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Stack Emissions Testing Report

Total Particulate Matter

Chlorides

Clarksteel Galvanising Limited

Yaxley

Fume Extraction System

Test Date	1st April 1998
Report by	Chris Lindsay
Checked by	Craig Goulding
Authorised by	Alastair Wolff

QUALITY ASSURED FIRM ISO 9001 SGS

NATIONAL ACCREDITATION OF CERTIFICATION BODIES

Job No. ENV 1203

Contents

Introduction

Clarkesteel Galvanising Limited operate a Hot Dip Galvanising Process at Yaxley which is subject to Local Air Pollution Control, by Huntingdonshire District Council under the Environmental Protection Act 1990.

Scientifics Limited, were commissioned by Clarksteel galvanising Limited to carry out stack emissions testing to determine the releases of total particulate matter and chlorides from the following Plant under normal operating conditions.

Company	Clarksteel Galvanising Limited
Site	Yaxley
Stack	Fume Extraction System
Test Date	1st April 1998
Time Test Started	09:00
Time Test Ended	12:30
Process	'Hot Dip Galvanising Processes'
Guidance Note	PG 2/2 (96)
Abatement Plant	Bag Filter
Materials Processed	Miscellaneous Steelwork
Operating Conditions	20 Tonnes/Day

Throughout sampling, the operating conditions were maintained as above.
Any deviations from BS 3405 : 1983 are noted in the conclusion.

Written Summary

Total Particulate Matter	Passed

vo particulate tests were performed during continuous operating conditions. ıe mean sampling time was 20 minutes. The mean particulate ›ncentration was 6.45 mg/m^3 at reference conditions. This value is ›low the emission limit of 15 mg/m^3 specified in PG 2/2 (96).

ıe tests were performed in accordance with the main procedural requirements BS 3405 : 1983 using a Ströhlein STE 4 isokinetic particulate sampling train.

Chlorides	Passed

'o chlorides tests were performed during continuous operating conditions. mean chlorides (as hydrogen chloride excluding particulate matter) ncentration was 0.98 mg/m^3 at reference conditions. This value is ͽlow the emission limit of 30 mg/m^3 specified in PG 2/2 (96).

e tests were performed using a heated sampling line and impinger collection ntaining 3% H_2O_2 solution with analysis by ion chromatography in a NAMAS credited laboratory.

Emissions Summary

Company	Clarksteel Galvanising Limited
Site	Yaxley
Stack	Fume Extraction System
Test Date	1st April 1998
Time Test Started	09:00
Time Test Ended	12:30

Parameter	Units	Result	Limit	Outcome
Total Particulate Matter	mg/m^3	6.45	15	Passed
Particulate Emission Rate	g/s	0.041	-	-
Chlorides	mg/m^3	0.98	30	Passed
Stack Gas Temperature	°C	27	-	-
Stack Gas Volumetric Flow Rate	m^3/hr	25531	-	-
Stack Gas Velocity	m/s	20.74	-	-

All results are mean values, with pollutant concentrations expressed at reference conditions.

Reference conditions are 273K, 101.3 kPa, without correction for water vapour content.

Total Particulate Matter Summary

Sample	Sampling Times	Concentration (mg/m^3)	Limit (mg/m^3)
Run 1	10:53 - 11:14	6.33	-
Run 2	11:21 - 11:42	6.58	-
Mean Particulate Concentration		6.45	15

Sample	Sampling Times	Emission Rate (g/s)	Ratio of Particulate Emission Rates
Run 1	10:53 - 11:14	0.040	-
Run 2	11:21 - 11:42	0.042	-
Mean Particulate Emission Rate		0.041	1.04 : 1

Reference conditions are 273K, 101.3 kPa, without correction for water vapour content.

Chlorides Summary

hlorides	Lab Result (mg)	Volume Sampled (m^3)	Concentration (mg/m^3)	Limit (mg/m^3)
un 1	0.11	0.0917	1.20	-
un 2	0.07	0.0917	0.76	-
lean Chlorides Concentration		-	0.98	30

eference conditions are 273K, 101.3 kPa, without correction for water vapour content.

Calculations - Run 1

1. Stack Gas Velocity (V)

V =	$0.075 \times Cp \times \sqrt{\Delta P} \times \sqrt{T}$
V =	Velocity (m/s)
Cp =	Pitot Tube Calibration Coefficient
ΔP =	Mean Differential Pressure (Pa)
T =	Mean Temperature (K)

2. Stack Gas Volumetric Flow Rate (Q)

Stack Gas Velocity (V)	20.71 m/s
Stack Diameter (D)	0.57 m
Stack Area (A)	0.34 m^2
Stack Temperature (T)	300.00 K
Atmospheric Pressure (P_A)	100.70 kPa
Static Pressure (P_{St})	-0.70 kPa
Standard Barometric Pressure (P_B)	101.30 kPa

$$Q_{(STP)} = \frac{273}{T} \times \frac{(P_A + P_{St})}{P_B} \times V \times A \qquad Q_{(actual)} = V \times A$$

$Q_{(STP)}$ = 6.36 m^3/s **$Q_{(actual)}$ = 7.08 m^3/s**

3. Cumulative Sampling Mass Emission (M)

No of Sampling Points (n)	4
Duration at each point (s)	300 s
Nozzle used	8.00 mm
Nozzle area (a)	50.27 mm^2
Particulate mass (m)	0.0071 g
Stack Area (A)	0.34 m^2

$$M = \frac{(A \times m)}{(n \times a \times s)} \times 10^6 = 4.0E\text{-}02 \ g/s$$

M = 0.040 g/s

4. Particulate Concentration (C) at 273K, 101.3 kPa

$$C = (M / Q_{(STP)}) \times 1000$$

C = 6.33 mg/m^3

Calculations - Run 2

1. Stack Gas Velocity (V)

V =	$0.075 \times Cp \times \sqrt{\Delta P} \times \sqrt{T}$
V =	Velocity (m/s)
Cp =	Pitot Tube Calibration Coefficient
ΔP =	Mean Differential Pressure (Pa)
T =	Mean Temperature (K)

2. Stack Gas Volumetric Flow Rate (Q)

Stack Gas Velocity (V)	20.76 m/s
Stack Diameter (D)	0.57 m
Stack Area (A)	0.34 m^2
Stack Temperature (T)	300.00 K
Atmospheric Pressure (P_A)	100.70 kPa
Static Pressure (P_{St})	-0.70 kPa
Standard Barometric Pressure (P_B)	101.30 kPa

$$Q_{(STP)} = \frac{273}{T} \times \frac{(P_A + P_{St})}{P_B} \times V \times A \qquad Q_{(actual)} = V \times A$$

$Q_{(STP)}$ = 6.38 m^3/s **$Q_{(actual)}$ = 7.10 m^3/s**

3. Cumulative Sampling Mass Emission (M)

No of Sampling Points (n)	4
Duration at each point (s)	300 s
Nozzle used	8.00 mm
Nozzle area (a)	50.27 mm^2
Particulate mass (m)	0.0074 g
Stack Area (A)	0.34 m^2

$$M = \frac{(A \times m)}{(n \times a \times s)} \times 10^6 = 4.2E\text{-}02 \text{ g/s}$$

M = 0.042 g/s

4. Particulate Concentration (C) at 273K, 101.3 kPa

$C = (M / Q_{(STP)}) \times 1000$

C = 6.58 mg/m^3

Total Particulate Matter Sampling Methodology

Checks Carried Out Before Arrival On Site

Filter Preparation

Paper Thimbles are dried then cooled in a dessicator and weighed as soon as is practical. They are weighed on a 4-figure balance (accurate to + 0.1 mg).

The filters are placed in clean individual petri dishes and transported on site in a filter box. Spare filters are also prepared in case of accidents.

Isokinetic Particulate Measuring Equipment

The STE4, isokinetic particulate measuring equipment, is cleaned and checked for any obvious flaws before use. The silicon and rubber tubing are checked for any damage and the filter head and nozzles are cleaned.

Pitot Tube and Gauge

The pitot tube is checked for any flaws, such as blockages and damaged heads. The gas velocity gauge is examined to ensure that the inlet holes are free from obstruction. The power supply of the gauge is checked and the instrument's zero point adjusted if necessary. The connection tubes from the pitot tube to the gauge are checked for any holes and are taped together to avoid any false reading due to differential pressures.

Thermocouple

Temperature is measured using a K type thermocouple which is externally checked for any faults before use. The thermocouple and display unit are calibrated quarterly. The power supply is checked before use.

Sampling Procedure On Site

A stainless steel rod is used to measure the internal diameter of the stack. The diameter (D) is entered into a palmtop computer and the specific monitoring points are calculated using the following equations : 0.15 x D and 0.85 x D for circular stacks and 0.25 x D and 0.75 x D for square stacks, for 4 point sampling. For 8 point sampling the following equations are used, 0.065 x D, 0.25 x D, 0.75 x D and 0.935 x D for circular stacks and 0.125 x D, 0.375 x D, 0.625 x D and 0.875 x D for square stacks.

The pitot tube is used to carry out a preliminary survey of the stack. Dynamic pressure is measured at 10 points along the proposed sampling plane. If the highest to lowest dynamic pressure ratio exceeds 9:1 or if the gas velocity highest to lowest ratio exceeds 3:1 another sampling plane should be used.

If the ratio of the highest to lowest dynamic pressure is less than 4:1 then 4 point sampling is undertaken. If the ratio exceeds this amount then 8 point sampling is undertaken.

Temperature is measured at 10 points along the sampling plane and an average temperature calculated. If the temperature at any of the sampling points differs by more than $\pm$ 10% to that of the average temperature, then that point will not be used.

The pitot tube is blown down to remove any dust particles. The connection tubes are then fastened from the pitot tube to the gauge via non-return valves. Dynamic pressure, static pressure and temperature readings are taken at the appropriate sample points.

This information is entered into the palmtop computer, where local and average velocity calculations are made.

From the velocity calculation, the appropriate nozzle size and volumetric flow rate (suction) are determined to ensure true isokinetic sampling.

The nozzle is then attached to the STE4 and a filter sleeve inserted. Before the first sampling run can be performed, a leak check is carried out.

The STE4's sampling probe is then placed securely in the stack at a right angle to the direction of the gas flow and positioned at the first calculated monitoring point. The probe is left without suction for about 5 minutes to attain the stack temperature.

With the air by-pass control valve fully open, the suction pump is switched on and the flow rate set to the required level for sampling. The time of sampling is recorded. The probe is moved to position 2 after a designated time interval.

When sampling is complete, the filter sleeve is removed from the filter head and placed in it's glass filter container. The dynamic pressure and temperature at each of the sampling points are then measured.

A new filter is placed within the filter head and the sampling procedure is repeated as above in order to collect a second sample.

On Site Isokinetic Data Sheet

Preliminary Stack Survey		Sampling Line A		Sampling Line B	
Traverse Point	Distance in Stack (m)	Dynamic Pressure (Pa)	Temperature (°C)	Dynamic Pressure (Pa)	Temperature (°C)
1	0.03	237	27	-	-
2	0.09	276	27	-	-
3	0.14	342	27	-	-
4	0.20	349	27	-	-
5	0.26	327	27	-	-
6	0.31	331	27	-	-
7	0.37	383	27	-	-
8	0.43	412	27	-	-
9	0.48	420	27	-	-
10	0.54	384	27	-	-
Mean	-	346	27	-	-

Lowest Dynamic Pressure (any line) 237 Ratio of Above 1.8 : 1

Highest Dynamic Pressure (any line) 420 (Highest permitted ratio 9:1)

Temperature Range permitted for any point is between -1 and 60 °C.

Run 1		Sampling Time (mins)	20	Nozzle size used (mm)		8
Sampling Point	Dynamic Pressure (Pa)		Temperature (°C)		Velocity (m/s)		Flowmeter set at (m³/hr)
	Initial	Final	Initial	Final	Initial	Final	
1	276	278	27	27	18.13	18.19	3.17
2	342	344	27	27	20.18	20.24	3.54
3	412	414	27	27	22.15	22.20	3.87
4	420	415	27	27	22.36	22.23	3.91
Mean	363	363	27	27	20.70	20.72	3.62

Difference between Initial Velocity and Final Velocity = 0.05 % (Limit permitted is ± 5%)

Start Filter Weight = 0.8959 g Sample Weight = 0.0071 g

End Filter Weight = 0.9030 g Sample as % of Filter Weight = 0.79 %

Run 2		Sampling Time (mins)	20	Nozzle size used (mm)		8
Sampling Point	Dynamic Pressure (Pa)		Temperature (°C)		Velocity (m/s)		Flowmeter set at (m³/hr)
	Initial	Final	Initial	Final	Initial	Final	
1	278	275	27	27	18.19	18.10	3.18
2	344	350	27	27	20.24	20.41	3.54
3	414	416	27	27	22.20	22.26	3.89
4	415	424	27	27	22.23	22.47	3.89
Mean	363	366	27	27	20.72	20.81	3.63

Difference between Initial Velocity and Final Velocity = 0.45 % (Limit permitted is ± 5%)

Start Filter Weight = 1.0024 g Sample Weight = 0.0074 g

End Filter Weight = 1.0098 g Sample as % of Filter Weight = 0.74 %

Chlorides Sampling Methodology

he concentration of chlorides in the stack gases are determined using wet chemistry technique.

he sampling train used consists of the following:

A series of 3 glass impingers with ball and socket joints which are made fully airtight. An in stack filter is used before the first impinger, to remove any particulate matter from the stack gas. The first and second impingers contain 3% H_2O_2 solution (prepared at a NAMAS accredited laboratory). The third impinger contains silica gel. All mpingers are placed in a cold water or ice bath.

A dry gas meter to record the volume of air sampled. The air temperature entering the meter and the vacuum pressure of the meter are measured and used to correct the volume sampled to standard conditions. The vacuum pressure gauge used has a NAMAS accredited calibration certificate and the thermocouple is tested regularly against a NAMAS accredited calibrated thermometer.

A 110 volt pump sucking at a rate of 3 m^3 per hour which is set to the required flow rate by a control valve according to the specific stack conditions.

ll equipment is checked and all glassware cleaned in accordance with strict cleaning rocedures prior to arrival on site. Sterile containers provided by our laboratory are ken to site to store the samples once they have been collected.

wo samples are collected along with an additional sample of solution, which is nalysed to determine the blank value of the solution. These are all analysed in a NAMAS ccredited laboratory by ion chromatography.

ctual Volume Sampled (V_{ac})

$$V_{ac} = \text{Measured Vol Sampled } (m^3) \times \frac{\text{Standard Temperature (273 K)}}{\text{Temperature at the Gas Meter (K)}} \times \frac{\text{Absolute Pressure (kPa)}}{\text{Standard Pressure (kPa)}}$$

Quality Assurance Checklist

Velocity Measurements:

Water droplets were not present. ✓

Direction of gas flow within ± 20° of stack axis. ✓

Dynamic pressures > 5 Pa at all sampling points. ✓

Total Particulate Matter:

Sampling plane correctly positioned. ✓

Sampling from centres of equal areas. ✓

Sampling at each point not less than 3 minutes. ✓

Constant 'as' during cumulative sampling. ✓

Direction of gas flow within ± 20° of stack axis. ✓

Isokinetic flow maintained during sampling. ✓

Leak check performed after each run and passed. ✓

Sample Handling:

Minimum mass of samples collected > 0.3% of filter masses. ✓

Samples achieved stable weights. ✓

Particulate samples sent for analysis. ✓

QA Procedures:

File saved to disk. ✓

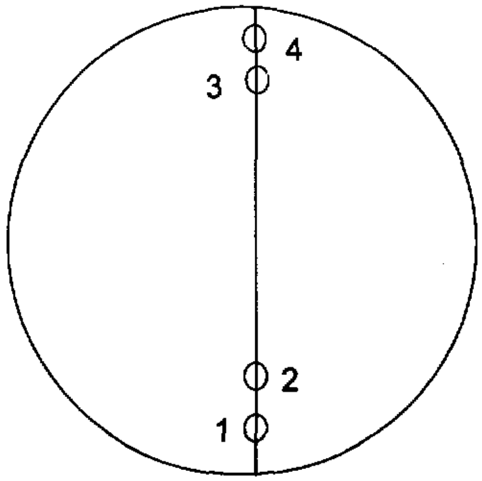
Hard copy made. ✓

On site isokinetic data sheet filed. ✓

Signed: [signature]

Chris Lindsay Team Leader

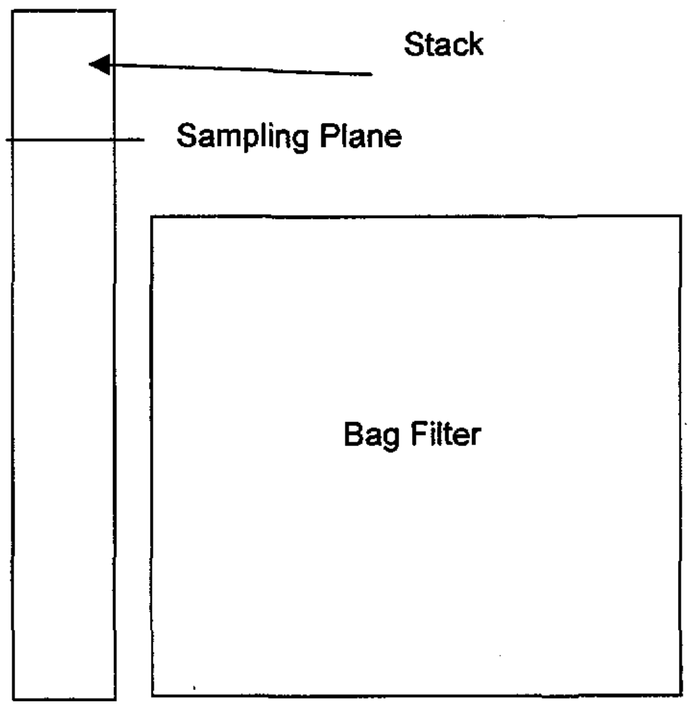
Stack Diagram



Stack Diameter (D) = 0.57 m
Stack Area (A) = 0.34 m^2

Sample Point	Distance as a % of D	Distance in m
1	15	0.04
2	85	0.21
3	15	0.36
4	85	0.50

Plant Layout



Environmental Monitoring Team

Environmental Team Leader	Chris Lindsay BSc (Hons) Engineering Physics AEA Technology - Level 2 Isokinetic Sampling Engineer
Environmental Technician	Adrian Burrows BSc (Hons) Biological Sciences

Report by	Chris Lindsay	Signed
Checked by	Craig Goulding	pp Signed
Authorised by	Alastair Wolff	Signed

Conclusion

The results of these tests demonstrate that under normal operating conditions, this Plant is being operated in full compliance with both the total particulate matter and chlorides emission limits specified in its LAPC 'Part B' Process Authorisation.

Testing was fully in accordance with BS 3405 : 1983, apart from the fact that only one sampling line was used, as only one of the sampling ports could physically be removed. However four sampling points were used on the one available sampling line, rather than just two.

Good housekeeping and maintenance of the ducting and abatement plant should be maintained to continue this level of Plant performance.

A regular programme of stack emissions testing in accordance with the Plant's LAPC 'Part B' Process Authorisation will be required to demonstrate continued compliance.