Variation application supporting document – Higher volatile matter coal use

Aberthaw Power Station EP RP3133LD/V013

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RWE Generation UK plc Aberthaw Power Station
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Variation application supporting document – Higher volatile matter coal use

Prepared for Natural Resources Wales

This report is intended to support the Environmental Permit Variation to allow burning of higher volatile matter coals (HMVCs) at Aberthaw Power Station. The proposal provides a cost effective decrease in NOx emissions to meet the required revised emission limit values.

The modifications will not significantly impact on other emissions from the station.

HVMC is inherently more volatile and has the propensity to self-heat and cause problems in materials handling and milling systems and hence the Station is investing £5M in mitigating these risks to safe levels through an extensive programme of fire detection and prevention measures, detailed in this document.

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1. Introduction

This document is submitted to support a permit variation to allow changes to the fuel diet and corresponding fuel handling systems at Aberthaw Power Station.

1.1. Description of Proposal

Aberthaw Power Station's boilers were designed to burn exclusively coals or coal blends with a low volatile matter content (between 9% and 14%). As part of a programme to reduce levels of oxides of nitrogen (NOx) the possibility of widening the volatile matter content range for coals that Aberthaw can burn upwards was considered, to include coals that are typically burnt at other coal-fired power stations in the UK and worldwide. These are bituminous coals, with a volatile matter content between 20 and 36%, these will be referred to as High Volatile Matter Coals (HVMC) in the remainder of this document.

It has been determined that in order for Aberthaw to be able to take HVMC the station will not have to make any changes to its boilers beyond those already underway or planned (see below). As such, Aberthaw's boilers will remain as the original low volatile matter coal (LVMC) design and the station would still be able to burn the LVMC that it currently uses should they be available.

RWE Generation UK recently invested (2015) in a Low NOx Boiler (LNBo) conversion on Unit 9 at Aberthaw. The cost of this investment was approximately £12m. The changes are described in (ENV/581/2015) previously submitted to Natural Resources Wales. Updated evaluations of future investment programmes against economic viability and the likely future role of coal have concluded that a combination of boiler modifications and a switch to HVMC should be utilised rather than similar LNBo conversions on Units 7 and 8. The boiler modifications carried out are the installation of air staging plates installed in the upper and middle windbox plenum chambers. These plates have restricted the secondary air flow to the upper and middle windbox to stage combustion on these units and reduce NOx emissions. Unit 8 had the air staging plates installed in June 2016 and Unit 7 in September 2016. Both units have operated since then with the plates installed.

To ensure that HVMC can be handled safely an extensive upgrade project will be required that will include some physical reinforcement of the station's milling systems and the installation of mill safety detection and overpressure suppression systems. To understand in more detail the issues surrounding the handling, milling and combustion of HVMC, and so inform future coal procurement and site investment options, Aberthaw carried out some short-duration trial burns of HVMC during 2016. These trials, followed a full engineering risk assessment by internal experts and a detailed Engineering Test Plan, they were carried out under strictly controlled conditions and did not involve any engineering modifications to the either the station's coal handling, milling equipment or the boilers.

A report on the trials has already been submitted to Natural Resources Wales (NRW) as a response to Improvement Condition 40, An extract is given below from the NRW Compliance Assessment Report (CAR) , the action is addressed in Section 2.6 below.

Extract from CAR

Coal trial report (IC40)

The trial report is noted. As the trial coal (Kedrovosky) is already part of the Aberthaw fuel diet there is little benefit in describing potential differences in ash quality (for landfill hydrogeological reasons) and trace element composition (for air quality and water priority hazardous substances discharge purposes). However, these aspects should be addressed in detail in any application made to permit permanent change to bituminous coal-firing.

ACTION: RWE to ensure that changes in ash quality and trace element composition are addressed in any application to permit permanent change to bituminous coal-firing.

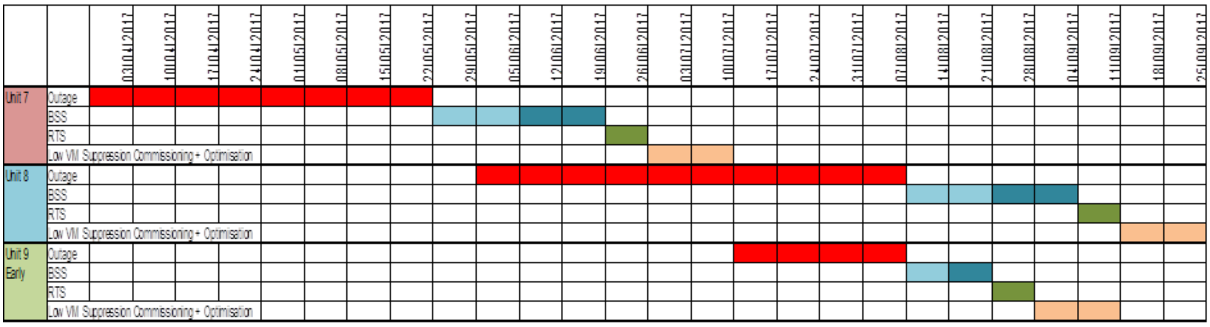
Appendix A of this document also details changes required to the permit in relation to start up and shutdown not related to the change to HVMC.

1.2. Programme

An indicative programme is outlined below, note that this is subject to change.

<u>KEY DATES</u>

- 31st Mar   Unit 7 upgrades begin.
- 1st May   Fuel route upgrades complete to enable coal stocking.
- 30th May   Unit 8 upgrades begin.
- 27th Jun   Unit 7 suppression system commissioning starts.
- 11th Jul   Unit 9 upgrades begin.
- 29th Aug   Unit 9 suppression system commissioning starts.
- 12th Sept   Unit 8 suppression system commissioning starts.
- 1st Oct   Installation complete, and optimisation begins



1.3. Regulatory Context

Aberthaw is currently part of the UK's Transitional National Plan (TNP). Under Article 32(2) of the IED plant in the TNP are required to meet the ELV requirements of the LCPD. The CJEU Judgement in September 2016 determined that the applicable monthly average LCPD ELV for Aberthaw is 500 mg/Nm^3, rather than the value for the use of low volatile coal applied by the UK. The measures outlined in this permit variation will allow Aberthaw to meet the revised ELV requirement.

The IED BAT ESI Review Paper[1] sets out the principles adopted by EA and NRW for establishing BAT. Following these principles RWE's response to the Regulation 61 notice (Reg61respMar02) proposes a limit of 605 mg/Nm^3 for the 95th percentile of validated daily means, based on the available data on likely NOx emissions described in Section 2.4 of this report.

2. Changes proposed

2.1. Site Boundary

There will be no changes to the site boundary.

[1] IED BAT ESI Review Paper 28th October 2014: BAT review for the period 1 January 2016 until implementation of new BAT conclusions, or end of the TNP/LLD (as appropriate) E&W

2.2. Technical standards

The technical standards being followed are:

- Getting the basics right – how to comply with your environmental permit
- EPR 1.01 Combustion Activities
- At the present time the European BAT Reference document (BREF) for Large Combustion Plants is being reviewed. In the interim the technical standard to be used is the IED BAT ESI Review paper[1] . The applicable ELVs are discussed in more detail in the response to the Regulation 61 notice submitted in March 2017 (Reg61respMar02). This variation supporting document details the measures to achieve these ELVs.

The changes to the operational techniques as a result of the use of HVMC are described in sections 2.3 to 2.16 below.

2.3. Storage and handling

HVMC is inherently more volatile and has the propensity to self-heat and cause problems in materials handling and milling systems and hence the Station is investing £5M in mitigating these risks to safe levels through an extensive programme of fire detection and prevention measures.

The current coal handling system / fuel route involves coal being received via rail wagon, offloaded to an underground unloading hopper and transferred via covered conveyor to a transfer house. The coal is then either transferred from the transfer house via a further set of conveyors to a series of bunkers within the boiler house and then onward through the pulverising mills and associated dynamic classifers to the boiler for combustion or transferred via a separate set of conveyors to the stockground, where the coal is stockpiled until required. Mobile plant is used to reclaim coal from the stockpiles and deliver it into the reclaim hopper. The coal is then conveyed to the transfer house onward to the boilers as described in the direct train transfer process. The upstream Port and train arrangements are suitable for higher volatile coals so there are no modifications needed. There will be some procedural changes required to coal stocking practices, in terms of compaction arrangements, temperature monitoring and ensuring the edges of stockpiles are accessible around all the periphery to allow access if required. These changes will be detailed in the site's local procedures.

The multiple transfers described above during the coal handling processes can lead to localised releases of coal dust within the buildings. Accumulated HVMC dust can readily ignite if exposed to an ignition source such as localised heating originating from a defective conveyor roller or may even self ignite. There are also notable concerns with the capability of HVMC to readily form combustible dust-air mixtures during transfers etc and these mixtures may become explosive. Note that these risks are new for Aberthaw however they are no different to other coal fired power stations across the UK and wider which routinely burn these HVMCs. At Aberthaw a comprehensive upgrade of the fire management system is being installed during the outage periods supporting the conversion programme to afford the safe handling and firing of HVMC. The basic overview of the proposed new fire management systems are depicted in Appendix B.

These upgrades include installation of :

- Additional heat activated sprinklers throughout the fuel handling system with reduced reaction time i.e more sensitive.
- Linear heat detectors along conveyor tunnels, walkways, squeeze ways to detect static fires.

- Infra-red black body heat detectors after each transfer point to detect smouldering coal and initiate conveyor stop.
- Tidal switches to identify blockages in coal chutes prompting conveyor feeding chute to be stopped.
- Dust suppression systems at identified potentially high generated dust areas.
- Extensions to the existing vacuum cleaning plant to allow cleaning of more of the fuel route.
- Bunker top carbon monoxide (CO) detectors, alarms and warning beacons.
- Bunker lighting replacements, replacing high intensity lighting with ATEX rated fittings.
- Bunker fire foam firefighting equipment.
- Bunker emptying facilities.
- CO detectors fitted to primary air inlet elbows.
- CO detectors fitted to each dynamic classifier and the removal of potential deposition sites within static classifiers.
- Additional fire hose connection points to aid potential fires in coal feeders and bunkers.
- Automated bunker gates to allow remote opening and closing of bunker gates in the event of a coal hang up or to aid de-bunkering in the event of a bunker fire. Upgrade will also initiate mill start permissive. Permissive prevents mill start-up unless gates sufficiently opened, guards against loss of coal events & hang-ups leading to fires.
- Mill explosion suppression system to prevent pulverised fuel plant explosions from reaching pressures greater than system containment capability – operation will raise alarm and initiate controlled mill shutdown. Suppression system will be sodium bicarbonate system .
- Fast acting burner shut off dampers to provide rapid isolation of the milling system from the furnace post activation of the explosion suppression system and thereby prevent subsequent events such as “blowback”. (It is noted as the time of submission of this document the final detail of this installation had yet to be determined and offers potential to impact the expected project programme as illustrated on page 6).
- Rotary valves fitted with temperature and blockage detection in place of current dynamic classifier grit return valves.
- Loss of coal flow detectors alarmed to provide early warning to operations staff.
- Mill bay hazard warning system equipped with visual and audible alarms to alert personnel of potential hazardous events. System to be linked to boiler evacuation alarm.
- Mechanical modifications to mill to remove areas where pulverised fuel could accumulate
- Hot air shut off damper interspace vents to limit hot air accessing out of service mill.
- Out of service mill drum rotation capability prompted by CO detection system to prevent coal self-heating in mill.
- Improved furnace control and protection through implementation of enhanced Boiler Safety System (BSS).

In addition, an extensive number of operational procedures will be updated and operator training will be undertaken in order to satisfy the requirements of the Pulverised Fuel Code of Practice.

HWMCs are typically harder than the LVMCs currently received at Aberthaw (i.e. have a lower Hardgrove Grindability Index) which affects mill operational performance. In order for the mills to maintain the required throughput and achieve the required PF fineness for combustion, dynamic classifier speeds will be lowered. This will increase the particle size distribution from the mills, which for a LVMC would likely lead to increases in carbon in ash. However, for a HVMC these potential carbon in ash increases are expected to be more than offset by the higher reactivity of the fuel, resulting in comparable carbon in ash performance.

2.4. Point source emissions to air

Currently there is only very limited data available to assess likely emissions performance when utilising HVMCs as conducting trials of higher volatility coal in a process designed for low volatile coal carries considerable safety risks which need to be carefully managed and therefore trial duration was minimised.

Sulphur Dioxide (SOx)

The HWMCs being evaluated for the project are typically lower in sulphur (less than 1% sulphur by weight) than the LWMCs currently fired at Aberthaw. An example Russian HVMC is typically 0.4%wt sulphur.

SOx emissions will therefore typically be less than 200mg/Nm^3 with the FGD in service when firing these coals. Overall no significant change in SOx emissions is expected from the change to HVMC. There are also not anticipated to be any changes to FGD performance as a result of firing HVMCs.

Dust

The HVMCs considered for the project are generally harder which will lead to higher boiler firing rates however by their nature HVMCs are more reactive, therefore overall it is expected that these will balance out and no significant change in Dust emissions is expected from the change to HVMCs.

Oxides of Nitrogen (NOx)

The volatile matter content of coal has been shown to effect NOx emissions with increasing volatile matter content decreasing NOx emissions due to altered combustion characteristics. The overall nitrogen content of HVMCs and LVMCs is similar, however, the partitioning of the nitrogen between the char and the volatile content within the coal notably differs. When LVMCs are fired, combustion is dominated by char combustion with nitrogen being driven off under oxidising conditions later in the flame resulting in increased NOx emissions. When HVMCs are fired there is a higher nitrogen yield from the volatiles which are driven off earlier in the combustion process under oxygen deficient conditions resulting in reduced NOx emissions. Therefore utilising HVMCs will lead to lower stack gas concentrations of NOx than current levels. The proportion of NO:NO_2 is expected to remain similar.

Trials were conducted on Unit 7 and Unit 9 with a higher volatile coal (Kedrovsky ~18-20%wt VM) on the 8th of March and 23rd June 2016 respectfully. During these trials NOx was measured at 720mg/Nm^3 on Unit 7 and 357mg/Nm^3 on Unit 9. It is thought that the NOx measured on the Unit 7 trial was sub optimal as the unit did not have air staging plates installed and combustion was not optimised to reduce NOx due to operational constraints.

The figures below show Aberthaw's NOx emissions whilst firing specific coals in relation to fuel ratio (ratio of fixed carbon to volatile matter). The relationship has then been extrapolated to estimate NOx emissions on a range of typical HVMCs. From the figures it is estimated that NOx performance on Units 7 and 8 will be in the region of 500-630mg/Nm^3 and 305-370mg/Nm^3 on Unit 9 at full load.

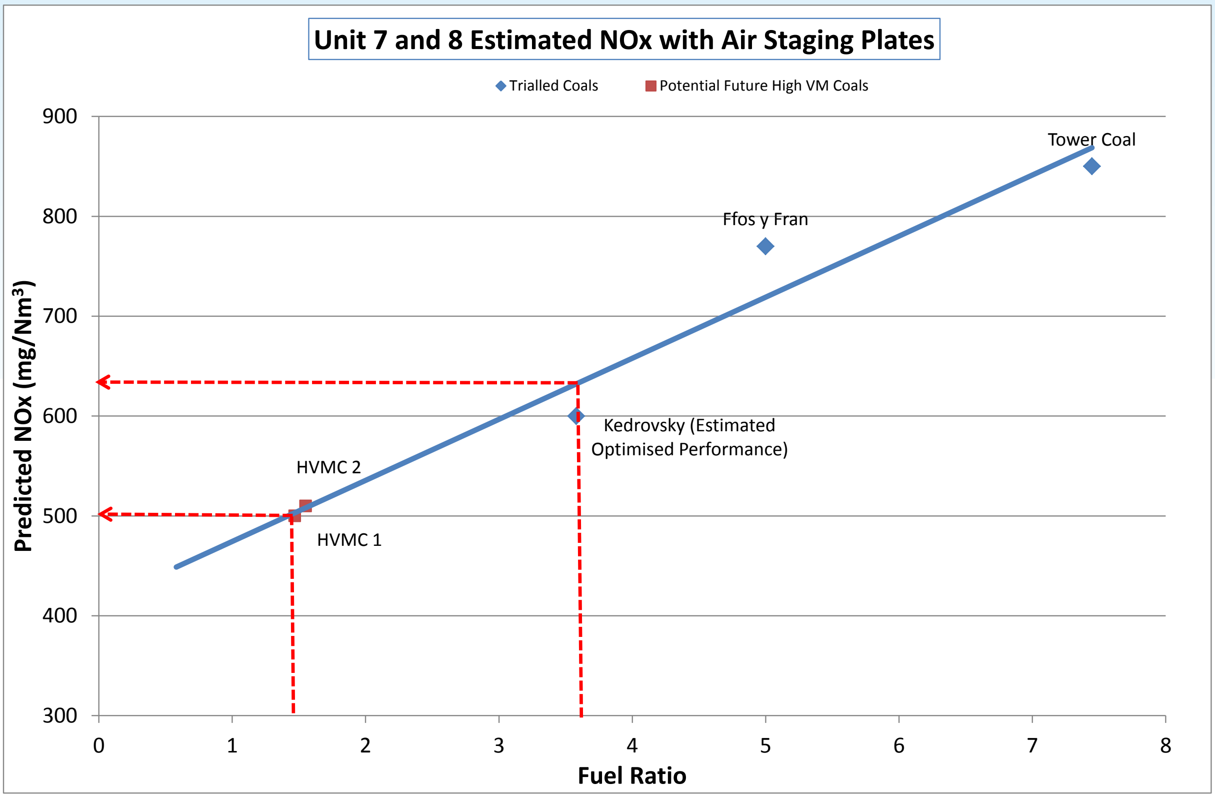


Figure 1 - Estimated NOx performance on Units 7 and 8

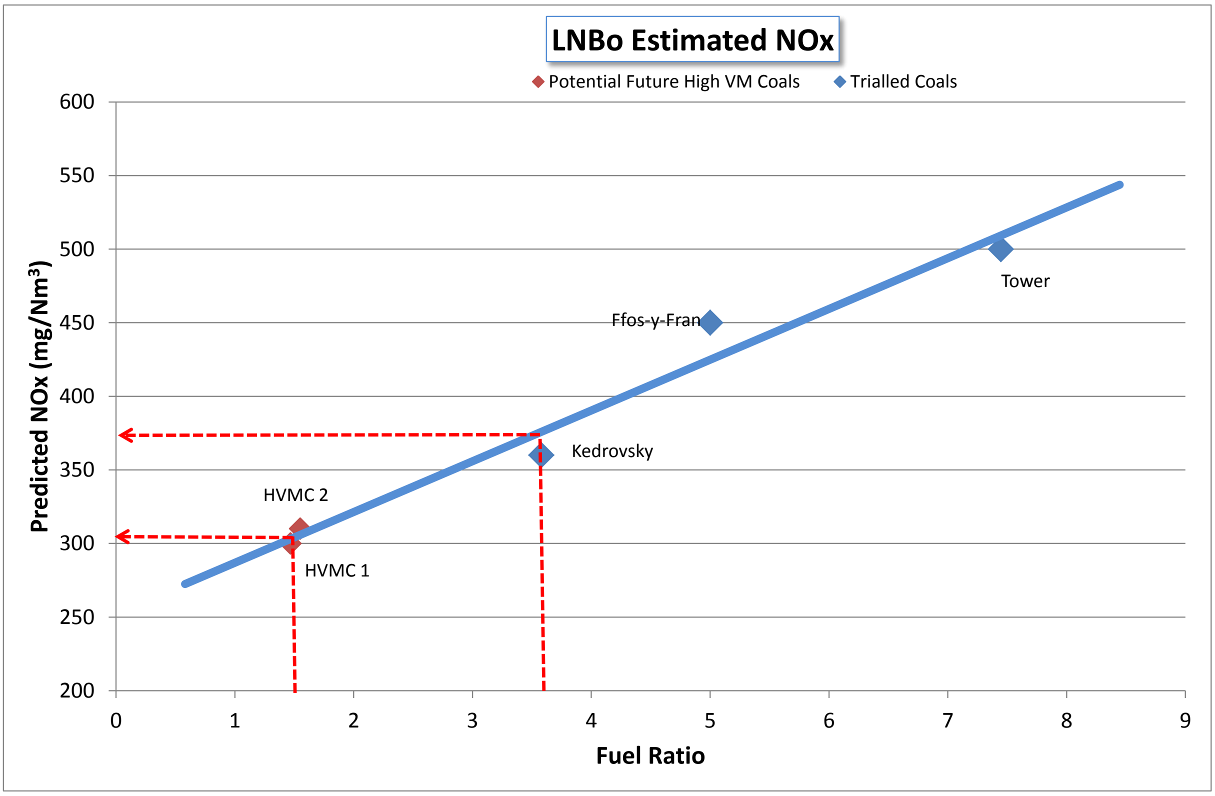


Figure 2 - Estimated NOx performance on Unit 9

Carbon Monoxide

As mentioned in the section on dust above, the generally harder HVMCs will lead to higher boiler firing rates however by their nature HVMCs are more reactive, therefore overall it is expected that these will balance out and no significant change in carbon monoxide emissions is expected from the change to HVMCs

Carbon in Ash

The higher volatile coal trials on Units 7 and 9 with Kedrovsky (~18-20%wt volatile matter) showed mixed changes in carbon in ash from the fuel change. On Unit 7 NOx emissions were reduced by ~15% in comparison to the baseline trials and carbon in ash was reduced from 13% to 6.5%. During the trial CO was kept at a comparative level and combustion was not aggressively staged. On Unit 9 NOx emissions were reduced by ~22% in comparison to the baseline trials and carbon in ash increased from 7% to 11.5%. During this trial CO increased when the fuel was changed due to changes in firing configuration. From these trials it is thought that overall carbon in ash will stay at approximately the same level as the increase in reactivity will be offset by the changes described previously in the dynamic classifiers.

2.5. Point source emissions to water

Trace element emission concentrations and mass emissions are generally expected to decrease as a result of the proposed change due to the lower trace element content of HVMCs along with the declining load factor of the station.

	Typical HVMC	Typical Welsh coal
Arsenic	15	18.95
Cadmium	0.11	0.3
Chromium	30	40.9
Copper	30	50.7
Lead	24	19.3
Mercury	0.09	0.1
Nickel	33	70.2
Zinc	25	39.9
Antimony	1.6	NA
Boron	28	37.3
Fluoride	75	80.6
Manganese	93	84.9
Selenium	2.1	1.5
Vanadium	51	70.7

Table 1 Example trace element analysis in coals (mg/kg)

NA – Not available

2.6. Ash quality

It is expected that there will be minor changes in the ash produced following the changes; the carbon in ash is likely to remain similar, however from the analysis above it is expected that trace elements are likely to be lower.

Typical analysis of the ash composition of a potential HVMC for Aberthaw is shown in Table 2 below. This analysis was taken from the average of five shipments of a Russian coal between May and August 2016 to Emmshaven Power Station in the Netherlands. This is compared to the latest values from Aberthaw. It can be seen that generally the analysis shows that the HVMC results are within the most recent Aberthaw range, or where they are outside this is marginal and the HVMC lower with the exception of the amounts of Silicon dioxide and Calcium oxide.

As the analysis is limited but suggests that ash changes will be minor a review of the hydrogeological risk assessment is not proposed at this time, but will be carried out on the normal review timescales.

	Example HVMC	**Aberthaw range (Mar 16-Jan17)**
Silicon Dioxide	55.7	49.6 - 54.0
Aluminium Oxide	21.8	28.7 - 33.0
Iron Oxide	6.7	5.8 - 9.4
Calcium Oxide	4.5	0.9 - 2.5
Magnesium Oxide	2.0	1.3 - 1.9
Sodium Oxide	0.8	0.6 - 0.9
Potassium Oxide	1.9	2.6 - 3.9
Manganese Dioxide	0.1	NM
Titanium Dioxide	0.9	1.0 - 1.1
Phosphorus Pentoxide	0.7	NM
Sulphur Trioxide	3.9	NM
Barium Oxide	0.2	NM
Strontium Oxide	0.2	NM

Table 2 Example ash analysis (% weight)

2.7. Fugitive emissions

There are not expected to be any additional fugitive emissions as a result of moving to higher volatile coals. The minor stocking changes detailed in Section 2.3 above are not expected to have an increase in fugitive emissions to air or water.

2.8. Management

There will be no major changes required to the management system although there will be changes to operating procedures required, these are detailed elsewhere in this document.

2.9. Raw materials

The HVMC are International coals already widely used within the UK and Europe, they will typically have a volatile matter content of 20-36%wt as received. There will be a specification that the coals are bought to and all coals will be assessed prior to arrival on site.

A typical analysis of a potential HVMC for Aberthaw is shown in Table 3 below. This analysis was taken from the average of five shipments of HVMC between May and August 2016 to Emmshaven Power Station in the Netherlands. This coal is a Russian high volatile coal proposed for use after the Aberthaw conversion.

		Example HVMC	Example LVMC
NCV (ar)	MJ/kg	25.3	26.7
HGI	%wt	58.7	65
Total Moisture (ar)	%wt	10.4	9.5
Ash (ar)	%wt	10.0	14.0
Vols (ar)	%wt	31.3	12.5
Sulphur (ar)	%wt	0.4	1.1
Chlorine (ar)	%wt	0.01	0.05
Fluorine (ar)	%wt	0.01	No analysis
Carbon (ar)	%wt	65.0	69.5
Hydrogen (ar)	%wt	4.3	3.1
Nitrogen (ar)	%wt	1.9	1.3
Oxygen (ar)	%wt	8.1	1.4

Table 3 Average Analysis of a Potential Aberthaw HVMC

2.10. Waste minimisation and handling

There will be no changes in terms of waste minimisation and handling.

2.11. Energy efficiency

There are no expected changes in energy efficiency as a result of the plant modifications to allow burning of HVMCs.

2.12. Accidents

Compared to the LVMCs currently burnt by Aberthaw, HVMCs present higher fire and explosion risks. These risks have been assessed by RWE Generation UK as part of the design phase of the project. The outcomes of those assessments have informed the requirements for the installation of new equipment and revisions to procedures and other documentation to control and mitigate these risks, including the Incident Management and Recovery Plan.

2.13. Noise

There are no expected changes in noise as a result of the plant modifications to allow burning of HVMCs.

2.14. Monitoring

Apart from the additional process monitoring for safety reasons there will be no additional monitoring required or changes in the monitoring equipment for environmental compliance purposes as a result of the proposed changes. Once the plant has been fully commissioned a review will be required to determine if a new QAL test will be required due to the reduction in NOx emissions from the stack.

2.15. Closure

The proposed changes have no material impact on the requirements at closure.

2.16. Installation issues

There are no wider installation issues as a result of the proposed changes.

3. Impacts

As discussed above, the proposal to move to HVMC leads to reductions in NOx and no change in emissions to dust or SOx emissions, also it is expected that water emissions will decrease as a result of the change therefore no detailed impact modelling has been carried out.

4. Justification of option choice

A number of cost benefit analyses of NOx abatement at Aberthaw have been undertaken over the past five years. These reflected the regulatory and market conditions at the time they were undertaken. A summary of these is given below before the updated analysis is described.

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 at that time.

In 2015 Salway's study was updated (Moores & Whitwell 2015) to reflect lower expected load factors at the end of the TNP period (17%) and a nominal station life of 10 years, at this time LNBo was judged to be a viable option. This study, which assumed that Aberthaw would continue to use the low volatile coal it was designed for, concluded that a Low NOx Boiler system was the best compliance route. Since this analysis there have been changes both in the policy context (the Government's planned phase-out of coal fired generation) and ongoing market changes which mean that the expectation is that load factors will reduce and the focus will be on providing generation at times of highest demand. Therefore there have been updated evaluations of investment options.

In this updated study the cost and benefits of a range of boiler modifications have been modelled over the expected life of the station.

The options considered are; the installation of the air staging plate modifications on units 7 & 8 and a switch to HVMC; the installation of two more LNBo systems; and the operation of three LNBo units with HVMC.

The 2015 report had shown that SCR was not a suitable abatement option due to the associated high costs and expected load factor over the remaining life of the station. These factors have not changed and hence SCR was not considered in the present study.

Assumptions

The cost per tonne NOx abated and Net Present Value (NPV) of the costs have been calculated for five options based on the assumptions in Table 4 below:

	Assumption	Comment
Load factor	17%	The station runs until the end of 2025 with a load factor of 17%, reflecting the IED hours limit which will apply at the end of the TNP. However, future load factors are uncertain and this represents an upper limit from mid 2020 onwards and a reduction in generation from this assumption will increase the cost per tonne NOx abated particularly for those abatement techniques with a high capital cost
Discount rate for NPV	8.5%	As per 2015 study
Fuel CV	Same for HVMC and LVMC	
Heat rate	9359MJ $MWhr^{-1}$	
Gas rate	3407Nm^3 $MWhr^{-1}$	
Carbon in Ash	• LNBo 14% • Existing non LNBo 13% • HVMC (all systems) 14% • Air staging plate modifications 14% • Air staging plate modifications & HVMC 14%	
Costs	• LNBo £12million (as was used previously). • Fire/explosion prevention: £5 million for all three units • Air staging plate modifications: £20 000 per unit • Opex for LNBo: £275 625 per annum per unit • Opex for HVMC & air staging plates: £0	Note at present we don't have a figure for the additional running costs of the systems required to consume HVMC. They are likely to be relatively low cost and for the purposes of this study are assumed to be cost free
NOx reduction	• Units 7 & 8 base case NOx: 1050 $mgNm^{-3}$ • LNBo: 500 $mgNm^{-3}$ (measured data September to end of 2016) • Air staging plates + LVMC:750 to 800 $mgNm^{-3}$ • HVMC: 30% reduction	

Table 4 Assumptions for Cost/Benefit Assessment

Taking these values for the cost and abatement offered by each option a station based cost/benefit assessment has been undertaken. The NPV cost per tonne and tonnes of NOx per year abated over the forecast life of the station for each technique are plotted in Figure 3 below:

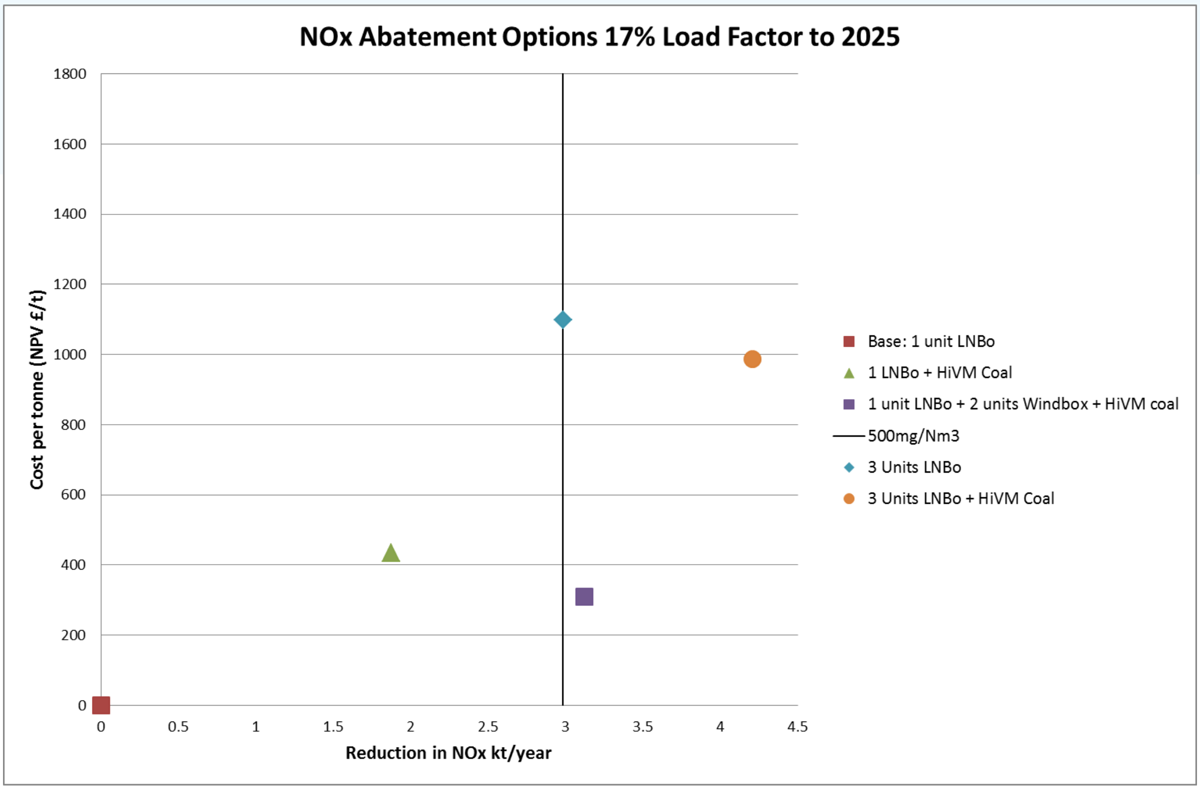


Figure 3 Cost per tonne and abatement per year for four NOx abatement options at Aberthaw Power Station

The use of HVMC at Aberthaw on all three units offers an abatement over current emissions. The cost of the abatement is £404 per tonne and the reduction is 1.97ktonne per year, however the station average stack gas concentration would be greater than 500 mg Nm^{-3}.

The installation of another two LNBo systems would reduce annual stack gas concentrations to 500mgNm-3 at a cost of £1099 per tonne.

The use of air staging plates and HVMC is shown in Figure 3 as reducing average NOx emissions below 500mg Nm-3 and costing less than full LNBo conversion (£309 per tonne). Further abatement can be obtained by using HVMC on an all LNBo station but at a cost per tonne that is three times as great (£986) as that for the air staging plates and HVMC options.

The air staging plates and conversion to use HVMC offer the cheapest option to achieve the required abatement at Aberthaw and therefore are considered to be BAT. The installation of these changes would not preclude further changes should they prove necessary.

5. Conclusion

The proposal to burn HVMC provides a cost effective decrease in NOx emissions to meet the required revised emission limit values.

The modifications will not significantly impact on other emissions from the station.

HVMC is inherently more volatile and has the propensity to self-heat and cause problems in materials handling and milling systems and hence the Station is investing £5M in mitigating these risks to safe levels through an extensive programme of fire detection and prevention measures, detailed in this document.

Appendix A

1. Amended Table S1.5 Start-up and Shut-down thresholds

Following an internal review of emissions monitoring and reporting it has been identified that the Minimum start up and shut-down load (MSUL/MSDL) needs to be changed to 385MWe Generated in order to account for variations in works power generation above the Stable Export Limit (SEL). Below is the proposed update to Table S1.5 in the Environmental Permit (RP3133LD/V012) and an updated justification originally provided in the Report 'Response to Regulation 60 Notice 2 (Ref. RP3133LD/REG60/150710) (Note no changes required to Figures 1 and 2).

Table S1.5 Start-up and Shut-down thresholds		
Emission Point and Unit Reference	**"Minimum start up load" Load in MW and as percent of rated electrical output (%) and discrete processes**	**"Minimum shut-down load" Load in MW and as percent of rated electrical output (%) and discrete processes**
A1, LCP283, Units 7, 8 and 9	385 MW; 72%	385 MW; 72%
A2, LCP423, GT7, GT8 and GT9	As soon as gas turbine start up is initiated.	As soon as the gas turbine is off load.

The declared Minimum Start-Up Load (MSUL) and Minimum Shutdown Load (MSDL) value of 385MWe Generated is equal to the Stable Export Limit (SEL) and accounts for variations in works power generation above SEL. SEL defines the load at which the boiler is able to safely and reliably deliver its electricity to the national grid i.e. stable generation without the need for oil support and thereby meets the definitions for MSUL/MSDL in Article 2 of the Implementing Decision 2012/249/EU, reiterated below.

"For the purposes of this Decision the following definitions apply:
(1) 'minimum start-up load for stable generation' means the minimum load compatible with the steady operation of the generating combustion plant following start-up initiation after which the plant is able to safely and reliably deliver its output to a network, grid, heat accumulator or industrial site;
(2) 'minimum shut-down load for stable generation' means the minimum load at which point the plant can no longer safely and reliably deliver its output to a network, grid, heat accumulator or industrial site and is considered to be shutting down."

The typical start-up and shut-down sequences described below summarise the key stages for reaching SEL and falling below SEL.

<u>Typical Start-up sequence</u>

- Commission ID and FD fans and purge the furnace of any potentially flammable materials.
- Commission oil burners to start warming through the furnace.
- Commission turbine and gradually increase speed.
- Commission the first PF mill. On a cold start this is done at the same time as synchronising to the grid otherwise it is done earlier.
- Commission the second, third & fourth PF mills to increase the output from the turbine to over 200MWe.
- Commission FGD on bypass and bring into service at 200MWe.
- Commission the fifth & sixth PF mill to increase the output from the turbine to over 300MWe. As the mill output increases, less oil is required to support combustion and the

oil burners can be progressively shut down.

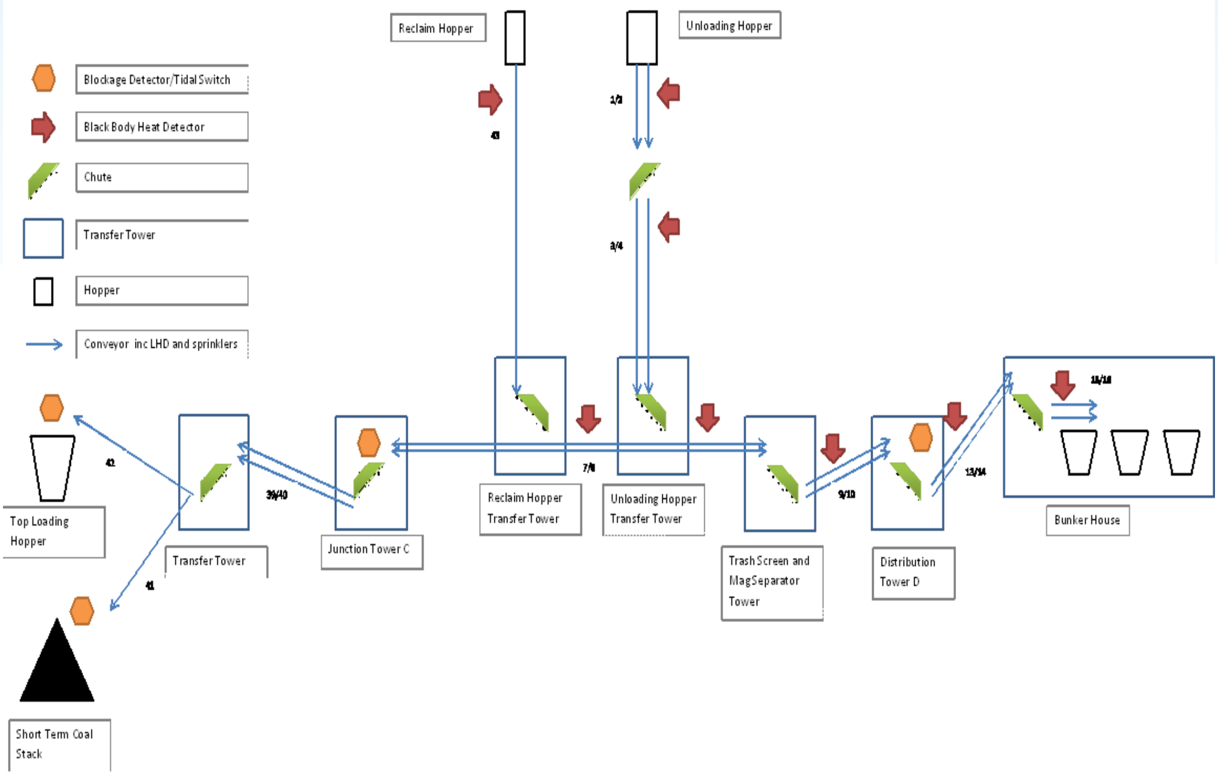
- Bring the steam feed pumps and HP heaters fully into service.
- Check boiler combustion conditions are stabilised and the main boiler feed pump is established. If so the oil burners can be shut off and stable generation reached. Occurs at 385MWe.

Typical Shut-down sequence

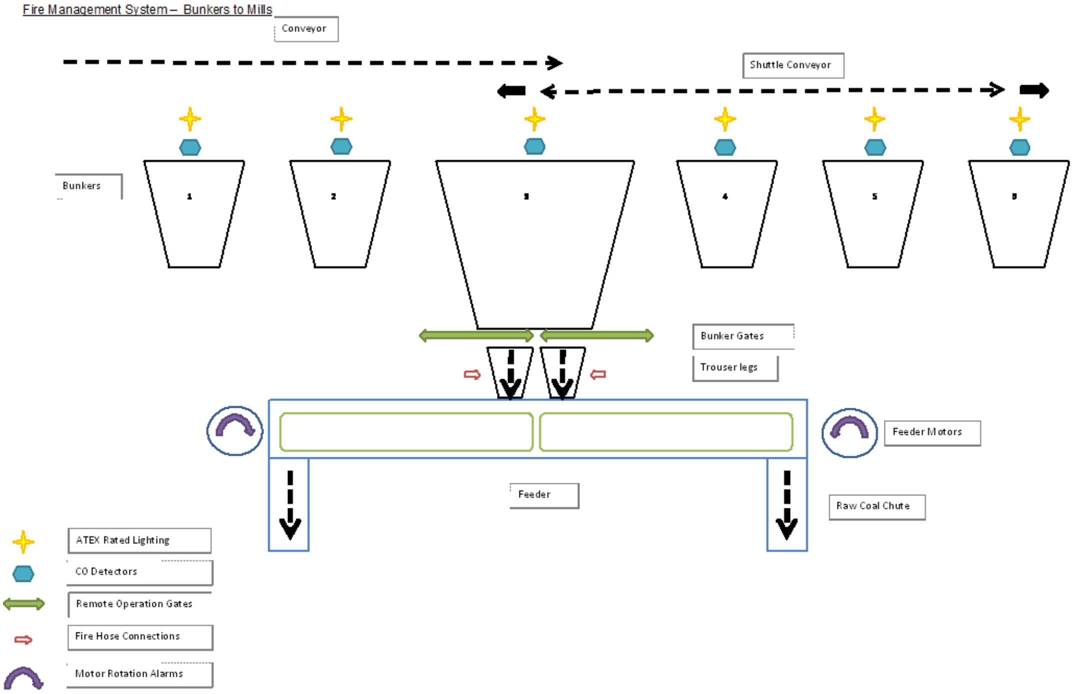
- Commission oil burners to ensure boiler stability throughout shutdown procedure.
- Shutdown PF mills sequentially to decrease the output from the turbine as the boiler pressure falls. For each mill stop feeding it coal and allow the remaining coal to mill off. Then trip the mill out of service.
- Reduce the output on the last mills. The unit output falls below stable generation. This occurs at 385MWe.
- Put FGD into bypass at 200MWe and shutdown.
- Shutdown the oil burners.
- Shutdown the ID and FD fans if the Unit not required or leave in service to force cool boiler for maintenance work.

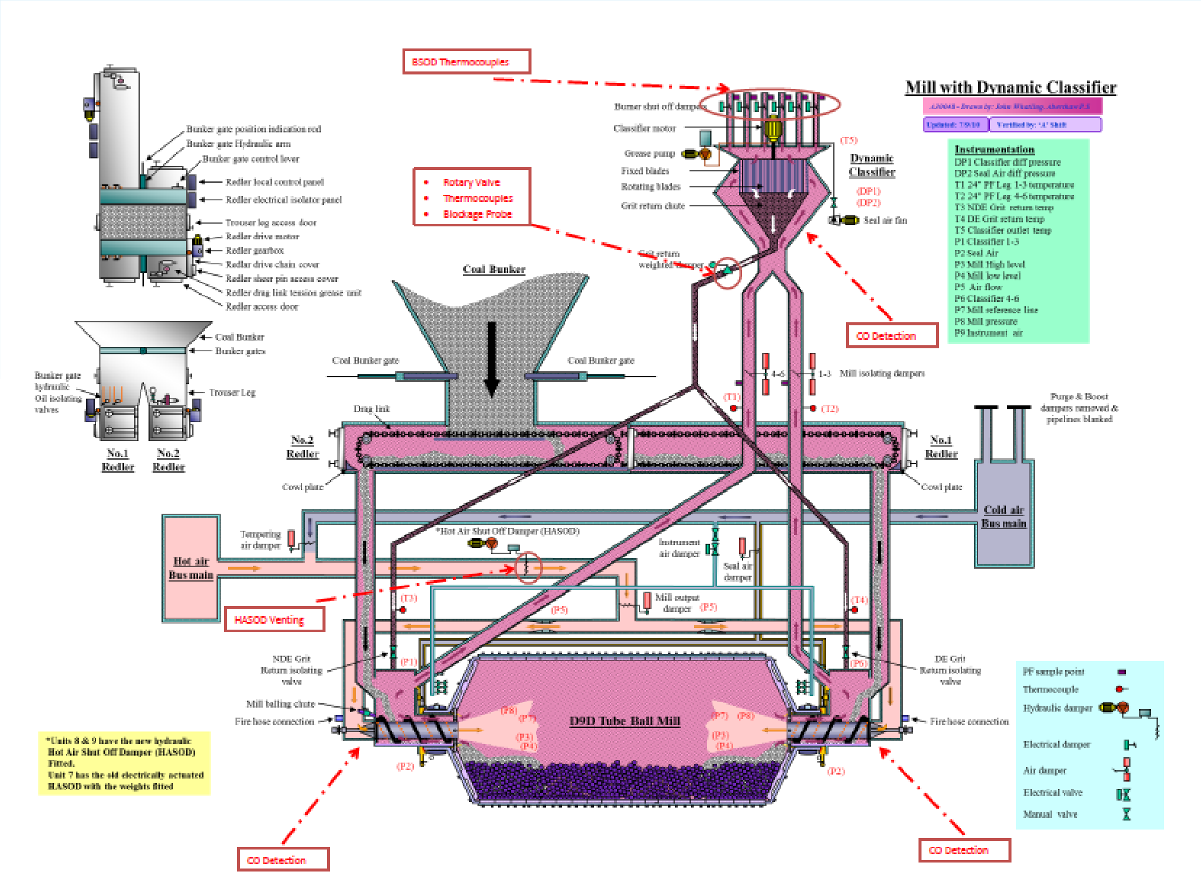
Appendix B – Overview of Fire Management Systems

Fire Management System – Coal receipt to Bunkers



Fire Management System – Bunkers to Mills





Mill with Dynamic Classifier
BSOD Thermocouples
Rotary Valve
Thermocouples
Blockage Probe
CO Detection
HASOD Venting
Coal Bunker
D9D Tube Ball Mill
Hot air Bus main
Cold air Bus main
No.1 Redler
No.2 Redler
Dynamic Classifier

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