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Your Exova Catalyst Contact: Toby Campbell (07825 130 074)

Stack Emissions Testing Report Commissioned by
Meggitt Aircraft Braking Systems

Installation Name & Address
Meggitt 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
16th November 2017

Job Reference Number
CAT-3579

Report Written by
Harpreet Badwal Team Leader MCERTS Level 2 MM 03 149 TE1 TE2 TE3 TE4

Report Approved by
Ian Baggley Team Leader MCERTS Level 2 MM 05 653 TE1 TE2 TE3 TE4

Report Date
13th December 2017

Version
Version 1

Signature of Report Approver
[redacted]

CONTENTS

Executive Summary

MONITORING OBJECTIVES

Meggitt Aircraft Braking Systems, Coventry
Plating Shop Main Stack
16th November 2017

Overall Aim of the Monitoring Campaign

Exova Catalyst were commissioned by Meggitt 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

MONITORING RESULTS

Meggitt Aircraft Braking Systems, Coventry
Plating Shop Main Stack
16th November 2017

where MU = Measurement Uncertainty associated with the Result

	Concentration				Mass Emission			
Parameter	**Units**	**Result**	**MU +/-**	**Limit**	**Units**	**Result**	**MU +/-**	**Limit**
Hydrogen Fluoride [1]	mg/m³	< 0.03	0.002	5	g/hr	< 1.6	0.13	-
Total Oxides of Nitrogen [1]	mg/m³	< 6.7	0.70	200	g/hr	< 329	37.9	-
Water Vapour	% v/v	2.1	0.10					
Stack Gas Temperature	°C	19.9						
Stack Gas Velocity	m/s	8.4	0.08					
Volumetric Flow Rate (ACTUAL)	m³/hr	53405	2475					
Volumetric Flow Rate (REF) [1]	m³/hr	49452	2292					

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.

MONITORING DATE(S) & TIMES

Meggitt Aircraft Braking Systems, Coventry
Plating Shop Main Stack
16th November 2017

Parameter		Units	Concentration	Units	Mass Emission	Sampling Date(s)	Sampling Times	Duration mins
Hydrogen Fluoride	R1	mg/m³	< 0.03	g/hr	< 1.6	16/11/2017	11:24 - 12:24	60
Total Oxides of Nitrogen	R1	mg/m³	< 6.7	g/hr	< 329	16/11/2017	10:16 - 11:16	60
Velocity & Volumetric Flow Rate	R1					16/11/2017	09:36 - 09:58	

All results are expressed at the respective reference conditions.

PROCESS DETAILS

Meggitt Aircraft Braking Systems, Coventry
Plating Shop Main Stack
16th November 2017

Standard Operating Conditions

Parameter	Value
Process Status	Normal Operation
Capacity (of 100%) and Tonnes / Hour	Standard Operating Capacity
Continuous or Batch Process	Continuous
Feedstock (if applicable)	Metallic Components
Abatement System	Wet Scrubber
Abatement System Running Status	On
Fuel	N/A
Plume Appearance	None Visible

MONITORING & ANALYTICAL METHODS

Meggitt Aircraft Braking Systems, Coventry
Plating Shop Main Stack
16th November 2017

	Monitoring				Analysis					
Parameter	**Standard**	**Technical Procedure**	**ISO 17025 Testing**	**Testing Lab**	**Analytical Procedure**	**Analytical Technique**	**ISO 17025 Analysis**	**Analysis Lab**	**MCERTS Testing**	**LOD (Average)**
Hydrogen Fluoride	ISO 15713	CAT-TP-10	Yes	CAT	AP-01	IC	Yes	CAT	Yes	0.03 mg/m³
Total Oxides of Nitrogen	US EPA M7D	CAT-TP-35	Yes	CAT	C27	IC	Yes	RPS	Yes	6.5 mg/m³
Water Vapour	EN 14790	CAT-TP-05	Yes	CAT	CAT-TP-05	Gravimetric	Yes	CAT	Yes	0.10 % v/v
Velocity & Vol. Flow Rate	EN 16911-1 (MID)	CAT-TP-41	Yes	CAT	Pitot Tube and Thermocouple				Yes	1.2 m/s

ANALYSIS LABORATORIES

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

Exova Catalyst (CAT)	ISO 17025 Accreditation Number: 4279
RPS Laboratories Ltd (RPS)	ISO 17025 Accreditation Number: 0605

SUMMARY OF SAMPLING DEVIATIONS

Parameter	**Run**	**Deviation**
All Parameters	All Runs	There are no deviations associated with the sampling employed.

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	-	Vertical
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

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

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	24.0					> 5 Pa	Yes
Mean Velocity	m/s	8.39					-	-
Lowest Gas Velocity	m/s	5.34					-	-
Highest Gas Velocity	m/s	12.42					-	-
Ratio of Above	: 1	2.33					< 3 : 1	Yes
Maximum Angle of Swirl	°	NM	NM	NM	NM	NM	NM	NM
No Local Negative Flow	-	Yes					-	Yes

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

PLANT PHOTOS

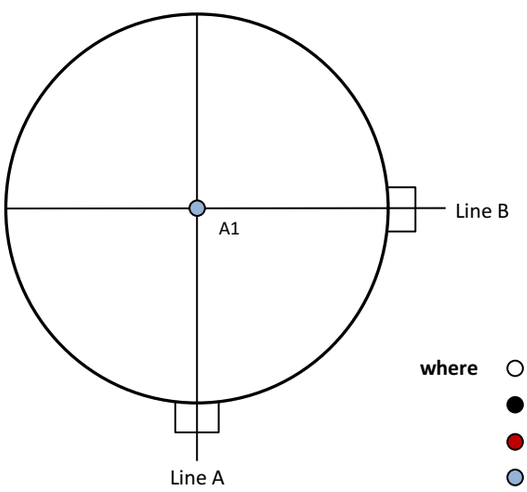
Photo 1

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

APPENDIX CONTENTS

STACK EMISSIONS MONITORING PERSONNEL

Position	Name	MCERTS Accreditation	MCERTS Number	Technical Endorsements
Team Leader	Harpreet Badwal	MCERTS Level 2	MM 03 149	TE1 TE2 TE3 TE4
Technician	Aaron Nagha	MCERTS Level 1	MM 16 1392	None

LIST OF EQUIPMENT

Extractive Sampling	
Equipment Type	**Equipment I.D.**
Control Box DGM (1)	-
Control Box DGM (2)	-
Box Thermocouples (1)	-
Box Thermocouples (2)	-
Umbilical (1)	-
Umbilical (2)	-
Oven Box (1)	-
Oven Box (2)	-
Heated Probe (1)	CAT 5.126
Heated Probe (2)	CAT 5.127
Heated Probe (3)	CAT 5.128
S-Pitot (1)	CAT 21S.57
S-Pitot (2)	-
L-Pitot	-
Site Balance	CAT 17.33
500g / 1Kg Check Weights	CAT 17.33 a & b
Last Impinger Arm	CAT 4.844
Callipers	-
Tubes Kit Thermocouple	-

Instrumental Analysers	
Equipment Type	**Equipment I.D.**
Horiba PG-350E	-
Horiba PG-250	-
Servomex 4900	-
Eco Physics CLD 822Mh	-
ABB AO2020-URAS26	-
Testo 350 XL	-
Ankersmid APS 313	-
Gasmet DX4000	-
Gasmet Sampling System	-
Bernath 3006 FID	-
M&C PSS	-
Mass Flow Controller (1)	-
Mass Flow Controller (2)	-
Mass View (1)	CAT 25.59
Mass View (2)	CAT 25.60
Hioki 5043 (V)	-
Easylogger EN-EL-12 Bit	-
Bioaerosols Temperature Logger	-
Electronic Refrigerator	-

Miscellaneous Items	
Equipment Type	**Equipment I.D.**
Digital Manometer (1)	CAT 3.142
Digital Manometer (2)	CAT 3.144
Digital Temperature Meter	-
Stopwatch	CAT 14.84
Barometer	CAT 13.40
Stack Thermocouple (1)	CAT 4.844
Stack Thermocouple (2)	CAT 4.016
Stack Thermocouple (3)	CAT 4.013
1m Heated Line (1)	-
1m Heated Line (2)	-
1m Heated Line (3)	-
5m Heated Line (1)	-
15m Heated Line (1)	-
20m Heated Line (1)	-
20m Heated Line (2)	-
Dual Channel Heater Controller	CAT 3.151
Single Channel Heater Controller	-
Laboratory Balance	
Tape Measure	CAT 16.45

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	19.9
Average Stack Gas Pressure	Pa	63.5
Average Stack Static Pressure, P_{static}	kPa	0.05
Average Barometric Pressure, P_b	kPa	100.6
Average Pitot Tube Calibration Coefficient, C_p	-	0.84

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 p	Conc kg/m^3 p_i
CO_2 (Estimated)	-	0.06	0.06	0.0006	44.01	1.9635	0.0012
O_2 (Estimated)	-	20.80	20.36	0.2080	32.00	1.4277	0.2970
N_2	-	79.14	77.45	0.7914	28.01	1.2498	0.9891
Moisture (H_2O)	-	-	2.14	0.0214	18.02	0.8037	0.0172

Where: p = M / 22.41

p_i = r x p

Calculation of Stack Gas Densities

Determinand	Units	Result
Dry Density (STP), P_{STD}	kg/m^3	1.2873
Wet Density (STP), P_{STW}	kg/m^3	1.2769
Dry Density (Actual), P_{Actual}	kg/m^3	1.1920
Average Wet Density (Actual), $P_{ActualW}$	kg/m^3	1.1824

Where: P_{STD} = sum of component concentrations, kg/m^3 (not including water vapour)

P_{STW} = sum of all wet concentrations / 100 x density, kg/m^3 (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	19.9	0.00
Total Pressure	kPa	100.6	101.3
Moisture	%	2.14	2.14

Gas Volumetric Flowrate (from Traverse)	Units	Result
Gas Volumetric Flowrate (Actual)	m^3/hr	53405
Gas Volumetric Flowrate (STP, Wet)	m^3/hr	49452
Gas Volumetric Flowrate (STP, Dry)	m^3/hr	48395
Gas Volumetric Flowrate REF [1]	m^3/hr	49452

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

(1 of 1)

Parameter	Units	Value
Date of Survey	-	16/11/2017
Time of Survey	-	09:36 - 09:58
Atmospheric Pressure	kPa	100.6
Average Stack Static Pressure	Pa	46
Result of Pitot Stagnation Test	-	Pass
Are Water Droplets Present?	-	No
Device Used	S-Type Pitot with KIMO MP 210 (500Pa)	

Parameter	Units	Value
Initial Pitot Leak Check	-	Pass
Final Pitot Leak Check	-	Pass
Orientation of Duct	-	Vertical
Pitot Tube, C_p	-	0.84
Number of Lines Available	-	2
Number of Lines Used	-	2

		Sampling Line A				Sampling Line B			
Traverse Point	Depth m	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s	ΔP Pa	Temp °C	Wet Density kg/m³	Velocity m/s
STATIC (Units: Pa)		*40.0*				*51.0*			
Mean		**74.7**	**19.7**	**1.183**	**9.07**	**52.2**	**20.2**	**1.181**	**7.72**
1	0.04	131.0	17.9	1.191	12.42	61.0	20.2	1.181	8.51
2	0.12	126.0	18.9	1.187	12.20	73.0	20.1	1.182	9.31
3	0.22	107.0	19.5	1.184	11.26	63.0	20.1	1.182	8.65
4	0.34	106.0	19.8	1.183	11.21	49.0	20.2	1.181	7.63
5	0.51	58.0	20.0	1.182	8.29	25.0	20.2	1.181	5.45
6	0.99	77.0	20.0	1.182	9.56	26.0	20.2	1.181	5.56
7	1.16	46.0	20.1	1.182	7.39	35.0	20.2	1.181	6.45
8	1.28	43.0	20.1	1.182	7.14	43.0	20.2	1.181	7.14
9	1.38	29.0	20.1	1.182	5.87	54.0	20.2	1.181	8.01
10	1.46	24.0	20.1	1.182	5.34	93.0	20.2	1.181	10.51

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)	1.264	Pa
- Resolution	u(res)	0.00087	
- Calibration	u(cal)	0.419	
- Drift	u(drift)	0.083	
- Lack of Fit	u(fit)	0.095	
- Overall corrections to dynamic measurements	u(Cf)	0.598	
Standard uncertainty associated with the molar mass of the gas	u(M)	0.00003	-
- $\varphi O_2,w$	-	20.356	
- $\varphi CO_2,w$	-	0.059	
- Oxygen, dry	u(ϕO_2,d)	0.637	
- Carbon Dioxide, dry	u(ϕCO_2,d)	0.002	
- Water Vapour	u(ϕH_2O)	0.109	
- Oxygen, wet	u(ϕO_2,w)	0.624	
- Carbon Dioxide, wet	u(ϕCO_2,w)	0.002	
Standard uncertainty associated with the stack temperature	u(Tc)	1.494	K
Standard uncertainty associated with the absolute pressure in the duct	u(pc)	175.694	Pa
- Atmospheric Pressure	u(patm)	175.692	
- Static Pressure	u(pstat)	0.894	
Standard uncertainty associated with the density in the duct	u(ρ)	0.00638	-
Standard uncertainty associated with the local velocities	u(vi)	0.104	Pa
Standard uncertainty associated with the mean velocity	u(v)	0.043	m/s
Standard uncertainty associated with the mean velocity (95% Confidence)	Uc(v)	0.083	m/s
Standard uncertainty associated with the mean velocity (95% Confidence), relative	Uc,rel(v)	0.99	%
Standard uncertainty associated with the volume flow rate (95% Confidence)	Uc(qV,w)	2475.0	m^3/hr
- $u^2(a)/a^2$	-	0.00053	
- $u^2(qV,w)/q^2V,w$	-	0.00056	
- $u^2(qV,w)$	-	1594554	
- u(qV,w)	-	1262.8	
Standard uncertainty associated with the volume flow rate (95% Confidence), relative	Uc,rel(qV,w)	4.63	%

HYDROGEN FLUORIDE: RESULTS SUMMARY

Meggitt Aircraft Braking Systems, Coventry

Plating Shop Main Stack

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	< 0.032		< 0.032
Uncertainty	±mg/m³	0.002		0.002
Mass Emission	g/hr	< 1.60		< 1.60
Uncertainty	±g/hr	0.13		0.13

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	1.95		1.95
Uncertainty	±% v/v	0.09		0.09

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	< 0.026		< 0.026

General Sampling Information

Parameter	Value	
Standard	ISO 15713	
Technical Procedure	CAT-TP-10	
Name of Analytical Laboratory	CAT	
Analytical Laboratory's Procedure	AP-01	
ISO 17025 Accredited Analysis?	Yes	
Date of Sample Analysis	24/11/2017	
Probe Material	Monel	
Filter Housing Material	Monel	
Impinger Material	Polyethylene	
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	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.

HYDROGEN FLUORIDE: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	11:24 - 12:24	
Sampling Dates	-	16/11/2017	
Sampling Device	-	MFC / MV	
Duration	mins	60	
Volume Sampled (STP, Dry)	m^3	0.5940	
Volume Sampled (STP, Wet)	m^3	0.6058	
Volume Sampled (REF)	m^3	0.6058	
Sample Flow Rate	l/min	9.90	
Laboratory Result for Front Impingers	µg/ml	< 0.05	
Laboratory Result for Back Impinger	µg/ml	< 0.05	
Volume in Front Impingers	ml	266.6	
Volume in Back Impinger	ml	126.6	
Mass in Front Impingers	µg	< 13.3	
Mass in Back Impinger	µg	< 6.3	
Total Mass Collected	µg	< 19.7	
Calculated Concentration	mg/m^3	< 0.03	
Liquid Trap Start Mass	g	1241.4	
Liquid Trap End Mass	g	1246.2	
Silica Trap Start Mass	g	1482.3	
Silica Trap End Mass	g	1487.0	
Total Mass Of Water Vapour	g	9.5	
Calculated Water Vapour	% v/v	1.95	

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

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	16/11/2017	
Average Volume Sampled (REF)	m^3	0.6058	
Laboratory Result for Impingers	µg/ml	< 0.05	
Volume in Impingers	ml	311.4	
Total Mass Collected	µg	< 15.6	
Calculated Concentration	mg/m^3	< 0.03	

HYDROGEN FLUORIDE: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	9.90	
Pre-Sampling Leak Rate	l/min	0.01	
Post-Sampling Leak Rate	l/min	0.01	
Allowable Leak Rate	l/min	0.20	
Leak Test Acceptable	-	Yes	

Absorption Efficiency	Units	Run 1	
Absorption Efficiency	%	100.0	
Allowable Absorption Efficiency	%	N/A [2]	
Absorption Efficiency Acceptable	-	N/A [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)	%	4.6	
Allowable MU	%	20	
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	9.50	
Pre-Sampling Leak Rate	l/min	0.01	
Post-Sampling Leak Rate	l/min	0.01	
Allowable Leak Rate	l/min	0.19	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m³	0.50	
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

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (STP)	V_m	0.59		uV_m	m^3	0.01	
Leak	L	0.10		uL	%	-	
Laboratory Result	L_r	2.65		uL_r	%	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (STP)	%	2.00		≤2%
Leak	%	0.10		≤2%
Laboratory Result	%	2.65		No Requirement

	Uncertainty in Measurement Units				Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**		**Run 1**	
Sampled Volume (STP)	V_m	m^3	0.59		0.05	
Leak	L	mg/m^3	0.000		1.00	
Laboratory Result	L_r	mg/m^3	0.001		1.00	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.0006	
Leak	mg/m^3	0.0000	
Laboratory Result	mg/m^3	0.0009	

	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	0.001	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.002	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.002	
Reported Uncertainty	mg/m^3	0.002	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	6.5	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	6.5	
Reported Uncertainty	%	6.5	

TOTAL OXIDES OF NITROGEN: RESULTS SUMMARY

Meggitt Aircraft Braking Systems, Coventry

Plating Shop Main Stack

Sample Runs

Parameter	Units	Run 1		Mean
Concentration	mg/m³	< 6.65		< 6.65
Uncertainty	±mg/m³	0.70		0.70
Mass Emission	g/hr	< 329		< 329
Uncertainty	±g/hr	37.9		37.9

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

Parameter	Units	Run 1		Mean
Water Vapour	% v/v	2.32		2.32
Uncertainty	±% v/v	0.12		0.12

NOTE: Where water droplets are present (See the Quality Assurance page), the Water Vapour concentration as found in Annex A of EN 14790 has been reported instead of the calculated value.

Blank Runs

Parameter	Units	Blank 1		Maximum
Concentration	mg/m³	< 6.65		< 6.65

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	29/11/2017	
Probe Material	Stainless Steel	
Filter Housing Material	Borosilicate Glass	
Impinger Material	Borosilicate Glass	
Absorption Solution	Potassium Permanganate Solution	
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.

TOTAL OXIDES OF NITROGEN: SAMPLING DETAILS

Sample Runs

Parameter	Units	Run 1	
Sampling Times	-	10:16 - 11:16	
Sampling Dates	-	16/11/2017	
Sampling Device	-	MFC / MV	
Duration	mins	60	
Volume Sampled (STP, Dry)	m^3	0.0267	
Volume Sampled (STP, Wet)	m^3	0.0274	
Volume Sampled (REF)	m^3	0.0274	
Sample Flow Rate	l/min	0.45	
Laboratory Result for Front Impingers	µg/ml	< 0.25	
Laboratory Result for Back Impinger	µg/ml	< 0.25	
Volume in Front Impingers	ml	485.6	
Volume in Back Impinger	ml	225.6	
Mass in Front Impingers	µg	< 121.4	
Mass in Back Impinger	µg	< 56.4	
Total Mass Collected	µg	< 177.8	
Calculated Concentration	mg/m^3	< 6.50	
Liquid Trap Start Mass	g	2928.6	
Liquid Trap End Mass	g	2928.7	
Silica Trap Start Mass	g	743.3	
Silica Trap End Mass	g	744.0	
Total Mass Of Water Vapour	g	0.8	
Calculated Water Vapour	% v/v	3.60	

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

Blank Runs

Parameter	Units	Blank 1	
Blank Dates	-	16/11/2017	
Average Volume Sampled (REF)	m^3	0.0274	
Laboratory Result for Impingers	µg/ml	< 0.25	
Volume in Impingers	ml	728.0	
Total Mass Collected	µg	< 182.0	
Calculated Concentration	mg/m^3	< 6.65	

TOTAL OXIDES OF NITROGEN: QUALITY ASSURANCE

Sample Runs

Leak Test Results	Units	Run 1	
Mean Sampling Rate	l/min	0.45	
Pre-Sampling Leak Rate	l/min	0.00	
Post-Sampling Leak Rate	l/min	0.00	
Allowable Leak Rate	l/min	0.01	
Leak Test Acceptable	-	Yes	

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

Water Droplets	Units	Run 1	
Are Water Droplets Present	-	Yes	

MU (Concurrent Water Vapour)	Units	Run 1	
Measurement Uncertainty (MU)	%	5.0	
Allowable MU	%	20	
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	0.45	
Pre-Sampling Leak Rate	l/min	0.00	
Post-Sampling Leak Rate	l/min	0.00	
Allowable Leak Rate	l/min	0.01	
Leak Test Acceptable	-	Yes	

Validity of Blank vs ELV	Units	Blank 1	
Allowable Blank	mg/m³	20.0	
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 OXIDES OF NITROGEN: MEASUREMENT UNCERTAINTY CALCULATIONS

	Value			Standard uncertainty			
Measured Quantities	**Symbol**	**Run 1**		**Symbol**	**Units**	**Run 1**	
Sampled Volume (STP)	V_m	0.03		uV_m	m^3	0.0005	
Leak	L	0.00		uL	%	-	
Laboratory Result	L_r	5.00		uL_r	%	-	

	Uncertainty as a Percentage			
Measured Quantities	**Units**	**Run 1**		**Requirement of Standard**
Sampled Volume (STP)	%	2.00		≤2%
Leak	%	0.00		≤2%
Laboratory Result	%	5.00		No Requirement

	Uncertainty in Measurement Units				Sensitivity Coefficient	
Measured Quantities	**Symbol**	**Units**	**Run 1**		**Run 1**	
Sampled Volume (STP)	V_m	m^3	0.03		249	
Leak	L	mg/m^3	0.00		1.00	
Laboratory Result	L_r	mg/m^3	0.33		1.00	

	Uncertainty in Result		
Measured Quantities	**Units**	**Run 1**	
Sampled Volume (STP)	mg/m^3	0.13	
Leak	mg/m^3	0.00	
Laboratory Result	mg/m^3	0.33	

	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	0.36	
Expanded uncertainty (95% confidence), without Oxygen Correction	mg/m^3	0.70	
Expanded uncertainty (95% confidence), with Oxygen Correction	mg/m^3	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	mg/m^3	0.70	
Reported Uncertainty	mg/m^3	0.70	
Expanded uncertainty (95% confidence), without Oxygen Correction	%	10.6	
Expanded uncertainty (95% confidence), with Oxygen Correction	%	N/A	
Expanded uncertainty (95% confidence), estimated with Method Deviations	%	10.6	
Reported Uncertainty	%	10.6	