
Number of values greater than:		
15 min threshold, no background		0
15 min threshold, 4 $\mu\text{g m}^{-3}$ background	$\leq 35 \text{ pa } > 266 \mu\text{g m}^{-3}$	0
NO_x STATISTICS (as NO₂ equivalent)		
Annual mean*	40 $\mu\text{g m}^{-3}$	6.5
99.8 th %ile hourly value*	200 $\mu\text{g m}^{-3}$	191
PM₁₀ STATISTICS		
Annual mean	40 $\mu\text{g m}^{-3}$	0.17
90.4 th %ile daily value	50 $\mu\text{g m}^{-3}$	0.63

Table 6.2 Dispersion modelling results at the point of maximum impact for hourly varying emissions during calendar year 2014.

Note: Values represent the modelled concentrations from station emissions and, except where stated in the table, do not include an allowance for background.

** Standard applies to NO₂ component, modelled values are total NO_x.*

The power station impacts for PM₁₀ correspond to ~1.3% of the AQS short-term and ~0.4% of the long-term objective. Since the maximum daily mean PM₁₀ was 2.8 $\mu\text{g m}^{-3}$, ~6% of the short-term AQS threshold concentration (50 $\mu\text{g m}^{-3}$), emissions from the station would not have contributed substantially to any exceedences of the AQS concentration threshold. Furthermore, the calculated power station contributions assumed that all emitted dust was PM₁₀ rather than the typical value of approximately 90%. Contributions would, therefore, have been smaller than the quoted values. Assuming PM_{2.5} constitutes 90% of PM₁₀ (see section 6.2), the annual mean PM_{2.5} concentration was ~0.15 $\mu\text{g m}^{-3}$, approximately 0.6% of the limit value (25 $\mu\text{g m}^{-3}$). Thus, power-station emissions of dust made no significant contribution to ambient concentrations of PM₁₀ or PM_{2.5} with respect to the AQS objectives.

7 Comparison between modelled and measured impacts

7.1 Quantitative comparison

Table 7.1 lists the values of the key AQS statistical concentration measures for SO₂ modelled at the locations of the Monitoring Plan site and the Vale of Glamorgan supplementary information site. In general, measurements and the equivalent

modelled concentration statistic can be expected to agree to within about a factor of two.

	AQS compliance value	Font-y-Gary	Highwayman Inn
SO₂ STATISTICS			
Period Mean ($\mu\text{g m}^{-3}$)		5.0	5.3
99.18%ile daily value ($\mu\text{g m}^{-3}$)	125	18	24
99.73%ile hourly value ($\mu\text{g m}^{-3}$)	350	39	47
99.90%ile 15-min value ($\mu\text{g m}^{-3}$)	266	52	65
Number of Readings Greater than:			
AQS Daily Threshold	$\leq 3 \text{ pa } > 125 \mu\text{g m}^{-3}$	0	0
AQS Hourly Threshold	$\leq 24 \text{ pa } > 350 \mu\text{g m}^{-3}$	0	0
AQS 15-minute Threshold	$\leq 35 \text{ pa } > 266 \mu\text{g m}^{-3}$	0	0

Table 7.1 Summary of modelled concentration statistics at locations of Monitoring Plan and Vale of Glamorgan supplementary information sites for calendar year 2014

Values include an allowance of $4 \mu\text{g m}^{-3}$ for background.

The modelled values at Font-y-Gary show small over-predictions of measured values. However, all values are within a factor of two and there were no predicted or measured exceedences of the $266 \mu\text{g m}^{-3}$ 15-min mean, the $350 \mu\text{g m}^{-3}$ hourly mean or $125 \mu\text{g m}^{-3}$ daily mean thresholds at either site. Comparison of modelled and measured values at the Highwayman Inn site are not meaningful because the statistics relate to less than half a year of monitoring.

7.2 Overall compliance assessment

Both the measured concentrations at the agreed Monitoring Plan site (Table 5.2) and those modelled at the point of maximum impact (Table 6.2), using the procedures agreed with the Environment Agency and NRW, indicate compliance with all relevant AQS objectives. Aberthaw Power Station was therefore in compliance with the requirement of its Environmental Permit with regard to AQS objectives during 2014.

The maximum predicted 99.9th%ile concentration was $66 \mu\text{g m}^{-3}$, excluding background. Since, the Font-y-Gary value without background ($48 \mu\text{g m}^{-3}$) was within 50% of the maximum, the measurement site meets the agreed criteria to be classed as “representative” of impacts from Aberthaw Power Station (Webb, 2004b) and is appropriate for judging compliance during the current review year.

8 Action to ensure future compliance

The station will be operated such that the predicted impacts are compliant with the most stringent requirements of

1. The station "A" limits for SO₂ and NO_x, as set out in the current Environmental Permit.
2. The requirements of the Air Quality Strategy with regard to the SO₂ and NO₂ objectives.
3. The station will operate to the LCPD “opted in” SO₂ ELV of 400 mg Nm^{-3} .

The JEP companies have developed a Risk Management Framework to ensure compliance with the AQS objectives (Hunter, 2005) which amplifies the basic principles outlined in the original Management Plans. The key elements of the Risk Management Framework are:

1. Prior to the start of the year:
 - Assessment of the impact of the expected range of operations against the SO₂ objective and consideration of the risk of non-compliance.
2. During the year:
 - Comparison of the number of monitored exceedences with various thresholds to indicate the risk of non-compliance.
 - Keeping a check on the likely impacts of elapsed and anticipated station operations.
 - Implementing appropriate mitigation when necessary and feasible.
3. End of the year:
 - Assess actual impacts as part of the AQMP review and consider whether there are any implications for managing future compliance.

As has been demonstrated in Sections 5 & 6, operation during the current review period has been compliant with all relevant AQS objectives by a substantial margin.

Comparison of modelling and monitoring data has built general confidence in using dispersion modelling as a predictor of the future impacts of the station. Results from earlier Joint Environmental Programme studies and JEP Member Company AQMP Annual Reviews for previous years show that model predictions of the 99.9th percentile 15-minute SO₂ concentrations are not, on average, significantly different (95% confidence level) from the measured values. Modelling is, therefore, normally an adequate tool for predicting future impacts when used with a suitable range of representative meteorology.

The impacts of the station on ambient air quality have been monitored continuously at the Font-y-Gary location in Table 5.1. It lies in the downwind direction from the station for the prevailing wind and close to the point of maximum impact predicted by the ADMS dispersion model. Any exceedences of the 15-minute SO₂ threshold (266 µg m⁻³, 100 ppb) are registered within one working day of their occurrence so that the running total of the number of exceedences in the calendar year can be monitored. This number of exceedences will be compared with the number anticipated for that stage in the year and the year-end expectation, taking into account the number measured to date and anticipated future station operation. If AQS compliance by year end is threatened, station operation will be reviewed to identify a feasible compliant operational scenario, including an appropriate margin of safety. When appropriate, the measurement data will be supplemented by quarterly modelling results and the implications of significant changes to the anticipated station operation for air quality impacts will be monitored.

9 Conclusions

- Both modelled and measured air quality around Aberthaw Power Station during the current review period, calendar year 2014, have been compliant with the relevant revised AQS targets.
- Actual impacts will be monitored during the year and, if necessary, appropriate modifications made to station operation.

10 References

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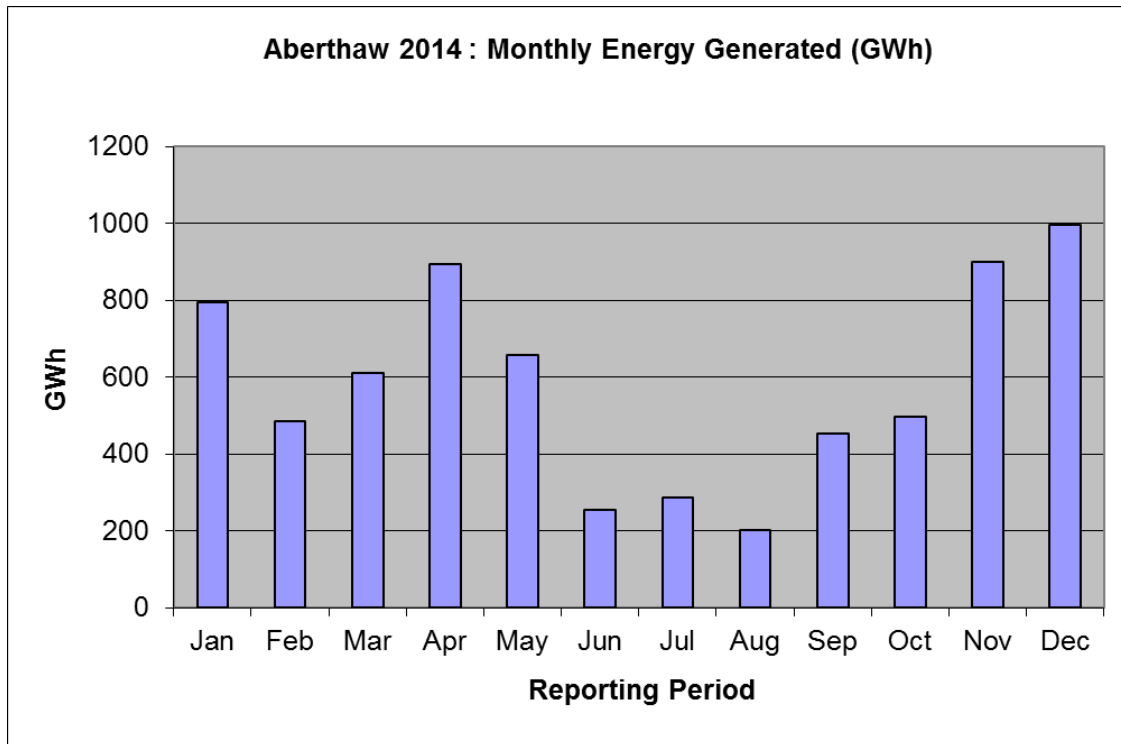


Figure 4.1 Monthly energy generated at Aberthaw Power Station during calendar year 2014

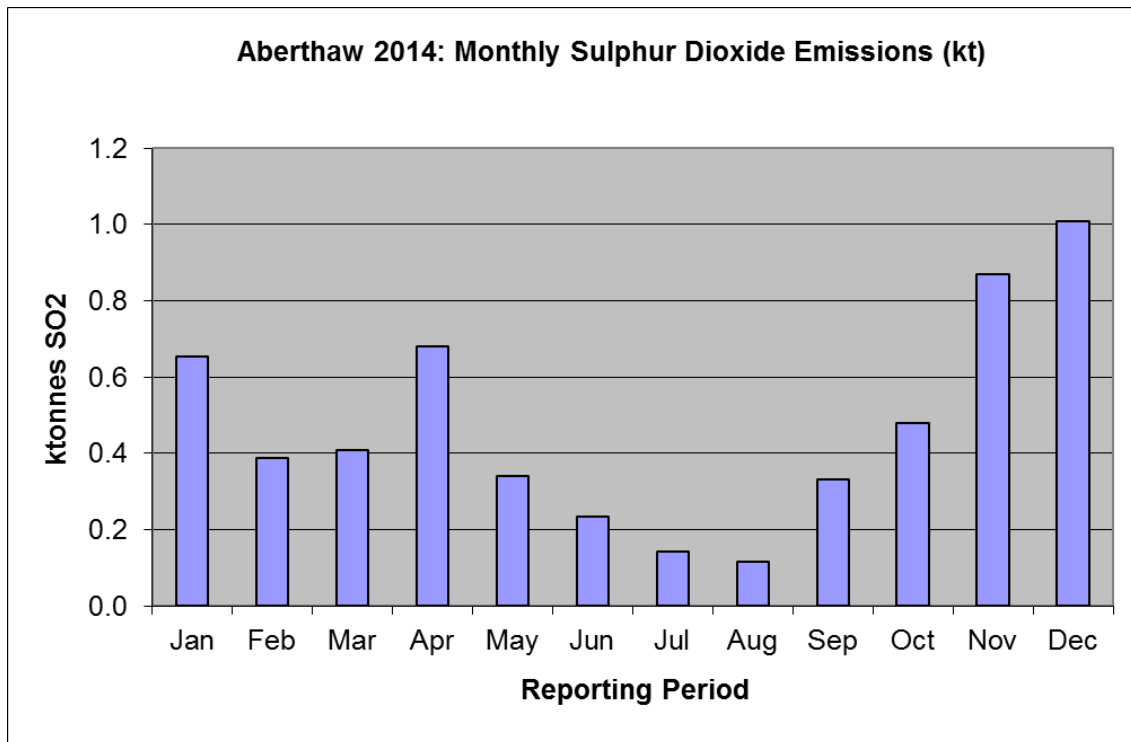


Figure 4.2 Monthly SO₂ emissions from Aberthaw Power Station during calendar year 2014

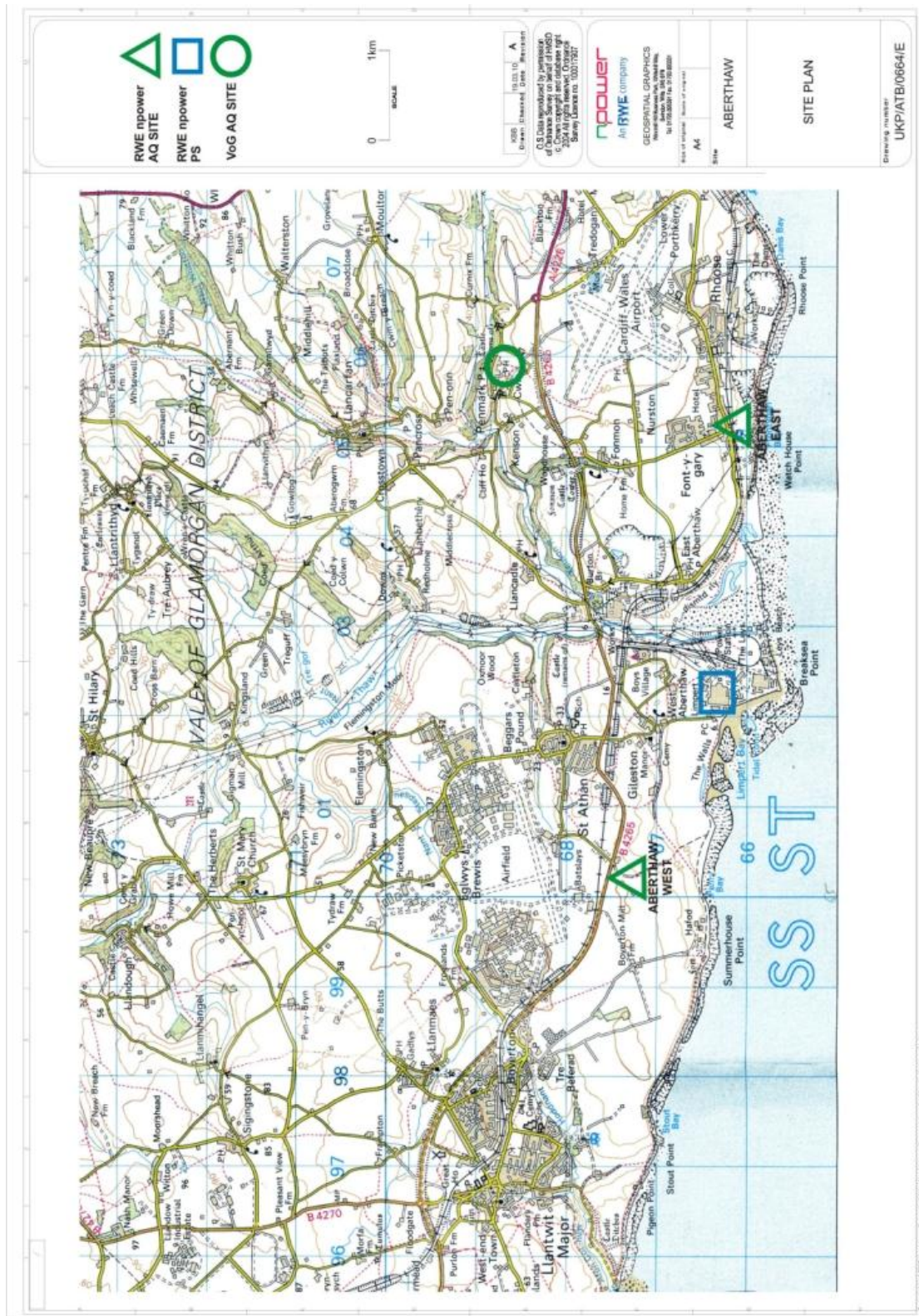


Figure 5.1 Locations of Aberthaw Power Station and the Monitoring Plan air quality measurement sites (Aberthaw West and VoG AQ site now closed)

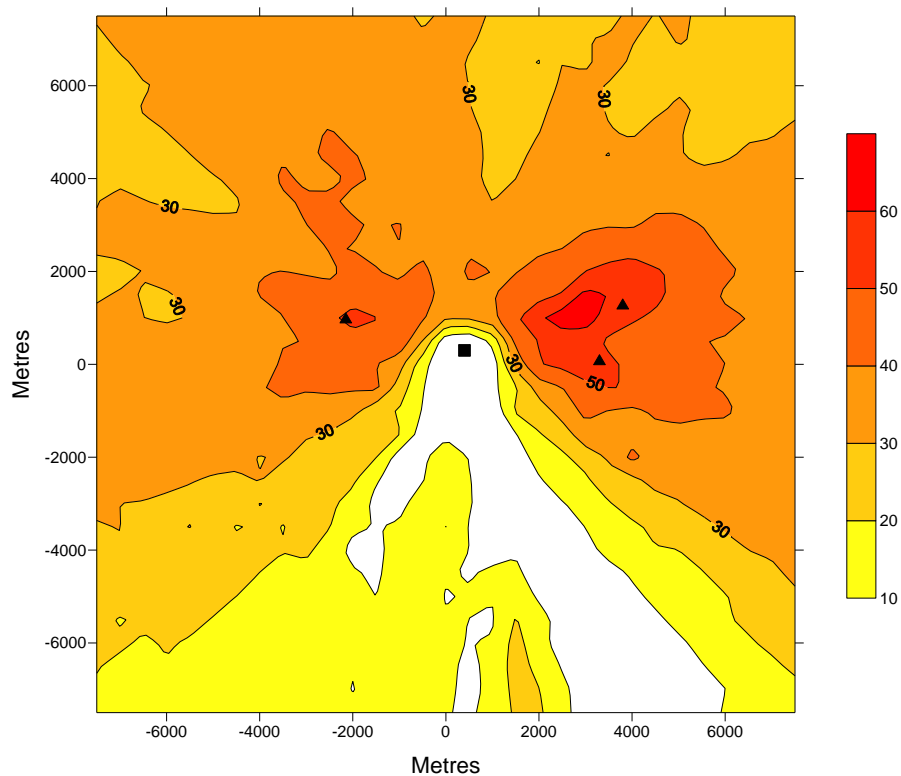


Figure 6.1 Contour plot of the modelled 99.9th percentile 15-min SO₂ concentrations ($\mu\text{g m}^{-3}$) due to emissions from Aberthaw Power Station during calendar year 2014

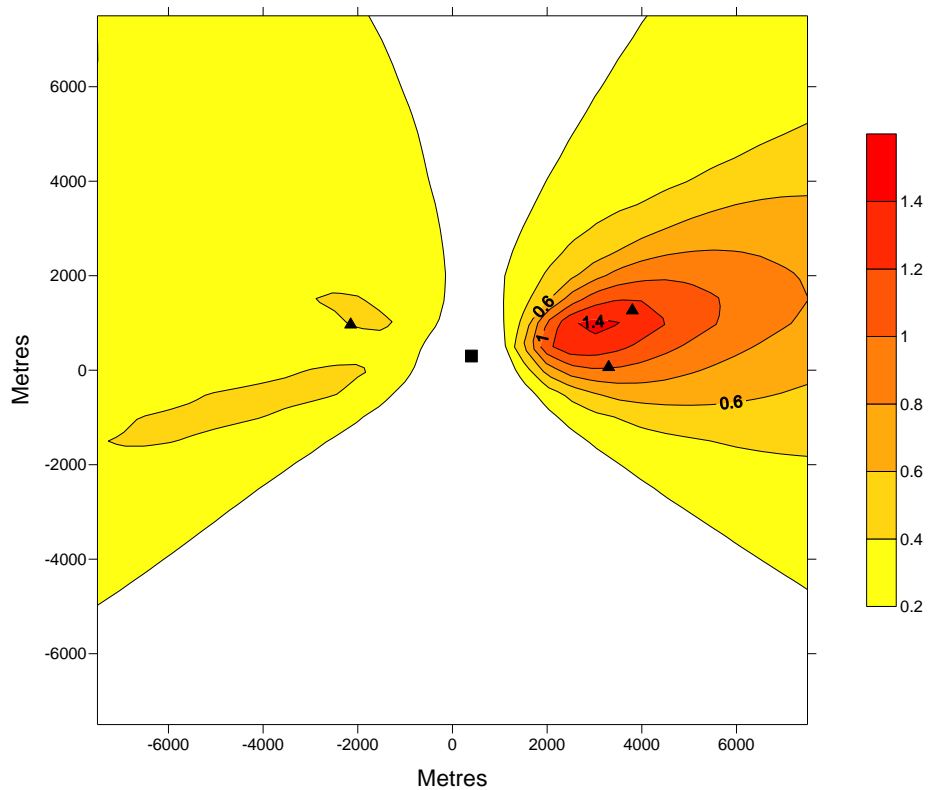


Figure 6.2 Contour plot of the modelled annual mean SO₂ concentrations ($\mu\text{g m}^{-3}$) due to emissions from Aberthaw Power Station during calendar year 2014

Air Quality at the Aberthaw Power Station Monitoring Plan Site

2014

Summary

A requirement of Improvement Conditions 8.3 and 8.4 of the Variation BG907C to the IPC authorisation AA2682 for Aberthaw Power Station issued by the Environment Agency (and now regulated by Natural Resources Wales - NRW) was to install air quality monitoring at at least one site to demonstrate compliance with Air Quality Strategy (AQS) objectives. The Monitoring Plan to meet this requirement has been developed using the Technical Monitoring Methodology agreed with the Environment Agency. Two sites were established around the power station in fulfilment of the improvement condition requirement, but one, Boverton Mill Farm, was closed in May 2005. A replacement site at Seaview Farm, grid reference ST002673 and approximately 2.5 km WNW (105°) from the station, was commissioned on 1st September 2009 and ran until 15th September 2011, after which it was decommissioned with agreement from the Environment Agency. Section 3.8 of Aberthaw Power Station's Environmental Permit RP3133LD requires implementation of the Air Quality Management Plan agreed under the IPC Improvement Condition.

The Font-y-Gary monitor has operated with a high level of reliability. It achieved an average of 90.2% data capture, with 91.4% from the sulphur dioxide analyser, 89.5% from the nitrogen oxides analyser, and 89.6% from the ozone analyser during the current reporting period, calendar year 2014.

The sulphur dioxide concentrations were within the EC Directive 2008/52/EC and the Revised UK Air Quality Strategy (AQS) limits and guidelines. There were no exceedences of the 15-minute, the 1-hour or the daily SO₂ AQS thresholds at Font-y-Gary. The compliance targets are ≤35 15-min periods, ≤24 hours and ≤3 days above the corresponding thresholds. All SO₂ targets under the EU Directive 2008/50/EC and under the UK Air Quality Strategy (AQS) were, therefore, in compliance during 2014.

Average concentrations of total nitrogen oxides were greater than the concentrations of sulphur dioxide. There were no exceedences of any human health NO₂ air quality statistic.

The EU Dir 2008/50/EC 8-hour Running Mean Guideline for ozone (120 µg/m³) was not exceeded and the UK AQ Strategy 8-hour Running Mean Guideline (100 µg/m³) was exceeded on seven occasions.

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1 Introduction

A requirement of Improvement Conditions 8.3 and 8.4 of the Variation BG907C to the IPC authorisation AA2682 for Aberthaw Power Station issued by the Environment Agency (and now regulated by Natural Resources Wales - NRW) was to install air quality monitoring to demonstrate compliance with Air Quality Strategy (AQS) objectives. The Monitoring Plan to meet this requirement has been developed using the Technical Monitoring Methodology described in Appendix C to the Management Plan for the station. Following this methodology, the monitoring sites described in Table A1 have been identified as appropriate and agreed with the Environment Agency. Section 3.8 of Aberthaw Power Station's Environmental Permit RP3133LD requires implementation of the Air Quality Management Plan agreed under the IPC Improvement Condition. The monitoring site and the power station locations are shown in Figure 5.1 of the main document.

Sites are in rural locations with, as far as practicable, minimal influence from local traffic and residential or commercial emissions. The site map (Figure 5.1 of the main report) shows the routes of local roads and residential buildings. There will, inevitably, be occasional vehicle movements very local to the sites and domestic coal or oil combustion at nearby properties. However, these are anticipated to have a minimal effect on the annual statistics which are the comparators for AQS target compliance.

Aberthaw West air quality monitoring station was commissioned at Seaview Farm on Sept 1st 2009. This replaced the Boverton Mill Farm station, which was decommissioned in May 2005, and provides an indication of background air quality around Aberthaw station. Since the installation and operation of FGD there has been a substantial reduction in SO₂ emissions and air quality impacts from the power station. In 2011, agreement was reached with the Environment Agency (EA) to close the upwind air quality monitoring site at Aberthaw West using a framework and criteria agreed between the EA and the Joint Environment Programme (Ref. ENV/467/2011). Subsequently, Aberthaw West was decommissioned on Sept 15th 2011.

Table A1 Aberthaw Monitoring Plan air quality measurement sites

Site	Location	Comment
Aberthaw - West	Seaview Farm ST002673 2.5 km WNW (105°)*	Site commissioned on 1 st Sept 2009 and closed on 15 th September 2011. SO ₂ and NO _x
Aberthaw - East	Font-y-Gary Pumping Station ST053661 2.9 km E (274°)*	SO ₂ , NO _x and O ₃ .

* Wind direction for the measurement site to be downwind of the station

2 Operation and instrumentation

The sites were operated under contract to RWE Generation UK plc by Bureau Veritas HS&E Ltd. Proprietary instrumentation was used for measurement of ambient gas concentrations and data logging. These were: API M100E for SO₂; API 200E for NO_x;

and API M400E for O₃. All these instruments operate using established techniques (UV-fluorescence for SO₂, chemi-luminescence for NO_x, and UV-absorption for O₃) and are from a reputable manufacturer. The gas analyser readings were recorded every minute using a Campbell Scientific CR10 data logger and hourly mean values calculated from these 1-minute readings. The data logger also controlled a daily gas analyser calibration for zero and span, using Purafil/charcoal filters and calibrated permeation tube sources of SO₂ or NO₂ to provide zero and span gas, respectively, for the SO₂ and NO_x analysers. Internal instrument zero and span sources were used for the O₃ analyser. These daily calibration readings were used as a check of instrument operation, i.e. as an indicator of malfunction or calibration drift. The gas analysis instruments were maintained and serviced to the manufacturer's schedule at six-monthly intervals.

Manual calibrations were carried out by the site operator every two weeks using cylinders of calibration gas traceable to National Physical Laboratory (NPL) primary standards. These fortnightly readings were used to calibrate the logged analyser readings taking into account, if appropriate, any indication of drift or malfunction indicated by the daily checks. The analyser 5 µm inlet filters were changed fortnightly at the time of the manual calibration and the PTFE sample lines and zero filters were changed every six months.

Data were transferred from the site loggers to the contractor's offices every working day and inspected for instrument malfunction. At the end of each month, calibrated hourly mean data were despatched to RWE Generation UK plc and incorporated into the RWE Generation UK plc Environment and Chemistry Department air quality database. Hourly mean values were set to "missing" where data coverage was <75% during the hour and when the contractors were confident, using their professional judgement, that the recorded values were invalid as a result of analyser calibration check, servicing, malfunction or other error.

These procedures ensured that the gas concentration measurements were made to standards equivalent to those of the DEFRA automated network. The measurements are estimated to be accurate to ±3 ppb or 10% of reading, whichever error was the larger.

3 Ambient air quality limits and guidelines

3.1 Protection of human health

There are several limit and guideline concentrations for sulphur dioxide, nitrogen dioxide and ozone which have been defined by EC Directive, WHO and the UK DEFRA to protect human health. The latest EC Directive for SO₂, NO₂ and ozone concentrations in ambient air is 2008/50/EC. The WHO guidelines were reviewed in 2000 (WHO, 2000) and recommend maximum concentrations which are considered non-hazardous to human health. The DEFRA categories are those used in weather forecasts and other UK air quality reports to indicate general air quality. Health advice based on the categories is available from telephone help-lines. Standards for these same species have been set by the DEFRA EPAQS panel; and objectives for the UK specified in the Revised UK Air Quality Strategy (DEFRA, 2007).

Exceedence of the EC Directive limits requires the government to institute action to remedy the situation. Exceedence of the EC Directive targets is not a breach of requirements but indicates that action to reduce concentrations should be

considered. Occasional breaches of the WHO guidelines at any particular location are not necessarily uncommon and not generally considered a cause for concern. Regular and prolonged exceedences would indicate that action may be required to improve air quality. The targets under EU Directive 2008/50/EC and the UK AQS objectives are attempts to quantify the exceedence level of WHO guidelines and the EPAQS standard for SO₂, respectively, at which action should be taken. The UK AQS brings the requirements of EU Directive 96/62 into UK legislation, although with earlier compliance dates in some cases, but also retains the additional EPAQS SO₂ standard at 99.9% compliance from the earlier Air Quality Strategy (1997). Neither the Revised AQS (DEFRA, 2007) nor EU Directive 2008/50/EC have proposed any revisions to the SO₂, NO_x, O₃ or PM₁₀ current objectives but proposed PM₁₀ limits for 2010 have been replaced by new targets and limits for PM_{2.5}. The percentage of time within each DEFRA category is a general guide to relative air quality.

The most relevant air quality limits and guidelines for the protection of human health are given in Tables A2a to A2c.

3.2 Protection of vegetation

There are no statutory limits for the protection of vegetation but guideline and recommended values have been proposed by WHO, IUFRO and UNECE. Targets have also been made under EU Directive 2008/50/EC. The 2008/50/EC Directive ecosystem limits apply to sites which are at least 5 km from a point source and representative of an area of at least 1000 km². Since the Monitoring Plan sites are at locations close to the maximum impact points from the station, and are closer than 5 km to the station, they are not "representative" as defined in the Directive. Thus, exceedences of the 2008/50/EC Directive ecosystem limits at the Monitoring Plan sites do not necessarily imply non-compliance as defined in the Directive.

The vegetation standards have generally been set at levels much lower than the damage thresholds for individual pollutants as a precaution against possible synergistic effects between different pollutants. They represent the pollutant level at which significant reductions in plant growth are believed to occur, when in combination with other pollutants considered likely to be present. The most-frequently quoted guideline and recommended values are given in Table A3. Percentile statistics with respect to WHO vegetation guidelines have been compiled and are represented in Table A7.

4 Results and discussion

4.1 Annual air quality summary

The monthly statistics for Font-y-Gary are given in Table A4. The table gives the percentage data capture for SO₂, NO_x and O₃ for each month together with the monthly mean, the maximum hourly mean and percentile concentrations relevant to the key health standards and guidelines listed in Tables A2a to A2c. These include the 99.73%ile of hourly mean SO₂, the 99.9%ile of 15-minute mean SO₂, the 99.8%ile of hourly mean NO₂ and the 97.3%ile and 93.15%ile maximum 8-hour running mean O₃ on each day measured during each month. The equivalent seasonal, i.e. April to September and October to March, statistics are also given in Table A4. Annual statistics are given in Table A5.

The 15-min mean SO₂, hourly mean NO₂ and NO_x, and 8-hour running mean O₃ concentrations at Font-y-Gary are shown in Figure A1. The graphs show the appropriate health guidelines. Only the NO₂ component of total nitrogen oxides is considered a hazard to health and, therefore, there are no limits or guidelines shown for NO_x.

Table A4 indicates that Font-y-Gary gave excellent data coverage throughout the majority of 2014, with a blip in April due to data logger issues. All data deletions were made by the site operating contractors (Bureau Veritas) as a result of their professional judgement of when data were invalid or insufficiently reliable. The data coverage target of ≥90% was achieved for SO₂ and if figures are rounded up also for NO_x and ozone. Annual coverage was 91.4% from the sulphur dioxide analyser, 89.5% from the nitrogen oxides analyser, and 89.6% from the ozone analyser.

The 15-min SO₂ and hourly mean NO₂ concentrations were generally quite low compared to the health standards shown on the diagrams (Figures A1). Ozone concentrations (Figure A1) were occasionally above the AQS threshold during the summer. Compliance with the various health and vegetation air quality guidelines is discussed in Section 5.

4.2 Effect of wind direction on air quality

The frequency of occurrence for each incoming wind direction during the 2014 calendar year is shown in Figure A2; the percentage figures given on the diagram are the percentages of "non-calm" winds (i.e. $\geq 0.5 \text{ m s}^{-1}$). The wind rose shows a bias for winds from westerly directions, but there is a significant proportion from easterly directions.

The mean concentrations of SO₂ and NO_x for each wind direction depend on the disposition of the various high and low level emission sources, the wind speed and the manner in which the emissions are dispersed in the atmosphere. Both the disposition of emission sources and the meteorology which determines dispersion are not uniform for all wind directions. The mean concentrations by wind direction for all "non-calm" conditions are illustrated in Figures A3 and A4. The lengths of the bars indicate the mean concentration for that wind sector, i.e. they give the mean concentrations for that source direction.

Wind shear with height results in power-station plumes travelling initially on a trajectory typically 10° to 20° greater than that measured at the standard 10 m height above ground level. Contributions from tall chimneys would thus appear to impact at ground level on wind trajectories typically a few degrees less than the receptor to source bearing. The wind roses, thus, need to be rotated a few degrees clockwise to represent contributions at ground level from tall chimney emissions.

The concentration wind rose for SO₂ is shown in Figure A3 and indicates that the greatest average SO₂ concentrations at Font-y-Gary are, marginally, from the west, the approximate direction of Aberthaw Power Station, though the effect is slight. Generally, concentrations are fairly evenly distributed around the compass. The concentration wind rose for NO_x in Figure A4 shows that large impacts arise from a wider range of possible sources mainly to the north, of which traffic is likely to be the significant contributor.

5 Compliance with ambient air quality limits and guidelines

5.1 Sulphur dioxide

The compliance statistics with respect to the health limits, guidelines, targets and objectives listed in Table A2a are summarised in Table A5. Data coverage figures are with reference to the full calendar year but the mean and percentile concentrations are over all the valid readings. The percentile concentrations listed in Table A5 correspond to the AQS targets. The annual mean SO₂ concentration was 4.3 µg m⁻³ at Font-y-Gary, that is 9% of the 50 µg m⁻³ WHO guideline. There were no exceedences of the 15-minute, 1-hour or daily SO₂ AQS thresholds compared to the compliance targets of ≤35 15-min periods, ≤24 hours and ≤3 days above the corresponding thresholds. Therefore, all limits, guidelines, targets and objectives under EU Directives and the UK Air Quality Strategy were met by considerable margins.

The compliance statistics with respect to the vegetation guidelines and objectives listed in Table A3 are summarised in Table A7. The annual mean and daily values and statistics were well below the EU Directive 2008/50/EC, and WHO guidelines, even for the most sensitive species, with no exceedences of any guideline.

5.2 Nitrogen dioxide

The compliance statistics with respect to the health limits, guidelines, targets and objectives listed in Table A2b are summarised in Table A5. The mean and percentile concentrations listed in Table A5 correspond to the AQS targets. The hourly variations in NO₂ concentrations shown in Figure A1 indicate that there were no exceedences of the WHO guideline, which is the basis for the EU Directive 2008/50/EC and UK AQS targets, or EPAQS standard. The EC Dir 85/203 Hourly Guideline (135 µg/m³) was also not exceeded. Annual mean NO₂ concentrations were substantially below the 40 µg m⁻³ AQS target, with 10 µg m⁻³ at Font-y-Gary.

The compliance statistics with respect to the vegetation guidelines and objectives listed in Table A3 are summarised in Table A7. NO_x met the annual mean AQS objective and other guidelines and but was higher than the 24h mean WHO guideline value on two days. This is quite common and is not a cause for concern given the highly protective nature of the 24h guideline and the lack of sensitive vegetation nearby. Also, it is likely that traffic is the main source of NO_x in the vicinity.

Figure A7 indicates that the annual mean NO_x impact at Font-y-Gary has decreased in 2014 compared to 2013, whilst the 99.8th percentile of hourly mean impacts has slightly increased.

5.3 Ozone

The compliance statistics with respect to the health limits, guidelines, targets and objectives listed in Table A2c are summarised in Table A6. The EU Directive 2008/50/EC and UK AQS targets for O₃ are framed in terms of the number of days during which the WHO guideline and EPAQS standard, respectively, are exceeded. The data in Table A6 indicate that there were no days which exceeded the WHO guideline and seven days on which the EPAQS standard was exceeded. The EU

Directive target is for a maximum of 25 days of exceedences and the AQS target is a maximum of ten days. Thus, both targets were met.

6 Trends in SO₂ and NO_x concentrations

The mean and various statistical measures (e.g. percentile values) of ambient concentrations in any particular year depend not only on the emissions as a function of time during the year but, also, on the pattern of meteorology during the period and the interaction between emissions and meteorology on an hour-by-hour, or shorter, basis. This is particularly true for the infrequent conditions associated with high percentile concentrations. There are, therefore, likely to be substantial annual variations and large inter-site variability in such concentration measures.

There have been no continuous measurements of SO₂ or NO_x concentrations around Aberthaw prior to 2002. Thus, the change in concentration measures with time covers over ten years and could now be assumed to be representative of any trend. The plots of the values of the annual mean and 99.9th percentile 15-min mean SO₂ concentrations are shown in Figure A5. Data were available for only about three months from Boverton Mill (the original Aberthaw West station) in 2003 and are not shown as they are not representative of annual statistics. Similarly, the Boverton Mill data cover only about 4.5 months in 2005 and are not shown. The data from 2009 at Seaview Farm (the new Aberthaw West site) is presented, but it should be noted that this is representative of only the last 4 months of the year. SO₂ measurements at Font-y-Gary (Aberthaw East) decreased from 2007, as expected, by the onset of operation of the FGD plant. The data trend at Seaview Farm is virtually identical to that at Font-y-Gary from 2009 and its annual mean is in fact higher. The 99.9th percentile of 15-min and annual mean SO₂ concentrations have shown small increases since 2009 but remained extremely small compared to their respective air quality standards, which suggests that the station is having an insignificant impact on ambient SO₂ concentrations.

The trend in two key measures of NO₂ ambient air concentrations are shown in Figure A6, the annual mean and the 99.8th percentile of hourly means (i.e. the target compliance measure under EU Directive 2008/50/EC and UK AQS). The equivalent statistics for total NO_x concentrations are shown in Figure A7. The annual mean NO₂ and NO_x concentrations have shown a general increase over the measurement period until 2007/2008, but from then appear to be following an overall downward or flat trend. The 99.8th percentile NO₂ and NO_x concentrations both peaked in 2008, fell during 2009 and 2010, increased a little in 2011 before falling again in 2012 and further in 2013. Annual mean NO_x and NO₂ and 99.8th percentile NO₂ continued to fall in 2014 and there was a small increase in 99.8th percentile NO_x.

7 Conclusions

The Monitoring Plan site at Font-y-Gary has operated with a high level of reliability achieving 91.4% data capture from the sulphur dioxide analyser, 89.5% from the nitrogen oxides analyser, and 89.6% from the ozone analyser during the current reporting period, calendar year 2014.

The sulphur dioxide concentrations were within the EC Directive 2008/50/EC limits and guidelines. There were no exceedences of the 15-minute AQS threshold, the WHO hourly mean guideline, or the WHO daily mean guideline at Font-y-Gary compared to the compliance targets of ≤35 15-min periods, ≤24 hours and ≤3 days above the corresponding thresholds. The SO₂ targets under the EU Directive

2008/50/EC and under the UK Air Quality Strategy (AQS) were in compliance by substantial margins.

The concentrations of total nitrogen oxides were substantially greater than the concentrations of sulphur dioxide. The EU Directive 2008/50/EC and AQS targets were met and there were no exceedences of the WHO hourly NO₂ guideline.

The WHO 8-hourly mean guideline for O₃ (120 µg/m³) was not exceeded and the UK AQ Strategy 8-hour Running Mean Guideline (100 µg/m³) was exceeded on seven days; below the 10 day maximum compliance target under the UK AQS.

Over the thirteen years' worth of data now collected, the trend in sulphur dioxide was generally downwards until 2009 with small increases thereafter. NO₂ and annual mean NO_x concentrations have shown a downward trend since 2008, whilst 99.8th %ile NO_x has not shown a clear trend.

8 Acknowledgements

The network was operated under contract to RWE Generation UK plc by Bureau Veritas HS&E Ltd.

9 References

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Table A2a Limit and guideline values for effects of SO₂ on health

Limit or Guideline	SO ₂ µg/m ³	Averaging period and/or compliance level
EU Directive 2008/50/EC The Air Quality Standards Regulations, 2010 (by 31 December 2004)	350	≤24 (99.73%ile) hourly means higher over a calendar year
	125	≤3 (99.18%ile) daily means higher over a calendar year
WHO Guideline Values (2005 update)	500	10-minute mean
	20	Daily mean
EPAQS standard	266	15- minute mean
UK Air Quality Strategy The Air Quality (England) Regulations 2000 (and equivalents for Scotland, Wales and Northern Ireland) (by 31 December 2004)	350	≤24 (99.73%ile) hourly means higher over a calendar year
	125	≤3 (99.18%ile) daily means over a calendar year
(by 31 December 2005)	266	15- minute mean ≤35 (99.9%ile) 15-min means higher over a calendar year
DEFRA Air Quality Bands "Low"	≤266	15-minute mean
"Moderate"	267 - 532	
"High"	533 -1064	
"Very High"	≥1065	

Table A2b Limit and guideline values for effects of NO₂ on health

Limit or Guideline	NO ₂ µg/m ³	Averaging period and/or compliance level
EU Directive 2008/50/EC The Air Quality Standards Regulations, 2010 (by 1 January 2010)	200	≤18 (99.8%ile) hourly means over a calendar year
	40	Annual mean
WHO Guideline Values	200	Hourly mean
	40 -50	Annual mean
EPAQS Standard	287	Hourly mean
UK Air Quality Strategy The Air Quality (Wales) Regulations 2000 (by 2005)	200	≤18 (99.8%ile) hourly means over a calendar year
	40	Annual mean
DEFRA Air Quality Bands "Low"	≤200	Hourly mean
"Moderate"	201 – 400	
"High"	401 – 600	
"Very High"	≥601	

Table A2c Limit and guideline values for effects of O₃ on health

Limit or Guideline	O ₃ µg/m ³	Averaging period and/or compliance level
EU Directive 2008/50/EC The Air Quality Standards Regulations, 2010 (by 2010)	120	Maximum daily 8-hour running mean ≤25 (93.2%ile) days in a year with exceedences, averaged over 3 years
WHO Guideline Value	120	Running 8-hourly mean
UK Air Quality Strategy The Air Quality (Wales) Regulations 2000 (by 2005)	100	Running 8-hour mean ≤10 (97.3%ile) days in a year with exceedences
DEFRA Air Quality Bands "Low"	≤100	Running 8-hour mean
"Moderate"	101-160	
"High"	161-240	
"Very High"	≥241	

Table A3: Guideline and recommended values for effects on vegetation

Guideline or Recommendation	SO ₂ µg/m ³	NO _x µg/m ³
EC Directive 2008/50/EC Guideline Values The Air Quality Standards Regulations, 2010 Annual mean (by 19 th July 2001)	20 ¹	30
UK Air Quality Strategy Annual mean (by 31 st December 2000)	20 ¹	30
WHO Guidelines² Agricultural crops	30 ¹	
Forest and natural vegetation Annual mean 24h mean	20 ¹	30 75
Sensitive forest and natural vegetation	15 ¹	
Lichens	10 ¹	

1 Annual and Winter means

2 Air Quality Guidelines for Europe, 2nd Edition. 2000

Table A4 Font-y-Gary, 1 January to 31 December, 2014**Monthly and Seasonal Summary Statistics, Gas Concentrations in $\mu\text{g m}^{-3}$**

Month		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Summer	Winter
SO ₂	% Data Capture	99.2	83.5	58.5	68.9	99.7	99.9	99.2	99.9	99.2	99.5	89.0	99.5	94.5	88.3
	% Data Capture	99.1	83.5	58.6	38.9	99.6	99.6	99.3	99.9	99.0	99.5	95.8	99.7	89.5	89.4
	% Data Capture	99.2	83.5	67.9	46.0	99.7	99.9	95.8	99.9	99.3	95.2	88.1	99.7	90.2	89.0
SO ₂	Mean	4.2	3.6	4.5	4.5	4.3	4.0	4.5	3.9	4.7	4.7	2.9	5.0	4.3	4.2
	Maximum Hour	83	24	45	24	43	29	27	24	48	27	40	53	48	83
	99.7%ile Hour	21	19	37	13	27	21	16	16	43	19	27	35	27	32
	99.9%ile 15-minute	56	32	53	19	45	35	27	24	45	30	42	54	40	45
NO ₂	Mean	9.9	6.1	15.3	10.9	9.3	7.7	8.5	6.5	13.2	7.4	14.9	15.0	9.2	11.3
	Maximum Hour	59	42	78	82	61	97	44	36	50	82	57	92	97	92
	99.8%ile Hour	54	36	71	75	48	42	40	27	42	50	54	84	46	69
	Mean	15.5	10.4	29.6	16.9	17.9	12.3	16.7	12.0	18.3	11.3	23.9	27.6	15.5	19.3
NO _x	Maximum Hour	225	126	399	363	285	126	159	113	94	189	170	437	363	437
	99.8%ile Hour	130	96	380	264	201	86	145	82	80	132	136	394	178	252
	Mean	62.6	72.2	59.2	61.6	65.4	55.5	53.6	54.9	48.3	52.1	36.8	50.9	56.1	55.2
	Maximum Hour	94	90	102	102	115	100	129	84	98	78	84	84	129	102
O ₃	97.3%ile Daily Max.	44	42	45	49	53	46	56	39	42	37	39	41	52	44
	93.2%ile Daily Max.	41	41	44	48	50	44	53	39	40	35	38	38	48	41

Table A5 Aberthaw Monitoring Plan Site, 1 January to 31 December 2014
Annual Summary Statistics for SO₂ and NO₂ in µg m⁻³
with respect to health limits and guidelines

	Font-y-Gary
SO₂ STATISTICS	
Annual Mean (µg/m ³)	4.3
98%ile Daily Mean (µg/m ³)	11
99.18%ile Daily Mean (µg/m ³)	14
99.73%ile Hourly Mean (µg/m ³)	32
99.9%ile 15-minute Means (µg/m ³)	43
Maximum 15-minute Mean (µg/m ³)	130
Number of Readings Greater than:	
UK AQ Strategy and EU Daily Limit (125 µg/m ³)	0
-{Target is <=3 days pa, i.e. 99.18%ile} (%age Achieved)	100
UK AQ Strategy and EU Hourly Limit (350 µg/m ³)	0
-{Target is <=24 hours pa, i.e. 99.73%ile} (%age Achieved)	100
UK AQ Strategy 15-min Limit (266 µg/m ³)	0
-{Target is <=99.9%ile, i.e. <=35 pa} (%age Achieved)	100
- Number of days containing an exceedence	0
Number of 15-min periods in:	
DEFRA "Moderate" Band (266-532 µg/m ³)	0
DEFRA "High" Band (532-1064 µg/m ³)	0
DEFRA "Very High" Band (>=1064 µg/m ³)	0
NO₂ STATISTICS	
Annual Mean (µg/m ³)	10
98%ile Hourly Mean (µg/m ³)	40
99.8%ile Hourly Mean (µg/m ³)	66
Maximum Hourly Mean (µg/m ³)	97
Annual NO _x Mean (µg/m ³)	17
Maximum Hourly NO _x Mean (µg/m ³)	437
Number of Readings Greater than:	
EC Dir 85/203 Hourly Guideline (135µg/m ³)	0
-{Guideline is 98%ile, i.e. <=175 hours pa} (%age Achieved)	100
UK AQ Strategy and EU Hourly Limit (200µg/m ³)	0
-{Target is <=18hr pa, i.e. 99.8%} (%age Achieved)	100
- Number of days containing an exceedences	0
EPAQS Hourly Guideline (287µg/m ³)	0
WHO Daily Mean Guideline (150 µg/m ³)	0
Number of Hours in:	
DEFRA "Moderate" Band (287-573 µg/m ³)	0
DEFRA "High" Band (573-764 µg/m ³)	0
DEFRA "Very High" Band (>=764 µg/m ³)	0
DATA COVERAGE FOR PERIOD (%):	
SO ₂	91.4
NO ₂	89.5
NO _x	89.5

Table A6 Aberthaw Monitoring Plan Site, 1 January to 31 December 2014
Annual Summary Statistics for O₃ in µg m⁻³
with respect to health limits and guidelines

		Font-y-Gary
O₃ STATISTICS		
Annual Mean (µg/m ³)		56
Maximum 8-hour Running Mean (µg/m ³)		119
Number of Days which exceeded:		
EU Dir 2008/50/EC 8-hour Running Mean Guideline (120 µg/m ³)	(%age Achieved)	0
-{Target is <= 25 days pa, i.e. 93.2%ile}		100
UK AQ Strategy 8-hour Running Mean Guideline (100 µg/m ³)	(%age Achieved)	7
-{Target is <=10 days pa, i.e. 97%ile}		97.9
Number of Hours in:		
DEFRA "Moderate" Band (8h >=100µg/m ³)		49
DEFRA "High" Band (1h 180-360µg/m ³)		0
DEFRA "Very High" Band (1h >=360µg/m ³)		0
DATA COVERAGE FOR PERIOD (%):		
O ₃		89.6

**Table A7 Aberthaw Monitoring Plan Site, 1 January to 31 December 2014,
Summary Statistics for SO₂ and NO_x in µg m⁻³
with respect to vegetation guidelines**

	Font y Gary
SO2 STATISTICS	
Annual Mean Value (µg/m ³)	4.3
Winter Mean Value (µg/m ³)	4.2
Corresponding Annual & Winter Mean Guidelines:	
UK National Air Quality Strategy Objectives	- 20 µg/m ³
EU Dir 2008/50/EC General Vegetation	- 20 µg/m ³
WHO Crops	- 30 µg/m ³
WHO Forest & Natural Vegetation	- 20 µg/m ³
WHO Sensitive Forest & Natural Vegetation	- 15 µg/m ³
WHO & UNECE Lichen	- 10 µg/m ³
UNECE Agricultural	- 30 µg/m ³
UNECE Natural Vegetation	- 20 µg/m ³
UNECE Forest	- 20 µg/m ³
IUFRO Normal Woodland (Annual only)	- 50 µg/m ³
IUFRO Suboptimal Woodland (Annual only)	- 25 µg/m ³
97.5%ile of 30-minute means (µg/m ³)	13
Corresponding Guidelines:	
IUFRO Normal Woodland	- 150 µg/m ³
IUFRO Suboptimal Woodland	- 75 µg/m ³
Number of Days with Readings Above:	
WHO General Vegetation Daily Guideline	- 100 µg/m ³
IUFRO Normal Woodland Guideline	- 100 µg/m ³
Winter (12 days maximum)	0
Summer (12 days maximum)	0
IUFRO Suboptimal Woodland Guideline	- 50 µg/m ³
Winter (12 days maximum)	0
Summer (12 days maximum)	0
NOx STATISTICS	
Annual Mean NOx Value (µg/m ³)	17
Corresponding Annual Mean Guidelines:	
UK National Air Quality Strategy Objectives	- 30 µg/m ³
EU 2008/50/EC, WHO & UNECE General Vegetation	- 30 µg/m ³
Maximum 24h Mean NOx Value (µg/m ³)	150
Corresponding 24h Mean Guideline:	
WHO Forest & Natural Vegetation	- 75 µg/m ³

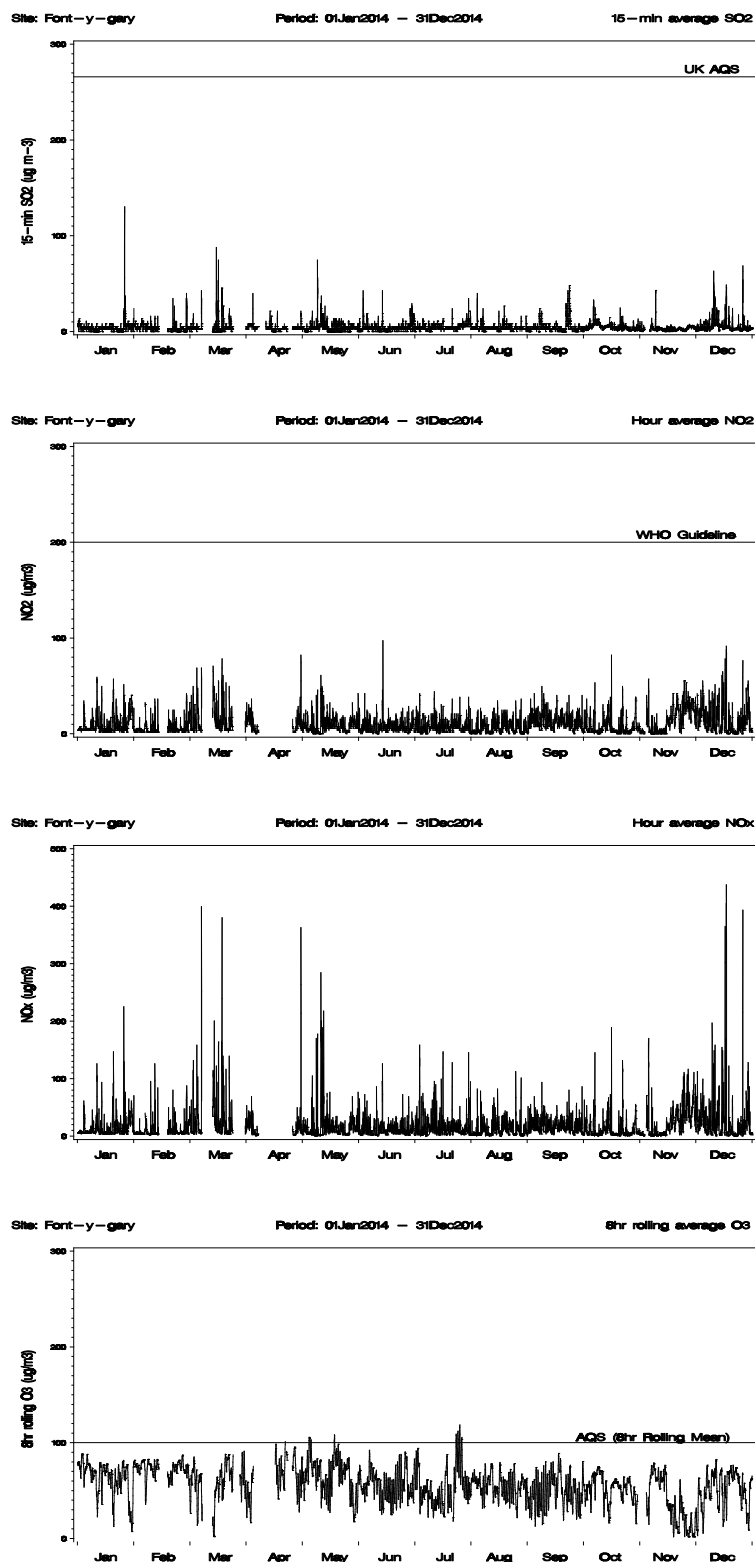
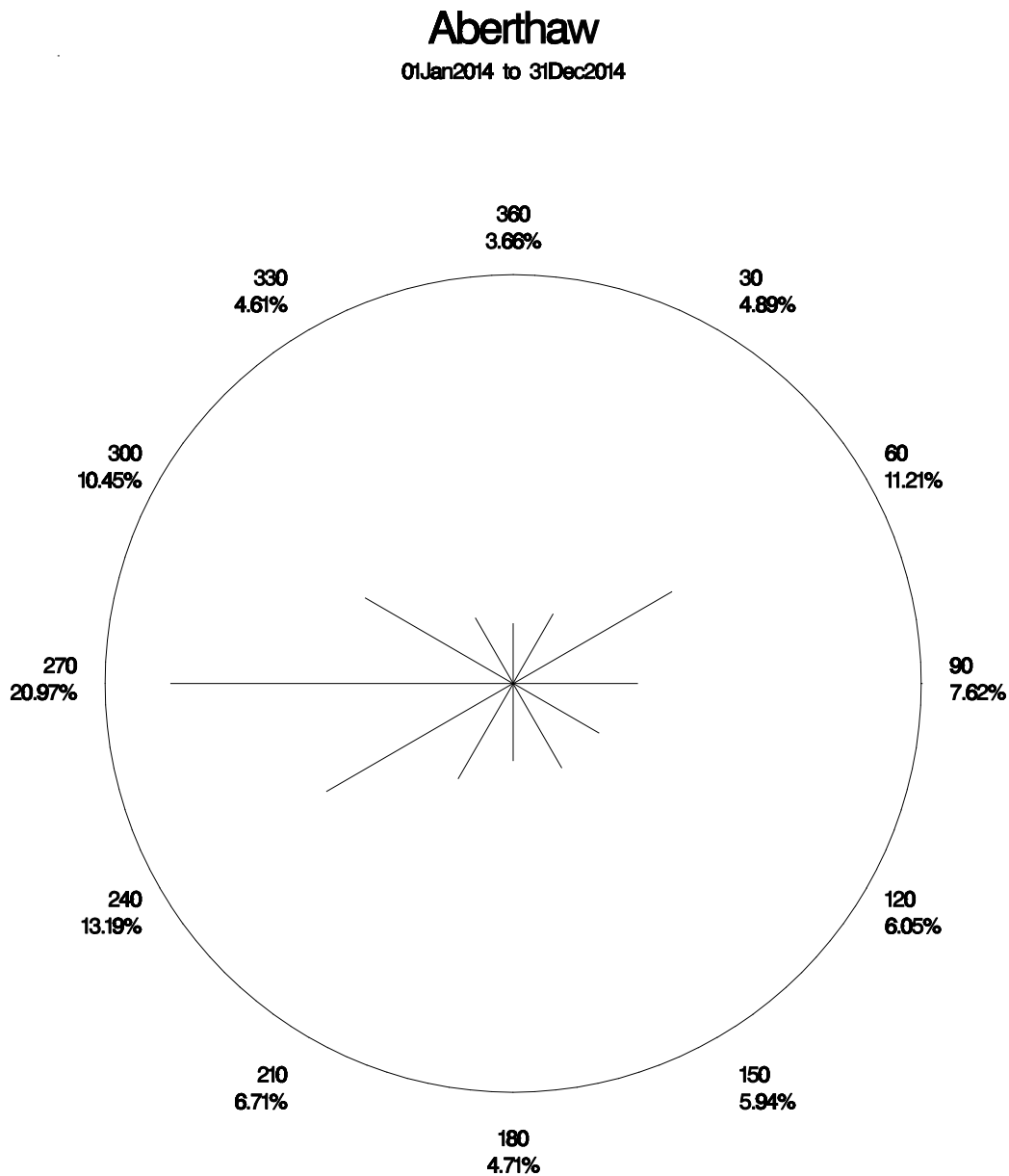


Figure A1: 15-min SO₂, hourly NO₂ and NO_x and 8h O₃ concentrations in µg m⁻³ at Font-y-Gary during calendar year 2014



Wind Distribution

Bearing in degrees and Percent Occurrence

Calm < 0.5 m s⁻¹ not shown Circle = 25 %

Figure A2: Percent wind frequency distribution at Aberthaw during calendar year 2014. Data from St Athan. Circle = 30%.

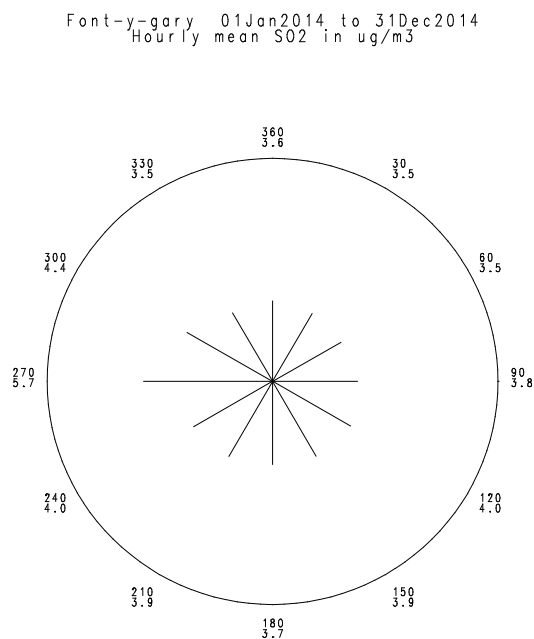


Figure A3: Mean SO₂ wind rose for Font-y-Gary during calendar year 2014.
Circle = 10 µg m⁻³

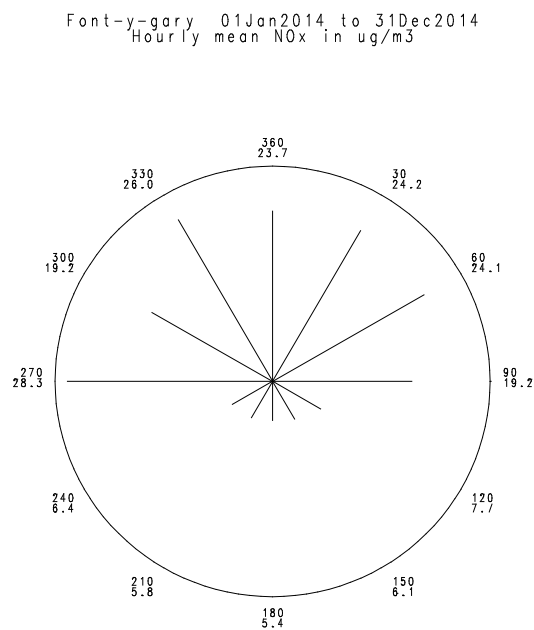


Figure A4: Mean NO_x wind rose for Font-y-Gary during calendar year 2014.
Circle = 40 $\mu\text{g m}^{-3}$

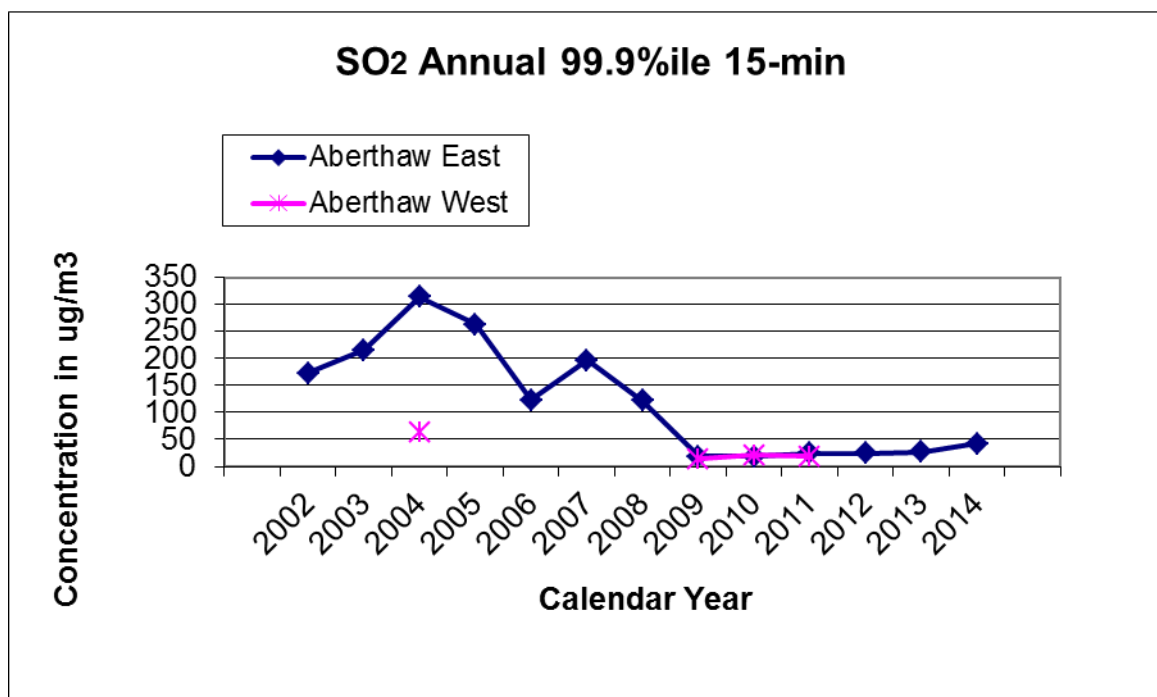
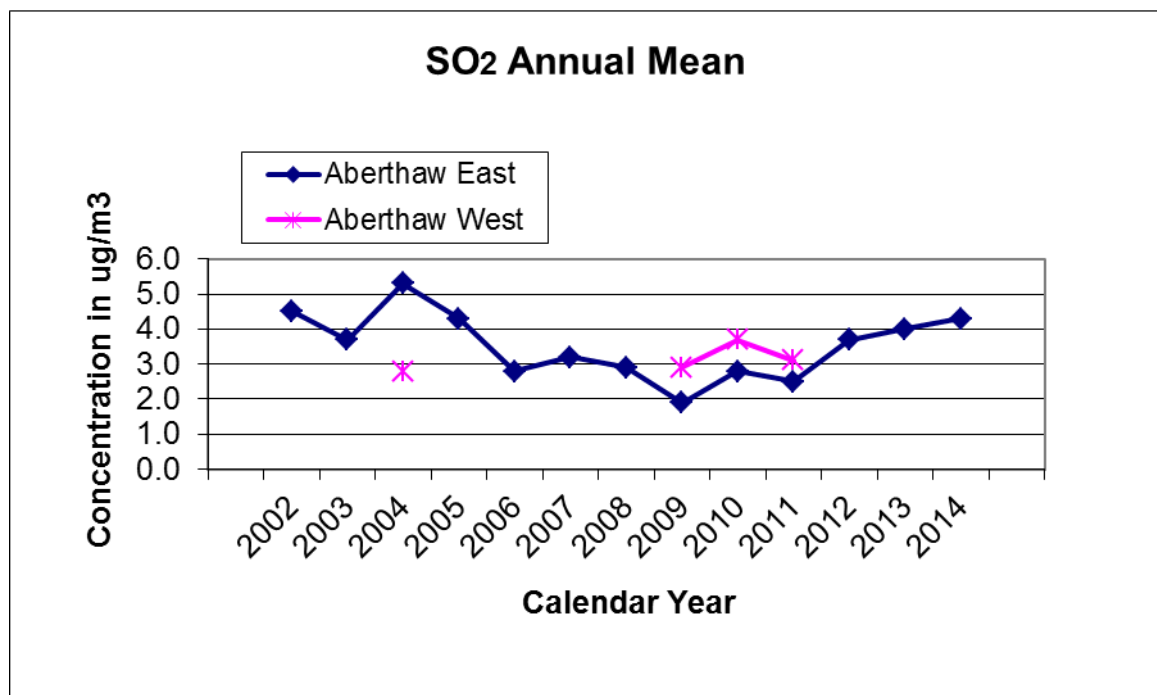


Figure A5 Trend in annual mean and 99.9%ile 15-min mean SO₂ concentrations at Aberthaw sites

Aberthaw East is the Font-y-Gary site. Aberthaw West was initially the Boverton Mill Farm site, which closed in 2005 and the Seaview Farm site from 2009 until its closure in 2011.

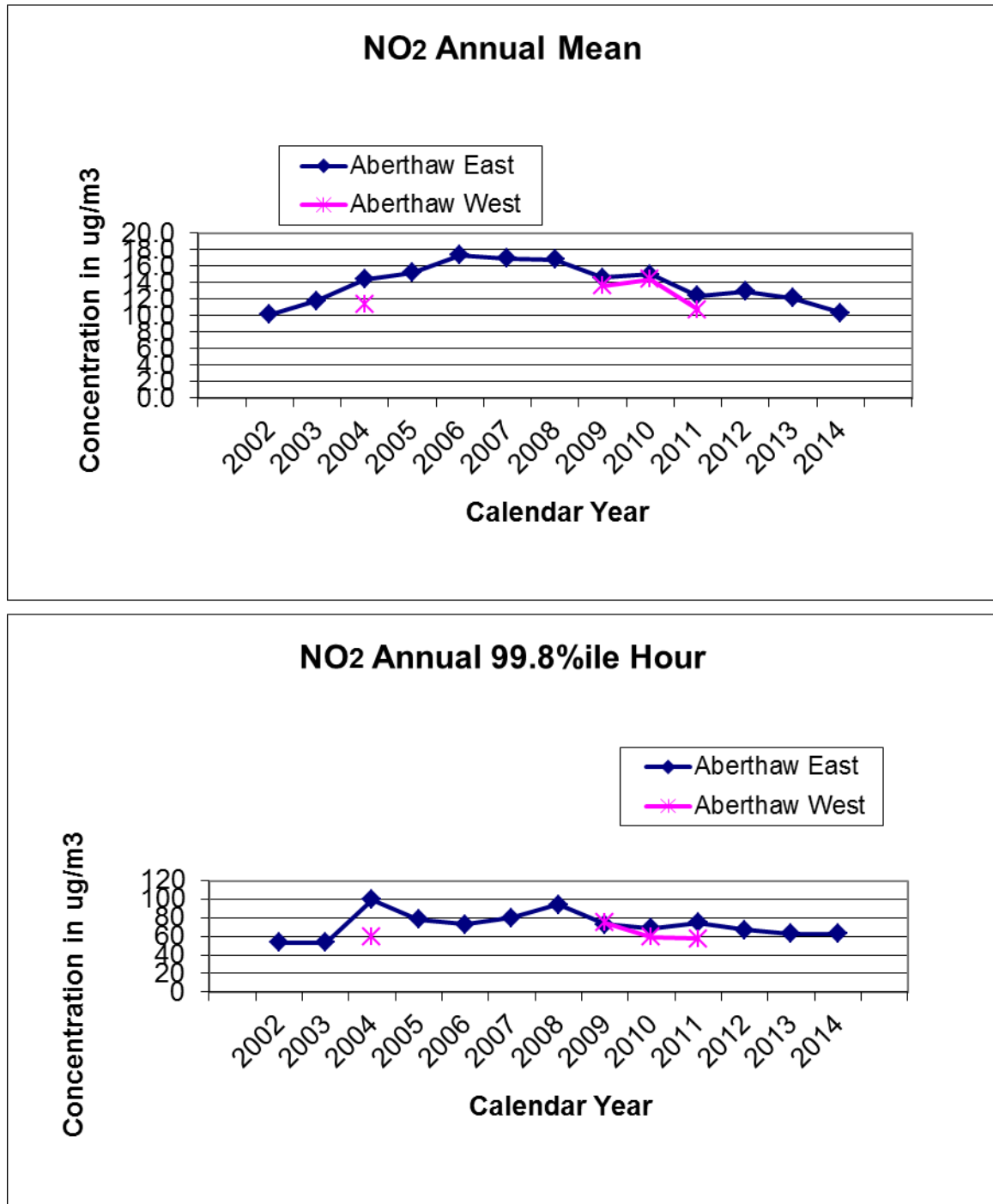


Figure A6 Trend in annual mean and 99.8%ile hourly mean NO₂ concentrations at Aberthaw sites

Aberthaw East is the Font-y-Gary site. Aberthaw West was initially the Boverton Mill Farm site, which closed in 2005 and the Seaview Farm site from 2009 until its closure in 2011.

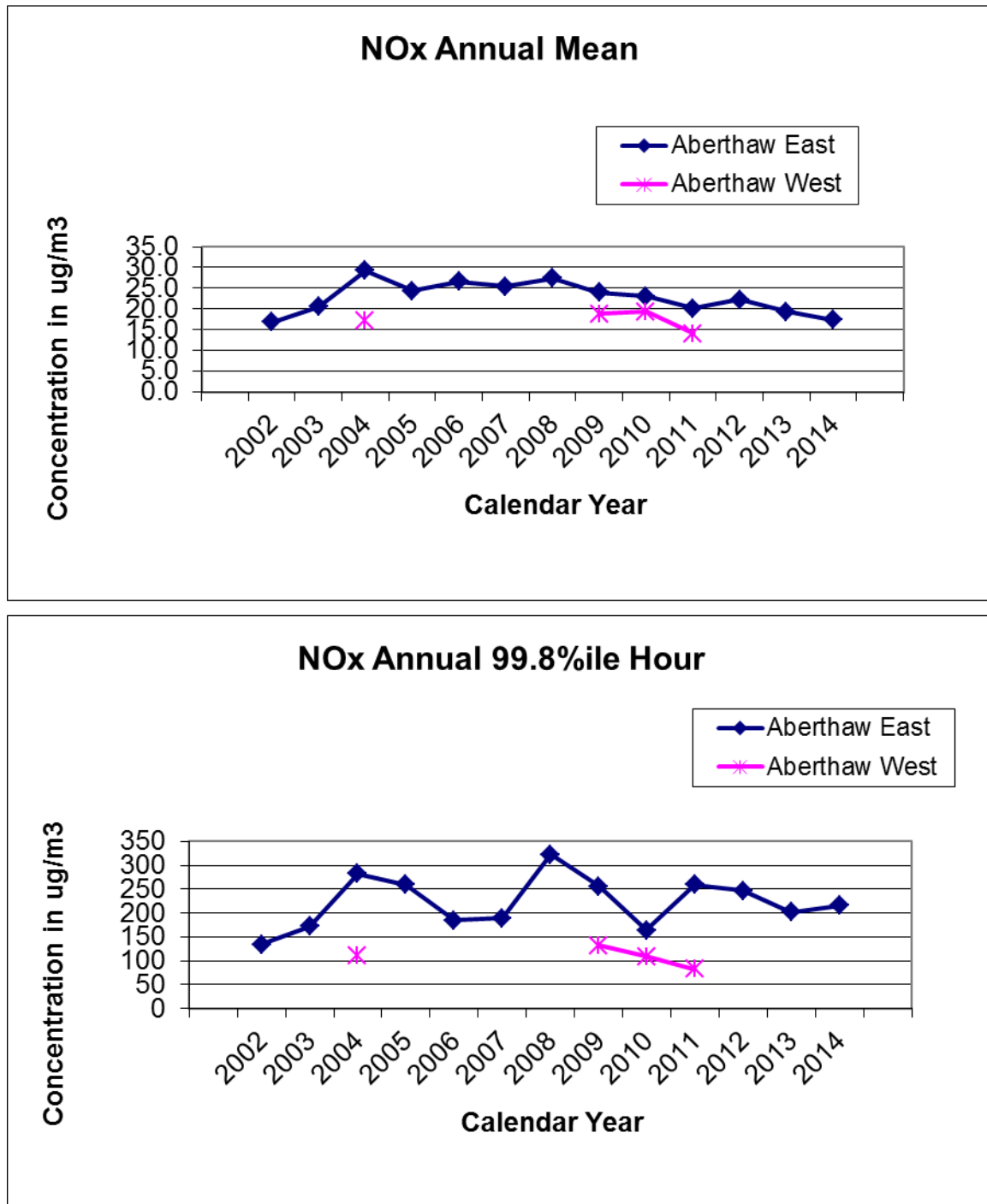


Figure A7 Trend in annual mean and 99.8%ile hourly mean NO_x concentrations at Aberthaw sites

Aberthaw East is the Font-y-Gary site. Aberthaw West was initially the Boverton Mill Farm site, which closed in 2005 and the Seaview Farm site from 2009 until its closure in 2011.