12.0 AIR QUALITY

12.1 Air Quality

Background

12.1.1 The only significant source of atmospheric emissions from the Brigg REP would be the main chimney, containing a single flue. These emissions would be regulated by the Environment Agency under the terms of an Environmental Permit and would comply with the requirements of the Large Combustion Plant Directive.

Methodology

12.1.2 The assessment contains the following sections:

- a statement of the current air quality standards and guidelines which apply to the pollutants which would be released from the plant;
- an assessment of the current air quality in the vicinity of the site;
- a description of the methodology used in the air dispersion modelling, including assumptions and data used;
- a description of the results of the air dispersion modelling, including dispersion diagrams;
- conclusions.

12.2 Air Quality Standards and Guidelines

12.2.1 In the UK, air quality standards and objectives for major pollutants are described in The Air Quality Strategy for England, Scotland, Wales and Northern Ireland 2007 (known as the National Air Quality Strategy or NAQS). This document builds on the previous NAQS, published in 2000, and a 2003 Addendum to the NAQS.

12.2.2 The air quality standards are implemented in a series of Statutory Instruments:

- The Air Quality (England) Regulations 2000 (SI 2000/928), as amended by The Air Quality (England) (Amendment) Regulations 2002 (SI 2002/3043);
- The Air Quality Standards Regulations 2007 (SI 2007/64).

12.2.3 For other pollutants, the Environment Agency (EA) sets Environmental Assessment Levels (EALs) in Appendix D to Technical Guidance Note H1: Environmental Assessment and Appraisal of BAT ("TGN H1"). The long term and short term EALs from this document have been used when the NAQS does not contain relevant standards.

12.2.4 Both AQSs and EALs are set at levels well below those at which significant adverse health effects have been observed in the general population and in particularly sensitive groups.

12.2.5 A number of other standards and guidelines are listed for the protection of vegetation and sensitive ecosystems. Some of these are listed in TGN H1 and others are available from the APIS database from English Nature.

Nitrogen Dioxide

12.2.6 All combustion processes produce nitric oxide (NO) and nitrogen dioxide (NO_2), which are together referred to as NOx. In general, the majority of the NOx released is in the form of NO, which then reacts with ozone in the atmosphere to form NO_2. Of the two compounds, nitrogen dioxide is associated with adverse effects on human health, principally relating to respiratory illness.

12.2.7 The major sources of NOx in the UK are road transport and power stations. According to the most recent annual report from the National Atmospheric Emissions Inventory (NAEI), road transport accounted for 37% of UK emissions, with power stations accounting for a further 27%. High levels of NOx in urban areas are almost always associated with high traffic densities.

12.2.8 The NAQS includes two objectives to be achieved by 31 December 2005:

- A limit for the annual mean of 40 μg/m^3;

- A limit for the one-hour mean of 200 μg/m^3, not to be exceeded more than 18 times a year (equivalent to the 99.79th percentile).

12.2.9 The NAQS also contains an additional target for the protection of sensitive vegetation and ecosystems, which is an annual limit of 30 μg/m^3 for the annual mean concentrations of nitrogen oxides.

Sulphur Dioxide

12.2.10 Sulphur dioxide is predominantly released by the combustion of fuels containing sulphur. Around 68% of UK emissions were associated with power stations in 2004, with much of the remainder associated with other combustion processes. Emissions of SO_2 have reduced by 87% since 1970, due to the reduction in coal combustion and the installation of flue gas desulphurisation plants on a number of large coal-fired power stations.

12.2.11 Sulphur dioxide is an irritant when inhaled. The NAQS contains three objectives for the control of SO_2:

- a limit for the one hour mean of 350 μg/m^3, not to be exceeded more than 24 times a year (the 99.73rd percentile) to be achieved by 31 December 2004;
- a limit for the 15 minute mean of 266 μg/m^3, not to be exceeded more than 35 times a year (the 99.9th percentile), to be achieved by 31 December 2005;
- a limit for the daily mean of 125 μg/m^3, not to be exceeded more than 3 times a year (the 99.2nd percentile), to be achieved by 31 December 2004.

12.2.12 The NAQS also contains two additional targets for the protection of sensitive vegetation and ecosystems:

- an annual limit of 20 μg/m^3;
- a winter average limit of 20 μg/m^3.

Particulate matter

12.2.13 Concerns over the health impact of solid matter suspended in the atmosphere tend to focus on particles with a diameter of less than 10 µm, known as PM_{10}s. These particles have the ability to enter and remain in the lungs. Various epidemiological studies have shown increases in mortality associated with high levels of PM_{10}s, although the underlying mechanism for this effect is not yet understood.

12.2.14 Significant sources of PM_{10}s are road transport (22%), quarrying (16%) and stationary combustion (34%). The NAQS includes two objectives for PM_{10}s to be achieved by the end of 2004, both of which are included in European Directives:

- A limit for the annual mean of 40 µg/m^3, to be achieved by 2004.
- A daily limit of 50 µg/m^3, not to be exceeded more than 35 times a year (the 90.4th percentile) to be achieved by 2004.

12.2.15 The previous NAQS included some provisional objectives for 2010. These have been replaced by an exposure reduction objective for $PM_{2.5}$s in urban areas and a target value for $PM_{2.5}$s of 25 µg/m^3 as an annual mean. This target value is included in the latest Air Quality Directive 2008/50/EC.

Carbon Monoxide

12.2.16 Carbon Monoxide is produced by the incomplete combustion of fuels containing carbon. By far the most significant source is road transport, which produces 67% of the UK's emissions. Carbon monoxide can interfere with the processes that transport oxygen around the body, which can prove fatal at very high levels.

12.2.17 Concentrations in the UK are well below levels at which health effects can occur. The NAQS includes the following objectives for the control of carbon monoxide:

- A limit for the 8-hour running mean of 10 mg/m^3, to be achieved by 1 January 2005.

Hydrogen Chloride

12.2.18 There are no standards for hydrogen chloride, but the Environment Agency regulates the emissions of HCl. Technical Guidance Note H1 defines the short-term EAL as 800 µg/m^3 and the long-term EAL as 20 µg/m^3. EPAQS have recently recommended a short term EAL of 750 µg/m^3.

Deposition

12.2.19 As stated in section 3.4 of Technical Guidance Note H1, "there are no Environmental Quality Standards in the UK for releases to land by deposition and very little information is available to date from any source on suitable benchmarks." No Maximum Deposition Rates (MDR) have been determined for any of the substances that could be released by the REP.

Summary

12.2.20 The table below summarises the air quality standards and guidelines used in the air quality assessment. The sources for each of the values can be found in the preceding sections. Where more than one standard exists for a given averaging period for a given pollutant, the most stringent standard has been used.

Table 12.1: Air Quality Standards (AQS) and Environmental Assessment Levels (EALs)

Pollutant	Limit Value (µg/m^3)	Averaging Period	Frequency of exceedence
Nitrogen Dioxide	200	1 hour	18 times per year (99.79th %ile)
	40	Annual	-
Sulphur Dioxide	266	15 minutes	35 times per year (99.9th %ile)
	350	1 hour	24 times per year (99.73rd %ile)
	125	24 hours	3 times per year (99.18th %ile)
Particulate matter (PM_{10})	50	24 hours	35 times per year (90.4th %ile)
	40	Annual	-
Particulate matter ($PM_{2.5}$)	25	Annual	
Carbon Monoxide	10,000	8 hours, running	-
Hydrogen chloride	750	1 hour	-
	20	Annual	-

12.3 Background Air Quality

12.3.1 There is a limited amount of air quality monitoring carried out in the vicinity of the site. The available information is reviewed in this section.

Automatic Monitoring Stations

12.3.2 There are only two automatic monitoring stations within 30 km of the site:

- Scunthorpe Town, an Urban Industrial site, located 9.5 km from Brigg REP;
- Hull Freetown, an Urban Central site, located 25.6 km from Brigg REP.

Table 12.2: Automatic Monitoring Results, Near Brigg REP

Pollutant	Quantity	Scunthorpe Town			Hull Free Town			AQS
	(µg/m^3)	**2005**	**2006**	**2007**	**2005**	**2006**	**2007**	
Nitrogen Dioxide	Annual Average	-	-	-	21.4	23.5	20.2	40
	99.79th %ile of hourly means	-	-	-	82.0	82.0	82.0	200
Particulate Matter	Annual mean	24.8	29.5	24.6	22.7	25.1	18.4	40
	90.4th %ile of daily means	47.0	57.0	46.0	40.0	43.0	35.0	50
Sulphur dioxide	Annual Average	8.1	7.5	6.3	4.7	4.7	3.4	-
	99.73rd %ile of hourly means	69.0	104.0	92.3	37.0	37.0	36.6	350

Note:
Data for Scunthorpe Town and Hull Free Town is ratified up to 1/10/2007

12.3.3 The nitrogen dioxide annual mean concentrations were below the air quality objectives at the Scunthorpe Town and the Hull Free Town site for all years. The 99.79th%iles of hourly means at both sites were also below air quality objectives.

12.3.4 The particulate matter annual mean concentrations were below the air quality objectives at Scunthorpe Town and the Hull Free Town but the air quality objective for the 90.4th%iles of daily means was exceeded at Scunthorpe Town site in 2006. However, the Scunthorpe Town site is an urban industrial station located close to the steel works and so measured concentrations of pollutants are likely to be greater than in the semi-rural area around the Brigg REP.

National Nitrogen Dioxide Survey Results

12.3.5 There are 11 sites within about 25 km of the site that monitored nitrogen dioxide (NO2) concentrations as part of DEFRA's national NO2 diffusion tube survey between. The monitoring sites considered fall into three categories:

- Roadside (R), 1-5 m from a busy road (8 sites);

- Urban Background (B), more than 50 metres from any road (2 sites). (Both of these sites closed on 30/12/05. One of the sites is 1.7 km away, the other is 19.4km away)
- Kerbside (K), directly adjacent to a road (1 site).

12.3.6 The data from the diffusion tube sites has been analysed to give the results shown below.

Table 12.3: Diffusion Tube Survey Results, 2004-2006

Type of Site	Average Concentration of All Tubes (µg/m^3)			Highest Annual (µg/m^3)			Highest Monthly (µg/m^3)		
	2004	2005	2006	2004	2005	2006	2004	2005	2006
Roadside	31.3	31.5	33.8	36.0	36.1	32.0	45.0	47.0	169.0
Urban Background	21.5	20.5	-	24.3	22.8	-	35.0	34.0	-
Kerbside	-	42.0	39.5	-	42.0	39.5	-	50.0	49.0

12.3.7 The air quality objective of 40 µg/m^3 as an annual average was not exceeded at any of the roadside or urban background sites, but was exceeded for one year for the kerbside site.

12.3.8 The background sites are more likely to be representative of the area around the Brigg Plant. The highest annual average at a background site was 24.3 µg/m^3.

National Modelling Data

12.3.9 In order to assist councils with their responsibilities under Local Air Quality Management (LAQM), NETCEN have modelled the background concentration of pollutants throughout the UK on a 1 km by 1 km grid. This model is based on known pollution sources and background measurements. The predicted concentrations closest to the site (at 498500, 406500) were as follows:

- Nitrogen dioxide 18.2 µg/m^3 for 2005;
- Sulphur dioxide 6.49 µg/m^3 for 2001;
- PM10s 21.6 µg/m^3 for 2005;
- Carbon monoxide 0.274 mg/m^3 for 2001;

12.3.10 All of these predicted concentrations are well below the relevant air quality objectives.

North Lincolnshire Local Air Quality Management

12.3.11 There are a number of large industrial sites within North Lincolnshire, including the steelworks at Scunthorpe and an oil refinery at Killingholme. North Lincolnshire Council has set up a local air quality management area to account for emissions from these industrial sites. As part of this, NO_2 and benzene diffusion tubes were put in place across North Lincolnshire. A summary of the NO_2 diffusion tube results is given below.

12.3.12 The closest NO_2 diffusion tubes are in Brigg, but these are kerbside monitoring points. In fact, all the NO2 diffusion tubes are either at kerbside or roadside points. The data from the diffusion tubes in various locations are given below.

Table 12.4: Diffusion Tube Results, 2004-2005

Location	Type (no.)	Average Concentration of Tubes (µg/m^3) 2004	Average Concentration of Tubes (µg/m^3) 2005
Scunthorpe	Kerbside (9)	42.0	40.9
Messingham	Kerbside (2)	28.0	27.5
Brigg	Kerbside (5)	30.2	29.6

12.3.13 The air quality objective of 40 µg/m^3 was not exceeded at any of the kerbside locations in Brigg or Messingham but was at Scunthorpe at 6 out of the 9 sites.

Background Concentrations Used

12.3.14 The NETCEN figures have been used for carbon monoxide since the monitoring stations do not provide suitable data.

12.3.15 For nitrogen dioxide, we have used a background concentration of 24.3 µg/m^3, which is the highest concentration measured by an urban background diffusion tube.

12.3.16 For particulates, we have used a background concentration of 21.6 μg/m^3, which is the NETCEN concentration but is very similar to the average recorded concentration at Hull Free Town of 22 μg/m^3. The monitoring station in Scunthorpe is likely to be affected by the adjacent steelworks and so will not be representative of the local area around the Brigg REP.

12.3.17 For sulphur dioxide, we have used the NETCEN concentration of 6.49 μg/m^3. This is similar to the average recorded concentration at Scunthorpe of 7.3 μg/^{3}, but the monitoring at Scunthorpe is likely to be affected by the adjacent steelworks and so may not be representative of the local area around the Brigg REP.

12.4 Air Quality Modelling Methodology

Stack Height Calculation

12.4.1 The first stage of the assessment of the impact on air quality is to select a suitable stack height for the plant. This was done using the method detailed in Technical Guidance Note (Dispersion) D1. The calculation is attached in Appendix 12.1, and gives a recommended stack height of 57 metres above ground level. This differs from the previous application, which produced a recommended stack height of 62m. The reduction is caused solely by the reduction in particulate emissions (the previous submission assumed a limit of 30mg/Nm^3; the current application assumes a limit of 20mg/Nm^3). The emissions concentrations for all other pollutants are unchanged. Therefore, a lower stack would increase the contribution to ground level concentrations of all pollutants other than particulate matter when compared to the previous application. This effect is examined in Section 12.5.24 in the context of NOx emissions. Decreasing stack height does increase the impact of a development on ground level air quality but this may be justified on the grounds of reduced visual impact. However, visual impact is less critical in this development by virtue of the presence of four 70m stacks immediately to the south of the development, which would in any case have a greater impact on views than the single Brigg REP stack. On balance, the applicant has decided to retain the original stack height of 62m; as such, the decrease in emissions levels would manifest in a reduction in the contribution to ground level concentrations of particulate matter.

Model Selection

12.4.2 The detailed flue gas dispersion modelling was carried out using the computer model ADMS 4, developed and supplied by Cambridge Environmental Research Consultants (CERC). This is a new generation dispersion model, which characterises the atmospheric boundary layer in terms of the Monin-Obukhov length and the boundary layer depth. In addition, the model uses a skewed Gaussian distribution for dispersion under convective conditions, to take into account the skewed nature of turbulence. Modules within the model take account of the effect of complex terrain, nearby buildings and atmospheric chemistry.

12.4.3 ADMS is one of the few dispersion models accepted by the Environment Agency for the prediction of emissions for planning and PPC (Pollution Prevention and Control) purposes.

Atmospheric Chemistry

12.4.4 The plant will release nitric oxide (NO) and nitrogen dioxide (NO_2) which are together referred to as NOx. In the atmosphere, NO will be converted to NO_2 in a reaction with ozone which is influenced by solar radiation. Since the air quality objectives are expressed in terms of NO_2, it is important to be able to assess the conversion rate of NO to NO_2.

12.4.5 ADMS 4 includes a chemistry module, which models the progress of this reaction in the atmosphere. This module requires the background concentrations of NO_2, NO and ozone to be provided.

12.4.6 The background concentrations of NO_2, NO and ozone have been used from a number of sources, data from 2003 onwards was available from the Hull Freetown monitoring station and from 1999 to 2001 from Hull city centre monitoring station. For 2002 incomplete data sets were available from these locations, so data from Rotherham was used instead. Since these background concentrations are available, the chemistry module has been used in this assessment.

Source and Emission Data

12.4.7 The principal inputs to the model with respect to the releases from the main stack are shown in Table 12.5 below.

Table 12.5: Source and Emissions Data

Item	**Unit**	**Brigg REP**	
Stack Height	m	62	
Effective Internal Stack Diameter	m	1.95	
Stack Position (Easting, Northing)	m, m	498902,406175	
Stack Flue Gas Exit Velocity	m/s	20.92	
Flue Gas Conditions			
Temperature	°C	134	
Oxygen	% v/v, dry	4.92	
Moisture Content	% v/v	16.38	
Volume at reference conditions (dry)	Nm^3/s	37.6	
	Nm^3/h	135,234	
Volume at discharge conditions (wet)	Am^3/s	41.9	
	Am^3/h	150,850	
Emissions		**Conc. (mg/m^3)**	**Rate (g/s)**
Oxides of nitrogen (as NO_2)		300	11.270
Sulphur dioxide		100	3.757
Carbon monoxide		375	14.087
Particulates (PM_{10})		20	0.751
Hydrogen Chloride		30	1.127
Note: Emission concentrations are for dry flue gas, 6% oxygen.			

12.4.8 Weather data was taken into account by using data from the Met. Office for Leconfield weather station and Waddington weather station.

12.4.9 Leconfield weather station is located 40km north of Brigg, but it is north of the river Humber. Five years of weather data have been used between 2003 and 2007 to ensure that fluctuations in the weather conditions are taken into account. The wind roses for each year are attached in Figure 12.1. The prevailing winds are predominantly from the west.

12.4.10 Waddington weather station is located 50km south of Brigg. Weather data for the years 1999-2003 have been used. The wind roses in Figure 12.2 show that the prevailing winds are from the south west and quite different from the wind roses seen at Leconfield.

12.4.11 Given the location of the proposed Brigg facility between these two stations, it is likely to experience a mixture of weather conditions. As such we have assessed the impact of the facility using data from both weather stations.

Buildings

12.4.12 The presence of adjacent buildings can significantly affect the dispersion of the atmospheric emissions in various ways,

- wind blowing around a building distorts the flow and creates zones of turbulence. The increased turbulence can cause greater plume mixing;
- the rise and trajectory of the plume may be depressed slightly by the flow distortion. This downwash leads to higher ground level concentrations closer to the stack than those which would be present without the building.

12.4.13 Because of the complex local effects the presence of buildings may have on the dispersion from the stack, the following buildings located on the site were modelled. This can be seen in table 12.6 below.

Table 12.6: Building Data

Item	Unit	Boiler House	Straw Barn #1	Straw Barn #2	Wood Storage	Turbine Hall
Effective Building Height	m	32.00	18.00	18.00	14.1	12.0
Building Length	m	31.53	42.79	42.8	42.9	43.2
Building Width	m	33.24	73.79	73.8	14.7	30.7
Position of building centre (Eastings, Northings)	m, m	498931.5, 406140	498861.3, 406062.2	498849.2, 406134	498943, 406076	498961.3, 406150.3
Angle of building to north (clockwise)	°	80.5	80.5	80.5	80.5	80.5

Sensitive Receptors

12.4.14 The general approach to the assessment of the impact of air quality on human health is to evaluate the highest predicted contribution of the emissions to ground level concentrations of pollutants at any point in the vicinity, irrespective of the occupancy of the location of that highest predicted contribution. In addition, the predicted contribution at a number of sensitive receptors has also been evaluated. These sensitive receptors are shown on Figure 12.3, and listed below.

1. House West;
2. House North West;
3. House North;
4. House North East;
5. Brigg School.

12.4.15 The impact on sensitive environmental receptors has been considered, but there are no international sensitive environmental areas within 10 km of the plant or SSSI's within 5km of the plant. There are a number of SSSIs within 10 km, which are considered later in this section.

12.5 Results

12.5.1 The full results of the dispersion modelling of the emissions from the plant stack can be found in the table below.

12.5.2 According to the Environment Agency's Technical Guidance Note H1, the contribution to air quality is considered to be insignificant if the short-term contribution is less than 10% of the air quality objective and the long-term contribution is less than 1% of the air quality objective. , The predicted contributions to the AQA/EAL are shown in Table 12.7, which shows that no contributions are considered to be significant.

Table 12.6: Stack Emission Dispersion Modelling Results

Pollutant	**Measure**	**Contribution to Ground Level Concentration at point of greatest impact (µg/m3)**			**Max as % of AQO/ EAL**
		Maximum Waddington 1999-2003	**Maximum Leconfield 2003-2007**	**Overall Maximum**	
Nitrogen dioxide	Annual Mean	0.32	0.33	**0.33**	0.82%
	99.79th %ile of hourly means	3.33	6.54	**6.54**	3.27%
Sulphur dioxide	99.9th %ile of 15 min. means	12.68	12.75	**12.75**	4.79%
	99.73rd %ile of hourly means	11.10	10.85	**11.10**	3.17%
	99.18th %ile of daily means	5.96	4.51	**5.96**	4.77%
Particulate matter (PM_{10})	Annual mean	0.11	0.09	**0.11**	0.27%
	90.41st%ile of daily means	0.35	0.32	**0.35**	0.70%
Carbon monoxide	8 hour running mean	51.60	43.20	**51.60**	0.52%
Hydrogen chloride	Annual mean	0.16	0.13	**0.16**	0.81%
	Hourly mean	4.69	4.21	**4.69**	0.63%

Sensitive Receptors

12.5.3 The following discussion focuses on the contributions to ground level concentrations at the point of greatest impact. This point does not coincide with any of the sensitive receptors shown on Figure 12.3. This is illustrated in the table below, which shows the highest predicted contribution of stack emissions to ground level concentrations of nitrogen dioxide and sulphur dioxide at the sensitive receptors and compares these results with the highest predicted contribution at the point of maximum impact. (The results for other pollutants are similar, but are not shown for clarity.)

12.5.4 It can be seen that the contribution at sensitive receptors is well below the contribution at the point of maximum impact.

Table 12.8: Stack Emission Dispersion Modelling Results, Sensitive Receptors

Pollutant	Quantity	Maximum Contribution to Ground Level Concentration at Specified Points (µg/m^3) 1999-2007					
		House West	House North West	House North	House North East	Brigg School	Point of Max Impact
Nitrogen dioxide	Annual Mean	0.138	0.184	0.101	0.263	0.138	**0.33**
	99.79th %ile of hourly means	0.350	0.274	0.741	2.063	0.003	**6.54**
Sulphur dioxide	99.9th %ile of 15 min. means	6.569	10.521	9.023	6.069	3.965	**12.75**
	99.73rd %ile of hourly means	5.823	9.322	6.085	5.415	3.249	**11.10**
	99.18th %ile of daily means	2.484	3.426	1.328	2.575	1.784	**5.96**

Nitrogen Dioxide

12.5.5 The predicted concentrations for nitrogen dioxide are based on the assumption that 10% of the NOx is released as NO_2, with the remainder being released as NO and oxidised to NO_2 in the atmosphere.

12.5.6 The highest contribution of the stack emissions to the annual average ground level concentration of nitrogen dioxide is predicted to be 0.33 µg/m^3, based on 2004 weather data at Leconfield. This peak occurs about 800 metres away from the stack in a easterly direction and is 0.8% of the air quality objective. This distribution is shown in Figure 12.4.

12.5.7 If the highest contribution is added to the background concentration of 24.3 μg/m^3, the total predicted ground level concentration is 24.6 μg/m^3, which is well below the AQO of 40 μg/m^3.

12.5.8 The highest 99.79th percentile hourly average ground level concentration of nitrogen dioxide from the plant is predicted to be 6.54 μg/m^3, based on 2007 weather data at Leconfield. This peak occurs about 300 metres away from the stack in a north easterly direction and is 3.3% of the air quality objective. This distribution is shown in Figure 12.5.

12.5.9 It would not be correct to add the peak short-term contribution from the plant to the highest recorded short-term background concentration, since the two peaks would not be coincident in time or space. Instead, Technical Guidance Note H1 recommends that the short-term process contribution should be added to twice the long-term ambient concentration. If the short-term peak is added to two times the background concentration, the total predicted ground level concentration is 55.1 μg/m^3, which is 28% of the AQO of 200 μg/m^3.

Sulphur Dioxide

12.5.10 The highest contribution to the 99.9th percentile of 15-minute means of ground level concentration of sulphur dioxide is predicted to be 12.75 μg/m^3 based on 2007 weather data at Leconfield and is 4.8% of the air quality objective. If this short-term peak is added to twice the annual average background concentration of 6.49 μg/m^3, the total predicted peak is 25.73 μg/m^3, which is around 9.7% of the air quality objective of 266 μg/m^3. This distribution is illustrated in Figure 12.6.

12.5.11 The highest contribution to the 99.73rd percentile hourly average ground level concentration of sulphur dioxide from the plant is predicted to be 11.1 μg/m^3, based on 2003 weather data from Waddington and is 3.2% of the air quality objective. If this short-term peak is added to twice the annual average background concentration, the total predicted peak is 24.1 μg/m^3, which is around 6.9% of the air quality objective of 350 μg/m^3.

12.5.12 The highest contribution to the 99.18th percentile daily average ground level concentration of sulphur dioxide is predicted to be 5.96 μg/m^3, based on 2002 weather data from Waddington and is 4.8% of the air quality objective. If this short-term peak is added to twice the annual average background concentration, the total predicted peak is 18.94 μg/m^3, which is around 15.2% of the air quality objective of 125 μg/m^3.

Particulate Matter

12.5.13 The highest contribution of the stack emissions to the annual average ground level concentration of particulate matter is predicted to be 0.11 μg/m^3, based on 1999 weather data from Waddington. This is 0.43% of the AQO. If the highest contribution is added to the background concentration of 21.6 μg/m^3, the total predicted ground level concentration is 21.7 μg/m^3, which is well below the AQO of 40 μg/m^3.

12.5.14 The highest contribution to the 90.4th percentile of the daily average ground level concentration is predicted to be 0.35 μg/m^3 based on 2000 weather data from Waddington. This is 0.7% of the EAL. This distribution is illustrated in Figure 12.7.

12.5.15 If this short-term peak is added to twice the annual average background concentration, the total predicted peak is 43.6 μg/m^3, which is less than the air quality objective of 50 μg/m^3.

12.5.16 The plant makes an insignificant contribution to both the long term and short term air quality standards using the screening methodology set out in the Environment Agency's Technical Guidance Note H1.

12.5.17 $PM_{2.5}$s are a fraction of PM_{10}s, so the concentration of $PM_{2.5}$s must be lower than the concentration of PM_{10}s. However if we assume a worst case situation, that all the PM10s are released as $PM_{2.5}$s the highest contribution of the stack emissions to the annual average ground level concentration of $PM_{2.5}$s would be 0.11 μg/m^3. This is 0.44% of the AQO for $PM_{2.5}$s, therefore the maximum contribution of the plant to the long term $PM_{2.5}$s concentration is insignificant.

Carbon Monoxide

12.5.18 The highest contribution of stack emissions to the eight-hourly running mean ground level concentration is predicted to be 51.6 μg/m^3, based on 2001 weather data from Waddington. This is 0.5% of the EAL. Therefore, the plant will not make a significant contribution to carbon monoxide levels in the atmosphere. Since the contribution is so low, no diagram for the dispersion is included.

Hydrogen Chloride

12.5.19 The highest contribution to the annual average ground level concentration of hydrogen chloride is predicted to be 0.16 μg/m^3, based on 1999 weather data from Waddington. This is around 0.8% of the AQO. The highest contribution to the hourly average ground level concentration is predicted to be 4.7 μg/m^3, which is 0.7% of the EAL. The distribution of the annual average concentration using 1999 weather data is illustrated in Figure 12.8.

Roughness Sensitivity

12.5.20 The sensitivity of the results to the surface roughness length has been assessed by running the model using 2006 weather data and a roughness length of 0.2, 0.3 and 0.5 metres, representative of agricultural areas (min), agricultural areas (max) and suburbia/parkland respectively. The results for nitrogen dioxide were as follows:

- the contribution to the annual average ground level concentration increased with increasing roughness length. The results were 0.29, 0.33 and 0.40 μg/m^3 respectively for the three roughness lengths in 2004 at Leconfield;
- the contribution to the 99.79th percentile of the hourly ground level concentration barely changed, being 2.20, 2.14 and 1.96 μg/m^3 respectively for the three roughness lengths in 2004 at Leconfield.

12.5.21 The selected roughness length of 0.3 metres is considered to be the most suitable roughness length to take account of the combination of flat land and light building density,

Sensitive Environmental Receptors

12.5.22 The Natural England website was used to identify all sensitive environmental areas within 10 km of the plant. The impact of air emissions on more distant sites is generally considered to be negligible.

12.5.23 The most significant areas are Ramsar sites, Special Protection Areas (SPA), Special Areas of Conservation (SAC) and Sites of Special Scientific Interest (SSSI).

12.5.24 There are no internationally protected sites within 10 km of the site, but there are a number of SSSIs (designated for biological rather than geological features) within this distance. These are listed below

Table 12.9: Stack Emission Dispersion Modelling Results, Sensitive Environmental Receptors

Site	Eastings	Northings	Distance from site (km)	Reason for designation
Manton & Twigmoor	494000	404400	5.2	Heathland, grassland and wetland
Broughton Far Wood	496000	410600	5.3	Commercial woodland
Broughton Alder Wood	496000	400900	6.0	Mixed deciduous woodland
Wrawby Moor	503200	411000	6.5	Woodland, marsh, moorland birch trees
Messingham Sand Quarry	491300	403500	8.1	Wetland and woodland
Risby Warren	492100	413500	10.0	Heathland

12.5.25 Since the concentration at the point of maximum impact for all emissions can be classed as insignificant, the effect on the above SSSI's can also be classed as insignificant.

Stack Height Sensitivity

12.5.26 The sensitivity of the results to changing the height of the main stack was considered by rerunning the model with stacks of 50 metres, 55 metres, 60 metres, 62 metres, 65 metres and 70 metres. This was done for weather data from 2004 at Leconfield. The predicted contribution of the emissions of nitrogen dioxide from the stack to the ground level concentrations are shown in the table below.

Table 12.10: Impact of Changing Stack Height on Nitrogen Dioxide Concentrations only

Boiler Stack Height (m)	Annual Average (µg/m^3)		99.79th percentile of hourly averages (µg/m^3)	
	Plant Contribution	Plant contribution plus background Concentration	Plant Contribution	Plant contribution plus twice the background Concentration
50	0.62	24.92	3.56	52.16
55	0.43	24.73	2.15	50.75
60	0.36	24.66	2.14	50.74
62	0.33	24.63	2.14	50.74
65	0.29	24.59	2.13	50.73
70	0.25	24.55	2.13	50.73

12.5.27 It can be seen that decreasing the stack height below a height of 60 metres has an impact on the peak contribution of plant emissions to the annual average concentration, increasing the annual average maximum ground level concentration to more than 1% of the air quality objective (i.e. above 0.4µg/m^3). This means that the impact on the ground level concentration could not be classed as insignificant.

12.5.28 An increase in stack height does not have a noticeable effect on the peak contribution of the plant to the 99.79th percentile of hourly means. An increase of 10 metres leads to a reduction of 0.1 μg/m^3, which is a reduction of 0.5% of the total concentration.

Summary

12.5.29 According to Technical Guidance Note H1, emissions are unlikely to lead to significant environmental impacts where:

- The contribution to long term ground level concentrations is less than 1% of the air quality standard; and
- the contribution to short term ground level concentrations is less than 10% of the air quality standard.

12.5.30 It can be seen that the emissions from the plant are unlikely to lead to significant environmental impacts on a short or long term basis for any of the pollutants.

12.5.31 Considering the combination of the emissions from the Brigg REP with background concentrations. In all cases, the air quality objective is not exceeded when background concentrations are considered.

Health Impact Assessment

12.5.32 For all substances released from the Brigg REP, the most significant effects on human health will arise by inhalation. As described in paragraph 12.2.4, the air quality standards discussed above have been set by the various authorities at a level which is considered to present minimum or zero risk to human health. It is widely accepted that, if the concentrations in the atmosphere are less than the air quality standards, then the pollutant is unlikely to have an adverse effect on human health.

12.5.33 Rather than attempting to identify the location of the most sensitive groups of people, the approach has been to predict the highest contribution of the plant at any point. The contribution of the plant to the most sensitive people is likely to be significantly lower than the highest contribution.

12.5.34 Therefore, since the highest contribution of the plant to ground level concentrations of any substance is less than 10% of the short term air quality objective and 1% of the long term air quality objective, even under the most adverse conditions, it can be seen that the plant is highly unlikely to have an adverse effect on human health.

Deposition Assessment

12.5.35 ADMS 4 includes deposition modules, the module incorporating dry deposition has been used to assess the impact of the facility on any potentially sensitive environment. Dry deposition occurs when material is lost from the plume at the surface of the ground. This is the primary method of deposition for particulate matter. All particulate matter was assumed to have a diameter of 10 microns.

12.5.36 Since deposition depends on atmospheric concentrations at ground level and is a long term phenomenon, the weather data used was for the years between 1999 and 2007.

12.5.37 The highest deposition rates for each substance are shown in the table below.

Table 12.11: Maximum Deposition Results, [1999-2007]

Substance	**Deposition Rate**	
	µg/m²/s	**mg/m²/day**
Nitrogen dioxide	0.002	0.208
Carbon monoxide	0.001	0.044
Particulate matter	0.006	0.532

12.5.38 For nitrogen, the maximum deposition rate is 0.208 mg/m²/day, which is equivalent to 0.760 kg NO_2/hectare/year, or 0.231 kg N/hectare/year. In addition, it should be noted that at least 90% of the NOx released by the plant is in the form of NO, which has a much lower deposition velocity than NO_2 and is very insoluble so has negligible wet deposition. Therefore, the contribution of the plant to the nitrogen load will be much lower than 0.231 kg N/hectare/year.

12.5.39 The local area is insensitive to nitrogen deposition. There are no sensitive environmental receptors in the vicinity and much of the adjacent agricultural land is treated with fertiliser in order to increase nitrogen levels in the soil.

Plume Visibility

12.5.40 A plume visibility assessment was carried out, with a water content in the flue gases of 16.4% by volume, or 0.115 kg water per kg dry gas. The results are shown in Table 12.12:

Table 12.12: Plume Visibility Results

Weather Data	Waddington 1999 – 2003	Leconfield 2003 – 2007	Average
Percentage of time plume is visible	13.3%	11.3%	**12.3%**
Longest Visible Plume Length (m)	283.5	246.7	**283.5**
Average Visible Plume Length (m)	60.3	44.1	**52.2**
Percentage of visible plumes that are greater than stack height	44.2%	22.6%	**33.4%**
Percentage of plumes that cross the site boundary	37.5%	18.7%	**28.1%**
Percentage of time that plumes cross the site boundary	5.0%	2.1%	**3.6%**

12.5.41 It can be seen that the plume is only visible for around 12% of the time, but only 33% of these visible plumes are greater than the stack height

12.5.42 The visible length of the plume is greater than the distance to the site boundary (between 60m and 150m dependant upon the wind direction) for 28% of the time that there is a visible plume, so the plume will pass outside the site boundary for only 3.5% of the time. The visible plume will rarely pass outside the site boundary.

12.5.43 It also worth noting that the plume never reaches the ground while visible. Therefore, the impact can be assessed as “Low” to “Insignificant” when applying the guidance in section 3.8.2 of Technical Guidance Note H1.

12.6 Other Potential Influences

12.6.1 Glanford Brigg Power Station is located adjacent to the south east of the Brigg REP site. This is a potential source of atmospheric emissions, which could combine with the emissions from Brigg REP. The potential interactions have been examined using dispersion modelling, based on information in the Glanford Brigg Power Station PPC Permit and in the air quality assessment which was submitted to support the PPC application for the Power Station in 2005.

Emissions from the Power Station

12.6.2 The plant currently operates as a peak demand station, but it cannot be assumed to operate as such in the future. Therefore, the maximum possible emissions from the plant have been modelled to determine a worst case. These results may over estimate the current emissions from the plant.

12.6.3 There are 4 stacks associated with the power station's gas turbines. The emissions from each of these stacks can be seen in the table below:

Table 12.13: Power Station Emissions

Item	Unit	Stack	
Stack Height	m	70	
Effective Internal Stack Diameter	m	3.35	
Stack Position (Eastings, Northings)			
Stack 1	m, m	466,030 , 406,175	
Stack 2	m, m	499,060 , 406,000	
Stack 3	m, m	499,160 , 406,000	
Stack 4	m, m	499,180 , 406,020	
Stack Flue Gas Exit Velocity	m/s	16.9	
Flue Gas Temperature	°C	110	
Emissions per stack		**Conc. (mg/m^3)**	**Rate (g/s)**
Oxides of nitrogen (as NO_2)		125	13.3
Carbon monoxide		10	1.1

Impact of Brigg Power Station Alone

12.6.4 The results of the dispersion modelling of the power station alone, without the straw plant, are shown below.

Table 12.14: Glanford Brigg Power Station Dispersion Modelling Results

Pollutant	Quantity	Contribution to Ground Level Concentration at point of greatest impact (µg/m3)			Max as % of AQO/ EAL
		Maximum Waddington 1999-2003	Maximum Leconfield 2003-2007	Overall Maximum	
Nitrogen dioxide	Annual Mean	0.89	0.96	**0.96**	2.41%
	99.79th %ile of hourly means	3.33	4.49	**4.49**	2.25%
Carbon monoxide	8 hour running mean	8.00	6.52	**8.00**	0.08%

12.6.5 The predicted contribution of the power station to the ground level concentration of carbon monoxide is insignificant. But the contribution of the power station on to the ground level concentration of nitrogen dioxide cannot be said to be insignificant.

Impact of Brigg REP and Brigg Power Station

12.6.6 The results of the dispersion modelling of the power station and Brigg REP require careful analysis. This is because the highest contributions from the two plants do not occur at the same place or under the same weather conditions. The table below shows the following quantities:

- The highest contribution to ground level concentrations from the power station and Brigg REP, operating independently.
- The highest contribution from the two plants in combination.
- The difference between the peak combined contribution and the contribution from the power station. This difference has been calculated for each year, with the maximum year on year difference between the peak contribution shown;
- The highest difference between the combined contribution and the power station’s contribution at any point. This shows the highest impact of the Brigg REP.

Table 12.15: Combined Power Station and Brigg REP Dispersion Modelling Results

Pollutant	Quantity	Peak Contribution (μg/m³)			Difference in Concentration at the point of maximum impact. (μg/m³)	Highest increase in Concentration at any point. (μg/m³)
		Brigg REP	Power Station	Both Brigg REP and Power Station		
Nitrogen dioxide	Annual Mean	0.33	0.96	1.33	0.59	0.63
	99.8th %ile of hourly means	6.54	4.49	7.50	3.01	5.46
Carbon monoxide	8 hour running mean	51.60	8.00	54.81	47.60	50.14

12.6.7 It can be seen that the long term emissions from the power station dominate the combined contribution for nitrogen dioxide. However the short term contribution of Brigg REP is greater than the power station even though the power station is emitting in total 4 times the mass of nitrogen dioxide but at a lower concentration from a taller stack.

12.6.8 For nitrogen dioxide, even if the combined contribution is added to the background concentration of 24.3 μg/m³, no breaches of air quality objectives are predicted. The predicted long term concentration is 25.6 μg/m³, which is well below the AQO of 40 μg/m³, and the predicted short term concentration is 56.1 μg/m³, which is substantially less than half of the AQO of 200 μg/m³. In addition the additional contribution to the peak contribution to the ground level concentration between the existing power station, at 0.96 μg/m³ and the power station and Brigg REP at 1.33 μg/m³ is 0.37 μg/m³ which is less than 1% of the air quality objective.

Road Traffic Impact Assessment

12.6.9 The traffic assessment has identified the following traffic flows associated with the plant for a base case year of 2012;

- 7 HGV's per weekday, increasing to 107 HGV's with the development load included. These values include lorries both going into and out of the plant,

- There will also be a total flow of 333 light vehicles per day, increasing to 369 with the development load. These values include vehicles both going into and out of the plant.

12.6.10 Changes in local air quality as a result of road traffic is based on long term increases in traffic. Although the traffic assessment considered a sensitivity load, which assumed a peak delivery rate based on the maximum unloading rate of the cranes within the facility, this sensitivity load can only be maintained on a short term basis and is therefore not relevant to the consideration of the long term air quality effects.

12.6.11 The development traffic flows are very small in the context of local traffic flows. The total traffic flow along the B1206 was measured as around 5595 vehicle movements, so that the plant would contribute around 4% of this flow

12.6.12 The assessment was carried out using the screening method outlined in Section 3 of Volume 11 of the Design Manual for Roads and Bridges (DMRB), produced by the Highways Agency. A software tool is available to implement this method. The following assumptions were made:

- Emission factors for typical vehicles in 2012 were selected.
- The receptor was taken to be 10 metres and 30 metres from the centre of the road.
- The average vehicle speed was taken as 50 km/h.
- The following traffic flows were used:

Table 12.16: Total Vehicle Movements along the site access road

Vehicle Movements	Cars	HGVs	Total
Baseline	333	7	340
Baseline + Development	369	107	476

12.6.13 These assumptions assume that all of the traffic from the plant travels down the same road. This may not be true for any other road other than the site access road from the B1206. Therefore, focusing on this access road will lead to an estimation of the highest annual average concentrations resulting from emissions from traffic associated with the plant.

12.6.14 The results of the assessment are shown below. All figures are annual average ground level concentrations.

Table 12.17: Results of Assessment of Traffic Emissions for the site access road

Pollutant		10m from road side		30m from road side	
		Nitrogen dioxide	**Particulate matter**	**Nitrogen dioxide**	**Particulate matter**
Predicted concentration from baseline traffic	µg/m^3	0.13	0.02	0.08	0.01
Predicted concentration from baseline and development traffic	µg/m^3	0.49	0.06	0.30	0.04
Air Quality Objective	µg/m^3	40	40	40	40
Total contribution of the baseline as percentage of AQO		0.33%	0.06%	0.20%	0.03%
Total contribution of the development and the baseline as percentage of AQO		1.22%	0.16%	0.76%	0.09%

12.6.15 The results show that the traffic from the plant makes a noticeable contribution to air quality in the vicinity of access road for nitrogen dioxide. This is because the plant is associated with a high proportion of the HGV's. However, the incremental contribution of the development only 10 metres from the road is still less than 1% of the air quality objective.

12.6.16 If the background concentration of nitrogen dioxide of 24.3 µg/m^3 is combined with the contribution from the background load of 0.49 µg/m^3, the total concentration of 24.79 µg/m^3 is well below the relevant air quality objectives.

12.6.17 The increase in traffic along the B1206 has been assessed. This has been carried out using traffic flows from a 2008 traffic survey. However, it should be noted that there was a previous traffic survey carried out in 2006. This showed a higher number of HGV's travelling along the B1206, with 213 HGV's in the 2006 survey compared to just 67 in the 2008 survey. The 2008 survey data has been used as this is considered to be more relevant and would present a worst case incremental increase:

Table 12.18: Total Vehicle Movements along the B1206

Vehicle Movements	Cars	HGVs	Total
Baseline	5528	67	5595
Baseline + Development	5564	167	5731

12.6.18 The results of the assessment are shown below. All figures are annual average ground level concentrations.

Table 12.19: Results of Assessment of Traffic Emissions for the B1206

Pollutant		10m from road side		30m from road side	
		Nitrogen dioxide	Particulate matter	Nitrogen dioxide	Particulate matter
Predicted concentration from baseline traffic	µg/m^3	1.40	0.38	0.88	0.22
Predicted concentration of baseline and development	µg/m^3	1.66	0.42	1.14	0.32
Air Quality Objective	µg/m^3	40	40	40	40
Total contribution of the baseline as percentage of AQO		3.50%	0.94%	2.20%	0.55%
Total contribution of the development and the baseline as percentage of AQO		4.15%	1.05%	2.84%	0.80%

12.6.19 The results show that the traffic associated with the development does not make a noticeable contribution, and that the overall impact is less significant when compared to the site access road due to the large traffic volumes that currently use the B1206. Using the higher base load HGV figures from the 2006 traffic survey would give a 2006 baseline case that is worse that the baseline and sensitivity run using the 2008 traffic flows.

12.6.20 If the background concentration of nitrogen dioxide of 24.3 µg/m^3 is combined with the contribution from the background and development load of 1.66 µg/m^3, the total concentration of 25.96 µg/m^3 is well below the relevant air quality objectives.

12.6.21 Traffic emissions are not predicted to lead to any breaches of air quality standards. The background concentrations measured by the automatic monitoring stations are urban central and urban industrial sites and so would take into account the impact of traffic.

12.7 Other Air Quality Impacts

12.7.1 During construction of the proposed facilities, there is the potential for short-term effects to occur, mainly in the form of dust emissions generated by earthmoving activities associated with the following construction operations:

- movement of vehicles and plant on exposed surfaces; and
- regrading and landscaping activity.

12.7.2 It is generally the case that potential nuisance from dust generated during construction activity does not arise until deposited dust levels at residential properties exceed a level of between 130 and 350 $mg/m^2/day$. For the majority of small to medium-sized construction projects, it is very unlikely that these levels would be reached, even at properties close to the construction activity (within 100 metres). Even for large construction projects, it is extremely unusual for properties beyond 250 metres to experience elevated dust deposition levels. In addition, fine particulate matter (PM_{10}) is not normally a problem from construction activity, as the particle sizes released are normally coarse. Given that the proposed site is located approximately 400 metres from the nearest residential property, and it is considered to be a small to medium-sized construction project, no material impacts associated with dust would occur.

12.7.3 Notwithstanding the above, measures that could be implemented to prevent the occurrence of dust problems are relatively straightforward and practical. As a consequence, the following would be incorporated into the Construction Management Plan:

- design of working methods to minimise dust generation;
- identification of all potentially dusty activities prior to starting work and incorporation of mitigation;
- misting/watering of all dusty areas on a regular basis during dry periods to reduce dust suspension;

- deployment of street washing /sweeping units to clean deposits from the highway;
- sheeting/covering of all lorry loads of exported/imported/transferred material;
- location of temporary stockpiles of material away from properties and designed to minimise wind blown dust emissions;
- limitations of vehicle speeds on unmade haul roads to <20 km/h; and
- maintenance of engines on all plant and equipment to minimise exhaust emissions.

12.8 Conclusions

12.8.1 The methodology used in this assessment of the impact on air quality of the Brigg REP uses a number of conservative assumptions. These include the following:

- it is assumed that the plant will continually operate at its maximum emission limits. In practice, this will not be the case and actual emissions will be less than the limits.
- the maximum ground level concentrations are considered in each case. These concentrations occur in small areas; in general, the concentration will be much lower.

12.8.2 Even with these conservative assumptions, the concentration of all pollutants is less than 10% of the short term air quality standard or guideline and less than 1% of the long term air quality standard (AQS) or guideline for all the pollutants.

12.8.3 The increase in the maximum ground level concentration when considering the combined emissions from Brigg Power station and Brigg REP is less than 1% of the AQS or guideline for all the pollutants.

12.8.4 The peak long and short term concentrations have been combined with pessimistic background concentrations for comparison with air quality standards and guidelines. No breaches of any of the standards or guidelines are predicted.

12.8.5 Emissions from traffic sources do not lead to a significant increase in ground level concentrations on the B1206, but do lead to a slightly significant increase on the access road. However no breaches of air quality standards are predicted when combined with background emissions.

12.8.6 It can be concluded that the impact on both the local community and the general population from the atmospheric emissions from the Brigg REP will be insignificant.