

EMISSIONS MONITORING SURVEY

Prepared for:

ConvaTec
Unit 1 & 2
Heads of the Valley Industrial Estate
Rhymney
NP22 5RL

Permit Number	: NP3433BC & TP3535LH
Variation Number	: ...
Installation	: Bioscrubber Stack & Spin Line
Visit Details	: Annual Compliance
Job Number	: P2121
Report Number	: R001
Report Issue Date	: 19 th December 2014
Survey Dates	: 11 th & 13 th November 2014

Prepared by:

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Report Issue:		FINAL	
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		Signature:	
Date:	19 th December 2014	Date:	19 th December 2014

This report is not to be used for contractual or engineering purposes unless this approval sheet is signed where indicated by the approver and the report is designated "FINAL".



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Opinions and Interpretation expressed within this report are outside the scope of the UKAS accreditation.

MCERTS requirements mean that comparison of results with emissions limit values is not permitted within this report.

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PART 1 - EXECUTIVE SUMMARY

1 Monitoring Objectives

Environmental Compliance Ltd (ECL) was commissioned by **ConvaTec** to undertake an emission monitoring survey at their **Rhymney** facility. This report presents the findings of the study.

The monitoring at this installation was carried out in accordance with our quotation reference **DHFB/P2121/Q001**, for compliance check monitoring of emissions to air. The substances requested for monitoring at each emissions point are listed below:

Substances to be monitored	Emission Point Identification			
	NP3433BC	TP3535LH		
	A1	A1	A2	A3
Total Organic Carbon (TVOC)	● U	● U	● U	● U

- Denotes the substances to be monitored.

U

Denotes UKAS accreditation is held for monitoring that substance, but does not mean that it has been claimed which will depend on whether the testing could be completed in accordance with the Standard Reference Method.

Special Requirements: Normal operation.

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1.1 Monitoring Results

Emission Point Reference (NP3433BC)	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Units	Uncertainty %	Reference Conditions 273 K, 101.3 kPa	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method	Tick if non-conforming test (see Sections 2 & 5)	Operating Status
A1 Bioscrubber Stack	TVOC as Carbon	...	358.98	mgC/m ³	4	Wet Gas	13/11/2014	11:33 – 15:32	BS EN 12619:2013	UKAS / MCERTS		Normal

Notes

The average figure presented in the table above for TVOC is the average result over the 4 hr sample period.

The uncertainty figures presented in Table 1.1 TVOC are “measurement uncertainty” figures, which do not take into account the variability of the measured sample values. The “uncertainty of measurement results” figures, which do include this contribution, are presented in the appendices of the report for these determinands.

Emission Limit Value
Periodic Monitoring Result
Uncertainty
Reference Conditions
Monitoring Method Reference
Accreditation for use of Method
Operating Status
\$
NU
NA

The emission limit value is that stated in the permit and will be expressed as a concentration or a mass emission.
The result given is expressed in the same terms and units as the emission limit value.
The uncertainty associated with the quoted result is at the 95% confidence interval. The Uncertainty results **DO NOT** take into account the effect of the sample location limitations.
All results are expressed at 273 K and 101.3kPa. The oxygen and moisture corrections are stated.
The method stated is in accordance with the Environment Agency Technical Guidance Note M2, or other method approved by the Environment Agency.
The details indicate the accreditation for the use of the complete monitoring method, e.g. MCERTs, UKAS. If use of the method is not accredited " NA" is stated.
The details indicate the feedstock and the loading rate of the plant during monitoring.
Chemical Analysis on sample reagents was performed by an External Laboratory as detailed in Section 4
UKAS Accreditation Held but UKAS Accreditation cannot be claimed for the test as sampling did not comply with the Standard Reference Method (SRM), see section 2 & 5
Method is NOT UKAS Accredited.

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Emission Point Reference (TP3535LH)	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Units	Uncertainty %	Reference Conditions 273 K, 101.3 kPa	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method	Tick if non-conforming test (see Sections 2 & 5)	Operating Status
A1	TVOC as Carbon	...	91.72	mgC/m ³	4	Wet Gas	13/11/2014	09:00 – 12:59	BS EN 12619:2013	UKAS / MCERTS		Normal
A2	TVOC as Carbon	...	263.67	mgC/m ³	3	Wet Gas	11/11/2014	09:00 – 12:59	BS EN 12619:2013	UKAS / MCERTS		
A3	TVOC as Carbon	...	173.45	mgC/m ³	3	Wet Gas		09:00 – 12:59	BS EN 12619:2013	UKAS / MCERTS		

Notes

For TVOC, permit requires data to be reported as hourly averages.

The average figure presented in the table above for TVOC is the maximum hourly average result during the 4 hr sample period.

All other hour averages are presented in the tables section in the appendices of this report.

The uncertainty figures presented for TVOC are “measurement uncertainty” figures, which do not take into account the variability of the measured sample values.

The “uncertainty of measurement results” figures, which do include this contribution, are presented in the appendices of the report for these determinands.

Emission Limit Value
Periodic Monitoring Result
Uncertainty
Reference Conditions
Monitoring Method Reference
Accreditation for use of Method
Operating Status
\$
NU
NA

The emission limit value is that stated in the permit and will be expressed as a concentration or a mass emission.
The result given is expressed in the same terms and units as the emission limit value.
The uncertainty associated with the quoted result is at the 95% confidence interval. The Uncertainty results **DO NOT** take into account the effect of the sample location limitations.
All results are expressed at 273 K and 101.3kPa. The oxygen and moisture corrections are stated.
The method stated is in accordance with the Environment Agency Technical Guidance Note M2, or other method approved by the Environment Agency.
The details indicate the accreditation for the use of the complete monitoring method, e.g. MCERTs, UKAS. If use of the method is not accredited " NA" is stated.
The details indicate the feedstock and the loading rate of the plant during monitoring.
Chemical Analysis on sample reagents was performed by an External Laboratory as detailed in Section 4
UKAS Accreditation Held but UKAS Accreditation cannot be claimed for the test as sampling did not comply with the Standard Reference Method (SRM), see section 2 & 5
Method is NOT UKAS Accredited.

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1.2 Operating Information

Emission Point Reference (NP3433BC)	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load	Comparison of Operator CEMS and Periodic Monitoring Results					
							Parameter	Date	Time	CEMS Results	Periodic Monitoring Results	Units
A1	Continuous	NA	NA	Solvent	Packed Tower	Normal	TVOC	13/11/2014	11:33 – 15:32	174 ¹	358.98	mgC/m ³

Emission Point Reference (TP3535LH)	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load	Comparison of Operator CEMS and Periodic Monitoring Results					
							Parameter	Date	Time	CEMS Results	Periodic Monitoring Results	Units
A1	Batch	4 Hours	NA	Unknown	None	Normal	No CEMS installed					
A2	Batch											
A3	Batch											

Notes:

Process Type State whether the process is a continuous or batch process.
Process Duration If a batch process, state the duration, frequency and details of the portion of the batch sampled. If continuous state "NA"
Fuel If applicable, state the fuel type If not applicable state "NA"
Feedstock State the feedstock type
Abatement State the type and whether operational during monitoring. If not applicable state "NA"
Load State the normal load, throughput or rating of the plant
CEMS Data Enter this data for each CEM installed if it has been provided by operator otherwise state "NP" (NOT PROVIDED)

¹ CEM result under investigation by site

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2 Monitoring Deviations

The objective of the survey was to measure the concentrations of pollutants from the processes / locations as detailed in Section 1. This survey meets the requirements of the site's **PPC Permit Number: NP3433BC & TP3535LH** where UKAS and MCERTS accreditation has and could be claimed for the testing in the monitoring results table.

There were no modifications to the sampling procedures (TPDs) listed in section 4.

There was one deviation from the original and agreed emissions monitoring schedule as follows:

- The permit stipulates the monitoring method BS EN 13526: 2002 for monitoring of TVOCs. Please note that this method has now been superseded by BS EN 12619:2013. Consequently, BS EN 12619:2013 was followed during this survey.

There were no non-conforming tests.

Homogeneity tests have not been completed for pollutants at the following locations:

- **Permit Ref: NP3433BC A1** – Not applicable to this location as the duct area is $< 1\text{m}^2$ and not requested by client.
- **Permit Ref: TP3535LH A1** – Not applicable to this location as the duct area is $< 1\text{m}^2$ and not requested by client.
- **Permit Ref: TP3535LH A2** – Not applicable to this location as the duct area is $< 1\text{m}^2$ and not requested by client.
- **Permit Ref: TP3535LH A3** – Not applicable to this location as the duct area is $< 1\text{m}^2$ and not requested by client.

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PART 2 – SUPPORTING INFORMATION

3 SAMPLING STAFF DETAILS

Site Sampling Team

Names of Site Team	Dates on Site	MCERTS No.	LEVEL	Technical Endorsements
Mike Mullett	11 th & 13 th November 2014	MM 05 683	2	TE1, TE2, TE3, TE4
Jon Litterick	13 th November 2014	MM 03 236	2	TE1, TE2, TE3, TE4

Report Reviewer

Name	MCERTS No.	LEVEL	Technical Endorsements
Sam Brookes	MM 06 775	2	TE1, TE2, TE3, TE4

Technical Endorsement Key:-

TE1 – Isokinetic Particulates, Temperature & Velocity Profiles, Oxygen.

TE2 – Isokinetic Extractive Pollutants:- Metals, Dioxin & Furans, PAHs, PCBs, HCl, HF.

TE3 – Non-Isokinetic Extractive Pollutants:- Speciated VOCs, HF, HCl, Cyanide.

TE4 – Continuous Analysers (Combustion Gases):- TVOC, CO, NO_x, SO₂.

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4 SAMPLING PROTOCOLS / METHODOLOGIES

Any required modifications to the Technical Procedure Documents (TPDs) specified below will be detailed in Section 2 of this report.

TVOC as Carbon

Testing was carried out using an MCERTS Certified Signal 3030PM FID and heated gas sample line, with reference to the manufacturer's operation handbook, **BS EN 12619:2013** and in-house technical procedure **ECL/TPD/032A**.

The analyser was calibrated on site using certified propane span gases, (made up in synthetic air) which are traceable to ISO 17025 standard. (with uncertainty < 2%).

Zero measurements were performed using synthetic air zero gas, with TVOC content less than 0.2 mg/m³ (or purity greater than 99.998%).

The analyser was calibrated directly into the sample inlet and then checked through the entire sampling system (including sampling probe, heated filter and heated gas transport lines). Data was corrected by molecular weight to TVOCs as total carbon.

Data was recorded as minute averages over each test period. The data is presented in the Figures Section and the minute averaged data is detailed in the Tables Section.

Pressure, Temperature and Velocity

Testing was carried out using a sampling system in accordance with **BS EN 13284-1 & MID** and In-house technical procedure **ECL/TPD/022**.

Temperature was recorded using a thermocouple and digital temperature reader.

Velocity and pressure were recorded using an "L" type or "S" type pitot and digital manometer, data being recorded in Pascals.

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5 SAMPLE POINT DESCRIPTIONS

The homogeneity test is applicable to combustion processes. This includes but is not restricted to, those regulated under the Waste Incineration Directive (**WID**) and the Large Combustion Plant Directive (**LCPD**).

Homogeneity testing has not been completed at these locations in accordance with the mandatory requirements of the regulatory authority.

The test is not usually required for stacks with sampling plane areas of $< 1\text{m}^2$ (below 1.13m in diameter for circular ducts).

The sample locations that were monitored are detailed below:-

NP3433BC – A1 Bioscrubber Stack

The sampling platform does not currently meet the requirements detailed in *Technical Guidance Note (Monitoring) M1 "Sampling requirements for stack-emission monitoring"* Environment Agency, and BS EN 13284-1 due to the platform being too narrow. However, it is suitable for sampling for TVOCs.

The stack diameter is 0.60m and the sample platform width back from the sample port is 1.00m.

Two sample ports are located on the stack at 90 degrees to each other and are located on the same plane. These sample ports are located at a height of approximately 1.0m from the working sample platform.

Access to the sample platform was attained by means of a permanent ladder attached to the stack.

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TP3535LH – A1, A2 & A3 Spin Line

The temporary sampling platform for A1, A2 and A3 does not currently meet the requirements detailed in *Technical Guidance Note (Monitoring) M1 "Sampling requirements for stack-emission monitoring"* Environment Agency, and BS EN 13284-1 due to the platform being too narrow. However, it is suitable for sampling for TVOCs.

The duct diameter for A1 and A2 is 0.30m. The stack diameter for A3 is 0.40m. The sample platform width back from the sample port is up to 1.0m.

Each duct has a single 4" BSP port on it located at approximately 0.5m from the sample platform.

Access to the sample platform was attained by means of a temporary ladder located next to the platform.

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EQUIPMENT IDs (Pre site checklist from SSP)

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PRE SITE EQUIPMENT CHECKLIST/ EQUIPMENT USED

(Completed before departure to site and when on site in full)

Equipment	Equip. Type	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:
MST console/pump	E001								
MST Nozzle set									
MST "S" Type Pitot		635							
MST Probe									
MST Hot Box									
MST Impinger Arm									
Barometer		629							
Site Balance									
Site Check weights									
Horiba	E002								
Heated Probe / Filter									
Chiller									
Sonimix / MFC									
Heated Line									
FID	E003	211	304						
Heated Line		968	1013	874	1014				
Heated Probe / Filter		919	572						
Testo	E004								
FTIR	E005								
Heated Probe / Filter									
Heated Line									
Stackmite	E006								
"L" Type Pitot		067							
Digital Manometer		456							
Stack Thermocouple		866							
Thermocouple Reader		414							
Nozzle Set									
Workhorse Pumps	E007								
Low Flow Pumps									

Quantity of Ice Required / Used for Survey	n/a	Bags (2kg bags)
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FIGURES

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Figure 1

**TVOC Data Recorded From ConvaTech, Rhymney, A1 - Scubber Exhaust (NP3433BC),
on 13/11/2014, Between 11:33 and 15:32**

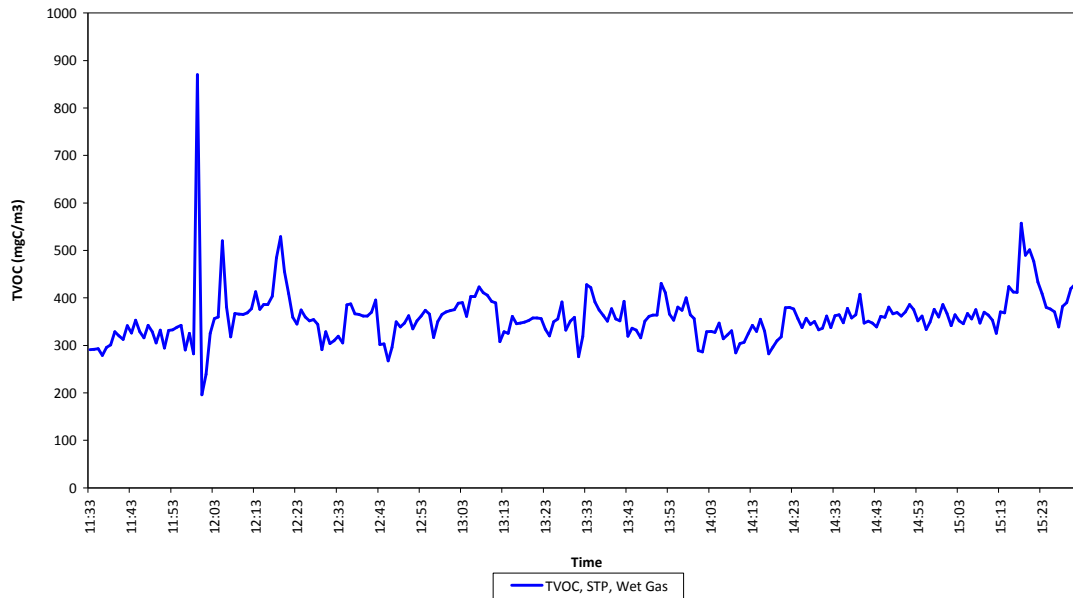
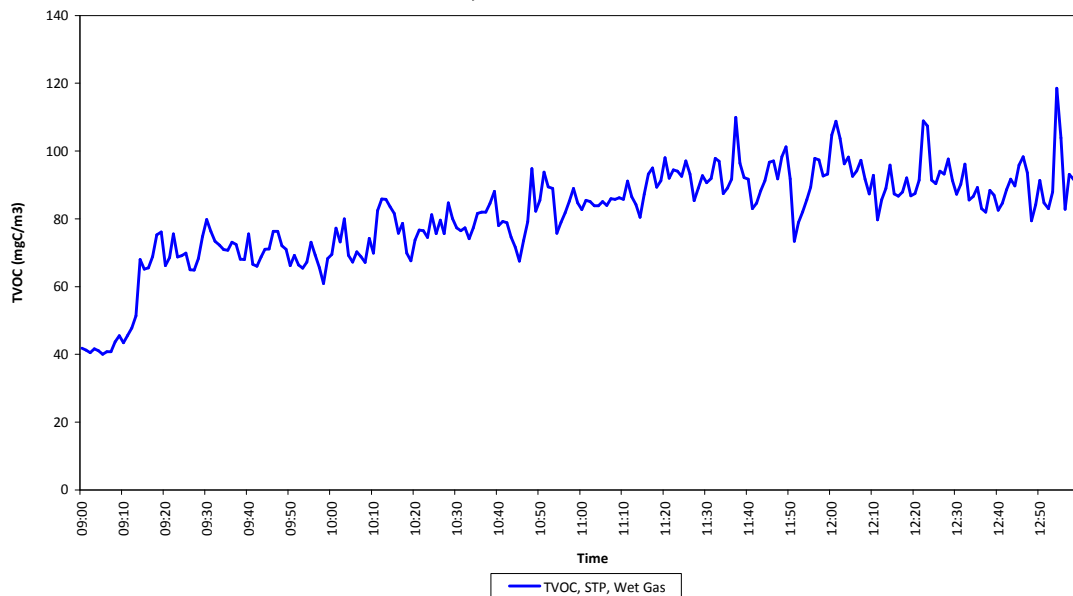


Figure 2

**TVOC Data Recorded From ConvaTech, Rhymney, A1 - Spin Line (TP3535LH), on
13/11/2014, Between 09:00 and 12:59**



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Figure 3

TVOC Data Recorded From ConvaTech, Rhymney, A2 - Spin Line (TP3535LH), on
11/11/2014, Between 09:00 and 12:59

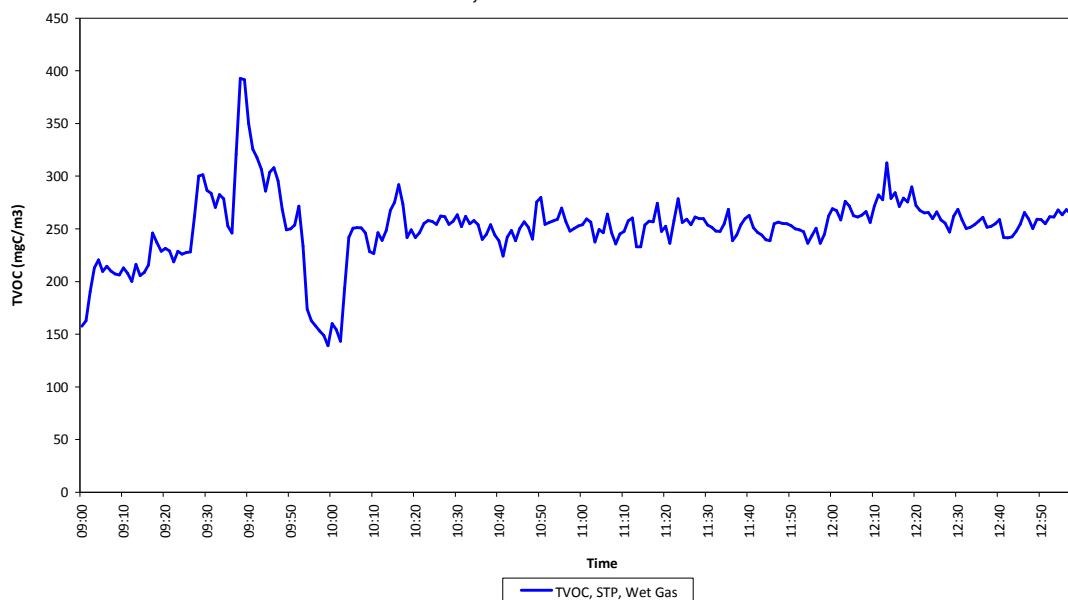
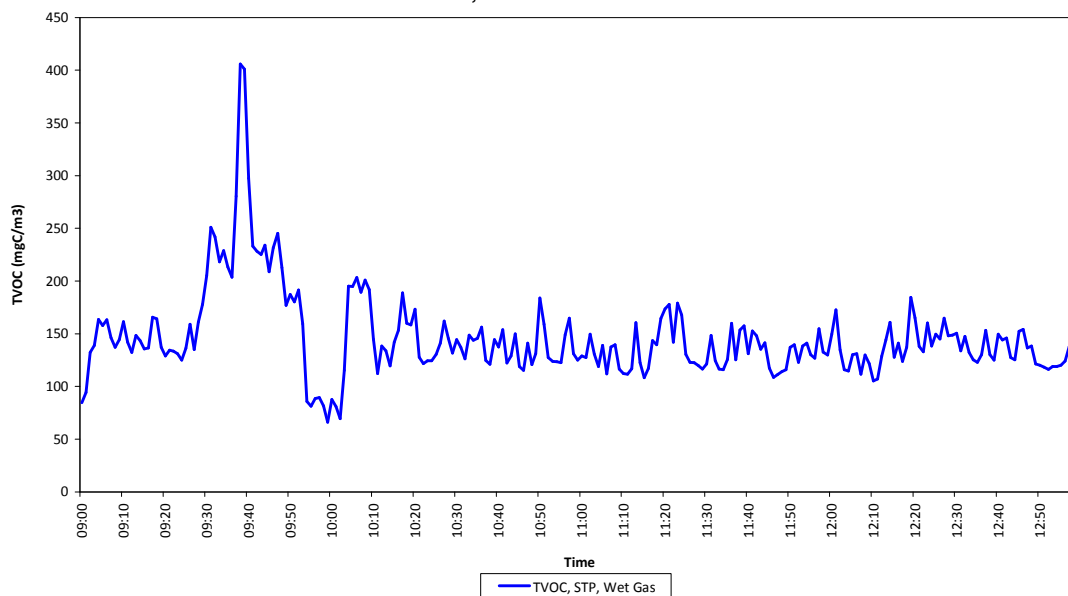


Figure 4

TVOC Data Recorded From ConvaTech, Rhymney, A3 - Spin Line (TP3535LH), on
11/11/2014, Between 09:00 and 12:59



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TABLES

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Table 1 – TVOC
Data Recorded from A1 – Scrubber Exhaust
Sample Period: 11:33 – 15:32 on the 13th November 2014

Volumetric Flowrate (Reference Conditions) = **4.16 m³/sec ***

	Average	Emission Rate
	mgC/m ³	Kg/hr
TVOC (as carbon)*	358.98	5.376

* Reference Conditions (273K, 101.3 kPa, Wet Gas)

- Volumetric Flowrate taken from Velocity Traverse -

Table 2 – TVOC
Data Recorded from A1 – Spin Line
Sample Period: 09:00 – 12:59 on the 13th November 2014

Volumetric Flowrate (Reference Conditions) = **1.62 m³/sec ***

	Average	Emission Rate
TVOC (as carbon)*	mgC/m ³	Kg/hr
09:00 – 09:59	63.78	0.372
10:00 – 10:59	78.49	0.458
11:00 – 11:59	90.17	0.526
12:00 – 12:59	91.72	0.535

* Reference Conditions (273K, 101.3 kPa, Wet Gas)

- Volumetric Flowrate taken from Velocity Traverse -

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Table 3 – TVOC
Data Recorded from A2 – Spin Line
Sample Period: 09:00 – 12:59 on the 11th November 2014

Volumetric Flowrate (Reference Conditions) = **0.96 m³/sec ***

	Average	Emission Rate
TVOC (as carbon)*	mgC/m³	Kg/hr
09:00 – 09:59	243.09	0.840
10:00 – 10:59	246.77	0.853
11:00 – 11:59	251.48	0.869
12:00 – 12:59	263.67	0.911

*** Reference Conditions (273K, 101.3 kPa, Wet Gas)**

- Volumetric Flowrate taken from Velocity Traverse -

Table 4 – TVOC
Data Recorded from A3 – Spin Line
Sample Period: 09:00 – 12:59 on the 11th November 2014

Volumetric Flowrate (Reference Conditions) = **1.04 m³/sec ***

	Average	Emission Rate
TVOC (as carbon)*	mgCm³	Kg/hr
09:00 – 09:59	173.45	0.649
10:00 – 10:59	141.40	0.529
11:00 – 11:59	133.79	0.501
12:00 – 12:59	136.17	0.510

*** Reference Conditions (273K, 101.3 kPa, Wet Gas)**

- Volumetric Flowrate taken from Velocity Traverse -

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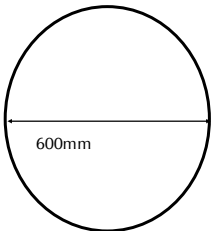
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VELOCITY TRAVERSE PROFILES

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Company	ConvaTech	Stack Diameter (mm)	600	Pitot tube coefficient	0.82
Site	Rhymney	Port Length (mm)	80	Pitot Id	635
Location	Scrubber Exhaust	Duct Length (mm) A		Stack Thermocouple ID	866
Stack	A1	Duct width (mm) B		Stack Temp Reader ID	414
Job No	P2121	Barometric Pressure. (mb)	951	Manometer ID	456
Operators	MM & IL	Static Pressure. (mm H ₂ O)	-16	Barometer ID	629

Diagram/ Description of Cross Section of Stack/Duct



A circular cross-section diagram of a stack or duct. A horizontal line with arrows at both ends passes through the center of the circle, indicating the diameter. Below the line, the text "600mm" is written.

Suitability of Sampling Position	Actual Stack Conditions
Permitted highest:lowest flow pressure ratio = 9:1	1.3:1
Average deviation of flow from axis < 15°	< 15
X-sectional area for stacks = πr^2	0.28 m ²
X-sectional area for ducts = L x B	0.000 m ²
Suitability of Position for Sampling	OK for gases

Gas Velocity (as Measured)	16.92	m/sec
Gas Velocity (Reference Conditions)	14.72	m/sec*
Volumetric Flowrate (as Measured)	4.78	m ³ /sec
Volumetric Flowrate (Reference Conditions)	4.16	m ³ /sec*

Compliance With Positional Requirements?		
Height of sample ports from Platform		1
Number of sample ports		2
Width of platform (port back to handrail)		1
Nearest downstream disturbance	Exit	2.
Nearest upstream disturbance	Diameter Change	1.

Disturbances are classed as bends, fans or diameter variations

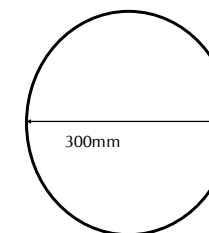
Company	ConvaTech	Stack Diameter (mm)	300	Pitot tube coefficient	1
Site	Rhymney	Port Length (mm)	90	Pitot Id	635
Location	Spin Line	Duct Length (mm) A		Stack Thermocouple ID	866
Stack	A1	Duct width (mm) B		Stack Temp Reader ID	414
Job No	P2121	Barometric Pressure. (mb)	997	Manometer ID	456
Operators	MM & IL	Static Pressure. (mm H ₂ O)	-71.35575943	Barometer ID	629

Only one port on duct, not possible to measure swirl

Suitability of Sampling Position	Actual Stack Conditions
Permitted highest:lowest flow pressure ratio = 9:1	1.3:1
Average deviation of flow from axis < 15°	...
X-sectional area for stacks = πr^2	0.07 m ²
X-sectional area for ducts = L x B	0.000 m ²
Suitability of Position for Sampling	Ok for gases

Gas Velocity (as Measured)	26.27	m/sec
Gas Velocity (Reference Conditions)	22.83	m/sec*
Volumetric Flowrate (as Measured)	1.86	m ³ /sec
Volumetric Flowrate (Reference Conditions)	1.61	m ³ /sec*

Diagram/ Description of Cross Section of Stack/Duct



Height of sample ports from Platform	0.5m
Number of sample ports	1
Width of platform (port back to handrail)	1.0m

Nearest downstream disturbance	Bend	0.5m
Nearest upstream disturbance	Bend	1.3m
Disturbances are classed as bends, fans or diameter variations		

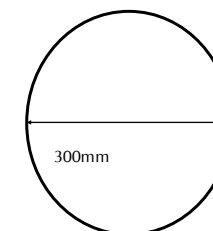
Company	ConvaTech	Stack Diameter (mm)	300	Pitot tube coefficient	1
Site	Rhymney	Port Length (mm)	90	Pitot Id	067
Location	Spin Line	Duct Length (mm) A		Stack Thermocouple ID	866
Stack	A2	Duct width (mm) B		Stack Temp Reader ID	414
Job No	P2121	Barometric Pressure. (mb)	997	Manometer ID	456
Operators	MM	Static Pressure. (mm H ₂ O)	12.2	Barometer ID	629

Only one port on duct, not possible to measure swirl

Suitability of Sampling Position	Actual Stack Conditions
Permitted highest:lowest flow pressure ratio = 9:1	1.27:1
Average deviation of flow from axis < 15°	...
X-sectional area for stacks = πr^2	0.07 m ²
X-sectional area for ducts = L x B	0.000 m ²
Suitability of Position for Sampling	Ok for gases

Gas Velocity (as Measured)	15.05	m/sec
Gas Velocity (Reference Conditions)	13.63	m/sec*
Volumetric Flowrate (as Measured)	1.06	m ³ /sec
Volumetric Flowrate (Reference Conditions)	0.96	m ³ /sec*

Diagram/ Description of Cross Section of Stack/Duct



Height of sample ports from Platform	1.0m
Number of sample ports	1
Width of platform (port back to handrail)	1.0m

Nearest downstream disturbance	Bend	0.5m
Nearest upstream disturbance	Bend	0.5m
Disturbances are classed as bends, fans or diameter variations		

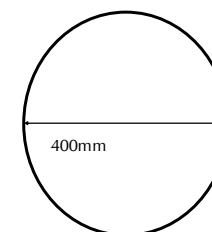
Company	ConvaTech	Stack Diameter (mm)	400	Pitot tube coefficient	0.82
Site	Rhymney	Port Length (mm)	180	Pitot Id	635
Location	Spin Line	Duct Length (mm) A		Stack Thermocouple ID	866
Stack	A3	Duct width (mm) B		Stack Temp Reader ID	414
Job No	P2121	Barometric Pressure. (mb)	997	Manometer ID	456
Operators	MM	Static Pressure. (mm H ₂ O)	5.6	Barometer ID	629

Only one port on duct, not possible to measure swirl

Suitability of Sampling Position	Actual Stack Conditions
Permitted highest:lowest flow pressure ratio = 9:1	1.27:1
Average deviation of flow from axis $< 15^\circ$	...
X-sectional area for stacks = πr^2	0.13 m ²
X-sectional area for ducts = L x B	0.000 m ²
Suitability of Position for Sampling	Ok for gases

Gas Velocity (as Measured)	9.05	m/sec
Gas Velocity (Reference Conditions)	8.25	m/sec*
Volumetric Flowrate (as Measured)	1.14	m ³ /sec
Volumetric Flowrate (Reference Conditions)	1.04	m ³ /sec*

Diagram/ Description of Cross Section of Stack/Duct



Height of sample ports from Platform	1.0m
Number of sample ports	1
Width of platform (port back to handrail)	> 2.0m

Nearest downstream disturbance	Bend	0.5m
Nearest upstream disturbance	Bend	0.5m
Disturbances are classed as bends, fans or diameter variations		

ConvaTec
Permit No
Variation No
Report Ref

: NP3433BC & TP3535LH
: ...
: P2121 : R001

Installation Name
Visit Details
Survey Dates
Report Issue Date

: Bioscrubber Stack & Spin Line
: Annual Compliance
: 11th & 13th November 2014
: 19th December 2014

FIELD CALIBRATION

ConvaTec
 Permit No : NP3433BC & TP3535LH
 Variation No : ...
 Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
 Visit Details : Annual Compliance
 Survey Dates : 11th & 13th November 2014
 Report Issue Date : 19th December 2014

A1 – Scrubber Exhaust

TVOC - FIELD DATA SHEET

Client	ConvaTech	Barometric Pressure mb	997
Site	Rhymney	Barometer ID	ECL/ID/ 629
Date	13/11/2014	Analyser ID	ECL/ID/ 211
Location	Scrubber Exhaust	Sonimix/ MFC ID	ECL/ID/ ...
Stack ID	A1	Heated Line/ Controller ID	ECL/ID/ 968 / 874
Stack Temp °C	21	Heated Line Set Temp °C	180 YES
Ambient Temp (sampling)	1 = 14.6 2 = 14.7 3 = 14.1	Heated Line Length	20 m
Ambient Temp (sampling)	4 = 14.3 5 = 14.6 6 = 14.7	Heated Probe Filter ID	ECL/ID/ 919
Job No	P2121	Heated Filter Set Temp °C	180 YES
Operators	JL & MM	Logger ID	922

Calibration Gas Details

Calibration Gas	Gas Bottle ID	Gas Value	Uncertainty of Gas (k=2)	Propane	Analyser Range	Span Gas value used
Zero Gas (Synthetic Air)	Gas/ 1402	...	...		1000 ppm	299.5 ppm
Hydrogen / Helium	Gas/ 1385	...	...			
Propane (In Air)	Gas/ 1225	299.5 ppm	1%			

Analyser Range should be not less than the expected peak emissions.

Span Gas Values should be either *approximately the half-hourly ELV* **OR** *50% to 90% of the Selected Analyser Range.*

Direct Calibration (Rear of Analyser)						
Zero Cal		Span Gas Cal		Zero Check		
Start Time	End Time	Start Time	End Time	Start Time	End Time	
ZERO /SPAN/ ZERO	09:33 09:37	09:36	09:43	09:50	09:55	

NOTE: RESPONSE TIME

Response Time to be carried out at the same time as "Span Check" on system verification (via the sample probe)
 Start Time = when gas turned on. 90% Time = when analyser displays 90% of span gas value used. Response must be within 200 seconds.

Pre-Cal Ambient Temp °C		PRE System Verification Check (Down Line)				Response Time		
Max	Min	Zero Check		Span Check		SYSTEM Span Gas Cal		
Start Time	End Time	Start Time	End Time	Start Time	End Time	Start Time	90% Time	less than 200s (Y/N)
14.4	14.3					10:24:00	10:24:59	Y
ZERO / SPAN		10:19	10:23	10:26	10:30			

	Start Time	End Time	Location	Production Details	
Sample Period	11:30	15:40	A1	Normal	
Sample Period					
Sample Period					
Sample Period					
Sample Period					
Sample Period					

Post-Cal Ambient Temp °C		POST System Verification Check (Down Line)			
Max	Min	Zero Check		Span Check	
Start Time	End Time	Start Time	End Time	Start Time	End Time
14.7	14.6				
ZERO / SPAN		15:46	15:50	15:53	15:57

Process Details / Comments

ConvaTec
Permit No
Variation No
Report Ref

: NP3433BC & TP3535LH
: ...
: P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
Visit Details : Annual Compliance
Survey Dates : 11th & 13th November 2014
Report Issue Date : 19th December 2014

Calibration Summary		TVOC ppm
Analyser Range		1000
Repeatability at Zero		2
Span Gas Concentration Applied		299.5
Zero Gas Concentration Applied		0
Direct Cal	Zero	0.00
	Span	299.5
	Zero	-0.02
Difference (Zero)		0.0212
< 2 × Repeatability @ Zero?		YES
Pre Test (System)	Zero	3.54
	Span	301.6
	Difference (Zero)	3.5407
< 2% Relative to Direct Span		YES
Difference (Span)		2.1261
< 2% Relative to Direct Span		YES
Post Test (System)	Zero	-0.02
	Span	290.2
	Difference (Zero)	3.5619
Zero Drift < 2% of Applied Span?		YES
Difference (Span)		11.3959
Span Drift < 2% of Applied Span?		NO
Zero and Span Drift < 5% of Applied Span?		YES

ConvaTec
 Permit No : NP3433BC & TP3535LH
 Variation No : ...
 Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
 Visit Details : Annual Compliance
 Survey Dates : 11th & 13th November 2014
 Report Issue Date : 19th December 2014

A1 – Spin Line

TVOC - FIELD DATA SHEET

Client	ConvaTech			Barometric Pressure mb	997	
Site	Rhymney			Barometer ID	ECL/ID/ 629	
Date	13/11/2014			Analysers ID	ECL/ID/ 304	
Location	Spin Line			Sonimix/ MFC ID	ECL/ID/	
Stack ID	A1			Heated Line/ Controller ID	ECL/ID/ 1013 / 1014	
Stack Temp °C	34			Heated Line Set Temp °C	180	YES
Ambient Temp (sampling)	1 = 26.1	2 = 26.1	3 = 26.3	Heated Line Length	10	m
Ambient Temp (sampling)	4 = 26.2	5 = 26.4	6 = 26.5	Heated Probe Filter ID	ECL/ID/ 572	
Job No	P2121			Heated Filter Set Temp °C	180	YES
Operators	MM + JL			Logger ID	924	

Calibration Gas Details

Calibration Gas	Gas Bottle ID	Gas Value	Uncertainty of Gas (k=2)	Propane	Analysers Range	Span Gas value used
Zero Gas (Synthetic Air)	Gas/ 1402	...	...		400 ppm	315.0 ppm
Hydrogen / Helium	Gas/ 1383	...	...			
Propane (In Air)	Gas/ 1343	315.0 ppm	1%			

Analysers Range should be not less than the expected peak emissions.

Span Gas Values should be either approximately the half-hourly ELV OR 50% to 90% of the Selected Analysers Range.

Direct Calibration (Rear of Analyser)					
Zero Cal		Span Gas Cal		Zero Check	
Start Time	End Time	Start Time	End Time	Start Time	End Time
ZERO /SPAN/ ZERO	See	11th	November	00:00	

NOTE: RESPONSE TIME

Response Time to be carried out at the same time as "Span Check" on system verification (via the sample probe)
 Start Time = when gas turned on. 90% Time = when analyser displays 90% of span gas value used. Response must be within 200 seconds.

Pre-Cal Ambient Temp °C		PRE System Verification Check (Down Line)				Response Time		
Max	Min	Zero Check		Span Check		SYSTEM Span Gas Cal		
26.2	26.1	Start Time	End Time	Start Time	End Time	Start Time	90% Time	less than 200s (Y/N)
						08:12:00	08:12:00	Y

	Start Time	End Time	Location	Production Details	
Sample Period	09:00	12:59	A1	Normal	
Sample Period					
Sample Period					
Sample Period					
Sample Period					
Sample Period					

Post-Cal Ambient Temp °C		POST System Verification Check (Down Line)			
Max	Min	Zero Check		Span Check	
26.5	26.3	Start Time	End Time	Start Time	End Time

Process Details / Comments

ConvaTec
Permit No
Variation No
Report Ref

: NP3433BC & TP3535LH
: ...
: P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
Visit Details : Annual Compliance
Survey Dates : 11th & 13th November 2014
Report Issue Date : 19th December 2014

Calibration Summary		TVOC ppm
Analyser Range		400
Repeatability at Zero		2
Span Gas Concentration Applied		315
Zero Gas Concentration Applied		0
Direct Cal	Zero	0.00
	Span	315.0
	Zero	0.63
Difference (Zero)		0.6333
< 2 × Repeatability @ Zero?		YES
Pre Test (System)	Zero	0.81
	Span	319.8
	Difference (Zero)	0.8115
< 2% Relative to Direct Span		YES
Difference (Span)		4.8479
< 2% Relative to Direct Span		YES
Post Test (System)	Zero	0.14
	Span	326.2
	Difference (Zero)	0.6708
Zero Drift < 2% of Applied Span?		YES
Difference (Span)		6.3255
Span Drift < 2% of Applied Span?		NO
Zero and Span Drift < 5% of Applied Span?		YES

ConvaTec
 Permit No : NP3433BC & TP3535LH
 Variation No : ...
 Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
 Visit Details : Annual Compliance
 Survey Dates : 11th & 13th November 2014
 Report Issue Date : 19th December 2014

A2 – Spin Line

TVOC - FIELD DATA SHEET

Client	ConvaTech	Barometric Pressure mb	991
Site	Rhymney	Barometer ID	ECL/ID/ 629
Date	11/11/2014	Analyser ID	ECL/ID/ 304
Location	Spin Line	Sonimix/ MFC ID	ECL/ID/
Stack ID	A2	Heated Line/ Controller ID	ECL/ID/ 1013 / 1014
Stack Temp °C	22	Heated Line Set Temp °C	180 YES
Ambient Temp (sampling)	1 = 24.3 2 = 24.2 3 = 24.4	Heated Line Length	20 m
Ambient Temp (sampling)	4 = 24.6 5 = 24.7 6 = 24.6	Heated Probe Filter ID	ECL/ID/ 572
Job No	P2121	Heated Filter Set Temp °C	180 YES
Operators	MM	Logger ID	924

Calibration Gas Details

Calibration Gas	Gas Bottle ID	Gas Value	Uncertainty of Gas (k=2)	Propane	Analyser Range	Span Gas value used
Zero Gas (Synthetic Air)	Gas/ 1402	...	...		400 ppm	315.0 ppm
Hydrogen / Helium	Gas/ 1382	...	...			
Propane (In Air)	Gas/ 1343	315.0 ppm	1%			

Analyser Range should be not less than the expected peak emissions.

Span Gas Values should be either *approximately the half-hourly ELV* **OR** *50% to 90% of the Selected Analyser Range.*

Direct Calibration (Rear of Analyser)						
Zero Cal		Span Gas Cal		Zero Check		
Start Time	End Time	Start Time	End Time	Start Time	End Time	
ZERO /SPAN/ ZERO	07:56 08:00	08:06	08:10	08:13	08:17	

NOTE: RESPONSE TIME

Response Time to be carried out at the same time as "Span Check" on system verification (via the sample probe)
 Start Time = when gas turned on. 90% Time = when analyser displays 90% of span gas value used. Response must be within 200 seconds.

Pre-Cal Ambient Temp °C		PRE System Verification Check (Down Line)				Response Time		
Max	Min	Zero Check		Span Check		SYSTEM Span Gas Cal		
Start Time	End Time	Start Time	End Time	Start Time	End Time	Start Time	90% Time	less than 200s (Y/N)
24.2	24					08:23:00	08:24:00	Y
ZERO / SPAN		08:19	08:23	08:25	08:29			

Start Time	End Time	Location	Production Details	
Sample Period	09:00 13:00	A2	Normal	
Sample Period				
Sample Period				
Sample Period				
Sample Period				
Sample Period				

Post-Cal Ambient Temp °C		POST System Verification Check (Down Line)			
Max	Min	Zero Check		Span Check	
Start Time	End Time	Start Time	End Time	Start Time	End Time
24	23.9				
ZERO / SPAN		13:12	13:16	13:19	13:23

Process Details / Comments

ConvaTec
Permit No
Variation No
Report Ref

: NP3433BC & TP3535LH
: ...
: P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
Visit Details : Annual Compliance
Survey Dates : 11th & 13th November 2014
Report Issue Date : 19th December 2014

Calibration Summary		TVOC ppm
Analyser Range		400
Repeatability at Zero		2
Span Gas Concentration Applied		315
Zero Gas Concentration Applied		0
Direct Cal	Zero	0.00
	Span	315.0
	Zero	0.63
Difference (Zero)		0.6333
< 2 × Repeatability @ Zero?		YES
Pre Test (System)	Zero	0.55
	Span	311.7
	Difference (Zero)	0.5488
< 2% Relative to Direct Span		YES
Difference (Span)		3.3478
< 2% Relative to Direct Span		YES
Post Test (System)	Zero	0.54
	Span	309.9
	Difference (Zero)	0.0084
Zero Drift < 2% of Applied Span?		YES
Difference (Span)		1.7140
Span Drift < 2% of Applied Span?		YES
Zero and Span Drift < 5% of Applied Span?		YES

ConvaTec
 Permit No : NP3433BC & TP3535LH
 Variation No : ...
 Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
 Visit Details : Annual Compliance
 Survey Dates : 11th & 13th November 2014
 Report Issue Date : 19th December 2014

A3 – Spin Line

TVOC - FIELD DATA SHEET

Client	ConvaTech	Barometric Pressure mb	991
Site	Rhymney	Barometer ID	ECL/ID/ 629
Date	11/11/2014	Analysers ID	ECL/ID/ 211
Location	Spin Line	Sonimix/ MFC ID	ECL/ID/
Stack ID	A3	Heated Line/ Controller ID	ECL/ID/ 968 / 874
Stack Temp °C	22	Heated Line Set Temp °C	180 YES
Ambient Temp (sampling)	1 = 24.3 2 = 24.2 3 = 24.4	Heated Line Length	20 m
Ambient Temp (sampling)	4 = 24.6 5 = 24.7 6 = 24.6	Heated Probe Filter ID	ECL/ID/ 919
Job No	P2121	Heated Filter Set Temp °C	180 YES
Operators	MM	Logger ID	922

Calibration Gas Details

Calibration Gas	Gas Bottle ID	Gas Value	Uncertainty of Gas (k=2)	Analysers Range	Span Gas value used
Zero Gas (Synthetic Air)	Gas/ 1403	...	...	Propane	400 ppm 299.5 ppm
Hydrogen / Helium	Gas/ 1385	...	...		
Propane (In Air)	Gas/ 1276	299.5 ppm	1%		

Analysers Range should be not less than the expected peak emissions.

Span Gas Values should be either approximately the half-hourly ELV OR 50% to 90% of the Selected Analysers Range.

Direct Calibration (Rear of Analyser)						
Zero Cal		Span Gas Cal		Zero Check		
Start Time	End Time	Start Time	End Time	Start Time	End Time	
ZERO /SPAN/ ZERO	08:10 08:14	08:16	08:20	08:22	08:26	

NOTE: RESPONSE TIME

Response Time to be carried out at the same time as "Span Check" on system verification (via the sample probe)
 Start Time = when gas turned on. 90% Time = when analyser displays 90% of span gas value used. Response must be within 200 seconds.

Pre-Cal Ambient Temp °C		PRE System Verification Check (Down Line)				Response Time		
Max	Min	Zero Check		Span Check		SYSTEM Span Gas Cal		
24.2	24	Start Time	End Time	Start Time	End Time	Start Time	90% Time	less than 200s (Y/N)
		ZERO / SPAN	08:28 08:32	08:35	08:39	08:35:00	08:36:00	Y

	Start Time	End Time	Location	Production Details	
Sample Period	09:00	13:00	A3	Normal	
Sample Period					
Sample Period					
Sample Period					
Sample Period					
Sample Period					

Post-Cal Ambient Temp °C		POST System Verification Check (Down Line)			
Max	Min	Zero Check		Span Check	
24	23.9	Start Time	End Time	Start Time	End Time
		ZERO / SPAN	13:19 13:23	13:27	13:31

Process Details / Comments

ConvaTec
Permit No
Variation No
Report Ref

: NP3433BC & TP3535LH
: ...
: P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
Visit Details : Annual Compliance
Survey Dates : 11th & 13th November 2014
Report Issue Date : 19th December 2014

Calibration Summary		TVOC ppm
Analyser Range		400
Repeatability at Zero		2
Span Gas Concentration Applied		299.5
Zero Gas Concentration Applied		0
Direct Cal	Zero	0.00
	Span	299.5
	Zero	-0.25
Difference (Zero)		0.2512
< 2 × Repeatability @ Zero?		YES
Pre Test (System)	Zero	0.35
	Span	298.7
	Difference (Zero)	0.3518
< 2% Relative to Direct Span		YES
Difference (Span)		0.8099
< 2% Relative to Direct Span		YES
Post Test (System)	Zero	0.24
	Span	293.3
	Difference (Zero)	0.1130
Zero Drift < 2% of Applied Span?		YES
Difference (Span)		5.3607
Span Drift < 2% of Applied Span?		YES
Zero and Span Drift < 5% of Applied Span?		YES

ConvaTec
Permit No
Variation No
Report Ref

: NP3433BC & TP3535LH
: ...
: P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
Visit Details : Annual Compliance
Survey Dates : 11th & 13th November 2014
Report Issue Date : 19th December 2014

UNCERTAINTY CALCULATIONS

ConvaTec
 Permit No : NP3433BC & TP3535LH
 Variation No : ...
 Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
 Visit Details : Annual Compliance
 Survey Dates : 11th & 13th November 2014
 Report Issue Date : 19th December 2014

Scrubber Exhaust – A1 – Measurement Uncertainty

A1 - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Min Certified Ranges
			TVOC 0 - 15 mgC/m ³
Lack of fit ⁽¹⁾	u_{lof}	Rectangular (Divisor = $\sqrt{3}$)	0.73
Span drift ⁽²⁾	$u_{d,s}$	Rectangular (Divisor = $\sqrt{3}$)	0.35
Repeatability Standard Deviation (span) ⁽³⁾	u_r	Normal (Divisor = 1)	56.12
Losses / leakage in the sample system ⁽⁴⁾	u_{loss}	Rectangular (Divisor = $\sqrt{3}$)	14.17
Temperature dependant span drift ⁽⁵⁾	u_t	Rectangular (Divisor = $\sqrt{3}$)	0.30
Interferents ⁽¹⁾	u_i	Rectangular (Divisor = $\sqrt{3}$)	4.39
Uncertainty of Reference Gas ⁽⁶⁾	u_{ref}	Rectangular (Divisor = $\sqrt{3}$)	8.34

Note:

$$\text{when } |(x_{i,\max} - x_{i,\text{adj}})| = |(x_{i,\min} - x_{i,\text{adj}})|, \text{ then } u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$$

- Expressed as a percentage of the certified range
- Expressed as maximum drift per 24hr period as percentage of the certified range
- Expressed as a percentage of the certified range
- Expressed as a percentage of the certified range
- Expressed as a percentage of the certified range per one degree centigrade
- Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol taking account of an additional uncertainty of 2% for gas blending
- Expressed as a percentage of the certified range

A1 - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 2

Performance Characteristics	Uncertainty	Value of Standard Uncertainty	*TVOC 0 - 15 mgC/m ³
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.064
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.031
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}} =$	8.42
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	1.23
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t \times R_i}{100} \times \sqrt{\frac{(x_{i,\max} - x_{i,\text{adj}})^2 + (x_{i,\min} - x_{i,\text{adj}})(x_{i,\max} - x_{i,\text{adj}}) + (x_{i,\min} - x_{i,\text{adj}})^2}{3}}$	0.0052
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.38
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	4.81
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2}$	9.79
Expanded measurement uncertainty (at 95% confidence)		$U_{EXP} = 2 \times u_c$	19.58
Applied Span Concentration			481.30
Measured Span Concentration, STP Dry Gas			476.73
Expanded measurement uncertainty as % of Applied Span			4 %

* Signal 3030 FID

ConvaTec
 Permit No : NP3433BC & TP3535LH
 Variation No : ...
 Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
 Visit Details : Annual Compliance
 Survey Dates : 11th & 13th November 2014
 Report Issue Date : 19th December 2014

Scrubber Exhaust – A1 – Uncertainty of Measurement

A1 - TVOC - Uncertainty of Measurement Results - Calculations Part 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Min Certified Range
				TVOC 0 - 15 mgC/m ³
Lack of fit ⁽¹⁾	u_{lof}	Rectangular	$\sqrt{3}$	0.73
Span drift ⁽²⁾	$u_{d,s}$			0.35
Losses / leakage in the sample system ⁽⁴⁾	u_{loss}			0.71
Temperature dependant span drift ⁽⁵⁾	u_t			0.30
Interferents ⁽¹⁾	u_i			4.39
Effect of Voltage Fluctuation ⁽⁷⁾	u_v			1.80
Effect of Oxygen Synergism ⁽⁷⁾	u_{syn}			

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,max} - x_{i,adj})^2 + (x_{i,min} - x_{i,adj})^2}{3}}$, when $|x_{i,max} - x_{i,adj}| = |x_{i,min} - x_{i,adj}|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below), $\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$

Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	TVOC 0 - 15 mgC/m ³
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.064
Span drift	$u_{d,s}$			0.031
Temperature dependant span drift	u_t			0.0090
Interferents	u_i			0.38
Effect of Voltage Fluctuation (See Note)	u_v			0.16

A1 - TVOC - Uncertainty of Measurement Results - Calculations Part 2

Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	TVOC 0 - 15 mgC/m ³
Losses / leakage in the sample system	u_{loss}	13/11/14 11:33 - 15:32	2.55
Standard Error of Measured Value	u_{SE}	13/11/14 11:33 - 15:32	3.58

Effect on Uncertainty Caused by Oxygen

$$u_{Corr_{O_2}} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured}) \times (20.9\% - O_{2,measured})} \times \text{Uncertainty of } O_2 \text{ Meas} =$$

$$f_{O_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 1.0000$$

$$u_{f_{O_2}} = \frac{u_{Corr_{O_2}}}{f_{O_2}} \times 100 = 0.00 \%$$

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$$u_{combined} = \sqrt{\sum (u_{f_{O_2}})^2 + (\text{Uncertainty of Measurement of Determinand})^2}$$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$$\therefore u(x_i) = C_i u_i \text{ where } C_i = \frac{\partial f}{\partial x_i}$$

A1 - TVOC - Uncertainty of Measurement Results - Calculations Part 3

Uncertainty	Date & Time	*TVOC 0 - 15 mgC/m ³
Measured Concentration		358.98
Expanded Uncertainty as Percentage of Measured Concentration	13/11/14 11:33 - 15:32	2 %

$$\text{Combined Standard Uncertainty } u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{v}^2 + u_{syn}^2}$$

$$\text{Expanded uncertainty (at 95% confidence)} U_{Exp} = 2 \times u_c$$

- Expressed as a percentage of the certified range
- Expressed as a percentage of the certified range as maximum drift per 24hr period
- Expressed as a percentage of the certified range
- Expressed as a percentage of the applied span concentration
- Expressed as a percentage of the certified range per one degree centigrade
- Where the uncertainty of moisture is taken from the manual extract test calculations.
- Expressed as a percentage of the certified range
- Where no uncertainty is presented above, the uncertainty is > 100%

ConvaTec
 Permit No : NP3433BC & TP3535LH
 Variation No : ...
 Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
 Visit Details : Annual Compliance
 Survey Dates : 11th & 13th November 2014
 Report Issue Date : 19th December 2014

Spin Line – A1 – Measurement Uncertainty

A1 - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Min Certified Ranges
			TVOC 0 - 15 mgC/m ³
Lack of fit ⁽¹⁾	u_{lof}	Rectangular (Divisor = $\sqrt{3}$)	0.73
Span drift ⁽²⁾	$u_{d,s}$	Rectangular (Divisor = $\sqrt{3}$)	0.35
Repeatability Standard Deviation (span) ⁽³⁾	u_r	Normal (Divisor = 1)	51.76
Losses / leakage in the sample system ⁽⁴⁾	u_{loss}	Rectangular (Divisor = $\sqrt{3}$)	32.32
Temperature dependant span drift ⁽⁵⁾	u_t	Rectangular (Divisor = $\sqrt{3}$)	0.30
Interferents ⁽¹⁾	u_i	Rectangular (Divisor = $\sqrt{3}$)	4.39
Uncertainty of Reference Gas ⁽⁶⁾	u_{ref}	Rectangular (Divisor = $\sqrt{3}$)	8.77

Note:

$$\text{when } |(x_{i,\max} - x_{i,\text{adj}})| = |(x_{i,\min} - x_{i,\text{adj}})|, \text{ then } u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$$

- Expressed as a percentage of the certified range
- Expressed as maximum drift per 24hr period as percentage of the certified range
- Expressed as a percentage of the certified range
- Expressed as a percentage of the certified range
- Expressed as a percentage of the certified range per one degree centigrade
- Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol taking account of an additional uncertainty of 2% for gas blending
- Expressed as a percentage of the certified range

A1 - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 2

Performance Characteristics	Uncertainty	Value of Standard Uncertainty	*TVOC 0 - 15 mgC/m ³
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.064
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.031
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}} =$	7.76
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	2.80
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t \times R_i}{100} \times \sqrt{\frac{(x_{i,\max} - x_{i,\text{adj}})^2 + (x_{i,\min} - x_{i,\text{adj}})(x_{i,\max} - x_{i,\text{adj}}) + (x_{i,\min} - x_{i,\text{adj}})^2}{3}}$	0.0052
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.38
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	5.06
Combined Standard Uncertainty			9.70
Expanded measurement uncertainty (at 95% confidence)			19.40
Applied Span Concentration			506.21
Measured Span Concentration, STP Dry Gas			514.79
Expanded measurement uncertainty as % of Applied Span			4 %

* Signal 3030 FID

ConvaTec
Permit No : NP3433BC & TP3535LH
Variation No : ...
Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
Visit Details : Annual Compliance
Survey Dates : 11th & 13th November 2014
Report Issue Date : 19th December 2014

Spin Line – A1 – Uncertainty of Measurement

A1 - TVOC - Uncertainty of Measurement Results - Calculations Part 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Min Certified Range
				TVOC 0 - 15 mgC/m ³
Lack of fit ⁽¹⁾	u_{lof}	Rectangular	$\sqrt{3}$	0.73
Span drift ⁽²⁾	$u_{d,s}$			0.35
Losses / leakage in the sample system ⁽⁴⁾	u_{loss}			1.54
Temperature dependant span drift ⁽⁵⁾	u_t			0.30
Interferents ⁽¹⁾	u_i			4.39
Effect of Voltage Fluctuation ⁽⁷⁾	u_v			1.80
Effect of Oxygen Synergism ⁽⁷⁾	u_{syn}			

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,max} - x_{i,adj})^2 + (x_{i,min} - x_{i,adj})^2 + (x_{i,max} - x_{i,adj}) + (x_{i,min} - x_{i,adj})^2}{3}}$, when $|(x_{i,max} - x_{i,adj})| = |(x_{i,min} - x_{i,adj})|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below), $\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$

Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	TVOC 0 - 15 mgC/m ³
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.064
Span drift	$u_{d,s}$			0.031
Temperature dependant span drift	u_t			0.0052
Interferents	u_i			0.38
Effect of Voltage Fluctuation (See Note)	u_v			0.16

A1 - TVOC - Uncertainty of Measurement Results - Calculations Part 2

Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	TVOC 0 - 15 mgC/m ³
Losses / leakage in the sample system	u_{loss}	13/11/14 09:00 - 09:59	0.98
		13/11/14 10:00 - 10:59	1.21
		13/11/14 11:00 - 11:59	1.39
		13/11/14 12:00 - 12:59	1.41
Standard Error of Measured Value	u_{SE}	13/11/14 09:00 - 09:59	1.56
		13/11/14 10:00 - 10:59	0.85
		13/11/14 11:00 - 11:59	0.80
		13/11/14 12:00 - 12:59	0.99

Effect on Uncertainty Caused by Oxygen

$$u_{Corr_{O_2}} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})(20.9\% - O_{2,measured})} \times \text{Uncertainty of } O_2 \text{ Meas} =$$

$$f_{O_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 1.0000$$

$$uf_{O_2} = \frac{u_{Corr_{O_2}}}{f_{O_2}} \times 100 = 0.00 \%$$

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$$u_{combined} = \sqrt{\sum (uf_{O_2})^2 + (\text{Uncertainty of Measurement of Determinand})^2}$$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$$\therefore u(x_i) = C_i u_i \text{ where } C_i = \frac{\partial f}{\partial x_i}$$

Uncertainty	Date & Time	*TVOC 0 - 15 mgC/m ³
Measured Concentration	13/11/14 09:00 - 09:59	63.78
Expanded Uncertainty as Percentage of Measured Concentration		6 %
Measured Concentration	13/11/14 10:00 - 10:59	78.49
Expanded Uncertainty as Percentage of Measured Concentration		4 %
Measured Concentration	13/11/14 11:00 - 11:59	90.17
Expanded Uncertainty as Percentage of Measured Concentration		4 %
Measured Concentration	13/11/14 12:00 - 12:59	91.72
Expanded Uncertainty as Percentage of Measured Concentration		4 %

Expanded uncertainty (at 95% confidence) $U_{Exp} = 2 \times u_c$

- 1 Expressed as a percentage of the certified range
- 2 Expressed as a percentage of the certified range as maximum drift per 24hr period
- 3 Expressed as a percentage of the certified range
- 4 Expressed as a percentage of the applied span concentration
- 5 Expressed as a percentage of the certified range per one degree centigrade
- 6 Where the uncertainty of moisture is taken from the manual extract test calculations.
- 7 Expressed as a percentage of the certified range
- 8 Where no uncertainty is presented above, the uncertainty is >100%

ConvaTec
 Permit No : NP3433BC & TP3535LH
 Variation No : ...
 Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
 Visit Details : Annual Compliance
 Survey Dates : 11th & 13th November 2014
 Report Issue Date : 19th December 2014

Spin Line – A2 – Measurement Uncertainty

A2 - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Min Certified Ranges
			TVOC 0 - 15 mgC/m ³
Lack of fit ⁽¹⁾	u_{lof}	Rectangular (Divisor = $\sqrt{3}$)	0.73
Span drift ⁽²⁾	$u_{d,s}$	Rectangular (Divisor = $\sqrt{3}$)	0.35
Repeatability Standard Deviation (span) ⁽³⁾	u_r	Normal (Divisor = 1)	23.96
Losses / leakage in the sample system ⁽⁴⁾	u_{loss}	Rectangular (Divisor = $\sqrt{3}$)	22.32
Temperature dependant span drift ⁽⁵⁾	u_t	Rectangular (Divisor = $\sqrt{3}$)	0.30
Interferents ⁽¹⁾	u_i	Rectangular (Divisor = $\sqrt{3}$)	4.39
Uncertainty of Reference Gas ⁽⁶⁾	u_{ref}	Rectangular (Divisor = $\sqrt{3}$)	8.77

Note:

$$\text{when } |(x_{i,\max} - x_{i,\text{adj}})| = |(x_{i,\min} - x_{i,\text{adj}})|, \text{ then } u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$$

- Expressed as a percentage of the certified range
- Expressed as maximum drift per 24hr period as percentage of the certified range
- Expressed as a percentage of the certified range
- Expressed as a percentage of the certified range
- Expressed as a percentage of the certified range per one degree centigrade
- Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol taking account of an additional uncertainty of 2% for gas blending
- Expressed as a percentage of the certified range

A2 - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 2

Performance Characteristics	Uncertainty	Value of Standard Uncertainty	*TVOC 0 - 15 mgC/m ³
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.064
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.031
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}} =$	3.59
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	1.93
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t \times R_i}{100} \times \sqrt{\frac{(x_{i,\max} - x_{i,\text{adj}})^2 + (x_{i,\min} - x_{i,\text{adj}})(x_{i,\max} - x_{i,\text{adj}}) + (x_{i,\min} - x_{i,\text{adj}})^2}{3}}$	0.0039
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.38
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	5.06
Combined Standard Uncertainty			6.53
Expanded measurement uncertainty (at 95% confidence)			13.06
Applied Span Concentration			506.21
Measured Span Concentration, STP Dry Gas			501.98
Expanded measurement uncertainty as % of Applied Span			3 %

* Signal 3030 FID

ConvaTec
Permit No : NP3433BC & TP3535LH
Variation No : ...
Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
Visit Details : Annual Compliance
Survey Dates : 11th & 13th November 2014
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Spin Line – A2 – Uncertainty of Measurement

A2 - TVOC - Uncertainty of Measurement Results - Calculations Part 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Min Certified Range
				TVOC 0 - 15 mgC/m ³
Lack of fit ⁽¹⁾	u_{lof}	Rectangular	$\sqrt{3}$	0.73
Span drift ⁽²⁾	$u_{d,s}$			0.35
Losses / leakage in the sample system ⁽⁴⁾	u_{loss}			1.06
Temperature dependant span drift ⁽⁵⁾	u_t			0.30
Interferents ⁽¹⁾	u_i			4.39
Effect of Voltage Fluctuation ⁽⁷⁾	u_v			1.80
Effect of Oxygen Synergism ⁽⁷⁾	u_{syn}			

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,max} - x_{i,adj})^2 + (x_{i,min} - x_{i,adj})^2}{3}}$, when $|(x_{i,max} - x_{i,adj})| = |(x_{i,min} - x_{i,adj})|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below), $\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$

Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	TVOC 0 - 15 mgC/m ³
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.064
Span drift	$u_{d,s}$			0.031
Temperature dependant span drift	u_t			0.019
Interferents	u_i			0.38
Effect of Voltage Fluctuation (See Note)	u_v			0.16

A2 - TVOC - Uncertainty of Measurement Results - Calculations Part 2

Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	TVOC 0 - 15 mgC/m ³
Losses / leakage in the sample system	u_{loss}	11/11/14 09:00 - 09:59	2.58
		11/11/14 10:00 - 10:59	2.62
		11/11/14 11:00 - 11:59	2.67
		11/11/14 12:00 - 12:59	2.80
Standard Error of Measured Value	u_{SE}	11/11/14 09:00 - 09:59	7.27
		11/11/14 10:00 - 10:59	3.37
		11/11/14 11:00 - 11:59	1.23
		11/11/14 12:00 - 12:59	1.58

Effect on Uncertainty Caused by Oxygen

$$u_{Corr_{O_2}} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})(20.9\% - O_{2,measured})} \times \text{Uncertainty of } O_2 \text{ Meas} =$$

$$f_{O_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 1.0000$$

$$uf_{O_2} = \frac{u_{Corr_{O_2}}}{f_{O_2}} \times 100 = 0.00 \%$$

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$$u_{combined} = \sqrt{\sum (uf_{O_2})^2 + (\text{Uncertainty of Measurement of Determinand})^2}$$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$$\therefore u(x_i) = C_i u_i \text{ where } C_i = \frac{\partial f}{\partial x_i}$$

Environmental Compliance Limited

ConvaTec
Permit No : NP3433BC & TP3535LH
Variation No : ...
Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
Visit Details : Annual Compliance
Survey Dates : 11th & 13th November 2014
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A2 - TVOC - Uncertainty of Measurement Results - Calculations Part 3

Uncertainty	Date & Time	*TVOC 0 - 15 mgC/m ³
Measured Concentration	11/11/14 09:00 - 09:59	243.09
Expanded Uncertainty as Percentage of Measured Concentration		6 %
Measured Concentration	11/11/14 10:00 - 10:59	246.77
Expanded Uncertainty as Percentage of Measured Concentration		3 %
Measured Concentration	11/11/14 11:00 - 11:59	251.48
Expanded Uncertainty as Percentage of Measured Concentration		2 %
Measured Concentration	11/11/14 12:00 - 12:59	263.67
Expanded Uncertainty as Percentage of Measured Concentration		2 %

Combined Standard Uncertainty $u_c = \sqrt{u_{bf}^2 + u_{d,s}^2 + u_c^2 + u_{mo}^2 + u_c^2 + u_c^2 + u_{ref}^2 + u_c^2 + u_{syn}^2}$

Expanded uncertainty (at 95% confidence) $U_{Exp} = 2 \times u_c$

- 1 Expressed as a percentage of the certified range
- 2 Expressed as a percentage of the certified range as maximum drift per 24hr period
- 3 Expressed as a percentage of the certified range
- 4 Expressed as a percentage of the applied span concentration
- 5 Expressed as a percentage of the certified range per one degree centigrade
- 6 Where the uncertainty of moisture is taken from the manual extract test calculations.
- 7 Expressed as a percentage of the certified range
- 8 Where no uncertainty is presented above, the uncertainty is > 100%

ConvaTec
 Permit No : NP3433BC & TP3535LH
 Variation No : ...
 Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
 Visit Details : Annual Compliance
 Survey Dates : 11th & 13th November 2014
 Report Issue Date : 19th December 2014

Spin Line – A3 – Measurement Uncertainty

A3 - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Min Certified Ranges
			TVOC 0 - 15 mgC/m ³
Lack of fit ⁽¹⁾	u_{lof}	Rectangular (Divisor = $\sqrt{3}$)	0.73
Span drift ⁽²⁾	$u_{d,s}$	Rectangular (Divisor = $\sqrt{3}$)	0.35
Repeatability Standard Deviation (span) ⁽³⁾	u_r	Normal (Divisor = 1)	38.35
Losses / leakage in the sample system ⁽⁴⁾	u_{loss}	Rectangular (Divisor = $\sqrt{3}$)	5.40
Temperature dependant span drift ⁽⁵⁾	u_t	Rectangular (Divisor = $\sqrt{3}$)	0.30
Interferents ⁽¹⁾	u_i	Rectangular (Divisor = $\sqrt{3}$)	4.39
Uncertainty of Reference Gas ⁽⁶⁾	u_{ref}	Rectangular (Divisor = $\sqrt{3}$)	8.34

Note:

$$\text{when } |(x_{i,\max} - x_{i,\text{adj}})| = |(x_{i,\min} - x_{i,\text{adj}})|, \text{ then } u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$$

- Expressed as a percentage of the certified range
- Expressed as maximum drift per 24hr period as percentage of the certified range
- Expressed as a percentage of the certified range
- Expressed as a percentage of the certified range
- Expressed as a percentage of the certified range per one degree centigrade
- Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol taking account of an additional uncertainty of 2% for gas blending
- Expressed as a percentage of the certified range

A3 - TVOC - Measurement Uncertainty - Uncertainty Calculations Table 2

Performance Characteristics	Uncertainty	Value of Standard Uncertainty	*TVOC 0 - 15 mgC/m ³
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.064
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.031
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}} =$	5.75
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	0.47
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t \times R_i}{100} \times \sqrt{\frac{(x_{i,\max} - x_{i,\text{adj}})^2 + (x_{i,\min} - x_{i,\text{adj}})(x_{i,\max} - x_{i,\text{adj}}) + (x_{i,\min} - x_{i,\text{adj}})^2}{3}}$	0.0039
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.38
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	4.81
Combined Standard Uncertainty			7.54
Expanded measurement uncertainty (at 95% confidence)			15.07
Applied Span Concentration			481.30
Measured Span Concentration, STP Dry Gas			476.77
Expanded measurement uncertainty as % of Applied Span			3 %

* Signal 3030 FID

ConvaTec
Permit No : NP3433BC & TP3535LH
Variation No : ...
Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
Visit Details : Annual Compliance
Survey Dates : 11th & 13th November 2014
Report Issue Date : 19th December 2014

Spin Line – A3 – Uncertainty of Measurement

A3 - TVOC - Uncertainty of Measurement Results - Calculations Part 1

Performance Characteristics	Standard Uncertainty (% of Range)	Distribution	Divisor	Min Certified Range
				TVOC 0 - 15 mgC/m ³
Lack of fit ⁽¹⁾	u_{lof}	Rectangular	$\sqrt{3}$	0.73
Span drift ⁽²⁾	$u_{d,s}$			0.35
Losses / leakage in the sample system ⁽⁴⁾	u_{loss}			0.27
Temperature dependant span drift ⁽⁵⁾	u_t			0.30
Interferents ⁽¹⁾	u_i			4.39
Effect of Voltage Fluctuation ⁽⁷⁾	u_v			1.80
Effect of Oxygen Synergism ⁽⁷⁾	u_{syn}			

Notes:

For rectangular distributions, $u(x_i) = \frac{u \times R_i}{\sqrt{3}}$

For $u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,max} - x_{i,adj})^2 + (x_{i,min} - x_{i,adj})^2 + (x_{i,max} - x_{i,min})^2}{3}}$, when $|(x_{i,max} - x_{i,adj})| = |(x_{i,min} - x_{i,adj})|$, then $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$

Where $u(x_i) = \frac{\sigma}{\sqrt{n}}$ (See note 6 below), $\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}}$

Performance Characteristics	Uncertainty (Units of final measurement)	Distribution	Divisor	TVOC 0 - 15 mgC/m ³
Lack of fit	u_{lof}	Rectangular	$\sqrt{3}$	0.064
Span drift	$u_{d,s}$			0.031
Temperature dependant span drift	u_t			0.019
Interferents	u_i			0.38
Effect of Voltage Fluctuation (See Note)	u_v			0.16

A3 - TVOC - Uncertainty of Measurement Results - Calculations Part 2

Performance Characteristics	Uncertainty (Units of final measurement)	Date & Time	TVOC 0 - 15 mgC/m ³
Losses / leakage in the sample system	u_{loss}	11/11/14 09:00 - 09:59	0.47
		11/11/14 10:00 - 10:59	0.38
		11/11/14 11:00 - 11:59	0.36
		11/11/14 12:00 - 12:59	0.37
Standard Error of Measured Value	u_{SE}	11/11/14 09:00 - 09:59	8.72
		11/11/14 10:00 - 10:59	3.59
		11/11/14 11:00 - 11:59	2.34
		11/11/14 12:00 - 12:59	2.11

Effect on Uncertainty Caused by Oxygen

$$u_{Corr_{O_2}} = \frac{20.9\% - O_{2,ref}}{(20.9\% - O_{2,measured})(20.9\% - O_{2,measured})} \times \text{Uncertainty of } O_2 \text{ Mes} =$$

$$f_{O_2} = \frac{20.9\% - O_{2,ref}}{20.9\% - O_{2,measured}} = 1.0000$$

$$uf_{O_2} = \frac{u_{Corr_{O_2}}}{f_{O_2}} \times 100 = 0.00 \%$$

The effect of oxygen on the overall uncertainties (below) is incorporated using the following equation:-

$$u_{combined} = \sqrt{\sum (uf_{O_2})^2 + (\text{Uncertainty of Measurement of Determinand})^2}$$

Where oxygen or moisture correction is required, uncertainty based on the standard error of the measured peripheral value is converted to units of final measurement using a sensitivity coefficient C,

$$\therefore u(x_i) = C_i u_i \text{ where } C_i = \frac{\partial f}{\partial x_i}$$

Environmental Compliance Limited

ConvaTec
Permit No : NP3433BC & TP3535LH
Variation No : ...
Report Ref : P2121 : R001

Installation Name : Bioscrubber Stack & Spin Line
Visit Details : Annual Compliance
Survey Dates : 11th & 13th November 2014
Report Issue Date : 19th December 2014

A3 - TVOC - Uncertainty of Measurement Results - Calculations Part 3

Uncertainty	Date & Time	*TVOC 0 - 15 mgC/m ³
Measured Concentration	11/11/14 09:00 - 09:59	173.45
Expanded Uncertainty as Percentage of Measured Concentration		10 %
Measured Concentration	11/11/14 10:00 - 10:59	141.40
Expanded Uncertainty as Percentage of Measured Concentration		5 %
Measured Concentration	11/11/14 11:00 - 11:59	133.79
Expanded Uncertainty as Percentage of Measured Concentration		4 %
Measured Concentration	11/11/14 12:00 - 12:59	136.17
Expanded Uncertainty as Percentage of Measured Concentration		3 %

Combined Standard Uncertainty $u_c = \sqrt{u_{bf}^2 + u_{d,s}^2 + u_e^2 + u_{hm}^2 + u_i^2 + u_l^2 + u_{ref}^2 + u_c^2 + u_{syn}^2}$

Expanded uncertainty (at 95% confidence) $U_{Exp} = 2 \times u_c$

- 1 Expressed as a percentage of the certified range
- 2 Expressed as a percentage of the certified range as maximum drift per 24hr period
- 3 Expressed as a percentage of the certified range
- 4 Expressed as a percentage of the applied span concentration
- 5 Expressed as a percentage of the certified range per one degree centigrade
- 6 Where the uncertainty of moisture is taken from the manual extract test calculations.
- 7 Expressed as a percentage of the certified range
- 8 Where no uncertainty is presented above, the uncertainty is > 100%