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EN 15259 Homogeneity Test Report Commissioned by
B&W Volund

Installation Name & Address
B&W Volund
Margam Green Energy Plant
Land Off Longlands Lane (Heol Cae'r Bont)
Margam
Port Talbot
SA13 2NW

EPR Permit: EPR/DP3137EG

Stack Reference
A1 - Main Stack

Dates of the Homogeneity Test
23rd October 2018

Job Reference Number
CAT-4504

Report Written by
David Burns Team Leader MCERTS Level 2 MM 05 579 TE1 TE2 TE3 TE4

Report Approved by
Matthew Pendlebury Team Leader MCERTS Level 2 MM 04 535 TE1 TE2 TE3 TE4

Report Date
23rd November 2018

Version
Version 1

Signature of Report Approver


CONTENTS

Opinions and interpretations expressed herein are outside the scope of Exova Catalyst's ISO 17025 accreditation.

Executive Summary

(Page 1 of 5)

MONITORING OBJECTIVES

B&W Volund, Margam
A1 - Main Stack
23rd October 2018

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by B&W Volund to carry out a EN 15259 Homogeneity Test on the A1 - Main Stack at Margam.

The aim of the monitoring campaign was to perform a BS EN 15259 Homogeneity Test to determine whether multiple sample points are required when performing non-isokinetic / gaseous phase periodic monitoring.

Special Requirements

There were no special requirements.

MONITORING RESULTS

B&W Volund, Margam
A1 - Main Stack
23rd October 2018

Parameter	Result	Representative Point	Sampling Date(s)	Sampling Times
Total VOCs (as Carbon)	Homogeneous	Any Point	23/10/2018	16:08 - 17:30
Oxides of Nitrogen (as NO_2)	Homogeneous	Any Point	23/10/2018	16:08 - 17:30
Sulphur Dioxide	Homogeneous	Any Point	23/10/2018	16:08 - 17:30
Carbon Monoxide	Homogeneous	Any Point	23/10/2018	16:08 - 17:30
Oxygen	Homogeneous	Any Point	23/10/2018	16:08 - 17:30

PROCESS DETAILS

B&W Volund, Margam
A1 - Main Stack
23rd October 2018

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	Standard Operating Capacity
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Biomass
Abatement System	N/A
Abatement System Running Status	N/A
Fuel	Biomass
Plume Appearance	None Visible

Executive Summary

MONITORING & ANALYTICAL METHODS

B&W Volund, Margam
A1 - Main Stack
23rd October 2018

		Traversing Analyser (C_{grid})				Fixed Analyser (C_{ref})	
Parameter	**Status of Testing**	**Standard**	**Technical Procedure**	**Equipment Used**	**Measurement Technique**	**Equipment Used**	**Measurement Technique**
Total VOCs (as Carbon)	MCERTS	BS EN 12619	CAT-TP-20	Sick 3006 FID	FID	MCS100FT	FID
Oxides of Nitrogen (as NO_2)	MCERTS	TGN M22	CAT-TP-22	Gasmet DX-4000	FTIR	MCS100FT	FTIR
Sulphur Dioxide	MCERTS	TGN M22	CAT-TP-22	Gasmet DX-4000	FTIR	MCS100FT	FTIR
Carbon Monoxide	MCERTS	TGN M22	CAT-TP-22	Gasmet DX-4000	FTIR	MCS100FT	FTIR
Oxygen	MCERTS	BS EN 14789	CAT-TP-39	Horiba PG-350E	Paramagnetic Cell	MCS100FT	Zirconia Cell

NOTE: The use of Oxygen as a surrogate for HCl, HF & NH_4, and Total VOCs as a surrogate for Speciated VOCs is allowable under MID EN 15259.

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
All Parameters	All Runs	There are no deviations associated with the sampling employed.

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	2.20
Width	m	-
Area	m²	3.80
Port Depth	cm	24
Orientation of Duct	-	Vertical
Sample Port Size	-	5" Flange

Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	Permanent
Inside / Outside	Outside

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	Yes
Obstructions do not hamper insertion of sampling equipment	Yes
Easy Access Available	Yes
Safe Access Available	Yes

Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements specified in EA Guidance Note M1 and EN 15259, and therefore there are no improvement recommendations.

Executive Summary

PLANT PHOTOS

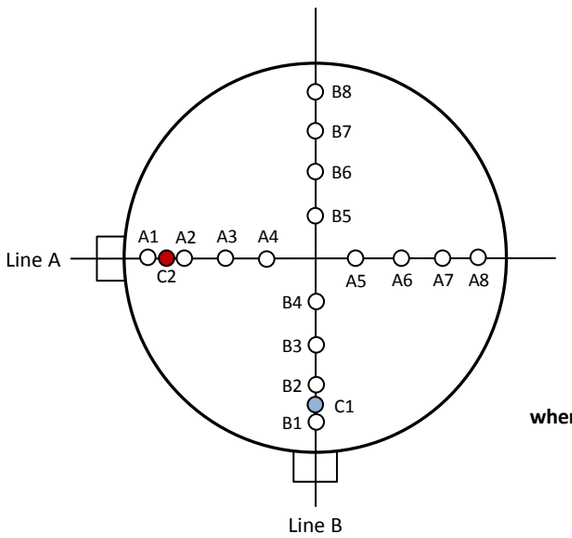
Photo 1

Photo 2

Photo 3

Photo 4

SAMPLE POINTS



where
- ○ = isokinetic point sampled at
- ● = isokinetic point not sampled at
- ● = combustion gases sample point
- ● = non-isokinetic sample point

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	David Burns	MCERTS Level 2	MM 05 579	TE1 TE2 TE3 TE4
Technician	Lee Heaton	MCERTS Level 1	MM 18 1433	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.58
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.148
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.148
Umbilical (2)	-
Oven Box (1)	CAT 12.201
Oven Box (2)	-
Heated Probe (1)	CAT 5.129
Heated Probe (2)	CAT 5.130
Heated Probe (3)	CAT 5.131
S-Pitot (1)	CAT 21P.97
S-Pitot (2)	CAT 21S.56
L-Pitot	CAT 21L.41
500g Check Weight	CAT 17.38
1Kg Check Weight	CAT 17.38
Last Impinger Arm	CAT 4.902/4.903
Callipers	CAT 23.41
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-350E	CAT 39.11
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Servomex 5200MP	-
Ankersmid APS 313	CAT 4.848
Gasmet DX4000	-
Gasmet Sampling System	CAT 19.4
Bernath 3006 FID	CAT 8.32
M&C PSS	CAT 12.108
Mass Flow Controller (1)	CAT 6.63
Mass Flow Controller (2)	CAT 6.64
Mass View (1)	CAT 25.61
Mass View (2)	CAT 25.62
Hioki 5043 (V)	CAT 11.70
Easylogger EN-EL-12 Bit	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.143
Digital Manometer (2)	CAT 3.145
Digital Temperature Meter	-
Stopwatch	CAT 14.86
Barometer	CAT 13.41
Stack Thermocouple (1)	CAT 4.1014
Stack Thermocouple (2)	CAT 4.1041
Stack Thermocouple (3)	CAT 4.0014
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.119
20m Heated Line (2)	-
Dual Channel Heater Controller	CAT 3.002
Single Channel Heater Controlle	CAT 20.119
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.49

TOTAL VOCs (AS CARBON): HOMOGENEITY TEST

General Information	Value	General Information	Value
No. of Analysers Used	2	Traversing Analyser T_{95} (s)	90
Traversing Analyser	Sick 3006 FID	Fixed Analyser T_{95} (s)	90
Fixed Analyser	MCS100FT	Daily ELV (mg/m³)	15

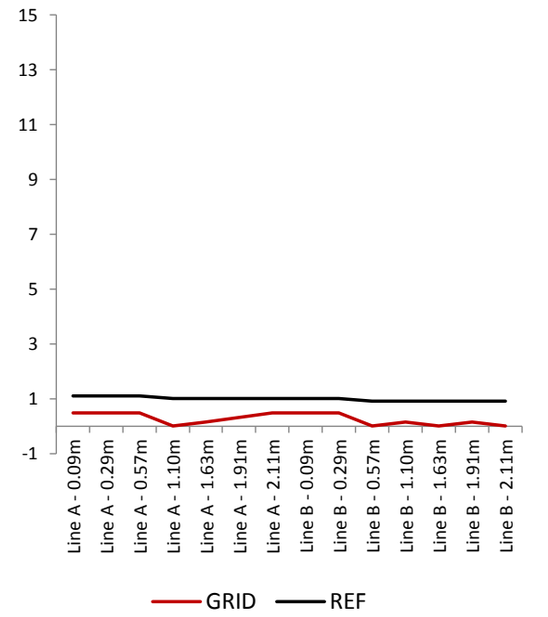
Paired Measurements

Line - Depth	Time Point Taken	c_{grid} mg/m³	c_{ref} mg/m³	c_{grid} / c_{ref} %
Line A - 0.09m	16:08	0.48	1.10	43.6
Line A - 0.29m	16:14	0.48	1.10	43.6
Line A - 0.57m	16:20	0.48	1.10	43.6
Line A - 1.10m	16:26	0.00	1.00	0.00
Line A - 1.63m	16:32	0.16	1.00	16.0
Line A - 1.91m	16:38	0.32	1.00	32.0
Line A - 2.11m	16:44	0.48	1.00	48.0
Line B - 0.09m	16:54	0.48	1.00	48.0
Line B - 0.29m	17:00	0.48	1.00	48.0
Line B - 0.57m	17:06	0.00	0.90	0.00
Line B - 1.10m	17:12	0.16	0.90	17.8
Line B - 1.63m	17:18	0.00	0.90	0.00
Line B - 1.91m	17:24	0.16	0.90	17.8
Line B - 2.11m	17:30	0.00	0.90	0.00

TOTAL VOCs (AS CARBON): HOMOGENEITY TEST (continued)

EN 15259 Calculations			
	c_{grid}	c_{ref}	c_{grid} / c_{ref}
Mean Value	0.26	0.99	25.6
Standard Deviation	s_{grid}	s_{ref}	5% Daily ELV
	0.21	0.08	0.75
Number of Measurements	14		
Degrees of Freedom	13		
Homogeneity Test:			
Test Value $(s_{grid}/s_{ref})^2$	N/A		
F_{95}%	N/A		
Waste Gas Classification	Homogeneous		
Standard Deviation of time, s_{ref}	N/A		
Standard Deviation of position, s_{pos}	N/A		
Permissible expanded uncertainty U_{perm}	N/A		
$t_{N-1;\,0.95}$	N/A		
U_{pos}	N/A		
$U_{pos} \leq 0.5\ U_{perm}$	N/A		
Required measurement type	Any Point		
Minimum deviation value from mean	N/A		
Representative measurement point	N/A		
c_{grid} / c_{ref} at representative measurement point	N/A		

CHART - C_{grid} vs C_{ref}



NOTE: Homogeneous if either $S_{grid} \leq S_{ref}$, or Test Value $(S_{grid}/S_{ref})^2 < F_{95}$%

MID 15259 states that any sample point in the duct may be used (i.e. it is defined as being homogeneous) if the value for Sgrid (in the table above) is <5% of the Daily ELV

OXIDES OF NITROGEN (as NO_2): HOMOGENEITY TEST

General Information	Value	General Information	Value
No. of Analysers Used	2	Traversing Analyser T_{95} (s)	90
Traversing Analyser	Gasmet DX-4000	Fixed Analyser T_{95} (s)	90
Fixed Analyser	MCS100FT	Daily ELV (mg/m³)	300

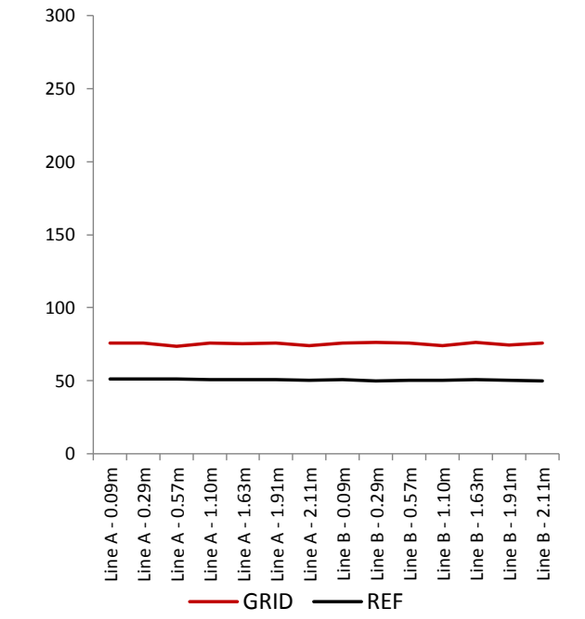
Paired Measurements

Line - Depth	Time Point Taken	c_{grid} mg/m³	c_{ref} mg/m³	c_{grid} / c_{ref} %
Line A - 0.09m	16:08	75.7	51.2	148.1
Line A - 0.29m	16:14	75.7	51.3	147.7
Line A - 0.57m	16:20	73.6	51.4	143.3
Line A - 1.10m	16:26	75.9	50.7	149.9
Line A - 1.63m	16:32	75.5	50.9	148.5
Line A - 1.91m	16:38	75.7	50.7	149.5
Line A - 2.11m	16:44	73.9	50.4	146.7
Line B - 0.09m	16:54	75.7	50.9	148.8
Line B - 0.29m	17:00	76.2	50.0	152.6
Line B - 0.57m	17:06	75.6	50.3	150.5
Line B - 1.10m	17:12	73.9	50.6	146.1
Line B - 1.63m	17:18	76.4	50.8	150.5
Line B - 1.91m	17:24	74.5	50.5	147.7
Line B - 2.11m	17:30	75.7	50.0	151.5

OXIDES OF NITROGEN (as NO_2): HOMOGENEITY TEST (continued)

EN 15259 Calculations			
	c_{grid}	c_{ref}	c_{grid} / c_{ref}
Mean Value	75.3	50.6	148.7
Standard Deviation	s_{grid}	s_{ref}	5% Daily ELV
	0.92	0.44	15.0
Number of Measurements	14		
Degrees of Freedom	13		
Homogeneity Test:			
Test Value $(s_{grid}/s_{ref})^2$	N/A		
F_{95}%	N/A		
Waste Gas Classification	Homogeneous		
Standard Deviation of time, s_{ref}	N/A		
Standard Deviation of position, s_{pos}	N/A		
Permissible expanded uncertainty U_{perm}	N/A		
$t_{N-1;\,0.95}$	N/A		
U_{pos}	N/A		
$U_{pos} \leq 0.5\ U_{perm}$	N/A		
Required measurement type	Any Point		
Minimum deviation value from mean	N/A		
Representative measurement point	N/A		
c_{grid} / c_{ref} at representative measurement point	N/A		

CHART - C_{grid} vs C_{ref}



NOTE: Homogeneous if either $S_{grid} \leq S_{ref}$, or Test Value $(S_{grid}/S_{ref})^2 < F_{95}$%

MID 15259 states that any sample point in the duct may be used (i.e. it is defined as being homogeneous) if the value for Sgrid (in the table above) is <5% of the Daily ELV

SULPHUR DIOXIDE: HOMOGENEITY TEST

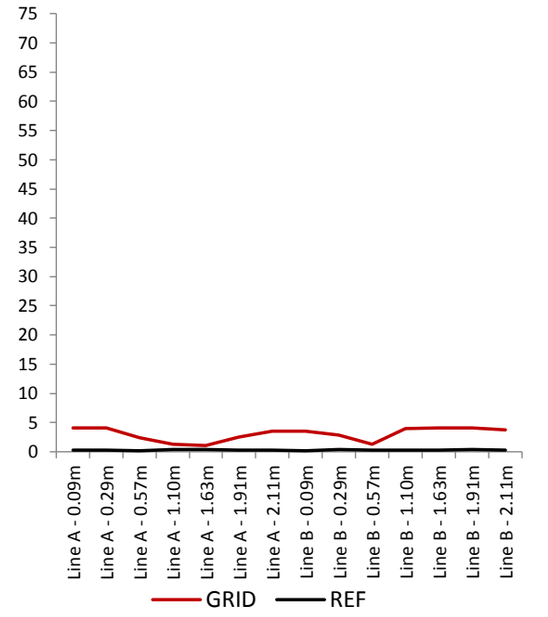
General Information	Value	General Information	Value
No. of Analysers Used	2	Traversing Analyser T_{95} (s)	90
Traversing Analyser	Gasmet DX-4000	Fixed Analyser T_{95} (s)	90
Fixed Analyser	MCS100FT	Daily ELV (mg/m³)	75

Paired Measurements				
Line - Depth	Time Point Taken	c_{grid} mg/m³	c_{ref} mg/m³	c_{grid} / c_{ref} %
Line A - 0.09m	16:08	4.05	0.30	1353.7
Line A - 0.29m	16:14	4.08	0.30	1363.3
Line A - 0.57m	16:20	2.46	0.20	1229.8
Line A - 1.10m	16:26	1.26	0.40	314.6
Line A - 1.63m	16:32	1.09	0.40	271.7
Line A - 1.91m	16:38	2.48	0.30	829.4
Line A - 2.11m	16:44	3.51	0.30	1172.6
Line B - 0.09m	16:54	3.48	0.20	1744.6
Line B - 0.29m	17:00	2.91	0.40	729.3
Line B - 0.57m	17:06	1.26	0.30	419.5
Line B - 1.10m	17:12	3.97	0.30	1325.1
Line B - 1.63m	17:18	4.05	0.30	1353.7
Line B - 1.91m	17:24	4.14	0.40	1036.8
Line B - 2.11m	17:30	3.77	0.30	1258.4

SULPHUR DIOXIDE: HOMOGENEITY TEST (continued)

EN 15259 Calculations			
	c_{grid}	c_{ref}	c_{grid} / c_{ref}
Mean Value	3.04	0.31	1028.7
Standard Deviation	s_{grid}	s_{ref}	5% Daily ELV
	1.14	0.07	3.75
Number of Measurements	14		
Degrees of Freedom	13		
Homogeneity Test:			
Test Value $(s_{grid}/s_{ref})^2$	N/A		
F_{95}%	N/A		
Waste Gas Classification	Homogeneous		
Standard Deviation of time, s_{ref}	N/A		
Standard Deviation of position, s_{pos}	N/A		
Permissible expanded uncertainty U_{perm}	N/A		
$t_{N-1;\,0.95}$	N/A		
U_{pos}	N/A		
$U_{pos} \leq 0.5\ U_{perm}$	N/A		
Required measurement type	Any Point		
Minimum deviation value from mean	N/A		
Representative measurement point	N/A		
c_{grid} / c_{ref} at representative measurement point	N/A		

CHART - C_{grid} vs C_{ref}



NOTE: Homogeneous if either $S_{grid} \leq S_{ref}$, or Test Value $(S_{grid}/S_{ref})^2 < F_{95}$%

MID 15259 states that any sample point in the duct may be used (i.e. it is defined as being homogeneous) if the value for Sgrid (in the table above) is <5% of the Daily ELV

CARBON MONOXIDE: HOMOGENEITY TEST

General Information	Value	General Information	Value
No. of Analysers Used	2	Traversing Analyser T_{95} (s)	90
Traversing Analyser	Gasmet DX-4000	Fixed Analyser T_{95} (s)	90
Fixed Analyser	MCS100FT	Daily ELV (mg/m³)	75

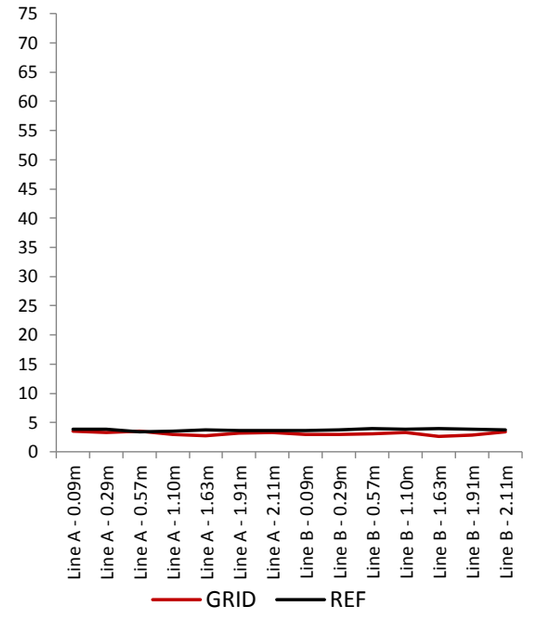
Paired Measurements

Line - Depth	Time Point Taken	c_{grid} mg/m³	c_{ref} mg/m³	c_{grid} / c_{ref} %
Line A - 0.09m	16:08	3.49	3.90	89.4
Line A - 0.29m	16:14	3.29	3.90	84.3
Line A - 0.57m	16:20	3.59	3.40	105.5
Line A - 1.10m	16:26	2.95	3.50	84.3
Line A - 1.63m	16:32	2.77	3.80	73.0
Line A - 1.91m	16:38	3.19	3.70	86.1
Line A - 2.11m	16:44	3.34	3.70	90.2
Line B - 0.09m	16:54	2.95	3.70	79.7
Line B - 0.29m	17:00	3.04	3.80	79.9
Line B - 0.57m	17:06	3.14	4.00	78.4
Line B - 1.10m	17:12	3.34	3.90	85.6
Line B - 1.63m	17:18	2.65	4.00	66.3
Line B - 1.91m	17:24	2.92	3.90	75.0
Line B - 2.11m	17:30	3.39	3.80	89.1

CARBON MONOXIDE: HOMOGENEITY TEST (continued)

EN 15259 Calculations			
	c_{grid}	c_{ref}	c_{grid} / c_{ref}
Mean Value	3.14	3.78	83.4
Standard Deviation	s_{grid}	s_{ref}	5% Daily ELV
	0.28	0.17	3.75
Number of Measurements	14		
Degrees of Freedom	13		
Homogeneity Test:			
Test Value $(s_{grid}/s_{ref})^2$	N/A		
F_{95}%	N/A		
Waste Gas Classification	Homogeneous		
Standard Deviation of time, s_{ref}	N/A		
Standard Deviation of position, s_{pos}	N/A		
Permissible expanded uncertainty U_{perm}	N/A		
$t_{N-1;\,0.95}$	N/A		
U_{pos}	N/A		
$U_{pos} \leq 0.5\ U_{perm}$	N/A		
Required measurement type	Any Point		
Minimum deviation value from mean	N/A		
Representative measurement point	N/A		
c_{grid} / c_{ref} at representative measurement point	N/A		

CHART - C_{grid} vs C_{ref}



NOTE: Homogeneous if either $S_{grid} \leq S_{ref}$, or Test Value $(S_{grid}/S_{ref})^2 < F_{95}$%

MID 15259 states that any sample point in the duct may be used (i.e. it is defined as being homogeneous) if the value for Sgrid (in the table above) is <5% of the Daily ELV

OXYGEN: HOMOGENEITY TEST

General Information	Value	General Information	Value
No. of Analysers Used	2	Traversing Analyser T_{95} (s)	90
Traversing Analyser	Horiba PG-350E	Fixed Analyser T_{95} (s)	90
Fixed Analyser	MCS100FT	Virtual Daily ELV (% v/v)	21

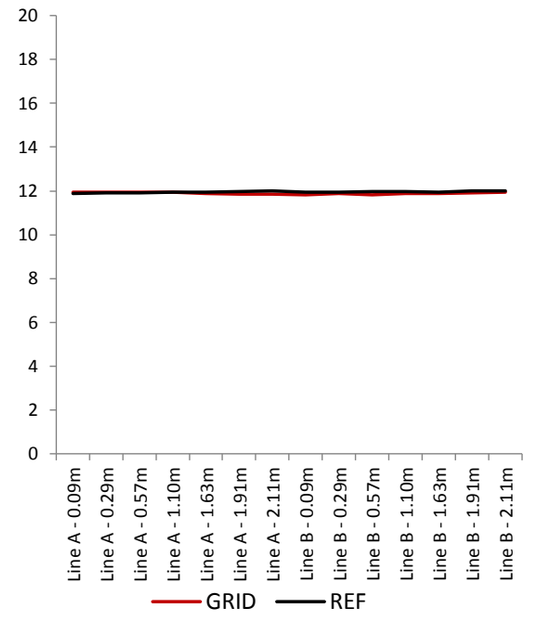
Paired Measurements

Line - Depth	Time Point Taken	c_{grid} % v/v	c_{ref} % v/v	c_{grid} / c_{ref} %
Line A - 0.09m	16:08	11.9	11.9	100.5
Line A - 0.29m	16:14	11.9	11.9	100.2
Line A - 0.57m	16:20	11.9	11.9	100.3
Line A - 1.10m	16:26	11.9	12.0	99.9
Line A - 1.63m	16:32	11.9	11.9	99.4
Line A - 1.91m	16:38	11.9	12.0	99.0
Line A - 2.11m	16:44	11.9	12.0	98.8
Line B - 0.09m	16:54	11.8	12.0	99.0
Line B - 0.29m	17:00	11.9	11.9	99.5
Line B - 0.57m	17:06	11.8	12.0	98.7
Line B - 1.10m	17:12	11.9	12.0	99.2
Line B - 1.63m	17:18	11.9	11.9	99.5
Line B - 1.91m	17:24	11.9	12.0	99.3
Line B - 2.11m	17:30	11.9	12.0	99.4

OXYGEN: HOMOGENEITY TEST (continued)

EN 15259 Calculations			
	c_{grid}	c_{ref}	c_{grid} / c_{ref}
Mean Value	11.9	12.0	99.5
Standard Deviation	s_{grid}	s_{ref}	Allowable
	0.04	0.04	0.30
Number of Measurements	14		
Degrees of Freedom	13		
Homogeneity Test:			
Test Value $(s_{grid}/s_{ref})^2$	N/A		
F_{95}%	N/A		
Waste Gas Classification	Homogeneous		
Standard Deviation of time, s_{ref}	N/A		
Standard Deviation of position, s_{pos}	N/A		
Permissible expanded uncertainty U_{perm}	N/A		
$t_{N-1;\,0.95}$	N/A		
U_{pos}	N/A		
$U_{pos} \leq 0.5\ U_{perm}$	N/A		
Required measurement type	Any Point		
Minimum deviation value from mean	N/A		
Representative measurement point	N/A		
c_{grid} / c_{ref} at representative measurement point	N/A		

CHART - C_{grid} vs C_{ref}



NOTE: Homogeneous if either $S_{grid} \leq S_{ref}$, or Test Value $(S_{grid}/S_{ref})^2 < F_{95}$%

MID 15259 states that any sample point in the duct may be used (i.e. it is defined as being homogeneous) if the value for Sgrid (in the table above) is <0.3