# VOLATILE ORGANIC COMPOUNDS EMISSIONS COMPLIANCE TESTING AT PAXFORD COMPOSITES LTD IN MARCH 2010

FOR: Paxford Composites Ltd 2-4 Redwongs Way Huntingdon Cambridgeshire PE29 7HB

FAO:

Mr Neil Search

Work By: K C Blakley and M R Ellison

Reference:105435\QE8400\PX0	Page 1 of 22	
Date of issue:		
	Name:	
MCerts Level 2 Approver	Signed:	for Managing Director
Name: Kevin Blakley		
Signature:		

	Par	t 1: - Executive	Summary –Co	ompliance Report		
Process Operator Paxford Compo	ſ	Laveutin	LA Permit No B01/02			
		Site Specific Protocol Reference PX02MAR10\SSP				
Address Paxford Composites Ltd 2-4 Redwones Way			Contact Neil Search			
2-4 Redwongs W Huntingdon Cambridgeshire			Tel No 01480453537 Email			
PE29 7HB				aaxfordcomposites.co.uk		
Tests carried out Compliance VOCs of 3 Spray Booths Testing laboratory National Physical Laboratory			Dates tests carried out 31 <sup>st</sup> March 2010 UKAS Accreditation No 0002			
						Address Hampton Road Teddington
TW11 OLW			Tel No 020 8943 6118			
			Email <u>kevin.blakley@npl.co.uk</u>			
Species to be mo	nitored	Volatile Organ	ic Compounds			
Emissions Lin (ELV)	nit Values	Volatile Organ	ic Compounds -	150 mg m <sup>-3</sup> (expressed as carbon)		
Compliance with	standards	I	Yes			
Deviations from	standards			No		
Corrective action	Corrective actions required			No		
Test Team	Kevin Blak	dey and Matthe	w Ellison	· · · · · · · · · · · · · · · · · · ·		
Full report reference number			PX02MAR10			
Summary report	submitted by		Signature	MCERTs ID No: -		
Kevin Blakley				Level 2, TE1,2,3,4		

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# **1.1 MONITORING OBJECTIVES**

NPL were awarded a contract by Paxford Composites Ltd to conduct emissions compliance testing at their facility located in Huntingdon, Cambridgshire. Work was conducted on the 18<sup>th</sup> February to make the necessary measurements from their spray painting enclosures, known as Spray Booth 1 (SB1), Spray Booth 2 (SB2) and Spray Booth 3 (SB3).

The requirements of the contract were to quantify volatile organic compounds (VOC's) from the sources described above over a 30-minute period.

VOC concentrations are expressed as carbon at reference conditions of 273.15K, 101.325 kPa on a wet gas basis.

Field	Units			
Stack I.D.		SB1	SB2	SB3
Date		31/03/2010	31/03/2010	31/03/2010
Sample Period (BST)	From hh:mm	10:15	12:45	14:00
Sample Ferrou (BSF)	To hh:mm	10:45	13:15	14:30
Sample Duration	min	30	30	30
30-minute mean Concentration for Period	mg m <sup>-3</sup> , Ref. Conditions	20.5	30.9	25.3
Expanded Uncertainty	mg m <sup>-3</sup> , 95% conf. k=2	+/-1.3	+/-1.4	+/-1.4
Emission Limit Value (ELV)	mg m <sup>-3</sup> , Ref. Conditions	150	150	150
Percentage of ELV	%	14	21	17
<b>Reference</b> Conditions	273.15K, 101.3	325 kPa, Wet	Gas Basis	

# **1.2 VOC MONITORING RESULTS**

### Notes: -

The VOC (mg/m<sup>3</sup>) results above are expressed as Carbon and these were calculated using the prescribed method described in the Environmental Agency Technical Guidance Note M16 for Volatile Organic Compounds.

# **1.3 PLANT AND EQUIPMENT OPERATING INFORMATION**

### 1.3.1 Paxford Composites Spray Booths 1-3

The spray booths at Paxford Composites consist of three sealed rooms, approximately the size of a large household car garages. They are used as batch processes and air is pumped into the booths from outside the building and the spray painting process is carried out manually using 2 to 3 skilled workers. The air inside the booth can be heated if required for curing treatment of the components. Owing to the business requirements, many layers of paint are required to achieve the smooth finish. As a result, a typical single layer spray time would normally be approximately 20 minutes but depends on the size and type of item being sprayed. This process is then repeated after the item has been brushed down and ready for a further coating. The paint filled air inside the booths are removed via ceiling filters (which covers the entire surface areas of the ceilings) to remove particulate matter. The air is then exhausted to atmosphere.

On each spray booth, the sample position was downstream of the particulate filters. The sample points were 10mm holes, suitable for monitoring VOCs to the relevant CEN Standard, See Figures 1-3.

At the time of monitoring, spray painting workers were asked to carry out their normal task in order to create representative conditions of routine activity within the spray booths. It should be noted that at the time of monitoring, there were no items being physically sprayed, therefore all of the paint would have been expelled through the exhaust ducting rather than coating surfaces of the items. It was the site's opinion that this may lead to higher levels of VOCs being emitted than would usually be seen.

# **1.4 MONITORING DEVIATIONS**

The testing was fully compliant with the relative standard BS EN13526: 2002. See Appendix 1 for Test Techniques and Protocols.

# **1.5 CONCLUSIONS**

Concentrations of volatile organic compounds, measured from the three spray booths at Paxford Composites Ltd, were carried out on the 31<sup>st</sup> March 2010.

Particulates monitoring could not be undertaken as required in the sites permit due to the size of the ports available. Therefore, it is recommended the site fit suitable ports to allow the particulate monitoring to be undertaken as described in BS EN15259: 2007.

### **1.6 REFERENCES**

1. Guidance on Assessing Measurement Uncertainty in Stack Emissions Monitoring, by Pullen J and Robinson R, Source Testing Association, Quality Guidance Note QGN1.

	Part	2: - Supportin	g Information_(	Compliance Report		
Process Operator			LA Permit No			
Paxford Compo			B01/02			
			Site Specific Protocol Reference			
			PX02MAR10\S			
Address			Contact			
Paxford Composi	Paxford Composites Ltd 2-4 Redwongs Way Huntingdon					
Cambridgeshire			Email			
РЕ29 7НВ	PE29 7HB		neil.search@pa	axfordcomposites.co.uk		
Tests carried	ests carried <b>Compliance VOCs of 3</b>		Dates tests carri			
out	Spray Booths		31 <sup>st</sup> March 201	0		
Testing laborator	•		UKAS Accredit	ation No		
National Physics	al Laborator	y	0002			
Address	Hampton Road					
Hampton Road Teddington				KevinBlakley		
TW11 OLW			Tel No			
1			020 8943 6118			
			Email			
			kevin.blakley@npl.co.uk anic Compounds			
Species to be mo	nitored	Volatile Organ				
Emissions Lin (ELV)	nit Values	Volatile Organ	nic Compounds - 1	150 mg m <sup>-3</sup> (expressed as carbon)		
Compliance with	standards	<u> </u>	Yes			
Deviations from	standards			No		
Corrective action	s required		No			
Test Team	Kevin Blal	ley and Matthe	ew Ellison			
Full report reference number			PX02MAR10			
Summary report	submitted by	,	Signature	MCERTs ID No: -		
<b>Kevin Blakley</b>				Level 2, TE1,2,3,4		

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# 2.1 APPENDIX 1

# 2.1.1 Emission Testing Personnel Information

NAME	NPL Position	MCerts I.D. No.	Level/Endorsements	Function
Matthew Ellison	RS	MM-05-682	Level 2, TE1, TE2, TE3, TE4	Team Leader
Kevin Blakley	SRS	MM-03-317	Level 2, TE1, TE2, TE3, TE4	Team Leader

# 2.1.2 Test Techniques and Protocols

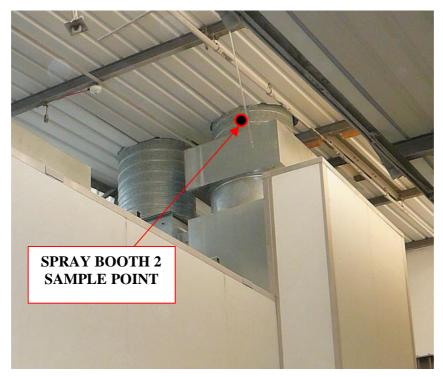
Date of Tests	31 <sup>st</sup> March 2010
Main	
Pollutants	1. Volatile Organic Compounds (VOCs)
Measured	
Test Methods	1. Flame Ionisation Detector, Sick-Maihak. Serial No. AS0202 to BS EN 13526:2002. MCertified Instrument No – Sira MC 040037/02
Procedure	1. <b>QPAS B 538</b> :- STACK GAS SAMPLING FOR CARBON MONOXIDE, CARBON DIOXIDE, OXYGEN, SULPHUR DIOXIDE, VOLATILE ORGANIC COMPOUNDS AND NITROGEN OXIDES USING EXTRACTIVE INSTRUMENTAL TECHNIQUES.

# 2.2 APPENDIX 2 2.2.1 Sample Point Details

Figure 1. Spray Booth 1 Sample Position



Figure 2. Spray Booth 2 Sample Position



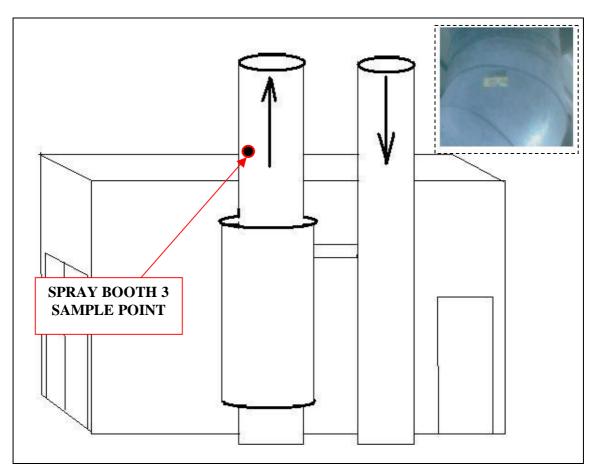
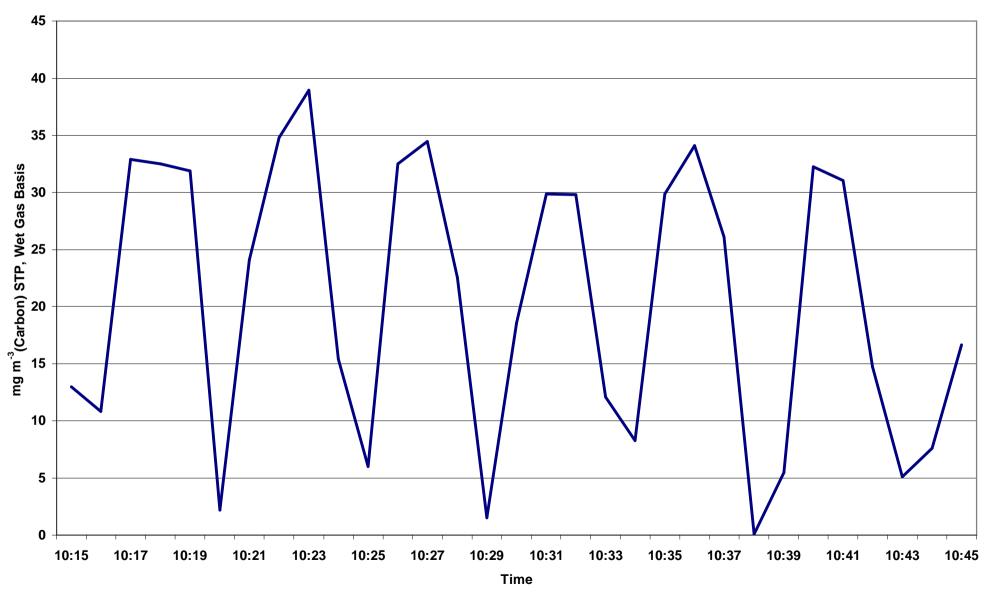


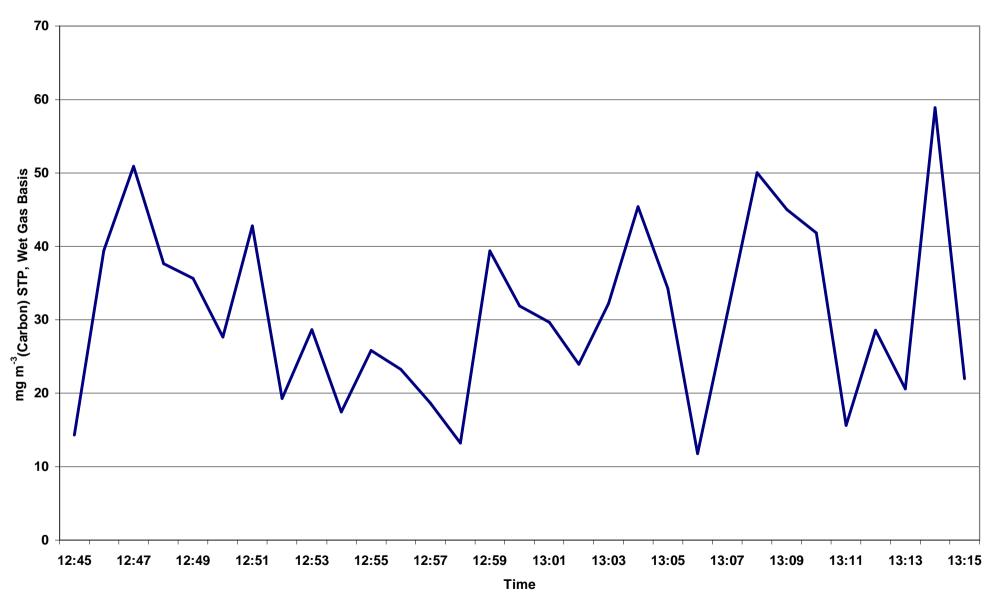
Figure 3. Spray Booth 3 Sample Position

# 2.2.2 VOC 1 Minute Averaged Graphs

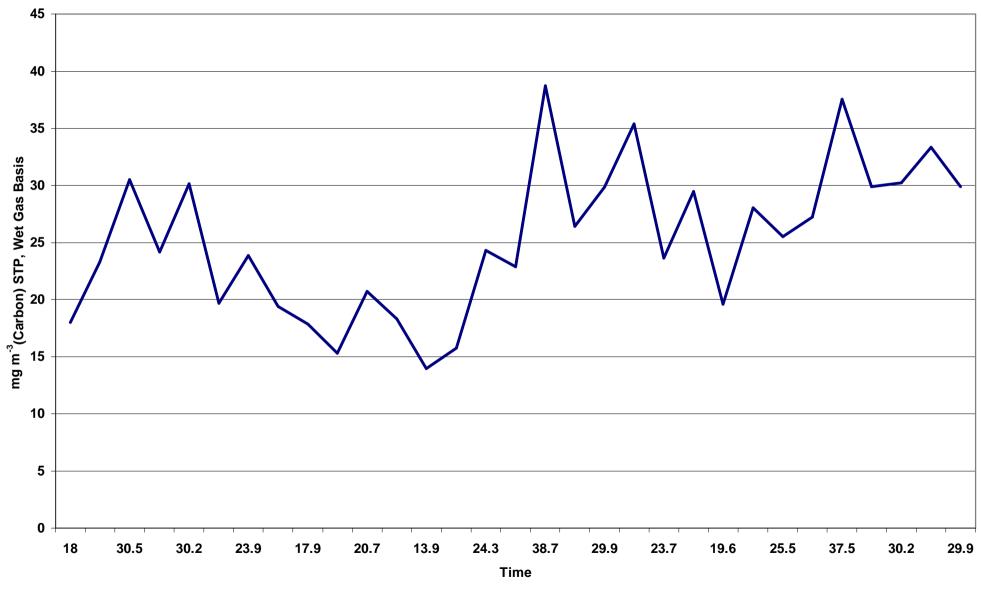
2.2.2.1 Figure 4. Spray Booth 1. 1-Minute Averages of Volatile Organic Compounds (VOC). Expressed as mg m<sup>-3</sup> (Carbon) at 273K, 101.3kPa, Wet Gas Basis



2.2.2.2 Figure 5. Spray Booth 2. 1-Minute Averages of Volatile Organic Compounds (VOC). Expressed as mg m<sup>-3</sup> (Carbon) at 273K, 101.3kPa, Wet Gas Basis



2.2.2.3 Figure 6. Spray Booth 3. 1-Minute Averages of Volatile Organic Compounds (VOC). Expressed as mg m<sup>-3</sup> (Carbon) at 273K, 101.3kPa, Wet Gas Basis



# 2.2.3 Gas Measurements

### **Calibration Log**

	Instrument S		Туре	-		Job No:	PAXO	LMARIO	Page N
	AS	- 6202	.02			- Client St			
and the second	Mobile Lab:		VOC	NPL	an		ulpment: N	ORD COMPOSITES ONE A3	2 of
Gas Cyl. No.	1159	85	Gas Cył Conc.	51.4	Prografi ppin	Date. 3	3/10	Instrument Range: Ö – 10 (	) prim
Саі Туре	Time (Start and Finish)	Initial Reading	initial Gain/Setting (i app.)	f Final Reading	Final Gain/Setting (i app.)	f System(S) Direct(D)	Total Regulato Pressure (bar/F delete as app.	el Comment	Signatu
Check Zero	i4:45					D		Zero dift <u>: = 2</u> %	ne
Zero Adj	14:46	0.064	4.75	0.007	4.65	D	1210	Span Drift: <u>&lt;2.</u> %	no
Check Span	14:47					0	(A	Response Time : 20 sec	UN
Span Adj	14:48	5.109	2.71	5.142	2.73	D	60	Span Value: <u>51:4 %</u>	The
Check Zero	14:49	0.002	4.65			D	210		Tus
eck Zero	15:22	0.009	4.65			p	210		Zus
Check Span	15:23	5.062	2.73			p	60		TAR
Zero Adj						1			AV. JN
Span Adj									
Check Zero	15:25	0.005	2.73			P	210	n die name die die die die die die die die die di	UB
	Instrument SN:		Тура						
		-							
	Mobile Lab:		CO2	NPL					
ias Cyl. No.	Mobile Lab:		CO2 Gas Cyl Conc.	NPL	% vol	Date.		Instrument Range:	
	Mobile Lab; Time (Start and Finish)	Initial Reading	Gas Cyl	NPL Final Reading	% vol Finat Gain/Setting (if app.)	Date. System(S) / Direct(D)	Total Regulator Pressure (bat/Pei delete as app.)	Instrument Range: Comment	Signature
ias Cyl. No.	Time (Start and	Initial Reading	Gas Cyl Conc. Initial Saln/Setting (if		Final Gain/Setting (if	System(S)/	Pressure (bar/Psi delete as app.)		Signature
Gal Type	Time (Start and	Initial Reading	Gas Cyl Conc. Initial Saln/Setting (if		Final Gain/Setting (if	System(S)/	Pressure (bar/Pst delete as app.)	Comment	Signature
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ias Cyl. No. Cal Type uneck Zero Zero Adj	Time (Start and	Initial Reading	Gas Cyl Conc. Initial Saln/Setting (if		Final Gain/Setting (if	System(S)/	Pressure (bar/Pei delete as app.)	Comment Zero difi:% Span Drift:%	Signature
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Gal Type Check Zero Zero Adj Check Span Span Adj	Time (Start and	Initial Reading	Gas Cyl Conc. Initial Saln/Setting (if		Final Gain/Setting (if	System(S)/	Pressure (bar/Pei delete as app.)	Comment Zero dift:% Span Drift:% Response Time :sec	Signature
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Cal Type Cal Type Cal Type Check Zero Zero Adj Check Span Span Adj Check Zero Check Zero Check Span	Time (Start and	Initial Reading	Gas Cyl Conc. Initial Saln/Setting (if		Final Gain/Setting (if	System(S)/	Pressure (bar/Pei delete as app.)	Comment Zero dift:% Span Drift:% Response Time :sec	Signature

# IF REGULATOR PRESSURE IS LESS THAN 500 PSI ( 35 bar) CONTACT SUPPLIER IMMEDIATELY

# MCERTS LEVEL2 with TE4

Name: K. BLAKLEY

NPL Ltd: 15 OCT 2009 Author: KCB

Revision 3 QPAS B 538

### **Calibration Log**

	Instrument	SN:	Туре			Job No:	PAYOZ M,	APIN	Page No
	As	-0202				-1			-35
	Mobile Lab;	TP A.V.F	<u></u>	- NPL		Cilent Si	Cilent site: fayford compositos - Al		
Gas Cui M	Mobile Lab: TRANSIT as Cyl. No. 115085			Gas Cvl			Other Equipment:		
	<u>•   5989</u>	) 	Gas Cyl Conc.	51.4	PROPARE	Date. 31	103/10	Instrument Range: 0 - 100	PPn and
Cal Type	Time (Start and Finish)	Initial Reading	Initial Gain/Setting (i app.)	if Finst Reading	Final Gain/Setting (i app.)	if Direct(D)	/ Total Regulator Pressure (bar/Pr delete as app.)	t Comment	Signatur
Check Zero	10:1\$	. 210	L Cub			D	0 44	Zero difi: <u>&lt; 2 %</u>	no
Zero Adj	10:18	0.248	4.80	0.002	4:54	D	- 3000 K.	Zero difi: <u>&lt;2                                    </u>	MB
Check Span	15:21					D			
Span Adj	16:23	5.380	2.68	5.148	2:58	D	60Bar	Response Time : 20 sec Span Value: 5/4 ppm	Two
Check Zero		4.64				12	1		W
sck Zero		0.001				D	3000 15.		ws
Check Span	12:23		1 .			D	3000151		
Zero Adj	12.00		7:00				60kor		INS
Span Adj									
Chack Zero	17.211	0.002	<u> </u>			~			
	Liber	- 002	4:64			<u>D</u>	300015		w
	Instrument SN		Туре			Job No:	Axaz M	4610	
	Az-	0202	.85					Compsiles - A	
	Mobile Lab:		Voc	NPL		Other Equi	· •	a. 1 - 3 - 17	1
3as Cyl. No.	115985		Gas Cyl Conc.	51.4 p		Date. 31/		Instrument Range: 0 - 100 PK	<u>الــــــــــــــــــــــــــــــــــــ</u>
Cal Type	Time (Start and Finish)	Initial Reading	Initial Galn/Setting (if app.)	Final Reading	Final Gain/Setting (if app.)	System(S) / Direct(D)	Total Regulator Pressure (bar/Psi delete as app.)	Comment	Signature
vneck Zero	11:46	<b>_</b>		Contractor and the second	and an an entropy of the second				
	11,70	-0.3				$\supset$	2 2	ero difi: <u>&lt;2</u> %	nt.
Zero Adj	11:48	-0.3	<u> </u>	-0.01	~	$\overline{P}$	3000\$i	iero dīfi <u>: &lt;2 %</u> pan Drīfi: <u>&lt;2 %</u>	NE NE
Zero Adj Check Span	11:48			-0.01	~		3000\$i	iero dīk <u>: &lt;2 %</u> pan Drīk: <u>&lt;2 %</u> esponse Time :2 <i>0</i> sec	ME
	11:48	-0.3 4.919	-		(	$\mathcal{P}$	60 Bar	esponse Time : 20 sec	NE NE
Check Span		4.919		-0:01 5:138	-	P P	60 Bor		ME ME ME
Check Span Span Adj	1:48  1:52  1:54	4.919 0.009				AAA	60 Bar s 3000 [5;1	esponse Time : 20 sec	ME ME ME
Check Span Span Adj Check Zero	11:48 11:52 11:54 11:57 14:15	4.919 0.009 0.007	<u> </u>			AAAA	60 Bar " 3000 15;" 3000 15;	esponse Time : 20 sec	ME ME ME ME
Check Span Span Adj Check Zero Check Zero heck Span	11:48 11:52 11:54 11:57	4.919 0.009	, ,			AAA	60 Bar s 3000 [5;1	esponse Time : 20 sec	ME ME ME
Check Span Span Adj Check Zero Check Zero	11:48 11:52 11:54 11:57 14:15	4.919 0.009 0.007	, ,			AAAA	60 Bar " 3000 15;" 3000 15;	esponse Time : 20 sec	ME ME ME ME
Check Span Span Adj Check Zero iheck Zero heck Span Zero Adj	11:48 11:52 11:54 11:57 14:15	4.919 0.009 0.007	, ,			P P P P	60 Bar " 3000 15;" 3000 15;	esponse Time : 20 sec	ME ME ME ME

# IF REGULATOR PRESSURE IS LESS THAN 500 PSI ( 35 bar) CONTACT SUPPLIER IMMEDIATELY

MCERTS LEVEL2 with TE4 MCERTS ID: MM-03-317 Name: K BLAKLEY

NPL Ltd: 15 OCT 2009 Author: KCB

Revision 3 QPAS B 538

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## 2.2.4 Calculations Used in Reporting Results

The following equation can be used to convert propane volume concentrations to total organic carbon mass concentrations:

$$C_{\rm m} = C_v \frac{3 \,\mathrm{x} \,\mathrm{M_c}}{\mathrm{V_m}} \,\mathrm{mg/m^3}$$

where:-

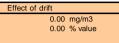
 $C_{\rm m}$  is the TOC concentration in milligrams per cubic metre (273 K;1013 hPa).  $C_{\rm v}$  is the volume concentration of propane in ppm (by volume).  $M_{\rm c}$  is the molar mass of carbon (=12 g/mole).  $V_{\rm M}$  is the molar volume (=22,4 l/mole).

# 2.2.5 Uncertainty Calculations

#### Uncertainty calculation for Gaseous Measurement BS EN 13526 VOCs

Limit value	150	mg.m <sup>-3</sup> (corrected) Carbon	Gas	Propane		Correction for refe
			Full Scale	100	ppm	
Measured concentration	12.77	ppm	Cal gas conc	51.4	ppm	
Measured concentration	20.50	mg.m <sup>-3</sup> (273K, 101.3kPa) Carbon	Conversion	0.62305296		
			Full Scale	62.30529595	mg.m <sup>-3</sup> (Carbon)	Factors
		•	Cal gas conc	32.02492212	mg.m <sup>⁻³</sup> (Carbon)	Correction Factor
Performance characteristics		Value			specification	Effect of drift
Response time		20	seconds		180.000	0.00
Number of readings in measurement		30				0.00
Repeatability at zero		0.005	% full scale		0.200	
Repeatability at span level		0.083	% full scale		2.000	
Deviation from linearity		-1.46	% of value		2.000	
Zero drift		0	% full scale		2.000	
Span drift		0	% full scale		2.000	flow
volume or pressure flow dependence		0.02	% of full scale/kPa		0.033	pressure
atmospheric pressure dependence		0	% of value/kPa		0.750	temp
ambient temperature dependence		0.025	% full scale/10K		0.300	NH3 range
NH3 (20 mg/m3) CO2 (15%)		0	mg/m3 % by vol			CO2 range H2O range
H2O (30%)		0.0	% by vol		4.000	Instrument Voltage R
dependence on voltage		1.05	% full scale/10V		2%fs/10V	Voltage
losses in the line (leak)		0	% of value		2% of value	voltage
Uncertainty of calibration gas		2	% of value		270 01 Value	
		Measurement performa		arv conditions		
Performance characteristic			Uncertainty		Value of u	ncertainty quantity
Standard deviation of repeatability at	zero		u <sub>r0</sub>		for mean	use rep at span
Standard deviation of repeatability at	span level		Urs		for mean	0.02
Lack of fit			U <sub>fit</sub>			-0.53
Drift			U <sub>0dr</sub>			0.00
volume or pressure flow dependence			U <sub>spres</sub>			0.00
atmopsheric pressure dependence			Uapres			0.00
ambient temperature dependence			Utemp			0.00
NH3 (20 mg/m3)			U <sub>interf</sub>			0.00
CO2 (15%)						0.00
H2O (30%)						0.00
Dependence on voltage			U <sub>volt</sub>			0.33
losses in the line (leak)			u <sub>leak</sub>			0.00
Uncertainty of calibration gas			U <sub>calib</sub>			0.24
				. 3	•	
Measurement uncertainty		Result	20.50	mg/m <sup>3</sup>	-	
Combined uncertainty			0.67	mg/m <sup>3</sup>		
Expanded uncertainty	k =	2	1.33	mg/m <sup>3</sup>		

Correction for reference conditions							
		O2, %	Temperature, K				
	ref	21.00	0.00	101.30	273.00		
	measured	21.00	0.00	101.30	273.00		
Factors		1.00	1.00	1.00	1.00		
Correction Factor		1.00					



	ranges			
	min	max	value at calib	
flow	1.9	2.1	2	
pressure	101.30	101.3	101.3	
temp	289	289	289	
NH3 range	0	0	0	
CO2 range	0	15	0	
H2O range	0	0	0	
Instrument Voltage Rating			110	
Voltage	104.5	115.5	110	

0.00 0.00
0.00
0.00
0.00

Measurement uncertainty		Result	20.50	mg/m <sup>3</sup>
Combined uncertainty			0.67	mg/m <sup>3</sup>
Expanded uncertainty	k =	2	1.33	mg/m <sup>3</sup>
Uncertainty corrected to std conds			1.33	mg.m-3 (corrected)
Expanded uncertainty expressed with a level of confidence of 95%		0.89	% ELV	
Expanded uncertainty expressed with a level of confidence of 95%			1.33	mg.m <sup>-3</sup>

Note:

Enter values into green boxes

Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed by R Robinson, NPL

#### Uncertainty calculation for Gaseous Measurement BS EN 13526 VOCs

Limit value	150	mg.m <sup>-3</sup> (corrected) Carbon	Gas	Propane		Correcti
			Full Scale	100	ppm	
Measured concentration		ppm	Cal gas conc	51.4	ppm	
Measured concentration	30.90	mg.m <sup>⁻³</sup> (273K, 101.3kPa) Carbon	Conversion	0.62305296		
			Full Scale	62.30529595	mg.m⁻³ (Carbon)	Factors
			Cal gas conc	32.02492212	mg.m <sup>-³</sup> (Carbon)	Correcti
					141 - 4	="
Performance characteristics		Value			specification	Effe
Response time	J	20	seconds		180.000	
Number of readings in measurement			% full scale		0.200	
Repeatability at zero		0.005				
Repeatability at span level		0.083	% full scale		2.000	
Deviation from linearity		-1.46	% of value		2.000	
Zero drift		0	% full scale		2.000	
Span drift		0	% full scale		2.000	flow
volume or pressure flow dependence		0.02	% of full scale/kPa		0.033	pressure
atmospheric pressure dependence		0	% of value/kPa		0.750	temp
ambient temperature dependence		0.025	% full scale/10K		0.300	NH3 ran
NH3 (20 mg/m3) CO2 (15%)		0	mg/m3 % by vol			CO2 ran H2O ran
H2O (30%)		0.0	% by vol		4.000	Instrum
dependence on voltage		1.05	% full scale/10V		2%fs/10V	Voltage
losses in the line (leak)		0	% of value		2% of value	voltage
Uncertainty of calibration gas		2	% of value			
			ance related to stationa	arv conditions		
Performance characteristic			Uncertainty		Value of uncer	tainty quantity
Standard deviation of repeatability a	t zero		u <sub>r0</sub>		for mean	use r
Standard deviation of repeatability at	span level		Urs		for mean	
Lack of fit			u <sub>fit</sub>			
Drift						
			U <sub>0dr</sub>			
volume or pressure flow dependence			U <sub>spres</sub>			
atmopsheric pressure dependence			Uapres			
ambient temperature dependence			u <sub>temp</sub>			
			Uinterf			
NH3 (20 mg/m3)					1	
NH3 (20 mg/m3) CO2 (15%)						
CO2 (15%)			U <sub>volt</sub>			
CO2 (15%) H2O (30%)			U <sub>volt</sub>			
CO2 (15%) H2O (30%) Dependence on voltage						
CO2 (15%) H2O (30%) Dependence on voltage losses in the line (leak)			U <sub>leak</sub>			
CO2 (15%) H2O (30%) Dependence on voltage losses in the line (leak)		Result	U <sub>leak</sub>	mg/m <sup>3</sup>		
CO2 (15%) H2O (30%) Dependence on voltage losses in the line (leak) Uncertainty of calibration gas		Result	U <sub>leak</sub> U <sub>calib</sub>	mg/m <sup>3</sup>		
CO2 (15%) H2O (30%) Dependence on voltage losses in the line (leak) Uncertainty of calibration gas Measurement uncertainty	k =	Result 2	U <sub>leak</sub> U <sub>calib</sub> 30.90			
CO2 (15%) H2O (30%) Dependence on voltage losses in the line (leak) Uncertainty of calibration gas Measurement uncertainty Combined uncertainty	k =		U <sub>keak</sub> U <sub>calib</sub> 30.90 0.72	mg/m <sup>3</sup>		
CO2 (15%) H2O (30%) Dependence on voltage Iosses in the line (leak) Uncertainty of calibration gas Measurement uncertainty Combined uncertainty Expanded uncertainty			Uleak Ucallb 30.90 0.72 1.43 1.43	mg/m <sup>3</sup> mg/m <sup>3</sup>		

Correction for reference conditions						
		O2, % Moisture, % Pressure, KPa T				
	ref	21.00	0.00	101.30	273.00	
	measured	21.00	0.00	101.30	273.00	
Factors		1.00	1.00	1.00	1.00	
Correction Factor		1.00				

Effect of	drift		
	0.00	mg/m3	
	0.00	% value	

use rep at span 0.02 -0.53 0.00 0.00 0.00 0.00 0.00 0.00

0.00

0.33 0.00 0.36

	ranges min	max	value at calib	
flow	1.9	2.1	2	
pressure	101.30	101.3	101.3	
temp	289	289	289	
NH3 range	0	0	0	
CO2 range	0	15	0	
H2O range	0	0	0	
Instrument Voltage Ra	ating		110	
Voltage	104.5	115.5	110	

Use largest negative or	positive in	terferent effect
0	0.00	
0	0.00	
0	0.00	
0	0.00	
Interference uncertainty		0.00

Note:

Enter values into green boxes

Dark blue boxes indicate information that can be obtained from MCERTS tests

Developed by R Robinson, NPL

#### Uncertainty calculation for Gaseous Measurement BS EN 13526 VOCs

Limit value	150	mg.m <sup>-3</sup> (corrected) Carbon	Gas	Propane		Correct
		-	Full Scale		ppm	
Measured concentration		ppm	Cal gas conc	51.4	ppm	
Measured concentration	25.30	mg.m <sup>-3</sup> (273K, 101.3kPa) Carbon	Conversion	0.62305296		
			Full Scale		mg.m⁻³ (Carbon)	Factors
			Cal gas conc	32.02492212	mg.m <sup>⁻³</sup> (Carbon)	Correct
Derfermen en ek eresteristiss		Value				<b>F#</b>
Performance characteristics Response time		Value 20	seconds		specification 180.000	Effe
Number of readings in measurement	1	30	seconds		180.000	
Repeatability at zero		0.005	% full scale		0.200	
, ,						
Repeatability at span level		0.083	% full scale		2.000	
Deviation from linearity		-1.46	% of value		2.000	
Zero drift		0	% full scale		2.000	0
Span drift		0 0.02	% full scale		2.000	flow
volume or pressure flow dependence atmospheric pressure dependence	1	0.02	% of full scale/kPa % of value/kPa		0.033 0.750	pressur
ambient temperature dependence		0.025	% full scale/10K		0.300	temp NH3 rai
NH3 (20 mg/m3)		0.025	mg/m3		0.300	CO2 ra
CO2 (15%)		0	% by vol			H2O ra
H2O (30%)		0.0	% by vol		4,000	Instrum
dependence on voltage		1.05	% full scale/10V		2%fs/10V	Voltage
losses in the line (leak)		0	% of value		2% of value	- in a g
Uncertainty of calibration gas		2	% of value			
		Measurement perform	nance related to stationa	ry conditions		
Performance characteristic			Uncertainty		Value of uncer	rtainty quantity
Standard deviation of repeatability a	zero		u <sub>r0</sub>		for mean	use
Standard deviation of repeatability at	span level		Urs		for mean	
Lack of fit			U <sub>fit</sub>			
Drift			u <sub>0dr</sub>			
volume or pressure flow dependence			U <sub>spres</sub>			
atmopsheric pressure dependence						
			Uapres			
ambient temperature dependence			U <sub>temp</sub>			
NH3 (20 mg/m3)			Uinterf			
CO2 (15%)						
H2O (30%)						
Dependence on voltage			Uvolt			
losses in the line (leak)			Uleak			
Uncertainty of calibration gas			U <sub>calib</sub>			
Maaaaaaaaaaaaaaaaaaaaaaaa		Desult	05.00		1	
Measurement uncertainty		Result	25.30	mg/m <sup>3</sup>		
Combined uncertainty			0.69	mg/m <sup>3</sup>		
Expanded uncertainty	k =	2	1.37	mg/m <sup>3</sup>		
Uncertainty corrected to std conds			1.37	mg.m-3 (corrected)		
		the played of confidence of OE%	0.02	8 % ELV		
Expanded uncertainty	expressed wi	th a level of confidence of 95%	0.92			

Correction for reference conditions							
		O2, %	Moisture, %	Pressure, KPa	Temperature, K		
	ref	21.00	0.00	101.30	273.00		
	measured	21.00	0.00	101.30	273.00		
Factors		1.00	1.00	1.00	1.00		
Correction Factor		1.00					



use rep at span 0.02

-0.53

0.00 0.00 0.00 0.00 0.00 0.00

0.00

0.33 0.00 0.29

	ranges min	max	value at calib	
flow	1.9	2.1	2	
pressure	101.30	101.3	101.3	
temp	289	289	289	
NH3 range	0	0	0	
CO2 range	0	15	0	
H2O range	0	0	0	
Instrument Voltage R	ating		110	
Voltage	104.5	115.5	110	

0	0.00	
0	0.00	
0	0.00	
0	0.00	
Interference uncertainty		0.00

Use largest negative or positive interferent effect

Note:

Enter values into green boxes

Dark blue boxes indicate information that can be obtained from MCERTS tests

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