Dispersion Modelling and Impact Assessment

BRef Compliance

Lynemouth Power Limited

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1. Introduction

AECOM Infrastructure & Environment UK Ltd ("AECOM") has been commissioned by Lynemouth Power Limited ("LPL") to undertake an assessment of the application of Best Available Techniques (BAT) for the Biomass-fired boilers at the Lynemouth Power Station ("LPS"), Northumberland, currently being commissioned under the Environmental Permit (EP) EPR/FP3137CG/V008.

The *Large Combustion Plant BAT Reference document* (LCP BRef, 2017) sets out the expected emission levels associated with the application of BAT (BAT-AELs) across a range of combustion technologies and feedstocks, including biomass.

The design for the biomass combustion units is capable of meeting the emission limits for oxides of nitrogen (NO_x) and dust (as total particulate matter, PM) as set out in the Industrial Emissions Directive (IED) through the use of primary control measures and the existing secondary abatement techniques applied at the plant. However, compliance with the recently issued LCP BRef BAT-AELs would require additional abatement.

A BAT assessment and cost benefit analysis (CBA) has been carried out in order to identify BAT for the biomass-fired LPS, in terms of the costs of the application of the potential techniques to achieve the BAT-AELs against the relative change in NO_x and PM emissions, while also considering the potential NH_3 slip from secondary abatement of NO_x emissions if installed.

This technical appendix supports the BAT assessment and presents the dispersion modelling and impact assessment of emissions to air associated with the alternative options as presented within the main report, *BAT and Options Appraisal for Biomass Generation*.

The scenarios modelled (with reference to the main report) are summarised as follows:

- Scenario 1: Proposed derogation (NO_x Option 2; PM Option 2);
- Scenario 2: Emissions at the upper limit of BAT-AELs with applied technology (NO_x Option 3-SNCR, with ammonia (NH_3 slip); PM Option 3 - ESP);

The assessment of impacts has been carried out in accordance with the EA's guidance for *Air emissions risk assessment for your environmental permit* ("EPR guidance"), 2016. The emissions to air are considered to require detailed dispersion modelling, as for previous assessments for the installation, and therefore Stages 1 and 2 of the EA screening methodology have been omitted from this report.

2. Air Quality Assessment Criteria

2.1 Air Quality Standards

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (AQS) defines air quality standards and objectives for the most common pollutants that must be achieved on a national scale by a set date. These objectives include nitrogen dioxide (NO_2) which is of interest in this study. The EU has also set mandatory limit values which are the same as the objectives for NO_2. The objectives and EU limit values apply outside of the workplace where the public are not normally present. Local Authorities are required by the UK Government to assess local air quality, to establish whether the AQS objectives are being achieved, and Defra has responsibility for coordinating assessments for the UK as whole.

Critical Levels of atmospheric pollutants are defined for the protection of sensitive habitat sites, and are "*concentrations of pollutants in the atmosphere above which direct adverse effects on...plants [and] ecosystems...may occur according to present knowledge*"[1].

In addition, the Environment Agency (EA) has defined Environmental Assessment Levels (EALs) for pollutant species without AQS objectives; these are published in the EPR guidance and include ammonia (NH_3).

The AQS objectives and EALs relevant to this assessment are shown in Table 1.

Table 1: Air Quality Assessment Levels

Species	Concentration (µg/m^3)	Averaging Period	Objective
Nitrogen dioxide (NO_2)	200	1-hour (as 99.79th %ile)	AQS
	40	Annual	AQS
Oxides of nitrogen (NOx)	75	Daily	Critical Level*
	30	Annual	Critical Level*
Particulate Matter as PM_{10}	50	Daily (as 90.4th %ile)	AQS
	40	Annual	AQS
Particulate Matter as $PM_{2.5}$	25	Annual	AQS
Ammonia (NH_3)	2,500	Hourly	EAL
	180	Annual	EAL
	1 (lichens or bryophytes) 3 (higher plants)	Annual	Critical Level*

*Critical Levels defined for protected conservation areas

In addition to the above Critical Levels set in the legislation, there are non-legislative limits (Critical Loads) that have been derived for different habitats and relate to the deposition of nitrogen and acidifying species; Critical Loads are defined as "*a quantitative estimate of exposure to one or more pollutant below which significant harmful effects on specified elements of the environment do not occur according to present knowledge*"[1].

There are additional air quality objectives and targets defined for other pollutants which may be emitted from biomass combustion, including sulphur dioxide (SO_2), hydrogen chloride (HCl) and hydrogen fluoride (HF), however the BAT assessment does not specifically address the abatement of these pollutant species, and therefore reference is made only to these species in the calculation of acid deposition relative to the Critical Load as defined above.

Critical Loads are habitat-specific and are provided within the results tables in Section 5, for the protected conservation areas identified within this assessment.

2.2 Baseline Air Quality

Baseline air quality data has been obtained from Defra published maps for the site vicinity. The most recently available data is for 2015, projected for future years. The annual mean baseline pollutant concentrations for the site vicinity are shown in Table 2.

[1] Centre for Ecology and Hydrology and APIS (2016) http://www.apis.ac.uk

Table 2: Background Concentrations (Grid Square 430500, 589500)

Pollutant	Background Data (µg/m[3])
NO_2 (2018)	6.1
PM_{10} (2018)	8.3
$PM_{2.5}$ (2018)	5.5

Northumberland Council has no active Air Quality Management Areas (AQMAs) declared.

The installation lies within 10km of a number of protected conservation areas. Pollutant baseline concentrations have been determined from the UK Air Pollution Information System (APIS)[1] for the identified conservation areas and are detailed within the results tables in Section 5.

The annual mean baseline NH_3 for the site vicinity has been assumed from the data presented in APIS for the adjacent SPA, at 0.8µg/m^3.

2.3 Protected Conservation Areas

The installation lies within 10km of a number of protected conservation areas. The coastal areas to the north and south of the installation are designated for biological interest for communities of breeding birds and waders and their supporting habitats, for which designations include Northumbria SPA and Ramsar and Northumberland Shore SSSI which each cover numerous sites along the Northumberland and Durham coasts. Component SSSIs, designated for biological interest close to the installation, include Cresswell Ponds SSSI and Hadston Links SSSI.

Other local designations include Cresswell Dunes LNR; and geological interest (Cresswell and Newbiggin Shores SSSI). Inland designations, within the specified distance in the Risk Assessment methodology, include Hawthorn Cottage Pasture SSSI and Willowburn Pasture SSSI both designated for grassland habitat.

For deposition impacts, the data published on the Defra Magic mapping site, JNCC website and Natural England website for statutory designated sites have been reviewed to determine the proximity of specified habitats that are sensitive to nutrient nitrogen and acid deposition. The maximum process contribution at sensitive habitat locations has been considered in order to present an assessment of the maximum impact on the designated site.

The deposition-sensitive habitats identified within the coastal protected conservation areas are summarised below:

- The most sensitive feature to acid deposition is supralittoral sediment, featuring coastal stable dune grasslands (acid type) although this is not in evidence close to the Installation, with the closest mapped habitat at Bamburgh Coast and Hills SSSI, more than 40km north. Mapped coastal stable dune grasslands (calcareous type) are only located more than 20km from the Installation, to the south at Durham Coast SSSI. The Hadston Links SSSI, located 8km to the north features coastal stable dune grasslands although the grassland type is not specified.
- The most sensitive features to nutrient nitrogen deposition are coastal stable dune grasslands (acid type), potentially located at Hadston Links SSSI, and littoral rock and sediment featuring pioneer low-mid-upper saltmarsh which can be found at Blyth within the Northumbria Shore SSSI, 7km to the south and areas of saltmarsh and mudflats located at the River Coquet SSSI and Warkworth Dunes and Saltmarsh SSSI 15km north.

The habitat located in close proximity to the Installation is described as littoral rock, which is not sensitive to acid deposition, and nearby Cresswell Ponds featuring saline lagoon habitat for which no sensitivity is described within APIS. Coastal sand dunes, described under the Priority Habitat Inventory, are present within 1km of the installation, although these are not located within the protected conservation areas.

In order to present a conservative assessment of deposition impacts, the coastal stable dune acid grasslands, and pioneer low-mid-upper saltmarsh habitat features have been assumed to be present at the location of maximum process contributions within the protected conservation area.

The coastal and grassland habitats represented in the identified protected conservation areas are not typically associated with lichens and bryophytes and therefore the ammonia Critical Level for higher plants has been assumed in the assessment.

2.4 Criteria for Insignificance

The predicted ground-level process contributions, at maximum off-site and receptor locations, have been compared against the AQS, EAL and CL to determine the significance of the long-term and short-term impacts arising from each model scenario. The significance of impacts has been assessed following the EPR guidance criteria as summarised below.

The total Process Contribution (PC) is defined as having an “insignificant” impact where:

- PC <= 1% of the AQS, EAL or CL for long term releases; and
- PC <= 10% of the AQS, EAL or CL for short term releases.

For those PCs not screened as insignificant, an estimate of the predicted environmental concentration (PEC) has been made, by adding the PC to an appropriate estimate of the Background Concentration (BC), where the short-term BC is assumed to be represented by twice the annual mean BC. The PEC can then be compared with the appropriate AQS, EAL or CL to determine whether the modelled emission could result in exceedance of an environment standard.

The PEC is defined as having an “insignificant” impact where:

- PEC < 70% of the AQS, EAL or CL for long term releases; and
- PC < 20% of the short term AQS or EAL minus twice the long-term background concentration (BC) for short term releases.

For local nature sites within the specified distance, the emissions are considered to have an “insignificant” impact where:

- PC < 100% of the CL for long term releases; and
- PC < 100% of the CL for short term releases.

In accordance with the Risk Assessment methodology, further action is not required where:

- the proposed emissions comply with BAT associated emission levels (AELs); and
- the resulting PECs won’t exceed environmental standards.

An assessment of nutrient nitrogen enrichment has been undertaken by applying published deposition factors to the predicted annual average NO_2 concentrations at the identified statutory habitat sites, determined through dispersion modelling, to calculate nitrogen deposition rates. These deposition rates have then been compared to the Critical Loads for nitrogen, published by APIS, for the most sensitive species in each individual habitat site, taking into consideration the baseline air quality.

Increases in acidity from deposition contributions of N from the PC have also been considered. In this assessment, the nitrogen kilo equivalent (Keq/ha/yr), which are the units in which acidity Critical Loads are described, have been derived from nitrogen deposition modelling values, using standard conversion factors. The acidity deposition rates and baseline deposition rates have been used within the Critical Load Function Tool in APIS to determine whether the PC would result in exceedance of the defined Critical Load for the most sensitive feature. PCs of SO_2 and HCl to the acidity deposition rate have been estimated from factoring the annual mean NO_x PC. Non-statutory habitat sites have not been assessed, as the sensitive species present at these receptors and their associated Critical Loads for nutrient and acid deposition are not on public records.

3. Emissions Inventory

3.1 Modelled Emission Parameters

The dispersion modelling has used data provided by LPL for the proposed biomass design basis for emissions to air, as summarised in Tables 3 and 4, with alternative pollutant concentrations (design ELV or BAT-AEL) as identified through the Options Appraisal.

For the purposes of the assessment, it is assumed that all three boiler units are operational on a continuous basis throughout the year to obtain the maximum predicted short-term impacts from peak operation, and with long-term impacts factored as appropriate by the typical annual operation, assumed to be 90% average load. The three boiler units vent to atmosphere via a single windshield and therefore the emissions have been modelled as a single source.

The annual mean BAT-AEL or monthly mean IED limit has been assumed as the long-term average emission concentration. The IED states that the daily average concentration should not exceed 110% of the ELV and therefore these conditions have been used as the basis for determining the short-term emission concentrations for dispersion modelling and assessment against the daily ecological and hourly human health air quality standards.

Table 3: Modelled emission parameters

Parameter	Boiler stack (A1, A2, A3 combined)
Grid Reference (x,y)	430625, 590156
Release height (m)	114.3
Effective stack diameter (m)	6.09
Maximum Actual flow rate (m^3/s) (4.5% O_2, 11% moisture)	591
Maximum Normalised flow rate (Nm^3/s) (6% O_2, dry, 273K)	381
Efflux velocity (m/s)	20.3
Temp (°C)	140

Table 4: Modelled pollutant emissions levels

Scenario	Emission concentration (mg/Nm^3)			Mass emission rate (g/s)		
	NO_x	PM	NH_3	NO_x	PM	NH_3
1 – Short-term plant emissions	220*	20*	-	83.9	7.6	-
1 – Long-term plant emissions	200*	20*	-	68.6	6.9	-
2 – BAT-AEL upper limit Short-term	200	16	10	76.3	6.1	3.8
2 – BAT-AEL upper limit Long-term	160	10	10	54.9	3.4	3.4

Notes: * Proposed Derogation emission concentration
Reference conditions: 6% O_2, dry, 273K

For the purposes of detailed modelling, and in accordance with the Risk Assessment methodology, it is assumed that 70% of emitted NO_x is oxidised to NO_2 in the long-term and 35% of the emitted NO_x is oxidised to NO_2 in the local vicinity of the site in the short-term.

3.2 National Emissions Ceiling Directive

The revised NECD (2016/2284/EU), which entered into force on 31st December 2016, sets new emission reduction commitments for each Member State for the total emissions of NOx, oxides of sulphur, non-methane volatile organic compounds, ammonia and particulate matter (less than 2.5µm in diameter) in 2020 and 2030.

The reduction commitments for the UK are to reduce annual NO_x emissions by 55% from the 2005 baseline from 2020 to 2029 and to reduce NH_3 emissions by 8% from the 2005 baseline from 2020 to 2029. The $PM_{2.5}$ annual emission reduction compared with 2005 baseline from 2020 to 2029 is 30%.

The NECD was transcribed into UK regulations in the National Emissions Ceiling Regulations 2018 (S.I 2018 No.129).

The total emissions within the United Kingdom of each relevant pollutant should not exceed the amount specified in the Schedule of the regulations. The relevant emission ceilings relating to emissions from the proposed options are:

- NOx = 1,167 Kilotonnes (to 2019);
- Ammonia = 297 Kilotonnes (to 2019);

Table 5: NEC contribution of LPS proposed options

Option	Annual emissions (tonnes)	% of NEC (2019 ceiling)
Scenario 1: Proposed derogation; control of NOx emissions through Primary Means	2,164	0.19%
Scenario 2: Emissions of NOx at upper limit of BAT-AEL through use of SNCR	1,732	0.15%
Scenario 1: Mass emission of PM [as $PM_{2.5}$, assuming 5% by weight]	216 [10.8]	-
Scenario 2: Mass emission of PM [as $PM_{2.5}$, assuming 5% by weight]	108 [5.4]	-

It is considered that the NOx emissions from Scenario 1 (the proposed derogation) for LPS will have a limited impact on the UK's overall NOx emissions, and minimal impact on the UK's ability to remain below the emission ceiling.

The calculated ammonia emission from Scenario 2 represents 0.04% of the UK emission ceiling of 297Kt. The impact of the use of SNCR abatement on the UK's ability to remain below the emission ceiling would be minimal.

4. Dispersion Model Input Parameters

4.1 Model Selection

Dispersion modelling of emissions has been used to provide a detailed assessment of the impact on the environment associated with the alternative options considered within the BAT assessment.

The model calculates the predicted ground level concentration arising from the emissions to atmosphere based on Gaussian approximation techniques. The model that has been employed is the new generation model ADMS (Version 5.2), which has been developed for regulatory use.

The model uses hourly sequential meteorological data to enable a realistic assessment of dispersion from point sources to be conducted for weather conditions that are directly applicable to the site.

Sensitivity analysis of the model results to variation in the model inputs has been undertaken as part of this assessment and is detailed in Section 4.5, including the use of the AERMOD module built into ADMS, as AERMOD was identified within an EA report[2] as providing more conservative results.

The degree of turbulence in the atmosphere affects the rate at which pollutants from point sources are dispersed in the environment; the more unstable the atmosphere, the greater the degree of mixing. While this is in principle the desired effect for the release of pollutants through stacks at elevated heights, this can also lead to localised peak concentrations if the plume is rapidly brought to ground level.

Various parameters can affect the degree of dispersion from a source, and these are accounted for in the development of the modelling scenarios as detailed in the following sections. The presence of elevated or complex terrain in the vicinity of the source can affect the flow pattern of the wind field, which can in turn bring a plume to ground more rapidly. Buildings of sufficient height located close to the emission sources can affect dispersion, inducing downwash in the emitted plume and entraining pollutants towards ground level.

4.2 Modelled Domain and Receptors

The assessment has considered the maximum off-site predicted concentration for the purposes of human health impact assessment against the AQS objectives, as determined through review of isopleth figures and maximum model output.

The maximum predicted concentrations at identified ecological receptors have been determined from isopleth figures (gridded points) for those receptors close to the Installation, and from discrete modelled points for more remote ecological receptors and nearby human health receptors. Receptors included within the model are summarised in Table 6 below.

Table 6: Discrete receptors included in the dispersion model

Receptor ID	Receptor Name	Receptor Type	Grid Reference	Location from Installation
E1a	Northumbria Coast	SPA, Ramsar	430150, 591650[1]	1.6km N
E1b	Northumbria Coast	SPA, Ramsar	431280, 589540[1]	0.9km SE
E2a	Northumberland Shores	SSSI	430220, 591430[1]	1.3km N
E2b	Northumberland Shores	SSSI	431120, 589640[1]	0.7km SE
E3	Cresswell Dunes	LNR	430200, 590700[1]	0.7km NW
E4	Hawthorn Cottage Pasture	SSSI	426326, 588834	4.5km SW
E5	Willow Burn Pasture	SSSI	424432, 584030	8.7km SW
R1	Woodhorn Grange	Residential	429111, 589618	1.6km W
R2	Woodhorn Colliery Museum	Residential	428800, 588400	2.5km SW
R3	Lynefield House	Residential	430093, 589761	0.7km SW
R4	Woodhorn Village	Residential	429800, 588900	1.5km SW
R5	Bridge Road, Lynemouth	Residential	429460, 590800	1.3km NW
R6	Sea View, Lynemouth	Residential	429720, 591030	1.3km NW

Notes [1] Closest discrete modelled point

The nearest residential receptor is at Lynefield House, 700m to the south-west. The dispersion model has included a grid extending 2.5km from the Installation with grid points at 90m intervals, which is considered appropriate to the stack height and receptor locations. Predicted concentrations at discrete receptor locations are unaffected by grid spacing.

[2] *Air Quality and Human Health Impact Assessment, Alcan Aluminium, Lynemouth, Northumberland*, Environment Agency AQMAU/C493 (C404)-RP01, January 2009

4.3 Building and Terrain Effects

The dispersion of emissions to air can be significantly affected by the presence of buildings or structures near to the emission points. The wind field can become entrained into the wake of buildings, which causes the wind to be directed to ground level more rapidly than in the absence of a building. If an emission is entrained into this deviated wind field, this can give rise to elevated ground-level concentrations. Building effects are typically considered where a structure of height greater than 40% of the stack height is situated within 8 to 10 stack heights of the emissions source.

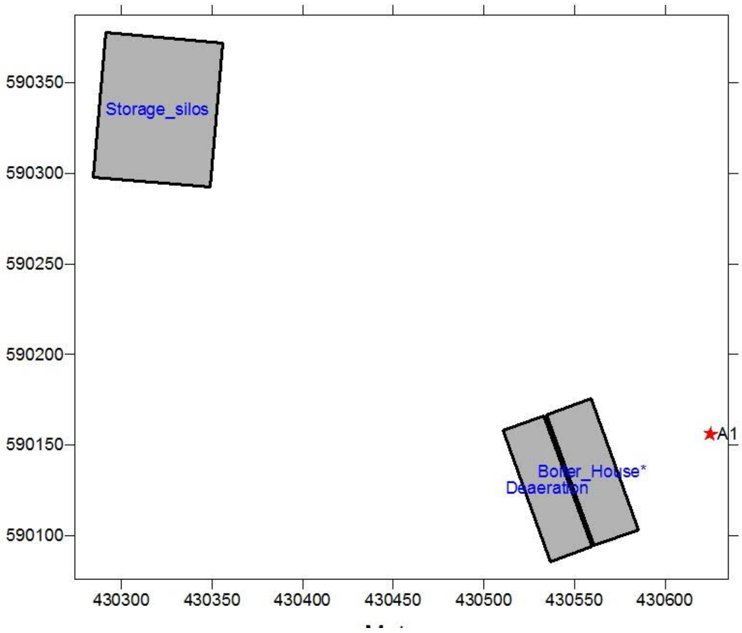
The buildings associated with the Installation that are considered to be of sufficient height and massing to potentially impact on the dispersion of emissions from the release points have been included within the model and are described in Table 7. A visualisation of the buildings in relation to the location of the emission point is shown in Figure 1 below.

Table 7: Buildings data included in the dispersion model

Building	Grid Reference[1]	Height (m)	Length (m)	Width/ Diameter (m)	Angle[2]
Boiler House	430560, 590135	60	77	26	160
De-aeration	430535, 590126	50	77	24	160
Storage silos (as block of 6)	430320, 590335	48	80	65	5

Notes: [1]Grid reference of building centre; [2]Angle of building length to grid north

Figure 1: Visualisation of buildings included in the dispersion model



The Installation is situated in an area of flat terrain, adjacent to the coast. Surface roughness of between 0.2-0.5m has been selected to represent the local land area, with the area off-shore represented by a surface roughness of 0.002m. The coastline module in ADMS5, which allows for the prediction of impacts from on-shore winds when the sea is cooler than the land, has not been used in this study as on-shore winds make up a small proportion (<10%) of the meteorological conditions at the monitoring station therefore will have only a small effect on the long-term impacts. Furthermore the use of the coastline module in ADMS5 precludes the use of the buildings module, which is considered to have a significant effect on the predicted concentrations.

Site-specific terrain data has not been used in the model, as typically terrain data will only have a marked effect on predicted concentrations where hills with gradient of more than 1 in 10 are present in the vicinity of the source, which is not the case at this site.

Sensitivity analysis of the ADMS model to a number of the input parameters, including the use of variable surface roughness and the inclusion of buildings has been carried out and is detailed in Section 4.5.

4.4 Meteorological Data

The dispersion of emissions from a point source is largely dependent on atmospheric stability and turbulent mixing in the atmosphere, which in turn are dependent on wind speed and direction, ambient temperature, cloud cover and the friction created by buildings and local terrain.

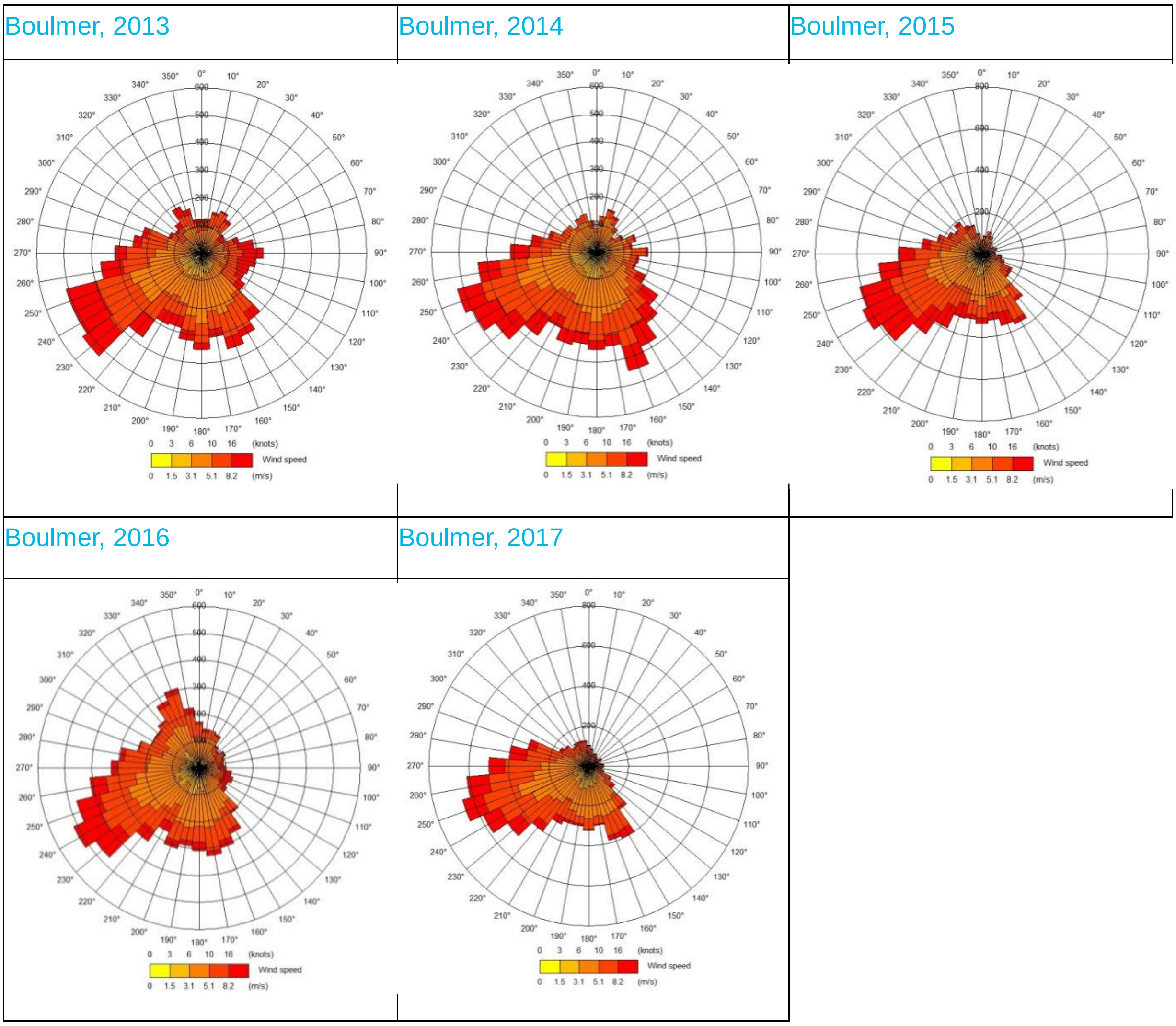
Actual measured hourly-sequential meteorological data is available for input into dispersion models, and it is important to select data as representative as possible for the site that is modelled. This is usually achieved by selecting a meteorological station as close to the site as possible, although other stations may be used if the local terrain and conditions vary considerably, or if the station does not provide sufficient data.

The meteorological site that was selected for the assessment was for Boulmer, located approximately 24km north of the Installation, at a flat airfield.

The modelling for this assessment has utilised meteorological data for the period 2013-2017, and all results have been reported for the worst case meteorological year.

The windroses for Boulmer are shown in Figure 2 below.

Figure 2: Wind-roses, Boulmer



4.5 Sensitivity Analysis

The sensitivity of predicted results to dispersion model input parameters has been assessed in order to identify the realistic worst-case process contributions (PC) at off-site locations and at sensitive ecological receptors. These variables include:

- Meteorological data, for which five years' data from a representative meteorological station (Boulmer) have been used;
- Representation of surface roughness within the model;
- Grid resolution;
- Representation of buildings that could affect dispersion from the source; and
- Use of AERMOD module within ADMS to predict concentrations.

The maximum long-term predicted concentration of NO_2 at the worst-case off-site location, and NO_x at the worst-affected ecological receptor, associated with the variable input parameters are presented in Table 8, as the percentage of maximum reported values for Scenario 1.

Table 8: Dispersion model sensitivity analysis

Model input variable	Maximum annual mean offsite NO_2 PC	Maximum annual mean NO_x PC at ecological receptor
Meteorological data (5-year min-max)	62%-100%	56%-100%
Non-variable surface roughness (0.2m)	122%	150%
Grid resolution (80m spacing)	68%	91%
Buildings representation (without inclusion of buildings)	57%	85%
AERMOD representation	59%	72%

The variation in maximum annual mean PC with meteorological data is 56-62%, equivalent to an overall uncertainty associated with the annual mean maximum off-site PC of -0.8% of the AQS for human health and -0.5% of the Critical Level at the worst-affected ecological receptor.

A variable surface roughness file was included in the dispersion model to account for differences in ground-level turbulence between on-shore features such as urban areas and fields, and off-shore areas. The maximum predicted concentrations without the variable surface roughness file were 120-150% higher than those reported in the model, however as no terrain files are included in the model, the use of variable surface roughness is considered appropriate.

The reported results include modelled buildings, as shown in Table 7. The modelled PC with buildings included is 57% of the reported annual mean at maximum off-site location, and 85% of the reported annual mean at the worst-affected ecological receptor.

AERMOD modelling predicted lower long-term concentrations than ADMS, with a maximum off-site concentration representing -0.9% of the AQS for human health and -0.3% of the Critical Level at the ecological receptor.

With the exception of surface roughness representation, the overall worst-case input parameters have been used to generate the PCs used in this assessment. Application of the above sensitivity results to PCs does not change the conclusions of the assessment.

5. Predicted Results

The predicted PC and PEC from each model scenario have been compared against the appropriate AQS or EAL to assess whether the potential impacts on air quality for human health and protected conservation sites are predicted to be insignificant, or whether the scenario could result in exceedance of an environmental standard. The results are shown in the Tables below.

5.1 Human Health Impacts

5.1.1 Nitrogen Dioxide

The maximum predicted hourly mean NO_2 process contribution (as 99.79th %ile) is below the threshold for insignificance (10% of the AQS) for both Scenarios 1 and 2 at off-site locations and identified sensitive human health receptors.

The mean NO_2 PCs at sensitive human health receptors are also below the threshold for insignificance (<1% of the AQS) for both scenarios, although the maximum off-site PC is 2.5% of the AQS for Scenario 1 (current design ELV) and 2.0% for Scenario 2 (SNCR use). The baseline NO_2 is low however, and both scenarios are predicted to result in maximum PEC well below the AQS at 22%.

The impacts from NO_2 at the current design ELV on human health are therefore considered to be insignificant, similarly for NO_2 at the BAT-AEL with the potential use of SNCR.

5.1.2 Particulates

Predicted maximum ground level concentrations from Installation particulate emissions at the current design ELV, and at the BAT-AEL, are considered to be insignificant in both the short-term and long-term as the PCs are less than 10% of the daily mean PM_{10} AQS (as the 90.4th %ile), less than 1% of the annual mean PM_{10} AQS, and less than 1% of the annual mean $PM_{2.5}$ AQS, for each scenario. The assessment has assumed that the particulate emission is entirely PM_{10} or $PM_{2.5}$ for the purpose of comparison with the AQS objectives, as a conservative assumption.

5.1.3 Ammonia

Emissions of ammonia associated with slip from use of SNCR, at the upper BAT-AEL are predicted to result in insignificant impacts on air quality for human health as the maximum PCs are below the threshold for insignificance when compared against the short-term and long-term EALs.

Table 9: Maximum Predicted Human health impacts from NO_2

Scenario	Measured as	PC (µg/m^3)	PC/AQS	Insignificant?	BC (µg/m^3)	PEC (µg/m^3)	PEC/AQS or headroom	Insignificant?
1	Annual mean (max offsite)	1.02	2.5%	**No**	7.8	8.8	22%	Yes
	Annual mean (max receptor)	0.31	0.8%	Yes	-	-	-	-
	Hourly mean (99.79th %ile, max offsite)	14.9	7.4%	Yes	-	-	-	-
	Hourly mean (99.79th %ile, max receptor)	8.3	4.1%	Yes	-	-	-	-
2	Annual mean (max offsite)	0.81	2.0%	**No**	7.8	8.6	22%	Yes
	Annual mean (max receptor)	0.25	0.6%	Yes	-	-	-	-
	Hourly mean (99.79th %ile, max offsite)	13.6	6.8%	Yes	-	-	-	-
	Hourly mean (99.79th %ile, max receptor)	7.54	3.8%	Yes	-	-	-	-

Annual mean AQS= 40µg/m^3
Hourly mean AQS=200µg/m^3

Table 10: Maximum Predicted Human health impacts from Particulates

Scenario	Measured as	PC (µg/m^3)	PC/AQS	Insignificant?
1	PM_{10} annual mean (max offsite)	0.15	0.4%	Yes
	PM_{10} annual mean (max receptor)	0.04	0.1%	Yes
	$PM_{2.5}$ annual mean (max offsite)	0.15	0.6%	Yes
	PM_{10} daily mean (90.4th %ile, max offsite)	0.57	1.1%	Yes
	PM_{10} daily mean (90.4th %ile, max receptor)	0.22	0.4%	Yes
2	PM_{10} annual mean (max offsite)	0.07	0.2%	Yes
	PM_{10} annual mean (max receptor)	0.02	0.1%	Yes
	$PM_{2.5}$ annual mean (max offsite)	0.07	0.3%	Yes
	PM_{10} daily mean (90.4th %ile, max offsite)	0.46	0.9%	Yes
	PM_{10} daily mean (90.4th %ile, max receptor)	0.18	0.4%	Yes

PM_{10} annual mean AQS= 40µg/m^3
PM_{10} daily mean AQS=50µg/m^3
$PM_{2.5}$ annual mean AQS= 25µg/m^3

Table 11: Maximum Predicted Human health impacts from NH_3

Scenario	Measured as	PC (µg/m^3)	PC/AQS	Insignificant?
2	Annual mean (max offsite)	0.07	<0.1%	Yes
	Annual mean (max receptor)	0.02	<0.1%	Yes
	Hourly mean (max offsite)	2.31	0.1%	Yes
	Hourly mean (max receptor)	1.42	0.1%	Yes

Annual mean AQS= 180µg/m^3
Hourly mean AQS=2,500µg/m^3

5.2 Ecological Impacts

The maximum ground level pollutant concentrations and pollutant deposition rates have been determined for protected conservation sites within the specified distance through review of discrete receptor points, and isopleth plots of pollutant dispersion from the Installation. Conservative assumptions have been made with respect to the presence of sensitive habitat features within the protected conservation sites, as discussed in Section 2.3.

5.2.1 Atmospheric Pollutants

Predicted ground level concentrations from Installation NO_x emissions from Scenario 1 at the maximum impact location represents 35% of the daily mean Critical Level, whilst Scenario 2 represents 32% of the Critical Level. The PCs predicted at the current design ELV, and at the BAT-AEL, are considered to be insignificant in the short-term as, whilst the daily mean NO_x PCs are greater than the 20% screening threshold at the nearby protected conservation areas (E1-E3), the PECs are less than 100% of the daily mean Critical Level at these receptors.

The daily mean NO_x PCs at E4 and E5 are below the short-term threshold for insignificance. The annual mean NO_x PC at all identified protected conservation areas is below the long-term threshold for insignificance (<1% of the annual mean Critical Level) for both Scenarios 1 and 2.

Emissions of ammonia associated with slip from use of SNCR in Scenario 2, at the upper BAT-AEL, are predicted to result in insignificant impacts on air quality for protected conservation areas as the maximum PCs are below the threshold for insignificance when compared against the long-term Critical Level for ammonia.

Atmospheric pollutant impacts from the Installation on protected conservation areas are not considered to be significant for the emissions at design ELVs or at the BAT-AELs.

5.2.2 Deposition to Land

Nutrient nitrogen deposition to land from Installation process contributions of NO_x at the design ELV is predicted to be below the threshold for insignificance (<1%) when compared with the habitat-specific Critical Loads for most sensitive features in the identified protected conservation areas. Scenario 2, in which emissions from the Installation include lower NO_x, and ammonia in the nitrogen deposition calculation, is predicted to result in slightly higher nutrient nitrogen deposition rates, but still with the PC less than 1% of the defined Critical Loads for each protected conservation area.

Acid deposition, which includes process contributions from nitrogen, sulphur and hydrogen chloride, has been calculated using the APIS tool. For each of the protected conservation areas the baseline N deposition exceeds the CLMinN and therefore the contribution from sulphur (and HCl) is taken into account and the PEC compared with the CLMaxN.

The PC to acid deposition at the Northumbria SPA, Ramsar (E1), assuming the most sensitive habitat type (supralittoral sediment, acid grassland) is present at the maximum impact location, is predicted to be 3.8% of the Critical Load (CLMaxN)) for acid grassland habitat for Scenario 1, and 4.3% of the CLMaxN for Scenario2. The PEC is predicted to exceed the Critical Load and therefore such a contribution would require further evaluation to be considered acceptable. However there is no record of acid grasslands within the SPA area impacted by the process contribution, and therefore this assessment is considered to be conservative.

The PC to acid deposition at the Hawthorn Cottage Pasture SSSI (E4) is predicted to be below the insignificance threshold (<1% of the Critical Load (CLMaxN)) for calcareous grassland habitat for both emission scenarios. The PC to acid deposition at the Willow Burn Pasture SSSI (E5) is predicted to be below the insignificance threshold (<1% of the Critical Load (CLMaxN)) for acid grassland habitat for both emission scenarios.

Broadly, the assessment does not identify either emissions scenario to provide a lesser impact on the protected conservation areas than the other and therefore neither emissions scenario is considered to be the better option.

Table 12: Ecological impacts from atmospheric NOx

Scenario	Receptor	Measured as	PC (µg/m^3)	PC/ AQS	Insignificant?	BC (µg/m^3)	PEC (µg/m^3)	PEC/ AQS	Insignificant?
1	**E1** Northumbria Coast SPA, Ramsar	Annual mean	0.23	0.8%	Yes	-	-	-	-
		Daily mean	26.0	35%	**No**	16.8	42.8	57%	Yes
	E2 Northumberland Shore SSSI	Annual mean	0.23	0.8%	Yes	-	-	-	-
		Daily mean	26.0	35%	**No**	16.8	42.8	57%	Yes
	E3 Cresswell Dunes NNR	Annual mean	0.25	0.8%	Yes	-	-	-	-
		Daily mean	22.0	29%	**No**	16.8	38.8	38%	Yes
	E4 Hawthorn Cottage Pasture SSSI	Annual mean	0.09	0.3%	Yes	-	-	-	-
		Daily mean	15.0	20%	Yes	-	-	-	-
	E5 Willow Burn Pasture SSSI	Annual mean	0.07	0.2%	Yes	-	-	-	-
		Daily mean	11.03	15%	Yes	-	-	-	-
2	**E1** Northumbria Coast SPA, Ramsar	Annual mean	0.18	0.6%	Yes	-	-	-	-
		Daily mean	24.0	32%	**No**	16.8	40.8	54%	Yes
	E2 Northumberland Shore SSSI	Annual mean	0.18	0.6%	Yes	-	-	-	-
		Daily mean	24.0	32%	**No**	16.8	40.8	54%	Yes
	E3 Cresswell Dunes NNR	Annual mean	0.20	0.7%	Yes	-	-	-	-
		Daily mean	20.0	27%	**No**	16.8	38.4	35%	Yes
	E4 Hawthorn Cottage Pasture SSSI	Annual mean	0.07	0.2%	Yes	-	-	-	-
		Daily mean	13.6	18%	Yes	-	-	-	-
	E5 Willow Burn Pasture SSSI	Annual mean	0.06	0.2%	Yes	-	-	-	-
		Daily mean	10.0	13%	Yes	-	-	-	-

Annual mean CL= 30µg/m^3
Daily mean CL=75µg/m^3

Short-term background concentration is assumed to be twice the annual mean

Table 13: Ecological impacts from atmospheric NH_3

Scenario		Measured as	Maximum offsite PC ($\mu g/m^3$)	PC/AQS	Insignificant?
2	**E1** Northumbria Coast SPA, Ramsar	Annual mean	0.011	0.4%	Yes
	E2 Northumberland Shore SSSI	Annual mean	0.011	0.4%	Yes
	E3 Cresswell Dunes NNR	Annual mean	0.012	0.4%	Yes
	E4 Hawthorn Cottage Pasture SSSI	Annual mean	0.005	0.2%	Yes
	E5 Willow Burn Pasture SSSI	Annual mean	0.003	0.1%	Yes

Critical Level = 3µg/m³

Table 14: Nutrient nitrogen deposition impacts

Scenario	Receptor	Habitat	Empirical Critical Load	Maximum annual mean PC (kg N/Ha/Yr)	PC/CL (lower)	Insignificant?	BC (kg N/Ha/Yr)	PEC (kg N/Ha/Yr)	PEC/CL (lower)	Insignificant?
1	**E1** Northumbria Coast SPA, Ramsar	Coastal stable dune grasslands – acid	8-10	0.023	0.3%	Yes	-	-	-	-
	E2 Northumberland Shore SSSI	Littoral rock & sediment, low-mid-upper saltmarsh	20-30	0.023	0.1%	Yes	-	-	-	-
	E4 Hawthorn Cottage Pasture SSSI	Neutral grassland, low & medium altitude haymeadows	20-30	0.009	<0.1%	Yes	-	-	-	-
	E5 Willow Burn Pasture SSSI	Neutral grassland, low & medium altitude haymeadows	20-30	0.007	<0.1%	Yes	-	-	-	-
2	**E1** Northumbria Coast SPA, Ramsar	Coastal stable dune grasslands – acid	8-10	0.078 *(of which 0.06 NH_3)*	0.98%	Yes	-	-	-	-
	E2 Northumberland Shore SSSI	Littoral rock & sediment, low-mid-upper saltmarsh	20-30	0.078 *(of which 0.06 NH_3)*	0.4%	Yes	-	-	-	-
	E4 Hawthorn Cottage Pasture SSSI	Neutral grassland, low & medium altitude haymeadows	20-30	0.031 *(of which 0.02 NH_3)*	0.2%	Yes	-	-	-	-
	E5 Willow Burn Pasture SSSI	Neutral grassland, low & medium altitude haymeadows	20-30	0.024 *(of which 0.02 NH_3)*	0.1%	Yes	-	-	-	-

Table 15: Acid deposition impacts

Scenario	Receptor (Critical Load Class: most sensitive species)	*Empirical Critical Load (keq N/Ha/yr)*	*Empirical Critical Load (keq S/Ha/yr)*	*Total Baseline (N:S keq/Ha/yr)*[1]	PC N to acid deposition	PC (S+HCl) to acid deposition[1]	PEC N deposition (<CLMinN?)	PC/Critical Load (CLMaxN)	PEC/Critical Load (CLMaxN)	Insignificant?
1	**E1** Coastal stable dunes, acid grassland	0.22-0.79	0.42	0.59:0.30	0.0017	0.0284	0.592 (>CLMinN)	3.8%	118%	**No**
	E2 Littoral rock & sediment	Not sensitive to acid deposition								
	E4 Neutral grassland, calcareous	0.86-4.86	4.00	1.40:0.24	0.0006	0.0111	1.400 (>CLMinN)	0.2%	34%	Yes
	E5 Neutral grassland, acid	0.44-2.80	1.57	1.11:0.18	0.0005	0.0084	1.110 (>CLMinN)	0.3%	46%	Yes
2	**E1** Coastal stable dunes, acid grassland	0.22-0.79	0.42	0.59:0.30	0.0056	0.0284	0.596 (>CLMinN)	4.3%	118%	**No**
	E2 Littoral rock & sediment	Not sensitive to acid deposition								
	E4 Neutral grassland, calcareous	0.86-4.86	4.00	1.40:0.24	0.0022	0.0111	1.401 (>CLMinN)	0.3%	34%	Yes
	E5 Neutral grassland, acid	0.44-2.80	1.57	1.11:0.18	0.0016	0.0084	1.111 (>CLMinN)	0.4%	46%	Yes

Notes: [1] SO_2 and HCl contribution factored from NOx concentration, based on SO_2 ELV emission rate of 200mg/Nm^3, HCl emission rate of 5mg/Nm^3.

6. Options Appraisal

The assessment of the two emission scenarios, Scenario 1 at current design ELVs, and Scenario 2 at BAT-AELs, does not identify either as unacceptable with respect to impacts on air quality for human health as the process contributions are considered insignificant in both cases.

Conservatively assuming the most sensitive habitat type (supralittoral sediment, acid grassland) is present at the maximum impact location; Scenario 1 represents a slightly lower impact than Scenario 2 with respect to acid deposition, as a result of the only modest improvement in NO_x concentration with additional ammonia emissions from secondary abatement in Scenario 2. However, broadly the assessment of the two emission scenarios with respect to impacts on protected conservation areas does not identify either scenario to have a lesser impact than the other.

The two emission scenarios are therefore ranked equally within the Environmental Risk Assessment.

7. Conclusion

The air impacts from the installation are not significantly improved through the adoption of additional secondary abatement on the power station to achieve compliance with the BAT-AELs. There are therefore negligible air quality benefits from achieving the tighter emission levels from the power station.

Appendix A : Isopleth showing Scenario 1: annual mean NO_x process contribution ($\mu g/m^3$)