

clw



## **AIR & EMISSIONS TESTING GROUP**

52 Offerton Industrial Estate, Hempshaw Lane, Stockport, SK2 5TJ.

Tel: 0161 477 3004 Fax: 0161 480 4642

Mobile: 07973 319576 (24 Hours)

Email: james.bealing@scientifics.com

### **Stack Emissions Testing Report**

**Total Particulate Matter  
Chlorides (as HCl)**

**Clarksteel Galvanising Limited**

**Yaxley**

**Fume Extraction System**

**Test Date 17th April 2001**

**Report by Andrew Palliser**

**Job Number LAB 2937**



## Contents

	Page
Introduction	1
Written Summary	2
Emissions Summary	3
Total Particulate Matter Summary	4
Chlorides (as HCl) Summary	4
Calculations	5 & 6
Total Particulate Matter Sampling Methodology	7 & 8
On Site Isokinetic Data Sheet	9
Chlorides (as HCl) Sampling Methodology	10
Quality Assurance Checklist	11
Stack Diagram	12
Plant Layout	12
Environmental Monitoring Team	13
Conclusion	14

## Introduction

Clarksteel 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, Part 1.

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	17th April 2001
Time Test Started	13:20
Time Test Ended	14:40
Abatement Plant	Bag Filter
Operating Conditions	4-5 Dips/Hour
Materials Processed	Structural Steel
Fuel Type (If Applicable)	N/A
Plume Appearance	None Visible
Process	'Hot Dip Galvanising Processes'
Process Guidance Note	PG 2/2 (96)
Authorisation	N/A

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**

Two particulate tests were performed during continuous operating conditions.

The mean sampling time was 20 minutes.

The mean particulate concentration was 2.3 mg/m<sup>3</sup> at reference conditions.

This value is below the emission limit of 15 mg/m<sup>3</sup> specified in PG 2/2 (96).

Results given have been referenced to 273K, 101.3kPa, without correction for water vapour content.

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

### **Chlorides (as hydrogen chloride excluding particulate matter)**

**Passed**

Two chlorides tests were performed, during continuous operating conditions.

The mean sampling time was 30 minutes.

The mean chlorides (as hydrogen chloride excluding particulate matter) concentration was < 2.2 mg/m<sup>3</sup> at reference conditions.

This value is below the emission limit of 30 mg/m<sup>3</sup> specified in PG 2/2 (96).

Results given have been referenced to 273K, 101.3kPa, without correction for water vapour content.

The tests were performed using a glass lined sampling probe and impinger collection containing HPLC grade water with analysis by ion chromatography in an accredited laboratory.

## Emissions Summary

Company Clarksteel Galvanising Limited  
Site Yaxley  
Stack Fume Extraction System  
Test Date 17th April 2001

Parameter	Units	Result	Limit	Outcome
Total Particulate Matter	mg/m <sup>3</sup>	2.3	15	Passed
Particulate Emission Rate	g/s	0.01	-	-
Chlorides (as HCl)	mg/m <sup>3</sup>	< 2.2	30	Passed
Chlorides Emission Rate	g/s	< 0.01	-	-
Stack Gas Temperature	°C	20	-	-
Stack Gas Volumetric Flow Rate	m <sup>3</sup> /hr	16561	-	-
Stack Gas Velocity	m/s	18.0	-	-

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	Limit
Run 1	13:35 - 13:55	2.6 mg/m <sup>3</sup>	-
Run 2	14:00 - 14:20	2.0 mg/m <sup>3</sup>	-
Mean Particulate Concentration		2.3 mg/m <sup>3</sup>	15 mg/m <sup>3</sup>

Sample	Sampling Times	Particulate Emission Rate	Ratio of Particulate Emission Rates
Run 1	13:35 - 13:55	0.011 g/s	-
Run 2	14:00 - 14:20	0.008 g/s	-
Mean Particulate Emission Rate		0.009 g/s	1.27 : 1

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

## Chlorides (as HCl) Summary

Chlorides	Laboratory Result mg	Volume Sampled m <sup>3</sup>	Concentration mg/m <sup>3</sup>	Limit mg/m <sup>3</sup>
Run 1	< 0.15	0.09	< 1.7	-
Run 2	< 0.23	0.09	< 2.6	-
Mean Chlorides Concentration			< 2.2	30

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

# Calculations - Run 1

## 1. Stack Gas Velocity (V)

$$V = 0.075 \times C_p \times \sqrt{\Delta P} \times \sqrt{T}$$

V = Velocity (m/s)  
C<sub>p</sub> = Pitot Tube Calibration Coefficient  
ΔP = Mean Differential Pressure (Pa)  
T = Mean Temperature (K)

## 2. Stack Gas Volumetric Flow Rate (Q)

Stack Gas Velocity (V)	17.98 m/s
Stack Diameter (D)	0.57 m
Stack Area (A)	0.26 m <sup>2</sup>
Stack Temperature (T)	303 K
Atmospheric Pressure (P <sub>A</sub> )	99.40 kPa
Static Pressure (P <sub>st</sub> )	-0.25 kPa
Standard Barometric Pressure (P <sub>B</sub> )	101.30 kPa

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

$$Q_{(actual)} = V \times A$$

$$Q_{(STP)} = 4.05 \text{ m}^3/\text{s}$$

$$Q_{(actual)} = 4.59 \text{ m}^3/\text{s}$$

## 3. Particulate Mass Emission Rate (M)

No. of Sampling Points (n)	4
Duration at each point (s)	300 s
Nozzle area (a)	28.28 mm <sup>2</sup>
Particulate mass (m)	0.0014 g
Stack Area (A)	0.26 m <sup>2</sup>

$$M = \frac{(A \times m)}{(n \times a \times s)} \times 10^6 = 1.1\text{E-}02 \text{ g/s}$$

$$M = 0.011 \text{ g/s}$$

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

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

$$C = 2.60 \text{ mg/m}^3$$

## Calculations - Run 2

### 1. Stack Gas Velocity (V)

$$V = 0.075 \times C_p \times \sqrt{\Delta P} \times \sqrt{T}$$

V = Velocity (m/s)  
C<sub>p</sub> = Pitot Tube Calibration Coefficient  
ΔP = Mean Differential Pressure (Pa)  
T = Mean Temperature (K)

### 2. Stack Gas Volumetric Flow Rate (Q)

Stack Gas Velocity (V)	18.07 m/s
Stack Diameter (D)	0.57 m
Stack Area (A)	0.26 m <sup>2</sup>
Stack Temperature (T)	305 K
Atmospheric Pressure (P <sub>A</sub> )	99.40 kPa
Static Pressure (P <sub>St</sub> )	-0.25 kPa
Standard Barometric Pressure (P <sub>B</sub> )	101.30 kPa

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

$$Q_{(STP)} = 4.04 \text{ m}^3/\text{s} \quad Q_{(actual)} = 4.61 \text{ m}^3/\text{s}$$

### 3. Particulate Mass Emission Rate (M)

No. of Sampling Points (n)	4
Duration at each point (s)	300 s
Nozzle area (a)	28.28 mm <sup>2</sup>
Particulate mass (m)	0.0011 g
Stack Area (A)	0.26 m <sup>2</sup>

$$M = \frac{(A \times m)}{(n \times a \times s)} \times 10^6 = 8.3E-03 \text{ g/s}$$

$$M = 0.0083 \text{ g/s}$$

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

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

$$C = 2.05 \text{ mg/m}^3$$

# Total Particulate Matter Sampling Methodology

## Job Preparation

A pre-site survey must first be undertaken to obtain the following information. Client details (full address & contact names), description of stack (name & location), sampling platform / access (Permanent - platform of adequate size & load capability, kick boards, hand & middle rails, free from debris, good drainage, fixed ladders with hoops and chain. Temporary - adequate size & load capability, stabilising legs, valid inspection tag, kick boards, hand & middle rails. Both types of platform must have a secure anchorage point to fix pulley system) hazards (dust, noise, temperature, gases/vapours, vibration, light, moving machinery, electricity etc) power supply and location, additional PPE required (high temperature gloves/overalls, PPE).

The Strohlein STE 4, isokinetic particulate measurement equipment, is fully inspected prior to use and it's calibration status observed. This includes:

**Pitot Tube** - All pitot tubes are physically checked for damage, paying particular attention to the inlet holes. All dirt and blockages are removed.

**Micromanometer** - Digital differential pressure meters are used capable of measuring pressure in the range 0 Pa to 2250 Pa with a sensitivity of  $\pm 1$  Pa. These instruments are checked for obvious physical damage, battery life tested and calibrated status observed.

**Thermocouple** - Temperature is measured using k type thermocouples. Each thermocouple is inspected for obvious damage and it's calibration status observed. Digital temperature meters are used in conjunction with K type thermocouples. These are also checked for obvious physical damage and their battery life tested.

**Nozzles** - All nozzles used have been constructed in accordance BS 3405 : 1983, section 5.3.2. Each nozzle is physically checked for damage and removed if necessary. The nozzle calibration status is observed.

**Flowmeter** - The flowmeter is checked for blockages and obvious physical damage. It's calibration status is also observed.

**Balance** - A Mettler Toledo balance is used to weigh filters. The balance is positioned on a solid base located in a specially built weighing room. The balance is serviced and calibrated routinely each year by the manufacturer and also checked daily with in-house check weights.

**Rope Kit** - All lifting tackle i.e. rope, pulleys, karabiners, brakes and slings are physically checked for cuts and contamination.

Should the calibration certainty of any of the above equipment be in question, that item of equipment must be recalibrated and replaced if necessary.

## Filter Selection and Preparation

Stack conditions can vary greatly for temperature, moisture, acidity, low and heavy particulate loading.

Following the pre-site survey, the stack gas condition should be known and the appropriate filter can be selected and prepared as described below.

Filter mediums - glass wool, quartz wool, Gelman Sciences A/C Glass Fibre filter papers, Gelman Sciences Low Ash PVC membrane filter papers, Schleicher & Schuell Glass Fibre Thimbles or Schleicher & Schuell Quartz Thimbles.

Filters are prepared by drying in an oven at 120°C for a period of one hour and then placed to cool in a dessicator. The filters are weighed accurately on a 4-figure balance and then placed in clean individual petri dishes and transported to site in a filter storage box. Spare filters are also prepared to allow for accidents and to obtain blank values.

## Sampling Procedure

### Suitability of Sampling Location

Before sampling can commence, a preliminary velocity and temperature survey must be undertaken along the two sampling lines at ten equally spaced points excluding the region within 5% of the effective flue diameter from the wall. The stack diameter is measured using a steel rod. If the ratio of the highest to lowest dynamic pressures exceeds 9:1 or if the ratio of the highest to lowest gas velocities exceeds 3:1, another sampling plane should be used. Sampling is undertaken from either four or eight sampling points.



Four sampling points are used when the ratio of the highest to lowest dynamic pressures is less than 4:1 and eight sampling points when the ratio of highest to lowest dynamic pressures exceeds 4:1 but less than 9:1 or the stack area exceeds 2.5 m<sup>2</sup>. Temperature is also measured at ten equally spaced points along the sampling lines and an average temperature calculated. Should the temperature at any of the sampling points differ by more than  $\pm 10\%$  from that of the average temperature, then that point must not be used.

The required number of sampling points can now be calculated using the following:

4 point sampling, circular stacks: 0.15 x D and 0.85 x D.

4 point sampling, square stacks: 0.25 x D and 0.75 x D.

8 point sampling, circular stacks: 0.065 x D, 0.25 x D, 0.75 x D and 0.935 x D.

8 point sampling, square stacks: 0.125 x D, 0.375 x D, 0.625 x D and 0.875 x D.

### **Leak Checks**

A leak check should be undertaken before and after the iso-kinetic sampling is carried out. This is to make sure that all suction is taken at the sampling nozzle.

### **Sampling**

Once the iso-kinetic sampling flow rates have been calculated, the probe is inserted into the stack at 90° to the stack gas flow, as not to impinge any particulate matter on to the filter media prior to sampling. Allow the filter head and probe to attain the stack gas temperature. Start the suction device, and set the flowmeter to the correct suction rate for isokinetic sampling. At the same time turn the nozzle into flow and start the timing device.

### **Duration of Sampling Time**

Duration of sampling time depends on :

- (a) ensuring adequate quantities of particulate matter on the filter for weighing ( $> 0.3\%$  of the filter weight).
- (b) whether cumulative or incremental sampling is undertaken.
- (c) the number of sampling points i.e. either 4 or 8 point sampling.
- (d) the continuity of plant operation.

### **Cumulative Sampling**

After the first sample is taken from the first sampling position the control valve is closed simultaneously turning the sampling probe 90° to the stack gas flow, moving the probe to the next sample position. This process should be repeated until all the sample points have been used once.

### **Repeat Velocity and Temperature Readings**

At each of the sampling points repeat the readings for the stack gas flow rate and stack gas temperatures. Calculate the new iso-kinetic sampling flow rates. If the stack gas velocity is more than  $\pm 5\%$  from the initial readings the test result shall not be regarded as having the required accuracy. The new temperature reading should not exceed the permitted range calculated in the preliminary survey. i.e. it should be within  $\pm 10\%$  of the original mean temperature.

**N.B.** The filter head should be cleaned and the particulate matter added to the particulate matter on the filter.

The Sampling procedure should be repeated to obtain a duplicate sample, the ratio of the two particulate emission rates should not exceed 1.5 : 1.

### **Weighing of Sample**

The used filter should be placed in an oven at 105° C and dried thoroughly, cooled and equilibrated in a desiccator and weighed as quickly as possible so as to avoid any errors due to moisture absorption onto the filter. The gross weight of the filter should be measured to within  $\pm 0.1$  mg. The filter weight and any residual particulate matter from the filter head can then be used in the final report to calculate the particulate concentration.

## 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	198	30	250	30
2	0.09	209	30	287	30
3	0.14	248	30	292	30
4	0.20	239	30	305	30
5	0.26	295	30	301	30
6	0.31	286	30	246	30
7	0.37	284	30	267	30
8	0.43	304	30	240	30
9	0.48	310	30	271	30
10	0.54	319	30	260	30
Mean	-	269	30	272	30

Lowest Dynamic Pressure (any line)      198      Ratio of Above      1.61 : 1  
 Highest Dynamic Pressure (any line)      319      (Highest permitted ratio 9:1)  
 Temperature Range permitted for any point is between      0      to      60      °C

Run 1		Sampling Time (mins)		Nozzle size used (mm)			
Sampling Point	Dynamic Pressure (Pa)		Temperature (°C)		Velocity (m/s)		Flowmeter (m <sup>3</sup> /hr)
	Initial	Final	Initial	Final	Initial	Final	
1	209	212	30	30	15.85	15.97	1.55
2	310	307	30	30	19.31	19.21	1.89
3	287	292	30	30	18.58	18.74	1.81
4	271	274	30	30	18.05	18.15	1.76
Mean	269	271	30	30	17.95	18.02	1.75

Difference between Initial Velocity and Final Velocity =      0.39 %      (Limit permitted is ± 5%)

Start Filter Weight =      0.1200 g      Sample Weight =      0.0014 g  
 End Filter Weight =      0.1214 g      Sample as % of Filter Weight =      1.17 %

Run 2		Sampling Time (mins)		Nozzle size used (mm)			
Sampling Point	Dynamic Pressure (Pa)		Temperature (°C)		Velocity (m/s)		Flowmeter (m <sup>3</sup> /hr)
	Initial	Final	Initial	Final	Initial	Final	
1	212	210	30	34	15.97	16.00	1.56
2	307	312	30	34	19.21	19.50	1.88
3	292	289	30	34	18.74	18.77	1.83
4	274	272	30	34	18.15	18.21	1.77
Mean	271	271	30	34	18.02	18.12	1.76

Difference between Initial Velocity and Final Velocity =      0.54 %      (Limit permitted is ± 5%)

Start Filter Weight =      0.1200 g      Sample Weight =      0.0011 g  
 End Filter Weight =      0.1211 g      Sample as % of Filter Weight =      0.92 %

## **Chlorides Sampling Methodology**

The sampling was performed using a 'non-isokinetic method' using an 'in house' sampling train. Samples are collected using a wet chemistry technique, with concentrations determined using analysis by ion chromatography at an accredited laboratory.

### **Sampling Principle**

Sampling of the gas is carried out by extracting it representatively and collecting gaseous elements in an absorption reagent (chloride free water). Particles and dusts, which contain solid chlorides and fluorides, are removed by filtration.

All compounds which are volatile at the filtration temperature and produce chloride ions upon dissolution during sampling are measured by this method, which therefore gives the volatile inorganic chlorides content of the gases expressed as HCl. In most cases, this corresponds to the hydrogen chloride content.

### **Summary of Sampling Apparatus & Sampling Procedure**

The sampling train consists of an 'in stack' plane 25/50 mm diameter filter, a sampling probe of 6mm internal diameter, both constructed from PTFE/glass, upstream of the washing bottles.

Prior to each series of measurements, the probe is cleaned and a new filter installed in the filter holder. The washing bottles and connecting line are carefully rinsed with absorption reagent and the required volume of reagent placed in the bottles ready for sampling. The sampling train is assembled and a leak test is performed before each sampling operation. Before each measuring series is performed the determination of an equipment blank. The probe is installed in the duct and conditioned for 10 minutes to attain working temperature. The gas meter start volume is recorded, the pump started and the volume flow rate adjusted to approximately 2 l/min. During sampling the pressure, temperature and flow at the gas meter is recorded. The sampling time is approximately 30 min, because of the potential for HCl losses during transient phases of sampling. At the end of the sampling period the pump is stopped and the final gas meter volume recorded. The probe is withdrawn from the duct and the washing bottles dismantled and rinsed together with the connecting line in which condensation occurs. The absorption reagent is placed in a sample bottle, to which the rinse is added, and clearly labelled.

## Quality Assurance Checklist

### Velocity Measurements:

- Water droplets were not present. No
- Direction of gas flow within  $\pm 20^\circ$  of stack axis. Yes
- Dynamic Pressures  $> 5 \text{ Pa}$  at all sampling points. Yes
- Ratio of highest to lowest dynamic pressures  $< 9 : 1$ . Yes

### Sampling:

- Sampling plane correctly positioned. Yes
- Area of sampling apparatus not  $> 10\%$  of stack area. Yes
- Sampling from centres of equal areas. Yes
- Sampling at each point not less than 3 minutes. Yes
- Nozzle facing directly upstream to within  $\pm 10^\circ$ . Yes
- Leak check performed after each run and passed. Yes

### Sample Handling:

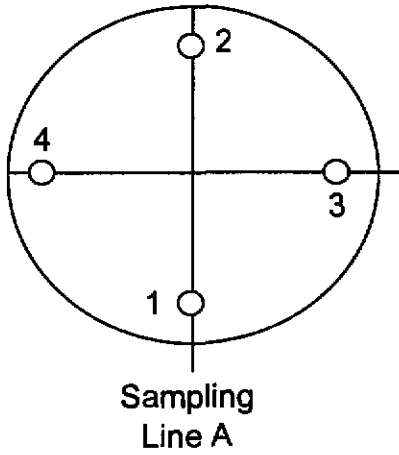
- Minimum weight of samples collected  $> 0.3\%$  of filter weights. Yes
- Samples achieved stable weights. Yes
- Particulate samples sent for lead analysis. Yes

### QA Procedures:

- File saved to disk. Yes
- Hard copy made. Yes
- On site isokinetic data sheet filed. Yes

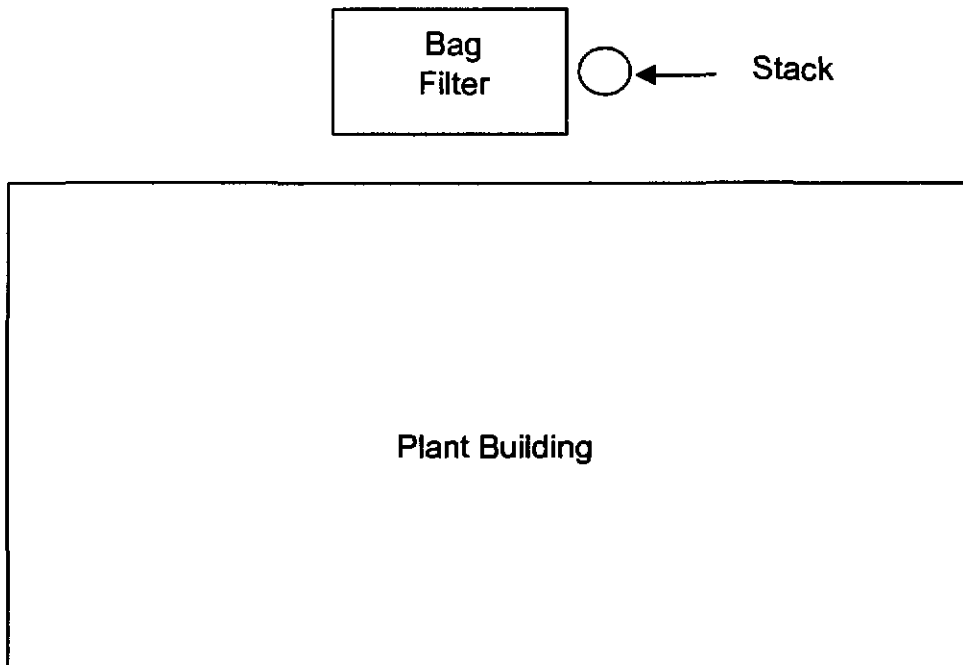
## Stack Diagram

Stack Diameter (D) = 0.57 m  
Stack Area (A) = 0.26 m<sup>2</sup>



Sampling Point	Distance as a % of D	Distance in m
1	15	0.09
2	85	0.48
3	15	0.09
4	85	0.48

## Plant Layout




## Environmental Monitoring Team

Environmental Team Leader    Andrew Palliser  
BSc (Hons) Environmental Studies

Environmental Technician    Daniel Pryke  
BSc (Hons) Environmental Studies

Report by    Andrew Palliser  
Team Leader

Checked and authorised by        Signed  
30/4/07    Dated

## **Conclusion**

The results of this test 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 PG 2/2 (96).

Testing was fully in accordance with BS 3405 : 1983.

Good housekeeping and maintenance of the ducting and abatement plant should be continued in order to maintain this level of Plant performance.

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