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Stack Emissions Testing Report Commissioned by
Meggit Aircraft Braking Systems

Installation Name & Address
Meggit Aircraft Braking Systems
Holbrook Lane
Coventry
West Midlands
CV6 4AA

PPC Permit: PPC/156

Stack Reference
Plating Shop Main Stack

Dates of the Monitoring Campaign
15th January 2020

Job Reference Number
EST-5399

Report Written by
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Signature of Report Approver

CONTENTS

TITLE PAGE

CONTENTS

EXECUTIVE SUMMARY

Monitoring Objectives	3
Monitoring Results	4
Monitoring Dates & Times	5
Process Details	6
Monitoring & Analytical Methods	7
Summary of Sampling Deviations	7
Sampling Location	8
Plant Photos / Sample Points	9

APPENDIX 1 - Monitoring Personnel & List of Equipment

APPENDIX 2 - Raw Data, Sampling Equations & Charts

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Executive Summary

(Page 1 of 7)

MONITORING OBJECTIVES

Meggit Aircraft Braking Systems, Coventry
Plating Shop Main Stack
15th January 2020

Overall Aim of the Monitoring Campaign

Element were commissioned by Meggit Aircraft Braking Systems to carry out stack emissions testing on the Plating Shop 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

Hydrogen Fluoride, Total Oxides of Nitrogen

Executive Summary

(Page 2 of 7)

MONITORING RESULTS

Meggit Aircraft Braking Systems, Coventry

Plating Shop Main Stack

15th January 2020

where MU = Measurement Uncertainty associated with the Result

Parameter	Concentration				Mass Emission			
	Units	Result	MU +/-	Limit	Units	Result	MU +/-	Limit
Hydrogen Fluoride	¹ mg/m ³	< 0.04	0.002	5	g/hr	< 1.8	0.25	-
Total Oxides of Nitrogen	¹ mg/m ³	52.8	15.9	200	g/hr	2651	857	-
Water Vapour	% v/v	1.4	0.50					
Stack Gas Temperature	°C	20.5						
Stack Gas Velocity	m/s	8.6	0.95					
Volumetric Flow Rate (ACTUAL)	m ³ /hr	54492	6506					
Volumetric Flow Rate (REF)	¹ m ³ /hr	50166	5989					

NOTE: VOLUMETRIC FLOW RATE & VELOCITY DATA TAKEN FROM THE PRELIMINARY VELOCITY TRAVERSE.

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

Executive Summary

(Page 3 of 7)

MONITORING DATE(S) & TIMES

Meggitt Aircraft Braking Systems, Coventry
 Plating Shop Main Stack
 15th January 2020

Parameter	Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Hydrogen Fluoride	R1 mg/m ³	< 0.04	g/hr	< 1.8	15/01/2020	11:30 - 12:30	60
Total Oxides of Nitrogen	R1 mg/m ³	52.8	g/hr	2651	15/01/2020	11:30 - 12:30	60
Velocity Traverse	R1				15/01/2020	10:32 - 10:55	

All results are expressed at the respective reference conditions.

Executive Summary

(Page 4 of 7)

PROCESS DETAILS

Meggit Aircraft Braking Systems, Coventry
 Plating Shop Main Stack
 15th January 2020

Standard Operating Conditions

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

Site Specific Operating Conditions

Parameter	Status
Surface Treatment 1	Passivation (PRO 227) - Parts In Nitric VAT
Surface Treatment 2	Sulphuric Anodise - Parts In Sulphuric Vat
Surface Treatment 3	Pickle (Pro375) - Parts in Deoxidiser

Executive Summary

(Page 5 of 7)

MONITORING & ANALYTICAL METHODS

Meggit Aircraft Braking Systems, Coventry

Plating Shop Main Stack

15th January 2020

Parameter	Monitoring				Analysis				MCERTS Testing	LOD (Average)
	Standard	Technical Procedure	ISO 17025 Testing	Testing Lab	Analytical Procedure	Analytical Technique	ISO 17025 Analysis	Analysis Lab		
Hydrogen Fluoride	ISO 15713	CAT-TP-10	Yes	EET	CAT-AP-01	IC	Yes	EET	Yes	0.036 mg/m ³
Total Oxides of Nitrogen	US EPA M7D	CAT-TP-35	Yes	EET	C27	IC	Yes	RPS	Yes	6.525 mg/m ³
Water Vapour	EN 14790	CAT-TP-05	Yes	EET	CAT-TP-05	Gravimetric	Yes	EET	Yes	0.1 % v/v
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	EET	Pitot Tube and Thermocouple				Yes	1.8 m/s

ANALYSIS LABORATORIES

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

Element Stockport (EET)	ISO 17025 Accreditation Number: 4279
RPS Laboratories Ltd (RPS)	ISO 17025 Accreditation Number: 0605

SUMMARY OF SAMPLING DEVIATIONS

Parameter	Run	Deviation
Total Oxides of Nitrogen	1	The measurement uncertainty for water vapour was greater than 20%. This was due to the low level of water vapour which was found to be present in the stack.
Total Oxides of Nitrogen	1	The blank result was higher than 10% of the ELV, however it should be noted that the results were of an extremely low order. [50 - 75% higher]

Executive Summary

(Page 6 of 7)

SUITABILITY OF SAMPLING LOCATION

Duct Characteristics

Parameter	Units	Value
Type	-	Circular
Depth	m	1.50
Width	m	-
Area	m ²	1.77
Port Depth	cm	9
Orientation of Duct	-	Angled
Number of Ports	-	2
Sample Port Size	-	4" BSP

Location of Sampling Platform

General Platform Information	Value
Permanent / Temporary Platform	Permanent
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

Although this platform does not meet the requirements in the Environment Agency's Technical Guidance Note M1 and EN 15259, it is adequate for the testing carried out on this stack.

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	24.5	> 5 Pa	Yes
Mean Velocity	m/s	8.56	-	-
Lowest Gas Velocity	m/s	5.35	-	-
Highest Gas Velocity	m/s	12.17	-	-
Ratio of Above	: 1	2.28	< 3 : 1	Yes
Maximum Angle of Swirl	°	NM	NM	NM
No Local Negative Flow	-	Yes	-	Yes

Where NM = Not Measured as no Isokinetic sampling was performed.

Executive Summary
 (Page 7 of 7)

PLANT PHOTOS

Photo 1



Photo 2



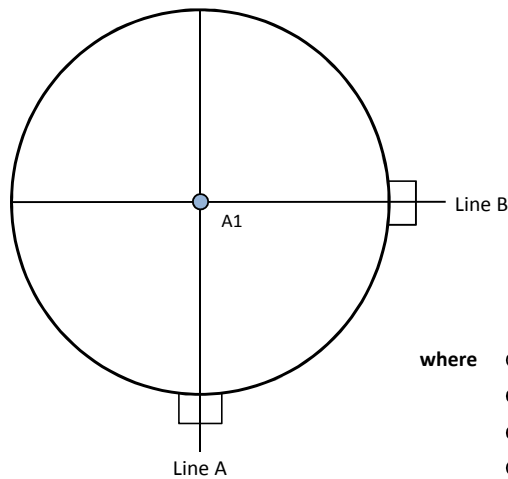
Photo 3



Photo 4



SAMPLE POINTS



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

APPENDICES

APPENDIX CONTENTS

APPENDIX 1 - Stack Emissions Monitoring Personnel, List of Equipment & Methods and Technical Procedures Used

APPENDIX 2 - Summaries, Calculations, Raw Data and Charts

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Danny Pryke	MCERTS Level 2	MM 03 163	TE1 TE2 TE3 TE4
Trainee	Chris Whitley	MCERTS Trainee	MM 19 1543	None

LIST OF EQUIPMENT

Extractive Sampling		Instrumental Analysers		Miscellaneous Items	
Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.	Equipment Type	Equipment I.D.
Control Box DGM (1)	CAT 7.62	Horiba PG-250	-	Digital Manometer (1)	-
Control Box DGM (2)	-	Horiba PG-250 SRM	-	Digital Manometer (2)	-
Box Thermocouples (1)	CAT 3.132	Servomex 4900	-	Digital Temperature Meter	-
Box Thermocouples (2)	-	Eco Physics CLD 822Mh	-	Stopwatch	-
Umbilical (1)	CAT 3.132	ABB AO2020-URAS26	-	Barometer	-
Umbilical (2)	-	Testo 350 XL	-	Stack Thermocouple (1)	CAT 4.103
Oven Box (1)	CAT 12.78	JCT JCC P1 Cooler	-	Stack Thermocouple (2)	-
Oven Box (2)	-	ProtIR 204M	-	Stack Thermocouple (3)	-
Heated Probe (1)	CAT 5.133	Gasmet Sampling System	-	1m Heated Line (1)	-
Heated Probe (2)	-	Bernath 3006 FID	-	1m Heated Line (2)	-
Heated Probe (3)	-	M&C PSS	-	1m Heated Line (3)	-
S-Pitot (1)	CAT 21B.116	Mass Flow Controller (1)	-	5m Heated Line (1)	-
S-Pitot (2)	-	Mass Flow Controller (2)	-	15m Heated Line (1)	-
L-Pitot	-	Mass View (1)	CAT DP	20m Heated Line (1)	-
Site Balance	CAT 17.26	Mass View (2)	CAT DP	20m Heated Line (2)	-
500g / 1Kg Check Weights	CAT 17.26	Hioki 5043 (V)	-	Dual Channel Heater Controller	-
Last Impinger Arm	CAT 4.839	Hioki 5031 (mA)	-	Single Channel Heater Controller	-
Callipers	CAT 23.27	Bioaerosols Temperature Logger	-	Laboratory Balance	-
Tubes Kit Thermocouple	-	Electronic Refrigerator	-	Tape Measure	CAT 17.22

METHODS & TECHNICAL PROCEDURES USED

Parameter	Standard	Technical Procedure
Hydrogen Fluoride	ISO 15713	CAT-TP-10
Total Oxides of Nitrogen	US EPA M7D	CAT-TP-35
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	1.50
Stack Width, W	m	-
Stack Area, A	m ²	1.77
Average Stack Gas Temperature, T _a	°C	20.5
Average Stack Gas Pressure	mmH ₂ O	6.9
Average Stack Static Pressure, P _{static}	kPa	0.060
Average Barometric Pressure, P _b	kPa	100.2
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/m ³ ρ	Conc kg/m ³ ρ _i
CO ₂ (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.00118
O ₂ (Estimated)	-	20.80	20.51	0.2080	32.00	1.4277	0.29696
N ₂	-	79.14	78.05	0.7914	28.01	1.2498	0.98913
Moisture (H ₂ O)	-	-	1.38	0.0138	18.02	0.8037	0.01111

Where: $\rho = M / 22.41$
 $\rho_i = r \times \rho$

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P _{STD}	kg/m ³	1.287
Wet Density (STP), P _{STW}	kg/m ³	1.281
Dry Density (Actual), P _{Actual}	kg/m ³	1.185
Average Wet Density (Actual), P _{ActualW}	kg/m ³	1.179

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} x (T_s / P_s) x (P_a / T_a)

Calculation of Stack Gas Volumetric Flowrate, Q

Duct gas flow conditions	Units	Actual	REF ¹
Temperature	°C	20.5	0.0
Total Pressure	kPa	100.3	101.3
Moisture	%	1.38	1.38

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m ³ /hr	54492
Gas Volumetric Flowrate (STP, Wet)	m ³ /hr	50166
Gas Volumetric Flowrate (STP, Dry)	m ³ /hr	49472
Gas Volumetric Flowrate REF ¹	m ³ /hr	50166

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	15/01/2020
Time of Survey	-	10:32 - 10:55
Atmospheric Pressure	kPa	100.2
Average Stack Static Pressure	Pa	60
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	Yes
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	-	Angled
Pitot Tube, C _p	-	0.83
Number of Lines Available	-	2
Number of Lines Used	-	2

Traverse Point	Depth m	ΔP mmH ₂ O	Sampling Line A				Swirl °	ΔP mmH ₂ O	Sampling Line B			
			Temp °C	Wet Density kg/m ³	Velocity m/s	Temp °C			Wet Density kg/m ³	Velocity m/s	Swirl °	
<i>STATIC (Units: Pa)</i>		<i>60.0</i>					<i>60.0</i>					
Mean		7.8	20.3	1.180	9.13		6.0	20.8	1.178	8.00		
1	0.10	13.0	20.0	1.181	12.17		10.5	21.0	1.177	10.96		
2	0.38	8.0	20.0	1.181	9.55		7.0	21.0	1.177	8.95		
3	1.13	7.0	21.0	1.177	8.95		4.0	20.0	1.181	6.75		
4	1.40	3.0	20.0	1.181	5.85		2.5	21.0	1.177	5.35		

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	$u(\Delta p_i)$	1.821	Pa
- Resolution	$u(res)$	0.52154	
- Calibration	$u(cal)$	0.473	
- Drift	$u(drift)$	1.096	
- Lack of Fit	$u(fit)$	0.226	
- Overall corrections to dynamic measurements	$u(C_f)$	2.317	
Standard uncertainty associated with the molar mass of the gas	$u(M)$	0.00003	-
- $\phi_{O_2,w}$	-	20.512	
- $\phi_{CO_2,w}$	-	0.059	
- Oxygen, dry	$u(\phi_{O_2,d})$	0.637	
- Carbon Dioxide, dry	$u(\phi_{CO_2,d})$	0.002	
- Water Vapour	$u(\phi_{H_2O})$	0.071	
- Oxygen, wet	$u(\phi_{O_2,w})$	0.628	
- Carbon Dioxide, wet	$u(\phi_{CO_2,w})$	0.002	
Standard uncertainty associated with the stack temperature	$u(T_c)$	1.497	K
Standard uncertainty associated with the absolute pressure in the duct	$u(p_c)$	175.697	Pa
- Atmospheric Pressure	$u(p_{atm})$	175.692	
- Static Pressure	$u(p_{stat})$	1.288	
Standard uncertainty associated with the density in the duct	$u(\rho)$	0.00636	-
Standard uncertainty associated with the local velocities	$u(v_i)$	1.310	Pa
Standard uncertainty associated with the mean velocity	$u(\bar{v})$	0.483	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	$U_c(v)$	0.946	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	$U_{c,rel}(v)$	11.05	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	$U_c(qV,w)$	6506.0	m ³ /hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00371	
- $u^2(qV,w)$	-	11018266	
- $u(qV,w)$	-	3319.4	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	$U_{c,rel}(qV,w)$	11.94	%

HYDROGEN FLUORIDE: RESULTS SUMMARY

Meggit Aircraft Braking Systems, Coventry
Plating Shop Main Stack

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	< 0.036	< 0.036
Uncertainty	±mg/m ³	0.002	0.002
Mass Emission	g/hr	< 1.82	< 1.82
Uncertainty	±g/hr	0.25	0.25

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	1.48	1.48
Uncertainty	±% v/v	0.08	0.08

Blank Runs

Parameter	Units	Blank 1	Maximum
Concentration	mg/m ³	< 0.03	< 0.03

General Sampling Information

Parameter	Value
Standard	ISO 15713
Technical Procedure	CAT-TP-10
Name of Analytical Laboratory	EET
Analytical Laboratory's Procedure	CAT-AP-01
ISO 17025 Accredited Analysis?	Yes
Date of Sample Analysis	20/01/2020
Probe Material	Monel
Filter Housing Material	Monel
Impinger Material	Quartz Glass
Absorption Solution	0.1 mol/l Sodium Hydroxide
Positioning of Filter	In Stack
Filter Size and Material	47mm Quartz Fibre
Number of Sampling Lines Used	1 / 1
Number of Sampling Points Used	1 / 1
Sample Point I.D.'s	A1

FORMAT: Number Used / Number Required

FORMAT: Number Used / Number Required

Reference Conditions

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

HYDROGEN FLUORIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	11:30 - 12:30
Sampling Dates	-	15/01/2020
Sampling Device	-	MFC / MV
Duration	mins	60
Volume Sampled (STP, Dry)	m ³	0.5297
Volume Sampled (STP, Wet)	m ³	0.5377
Volume Sampled (REF)	m ³	0.5377
Sample Flow Rate	l/min	8.83
Laboratory Result for Front Impingers	µg/ml	< 0.05
Laboratory Result for Back Impinger	µg/ml	< 0.05
Volume in Front Impingers	ml	288.4
Volume in Back Impinger	ml	102.8
Mass in Front Impingers	µg	< 14.4
Mass in Back Impinger	µg	< 5.1
Total Mass Collected	µg	< 19.6
Calculated Concentration	mg/m ³	< 0.04
Liquid Trap Start Mass	g	1236.5
Liquid Trap End Mass	g	1239.8
Silica Trap Start Mass	g	520.9
Silica Trap End Mass	g	524.0
Total Mass Of Water Vapour	g	6.4
Calculated Water Vapour	% v/v	1.48

Where: MFC stands for Mass Flow Controller, MV stands for Mass View Flowmeter

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	15/01/2020
Average Volume Sampled (REF)	m ³	0.5377
Laboratory Result for Impingers	µg/ml	< 0.05
Volume in Impingers	ml	318.4
Total Mass Collected	µg	< 15.9
Calculated Concentration	mg/m ³	< 0.03

HYDROGEN FLUORIDE: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	8.8
Pre-Sampling Leak Rate	l/min	0.05
Post-Sampling Leak Rate	l/min	0.08
Allowable Leak Rate	l/min	0.18
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	100.0
Allowable Absorption Efficiency	%	N/A ²
Absorption Efficiency Acceptable	-	Yes ²

² The concentration is less than 30% of the ELV, therefore no assessment against an allowable efficiency is required.

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

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	9.5
Pre-Sampling Leak Rate	l/min	0.05
Post-Sampling Leak Rate	l/min	0.07
Allowable Leak Rate	l/min	0.19
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m ³	0.5
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	

HYDROGEN FLUORIDE: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		Standard uncertainty		
	Symbol	Run 1	Symbol	Units	Run 1
Sampled Volume (STP)	V _m	0.5297	uV _m	m ³	0.0106
Leak	L	0.91	uL	%	-
Laboratory Result	L _r	2.65	uL _r	%	-

Measured Quantities	Uncertainty as a Percentage		Requirement of Standard
	Units	Run 1	
Sampled Volume (STP)	%	2.00	≤2%
Leak	%	0.91	≤2%
Laboratory Result	%	2.65	No Requirement

Measured Quantities	Uncertainty in Measurement Units			Sensitivity Coefficient
	Symbol	Units	Run 1	
Sampled Volume (STP)	V _m	m ³	0.5297	0.07
Leak	L	mg/m ³	0.000	1.00
Laboratory Result	L _r	mg/m ³	0.001	1.00

Measured Quantities	Uncertainty in Result	
	Units	Run 1
Sampled Volume (STP)	mg/m ³	0.001
Leak	mg/m ³	0.0002
Laboratory Result	mg/m ³	0.0010

Measured Quantities	Oxygen Correction Part of MU Budget	
	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	0.00
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m ³	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	0.00
Reported Uncertainty	mg/m ³	0.00
Expanded uncertainty (95% confidence), without Oxygen Correction	%	6.6
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	6.6
Reported Uncertainty	%	6.6

TOTAL OXIDES OF NITROGEN: RESULTS SUMMARY

Meggitt Aircraft Braking Systems, Coventry
Plating Shop Main Stack

Sample Runs

Parameter	Units	Run 1	Mean
Concentration	mg/m ³	52.8	52.8
Uncertainty	±mg/m ³	15.9	15.9
Mass Emission	g/hr	2651	2651
Uncertainty	±g/hr	857	857

Parameter	Units	Run 1	Mean
Water Vapour	% v/v	1.3	1.3
Uncertainty	±% v/v	0.92	0.92

Blank Runs

Parameter	Units	Blank 1	Maximum
Concentration	mg/m ³	46.4	46.4

General Sampling Information

Parameter	Value	
Standard	US EPA M7D	
Technical Procedure	CAT-TP-35	
Name of Analytical Laboratory	RPS	
Analytical Laboratory's Procedure	C27	
ISO 17025 Accredited Analysis?	Yes	
Date of Sample Analysis	29/01/2020	
Probe Material	Titanium	
Filter Housing Material	Titanium	
Impinger Material	Quartz Glass	
Absorption Solution	Potassium Permanganate Solution	
Positioning of Filter	In 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.

TOTAL OXIDES OF NITROGEN: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1
Sampling Times	-	11:30 - 12:30
Sampling Dates	-	15/01/2020
Sampling Device	-	MFC / MV
Duration	mins	60
Volume Sampled (STP, Dry)	m ³	0.0288
Volume Sampled (STP, Wet)	m ³	0.0292
Volume Sampled (REF)	m ³	0.0292
Sample Flow Rate	l/min	0.48
Laboratory Result for Front Impingers	µg/ml	2.00
Laboratory Result for Back Impinger	µg/ml	2.18
Volume in Front Impingers	ml	656.6
Volume in Back Impinger	ml	104.3
Mass in Front Impingers	µg	1313.2
Mass in Back Impinger	µg	227.4
Total Mass Collected	µg	1540.6
Calculated Concentration	mg/m ³	52.85
Liquid Trap Start Mass	g	2290.9
Liquid Trap End Mass	g	2291.1
Silica Trap Start Mass	g	890.4
Silica Trap End Mass	g	890.5
Total Mass Of Water Vapour	g	0.3
Calculated Water Vapour	% v/v	1.28

Where: MFC stands for Mass Flow Controller, MV stands for Mass View Flowmeter

Blank Runs

Parameter	Units	Blank 1
Blank Dates	-	15/01/2020
Average Volume Sampled (REF)	m ³	0.0292
Laboratory Result for Impingers	µg/ml	1.65
Volume in Impingers	ml	819.4
Total Mass Collected	µg	1352.0
Calculated Concentration	mg/m ³	46.38

TOTAL OXIDES OF NITROGEN: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1
Mean Sampling Rate	l/min	0.5
Pre-Sampling Leak Rate	l/min	0.01
Post-Sampling Leak Rate	l/min	0.01
Allowable Leak Rate	l/min	0.01
Leak Test Acceptable	-	Yes

Absorption Efficiency	Units	Run 1
Absorption Efficiency	%	85.2
Allowable Absorption Efficiency	%	N/A
Absorption Efficiency Acceptable	-	N/A

Water Droplets	Units	Run 1
Are Water Droplets Present	-	No

MU (Concurrent Water Vapour)	Units	Run 1
Measurement Uncertainty (MU)	%	72.0
Allowable MU	%	20.0
MU Acceptable	%	No

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

Test Conditions	Units	Run 1
Ambient Temperature Recorded?	-	Yes

Blank Runs

Leak Test Results	Units	Blank 1
Expected Sampling Rate	l/min	0.5
Pre-Sampling Leak Rate	l/min	0.01
Post-Sampling Leak Rate	l/min	0.01
Allowable Leak Rate	l/min	0.01
Leak Test Acceptable	-	Yes

Validity of Blank vs ELV	Units	Blank 1
Allowable Blank	mg/m ³	20.0
Blank Acceptable	-	No

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 measurement uncertainty for water vapour was greater than 20%. This was due to the low level of water vapour which was found to be present in the stack.	wx	
The blank result was higher than 10% of the ELV, however it should be noted that the results were of an extremely low order. [50 - 75% higher]	x	

TOTAL OXIDES OF NITROGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

Measured Quantities	Value		Standard uncertainty		
	Symbol	Run 1	Symbol	Units	Run 1
Sampled Volume (STP)	V _m	0.0288	uV _m	m ³	0.0006
Leak	L	1.25	uL	%	-
Laboratory Result	L _r	10.00	uL _r	%	-

Measured Quantities	Uncertainty as a Percentage		Requirement of Standard
	Units	Run 1	
Sampled Volume (STP)	%	2.00	≤2%
Leak	%	1.25	≤2%
Laboratory Result	%	10.00	No Requirement

Measured Quantities	Uncertainty in Measurement Units			Sensitivity Coefficient
	Symbol	Units	Run 1	
Sampled Volume (STP)	V _m	m ³	0.0288	1836.44
Leak	L	mg/m ³	0.382	1.00
Laboratory Result	L _r	mg/m ³	5.285	1.00

Measured Quantities	Uncertainty in Result	
	Units	Run 1
Sampled Volume (STP)	mg/m ³	1.057
Leak	mg/m ³	0.3818
Laboratory Result	mg/m ³	5.2848

Measured Quantities	Oxygen Correction Part of MU Budget	
	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	5.40
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m ³	10.59
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m ³	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m ³	15.88
Reported Uncertainty	mg/m ³	15.88
Expanded uncertainty (95% confidence), without Oxygen Correction	%	20.0
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	30.1
Reported Uncertainty	%	30.1