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Stack Emissions Testing Report

Total Particulate Matter

Report Date / Version:	20th February 2008 / Version 2
Report By: MCERTS Number: MCERTS Level: Technical Endorsements:	Nick Agopian MM 08 902 MCERTS Trainee -
Report Approved By: MCERTS Number: Business Title: Technical Endorsements: Signature:	Mark Allison MM 03 162 Level 2 - Team Leader TE1, TE2, TE3 & TE4

Hanson Aggregates Limited

St Ives

Coating Plant

Sampling Date/s:
14th February 2008

Job Number:
LCH 00013

CONTENTS

EXECUTIVE SUMMARY (Page 1 of 9)

Stack Emissions Monitoring Objectives

Hanson Aggregates Limited operates a mineral drying and roadstone coating process at St Ives Coating Plant which is subject to a LAPPC Guidance Note, under the Pollution Prevention & Control Regulations 2000.

Scientifics Limited were commissioned by Hanson Aggregates Limited to carry out stack emissions monitoring to determine the release of total particulate matter from the following Plant under Normal operating conditions.

The results of this test shall be used to demonstrate compliance with an emission limit value for total particulate matter as specified in the Plant's LAPPC Guidance Note, PG 3/15a (04).

Plant

Coating Plant

Operator

LAPPC Guidance Note: PG 3/15a (04)

Hanson Aggregates Limited
St Ives Coating Plant
Meadow Lane
St Ives
Cambridgeshire
PE27 4LG

Stack Emissions Monitoring

Scientifics Limited - Swindon Laboratory
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Bristol Street
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SN1 5ET
UKAS and MCERTS Number: 1015

Opinions and interpretations expressed herein are outside the scope of UKAS accreditation.

EXECUTIVE SUMMARY (Page 2 of 9)

Emissions Summary

Hanson Aggregates Limited, St Ives
Coating Plant
14th February 2008

Parameter	Units	Result	Uncertainty +/-	Limit	Outcome
Total Particulate Matter	mg/m³	41	2.3	50	Passed
Particulate Emission Rate	g/hr	2835	161	-	-
Moisture	%	7.2	0.72	-	-
Stack Gas Temperature	°C	91	-	-	-
Stack Gas Velocity	m/s	16.4	-	-	-
Gas Volumetric Flow Rate (Actual)	m³/hr	90670	-	-	-
Gas Volumetric Flow Rate (STP, Wet)	m³/hr	69272	-	-	-
Gas Volumetric Flow Rate (STP, Dry)	m³/hr	64270	-	-	-

All results are mean values, with pollutant concentrations expressed at reference conditions.

Particulate Matter: Reference conditions are 273K, 101.3kPa, without correction for water vapour content.

EXECUTIVE SUMMARY (Page 3 of 9)

Monitoring Times

Parameter	Sampling Date	Sampling Times	Sampling Duration
Total Particulate Matter	14th February 2008	09:05 - 09:23 09:25 - 09:43	36 minutes

Process Details

Parameter	Process Details
Process Status	Normal
Capacity and / or Production Rate	110 Tonnes / Hour
Continuous or Batch Process	Batch
Feedstock (if applicable)	20mm gravel
Abatement System	Bag Filter
Abatement System Running Status	On
Fuel (if applicable)	Cleaned Fuel Oil
Plume Appearance	Slight Plume Visible

EXECUTIVE SUMMARY (Page 4 of 9)

Monitoring Methods

The selection of standard methods employed by Scientifics is determined, wherever possible by the hierarchy of method selection outlined in Environment Agency Technical Guidance Document (Monitoring) M2. i.e. CEN, ISO, BS, US EPA etc.

The table below summarises the monitoring methods, techniques and technical procedures employed, and details any deviations from the aforementioned hierarchy:

Sampling Methods with Subsequent Analysis

Species	Standard Method	Scientifics Technical Procedure	UKAS Lab Number	MCERTS Accredited Method	Limit of Detection (LOD)	MU of Method +/- %	MU +/- %
TPM	BS ISO 9096	AE 006	1015	Yes	0.49 mg/m³	30%	6% (C)
H_2O	BS EN 14790	AE 004	1015	Yes	0.1%	10%	-

where C = Calculated Measurement Uncertainty, E = Estimated Measurement Uncertainty

EXECUTIVE SUMMARY (Page 5 of 9)

Analytical Methods

The following tables list the analytical methods employed together with the custody and archiving details:

Sampling Methods with Subsequent Analysis

Species	Analytical Technique	Analytical Procedure	UKAS Lab Number	UKAS Accredited Analysis	Laboratory	Sample Archive Location	Archive Period
TPM	Gravimetric	AE 006	1015	Yes	Swindon	Swindon	3 months
H_2O	Gravimetric	AE 004	1015	Yes	Swindon	Swindon	3 months

EXECUTIVE SUMMARY (Page 6 of 9)

Measurement Uncertainty (MU)

Total Particulate Matter

There are 4 ways in which to report measurement uncertainty for total particulate matter. These are listed in the hierarchical table below. The table also indicates which method has been taken to work out the MU for the parameters listed in this report.

MU Reported	Yes / No
a) Report a calculated MU	Yes
b) Report an estimated MU if there are any deviations from the sampling plane validation criteria	-
c) Report an estimated MU if there are any deviations from the specified method	-
d) Report the MU specified in the method	-

NOTE: The estimated uncertainty is based upon a calculated MU, coupled with the experience of the Stack Emissions Test house.

EXECUTIVE SUMMARY (Page 7 of 9)

Sampling Location

Sampling Plane Validation Criteria (BS ISO 9096)	Value	Units	Requirement	Compliance	Method
Lowest Differential Pressure	177	Pa	> 5 Pa	Yes	All
Lowest Gas Velocity	81.33	m/s	-	-	-
Highest Gas Velocity	94.50	m/s	-	-	-
Ratio of Above	1.16	: 1	< 3 : 1	Yes	All
Mean Velocity	88.95	m/s	-	-	-
Angle of flow with regard to duct axis	0	^{o}	< 15^{o}	Yes	All
No local negative flow	-	-	-	Yes	All
Highly homogeneous flow stream / gas velocity	-	-	-	Yes	ISO 10396

Duct Characteristics

	Value	Units
Type	Circular	-
Depth	1.40	m
Width	-	m
Area	1.54	m^2
Port Depth	90	mm

Sampling Lines & Sample Points

	TPM
Sample Port Size	4 inch BSP
Number Used	2
Orientation	Horizontal
Number Points / Line	6
In Stack / Out Stack Filtration	In Stack

Sampling Platform

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

Annex A (BS ISO 9096) Normative requirements	
Minimum Platform Area 5 m^2	Yes
Platform has 2 levels of handrails (approximately 0.5 m & 1.0 m high)	Yes
Platform has vertical base boards (approximately 0.25 m high)	Yes
Platform has removable chains / self closing gates at the top of ladders	Yes
Handrail / obstructions do not hamper insertion of sampling equipment	Yes
Depth of Platform = Minimum of 2m or Probe Length + 1m	Yes

Sampling Location / Platform Improvement Recommendations

The sampling location meets all the requirements as specified in BS ISO 9096.

EXECUTIVE SUMMARY (Page 8 of 9)

Sampling & Analytical Method Deviations

In this instance there were no deviations from the sampling methods employed.

EXECUTIVE SUMMARY (Page 9 of 9)

Conclusion & Discussion

The results of these tests demonstrate that under normal operating conditions, this Plant is being operated in full compliance with the emission limits specified in its LAPPC Guidance Note, PG 3/15a (04).

A regular programme of stack emissions testing in accordance with the Plant's LAPPC Guidance Note, PG 3/15a (04), will be required to demonstrate continued compliance.

APPENDICES

CONTENTS

STACK EMISSIONS MONITORING TEAM

Environmental Team Leader	Mark Allison MCERTS Level 2, Technical Endorsements 1, 2, 3 & 4 MM 03 162 BSc (Hons) Environmental and Resource Science
Environmental Technician	Nick Agopian MCERTS Trainee MM 08 902 BSc (Hons) Environmental Earth Science

TOTAL PARTICULATE MATTER SUMMARY

Hanson Aggregates Limited, St Ives
Coating Plant
14th February 2008

Test	Sampling Times	Duration min	Concentration mg/m³	Emission Rate g/hr
Particulate Matter	09:05 - 09:23 09:25 - 09:43	36	41	2835

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

Overall Blank Value mg/m³	Daily Emission Limit Value mg/m³	Weighing Uncertainty ± mg
0.57	50	0.37

Acetone Blank Value mg/l	Acceptable Value mg/l
0.73	10

ISOKINETIC SAMPLING EQUATIONS 1 — Total Particulate Matter

Test	1	Units
Absolute pressure of stack gas, P_s		
Barometric pressure, P_b	775.5	mm Hg
Stack static pressure, P_{static}	-5.6	mm H_2O
$P_s = P_b + \frac{(P_{static})}{13.6}$	775.1	mm Hg
Volume of water vapour collected, V_{wstd}		
Impinger volume collected	0	ml
Silica gel weight increase	44	g
Total volume of liquid collected, V_{lc}	44	ml
$V_{wstd} = (0.001246)(V_{lc})$	0.0551	m³
Volume of gas metered dry, V_{mstd}		
Volume of gas sample through gas meter, V_m	0.7212	m³
Gas meter correction factor, Y_d	0.983	-
Average dry gas meter temperature, T_m	7.4	°C
Average pressure drop across orifice, ΔH	44.6	mm H_2O
$V_{mstd} = \frac{(0.3592)(V_m)(P_b+(\Delta H/13.6))(Y_d)}{T_m + 273}$	0.7074	m³
Volume of gas metered wet, V_{mstw}		
$V_{mstw} = V_{mstd} + V_{wstd}$	0.7624	m³
Moisture content, B_{wo}		
$B_{wo} = \frac{V_{wstd}}{V_{mstd} + V_{wstd}}$	0.072	m³
	7.22	%
Molecular weight of dry gas stream, M_d		
CO_2	0.07	%
O_2	20.8	%
Total	20.9	%
N_2 (100 -Total)	79.1	%
$M_d = 0.44(\%CO_2)+0.32(\%O_2)+0.28(\%N_2)$	28.84	g/gmol
Molecular weight of stack gas (wet), M_s		
$M_s = M_d(1 - B_{wo}) + 18(B_{wo})$	28.06	g/gmol
Velocity of stack gas, V_s		
Pitot tube velocity constant, K_p	34.97	-
Velocity pressure coefficient, C_p	0.80	-
Average of velocity heads, ΔP_{avg}	20.41	mm H_2O
Average square root of velocity heads, $\sqrt{\Delta P}$	4.52	$\sqrt{}$mm H_2O
Average stack gas temperature, T_s	91	°C
$V_s = \frac{(K_p)(C_p)(\sqrt{\Delta P})(\sqrt{T_s} + 273)}{\sqrt{(M_s)(P_s)}}$	16.36	m/s

ISOKINETIC SAMPLING EQUATIONS 2 — Total Particulate Matter

Test	1	Units
Actual flow of stack gas, Q_a		
Area of stack, A_s	1.54	m³
$Q_a = (60)(A_s)(V_s)$	1511.2	m³/min
Dry total flow of stack gas, Q_{std}		
Conversion factor (K/mm.Hg)	0.3592	-
$Q_{std} = \frac{(Q_a)P_s(0.3592)(1-B_{wo})}{(T_s)+273}$	1071.2	m³/min
Wet total flow of stack gas, Q_{stw}		
Conversion factor (K/mm.Hg)	0.3592	-
$Q_{stw} = \frac{(Q_a)P_s(0.3592)}{(T_s)+273}$	1154.5	m³/min
Percent isokinetic, %I		
Nozzle diameter, D_n	5.73	mm
Nozzle area, A_n	25.79	mm²
Total sampling time, θ	36	min
$\%I = \frac{(4.6398E6)(T_s+273)(V_{mstd})}{(P_s)(V_s)(A_n)(\theta)(1-B_{wo})}$	109.5	%
Acceptable isokinetic range 90% to 110%	Yes	-
Particulate Concentration, C		
Mass of particulate collected on filter, M_f	0.0218	g
Mass of particulate collected in probe, M_p	0.0094	g
Mass of total particulate collected, M_n	0.0312	g
$C_{wet} = \frac{M_n}{V_{mstw}}$	40.92	mg/m³
$C_{dry} = \frac{M_n}{V_{mstd}}$	44.11	mg/m³
Particulate Emission Rates, E		
$E = [(C_{wet})(Q_{stw})(60)] / 1000$	2834.8	g/hr
Weighing, Conditioning & Filtration Temperatures		
Pre-conditioning temperature	180	°C
Maximum filtration temperature	95	°C
Post-conditioning temperature	160	°C

TOTAL PARTICULATE MATTER QUALITY ASSURANCE CHECKLIST

Leak Test Results	Value	Units
Mean Sampling Rate	19.7	litre/min
Pre-sampling Leak Rate	0.10	litre/min
Post-sampling Leak Rate	0.10	litre/min
Acceptable Leak Rate	0.39	litre/min
Leak Tests Acceptable	Yes	-

Overall Blank Value	Value	Units
Overall Blank Value	0.57	mg/m³
Daily Emission Limit Value	50	mg/m³
Acceptable Blank Value	5	mg/m³
Overall Blank Acceptable	Yes	-

Isokinetic Criterion Compliance	Value	Units	
Isokinetic Variation	109.5	%	
Acceptable Isokineticity	Yes	-	**Acceptable isokinetic range 90% to 110%**

Total Particulate Matter Filters	Value	Units	
Filter Material	GF	-	**GF = Glass Fibre** **QF = Quartz Fibre**
Filter Size	47	mm	

PRELIMINARY STACK SURVEY

Hanson Aggregates Limited, St Ives
Coating Plant
14th February 2008

Time of Survey	08:44 - 08:48
Velocity Measurement Device:	S-Type Pitot

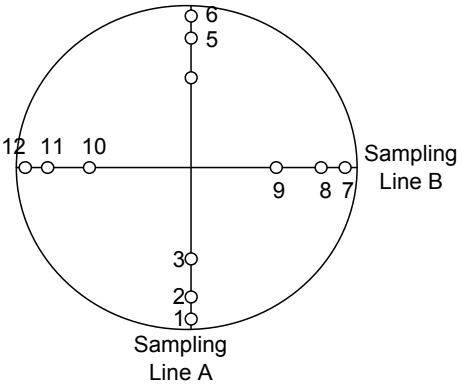
Sampling Line A							
Traverse Point	Distance into duct (m)	ΔP pt mmH_2O	ΔP pt Pa	Temp ^oC	Velocity m/s	O_2 % Vol	Angle of Swirl ^{o}
1	0.07	18.0	176	88	81.33	-	0
2	0.21	20.0	196	88	85.73	-	
3	0.35	23.4	229	88	92.73	-	
4	0.49	21.2	208	88	88.26	-	
5	0.63	22.5	221	88	90.93	-	
6	0.77	24.0	235	88	93.91	-	
7	0.91	23.0	225	88	91.93	-	
8	1.05	23.8	233	88	93.52	-	
9	1.19	20.9	205	88	87.64	-	
10	1.33	21.5	211	88	88.89	-	0
Mean	-	21.8	214	88	89.49	-	

Sampling Line B							
Traverse Point	Distance into duct (m)	ΔP pt mmH_2O	ΔP pt Pa	Temp ^oC	Velocity m/s	O_2 % Vol	Angle of Swirl ^{o}
1	0.07	19.5	191	88	84.65	-	0
2	0.21	18.5	181	88	82.45	-	
3	0.35	20.4	200	88	86.58	-	
4	0.49	21.8	214	88	89.50	-	
5	0.63	22.6	221	88	91.13	-	
6	0.77	24.3	238	88	94.50	-	
7	0.91	23.7	232	88	93.32	-	
8	1.05	22.5	221	88	90.93	-	
9	1.19	19.5	191	88	84.65	-	
10	1.33	20.3	199	88	86.37	-	0
Mean	-	21.3	209	88	88.41	-	

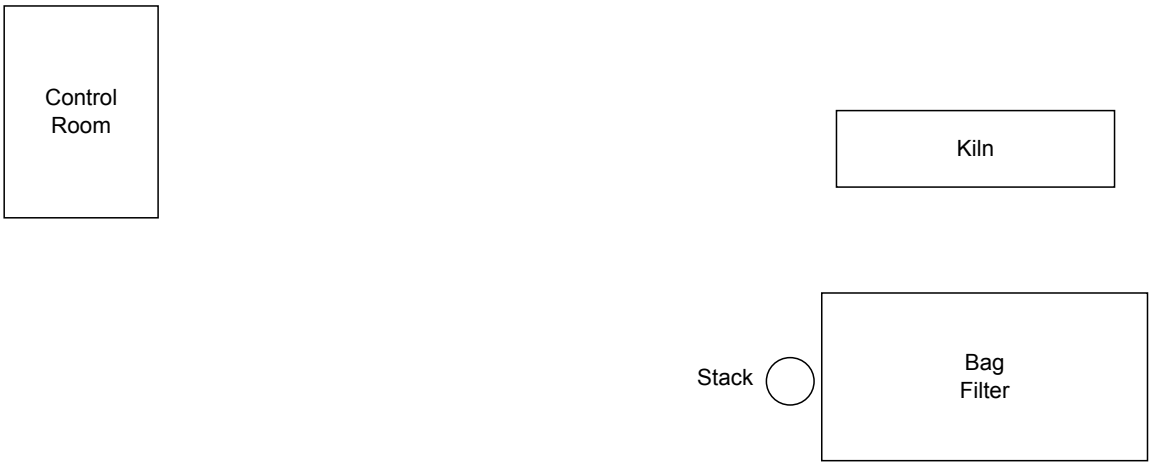
STACK DIAGRAM

	Value	Units
Stack Depth	1.40	m
Stack Width	-	m
Area	1.54	m^2

Sampling Point	Distance (% of Depth)	Distance into Stack	Units
1, 7	4.4	0.06	m
2, 8	14.6	0.20	m
3, 9	29.6	0.41	m
4, 10	70.4	0.99	m
5, 11	85.4	1.20	m
6, 12	95.6	1.34	m



PLANT LAYOUT



APPENDIX 3 - Calibrateable Equipment Checklist

CALIBRATEABLE EQUIPMENT CHECKLIST

Extractive Sampling		Instrumental Analyser/s		Miscellaneous	
Equipment	**Equipment I.D.**	**Equipment**	**Equipment I.D.**	**Equipment**	**Equipment I.D.**
Control Box DGM	LCH 13-01	Horiba PG-250 Analyser	-	Laboratory Balance	LSW 5010
Box Thermocouples	LCH 13-01	Horiba PG-200 Cooler	-	Tape Measure	LAB 1177
Meter In Thermocouple	LCH 13-01	JCT JCC P-1 Cooler	-	Stopwatch	-
Meter Out Thermocouple	LCH 13-01	Testo 350 Analyser	-	Protractor	LAB 0960
Control Box Timer	LCH 17-01	Testo 339 Cooler	-	Barometer	LAB 1174
Umbilical	LCH 03-02	FT-IR	-	Digital Micromanometer	-
Oven Box	LSW 09-12	FT-IR Oven Box	-	Digital Temperature Meter	-
Probe	LSW 11-23	Bernath 3006 FID	-	Stack Thermocouple	LSW 11-23
S-Pitot	LSW 06-23	Signal 3010 MINIFID	-	Drycal	-
L-Pitot	-	Signal 3030 FID	-	Mass Flow Controller	-
Site Balance	LAB 0157	Servomex 570A	-	Mass Flow Control Box	-
Last Impinger Arm	-	JCT Heated Head Filter	-	1m Heated Line	-
Callipers	LSW 30-02			5m Heated Line (1)	-
Small DGM	-			5m Heated Line (2)	-
				10m Heated Line (1)	-
				10m Heated Line (2)	-
				15m Heated Line (1)	-
				15m Heated Line (2)	-
				20m Heated Line (1)	
				20m Heated Line (2)	

NOTE: If the equipment I.D is represented by a dash (-), then this piece of equipment has not been used for this test.

MEASUREMENT UNCERTAINTY BUDGET - TOTAL PARTICULATE MATTER

	Value	Units
Limit value	50	mg/m³
Measured concentration	41	mg/m³
Reference oxygen	N/A	% by volume

Measured Quantities	Symbol	Value	Units
Sampled Volume	V_m	0.7074	m³
Sampled Gas Temperature	T_m	280	K
Sampled Gas Pressure	ρ_m	103.4	KPa
Sampled Gas Humidity	H_m	0.0	% by volume
Oxygen Content	$O_{2,m}$	N/A	% by volume
Mass of Particulate	m	31.2	mg
Leak	L	0.51	%
Uncollected Mass	UCM	0.40	mg

NOTE: Sampled Gas Temperature, Pressure and Humidity are at the Dry Gas Meter.

Standard Uncertainty	Symbol	Value	Units	Uncertainty as a %	Uncertainty Required	Uncertainty Met?
Sampled Volume	uV_m	0.0141	m³	2.0	$\leq$ 2%	Yes
Sampled Gas Temperature	uT_m	3	K	1.0	$\leq$ 1%	Yes
Sampled Gas Pressure	$u\rho_m$	1.0340	KPa	1.0	$\leq$ 1%	Yes
Sampled Gas Humidity	uH_m	0.0000	% by volume	0.0	$\leq$ 1%	Yes
Oxygen Content	$uO_{2,m}$	N/A	% by volume	N/A	$\leq$ 5%	N/A
Mass of Particulate	um	0.3700	mg	1.0	$\leq$ 5% of ELV	Yes
Leak	-	-	-	0.5	$\leq$ 2%	Yes
Uncollected Mass	-	-	-	1.0	$\leq$ 10% of ELV	Yes

Parameter	Symbol	Value	Units	Uncertainty in Result	Units	Uncertainty as a %	Units
Volume (STP)	V	0.7030	m³	1.01	mg/m³	2.46	%
Mass of Particulate	m	31.2	mg	0.49	mg/m³	1.19	%
Factor for O2 Correction	fc	N/A	-	0.00	mg/m³	0.00	%
Leak	L	0.12	mg/m³	0.12	mg/m³	0.29	%
Uncollected mass	UCM	0.23	mg	0.30	mg/m³	0.74	%
Combined uncertainty				1.17	mg/m³	2.84	%

Uncertainty expressed at a 95% confidence level (where k = 2)	**2.33**	**mg/m³**	**5.69**	**%**

(k is a coverage factor which gives a 95% confidence in the quoted figures)