SCAIL Assessment of Emissions to Atmosphere from Three Boilers: BAe Warton

P2505

A Report Prepared for
Earth & Marine Environmental
Consultants Ltd
By ADM Ltd
20 Lickfolds Road
Farnham
Surrey, GU10 4AE, UK
Tel: +44 (0) 7767 636941
Email: post@ADMLtd.com
Web: www.AboutAir.com

ADM Ltd

Principal Author: David Harvey BSc, MBA, FIAQM
Client: Earth & Marine Environmental Consultants Ltd

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1 INTRODUCTION

Earth & Marine Environmental Consultants Ltd has commissioned Atmospheric Dispersion Modelling Ltd (ADM Ltd) to undertake an SCAIL assessment of emissions to the atmosphere from two existing gas-fuelled boilers at BAe Warton, PR4 1AX.

'Simple Calculation of Atmospheric Impact Limits from Combustion Sources (SCAIL-Combustion) is a screening tool for assessing the impact from Combustion plants on human health and on seminatural areas like SSSIs and SACs.' (1).

The Environment Agency (EA) has requested an SCAIL assessment of emissions from the boilers. Given that only two of the three boilers will ever operate at the same time, this assessment considers emissons from two boilers each operating for 50% of the year. Also, emissions data are only available from two of the three boilers.

This report provides the required SCAIL assessment for emissions to the atmosphere from the boilers.

About the Author

This SCAIL assessment and report was prepared by David Harvey, MBA BSc FIAQM, who has 30 years of experience in air quality. Mr Harvey is a Director of ADM Ltd, a company he founded in 1997 and is a Fellow of the Institute of Air Quality Management (FIAQM). Fellowship is for '*professionals who have had a distinguished career in the field of air quality*'.

(1) UK Centre for Ecology & Hydrology (June 2023) SCAIL-Combustions: User Guide.

2 DATA REQUIRED FOR SCAIL ASSESSMENT

2.1 INTRODUCTION

This section presents the data required for the SCAIL assessment.

2.2 EMISSIONS DATA

Table 2.1 shows the parameters which describe the physical properties of emissions from the existing boilers, as required for the SCAIL assessment. The modelling assumes that two boilers operate for 50% of the time

Table 2.1 Emissions and Physical Properties

Parameter	W363 HTHW Boiler 1	W363 HTHW Boiler 2
Number of flues (per boiler)	1	1
Release height above ground level (m)	27	27
Exit velocity (m s^{-1})	9.5	16.0
Flue diameter (m)	0.55	0.55
Flue gas emission temperature (deg C)	182	204
Actual volumetric flow rate per flue (Am^3 hr^{-1})	9,011	13,168
Normalised volumetric flow per flue (Nm^3 hr^1) (a)	5,263	6,498
Normalised volumetric flow per flue (Nm^3 s^1) (a)	1.46	1.81
Oxides of nitrogen (NO_x, mg Nm^{-3}) (a)	178	133
Nitrogen dioxide (NO_2, g s^{-1})	0.26	0.24
Percentate operation (%) (b)	50	50

(a) Corrected for: temperature; 273 k; pressure; 101.3kPa (1 atmosphere); dry; 3% v/v O_2.
(b) Actual operation of 33% for each of the three boilers.

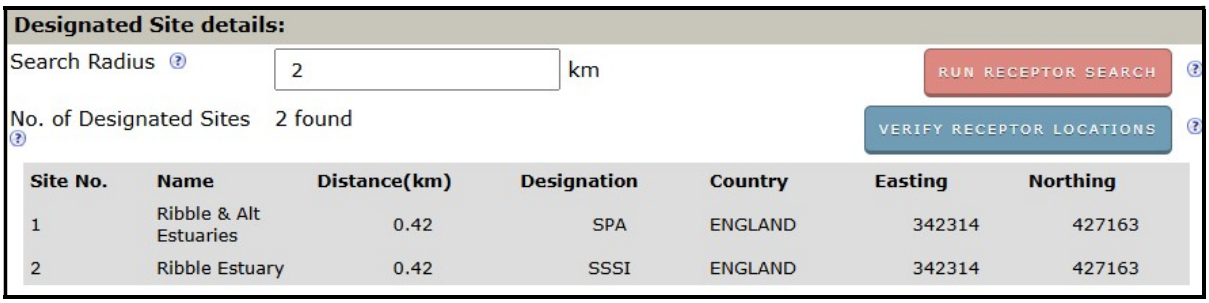
2.3 RECEPTORS

The SCAIL assessment tool automatically identifies nature conservation sites and includes them in the assessment. There is one area of nature conservation within 2 km of the installation which is covered by four designations:.

- Ribble & Alt Estuaries: Special Protection Area (SPA)
- Ribble Estuary: Marine Conservation Zone (MCZ)
- Ribble & Alt Estuaries: Ramsar
- Ribble Estuary: Site of Special Scientific Interest (SSSI)

Details included in the SCAIL assessment for the ecological sites are shown below in **Figure 2.1.**

Figure 2.1: Designated Sites Details as Generated by SCAIL

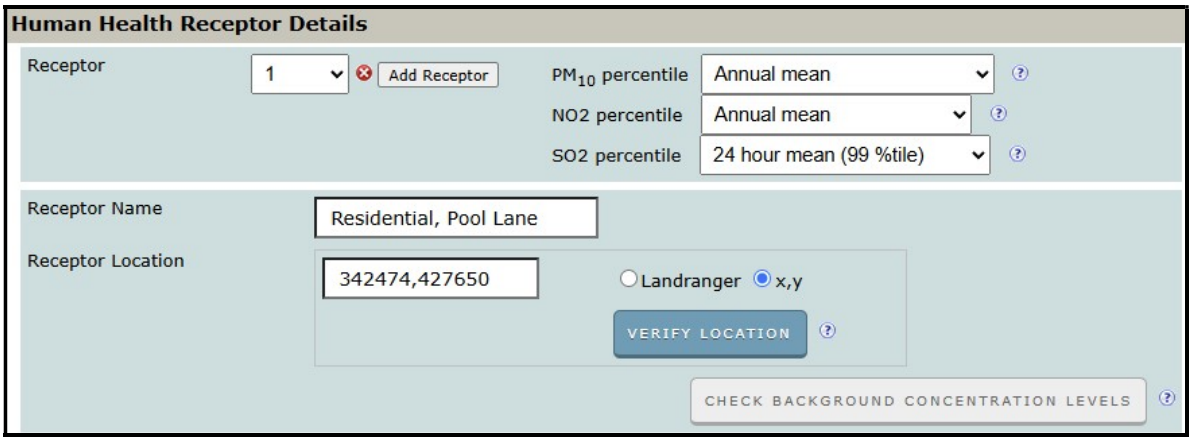


Site No.	Name	Distance(km)	Designation	Country	Easting	Northing
1	Ribble & Alt Estuaries	0.42	SPA	ENGLAND	342314	427163
2	Ribble Estuary	0.42	SSSI	ENGLAND	342314	427163

In addition to consideration of the nature conservation site, the closest specific receptor relevant to human health exposure has been included. This is the residential property off Pool Lane, which is 500 m to the east of the location of the boilers (OS grid reference: 342474,427650)

Details included in the SCAIL assessment for the human health receptor are shown below in **Figure 2.2.**

Figure 2.2: Human Health Receptor Details



3 SCAIL ASSESSMENT

3.1 INTRODUCTION

This section presents the results of the SCAIL assessment.

3.2 HUMAN HEALTH

Figure 3.1 shows the SCAIL-generated impacts at the closest human health receptor. The nitrogen dioxide (NO_2) process contribution (PC) is 0.15 μg $m^{-3,}$ which is 0.4% of the assessment criteria (40 μg m^{-3}) and therefore insignificant.

Figure 3.1 SCAIL Generated Impacts: Human Health

Site Information	Residential| Pool Lane
Country:	England
Site Name:	Residential| Pool Lane
Site Code:	N/A
Designation Status:	Human Health Receptor
Distance from Installation (m):	511
Receptor Type:	N/A
Grid Reference:	342474,427650
Met Site:	CROS
Run Mode:	Conservative
NO2 Limit:	Annual mean
SO2 Limit:	24 hour mean
PM_{10} Limit:	Annual mean

Installation Information

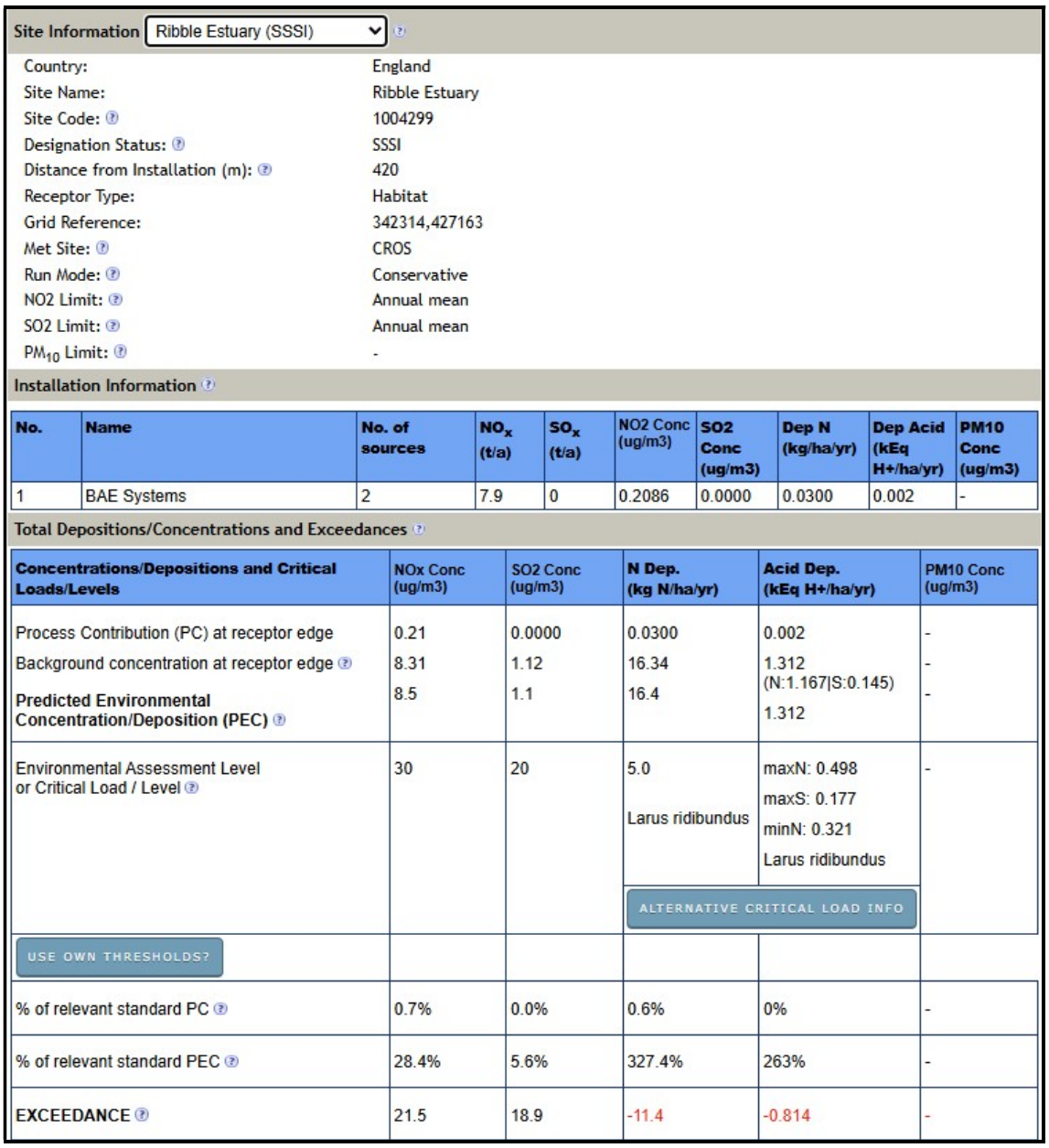
No.	Name	No. of sources	NO_x (t/a)	SO_x (t/a)	NO2 Conc (ug/m3)	SO2 Conc (ug/m3)	Dep N (kg/ha/yr)	Dep Acid (kEq H+/ha/yr)	PM10 Conc (ug/m3)
1	BAE Systems	2	7.9	0	0.1	0.0	-	-	0.0

Total Depositions/Concentrations and Exceedances

Concentrations/Depositions and Critical Loads/Levels	NO2 Conc (ug/m3)	SO2 Conc (ug/m3)	N Dep. (kg N/ha/yr)	Acid Dep. (kEq H+/ha/yr)	PM10 Conc (ug/m3)
Process Contribution (PC) at receptor edge	0.15	0.0	-	-	0.0
Background concentration at receptor edge	6.48	2.24	-	-	9.90
Predicted Environmental Concentration/Deposition (PEC)	6.6	2.2	-	-	9.9
Environmental Assessment Level or Critical Load / Level	40	125	-	- - - -	40
			ALTERNATIVE CRITICAL LOAD INFO		
USE OWN THRESHOLDS?					
% of relevant standard PC	0.4%	0.0%	-	-	0%
% of relevant standard PEC	16.6%	1.8%	-	-	25%
EXCEEDANCE	33.4	122.8	-	-	30.1

Figure 3.2 shows the SCAIL-generated impacts at the Ribble Estuary SSSI.

Figure 3.2 SCAIL Generated Impacts: Ribble Estuary SSSI



Site Information: Ribble Estuary (SSSI)

Country:	England
Site Name:	Ribble Estuary
Site Code:	1004299
Designation Status:	SSSI
Distance from Installation (m):	420
Receptor Type:	Habitat
Grid Reference:	342314,427163
Met Site:	CROS
Run Mode:	Conservative
NO2 Limit:	Annual mean
SO2 Limit:	Annual mean
PM_{10} Limit:	-

Installation Information

No.	Name	No. of sources	NO_x (t/a)	SO_x (t/a)	NO2 Conc (ug/m3)	SO2 Conc (ug/m3)	Dep N (kg/ha/yr)	Dep Acid (kEq H+/ha/yr)	PM10 Conc (ug/m3)
1	BAE Systems	2	7.9	0	0.2086	0.0000	0.0300	0.002	-

Total Depositions/Concentrations and Exceedances

Concentrations/Depositions and Critical Loads/Levels	NOx Conc (ug/m3)	SO2 Conc (ug/m3)	N Dep. (kg N/ha/yr)	Acid Dep. (kEq H+/ha/yr)	PM10 Conc (ug/m3)
Process Contribution (PC) at receptor edge	0.21	0.0000	0.0300	0.002	-
Background concentration at receptor edge	8.31	1.12	16.34	1.312 (N:1.167|S:0.145)	-
Predicted Environmental Concentration/Deposition (PEC)	8.5	1.1	16.4	1.312	-
Environmental Assessment Level or Critical Load / Level	30	20	5.0 Larus ridibundus	maxN: 0.498 maxS: 0.177 minN: 0.321 Larus ridibundus	-
			ALTERNATIVE CRITICAL LOAD INFO		
USE OWN THRESHOLDS?					
% of relevant standard PC	0.7%	0.0%	0.6%	0%	-
% of relevant standard PEC	28.4%	5.6%	327.4%	263%	-
EXCEEDANCE	21.5	18.9	-11.4	-0.814	-

Figure 3.2 shows that the process contribution (PC) of the oxides of nitrogen (NO_x) is 0.7% of the critical level of 30 μg m^{-3} and 0.6% of the critical load of 5 kg N ha^{-1} yr^{-1}. As both the predicted impacts are less than 1% of the critical level and critical load, the impacts are insignificant.

Figure 3.3 shows the impacts at the Ribble & Alt Estuaries, Special Protection Area (SPA).

Figure 3.3 **SCAIL Generated Impacts:** Ribble & Alt Estuaries: Special Protection Area (SPA)

Site Information Ribble & Alt Estuaries (SPA)

Country:	England
Site Name:	Ribble & Alt Estuaries
Site Code:	UK9005103
Designation Status:	SPA
Distance from Installation (m):	420
Receptor Type:	Habitat
Grid Reference:	342314,427163
Met Site:	CROS
Run Mode:	Conservative
NO2 Limit:	Annual mean
SO2 Limit:	Annual mean
PM_{10} Limit:	-

Installation Information

No.	Name	No. of sources	NO_x (t/a)	SO_x (t/a)	NO2 Conc (ug/m3)	SO2 Conc (ug/m3)	Dep N (kg/ha/yr)	Dep Acid (kEq H+/ha/yr)	PM10 Conc (ug/m3)
1	BAE Systems	2	7.9	0	0.2086	0.0000	0.0300	0.002	-

Total Depositions/Concentrations and Exceedances

Concentrations/Depositions and Critical Loads/Levels	NOx Conc (ug/m3)	SO2 Conc (ug/m3)	N Dep. (kg N/ha/yr)	Acid Dep. (kEq H+/ha/yr)	PM10 Conc (ug/m3)
Process Contribution (PC) at receptor edge	0.21	0.0000	0.0300	0.002	-
Background concentration at receptor edge	8.31	1.12	16.34	1.312 (N:1.167|S:0.145)	-
Predicted Environmental Concentration/Deposition (PEC)	8.5	1.1	16.4	1.312	-
Environmental Assessment Level or Critical Load / Level	30	20	2.0 Melanitta nigra (Western Siberia/Western & Northern Europe/North-western Africa)	maxN: 0.481 maxS: 0.160 minN: 0.321 Larus ridibundus (North-western Europe - breeding)	-
			ALTERNATIVE CRITICAL LOAD INFO		
USE OWN THRESHOLDS?					
% of relevant standard PC	0.7%	0.0%	1.5%	0%	-
% of relevant standard PEC	28.4%	5.6%	818.5%	273%	-
EXCEEDANCE	21.5	18.9	-14.4	-0.831	-

Figure 3.3 shows that the process contribution (PC) of the oxides of nitrogen (NO_x) is 0.7% of the critical level of 30 μg m^{-3} and therefore insignificant.

For nutrient nitrogen deposition at the SPA (which is the same location as the SSSI), the SCAIL assessment selects the critical load to be 2 kg N ha^{-1} yr^{-1}, which results in an impact of 1.5% and therefore higher than the usual threshold for insignificance of 1%. It is, however, considered that the critical load of 2 kg N ha^{-1} yr^{-1} is not the correct value to use as it is for '*permanent oligotrophic lakes, ponds and pools*' of which there are none in the region of the installation (see **Figure 3.4**).

Figure 3.4 SCAIL table of Critical Loads for Ribble & Alt Estuaries SPA

Critical Loads for Nitrogen

Interest Feature Name	Nitrogen Critical Load Habitat Class	Minimum Critical Load (kg N/ha/yr)
Melanitta nigra (Western Siberia/Western & Northern Europe/North-western Africa)	Permanent oligotrophic lakes, ponds and pools (including softwater lakes)	2
Charadrius hiaticula (Europe/Northern Africa - wintering)	Coastal dune grasslands (grey dunes)	5
Larus ridibundus (North-western Europe - breeding)	Coastal dune grasslands (grey dunes)	5
Larus ridibundus (North-western Europe - breeding)	Raised and blanket bogs	5
Numenius phaeopus (Europe/Western Africa)	Northern wet heath: U? Callunadominated wet heath (upland)	5

The Air Pollution Information System (APIS) states that the critical loads used in APIS are from a 2022 review of empirical critical loads of nitrogen for Europe [(1) (2)]. This report includes **Table 11.1** (see below).

This table shows that an appropriate critical load for the Ribble & Alt Estuaries SPA would be 10-20 kg N ha^{-1} yr^{-1}.

It should also be noted that Note b in this table states '*Apply the lower end of the range [2-10 kg N $ha^{-1}yr^{-1}$] to clear-water sub-Arctic and alpine lakes*'. Therefore, 2 kg N ha^{-1} yr^{-1} is incorrect for an estuary.

Adopting a conservative approach, it is suggested that a value of 5 kg N ha^{-1} yr^{-1} is appropriate for the SPA (the same as for the SSSI). Using a critical load of 5 kg N ha^{-1} yr^{-1} results in the SCAIL-generated impact being less than 1% and therefore insignificant.

(1) https://www.apis.ac.uk/critical-loads-and-critical-levels-guide-data-provided-apis#_Toc279788052.
(2) German Environment Agency (2022) Review and revision of empirical critical loads of nitrogen for Europe.

Table 11.1. Overview of empirical N critical loads (kg N ha^{-1} yr^{-1}) to natural and semi-natural ecosystems (column 1), classified according to EUNIS (column 2), as established in 2011 (column 3), and as revised in 2022 (column 4). The reliability is indicated by ## reliable; # quite reliable and (#) expert judgement (column 5). Column 6 provides a selection of effects that may occur when critical loads are exceeded. Finally, changes with respect to 2011 are indicated as values in bold.

Ecosystem type	EUNIS code	2011 kg N ha^{-1} yr^{-1}	2022 kg N ha^{-1} yr^{-1}	2022 reliability	Indication of exceedance
Marine habitats (MA)					
Atlantic upper-mid salt marshes	MA223	20-30	**10-20**	(#)	Increase in dominance of graminoids; decline positive indicator species
Atlantic mid-low salt marshes	MA224	20-30	**10-20**	(#)	Increase in late successional species; decline positive indicator species
Atlantic pioneer salt marshes	MA225	20-30	20-30	(#)	Increase in late successional species; increase in productivity species
Coastal habitat (N)					
Shifting coastal dunes	N13, N14	10-20	10-20	#	Biomass increase; increased N leaching; reduced root biomass
Coastal dune grasslands (grey dunes)	N15	8-15	5-15	##	Increased biomass and cover of graminoids and mesophilic forbs; decrease in oligotrophic species including lichens; increased tissue N; increased N leaching; soil acidification
Coastal dune heaths	N18, N19	10-20	10-**15**	#	Increased plant production; increased N leaching; accelerated succession; typical lichen C:N decrease; increased yearly increment *Calluna*
Moist and wet dune slacks	N1H	10-20	**5-15**	#	Increased cover of graminoids and mesophilic forbs; decrease in oligotrophic species; increased Ellenberg N
Dune-slack pools (freshwater aquatic communities of permanent Atlantic	N1H1, N1J1	10-20	10-20	(#)	Increased biomass and rate of succession

Ecosystem type	EUNIS code	2011 kg N ha^{-1} yr^{-1}	2022 kg N ha^{-1} yr^{-1}	2022 reliability	Indication of exceedance
Inland surface water habitats (C) [a]					
Permanent oligotrophic lakes, ponds and pools (including soft-water lakes)	C1.1	3-10	**2-10** [b]	##	Increased algal productivity and a shift in nutrient limitation of phytoplankton from N to P; shifts in macrophyte community

Source: German Environment Agency (2022) Review and revision of empirical critical loads of nitrogen for Europe

Note (b): This CLempN should only be applied to oligotrophic waters with low alkalinity and with no significant agricultural or other human inputs. Apply the lower end of the range to clear-water sub-Arctic and alpine lakes, the middle range to boreal lakes and the higher end of the range to Atlantic soft waters.