

EMISSIONS MONITORING SURVEY

Prepared for:

TRW Automotive Braking Systems.

New Road, New Inn

Pontypool

Torfaen

NP4 0TL

Permit Number	: EPR/DP3430LX
Variation Number	: V002
Installation	: Zinc Nickel Process – A8/1 & A8/2
Visit Details	: Permit IC 10 sampling
Job Number	: P2407
Report Number	: R002
Report Issue Date	: 22nd May 2015
Survey Dates	: 29th April 2015

Prepared by:

Environmental Compliance Limited

Unit G1

Main Avenue

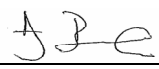
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Report Issue:		FINAL	
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Name:	Jon Litterick	Name:	Andy Barnes
		MCERTS No:	MM 03 235
		Signature:	
Date:	21/05/15	Date:	22/05/15

This report is not to be used for contractual or engineering purposes unless this approval sheet is signed where indicated by the approver and the report is designated "FINAL".



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TRW Automotive Braking Systems

Permit No : EPR/DP3430LX
Variation No : V002
Report Ref : P2407 : R002

Installation Name

Visit Details

Survey Dates

Report Issue Date

: Zinc Nickel Process
: Permit IC 10 sampling
: 29th April 2015
: 22nd May 2015

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MCERTS requirements mean that comparison of results with emissions limit values is not permitted within this report.

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PART 1 - EXECUTIVE SUMMARY

1 Monitoring Objectives

Environmental Compliance Ltd (ECL) was commissioned by **TRW Automotive Braking Systems** to undertake an emission monitoring survey at their **Pontypool Site**. This report presents the findings of the study.

The monitoring at this installation was carried out in accordance with our quotation reference **PC/P2407/Q002**, for check monitoring of emissions to air. The substances requested for monitoring at each emissions point are listed below:

Substances to be monitored	Emission Point Identification	
	Zinc-Nickel Plating Process Extraction – A8/1	Zinc-Nickel Plating Process Extraction – A8/2
Velocity / Flowrate	• U	• U
Hydrogen Chloride	• U	• U
Hydrogen Fluoride	• U	• U

• Denotes the substances to be monitored.

U

Denotes **UKAS accreditation is held for monitoring that substance, but does not mean that it has been claimed which will depend on whether the testing could be completed in accordance with the Standard Reference Method.**

Special Requirements: *"Normal Operating Conditions."*

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1.1 Monitoring Results

Emission Point Reference	Substance to be Monitored	Emission Limit Value	Periodic Monitoring Result	Units	Uncertainty %	Reference Conditions 273 K, 101.3 kPa	Date of Sampling	Start and End Times	Monitoring Method Reference	Accreditation for use of Method	Tick if non-conforming test (see Sections 2 & 5)	Operating Status
A8/1 (LHS)	Volumetric Flowrate	n/a	18.977	m ³ /sec	4	Stack Conditions	29/04/15	09:00 – 09:30	BS EN 16911-1	UKAS / MCERTS	✓	Normal
	Volumetric Flowrate	n/a	17.339	m ³ /sec	5	& Wet Gas	29/04/15	09:00 – 09:30	BS EN 16911-1	UKAS / MCERTS	✓	
	Hydrogen Chloride \$	n/a	0.77	mg/m ³	13	& Wet Gas	29/04/15	10:10 – 11:10	BS EN 1911	UKAS / MCERTS		
	Hydrogen Fluoride \$	n/a	<0.05	mg/m ³	13	& Wet Gas	29/04/15	11:35 – 12:35	BS ISO 15713 & MID	UKAS / MCERTS		
A8/2 (RHS)	Volumetric Flowrate	n/a	14.131	m ³ /sec	6	Stack Conditions	29/04/15	12:45 – 13:18	BS EN 16911-1	UKAS / MCERTS	✓	Normal
	Volumetric Flowrate	n/a	12.875	m ³ /sec	7	& Wet Gas	29/04/15	12:45 – 13:18	BS EN 16911-1	UKAS / MCERTS	✓	
	Hydrogen Chloride \$	n/a	1.22	mg/m ³	13	& Wet Gas	29/04/15	13:25 – 14:25	BS EN 1911	UKAS / MCERTS		
	Hydrogen Fluoride \$	n/a	<0.05	mg/m ³	13	& Wet Gas	29/04/15	14:42 – 15:42	BS ISO 15713 & MID	UKAS / MCERTS		

The volumetric flowrate shown above is that from the initial pitot traverse .

Any other flow measurements made during isokinetic sampling and/ or repeat traverses are shown later in the tables section.

Notes

Emission Limit Value
Periodic Monitoring Result

Uncertainty

Reference Conditions

Monitoring Method Reference

Accreditation for use of Method

Operating Status

\$

NU

NA

The emission limit value is that stated in the permit and will be expressed as a concentration or a mass emission.

The result given is expressed in the same terms and units as the emission limit value.

The uncertainty associated with the quoted result is at the 95% confidence interval. The Uncertainty results **DO NOT** take into account the effect of the sample location limitations.

All results are expressed at 273 K and 101.3kPa. The oxygen and moisture corrections are stated.

The method stated is in accordance with the Environment Agency Technical Guidance Note M2, or other method approved by the Environment Agency.

The details indicate the accreditation for the use of the complete monitoring method, e.g. MCERTs, UKAS. If use of the method is not accredited " NA" is stated.

The details indicate the feedstock and the loading rate of the plant during monitoring.

Chemical Analysis on sample reagents was performed by an External Laboratory as detailed in Section 4

UKAS Accreditation Held but UKAS Accreditation cannot be claimed for the test as sampling did not comply with the Standard Reference Method (SRM), see section 2 & 5

Method is NOT UKAS Accredited.

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1.2 Operating Information

Emission Point Reference	Process Type	Process Duration	Fuel	Feedstock	Abatement	Load	Comparison of Operator CEMS and Periodic Monitoring Results					
							Parameter	Date	Time	CEMS Results	Periodic Monitoring Results	Units
A8/1 & A8/2	Continuous	n/a	n/a	n/a	Scrubber	Normal	...	...	...	NP	...	...

Notes:

Process Type	State whether the process is a continuous or batch process.
Process Duration	If a batch process, state the duration, frequency and details of the portion of the batch sampled. If continuous state "NA"
Fuel	If applicable, state the fuel type If not applicable state "NA"
Feedstock	State the feedstock type
Abatement	State the type and whether operational during monitoring. If not applicable state "NA"
Load	State the normal load, throughput or rating of the plant
CEMS Data	Enter this data for each CEM installed if it is has been provided by operator otherwise state "NP" (NOT PROVIDED)

2 Monitoring Deviations

The objective of the survey was to measure the concentrations of pollutants from the processes / locations as detailed in Section 1. This survey meets the requirements of the site's **PPC Permit Number: EPR/DP3430LX** where UKAS and MCERTS accreditation has and could be claimed for the testing in the monitoring results table.

There were no modifications to the sampling procedures (TPDs) listed in section 4.

There were no substance deviations from the original and agreed emissions monitoring schedule.

Non-conforming tests are as follows:-

Flowrate tests are non-conforming, as there is only one sampling port available in each case, rather than three as required by the sampling standard. Extra sample points were used on the one available sample line.

Swirl in excess of the 15 degree maximum allowable was recorded at a number of sample points in both stacks. As required by BS EN 16911-1, the reported volumetric flowrates exclude points where the swirl exceeds 15 degrees.

The Uncertainty of the reported concentrations for these pollutant results DOES NOT take into account the effect of non-conformities or sample location limitations.

Homogeneity tests have not been completed for pollutants at these sampling locations, such tests are not applicable to these locations and were not requested by the client.

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PART 2 – SUPPORTING INFORMATION

3 SAMPLING STAFF DETAILS

Site Sampling Team

Names of Site Team	Dates on Site	MCERTS No.	LEVEL	Technical Endorsements
Jon Litterick	29/04/15	MM 03 236	2	TE1, TE2, TE3, TE4
Steve Heginbotham	29/04/15	MM 03 169	1	----

Report Reviewer

Name	MCERTS No.	LEVEL	Technical Endorsements
Andy Barnes	MM 03 235	2	TE1, TE2, TE3, TE4

Technical Endorsement Key:-

TE1 – Isokinetic Particulates, Temperature & Velocity Profiles, Oxygen.

TE2 – Isokinetic Extractive Pollutants:- Metals, Dioxin & Furans, PAHs, PCBs, HCl, HF.

TE3 – Non-Isokinetic Extractive Pollutants:- Speciated VOCs, HF, HCl, Cyanide.

TE4 – Continuous Analysers (Combustion Gases):- TVOC, CO, NO_x, SO₂.

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4 SAMPLING PROTOCOLS / METHODOLOGIES

Any required modifications to the Technical Procedure Documents (TPDs) specified below will be detailed in section 2 of this report.

Stand alone velocity measurements and those made to support isokinetic are conducted using BS EN 16911-1:2013 & MID

Pressure, Temperature and Velocity

Testing was carried out using a sampling system in accordance with **BS EN ISO 16911-1 & MID** and In-house technical procedure **ECL/TPD/022**.

Temperature was recorded using a thermocouple and digital temperature reader.

Velocity and pressure were recorded using an "S" type pitot and inclined manometer, data being recorded in mm H₂O.

Water Vapour

Testing was carried out using a Universal Stack Sampling system in accordance with **BS EN 14790** and In-house technical procedure **ECL/TPD/082**.

In this method the stack gases are filtered (in-stack unheated filter or out-stack heated filter) to remove particulate matter. The gases are then passed through a **heated probe** and then to a cooled moisture trapping unit. All unheated parts of the sample train (outside the sample port) which come into contact with stack gas are weighed pre and post sampling in order to determine the weight gain.

After each test, a visual inspection of the last impinger is made to confirm that at least 50% of the silica gel column has not changed colour. This indicates satisfactory collection of water vapour.

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Hydrogen Chloride

Testing was carried out non-isokinetically using a Universal Stack Sampling system in accordance with **BS EN 1911** and In-house technical procedure **ECL/TPD/036**. Non-isokinetic sampling can only take place if there are no droplets present in the stack gas.

In this method the stack gases are filtered to remove particulate matter then the gases are passed through a series of impingers. The first two or three impingers each containing 100ml of De-ionised Water and finally through an impinger containing a measured quantity of silica gel.

The impingers containing the de-ionised water are analysed for concentrations of Hydrogen Chloride by IC (Ion Chromatography).

Scientific Analysis Laboratories Ltd (SAL) who are situated in Manchester carried out the analysis of the samples. **SAL** are UKAS accredited for this analysis. In addition to the survey samples, appropriate field blanks and efficiency checks are submitted as part of the technical procedure.

Hydrogen Fluoride

Testing was carried out non-isokinetically using a Universal Stack Sampling system in accordance with **BS ISO 15713** and In-house technical procedure **ECL/TPD/083**. Non-isokinetic sampling can only take place if there are no droplets present in the stack gas.

In this method the stack gases are filtered (quartz filter) to remove particulate matter then the gases are passed through a series of impingers, the first two or three impingers each containing a measured quantity of 0.1N Sodium Hydroxide and finally through an impinger containing a measured quantity of silica gel.

The impingers containing the sodium hydroxide are analysed for concentrations of Hydrogen Fluoride by IC (Ion Chromatography).

Scientific Analysis Laboratories Ltd (SAL) who are situated in Manchester carried out the analysis of the samples. **SAL** are UKAS accredited for this analysis. In addition to the survey samples, appropriate field blanks and efficiency checks are submitted as part of the technical procedure.

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5 SAMPLE POINT DESCRIPTIONS

The homogeneity test is applicable to combustion processes. This includes but is not restricted to, those regulated under the Waste Incineration Directive (**WID**) and the Large Combustion Plant Directive (**LCPD**).

Homogeneity testing has not been completed at these locations.

The test is not usually required for stacks with sampling plane areas of <1m² (below 1.13m in diameter for circular ducts).

The sample locations that were monitored are detailed below:-

Zinc/ Nickel Line Extraction A8/1 & A8/2

These two extraction points are largely identical and in fact are two stacks split from the same extraction system.

The stack dimensions are 1.52 m by 1.05 m and the sample platform width back from the sample port is 1.0m.

One sample port is located on the longest side of each rectangular duct, these sample ports are located at a height of approximately 0.5m from the working sample platform.

Access to the sample platform was attained by means of permanent hooped ladders accessed from outside the building.

Whilst the platform is large enough to facilitate non-isokinetic sampling, it would be too small to allow multipoint isokinetic sampling across the duct.

There is significant swirl evident in the flow measurements at both locations. This does not affect the non-isokinetic sampling but does impact on the accuracy of flowrate measurements.

The Uncertainty of the reported concentrations for these pollutant results DOES NOT take into account the effect of non-conformities or sample location limitations.

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EQUIPMENT IDs
(Pre site checklist from SSP)

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PRE SITE EQUIPMENT CHECKLIST/ EQUIPMENT USED

(Completed before departure to site and when on site in full)

Equipment	Equip. Type	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:	ID No:
MST console/pump	E001	U002							
MST Nozzle set									
MST "S" Type Pitot		602							
MST Probe		135	805						
MST Hot Box		400							
MST Impinger Arm		323							
Barometer		204							
Site Balance		88							
Site Check weights		276							
		277							
Horiba	E002								
Heated Probe / Filter									
Chiller									
Sonimix / MFC									
Heated Line									
FID	E003								
Heated Line									
Heated Probe / Filter									
Testo	E004								
FTIR	E005								
Heated Probe / Filter									
Heated Line									
Stackmite	E006								
"L" Type Pitot									
Digital Manometer									
Stack Thermocouple									
Thermocouple Reader									
Nozzle Set									
Workhorse Pumps	E007								
Low Flow Pumps									

Quantity of Ice Required / Used for Survey	4	Bags (2kg bags)
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TRW Automotive Braking Systems		Installation Name	: Zinc Nickel Process
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TABLES

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Table 1 – HCl

Data Recorded from LHS - A8/1 - Zinc / Nickel Extraction

Emission Parameter	Units	HCl	Blank
Duct Length	metres	1.05	
Duct Width	metres	1.52	...
Area of Sample Plane	m ²	1.596	
Moisture Content	%	0.77	
Oxygen Content	%	20.90	
Stack Temperature	°C	23	
Gas Velocity (as Measured)	m/sec	11.89	
Gas Velocity (Reference Conditions)	m/sec*	10.86	
Volumetric Flowrate (as Measured)	m ³ /sec	18.98	
Volumetric Flowrate (Reference Conditions)	m ³ /sec*	17.34	
Dry Gas Molecular Weight	g/gmole	28.8400016	
Sample Date	...	29/04/2015	
Sample Period	...	10:10 - 11:10	
Sample Volume (reference Conditions)	m ³ *	0.919	0.919
Sample Reference	ECL/15/	1897 & 98	1899
Mass of Hydrogen Chloride Collected	mg	0.71	0.02
Concentration of Hydrogen Chloride	mg/m ³ *	0.77	0.02
Emission Rate of Hydrogen Chloride	g/hr	48.23	...
Expanded Uncertainty (% Relative)	%	13	...
Impinger Collection Efficiency	%	99	...

*Reference Conditions (273K, 101.3kPa, Wet Gas)

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Table 2 – HF

Data Recorded from LHS - A8/1 - Zinc / Nickel Extraction

Emission Parameter	Units	HF	Blank
Duct Length	metres	1.05	
Duct Width	metres	1.52	...
Area of Sample Plane	m ²	1.596	
Moisture Content	%	1.56	
Oxygen Content	%	20.90	
Stack Temperature	°C	24	
Gas Velocity (as Measured)	m/sec	11.89	
Gas Velocity (Reference Conditions)	m/sec*	10.86	
Volumetric Flowrate (as Measured)	m ³ /sec	18.98	
Volumetric Flowrate (Reference Conditions)	m ³ /sec*	17.34	
Dry Gas Molecular Weight	g/gmole	28.8400016	
Sample Date	...	29/04/2015	
Sample Period	...	11:35 - 12:35	
Sample Volume (reference Conditions)	m ³ *	0.574	0.574
Sample Reference	ECL/15/	1900 & 1901	1902
Mass of Hydrogen Fluoride Collected	mg	0.03	0.02
Concentration of Hydrogen Fluoride	mg/m ³ *	0.05	0.03
Emission Rate of Hydrogen Fluoride	g/hr	2.83	...
Expanded Uncertainty (% Relative)	%	13	...
Impinger Collection Efficiency	%	69	...

*Reference Conditions (273K, 101.3kPa, Wet Gas)

HF impinger efficiency is calculated as below 95%, however ALL HF impinger concentration are below the analytical limit of detection (LOD) and so the efficiency test is not required/ appropriate.

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Table 3 – HCl

Data Recorded from RHS - A8/2 - Zinc / Nickel Extraction

Emission Parameter	Units	HCl	Blank
Duct Length	metres	1.05	
Duct Width	metres	1.52	...
Area of Sample Plane	m ²	1.596	
Moisture Content	%	0.73	
Oxygen Content	%	20.90	
Stack Temperature	°C	24	
Gas Velocity (as Measured)	m/sec	8.85	
Gas Velocity (Reference Conditions)	m/sec*	8.06	
Volumetric Flowrate (as Measured)	m ³ /sec	14.12	
Volumetric Flowrate (Reference Conditions)	m ³ /sec*	12.87	
Dry Gas Molecular Weight	g/gmole	28.8400016	
Sample Date	...	29/04/2015	
Sample Period	...	13:25 - 14:25	
Sample Volume (reference Conditions)	m ³ *	0.922	0.922
Sample Reference	ECL/15/	1903 & 1904	1905
Mass of Hydrogen Chloride Collected	mg	1.12	0.02
Concentration of Hydrogen Chloride	mg/m ³ *	1.22	0.02
Emission Rate of Hydrogen Chloride	g/hr	56.47	...
Expanded Uncertainty (% Relative)	%	13	...
Impinger Collection Efficiency	%	99	...

*Reference Conditions (273K, 101.3kPa, Wet Gas)

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Table 4 – HF

Data Recorded from RHS - A8/2 - Zinc / Nickel Extraction

Emission Parameter	Units	HF	Blank
Duct Length	metres	1.05	
Duct Width	metres	1.52	...
Area of Sample Plane	m ²	1.596	
Moisture Content	%	0.71	
Oxygen Content	%	20.90	
Stack Temperature	°C	24	
Gas Velocity (as Measured)	m/sec	8.85	
Gas Velocity (Reference Conditions)	m/sec*	8.06	
Volumetric Flowrate (as Measured)	m ³ /sec	14.12	
Volumetric Flowrate (Reference Conditions)	m ³ /sec*	12.87	
Dry Gas Molecular Weight	g/gmole	28.8400016	
Sample Date	...	29/04/2015	
Sample Period	...	14:42 - 15:42	
Sample Volume (reference Conditions)	m ³ *	0.594	0.594
Sample Reference	ECL/15/	1906 & 1907	1908
Mass of Hydrogen Fluoride Collected	mg	0.03	0.02
Concentration of Hydrogen Fluoride	mg/m ³ *	0.05	0.03
Emission Rate of Hydrogen Fluoride	g/hr	2.34	...
Expanded Uncertainty (% Relative)	%	13	...
Impinger Collection Efficiency	%	75	...

*Reference Conditions (273K, 101.3kPa, Wet Gas)

HF impinger efficiency is calculated as below 95%, however ALL HF impinger concentration are below the analytical limit of detection (LOD) and so the efficiency test is not required/ appropriate.

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VELOCITY TRAVERSE PROFILES

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Environmental Compliance Limited	Traverse Data Profoma	Date of Measurement	29/04/2015
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Company	TRW	Stack Diameter Port A (mm)		Average Stack Diameter (mm)		Pitot tube coefficient	0.83
Site	Pontypool	Stack Diameter Port B (mm)		Port Length (mm)		Pitot Id	602
Location	Zinck / Nickel Extraction	Duct Length Port A (mm)	1050	Average Duct Length (mm) L	1050	Stack Thermocouple ID	857
Stack	LHS - A8/1	Duct Length Port B (mm)		Duct width (mm) B	1520	Stack Temp Reader ID	116
Job No	P2407	Duct Length Port C (mm)		Barometric Pressure. (mb)	1002	Manometer ID	115
Operators	JL/ SHeg	Duct Length Port D (mm)		Ave Static Press. (mm H ₂ O)	4.00	Barometer ID	204

Pre - Traverse Checks Carried Out	Time	Pass/ Fail
Pre - Traverse Visual Inspection	09:00:00	Pass
Pre - Traverse Pitot Leak Check	09:01:00	Pass

Smooth Walls

Static Pressure Readings (mm H₂O)

Port A	Port B	Port C	Port D
4.00			

Port/ Point	Distance to Point (mm)	Time	Temperature Readings (°C)			(ΔP) Pitot Readings (mm H ₂ O)			Average Temp. (°C)	Average (ΔP) (mm H ₂ O)	Swirl Test ° From Reference
			1	2	3	1	2	3			
A1	58	09:05:00	20.0	20.0	20.0	10.0	10.0	10.2	20.0	10.1	5
A2	175	09:10:00	23.0	23.0	23.0	15.2	15.2	15.0	23.0	15.1	10
A3	292	09:13:00	23.0	23.0	23.0	16.4	16.6	16.4	23.0	Excluded, Swirl	20
A4	408	09:16:00	23.0	23.0	23.0	14.2	14.0	14.0	23.0	Excluded, Swirl	20
A5	525	09:18:00	23.0	23.0	23.0	12.4	12.2	12.0	23.0	Excluded, Swirl	20
A6	642	09:20:00	23.0	23.0	23.0	10.8	10.4	10.6	23.0	Excluded, Swirl	25
A7	758	09:22:00	23.0	23.0	23.0	8.6	8.4	8.4	23.0	Excluded, Swirl	25
A8	875	09:24:00	23.0	23.0	23.0	6.6	6.2	6.4	23.0	Excluded, Swirl	30
A9	992	09:26:00	23.0	23.0	23.0	5.6	5.6	5.2	23.0	Excluded, Swirl	30
Blockage Check @ A1 (L-Type Pitot Only)			Mean			Mean			204.0	25.2	Total
			Difference <5% from Initial ?			Difference <5% from Initial ?			23.0	15.1	Max
									20.0	10.1	Min
									22.7	12.6	Average

Post - Traverse Checks Carried Out	Time	Pass/ Fail
Post - Traverse Visual Inspection	09:30:00	Pass

Stagnation Check (S-type Pitot Only)	Time	Reading
Static Pressure Via Positive Leg (mm H ₂ O)	09:26:00	4.00
Static Pressure Via Negative Leg (mm H ₂ O)	09:28:00	4.00
Difference (Pa) < 1 mm H ₂ O ?		0.00

Average temp (K)	295.667
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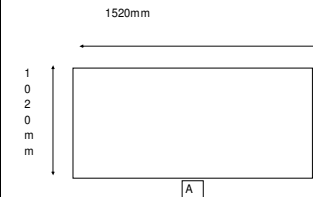
Suitability of Sampling Position	Actual Stack Conditions
Highest/lowest flow pressure ratio < 9:1?	2.93:1
Maximum deviation of flow from axis < 15°?	30
X-sectional area for stacks = πr ²	m ²
X-sectional area for ducts = L x B	1.596 m ²
Suitability of Position for Sampling	NOT FOR ISOKINETIC

Stack Moisture	0.1	%	Gas Velocity (as Measured) Adjusted for Smooth Walls	11.89051	m/sec
Measured Oxygen	20.9	%	Gas Velocity (Reference Conditions) Adjusted for Smooth Walls	10.86398	m/sec*
Measured Carbon Dioxide	0	%	Volumetric Flowrate (as Measured) Adjusted for Smooth Walls	18.97725	m ³ /sec
Dry Gas Molecular Weight	28.83600	g/g mole	Volumetric Flowrate (Ref Cond) Adjusted for Smooth Walls	17.33890	m ³ /sec*

*Reference Conditions: 273K, 101.3kPa, Wet Gas

NOTE: Velocity / volume flowrate calculations exclude contributions from the measurement point(s) where swirl >15°

Diagram/ Description of Cross Section of Stack/Duct



Notes
Including expected or actual deviations from procedures / non-conformities

Significant swirl in duct, flow will be an estimate only

Compliance With Positional Requirements?

Height of sample ports from Platform	0.5m
Number of sample ports	1
Width of platform (port back to handrail)	1.0m

Nearest downstream disturbance	Exit	1.5m
Nearest upstream disturbance	Fan	2.5m

Disturbances are classed as bends, fans or diameter variations

Installation Name : Zinc Nickel Process
Visit Details : Permit IC 10 sampling
Survey Dates : 29th April 2015
Report Issue Date : 22nd May 2015

Port A	Port B	Port C	Port D
2.00			

[illegible]

Post - Traverse Checks Carried Out	Time	Pass/ Fail
Post - Traverse Visual Inspection	13:18:00	Pass

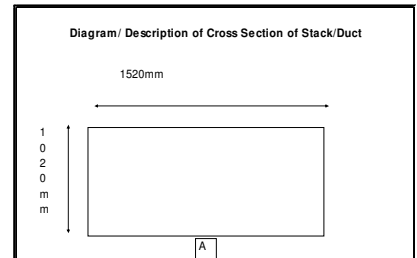
Stagnation Check (S-type Pitot Only)	Time	Reading
Static Pressure Via Positive Leg (mm H ₂ O)	13:16:00	2.00
Static Pressure Via Negative Leg (mm H ₂ O)	13:15:00	2.00
Difference (Pa) < 1 mm H ₂ O ?		0.00

Average temp (K)	296.444
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Suitability of Sampling Position	Actual Stack Conditions
Highest:lowest flow pressure ratio < 9:1?	1.53:1
Maximum deviation of flow from axis <15°?	30
X-sectional area for stacks= πr^2	m ²
X-sectional area for ducts = L x B	1.596 m ²
Suitability of Position for Sampling	NOT FOR ISOKINETIC

Stack Moisture	0.1	%	Gas Velocity (as Measured) Adjusted for Smooth Walls	8.85399	m/sec
Measured Oxygen	20.9	%	Gas Velocity (Reference Conditions) Adjusted for Smooth Walls	8.06680	m/sec*
Measured Carbon Dioxide	0	%	Volumetric Flowrate (as Measured) Adjusted for Smooth Walls	14.13097	m ³ /sec
Dry Gas Molecular Weight	28.83600	q/q mole	Volumetric Flowrate (Ref Cond) Adjusted for Smooth Walls	12.87462	m ³ /sec*

NOTE: Velocity / volume flowrate calculations exclude contributions from the measurement point(s) where swirl >15°



Notes
Including expected or actual deviations from procedures / non-conformities

Significant swirl in duct, flow will be an estimate only

Compliance With Positional Requirements?

Height of sample ports from Platform	0.5m
Number of sample ports	1
Width of platform (port back to handrail)	1.0m

Nearest downstream disturbance	Exit	1.5m
Nearest upstream disturbance	Fan	2.5m
Disturbances are classed as bends, fans or diameter variations		

Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process

Visit Details : Permit IC 10 sampling

Survey Dates : 29th April 2015

Report Issue Date : 22nd May 2015

FIELD SAMPLING DATA

Environmental Compliance Limited

TRW Automotive Braking Systems
Permit No : **EPR/DP3430LX**
Variation No : **V002**
Report Ref : **P2407** : **R002**

Installation Name : Zinc Nickel Process
Visit Details : Permit IC 10 sampling
Survey Dates : 29th April 2015
Report Issue Date : 22nd May 2015

Environmental Compliance Limited			NON ISOKINETIC SAMPLING PROFORMA				Date of Measurement		29/04/2015		If moisture was not measured see detailed notes below.	
ECL/TPD			36				Time taken to change Ports		Start Time		End Time	
									10:10		11:10	
									60		Additional Moisture Weighings	
Client	TRW	Stack Profile	Rectangular	Console Id	U002	Barometer id	204	Impinger 1	DI H2O	Item Name		
Site	Pontypool	Stack Area (m²)	1.60	Pump Id	U002	Nozzle id	n/a	SOL	2720	Start Weight (g)		
Location	Zinc / Nickel Extraction	Barometric Pressure (mb)	1002	Probe Id	135	Nozzle size	n/a	Start Weight (g)	664.6	End Weight (g)		
Stack ID	LHS - A81	Static Pres. (mm Hg)	1	DOM Yr	1,037	Filter id	04A	End Weight (g)	662.3	Total weight (g)	0	
Test No.	HC	Pilot coefficient	n/a	APR	41.83	Pilot ID	n/a	Total weight (g)	-2.3	Item Name		
Job No	P2407	Probe Heater Setting (°C)	150	Impinger Id	323	Hot Box ID	400	Impinger 2	DI H2O	Start Weight (g)		
ECL Site Staff	JL / SHEG	Hot Box Setting (°C)	160	Balance Id	88			SOL	2720	End Weight (g)		
								Start Weight (g)	660.9	Total weight (g)	0	
								End Weight (g)	663.1	Item Name		
								Total weight (g)	2.2	Start Weight (g)		
Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5	Total		Impinger3	DIH2O	Start Weight (g)		
Start Volume	2545.4							SOL	2720	End Weight (g)		
Final Volume	3491.2							Start Weight (g)	657.7	Total weight (g)	0	
Total Volume	945.8	0.0	0.0	0.0	0.0	0.0	945.8	End Weight (g)	663.1	Item Name		
Leak Check	First	Second	Third	Fourth	Fifth			Total weight (g)	2.2	Start Weight (g)		
Leak rate l/min	0	0						Impinger3	DIH2O	Start Weight (g)		
Vacuum "Hg	8	8						SOL	2720	End Weight (g)		
Time of Check	10:04	11:11						Start Weight (g)	650.7	Total weight (g)	0	
Set Rate l/min	15	16						End Weight (g)	651.7	Item Name		
Leak -25.1	YES							Total weight (g)	1	Start Weight (g)		
Traverse Point	CP	CP	CP	CP	CP	CP	CP	Impinger 4	Empty	End Weight (g)		
Time/Point (mins)	0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60		SOL		Total weight (g)	0	
AP (mm H2O)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Start Weight (g)	492.6	Item Name		
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	End Weight (g)	493.5	Start Weight (g)		
AH (Orifice)	25.00	25.00	25.00	25.00	25.00	25.00	n/a	Total weight (g)	0.9	End Weight (g)		
Meter (Tm in)	17.00	20.00	21.00	21.00	20.00	21.00	n/a	Impinger 5	Silica	Total weight (g)	0	
Meter (Tm out)	15.00	15.00	16.00	17.00	17.00	17.00	n/a	SOL		Item Name		
Stack Temp (Ts)	23.00	23.00	23.00	23.00	23.00	23.00	n/a	Start Weight (g)	809	Start Weight (g)		
Impinger T Outlet	12.00	11.00	12.00	14.00	13.00	14.00	n/a	End Weight (g)	812.9	End Weight (g)		
Vacuum (" Hg)	1.00	1.00	1.00	1.00	1.00	1.00	n/a	Total weight (g)	3.9	Total weight (g)	0	
Traverse Point								Impinger 6		Item Name		
Time/Point(mins)								SOL		Start Weight (g)		
AP (mm H2O)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Start Weight (g)		End Weight (g)		
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	End Weight (g)		Total weight (g)	0	
AH (Orifice)								Total weight (g)	0	Item Name		
Meter (Tm in)								Impinger 7		Start Weight (g)		
Meter (Tm out)								SOL		End Weight (g)		
Stack Temp (Ts)								Start Weight (g)		Total weight (g)	0	
Impinger T Outlet								End Weight (g)		Item Name		
Vacuum (" Hg)								Total weight (g)	0	Start Weight (g)		
Traverse Point								Impinger 8		End Weight (g)		
Time/Point(mins)								SOL		Total weight (g)	0	
AP (mm H2O)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Start Weight (g)		Item Name		
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	End Weight (g)	0	Start Weight (g)		
AH (Orifice)								Total weight (g)	0	End Weight (g)		
Meter (Tm in)								Impinger 8		Total weight (g)	0	
Meter (Tm out)								SOL		Item Name		
Stack Temp (Ts)								Start Weight (g)		Start Weight (g)		
Impinger T Outlet								End Weight (g)		End Weight (g)		
Vacuum (" Hg)								Total weight (g)	5.70	Total weight (g)	0	
Traverse Point								Silica -50% used	YES	If moisture was not measured and gas was dried before entering the gas meter, Impinger weights must be included to produce the moisture concentration used in the isokinetic calculations. If the gas was not dried before it entered the gas meter then Impinger weights may be included to produce a nominal 0.1% moisture value.		
Time/Point(mins)								At end of Test? Y/N				
AP (mm H2O)	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Rinse Solutions used				
K factor	n/a	n/a	n/a	n/a	n/a	n/a	n/a	Solution	SOL NO			
AH (Orifice)								DI Water	2720			
Meter (Tm in)								Acetone				
Meter (Tm out)												
Stack Temp (Ts)												
Impinger T Outlet												
Vacuum (" Hg)												

Environmental Compliance Limited

TRW Automotive Braking Systems
 Permit No : EPR/DP3430LX
 Variation No : V002
 Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process
 Visit Details : Permit IC 10 sampling
 Survey Dates : 29th April 2015
 Report Issue Date : 22nd May 2015

Environmental Compliance Limited		NON ISOKINETIC SAMPLING PROFORMA		Date of Measurement		29/04/2015	
ECL/TPD/ 83		Time taken to change Ports		Start Time		11:35	
				End Time		12:35	
				Test Duration		60 mins	
Client	TRW	Stack Profile	Rectangular	Console Id	U002	Barometer Id	204
Site	Pontypool	Stack Area (m²)	1.60	Pump Id	U002	Nozzle Id	n/a
Location	Zinc / Nickel Extraction	Barometric Pressure (mb)	1002	Probe Id	805	Nozzle size	n/a
Stack ID	LHS - A6/1	Static Pres. (mm H ₂ O)	4	DGM Yd	1.037	Filter Id	QMA
Test No.	HF	Pilot coefficient	n/a	ΔHP	41.83	Pilot Id	n/a
Job No	P2407	Probe Heater Settings (°C)	150	Impinger Id	323	Hot Box Id	400
ECL Site Staff	JL / SHEG	Hot Box Settings (°C)	150	Balance Id	88		
Start Volume		Sample	Leak 1	Leak 2	Leak 3	Leak 4	Leak 5
Final Volume		4133.1					
Total Volume		589.2	0.0	0.0	0.0	0.0	589.2
Leak Check		First	Second	Third	Fourth	Fifth	
Leak rate l/min		0					
Vacuum "Hg		5					
Time of Check		11:23	12:37				
Set Rate l/min		15					
Leak <2%?		YES	YES				
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
Stack Temp (Ts)		23.00	24.00	24.00	24.00	24.00	23.83
Impinger T Outlet		13.00	14.00	14.00	15.00	16.00	14.67
Vacuum (" Hg)		3.00	3.00	3.00	3.00	3.00	3.00
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
Stack Temp (Ts)		23.00	24.00	24.00	24.00	24.00	23.83
Impinger T Outlet		13.00	14.00	14.00	15.00	16.00	14.67
Vacuum (" Hg)		3.00	3.00	3.00	3.00	3.00	3.00
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
Stack Temp (Ts)		23.00	24.00	24.00	24.00	24.00	23.83
Impinger T Outlet		13.00	14.00	14.00	15.00	16.00	14.67
Vacuum (" Hg)		3.00	3.00	3.00	3.00	3.00	3.00
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
Stack Temp (Ts)		23.00	24.00	24.00	24.00	24.00	23.83
Impinger T Outlet		13.00	14.00	14.00	15.00	16.00	14.67
Vacuum (" Hg)		3.00	3.00	3.00	3.00	3.00	3.00
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
Stack Temp (Ts)		23.00	24.00	24.00	24.00	24.00	23.83
Impinger T Outlet		13.00	14.00	14.00	15.00	16.00	14.67
Vacuum (" Hg)		3.00	3.00	3.00	3.00	3.00	3.00
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
Stack Temp (Ts)		23.00	24.00	24.00	24.00	24.00	23.83
Impinger T Outlet		13.00	14.00	14.00	15.00	16.00	14.67
Vacuum (" Hg)		3.00	3.00	3.00	3.00	3.00	3.00
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
Stack Temp (Ts)		23.00	24.00	24.00	24.00	24.00	23.83
Impinger T Outlet		13.00	14.00	14.00	15.00	16.00	14.67
Vacuum (" Hg)		3.00	3.00	3.00	3.00	3.00	3.00
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
Stack Temp (Ts)		23.00	24.00	24.00	24.00	24.00	23.83
Impinger T Outlet		13.00	14.00	14.00	15.00	16.00	14.67
Vacuum (" Hg)		3.00	3.00	3.00	3.00	3.00	3.00
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
Stack Temp (Ts)		23.00	24.00	24.00	24.00	24.00	23.83
Impinger T Outlet		13.00	14.00	14.00	15.00	16.00	14.67
Vacuum (" Hg)		3.00	3.00	3.00	3.00	3.00	3.00
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
Stack Temp (Ts)		23.00	24.00	24.00	24.00	24.00	23.83
Impinger T Outlet		13.00	14.00	14.00	15.00	16.00	14.67
Vacuum (" Hg)		3.00	3.00	3.00	3.00	3.00	3.00
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
Stack Temp (Ts)		23.00	24.00	24.00	24.00	24.00	23.83
Impinger T Outlet		13.00	14.00	14.00	15.00	16.00	14.67
Vacuum (" Hg)		3.00	3.00	3.00	3.00	3.00	3.00
Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
Meter (Tm out)		19.00	19.00	19.00	19.00	19.00	18.67
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Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00
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Traverse Point		CP	CP	CP	CP	CP	CP
Time Point (mins)		0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60
ΔP (mm H ₂ O)		n/a	n/a	n/a	n/a	n/a	n/a
K factor		n/a	n/a	n/a	n/a	n/a	n/a
ΔH (Orifice)		10.00	10.00	10.00	10.00	10.00	10.00
Meter (Tm in)		19.00	19.00	20.00	20.00	21.00	21.00

Environmental Compliance Limited

TRW Automotive Braking Systems
Permit No : EPR/DP3430LX
Variation No : V002
Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process
Visit Details : Permit IC 10 sampling
Survey Dates : 29th April 2015
Report Issue Date : 22nd May 2015

Environmental Compliance Limited		NON ISOKINETIC SAMPLING PROFORMA		Date of Measurement		29/04/2015																																																																																																																																													
ECL/TPD/ 36		Time taken to change Ports		Start Time		13:25																																																																																																																																													
				End Time		14:25																																																																																																																																													
				Test Duration		60 mins																																																																																																																																													
Client	TRW	Stack Profile	Rectangular	Console Id	U002	Barometer Id	204																																																																																																																																												
Site	Pontypool	Stack Area (m²)	1.60	Pump Id	U002	Nozzle Id	n/a																																																																																																																																												
Location	Zinc / Nickel Extraction	Barometric Pressure (mb)	1002	Probe Id	135	Nozzle size	n/a																																																																																																																																												
Stack ID	RHS - A8/2	Static Pres. (mm H ₂ O)	2	DGM Yd	1.037	Filter Id	QMA																																																																																																																																												
Test No.	HCI	Pilot coefficient	n/a	ΔHP	41.83	Pilot Id	n/a																																																																																																																																												
Job No	P2407	Probe Heater Settings (°C)	150	Impinger Id	323	Hot Box Id	400																																																																																																																																												
ECL Site Staff	JL / SHEG	Hot Box Settings (°C)	150	Balance Id	88																																																																																																																																														
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Environmental Compliance Limited

TRW Automotive Braking Systems
Permit No : EPR/DP3430LX
Variation No : V002
Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process
Visit Details : Permit IC 10 sampling
Survey Dates : 29th April 2015
Report Issue Date : 22nd May 2015

Environmental Compliance Limited		NON ISOKINETIC SAMPLING PROFORMA		Date of Measurement		29/04/2015																																																																																																																																													
ECL/TPD/ 83		Time taken to change Ports		Start Time		14:42																																																																																																																																													
				End Time		15:42																																																																																																																																													
				Test Duration		60 mins																																																																																																																																													
Client	TRW	Stack Profile	Rectangular	Console Id	U002	Barometer Id	204																																																																																																																																												
Site	Pontypool	Stack Area (m²)	1.60	Pump Id	U002	Nozzle Id	n/a																																																																																																																																												
Location	Zinc / Nickel Extraction	Barometric Pressure (mb)	1002	Probe Id	805	Nozzle size	n/a																																																																																																																																												
Stack ID	RHS - A8-2	Static Pres. (mm H ₂ O)	2	DGM Yd	1.037	Filter Id	QMA																																																																																																																																												
Test No.	HF	Pilot coefficient	n/a	ΔHP	41.83	Pilot Id	n/a																																																																																																																																												
Job No	P2407	Probe Heater Settings (°C)	150	Impinger Id	323	Hot Box Id	400																																																																																																																																												
ECL Site Staff	JL / SHEG	Hot Box Settings (°C)	150	Balance Id	88																																																																																																																																														
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Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process

Visit Details : Permit IC 10 sampling

Survey Dates : 29th April 2015

Report Issue Date : 22nd May 2015

LABORATORY ANALYSIS RESULTS

Environmental Compliance Limited

TRW Automotive Braking Systems
Permit No : EPR/DP3430LX
Variation No : V002
Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process
Visit Details : Permit IC 10 sampling
Survey Dates : 29th April 2015
Report Issue Date : 22nd May 2015



Scientific Analysis Laboratories is a
limited company registered in England and
Wales (No 2514788) whose address is at
Hadfield House, Hadfield Street, Manchester M16 9FE

Scientific Analysis Laboratories Ltd Certificate of Analysis

Hadfield House
Hadfield Street
Combrook
Manchester
M16 9FE
Tel : 0161 874 2400
Fax : 0161 874 2404

Report Number: 475260-1

Date of Report: 14-May-2015

Customer: Environmental Compliance Ltd
Unit G1
Main Avenue
Treforest Industrial Estate
Pontypridd
CF37 5BF

Customer Contact: Mr John Litterick

Customer Job Reference: P2407

Customer Purchase Order: E3962

Date Job Received at SAL: 05-May-2015

Date Analysis Started: 07-May-2015

Date Analysis Completed: 14-May-2015

The results reported relate to samples received in the laboratory
Opinions and interpretations expressed herein are outside the scope of UKAS accreditation
This report should not be reproduced except in full without the written approval of the laboratory
Tests covered by this certificate were conducted in accordance with SAL SOPs
All results have been reviewed in accordance with Section 25 of the SAL Quality Manual



Report checked
and authorised by :
Kayleigh McCann
Project Manager

Issued by :
Kayleigh McCann
Project Manager

Validity unknown
Digitally signed by Kayleigh
McCann
Date: 2015.05.14 17:30:26 BST
Reason: Issued
Location: SAL

Page 1 of 3

475260-1

Environmental Compliance Limited

TRW Automotive Braking Systems
 Permit No : EPR/DP3430LX
 Variation No : V002
 Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process
 Visit Details : Permit IC 10 sampling
 Survey Dates : 29th April 2015
 Report Issue Date : 22nd May 2015

SAL Reference: 475260									
Customer Reference: P2407									
Filter GFA 37mm		Analysed as Filter GFA 37mm							
Miscellaneous									
SAL Reference					475260 001	475260 003	475260 005	475260 007	475260 009
Customer Sample Reference					ECL/15/1885	ECL/15/1887	ECL/15/1889	ECL/15/1891	ECL/15/1893
Test Sample					AR	AR	AR	AR	AR
Determinand	Method	LOD	Units	Symbol					
Particulates (Total)	Grav (5 Dec)	0.05	mg	U	<0.05	<0.05	<0.05	<0.05	<0.05
Weight Gain	Grav		mg	U	-0.02	0.00	-0.13	0.04	-0.01

SAL Reference: 475260									
Customer Reference: P2407									
Wash(Acetone)		Analysed as Wash(Acetone)							
Miscellaneous									
		SAL Reference		475260 002	475260 004	475260 006	475260 008	475260 010	
		Customer Sample Reference		ECL/15/1886	ECL/15/1888	ECL/15/1890	ECL/15/1892	ECL/15/1894	
		Test Sample		AR	AR	AR	AR	AR	
Determinand	Method	LOD	Units	Symbol					
Particulates (Total)	Grav	0.3	mg	U	<0.3	<0.3	<0.3	<0.3	<0.3

SAL Reference: 475260									
Customer Reference: P2407									
Impinger(DI water)		Analysed as Impinger(DI water)							
Miscellaneous									
		SAL Reference		475260 013	475260 014	475260 015	475260 019	475260 020	
		Customer Sample Reference		ECL/15/1897	ECL/15/1898	ECL/15/1899	ECL/15/1903	ECL/15/1904	
		Test Sample		AR	AR	AR	AR	AR	
Determinand	Method	LOD	Units	Symbol					
Hydrogen Chloride	IC	0.05	mg/l	U	(13) 2.0	(13) <0.05	(13) <0.05	(13) 3.0	(13) 0.08
Volume	Vol	1	ml	U	350	200	400	370	180

SAL Reference: 475260 Customer Reference: P2407									
Impinger(DI water) Analysed as Impinger(DI water) Miscellaneous									
SAL Reference		475260 021							
Customer Sample Reference		ECL/15/1905							
Test Sample		AR							
Determinand	Method	LOD	Units	Symbol					
Hydrogen Chloride	IC	0.05	mg/l	U	(13) <0.05				
Volume	Vol	1	ml	U	390				

SAL Reference: 475260									
Customer Reference: P2407									
Impinger (sodium hydroxide)		Analysed as Impinger (sodium hydroxide)							
Miscellaneous									
SAL Reference					475260 016	475260 017	475260 018	475260 022	475260 023
Customer Sample Reference					ECL/15/1900	ECL/15/1901	ECL/15/1902	ECL/15/1906	ECL/15/1907
Test Sample					AR	AR	AR	AR	AR
Determinand	Method	LOD	Units	Symbol					
Hydrogen Fluoride	IC (acetate separation method)	0.05	mg/l	U	(13) <0.05	<0.05	<0.05	<0.05	<0.05
Volume	Vol	1	ml	U	360	160	300	450	150

Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name

Visit Details

Survey Dates

Report Issue Date

: Zinc Nickel Process

: Permit IC 10 sampling

: 29th April 2015

: 22nd May 2015

SAL Reference: 475260					
Customer Reference: P2407					
Impinger (sodium hydroxide) Analysed as Impinger (sodium hydroxide)					
Miscellaneous					
SAL Reference				475260 024	
Customer Sample Reference				ECL/15/1908	
Test Sample				AR	
Determinand	Method	LOD	Units	Symbol	
Hydrogen Fluoride	IC (acetate separation method)	0.05	mg/l	U	<0.05
Volume	Vol	1	ml	U	380

Index to symbols used in 475260-1

Value	Description
AR	As Received
13	Results have been blank corrected.
U	Analysis is UKAS accredited



Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process

Visit Details : Permit IC 10 sampling

Survey Dates : 29th April 2015

Report Issue Date : 22nd May 2015

UNCERTAINTY CALCULATIONS

Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process

Visit Details : Permit IC 10 sampling

Survey Dates : 29th April 2015

Report Issue Date : 22nd May 2015

Site: Pontypool
Location: LHS - A8/1

$$u_{\text{mass}} = \sqrt{\sum (u_{\text{filter}})^2 + (u_{\text{solution}})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Filter mg	Uncert (%) Solution mg	Standard Filter mg	Uncertainty Solution mg	Combined Uncertainty mg
HCl								
...	...	...	...	...	...	...	...	...
Hydrogen Chloride	...	0.71	0.71	...	0.0923	...	0.0462	0.0462
...	...	...	...	...	...	...	...	...
...								
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

	HCl		Standard Uncertainty @ 95%
Sampled Volume (V _m)	0.95	m ³	uV _m 0.001 m ³
Meter Correction Factor (Y _d)	1.04	...	...
Meter Temperature (T _m)	291.08	k	uT _m 1.5 k
Average Differential Pressure (ΔH)	25.00	mmH ₂ O	uΔH 0.25 mmH ₂ O
Barometric Pressure (p _b)	751.56	mmHg	up _b 3.8 mmHg
ΔH + ps (p _m)	100.44	kPa	...
Oxygen content (O _{2,m})	21.00	% by volume	uO _{2,m} = σ/√n 0.00 % by volume
Moisture Content (H ₂ O)	0.77	% by volume	uH ₂ O 0.17 % by volume

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C is the sensitivity coefficient, u is the standard uncertainty and i is the index identifying the contributing factor e.g. $i = uV_m, uT_m$ etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

HCl:

$$f_{s, \text{wet}} = \frac{100}{(100 - H_2O)} = 1.01$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up_b) & measured temperature of dry gas uncertainty component (uT_{m dry})

HCl:

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = 0.972$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.97	0.97	0.0000948	0.0000237
up _b	0.98	0.97	0.00129	0.00484
uT _m	0.98	0.97	0.00334	0.00501
H ₂ O	0.97	0.97	0.00979	0.00164

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_b)^2}}{(P_b/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{(100/(100-H_2O))}\right)^2} = 0.00677$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

HCl:

$$V_{std} = V_{measured} \times f_s = 0.919$$

	Maximum m ³	Minimum m ³	Sensitivity	Standard Uncertainty (m ³)
Effect of uV _{std}	0.93	0.91	0.95	0.00640
Effect of uV _m	0.92	0.92	0.97	0.000972

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = 0.00613$$

Uncertainty of Oxygen Correction Factor (%):-

HCl:

$$f_{O_2} = \frac{20.9\% - O_{2, \text{ref}}}{20.9\% - O_{2, \text{measured}}} = 1.00$$

$$u_{\text{Corr}^{O_2}} = \frac{20.9\% - O_{2, \text{ref}}}{(20.9\% - O_{2, \text{measured}}) \times (20.9\% - O_{2, \text{measured}})} \times \text{Uncertainty of } O_2 \text{ Measurement} = 1.00$$

$$uf_{O_2} = \frac{u_{\text{Corr}^{O_2}}}{f_{O_2}} \times 100 = 0.00 \%$$

Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process

Visit Details : Permit IC 10 sampling

Survey Dates : 29th April 2015

Report Issue Date : 22nd May 2015

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Determinand	HCl:			
	Maximum mg/Nm ³	Minimum mg/Nm ³	Sensitivity	uM mg/Nm ³
...	...	...	...	...
...	...	...	...	...
Hydrogen Chloride	0.82	0.72	1.09	0.0502
...	...	...	...	...

Uncertainty in final measurement @ reference conditions due to uncertainty component arising from leak and/or loss (assumed 2% max) in the sample system (uL)

Determinand	HCl:
	uL mg/Nm ³
...	...
...	...
Hydrogen Chloride	0.00892
...	...

Uncertainty in final measurement @ Reference Conditions due to uVstp

Determinand	HCl:			
	Maximum mg/Nm ³	Minimum mg/Nm ³	Sensitivity	uVstp mg/Nm ³
...	...	...	...	...
...	...	...	...	...
Hydrogen Chloride	0.78	0.77	0.84	0.00515
...	...	...	...	...

Combined Uncertainty excluding oxygen contribution

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (uV_{stp})^2}$$

Determinand	HCl:			
	Combined Uncertainty mg/Nm ³	Expanded Uncertainty mg/Nm ³	Measured Concentration mg/Nm ³	Percent of Measured Concentration
...	...	...	...	...
...	...	...	...	...
Hydrogen Chloride	0.0513	0.10	0.77	13.27
...	...	...	...	...

Combined Uncertainty including oxygen contribution

$$u_{combined} = \sqrt{\sum (uf_{o_2})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corr'n Factor	Overall Measurement Uncertainty inc O ₂ Corr'n factor (Ucombined)
			...
...	...	...	...
...	...	...	...
Hydrogen Chloride	13.27	0.00	13.27
...	...	...	...

Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process

Visit Details : Permit IC 10 sampling

Survey Dates : 29th April 2015

Report Issue Date : 22nd May 2015

Site: Pontypool
Location: LHS - A8/1

$$u_{\text{mass}} = \sqrt{\sum (u_{\text{filter}})^2 + (u_{\text{solution}})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Filter mg	Uncert (%) Solution mg	K=2	Standard Uncertainty Filter mg	Solution mg	Combined Uncertainty mg
HF									
...	...	...	...	...	...	...	...	...	...
Hydrogen Fluoride	...	0.0260	0.0260	...	0.00338	...	...	0.00169	0.00169
...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...

	HF		Standard Uncertainty @ 95%
Sampled Volume (V _m)	0.59	m ³	uV _m 0.001 m ³
Meter Correction Factor (Y _d)	1.04	...	...
Meter Temperature (T _m)	292.33	k	uT _m 1.5 k
Average Differential Pressure (ΔH)	10.00	mmH ₂ O	uΔH 0.25 mmH ₂ O
Barometric Pressure (p _b)	751.56	mmHg	up _b 3.8 mmHg
ΔH + ps (p _m)	100.30	kPa	...
Oxygen content (O _{2,m})	21.00	% by volume	uO _{2,m} = σ/√n 0.00
Moisture Content (H ₂ O)	1.56	% by volume	uH ₂ O 0.27

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C_i is the sensitivity coefficient, u_i is the standard uncertainty and i is the index identifying the contributing factor e.g. $i = uV_m, uT_m$ etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

HF:

$$f_{s, \text{wet}} = \frac{100}{(100 - H_2O)} = 1.02$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up_b) & measured temperature of dry gas uncertainty component (uT_{m dry})

HF:

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = 0.974$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.97	0.97	0.0000952	0.0000238
up _b	0.98	0.97	0.00129	0.00485
uT _m	0.98	0.97	0.00333	0.00500
H ₂ O	0.98	0.97	0.00989	0.00266

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_b)^2}}{(P_b/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{(100/(100-H_2O))}\right)^2} = 0.00707$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

HF:

$$V_{std} = V_{measured} \times f_s = 0.574$$

	Maximum m ³	Minimum m ³	Sensitivity	Standard Uncertainty (m ³)
Effect of uV _{std}	0.58	0.57	0.59	0.00416
Effect of uV _m	0.57	0.57	0.97	0.000974

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = 0.00263$$

Uncertainty of Oxygen Correction Factor (%):-

HF:

$$f_{O_2} = \frac{20.9\% - O_{2, \text{ref}}}{20.9\% - O_{2, \text{measured}}} = 1.00$$

$$u_{\text{Corr}^{O_2}} = \frac{20.9\% - O_{2, \text{ref}}}{(20.9\% - O_{2, \text{measured}}) \times (20.9\% - O_{2, \text{measured}})} \times \text{Uncertainty of } O_2 \text{ Measurement} = 1.00$$

$$uf_{O_2} = \frac{u_{\text{Corr}^{O_2}}}{f_{O_2}} \times 100 = 0.00\%$$

Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process

Visit Details : Permit IC 10 sampling

Survey Dates : 29th April 2015

Report Issue Date : 22nd May 2015

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Determinand	HF:			
	Maximum mg/Nm ³	Minimum mg/Nm ³	Sensitivity	uM mg/Nm ³
...	...	...	...	...
...	...	...	...	...
Hydrogen Fluoride	0.0483	0.0424	1.74	0.00295
...	...	...	...	...

Uncertainty in final measurement @ reference conditions due to uncertainty component arising from leak and/or loss (assumed 2% max) in the sample system (uL)

Determinand	HF:	
	uL mg/Nm ³	
...	...	
...	...	
Hydrogen Fluoride	0.000523	
...	...	

Uncertainty in final measurement @ Reference Conditions due to uVstp

Determinand	HF:			
	Maximum mg/Nm ³	Minimum mg/Nm ³	Sensitivity	uVstp mg/Nm ³
...	...	...	...	...
...	...	...	...	...
Hydrogen Fluoride	0.0455	0.0451	0.0790	0.000208
...	...	...	...	...

Combined Uncertainty excluding oxygen contribution

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (u_{Vstp})^2}$$

Determinand	HF:			
	Combined Uncertainty mg/Nm ³	Expanded Uncertainty mg/Nm ³	Measured Concentration mg/Nm ³	Percent of Measured Concentration
...	...	...	...	...
...	...	...	...	...
Hydrogen Fluoride	0.00300	0.00600	0.0453	13.24
...	...	...	...	...

Combined Uncertainty including oxygen contribution

$$u_{combined} = \sqrt{\sum (u_{f_{O_2}})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corr'n Factor	Overall Measurement Uncertainty inc O ₂ Corr'n factor (Ucombined)
...	...	...	...
...	...	...	...
Hydrogen Fluoride	13.24	0.00	13.24
...	...	...	...

Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process

Visit Details : Permit IC 10 sampling

Survey Dates : 29th April 2015

Report Issue Date : 22nd May 2015

Site: Pontypool
Location: RHS - A8/2

$$u_{\text{mass}} = \sqrt{\sum (u_{\text{filter}})^2 + (u_{\text{solution}})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Filter mg	Uncert (%) Solution mg	Standard Filter mg	Uncertainty Solution mg	Combined Uncertainty mg
HCl								
...	...	...	...	...	...	...	...	...
Hydrogen Chloride	...	1.12	1.12	...	0.15	...	0.0731	0.0731
...	...	...	...	...	...	...	...	...
...								
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...

	HCl		Standard Uncertainty @ 95%
Sampled Volume (V _m)	0.95	m ³	uV _m 0.001 m ³
Meter Correction Factor (Y _d)	1.04	...	...
Meter Temperature (T _m)	290.00	k	uT _m 1.5 k
Average Differential Pressure (ΔH)	25.00	mmH ₂ O	uΔH 0.25 mmH ₂ O
Barometric Pressure (p _b)	751.56	mmHg	up _b 3.8 mmHg
ΔH + ps (p _m)	100.44	kPa	...
Oxygen content (O _{2,m})	21.00	% by volume	uO _{2,m} = σ/√n 0.00 % by volume
Moisture Content (H ₂ O)	0.73	% by volume	uH ₂ O 0.17 % by volume

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C is the sensitivity coefficient, u is the standard uncertainty and i is the index identifying the contributing factor e.g. $i = uV_m, uT_m$ etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

HCl:

$$f_{s, \text{wet}} = \frac{100}{(100 - H_2O)} = 1.01$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up_b) & measured temperature of dry gas uncertainty component (uT_{m dry})

HCl:

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = 0.975$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.97	0.97	0.0000951	0.0000238
up _b	0.98	0.97	0.00129	0.00485
uT _m	0.98	0.97	0.00336	0.00504
H ₂ O	0.98	0.97	0.00982	0.00163

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_b)^2}}{(P_b/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{(100/(100-H_2O))}\right)^2} = 0.00683$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

HCl:

$$V_{std} = V_{measured} \times f_s = 0.922$$

	Maximum m ³	Minimum m ³	Sensitivity	Standard Uncertainty (m ³)
Effect of uV _{std}	0.93	0.92	0.95	0.00647
Effect of uV _m	0.92	0.92	0.97	0.000975

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = 0.00619$$

Uncertainty of Oxygen Correction Factor (%):-

HCl:

$$f_{O_2} = \frac{20.9\% - O_{2, \text{ref}}}{20.9\% - O_{2, \text{measured}}} = 1.00$$

$$u_{\text{Corr}^{O_2}} = \frac{20.9\% - O_{2, \text{ref}}}{(20.9\% - O_{2, \text{measured}}) \times (20.9\% - O_{2, \text{measured}})} \times \text{Uncertainty of } O_2 \text{ Measurement} = 1.00$$

$$uf_{O_2} = \frac{u_{\text{Corr}^{O_2}}}{f_{O_2}} \times 100 = 0.00 \%$$

Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process

Visit Details : Permit IC 10 sampling

Survey Dates : 29th April 2015

Report Issue Date : 22nd May 2015

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Determinand	HCl:			
	Maximum mg/Nm ³	Minimum mg/Nm ³	Sensitivity	uM mg/Nm ³
...	...	...	...	...
...	...	...	...	...
Hydrogen Chloride	1.30	1.14	1.08	0.0792
...	...	...	...	...

Uncertainty in final measurement @ reference conditions due to uncertainty component arising from leak and/or loss (assumed 2% max) in the sample system (uL)

Determinand	HCl:	
	uL mg/Nm ³	
...	...	
...	...	
Hydrogen Chloride	0.0141	
...	...	

Uncertainty in final measurement @ Reference Conditions due to uVstp

Determinand	HCl:			
	Maximum mg/Nm ³	Minimum mg/Nm ³	Sensitivity	uVstp mg/Nm ³
...	...	...	...	...
...	...	...	...	...
Hydrogen Chloride	1.23	1.21	1.32	0.00818
...	...	...	...	...

Combined Uncertainty excluding oxygen contribution

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (u_{Vstp})^2}$$

Determinand	HCl:			
	Combined Uncertainty mg/Nm ³	Expanded Uncertainty mg/Nm ³	Measured Concentration mg/Nm ³	Percent of Measured Concentration
...	...	...	...	...
...	...	...	...	...
Hydrogen Chloride	0.0809	0.16	1.22	13.27
...	...	...	...	...

Combined Uncertainty including oxygen contribution

$$u_{combined} = \sqrt{\sum (u_{f_{O_2}})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corr'n Factor	Overall Measurement Uncertainty inc O ₂ Corr'n factor (Ucombined)
...	...	...	...
...	...	...	...
Hydrogen Chloride	13.27	0.00	13.27
...	...	...	...

Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process

Visit Details : Permit IC 10 sampling

Survey Dates : 29th April 2015

Report Issue Date : 22nd May 2015

Site: Pontypool
Location: RHS - A8/2

$$u_{\text{mass}} = \sqrt{\sum (u_{\text{filter}})^2 + (u_{\text{solution}})^2}$$

Determinand	Filter mg	Solution mg	Recovered Mass mg	LAB Method Filter mg	Uncert (%) Solution mg	K=2	Standard Uncertainty Filter mg	Solution mg	Combined Uncertainty mg
HF									
...	...	...	...	...	...	...	...	...	...
Hydrogen Fluoride	...	0.0300	0.0300	...	0.00390	...	...	0.00195	0.00195
...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...

	HF		Standard Uncertainty @ 95%
Sampled Volume (V _m)	0.61	m ³	uV _m 0.001 m ³
Meter Correction Factor (Y _d)	1.04	...	...
Meter Temperature (T _m)	287.42	k	uT _m 1.5 k
Average Differential Pressure (ΔH)	10.00	mmH ₂ O	uΔH 0.25 mmH ₂ O
Barometric Pressure (p _b)	751.56	mmHg	up _b 3.8 mmHg
ΔH + ps (p _m)	100.30	kPa	...
Oxygen content (O _{2,m})	21.00	% by volume	uO _{2,m} = σ/√n 0.00
Moisture Content (H ₂ O)	0.71	% by volume	uH ₂ O 0.26

Note: In the following calculations, the sensitivity coefficient (C) is estimated using: $C_i = \frac{\partial f}{\partial x_i}$

For each factor, uncertainty is then calculated by $C_i u_i$ where C is the sensitivity coefficient, u is the standard uncertainty and i is the index identifying the contributing factor e.g. $i = uV_m, uT_m$ etc.

Where results are required at wet conditions, the following correction factor is used to convert the data from the dry gas meter:

HF:

$$f_{s, \text{wet}} = \frac{100}{(100 - H_2O)} = 1.01$$

Uncertainty in correction factor to STP due to measured ΔH uncertainty component (uΔH), measured stack pressure uncertainty component (up_b) & measured temperature of dry gas uncertainty component (uT_{m dry})

HF:

$$f_s = \frac{273}{760} \times \frac{P_b + \frac{\Delta H}{13.6}}{T_m} \times Y_d = 0.982$$

	Maximum	Minimum	Sensitivity	ufstp
uΔH	0.98	0.98	0.0000960	0.0000240
up _b	0.99	0.98	0.00131	0.00489
uT _m	0.99	0.98	0.00342	0.00513
H ₂ O	0.98	0.98	0.00989	0.00254

$$\frac{uf_s}{f_s} = \sqrt{\left(\frac{\sqrt{(u\Delta H)^2 + (uP_b)^2}}{(P_b/101.3)}\right)^2 + \left(\frac{uT_m}{(T_m/273.15)}\right)^2 + \left(\frac{uH_2O}{(100/(100-H_2O))}\right)^2} = 0.00725$$

Uncertainty in volume @ STP due to volume correction factor uncertainty component (uV_{std}) & volume uncertainty component (uV_m)

HF:

$$V_{std} = V_{measured} \times f_s = 0.594$$

	Maximum m ³	Minimum m ³	Sensitivity	Standard Uncertainty (m ³)
Effect of uV _{std}	0.60	0.59	0.61	0.00439
Effect of uV _m	0.60	0.59	0.98	0.000982

Combined Standard Uncertainty

$$\frac{uV_{std}}{V_{std}} = \sqrt{\left(\frac{uV_{std}}{f_s}\right)^2 + \left(\frac{uV_m}{V_m}\right)^2} = 0.00283$$

Uncertainty of Oxygen Correction Factor (%):-

HF:

$$f_{O_2} = \frac{20.9\% - O_{2, \text{ref}}}{20.9\% - O_{2, \text{measured}}} = 1.00$$

$$u_{\text{Corr}^{O_2}} = \frac{20.9\% - O_{2, \text{ref}}}{(20.9\% - O_{2, \text{measured}}) \times (20.9\% - O_{2, \text{measured}})} \times \text{Uncertainty of } O_2 \text{ Measurement} = 1.00$$

$$uf_{O_2} = \frac{u_{\text{Corr}^{O_2}}}{f_{O_2}} \times 100 = 0.00 \%$$

Environmental Compliance Limited

TRW Automotive Braking Systems

Permit No : EPR/DP3430LX

Variation No : V002

Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process

Visit Details : Permit IC 10 sampling

Survey Dates : 29th April 2015

Report Issue Date : 22nd May 2015

Uncertainty in final measurement @ reference conditions due to mass uncertainty component (uM)

Determinand	HF:			
	Maximum mg/Nm ³	Minimum mg/Nm ³	Sensitivity	uM mg/Nm ³
...	...	...	...	...
...	...	...	...	...
Hydrogen Fluoride	0.0538	0.0472	1.68	0.00328
...	...	...	...	...

Uncertainty in final measurement @ reference conditions due to uncertainty component arising from leak and/or loss (assumed 2% max) in the sample system (uL)

Determinand	HF:
	uL mg/Nm ³
...	...
...	...
Hydrogen Fluoride	0.000583
...	...

Uncertainty in final measurement @ Reference Conditions due to uVstp

Determinand	HF:			
	Maximum mg/Nm ³	Minimum mg/Nm ³	Sensitivity	uVstp mg/Nm ³
...	...	...	...	...
...	...	...	...	...
Hydrogen Fluoride	0.0507	0.0502	0.0849	0.000240
...	...	...	...	...

Combined Uncertainty excluding oxygen contribution

$$u_{combined} = \sqrt{\sum (u_M)^2 + (u_L)^2 + (u_{Vstp})^2}$$

Determinand	HF:			
	Combined Uncertainty mg/Nm ³	Expanded Uncertainty mg/Nm ³	Measured Concentration mg/Nm ³	Percent of Measured Concentration
...	...	...	...	...
...	...	...	...	...
Hydrogen Fluoride	0.00334	0.00668	0.0505	13.24
...	...	...	...	...

Combined Uncertainty including oxygen contribution

$$u_{combined} = \sqrt{\sum (u_{f_{O_2}})^2 + (Uncertainty\ of\ Measurement\ of\ Determinand)^2}$$

Determinand	Measurement Uncertainty of Determinand	Measurement Uncertainty of Oxygen Corr'n Factor	Overall Measurement Uncertainty inc O ₂ Corr'n factor (Ucombined)
...	...	...	...
...	...	...	...
Hydrogen Fluoride	13.24	0.00	13.24
...	...	...	...

Environmental Compliance Limited

TRW Automotive Braking Systems
 Permit No : EPR/DP3430LX
 Variation No : V002
 Report Ref : P2407 : R002

Installation Name : Zinc Nickel Process
 Visit Details : Permit IC 10 sampling
 Survey Dates : 29th April 2015
 Report Issue Date : 22nd May 2015

Stack Reference LHS - A8/1

Measurement Uncertainty Calculations - Velocity at Stack Conditions

Contribution From	Standard u/c (mm H ₂ O)	
Pitot Calibration Uncertainty Contribution	0.063	A
Manometer Calibration Uncertainty Contribution	0.063	B
Variation in Actual Pitot reading at sample points	0.14	C
Combined u/c (mm H ₂ O) =	Combined u/c (mm H ₂ O)	
SQRT $(A/\sqrt{3})^2 + (B/\sqrt{3})^2 + (C/\sqrt{3})^2$	0.10	
Expanded Uncertainty of Flow Measurements (mm H₂O)	0.20	
	Standard u/c (K)	
Temperature Calibration (K)	1.48	D
Variation in Actual Temp reading at sample points	0.00	E
Combined u/c of Temp (K)	Combined u/c (K)	
SQRT $((D/\sqrt{3})^2 + (E/\sqrt{3})^2)$	0.85	
Expanded Uncertainty of Temp Measurements (K)	1.71	
Measured Average Velocity (m/s) at Stack Conds	11.95	
Maximum Average Velocity (m/s) at Stack Conds	12.08	
Standard Uncertainty Velocity at Stack Conditions (%)	1.07	
Expanded Uncertainty Velocity (at Stack Conditions)	2.13 (%)	

Measurement Uncertainty Calculations - Flowrate at Stack Conditions

Contribution From	Standard u/c (m ³)
Area (m ²)	0.01596
Measured Average Flowrate (m ³ /s) at Stack Conds	19.07
Maximum Average Flowrate (m ³ /s) at Stack Conds	19.47
Standard Uncertainty Flowrate (m ³ /s) at Stack Conditions (%)	2.08
Expanded Uncertainty Flowrate (m³/s) at Stack Conditions	4.15 (%)

Measurement Uncertainty Calculations - Flowrate at STP & Wet Gas

Contribution From	Standard u/c (%)
Temperature Calibration (K)	0.5
Barometer Calibration	0.5
Measured Average Flowrate (m ³ /s) at STP Wet	17.42
Maximum Average Flowrate (m ³ /s) at STP Wet	17.86
Standard Uncertainty Flowrate (m ³ /s) at STP Wet	2.55
Expanded Uncertainty Flowrate (m³/s) at STP Wet	5.09 (%)

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Stack Reference RHS - A8/2

Measurement Uncertainty Calculations - Velocity at Stack Conditions

Contribution From	Standard u/c (mm H ₂ O)	
Pitot Calibration Uncertainty Contribution	0.035	A
Manometer Calibration Uncertainty Contribution	0.035	B
Variation in Actual Pitot reading at sample points	0.18	C
Combined u/c (mm H ₂ O) =	Combined u/c (mm H ₂ O)	
SQRT (A/ ³) ² + (B/ ³) ² + (C/ ³) ²)	0.11	
Expanded Uncertainty of Flow Measurements (mm H₂O)	0.21	
	Standard u/c (K)	
Temperature Calibration (K)	1.48	D
Variation in Actual Temp reading at sample points	0.00	E
Combined u/c of Temp (K)	Combined u/c (K)	
SQRT ((D/ ³) ² + (E/ ³) ²)	0.86	
Expanded Uncertainty of Temp Measurements (K)	1.71	
Measured Average Velocity (m/s) at Stack Conds	8.90	
Maximum Average Velocity (m/s) at Stack Conds	9.06	
Standard Uncertainty Velocity at Stack Conditions (%)	1.82	
Expanded Uncertainty Velocity (at Stack Conditions)	3.64 (%)	

Measurement Uncertainty Calculations - Flowrate at Stack Conditions

Contribution From	Standard u/c (m ³)
Area (m ²)	0.01596
Measured Average Flowrate (m ³ /s) at Stack Conds	14.20
Maximum Average Flowrate (m ³ /s) at Stack Conds	14.61
Standard Uncertainty Flowrate (m ³ /s) at Stack Conditions (%)	2.84
Expanded Uncertainty Flowrate (m³/s) at Stack Conditions	5.68 (%)

Measurement Uncertainty Calculations - Flowrate at STP & Wet Gas

Contribution From	Standard u/c (%)
Temperature Calibration (K)	0.5
Barometer Calibration	0.5
Measured Average Flowrate (m ³ /s) at STP Wet	12.94
Maximum Average Flowrate (m ³ /s) at STP Wet	13.37
Standard Uncertainty Flowrate (m ³ /s) at STP Wet	3.31
Expanded Uncertainty Flowrate (m³/s) at STP Wet	6.63 (%)