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**Emissions Testing of Spray Booths
At WMK 30th November 2005**

**Report Prepared for Aspen Environmental Ltd by
Dr G.W. Buck (Director)
J672
January 2006**

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Appendix Page

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Introduction

WMK Accident Repair Ltd operate a bodyshop in Keresley in Coventry. The bodyshop has two spraybooths located side by side at the end of the property.

Dr Buck & Miss Lunnon of Aspen Environmental Ltd, visited the site on the 30th Novemeber 2005 to undertake the sampling of site emissions.

The two spraybooths have circular profile exhausts extending approximately 3m above the metal roof. Both have reductions in the stack diameter (Venturis) at the top to increase the final exhaust velocity.

For identification purposes, the booths are defined throughout the report by their manufacturers. The smaller spraybooth is a Burntwood Booth, and the larger Spraybooth is a Spraybake Booth with Junair select control.

Methodology

The test procedure followed the main procedural points of ISO 9096:2003 for sampling of particulates in the exhausts.

Sampling was undertaken when spraying was in process in the booth below, and the exhaust was functioning. In both cases after the spraying was complete, the booth moved into a bake function, circulating warm air to the dry paint, and with the exhaust blocked off.

The flow in the Burntwood booth exhaust was very turbulent, with some negative flows recorded. However the positioning of the sampling points was optimal, and for this booth sampling was undertaken at a single centre point location. ✱

For each booth two samples were collected while spraying was underway on the same vehicle part. The item sprayed in the Spraybake Booth was a vehicle bonnet section. For the first sample the spray was base coat blue (water based), and the second was clearcoat (solvent based). Similarly in the Burntwood Booth white basecoat and clearcoat were applied to the front wing of a vehicle.

Dr Buck is personally MCerted to Team Leader grade, with technical endorsements TE1 (particulates) TE3 (gas analysis by manual methods) & TE4 (gas analysis by instrumental methods). Aspen Environmental Ltd is UKAS and MCerts accreditation for gas and organic analysis (UKAS Lab No. 2395), endorsed by the STA for particulate testing and gas analysis, and the company hopes to be UKAS MCerts accredited for particulate sampling (and some other methods) early in 2006.

Results

The results are presented in a summary table below, which shows the emissions of particulates from the two booths. Each parameter was sampled twice in each exhaust, and the individual results are shown, plus a mean result. In each case an estimated uncertainty on the results is included, and the emission limits set by PG Note 6/34 2003 is included for comparison with the result.

WMK Accident Repair: Spray Booth Emissions 30th November 2005			
Total Particulates	mg/m³ Normalised to 273K, 1013 mb, dry gas	Uncertainty in Measurements	Emission Limit In mg/Nm³ PG 6/34 (July 2003)
Burntwood Booth	3.8 33.7		
Mean	< 5	± 0.04	10
Spraybake Booth	13 9.3		
Mean	11.2	± 0.1	10

The remaining results tables are included in the appendix as follows:

Appendix page 1 shows all the measurements associated with the particulate sampling, including filter references, gas meter readings, temperature readings, sampling times and filter weights. It also includes the derived results of sample volume (ambient and normal), and particulate weight and concentration. The page also includes two separate tables showing the calculation of isokinetic sampling efficiency based on the stack flow rate and test sampling rate.

Appendix 2 and 3 are two tables of pitot tube measurements showing all the readings across the two traverses. The turbulence in No. 1 can clearly be seen, and the better performance of No. 2. The table shows the calculation of velocity and volume flow in each stack.

Appendix 4 and 5 are copies of the on-site data sheets, and show all the data recorded in its original form. In each case the flow rates are calculated for site work, which determines the isokinetic rate at each sampling point.

Note on Results

The result for the Burntwood booth needs some explanation. The second sample for the clearcoat spray picked up a series of large lumps of black material presumably broken away from the stack interior. Most of this material was removed from the filter by the lab, but some was still attached, and could not be removed without damaging the filter, which accounts for the elevated result in the summary table & Appendix table 1.

Previous results from this and other spraybooths, reflect the fact that less clearcoat is applied to a vehicle respray than basecoat, and that the particulate concentration emitted by clearcoat is almost always significantly less than that for basecoat, as is seen in the Spraybake booth results.

Hence the final result of less than 5 presented in the summary table.

Appendix

WMK Motors, Coventry

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Particulate Emissions from Spray Booths (30/11/2005)

Filter Ref	Dry Gas Meter:			Temperature ° C		Normal Sample Volume Litres	Time			Filter Weight		Particulate	
	DGM Factor =	1.03		Stack	Gas Meter		Initial	Final	Elapsed minutes	Initial mg	Final mg	Acetone mg	Concentration mg/m3

Spray Bake Booth

Barometric Pressure =		999	mb											
29597	289635.8	289704.0	68.2	22	28	59.2	10.26	10.32	8	32.724	33.196	0.472	0.3	13.04
29566	289710.4	289774.3	63.9	22	28	55.5	12.13	12.21	8	33.140	33.054	-0.086	0.6	9.26
Total						114.7								

Burntwood Booth

Barometric Pressure =		999	mb											
29580	289774.2	289813.5	39.3	13	11	36.2	13.05	13.12	7	32.507	32.444	-0.063	0.2	3.79
29579	289813.5	289839.8	26.3	13	11	24.2	13.38	13.43	5	33.154	33.670	0.516	0.3	33.71
Total						60.4								

29602	Control											35.287	35.311	0.024	0.3
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Isokinetic Sampling Efficiency

Spray Bake Booth			Sample Volume in Litres	
Isokinetic points mean Velocity	7.95	Nm / s	Theoretical	95.9
Sampling Tip Diameter	4	mm	Actual	114.7
Sampling Time	16	minutes	% Isokinetic	119.6

Burntwood Booth			Sample Volume in Litres	
Isokinetic point Velocity	6.4	Nm / s	Theoretical	57.9
Sampling Tip Diameter	4	mm	Actual	60.4
Sampling Time	12	minutes	% Isokinetic	104.3

Pitot Flow Measurements

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Client: WMK Motors	Time & Date: 13.05 - 13.42 30/11/2005
Address: Coventry	Operator: GB & KL
	Job Number: 672
	Location: Burntwood Booth

Details of Duct	Atmospheric Pressure (Pa) millibars
Duct Shape: Vertical Circular	Initial: 999
Dimension / Diameter: (cm) 60	Final: 999
Area: sq metres 0.28	Mean: 999

Pitot Tube Position:	Distance into Duct		Axis 1:			Axis 2:		
	% Diameter	cm	Velocity Pressure Pv Pascals	Static Pressure Ps Pascals	Duct Temp ° Celsius	Velocity Pressure Pv Pascals	Static Pressure Ps Pascals	Duct Temp ° Celsius
1	1.9	1.1	0	60	22	10	40	21
2	7.7	4.6	0	40	22	60	25	20
3	15.3	9.2	0	5	22	0	-6	22
4	21.7	13.0	30	-40	22	0	-40	22
5	36.1	21.7	18	-29	22	32	-40	22
6	63.9	38.3	6	-18	22	9	-30	22
7	78.3	47.0	0	22	22	0	0	22
8	84.7	50.8	0	60	22	23	34	22
9	92.3	55.4	0	77	22	11	70	22
10	98.1	58.9	5	88	22	20	100	22

RMS & Means:	11.34	26.5	22	24.20	15.3	21.7
Mean Pv (Pascals)	17.77	Mean T in K (°C + 273)				294.85
Static Pressure (Pa)	20.9	Pitot Tube	200	K Factor		1

Duct Velocity (V) @ Temperature (T) in metres per second	5.49
Duct Velocity (V) @ 273K, 1013mb, in metres per second	5.01
Duct Volume Flow @ T in cubic metres per second	1.55
Duct Volume Flow @ 273K, 1013mb, in cubic metres per second	1.42
Duct Volume Flow @ 273K, 1013mb, in cubic feet per minute	3001
Duct Volume Flow @ Temperature (T) in cubic feet per minute	3287

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Pitot Flow Measurements

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Client: WMK Motors	Time & Date: 10.32 - 12.21 30/11/2005
Address: Coventry	Operator: GB & KL
	Job Number: 672
	Location: Spraybake Booth Booth

Details of Duct	Atmospheric Pressure (Pa) millibars
Duct Shape: Vertical Circular	Initial: 999
Dimension / Diameter: (cm) 72	Final: 999
Area: sq metres 0.41	Mean: 999

Pitot Tube Position:	Distance into Duct		Axis 1:			Axis 2:		
	% Diameter	cm	Velocity Pressure Pv	Static Pressure Ps	Duct Temp ° Celsius	Velocity Pressure Pv	Static Pressure Ps	Duct Temp ° Celsius
			Pascals	Pascals		Pascals	Pascals	
1	1.9	1.4	130	-20	26	55	-69	27
2	7.7	5.5	113	-10	25	10	-73	26
3	15.3	11.0	118	0	25	13	-80	25
4	21.7	15.6	95	-15	24.8	22	-90	25
5	36.1	26.0	91	-45	24.7	57	-80	25
6	63.9	46.0	51	-60	24.5	105	-80	25
7	78.3	56.4	55	-60	27	74	-80	25
8	84.7	61.0	52	-50	27	102	-70	25
9	92.3	66.5	37	-28	27	103	-30	25
10	98.1	70.6	50	-8	27	124	-15	23

RMS & Means:	85.50	-29.6	25.8	77.41	-66.7	25.1
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Mean Pv (Pascals)	81.45	Mean T in K (°C + 273)	298.45
Static Pressure (Pa)	-48.15	Pitot Tube	200
		K Factor	1

Duct Velocity (V) @ Temperature (T) in metres per second	11.82
Duct Velocity (V) @ 273K, 1013mb, in metres per second	10.67
Duct Volume Flow @ T in cubic metres per second	4.81
Duct Volume Flow @ 273K, 1013mb, in cubic metres per second	4.34
Duct Volume Flow @ 273K, 1013mb, in cubic feet per minute	9202
Duct Volume Flow @ Temperature (T) in cubic feet per minute	10200

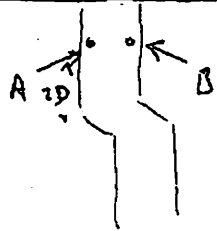
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General Sampling Data Form

Location & Drawing

WMK Coventry
30/11/05
Spray Bake Booth
Ladder access.




Location					
Date	30/11/05	Time	10:25		
Barometric Pressure	mb		999		
Temperature °C	Exhaust				
	Ambient		22		
	Gas Meter		28		

Pitot Tube Traverses (Measurements in Pascals) Stack Dimensions (cm) & Aspect 720cm circ. w/A ↑

Position	Time	1	2	3	4	5	6	7	8	9	10	Mean	Static
Pv A	10:20	130	113	118	95	91	51	55	52	37	50		
Ps		-20	-10	0	-15	-45	-50	-60	-50	-28	-8		
T	10:35	26	23	25	24.8	24.7	24.5	27	27	27	27		
Pv B	10:34	55	10	13	22	37	105	74	102	103	124		
Ps		-69	-73	-80	-90	-80	-80	-80	-70	-30	-15		
T	10:38	27	26	25	25	25	25	25	25	25	25		

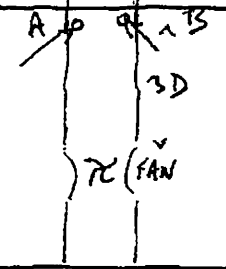
Vacuum Check Flow @ Ambient 10.5 m/s Sampling Flow 8.0 L/min Tip Diameter 4 mm Pitot Tube 200

Sample Reference	Position	Time		Gas Meter / Counter		Sampling Points	Equipment
		Initial	Final	Initial	Final		
29597				289635.0	289635.8	A 11 14 10.6 l/m (11)	223 Pump
(Base coat)	A+B (B11)				289689	A 60 11 8.3 l/m (17)	97 Gasmeter
	(B60)	10:32	10:34		289704	B 11 (A.T) 7.1 5.4 l/m (17)	83 Gas Temp
	(A11)	10:26			289658	B 60 10 7.5 l/m (29)	77 Silica Gel
	(B60)	10:28			289676		X Condenser
29566	A&B			2897104		2 minutes per point	234 Thermocouple
(Top coat)	(A11)	12:13			289732.1		Operator 
	(A60)	12:15			289742.5		
	(B11)	12:17			289759.8		
	(B60)	12:19	12:21		289772.3		
29602	CONTROL						Normal Flow 10.67

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General Sampling Data Form

Location & Drawing WMK Coventry Smaller Booth Burntwood Booth Ladder Access	Location												
	Date	30/11/05	Time	12:35									
	Barometric Pressure	mb	999										
	Temperature °C	Exhaust											
		Ambient	13										
	Gas Meter	11											



Pitot Tube Traverses (Measurements in Pascals)				Stack Dimensions (cm) & Aspect									
Position	Time	1	2	3	4	5	6	7	8	9	10	Mean	Static
Pv A	12:37	-30	-40	-20	30	18	6	-30	-50	-64	-5		
Ps		+60	+40	+5	-40	-29	-18	+22	+60	+77	+88		
T	12:45	22	22	22	22	22	22	22	22	22	22		
Pv B	12:40	+10	+60	+30-60	-5	+32	+9	0	+23	+11	+20		
Ps		+40	+25	-6	-40	-40	-30	0	+34	+70	+100		
T	12:44	22	22	22	22	22	22	22	22	22	22		

Vacuum Check: Flow @ Ambient 6.4 m/s, Sampling Flow 4.8 L/min, Tip Diameter 4 mm, Pitot Tube 200

Sample Reference	Position	Time		Gas Meter / Counter		Sampling Points	Equipment
		Initial	Final	Initial	Final		
29580	Centre (base coat)	13:05		289774.2		4.8 l/m = 5.2 machine 7 minutes total sampling 6.5 mins spraying time	223 Pump
		13:12		289813.5			80 Flowmeter
							97 Gasmeter
							83 Gas Temp
29579	Centre (top coat)	13:38		289813.5		3.3 mins spraying time 5 mins sampling - black cap from chimney in filter - R. hand & knock off & reweigh	77 Silica Gel
		13:42		289839.8			X Condenser
							234 Thermocouple

Operator

Normal Flow
 5.01