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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 [Standby Analyser]

Dates of the Monitoring Campaign
14th-23rd November 2023

Job Reference Number
EMT07766

Report Written by
Dave Allan
Technical Advisor
MCERTS Level 2
MM 02 137
TE1 TE2 TE3 TE4

Report Approved by
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MCERTS Level 2
MM 03 216
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Report Date
21st December 2023

Report Version
Version 2

Signature of Report Approver

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

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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.

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Limerick
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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 [Standby 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 = 1.0652x + 0.0426	Pass	0 to 22.5 mg/m³	0 to 25 mg/m³	y = 1.0652x + 0.0426
Oxides of Nitrogen (as NO_2)	Yes	Procedure A	y = 1.0263x + 18.7805	Pass	0 to 982.5 mg/m³	N/A	y = 1.0263x + 18.7805
Sulphur Dioxide	Yes	Procedure C	y = 0.9300x + 1.8381	Pass	0 to 11.1 mg/m³	N/A	y = 0.9300x + 1.8381
Carbon Monoxide	Yes	Procedure B	y = 0.9994x - 0.0600	Pass	0 to 423.8 mg/m³	0 to 1210.2 mg/m³	y = 0.9994x - 0.0600
Hydrogen Chloride	Yes	Procedure C	y = 1.0150x - 0.0515	Pass	0 to 2.0 mg/m³	N/A	y = 1.0150x - 0.0515
Hydrogen Fluoride	Yes	Procedure C	y = 1.0004x + 0.0382	Pass	0 to 0.2 mg/m³	N/A	y = 1.0004x + 0.0382
Ammonia	Yes	Procedure B	y = 0.9420x + 0.9515	Pass	0 to 34.5 mg/m³	0 to 50 mg/m³	y = 0.9420x + 0.9515
Water Vapour (% v/v)	Yes	Procedure B	y = 0.9383x + 0.0281	Pass	0 to 12.9 % v/v	N/A	y = 0.9383x + 0.0281
Oxygen (% v/v)	Yes	Procedure B	y = 1.0137x - 0.0912	Pass	0 to 13.1 % v/v	N/A	y = 1.0137x - 0.0912
Carbon Dioxide (% v/v)	Yes	Procedure A	y = 1.4387x - 7.0328	Pass	0 to 17.7 % v/v	N/A	y = 1.4387x - 7.0328

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.

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

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REGULATORY INFORMATION

Irish Cement Ltd, Limerick
A2-01 Kiln 6 [Standby 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/m³)	Daily or 48hr Average ELV (mg/m³)	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**

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OPERATIONAL INFORMATION AND SITE MONITORING PROVISIONS

Irish Cement Ltd, Limerick
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14th-23rd November 2023

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

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MONITORING PROVISIONS AT THE INSTALLATION - PERIODIC MONITORING

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Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	2.60
Width	m	-
Area	m²	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

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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
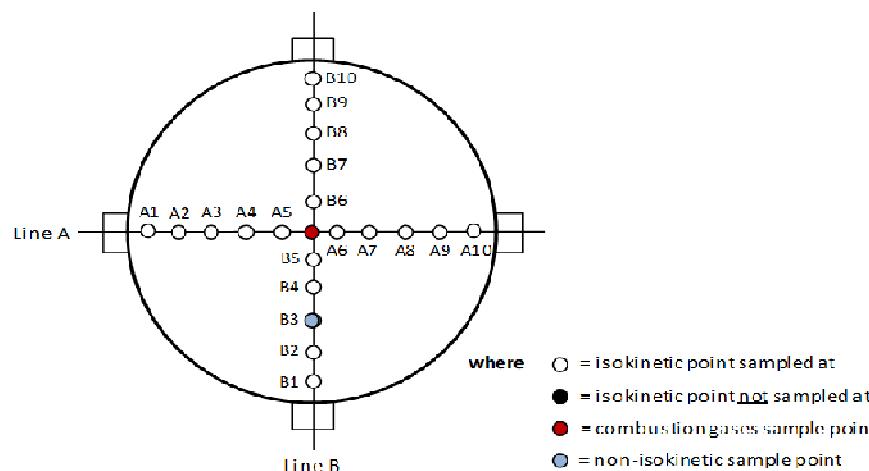
Photo 1

Photo 2

Sample Points

where
- ○ = isokinetic point sampled at
- ● = isokinetic point _not_ sampled at
- ● = combustion gases sample point
- ◐ = non-isokinetic sample point

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CONTINUOUS EMISSION MONITORs (CEMs) AT THE INSTALLATION

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Main Determinand	Type	Instrument Name	Instrument Serial Number	Measurement Principle	Certified Range (mg/m³)	QAL1 Compliant	MCERTS Number
Total Particulate Matter	In-Situ	PCME View QAL 181	-	Light Scatter	0 to 7.5	Yes	MC090152/04
Total VOCs	Extractive	ABB ACF5000	F.3.411677.1	FID	0 to 15	Yes	MC160309/04
Oxides of Nitrogen (as NO₂)	Extractive	ABB ACF5000	F.3.411677.1	FTIR	0 to 150	Yes	MC160309/04
Sulphur Dioxide	Extractive	ABB ACF5000	F.3.411677.1	FTIR	0 to 75	Yes	MC160309/04
Carbon Monoxide	Extractive	ABB ACF5000	F.3.411677.1	FTIR	0 to 75	Yes	MC160309/04
Hydrogen Chloride	Extractive	ABB ACF5000	F.3.411677.1	FTIR	0 to 15	Yes	MC160309/04
Hydrogen Fluoride	Extractive	ABB ACF5000	F.3.411677.1	FTIR	0 to 3	Yes	MC160309/04
Ammonia	Extractive	ABB ACF5000	F.3.411677.1	FTIR	0 to 5	Yes	MC160309/04
Water Vapour	Extractive	ABB ACF5000	F.3.411677.1	FTIR	0 to 40%	Yes	MC160309/04
Oxygen (Wet)	Extractive	ABB ACF5000	F.3.411677.1	Zirconia	0 to 25	Yes	MC160309/04
Carbon Dioxide	Extractive	ABB ACF5000	F.3.411677.1	FTIR	0 to 30%	Yes	MC160309/04

Peripheral Determinand	Recorded	Instrument Name
Temperature	Yes	Unknown
Pressure	Yes	Unknown

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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 Certified (mg/m³)	Instrumental Ranges Operational (mg/m³)	MCERTS Number	Reference Method	MU [2] (%)
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

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**

LIST OF EQUIPMENT

Extractive Sampling

Equipment Type	Equipment I.D.
Control Box DGM (1)	CAT 7.991
Control Box DGM (2)	CAT 7.1000
Box Thermocouples (1)	CAT 3.103
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.103
Umbilical (2)	CAT 3.10004
Oven Box (1)	CAT 12.29
Oven Box (2)	CAT 12.115
Heated Probe (1)	CAT 5.51
Heated Probe (2)	CAT 5.57
Heated Probe (3)	-
S-Pitot (1)	CAT 21p.177
S-Pitot (2)	CAT 21p.165
L-Pitot	-
500g Check Weight	CAT 17.1
1Kg Check Weight	CAT 17.1
Last Impinger Arm	CAT 4.0001
Callipers	CAT 23.11
Tubes Kit Thermocouple	-

Instrumental Analysers

Equipment Type	Equipment I.D.
Horiba PG-350E	CAT 39.6
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
JCT JCC P1 Cooler	CAT 4.1122
Gasmet DX4000	CAT 19.7
Gasmet Sampling System	CAT 10.4
Sick 3006	CAT 8.15
Ankersmid APP100	CAT 12.134
Mass Flow Controller (1)	CAT 6.59
Mass Flow Controller (2)	CAT 6.70
Mass View (1)	CAT 25.87
Mass View (2)	-
Hioki 5043 (V)	CAT 11.53
Hioki 5031 (mA)	-

Miscellaneous Items

| Equipment Type	Equipment I.D.
Digital Manometer (1)	CAT 3.250
Digital Manometer (2)	-
Digital Temperature Meter	CAT 3.250
Stopwatch	CAT 14.53
Barometer	CAT 13.39
Stack Thermocouple (1)	CAT 4.1581
Stack Thermocouple (2)	-
Stack Thermocouple (3)	-
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	CAT 20.998
20m Heated Line (1)	-
20m Heated Line (2)	-
Dual Channel Heater Controller	-
Single Channel Heater Controller	CAT 20.998
Laboratory Balance	CAT 1.18 / 1.18a
Tape Measure	CAT 16.94

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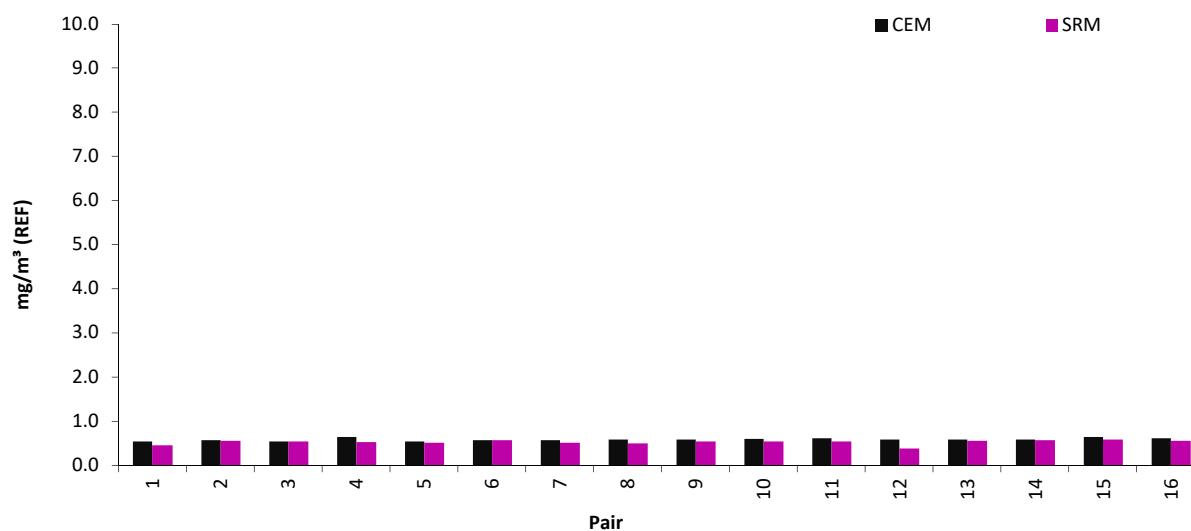
TOTAL PARTICULATE MATTER: QAL2 CALCULATIONS

Irish Cement Ltd, Limerick

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Pair	Date	Times	x, CEM (ACTUAL) mg/m³	y, SRM (ACTUAL) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	Filter ID Number (47-XXXX)
1	14/11/2023	12:00 - 13:00	0.29	0.23	0.55	0.46	47-105038
2	14/11/2023	13:30 - 14:32	0.30	0.27	0.58	0.56	47-105098
3	14/11/2023	14:45 - 15:52	0.29	0.27	0.55	0.54	47-104731
4	15/11/2023	08:56 - 09:58	0.35	0.29	0.65	0.53	47-105099
5	15/11/2023	10:00 - 11:00	0.30	0.28	0.55	0.52	47-104505
6	15/11/2023	11:05 - 12:05	0.30	0.28	0.58	0.57	47-105089
7	15/11/2023	12:07 - 13:07	0.31	0.27	0.58	0.51	47-105110
8	15/11/2023	13:10 - 14:10	0.31	0.27	0.59	0.51	47-105116
9	15/11/2023	14:12 - 15:15	0.30	0.27	0.59	0.55	47-105077
10	15/11/2023	15:15 - 16:15	0.31	0.27	0.61	0.54	47-104504
11	16/11/2023	08:45 - 09:45	0.32	0.28	0.61	0.54	47-104507
12	16/11/2023	09:47 - 10:48	0.30	0.19	0.59	0.39	47-105212
13	16/11/2023	11:54 - 12:55	0.30	0.28	0.59	0.56	47-104508
14	16/11/2023	12:58 - 13:58	0.30	0.29	0.59	0.57	47-105097
15	16/11/2023	14:00 - 15:02	0.33	0.30	0.64	0.60	47-104741
16	16/11/2023	15:05 - 16:07	0.31	0.28	0.62	0.56	47-104740
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.

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TOTAL VOCs: QAL2 CALCULATIONS

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Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O_2) mg/m³	x - x_{av} (A)	y - y_{av} (B)	(A) x (B)	(x - x_{av})²	CAL CEM (STP, WET) mg/m³
L1	Surrogate	Near Zero	-0.04	0.00	0.00	-15.26	-16.25	248.05	232.87	0.00
1	21/11/2023	13:02 - 13:32	15.62	16.56	18.69	0.40	0.30	0.12	0.16	16.68
2	21/11/2023	14:02 - 14:32	15.69	17.89	20.44	0.47	1.63	0.77	0.22	16.76
3	21/11/2023	17:02 - 17:32	14.40	14.90	17.45	-0.82	-1.35	1.10	0.67	15.39
4	21/11/2023	18:02 - 18:32	14.93	16.59	18.46	-0.29	0.34	-0.10	0.08	15.95
5	21/11/2023	19:02 - 19:32	15.13	16.80	18.86	-0.09	0.54	-0.05	0.01	16.16
6	21/11/2023	20:02 - 20:32	15.29	17.15	19.03	0.07	0.90	0.06	0.00	16.33
7	21/11/2023	21:02 - 21:32	15.38	16.94	19.51	0.16	0.68	0.11	0.03	16.43
8	22/11/2023	10:02 - 10:32	16.40	17.10	18.79	1.18	0.84	0.99	1.39	17.51
9	22/11/2023	11:02 - 11:32	16.69	18.13	20.35	1.47	1.87	2.75	2.16	17.82
10	22/11/2023	12:02 - 12:32	16.53	18.38	20.57	1.31	2.12	2.77	1.71	17.65
11	22/11/2023	13:02 - 13:32	15.92	17.33	19.67	0.70	1.07	0.75	0.48	17.00
12	22/11/2023	14:02 - 14:32	15.11	16.59	18.96	-0.11	0.33	-0.04	0.01	16.14
13	22/11/2023	16:02 - 16:32	16.49	17.40	19.72	1.27	1.15	1.46	1.62	17.61
14	22/11/2023	18:02 - 18:32	17.12	18.29	20.17	1.90	2.03	3.85	3.59	18.27
15	22/11/2023	19:02 - 19:32	16.23	17.32	19.65	1.01	1.07	1.07	1.01	17.33
16	22/11/2023	20:02 - 20:32	16.39	17.07	19.43	1.17	0.82	0.96	1.38	17.51
17	22/11/2023	21:02 - 21:32	16.34	17.18	19.61	1.12	0.92	1.04	1.26	17.45
18	22/11/2023	22:02 - 22:32	15.52	16.37	20.19	0.30	0.12	0.03	0.09	16.57
19	22/11/2023	23:02 - 23:32	16.90	16.88	18.98	1.68	0.63	1.05	2.82	18.04
20	23/11/2023	00:02 - 00:32	16.29	16.35	18.55	1.07	0.09	0.10	1.13	17.39
21	23/11/2023	01:02 - 01:32	16.51	16.40	18.65	1.29	0.14	0.19	1.67	17.63
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Irish Cement Ltd
Limerick
A2-01 Kiln 6 [Standby Analyser]

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06

TOTAL VOCs: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O_2) mg/m³	x - x_{av} (A)	y - y_{av} (B)	(A) x (B)	(x - x_{av})²	CAL CEM (STP, WET) mg/m³
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		MAX SRM - MIN SRM	3.12			SUM	267.06	254.37	
		(DAILY) DELV (mg/m³)	25						
		95% CI MU (%)	30		**PROCEDURE A**	If (MAX SRM - MIN SRM) > 95% CI at Daily ELV			
		95% CI at DELV (mg/m³)	7.5		**PROCEDURE B**	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV			
		15% of ELV	3.8			and MIN SRM ≥ 15% of Daily ELV			
		PROCEDURE (A, B, C)	B		**PROCEDURE C**	If (MAX SRM - MIN SRM) < 95% CI at Daily ELV			

WHERE OFFSET = -0.04

and MIN SRM < 15% of Daily ELV

Outliers Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	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	14.63	0.00	SRM offline/calibrating
2	21/11/2023	16:02 - 16:32	15.04	0.00	SRM offline/calibrating
3	21/11/2023	22:02 - 23:32	-	-	SRM offline
4	22/11/2023	00:02 - 09:32	-	-	SRM offline
5	22/11/2023	15:02 - 15:32	15.40	0.00	SRM offline/calibrating
6	22/11/2023	17:02 - 17:32	16.86	0.00	SRM offline/calibrating
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Irish Cement Ltd
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EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
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TOTAL VOCs: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Derivation of Calibration Function
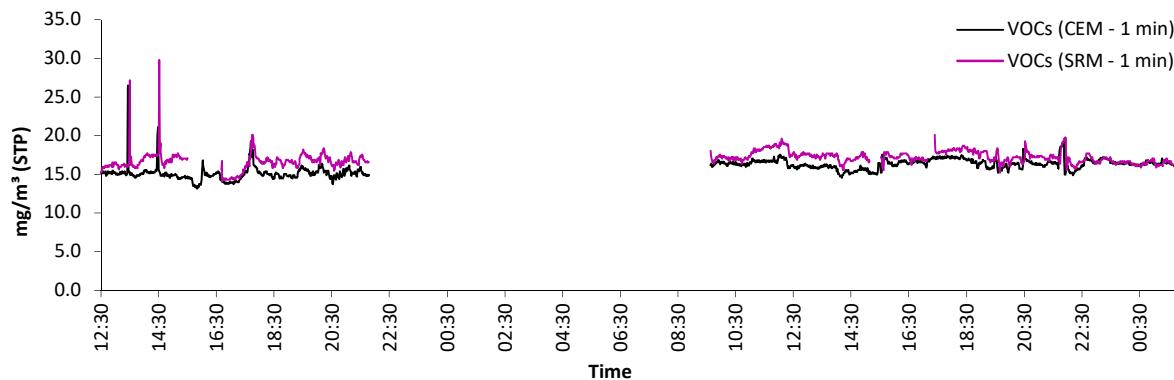
b =	1.0652	a =	0.0426		**CALIBRATION FUNCTION =**	**y = 1.0652x + 0.0426**

where

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

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

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

y = 1.0652x + 0.0426
R² = 1

Irish Cement Ltd
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A2-01 Kiln 6 [Standby Analyser]

EL-LS-OP-SE-X-EWB 105 (Version AI)
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TOTAL VOCs: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Variability Test Data

where CAL = Calibrated using QAL2 calibration functions

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	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	-0.04	0.00
1	21/11/2023	13:02 - 13:32	16.68	12.76	12.00	11.98	9.86	9.91	9.93	18.80	18.69	17.60	-0.11
2	21/11/2023	14:02 - 14:32	16.76	12.65	11.90	12.03	10.07	10.11	10.06	19.22	20.44	18.00	1.22
3	21/11/2023	17:02 - 17:32	15.39	11.21	10.54	10.47	10.49	10.54	10.50	18.09	17.45	16.94	-0.64
4	21/11/2023	18:02 - 18:32	15.95	12.27	11.54	11.61	9.83	9.88	9.82	17.83	18.46	16.69	0.64
5	21/11/2023	19:02 - 19:32	16.16	12.50	11.75	11.77	9.92	9.97	9.90	18.26	18.86	17.10	0.60
6	21/11/2023	20:02 - 20:32	16.33	12.11	11.40	11.62	9.79	9.83	9.78	18.15	19.03	17.00	0.87
7	21/11/2023	21:02 - 21:32	16.43	11.73	11.04	11.27	10.24	10.29	10.24	18.96	19.51	17.76	0.55
8	22/11/2023	10:02 - 10:32	17.51	12.55	11.81	11.79	9.59	9.63	9.65	19.21	18.79	17.99	-0.42
9	22/11/2023	11:02 - 11:32	17.82	12.25	11.53	11.61	9.86	9.90	9.91	19.97	20.35	18.70	0.38
10	22/11/2023	12:02 - 12:32	17.65	12.17	11.44	11.56	9.82	9.86	9.89	19.67	20.57	18.42	0.90
11	22/11/2023	13:02 - 13:32	17.00	12.35	11.62	11.77	9.95	9.99	10.02	19.21	19.67	17.99	0.46
12	22/11/2023	14:02 - 14:32	16.14	10.88	10.24	10.55	10.20	10.25	10.24	18.40	18.96	17.23	0.56
13	22/11/2023	16:02 - 16:32	17.61	11.98	11.27	11.42	9.99	10.03	10.04	19.91	19.72	18.64	-0.19
14	22/11/2023	18:02 - 18:32	18.27	11.41	10.74	10.90	9.76	9.80	9.81	20.11	20.17	18.84	0.06
15	22/11/2023	19:02 - 19:32	17.33	10.95	10.30	10.18	10.12	10.17	10.20	19.62	19.65	18.37	0.03
16	22/11/2023	20:02 - 20:32	17.51	11.01	10.36	10.49	10.12	10.16	10.20	19.82	19.43	18.57	-0.39
17	22/11/2023	21:02 - 21:32	17.45	11.76	11.07	11.11	10.08	10.13	10.16	19.85	19.61	18.59	-0.24
18	22/11/2023	22:02 - 22:32	16.57	10.09	9.49	9.53	11.08	11.14	11.14	20.42	20.19	19.12	-0.24
19	22/11/2023	23:02 - 23:32	18.04	10.99	10.34	10.28	10.00	10.05	10.09	20.21	18.98	18.93	-1.23
20	23/11/2023	00:02 - 00:32	17.39	11.23	10.56	10.62	10.08	10.13	10.15	19.68	18.55	18.43	-1.13
21	23/11/2023	01:02 - 01:32	17.63	11.34	10.67	10.80	10.10	10.15	10.15	20.01	18.65	18.74	-1.37
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TOTAL VOCs: QAL2 CALCULATIONS

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A2-01 Kiln 6 [Standby Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	ys, SRM - CAL CEM
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									MAX	**AVERAGE**	**AVERAGE**	**Sd**
									20.42	19.32	18.08	0.72

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	3.83
Kv for 21 Pairs of Data	0.9824

The variability is accepted if Sd ≤ Q_o x Kv.

Parameter	Value
Standard Deviation (Sd)	0.72
Q_o x Kv	3.76
Outcome of Variability Test	**Pass**

Valid Calibration Range

Maximum CAL CEM Value (mg/m³)	20.4

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/m³)	0 to 22.5
b) Calibrated Range (20% of Daily ELV) (mg/m³)	0 to 5.0
Greater of (a) or (b)	0 to 22.5

Surrogate Extension Applied?	Yes

Maximum surrogate extension allowable is up to the Daily ELV.

Conc. of Surrogate (mg/m³) y	39.9
Reading on CEM (mg/m³) x	39.7
Cal Reading on CEM (mg/m³) x	42.3

Valid Calibration Range (at REF conditions)	**0 to 25 mg/m³**
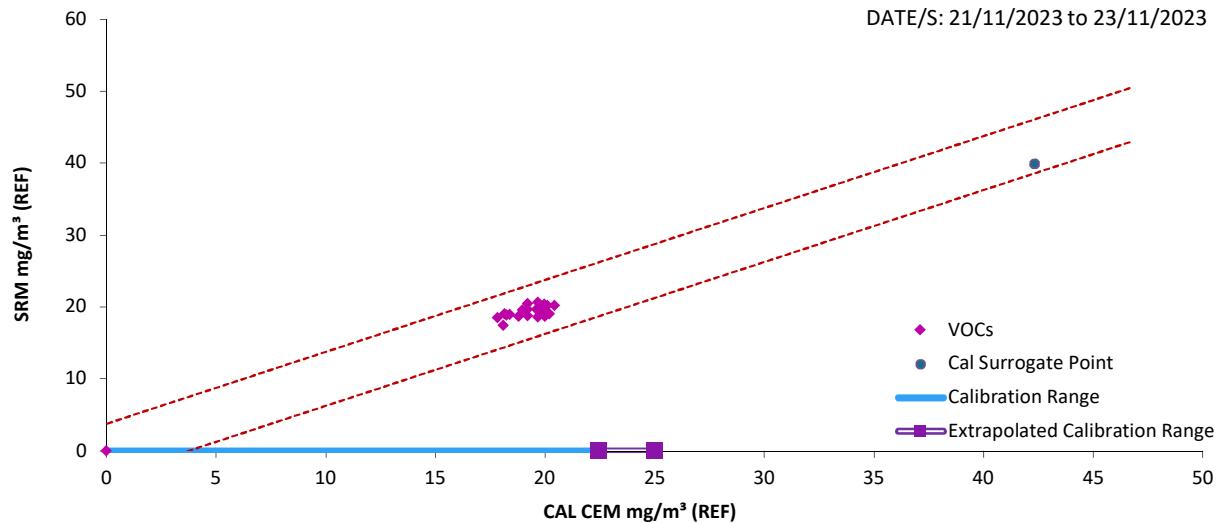
Irish Cement Ltd
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EL-LS-OP-SE-X-EWB 105 (Version AI)
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TOTAL VOCs: QAL2 CALCULATIONS

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

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	x - x_av (A)	y - y_av (B)	(A) x (B)	(x - x_av)²	CAL CEM (STP, WET) mg/m³
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	378.25	410.90	510.30	5.92	9.99	59.10	35.00	406.98
2	14/11/2023	18:02 - 18:32	383.06	411.33	506.27	10.73	10.42	111.77	115.06	411.92
3	14/11/2023	19:02 - 19:32	373.90	398.62	495.65	1.57	-2.29	-3.58	2.45	402.52
4	14/11/2023	20:02 - 20:32	372.75	396.96	499.81	0.42	-3.95	-1.64	0.17	401.34
5	14/11/2023	21:02 - 21:32	379.78	402.02	509.02	7.45	1.11	8.30	55.48	408.55
6	14/11/2023	23:02 - 23:32	368.09	387.99	492.34	-4.24	-12.92	54.77	17.98	396.56
7	15/11/2023	00:02 - 00:32	359.68	377.49	474.18	-12.65	-23.42	296.40	160.11	387.92
8	15/11/2023	01:02 - 01:32	388.58	411.19	503.49	16.24	10.28	166.92	263.88	417.58
9	15/11/2023	02:02 - 02:32	371.60	390.26	491.13	-0.73	-10.65	7.80	0.54	400.16
10	15/11/2023	04:02 - 04:32	377.04	393.35	492.82	4.71	-7.56	-35.61	22.17	405.74
11	15/11/2023	05:02 - 05:32	389.31	409.21	508.01	16.97	8.30	140.86	288.13	418.33
12	15/11/2023	06:02 - 06:32	373.57	390.60	495.16	1.24	-10.31	-12.79	1.54	402.18
13	15/11/2023	07:02 - 07:32	373.34	389.45	493.41	1.01	-11.46	-11.58	1.02	401.95
14	15/11/2023	09:02 - 09:32	369.09	406.37	519.43	-3.24	5.46	-17.72	10.52	397.58
15	15/11/2023	10:02 - 10:32	365.52	399.85	487.23	-6.81	-1.06	7.20	46.36	393.92
16	15/11/2023	11:02 - 11:32	324.11	354.80	440.89	-48.22	-46.11	2223.47	2325.22	351.42
17	15/11/2023	12:02 - 12:32	348.55	384.55	486.03	-23.79	-16.36	389.10	565.79	376.50
18	15/11/2023	15:02 - 15:32	348.10	393.66	516.20	-24.23	-7.25	175.56	587.02	376.04
19	15/11/2023	17:02 - 17:32	393.22	429.65	531.15	20.88	28.74	600.07	436.07	422.34
20	15/11/2023	18:02 - 18:32	397.68	443.26	547.78	25.35	42.35	1073.53	642.56	426.93
21	15/11/2023	19:02 - 19:32	363.93	400.65	503.01	-8.40	-0.26	2.19	70.55	392.29
22	15/11/2023	20:02 - 20:32	386.05	415.54	524.36	13.72	14.63	200.64	188.12	414.99
23	15/11/2023	21:02 - 21:32	385.97	405.82	515.59	13.64	4.91	66.95	186.00	414.91
24	15/11/2023	22:02 - 22:32	345.54	366.72	478.28	-26.80	-34.19	916.04	718.04	373.41
25	15/11/2023	23:02 - 23:32	415.96	439.77	569.52	43.63	38.86	1695.35	1903.56	445.69
26	16/11/2023	00:02 - 00:32	287.09	310.70	394.73	-85.25	-90.21	7689.58	7266.71	313.42
27	16/11/2023	01:02 - 01:32	384.21	409.77	525.54	11.88	8.86	105.26	141.04	413.10
28	16/11/2023	02:02 - 02:32	444.11	472.78	609.98	71.78	71.87	5158.76	5152.39	474.58
29	16/11/2023	03:02 - 03:32	672.79	703.67	892.97	300.46	302.76	90966.63	90275.33	709.27
30	16/11/2023	04:02 - 04:32	116.78	135.51	172.87	-255.55	-265.40	67823.93	65306.56	138.63
31	16/11/2023	05:02 - 05:32	371.64	396.10	501.73	-0.70	-4.81	3.34	0.48	400.20
32	16/11/2023	06:02 - 06:32	375.16	399.31	504.53	2.83	-1.60	-4.52	8.01	403.82
33	16/11/2023	07:02 - 07:32	394.10	422.46	523.87	21.76	21.55	469.00	473.64	423.25
34	16/11/2023	09:02 - 09:32	426.54	466.18	591.99	54.21	65.27	3538.28	2938.42	456.54
35	16/11/2023	10:02 - 10:32	358.40	397.21	514.90	-13.94	-3.70	51.59	194.27	386.61
36	16/11/2023	11:02 - 11:32	358.95	377.58	487.62	-13.38	-23.33	312.15	179.07	387.18
37	16/11/2023	17:02 - 17:32	368.05	392.91	504.42	-4.28	-8.00	34.21	18.30	396.52
38	16/11/2023	18:02 - 18:32	385.13	407.42	510.57	12.80	6.51	83.28	163.73	414.04
39	16/11/2023	19:02 - 19:32	348.95	364.32	476.71	-23.38	-36.59	855.60	546.84	376.91
40	16/11/2023	20:02 - 20:32	397.62	418.24	533.11	25.29	17.33	438.32	639.64	426.87
41	16/11/2023	21:02 - 21:32	364.93	381.09	497.48	-7.40	-19.82	146.71	54.81	393.31
42	16/11/2023	22:02 - 22:32	322.81	333.35	431.74	-49.52	-67.56	3345.78	2452.66	350.08
43	16/11/2023	23:02 - 23:32	390.90	405.67	490.02	18.56	4.76	88.34	344.60	419.96
44	17/11/2023	00:02 - 00:32	370.32	382.19	496.13	-2.02	-18.72	37.77	4.07	398.84
45	17/11/2023	01:02 - 01:32	395.88	407.43	524.22	23.55	6.52	153.50	554.46	425.08
46	17/11/2023	02:02 - 02:32	359.32	378.78	484.75	-13.02	-22.13	288.06	169.47	387.55
47	17/11/2023	03:02 - 03:32	360.64	378.11	499.53	-11.69	-22.80	266.61	136.77	388.91
48	17/11/2023	04:02 - 04:32	377.04	398.56	518.73	4.71	-2.35	-11.07	22.17	405.74
49	17/11/2023	05:02 - 05:32	377.64	398.86	506.40	5.30	-2.05	-10.85	28.11	406.35
50	17/11/2023	06:02 - 06:32	380.74	406.56	517.10	8.41	5.65	47.47	70.68	409.54
51	17/11/2023	07:02 - 07:32	332.31	367.67	466.20	-40.02	-33.24	1330.36	1601.56	359.84
52	17/11/2023	09:02 - 09:32	423.80	470.41	594.56	51.47	69.49	3576.71	2648.88	453.73
53	17/11/2023	10:02 - 10:32	338.04	378.44	485.80	-34.29	-22.47	770.30	1175.68	365.72
54	17/11/2023	11:02 - 11:32	406.78	450.80	557.42	34.45	49.89	1718.68	1186.88	436.27
55	17/11/2023	12:02 - 12:32	320.24	342.17	428.25	-52.09	-58.74	3059.63	2713.56	347.45
56	17/11/2023	13:02 - 13:32	436.62	480.42	611.05	64.29	79.51	5111.30	4132.97	466.89
57	17/11/2023	15:02 - 15:32	369.32	409.27	544.20	-3.01	8.36	-25.20	9.09	397.82
58	17/11/2023	16:02 - 16:32	351.92	390.04	516.26	-20.41	-10.87	221.84	416.72	379.96
59	17/11/2023	17:02 - 17:32	370.72	410.62	537.93	-1.61	9.71	-15.68	2.61	399.25
60	17/11/2023	19:02 - 19:32	354.49	394.17	514.59	-17.85	-6.74	120.32	318.50	382.59
61	17/11/2023	20:02 - 20:32	353.49	393.50	514.46	-18.84	-7.41	139.68	355.10	381.57
62	17/11/2023	21:02 - 21:32	355.27	391.24	513.79	-17.06	-9.67	164.95	291.06	383.40
63	17/11/2023	22:02 - 22:32	350.58	381.62	498.11	-21.76	-19.30	419.80	473.35	378.58

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

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
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Industrial Emissions Licence: P0029-06

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	x - x_av (A)	y - y_av (B)	(A) x (B)	(x - x_av)²	CAL CEM (STP, WET) mg/m³
64	17/11/2023	23:02 - 23:32	361.23	401.02	519.27	-11.10	0.11	-1.26	123.25	389.52
65	18/11/2023	00:02 - 00:32	352.88	388.59	506.27	-19.46	-12.32	239.78	378.55	380.94
66	18/11/2023	01:02 - 01:32	382.16	425.70	533.18	9.82	24.78	243.50	96.52	410.99
67	18/11/2023	02:02 - 02:32	368.65	410.04	521.95	-3.69	9.13	-33.64	13.58	397.13
68	18/11/2023	03:02 - 03:32	352.40	391.42	511.20	-19.94	-9.49	189.12	397.42	380.45
69	18/11/2023	04:02 - 04:32	387.68	430.86	557.05	15.34	29.95	459.53	235.42	416.66
70										
71										
72										
73										
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MAX SRM - MIN SRM	720.09	
(DAILY) DELV (mg/m³)	500	
95% CI MU (%)	20	
95% CI at DELV (mg/m³)	100.0	
15% of ELV	75.0	
PROCEDURE (A, B, C)	A	

SUM	207680.58	202356.28

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/m³	y, SRM (STP, WET) mg/m³	Reason for Data Pair Removal (Statistical Outliers removed following outlier test, other data removed prior to this test)
1	15/11/2023	08:02 - 08:32	331.36	0.00	SRM offline/calibrating
2	15/11/2023	14:02 - 14:32	431.51	0.00	SRM offline/calibrating
3	15/11/2023	16:02 - 16:32	361.46	0.00	SRM offline/calibrating
4	16/11/2023	08:02 - 08:32	358.61	0.00	SRM offline/calibrating
5	16/11/2023	16:02 - 16:32	358.20	0.00	SRM offline/calibrating
6	17/11/2023	08:02 - 08:32	451.05	0.00	SRM offline/calibrating
7	14/11/2023	22:02 - 22:32	378.40	405.90	Peripheral data outliers (Water Vapour)
8	15/11/2023	03:02 - 03:32	390.19	405.55	Peripheral data outliers (Water Vapour)
9	17/11/2023	14:02 - 14:32	499.36	556.89	Peripheral data outliers (Water Vapour)
10	17/11/2023	18:02 - 18:32	370.91	411.22	Peripheral data outliers (Water Vapour)
11	16/11/2023	12:02 - 12:32	316.66	328.79	Peripheral data outliers (Oxygen)
12	16/11/2023	13:02 - 13:32	388.77	409.55	Peripheral data outliers (Oxygen)
13	16/11/2023	14:02 - 14:32	357.65	378.19	Peripheral data outliers (Oxygen)
14	16/11/2023	15:02 - 15:32	375.26	403.03	Peripheral data outliers (Oxygen)
15	16/11/2023	15:02 - 15:32	375.26	403.03	Peripheral data outliers (Oxygen)
16	15/11/2023	13:02 - 13:32	432.94	482.81	Statistical outlier
17					
18					
19					
20					
21					
22					
23					
24					
25					

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OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Derivation of Calibration Function
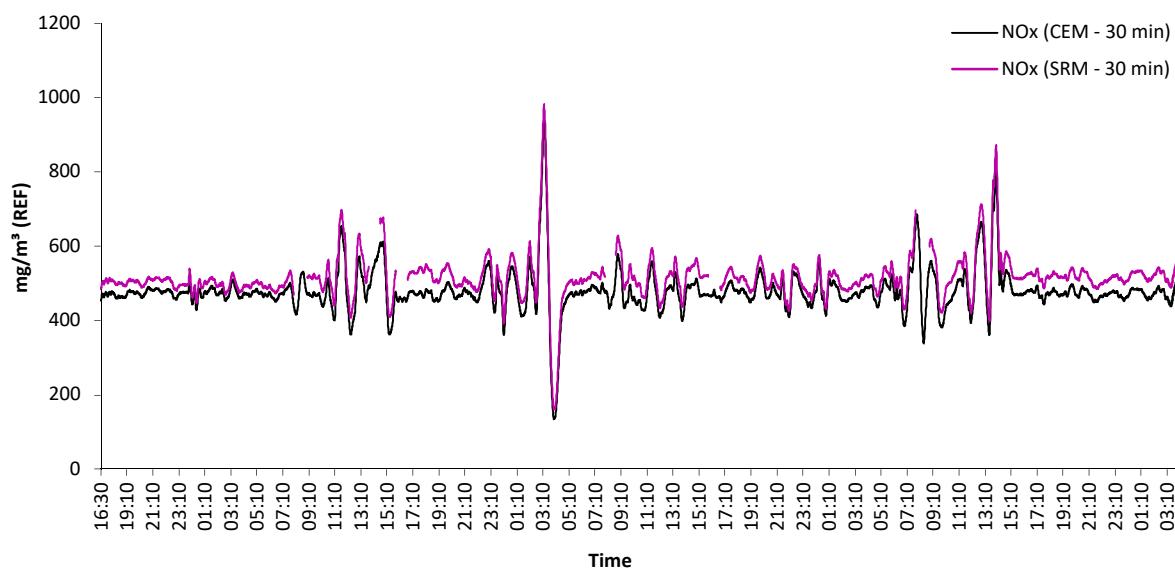
b =	1.0263	a =	18.7805		**CALIBRATION FUNCTION =**	**y = 1.0263x + 18.7805**

where

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

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

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

PLOT 2: Calibration Graph for Procedure A

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OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

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A2-01 Kiln 6 [Standby Analyser]

Variability Test Data

where CAL = Calibrated using QAL2 calibration functions

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CAL CEM Oxygen (DRY) % v/v		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	ys, SRM - CAL CEM
						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	406.98	11.21	10.55	10.47	11.17	N/A	11.11	508.98	510.30	473.05	1.31
2	14/11/2023	18:02 - 18:32	411.92	11.03	10.38	10.34	11.09	N/A	11.03	510.06	506.27	474.32	-3.78
3	14/11/2023	19:02 - 19:32	402.52	10.73	10.09	10.00	11.22	N/A	11.17	503.37	495.65	467.58	-7.72
4	14/11/2023	20:02 - 20:32	401.34	11.79	11.09	11.16	11.21	N/A	11.17	507.35	499.81	471.21	-7.54
5	14/11/2023	21:02 - 21:32	408.55	12.13	11.41	11.50	11.20	N/A	11.18	517.90	509.02	481.43	-8.88
6	14/11/2023	23:02 - 23:32	396.56	11.10	10.45	10.44	11.38	N/A	11.32	506.24	492.34	469.90	-13.89
7	15/11/2023	00:02 - 00:32	387.92	10.67	10.04	10.01	11.32	N/A	11.27	489.97	474.18	454.30	-15.79
8	15/11/2023	01:02 - 01:32	417.58	11.62	10.93	10.94	10.90	N/A	10.91	510.64	503.49	475.17	-7.15
9	15/11/2023	02:02 - 02:32	400.16	11.77	11.07	11.12	11.17	N/A	11.17	503.56	491.13	467.63	-12.44
10	15/11/2023	04:02 - 04:32	405.74	11.68	10.99	11.04	11.15	N/A	11.13	509.19	492.82	473.18	-16.37
11	15/11/2023	05:02 - 05:32	418.33	11.66	10.97	10.98	11.06	N/A	11.05	520.23	508.01	484.14	-12.23
12	15/11/2023	06:02 - 06:32	402.18	11.34	10.67	10.66	11.33	N/A	11.29	512.25	495.16	475.81	-17.09
13	15/11/2023	07:02 - 07:32	401.95	11.40	10.73	10.74	11.30	N/A	11.27	510.35	493.41	474.03	-16.94
14	15/11/2023	09:02 - 09:32	397.58	11.39	10.71	10.72	11.37	N/A	11.36	508.41	519.43	471.97	11.02
15	15/11/2023	10:02 - 10:32	393.92	10.64	10.01	9.91	10.96	N/A	10.98	479.71	487.23	445.12	7.53
16	15/11/2023	11:02 - 11:32	351.42	11.12	10.46	10.44	11.05	N/A	11.12	433.99	440.89	400.27	6.90
17	15/11/2023	12:02 - 12:32	376.50	10.79	10.15	10.09	11.34	N/A	11.32	476.93	486.03	441.52	9.10
18	15/11/2023	15:02 - 15:32	376.04	12.10	11.38	11.48	11.67	N/A	11.52	500.17	516.20	463.00	16.03
19	15/11/2023	17:02 - 17:32	422.34	11.17	10.51	10.45	10.91	N/A	11.06	514.32	531.15	478.85	16.82
20	15/11/2023	18:02 - 18:32	426.93	11.82	11.12	11.13	10.77	N/A	10.98	516.67	547.78	481.27	31.12
21	15/11/2023	19:02 - 19:32	392.29	11.52	10.84	10.80	11.08	N/A	11.18	488.06	503.01	452.78	14.95
22	15/11/2023	20:02 - 20:32	414.99	11.50	10.82	10.79	11.16	N/A	11.23	519.99	524.36	483.73	4.38
23	15/11/2023	21:02 - 21:32	414.91	11.67	10.98	10.97	11.21	N/A	11.27	523.49	515.59	486.98	-7.90
24	15/11/2023	22:02 - 22:32	373.41	11.07	10.41	10.37	11.55	N/A	11.59	485.35	478.28	449.12	-7.07
25	15/11/2023	23:02 - 23:32	445.69	10.92	10.28	10.24	11.52	N/A	11.54	576.25	569.52	537.82	-6.73
26	16/11/2023	00:02 - 00:32	313.42	10.80	10.16	10.13	11.33	N/A	11.37	396.73	394.73	363.39	-2.00
27	16/11/2023	01:02 - 01:32	413.10	11.62	10.93	11.00	11.33	N/A	11.36	527.73	525.54	490.83	-2.19
28	16/11/2023	02:02 - 02:32	474.58	11.33	10.66	10.58	11.40	N/A	11.47	608.55	609.98	569.48	1.44
29	16/11/2023	03:02 - 03:32	709.27	11.74	11.04	11.13	11.18	N/A	11.25	893.22	892.97	847.27	-0.25
30	16/11/2023	04:02 - 04:32	138.63	11.62	10.93	10.95	11.21	N/A	11.32	174.82	172.87	147.26	-1.95
31	16/11/2023	05:02 - 05:32	400.20	11.85	11.14	11.18	11.17	N/A	11.22	504.11	501.73	468.14	-2.39
32	16/11/2023	06:02 - 06:32	403.82	11.58	10.89	10.84	11.22	N/A	11.24	509.83	504.53	473.65	-5.30
33	16/11/2023	07:02 - 07:32	423.25	11.20	10.54	10.50	11.06	N/A	11.09	523.44	523.87	487.39	0.43
34	16/11/2023	09:02 - 09:32	456.54	10.57	9.95	9.88	11.36	N/A	11.39	578.25	591.99	540.25	13.74
35	16/11/2023	10:02 - 10:32	386.61	11.14	10.48	10.47	11.46	N/A	11.52	497.82	514.90	461.49	17.09
36	16/11/2023	11:02 - 11:32	387.18	11.29	10.62	10.65	11.31	N/A	11.47	491.47	487.62	455.65	-3.85
37	16/11/2023	17:02 - 17:32	396.52	12.36	11.62	11.64	11.24	N/A	11.30	505.45	504.42	469.17	-1.04
38	16/11/2023	18:02 - 18:32	414.04	12.06	11.35	11.33	11.01	N/A	11.10	514.50	510.57	478.57	-3.94
39	16/11/2023	19:02 - 19:32	376.91	11.92	11.21	11.16	11.43	N/A	11.54	487.73	476.71	451.55	-11.03
40	16/11/2023	20:02 - 20:32	426.87	11.96	11.25	11.24	11.22	N/A	11.28	541.17	533.11	504.10	-8.06
41	16/11/2023	21:02 - 21:32	393.31	12.20	11.47	11.51	11.37	N/A	11.48	507.30	497.48	470.69	-9.82
42	16/11/2023	22:02 - 22:32	350.08	11.83	11.12	11.13	11.36	N/A	11.44	449.33	431.74	414.32	-17.59
43	16/11/2023	23:02 - 23:32	419.96	12.31	11.58	11.60	10.67	N/A	10.70	505.55	490.02	470.56	-15.53
44	17/11/2023	00:02 - 00:32	398.84	12.28	11.55	11.62	11.34	N/A	11.41	513.67	496.13	476.93	-17.54
45	17/11/2023	01:02 - 01:32	425.08	12.00	11.29	11.31	11.31	N/A	11.36	543.98	524.22	506.62	-19.76
46	17/11/2023	02:02 - 02:32	387.55	12.18	11.45	11.42	11.17	N/A	11.30	489.65	484.75	453.97	-4.90
47	17/11/2023	03:02 - 03:32	388.91	11.90	11.20	11.20	11.55	N/A	11.62	509.83	499.53	472.77	-10.31
48	17/11/2023	04:02 - 04:32	405.74	11.60	10.91	10.99	11.45	N/A	11.51	524.48	518.73	487.38	-5.75
49	17/11/2023	05:02 - 05:32	406.35	11.58	10.90	10.98	11.20	N/A	11.27	512.08	506.40	475.89	-5.68
50	17/11/2023	06:02 - 06:32	409.54	11.75	11.05	11.07	11.25	N/A	11.27	519.33	517.10	482.81	-2.23
51	17/11/2023	07:02 - 07:32	359.84	11.15	10.49	10.46	11.32	N/A	11.31	456.73	466.20	421.80	9.47
52	17/11/2023	09:02 - 09:32	453.73	12.04	11.33	11.38	11.22	N/A	11.18	575.44	594.56	537.48	19.12
53	17/11/2023	10:02 - 10:32	365.72	11.53	10.84	10.83	11.43	N/A	11.39	471.74	485.80	436.04	14.06
54	17/11/2023	11:02 - 11:32	436.27	11.72	11.02	11.03	11.10	N/A	11.00	544.87	557.42	508.05	12.55
55	17/11/2023	12:02 - 12:32	347.45	10.98	10.33	10.22	11.33	N/A	11.21	440.61	428.25	406.11	-12.36
56	17/11/2023	13:02 - 13:32	466.89	12.08	11.36	11.46	11.38	N/A	11.23	602.61	611.05	563.54	8.44
57	17/11/2023	15:02 - 15:32	397.82	11.03	10.38	10.34	11.90	N/A	11.77	536.58	544.20	498.15	7.61
58	17/11/2023	16:02 - 16:32	379.96	10.94	10.29	10.34	11.86	N/A	11.73	509.80	516.26	472.18	6.46
59	17/11/2023	17:02 - 17:32	399.25	10.85	10.21	10.14	11.79	N/A	11.66	530.88	537.93	492.94	7.05
60	17/11/2023	19:02 - 19:32	382.59	11.14	10.48	10.38	11.68	N/A	11.60	504.49	514.59	467.43	10.09
61	17/11/2023	20:02 - 20:32	381.57	10.83	10.19	10.17	11.74	N/A	11.63	504.63	514.46	467.49	9.83
62	17/11/2023	21:02 - 21:32	383.40	11.61	10.92	10.91	11.70	N/A	11.60	508.96	513.79	471.62	4.83
63	17/11/2023	22:02 - 22:32	378.58	11.19	10.53	10.50	11.72	N/A	11.58	501.28	498.11	464.20	-3.17

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OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CAL CEM Oxygen (DRY) % v/v		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	ys, SRM - CAL CEM
								where CAL = Calibrated using QAL2 calibration functions					
64	17/11/2023	23:02 - 23:32	389.52	11.35	10.68	10.68	11.63	N/A	11.49	512.11	519.27	474.93	7.15
65	18/11/2023	00:02 - 00:32	380.94	11.30	10.63	10.63	11.65	N/A	11.55	501.35	506.27	464.41	4.92
66	18/11/2023	01:02 - 01:32	410.99	11.45	10.78	10.71	11.25	N/A	11.16	519.62	533.18	483.17	13.55
67	18/11/2023	02:02 - 02:32	397.13	11.43	10.75	10.69	11.39	N/A	11.32	509.36	521.95	472.84	12.58
68	18/11/2023	03:02 - 03:32	380.45	11.77	11.07	11.09	11.59	N/A	11.53	500.31	511.20	463.42	10.90
69	18/11/2023	04:02 - 04:32	416.66	11.51	10.83	10.89	11.53	N/A	11.45	542.71	557.05	504.96	14.34
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89													
90													
									MAX	**AVERAGE**	**AVERAGE**	**Sd**	
									893.22	510.64	474.28	11.20	

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	51.02
Kv for 69 Pairs of Data	0.9885

The variability is accepted if Sd ≤ Q_o x Kv.

Parameter	Value
Standard Deviation (Sd)	11.20
Q_o x Kv	50.43
Outcome of Variability Test	**Pass**

Valid Calibration Range

Maximum CAL CEM Value (mg/m³)	893.2

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/m³)	0 to 982.5
b) Calibrated Range (20% of Daily ELV) (mg/m³)	0 to 100.0

Greater of (a) or (b)	0 to 982.5

Surrogate Extension Applied?	No

Valid Calibration Range (at REF conditions)	**0 to 982.5 mg/m³**
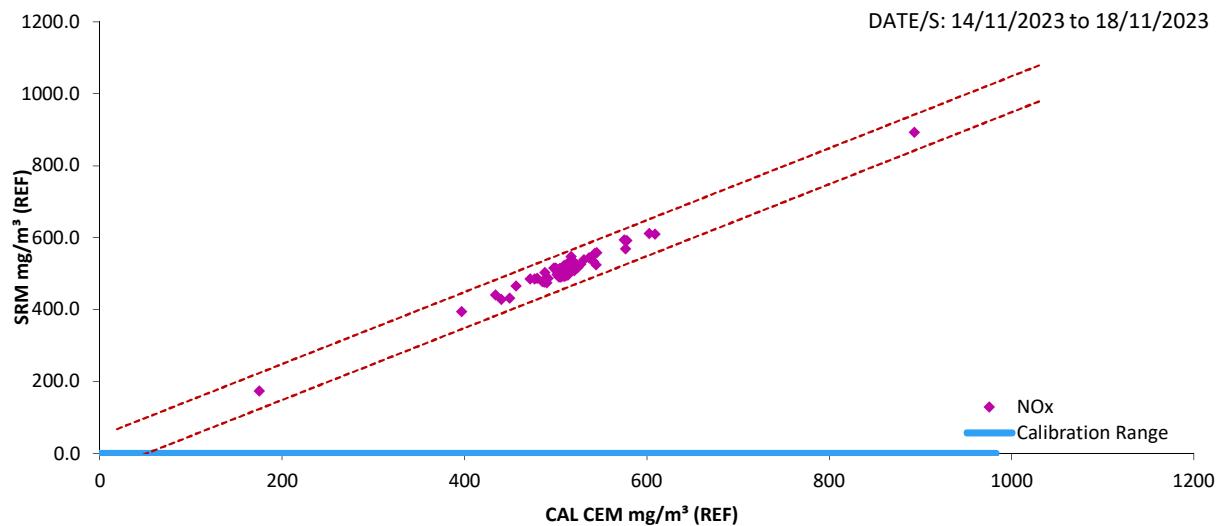
Irish Cement Ltd
Limerick
A2-01 Kiln 6 [Standby Analyser]

EL-LS-OP-SE-X-EWB 105 (Version AI)
22 of 77

Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06

OXIDES OF NITROGEN (as NO₂): QAL2 CALCULATIONS

(Page 6 of 6)

Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

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

DATE/S: 14/11/2023 to 18/11/2023

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 1 of 6)

Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	x - x$_{av}$ (A)	y - y$_{av}$ (B)	(A) x (B)	(x - x$_{av}$)²	CAL CEM (STP, WET) mg/m³
H1	Surrogate	High	38.73	38.66	38.66	35.94	34.22	1229.93	1291.48	37.86
L1	Surrogate	Near Zero	0.26	0.00	0.00	-2.53	-4.44	11.23	6.41	2.08
1	14/11/2023	12:00 - 13:00	2.60	1.11	1.38	-0.19	-3.32	0.64	0.04	4.26
2	14/11/2023	13:30 - 14:32	0.00	4.02	5.20	-2.79	-0.42	1.16	7.80	1.84
3	14/11/2023	14:45 - 15:52	0.00	2.64	3.41	-2.79	-1.79	5.01	7.80	1.84
4	15/11/2023	08:56 - 09:58	0.00	2.48	3.02	-2.79	-1.96	5.46	7.80	1.84
5	15/11/2023	10:00 - 11:00	6.94	5.12	6.10	4.15	0.68	2.83	17.20	8.29
6	15/11/2023	11:05 - 12:05	0.00	5.28	6.72	-2.79	0.84	-2.35	7.80	1.84
7	15/11/2023	12:07 - 13:07	1.74	3.29	4.02	-1.05	-1.15	1.21	1.11	3.46
8	15/11/2023	13:10 - 14:10	0.00	1.85	2.29	-2.79	-2.58	7.21	7.80	1.84
9	15/11/2023	14:12 - 15:15	0.00	1.98	2.58	-2.79	-2.45	6.85	7.80	1.84
10	15/11/2023	15:15 - 16:15	0.00	0.80	1.03	-2.79	-3.64	10.16	7.80	1.84
11	16/11/2023	09:47 - 10:48	0.00	2.73	3.53	-2.79	-1.70	4.75	7.80	1.84
12	16/11/2023	10:50 - 11:52	0.00	1.63	2.08	-2.79	-2.81	7.84	7.80	1.84
13	16/11/2023	11:54 - 12:55	0.00	0.79	1.02	-2.79	-3.65	10.18	7.80	1.84
14	16/11/2023	12:58 - 13:58	0.00	2.85	3.63	-2.79	-1.59	4.43	7.80	1.84
15	16/11/2023	14:00 - 15:02	0.00	2.06	2.63	-2.79	-2.38	6.63	7.80	1.84
16	16/11/2023	15:05 - 16:07	0.00	2.54	3.28	-2.79	-1.89	5.29	7.80	1.84
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Irish Cement Ltd
Limerick
A2-01 Kiln 6 [Standby Analyser]

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06

SULPHUR DIOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	x - x_av (A)	y - y_av (B)	(A) x (B)	(x - x_av)²	CAL CEM (STP, WET) mg/m³
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MAX SRM - MIN SRM	5.70	
(DAILY) DELV (mg/m³)	50	
95% CI MU (%)	20	
95% CI at DELV (mg/m³)	10.0	
15% of ELV	7.5	
PROCEDURE (A, B, C)	C	

SUM	1318.47

(x - x_av)² column SUM: 1417.64

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/m³	y, SRM (STP, WET) mg/m³	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	0.00	15.01	Statistical outlier
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Irish Cement Ltd
Limerick
A2-01 Kiln 6 [Standby Analyser]

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06

SULPHUR DIOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Derivation of Calibration Function

b =	0.9300	a =	1.8381
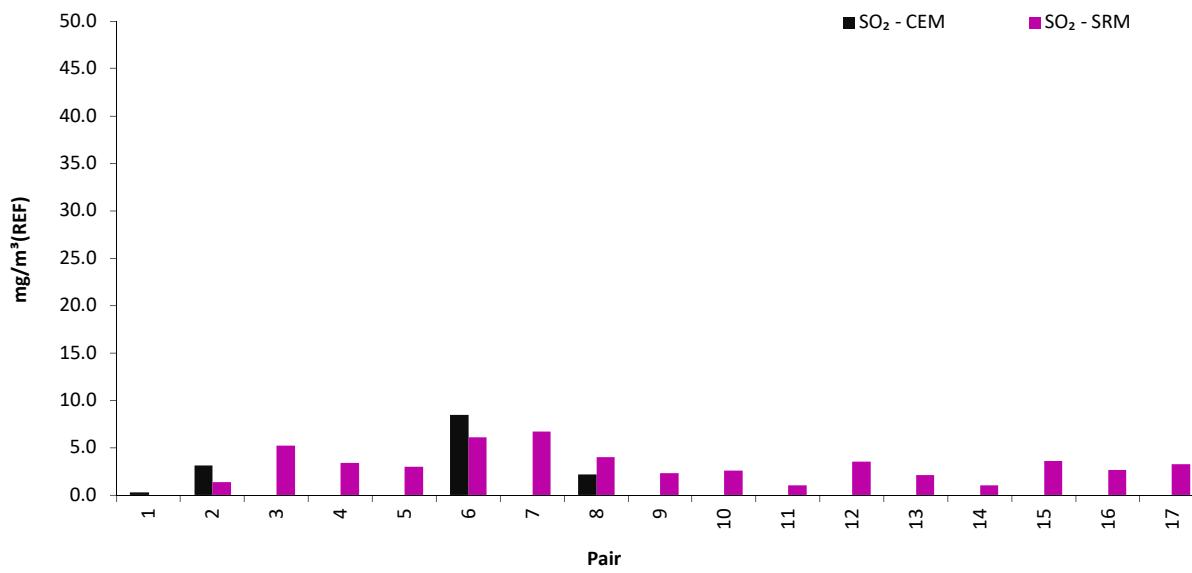
CALIBRATION FUNCTION =	y = 0.9300x + 1.8381

where

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

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

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

PLOT 2: Calibration Graph for Procedure C

SULPHUR DIOXIDE: QAL2 CALCULATIONS

(Page 4 of 6)

Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Variability Test Data

where CAL = Calibrated using QAL2 calibration functions

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CAL CEM Oxygen (DRY) % v/v		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	ys, SRM - CAL CEM
H1	Surrogate	High	37.86	N/A	N/A	N/A	N/A	N/A	N/A	37.86	38.66	38.73	0.80
L1	Surrogate	Near Zero	2.08	N/A	N/A	N/A	N/A	N/A	N/A	2.08	0.00	0.26	-2.08
1	14/11/2023	12:00 - 13:00	4.26	12.04	11.33	10.10	10.62	N/A	11.13	5.08	1.38	3.11	-3.70
2	14/11/2023	13:30 - 14:32	1.84	11.16	10.50	10.78	11.63	N/A	11.47	2.41	5.20	0.00	2.79
3	14/11/2023	14:45 - 15:52	1.84	11.98	11.27	9.76	11.07	N/A	11.54	2.29	3.41	0.00	1.11
4	15/11/2023	08:56 - 09:58	1.84	11.45	10.77	9.25	11.38	N/A	11.06	2.36	3.02	0.00	0.67
5	15/11/2023	10:00 - 11:00	8.29	10.62	9.99	10.13	10.99	N/A	10.73	10.13	6.10	8.48	-4.03
6	15/11/2023	11:05 - 12:05	1.84	10.95	10.30	9.55	11.12	N/A	11.44	2.28	6.72	0.00	4.44
7	15/11/2023	12:07 - 13:07	3.46	10.81	10.17	10.00	11.32	N/A	10.99	4.37	4.02	2.20	-0.35
8	15/11/2023	13:10 - 14:10	1.84	12.05	11.33	9.96	10.84	N/A	11.10	2.24	2.29	0.00	0.04
9	15/11/2023	14:12 - 15:15	1.84	12.72	11.97	12.42	11.10	N/A	11.33	2.32	2.58	0.00	0.25
10	15/11/2023	15:15 - 16:15	1.84	11.80	11.10	10.75	11.60	N/A	11.45	2.42	1.03	0.00	-1.39
11	16/11/2023	09:47 - 10:48	1.84	11.23	10.56	9.93	11.39	N/A	11.53	2.35	3.53	0.00	1.18
12	16/11/2023	10:50 - 11:52	1.84	11.28	10.61	9.08	11.47	N/A	11.53	2.37	2.08	0.00	-0.29
13	16/11/2023	11:54 - 12:55	1.84	11.98	11.27	9.36	11.38	N/A	11.57	2.37	1.02	0.00	-1.35
14	16/11/2023	12:58 - 13:58	1.84	11.76	11.06	9.69	11.08	N/A	11.45	2.29	3.63	0.00	1.34
15	16/11/2023	14:00 - 15:02	1.84	11.96	11.25	7.97	11.51	N/A	11.62	2.40	2.63	0.00	0.22
16	16/11/2023	15:05 - 16:07	1.84	12.47	11.73	9.19	11.37	N/A	11.62	2.38	3.28	0.00	0.90
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Irish Cement Ltd
Limerick
A2-01 Kiln 6 [Standby Analyser]

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06

SULPHUR DIOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Variability Test Data (continued)

where CAL = Calibrated using QAL2 calibration functions

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CAL CEM Oxygen (DRY) % v/v		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	ys, SRM - CAL CEM
64													
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									MAX	**AVERAGE**	**AVERAGE**	**Sd**
									10.13	3.24	0.86	2.11

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	5.10
Kv for 16 Pairs of Data	0.9777

The variability is accepted if Sd $\leq Q_o$ x Kv.

Parameter	Value
Standard Deviation (Sd)	2.11
Q_o x Kv	4.99
Outcome of Variability Test	**Pass**

Procedure C Acceptability Test

Average of UNCAL CEM (1)	0.86
Average of SRM (2)	3.24
ABS Difference (1) & (2)	2.38
Outcome of Procedure C Acceptability Test	**Pass**

Valid Calibration Range

Maximum CAL CEM Value (mg/m³)	10.1

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/m³)	0 to 11.1
b) Calibrated Range (20% of Daily ELV) (mg/m³)	0 to 10.0

Greater of (a) or (b)	0 to 11.1

Surrogate Extension Applied?	NOT PERMISSIBLE

Valid Calibration Range (at REF conditions)	**0 to 11.1 mg/m³**
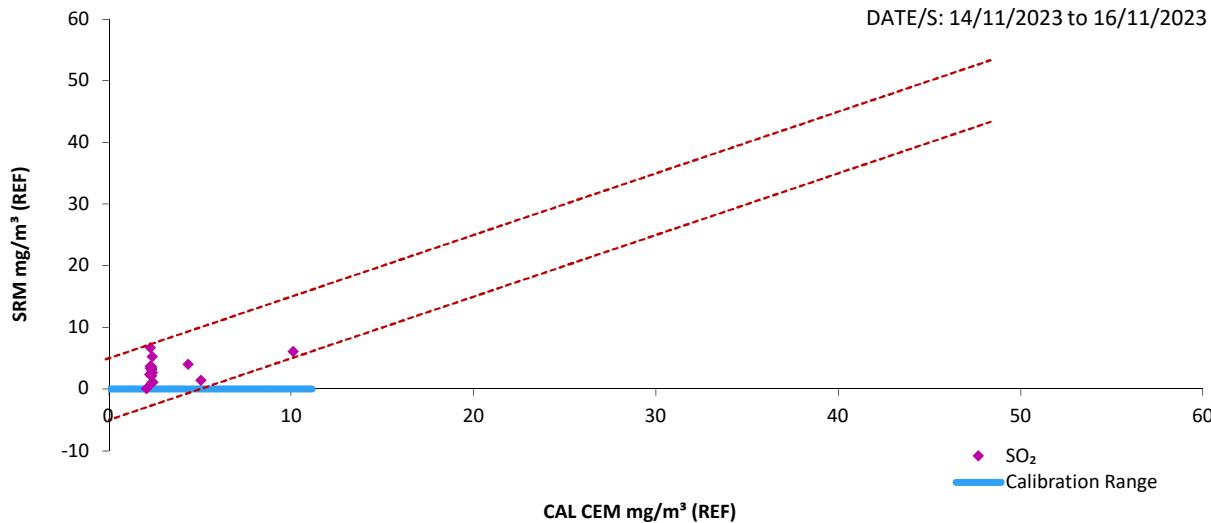
Irish Cement Ltd
Limerick
A2-01 Kiln 6 [Standby Analyser]

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06

SULPHUR DIOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

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

DATE/S: 14/11/2023 to 16/11/2023

SRM mg/m³ (REF)

CAL CEM mg/m³ (REF)

◆ SO₂

Calibration Range

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

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06

CARBON MONOXIDE: QAL2 CALCULATIONS

(Page 1 of 6)

Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	x - x_av (A)	y - y_av (B)	(A) x (B)	(x - x_av)²	CAL CEM (STP, WET) mg/m³
L1	Surrogate	Near Zero	0.06	0.00	0.00	-229.97	-229.84	52857.56	52888.46	0.00
1	14/11/2023	17:02 - 17:32	244.55	242.94	301.71	14.51	13.10	190.14	210.66	244.35
2	14/11/2023	18:02 - 18:32	253.21	251.29	309.30	23.18	21.45	497.21	537.17	253.00
3	14/11/2023	19:02 - 19:32	254.44	253.38	315.05	24.41	23.54	574.64	595.78	254.23
4	14/11/2023	20:02 - 20:32	243.09	241.94	304.63	13.06	12.10	158.04	170.51	242.89
5	14/11/2023	21:02 - 21:32	250.90	249.21	315.53	20.86	19.36	403.98	435.22	250.69
6	14/11/2023	23:02 - 23:32	249.33	248.64	315.52	19.29	18.80	362.81	372.28	249.12
7	15/11/2023	00:02 - 00:32	279.38	281.86	354.06	49.35	52.02	2567.20	2435.29	279.16
8	15/11/2023	01:02 - 01:32	265.12	264.06	323.33	35.09	34.22	1200.48	1231.03	264.91
9	15/11/2023	02:02 - 02:32	254.82	254.53	320.31	24.78	24.69	611.76	614.09	254.61
10	15/11/2023	04:02 - 04:32	255.82	254.66	319.06	25.79	24.82	640.16	665.09	255.61
11	15/11/2023	05:02 - 05:32	258.14	256.56	318.50	28.10	26.72	750.83	789.84	257.93
12	15/11/2023	06:02 - 06:32	255.00	252.98	320.71	24.97	23.14	577.87	623.46	254.80
13	15/11/2023	07:02 - 07:32	254.70	253.31	320.92	24.67	23.47	578.92	608.54	254.49
14	15/11/2023	09:02 - 09:32	233.54	234.60	299.87	3.61	4.76	17.19	13.05	233.45
15	15/11/2023	10:02 - 10:32	267.10	267.98	326.54	37.06	38.14	1413.63	1373.80	266.88
16	15/11/2023	11:02 - 11:32	266.91	269.97	335.48	36.88	40.13	1479.81	1359.91	266.70
17	15/11/2023	12:02 - 12:32	236.90	237.89	300.67	6.86	8.05	55.22	47.07	236.70
18	15/11/2023	13:02 - 13:32	185.78	185.37	230.96	-44.25	-44.47	1968.02	1958.24	185.61
19	15/11/2023	17:02 - 17:32	274.79	276.95	342.38	44.76	47.11	2108.31	2003.08	274.57
20	15/11/2023	18:02 - 18:32	268.07	271.59	335.63	38.04	41.75	1587.79	1446.67	267.85
21	15/11/2023	19:02 - 19:32	259.11	260.61	327.20	29.08	30.77	894.72	845.36	258.90
22	15/11/2023	20:02 - 20:32	243.35	242.62	306.15	13.32	12.78	170.16	177.40	243.15
23	15/11/2023	21:02 - 21:32	249.40	247.30	314.19	19.37	17.46	338.16	375.14	249.20
24	15/11/2023	22:02 - 22:32	260.90	258.99	337.77	30.87	29.15	899.69	952.83	260.69
25	15/11/2023	23:02 - 23:32	231.44	230.66	298.72	1.41	0.82	1.15	1.99	231.25
26	16/11/2023	00:02 - 00:32	304.59	304.63	387.01	74.55	74.79	5575.45	5557.84	304.35
27	16/11/2023	01:02 - 01:32	230.10	229.45	294.27	0.06	-0.39	-0.02	0.00	229.90
28	16/11/2023	02:02 - 02:32	286.74	290.04	374.21	56.70	60.20	3413.30	3215.28	286.51
29	16/11/2023	03:02 - 03:32	220.39	219.11	278.05	-9.64	-10.74	103.51	92.97	220.20
30	16/11/2023	05:02 - 05:32	256.09	256.17	324.48	26.05	26.33	685.87	678.62	255.88
31	16/11/2023	06:02 - 06:32	271.24	271.49	343.03	41.21	41.65	1716.48	1698.15	271.03
32	16/11/2023	07:02 - 07:32	275.80	277.29	343.86	45.76	47.45	2171.65	2094.38	275.58
33	16/11/2023	09:02 - 09:32	237.61	239.63	304.29	7.57	9.79	74.08	57.31	237.41
34	16/11/2023	10:02 - 10:32	237.38	240.74	312.07	7.35	10.90	80.04	53.97	237.18
35	16/11/2023	11:02 - 11:32	241.67	240.23	310.24	11.64	10.39	120.98	135.47	241.47
36	16/11/2023	17:02 - 17:32	214.64	213.76	274.42	-15.39	-16.08	247.52	236.88	214.46
37	16/11/2023	18:02 - 18:32	205.57	203.30	254.77	-24.46	-26.54	649.27	598.52	205.39
38	16/11/2023	19:02 - 19:32	208.48	206.32	269.97	-21.55	-23.52	506.86	464.49	208.30
39	16/11/2023	20:02 - 20:32	195.79	192.91	245.90	-34.25	-36.93	1264.56	1172.80	195.61
40	16/11/2023	21:02 - 21:32	187.84	185.18	241.73	-42.20	-44.66	1884.80	1780.74	187.67
41	16/11/2023	22:02 - 22:32	267.96	267.75	346.78	37.92	37.91	1437.82	1438.21	267.74
42	16/11/2023	23:02 - 23:32	218.79	216.08	261.01	-11.25	-13.76	154.81	126.53	218.60
43	17/11/2023	00:02 - 00:32	211.25	209.33	271.73	-18.79	-20.51	385.40	353.03	211.06
44	17/11/2023	01:02 - 01:32	223.45	221.24	284.65	-6.58	-8.60	56.62	43.31	223.26
45	17/11/2023	02:02 - 02:32	216.55	214.99	275.13	-13.49	-14.85	200.37	181.95	216.36
46	17/11/2023	03:02 - 03:32	203.52	200.95	265.47	-26.52	-28.89	766.19	703.21	203.34
47	17/11/2023	04:02 - 04:32	203.55	202.42	263.46	-26.48	-27.42	726.01	701.19	203.38
48	17/11/2023	05:02 - 05:32	203.67	200.87	255.02	-26.37	-28.97	764.00	695.31	203.49
49	17/11/2023	06:02 - 06:32	214.90	212.65	270.47	-15.13	-17.19	260.11	228.94	214.72
50	17/11/2023	07:02 - 07:32	276.55	280.01	355.05	46.51	50.17	2333.44	2163.32	276.32
51	17/11/2023	09:02 - 09:32	191.12	191.90	242.55	-38.91	-37.94	1476.40	1514.32	190.95
52	17/11/2023	10:02 - 10:32	222.71	224.14	287.72	-7.33	-5.70	41.75	53.69	222.52
53	17/11/2023	11:02 - 11:32	216.92	217.33	268.74	-13.11	-12.51	164.05	171.98	216.73
54	17/11/2023	12:02 - 12:32	256.80	254.79	318.89	26.76	24.95	667.65	716.15	256.59
55	17/11/2023	13:02 - 13:32	181.83	180.23	229.24	-48.21	-49.61	2391.54	2324.15	181.66
56	17/11/2023	14:02 - 14:32	198.81	198.99	262.06	-31.22	-30.85	963.08	974.77	198.64
57	17/11/2023	15:02 - 15:32	196.01	196.75	261.62	-34.02	-33.09	1125.74	1157.45	195.84
58	17/11/2023	16:02 - 16:32	212.89	213.70	282.85	-17.15	-16.14	276.80	294.01	212.70
59	17/11/2023	17:02 - 17:32	205.31	206.29	270.25	-24.73	-23.55	582.24	611.35	205.13
60	17/11/2023	19:02 - 19:32	216.55	217.01	283.30	-13.49	-12.84	173.12	181.92	216.36
61	17/11/2023	20:02 - 20:32	217.00	217.98	284.99	-13.04	-11.86	154.66	170.03	216.81
62	17/11/2023	21:02 - 21:32	201.50	202.27	265.62	-28.53	-27.57	786.78	814.20	201.32
63	17/11/2023	22:02 - 22:32	219.91	219.18	286.08	-10.13	-10.67	108.01	102.56	219.72

Irish Cement Ltd
Limerick
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CARBON MONOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O_2) mg/m³	x - x_{av} (A)	y - y_{av} (B)	(A) x (B)	(x - x_{av})²	CAL CEM (STP, WET) mg/m³
64	17/11/2023	23:02 - 23:32	216.55	217.99	282.26	-13.49	-11.85	159.85	181.91	216.36
65	18/11/2023	00:02 - 00:32	214.01	215.53	280.80	-16.03	-14.31	229.38	256.86	213.82
66	18/11/2023	01:02 - 01:32	216.21	217.56	272.50	-13.82	-12.28	169.70	191.08	216.03
67	18/11/2023	02:02 - 02:32	210.95	212.38	270.34	-19.09	-17.46	333.29	364.33	210.76
68	18/11/2023	03:02 - 03:32	207.10	208.14	271.83	-22.93	-21.70	497.63	525.92	206.92
69	18/11/2023	04:02 - 04:32	190.19	190.27	246.00	-39.85	-39.57	1576.75	1587.69	190.02
70										
71										
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MAX SRM - MIN SRM	157.77	
(DAILY) DELV (mg/m³)	1500	
95% CI MU (%)	20	
95% CI at DELV (mg/m³)	300.0	
15% of ELV	225.0	
PROCEDURE (A, B, C)	B	

SUM	110362.99 109398.80

WHERE OFFSET = 0.06

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/m³	y, SRM (STP, WET) mg/m³	Reason for Data Pair Removal (Statistical Outliers removed following outlier test, other data removed prior to this test)
1	15/11/2023	08:02 - 08:32	255.30	0.00	SRM offline/calibrating
2	15/11/2023	14:02 - 14:32	186.49	0.00	SRM offline/calibrating
3	15/11/2023	16:02 - 16:32	271.51	0.00	SRM offline/calibrating
4	16/11/2023	08:02 - 08:32	262.21	0.00	SRM offline/calibrating
5	16/11/2023	16:02 - 16:32	178.99	0.00	SRM offline/calibrating
6	17/11/2023	08:02 - 08:32	237.61	0.00	SRM offline/calibrating
7	14/11/2023	22:02 - 22:32	260.79	260.96	Peripheral data outliers (Water Vapour)
8	15/11/2023	03:02 - 03:32	239.85	237.07	Peripheral data outliers (Water Vapour)
9	17/11/2023	18:02 - 18:32	224.72	224.73	Peripheral data outliers (Water Vapour)
10	16/11/2023	12:02 - 12:32	228.19	227.11	Peripheral data outliers (Oxygen)
11	16/11/2023	13:02 - 13:32	214.68	212.94	Peripheral data outliers (Oxygen)
12	16/11/2023	14:02 - 14:32	225.10	223.61	Peripheral data outliers (Oxygen)
13	16/11/2023	15:02 - 15:32	183.54	181.06	Peripheral data outliers (Oxygen)
14	15/11/2023	15:02 - 15:32	262.73	270.29	Statistical outlier
15	16/11/2023	04:02 - 04:32	391.84	404.06	Statistical outlier
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

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CARBON MONOXIDE: QAL2 CALCULATIONS

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Derivation of Calibration Function
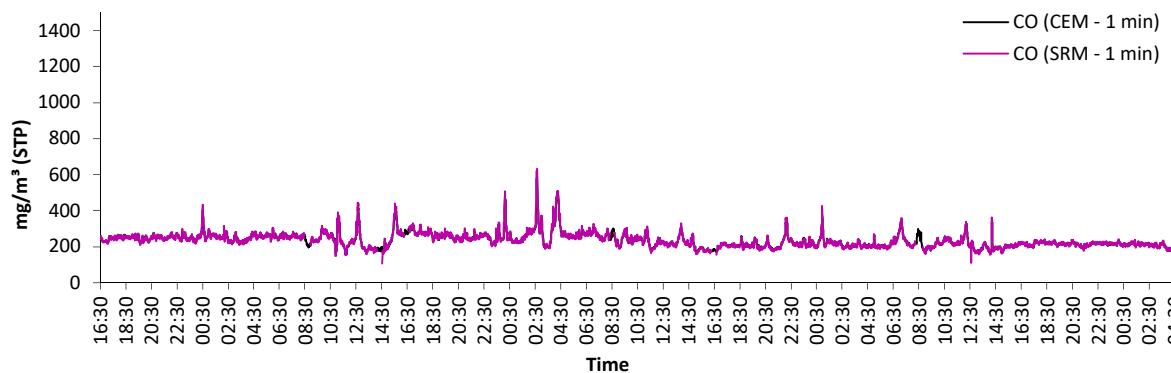
b =	0.9994	a =	-0.0600

CALIBRATION FUNCTION =	**y = 0.9994x - 0.0600**

where

For Procedure A / C   b = [(x - x_{av}) x (y - y_{az})] / (x - x_{av})² and a = MEAN(y) - [MEAN(x) x b]

Procedure B   b = MEAN(y) / [MEAN(x) - OFFSET] and a = -b x 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

y = 0.9994x - 0.06
R² = 1

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Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CAL CEM Oxygen (DRY) % v/v		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O_2) mg/m³	SRM (STP, DRY, 10% O_2) mg/m³	UNCAL CEM (STP, DRY, 10% O_2) mg/m³	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	0.06	0.00
1	14/11/2023	17:02 - 17:32	244.35	11.21	10.55	10.47	11.17	N/A	11.11	305.59	301.71	305.84	-3.88
2	14/11/2023	18:02 - 18:32	253.00	11.03	10.38	10.34	11.09	N/A	11.03	313.28	309.30	313.54	-3.98
3	14/11/2023	19:02 - 19:32	254.23	10.73	10.09	10.00	11.22	N/A	11.17	317.94	315.05	318.20	-2.88
4	14/11/2023	20:02 - 20:32	242.89	11.79	11.09	11.16	11.21	N/A	11.17	307.05	304.63	307.30	-2.42
5	14/11/2023	21:02 - 21:32	250.69	12.13	11.41	11.50	11.20	N/A	11.18	317.79	315.53	318.05	-2.26
6	14/11/2023	23:02 - 23:32	249.12	11.10	10.45	10.44	11.38	N/A	11.32	318.03	315.52	318.29	-2.51
7	15/11/2023	00:02 - 00:32	279.16	10.67	10.04	10.01	11.32	N/A	11.27	352.60	354.06	352.88	1.47
8	15/11/2023	01:02 - 01:32	264.91	11.62	10.93	10.94	10.90	N/A	10.91	323.94	323.33	324.20	-0.61
9	15/11/2023	02:02 - 02:32	254.61	11.77	11.07	11.12	11.17	N/A	11.17	320.40	320.31	320.66	-0.09
10	15/11/2023	04:02 - 04:32	255.61	11.68	10.99	11.04	11.15	N/A	11.13	320.79	319.06	321.05	-1.72
11	15/11/2023	05:02 - 05:32	257.93	11.66	10.97	10.98	11.06	N/A	11.05	320.76	318.50	321.02	-2.26
12	15/11/2023	06:02 - 06:32	254.80	11.34	10.67	10.66	11.33	N/A	11.29	324.53	320.71	324.79	-3.82
13	15/11/2023	07:02 - 07:32	254.49	11.40	10.73	10.74	11.30	N/A	11.27	323.13	320.92	323.39	-2.20
14	15/11/2023	09:02 - 09:32	233.45	11.39	10.71	10.72	11.37	N/A	11.36	298.53	299.87	298.78	1.34
15	15/11/2023	10:02 - 10:32	266.88	10.64	10.01	9.91	10.96	N/A	10.98	325.00	326.54	325.27	1.54
16	15/11/2023	11:02 - 11:32	266.70	11.12	10.46	10.44	11.05	N/A	11.12	329.36	335.48	329.63	6.12
17	15/11/2023	12:02 - 12:32	236.70	10.79	10.15	10.09	11.34	N/A	11.32	299.84	300.67	300.09	0.83
18	15/11/2023	13:02 - 13:32	185.61	12.36	11.62	11.75	11.03	N/A	11.00	231.69	230.96	231.90	-0.73
19	15/11/2023	17:02 - 17:32	274.57	11.17	10.51	10.45	10.91	N/A	11.06	334.37	342.38	334.64	8.01
20	15/11/2023	18:02 - 18:32	267.85	11.82	11.12	11.13	10.77	N/A	10.98	324.16	335.63	324.42	11.47
21	15/11/2023	19:02 - 19:32	258.90	11.52	10.84	10.80	11.08	N/A	11.18	322.10	327.20	322.37	5.09
22	15/11/2023	20:02 - 20:32	243.15	11.50	10.82	10.79	11.16	N/A	11.23	304.67	306.15	304.93	1.48
23	15/11/2023	21:02 - 21:32	249.20	11.67	10.98	10.97	11.21	N/A	11.27	314.41	314.19	314.67	-0.22
24	15/11/2023	22:02 - 22:32	260.69	11.07	10.41	10.37	11.55	N/A	11.59	338.84	337.77	339.11	-1.07
25	15/11/2023	23:02 - 23:32	231.25	10.92	10.28	10.24	11.52	N/A	11.54	298.99	298.72	299.25	-0.28
26	16/11/2023	00:02 - 00:32	304.35	10.80	10.16	10.13	11.33	N/A	11.37	385.24	387.01	385.54	1.77
27	16/11/2023	01:02 - 01:32	229.90	11.62	10.93	11.00	11.33	N/A	11.36	293.70	294.27	293.95	0.57
28	16/11/2023	02:02 - 02:32	286.51	11.33	10.66	10.58	11.40	N/A	11.47	367.39	374.21	367.68	6.82
29	16/11/2023	03:02 - 03:32	220.20	11.74	11.04	11.13	11.18	N/A	11.25	277.31	278.05	277.55	0.74
30	16/11/2023	05:02 - 05:32	255.88	11.85	11.14	11.18	11.17	N/A	11.22	322.32	324.48	322.58	2.16
31	16/11/2023	06:02 - 06:32	271.03	11.58	10.89	10.84	11.22	N/A	11.24	342.18	343.03	342.45	0.86
32	16/11/2023	07:02 - 07:32	275.58	11.20	10.54	10.50	11.06	N/A	11.09	340.81	343.86	341.09	3.04
33	16/11/2023	09:02 - 09:32	237.41	10.57	9.95	9.88	11.36	N/A	11.39	300.70	304.29	300.95	3.60
34	16/11/2023	10:02 - 10:32	237.18	11.14	10.48	10.47	11.46	N/A	11.52	305.41	312.07	305.67	6.66
35	16/11/2023	11:02 - 11:32	241.47	11.29	10.62	10.65	11.31	N/A	11.47	306.52	310.24	306.78	3.72
36	16/11/2023	17:02 - 17:32	214.46	12.36	11.62	11.64	11.24	N/A	11.30	273.38	274.42	273.61	1.04
37	16/11/2023	18:02 - 18:32	205.39	12.06	11.35	11.33	11.01	N/A	11.10	255.22	254.77	255.45	-0.45
38	16/11/2023	19:02 - 19:32	208.30	11.92	11.21	11.16	11.43	N/A	11.54	269.55	269.97	269.78	0.42
39	16/11/2023	20:02 - 20:32	195.61	11.96	11.25	11.24	11.22	N/A	11.28	247.99	245.90	248.22	-2.09
40	16/11/2023	21:02 - 21:32	187.67	12.20	11.47	11.51	11.37	N/A	11.48	242.05	241.73	242.27	-0.33
41	16/11/2023	22:02 - 22:32	267.74	11.83	11.12	11.13	11.36	N/A	11.44	343.65	346.78	343.92	3.13
42	16/11/2023	23:02 - 23:32	218.60	12.31	11.58	11.60	10.67	N/A	10.70	263.15	261.01	263.38	-2.14
43	17/11/2023	00:02 - 00:32	211.06	12.28	11.55	11.62	11.34	N/A	11.41	271.83	271.73	272.07	-0.10
44	17/11/2023	01:02 - 01:32	223.26	12.00	11.29	11.31	11.31	N/A	11.36	285.72	284.65	285.96	-1.06
45	17/11/2023	02:02 - 02:32	216.36	12.18	11.45	11.42	11.17	N/A	11.30	273.36	275.13	273.59	1.77
46	17/11/2023	03:02 - 03:32	203.34	11.90	11.20	11.20	11.55	N/A	11.62	266.56	265.47	266.80	-1.09
47	17/11/2023	04:02 - 04:32	203.38	11.60	10.91	10.99	11.45	N/A	11.51	262.89	263.46	263.13	0.56
48	17/11/2023	05:02 - 05:32	203.49	11.58	10.90	10.98	11.20	N/A	11.27	256.43	255.02	256.66	-1.41
49	17/11/2023	06:02 - 06:32	214.72	11.75	11.05	11.07	11.25	N/A	11.27	272.28	270.47	272.51	-1.81
50	17/11/2023	07:02 - 07:32	276.32	11.15	10.49	10.46	11.32	N/A	11.31	350.73	355.05	351.01	4.32
51	17/11/2023	09:02 - 09:32	190.95	12.04	11.33	11.38	11.22	N/A	11.18	242.17	242.55	242.39	0.38
52	17/11/2023	10:02 - 10:32	222.52	11.53	10.84	10.83	11.43	N/A	11.39	287.02	287.72	287.27	0.70
53	17/11/2023	11:02 - 11:32	216.73	11.72	11.02	11.03	11.10	N/A	11.00	270.69	268.74	270.92	-1.95
54	17/11/2023	12:02 - 12:32	256.59	10.98	10.33	10.22	11.33	N/A	11.21	325.38	318.89	325.65	-6.50
55	17/11/2023	13:02 - 13:32	181.66	12.08	11.36	11.46	11.38	N/A	11.23	234.47	229.24	234.68	-5.22
56	17/11/2023	14:02 - 14:32	198.64	11.98	11.27	11.41	11.68	N/A	11.57	264.12	262.06	264.35	-2.06
57	17/11/2023	15:02 - 15:32	195.84	11.03	10.38	10.34	11.90	N/A	11.77	264.15	261.62	264.39	-2.54
58	17/11/2023	16:02 - 16:32	212.70	10.94	10.29	10.34	11.86	N/A	11.73	285.39	282.85	285.64	-2.54
59	17/11/2023	17:02 - 17:32	205.13	10.85	10.21	10.14	11.79	N/A	11.66	272.76	270.25	273.00	-2.51
60	17/11/2023	19:02 - 19:32	216.36	11.14	10.48	10.38	11.68	N/A	11.60	285.30	283.30	285.54	-1.99
61	17/11/2023	20:02 - 20:32	216.81	10.83	10.19	10.17	11.74	N/A	11.63	286.73	284.99	286.98	-1.74
62	17/11/2023	21:02 - 21:32	201.32	11.61	10.92	10.91	11.70	N/A	11.60	267.26	265.62	267.49	-1.63
63	17/11/2023	22:02 - 22:32	219.72	11.19	10.53	10.50	11.72	N/A	11.58	290.93	286.08	291.18	-4.85

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CARBON MONOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Variability Test Data (continued)

where CAL = Calibrated using QAL2 calibration functions

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CAL CEM Oxygen (DRY) % v/v		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	ys, SRM - CAL CEM
64	17/11/2023	23:02 - 23:32	216.36	11.35	10.68	10.68	11.63	N/A	11.49	284.46	282.26	284.70	-2.19
65	18/11/2023	00:02 - 00:32	213.82	11.30	10.63	10.63	11.65	N/A	11.55	281.41	280.80	281.65	-0.61
66	18/11/2023	01:02 - 01:32	216.03	11.45	10.78	10.71	11.25	N/A	11.16	273.12	272.50	273.36	-0.63
67	18/11/2023	02:02 - 02:32	210.76	11.43	10.75	10.69	11.39	N/A	11.32	270.33	270.34	270.57	0.01
68	18/11/2023	03:02 - 03:32	206.92	11.77	11.07	11.09	11.59	N/A	11.53	272.11	271.83	272.35	-0.27
69	18/11/2023	04:02 - 04:32	190.02	11.51	10.83	10.89	11.53	N/A	11.45	247.50	246.00	247.73	-1.51
70													
71													
72													
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85													
86													
87													
88													
89													
90													
									MAX	**AVERAGE**	**AVERAGE**		**Sd**
									385.24	296.65	296.91		3.16

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	153.06
Kv for 69 Pairs of Data	0.9885

The variability is accepted if Sd ≤ Q_o x Kv.

Parameter	Value
Standard Deviation (Sd)	3.16
Q_o x Kv	151.30
Outcome of Variability Test	**Pass**

Valid Calibration Range

Maximum CAL CEM Value (mg/m³)	385.2

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/m³)	0 to 423.8
b) Calibrated Range (20% of Daily ELV) (mg/m³)	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/m³) y	1206.7
Reading on CEM (mg/m³) x	1211.0
Cal Reading on CEM (mg/m³) x	1210.2

Valid Calibration Range (at REF conditions)	**0 to 1210.2 mg/m³**
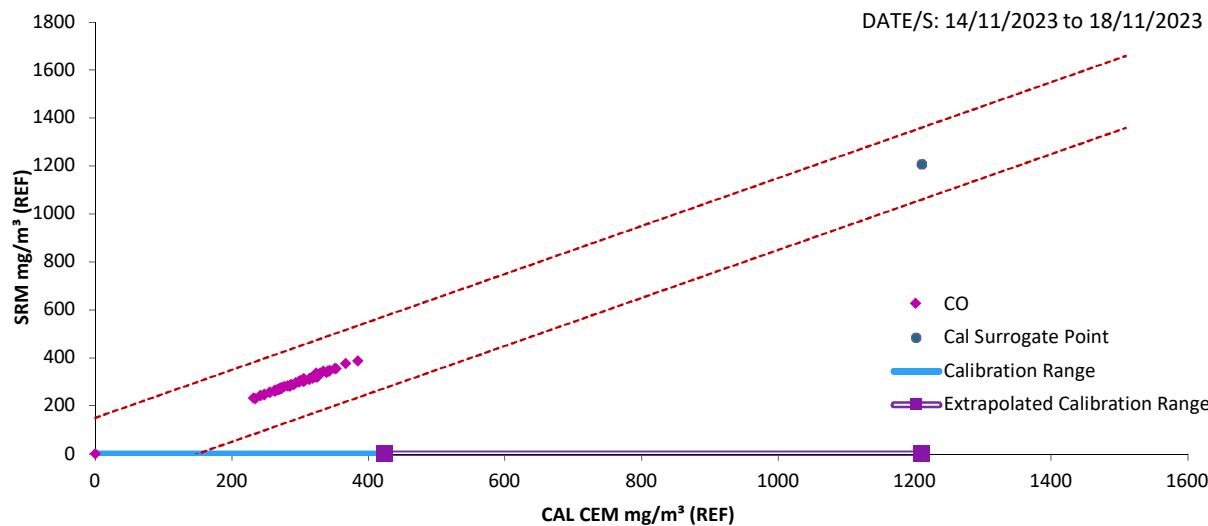
Irish Cement Ltd
Limerick
A2-01 Kiln 6 [Standby Analyser]

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
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CARBON MONOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

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

DATE/S: 14/11/2023 to 18/11/2023

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

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06

HYDROGEN CHLORIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	x - x_av (A)	y - y_av (B)	(A) x (B)	(x - x_av)²	CAL CEM (STP, WET) mg/m³
H1	Surrogate	High	78.85	80.00	80.00	77.16	78.34	6044.62	5953.86	79.98
L1	Surrogate	Near Zero	0.03	0.00	0.00	-1.66	-1.66	2.76	2.75	-0.02
1	14/11/2023	17:02 - 17:32	0.42	0.52	0.64	-1.27	-1.14	1.46	1.62	0.37
2	14/11/2023	18:02 - 18:32	0.45	0.49	0.60	-1.24	-1.18	1.45	1.53	0.41
3	14/11/2023	19:02 - 19:32	0.44	0.49	0.61	-1.25	-1.18	1.46	1.55	0.40
4	14/11/2023	20:02 - 20:32	0.45	0.54	0.68	-1.24	-1.12	1.39	1.54	0.40
5	14/11/2023	21:02 - 21:32	0.42	0.49	0.62	-1.27	-1.18	1.49	1.62	0.37
6	14/11/2023	23:02 - 23:32	0.42	0.55	0.70	-1.27	-1.11	1.41	1.62	0.37
7	15/11/2023	00:02 - 00:32	0.42	0.44	0.55	-1.26	-1.22	1.55	1.60	0.38
8	15/11/2023	01:02 - 01:32	0.50	0.47	0.57	-1.19	-1.20	1.42	1.41	0.46
9	15/11/2023	02:02 - 02:32	0.44	0.55	0.69	-1.25	-1.12	1.40	1.57	0.39
10	15/11/2023	04:02 - 04:32	0.45	0.49	0.62	-1.24	-1.17	1.45	1.54	0.40
11	15/11/2023	05:02 - 05:32	0.46	0.47	0.58	-1.23	-1.19	1.47	1.51	0.42
12	15/11/2023	06:02 - 06:32	0.42	0.45	0.58	-1.27	-1.21	1.53	1.61	0.38
13	15/11/2023	07:02 - 07:32	0.42	0.54	0.68	-1.27	-1.12	1.43	1.62	0.37
14	15/11/2023	09:02 - 09:32	0.41	0.44	0.56	-1.28	-1.22	1.56	1.63	0.37
15	15/11/2023	10:02 - 10:32	0.67	0.48	0.58	-1.01	-1.19	1.21	1.03	0.63
16	15/11/2023	11:02 - 11:32	0.86	0.63	0.78	-0.83	-1.03	0.86	0.69	0.82
17	15/11/2023	12:02 - 12:32	0.59	0.48	0.61	-1.10	-1.18	1.31	1.22	0.54
18	15/11/2023	13:02 - 13:32	0.48	0.45	0.57	-1.21	-1.21	1.46	1.47	0.43
19	15/11/2023	15:02 - 15:32	0.37	0.49	0.64	-1.32	-1.17	1.55	1.74	0.32
20	15/11/2023	17:02 - 17:32	0.41	0.56	0.69	-1.28	-1.10	1.41	1.63	0.37
21	15/11/2023	18:02 - 18:32	0.43	0.46	0.57	-1.26	-1.20	1.51	1.58	0.39
22	15/11/2023	19:02 - 19:32	0.44	0.42	0.52	-1.25	-1.25	1.56	1.57	0.39
23	15/11/2023	20:02 - 20:32	0.41	0.45	0.56	-1.28	-1.22	1.55	1.63	0.37
24	15/11/2023	21:02 - 21:32	0.40	0.45	0.57	-1.29	-1.21	1.56	1.66	0.35
25	15/11/2023	22:02 - 22:32	0.37	0.47	0.61	-1.32	-1.20	1.58	1.75	0.32
26	15/11/2023	23:02 - 23:32	0.39	0.45	0.58	-1.30	-1.21	1.57	1.68	0.35
27	16/11/2023	00:02 - 00:32	0.42	0.42	0.53	-1.27	-1.24	1.58	1.61	0.37
28	16/11/2023	01:02 - 01:32	0.43	0.42	0.54	-1.26	-1.24	1.57	1.60	0.38
29	16/11/2023	02:02 - 02:32	0.41	0.44	0.57	-1.28	-1.22	1.57	1.64	0.36
30	16/11/2023	03:02 - 03:32	0.46	0.42	0.54	-1.23	-1.24	1.53	1.52	0.41
31	16/11/2023	04:02 - 04:32	0.46	0.43	0.55	-1.23	-1.23	1.52	1.51	0.41
32	16/11/2023	05:02 - 05:32	0.45	0.52	0.66	-1.24	-1.14	1.42	1.54	0.40
33	16/11/2023	06:02 - 06:32	0.44	0.45	0.56	-1.24	-1.22	1.51	1.55	0.40
34	16/11/2023	07:02 - 07:32	0.45	0.44	0.55	-1.24	-1.22	1.51	1.53	0.41
35	16/11/2023	09:02 - 09:32	0.42	0.40	0.51	-1.27	-1.26	1.60	1.62	0.37
36	16/11/2023	10:02 - 10:32	0.42	0.42	0.54	-1.27	-1.24	1.57	1.60	0.38
37	16/11/2023	11:02 - 11:32	0.41	0.52	0.67	-1.27	-1.14	1.45	1.63	0.37
38	16/11/2023	17:02 - 17:32	0.54	0.47	0.61	-1.15	-1.19	1.37	1.32	0.50
39	16/11/2023	18:02 - 18:32	0.55	0.50	0.62	-1.14	-1.17	1.33	1.30	0.51
40	16/11/2023	19:02 - 19:32	0.52	0.43	0.56	-1.17	-1.23	1.44	1.37	0.48
41	16/11/2023	20:02 - 20:32	0.55	0.55	0.70	-1.13	-1.11	1.26	1.29	0.51
42	16/11/2023	21:02 - 21:32	0.47	0.56	0.73	-1.22	-1.10	1.34	1.48	0.43
43	16/11/2023	22:02 - 22:32	0.47	0.55	0.71	-1.22	-1.12	1.36	1.48	0.43
44	16/11/2023	23:02 - 23:32	0.58	0.49	0.59	-1.11	-1.17	1.30	1.24	0.53
45	17/11/2023	00:02 - 00:32	0.49	0.49	0.64	-1.20	-1.17	1.40	1.43	0.45
46	17/11/2023	01:02 - 01:32	0.53	0.49	0.64	-1.15	-1.17	1.35	1.33	0.49
47	17/11/2023	02:02 - 02:32	0.59	0.51	0.66	-1.10	-1.15	1.27	1.21	0.54
48	17/11/2023	03:02 - 03:32	0.57	0.53	0.70	-1.12	-1.13	1.26	1.25	0.53
49	17/11/2023	04:02 - 04:32	0.66	0.48	0.62	-1.03	-1.18	1.22	1.06	0.62
50	17/11/2023	05:02 - 05:32	0.60	0.50	0.64	-1.09	-1.16	1.26	1.19	0.56
51	17/11/2023	06:02 - 06:32	0.70	0.54	0.69	-0.99	-1.12	1.11	0.98	0.66
52	17/11/2023	07:02 - 07:32	0.71	0.46	0.58	-0.98	-1.20	1.17	0.95	0.67
53	17/11/2023	11:02 - 11:32	0.65	0.57	0.71	-1.04	-1.09	1.13	1.08	0.61
54	17/11/2023	12:02 - 12:32	0.77	0.70	0.88	-0.92	-0.96	0.88	0.84	0.73
55	17/11/2023	13:02 - 13:32	0.78	0.70	0.89	-0.91	-0.96	0.88	0.83	0.74
56	17/11/2023	14:02 - 14:32	0.58	0.51	0.67	-1.10	-1.15	1.27	1.22	0.54
57	17/11/2023	15:02 - 15:32	0.72	0.58	0.78	-0.97	-1.08	1.05	0.94	0.68
58	17/11/2023	16:02 - 16:32	0.85	0.69	0.92	-0.84	-0.97	0.82	0.71	0.81
59	17/11/2023	17:02 - 17:32	0.92	0.75	0.98	-0.76	-0.91	0.70	0.58	0.89
60	17/11/2023	19:02 - 19:32	0.98	0.80	1.04	-0.71	-0.86	0.61	0.50	0.94
61	17/11/2023	20:02 - 20:32	0.99	0.65	0.85	-0.70	-1.01	0.71	0.49	0.95
62	17/11/2023	21:02 - 21:32	0.85	0.87	1.14	-0.83	-0.79	0.66	0.70	0.82
63	17/11/2023	22:02 - 22:32	0.85	0.61	0.79	-0.84	-1.06	0.89	0.71	0.81

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Limerick
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HYDROGEN CHLORIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O$_2$) mg/m³	x - x$_{av}$ (A)	y - y$_{av}$ (B)	(A) x (B)	(x - x$_{av}$)²	CAL CEM (STP, WET) mg/m³
64	17/11/2023	23:02 - 23:32	0.86	0.59	0.76	-0.83	-1.07	0.89	0.69	0.82
65	18/11/2023	00:02 - 00:32	0.89	0.57	0.74	-0.79	-1.10	0.87	0.63	0.86
66	18/11/2023	03:02 - 03:32	0.89	0.53	0.69	-0.80	-1.13	0.90	0.64	0.85
67	18/11/2023	04:02 - 04:32	0.83	0.45	0.59	-0.86	-1.21	1.03	0.73	0.79
68										
69										
70										
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MAX SRM - MIN SRM	0.64	
(DAILY) DELV (mg/m³)	10	
95% CI MU (%)	40	
95% CI at DELV (mg/m³)	4.0	
15% of ELV	1.5	
PROCEDURE (A, B, C)	C	

	SUM	6134.56	6043.74

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/m³	y, SRM (STP, WET) mg/m³	Reason for Data Pair Removal (Statistical Outliers removed following outlier test, other data removed prior to this test)
1	15/11/2023	08:02 - 08:32	0.43	0.00	SRM offline/calibrating
2	15/11/2023	14:02 - 14:32	0.40	0.00	SRM offline/calibrating
3	15/11/2023	16:02 - 16:32	0.36	0.00	SRM offline/calibrating
4	16/11/2023	08:02 - 08:32	0.43	0.00	SRM offline/calibrating
5	16/11/2023	16:02 - 16:32	0.56	0.00	SRM offline/calibrating
6	17/11/2023	08:02 - 08:32	0.85	0.00	SRM offline/calibrating
7	14/11/2023	22:02 - 22:32	0.43	0.51	Peripheral data outliers (Water Vapour)
8	15/11/2023	03:02 - 03:32	0.45	0.48	Peripheral data outliers (Water Vapour)
9	17/11/2023	18:02 - 18:32	1.13	0.87	Peripheral data outliers (Water Vapour)
10	16/11/2023	12:02 - 12:32	0.46	0.52	Peripheral data outliers (Oxygen)
11	16/11/2023	13:02 - 13:32	0.48	0.46	Peripheral data outliers (Oxygen)
12	16/11/2023	14:02 - 14:32	0.51	0.63	Peripheral data outliers (Oxygen)
13	16/11/2023	15:02 - 15:32	0.52	0.58	Peripheral data outliers (Oxygen)
14	17/11/2023	09:02 - 09:32	0.64	0.99	Statistical outlier
15	17/11/2023	10:02 - 10:32	0.63	1.21	Statistical outlier
16	18/11/2023	01:02 - 01:32	1.00	0.50	Statistical outlier
17	18/11/2023	02:02 - 02:32	1.18	0.51	Statistical outlier
18					
19					
20					
21					
22					
23					
24					
25					

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HYDROGEN CHLORIDE: QAL2 CALCULATIONS

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Derivation of Calibration Function
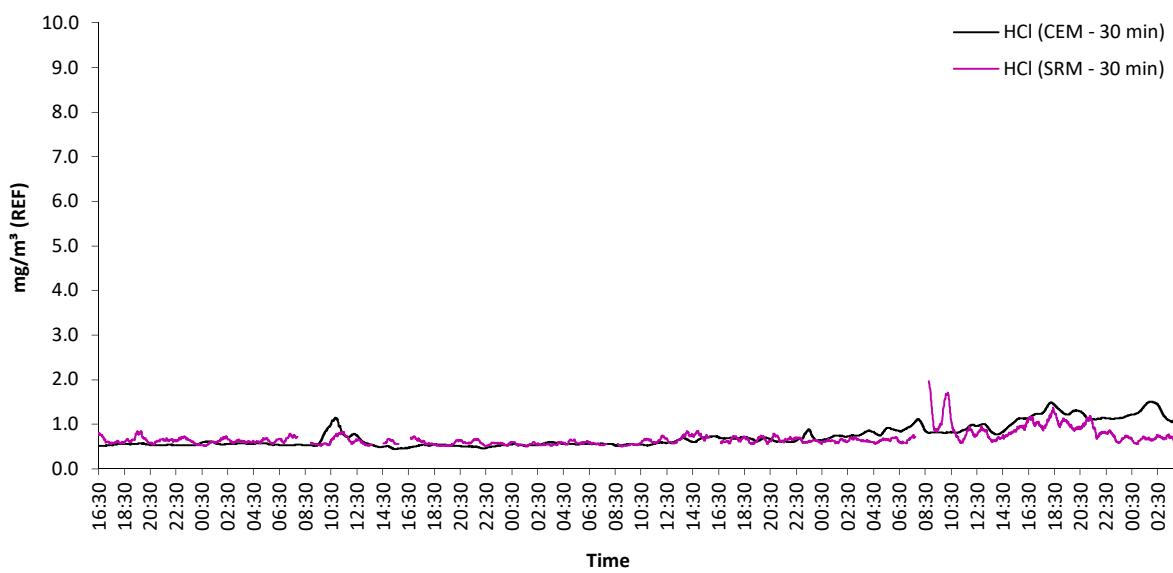
b =	1.0150	a =	-0.0515		CALIBRATION FUNCTION =	y = 1.0150x - 0.0515

where

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

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

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

PLOT 2: Calibration Graph for Procedure C

$y = 1.015x - 0.0515$
$R^2 = 0.9998$

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HYDROGEN CHLORIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CAL CEM Oxygen (DRY) % v/v		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	ys, SRM - CAL CEM
H1	Surrogate	High	79.98	N/A	N/A	N/A	N/A	N/A	N/A	79.98	80.00	78.85	0.02
L1	Surrogate	Near Zero	-0.02	N/A	N/A	N/A	N/A	N/A	N/A	-0.02	0.00	0.03	0.02
1	14/11/2023	17:02 - 17:32	0.37	11.21	10.55	10.47	11.17	N/A	11.11	0.46	0.64	0.52	0.18
2	14/11/2023	18:02 - 18:32	0.41	11.03	10.38	10.34	11.09	N/A	11.03	0.51	0.60	0.56	0.09
3	14/11/2023	19:02 - 19:32	0.40	10.73	10.09	10.00	11.22	N/A	11.17	0.50	0.61	0.55	0.11
4	14/11/2023	20:02 - 20:32	0.40	11.79	11.09	11.16	11.21	N/A	11.17	0.51	0.68	0.57	0.17
5	14/11/2023	21:02 - 21:32	0.37	12.13	11.41	11.50	11.20	N/A	11.18	0.47	0.62	0.53	0.15
6	14/11/2023	23:02 - 23:32	0.37	11.10	10.45	10.44	11.38	N/A	11.32	0.48	0.70	0.53	0.23
7	15/11/2023	00:02 - 00:32	0.38	10.67	10.04	10.01	11.32	N/A	11.27	0.48	0.55	0.54	0.07
8	15/11/2023	01:02 - 01:32	0.46	11.62	10.93	10.94	10.90	N/A	10.91	0.56	0.57	0.61	0.01
9	15/11/2023	02:02 - 02:32	0.39	11.77	11.07	11.12	11.17	N/A	11.17	0.49	0.69	0.55	0.19
10	15/11/2023	04:02 - 04:32	0.40	11.68	10.99	11.04	11.15	N/A	11.13	0.51	0.62	0.56	0.11
11	15/11/2023	05:02 - 05:32	0.42	11.66	10.97	10.98	11.06	N/A	11.05	0.52	0.58	0.57	0.06
12	15/11/2023	06:02 - 06:32	0.38	11.34	10.67	10.66	11.33	N/A	11.29	0.48	0.58	0.54	0.10
13	15/11/2023	07:02 - 07:32	0.37	11.40	10.73	10.74	11.30	N/A	11.27	0.47	0.68	0.53	0.21
14	15/11/2023	09:02 - 09:32	0.37	11.39	10.71	10.72	11.37	N/A	11.36	0.47	0.56	0.53	0.10
15	15/11/2023	10:02 - 10:32	0.63	10.64	10.01	9.91	10.96	N/A	10.98	0.77	0.58	0.82	-0.19
16	15/11/2023	11:02 - 11:32	0.82	11.12	10.46	10.44	11.05	N/A	11.12	1.01	0.78	1.06	-0.23
17	15/11/2023	12:02 - 12:32	0.54	10.79	10.15	10.09	11.34	N/A	11.32	0.69	0.61	0.74	-0.08
18	15/11/2023	13:02 - 13:32	0.43	12.36	11.62	11.75	11.03	N/A	11.00	0.54	0.57	0.60	0.03
19	15/11/2023	15:02 - 15:32	0.32	12.10	11.38	11.48	11.67	N/A	11.52	0.43	0.64	0.49	0.21
20	15/11/2023	17:02 - 17:32	0.37	11.17	10.51	10.45	10.91	N/A	11.06	0.45	0.69	0.50	0.25
21	15/11/2023	18:02 - 18:32	0.39	11.82	11.12	11.13	10.77	N/A	10.98	0.47	0.57	0.52	0.10
22	15/11/2023	19:02 - 19:32	0.39	11.52	10.84	10.80	11.08	N/A	11.18	0.49	0.52	0.54	0.04
23	15/11/2023	20:02 - 20:32	0.37	11.50	10.82	10.79	11.16	N/A	11.23	0.46	0.56	0.52	0.11
24	15/11/2023	21:02 - 21:32	0.35	11.67	10.98	10.97	11.21	N/A	11.27	0.45	0.57	0.50	0.12
25	15/11/2023	22:02 - 22:32	0.32	11.07	10.41	10.37	11.55	N/A	11.59	0.42	0.61	0.48	0.19
26	15/11/2023	23:02 - 23:32	0.35	10.92	10.28	10.24	11.52	N/A	11.54	0.45	0.58	0.51	0.14
27	16/11/2023	00:02 - 00:32	0.37	10.80	10.16	10.13	11.33	N/A	11.37	0.47	0.53	0.53	0.06
28	16/11/2023	01:02 - 01:32	0.38	11.62	10.93	11.00	11.33	N/A	11.36	0.49	0.54	0.54	0.05
29	16/11/2023	02:02 - 02:32	0.36	11.33	10.66	10.58	11.40	N/A	11.47	0.47	0.57	0.52	0.10
30	16/11/2023	03:02 - 03:32	0.41	11.74	11.04	11.13	11.18	N/A	11.25	0.52	0.54	0.57	0.02
31	16/11/2023	04:02 - 04:32	0.41	11.62	10.93	10.95	11.21	N/A	11.32	0.52	0.55	0.58	0.02
32	16/11/2023	05:02 - 05:32	0.40	11.85	11.14	11.18	11.17	N/A	11.22	0.51	0.66	0.56	0.15
33	16/11/2023	06:02 - 06:32	0.40	11.58	10.89	10.84	11.22	N/A	11.24	0.50	0.56	0.56	0.06
34	16/11/2023	07:02 - 07:32	0.41	11.20	10.54	10.50	11.06	N/A	11.09	0.50	0.55	0.56	0.05
35	16/11/2023	09:02 - 09:32	0.37	10.57	9.95	9.88	11.36	N/A	11.39	0.47	0.51	0.53	0.04
36	16/11/2023	10:02 - 10:32	0.38	11.14	10.48	10.47	11.46	N/A	11.52	0.49	0.54	0.54	0.06
37	16/11/2023	11:02 - 11:32	0.37	11.29	10.62	10.65	11.31	N/A	11.47	0.47	0.67	0.53	0.21
38	16/11/2023	17:02 - 17:32	0.50	12.36	11.62	11.64	11.24	N/A	11.30	0.63	0.61	0.69	-0.02
39	16/11/2023	18:02 - 18:32	0.51	12.06	11.35	11.33	11.01	N/A	11.10	0.63	0.62	0.68	-0.01
40	16/11/2023	19:02 - 19:32	0.48	11.92	11.21	11.16	11.43	N/A	11.54	0.62	0.56	0.67	-0.05
41	16/11/2023	20:02 - 20:32	0.51	11.96	11.25	11.24	11.22	N/A	11.28	0.65	0.70	0.70	0.05
42	16/11/2023	21:02 - 21:32	0.43	12.20	11.47	11.51	11.37	N/A	11.48	0.55	0.73	0.61	0.18
43	16/11/2023	22:02 - 22:32	0.43	11.83	11.12	11.13	11.36	N/A	11.44	0.55	0.71	0.61	0.16
44	16/11/2023	23:02 - 23:32	0.53	12.31	11.58	11.60	10.67	N/A	10.70	0.64	0.59	0.69	-0.05
45	17/11/2023	00:02 - 00:32	0.45	12.28	11.55	11.62	11.34	N/A	11.41	0.58	0.64	0.63	0.06
46	17/11/2023	01:02 - 01:32	0.49	12.00	11.29	11.31	11.31	N/A	11.36	0.63	0.64	0.68	0.01
47	17/11/2023	02:02 - 02:32	0.54	12.18	11.45	11.42	11.17	N/A	11.30	0.69	0.66	0.74	-0.03
48	17/11/2023	03:02 - 03:32	0.53	11.90	11.20	11.20	11.55	N/A	11.62	0.69	0.70	0.75	0.01
49	17/11/2023	04:02 - 04:32	0.62	11.60	10.91	10.99	11.45	N/A	11.51	0.80	0.62	0.85	-0.18
50	17/11/2023	05:02 - 05:32	0.56	11.58	10.90	10.98	11.20	N/A	11.27	0.70	0.64	0.76	-0.06
51	17/11/2023	06:02 - 06:32	0.66	11.75	11.05	11.07	11.25	N/A	11.27	0.83	0.69	0.88	-0.14
52	17/11/2023	07:02 - 07:32	0.67	11.15	10.49	10.46	11.32	N/A	11.31	0.85	0.58	0.91	-0.27
53	17/11/2023	11:02 - 11:32	0.61	11.72	11.02	11.03	11.10	N/A	11.00	0.76	0.71	0.81	-0.06
54	17/11/2023	12:02 - 12:32	0.73	10.98	10.33	10.22	11.33	N/A	11.21	0.93	0.88	0.98	-0.05
55	17/11/2023	13:02 - 13:32	0.74	12.08	11.36	11.46	11.38	N/A	11.23	0.96	0.89	1.01	-0.07
56	17/11/2023	14:02 - 14:32	0.54	11.98	11.27	11.41	11.68	N/A	11.57	0.72	0.67	0.78	-0.05
57	17/11/2023	15:02 - 15:32	0.68	11.03	10.38	10.34	11.90	N/A	11.77	0.92	0.78	0.97	-0.14
58	17/11/2023	16:02 - 16:32	0.81	10.94	10.29	10.34	11.86	N/A	11.73	1.08	0.92	1.13	-0.16
59	17/11/2023	17:02 - 17:32	0.89	10.85	10.21	10.14	11.79	N/A	11.66	1.18	0.98	1.23	-0.19
60	17/11/2023	19:02 - 19:32	0.94	11.14	10.48	10.38	11.68	N/A	11.60	1.24	1.04	1.29	-0.20
61	17/11/2023	20:02 - 20:32	0.95	10.83	10.19	10.17	11.74	N/A	11.63	1.25	0.85	1.30	-0.41
62	17/11/2023	21:02 - 21:32	0.82	11.61	10.92	10.91	11.70	N/A	11.60	1.08	1.14	1.13	0.06
63	17/11/2023	22:02 - 22:32	0.81	11.19	10.53	10.50	11.72	N/A	11.58	1.07	0.79	1.12	-0.28

where CAL = Calibrated using QAL2 calibration functions

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

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HYDROGEN CHLORIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CAL CEM Oxygen (DRY) % v/v		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	ys, SRM - CAL CEM
64	17/11/2023	23:02 - 23:32	0.82	11.35	10.68	10.68	11.63	N/A	11.49	1.08	0.76	1.13	-0.31
65	18/11/2023	00:02 - 00:32	0.86	11.30	10.63	10.63	11.65	N/A	11.55	1.13	0.74	1.18	-0.39
66	18/11/2023	03:02 - 03:32	0.85	11.77	11.07	11.09	11.59	N/A	11.53	1.12	0.69	1.17	-0.43
67	18/11/2023	04:02 - 04:32	0.79	11.51	10.83	10.89	11.53	N/A	11.45	1.03	0.59	1.09	-0.45
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									MAX	**AVERAGE**	**AVERAGE**	**Sd**	
									1.25	0.66	0.72	0.17	

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

Qo = ELV x (MU / 100) / 1.96	2.04
Kv for 67 Pairs of Data	0.9885

The variability is accepted if Sd ≤ Qo x Kv.

Parameter	Value
Standard Deviation (Sd)	0.17
Qo x Kv	2.02
Outcome of Variability Test	**Pass**

Procedure C Acceptability Test

Average of UNCAL CEM (1)	0.72
Average of SRM (2)	0.66
ABS Difference (1) & (2)	0.06
Outcome of Procedure C Acceptability Test	**Pass**

Valid Calibration Range

Maximum CAL CEM Value (mg/m³)	1.3

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/m³)	0 to 1.4
b) Calibrated Range (20% of Daily ELV) (mg/m³)	0 to 2.0

Greater of (a) or (b)	0 to 2.0

Surrogate Extension Applied?	NOT PERMISSIBLE

Valid Calibration Range (at REF conditions)	**0 to 2.0 mg/m³**
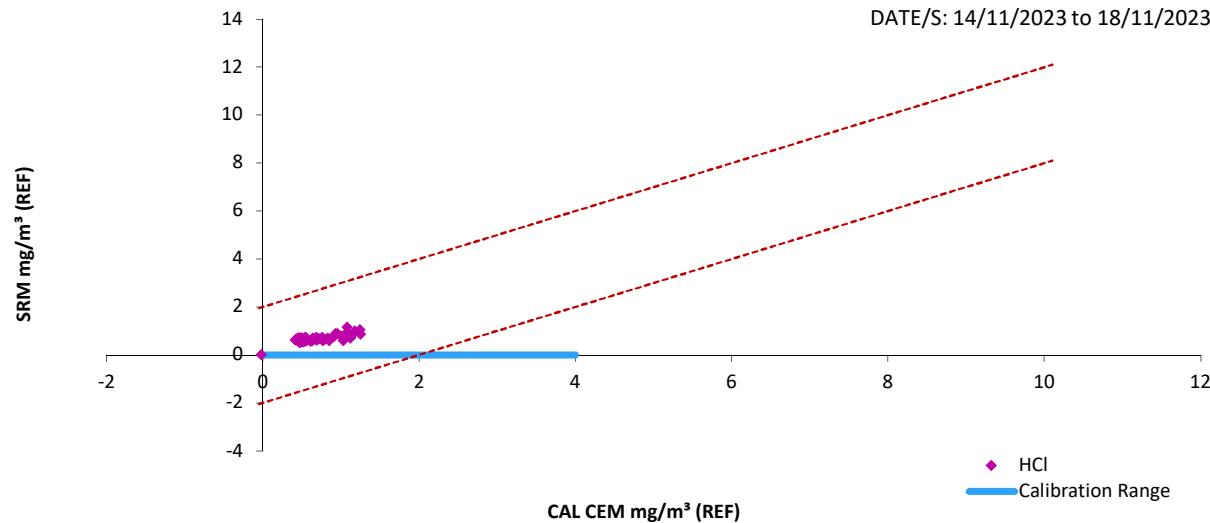
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Limerick
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HYDROGEN CHLORIDE: QAL2 CALCULATIONS

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

DATE/S: 14/11/2023 to 18/11/2023

HYDROGEN FLUORIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O_2) mg/m³	x - x_{av} (A)	y - y_{av} (B)	(A) x (B)	$(x - x_{av})^2$	CAL CEM (STP, WET) mg/m³
H1	Surrogate	High	4.46	4.50	4.50	4.20	4.20	17.64	17.63	4.50
L1	Surrogate	Near Zero	0.00	0.00	0.00	-0.26	-0.30	0.08	0.07	0.04
1	14/11/2023	12:30 - 13:00	0.01	0.05	0.07	-0.25	-0.25	0.06	0.06	0.05
2	14/11/2023	14:45 - 15:15	0.01	0.06	0.07	-0.25	-0.24	0.06	0.06	0.05
3	15/11/2023	08:58 - 09:28	0.01	0.05	0.07	-0.25	-0.25	0.06	0.06	0.05
4	15/11/2023	10:00 - 10:30	0.02	0.05	0.06	-0.24	-0.25	0.06	0.06	0.06
5	15/11/2023	11:05 - 11:35	0.01	0.08	0.09	-0.25	-0.22	0.06	0.06	0.05
6	15/11/2023	12:05 - 12:35	0.02	0.08	0.11	-0.25	-0.22	0.05	0.06	0.05
7	15/11/2023	14:10 - 14:42	0.01	0.05	0.07	-0.25	-0.25	0.06	0.06	0.05
8	15/11/2023	14:12 - 14:42	0.01	0.05	0.07	-0.25	-0.25	0.06	0.06	0.05
9	15/11/2023	15:15 - 15:45	0.01	0.05	0.06	-0.25	-0.25	0.06	0.06	0.05
10	16/11/2023	08:45 - 09:15	0.02	0.05	0.06	-0.24	-0.25	0.06	0.06	0.06
11	16/11/2023	09:47 - 10:17	0.02	0.05	0.06	-0.24	-0.25	0.06	0.06	0.06
12	16/11/2023	10:50 - 11:20	0.01	0.05	0.06	-0.25	-0.25	0.06	0.06	0.05
13	16/11/2023	10:55 - 11:25	0.01	0.05	0.06	-0.25	-0.25	0.06	0.06	0.05
14	16/11/2023	12:58 - 13:28	0.01	0.05	0.06	-0.25	-0.25	0.06	0.06	0.05
15	16/11/2023	14:00 - 14:30	0.02	0.05	0.06	-0.24	-0.25	0.06	0.06	0.06
16	16/11/2023	15:05 - 15:35	0.02	0.07	0.10	-0.24	-0.23	0.06	0.06	0.06
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HYDROGEN FLUORIDE: QAL2 CALCULATIONS

Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	x - x$_{av}$ (A)	y - y$_{av}$ (B)	(A) x (B)	(x - x$_{av}$)²	CAL CEM (STP, WET) mg/m³
64										
65										
66										
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MAX SRM - MIN SRM	0.05	
(DAILY) DELV (mg/m³)	1	
95% CI MU (%)	40	
95% CI at DELV (mg/m³)	0.4	
15% of ELV	0.2	
PROCEDURE (A, B, C)	C	

SUM	18.68	18.67

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/m³	y, SRM (STP, WET) mg/m³	Reason for Data Pair Removal (Statistical Outliers removed following outlier test, other data removed prior to this test)
1	14/11/2023	13:30 - 14:00	0.02	0.09	Statistical outlier
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HYDROGEN FLUORIDE: QAL2 CALCULATIONS

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Derivation of Calibration Function

b =	1.0004	a =	0.0382
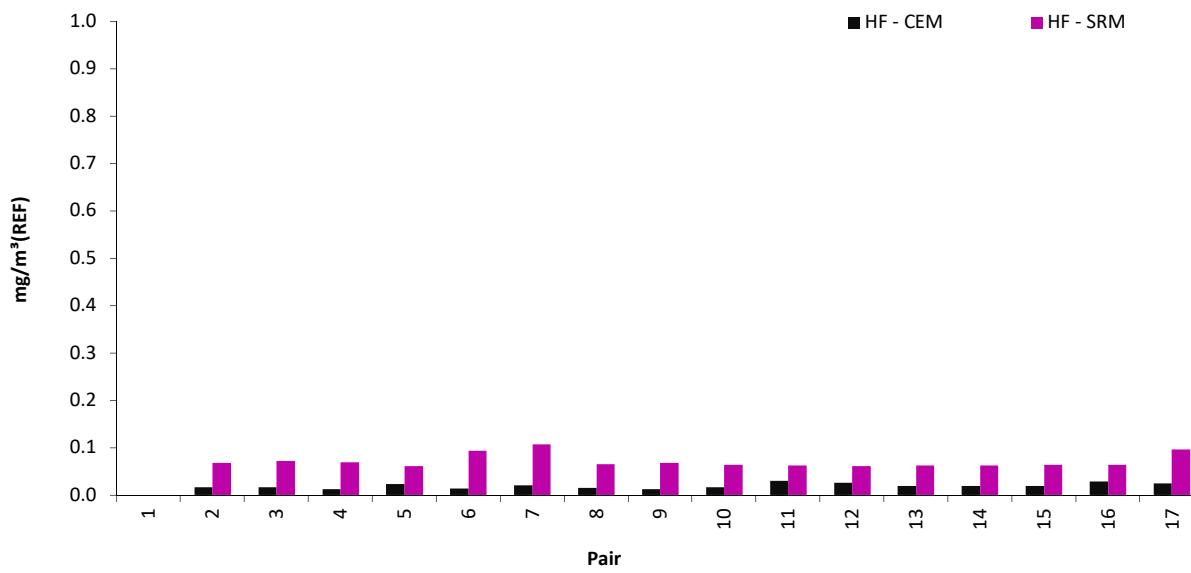
CALIBRATION FUNCTION =	y = 1.0004x + 0.0382

where

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

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HYDROGEN FLUORIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Variability Test Data

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O_2) mg/m³	SRM (STP, DRY, 10% O_2) mg/m³	UNCAL CEM (STP, DRY, 10% O_2) mg/m³	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	4.46	0.00
L1	Surrogate	Near Zero	0.04	N/A	N/A	N/A	N/A	N/A	N/A	0.04	0.00	0.00	-0.04
1	14/11/2023	12:30 - 13:00	0.05	12.04	11.33	10.01	10.62	10.67	11.59	0.06	0.07	0.02	0.01
2	14/11/2023	14:45 - 15:15	0.05	11.98	11.27	10.59	11.07	11.13	11.17	0.06	0.07	0.02	0.01
3	15/11/2023	08:58 - 09:28	0.05	11.45	10.77	10.65	11.38	11.45	11.34	0.06	0.07	0.01	0.01
4	15/11/2023	10:00 - 10:30	0.06	10.62	9.99	9.01	10.99	11.05	10.99	0.07	0.06	0.02	-0.01
5	15/11/2023	11:05 - 11:35	0.05	10.95	10.30	9.80	11.12	11.18	11.07	0.06	0.09	0.01	0.03
6	15/11/2023	12:05 - 12:35	0.05	10.81	10.17	12.74	11.32	11.38	11.24	0.07	0.11	0.02	0.04
7	15/11/2023	14:10 - 14:42	0.05	12.05	11.33	10.34	10.84	10.90	11.04	0.06	0.07	0.02	0.00
8	15/11/2023	14:12 - 14:42	0.05	12.72	11.97	10.74	11.10	11.16	11.21	0.06	0.07	0.01	0.01
9	15/11/2023	15:15 - 15:45	0.05	11.80	11.10	9.78	11.60	11.67	11.41	0.07	0.06	0.02	0.00
10	16/11/2023	08:45 - 09:15	0.06	10.97	10.32	9.65	11.41	11.47	11.42	0.08	0.06	0.03	-0.02
11	16/11/2023	09:47 - 10:17	0.06	11.23	10.56	8.78	11.39	11.45	11.40	0.08	0.06	0.03	-0.01
12	16/11/2023	10:50 - 11:20	0.05	11.28	10.61	10.88	11.47	11.53	11.58	0.07	0.06	0.02	-0.01
13	16/11/2023	10:55 - 11:25	0.05	11.98	11.27	10.33	11.38	11.44	11.56	0.07	0.06	0.02	-0.01
14	16/11/2023	12:58 - 13:28	0.05	11.76	11.06	9.63	11.08	11.14	11.29	0.07	0.06	0.02	0.00
15	16/11/2023	14:00 - 14:30	0.06	11.96	11.25	9.51	11.51	11.58	11.78	0.08	0.06	0.03	-0.01
16	16/11/2023	15:05 - 15:35	0.06	12.47	11.73	14.63	11.37	11.43	11.64	0.07	0.10	0.02	0.02
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where CAL = Calibrated using QAL2 calibration functions

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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06

HYDROGEN FLUORIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Variability Test Data (continued)

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CEM Oxygen (DRY) % v/v	CAL CEM Oxygen (DRY) % v/v	SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	ys, SRM - CAL CEM
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**
										0.08	0.07	0.02	0.02

where CAL = Calibrated using QAL2 calibration functions

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	0.20
Kv for 16 Pairs of Data	0.9777

The variability is accepted if Sd ≤ Q_o x Kv.

Parameter	Value
Standard Deviation (Sd)	0.02
Q_o x Kv	0.20
Outcome of Variability Test	**Pass**

Procedure C Acceptability Test

Average of UNCAL CEM (1)	0.02
Average of SRM (2)	0.07
ABS Difference (1) & (2)	0.05
Outcome of Procedure C Acceptability Test	**Pass**

Valid Calibration Range

Maximum CAL CEM Value (mg/m³)	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/m³)	0 to 0.1
b) Calibrated Range (20% of Daily ELV) (mg/m³)	0 to 0.2

Greater of (a) or (b)	0 to 0.2

Surrogate Extension Applied?	NOT PERMISSIBLE

Valid Calibration Range (at REF conditions)	**0 to 0.2 mg/m³**
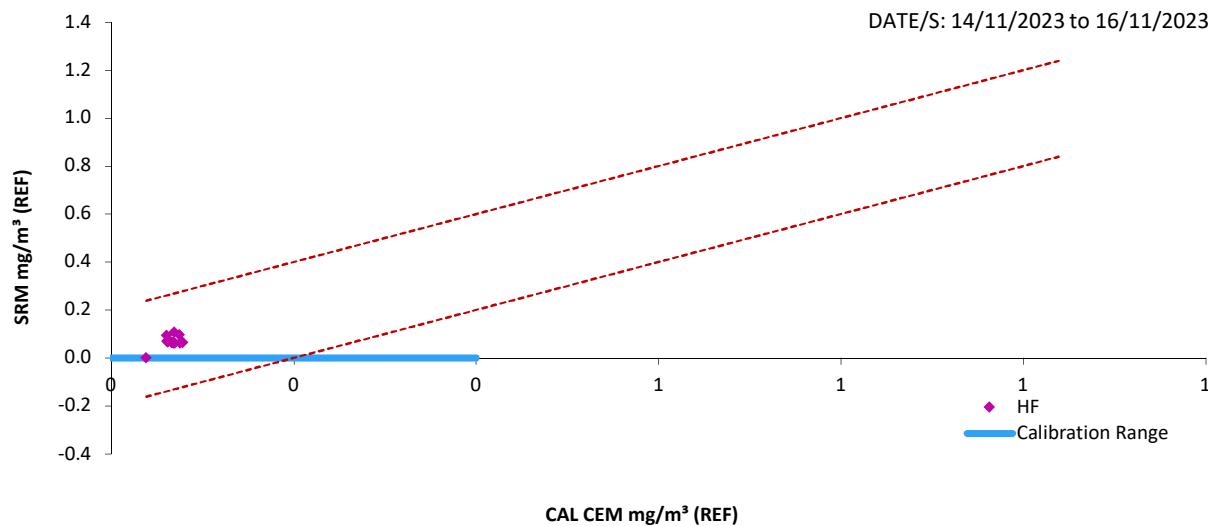
Irish Cement Ltd
Limerick
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Job Number: EMT07766, Version 2
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HYDROGEN FLUORIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

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

DATE/S: 14/11/2023 to 16/11/2023

CAL CEM mg/m³ (REF)

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Limerick
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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

Calibration Data

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	x - x$_{av}$ (A)	y - y$_{av}$ (B)	(A) x (B)	(x - x$_{av}$)²	CAL CEM (STP, WET) mg/m³
L1	Surrogate	Near Zero	-1.01	0.00	0.00	-20.38	-19.20	391.15	415.22	0.00
1	14/11/2023	17:02 - 17:32	18.48	18.09	22.46	-0.89	-1.11	0.98	0.79	18.36
2	14/11/2023	18:02 - 18:32	18.81	18.66	22.97	-0.56	-0.54	0.30	0.31	18.67
3	14/11/2023	19:02 - 19:32	19.40	19.08	23.72	0.03	-0.12	0.00	0.00	19.23
4	14/11/2023	20:02 - 20:32	19.80	19.88	25.03	0.43	0.68	0.29	0.18	19.60
5	14/11/2023	21:02 - 21:32	18.75	18.84	23.85	-0.62	-0.36	0.22	0.38	18.61
6	14/11/2023	23:02 - 23:32	18.88	18.82	23.89	-0.49	-0.37	0.18	0.24	18.74
7	15/11/2023	00:02 - 00:32	20.29	20.30	25.50	0.92	1.11	1.02	0.85	20.06
8	15/11/2023	01:02 - 01:32	20.28	20.24	24.79	0.91	1.05	0.95	0.83	20.05
9	15/11/2023	02:02 - 02:32	19.59	19.68	24.77	0.22	0.49	0.11	0.05	19.40
10	15/11/2023	04:02 - 04:32	20.04	20.07	25.15	0.67	0.87	0.59	0.45	19.83
11	15/11/2023	05:02 - 05:32	19.68	19.61	24.34	0.32	0.41	0.13	0.10	19.49
12	15/11/2023	06:02 - 06:32	18.42	18.43	23.36	-0.95	-0.77	0.73	0.90	18.30
13	15/11/2023	07:02 - 07:32	18.79	18.75	23.76	-0.57	-0.44	0.25	0.33	18.65
14	15/11/2023	09:02 - 09:32	19.43	19.04	24.34	0.06	-0.15	-0.01	0.00	19.25
15	15/11/2023	10:02 - 10:32	25.82	25.60	31.20	6.45	6.41	41.33	41.61	25.27
16	15/11/2023	11:02 - 11:32	24.88	24.54	30.50	5.52	5.35	29.50	30.42	24.39
17	15/11/2023	12:02 - 12:32	19.52	19.39	24.51	0.15	0.20	0.03	0.02	19.34
18	15/11/2023	13:02 - 13:32	22.00	22.09	27.52	2.63	2.89	7.62	6.94	21.68
19	15/11/2023	15:02 - 15:32	20.01	20.01	26.24	0.64	0.81	0.52	0.41	19.80
20	15/11/2023	17:02 - 17:32	19.62	19.56	24.18	0.25	0.36	0.09	0.06	19.43
21	15/11/2023	18:02 - 18:32	20.44	20.47	25.29	1.07	1.27	1.36	1.15	20.20
22	15/11/2023	19:02 - 19:32	20.21	20.21	25.37	0.84	1.01	0.85	0.70	19.99
23	15/11/2023	20:02 - 20:32	19.90	19.62	24.75	0.53	0.42	0.22	0.28	19.69
24	15/11/2023	21:02 - 21:32	20.87	20.72	26.32	1.50	1.52	2.29	2.26	20.61
25	15/11/2023	22:02 - 22:32	18.73	18.79	24.51	-0.64	-0.40	0.26	0.41	18.59
26	15/11/2023	23:02 - 23:32	20.22	20.33	26.32	0.85	1.13	0.96	0.72	20.00
27	16/11/2023	00:02 - 00:32	21.03	21.18	26.90	1.66	1.98	3.30	2.77	20.76
28	16/11/2023	01:02 - 01:32	20.91	21.03	26.98	1.54	1.84	2.84	2.38	20.65
29	16/11/2023	02:02 - 02:32	20.23	19.98	25.78	0.86	0.79	0.68	0.74	20.01
30	16/11/2023	03:02 - 03:32	20.52	20.84	26.45	1.15	1.65	1.90	1.32	20.28
31	16/11/2023	04:02 - 04:32	25.36	25.22	32.18	5.99	6.03	36.08	35.87	24.84
32	16/11/2023	05:02 - 05:32	20.93	20.94	26.53	1.57	1.75	2.74	2.46	20.67
33	16/11/2023	06:02 - 06:32	20.27	20.17	25.48	0.90	0.97	0.88	0.81	20.05
34	16/11/2023	07:02 - 07:32	19.96	20.31	25.18	0.60	1.11	0.66	0.36	19.76
35	16/11/2023	09:02 - 09:32	20.50	20.32	25.80	1.13	1.12	1.27	1.28	20.26
36	16/11/2023	10:02 - 10:32	20.17	20.25	26.25	0.81	1.06	0.85	0.65	19.95
37	16/11/2023	11:02 - 11:32	19.13	19.12	24.69	-0.23	-0.07	0.02	0.05	18.98
38	16/11/2023	17:02 - 17:32	20.63	19.82	25.45	1.26	0.63	0.79	1.58	20.38
39	16/11/2023	18:02 - 18:32	20.99	20.52	25.71	1.62	1.32	2.14	2.64	20.73
40	16/11/2023	19:02 - 19:32	19.97	19.24	25.18	0.61	0.05	0.03	0.37	19.77
41	16/11/2023	20:02 - 20:32	20.48	19.71	25.12	1.11	0.51	0.57	1.24	20.24
42	16/11/2023	21:02 - 21:32	20.82	20.26	26.44	1.45	1.06	1.54	2.11	20.56
43	16/11/2023	22:02 - 22:32	18.98	18.47	23.92	-0.39	-0.73	0.28	0.15	18.83
44	16/11/2023	23:02 - 23:32	22.96	22.12	26.72	3.59	2.92	10.50	12.90	22.58
45	17/11/2023	00:02 - 00:32	20.10	19.52	25.34	0.74	0.32	0.24	0.54	19.89
46	17/11/2023	01:02 - 01:32	19.46	18.82	24.21	0.10	-0.38	-0.04	0.01	19.29
47	17/11/2023	02:02 - 02:32	20.88	20.00	25.59	1.52	0.80	1.22	2.30	20.63
48	17/11/2023	04:02 - 04:32	19.81	19.20	24.99	0.44	0.00	0.00	0.20	19.61
49	17/11/2023	05:02 - 05:32	20.26	19.73	25.05	0.90	0.53	0.48	0.80	20.04
50	17/11/2023	06:02 - 06:32	20.28	19.42	24.71	0.91	0.23	0.21	0.83	20.06
51	17/11/2023	07:02 - 07:32	18.06	17.47	22.15	-1.31	-1.73	2.26	1.72	17.96
52	17/11/2023	09:02 - 09:32	19.77	20.01	25.29	0.41	0.81	0.33	0.17	19.58
53	17/11/2023	11:02 - 11:32	18.96	19.20	23.74	-0.40	0.00	0.00	0.16	18.82
54	17/11/2023	12:02 - 12:32	18.75	18.54	23.20	-0.62	-0.66	0.41	0.39	18.61
55	17/11/2023	13:02 - 13:32	20.48	20.69	26.32	1.12	1.50	1.67	1.25	20.25
56	17/11/2023	14:02 - 14:32	19.84	20.26	26.68	0.48	1.06	0.50	0.23	19.64
57	17/11/2023	15:02 - 15:32	18.08	18.20	24.19	-1.29	-1.00	1.29	1.66	17.98
58	17/11/2023	16:02 - 16:32	17.31	17.56	23.25	-2.05	-1.63	3.35	4.21	17.26
59	17/11/2023	17:02 - 17:32	17.28	17.19	22.52	-2.09	-2.01	4.19	4.35	17.23
60	17/11/2023	19:02 - 19:32	17.24	17.08	22.30	-2.12	-2.12	4.49	4.51	17.20
61	17/11/2023	20:02 - 20:32	17.40	17.47	22.84	-1.96	-1.72	3.38	3.86	17.35
62	17/11/2023	21:02 - 21:32	17.41	17.32	22.74	-1.95	-1.88	3.67	3.82	17.36
63	17/11/2023	22:02 - 22:32	16.75	16.45	21.47	-2.62	-2.74	7.19	6.86	16.73

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Calibration Data (continued)

Pair	Date	Time (30-minute Average)	x, CEM (STP, WET) mg/m³	y, SRM (STP, WET) mg/m³	SRM (STP, DRY, 10% O_2) mg/m³	x - x$_{av}$ (A)	y - y$_{av}$ (B)	(A) x (B)	(x - x$_{av}$)²	CAL CEM (STP, WET) mg/m³
64	17/11/2023	23:02 - 23:32	16.64	16.17	20.93	-2.73	-3.03	8.26	7.44	16.63
65	18/11/2023	00:02 - 00:32	16.79	16.21	21.12	-2.58	-2.99	7.70	6.64	16.77
66	18/11/2023	01:02 - 01:32	17.66	17.19	21.53	-1.70	-2.00	3.41	2.90	17.59
67	18/11/2023	02:02 - 02:32	17.63	17.02	21.67	-1.74	-2.17	3.77	3.01	17.56
68	18/11/2023	03:02 - 03:32	16.60	16.58	21.66	-2.77	-2.61	7.24	7.67	16.59
69	18/11/2023	04:02 - 04:32	16.56	16.09	20.80	-2.81	-3.11	8.73	7.89	16.55
70										
71										
72										
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89										
90										

MAX SRM - MIN SRM	11.37	
(DAILY) DELV (mg/m³)	50	
95% CI MU (%)	40	
TYPE of ELV — 95% CI at ELV (mg/m³)	20.0	
15% of ELV	7.5	
PROCEDURE (A, B, C)	B	

WHERE OFFSET = -1.01

SUM	622.94	648.72

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/m³	y, SRM (STP, WET) mg/m³	Reason for Data Pair Removal (Statistical Outliers removed following outlier test, other data removed prior to this test)
1	15/11/2023	08:02 - 08:32	19.82	0.00	SRM offline/calibrating
2	15/11/2023	14:02 - 14:32	21.91	0.00	SRM offline/calibrating
3	15/11/2023	16:02 - 16:32	18.26	0.00	SRM offline/calibrating
4	16/11/2023	08:02 - 08:32	19.44	0.00	SRM offline/calibrating
5	16/11/2023	16:02 - 16:32	21.74	0.00	SRM offline/calibrating
6	17/11/2023	08:02 - 08:32	19.29	0.00	SRM offline/calibrating
7	14/11/2023	22:02 - 22:32	18.15	18.27	Peripheral data outliers (Water Vapour)
8	15/11/2023	03:02 - 03:32	20.10	20.10	Peripheral data outliers (Water Vapour)
9	17/11/2023	18:02 - 18:32	18.03	17.92	Peripheral data outliers (Water Vapour)
10	16/11/2023	12:02 - 12:32	21.14	20.92	Peripheral data outliers (Oxygen)
11	16/11/2023	13:02 - 13:32	21.72	21.58	Peripheral data outliers (Oxygen)
12	16/11/2023	14:02 - 14:32	19.41	19.47	Peripheral data outliers (Oxygen)
13	16/11/2023	15:02 - 15:32	21.68	21.62	Peripheral data outliers (Oxygen)
14	17/11/2023	03:02 - 03:32	20.14	19.07	Statistical outlier
15	17/11/2023	10:02 - 10:32	20.11	20.66	Statistical outlier
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

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Derivation of Calibration Function

b =	0.9420	a =	0.9515
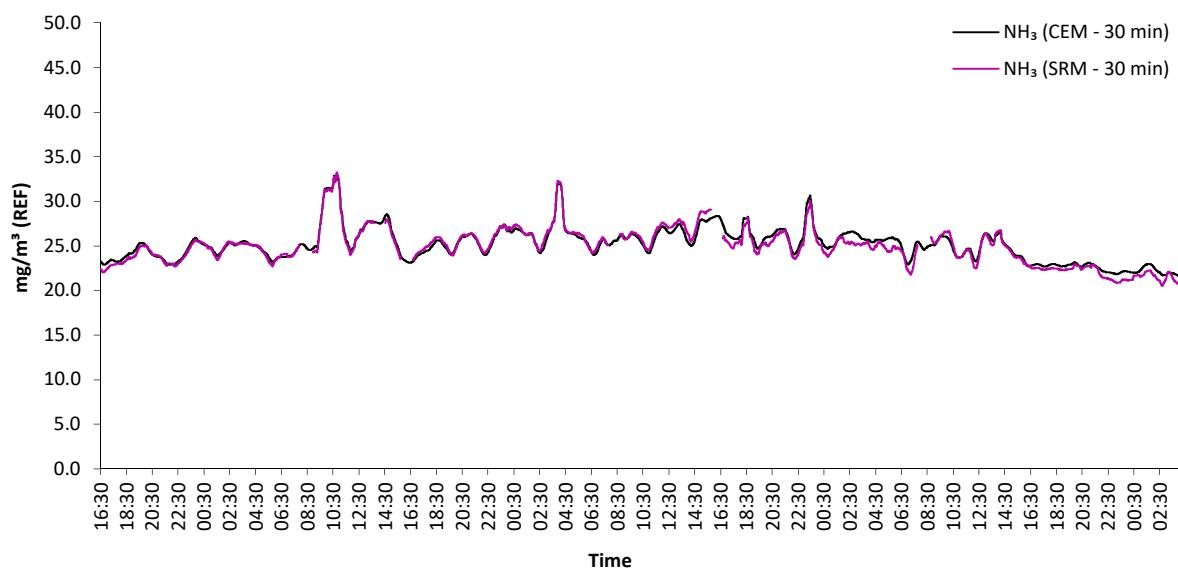
CALIBRATION FUNCTION =	y = 0.9420x + 0.9515

where

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

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

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

PLOT 2: Calibration Graph for Procedure B

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A2-01 Kiln 6 [Standby Analyser]

Variability Test Data

where CAL = Calibrated using QAL2 calibration functions

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CAL CEM Oxygen (DRY) % v/v		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O_2) mg/m³	SRM (STP, DRY, 10% O_2) mg/m³	UNCAL CEM (STP, DRY, 10% O_2) mg/m³	ys, SRM - CAL CEM
					N/A		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	-1.01	0.00
1	14/11/2023	17:02 - 17:32	18.36	11.21	10.55	10.47	11.17	N/A	11.11	22.96	22.46	23.11	-0.50
2	14/11/2023	18:02 - 18:32	18.67	11.03	10.38	10.34	11.09	N/A	11.03	23.11	22.97	23.29	-0.15
3	14/11/2023	19:02 - 19:32	19.23	10.73	10.09	10.00	11.22	N/A	11.17	24.05	23.72	24.26	-0.33
4	14/11/2023	20:02 - 20:32	19.60	11.79	11.09	11.16	11.21	N/A	11.17	24.78	25.03	25.03	0.25
5	14/11/2023	21:02 - 21:32	18.61	12.13	11.41	11.50	11.20	N/A	11.18	23.60	23.85	23.77	0.26
6	14/11/2023	23:02 - 23:32	18.74	11.10	10.45	10.44	11.38	N/A	11.32	23.92	23.89	24.10	-0.03
7	15/11/2023	00:02 - 00:32	20.06	10.67	10.04	10.01	11.32	N/A	11.27	25.34	25.50	25.62	0.16
8	15/11/2023	01:02 - 01:32	20.05	11.62	10.93	10.94	10.90	N/A	10.91	24.52	24.79	24.80	0.27
9	15/11/2023	02:02 - 02:32	19.40	11.77	11.07	11.12	11.17	N/A	11.17	24.42	24.77	24.65	0.36
10	15/11/2023	04:02 - 04:32	19.83	11.68	10.99	11.04	11.15	N/A	11.13	24.88	25.15	25.15	0.26
11	15/11/2023	05:02 - 05:32	19.49	11.66	10.97	10.98	11.06	N/A	11.05	24.24	24.34	24.48	0.10
12	15/11/2023	06:02 - 06:32	18.30	11.34	10.67	10.66	11.33	N/A	11.29	23.31	23.36	23.46	0.05
13	15/11/2023	07:02 - 07:32	18.65	11.40	10.73	10.74	11.30	N/A	11.27	23.69	23.76	23.86	0.08
14	15/11/2023	09:02 - 09:32	19.25	11.39	10.71	10.72	11.37	N/A	11.36	24.62	24.34	24.84	-0.28
15	15/11/2023	10:02 - 10:32	25.27	10.64	10.01	9.91	10.96	N/A	10.98	30.78	31.20	31.44	0.42
16	15/11/2023	11:02 - 11:32	24.39	11.12	10.46	10.44	11.05	N/A	11.12	30.12	30.50	30.73	0.38
17	15/11/2023	12:02 - 12:32	19.34	10.79	10.15	10.09	11.34	N/A	11.32	24.50	24.51	24.72	0.02
18	15/11/2023	13:02 - 13:32	21.68	12.36	11.62	11.75	11.03	N/A	11.00	27.06	27.52	27.46	0.46
19	15/11/2023	15:02 - 15:32	19.80	12.10	11.38	11.48	11.67	N/A	11.52	26.34	26.24	26.61	-0.10
20	15/11/2023	17:02 - 17:32	19.43	11.17	10.51	10.45	10.91	N/A	11.06	23.67	24.18	23.89	0.51
21	15/11/2023	18:02 - 18:32	20.20	11.82	11.12	11.13	10.77	N/A	10.98	24.45	25.29	24.73	0.84
22	15/11/2023	19:02 - 19:32	19.99	11.52	10.84	10.80	11.08	N/A	11.18	24.86	25.37	25.14	0.50
23	15/11/2023	20:02 - 20:32	19.69	11.50	10.82	10.79	11.16	N/A	11.23	24.68	24.75	24.93	0.08
24	15/11/2023	21:02 - 21:32	20.61	11.67	10.98	10.97	11.21	N/A	11.27	26.01	26.32	26.33	0.31
25	15/11/2023	22:02 - 22:32	18.59	11.07	10.41	10.37	11.55	N/A	11.59	24.16	24.51	24.34	0.34
26	15/11/2023	23:02 - 23:32	20.00	10.92	10.28	10.24	11.52	N/A	11.54	25.86	26.32	26.14	0.47
27	16/11/2023	00:02 - 00:32	20.76	10.80	10.16	10.13	11.33	N/A	11.37	26.28	26.90	26.62	0.62
28	16/11/2023	01:02 - 01:32	20.65	11.62	10.93	11.00	11.33	N/A	11.36	26.38	26.98	26.71	0.60
29	16/11/2023	02:02 - 02:32	20.01	11.33	10.66	10.58	11.40	N/A	11.47	25.65	25.78	25.94	0.13
30	16/11/2023	03:02 - 03:32	20.28	11.74	11.04	11.13	11.18	N/A	11.25	25.54	26.45	25.84	0.91
31	16/11/2023	04:02 - 04:32	24.84	11.62	10.93	10.95	11.21	N/A	11.32	31.32	32.18	31.97	0.85
32	16/11/2023	05:02 - 05:32	20.67	11.85	11.14	11.18	11.17	N/A	11.22	26.04	26.53	26.37	0.49
33	16/11/2023	06:02 - 06:32	20.05	11.58	10.89	10.84	11.22	N/A	11.24	25.31	25.48	25.59	0.17
34	16/11/2023	07:02 - 07:32	19.76	11.20	10.54	10.50	11.06	N/A	11.09	24.44	25.18	24.69	0.75
35	16/11/2023	09:02 - 09:32	20.26	10.57	9.95	9.88	11.36	N/A	11.39	25.66	25.80	25.96	0.14
36	16/11/2023	10:02 - 10:32	19.95	11.14	10.48	10.47	11.46	N/A	11.52	25.69	26.25	25.97	0.56
37	16/11/2023	11:02 - 11:32	18.98	11.29	10.62	10.65	11.31	N/A	11.47	24.09	24.69	24.29	0.61
38	16/11/2023	17:02 - 17:32	20.38	12.36	11.62	11.64	11.24	N/A	11.30	25.98	25.45	26.29	-0.53
39	16/11/2023	18:02 - 18:32	20.73	12.06	11.35	11.33	11.01	N/A	11.10	25.76	25.71	26.08	-0.05
40	16/11/2023	19:02 - 19:32	19.77	11.92	11.21	11.16	11.43	N/A	11.54	25.58	25.18	25.85	-0.40
41	16/11/2023	20:02 - 20:32	20.24	11.96	11.25	11.24	11.22	N/A	11.28	25.66	25.12	25.96	-0.55
42	16/11/2023	21:02 - 21:32	20.56	12.20	11.47	11.51	11.37	N/A	11.48	26.52	26.44	26.85	-0.08
43	16/11/2023	22:02 - 22:32	18.83	11.83	11.12	11.13	11.36	N/A	11.44	24.17	23.92	24.36	-0.25
44	16/11/2023	23:02 - 23:32	22.58	12.31	11.58	11.60	10.67	N/A	10.70	27.18	26.72	27.64	-0.47
45	17/11/2023	00:02 - 00:32	19.89	12.28	11.55	11.62	11.34	N/A	11.41	25.62	25.34	25.89	-0.28
46	17/11/2023	01:02 - 01:32	19.29	12.00	11.29	11.31	11.31	N/A	11.36	24.68	24.21	24.91	-0.47
47	17/11/2023	02:02 - 02:32	20.63	12.18	11.45	11.42	11.17	N/A	11.30	26.06	25.59	26.39	-0.46
48	17/11/2023	04:02 - 04:32	19.61	11.60	10.91	10.99	11.45	N/A	11.51	25.35	24.99	25.61	-0.36
49	17/11/2023	05:02 - 05:32	20.04	11.58	10.90	10.98	11.20	N/A	11.27	25.25	25.05	25.54	-0.21
50	17/11/2023	06:02 - 06:32	20.06	11.75	11.05	11.07	11.25	N/A	11.27	25.43	24.71	25.72	-0.73
51	17/11/2023	07:02 - 07:32	17.96	11.15	10.49	10.46	11.32	N/A	11.31	22.80	22.15	22.92	-0.65
52	17/11/2023	09:02 - 09:32	19.58	12.04	11.33	11.38	11.22	N/A	11.18	24.83	25.29	25.08	0.46
53	17/11/2023	11:02 - 11:32	18.82	11.72	11.02	11.03	11.10	N/A	11.00	23.50	23.74	23.68	0.24
54	17/11/2023	12:02 - 12:32	18.61	10.98	10.33	10.22	11.33	N/A	11.21	23.60	23.20	23.77	-0.40
55	17/11/2023	13:02 - 13:32	20.25	12.08	11.36	11.46	11.38	N/A	11.23	26.13	26.32	26.44	0.19
56	17/11/2023	14:02 - 14:32	19.64	11.98	11.27	11.41	11.68	N/A	11.57	26.12	26.68	26.38	0.56
57	17/11/2023	15:02 - 15:32	17.98	11.03	10.38	10.34	11.90	N/A	11.77	24.25	24.19	24.38	-0.06
58	17/11/2023	16:02 - 16:32	17.26	10.94	10.29	10.34	11.86	N/A	11.73	23.16	23.25	23.23	0.09
59	17/11/2023	17:02 - 17:32	17.23	10.85	10.21	10.14	11.79	N/A	11.66	22.91	22.52	22.98	-0.39
60	17/11/2023	19:02 - 19:32	17.20	11.14	10.48	10.38	11.68	N/A	11.60	22.68	22.30	22.74	-0.38
61	17/11/2023	20:02 - 20:32	17.35	10.83	10.19	10.17	11.74	N/A	11.63	22.94	22.84	23.02	-0.10
62	17/11/2023	21:02 - 21:32	17.36	11.61	10.92	10.91	11.70	N/A	11.60	23.04	22.74	23.12	-0.30
63	17/11/2023	22:02 - 22:32	16.73	11.19	10.53	10.50	11.72	N/A	11.58	22.15	21.47	22.18	-0.68

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Variability Test Data (continued)

where CAL = Calibrated using QAL2 calibration functions

Pair	Date	Time (30-minute Average)	CAL CEM (STP, WET) mg/m³	CEM Water Vapour % v/v	CAL CEM Water Vapour % v/v	SRM Water Vapour % v/v	CAL CEM Oxygen (DRY) % v/v		SRM Oxygen (DRY) % v/v	CAL CEM (STP, DRY, 10% O₂) mg/m³	SRM (STP, DRY, 10% O₂) mg/m³	UNCAL CEM (STP, DRY, 10% O₂) mg/m³	ys, SRM - CAL CEM
64	17/11/2023	23:02 - 23:32	16.63	11.35	10.68	10.68	11.63	N/A	11.49	21.86	20.93	21.88	-0.93
65	18/11/2023	00:02 - 00:32	16.77	11.30	10.63	10.63	11.65	N/A	11.55	22.07	21.12	22.10	-0.95
66	18/11/2023	01:02 - 01:32	17.59	11.45	10.78	10.71	11.25	N/A	11.16	22.24	21.53	22.33	-0.71
67	18/11/2023	02:02 - 02:32	17.56	11.43	10.75	10.69	11.39	N/A	11.32	22.52	21.67	22.62	-0.85
68	18/11/2023	03:02 - 03:32	16.59	11.77	11.07	11.09	11.59	N/A	11.53	21.81	21.66	21.83	-0.16
69	18/11/2023	04:02 - 04:32	16.55	11.51	10.83	10.89	11.53	N/A	11.45	21.56	20.80	21.57	-0.76
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**	
									31.32	24.78	25.02	0.47	

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	10.20
Kv for 69 Pairs of Data	0.9885

The variability is accepted if Sd ≤ Q_o x Kv.

Parameter	Value
Standard Deviation (Sd)	0.47
Q_o x Kv	10.09
Outcome of Variability Test	**Pass**

Valid Calibration Range

Maximum CAL CEM Value (mg/m³)	31.3

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/m³)	0 to 34.5
b) Calibrated Range (20% of Daily ELV) (mg/m³)	0 to 10.0

Greater of (a) or (b)	0 to 34.5

Surrogate Extension Applied?	Yes

Maximum surrogate extension allowable is up to the Daily ELV.

Conc. of Surrogate (mg/m³) y	60.0
Reading on CEM (mg/m³) x	55.6
Cal Reading on CEM (mg/m³) x	53.3

Valid Calibration Range (at REF conditions)	**0 to 50 mg/m³**
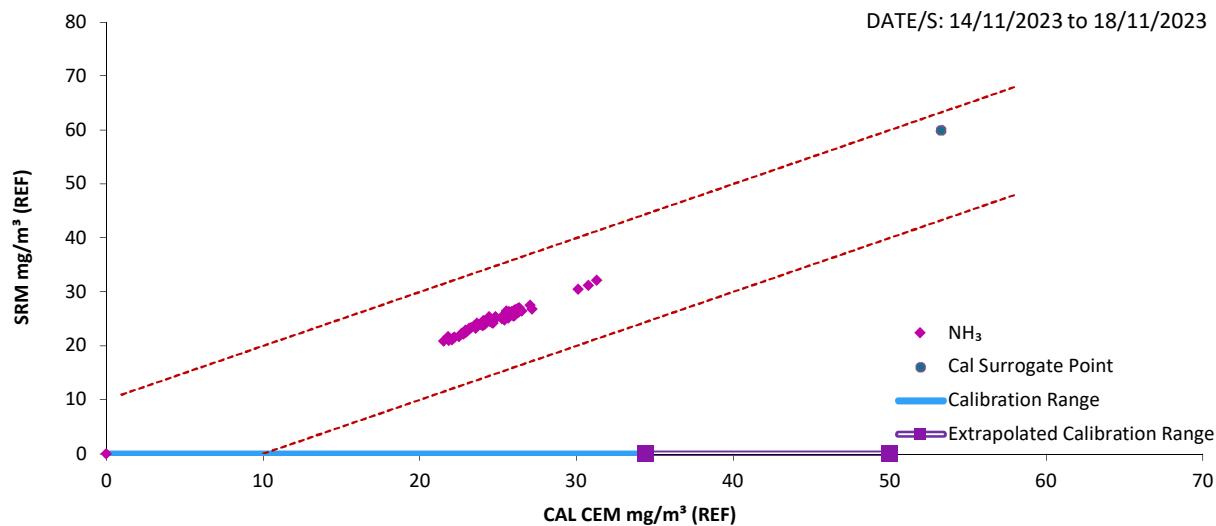
Irish Cement Ltd
Limerick
A2-01 Kiln 6 [Standby Analyser]

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

DATE/S: 14/11/2023 to 18/11/2023

WATER VAPOUR: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby 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	-0.03	0.00	-11.40	-10.70	122.00	130.03	0.00
1	14/11/2023	17:02 - 17:32	11.21	10.47	-0.16	-0.23	0.04	0.03	10.55
2	14/11/2023	18:02 - 18:32	11.03	10.34	-0.34	-0.36	0.12	0.11	10.38
3	14/11/2023	19:02 - 19:32	10.73	10.00	-0.65	-0.70	0.45	0.42	10.09
4	14/11/2023	20:02 - 20:32	11.79	11.16	0.42	0.46	0.19	0.18	11.09
5	14/11/2023	21:02 - 21:32	12.13	11.50	0.76	0.80	0.61	0.58	11.41
6	14/11/2023	23:02 - 23:32	11.10	10.44	-0.27	-0.26	0.07	0.07	10.45
7	15/11/2023	00:02 - 00:32	10.67	10.01	-0.70	-0.69	0.49	0.50	10.04
8	15/11/2023	01:02 - 01:32	11.62	10.94	0.25	0.24	0.06	0.06	10.93
9	15/11/2023	02:02 - 02:32	11.77	11.12	0.39	0.42	0.17	0.15	11.07
10	15/11/2023	04:02 - 04:32	11.68	11.04	0.31	0.34	0.11	0.10	10.99
11	15/11/2023	05:02 - 05:32	11.66	10.98	0.29	0.28	0.08	0.08	10.97
12	15/11/2023	06:02 - 06:32	11.34	10.66	-0.03	-0.04	0.00	0.00	10.67
13	15/11/2023	07:02 - 07:32	11.40	10.74	0.03	0.04	0.00	0.00	10.73
14	15/11/2023	09:02 - 09:32	11.39	10.72	0.02	0.02	0.00	0.00	10.71
15	15/11/2023	10:02 - 10:32	10.64	9.91	-0.73	-0.79	0.58	0.54	10.01
16	15/11/2023	11:02 - 11:32	11.12	10.44	-0.26	-0.26	0.07	0.07	10.46
17	15/11/2023	12:02 - 12:32	10.79	10.09	-0.59	-0.61	0.36	0.34	10.15
18	15/11/2023	13:02 - 13:32	12.36	11.75	0.99	1.05	1.03	0.97	11.62
19	15/11/2023	15:02 - 15:32	12.10	11.48	0.73	0.78	0.57	0.53	11.38
20	15/11/2023	17:02 - 17:32	11.17	10.45	-0.20	-0.25	0.05	0.04	10.51
21	15/11/2023	18:02 - 18:32	11.82	11.13	0.45	0.43	0.19	0.20	11.12
22	15/11/2023	19:02 - 19:32	11.52	10.80	0.15	0.10	0.01	0.02	10.84
23	15/11/2023	20:02 - 20:32	11.50	10.79	0.12	0.09	0.01	0.02	10.82
24	15/11/2023	21:02 - 21:32	11.67	10.97	0.30	0.27	0.08	0.09	10.98
25	15/11/2023	22:02 - 22:32	11.07	10.37	-0.31	-0.33	0.10	0.09	10.41
26	15/11/2023	23:02 - 23:32	10.92	10.24	-0.45	-0.46	0.20	0.20	10.28
27	16/11/2023	00:02 - 00:32	10.80	10.13	-0.58	-0.57	0.33	0.33	10.16
28	16/11/2023	01:02 - 01:32	11.62	11.00	0.25	0.30	0.07	0.06	10.93
29	16/11/2023	02:02 - 02:32	11.33	10.58	-0.04	-0.12	0.00	0.00	10.66
30	16/11/2023	03:02 - 03:32	11.74	11.13	0.37	0.44	0.16	0.13	11.04
31	16/11/2023	04:02 - 04:32	11.62	10.95	0.25	0.25	0.06	0.06	10.93
32	16/11/2023	05:02 - 05:32	11.85	11.18	0.47	0.48	0.23	0.22	11.14
33	16/11/2023	06:02 - 06:32	11.58	10.84	0.20	0.14	0.03	0.04	10.89
34	16/11/2023	07:02 - 07:32	11.20	10.50	-0.17	-0.20	0.03	0.03	10.54
35	16/11/2023	09:02 - 09:32	10.57	9.88	-0.80	-0.82	0.66	0.64	9.95
36	16/11/2023	10:02 - 10:32	11.14	10.47	-0.23	-0.23	0.05	0.05	10.48
37	16/11/2023	11:02 - 11:32	11.29	10.65	-0.09	-0.05	0.00	0.01	10.62
38	16/11/2023	12:02 - 12:32	11.99	11.35	0.62	0.66	0.40	0.38	11.28
39	16/11/2023	13:02 - 13:32	11.83	11.11	0.46	0.41	0.19	0.21	11.13
40	16/11/2023	14:02 - 14:32	11.95	11.29	0.57	0.59	0.34	0.33	11.24
41	16/11/2023	15:02 - 15:32	12.45	11.77	1.08	1.07	1.16	1.17	11.71
42	16/11/2023	17:02 - 17:32	12.36	11.64	0.98	0.94	0.93	0.97	11.62
43	16/11/2023	18:02 - 18:32	12.06	11.33	0.69	0.63	0.43	0.48	11.35
44	16/11/2023	19:02 - 19:32	11.92	11.16	0.54	0.47	0.25	0.30	11.21
45	16/11/2023	20:02 - 20:32	11.96	11.24	0.59	0.54	0.32	0.35	11.25
46	16/11/2023	21:02 - 21:32	12.20	11.51	0.83	0.81	0.67	0.68	11.47
47	16/11/2023	22:02 - 22:32	11.83	11.13	0.45	0.43	0.20	0.20	11.12
48	16/11/2023	23:02 - 23:32	12.31	11.60	0.94	0.90	0.85	0.88	11.58
49	17/11/2023	00:02 - 00:32	12.28	11.62	0.91	0.92	0.84	0.82	11.55
50	17/11/2023	01:02 - 01:32	12.00	11.31	0.63	0.61	0.38	0.40	11.29
51	17/11/2023	02:02 - 02:32	12.18	11.42	0.80	0.72	0.58	0.64	11.45
52	17/11/2023	03:02 - 03:32	11.90	11.20	0.53	0.50	0.26	0.28	11.20
53	17/11/2023	04:02 - 04:32	11.60	10.99	0.23	0.29	0.07	0.05	10.91
54	17/11/2023	05:02 - 05:32	11.58	10.98	0.21	0.29	0.06	0.04	10.90
55	17/11/2023	06:02 - 06:32	11.75	11.07	0.38	0.37	0.14	0.14	11.05
56	17/11/2023	07:02 - 07:32	11.15	10.46	-0.22	-0.24	0.05	0.05	10.49
57	17/11/2023	09:02 - 09:32	12.04	11.38	0.67	0.68	0.45	0.45	11.33
58	17/11/2023	10:02 - 10:32	11.53	10.83	0.15	0.13	0.02	0.02	10.84
59	17/11/2023	11:02 - 11:32	11.72	11.03	0.34	0.33	0.11	0.12	11.02
60	17/11/2023	12:02 - 12:32	10.98	10.22	-0.39	-0.48	0.19	0.15	10.33
61	17/11/2023	13:02 - 13:32	12.08	11.46	0.71	0.76	0.54	0.50	11.36
62	17/11/2023	15:02 - 15:32	11.03	10.34	-0.34	-0.36	0.12	0.12	10.38
63	17/11/2023	16:02 - 16:32	10.94	10.34	-0.43	-0.36	0.16	0.19	10.29
64	17/11/2023	17:02 - 17:32	10.85	10.14	-0.52	-0.55	0.29	0.27	10.21
65	17/11/2023	19:02 - 19:32	11.14	10.38	-0.24	-0.32	0.08	0.06	10.48

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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	17/11/2023	20:02 - 20:32	10.83	10.17	-0.54	-0.53	0.29	0.29	10.19
67	17/11/2023	21:02 - 21:32	11.61	10.91	0.24	0.21	0.05	0.06	10.92
68	17/11/2023	22:02 - 22:32	11.19	10.50	-0.18	-0.20	0.04	0.03	10.53
69	17/11/2023	23:02 - 23:32	11.35	10.68	-0.02	-0.02	0.00	0.00	10.68
70	18/11/2023	00:02 - 00:32	11.30	10.63	-0.07	-0.07	0.00	0.00	10.63
71	18/11/2023	01:02 - 01:32	11.45	10.71	0.08	0.01	0.00	0.01	10.78
72	18/11/2023	02:02 - 02:32	11.43	10.69	0.05	-0.01	0.00	0.00	10.75
73	18/11/2023	03:02 - 03:32	11.77	11.09	0.39	0.39	0.15	0.15	11.07
74	18/11/2023	04:02 - 04:32	11.51	10.89	0.14	0.19	0.03	0.02	10.83
75									
76									
77									
78									
79									
80									
81									
82									
83									
84									
85									
86									
87									
88									
89									
90									

MAX SRM - MIN SRM	1.90	
(DAILY) DELV (% v/v)	30	
95% CI MU (%)	30	
95% CI at DELV (% v/v)	9.0	
PROCEDURE (A OR B)	B	

SUM: 139.91 (A x B), 147.81 ((x - x_av)²)

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 = -0.03

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	15/11/2023	08:02 - 08:32	11.94	0.00	SRM offline/calibrating
2	15/11/2023	14:02 - 14:32	12.63	0.00	SRM offline/calibrating
3	15/11/2023	16:02 - 16:32	11.42	0.00	SRM offline/calibrating
4	16/11/2023	08:02 - 08:32	11.10	0.00	SRM offline/calibrating
5	16/11/2023	16:02 - 16:32	12.44	0.00	SRM offline/calibrating
6	17/11/2023	08:02 - 08:32	11.67	0.00	SRM offline/calibrating
7	14/11/2023	22:02 - 22:32	11.77	11.22	Statistical outlier
8	15/11/2023	03:02 - 03:32	11.85	11.28	Statistical outlier
9	17/11/2023	14:02 - 14:32	11.98	11.41	Statistical outlier
10	17/11/2023	18:02 - 18:32	10.83	10.05	Statistical outlier
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

Irish Cement Ltd
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A2-01 Kiln 6 [Standby Analyser]

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Derivation of Calibration Function

b =	0.9383	a =	0.0281
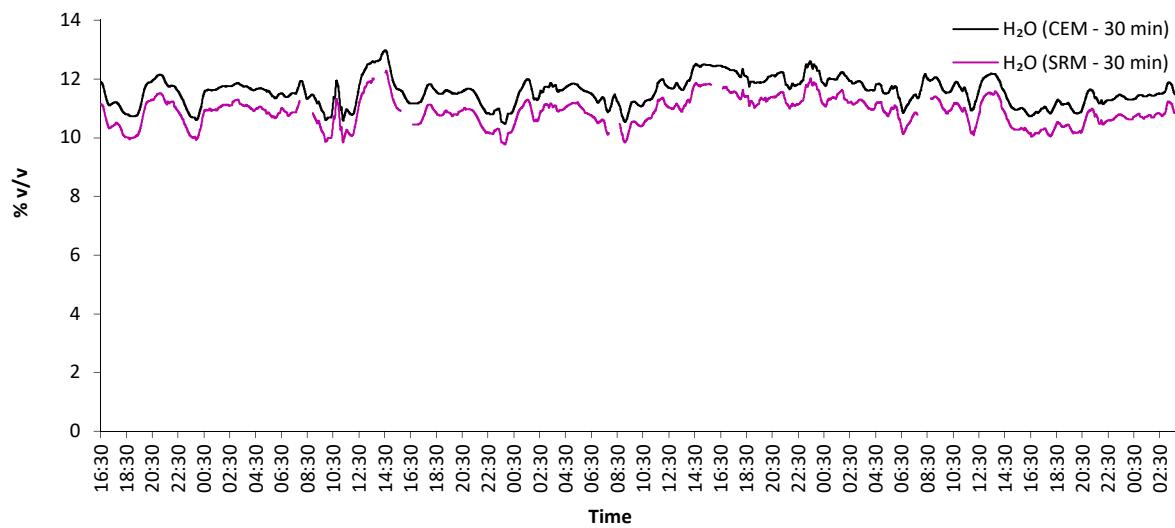
CALIBRATION FUNCTION =	y = 0.9383x + 0.0281

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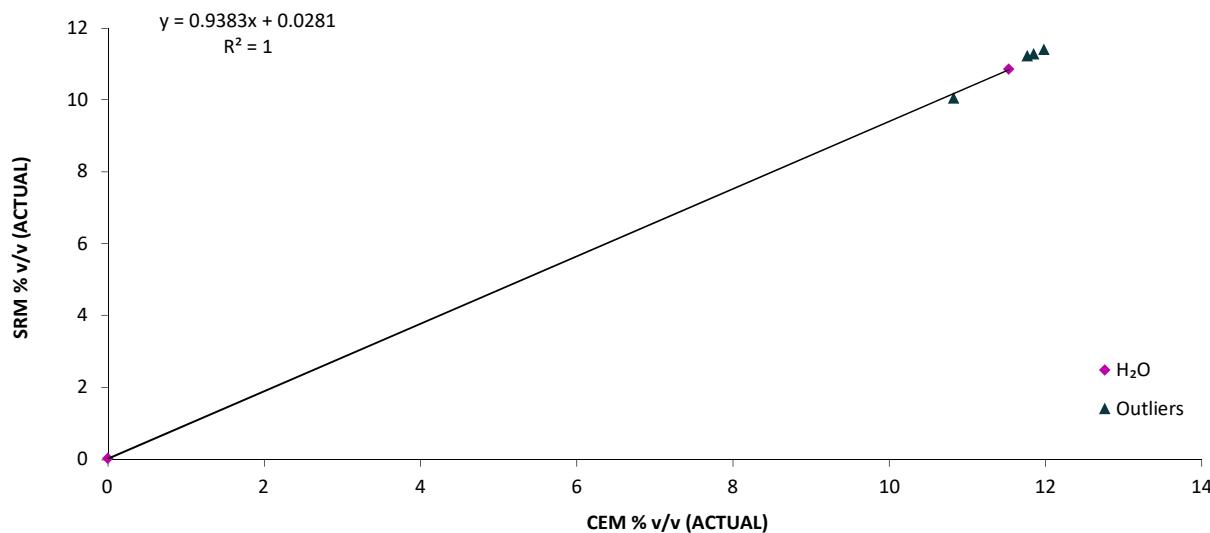
For Method A $b = [(x - x_{av}) \times (y - y_{az})] / (x - x_{av})^2$ and $a = MEAN(y) - [MEAN(x) \times b]$

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

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

PLOT 2: Calibration Graph for Method B

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A2-01 Kiln 6 [Standby 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	-0.03	0.00
1	14/11/2023	17:02 - 17:32	10.55	10.47	11.21	-0.08
2	14/11/2023	18:02 - 18:32	10.38	10.34	11.03	-0.04
3	14/11/2023	19:02 - 19:32	10.09	10.00	10.73	-0.09
4	14/11/2023	20:02 - 20:32	11.09	11.16	11.79	0.07
5	14/11/2023	21:02 - 21:32	11.41	11.50	12.13	0.09
6	14/11/2023	23:02 - 23:32	10.45	10.44	11.10	-0.01
7	15/11/2023	00:02 - 00:32	10.04	10.01	10.67	-0.03
8	15/11/2023	01:02 - 01:32	10.93	10.94	11.62	0.01
9	15/11/2023	02:02 - 02:32	11.07	11.12	11.77	0.05
10	15/11/2023	04:02 - 04:32	10.99	11.04	11.68	0.04
11	15/11/2023	05:02 - 05:32	10.97	10.98	11.66	0.01
12	15/11/2023	06:02 - 06:32	10.67	10.66	11.34	0.00
13	15/11/2023	07:02 - 07:32	10.73	10.74	11.40	0.01
14	15/11/2023	09:02 - 09:32	10.71	10.72	11.39	0.00
15	15/11/2023	10:02 - 10:32	10.01	9.91	10.64	-0.10
16	15/11/2023	11:02 - 11:32	10.46	10.44	11.12	-0.02
17	15/11/2023	12:02 - 12:32	10.15	10.09	10.79	-0.06
18	15/11/2023	13:02 - 13:32	11.62	11.75	12.36	0.13
19	15/11/2023	15:02 - 15:32	11.38	11.48	12.10	0.09
20	15/11/2023	17:02 - 17:32	10.51	10.45	11.17	-0.06
21	15/11/2023	18:02 - 18:32	11.12	11.13	11.82	0.01
22	15/11/2023	19:02 - 19:32	10.84	10.80	11.52	-0.05
23	15/11/2023	20:02 - 20:32	10.82	10.79	11.50	-0.02
24	15/11/2023	21:02 - 21:32	10.98	10.97	11.67	0.00
25	15/11/2023	22:02 - 22:32	10.41	10.37	11.07	-0.04
26	15/11/2023	23:02 - 23:32	10.28	10.24	10.92	-0.04
27	16/11/2023	00:02 - 00:32	10.16	10.13	10.80	-0.03
28	16/11/2023	01:02 - 01:32	10.93	11.00	11.62	0.06
29	16/11/2023	02:02 - 02:32	10.66	10.58	11.33	-0.08
30	16/11/2023	03:02 - 03:32	11.04	11.13	11.74	0.09
31	16/11/2023	04:02 - 04:32	10.93	10.95	11.62	0.02
32	16/11/2023	05:02 - 05:32	11.14	11.18	11.85	0.04
33	16/11/2023	06:02 - 06:32	10.89	10.84	11.58	-0.05
34	16/11/2023	07:02 - 07:32	10.54	10.50	11.20	-0.03
35	16/11/2023	09:02 - 09:32	9.95	9.88	10.57	-0.07
36	16/11/2023	10:02 - 10:32	10.48	10.47	11.14	-0.02
37	16/11/2023	11:02 - 11:32	10.62	10.65	11.29	0.03
38	16/11/2023	12:02 - 12:32	11.28	11.35	11.99	0.08
39	16/11/2023	13:02 - 13:32	11.13	11.11	11.83	-0.01
40	16/11/2023	14:02 - 14:32	11.24	11.29	11.95	0.05
41	16/11/2023	15:02 - 15:32	11.71	11.77	12.45	0.06
42	16/11/2023	17:02 - 17:32	11.62	11.64	12.36	0.02
43	16/11/2023	18:02 - 18:32	11.35	11.33	12.06	-0.02
44	16/11/2023	19:02 - 19:32	11.21	11.16	11.92	-0.05
45	16/11/2023	20:02 - 20:32	11.25	11.24	11.96	-0.01
46	16/11/2023	21:02 - 21:32	11.47	11.51	12.20	0.03
47	16/11/2023	22:02 - 22:32	11.12	11.13	11.83	0.01
48	16/11/2023	23:02 - 23:32	11.58	11.60	12.31	0.03
49	17/11/2023	00:02 - 00:32	11.55	11.62	12.28	0.07
50	17/11/2023	01:02 - 01:32	11.29	11.31	12.00	0.02
51	17/11/2023	02:02 - 02:32	11.45	11.42	12.18	-0.03
52	17/11/2023	03:02 - 03:32	11.20	11.20	11.90	0.00
53	17/11/2023	04:02 - 04:32	10.91	10.99	11.60	0.07
54	17/11/2023	05:02 - 05:32	10.90	10.98	11.58	0.09
55	17/11/2023	06:02 - 06:32	11.05	11.07	11.75	0.02
56	17/11/2023	07:02 - 07:32	10.49	10.46	11.15	-0.03
57	17/11/2023	09:02 - 09:32	11.33	11.38	12.04	0.05
58	17/11/2023	10:02 - 10:32	10.84	10.83	11.53	-0.01
59	17/11/2023	11:02 - 11:32	11.02	11.03	11.72	0.01
60	17/11/2023	12:02 - 12:32	10.33	10.22	10.98	-0.12
61	17/11/2023	13:02 - 13:32	11.36	11.46	12.08	0.10
62	17/11/2023	15:02 - 15:32	10.38	10.34	11.03	-0.04
63	17/11/2023	16:02 - 16:32	10.29	10.34	10.94	0.05
64	17/11/2023	17:02 - 17:32	10.21	10.14	10.85	-0.07
65	17/11/2023	19:02 - 19:32	10.48	10.38	11.14	-0.10

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WATER VAPOUR: QAL2 CALCULATIONS

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A2-01 Kiln 6 [Standby 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	17/11/2023	20:02 - 20:32	10.19	10.17	10.83	-0.02
67	17/11/2023	21:02 - 21:32	10.92	10.91	11.61	-0.01
68	17/11/2023	22:02 - 22:32	10.53	10.50	11.19	-0.03
69	17/11/2023	23:02 - 23:32	10.68	10.68	11.35	0.00
70	18/11/2023	00:02 - 00:32	10.63	10.63	11.30	0.00
71	18/11/2023	01:02 - 01:32	10.78	10.71	11.45	-0.06
72	18/11/2023	02:02 - 02:32	10.75	10.69	11.43	-0.06
73	18/11/2023	03:02 - 03:32	11.07	11.09	11.77	0.03
74	18/11/2023	04:02 - 04:32	10.83	10.89	11.51	0.06
75						
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
			MAX	**AVERAGE**	**AVERAGE**	**Sd**
			11.71	10.84	11.53	0.05

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	4.59
Kv for 74 Pairs of Data	0.9885

The variability is accepted if Sd ≤ Q_o x Kv

Parameter	Value
Standard Deviation (Sd)	0.05
Q_o x Kv	4.54
Outcome of Variability Test	**Pass**
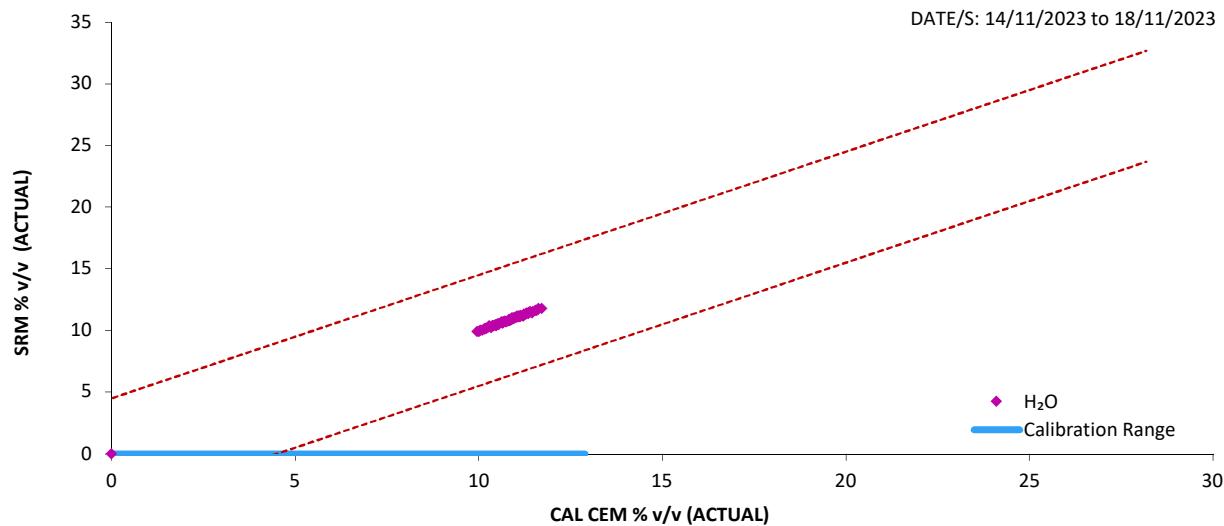
Valid Calibration Range

Maximum CAL CEM Value (% v/v)	11.7
Allowable Extension (%)	10

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

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

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OXYGEN: QAL2 CALCULATIONS

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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	-9.81	-9.95	97.61	96.29	0.00
1	14/11/2023	17:02 - 17:32	9.94	9.94	11.11	0.04	0.00	0.00	0.00	9.99
2	14/11/2023	18:02 - 18:32	9.89	9.89	11.03	-0.01	-0.06	0.00	0.00	9.94
3	14/11/2023	19:02 - 19:32	10.04	10.05	11.17	0.14	0.11	0.01	0.02	10.08
4	14/11/2023	20:02 - 20:32	9.92	9.92	11.17	0.02	-0.03	0.00	0.00	9.97
5	14/11/2023	21:02 - 21:32	9.88	9.90	11.18	-0.02	-0.05	0.00	0.00	9.93
6	14/11/2023	23:02 - 23:32	10.14	10.14	11.32	0.24	0.19	0.05	0.06	10.19
7	15/11/2023	00:02 - 00:32	10.14	10.14	11.27	0.23	0.19	0.05	0.05	10.18
8	15/11/2023	01:02 - 01:32	9.67	9.72	10.91	-0.24	-0.23	0.05	0.06	9.71
9	15/11/2023	02:02 - 02:32	9.89	9.92	11.17	-0.01	-0.02	0.00	0.00	9.93
10	15/11/2023	04:02 - 04:32	9.88	9.90	11.13	-0.02	-0.04	0.00	0.00	9.93
11	15/11/2023	05:02 - 05:32	9.81	9.83	11.05	-0.10	-0.11	0.01	0.01	9.85
12	15/11/2023	06:02 - 06:32	10.08	10.08	11.29	0.17	0.14	0.02	0.03	10.12
13	15/11/2023	07:02 - 07:32	10.04	10.06	11.27	0.13	0.11	0.02	0.02	10.08
14	15/11/2023	09:02 - 09:32	10.10	10.14	11.36	0.20	0.20	0.04	0.04	10.15
15	15/11/2023	10:02 - 10:32	9.82	9.89	10.98	-0.08	-0.06	0.00	0.01	9.86
16	15/11/2023	11:02 - 11:32	9.85	9.96	11.12	-0.05	0.01	0.00	0.00	9.90
17	15/11/2023	12:02 - 12:32	10.14	10.18	11.32	0.23	0.23	0.05	0.05	10.19
18	15/11/2023	13:02 - 13:32	9.70	9.70	11.00	-0.20	-0.24	0.05	0.04	9.75
19	15/11/2023	15:02 - 15:32	10.29	10.20	11.52	0.39	0.25	0.10	0.15	10.34
20	15/11/2023	17:02 - 17:32	9.72	9.91	11.06	-0.19	-0.04	0.01	0.03	9.76
21	15/11/2023	18:02 - 18:32	9.54	9.76	10.98	-0.37	-0.19	0.07	0.13	9.58
22	15/11/2023	19:02 - 19:32	9.84	9.97	11.18	-0.06	0.02	0.00	0.00	9.88
23	15/11/2023	20:02 - 20:32	9.91	10.02	11.23	0.00	0.07	0.00	0.00	9.95
24	15/11/2023	21:02 - 21:32	9.93	10.04	11.27	0.03	0.09	0.00	0.00	9.98
25	15/11/2023	22:02 - 22:32	10.30	10.39	11.59	0.40	0.44	0.18	0.16	10.35
26	15/11/2023	23:02 - 23:32	10.28	10.36	11.54	0.38	0.41	0.16	0.15	10.33
27	16/11/2023	00:02 - 00:32	10.13	10.21	11.37	0.23	0.27	0.06	0.05	10.18
28	16/11/2023	01:02 - 01:32	10.05	10.11	11.36	0.14	0.17	0.02	0.02	10.09
29	16/11/2023	02:02 - 02:32	10.14	10.25	11.47	0.23	0.30	0.07	0.05	10.18
30	16/11/2023	03:02 - 03:32	9.90	9.99	11.25	0.00	0.05	0.00	0.00	9.95
31	16/11/2023	04:02 - 04:32	9.94	10.08	11.32	0.03	0.13	0.00	0.00	9.98
32	16/11/2023	05:02 - 05:32	9.88	9.97	11.22	-0.02	0.02	0.00	0.00	9.93
33	16/11/2023	06:02 - 06:32	9.96	10.02	11.24	0.05	0.07	0.00	0.00	10.00
34	16/11/2023	07:02 - 07:32	9.85	9.92	11.09	-0.05	-0.02	0.00	0.00	9.89
35	16/11/2023	09:02 - 09:32	10.18	10.26	11.39	0.27	0.32	0.09	0.08	10.23
36	16/11/2023	10:02 - 10:32	10.21	10.32	11.52	0.30	0.37	0.11	0.09	10.26
37	16/11/2023	11:02 - 11:32	10.06	10.25	11.47	0.16	0.30	0.05	0.02	10.10
38	16/11/2023	17:02 - 17:32	9.89	9.99	11.30	-0.02	0.04	0.00	0.00	9.93
39	16/11/2023	18:02 - 18:32	9.72	9.84	11.10	-0.18	-0.10	0.02	0.03	9.76
40	16/11/2023	19:02 - 19:32	10.10	10.25	11.54	0.20	0.30	0.06	0.04	10.15
41	16/11/2023	20:02 - 20:32	9.92	10.01	11.28	0.01	0.06	0.00	0.00	9.96
42	16/11/2023	21:02 - 21:32	10.02	10.16	11.48	0.11	0.21	0.02	0.01	10.06
43	16/11/2023	22:02 - 22:32	10.05	10.17	11.44	0.14	0.22	0.03	0.02	10.09
44	16/11/2023	23:02 - 23:32	9.39	9.46	10.70	-0.51	-0.49	0.25	0.26	9.43
45	17/11/2023	00:02 - 00:32	9.99	10.09	11.41	0.08	0.14	0.01	0.01	10.03
46	17/11/2023	01:02 - 01:32	9.99	10.08	11.36	0.08	0.13	0.01	0.01	10.03
47	17/11/2023	02:02 - 02:32	9.84	10.01	11.30	-0.06	0.06	0.00	0.00	9.89
48	17/11/2023	03:02 - 03:32	10.21	10.32	11.62	0.31	0.37	0.11	0.09	10.26
49	17/11/2023	04:02 - 04:32	10.15	10.24	11.51	0.25	0.29	0.07	0.06	10.20
50	17/11/2023	05:02 - 05:32	9.94	10.03	11.27	0.03	0.08	0.00	0.00	9.98
51	17/11/2023	06:02 - 06:32	9.96	10.03	11.27	0.06	0.08	0.00	0.00	10.00
52	17/11/2023	07:02 - 07:32	10.08	10.13	11.31	0.18	0.18	0.03	0.03	10.13
53	17/11/2023	09:02 - 09:32	9.90	9.91	11.18	0.00	-0.04	0.00	0.00	9.95
54	17/11/2023	10:02 - 10:32	10.15	10.16	11.39	0.24	0.21	0.05	0.06	10.19
55	17/11/2023	11:02 - 11:32	9.83	9.79	11.00	-0.07	-0.16	0.01	0.00	9.88
56	17/11/2023	12:02 - 12:32	10.11	10.07	11.21	0.21	0.12	0.02	0.04	10.16
57	17/11/2023	13:02 - 13:32	10.04	9.94	11.23	0.14	0.00	0.00	0.02	10.09
58	17/11/2023	15:02 - 15:32	10.61	10.56	11.77	0.71	0.61	0.43	0.50	10.67
59	17/11/2023	16:02 - 16:32	10.59	10.52	11.73	0.68	0.57	0.39	0.47	10.64
60	17/11/2023	17:02 - 17:32	10.53	10.47	11.66	0.63	0.53	0.33	0.39	10.58
61	17/11/2023	19:02 - 19:32	10.41	10.39	11.60	0.50	0.45	0.23	0.25	10.46
62	17/11/2023	20:02 - 20:32	10.49	10.45	11.63	0.59	0.50	0.30	0.34	10.54
63	17/11/2023	21:02 - 21:32	10.37	10.33	11.60	0.47	0.38	0.18	0.22	10.42
64	17/11/2023	22:02 - 22:32	10.43	10.37	11.58	0.53	0.42	0.22	0.28	10.48
65	17/11/2023	23:02 - 23:32	10.34	10.26	11.49	0.44	0.32	0.14	0.19	10.39

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

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Industrial Emissions Licence: P0029-06

OXYGEN: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

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	00:02 - 00:32	10.36	10.32	11.55	0.45	0.38	0.17	0.21	10.41
67	18/11/2023	01:02 - 01:32	9.99	9.97	11.16	0.09	0.02	0.00	0.01	10.04
68	18/11/2023	02:02 - 02:32	10.12	10.11	11.32	0.22	0.17	0.04	0.05	10.17
69	18/11/2023	03:02 - 03:32	10.26	10.25	11.53	0.36	0.30	0.11	0.13	10.31
70	18/11/2023	04:02 - 04:32	10.23	10.20	11.45	0.33	0.26	0.08	0.11	10.28
71										
72										
73										
74										
75										
76										
77										
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79										
80										
81										
82										
83										
84										
85										
86										
87										
88										
89										
90										

MAX SRM - MIN SRM	1.08	
(DAILY) DELV (% v/v)	21	
95% CI MU (%)	10	
95% CI at DELV (% v/v)	2.1	
PROCEDURE (A OR B)	B	

SUM: 102.21   101.48

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	15/11/2023	08:02 - 08:32	9.94	0.00	SRM offline/calibrating
2	15/11/2023	14:02 - 14:32	9.71	0.00	SRM offline/calibrating
3	15/11/2023	16:02 - 16:32	10.11	0.00	SRM offline/calibrating
4	16/11/2023	08:02 - 08:32	10.27	0.00	SRM offline/calibrating
5	16/11/2023	16:02 - 16:32	10.04	0.00	SRM offline/calibrating
6	17/11/2023	08:02 - 08:32	10.12	0.00	SRM offline/calibrating
7	14/11/2023	22:02 - 22:32	9.90	9.89	Peripheral data outliers (Water Vapour)
8	15/11/2023	03:02 - 03:32	9.81	9.84	Peripheral data outliers (Water Vapour)
9	17/11/2023	14:02 - 14:32	10.31	10.25	Peripheral data outliers (Water Vapour)
10	17/11/2023	18:02 - 18:32	10.15	10.10	Peripheral data outliers (Water Vapour)
11	16/11/2023	12:02 - 12:32	10.03	10.29	Statistical outlier
12	16/11/2023	13:02 - 13:32	9.77	10.03	Statistical outlier
13	16/11/2023	14:02 - 14:32	10.15	10.45	Statistical outlier
14	16/11/2023	15:02 - 15:32	9.97	10.28	Statistical outlier
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

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A2-01 Kiln 6 [Standby Analyser]

Derivation of Calibration Function

b =	1.0137	a =	-0.0912
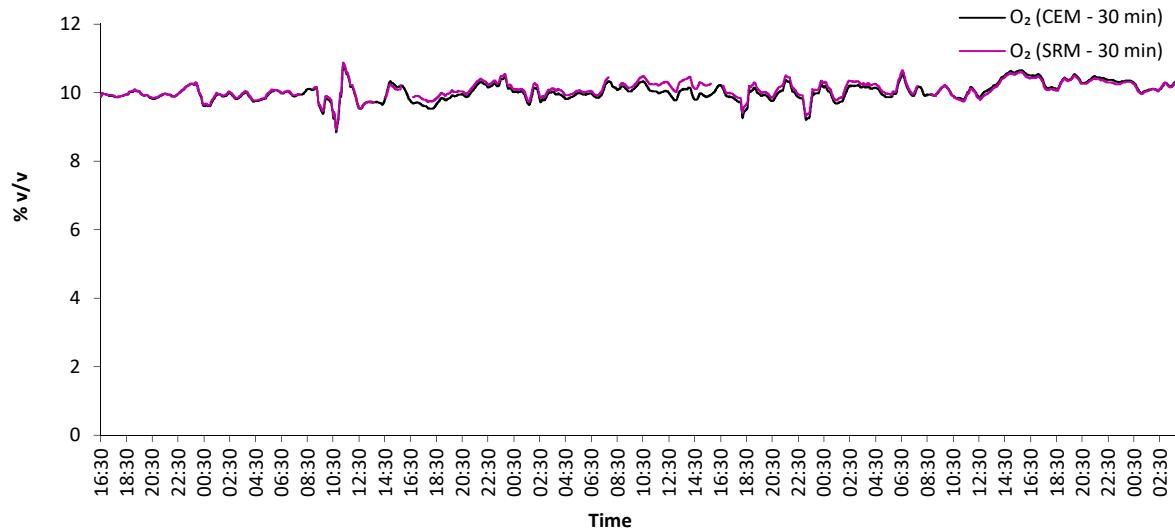
CALIBRATION FUNCTION =	y = 1.0137x - 0.0912

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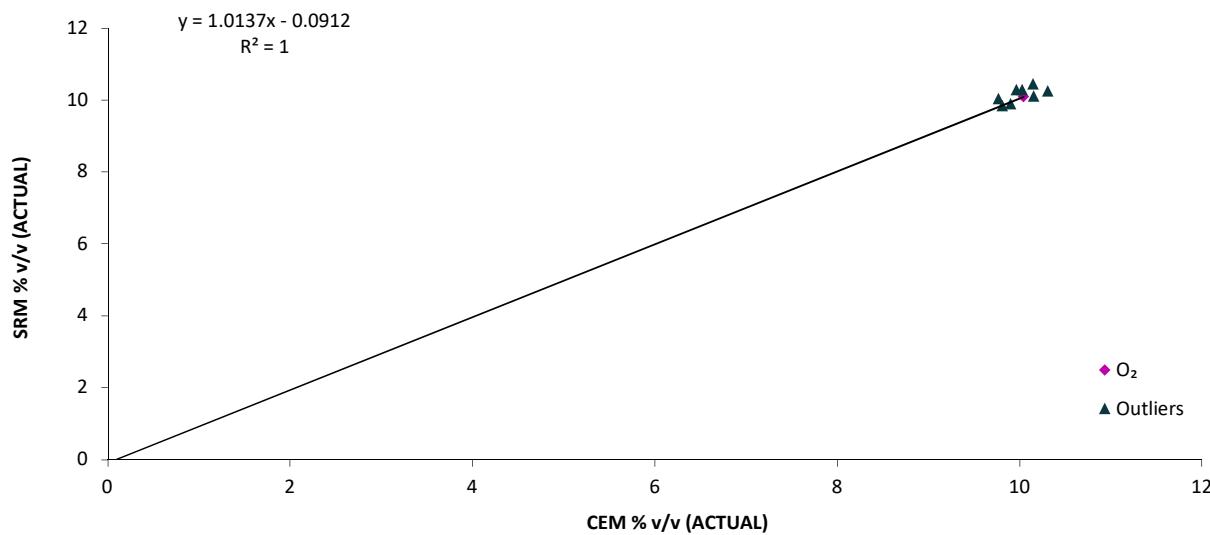
For Method A $b = [(x - x_{av}) \times (y - y_{az})] / (x - x_{av})^2$ and $a = MEAN(y) - [MEAN(x) \times b]$

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

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

PLOT 2: Calibration Graph for Method B

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OXYGEN: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby Analyser]

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	11.17	11.11	9.94	-0.06
2	14/11/2023	18:02 - 18:32	11.09	11.03	9.89	-0.06
3	14/11/2023	19:02 - 19:32	11.22	11.17	10.04	-0.05
4	14/11/2023	20:02 - 20:32	11.21	11.17	9.92	-0.05
5	14/11/2023	21:02 - 21:32	11.20	11.18	9.88	-0.02
6	14/11/2023	23:02 - 23:32	11.38	11.32	10.14	-0.06
7	15/11/2023	00:02 - 00:32	11.32	11.27	10.14	-0.05
8	15/11/2023	01:02 - 01:32	10.90	10.91	9.67	0.01
9	15/11/2023	02:02 - 02:32	11.17	11.17	9.89	-0.01
10	15/11/2023	04:02 - 04:32	11.15	11.13	9.88	-0.02
11	15/11/2023	05:02 - 05:32	11.06	11.05	9.81	-0.02
12	15/11/2023	06:02 - 06:32	11.33	11.29	10.08	-0.05
13	15/11/2023	07:02 - 07:32	11.30	11.27	10.04	-0.02
14	15/11/2023	09:02 - 09:32	11.37	11.36	10.10	0.00
15	15/11/2023	10:02 - 10:32	10.96	10.98	9.82	0.02
16	15/11/2023	11:02 - 11:32	11.05	11.12	9.85	0.06
17	15/11/2023	12:02 - 12:32	11.34	11.32	10.14	-0.02
18	15/11/2023	13:02 - 13:32	11.03	11.00	9.70	-0.03
19	15/11/2023	15:02 - 15:32	11.67	11.52	10.29	-0.14
20	15/11/2023	17:02 - 17:32	10.91	11.06	9.72	0.16
21	15/11/2023	18:02 - 18:32	10.77	10.98	9.54	0.21
22	15/11/2023	19:02 - 19:32	11.08	11.18	9.84	0.09
23	15/11/2023	20:02 - 20:32	11.16	11.23	9.91	0.07
24	15/11/2023	21:02 - 21:32	11.21	11.27	9.93	0.07
25	15/11/2023	22:02 - 22:32	11.55	11.59	10.30	0.04
26	15/11/2023	23:02 - 23:32	11.52	11.54	10.28	0.02
27	16/11/2023	00:02 - 00:32	11.33	11.37	10.13	0.04
28	16/11/2023	01:02 - 01:32	11.33	11.36	10.05	0.03
29	16/11/2023	02:02 - 02:32	11.40	11.47	10.14	0.07
30	16/11/2023	03:02 - 03:32	11.18	11.25	9.90	0.06
31	16/11/2023	04:02 - 04:32	11.21	11.32	9.94	0.11
32	16/11/2023	05:02 - 05:32	11.17	11.22	9.88	0.05
33	16/11/2023	06:02 - 06:32	11.22	11.24	9.96	0.01
34	16/11/2023	07:02 - 07:32	11.06	11.09	9.85	0.03
35	16/11/2023	09:02 - 09:32	11.36	11.39	10.18	0.03
36	16/11/2023	10:02 - 10:32	11.46	11.52	10.21	0.07
37	16/11/2023	11:02 - 11:32	11.31	11.47	10.06	0.16
38	16/11/2023	17:02 - 17:32	11.24	11.30	9.89	0.07
39	16/11/2023	18:02 - 18:32	11.01	11.10	9.72	0.09
40	16/11/2023	19:02 - 19:32	11.43	11.54	10.10	0.11
41	16/11/2023	20:02 - 20:32	11.22	11.28	9.92	0.05
42	16/11/2023	21:02 - 21:32	11.37	11.48	10.02	0.11
43	16/11/2023	22:02 - 22:32	11.36	11.44	10.05	0.09
44	16/11/2023	23:02 - 23:32	10.67	10.70	9.39	0.03
45	17/11/2023	00:02 - 00:32	11.34	11.41	9.99	0.07
46	17/11/2023	01:02 - 01:32	11.31	11.36	9.99	0.05
47	17/11/2023	02:02 - 02:32	11.17	11.30	9.84	0.13
48	17/11/2023	03:02 - 03:32	11.55	11.62	10.21	0.07
49	17/11/2023	04:02 - 04:32	11.45	11.51	10.15	0.06
50	17/11/2023	05:02 - 05:32	11.20	11.27	9.94	0.06
51	17/11/2023	06:02 - 06:32	11.25	11.27	9.96	0.03
52	17/11/2023	07:02 - 07:32	11.32	11.31	10.08	-0.01
53	17/11/2023	09:02 - 09:32	11.22	11.18	9.90	-0.04
54	17/11/2023	10:02 - 10:32	11.43	11.39	10.15	-0.04
55	17/11/2023	11:02 - 11:32	11.10	11.00	9.83	-0.10
56	17/11/2023	12:02 - 12:32	11.33	11.21	10.11	-0.12
57	17/11/2023	13:02 - 13:32	11.38	11.23	10.04	-0.15
58	17/11/2023	15:02 - 15:32	11.90	11.77	10.61	-0.13
59	17/11/2023	16:02 - 16:32	11.86	11.73	10.59	-0.13
60	17/11/2023	17:02 - 17:32	11.79	11.66	10.53	-0.13
61	17/11/2023	19:02 - 19:32	11.68	11.60	10.41	-0.08
62	17/11/2023	20:02 - 20:32	11.74	11.63	10.49	-0.10
63	17/11/2023	21:02 - 21:32	11.70	11.60	10.37	-0.10
64	17/11/2023	22:02 - 22:32	11.72	11.58	10.43	-0.13
65	17/11/2023	23:02 - 23:32	11.63	11.49	10.34	-0.14

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OXYGEN: QAL2 CALCULATIONS

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A2-01 Kiln 6 [Standby 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	00:02 - 00:32	11.65	11.55	10.36	-0.09
67	18/11/2023	01:02 - 01:32	11.25	11.16	9.99	-0.09
68	18/11/2023	02:02 - 02:32	11.39	11.32	10.12	-0.07
69	18/11/2023	03:02 - 03:32	11.59	11.53	10.26	-0.07
70	18/11/2023	04:02 - 04:32	11.53	11.45	10.23	-0.08
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	10.04	0.08

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	1.07
Kv for 70 Pairs of Data	0.9885

The variability is accepted if Sd ≤ Q_o x Kv

Parameter	Value
Standard Deviation (Sd)	0.08
Q_o x Kv	1.06
Outcome of Variability Test	**Pass**
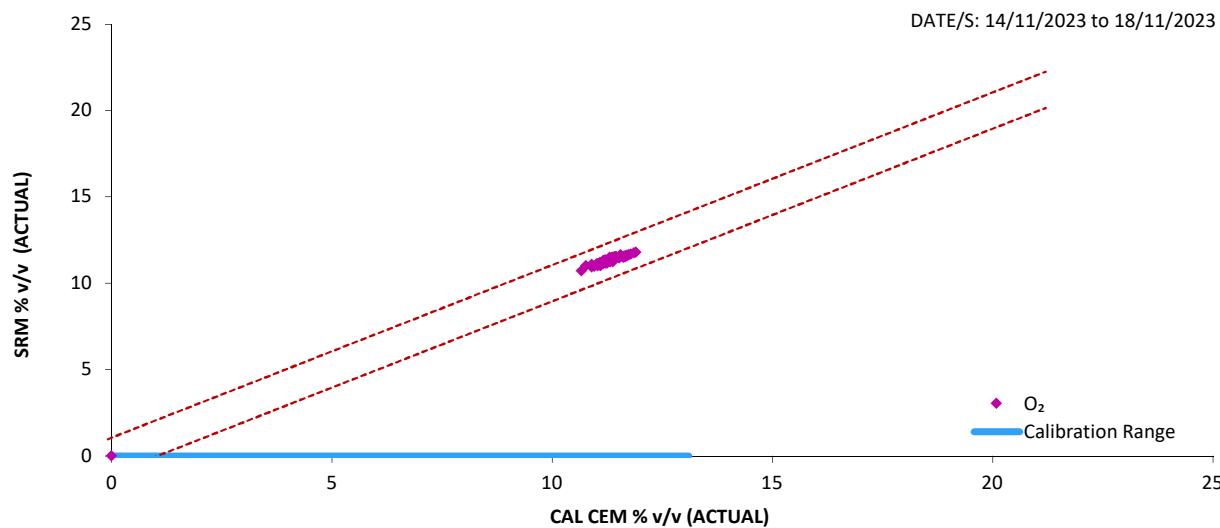
Valid Calibration Range

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

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

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A2-01 Kiln 6 [Standby Analyser]

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

DATE/S: 14/11/2023 to 18/11/2023

Irish Cement Ltd
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CARBON DIOXIDE: QAL2 CALCULATIONS

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Irish Cement Ltd, Limerick

A2-01 Kiln 6 [Standby 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	15.56	15.39	0.36	0.56	0.20	0.13	15.35
2	14/11/2023	18:02 - 18:32	15.71	15.64	0.52	0.82	0.42	0.27	15.57
3	14/11/2023	19:02 - 19:32	15.43	15.24	0.24	0.42	0.10	0.06	15.17
4	14/11/2023	20:02 - 20:32	15.33	15.12	0.14	0.30	0.04	0.02	15.02
5	14/11/2023	21:02 - 21:32	15.35	15.19	0.16	0.37	0.06	0.02	15.05
6	14/11/2023	23:02 - 23:32	15.16	14.97	-0.03	0.14	0.00	0.00	14.78
7	15/11/2023	00:02 - 00:32	15.34	15.18	0.15	0.35	0.05	0.02	15.04
8	15/11/2023	01:02 - 01:32	15.88	15.85	0.68	1.02	0.70	0.47	15.81
9	15/11/2023	02:02 - 02:32	15.29	15.09	0.10	0.27	0.03	0.01	14.97
10	15/11/2023	04:02 - 04:32	15.38	15.21	0.18	0.39	0.07	0.03	15.09
11	15/11/2023	05:02 - 05:32	15.67	15.63	0.48	0.80	0.38	0.23	15.51
12	15/11/2023	06:02 - 06:32	15.30	15.17	0.11	0.34	0.04	0.01	14.98
13	15/11/2023	07:02 - 07:32	15.34	15.17	0.14	0.34	0.05	0.02	15.03
14	15/11/2023	09:02 - 09:32	15.19	15.03	-0.01	0.20	0.00	0.00	14.81
15	15/11/2023	10:02 - 10:32	15.89	15.87	0.70	1.05	0.73	0.49	15.83
16	15/11/2023	11:02 - 11:32	16.03	15.84	0.84	1.02	0.85	0.70	16.03
17	15/11/2023	12:02 - 12:32	14.79	14.49	-0.40	-0.34	0.14	0.16	14.24
18	15/11/2023	13:02 - 13:32	15.00	14.68	-0.19	-0.14	0.03	0.04	14.55
19	15/11/2023	15:02 - 15:32	14.88	14.57	-0.32	-0.26	0.08	0.10	14.37
20	15/11/2023	17:02 - 17:32	16.07	16.11	0.87	1.29	1.12	0.76	16.08
21	15/11/2023	18:02 - 18:32	15.95	15.93	0.76	1.11	0.84	0.57	15.91
22	15/11/2023	19:02 - 19:32	15.67	15.56	0.47	0.74	0.35	0.22	15.51
23	15/11/2023	20:02 - 20:32	15.38	15.15	0.18	0.32	0.06	0.03	15.09
24	15/11/2023	21:02 - 21:32	15.29	15.00	0.10	0.17	0.02	0.01	14.96
25	15/11/2023	22:02 - 22:32	15.19	14.87	-0.01	0.04	0.00	0.00	14.82
26	15/11/2023	23:02 - 23:32	14.93	14.57	-0.26	-0.26	0.07	0.07	14.45
27	16/11/2023	00:02 - 00:32	15.39	15.10	0.20	0.27	0.05	0.04	15.11
28	16/11/2023	01:02 - 01:32	15.15	14.77	-0.05	-0.06	0.00	0.00	14.76
29	16/11/2023	02:02 - 02:32	15.23	14.87	0.04	0.05	0.00	0.00	14.88
30	16/11/2023	03:02 - 03:32	15.12	14.73	-0.07	-0.10	0.01	0.00	14.73
31	16/11/2023	04:02 - 04:32	15.35	15.02	0.16	0.19	0.03	0.02	15.05
32	16/11/2023	05:02 - 05:32	15.35	15.02	0.16	0.20	0.03	0.02	15.05
33	16/11/2023	06:02 - 06:32	15.53	15.28	0.33	0.46	0.15	0.11	15.31
34	16/11/2023	07:02 - 07:32	15.67	15.44	0.47	0.61	0.29	0.22	15.50
35	16/11/2023	09:02 - 09:32	15.14	14.78	-0.05	-0.05	0.00	0.00	14.75
36	16/11/2023	10:02 - 10:32	15.04	14.70	-0.15	-0.13	0.02	0.02	14.60
37	16/11/2023	11:02 - 11:32	15.47	15.23	0.28	0.41	0.11	0.08	15.23
38	16/11/2023	17:02 - 17:32	15.35	14.98	0.16	0.16	0.03	0.03	15.05
39	16/11/2023	18:02 - 18:32	15.49	15.19	0.29	0.37	0.11	0.09	15.25
40	16/11/2023	19:02 - 19:32	15.00	14.52	-0.19	-0.31	0.06	0.04	14.55
41	16/11/2023	20:02 - 20:32	15.09	14.69	-0.11	-0.14	0.01	0.01	14.67
42	16/11/2023	21:02 - 21:32	14.81	14.31	-0.38	-0.52	0.20	0.15	14.27
43	16/11/2023	22:02 - 22:32	15.33	14.99	0.14	0.17	0.02	0.02	15.02
44	16/11/2023	23:02 - 23:32	15.78	15.43	0.59	0.61	0.36	0.35	15.67
45	17/11/2023	00:02 - 00:32	15.00	14.55	-0.20	-0.28	0.05	0.04	14.54
46	17/11/2023	01:02 - 01:32	15.11	14.66	-0.09	-0.17	0.01	0.01	14.70
47	17/11/2023	02:02 - 02:32	15.18	14.73	-0.01	-0.10	0.00	0.00	14.80
48	17/11/2023	03:02 - 03:32	14.74	14.21	-0.45	-0.61	0.28	0.21	14.17
49	17/11/2023	04:02 - 04:32	14.96	14.37	-0.24	-0.46	0.11	0.06	14.48
50	17/11/2023	05:02 - 05:32	15.37	14.97	0.18	0.15	0.03	0.03	15.08
51	17/11/2023	06:02 - 06:32	15.21	14.81	0.02	-0.02	0.00	0.00	14.85
52	17/11/2023	07:02 - 07:32	15.46	15.10	0.27	0.27	0.07	0.07	15.21
53	17/11/2023	09:02 - 09:32	15.01	14.47	-0.18	-0.35	0.06	0.03	14.56
54	17/11/2023	10:02 - 10:32	15.08	14.58	-0.12	-0.25	0.03	0.01	14.66
55	17/11/2023	11:02 - 11:32	15.62	15.25	0.42	0.42	0.18	0.18	15.43
56	17/11/2023	12:02 - 12:32	15.46	14.98	0.26	0.15	0.04	0.07	15.20
57	17/11/2023	13:02 - 13:32	14.77	14.15	-0.42	-0.67	0.28	0.18	14.22
58	17/11/2023	15:02 - 15:32	14.33	13.66	-0.86	-1.16	1.00	0.74	13.59
59	17/11/2023	16:02 - 16:32	14.42	13.73	-0.77	-1.10	0.85	0.60	13.71
60	17/11/2023	17:02 - 17:32	14.46	13.79	-0.74	-1.03	0.76	0.54	13.77
61	17/11/2023	19:02 - 19:32	14.62	13.93	-0.57	-0.89	0.51	0.33	14.00
62	17/11/2023	20:02 - 20:32	14.56	13.85	-0.63	-0.98	0.62	0.40	13.92
63	17/11/2023	21:02 - 21:32	14.46	13.75	-0.73	-1.08	0.79	0.54	13.77
64	17/11/2023	22:02 - 22:32	14.68	13.98	-0.51	-0.85	0.44	0.26	14.09
65	17/11/2023	23:02 - 23:32	14.71	14.02	-0.48	-0.81	0.39	0.23	14.13

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CARBON DIOXIDE: QAL2 CALCULATIONS

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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	18/11/2023	00:02 - 00:32	14.70	14.00	-0.49	-0.82	0.40	0.24	14.12
67	18/11/2023	01:02 - 01:32	15.13	14.55	-0.06	-0.27	0.02	0.00	14.74
68	18/11/2023	02:02 - 02:32	15.02	14.41	-0.18	-0.41	0.07	0.03	14.57
69	18/11/2023	03:02 - 03:32	14.58	13.83	-0.62	-1.00	0.61	0.38	13.94
70	18/11/2023	04:02 - 04:32	14.64	13.88	-0.55	-0.95	0.52	0.30	14.03
71									
72									
73									
74									
75									
76									
77									
78									
79									
80									
81									
82									
83									
84									
85									
86									
87									
88									
89									
90									

MAX SRM - MIN SRM	2.45	SUM	16.04	11.15
(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	15/11/2023	08:02 - 08:32	15.33	0.00	SRM offline/calibrating
2	15/11/2023	14:02 - 14:32	14.98	0.00	SRM offline/calibrating
3	15/11/2023	16:02 - 16:32	15.54	0.00	SRM offline/calibrating
4	16/11/2023	08:02 - 08:32	14.94	0.00	SRM offline/calibrating
5	16/11/2023	16:02 - 16:32	14.73	0.00	SRM offline/calibrating
6	17/11/2023	08:02 - 08:32	14.94	0.00	SRM offline/calibrating
7	14/11/2023	22:02 - 22:32	15.39	15.22	Peripheral data outliers (Water Vapour)
8	15/11/2023	03:02 - 03:32	15.36	15.17	Peripheral data outliers (Water Vapour)
9	17/11/2023	14:02 - 14:32	14.66	14.07	Peripheral data outliers (Water Vapour)
10	17/11/2023	18:02 - 18:32	15.14	14.63	Peripheral data outliers (Water Vapour)
11	16/11/2023	12:02 - 12:32	15.02	14.62	Peripheral data outliers (Oxygen)
12	16/11/2023	13:02 - 13:32	15.37	15.11	Peripheral data outliers (Oxygen)
13	16/11/2023	14:02 - 14:32	15.03	14.55	Peripheral data outliers (Oxygen)
14	16/11/2023	15:02 - 15:32	14.80	14.23	Peripheral data outliers (Oxygen)
15					
16					
17					
18					
19					
20					
21					
22					
23					
24					
25					

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CARBON DIOXIDE: QAL2 CALCULATIONS

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Derivation of Calibration Function

b =	1.4387	a =	-7.0328
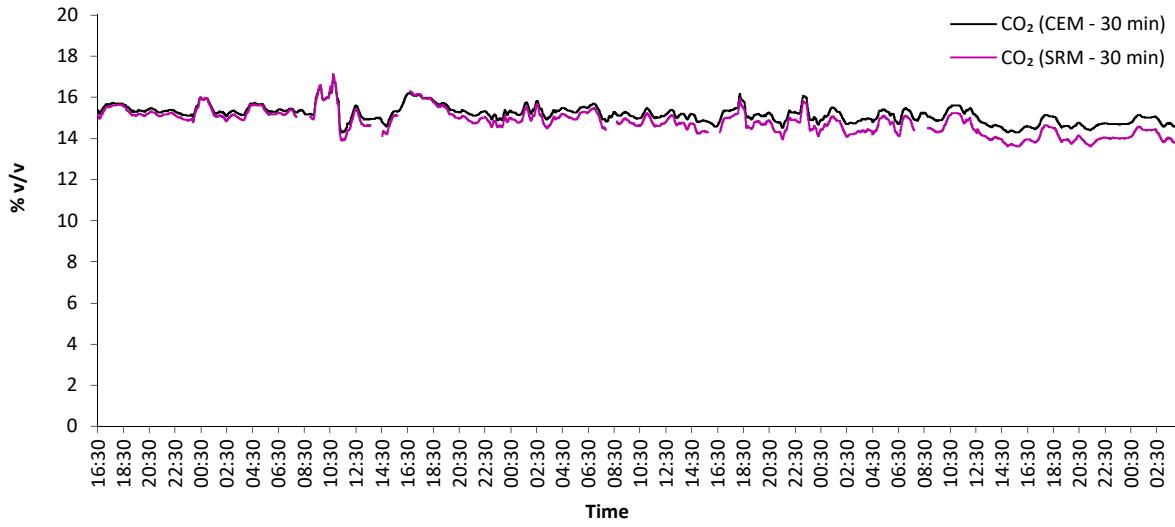
CALIBRATION FUNCTION =	**y = 1.4387x - 7.0328**

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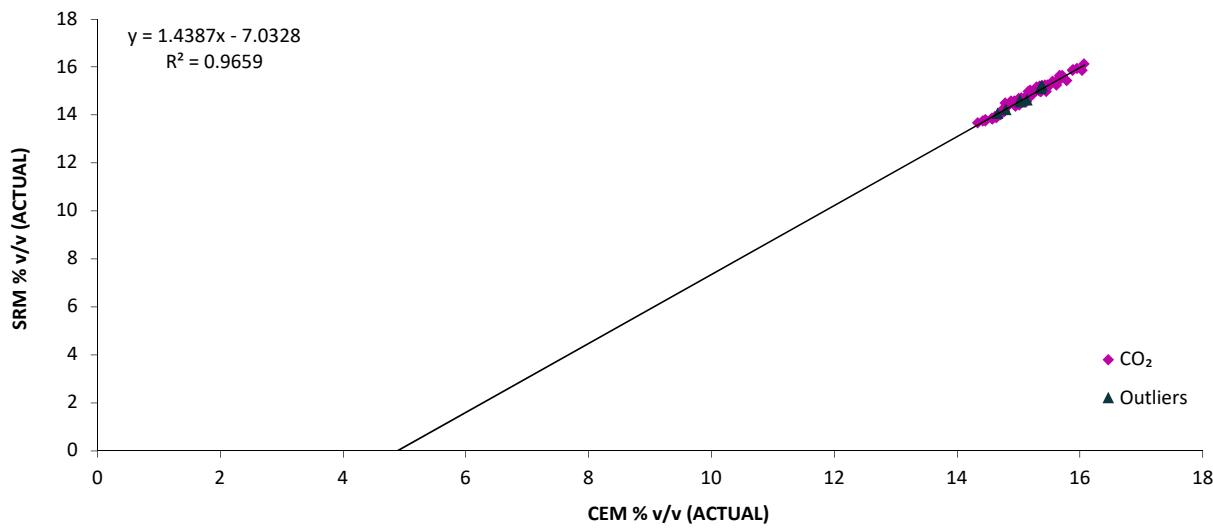
For Method A $b = [(x - x_{av}) \times (y - y_{az})] / (x - x_{av})^2$ and $a = MEAN(y) - [MEAN(x) \times b]$

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

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

PLOT 2: Calibration Graph for Method A

$y = 1.4387x - 7.0328$
$R^2 = 0.9659$

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CARBON DIOXIDE: QAL2 CALCULATIONS

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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	15.35	15.39	15.56	0.04
2	14/11/2023	18:02 - 18:32	15.57	15.64	15.71	0.07
3	14/11/2023	19:02 - 19:32	15.17	15.24	15.43	0.08
4	14/11/2023	20:02 - 20:32	15.02	15.12	15.33	0.10
5	14/11/2023	21:02 - 21:32	15.05	15.19	15.35	0.14
6	14/11/2023	23:02 - 23:32	14.78	14.97	15.16	0.19
7	15/11/2023	00:02 - 00:32	15.04	15.18	15.34	0.14
8	15/11/2023	01:02 - 01:32	15.81	15.85	15.88	0.04
9	15/11/2023	02:02 - 02:32	14.97	15.09	15.29	0.12
10	15/11/2023	04:02 - 04:32	15.09	15.21	15.38	0.12
11	15/11/2023	05:02 - 05:32	15.51	15.63	15.67	0.11
12	15/11/2023	06:02 - 06:32	14.98	15.17	15.30	0.19
13	15/11/2023	07:02 - 07:32	15.03	15.17	15.34	0.14
14	15/11/2023	09:02 - 09:32	14.81	15.03	15.19	0.21
15	15/11/2023	10:02 - 10:32	15.83	15.87	15.89	0.04
16	15/11/2023	11:02 - 11:32	16.03	15.84	16.03	-0.19
17	15/11/2023	12:02 - 12:32	14.24	14.49	14.79	0.24
18	15/11/2023	13:02 - 13:32	14.55	14.68	15.00	0.13
19	15/11/2023	15:02 - 15:32	14.37	14.57	14.88	0.20
20	15/11/2023	17:02 - 17:32	16.08	16.11	16.07	0.03
21	15/11/2023	18:02 - 18:32	15.91	15.93	15.95	0.02
22	15/11/2023	19:02 - 19:32	15.51	15.56	15.67	0.06
23	15/11/2023	20:02 - 20:32	15.09	15.15	15.38	0.06
24	15/11/2023	21:02 - 21:32	14.96	15.00	15.29	0.03
25	15/11/2023	22:02 - 22:32	14.82	14.87	15.19	0.05
26	15/11/2023	23:02 - 23:32	14.45	14.57	14.93	0.12
27	16/11/2023	00:02 - 00:32	15.11	15.10	15.39	-0.01
28	16/11/2023	01:02 - 01:32	14.76	14.77	15.15	0.01
29	16/11/2023	02:02 - 02:32	14.88	14.87	15.23	0.00
30	16/11/2023	03:02 - 03:32	14.73	14.73	15.12	0.00
31	16/11/2023	04:02 - 04:32	15.05	15.02	15.35	-0.04
32	16/11/2023	05:02 - 05:32	15.05	15.02	15.35	-0.03
33	16/11/2023	06:02 - 06:32	15.31	15.28	15.53	-0.02
34	16/11/2023	07:02 - 07:32	15.50	15.44	15.67	-0.07
35	16/11/2023	09:02 - 09:32	14.75	14.78	15.14	0.02
36	16/11/2023	10:02 - 10:32	14.60	14.70	15.04	0.09
37	16/11/2023	11:02 - 11:32	15.23	15.23	15.47	0.00
38	16/11/2023	17:02 - 17:32	15.05	14.98	15.35	-0.07
39	16/11/2023	18:02 - 18:32	15.25	15.19	15.49	-0.05
40	16/11/2023	19:02 - 19:32	14.55	14.52	15.00	-0.03
41	16/11/2023	20:02 - 20:32	14.67	14.69	15.09	0.02
42	16/11/2023	21:02 - 21:32	14.27	14.31	14.81	0.04
43	16/11/2023	22:02 - 22:32	15.02	14.99	15.33	-0.03
44	16/11/2023	23:02 - 23:32	15.67	15.43	15.78	-0.24
45	17/11/2023	00:02 - 00:32	14.54	14.55	15.00	0.01
46	17/11/2023	01:02 - 01:32	14.70	14.66	15.11	-0.04
47	17/11/2023	02:02 - 02:32	14.80	14.73	15.18	-0.08
48	17/11/2023	03:02 - 03:32	14.17	14.21	14.74	0.04
49	17/11/2023	04:02 - 04:32	14.48	14.37	14.96	-0.12
50	17/11/2023	05:02 - 05:32	15.08	14.97	15.37	-0.10
51	17/11/2023	06:02 - 06:32	14.85	14.81	15.21	-0.05
52	17/11/2023	07:02 - 07:32	15.21	15.10	15.46	-0.11
53	17/11/2023	09:02 - 09:32	14.56	14.47	15.01	-0.09
54	17/11/2023	10:02 - 10:32	14.66	14.58	15.08	-0.08
55	17/11/2023	11:02 - 11:32	15.43	15.25	15.62	-0.19
56	17/11/2023	12:02 - 12:32	15.20	14.98	15.46	-0.23
57	17/11/2023	13:02 - 13:32	14.22	14.15	14.77	-0.07
58	17/11/2023	15:02 - 15:32	13.59	13.66	14.33	0.08
59	17/11/2023	16:02 - 16:32	13.71	13.73	14.42	0.02
60	17/11/2023	17:02 - 17:32	13.77	13.79	14.46	0.03
61	17/11/2023	19:02 - 19:32	14.00	13.93	14.62	-0.07
62	17/11/2023	20:02 - 20:32	13.92	13.85	14.56	-0.07
63	17/11/2023	21:02 - 21:32	13.77	13.75	14.46	-0.03
64	17/11/2023	22:02 - 22:32	14.09	13.98	14.68	-0.11
65	17/11/2023	23:02 - 23:32	14.13	14.02	14.71	-0.11

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CARBON DIOXIDE: QAL2 CALCULATIONS

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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	18/11/2023	00:02 - 00:32	14.12	14.00	14.70	-0.11
67	18/11/2023	01:02 - 01:32	14.74	14.55	15.13	-0.19
68	18/11/2023	02:02 - 02:32	14.57	14.41	15.02	-0.16
69	18/11/2023	03:02 - 03:32	13.94	13.83	14.58	-0.11
70	18/11/2023	04:02 - 04:32	14.03	13.88	14.64	-0.15
71						
72						
73						
74						
75						
76						
77						
78						
79						
80						
81						
82						
83						
84						
85						
86						
87						
88						
89						
90						
			MAX	**AVERAGE**	**AVERAGE**	**Sd**
			16.08	14.83	15.19	0.11

Test of Variability

Q_o = ELV x (MU / 100) / 1.96	0.87
Kv for 70 Pairs of Data	0.9885

The variability is accepted if Sd ≤ Q_o x Kv

Parameter	Value
Standard Deviation (Sd)	0.11
Q_o x Kv	0.86
Outcome of Variability Test	**Pass**
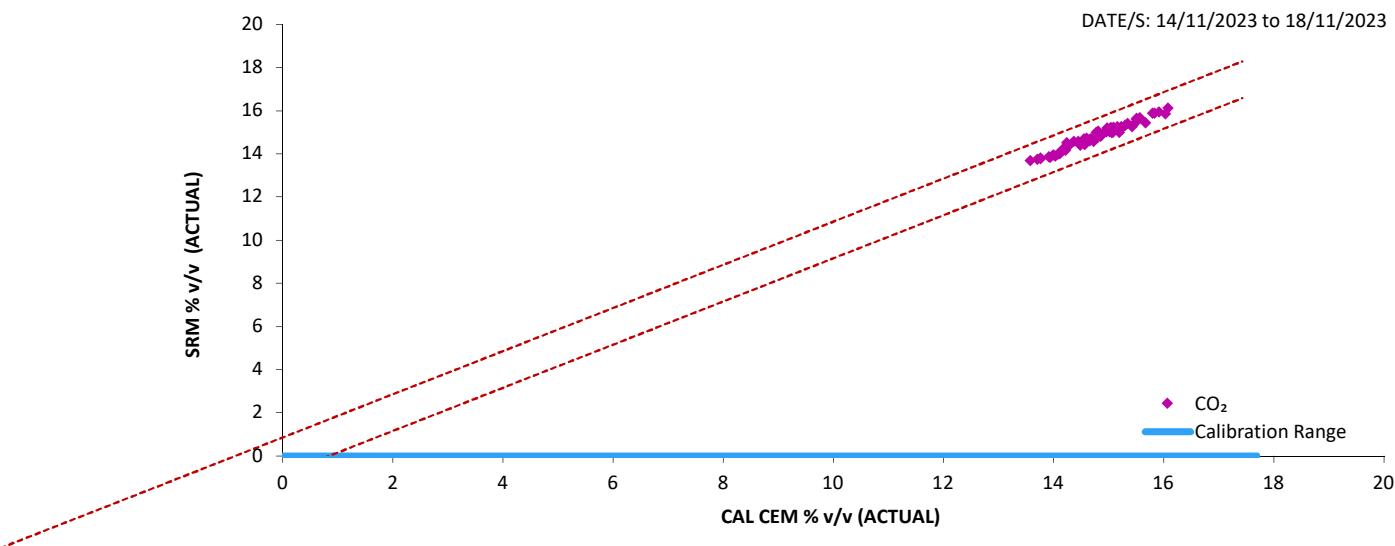
Valid Calibration Range

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

Valid Calibration Range	**0 to 17.7 % v/v**

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

DATE/S: 14/11/2023 to 18/11/2023

Y-axis: SRM % v/v (ACTUAL)

X-axis: CAL CEM % v/v (ACTUAL)

Legend: ♦ CO_2 — Calibration Range

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FUNCTIONAL CHECKS OF CEM

Irish Cement Ltd, Limerick

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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/m³ / %)	QAL3 Check Gas Supplier	Cylinder Number	Cylinder Expiry Date	Certified Accuracy
Total VOCs	C_3H_8					
Nitrogen Monoxide	NO					
Nitrogen Dioxide	NO_2					
Sulphur Dioxide	SO_2					
Carbon Monoxide	CO		See appended ABB service / linearity report			
Hydrogen Chloride	HCl					
Hydrogen Fluoride	HF					
Ammonia	NH_3					
Water Vapour	H_2O					
Oxygen	O_2					
Carbon Dioxide	CO_2					
Zero Gas	AIR					

CEM Checks

Parameter	Analyser System Check					Sampling Line System Check			
	Gas Conc. (mg/m³ / %)	Zero (mg/m³ / %)	Span (mg/m³ / %)	Response (T_{90} - secs)		Gas Conc. (mg/m³ / %)	Zero (mg/m³ / %)	Span (mg/m³ / %)	Response (T_{90} - secs)
Total VOCs									
Nitrogen Monoxide									
Nitrogen Dioxide									
Sulphur Dioxide									
Carbon Monoxide									
Hydrogen Chloride	See appended ABB service / linearity report					Not completed			
Hydrogen Fluoride									
Ammonia									
Water Vapour									
Oxygen									
Carbon Dioxide									

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

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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.

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

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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 ≤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

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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06

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

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

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
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PRO-FORMA FOR ASSESSING AND REPORTING THE RESULTS OF THE FUNCTIONAL TESTS

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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	

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

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06
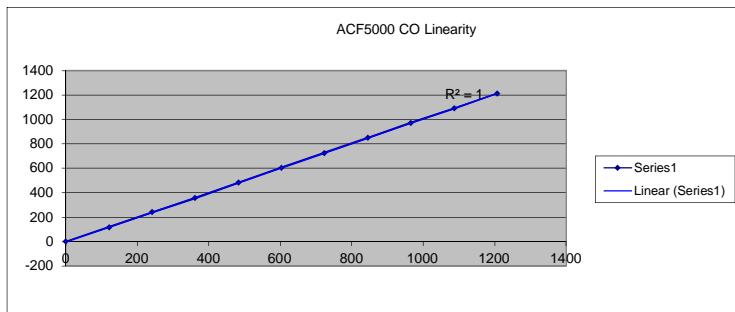
Version Number	Record of changes made within this version of the document
V1	The original document issued to the client
V2	Fuel and Abatement type updated at client request to include SRF and Lime Injection

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

EL-LS-OP-SE-X-EWB 105 (Version AI)
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Job Number: EMT07766, Version 2
Sample Date/s: 14th-23rd November 2023
Industrial Emissions Licence: P0029-06

CO				Seial No: F.3.411677.1

Concentration		Range:	4000 Mg/m3

Actual	Result	Error (% Range)	Gain
0.00	0.06	0.00	
120.67	119.06	0.04	
241.34	241.13	0.01	
362.00	357.48	0.11	
482.67	481.49	0.03	
603.34	605.81	-0.06	
724.01	726.84	-0.07	
844.68	850.06	-0.13	
965.34	972.35	-0.18	
1086.01	1091.41	-0.13	
1206.68	1210.96	-0.11	

Gas Supplier:	BOC		
Certificate:	23/023876		
Mix Date:			
Expiry Date:	13/09/25		
Concentration:		mg/m³	@ 15°C
Equivalent Concentration:	1206.681	mg/m³	@ 0°C
Equivalent Concentration:	965	ppm	

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	118.3	240.0	356.0	480.6	607.9	727.8	849.2	971.8	1090.9	1209.9
	0.1	118.3	240.0	356.0	480.6	607.9	727.8	849.2	971.8	1090.9	1209.9
	0.1	118.3	240.0	356.0	480.6	607.9	727.8	850.7	971.8	1090.9	1209.9
	0.1	118.3	241.6	358.0	481.1	607.9	726.5	850.7	972.7	1090.9	1209.9
	0.1	118.3	241.6	358.0	481.1	605.1	726.5	850.7	972.7	1090.9	1209.7
	0.1	119.8	241.6	358.0	481.1	605.1	726.5	850.0	972.7	1091.9	1209.7
	0.1	119.8	241.6	358.2	482.4	604.1	726.5	850.0	972.7	1091.9	1209.7
	0.1	119.8	241.6	358.2	482.4	604.1	726.5	850.0	972.4	1091.9	1213.6
	0.1	119.8	241.6	358.2	482.4	604.1	726.5	850.0	972.4	1091.9	1213.6
	0.1	119.8	241.6	358.2	482.4	604.1	726.5	850.0	972.4	1091.9	1213.6
Average	0.06	119.06	241.13	357.48	481.49	605.81	726.84	850.06	972.35	1091.41	1210.96
Standard Deviation	0.00	0.82	0.79	1.00	0.84	1.80	0.63	0.56	0.42	0.53	1.83
Average Error (% Range)	0.00%	0.04%	0.01%	0.11%	0.03%	-0.06%	-0.07%	-0.13%	-0.18%	-0.13%	-0.11%

ACF5000 CO Linearity

R² = 1

- Series1
- Linear (Series1)

Secondary ACF5000 Collective CO Linearity Result 17-Oct-23
CO Linearity Test Oct 2023 Validation
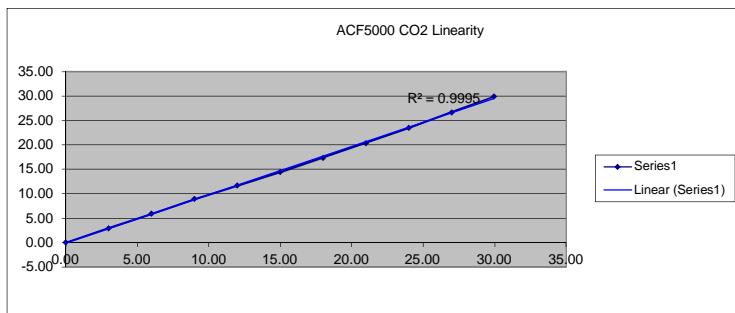
CO2 Seial No: F.3.411677.1

Concentration				Range:	30 Vol%
Actual	Result	Error (% Range)	Gain		
0.00	0.02	0.00			
3.00	2.93	0.22			
5.99	5.89	0.35			
8.99	8.91	0.26			
11.99	11.65	1.14			
14.99	14.43	1.84			
17.98	17.39	1.96			
20.98	20.40	1.95			
23.98	23.49	1.62			
26.97	26.66	1.05			
29.97	29.94	0.11			

Gas Supplier:	BOC
Certificate:	21/011586
Mix Date:	
Expiry Date:	20/04/25
Concentration:	mg/m^3 @ 15°C
Equivalent Concentration:	29.97 Vol% @ 0°C
Equivalent Concentration:	29970 ppm

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	2.9	5.9	8.9	11.7	14.4	17.4	20.4	23.4	26.6	29.9
	0.0	2.9	5.9	8.9	11.7	14.4	17.4	20.4	23.4	26.6	29.9
	0.0	2.9	5.9	8.9	11.7	14.4	17.4	20.4	23.5	26.6	29.9
	0.0	2.9	5.9	9.0	11.6	14.4	17.4	20.4	23.5	26.6	29.9
	0.0	2.9	5.9	9.0	11.6	14.4	17.4	20.4	23.5	26.7	29.9
	0.0	2.9	5.9	9.0	11.6	14.4	17.4	20.4	23.5	26.7	30.0
	0.0	2.9	5.9	8.9	11.6	14.4	17.4	20.4	23.5	26.7	30.0
	0.0	2.9	5.9	8.9	11.6	14.4	17.4	20.4	23.5	26.7	30.0
	0.0	2.9	5.9	8.9	11.6	14.4	17.4	20.4	23.4	26.7	30.0
	0.0	2.9	5.9	8.9	11.6	14.4	17.4	20.4	23.4	26.7	30.0
Average	0.02	2.93	5.89	8.91	11.65	14.43	17.39	20.40	23.49	26.66	29.94
Standard Deviation	0.00	0.01	0.01	0.04	0.03	0.02	0.02	0.00	0.05	0.05	0.04
Average Error (% Range)	-0.08%	0.22%	0.35%	0.26%	1.14%	1.84%	1.96%	1.95%	1.62%	1.05%	0.11%

ACF5000 CO2 Linearity

R² = 0.9995

Series1 — Linear (Series1)
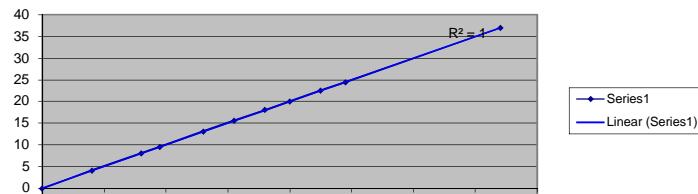
H2O				Seial No: F.3.411677.1	
Concentration		Range:	40 Vol%		
		Error		Gas Supplier:	Hovacal TELabs
Actual	Result	(% Range)	Gain	Cylinder No:	TE230717W2
0.00	-0.03	0.07		Mix Date:	
4.00	4.06	-0.14		Expiry Date:	One Month From Opening
8.00	8.09	-0.23		Concentration:	Vol% @ 15°C
9.50	9.56	-0.15		Equivalent Concentration:	40 Vol% @ 0°C
13.00	13.08	-0.20		Equivalent Concentration:	Vol%
15.50	15.58	-0.21			
18.00	18.03	-0.08			
20.00	20.01	-0.03			
22.50	22.51	-0.03			
24.50	24.47	0.07			
37.00	36.96	0.10			

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	4.1	8.1	9.6	13.1	15.6	18.0	20.1	22.5	24.5	37.0
	0.0	4.1	8.1	9.6	13.1	15.6	18.0	20.1	22.5	24.5	37.0
	0.0	4.1	8.1	9.6	13.1	15.6	18.0	20.0	22.5	24.5	37.0
	0.0	4.1	8.1	9.6	13.1	15.6	18.0	20.0	22.5	24.5	37.0
	0.0	4.1	8.1	9.5	13.1	15.6	18.0	20.0	22.5	24.5	37.0
	0.0	4.0	8.1	9.5	13.1	15.6	18.0	20.0	22.5	24.5	37.0
	0.0	4.0	8.1	9.5	13.1	15.6	18.0	20.0	22.5	24.4	36.9
	0.0	4.0	8.1	9.5	13.1	15.6	18.0	20.0	22.5	24.4	36.9
	0.0	4.0	8.1	9.5	13.1	15.6	18.0	20.0	22.5	24.4	36.9
	0.0	4.0	8.1	9.5	13.1	15.6	18.0	20.0	22.5	24.4	36.9
Average	-0.03	4.06	8.09	9.56	13.08	15.58	18.03	20.01	22.51	24.47	36.96
Standard Deviation	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.02	0.01	0.04	0.03
Average Error (% Range)	0.07%	-0.14%	-0.23%	-0.15%	-0.20%	-0.21%	-0.08%	-0.03%	-0.03%	0.07%	0.10%

ACF5000 H2O Linearity

$R^2 = 1$

- Series1
- Linear (Series1)
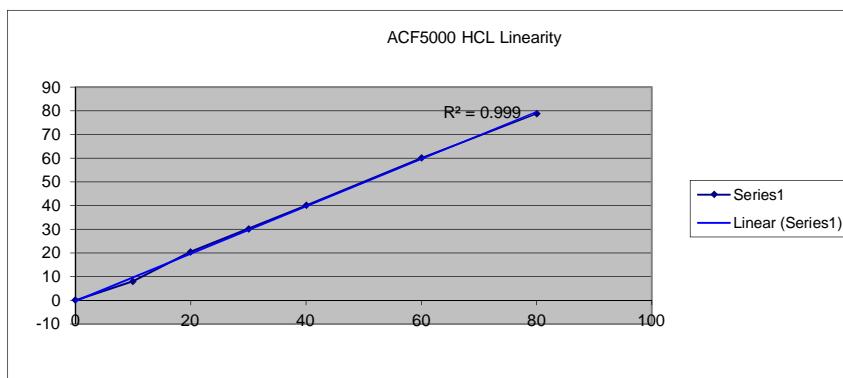
HCL	Seial No: F.3.411677.1	

Concentration — Range: 100 mg/m3

Actual	Result	Error (% Range)	Gain
0.00	0.03	-0.03	
10.00	7.98	2.02	
20.00	20.41	-0.41	
30.00	30.17	-0.17	
40.00	40.12	-0.12	
60.00	60.06	-0.06	
80.00	78.85	1.15	

Gas Supplier:	Hovacal TELabs
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
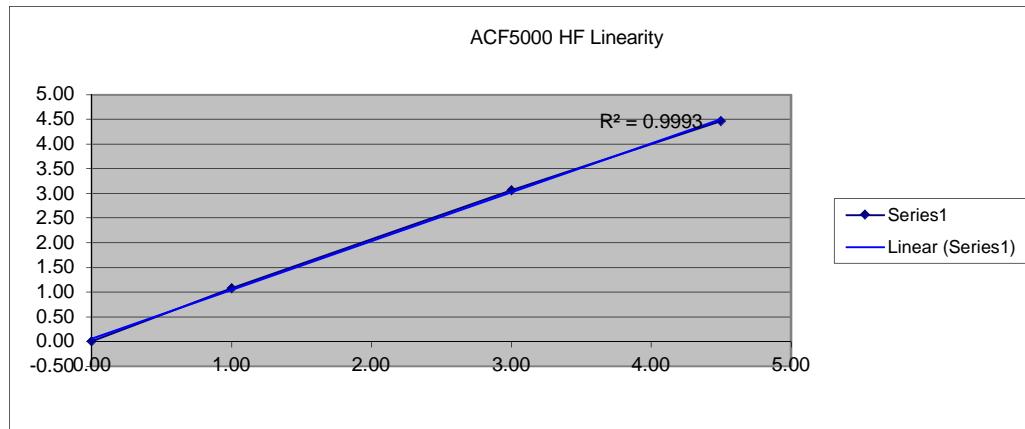
	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
	0.0	8.2	20.5	30.3	40.2	60.1	78.7
	0.0	8.2	20.4	30.1	40.2	60.1	78.9
	0.0	8.2	20.4	30.1	40.1	60.1	78.9
	0.0	7.7	20.4	30.1	40.1	60.1	78.9
	0.0	7.7	20.4	30.1	40.1	60.1	78.8
	0.0	7.7	20.4	30.2	40.0	59.8	78.8
Average	0.03	7.98	20.41	30.17	40.12	60.06	78.85
Standard Deviation	0.01	0.27	0.02	0.06	0.08	0.10	0.11
Average Error (% Range)	-0.03%	2.02%	-0.41%	-0.17%	-0.12%	-0.06%	1.15%

ACF5000 HCL Linearity

R² = 0.999

Series1
Linear (Series1)

Secondary ACF5000 Collective HCL Linearity Result 18-Oct-23
HCL Linearity Test Oct-2023 Validation

HF				Seial No: F.3.411677.1	

Concentration		Range:	6 mg/m3		Gas Supplier: Hovacal TELabs

Actual	Result	Error (% Range)	Gain
0.00	0.00	0.04	
1.00	1.09	-1.42	
3.00	3.07	-1.11	
4.50	4.46	0.64	

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	1.1	3.1	4.5
	0.0	1.1	3.1	4.5
	0.0	1.1	3.1	4.5
	0.0	1.1	3.1	4.5
	0.0	1.1	3.1	4.5
	0.0	1.1	3.1	4.5
Average	0.00	1.09	3.07	4.46
Standard Deviation	0.00	0.00	0.00	0.00
Average Error (% Range)	0.04%	-1.42%	-1.11%	0.64%

ACF5000 HF Linearity

$R^2 = 0.9993$

Series1
Linear (Series1)
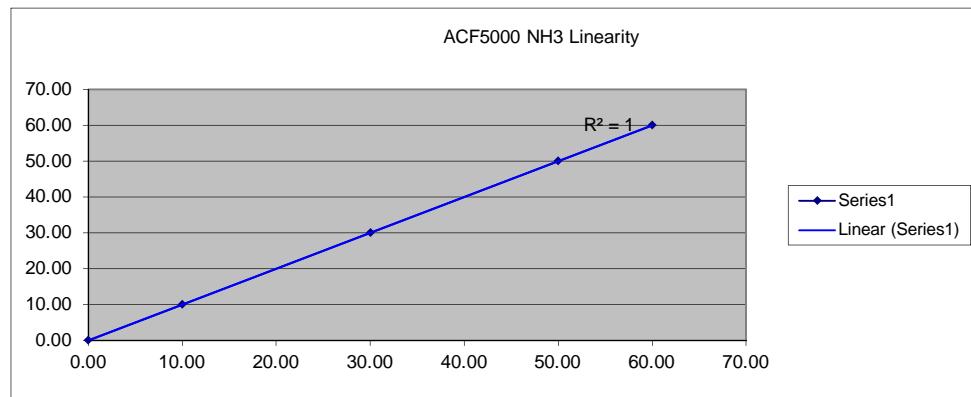
NH3		Seial No: F.3.411677.1					
Concentration		Range:	230 mg/m3		Gas Supplier:	Hovacal TELabs	
Actual	Result	Error (% Range)	Gain		Cylinder No:	OB230809D	
0.00	-1.01	0.44			Mix Date:		
10.00	9.52	0.21			Expiry Date:	09/11/23	
30.00	28.31	0.74			Concentration:	mg/m3	@ 15°C
50.00	46.31	1.60			Equivalent Concentration:	70 mg/m3	@ 0°C
60.00	55.55	1.93			Equivalent Concentration:	mg/m3	

Statistics

	Level 0	Level 1	Level 2	Level 3	Level 4
	-1.0	9.6	28.4	46.3	55.5
	-1.0	9.6	28.4	46.3	55.5
	-1.0	9.5	28.4	46.3	55.5
	-1.0	9.5	28.3	46.3	55.6
	-1.0	9.5	28.3	46.3	55.6
	-1.0	9.5	28.2	46.2	55.6
Average	-1.01	9.52	28.31	46.31	55.55
Standard Deviation	0.00	0.04	0.06	0.03	0.07
Average Error (% Range)	0.44%	0.21%	0.74%	1.60%	1.93%

ACF5000 NH3 Linearity

$R^2 = 1$

Series1
Linear (Series1)

Secondary ACF5000 Collective NH3 Linearity Result Oct-23
NH3 Linearity Test Oct 2023 Validation
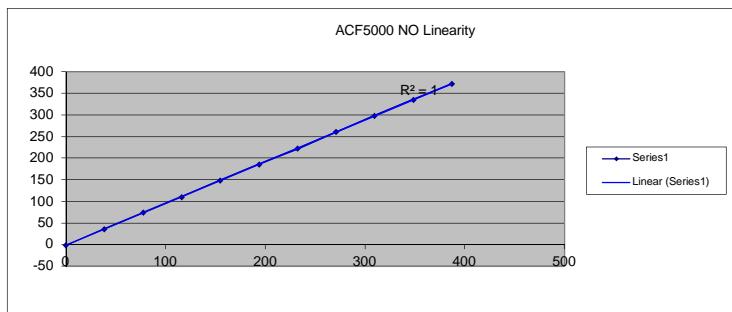
NO		Seial No: F.3.411677.1					
Concentration		Range:	2000	Mg/m3		Gas Supplier:	BOC
Actual	Result	Error (% Range)	Gain			Cylinder No:	23/023876
0.00	-1.17	0.06				Mix Date:	
38.72	35.80	0.15				Expiry Date:	12/09/23
77.44	73.38	0.20				Concentration:	mg/m³ @ 15°C
116.15	109.78	0.32				Equivalent Concentration:	387.1826 mg/m³ @ 0°C
154.87	148.30	0.33				Equivalent Concentration:	289 ppm
193.59	185.50	0.40					
232.31	221.81	0.52					
271.03	260.47	0.53					
309.75	298.10	0.58					
348.46	335.40	0.65					
387.18	372.44	0.74					

Statistics

	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10
	-1.2	35.3	73.1	109.1	148.0	185.5	220.7	260.7	297.7	335.7	371.8
	-1.2	35.3	73.1	109.1	148.0	185.5	220.7	260.7	297.7	335.7	371.8
	-1.2	35.3	73.1	109.1	148.0	185.5	220.7	260.3	298.4	335.4	371.8
	-1.2	35.3	73.1	109.1	148.0	185.5	220.7	260.3	298.4	335.4	372.4
	-1.2	35.3	73.1	110.2	148.5	185.5	220.7	260.3	298.4	335.4	372.4
	-1.2	36.2	73.7	110.2	148.5	185.5	222.9	260.3	298.4	335.4	372.4
	-1.2	36.2	73.7	110.2	148.5	185.5	222.9	260.5	298.0	335.3	373.0
	-1.2	36.2	73.7	110.2	148.5	185.5	222.9	260.5	298.0	335.3	373.0
	-1.2	36.2	73.7	110.2	148.5	185.5	222.9	260.5	298.0	335.3	373.0
	-1.2	36.2	73.7	110.2	148.5	185.5	222.9	260.5	298.0	335.3	373.0
Average	-1.17	35.80	73.38	109.78	148.30	185.50	221.81	260.47	298.10	335.40	372.44
Standard Deviation	0.02	0.48	0.35	0.60	0.23	0.02	1.15	0.16	0.29	0.16	0.51
Average Error (% Range)	0.06%	0.15%	0.20%	0.32%	0.33%	0.40%	0.52%	0.53%	0.58%	0.65%	0.74%

ACF5000 NO Linearity

R² = 1

- Series1
- Linear (Series1)
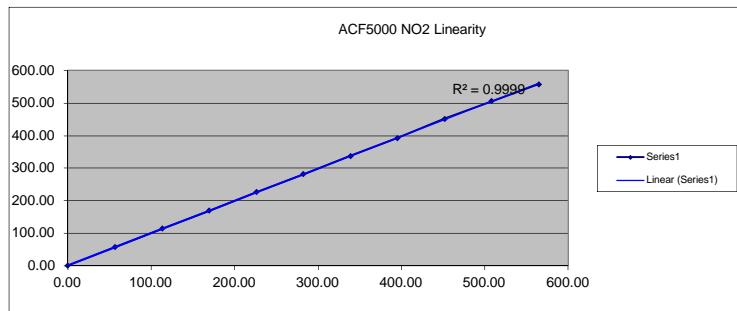
NO2				Seial No: F.3.411677.1

Concentration					Range:	600 Mg/m3

Actual	Result	Error (% Range)	Gain
0.00	0.57	-0.10	
56.49	56.78	-0.05	
112.97	113.93	-0.16	
169.46	169.45	0.00	
225.94	226.37	-0.07	
282.43	281.85	0.10	
338.91	337.51	0.23	
395.40	392.52	0.48	
451.88	451.98	-0.02	
508.37	505.59	0.46	
564.85	558.40	1.08	

Gas Supplier:	BOC		
Certificate:	23/011803		
Mix Date:			
Expiry Date:	02/05/26		
Concentration:		mg/m^3	@ 15°C
Equivalent Concentration:	564.8549	mg/m^3	@ 0°C
Equivalent Concentration:	275	ppm	

Statistics

	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10
	0.5	57.1	114.5	169.7	227.2	282.3	337.5	392.6	455.4	505.5	557.7
	0.5	57.1	114.5	169.7	227.2	282.3	337.5	392.6	455.4	505.5	557.7
	0.5	56.7	113.9	169.7	226.1	282.3	337.5	392.6	451.7	505.5	557.8
	0.5	56.7	113.9	169.7	226.1	282.3	337.5	392.6	451.7	505.8	557.8
	0.5	56.7	113.9	169.5	226.1	282.3	337.5	391.9	451.7	505.8	557.8
	0.5	56.7	113.9	169.5	226.1	282.3	337.5	391.9	450.8	505.8	559.0
	0.5	56.7	113.9	169.5	226.1	282.0	337.5	392.7	450.8	505.8	559.0
	0.8	56.7	113.9	169.5	226.1	282.0	337.5	392.7	450.8	505.8	559.0
	0.8	56.7	113.4	169.0	226.3	280.5	337.5	392.7	450.8	505.2	559.0
	0.8	56.7	113.4	169.0	226.3	280.5	337.5	392.7	450.8	505.2	559.0
Average	0.57	56.78	113.93	169.45	226.37	281.85	337.51	392.52	451.98	505.59	558.40
Standard Deviation	0.14	0.19	0.37	0.24	0.45	0.74	0.02	0.34	1.83	0.24	0.64
Average Error (% Range)	-0.10%	-0.05%	-0.16%	0.00%	-0.07%	0.10%	0.23%	0.48%	-0.02%	0.46%	1.08%

ACF5000 NO2 Linearity

R² = 0.9999

Series1
Linear (Series1)

Secondary ACF5000 Collective NO2 Linearity Result 18-Oct-23
NO2 Linearity Test Oct 2023 Validation
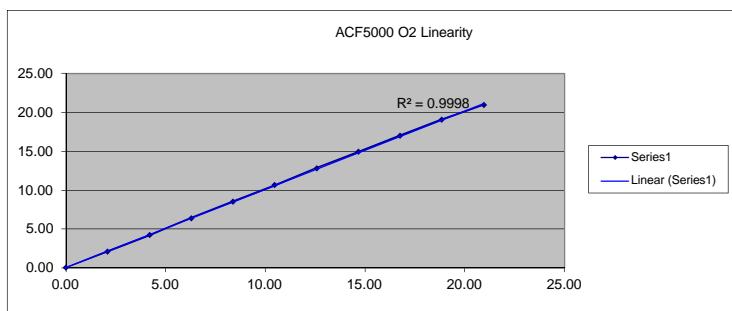
O2				Serial No: F.3.411677.1
Concentration		Range:	25 Vol%	
Actual	Result	Error (% Range)	Gain	
0.00	0.09	-0.35		
2.09	2.12	-0.12		
4.19	4.24	-0.20		
6.29	6.40	-0.44		
8.38	8.54	-0.64		
10.48	10.67	-0.76		
12.57	12.82	-1.00		
14.67	14.93	-1.04		
16.77	17.03	-1.04		
18.86	19.08	-0.88		
20.96	20.95	0.04		

Gas Supplier:	Air	
Cylinder No:	Nitrogen	
Mix Date:		
Expiry Date:		
Concentration:	0 Vol%	@ 15°C
Equivalent Concentration:	20.96 Vol%	@ 0°C
Equivalent Concentration:	Vol%	

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	2.1	4.2	6.4	8.5	10.7	12.8	14.9	17.0	19.1	21.0
	0.1	2.1	4.2	6.4	8.5	10.7	12.8	14.9	17.0	19.1	21.0
	0.1	2.1	4.2	6.4	8.5	10.7	12.8	14.9	17.0	19.1	21.0
	0.1	2.1	4.2	6.4	8.5	10.7	12.8	14.9	17.0	19.1	21.0
	0.1	2.1	4.2	6.4	8.5	10.7	12.8	14.9	17.0	19.1	21.0
	0.1	2.1	4.2	6.4	8.5	10.7	12.8	14.9	17.0	19.1	21.0
	0.1	2.1	4.2	6.4	8.5	10.7	12.8	14.9	17.0	19.1	21.0
	0.1	2.1	4.2	6.4	8.5	10.7	12.8	14.9	17.0	19.1	21.0
	0.1	2.1	4.2	6.4	8.5	10.7	12.8	14.9	17.0	19.1	21.0
	0.1	2.1	4.2	6.4	8.5	10.7	12.8	14.9	17.0	19.1	21.0
Average	0.09	2.12	4.24	6.40	8.54	10.67	12.82	14.93	17.03	19.08	20.95
Standard Deviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average Error (% Range)	-0.35%	-0.12%	-0.20%	-0.44%	-0.64%	-0.76%	-1.00%	-1.04%	-1.04%	-0.88%	0.04%

ACF5000 O2 Linearity

$R^2 = 0.9998$

- Series1
- Linear (Series1)
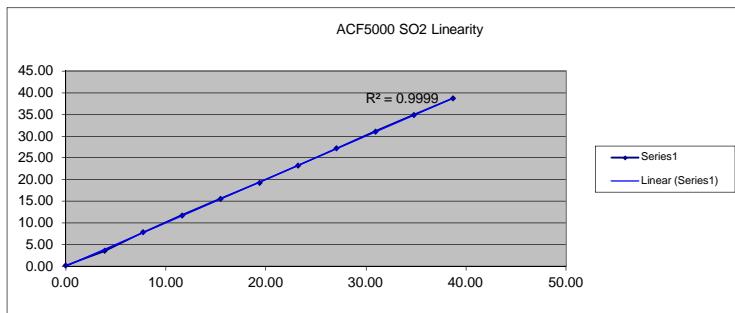
SO2				Seial No: F.3.411677.1

Concentration		Range:	1500 Mg/m3		Gas Supplier:	BOC

Actual	Result	Error (% Range)	Gain
0.00	0.26	-0.02	
3.87	3.55	0.02	
7.73	7.84	-0.01	
11.60	11.71	-0.01	
15.47	15.56	-0.01	
19.33	19.28	0.00	
23.20	23.17	0.00	
27.07	27.19	-0.01	
30.93	31.08	-0.01	
34.80	34.89	-0.01	
38.66	38.73	0.00	

Certificate: 23/023876
Mix Date:
Expiry Date: 12/09/23
Concentration: mg/m³ @ 15°C
Equivalent Concentration: 38.66479 mg/m³ @ 0°C
Equivalent Concentration: 13.52 ppm

Statistics

	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7	Level 8	Level 9	Level 10
	0.3	3.5	7.8	11.7	15.5	19.3	22.9	27.2	31.0	34.9	38.7
	0.3	3.5	7.8	11.7	15.6	19.3	22.9	27.2	31.0	34.9	38.7
	0.3	3.5	7.8	11.7	15.6	19.3	23.1	27.2	31.0	34.8	38.7
	0.3	3.5	7.8	11.7	15.6	19.2	23.1	27.2	31.1	34.8	38.9
	0.3	3.5	7.8	11.7	15.6	19.2	23.1	27.2	31.1	34.8	38.9
	0.2	3.5	7.9	11.7	15.5	19.2	23.1	27.2	31.1	34.8	38.9
	0.2	3.7	7.9	11.8	15.5	19.3	23.4	27.2	31.1	35.1	38.7
	0.2	3.7	7.9	11.8	15.5	19.3	23.4	27.2	31.1	35.1	38.7
	0.2	3.7	7.9	11.8	15.5	19.3	23.4	27.2	31.1	35.1	38.7
	0.2	3.7	7.9	11.8	15.5	19.3	23.4	27.2	31.1	35.1	38.7
Average	0.26	3.55	7.84	11.71	15.56	19.28	23.17	27.19	31.08	34.89	38.73
Standard Deviation	0.05	0.09	0.03	0.04	0.06	0.06	0.22	0.03	0.08	0.14	0.10
Average Error (% Range)	-0.02%	0.02%	-0.01%	-0.01%	-0.01%	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%

ACF5000 SO2 Linearity

R² = 0.9999

Series1
Linear (Series1)
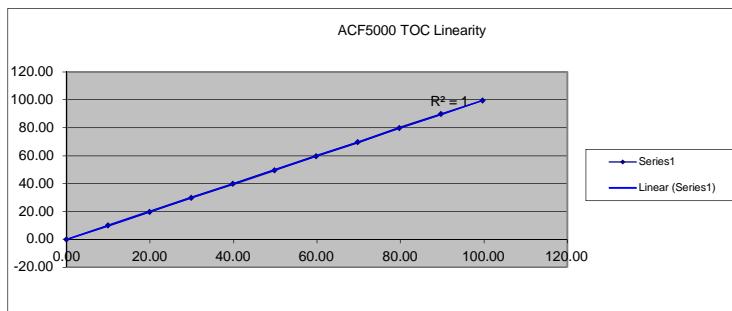
TOC				Serial No: F.3.411677.1

Concentration		Range:	100 mgC/m3

Gas Supplier: BOC

Actual	Result	Error (% Range)	Gain			
				Certificate:	22/032262	
0.00	-0.04	0.04		Mix Date:		
9.97	9.91	0.05	10.000	Expiry Date:	16/11/26	
19.93	19.80	0.13	20.000	Concentration:		mg/m3 @ 15°C
29.90	29.76	0.14	30.000	Equivalent Concentration:	99.6636	mgC/m3 @ 0°C
39.87	39.70	0.17	40.000	Equivalent Concentration:	62	ppm
49.83	49.66	0.17	50.000			
59.80	59.60	0.20	60.000			
69.76	69.54	0.23	70.000			
79.73	79.78	-0.05	80.000			
89.70	89.70	0.00	90.000			
99.66	99.40	0.26	100.000			

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	9.9	19.8	29.8	39.7	49.7	59.6	69.5	79.8	89.7	99.4
	0.0	9.9	19.8	29.8	39.7	49.7	59.6	69.5	79.8	89.7	99.4
	0.0	9.9	19.8	29.8	39.7	49.7	59.6	69.5	79.8	89.7	99.4
	0.0	9.9	19.8	29.8	39.7	49.7	59.6	69.5	79.8	89.7	99.4
	0.0	9.9	19.8	29.8	39.7	49.7	59.6	69.5	79.8	89.7	99.4
	0.0	9.9	19.8	29.8	39.7	49.7	59.6	69.5	79.8	89.7	99.4
	0.0	9.9	19.8	29.8	39.7	49.7	59.6	69.5	79.8	89.7	99.4
	0.0	9.9	19.8	29.8	39.7	49.7	59.6	69.5	79.8	89.7	99.4
	0.0	9.9	19.8	29.8	39.7	49.7	59.6	69.5	79.8	89.7	99.4
	0.0	9.9	19.8	29.8	39.7	49.7	59.6	69.5	79.8	89.7	99.4
Average	-0.04	9.91	19.80	29.76	39.70	49.66	59.60	69.54	79.78	89.70	99.40
Standard Deviation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Average Error (% Range)	0.04%	0.05%	0.13%	0.14%	0.17%	0.17%	0.20%	0.23%	-0.05%	0.00%	0.26%

ACF5000 TOC Linearity

R² = 1

Series1
Linear (Series1)

Secondary ACF5000 Collective TOC Linearity Result 23-Oct-23
TOC Linearity Test Oct 2023 Validation

SERVICE REPORT

ABB

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:

PHONE:

DESCRIPTION OF WORK:

DETAILS OF WORK CARRIED OUT:

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

ENGINEER'S SIGNATURE *Eduardo Albor* ....

CUSTOMER'S SIGNATURE ....

ABB Dublin Tel: 01 4057300 Fax: 01 4057327   ABB Cork Tel: 021 4971000 Fax: 01 4057327