

AST SURVEY

Prepared for:

Engie.

Barry Cogeneration Plant

Barry Silicon Based Manufacturing Installation

Winbourne Road

Dock No.2

Barry

CF63 3DH

Permit Number	: EPR/JP3632ZH
Variation Number	: EPR/JP3632ZH/V002
Installation	: Dow Corning CHP
Visit Details	: AST 2016
Job Number	: P2897
Report Number	: R001
Report Issue Date	: 1st November 2016
Survey Dates	: 23rd to 25th August 2016

Prepared by:

Environmental Compliance Limited

Unit G1

Main Avenue

Treforest Industrial Estate

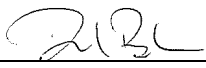
Pontypridd

CF37 5BF.

Tel: 01443 841760

Fax: 01443 841761

Email: admin@envirocompli.com

Report Issue:		FINAL	
Report Prepared by:		Report Reviewed & Approved by MCERTS Level Two Technical Endorsements TE1, TE2, TE3 & TE4	
Name:	Sam Brookes	Name:	David Boles
		MCERTS No:	MM 03 215
		Signature:	
Date:	31/10/2016	Date:	01/11/2016

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Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

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Engine :
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

TABLE OF CONTENTS

Section	Description	Page
1	EXECUTIVE SUMMARY	05
1.1	Summary of Results	06
1.2	Details of Any Deviations from SRMs & EN 14181	09
2	INSTALLATION INFORMATION	11
2.1	Details of Installation & Regulated Determinands	11
2.2	Operating Information and site monitoring-provisions	12
2.2.1.1	Process Details Incl. Abatement	12
2.2.1.2	Historical Data Analysis and Expected Process Variation	13
2.2.2	Fuel Details	14
2.2.3	Type of abatement and its effect on emissions	14
2.3	Monitoring Provisions at the Installation – Periodic Monitoring	15
2.3.1	Stack & Sampling Ports	15
2.3.2	Monitoring platform and site-provisions inc grid sampling	17
2.4	Continuous Emission Monitoring Systems (CEMs) at the Installation	18
2.4.1	Details of CEM for each Regulated Determinand	18
2.4.2	Details of CEM for each Peripheral Determinand	18
3	MONITORING CAMPAIGN	19
3.1	Site Team Details	19
3.2	Standard Reference Methods (SRMs)	20
3.3	Introduction	21
3.4	Objectives	22
3.5	Sampling Protocols / Methodologies	23
3.5.1	Combustion Gases (NO, CO & O ₂)	23
4	MONITORING DATA & CALCULATIONS	24
5	RESULTS OF THE FUNCTIONAL TESTS	69
5.1	Functional Test Summary	69
5.2	Documentation & Records	73
5.3	Linearity Testing	75

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

Section	Description	Page
6	UNCERTAINTY CALCULATIONS AND DRIFT CORRECTION	108
	6.1 Contributing Factors to Combustion Gases Uncertainty	108
7	REFERENCE MATERIALS	112
	7.1 SRM Reference Materials	112
	7.2 SRM Calibration Validation Summaries	113
	7.3 CEM Reference Materials	119
8	DATA VALUES	117
	8.1 Outlying Value Calculation Procedure	118
	8.2 Time Series Plots of Minute Averages	119
9	CEM QAL3 DATA	124
	9.1 CEM QAL3 Control Charts	124
	9.2 CEM QAL3 Data	133
10	EQUIPMENT USED	134
11	CEM SERVICE REPORT	135

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

1.0 EXECUTIVE SUMMARY

Environmental Compliance Ltd (ECL) was commissioned by **Mr. Paul Gardner** of **Engie** to undertake to undertake an AST calibration validation procedure in accordance with BS EN 14181, the Environment Agency's Technical Guidance Note M20 & MID.

This report presents the findings of the study.

The substances requested for monitoring at each emissions point are listed below:

Substances to be monitored	Emission Point Identification
	A1, A2 & A3
Oxides of Nitrogen as Nitrogen Monoxide ¹	• U
Carbon Monoxide	• U
Oxygen	• U

- Denotes the substances to be monitored.
- U Denotes UKAS accreditation is held for monitoring² that substance.

Special Requirements: *Conduct parallel monitoring under normal operating conditions. Aim for as large a spread of data as possible within normal operating parameters.*

¹ CEM measures NO only therefore SRM to measure NO only as detailed in Section 6.5 of Annex A MID 14181 in EA TGN M20 Version 3, June 2015.

² UKAS / MCERTS accreditation is held by ECL for the sampling method and data analysis in accordance with the requirements of BS EN 14181:2014 for the specific determinand(s) indicated above. Where applicable the sub-contract laboratory will be UKAS accredited for analysis of samples.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

1.1 Summary of Results

BS EN 14181 Test Designation:		AST			Stack Designation:	A1 HR-001A		
Determinands	Calibration Function		Units of Calibration Function	Conditions of Calibration Function	Valid Calibration Range Based on Calibrated CEMs Data (273K, 101.3 kPa, Dry Gas, 15% Oxygen) ³	Extrapolated Range Based on Reference Materials (From Previous QAL 2)	PASS / FAIL	
	<i>a</i>	<i>b</i>					Variability	Calibration Validation
Oxides of Nitrogen as (NO)	- 0.9335	1.0056	ppm	273K, 101.3 kPa, Dry Gas	0 – 57.88 mg/m ³	... ⁴	PASS	PASS
Carbon Monoxide	0.3218	1.0096	ppm	273K, 101.3 kPa, Dry Gas	0 – 31.01 mg/m ³	... ⁴	PASS	PASS
Oxygen ⁵	- 0.4262	1.0249	%Vol	273K, 101.3 kPa, Dry Gas	0 – 17.47 %Vol	0 – 21.01 %Vol	PASS	PASS

The calibration function, once applied, only remains valid as long as the QAL3 data remains within control limits, and that there are no manual adjustments made to the CEMs other than those allowed to bring the settings back within QAL3 control limits (Annex A MID 14181, Appendix 1, TGN M20, Version 3 June 2015).⁶

The valid calibration range is from zero to the maximum calibrated CEM value at reference conditions during the QAL2 plus an extension of 10%, or 20% of the ELV whichever is greater (EN 14181: 2014, Section 6.5). Data from the AST may be used to extend the valid calibration range to the maximum measured CEM value at reference conditions from the AST plus an extensions of 10% provided that the range does not exceed 50% of the ELV.

³ Data from AST may be used to extend the valid calibration range to the maximum measured CEM value at reference conditions from the AST plus an extensions of 10% provided that the range does not exceed 50% of the ELV.

³ Reference material at zero and a concentration close to ELV shall be used for linear extrapolation providing that the deviation at the ELV is less than the maximum permissible uncertainty and the deviation at zero is less than 10% of the ELV (EN 14181: 2014, Section 6.5).

⁴ During the QAL2 an extrapolated calibration range was included for NO and CO on A1 that exceeded the ELV. This has since been removed for this AST as MID 14181 states that the calibration range may be extrapolated "to the ELV" (Section 6.5, MID 14181).

⁵ Default values of 10% for the 95% confidence interval and 21% for the ELV were used for oxygen in this QAL2 (MID 14181, section 6.3 iv, a.)

⁶ If exceedances of the valid calibration range are caused by plant failures, a new QAL2 is not needed after fixing the plant failure.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

BS EN 14181 Test Designation:		AST			Stack Designation:	A2 FB-001		
Determinands	Calibration Function		Units of Calibration Function	Conditions of Calibration Function	Valid Calibration Range Based on Calibrated CEMs Data (273K, 101.3 kPa, Dry Gas, 3% Oxygen) ⁷	Extrapolated Range Based on Reference Materials (From Previous QAL 2)	PASS / FAIL	
	<i>a</i>	<i>b</i>					Variability	Calibration Validation
Oxides of Nitrogen as (NO)	0.0091	0.9141	ppm	273K, 101.3 kPa, Dry Gas	0 – 51.32 mg/m ³	0 – 120.82 mg/m ³	PASS	PASS
Carbon Monoxide	0.1111	1.0552	ppm	273K, 101.3 kPa, Dry Gas	0 – 22.59 mg/m ³	0 – 87.50 mg/m ³	PASS	PASS
Oxygen ⁸	0.0098	0.9788	%Vol	273K, 101.3 kPa, Dry Gas	0 – 10.07 %Vol	0 – 20.49 %Vol	PASS	PASS

The calibration function, once applied, only remains valid as long as the QAL3 data remains within control limits, and that there are no manual adjustments made to the CEMs other than those allowed to bring the settings back within QAL3 control limits (Annex A MID 14181, Appendix 1, TGN M20, Version 3 June 2015). ⁹

The valid calibration range is from zero to the maximum calibrated CEM value at reference conditions during the QAL2 plus an extension of 10%, or 20% of the ELV whichever is greater (EN 14181: 2014, Section 6.5). Data from the AST may be used to extend the valid calibration range to the maximum measured CEM value at reference conditions from the AST plus an extensions of 10% provided that the range does not exceed 50% of the ELV.

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⁷ Reference material at zero and a concentration close to ELV shall be used for linear extrapolation providing that the deviation at the ELV is less than the maximum permissible uncertainty and the deviation at zero is less than 10% of the ELV (EN 14181: 2014, Section 6.5).

⁸ Default values of 10% for the 95% confidence interval and 21% for the ELV were used for oxygen in this QAL2 (MID 14181, section 6.3 iv, a.)

⁹ If exceedances of the valid calibration range are caused by plant failures, a new QAL2 is not needed after fixing the plant failure.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

BS EN 14181 Test Designation:		AST			Stack Designation:	A3 HR-001B		
Determinands	Calibration Function		Units of Calibration Function	Conditions of Calibration Function	Valid Calibration Range Based on Calibrated CEMs Data (273K, 101.3 kPa, Dry Gas, 15% Oxygen) ¹⁰	Extrapolated Range Based on Reference Materials (From Previous QAL 2)	PASS / FAIL	
	<i>a</i>	<i>b</i>					Variability	Calibration Validation
Oxides of Nitrogen as (NO)	- 1.5148	0.9849	ppm	273K, 101.3 kPa, Dry Gas	0 – 51.22 mg/m ³	... ¹¹	PASS	PASS
Carbon Monoxide	1.2686	0.8611	ppm	273K, 101.3 kPa, Dry Gas	0 – 15.95 mg/m ³	0 – 72.42 mg/m ³	PASS	PASS
Oxygen ¹²	- 0.1857	1.0149	%Vol	273K, 101.3 kPa, Dry Gas	0 – 17.86 %Vol	0 – 21.10 %Vol	PASS	PASS

The calibration function, once applied, only remains valid as long as the QAL3 data remains within control limits, and that there are no manual adjustments made to the CEMs other than those allowed to bring the settings back within QAL3 control limits (Annex A MID 14181, Appendix 1, TGN M20, Version 3 June 2015). ¹³

The valid calibration range is from zero to the maximum calibrated CEM value at reference conditions during the QAL2 plus an extension of 10%, or 20% of the ELV whichever is greater (EN 14181: 2014, Section 6.5). Data from the AST may be used to extend the valid calibration range to the maximum measured CEM value at reference conditions from the AST plus an extensions of 10% provided that the range does not exceed 50% of the ELV.

¹⁰ Data from AST may be used to extend the valid calibration range to the maximum measured CEM value at reference conditions from the AST plus an extensions of 10% provided that the range does not exceed 50% of the ELV.

¹⁰ Reference material at zero and a concentration close to ELV shall be used for linear extrapolation providing that the deviation at the ELV is less than the maximum permissible uncertainty and the deviation at zero is less than 10% of the ELV (EN 14181: 2014, Section 6.5).

¹¹ During the QAL2 an extrapolated calibration range was included for NO on A3 that exceeded the ELV. This has since been removed for this AST as MID 14181 states that the calibration range may be extrapolated "to the ELV" (Section 6.5, MID 14181).

¹² Default values of 10% for the 95% confidence interval and 21% for the ELV were used for oxygen in this QAL2 (MID 14181, section 6.3 iv, a.)

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Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

1.2 Details of Any Deviations from SRMs & EN 14181

Functional tests audit carried out by: (If elements of the tests were carried out by a third party)	Name: Not carried out, CEM supplier on-site prior to E.C.L. attendance. Linearity carried out by Sam Brookes (E.C.L.)	MCERTS No.: Sam Brookes = MM 06 775
Were there any deviations from SRMs?	NO – But note observations below	
Were there any deviations from EN14181?	YES	
Were there any corrective actions required?	YES	

Details of any Deviations from SRM – None but three observations noted below

Deviation	Reason for Deviation	Impact on Final Result?	Actions Required as a Result of Deviation?
Not a deviation from the SRM but please note that the ELVs have changed since the last report	New permit issued	Original QAL2 may not be valid due to the change however all parameters pass both the calibration validation and the variability tests using the new ELVs in the AST	None. Please note a new QAL2 is due next year
Not a deviation from the SRM but please note that the raw CEM reference conditions have changed since the last report	Raw conditions of CEM no longer has oxygen correction in place (noted as a deviation in previous AST reports) as it is now at STP Dry and in ppm	Original QAL2 may not be valid due to the change however all parameters pass both the calibration validation and the variability tests using the new raw reference conditions in the AST	None. Please note a new QAL2 is due next year
Not a deviation from the SRM but please note that the permit reference conditions have changed for A2 since the last report	A2 reference oxygen is now stated as 3% in new site permit, 15% was used in previous reports	Original QAL2 may not be valid due to the change however all parameters pass both the calibration validation and the variability tests using the amended oxygen reference conditions in the AST	None. Please note a new QAL2 is due next year

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

Details of any Deviations from EN 14181: 2014

Deviation	Reason for Deviation	Impact on Final Result?	Actions Required as a Result of Deviation?
Functional tests do not comply with requirements of Annex A, EN 14181: 2014	CEM supplier service report contains does not contain all the necessary details for the functional tests. There is limited or no information on the sampling system, serviceability, leak test, zero and span check, interferences and response time	Functional tests are a mandatory requirement of EN 14181 (Section 6.2). Please note that ECL carried out the linearity tests and comply with EN 14181. In addition, a QAL3 audit was carried out and is in compliance with EN 14181	Operator to investigate with CEM supplier to make sure that the service report meets the requirements outlined in Annex A of EN 14181. Recommend that a functional test audit is carried out when CEM supplier is on-site for future AST / QAL2s

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

2.0 INSTALLATION INFORMATION

2.1 Regulatory Information

2.1.1 Installation

Barry Cogeneration Plant

2.1.2 Address

Engie, Barry Cogeneration Plant, Barry Silicon Based Manufacturing Installation, Winbourne Road, Dock No.2, Barry, CF63 3DH.

2.1.3 Sector

WID (WID & LCPD have been recast within the Industrial Emissions Directive 2010/75/EU)

2.1.4 Date of the last QAL2 / AST

AST survey P2522 / R001 issued 12/11/2016

2.1.5 Regulated determinands and emissions limit values

Determinand	Emission Point	Short Term ELV ¹⁴	Daily ELV	Allowable Uncertainty ¹⁵
Oxides of Nitrogen ¹⁶ (NO and NO ₂ expressed as NO ₂)	A1 & A3	125 mg/m ³	125 mg/m ³	20%
Carbon Monoxide		80 mg/m ³	80 mg/m ³	* 10%
Oxides of Nitrogen ¹⁷ (NO and NO ₂ expressed as NO ₂)	A2	250 mg/m ³	250 mg/m ³	20%
Carbon Monoxide		200 mg/m ³	110 mg/m ³	* 10%

*** Please note: a 95% confidence interval of 20% may be used for CO for the test of variability (Section 8.5, MID 14181, TGN M20 Version 3).**

2.1.6 Permit Reference Number

EPR/JP3632ZH/V002

¹⁴ This is typically a 30 minute average or 1 hour average

¹⁵ This is expressed as a 95% confidence interval within WID or LCPD

¹⁶ CEM measures NO alone and therefore SRM measured NO only for the AST. NO equivalent ELV of 81.5 mg/m³ calculated from the ELV for Oxides of Nitrogen (NO and NO₂ expressed as NO₂) for use in the AST.

¹⁷ CEM measures NO alone and therefore SRM measured NO only for the AST. NO equivalent ELV of 163 mg/m³ calculated from the ELV for Oxides of Nitrogen (NO and NO₂ expressed as NO₂) for use in the AST.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

2.2 Operating Information and site monitoring-provisions

2.2.1.1 Process Details

Emission Point Reference	Date(s)	Process Type	Process ¹⁸ Duration	Load	Expected Variations in Emissions	Influence on sampling times
A1	23/08/2016	HRS	Continuous	70 MWth	Low but depends on steam demand, load may go up or down	Keep to 1 hour as done in original QAL2
A2	24/08/2016	HP Fired Boiler	Continuous	69 MWth		
A3	25/08/2016	HRS	Continuous	70 MWth		

Substance to be Monitored	Automatic CEM Zero & Span						
	Zero	¹⁹ Concentration	Span	Concentration	²⁰ Type	²¹ Frequency	Time(s)
Oxides of Nitrogen as (NO)	Y	Ambient Air	Y	197.9 ppm	Reference Gas	Monthly	Unknown, variable
Carbon Monoxide	Y	Ambient Air	Y	199.904 ppm	Reference Gas	Monthly	Unknown, variable
Oxygen (Dry)	Y	Ambient Air	Y	Ambient Air	Ambient Air	Monthly	Unknown, variable

¹⁸ Please state continuous or batch process

¹⁹ This value is typically zero, although for some analysers, it may be a low concentration value.

²⁰ Indicate reference gas, gas filled cell, filter, other (specify).

²¹ Indicate daily, fortnightly, monthly etc.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

2.2.1.2 Historical Data Analysis and Expected Process Variation

A1

Substance to be Monitored	Duration of Data Analysed (hours)	Daily ELV	Mean Hourly Averaged Value	Maximum Hourly Averaged Value	Minimum Hourly Averaged Value	Standard Deviation of Hourly Averaged Value	Are Emissions at or near zero (i.e. no more than 5% of the ELV)?	Notes
Oxides of Nitrogen as (NO)	6	²² 81.5 mg/m ³	60.98 mg/m ³	62.11 mg/m ³	59.95 mg/m ³	0.73 mg/m ³	NO	High level cluster
Carbon Monoxide		80 mg/m ³	5.03 mg/m ³	6.23 mg/m ³	4.56 mg/m ³	0.63 mg/m ³	NO	Close to 5% ELV, little variance
Oxygen		21 %Vol	8.77 %Vol	8.92 %Vol	8.61 %Vol	0.13 %Vol	NO	High level cluster

A2

Substance to be Monitored	Duration of Data Analysed (hours)	Daily ELV	Mean Hourly Averaged Value	Maximum Hourly Averaged Value	Minimum Hourly Averaged Value	Standard Deviation of Hourly Averaged Value	Are Emissions at or near zero (i.e. no more than 5% of the ELV)?	Notes
Oxides of Nitrogen as (NO)	6	¹⁹ 163 mg/m ³	59.13 mg/m ³	59.93 mg/m ³	57.47 mg/m ³	0.87 mg/m ³	NO	High level cluster
Carbon Monoxide		110 mg/m ³	41.04 mg/m ³	46.78 mg/m ³	36.54 mg/m ³	3.99 mg/m ³	NO	High level cluster
Oxygen		21 %Vol	11.11 %Vol	11.31 %Vol	10.82 %Vol	0.18 %Vol	NO	High level cluster

A3

Substance to be Monitored	Duration of Data Analysed (hours)	Daily ELV	Mean Hourly Averaged Value	Maximum Hourly Averaged Value	Minimum Hourly Averaged Value	Standard Deviation of Hourly Averaged Value	Are Emissions at or near zero (i.e. no more than 5% of the ELV)?	Notes
Oxides of Nitrogen as (NO)	6	¹⁹ 81.5 mg/m ³	65.14 mg/m ³	78.71 mg/m ³	52.05 mg/m ³	12.29 mg/m ³	NO	Procedure A
Carbon Monoxide		80 mg/m ³	13.57 mg/m ³	19.52 mg/m ³	2.82 mg/m ³	8.23 mg/m ³	NO	Procedure A
Oxygen		21 %Vol	12.91 %Vol	16.14 %Vol	8.05 %Vol	3.85 %Vol	NO	Procedure A

- Data for A1, A2 & A3 taken from 2015 AST. All data expressed at reference conditions 273K, 101.3kPa, Dry Gas & Oxygen Corrected (where applicable)

²² ELV for NO calculated from permit ELV for Oxides of Nitrogen (NO and NO₂ expressed as NO₂).

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

2.2.2 Fuel Details

Emission Point Reference	Date(s)	Primary Fuel	Typical Operating Hours on Primary Fuel (as % of Total)	Secondary Fuel	Typical Operating Hours on Secondary Fuel (as % of Total)	Emissions Profile for Secondary Fuel Significantly Different?	Independent AST Required?
A1	23/08/2016	Gas	>95 %	Fuel Oil	< 5%	NO	NO
A2	24/08/2016	Gas	>95 %	Fuel Oil	< 5%	NO	NO
A3	25/08/2016	Gas	>95 %	Fuel Oil	< 5%	NO	NO

2.2.3 Type of Abatement and Effect on Emissions

Emission Point Reference	Abatement (eg. ESP, Bag Filter etc)	Effect on Emissions (if none state 'None')
A1	NONE	NOT APPLICABLE
A2	NONE	NOT APPLICABLE
A3	NONE	NOT APPLICABLE

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

2.3 Monitoring provisions at the installation – Periodic Monitoring

2.3.1 Stack and Sampling Ports

HR-001A	A1
FB-001	A2
HR-001B	A3
Stack Shape	A1, A2 & A3 share a platform, see figure 1
Stack Shape	Circular
Dimensions (m)	A1 is 1.64m, A2 is 1.59m & A3 is 1.58m
Number of Sampling Ports	2 per stack
Orientation of sampling ports	90 degrees
Height of Ports from Sampling Platform (m)	1m
Sample platform width back from the sample port (m)	1m
Height of Platform from Ground Level (m)	11.9m
Details of access to sampling platform	Two vertical ladders A1, A2 & A3 share one common platform

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

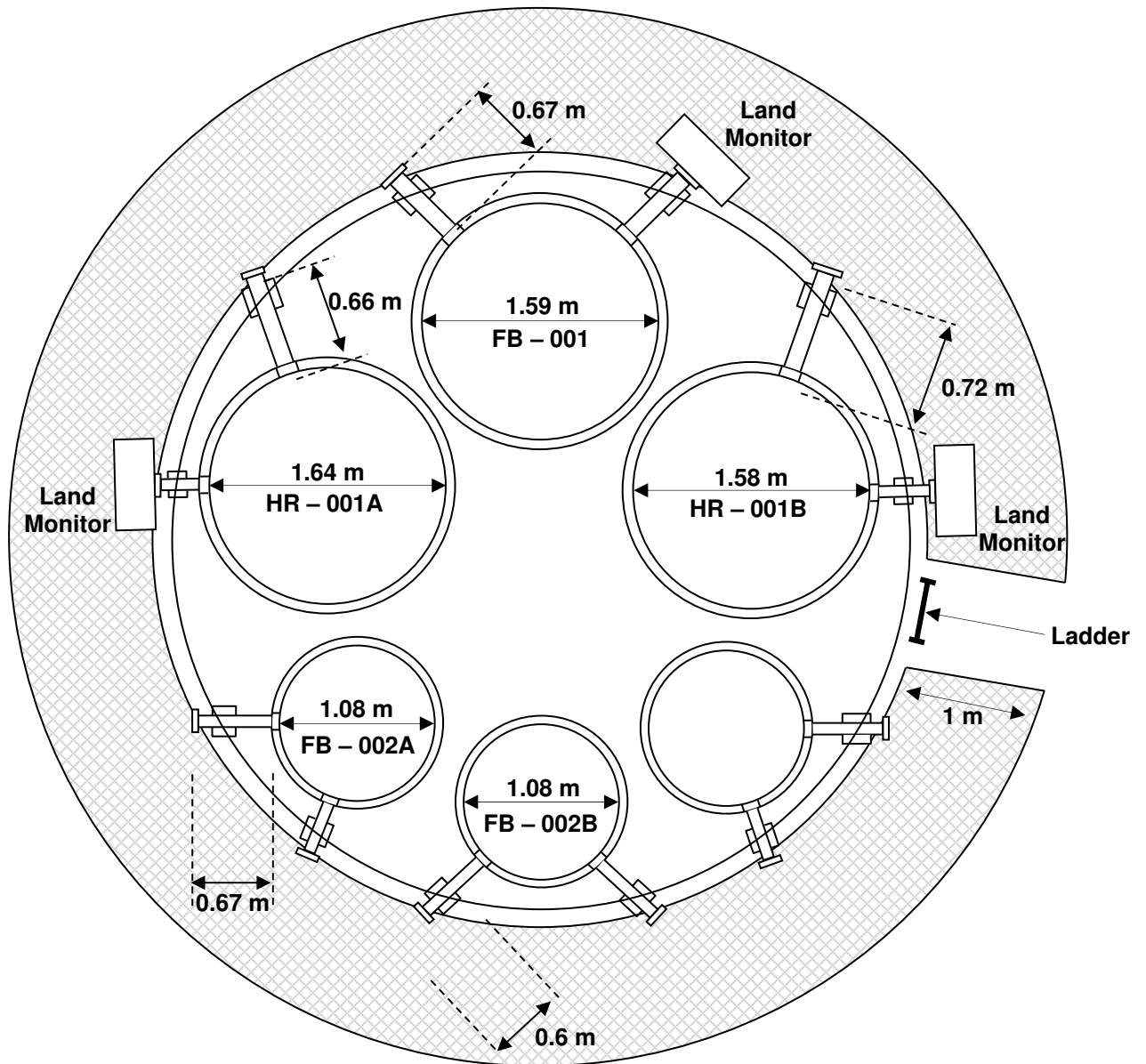


Figure 1. Diagram of sampling location

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

2.3.2 Monitoring platform and site-provisions inc. details on grid sampling

Test Component	Yes	No	Notes
Safe and clean working environment with sufficient space and weather protection?	✓		CEMs on platform but all weather protected
Easy and safe access to all elements of the CEM?	✓		Vertical ladders give access to permanent platform from which the CEM can be reached. CEM is weather protected but platform is open to the elements
Adequate supplies of reference materials, tools and spare parts?	✓		Available in office but also CEM supplier can be called out if required
Are there facilities to introduce the reference materials for gaseous-monitoring systems, both at the inlet of the sampling line (where present), and at the inlet of the CEM?	✓		Lines running up from ground level and CEM can also be accessed on the platform to introduce calibration gases
Does the sampling platform currently meet the requirements detailed in <i>Technical Guidance Note (Monitoring) M1 "Sampling requirements for stack-emission monitoring" Environment Agency and MID 15259</i> ?	✓		Small platform dimensions but sufficient space for combustion gas sampling
Has homogeneity at the sample plane been determined to EN 15259 for all measured components? If yes, state date and report reference in 'Notes'. If no, is the stack exempt due to small dimensions (diameter <1.13m or stack area <1m ²)?	✓		See report JCC7671/R/10/81184/05
If homogeneity has not been determined, and the stack is not exempt, was grid sampling undertaken? If no, detail the reasons in 'Notes'.	N/A		Not applicable
Ratio of highest to lowest flowrates (if applicable)	N/A		Not applicable

Engie
 Permit No : EPR/IP3632ZH
 Variation No : EPR/IP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

2.4 Continuous Emission Monitoring Systems (CEMs) at the Installation

2.4.1 Details of CEM for each Regulated Determinand

Substance to be monitored	Instrument					Instrument Auto - Calibration ²³		Upper limit of		Minimum Certified Range Meets QAL1 Multiplier Rule? ²⁴
	Location of CEM Sampling and Measurement	Type ²⁵	Brand	Model	Measurement Principle	Zero	Span	Certified Range	Operational Range	
Oxides of Nitrogen as (NO)	All CEM probes and analysers housed on shared permanent platform for A1, A2 & A3 accessed via vertical ladders	Extractive	LAND	FGA950E	Electrochemical Cell	Yes	Yes	0 – 200 mg/m ³	0 – 400 mg/m ³	Yes
Carbon Monoxide		Extractive	LAND	FGA950E	Electrochemical Cell	Yes	Yes	0 – 150 mg/m ³	0 – 300 mg/m ³	Yes

2.4.2 Details of CEM for each Peripheral Determinand

Substance to be monitored	Measured & Recorded?	Instrument				Instrument Auto - Calibration ²³		Upper limit of	
		Type	Brand	Model	Measurement Principle	Zero	Span	Certified Range	Operational Range
Oxygen (Dry)	Yes	Extractive	LAND	FGA950E	Electrochemical Cell	Yes	Yes	0 – 12 %Vol	0 – 25 %Vol
Oxygen (Wet)	No	Not applicable							
Moisture	No								
Temperature	No								
Pressure	No								

²³ Measured data pairs recorded during automatic zero and span operations are not included in the valid time averaged data used to calculate the QAL2 calibration function.

²⁴ Typically, minimum certified range should not exceed 1.5 X Daily ELV for WID sites and 2.5 X Daily ELV for LCPD sites. (LCPD and WID have been recast within the Industrial Emissions Directive 2010/75/EU)

²⁵ E.g. cross-duct, in-situ or extractive.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

3.0 Monitoring Campaign

3.1 Site Team Details

Name	Dates on Site	MCERTS Number	LEVEL	TE	Expiry Date
David Boles	22 – 25/08/2016	MM 03 215	2	TE1	30.09.18
				TE2	31.03.20
				TE3	30.09.17
				TE4	30.06.19

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

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):- VOCs, CO, NOx, SO₂, O₂.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

3.2 Standard Reference Methods (SRMs)

Determinand	Instrument	Measurement Principle	SRM Standard	Operational Range	Minimum Certified Range	Expanded Uncertainty @ 95% Confidence	UKAS Accreditation For Method?	Tick if non-conforming test (see Section 1C)
Oxides of Nitrogen (as NO)	Horiba PG 350	Chemiluminescence	BS EN 14792: 2005		0 – 134 mg/m ³ (as NO _x)	²⁶ 3%	YES	
Carbon Monoxide	Horiba PG 350	NDIR	BS EN 15058: 2006		0 – 75 mg/m ³	²⁷ 4%	YES	
Oxygen	Horiba PG 350	Paramagnetic	BS EN 14789:2005		0 – 10 % Vol	²⁸ 5%	YES	

Stand-alone velocity measurements and those made to support isokinetic sampling after 01/01/2015 are conducted using BS EN 16911-1:2013 & MID

²⁶ Based on an applied span of 123 mg/m³ at 273K, 101.3 kPa, Dry Gas.

²⁷ Based on an applied span of 75 mg/m³ at 273K, 101.3 kPa, Dry Gas.

²⁸ Based on an applied span of 14.97%Vol at 273K, 101.3 kPa, Dry Gas.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

3.3 Introduction

Environmental Compliance Ltd (ECL) was commissioned by **Engie** to undertake an Annual Surveillance Test (AST) on the CHP of their plant located at **Barry Cogeneration Plant, Barry Silicon Based Manufacturing Installation, Winbourne Road, Dock No.2, Barry, CF63 3DH**. This report presents the findings of the study.

The AST testing was carried out by the site sampling team detailed in the table below at the request of **Mr. Paul Gardner** in accordance with quotation reference **DHFB/P2897/Q001**.

Report Reviewer

Name	MCERTS Number	LEVEL	TE	Expiry Date
David Boles	MM 03 215	2	TE1	30.09.18
			TE2	31.03.20
			TE3	30.09.17
			TE4	30.06.19

Technical Endorsement Key:-

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

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):- VOCs, CO, NOx, SO₂, O₂.

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

3.4 Objectives

The objective of the survey was to record parallel measurements of the concentrations of pollutants from the processes / locations, as detailed in the Executive Summary, using the in-situ Continuous Emissions Monitoring System (CEM) and a suitable Standard Reference Method (SRM).

Sampling is carried out over a minimum of 1 day with the sampling period spread evenly over the entire test day. Typically, a minimum of eight hours of data is collected over the test day unless limited by the process duration.

Parallel measurements made for the purpose of AST testing were subsequently analysed in accordance with the requirements of BS EN 14181: 2014 and the Environment Agency's Technical Guidance Note M20 in order to determine the ongoing validity of the calibration function and valid calibration range, derived during the previous QAL2, for each measured determinand.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

3.5 Sampling Protocols / Methodologies

Any required modifications to the Technical Procedure Documents (TPDs) specified below will be detailed in section 1C of this report.

3.5.1 Combustion Gases (NO, CO & O₂)

Measurements of combustion gases were carried out using an MCERTS Certified Horiba PG 350 stack analyser. Continuous monitoring of emissions was undertaken over each test period recording minute averaged data (one measurement every 60 seconds). The measurement techniques for each determinand are as follows:

<u>Determinand</u>	<u>Technique</u>	<u>SRM</u>
• NO	Chemiluminescence	BS EN 14792: 2005
• CO	Non dispersive infrared	BS EN 15058: 2006
• O ₂	Galvanic	BS EN 14789: 2005

The analyser was set up with reference to the manufacturer's operator handbook and the in-house technical procedure **ECL/TPD/033d**. The analyser was calibrated on site using certified gases which are traceable to ISO 17025 (with uncertainty <2%). Zero measurements were performed using Nitrogen. The analyser was calibrated directly into the sample inlet and then checked through the entire sampling system (including sampling probe, heated & unheated gas transport lines and gas drying/ conditioning system).

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

4B MONITORING DATA & CALCULATIONS

A1

B4.1a & B4.2a

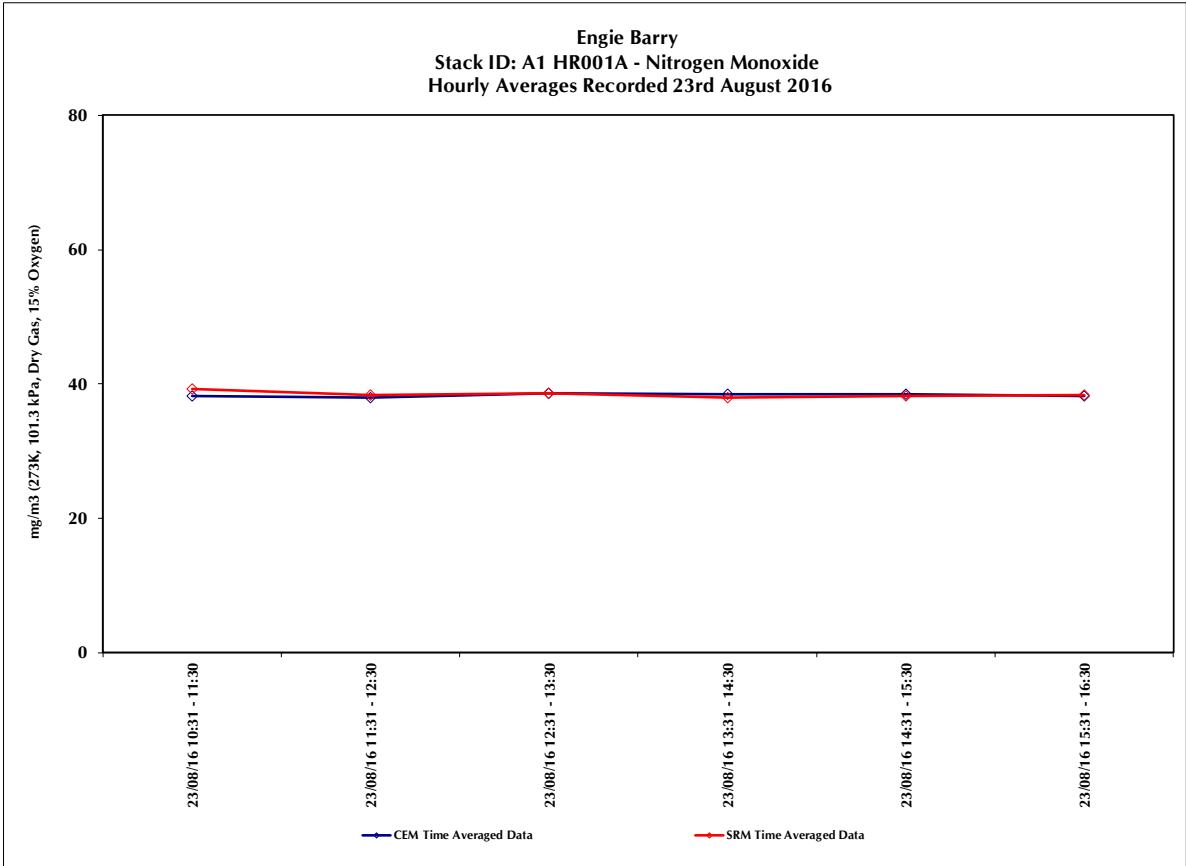
Incorporating: Table 4.1 Raw Monitoring Data & Table 4.2 Standardised Monitoring Data for NO

Raw Monitoring CEM Data							Standardised Data
Date	Time	CEM Hourly averages ppm Uncalibrated ⁽¹⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	CEM Hourly averages mg/m ³ Uncalibrated ⁽²⁾
23/08/2016	10:31 - 11:30	55.26	-	-	-	9.50	38.29
23/08/2016	11:31 - 12:30	53.06	-	-	-	9.87	37.99
23/08/2016	12:31 - 13:30	56.59	-	-	-	9.34	38.69
23/08/2016	13:31 - 14:30	55.50	-	-	-	9.51	38.48
23/08/2016	14:31 - 15:30	62.70	-	-	-	8.05	38.55
23/08/2016	15:31 - 16:30	62.52	-	-	-	7.99	38.26
(1) CEM data conditions: 273K, 101.3 kPa, Dry Gas							
(2) CEM data conditions: 273K, 101.3 kPa, Dry Gas, 15% Oxygen							
Raw Monitoring SRM Data							Standardised Data
Date	Time	SRM Hourly averages ppm ⁽³⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	SRM Hourly averages mg/m ³ ⁽⁴⁾
23/08/2016	10:31 - 11:30	57.25	-	-	-	9.39	39.28
23/08/2016	11:31 - 12:30	54.28	-	-	-	9.73	38.39
23/08/2016	12:31 - 13:30	57.49	-	-	-	9.13	38.58
23/08/2016	13:31 - 14:30	56.08	-	-	-	9.25	38.01
23/08/2016	14:31 - 15:30	63.58	-	-	-	7.76	38.22
23/08/2016	15:31 - 16:30	63.88	-	-	-	7.73	38.31
(3) SRM data conditions: 273K, 101.3 kPa, Dry Gas							
(4) SRM data conditions: 273K, 101.3 kPa, Dry Gas, 15% Oxygen							

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

B4.3a
Plot 1 - Time Series Plot of Standardised Time Averaged SRM/CEM Monitoring Data Pairs for NO



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.4a**Calculation and procedure – Elimination of outliers for NO**

Please note: Only those averages separated by at least 1 hour have been carried forward to the outlier test. After removal of any outliers, highlighted as “outlier” below, all other averages, highlighted as “yes” below, will be taken forward to the calibration coefficient validation.

n	Date	Time	SRM ppm	CEM ppm	$ D_i $	$ D_i - \bar{D}_i $	$ D_i - \bar{D}_i < 2\sigma?$
1	23/08/2016	10:31 - 11:30	57.25	55.26	1.99	0.83	YES
2	23/08/2016	11:31 - 12:30	54.28	53.06	1.22	0.07	YES
3	23/08/2016	12:31 - 13:30	57.49	56.59	0.89	0.26	YES
4	23/08/2016	13:31 - 14:30	56.08	55.50	0.58	0.57	YES
5	23/08/2016	14:31 - 15:30	63.58	62.70	0.89	0.27	YES
6	23/08/2016	15:31 - 16:30	63.88	62.52	1.36	0.21	YES

Slope	0.99	Mean	1.16
Intercept	1.94	Stdev	0.4911
R ²	0.99		

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.5a**Table 4.3 – data used to calculate calibrated values for NO**

QAL2 Calibration function: $y=1.0056x-0.9335$								Standardised Data	
Date	Time	CEM Hourly averages ppm Uncalibrated ⁽¹⁾	CEM Hourly averages ppm Calibrated ⁽¹⁾	CEM Temp (K)	CEM Pressure (kPa)	CEM Moisture (%)	CEM Oxygen (%) Dry	CEM Hourly averages mg/m ³ Calibrated ⁽²⁾	SRM Hourly averages mg/m ³ ⁽²⁾
23/08/2016	10:31 - 11:30	55.26	54.64	-	-	-	9.50	37.86	39.28
23/08/2016	11:31 - 12:30	53.06	52.42	-	-	-	9.87	37.54	38.39
23/08/2016	12:31 - 13:30	56.59	55.98	-	-	-	9.34	38.27	38.58
23/08/2016	13:31 - 14:30	55.50	54.88	-	-	-	9.51	38.05	38.01
23/08/2016	14:31 - 15:30	62.70	62.11	-	-	-	8.05	38.19	38.22
23/08/2016	15:31 - 16:30	62.52	61.93	-	-	-	7.99	37.90	38.31

(1) 273K, 101.3 kPa, Dry Gas

(2) 273K, 101.3 kPa, Dry Gas, 15% Oxygen

B4.6a & B4.7a

Incorporating: Table 4.5 – Data used for the variability test & Calculation – the variability test and the acceptance test for NO

Determinand: Nitrogen Monoxide						QAL2 Calibration function: y=1.0056x-0.9335		
CEM Measured mg/m³	SRM Measured mg/m³	Calibrated CEM mg/m³	SRM Measured @ Reference conditions mg/m³	CEM Measured @ Reference conditions mg/m³	Calibrated CEM @ Reference Conditions mg/m³	Residual Value	Deviation of Residual from Mean	
x_i	y_i	$\hat{y}_i$	$y_{i,s}$	$x_{i,s}$	$\hat{y}_{i,s}$	$D_i = (y_{i,s} - \hat{y}_{i,s})$	$(D_i - \overline{D})$	$(D_i - \overline{D})^2$
74.00	76.66	73.16	39.28	38.29	37.86	1.42	0.93	0.858
71.04	72.68	70.19	38.39	37.99	37.54	0.85	0.35	0.123
75.78	76.97	74.95	38.58	38.69	38.27	0.31	-0.19	0.036
74.31	75.09	73.48	38.01	38.48	38.05	-0.03	-0.53	0.282
83.95	85.14	83.17	38.22	38.55	38.19	0.03	-0.47	0.218
83.71	85.54	82.93	38.31	38.26	37.90	0.41	-0.09	0.01
Sum						2.99	0.00	1.53
$\overline{D} = \frac{1}{N} \sum_{i=1}^N D_i = 0.50$								
$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \overline{D})^2} = \text{SQRT}(0.31) = 0.55$								
$\begin{aligned} N &= 6 \\ K_v &= 0.93 \\ p &= 20 \\ E &= 82 \end{aligned}$								
$\sigma_0 = \frac{pE}{1.96} = 8.32$								
$1.5\sigma_0 k_v = 11.64$								
$S_D \leq 1.5\sigma_0 k_v = 0.55 \text{ mg/m}^3 < 11.64 \text{ mg/m}^3 - \text{Pass Variability Test}$								
$t_{0.95}(N-1) = 2.13$								
$t_{0.95}(N-1) \frac{S_D}{\sqrt{N}} + \sigma_0 = 8.80$								
$ \overline{D} \quad 0.5\text{mg/m}^3 < 8.8\text{mg/m}^3 - \text{Calibration Remains Valid}$								

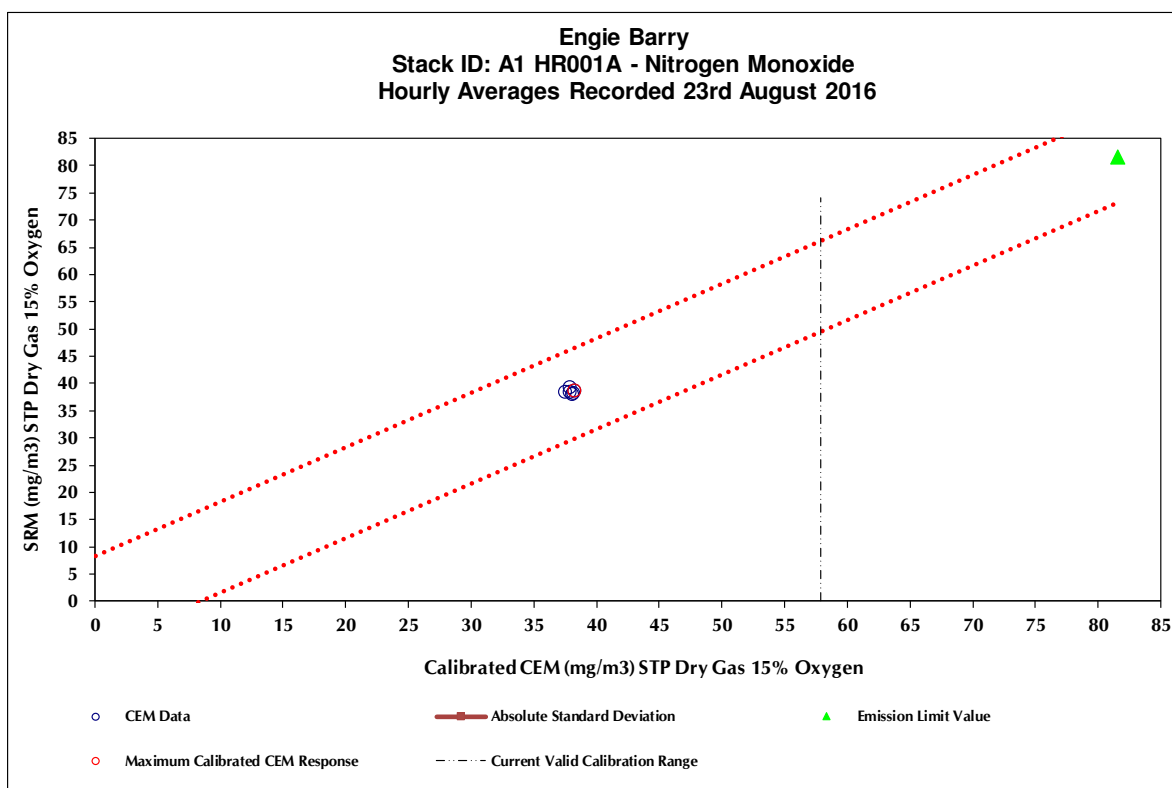
Reference Conditions 273K, 101.3 kPa, Dry Gas, 15% Oxygen

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.8a

Plot 2 – X-Y Plot of Standardised SRM Data Versus Standardised CEM Data for NO



B4.9a

Summary of the Valid Calibration Range for NO

Summary of Valid Calibration Range

Slope:	1.0056	...
Intercept:	-0.9335	mg/m ³
Daily ELV	81.52	mg/m ³
Allowable 95% Confidence Interval	± 8.32	mg/m ³
Upper Limit of Current Valid Calibration Range	57.88	mg/m ³
Maximum Calibrated CEM @ Reference Conditions	38.27	mg/m ³
Corresponding SRM @ Reference Conditions	38.58	mg/m ³
Allowable Range for Calibrated CEM Response i.e. SRM Concentration ± 8.32%	30.26 - 46.89	mg/m ³
Calibrated Value of CEM Response Falls Within Allowable Range?	YES	...
Maximum Calibrated CEM @ Reference Conditions plus 10% extension < 50% ELV?	N/A	...
Extended Valid Calibration Range	N/A	mg/m ³

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.1b & B4.2b**Incorporating: Table 4.1 Raw Monitoring Data & Table 4.2 Standardised Monitoring Data for CO**

Raw Monitoring CEM Data							Standardised Data
Date	Time	CEM Hourly averages ppm Uncalibrated ⁽¹⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	CEM Hourly averages mg/m ³ Uncalibrated ⁽²⁾
23/08/2016	10:31 - 11:30	1.69	-	-	-	9.50	1.09
23/08/2016	11:31 - 12:30	4.08	-	-	-	9.87	2.72
23/08/2016	12:31 - 13:30	2.03	-	-	-	9.34	1.30
23/08/2016	13:31 - 14:30	3.66	-	-	-	9.51	2.37
23/08/2016	14:31 - 15:30	1.08	-	-	-	8.05	0.62
23/08/2016	15:31 - 16:30	1.25	-	-	-	7.99	0.71

(1) CEM data conditions: 273K, 101.3 kPa, Dry Gas

(2) CEM data conditions: 273K, 101.3 kPa, Dry Gas, 15% Oxygen

Raw Monitoring SRM Data							Standardised Data
Date	Time	SRM Hourly averages ppm ⁽³⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	SRM Hourly averages mg/m ³ ⁽⁴⁾
23/08/2016	10:31 - 11:30	2.92	-	-	-	9.39	1.87
23/08/2016	11:31 - 12:30	5.14	-	-	-	9.73	3.39
23/08/2016	12:31 - 13:30	1.65	-	-	-	9.13	1.04
23/08/2016	13:31 - 14:30	3.08	-	-	-	9.25	1.95
23/08/2016	14:31 - 15:30	-0.54	-	-	-	7.76	-0.30
23/08/2016	15:31 - 16:30	-0.62	-	-	-	7.73	-0.35

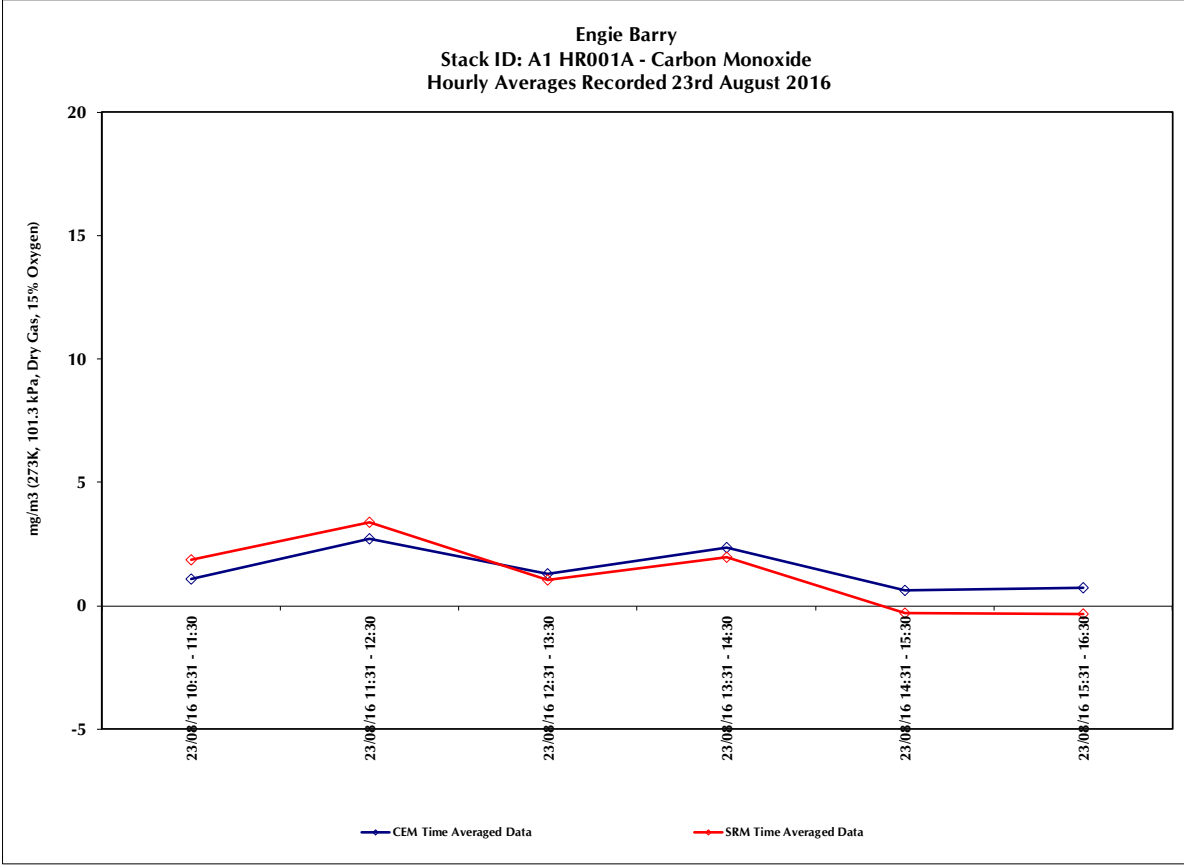
(3) SRM data conditions: 273K, 101.3 kPa, Dry Gas

(4) SRM data conditions: 273K, 101.3 kPa, Dry Gas, 15% Oxygen

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

B4.3b
Plot 1 - Time Series Plot of Standardised Time Averaged SRM/CEM Monitoring Data Pairs for CO



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.4b**Calculation and procedure – Elimination of outliers for CO**

Please note: Only those averages separated by at least 1 hour have been carried forward to the outlier test. After removal of any outliers, highlighted as “outlier” below, all other averages, highlighted as “yes” below, will be taken forward to the calibration coefficient validation.

n	Date	Time	SRM ppm	CEM ppm	$ D_i $	$ D_i - \bar{D}_i $	$ D_i - \bar{D}_i < 2\sigma?$
1	23/08/2016	10:31 - 11:30	2.92	1.69	1.23	1.59	YES
2	23/08/2016	11:31 - 12:30	5.14	4.08	1.06	1.42	YES
3	23/08/2016	12:31 - 13:30	1.65	2.03	-0.38	0.02	YES
4	23/08/2016	13:31 - 14:30	3.08	3.66	-0.58	0.22	YES
5	23/08/2016	14:31 - 15:30	-0.54	1.08	-1.63	1.27	YES
6	23/08/2016	15:31 - 16:30	-0.62	1.25	-1.86	1.50	YES

Slope	1.54	Mean	-0.36
Intercept	-1.61	Stdev	1.3019
R ²	0.76		

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.5b**Table 4.3 – data used to calculate calibrated values for CO**

QAL2 Calibration function: $y=1.0096x+0.3218$								Standardised Data	
Date	Time	CEM Hourly averages ppm Uncalibrated ⁽¹⁾	CEM Hourly averages ppm Calibrated ⁽¹⁾	CEM Temp (K)	CEM Pressure (kPa)	CEM Moisture (%)	CEM Oxygen (%) Dry	CEM Hourly averages mg/m ³ Calibrated ⁽²⁾	SRM Hourly averages mg/m ³ ⁽²⁾
23/08/2016	10:31 - 11:30	1.69	2.03	-	-	-	9.50	1.31	1.87
23/08/2016	11:31 - 12:30	4.08	4.44	-	-	-	9.87	2.97	3.39
23/08/2016	12:31 - 13:30	2.03	2.37	-	-	-	9.34	1.52	1.04
23/08/2016	13:31 - 14:30	3.66	4.02	-	-	-	9.51	2.60	1.95
23/08/2016	14:31 - 15:30	1.08	1.42	-	-	-	8.05	0.81	-0.30
23/08/2016	15:31 - 16:30	1.25	1.58	-	-	-	7.99	0.90	-0.35

(1) 273K, 101.3 kPa, Dry Gas

(2) 273K, 101.3 kPa, Dry Gas, 15% Oxygen

B4.6b & B4.7b

Incorporating: Table 4.5 – Data used for the variability test & Calculation – the variability test and the acceptance test for CO

Determinand: Carbon Monoxide					QAL2 Calibration function: y=1.0096x+0.3218			
CEM Measured mg/m ³	SRM Measured mg/m ³	Calibrated CEM mg/m ³	SRM Measured @ Reference conditions mg/m ³	CEM Measured @ Reference conditions mg/m ³	Calibrated CEM @ Reference Conditions mg/m ³	Residual Value	Deviation of Residual from Mean	
x_i	y_i	$\hat{y}_i$	$y_{i,s}$	$x_{i,s}$	$\hat{y}_{i,s}$	$D_i = (y_{i,s} - \hat{y}_{i,s})$	$(D_i - \overline{D})$	$(D_i - \overline{D})^2$
2.11	3.66	2.54	1.87	1.09	1.31	0.56	0.98	0.959
5.09	6.42	5.54	3.39	2.72	2.97	0.43	0.84	0.713
2.54	2.07	2.97	1.04	1.30	1.52	-0.48	-0.06	0.004
4.58	3.85	5.03	1.95	2.37	2.60	-0.65	-0.23	0.055
1.35	-0.68	1.77	-0.30	0.62	0.81	-1.12	-0.70	0.488
1.56	-0.77	1.98	-0.35	0.71	0.90	-1.25	-0.83	0.69
Sum						-2.51	0.00	2.91
$\overline{D} = \frac{1}{N} \sum_{i=1}^N D_i = -0.42$								
$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \overline{D})^2} = \text{SQRT}(0.58) = 0.76$								
$N = 6$								
$K_v = 0.93$								
$p = 20$								
$E = 80$								
$\sigma_0 = \frac{pE}{1.96} = 8.16$								
$1.5\sigma_0 k_v = 11.42$								
$s_D \leq 1.5\sigma_0 k_v = 0.76 \text{ mg/m}^3 < 11.42 \text{ mg/m}^3 - \text{Pass Variability Test}$								
$t_{0.95}(N-1) = 2.13$								
$t_{0.95}(N-1) \frac{S_D}{\sqrt{N}} + \sigma_0 = 8.83$								
$ \overline{D} \quad 0.42\text{mg/m}^3 < 8.83\text{mg/m}^3 - \text{Calibration Remains Valid}$								

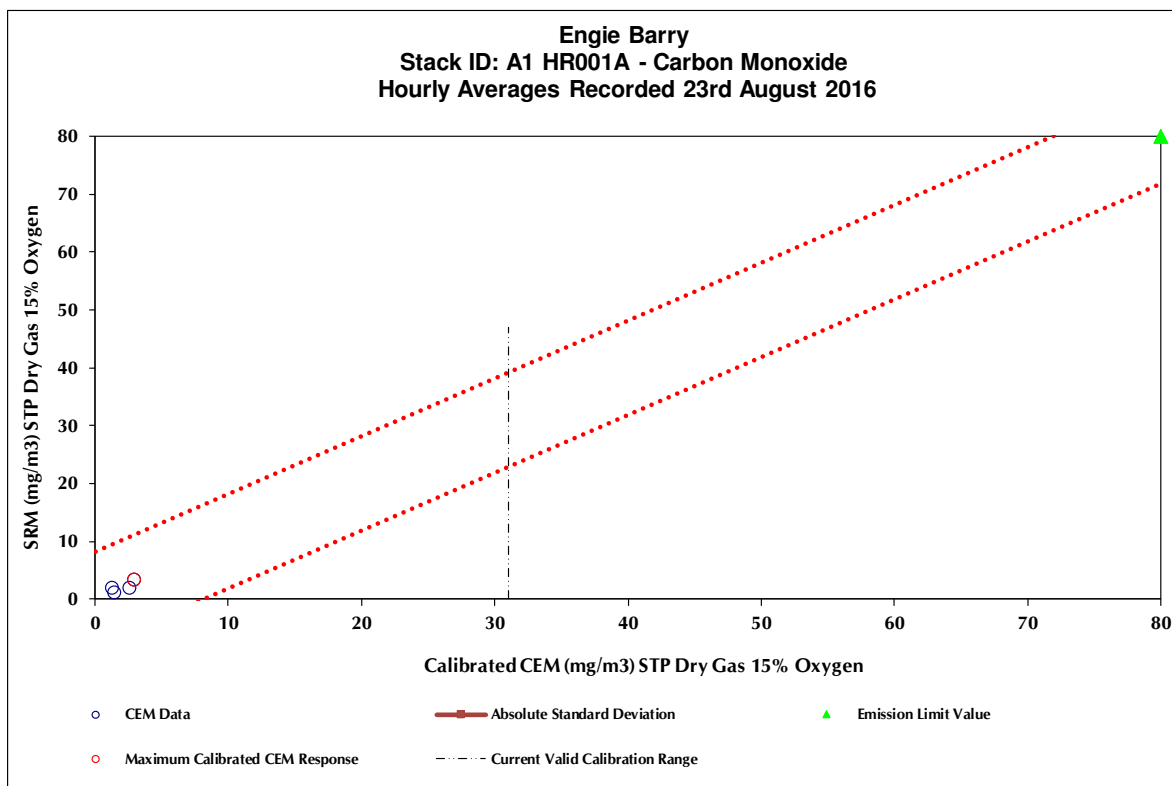
Reference Conditions 273K, 101.3 kPa, Dry Gas, 15% Oxygen

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.8b

Plot 2 – X-Y Plot of Standardised SRM Data Versus Standardised CEM Data for CO



B4.9b

Summary of the Valid Calibration Range for CO

Summary of Valid Calibration Range

Slope:	1.0096	...
Intercept:	0.3218	mg/m ³
Daily ELV	80.00	mg/m ³
Allowable 95% Confidence Interval	± 8.16	mg/m ³
Upper Limit of Current Valid Calibration Range	31.01	mg/m ³
Maximum Calibrated CEM @ Reference Conditions	2.97	mg/m ³
Corresponding SRM @ Reference Conditions	3.39	mg/m ³
Allowable Range for Calibrated CEM Response i.e. SRM Concentration ± 8.16%	-4.77 - 11.55	mg/m ³
Calibrated Value of CEM Response Falls Within Allowable Range?	YES	...
Maximum Calibrated CEM @ Reference Conditions plus 10% extension < 50% ELV?	N/A	...
Extended Valid Calibration Range	N/A	mg/m ³

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.1c & B4.2c

Incorporating: Table 4.1 Raw Monitoring Data & Table 4.2 Standardised Monitoring Data for O₂

Raw Monitoring CEM Data							Standardised Data
Date	Time	CEM Hourly averages %Vol Uncalibrated ⁽¹⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	CEM Hourly averages %Vol Uncalibrated ⁽²⁾
23/08/2016	10:31 - 11:30	9.50	-	-	-	-	9.50
23/08/2016	11:31 - 12:30	9.87	-	-	-	-	9.87
23/08/2016	12:31 - 13:30	9.34	-	-	-	-	9.34
23/08/2016	13:31 - 14:30	9.51	-	-	-	-	9.51
23/08/2016	14:31 - 15:30	8.05	-	-	-	-	8.05
23/08/2016	15:31 - 16:30	7.99	-	-	-	-	7.99

(1) CEM data conditions: 273K, 101.3 kPa, Dry Gas

(2) CEM data conditions: 273K, 101.3 kPa, Dry Gas, Stack Oxygen

Raw Monitoring SRM Data							Standardised Data
Date	Time	SRM Hourly averages %Vol ⁽³⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	SRM Hourly averages %Vol ⁽⁴⁾
23/08/2016	10:31 - 11:30	9.39	-	-	-	-	9.39
23/08/2016	11:31 - 12:30	9.73	-	-	-	-	9.73
23/08/2016	12:31 - 13:30	9.13	-	-	-	-	9.13
23/08/2016	13:31 - 14:30	9.25	-	-	-	-	9.25
23/08/2016	14:31 - 15:30	7.76	-	-	-	-	7.76
23/08/2016	15:31 - 16:30	7.73	-	-	-	-	7.73

(3) SRM data conditions: 273K, 101.3 kPa, Dry Gas

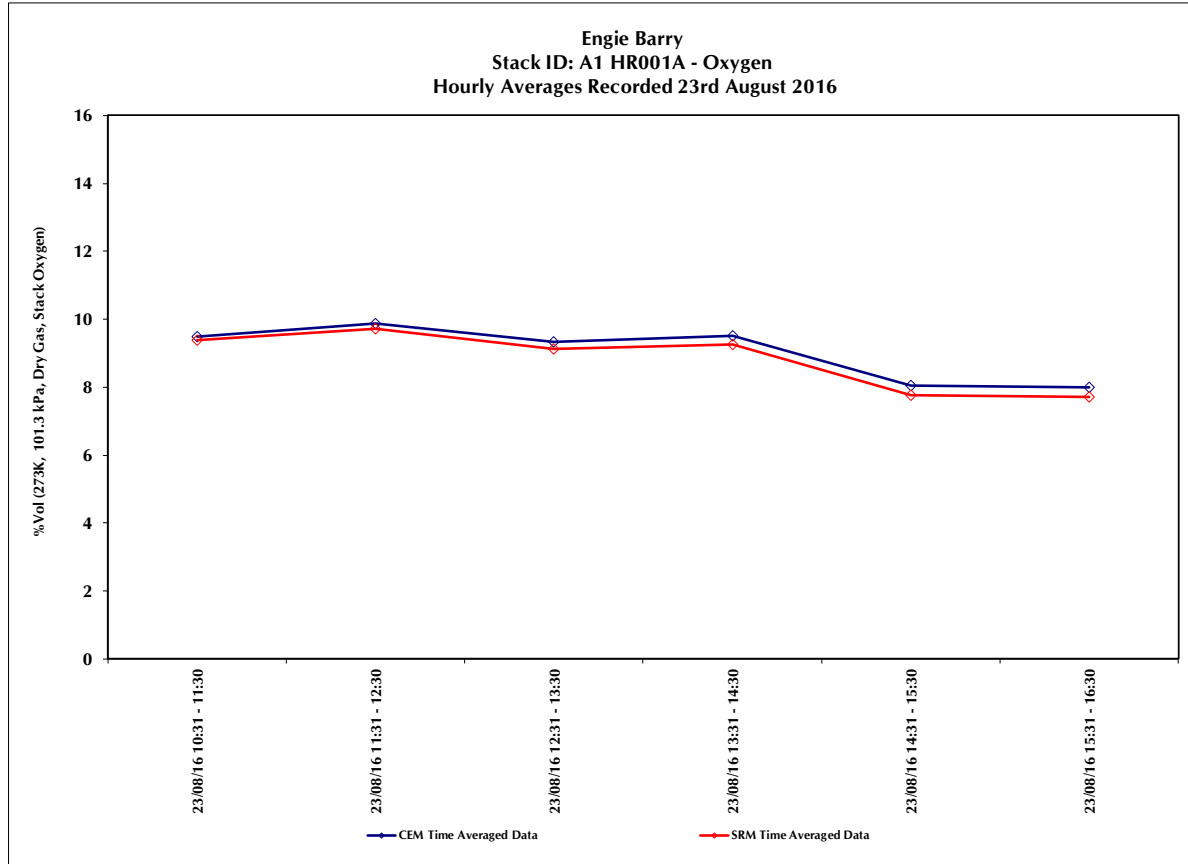
(4) SRM data conditions: 273K, 101.3 kPa, Dry Gas, Stack Oxygen

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.3c

Plot 1 - Time Series Plot of Standardised Time Averaged SRM/CEM Monitoring Data Pairs for O2



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.4c**Calculation and procedure – Elimination of outliers for O2**

Please note: Only those averages separated by at least 1 hour have been carried forward to the outlier test. After removal of any outliers, highlighted as “outlier” below, all other averages, highlighted as “yes” below, will be taken forward to the calibration coefficient validation.

n	Date	Time	SRM % Vol	CEM % Vol	$ D_i $	$ D_i - \bar{D}_i $	$ D_i - \bar{D}_i < 2\sigma?$
1	23/08/2016	10:31 - 11:30	9.39	9.50	-0.11	0.10	YES
2	23/08/2016	11:31 - 12:30	9.73	9.87	-0.14	0.08	YES
3	23/08/2016	12:31 - 13:30	9.13	9.34	-0.22	0.00	YES
4	23/08/2016	13:31 - 14:30	9.25	9.51	-0.26	0.05	YES
5	23/08/2016	14:31 - 15:30	7.76	8.05	-0.29	0.08	YES
6	23/08/2016	15:31 - 16:30	7.73	7.99	-0.26	0.05	YES

Slope	1.07	Mean	-0.21
Intercept	-0.82	Stdev	0.0738
R ²	1.00		

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.5c**Table 4.3 – data used to calculate calibrated values for O2**

QAL2 Calibration function: $y=1.0249x-0.4262$								Standardised Data	
Date	Time	CEM Hourly averages %Vol Uncalibrated ⁽¹⁾	CEM Hourly averages %Vol Calibrated ⁽¹⁾	CEM Temp (K)	CEM Pressure (kPa)	CEM Moisture (%)	CEM Oxygen (%) Dry	CEM Hourly averages %Vol Calibrated ⁽²⁾	SRM Hourly averages %Vol ⁽²⁾
23/08/2016	10:31 - 11:30	9.50	9.31	-	-	-	-	9.31	9.39
23/08/2016	11:31 - 12:30	9.87	9.69	-	-	-	-	9.69	9.73
23/08/2016	12:31 - 13:30	9.34	9.15	-	-	-	-	9.15	9.13
23/08/2016	13:31 - 14:30	9.51	9.32	-	-	-	-	9.32	9.25
23/08/2016	14:31 - 15:30	8.05	7.83	-	-	-	-	7.83	7.76
23/08/2016	15:31 - 16:30	7.99	7.76	-	-	-	-	7.76	7.73

(1) 273K, 101.3 kPa, Dry Gas

(2) 273K, 101.3 kPa, Dry Gas, Stack Oxygen

B4.6c & B4.7c

Incorporating: Table 4.5 – Data used for the variability test & Calculation – the variability test and the acceptance test for O2

Determinand: Oxygen						QAL2 Calibration function: y=1.0249x-0.4262			
CEM Measured %Vol	SRM Measured %Vol	Calibrated CEM %Vol	SRM Measured @ Reference conditions %Vol	CEM Measured @ Reference conditions %Vol	Calibrated CEM @ Reference Conditions %Vol	Residual Value	Deviation of Residual from Mean		
x_i	y_i	$\hat{y}_i$	$y_{i,s}$	$x_{i,s}$	$\hat{y}_{i,s}$	$D_i = (y_{i,s} - \hat{y}_{i,s})$	$(D_i - \overline{D})$	$(D_i - \overline{D})^2$	
9.50	9.39	9.31	9.39	9.50	9.31	0.08	0.09	0.008	
9.87	9.73	9.69	9.73	9.87	9.69	0.04	0.05	0.003	
9.34	9.13	9.15	9.13	9.34	9.15	-0.02	-0.01	0.000	
9.51	9.25	9.32	9.25	9.51	9.32	-0.07	-0.06	0.003	
8.05	7.76	7.83	7.76	8.05	7.83	-0.07	-0.05	0.003	
7.99	7.73	7.76	7.73	7.99	7.76	-0.04	-0.02	0.00	
Sum						-0.08	0.00	0.02	
$\overline{D} = \frac{1}{N} \sum_{i=1}^N D_i = -0.01$									
$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \overline{D})^2} = \text{SQRT}(0) = 0.06$									
$N = 6$									
$K_v = 0.93$									
$p = 10$									
$E = 21$									
$\sigma_0 = \frac{pE}{1.96} = 1.07$									
$1.5\sigma_0 k_v = 1.50$									
$s_D \leq 1.5\sigma_0 k_v = 0.06 \text{ \%Vol} < 1.5 \text{ \%Vol} - \text{Pass Variability Test}$									
$t_{0.95}(N-1) = 2.13$									
$t_{0.95}(N-1) \frac{S_D}{\sqrt{N}} + \sigma_0 = 1.12$									
$ \overline{D} \quad 0.01\% \text{Vol} < 1.12\% \text{Vol} - \text{Calibration Remains Valid}$									

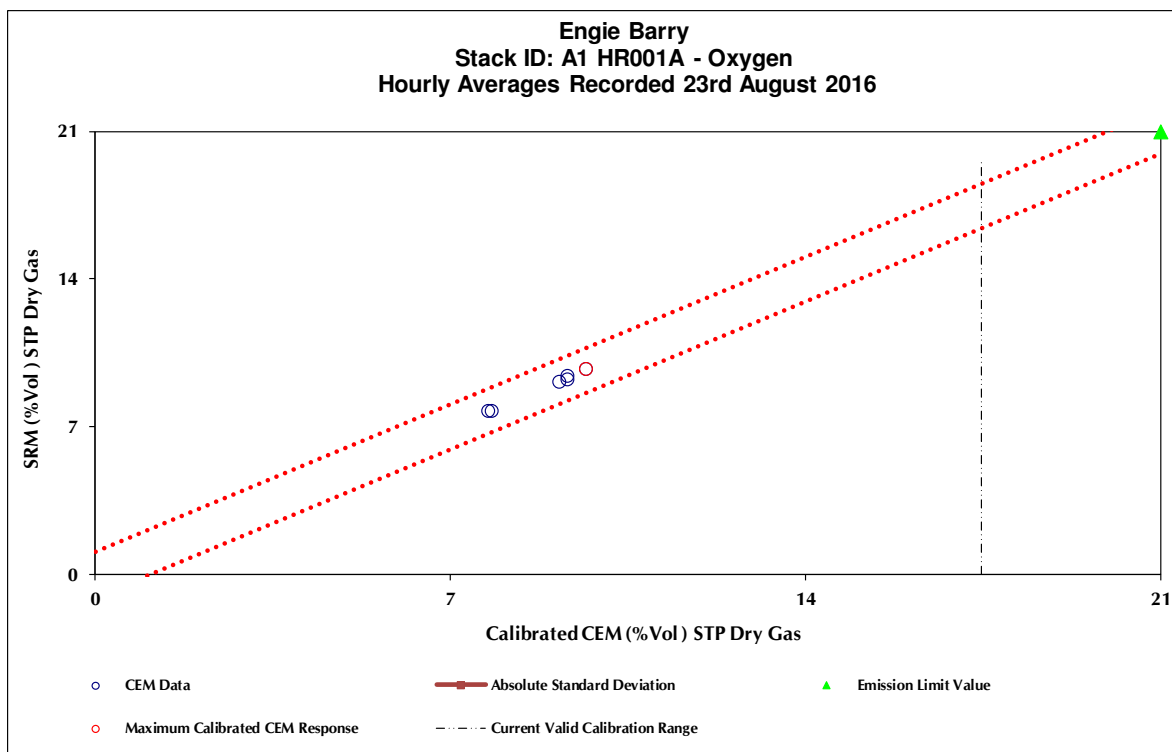
Reference Conditions 273K, 101.3 kPa, Dry Gas

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.8c

Plot 2 – X-Y Plot of Standardised SRM Data Versus Standardised CEM Data for O2



B4.9c

Summary of the Valid Calibration Range for O2

Summary of Valid Calibration Range

Slope:	1.0249	...
Intercept:	-0.4262	%Vol
Daily ELV	21.00	%Vol
Allowable 95% Confidence Interval	± 1.07	%Vol
Upper Limit of Current Valid Calibration Range	17.47	%Vol
Maximum Calibrated CEM @ Reference Conditions	9.69	%Vol
Corresponding SRM @ Reference Conditions	9.73	%Vol
Allowable Range for Calibrated CEM Response i.e. SRM Concentration ± 1.07%	8.66 - 10.8	%Vol
Calibrated Value of CEM Response Falls Within Allowable Range?	YES	...
Maximum Calibrated CEM @ Reference Conditions plus 10% extension < 50% ELV?	N/A	...
Extended Valid Calibration Range	N/A	%Vol

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

A2

B4.1a & B4.2a

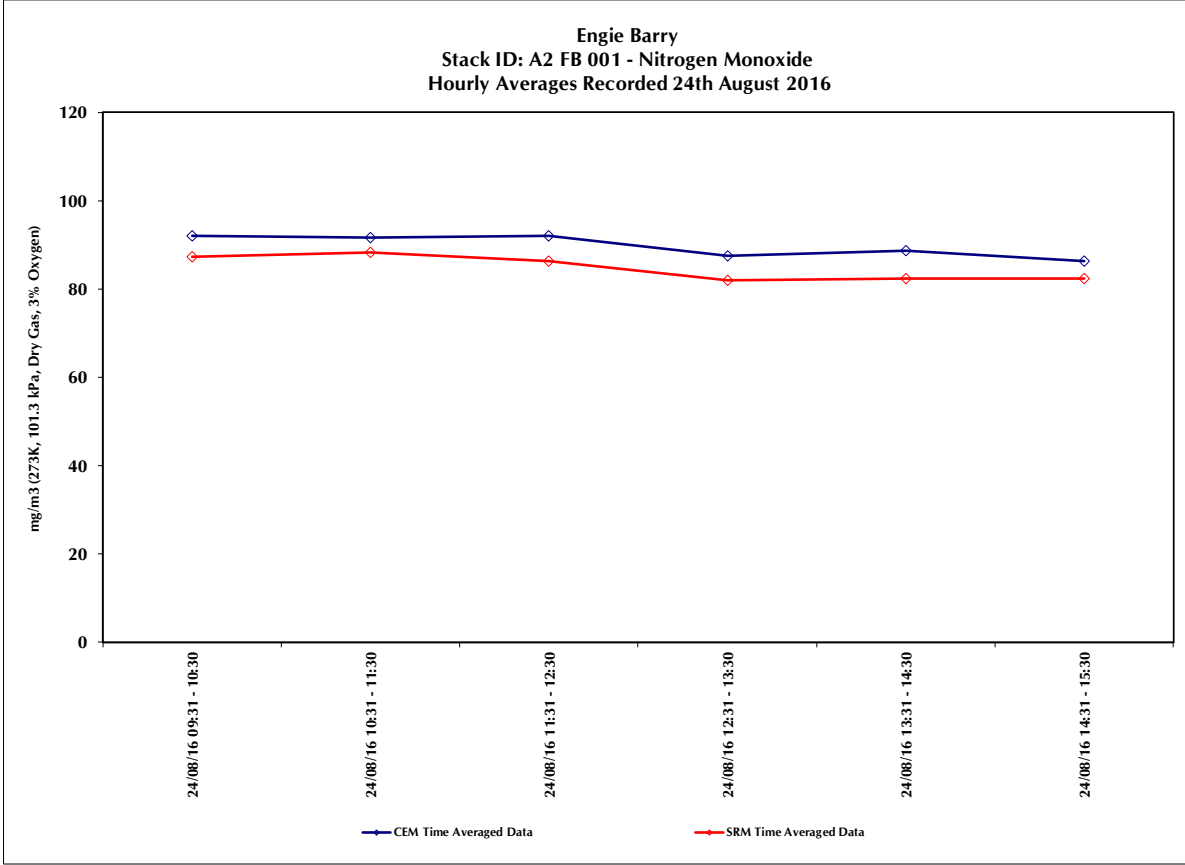
Incorporating: Table 4.1 Raw Monitoring Data & Table 4.2 Standardised Monitoring Data for NO

Raw Monitoring CEM Data							Standardised Data
Date	Time	CEM Hourly averages mg/m ³ Uncalibrated (1)	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	CEM Hourly averages mg/m ³ Uncalibrated (2)
24/08/2016	09:31 - 10:30	55.64	-	-	-	10.09	92.09
24/08/2016	10:31 - 11:30	54.75	-	-	-	10.20	91.61
24/08/2016	11:31 - 12:30	54.25	-	-	-	10.37	92.18
24/08/2016	12:31 - 13:30	31.08	-	-	-	14.54	87.44
24/08/2016	13:31 - 14:30	26.42	-	-	-	15.57	88.67
24/08/2016	14:31 - 15:30	26.49	-	-	-	15.41	86.33
(1) CEM data conditions: 273K, 101.3 kPa, Dry Gas							
(2) CEM data conditions: 273K, 101.3 kPa, Dry Gas, 3% Oxygen							
Raw Monitoring SRM Data							Standardised Data
Date	Time	SRM Hourly averages mg/m ³ (3)	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	SRM Hourly averages mg/m ³ (4)
24/08/2016	09:31 - 10:30	52.49	-	-	-	10.14	87.34
24/08/2016	10:31 - 11:30	52.29	-	-	-	10.31	88.34
24/08/2016	11:31 - 12:30	50.90	-	-	-	10.35	86.34
24/08/2016	12:31 - 13:30	28.44	-	-	-	14.69	82.03
24/08/2016	13:31 - 14:30	22.54	-	-	-	16.00	82.39
24/08/2016	14:31 - 15:30	22.30	-	-	-	16.06	82.48
(3) SRM data conditions: 273K, 101.3 kPa, Dry Gas							
(4) SRM data conditions: 273K, 101.3 kPa, Dry Gas, 3% Oxygen							

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

B4.3a
Plot 1 - Time Series Plot of Standardised Time Averaged SRM/CEM Monitoring Data Pairs for NO



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.4a**Calculation and procedure – Elimination of outliers for NO**

Please note: Only those averages separated by at least 1 hour have been carried forward to the outlier test. After removal of any outliers, highlighted as “outlier” below, all other averages, highlighted as “yes” below, will be taken forward to the calibration coefficient validation.

n	Date	Time	SRM ppm	CEM ppm	$ D_i $	$ D_i - \bar{D}_i $	$ D_i - \bar{D}_i < 2\sigma?$
1	24/08/2016	09:31 - 10:30	52.49	55.64	-3.14	0.14	YES
2	24/08/2016	10:31 - 11:30	52.29	54.75	-2.46	0.81	YES
3	24/08/2016	11:31 - 12:30	50.90	54.25	-3.35	0.07	YES
4	24/08/2016	12:31 - 13:30	28.44	31.08	-2.63	0.64	YES
5	24/08/2016	13:31 - 14:30	22.54	26.42	-3.88	0.61	YES
6	24/08/2016	14:31 - 15:30	22.30	26.49	-4.19	0.91	YES

Slope	1.03	Mean	-3.28
Intercept	-4.33	Stdev	0.6778
R ²	1.00		

Engie
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 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.5a**Table 4.3 – data used to calculate calibrated values for NO**

QAL2 Calibration function: $y=0.9141x+0.0091$								Standardised Data	
Date	Time	CEM Hourly averages mg/m ³ Uncalibrated ⁽¹⁾	CEM Hourly averages mg/m ³ Calibrated ⁽¹⁾	CEM Temp (K)	CEM Pressure (kPa)	CEM Moisture (%)	CEM Oxygen (%) Dry	CEM Hourly averages mg/m ³ Calibrated ⁽²⁾	SRM Hourly averages mg/m ³ ⁽²⁾
24/08/2016	09:31 - 10:30	55.64	50.87	-	-	-	10.09	84.19	87.34
24/08/2016	10:31 - 11:30	54.75	50.06	-	-	-	10.20	83.76	88.34
24/08/2016	11:31 - 12:30	54.25	49.60	-	-	-	10.37	84.28	86.34
24/08/2016	12:31 - 13:30	31.08	28.42	-	-	-	14.54	79.95	82.03
24/08/2016	13:31 - 14:30	26.42	24.16	-	-	-	15.57	81.09	82.39
24/08/2016	14:31 - 15:30	26.49	24.22	-	-	-	15.41	78.95	82.48

(1) 273K, 101.3 kPa, Dry Gas

(2) 273K, 101.3 kPa, Dry Gas, 3% Oxygen

B4.6a & B4.7a

Incorporating: Table 4.5 – Data used for the variability test & Calculation – the variability test and the acceptance test for NO

Determinand: Nitrogen Monoxide					QAL2 Calibration function: y=0.9141x+0.0091			
CEM Measured mg/m ³	SRM Measured mg/m ³	Calibrated CEM mg/m ³	SRM Measured @ Reference conditions mg/m ³	CEM Measured @ Reference conditions mg/m ³	Calibrated CEM @ Reference Conditions mg/m ³	Residual Value	Deviation of Residual from Mean	
x_i	y_i	$\hat{y}_i$	$y_{i,s}$	$x_{i,s}$	$\hat{y}_{i,s}$	$D_i = (y_{i,s} - \hat{y}_{i,s})$	$(D_i - \overline{D})$	$(D_i - \overline{D})^2$
55.64	52.49	50.87	87.34	92.09	84.19	3.15	0.36	0.13
54.75	52.29	50.06	88.34	91.61	83.76	4.59	1.80	3.24
54.25	50.90	49.60	86.34	92.18	84.28	2.06	-0.72	0.52
31.08	28.44	28.42	82.03	87.44	79.95	2.08	-0.71	0.50
26.42	22.54	24.16	82.39	88.67	81.09	1.31	-1.48	2.19
26.49	22.30	24.22	82.48	86.33	78.95	3.53	0.75	0.56
Sum						16.72	8.88E-16	7.15
$\overline{D} = \frac{1}{N} \sum_{i=1}^N D_i = 2.79$								
$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \overline{D})^2} = \text{SQRT}(1.43) = 1.20$								
$N = 6$								
$K_v = 0.93$								
$p = 20$								
$E = 163$								
$\sigma_0 = \frac{pE}{1.96} = 16.64$								
$1.5\sigma_0 k_v = 23.28$								
$s_D \leq 1.5\sigma_0 k_v = 1.2 \text{ mg/m}^3 < 23.28 \text{ mg/m}^3 - \text{Pass Variability Test}$								
$t_{0.95}(N-1) = 2.13$								
$t_{0.95}(N-1) \frac{S_D}{\sqrt{N}} + \sigma_0 = 17.68$								
$ \overline{D} \quad 2.79\text{mg/m}^3 < 17.68\text{mg/m}^3 - \text{Calibration Remains Valid}$								

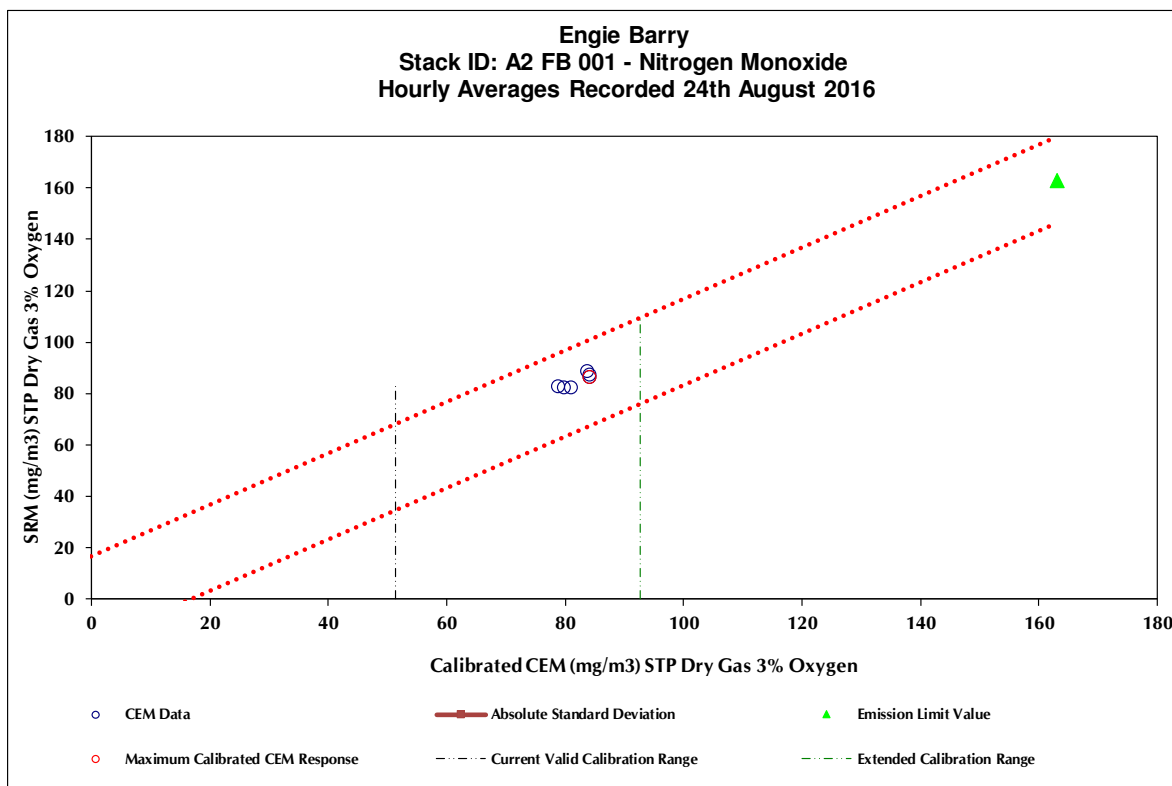
Reference Conditions 273K, 101.3 kPa, Dry Gas, 3% Oxygen

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.8a

Plot 2 – X-Y Plot of Standardised SRM Data Versus Standardised CEM Data for NO



B4.9a

Summary of the Valid Calibration Range for NO

Summary of Valid Calibration Range

Slope:	0.9141	...
Intercept:	0.0091	mg/m ³
Daily ELV	163.04	mg/m ³
Allowable 95% Confidence Interval	± 16.64	mg/m ³
Upper Limit of Current Valid Calibration Range	51.32	mg/m ³
Maximum Calibrated CEM @ Reference Conditions	84.28	mg/m ³
Corresponding SRM @ Reference Conditions	86.34	mg/m ³
Allowable Range for Calibrated CEM Response i.e. SRM Concentration ± 16.64%	69.71 - 102.98	mg/m ³
Calibrated Value of CEM Response Falls Within Allowable Range?	YES	...
Maximum Calibrated CEM @ Reference Conditions plus 10% extension < 50% ELV?	NO	...
Extended Valid Calibration Range	NO	mg/m ³

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.1b & B4.2b**Incorporating: Table 4.1 Raw Monitoring Data & Table 4.2 Standardised Monitoring Data for CO**

Raw Monitoring CEM Data							Standardised Data
Date	Time	CEM Hourly averages mg/m ³ Uncalibrated (1)	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	CEM Hourly averages mg/m ³ Uncalibrated (2)
24/08/2016	09:31 - 10:30	40.64	-	-	-	10.09	67.26
24/08/2016	10:31 - 11:30	40.85	-	-	-	10.20	68.35
24/08/2016	11:31 - 12:30	41.71	-	-	-	10.37	70.87
24/08/2016	12:31 - 13:30	29.11	-	-	-	14.54	81.89
24/08/2016	13:31 - 14:30	13.67	-	-	-	15.57	45.89
24/08/2016	14:31 - 15:30	19.53	-	-	-	15.41	63.67

(1) CEM data conditions: 273K, 101.3 kPa, Dry Gas

(2) CEM data conditions: 273K, 101.3 kPa, Dry Gas, 3% Oxygen

Raw Monitoring SRM Data							Standardised Data
Date	Time	SRM Hourly averages mg/m ³ (3)	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	SRM Hourly averages mg/m ³ (4)
24/08/2016	09:31 - 10:30	44.88	-	-	-	10.14	74.68
24/08/2016	10:31 - 11:30	45.34	-	-	-	10.31	76.60
24/08/2016	11:31 - 12:30	44.26	-	-	-	10.35	75.09
24/08/2016	12:31 - 13:30	24.61	-	-	-	14.69	70.99
24/08/2016	13:31 - 14:30	14.30	-	-	-	16.00	52.29
24/08/2016	14:31 - 15:30	14.99	-	-	-	16.06	55.45

(3) SRM data conditions: 273K, 101.3 kPa, Dry Gas

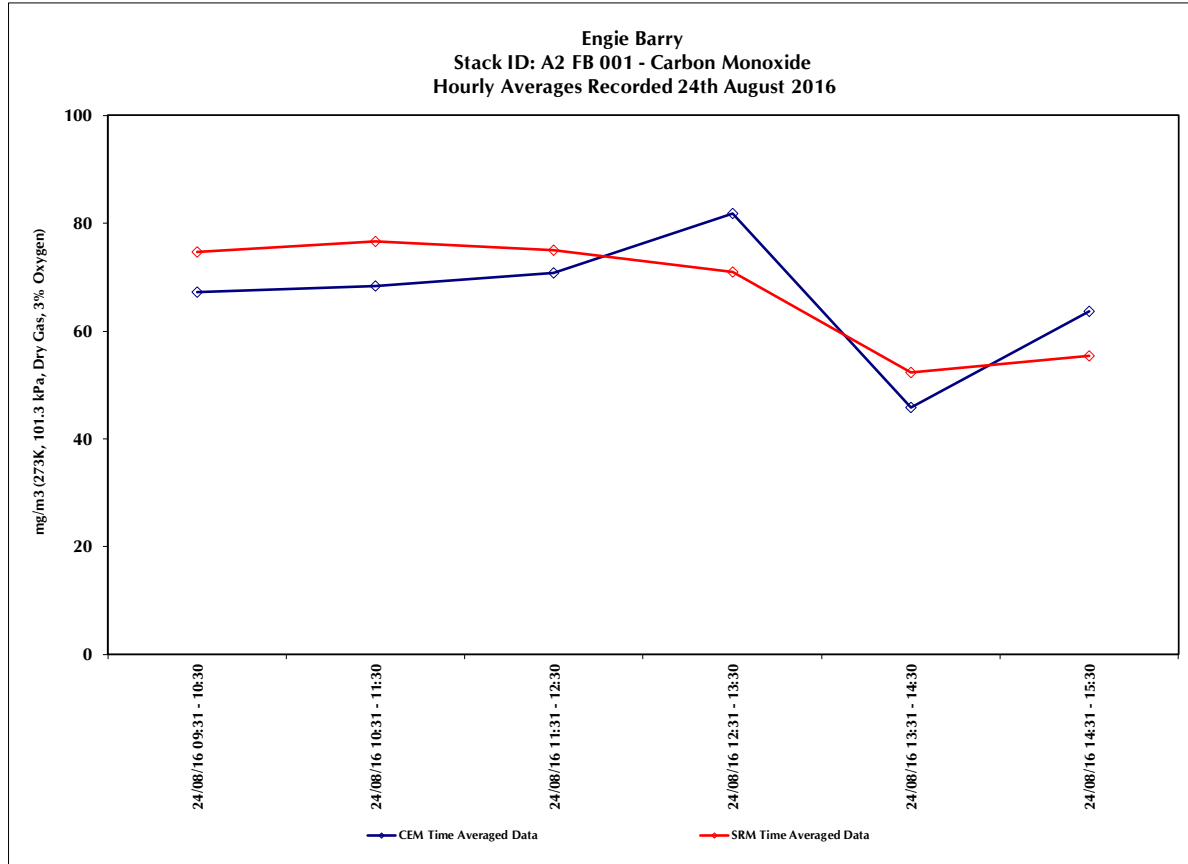
(4) SRM data conditions: 273K, 101.3 kPa, Dry Gas, 3% Oxygen

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.3b

Plot 1 - Time Series Plot of Standardised Time Averaged SRM/CEM Monitoring Data Pairs for CO



Engie
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 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.4b**Calculation and procedure – Elimination of outliers for CO**

Please note: Only those averages separated by at least 1 hour have been carried forward to the outlier test. After removal of any outliers, highlighted as “outlier” below, all other averages, highlighted as “yes” below, will be taken forward to the calibration coefficient validation.

n	Date	Time	SRM ppm	CEM ppm	$ D_i $	$ D_i - \bar{D}_i $	$ D_i - \bar{D}_i < 2\sigma?$
1	24/08/2016	09:31 - 10:30	44.88	40.64	4.25	3.77	YES
2	24/08/2016	10:31 - 11:30	45.34	40.85	4.49	4.01	YES
3	24/08/2016	11:31 - 12:30	44.26	41.71	2.55	2.07	YES
4	24/08/2016	12:31 - 13:30	24.61	29.11	-4.49	4.97	YES
5	24/08/2016	13:31 - 14:30	14.30	13.67	0.63	0.15	YES
6	24/08/2016	14:31 - 15:30	14.99	19.53	-4.54	5.02	YES

Slope	1.22	Mean	0.48
Intercept	-6.31	Stdev	4.1112
R ²	0.96		

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.5b**Table 4.3 – data used to calculate calibrated values for CO**

QAL2 Calibration function: $y=1.0552x+0.1111$								Standardised Data	
Date	Time	CEM Hourly averages mg/m ³ Uncalibrated ⁽¹⁾	CEM Hourly averages mg/m ³ Calibrated ⁽¹⁾	CEM Temp (K)	CEM Pressure (kPa)	CEM Moisture (%)	CEM Oxygen (%) Dry	CEM Hourly averages mg/m ³ Calibrated ⁽²⁾	SRM Hourly averages mg/m ³ ⁽²⁾
24/08/2016	09:31 - 10:30	40.64	42.99	-	-	-	10.09	71.16	74.68
24/08/2016	10:31 - 11:30	40.85	43.21	-	-	-	10.20	72.31	76.60
24/08/2016	11:31 - 12:30	41.71	44.12	-	-	-	10.37	74.97	75.09
24/08/2016	12:31 - 13:30	29.11	30.82	-	-	-	14.54	86.72	70.99
24/08/2016	13:31 - 14:30	13.67	14.54	-	-	-	15.57	48.79	52.29
24/08/2016	14:31 - 15:30	19.53	20.72	-	-	-	15.41	67.55	55.45

(1) 273K, 101.3 kPa, Dry Gas
 (2) 273K, 101.3 kPa, Dry Gas, 3% Oxygen

B4.6b & B4.7b

Incorporating: Table 4.5 – Data used for the variability test & Calculation – the variability test and the acceptance test for CO

Determinand: Carbon Monoxide				QAL2 Calibration function: $y=1.0552x+0.1111$				
CEM Measured mg/m ³	SRM Measured mg/m ³	Calibrated CEM mg/m ³	SRM Measured @ Reference conditions mg/m ³	CEM Measured @ Reference conditions mg/m ³	Calibrated CEM @ Reference Conditions mg/m ³	Residual Value	Deviation of Residual from Mean	
x_i	y_i	$\hat{y}_i$	$y_{i,s}$	$x_{i,s}$	$\hat{y}_{i,s}$	$D_i = (y_{i,s} - \hat{y}_{i,s})$	$(D_i - \bar{D})$	$(D_i - \bar{D})^2$
40.64	44.88	42.99	74.68	67.26	71.16	3.52	6.26	39.13
40.85	45.34	43.21	76.60	68.35	72.31	4.29	7.03	49.37
41.71	44.26	44.12	75.09	70.87	74.97	0.11	2.85	8.11
29.11	24.61	30.82	70.99	81.89	86.72	-15.73	-13.00	168.94
13.67	14.30	14.54	52.29	45.89	48.79	3.50	6.23	38.84
19.53	14.99	20.72	55.45	63.67	67.55	-12.10	-9.36	87.66
Sum						-16.40	0.00	392.04
$\bar{D} = \frac{1}{N} \sum_{i=1}^N D_i = -2.73$								
$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \bar{D})^2} = \text{SQRT}(78.41) = 8.85$								
$N = 6$								
$K_v = 0.93$								
$p = 20$								
$E = 110$								
$\sigma_0 = \frac{pE}{1.96} = 11.22$								
$1.5\sigma_0 k_v = 15.71$								
$S_D \leq 1.5\sigma_0 k_v = 8.85 \text{ mg/m}^3 < 15.71 \text{ mg/m}^3 - \text{Pass Variability Test}$								
$t_{0.95}(N-1) = 2.13$								
$t_{0.95}(N-1) \frac{S_D}{\sqrt{N}} + \sigma_0 = 18.93$								
$ \bar{D} \quad 2.73 \text{ mg/m}^3 < 18.93 \text{ mg/m}^3 - \text{Calibration Remains Valid}$								

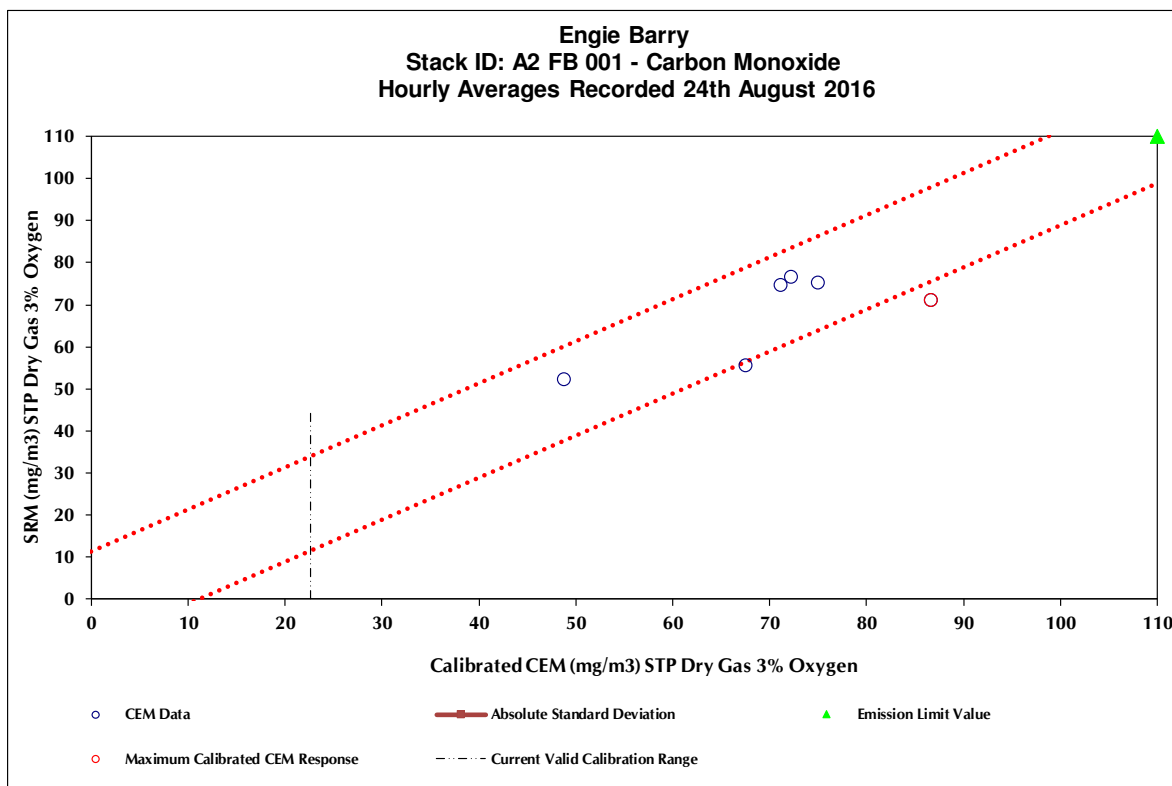
Reference Conditions 273K, 101.3 kPa, Dry Gas, 3% Oxygen

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.8b

Plot 2 – X-Y Plot of Standardised SRM Data Versus Standardised CEM Data for CO



B4.9b

Summary of the Valid Calibration Range for CO

Summary of Valid Calibration Range

Slope:	1.0552	...
Intercept:	0.1111	mg/m ³
Daily ELV	110.00	mg/m ³
Allowable 95% Confidence Interval	± 11.22	mg/m ³
Upper Limit of Current Valid Calibration Range	22.59	mg/m ³
Maximum Calibrated CEM @ Reference Conditions	86.72	mg/m ³
Corresponding SRM @ Reference Conditions	70.99	mg/m ³
Allowable Range for Calibrated CEM Response i.e. SRM Concentration ± 11.22%	59.77 - 82.22	mg/m ³
Calibrated Value of CEM Response Falls Within Allowable Range?	NO	...
Maximum Calibrated CEM @ Reference Conditions plus 10% extension < 50% ELV?	NO	...
Extended Valid Calibration Range	N/A	mg/m ³

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.1c & B4.2c**Incorporating: Table 4.1 Raw Monitoring Data & Table 4.2 Standardised Monitoring Data for O2**

Raw Monitoring CEM Data							Standardised Data
Date	Time	CEM Hourly averages %Vol Uncalibrated ⁽¹⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	CEM Hourly averages %Vol Uncalibrated ⁽²⁾
24/08/2016	09:31 - 10:30	10.09	-	-	-	-	10.09
24/08/2016	10:31 - 11:30	10.20	-	-	-	-	10.20
24/08/2016	11:31 - 12:30	10.37	-	-	-	-	10.37
24/08/2016	12:31 - 13:30	14.54	-	-	-	-	14.54
24/08/2016	13:31 - 14:30	15.57	-	-	-	-	15.57
24/08/2016	14:31 - 15:30	15.41	-	-	-	-	15.41

(1) CEM data conditions: 273K, 101.3 kPa, Dry Gas

(2) CEM data conditions: 273K, 101.3 kPa, Dry Gas, Stack Oxygen

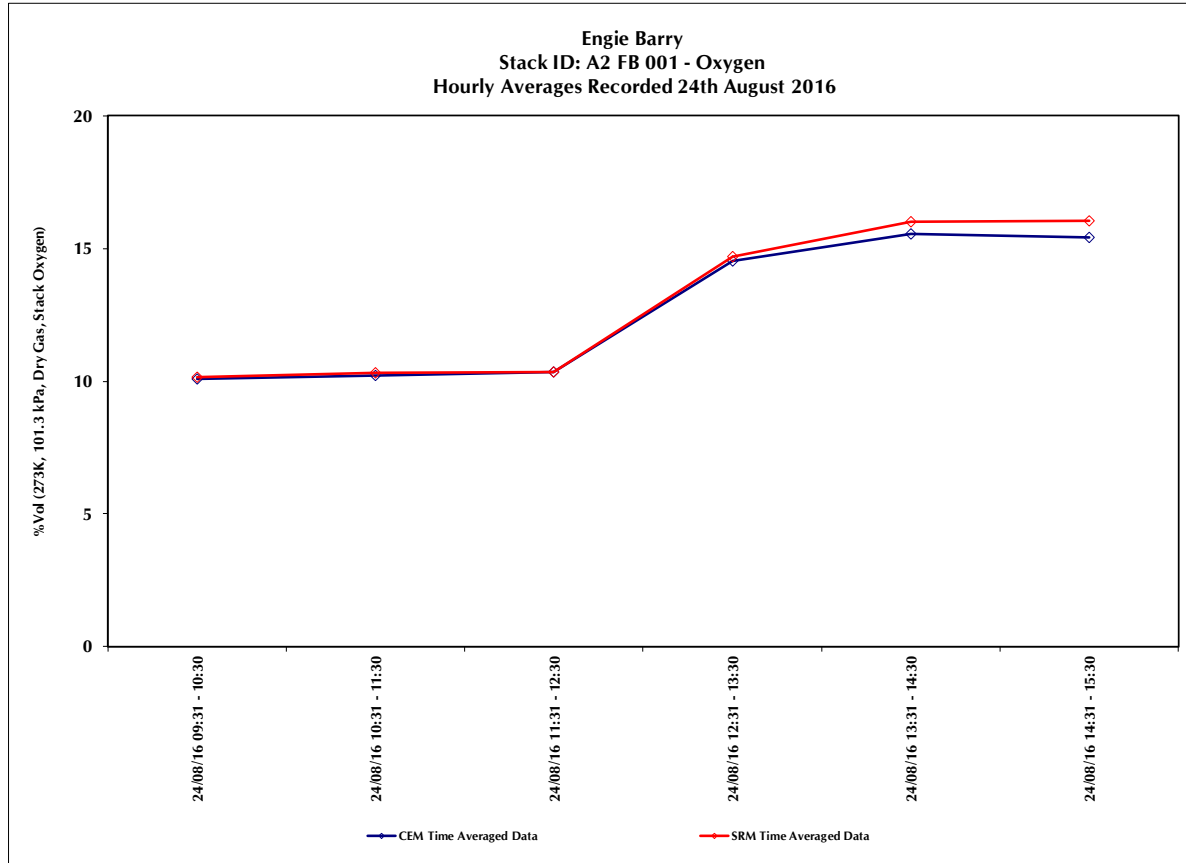
Raw Monitoring SRM Data							Standardised Data
Date	Time	SRM Hourly averages %Vol ⁽³⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	SRM Hourly averages %Vol ⁽⁴⁾
24/08/2016	09:31 - 10:30	10.14	-	-	-	-	10.14
24/08/2016	10:31 - 11:30	10.31	-	-	-	-	10.31
24/08/2016	11:31 - 12:30	10.35	-	-	-	-	10.35
24/08/2016	12:31 - 13:30	14.69	-	-	-	-	14.69
24/08/2016	13:31 - 14:30	16.00	-	-	-	-	16.00
24/08/2016	14:31 - 15:30	16.06	-	-	-	-	16.06

(3) SRM data conditions: 273K, 101.3 kPa, Dry Gas

(4) SRM data conditions: 273K, 101.3 kPa, Dry Gas, Stack Oxygen

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

B4.3c**Plot 1 - Time Series Plot of Standardised Time Averaged SRM/CEM Monitoring Data Pairs for O2**

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.4c**Calculation and procedure – Elimination of outliers for O2**

Please note: Only those averages separated by at least 1 hour have been carried forward to the outlier test. After removal of any outliers, highlighted as “outlier” below, all other averages, highlighted as “yes” below, will be taken forward to the calibration coefficient validation.

n	Date	Time	SRM % Vol	CEM % Vol	$ D_i $	$ D_i - \bar{D}_i $	$ D_i - \bar{D}_i < 2\sigma?$
1	24/08/2016	09:31 - 10:30	10.14	10.09	0.06	0.17	YES
2	24/08/2016	10:31 - 11:30	10.31	10.20	0.10	0.13	YES
3	24/08/2016	11:31 - 12:30	10.35	10.37	-0.02	0.25	YES
4	24/08/2016	12:31 - 13:30	14.69	14.54	0.16	0.08	YES
5	24/08/2016	13:31 - 14:30	16.00	15.57	0.44	0.21	YES
6	24/08/2016	14:31 - 15:30	16.06	15.41	0.65	0.42	YES

Slope	1.08	Mean	0.23
Intercept	-0.77	Stdev	0.2587
R ²	1.00		

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.5c**Table 4.3 – data used to calculate calibrated values for O2**

QAL2 Calibration function: $y=0.9788x+0.0098$								Standardised Data	
Date	Time	CEM Hourly averages %Vol Uncalibrated ⁽¹⁾	CEM Hourly averages %Vol Calibrated ⁽¹⁾	CEM Temp (K)	CEM Pressure (kPa)	CEM Moisture (%)	CEM Oxygen (%) Dry	CEM Hourly averages %Vol Calibrated ⁽²⁾	SRM Hourly averages %Vol ⁽²⁾
24/08/2016	09:31 - 10:30	10.09	9.88	-	-	-	-	9.88	10.14
24/08/2016	10:31 - 11:30	10.20	10.00	-	-	-	-	10.00	10.31
24/08/2016	11:31 - 12:30	10.37	10.16	-	-	-	-	10.16	10.35
24/08/2016	12:31 - 13:30	14.54	14.24	-	-	-	-	14.24	14.69
24/08/2016	13:31 - 14:30	15.57	15.25	-	-	-	-	15.25	16.00
24/08/2016	14:31 - 15:30	15.41	15.09	-	-	-	-	15.09	16.06

(1) 273K, 101.3 kPa, Dry Gas

(2) 273K, 101.3 kPa, Dry Gas, Stack Oxygen

B4.6c & B4.7c

Incorporating: Table 4.5 – Data used for the variability test & Calculation – the variability test and the acceptance test for O2

Determinand: Oxygen						QAL2 Calibration function: $y=0.9788x+0.0098$			
CEM Measured %Vol	SRM Measured %Vol	Calibrated CEM %Vol	SRM Measured @ Reference conditions %Vol	CEM Measured @ Reference conditions %Vol	Calibrated CEM @ Reference Conditions %Vol	Residual Value	Deviation of Residual from Mean		
x_i	y_i	$\hat{y}_i$	$y_{i,s}$	$x_{i,s}$	$\hat{y}_{i,s}$	$D_i = (y_{i,s} - \hat{y}_{i,s})$	$(D_i - \bar{D})$	$(D_i - \bar{D})^2$	
10.09	10.14	9.88	10.14	10.09	9.88	0.26	-0.23	0.053	
10.20	10.31	10.00	10.31	10.20	10.00	0.31	-0.18	0.033	
10.37	10.35	10.16	10.35	10.37	10.16	0.19	-0.30	0.089	
14.54	14.69	14.24	14.69	14.54	14.24	0.45	-0.04	0.001	
15.57	16.00	15.25	16.00	15.57	15.25	0.76	0.27	0.071	
15.41	16.06	15.09	16.06	15.41	15.09	0.97	0.48	0.23	
Sum						2.94	0.00	0.48	
$\bar{D} = \frac{1}{N} \sum_{i=1}^N D_i = 0.49$									
$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \bar{D})^2} = \text{SQRT}(0.1) = 0.31$									
$N = 6$									
$K_v = 0.93$									
$p = 10$									
$E = 21$									
$\sigma_0 = \frac{pE}{1.96} = 1.07$									
$1.5\sigma_0 k_v = 1.50$									
$S_D \leq 1.5\sigma_0 k_v = 0.31 \% \text{Vol} < 1.5 \% \text{Vol} - \text{Pass Variability Test}$									
$t_{0.95}(N-1) = 2.13$									
$t_{0.95}(N-1) \frac{S_D}{\sqrt{N}} + \sigma_0 = 1.34$									
$ \bar{D} \quad 0.49\% \text{Vol} < 1.34\% \text{Vol} - \text{Calibration Remains Valid}$									

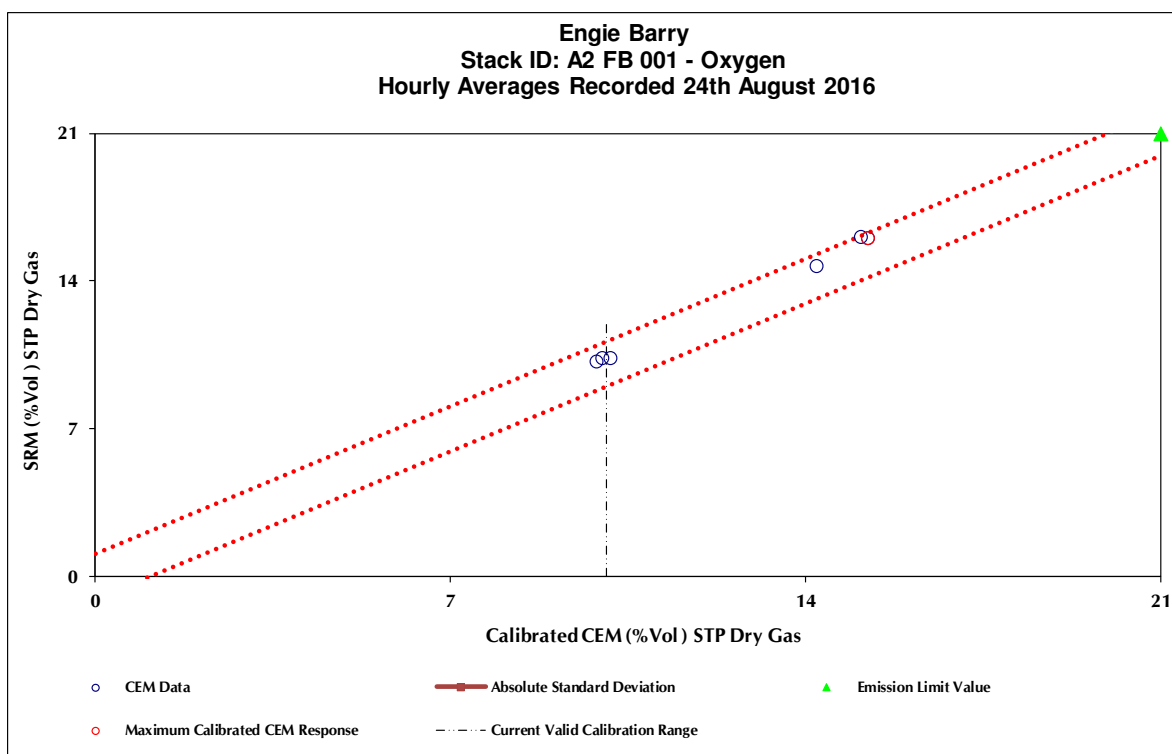
Reference Conditions 273K, 101.3 kPa, Dry Gas

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.8c

Plot 2 – X-Y Plot of Standardised SRM Data Versus Standardised CEM Data for O₂



B4.9c

Summary of the Valid Calibration Range for O₂

Summary of Valid Calibration Range

Slope:	0.9788	...
Intercept:	0.0098	%Vol
Daily ELV	21.00	%Vol
Allowable 95% Confidence Interval	± 1.07	%Vol
Upper Limit of Current Valid Calibration Range	10.07	%Vol
Maximum Calibrated CEM @ Reference Conditions	15.25	%Vol
Corresponding SRM @ Reference Conditions	16.00	%Vol
Allowable Range for Calibrated CEM Response i.e. SRM Concentration ± 1.07%	14.93 - 17.07	%Vol
Calibrated Value of CEM Response Falls Within Allowable Range?	YES	...
Maximum Calibrated CEM @ Reference Conditions plus 10% extension < 50% ELV?	NO	...
Extended Valid Calibration Range	NO	%Vol

Engie
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 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

A3

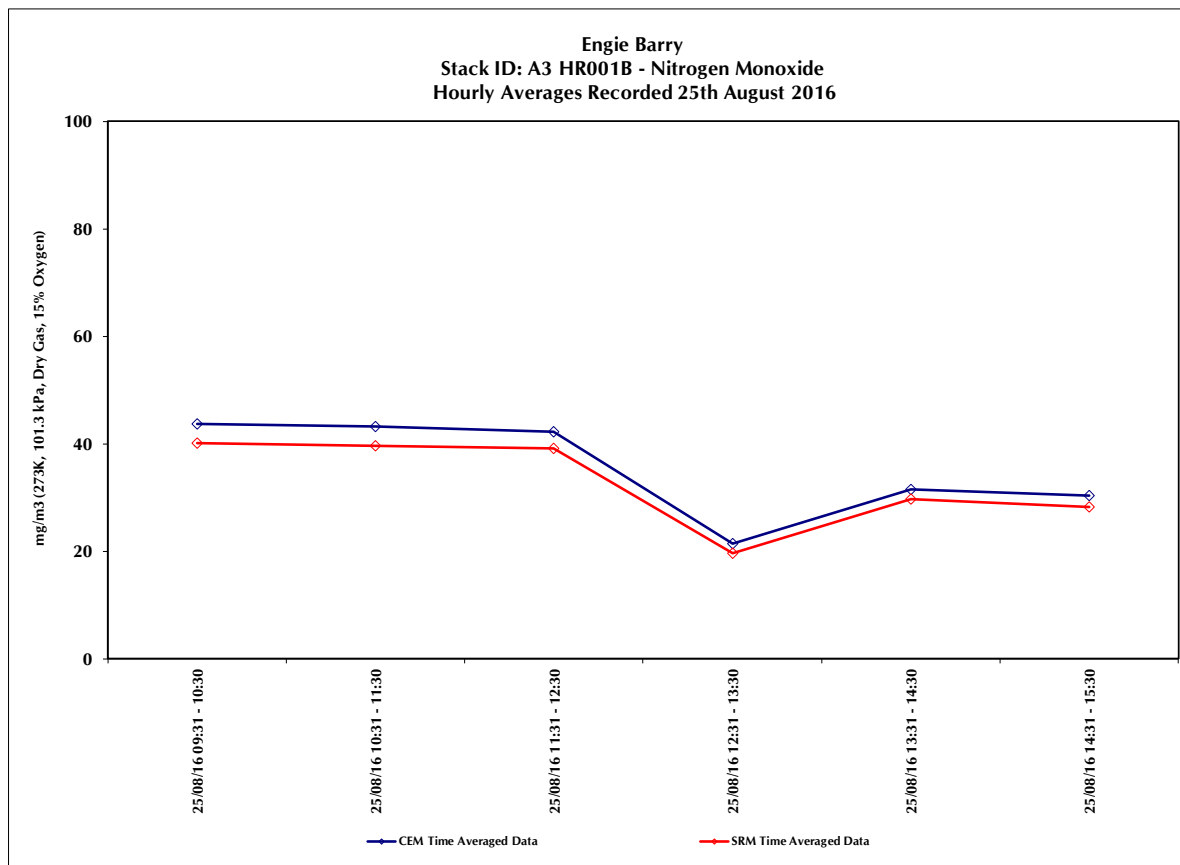
B4.1a & B4.2a

Incorporating: Table 4.1 Raw Monitoring Data & Table 4.2 Standardised Monitoring Data for NO

Raw Monitoring CEM Data							Standardised Data
Date	Time	CEM Hourly averages ppm Uncalibrated ⁽¹⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	CEM Hourly averages mg/m ³ Uncalibrated ⁽²⁾
25/08/2016	09:31 - 10:30	26.20	-	-	-	16.17	43.77
25/08/2016	10:31 - 11:30	25.99	-	-	-	16.15	43.21
25/08/2016	11:31 - 12:30	25.50	-	-	-	16.14	42.29
25/08/2016	12:31 - 13:30	23.00	-	-	-	12.43	21.46
25/08/2016	13:31 - 14:30	41.19	-	-	-	10.58	31.53
25/08/2016	14:31 - 15:30	38.15	-	-	-	10.98	30.37
(1) CEM data conditions: 273K, 101.3 kPa, Dry Gas							
(2) CEM data conditions: 273K, 101.3 kPa, Dry Gas, 15% Oxygen							
Raw Monitoring SRM Data							Standardised Data
Date	Time	SRM Hourly averages ppm ⁽³⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	SRM Hourly averages mg/m ³ ⁽⁴⁾
25/08/2016	09:31 - 10:30	24.79	-	-	-	16.01	40.08
25/08/2016	10:31 - 11:30	24.64	-	-	-	15.99	39.63
25/08/2016	11:31 - 12:30	24.32	-	-	-	15.99	39.13
25/08/2016	12:31 - 13:30	21.31	-	-	-	12.31	19.60
25/08/2016	13:31 - 14:30	39.13	-	-	-	10.50	29.72
25/08/2016	14:31 - 15:30	36.05	-	-	-	10.85	28.34
(3) SRM data conditions: 273K, 101.3 kPa, Dry Gas							
(4) SRM data conditions: 273K, 101.3 kPa, Dry Gas, 15% Oxygen							

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

B4.3a**Plot 1 - Time Series Plot of Standardised Time Averaged SRM/CEM Monitoring Data Pairs for NO**

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.4a**Calculation and procedure – Elimination of outliers for NO**

Please note: Only those averages separated by at least 1 hour have been carried forward to the outlier test. After removal of any outliers, highlighted as “outlier” below, all other averages, highlighted as “yes” below, will be taken forward to the calibration coefficient validation.

n	Date	Time	SRM ppm	CEM ppm	$ D_i $	$ D_i - \bar{D}_i $	$ D_i - \bar{D}_i < 2\sigma?$
1	25/08/2016	09:31 - 10:30	24.79	26.20	-1.41	0.22	YES
2	25/08/2016	10:31 - 11:30	24.64	25.99	-1.35	0.28	YES
3	25/08/2016	11:31 - 12:30	24.32	25.50	-1.17	0.46	YES
4	25/08/2016	12:31 - 13:30	21.31	23.00	-1.69	0.06	YES
5	25/08/2016	13:31 - 14:30	39.13	41.19	-2.06	0.43	YES
6	25/08/2016	14:31 - 15:30	36.05	38.15	-2.10	0.47	YES

Slope	0.96	Mean	-1.63
Intercept	-0.37	Stdev	0.3882
R ²	1.00		

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.5a**Table 4.3 – data used to calculate calibrated values for NO**

QAL2 Calibration function: $y=0.9849x-1.5148$								Standardised Data	
Date	Time	CEM Hourly averages ppm Uncalibrated ⁽¹⁾	CEM Hourly averages ppm Calibrated ⁽¹⁾	CEM Temp (K)	CEM Pressure (kPa)	CEM Moisture (%)	CEM Oxygen (%) Dry	CEM Hourly averages mg/m ³ Calibrated ⁽²⁾	SRM Hourly averages mg/m ³ ⁽²⁾
25/08/2016	09:31 - 10:30	26.20	24.29	-	-	-	16.17	40.58	40.08
25/08/2016	10:31 - 11:30	25.99	24.08	-	-	-	16.15	40.04	39.63
25/08/2016	11:31 - 12:30	25.50	23.60	-	-	-	16.14	39.14	39.13
25/08/2016	12:31 - 13:30	23.00	21.14	-	-	-	12.43	19.72	19.60
25/08/2016	13:31 - 14:30	41.19	39.05	-	-	-	10.58	29.90	29.72
25/08/2016	14:31 - 15:30	38.15	36.06	-	-	-	10.98	28.71	28.34

(1) 273K, 101.3 kPa, Dry Gas

(2) 273K, 101.3 kPa, Dry Gas, 15% Oxygen

B4.6a & B4.7a

Incorporating: Table 4.5 – Data used for the variability test & Calculation – the variability test and the acceptance test for NO

Determinand: Nitrogen Monoxide					QAL2 Calibration function: y=0.9849x-1.5148			
CEM Measured mg/m ³	SRM Measured mg/m ³	Calibrated CEM mg/m ³	SRM Measured @ Reference conditions mg/m ³	CEM Measured @ Reference conditions mg/m ³	Calibrated CEM @ Reference Conditions mg/m ³	Residual Value	Deviation of Residual from Mean	
x_i	y_i	$\hat{y}_i$	$y_{i,s}$	$x_{i,s}$	$\hat{y}_{i,s}$	$D_i = (y_{i,s} - \hat{y}_{i,s})$	$(D_i - \overline{D})$	$(D_i - \overline{D})^2$
35.08	33.20	32.52	40.08	43.77	40.58	-0.50	-0.24	0.056
34.80	32.99	32.24	39.63	43.21	40.04	-0.41	-0.14	0.020
34.14	32.57	31.59	39.13	42.29	39.14	-0.01	0.25	0.064
30.80	28.53	28.30	19.60	21.46	19.72	-0.12	0.14	0.020
55.16	52.40	52.29	29.72	31.53	29.90	-0.18	0.08	0.007
51.08	48.27	48.28	28.34	30.37	28.71	-0.36	-0.10	0.01
Sum						-1.58	0.00	0.18
$\overline{D} = \frac{1}{N} \sum_{i=1}^N D_i = -0.26$								
$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \overline{D})^2} = \text{SQRT}(0.04) = 0.19$								
$N = 6$								
$K_v = 0.93$								
$p = 20$								
$E = 82$								
$\sigma_0 = \frac{pE}{1.96} = 8.32$								
$1.5\sigma_0 k_v = 11.64$								
$s_D \leq 1.5\sigma_0 k_v = 0.19 \text{ mg/m}^3 < 11.64 \text{ mg/m}^3 - \text{Pass Variability Test}$								
$t_{0.95}(N-1) = 2.13$								
$t_{0.95}(N-1) \frac{S_D}{\sqrt{N}} + \sigma_0 = 8.48$								
$ \overline{D} \quad 0.26\text{mg/m}^3 < 8.48\text{mg/m}^3 - \text{Calibration Remains Valid}$								

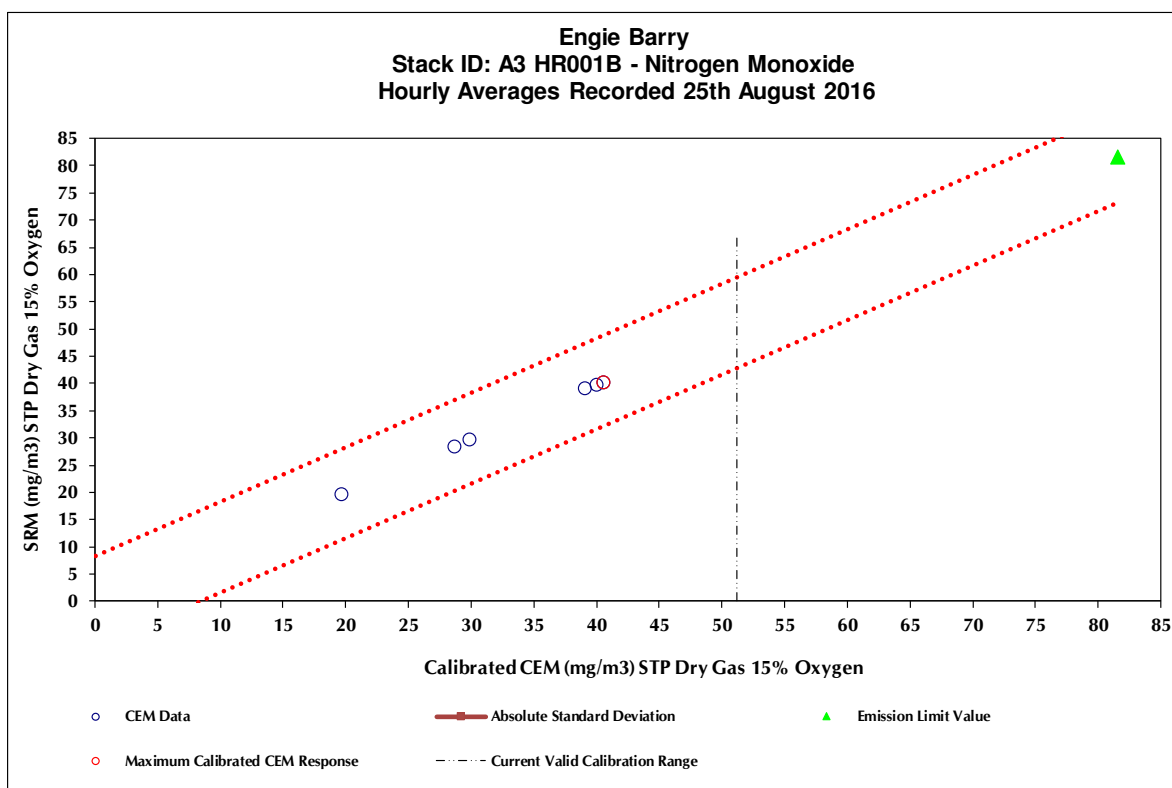
Reference Conditions 273K, 101.3 kPa, Dry Gas, 15% Oxygen

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.8a

Plot 2 – X-Y Plot of Standardised SRM Data Versus Standardised CEM Data for NO



B4.9a

Summary of the Valid Calibration Range for NO

Summary of Valid Calibration Range

Slope:	0.9849	...
Intercept:	-1.5148	mg/m ³
Daily ELV	81.52	mg/m ³
Allowable 95% Confidence Interval	± 8.32	mg/m ³
Upper Limit of Current Valid Calibration Range	51.22	mg/m ³
Maximum Calibrated CEM @ Reference Conditions	40.58	mg/m ³
Corresponding SRM @ Reference Conditions	40.08	mg/m ³
Allowable Range for Calibrated CEM Response i.e. SRM Concentration ± 8.32%	31.76 - 48.4	mg/m ³
Calibrated Value of CEM Response Falls Within Allowable Range?	YES	...
Maximum Calibrated CEM @ Reference Conditions plus 10% extension < 50% ELV?	N/A	...
Extended Valid Calibration Range	N/A	mg/m ³

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.1b & B4.2b**Incorporating: Table 4.1 Raw Monitoring Data & Table 4.2 Standardised Monitoring Data for CO**

Raw Monitoring CEM Data							Standardised Data
Date	Time	CEM Hourly averages mg/m ³ Uncalibrated (1)	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	CEM Hourly averages mg/m ³ Uncalibrated (2)
25/08/2016	09:31 - 10:30	11.46	-	-	-	16.17	14.30
25/08/2016	10:31 - 11:30	11.23	-	-	-	16.15	13.94
25/08/2016	11:31 - 12:30	11.50	-	-	-	16.14	14.24
25/08/2016	13:31 - 14:30	7.29	-	-	-	10.58	4.17
25/08/2016	14:31 - 15:30	13.29	-	-	-	10.98	7.90

(1) CEM data conditions: 273K, 101.3 kPa, Dry Gas

(2) CEM data conditions: 273K, 101.3 kPa, Dry Gas, 15% Oxygen

Raw Monitoring SRM Data							Standardised Data
Date	Time	SRM Hourly averages mg/m ³ (3)	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	SRM Hourly averages mg/m ³ (4)
25/08/2016	09:31 - 10:30	10.92	-	-	-	16.01	13.18
25/08/2016	10:31 - 11:30	10.85	-	-	-	15.99	13.03
25/08/2016	11:31 - 12:30	11.10	-	-	-	15.99	13.33
25/08/2016	13:31 - 14:30	7.17	-	-	-	10.50	4.07
25/08/2016	14:31 - 15:30	12.65	-	-	-	10.85	7.43

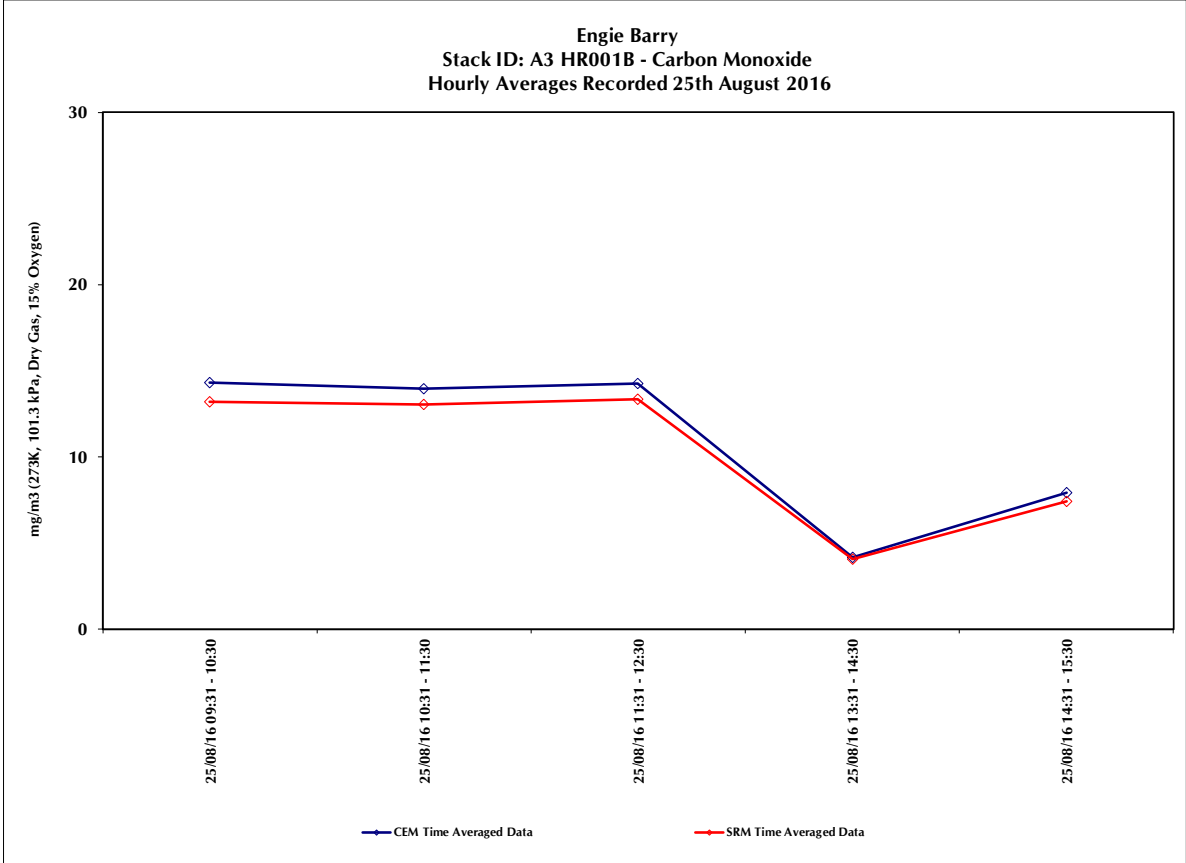
(3) SRM data conditions: 273K, 101.3 kPa, Dry Gas

(4) SRM data conditions: 273K, 101.3 kPa, Dry Gas, 15% Oxygen

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

B4.3b
Plot 1 - Time Series Plot of Standardised Time Averaged SRM/CEM Monitoring Data Pairs for CO



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.4b**Calculation and procedure – Elimination of outliers for CO**

Please note: Only those averages separated by at least 1 hour have been carried forward to the outlier test. After removal of any outliers, highlighted as “outlier” below, all other averages, highlighted as “yes” below, will be taken forward to the calibration coefficient validation.

n	Date	Time	SRM ppm	CEM ppm	$ D_i $	$ D_i - \bar{D}_i $	$ D_i - \bar{D}_i < 2\sigma?$
1	25/08/2016	09:31 - 10:30	10.92	11.46	-0.54	0.35	YES
2	25/08/2016	10:31 - 11:30	10.85	11.23	-0.38	0.51	YES
3	25/08/2016	11:31 - 12:30	11.10	11.50	-0.40	0.50	YES
4	25/08/2016	12:31 - 13:30	53.40	56.68	-3.29	2.39	Outlier
5	25/08/2016	13:31 - 14:30	7.17	7.29	-0.12	0.78	YES
6	25/08/2016	14:31 - 15:30	12.65	13.29	-0.63	0.26	YES

Slope	0.94	Mean	-0.89
Intercept	0.28	Stdev	1.1858
R ²	1.00		

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.5b**Table 4.3 – data used to calculate calibrated values for CO**

QAL2 Calibration function: $y=0.8611x+1.2686$								Standardised Data	
Date	Time	CEM Hourly averages mg/m ³ Uncalibrated ⁽¹⁾	CEM Hourly averages mg/m ³ Calibrated ⁽¹⁾	CEM Temp (K)	CEM Pressure (kPa)	CEM Moisture (%)	CEM Oxygen (%) Dry	CEM Hourly averages mg/m ³ Calibrated ⁽²⁾	SRM Hourly averages mg/m ³ ⁽²⁾
25/08/2016	09:31 - 10:30	11.46	11.14	-	-	-	16.17	13.89	13.18
25/08/2016	10:31 - 11:30	11.23	10.94	-	-	-	16.15	13.58	13.03
25/08/2016	11:31 - 12:30	11.50	11.17	-	-	-	16.14	13.84	13.33
25/08/2016	13:31 - 14:30	7.29	7.55	-	-	-	10.58	4.31	4.07
25/08/2016	14:31 - 15:30	13.29	12.71	-	-	-	10.98	7.56	7.43

(1) 273K, 101.3 kPa, Dry Gas

(2) 273K, 101.3 kPa, Dry Gas, 15% Oxygen

B4.6b & B4.7b

Incorporating: Table 4.5 – Data used for the variability test & Calculation – the variability test and the acceptance test for CO

Determinand: Carbon Monoxide						QAL2 Calibration function: $y=0.8611x+1.2686$		
CEM Measured mg/m ³	SRM Measured mg/m ³	Calibrated CEM mg/m ³	SRM Measured @ Reference conditions mg/m ³	CEM Measured @ Reference conditions mg/m ³	Calibrated CEM @ Reference Conditions mg/m ³	Residual Value	Deviation of Residual from Mean	
x_i	y_i	$\hat{y}_i$	$y_{i,s}$	$x_{i,s}$	$\hat{y}_{i,s}$	$D_i = (y_{i,s} - \hat{y}_{i,s})$	$(D_i - \bar{D})$	$(D_i - \bar{D})^2$
11.46	10.92	11.14	13.18	14.30	13.89	-0.72	-0.29	0.083
11.23	10.85	10.94	13.03	13.94	13.58	-0.56	-0.13	0.016
11.50	11.10	11.17	13.33	14.24	13.84	-0.50	-0.07	0.005
7.29	7.17	7.55	4.07	4.17	4.31	-0.25	0.18	0.034
13.29	12.65	12.71	7.43	7.90	7.56	-0.13	0.30	0.091
Sum						-2.15	0.00	0.23
$\bar{D} = \frac{1}{N} \sum_{i=1}^N D_i = -0.43$								
$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \bar{D})^2} = \text{SQRT}(0.06) = 0.24$								
$N = 5$								
$K_v = 0.92$								
$p = 20$								
$E = 80$								
$\sigma_0 = \frac{pE}{1.96} = 8.16$								
$1.5\sigma_0 k_v = 11.22$								
$S_D \leq 1.5\sigma_0 k_v = 0.24 \text{ mg/m}^3 < 11.22 \text{ mg/m}^3 - \text{Pass Variability Test}$								
$t_{0.95}(N-1) = 2.35$								
$t_{0.95}(N-1) \frac{S_D}{\sqrt{N}} + \sigma_0 = 8.42$								
$ \bar{D} \quad 0.43 \text{ mg/m}^3 < 8.42 \text{ mg/m}^3 - \text{Calibration Remains Valid}$								

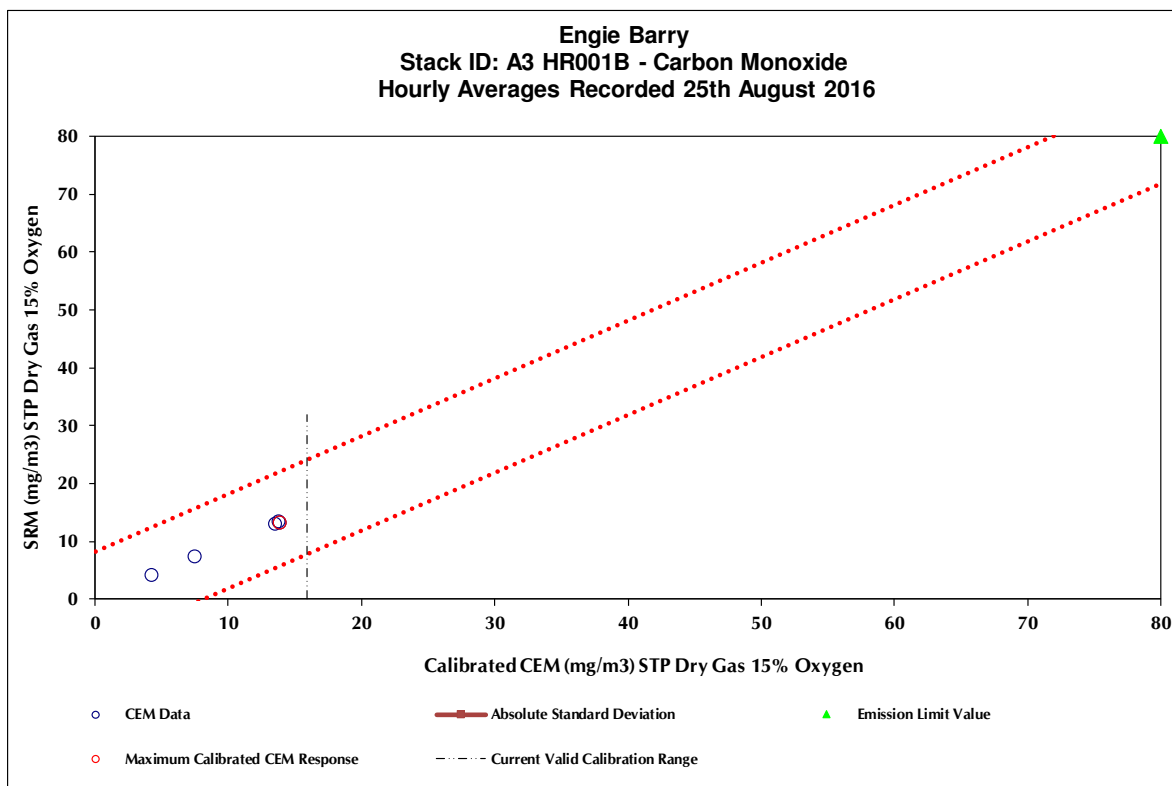
Reference Conditions 273K, 101.3 kPa, Dry Gas, 15% Oxygen

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.8b

Plot 2 – X-Y Plot of Standardised SRM Data Versus Standardised CEM Data for CO



B4.9b

Summary of the Valid Calibration Range for CO

Summary of Valid Calibration Range

Slope:	0.8611	...
Intercept:	1.2686	mg/m ³
Daily ELV	80.00	mg/m ³
Allowable 95% Confidence Interval	±8.16	mg/m ³
Upper Limit of Current Valid Calibration Range	15.95	mg/m ³
Maximum Calibrated CEM @ Reference Conditions	13.89	mg/m ³
Corresponding SRM @ Reference Conditions	13.18	mg/m ³
Allowable Range for Calibrated CEM Response i.e. SRM Concentration ±8.16%	5.01 - 21.34	mg/m ³
Calibrated Value of CEM Response Falls Within Allowable Range?	YES	...
Maximum Calibrated CEM @ Reference Conditions plus 10% extension < 50% ELV?	N/A	...
Extended Valid Calibration Range	N/A	mg/m ³

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.1c & B4.2c**Incorporating: Table 4.1 Raw Monitoring Data & Table 4.2 Standardised Monitoring Data for O2**

Raw Monitoring CEM Data							Standardised Data
Date	Time	CEM Hourly averages %Vol Uncalibrated ⁽¹⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	CEM Hourly averages %Vol Uncalibrated ⁽²⁾
25/08/2016	09:31 - 10:30	16.17	-	-	-	-	16.17
25/08/2016	10:31 - 11:30	16.15	-	-	-	-	16.15
25/08/2016	11:31 - 12:30	16.14	-	-	-	-	16.14
25/08/2016	12:31 - 13:30	12.43	-	-	-	-	12.43
25/08/2016	13:31 - 14:30	10.58	-	-	-	-	10.58
25/08/2016	14:31 - 15:30	10.98	-	-	-	-	10.98

(1) CEM data conditions: 273K, 101.3 kPa, Dry Gas

(2) CEM data conditions: 273K, 101.3 kPa, Dry Gas, Stack Oxygen

Raw Monitoring SRM Data							Standardised Data
Date	Time	SRM Hourly averages %Vol ⁽³⁾	Temp (K)	Pressure (kPa)	Moisture (%)	Oxygen (%) Dry	SRM Hourly averages %Vol ⁽⁴⁾
25/08/2016	09:31 - 10:30	16.01	-	-	-	-	16.01
25/08/2016	10:31 - 11:30	15.99	-	-	-	-	15.99
25/08/2016	11:31 - 12:30	15.99	-	-	-	-	15.99
25/08/2016	12:31 - 13:30	12.31	-	-	-	-	12.31
25/08/2016	13:31 - 14:30	10.50	-	-	-	-	10.50
25/08/2016	14:31 - 15:30	10.85	-	-	-	-	10.85

(3) SRM data conditions: 273K, 101.3 kPa, Dry Gas

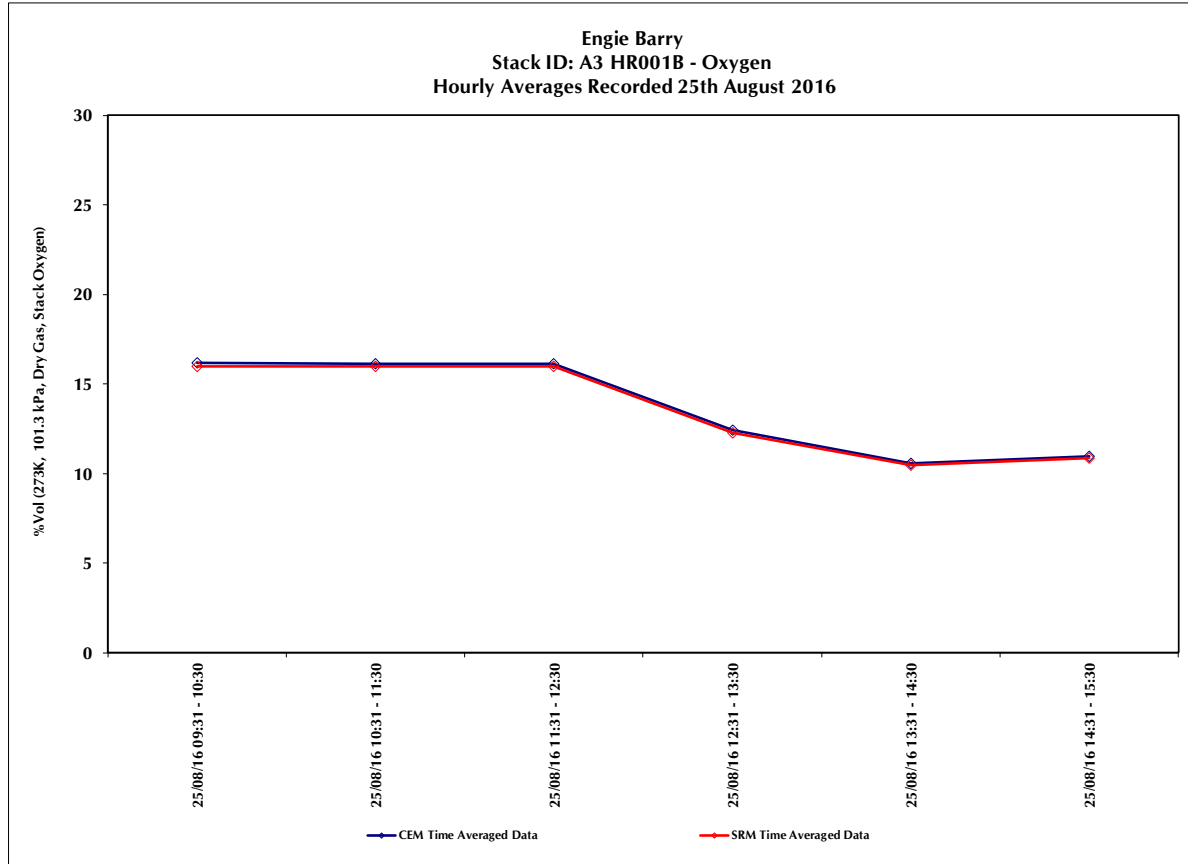
(4) SRM data conditions: 273K, 101.3 kPa, Dry Gas, Stack Oxygen

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.3c

Plot 1 - Time Series Plot of Standardised Time Averaged SRM/CEM Monitoring Data Pairs for O2



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.4c**Calculation and procedure – Elimination of outliers for O2**

Please note: Only those averages separated by at least 1 hour have been carried forward to the outlier test. After removal of any outliers, highlighted as “outlier” below, all other averages, highlighted as “yes” below, will be taken forward to the calibration coefficient validation.

n	Date	Time	SRM % Vol	CEM % Vol	$ D_i $	$ D_i - \bar{D}_i $	$ D_i - \bar{D}_i < 2\sigma?$
1	25/08/2016	09:31 - 10:30	16.01	16.17	-0.16	0.03	YES
2	25/08/2016	10:31 - 11:30	15.99	16.15	-0.16	0.03	YES
3	25/08/2016	11:31 - 12:30	15.99	16.14	-0.15	0.02	YES
4	25/08/2016	12:31 - 13:30	12.31	12.43	-0.12	0.01	YES
5	25/08/2016	13:31 - 14:30	10.50	10.58	-0.08	0.05	YES
6	25/08/2016	14:31 - 15:30	10.85	10.98	-0.12	0.01	YES

Slope	0.99	Mean	-0.13
Intercept	0.00	Stdev	0.0298
R ²	1.00		

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.5c**Table 4.3 – data used to calculate calibrated values for O2**

QAL2 Calibration function: $y=1.0149x-0.1857$								Standardised Data	
Date	Time	CEM Hourly averages %Vol Uncalibrated ⁽¹⁾	CEM Hourly averages %Vol Calibrated ⁽¹⁾	CEM Temp (K)	CEM Pressure (kPa)	CEM Moisture (%)	CEM Oxygen (%) Dry	CEM Hourly averages %Vol Calibrated ⁽²⁾	SRM Hourly averages %Vol ⁽²⁾
25/08/2016	09:31 - 10:30	16.17	16.23	-	-	-	-	16.23	16.01
25/08/2016	10:31 - 11:30	16.15	16.20	-	-	-	-	16.20	15.99
25/08/2016	11:31 - 12:30	16.14	16.19	-	-	-	-	16.19	15.99
25/08/2016	12:31 - 13:30	12.43	12.43	-	-	-	-	12.43	12.31
25/08/2016	13:31 - 14:30	10.58	10.55	-	-	-	-	10.55	10.50
25/08/2016	14:31 - 15:30	10.98	10.95	-	-	-	-	10.95	10.85

(1) 273K, 101.3 kPa, Dry Gas

(2) 273K, 101.3 kPa, Dry Gas, Stack Oxygen

B4.6c & B4.7c

Incorporating: Table 4.5 – Data used for the variability test & Calculation – the variability test and the acceptance test for O2

Determinand: Oxygen						QAL2 Calibration function: $y=1.0149x-0.1857$			
CEM Measured %Vol	SRM Measured %Vol	Calibrated CEM %Vol	SRM Measured @ Reference conditions %Vol	CEM Measured @ Reference conditions %Vol	Calibrated CEM @ Reference Conditions %Vol	Residual Value	Deviation of Residual from Mean		
x_i	y_i	$\hat{y}_i$	$y_{i,s}$	$x_{i,s}$	$\hat{y}_{i,s}$	$D_i = (y_{i,s} - \hat{y}_{i,s})$	$(D_i - \bar{D})$	$(D_i - \bar{D})^2$	
16.17	16.01	16.23	16.01	16.17	16.23	-0.21	-0.06	0.004	
16.15	15.99	16.20	15.99	16.15	16.20	-0.22	-0.06	0.004	
16.14	15.99	16.19	15.99	16.14	16.19	-0.20	-0.05	0.003	
12.43	12.31	12.43	12.31	12.43	12.43	-0.12	0.03	0.001	
10.58	10.50	10.55	10.50	10.58	10.55	-0.05	0.10	0.009	
10.98	10.85	10.95	10.85	10.98	10.95	-0.10	0.05	0.00	
Sum						-0.91	0.00	0.02	
$\bar{D} = \frac{1}{N} \sum_{i=1}^N D_i = -0.15$									
$S_D = \sqrt{\frac{1}{N-1} \sum_{i=1}^N (D_i - \bar{D})^2} = \text{SQRT}(0) = 0.07$									
$N = 6$									
$K_v = 0.93$									
$p = 10$									
$E = 21$									
$\sigma_0 = \frac{pE}{1.96} = 1.07$									
$1.5\sigma_0 k_v = 1.50$									
$s_D \leq 1.5\sigma_0 k_v = 0.07 \% \text{Vol} < 1.5 \% \text{Vol} - \text{Pass Variability Test}$									
$t_{0.95}(N-1) = 2.13$									
$t_{0.95}(N-1) \frac{S_D}{\sqrt{N}} + \sigma_0 = 1.13$									
$ \bar{D} \quad 0.15\% \text{Vol} < 1.13\% \text{Vol} - \text{Calibration Remains Valid}$									

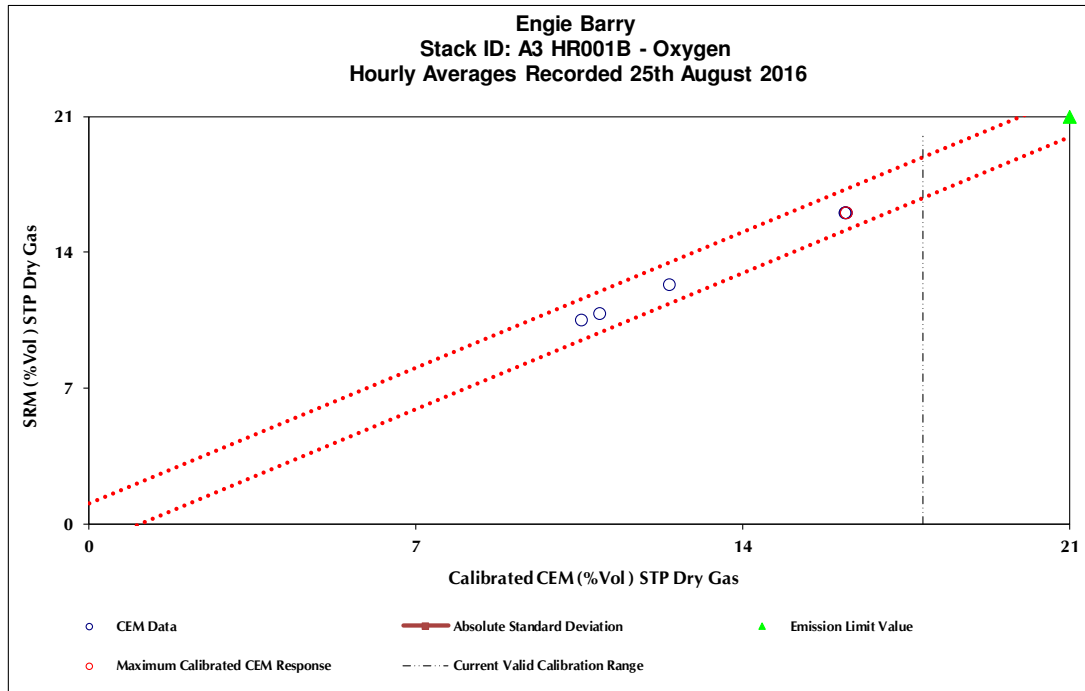
Reference Conditions 273K, 101.3 kPa, Dry Gas

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

B4.8c

Plot 2 – X-Y Plot of Standardised SRM Data Versus Standardised CEM Data for O₂



B4.9c

Summary of the Valid Calibration Range for O₂

Summary of Valid Calibration Range

Slope:	1.0149	...
Intercept:	-0.1857	%Vol
Daily ELV	21.00	%Vol
Allowable 95% Confidence Interval	± 1.07	%Vol
Upper Limit of Current Valid Calibration Range	17.86	%Vol
Maximum Calibrated CEM @ Reference Conditions	16.23	%Vol
Corresponding SRM @ Reference Conditions	16.01	%Vol
Allowable Range for Calibrated CEM Response i.e. SRM Concentration ± 1.07%	14.94 - 17.08	%Vol
Calibrated Value of CEM Response Falls Within Allowable Range?	YES	...
Maximum Calibrated CEM @ Reference Conditions plus 10% extension < 50% ELV?	N/A	...
Extended Valid Calibration Range	N/A	%Vol

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5 – RESULTS OF THE FUNCTIONAL TESTS

5.1 Functional Test Summary

Requirement	✓	Notes
1. Alignment & Cleanliness	Yes ☐ No ☐ N/A ☒	
<i>A visual inspection, with reference to the CEMs manuals, shall be carried out on the following when applicable:</i>		
• Internal check of the Analyser	N/A	
• Cleanliness of optical components	N/A	
• Flushing air supply	N/A	
• Obstructions in optical path	N/A	
<i>Following re-assembly at the sampling location, the following minimum checks have been carried out:</i>		
• Alignment of the measuring system	N/A	
• Contamination control (internal check of optical surfaces)	N/A	
2. Sampling Systems	Yes ☒ No ☐ N/A ☐	
<i>A visual inspection has been carried out and the condition of the elements of the sampling system noted (where applicable):</i>		
• Sampling probe	N	No details
• Gas conditioning systems	N/A	
• Pumps	N	No details
• All connections	Y	Visual check of sampling system, in good condition
• Sample lines	Y	Visual check of sampling system, in good condition
• Power supplies	Y	Powered off and isolated for service, all ok
• Filters	N	No details
• NOx converters – if the sampling system contains a NOx converter, then the test laboratory shall record when the last efficiency test was performed, and the result of this test	N/A	
• The sampling system shall be in good condition and free of any visible faults, which may decrease the quality of data	Y	No faults, service carried out, all reported as ok.
3. Leak testing	Yes ☒ No ☐ N/A ☐	
• Leak testing shall be performed according to the CEMs manuals. The test shall cover the entire sampling system.	Y	Use of LAND manometer, gas path integrity reported as sound
4. Zero and Span check	Yes ☒ No ☐ N/A ☐	
• Reference zero and span materials shall be used to verify the corresponding readings of the CEM.	Y	Calibration gas CO and NO used (both 200 ppm)
• In case of non-extractive CEM, zero and span checks shall be performed using a reference-path free of flue gas before and after readjustment and after re-assembly of the CEM at the measurement location.	N/A	
5. Linearity	Yes ☒ No ☐ N/A ☐	
• During the calibration/linearity tests the applied concentrations should be logged onto the DAHS to prove the complete system (i.e. concentration applied to the instrument is represented by the instrument output and identical to the value logged on the DAHS). DAHS logged values should	Y	Witnessed on site by E.C.L.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

Requirement	✓	Notes
be included in the instrument service report.		
The linearity of the CEMs response shall be checked using five different reference materials, including a zero concentration.	Y	Done in accordance to EN 14181
The reference material with zero concentration, as well as the reference materials with four difference concentrations, shall have a verifiable quantity and quality.²⁹	Y	ISO 17025 accredited gas cylinders
In case of gaseous reference materials, these four reference materials can be obtained from different gas cylinders or can be prepared by means of a calibrated dilution system from one single gas concentration.	Y	Separate cylinders for NO, CO and O2 with gas blender to gain different concentrations of each gas
The reference material concentrations shall be selected such that the measured values are at approximately 20%, 40%, 60% and 80% of a range that is at least the short-term ELV. It is necessary to know the values of the ratios of their concentrations precisely enough so that an incorrect failure of the linearity does not occur. The dry reference material shall be applied to the inlet of the CEM.	Y	Done at short-term ELV where applicable
<i>The individual CEMs are tested using the following concentrations applied in a randomised sequence:</i>		
Reference material with zero concentration;	Y	Ok
Reference material concentration approximately 20% of the range;	Y	Ok
Reference material concentration approximately 40% of the range;	Y	Ok
Reference material concentration approximately 60% of the range;	Y	Ok
Reference material concentration approximately 80% of the range;	Y	Ok
Reference material with zero concentration;	Y	Ok
After a change in concentration, the first instrument reading shall ordinarily be taken after a time period equal to at least three times the response time of the CEM.	Y	Risk based approach, all residual test pass, ok
At each reference material concentration, at least three readings shall be made, six readings shall be taken at zero.	Y	Ok
The time period between the start of each of the three readings shall be separated by at least four times the response time.	Y	Risk based approach, all residual test pass, ok
<i>A risk-based approach to linearity testing may be applied in order to reduce the time for the tests. For example, the readings may be taken after less than 3x the response time; however, if the CEM fails the linearity test then the test shall be repeated after a period of at least 3x the response time as stated above. Alternatively, the number of repetitions of the test may be reduced if the CEM passes the required performance criteria by a factor of at least 2 (i.e. half the allowable residual). Increasing the waiting time to 5x the response time, for example, may be a means of meeting this requirement.</i> <i>Where no other method is possible, the linearity can also be performed with the aid of reference materials such as grating filter or gas filters.</i>		

²⁹ Please note: if the linearity data is to be used for Method C calibration purposes then the test gases must be accredited (Section 6.3 vii, MID 14181).

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

Requirement	✓	Notes
<i>The linearity shall be calculated and tested using the procedure as given in EN 14181, Annex B. If the CEM does not pass this test, then the problem shall be identified and rectified.</i>		

6. Interferences	Yes ☐	No ☒	N/A ☐
A test shall be undertaken if the process gases to be monitored contain components that are known interferences, as identified during QAL1 and there is a failure of the QAL2 or AST which could be due to interferences.	N	No details	

7. Zero and Span drift (Audit)	Yes ☒	No ☐	N/A ☐
The test laboratory shall assess whether the operator has a QAL3 procedure in place, and whether the operator has applied this procedure. The evidence would comprise (i) a document procedure, (ii) zero and span data, (iii) control charts.	Y	QAL3 data provided, see Section 9 of this report for details	

8. Response Time	Yes ☒	No ☐	N/A ☐
Please indicate the length of sample line if known.	N	Unknown	
The response time of the CEM shall be checked. This can be performed, if appropriate, by feeding of the reference material at the end of the sampling probe. The response time shall not exceed the performance requirement applied during the QAL1 tests.	N	No details on service report Response time witnessed during E.C.L. linearity tests, And appeared to be ok and <60 seconds.	

Requirement	✓	Notes
9. Service Report	Yes ☒	No ☐ N/A ☐
<i>As a minimum requirement the service report should include the following:</i>		
Document reference for work instruction for the type of work being undertaken	Y	Section 7. 770-053
Instrument manufacturer	Y	LAND
Instrument type	N	No details
Instrument model	Y	FGA 950E
Instrument Serial No	Y	0292699, 0292697 & 9492050
Operating principle	Y	Electro-chemical sensors NO, CO, O2
Operating range	N	No details
Certification details	Y	MCERTS
Compliance with MCERTS (including certificate no.)	Y	MC 040019 / 00
Location	Y	HRS001A,
Date and time work was undertaken	Y	Date 10/08/2016 but no times
Equipment used – type, serial no's, calibration dates	N	No details
Gases used – certificate numbers, expiry dates, binary / mix	Y	Air Products site cylinders and also ISO 17025 accredited mixtures for linearity, see Section 7 of this report for further details
NOx converter efficiency test, if applicable	N/A	
Calibration and linearity data (as required by EN14181) where linearity testing is carried out during the service	Y	See Section 5 of this report for details

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

Logged data for period of calibration and linearity where linearity testing is carried out during the service³⁰	Y	Witnessed by E.C.L. on site 12.08.2016
Name and signature of service engineer	Y	Andrew Garratt and signed
10. Comments Note: Documents and records (Annex A.4, BS EN 14181: 2014) and Serviceability (Annex A.5, BS EN 14181: 2014) are covered in ECL document ECL/QFR/114. Functional tests carried out on peripheral parameters (Section 6.2, BS EN 14181: 2014)? Yes Details: Oxygen checked, moisture not measured.		

³⁰ Note: There may be gaps in the data, however, for various reasons; for example, if the CEMs are removed from the stack for the linearity test. In such cases, the test laboratory shall state why there are gaps in the data (Appendix 1, MID 14181).

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.2 Documentation & Records

Test	Test Component	Yes	No	Notes
Name of person(s) performing the functional tests and person(s) witnessing the functional tests (if applicable)		...		Andrew Garratt (LAND) carried out CEM service 10.08.2016 and Sam Brookes (E.C.L.) carried out linearity tests 12.08.2016. No functional test audit was carried out as LAND were on-site prior to E.C.L.
The CEM is covered by a current service contract ³¹ with the CEM manufacturer / supplier or other 3 rd party. The CEM manual / service agreement clearly indicate the elements covered at each service together with the associated service intervals.		✓		With LAND Ametek, in place but not witnessed on site
Documentation & Records (These must be controlled, readily accessible & up to date)	Plan of the CEM ³²	✓		Copy with Paul Gardner
	Details of performance testing and certification of the CEM	✓		In-house folder "ENV 10"
	All manuals (maintenance, users etc)	✓		In-house folder "ENV 10"
	Log books to documents possible malfunctions and action taken ³³	✓		Envirosoft reports and in control room
	Service Reports	✓		In-house folder "ENV 10"
	QAL3 documentation including action taken as a result of out of control situations ³⁴	✓		In-house folder "ENV 10"
	Management system procedures ³⁵ for maintenance, calibration & training	✓		SAM FM generates work orders
	Training records ³⁶	✓		Two staff trained by CEM supplier
	Maintenance schedules	✓		Control room
	Auditing plans / records ³⁷	✓		In-house folder "ENV 10"

³¹ If the CEM is not currently covered by a servicing or maintenance contract, indicate in the notes section what procedures are currently in place to ensure the CEM remains at a functional level suitable for its purpose. Elements included are typically sampling probe, gas conditioning system, pumps, all connections, sample lines, power supplies, filters etc.

³² A generic layout plan of the probe, sample lines & system (if present) and analyser may often be found in the CEM manual.

³³ Documentation of CEM performance e.g. possible malfunctions, remedial actions taken etc.

³⁴ Following QAL2 calibration testing a QAL3, as outlined in BS EN 14181, should be implemented to ensure the continuing validity of CEM data. Further details of the QAL3 requirements can be found in the Environment Agency's Technical Guidance Note M20.

³⁵ All internal procedures relating to the operation of the CEM, including maintenance, calibration and training.

³⁶ Evidence of all training undertaken by individuals operating or maintaining the CEM and associated software should be maintained on file. Training may be provided in-house or externally by suitably qualified personnel.

limited

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

Test Component	Yes	No	Notes
Free and clean working environment with sufficient space and weather protection	✓		CEM in weather protected box on permanent platform at height that can be exposed but plenty of space
Easy and safe access to all elements of the CEM	✓		Access is via a series of vertical ladders with cages and self-closing gates
Adequate supplies of reference materials, tools and spare parts	✓		Limited supplies, LAND on call out
Please confirm whether calibration gas can be introduced via the inlet of the sampling line and at the inlet of the analyser	✓		Linearity done direct to CEM by E.C.L. no details of LAND gas application to analyser

cluded in Section 11 at the back of this report.

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3 Linearity Testing

Please note:

The linearity check is mandatory for both QAL2 and AST as detailed in Table A.1, Annex A, BS EN 14181: 2014.

5.3.1 Method

Dry reference gases traceable to national standards are applied to the CEM at several different concentrations³⁸ (approximately 20%, 40%, 60% & 80% of at least the short-term ELV), with a zero (nitrogen) concentration being applied twice.

Gases are applied in a random order to avoid hysteresis effects, with a minimum of three readings recorded for each concentration applied. For each concentration, the start of each reading should be separated by a minimum of four times the response time.

Where individual gases at the required concentrations are unavailable, gas at a suitable concentration is blended with nitrogen to the required concentration.

Application of reference materials was undertaken by Sam Brookes (E.C.L.) on the 12th August 2016 and the data recorded. Manually recorded data was verified against data logged by the environmental data management software.

Data was analysed by Environmental Compliance Limited in accordance with the requirements of Annex B of BS EN 14181:2014.

³⁸ Specific concentrations used in each linearity test will be specified in the calculation details for each determinand.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.3.2 Data Analysis

Coefficient “a”

The coefficient “a” is calculated as follows:

$$a = \frac{1}{n} \sum_{i=1}^n x_i$$

Where:

a is the average value of the x values

x_i is the individual CEM readings

n is the number of measured signals

Coefficient “B”

The coefficient “B” is calculated as follows:

$$B = \frac{\sum_{i=1}^n x_i (c_i - \bar{c})}{\sum_{i=1}^n (c_i - \bar{c})^2}$$

Where:

$\bar{c}$ is the mean of the reference material values

c_i is the individual reference material value

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

Coefficient “A”

The coefficient “A” is calculated as follows:

$$A = a - B\bar{C}$$

Regression Function for the Linearity Test

This is expressed as:

$$x_i = A + Bc_i$$

Establish the Mean CEM Reading

For each reference concentration, the corresponding mean CEM reading is calculated using the equation below:

$$\bar{x}_c = \frac{1}{m_c} \sum_{i=1}^{m_c} x_{c,i}$$

Where:

$\bar{x}_c$ is the mean CEM reading at reference concentration c

$x_{c,i}$ is the individual CEM reading at reference concentration c

m_c is the number of repetitions at each reference concentration ($m_c=3$)

Calculate the Residual d_c at Each Reference Concentration

At each reference concentration (c), the residual between the mean CEM response and the calibrated reference concentration is calculated using the equation below:

$$d_c = \bar{x}_c - (A + Bc)$$

Each residual is converted into a relative value to the upper limit of the analyser range (x_u) using the equation below:

$$d_{c,rel} = \frac{d_c}{x_u} \times 100$$

The magnitude of the relative residuals $d_{c,rel}$ must be <5%.

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.3 95% Confidence Interval (CI) & Prediction Interval (PI) of Regression

A regression line represents the mean values of $\hat{y}$ for each value of x_i . Each measured CEM value represents the mean of a normally distributed population of possible values of $\hat{y}$. We can therefore calculate the confidence interval of each measured CEM value using the following formula:

$$CI = \hat{y}_i \pm t_{\frac{\alpha}{2}, N-2} SE \sqrt{\frac{1}{N} + \frac{(x_i - \bar{x})^2}{\sum_{i=1}^N (x_i - \bar{x})^2}}$$

Where:

$\hat{y}_i$ ith measured CEM value
 $t_{\alpha/2, N-2}$ value from the students t distribution with N-2 degrees of freedom
 N number of data values
 x_i ith applied reference concentration
 $\bar{x}$ mean applied reference concentration
 SE standard deviation of residuals

Where SE is the square root of the Standard Error of the Estimate (MSe):

$$SE = \sqrt{MSe} = \sqrt{\frac{\sum_{i=1}^N (y_i - \hat{y}_i)^2}{N - 2}}$$

y_i = ith CEM measured value

A plot of the resulting data points gives us the “Working-Hotelling Confidence Band” for the entire regression line which is based on the mean responses for each given value of x_i .

From a more practical perspective, we are often interested in future values of $\hat{y}$ based on values of x which are independent of any previous values of x_i used in calculating the linear relationship. For each future value of $\hat{y}$ we can calculate the “Prediction Interval” which is essentially a “Confidence Interval” for future observations using the following formula:

$$CI = \hat{y}_i \pm t_{\frac{\alpha}{2}, N-2} SE \sqrt{1 + \frac{1}{N} + \frac{(x_i - \bar{x})^2}{\sum_{i=1}^N (x_i - \bar{x})^2}}$$

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.3.4 95% Confidence Interval (CI) for Slope (B) of Linearity Results

The 95% confidence interval of the linearity regression slope (coefficient B) is calculated as follows:

$$95\% CI = S_b \times t_{\alpha/2, N-2}$$

Where:

S_b standard error of the slope;

$t_{\alpha/2, N-2}$ Student's t value at a probability of $\alpha/2$ with N-2 degrees of freedom.

The standard error of the slope is calculated using:

$$S_b = \frac{S_{est}}{\sqrt{SSX}}$$

Where:

S_{est} standard deviation of the residuals of estimated values ($\hat{y}$) based on the linearity coefficients A & B.

SSX sum of squares of x

Standard deviation of the residuals (S_{est}) is:

$$S_{est} = \sqrt{\frac{SS\hat{Y}}{N-2}} = \sqrt{\frac{\sum (y_i - \hat{y})^2}{N-2}}$$

Where:

y_i mean measured CEM concentration at concentration i ;

$\hat{y}$ estimated concentration based on linearity coefficients A & B;

N number of applied concentrations i .

Sum of squares of x is:

$$SSX = \sum (x_i - \bar{x})^2$$

Where:

x_i applied reference concentration i ;

$\bar{x}$ mean applied reference concentration.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.3.5 95% Confidence Interval (CI) for Intercept (A) of Linearity Results

The 95% confidence interval of the linearity regression intercept (coefficient A) is calculated as follows:

$$95\% CI = S_a \times t_{\alpha/2, N-2}$$

Where:

S_a standard error of the intercept;

$t_{\alpha/2, N-2}$ Student's t value at a probability of $\alpha/2$ with N-2 degrees of freedom.

The standard error of the intercept is calculated using:

$$S_a = s_{est} \sqrt{\frac{\sum x_i^2}{N \sum (x_i - \bar{x})^2}}$$

Where

s_{est} standard deviation of the residuals of estimated values ($\hat{y}$) based on the linearity coefficients A & B;

x_i applied reference concentration i ;

$\bar{x}$ mean applied reference concentration;

N number of applied concentrations i .

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6 Linearity Results

A1

5.3.6.1.1 Linearity Calculations for NO

Engie, Barry

Linearity test for Nitrogen Monoxide - 12/08/2016

Daily ELV: 60.88 ppm

Linearised Range: 121.76 ppm

Date	Time	% Linearised Range	Reference Concentration ppm	Measured CEM Concentration ppm	$\bar{Y}_c = \frac{1}{m_c} \sum_{i=1}^{m_c} Y_{c,i}$ ppm	$(x_i - x_z)$ ppm	$(x_i - x_z)^2$ ppm	$y_i(x_i - x_z)$ ppm	$d_c = \bar{Y}_c - (A + Bx_z)$ ppm	$d_{c,rel} = \frac{d_c}{x_u} \times 100\%$	$d_{c,rel} < 5\%$?
12/08/16	09:46	0%	0	0.00	-0.05	-40.60	1648.09	0.00	-0.15	-0.12%	PASS
	09:47			-0.05				2.03			
	09:48			-0.10				4.06			
12/08/16	09:53	60%	73.19	70.05	70.56	32.59	1062.33	2283.16	-0.15	-0.12%	PASS
	09:54			70.68				2303.53			
	09:55			70.95				2312.50			
12/08/16	09:59	20%	24.05	23.98	23.73	-16.55	273.79	-396.71	0.42	0.35%	PASS
	10:00			23.63				-390.92			
	10:01			23.58				-390.09			
12/08/16	10:05	80%	97.24	94.28	93.87	56.64	3208.47	5340.05	-0.04	-0.04%	PASS
	10:06			93.53				5297.57			
	10:07			93.80				5313.14			
12/08/16	10:10	40%	49.1	47.58	47.58	8.50	72.31	404.55	0.11	0.09%	PASS
	10:11			47.65				405.18			
	10:12			47.50				403.91			
12/08/16	10:16	0%	0	-0.05	-0.08	-40.60	1648.09	2.03	-0.18	-0.15%	PASS
	10:17			-0.10				4.06			
	10:18			-0.10				4.06			

Sum	730.74	706.78
Mean ($\bar{X}_z$)	40.60	39.27
Count (n)	...	18

23739.21	22902.12
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$$a = \frac{1}{n} \sum_{i=1}^n Y_i \quad \boxed{39.27}$$

$$B = \frac{\sum_{i=1}^n Y_i (X_i - X_z)}{\sum_{i=1}^n (X_i - X_z)^2} \quad \boxed{0.9647} \quad \pm 0.008$$

$$A = a - B X_z \quad \boxed{0.1001} \quad \pm 0.443$$

$$\text{Range (} X_u \text{)} \quad \boxed{122} \text{ ppm}$$

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.1.2 95% CI & PI Calculations for NO

95% Confidence Intervals

$\hat{y}$	$(y - \hat{y})^2$	x^2	$(\hat{y} - \bar{y})^2$	95% CI	95% PI
0.10	0.023	0.00	1533.91	0.44	0.85
70.71	0.023	5356.78	988.73	0.40	0.82
23.30	0.18	578.40	254.82	0.32	0.79
93.91	0.002	9455.62	2986.18	0.55	0.91
47.47	0.01	2410.81	67.30	0.30	0.78
0.10	0.03	0.00	1533.91	0.44	0.85

MSE: 0.07

95% Confidence Interval of Slope

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.2603$$

$$\sqrt{SSX} \quad 88.96$$

$$s_b = \frac{s_{est}}{\sqrt{SSX}} \quad 0.0029$$

$$t_{\alpha/2, N-2} \quad 2.78$$

$$95\% CI = s_b \times t_{\alpha/2, N-2} \quad 0.008$$

95% Confidence Interval of Intercept

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.2603$$

$$n \sum (x - \bar{x})^2 \quad 47478.42$$

$$\sum x^2 \quad 17801.61$$

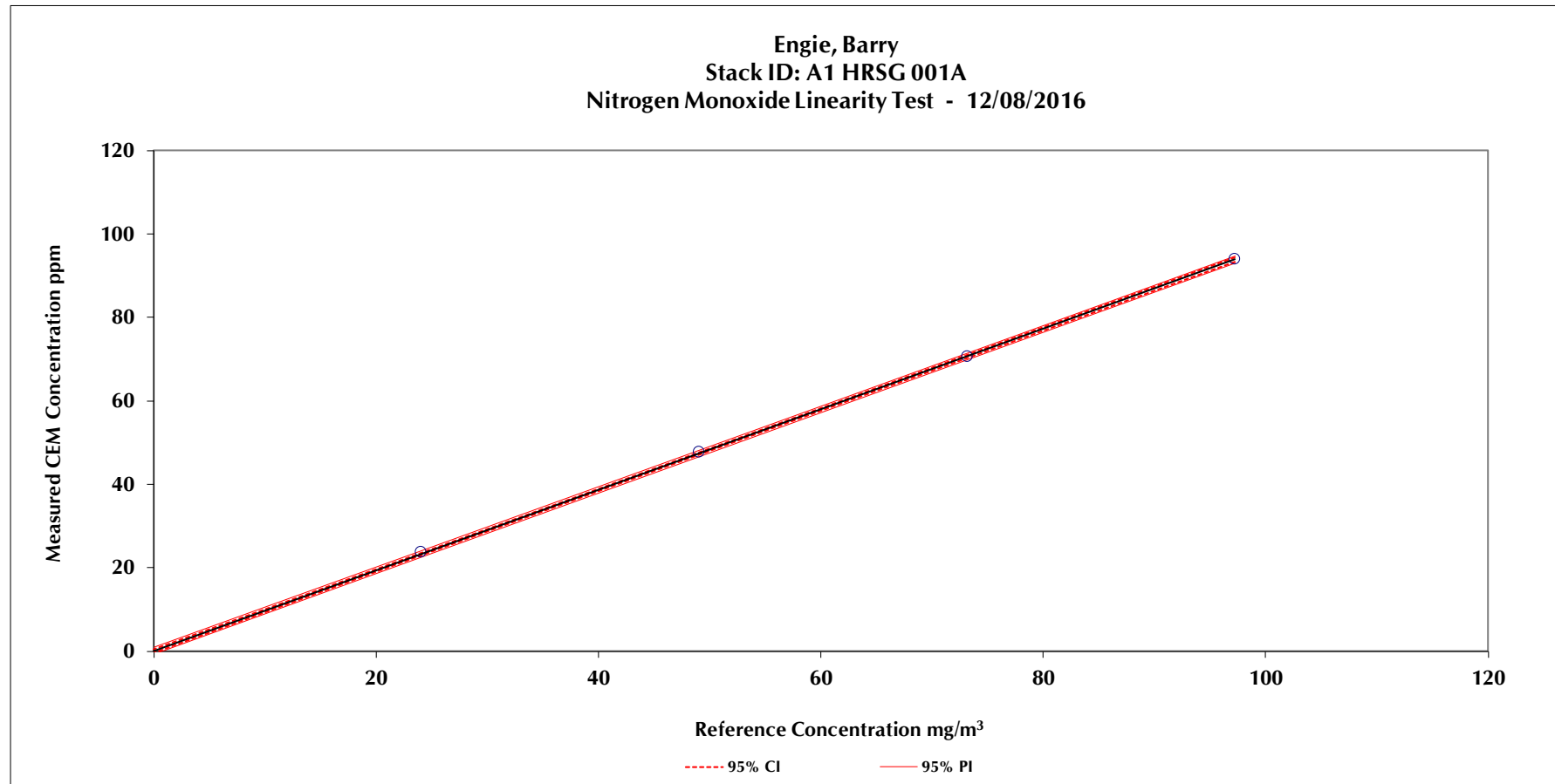
$$s_a = s_{est} \sqrt{\frac{\sum x^2}{n \sum (x - \bar{x})^2}} \quad 0.16$$

$$95\% CI = s_a \times t_{\alpha/2, N-2} \quad 0.44$$

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.1.3 XY Plot of Measured CEM Concentration Vs Concentration of Applied Reference Materials for NO



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.3.6.2.1 Linearity Calculations for CO

Engie, Barry

Linearity test for Carbon Monoxide - 12/08/2016

Daily ELV: 64 ppm

Linearised Range: 128 ppm

Date	Time	% Linearised Range	Reference Concentration ppm	Measured CEM Concentration ppm	$\bar{Y}_c = \frac{1}{m_c} \sum_{i=1}^m Y_{c,i}$ ppm	$(x_i - x_z)$ ppm	$(x_i - x_z)^2$ ppm	$y_i(x_i - x_z)$ ppm	$d_c = \bar{Y}_c - (A + Bx)$ ppm	$d_{c,rel} = \frac{d_c}{x_u} \times 100\%$	$d_{c,rel} < 5\%$?
12/08/16	10:16	0%	0	0.65	0.62	-42.70	1823.57	-27.76	-0.45	-0.35%	PASS
	10:17			0.60				-25.62			
	10:18			0.60				-25.62			
12/08/16	10:23	60%	77.11	77.80	77.53	34.41	1183.82	2676.84	0.18	0.14%	PASS
	10:24			77.23				2657.05			
	10:25			77.58				2669.10			
12/08/16	10:28	20%	25.7	27.15	27.03	-17.00	289.11	-461.64	0.54	0.42%	PASS
	10:29			27.00				-459.09			
	10:30			26.93				-457.81			
12/08/16	10:34	80%	102.01	101.20	101.42	59.31	3517.28	6001.83	-0.57	-0.44%	PASS
	10:35			101.43				6015.18			
	10:36			101.63				6027.04			
12/08/16	10:41	40%	51.4	52.63	52.49	8.70	75.63	457.66	0.58	0.45%	PASS
	10:42			52.50				456.58			
	10:43			52.35				455.27			
12/08/16	10:47	0%	0	0.70	0.78	-42.70	1823.57	-29.89	-0.29	-0.22%	PASS
	10:48			0.80				-34.16			
	10:49			0.83				-35.23			

Sum	768.66	779.58
Mean ($\bar{X}_z$)	42.70	43.31
Count (n)	...	18

26138.98	25859.72
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$$a = \frac{1}{n} \sum_{i=1}^n Y_i \quad \boxed{43.31}$$

$$B = \frac{\sum_{i=1}^n Y_i (X_i - \bar{X}_z)}{\sum_{i=1}^n (X_i - \bar{X}_z)^2} \quad \boxed{0.9893} \quad \pm 0.017$$

$$A = a - B\bar{X}_z \quad \boxed{1.0626} \quad \pm 0.955$$

$$\text{Range (} \bar{X}_u \text{)} \quad \boxed{128} \text{ ppm}$$

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.2.2 95% CI & PI Calculations for CO

95% Confidence Intervals

$\hat{y}$	$(y - \hat{y})^2$	x^2	$(\hat{y} - \bar{y})^2$	95% CI	95% PI
1.06	0.199	0.00	1784.82	0.95	1.83
77.35	0.034	5945.95	1158.66	0.86	1.78
26.49	0.29	660.49	282.97	0.70	1.71
101.98	0.320	10406.04	3442.53	1.18	1.95
51.91	0.33	2641.96	74.02	0.65	1.69
1.06	0.08	0.00	1784.82	0.95	1.83

MSE: 0.31

95% Confidence Interval of Slope

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.5610$$

$$\sqrt{SSX} \quad 93.34$$

$$s_b = \frac{s_{est}}{\sqrt{SSX}} \quad 0.0060$$

$$t_{\alpha/2, N-2} \quad 2.78$$

$$95\% CI = s_b \times t_{\alpha/2, N-2} \quad 0.017$$

95% Confidence Interval of Intercept

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.5610$$

$$n \sum (x - \bar{x})^2 \quad 52277.96$$

$$\sum x^2 \quad 19654.44$$

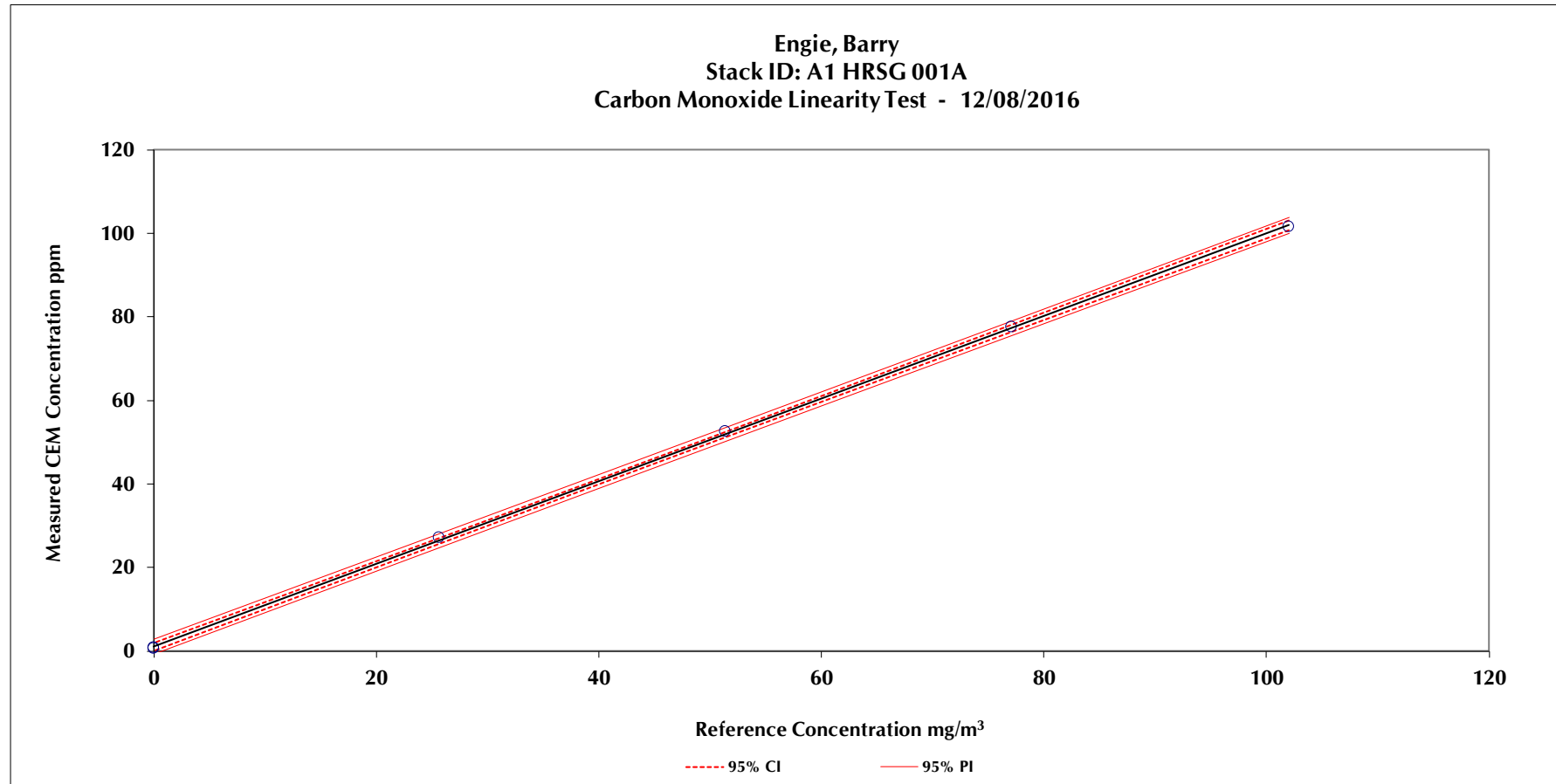
$$s_a = s_{est} \sqrt{\frac{\sum x^2}{n \sum (x - \bar{x})^2}} \quad 0.34$$

$$95\% CI = s_a \times t_{\alpha/2, N-2} \quad 0.95$$

Engie
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Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.2.3 XY Plot of Measured CEM Concentration Vs Concentration of Applied Reference Materials for CO



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.3.6.3.1 Linearity Calculations for O2

Engie, Barry

Linearity test for Oxygen - 12/08/2016

Daily ELV: 21 %Vol

Linearised Range: 21 %Vol

Date	Time	% Linearised Range	Reference Concentration % Vol	Measured CEM Concentration % Vol	$\bar{Y}_c = \frac{1}{m} \sum_{i=1}^m Y_{c,i}$ % Vol	$(x_i - x_z)$ % Vol	$(x_i - x_z)^2$ % Vol	$y_i(x_i - x_z)$ % Vol	$d_c = \bar{Y}_c - (A + Bx)$ % Vol	$d_{c,rel} = \frac{d_c}{x_u} \times 100\%$	$d_{c,rel} < 5\%$?
12/08/16	10:47	0%	0	-0.02	-0.02	-6.67	44.42	0.13	0.00	0.00%	PASS
	10:48			-0.02				0.13			
	10:49			-0.02				0.13			
12/08/16	10:53	62%	12.99	12.90	12.91	6.33	40.01	81.59	0.06	0.27%	PASS
	10:54			12.91				81.62			
	10:55			12.94				81.81			
12/08/16	10:58	19%	4.01	3.95	3.97	-2.66	7.05	-10.49	0.02	0.09%	PASS
	10:59			4.00				-10.63			
	11:00			3.97				-10.53			
12/08/16	11:04	71%	14.97	14.81	14.81	8.31	68.97	122.96	-0.01	-0.05%	PASS
	11:05			14.81				123.00			
	11:06			14.81				123.02			
12/08/16	11:09	38%	8.02	7.85	7.85	1.36	1.84	10.64	-0.08	-0.38%	PASS
	11:10			7.85				10.64			
	11:11			7.85				10.63			
12/08/16	11:15	0%	0	0.00	0.00	-6.67	44.42	0.00	0.02	0.08%	PASS
	11:16			0.00				0.00			
	11:17			-0.01				0.07			

Sum	119.97	118.57
Mean ($\bar{X}_z$)	6.67	6.59
Count (n)	...	18

620.12	614.73
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$$a = \frac{1}{n} \sum_{i=1}^n Y_i \quad \boxed{6.59}$$

$$B = \frac{\sum_{i=1}^n Y_i (X_i - \bar{X}_z)}{\sum_{i=1}^n (X_i - \bar{X}_z)^2} \quad \boxed{0.9913} \quad \pm 0.01$$

$$A = a - B\bar{X}_z \quad \boxed{-0.0198} \quad \pm 0.086$$

$$\text{Range (} X_u \text{)} \quad \boxed{21} \quad \% \text{ Vol}$$

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.3.2 95% CI & PI Calculations for O2

95% Confidence Intervals

$\hat{y}$	$(y - \hat{y})^2$	x^2	$(\hat{y} - \bar{y})^2$	95% CI	95% PI
-0.02	0.000	0.00	43.65	0.09	0.16
12.86	0.003	168.74	39.31	0.08	0.16
3.96	0.00	16.08	6.93	0.06	0.15
14.82	0.000	224.10	67.78	0.10	0.17
7.93	0.01	64.32	1.80	0.06	0.15
-0.02	0.00	0.00	43.65	0.09	0.16

MSE: 0.00

95% Confidence Interval of Slope

$$s_{est} = \sqrt{\frac{SS\hat{Y}}{N-2}} \quad 0.0504$$

$$\sqrt{SSX} \quad 14.38$$

$$s_b = \frac{s_{est}}{\sqrt{SSX}} \quad 0.0035$$

$$t_{\alpha/2, N-2} \quad 2.78$$

$$95\% CI = s_b \times t_{\alpha/2, N-2} \quad 0.010$$

95% Confidence Interval of Intercept

$$s_{est} = \sqrt{\frac{SS\hat{Y}}{N-2}} \quad 0.0504$$

$$n \sum (x - \bar{x})^2 \quad 1240.25$$

$$\sum x^2 \quad 473.24$$

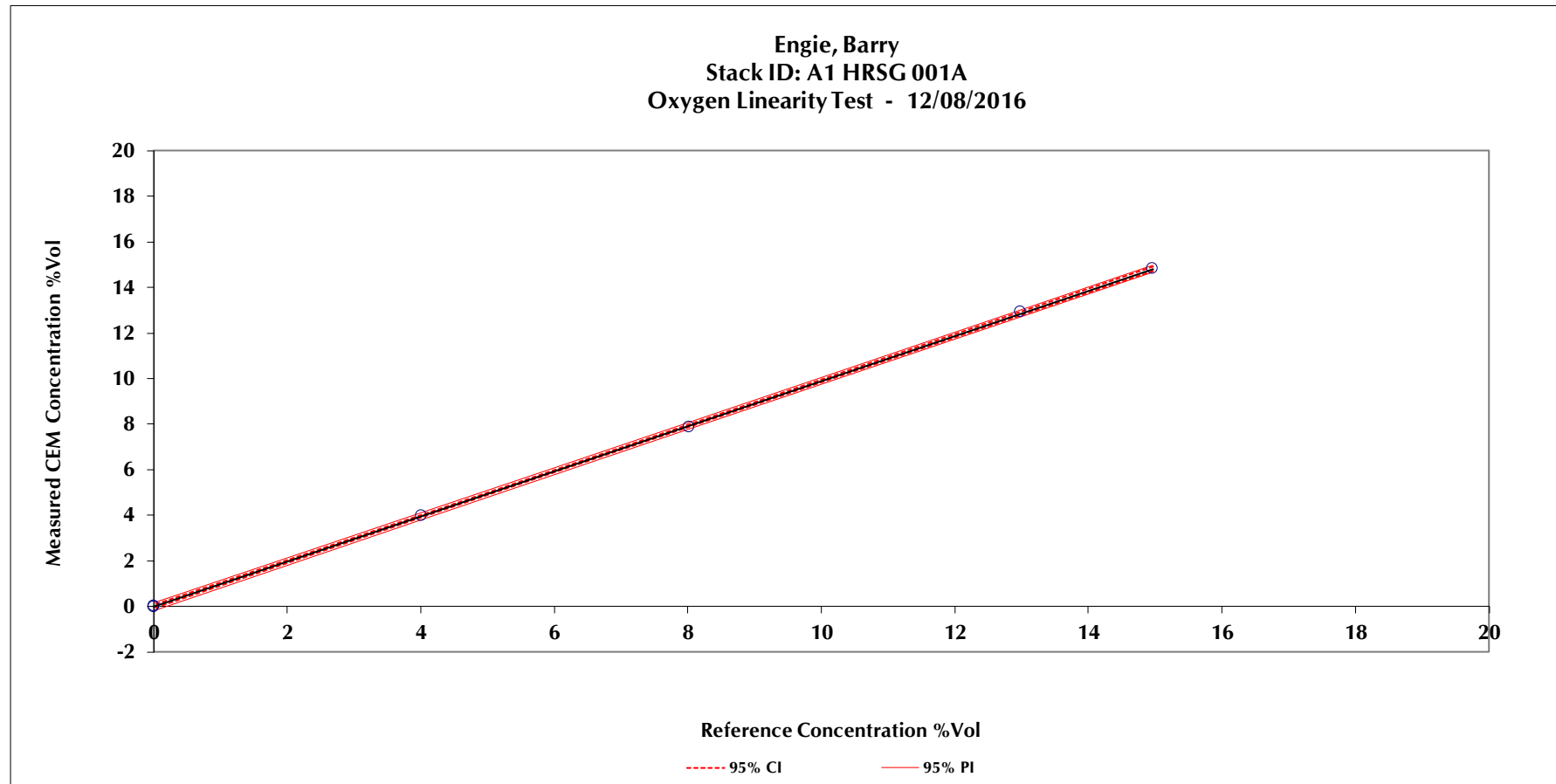
$$s_a = s_{est} \sqrt{\frac{\sum x^2}{n \sum (x - \bar{x})^2}} \quad 0.03$$

$$95\% CI = s_a \times t_{\alpha/2, N-2} \quad 0.09$$

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Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.3.3 XY Plot of Measured CEM Concentration Vs Concentration of Applied Reference Materials for O2



Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

A2

5.3.6.1.1 Linearity Calculations for NO

Engie, Barry

Linearity test for Nitrogen Monoxide - 12/08/2016

Daily ELV: 121.77 ppm

Linearised Range: 243.54 ppm

Date	Time	% Linearised Range	Reference Concentration ppm	Measured CEM Concentration ppm	$\bar{Y}_c = \frac{1}{m_c} \sum_{i=1}^m Y_{c,i}$ ppm	$(x_1 - x_2)$ ppm	$(x_1 - x_2)^2$ ppm	$y_i(x_1 - x_2)$ ppm	$d_c = \bar{Y}_c - (A + Bx_c)$ ppm	$d_{c,rel} = \frac{d_c}{X_u} \times 100\%$	$d_{c,rel} < 5\%$?
12/08/16	11:29	0%	0	-0.30	-0.30	-81.21	6594.52	24.36	-0.03	-0.01%	PASS
	11:30			-0.30				24.36			
	11:31			-0.30				24.36			
12/08/16	11:36	60%	146.38	146.65	147.37	65.17	4247.56	9557.67	-1.02	-0.42%	PASS
	11:37			147.23				9595.14			
	11:38			148.23				9660.32			
12/08/16	11:42	20%	49.14	49.55	49.31	-32.07	1028.27	-1588.90	-0.33	-0.13%	PASS
	11:43			49.18				-1576.88			
	11:44			49.20				-1577.68			
12/08/16	11:50	80%	194.48	197.23	197.33	113.27	12830.85	22340.33	0.10	0.04%	PASS
	11:51			197.73				22396.97			
	11:52			197.05				22320.51			
12/08/16	11:56	40%	97.24	100.20	99.98	16.03	257.07	1606.54	1.49	0.61%	PASS
	11:57			99.98				1602.93			
	11:58			99.75				1599.33			
12/08/16	12:03	0%	0	-0.48	-0.49	-81.21	6594.52	38.57	-0.22	-0.09%	PASS
	12:04			-0.50				40.60			
	12:05			-0.50				40.60			

Sum	1461.72	1479.58
Mean (X_z)	81.21	82.20
Count (n)	...	18

94658.39	96129.15
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$$a = \frac{1}{n} \sum_{i=1}^n Y_i \quad \boxed{82.20}$$

$$B = \frac{\sum_{i=1}^n Y_i (X_i - X_z)}{\sum_{i=1}^n (X_i - X_z)^2} \quad \boxed{1.0155} \quad \pm 0.014$$

$$A = a - BX_z \quad \boxed{-0.2698} \quad \pm 1.577$$

$$\text{Range (} X_u \text{)} \quad \boxed{244} \text{ ppm}$$

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.3.6.1.2 95% CI & PI Calculations for NO

95% Confidence Intervals

$\hat{y}$	$(y - \hat{y})^2$	x^2	$(\hat{y} - \bar{y})^2$	95% CI	95% PI
-0.27	0.001	0.00	6801.04	1.58	3.02
148.38	1.036	21427.10	4380.58	1.41	2.93
49.63	0.11	2414.74	1060.47	1.15	2.82
197.23	0.010	37822.47	13232.67	1.95	3.23
98.48	2.23	9455.62	265.12	1.08	2.79
-0.27	0.05	0.00	6801.04	1.58	3.02

MSE: 0.86

95% Confidence Interval of Slope

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.9266$$

$$\sqrt{SSX} \quad 177.63$$

$$s_b = \frac{s_{est}}{\sqrt{SSX}} \quad 0.0052$$

$$t_{\alpha/2, N-2} \quad 2.78$$

$$95\% CI = s_b \times t_{\alpha/2, N-2} \quad 0.014$$

95% Confidence Interval of Intercept

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.9266$$

$$n \sum (x - \bar{x})^2 \quad 189316.77$$

$$\sum x^2 \quad 71119.93$$

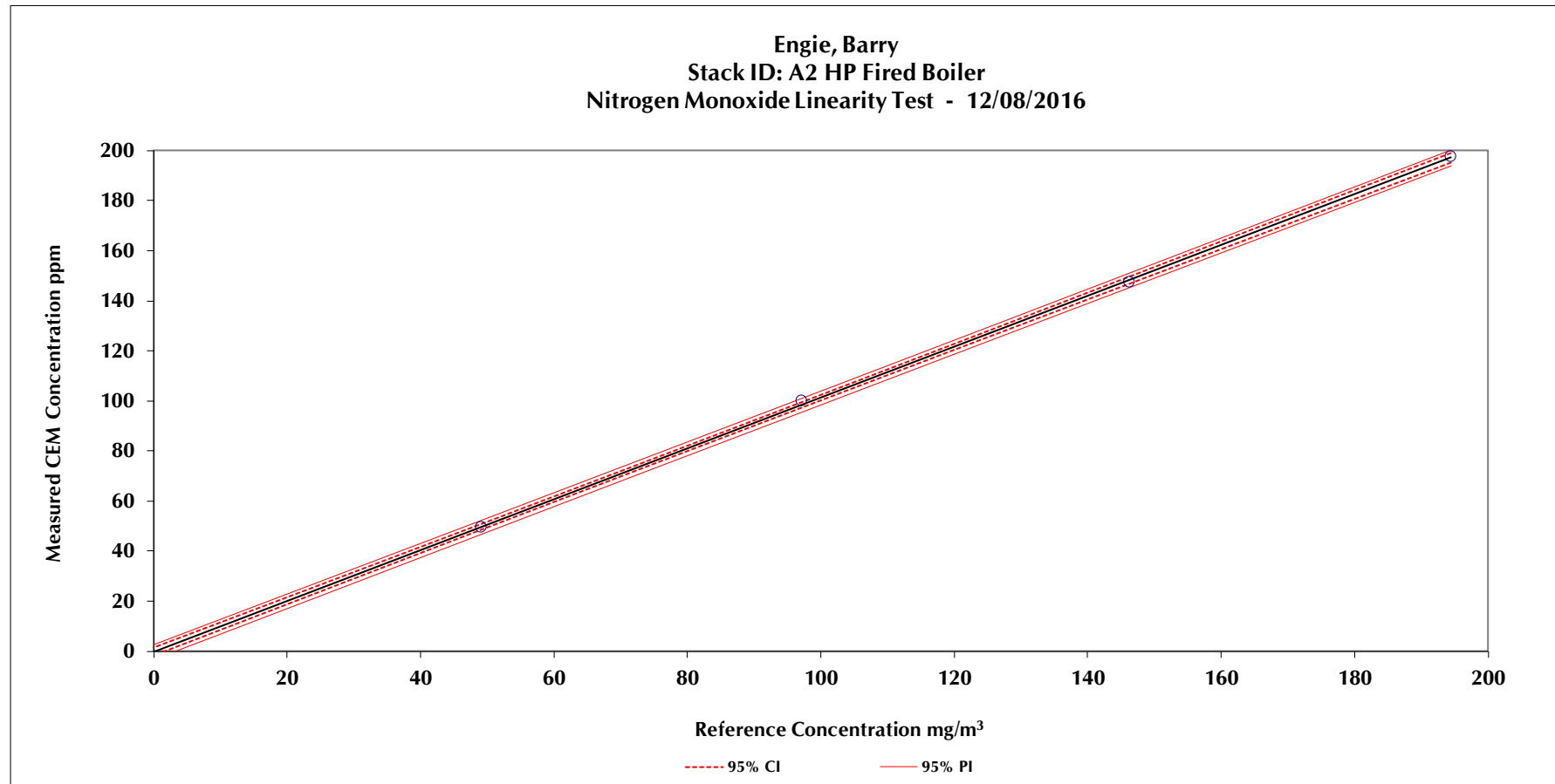
$$s_a = s_{est} \sqrt{\frac{\sum x^2}{n \sum (x - \bar{x})^2}} \quad 0.57$$

$$95\% CI = s_a \times t_{\alpha/2, N-2} \quad 1.58$$

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.1.3 XY Plot of Measured CEM Concentration Vs Concentration of Applied Reference Materials for NO



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.3.6.2.1 Linearity Calculations for CO

Engie, Barry

Linearity test for Carbon Monoxide - 12/08/2016

Daily ELV: 88 ppm

Linearised Range: 176 ppm

Date	Time	% Linearised Range	Reference Concentration ppm	Measured CEM Concentration ppm	$\bar{Y}_c = \frac{1}{m_c} \sum_{i=1}^m Y_{c,i}$ ppm	$(x_i - x_z)$ ppm	$(x_i - x_z)^2$ ppm	$y_i(x_i - x_z)$ ppm	$d_c = \bar{Y}_c - (A + Bx_z)$ ppm	$d_{c,rel} = \frac{d_c}{x_u} \times 100\%$	$d_{c,rel} < 5\%?$
12/08/16	12:03	0%	0	1.55	1.51	-58.77	3453.52	-91.09	-0.10	-0.05%	PASS
	12:04			1.45				-85.21			
	12:05			1.53				-89.62			
12/08/16	12:09	60%	106.02	106.08	105.83	47.25	2232.88	5012.40	0.91	0.52%	PASS
	12:10			105.60				4989.95			
	12:11			105.83				5000.58			
12/08/16	12:15	20%	35.34	36.63	36.73	-23.43	548.81	-858.00	0.69	0.39%	PASS
	12:16			36.60				-857.42			
	12:17			36.98				-866.20			
12/08/16	12:23	80%	141.36	138.28	138.18	82.59	6821.66	11420.59	-1.19	-0.67%	PASS
	12:24			137.45				11352.45			
	12:25			138.80				11463.95			
12/08/16	12:29	40%	69.88	70.38	70.37	11.11	123.51	782.10	0.66	0.38%	PASS
	12:30			70.50				783.49			
	12:31			70.23				780.43			
12/08/16	12:38	0%	0	0.68	0.62	-58.77	3453.52	-39.67	-0.99	-0.56%	PASS
	12:39			0.60				-35.26			
	12:40			0.58				-33.79			

Sum	1057.80	1059.70
Mean ($\bar{X}_z$)	58.77	58.87
Count (n)	...	18

49901.68	48629.70
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$$a = \frac{1}{n} \sum_{i=1}^n Y_i \quad \boxed{58.87}$$

$$B = \frac{\sum_{i=1}^n Y_i (X_i - X_z)}{\sum_{i=1}^n (X_i - X_z)^2} \quad \boxed{0.9745} \quad \pm 0.022$$

$$A = a - Bx_z \quad \boxed{1.6035} \quad \pm 1.728$$

$$\text{Range (} X_u \text{)} \quad \boxed{176} \text{ ppm}$$

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.2.2 95% CI & PI Calculations for CO

95% Confidence Intervals

$\hat{y}$	$(y - \hat{y})^2$	x^2	$(\hat{y} - \bar{y})^2$	95% CI	95% PI
1.60	0.009	0.00	3279.71	1.73	3.31
104.92	0.832	11240.24	2120.50	1.55	3.22
36.04	0.48	1248.92	521.19	1.26	3.09
139.36	1.405	19982.65	6478.33	2.14	3.55
69.70	0.44	4883.21	117.29	1.18	3.06
1.60	0.97	0.00	3279.71	1.73	3.31

MSE: 1.03

95% Confidence Interval of Slope

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 1.0171$$

$$\sqrt{SSX} \quad 128.97$$

$$s_b = \frac{s_{est}}{\sqrt{SSX}} \quad 0.0079$$

$$t_{\alpha/2, N-2} \quad 2.78$$

$$95\% \text{ CI} = s_b \times t_{\alpha/2, N-2} \quad 0.022$$

95% Confidence Interval of Intercept

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 1.0171$$

$$n \sum (x - \bar{x})^2 \quad 99803.36$$

$$\sum x^2 \quad 37355.02$$

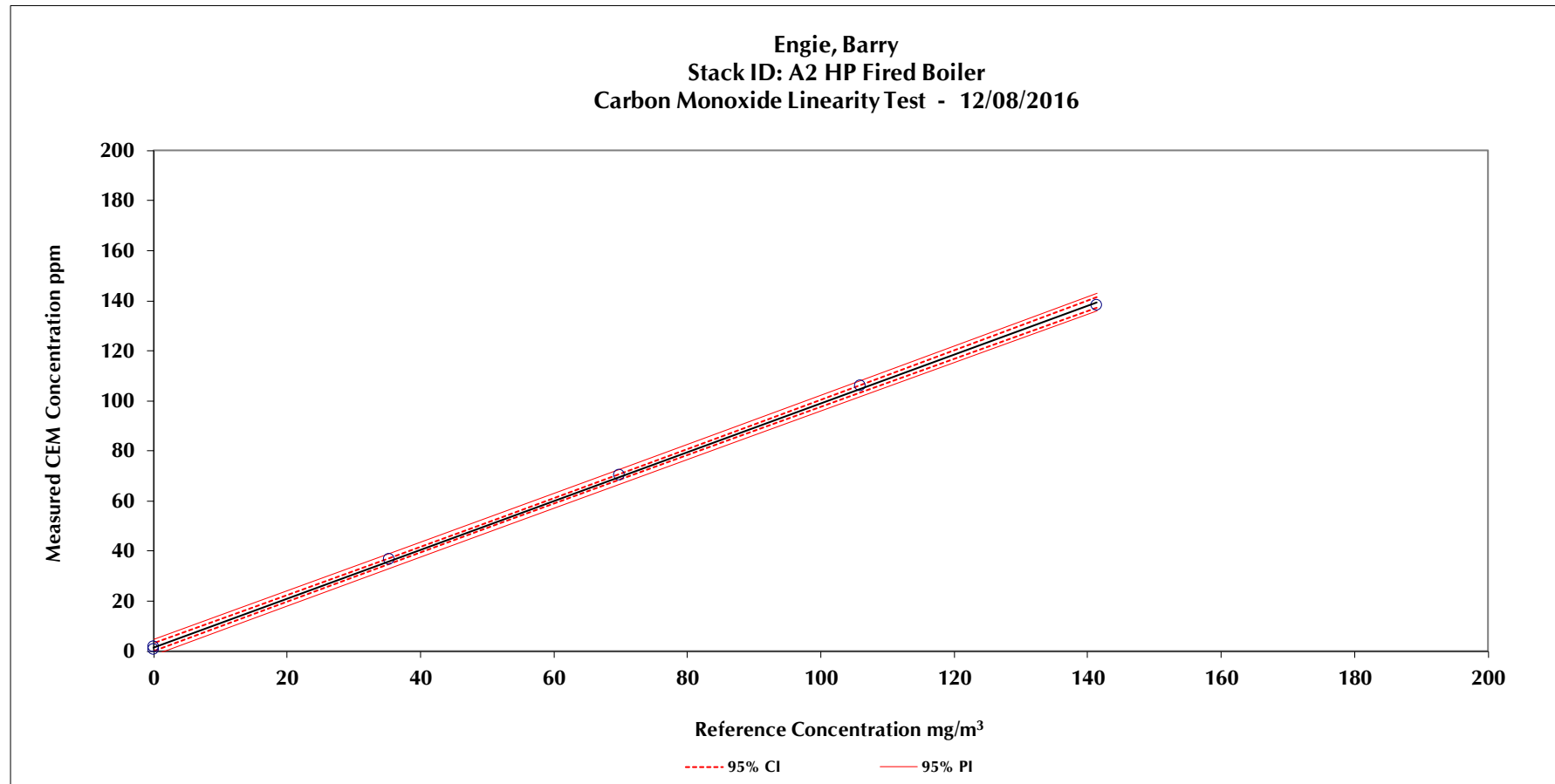
$$s_a = s_{est} \sqrt{\frac{\sum x^2}{n \sum (x - \bar{x})^2}} \quad 0.62$$

$$95\% \text{ CI} = s_a \times t_{\alpha/2, N-2} \quad 1.73$$

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.2.3 XY Plot of Measured CEM Concentration Vs Concentration of Applied Reference Materials for CO



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.3.6.3.1 Linearity Calculations for O2

Engie, Barry

Linearity test for Oxygen - 12/08/2016

Daily ELV: 21 %Vol

Linearised Range: 21 %Vol

Date	Time	% Linearised Range	Reference Concentration %Vol	Measured CEM Concentration %Vol	$\bar{Y}_c = \frac{1}{m_c} \sum_{i=1}^{m_c} Y_{c,i}$ %Vol	$(x_i - x_z)$ %Vol	$(x_i - x_z)^2$ %Vol	$y_i(x_i - x_z)$ %Vol	$d_c = \bar{Y}_c - (A + Bx_z)$ %Vol	$d_{c,rel} = \frac{d_c}{x_u} \times 100\%$	$d_{c,rel} < 5\%$?
12/08/16	12:38	0%	0	-0.01	-0.01	-6.67	44.42	0.07	-0.02	-0.09%	PASS
	12:39			-0.01				0.07			
	12:40			0.00				0.00			
12/08/16	12:44	62%	12.99	12.64	12.70	6.33	40.01	79.96	0.02	0.10%	PASS
	12:45			12.73				80.52			
	12:46			12.73				80.49			
12/08/16	12:51	19%	4.01	3.95	3.95	-2.66	7.05	-10.49	0.03	0.13%	PASS
	12:52			3.94				-10.47			
	12:53			3.95				-10.49			
12/08/16	12:57	71%	14.97	14.57	14.58	8.31	68.97	121.00	-0.03	-0.16%	PASS
	12:58			14.58				121.05			
	12:59			14.58				121.09			
12/08/16	13:02	38%	8.02	7.85	7.85	1.36	1.84	10.64	0.02	0.09%	PASS
	13:03			7.86				10.65			
	13:04			7.84				10.63			
12/08/16	13:10	0%	0	0.02	0.00	-6.67	44.42	-0.12	-0.01	-0.06%	PASS
	13:11			-0.01				0.07			
	13:12			-0.01				0.07			

Sum	119.97	117.20
Mean (X_z)	6.67	6.51
Count (n)	...	18

620.12	604.72
--------	--------

$$a = \frac{1}{n} \sum_{i=1}^n Y_i \quad \boxed{6.51}$$

$$B = \frac{\sum_{i=1}^n Y_i (X_i - X_z)}{\sum_{i=1}^n (X_i - X_z)^2} \quad \boxed{0.9752} \quad \pm 0.005$$

$$A = a - Bx_z \quad \boxed{0.0116} \quad \pm 0.048$$

$$\text{Range (} X_u \text{)} \quad \boxed{21} \quad \% \text{Vol}$$

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.3.6.3.2 95% CI & PI Calculations for O2

95% Confidence Intervals

$\hat{y}$	$(y - \hat{y})^2$	x^2	$(\hat{y} - \bar{y})^2$	95% CI	95% PI
0.01	0.000	0.00	42.24	0.05	0.09
12.68	0.000	168.74	38.04	0.05	0.09
3.92	0.00	16.08	6.70	0.03	0.09
14.61	0.001	224.10	65.59	0.06	0.10
7.83	0.00	64.32	1.75	0.03	0.08
0.01	0.00	0.00	42.24	0.05	0.09

MSE: 0.00

95% Confidence Interval of Slope

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.0280$$

$$\sqrt{SSX} \quad 14.38$$

$$s_b = \frac{s_{est}}{\sqrt{SSX}} \quad 0.0019$$

$$t_{\alpha/2, N-2} \quad 2.78$$

$$95\% CI = s_b \times t_{\alpha/2, N-2} \quad 0.005$$

95% Confidence Interval of Intercept

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.0280$$

$$n \sum (x - \bar{x})^2 \quad 1240.25$$

$$\sum x^2 \quad 473.24$$

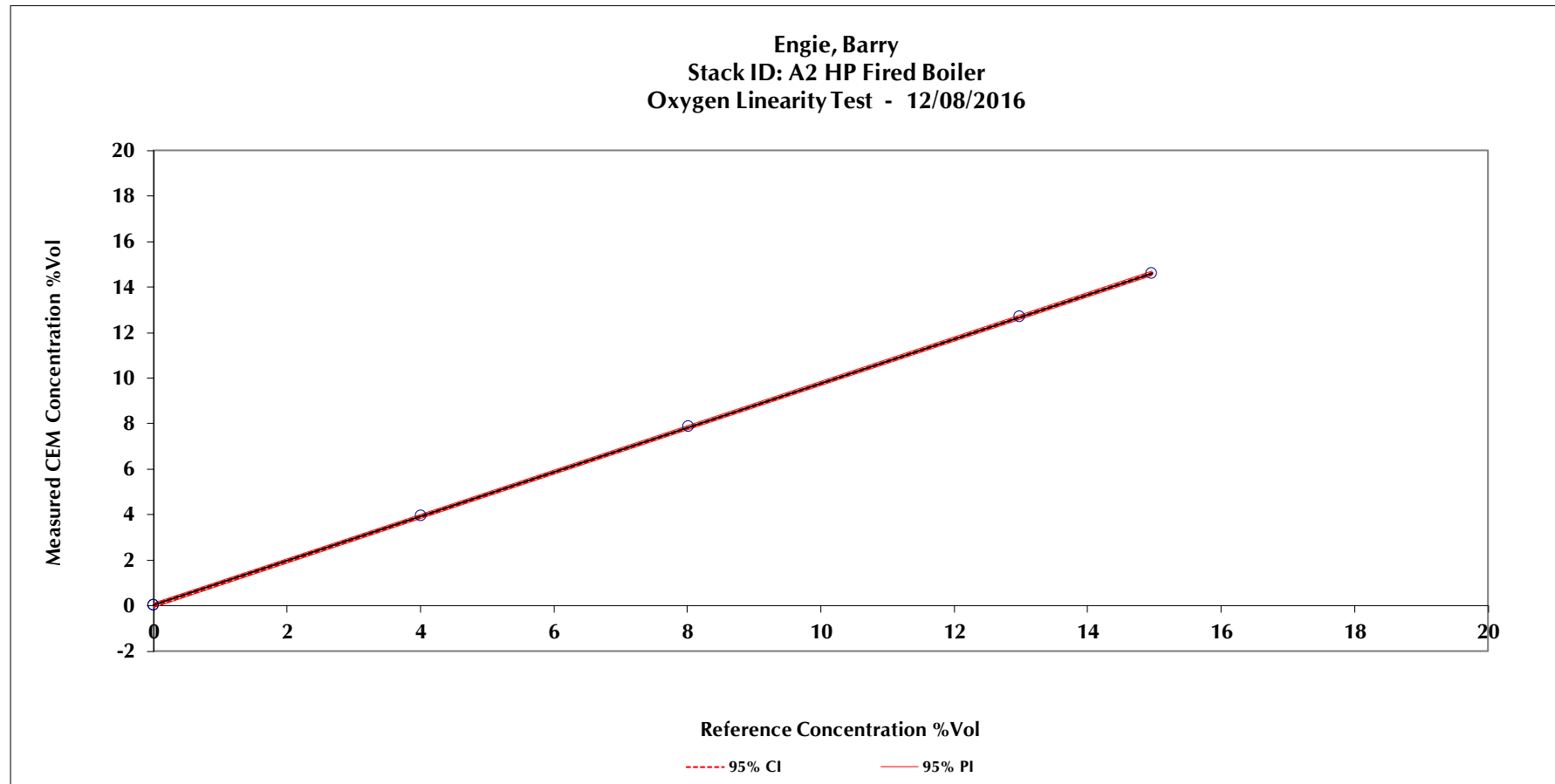
$$s_a = s_{est} \sqrt{\frac{\sum x^2}{n \sum (x - \bar{x})^2}} \quad 0.02$$

$$95\% CI = s_a \times t_{\alpha/2, N-2} \quad 0.05$$

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.3.3 XY Plot of Measured CEM Concentration Vs Concentration of Applied Reference Materials for O2



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

A3

5.3.6.1.1 Linearity Calculations for NO

Engie, Barry

Linearity test for Nitrogen Monoxide - 12/08/2016

Daily ELV: 60.88 ppm

Linearised Range: 121.76 ppm

Date	Time	% Linearised Range	Reference Concentration ppm	Measured CEM Concentration ppm	$\bar{Y}_c = \frac{1}{m_c} \sum_{i=1}^{m_c} Y_{c,i}$ ppm	$(x_i - x_z)$ ppm	$(x_i - x_z)^2$ ppm	$y_i(x_i - x_z)$ ppm	$d_c = \bar{Y}_c - (A + Bx_z)$ ppm	$d_{c,rel} = \frac{d_c}{X_u} \times 100\%$	$d_{c,rel} < 5\%$?
12/08/16	13:17	0%	0	0.05	0.02	-40.60	1648.09	-2.03	-0.04	-0.03%	PASS
	13:18			0.00				0.00			
	13:19			0.00				0.00			
12/08/16	13:23	60%	73.19	71.05	71.15	32.59	1062.33	2315.76	0.38	0.31%	PASS
	13:24			71.25				2322.28			
	13:25			71.15				2319.02			
12/08/16	13:28	20%	24.05	23.68	23.36	-16.55	273.79	-391.74	0.07	0.05%	PASS
	13:29			23.03				-380.99			
	13:30			23.38				-386.78			
12/08/16	13:34	80%	97.24	93.45	93.76	56.64	3208.47	5293.32	-0.25	-0.21%	PASS
	13:35			93.93				5320.23			
	13:36			93.90				5318.81			
12/08/16	13:39	40%	49.1	47.73	47.39	8.50	72.31	405.82	-0.10	-0.08%	PASS
	13:40			47.38				402.85			
	13:41			47.08				400.29			
12/08/16	13:49	0%	0	0.00	0.00	-40.60	1648.09	0.00	-0.05	-0.04%	PASS
	13:50			0.00				0.00			
	13:51			0.00				0.00			

Sum	730.74	707.03
Mean (X_z)	40.60	39.28
Count (n)	...	18

23739.21	22936.82
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$$a = \frac{1}{n} \sum_{i=1}^n Y_i = 39.28$$

$$B = \frac{\sum_{i=1}^n Y_i (X_i - X_z)}{\sum_{i=1}^n (X_i - X_z)^2} = 0.9662 \pm 0.007$$

$$A = a - BX_z = 0.0547 \pm 0.404$$

$$\text{Range } (X_u) = 122 \text{ ppm}$$

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Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.1.2 95% CI & PI Calculations for NO

95% Confidence Intervals

$\hat{y}$	$(y - \hat{y})^2$	x^2	$(\hat{y} - \bar{y})^2$	95% CI	95% PI
0.05	0.001	0.00	1538.56	0.40	0.77
70.77	0.144	5356.78	991.73	0.36	0.75
23.29	0.00	578.40	255.60	0.30	0.72
94.01	0.062	9455.62	2995.24	0.50	0.83
47.50	0.01	2410.81	67.50	0.28	0.72
0.05	0.00	0.00	1538.56	0.40	0.77

MSE: 0.06

95% Confidence Interval of Slope

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.2375$$

$$\sqrt{SSX} \quad 88.96$$

$$s_b = \frac{s_{est}}{\sqrt{SSX}} \quad 0.0027$$

$$t_{\alpha/2, N-2} \quad 2.78$$

$$95\% CI = s_b \times t_{\alpha/2, N-2} \quad 0.007$$

95% Confidence Interval of Intercept

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.2375$$

$$n \sum (x - \bar{x})^2 \quad 47478.42$$

$$\sum x^2 \quad 17801.61$$

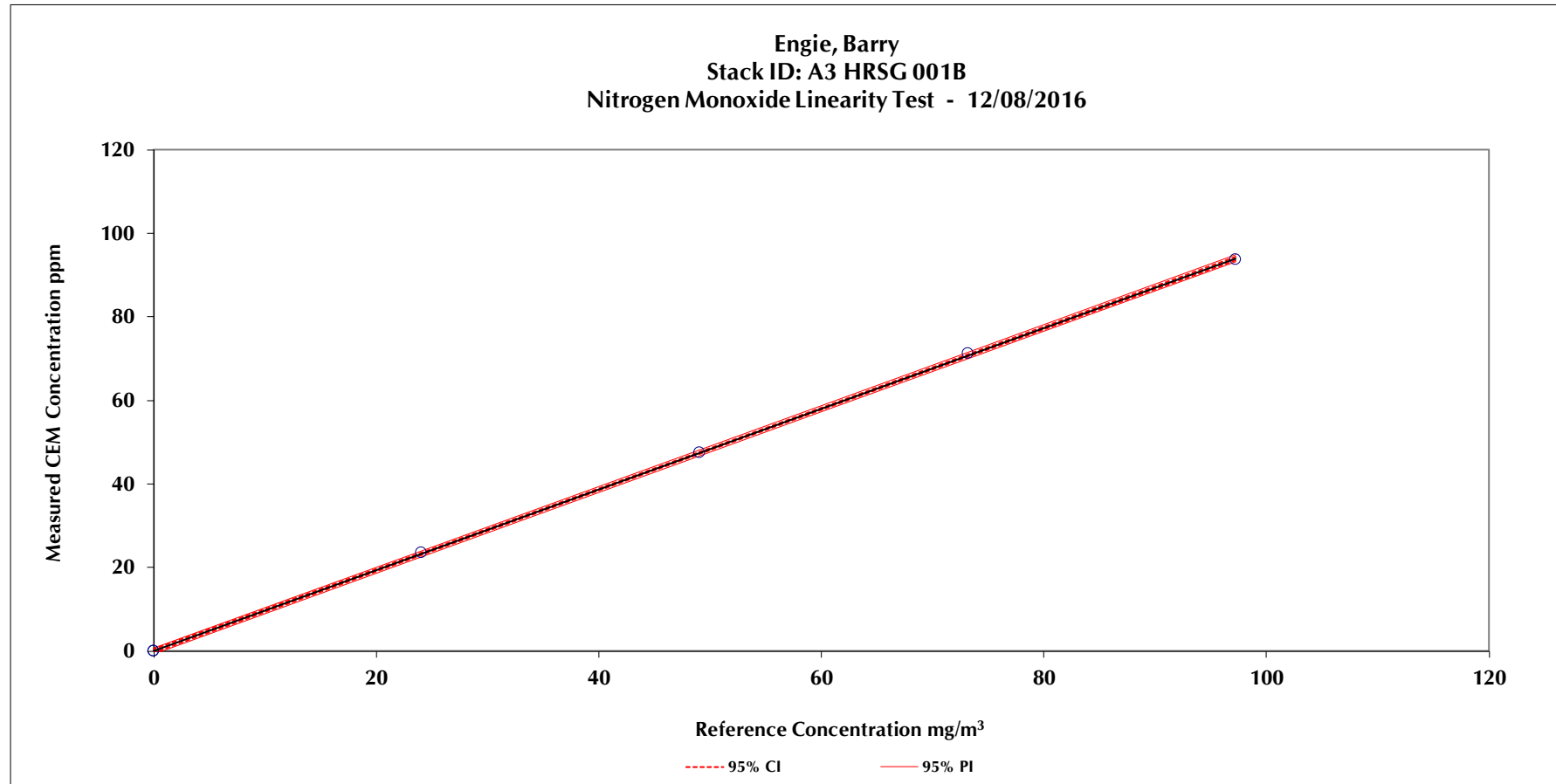
$$s_a = s_{est} \sqrt{\frac{\sum x^2}{n \sum (x - \bar{x})^2}} \quad 0.15$$

$$95\% CI = s_a \times t_{\alpha/2, N-2} \quad 0.40$$

Engie
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Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.1.3 XY Plot of Measured CEM Concentration Vs Concentration of Applied Reference Materials for NO



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.3.6.2.1 Linearity Calculations for CO

Engie, Barry

Linearity test for Carbon Monoxide - 12/08/2016

Daily ELV: 64 ppm

Linearised Range: 128 ppm

Date	Time	% Linearised Range	Reference Concentration ppm	Measured CEM Concentration ppm	$\bar{Y}_c = \frac{1}{m} \sum_{i=1}^m Y_{c,i}$ ppm	$(x_i - x_z)$ ppm	$(x_i - x_z)^2$ ppm	$y_i(x_i - x_z)$ ppm	$d_c = \bar{Y}_c - (A + Bx)$ ppm	$d_{c,rel} = \frac{d_c}{x_u} \times 100\%$	$d_{c,rel} < 5\%$?
12/08/16	13:49	0%	0	0.08	0.09	-42.70	1823.57	-3.20	-0.49	-0.38%	PASS
	13:50			0.13				-5.34			
	13:51			0.08				-3.20			
12/08/16	13:56	60%	77.11	75.95	76.48	34.41	1183.82	2613.19	0.03	0.02%	PASS
	13:57			76.80				2642.43			
	13:58			76.70				2638.99			
12/08/16	14:02	20%	25.7	25.90	25.70	-17.00	289.11	-440.39	-0.17	-0.13%	PASS
	14:03			25.68				-436.56			
	14:04			25.53				-434.01			
12/08/16	14:09	80%	102.01	100.33	100.42	59.31	3517.28	5949.94	-0.54	-0.42%	PASS
	14:10			100.40				5954.39			
	14:11			100.53				5961.80			
12/08/16	14:14	40%	51.4	52.08	52.28	8.70	75.63	452.88	1.12	0.87%	PASS
	14:15			52.23				454.18			
	14:16			52.53				456.79			
12/08/16	14:21	0%	0	0.70	0.63	-42.70	1823.57	-29.89	0.05	0.04%	PASS
	14:22			0.65				-27.76			
	14:23			0.53				-22.42			

Sum	768.66	766.78
Mean (X_z)	42.70	42.60
Count (n)	...	18

26138.98	25721.83
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$$a = \frac{1}{n} \sum_{i=1}^n Y_i \quad \boxed{42.60}$$

$$B = \frac{\sum_{i=1}^n Y_i (X_i - X_z)}{\sum_{i=1}^n (X_i - X_z)^2} \quad \boxed{0.9840} \quad \pm 0.02$$

$$A = a - BX_z \quad \boxed{0.5768} \quad \pm 1.146$$

$$\text{Range (} X_u \text{)} \quad \boxed{128} \text{ ppm}$$

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Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
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Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.2.2 95% CI & PI Calculations for CO

95% Confidence Intervals

$\hat{y}$	$(y - \hat{y})^2$	x^2	$(\hat{y} - \bar{y})^2$	95% CI	95% PI
0.58	0.235	0.00	1765.83	1.15	2.19
76.46	0.001	5945.95	1146.33	1.03	2.13
25.87	0.03	660.49	279.96	0.84	2.05
100.96	0.294	10406.04	3405.91	1.41	2.34
51.16	1.25	2641.96	73.24	0.78	2.03
0.58	0.00	0.00	1765.83	1.15	2.19

MSE: 0.45

95% Confidence Interval of Slope

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.6729$$

$$\sqrt{SSX} \quad 93.34$$

$$s_b = \frac{s_{est}}{\sqrt{SSX}} \quad 0.0072$$

$$t_{\alpha/2, N-2} \quad 2.78$$

$$95\% CI = s_b \times t_{\alpha/2, N-2} \quad 0.020$$

95% Confidence Interval of Intercept

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.6729$$

$$n \sum (x - \bar{x})^2 \quad 52277.96$$

$$\sum x^2 \quad 19654.44$$

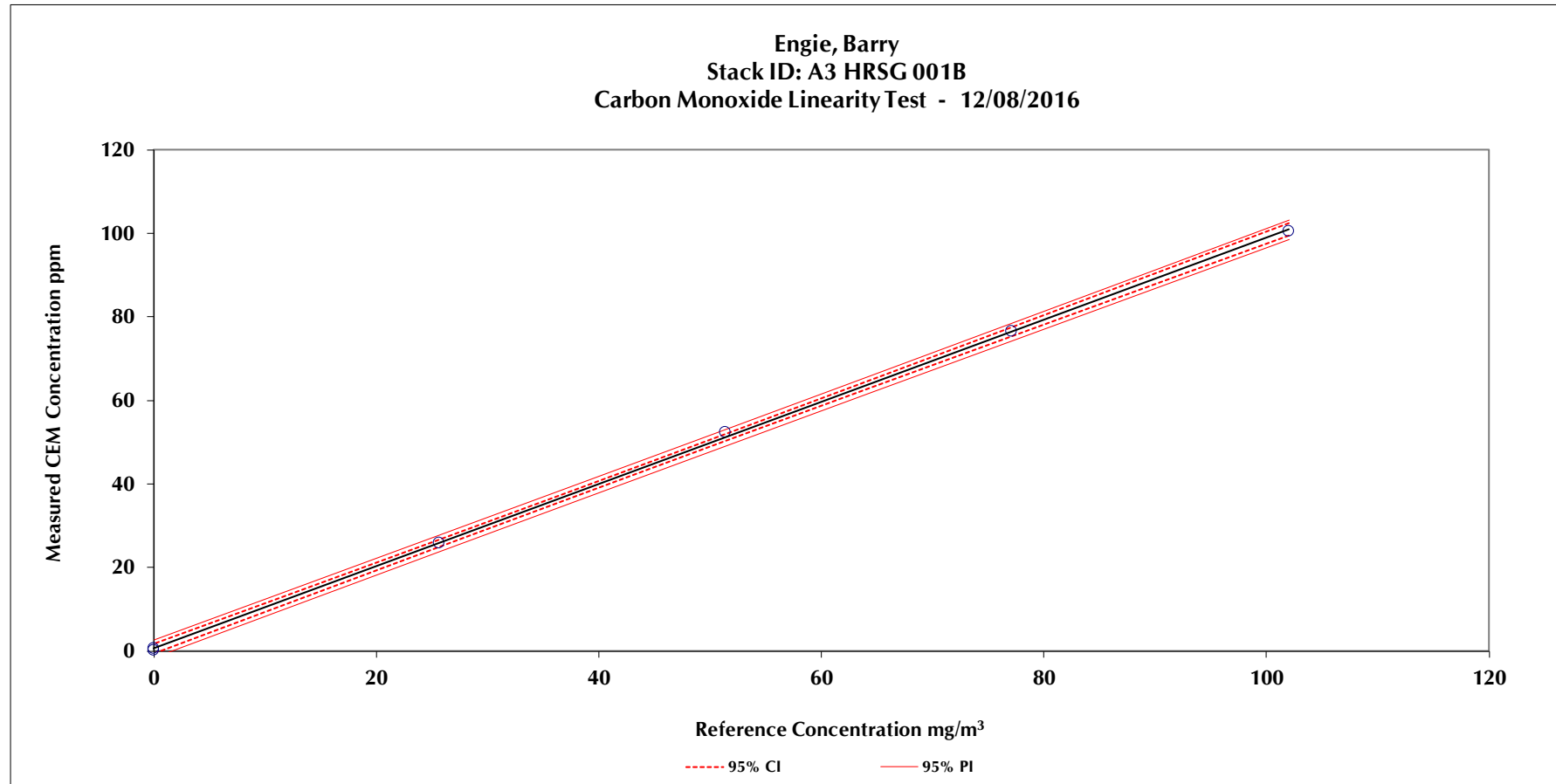
$$s_a = s_{est} \sqrt{\frac{\sum x^2}{n \sum (x - \bar{x})^2}} \quad 0.41$$

$$95\% CI = s_a \times t_{\alpha/2, N-2} \quad 1.15$$

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Permit No : EPR/JP3632ZH
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Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.2.3 XY Plot of Measured CEM Concentration Vs Concentration of Applied Reference Materials for CO



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

5.3.6.3.1 Linearity Calculations for O2

Engie, Barry

Linearity test for Oxygen - 12/08/2016

Daily ELV: 21 %Vol

Linearised Range: 21 %Vol

Date	Time	% Linearised Range	Reference Concentration %Vol	Measured CEM Concentration %Vol	$\bar{Y}_c = \frac{1}{m} \sum_{i=1}^m Y_{c,i}$ %Vol	$(x_i - x_z)$ %Vol	$(x_i - x_z)^2$ %Vol	$y_i(x_i - x_z)$ %Vol	$d_c = \bar{Y}_c - (A + Bx_z)$ %Vol	$d_{c,rel} = \frac{d_c}{x_u} \times 100\%$	$d_{c,rel} < 5\%$?
12/08/16	14:21	0%	0	0.09	0.09	-6.67	44.42	-0.60	-0.02	-0.10%	PASS
	14:22			0.09				-0.58			
	14:23			0.08				-0.53			
12/08/16	14:28	62%	12.99	13.00	12.99	6.33	40.01	82.19	0.09	0.41%	PASS
	14:29			12.99				82.18			
	14:30			12.99				82.18			
12/08/16	14:34	19%	4.01	4.15	4.15	-2.66	7.05	-11.02	0.09	0.42%	PASS
	14:35			4.14				-11.00			
	14:36			4.14				-10.99			
12/08/16	14:40	71%	14.97	14.69	14.73	8.31	68.97	122.00	-0.13	-0.64%	PASS
	14:41			14.70				122.08			
	14:42			14.79				122.79			
12/08/16	14:47	38%	8.02	8.08	8.08	1.36	1.84	10.95	0.07	0.31%	PASS
	14:48			8.07				10.94			
	14:49			8.07				10.93			
12/08/16	14:53	0%	0	0.02	0.02	-6.67	44.42	-0.13	-0.09	-0.41%	PASS
	14:54			0.02				-0.13			
	14:55			0.02				-0.13			

Sum	119.97	120.13
Mean (X_z)	6.67	6.67
Count (n)	...	18

620.12	611.12
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$$a = \frac{1}{n} \sum_{i=1}^n Y_i \quad \boxed{6.67}$$

$$B = \frac{\sum_{i=1}^n Y_i (X_i - X_z)}{\sum_{i=1}^n (X_i - X_z)^2} \quad \boxed{0.9855} \quad \pm 0.02$$

$$A = a - Bx_z \quad \boxed{0.1059} \quad \pm 0.182$$

$$\text{Range (} X_u \text{)} \quad \boxed{21} \quad \% \text{Vol}$$

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 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

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 Report Issue Date : 1st November 2016

5.3.6.3.2 95% CI & PI Calculations for O2

95% Confidence Intervals

$\hat{y}$	$(y - \hat{y})^2$	x^2	$(\hat{y} - \bar{y})^2$	95% CI	95% PI
0.11	0.000	0.00	43.14	0.18	0.35
12.91	0.007	168.74	38.85	0.18	0.34
4.06	0.01	16.08	6.85	0.13	0.32
14.86	0.018	224.10	66.98	0.21	0.36
8.01	0.00	64.32	1.78	0.12	0.32
0.11	0.01	0.00	43.14	0.18	0.35

MSE: 0.01

95% Confidence Interval of Slope

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.1060$$

$$\sqrt{SSX} \quad 14.38$$

$$s_b = \frac{s_{est}}{\sqrt{SSX}} \quad 0.0074$$

$$t_{\alpha/2, N-2} \quad 2.78$$

$$95\% CI = s_b \times t_{\alpha/2, N-2} \quad 0.020$$

95% Confidence Interval of Intercept

$$s_{est} = \sqrt{\frac{SS \hat{Y}}{N - 2}} \quad 0.1060$$

$$n \sum (x - \bar{x})^2 \quad 1240.25$$

$$\sum x^2 \quad 473.24$$

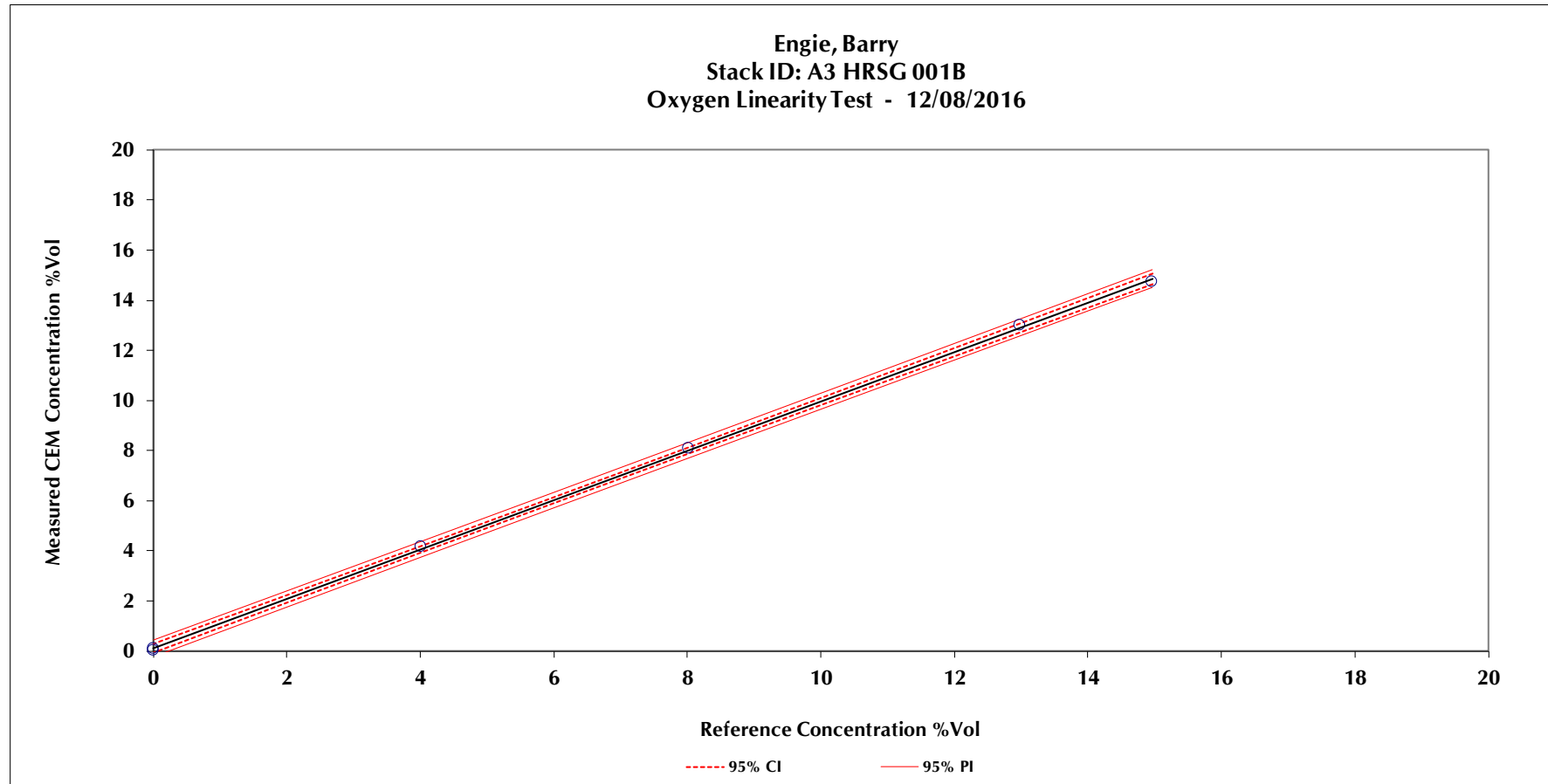
$$s_a = s_{est} \sqrt{\frac{\sum x^2}{n \sum (x - \bar{x})^2}} \quad 0.07$$

$$95\% CI = s_a \times t_{\alpha/2, N-2} \quad 0.18$$

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
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Installation Name : Dow Corning CHP
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Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

5.3.6.3.3 XY Plot of Measured CEM Concentration Vs Concentration of Applied Reference Materials for O2



Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

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 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

6 UNCERTAINTY CALCULATIONS

6.1.1 Contributing Factors to Combustion Gases Uncertainty

The following contributing factors have been included in the determination of the analyser uncertainty for combustion gases measured by the **Horiba PG350**:

Performance Characteristic	Standard Uncertainty	Value of Standard Uncertainty
Lack of fit	u_{lof}	³⁹ $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$
Span drift	$u_{d,s}$	$u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$
Repeatability Standard Deviation (span)	u_r	$\sigma_i = \Delta x_i$
Losses / leakage in the sample system	u_{loss}	⁴⁰ $u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$
Temperature dependant span drift See Note	u_t	$u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,max} - x_{i,adj})^2 + (x_{i,min} - x_{i,adj})(x_{i,max} - x_{i,adj}) + (x_{i,min} - x_{i,adj})^2}{3}}$
Interferents	u_i	$u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \Delta x_i$
⁴¹ Effect of Voltage Fluctuation See Note	u_v	$u(x_i) = \Delta x_i \sqrt{\frac{(x_{i,max} - x_{i,adj})^2 + (x_{i,min} - x_{i,adj})(x_{i,max} - x_{i,adj}) + (x_{i,min} - x_{i,adj})^2}{3}}$
⁴² Effect of Oxygen Synergism	u_{syn}	$u(x_i) = \frac{\Delta x_i}{\sqrt{3}}$
Combined Standard Uncertainty $u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2 + u_v^2 + u_{syn}^2}$		
Expanded uncertainty (at 95% confidence) $U_{Exp} = 2 \times u_c$		

39 Where Δx_i is the percent of range in mg/m³ (or %Vol).

40 Where Δx_i is the percent of the measured value in mg/m³ (or %Vol).

41 Applies to TOC analyser only.

42 Applies to TOC analyser only.

Engie
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 Variation No : EPR/JP3632ZH/V002
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 Report Issue Date : 1st November 2016

6.1.2 Combustion Gas Uncertainty

A1 23/08/2016

Measurement Uncertainty Calculations Part 1

Horiba PG 350 Performance Characteristics	Standard Uncertainty (% of Range)	Distributioun	Minimum Certified Range (R _i)		
			NO 0 - 134 mg/m ³	CO 0 - 75 mg/m ³	O ₂ 0 - 25 %Vol
Lack of fit ⁽¹⁾	u_{lof}	Rectangular (Divisor = $\sqrt{3}$)	0.75	0.61	0.10
Span drift ⁽²⁾	$u_{d,s}$	Rectangular (Divisor = $\sqrt{3}$)	0.09	0.06	0.006
Repeatability Standard Deviation (span) ⁽³⁾	u_r	Normal (Divisor = 1)	0.43	0.91	0.33
Losses / leakage in the sample system ⁽⁴⁾	u_{loss}	Rectangular (Divisor = $\sqrt{3}$)	0.15	0.33	0.28
Temperature dependant span drift ⁽⁵⁾	u_t	Rectangular (Divisor = $\sqrt{3}$)	1.20	2.000	0.150
Interferents ⁽¹⁾	u_i	Rectangular (Divisor = $\sqrt{3}$)	0.52	0.87	
Uncertainty of Reference Gas ⁽⁶⁾	u_{ref}	Rectangular (Divisor = $\sqrt{3}$)	2.13	1.30	0.15

Note:

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

- 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 certified range
- 5 Expressed as a percentage of the certified range per one degree centigrade
- 6 Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol inc additional uncertainty of 2% for gas blending
- 7 Applies to TVOC only

Measurement Uncertainty Calculations Part 2

Horiba PG 350 Performance Characteristics	Uncertainty	Value of Standard Uncertainty	NO 0 - 134 mg/m ³	CO 0 - 75 mg/m ³	O ₂ 0 - 25 %Vol
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.58	0.26	0.014
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.07	0.02	0.0008
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}} =$	0.43	0.91	0.33
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	0.12	0.14	0.04
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t \times R_i}{100} \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	0.93	0.866	0.022
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.40	0.38	
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	1.23	0.75	0.086
Combined Standard Uncertainty			1.75	1.54	0.34
Expanded measurement uncertainty (at 95% confidence)			3.51	3.08	0.68
Applied Span Concentration			123.00	75.00	14.97
Measured Span Concentration, STP Dry Gas			123.31	75.83	14.83
Expanded measurement uncertainty as % of Applied Span			3%	4%	5%

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

A2 24/08/2016

Measurement Uncertainty Calculations Part 1

Horiba PG 350 Performance Characteristics	Standard Uncertainty (% of Range)	Distributiouon	Minimum Certified Range (R _i)		
			NO 0 - 134 mg/m ³	CO 0 - 75 mg/m ³	O ₂ 0 - 25 %Vol
Lack of fit ⁽¹⁾	u_{lof}	Rectangular (Divisor = $\sqrt{3}$)	0.75	0.61	0.10
Span drift ⁽²⁾	$u_{d,s}$	Rectangular (Divisor = $\sqrt{3}$)	0.09	0.06	0.006
Repeatability Standard Deviation (span) ⁽³⁾	u_r	Normal (Divisor = 1)	0.28	0.21	0.02
Losses / leakage in the sample system ⁽⁴⁾	u_{loss}	Rectangular (Divisor = $\sqrt{3}$)	0.07	0.61	0.08
Temperature dependant span drift ⁽⁵⁾	u_t	Rectangular (Divisor = $\sqrt{3}$)	1.20	2.000	0.150
Interferents ⁽¹⁾	u_i	Rectangular (Divisor = $\sqrt{3}$)	0.52	0.87	
Uncertainty of Reference Gas ⁽⁶⁾	u_{ref}	Rectangular (Divisor = $\sqrt{3}$)	2.13	1.30	0.15

Note:

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

- 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 certified range
- 5 Expressed as a percentage of the certified range per one degree centigrade
- 6 Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol inc additional uncertainty of 2% for gas blending
- 7 Applies to TVOC only

Measurement Uncertainty Calculations Part 2

Horiba PG 350 Performance Characteristics	Uncertainty	Value of Standard Uncertainty	NO 0 - 134 mg/m ³	CO 0 - 75 mg/m ³	O ₂ 0 - 25 %Vol
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.58	0.26	0.014
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.07	0.02	0.0008
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}} =$	0.28	0.21	0.02
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	0.06	0.26	0.01
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t \times R_i}{100} \times \sqrt{\frac{(x_{i,max} - x_{adj})^2 + (x_{i,min} - x_{adj})(x_{i,max} - x_{adj}) + (x_{i,min} - x_{adj})^2}{3}}$	0.93	0.866	0.022
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.40	0.38	
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	1.23	0.75	0.086
Combined Standard Uncertainty		$u_c = \sqrt{u_{lof}^2 + u_{d,s}^2 + u_r^2 + u_{loss}^2 + u_t^2 + u_i^2 + u_{ref}^2}$	1.72	1.28	0.09
Expanded measurement uncertainty (at 95% confidence)		$U_{EXP} = 2 \times u_c$	3.44	2.56	0.19
Applied Span Concentration			123.00	75.00	14.97
Measured Span Concentration, STP Dry Gas			123.18	75.52	14.99
Expanded measurement uncertainty as % of Applied Span			3%	3%	1%

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

A3 25/08/2016**Measurement Uncertainty Calculations Part 1**

Horiba PG 350 Performance Characteristics	Standard Uncertainty (% of Range)	Distributioun	Minimum Certified Range (R _i)		
			NO 0 - 134 mg/m ³	CO 0 - 75 mg/m ³	O ₂ 0 - 25 %Vol
Lack of fit ⁽¹⁾	u_{lof}	Rectangular (Divisor = $\sqrt{3}$)	0.75	0.61	0.10
Span drift ⁽²⁾	$u_{d,s}$	Rectangular (Divisor = $\sqrt{3}$)	0.094	0.056	0.0057
Repeatability Standard Deviation (span) ⁽³⁾	u_r	Normal (Divisor = 1)	0.97	0.56	0.22
Losses / leakage in the sample system ⁽⁴⁾	u_{loss}	Rectangular (Divisor = $\sqrt{3}$)	0.094	0.49	0.32
Temperature dependant span drift ⁽⁵⁾	u_t	Rectangular (Divisor = $\sqrt{3}$)	1.20	2.00	0.15
Interferents ⁽¹⁾	u_i	Rectangular (Divisor = $\sqrt{3}$)	0.52	0.87	
Uncertainty of Reference Gas ⁽⁶⁾	u_{ref}	Rectangular (Divisor = $\sqrt{3}$)	2.13	1.30	0.15

Note:

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

- 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 certified range
- 5 Expressed as a percentage of the certified range per one degree centigrade
- 6 Expressed as standard uncertainty in units of measurement i.e. mg/m³ / %Vol inc additional uncertainty of 2% for gas blending
- 7 Applies to TVOC only

Measurement Uncertainty Calculations Part 2

Horiba PG 350 Performance Characteristics	Uncertainty	Value of Standard Uncertainty	NO 0 - 134 mg/m ³	CO 0 - 75 mg/m ³	O ₂ 0 - 25 %Vol
Lack of fit	u_{lof}	$u(x_i) = \frac{u_{lof} \times R_i}{\sqrt{3}} =$	0.58	0.26	0.014
Span drift	$u_{d,s}$	$u(x_i) = \frac{u_{d,s} \times R_i}{\sqrt{3}} =$	0.073	0.024	0.00082
Repeatability Standard Deviation (span)	u_r	$\sigma = \sqrt{\frac{\sum_{i=1}^n (x_i - \bar{x})^2}{n-1}} =$	0.97	0.56	0.22
Losses / leakage in the sample system	u_{loss}	$u(x_i) = \frac{u_{loss} \times R_i}{\sqrt{3}} =$	0.072	0.21	0.047
Temperature dependant span drift	u_t	$u(x_i) = \frac{u_t}{100} \times R_i \times \sqrt{\frac{(x_{i,\max} - x_{adj})^2 + (x_{i,\min} - x_{adj})(x_{i,\max} - x_{adj}) + (x_{i,\min} - x_{adj})^2}{3}}$	0.93	0.87	0.022
Interferents	u_i	$u(x_i) = \frac{u_i \times R_i}{\sqrt{3}} =$	0.40	0.38	
Uncertainty of Reference Gas	u_{ref}	$u(x_i) = \frac{u_{ref}}{\sqrt{3}} =$	1.23	0.75	0.086
Combined Standard Uncertainty			1.95	1.37	0.24
Expanded measurement uncertainty (at 95% confidence)			3.91	2.74	0.48
Applied Span Concentration			123.00	75.00	14.97
Measured Span Concentration, STP Dry Gas			122.16	75.03	14.89
Expanded measurement uncertainty as % of Applied Span			3%	4%	3%

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

7 REFERENCE MATERIALS

7.1 SRM Reference Materials

Calibration Gas	Concentration	Supplier	Cylinder Solution ID.	Expiry Date	Uncertainty
NO	261.4 ppm	Air Liquide	GAS / 1590	20/11/2018	± 1%
CO	200.1 ppm	Air Liquide	GAS / 1602	20/01/2019	± 1%
O ₂	14.97 %	Air Liquide	GAS / 1557	23/06/2018	± 1%

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

7.2 SRM Calibration Validation Summary

A1 23/08/2016

Units

Mean Initial Direct Zero
 Mean Confirmation Direct Zero
 Difference in Direct Zero
 Repeatability at Zero
 <2 x Repeatability at Zero?

Mean Pre Test Zero
 % of Measurement Range?
 Detection Limit (LOD)

Actual Applied Span Concentration

Mean Pre Test System Zero
 Difference $\leq \pm 2\%$ of Span Value (5% for SO₂)?

Mean Post Test Zero
 % of Certified Range?
 Zero Drift $\leq \pm 5\%$ of Applied Span?

Mean Pre Test System Span
 Difference $\leq \pm 2\%$ of Span Value (5% for SO₂)?

Mean Post Test System Span
 Span Drift $\leq \pm 5\%$ Span Value?

Horiba PG 350 Measurement Ranges:		
NO as NO ₂	CO	O ₂
205	125	25
mg/m ³	mg/m ³	%Vol
Zero Values (Direct)		
-0.10	-0.27	-0.01
-0.10	-0.26	-0.05
0.00	0.01	0.04
2.05	1.25	0.20
YES	YES	YES
Pre Zero Values (System)		
-0.10	-0.46	-0.01
-0.05%	-0.37%	-0.03%
0.05	0.82	0.20
Applied Span:		
NO	CO	O ₂
123.00	75.00	14.97
Pre Test System Zero Values		
-0.10	-0.46	-0.01
0.08%	0.62%	0.04%
Post Zero Values (System)		
0.18	-0.62	-0.14
0.09%	-0.50%	-0.57%
0.23%	0.21%	0.91%
Pre Test System Span Values		
122.80	75.25	14.90
0.17%	0.33%	0.47%
Post Test System Span Values		
123.82	76.42	14.77
0.83%	1.55%	0.89%
0.83%	1.55%	0.91%
See Note 3	See Note 3	See Note 3

NOTE 1: Data Invalid! Contact Quality Manager!

NOTE 2: Correct test data for drift!

NOTE 3: No drift correction required.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

A2 24/08/2016

Units

Mean Initial Direct Zero
 Mean Confirmation Direct Zero
 Difference in Direct Zero
 Repeatability at Zero
 <2 x Repeatability at Zero?

Mean Pre Test Zero
 % of Measurement Range?
 Detection Limit (LOD)

Actual Applied Span Concentration

Mean Pre Test System Zero
 Difference $\leq \pm 2\%$ of Span Value (5% for SO₂)?

Mean Post Test Zero
 % of Certified Range?
 Zero Drift $\leq \pm 5\%$ of Applied Span?

Mean Pre Test System Span
 Difference $\leq \pm 2\%$ of Span Value (5% for SO₂)?

Mean Post Test System Span
 Span Drift $\leq \pm 5\%$ Span Value?

Horiba PG 350 Measurement Ranges:		
NO as NO₂	CO	O₂
205	125	25
mg/m³	mg/m³	%Vol
Zero Values (Direct)		
-0.10	-0.27	-0.01
-0.10	-0.26	-0.05
0.00	0.01	0.04
2.05	1.25	0.20
YES	YES	YES
Pre Zero Values (System)		
-0.14	-0.77	0.06
-0.07%	-0.62%	0.24%
0.07	0.54	0.20
Applied Span:		
NO	CO	O₂
123.00	75.00	14.97
Pre Test System Zero Values		
-0.14	-0.77	0.06
0.12%	1.03%	0.41%
Post Zero Values (System)		
0.04	-0.69	0.11
0.02%	-0.55%	0.46%
0.14%	0.11%	0.36%
Pre Test System Span Values		
122.90	75.45	14.99
0.08%	0.61%	0.13%
Post Test System Span Values		
123.46	75.59	14.98
0.45%	0.17%	0.05%

0.45% 0.17% 0.36%

See Note 3 See Note 3 See Note 3

NOTE 1: Data Invalid! Contact Quality Manager!

NOTE 2: Correct test data for drift!

NOTE 3: No drift correction required.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

A3 25/08/2016

Units

Mean Initial Direct Zero
 Mean Confirmation Direct Zero
 Difference in Direct Zero
 Repeatability at Zero
 <2 x Repeatability at Zero?

Mean Pre Test Zero
 % of Measurement Range?
 Detection Limit (LOD)

Actual Applied Span Concentration

Mean Pre Test System Zero
 Difference $\leq \pm 2\%$ of Span Value (5% for SO₂)?

Mean Post Test Zero
 % of Certified Range?
 Zero Drift $\leq \pm 5\%$ of Applied Span?

Mean Pre Test System Span
 Difference $\leq \pm 2\%$ of Span Value (5% for SO₂)?

Mean Post Test System Span
 Span Drift $\leq \pm 5\%$ Span Value?

Horiba PG 350 Measurement Ranges:		
NO as NO₂	CO	O₂
205	125	25
mg/m³	mg/m³	%Vol
Zero Values (Direct)		
-0.10	-0.27	-0.01
-0.10	-0.26	-0.05
0.00	0.01	0.04
2.05	1.25	0.20
YES	YES	YES
Pre Zero Values (System)		
-0.27	-0.92	-0.02
-0.13%	-0.74%	-0.07%
0.04	0.00	0.20
Applied Span:		
NO	CO	O₂
123.00	75.00	14.97
Pre Test System Zero Values		
-0.27	-0.92	-0.02
0.22%	1.23%	0.12%
Post Zero Values (System)		
0.06	-0.45	0.04
0.03%	-0.36%	0.17%
0.27%	0.63%	0.40%
Pre Test System Span Values		
123.13	75.37	14.89
0.10%	0.49%	0.54%
Post Test System Span Values		
121.19	74.70	14.89
1.57%	0.89%	0.01%

1.57% 0.89% 0.40%

See Note 3 See Note 3 See Note 3

NOTE 1: Data Invalid! Contact Quality Manager!

NOTE 2: Correct test data for drift!

NOTE 3: No drift correction required.

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

7.3 CEM Reference Materials

Calibration Gas	Concentration	Supplier	Cylinder Solution ID.	Expiry Date	Uncertainty
NO	197.9 ppm	Air Products	522021	08/12/2018	± 2%
CO	199.904 ppm	Air Products	1770A	16/01/2019	± 0.5%
O ₂	Ambient Air Only				

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

8 DATA VALUES

8.1 Outlying Value Calculation Procedure

Once the SRM/CEM data pair averages have been established, calculate the difference between the SRM and CEM values (D_i) for each data pair and subsequently, the mean ($\bar{D}$) and standard deviation (σ) of the differences D_i . If the difference between D_i and $\bar{D}$ for each SRM/CEM pair is greater than twice σ , then that SRM/CEM pair may be considered a possible outlier and can be removed from further calculations.

The calibrated CEM value was then calculated and the magnitude of the associated residual ($|D_i|$) was found using:

$$D_i = y_i - x_i$$

Where:

D_i calculated Residual
 y_i time averaged measurement of SRM
 x_i time averaged measurement of CEM

The mean residual ($\bar{D}_i$) and the standard deviation of the residuals are calculated as follows:

$$\bar{D}_i = \frac{\sum_{i=1}^n D_i}{n} \qquad S_{residuals} = \sqrt{\frac{\sum_{i=1}^n (D_i - \bar{D}_i)^2}{n-1}}$$

Where:

n = Number of half hourly averages

The magnitude of the difference between each residual (D_i) and the mean residual ($\bar{D}_i$) is calculated and compared with $S_{residuals}$. Where $|D_i - \bar{D}_i| > 2 \times S_{residuals}$ (i.e. $2 \times$ standard deviation $\sim$ 95% confidence), the SRM / CEM data pair is discarded from future consideration as a potential outlier. The above procedure should be repeated no more than once.

Care should be taken when deciding whether an SRM/CEM data pair is a potential outlier. Where the value of the slope & intercept of the SRM & CEM data pairs is non-significant as indicated by the R^2 value, the range of data is less than 15% of the Daily ELV or the data is unduly influenced by upscale data points, false positives may be identified.

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

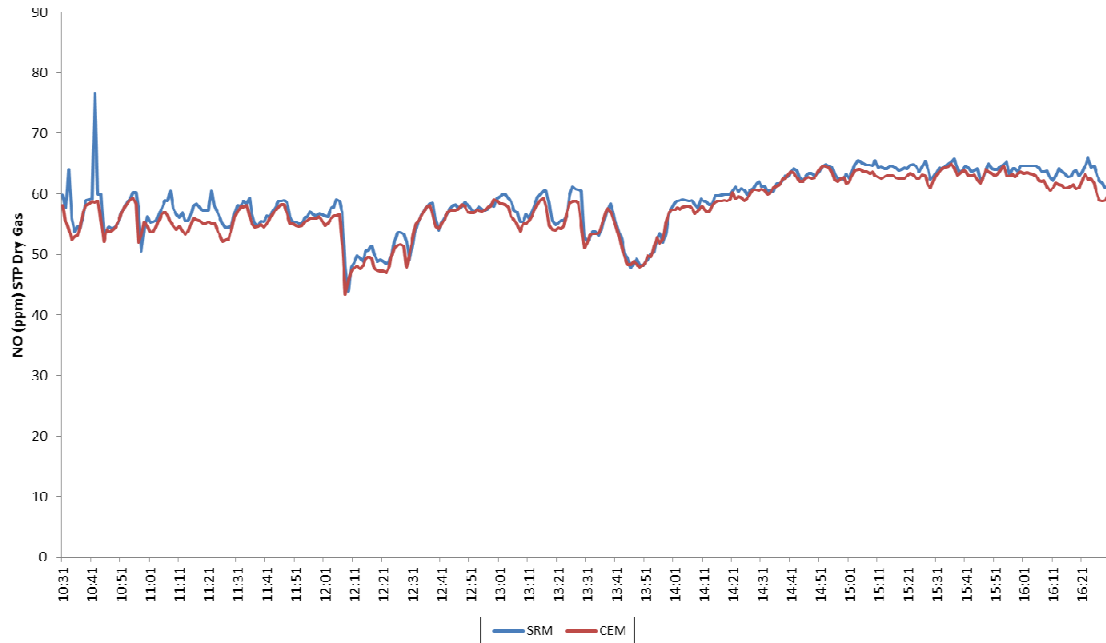
Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

8.2 Time Series Plots of Minute Averages

A1

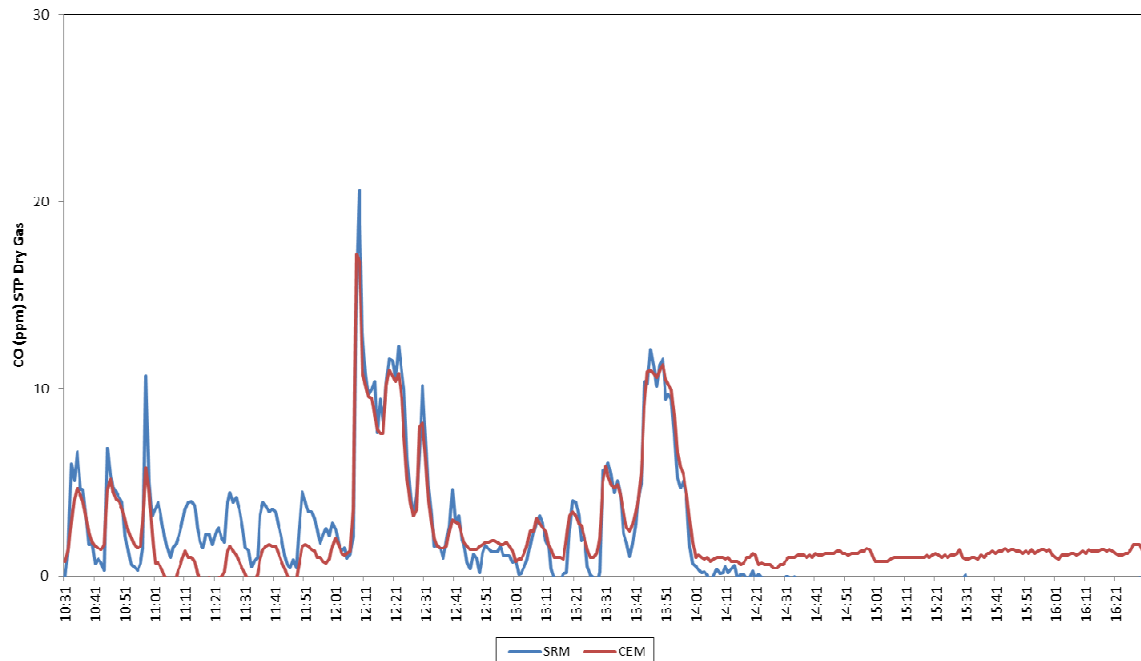
NO

Time Series Plot of SRM and CEM NO Readings
A1 HR-001A on 23/08/2016



CO

Time Series Plot of SRM and CEM CO Readings
A1 HR-001A on 23/08/2016



Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

O2

Time Series Plot of SRM and CEM O2 Readings
A1 HR-001A on 23/08/2016



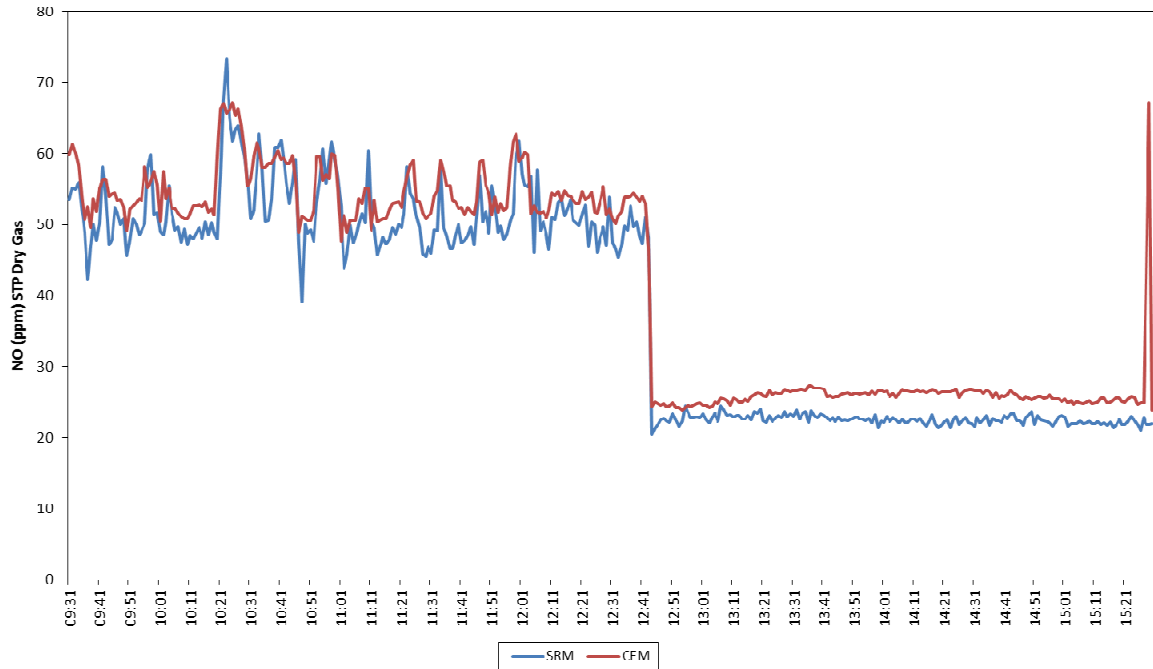
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Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

A2

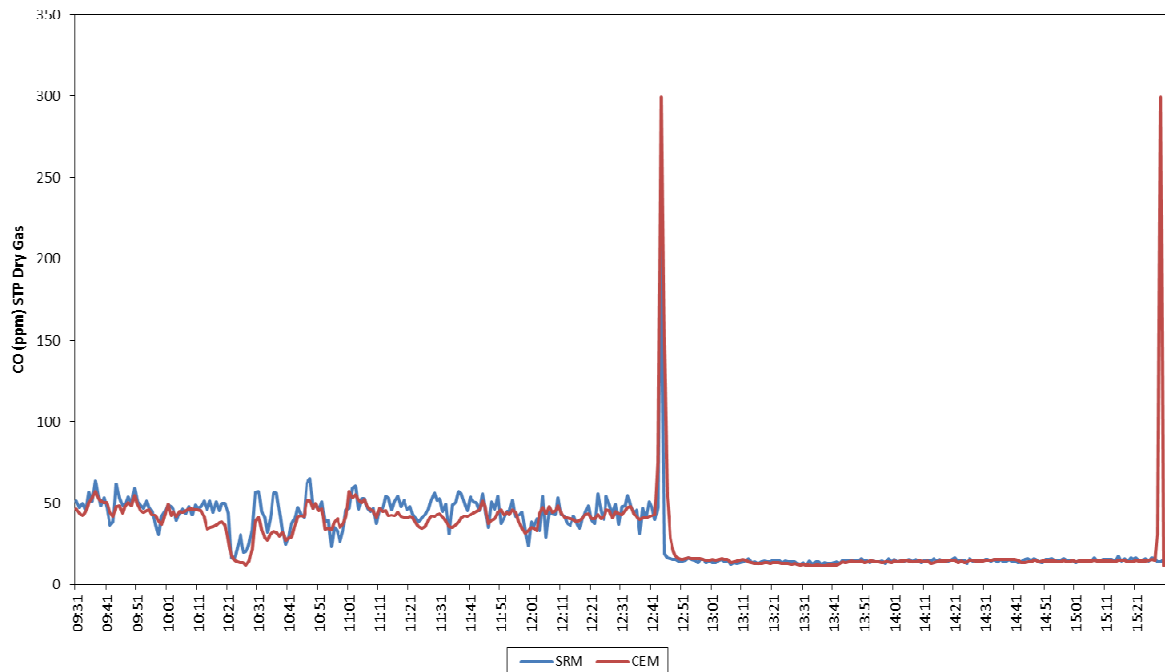
NO

**Time Series Plot of SRM and CEM NO Readings
A2 FB 001 on 24/08/2016**



CO

**Time Series Plot of SRM and CEM CO Readings
A2 FB 001 on 24/08/2016**

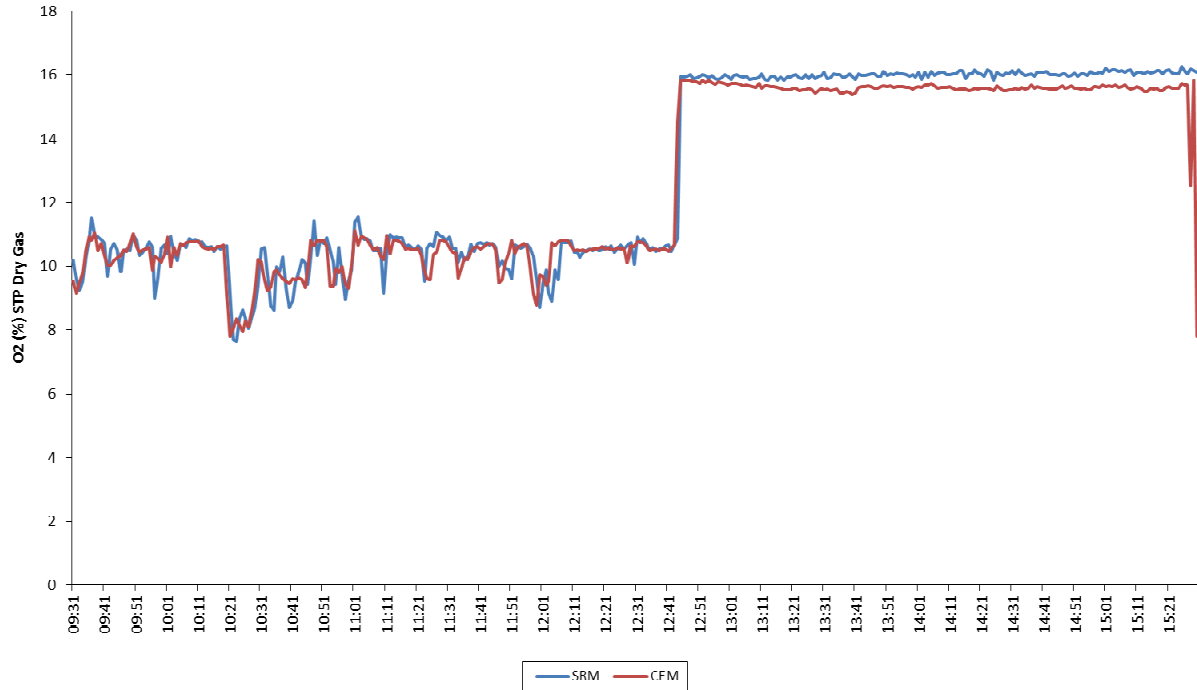


Engie
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Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

O2

Time Series Plot of SRM and CEM O2 Readings
A2 FB 001 on 24/08/2016



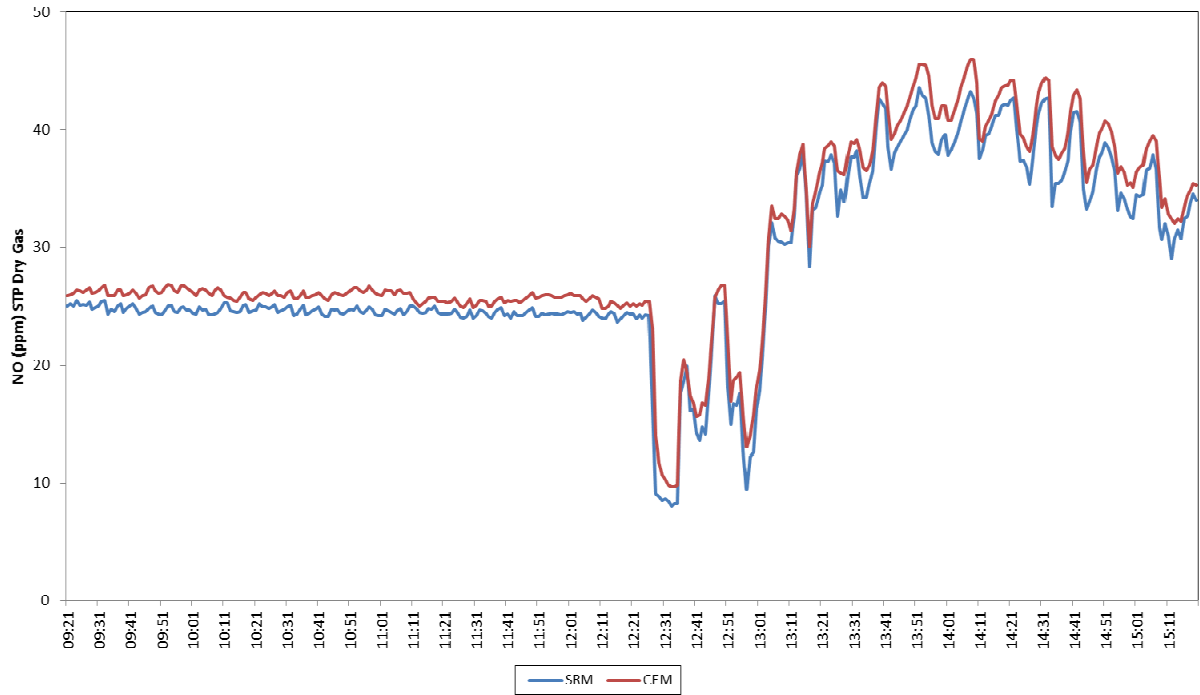
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Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

A3

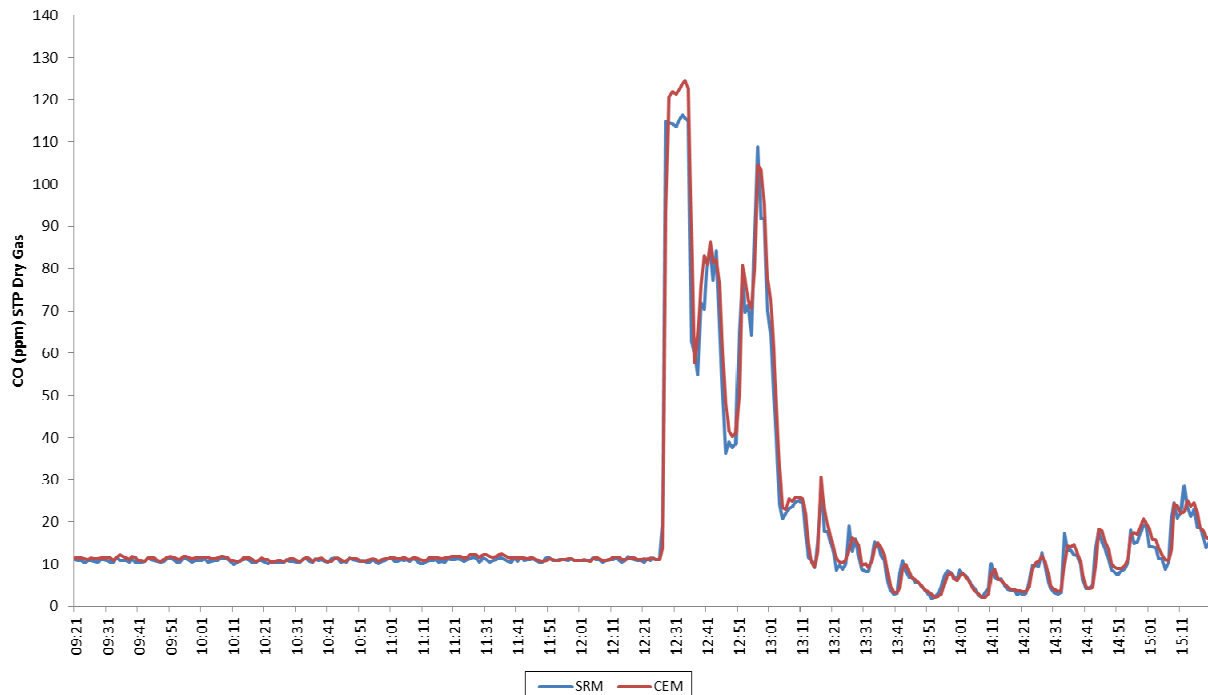
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**Time Series Plot of SRM and CEM NO Readings
A3 HR 001B on 25/08/2016**



CO

**Time Series Plot of SRM and CEM CO Readings
A3 HR 001B on 25/08/2016**



Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

O2

**Time Series Plot of SRM and CEM O2 Readings
A3 HR 001B on 25/08/2016**



Engie
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 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

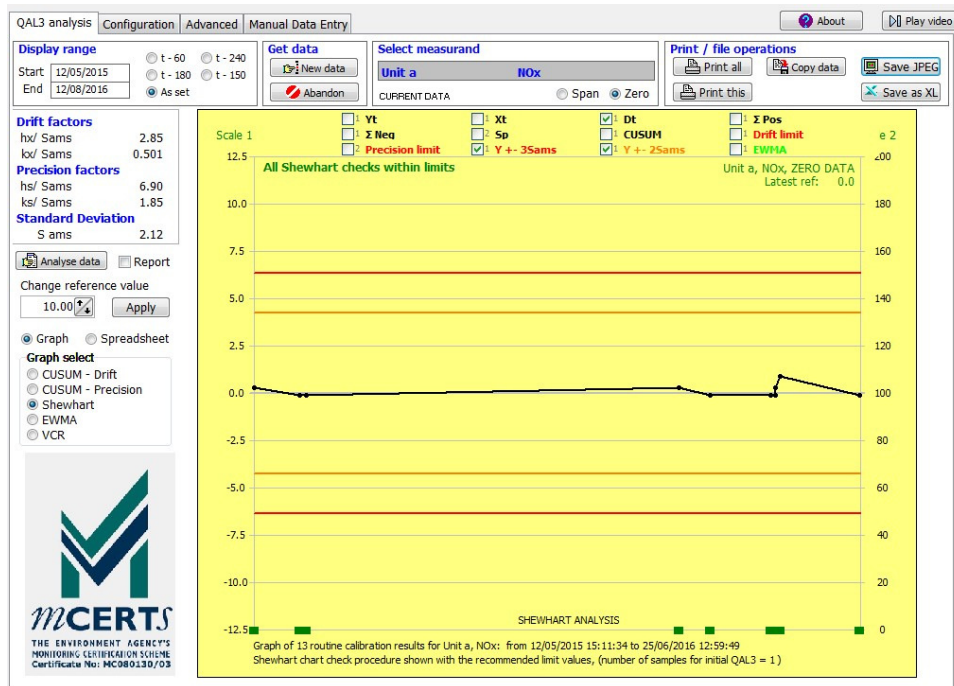
Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

9 CEM QAL3 DATA

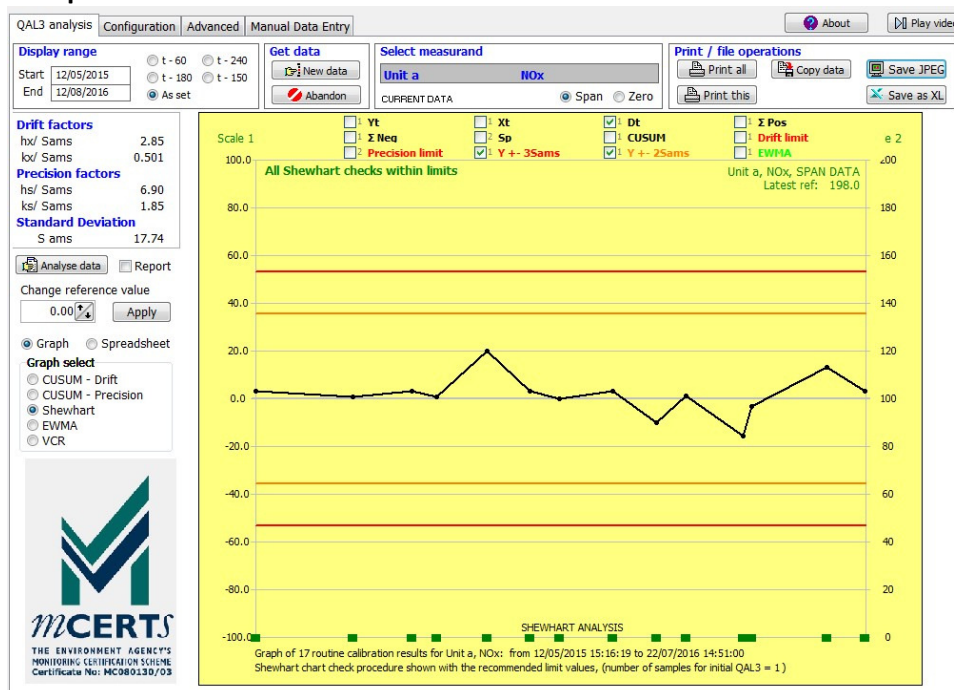
9.1 QAL3 Control Charts

A1

NO Zero



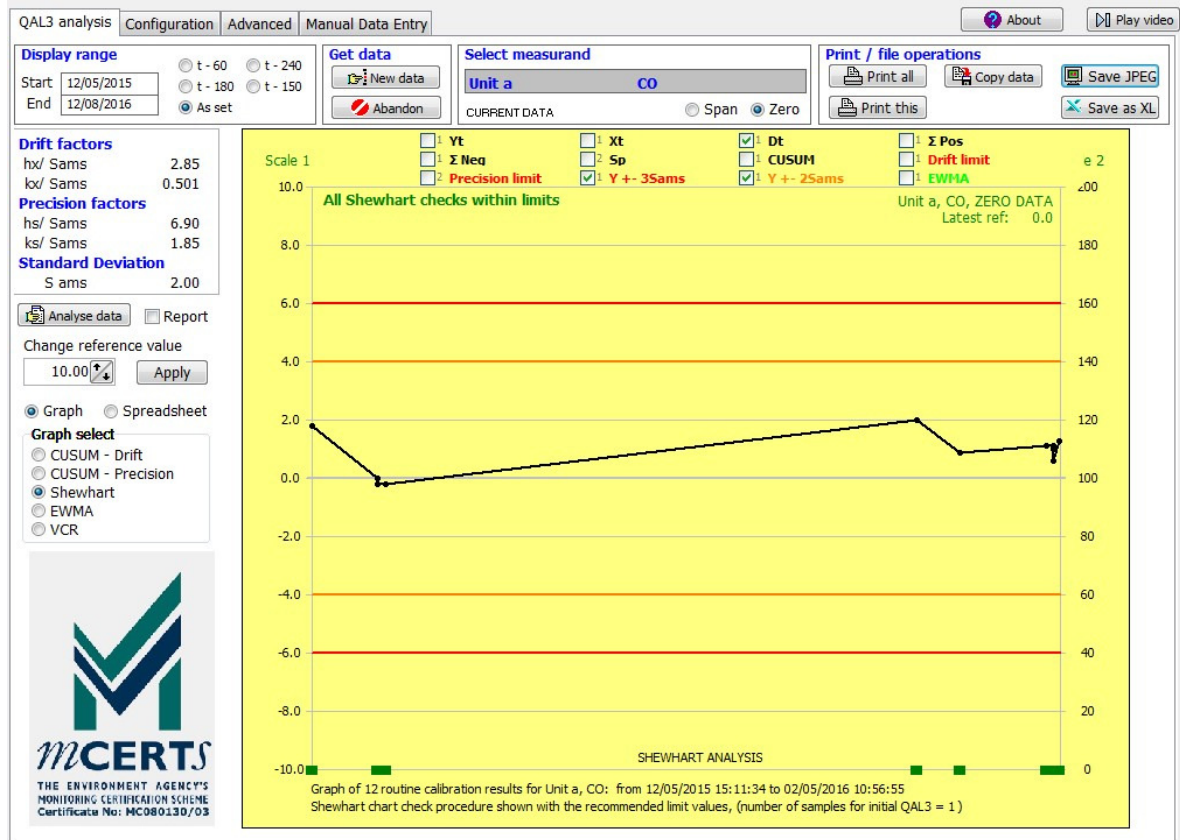
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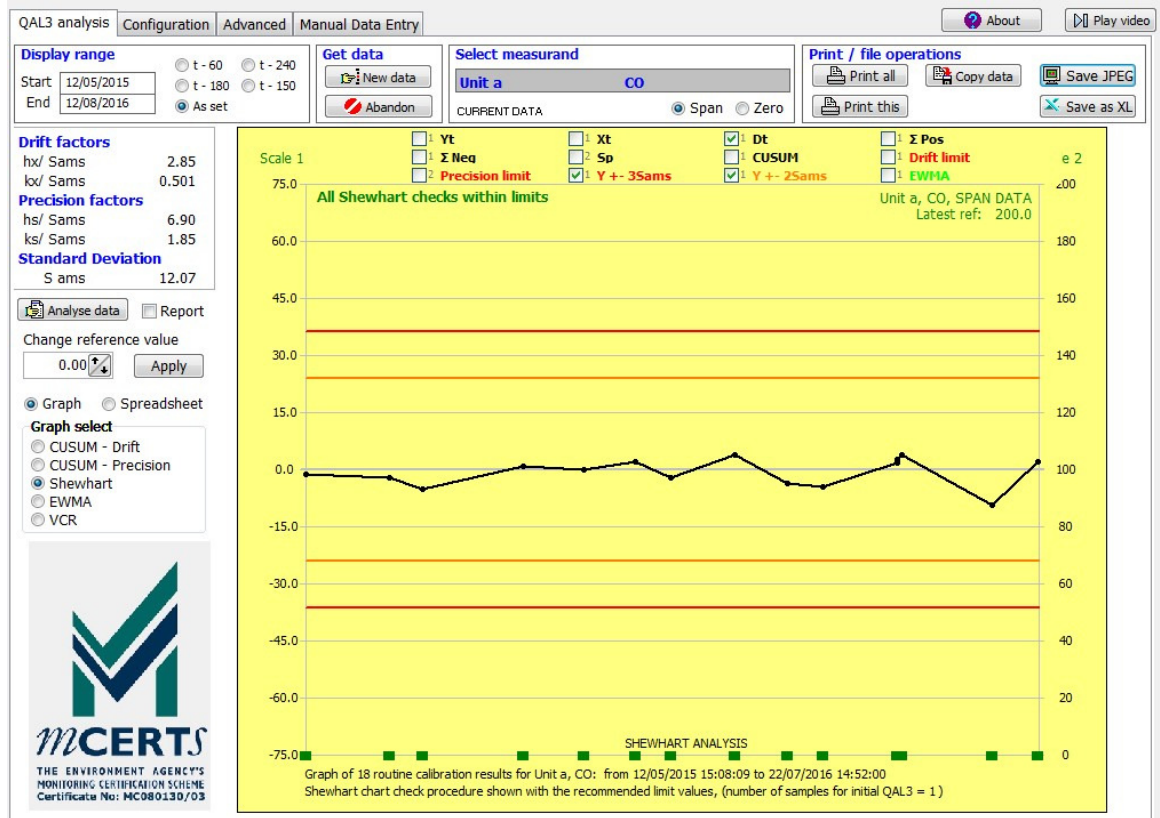
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 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

CO Zero



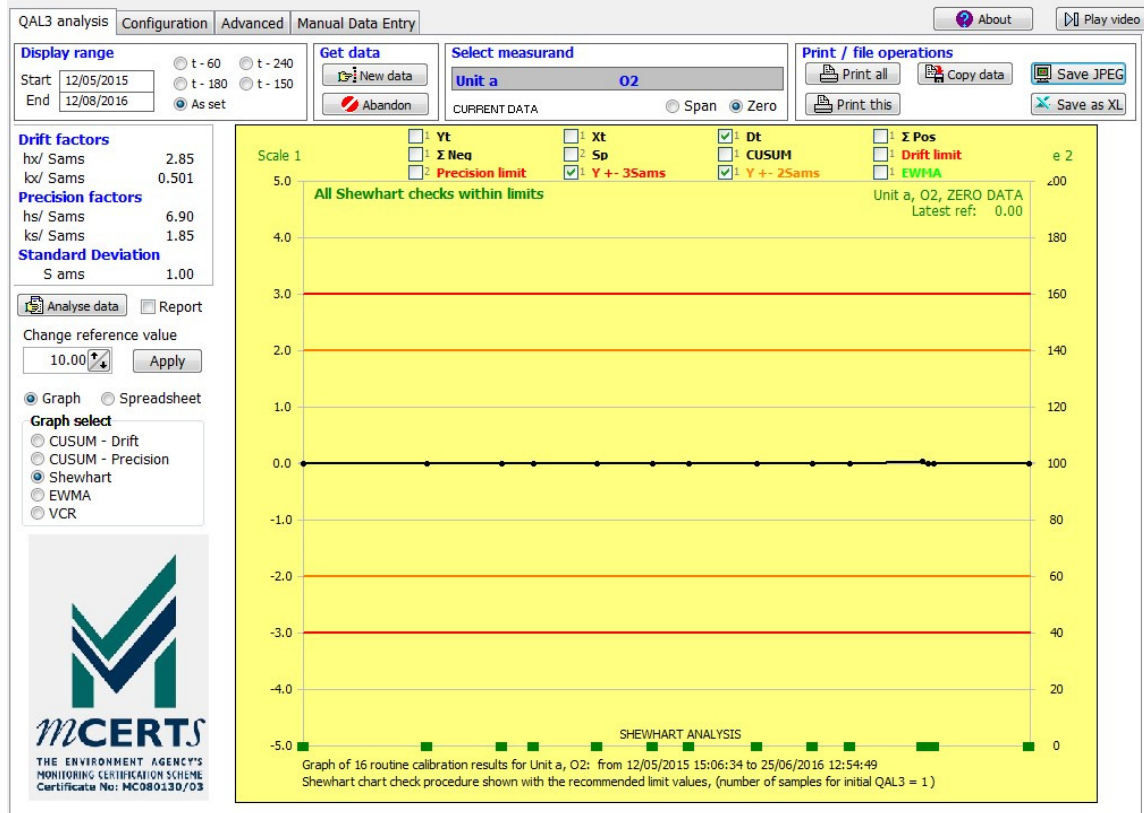
CO Span



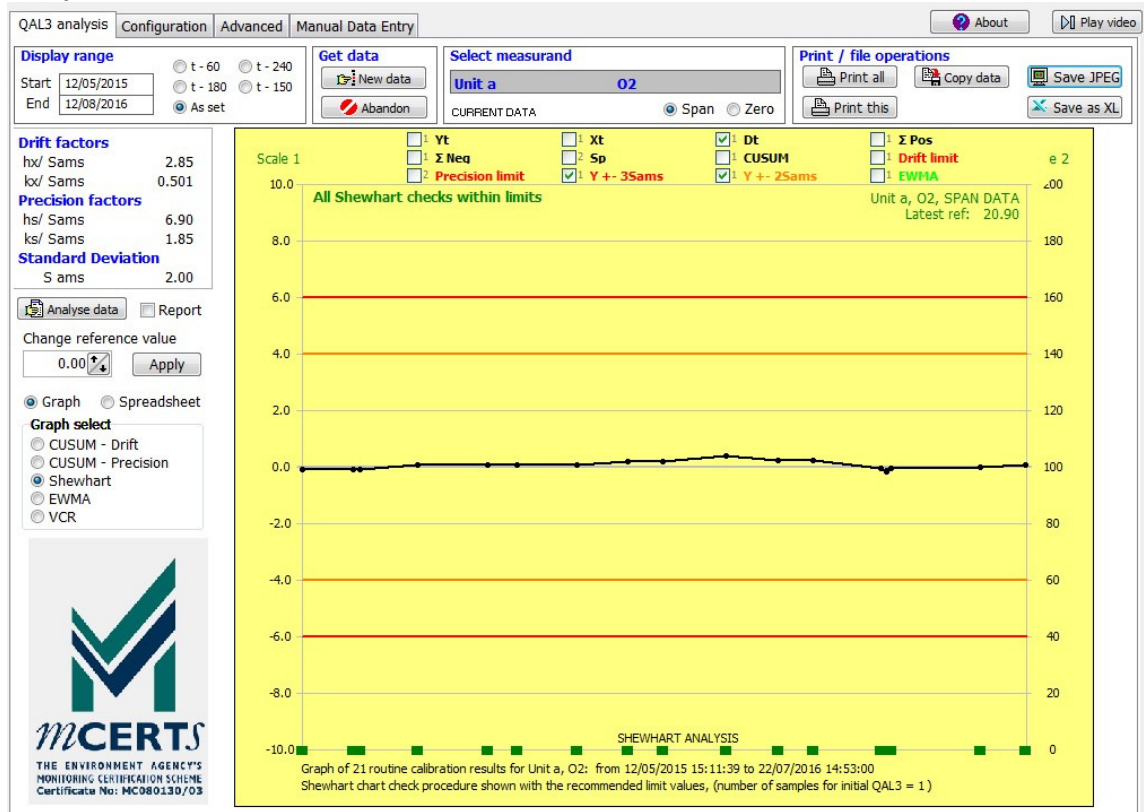
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 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

O2 Zero



O2 Span

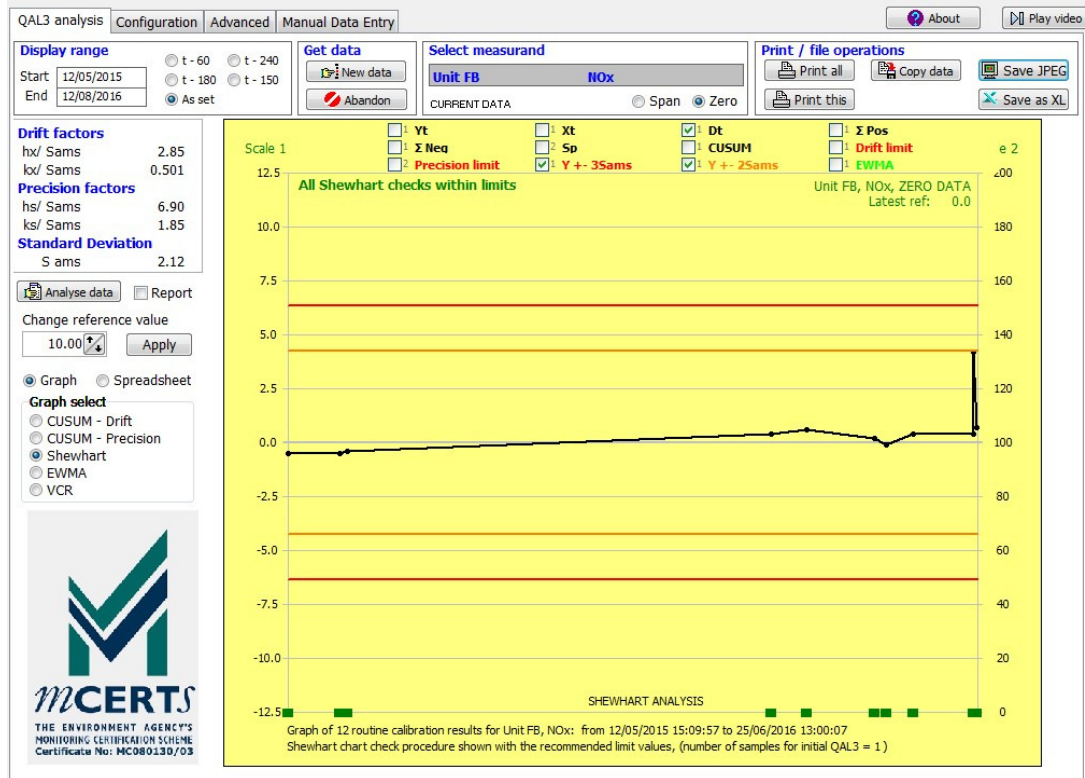


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 Report Ref : P2897 : R001

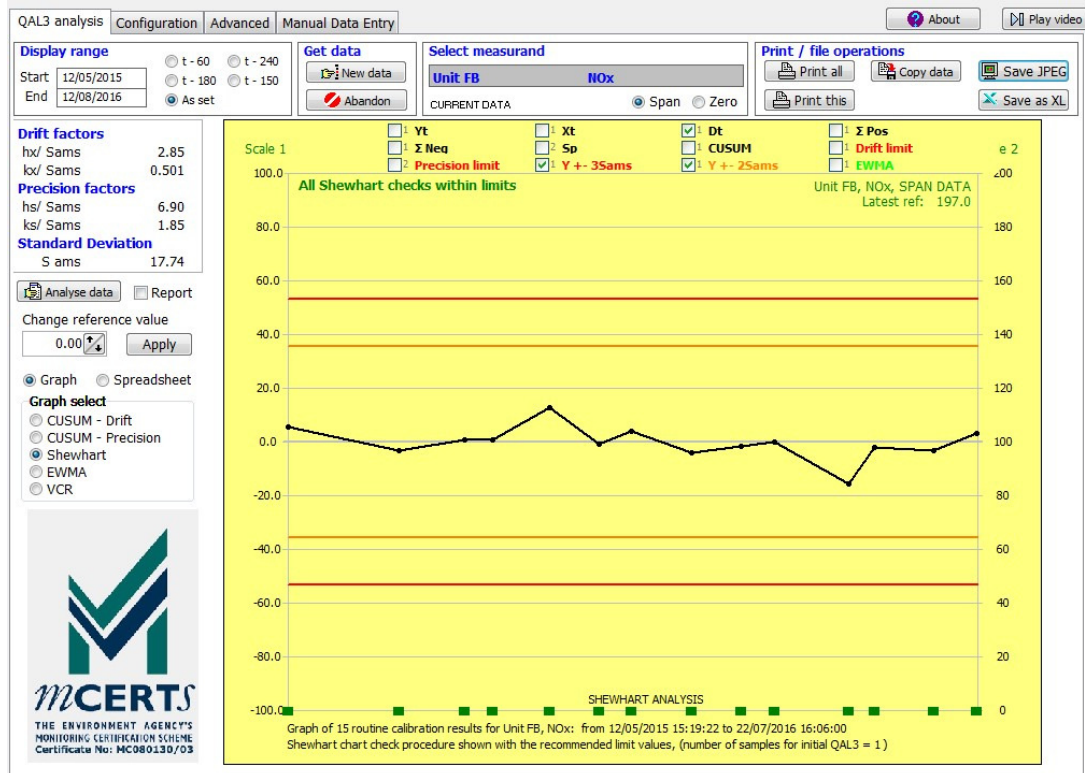
Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

A2

NO Zero



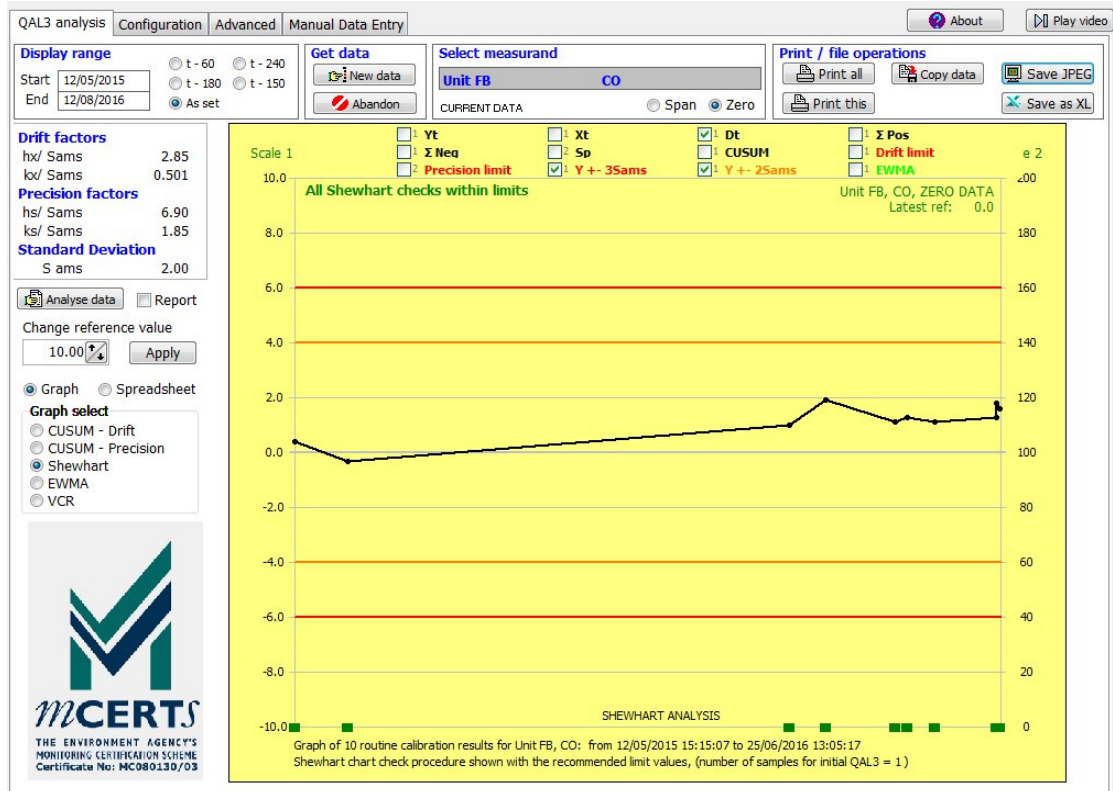
NO Span



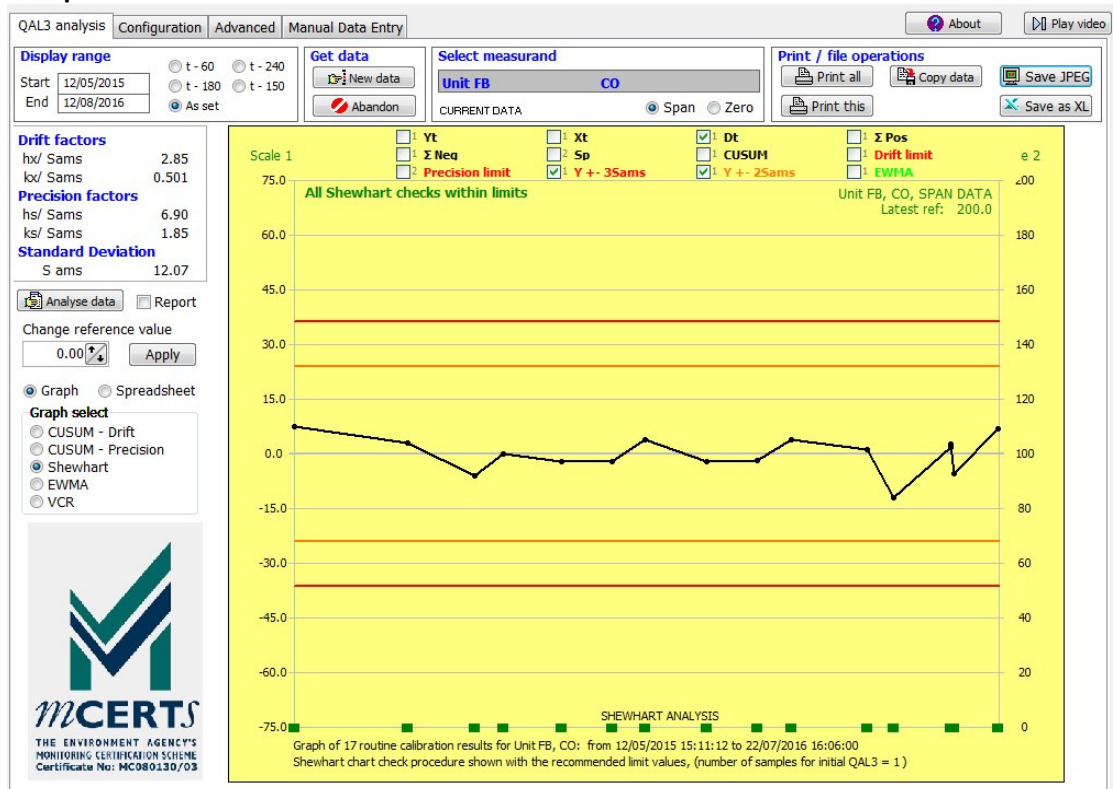
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 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

CO Zero



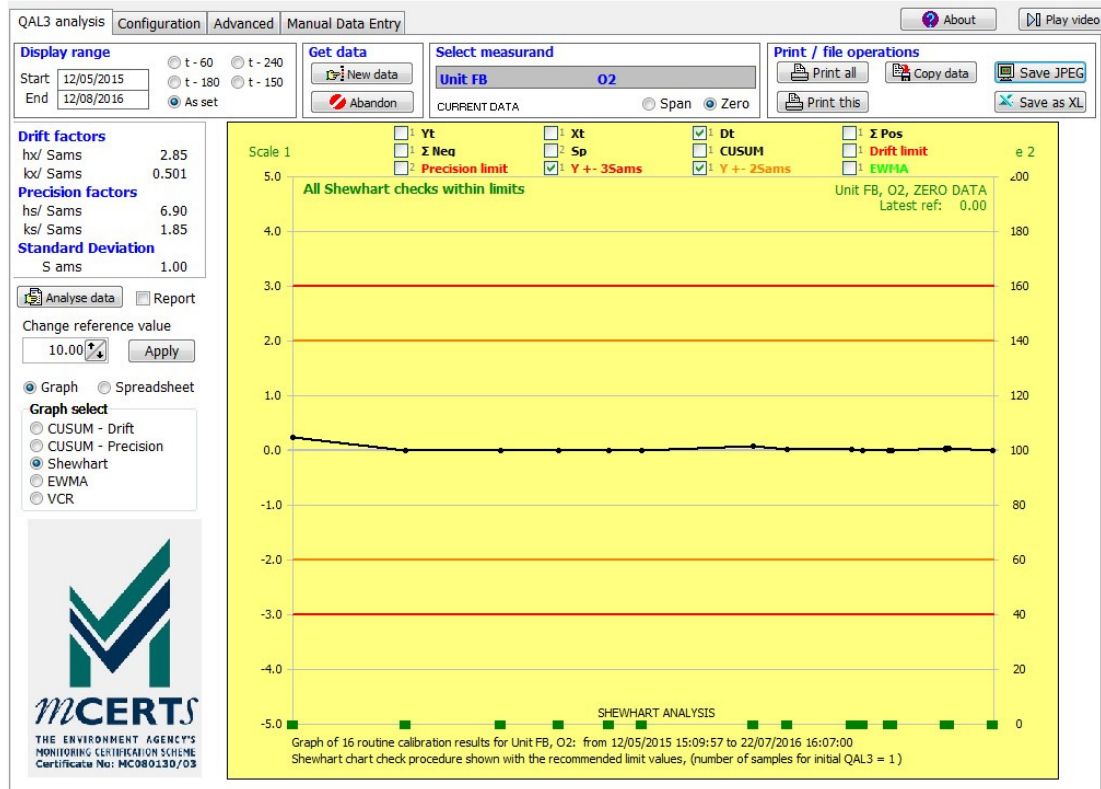
CO Span



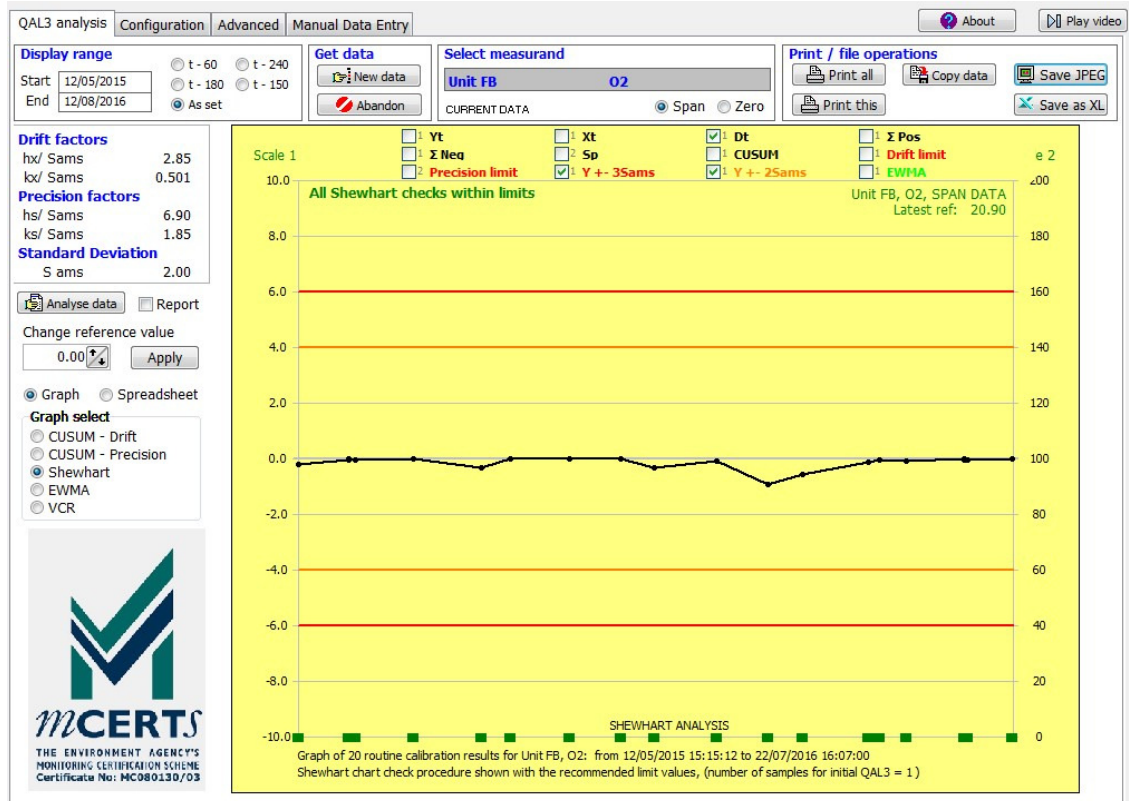
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Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

O2 Zero



O2 Span

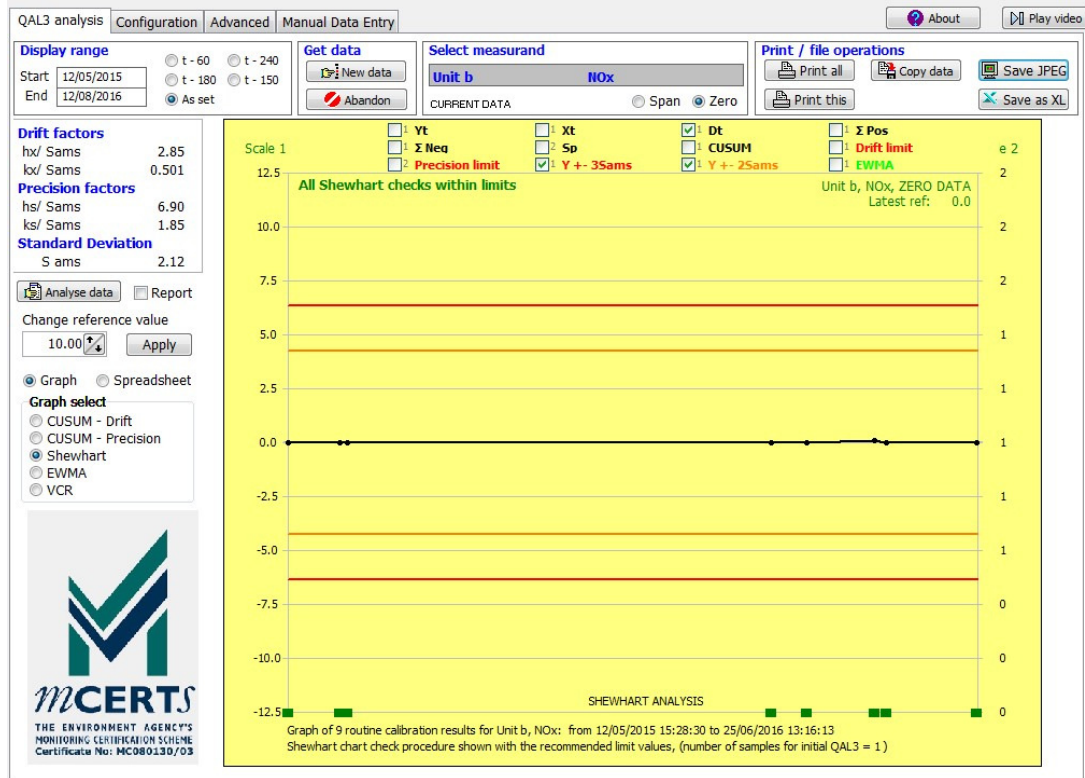


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 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

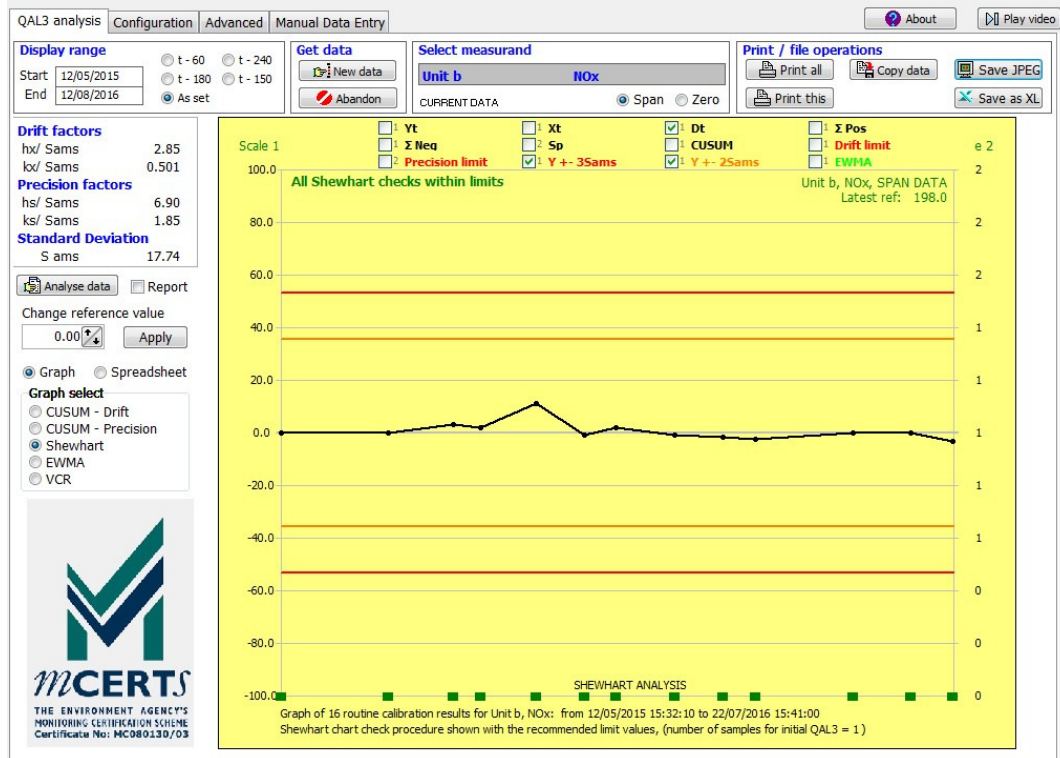
Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

A3

NO Zero



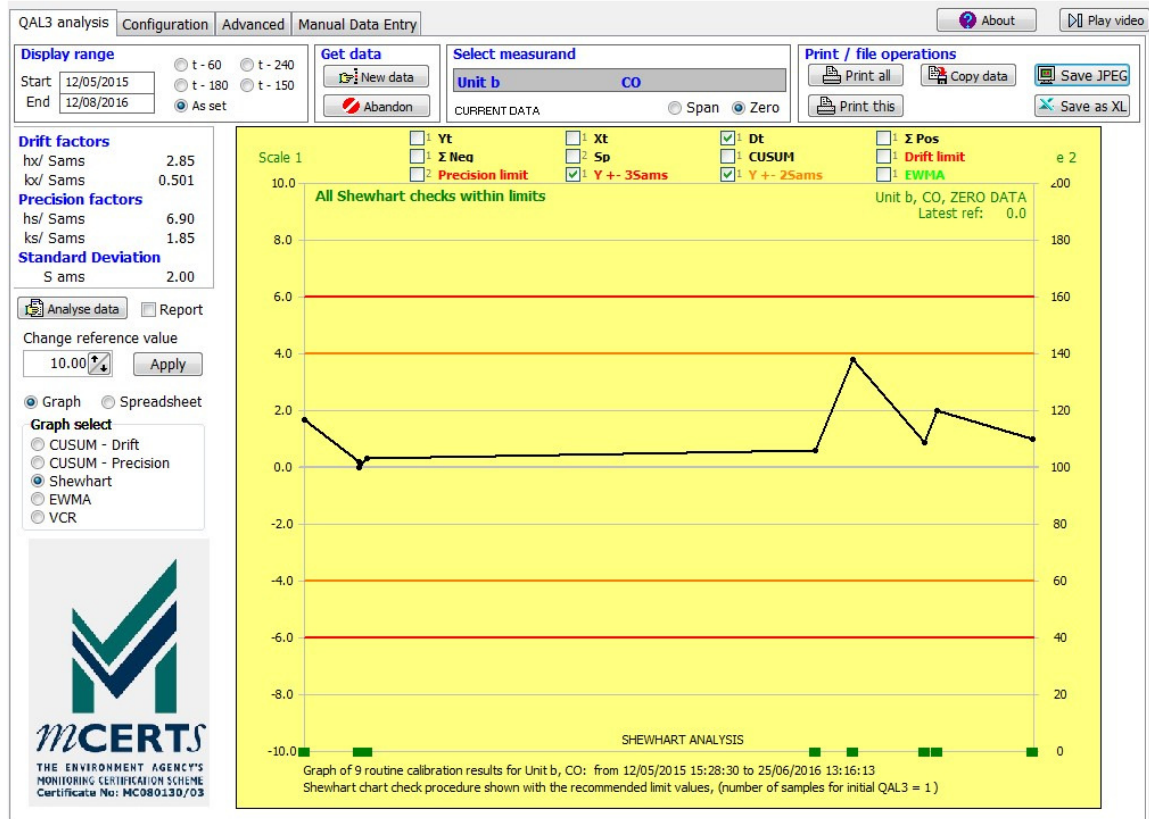
NO Span



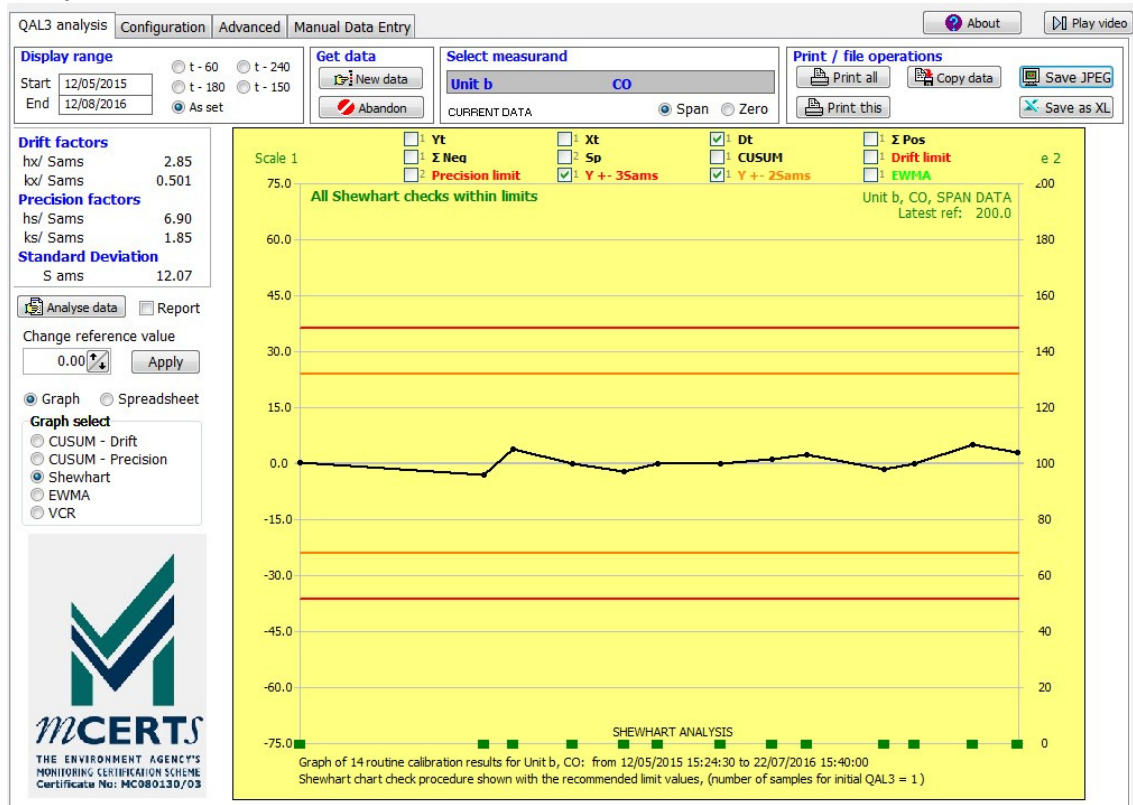
Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

CO Zero



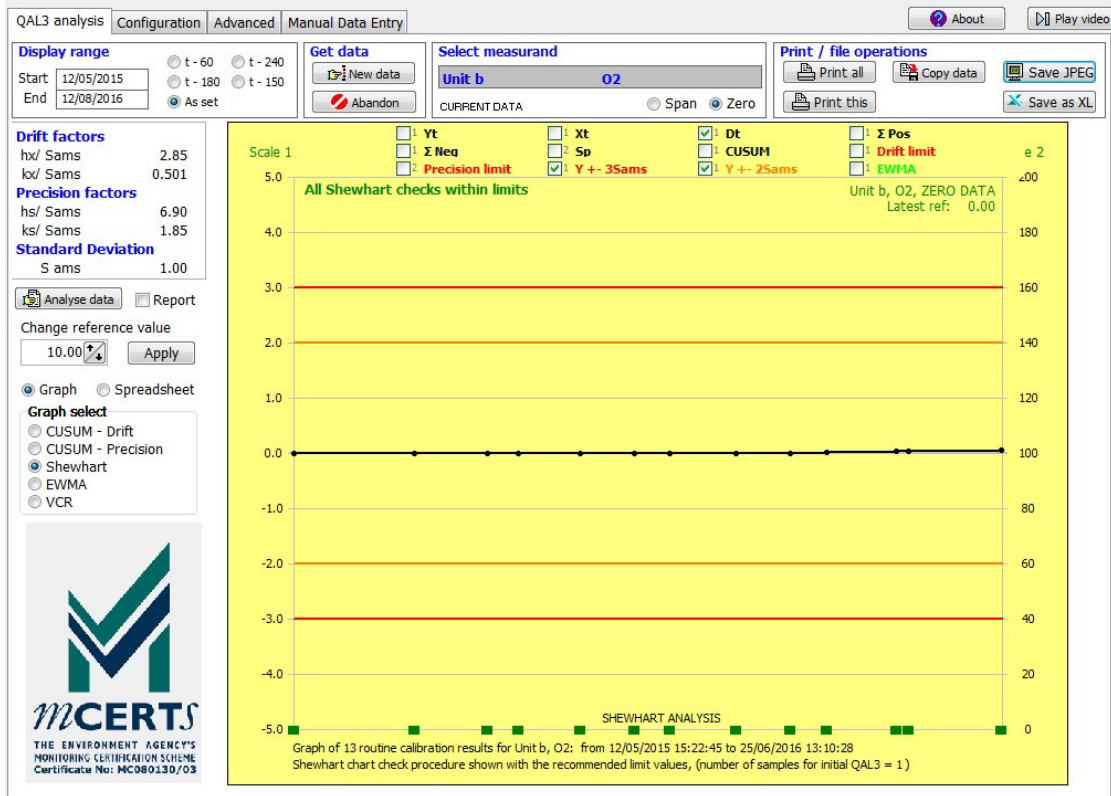
CO Span



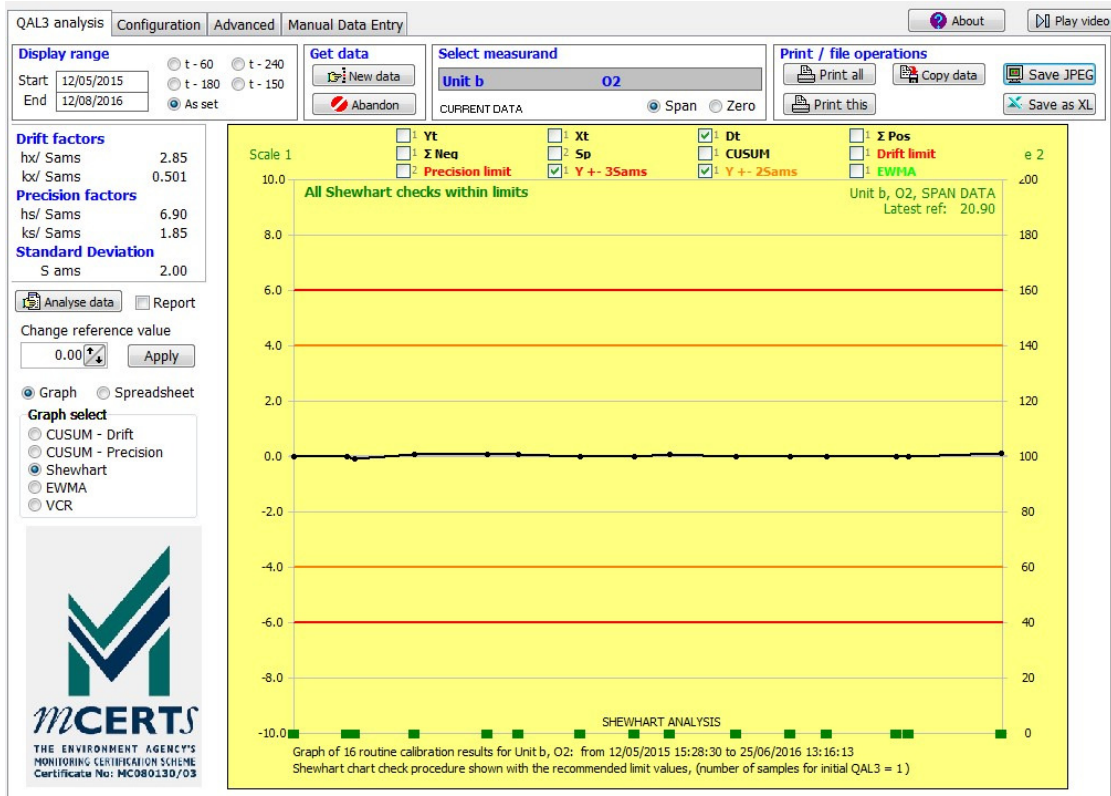
Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

O2 Zero



O2 Span



Engie
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Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
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Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

9.2 QAL3 CEM Logged Data

Available on request from operator and saved on system. All control charts are within limits.

Engie
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 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

10 EQUIPMENT USED

Equipment	Equipment Type	ID No:	ID No:	ID No:	ID No:
MST console/pump	E001				
MST Nozzle set					
MST “S” Type Pitot					
MST Probe					
MST Hot Box					
MST Impinger Arm					
Barometer		1046			
Site Balance					
Site Check weights					
Horiba	E002	969	1065		
Heated Probe Filter		631			
Chiller		1092			
Sonimix / MFC		761	934		
Heated Line		1013	1014		
FID	E003				
Heated Line					
Heated Probe Filter					
Testo	E004				
FTIR	E005				
Heated Probe Filter					
Heated Line					
Stackmite	E006				
“L” Type Pitot					
Digital Manometer					
Stack Thermocouple					
Thermocouple Reader					
Nozzle Set					

Quantity of ice used: N/A

Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016

11 CEM SERVICE REPORTS



Service Visit Report

Customer Name:	Cofely Industrial Services	Date of visit:	10 th August 2016
Site Address:	Dow Corning CHP Winbourne Road Dock No 2 Barry	Land Engineer:	Andrew Garratt
		Visit Type:	PM
		Equipment:	3 off Land FGA 950E Extractive
		Range	0 to
Post Code:	CF63 3DH	MCerts Ref.	Sira MC 040019/00
Contact name:	Paul Gardner	Ref. doc.	Section 7. 770-053 FGA 900 930 950 rev0 operating manual.pdf
Contact telephone No:	01446 723002		
Customer Order No.:			
Land Order Ref.			

Customer Request:	Request to verify that all Land FGA instruments used at plant are accurate/functioning ok.
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Work Carried out:	FGA950E s/n=9492050 HRS001B System Ok on arrival. Pre service parameters taken and analysed. Analyser powered off and all services isolated. Service performed in accordance with OEM procedures and maintenance schedule. System leak check performed. Instrument Calibrated, the sensor gains have been adjusted and all drift values reset. Post service & Calibration parameters taken and analysed. Instruments left in a fully operational condition without faults present. Leak test performed, using Land manometer. Resulting in no leak found. A visual inspection of the system was done. 1. Cleanliness – Internal condition of Analyser was good. Externally slight weathering. 2. Visual condition of sampling system - Overall in good condition inside of the unit with signs of weathering to the exterior. 3. Leak test (manometer) - Gas path integrity was found to be sound. 4. The Land analyser functions as an extractive analyser drawing the sample from the stack and passing the sample over Individual Electro-Chemical Sensors in order to measure CO, O2 and NO. 5. The response time of the Sensors to calibration gas is something which is measured during Linearity testing of an AST test. Calibration Gases Used: 1. Air Products Carbon Monoxide(CO) Cylinder No: 321973 at 200.52PPM 2. Air Products Nitrogen Oxide(NO) Cylinder No: 322666 at 199.00PPM S/N of Cells fitted: NO 207016 O2 1239026 CO 5671085
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Engie
 Permit No : EPR/JP3632ZH
 Variation No : EPR/JP3632ZH/V002
 Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
 Visit Details : AST 2016
 Survey Dates : 23rd to 25th August 2016
 Report Issue Date : 1st November 2016



FGA950E s/n=0292697 HP Fired Boiler

System Ok on arrival. Pre service parameters taken and analysed. Analyser powered off and all services isolated. Service performed in accordance with OEM procedures and maintenance schedule. System leak check performed. Instrument Calibrated, the sensor gains have been adjusted and all drift values reset. Post service & Calibration parameters taken and analysed. Instruments left in a fully operational condition without faults present. Leak test performed, using Land manometer. Resulting in no leak found. A visual inspection of the system was done. Over all in good condition to the inside of the unit with signs of weathering to the outer box.

1. Cleanliness – Internal condition of Analyser was good. Externally slight weathering.
2. Visual condition of sampling system - Overall in good condition inside of the unit with signs of weathering to the exterior.
3. Leak test (manometer) - Gas path integrity was found to be sound.
4. The Land analyser functions as an extractive analyser drawing the sample from the stack and passing the sample over Individual Electro-chemical Sensors in order to measure CO, O2 and NO.
5. The response time of the Sensors to calibration gas is something which is measured during Linearity testing of the unit.

Calibration Gases Used:

3. Air Products Carbon Monoxide(CO) Cylinder No: 321973 at 200.52PPM
4. Air Products Nitrogen Oxide(NO) Cylinder No: 322666 at 199.00PPM

S/N of Cells fitted:

NO 208016
 O2 1108114
 CO 5699016

FGA950E s/n= 0292699 HRSG001A

System Ok on arrival. Pre service parameters taken and analysed. Analyser powered off and all services isolated. Service performed in accordance with OEM procedures and maintenance schedule. System leak check performed. Instrument Calibrated, the sensor gains have been adjusted and all drift values reset. Post service & Calibration parameters taken and analysed. Instruments left in a fully operational condition without faults present. Leak test performed, using Land manometer. Resulting in no leak found. A visual inspection of the system was done. Small advisories, on weathering to auto cal PCB. Clips and brackets broken causing stress and tension to pipes and cables. Outer enclosure signs of corrosion.

1. Cleanliness – Internal condition of Analyser was good. Externally slight weathering.
2. Visual condition of sampling system - Overall in good condition inside of the unit with signs of weathering to the exterior.
3. Leak test (manometer) - Gas path integrity was found to be sound.
4. The Land analyser functions as an extractive analyser drawing the sample from the stack and passing the sample over Individual Electro-chemical Sensors in order to measure CO, O2 and NO.
5. The response time of the Sensors to calibration gas is something which is measured during Linearity testing of the unit.

Environmental Compliance Limited

Engie
Permit No : EPR/JP3632ZH
Variation No : EPR/JP3632ZH/V002
Report Ref : P2897 : R001

Installation Name : Dow Corning CHP
Visit Details : AST 2016
Survey Dates : 23rd to 25th August 2016
Report Issue Date : 1st November 2016

Calibration Gases Used:

5. Air Products Carbon Monoxide(CO) Cylinder No: 321973 at 200.52PPM
6. Air Products Nitrogen Oxide(NO) Cylinder No: 322666 at 199.00PPM

S/N of Cells fitted:

NO 178025
O2 1238026
CO 5667105