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**MONITORING OF EMISSIONS FROM
THE ANIMAL FEED PROCESS
29 & 30 January, 2009**

For Sundown Products Ltd

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Issued : 25 February, 2009
Reference : 71031p1r0

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CONTENTS	Page No.
EXECUTIVE SUMMARY	3
1. INTRODUCTION	4
1.1 Background	4
1.2 Scope of the Survey	4
1.3 Sampling Personnel	4
2. METHODOLOGY	5
2.1 Species and Techniques	5
2.2 Sampling & Analytical Methodology	5
3. SAMPLING AND OPERATIONAL DETAILS	7
3.1 Process Description	7
3.2 Sampling Positions	7
3.3 Uncertainty	7
3.4 Emission Monitoring Survey Details	8
4. RESULTS AND DISCUSSION	9
4.1 Initial Velocity and Temperature Traverse	9
4.2 Particulate Matter	9
4.3 Combustion Gases	9
TABLES (6 Additional Pages)	
1 Flow Data	
2 Particulate Emission Data – Dryer	
3 Particulate Emission Data – Cooler	
4 Particulate Emission Data – Secondary Cyclone	
5 Oxygen Data - Dryer Stack	
APPENDICES (1 Additional Page)	
1 Calculations	

EXECUTIVE SUMMARY

Resource & Environmental Consultants (REC) Ltd was commissioned by Sundown Products Ltd to monitor emissions of pollutants released from the animal feed manufacturing process at their site in Huntingdon, Cambridgeshire.

In accordance with the requirements of their site permit, monitoring has been undertaken for the following pollutants:-

- Total Particulate Matter
- Oxygen (O₂) for reference purposes on the Dryer stack only

The following results were obtained from the emission monitoring survey and are compared with the current permit limit:-

Species	Accreditation Status	Average Emission Concentration (mg/Nm ³)		
		Secondary Cyclone	Cooler	Dryer
Particulates	A	-	35.6	108.4
Particulates	E	24.1	-	-
Permit Limit		20	150	150

NOTE 1: Data from all sources except Dryer are expressed in mg/Nm³ at 273K, 101.3kPa, wet gas without correction for moisture and oxygen content unless otherwise stated. Data from Dryer expressed in mg/Nm³ at 273K, 101.3kPa, wet gas and corrected to 17% oxygen content

NOTE: UKAS status:- (A) REC Ltd accredited for sampling and analysis. (B) REC Ltd accredited for sampling only, UKAS accredited analysis conducted by SAL Ltd. (C) REC Ltd accredited for sampling, analysis not UKAS accredited. (D) REC Ltd not accredited for sampling, UKAS accredited analysis conducted by SAL Ltd. (E) REC Ltd not accredited for sampling, analysis not UKAS accredited.

1. INTRODUCTION

1.1 Background

Sundown Products Ltd commissioned REC Ltd to conduct an emission monitoring survey on their various process emission stacks from the animal feed manufacturing process at their site in Huntingdon, Cambridgeshire.

1.2 Scope of the Survey

An emission monitoring survey was required to determine the release concentrations of particulate matter from the process emission points. In addition O₂ concentrations were to be measured from the Dryer Stack to allow emission results to be reported at the appropriate standard reference conditions.

Ancillary measurements of stack dimensions, temperature and velocity were also made.

Results were to be reported at 273K, 101.3kPa, without correction for moisture and oxygen content. Results from the Dryer were to be referenced to 17% O₂ content.

1.3 Sampling Personnel

Monitoring was conducted by the following REC Ltd permanent staff:-

- David Burns - Team Leader, MM05 579, MCERTS Level 2, TE1
- Michelle Edwards - Assistant, MM05 659, MCERTS Level 1, TE1

2. METHODOLOGY

2.1 Species and Techniques

The following table shows the reference methods used for the emission monitoring survey:

Species	Accreditation Status	Method	Uncertainty $\pm\%$	Limit of Detection
Moisture	A	In house method MM0010 based on BS EN 14790	20	0.1%vol
Particulate Matter	A	In house method MM0009 based on BS ISO 9096	10	1 mg/m ³
Particulate Matter	E	In house method based on BS 3405	25	1 mg/m ³
Oxygen	A	In house method MM0002 based on ISO 12039	10	0.1%vol

NOTE: UKAS status:- (A) REC Ltd accredited for sampling and analysis. (B) REC Ltd accredited for sampling only, UKAS accredited analysis conducted by SAL Ltd. (C) REC Ltd not accredited for sampling, UKAS accredited analysis conducted by SAL Ltd. (D) REC Ltd accredited for sampling, analysis not UKAS accredited. (E) REC Ltd not accredited for sampling, analysis not UKAS accredited.

2.2 Sampling & Analytical Methodology

Total Particulate Matter

To determine the concentration of particulate matter in emissions, isokinetic stack sampling equipment satisfying the requirements of BS ISO 9096 was utilised and in-house method MM0009 followed.

The Standard describes the methodology for measuring particulate matter under defined conditions and at discrete locations in the duct. Sampling is carried out under isokinetic sampling conditions i.e. the flowrate through the sampling nozzle is adjusted to equal the flowrate in the duct at the sampling positions. Velocity pressures were recorded throughout the monitoring period by means of an 'S' type pitot integral to the sampling probe and nozzle assembly.

A sample of the exhaust stream was removed from the stack via a titanium nozzle and titanium lined heated probe. It was then passed through a quartz fibre filter contained in a heated oven compartment. The temperature of the probe and filter box were maintained at 160°C i.e. above the dew point of the stack gases, to ensure moisture did not condense on the filter. Each filter used complied with the requirements of Section 6.2.7 of BS EN 13284-1:2001 in that the efficiency was better than 99.5% for particles of 0.3µm diameter (or 99.9% for particles of 0.6µm diameter).

The impinger train was seated in a water bath to cool the gas stream and condense out less volatile gases and water vapour.

The first two impingers encountered by the gas stream contained deionised water. The third impinger was left empty and the fourth contained anhydrous silica gel which was used to dry the gas stream before passing it through a dry gas meter (DGM) to measure the volume of gas sampled.

All the impingers were weighed before and after the sampling run in order to determine the mass of water condensed by the impinger train (in house Method MM00010).

Upon completion of sampling, the filter was removed to a clean petri dish, labelled and sealed. The probe and filter housing were rinsed with acetone and water. The washings were collected in a container and submitted for analysis along with the filter.

Due to access restrictions on the Cyclone stack, REC could not conduct particulate sampling in accordance with BS EN 13284 or BS ISO 9096. To determine the concentration of particulate matter in the emissions, stack sampling equipment satisfying the requirements of BS 3405 was used. REC is not accredited for particulate sampling to this standard.

The Standard describes the methodology for measuring particulate matter under defined conditions and at discrete locations in the duct. Sampling is carried out under isokinetic sampling conditions i.e. the flow rate through the sampling nozzle is adjusted to equal the flow rate in the duct at the sampling positions.

Combustion Gases

To determine the concentration of the combustion gas (O₂) in emissions, a Testotherm Model 350XL was used. The analyser incorporates a gas conditioner to enable the gas stream to be presented to the electrochemical cells on a dry gas basis. In house method MM0002 was followed.

The analyser satisfies the requirements of the following Standards:-

O₂ - ISO 12039

For each parameter the measured value (m.v.) and accuracy associated with this type of measurement using the Testo 350XL is:

O₂ ± 0.8% of full scale deflection

The analyser would be calibrated against traceable test gases prior to the survey.

The Standards describe the methodology for measuring the combustion gases listed above under defined conditions in the duct. Sampling is carried out under anisokinetic sampling conditions as it is assumed that the gas is homogenous across the sample plane.

Stack Temperature and Velocity

To determine the stack temperature, a calibrated thermocouple and digital indicator were employed. The exhaust gas velocity was investigated using a pitot static probe (to MM0009) and digital manometer.

3. SAMPLING AND OPERATIONAL DETAILS

3.1 Process Description

The operations at Sundown Products Ltd are authorised under an IPPC Part B permit issued by the Local Authority under the Pollution Prevention & Control Regs 2000.

The process is therefore under Local Authority regulation and must demonstrate compliance with the emission limits stipulated in the site permit.

The site manufactures a wide range of animal feeds mainly for the equine and poultry markets.

3.2 Sampling Positions

On the Secondary Cyclone 1 x 4" BSP was installed on a horizontal plane less than 4 hydraulic diameters from any possible flow disturbance. Access was provided on a small platform that did not meet EA TGN M1 requirements and would not allow safe sampling to BS ISO 9096. Sampling to BS 3405 was therefore undertaken outside our scope of accreditation.

On both the Cooler and Dryer 1x 4" BSP were installed on a horizontal plane. The sample points provided were at least 4 x hydraulic diameters from any flow disturbance both upstream and downstream of the sample plane. However due to the small size of the platforms provided, sampling could only be carried out at a limited number of points across each sampling plane.

The sample planes and platform sizes do not meet the requirements stated in Environment Agency Technical Guidance Note M1. TGN M1 states that 2 x 5" BSP sockets are required for sampling.

The initial temperature and velocity traverse conducted along the sample plane showed that the flow requirements of TGN M1 were however met.

3.3 Uncertainty

On the Cyclone the standard methods were fully complied with, consequently the standard uncertainties apply.

Due to the access restrictions on the Cooler and Dryer, only a single sampling plane could be utilised and at limited points. This will increase the measurement uncertainty from the standard quoted.

3.4 Emission Monitoring Survey Details

The emission monitoring survey was carried out on the animal feed manufacturing process over the period 29 & 30 January, 2009. The table below summarises the actual sampling periods.

SAMPLING PERIODS

Emission Stack	Parameter	Sample Time & Date
Dryer	Particulates & O ₂	14:49 to 13:49, 29/1/09
Cooler	Particulates	11:15 to 12:15, 30/1/09
Secondary Cyclone	Particulates	13:24 to 13:54, 29/1/09

4. RESULTS AND DISCUSSION

4.1 Initial Velocity and Temperature Traverse

An initial pitot-static pressure and temperature traverse was carried out. From these data stack velocity, expressed in metres per second (m/s), and volumetric flowrates expressed in cubic metre per hour (m³/hr) have been calculated.

The results are reported at actual stack conditions and the volumetric flowrate is further expressed at the standard reference conditions of 273K, 101.3kPa i.e. standard temperature and pressure (STP). The results are summarised in Table 1.

4.2 Particulate Matter

The results of the particulate sampling runs are summarised in Tables 2 to 5. From the mass of particulate matter on the filter and in the acetone/water wash residue and volume sampled an emission concentration was calculated.

The results for all sources except the Dryer are expressed in mg/m³ at 273K, 101.3kPa, without correction for moisture and oxygen content.

The results for the Dryer are expressed in mg/m³ at 273K, 101.3kPa, without correction for moisture content and referenced to 17% O₂ content.

4.3 Combustion Gases

The results of the oxygen monitoring test on the Dryer are summarised in Table 6. The table presents the average of concentrations measured throughout the sample period. Concentrations are expressed as a percentage by volume (%vol).

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TABLES

TABLE 1

FLOW DATA

Stack Ref.	Stack Temp	Av Pitot ΔP	X-Sect. Area	Velocity (actual)	Volume Flow (m ³ /hr)	
	(°C)	(Pa)	(m ²)	(m/s)	(actual)	(@ ntp)
Dryer	82	333	0.785	25.6	72,479	55,791
Cooler	31	61	0.385	10.2	14,128	12,683
Secondary Cyclone	28	22	0.196	6.1	4,325	3,931

TABLE 2

PARTICULATE EMISSION DATA – DRYER

DATE: 29/1/09

14:49 to 13:49

Sampling Data		
Run Time (min)	60	
Total mass H ₂ O collected (g)	74.2	
Pitot tube constant, C _p	0.85	
Dry gas meter (DGM) volume (litres)	671.00	
Temperature DGM (°C)	11	
Temperature stack (°C)	88	
Mean pitot tube pressure drop, delta P (cm H ₂ O)	0.13	
Orifice meter pressure drop, delta H (cm H ₂ O)	1.37	
Barometric Pressure (kPa)	103.2	
X-sectional area of stack (m ²)	0.785	
Nozzle size (mm)	9.03	
Flow Data		
Velocity, actual (m/s)	4.4	
Velocity, ntp (m/s)	3.3	
Vol. Flow, actual (m ³ /hr)	12339	
Vol. Flow, ntp (m ³ /hr)	9429	
Volume sampled, ntp, dry gas (m ³)	0.664	
Volume sampled, ntp, wet gas (m ³)	0.756	
Analytical Data		
Filter Weight Gain (mg)	46.7	
Acetone Wash Residue Weight (mg)	6.8	
Total Particulates (mg)	53.5	
Partics Field Blank (mg)	4.0	
Blank % of ELV	4.0	
Emission Data		
	As Measd	@ Ref O ₂
O ₂ (%vol)	18.0	
H ₂ O (% vol)	12.2	
Percentage Isokinetic	98.3	
Particulates (mg/m ³)	80.6	108.4

TABLE 3

PARTICULATE EMISSION DATA – COOLER

DATE: 30/1/09

11:15 to 12:15

Sampling Data	
Run Time (min)	60
Total mass H ₂ O collected (g)	4.7
Pitot tube constant, C _p	0.85
Dry gas meter (DGM) volume (litres)	353.00
Temperature DGM (°C)	17
Temperature stack (°C)	29
Mean pitot tube pressure drop, delta P (cm H ₂ O)	0.70
Orifice meter pressure drop, delta H (cm H ₂ O)	0.37
Barometric Pressure (kPa)	101.9
X-sectional area of stack (m ²)	0.385
Nozzle size (mm)	3.99
Flow Data	
Velocity, actual (m/s)	9.2
Velocity, ntp (m/s)	8.4
Vol. Flow, actual (m ³ /hr)	12786
Vol. Flow, ntp (m ³ /hr)	11581
Volume sampled, ntp, dry gas (m ³)	0.337
Volume sampled, ntp, wet gas (m ³)	0.343
Analytical Data	
Filter Weight Gain (mg)	5.2
Acetone Wash Residue Weight (mg)	7.0
Total Particulates (mg)	12.2
Partics Field Blank (mg)	1.0
Blank % of ELV	1.9
Emission Data	
H ₂ O (% vol)	1.7
Percentage Isokinetic	91.2
Particulates (mg/m ³)	35.6

TABLE 4

PARTICULATE EMISSION DATA – SECONDARY CYCLONE

Sampling Data	Cyclone	
	Run 1	Run 2
DGM Start (m ³)	333.457	333.742
DGM End (m ³)	333.738	334.049
Volume Sampled (m ³)	0.281	0.307
Ambient Temp (°C)	10.6	10.6
Ambient Press (kPa)	101.9	101.9
Volume Sampled, 273K, 101.3kPa (m ³)	0.272	0.297
Analytical Data	AQ13973	AQ13972
Filter Weight Gain (mg)	0.2	3.8
Acetone Wash Residue (mg)	3.2	6.8
Total Particulate Matter (mg)	3.4	10.6
Emission Concentration Data		
Total Particulate Matter (mg/m ³)	12.6	35.6

TABLE 5

OXYGEN DATA – DRYER STACK

Stack Ref.	O ₂ (%vol)
Dryer Stack	18.0

APPENDIX 1

Calculations

Conversion Factors

ppm @ mg/Nm³ (at 273K, 101.3kPa: STP)

CO	X	1.25	
SO ₂	X	2.86	
VOC's	X	0.53	(as total Carbon)
NO _x	X	2.05	(as NO ₂)

Oxygen Correction to Reference Value

Concentration at (STP) -> Concentration at 273K, 101.3kPa, reference O₂ and Dry Gas, i.e.
Concentration X ((20.9-O₂ ref)/(20.9-O₂ measured)) = Concentration at ref Oxygen state.

Example Calculation

SO₂ concentration at STP = 170.7 mg/Nm³

Oxygen percentage in gas stream = 13.8%

Reference Oxygen = 11%

SO₂ concentration at reference O₂ conditions = 170.7 ((20.9-11)/(20.9-13.8))
= 238 mg/Nm³ at 273K, 101.3kPa,
11% O₂ and Dry Gas

Moisture Correction (Wet to Dry)

Concentration of Gas Dry = Concentration of x 100/100-Bws Gas Wet

Concentration of Gas Wet = Concentration of x 100-Bws/100 Gas Dry

Where Bws = moisture content of gas stream in percent (Vol/Vol).

Example

VOC concentration = 25 mg/Nm³ (Wet)

Moisture Content = 27.1%

Concentration of VOC = 25 (100/(100-27.1))

Carbon (C) to Trichloethylene (TCE)

ppm TCE = ppm C x 0.6715

TCE in mg/m³ = TCE ppm x 5.864 (Mol Wt/22.4)