Aberthaw Power Station: Application for a variation to permit EPR/RP3133LD

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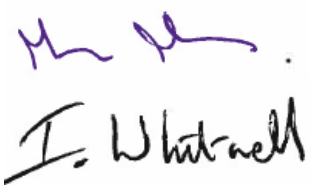
Prepared by: Ian Whitwell & Andy Moores	

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Summary

This report is intended to support the Environmental Permit Variation for an upgrade to the boilers at Aberthaw Power Station to reduce NOx emissions to air by up to 60%. The proposed modifications will install Low NOx Boiler Technology to all three units at Aberthaw, starting with Unit 9. The modifications provide a cost effective NOx abatement of stack gas concentrations expected to be in the range 450 to 600mg/Nm^3. Fitting Low NOx Boiler systems at Aberthaw would not prevent the fitting of additional abatement to reduce NOx further in the future.

The modifications will not significantly impact on other emissions from the station. The proposed installation at Aberthaw will require a period post commissioning during which the boiler performance will be optimised for the full range of coals burnt at the station.
Aberthaw's existing emission limits provide the flexibility required to undertake commissioning and optimisation of the Low NOx Boilers and it is proposed that existing permit conditions remain in force until the end of an agreed commissioning and optimisation phase. At the end of this phase RWE Generation UK will provide a commissioning report.

1 Introduction

This document is written to support the Environmental Permit Variation application for a proposed upgrade of Aberthaw Power Station. The power station currently has an environmental permit EPR/RP3133LD.

This document focuses on the changes in the information in the Environmental Permit and supporting information in the associated 2006 PPC application that would occur as a result of the proposed upgrade. It is submitted to support the variation application alongside the application forms. This document supplements the answers in Forms EPA, EPC2 and EPC3 – Varying a bespoke permit.

A summary of the timetable for the proposed upgrade is detailed below:-

Activity/Event	Date
Shutdown Unit 9	May 2015
Unit 9 Return to Service/Commissioning	September 2015
Unit 9 Handover to RWE	Dec 2015
Unit 9 Optimisation	Post Dec 2015
Begin work on Units 8 & 7	2017

Lessons learnt from the installation to Unit 9 will be incorporated into the timetable for the installation on Units 7 & 8.

It is critical that the permit determination is completed by the end of August 2015 to allow Unit 9 to return to commercial service by September 2015.

2 Description of Proposal

The downshot boilers installed at Aberthaw are unique in UK generation plant and are designed to allow the use of indigenous low volatile coals. Compared to power plant designed to only burn higher volatile coals the existing Aberthaw boiler design results in relatively higher NOx concentrations in the stack gas. The intrinsic relatively high NOx emissions are reflected in the current NOx Emission Limit Value (ELV) and BAT for Aberthaw.

RWE Generation UK plan to invest in Low NOx Boilers (LNBo) at Aberthaw Power Station. The cost for the first unit is £12m. The LNBo units will retain the ability to burn indigenous coal but with a significant reduction in NOx emissions.

Several companies offer LNBo technology, with differences in the detail, but the fundamentals of controlling fuel NOx formation remain the same.

The LNBo system controls NOx by creating a stable flame and controlling the staging of air to the boiler. This process limits the formation of NOx thermally and from nitrogen contained within the fuel.

In the LNBo design to be fitted on Unit 9, the pulverised fuel will be supplied to cyclone separators. There are two cyclones per burner. Within the cyclone, the majority of coal particles and a proportion of the primary air are directed to the main burner nozzles, while the remaining air and the lighter coal particles are passed via the vent pipe to a nozzle adjacent to the main nozzle. The original cyclones were mounted horizontally and prone to blockage. They suffered from rapid erosion and hence were removed over 20 years ago. The new cyclones are a vertical design that is reported not to suffer from the blockage and erosion issues experienced previously. The new cyclones are the standard Foster Wheeler design which have been used for many years at other power plants.

In addition to the new burners & cyclones, it is necessary to modify the existing boiler to provide Overfire Air (OFA) ports and ducting. Other changes are needed to the existing combustion air system to provide enhanced control of air flow. For the Unit 9 conversion it is necessary to install 36 new arch burners, each with 2 cyclones and vent pipes. Every burner installation requires 9 boiler tubes to be cut and new tube sections welded back in. Each burner has an associated OFA nozzle with ducting and automated control and isolation dampers.

Work is also required to the mills that feed the boiler with pulverised coal (PF). The mill modifications include changes to the ball charge, adjustments to the dynamic classifiers and new instrumentation. These changes being required to provide the PF/air flow and PF particle size distribution for the LNBo system.

There are a number of LNBo vendors and several power plant have been fitted with the technology. In Europe a LNBo has been fitted to the Compostilla power station in Spain. RWE Generation UK have been unable to find public domain reports of the Compostilla experience to include with this variation application. However whilst the Aberthaw LNBo design incorporates several of the features at Compostilla it differs in some areas, for example it has a different classifier on the mills, the cyclones vent to the boiler arch rather than to overfire air (as at Compostilla), secondary windbox layouts are different and Aberthaw operates burners individually whereas Compostilla operates burners in mill groups. Added to this, the Compostilla coals are predominantly high ash from local mines and therefore don't vary to the same extent as those burnt at Aberthaw. The Compostilla experience was judged therefore as indicative only for LNBo performance at Aberthaw.

The Unit 9 LNBo design may allow a change in Stable Export Limit (SEL)/Minimum Start Up and Shut Down Load (MSUL/MSDL). However the potential for a change will require investigation following optimisation of LNBo operation for the current load range. RWE Generation UK therefore expect to operate at the current SEL until the potential for a change has been fully evaluated. It is not expected that a change to SEL will affect the load at which FGD comes into service only the point at which oil support

for furnace safety is a requirement. MSUL/MSDL will match those declared in the Regulation 60 Notice. These will be reviewed during the commissioning and optimisation of the plant changes.

Aberthaw's existing emission limits provide the flexibility required to undertake commissioning and optimisation of the LNBo and it is proposed that existing permit conditions remain in force until the end of an agreed commissioning and optimisation phase. At the end of this phase, RWE Generation UK will provide a commissioning report which will provide information on both NOx concentrations and potential for changes to SEL/MSUL.

There is no work proposed for the Open Cycle Gas Turbine (OCGT).

3 Regulatory Context

From 1st January 2016, all large combustion plant including Aberthaw Power Station has to comply with the requirements of the Industrial Emissions Directive (IED). There are a range of compliance pathways available within the IED

- Compliance with Emission Limit Values (ELVs) specified in IED from the 1st January 2016. This includes derogations for low load factor and emergency use plant.
- Participation in the Transitional National Plan between 01/01/2016 and 30/06/2020. After this date plant must comply with IED ELVs
- Take a Limited Life Derogation and operate for no more than 17,500 hours between 01/01/2016 and 31/12/2023. Plants taking this option must close by the end of this period.

For all compliance routes stations must apply Best Available Techniques (BAT) to reduce emissions. EA & NRW have published (October 2014) an interim BAT Review that sets out EA & NRW's approach to implementing the IED within the coal and gas fired electricity supply industry from 1st Jan 2016 until the implementation of the LCP BREF conclusions. Due to the downshot boilers at Aberthaw and their uniqueness in the UK a site specific BAT assessment was carried out and the EA/NRW document includes a summary of the current, LCPD and interim BAT ELVs for Aberthaw and is reproduced below. The units are mg/Nm^3.

Limit Source	Annual	Monthly	48 hourly	24 hourly
TWG 19	980-1050			
Current LCPD		1100/1200	1210/1320	
				24 hour (110%*48hour)
BAT		1050	980	1080

In November 2014, NRW issued a Regulation 60 notice to all plant that will come under the IED and asked them to specify which compliance route they would be taking and confirm ELVs. The response which is to be submitted at the end of March 2015 will identify that Aberthaw will not be intending full compliance with the IED ELVs but will

be either entering the Transitional National Plan, taking the Limited Lifetime Derogation or the Limited Hours Derogation. The final decision on compliance route will be made during 2015.

4 Site Boundary

There will be no change in the EP boundary as a result of this variation. Some land may be used for temporary contractor use during the boiler conversion.

5 Technical Standards

The standards discussed below are from EPR 1.00 “How to comply with your permit” and EPR 1.01 “Combustion Activities”. The following information on operational techniques is provided in addition to that provided in the original application unless it is indicated that it is to replace information previously supplied.

5.1 Storage and Handling

There are no changes in relation to the coal storage on the Aberthaw site. There will be changes to the ball charge of the mills, that prepare the coal for use in the boiler, to modify the particle size distribution. The overall fuel handling concept will remain the same.

There will be no changes to storage of heavy fuel oil (HFO) or biomass. Nor will there be changes in the storage or handling of distillate fuel oil used in Open Cycle Gas turbines on site.

5.2 Point Source emissions to air

5.2.1 Control of oxides of nitrogen (NOx)

The LNBo installation will lead to lower stack gas concentrations of NOx than current levels. It is expected that the Unit 9 LNBo will achieve emissions in the range of 450 to 600 mg/Nm^3.The final emission rate may vary depending on the coal fed to the boiler, and the relationship between coal quality and type will be assessed during the commissioning and optimisation phase. There is not expected to be any change to the ratio of NO:NO2 resulting from the proposed LNBo.

5.2.2 Control of sulphur dioxide

Stack gas concentrations of sulphur dioxide will remain unchanged as a result of the upgrade because this is a property of the coal and FGD, not the firing system.

5.2.3 Control of dust

No change is expected to dust concentrations.

5.2.4 Carbon monoxide

There may be a small increase in carbon monoxide concentration from the LNBo compared to the current boiler. There will be a period of optimisation of CO and NOx for each boiler conversion. Emissions will remain within the normal range.

5.2.5 Carbon dioxide emissions

There should be no significant change in carbon dioxide emissions per kWh generated following the installation of the Unit 9 LNBo.

5.3 Point source emissions to water

There are no expected changes in the emissions to water as a result of the upgrade and all water emissions will remain within existing permitted levels.

5.4 Carbon in ash

There may be an increase in carbon in ash with the new boiler system. Managing levels of carbon in ash will be part of the LNBo commissioning and optimisation process. However carbon in ash levels will remain within levels that allow reuse of the ash, i.e. it will remain quality protocol-compliant.

5.5 Fugitive emissions

5.5.1 Fugitive emissions to air

There should be significant change in fugitive emissions to air from the LNBo modifications.

5.5.2 Fugitive emissions to water

There will be no increase in fugitive emissions to water as a result of the upgrade to the boiler.

5.5.3 Odour

There will be no change to odour at Aberthaw following the modifications to the boiler.

5.6 Management

There will be no changes to the existing management systems as a result of the upgrade.

5.7 Raw materials

As a primary NOx abatement technology there are no additional raw materials required with the LNBo system.

5.8 Waste minimisation and handling

There will be no changes in waste handling and recovery on the installation as a result of the proposed modifications.

5.9 Energy efficiency

The proposed upgrade of the boilers at Aberthaw will not significantly change the boiler efficiency. The expected increase in carbon in ash from, current typical, value of 8% to 13% with the LNBo results in a predicted reduction of 0.3% in unit efficiency.

5.10 Accidents

There will be no changes required in terms of accident management as a result of the proposed upgrade.

5.11 Noise

There will be no significant change to noise following the modifications.

5.12 Monitoring

There will be no changes in the monitoring equipment installed on the installation for compliance purposes as a result of the proposed boiler modifications. There will be some changes to the boiler instrumentation for process control purposes. LNBo modification is not considered a major change in terms of CEMs and the instrument range for NOx remains within the valid range. An Annual Surveillance Test (AST - which evaluates the CEM to show that it continues to function correctly and the calibration function is valid) should be sufficient. However, it is possible that a Quality Assurance Level (QAL) 2 test (recalibration) may be necessary once the boiler modifications are completed. RWE Generation UK have provisionally booked a test for December to carry out either an AST or a QAL2 test procedure.

5.13 Closure

It is not anticipated that the proposed upgrade will have any effect on the current closure plan.

5.14 Installation Issues

The proposed upgrade will have no changes in the measures to be undertaken in respect of interactions with national grid and the on-site above ground installation.

6 Impacts

The proposed Unit 9 LNBo will reduce the NOx emission concentrations of the modified units from the current 1050mg/Nm^3 to the range 450 to 600mg/Nm^3. The final NOx concentration will be achieved after a period of optimisation and may vary with the coal diet.

It is expected that there will be an increase in carbon in ash. The ash quality will remain within quality protocols but there will be a minor reduction in boiler conversion efficiency (of approximately 0.3%) because of this.

As a primary NOx abatement technology, LNBo does not require the use of additional chemical inputs as is the case with some secondary abatement options (such as SCR).

Other emissions will remain within current permitted limits.

7 Justification of option choice

The decision to proceed with LNBo investment has taken into account the range of possible future compliance pathways for Aberthaw.

Salway (2012) undertook a H1 assessment for NOx abatement at Aberthaw power station. This study assumed a level of NOx abatement to meet full IED ELV compliance. Salway concluded that some primary measures (Thermal Input Biasing, Combustion Control and Dynamic Classifiers) with Selective Catalytic Reduction (SCR) as a secondary abatement stage was BAT at Aberthaw to achieve the 200mg/Nm^3 IED ELV. Full IED compliance would allow a plant to operate under IED without restriction on load factor and Salway assumed a high (70%) load factor in his analysis. The Inerco LNBo was considered as an option to reduce ammonia use in the SCR by reducing the NOx concentration from the boiler. However, at the time there was limited experience of LNBo and hence it was not judged to be a viable BAT option.

Since 2012 confidence has grown in the LNBo system with the increased number of installations and longer operational experience that is now available. The installation of LNBo at a site is expected to increase carbon in ash and good control of carbon in ash is considered to a prerequisite to installation of LNBo. Dynamic Classifiers have been successfully installed and operated at Aberthaw to control carbon in ash. This successful installation and operation of Dynamic Classifiers at Aberthaw also increases confidence in the potential of LNBo system at Aberthaw. As stated in section 3 above RWE have also decided that it will take one of the IED derogations in the short term rather than opt for full ELV compliance and therefore the BAT requirements are different to those that were assumed in Salway (2012).

The LNBo technology alone would not allow compliance with the IED NOx ELV of 200mg/Nm^3 but would not prevent RWE Generation UK fitting secondary abatement to achieve the ELV should the station decide to adopt that compliance route in the future. Alternatively if a Limited Hours Derogation were taken the LNBo technology provides a means, alone or with secondary abatement, of meeting the 450mg/Nm^3 limit.

It is possible to rework Salway's 2012 H1 study to compare the cost effectiveness of LNBo and SCR abatement solutions. Assuming a load factor of 17% and a LNBo cost of £12million with other assumptions, such as a nominal station life of 10 years, as in Salway's study gives a Net Present Value of £40.8 million for LNBo and £128.2million for the SCR option. The total abatement is 85,520 tonnes for LNBo and 107,300 tonnes for SCR. This gives a LNBo abatement cost of £447/tonne and £1195/tonne for SCR. An increase in load factor will tend to improve the abatement figure for the SCR technology however LNBo technology alone will not allow high load factor operation after the end of the Transitional National Plan. The stack gas emission profile with the proposed investment program is plotted in Figure 1 below:

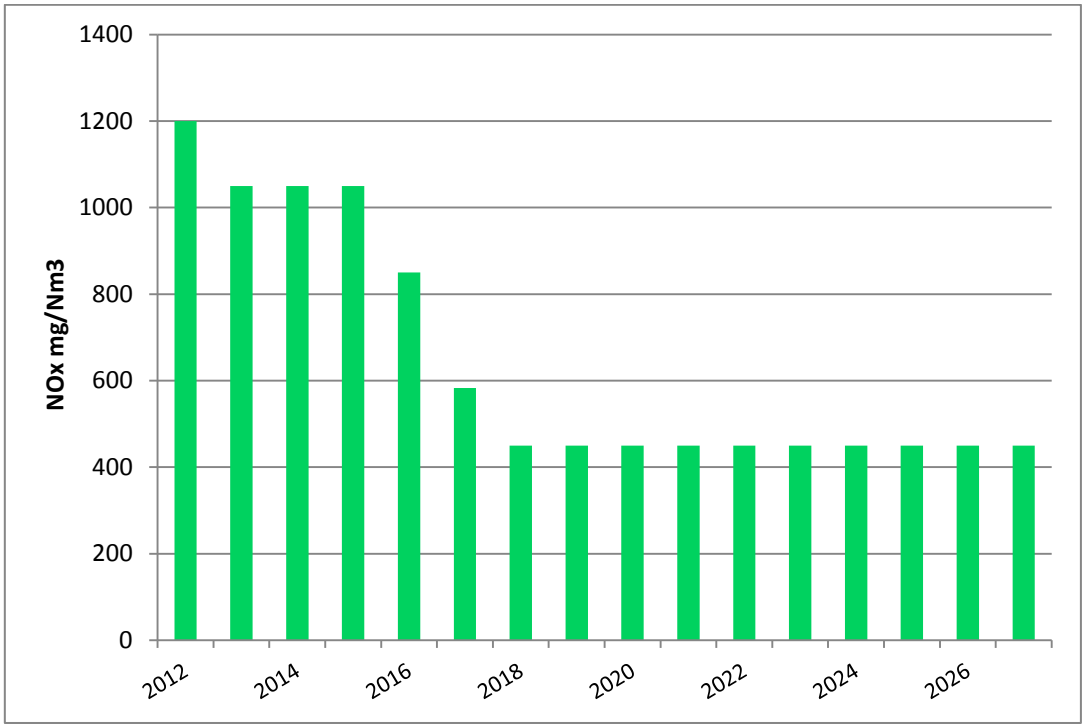

Figure 1 Anticipated Station NOx concentration with the proposed investment program (assumes LNBo at 450mg/Nm^3)

Compared to the SCR abatement based approach recommended by Salway, the LNBo considered in this change, provides a cost effective NOx abatement of stack gas concentrations to the range 450 to 600mg/Nm^3 given the lack of certainty regarding future IED compliance routes. There are no other primary measures that have the potential to offer significant abatement of NOx at Aberthaw. Dynamic classifiers were identified by Salway as a primary abatement option at Aberthaw and have already been installed. Salway also identified Thermal Input Biasing as a primary abatement option, Thermal Input Biasing is currently in operation at Aberthaw.

In conclusion, LNBo Technology provides a cost effective means of reducing stack gas NOx concentrations and will not prevent additional abatement technology from being installed at a later date.

8 References

Environment Agency; How to comply with your Environmental Permit (EPR 1.00)

Environment Agency; How to comply with your environmental permit. Additional guidance for Combustion Activities (EPR 1.01)

Environment Agency. BAT Review for the period 1 January 2016 until implementation of new BAT conclusions or end of the TNP/LLD (as appropriate) E&W. Paper 23/10/14

Salway, AG (2012) H1 Options Appraisal of NOx Abatement Measures for Aberthaw Power Station ENV/505/2012 July 2012

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