# REPORT ON STACK MONITORING

AT

DURAPIPE – S&LP

FOR

DURAPIPE – S&LP

HUNTINGDON, CAMBRIDGESHIRE, PE18 7DJ

BY

ASSOCIATED LABORATORY SERVICES LIMITED
BOCKING, BRAINTREE, ESSEX
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JUNE 1999

REPORT NO. 13908

# INDEX



Appendices

## 1. SCOPE OF WORK

A stack sampling survey was carried out at the Huntingdon Works of Durapipe-S&LP. Processing involves removal of plastic from steel tooling using a fluidised bed furnace.

Emissions are vented to atmosphere via a cyclone system and a single vertical stack. Measurements were carried out through sampling ports installed in the side wall of the stack.

In order to provide the data required for calibration of the continuous monitor installed in the stack, Associated Laboratory Services Ltd were commissioned to carry out an isokinetic sampling survey for particulates. In addition, volatile organic compounds were monitored, including an assessment of residual natural gas.

In accordance with the 1996 Revision of PG2/9 (96) Metal Decontamination Processes, moisture was also measured in order to correct the results to reference conditions (the oxygen correction not being required for fluidised bed systems).

Measurements were carried out on 17 June 1999.

## 2. TEST METHOD & CONDITIONS

### 2.1 Test Method

Sampling was undertaken at the 2 sampling ports installed in the stack.

Measurements were carried out as follows:-

Gas Temperature

The temperature of the gas in the ducts was measured using a digital thermometer, the thermocouple of which was inserted into the ductwork.

Gas Velocities

Gas velocities were calculated from velocity pressure readings obtained using a pitot tube and electronic micro manometer.

Total Particulates

The sampling of particulates was undertaken in accordance with the requirements of BS3405. Collection of particulates was to pre-weighed glass fibre filters using a stainless steel probe with 4mm tip. Cumulative samples were collected using 2 sampling points per axis.

Moisture

Moisture was determined by absorption on silica gel in accordance with the general requirements of US EPA Method 4.

Volatile Organic Compounds

Real time measurements of total VOC's were carried out with a portable GasTec Analyser, with flame ionisation detection.

Residual natural gas was assessed using the GasTec Analyser, but with a carbon filter inserted in line to remove VOC's other than low molecular weight alkanes.

Alkane VOC's (i.e. residual natural gas) was also checked by sampling with Gresham tubes, and laboratory analysis by GC/FID.

## 2.2 Sampling & Conditions

All sampling was carried out whilst plastic removal was being carried out. Sampling was commenced at the beginning of the batch cycle, and consequently is expected to correspond to the highest level of emissions.

Following profiling of temperature and pressure within the stack, 2 cumulative isokinetic particulate samples were collected. During the same period, real time measurements of VOC's were carried out, and moisture samples collected. VOC measurements were continued to the end of the process cycle.

Measured variations in temperature and velocity pressure were within the permitted range, and consequently the sampling complied with the requirements of BS 3405.

## 3. RESULTS & DISCUSSION

### 3.1 Results

The results are detailed in Appendix IV to VIII.

Ambient temperature and pressure was measured for the purpose of calculating concentrations in accordance with standard reference conditions. Results are converted to standard conditions 273°K and 1013 mbar, also corrected for moisture.

In summary the results are as follows:-

| Parameter | 1st Run | 2nd Run | Mean Value |
|---|---|---|---|
| Particulates $mg/m^3$ | | | |
| - at 273°K and 1013 mbar | 17.3 | 1.4 | 9.3 |
| - at 273°K, 1013 mbar, & dry gas | 17.4 | 1.4 | 9.4 |

The average flow velocity at the sampling point in the stack was 17.4 metre per second (at gas temperature), giving a mean gas flowrate of $4.83m^3$ per second (at 273°K).

VOC levels during the process cycle were as follows

| Time | Total VOC's as C with carbon absorption 273°C, 1013mbar dry gas $mg/m^3$ | Total VOC's as C without carbon absorption 273°C, 1013mbar dry gas $mg/m^3$ | Alkanes $C^1$ - $C^4$ as C $mg/m^3$ |
|---|---|---|---|
| 11.00 | - | - | 395 |
| 12.02-12.32 | 370 | - | - |
| 12.50 | - | - | 420 |
| 13.00-13.30 | 795 | - | - |
| 13.50 | - | - | 340 |
| 14.10-14.40 | - | 650 | - |
| 15.00 | - | - | 275 |
| 15.04-15.34 | - | 625 | - |
| 16.15 | - | - | 240 |

NOTE - Stripping with cage lowered between about 11.20 and 16.00.

3.2 Discussion

Particulates

The measurement of particulates gave a significant change in results, which exceed the prescribed ratio of 1.5 to 1. It is noted that the highest result was at the beginning of the stripping operation and that one large unit was being stripped (previous measurements were carried out with several smaller units being stripped).

However, results are still below the emission standard of 50 mg/kg. ? ($mg/m^3$)

The sampling flow rates are within the permitted range for isokinetic conditions, and all other measurements and variations in results comply with the requirements of BS3405.

VOC's

VOC levels are within the range as previously measured.

The total VOC profile is similar to previous profiles commencing at about 370 mg/kg after the cage is lowered, rising to nearly 800 mg/kg and decaying to 650 mg/kg then 625 mg/kg at the end of the cycle. On that basis the use or not of carbon absorption (which removes VOC's other than low molecular weight alkane hydrocarbons) appears not to have a significant effect. Such results would be consistent with the VOC's principally consisting of low molecular weight alkane hydrocarbons (i.e. residual natural gas).

However, the above inference is not consistent with the measured levels of C1 to C4 alkanes using Gresham tubes. Whereas the initial results are similar (i.e. around 400 mg/kg as C), the Gresham tube results gradually decay.

## 4. CONCLUSIONS

These conclusions are based on the measurements as carried out at the emission stack associated with cyclone filters for the fluidised bed furnace at the Huntingdon Works of Durapipe S&LP on 17 June 1999.

### 4.1 Results

Sampling was carried out during the complete cycle for the furnace.

The results are summarised as follows

a) Particulates

| | At 273°K, 1013 mbar, dry gas |
|---|---|
| 1st Sample | 17.4 $mg/m^3$ |
| 2nd Sample | 1.4 $mg/m^3$ |

b) Flow rates at sampling port

| | | |
|---|---|---|
| Velocity | 17.4 | metre per second (at gas temperature) |
| Gas flowrate | 4.83 | $m^3$ per second (at 273°K). |

c) VOC's

| | | At 273°K, 1013 mbar, dry gas |
|---|---|---|
| 1st Sample (with carbon absorption) | | 370 $mg/m^3$ as C |
| 2nd Sample (with carbon absorption) | | 795 $mg/m^3$ as C |
| 3rd Sample (without carbon absorption) | | 650 $mg/m^3$ as C |
| 4th Sample (without carbon absorption) | | 625 $mg/m^3$ as C |
| Gresham tube samples | Range | 420-240 $mg/m^3$ as C |

### 4.2 Conclusions

Although the ratio of particulate results exceeds the prescribed ratio of 1.5 to 1, all pressure and temperature measurements and variations in measurements are within the limits prescribed by BS 3405. As with previous measurements, overall particulate levels are well below the emission standard.

Stack emission velocity exceeds the minimum as recommended in the process guidance note.

VOC levels are in the same range as previous measurements. Real time measurements with a GasTec analyser show a typical profile of increase and decay - the insertion of a carbon filter with the sampling line appears not to have a significant affect, suggesting that the VOC's are principally residual natural gas. However testing of residual natural gas using Gresham tubes gives lower results.

In conclusion, whereas the more detailed assessment of VOC's shows a high proportion of residual natural gas, the results are not sufficiently conclusive to demonstrate that VOC's directly resulting from the stripping operation are below the emission standard.

For and on behalf of
ASSOCIATED LABORATORY SERVICES LIMITED

K S Axon

# INSTRUMENT CALIBRATION REPORT

Company : Durapipe – S&LP
Site Address: St Peters Road, Huntingdon, Cambridgeshire
Plant Identification: Fluidised Bed Furnace
Product/Process: Removal of plastics from steel tooling

Date of Sampling : 17 June 1999
PCME Job No. N/A
ALS Job No. 13908
DISC/File Reference
Test Carried Out by PDH Willcock

Instrument Settings During Sample  Instrument : SL600  Channel # : 1

DT-770/SC-600

Instrument Checks : Pass
Correct Time : Corrected
Sensitivity : Md
Old Cal Factor : 002.0000
(in use during sampling)
Flow Compensation : OFF
O2 Compensation : OFF

DT-200

Course Gain Position : _____
Fine Gain Display : _____
Filter Position : _____
Course Gain : _____
Fine Gain : _____

Instrument Results

| Run | Start Time | Finish Time | Duration (Mins) | Instrument Average (Y) | Instrument Max | Dust Conc mg/m³ (X) |
|---|---|---|---|---|---|---|
| 1. | 12.00 | 12.30 | 30 | 7.30 | 8.57 | 17.3 |
| 2. | 12.58 | 13.28 | 30 | 5.35 | 6.11 | 1.4 |
| 3. | | | | | | |
| 4. | | | | | | |
| | | | | | | |
| Time Weighted Average | - - - - | - - - - | - - - - | 6.3 | - - - - | 9.3 |

Calibration Calculations

X (from Iso test ) =
Y (Inst response) =

Scaling factor = X = _____ =

New Gain Cal Factor = scaling fctor = Gain x old Cal Factor =

Instrument Settings for Calibration

**DT-770/SC-600**

Cal Factor : _____

**DT-200**

CG Position : _____
FG Display : _____
Course Gain : _____
Fine Gain : _____

Product/Process : Removal of plastic residue from steel tooling

Table A

Process Conditions

| | |
|---|---|
| Arrestment Type : | Cyclone Filter |
| Particulate Type : | Plastic |
| Gas Temperature : | 81°C |
| Gas Flow Rate : | 4.83 $m^3$/sec |
| Appearance of Plume : | Invisible |
| Load of Plant : | Average |

Table B

Results

| | Run 1 | Run 2 |
|---|---|---|
| Date : | 17.06.99 | 17.06.99 |
| Test Period | 12.00-12.30 | 12.58-13.28 |
| Duration | 30 mins | 30 mins |
| Gas Temperature : | 81°C | 81°C |
| Mean Velocity at Sampling Points | 17.4 m/sec | 17.4 m/sec |
| Particulates at STP (1) | 17.3 mg/$m^3$ | 1.4 mg/$m^3$ |
| Particulates at normalised conditions (2) | 17.4 mg/$Nm^3$ | 1.4 mg/$Nm^3$ |

(1) Particulates stated at 273K, 101.3kPa.

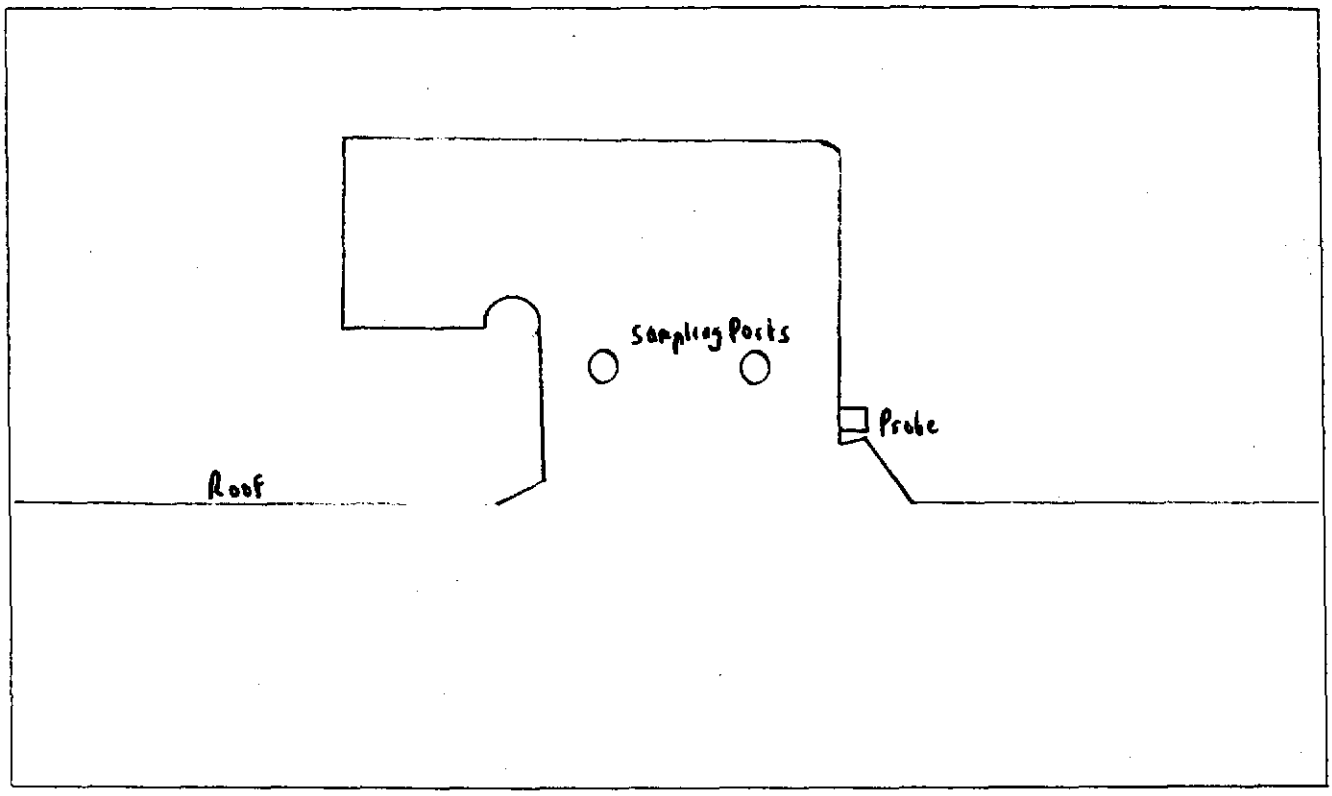
(2) Normalised conditions are 273K, 101.3kPa, dry gas.

# PLANT LAYOUT

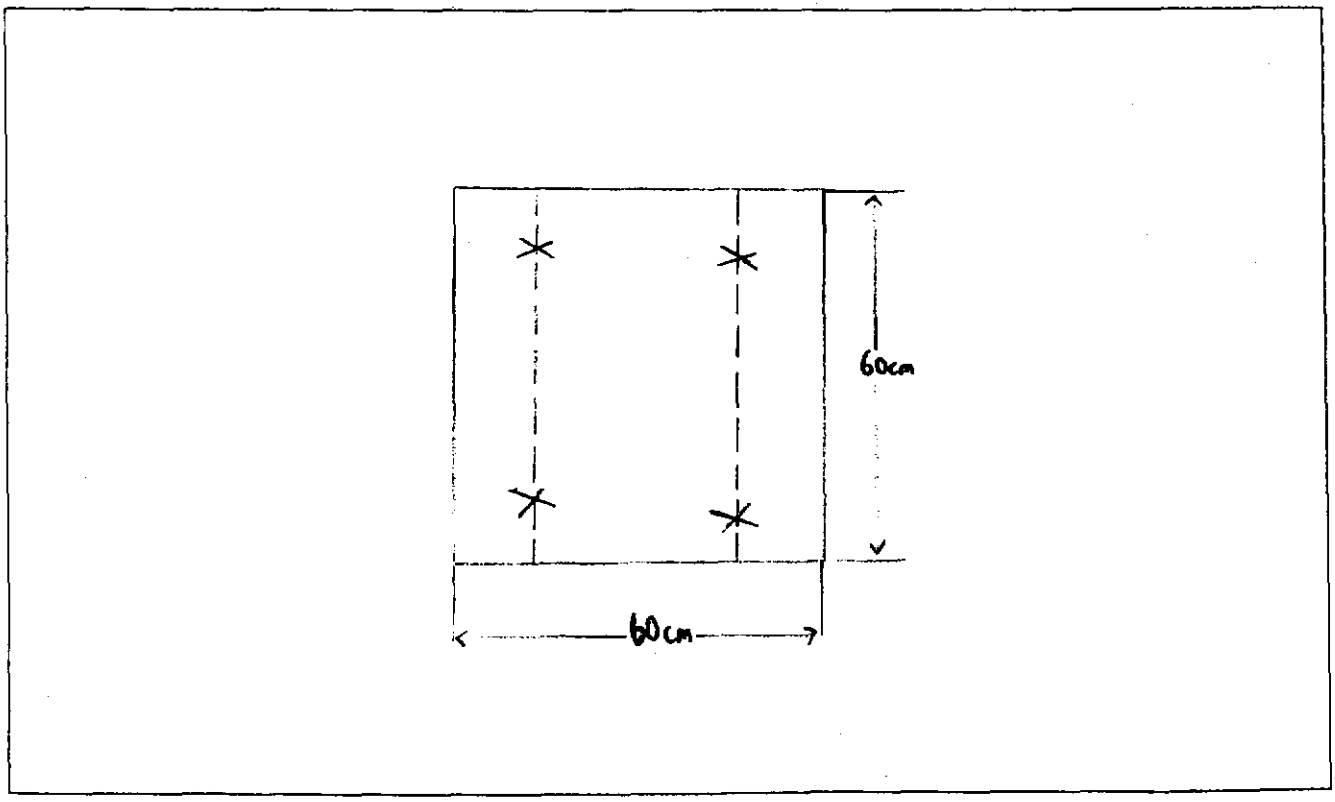
Site: Durapipe-S&LP, Huntingdon, Cambridgeshire

Plant: Cyclone Filter

1) Plant layout showing instrument location and sample place




2) Section of duct at sample place and dimensions



# STACK PARTICULATES MEASUREMENT

Client : Durapipe – S&LP
Site : St Peters Road, Huntingdon
Cambridgeshire

Date : 17 June 1999
Time : 11.30 hrs
Operator : PDH Willcock

Plant : Cyclone Filter
Plant Load: Normal

Appearance of Plume Invisible
Product/Process Removal of plastic residue from steel tooling

| Details of Duct | | Atmospheric Conditions | | |
|---|---|---|---|---|
| | | Time | Pressure (Pa) in mb | Temperature °C |
| Shape | Square | Initial | 1016 | 22.4 |
| Dimension/Diameter | 60cm | Final | 1017 | 24.3 |
| Area | 0.36² | Average | 1017 | 23.4 |
| | | | | |

1) Readings before sampling

| Position | Axis 1 | | | Axis 2 | | |
|---|---|---|---|---|---|---|
| | Distance into Duct (cms) | Velocity Pressure (Pascals) | Gas Temperature °C | Distance into Duct (cms) | Velocity Pressure (Pascals | Gas Temperature °C |
| 1. | 3 | 200 | 81.3 | 3 | 170 | 81.0 |
| 2. | 9 | 195 | 81.3 | 9 | 170 | 81.0 |
| 3. | 15 | 190 | 81.3 | 15 | 180 | 81.1 |
| 4. | 21 | 185 | 81.4 | 21 | 130 | 81.1 |
| 5. | 27 | 170 | 81.4 | 27 | 100 | 81.1 |
| 6. | 33 | 160 | 81.4 | 33 | 110 | 81.2 |
| 7. | 39 | 160 | 81.4 | 39 | 100 | 81.2 |
| 8. | 45 | 160 | 81.5 | 45 | 105 | 81.3 |
| 9. | 51 | 150 | 81.5 | 51 | 110 | 81.3 |
| 10. | 57 | 140 | 81.5 | 57 | 110 | 81.3 |
| | Average | 171 | 81.4 | Average | 126.5 | 81.2 |
| | Mean Pv (in Pascals) : 149 | | | Mean Tp (in °K = °C + 273): 354 | | |
| | Static Pressure, Ps (in Pascals): 230 | | | | | |

High gas temperature = 81.5 Lowest gas temperature = 81.0

Permitted range of gas temperature readings (in °C) = (0.9Tp - 273) to (1.1Tp - 273) = 46°C to 116°C

Highest Pv = 200 pascals Lowest Pv = 100 pascals

Ratio $\frac{\text{Pv highest}}{\text{Pv lowest}}$ = 2/1 (maximum permitted ratio = 9/1)

## STACK PARTICULATES MEASUREMENTS

4) Weighing Results

| Sample No. | Filter No. | Weights (mg) | | |
|---|---|---|---|---|
| | | Before | After | Solids Collected |
| A | 1 | 86.61 | 92.46 | 5.85 |
| B | 2 | 87.95 | 88.40 | 0.45 |

5) Calculations

5.1 Mean Gas Velocity at Gas Temperature

V mean = 0.075 √Pv average √(T average + 273) m/sec

where Pv average = mean velocity pressure (pascals) } see 2
T average = mean gas temperature at the sampling points} above

V mean = 0.075 x 12.3√354

= 17.4 m/sec

5.2 Mean Gas Flowrate at 273°K

$$Q = V \text{ mean} \times A \left( \frac{273}{273 + T \text{ average}} \right) \text{ m}^3/\text{sec}$$

where V mean = mean gas velocity (see 5.1 above)

A = internal area of duct in m²

T average = mean gas temperature at the sampling points

$$Q = 17.4 \times 0.36 \times \frac{273}{(273 + 81)}$$

= 4.83 m³/sec

**STACK MONITORING – DURAPIPE – S&LP**

ANALYSIS RESULTS - MOISTURE

Date of Sampling 17 June 1999
Sample Location St Peters Road, Huntingdon, Cambridgeshire
Plant Fluidised Bed Furnace
Ambient Conditions 1017 mbar 23.4°C

| Sample Reference | Time | | | Sampling Rate l/min | Sampling Volume litres | | Wt of water gm | Moisture Level | |
|---|---|---|---|---|---|---|---|---|---|
| | Initial | Final | Elapsed | | Recorded | Normalised | | gm/litre | % vol/vol* |
| M1 | 12.00 | 12.30 | 00.30 | 11 | 367 | 339 | 3.75 | 0.011 | 1.4 |
| M2 | 12.58 | 13.28 | 00.30 | 11 | 358 | 330 | 3.49 | 0.011 | 1.4 |

Normalised at 273°K and 1013 mbar.
* 1 mole of water occupies 22.4 litre at normalised conditions.
Determined by absorption onto silica gel in accordance with general requirements of US EPA Method 4.

For and on behalf of
ASSOCIATED LABORATORY SERVICES LIMITED

28 June 1999

K S Axon

**STACK MONITORING – DURAPIPE – S&LP**

ANALYSIS RESULTS - PARTICULATES

Date of Sampling 17 June 1999
Sample Location St Peters Road, Huntingdon, Cambridgeshire
Plant Fluidised Bed Furnace
Ambient Conditions 1001 mbar 23.4°C

| Sampling Location | Sampling Reference | Sampling Volume $m^3$ | | Moisture Level % vol/vol | Particulates | | |
|---|---|---|---|---|---|---|---|
| | | Recorded | Normalised | | On Filter mg | Concentration at 273°K, 1013 mbar $mg/m^3$ | Concentration at 273°K, 1013 mbar, dry gas $mg/m^3$ |
| 1 | A | 0.367 | 0.339 | 1.4 | 5.85 | 17.3 | 17.5 |
| 2 | B | 0.358 | 0.330 | 1.4 | 0.45 | 1.4 | 1.4 |

Normalised at 273°K and 1013 mbar.
Sampled in accordance with BS 3405 1983 Measurement of Particulate Emission including Grit and Dust (Simplified Method).

For and on behalf of
ASSOCIATED LABORATORY SERVICES LIMITED

28 June 1999

K S Axon

**STACK MONITORING – DURAPIPE – S&LP**

ANALYSIS RESULTS - VOLATILE ORGANIC COMPOUNDS (WITH CARBON ABSORPTION)

| | |
|---|---|
| Date of Sampling | 17 June 1999 |
| Sample Location | St Peters Road, Huntingdon, Cambridgeshire |
| Plant | Fluidised Bed Furnace |
| Ambient Conditions | 1017 mbar 23.4°C |

| Run | Time | Instrument Reading | Total VOC's as C at 273°K & 1013mbar mg/m | Total VOC's as C at 273°K, 1013 mbar, dry gas mg/m$^3$ |
|---|---|---|---|---|
| 1 | 12.02 | 180 | 140 | |
| | 12.04 | 280 | 217 | |
| | 12.06 | 300 | 233 | |
| | 12.08 | 400 | 310 | |
| | 12.10 | 320 | 248 | |
| | 12.12 | 400 | 310 | |
| | 12.14 | 400 | 310 | |
| | 12.16 | 400 | 310 | |
| | 12.18 | 500 | 388 | |
| | 12.20 | 500 | 388 | |
| | 12.22 | 450 | 349 | |
| | 12.24 | 600 | 465 | |
| | 12.26 | 700 | 543 | |
| | 12.28 | 700 | 543 | |
| | 12.30 | 700 | 543 | |
| | 12.32 | 700 | 543 | |
| Run 1 Average | | | 365 | 370* |
| 2 | 13.00 | 1000 | 775 | |
| | 13.02 | 1100 | 853 | |
| | 13.04 | 1000 | 775 | |
| | 13.06 | 1000 | 775 | |
| | 13.08 | 1000 | 775 | |
| | 13.10 | 1000 | 775 | |
| | 13.12 | 1000 | 775 | |
| | 13.14 | 1000 | 775 | |
| | 13.16 | 1100 | 853 | |
| | 13.18 | 1000 | 775 | |
| | 13.20 | 1000 | 775 | |
| | 13.22 | 1000 | 775 | |
| | 13.24 | 1000 | 775 | |
| | 13.26 | 1000 | 775 | |
| | 13.28 | 1000 | 775 | |
| | 13.30 | 1000 | 775 | |
| Run 2 Average | | | 785 | 795* |

Direct stack readings using a Gas Tec Analyser with flame ionisation detection. Calibration factor = 0.833 (n-Hexane standard). Nomalised at 273°K & 1013mbar.
* Corrected for 1.4% moisture.

For and on behalf of
ASSOCIATED LABORATORY SERVICES LIMITED 28 June 1999

K S Axon

## STACK MONITORING – DURAPIPE – S&LP

ANALYSIS RESULTS - VOLATILE ORGANIC COMPOUNDS (WITHOUT CARBON ABSORPTION)

| | |
|---|---|
| Date of Sampling | 17 June 1999 |
| Sample Location | St Peters Road, Huntingdon, Cambridgeshire |
| Plant | Fluidised Bed Furnace |
| Ambient Conditions | 1017 mbar 23.4°C |

| Run | Time | Instrument Reading | Total VOC's as C at 273°K & 1013mbar mg/m | Total VOC's as C at 273°K, 1013 mbar, dry gas mg/m$^3$ |
|---|---|---|---|---|
| 3 | 14.10 | 750 | 581 | |
| | 14.14 | 700 | 543 | |
| | 14.14 | 700 | 543 | |
| | 14.16 | 800 | 620 | |
| | 14.18 | 800 | 620 | |
| | 14.20 | 1000 | 775 | |
| | 14.22 | 900 | 698 | |
| | 14.24 | 1100 | 853 | |
| | 14.26 | 1000 | 775 | |
| | 14.28 | 800 | 620 | |
| | 14.30 | 800 | 620 | |
| | 14.32 | 700 | 543 | |
| | 14.34 | 800 | 620 | |
| | 14.36 | 900 | 698 | |
| | 14.38 | 800 | 620 | |
| | 14.40 | 700 | 543 | |
| Run 3 Average | | | 642 | 650* |
| 4 | 15.04 | 700 | 543 | |
| | 15.06 | 600 | 465 | |
| | 15.08 | 700 | 543 | |
| | 15.10 | 1000 | 775 | |
| | 15.12 | 800 | 620 | |
| | 15.14 | 800 | 620 | |
| | 15.16 | 700 | 543 | |
| | 15.18 | 800 | 620 | |
| | 15.20 | 800 | 620 | |
| | 15.22 | 800 | 620 | |
| | 15.24 | 700 | 543 | |
| | 15.26 | 1000 | 775 | |
| | 15.28 | 700 | 543 | |
| | 15.30 | 900 | 698 | |
| | 15.32 | 800 | 620 | |
| | 15.34 | 900 | 698 | |
| Run 2 Average | | | 615 | 625* |

Direct stack readings using a Gas Tec Analyser with flame ionisation detection. Calibration factor = 0.833 (n-Hexane standard). Nomalised at 273°K & 1013mbar.
* Corrected for 1.4% moisture.

For and on behalf of
ASSOCIATED LABORATORY SERVICES LIMITED 28 June 1999

KS Axon

**STACK MONITORING – DURAPIPE – S&LP**

ANALYSIS RESULTS - VOLATILE ORGANIC COMPOUNDS (GRESHAM TUBES)

Date of Sampling 17 June 1999
Sample Location St Peters Road, Huntingdon, Cambridgeshire
Plant Fluidised Bed Furnace
Ambient Conditions 1017 mbar 23.4°C

| Time | Plant condition | VOC's ppm | | | | | $C^1$ - $C^4$ Alkanes as C mg/m$^3$ |
|---|---|---|---|---|---|---|---|
| | | Methane | Ethane | Propane | Butane | Total | |
| 11.00 | Before stripping - burner on | 665 | 20 | 5 | <5 | 690 | 395 |
| 12.50 | Stripping | 700 | 25 | 5 | <5 | 730 | 420 |
| 13.50 | Stripping | 565 | 20 | 5 | <5 | 590 | 340 |
| 15.00 | Stripping | 460 | 15 | 5 | <5 | 480 | 275 |
| 16.15 | Cage removed - burner on | 400 | 15 | 5 | <5 | 420 | 240 |

Stack sampling using Gresham Tube.
Analysis by gas chromatography, with FID detection.

For and on behalf of
ASSOCIATED LABORATORY SERVICES LIMITED

28 June 1999

K S Axon

Public Register

# REPORT ON STACK MONITORING

AT

DURAPIPE – S&LP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HUNTINGDON, CAMBRIDGESHIRE, PE18 7DJ

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ASSOCIATED LABORATORY SERVICES LIMITED
BOCKING, BRAINTREE, ESSEX
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APRIL 1998

REPORT NO. 12791

## INDEX



Appendices

## 1. SCOPE OF WORK

A stack sampling survey was carried out at the Huntingdon Works of Stewarts & Lloyds Plastics. Processing involves removal of plastic from steel tooling using a fluidised bed furnace.

Emissions are vented to atmosphere via a cyclone system and a single vertical stack. Measurements were carried out through sampling ports installed in the side wall of the stack.

In order to provide the data required for calibration of the continuous monitor installed in the stack, Associated Laboratory Services Ltd were commissioned to carry out an isokinetic sampling survey for particulates. In addition, volatile organic compounds were monitored.

In accordance with the 1996 Revision of PG2/9 (96) Metal Decontamination Processes, moisture was also measured in order to correct the results to reference conditions (the oxygen correction not being required for fluidised bed systems).

Measurements were carried out on 20 April 1998

## 2. TEST METHOD & CONDITIONS

### 2.1 Test Method

Sampling was undertaken at the 2 sampling ports installed in the stack.

Measurements were carried out as follows:-

Gas Temperature

The temperature of the gas in the ducts was measured using a digital thermometer, the thermocouple of which was inserted into the ductwork.

Gas Velocities

Gas velocities were calculated from velocity pressure readings obtained using a pitot tube and electronic micro manometer.

Total Particulates

The sampling of particulates was undertaken in accordance with the requirements of BS3405. Collection of particulates was to pre-weighed glass fibre filters using a stainless steel probe with 4mm tip. Cumulative samples were collected using 2 sampling points per axis.

Moisture

Moisture was determined by absorption on silica gel in accordance with the general requirements of US EPA Method 4.

Volatile Organic Compounds

Real time measurements of VOC's were carried out with a portable GasTec Analyser, with flame ionisation detection.

## 2.2 Sampling & Conditions

All sampling was carried out whilst plastic removal was being carried out. Sampling was commenced at the beginning of the batch cycle, and consequently is expected to correspond to the highest level of emissions.

Following profiling of temperature and pressure within the stack, 2 cumulative isokinetic particulate samples were collected. During the same period, real time measurements of VOC's were carried out, and moisture samples collected.

Measured variations in temperature and velocity pressure were within the permitted range, and consequentlly the sampling complied with the requirements of BS 3405.

## 3. RESULTS & DISCUSSION

### 3.1 Results

The results are detailed in Appendix IV to VIII.

Ambient temperature and pressure was measured for the purpose of calculating concentrations in accordance with standard reference conditions. Results are converted to standard conditions 273°K and 1013 mbar, also corrected for moisture.

In summary the results are as follows:-

| Parameter | 1st Run | 2nd Run | Mean Value |
|---|---|---|---|
| Particulates $mg/m^3$ | | | |
| - at 273°K and 1013 mbar | 5.1 | 5.7 | 5.4 |
| - at 273°K, 1013 mbar, & dry gas | 5.2 | 5.8 | 5.5 |
| VOC's $mg/m^3$ | | | |
| - at 273°K and 1013 mbar | 349 | 1503 | |
| - at 273°K, 1013 mbar, & dry gas | 353 | 1508 | |

The average flow velocity at the sampling point in the stack was 17.9 metre per second (at gas temperature), giving a mean gas flowrate of $5.13m^3$ per second (at 273°K).

### 3.2 Discussion

Particulates

The measurement of total particulates gave results corrected for temperature and pressure which are in similar ratio to the instrument readings, and are within the ratio of 1.5 to 1 as prescribed.

The sampling flow rates are in the permitted range for isokinetic conditions, and all other measurements and variations in results comply with the requirements of BS 3405.

VOC's

VOC levels corrected for temperature and pressure, are within the range as previously measured. As expected, the second result is much higher than the first, being during the period of the operating cycle when higher VOC emissions occur.

## 4. CONCLUSIONS

These conclusions are based on the measurements as carried out at the emission stack associated with cyclone filters for the fluidised bed furnace at the Huntingdon Works of Stewarts & Lloyds Plastics.

### 4.1 Results

Sampling was carried out during the early stages of the batch cycle, and consequently is expected to correspond to higher levels of emissions.

The results are summarised as follows

| a) Particulates | At 273°K & 1013 mbar | At 273°K, 1013 mbar, dry gas |
|---|---|---|
| 1st Sample | 5.1 mg/Nm$^3$ | 5.2 mg/Nm$^3$ |
| 2nd Sample | 5.7 mg/Nm$^3$ | 5.8 mg/Nm$^3$ |
| b) VOC's | | |
| 1st Sample | 349 mg/Nm$^3$ | 353 mg/Nm$^3$ |
| 2nd Sample | 1503 mg/Nm$^3$ | 1508 mg/Nm$^3$ |

c) Flow rates at sampling port

| | | |
|---|---|---|
| Velocity | 17.9 | metre per second (at gas temperature) |
| Gas flowrate | 5.13 | m$^3$ per second (at 273°K). |

### 4.2 Validity of Results

The validity of results is based on

a) Pressure and temperature measurements and variations in measurements are within the prescribed limits, and consequently comply with BS 3405.

b) The ratio of particulate results (at 273°K and 1013mbar) is less than 1.5 to 1, and consequently complies with BS 3405.

For and on behalf of
ASSOCIATED LABORATORY SERVICES LIMITED

K S Axon

# INSTRUMENT CALIBRATION REPORT

Company : Durapipe – S&LP
Site Address: St Peters Road
Huntingdon
Cambridgeshire
Plant Identification: Fluidised Bed Furnace
Product/Process: Removal of plastics from steel tooling

Date of Sampling : 20 April 1998
PCME Job No. N/A
ALS Job No. 12791
DISC/File Reference
Test Carried Out by PDH Willcock

---

Instrument Settings During Sample  Instrument : SL600  Channel # : 1

DT-770/SC-600

Instrument Checks : Pass
Correct Time : Corrected
Sensitivity : Md
Old Cal Factor : 003.7100
(in use during sampling)
Flow Compensation : OFF
O2 Compensation : OFF

DT-200

Course Gain Position : _____
Fine Gain Display : _____

Filter Position : _____

Course Gain : _____
Fine Gain : _____

---

Instrument Results

| Run | Start Time | Finish Time | Duration (Mins) | Instrument Average (Y) | Instrument Max | Dust Conc mg/m$^3$ (X) |
|---|---|---|---|---|---|---|
| 1. | 11.19 | 11.49 | 30 | 9.33 | 12.1 | 5.1 |
| 2. | 12.01 | 12.31 | 30 | 10.7 | 12.7 | 5.7 |
| 3. | | | | | | |
| 4. | | | | | | |
| | | | | | | |
| Time Weighted Average | - - - - | - - - - | - - - - | 10.0 | - - - - | 5.4 |

Calibration Calculations

X (from Iso test ) =
Y (Inst response) =

Scaling factor = X = _____ =

New Gain Cal Factor = scaling fctor = x old Gain Cal Factor =

Instrument Settings for Calibration

**DT-770/SC-600**

Cal Factor : _____

**DT-200**

CG Position : _____
FG Display : _____
Course Gain : _____
Fine Gain : _____

Product/Process : Removal of plastic residue from steel tooling

Table A

Process Conditions

| | |
|---|---|
| Arrestment Type : | Cyclone Filter |
| Particulate Type : | Plastic |
| Gas Temperature : | 70°C |
| Gas Flow Rate : | 5.13 $m^3$/sec |
| Appearance of Plume : | Invisible |
| Load of Plant : | Average |

Table B

Results

| | Run 1 | Run 2 |
|---|---|---|
| Date : | 20.04.98 | 20.04.98 |
| Test Period | 11.19-11.49 | 12.01-12.31 |
| Duration | 30 mins | 30 mins |
| Gas Temperature : | 70°C | 70°C |
| Mean Velocity at Sampling Points | 17.9 m/sec | 17.9 m/sed |
| Particulates at STP (1) | 5.1 mg/$m^3$ | 5.7 mg/$m^3$ |
| Particulates at normalised conditions (2) | 5.2 mg/$Nm^3$ | 5.8 mg/$Nm^3$ |

(1) Particulates stated at 273K, 101.3kPa.

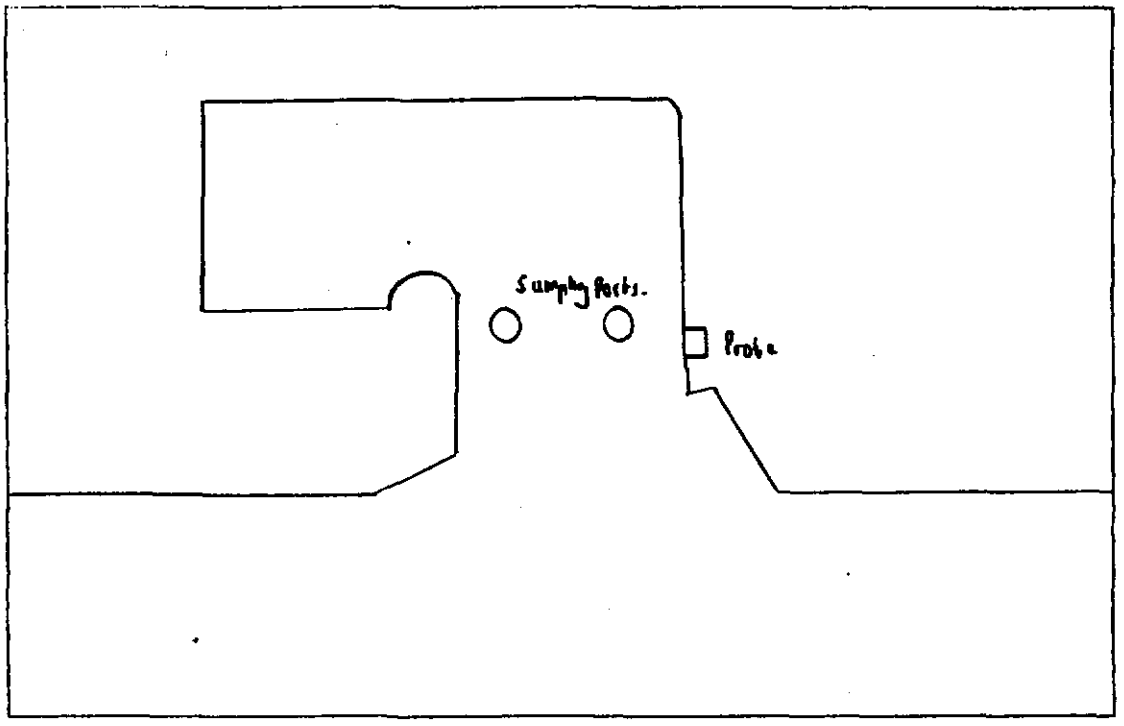
(2) Normalised conditions are 273K, 101.3kPa.

PLANT LAYOUT

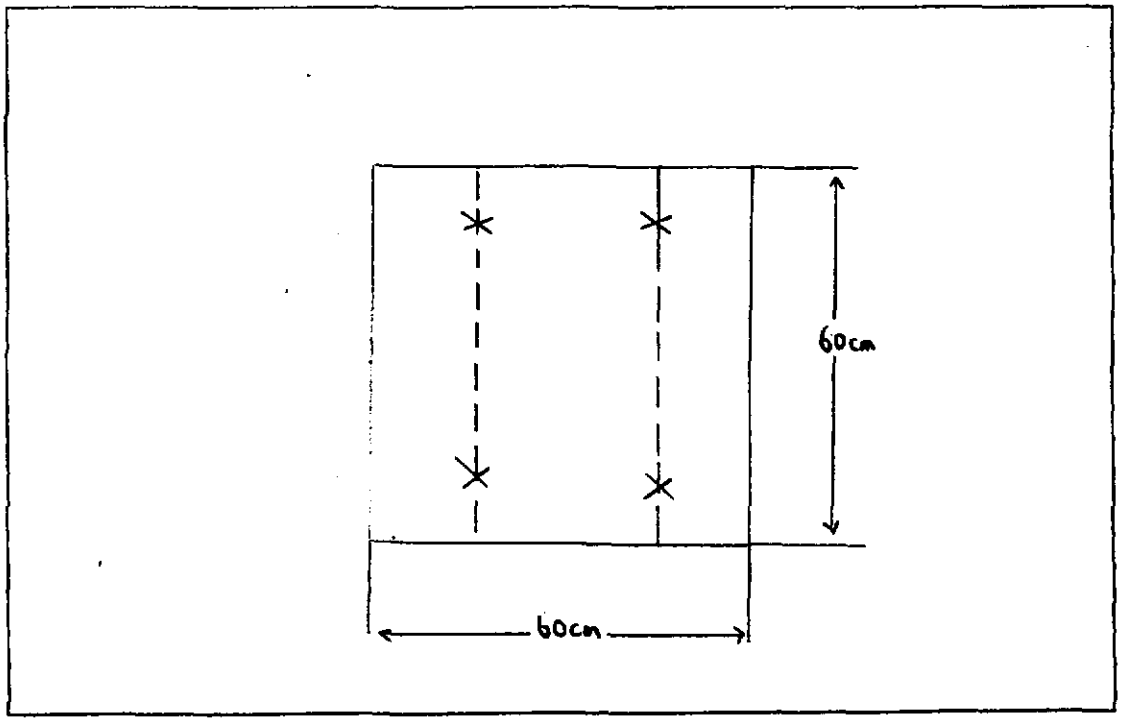
Site Durapipe – S & LP
St Peters Rd, Huntingdon

Plant Fluidised Bed Furnace

1) Plant layout showing instrument location and sample place




2) Section of duct at sample place and dimensions



# STACK PARTICULATES MEASUREMENT

Client : Durapipe – S&LP
Site : St Peters Road, Huntingdon
Cambridgeshire

Date : 20 April 1998
Time : 10.30 hrs
Operator : PDH Willcock

Plant : Cyclone Filter
Plant Load: Normal

Appearance of Plume Invisible
Product/Process Removal of plastic residue from steel tooling

| Details of Duct | | Atmospheric Conditions | | |
|---|---|---|---|---|
| | | Time | Pressure (Pa) in mb | Temperature °C |
| Shape | Square | Initial | 1021 | 16.5 |
| Dimension/Diameter | 60cm | Final | 1007 | 16.4 |
| Area | $0.36^2$ | Average | 1014 | 16.5 |

1) Readings before sampling

| Position | Axis 1 | | | Axis 2 | | |
|---|---|---|---|---|---|---|
| | Distance into Duct (cms) | Velocity Pressure (Pascals) | Gas Temperature °C | Distance into Duct (cms) | Velocity Pressure (Pascals | Gas Temperature °C |
| 1. | 3 | 200 | 69.9 | 3 | 180 | 70.2 |
| 2. | 9 | 200 | 69.9 | 9 | 160 | 70.2 |
| 3. | 15 | 200 | 68.7 | 15 | 170 | 70.1 |
| 4. | 21 | 190 | 68.7 | 21 | 130 | 70.1 |
| 5. | 27 | 180 | 68.6 | 27 | 100 | 70.0 |
| 6. | 33 | 180 | 68.6 | 33 | 100 | 69.9 |
| 7. | 39 | 180 | 68.5 | 39 | 110 | 69.8 |
| 8. | 45 | 180 | 68.3 | 45 | 110 | 69.8 |
| 9. | 51 | 160 | 68.2 | 51 | 100 | 69.7 |
| 10. | 57 | 140 | 68.1 | 57 | 120 | 69.7 |
| | Average | 181 | 68.8 | Average | 128 | 70.0 |
| | Mean Pv (in Pascals) : 155 | | | Mean Tp (in °K = °C + 273): 343 | | |
| | Static Pressure, Ps (in Pascals): 270 | | | | | |

High gas temperature = 70.2 Lowest gas temperature = 68.1

Permitted range of gas temperature readings (in °C) = (0.9Tp - 273) to (1.1Tp - 273) = 65°C to 140°C

Highest Pv = 200 pascals Lowest Pv = 100 pascals

Ratio $\frac{\text{Pv highest}}{\text{Pv lowest}}$ = 2/1 (maximum permitted ratio = 9/1)

## Stack Particulates Measurements

2) Readings at Sampling

| Axis | Distance into Duct (cm) | Gas Temperature °C | | Velocity Pressure (Pascals) | | | |
|---|---|---|---|---|---|---|---|
| | | Initial | Final | Initial | Final | Average | √Average |
| 1 | 15 | 69.7 | 65.3 | 200 | 200 | 200 | 14.1 |
| | 45 | 68.3 | 65.1 | 180 | 190 | 185 | 13.6 |
| | | | | | | | |
| | | | | | | | |
| 2 | 15 | 70.1 | 67.5 | 170 | 180 | 175 | 13.2 |
| | 45 | 69.8 | 67.0 | 110 | 110 | 110 | 10.5 |
| | | | | | | | |
| | | | | | | | |
| | Totals | 277.9 | 364.9 | 660 | 680 | ------- | 51.4 |
| | Average | 69.5 | 66.2 | ------- | ------- | ------- | 12.9 |

Permitted range of total Pv final = 0.9 x total Pv initial to 1.1 x total Pv initial
= 594 pascals to 726 pascals

3) Sampling Conditions

| Sample Reference | Axis | Time | | | Nozzle Diameter mm | Sample Rate l/min | Gas Meter Volme (litres) | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Initial | Final | Elapsed | | | Initial | Final | Total |
| 1 | A | 11.19 | 11.49 | 30 mins | 4 | 11 | 260535 | 260887 | 352 |
| | | | | | | | | | |
| 2 | B | 12.01 | 12.31 | 30 mins | 4 | 11 | 260887 | 261240 | 353 |
| | | | | | | | | | |

## STACK PARTICULATES MEASUREMENTS

4) Weighing Results

| Sample No. | Filter No. | Weights (mg) | | |
|---|---|---|---|---|
| | | Before | After | Solids Collected |
| A | 1 | 86.76 | 88.48 | 1.72 |
| B | 2 | 86.95 | 88.86 | 1.91 |

5) Calculations

5.1 Mean Gas Velocity at Gas Temperature

V mean = 0.075 √Pv average √(T average + 273) m/sec

where Pv average = mean velocity pressure (pascals) } see 2
T average = mean gas temperature at the sampling points} above

V mean = 0.075 x 12.9√343

= 17.9 m/sec

5.2 Mean Gas Flowrate at 273°K

$$Q = V \text{ mean} \times A \left( \frac{273}{273 + T \text{ average}} \right) \text{ m}^3\text{/sec}$$

where V mean = mean gas velocity (see 5.1 above)

A = internal area of duct in $m^2$

T average = mean gas temperature at the sampling points

$$Q = 17.9 \times 0.36 \times \frac{273}{(273 + 70)}$$

= 5.13 $m^3$/sec

## STACK MONITORING – DURAPIPE – S&LP

## ANALYSIS RESULTS - MOISTURE

Date of Sampling 20 April 1998
Sample Location St Peters Road, Huntingdon, Cambridgeshire
Plant Fluidised Bed Furnace
Ambient Conditions 1013 mbar 14.8°C

| Sample Reference | Time | | | Sampling Rate l/min | Sampling Volume litres | | Wt of water gm | Moisture Level | |
|---|---|---|---|---|---|---|---|---|---|
| | Initial | Final | Elapsed | | Recorded | Normalised | | gm/litre | % vol/vol* |
| M1 | 11.19 | 11.49 | 00.30 | 11 | 352 | 334 | 2.80 | 0.008 | 0.99 |
| M2 | 12.01 | 12.31 | 00.30 | 11 | 353 | 335 | 2.11 | 0.006 | 0.74 |

Normalised at 273°K and 1013 mbar.
* 1 mole of water occupies 22.4 litre at normalised conditions.
Determined by absorption onto silica gel in accordance with general requirements of US EPA Method 4.

For and on behalf of
ASSOCIATED LABORATORY SERVICES LIMITED

27 April 1998

KS Axon

**STACK MONITORING – DURAPIPE – S&LP**

ANALYSIS RESULTS - PARTICULATES

Date of Sampling 20 April 1998
Sample Location St Peters Road, Huntingdon, Cambridgeshire
Plant Fluidised Bed Furnace
Ambient Conditions 1013 mbar 14.8°C

| Sampling Location | Sampling Reference | Sampling Volume $m^3$ | | Moisture Level % vol/vol | Particulates | | |
|---|---|---|---|---|---|---|---|
| | | Recorded | Normalised | | On Filter mg | Concentration at 273°K, 1013 mbar $mg/m^3$ | Concentration at 273°K, 1013 mbar, dry gas $mg/m^3$ |
| 1 | A | 0.352 | 0.334 | 0.99 | 1.72 | 5.1 | 5.2 |
| 2 | B | 0.353 | 0.335 | 0.74 | 1.91 | 5.7 | 5.8 |

Normalised at 273°K and 1013 mbar.
Sampled in accordance with BS 3405 1983 Measurement of Particulate Emission including Grit and Dust (Simplified Method).

For and on behalf of
ASSOCIATED LABORATORY SERVICES LIMITED

27 April 1998

K S Axon

**STACK MONITORING – DURAPIPE – S&LP**

ANALYSIS RESULTS - VOLATILE ORGANIC COMPOUNDS

**Date** of Sampling 20 April 1998
**Sample** Location St Peters Road, *Huntingdon, Cambridgeshire*
**Plant** Fluidised Bed Furnace
**Ambient** Conditions 1013 mbar 14.85°C

| Run | Time | Instrument Reading | Total VOC's as C at 273°K & 1013mbar mg/m | Total VOC's as C at 273°K, 1013 mbar, dry gas mg/m$^3$ |
|---|---|---|---|---|
| 1 | 11.25 | 200 | 904 | |
| | 11.28 | 210 | 949 | |
| | 11.29 | 150 | 678 | |
| | 11.31 | 100 | 452 | |
| | 11.33 | 70 | 316 | |
| | 11.35 | 70 | 316 | |
| | 11.37 | 40 | 181 | |
| | 11.39 | 40 | 181 | |
| | 11.41 | 30 | 136 | |
| | 11.43 | 22 | 99 | |
| | 11.45 | 28 | 127 | |
| | 11.47 | 25 | 113 | |
| | 11.49 | 20 | 90 | |
| Run 1 Average | | | 349 | 353* |
| 2 | 12.02 | 50 | 226 | |
| | 12.04 | 70 | 316 | |
| | 12.06 | 110 | 497 | |
| | 12.08 | 130 | 588 | |
| | 12.10 | 210 | 949 | |
| | 12.12 | 200 | 904 | |
| | 12.14 | 250 | 1130 | |
| | 12.16 | 280 | 1266 | |
| | 12.18 | 300 | 1356 | |
| | 12.20 | 320 | 1446 | |
| | 12.22 | 500 | 2260 | |
| | 12.24 | 500 | 2260 | |
| | 12.26 | 580 | 2622 | |
| | 12.28 | 580 | 2712 | |
| | 12.30 | 600 | 2712 | |
| | 12.32 | 620 | 2802 | |
| Run 2 Average | | | 1503 | 1518** |

**Direct** stack readings using a Gas Tec Analyser with flame ionisation detection. Calibration factor = 4.76 (n-Hexane standard). Nomalised at 273°K & 1013mbar.
* Corrected for 0.99% moisture. ** Corrected for 0.74% moisture

For and on behalf of
ASSOCIATED LABORATORY SERVICES LIMITED 14th April 1997

KS Axon