

**PADESWOOD CEMENT KILN  
MONITORING AUDIT  
for: EMISSION WATCH**

**August 2007**

**R1050-R01a**

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	<b>Name</b>	<b>Signature</b>	<b>Date</b>
Author	Laura Dreiling		
Checked	Alex Grant		

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## 1 Introduction

- 1.1 A new vertical kiln has been installed by Castle Cement at the cement works at Padeswood, near Mold, and became operational in July 2005. This kiln resulted in the closure of the existing kilns at the plant. The kiln is partially powered by alternative fuels including Cemfuel, which is processed from the residue of recycled waste solvents, and Profuel, which comprises paper and plastic waste. Vehicle tyres may also be used in the future as an alternative fuel.
- 1.2 As a result of concerns about emissions of particulate matter and airborne contaminants, Emissions Watch has undertaken monitoring of particulates in the vicinity of the cement works since February 2005. The monitoring continues at present. Emission Watch is concerned that the monitoring strategy and data obtained comply with current standards and will withstand scrutiny before being placed in the public domain.
- 1.3 Smith Grant LLP (SGP) was instructed by Emission Watch to audit the monitoring carried out to date.

## 2 Scope

- 2.1 The aim of the audit is to determine whether data which have been, and are being, obtained provide a true representation of particulate and contaminant levels in the vicinity of the plant, and of the probable source(s). The following aspects of the monitoring scheme have been assessed:

- objectives of the monitoring
- instruments used
- sampling locations
- sampling and averaging periods
- maintenance and calibration
- data; traceability, capture rate, accuracy, precision
- data transfer
- meteorological data

- 2.2 Reference is made as appropriate to Environment Agency guidance <sup>1,2</sup>.

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<sup>1</sup> Technical Guidance Note M8, *Environmental Monitoring Strategy – Ambient Air*, Environment Agency, 2000

<sup>2</sup> Technical Guidance Note M9, *Monitoring Methods for Ambient Air*, Environment Agency, 2000

- 2.3 It is understood that the interpretation of the data will be carried out in the course of a further study in due course. This report does not interpret the data obtained to date.

### **3 Site Setting**

3.1 The area surrounding the cement plant at Padeswood is predominantly agricultural with residential settlements. Pen y Mynydd lies 1.2km to the east of the kiln, with Pen y Ffordd 1km to the southeast and Buckley 1.2km to the northwest. Other residential properties in the area include:

- Padeswood Hall and nearby properties, 420m north,
- Dike Farm, 600m southwest,
- Oak Tree Farm, 700m northeast,
- Ty Gwyn, 720m northwest,
- Ash Tree Farm, 920m northeast, and
- Rhyd-y-Defaid, 1200m south.

3.2 The annual wind rose for Hawarden, which lies about 6km northeast of the kiln, indicates that the prevailing winds, which are affected by high ground to the southwest and the Dee Estuary to the northeast, blow from the southwest, west and northwest and from the southeast.

3.3 The land in the vicinity of the kiln is gently undulating and is unlikely to significantly affect the migration and dispersion of stack emissions between the kiln and the receptors noted above.

3.4 There are no other significant industrial sources of particulate matter in the immediate vicinity of the kiln.

### **4 Methodology**

4.1 Monitoring at the four original locations commenced in February 2005 with the new kiln becoming operational in July 2005.

4.2 Three Topas (Turnkey Optical Particle Analysis System) fixed particulate monitors and one Turnkey Osiris particulate monitor were located upwind and downwind, in the prevailing wind directions, of the kiln.

- 4.3 The locations are described here:
- Buckley South: Topas monitor (TNT 1205), 2km WNW of the kiln
  - Central Pen-y-Ffordd: Topas monitor (TNT 1206), 1.2km E of the kiln
  - Spon Green: Topas monitor (TNT 1220), 1.4km NNW of the kiln
  - Pen y Ffordd South (until 13 April 2007): Osiris monitor (TNO 2512), 1.8km SSE of the kiln
- 4.4 The instrument at Pen y Ffordd South was relocated on 13 April 2007 to Pen y Ffordd East, 2.3km ESE of the kiln
- 4.5 The locations of the particulate monitors were visited on 23<sup>rd</sup> May 2007 by Alex Grant and Laura Dreiling (SGP) accompanied by Mrs Chris Hall (Emission Watch).
- 4.6 The monitor at Buckley South (TNT 1205) is located in an open position within the within an area of garden, adjacent to pasture. The particulate monitor is mounted, with the sampling inlet approximately 1.5m from the ground. Some vegetation growth is present around the base of the monitor casing, but is below the level of the sampling inlet, and there are no overhanging trees or structures or obstructions. The kiln is in direct the line of sight. The Vodafone signal is reportedly weak at this location.
- 4.7 The monitor at Central Pen y Ffordd (TNT 1206) is located on a flat roof. The monitor inlet is mounted approximately 1.5m above the roof level and more than 5m above ground level. A gas heating flue is present approximately 3m to the southeast of the monitor. There is a clear line of sight to the kiln to the west from this location with no major obstructions or overhanging objects present.
- 4.8 The monitor at Spon Green (TNT 1220) is located in the rear garden of a residential property in southern Buckley. There are various garden sheds present but the instrument is mounted on a stone structure with sampling inlet more than 2m above ground level, and above the roof lines of the sheds. Agricultural land lies to the rear of the property, beyond which the cement plant is visible. There are no major obstructions or overhanging structures or trees affecting the monitor. Localised distortion of wind direction is likely to occur due to the built-up area behind the monitor.
- 4.9 The Osiris (TNO 2510) monitor was located at a Pen-y-Ffordd South until 13 April 2007. The monitor was fixed to the side of a brick outbuilding with the sample inlet rising above the level of the roof more than 2m above ground level. The monitor was removed from

this location due to the rapid growth of a nearby tree, although this was not interfering with the line of sight from the kiln.

- 4.10 The instrument was re-located to Pen-y-Ffordd East and is now located on the gable end of a barn. A tree is present approximately 15m from this position, and is partially in line of sight of the kiln. It was also noted that the mast for the weather station stood between the sampling head and the kiln.
- 4.11 The Topas and Osiris monitors operate on a light scattering principle and are similar in essential respects. A photometer gives a continuous and simultaneous measurement of airborne PM1, PM2.5, PM10 and TSP concentrations. However, a scaling factor is required to provide gravimetric equivalent concentrations.
- 4.12 The instruments are set up for unattended operation. Technical support and field service is provided by Turnkey Instruments Ltd.
- 4.13 The original positions of the instruments were such that upwind / downwind comparisons can be made when the winds blow from the west and northwest or from the east and southeast. The revised location of the Osiris TNO2510 has resulted in a narrowing of the cover downwind when the winds blow from the northwest. However, it is at a distance of almost twice that of Topas TNT 1206, the opportunity now exists to assess the downwind attenuation of particulates concentrations when the winds blow from the west or northwest.
- 4.14 A wind vane and anemometer are attached to each instrument and record wind direction and speed. In addition, daily atmospheric pressure and rainfall data at Hawarden are obtained from the Met Office.
- 4.15 The instruments have been set to record total suspended particulates (TSP), PM10, PM2.5 and PM1 at 15 second intervals, with a 15 minute averaging period.
- 4.16 All calibration, servicing and the changing of filters is carried out by Turnkey Instruments Ltd. A maintenance log book is kept to record every visit to the monitors and work carried out on each occasion. Copies of calibration certificates for each monitor are provided in Appendix A. Emission Watch does not enter the locked cabinets containing the monitors for any purpose.
- 4.17 Data transfer is conducted by Mrs Hall. The data are downloaded from the particulate monitors by telemetry using AirQ32 twice per week and are exported to Microsoft Excel for ease of use and to provide an accessible format.

4.18 The data are saved in raw format as downloaded from each particulate monitor. On occasions negative readings are recorded. These data are removed and saved as a separate file ready for analysis. Negative data arise for three known reasons.

- high wind speeds,
- Vodafone line (telemetry) failure, and
- PM1 readings below 0.6 are recorded as a negative.

4.19 The data capture rate is reportedly 99%.

4.20 Pre-weighed filters, which are inserted in the back of the instrument, are analysed for total particulate, aluminium, arsenic, barium, cadmium, calcium, cobalt, copper, iron, lead, magnesium, manganese, mercury, molybdenum, nickel, selenium, vanadium, zinc, uranium, potassium, and sodium.

4.21 The filters are supplied in individual packets which are uniquely identified. Filters are handled with tweezers to ensure that cross-contamination does not occur. The sampling period is two-monthly and the packet is retained in the casing of the instrument for the duration of the sampling period. At the end of this period the filter is replaced in the correct packet and sent to TES Bretby for analysis.

4.22 On inquiry, TES have advised SGP that they hold UKAS-accreditation for the determination of total suspended particulates held on filters but they do not hold accreditation for the determination of metals held on filters. It is understood that Scientifics, which was recently acquired by the TES's parent company, is accredited for these analyses and that this work will be carried out by Scientifics for future samples.

## 5 **Assessment**

### 5.1 Instrument Type

5.1.1 The Topas and Osiris particulate monitors provide continuous real-time data which readily permit the identification of any short-term periods of elevated airborne particulates and their correlation with events at the kiln and or diary records. The use of a continuous method is appropriate as emissions from the kiln have the potential to vary frequently and significantly.

- 5.1.2 The co-location of a weather station with each monitor will permit directional apportionment of the reported particulates concentrations and thus determine the probability of the kiln being the source of any elevated levels.
- 5.1.3 The use of telemetry to download the data minimises the requirement to physically attend the instruments, and thus avoid any unnecessary disturbance which might cause a temporary increase in local particulates levels. However, the weak Vodafone signal at Buckley South (TNT 1205) results in the occasional loss of data.
- 5.1.4 The most significant drawback of the Topas and Osiris instruments is that they are based on light-scattering technology and do not therefore provide direct gravimetric concentrations. Turnkey have previously provided SGP with data showing good correlation with the outputs from a TEOM<sup>3</sup>. Data from a TEOM require to be multiplied by a factor of 1.3 to provide a gravimetric equivalent and the data from the Turnkey instruments require also to be factored.

## 5.2 Instrument Set-up

- 5.2.1 The EA guidance indicates that a monitoring period of a year or more is necessary to take account of the full range of variables including seasonal variations, diurnal cycles in meteorological conditions and weekday / weekend differences. SGP is aware also of suggestions that emissions from the kiln may vary between day and night. The monitoring has been carried out continuously over 24 hours since February 2005, thus according with the EA's recommendations.
- 5.2.2 The choice of averaging period for a monitoring programme is influenced by the predicted short term variability in pollutant concentrations and whether such peaks are important. It is also important to ensure that the averaging period is consistent with, or less than, that of relevant air quality criterion, in this case the 24 hour objective. Balanced with this are considerations of data management. The choice of readings every 15 seconds, with a 15 minute averaging period, accords with these principles.
- 5.2.3 As already noted, the co-location of a weather station at each location will facilitate the directional analysis of the data, thus permitting an apportionment to be made of the likely source(s) of airborne particulates.

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<sup>3</sup> Tapered element oscillating microbalance

### 5.3 Locations

5.3.1 The site requirements for active sampling methods are laid out in the EA guidance:

- Sampling inlet should generally be approximately 2m or more above ground level.
- Samplers should not be located in lee of major obstructions. The top of obstructions should subtend less than a 30° angle with the horizontal of the sampling point.
- There should be no overhanging trees or structures, with samplers open to the sky. US guidance sets 20m as a minimum distance from the drip line of trees.
- Sampling sites must be accessible for servicing, calibration and the collection of data.
- Sites should be in a secure location where the risks of vandalism or accidental damage is minimised.
- There should be access to services, ie, mains electricity and telephone line for the download of data.

5.3.2 The monitoring locations are summarised in the following table.

Monitor	Buckley South (TNT 1205)	Central Pen-y-Ffordd (TNT 1206)	Spon Green (TNT 1220)	Pen-y-Ffordd South (TNO 2510)	Pen-y-Ffordd East (TNO 2510)
Inlet > 2m above ground level	✘	✓	✓	✓	✓
Not in lee of any major obstruction	✓	✓	✓	✓	✘
No overhanging trees or structures	✓	✓	✓	✓	✓
Accessible for servicing, calibration and collection of data	✓	✓	✓	✓	✓
Secure location	✓	✓	✓	✓	✓
Access to services	✓	✓	✓	✓	✓

**Table 1: Assessment of particulate monitor locations against EA guidance.**

5.4 In general, the installations show good compliance with the EA guidance.

5.5 The inlet of the monitor at Buckley South (TNT 1205) is located approximately 1.5m above ground level and is slightly lower than recommended. The instrument stands clear

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of any vegetation and is located near the crest of rising ground. The data from this instrument are unlikely to be affected significantly.

- 5.6 As originally installed, a large tree stood about 15m from the inlet of the monitor at Pen-y-Ffordd East (TNO 2510) and in line of sight from the kiln. The weather mast for the monitor also lay immediately between the inlet and the kiln. The monitor has since been moved onto the opposite end of the barn to present a clear line of sight to the kiln, with the revised position inspected by L Dreiling (SGP). As a result the monitor was effectively rotated by 90°, thus moving the weather mast out of the line with the kiln.
- 5.7 The monitor at central Pen y Ffordd is only 3m from the outlet from a gas central heating flue which was, it is understood, erected in winter 2006 and, although this lies to the side of the inlet relative to the kiln, emissions from the flue may confound the more recent data, particularly during still conditions. This position has now been altered so that the monitor lies more than 10m from the flue. The revised position was inspected by L Dreiling (SGP).
- 5.8 The original array of monitors gave good coverage in the northwest and east / south sectors and the data will permit upwind / downwind analysis of the particulates concentrations for winds in these sectors. These directions will permit an assessment to be made of the impacts at the principal residential areas in the immediate locality, namely, Buckley / Mynydd Isa and Pen y Ffordd.
- 5.9 However, there is a large gap in the coverage towards the north and northeast of the kiln and there is therefore no assessment possible of the impacts in the residential areas of Little Mountain, Dobs Hill or the northern end of Penymynydd. Winds blow from the south and southwest, from the kiln towards these areas, for a total of 27% of the time annually. There is no coverage either towards the southwest and no assessment is possible of the impacts at Pontblyddyn, although the frequency of winds from the northeast is just 3% of the time annually.
- 5.10 The recent relocation of TNO 2510 from Pen-y-Ffordd South to Pen-y-Ffordd East further narrows the angular coverage towards the southeast. However, this will improve the coverage across the southern part of Pen y Ffordd. The relative records at central Pen y Ffordd and Pen-y-Ffordd East will also permit a partial assessment of the attenuation in particulate levels downwind of the kiln.

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### 5.11 QA Procedures

5.11.1 As noted previously, the data must be converted with a scaling factor to obtain the gravimetric equivalents and, as a result, the reported PM10 concentrations do not comply with the reference method BS EN 12341. At best therefore, the data can provide only an indication of absolute PM10 concentrations for comparison with the NAQS objectives. However, the continuous real-time data, coupled with the directional weather data, will permit a detailed assessment to be made of the relative emissions from the kiln and their likely impact in the locality.

5.11.2 The monitors are managed entirely by the manufacturers, Turnkey, who keep full maintenance and calibration records. Emission Watch does not enter the locked cabinets for any purpose and, subject to the instruments remaining in calibration, the data can be taken to be uncorrupted and reliable.

5.11.3 The data are downloaded by telemetry directly into the AQ32 software and full sets of the original data, including back-ups, are retained for future use.

5.11.4 The reported data capture of 99% is very high and any conclusions which may be drawn from the data are likely to be fully representative of the actual conditions.

### 5.12 Analyses

5.12.1 As already noted, the analyses of metals held on filters are not UKAS-accredited but measures are in hand to use accredited laboratories for all future analyses. The detection limits are sufficiently low to permit comparison with the environmental assessment limits for the process. These will be detailed in the Pollution Prevention and Control permit issued by the EA for the process.

### 5.13 Other Monitoring

5.13.1 Castle Cement operates a TEOM PM10 monitor at the bowling green about 200m from the central Pen y Ffordd monitor.

5.13.2 The EA operates an air quality monitoring station adjacent to the village community centre about 200m from the same monitor. This includes a TEOM and monitors for nitrogen dioxide and sulphur dioxide.

5.13.3 No data from either of these stations has been inspected.

## 6 Conclusions and Recommendations

- 6.1 Overall, the monitoring scheme has been well designed and executed, and is likely to provide a large volume of data to indicate the impact of emissions from the kiln on the surrounding area.
- 6.2 The use of light-scattering Osiris and Topas instruments does not comply with the reference method BS EN 12341 and therefore direct comparisons of the data with the NAQS objectives for PM10 is inadvisable. However, the use of a conversion factor may give a good indication of the actual particulate concentrations. The deployment of the monitors approximately along the northwest / southeast axis from the kiln, coupled with directional weather data, will permit an assessment of the relative impacts of emissions from the kiln on the residential areas of Buckley / Mynydd Isa and Pen y Ffordd. The use of real-time monitors will also permit an assessment to be made of any diurnal or seasonal impacts, or those associated with specific events at the kiln and diary records.
- 6.3 There is a gap in the coverage towards the northeast, in the area of Little Mountain, Dobs Hill and the northern part of Pen-y-Mynnydd. Winds blow from the kiln towards this area for a significant proportion of the time annually and, subject to funding, consideration could be given to the installation of a further monitor to close this gap. There is a similar gap to the southwest, towards Pontblyddyn, but the frequency of winds from the northeast is very low.
- 6.4 The location nearby of the other monitors operated by Castle Cement and the EA will permit a ready comparison of the data obtained at central Pen y Ffordd. This may allow firmer conclusions to be drawn in terms of the NAQS objectives.
- 6.5 Detailed recommendations have been made in respect of adjustments to the locations of the monitors at central Pen y Ffordd and Pen-y-Ffordd East, and these have since been implemented.
- 6.6 No significant shortfalls in QA have been identified.

**Appendix A**  
**Calibration Certificates**