

STACK EMISSIONS MONITORING REPORT



Unit 20
The Falcon Business Centre
Romford
RM3 8UR
Tel: 01283 554373

Your contact at SOCOTEC LTD

Paul Jones
Project Manager - Romford
Tel: 07725 213132
Email: paul.jones@socotec.com

Operator & Address:

IKO Insulations UK Ltd
Founders House
Pierson Road
The Enterprise Campus
Alconbury Weald
Huntingdon
Cambridgeshire
PE28 4YA

Permit Reference:

EPR Permit: EPR B04/18

Release Point:

Dust Extract Exhaust

Sampling Date(s):

17th October 2019

SOCOTEC Job Number:	LRO1836
Report Date:	05-Nov-19
Version:	1
Report By:	Carl Redgrove
MCERTS Number:	MM 03 173
MCERTS Level:	MCERTS Level 2 - Team Leader
Technical Endorsements:	1, 2, 3 & 4
Report Approved By:	Nik Agopian
MCERTS Number:	MM 08 902
Business Title:	MCERTS Level 2 - Team Leader
Technical Endorsements:	1, 2, 3 & 4
Signature:	



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EXECUTIVE SUMMARY

MONITORING OBJECTIVES

IKO Insulations UK Ltd operates a insulation foam cut into blocks and dust extracted. the dust extract unit converts the dust into briquettes process at Huntingdon which is subject to EPR Permit EPR B04/18, under the Environmental Permitting Regulations 2010.

SOCOTEC LTD were commissioned by Mark Thorne to carry out stack emissions monitoring to determine the release of prescribed pollutants from the following Plant under normal operating conditions.

The results of these tests shall be used to demonstrate compliance with a set of emission limit values for prescribed pollutants as specified in the Plant's EPR Permit, EPR B04/18.

Plant

Dust Extract Exhaust

Operator

IKO Insulations UK Ltd
Founders House
Pierson Road
The Enterprise Campus
Alconbury Weald
Huntingdon
Cambridgeshire

EPR Permit: EPR B04/18

Stack Emissions Monitoring Test House

SOCOTEC - Romford Laboratory
Unit 20
The Falcon Business Centre
Romford
RM3 8UR
UKAS and MCERTS Accreditation Number: 1015

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

MCERTS accredited results will only be claimed where both the sampling and analytical stages are UKAS accredited.

This test report shall not be reproduced, except in full, without written approval of SOCOTEC LTD.

EXECUTIVE SUMMARY

EMISSIONS SUMMARY					
Parameter	Units	Result	Calculated Uncertainty +/-	Emission Limit Value (ELV)	MCERTS accredited result
Total Particulate Matter	mg/m ³	0.57	0.94	50	✓
Particulate Emission Rate	g/hr	41	68.0	-	
Isocyanates	mg/m ³	0.002	0.001	0.1	✓
Isocyanates Emission Rate	g/hr	0.12	0.060	-	
VOC Screening	mg/m ³	47	4.7	-	✓
VOC Screening Emission Rate	g/hr	3395	340	-	
Total Volatile Organic Compounds	mg/m ³	105	1.8	-	✓
Total Volatile Organic Compounds Emission Rate	g/hr	7603	129	-	
Moisture	%	1.2	0.04	-	✓
Stack Gas Temperature	°C	29	-	-	✗
Stack Gas Velocity	m/s	8.7	0.21	-	
Gas Volumetric Flow Rate (Actual)	m ³ /hr	81154	4542	-	
Gas Volumetric Flow Rate (STP, Wet)	m ³ /hr	72270	4045	-	
Gas Volumetric Flow Rate (STP, Dry)	m ³ /hr	71404	3997	-	
Gas Volumetric Flow Rate at Reference Conditions	m ³ /hr	72270	4045	-	

ND = None Detected,

Results at or below the limit of detection are highlighted by bold italic text.

The above volumetric flow rate is calculated using data from the preliminary survey. Mass emissions for non isokinetic tests are calculated using these values. For all isokinetic testing the mass emission is calculated using test specific flow data and not the above values.

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

EXECUTIVE SUMMARY

MONITORING TIMES			
Parameter	Sampling Date(s)	Sampling Times	Sampling Duration
Total Particulate Matter Run 1	17 October 2019	10:24 - 11:25	60 minutes
Isocyanates Run 1	16 October 2019	11:35 - 13:36	120 minutes
VOC Screening Run 1	17 October 2019	11:46 - 12:46	60 minutes
Total Volatile Organic Compounds Run 1	17 October 2019	11:46 - 12:46	60 minutes
Preliminary Stack Traverse	16 October 2019	10:05	-

EXECUTIVE SUMMARY

PROCESS DETAILS

Parameter	Process Details
Description of process	Insulation Foam cut into blocks and dust extracted. The dust extract unit converts tl
Continuous or batch	Continuous
Product Details	Foam
Part of batch to be monitored (if applicable)	N/A
Normal load, throughput or continuous rating	Normal
Fuel used during monitoring	n/a
Abatement	Bag Filters
Plume Appearance	None visible

EXECUTIVE SUMMARY

Monitoring Methods

The selection of standard reference / alternative methods employed by SOCOTEC is determined, wherever possible by the hierarchy of method selection outlined in Environment Agency Technical Guidance Note (Monitoring) M2.

MONITORING METHODS							
Species	Method Standard Reference Method / Alternative Method	SOCOTEC Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Limit of Detection (LOD)	Calculated MU +/- % Result	Calculated MU +/- % ELV
Total Particulate Matter	SRM - BS EN 13284-1	AE 104	1015	Yes	0.47 mg/m ³	166.7%	1.9%
Isocyanates	SRM - US EPA CTM 036	AE 116	1015	Yes	0.0001 mg/m ³	52.1%	0.8%
VOC Screening	SRM - PD CEN-TS 13649:2014	AE 118	1015	Yes	0.04 mg/m ³	10%	N/A - No ELV
Total Volatile Organic Compounds	SRM - BS EN 12619:2013	AE 102	1015	Yes	0.35 mg/m ³	1.7%	N/A - No ELV
Moisture	SRM - BS EN 14790	AE 105	1015	Yes	0.01%	3.52%	N/A - No ELV
Velocity	SRM - BS EN ISO 16911-1	AE 154	1015	No	5 Pa	2.4%	N/A - No ELV
Volumetric Flow Rate	SRM - BS EN ISO 16911-1	AE 154	1015	No	-	5.6%	N/A - No ELV

BS EN 14790 has been validated over a range of 4 - 40%. It is however the preferred method of the Environment Agency for concentrations below 4%

EXECUTIVE SUMMARY

Analytical Methods

The following tables list the analytical methods employed together with the custody details. Unless otherwise stated the samples are archived at the analysis lab location.

SAMPLING METHODS WITH SUBSEQUENT ANALYSIS							
Species	Analytical Technique	Analytical Procedure	UKAS Lab Number	UKAS Accredited Lab Analysis	Analysis Lab	Analysis Report number	Archive Period
Total Particulate Matter	Gravimetric	AE 106	1015	Yes	SOCOTEC (Cirencester)	N/A	8 Weeks
Isocyanates	High performance Liquid Chromatography - Ultra Violet	M119	0605	Yes	RPS	WK19-9993	8 Weeks
VOC Screening	ATD-GC/MS	IHM	1252	Yes	SOCOTEC (Bretby)	ASC/41631	8 Weeks

ON-SITE TESTING							
Species	Analytical Technique	Analytical Procedure	UKAS Lab Number	MCERTS Accredited Analysis	Laboratory	Data Archive Location	Archive Period
Total Volatile Organic Compounds	Flame Ionisation Detection	AE 102	1015	Yes	SOCOTEC Romford	SOCOTEC Romford	5 years
Moisture	Gravimetric	AE 105	1015	Yes	SOCOTEC Romford	-	-

EXECUTIVE SUMMARY

SAMPLING LOCATION					
Sampling Plane Validation Criteria	Value	Units	Requirement	Compliant	Method
Lowest Differential Pressure	31	Pa	≥ 5 Pa	Yes	BS EN 15259
Lowest Gas Velocity	6.6	m/s	-	-	-
Highest Gas Velocity	10.8	m/s	-	-	-
Ratio of Gas Velocities	1.6	: 1	$< 3 : 1$	Yes	BS EN 15259
Mean Velocity	8.7	m/s	-	-	-
Maximum angle of flow with regard to duct axis	< 15	$^{\circ}$	$< 15^{\circ}$	Yes	BS EN 15259
No local negative flow	No	-	-	No	BS EN 15259

DUCT CHARACTERISTICS		
	Value	Units
Shape	Rectangular	-
Depth	1.90	m
Width	1.37	m
Area	2.60	m ²
Port Depth	60	mm

SAMPLING LINES & POINTS		
	Isokinetic	Non-Iso & Gases
Sample port size	4" BSP	-
Number of lines used	2	-
Number of points / line	4	-
Duct orientation	Vertical	-
Filtration	In	-
Filtration for TPM	Quartz	-

SAMPLING PLATFORM	
General Platform Information	
Permanent / Temporary Platform / Ground level / Floor Level / Roof	Temporary
Inside / Outside	Outside

M1 Platform requirements	
Is there a sufficient working area so work can be performed in a compliant manner	Yes
Platform has 2 levels of handrails (approximately 0.5 m & 1.0 m high)	Yes
Platform has vertical base boards (approximately 0.25 m high)	Yes
Platform has removable chains / self closing gates at the top of ladders	Yes
Handrail / obstructions do not hamper insertion of sampling equipment	Yes
Depth of Platform = $>$ Stack depth / diameter + wall and port thickness + 1.5m	Yes

Sampling Platform Improvement Recommendations (if applicable)

The sampling location meets all the requirements as specified in EA Guidance Note M1.

EXECUTIVE SUMMARY

Sampling & Analytical Method Deviations

In this instance there were no deviations from the sampling and analytical methods employed.

APPENDICES

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APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

APPENDIX 3 - Measurement Uncertainty Budget Calculations

APPENDIX 1 - Monitoring Schedule, Calibration Checklist & Monitoring Team

MONITORING SCHEDULE					
Species	Method Standard Reference Method / Alternative Method	SOCOTEC Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Number of Samples
Total Particulate Matter	SRM - BS EN 13284-1	AE 104	1015	Yes	1
Isocyanates	SRM - US EPA CTM 036	AE 116	1015	Yes	1
VOC Screening	SRM - PD CEN-TS 13649:2014	AE 118	1015	Yes	1
Total Volatile Organic Compounds	SRM - BS EN 12619:2013	AE 102	1015	Yes	1
Moisture	SRM - BS EN 14790	AE 105	1015	Yes	1
Velocity	SRM - BS EN ISO 16911-1	AE 154	1015	No	1

APPENDIX 1 - Monitoring Schedule, Calibration Checklist & Monitoring Team

CALIBRATEABLE EQUIPMENT CHECKLIST					
Extractive Sampling		Instrumental Analyser/s		Miscellaneous	
Equipment	Equipment I.D.	Equipment	Equipment I.D.	Equipment	Equipment I.D.
Control Box DGM	P1959	Horiba PG-250 Analyser	-	Laboratory Balance	-
Box Thermocouples	P1959	FT-IR Gasmet	-	Tape Measure	P2255
Meter In Thermocouple	P1959	FT-IR Oven Box	-	Stopwatch	-
Meter Out Thermocouple	P1959	Bernath 3006 FID	P2596	Protractor	-
Control Box Timer	P1959	Signal 3030 FID	-	Barometer	P2748
Oven Box	-	Servomex	-	Digital Micromanometer	-
Probe	-	JCT Heated Head Filter	-	Digital Temperature Meter	-
Probe Thermocouple	P2713	Thermo FID	-	Stack Thermocouple	P2714
Probe	-	Stackmaster	-	Mass Flow Controller	P2950
Probe Thermocouple	-	FTIR Heater Box for Heated Line	-	MFC Display module	P2950
S-Pitot	-	Anemometer	-	1m Heated Line (1)	-
L-Pitot	-	Ecophysix NOx Analyser	-	1m Heated Line (2)	-
Site Balance	P1774	Chiller (JCT/MAK 10)	-	1m Heated Line (3)	-
Last Impinger Arm	-	Heated Line Controller (1)	P2806	5m Heated Line (1)	-
Dioxins Cond. Thermocouple	-	Heated Line Controller (2)	-	10m Heated Line (1)	-
Callipers	-	Site temperature Logger	-	10m Heated Line (2)	-
Small DGM	-		-	15m Heated Line (1)	-
Heater Controller	-		-	20m Heated Line (1)	P2780
Inclinometer (Swirl Device)	P2094		-	20m Heated Line (2)	-

NOTE: If the equipment I.D is represented by a dash (-), then this piece of equipment has not been used for this test.

CALIBRATION GASES					
Gas (traceable to ISO 17025)	Cylinder I.D Number	Supplier	ppm	%	Analytical Tolerance +/- %
Propane	PC9	BOC	81.1	-	2.0
-	-	-	-	-	-

STACK EMISSIONS MONITORING TEAM

MONITORING TEAM								
Personnel	MCERTS Number	MCERTS		TE / H&S Qualifications and Expiry Date				
		Level	Expiry	TE1	TE2	TE3	TE4	H&S
Carl Redgrove	MM 03 173	MCERTS Level 2	Mar-20	Oct-24	Mar-20	Mar-21	Jun-21	Apr-24
Allan Kigozi	MM 16 1368	MCERTS Level 1	May-21	-	-	-	-	May-21

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

TOTAL PARTICULATE MATTER SUMMARY					
Parameter	Sampling Times	Concentration mg/m ³	Uncertainty mg/m ³	ELV mg/m ³	Emission Rate g/hr
Run 1	10:24 - 11:25 17 October 2019	0.6	0.94	50	41
Blank	-	0.47	-	-	-

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

Acetone Blank Value mg/l	Acceptable Value mg/l
2.0	10

FILTER INFORMATION

SAMPLES								
Test	Filter & Probe Rinse Number	Filter Start Weight g	Filter End Weight g	Mass Gained on Filter g	Probe Rinse Start Weight g	Probe Rinse End Weight g	Mass Gained on Probe g	Combined Total Mass Gained g
Run 1	312313.00000	0.14050	0.13990	-0.00060	71.24530	71.24650	0.00120	0.00060

If total mass gained is less than the LOD then the LOD is reported

BLANKS								
Test	Filter & Probe Number	Filter Start Weight g	Filter End Weight g	Mass Gained Filter g	Probe Start Weight g	Probe End Weight g	Mass Gained Probe g	Combined Total Mass Gained g
Run 1	310650	0.14970	0.14950	-0.00020	68.72330	68.72340	0.00010	0.00050

If total mass gained is less than the LOD then the LOD is reported

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

ISOKINETIC SAMPLING EQUATIONS - RUN 1				TPM
Absolute pressure of stack gas, P_s				
Barometric pressure, P _b	Kpa	99.7		
Stack static pressure, P _{static}	pa	94		
P _s = P _b + P _{static}	Kpa	99.8		
Vol. of water vapour collected, V_{wstd}				
Moisture trap weight increase, V _{lc}	g	10.2		
V _{wstd} = (0.001246)(V _{lc})	m ³	0.0127092		
Volume of gas metered dry, V_{mstd}				
Volume of gas sample through gas meter, V _m		1.135		
Gas meter correction factor, Y _d		0.994		
Mean dry gas meter temperature, T _m		290		
Mean pressure drop across orifice, DH	mmH ₂ O	32.425		
V _{mstd} = $\frac{(0.3592)(V_m)(P_b + (DH/13.6))(Y_d)}{T_m}$	m ³	1.048		
Volume of gas metered wet, V_{mstw}				
V _{mstw} = V _{mstd} + V _{wstd}	m ³	1.0602		
Vol. of gas metered at O₂ Ref. Cond., V_{mstd@X%O2}				
Is the process burning hazardous waste? (If yes, no favourable oxygen correction)		No		
% oxygen measured in gas stream, act%O ₂		20.9		
% oxygen reference condition		21		
O ₂ Reference O ₂ Ref = 21.0 - act%O ₂		No O2 Ref		
Factor		21.0 - ref%O ₂		
V _{mstd@X%oxygen} = (V _{mstd}) (O ₂ Ref)	m ³	No O2 Ref		
Moisture content, B_{w0}				
B _{w0} = $\frac{V_{wstd}}{V_{mstd} + V_{wstd}}$		0.0120		
	%	1.20		
Moisture by FTIR				
	%	-		
Velocity of stack gas, V_s				
Velocity pressure coefficient, C _p		0.86		
Mean of velocity heads, DP _{avg}	Pa	57.66		
Mean stack gas temperature, T _s	K	302		
Gas density (wet, ambient), p				
p = (M _s *P _s)/(8.314*T _s)	kg/m ³	1.141		
Stack Velocity, V _s				
$V_s = C_p \sqrt{\frac{\Delta DP_{avg}}{p}}$	m/s	8.65		
Molecular weight of dry gas, M_d				
CO ₂	%	0.03		
O ₂	%	20.90		
Total	%	20.93		
N ₂ (100 - Total)	%	79.07		
M _d = 0.44(%CO ₂) + 0.32(%O ₂) + 0.28(%N ₂)		28.84		
Molecular weight of wet gas, M_s				
M _s = M _d (1 - B _{w0}) + 18(B _{w0})	g/gmol	28.71		
Actual flow of stack gas, Q_a				
Area of stack, A _s	m ²	2.60		
Q _a = (60)(A _s)(V _s)	m ³ /min	1350.2		
Total flow of stack gas, Q				
Conversion factor (K/mm.Hg)		0.3592		
Q _{std} = $\frac{(Q_a)P_s(0.3592)(1-B_{w0})}{(T_s)}$	Dry	1187.6		
Q _{stdO2} = $\frac{(Q_a)P_s(0.3592)(1-B_{w0})(O_2REF)}{(T_s)}$	@O ₂ ref	No O2 Ref		
Q _{stw} = $\frac{(Q_a)P_s(0.3592)}{(T_s)}$	Wet	1201.98		
Percent isokinetic, %I				
Nozzle diameter, D _n	mm	6.90		
Nozzle area, A _n	mm ²	37.40		
Total sampling time, q	min	60		
%I = $\frac{(4.6398E6)(T_s)(V_{mstd})}{(P_s)(V_s)(A_n)(q)(1-B_{w0})}$	%	102.3		
Acceptable isokinetic range 95% to 115%		Yes		
Particulate Concentration, C				
Mass collected on filter, M _f	g	-0.00060		
Mass collected in probe, M _p	g	0.00120		
Total mass collected, M _n	g	0.00060		
C _{wet} = $\frac{M_n}{V_{mstw}}$	mg/m ³	0.566		
C _{dry} = $\frac{M_n}{V_{mstd}}$	mg/m ³	0.573		
C _{dry@X%O2} = $\frac{M_n}{V_{mstd@X\%oxygen}}$	mg/m ³	No O2 Ref		
Particulate Emission Rates, E				
E = [(C _{wet})(Q _{stw})(60)] / 1000		40.81		

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

TOTAL PARTICULATE MATTER QUALITY ASSURANCE CHECKLIST

LEAK RATE						
Run	Mean Sampling Rate litre/min	Pre-sampling Leak Rate litre/min	Post-sampling Leak Rate litre/min	Maximum Vacuum mm Hg	Acceptable Leak Rate litre/min	Leak Tests Acceptable?
Run 1	18.80	0.08	0.11	-254	0.38	Yes

ISOKINETICITY		
Run	Isokinetic Variation %	Acceptable Isokineticity
Run 1	102.32	Yes

Acceptable isokinetic range 95% to 115%

WEIGHING BALANCE UNCERTAINTY			
Run	Result mg/m ³	5% ELV mg/m ³	LOD < 5% ELV
Run 1	0.47	2.5	Yes

The above is based on both the Filter and rinse uncertainty

BLANK VALUE				
Run	Overall Blank Value mg/m ³	Daily Emission Limit Value mg/m ³	Acceptable Blank Value mg/m ³	Overall Blank Acceptable mg/m ³
Blank 1	0.47	50	5.0	Yes

FILTERS					
Run	Filter Material	Filter Size mm	Max Filtration Temperature °C	Pre-use Filter Conditioning Temperature °C	Post-use Filter Conditioning Temperature °C
Run 1	Quartz Fibre	47	29	180	160

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

ISOCYANATES SUMMARY					
Test	Sampling Times	Concentration mg/m ³	LOD mg/m ³	ELV mg/m ³	Emission Rate g/hr
Run 1	11:35 - 13:36 16 October 2019	0.002	0.0001	0.1	0.1
Field Blank	-	0.0001	-	-	-

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

INDIVIDUAL ISOCYANATES SUMMARY					
Test		Lab Result ug	Concentration mg/m ³	LOD mg/m ³	Emission Rate g/hr
Run 1	HDI	0.07	0.00004	0.00004	0.003
	MDI	1.56	0.0008	0.00004	0.056
	TDI	1.56	0.0008	0.00004	0.056
Blank 1	HDI	0.07	0.0000	0.00004	0.003
	MDI	0.07	0.0000	0.00004	0.003
	TDI	0.13	0.0001	0.00004	0.005

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

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

ISOKINETIC SAMPLING EQUATIONS 1			ISOCYANATES	
Absolute pressure of stack gas, P_s			Velocity of stack gas, V_s	
Barometric pressure, P _b	kPa	100	Velocity pressure coefficient, C _p	0.86
Stack static pressure, P _{static}	Pa	94	Mean of velocity heads, DP _{avg}	Pa 57
P _s = P _b + (P _{static})	KPa	100	Mean stack gas temperature, T _s	K 302
13.6			Gas density (wet, ambient), ρ	
Vol. of water vapour collected, V_{wstd}			p = (M _s *P _s)/(8.314*T _s)	kg/m ³ 1.141
Moisture trap weight increase, V _{lc}	g	-	Stack Velocity, V _s	
V _{wstd} = (0.001246)(V _{lc})	m ³	-	$V_s = Cp \sqrt{\frac{\Delta DP_{avg}}{p}}$	m/s 8.61
Volume of gas metered dry, V_{mstd}			Actual flow of stack gas, Q_a	
Volume of gas sample through gas meter, V _m	m ³	2.2130	Area of stack, A _s	2.60
Gas meter correction factor, Y _d		0.9939	Q _a = (60)(A _s)(V _s)	m ³ /min 1345
Mean dry gas meter temperature, T _m	K	302	Dry total flow of stack gas, Q_{std}	
Mean pressure drop across orifice, DH	mmH ₂ O	33.109	Conversion factor (K/mm.Hg)	0.3592
V _{mstd} = $\frac{(0.3592)(V_m)(P_b + (DH/13.6))(Y_d)}{T_m + 273}$		1.963	Q _{std} = $\frac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s) + 273}$	m ³ /min 1183.36
Volume of gas metered wet, V_{mstw}			Wet total flow of stack gas, Q_{stw}	
V _{mstw} = V _{mstd} + V _{wstd}	m ³	1.9864	Q _{stw} = $\frac{(Q_a)P_s(0.3592)}{(T_s) + 273}$	m ³ /min 1197.7
Vol. of gas metered at O₂ Ref. Cond., V_{mstd@X%O2}			Dry total flow of stack gas at X% O₂, Q_{stdO2}	
Is the process burning hazardous waste? (If yes, no favourable oxygen correction)	No		Q _{stdO2} = $\frac{(Q_a)P_s(0.3592)(1-B_{wo})(O_2REF)}{(T_s) + 273}$	m ³ /min No O2 Ref
% oxygen measured in gas stream, act%O ₂	20.9		Percent isokinetic, %I	
% oxygen reference condition	21		Nozzle diameter, D _n	mm 6.90
O ₂ Reference O2 Ref = 21.0 - act%O ₂	No O2 Ref		Nozzle area, A _n	mm ² 37.40
Factor 21.0 - ref%O ₂	No O2 Ref		Total sampling time, q	min 120
V _{mstd@X%oxygen} = (V _{mstd} / (O ₂ Ref))	m ³	No O2 Ref	%I = $\frac{(4.6398E6)(T_s)(V_{mstw})}{(P_s)(V_s)(A_n)(q)(1-B_{wo})}$	% 97
Moisture content, B_{wo}			Acceptable isokinetic range 95% to 115%	
B _{wo} = $\frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	%	0.0120	Isocyanates Concentration, C	
	%	1.20	Mass of isocyanates collected, M	ug 3
Moisture by FTIR			C _{wet} = $\frac{M_n}{V_{mstw}}$	mg/m ³ 0.002
Molecular weight of dry gas, M_d			C _{dry} = $\frac{M_n}{V_{mstd}}$	mg/m ³ 0.002
CO ₂	%	0.03	C _{dry@X%O2} = $\frac{M_n}{V_{mstd@X\%oxygen}}$	mg/m ³ No O2 Ref
O ₂	%	20.90	Isocyanates Emission Rates, E	
Total	%	20.93	E = [(C _{wet})(Q _{stw})(60)] / 1000	g/hr 0.12
N ₂ (100 - Total)	%	79.07		
M _d = 0.44(%CO ₂) + 0.32(%O ₂) + 0.28(%N ₂)		28.84		
Molecular weight of wet gas, M_s				
M _s = M _d (1 - B _{wo}) + 18(B _{wo})	g/gmol	28.7		

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

ISOCYANATES QUALITY ASSURANCE CHECKLIST

Leak Test Results	Mean Sampling Rate	Pre-sampling Leak Rate	Post-sampling Leak Rate	Maximum Vacuum	Acceptable Leak Rate	Leak Tests Acceptable
	litre/min	litre/min	litre/min	mm Hg	litre/min	
Run 1	18.3	0.18	0.17	-254	0.37	Yes

Isokinetic Criterion Compliance	Isokinetic Variation %	Acceptable Isokineticity
Run 1	97.4	Yes

Filtration	Filter Material	Filter Size	Maximum Filtration Temperature	Filters Coated with
		mm	°C	
Run 1	Quartz Fibre	47	0	1-(2-pyridyl)piperazine

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

VOC SCREENING SUMMARY					
Test	Sampling Times	Concentration mg/m ³	LOD mg/m ³	ELV mg/m ³	Emission Rate g/hr
Run 1	11:46 - 12:46 17 October 2019	46.98	0.04	-	3395
Field Blank	-	0.04	-	-	-

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

VOC SCREENING RESULTS							
Substance	LOD (ug)	Run 1 (ug)		Run 1 (mg/m ³)			Mass Emission (g/hr)
		Front	Back	Front	Back	Total	
Butane, 2-methyl-	0.02	140	0.09	46.7	0.03	46.70	3375
2-Butanone	0.02	0.27	0.02	0.09	0.01	0.10	7.0
Unknown (Ions 41, 57)	0.02	0.22	0.02	0.07	0.01	0.08	5.8
Octamethylcyclotetrasiloxane	0.02	0.1	0.02	0.03	0.01	0.04	2.9
Acetone	0.02	0.0	0.1	0	0.03	0.03	2.4
Toluene	0.02	0.0	0.1	0	0.03	0.03	2.4
Total	0.12	140.59	0.35	46.86	0.12	46.98	3395

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

VOC SCREENING RESULTS BLANK			
Substance	LOD (ug)	Blank (ug)	
		(ug)	mg/m ³
Butane, 2-methyl-	0.02	0.02	0.007
2-Butanone	0.02	0.02	0.007
Unknown (Ions 41, 57)	0.02	0.02	0.007
Octamethylcyclotetrasiloxane	0.02	0.02	0.007
Acetone	0.02	0.02	0.007
Toluene	0.02	0.02	0.007
Total	0.12	0.12	0.04

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

VOC SCREENING QUALITY ASSURANCE

Leak Test Results	Mean Sampling Rate l/min	Pre sampling leak rate l/min	Post sampling leak rate l/min	Acceptable leak rate l/min	Leak Tests Acceptable?
Run 1	0.05	0	0	0.00	Yes

	Type of tube	Max. Tube Temperature °C	Temperature during storage / transit <25°C
Run 1	Dual Bed	29	Yes

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

TOTAL VOLATILE ORGANIC COMPOUNDS SUMMARY

Test	Sampling Times	Concentration mg/m ³	LOD mg/m ³	ELV mg/m ³	Emission Rate g/hr
Run 1	11:46 - 12:46 17 October 2019	105.2	0.22	-	7603

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

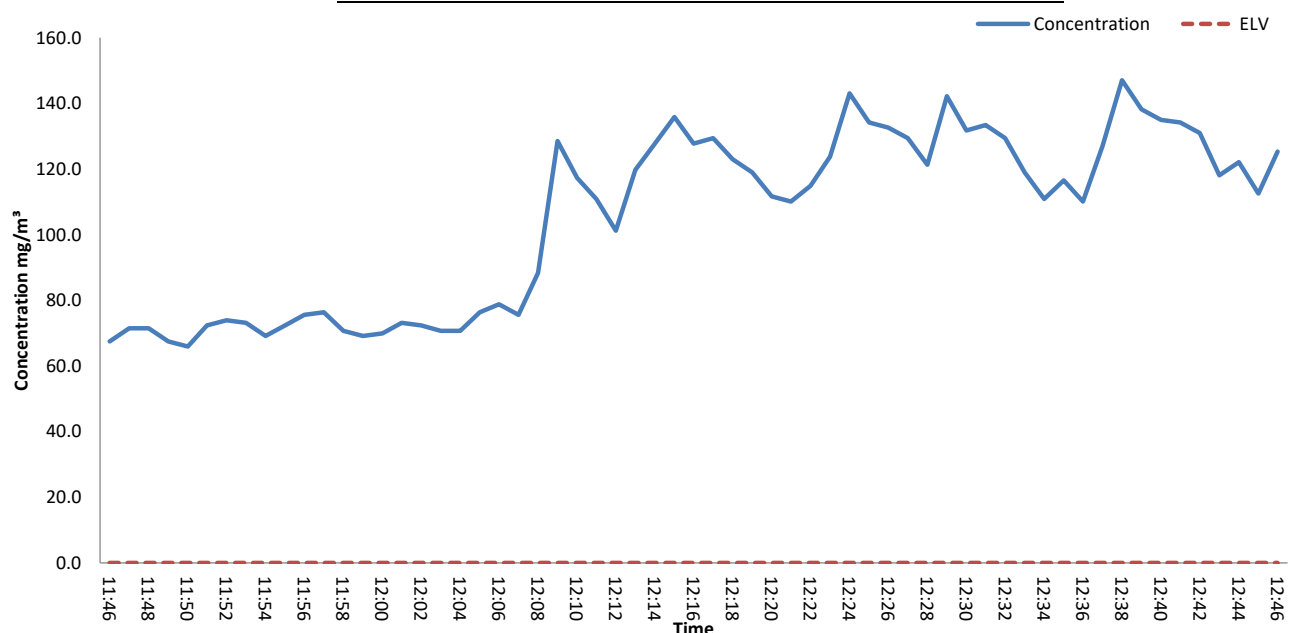
INSTRUMENTAL SPAN & ZERO CHECKS

PRE-SAMPLING CALIBRATION CHECKS								
Date	17 October 2019							
Start Time	11:23							
End Time	11:40							
Gas	Gas Conc (ppm)	Range	Instrument Zero Reading	Instrument Span Reading	Instrument Zero Reading	Zero Down line reading	Span down line reading	Leak Rate (%)
Propane	81.1	100	0.00	81.0	0.00	0.00	81.0	0.00

Zero and Span gas contained 20.4% Oxygen

POST-SAMPLING CALIBRATION CHECKS								
Date	17 October 2019							
Start Time	13:05							
End Time	13:16							
Gas	Mean Raw Value ppm	Zero down line reading	Span down line reading	Zero Drift (%)	Span Drift (%)	Corrected for Zero Drift	Corrected for Span Drift	Corrected Values ppm / %
Propane	65.46	0.00	80.5	0.00	0.00	x	x	N/A - not corrected

TOTAL VOLATILE ORGANIC COMPOUNDS EMISSIONS CHART



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

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

MOISTURE CALCULATIONS

Moisture Determination - Isokinetic							
Test Number	Sampling Time and Date	Start Weight	End Weight	Total gain	Concentration	LOD	Uncertainty
		kg	kg	kg	%	%	%
Run 1	10:24 - 11:25 17 October 2019	4.4799	4.4901	0.0102	1.2	0.01	3.5

Moisture Quality Assurance							
Test Number	Sampling Duration	Total Volume Sampled	Sampling Rate	Start Leak Rate	End Leak Rate	Acceptable Leak Rate	Leak Tests Acceptable?
	mins	l	l/min	l/min	l/min	l/min	
Run 1	60	1060	18.8	0.08	0.11	0.38	Yes

PRELIMINARY STACK SURVEY

Stack Characteristics		
Stack Diameter / Depth, D	1.90	m
Stack Width, W	1.37	m
Stack Area, A	2.60	m ²
Average stack gas temperature	29	°C
Stack static pressure	0.094	kPa
Barometric Pressure	99.7	kPa

Stack Gas Composition & Molecular Weights								
Component	Molar Mass M	Density kg/m ³ p	Conc Dry % Vol	Dry Volume Fraction r	Dry Conc kg/m ³ pi	Conc Wet % Vol	Wet Volume Fraction r	Wet Conc kg/m ³ pi
CO ₂	44	1.963059	0.028571	0.000286	0.000561	0.028229	0.000282	0.000554
O ₂	32	1.427679	20.900000	0.209000	0.298385	20.649472	0.206495	0.294808
N ₂	28	1.249219	79.071429	0.790714	0.987775	78.123600	0.781236	0.975935
H ₂ O	18	0.803070	-	-	-	1.198699	0.011987	0.009626

Where: $p = M / 22.41$ $pi = r \times p$

Calculation of Stack Gas Densities		
Determinand	Result	Units
Dry Density (STP), P_{STD}	1.2867	kg/m ³
Wet Density (STP), P_{STW}	1.2809	kg/m ³
Dry Density (Actual), P_{Actual}	1.1459	kg/m ³
Average Wet Density (Actual), $P_{ActualW}$	1.141	kg/m ³

Where:

P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

$P_{STW} = (P_{STD} + pi \text{ of H}_2\text{O}) / (1 + (pi \text{ of H}_2\text{O} / 0.8036))$

$P_{Actual} = P_{STD} \times (Ts / Ps) \times (Pa / Ta)$

$P_{ActualW} = P_{STW} \times (Ts / Ps) \times (Pa / Ta)$

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

PRELIMINARY STACK SURVEY

TRAVERSE 1

Date of Survey	16 October 2019
Time of Survey	10:05
Velocity Measurement Device:	S-Type Pitot

Sampling Line A								
Traverse Point	Distance into duct (m)	DP pt Pa (average of 3 readings)	DP pt mmH ₂ O (average of 3 readings)	Temp °C	Velocity m/s	Volumetric Flow Rate (actual) m ³ /s	O ₂ % Vol	Angle of Swirl °
1	0.16	33.3	3.4	29	6.6	17.1	-	8
2	0.48	35.6	3.6	29	6.8	17.7	-	12
3	0.79	34.0	3.5	29	6.6	17.3	-	15
4	1.11	50.0	5.1	29	8.0	21.0	-	8
5	1.43	39.9	4.1	29	7.2	18.7	-	6
6	1.74	41.5	4.2	29	7.3	19.1	-	14
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
Mean	-	39.0	4.0	29	7.1	18.5	-	-

Sampling Line B								
Traverse Point	Distance into duct (m)	DP pt Pa (average of 3 readings)	DP pt mmH ₂ O (average of 3 readings)	Temp °C	Velocity m/s	Volumetric Flow Rate (actual) m ³ /s	O ₂ % Vol	Angle of Swirl °
1	0.16	76.1	7.8	29	9.9	25.9	-	5
2	0.48	76.8	7.8	29	10.0	26.0	-	9
3	0.79	75.5	7.7	29	9.9	25.7	-	6
4	1.11	81.7	8.3	29	10.3	26.8	-	8
5	1.43	84.6	8.6	29	10.5	27.3	-	9
6	1.74	89.8	9.2	29	10.8	28.1	-	7
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-
Mean	-	80.7	8.2	29	10.2	26.6	-	-

PRELIMINARY STACK SURVEY QUALITY ASSURANCE CHECKLIST

PITOT LEAK CHECK								
Run	Pre Traverse Leak Rate				Post Traverse Leak Rate			
	Start Value mmH ₂ O	End Value mmH ₂ O	Difference %	Outcome	Start Value mmH ₂ O	End Value mmH ₂ O	Difference %	Outcome
Run 1	125	122	2.4	Pass	125	124	0.8	Pass

To complete a compliant pitot leak check a pressure of over 80 mmH₂O (or 800 Pa) is applied and the pressure drop monitored over 5 mins. A drop of less than 5% must be observed.

S-Type Pitot Stagnation Check				
Run	Stagnation (Pa)	Reference (Pa)	Difference (Pa)	Outcome (Permitted +/- 10 Pa)
Run 1	100	99	1.0	Pass

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

PRELIMINARY STACK SURVEY (CONTINUED)

Sampling Plane Validation Criteria				
EA Technical Guidance Note (Monitoring) M1	Result	Units	Requirement	Compliant
Lowest Differential Pressure	33	Pa	≥ 5 Pa	Yes
Lowest Gas Velocity	6.6	m/s	-	-
Highest Gas Velocity	10.8	m/s	-	-
Ratio of Gas Velocities	1.6	-	$< 3 : 1$	Yes
Maximum angle of flow with regard to duct axis	< 15	$^{\circ}$	$< 15^{\circ}$	Yes
No local negative flow	No	-	-	No

Calculation of Stack Gas Velocity, V		
Velocity at Traverse Point, $V = K_{pt} \times (1-e) \times 0(2 * DP_{pt} / P_{ActualW})$		
Where: K_{pt} = Pitot tube calibration coefficient $(1-e)$ = Compressibility correction factor, assumed at a constant 0.998		
Average Stack Gas Velocity, V_a	8.7	m/s

Calculation of Stack Gas Volumetric Flowrate, Q			
Duct gas flow conditions	Actual	Reference	Units
Temperature	29	0	$^{\circ}\text{C}$
Total Pressure	99.794	101.3	kPa
Oxygen	20.9	21	%
Moisture	1.20	1.20	%
Pitot tube calibration coefficient, K_{pt}	0.86		

Gas Volumetric Flowrate	Result	Units
Average Stack Gas Velocity (V_a)	8.66	m/s
Stack Area (A)	2.60	m^2
Gas Volumetric Flowrate (Actual), Q_{Actual}	81154	m^3/hr
Gas Volumetric Flowrate (STP, Wet), Q_{STP}	72270	m^3/hr
Gas Volumetric Flowrate (STP, Dry), $Q_{STP,Dry}$	71404	m^3/hr
Gas Volumetric Flowrate (REF), Q_{Ref}	72270	m^3/hr

Where:

$$Q_{Actual} = V_a \times A \times 3600$$

$$Q_{STP} = Q_{Actual} \times (T_s / T_a) \times (P_a / P_s) \times 3600$$

$$Q_{STP,Dry} = Q_{STP} / (100 - (100 / Ma)) \times 3600$$

$$Q_{Ref} = Q_{STP} \times ((100 - Ma) / (100 - Ms)) \times ((21 - O_{2a}) / (21 - O_{2s}))$$

Nomenclature:

T_s = Absolute Temperature, Standard Conditions, 273 K

P_s = Absolute Pressure, Standard Conditions, 101.3 kPa

T_a = Absolute Temperature, Actual Conditions, K

P_a = Absolute Pressure, Actual Conditions, kPa

Ma = Water vapour, Actual Conditions, % Vol

Ms = Water vapour, Reference Conditions, % Vol

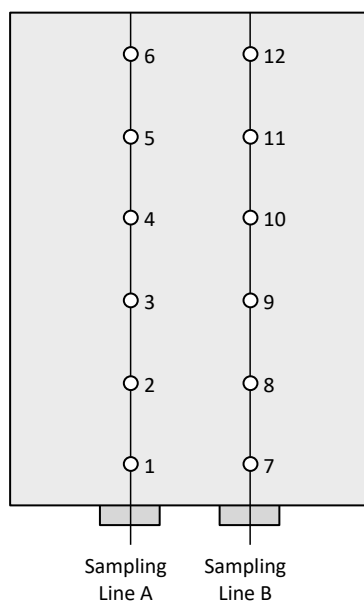
O_{2a} = Oxygen, Actual Conditions, % Vol

O_{2s} = Oxygen, Reference Conditions, % Vol

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

STACK DIAGRAM

	Value	Units
Stack Depth	1.90	m
Stack Width	1.37	m
Area	2.60	m ²



Non-Isokinetic/Gases Sampling			
Sampling Point	Distance (% of Depth)	Distance into Stack	Units
-	-	-	-

Isokinetic Sampling			
Sampling Point	Distance (% of Depth)	Distance into Stack (m)	Swirl °
1	8.3	0.16	< 15
2	25.0	0.48	< 15
3	41.7	0.79	< 15
4	58.3	1.11	< 15
5	75.0	1.43	< 15
6	91.7	1.74	< 15
7	8.3	0.16	< 15
8	25.0	0.48	< 15
9	41.7	0.79	< 15
10	58.3	1.11	< 15
11	75.0	1.43	< 15
12	91.7	1.74	< 15
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

- | Isokinetic sampling point
- | Isokinetic sampling points not used
- | Non Isokinetic/Gases sampling point

SAMPLING LOCATION



APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - TOTAL PARTICULATE MATTER

Run	Sampled Volume m ³	Sampled Gas Temp K	Sampled Gas Pressure kPa	Sampled Gas Humidity % by volume	Oxygen Content % by volume	Limit of Detection % by mass	Leak %	Uncollected Mass mg
MU required	≤ 2%	≤ 2%	≤ 1%	≤ 1%	≤ 10%	≤ 5% of ELV	≤ 2%	≤ 10% of ELV
Run 1	0.001	2.0	0.50	1.0	N/A	0.5000	-	-
as a %	0.10	0.66	0.50	1.0	N/A	0.94317	0.59	0.001
compliant?	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes

Run	Volume (STP) m ³	Mass of particulate mg	O ₂ Correction -	Leak mg/m ³	Uncollected Mass mg	Combined uncertainty
Run 1	0.93	0.6000	1.0	0.002	0.0003	-
MU as mg/m ³	0.01	0.4716	-	0.002	0.0003	0.47
MU as %	1.30	83.3333	-	0.338	0.0481	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	0.94	mg/m³	166.69	% Result	1.89	% ELV
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(k is a coverage factor which gives a 95% confidence in the quoted figures)

Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - ISOCYANATES

Run	Sampled Volume m ³	Sampled Gas Temp K	Sampled Gas Pressure kPa	Sampled Gas Humidity % by volume	Oxygen Content % by volume	Leak %	Uncollected Mass mg
MU required	≤ 2%	≤ 2%	≤ 1%	≤ 1%	≤ 10%	≤ 2%	≤ 10% of ELV
Run 1	0.001	2	0.5	1	N/A	-	-
as a %	0.05	0.67	0.50	1.00	N/A	0.93	0.07
compliant?	Yes	Yes	Yes	Yes	N/A	Yes	Yes

Run	Volume (STP) m ³	Mass of Isocyanates mg	O ₂ Correction	Leak mg/m ³	Uncollected Mass mg	Combined uncertainty
Run 1	1.79	0.0032	1.00	0.000	0.0000	-
MU as mg/m ³	0.00	0.0004	-	0.000	0.0000	1.90
MU as %	1.30	0.0026	-	0.535	1.27	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	0.001	mg/m³	52.09	% Result	0.84	% ELV
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(k is a coverage factor which gives a 95% confidence in the quoted figures)

Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - VOC SCREENING

Standard Uncertainty

Run	Sampled Volume m ³	Sampled Gas Temp K	Sampled Gas Pressure kPa	Sampled Gas Humidity % by volume	Oxygen Content % by volume	Limit of Detection % by mass	Leak %	Uncollected Mass mg
MU required	≤ 2%	≤ 2%	≤ 1%	≤ 1%	≤ 10%	≤ 5% of ELV	≤ 2%	≤ 10% of ELV
Run 1	0	2	0.5	1	N/A	0.00012	-	-
as a %	0.0000	0.6873	0.4946	1.0000	N/A	N/A	0.0000	N/A
compliant?	Yes	Yes	Yes	Yes	N/A	N/A	Yes	No

Run	Volume (STP) m ³	Mass of Total VOC mg	O2 Correction -	Leak mg/m ³	Uncollected Mass mg	Lab Uncertainty mg	Combined uncertainty
Run 1	0.003	0.141	1.000	0.000	0.000	-	-
MU as mg/m ³	0.000	0.040	-	0.000	0.023	2.349	2.349
MU as %	0.000	0.085	-	0.000	0.049	5.000	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	4.699	mg/m³	10.00	% Result	N/A	% ELV
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Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - MOISTURE

Run	Sampled Volume m ³	Sampled Gas Temp K	Sampled Gas Pressure kPa	Sampled Gas Humidity % by volume	Oxygen Content % by volume	Leak %
MU required	≤ 2%	≤ 2%	≤ 1%	≤ 1%	≤ 10%	≤ 2%
Run 1	0.001	2.0	0.50	1.0	N/A	-
as a %	0.10	0.66	0.50	1.0	N/A	0.59
compliant?	Yes	Yes	Yes	Yes	N/A	Yes

Run	Volume (STP) m ³	Mass Gained mg	O ₂ Correction -	Leak mg/m ³	Uncollected Mass mg	Combined uncertainty
Run 1	0.93	10200	1.0	32.89	58	-
MU as % v/v	0.02	0.01	-	0.00	0.007	0.02
MU as %	1.30	0.98	-	0.34	0.57	-

R1 - Uncertainty expressed at a 95% confidence level (where k = 2)	0.04	% v/v	3.52	%
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APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - VOLATILE ORGANIC COMPOUNDS RUN 1

Measured Concentration	105.2	mg/m ³
Limit	-	mg/m ³
Calibration Gas Concentration	129.76	mg/m ³
Range	160	mg/m ³

Performance characteristics	Value	Units	specification	MU Met?
Response time	32	seconds	<180	Yes
Logger sampling interval	60	seconds	-	-
Measurement period	60	minutes	-	-
Number of readings in measurement	60	-	-	-
Repeatability at zero	0.25	% full scale	<1 % range	Yes
Repeatability at span level	0.15	% full scale	<2 % range	Yes
Deviation from linearity	0.70	% of value	<2 % range	Yes
Zero drift	0.00	% full scale	<2% range / 24hr	Yes
Span drift	0.00	% full scale	<2% range / 24hr	Yes
volume or pressure flow dependence	0.02	% of full scale/3 kPa	<2 % / 3 kPa	Yes
atmospheric pressure dependence	0.80	% of full scale/2 kPa	<3% / 2 kPa	Yes
ambient temperature dependence	0.01	% full scale/10K	<3% range / 10 K	Yes
dependence on voltage	0.10	% full scale/10V	< 0.1%vol /10 volt	Yes
losses in the line (leak)	0.00	% of value	< 2% of span gas value	Yes
Uncertainty of calibration gas	1.0	% of value	< 2% of value	Yes

Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	ur0	0.02
Standard deviation of repeatability at span level	urs	0.02
Lack of fit	ufit	0.65
Drift	u0dr	0.00
volume or pressure flow dependence	uspres	0.00
atmospheric pressure dependence	uapres	0.04
ambient temperature dependence	utemp	0.00
Dependence on voltage	uvolt	0.14
losses in the line (leak)	uleak	0.00
Uncertainty of calibration gas	ucalib	0.61
Uncertainty in factor	uf	0.00

Measurement uncertainty Measured Concentration	105.20	mg/m ³
Combined uncertainty	0.90	mg/m ³
Expanded uncertainty	1.76	mg/m ³

Expanded uncertainty expressed with a level of confidence of 95%	-	% ELV
Expanded uncertainty expressed with a level of confidence of 95%	1.76	mg/m ³
Expanded uncertainty expressed with a level of confidence of 95%	1.67	% value

Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

APPENDIX 3 - Measurement Uncertainty Budget Calculations

MEASUREMENT UNCERTAINTY BUDGET - VELOCITY & VOLUMETRIC FLOW RATE

Measured Velocity at Actual Conditions	8.7	m/s
Measured Volumetric Flow rate at Actual Conditions	81154	m ³ /hr

Performance Characteristics & Source of Value	Units	Values	Requirement	Compliant
Uncertainty of Local Gas Velocity Determination				
Uncertainty of pitot tube coefficient	-	0.010		
Uncertainty of mean local dynamic pressures	-	0.63		
Factor loading, function of the number of measurements.	3 readings	0.591	minimum 3	Yes
Range of measurement device	pa	1000		
Resolution	pa	1.00		
Calibration uncertainty	pa	10.59	<1% of Value or 20 Pa whichever is greater	Yes
Drift	% range	0.10		
Linearity	% range	0.06	<2% of value	Yes
Uncertainty of gas density determination				
Uncertainty of molar mass determination	kg/mol	0.00003		
Uncertainty of temperature measurement	K	1.54	<1% of value	Yes
Uncertainty of absolute pressure in the duct	pa	509		
Uncertainty associated with the estimate of density	-	0.007		
Uncertainty associated with the measurement of local velocity	-	0.0001		
Uncertainty associated with the measurement of mean velocity	-	0.0001		

Measurement Uncertainty - Velocity	m/s
Combined uncertainty	0.11
Expanded uncertainty at a 95% Confidence Interval	0.21

Note - The expanded uncertainty uses a coverage factor of $k = 2$.

Expanded Measurement Uncertainty of Velocity at a 95% Confidence Interval	%
Expressed as a % of the Measured Velocity	1.2
Expanded uncertainty at a 95% Confidence Interval	2.4

Measurement Uncertainty Volumetric Flow Rate	m ³ /hr
Combined uncertainty	2318
Expanded uncertainty at a 95% Confidence Interval	4542

Note - The expanded uncertainty uses a coverage factor of $k = 2$.

Expanded Measurement Uncertainty of Volumetric Flow Rate at a 95% Confidence Interval	%
Expressed as a % of the Measured Volumetric Flow Rate	2.9
Expanded uncertainty at a 95% Confidence Interval	5.6

Reference – SOCOTEC Technical Procedure AE150 Estimation of Uncertainty of Measurement

END OF REPORT

Thank you for choosing SOCOTEC for your environmental monitoring needs. We hope our services have met your requirements and that you are fully satisfied with your experience of working with us, we really do value your custom and would welcome your feedback. We would appreciate it if you could take a moment to complete a short online questionnaire so that we can improve our operations and address any areas that have not met with your expectations, by clicking on the following

https://www.surveymonkey.co.uk/r/CAE_customer_feedback_weblink