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EN 14181 QAL2 Report Commissioned by
Irish Cement Ltd

Installation Name & Address

Irish Cement Ltd
Limerick Works
Castlemungret
County Limerick

Primary Site Contact: Eve Howard

Industrial Emissions Licence: P0029-06

Stack Reference

A2-01 Kiln 6 [Duty Analyser]

Dates of the Monitoring Campaign

14th-23rd November 2023

Job Reference Number


EMT07766

Report Written by
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Opinions and interpretations expressed herein are outside the scope of Element's INAB accreditation.

This test report shall not be reproduced, except in full, without the written approval of Element Materials Technology.

This test report has been written to fully comply with the requirements in EN 14181:2014 and the Environmental Protection Agency's Air Guidance Note AG3 version 4.

This version of the test report supersedes the previous version of the test report. Please destroy all previous versions to ensure no confusion arises from having multiple test reports in existence.

Executive Summary (Page 1 of 2)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]
14th-23rd November 2023

Overall Aim of the Monitoring Campaign

Element were commissioned by Irish Cement Ltd to carry out stack emissions testing on the A2-01 Kiln 6 [Duty Analyser] Stack at Limerick.

The aim of the monitoring campaign was to perform a QAL2 Calibration Exercise on the Continuous Emissions Monitor (CEM), which is installed on the Plant, following the requirements of EN 14181.

Special Requirements

There were no special requirements.

QAL2 CALIBRATION SUMMARY

Parameter	Calibration Function derived from QAL2?	EN 14181 Procedure used to Derive the Calibration Function	Calibration Function Derived	Result of Variability Test	Valid Calibration Range @ REF Conditions	Range after Surrogate Extension @ REF Conditions	Calibration Function to Apply to the Data Acquisition Handling Software (See Conclusions)
Total Particulate Matter	No	Not Derived	N/A	N/A	N/A	N/A	$y = x$
Total VOCs	Yes	Procedure B	$y = 0.7638x - 0.0153$	Pass	0 to 21.9 mg/m ³	N/A	$y = 0.7638x - 0.0153$
Oxides of Nitrogen (as NO ₂)	Yes	Procedure A	$y = 0.9996x + 10.0912$	Pass	0 to 981.9 mg/m ³	N/A	$y = 0.9996x + 10.0912$
Sulphur Dioxide	Yes	Procedure C	$y = 1.0182x - 8.8827$	Pass	0 to 15.6 mg/m ³	N/A	$y = 1.0182x - 8.8827$
Carbon Monoxide	Yes	Procedure B	$y = 1.0214x + 0.0306$	Pass	0 to 423.8 mg/m ³	0 to 1225.6 mg/m ³	$y = 1.0214x + 0.0306$
Hydrogen Chloride	Yes	Procedure C	$y = 0.9855x - 0.2520$	Pass	0 to 2.0 mg/m ³	N/A	$y = 0.9855x - 0.2520$
Hydrogen Fluoride	Yes	Procedure C	$y = 0.9965x + 0.0252$	Pass	0 to 0.2 mg/m ³	N/A	$y = 0.9965x + 0.0252$
Ammonia	Yes	Procedure B	$y = 0.9663x + 0.0870$	Pass	0 to 34.7 mg/m ³	0 to 50 mg/m ³	$y = 0.9663x + 0.0870$
Water Vapour (% v/v)	Yes	Procedure B	$y = 0.9741x + 0.0000$	Pass	0 to 12.9 % v/v	N/A	$y = 0.9741x + 0.0000$
Oxygen (% v/v)	Yes	Procedure B	$y = 1.0347x - 0.0931$	Pass	0 to 13.1 % v/v	N/A	$y = 1.0347x - 0.0931$
Carbon Dioxide (% v/v)	Yes	Procedure A	$y = 1.4304x - 7.6508$	Pass	0 to 17.7 % v/v	N/A	$y = 1.4304x - 7.6508$
Volume Flow Rate (m ³ /s)	Yes	Procedure D	$y = 0.8212x + 0.0000$	Pass	0 to 85.1 m ³ /s	N/A	$y = 0.8212x + 0.0000$

The calibration functions, once applied, only remain 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 the QAL3 control limit.

All calibration functions throughout this report are given in the form $y = bx + a$, where b is the gradient and a is the intercept.

All calibration functions relate to mg/m³, unless otherwise stated.

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CONCLUSIONS, DISCUSSIONS & ACTIONS FROM THE SAMPLING EXERCISE

QAL 2 SUMMARY - All parameters except Total Particulate Matter

A valid calibration function has been derived from the parallel tests which passes the variability test. This calibration function should be used and entered into the Data Acquisition Handling Software (DAHS).

QAL 2 SUMMARY - Total Particulate Matter

As the Total Particulate Matter emissions are of a low order (less than the 95% Confidence Interval [CI] of the Daily ELV, which is 30%) and it is not possible to use Procedure C for particulates as there are no suitable surrogates available, therefore a valid calibration function has not been derived from the parallel tests. The results of the parallel monitoring exercise can be seen in Section 4A of this test report. In these circumstances AG3 suggests that, if agreed with the EPA, a minimum of 5 x Total Particulate Matter sample runs can be performed, ensuring that the total sampling time is >7.5hrs, over a minimum of 3 days. This is to verify that the emissions are of a continuing low order. Taking this approach, the CEM is effectively being used as a qualitative indicator of rising emissions rather than a quantitative monitor. The EPA should be informed if this approach has been taken.

QAL2 SUMMARY - Sulphur Dioxide

From the CEM & SRM paired data, the low level cluster and spread of data, Procedure C has been selected as determined by (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV. A function has been derived using procedure C with zero and span surrogate values. Although the test of " Procedure C acceptability" fails (based on the difference between, average uncal CEM and average SRM data against the allowable (95% CI of daily ELV), the defining Variability test passes, which gives confidence in the derived function.

FUNCTIONAL TEST ASSESSMENT

The functional tests were performed within 30 days of the 14181 exercise being performed.

LINEARITY SUMMARY - All parameters except Total Particulate Matter

The CEM was found to give a linear response to the test gases supplied to the analyser, passing the EN 14181 test of residuals requirement.

SUMMARY OF STANDARD REFERENCE METHOD & EN 14181 DEVIATIONS

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

Section 2: Information about the Regulated Installation

REGULATORY INFORMATION

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]
14th-23rd November 2023

Parameter	Value
Name of the Installation	Limerick
Address of the Installation	See Title Page
Sector of the Installation	Cement & Lime
Permit Number	P0029-06
Date of the Last QAL2 / AST Campaign	3rd-5th October 2022
Date CEMs Data Obtained by Element	24th November 2023

Regulated Determinands and Emission Limit Values (ELVs)

Determinand	Short-Term ELV (mg/m ³)	Daily or 48hr Average ELV (mg/m ³)	Uncertainty Requirement (%)
Total Particulate Matter	-	10	30
Total VOCs	-	25	30
Oxides of Nitrogen (as NO ₂)	-	500	20
Sulphur Dioxide	-	50	20
Carbon Monoxide	-	1500	10 ¹
Hydrogen Chloride	-	10	40
Hydrogen Fluoride	-	1	40
Ammonia	-	50	40

¹ AG3, Version 4, allows the use of a 95% confidence interval of 20% for CO for EN 14181 calculations

OPERATIONAL INFORMATION AND SITE MONITORING PROVISIONS

Irish Cement Ltd, Limerick
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Process Type and Variations in Emissions

Parameter	Value
Continuous or batch process	Continuous
Were there any variations in emissions during the EN 14181 test (e.g. Load changes)	Yes, natural process variation
Will these variations affect the representative nature of the collected data?	No
Are there any factors that may affect the collected data (e.g. auto-calibrations, plant start up and shut down)	Auto-calibrations removed (every 12 hours)
Reviewing historical Plant data, were low emissions expected for any determinands?	Yes - Total Particulate Matter, Hydrogen Chloride and Hydrogen Fluoride
Was the CEM reading zero for any determinands, if so, was this investigated to ensure it was working?	No
What product was being processed during the tests?	Cement Kiln

Type of Fuel

Parameter	Value
Fuel type used during the EN 14181 test (include proportions for co-incineration)	Petcoke and SRF
Are multiple calibration functions required if the emissions vary due to different fuel types being used?	No

Abatement

Parameter	Value
Type of Abatement System	Bag Filter, Lime Injection and SNCR
Running Status	Operational

MONITORING PROVISIONS AT THE INSTALLATION - PERIODIC MONITORING

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Irish Cement Ltd, Limerick
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Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	2.60
Width	m	-
Area	m ²	5.31
Port Depth	cm	21
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	5" Flange

Location of Sampling Platform

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

Platform Details

EPA Air Guidance Note AG1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	Yes
Access to sample ports unhindered by obstructions	Yes
Safe access available	Yes
Easy access available	Yes

Sampling Location / Platform Improvement Recommendations

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

EN 15259 Homogeneity Test Requirements

A valid EN 15259 Homogeneity test was performed by Element on this Stack on 19th June 2021, Report ID: EMT01136, and the stack gas profile was found to be homogenous.

Sampling Plane Validation Criteria (EN 15259)

Criteria in AG1	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	603	> 5 Pa	Yes
Mean Velocity	m/s	34		
Lowest Gas Velocity	m/s	27		
Highest Gas Velocity	m/s	36		
Ratio of Above	: 1	1.3	< 3 : 1	Yes
Maximum Angle of Swirl	°	8	< 15°	Yes
No Local Negative Flow	-	Yes		Yes

MONITORING PROVISIONS AT THE INSTALLATION - PERIODIC MONITORING

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Irish Cement Ltd, Limerick
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Pro-forma for Site Provisions for Monitoring

Requirement	Compliant	Notes
A safe and clean working environment with sufficient space and weather protection.	Yes	
Easy and safe access to the CEM.	Yes	
Adequate supplies of reference materials, tools and spare parts.	Yes	
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.	Yes	
Compliance with EN 15259	Yes	See the Sampling Plane Validation Criteria table on the previous page.

Plant Photos

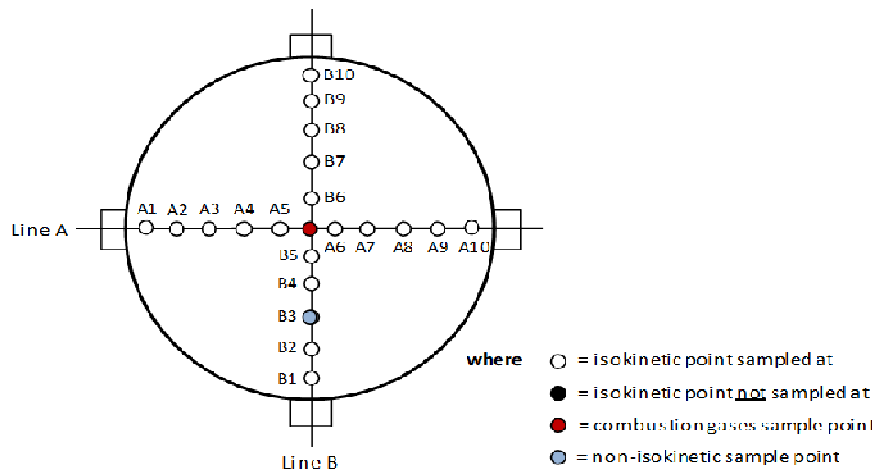
Photo 1



Photo 2



Sample Points



Section 2: Information about the Regulated Installation

CONTINUOUS EMISSION MONITORs (CEMs) AT THE INSTALLATION

Irish Cement Ltd, Limerick
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Main Determinand	Type	Instrument Name	Instrument Serial Number	Measurement Principle	Certified Range (mg/m ³)	QAL1 Compliant	MCERTS Number
Total Particulate Matter	In-Situ	PCME View QAL 181	54075	Light Scatter	0 to 7.5	Yes	MC090152/04
Total VOCs	Extractive	ABB ACF5000	F.3.374483.7	FID	0 to 15	Yes	MC160309/04
Oxides of Nitrogen (as NO ₂)	Extractive	ABB ACF5000	F.3.374483.7	FTIR	0 to 150	Yes	MC160309/04
Sulphur Dioxide	Extractive	ABB ACF5000	F.3.374483.7	FTIR	0 to 75	Yes	MC160309/04
Carbon Monoxide	Extractive	ABB ACF5000	F.3.374483.7	FTIR	0 to 75	Yes	MC160309/04
Hydrogen Chloride	Extractive	ABB ACF5000	F.3.374483.7	FTIR	0 to 15	Yes	MC160309/04
Hydrogen Fluoride	Extractive	ABB ACF5000	F.3.374483.7	FTIR	0 to 3	Yes	MC160309/04
Ammonia	Extractive	ABB ACF5000	F.3.374483.7	FTIR	0 to 5	Yes	MC160309/04
Water Vapour	Extractive	ABB ACF5000	F.3.374483.7	FTIR	0 to 40%	Yes	MC160309/04
Oxygen (Wet)	Extractive	ABB ACF5000	F.3.374483.7	Zirconia	0 to 25	Yes	MC160309/04
Carbon Dioxide	Extractive	ABB ACF5000	F.3.374483.7	FTIR	0 to 30%	Yes	MC160309/04
Volume Flow Rate	In-Situ	Durag D-FL 100	1270977	Differential Pressure	3- 30m/s	Yes	MC060071/03

Peripheral Determinand	Recorded	Instrument Name
Temperature	Yes	Unknown
Pressure	Yes	Unknown

Section 3 - Information about the Monitoring Campaign

TEST LABORATORY STAFF

Position	Name	MCERTS Accreditation	MCERTS Number & Expiry Date	Technical Endorsements
Team Leader	Mateusz Terlecki	MCERTS Level 2	MM17 1448	TE1 TE2 TE3 TE4
Team Leader	Simon FitzHugh	MCERTS Level 2	MM20 1595	TE1

STANDARD REFERENCE METHODS (SRMs)

Element hold INAB and MCERTS Accreditation for performing QAL2 and ASTs, to EN 14181.

Determinand	Instrument Name	Measurement Principle	Instrumental Ranges		MCERTS Number	Reference Method	MU ² (%)
			Certified (mg/m ³)	Operational (mg/m ³)			
Total Particulate Matter	MST	Gravimetric	N/A - SRM	N/A - SRM	N/A	EN 13284-1	10
Total VOCs	Sick Maihak 3006	FID	0 - 15	0 - 160	MC 040036	EN 12619	10
Oxides of Nitrogen (as NO ₂)	Gasmet DX4000	FTIR	0 - 200	0 - 615	MC 030014	CEN/TS 17337	10
Sulphur Dioxide	MST	Ion Chromatography	N/A - SRM	N/A - SRM	N/A	CEN/TS 17021	10
Carbon Monoxide	Gasmet DX4000	FTIR	0 - 75	0 - 625	MC 030014	CEN/TS 173372	10
Hydrogen Chloride	Gasmet DX4000	FTIR	0 - 15	0 - 16	MC 030014	CEN/TS 17337	10
Hydrogen Fluoride	MST	Ion Chromatography	N/A - SRM	N/A - SRM	N/A	CEN/TS 17340	10
Ammonia	Gasmet DX4000	FTIR	N/A	0 - 38	MC 030014	CEN/TS 17337	10
Water Vapour	Gasmet DX4000	FTIR	0 - 30%	0 - 30%	MC 030014	CEN/TS 17337	5
Oxygen (Dry)	Horiba PG-350E	Paramagnetic Cell	0 - 25%	0 - 25%	MC 130223	EN 14789	5
Carbon Dioxide	Gasmet DX4000	FTIR	0 - 25%	0 - 25%	MC 030014	CEN/TS 17337	5
Volume Flow Rate	S-Pitot & MST	Pressure & Temperature	N/A - SRM	N/A - SRM	N/A	EN 16911-1	5

NOTE 1: Element hold INAB and MCERTS Accreditation for all Standard Reference Method Tests performed.

NOTE 2: The MU specified in this column is reported as the MU at the Daily ELV (not the MU percentage of concentration measured.)

where: **MST stands for Manual Sampling Train**

NOTE 2: Volume Flow Rate calibration is performed following the procedural requirements of EN ISO 16911-2, Element do not hold accreditation for this Method at this time.

LIST OF EQUIPMENT

Extractive Sampling		Instrumental Analysers		Miscellaneous Items	
Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.
Control Box DGM (1)	CAT 7.991	Horiba PG-350E	CAT 39.6	Digital Manometer (1)	CAT 3.250
Control Box DGM (2)	CAT 7.1000	Horiba PG-250	-	Digital Manometer (2)	-
Box Thermocouples (1)	CAT 3.103	Servomex 4900	-	Digital Temperature Meter	CAT 3.250
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	CAT 14.53
Umbilical (1)	CAT 3.103	ABB AO2020-URAS26	-	Barometer	CAT 13.39
Umbilical (2)	CAT 3.10004	Testo 350 XL	-	Stack Thermocouple (1)	CAT 4.1581
Oven Box (1)	CAT 12.29	JCT JCC P1 Cooler	CAT 4.1122	Stack Thermocouple (2)	-
Oven Box (2)	CAT 12.115	Gasmet DX4000	CAT 19.7	Stack Thermocouple (3)	-
Heated Probe (1)	CAT 5.51	Gasmet Sampling System	CAT 10.4	1m Heated Line (1)	-
Heated Probe (2)	CAT 5.57	Sick 3006	CAT 8.15	1m Heated Line (2)	-
Heated Probe (3)	-	Ankersmid APP100	CAT 12.134	1m Heated Line (3)	-
S-Pitot (1)	CAT 21p.177	Mass Flow Controller (1)	CAT 6.59	5m Heated Line (1)	-
S-Pitot (2)	CAT 21p.165	Mass Flow Controller (2)	CAT 6.70	15m Heated Line (1)	CAT 20.998
L-Pitot	-	Mass View (1)	CAT 25.87	20m Heated Line (1)	-
500g Check Weight	CAT 17.1	Mass View (2)	-	20m Heated Line (2)	-
1Kg Check Weight	CAT 17.1	Hioki 5043 (V)	CAT 11.53	Dual Channel Heater Controller	-
Last Impinger Arm	CAT 4.0001	Hioki 5031 (mA)	-	Single Channel Heater Controller	CAT 20.998
Callipers	CAT 23.11			Laboratory Balance	CAT 1.18 / 1.18a
Tubes Kit Thermocouple	-			Tape Measure	CAT 16.94

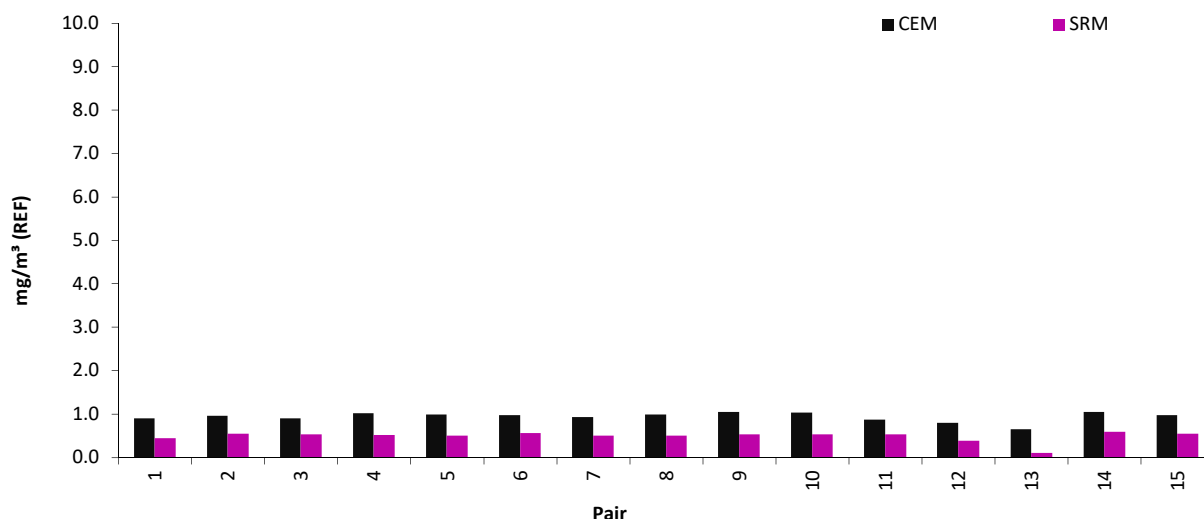
Section 4A - Data and Calculations - QAL2

TOTAL PARTICULATE MATTER: QAL2 CALCULATIONS

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Pair	Date	Times	x, CEM (ACTUAL) mg/m ³	y, SRM (ACTUAL) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	Filter ID Number (47-XXXX)
1	14/11/2023	12:00 - 13:00	0.49	0.23	0.91	0.46	47-105038
2	14/11/2023	13:30 - 14:32	0.51	0.27	0.96	0.56	47-105098
3	14/11/2023	14:45 - 15:52	0.49	0.27	0.91	0.54	47-104731
4	15/11/2023	08:56 - 09:58	0.57	0.29	1.02	0.53	47-105099
5	15/11/2023	10:00 - 11:00	0.56	0.28	1.00	0.52	47-104505
6	15/11/2023	11:05 - 12:05	0.52	0.28	0.98	0.57	47-105089
7	15/11/2023	12:07 - 13:07	0.51	0.27	0.94	0.51	47-105110
8	15/11/2023	13:10 - 14:10	0.53	0.27	1.00	0.51	47-105116
9	15/11/2023	14:12 - 15:15	0.55	0.27	1.06	0.55	47-105077
10	15/11/2023	15:15 - 16:15	0.55	0.27	1.04	0.54	47-104504
11	16/11/2023	08:45 - 09:45	0.47	0.28	0.88	0.54	47-104507
12	16/11/2023	09:47 - 10:48	0.42	0.19	0.80	0.39	47-105212
13	16/11/2023	10:50 - 11:52	0.35	0.06	0.65	0.11	47-105211
14	16/11/2023	14:00 - 15:02	0.56	0.30	1.06	0.60	47-104741
15	16/11/2023	15:05 - 16:07	0.51	0.28	0.98	0.56	47-104740
16							
17							
18							
19							
20							
21							
22							
23							
24							
25							
26							
27							
28							
29							
30							
DAILY ELV	-	-	-	-	-	10	

PLOT 1: BAR CHART FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED)



It can be seen from the table and graphical representation of data (above) that the emissions are of a low order (less than the 95% Confidence Interval, which is 30% of the Daily ELV) and the spread of data is poor. In these circumstances EPA document AG3 allows an alternative approach to be taken. A minimum of 5 x Total Particulate Matter runs may be performed, ensuring that the total sampling time is >7.5hrs. These results should verify that the emissions are low. Surrogates should be used to check the linearity, zero and span settings of the monitor, and finally the monitor should be set on its most sensitive range in order to alert the operator that the control devices for particulates (i.e. the abatement system) may need attention if an increase in the emissions is observed.

Section 4A - Data and Calculations - QAL2

TOTAL VOCs: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
L1	Surrogate	Near Zero	0.02	0.00	0.00	-21.05	-16.08	338.47	443.14	0.00
1	21/11/2023	13:02 - 13:32	21.66	16.56	18.69	0.59	0.48	0.28	0.35	16.53
2	21/11/2023	17:02 - 17:32	19.98	14.90	17.45	-1.09	-1.17	1.28	1.20	15.24
3	21/11/2023	18:02 - 18:32	21.57	16.59	18.46	0.50	0.51	0.26	0.25	16.46
4	21/11/2023	19:02 - 19:32	21.06	16.80	18.86	-0.01	0.72	-0.01	0.00	16.07
5	21/11/2023	21:02 - 21:32	21.62	16.94	19.51	0.55	0.86	0.47	0.30	16.50
6	22/11/2023	10:02 - 10:32	23.15	17.10	18.79	2.08	1.02	2.11	4.32	17.67
7	22/11/2023	11:02 - 11:32	22.77	18.13	20.35	1.70	2.05	3.49	2.90	17.38
8	22/11/2023	12:02 - 12:32	23.01	18.38	20.57	1.94	2.30	4.45	3.75	17.56
9	22/11/2023	13:02 - 13:32	22.15	17.33	19.67	1.08	1.25	1.35	1.17	16.90
10	22/11/2023	14:02 - 14:32	21.30	16.59	18.96	0.23	0.51	0.12	0.05	16.26
11	22/11/2023	16:02 - 16:32	22.29	17.40	19.72	1.22	1.32	1.61	1.48	17.01
12	22/11/2023	18:02 - 18:32	23.92	18.29	20.17	2.85	2.21	6.28	8.10	18.25
13	22/11/2023	19:02 - 19:32	22.87	17.32	19.65	1.80	1.24	2.24	3.24	17.45
14	22/11/2023	21:02 - 21:32	22.66	17.18	19.61	1.59	1.10	1.74	2.52	17.29
15	22/11/2023	22:02 - 22:32	21.19	16.37	20.19	0.11	0.29	0.03	0.01	16.17
16	22/11/2023	23:02 - 23:32	23.43	16.88	18.98	2.36	0.80	1.89	5.55	17.88
17	23/11/2023	00:02 - 00:32	22.83	16.35	18.55	1.76	0.27	0.47	3.10	17.42
18	23/11/2023	01:02 - 01:32	22.88	16.40	18.65	1.81	0.32	0.58	3.27	17.46
19										
20										
21										
22										
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Section 4A - Data and Calculations - QAL2

TOTAL VOCs: QAL2 CALCULATIONS

(Page 2 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³	
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					MAX SRM - MIN SRM	3.12					
					(DAILY) DELV (mg/m ³)	25					
					95% CI MU (%)	30					
					95% CI at DELV (mg/m ³)	7.5					
					15% of ELV	3.8					
					PROCEDURE (A, B, C)	B					
							SUM	367.13	484.71		

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV
PROCEDURE C If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV

WHERE OFFSET = 0.02

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
(Statistical Outliers removed following outlier test, other data removed prior to this test)					
1	21/11/2023	15:02 - 15:32	21.20	0.00	SRM calibrating
2	21/11/2023	16:02 - 16:32	20.96	0.00	SRM calibrating
3	21/11/2023	20:02 - 20:32	0.00	17.15	Instrument performing an auto-zero
4	21/11/2023	22:02 - 23:32	-	-	SRM Offline
5	22/11/2023	00:02 - 09:32	-	-	SRM Offline
6	22/11/2023	15:02 - 15:32	21.20	0.00	SRM calibrating
7	22/11/2023	17:02 - 17:32	23.61	0.00	SRM calibrating
8	22/11/2023	20:02 - 20:32	0.00	17.07	Instrument performing an auto-zero
9	21/11/2023	14:02 - 14:32	21.42	17.89	Statistical outlier
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Section 4A - Data and Calculations - QAL2

TOTAL VOCs: QAL2 CALCULATIONS

(Page 3 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Derivation of Calibration Function

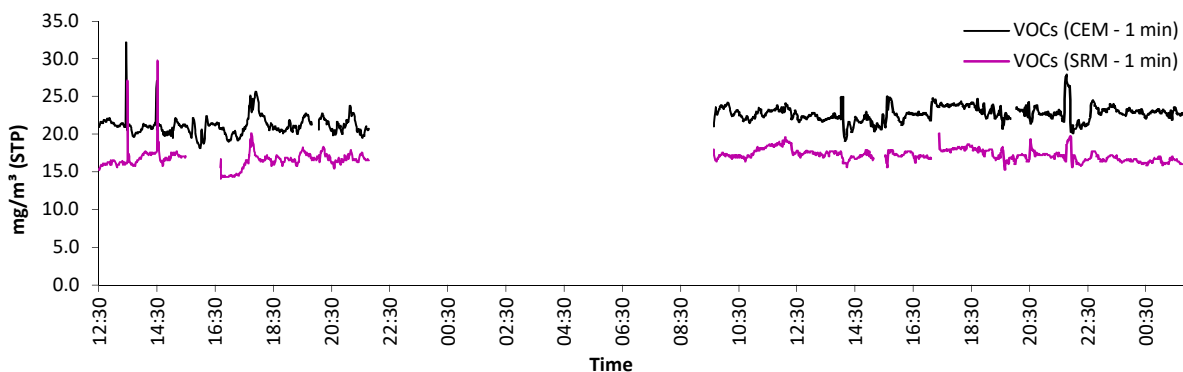
b =	0.7638	a =	-0.0153
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CALIBRATION FUNCTION =	y = 0.7638x - 0.0153
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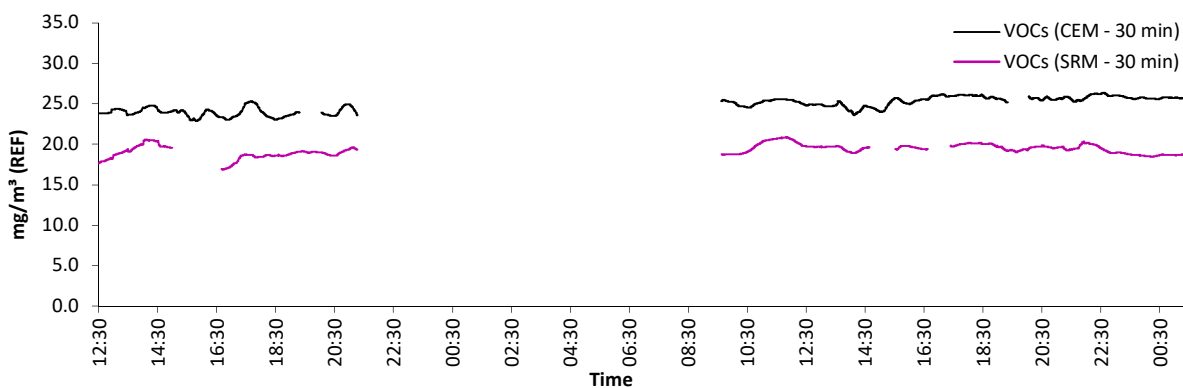
where

For Procedure A / C $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$
 Procedure B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

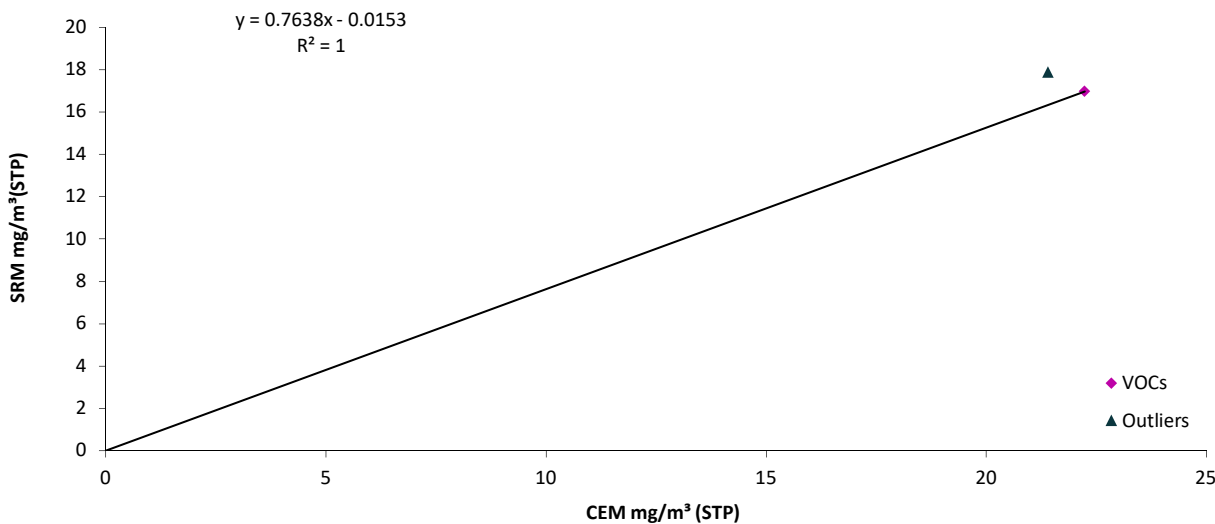
PLOT 1a: GRAPH FOR STP SRM vs STP CEMS (NON-STANDARDISED) (1 minute readings)



PLOT 1: GRAPH FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED) (30 minute rolling averages)



PLOT 2: Calibration Graph for Procedure B



Section 4A - Data and Calculations - QAL2

TOTAL VOCs: QAL2 CALCULATIONS

(Page 4 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL			CAL			where CAL = Calibrated using QAL2 calibration functions			
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM	
					N/A			N/A						
L1	Surrogate	Near Zero	0.00	N/A	N/A	N/A	N/A	N/A	N/A	0.00	0.00	0.02	0.00	
1	21/11/2023	13:02 - 13:32	16.53	12.37	12.05	11.98	9.62	9.86	9.93	18.56	18.69	24.32	0.13	
2	21/11/2023	17:02 - 17:32	15.24	10.82	10.54	10.47	10.21	10.47	10.50	17.80	17.45	23.33	-0.36	
3	21/11/2023	18:02 - 18:32	16.46	11.86	11.56	11.61	9.57	9.81	9.82	18.30	18.46	23.98	0.16	
4	21/11/2023	19:02 - 19:32	16.07	12.10	11.79	11.77	9.66	9.90	9.90	18.05	18.86	23.66	0.81	
5	21/11/2023	21:02 - 21:32	16.50	11.33	11.04	11.27	9.98	10.23	10.24	18.93	19.51	24.81	0.58	
6	22/11/2023	10:02 - 10:32	17.67	12.16	11.84	11.79	9.31	9.54	9.65	19.24	18.79	25.21	-0.45	
7	22/11/2023	11:02 - 11:32	17.38	11.85	11.55	11.61	9.57	9.81	9.91	19.31	20.35	25.31	1.04	
8	22/11/2023	12:02 - 12:32	17.56	11.73	11.43	11.56	9.54	9.78	9.89	19.43	20.57	25.46	1.14	
9	22/11/2023	13:02 - 13:32	16.90	11.96	11.65	11.77	9.67	9.91	10.02	18.98	19.67	24.88	0.69	
10	22/11/2023	14:02 - 14:32	16.26	10.49	10.22	10.55	9.91	10.16	10.24	18.37	18.96	24.08	0.58	
11	22/11/2023	16:02 - 16:32	17.01	11.60	11.30	11.42	9.70	9.95	10.04	19.08	19.72	25.00	0.64	
12	22/11/2023	18:02 - 18:32	18.25	11.01	10.72	10.90	9.47	9.70	9.81	19.90	20.17	26.08	0.26	
13	22/11/2023	19:02 - 19:32	17.45	10.54	10.27	10.18	9.82	10.07	10.20	19.57	19.65	25.65	0.07	
14	22/11/2023	21:02 - 21:32	17.29	11.38	11.08	11.11	9.82	10.06	10.16	19.56	19.61	25.63	0.05	
15	22/11/2023	22:02 - 22:32	16.17	9.70	9.45	9.53	10.78	11.06	11.14	19.75	20.19	25.88	0.44	
16	22/11/2023	23:02 - 23:32	17.88	10.60	10.33	10.28	9.73	9.97	10.09	19.88	18.98	26.06	-0.91	
17	23/11/2023	00:02 - 00:32	17.42	10.84	10.56	10.62	9.81	10.06	10.15	19.58	18.55	25.66	-1.03	
18	23/11/2023	01:02 - 01:32	17.46	10.95	10.67	10.80	9.82	10.07	10.15	19.67	18.65	25.78	-1.03	
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Section 4A - Data and Calculations - QAL2

TOTAL VOCs: QAL2 CALCULATIONS

(Page 5 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL			CAL			where CAL = Calibrated using QAL2 calibration functions			
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM	
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											MAX	AVERAGE	AVERAGE	Sd
											19.90	19.27	25.04	0.67

Test of Variability

$Q_0 = ELV \times (MU / 100) / 1.96$	3.83
Kv for 18 Pairs of Data	0.9803

The variability is accepted if $Sd \leq Q_0 \times Kv$.

Parameter	Value
Standard Deviation (Sd)	0.67
$Q_0 \times Kv$	3.75
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	19.9
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The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 21.9
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 5.0

Greater of (a) or (b)	0 to 21.9
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Surrogate Extension Applied?	No
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Valid Calibration Range (at REF conditions)	0 to 21.9 mg/m³
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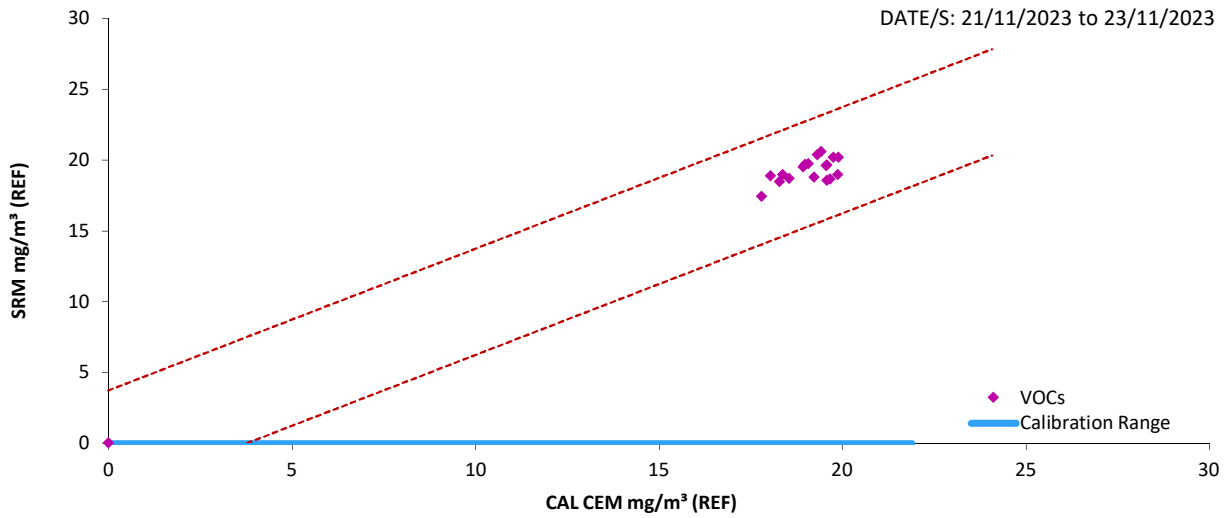
Section 4A - Data and Calculations - QAL2

TOTAL VOCs: QAL2 CALCULATIONS

(Page 6 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

(Page 1 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
L1	Surrogate	Near Zero	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1	14/11/2023	17:02 - 17:32	398.10	410.90	510.30	6.18	9.06	56.00	38.21	408.02
2	14/11/2023	18:02 - 18:32	403.01	411.33	506.27	11.09	9.49	105.22	122.90	412.92
3	14/11/2023	19:02 - 19:32	391.45	398.62	495.65	-0.47	-3.21	1.51	0.22	401.37
4	14/11/2023	21:02 - 21:32	398.85	402.02	509.02	6.93	0.19	1.29	48.00	408.76
5	14/11/2023	23:02 - 23:32	387.03	387.99	492.34	-4.90	-13.84	67.77	23.96	396.95
6	15/11/2023	00:02 - 00:32	376.83	377.49	474.18	-15.09	-24.35	367.54	227.77	386.75
7	15/11/2023	01:02 - 01:32	408.74	411.19	503.49	16.82	9.35	157.18	282.78	418.65
8	15/11/2023	02:02 - 02:32	390.49	390.26	491.13	-1.43	-11.58	16.53	2.04	400.41
9	15/11/2023	04:02 - 04:32	396.24	393.35	492.82	4.32	-8.49	-36.69	18.67	406.16
10	15/11/2023	05:02 - 05:32	408.37	409.21	508.01	16.45	7.37	121.24	270.66	418.28
11	15/11/2023	06:02 - 06:32	393.06	390.60	495.16	1.14	-11.24	-12.82	1.30	402.98
12	15/11/2023	07:02 - 07:32	391.53	389.45	493.41	-0.39	-12.38	4.86	0.15	401.45
13	15/11/2023	09:02 - 09:32	387.77	406.37	519.43	-4.15	4.53	-18.81	17.22	397.69
14	15/11/2023	10:02 - 10:32	388.21	399.85	487.23	-3.71	-1.99	7.37	13.74	398.13
15	15/11/2023	11:02 - 11:32	343.22	354.80	440.89	-48.70	-47.04	2291.01	2372.09	353.16
16	15/11/2023	12:02 - 12:32	366.29	384.55	486.03	-25.63	-17.29	443.07	656.91	376.22
17	15/11/2023	13:02 - 13:32	456.13	482.81	601.55	64.21	80.97	5198.83	4122.73	466.02
18	15/11/2023	15:02 - 15:32	366.92	393.66	516.20	-25.00	-8.17	204.36	624.90	376.85
19	15/11/2023	17:02 - 17:32	414.74	429.65	531.15	22.82	27.81	634.42	520.54	424.64
20	15/11/2023	18:02 - 18:32	418.61	443.26	547.78	26.69	41.42	1105.35	712.10	428.51
21	15/11/2023	19:02 - 19:32	380.51	400.65	503.01	-11.41	-1.19	13.57	130.24	390.43
22	15/11/2023	21:02 - 21:32	405.71	405.82	515.59	13.79	3.98	54.89	190.12	415.62
23	15/11/2023	22:02 - 22:32	364.47	366.72	478.28	-27.45	-35.11	963.90	753.53	374.40
24	15/11/2023	23:02 - 23:32	439.71	439.77	569.52	47.78	37.93	1812.42	2283.40	449.60
25	16/11/2023	00:02 - 00:32	303.64	310.70	394.73	-88.28	-91.13	8045.04	7792.77	313.60
26	16/11/2023	01:02 - 01:32	403.45	409.77	525.54	11.53	7.93	91.47	132.88	413.36
27	16/11/2023	02:02 - 02:32	465.27	472.78	609.98	73.35	70.94	5203.35	5380.00	475.16
28	16/11/2023	03:02 - 03:32	699.47	703.67	892.97	307.55	301.83	92826.86	94584.70	709.25
29	16/11/2023	04:02 - 04:32	126.13	135.51	172.87	-265.79	-266.33	70787.31	70642.72	136.17
30	16/11/2023	05:02 - 05:32	391.11	396.10	501.73	-0.81	-5.74	4.67	0.66	401.03
31	16/11/2023	06:02 - 06:32	397.47	399.31	504.53	5.55	-2.53	-14.01	30.78	407.38
32	16/11/2023	07:02 - 07:32	414.47	422.46	523.87	22.55	20.62	464.93	508.33	424.38
33	16/11/2023	09:02 - 09:32	447.24	466.18	591.99	55.32	64.34	3559.33	3059.96	457.13
34	16/11/2023	10:02 - 10:32	377.98	397.21	514.90	-13.94	-4.63	64.55	194.34	387.90
35	16/11/2023	11:02 - 11:32	376.87	377.58	487.62	-15.05	-24.25	365.08	226.56	386.79
36	16/11/2023	17:02 - 17:32	387.10	392.91	504.42	-4.82	-8.92	43.00	23.22	397.02
37	16/11/2023	18:02 - 18:32	406.36	407.42	510.57	14.44	5.58	80.58	208.52	416.27
38	16/11/2023	19:02 - 19:32	365.75	364.32	476.71	-26.17	-37.52	981.70	684.71	375.68
39	16/11/2023	21:02 - 21:32	384.23	381.09	497.48	-7.69	-20.75	159.61	59.18	394.15
40	16/11/2023	22:02 - 22:32	336.03	333.35	431.74	-55.89	-68.49	3827.73	3123.68	345.97
41	16/11/2023	23:02 - 23:32	410.35	405.67	490.02	18.43	3.83	70.58	339.54	420.26
42	17/11/2023	00:02 - 00:32	387.75	382.19	496.13	-4.17	-19.65	81.87	17.37	397.67
43	17/11/2023	01:02 - 01:32	413.91	407.43	524.22	21.99	5.59	122.93	483.61	423.82
44	17/11/2023	02:02 - 02:32	379.55	378.78	484.75	-12.37	-23.06	285.20	153.01	389.47
45	17/11/2023	03:02 - 03:32	378.98	378.11	499.53	-12.94	-23.73	307.13	167.57	388.90
46	17/11/2023	04:02 - 04:32	394.69	398.56	518.73	2.77	-3.28	-9.08	7.68	404.61
47	17/11/2023	05:02 - 05:32	396.70	398.86	506.40	4.78	-2.97	-14.23	22.87	406.62
48	17/11/2023	06:02 - 06:32	400.38	406.56	517.10	8.46	4.72	39.92	71.60	410.30
49	17/11/2023	07:02 - 07:32	348.49	367.67	466.20	-43.43	-34.17	1484.18	1886.46	358.42
50	17/11/2023	09:02 - 09:32	443.92	470.41	594.56	52.00	68.57	3565.47	2704.05	453.82
51	17/11/2023	10:02 - 10:32	356.42	378.44	485.80	-35.50	-23.39	830.48	1260.20	366.36
52	17/11/2023	11:02 - 11:32	428.44	450.80	557.42	36.52	48.96	1787.78	1333.41	438.34
53	17/11/2023	12:02 - 12:32	336.80	342.17	428.25	-55.12	-59.66	3288.86	3038.52	346.74
54	17/11/2023	13:02 - 13:32	459.00	480.42	611.05	67.08	78.58	5271.10	4499.96	468.89
55	17/11/2023	15:02 - 15:32	386.89	409.27	544.20	-5.03	7.43	-37.36	25.29	396.81
56	17/11/2023	16:02 - 16:32	368.57	390.04	516.26	-23.35	-11.80	275.44	545.22	378.50
57	17/11/2023	17:02 - 17:32	388.98	410.62	537.93	-2.94	8.78	-25.83	8.65	398.90
58	17/11/2023	19:02 - 19:32	372.02	394.17	514.59	-19.90	-7.67	152.65	396.03	381.95
59	17/11/2023	21:02 - 21:32	372.10	391.24	513.79	-19.82	-10.60	210.08	392.98	382.02
60	17/11/2023	22:02 - 22:32	368.26	381.62	498.11	-23.66	-20.22	478.44	559.65	378.19
61	17/11/2023	23:02 - 23:32	379.44	401.02	519.27	-12.48	-0.82	10.18	155.84	389.36
62	18/11/2023	00:02 - 00:32	368.63	388.59	506.27	-23.29	-13.25	308.68	542.52	378.56
63	18/11/2023	01:02 - 01:32	402.36	425.70	533.18	10.44	23.86	248.96	108.91	412.27

Section 4A - Data and Calculations - QAL2

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

(Page 2 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³	
64	18/11/2023	02:02 - 02:32	387.16	410.04	521.95	-4.76	8.20	-39.05	22.67	397.08	
65	18/11/2023	03:02 - 03:32	370.95	391.42	511.20	-20.97	-10.42	218.45	439.93	380.87	
66	18/11/2023	04:02 - 04:32	407.49	430.86	557.05	15.57	29.02	451.88	242.45	417.40	
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88											
89											
90											
					MAX SRM - MIN SRM	720.09			SUM	219415.89	219513.15
					(DAILY) DELV (mg/m ³)	500					
					95% CI MU (%)	20					
					95% CI at DELV (mg/m ³)	100.0					
					15% of ELV	75.0					
					PROCEDURE (A, B, C)	A					

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV
PROCEDURE C If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
(Statistical Outliers removed following outlier test, other data removed prior to this test)					
1	14/11/2023	20:02 - 20:32	0.00	396.96	Instrument performing an auto-zero
2	15/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
3	15/11/2023	14:02 - 14:32	455.54	0.00	SRM offline/calibrating
4	15/11/2023	16:02 - 16:32	378.25	0.00	SRM offline/calibrating
5	15/11/2023	20:02 - 20:32	0.00	415.54	Instrument performing an auto-zero
6	16/11/2023	08:02 - 08:32	379.05	0.00	SRM offline/calibrating
7	16/11/2023	16:02 - 16:32	377.33	0.00	SRM offline/calibrating
8	16/11/2023	20:02 - 20:32	0.00	418.24	Instrument performing an auto-zero
9	17/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
10	17/11/2023	20:02 - 20:32	0.00	393.50	Instrument performing an auto-zero
11	14/11/2023	22:02 - 22:32	395.92	405.90	Peripheral data outliers (Water Vapour)
12	15/11/2023	03:02 - 03:32	409.66	405.55	Peripheral data outliers (Water Vapour)
13	17/11/2023	14:02 - 14:32	533.47	556.89	Peripheral data outliers (Water Vapour)
14	17/11/2023	18:02 - 18:32	388.87	411.22	Peripheral data outliers (Water Vapour)
15	16/11/2023	12:02 - 12:32	334.42	328.79	Peripheral data outliers (Oxygen)
16	16/11/2023	13:02 - 13:32	409.16	409.55	Peripheral data outliers (Oxygen)
17	16/11/2023	14:02 - 14:32	375.58	378.19	Peripheral data outliers (Oxygen)
18	16/11/2023	15:02 - 15:32	396.76	403.03	Peripheral data outliers (Oxygen)
19					
20					
21					
22					
23					
24					
25					

Section 4A - Data and Calculations - QAL2

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

(Page 3 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Derivation of Calibration Function

b =	0.9996	a =	10.0912
-----	--------	-----	---------

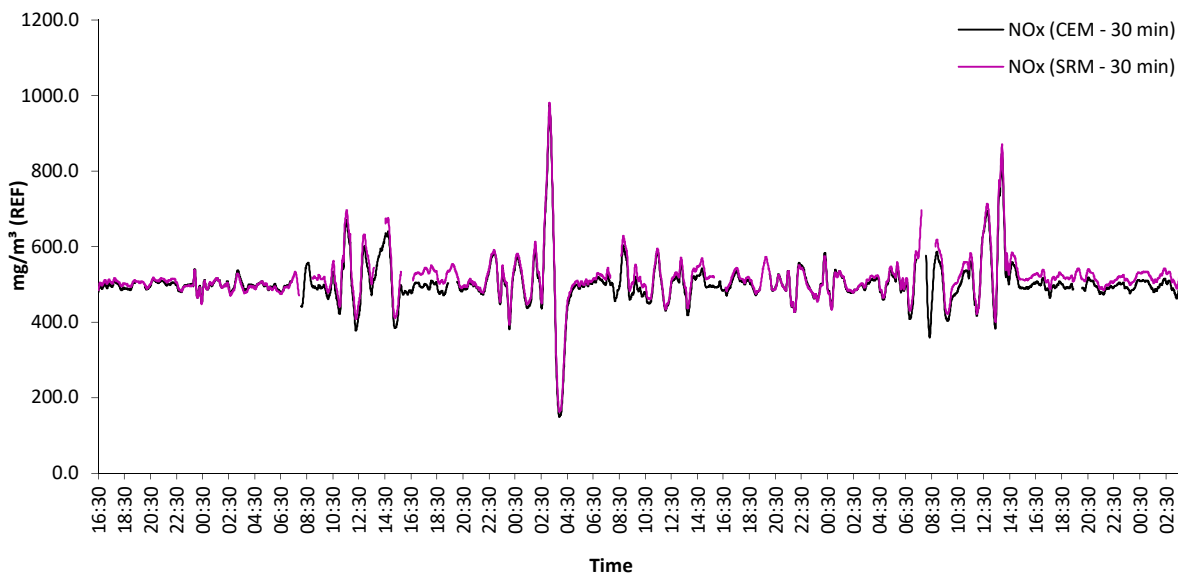
CALIBRATION FUNCTION =	y = 0.9996x + 10.0912
-------------------------------	------------------------------

where

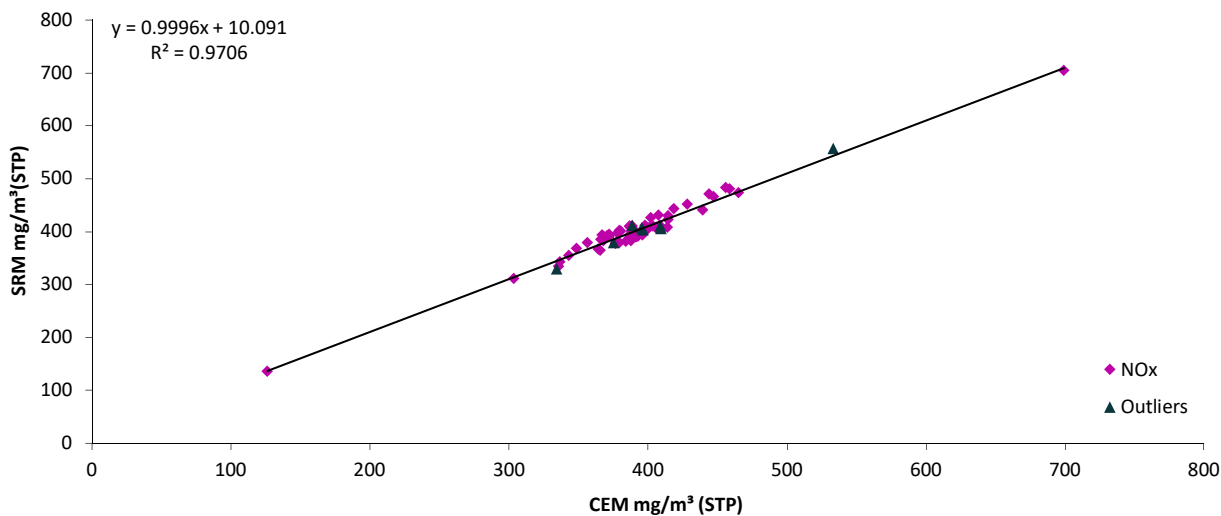
For Procedure A / C $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$

Procedure B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: GRAPH FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED) (30 minute rolling averages)



PLOT 2: Calibration Graph for Procedure A



Section 4A - Data and Calculations - QAL2

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
					N/A			N/A					
L1	Surrogate	Near Zero	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1	14/11/2023	17:02 - 17:32	408.02	10.81	10.53	10.47	11.20	N/A	11.11	511.71	510.30	499.27	-1.41
2	14/11/2023	18:02 - 18:32	412.92	10.62	10.35	10.34	11.11	N/A	11.03	512.37	506.27	500.07	-6.09
3	14/11/2023	19:02 - 19:32	401.37	10.32	10.06	10.00	11.25	N/A	11.17	503.53	495.65	491.09	-7.88
4	14/11/2023	21:02 - 21:32	408.76	11.75	11.44	11.50	11.20	N/A	11.18	518.08	509.02	505.52	-9.06
5	14/11/2023	23:02 - 23:32	396.95	10.70	10.42	10.44	11.36	N/A	11.32	505.71	492.34	493.07	-13.37
6	15/11/2023	00:02 - 00:32	386.75	10.28	10.01	10.01	11.31	N/A	11.27	487.79	474.18	475.27	-13.61
7	15/11/2023	01:02 - 01:32	418.65	11.21	10.92	10.94	10.89	N/A	10.91	511.29	503.49	499.19	-7.80
8	15/11/2023	02:02 - 02:32	400.41	11.38	11.08	11.12	11.18	N/A	11.17	504.26	491.13	491.77	-13.14
9	15/11/2023	04:02 - 04:32	406.16	11.29	11.00	11.04	11.16	N/A	11.13	510.34	492.82	497.88	-17.52
10	15/11/2023	05:02 - 05:32	418.28	11.25	10.96	10.98	11.07	N/A	11.05	520.17	508.01	507.84	-12.16
11	15/11/2023	06:02 - 06:32	402.98	10.95	10.67	10.66	11.33	N/A	11.29	513.37	495.16	500.74	-18.21
12	15/11/2023	07:02 - 07:32	401.45	11.02	10.74	10.74	11.31	N/A	11.27	510.51	493.41	497.90	-17.10
13	15/11/2023	09:02 - 09:32	397.69	11.01	10.72	10.72	11.34	N/A	11.36	507.07	519.43	494.42	12.36
14	15/11/2023	10:02 - 10:32	398.13	10.22	9.95	9.91	10.94	N/A	10.98	483.42	487.23	471.38	3.81
15	15/11/2023	11:02 - 11:32	353.16	10.75	10.47	10.44	11.02	N/A	11.12	434.79	440.89	422.55	6.11
16	15/11/2023	12:02 - 12:32	376.22	10.39	10.12	10.09	11.33	N/A	11.32	476.02	486.03	463.46	10.01
17	15/11/2023	13:02 - 13:32	466.02	11.97	11.66	11.75	11.04	N/A	11.00	582.78	601.55	570.41	18.77
18	15/11/2023	15:02 - 15:32	376.85	11.73	11.42	11.48	11.67	N/A	11.52	501.74	516.20	488.52	14.46
19	15/11/2023	17:02 - 17:32	424.64	10.76	10.48	10.45	10.87	N/A	11.06	515.23	531.15	503.21	15.92
20	15/11/2023	18:02 - 18:32	428.51	11.43	11.13	11.13	10.75	N/A	10.98	517.51	547.78	505.55	30.27
21	15/11/2023	19:02 - 19:32	390.43	11.11	10.83	10.80	11.06	N/A	11.18	484.34	503.01	472.03	18.67
22	15/11/2023	21:02 - 21:32	415.62	11.28	10.98	10.97	11.21	N/A	11.27	524.58	515.59	512.07	-9.00
23	15/11/2023	22:02 - 22:32	374.40	10.68	10.40	10.37	11.54	N/A	11.59	485.85	478.28	472.96	-7.57
24	15/11/2023	23:02 - 23:32	449.60	10.53	10.25	10.24	11.51	N/A	11.54	580.55	569.52	567.78	-11.03
25	16/11/2023	00:02 - 00:32	313.60	10.40	10.13	10.13	11.31	N/A	11.37	396.28	394.73	383.70	-1.55
26	16/11/2023	01:02 - 01:32	413.36	11.23	10.94	11.00	11.33	N/A	11.36	527.72	525.54	515.07	-2.18
27	16/11/2023	02:02 - 02:32	475.16	10.92	10.64	10.58	11.39	N/A	11.47	608.41	609.98	595.75	1.57
28	16/11/2023	03:02 - 03:32	709.25	11.34	11.04	11.13	11.18	N/A	11.25	892.67	892.97	880.36	0.29
29	16/11/2023	04:02 - 04:32	136.17	11.23	10.94	10.95	11.21	N/A	11.32	171.78	172.87	159.12	1.09
30	16/11/2023	05:02 - 05:32	401.03	11.45	11.15	11.18	11.16	N/A	11.22	504.79	501.73	492.30	-3.06
31	16/11/2023	06:02 - 06:32	407.38	11.17	10.88	10.84	11.20	N/A	11.24	513.31	504.53	500.81	-8.77
32	16/11/2023	07:02 - 07:32	424.38	10.78	10.50	10.50	11.04	N/A	11.09	523.51	523.87	511.29	0.36
33	16/11/2023	09:02 - 09:32	457.13	10.19	9.92	9.88	11.35	N/A	11.39	578.53	591.99	566.01	13.46
34	16/11/2023	10:02 - 10:32	387.90	10.75	10.48	10.47	11.45	N/A	11.52	499.34	514.90	486.57	15.56
35	16/11/2023	11:02 - 11:32	386.79	10.90	10.62	10.65	11.30	N/A	11.47	490.57	487.62	477.99	-2.95
36	16/11/2023	17:02 - 17:32	397.02	11.96	11.65	11.64	11.23	N/A	11.30	505.83	504.42	493.19	-1.41
37	16/11/2023	18:02 - 18:32	416.27	11.66	11.36	11.33	11.01	N/A	11.10	517.08	510.57	504.77	-6.52
38	16/11/2023	19:02 - 19:32	375.68	11.50	11.20	11.16	11.43	N/A	11.54	486.29	476.71	473.44	-9.58
39	16/11/2023	21:02 - 21:32	394.15	11.81	11.50	11.51	11.39	N/A	11.48	509.59	497.48	496.77	-12.12
40	16/11/2023	22:02 - 22:32	345.97	11.44	11.14	11.13	11.36	N/A	11.44	444.09	431.74	431.33	-12.35
41	16/11/2023	23:02 - 23:32	420.26	11.89	11.58	11.60	10.68	N/A	10.70	506.44	490.02	494.50	-16.42
42	17/11/2023	00:02 - 00:32	397.67	11.89	11.58	11.62	11.35	N/A	11.41	512.90	496.13	500.10	-16.76
43	17/11/2023	01:02 - 01:32	423.82	11.61	11.31	11.31	11.32	N/A	11.36	543.12	524.22	530.42	-18.90
44	17/11/2023	02:02 - 02:32	389.47	11.77	11.47	11.42	11.19	N/A	11.30	493.08	484.75	480.51	-8.33
45	17/11/2023	03:02 - 03:32	388.90	11.51	11.21	11.20	11.57	N/A	11.62	510.78	499.53	497.75	-11.26
46	17/11/2023	04:02 - 04:32	404.61	11.22	10.93	10.99	11.46	N/A	11.51	523.70	518.73	510.86	-4.96
47	17/11/2023	05:02 - 05:32	406.62	11.19	10.90	10.98	11.21	N/A	11.27	512.55	506.40	500.06	-6.16
48	17/11/2023	06:02 - 06:32	410.30	11.34	11.04	11.07	11.25	N/A	11.27	520.30	517.10	507.73	-3.20
49	17/11/2023	07:02 - 07:32	358.42	10.76	10.48	10.46	11.31	N/A	11.31	454.59	466.20	441.98	11.62
50	17/11/2023	09:02 - 09:32	453.82	11.66	11.35	11.38	11.23	N/A	11.18	576.26	594.56	563.70	18.29
51	17/11/2023	10:02 - 10:32	366.36	11.14	10.85	10.83	11.43	N/A	11.39	472.54	485.80	459.72	13.26
52	17/11/2023	11:02 - 11:32	438.34	11.31	11.02	11.03	11.08	N/A	11.00	546.41	557.42	534.07	11.01
53	17/11/2023	12:02 - 12:32	346.74	10.57	10.30	10.22	11.31	N/A	11.21	438.88	428.25	426.30	-10.63
54	17/11/2023	13:02 - 13:32	468.89	11.70	11.40	11.46	11.40	N/A	11.23	606.10	611.05	593.32	4.96
55	17/11/2023	15:02 - 15:32	396.81	10.65	10.37	10.34	11.90	N/A	11.77	534.90	544.20	521.53	9.29
56	17/11/2023	16:02 - 16:32	378.50	10.56	10.29	10.34	11.85	N/A	11.73	507.06	516.26	493.76	9.20
57	17/11/2023	17:02 - 17:32	398.90	10.47	10.20	10.14	11.77	N/A	11.66	529.32	537.93	516.16	8.61
58	17/11/2023	19:02 - 19:32	381.95	10.73	10.45	10.38	11.66	N/A	11.60	502.44	514.59	489.38	12.15
59	17/11/2023	21:02 - 21:32	382.02	11.23	10.94	10.91	11.74	N/A	11.60	509.60	513.79	496.36	4.19
60	17/11/2023	22:02 - 22:32	378.19	10.82	10.54	10.50	11.74	N/A	11.58	502.37	498.11	489.18	-4.26
61	17/11/2023	23:02 - 23:32	389.36	10.96	10.68	10.68	11.65	N/A	11.49	513.04	519.27	499.96	6.23
62	18/11/2023	00:02 - 00:32	378.56	10.93	10.65	10.63	11.67	N/A	11.55	499.55	506.27	486.45	6.72
63	18/11/2023	01:02 - 01:32	412.27	11.05	10.76	10.71	11.27	N/A	11.16	522.15	533.18	509.59	11.03

where CAL = Calibrated using QAL2 calibration functions

Section 4A - Data and Calculations - QAL2

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
64	18/11/2023	02:02 - 02:32	397.08	11.02	10.74	10.69	11.41	N/A	11.32	510.03	521.95	497.29	11.92
65	18/11/2023	03:02 - 03:32	380.87	11.38	11.09	11.09	11.62	N/A	11.53	502.45	511.20	489.36	8.75
66	18/11/2023	04:02 - 04:32	417.40	11.12	10.83	10.89	11.55	N/A	11.45	545.03	557.05	532.09	12.02
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89													
90													
										MAX	AVERAGE	AVERAGE	Sd
										892.67	511.58	499.01	11.47

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

$Q_0 = ELV \times (MU / 100) / 1.96$	51.02
Kv for 66 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_0 \times Kv$.

Parameter	Value
Standard Deviation (Sd)	11.47
$Q_0 \times Kv$	50.43
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	892.7
--	-------

The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 981.9
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 100.0

Greater of (a) or (b)	0 to 981.9
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Surrogate Extension Applied?	No
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Valid Calibration Range (at REF conditions)	0 to 981.9 mg/m³
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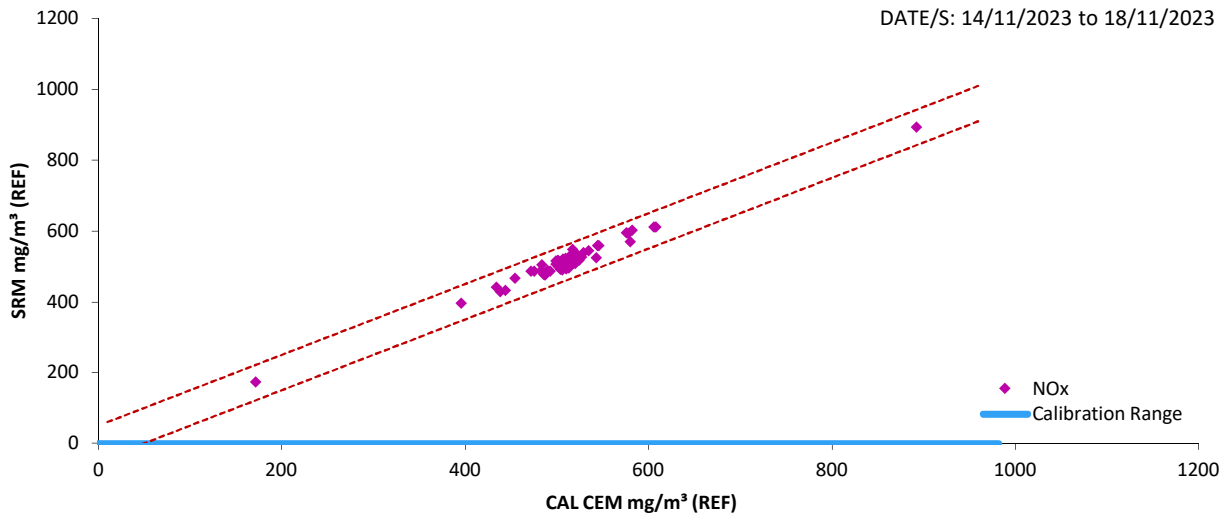
Section 4A - Data and Calculations - QAL2

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

SULPHUR DIOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
H1	Surrogate	High	34.96	34.80	34.80	22.09	30.58	675.51	488.00	26.71
L1	Surrogate	Near Zero	-0.07	0.00	0.00	-12.94	-4.22	54.62	167.43	-8.95
1	14/11/2023	12:00 - 13:00	10.63	1.11	1.38	-2.24	-3.11	6.96	5.01	1.94
2	14/11/2023	13:30 - 14:32	10.77	4.02	5.20	-2.10	-0.20	0.42	4.43	2.08
3	14/11/2023	14:45 - 15:52	11.39	2.64	3.41	-1.48	-1.58	2.33	2.19	2.72
4	15/11/2023	08:56 - 09:58	13.95	2.48	3.02	1.08	-1.74	-1.89	1.18	5.33
5	15/11/2023	10:00 - 11:00	20.66	5.12	6.10	7.79	0.90	6.98	60.65	12.15
6	15/11/2023	11:05 - 12:05	13.14	5.28	6.72	0.27	1.06	0.29	0.07	4.50
7	15/11/2023	12:07 - 13:07	12.20	3.29	4.02	-0.67	-0.93	0.63	0.45	3.53
8	15/11/2023	13:10 - 14:10	10.58	1.85	2.29	-2.29	-2.37	5.42	5.24	1.89
9	15/11/2023	14:12 - 15:15	9.38	1.98	2.58	-3.49	-2.24	7.82	12.19	0.67
10	15/11/2023	15:15 - 16:15	9.11	0.80	1.03	-3.76	-3.42	12.86	14.10	0.40
11	16/11/2023	09:47 - 10:48	11.72	2.73	3.53	-1.15	-1.49	1.71	1.33	3.05
12	16/11/2023	10:50 - 11:52	12.37	1.63	2.08	-0.50	-2.59	1.29	0.25	3.72
13	16/11/2023	11:54 - 12:55	12.29	0.79	1.02	-0.58	-3.43	2.00	0.34	3.63
14	16/11/2023	12:58 - 13:58	13.28	2.85	3.63	0.41	-1.37	-0.56	0.17	4.64
15	16/11/2023	14:00 - 15:02	12.88	2.06	2.63	0.01	-2.16	-0.02	0.00	4.23
16	16/11/2023	15:05 - 16:07	12.42	2.54	3.28	-0.45	-1.68	0.76	0.20	3.76
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Section 4A - Data and Calculations - QAL2

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 2 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³	
64											
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					MAX SRM - MIN SRM	5.70					
					(DAILY) DELV (mg/m ³)	50					
					95% CI MU (%)	20					
					95% CI at DELV (mg/m ³)	10.0					
					15% of ELV	7.5					
					PROCEDURE (A, B, C)	C					
							SUM	777.11	763.22		
							PROCEDURE A	If (MAX SRM - MIN SRM) > 95% CI at Daily ELV			
							PROCEDURE B	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV			
							PROCEDURE C	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV			

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
(Statistical Outliers removed following outlier test, other data removed prior to this test)					
1	16/11/2023	08:45 - 09:45	12.69	15.01	Statistical outlier
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Section 4A - Data and Calculations - QAL2

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 3 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Derivation of Calibration Function

b =	1.0182	a =	-8.8827
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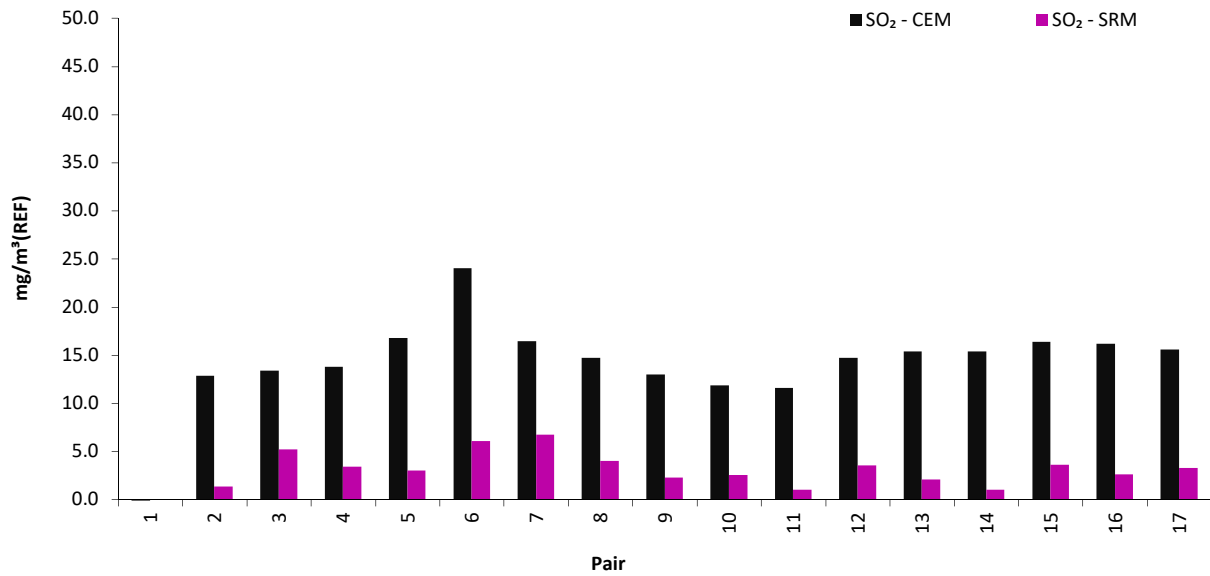
CALIBRATION FUNCTION =	y = 1.0182x - 8.8827
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where

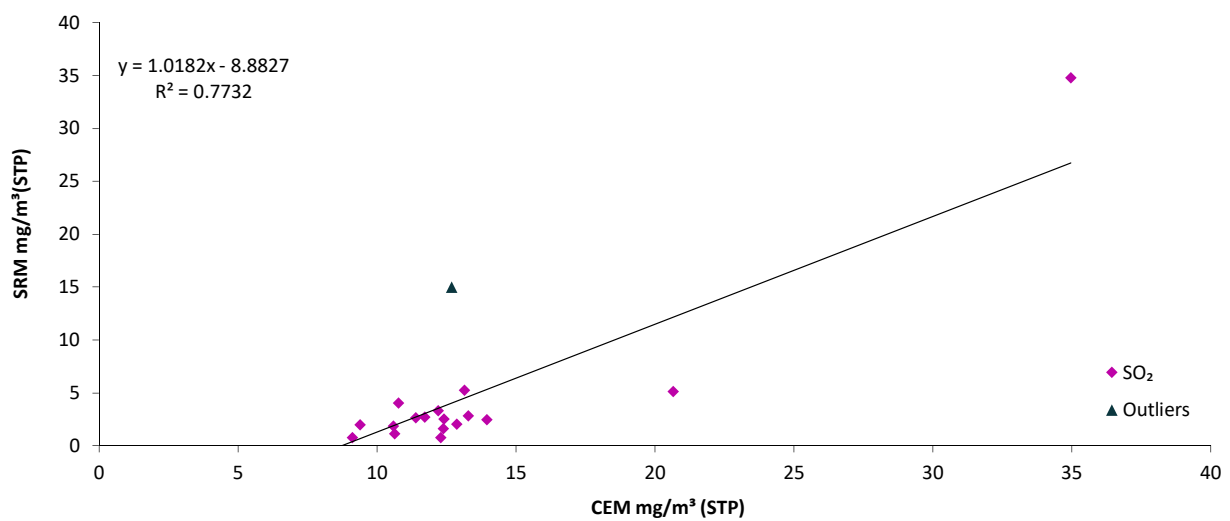
For Procedure A / C $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$

Procedure B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: BAR CHART FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED)



PLOT 2: Calibration Graph for Procedure C



Section 4A - Data and Calculations - QAL2

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 4 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL		CAL		where CAL = Calibrated using QAL2 calibration functions						
			CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM	
H1	Surrogate	High	26.71	N/A	N/A	N/A	N/A	N/A	N/A	26.71	34.80	34.96	8.09
L1	Surrogate	Near Zero	-8.95	N/A	N/A	N/A	N/A	N/A	N/A	-8.95	0.00	-0.07	8.95
1	14/11/2023	12:00 - 13:00	1.94	11.61	11.31	10.10	10.73	N/A	11.13	2.34	1.38	12.84	-0.96
2	14/11/2023	13:30 - 14:32	2.08	11.11	10.82	10.78	11.09	N/A	11.47	2.59	5.20	13.40	2.61
3	14/11/2023	14:45 - 15:52	2.72	11.46	11.17	9.76	10.78	N/A	11.54	3.29	3.41	13.81	0.12
4	15/11/2023	08:56 - 09:58	5.33	10.90	10.62	9.25	10.79	N/A	11.06	6.42	3.02	16.81	-3.39
5	15/11/2023	10:00 - 11:00	12.15	10.46	10.19	10.13	10.47	N/A	10.73	14.14	6.10	24.03	-8.04
6	15/11/2023	11:05 - 12:05	4.50	10.57	10.29	9.55	11.19	N/A	11.44	5.62	6.72	16.42	1.09
7	15/11/2023	12:07 - 13:07	3.53	11.02	10.73	10.00	10.78	N/A	10.99	4.26	4.02	14.71	-0.24
8	15/11/2023	13:10 - 14:10	1.89	12.15	11.84	9.96	10.86	N/A	11.10	2.33	2.29	13.02	-0.04
9	15/11/2023	14:12 - 15:15	0.67	12.36	12.04	12.42	11.10	N/A	11.33	0.84	2.58	11.85	1.73
10	15/11/2023	15:15 - 16:15	0.40	11.32	11.03	10.75	11.28	N/A	11.45	0.50	1.03	11.59	0.52
11	16/11/2023	09:47 - 10:48	3.05	10.76	10.48	9.93	11.21	N/A	11.53	3.83	3.53	14.71	-0.30
12	16/11/2023	10:50 - 11:52	3.72	10.99	10.71	9.08	11.11	N/A	11.53	4.63	2.08	15.42	-2.55
13	16/11/2023	11:54 - 12:55	3.63	11.47	11.17	9.36	11.09	N/A	11.57	4.54	1.02	15.36	-3.52
14	16/11/2023	12:58 - 13:58	4.64	11.29	11.00	9.69	10.97	N/A	11.45	5.71	3.63	16.36	-2.08
15	16/11/2023	14:00 - 15:02	4.23	11.84	11.53	7.97	11.09	N/A	11.62	5.31	2.63	16.16	-2.68
16	16/11/2023	15:05 - 16:07	3.76	12.10	11.78	9.19	11.08	N/A	11.62	4.73	3.28	15.61	-1.45
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Section 4A - Data and Calculations - QAL2

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 5 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
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										MAX	AVERAGE	AVERAGE	Sd
										14.14	3.24	15.13	2.56

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

$Q_0 = ELV \times (MU / 100) / 1.96$	5.10
Kv for 16 Pairs of Data	0.9777

The variability is accepted if $Sd \leq Q_0 \times Kv$.

Parameter	Value
Standard Deviation (Sd)	2.56
$Q_0 \times Kv$	4.99
Outcome of Variability Test	Pass

Procedure C Acceptability Test

Average of UNCAL CEM (1)	15.13
Average of SRM (2)	3.24
ABS Difference (1) & (2)	11.89
Outcome of Procedure C Acceptability Test	Fail

Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	14.1
--	------

The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 15.6
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 10.0

Greater of (a) or (b)	0 to 15.6
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Surrogate Extension Applied?	NOT PERMISSIBLE
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Valid Calibration Range (at REF conditions)	0 to 15.6 mg/m³
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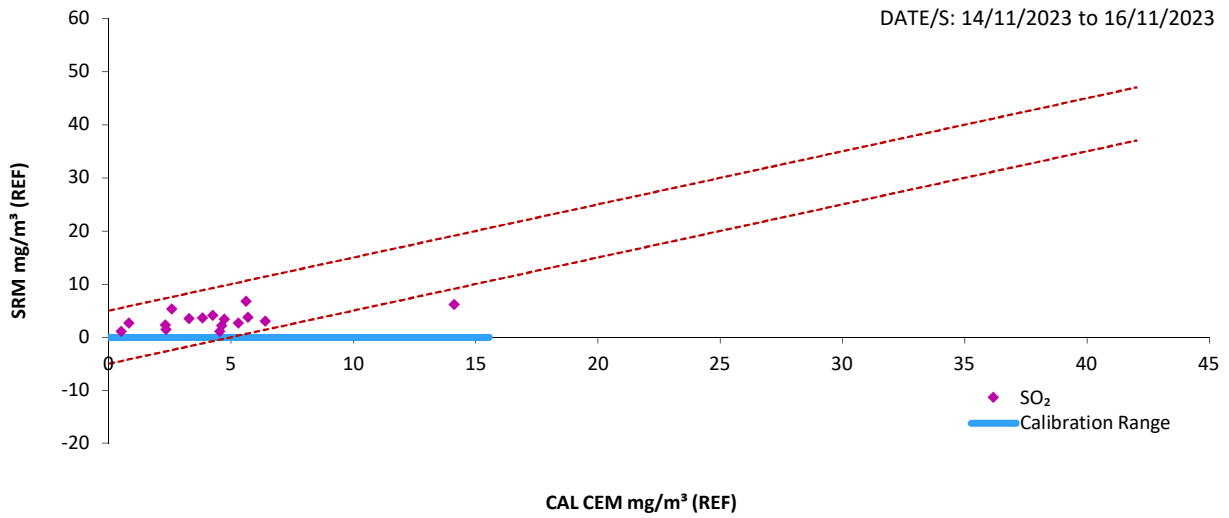
Section 4A - Data and Calculations - QAL2

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 6 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

CARBON MONOXIDE: QAL2 CALCULATIONS

(Page 1 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
L1	Surrogate	Near Zero	-0.03	0.00	0.00	-225.85	-230.68	52099.71	51008.18	0.00
1	14/11/2023	17:02 - 17:32	239.40	242.94	301.71	13.58	12.26	166.42	184.31	244.55
2	14/11/2023	18:02 - 18:32	248.02	251.29	309.30	22.20	20.61	457.61	492.96	253.36
3	14/11/2023	19:02 - 19:32	249.10	253.38	315.05	23.28	22.70	528.56	542.16	254.47
4	14/11/2023	21:02 - 21:32	245.48	249.21	315.53	19.66	18.52	364.21	386.65	250.77
5	14/11/2023	23:02 - 23:32	244.21	248.64	315.52	18.39	17.96	330.39	338.34	249.47
6	15/11/2023	00:02 - 00:32	275.20	281.86	354.06	49.38	51.18	2527.30	2438.52	281.12
7	15/11/2023	01:02 - 01:32	259.93	264.06	323.33	34.11	33.37	1138.39	1163.57	265.52
8	15/11/2023	02:02 - 02:32	249.63	254.53	320.31	23.81	23.84	567.64	566.74	255.00
9	15/11/2023	04:02 - 04:32	250.22	254.66	319.06	24.40	23.98	585.23	595.57	255.61
10	15/11/2023	05:02 - 05:32	252.24	256.56	318.50	26.42	25.87	683.59	698.02	257.67
11	15/11/2023	06:02 - 06:32	249.55	252.98	320.71	23.73	22.30	529.25	563.21	254.92
12	15/11/2023	07:02 - 07:32	248.95	253.31	320.92	23.13	22.63	523.43	535.21	254.31
13	15/11/2023	09:02 - 09:32	228.05	234.60	299.87	2.23	3.92	8.72	4.96	232.96
14	15/11/2023	10:02 - 10:32	262.14	267.98	326.54	36.32	37.30	1354.46	1318.80	267.78
15	15/11/2023	11:02 - 11:32	261.42	269.97	335.48	35.60	39.29	1398.75	1267.67	267.05
16	15/11/2023	12:02 - 12:32	231.52	237.89	300.67	5.70	7.21	41.07	32.48	236.50
17	15/11/2023	13:02 - 13:32	180.74	185.37	230.96	-45.08	-45.32	2042.69	2031.96	184.64
18	15/11/2023	17:02 - 17:32	269.34	276.95	342.38	43.52	46.26	2013.45	1894.03	275.13
19	15/11/2023	18:02 - 18:32	262.32	271.59	335.63	36.50	40.90	1492.99	1332.30	267.96
20	15/11/2023	19:02 - 19:32	254.00	260.61	327.20	28.18	29.93	843.30	793.85	259.46
21	15/11/2023	21:02 - 21:32	243.80	247.30	314.19	17.98	16.62	298.80	323.37	249.05
22	15/11/2023	22:02 - 22:32	254.55	258.99	337.77	28.73	28.30	813.31	825.70	260.03
23	15/11/2023	23:02 - 23:32	225.81	230.66	298.72	-0.01	-0.02	0.00	0.00	230.67
24	16/11/2023	00:02 - 00:32	298.46	304.63	387.01	72.64	73.94	5371.55	5276.96	304.88
25	16/11/2023	01:02 - 01:32	224.87	229.45	294.27	-0.95	-1.23	1.17	0.90	229.71
26	16/11/2023	02:02 - 02:32	280.54	290.04	374.21	54.72	59.35	3247.87	2994.40	286.57
27	16/11/2023	03:02 - 03:32	216.85	219.11	278.05	-8.97	-11.58	103.90	80.54	221.52
28	16/11/2023	05:02 - 05:32	250.30	256.17	324.48	24.48	25.49	623.89	599.23	255.69
29	16/11/2023	06:02 - 06:32	264.71	271.49	343.03	38.89	40.81	1587.17	1512.49	270.41
30	16/11/2023	07:02 - 07:32	270.95	277.29	343.86	45.13	46.61	2103.33	2036.35	276.77
31	16/11/2023	09:02 - 09:32	232.00	239.63	304.29	6.18	8.94	55.30	38.25	237.00
32	16/11/2023	10:02 - 10:32	232.68	240.74	312.07	6.86	10.05	68.93	47.02	237.69
33	16/11/2023	11:02 - 11:32	236.41	240.23	310.24	10.59	9.55	101.15	112.14	241.50
34	16/11/2023	17:02 - 17:32	209.75	213.76	274.42	-16.07	-16.92	271.94	258.17	214.27
35	16/11/2023	18:02 - 18:32	201.35	203.30	254.77	-24.47	-27.38	669.98	598.68	205.69
36	16/11/2023	19:02 - 19:32	203.78	206.32	269.97	-22.04	-24.36	536.94	485.84	208.17
37	16/11/2023	21:02 - 21:32	183.80	185.18	241.73	-42.02	-45.51	1912.00	1765.29	187.77
38	16/11/2023	22:02 - 22:32	263.55	267.75	346.78	37.73	37.07	1398.80	1423.78	269.22
39	16/11/2023	23:02 - 23:32	212.85	216.08	261.01	-12.97	-14.61	189.40	168.17	217.44
40	17/11/2023	00:02 - 00:32	206.88	209.33	271.73	-18.94	-21.35	404.51	358.83	211.33
41	17/11/2023	01:02 - 01:32	218.41	221.24	284.65	-7.41	-9.45	69.97	54.86	223.12
42	17/11/2023	02:02 - 02:32	211.88	214.99	275.13	-13.94	-15.70	218.82	194.33	216.44
43	17/11/2023	03:02 - 03:32	198.51	200.95	265.47	-27.31	-29.74	811.95	745.60	202.79
44	17/11/2023	04:02 - 04:32	198.96	202.42	263.46	-26.86	-28.26	758.95	721.28	203.25
45	17/11/2023	05:02 - 05:32	199.37	200.87	255.02	-26.45	-29.82	788.57	699.48	203.67
46	17/11/2023	06:02 - 06:32	209.72	212.65	270.47	-16.10	-18.03	290.42	259.36	214.23
47	17/11/2023	07:02 - 07:32	271.17	280.01	355.05	45.35	49.33	2236.93	2056.54	277.00
48	17/11/2023	09:02 - 09:32	186.23	191.90	242.55	-39.59	-38.78	1535.35	1567.28	190.25
49	17/11/2023	10:02 - 10:32	217.22	224.14	287.72	-8.60	-6.54	56.25	73.97	221.90
50	17/11/2023	11:02 - 11:32	211.80	217.33	268.74	-14.02	-13.35	187.13	196.42	216.37
51	17/11/2023	12:02 - 12:32	251.05	254.79	318.89	25.23	24.11	608.09	636.31	256.45
52	17/11/2023	13:02 - 13:32	177.49	180.23	229.24	-48.33	-50.45	2438.00	2335.34	181.32
53	17/11/2023	15:02 - 15:32	191.50	196.75	261.62	-34.32	-33.93	1164.70	1178.19	195.62
54	17/11/2023	16:02 - 16:32	208.41	213.70	282.85	-17.41	-16.99	295.74	303.15	212.90
55	17/11/2023	17:02 - 17:32	200.72	206.29	270.25	-25.10	-24.39	612.25	630.12	205.04
56	17/11/2023	19:02 - 19:32	211.73	217.01	283.30	-14.09	-13.68	192.71	198.52	216.29
57	17/11/2023	21:02 - 21:32	197.36	202.27	265.62	-28.46	-28.42	808.80	810.17	201.61
58	17/11/2023	22:02 - 22:32	214.83	219.18	286.08	-10.99	-11.51	126.47	120.78	219.46
59	17/11/2023	23:02 - 23:32	211.92	217.99	282.26	-13.90	-12.69	176.46	193.24	216.48
60	18/11/2023	00:02 - 00:32	209.42	215.53	280.80	-16.40	-15.15	248.59	269.08	213.93
61	18/11/2023	01:02 - 01:32	211.21	217.56	272.50	-14.61	-13.12	191.69	213.51	215.76
62	18/11/2023	02:02 - 02:32	206.17	212.38	270.34	-19.65	-18.30	359.69	386.17	210.61
63	18/11/2023	03:02 - 03:32	202.14	208.14	271.83	-23.68	-22.54	533.89	560.97	206.49

Section 4A - Data and Calculations - QAL2

CARBON MONOXIDE: QAL2 CALCULATIONS

(Page 2 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
64	18/11/2023	04:02 - 04:32	185.74	190.27	246.00	-40.08	-40.41	1619.57	1606.01	189.75
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90										
MAX SRM - MIN SRM					157.77	SUM		105788.08	103106.25	
(DAILY) DELV (mg/m ³)					1500					
95% CI MU (%)					20					
95% CI at DELV (mg/m ³)					300.0					
15% of ELV					225.0					
PROCEDURE (A, B, C)					B					

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV
PROCEDURE C If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV

WHERE OFFSET = -0.03

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
(Statistical Outliers removed following outlier test, other data removed prior to this test)					
1	14/11/2023	20:02 - 20:32	0.00	241.94	Instrument performing an auto-zero
2	15/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
3	15/11/2023	14:02 - 14:32	181.34	0.00	SRM offline/calibrating
4	15/11/2023	16:02 - 16:32	266.20	0.00	SRM offline/calibrating
5	15/11/2023	20:02 - 20:32	0.00	242.62	Instrument performing an auto-zero
6	16/11/2023	08:02 - 08:32	256.83	0.00	SRM offline/calibrating
7	16/11/2023	16:02 - 16:32	174.77	0.00	SRM offline/calibrating
8	16/11/2023	20:02 - 20:32	0.00	192.91	Instrument performing an auto-zero
9	17/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
10	17/11/2023	20:02 - 20:32	0.00	217.98	Instrument performing an auto-zero
11	14/11/2023	22:02 - 22:32	255.30	260.96	Peripheral data outliers (Water Vapour)
12	15/11/2023	03:02 - 03:32	234.21	237.07	Peripheral data outliers (Water Vapour)
13	17/11/2023	14:02 - 14:32	192.84	198.99	Peripheral data outliers (Water Vapour)
14	17/11/2023	18:02 - 18:32	219.83	224.73	Peripheral data outliers (Water Vapour)
15	16/11/2023	12:02 - 12:32	223.19	227.11	Peripheral data outliers (Oxygen)
16	16/11/2023	13:02 - 13:32	210.31	212.94	Peripheral data outliers (Oxygen)
17	16/11/2023	14:02 - 14:32	219.98	223.61	Peripheral data outliers (Oxygen)
18	16/11/2023	15:02 - 15:32	179.10	181.06	Peripheral data outliers (Oxygen)
19	15/11/2023	15:02 - 15:32	255.97	270.29	Statistical outlier
20	16/11/2023	04:02 - 04:32	385.38	404.06	Statistical outlier
21					
22					
23					
24					
25					

Section 4A - Data and Calculations - QAL2

CARBON MONOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Derivation of Calibration Function

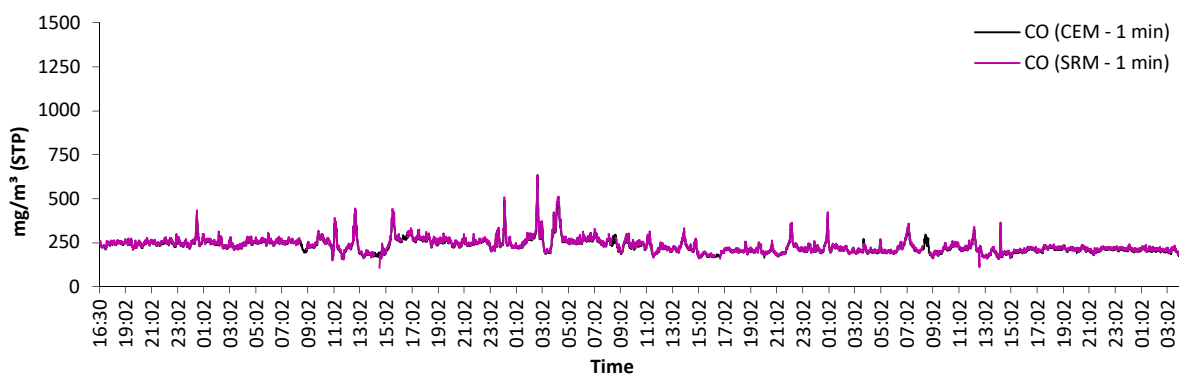
b =	1.0214	a =	0.0306
-----	--------	-----	--------

CALIBRATION FUNCTION =	y = 1.0214x + 0.0306
-------------------------------	-----------------------------

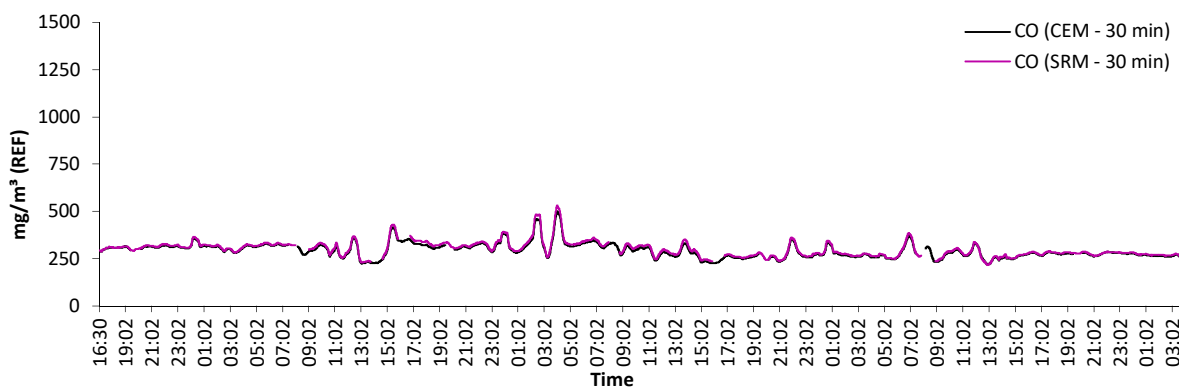
where

For Procedure A / C $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$
 Procedure B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

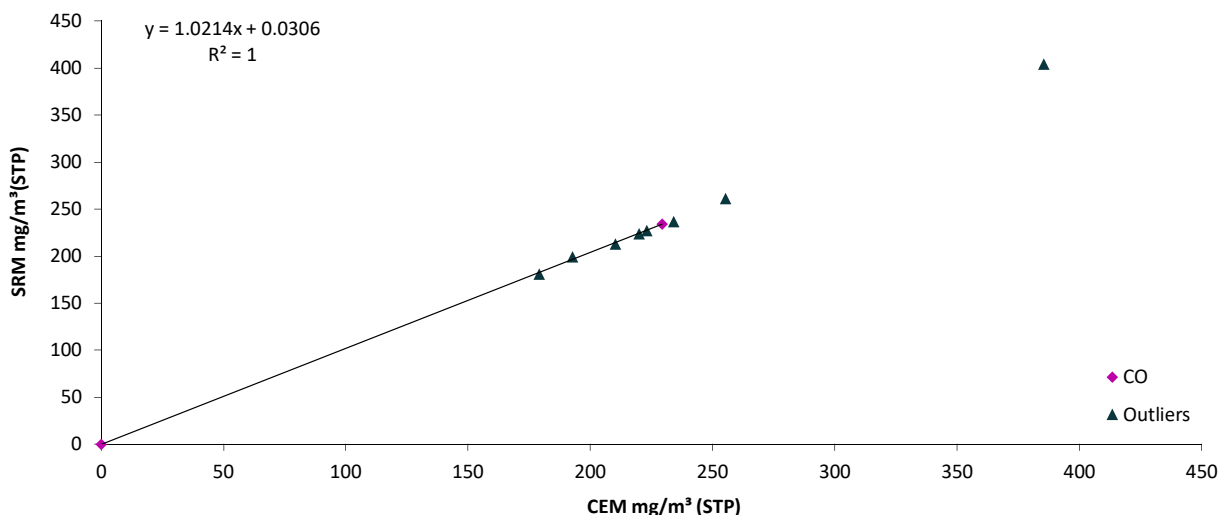
PLOT 1a: GRAPH FOR STP SRM vs STP CEMS (NON-STANDARDISED) (1 minute readings)



PLOT 1: GRAPH FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED) (30 minute rolling averages)



PLOT 2: Calibration Graph for Procedure B



Section 4A - Data and Calculations - QAL2

CARBON MONOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
					N/A			N/A					
L1	Surrogate	Near Zero	0.00	N/A	N/A	N/A	N/A	N/A	N/A	0.00	0.00	-0.03	0.00
1	14/11/2023	17:02 - 17:32	244.55	10.81	10.53	10.47	11.20	N/A	11.11	306.70	301.71	300.23	-4.99
2	14/11/2023	18:02 - 18:32	253.36	10.62	10.35	10.34	11.11	N/A	11.03	314.38	309.30	307.76	-5.08
3	14/11/2023	19:02 - 19:32	254.47	10.32	10.06	10.00	11.25	N/A	11.17	319.23	315.05	312.51	-4.18
4	14/11/2023	21:02 - 21:32	250.77	11.75	11.44	11.50	11.20	N/A	11.18	317.83	315.53	311.14	-2.30
5	14/11/2023	23:02 - 23:32	249.47	10.70	10.42	10.44	11.36	N/A	11.32	317.83	315.52	311.13	-2.31
6	15/11/2023	00:02 - 00:32	281.12	10.28	10.01	10.01	11.31	N/A	11.27	354.56	354.06	347.10	-0.50
7	15/11/2023	01:02 - 01:32	265.52	11.21	10.92	10.94	10.89	N/A	10.91	324.28	323.33	317.45	-0.95
8	15/11/2023	02:02 - 02:32	255.00	11.38	11.08	11.12	11.18	N/A	11.17	321.14	320.31	314.37	-0.82
9	15/11/2023	04:02 - 04:32	255.61	11.29	11.00	11.04	11.16	N/A	11.13	321.17	319.06	314.41	-2.11
10	15/11/2023	05:02 - 05:32	257.67	11.25	10.96	10.98	11.07	N/A	11.05	320.43	318.50	313.68	-1.93
11	15/11/2023	06:02 - 06:32	254.92	10.95	10.67	10.66	11.33	N/A	11.29	324.76	320.71	317.91	-4.05
12	15/11/2023	07:02 - 07:32	254.31	11.02	10.74	10.74	11.31	N/A	11.27	323.41	320.92	316.59	-2.48
13	15/11/2023	09:02 - 09:32	232.96	11.01	10.72	10.72	11.34	N/A	11.36	297.03	299.87	290.76	2.84
14	15/11/2023	10:02 - 10:32	267.78	10.22	9.95	9.91	10.94	N/A	10.98	325.14	326.54	318.29	1.40
15	15/11/2023	11:02 - 11:32	267.05	10.75	10.47	10.44	11.02	N/A	11.12	328.77	335.48	321.85	6.70
16	15/11/2023	12:02 - 12:32	236.50	10.39	10.12	10.09	11.33	N/A	11.32	299.24	300.67	292.93	1.42
17	15/11/2023	13:02 - 13:32	184.64	11.97	11.66	11.75	11.04	N/A	11.00	230.90	230.96	226.03	0.06
18	15/11/2023	17:02 - 17:32	275.13	10.76	10.48	10.45	10.87	N/A	11.06	333.83	342.38	326.80	8.55
19	15/11/2023	18:02 - 18:32	267.96	11.43	11.13	11.13	10.75	N/A	10.98	323.62	335.63	316.80	12.01
20	15/11/2023	19:02 - 19:32	259.46	11.11	10.83	10.80	11.06	N/A	11.18	321.87	327.20	315.09	5.33
21	15/11/2023	21:02 - 21:32	249.05	11.28	10.98	10.97	11.21	N/A	11.27	314.34	314.19	307.72	-0.15
22	15/11/2023	22:02 - 22:32	260.03	10.68	10.40	10.37	11.54	N/A	11.59	337.44	337.77	330.33	0.33
23	15/11/2023	23:02 - 23:32	230.67	10.53	10.25	10.24	11.51	N/A	11.54	297.85	298.72	291.57	0.86
24	16/11/2023	00:02 - 00:32	304.88	10.40	10.13	10.13	11.31	N/A	11.37	385.26	387.01	377.15	1.75
25	16/11/2023	01:02 - 01:32	229.71	11.23	10.94	11.00	11.33	N/A	11.36	293.27	294.27	287.09	1.01
26	16/11/2023	02:02 - 02:32	286.57	10.92	10.64	10.58	11.39	N/A	11.47	366.94	374.21	359.22	7.26
27	16/11/2023	03:02 - 03:32	221.52	11.34	11.04	11.13	11.18	N/A	11.25	278.80	278.05	272.93	-0.76
28	16/11/2023	05:02 - 05:32	255.69	11.45	11.15	11.18	11.16	N/A	11.22	321.84	324.48	315.06	2.64
29	16/11/2023	06:02 - 06:32	270.41	11.17	10.88	10.84	11.20	N/A	11.24	340.71	343.03	333.54	2.32
30	16/11/2023	07:02 - 07:32	276.77	10.78	10.50	10.50	11.04	N/A	11.09	341.43	343.86	334.24	2.43
31	16/11/2023	09:02 - 09:32	237.00	10.19	9.92	9.88	11.35	N/A	11.39	299.94	304.29	293.62	4.35
32	16/11/2023	10:02 - 10:32	237.69	10.75	10.48	10.47	11.45	N/A	11.52	305.97	312.07	299.52	6.10
33	16/11/2023	11:02 - 11:32	241.50	10.90	10.62	10.65	11.30	N/A	11.47	306.30	310.24	299.84	3.95
34	16/11/2023	17:02 - 17:32	214.27	11.96	11.65	11.64	11.23	N/A	11.30	272.99	274.42	267.24	1.42
35	16/11/2023	18:02 - 18:32	205.69	11.66	11.36	11.33	11.01	N/A	11.10	255.50	254.77	250.11	-0.73
36	16/11/2023	19:02 - 19:32	208.17	11.50	11.20	11.16	11.43	N/A	11.54	269.46	269.97	263.77	0.51
37	16/11/2023	21:02 - 21:32	187.77	11.81	11.50	11.51	11.39	N/A	11.48	242.77	241.73	237.64	-1.04
38	16/11/2023	22:02 - 22:32	269.22	11.44	11.14	11.13	11.36	N/A	11.44	345.57	346.78	338.29	1.21
39	16/11/2023	23:02 - 23:32	217.44	11.89	11.58	11.60	10.68	N/A	10.70	262.03	261.01	256.50	-1.02
40	17/11/2023	00:02 - 00:32	211.33	11.89	11.58	11.62	11.35	N/A	11.41	272.57	271.73	266.82	-0.83
41	17/11/2023	01:02 - 01:32	223.12	11.61	11.31	11.31	11.32	N/A	11.36	285.92	284.65	279.89	-1.27
42	17/11/2023	02:02 - 02:32	216.44	11.77	11.47	11.42	11.19	N/A	11.30	274.02	275.13	268.24	1.11
43	17/11/2023	03:02 - 03:32	202.79	11.51	11.21	11.20	11.57	N/A	11.62	266.35	265.47	260.73	-0.88
44	17/11/2023	04:02 - 04:32	203.25	11.22	10.93	10.99	11.46	N/A	11.51	263.08	263.46	257.53	0.38
45	17/11/2023	05:02 - 05:32	203.67	11.19	10.90	10.98	11.21	N/A	11.27	256.73	255.02	251.31	-1.71
46	17/11/2023	06:02 - 06:32	214.23	11.34	11.04	11.07	11.25	N/A	11.27	271.67	270.47	265.94	-1.20
47	17/11/2023	07:02 - 07:32	277.00	10.76	10.48	10.46	11.31	N/A	11.31	351.32	355.05	343.92	3.73
48	17/11/2023	09:02 - 09:32	190.25	11.66	11.35	11.38	11.23	N/A	11.18	241.58	242.55	236.48	0.97
49	17/11/2023	10:02 - 10:32	221.90	11.14	10.85	10.83	11.43	N/A	11.39	286.21	287.72	280.18	1.51
50	17/11/2023	11:02 - 11:32	216.37	11.31	11.02	11.03	11.08	N/A	11.00	269.71	268.74	264.02	-0.98
51	17/11/2023	12:02 - 12:32	256.45	10.57	10.30	10.22	11.31	N/A	11.21	324.60	318.89	317.76	-5.71
52	17/11/2023	13:02 - 13:32	181.32	11.70	11.40	11.46	11.40	N/A	11.23	234.38	229.24	229.43	-5.14
53	17/11/2023	15:02 - 15:32	195.62	10.65	10.37	10.34	11.90	N/A	11.77	263.70	261.62	258.14	-2.08
54	17/11/2023	16:02 - 16:32	212.90	10.56	10.29	10.34	11.85	N/A	11.73	285.21	282.85	279.20	-2.36
55	17/11/2023	17:02 - 17:32	205.04	10.47	10.20	10.14	11.77	N/A	11.66	272.08	270.25	266.34	-1.83
56	17/11/2023	19:02 - 19:32	216.29	10.73	10.45	10.38	11.66	N/A	11.60	284.52	283.30	278.52	-1.22
57	17/11/2023	21:02 - 21:32	201.61	11.23	10.94	10.91	11.74	N/A	11.60	268.94	265.62	263.26	-3.31
58	17/11/2023	22:02 - 22:32	219.46	10.82	10.54	10.50	11.74	N/A	11.58	291.51	286.08	285.37	-5.43
59	17/11/2023	23:02 - 23:32	216.48	10.96	10.68	10.68	11.65	N/A	11.49	285.25	282.26	279.23	-2.98
60	18/11/2023	00:02 - 00:32	213.93	10.93	10.65	10.63	11.67	N/A	11.55	282.30	280.80	276.35	-1.50
61	18/11/2023	01:02 - 01:32	215.76	11.05	10.76	10.71	11.27	N/A	11.16	273.26	272.50	267.50	-0.77
62	18/11/2023	02:02 - 02:32	210.61	11.02	10.74	10.69	11.41	N/A	11.32	270.52	270.34	264.82	-0.18
63	18/11/2023	03:02 - 03:32	206.49	11.38	11.09	11.09	11.62	N/A	11.53	272.41	271.83	266.66	-0.57

where CAL = Calibrated using QAL2 calibration functions

Section 4A - Data and Calculations - QAL2

CARBON MONOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
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Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
64	18/11/2023	04:02 - 04:32	189.75	11.12	10.83	10.89	11.55	N/A	11.45	247.77	246.00	242.54	-1.77
65													
66													
67													
68													
69													
70													
71													
72													
73													
74													
75													
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84													
85													
86													
87													
88													
89													
90													
										MAX	AVERAGE	AVERAGE	Sd
										385.26	297.89	291.54	3.39

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

$Q_0 = ELV \times (MU / 100) / 1.96$	153.06
Kv for 64 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_0 \times Kv$.

Parameter	Value
Standard Deviation (Sd)	3.39
$Q_0 \times Kv$	151.30
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	385.3
--	-------

The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 423.8
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 300.0

Greater of (a) or (b)	0 to 423.8
-----------------------	------------

Surrogate Extension Applied?	Yes
------------------------------	-----

Maximum surrogate extension allowable is up to the Daily ELV.

Conc. of Surrogate (mg/m ³) y	1206.7
Reading on CEM (mg/m ³) x	1199.9
Cal Reading on CEM (mg/m ³) x	1225.6

Valid Calibration Range (at REF conditions)	0 to 1225.6 mg/m³
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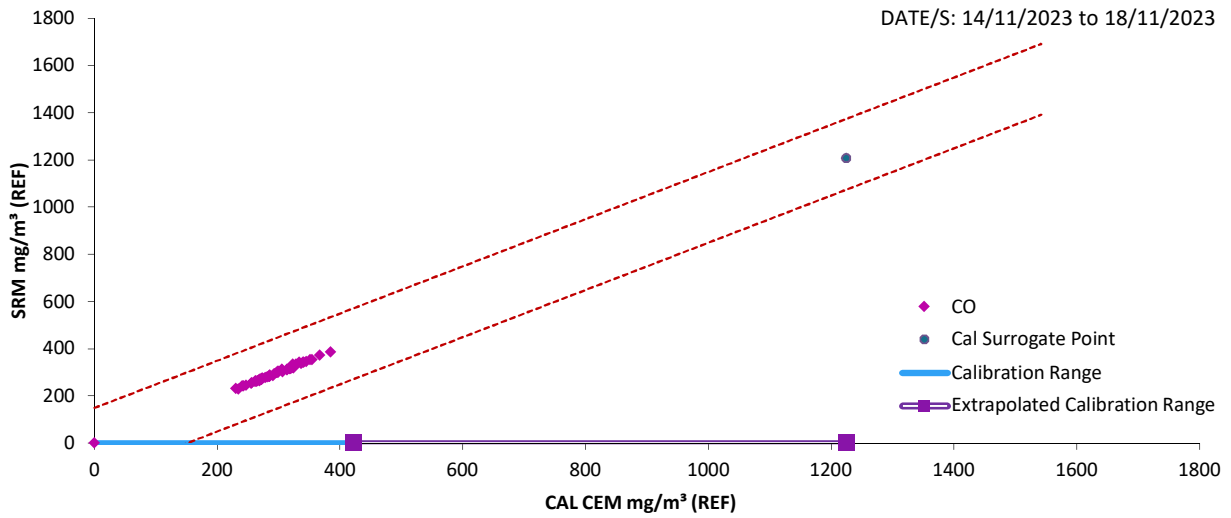
Section 4A - Data and Calculations - QAL2

CARBON MONOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

HYDROGEN CHLORIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
H1	Surrogate	High	81.39	80.00	80.00	79.41	78.30	6217.44	6305.52	79.96
L1	Surrogate	Near Zero	0.01	0.00	0.00	-1.97	-1.70	3.36	3.89	-0.24
1	14/11/2023	17:02 - 17:32	0.55	0.52	0.64	-1.43	-1.18	1.69	2.04	0.29
2	14/11/2023	18:02 - 18:32	0.59	0.49	0.60	-1.39	-1.21	1.69	1.93	0.33
3	14/11/2023	19:02 - 19:32	0.59	0.49	0.61	-1.39	-1.21	1.69	1.93	0.33
4	14/11/2023	21:02 - 21:32	0.51	0.49	0.62	-1.47	-1.21	1.78	2.16	0.25
5	14/11/2023	23:02 - 23:32	0.54	0.55	0.70	-1.44	-1.15	1.66	2.09	0.28
6	15/11/2023	00:02 - 00:32	0.55	0.44	0.55	-1.43	-1.26	1.81	2.05	0.29
7	15/11/2023	01:02 - 01:32	0.69	0.47	0.57	-1.29	-1.24	1.59	1.66	0.43
8	15/11/2023	02:02 - 02:32	0.57	0.55	0.69	-1.41	-1.16	1.63	2.00	0.31
9	15/11/2023	04:02 - 04:32	0.58	0.49	0.62	-1.40	-1.21	1.69	1.96	0.32
10	15/11/2023	05:02 - 05:32	0.63	0.47	0.58	-1.35	-1.23	1.66	1.82	0.37
11	15/11/2023	06:02 - 06:32	0.57	0.45	0.58	-1.42	-1.25	1.77	2.01	0.31
12	15/11/2023	07:02 - 07:32	0.54	0.54	0.68	-1.45	-1.16	1.68	2.09	0.28
13	15/11/2023	09:02 - 09:32	0.48	0.44	0.56	-1.50	-1.26	1.89	2.25	0.22
14	15/11/2023	10:02 - 10:32	0.87	0.48	0.58	-1.11	-1.23	1.36	1.23	0.61
15	15/11/2023	11:02 - 11:32	1.12	0.63	0.78	-0.86	-1.07	0.93	0.75	0.85
16	15/11/2023	12:02 - 12:32	0.76	0.48	0.61	-1.22	-1.22	1.49	1.49	0.50
17	15/11/2023	13:02 - 13:32	0.59	0.45	0.57	-1.39	-1.25	1.74	1.94	0.33
18	15/11/2023	15:02 - 15:32	0.40	0.49	0.64	-1.58	-1.21	1.91	2.49	0.15
19	15/11/2023	17:02 - 17:32	0.47	0.56	0.69	-1.51	-1.14	1.72	2.27	0.22
20	15/11/2023	18:02 - 18:32	0.54	0.46	0.57	-1.44	-1.24	1.79	2.08	0.28
21	15/11/2023	19:02 - 19:32	0.55	0.42	0.52	-1.44	-1.29	1.85	2.07	0.29
22	15/11/2023	21:02 - 21:32	0.58	0.45	0.57	-1.40	-1.25	1.76	1.97	0.32
23	15/11/2023	22:02 - 22:32	0.51	0.47	0.61	-1.47	-1.23	1.82	2.16	0.25
24	15/11/2023	23:02 - 23:32	0.58	0.45	0.58	-1.40	-1.25	1.75	1.95	0.32
25	16/11/2023	00:02 - 00:32	0.59	0.42	0.53	-1.39	-1.28	1.78	1.93	0.33
26	16/11/2023	01:02 - 01:32	0.63	0.42	0.54	-1.36	-1.28	1.74	1.84	0.36
27	16/11/2023	02:02 - 02:32	0.60	0.44	0.57	-1.39	-1.26	1.75	1.92	0.34
28	16/11/2023	03:02 - 03:32	0.63	0.42	0.54	-1.36	-1.28	1.73	1.84	0.36
29	16/11/2023	04:02 - 04:32	0.69	0.43	0.55	-1.29	-1.27	1.65	1.68	0.43
30	16/11/2023	05:02 - 05:32	0.68	0.52	0.66	-1.31	-1.18	1.54	1.70	0.42
31	16/11/2023	06:02 - 06:32	0.67	0.45	0.56	-1.31	-1.25	1.64	1.71	0.41
32	16/11/2023	07:02 - 07:32	0.70	0.44	0.55	-1.29	-1.26	1.62	1.66	0.43
33	16/11/2023	09:02 - 09:32	0.60	0.40	0.51	-1.38	-1.30	1.80	1.91	0.34
34	16/11/2023	10:02 - 10:32	0.64	0.42	0.54	-1.34	-1.28	1.72	1.80	0.38
35	16/11/2023	11:02 - 11:32	0.60	0.52	0.67	-1.38	-1.18	1.63	1.91	0.34
36	16/11/2023	17:02 - 17:32	0.75	0.47	0.61	-1.23	-1.23	1.51	1.51	0.49
37	16/11/2023	18:02 - 18:32	0.84	0.50	0.62	-1.15	-1.21	1.38	1.31	0.57
38	16/11/2023	19:02 - 19:32	0.78	0.43	0.56	-1.21	-1.27	1.53	1.46	0.51
39	16/11/2023	21:02 - 21:32	0.72	0.56	0.73	-1.27	-1.14	1.45	1.61	0.45
40	16/11/2023	22:02 - 22:32	0.72	0.55	0.71	-1.26	-1.16	1.46	1.59	0.46
41	16/11/2023	23:02 - 23:32	0.83	0.49	0.59	-1.15	-1.21	1.39	1.33	0.57
42	17/11/2023	00:02 - 00:32	0.76	0.49	0.64	-1.22	-1.21	1.48	1.49	0.50
43	17/11/2023	01:02 - 01:32	0.83	0.49	0.64	-1.16	-1.21	1.40	1.34	0.56
44	17/11/2023	02:02 - 02:32	0.89	0.51	0.66	-1.09	-1.19	1.30	1.19	0.63
45	17/11/2023	03:02 - 03:32	0.82	0.53	0.70	-1.16	-1.17	1.35	1.34	0.56
46	17/11/2023	04:02 - 04:32	0.97	0.48	0.62	-1.01	-1.22	1.24	1.03	0.70
47	17/11/2023	05:02 - 05:32	0.89	0.50	0.64	-1.09	-1.20	1.31	1.20	0.62
48	17/11/2023	06:02 - 06:32	1.04	0.54	0.69	-0.94	-1.16	1.09	0.89	0.77
49	17/11/2023	07:02 - 07:32	1.05	0.46	0.58	-0.93	-1.24	1.16	0.86	0.79
50	17/11/2023	09:02 - 09:32	0.81	0.99	1.25	-1.17	-0.71	0.83	1.37	0.55
51	17/11/2023	11:02 - 11:32	0.83	0.57	0.71	-1.15	-1.13	1.30	1.32	0.57
52	17/11/2023	12:02 - 12:32	1.01	0.70	0.88	-0.97	-1.00	0.97	0.94	0.75
53	17/11/2023	13:02 - 13:32	1.02	0.70	0.89	-0.96	-1.00	0.97	0.93	0.75
54	17/11/2023	15:02 - 15:32	0.92	0.58	0.78	-1.06	-1.12	1.19	1.13	0.65
55	17/11/2023	16:02 - 16:32	1.10	0.69	0.92	-0.89	-1.01	0.89	0.79	0.83
56	17/11/2023	17:02 - 17:32	1.20	0.75	0.98	-0.78	-0.95	0.74	0.61	0.93
57	17/11/2023	19:02 - 19:32	1.30	0.80	1.04	-0.69	-0.90	0.62	0.47	1.03
58	17/11/2023	21:02 - 21:32	1.16	0.87	1.14	-0.83	-0.83	0.69	0.68	0.89
59	17/11/2023	22:02 - 22:32	1.13	0.61	0.79	-0.85	-1.10	0.93	0.72	0.87
60	17/11/2023	23:02 - 23:32	1.14	0.59	0.76	-0.84	-1.11	0.93	0.70	0.87
61	18/11/2023	00:02 - 00:32	1.21	0.57	0.74	-0.78	-1.14	0.88	0.60	0.94
62	18/11/2023	01:02 - 01:32	1.36	0.50	0.63	-0.62	-1.20	0.74	0.38	1.09
63	18/11/2023	02:02 - 02:32	1.61	0.51	0.64	-0.37	-1.20	0.44	0.14	1.34

Section 4A - Data and Calculations - QAL2

HYDROGEN CHLORIDE: QAL2 CALCULATIONS

(Page 2 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
64	18/11/2023	03:02 - 03:32	1.21	0.53	0.69	-0.77	-1.17	0.91	0.60	0.94
65	18/11/2023	04:02 - 04:32	1.13	0.45	0.59	-0.85	-1.25	1.07	0.73	0.86
66										
67										
68										
69										
70										
71										
72										
73										
74										
75										
76										
77										
78										
79										
80										
81										
82										
83										
84										
85										
86										
87										
88										
89										
90										
MAX SRM - MIN SRM					0.74	SUM		6312.92	6405.97	
(DAILY) DELV (mg/m ³)					10					
95% CI MU (%)					40					
95% CI at DELV (mg/m ³)					4.0					
15% of ELV					1.5					
PROCEDURE (A, B, C)					C					

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV
PROCEDURE C If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
(Statistical Outliers removed following outlier test, other data removed prior to this test)					
1	14/11/2023	20:02 - 20:32	0.00	0.54	Instrument performing an auto-zero
2	15/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
3	15/11/2023	14:02 - 14:32	0.47	0.00	SRM offline/calibrating
4	15/11/2023	16:02 - 16:32	0.37	0.00	SRM offline/calibrating
5	15/11/2023	20:02 - 20:32	0.00	0.45	Instrument performing an auto-zero
6	16/11/2023	08:02 - 08:32	0.63	0.00	SRM offline/calibrating
7	16/11/2023	16:02 - 16:32	0.84	0.00	SRM offline/calibrating
8	16/11/2023	20:02 - 20:32	0.00	0.55	Instrument performing an auto-zero
9	17/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
10	17/11/2023	20:02 - 20:32	0.00	0.65	Instrument performing an auto-zero
11	14/11/2023	22:02 - 22:32	0.54	0.51	Peripheral data outliers (Water Vapour)
12	15/11/2023	03:02 - 03:32	0.62	0.48	Peripheral data outliers (Water Vapour)
13	17/11/2023	14:02 - 14:32	0.70	0.51	Peripheral data outliers (Water Vapour)
14	17/11/2023	18:02 - 18:32	1.49	0.87	Peripheral data outliers (Water Vapour)
15	16/11/2023	12:02 - 12:32	0.68	0.52	Peripheral data outliers (Oxygen)
16	16/11/2023	13:02 - 13:32	0.73	0.46	Peripheral data outliers (Oxygen)
17	16/11/2023	14:02 - 14:32	0.75	0.63	Peripheral data outliers (Oxygen)
18	16/11/2023	15:02 - 15:32	0.75	0.58	Peripheral data outliers (Oxygen)
19	17/11/2023	10:02 - 10:32	0.76	1.21	Statistical outlier
20					
21					
22					
23					
24					
25					

Section 4A - Data and Calculations - QAL2

HYDROGEN CHLORIDE: QAL2 CALCULATIONS

(Page 3 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Derivation of Calibration Function

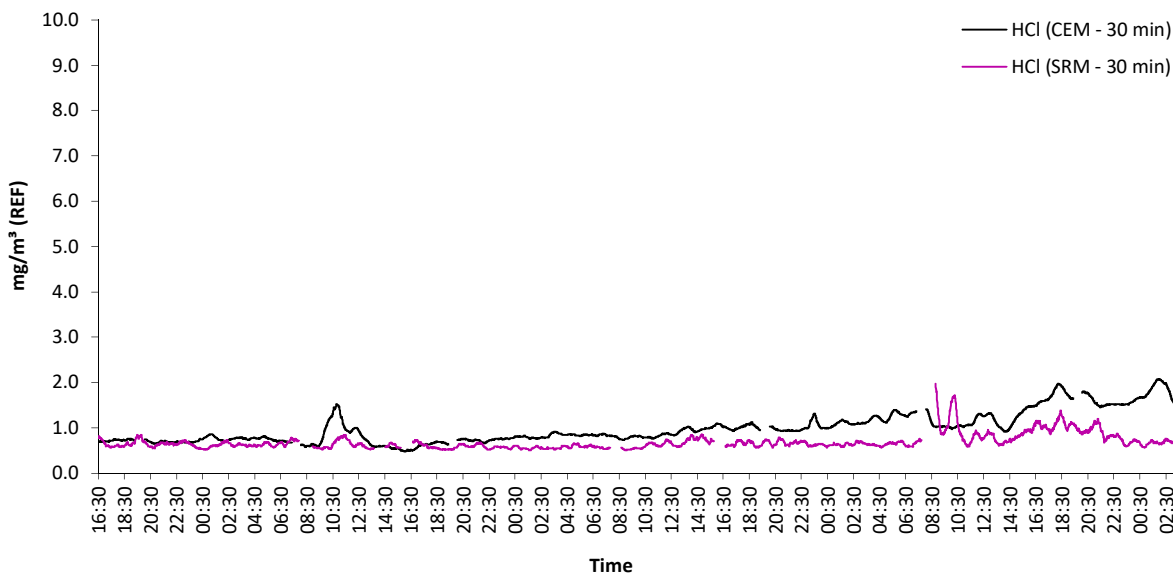
b =	0.9855	a =	-0.2520
-----	--------	-----	---------

CALIBRATION FUNCTION =	y = 0.9855x - 0.2520
-------------------------------	-----------------------------

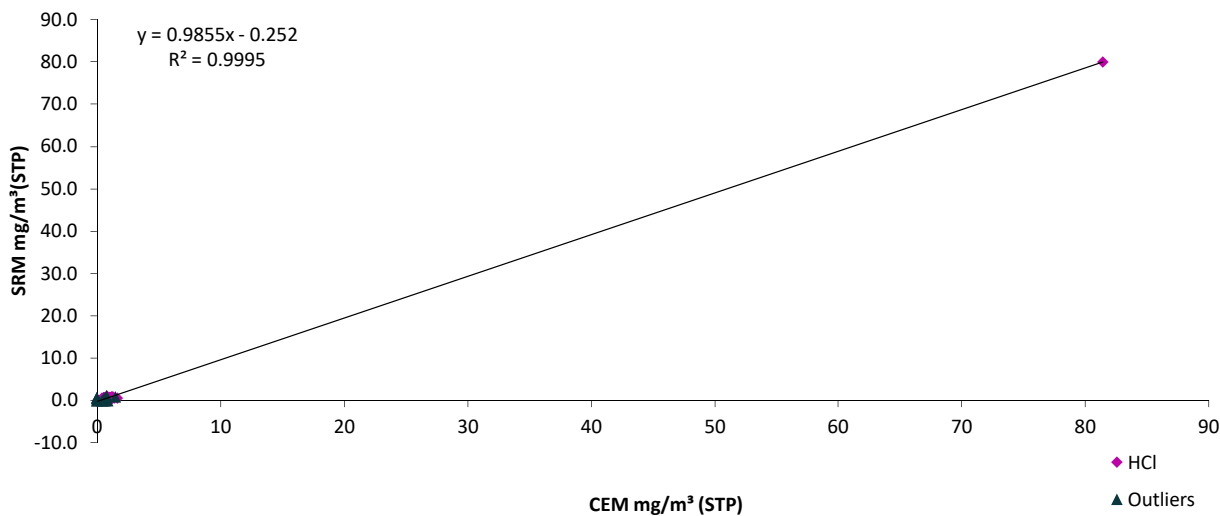
where

For Procedure A / C $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$
 Procedure B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: GRAPH FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED) (30 minute rolling averages)



PLOT 2: Calibration Graph for Procedure C



HYDROGEN CHLORIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
H1	Surrogate	High	79.96	N/A	N/A	N/A	N/A	N/A	N/A	79.96	80.00	81.39	0.04
L1	Surrogate	Near Zero	-0.24	N/A	N/A	N/A	N/A	N/A	N/A	-0.24	0.00	0.01	0.24
1	14/11/2023	17:02 - 17:32	0.29	10.81	10.53	10.47	11.20	N/A	11.11	0.37	0.64	0.69	0.28
2	14/11/2023	18:02 - 18:32	0.33	10.62	10.35	10.34	11.11	N/A	11.03	0.41	0.60	0.74	0.19
3	14/11/2023	19:02 - 19:32	0.33	10.32	10.06	10.00	11.25	N/A	11.17	0.42	0.61	0.75	0.19
4	14/11/2023	21:02 - 21:32	0.25	11.75	11.44	11.50	11.20	N/A	11.18	0.32	0.62	0.65	0.29
5	14/11/2023	23:02 - 23:32	0.28	10.70	10.42	10.44	11.36	N/A	11.32	0.35	0.70	0.69	0.35
6	15/11/2023	00:02 - 00:32	0.29	10.28	10.01	10.01	11.31	N/A	11.27	0.37	0.55	0.69	0.19
7	15/11/2023	01:02 - 01:32	0.43	11.21	10.92	10.94	10.89	N/A	10.91	0.53	0.57	0.85	0.04
8	15/11/2023	02:02 - 02:32	0.31	11.38	11.08	11.12	11.18	N/A	11.17	0.39	0.69	0.72	0.30
9	15/11/2023	04:02 - 04:32	0.32	11.29	11.00	11.04	11.16	N/A	11.13	0.40	0.62	0.73	0.21
10	15/11/2023	05:02 - 05:32	0.37	11.25	10.96	10.98	11.07	N/A	11.05	0.46	0.58	0.79	0.12
11	15/11/2023	06:02 - 06:32	0.31	10.95	10.67	10.66	11.33	N/A	11.29	0.39	0.58	0.72	0.19
12	15/11/2023	07:02 - 07:32	0.28	11.02	10.74	10.74	11.31	N/A	11.27	0.35	0.68	0.68	0.33
13	15/11/2023	09:02 - 09:32	0.22	11.01	10.72	10.72	11.34	N/A	11.36	0.29	0.56	0.62	0.28
14	15/11/2023	10:02 - 10:32	0.61	10.22	9.95	9.91	10.94	N/A	10.98	0.74	0.58	1.06	-0.16
15	15/11/2023	11:02 - 11:32	0.85	10.75	10.47	10.44	11.02	N/A	11.12	1.05	0.78	1.38	-0.26
16	15/11/2023	12:02 - 12:32	0.50	10.39	10.12	10.09	11.33	N/A	11.32	0.63	0.61	0.96	-0.03
17	15/11/2023	13:02 - 13:32	0.33	11.97	11.66	11.75	11.04	N/A	11.00	0.41	0.57	0.74	0.16
18	15/11/2023	15:02 - 15:32	0.15	11.73	11.42	11.48	11.67	N/A	11.52	0.19	0.64	0.54	0.45
19	15/11/2023	17:02 - 17:32	0.22	10.76	10.48	10.45	10.87	N/A	11.06	0.26	0.69	0.58	0.43
20	15/11/2023	18:02 - 18:32	0.28	11.43	11.13	11.13	10.75	N/A	10.98	0.34	0.57	0.65	0.23
21	15/11/2023	19:02 - 19:32	0.29	11.11	10.83	10.80	11.06	N/A	11.18	0.35	0.52	0.68	0.17
22	15/11/2023	21:02 - 21:32	0.32	11.28	10.98	10.97	11.21	N/A	11.27	0.40	0.57	0.73	0.17
23	15/11/2023	22:02 - 22:32	0.25	10.68	10.40	10.37	11.54	N/A	11.59	0.33	0.61	0.67	0.28
24	15/11/2023	23:02 - 23:32	0.32	10.53	10.25	10.24	11.51	N/A	11.54	0.42	0.58	0.76	0.16
25	16/11/2023	00:02 - 00:32	0.33	10.40	10.13	10.13	11.31	N/A	11.37	0.42	0.53	0.75	0.11
26	16/11/2023	01:02 - 01:32	0.36	11.23	10.94	11.00	11.33	N/A	11.36	0.47	0.54	0.80	0.07
27	16/11/2023	02:02 - 02:32	0.34	10.92	10.64	10.58	11.39	N/A	11.47	0.43	0.57	0.76	0.14
28	16/11/2023	03:02 - 03:32	0.36	11.34	11.04	11.13	11.18	N/A	11.25	0.46	0.54	0.79	0.08
29	16/11/2023	04:02 - 04:32	0.43	11.23	10.94	10.95	11.21	N/A	11.32	0.54	0.55	0.87	0.01
30	16/11/2023	05:02 - 05:32	0.42	11.45	11.15	11.18	11.16	N/A	11.22	0.52	0.66	0.85	0.13
31	16/11/2023	06:02 - 06:32	0.41	11.17	10.88	10.84	11.20	N/A	11.24	0.52	0.56	0.85	0.05
32	16/11/2023	07:02 - 07:32	0.43	10.78	10.50	10.50	11.04	N/A	11.09	0.54	0.55	0.86	0.01
33	16/11/2023	09:02 - 09:32	0.34	10.19	9.92	9.88	11.35	N/A	11.39	0.43	0.51	0.76	0.08
34	16/11/2023	10:02 - 10:32	0.38	10.75	10.48	10.47	11.45	N/A	11.52	0.49	0.54	0.82	0.06
35	16/11/2023	11:02 - 11:32	0.34	10.90	10.62	10.65	11.30	N/A	11.47	0.43	0.67	0.76	0.24
36	16/11/2023	17:02 - 17:32	0.49	11.96	11.65	11.64	11.23	N/A	11.30	0.63	0.61	0.96	-0.02
37	16/11/2023	18:02 - 18:32	0.57	11.66	11.36	11.33	11.01	N/A	11.10	0.71	0.62	1.04	-0.09
38	16/11/2023	19:02 - 19:32	0.51	11.50	11.20	11.16	11.43	N/A	11.54	0.66	0.56	1.00	-0.10
39	16/11/2023	21:02 - 21:32	0.45	11.81	11.50	11.51	11.39	N/A	11.48	0.59	0.73	0.92	0.14
40	16/11/2023	22:02 - 22:32	0.46	11.44	11.14	11.13	11.36	N/A	11.44	0.59	0.71	0.92	0.12
41	16/11/2023	23:02 - 23:32	0.57	11.89	11.58	11.60	10.68	N/A	10.70	0.68	0.59	1.00	-0.09
42	17/11/2023	00:02 - 00:32	0.50	11.89	11.58	11.62	11.35	N/A	11.41	0.64	0.64	0.98	0.00
43	17/11/2023	01:02 - 01:32	0.56	11.61	11.31	11.31	11.32	N/A	11.36	0.72	0.64	1.06	-0.08
44	17/11/2023	02:02 - 02:32	0.63	11.77	11.47	11.42	11.19	N/A	11.30	0.79	0.66	1.13	-0.14
45	17/11/2023	03:02 - 03:32	0.56	11.51	11.21	11.20	11.57	N/A	11.62	0.74	0.70	1.08	-0.03
46	17/11/2023	04:02 - 04:32	0.70	11.22	10.93	10.99	11.46	N/A	11.51	0.91	0.62	1.25	-0.29
47	17/11/2023	05:02 - 05:32	0.62	11.19	10.90	10.98	11.21	N/A	11.27	0.79	0.64	1.12	-0.15
48	17/11/2023	06:02 - 06:32	0.77	11.34	11.04	11.07	11.25	N/A	11.27	0.98	0.69	1.32	-0.29
49	17/11/2023	07:02 - 07:32	0.79	10.76	10.48	10.46	11.31	N/A	11.31	1.00	0.58	1.34	-0.42
50	17/11/2023	09:02 - 09:32	0.55	11.66	11.35	11.38	11.23	N/A	11.18	0.69	1.25	1.03	0.56
51	17/11/2023	11:02 - 11:32	0.57	11.31	11.02	11.03	11.08	N/A	11.00	0.71	0.71	1.04	-0.01
52	17/11/2023	12:02 - 12:32	0.75	10.57	10.30	10.22	11.31	N/A	11.21	0.95	0.88	1.28	-0.06
53	17/11/2023	13:02 - 13:32	0.75	11.70	11.40	11.46	11.40	N/A	11.23	0.97	0.89	1.32	-0.09
54	17/11/2023	15:02 - 15:32	0.65	10.65	10.37	10.34	11.90	N/A	11.77	0.88	0.78	1.24	-0.11
55	17/11/2023	16:02 - 16:32	0.83	10.56	10.29	10.34	11.85	N/A	11.73	1.11	0.92	1.47	-0.19
56	17/11/2023	17:02 - 17:32	0.93	10.47	10.20	10.14	11.77	N/A	11.66	1.24	0.98	1.59	-0.25
57	17/11/2023	19:02 - 19:32	1.03	10.73	10.45	10.38	11.66	N/A	11.60	1.35	1.04	1.71	-0.31
58	17/11/2023	21:02 - 21:32	0.89	11.23	10.94	10.91	11.74	N/A	11.60	1.19	1.14	1.54	-0.04
59	17/11/2023	22:02 - 22:32	0.87	10.82	10.54	10.50	11.74	N/A	11.58	1.15	0.79	1.51	-0.36
60	17/11/2023	23:02 - 23:32	0.87	10.96	10.68	10.68	11.65	N/A	11.49	1.15	0.76	1.51	-0.39
61	18/11/2023	00:02 - 00:32	0.94	10.93	10.65	10.63	11.67	N/A	11.55	1.24	0.74	1.59	-0.50
62	18/11/2023	01:02 - 01:32	1.09	11.05	10.76	10.71	11.27	N/A	11.16	1.38	0.63	1.73	-0.75
63	18/11/2023	02:02 - 02:32	1.34	11.02	10.74	10.69	11.41	N/A	11.32	1.72	0.64	2.07	-1.07

where CAL = Calibrated using QAL2 calibration functions

Section 4A - Data and Calculations - QAL2

HYDROGEN CHLORIDE: QAL2 CALCULATIONS

(Page 5 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
64	18/11/2023	03:02 - 03:32	0.94	11.38	11.09	11.09	11.62	N/A	11.53	1.24	0.69	1.59	-0.55
65	18/11/2023	04:02 - 04:32	0.86	11.12	10.83	10.89	11.55	N/A	11.45	1.12	0.59	1.47	-0.54
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										MAX	AVERAGE	AVERAGE	Sd
										1.72	0.67	1.01	0.29

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

$Q_0 = ELV \times (MU / 100) / 1.96$	2.04
Kv for 65 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_0 \times Kv$.

Parameter	Value
Standard Deviation (Sd)	0.29
$Q_0 \times Kv$	2.02
Outcome of Variability Test	Pass

Procedure C Acceptability Test

Average of UNCAL CEM (1)	1.01
Average of SRM (2)	0.67
ABS Difference (1) & (2)	0.34
Outcome of Procedure C Acceptability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	1.7
--	-----

The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 1.9
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 2.0

Greater of (a) or (b)	0 to 2.0
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Surrogate Extension Applied?	NOT PERMISSIBLE
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Valid Calibration Range (at REF conditions)	0 to 2.0 mg/m³
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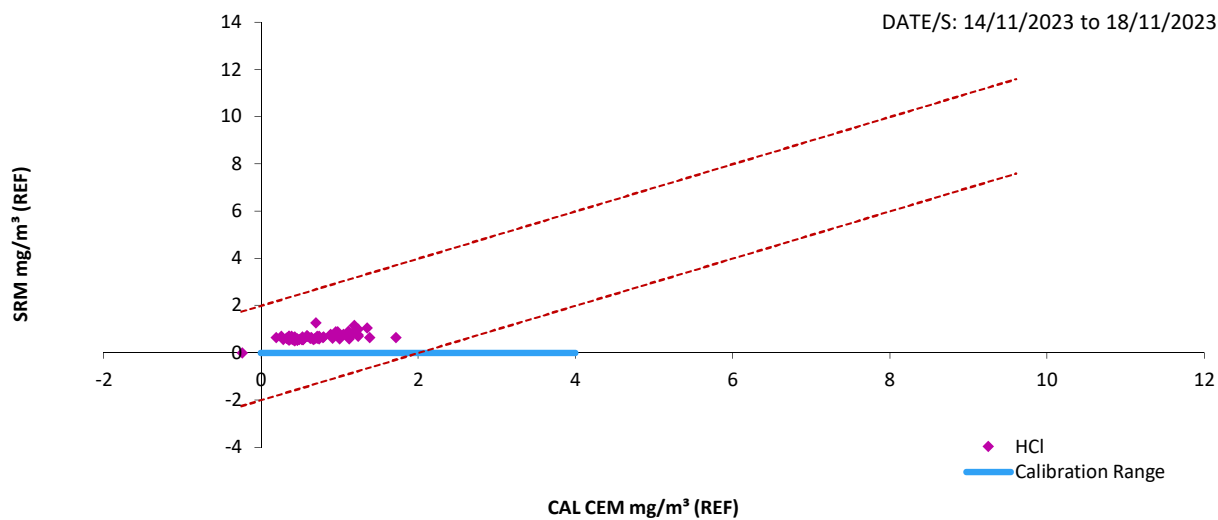
Section 4A - Data and Calculations - QAL2

HYDROGEN CHLORIDE: QAL2 CALCULATIONS

(Page 6 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

HYDROGEN FLUORIDE: QAL2 CALCULATIONS

(Page 1 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
H1	Surrogate	High	4.49	4.50	4.50	4.23	4.21	17.80	17.86	4.50
L1	Surrogate	Near Zero	0.00	0.00	0.00	-0.26	-0.29	0.08	0.07	0.03
1	14/11/2023	12:30 - 13:00	0.02	0.05	0.07	-0.24	-0.24	0.06	0.06	0.05
2	14/11/2023	13:30 - 14:00	0.02	0.09	0.13	-0.24	-0.20	0.05	0.06	0.05
3	14/11/2023	14:45 - 15:15	0.03	0.06	0.07	-0.24	-0.23	0.06	0.06	0.05
4	15/11/2023	08:58 - 09:28	0.02	0.05	0.07	-0.24	-0.23	0.06	0.06	0.05
5	15/11/2023	10:00 - 10:30	0.03	0.05	0.06	-0.23	-0.24	0.06	0.06	0.05
6	15/11/2023	11:05 - 11:35	0.02	0.08	0.09	-0.24	-0.21	0.05	0.06	0.05
7	15/11/2023	12:05 - 12:35	0.02	0.08	0.11	-0.24	-0.21	0.05	0.06	0.05
8	15/11/2023	14:10 - 14:42	0.02	0.05	0.07	-0.25	-0.24	0.06	0.06	0.04
9	15/11/2023	14:12 - 14:42	0.01	0.05	0.07	-0.25	-0.23	0.06	0.06	0.04
10	15/11/2023	15:15 - 15:45	0.02	0.05	0.06	-0.25	-0.24	0.06	0.06	0.04
11	16/11/2023	08:45 - 09:15	0.04	0.05	0.06	-0.22	-0.24	0.05	0.05	0.07
12	16/11/2023	09:47 - 10:17	0.04	0.05	0.06	-0.22	-0.24	0.05	0.05	0.07
13	16/11/2023	10:50 - 11:20	0.05	0.05	0.06	-0.22	-0.24	0.05	0.05	0.07
14	16/11/2023	10:55 - 11:25	0.04	0.05	0.06	-0.22	-0.24	0.05	0.05	0.07
15	16/11/2023	12:58 - 13:28	0.04	0.05	0.06	-0.22	-0.24	0.05	0.05	0.07
16	16/11/2023	14:00 - 14:30	0.05	0.05	0.06	-0.22	-0.24	0.05	0.05	0.07
17	16/11/2023	15:05 - 15:35	0.05	0.07	0.10	-0.22	-0.22	0.05	0.05	0.07
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Section 4A - Data and Calculations - QAL2

HYDROGEN FLUORIDE: QAL2 CALCULATIONS

(Page 2 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³	
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					MAX SRM - MIN SRM	0.07					
					(DAILY) DELV (mg/m ³)	1					
					95% CI MU (%)	40					
					95% CI at DELV (mg/m ³)	0.4					
					15% of ELV	0.2					
					PROCEDURE (A, B, C)	C					
							SUM	18.79	18.85		

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV
PROCEDURE C If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
(Statistical Outliers removed following outlier test, other data removed prior to this test)					
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Section 4A - Data and Calculations - QAL2

HYDROGEN FLUORIDE: QAL2 CALCULATIONS

(Page 3 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Derivation of Calibration Function

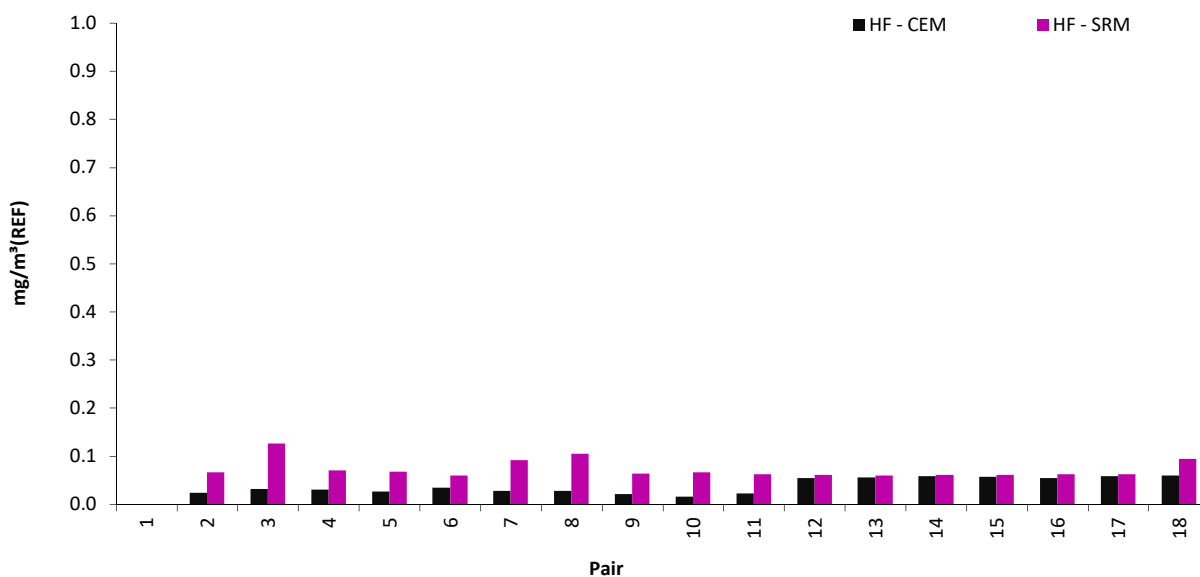
b =	0.9965	a =	0.0252
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CALIBRATION FUNCTION =	y = 0.9965x + 0.0252
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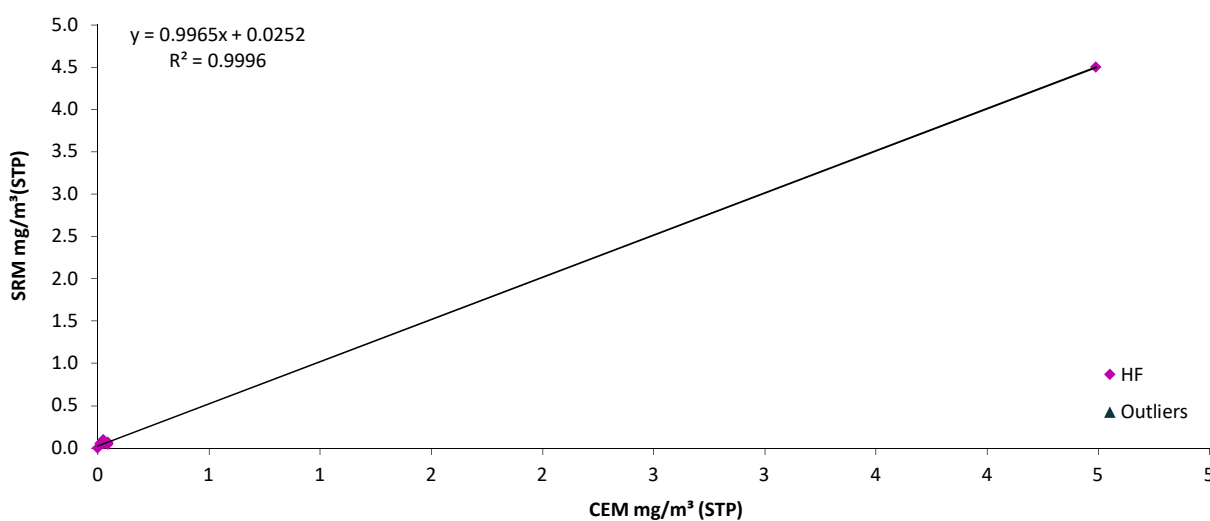
where

For Procedure A / C $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$
 Procedure B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: BAR CHART FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED)



PLOT 2: Calibration Graph for Procedure C



Section 4A - Data and Calculations - QAL2

HYDROGEN FLUORIDE: QAL2 CALCULATIONS

(Page 4 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL			CAL			where CAL = Calibrated using QAL2 calibration functions		
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM
H1	Surrogate	High	4.50	N/A	N/A	N/A	N/A	N/A	N/A	4.50	4.50	4.49	0.00
L1	Surrogate	Near Zero	0.03	N/A	N/A	N/A	N/A	N/A	N/A	0.03	0.00	0.00	-0.03
1	14/11/2023	12:30 - 13:00	0.05	11.58	11.28	10.01	10.34	10.60	11.59	0.05	0.07	0.02	0.01
2	14/11/2023	13:30 - 14:00	0.05	10.72	10.44	13.58	11.37	11.67	11.74	0.07	0.13	0.03	0.06
3	14/11/2023	14:45 - 15:15	0.05	11.62	11.32	10.59	10.83	11.11	11.17	0.06	0.07	0.03	0.01
4	15/11/2023	08:58 - 09:28	0.05	11.06	10.78	10.65	11.07	11.37	11.34	0.06	0.07	0.03	0.01
5	15/11/2023	10:00 - 10:30	0.05	10.20	9.94	9.01	10.71	10.98	10.99	0.07	0.06	0.04	-0.01
6	15/11/2023	11:05 - 11:35	0.05	10.58	10.30	9.80	10.83	11.11	11.07	0.06	0.09	0.03	0.03
7	15/11/2023	12:05 - 12:35	0.05	10.42	10.15	12.74	11.04	11.33	11.24	0.06	0.11	0.03	0.05
8	15/11/2023	14:10 - 14:42	0.04	11.66	11.36	10.34	10.58	10.85	11.04	0.05	0.07	0.02	0.01
9	15/11/2023	14:12 - 14:42	0.04	12.33	12.01	10.74	10.85	11.13	11.21	0.05	0.07	0.02	0.02
10	15/11/2023	15:15 - 15:45	0.04	11.42	11.12	9.78	11.32	11.62	11.41	0.06	0.06	0.02	0.01
11	16/11/2023	08:45 - 09:15	0.07	10.58	10.30	9.65	11.13	11.42	11.42	0.09	0.06	0.06	-0.02
12	16/11/2023	09:47 - 10:17	0.07	10.84	10.55	8.78	11.11	11.40	11.40	0.09	0.06	0.06	-0.03
13	16/11/2023	10:50 - 11:20	0.07	10.90	10.61	10.88	11.18	11.48	11.58	0.09	0.06	0.06	-0.03
14	16/11/2023	10:55 - 11:25	0.07	11.60	11.30	10.33	11.10	11.40	11.56	0.09	0.06	0.06	-0.03
15	16/11/2023	12:58 - 13:28	0.07	11.35	11.06	9.63	10.81	11.10	11.29	0.09	0.06	0.06	-0.02
16	16/11/2023	14:00 - 14:30	0.07	11.55	11.25	9.51	11.23	11.53	11.78	0.09	0.06	0.06	-0.03
17	16/11/2023	15:05 - 15:35	0.07	12.08	11.77	14.63	11.10	11.39	11.64	0.09	0.10	0.06	0.00
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Section 4A - Data and Calculations - QAL2

HYDROGEN FLUORIDE: QAL2 CALCULATIONS

(Page 5 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL			CAL			where CAL = Calibrated using QAL2 calibration functions			
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM	
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											MAX	AVERAGE	AVERAGE	Sd
											0.09	0.07	0.04	0.03

Test of Variability

$Q_0 = ELV \times (MU / 100) / 1.96$	0.20
Kv for 17 Pairs of Data	0.9791

The variability is accepted if $Sd \leq Q_0 \times Kv$.

Parameter	Value
Standard Deviation (Sd)	0.03
$Q_0 \times Kv$	0.20
Outcome of Variability Test	Pass

Procedure C Acceptability Test

Average of UNCAL CEM (1)	0.04
Average of SRM (2)	0.07
ABS Difference (1) & (2)	0.03
Outcome of Procedure C Acceptability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	0.1
--	-----

The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 0.1
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 0.2

Greater of (a) or (b)	0 to 0.2
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Surrogate Extension Applied?	NOT PERMISSIBLE
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Valid Calibration Range (at REF conditions)	0 to 0.2 mg/m³
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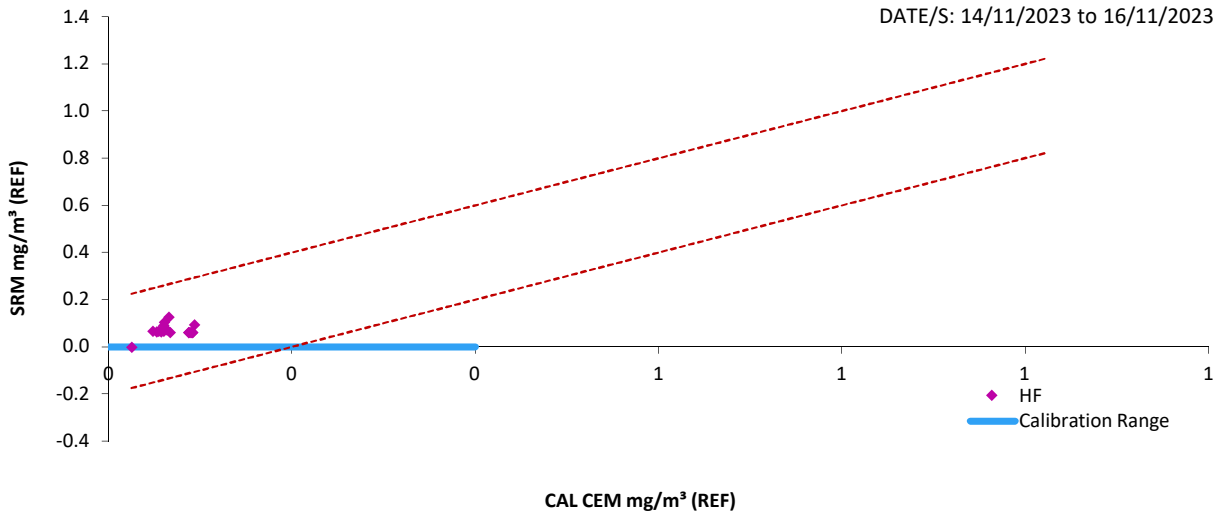
Section 4A - Data and Calculations - QAL2

HYDROGEN FLUORIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
 A2-01 Kiln 6 [Duty Analyser]

PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

AMMONIA: QAL2 CALCULATIONS

(Page 1 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³
L1	Surrogate	Near Zero	-0.09	0.00	0.00	-19.80	-19.14	378.92	392.12	0.00
1	14/11/2023	17:02 - 17:32	18.94	18.09	22.46	-0.78	-1.05	0.81	0.60	18.39
2	14/11/2023	18:02 - 18:32	19.17	18.66	22.97	-0.54	-0.48	0.26	0.29	18.62
3	14/11/2023	19:02 - 19:32	19.78	19.08	23.72	0.07	-0.06	0.00	0.00	19.20
4	14/11/2023	21:02 - 21:32	19.14	18.84	23.85	-0.57	-0.29	0.17	0.33	18.58
5	14/11/2023	23:02 - 23:32	19.32	18.82	23.89	-0.39	-0.31	0.12	0.15	18.76
6	15/11/2023	00:02 - 00:32	20.74	20.30	25.50	1.03	1.17	1.20	1.06	20.13
7	15/11/2023	01:02 - 01:32	20.63	20.24	24.79	0.92	1.11	1.02	0.85	20.02
8	15/11/2023	02:02 - 02:32	20.04	19.68	24.77	0.33	0.55	0.18	0.11	19.45
9	15/11/2023	04:02 - 04:32	20.45	20.07	25.15	0.73	0.93	0.69	0.54	19.84
10	15/11/2023	05:02 - 05:32	20.00	19.61	24.34	0.29	0.47	0.13	0.08	19.41
11	15/11/2023	06:02 - 06:32	18.88	18.43	23.36	-0.83	-0.71	0.59	0.70	18.33
12	15/11/2023	07:02 - 07:32	19.25	18.75	23.76	-0.47	-0.38	0.18	0.22	18.68
13	15/11/2023	09:02 - 09:32	19.70	19.04	24.34	-0.01	-0.09	0.00	0.00	19.12
14	15/11/2023	10:02 - 10:32	26.25	25.60	31.20	6.53	6.47	42.26	42.69	25.45
15	15/11/2023	11:02 - 11:32	24.84	24.54	30.50	5.13	5.41	27.74	26.31	24.09
16	15/11/2023	12:02 - 12:32	19.90	19.39	24.51	0.19	0.26	0.05	0.03	19.31
17	15/11/2023	13:02 - 13:32	22.50	22.09	27.52	2.79	2.95	8.23	7.77	21.83
18	15/11/2023	15:02 - 15:32	20.45	20.01	26.24	0.74	0.87	0.64	0.54	19.85
19	15/11/2023	17:02 - 17:32	20.11	19.56	24.18	0.40	0.42	0.17	0.16	19.52
20	15/11/2023	18:02 - 18:32	20.92	20.47	25.29	1.21	1.33	1.61	1.45	20.30
21	15/11/2023	19:02 - 19:32	20.62	20.21	25.37	0.91	1.07	0.98	0.83	20.02
22	15/11/2023	21:02 - 21:32	21.13	20.72	26.32	1.41	1.58	2.23	2.00	20.50
23	15/11/2023	22:02 - 22:32	19.13	18.79	24.51	-0.58	-0.34	0.20	0.34	18.57
24	15/11/2023	23:02 - 23:32	20.70	20.33	26.32	0.99	1.19	1.18	0.98	20.09
25	16/11/2023	00:02 - 00:32	21.47	21.18	26.90	1.76	2.04	3.60	3.11	20.84
26	16/11/2023	01:02 - 01:32	21.25	21.03	26.98	1.54	1.90	2.93	2.38	20.63
27	16/11/2023	02:02 - 02:32	20.50	19.98	25.78	0.79	0.85	0.67	0.63	19.90
28	16/11/2023	03:02 - 03:32	21.10	20.84	26.45	1.38	1.71	2.36	1.92	20.47
29	16/11/2023	04:02 - 04:32	25.79	25.22	32.18	6.08	6.09	37.00	36.97	25.01
30	16/11/2023	05:02 - 05:32	21.28	20.94	26.53	1.56	1.81	2.83	2.44	20.65
31	16/11/2023	06:02 - 06:32	20.55	20.17	25.48	0.84	1.03	0.87	0.71	19.95
32	16/11/2023	07:02 - 07:32	20.50	20.31	25.18	0.79	1.17	0.93	0.62	19.90
33	16/11/2023	09:02 - 09:32	20.91	20.32	25.80	1.20	1.18	1.42	1.44	20.29
34	16/11/2023	10:02 - 10:32	20.73	20.25	26.25	1.02	1.12	1.14	1.04	20.12
35	16/11/2023	11:02 - 11:32	19.63	19.12	24.69	-0.08	-0.01	0.00	0.01	19.06
36	16/11/2023	17:02 - 17:32	21.02	19.82	25.45	1.31	0.69	0.90	1.71	20.40
37	16/11/2023	18:02 - 18:32	21.44	20.52	25.71	1.73	1.38	2.39	3.00	20.81
38	16/11/2023	19:02 - 19:32	20.21	19.24	25.18	0.50	0.11	0.05	0.25	19.62
39	16/11/2023	21:02 - 21:32	21.28	20.26	26.44	1.57	1.12	1.76	2.46	20.65
40	16/11/2023	22:02 - 22:32	19.42	18.47	23.92	-0.29	-0.67	0.19	0.09	18.85
41	17/11/2023	00:02 - 00:32	20.53	19.52	25.34	0.82	0.38	0.31	0.67	19.92
42	17/11/2023	01:02 - 01:32	19.91	18.82	24.21	0.20	-0.32	-0.06	0.04	19.33
43	17/11/2023	02:02 - 02:32	21.25	20.00	25.59	1.54	0.86	1.33	2.36	20.62
44	17/11/2023	04:02 - 04:32	20.25	19.20	24.99	0.53	0.06	0.03	0.29	19.65
45	17/11/2023	05:02 - 05:32	20.71	19.73	25.05	1.00	0.59	0.59	1.00	20.10
46	17/11/2023	06:02 - 06:32	20.69	19.42	24.71	0.97	0.29	0.28	0.95	20.08
47	17/11/2023	07:02 - 07:32	18.55	17.47	22.15	-1.16	-1.67	1.94	1.36	18.01
48	17/11/2023	09:02 - 09:32	20.28	20.01	25.29	0.56	0.87	0.49	0.32	19.68
49	17/11/2023	11:02 - 11:32	19.37	19.20	23.74	-0.34	0.06	-0.02	0.12	18.80
50	17/11/2023	12:02 - 12:32	18.99	18.54	23.20	-0.72	-0.60	0.43	0.52	18.44
51	17/11/2023	13:02 - 13:32	20.94	20.69	26.32	1.23	1.56	1.92	1.51	20.32
52	17/11/2023	15:02 - 15:32	18.58	18.20	24.19	-1.13	-0.94	1.06	1.28	18.04
53	17/11/2023	16:02 - 16:32	17.76	17.56	23.25	-1.95	-1.57	3.07	3.81	17.25
54	17/11/2023	17:02 - 17:32	17.70	17.19	22.52	-2.01	-1.95	3.91	4.03	17.20
55	17/11/2023	19:02 - 19:32	17.60	17.08	22.30	-2.11	-2.06	4.34	4.45	17.10
56	17/11/2023	21:02 - 21:32	17.75	17.32	22.74	-1.96	-1.82	3.56	3.85	17.24
57	17/11/2023	22:02 - 22:32	17.03	16.45	21.47	-2.68	-2.68	7.20	7.20	16.54
58	17/11/2023	23:02 - 23:32	17.03	16.17	20.93	-2.68	-2.97	7.97	7.20	16.54
59	18/11/2023	00:02 - 00:32	17.20	16.21	21.12	-2.51	-2.93	7.34	6.29	16.71
60	18/11/2023	01:02 - 01:32	18.08	17.19	21.53	-1.63	-1.94	3.17	2.66	17.56
61	18/11/2023	02:02 - 02:32	17.94	17.02	21.67	-1.77	-2.11	3.74	3.13	17.43
62	18/11/2023	03:02 - 03:32	16.85	16.58	21.66	-2.86	-2.55	7.31	8.19	16.37
63	18/11/2023	04:02 - 04:32	17.00	16.09	20.80	-2.71	-3.05	8.25	7.34	16.52

Section 4A - Data and Calculations - QAL2

AMMONIA: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (STP, WET) mg/m ³	
64											
65											
66											
67											
68											
69											
70											
71											
72											
73											
74											
75											
76											
77											
78											
79											
80											
81											
82											
83											
84											
85											
86											
87											
88											
89											
90											
					MAX SRM - MIN SRM	11.37					
					(DAILY) DELV (mg/m ³)	50					
					95% CI MU (%)	40					
TYPE of ELV					95% CI at ELV (mg/m ³)	20.0					
					15% of ELV	7.5					
					PROCEDURE (A, B, C)	B					
							SUM	596.76	607.47		

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV
PROCEDURE C If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM < 15% of Daily ELV

WHERE OFFSET = -0.09

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m ³	y, SRM (STP, WET) mg/m ³	Reason for Data Pair Removal
(Statistical Outliers removed following outlier test, other data removed prior to this test)					
1	14/11/2023	20:02 - 20:32	0.00	19.88	Instrument performing an auto-zero
2	15/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
3	15/11/2023	14:02 - 14:32	22.34	0.00	SRM offline/calibrating
4	15/11/2023	16:02 - 16:32	18.85	0.00	SRM offline/calibrating
5	15/11/2023	20:02 - 20:32	0.00	19.62	Instrument performing an auto-zero
6	16/11/2023	08:02 - 08:32	19.86	0.00	SRM offline/calibrating
7	16/11/2023	16:02 - 16:32	22.14	0.00	SRM offline/calibrating
8	16/11/2023	20:02 - 20:32	0.00	19.71	Instrument performing an auto-zero
9	17/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
10	17/11/2023	20:02 - 20:32	0.00	17.47	Instrument performing an auto-zero
11	14/11/2023	22:02 - 22:32	18.60	18.27	Peripheral data outliers (Water Vapour)
12	15/11/2023	03:02 - 03:32	20.49	20.10	Peripheral data outliers (Water Vapour)
13	17/11/2023	14:02 - 14:32	20.35	20.26	Peripheral data outliers (Water Vapour)
14	17/11/2023	18:02 - 18:32	18.42	17.92	Peripheral data outliers (Water Vapour)
15	16/11/2023	12:02 - 12:32	21.52	20.92	Peripheral data outliers (Oxygen)
16	16/11/2023	13:02 - 13:32	22.10	21.58	Peripheral data outliers (Oxygen)
17	16/11/2023	14:02 - 14:32	19.77	19.47	Peripheral data outliers (Oxygen)
18	16/11/2023	15:02 - 15:32	22.11	21.62	Peripheral data outliers (Oxygen)
19	16/11/2023	23:02 - 23:32	23.65	22.12	Statistical outlier
20	17/11/2023	03:02 - 03:32	20.58	19.07	Statistical outlier
21	17/11/2023	10:02 - 10:32	20.22	20.66	Statistical outlier
22					
23					
24					
25					

Section 4A - Data and Calculations - QAL2

AMMONIA: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Derivation of Calibration Function

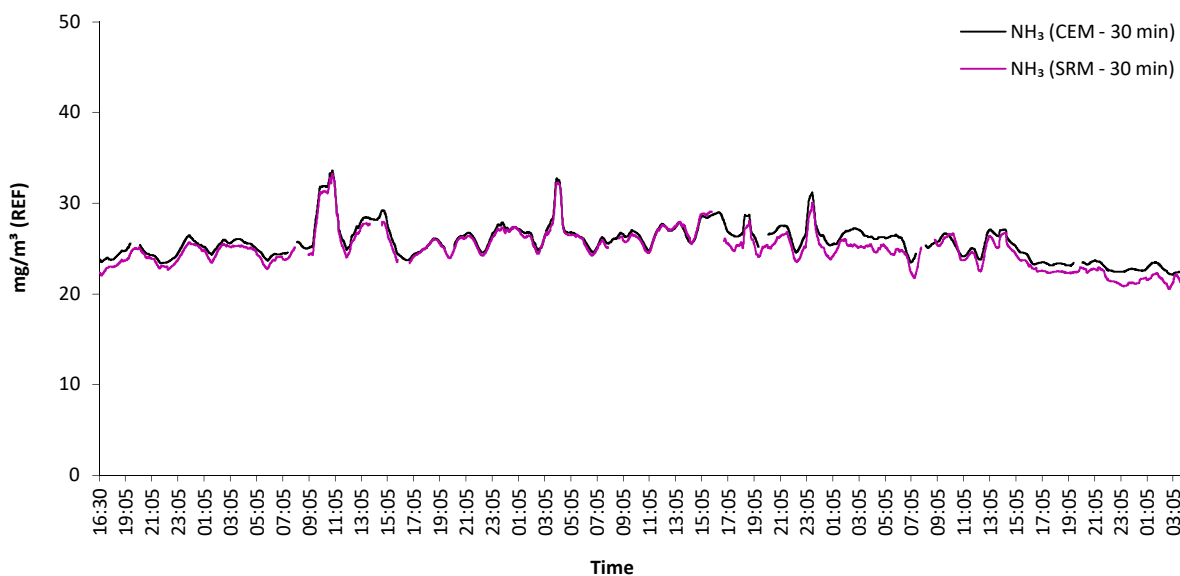
b =	0.9663	a =	0.0870
-----	--------	-----	--------

CALIBRATION FUNCTION =	y = 0.9663x + 0.0870
-------------------------------	-----------------------------

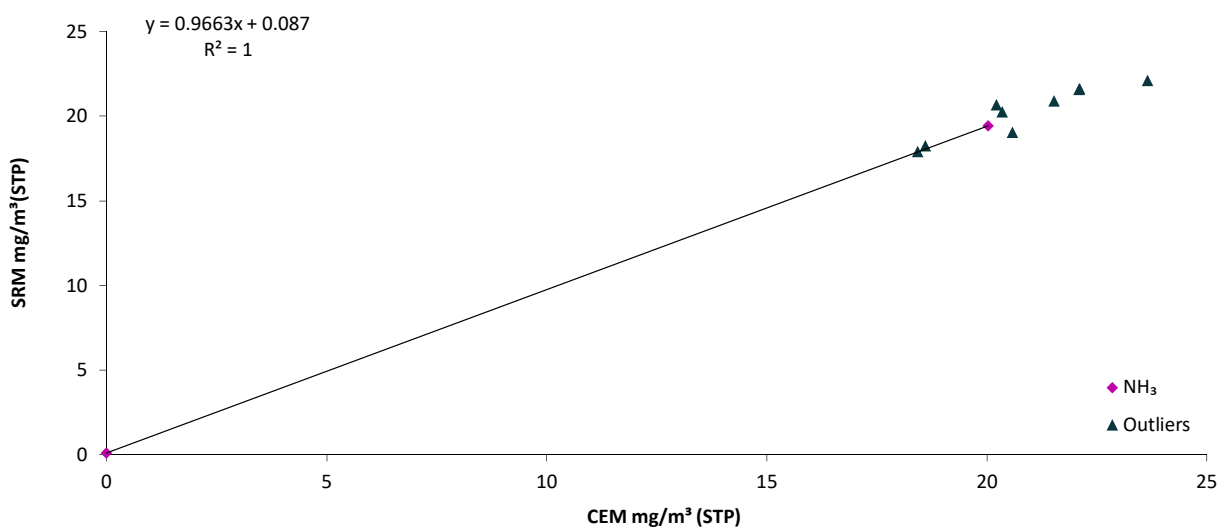
where

For Procedure A / C $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$
 Procedure B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: GRAPH FOR REFERENCE SRM vs REFERENCE CEM (STANDARDISED) (30 minute rolling averages)



PLOT 2: Calibration Graph for Procedure B



Section 4A - Data and Calculations - QAL2

AMMONIA: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
					N/A			N/A					
L1	Surrogate	Near Zero	0.00	N/A	N/A	N/A	N/A	N/A	N/A	0.00	0.00	-0.09	0.00
1	14/11/2023	17:02 - 17:32	18.39	10.81	10.53	10.47	11.20	N/A	11.11	23.06	22.46	23.75	-0.59
2	14/11/2023	18:02 - 18:32	18.62	10.62	10.35	10.34	11.11	N/A	11.03	23.10	22.97	23.79	-0.13
3	14/11/2023	19:02 - 19:32	19.20	10.32	10.06	10.00	11.25	N/A	11.17	24.09	23.72	24.82	-0.37
4	14/11/2023	21:02 - 21:32	18.58	11.75	11.44	11.50	11.20	N/A	11.18	23.55	23.85	24.26	0.31
5	14/11/2023	23:02 - 23:32	18.76	10.70	10.42	10.44	11.36	N/A	11.32	23.90	23.89	24.62	-0.01
6	15/11/2023	00:02 - 00:32	20.13	10.28	10.01	10.01	11.31	N/A	11.27	25.39	25.50	26.16	0.11
7	15/11/2023	01:02 - 01:32	20.02	11.21	10.92	10.94	10.89	N/A	10.91	24.46	24.79	25.20	0.33
8	15/11/2023	02:02 - 02:32	19.45	11.38	11.08	11.12	11.18	N/A	11.17	24.50	24.77	25.24	0.28
9	15/11/2023	04:02 - 04:32	19.84	11.29	11.00	11.04	11.16	N/A	11.13	24.94	25.15	25.69	0.21
10	15/11/2023	05:02 - 05:32	19.41	11.25	10.96	10.98	11.07	N/A	11.05	24.14	24.34	24.87	0.20
11	15/11/2023	06:02 - 06:32	18.33	10.95	10.67	10.66	11.33	N/A	11.29	23.35	23.36	24.05	0.01
12	15/11/2023	07:02 - 07:32	18.68	11.02	10.74	10.74	11.31	N/A	11.27	23.76	23.76	24.47	0.00
13	15/11/2023	09:02 - 09:32	19.12	11.01	10.72	10.72	11.34	N/A	11.36	24.38	24.34	25.12	-0.04
14	15/11/2023	10:02 - 10:32	25.45	10.22	9.95	9.91	10.94	N/A	10.98	30.90	31.20	31.87	0.30
15	15/11/2023	11:02 - 11:32	24.09	10.75	10.47	10.44	11.02	N/A	11.12	29.66	30.50	30.58	0.84
16	15/11/2023	12:02 - 12:32	19.31	10.39	10.12	10.09	11.33	N/A	11.32	24.44	24.51	25.18	0.07
17	15/11/2023	13:02 - 13:32	21.83	11.97	11.66	11.75	11.04	N/A	11.00	27.30	27.52	28.14	0.22
18	15/11/2023	15:02 - 15:32	19.85	11.73	11.42	11.48	11.67	N/A	11.52	26.42	26.24	27.23	-0.19
19	15/11/2023	17:02 - 17:32	19.52	10.76	10.48	10.45	10.87	N/A	11.06	23.68	24.18	24.40	0.49
20	15/11/2023	18:02 - 18:32	20.30	11.43	11.13	11.13	10.75	N/A	10.98	24.52	25.29	25.26	0.78
21	15/11/2023	19:02 - 19:32	20.02	11.11	10.83	10.80	11.06	N/A	11.18	24.83	25.37	25.59	0.54
22	15/11/2023	21:02 - 21:32	20.50	11.28	10.98	10.97	11.21	N/A	11.27	25.88	26.32	26.66	0.44
23	15/11/2023	22:02 - 22:32	18.57	10.68	10.40	10.37	11.54	N/A	11.59	24.10	24.51	24.82	0.41
24	15/11/2023	23:02 - 23:32	20.09	10.53	10.25	10.24	11.51	N/A	11.54	25.94	26.32	26.73	0.38
25	16/11/2023	00:02 - 00:32	20.84	10.40	10.13	10.13	11.31	N/A	11.37	26.33	26.90	27.14	0.57
26	16/11/2023	01:02 - 01:32	20.63	11.23	10.94	11.00	11.33	N/A	11.36	26.33	26.98	27.14	0.64
27	16/11/2023	02:02 - 02:32	19.90	10.92	10.64	10.58	11.39	N/A	11.47	25.48	25.78	26.25	0.30
28	16/11/2023	03:02 - 03:32	20.47	11.34	11.04	11.13	11.18	N/A	11.25	25.77	26.45	26.55	0.68
29	16/11/2023	04:02 - 04:32	25.01	11.23	10.94	10.95	11.21	N/A	11.32	31.55	32.18	32.54	0.62
30	16/11/2023	05:02 - 05:32	20.65	11.45	11.15	11.18	11.16	N/A	11.22	25.99	26.53	26.78	0.54
31	16/11/2023	06:02 - 06:32	19.95	11.17	10.88	10.84	11.20	N/A	11.24	25.13	25.48	25.90	0.35
32	16/11/2023	07:02 - 07:32	19.90	10.78	10.50	10.50	11.04	N/A	11.09	24.55	25.18	25.29	0.64
33	16/11/2023	09:02 - 09:32	20.29	10.19	9.92	9.88	11.35	N/A	11.39	25.68	25.80	26.46	0.12
34	16/11/2023	10:02 - 10:32	20.12	10.75	10.48	10.47	11.45	N/A	11.52	25.90	26.25	26.69	0.35
35	16/11/2023	11:02 - 11:32	19.06	10.90	10.62	10.65	11.30	N/A	11.47	24.17	24.69	24.90	0.52
36	16/11/2023	17:02 - 17:32	20.40	11.96	11.65	11.64	11.23	N/A	11.30	25.99	25.45	26.78	-0.54
37	16/11/2023	18:02 - 18:32	20.81	11.66	11.36	11.33	11.01	N/A	11.10	25.85	25.71	26.64	-0.14
38	16/11/2023	19:02 - 19:32	19.62	11.50	11.20	11.16	11.43	N/A	11.54	25.39	25.18	26.16	-0.22
39	16/11/2023	21:02 - 21:32	20.65	11.81	11.50	11.51	11.39	N/A	11.48	26.70	26.44	27.51	-0.26
40	16/11/2023	22:02 - 22:32	18.85	11.44	11.14	11.13	11.36	N/A	11.44	24.20	23.92	24.93	-0.28
41	17/11/2023	00:02 - 00:32	19.92	11.89	11.58	11.62	11.35	N/A	11.41	25.70	25.34	26.48	-0.36
42	17/11/2023	01:02 - 01:32	19.33	11.61	11.31	11.31	11.32	N/A	11.36	24.77	24.21	25.52	-0.55
43	17/11/2023	02:02 - 02:32	20.62	11.77	11.47	11.42	11.19	N/A	11.30	26.11	25.59	26.90	-0.51
44	17/11/2023	04:02 - 04:32	19.65	11.22	10.93	10.99	11.46	N/A	11.51	25.44	24.99	26.21	-0.45
45	17/11/2023	05:02 - 05:32	20.10	11.19	10.90	10.98	11.21	N/A	11.27	25.34	25.05	26.11	-0.29
46	17/11/2023	06:02 - 06:32	20.08	11.34	11.04	11.07	11.25	N/A	11.27	25.46	24.71	26.23	-0.75
47	17/11/2023	07:02 - 07:32	18.01	10.76	10.48	10.46	11.31	N/A	11.31	22.84	22.15	23.52	-0.69
48	17/11/2023	09:02 - 09:32	19.68	11.66	11.35	11.38	11.23	N/A	11.18	24.99	25.29	25.75	0.30
49	17/11/2023	11:02 - 11:32	18.80	11.31	11.02	11.03	11.08	N/A	11.00	23.44	23.74	24.14	0.30
50	17/11/2023	12:02 - 12:32	18.44	10.57	10.30	10.22	11.31	N/A	11.21	23.34	23.20	24.04	-0.14
51	17/11/2023	13:02 - 13:32	20.32	11.70	11.40	11.46	11.40	N/A	11.23	26.27	26.32	27.07	0.05
52	17/11/2023	15:02 - 15:32	18.04	10.65	10.37	10.34	11.90	N/A	11.77	24.32	24.19	25.05	-0.13
53	17/11/2023	16:02 - 16:32	17.25	10.56	10.29	10.34	11.85	N/A	11.73	23.11	23.25	23.79	0.14
54	17/11/2023	17:02 - 17:32	17.20	10.47	10.20	10.14	11.77	N/A	11.66	22.82	22.52	23.49	-0.30
55	17/11/2023	19:02 - 19:32	17.10	10.73	10.45	10.38	11.66	N/A	11.60	22.49	22.30	23.15	-0.19
56	17/11/2023	21:02 - 21:32	17.24	11.23	10.94	10.91	11.74	N/A	11.60	23.00	22.74	23.68	-0.25
57	17/11/2023	22:02 - 22:32	16.54	10.82	10.54	10.50	11.74	N/A	11.58	21.97	21.47	22.62	-0.50
58	17/11/2023	23:02 - 23:32	16.54	10.96	10.68	10.68	11.65	N/A	11.49	21.80	20.93	22.44	-0.86
59	18/11/2023	00:02 - 00:32	16.71	10.93	10.65	10.63	11.67	N/A	11.55	22.05	21.12	22.70	-0.94
60	18/11/2023	01:02 - 01:32	17.56	11.05	10.76	10.71	11.27	N/A	11.16	22.24	21.53	22.90	-0.71
61	18/11/2023	02:02 - 02:32	17.43	11.02	10.74	10.69	11.41	N/A	11.32	22.38	21.67	23.05	-0.71
62	18/11/2023	03:02 - 03:32	16.37	11.38	11.09	11.09	11.62	N/A	11.53	21.60	21.66	22.23	0.06
63	18/11/2023	04:02 - 04:32	16.52	11.12	10.83	10.89	11.55	N/A	11.45	21.57	20.80	22.20	-0.77

where CAL = Calibrated using QAL2 calibration functions

Section 4A - Data and Calculations - QAL2

AMMONIA: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m ³	CEM Water Vapour % v/v	CAL		CAL		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O ₂) mg/m ³	SRM (STP, DRY, 10% O ₂) mg/m ³	UNCAL CEM (STP, DRY, 10% O ₂) mg/m ³	ys, SRM - CAL CEM
					CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v					
64													
65													
66													
67													
68													
69													
70													
71													
72													
73													
74													
75													
76													
77													
78													
79													
80													
81													
82													
83													
84													
85													
86													
87													
88													
89													
90													
										MAX	AVERAGE	AVERAGE	Sd
										31.55	24.74	25.48	0.45

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

$Q_0 = ELV \times (MU / 100) / 1.96$	10.20
Kv for 63 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_0 \times Kv$.

Parameter	Value
Standard Deviation (Sd)	0.45
$Q_0 \times Kv$	10.09
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (mg/m ³)	31.6
--	------

The Calibration Range can be extended by the greater of a) 10% of the Maximum CAL CEM Value or b) Up to 20% of the Daily ELV.

a) Calibrated Range (10% extension) (mg/m ³)	0 to 34.7
b) Calibrated Range (20% of Daily ELV) (mg/m ³)	0 to 10.0

Greater of (a) or (b)	0 to 34.7
-----------------------	-----------

Surrogate Extension Applied?	Yes
------------------------------	-----

Maximum surrogate extension allowable is up to the Daily ELV.

Conc. of Surrogate (mg/m ³) y	60.0
Reading on CEM (mg/m ³) x	58.9
Cal Reading on CEM (mg/m ³) x	57.0

Valid Calibration Range (at REF conditions)	0 to 50 mg/m³
--	---------------------------------

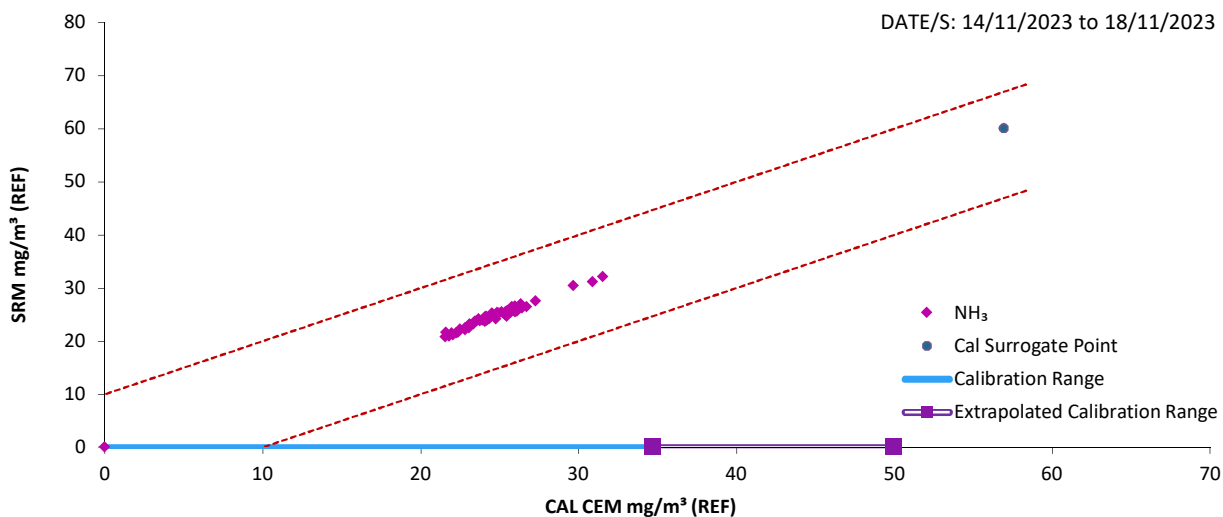
Section 4A - Data and Calculations - QAL2

AMMONIA: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
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PLOT 3: X-Y Plot - REF CAL CEM vs REF SRM Values



Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (ACTUAL) % v/v	y, SRM (ACTUAL) % v/v	x - x _{av} (A)	Y - Y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (ACTUAL) % v/v
L1	Surrogate	Near Zero	0.00	0.00	-10.98	-10.69	117.34	120.46	0.00
1	14/11/2023	17:02 - 17:32	10.81	10.47	-0.16	-0.22	0.04	0.03	10.53
2	14/11/2023	18:02 - 18:32	10.62	10.34	-0.35	-0.35	0.12	0.12	10.35
3	14/11/2023	19:02 - 19:32	10.32	10.00	-0.65	-0.69	0.45	0.42	10.06
4	14/11/2023	21:02 - 21:32	11.75	11.50	0.77	0.81	0.62	0.60	11.44
5	14/11/2023	23:02 - 23:32	10.70	10.44	-0.28	-0.26	0.07	0.08	10.42
6	15/11/2023	00:02 - 00:32	10.28	10.01	-0.70	-0.68	0.48	0.49	10.01
7	15/11/2023	01:02 - 01:32	11.21	10.94	0.24	0.25	0.06	0.06	10.92
8	15/11/2023	02:02 - 02:32	11.38	11.12	0.40	0.43	0.17	0.16	11.08
9	15/11/2023	04:02 - 04:32	11.29	11.04	0.31	0.34	0.11	0.10	11.00
10	15/11/2023	05:02 - 05:32	11.25	10.98	0.28	0.29	0.08	0.08	10.96
11	15/11/2023	06:02 - 06:32	10.95	10.66	-0.03	-0.03	0.00	0.00	10.67
12	15/11/2023	07:02 - 07:32	11.02	10.74	0.05	0.05	0.00	0.00	10.74
13	15/11/2023	09:02 - 09:32	11.01	10.72	0.03	0.03	0.00	0.00	10.72
14	15/11/2023	10:02 - 10:32	10.22	9.91	-0.76	-0.78	0.59	0.57	9.95
15	15/11/2023	11:02 - 11:32	10.75	10.44	-0.23	-0.25	0.06	0.05	10.47
16	15/11/2023	12:02 - 12:32	10.39	10.09	-0.58	-0.60	0.35	0.34	10.12
17	15/11/2023	13:02 - 13:32	11.97	11.75	1.00	1.06	1.06	1.00	11.66
18	15/11/2023	15:02 - 15:32	11.73	11.48	0.75	0.79	0.59	0.56	11.42
19	15/11/2023	17:02 - 17:32	10.76	10.45	-0.22	-0.24	0.05	0.05	10.48
20	15/11/2023	18:02 - 18:32	11.43	11.13	0.45	0.44	0.20	0.21	11.13
21	15/11/2023	19:02 - 19:32	11.11	10.80	0.14	0.10	0.01	0.02	10.83
22	15/11/2023	21:02 - 21:32	11.28	10.97	0.30	0.28	0.08	0.09	10.98
23	15/11/2023	22:02 - 22:32	10.68	10.37	-0.30	-0.32	0.10	0.09	10.40
24	15/11/2023	23:02 - 23:32	10.53	10.24	-0.45	-0.45	0.20	0.20	10.25
25	16/11/2023	00:02 - 00:32	10.40	10.13	-0.57	-0.56	0.32	0.33	10.13
26	16/11/2023	01:02 - 01:32	11.23	11.00	0.25	0.30	0.08	0.06	10.94
27	16/11/2023	02:02 - 02:32	10.92	10.58	-0.06	-0.11	0.01	0.00	10.64
28	16/11/2023	03:02 - 03:32	11.34	11.13	0.36	0.44	0.16	0.13	11.04
29	16/11/2023	04:02 - 04:32	11.23	10.95	0.25	0.26	0.07	0.06	10.94
30	16/11/2023	05:02 - 05:32	11.45	11.18	0.48	0.49	0.23	0.23	11.15
31	16/11/2023	06:02 - 06:32	11.17	10.84	0.19	0.15	0.03	0.04	10.88
32	16/11/2023	07:02 - 07:32	10.78	10.50	-0.19	-0.19	0.04	0.04	10.50
33	16/11/2023	09:02 - 09:32	10.19	9.88	-0.79	-0.82	0.64	0.62	9.92
34	16/11/2023	10:02 - 10:32	10.75	10.47	-0.22	-0.23	0.05	0.05	10.48
35	16/11/2023	11:02 - 11:32	10.90	10.65	-0.08	-0.04	0.00	0.01	10.62
36	16/11/2023	12:02 - 12:32	11.62	11.35	0.64	0.66	0.43	0.41	11.32
37	16/11/2023	13:02 - 13:32	11.42	11.11	0.45	0.42	0.19	0.20	11.13
38	16/11/2023	14:02 - 14:32	11.54	11.29	0.56	0.60	0.34	0.32	11.24
39	16/11/2023	15:02 - 15:32	12.07	11.77	1.09	1.08	1.18	1.19	11.75
40	16/11/2023	17:02 - 17:32	11.96	11.64	0.98	0.95	0.93	0.96	11.65
41	16/11/2023	18:02 - 18:32	11.66	11.33	0.68	0.64	0.43	0.47	11.36
42	16/11/2023	19:02 - 19:32	11.50	11.16	0.52	0.47	0.25	0.28	11.20
43	16/11/2023	21:02 - 21:32	11.81	11.51	0.83	0.82	0.68	0.69	11.50
44	16/11/2023	22:02 - 22:32	11.44	11.13	0.47	0.44	0.21	0.22	11.14
45	16/11/2023	23:02 - 23:32	11.89	11.60	0.91	0.91	0.83	0.83	11.58
46	17/11/2023	00:02 - 00:32	11.89	11.62	0.91	0.93	0.85	0.83	11.58
47	17/11/2023	01:02 - 01:32	11.61	11.31	0.63	0.62	0.39	0.40	11.31
48	17/11/2023	02:02 - 02:32	11.77	11.42	0.80	0.73	0.58	0.63	11.47
49	17/11/2023	03:02 - 03:32	11.51	11.20	0.53	0.51	0.27	0.28	11.21
50	17/11/2023	04:02 - 04:32	11.22	10.99	0.25	0.29	0.07	0.06	10.93
51	17/11/2023	05:02 - 05:32	11.19	10.98	0.21	0.29	0.06	0.05	10.90
52	17/11/2023	06:02 - 06:32	11.34	11.07	0.36	0.38	0.14	0.13	11.04
53	17/11/2023	07:02 - 07:32	10.76	10.46	-0.21	-0.23	0.05	0.05	10.48
54	17/11/2023	09:02 - 09:32	11.66	11.38	0.68	0.69	0.47	0.46	11.35
55	17/11/2023	10:02 - 10:32	11.14	10.83	0.16	0.14	0.02	0.03	10.85
56	17/11/2023	11:02 - 11:32	11.31	11.03	0.33	0.34	0.11	0.11	11.02
57	17/11/2023	12:02 - 12:32	10.57	10.22	-0.40	-0.47	0.19	0.16	10.30
58	17/11/2023	13:02 - 13:32	11.70	11.46	0.72	0.77	0.56	0.52	11.40
59	17/11/2023	15:02 - 15:32	10.65	10.34	-0.33	-0.35	0.12	0.11	10.37
60	17/11/2023	16:02 - 16:32	10.56	10.34	-0.41	-0.35	0.14	0.17	10.29
61	17/11/2023	17:02 - 17:32	10.47	10.14	-0.51	-0.55	0.28	0.26	10.20
62	17/11/2023	19:02 - 19:32	10.73	10.38	-0.25	-0.31	0.08	0.06	10.45
63	17/11/2023	21:02 - 21:32	11.23	10.91	0.26	0.22	0.06	0.07	10.94
64	17/11/2023	22:02 - 22:32	10.82	10.50	-0.15	-0.19	0.03	0.02	10.54
65	17/11/2023	23:02 - 23:32	10.96	10.68	-0.01	-0.02	0.00	0.00	10.68

Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (ACTUAL) % v/v	y, SRM (ACTUAL) % v/v	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (ACTUAL) % v/v	
66	18/11/2023	00:02 - 00:32	10.93	10.63	-0.05	-0.06	0.00	0.00	10.65	
67	18/11/2023	01:02 - 01:32	11.05	10.71	0.07	0.02	0.00	0.01	10.76	
68	18/11/2023	02:02 - 02:32	11.02	10.69	0.04	-0.01	0.00	0.00	10.74	
69	18/11/2023	03:02 - 03:32	11.38	11.09	0.41	0.40	0.16	0.16	11.09	
70	18/11/2023	04:02 - 04:32	11.12	10.89	0.14	0.20	0.03	0.02	10.83	
71										
72										
73										
74										
75										
76										
77										
78										
79										
80										
81										
82										
83										
84										
85										
86										
87										
88										
89										
90										
			MAX SRM - MIN SRM	1.90			SUM	134.58	137.49	
			(DAILY) DELV (% v/v)	30						
			95% CI MU (%)	30						
			95% CI at DELV (% v/v)	9.0						
			PROCEDURE (A OR B)	B						

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV

WHERE OFFSET = 0

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (ACTUAL) % v/v	y, SRM (ACTUAL) % v/v	Reason for Data Pair Removal
(Statistical Outliers removed following outlier test, other data removed prior to this test)					
1	14/11/2023	20:02 - 20:32	0.00	11.16	Instrument performing an auto-zero
2	15/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
3	15/11/2023	14:02 - 14:32	12.25	0.00	SRM offline/calibrating
4	15/11/2023	16:02 - 16:32	11.02	0.00	SRM offline/calibrating
5	15/11/2023	20:02 - 20:32	0.00	10.79	Instrument performing an auto-zero
6	16/11/2023	08:02 - 08:32	10.69	0.00	SRM offline/calibrating
7	16/11/2023	16:02 - 16:32	12.05	0.00	SRM offline/calibrating
8	16/11/2023	20:02 - 20:32	0.00	11.24	Instrument performing an auto-zero
9	17/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
10	17/11/2023	20:02 - 20:32	0.00	10.17	Instrument performing an auto-zero
11	14/11/2023	22:02 - 22:32	11.38	11.22	Statistical outlier
12	15/11/2023	03:02 - 03:32	11.46	11.28	Statistical outlier
13	17/11/2023	14:02 - 14:32	11.59	11.41	Statistical outlier
14	17/11/2023	18:02 - 18:32	10.42	10.05	Statistical outlier
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Derivation of Calibration Function

b =	0.9741	a =	0.0000
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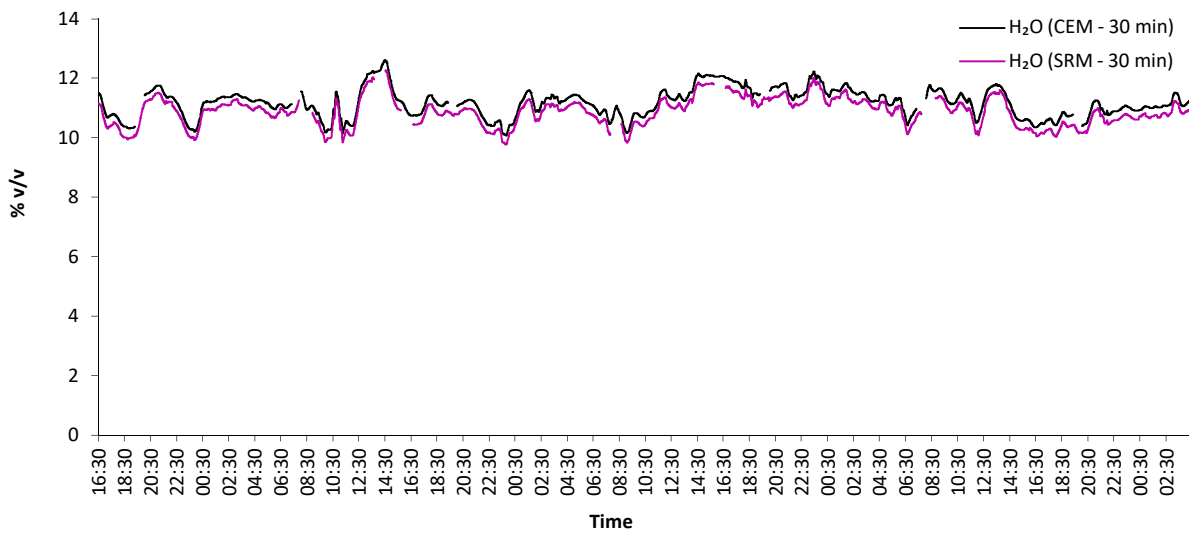
CALIBRATION FUNCTION =	y = 0.9741x + 0.0000
-------------------------------	-----------------------------

where

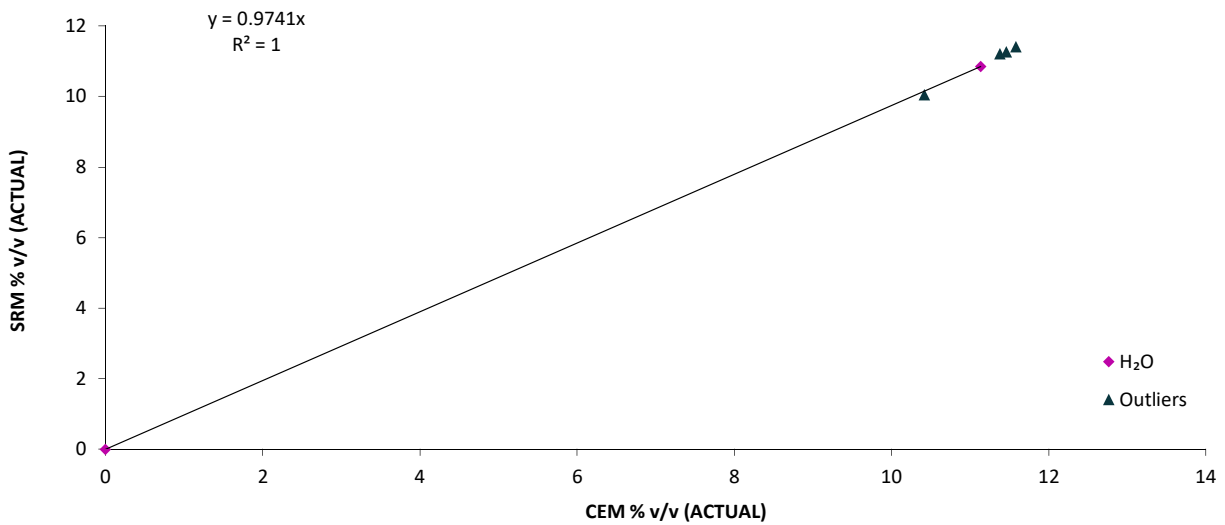
For Method A $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$

Method B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: GRAPH FOR STP SRM vs STP CEM (30 minute rolling averages)



PLOT 2: Calibration Graph for Method B



Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (ACTUAL) % v/v	ys, SRM (ACTUAL) % v/v	UNCAL CEM (ACTUAL) % v/v	ys, SRM - CAL CEM
L1	Surrogate	Near Zero	0.00	0.00	0.00	0.00
1	14/11/2023	17:02 - 17:32	10.53	10.47	10.81	-0.06
2	14/11/2023	18:02 - 18:32	10.35	10.34	10.62	0.00
3	14/11/2023	19:02 - 19:32	10.06	10.00	10.32	-0.05
4	14/11/2023	21:02 - 21:32	11.44	11.50	11.75	0.05
5	14/11/2023	23:02 - 23:32	10.42	10.44	10.70	0.01
6	15/11/2023	00:02 - 00:32	10.01	10.01	10.28	0.00
7	15/11/2023	01:02 - 01:32	10.92	10.94	11.21	0.02
8	15/11/2023	02:02 - 02:32	11.08	11.12	11.38	0.04
9	15/11/2023	04:02 - 04:32	11.00	11.04	11.29	0.04
10	15/11/2023	05:02 - 05:32	10.96	10.98	11.25	0.02
11	15/11/2023	06:02 - 06:32	10.67	10.66	10.95	0.00
12	15/11/2023	07:02 - 07:32	10.74	10.74	11.02	0.01
13	15/11/2023	09:02 - 09:32	10.72	10.72	11.01	0.00
14	15/11/2023	10:02 - 10:32	9.95	9.91	10.22	-0.04
15	15/11/2023	11:02 - 11:32	10.47	10.44	10.75	-0.03
16	15/11/2023	12:02 - 12:32	10.12	10.09	10.39	-0.03
17	15/11/2023	13:02 - 13:32	11.66	11.75	11.97	0.09
18	15/11/2023	15:02 - 15:32	11.42	11.48	11.73	0.06
19	15/11/2023	17:02 - 17:32	10.48	10.45	10.76	-0.03
20	15/11/2023	18:02 - 18:32	11.13	11.13	11.43	-0.01
21	15/11/2023	19:02 - 19:32	10.83	10.80	11.11	-0.03
22	15/11/2023	21:02 - 21:32	10.98	10.97	11.28	-0.01
23	15/11/2023	22:02 - 22:32	10.40	10.37	10.68	-0.03
24	15/11/2023	23:02 - 23:32	10.25	10.24	10.53	-0.01
25	16/11/2023	00:02 - 00:32	10.13	10.13	10.40	-0.01
26	16/11/2023	01:02 - 01:32	10.94	11.00	11.23	0.06
27	16/11/2023	02:02 - 02:32	10.64	10.58	10.92	-0.05
28	16/11/2023	03:02 - 03:32	11.04	11.13	11.34	0.09
29	16/11/2023	04:02 - 04:32	10.94	10.95	11.23	0.01
30	16/11/2023	05:02 - 05:32	11.15	11.18	11.45	0.03
31	16/11/2023	06:02 - 06:32	10.88	10.84	11.17	-0.04
32	16/11/2023	07:02 - 07:32	10.50	10.50	10.78	0.00
33	16/11/2023	09:02 - 09:32	9.92	9.88	10.19	-0.05
34	16/11/2023	10:02 - 10:32	10.48	10.47	10.75	-0.01
35	16/11/2023	11:02 - 11:32	10.62	10.65	10.90	0.03
36	16/11/2023	12:02 - 12:32	11.32	11.35	11.62	0.04
37	16/11/2023	13:02 - 13:32	11.13	11.11	11.42	-0.01
38	16/11/2023	14:02 - 14:32	11.24	11.29	11.54	0.05
39	16/11/2023	15:02 - 15:32	11.75	11.77	12.07	0.02
40	16/11/2023	17:02 - 17:32	11.65	11.64	11.96	-0.01
41	16/11/2023	18:02 - 18:32	11.36	11.33	11.66	-0.03
42	16/11/2023	19:02 - 19:32	11.20	11.16	11.50	-0.04
43	16/11/2023	21:02 - 21:32	11.50	11.51	11.81	0.01
44	16/11/2023	22:02 - 22:32	11.14	11.13	11.44	-0.01
45	16/11/2023	23:02 - 23:32	11.58	11.60	11.89	0.03
46	17/11/2023	00:02 - 00:32	11.58	11.62	11.89	0.04
47	17/11/2023	01:02 - 01:32	11.31	11.31	11.61	0.00
48	17/11/2023	02:02 - 02:32	11.47	11.42	11.77	-0.04
49	17/11/2023	03:02 - 03:32	11.21	11.20	11.51	-0.01
50	17/11/2023	04:02 - 04:32	10.93	10.99	11.22	0.05
51	17/11/2023	05:02 - 05:32	10.90	10.98	11.19	0.08
52	17/11/2023	06:02 - 06:32	11.04	11.07	11.34	0.03
53	17/11/2023	07:02 - 07:32	10.48	10.46	10.76	-0.02
54	17/11/2023	09:02 - 09:32	11.35	11.38	11.66	0.03
55	17/11/2023	10:02 - 10:32	10.85	10.83	11.14	-0.02
56	17/11/2023	11:02 - 11:32	11.02	11.03	11.31	0.01
57	17/11/2023	12:02 - 12:32	10.30	10.22	10.57	-0.08
58	17/11/2023	13:02 - 13:32	11.40	11.46	11.70	0.07
59	17/11/2023	15:02 - 15:32	10.37	10.34	10.65	-0.03
60	17/11/2023	16:02 - 16:32	10.29	10.34	10.56	0.05
61	17/11/2023	17:02 - 17:32	10.20	10.14	10.47	-0.05
62	17/11/2023	19:02 - 19:32	10.45	10.38	10.73	-0.07
63	17/11/2023	21:02 - 21:32	10.94	10.91	11.23	-0.03
64	17/11/2023	22:02 - 22:32	10.54	10.50	10.82	-0.04
65	17/11/2023	23:02 - 23:32	10.68	10.68	10.96	-0.01

Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (ACTUAL) % v/v	ys, SRM (ACTUAL) % v/v	UNCAL CEM (ACTUAL) % v/v	ys, SRM - CAL CEM
66	18/11/2023	00:02 - 00:32	10.65	10.63	10.93	-0.01
67	18/11/2023	01:02 - 01:32	10.76	10.71	11.05	-0.05
68	18/11/2023	02:02 - 02:32	10.74	10.69	11.02	-0.05
69	18/11/2023	03:02 - 03:32	11.09	11.09	11.38	0.01
70	18/11/2023	04:02 - 04:32	10.83	10.89	11.12	0.06
71						
72						
73						
74						
75						
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
			MAX	AVERAGE	AVERAGE	Sd
			11.75	10.84	11.13	0.04

Test of Variability

$Q_0 = ELV \times (MU / 100) / 1.96$	4.59
Kv for 70 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_0 \times Kv$

Parameter	Value
Standard Deviation (Sd)	0.04
$Q_0 \times Kv$	4.54
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (% v/v)	11.8
Allowable Extension (%)	10

Valid Calibration Range	0 to 12.9 % v/v
--------------------------------	------------------------

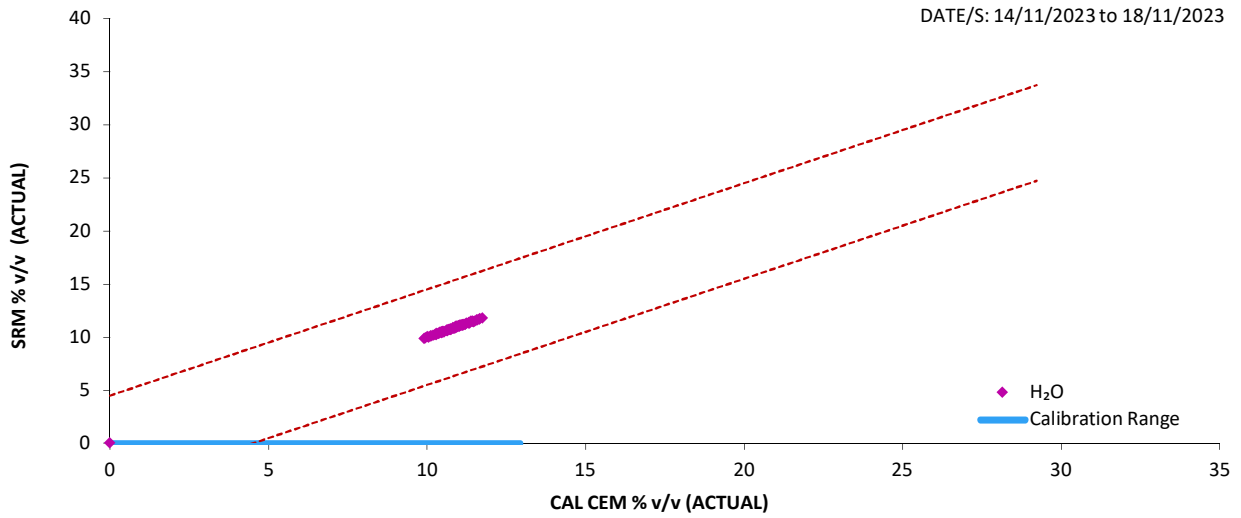
Section 4A - Data and Calculations - QAL2

WATER VAPOUR: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
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PLOT 3: X-Y Plot - ACTUAL CAL CEM vs ACTUAL SRM Values



Section 4A - Data and Calculations - QAL2

OXYGEN: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (WET) % v/v	y, SRM (WET) % v/v	SRM (DRY) % v/v	$x - x_{av}$ (A)	$y - y_{av}$ (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (WET) % v/v
L1	Surrogate	Near Zero	0.09	0.00	0.00	-9.61	-9.94	95.46	92.26	0.00
1	14/11/2023	17:02 - 17:32	9.77	9.94	11.11	0.08	0.01	0.00	0.01	10.02
2	14/11/2023	18:02 - 18:32	9.72	9.89	11.03	0.02	-0.05	0.00	0.00	9.96
3	14/11/2023	19:02 - 19:32	9.87	10.05	11.17	0.18	0.11	0.02	0.03	10.12
4	14/11/2023	21:02 - 21:32	9.68	9.90	11.18	-0.02	-0.04	0.00	0.00	9.92
5	14/11/2023	23:02 - 23:32	9.93	10.14	11.32	0.23	0.20	0.05	0.05	10.18
6	15/11/2023	00:02 - 00:32	9.92	10.14	11.27	0.23	0.20	0.05	0.05	10.18
7	15/11/2023	01:02 - 01:32	9.46	9.72	10.91	-0.23	-0.22	0.05	0.05	9.70
8	15/11/2023	02:02 - 02:32	9.69	9.92	11.17	0.00	-0.01	0.00	0.00	9.94
9	15/11/2023	04:02 - 04:32	9.69	9.90	11.13	0.00	-0.04	0.00	0.00	9.94
10	15/11/2023	05:02 - 05:32	9.61	9.83	11.05	-0.08	-0.10	0.01	0.01	9.85
11	15/11/2023	06:02 - 06:32	9.88	10.08	11.29	0.18	0.15	0.03	0.03	10.13
12	15/11/2023	07:02 - 07:32	9.85	10.06	11.27	0.15	0.12	0.02	0.02	10.10
13	15/11/2023	09:02 - 09:32	9.87	10.14	11.36	0.18	0.20	0.04	0.03	10.12
14	15/11/2023	10:02 - 10:32	9.61	9.89	10.98	-0.09	-0.05	0.00	0.01	9.85
15	15/11/2023	11:02 - 11:32	9.63	9.96	11.12	-0.07	0.02	0.00	0.00	9.87
16	15/11/2023	12:02 - 12:32	9.93	10.18	11.32	0.23	0.24	0.06	0.05	10.18
17	15/11/2023	13:02 - 13:32	9.52	9.70	11.00	-0.18	-0.23	0.04	0.03	9.75
18	15/11/2023	15:02 - 15:32	10.08	10.20	11.52	0.39	0.26	0.10	0.15	10.34
19	15/11/2023	17:02 - 17:32	9.50	9.91	11.06	-0.20	-0.03	0.01	0.04	9.73
20	15/11/2023	18:02 - 18:32	9.32	9.76	10.98	-0.37	-0.18	0.07	0.14	9.55
21	15/11/2023	19:02 - 19:32	9.62	9.97	11.18	-0.08	0.03	0.00	0.01	9.86
22	15/11/2023	21:02 - 21:32	9.73	10.04	11.27	0.04	0.10	0.00	0.00	9.98
23	15/11/2023	22:02 - 22:32	10.08	10.39	11.59	0.39	0.45	0.17	0.15	10.34
24	15/11/2023	23:02 - 23:32	10.07	10.36	11.54	0.38	0.42	0.16	0.14	10.33
25	16/11/2023	00:02 - 00:32	9.92	10.21	11.37	0.22	0.28	0.06	0.05	10.17
26	16/11/2023	01:02 - 01:32	9.84	10.11	11.36	0.14	0.18	0.03	0.02	10.09
27	16/11/2023	02:02 - 02:32	9.92	10.25	11.47	0.23	0.31	0.07	0.05	10.18
28	16/11/2023	03:02 - 03:32	9.70	9.99	11.25	0.00	0.06	0.00	0.00	9.94
29	16/11/2023	04:02 - 04:32	9.74	10.08	11.32	0.04	0.14	0.01	0.00	9.98
30	16/11/2023	05:02 - 05:32	9.68	9.97	11.22	-0.02	0.03	0.00	0.00	9.92
31	16/11/2023	06:02 - 06:32	9.74	10.02	11.24	0.05	0.08	0.00	0.00	9.99
32	16/11/2023	07:02 - 07:32	9.64	9.92	11.09	-0.06	-0.01	0.00	0.00	9.88
33	16/11/2023	09:02 - 09:32	9.97	10.26	11.39	0.28	0.33	0.09	0.08	10.22
34	16/11/2023	10:02 - 10:32	10.00	10.32	11.52	0.31	0.38	0.12	0.09	10.25
35	16/11/2023	11:02 - 11:32	9.85	10.25	11.47	0.15	0.31	0.05	0.02	10.10
36	16/11/2023	17:02 - 17:32	9.68	9.99	11.30	-0.02	0.05	0.00	0.00	9.92
37	16/11/2023	18:02 - 18:32	9.52	9.84	11.10	-0.17	-0.09	0.02	0.03	9.76
38	16/11/2023	19:02 - 19:32	9.90	10.25	11.54	0.20	0.31	0.06	0.04	10.15
39	16/11/2023	21:02 - 21:32	9.83	10.16	11.48	0.13	0.22	0.03	0.02	10.08
40	16/11/2023	22:02 - 22:32	9.84	10.17	11.44	0.15	0.23	0.03	0.02	10.09
41	16/11/2023	23:02 - 23:32	9.21	9.46	10.70	-0.48	-0.48	0.23	0.23	9.44
42	17/11/2023	00:02 - 00:32	9.79	10.09	11.41	0.10	0.15	0.01	0.01	10.04
43	17/11/2023	01:02 - 01:32	9.79	10.08	11.36	0.10	0.14	0.01	0.01	10.04
44	17/11/2023	02:02 - 02:32	9.66	10.01	11.30	-0.03	0.07	0.00	0.00	9.90
45	17/11/2023	03:02 - 03:32	10.02	10.32	11.62	0.32	0.38	0.12	0.10	10.27
46	17/11/2023	04:02 - 04:32	9.95	10.24	11.51	0.26	0.30	0.08	0.07	10.21
47	17/11/2023	05:02 - 05:32	9.74	10.03	11.27	0.04	0.09	0.00	0.00	9.98
48	17/11/2023	06:02 - 06:32	9.76	10.03	11.27	0.07	0.09	0.01	0.00	10.01
49	17/11/2023	07:02 - 07:32	9.88	10.13	11.31	0.18	0.19	0.03	0.03	10.13
50	17/11/2023	09:02 - 09:32	9.71	9.91	11.18	0.01	-0.03	0.00	0.00	9.95
51	17/11/2023	10:02 - 10:32	9.94	10.16	11.39	0.25	0.22	0.05	0.06	10.19
52	17/11/2023	11:02 - 11:32	9.62	9.79	11.00	-0.07	-0.15	0.01	0.01	9.86
53	17/11/2023	12:02 - 12:32	9.90	10.07	11.21	0.20	0.13	0.03	0.04	10.15
54	17/11/2023	13:02 - 13:32	9.85	9.94	11.23	0.15	0.01	0.00	0.02	10.10
55	17/11/2023	15:02 - 15:32	10.39	10.56	11.77	0.70	0.62	0.43	0.49	10.66
56	17/11/2023	16:02 - 16:32	10.36	10.52	11.73	0.67	0.58	0.39	0.44	10.63
57	17/11/2023	17:02 - 17:32	10.30	10.47	11.66	0.61	0.53	0.33	0.37	10.57
58	17/11/2023	19:02 - 19:32	10.18	10.39	11.60	0.49	0.46	0.22	0.24	10.44
59	17/11/2023	21:02 - 21:32	10.20	10.33	11.60	0.50	0.39	0.20	0.25	10.46
60	17/11/2023	22:02 - 22:32	10.24	10.37	11.58	0.55	0.43	0.24	0.30	10.51
61	17/11/2023	23:02 - 23:32	10.15	10.26	11.49	0.45	0.32	0.15	0.21	10.41
62	18/11/2023	00:02 - 00:32	10.17	10.32	11.55	0.47	0.39	0.18	0.22	10.43
63	18/11/2023	01:02 - 01:32	9.81	9.97	11.16	0.11	0.03	0.00	0.01	10.05
64	18/11/2023	02:02 - 02:32	9.93	10.11	11.32	0.24	0.18	0.04	0.06	10.18
65	18/11/2023	03:02 - 03:32	10.08	10.25	11.53	0.38	0.31	0.12	0.15	10.33

Section 4A - Data and Calculations - QAL2

OXYGEN: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
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Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (WET) % v/v	y, SRM (WET) % v/v	SRM (DRY) % v/v	$x - x_{av}$ (A)	$y - y_{av}$ (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (WET) % v/v
66	18/11/2023	04:02 - 04:32	10.05	10.20	11.45	0.35	0.27	0.09	0.12	10.30
67										
68										
69										
70										
71										
72										
73										
74										
75										
76										
77										
78										
79										
80										
81										
82										
83										
84										
85										
86										
87										
88										
89										
90										
MAX SRM - MIN SRM					1.08	SUM		99.86	97.16	
(DAILY) DELV (% v/v)					21					
95% CI MU (%)					10					
95% CI at DELV (% v/v)					2.1					
PROCEDURE (A OR B)					B					

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV

WHERE OFFSET = 0.09

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (WET) % v/v	y, SRM (WET) % v/v	Reason for Data Pair Removal
(Statistical Outliers removed following outlier test, other data removed prior to this test)					
1	14/11/2023	20:02 - 20:32	0.00	9.92	Instrument performing an auto-zero
2	15/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
3	15/11/2023	14:02 - 14:32	9.53	0.00	SRM offline/calibrating
4	15/11/2023	16:02 - 16:32	9.89	0.00	SRM offline/calibrating
5	15/11/2023	20:02 - 20:32	0.00	10.02	Instrument performing an auto-zero
6	16/11/2023	08:02 - 08:32	10.06	0.00	SRM offline/calibrating
7	16/11/2023	16:02 - 16:32	9.85	0.00	SRM offline/calibrating
8	16/11/2023	20:02 - 20:32	0.00	10.01	Instrument performing an auto-zero
9	17/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
10	17/11/2023	20:02 - 20:32	0.00	10.45	Instrument performing an auto-zero
11	14/11/2023	22:02 - 22:32	9.69	9.89	Peripheral data outliers (Water Vapour)
12	15/11/2023	03:02 - 03:32	9.62	9.84	Peripheral data outliers (Water Vapour)
13	17/11/2023	14:02 - 14:32	10.11	10.25	Peripheral data outliers (Water Vapour)
14	17/11/2023	18:02 - 18:32	9.93	10.10	Peripheral data outliers (Water Vapour)
15	16/11/2023	12:02 - 12:32	9.83	10.29	Statistical outlier
16	16/11/2023	13:02 - 13:32	9.58	10.03	Statistical outlier
17	16/11/2023	14:02 - 14:32	9.95	10.45	Statistical outlier
18	16/11/2023	15:02 - 15:32	9.78	10.28	Statistical outlier
19					
20					
21					
22					
23					
24					
25					

Section 4A - Data and Calculations - QAL2

OXYGEN: QAL2 CALCULATIONS

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Derivation of Calibration Function

b =	1.0347	a =	-0.0931
-----	--------	-----	---------

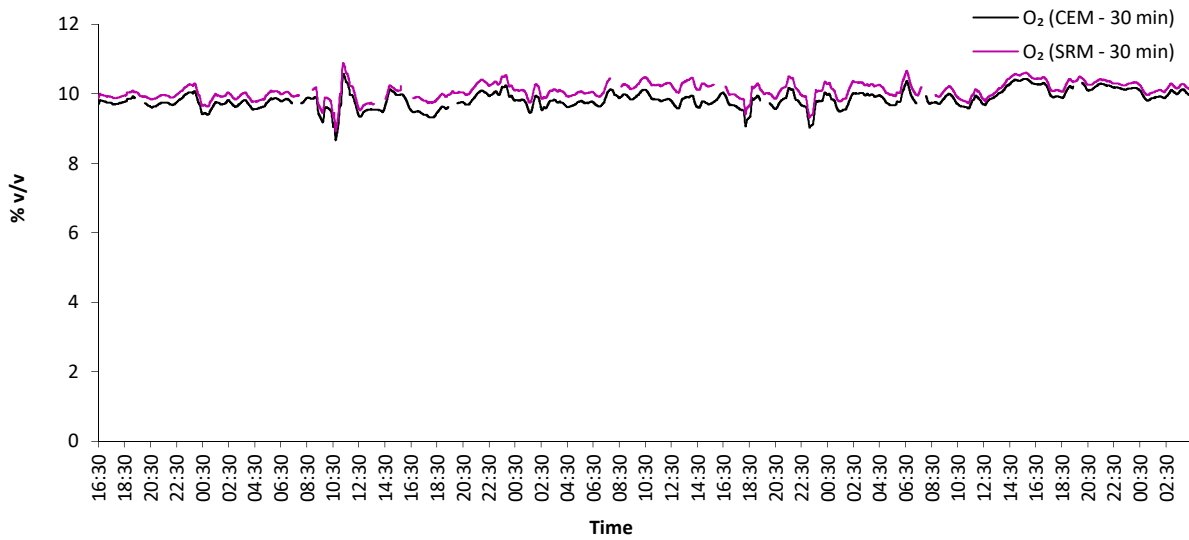
CALIBRATION FUNCTION =	y = 1.0347x - 0.0931
-------------------------------	-----------------------------

where

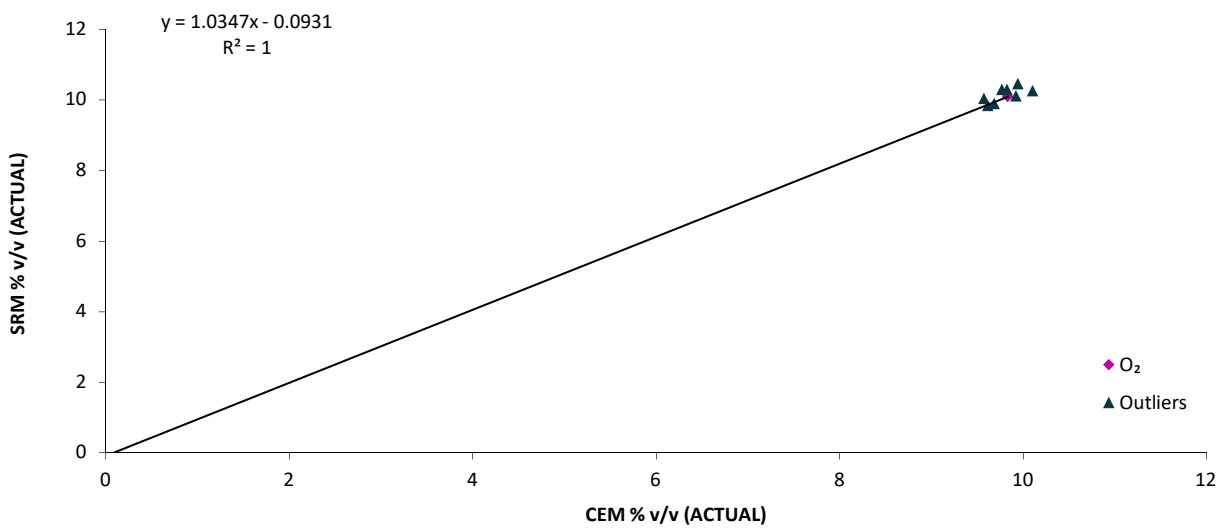
For Method A $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$

Method B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: GRAPH FOR STP SRM (WET) vs STP CEMS (WET) (30 minute rolling averages)



PLOT 2: Calibration Graph for Method B



Section 4A - Data and Calculations - QAL2

OXYGEN: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
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Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (DRY) % v/v	ys, SRM (DRY) % v/v	UNCAL CEM (WET) % v/v	ys, SRM - CAL CEM
L1	Surrogate	Near Zero	0.00	0.00	0.09	0.00
1	14/11/2023	17:02 - 17:32	11.20	11.11	9.77	-0.09
2	14/11/2023	18:02 - 18:32	11.11	11.03	9.72	-0.08
3	14/11/2023	19:02 - 19:32	11.25	11.17	9.87	-0.08
4	14/11/2023	21:02 - 21:32	11.20	11.18	9.68	-0.02
5	14/11/2023	23:02 - 23:32	11.36	11.32	9.93	-0.04
6	15/11/2023	00:02 - 00:32	11.31	11.27	9.92	-0.04
7	15/11/2023	01:02 - 01:32	10.89	10.91	9.46	0.02
8	15/11/2023	02:02 - 02:32	11.18	11.17	9.69	-0.01
9	15/11/2023	04:02 - 04:32	11.16	11.13	9.69	-0.03
10	15/11/2023	05:02 - 05:32	11.07	11.05	9.61	-0.02
11	15/11/2023	06:02 - 06:32	11.33	11.29	9.88	-0.05
12	15/11/2023	07:02 - 07:32	11.31	11.27	9.85	-0.04
13	15/11/2023	09:02 - 09:32	11.34	11.36	9.87	0.02
14	15/11/2023	10:02 - 10:32	10.94	10.98	9.61	0.04
15	15/11/2023	11:02 - 11:32	11.02	11.12	9.63	0.10
16	15/11/2023	12:02 - 12:32	11.33	11.32	9.93	-0.01
17	15/11/2023	13:02 - 13:32	11.04	11.00	9.52	-0.05
18	15/11/2023	15:02 - 15:32	11.67	11.52	10.08	-0.15
19	15/11/2023	17:02 - 17:32	10.87	11.06	9.50	0.19
20	15/11/2023	18:02 - 18:32	10.75	10.98	9.32	0.23
21	15/11/2023	19:02 - 19:32	11.06	11.18	9.62	0.12
22	15/11/2023	21:02 - 21:32	11.21	11.27	9.73	0.07
23	15/11/2023	22:02 - 22:32	11.54	11.59	10.08	0.05
24	15/11/2023	23:02 - 23:32	11.51	11.54	10.07	0.03
25	16/11/2023	00:02 - 00:32	11.31	11.37	9.92	0.05
26	16/11/2023	01:02 - 01:32	11.33	11.36	9.84	0.04
27	16/11/2023	02:02 - 02:32	11.39	11.47	9.92	0.08
28	16/11/2023	03:02 - 03:32	11.18	11.25	9.70	0.07
29	16/11/2023	04:02 - 04:32	11.21	11.32	9.74	0.11
30	16/11/2023	05:02 - 05:32	11.16	11.22	9.68	0.06
31	16/11/2023	06:02 - 06:32	11.20	11.24	9.74	0.03
32	16/11/2023	07:02 - 07:32	11.04	11.09	9.64	0.05
33	16/11/2023	09:02 - 09:32	11.35	11.39	9.97	0.04
34	16/11/2023	10:02 - 10:32	11.45	11.52	10.00	0.07
35	16/11/2023	11:02 - 11:32	11.30	11.47	9.85	0.17
36	16/11/2023	17:02 - 17:32	11.23	11.30	9.68	0.07
37	16/11/2023	18:02 - 18:32	11.01	11.10	9.52	0.09
38	16/11/2023	19:02 - 19:32	11.43	11.54	9.90	0.11
39	16/11/2023	21:02 - 21:32	11.39	11.48	9.83	0.09
40	16/11/2023	22:02 - 22:32	11.36	11.44	9.84	0.09
41	16/11/2023	23:02 - 23:32	10.68	10.70	9.21	0.02
42	17/11/2023	00:02 - 00:32	11.35	11.41	9.79	0.06
43	17/11/2023	01:02 - 01:32	11.32	11.36	9.79	0.04
44	17/11/2023	02:02 - 02:32	11.19	11.30	9.66	0.11
45	17/11/2023	03:02 - 03:32	11.57	11.62	10.02	0.06
46	17/11/2023	04:02 - 04:32	11.46	11.51	9.95	0.05
47	17/11/2023	05:02 - 05:32	11.21	11.27	9.74	0.06
48	17/11/2023	06:02 - 06:32	11.25	11.27	9.76	0.03
49	17/11/2023	07:02 - 07:32	11.31	11.31	9.88	0.00
50	17/11/2023	09:02 - 09:32	11.23	11.18	9.71	-0.05
51	17/11/2023	10:02 - 10:32	11.43	11.39	9.94	-0.04
52	17/11/2023	11:02 - 11:32	11.08	11.00	9.62	-0.08
53	17/11/2023	12:02 - 12:32	11.31	11.21	9.90	-0.10
54	17/11/2023	13:02 - 13:32	11.40	11.23	9.85	-0.16
55	17/11/2023	15:02 - 15:32	11.90	11.77	10.39	-0.12
56	17/11/2023	16:02 - 16:32	11.85	11.73	10.36	-0.12
57	17/11/2023	17:02 - 17:32	11.77	11.66	10.30	-0.11
58	17/11/2023	19:02 - 19:32	11.66	11.60	10.18	-0.06
59	17/11/2023	21:02 - 21:32	11.74	11.60	10.20	-0.14
60	17/11/2023	22:02 - 22:32	11.74	11.58	10.24	-0.16
61	17/11/2023	23:02 - 23:32	11.65	11.49	10.15	-0.16
62	18/11/2023	00:02 - 00:32	11.67	11.55	10.17	-0.12
63	18/11/2023	01:02 - 01:32	11.27	11.16	9.81	-0.10
64	18/11/2023	02:02 - 02:32	11.41	11.32	9.93	-0.08
65	18/11/2023	03:02 - 03:32	11.62	11.53	10.08	-0.10

Section 4A - Data and Calculations - QAL2

OXYGEN: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (DRY) % v/v	ys, SRM (DRY) % v/v	UNCAL CEM (WET) % v/v	ys, SRM - CAL CEM
66	18/11/2023	04:02 - 04:32	11.55	11.45	10.05	-0.10
67						
68						
69						
70						
71						
72						
73						
74						
75						
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
			MAX	AVERAGE	AVERAGE	Sd
			11.90	11.31	9.84	0.09

Test of Variability

$Q_0 = ELV \times (MU / 100) / 1.96$	1.07
Kv for 66 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_0 \times Kv$

Parameter	Value
Standard Deviation (Sd)	0.09
$Q_0 \times Kv$	1.06
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (% v/v)	11.9
Allowable Extension (%)	10

Valid Calibration Range	0 to 13.1 % v/v
--------------------------------	------------------------

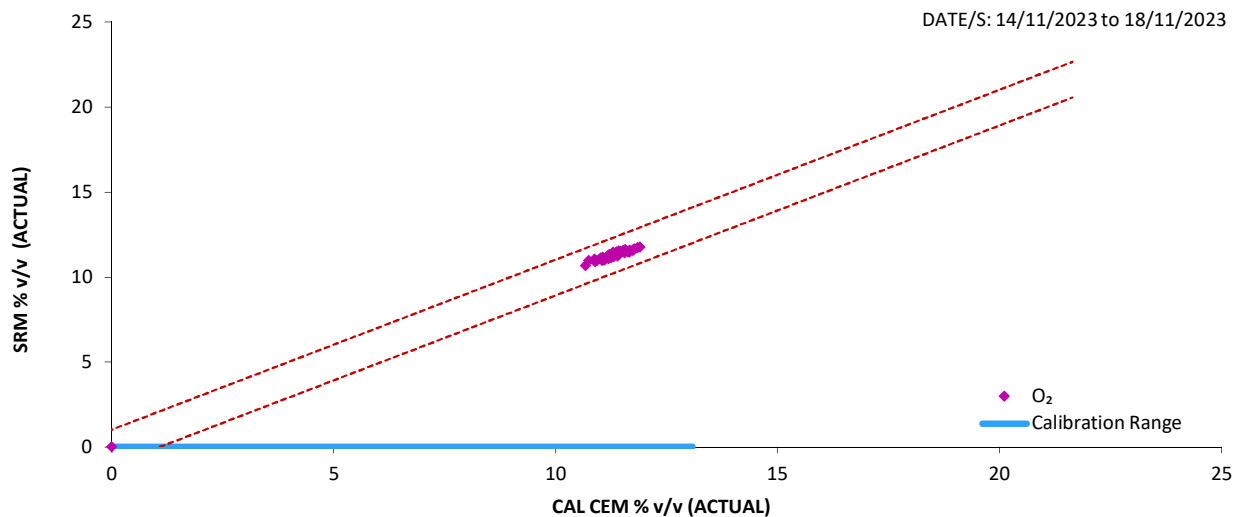
Section 4A - Data and Calculations - QAL2

OXYGEN: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
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PLOT 3: X-Y Plot - ACTUAL CAL CEM vs ACTUAL SRM Values



Section 4A - Data and Calculations - QAL2

CARBON DIOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (WET) % v/v	y, SRM (WET) % v/v	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (WET) % v/v
L1	Surrogate	Near Zero	N/A	N/A	N/A	N/A	N/A	N/A	N/A
1	14/11/2023	17:02 - 17:32	16.07	15.39	0.36	0.58	0.21	0.13	15.33
2	14/11/2023	18:02 - 18:32	16.23	15.64	0.52	0.83	0.43	0.27	15.56
3	14/11/2023	19:02 - 19:32	15.94	15.24	0.23	0.43	0.10	0.05	15.14
4	14/11/2023	21:02 - 21:32	15.87	15.19	0.17	0.38	0.06	0.03	15.05
5	14/11/2023	23:02 - 23:32	15.70	14.97	-0.01	0.16	0.00	0.00	14.80
6	15/11/2023	00:02 - 00:32	15.85	15.18	0.14	0.37	0.05	0.02	15.02
7	15/11/2023	01:02 - 01:32	16.39	15.85	0.68	1.04	0.71	0.47	15.79
8	15/11/2023	02:02 - 02:32	15.81	15.09	0.11	0.28	0.03	0.01	14.97
9	15/11/2023	04:02 - 04:32	15.91	15.21	0.20	0.40	0.08	0.04	15.10
10	15/11/2023	05:02 - 05:32	16.18	15.63	0.48	0.81	0.39	0.23	15.49
11	15/11/2023	06:02 - 06:32	15.82	15.17	0.12	0.35	0.04	0.01	14.98
12	15/11/2023	07:02 - 07:32	15.84	15.17	0.14	0.35	0.05	0.02	15.01
13	15/11/2023	09:02 - 09:32	15.71	15.03	0.01	0.21	0.00	0.00	14.83
14	15/11/2023	10:02 - 10:32	16.42	15.87	0.71	1.06	0.75	0.50	15.83
15	15/11/2023	11:02 - 11:32	16.58	15.84	0.87	1.03	0.90	0.76	16.06
16	15/11/2023	12:02 - 12:32	15.31	14.49	-0.40	-0.33	0.13	0.16	14.24
17	15/11/2023	13:02 - 13:32	15.51	14.68	-0.19	-0.13	0.03	0.04	14.54
18	15/11/2023	15:02 - 15:32	15.39	14.57	-0.32	-0.24	0.08	0.10	14.36
19	15/11/2023	18:02 - 18:32	16.44	15.93	0.74	1.12	0.82	0.54	15.87
20	15/11/2023	19:02 - 19:32	16.19	15.56	0.49	0.75	0.37	0.24	15.51
21	15/11/2023	21:02 - 21:32	15.80	15.00	0.09	0.18	0.02	0.01	14.95
22	15/11/2023	22:02 - 22:32	15.69	14.87	-0.02	0.05	0.00	0.00	14.79
23	15/11/2023	23:02 - 23:32	15.45	14.57	-0.26	-0.24	0.06	0.07	14.44
24	16/11/2023	00:02 - 00:32	15.90	15.10	0.20	0.28	0.06	0.04	15.10
25	16/11/2023	01:02 - 01:32	15.66	14.77	-0.04	-0.05	0.00	0.00	14.75
26	16/11/2023	02:02 - 02:32	15.75	14.87	0.05	0.06	0.00	0.00	14.88
27	16/11/2023	03:02 - 03:32	15.67	14.73	-0.03	-0.08	0.00	0.00	14.77
28	16/11/2023	04:02 - 04:32	15.87	15.02	0.17	0.20	0.03	0.03	15.06
29	16/11/2023	05:02 - 05:32	15.86	15.02	0.16	0.21	0.03	0.03	15.04
30	16/11/2023	06:02 - 06:32	16.04	15.28	0.34	0.47	0.16	0.11	15.29
31	16/11/2023	07:02 - 07:32	16.19	15.44	0.48	0.63	0.30	0.23	15.50
32	16/11/2023	09:02 - 09:32	15.66	14.78	-0.05	-0.04	0.00	0.00	14.74
33	16/11/2023	10:02 - 10:32	15.59	14.70	-0.12	-0.12	0.01	0.01	14.64
34	16/11/2023	11:02 - 11:32	15.98	15.23	0.27	0.42	0.11	0.07	15.20
35	16/11/2023	17:02 - 17:32	15.89	14.98	0.19	0.17	0.03	0.04	15.08
36	16/11/2023	18:02 - 18:32	16.01	15.19	0.30	0.38	0.12	0.09	15.25
37	16/11/2023	19:02 - 19:32	15.54	14.52	-0.16	-0.29	0.05	0.03	14.58
38	16/11/2023	21:02 - 21:32	15.36	14.31	-0.34	-0.51	0.17	0.12	14.32
39	16/11/2023	22:02 - 22:32	15.88	14.99	0.18	0.18	0.03	0.03	15.06
40	16/11/2023	23:02 - 23:32	16.25	15.43	0.55	0.62	0.34	0.30	15.60
41	17/11/2023	00:02 - 00:32	15.54	14.55	-0.17	-0.26	0.04	0.03	14.57
42	17/11/2023	01:02 - 01:32	15.64	14.66	-0.06	-0.16	0.01	0.00	14.72
43	17/11/2023	02:02 - 02:32	15.72	14.73	0.02	-0.09	0.00	0.00	14.84
44	17/11/2023	03:02 - 03:32	15.29	14.21	-0.41	-0.60	0.25	0.17	14.22
45	17/11/2023	04:02 - 04:32	15.49	14.37	-0.22	-0.45	0.10	0.05	14.50
46	17/11/2023	05:02 - 05:32	15.90	14.97	0.19	0.16	0.03	0.04	15.09
47	17/11/2023	06:02 - 06:32	15.75	14.81	0.05	-0.01	0.00	0.00	14.88
48	17/11/2023	07:02 - 07:32	15.98	15.10	0.28	0.28	0.08	0.08	15.21
49	17/11/2023	09:02 - 09:32	15.51	14.47	-0.19	-0.34	0.07	0.04	14.54
50	17/11/2023	10:02 - 10:32	15.56	14.58	-0.15	-0.24	0.03	0.02	14.61
51	17/11/2023	11:02 - 11:32	16.10	15.25	0.40	0.43	0.17	0.16	15.38
52	17/11/2023	12:02 - 12:32	15.94	14.98	0.24	0.16	0.04	0.06	15.16
53	17/11/2023	13:02 - 13:32	15.29	14.15	-0.42	-0.66	0.27	0.17	14.22
54	17/11/2023	15:02 - 15:32	14.80	13.66	-0.90	-1.15	1.04	0.82	13.52
55	17/11/2023	16:02 - 16:32	14.92	13.73	-0.78	-1.08	0.85	0.61	13.69
56	17/11/2023	17:02 - 17:32	14.96	13.79	-0.75	-1.02	0.76	0.56	13.75
57	17/11/2023	19:02 - 19:32	15.13	13.93	-0.58	-0.88	0.51	0.33	13.99
58	17/11/2023	21:02 - 21:32	15.00	13.75	-0.71	-1.07	0.75	0.50	13.80
59	17/11/2023	22:02 - 22:32	15.21	13.98	-0.50	-0.84	0.42	0.25	14.10
60	17/11/2023	23:02 - 23:32	15.24	14.02	-0.47	-0.80	0.37	0.22	14.14
61	18/11/2023	00:02 - 00:32	15.21	14.00	-0.49	-0.81	0.40	0.24	14.11
62	18/11/2023	01:02 - 01:32	15.64	14.55	-0.07	-0.26	0.02	0.00	14.71
63	18/11/2023	02:02 - 02:32	15.54	14.41	-0.16	-0.40	0.07	0.03	14.58
64	18/11/2023	03:02 - 03:32	15.09	13.83	-0.62	-0.99	0.61	0.38	13.93
65	18/11/2023	04:02 - 04:32	15.16	13.88	-0.55	-0.93	0.51	0.30	14.03

Section 4A - Data and Calculations - QAL2

CARBON DIOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (WET) % v/v	y, SRM (WET) % v/v	$x - x_{av}$ (A)	$y - y_{av}$ (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (WET) % v/v	
66										
67										
68										
69										
70										
71										
72										
73										
74										
75										
76										
77										
78										
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81										
82										
83										
84										
85										
86										
87										
88										
89										
90										
MAX SRM - MIN SRM				2.27			SUM	14.16	9.90	
(DAILY) DELV (% v/v)				17						
95% CI MU (%)				10						
95% CI at DELV (% v/v)				1.7						
PROCEDURE (A OR B)				A						

PROCEDURE A If (MAX SRM - MIN SRM) > 95% CI at Daily ELV
PROCEDURE B If (MAX SRM - MIN SRM) < 95% CI at Daily ELV and MIN SRM ≥ 15% of Daily ELV

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (WET) % v/v	y, SRM (WET) % v/v	Reason for Data Pair Removal
(Statistical Outliers removed following outlier test, other data removed prior to this test)					
1	14/11/2023	20:02 - 20:32	0.00	15.12	Instrument performing an auto-zero
2	15/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
3	15/11/2023	14:02 - 14:32	15.48	0.00	SRM offline/calibrating
4	15/11/2023	16:02 - 16:32	16.04	0.00	SRM offline/calibrating
5	15/11/2023	20:02 - 20:32	0.00	15.15	Instrument performing an auto-zero
6	16/11/2023	08:02 - 08:32	15.48	0.00	SRM offline/calibrating
7	16/11/2023	16:02 - 16:32	15.27	0.00	SRM offline/calibrating
8	16/11/2023	20:02 - 20:32	0.00	14.69	Instrument performing an auto-zero
9	17/11/2023	08:02 - 08:32	0.00	0.00	Instrument performing an auto-zero & SRM offline/calibrating
10	17/11/2023	20:02 - 20:32	0.00	13.85	Instrument performing an auto-zero
11	14/11/2023	22:02 - 22:32	15.90	15.22	Peripheral data outliers (Water Vapour)
12	15/11/2023	03:02 - 03:32	15.87	15.17	Peripheral data outliers (Water Vapour)
13	17/11/2023	14:02 - 14:32	15.19	14.07	Peripheral data outliers (Water Vapour)
14	17/11/2023	18:02 - 18:32	15.66	14.63	Peripheral data outliers (Water Vapour)
15	16/11/2023	12:02 - 12:32	15.55	14.62	Peripheral data outliers (Oxygen)
16	16/11/2023	13:02 - 13:32	15.90	15.11	Peripheral data outliers (Oxygen)
17	16/11/2023	14:02 - 14:32	15.55	14.55	Peripheral data outliers (Oxygen)
18	16/11/2023	15:02 - 15:32	15.34	14.23	Peripheral data outliers (Oxygen)
19	15/11/2023	17:02 - 17:32	16.57	16.11	Statistical outlier
20					
21					
22					
23					
24					
25					

Section 4A - Data and Calculations - QAL2

CARBON DIOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
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Derivation of Calibration Function

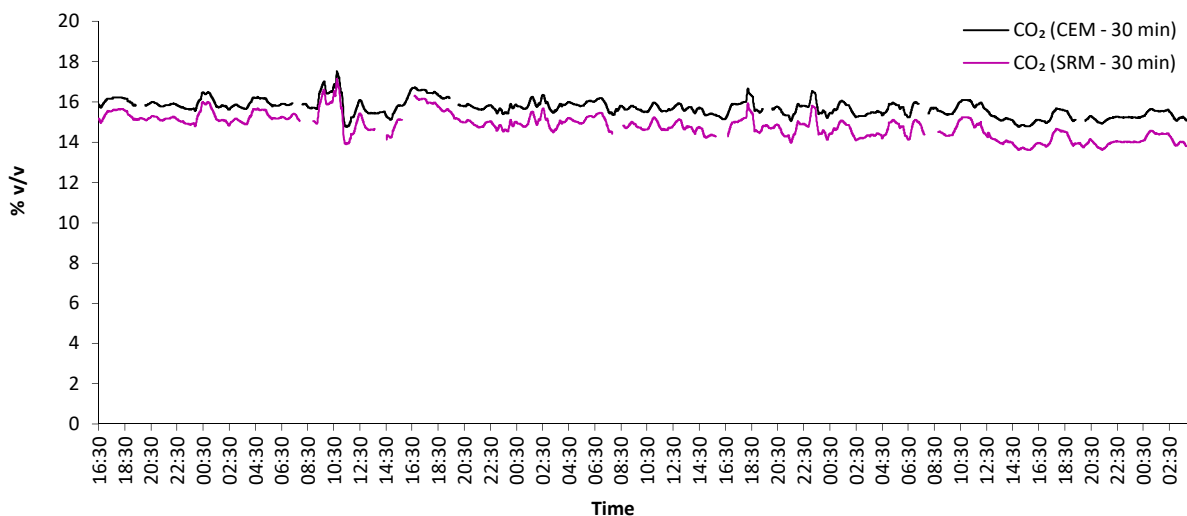
b =	1.4304	a =	-7.6508
-----	--------	-----	---------

CALIBRATION FUNCTION =	y = 1.4304x - 7.6508
-------------------------------	-----------------------------

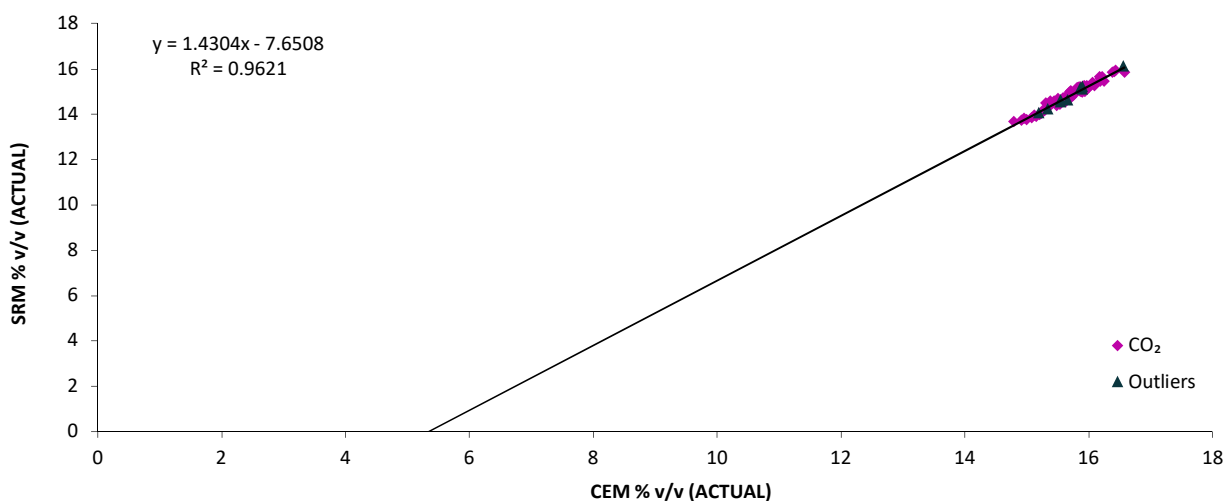
where

For Method A $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$
 Method B $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: GRAPH FOR STP SRM (WET) vs STP CEMS (WET) (30 minute rolling averages)



PLOT 2: Calibration Graph for Method A



Section 4A - Data and Calculations - QAL2

CARBON DIOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
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Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (WET) % v/v	ys, SRM (WET) % v/v	UNCAL CEM (WET) % v/v	ys, SRM - CAL CEM
L1	Surrogate	Near Zero	N/A	N/A	N/A	N/A
1	14/11/2023	17:02 - 17:32	15.33	15.39	16.07	0.06
2	14/11/2023	18:02 - 18:32	15.56	15.64	16.23	0.08
3	14/11/2023	19:02 - 19:32	15.14	15.24	15.94	0.10
4	14/11/2023	21:02 - 21:32	15.05	15.19	15.87	0.14
5	14/11/2023	23:02 - 23:32	14.80	14.97	15.70	0.17
6	15/11/2023	00:02 - 00:32	15.02	15.18	15.85	0.16
7	15/11/2023	01:02 - 01:32	15.79	15.85	16.39	0.06
8	15/11/2023	02:02 - 02:32	14.97	15.09	15.81	0.12
9	15/11/2023	04:02 - 04:32	15.10	15.21	15.91	0.11
10	15/11/2023	05:02 - 05:32	15.49	15.63	16.18	0.13
11	15/11/2023	06:02 - 06:32	14.98	15.17	15.82	0.19
12	15/11/2023	07:02 - 07:32	15.01	15.17	15.84	0.16
13	15/11/2023	09:02 - 09:32	14.83	15.03	15.71	0.20
14	15/11/2023	10:02 - 10:32	15.83	15.87	16.42	0.04
15	15/11/2023	11:02 - 11:32	16.06	15.84	16.58	-0.22
16	15/11/2023	12:02 - 12:32	14.24	14.49	15.31	0.24
17	15/11/2023	13:02 - 13:32	14.54	14.68	15.51	0.15
18	15/11/2023	15:02 - 15:32	14.36	14.57	15.39	0.21
19	15/11/2023	18:02 - 18:32	15.87	15.93	16.44	0.06
20	15/11/2023	19:02 - 19:32	15.51	15.56	16.19	0.05
21	15/11/2023	21:02 - 21:32	14.95	15.00	15.80	0.05
22	15/11/2023	22:02 - 22:32	14.79	14.87	15.69	0.08
23	15/11/2023	23:02 - 23:32	14.44	14.57	15.45	0.13
24	16/11/2023	00:02 - 00:32	15.10	15.10	15.90	0.00
25	16/11/2023	01:02 - 01:32	14.75	14.77	15.66	0.02
26	16/11/2023	02:02 - 02:32	14.88	14.87	15.75	-0.01
27	16/11/2023	03:02 - 03:32	14.77	14.73	15.67	-0.04
28	16/11/2023	04:02 - 04:32	15.06	15.02	15.87	-0.04
29	16/11/2023	05:02 - 05:32	15.04	15.02	15.86	-0.02
30	16/11/2023	06:02 - 06:32	15.29	15.28	16.04	-0.01
31	16/11/2023	07:02 - 07:32	15.50	15.44	16.19	-0.06
32	16/11/2023	09:02 - 09:32	14.74	14.78	15.66	0.03
33	16/11/2023	10:02 - 10:32	14.64	14.70	15.59	0.05
34	16/11/2023	11:02 - 11:32	15.20	15.23	15.98	0.03
35	16/11/2023	17:02 - 17:32	15.08	14.98	15.89	-0.10
36	16/11/2023	18:02 - 18:32	15.25	15.19	16.01	-0.05
37	16/11/2023	19:02 - 19:32	14.58	14.52	15.54	-0.06
38	16/11/2023	21:02 - 21:32	14.32	14.31	15.36	-0.02
39	16/11/2023	22:02 - 22:32	15.06	14.99	15.88	-0.07
40	16/11/2023	23:02 - 23:32	15.60	15.43	16.25	-0.17
41	17/11/2023	00:02 - 00:32	14.57	14.55	15.54	-0.02
42	17/11/2023	01:02 - 01:32	14.72	14.66	15.64	-0.06
43	17/11/2023	02:02 - 02:32	14.84	14.73	15.72	-0.11
44	17/11/2023	03:02 - 03:32	14.22	14.21	15.29	-0.01
45	17/11/2023	04:02 - 04:32	14.50	14.37	15.49	-0.14
46	17/11/2023	05:02 - 05:32	15.09	14.97	15.90	-0.12
47	17/11/2023	06:02 - 06:32	14.88	14.81	15.75	-0.08
48	17/11/2023	07:02 - 07:32	15.21	15.10	15.98	-0.12
49	17/11/2023	09:02 - 09:32	14.54	14.47	15.51	-0.07
50	17/11/2023	10:02 - 10:32	14.61	14.58	15.56	-0.03
51	17/11/2023	11:02 - 11:32	15.38	15.25	16.10	-0.13
52	17/11/2023	12:02 - 12:32	15.16	14.98	15.94	-0.18
53	17/11/2023	13:02 - 13:32	14.22	14.15	15.29	-0.06
54	17/11/2023	15:02 - 15:32	13.52	13.66	14.80	0.15
55	17/11/2023	16:02 - 16:32	13.69	13.73	14.92	0.04
56	17/11/2023	17:02 - 17:32	13.75	13.79	14.96	0.05
57	17/11/2023	19:02 - 19:32	13.99	13.93	15.13	-0.05
58	17/11/2023	21:02 - 21:32	13.80	13.75	15.00	-0.06
59	17/11/2023	22:02 - 22:32	14.10	13.98	15.21	-0.12
60	17/11/2023	23:02 - 23:32	14.14	14.02	15.24	-0.13
61	18/11/2023	00:02 - 00:32	14.11	14.00	15.21	-0.11
62	18/11/2023	01:02 - 01:32	14.71	14.55	15.64	-0.16
63	18/11/2023	02:02 - 02:32	14.58	14.41	15.54	-0.16
64	18/11/2023	03:02 - 03:32	13.93	13.83	15.09	-0.10
65	18/11/2023	04:02 - 04:32	14.03	13.88	15.16	-0.15

Section 4A - Data and Calculations - QAL2

CARBON DIOXIDE: QAL2 CALCULATIONS

(Page 5 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (WET) % v/v	ys, SRM (WET) % v/v	UNCAL CEM (WET) % v/v	ys, SRM - CAL CEM
66						
67						
68						
69						
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77						
78						
79						
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88						
89						
90						
			MAX	AVERAGE	AVERAGE	Sd
			16.06	14.81	15.70	0.11

Test of Variability

$Q_0 = ELV \times (MU / 100) / 1.96$	0.87
Kv for 65 Pairs of Data	0.9885

The variability is accepted if $Sd \leq Q_0 \times Kv$

Parameter	Value
Standard Deviation (Sd)	0.11
$Q_0 \times Kv$	0.86
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (% v/v)	16.1
Allowable Extension (%)	10

Valid Calibration Range	0 to 17.7 % v/v
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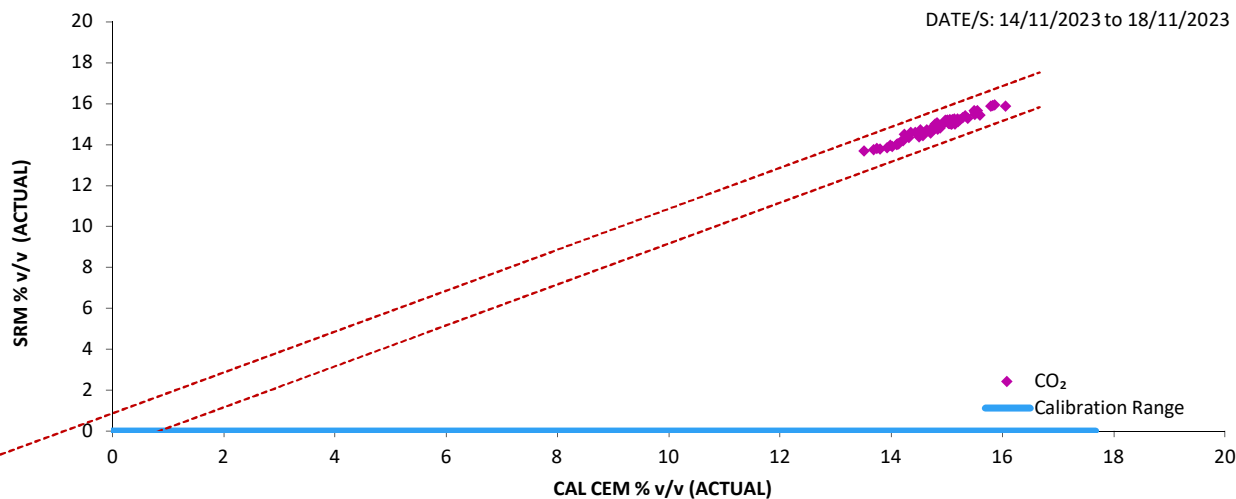
Section 4A - Data and Calculations - QAL2

CARBON DIOXIDE: QAL2 CALCULATIONS

(Page 6 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

PLOT 3: X-Y Plot - ACTUAL CAL CEM vs ACTUAL SRM Values



Section 4A - Data and Calculations - QAL2

VOLUME FLOW RATE: QAL2 CALCULATIONS

(Page 1 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data

Pair	Date	Time (20-minute Average)	x, CEM (ACTUAL) m ³ /s	y, SRM (ACTUAL) m ³ /s	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (ACTUAL) m ³ /s
1	15/11/2023	15:45 - 16:05	73.53	61.20	-8.96	-6.51	58.33	80.29	60.38
2	16/11/2023	10:24 - 10:44	79.00	61.55	-3.49	-6.16	21.52	12.18	64.87
3	16/11/2023	13:25 - 13:45	81.12	63.77	-1.37	-3.94	5.39	1.87	66.62
4	16/11/2023	14:30 - 14:50	79.91	61.73	-2.58	-5.98	15.43	6.65	65.62
5	16/11/2023	15:31 - 15:51	81.59	63.99	-0.90	-3.73	3.36	0.81	67.00
6	17/11/2023	08:35 - 08:55	85.07	70.28	2.58	2.56	6.61	6.66	69.86
7	17/11/2023	08:59 - 09:19	85.28	71.85	2.79	4.14	11.56	7.80	70.03
8	17/11/2023	09:22 - 09:42	85.38	71.42	2.89	3.71	10.71	8.33	70.11
9	17/11/2023	09:46 - 10:06	83.33	71.44	0.84	3.73	3.11	0.70	68.42
10	17/11/2023	10:10 - 10:30	81.60	69.79	-0.89	2.08	-1.84	0.79	67.01
11	17/11/2023	10:33 - 10:53	82.81	68.52	0.32	0.81	0.26	0.11	68.01
12	17/11/2023	10:57 - 11:17	83.63	68.41	1.14	0.70	0.80	1.30	68.68
13	17/11/2023	11:20 - 11:40	86.39	69.82	3.90	2.10	8.21	15.25	70.95
14	17/11/2023	11:44 - 12:04	83.88	71.49	1.39	3.78	5.24	1.92	68.88
15	17/11/2023	12:09 - 12:29	84.82	70.43	2.33	2.72	6.34	5.45	69.66
16									
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21									
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Section 4A - Data and Calculations - QAL2

VOLUME FLOW RATE: QAL2 CALCULATIONS

(Page 2 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Calibration Data (continued)

Pair	Date	Time (20-minute Average)	x, CEM (ACTUAL) m ³ /s	y, SRM (ACTUAL) m ³ /s	x - x _{av} (A)	y - y _{av} (B)	(A) x (B)	(x - x _{av}) ²	CAL CEM (ACTUAL) m ³ /s	
66										
67										
68										
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70										
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90										
			MAX SRM - MIN SRM	10.65			SUM	155.04	150.11	
			EFFECTIVE ELV (m ³ /s)	86.2						
			95% CI MU (%)	10.0			PROCEDURE A	If (MAX SRM - MIN SRM) ≥ 30% of MAX SRM		
			30% of EFFECTIVE ELV	21.6			PROCEDURE D	If (MAX SRM - MIN SRM) < 30% of MAX SRM		
			PROCEDURE (A OR D)	D			WHERE OFFSET = 0			

The Effective ELV is 120% of the Maximum SRM measured value

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (WET) m ³ /s	y, SRM (WET) m ³ /s	Reason for Data Pair Removal
(Statistical Outliers removed following outlier test, other data removed prior to this test)					
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24					
25					

Section 4A - Data and Calculations - QAL2

VOLUME FLOW RATE: QAL2 CALCULATIONS

(Page 3 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Derivation of Calibration Function

b =	0.8212	a =	0.0000
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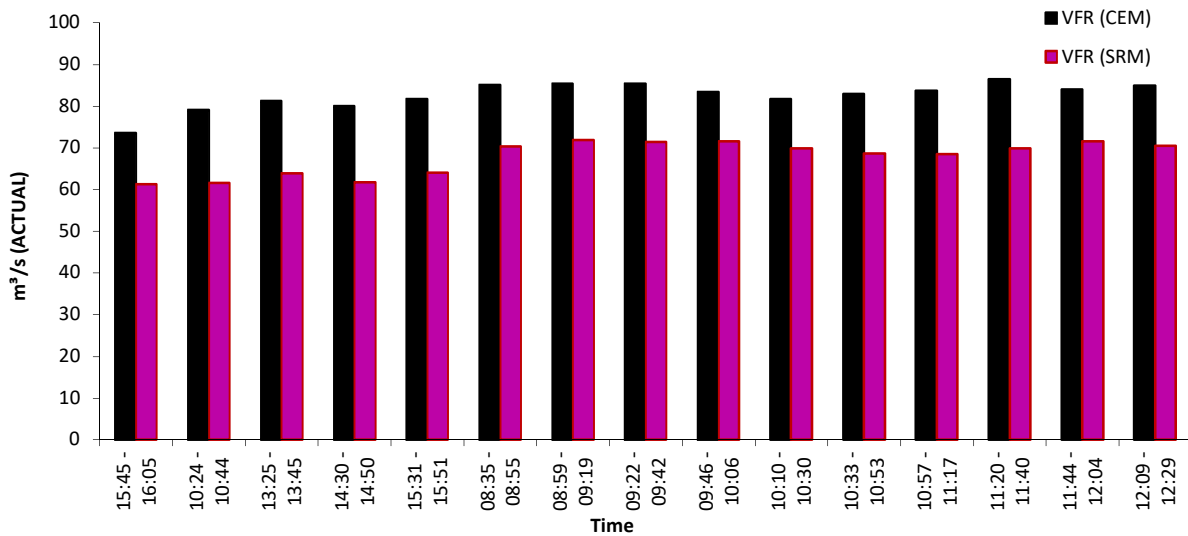
CALIBRATION FUNCTION =	y = 0.8212x + 0.0000
-------------------------------	-----------------------------

where

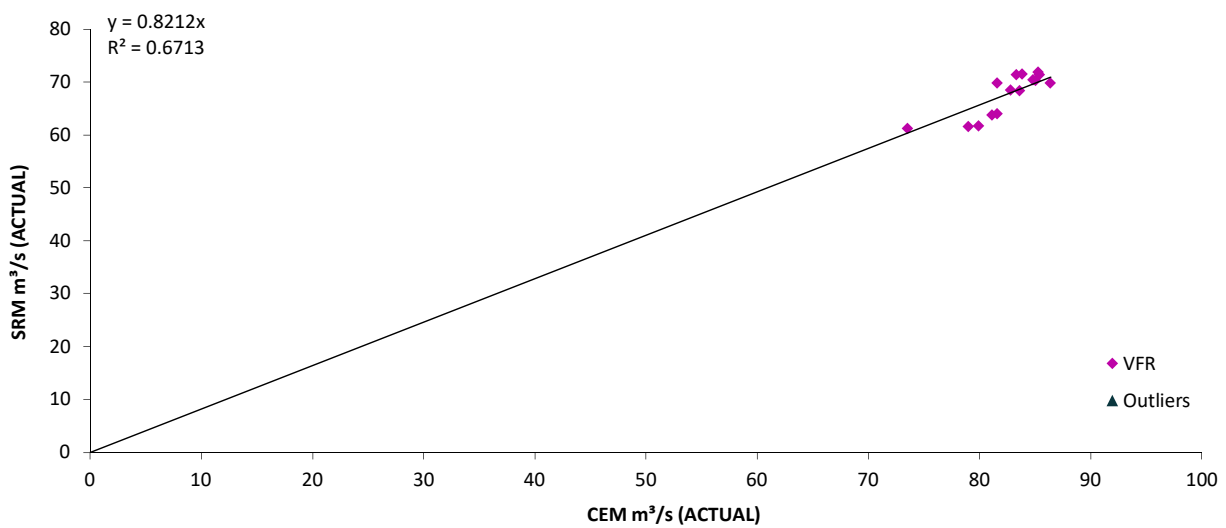
For Method A $b = [(x - x_{av}) \times (y - y_{av})] / (x - x_{av})^2$ and $a = \text{MEAN}(y) - [\text{MEAN}(x) \times b]$ (note: the linear regression line has been forced through the datum)

Method D $b = \text{MEAN}(y) / [\text{MEAN}(x) - \text{OFFSET}]$ and $a = -b \times \text{OFFSET}$

PLOT 1: BAR CHART FOR SRM vs CEM (20 minute averages)



PLOT 2: Calibration Graph for Procedure D



Section 4A - Data and Calculations - QAL2

VOLUME FLOW RATE: QAL2 CALCULATIONS

(Page 4 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data

Pair	Date	Time (20-minute Average)	CAL CEM (ACTUAL)	ys, SRM (ACTUAL) m ³ /s	UNCAL CEM (ACTUAL) m ³ /s	ys, SRM - CAL CEM
1	15/11/2023	15:45 - 16:05	60.38	61.20	73.53	0.82
2	16/11/2023	10:24 - 10:44	64.87	61.55	79.00	-3.32
3	16/11/2023	13:25 - 13:45	66.62	63.77	81.12	-2.84
4	16/11/2023	14:30 - 14:50	65.62	61.73	79.91	-3.89
5	16/11/2023	15:31 - 15:51	67.00	63.99	81.59	-3.01
6	17/11/2023	08:35 - 08:55	69.86	70.28	85.07	0.42
7	17/11/2023	08:59 - 09:19	70.03	71.85	85.28	1.82
8	17/11/2023	09:22 - 09:42	70.11	71.42	85.38	1.31
9	17/11/2023	09:46 - 10:06	68.42	71.44	83.33	3.02
10	17/11/2023	10:10 - 10:30	67.01	69.79	81.60	2.78
11	17/11/2023	10:33 - 10:53	68.01	68.52	82.81	0.52
12	17/11/2023	10:57 - 11:17	68.68	68.41	83.63	-0.26
13	17/11/2023	11:20 - 11:40	70.95	69.82	86.39	-1.13
14	17/11/2023	11:44 - 12:04	68.88	71.49	83.88	2.61
15	17/11/2023	12:09 - 12:29	69.66	70.43	84.82	0.77
16						
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Section 4A - Data and Calculations - QAL2

VOLUME FLOW RATE: QAL2 CALCULATIONS

(Page 5 of 6)

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Variability Test Data (continued)

Pair	Date	Time (20-minute Average)	CAL CEM (ACTUAL) m ³ /s	ys, SRM (ACTUAL) m ³ /s	UNCAL CEM (ACTUAL) m ³ /s	ys, SRM - CAL CEM
66						
67						
68						
69						
70						
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86						
87						
88						
89						
90						
			MAX	AVERAGE	AVERAGE	Sd
			70.95	67.71	82.49	2.32

Test of Variability

$Q_0 = ELV \times (MU / 100) / 1.96$	8.62
Kv for 15 Pairs of Data	0.9761

The variability is accepted if $Sd \leq Q_0 \times Kv$

Parameter	Value
Standard Deviation (Sd)	2.32
$Q_0 \times Kv$	8.42
Outcome of Variability Test	Pass

Valid Calibration Range

Maximum CAL CEM Value (m ³ /s)	70.9
Allowable Extension (%)	20

Valid Calibration Range	0 to 85.1 m³/s
--------------------------------	----------------------------------

Test of R²

Parameter	Value
Spread of AMS	14.89%
Spread of SRM	14.82%
R ²	0.6714
Outcome of Variability Test	N/A

R² should be >0.9, unless the spread of both AMS and SRM data are <15%, then the test is not required.

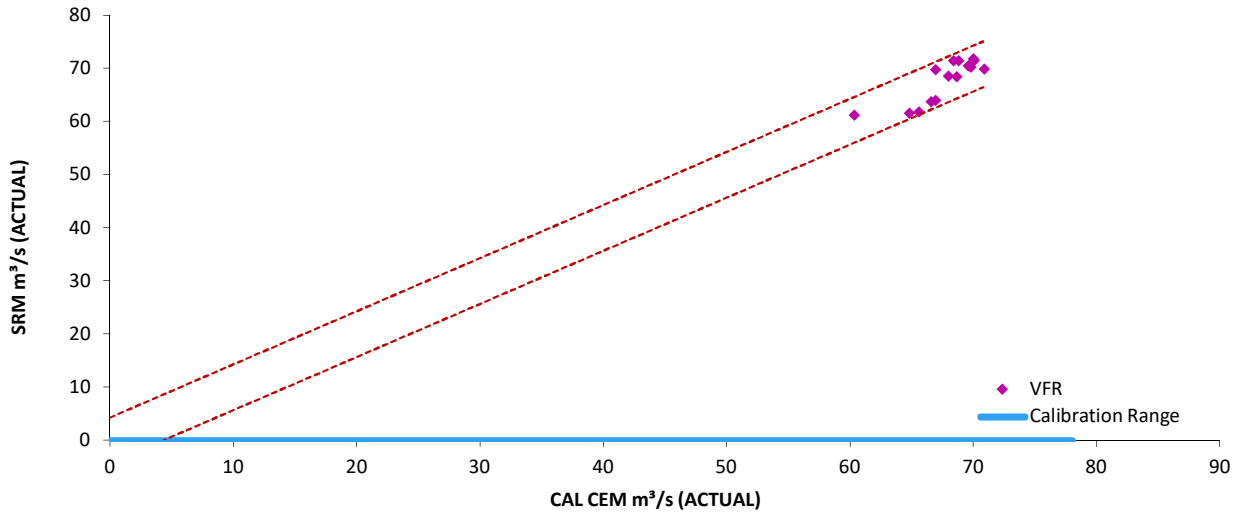
Section 4A - Data and Calculations - QAL2

VOLUME FLOW RATE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

PLOT 3: X-Y Plot - ACTUAL CAL CEM vs ACTUAL SRM Values



Section 5 - Results of the Functional Checks

FUNCTIONAL CHECKS OF CEM

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Duty Analyser]

Description of Functional Checks / Equipment Used for Linearity of Total Particulate Matter CEM

Before performing the parallel measurements, Element's Engineer checked the Data Acquisition Handling Software (DAHS) PC and noted that the readings looked "sensible" and no flatlining or repeating zeros were being output, giving an added confidence that the analyser was working correctly.

Reference Materials Available on Site

Parameter	QAL3 Check Gas	Concentration (mg/m ³ / %)	QAL3 Check Gas Supplier	Cylinder Number	Cylinder Expiry Date	Certified Accuracy
Total VOCs	C ₃ H ₈	See appended ABB service / linearity report				
Nitrogen Monoxide	NO					
Nitrogen Dioxide	NO ₂					
Sulphur Dioxide	SO ₂					
Carbon Monoxide	CO					
Hydrogen Chloride	HCl					
Hydrogen Fluoride	HF					
Ammonia	NH ₃					
Water Vapour	H ₂ O					
Oxygen	O ₂					
Carbon Dioxide	CO ₂					
Zero Gas	AIR					

CEM Checks

Parameter	Analyser System Check				Sampling Line System Check			
	Gas Conc. (mg/m ³ / %)	Zero (mg/m ³ / %)	Span (mg/m ³ / %)	Response (T ₉₀ - secs)	Gas Conc. (mg/m ³ / %)	Zero (mg/m ³ / %)	Span (mg/m ³ / %)	Response (T ₉₀ - secs)
Total VOCs	See appended ABB service / linearity report				Not completed			
Nitrogen Monoxide								
Nitrogen Dioxide								
Sulphur Dioxide								
Carbon Monoxide								
Hydrogen Chloride								
Hydrogen Fluoride								
Ammonia								
Water Vapour								
Oxygen								
Carbon Dioxide								

PRO-FORMA FOR ASSESSING AND REPORTING THE RESULTS OF THE FUNCTIONAL TESTS

(Page 1 of 4)

Functional Checks Performed By	Eduardo Albor
Date/s Functional Checks Performed	17th - 25th October 2023

1. Alignment and Cleanliness (Non-Extractive CEMs Only)		
Requirement	Performed	Notes
A visual inspection, with reference to the CEMs manuals, shall be carried out on the following when applicable:		
Internal check of the CEM.	No	Service report has not been seen by Element
Cleanliness of the optical components.	No	Service report has not been seen by Element
Flushing air supply.	No	Service report has not been seen by Element
Optical path free from obstructions.	No	Service report has not been seen by Element
After re-assembly at the measurement location, at least the following shall be checked:		
Alignment of the measuring system.	No	Service report has not been seen by Element
Contamination control (internal check of optical surfaces).	No	Service report has not been seen by Element

2. Sampling System (Extractive CEMs Only)		
Requirement	Performed	Notes
A visual inspection of the sampling system shall be performed, noting the condition of the following components, when fitted:		
Sampling probe.	No	No mention in the Service report
Gas conditioning systems.	No	No mention in the Service report
Pumps.	No	No mention in the Service report
All connections.	No	No mention in the Service report
Sample lines.	No	No mention in the Service report
Power supplies.	No	No mention in the Service report
Filters.	No	No mention in the Service report
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 the data.	No	No mention in the Service report

3. Leak testing		
Requirement	Performed	Notes
Leak Testing shall be performed according to the CEMs manuals. The test shall cover the entire sampling system.	No	See Section 5 of the Test Report - "CEMs Checks" for the results of the leak check.

4. Zero and Span Check		
Requirement	Performed	Notes
Reference zero and span materials shall be used to verify the corresponding readings of the CEMs. Ensure the reading on the DAHS Computer reflects the reading on the screen of the CEMs Analyser/s.	Yes	See Section 5 of the Test Report - "CEMs Checks" for the results of the zero and span checks. The reading on the DAHS was cross-referenced with the CEMs screen to ensure the logged reading was correct.

PRO-FORMA FOR ASSESSING AND REPORTING THE RESULTS OF THE FUNCTIONAL TESTS

(Page 2 of 4)

4. Zero and Span Check (continued)		
Requirement	Performed	Notes
For non-extractive CEMs, 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.	No	See Section 5 of the Test Report - "CEMs Checks" for the results of the zero and span checks. The reading on the DAHS was cross-referenced with the CEMs screen to ensure the logged reading was correct.

5. Linearity		
Requirement	Performed	Notes
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 be included in the instrument service report.	Yes	See appended Linearity Report
The linearity of the CEM response shall be checked using five different reference materials, including a zero concentration.	Yes	See appended Linearity Report
The reference material with zero concentration, as well as the reference materials with four different concentrations, shall have a verifiable quantity and quality.	Yes	See Section 5 of the Test Report - "Reference Materials Used for CEMs Linearity Checks".
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. The uncertainty must be $\leq 2\%$ and	Yes	See appended Linearity Report
The reference material concentrations shall be selected such that the measured values are at approximately 20%, 40%, 60% and 80% of the 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 test does not occur. The dry test reference material shall be applied to the inlet of the CEM. (i.e. not down the line)	Yes	See appended Linearity Report
The individual CEMs are tested using the following concentrations applied in a randomised sequence:		
Reference material with zero concentration	Yes	See appended Linearity Report
Reference material concentration approximately 20% of the range (i.e. the short-term ELV)	Yes	See appended Linearity Report
Reference material concentration approximately 40% of the range (i.e. the short-term ELV)	Yes	See appended Linearity Report
Reference material concentration approximately 60% of the range (i.e. the short-term ELV)	Yes	See appended Linearity Report
Reference material concentration approximately 80% of the range (i.e. the short-term ELV)	Yes	See appended Linearity Report
Reference material with zero concentration	Yes	See appended Linearity Report

6. Interferences		
Requirement	Performed	Notes
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.	No	No mention in the Service report

PRO-FORMA FOR ASSESSING AND REPORTING THE RESULTS OF THE FUNCTIONAL TESTS

(Page 3 of 4)

7. Zero and Span Drift Audit		
Requirement	Performed	Notes
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 documented procedure, (ii) zero and span data, (iii) control charts.	Yes	Procedure in place, carried out monthly and recorded.

8. Response Time		
Requirement	Performed	Notes
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. (i.e. 200 seconds)	No	Parameter specific response times can be found in the Zero and Span Gas Functional Test Table (above).

9. Service Report (THIS IS AN AUDIT OF THE SERVICE REPORT, STATE IF THE REQUIRED INFO IS PRESENT OR NOT IN THE SERVICE REPORT)		
Requirement	Performed	Notes
As a minimum requirement the service report should include the following:		
Document reference for work instruction for the type of work being undertaken.	Yes	See appended Service / Linearity Report
Instrument manufacturer.	Yes	See appended Service / Linearity Report
Instrument type.	Yes	See appended Service / Linearity Report
Instrument model.	Yes	See appended Service / Linearity Report
Instrument serial no.	Yes	See appended Service / Linearity Report
Operating principle.	Yes	See appended Service / Linearity Report
Operating range.	Yes	See appended Service / Linearity Report
Certification details.	No	
Compliance with MCERTS. (including certificate no.)	Yes	See appended Service / Linearity Report
Location.	Yes	See appended Service / Linearity Report
Date and time work was undertaken.	Yes	See appended Service / Linearity Report
Equipment used - type, serial no's, calibration dates.	Yes	See appended Service / Linearity Report
Gases used - certificate no's, expiry dates, binary or mixture.	Yes	See appended Service / Linearity Report
Calibration and linearity data as required by EN14181.	Yes	See appended Service / Linearity Report
Logged data for the period of calibration and linearity. NOTE: There may be gaps in the data, 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.	Yes	See appended Service / Linearity Report
Name and signature of the service engineer present on the service report?	Yes	See appended Service / Linearity Report

PRO-FORMA FOR ASSESSING AND REPORTING THE RESULTS OF THE FUNCTIONAL TESTS

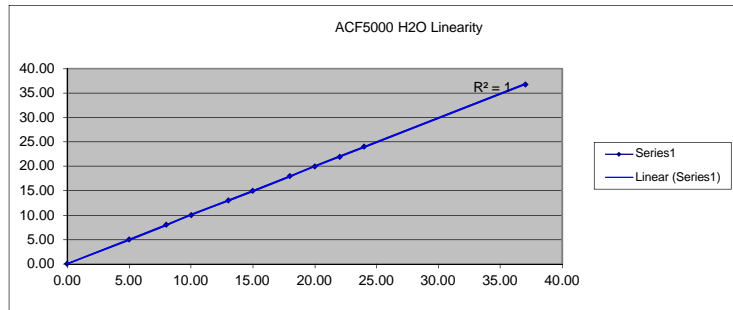
(Page 4 of 4)

10. Documentation and Records		
Requirement	Available	Notes
A plan of the CEM.	Yes	
All manuals (maintenance, users, etc).	Yes	
Log books to document possible malfunctions and action taken.	Yes	
Service reports.	Yes	
QAL3 documentation including actions taken as a result of out of control situations.	Yes	
Management system procedures for maintenance, calibration and training.	Yes	
Training records.	Yes	
Maintenance schedules.	Yes	
Auditing plans and records - evidence that the operator includes the procedures for the management of the CEMs within the auditing cycle of the management system.	Yes	
Existing instrument calibration functions / gain factors.	Yes	
Documentation and records audit completed and validated prior to commencing SRM testing.	Yes	

Version Number	Record of changes made within this version of the document
V1	The original document issued to the client
V2	Fuel and Abatement type updated at client request to include SRF and Lime Injection

H2O				Seial No: F.3.374483.7	
Concentration		Range:	40 Vol%	Gas Supplier: Hovacal TELabs	
Actual	Result	Error (% Range)	Gain	Cylinder No:	TE230717W2
0.00	0.00	-0.01		Mix Date:	
5.00	4.99	0.03		Expiry Date:	One Month From Opening
8.00	8.00	0.00		Concentration:	Vol%
10.00	10.02	-0.04		Equivalent Concentration:	40 Vol%
13.00	12.99	0.03		Equivalent Concentration:	Vol%
15.00	14.97	0.08			@ 15°C
18.00	17.97	0.06			@ 0°C
20.00	19.98	0.05			
22.00	22.00	0.01			
24.00	23.99	0.03			
37.00	36.83	0.42			

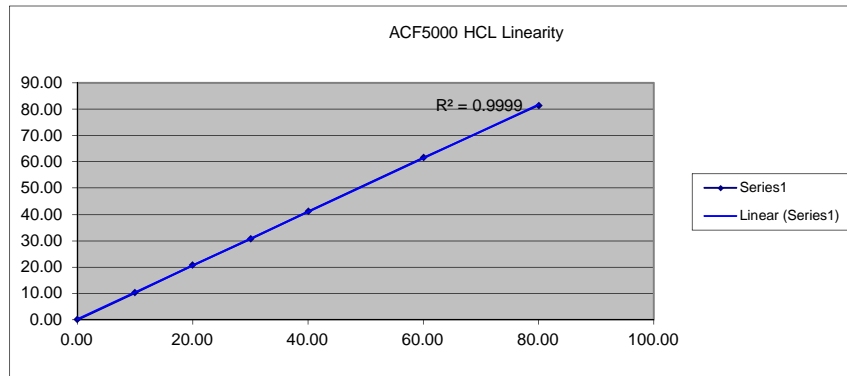
Statistics											
Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10	
0.0	5.0	8.0	10.0	13.0	15.0	18.0	20.0	22.0	24.0	36.9	
0.0	5.0	8.0	10.0	13.0	15.0	18.0	20.0	22.0	24.0	36.9	
0.0	5.0	8.0	10.0	13.0	15.0	18.0	20.0	22.0	24.0	36.9	
0.0	5.0	8.0	10.0	13.0	15.0	18.0	20.0	22.0	24.0	36.9	
0.0	5.0	8.0	10.0	13.0	15.0	18.0	20.0	22.0	24.0	36.9	
0.0	5.0	8.0	10.0	13.0	15.0	18.0	20.0	22.0	24.0	36.9	
0.0	5.0	8.0	10.0	13.0	15.0	18.0	20.0	22.0	24.0	36.8	
0.0	5.0	8.0	10.0	13.0	15.0	17.9	20.0	22.0	24.0	36.8	
0.0	5.0	8.0	10.0	13.0	15.0	17.9	20.0	22.0	24.0	36.8	
0.0	5.0	8.0	10.0	13.0	15.0	17.9	20.0	22.0	24.0	36.8	
Average	0.00	4.99	8.00	10.02	12.99	14.97	17.97	19.98	22.00	23.99	36.83
Standard Deviation	0.00	0.01	0.00	0.01	0.00	0.01	0.04	0.01	0.02	0.01	0.04
Average Error (% Range)	-0.01%	0.03%	0.00%	-0.04%	0.03%	0.08%	0.06%	0.05%	0.01%	0.03%	0.42%



HCL				Seial No: F.3.374483.7			
Concentration		Range:		100 mg/m3		Gas Supplier: Hovacal TELabs	
Actual	Result	Error (% Range)	Gain				
0.00	0.01	-0.01					
10.00	10.31	-0.31					
20.00	20.78	-0.78					
30.00	30.69	-0.69					
40.00	41.21	-1.21					
60.00	61.60	-1.60					
80.00	81.39	-1.39					

Cylinder No:	OB230801E		
Mix Date:			
Expiry Date:	01/11/23		
Concentration:		mg/m3	@ 15°C
Equivalent Concentration:	80	mg/m3	@ 0°C
Equivalent Concentration:		mg/m3	

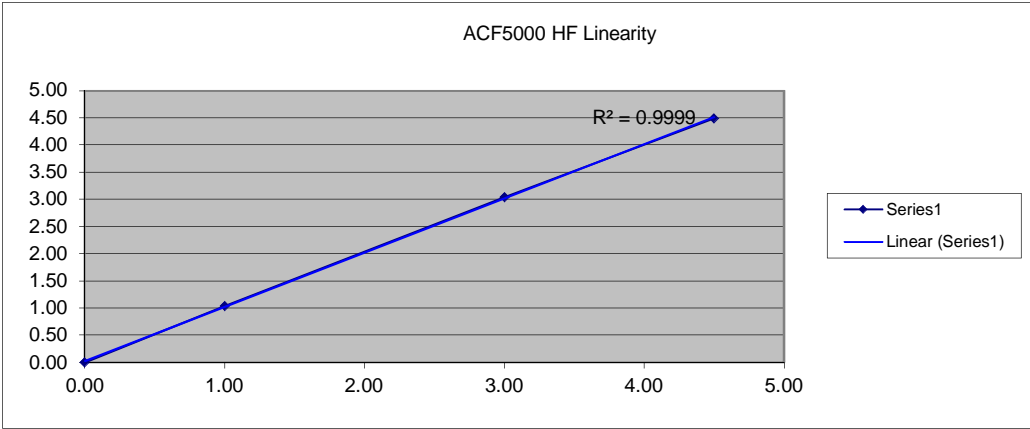
Statistics							
	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
	0.0	10.3	20.8	30.7	41.2	61.6	80.8
	0.0	10.3	20.8	30.7	41.2	61.6	81.4
	0.0	10.3	20.8	30.7	41.3	61.6	81.4
	0.0	10.3	20.8	30.7	41.3	61.6	81.4
	0.0	10.3	20.8	30.7	41.1	61.6	81.7
	0.0	10.3	20.8	30.7	41.1	61.8	81.7
Average	0.01	10.31	20.78	30.69	41.21	61.60	81.39
Standard Deviation	0.00	0.01	0.00	0.00	0.10	0.09	0.34
Average Error (% Range)	-0.01%	-0.31%	-0.78%	-0.69%	-1.21%	-1.60%	-1.39%



HF			
Concentration		Range:	6 mg/m3
Actual	Result	Error (% Range)	Gain
0.00	0.00	0.00	
1.00	1.03	-0.53	
3.00	3.04	-0.64	
4.50	4.49	0.14	

Gas Supplier:	Hovacal TELabs		
Cylinder No:	8082305		
Mix Date:			
Expiry Date:	07/02/24		
Concentration:		mg/m3	@ 15°C
Equivalent Concentration:	4.5	mg/m3	@ 0°C
Equivalent Concentration:		mg/m3	

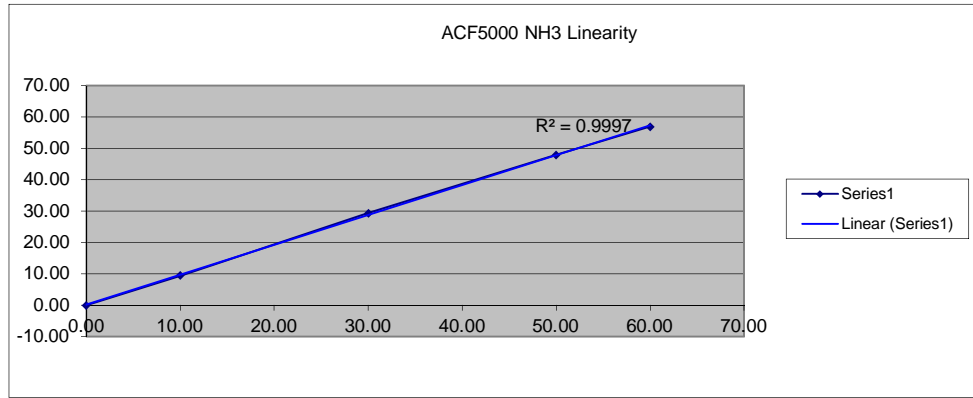
Statistics				
	Level 0	Level 1	Level 2	Level 3
	0.0	1.0	3.0	4.5
	0.0	1.0	3.0	4.5
	0.0	1.0	3.0	4.5
	0.0	1.0	3.1	4.5
	0.0	1.1	3.0	4.5
	0.0	1.1	3.0	4.5
Average	0.00	1.03	3.04	4.49
Standard Deviation	0.00	0.01	0.01	0.00
Average Error (% Range)	0.00%	-0.53%	-0.64%	0.14%



NH3			
Concentration		Range:	230 mg/m3
Actual	Result	Error (% Range)	Gain
0.00	-0.09	0.04	
10.00	9.40	0.26	
30.00	29.28	0.31	
50.00	47.90	0.91	
60.00	56.86	1.37	

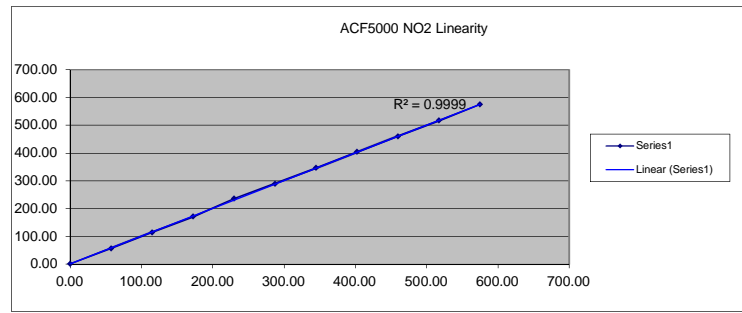
Gas Supplier:	Hovacal TELabs
Cylinder No:	OB230809D
Mix Date:	
Expiry Date:	09/11/23
Concentration:	mg/m3 @ 15°C
Equivalent Concentration:	70 mg/m3 @ 0°C
Equivalent Concentration:	mg/m3

Statistics					
	Level 0	Level 1	Level 2	Level 3	Level 4
	-0.1	9.4	29.3	47.9	56.9
	-0.1	9.4	29.3	47.9	56.9
	-0.1	9.4	29.3	47.9	56.9
	-0.1	9.4	29.2	47.9	56.9
	-0.1	9.4	29.2	47.9	56.9
Average	-0.09	9.40	29.28	47.90	56.86
Standard Deviation	0.00	0.04	0.03	0.01	0.00
Average Error (% Range)	0.04%	0.26%	0.31%	0.91%	1.37%



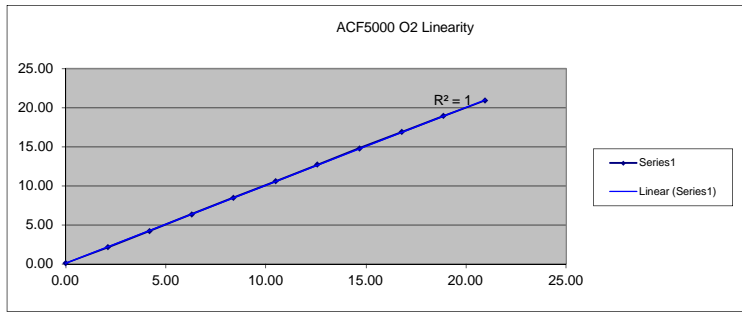
NO2				Seial No: F.3.374483.7	
Concentration		Range:	600 Mg/m3		
Actual	Result	Error (% Range)	Gain	Gas Supplier: BOC	
0.00	0.55	-0.09		Certificate: 23/024773	
57.51	57.48	0.01		Mix Date:	
115.03	114.53	0.08		Expiry Date: 21/09/26	
172.54	171.24	0.22		Concentration: mg/m ³ @ 15°C	
230.05	235.60	-0.92		Equivalent Concentration: 575.125 mg/m ³ @ 0°C	
287.56	290.00	-0.41		Equivalent Concentration: 280 ppm	
345.08	346.35	-0.21			
402.59	404.11	-0.25			
460.10	461.05	-0.16			
517.61	516.85	0.13			
575.13	575.91	-0.13			

Statistics											
Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10	
0.6	57.6	114.5	171.4	231.3	291.1	346.4	404.5	462.0	517.2	576.1	
0.6	57.6	114.5	171.4	231.3	291.1	346.4	404.5	462.0	517.2	576.1	
0.6	57.6	114.5	171.4	230.5	291.1	346.4	404.5	461.6	517.2	576.1	
0.6	57.3	114.5	171.4	230.5	291.1	346.4	403.7	461.6	516.6	576.1	
0.6	57.3	114.5	171.2	230.5	289.2	346.3	403.7	461.6	516.6	576.1	
0.5	57.3	114.5	171.2	230.5	289.2	346.3	403.7	460.4	516.6	575.6	
0.5	57.3	114.5	171.2	230.8	289.2	346.3	403.7	460.4	516.8	575.6	
0.5	57.7	114.6	171.0	230.8	289.3	346.3	404.3	460.4	516.8	575.6	
0.5	57.7	114.6	171.0	230.8	289.3	346.3	404.3	460.4	516.8	576.0	
0.5	57.7	114.6	171.0	230.8	289.3	346.3	404.3	460.4	516.8	576.0	
Average	0.55	57.48	114.53	171.24	230.77	290.00	346.35	404.11	461.05	516.85	575.91
Standard Deviation	0.03	0.17	0.05	0.16	0.35	0.98	0.07	0.35	0.73	0.25	0.20
Average Error (% Range)	-0.09%	0.01%	0.08%	0.22%	-0.12%	-0.41%	-0.21%	-0.25%	-0.16%	0.13%	-0.13%



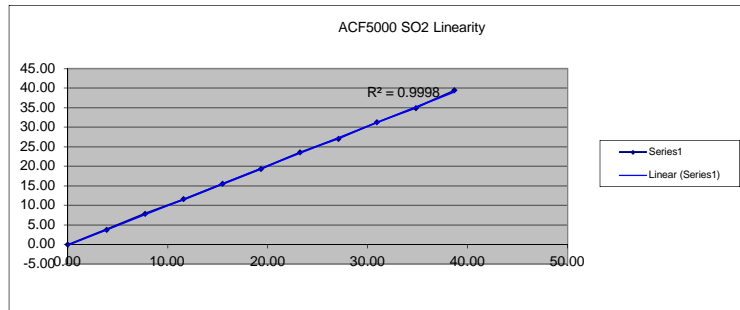
O2				Seial No: F.3.374483.7	
Concentration		Range:	25	Vol%	
Actual	Result	Error (% Range)	Gain	Gas Supplier:	Air
0.00	0.09	-0.37		Cylinder No:	Nitrogen
2.09	2.14	-0.18		Mix Date:	
4.19	4.24	-0.20		Expiry Date:	
6.29	6.36	-0.28		Concentration:	0 Vol% @ 15°C
8.38	8.48	-0.39		Equivalent Concentration:	20.96 Vol% @ 0°C
10.48	10.59	-0.45		Equivalent Concentration:	Vol%
12.57	12.71	-0.54			
14.67	14.80	-0.50			
16.77	16.88	-0.42			
18.86	18.93	-0.26			
20.96	20.96	0.00			

Statistics											
Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10	
0.1	2.13	4.25	6.37	8.48	10.60	12.71	14.80	16.89	18.90	20.92	
0.1	2.13	4.25	6.37	8.48	10.60	12.71	14.80	16.89	18.90	20.92	
0.1	2.13	4.25	6.37	8.48	10.60	12.71	14.80	16.89	18.90	20.92	
0.1	2.13	4.25	6.37	8.48	10.60	12.71	14.80	16.89	18.90	20.92	
0.1	2.13	4.25	6.37	8.48	10.60	12.71	14.80	16.89	18.90	20.92	
0.1	2.13	4.25	6.37	8.48	10.60	12.71	14.80	16.89	18.90	20.92	
0.1	2.13	4.23	6.37	8.47	10.58	12.70	14.79	16.87	18.95	21.00	
0.1	2.14	4.23	6.35	8.47	10.58	12.70	14.79	16.87	18.95	21.00	
0.1	2.14	4.23	6.35	8.47	10.58	12.70	14.79	16.87	18.95	21.00	
0.1	2.14	4.23	6.35	8.47	10.58	12.70	14.79	16.87	18.95	21.00	
0.1	2.14	4.23	6.35	8.47	10.58	12.70	14.79	16.87	18.95	21.00	
0.1	2.14	4.23	6.35	8.47	10.58	12.70	14.79	16.87	18.95	21.00	
Average	0.09	2.14	4.24	6.36	8.48	10.59	12.71	14.80	16.88	18.93	20.96
Standard Deviation	0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.01	0.01	0.03	0.04
Average Error (% Range)	-0.37%	-0.18%	-0.20%	-0.28%	-0.39%	-0.45%	-0.54%	-0.50%	-0.42%	-0.26%	0.00%



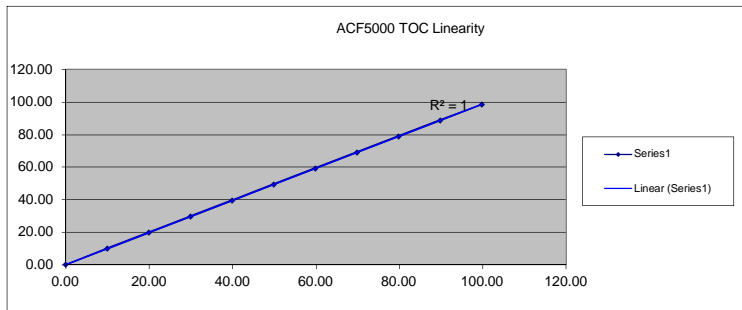
SO2				Seial No: F.3.374483.7			
Concentration		Range: 1500 Mg/m3		Gas Supplier: BOC			
Actual	Result	Error (% Range)	Gain				
0.00	-0.07	0.00		Certificate: 23/023876			
3.87	3.79	0.01		Mix Date:			
7.73	7.86	-0.01		Expiry Date: 13/09/25			
11.60	11.57	0.00		Concentration: mg/m ³ @ 15°C			
15.47	15.54	-0.01		Equivalent Concentration: 38.66479 mg/m ³ @ 0°C			
19.33	19.37	0.00		Equivalent Concentration: 13.52 ppm			
23.20	23.51	-0.02					
27.07	27.06	0.00					
30.93	31.22	-0.02					
34.80	34.96	-0.01					
38.66	39.43	-0.05					

Statistics											
	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10
	-0.1	4.0	7.8	11.8	15.7	19.4	23.6	26.9	31.4	35.1	41.1
	-0.1	4.0	7.8	11.8	15.7	19.4	23.6	26.9	31.4	35.1	41.1
	-0.1	4.0	7.8	11.7	15.7	19.4	23.6	26.9	31.4	35.1	41.1
	-0.1	3.6	7.9	11.7	15.6	19.5	23.5	26.9	31.4	34.9	38.7
	-0.1	3.6	7.9	11.7	15.6	19.5	23.5	26.9	31.1	34.9	38.7
	-0.1	3.6	7.9	11.4	15.6	19.5	23.5	26.9	31.1	34.9	38.7
	-0.1	3.7	7.9	11.4	15.4	19.2	23.5	27.3	31.1	34.9	38.7
	-0.1	3.7	7.9	11.4	15.4	19.2	23.5	27.3	31.1	34.9	38.7
	-0.1	3.7	7.9	11.4	15.4	19.2	23.5	27.3	31.1	34.9	38.7
	-0.1	3.7	7.9	11.4	15.4	19.2	23.5	27.3	31.1	34.9	38.7
Average	-0.07	3.79	7.86	11.57	15.54	19.37	23.51	27.06	31.22	34.96	39.43
Standard Deviation	0.00	0.18	0.04	0.18	0.09	0.11	0.05	0.17	0.16	0.13	1.13
Average Error (% Range)	0.00%	0.01%	-0.01%	0.00%	-0.01%	0.00%	-0.02%	0.00%	-0.02%	-0.01%	-0.05%



TOC				Seial No: F.3.374483.7			
Concentration		Range: 100 mgC/m3		Gas Supplier: BOC			
Actual	Result	Error (% Range)	Gain	Certificate: 22/032262			
0.00	0.02	-0.02		Mix Date:			
9.97	10.00	-0.03		Expiry Date: 16/11/26			
19.94	19.86	0.08		Concentration:		mg/m3	@ 15°C
29.91	29.70	0.21		Equivalent Concentration:		99.7 mgC/m3	@ 0°C
39.88	39.63	0.25		Equivalent Concentration:		62 ppm	
49.85	49.43	0.42					
59.82	59.26	0.56					
69.79	69.11	0.68					
79.76	79.01	0.75					
89.73	88.71	1.02					
99.70	98.46	1.24					

Statistics											
Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10	
0.0	10.0	19.9	29.8	39.8	49.6	59.2	69.04	79.18	88.98	98.35	
0.0	10.0	19.9	29.8	39.8	49.6	59.2	69.04	79.18	88.98	98.35	
0.0	10.0	19.9	29.8	39.8	49.6	59.2	69.04	79.18	88.98	98.35	
0.0	10.0	19.9	29.8	39.8	49.6	59.2	69.04	79.18	88.98	98.35	
0.0	10.0	19.9	29.8	39.4	49.3	59.4	69.04	78.84	88.98	98.57	
0.0	10.0	19.8	29.6	39.4	49.3	59.4	69.21	78.84	88.30	98.57	
0.0	10.0	19.8	29.6	39.4	49.3	59.4	69.21	78.84	88.30	98.57	
0.0	10.0	19.8	29.6	39.4	49.3	59.4	69.21	78.84	88.30	98.57	
0.0	10.0	19.8	29.6	39.4	49.3	59.4	69.21	78.84	88.30	98.57	
0.0	10.0	19.8	29.6	39.4	49.3	59.4	69.21	78.84	88.30	98.57	
0.02	10.00	19.86	29.70	39.63	49.43	59.26	69.11	79.01	88.71	98.46	
0.01	0.03	0.05	0.13	0.22	0.14	0.10	0.09	0.18	0.35	0.11	
-0.02%	-0.03%	0.08%	0.21%	0.25%	0.42%	0.56%	0.68%	0.75%	1.02%	1.24%	





SERVICE REPORT

SRN:

- Commissioning Breakdown
- Training Installation
- Maintenance Supervision
- Warranty Report General

ABB ENGINEERS NAME:

CUSTOMER ORDER No.

JOB No:

DATE OF VISIT:

CUSTOMER NAME:

CONTACT NAME:

CUSTOMER ADDRESS:

DESCRIPTION OF WORK:

PHONE:

DETAILS OF WORK CARRIED OUT:

SPARES USED DESCRIPTION	QTY	PART NUMBER	
1).....			
2).....			
3).....			

ENGINEER'S SIGNATURE *Eduardo Albor*

CUSTOMER'S SIGNATURE