

Leakey, Antony

From: AberthawEAreporting - UK <AberthawEAreporting@rwenpower.com>
Sent: 03 November 2015 10:37
To: Leakey, Antony; AberthawEAreporting - UK
Cc: Parr, Elizabeth
Subject: RE: Oat Husk Trial - RWE Generation UK plc, Aberthaw Power Station, Permit Ref. RP3133LD

Tony,

The report is ok to go on the public register.

Kind Regards,
Amy Lavisher
Environmental Compliance Engineer
RWE Generation UK plc

Aberthaw Power Station, The Leys, Aberthaw, Barry, CF62 4ZW
Tel (Internal): 7-357-2270
Tel (External): +44 (0)1446 752270
Mobile: +44 (0)7920 833031
Fax: +44 (0)1446 750844
Mail to: amy.lavisher@rwe.com

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From: Leakey, Antony [mailto:Antony.Leakey@cyfoethnaturiolcymru.gov.uk]
Sent: 03 November 2015 10:10
To: AberthawEAreporting - UK
Cc: Parr, Elizabeth
Subject: RE: Oat Husk Trial - RWE Generation UK plc, Aberthaw Power Station, Permit Ref. RP3133LD

Amy, we usually put these reports on the public register, but this one is marked "Confidential". Please can you confirm that the whole report can go on the public register or provide details and justification for the confidential aspects. If commercial confidentiality is agreed we will then need a redacted or public register version including the emissions data as a minimum.

Regards,

Tony Leakey
ARhLI Arbenigwr Technegol / PPC Technical Specialist
Cyfoeth Naturiol Cymru / Natural Resources Wales
Ffôn/Tel: 03000 653087
Ffôn symudol / Mobile: 07468 742350
E-bost/E-mail: antony.leakey@cyfoethnaturiolcymru.gov.uk / antony.leakey@naturalresourceswales.gov.uk
Gwefan / Website: www.cyfoethnaturiolcymru.gov.uk / www.naturalresourceswales.gov.uk

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From: AberthawEAreporting - UK [mailto:AberthawEAreporting@rwenpower.com]
Sent: 02 June 2015 14:26
To: Leakey, Antony



PR + File ~~PR~~ RP7173LD/4

Engineering Report Co-firing Oat Husk through Aberthaw Power Station

Reference Number: TECH/TEF/146/15

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Issue: 1

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Co-firing Oat Husk through Aberthaw Power Station

Prepared for:

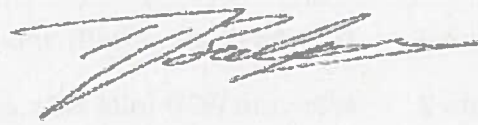
Aberthaw Power Station	
Client Contact :	Mark Picton
Contract No. :	

Prepared by:

Caroline Syred,
Lead Solid Fuels Engineer

**Reviewed by:**

Colin Burgess,
Process and Fuels Engineer

Authorised by:

Trudy Beeley
Senior Solid Fuel & Materials
Handling Engineer

Summary

RWE has investigated and used a range of suitable sources of renewable fuels for co-firing at Aberthaw Power Station for approximately ten years. Oat husk was identified as a potential renewable fuel for co-firing at Aberthaw.

This report describes the results of tests on Unit 7 at Aberthaw using the Phase 1 biomass firing system. It is intended that the oat husk will be included in the fuel matrix to allow for optimum flexibility when firing biomass through the plant.

The results of these tests demonstrated that oat husk can be readily utilised as a renewable fuel within the Phase 1 Biomass system. There was no detrimental effect on combustion and environmental performance detected at the co-firing rates used.

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1 Introduction

RWE has investigated and used a range of suitable sources of renewable fuels for co-firing at Aberthaw Power Station for approximately ten years. Oat husk was identified as a potential renewable fuel for co-firing at Aberthaw.

Unit 7 at Aberthaw currently burns sawdust supplied through the Phase 1 biomass plant. However there is a limited supply of suitable sawdust available and not all the capability of the plant is utilised. Oat husk is being investigated as a fuel that could potentially be used to fill some of the remaining Phase 1 capacity.

This report describes the results of the tests on Unit 7 using the Phase 1 biomass firing system. Tests were carried out co-firing 100% oat husks and a separate test firing a 50/50 blend of oat husk and sawdust. It is intended that oat husk will be used as one of the range of biofuels suitable for firing on this system.

2 Background

RWE Aberthaw Power Station is a three unit, 1550MW coal-fired plant consisting of three 535MW generating units. The units are arch (down-shot) fired boilers designed to fire low volatile semi-anthracite coal. Aberthaw has the capability to co-fire biomass through its units by direct injecting solid biomass through designated ports located above the coal burners. Unit 7 currently burns biomass through the Phase 1 biomass plant. The system has been used for approximately 10 years. The throughput of biomass depends on fuel type and can be up to 20 tonnes/hour.

When the biomass material was delivered to Aberthaw samples of the oat husk were taken as the material was tipped into the Phase 1 shed. The analysis results of a typical oat husk sample taken are presented in Table 1 below alongside an average sawdust (current biomass fuel) analysis for 2014 for comparison.

Table 1 Proximate and ultimate analysis of ground oat husk

	Sawdust	Oat Husk			
Reporting Basis	As Received	As Received		Dry	Dry Ash Free
Analyser	Average of	RWE		RWE	RWE
FCL ID no.	2014	24294-5 (ave)	24296-8 (ave)	24296-8 (ave)	24296-8 (ave)
Date of Sample	deliveries	14/05/2014	16/05/2014	16/05/2014	16/05/2014
Total Moisture (%)	50.6	10.8	10.8	n/a	n/a
Bound Moisture (%)	n/a	2.4	2.3	n/a	n/a
Ash (%)	0.2	3.6	3.7	3.8	n/a
Volatile Matter (%)	41.6	78.7	78.7	80.5	83.7
GCV (GJ/t)	10.07	18.42	18.45	18.89	19.62
NCV (GJ/t)	8.20	16.96	16.98	n/a	n/a
Hydrogen (%)	3	5.5	5.5	5.6	5.9
Carbon (%)	n/a	45.0	45.0	46.1	47.9
Nitrogen (%)	n/a	1.0	1.1	1.1	1.2
Sulphur (%)	0.01	0.09	0.10	0.10	0.10

The moisture content of the oat husk is significantly lower than that of the sawdust normally fired through the Phase 1 plant. This results in a significantly higher CV. The ash content of oat husk is higher than that of sawdust, however it is significantly less than coal. The oat husk has a slightly higher sulphur content than oat husk, however this remains much lower than many coals. Ash and size analysis for oat husk can be found in Appendix B.

3 Evaluation Exercise Programme

The tests reported here, were undertaken to demonstrate that firing oat husk at Aberthaw Power Station had no adverse operational or environmental impact. Tests were carried out during prolonged operation at a steady high load in order to establish that there were no significant variations in emissions compared to coal alone. The tests represent typical conditions and throughput rates under which it is envisaged that the oat husk will be fired via the Phase 1 biomass plant.

3.1 Baseline Test

A baseline test was carried out initially with Aberthaw Unit 7 firing coal only. This was used as a comparison and to evaluate any variation of the operational and environmental impact of oat husk on the performance of the Unit. The coal used during this test was a consistent blend of Welsh semi-anthracite coal, Ffos-y-fran and Tower.

3.2 100% Oat Husk Co-firing Test

A trial volume of 135 tonnes of oat husk was delivered to Aberthaw on the 14th and 16th of May 2014 in order to carry out a manual handling and combustion trial. The material was ground off-site before being delivered to Aberthaw by walking floor lorry. Initially 55 tonnes of material was delivered on the 14th May to assess the handling of the material. After this was successfully completed a further 80 tonnes was delivered on the 16th May for a full co-firing trial to assess operational and environmental impact on the boiler.

The same coal as the baseline test, a blend of Ffos-y-fran, was used during the co-firing of the oat husk. One hundred percent oat husk was fired through the biomass Phase 1 plant and direct injected into Unit 7 boiler via the biomass nozzle located above the coal burners.

3.3 Sawdust / Oat Husk Blend Co-firing Test

The current biomass material used through Aberthaw Phase 1 plant is sawdust. If oat husk was commercially burnt at Aberthaw there would be crossover periods when both materials were in the shed and a blend of the material would be sent through the plant. It was therefore decided to carry out a test with a blend of sawdust/oat husk (50:50). This would allow a comparison between co-firing 100% oat husk and a blend of oat husk / sawdust.

On the 17th November 50 tonnes of pre-milled oat husk was delivered to Aberthaw Power Station. The same quantity of sawdust was also delivered to Aberthaw and this was blended with the oat husk inside the Phase 1 shed on a 1:1 blend ratio.

show a reasonably steady level throughout the day indicating a consistent supply of Welsh coal was used throughout the trial. During both test periods when firing the biomass a small reduction in SO₂ emissions could be seen.

Within the accuracy of the analysers and the variation in the sulphur content of the coal there is no significant variation in the SO₂ emissions with co-firing. Oat husk does not have any adverse effect on these emissions when compared to those measured when firing coal only.

4.2.2 Nitrogen oxides (NO_x) emissions

The NO_x emissions during both the 100% oat husk firing trial and the blend of oat husk/sawdust trial can be seen in Appendix A. These figures show that whilst firing biomass there was a small decrease in NO_x emissions. This is also typical for sawdust firing.

During the 100% oat husk trial the NO_x emissions throughout the day were slightly lower than the blend of oat husk / sawdust due to operational issues. There was a mill out of service during the 100% oat husk trial resulting in limited combustion setup and optimisation so although NO_x was lower the combustion performance was not optimal.

4.2.3 Particulate matter emissions

The particulate dust emissions can be seen in Appendix A. These figures show the stack dust measured during the 100% oat husk and the blend of the oat husk/ sawdust trial, with and without the biomass firing.

During the 100% oat husk trial there is no variation in the dust particulates with and without the oat husk co-firing. The dust emissions are within normal operating range and below the environmental limits. With a blend of the oat husk / sawdust there was a small increase in dust emissions when the biomass was firing however this was down to operational conditions and was still within normal operating range and below environmental limits.

4.2.4 Continuous emissions monitors (CEMs)

All emissions monitoring results discussed above refer to data extracted from the station CEMs. The monitors are:

Sulphur dioxide	Procal
Nitrogen Oxide	Procal
Particulate matter	Erwin Sick

The Sulphur dioxide analyser is fitted into the FGD inlet duct and is routinely checked and calibrated according to the site procedures by the Instrument Maintenance Department. The NO_x and the Particulate matter analysers are fitted in the stack and are routinely maintained, checked and calibrated in accordance with site procedures and the appropriate EN standards.

Calibration records for the above monitors during the trial indicate that the monitors were in full compliance.

4.2.5 Ash analysis

During the evaluation, samples of the furnace bottom ash and precipitator fly ash (PFA) was taken.

First field centre hopper PFA samples were taken by station personnel during the baseline coal-only trial and when firing 100% oat husks. This was repeated for the oathusk / sawdust blend trial. The results (averaged) are shown in Table 3 below with the carbon content of the fly ash 8.1% with and without biomass firing. This is typical for this unit. This shows that firing oat husk had no impact on carbon-in-ash (CIA) levels.

Table 3 *Precipitator first field CIA during 100% Oat husk co-firing trial and 50/50 oat husk / sawdust trial*

	Date / Time	Average First Field %
Coal Only	16 th May 2014 11h00	8.1
Coal and Oat husk	16 th May 2014 14h00	8.1
Coal Only	17 th November 2014 14h00	12.8
Coal and Oat husk / sawdust blend	17 th November 2014 16h20	9.0

The carbon-in-ash is measured and recorded by the first field centre hopper Promecon analysers, shown in Appendix A. This shows there is no variation in CIA across the precipitator passes confirming there is no change in the carbon-in-ash values.

There was no oat husk detected within the samples of PFA when they were analysed at Process and Fuel Technology's Moredon Labs.

5 Conclusions

The experience gained during the full scale evaluation trial co-firing 100% oat husk and a 50/50 blend of sawdust and oat husk demonstrated that oat husk can be used as an alternative fuel for co-firing with coal.

The trial evaluation demonstrated that up to 10t/h of oat husk can be readily fired through the Phase 1 direct injection biomass system whilst maintaining emissions within the required environmental limits.

In conclusion, it can be deemed that operating with oat husk would have no detrimental effect on power plant emissions during normal operating conditions, and in addition would offer notable environmental advantages of being carbon neutral, with lower sulphur content and with a small reduction of NO_x seen.

Appendix A. Emissions Data

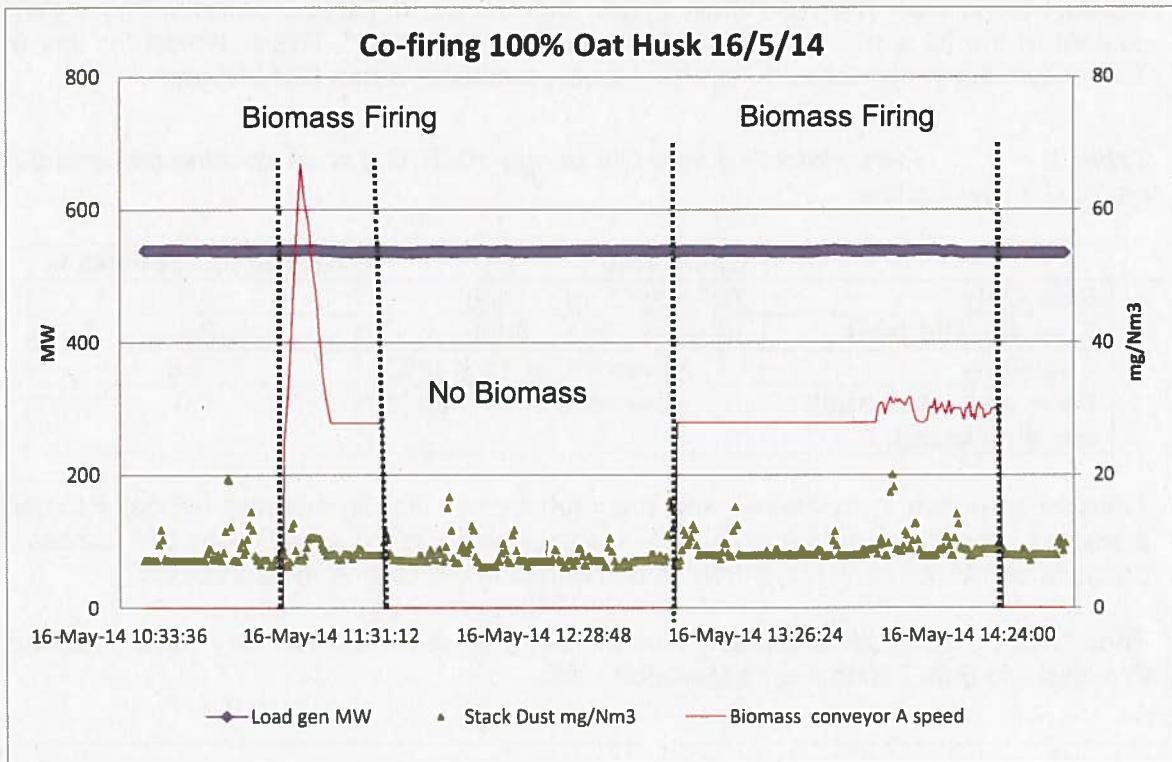


Figure 1. Dust Emissions with and without 100% Oat husk co-firing

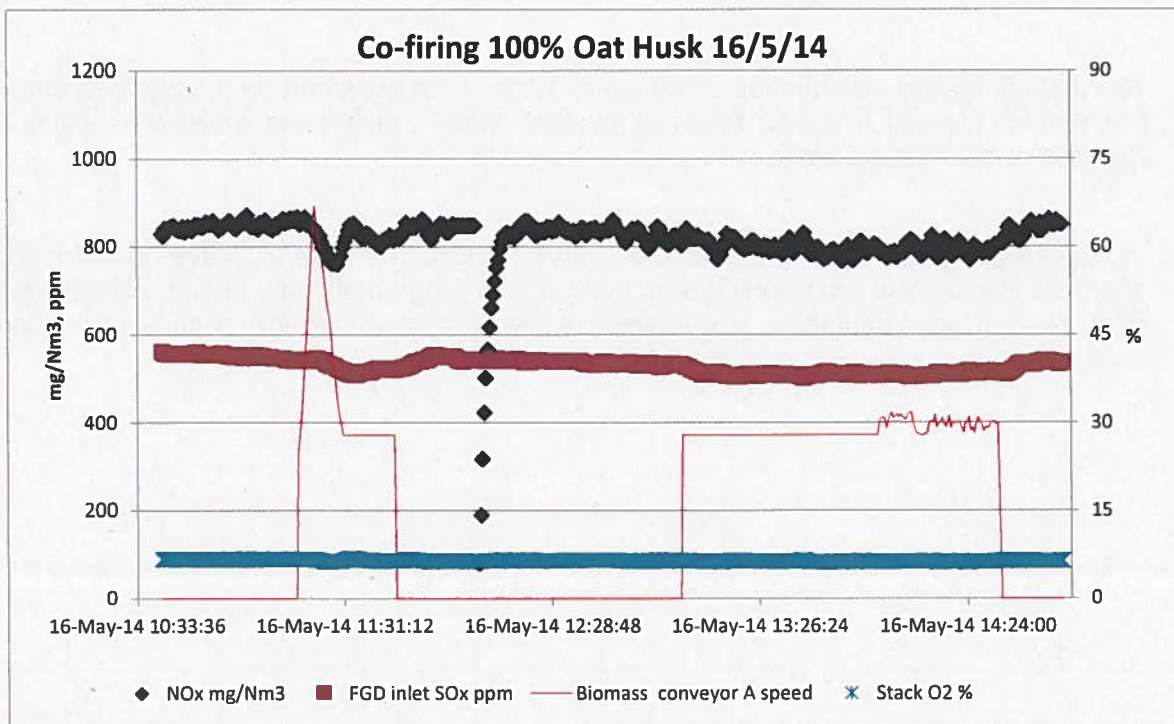


Figure 2. NOx and FGD inlet SOx with and without 100% Oat husk co-firing

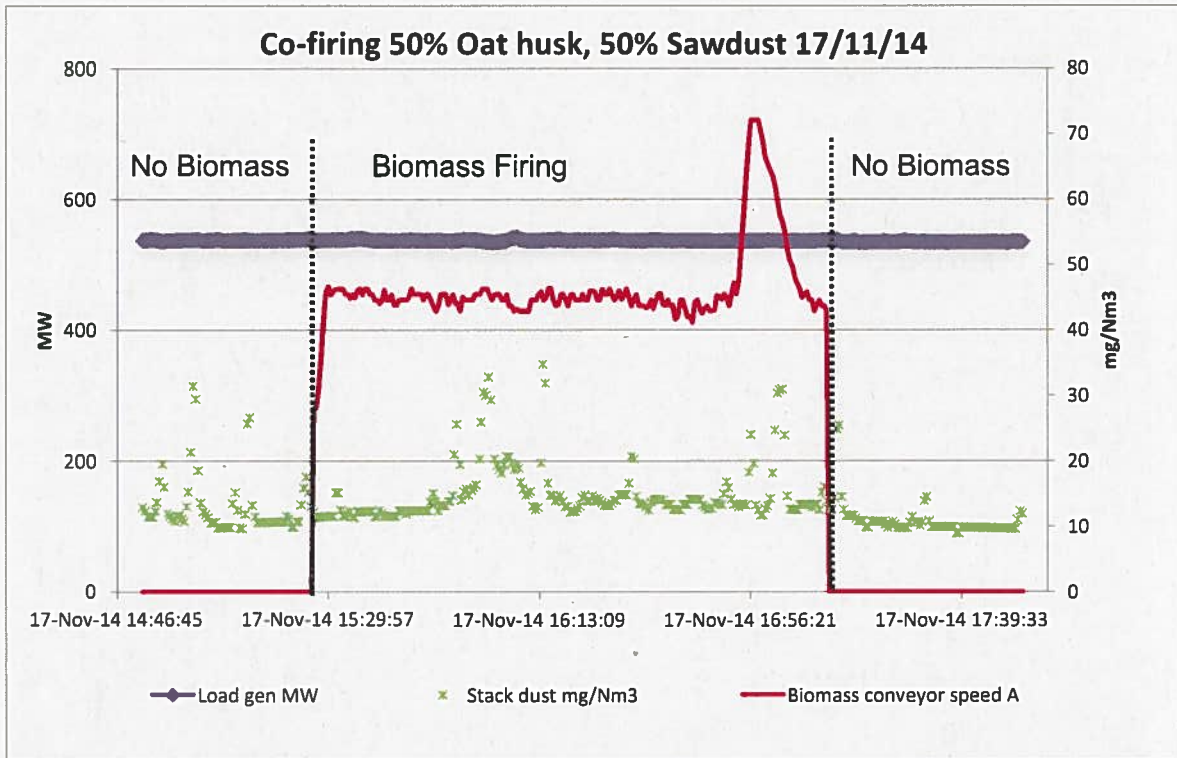


Figure 3. Dust Emissions with and without 50% Oat husk/ 50% Sawdust co-firing

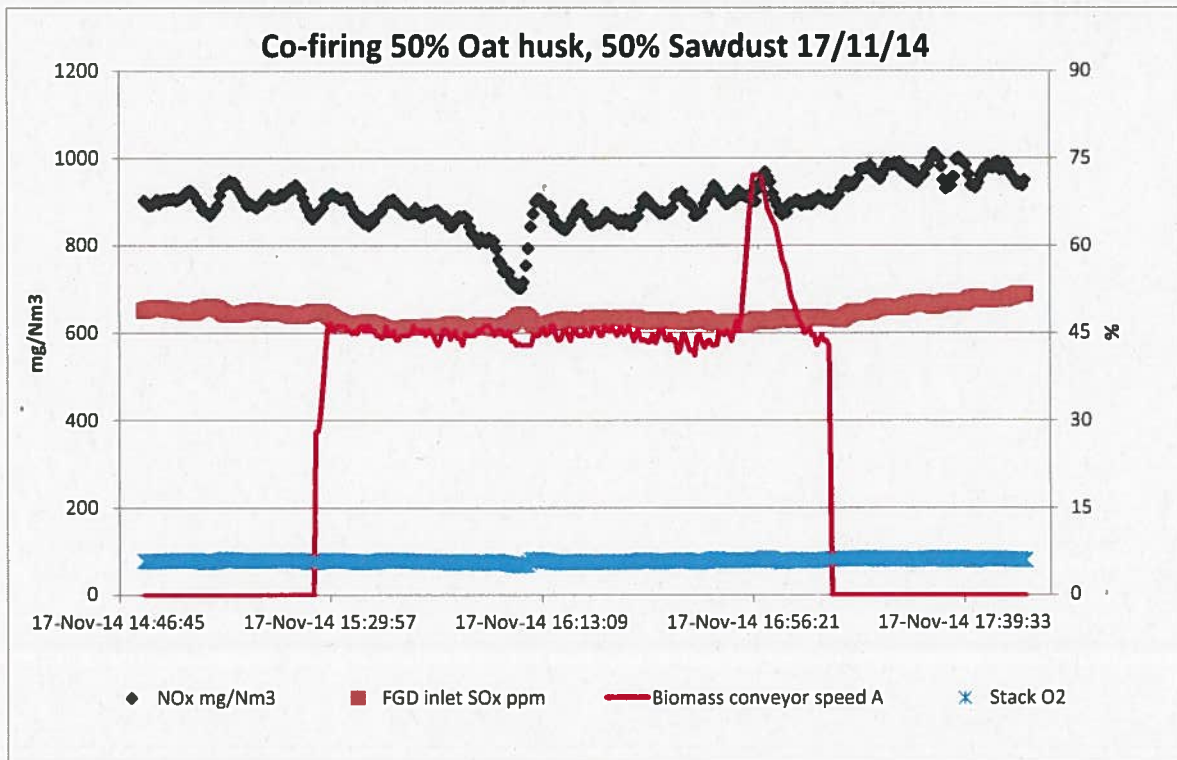


Figure 4. NOx and FGD inlet SOx with and without 50% Oat husk/ 50% Sawdust co-firing

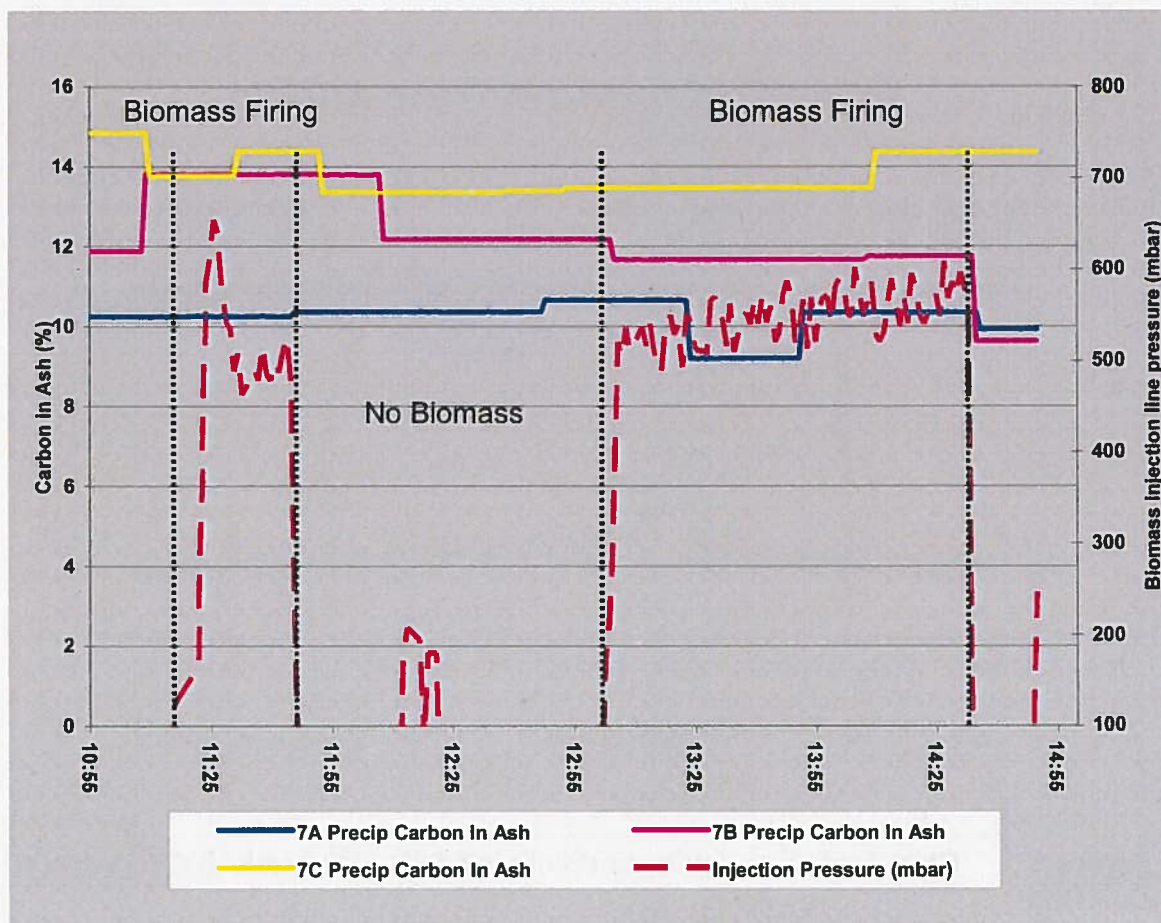


Figure 5. Precipitator Fly Ash when co-firing 100% oat husk

Appendix B. Fuel Analysis

Table 2. Size Analysis of oat husk

Analyser	RWE	RWE
FCL ID No.	24294/5	24296-8
Date of sample	14/05/2014	16/05/2014
< 0.5mm (%)	59.6	50.5
< 2mm (%)	99.2	98.4
< 3.15mm (%)	99.8	99.9
< 4.0mm (%)	100	100

Table 3. Major ash components of oat husk

Major Ash Species	Amount (AD %)
FCL ID No.	
Analyser	
SiO ₂	58.1
Al ₂ O ₃	<0.1
Fe ₂ O ₃	0.1
CaO	3.9
MgO	1.5
Na ₂ O	0.3
K ₂ O	14.5
SO ₃	1.7
P ₂ O ₅	8.2

RWE Npower plc
Windmill Hill Business Park
Whitehill Way
Swindon
Wiltshire
SN5 6PB

T +44 (0)1793 892900
F +44 (0)1793 892421
I <http://www.rwenpower.com>

Registered Office:
RWE Npower plc
Windmill Hill Business Park
Whitehill Way
Swindon
Wiltshire
SN5 6PB
Registered in England
& Wales: No. 3892782