Element Materials Technology, Unit 3, Wednesbury One, Black Country New Road, Wednesbury, WS10 7NZ
Your Element Contact: Derek Myers (07870 177 819)
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Stack Emissions Testing Report Commissioned by
Federal-Mogul Coventry Ltd

Installation Name & Address
Federal-Mogul Coventry Ltd
Holbrook Lane
Holbrook
Coventry
CV6 4BG

PPC Permit: PPC/197

Stack Reference
Main Stack

Dates of the Monitoring Campaign
17th May 2021

Job Reference Number
EMT00933

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

Report Approved by
Michelle Edwards Team Leader MCERTS Level 2 MM 05 659 TE1 TE2 TE3 TE4

Report Date
1st June 2021

Version
Version 1

Signature of Report Approver
[redacted]

CONTENTS

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

MONITORING OBJECTIVES

Federal-Mogul Coventry Ltd, Coventry
Main Stack
17th May 2021

Overall Aim of the Monitoring Campaign

Element were commissioned by Federal-Mogul Coventry Ltd to carry out stack emissions testing on the Main Stack at Coventry.

The aim of the monitoring campaign was to demonstrate compliance with a set of emission limit values (ELVs) as specified in the Site's Permit.

Special Requirements

There were no special requirements.

Target Parameters

Total Particulate Matter, Sulphur Dioxide, Cobalt, Chromium, Nickel

Executive Summary

MONITORING RESULTS

Federal-Mogul Coventry Ltd, Coventry
Main Stack
17th May 2021

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Total Particulate Matter [1]	mg/m³	0.08	0.17	20	g/hr	0.36	0.75	-
Sulphur Dioxide [1]	mg/m³	0.08	0.01	-	g/hr	0.36	0.08	-
Total Metals (Cobalt, Chromium, Nickel) [1]	mg/m³	< 0.0011	0.0002	5	g/hr	< 0.005	0.001	
Cobalt [1]	mg/m³	< 0.0003	0.00005	-	g/hr	< 0.001	0.0003	-
Chromium [1]	mg/m³	0.0004	0.0001	-	g/hr	0.002	0.0005	-
Nickel [1]	mg/m³	0.0003	0.00004	-	g/hr	0.001	0.0003	-
Water Vapour	% v/v	1.1	0.06					
Stack Gas Temperature	°C	28.3						
Stack Gas Velocity	m/s	21.9	3.8					
Volumetric Flow Rate (ACTUAL)	m³/hr	4851	865					
Volumetric Flow Rate (REF) [1]	m³/hr	4301	767					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM AN AVERAGE OF ALL OF THE ISOKINETIC RUNS.

[1] Reference Conditions (REF) are: 273K, 101.3kPa, without correction for water vapour content.

Executive Summary

MONITORING DATE(S) & TIMES

Federal-Mogul Coventry Ltd, Coventry
Main Stack
17th May 2021

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Total Particulate Matter	R1	mg/m³	0.08	g/hr	0.36	17/05/2021	07:05 - 08:40	95
Sulphur Dioxide	R1	mg/m³	0.08	g/hr	0.36	17/05/2021	07:05 - 08:40	95
Cobalt	R1	mg/m³	< 0.0003	g/hr	< 0.001	17/05/2021	09:49 - 11:19	90
Chromium	R1	mg/m³	0.0004	g/hr	0.002	17/05/2021	09:49 - 11:19	90
Nickel	R1	mg/m³	0.0003	g/hr	0.001	17/05/2021	09:49 - 11:19	90
Velocity Traverse	R1					17/05/2021	06:45 - 06:50	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Federal-Mogul Coventry Ltd, Coventry
Main Stack
17th May 2021

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	100% of Capacity
Continuous or Batch Process	Batch
Feedstock (if applicable)	Aluminium Scrap
Abatement System	Bag Filter
Abatement System Running Status	On
Fuel	Natural Gas
Plume Appearance	None Visible

Executive Summary

MONITORING & ANALYTICAL METHODS

Federal-Mogul Coventry Ltd, Coventry
Main Stack
17th May 2021

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**Sampling Status**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**Analysis Status**	**Analysis Lab**	**Overall Status**	**LOD (Average)**
Total Particulate Matter	EN 13284-1	CAT-TP-01	MCERTS	EET	CAT-TP-03	Gravimetric	MCERTS	EET	MCERTS	0.08 mg/m³
Sulphur Dioxide	EN 14791	CAT-TP-09	MCERTS	EET	CAT-AP-01	IC	MCERTS	EET	MCERTS	0.008 mg/m³
Cobalt	EN 14385	CAT-TP-06	MCERTS	EET	CAT-AP-07	ICP-MS	MCERTS	EET	MCERTS	0 mg/m³
Chromium	EN 14385	CAT-TP-06	MCERTS	EET	CAT-AP-07	ICP-MS	MCERTS	EET	MCERTS	0 mg/m³
Nickel	EN 14385	CAT-TP-06	MCERTS	EET	CAT-AP-07	ICP-MS	MCERTS	EET	MCERTS	0 mg/m³
Water Vapour	EN 14790	CAT-TP-05	MCERTS	EET	CAT-TP-05	Gravimetric	MCERTS	EET	MCERTS	0.10 % v/v
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	MCERTS	EET	Pitot Tube and Thermocouple				MCERTS	1.8 m/s

ANALYSIS LABORATORIES

(with short name reference as appears in the table above)

Element Materials Technology (EET)	ISO 17025 Accreditation Number: 4279

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Sulphur Dioxide	All Runs	The absorption efficiency was less than the required 95%. [50 - 75%]
Chromium	All Runs	The absorption efficiency was less than the required 90%. [75 - 90%]

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	0.28
Width	m	-
Area	m²	0.06
Port Depth	cm	9
Orientation of Duct	-	Vertical
Number of Ports	-	2
Sample Port Size	-	4" BSP

Location of Sampling Platform

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

Platform Details

EA Technical Guidance Note M1 / EN 15259 Platform Requirements	Value
Sufficient working area to manipulate probe and operate the measuring instruments	Yes
Platform has 2 levels of handrails (approx. 0.5m & 1.0m high)	Yes
Platform has vertical base boards (approx. 0.25m high)	Yes
Platform has chains / self closing gates at top of ladders	Yes
There are no obstructions present which hamper insertion of sampling equipment	Yes
Safe Access Available	Yes
Easy Access Available	Yes

Sampling Location / Platform Improvement Recommendations

All platforms should be designed in accordance with the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259.

EN 15259 Homogeneity Test Requirements

There is no requirement to perform a EN 15259 Homogeneity Test on this Stack.

Sampling Plane Validation Criteria (from EN 15259)

Criteria in EN 15259	Units	Traverse 1	Required	Compliant
Lowest Differential Pressure	Pa	392.3	> 5 Pa	Yes
Mean Velocity	m/s	21.65	-	-
Lowest Gas Velocity	m/s	21.65	-	-
Highest Gas Velocity	m/s	21.65	-	-
Ratio of Above	: 1	1.00	< 3 : 1	Yes
Maximum Angle of Swirl	°	0.00	< 15°	Yes
No Local Negative Flow	-	Yes	-	Yes

Executive Summary

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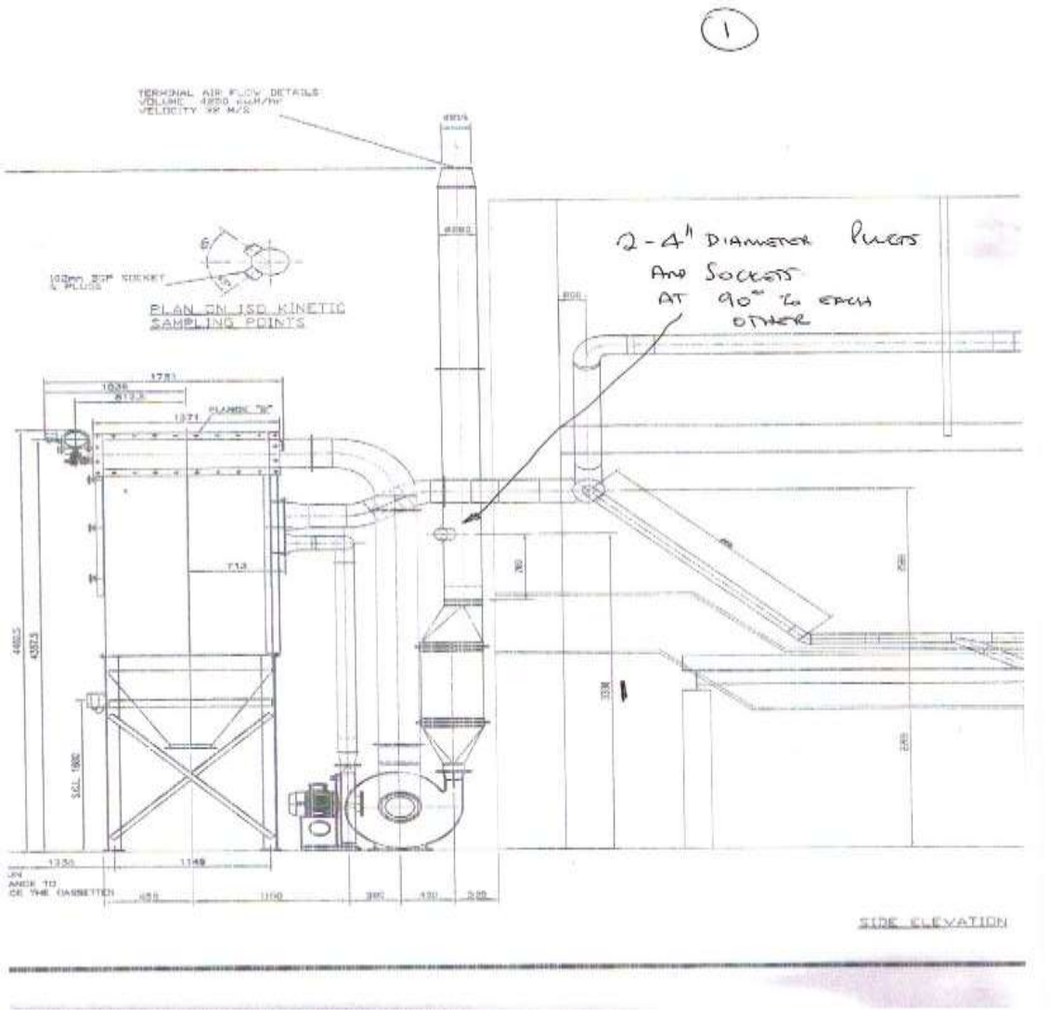
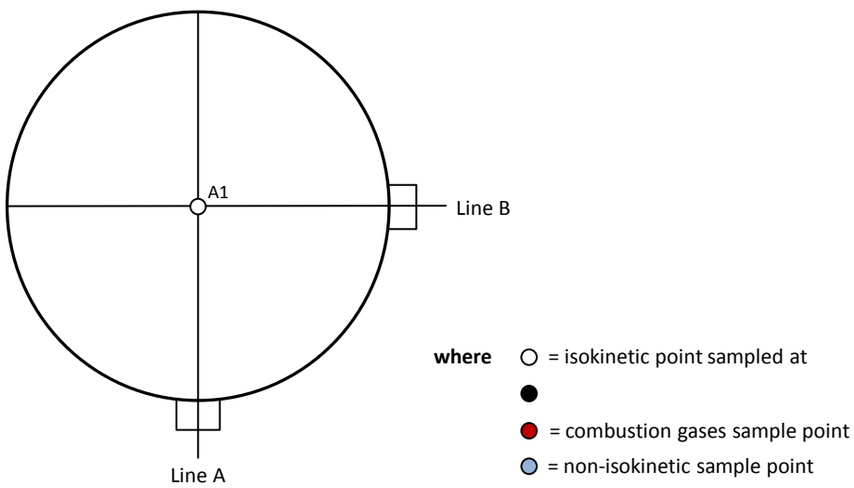
PLANT DIAGRAM



SAMPLE POINTS



APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	David Burns	MCERTS Level 2	MM 05 579	TE1 TE2 TE3 TE4
Team Leader	Lee Heaton	MCERTS Level 2	MM 17 1433	TE1 & TE4

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	CAT 7.66 / 7.58
Control Box DGM (2)	-
Box Thermocouples (1)	CAT 3.163 / 3.148
Box Thermocouples (2)	-
Umbilical (1)	CAT 3.148
Umbilical (2)	-
Oven Box (1)	CAT 12.201
Oven Box (2)	-
Heated Probe (1)	CAT 5.129
Heated Probe (2)	CAT 5.130
Heated Probe (3)	CAT 5.131
S-Pitot (1)	CAT 21P.97
S-Pitot (2)	CAT 21S.56
L-Pitot	CAT 21L.41
Site Balance	CAT 17.38
500g / 1Kg Check Weights	CAT 17.38
Last Impinger Arm	CAT 4.902/4.903
Callipers	CAT 23.41
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-350E	CAT 39.11
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Servomex 5200MP	CAT 24.14
MAK10 Cooler	CAT 4.1450
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	CAT 8.32
M&C PSS	CAT 12.108
Mass Flow Controller (1)	CAT 6.63
Mass Flow Controller (2)	CAT 6.64
Mass View (1)	CAT 25.61
Mass View (2)	CAT 25.62
Hioki 5043 (V)	CAT 11.115
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.143
Digital Manometer (2)	CAT 3.145
Digital Temperature Meter	-
Stopwatch	CAT 14.86
Barometer	CAT 13.41
Stack Thermocouple (1)	CAT 4.1467
Stack Thermocouple (2)	CAT 4.1442
Stack Thermocouple (3)	CAT 4.1391
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	CAT 20.119
20m Heated Line (2)	-
Dual Channel Heater Controller	CAT 3.002
Single Channel Heater Controller	CAT 20.119
Laboratory Balance	CAT 1.18, 1.18a, 1.18b
Tape Measure	CAT 16.49

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Total Particulate Matter	EN 13284-1	CAT-TP-01
Sulphur Dioxide	EN 14791	CAT-TP-09
Cobalt	EN 14385	CAT-TP-06
Chromium	EN 14385	CAT-TP-06
Nickel	EN 14385	CAT-TP-06
Water Vapour	EN 14790	CAT-TP-05
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41

PRELIMINARY STACK SURVEY: CALCULATIONS

General Stack Details

Stack Details (from Traverse)	Units	Value
Stack Diameter / Depth, D	m	0.28
Stack Width, W	m	-
Stack Area, A	m^2	0.06
Average Stack Gas Temperature, T_a	°C	23.0
Average Stack Gas Pressure	mmH_2O	40.0
Average Stack Static Pressure, P_{static}	kPa	0.232
Average Barometric Pressure, P_b	kPa	98.9
Average Pitot Tube Calibration Coefficient, C_p	-	0.83

Stack Gas Composition & Molecular Weights

Component	Conc ppm	Conc Dry % v/v	Conc Wet % v/v	Volume Fraction r	Molar Mass M	Density kg/m³ p	Conc kg/m³ p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O_2 (Estimated)	-	20.80	20.57	0.2080	32.00	1.4277	0.29696
N_2	-	79.14	78.26	0.7914	28.01	1.2498	0.98913
Moisture (H_2O)	-	-	1.12	0.0112	18.02	0.8037	0.00896

Where: $p = M / 22.41$

$p_i = r \times p$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m³	1.287
Wet Density (STP), P_{STW}	kg/m³	1.282
Dry Density (Actual), P_{Actual}	kg/m³	1.162
Average Wet Density (Actual), $P_{ActualW}$	kg/m³	1.157

Where: P_{STD} = sum of component concentrations, kg/m³ (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m³ (including water vapour)

$P_{Actual} = P_{STD} \times (T_{STP} / (P_{STP})) \times ((P_{static} + P_b) / T_a)$

$P_{ActualW}$ (at each sampling point) $= P_{STW} \times (T_s / P_s) \times (P_a / T_a)$

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF [1]
Temperature	°C	23.0	0.0
Total Pressure	kPa	99.1	101.3
Moisture	%	1.12	1.12

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m³/hr	4799
Gas Volumetric Flowrate (STP, Wet)	m³/hr	4332
Gas Volumetric Flowrate (STP, Dry)	m³/hr	4283
Gas Volumetric Flowrate REF [1]	m³/hr	4332

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID)

(1 of 1)

Parameter	Units	Value
Date of Survey	-	17/05/2021
Time of Survey	-	06:45 - 06:50
Atmospheric Pressure	kPa	98.9
Average Stack Static Pressure	Pa	232
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with Liquid Incline Manometer	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.83
Number of Lines Available	-	2
Number of Lines Used	-	1

		Sampling Line A					Sampling Line B - Not Required				
Traverse Point	Depth m	ΔP mmH_2O	Temp °C	Wet Density kg/m^3	Velocity m/s	Swirl °	ΔP	Temp °C	Wet Density kg/m^3	Velocity m/s	Swirl °
STATIC (Units: Pa)		*232.0*									
Mean		**40.0**	**23.0**	**1.157**	**21.65**						
1	0.14	40.0	23.0	1.157	21.65	0.0					

PRELIMINARY STACK SURVEY: VELOCITY TRAVERSE TO EN 16911-1 (MID) - MEASUREMENT UNCERTAINTY

(1 of 1)

Performance characteristics (Uncertainty Components)	Uncertainty	Value	Units
Standard Uncertainty on the coefficient of the Pitot Tube	u(k)	0.005	-
Standard Uncertainty associated with the mean local dynamic pressures	u(Δpi)	6.884	Pa
- Resolution	u(res)	0.52154	
- Calibration	u(cal)	16.022	
- Drift	u(drift)	1.096	
- Lack of Fit	u(fit)	28.750	
- Overall corrections to dynamic measurements	u(Cf)	46.390	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	20.568	
- $\varphi CO_2,w$	-	0.059	
- Oxygen, dry	u(ϕO_2,d)	0.637	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.057	
- Oxygen, wet	u(ϕO_2,w)	0.630	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.510	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.827	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	6.884	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00625	-
Standard uncertainty associated with the local velocities	u(vi)	1.905	Pa
Standard uncertainty associated with the mean velocity	u(v)	1.905	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	3.734	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	17.25	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	855.8	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00828	
- $u^2(qV,w)$	-	190660	
- u(qV,w)	-	436.6	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	17.83	%

TOTAL PARTICULATE MATTER: RESULTS SUMMARY

Federal-Mogul Coventry Ltd, Coventry
Main Stack

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.08		0.08
Uncertainty	±mg/m³	0.17		0.17
Mass Emission	g/hr	0.36		0.36
Uncertainty	±g/hr	0.75		0.75

NOTE: Where the maximum Blank concentration is higher than the Sample concentration, the maximum Blank concentration has been reported.

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	1.1		1.1
Uncertainty	±% v/v	0.06		0.06

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	0.08		0.08

NOTE: Where the Balance Uncertainty / Limit of Detection is higher than the Blank concentration, the Balance Uncertainty / Limit of Detection concentration has been reported.

General Sampling Information

Parameter	Value	
Standard	EN 13284-1	
Technical Procedure	CAT-TP-01	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

TOTAL PARTICULATE MATTER: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	741.8	
Stack static pressure, P_{static}	mmH_2O	23.7	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	743.6	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	8.5	
Total mass collected in impingers (silica trap)	g	10.1	
Total mass of liquid collected, V_{lc}	g	18.6	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0232	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	2.4080	
Gas meter correction factor, Y_d	-	0.9610	
Average dry gas meter temperature, T_m	°C	16.7	
Average pressure drop across orifice, ΔH	mmH_2O	61.8	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	2.1412	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0107	
B_{wo} as a percentage	% v/v	1.07	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	1.07	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	2.1644	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2 (Estimated)	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.73	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.83	
Average of velocity heads, ΔP_{avg}	mmH_2O	40.00	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	6.32	
Average stack gas temperature, T_s	°C	26.6	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	21.82	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.06	
$Q_a = (60)(A_s)(V_s)$	m^3/min	80.6	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	71.9	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	71.1	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	4.88	
Nozzle area, A_n	mm^2	18.68	
Total sampling time, q	min	95	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	104.5	

TOTAL PARTICULATE MATTER: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	07:05 - 08:40
Sampling Dates	-	17/05/2021
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	2.1644
Filter I.D. Number	-	47-74905
Start Filter Mass	g	0.14870
End Filter Mass	g	0.14870
Total Mass on Filter	g	0.00000
Probe Rinse I.D. Number	-	PR-47-74905
Start Probe Rinse Mass	g	2.94503
End Probe Rinse Mass	g	2.94518
Total Mass in Probe Rinse	g	0.00015
Total Mass Collected	mg	0.15
Calculated Concentration	mg/m^3	0.07
Balance Uncertainty / LOD	mg/m^3	0.08

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	17/05/2021
Average Volume Sampled (REF)	m^3	2.1644
Filter I.D. Number	-	47-77890
Start Filter Mass	g	0.14504
End Filter Mass	g	0.14513
Total Mass on Filter	g	0.00009
Probe Rinse I.D. Number	-	PR-47-77890
Start Probe Rinse Mass	g	2.73281
End Probe Rinse Mass	g	2.73283
Total Mass in Probe Rinse	g	0.00002
Total Mass Collected	mg	0.11
Calculated Concentration	mg/m^3	0.05
Balance Uncertainty / LOD	mg/m^3	0.08

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	24.4
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	0.20
Allowable Leak Rate	l/min	N/A
Leak Test Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.4
Allowable MU	%	20.0
MU Acceptable	%	Yes

Silica Gel (Concurrent Water Vapour)	Units	Run 1
Less than 50% Faded	%	Yes

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	104.5
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Weighing Uncertainty Criteria	Units	Run 1
Overall Weighing Uncertainty	± mg	0.36
Overall Weighing Uncertainty	± mg/m³	0.17
ELV [Daily ELV for IED]	mg/m³	20.00
Allowable Weighing Uncertainty	mg/m³	1.00
Weighing Uncertainty Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Pre-Conditioning Temperature	°C	180
Post-Conditioning Temperature	°C	160
Maximum Filter Temperature	°C	30

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

TOTAL PARTICULATE MATTER: QUALITY ASSURANCE

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	20.0
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	
Allowable Leak Rate	l/min	N/A
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m³	2.0
Blank Acceptable	-	Yes

Acetone / Water Rinse Blank	Units	Blank
Acetone / Water Rinse Value	mg/l	2.7
Allowable Blank	mg/l	10
Blank Acceptable	-	Yes

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
There are no deviations associated with the sampling employed.	wx	

TOTAL PARTICULATE MATTER: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	2.4080	uV_m	m^3	0.0482
Sampled Gas Temperature	T_m	289.7	uT_m	K	2.00
Sampled Gas Pressure	ρ_m	99.1	$u\rho_m$	kPa	0.50
Sampled Gas Humidity	H_m	0.00	uH_m	% v/v	1.00
Leak	L	0.00	uL	%	-
Mass of Particulate	m	0.18	um	mg	0.18
Uncollected Mass	UCM	0.11	uUCM	mg	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.69	≤1%
Sampled Gas Pressure	%	0.50	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.00	≤2%
Mass of Particulate	%	0.42	<5% of ELV
Uncollected Mass	%	-	-

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	2.1412	0.04
Leak	L	mg/m^3	0.000	1.00
Mass of Particulate	L_r	mg	0.180	0.46
Uncollected Mass	UCM	mg	0.06	0.46

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.002
Leak	mg/m^3	0.0000
Mass of Particulate	mg/m^3	0.0832
Uncollected Mass	mg/m^3	0.0293

	Oxygen Correction Part of MU Budget	
Measured Quantities	**Units**	**Run 1**
O_2 Correction Factor	-	N/A
Stack Gas O_2 Content	% v/v	N/A
MU for O_2 Correction	-	N/A
Overall MU For O_2 Measurement	%	N/A

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.09
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.17
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.17
Reported Uncertainty	mg/m^3	0.17
Expanded uncertainty (95% confidence), without Oxygen Correction	%	207.9
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	207.9
Reported Uncertainty	%	207.9

SULPHUR DIOXIDE: RESULTS SUMMARY

Federal-Mogul Coventry Ltd, Coventry
Main Stack

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.08		0.08
Uncertainty	±mg/m³	0.01		0.01
Mass Emission	g/hr	0.36		0.36
Uncertainty	±g/hr	0.08		0.08

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	1.1		1.1
Uncertainty	±% v/v	0.06		0.06

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	< 0.01		< 0.01

General Sampling Information

Parameter	Value	
Standard	EN 14791	
Technical Procedure	CAT-TP-09	
Name of Analytical Laboratory	EET	
Analytical Laboratory's Procedure	CAT-AP-01	
ISO 17025 Accredited Analysis?	MCERTS	
Date of Sample Analysis	20/05/2021	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Impinger Material	Polyethylene	
Absorption Solution	0.3% Hydrogen Peroxide	
Positioning of Filter	In Stack	
Filter Size and Material	47mm Glass Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

SULPHUR DIOXIDE: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1
Absolute pressure of stack gas, P_s		
Barometric pressure, P_b	mmHg	741.8
Stack static pressure, P_{static}	mmH_2O	23.7
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	743.6
Volume of water vapour collected, V_{wstd}		
Total mass collected in impingers (liquid trap)	g	8.5
Total mass collected in impingers (silica trap)	g	10.1
Total mass of liquid collected, V_{lc}	g	18.6
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0232
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m	m^3	2.4080
Gas meter correction factor, Y_d	-	0.9610
Average dry gas meter temperature, T_m	°C	16.7
Average pressure drop across orifice, ΔH	mmH_2O	61.8
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	2.1412
Moisture content, B_{wo} & R_{wv}		
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0107
B_{wo} as a percentage	% v/v	1.07
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	1.07
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	2.1644
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$		
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A
% oxygen reference condition, $REF\%O_2$	% v/v	N/A
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A
Molecular weight of dry gas stream, M_d		
CO_2 (Estimated)	% v/v	0.06
O_2 (Estimated)	% v/v	20.80
Total	% v/v	20.86
N_2	% v/v	79.14
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84
Molecular weight of stack gas (wet), M_s		
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.73
Velocity of stack gas, V_s		
Pitot tube velocity constant, K_p	-	34.97
Velocity pressure coefficient, C_p	-	0.83
Average of velocity heads, ΔP_{avg}	mmH_2O	40.00
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	6.32
Average stack gas temperature, T_s	°C	26.6
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	21.82
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})		
Area of stack, A_s	m^2	0.06
$Q_a = (60)(A_s)(V_s)$	m^3/min	80.6
Conversion factor (K/mm.Hg), C_f	-	0.3592
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	71.9
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	71.1
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A
Percent isokinetic, %I		
Nozzle diameter, D_n	mm	4.88
Nozzle area, A_n	mm^2	18.68
Total sampling time, q	min	95
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	104.5

SULPHUR DIOXIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	07:05 - 08:40
Sampling Dates	-	17/05/2021
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	2.1644
Laboratory Result for Front Impingers	µg/ml	0.52
Laboratory Result for Back Impinger	µg/ml	0.64
Volume in Front Impingers	ml	219.3
Volume in Back Impinger	ml	108.3
Mass in Front Impingers	µg	114.0
Mass in Back Impinger	µg	69.3
Total Mass Collected	µg	183.3
Calculated Concentration	mg/m^3	0.08

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	17/05/2021
Average Volume Sampled (REF)	m^3	2.1644
Laboratory Result for Impingers	µg/ml	< 0.05
Volume in Impingers	ml	309.5
Total Mass Collected	µg	< 15.5
Calculated Concentration	mg/m^3	< 0.01

SULPHUR DIOXIDE: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	24.4
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	0.20
Allowable Leak Rate	l/min	N/A
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	62.2
Allowable Absorption Efficiency	%	95
Absorption Efficiency Acceptable	-	No

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.4
Allowable MU	%	20.0
MU Acceptable	%	Yes

Silica Gel (Concurrent Water Vapour)	Units	Run 1
Less than 50% Faded	%	Yes

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	104.5
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Maximum Filter Temperature	°C	27

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

SULPHUR DIOXIDE: QUALITY ASSURANCE

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	20.0
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	
Allowable Leak Rate	l/min	N/A
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m³	N/A
Blank Acceptable	-	N/A

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
The absorption efficiency was less than the required 95%. [50 - 75%]	x	

SULPHUR DIOXIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	2.4080	uV_m	m^3	0.0482
Sampled Gas Temperature	T_m	289.7	uT_m	K	2.00
Sampled Gas Pressure	ρ_m	99.1	$u\rho_m$	kPa	0.50
Sampled Gas Humidity	H_m	0.00	uH_m	% v/v	1.00
Leak	L	0.00	uL	%	-
Laboratory Result	L_r	2.90	uL_r	%	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.69	≤1%
Sampled Gas Pressure	%	0.50	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.00	≤2%
Laboratory Result	%	2.90	No Requirement

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	2.1412	0.04
Leak	L	mg/m^3	0.000	1.00
Laboratory Result	L_r	mg/m^3	0.002	1.00

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.002
Leak	mg/m^3	0.0000
Laboratory Result	mg/m^3	0.0025

	Oxygen Correction Part of MU Budget	
Measured Quantities	**Units**	**Run 1**
O_2 Correction Factor	-	N/A
Stack Gas O_2 Content	% v/v	N/A
MU for O_2 Correction	-	N/A
Overall MU For O_2 Measurement	%	N/A

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.00
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.01
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.01
Reported Uncertainty	mg/m^3	0.01
Expanded uncertainty (95% confidence), without Oxygen Correction	%	7.6
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	10.7
Reported Uncertainty	%	10.7

COBALT: RESULTS SUMMARY

Federal-Mogul Coventry Ltd, Coventry
Main Stack

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	< 0.0003		< 0.0003
Uncertainty	±mg/m³	0.00005		0.00005
Mass Emission	g/hr	< 0.001		< 0.001
Uncertainty	±g/hr	0.0003		0.0003

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	1.1		1.1
Uncertainty	±% v/v	0.06		0.06

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	< 0.0003		< 0.0003

General Sampling Information

Parameter	Value	
Standard	EN 14385	
Technical Procedure	CAT-TP-06	
Name of Analytical Laboratory	EET	
Analytical Laboratory's Procedure	CAT-AP-07	
ISO 17025 Accredited Analysis?	MCERTS	
Date of Sample Analysis	25/05/2021	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Impinger Material	Borosilicate Glass	
Absorption Solution	Nitric Peroxide	
Positioning of Filter	Out Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

COBALT: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	741.8	
Stack static pressure, P_{static}	mmH_2O	23.7	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	743.6	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	7.0	
Total mass collected in impingers (silica trap)	g	11.6	
Total mass of liquid collected, V_{lc}	g	18.6	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0232	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	2.2800	
Gas meter correction factor, Y_d	-	0.9610	
Average dry gas meter temperature, T_m	°C	20.6	
Average pressure drop across orifice, ΔH	mmH_2O	62.1	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	2.0007	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0115	
B_{wo} as a percentage	% v/v	1.15	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	1.15	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	2.0239	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2 (Estimated)	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.72	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.83	
Average of velocity heads, ΔP_{avg}	mmH_2O	40.00	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	6.32	
Average stack gas temperature, T_s	°C	29.4	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	21.92	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.06	
$Q_a = (60)(A_s)(V_s)$	m^3/min	81.0	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	71.6	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	70.7	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	4.88	
Nozzle area, A_n	mm^2	18.68	
Total sampling time, q	min	90	
$\%I = (4.6398E^{6})(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	103.6	

COBALT: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	09:49 - 11:19
Sampling Dates	-	17/05/2021
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	2.0239
Mass on Filter / in Rinse	µg	< 0.50
Mass in Front Impingers	µg	< 0.05
Mass in Back Impinger	µg	< 0.03
Total Mass Collected	µg	< 0.57
Calculated Concentration	mg/m^3	< 0.0003
Reported Concentration	mg/m^3	< 0.0003

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	17/05/2021
Average Volume Sampled (REF)	m^3	2.0239
Mass on Filter / in Rinse	µg	< 0.50
Mass in Front Impingers	µg	< 0.04
Mass in Back Impinger	µg	< 0.02
Total Mass Collected	µg	< 0.56
Calculated Concentration	mg/m^3	< 0.0003
Reported Concentration	mg/m^3	< 0.0003

COBALT: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	24.3
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	N/A
Allowable Leak Rate	l/min	0.50
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	100.0
Allowable Absorption Efficiency	%	90
Absorption Efficiency Acceptable	-	Yes

Detection Limit	Units	Run 1
Detection Limit	µg/m³	0.3
Allowable Detection Limit	µg/m³	5
Detection Limit Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.4
Allowable MU	%	20.0
MU Acceptable	%	Yes

Silica Gel (Concurrent Water Vapour)	Units	Run 1
Less than 50% Faded	%	Yes

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	103.6
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Maximum Filter Temperature	°C	180

Impingers Exit Temperature	Units	Run 1
Maximum Temperature Recorded	°C	14
Maximum Allowable Temperature	°C	30
Exit Temperature Acceptable	-	Yes

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

COBALT: QUALITY ASSURANCE

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	25.0
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	N/A
Allowable Leak Rate	l/min	0.50
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m³	N/A
Blank Acceptable	-	N/A

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

COBALT: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	2.2800		uV_m	m^3	0.0456	
Sampled Gas Temperature	T_m	293.6		uT_m	K	2.00	
Sampled Gas Pressure	ρ_m	99.1		$u\rho_m$	kPa	0.50	
Sampled Gas Humidity	H_m	0.0		uH_m	% v/v	1.00	
Leak	L	0.00		uL	%	-	
Laboratory Result	L_r	7.70		uL_r	%	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.68		≤1%
Sampled Gas Pressure	%	0.50		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.00		≤2%
Laboratory Result	%	7.70		No Requirement

	Uncertainty in Measurement Units				Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**		**Run 1**	
Sampled Volume (STP)	V_m	m^3	2.0007		0.00	
Leak	L	mg/m^3	0.0000		1.00	
Laboratory Result	L_r	mg/m^3	0.0000		1.00	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.0000	
Leak	mg/m^3	0.0000	
Laboratory Result	mg/m^3	0.0000	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	%	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.0000
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.0000
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.0000
Reported Uncertainty	mg/m^3	0.0000
Expanded uncertainty (95% confidence), without Oxygen Correction	%	15.9
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	15.9
Reported Uncertainty	%	15.9

CHROMIUM: RESULTS SUMMARY

Federal-Mogul Coventry Ltd, Coventry
Main Stack

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.0004		0.0004
Uncertainty	±mg/m³	0.0001		0.0001
Mass Emission	g/hr	0.002		0.002
Uncertainty	±g/hr	0.0005		0.0005

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	1.1		1.1
Uncertainty	±% v/v	0.06		0.06

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	< 0.0003		< 0.0003

General Sampling Information

Parameter	Value	
Standard	EN 14385	
Technical Procedure	CAT-TP-06	
Name of Analytical Laboratory	EET	
Analytical Laboratory's Procedure	CAT-AP-07	
ISO 17025 Accredited Analysis?	MCERTS	
Date of Sample Analysis	25/05/2021	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Impinger Material	Borosilicate Glass	
Absorption Solution	Nitric Peroxide	
Positioning of Filter	Out Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

CHROMIUM: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1	
Absolute pressure of stack gas, P_s			
Barometric pressure, P_b	mmHg	741.8	
Stack static pressure, P_{static}	mmH_2O	23.7	
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	743.6	
Volume of water vapour collected, V_{wstd}			
Total mass collected in impingers (liquid trap)	g	7.0	
Total mass collected in impingers (silica trap)	g	11.6	
Total mass of liquid collected, V_{lc}	g	18.6	
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0232	
Volume of gas metered dry, V_{mstd}			
Volume of gas sample through gas meter, V_m	m^3	2.2800	
Gas meter correction factor, Y_d	-	0.9610	
Average dry gas meter temperature, T_m	°C	20.6	
Average pressure drop across orifice, ΔH	mmH_2O	62.1	
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	2.0007	
Moisture content, B_{wo} & R_{wv}			
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0115	
B_{wo} as a percentage	% v/v	1.15	
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	1.15	
Volume of gas metered wet, V_{mstw}			
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	2.0239	
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$			
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No	
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A	
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A	
% oxygen reference condition, $REF\%O_2$	% v/v	N/A	
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A	
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A	
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A	
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A	
Molecular weight of dry gas stream, M_d			
CO_2 (Estimated)	% v/v	0.06	
O_2 (Estimated)	% v/v	20.80	
Total	% v/v	20.86	
N_2	% v/v	79.14	
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84	
Molecular weight of stack gas (wet), M_s			
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.72	
Velocity of stack gas, V_s			
Pitot tube velocity constant, K_p	-	34.97	
Velocity pressure coefficient, C_p	-	0.83	
Average of velocity heads, ΔP_{avg}	mmH_2O	40.00	
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	6.32	
Average stack gas temperature, T_s	°C	29.4	
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	21.92	
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})			
Area of stack, A_s	m^2	0.06	
$Q_a = (60)(A_s)(V_s)$	m^3/min	81.0	
Conversion factor (K/mm.Hg), C_f	-	0.3592	
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	71.6	
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	70.7	
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A	
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A	
Percent isokinetic, %I			
Nozzle diameter, D_n	mm	4.88	
Nozzle area, A_n	mm^2	18.68	
Total sampling time, q	min	90	
$\%I = (4.6398E^6)(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	103.6	

CHROMIUM: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	09:49 - 11:19
Sampling Dates	-	17/05/2021
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	2.0239
Mass on Filter / in Rinse	µg	< 0.60
Mass in Front Impingers	µg	0.15
Mass in Back Impinger	µg	0.12
Total Mass Collected	µg	0.87
Calculated Concentration	mg/m^3	0.0004
Reported Concentration	mg/m^3	0.0004

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	17/05/2021
Average Volume Sampled (REF)	m^3	2.0239
Mass on Filter / in Rinse	µg	< 0.60
Mass in Front Impingers	µg	< 0.02
Mass in Back Impinger	µg	< 0.01
Total Mass Collected	µg	< 0.63
Calculated Concentration	mg/m^3	< 0.0003
Reported Concentration	mg/m^3	< 0.0003

CHROMIUM: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	24.3
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	N/A
Allowable Leak Rate	l/min	0.50
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	86.4
Allowable Absorption Efficiency	%	90
Absorption Efficiency Acceptable	-	No

Detection Limit	Units	Run 1
Detection Limit	µg/m³	0.3
Allowable Detection Limit	µg/m³	5.0
Detection Limit Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.4
Allowable MU	%	20.0
MU Acceptable	%	Yes

Silica Gel (Concurrent Water Vapour)	Units	Run 1
Less than 50% Faded	%	Yes

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	103.6
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Maximum Filter Temperature	°C	180

Impingers Exit Temperature	Units	Run 1
Maximum Temperature Recorded	°C	14
Maximum Allowable Temperature	°C	30
Exit Temperature Acceptable	-	Yes

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

CHROMIUM: QUALITY ASSURANCE

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	25.0
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	N/A
Allowable Leak Rate	l/min	0.50
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m³	N/A
Blank Acceptable	-	N/A

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
The absorption efficiency was less than the required 90%. [75 - 90%]	x	

CHROMIUM: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value		Standard uncertainty		
Measured Quantities	**Symbol**	**Run 1**	**Symbol**	**Units**	**Run 1**
Sampled Volume (Actual)	V_m	2.2800	uV_m	m^3	0.0456
Sampled Gas Temperature	T_m	293.6	uT_m	K	2.00
Sampled Gas Pressure	ρ_m	99.1	$u\rho_m$	kPa	0.50
Sampled Gas Humidity	H_m	0.00	uH_m	% v/v	1.00
Leak	L	0.00	uL	%	-
Laboratory Result	L_r	7.70	uL_r	%	-

	Uncertainty as a Percentage		
Measured Quantities	**Units**	**Run 1**	**Requirement of Standard**
Sampled Volume (Actual)	%	2.00	≤2%
Sampled Gas Temperature	%	0.68	≤1%
Sampled Gas Pressure	%	0.50	≤1%
Sampled Gas Humidity	%	1.00	≤1%
Leak	%	0.00	≤2%
Laboratory Result	%	7.70	No Requirement

	Uncertainty in Measurement Units			Sensitivity Coefficient
Measured Quantities	**Symbol**	**Units**	**Run 1**	**Run 1**
Sampled Volume (STP)	V_m	m^3	2.0007	0.00
Leak	L	mg/m^3	0.0000	1.00
Laboratory Result	L_r	mg/m^3	0.0000	1.00

	Uncertainty in Result	
Measured Quantities	**Units**	**Run 1**
Sampled Volume (STP)	mg/m^3	0.0000
Leak	mg/m^3	0.0000
Laboratory Result	mg/m^3	0.0000

	Oxygen Correction Part of MU Budget	
Measured Quantities	**Units**	**Run 1**
O_2 Correction Factor	-	N/A
Stack Gas O_2 Content	% v/v	N/A
MU for O_2 Correction	%	N/A
Overall MU For O_2 Measurement	%	N/A

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m^3	0.0000
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.0001
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.0001
Reported Uncertainty	mg/m^3	0.0001
Expanded uncertainty (95% confidence), without Oxygen Correction	%	15.9
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	19.1
Reported Uncertainty	%	19.1

NICKEL: RESULTS SUMMARY

Federal-Mogul Coventry Ltd, Coventry
Main Stack

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	0.0003		0.0003
Uncertainty	±mg/m³	0.00004		0.00004
Mass Emission	g/hr	0.001		0.001
Uncertainty	±g/hr	0.0003		0.0003

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	1.1		1.1
Uncertainty	±% v/v	0.06		0.06

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	< 0.0003		< 0.0003

General Sampling Information

Parameter	Value	
Standard	EN 14385	
Technical Procedure	CAT-TP-06	
Name of Analytical Laboratory	EET	
Analytical Laboratory's Procedure	CAT-AP-07	
ISO 17025 Accredited Analysis?	MCERTS	
Date of Sample Analysis	25/05/2021	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Impinger Material	Borosilicate Glass	
Absorption Solution	Nitric Peroxide	
Positioning of Filter	Out Stack	
Filter Size and Material	47mm Quartz Fibre	
Number of Sampling Lines Used	1 / 1	FORMAT: Number Used / Number Required
Number of Sampling Points Used	1 / 1	FORMAT: Number Used / Number Required
Sample Point I.D.'s	A1	

Reference Conditions

Reference Conditions are: 273K, 101.3kPa, without correction for water vapour content.

NICKEL: ISOKINETIC SAMPLING CALCULATIONS

Test	Units	Run 1
Absolute pressure of stack gas, P_s		
Barometric pressure, P_b	mmHg	741.8
Stack static pressure, P_{static}	mmH_2O	23.7
$P_s = (P_b + (P_{static} / 13.6)$	mmHg	743.6
Volume of water vapour collected, V_{wstd}		
Total mass collected in impingers (liquid trap)	g	7.0
Total mass collected in impingers (silica trap)	g	11.6
Total mass of liquid collected, V_{lc}	g	18.6
$V_{wstd} = (0.001246)(V_{lc})$	m^3	0.0232
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m	m^3	2.2800
Gas meter correction factor, Y_d	-	0.9610
Average dry gas meter temperature, T_m	°C	20.6
Average pressure drop across orifice, ΔH	mmH_2O	62.1
$V_{mstd} = ((0.3592)(V_m)(P_b + (\Delta H/13.6))(Y_d)) / (T_m + 273)$	m^3	2.0007
Moisture content, B_{wo} & R_{wv}		
$B_{wo} = V_{wstd} / (V_{mstd} + V_{wstd})$	m^3	0.0115
B_{wo} as a percentage	% v/v	1.15
Reported Water Vapour, checked with Tables in EN 14790, Rwv	% v/v	1.15
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = (V_{mstd})(100/(100 - R_{wv}))$	m^3	2.0239
Volume of gas metered at Oxygen Reference Conditions, $V_{mstd@X\%O_2}$ & $V_{mstw@X\%O_2}$		
IED & Incinerates Hazardous Material? (Yes = no positive O_2 correction)	-	No
% wet oxygen measured in gas stream, $ACT\%O_{2w}$	% v/v	N/A
% dry oxygen measured in gas stream, $ACT\%O_{2d}$	% v/v	N/A
% oxygen reference condition, $REF\%O_2$	% v/v	N/A
O_2 Reference Factor wet $(O_{2REFw}) = (21 - REF\%O_2) / (21 - ACT\%O_{2w})$	-	N/A
O_2 Reference Factor dry $(O_{2REFd}) = (21 - REF\%O_2) / (21 - ACT\%O_{2d})$	-	N/A
$V_{mstw@X\%oxygen} = (V_{mstw}) / (O_{2REFw})$	m^3	N/A
$V_{mstd@X\%oxygen} = (V_{mstd}) / (O_{2REFd})$	m^3	N/A
Molecular weight of dry gas stream, M_d		
CO_2 (Estimated)	% v/v	0.06
O_2 (Estimated)	% v/v	20.80
Total	% v/v	20.86
N_2	% v/v	79.14
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	g/gmol	28.84
Molecular weight of stack gas (wet), M_s		
$M_s = M_d(1 - (R_{wv}/100)) + 18(R_{wv}/100)$	g/gmol	28.72
Velocity of stack gas, V_s		
Pitot tube velocity constant, K_p	-	34.97
Velocity pressure coefficient, C_p	-	0.83
Average of velocity heads, ΔP_{avg}	mmH_2O	40.00
Average square root of velocity heads, √ΔP	$\sqrt{mmH_2O}$	6.32
Average stack gas temperature, T_s	°C	29.4
$V_s = ((K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)) / (\sqrt{(M_s)(P_s)})$	m/s	21.92
Total flow of stack gas: Actual (Q_a), Wet (Q_{stw}), Dry (Q_{std}), Wet@O_{2REF} (Q_{stwO_2}), Dry@O_{2REF} (Q_{stdO_2})		
Area of stack, A_s	m^2	0.06
$Q_a = (60)(A_s)(V_s)$	m^3/min	81.0
Conversion factor (K/mm.Hg), C_f	-	0.3592
$Q_{stw} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273)$	m^3/min	71.6
$Q_{std} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273)$	m^3/min	70.7
$Q_{stwO_2} = ((Q_a)(P_s)(C_f)) / ((T_s) + 273) / (O_{2REFw})$	m^3/min	N/A
$Q_{stdO_2} = ((Q_a)(P_s)(C_f)(1 - (R_{wv}/100))) / ((T_s) + 273) / (O_{2REFd})$	m^3/min	N/A
Percent isokinetic, %I		
Nozzle diameter, D_n	mm	4.88
Nozzle area, A_n	mm^2	18.68
Total sampling time, q	min	90
$\%I = (4.6398E^{6})(T_s+273)(V_{mstd}) / (P_s)(V_s)(A_n)(q)(1 - (R_{wv}/100))$	%	103.6

NICKEL: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	09:49 - 11:19
Sampling Dates	-	17/05/2021
Sampling Device	-	ISO
Volume Sampled (REF)	m^3	2.0239
Mass on Filter / in Rinse	µg	< 0.60
Mass in Front Impingers	µg	0.07
Mass in Back Impinger	µg	0.04
Total Mass Collected	µg	0.70
Calculated Concentration	mg/m^3	0.0003
Reported Concentration	mg/m^3	0.0003

Where: ISO stands for Manual Isokinetic Sampling Train

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	17/05/2021
Average Volume Sampled (REF)	m^3	2.0239
Mass on Filter / in Rinse	µg	< 0.60
Mass in Front Impingers	µg	< 0.04
Mass in Back Impinger	µg	< 0.02
Total Mass Collected	µg	< 0.66
Calculated Concentration	mg/m^3	< 0.0003
Reported Concentration	mg/m^3	< 0.0003

NICKEL: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	24.3
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	N/A
Allowable Leak Rate	l/min	0.50
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	94.9
Allowable Absorption Efficiency	%	90
Absorption Efficiency Acceptable	-	Yes

Detection Limit	Units	Run 1
Detection Limit	µg/m³	0.3
Allowable Detection Limit	µg/m³	5.0
Detection Limit Acceptable	-	Yes

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	5.4
Allowable MU	%	20.0
MU Acceptable	%	Yes

Silica Gel (Concurrent Water Vapour)	Units	Run 1
Less than 50% Faded	%	Yes

Isokinetic Criterion Compliance	Units	Run 1
Isokinetic Variation	%	103.6
Allowable Isokinetic Range	%	95 - 115
Isokineticity Acceptable	-	Yes

Filter Temperatures	Units	Run 1
Maximum Filter Temperature	°C	180

Impingers Exit Temperature	Units	Run 1
Maximum Temperature Recorded	°C	14
Maximum Allowable Temperature	°C	30
Exit Temperature Acceptable	-	Yes

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

NICKEL: QUALITY ASSURANCE

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	25.0
Pre-Sampling Leak Rate	l/min	0.00
Post-Sampling Leak Rate	l/min	N/A
Allowable Leak Rate	l/min	0.50
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m³	N/A
Blank Acceptable	-	N/A

Method Deviations

Nature of Deviation (x = deviation applies to the associated run, wx = deviation also applies to the concurrent water vapour run)	Run Number 1	
There are no deviations associated with the sampling employed.	x	

NICKEL: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (Actual)	V_m	2.2800		uV_m	m³	0.0456	
Sampled Gas Temperature	T_m	293.6		uT_m	K	2.00	
Sampled Gas Pressure	ρ_m	99.1		$u\rho_m$	kPa	0.50	
Sampled Gas Humidity	H_m	0.00		uH_m	% v/v	1.00	
Leak	L	0.00		uL	%	-	
Laboratory Result	L_r	5.90		uL_r	%	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (Actual)	%	2.00		≤2%
Sampled Gas Temperature	%	0.68		≤1%
Sampled Gas Pressure	%	0.50		≤1%
Sampled Gas Humidity	%	1.00		≤1%
Leak	%	0.00		≤2%
Laboratory Result	%	5.90		No Requirement

	Uncertainty in Measurement Units				Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**		**Run 1**	
Sampled Volume (STP)	V_m	m³	2.0007		0.00	
Leak	L	mg/m³	0.0000		1.00	
Laboratory Result	L_r	mg/m³	0.0000		1.00	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m³	0.0000	
Leak	mg/m³	0.0000	
Laboratory Result	mg/m³	0.0000	

	Oxygen Correction Part of MU Budget		
Measured Quantities	**Units**	**Run 1**	
O_2 Correction Factor	-	N/A	
Stack Gas O_2 Content	% v/v	N/A	
MU for O_2 Correction	%	N/A	
Overall MU For O_2 Measurement	%	N/A	

Parameter	**Units**	**Run 1**
Combined uncertainty	mg/m³	0.0000
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m³	0.0000
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m³	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m³	0.0000
Reported Uncertainty	mg/m³	0.0000
Expanded uncertainty (95% confidence), without Oxygen Correction	%	12.7
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	12.7
Reported Uncertainty	%	12.7

Version Number	Record of changes made within this version of the document
V1	The original document issued to the client