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**REPORT NO. 00305
MEASUREMENT OF
TOTAL PARTICULATE AND
VOC EMISSIONS
AT
VIP - HEINKE
HUNTINGDON
AUGUST 2001**

Client: VIP - HEINKE.
St Peter's Road
Huntingdon
Cambs.
PE18 7DJ

For the attention of: Mr D Rees

Dates of Field Work: 14/15/16 August 2001

Date of Report: 23 August 2001

Barry Thomas Fisher
MSc, Dip Occ Hyg, MBIQH, ROH

Registered Occupational Hygienist

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1 INTRODUCTION

At the request of Mr D Rees, various stack emissions were monitored for compliance with EPA requirements, i.e. for compliance with requirements of Process Guidance Note PG6/28 - Rubber Processes.

2 METHODOLOGY UTILISED

2.1 Total Particulate Matter - Stack emissions

The emissions from the exhaust stacks were measured by means of isokinetic sampling, carried out according to the main procedural requirements of BS 3405:1983 as specified in Secretary of State's Guidance Note PG6/28(92) - Rubber Processes.

Wherever possible the procedure followed was as follows. Prior to carrying out the isokinetic sampling it was necessary to establish the airflow and temperature profiles along two sampling lines across the stack.

The airflow profile was established by two six-point traverses arranged at right angles across the stack using a pitot static tube connected to a manometer.

The temperature profile was similarly measured using a digital K-Type thermometer.

All measurements were taken in a straight section of the discharge duct away from any obstructions that might cause disturbances in the airflow pattern etc. The girth of the stack was measured and the internal diameter of the stack was calculated. The volume airflow was calculated from the velocity measurements obtained above.

Once the airflow and temperature profiles had been established as suitable for isokinetic sampling, the air velocities were then measured at a further four positions located at the centres of four equal areas as required by BS 3405: 1983.

A sample was then taken at each of these four locations by drawing air through a suitably sized nozzle, conforming to the requirements of BS 3405: 1983, and collecting the particulate matter on a pre-weighed glass fibre filter (Whatman GF/A); the flow rates being adjusted to provide isokinetic sampling to match the air velocities already determined at each of these locations in the stack.

This procedure was then repeated to obtain a duplicate sample of the emissions.

After sampling the exposed filters were transported back to the laboratory and allowed to equilibrate for a period of 24 hours to allow time for evaporation of any adsorbed moisture before being re-weighed.

The total particulate matter in the emissions was then calculated from the results obtained.

On some of the stacks the skew pattern of the airflow within the duct made it impossible to obtain an accurate indication of the air velocity. It was found that the airflow was inclined in the region of 15-20° from the vertical indicating a swirling pattern of airflow within the duct. Therefore in these circumstances there was no alternative but to measure the airflow by angling the Pitot tube to the same extent followed by isokinetic sampling with the sampling probe similarly inclined.

2.2 **Volatile Organic Compounds (VOC's)**

A portable Flame Ionisation Detector (FID), Research Engineers - type GAS-TECH VOC, was used to measure the VOC content of the emissions.

Before use the instrument had been calibrated using methane. The results were calculated using the appropriate response factor for the compound being measured as specified by the manufacturers of the instrument.

In the case of rubber fume, the results are expressed in terms of methane-equivalent, as the composition of the fume is unknown.

3 **RESULTS**

3.1 The results of the various samples are given in the tables.

COMMENTS ON THE RESULTS

The limits set out for the emissions in PG6/28 are as follows:

Total Particulate Matter from the storage, handling or mixing of carbon black (applicable to stacks 43 & 44 only)	10 mg/m ³
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Total Particulate Matter other than from the storage, handling or mixing of carbon black	50 mg/m ³
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Volatile Organic Compounds (as total carbon excluding particulate matter)	50 mg/m ³
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All of the emissions measured were found to be well below the relevant limits in respect to Total Particulate Matter.

All of the rubber fume emissions were found to be well below the VOC emission limit.

On this occasion, whilst spraying small metal parts, the spray booth emissions were found to exceed the VOC limit; the concentrations being emitted were found to be in the range of 17 - 343 mg C/m³, with an average value of 191 mg C/m³.

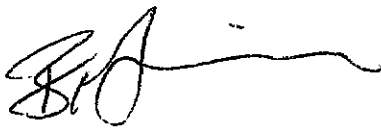
Also, the emissions from the Mindon oven adjacent to the spray booth were found to exceed the VOC limit; the concentrations being emitted were found to be in the range of 8 - 207 mg C/m³, with an average value of 108 mg C/m³.

CONCLUSIONS

The results of the Total Particulate Matter measurements have shown that the emissions, from all of the ten stacks measured, comply with the current limits in respect of PG6/28.

Once again, the results from the 33 stacks measured for rubber fume VOC's have shown that all of these emissions comply with the current limits in respect of PG6/28.

However, the VOC emissions from the metal preparation posts were once again found to be in excess of the VOC limit whilst spraying the small metal parts. However, we were told that the Local Authority were prepared to allow this to continue as the total annual consumption of solvents is less than 5 tonnes/annum.



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Consultant Occupational Hygienist

TABLE 1A

PITOT STATIC TUBE MEASUREMENT RECORD

FACTORY NAME: VIP

DATE: 15.8.01

STACK No: 24

CIRCULAR DUCT

DUCT DIAMETER: 0.300 m

NUMBER OF POINTS IN TRAVERSE: 6

IN-DUCT TEMPERATURE: 31°C

ATMOSPHERIC PRESSURE: 100.7 kPa

VELOCITY MEASUREMENTS:

Location No	Location Position (mm)	First Traverse (m/s)	Second Traverse (m/s)
1	10	8.0	8.5
2	41	8.0	8.5
3	96	8.0	8.0
4	204	6.5	7.0
5	260	6.5	7.0
6	290	5.5	6.0

RESULTS

AVERAGE VELOCITY 7.29 m/s

AVERAGE FLOW 30.9 m³/min

TABLE 1B

TOTAL PARTICULATE MATTER MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 15.8.01

STACK No: 24

SAMPLING NOZZLE SIZE: 5.0 mm

LOCATION (mm)	VELOCITY (m/s)	SAMPLING RATE (l/m)
First Traverse		
45	8.0	9.4
225	6.5	7.7
Second Traverse		
45	8.5	10.0
225	7.0	8.2

INITIAL SAMPLE

TOTAL VOLUME SAMPLED: 107.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.96 mg/m³

DUPLICATE SAMPLE

TOTAL VOLUME SAMPLED: 108.5 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.95 mg/m³

AVERAGE TOTAL PARTICULATE CONCENTRATION **0.96 mg/m³**

TABLE 2A

PITOT STATIC TUBE MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 15.8.01

STACK No: 29

CIRCULAR DUCT

DUCT DIAMETER: 0.300 m

NUMBER OF POINTS IN TRAVERSE: 6

IN-DUCT TEMPERATURE: 26°C

ATMOSPHERIC PRESSURE: 100.7 kPa

VELOCITY MEASUREMENTS:

Location No	Location Position (mm)	First Traverse (m/s)	Second Traverse (m/s)
1	10		
2	41		
3	96	Unable to quantify due to swirling	
4	204		
5	260		
6	290		

RESULTS

AVERAGE VELOCITY m/s

AVERAGE FLOW m³/min

TABLE 2B

TOTAL PARTICULATE MATTER MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 15.8.01

STACK No: 29

SAMPLING NOZZLE SIZE: 5.0 mm

LOCATION (mm)	VELOCITY (m/s)	SAMPLING RATE (l/m)
First Traverse		
45	2.0R	2.4
255	4.0L	4.8
Second Traverse		
45	3.0L	3.6
255	2.5L	3.0

INITIAL SAMPLE

TOTAL VOLUME SAMPLED: 32.5 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 1.05 mg/m³

DUPLICATE SAMPLE

TOTAL VOLUME SAMPLED: 33.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.34 mg/m³

AVERAGE TOTAL PARTICULATE CONCENTRATION **0.70 mg/m³**

TABLE 3A

PITOT STATIC TUBE MEASUREMENT RECORD

FACTORY NAME: VIP

DATE: 15.8.01

STACK No: 75

CIRCULAR DUCT

DUCT DIAMETER: 0.300 m

NUMBER OF POINTS IN TRAVERSE: 6

IN-DUCT TEMPERATURE: 38°C

ATMOSPHERIC PRESSURE: 100.7 kPa

VELOCITY MEASUREMENTS:

Location No	Location Position (mm)	First Traverse (m/s)	Second Traverse (m/s)
1	10	3.5	3.5
2	41	3.5	4.0
3	96	3.5	4.0
4	204	4.5	4.5
5	260	4.5	4.5
6	290	4.5	4.5

RESULTS

AVERAGE VELOCITY 4.08 m/s

AVERAGE FLOW 17.3 m³/min

TABLE 3B

TOTAL PARTICULATE MATTER MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 15.8.01

STACK No: 75

SAMPLING NOZZLE SIZE: 5.0 mm

LOCATION (mm)	VELOCITY (m/s)	SAMPLING RATE (l/m)
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First Traverse

45	3.5	4.1
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255	4.5	5.3
-----	-----	-----

Second Traverse

45	4.0	4.7
----	-----	-----

255	4.5	5.3
-----	-----	-----

INITIAL SAMPLE

TOTAL VOLUME SAMPLED: 47.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 3.61 mg/m³

DUPLICATE SAMPLE

TOTAL VOLUME SAMPLED: 49.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 4.85 mg/m³

AVERAGE TOTAL PARTICULATE CONCENTRATION **4.23 mg/m³**

TABLE 4A

PITOT STATIC TUBE MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 14.8.01

STACK No: 43

CIRCULAR DUCT

DUCT DIAMETER: 0.525 m

NUMBER OF POINTS IN TRAVERSE: 6

IN-DUCT TEMPERATURE: 25°C

ATMOSPHERIC PRESSURE: 100.9 kPa

VELOCITY MEASUREMENTS:

Location No	Location Position (mm)	First Traverse (m/s)	Second Traverse (m/s)
1	17	5.0	5.0
2	71	6.5	7.0
3	169	7.0	7.0
4	357	7.0	7.0
5	455	7.0	6.5
6	509	5.5	5.0

RESULTS

AVERAGE VELOCITY 6.29 m/s

AVERAGE FLOW 81.7 m³/min

TABLE 4B

TOTAL PARTICULATE MATTER MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 14.8.01

STACK No: 43

SAMPLING NOZZLE SIZE: 5.0 mm

LOCATION (mm)	VELOCITY (m/s)	SAMPLING RATE (l/m)
First Traverse		
79	6.5	7.7
447	7.0	8.2
Second Traverse		
79	7.0	8.2
447	6.5	7.7

INITIAL SAMPLE

TOTAL VOLUME SAMPLED: 93.5 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.72 mg/m³

DUPLICATE SAMPLE

TOTAL VOLUME SAMPLED: 96.5 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 1.28 mg/m³

AVERAGE TOTAL PARTICULATE CONCENTRATION **1.00 mg/m³**

TABLE 5A

PITOT STATIC TUBE MEASUREMENT RECORD

FACTORY NAME: VIP

DATE: 15.8.01

STACK No: 32

CIRCULAR DUCT

DUCT DIAMETER: 0.800 m

NUMBER OF POINTS IN TRAVERSE: 6

IN-DUCT TEMPERATURE: 34°C

ATMOSPHERIC PRESSURE: 100.7 kPa

VELOCITY MEASUREMENTS:

Location No	Location Position (mm)	First Traverse (m/s)	Second Traverse (m/s)
1	26	7.5	0
2	108	12.0	2.5
3	257	13.0	8.0
4	543	12.0	12.0
5	692	11.0	2.5
6	774	6.5	0

RESULTS

AVERAGE VELOCITY 7.25 m/s

AVERAGE FLOW 219 m³/min

TABLE 5B

TOTAL PARTICULATE MATTER MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 15.8.01

STACK No: 32

SAMPLING NOZZLE SIZE: 3.5 mm

LOCATION (mm)	VELOCITY (m/s)	SAMPLING RATE (l/m)
First Traverse		
120	12.0	6.9
680	11.0	6.4
Second Traverse		
120	2.5	1.5
680	2.5	1.5

INITIAL SAMPLE

TOTAL VOLUME SAMPLED: 43.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.51 mg/m³

DUPLICATE SAMPLE

TOTAL VOLUME SAMPLED: 45.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.48 mg/m³

AVERAGE TOTAL PARTICULATE CONCENTRATION **0.50 mg/m³**

TABLE 6A

PITOT STATIC TUBE MEASUREMENT RECORD

FACTORY NAME: V I P
DATE: 15.8.01
STACK No: 23

CIRCULAR DUCT

DUCT DIAMETER: 0.485 m
NUMBER OF POINTS IN TRAVERSE: 6
IN-DUCT TEMPERATURE: 36°C
ATMOSPHERIC PRESSURE: 100.7 kPa

VELOCITY MEASUREMENTS:

Location No	Location Position (mm)	First Traverse (m/s)	Second Traverse (m/s)
1	16	12.0	15.5
2	66	15.0	17.0
3	156	6.0	12.0
4	331	9.0	6.0
5	421	16.0	15.0
6	471	15.5	13.0

RESULTS

AVERAGE VELOCITY 12.7 m/s

AVERAGE FLOW 140 m³/min

TABLE 6B

TOTAL PARTICULATE MATTER MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 15.8.01

STACK No: 23

SAMPLING NOZZLE SIZE: 3.5 mm

LOCATION (mm)	VELOCITY (m/s)	SAMPLING RATE (l/m)
First Traverse		
73	15.0	8.7
412	16.0	9.2
Second Traverse		
73	17.0	9.8
412	15.0	8.7

INITIAL SAMPLE

TOTAL VOLUME SAMPLED: 111.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.50 mg/m³

DUPLICATE SAMPLE

TOTAL VOLUME SAMPLED: 111.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 1.00 mg/m³

AVERAGE TOTAL PARTICULATE CONCENTRATION **0.75 mg/m³**

TABLE 7A

PITOT STATIC TUBE MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 14.8.01

STACK No: 18

CIRCULAR DUCT

DUCT DIAMETER: 0.280 m

NUMBER OF POINTS IN TRAVERSE: 6

IN-DUCT TEMPERATURE: 29°C

ATMOSPHERIC PRESSURE: 100.9 kPa

VELOCITY MEASUREMENTS:

Location No	Location Position (mm)	First Traverse (m/s)	Second Traverse (m/s)
1	9	7.0	6.5
2	38	7.0	6.0
3	90	6.5	5.5
4	190	6.5	7.0
5	242	6.0	7.0
6	271	5.0	5.5

RESULTS

AVERAGE VELOCITY 6.29 m/s

AVERAGE FLOW 23.2 m³/min

TABLE 7B

TOTAL PARTICULATE MATTER MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 14.8.01

STACK No: 18

SAMPLING NOZZLE SIZE: 5.0 mm

LOCATION (mm)	VELOCITY (m/s)	SAMPLING RATE (l/m)
First Traverse		
42	7.0	8.2
238	6.0	7.1
Second Traverse		
42	6.0	7.1
238	7.0	8.2

INITIAL SAMPLE

TOTAL VOLUME SAMPLED: 88.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.26 mg/m³

DUPLICATE SAMPLE

TOTAL VOLUME SAMPLED: 89.5 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.25 mg/m³

AVERAGE TOTAL PARTICULATE CONCENTRATION **0.26 mg/m³**

TABLE 8A

PITOT STATIC TUBE MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 15.8.01

STACK No: 44

CIRCULAR DUCT

DUCT DIAMETER: 0.460 m

NUMBER OF POINTS IN TRAVERSE: 6

IN-DUCT TEMPERATURE: 40°C

ATMOSPHERIC PRESSURE: 100.7 kPa

VELOCITY MEASUREMENTS:

Location No	Location Position (mm)	First Traverse (m/s)	Second Traverse (m/s)
1	15	17.5	17.5
2	62	18.0	19.0
3	148	19.0	19.0
4	313	18.0	19.0
5	399	19.0	19.0
6	447	15.5	14.5

RESULTS

AVERAGE VELOCITY 17.9 m/s

AVERAGE FLOW 179.0 m³/min

TABLE 8B

TOTAL PARTICULATE MATTER MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 15.8.00

STACK No: 44

SAMPLING NOZZLE SIZE: 3.0 mm

LOCATION (mm)	VELOCITY (m/s)	SAMPLING RATE (l/m)
First Traverse		
69	18.0	7.6
392	19.0	8.1
Second Traverse		
69	19.0	8.1
392	19.0	8.1

INITIAL SAMPLE

TOTAL VOLUME SAMPLED: 96.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 2.14 mg/m³

DUPLICATE SAMPLE

TOTAL VOLUME SAMPLED: 96.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.72 mg/m³

AVERAGE TOTAL PARTICULATE CONCENTRATION **1.43 mg/m³**

TABLE 9A

PITOT STATIC TUBE MEASUREMENT RECORD

FACTORY NAME: VIP

DATE: 14.8.01

STACK No: 60

CIRCULAR DUCT

DUCT DIAMETER: 0.280 m

NUMBER OF POINTS IN TRAVERSE: 6

IN-DUCT TEMPERATURE: 28°C

ATMOSPHERIC PRESSURE: 100.9 kPa

VELOCITY MEASUREMENTS:

Location No	Location Position (mm)	First Traverse (m/s)	Second Traverse (m/s)
1	9	5.5	6.0
2	38	6.0	6.0
3	90	6.0	6.5
4	190	6.0	6.5
5	242	6.0	6.0
6	271	5.0	5.5

RESULTS

AVERAGE VELOCITY 5.92 m/s

AVERAGE FLOW 21.9 m³/min

TABLE 9B

TOTAL PARTICULATE MATTER MEASUREMENT RECORD

FACTORY NAME: V I P

DATE: 14.8.01

STACK No: 60

SAMPLING NOZZLE SIZE: 5.0 mm

LOCATION (mm)	VELOCITY (m/s)	SAMPLING RATE (l/m)
First Traverse		
42	6.0	7.1
238	6.0	7.1
Second Traverse		
42	6.0	7.1
238	6.0	7.1

INITIAL SAMPLE

TOTAL VOLUME SAMPLED: 82.5 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.27 mg/m³

DUPLICATE SAMPLE

TOTAL VOLUME SAMPLED: 85.0 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.27 mg/m³

AVERAGE TOTAL PARTICULATE CONCENTRATION **0.27 mg/m³**

TABLE 10A

PITOT STATIC TUBE MEASUREMENT RECORD

FACTORY NAME: V I P
DATE: 14.8.01
STACK No: 20

CIRCULAR DUCT

DUCT DIAMETER: 0.280 m
NUMBER OF POINTS IN TRAVERSE: 6
IN-DUCT TEMPERATURE: 28°C
ATMOSPHERIC PRESSURE: 100.9 kPa

VELOCITY MEASUREMENTS:

Location No	Location Position (mm)	First Traverse (m/s)	Second Traverse (m/s)
1	9	7.5	8.0
2	38	7.5	8.0
3	90	7.5	7.0
4	190	7.5	6.5
5	242	7.0	6.0
6	271	5.5	4.5

RESULTS

AVERAGE VELOCITY 6.88 m/s

AVERAGE FLOW 25.4 m³/min

TABLE 10B

TOTAL PARTICULATE MATTER MEASUREMENT RECORD

FACTORY NAME: VIP

DATE: 14.8.01

STACK No: 20

SAMPLING NOZZLE SIZE: 5.0 mm

LOCATION (mm)	VELOCITY (m/s)	SAMPLING RATE (l/m)
First Traverse		
42	7.5	8.8
238	7.0	8.2
Second Traverse		
42	8.0	9.4
238	6.0	7.1

INITIAL SAMPLE

TOTAL VOLUME SAMPLED: 98.5 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.23 mg/m³

DUPLICATE SAMPLE

TOTAL VOLUME SAMPLED: 97.5 Litres

TOTAL PARTICULATE CONCENTRATION
(REF. CONDITIONS): 0.12 mg/m³

AVERAGE TOTAL PARTICULATE CONCENTRATION **0.18 mg/m³**

TABLE 11

SUMMARY OF RESULTS (TOTAL PARTICULATE MATTER.)

(mg/m³)

<u>STACK No.</u>	<u>SAMPLE 1</u>	<u>SAMPLE 2</u>	<u>AVERAGE VALUE.</u>
24	0.96	0.95	0.96
29	1.05	0.34	0.70
75	3.61	4.85	4.23
43	0.72	1.28	1.00
32	0.51	0.48	0.50
23	0.50	1.00	0.75
18	0.26	0.25	0.26
44	2.14	0.72	1.43
60	0.27	0.27	0.27
20	0.23	0.12	0.18

Nb All results have been corrected to the standard reference conditions of 101.3 kPa and 273°K

TABLE 12

RUBBER FUME VOC RESULTS

<u>STACK No</u>	<u>FID READING</u> <u>(ppm CH₄ Equivalent)</u>	<u>VOC RESULT</u> <u>(mg C/m³)</u>
6	1	0.5
7	1	0.5
8	1	0.5
9	1	0.5
10	1	0.5
11	1	0.5
12	1	0.5
14	1	0.5
16	1	0.5
17	1	0.5
18	1	0.5
19	1	0.5
20	1	0.5
21	1	0.5
23	1	0.5
24	1	0.5
25	1	0.5
26	1	0.5
27	1	0.5
28	1	0.5
29	1	0.5
30	1	0.5
32	1	0.5
35	1	0.5
36	1	0.5
37	1	0.5
38	1	0.5
39	1	0.5
40	1	0.5
41	1	0.5
43	1	0.5
60	1	0.5
75	1	0.5

* based on methane equivalents as actual composition unknown

TABLE 13

VOC EMISSIONS FROM METAL PREPARATION DISCHARGES

SPRAY BOOTH

From a survey carried out in January 1999, the solvents being emitted from this spray booth were found to consist of a mixture of methyl isobutyl ketone, xylenes, and toluene.

The stack temperature during the measurement was found to be 21°C.

Assuming the same composition for the solvent mixture and correcting to reference conditions.

Whilst spraying small metal parts, the spray booth emissions were found to exceed the VOC limit; the concentrations being emitted were found to be in the range of 17 - 343 mg C/m³, with an average value of 191 mg C/m³.

MINDEN OVEN

This was assumed to be emitting a similar mixture of solvents. The stack temperature during the measurement was found to be 57°C.

Corrected to reference conditions, the emissions from the Mindon oven adjacent to the spray booth were found to exceed the VOC limit; the concentrations being emitted were found to be in the range of 8- 207 mg C/m³, with an average value of 108 mg C/m³.