

Report for the Periodic Monitoring of Emissions to Air from the Gas Engine Stack Located at B V Dairy, Shaftesbury.

Part 1: Executive Summary

Permit Number: HP3492EZ

Operator: Blackmore Vale Farm Cream Dairy

Installation: Biogas Engine



4251

Monitoring dates: 9th September 2020

Job Number: **R20421**

Version: 1

Address: **Blackmore Vale Farm Cream Limited**

B V Dairy

Wincombe Lane

Shaftesbury

Dorset

SP7 8QD

Monitoring Organisation: **EnviroDat Ltd.**

Address: Cutbush Commercial

Cutbush Lane East

Reading

RG2 9AF

Date of Report: 25th September 2020

Report Approved By: Bruce Kester

MCERTS Registration Number: MM03 190 (TE1, 2, 3 & 4)

Function: Technical Manager (Team Leader)

Signed:




CONTENTS

	Page No.
Part 1: Executive Summary	
1.1 Monitoring Objectives	3
1.2 Monitoring Results	4
1.3 Operating Information	5
1.4 Monitoring Deviations	5
 Part 2: Supporting Information	
2.1 Appendix I: General Information	6
2.2 Appendix II: Emission Point Reference Data & Results	8
2.3 Appendix III: Uncertainty Calculations	13
2.4 Appendix IV: Moisture Calculations	15
2.5 Appendix V: Acid Gas Calculations	16

Notes to Report.

- a). EnviroDat Ltd, Report Template V11.
- b). This report should not be reproduced except in full, without written approval of Envirodat Ltd.
- c). Opinions and Interpretations herein are outside the scope of UKAS/MCerts Accreditation.

PART 1: EXECUTIVE SUMMARY

1.1 Monitoring Objectives

Blackmore Vale Farm Cream Ltd. operate an anaerobic digestion plant at its facility located at Shaftesbury. This plant has the potential to pollute the atmosphere. Consequently, the processes involved are subject to regulation and periodic environmental monitoring is necessary under this regulation.

Biogas is piped to a spark ignition engine plant (Mercedes engine). This plant combusts the gas and produces electricity which is then sold onto the National Grid. There is a gas flare that is used as a stand-by to burn off excess gas or for use during engine breakdown or maintenance.

EnviroDat Ltd. was commissioned to monitor the engine for a suite of pollutants in order to provide data for environmental compliance.

The pollutants monitored are summarised below:

Substances to be monitored	Emission Point Identification
	Engine
Oxides of Nitrogen (NO _x as NO ₂)	✓
Carbon Monoxide (CO)	✓
Total Volatile Organic Compounds (VOCs)	✓
Sulphur Dioxide (SO ₂)	✓
Temperature	✓
Moisture (for correction)	✓
Oxygen (O ₂ - for correction)	✓
Special requirements	None requested

1.2 Monitoring Results

Emission Point Reference	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Estimate of Uncertainty (2σ at 95% confidence)	Units	Reference Conditions	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method (see note below)	Operating Status
Engine	Oxides of Nitrogen (as NO ₂)	500	443	±23	mg(N)m ⁻³	101.3 kPa, 273K, dry gas, 5% O ₂	09/09/20	09:40-10:40	BS EN 14792	A	At 100% capacity
	Carbon Monoxide	1400	504	±40	mg(N)m ⁻³				BS EN 15058	A	
	Volatile Organic Compounds (VOCs as carbon)	1000	303	±24	mg(N)m ⁻³				BS EN 12619	A	
	Sulphur Dioxide	350	40.8	±3	mg(N)m ⁻³				BS EN 14791	B	
	Temperature	>200	499	±3	°C	Stack Conditions		09:38	BS EN 16911	A	
	Moisture	-	13.7	n/a	%	101.3 kPa, 273K, dry gas		09:40-10:40	BS EN 14790	A	
	Oxygen	-	5.64	±0.33	%				BS EN 14789	A	

NOTE:

- A. EnviroDat Ltd MCerts/UKAS Accredited for sampling and analysis.
- B. EnviroDat Ltd MCerts/UKAS Accredited for sampling only, UKAS Accredited analysis conducted by sub-contract laboratory.
- C. EnviroDat Ltd UKAS Accredited for sampling only (further clarification is given in section 1.4). Analysis of this component is not UKAS Accredited.
- D. The method for sampling and analysis is not UKAS or MCerts Accredited, method follows documented in-house procedure (further clarification is given in section 1.4).
- E. The method for sampling is not UKAS or MCerts Accredited, UKAS Accredited analysis conducted by sub-contract laboratory.

1.3 Operating Information

Emission Point Reference	Date	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load	Comparison of Operator CEMS and Periodic Monitoring Results			
								Substance	CEMS Results	Periodic Monitoring Results	Units
Engine (2045)	9/09/20	Combustion	Continuous	BioGas as combustible methane	n/a	n/a	100% engine @ 190kWe	n/a	n/a	n/a	n/a

*obtained from client

1.4 Monitoring Deviations

Emission Point Reference	Substance Deviations	Monitoring Deviations	Other Relevant Issues
Engine	None	None	None

PART 2: SUPPORTING INFORMATION

2.1 Appendix I: General Information

2.1.1 Monitoring organisation staff details

Monitoring at B V Dairy was conducted by the following EnviroDat Engineers:

Team Leader, Bruce Kester - MCERTs Level II, TE1, 2, 3 & 4	MM03 190
Technician, Niall Kester - MCERTs Trainee	MM19 1373

2.1.2 Monitoring method details

Parameter	Standard Reference Method/Alternative	EnviroDat Procedure	MCerts Accreditation
Oxides of Nitrogen (as NO ₂)	BS EN 14792	SP14792	MCerts
Carbon Monoxide (CO)	BS EN 15058	SP15058	MCerts
Volatile Organic Compounds (VOCs)	BS EN 12619	SP12619	MCerts
Sulphur Dioxide	BS EN 14791	SP14791	MCerts
Temperature	BS EN ISO 16911-1	SP16911	MCerts
Moisture (H ₂ O)	BS EN 14790	SP14790	MCerts
Oxygen (O ₂)	BS EN 14789	SP14789	MCerts

2.1.3 Monitoring organisation equipment and gas check list references

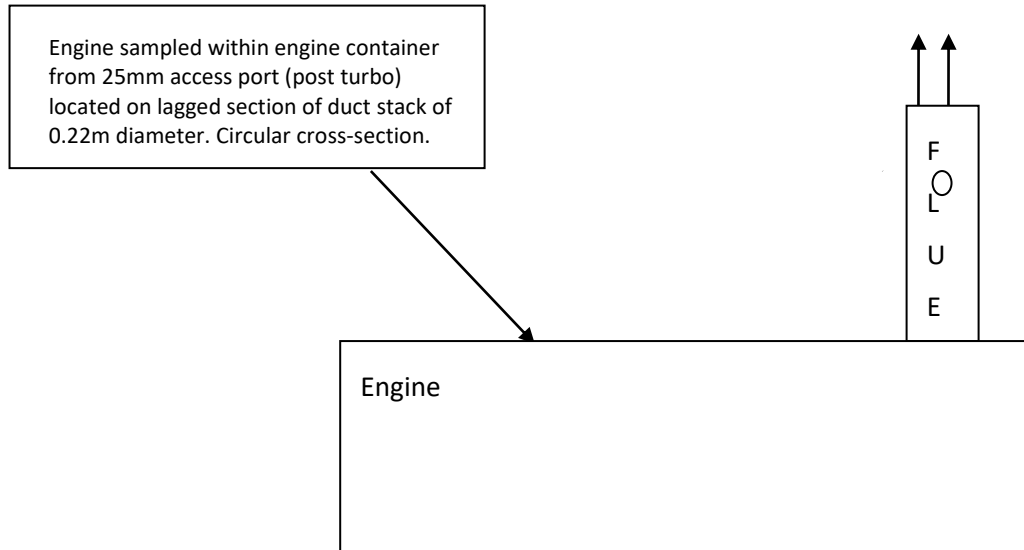
EQUIPMENT			
Item	Reference	Calibration Due	PAT Due
Portable Gas Analyser	PGA#03	17-Aug-21	Oct-20
Flame Ionisation Detector Analyser	FID#05	6-Mar-21	Oct-20

Gas Conditioner	COND#05	17-Aug-21	Oct-20
NOx Converter	CONV#04	1-Jan-21	Oct-20
Digital Barometer	DB#30	7-May-21	-
Balance	BAL#05	31-Mar-21	-
Heated Filter Head	HFH#04	1-Jan-21	Oct-20
Heated Line	HL#1, 2, 3	1-Jan-21	-
Timepiece	TP#13	5-Sep-21	-
Data logger	DL#01	28-Dec-20	-
'Apex' Kit	APEX#01	Various	Oct-20
Dry Gas Meter ('Apex')	DGM#15	19-Aug-21	-
Timepiece	TP#06	19-Aug-21	-
Thermocouple ('Apex')	TC#05	19-Aug-21	-
Thermocouple Reader ('Apex')	TCR#08	19-Aug-21	-
Manometer ('Apex' Orange)	MAN#02	19-Aug-21	-
Manometer ('Apex' Red)	MAN#03	19-Aug-21	-
Thermocouple ('Apex' Dogleg Exit)	TC#21	26-Jul-21	-
Tape Measure	TM#09	26-Jul-21	-

GAS CYLINDERS			
	Certificate No.	Level (ppm)	Validity
'Zero' Gas (%)	VC2686487	99.9995%	N/A
Oxygen Span Gas (%)	VC8172860	8.02%	30-Jan-21
VOC Span Gas	VC8172860	596	30-Jan-21
Carbon Monoxide Span Gas	VC109017	1212	14-Apr-21
Nitric Oxide Span Gas	VC109017	257.8	14-Apr-21

2.2 Appendix II: Emission Point Reference Data & Results

2.2.1 Diagram of Sampling Location on Engine



2.2.2 Homogeneity testing

BS EN 15259 stipulates that the exhaust gases emitted from combustion processes are tested to ensure homogeneity and that a representative sample is obtained during the monitoring, subject to a number of caveats as elucidated in Environment Agency guidance MID15259. The details of the testing at each emission point are summarised below:

Stack	Result of Homogeneity Testing
Engine	N/A –homogeneity testing only required on stacks exceeding 1.13 m diameter, as specified in MID 15259. Homogeneity assumed & single point sampling acceptable.

2.2.3 Gas analyser site measurements and calibrations

The data in the following Charts 1 – 3 and Table 1 are expressed in mgm^{-3} @ STP and is uncorrected for O_2 . In Addition, VOC results are expressed as carbon equivalent. This data was subsequently converted to reference oxygen concentrations (Section 1.2) with the addition of moisture correction for VOCs. Calibration data is shown in Table 2.

Chart 1, Engine - Oxides of Nitrogen Against Time

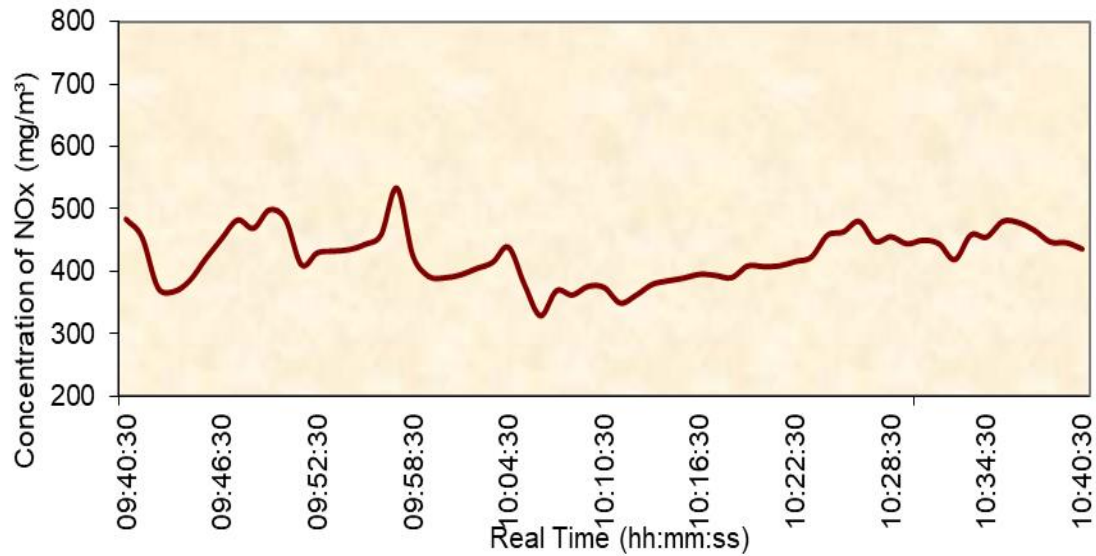
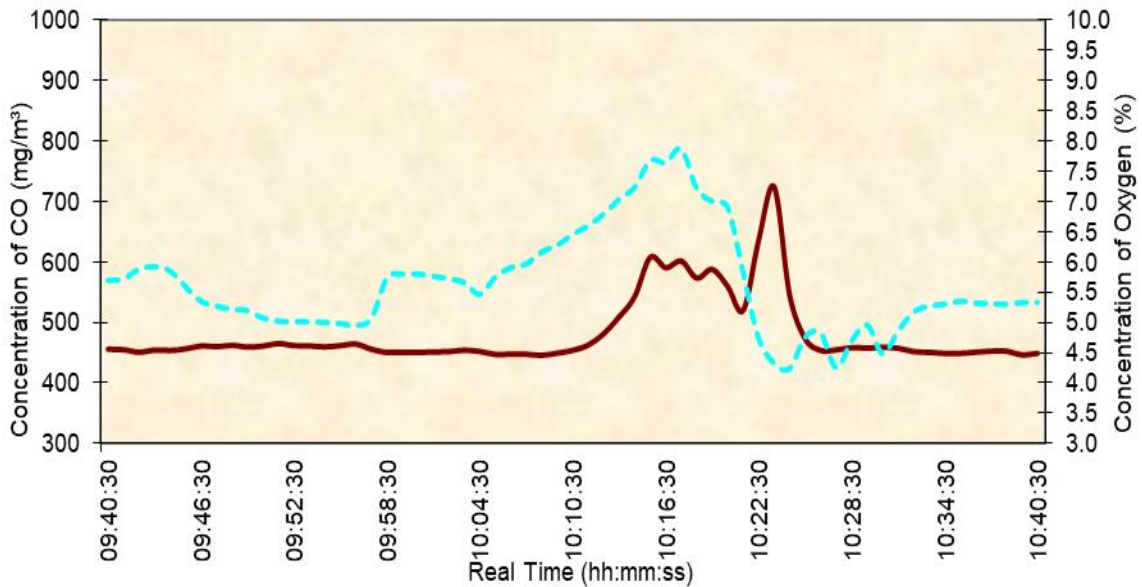
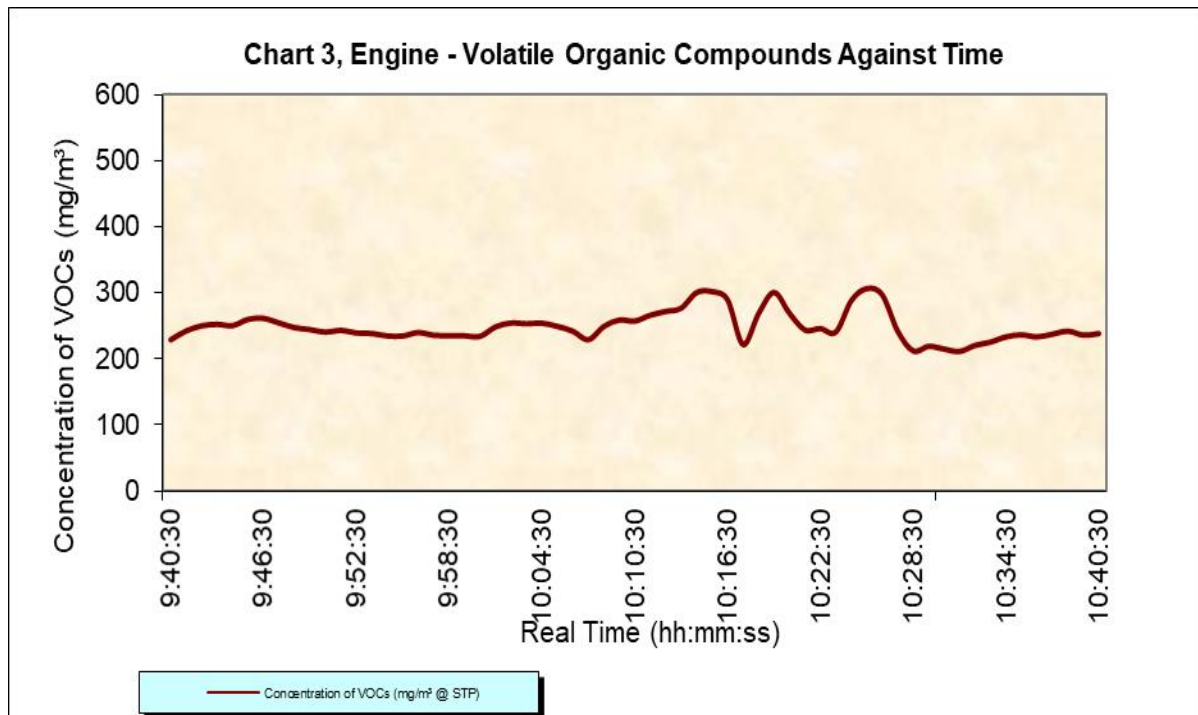


Chart 2, Engine - Oxygen & Carbon Monoxide Against Time



**Table 1 – Engine, Raw Data**

Time	Oxygen Dry Gas (%)	VOC Wet Gas (mgC/m³)	CO Dry Gas (mg/m³)	NO _x Dry Gas (mg/m³)	Comment
09:40:30	5.7	229.7	455.3	484.0	
09:41:30	5.7	243.2	454.4	455.3	
09:42:30	5.9	250.9	450.3	374.6	
09:43:30	5.9	253.1	453.8	368.4	
09:44:30	5.8	251.2	453.1	386.0	
09:45:30	5.6	260.7	455.8	421.1	
09:46:30	5.3	262.1	460.7	453.1	
09:47:30	5.3	255.2	459.4	482.8	
09:48:30	5.2	248.1	461.8	469.6	
09:49:30	5.2	245.3	458.8	499.1	
09:50:30	5.1	241.4	460.5	484.4	
09:51:30	5.0	244.0	464.6	411.2	
09:52:30	5.0	240.1	461.3	430.2	
09:53:30	5.0	239.3	460.9	433.0	
09:54:30	5.0	235.6	459.1	435.4	
09:55:30	5.0	235.4	461.3	443.8	
09:56:30	4.9	240.8	463.8	459.2	
09:57:30	5.1	236.6	455.2	533.8	
09:58:30	5.7	235.9	449.8	425.4	
09:59:30	5.8	235.8	450.2	392.5	

Time	Oxygen Dry Gas (%)	VOC Wet Gas (mgC/m ³)	CO Dry Gas (mg/m ³)	NO _x Dry Gas (mg/m ³)	Comment
10:00:30	5.8	235.0	449.8	390.5	
10:01:30	5.8	249.3	450.7	395.1	
10:02:30	5.7	255.1	451.2	405.2	
10:03:30	5.7	254.1	453.8	415.0	
10:04:30	5.5	254.9	451.5	439.2	
10:05:30	5.8	249.9	446.7	379.7	
10:06:30	5.9	242.7	447.0	329.8	
10:07:30	6.0	229.8	446.9	369.6	
10:08:30	6.2	249.9	445.1	363.0	
10:09:30	6.3	259.7	448.8	376.8	
10:10:30	6.5	258.1	453.5	375.0	
10:11:30	6.6	266.9	462.3	350.1	
10:12:30	6.8	272.7	481.0	362.6	
10:13:30	7.0	277.6	509.3	379.7	
10:14:30	7.2	301.3	542.9	385.6	
10:15:30	7.7	302.6	608.1	390.1	
10:16:30	7.6	290.3	590.7	396.0	
10:17:30	7.9	222.6	601.8	394.2	
10:18:30	7.2	269.2	573.4	390.7	
10:19:30	7.0	301.5	587.9	409.4	
10:20:30	6.9	269.8	559.5	408.4	
10:21:30	5.8	244.6	520.0	409.4	
10:22:30	4.7	246.7	636.9	416.6	
10:23:30	4.3	241.6	725.0	423.5	
10:24:30	4.2	289.1	544.5	458.3	
10:25:30	4.8	307.3	472.7	463.7	
10:26:30	4.8	297.6	453.3	480.6	
10:27:30	4.2	242.5	454.3	448.5	
10:28:30	4.7	212.8	457.8	456.0	
10:29:30	5.0	219.7	457.1	444.7	
10:30:30	4.5	215.7	458.4	450.4	
10:31:30	4.9	212.0	456.9	444.9	
10:32:30	5.2	221.3	451.3	419.5	
10:33:30	5.3	226.1	450.1	458.7	
10:34:30	5.3	234.2	448.3	455.7	
10:35:30	5.3	237.2	448.3	480.5	
10:36:30	5.3	234.2	450.5	478.6	
10:37:30	5.3	238.2	452.2	466.1	
10:38:30	5.3	242.8	451.9	447.6	
10:39:30	5.3	236.7	445.9	446.4	
10:40:30	5.3	239.1	448.5	436.4	

Table 2 – Calibration Data

ANALYSER CALIBRATION DATA					
Pre Sampling Check					
		NO (ppm)	CO (ppm)	O ₂ (%)	VOC's (ppm)
Range		500	2000	25	1000
Zero Gas	Cylinder No.	VC2686487			Scrubbed Air
Span Gas	Cylinder No.	VC109017	VC109017	VC8172860	VC8172860
	Certified Value	257.8	1212	8.02	596
Zero Check	Value	0.6	2	0.02	2
<2 x repeatability (Yes/No)		YES	YES	YES	YES
Down Line Zero & Span Check					
Zero Gas	Value	0.4	-1	0.01	3
	<2% of span	YES	YES	YES	YES
Span Gas	Value	256.8	1203	8.04	591
	Within 2% of span	YES	YES	YES	YES
Post Sampling Drift Check					
Zero Gas	Value	0.4	3	-0.01	2
	Drift (%)	0.0	0.3	0.2	0.2
	Validation	No Correction Required	No Correction Required	No Correction Required	No Correction Required
Span Gas	Value	256.8	1207	8.04	588
	Drift (%)	0.0	0.0	0.2	0.3
	Validation	No Correction Required	No Correction Required	No Correction Required	No Correction Required

2.3 Appendix III: Uncertainty Calculation

NOx - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	U_{r0}	0.80
Standard deviation of repeatability at span level	U_{rs}	0.10
Lack of fit	U_{rl}	2.37
Drift	U_{odr}	8.37
volume or pressure flow dependence	U_{spres}	0.06
atmospheric pressure dependence	U_{apres}	0.00
ambient temperature dependence	U_{temp}	0.00
NH ₃ (20 mg/m ³)	U_{interf}	0.14
CO ₂ (15%)	-	0.02
H ₂ O (30%)	-	0.01
Error in logger voltage	-	0.50
Dependence on voltage	U_{volt}	0.03
Converter efficiency	U_{ceff}	1.96
losses in the line (leak)	U_{leak}	4.91
Uncertainty of calibration gas	U_{calib}	4.91

NOx Measurement uncertainty		Result	424.89	mg/m ³
Combined uncertainty			11.31	mg/m ³
Expanded uncertainty	k = 2		22.62	mg/m ³
Uncertainty corrected to std conds			22.62	mg.m-3 (corrected)
Expanded uncertainty		expressed with a level of confidence of 95%		
		4.52 % ELV		
Expanded uncertainty		expressed with a level of confidence of 95%		
		22.62 mg.m⁻³ of result		

CO - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	U_{r0}	0.80
Standard deviation of repeatability at span level	U_{rs}	0.10
Lack of fit	U_{rl}	5.77
Drift	U_{odr}	17.23
volume or pressure flow dependence	U_{spres}	0.00
atmospheric pressure dependence	U_{apres}	0.00
ambient temperature dependence	U_{temp}	0.00
CO ₂ (15%)	U_{interf}	0.00
N ₂ O (40mgm ³)	-	0.00
CH ₄ (57mgm ³)	-	0.00
H ₂ O (1%)	-	0.00
Dependence on voltage	U_{volt}	0.03
Error in Logger reading	-	2.00
losses in the line (leak)	U_{leak}	5.58
Uncertainty of calibration gas	U_{calib}	5.58

CO Measurement uncertainty		Result	483.63	mg/m ³
Combined uncertainty			19.91	mg/m ³
Expanded uncertainty	k = 2		39.82	mg/m ³
Uncertainty corrected to std conds			39.82	mg.m-3 (corrected)
Expanded uncertainty		expressed with a level of confidence of 95%		
		2.84 % ELV		
Expanded uncertainty		expressed with a level of confidence of 95%		
		39.82 mg.m⁻³ of result		

VOC - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	U_{r0}	0.80
Standard deviation of repeatability at span level	U_{rs}	0.10
Lack of fit	U_{rl}	3.74
Drift	U_{odr}	10.80
volume or pressure flow dependence	U_{spres}	0.00
atmospheric pressure dependence	U_{apres}	0.00
ambient temperature dependence	U_{temp}	0.00
NH ₃ (20 mg/m ³)	U_{interf}	0.00
CO ₂ (15%)	-	0.00
H ₂ O (30%)	-	0.00
Error on Logger voltage	-	1.00
Dependence on voltage	U_{volt}	0.03
losses in the line (leak)	U_{leak}	2.90
Uncertainty of calibration gas	U_{calib}	2.90

VOC Measurement uncertainty		Result	251.39	mg/m ³
Combined uncertainty			12.19	mg/m ³
Expanded uncertainty	k = 2		24.38	mg/m ³
Uncertainty corrected to std conds			24.38	mg.m-3 (corrected)
Expanded uncertainty		expressed with a level of confidence of 95%		
		2.44 % ELV		
Expanded uncertainty		expressed with a level of confidence of 95%		
		24.38 mg.m⁻³ of result		

Oxygen - Measurement performance related to stationary conditions		
Performance characteristic	Uncertainty	Value of uncertainty quantity
Standard deviation of repeatability at zero	u_{r0}	0.20
Standard deviation of repeatability at span level	u_{rs}	0.03
Lack of fit	u_{rf}	0.07
Drift	u_{odr}	0.10
volume or pressure flow dependence	u_{spres}	0.00
atmospheric pressure dependence	u_{apres}	0.00
ambient temperature dependence	u_{temp}	0.00
CO ₂ (15%)	-	0.00
NO ₂ (300)	-	0.06
NO ₂ (30)	-	0.00
dependence on voltage	u_{volt}	0.02
losses in the line (leak)	u_{leak}	0.07
Error in Logger voltage	-	0.03
Uncertainty of calibration gas	u_{calib}	0.07

O₂ Measurement uncertainty	Result	5.64	%vol
Combined uncertainty		0.17	%vol
% of value		2.96	%
Expanded uncertainty	expressed with a level of confidence of 95%	5.93 % of value	
Expanded uncertainty	expressed with a level of confidence of 95%	0.33 % vol	

Sulphur Dioxide

Parameter	Value	Units	Sensitivity coeff	Uncertainty contribution	Uncertainty as %
Corrected Volume (standard conditio	V	0.50 m ³	78.14	0.47 mg.m ⁻³	1.20 %
Mass	m	32.28 mg	1.21	1.26 mg.m ⁻³	3.21 %
Factor for O ₂ Correction	fc	1.04	37.59	0.43 mg.m ⁻³	1.09 %
Leak	L	0.45 mg.m ⁻³	1.00	0.45 mg.m ⁻³	1.15 %
Combined uncertainty				1.48 mg.m⁻³	
Expanded uncertainty as percentage of measured value		7.56	% measured of value	expressed with a level of confidence of 95% (Using a coverage factor k=2)	
Expanded uncertainty in units of measurement		2.96	mg.m ⁻³		
Expanded uncertainty as percentage of limit value		0.85	% ELV		

2.4 Appendix IV: Moisture Calculations

Test No	T2
Date	9-9-20
pbar (mbar)	997
pbar (mmHg)	748
Nozzle Diameter (mm)	n/a
Temp of Meter (in)/(out) °C	22
DH _{ave} (mmH ₂ O)	10.0
DGM Cal Factor (Y)	0.9927

Site	BV Dairy Shaftsbury
Stack	Mercedes
Job Number:	R20421
Site Team:	BMK & NCK
Data Entered By:	BMK

Enter Data into coloured cells only

Start Volume Reading	324.4054	m³
End Volume Reading	325.0130	m³
Volume Sampled	0.6032	m³

Start time	09:40	hr:min
End time	10:40	hr:min
Total time	01:00	hr:min

IMPINGER	1	2	3	4	Initials of Analyst
Absorber Solution (Type):	H2O2	H2O2	H2O2	SILICA	
Sample No:	n/a	n/a	n/a	n/a	
Analysis Required:	n/a	n/a	n/a	n/a	
Initial Weight of Impingers plus absorber (g)	820.9	816.8	762.6	846.4	NCK
Final Weight of Impingers plus absorber (g)	880.9	819.1	762.8	854.0	NCK
Weight Gain (g)	60.0	2.3	0.2	7.6	

Total Weight Gain (1+2+3+4) (g)	70.1
---------------------------------	------

Gas Volume of water at 0°C and 101.3kPa (l)	87.27
Gas Meter volume at 0°C and 101.3kPa (l)	549.91

Moisture content of Gases (%)	13.7
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2.5 Appendix V: Acid Gas Calculations

SUMMARY OF ACID GAS IMPINGEMENT SAMPLING			
Stack ID		Mercedes	
Stack Dimensions	(m)	0.22	
Date of Test		09-Sep-20	09-Sep-20
TEST NUMBER		T1	T2
	Applied Standard	BS EN 14791	
Start Time	(hh:mm)	9:11	9:40
Stop Time	(hh:mm)	9:16	10:40
Duration	(minutes)	5	60
Sampled Gas Volume	(m ³)	Field Blank	0.6076
Mean Temperature DGM	(°C)		22.00
Mean Sample Pressure	(mmH ₂ O)		10.00
Mean Stack Temperature	(°C)		
Corrected Sampled Gas Vol.	(Sm ³ @20°C)		0.5905
Corrected Sampled Gas Vol.	(Nm ³ @STP)		0.5502
Average Flowrate	(l/min @STP)		9.17
Required Pollutant (eg:HCl, HF or SO ₂)		SO ₂	
Molecular Weight Pollutant		64	64
Determinant Species		Sulphate	
Molecular Weight Determinand		96	96
	Analysing Laboratory UKAS No.	0605	
Measured concentration(Front)	(ug/ml)	0.1	74.2
Solution Sample Volume	(ml)	380.0	435.0
Measured concentration(Back)	(ug/ml)	0.1	0.2
Solution Sample Volume	(ml)	200.0	195.0
	Efficiency of Capture (%)	N/A	99.89%
Total Determinand Mass	(mg)	0.035	32.312
Moles of Determinand (mol)	(mol)	0.000	0.337
Mass of Pollutant	(mg)	0.02	21.54
Concentration (@ STP, Dry)	(mg/m ³)	0.04	39.15
Stack Moisture	(%)v/v		13.68
Moisture Correction	dim'less	1.00	1.16
Stack Oxygen	(%)v/v	5.64	5.64
Oxygen Correction Factor	dim'less	1.04	1.04
	Net Correction Factor	1.04	1.04
Concentration @ Ref	(mg/(N)m ³)	0.04	40.79
Sample as a percentage of ELV	(%)	0.01%	11.65%
Blank Value	(mg/(N)m ³)	0.04	
Is Blank value < 10% of ELV		Yes	