Forth Energy

Chapter 9

Air Quality

Contents

9 Air Quality

9.1 Introduction

9.1.1 This Chapter provides an assessment of the potential air quality and health issues associated with emissions to air from the proposed Dundee Renewable Energy Plant. The facility will have a number of potential emission sources to air which may give rise to emissions of a range of substances. A detailed description of the development is given in Chapter 6 The Proposed Development. The potential sources, the substances emitted and how these have the potential to affect air quality are summarised below:

- Point source emissions of combustion gases from the main and auxiliary boilers could potentially have an effect on local air quality. The emissions considered include the substances associated with combustion: oxides of nitrogen (NO_x), carbon monoxide (CO), particulate matter (primarily PM_{10} and $PM_{2.5}$ i.e. those particles of 10 µm and 2.5 µm aerodynamic diameter or less respectively) and sulphur dioxide (SO_2). For completeness, to ensure the flexibility of fuels which may be employed, and to cover any potential abatement techniques agreed with the Scottish Environment Protection Agency (SEPA) as part of the Pollution Prevention and Control (PPC) permit application, this assessment also considers emissions of heavy metals, hydrogen chloride (HCl), hydrogen fluoride (HF), volatile organic compounds (VOCs), ammonia (NH_3), polycyclic aromatic hydrocarbons (PAHs) and dioxins and furans;
- Point source emissions of acidic compounds and nitrogen-containing species from the main and auxiliary boilers could potentially affect sensitive habitat sites such as Sites of Special Scientific Interest (SSSIs), Special Protection Area (SPA), Special Area of Conservation (SAC) and Ramsar sites. This could occur if the pH balance in soils at sensitive sites were to be influenced by the deposition of acid gases directly, or as acids in rainwater. Increased levels of nitrogen in soils and water bodies (known as eutrophication) can result in the growth of unwanted species, at the expense of other species which have evolved to cope with low levels of nitrogen. The substances of potential concern with regard to deposition comprise oxides of nitrogen, sulphur dioxide and ammonia;
- Emissions of pollutants from road traffic (oxides of nitrogen and PM_{10}) from vehicles travelling to and from the site during the construction, operation and decommissioning of the plant could potentially affect local air quality close to the routes between the site and the main road network;
- Dust generated during the construction and decommissioning of the Renewable Energy Plant could potentially cause a nuisance to local residents, unless properly controlled; and
- Fugitive emissions from the biomass handling and storage could potentially give rise to dust and odours at nearby sensitive locations, unless properly controlled.

9.1.2 The air quality assessment addresses the potential sources set out above. The predicted impacts are assessed against the current legislative objectives for the protection of human health and vegetation with the intention of confirming that, for all pollutants considered, the predicted environmental concentrations in the vicinity of the proposed Renewable Energy Plant (even when in conjunction with the other proposed developments in the area) will not exceed the Scottish Air Quality Objectives or other relevant health based benchmarks and guidelines.

9.1.3 In view of the potential for adverse environmental effects, the design and operation of the proposed Renewable Energy Plant is intended to ensure that emissions from the above processes are minimised or prevented where possible. A number of measures, as outlined below, are incorporated in the design of the plant (full details of the mitigation measures incorporated into the design and proposed for the development are set out in Section 9.6):

- Utilisation of modern technology, combustion controls and appropriate flue gas abatement techniques to minimise emissions from the boilers.
- Good construction practice and monitoring throughout the construction and decommissioning period; and
- Enclosing or utilising dedicated buildings for fuel storage and handling activities.

9.1.4 The need for, and the extent of, flue gas abatement techniques necessary to meet the relevant legislation and to reflect the nature of the fuels to be employed will be agreed in more detail with SEPA during the PPC permit application process.

9.2 Key Consultations

9.2.1 In addition to the dissemination of the Scoping Statement, discussions have been held with Dundee City Council and SEPA with regard to the scope and methodology of the assessment, and the nature and extent of baseline information available for use within the assessment.

9.3 Assessment Methodology and Significance Criteria

Assessment Methodology

9.3.1 This air quality impact assessment considers the impact on human health, vegetation and ecosystems associated with the emission and dispersion of emissions to air from the combustion of biomass during operation as well as the displacement and subsequent dispersion of dust during the construction and decommissioning of the Dundee Renewable Energy Plant. The assessment also considers the potential impacts associated with increased road traffic movements during the construction and operational phases.

9.3.2 The relevant air quality impact assessment criteria have been identified following a review of the standards and established guidelines for the protection of air quality for the relevant pollutants.

9.3.3 A review of existing ambient air quality in the area has been undertaken to understand the baseline conditions with respect to the above mentioned pollutants, including the location and nature of existing sources of emissions in the locality of the proposed development site. These existing conditions were determined by review of the extensive data already available for the area. It has not been necessary to carry out any new ambient air quality monitoring as it is considered that sufficient data are already available to undertake a robust assessment.

9.3.4 Detailed atmospheric dispersion modelling (using the Atmospheric Dispersion Modelling System, Version 4.2 (ADMS)) was the main technique used to identify the potential impact associated with the operation of the Renewable Energy Plant combustion plant. The ADMS model has been accepted by SEPA as a means of estimating the dispersion of operational emissions from a specific source (e.g. a stack), and the subsequent ground level concentrations at specified locations (e.g. a sensitive receptor). Modelling has been undertaken in accordance with the SEPA guidance 'Air dispersion modelling report guidelines'[1]. In doing so, the *process contribution* (PC) from the Renewable Energy Plant for a number of species are calculated based on the emissions parameters given in Table 9.7. Combining the PC with the existing ambient air quality levels produces the *predicted environmental concentration (PEC)* for each of the relevant pollutants. These PECs can then be compared with the appropriate air quality objective, benchmark or guideline value.

9.3.5 Using dispersion modelling, nitrogen and acid deposition have been predicted using the methodologies presented in the Environment Agency Technical Guidance note: AQTAG 06 "Technical Guidance on Detailed

[1] SEPA, IPPC H1, Environmental Assessment and Appraisal of BAT, July 2003

Modelling Approach for an Appropriate Assessment for Emissions to Air" (in the absence of Scottish guidance) as described in Appendix C.

9.3.6 A study grid extending 2.5 km in each direction from the proposed stack location has been utilised for assessing potential impacts at human sensitive locations. The air quality study area also extended to include sensitive habitat sites within 15 km of the proposed plant.

9.3.7 Several sensitivity analyses have been carried out to demonstrate the robustness of the model predictions and to ensure that predictions are more likely to be overestimates than underestimates.

9.3.8 Road traffic emissions associated with the development were assessed using a different dispersion modelling package designed for modelling road traffic emissions, ADMS-Roads Version 2.3. Concentrations of substances were assessed at nearby sensitive locations which are adjacent to the local road network which is forecast to carry the bulk of the traffic to and from the development.

9.3.9 Further details of the dispersion modelling methodology and inputs to the modelling study are included in Appendix C of the ES.

Air quality limits and significance criteria

9.3.10 Any exceedances of the air quality objectives or guidelines, described below, as a result of the proposed development, would be considered to be a significant impact in this assessment.

National Air Quality Strategy

9.3.11 The UK Air Quality Strategy[2] (AQS) stipulates a number of Air Quality Objectives (AQOs) with respect to ambient levels of air quality. These have been established for both the protection of human health and also the protection of vegetation and include the requirements of the relevant EU Directives[3] [4] [5] [6]. The Air Quality Objectives are laid down in the Air Quality (Scotland) Regulations and Air Quality Standards (Scotland) Regulations.[7] [8] [9] The objectives set for the protection of human health of relevance to the proposed project are summarised in Table 9.1. For those species for which there is no AQO, the Environmental Assessment Level (EAL) is considered, as described below.

9.3.12 AQOs are in place for nitrogen dioxide, carbon monoxide, PM_{10}, sulphur dioxide, arsenic, cadmium, lead and nickel although these only formally apply to locations where people are exposed for the relevant averaging periods.

9.3.13 Guidance is also set out in the Local Air Quality Management Technical Guidance (LAQM.TG(09))[10]

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[2] Department for Environment, Food and Rural Affairs and the Devolved Administrations, The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, July 2007

[3] First Air Quality Daughter Directive. Council Directive 1999/30/EC

[4] Second Air Quality Daughter Directive. Council Directive 2000/69/EC

[5] Fourth Air Quality Directive. Council Directive 2004/107/EC

[6] Air Quality Directive 2008/50/EC on ambient air quality and cleaner air for Europe

[7] The Air Quality Standards (Scotland) Regulations 2007 – Scottish Statutory Instrument 2007 No. 182

[8] The Air Quality (Scotland) Regulations 2000 - Scottish Statutory Instrument 2000 No. 97

[9] The Air Quality (Scotland) Amendment Regulations 2002 - Scottish Statutory Instrument 2002 No. 297

[10] The Scottish Executive, Local Air Quality Management Policy Guidance (Scotland) 2009 (LAQM.PG(S)(09))

Table 9.1: Air Quality Objectives Set Out in the Regulations [6, 7, 8]

Pollutants	Objective ($\mu g/m^3$)	Concentration measured as
Nitrogen dioxide	40	Annual mean
	200	1 hour mean not to be exceeded more than 18 times a year, (equivalent to the 98.8th percentile)
Oxides of nitrogen	30	Annual mean limit value for the protection of vegetation
Carbon monoxide	10,000	Maximum daily running 8 hour mean
Particulates (PM_{10})	18	Annual mean
	50	24 hour mean not to be exceeded more than 7 times per year (equivalent to the 98.08th percentile)
Sulphur dioxide	20	Annual mean limit value for the protection of vegetation
	350	1 hour mean not to be exceeded more than 24 times per year (equivalent to the 99.73th percentile)
	125	24 hour mean not to be exceeded more than 3 times per year (equivalent to the 99.18th percentile)
	266	15 minute mean not to be exceeded more than 35 times per year (equivalent to the 99.9th percentile)
Arsenic (As)	0.006	Annual mean
Lead (Pb)	0.5	Annual mean
Cadmium (Cd)	0.005	Annual mean
Nickel (Ni)	0.02	Annual mean

9.3.14 The AQS was updated in July 2007 when a non-statutory, annual average, target for $PM_{2.5}$ of 12 $\mu g/m^3$, to be achieved by 2020, was included. The strategy also introduced a target of a 15% reduction in concentrations of $PM_{2.5}$ at urban background locations between 2010 and 2020.

9.3.15 The UK Government intends that the objectives for the protection of vegetation and ecosystems will apply in those parts of the UK that are:

- Representative of at least 1,000 km²;
- More than 20 km from an agglomeration;
- More than 5 km away from industrial sources regulated under Part A of the 1990 Environment Act; and
- More than 5 km from motorways; and built up areas of more than 5,000 people.

9.3.16 The objectives presented above do not therefore apply to most of the designated sites within 15 km of the proposed installation, due to being within 5 km of a regulated Part A installation, a motorway or built up areas. However, to provide confidence that the proposed Dundee Renewable Energy Plant will not have a significant impact on nearby vegetation and ecosystems, the objectives are used here to assess the effects of air quality at all the statutory designated sites within 15 km of the site.

Environmental Assessment Levels

9.3.17 In addition to the Scottish AQOs, Environmental Assessment Levels (EALs) exist for the other substances assessed in this study, with the exception of dioxins and furans (these are assessed separately – see paragraphs 9.3.28 to 9.3.33), and volatile organic compounds (VOCs). The term "volatile organic compounds" covers a wide range of substances. There is no air quality standard for VOCs collectively, although air quality standards or guidelines are set for some individual VOCs.

9.3.18 EALs are set out in the latest H1 Environmental Risk Assessment guidance note[11]. SEPA advised that the EALs set out in this document should be used in combination with the SEPA H1 guidance note[12]. None of these recommendations currently have a statutory basis, but have been included in the study for completeness. Table 9.2 sets out the EALs relevant to this study.

Table 9.2: Environmental Assessment Levels (EALs)

Pollutant		Concentration ($\mu g/m^3$)	Measured as
Hydrogen chloride (HCl)		750	Maximum 1 hour mean (EPAQS recommendation)
		20	Annual mean
Hydrogen fluoride (HF)		160	Maximum 1 hour mean (EPAQS recommendation)
		16	Annual mean
Ammonia (NH_3)		2500	Maximum 1 hour mean
		180	Annual mean
		3	Annual mean guideline for protection of vegetation where moss / lichens are not a key habitat feature
		1	Annual mean guideline for protection of vegetation where moss / lichens are a key habitat feature
Antimony (Sb)		150	Maximum 1 hour mean
		5	Annual mean
Arsenic		15	Maximum 1 hour mean
		0.003	Annual mean (EPAQS recommendation)
Cadmium		1.5	Maximum 1 hour mean
Chromium	Cr (II and III)	150	Maximum 1 hour mean
		5	Annual mean
	Cr (VI)	0.0002	Annual mean
Cobalt (Co)		6	Maximum 1 hour mean
		0.2	Annual mean
Copper (Cu)		200	Maximum 1 hour mean
		10	Annual mean
Manganese (Mn)		1500	Maximum 1 hour mean
		0.15	Annual mean
Mercury (Hg)		7.5	Maximum 1 hour mean
		0.25	Annual mean
Nickel		30	Maximum 1 hour mean
Thallium (Tl)		30	Maximum 1 hour mean
		1	Annual mean
Vanadium (V)		1	Maximum 24 hour mean
		5	Annual mean
Note: The more stringent EAL value for arsenic used in preference to the AQO set out in Table 9.1			

9.3.19 For the purposes of this assessment, the Air Quality Objectives and EALs are collectively termed as Environmental Quality Standards (EQS) in the results tables set out in Section 9.7.

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[11] Environment Agency, H1 Environmental Risk Assessment, Annex (f) Air Emissions, April 2010

[12] Scottish Environment Protection Agency, IPPC H1, Environmental Assessment and Appraisal of BAT, July 2003

9.3.20 Many substances exhibit a threshold, below which there are no significant effects on health. The health effects of these substances will be managed by ensuring that the proposed process does not result in a breach of the air quality objectives or EALs specified above. Emissions of other substances do not exhibit any apparent threshold for effects. The health risks associated with these substances can be evaluated by ensuring that air quality standards and guidelines for these substances (where available) are not breached at relevant off-site locations. As well as this, it is also possible to calculate the potential effects on health due to forecast levels of some of these substances as a cross-check on the evaluation against air quality standards and guidelines.

9.3.21 Dioxins and furans are a group of chemicals with the full name of polychlorinated dibenzo para-dioxins (PCDDs) and poly-chlorinated dibenzo furans (PCDFs). Emissions of dioxins and furans from the proposed facilities could have an effect on health via exposure routes such as consumption of locally grown produce, as well as by breathing ambient air. This is because dioxins and furans deposited onto farmland, gardens or allotments can be absorbed into vegetables or by farm animals and subsequently consumed by people eating farm products. This will be assessed by estimating the highest likely exposure to dioxins and furans, and evaluating this against the UK standard for the tolerable daily intake of dioxins and furans.

9.3.22 The following text describes the methodology for assessing these impacts and the relevant significance criteria.

Dose-Response Factors

9.3.23 Dose-response factors are values which relate the change in a health outcome to the received dose of a substance or substances. They can be used in some circumstances to estimate the health consequences of substances which do not exhibit a threshold for health effects.

9.3.24 The World Health Organisation (WHO) has published a set of dose-response factors for exposure to genotoxic carcinogens. These set out the increased risk of cancer associated with exposure to increased airborne concentrations of specific substances. They are subject to considerable uncertainty, mainly because they are derived from exposure of populations in workplaces with very high levels of the substances under concern. By using the factors, the assumption is also made that the same response relative to an increased dose of the substance occurs right down to extremely low incremental concentrations.

9.3.25 The relevant substances and the associated dose-response factors are set out in Table 9.3.

Table 9.3: Dose-Response Functions for Exposure to Carcinogens

Substance	Dose-Response Factor (increase in lifetime cancer risk per 1 $\mu g/m^3$ increase in exposure)
Arsenic	$0.0025(\mu g/m^3)^{-1}$
Nickel	$0.00038(\mu g/m^3)^{-1}$
Chromium VI	$0.004(\mu g/m^3)$-1
Benzo(a)pyrene	$0.09(\mu g/m^3)^{-1}$

9.3.26 The incremental risk to health posed by exposure to the substances listed in Table 9.3 can be assessed against a reference point established in the Royal Committee on Environmental Pollution 17th report[13]. This report suggests that an individual development should not be permitted to result in an incremental health risk greater than one additional death per million population per year. Limiting individual development impacts in this way means that other influences on health such as diet, health, workplace exposure, and other sources of environmental pollution (e.g. road traffic) are much more significant influences on health.

[13] Royal Commission on Environmental Pollution, 17th Report "Incineration of Waste," 1995

9.3.27 The dose response factors given in Table 9.3 will be combined with the maximum modelled concentrations on the receptor grid to give the average incremental risk per year based on an average life span of 70 years.

Outline Exposure Assessment for Dioxins and Furans

9.3.28 One of the emissions from combustion processes that frequently gives rise to concern is the group of chemicals collectively known as 'dioxins and furans,' or simply 'dioxins'. These are present throughout the environment.

9.3.29 Emissions of dioxins and furans need to be assessed in a different way to other substances. For most emissions to air, exposure via inhalation is the main route of concern. The situation is different for dioxins and furans: inhalation exposure is usually only a minor source of exposure. The majority of dioxins and furans to which we are exposed enter the body via foods – particularly, meat, milk and fish products. This occurs because dioxins and furans can become concentrated in the food chain.

9.3.30 As no standards exist for ambient concentrations in air of dioxins and furans, an outline exposure assessment has been carried out to assess the potential health risk due to air emissions from the proposed development.

9.3.31 The outline exposure assessment was carried out using a model derived for Her Majesty's Inspectorate of Pollution (a forerunner to the Environment Agency and SEPA)[14] (in the absence of Scottish guidance). This document provides an assessment of exposure of local residents to emissions from Municipal Solid Waste (MSW) incinerator plant. It was adapted using the modelled levels of dioxins and furans set out in Table 9.8 below to give an estimate of the highest exposure likely to be experienced by people living near the proposed Renewable Energy Plant. Modelled predictions of dioxin concentrations have been assessed against the UK benchmark for the tolerable daily intake (TDI) of dioxins and furans of 2 picograms toxic equivalent per kilogram body weight per day (pq TEQ/ (kgBW – day))[15].

9.3.32 Emissions of dioxins and furans from the proposed Renewable Energy Plant could have an effect on health by routes such as consumption of locally grown produce, as well as by inhalation. This is because dioxins and furans deposited onto farmland, gardens or allotments can be absorbed into vegetables or by farm animals and subsequently be consumed by people eating these products. Possible public exposure to dioxins and furans was assessed in outline using a model prepared for Her Majesty's Inspectorate of Pollution. This model provides an assessment of public exposure via routes which include:

- Inhalation;
- Deposition on gardens and recreation areas, followed by dermal (skin) exposure;
- Deposition on gardens, allotments and farmland, followed by consumption of vegetation;
- Deposition on gardens, allotments and farmland, followed by consumption of eggs and poultry;
- Deposition on farmland, followed by consumption of beef, lamb and pork; and
- Deposition on watercourses, followed by consumption of fish.

9.3.33 Not all the exposure routes may apply to the study area at present, although over the project lifetime it is conceivable that most exposure routes considered in the model could occur. The estimated exposure routes can be assessed by comparison with the recommended UK Tolerable Daily Intake (TDI) of 2 picograms toxic equivalent (TEQ) per kilogram body weight per day. One picogram is a million millionth of a gram, or 10^{-12}

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[14] Her Majesty's Inspectorate Of Pollution, "Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes," HMIP/CPR2/41/1/181, 1996

[15] Food Standards Agency, Committee on Toxicity, "Statement on the tolerable daily intake for dioxins and dioxin-like polychlorinated biphenyls," 2001

grams. So, for an adult of body weight of 70kg, the tolerable daily intake would be 1.4×10^{-10} grams TEQ, or 0.00000000014 grams TEQ.

Critical Loads

9.3.34 Estimated critical loads for statutory designated habitat sites in the UK have been published by the Centre for Ecology and Hydrology (CEH) and are available from the UK Air Pollution Information System[16]. These are considered to be the maximum levels of acid and nutrient nitrogen that can be tolerated without harm to the most sensitive features of these habitat sites. Compliance with these benchmarks is likely to result in no significant adverse effects on the natural environment at these locations. The estimated critical loads for the designated habitat sites that will require a critical load assessment based on the results of the dispersion modelling study are set out in Table 9.4.

Table 9.4: Critical Load Values

Site Name	Estimated Critical Load for Deposition of:			
	Nitrogen-derived acid (kEqH+/ha-year) (high sulphur)	Nitrogen-derived acid (kEqH+/ha-year) (low sulphur)	Sulphur-derived acid (kEqH+/ha-year)	Nutrient nitrogen (kg N/ha-year)
Firth of Tay and Eden Estuary (SPA/SAC)	Not Sensitive to Acid Deposition			30 – 40
Barry Links (SAC)	0.22 – 1.25	0.61 – 1.64	0.39	10 – 20
Monifieth Bay (SSSI)	Not Sensitive to Acid Deposition			30 – 40
Tayport – Tentsmuir Coast (SSSI)	Not Sensitive to Acid Deposition			10 – 20

Note 1:Acid derived critical loads for Monifieth Bay assumed to be the same as Firth of Tay and Eden Estuary because site relevant critical load values were not available and based on advice provided by Scottish Natural Heritage.

kEqH+/ha-year: kilo-equivalents hydrogen ion per hectare per year

kgN/ha-year: kilograms of nitrogen per hectare per year

9.4 Baseline Conditions and Receptors

Surrounding Area

9.4.1 The location of the site is shown in Figure 1.1. Figures 6.1 and 6.2 show the two potential site layouts with A-frame and silo storage respectively. The maximum building envelope of both of these buildings, i.e. the A frame, has been used in this assessment. Figure 10.4 shows the topography of the terrain within the study area i.e. a 20 km by 20 km square, centred on the Dundee Renewable Energy Plant.

9.4.2 The development site is located adjacent to the King George V Wharf, on the Firth of Tay, to the south east of Dundee city centre. Topographical levels within the site do not vary significantly, however, the wider area containing the City of Dundee slopes up away from the Firth of Tay. The immediate vicinity of the site is mainly industrial in nature, including the docks and associated installations, as well as the adjacent oil refinery to the north. There are also residential properties, the closest being those adjacent to Broughty Ferry Road approximately 300m to the north of the stack location and the City Quay development adjacent to the Queen Elizabeth Wharf, approximately 500 m to the south west of the stack location.

9.4.3 The main plant area is bounded to the south by the Firth of Tay and to the north by the adjacent Nynas refinery.

16 UK Air Pollution Information System, http://www.apis.ac.uk/index.html

Ambient Air Quality Levels

9.4.4 In order to complete the assessment, it was necessary to combine modelled concentrations of substances emitted from the proposed plant with baseline concentrations present in the environment due to emissions from other sources.

9.4.5 Information on baseline air quality in the vicinity of the proposed facility was obtained or derived from a range of sources. Where local air quality monitoring data were available, this information was reviewed. Where no local information was available other appropriate sources of information were reviewed to obtain a representative assessment of local background air quality.

9.4.6 Dundee City Council (DCC) undertakes ambient air quality monitoring at a number of locations throughout their jurisdiction. The results of this monitoring are discussed below.

9.4.7 For each of the pollutants considered, the monitoring indicates that levels of most pollutants do not approach or exceed the relevant air quality guidelines. Dundee City Council has however declared an Air Quality Management Area (AQMA) encompassing the whole of the city as a result of levels of nitrogen dioxide predicted to exceed the annual mean air quality objective in the vicinity of a number of road junctions across the city, particularly in the busy city centre. The declaration of this AQMA indicates that the problems are largely as a result of emissions from road traffic on busy congested roads in or close to the city centre. Dundee City Council is also in the process of declaring the city an AQMA due to exceedances of the daily mean PM_{10} air quality objective for the same reasons as nitrogen dioxide.

9.4.8 The following sections review the ambient air quality data available for the pollutants of interest. A summary of the baseline air quality levels used in the assessment are shown in Table 9.7, with all background data considered shown in Appendix C of this report.

Oxides of Nitrogen and Nitrogen Dioxide

9.4.9 Nitrogen dioxide (NO_2) and nitric oxide (NO) are both oxides of nitrogen and together they are referred to as oxides of nitrogen. Principally, it is nitrogen dioxide which is associated with adverse effects on human health. The main source of oxides of nitrogen in the UK is road transport.

9.4.10 DCC does not currently operate an urban background automatic monitoring station for nitrogen dioxide. There are two automatic monitoring stations located at roadside locations in the city centre (Union Street and Whitehall Street). Nitrogen dioxide passive diffusion tube monitoring is undertaken at several urban background locations in Dundee. Communications with DCC[17] indicated that concentrations measured at these locations for the most recent available two years of monitoring were within the annual mean air quality objective value.

9.4.11 The ambient concentration of nitrogen dioxide adopted for this study was taken from the Earl Grey Place Park urban background diffusion tube location. Actual monitoring data has been used in preference over the background mapping data, with the Earl Grey Place Park location chosen due to its proximity to the location of the proposed facility and that measured nitrogen dioxide concentrations were higher than the other measured urban background concentrations. It is common practice in air quality assessments to predict a baseline nitrogen dioxide level for the first year of operation of a project as nationally, levels of this pollutant are expected to fall in the short to medium term. This is carried out on the basis of monitoring data currently available, using factors derived from information available on the UK Air Quality Archive website[18]. This has

[17] Email correspondence between SKM Enviros and DCC, dated 11 February 2010 and 2 June, 2010

[18] Department for Environment, Food and Rural Affairs and the Devolved Administrations, UK Air Quality Archive, www.airquality.co.uk, accessed April 2009

not been undertaken in this instance, because of ongoing concern regarding the expected reduction in future years.

9.4.12 The background level of oxides of nitrogen and nitrogen dioxide used in this assessment are shown in Table 9.7, with all considered data presented in Appendix C.

Particulate Matter

9.4.13 Air quality objectives have been set for particulate matter because of the relationships between airborne levels and potential human health effects. Until recently, the air quality objectives have been established with regard to particulate matter with an aerodynamic diameter of 10 microns or less (PM_{10}). PM_{10} has been linked to human health effects such as respiratory and cardiovascular diseases, and exacerbation of symptoms in those with pre-existing conditions. Recently, health effects associated with particulate matter have been linked with the more fine fraction; $PM_{2.5}$ (particulate matter with an aerodynamic diameter of 2.5 microns or less). The smaller size particles including any substances that may be adsorbed onto the particles, are able to penetrate deeper into the lung. As a result, a target value for levels of $PM_{2.5}$ and a target reduction level for urban background concentrations has been set across the UK.

PM_{10}

9.4.14 DCC monitors PM_{10} levels at one urban background location (Dundee Mains Loan), an urban industrial/roadside location (Broughty Ferry Road) and a roadside location (Union Street). Levels of PM_{10} are recorded using a tapered element oscillating micro-balance (TEOM) analyser at these three sites and also a gravimetric Partisol sampler at Broughty Ferry Road. Data were obtained for all these automatic monitoring stations for the previous 2 – 3 years of available data (www.scottishairquality.co.uk and from DCC). The Broughty Ferry station is the closest monitoring station to the site and the concentration recorded by the Partisol were . Predicted baseline levels of PM_{10} were then calculated for 2015, the year it is expected that the facility will become operational, using the methodology set out in Government LAQM guidance[19].

9.4.15 The concentrations of PM_{10} measured at the Broughty Ferry Road monitoring station were within the annual mean and short term daily air quality objective.

$PM_{2.5}$

9.4.16 At present, baseline levels of $PM_{2.5}$ are not monitored in Dundee. Baseline levels of $PM_{2.5}$ were calculated based on the average measured PM_{10} concentration from Broughty Ferry Road converted to $PM_{2.5}$ using the average factor of 0.66 from the Scottish Government report[20].

Sulphur Dioxide

9.4.17 Baseline levels of sulphur dioxide were obtained from the Broughty Ferry Road automatic monitoring station for the most recent year of fully ratified data.

Carbon Monoxide

9.4.18 Carbon monoxide is not monitored by DCC. Baseline levels of carbon monoxide were obtained from background maps produced by Defra and the Devolved Administrations[18]. Concentrations of carbon monoxide were obtained for the grid square where the proposed facility is located, and the eight immediately surrounding grid squares in each cardinal direction. The maximum carbon monoxide concentration from the grid squares was used in the assessment.

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[19] Department for Environment, Food and Rural Affairs and the Devolved Administrations, Local Air Quality Management, Technical Guidance LAQM.TG(09).

[20] AEA Technology, report for the Scottish Government, Measurement of PM_{10} and $PM_{2.5}$ in Scotland with Gravimetric Samplers, June 2009

Dioxins and Furans

9.4.19 Dioxins and furans are products of incomplete combustion and are considered carcinogenic. These substances are not widely monitored across the UK, and so there is very little available baseline data. Baseline levels of dioxins and furans were obtained from the results of a survey carried out at several locations across the UK, with the average recorded levels for 2008 across all sites used for this assessment. The baseline information was accessed via the UK National Air Quality Archive[18] where monitoring data from across the UK is stored centrally.

Polycyclic Aromatic Hydrocarbons

9.4.20 Polycyclic Aromatic Hydrocarbons (PAHs) are a group of persistent organic compounds generated via combustion processes, some of which are possible or proven human carcinogens. A study on PAHs carried out by the Expert Panel on Air Quality Standards (EPAQS)[21] provided an air quality guideline value for PAHs based on the level of one specific PAH, benzo(a)pyrene. As a result, background levels of benzo(a)pyrene have been considered for this study as an indicator of levels of PAHs.

9.4.21 Monitoring of PAHs is not generally undertaken by individual local authorities. Information on background levels of PAHs was obtained from the PAH monitoring network operated by Defra. The background concentration used in this assessment was the average value of benzo(a)pyrene across all monitoring locations during 2009 (the most recent year for which data is available) using the Andersen Sampler monitoring method.

Ammonia

9.4.22 Information on background levels of ammonia were sourced from the Centre for Ecology and Hydrology (CEH)[22] UK pollutant deposition website which collates data from the network supported by Defra and the Devolved Administrations. The closest monitoring location to the proposed development site, located in a similar setting, was the Edinburgh St Leonards automatic monitoring station. The average value for 2008 (the most recent year for which data is available) was used in this assessment.

Trace Metals

9.4.23 Data concerning trace metals was sourced from the UK National Air Quality Archive[18]. Background concentrations were available for arsenic, cadmium, chromium, copper, manganese, nickel, lead, vanadium and mercury (particle and vapour phase). Of the available monitoring locations, an average value for each metal was taken from the Bristol Avonmouth (urban background), Redcar Automatic Urban and Rural Network (AURN) (industrial background) and Motherwell Centre (urban background) monitoring sites. These sites were selected to provide a reasonable representation of the proposed facility location as locally recorded measurements were not available. As no information is available on background levels of antimony, cobalt, and thallium from this data source, measurement data from an alternative monitoring study was utilised (see Table 9.5).

Hydrogen Chloride

9.4.24 Hydrogen chloride and other acid gasses are monitored at different locations across the UK by the Acid Gases and Aerosol Monitoring Network. Background levels of hydrogen chloride were sourced from CEH[22]. The closest monitoring location to the proposed development site was the Bush 1 (LHS) monitoring station,

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[21] The Expert Panel on Air Quality Standards, Report on Polycyclic Aromatic Hydrocarbons. The Stationery Office, 1999

[22] Centre for Ecology and Hydrology, UK Pollutant Deposition – Ammonia, acid gases and aerosols, and heavy metals monitoring networks for the UK, http://www.uk-pollutantdeposition.ceh.ac.uk/networks Accessed February 2010

located approximately 10 kilometres south of the centre of Edinburgh. The average value for 2008 was used in this assessment.

Hydrogen Fluoride

9.4.25 Baseline monitoring of hydrogen fluoride is not carried out on an on-going basis across the UK. The concentration of hydrogen fluoride in ambient air was based on findings from a report by EPAQS in 2006[23]. A range of background concentration values was provided in the report for heavily industrialised urban areas within Europe with the maximum in the range adopted for use in this assessment.

Adopted Ambient Air Quality Levels

9.4.26 Appropriate background air quality levels upon which to base this assessment, have been established for each parameter, as described above

9.4.27 A summary of the ambient air quality levels adopted for the assessment are shown in Table 9.5, with all considered background levels provided in Appendix C.

Table 9.5: Adopted ambient air quality levels

Substance	Long-term mean baseline concentration (µg/m³)	Basis
Nitrogen dioxide	20.7	Maximum urban background diffusion tube results for year 2008 (Earl Grey Place Park). This value was doubled to obtain the short term concentration.*
Sulphur dioxide	5.1	Annual mean concentration measured level at DCC Broughty Ferry Road Monitoring Site – 2009. This value was doubled to obtain the short term concentration.
PM_{10}	16.1	Annual mean concentration from Broughty Ferry Road Partisol monitoring site – 2008
	40.3	98.08th percentile concentration from Broughty Ferry Road Partisol monitoring site – 2008.
$PM_{2.5}$	10.6	Annual mean PM_{10} concentration from Broughty Ferry Road monitoring site (2008) converted to $PM_{2.5}$ using a factor of 0.66
Hydrogen chloride	0.20	Level measured at Bush 1 (LHS), 2008. This value was doubled to obtain the short term concentration.
Hydrogen fluoride	3.5	Estimated maximum in industrial areas based on EPAQS report. This value was doubled to obtain the short term concentration.
Dioxins and furans	1.1×10^{-8}	Average measured levels during national surveys 2008 (value given is Toxic Equivalent (WHO, 2006), TEQ)
Arsenic	0.00051	Average level recorded across three national survey sites - 2009. These values were doubled to obtain the short term concentrations.
Cadmium	0.00017	
Chromium	0.00236	
Copper	0.00588	
Manganese	0.01180	
Nickel	0.00090	
Lead	0.00836	
Vanadium	0.00189	
Mercury	0.00204	

[23] The Expert Panel on Air Quality Standards, Guidelines for Halogens and Hydrogen Halides in Ambient Air for Protecting Human Health against Acute Irritancy Effects, 2006

Substance	Long-term mean baseline concentration (µg/m^3)	Basis
Antimony	0.0017	There is little information available on these substances. Level measured in Staffordshire for planning application in 2008, representative of semi-rural location[24]. These values were doubled to obtain the short term concentrations.
Cobalt	0.0007	
Thallium	0.0008	
PAH -(Benzo(a)pyrene)	0.46	Average measured levels during national surveys – 2009
Carbon monoxide	244	Maximum value from Defra background mapping of grid squares immediately surrounding the proposed site, centred on 341500, 730500 - 2001. This value was doubled to obtain the short term concentration.
Ammonia	1.2	Level measured at Edinburgh St Leonards - 2008. This value was doubled to obtain the short term concentration.
The short term background concentrations are mainly derived from doubling the annual mean background concentration as addressed in SEPAs H1 guidance[11]. See Appendix C for further details		

9.5 Potential Impacts

Construction

9.5.1 Construction of the proposed development has the potential to impact on local air quality principally through the generation and deposition of dust. There are no receptors directly downwind of the predominant wind direction (that is wind blowing from the west to south-west of the Renewable Energy Plant), within 500 m of the site boundary. However, residential properties are located on Broughty Ferry Road approximately 300 m to the north of the proposed area of construction works. There is therefore some small potential for unmitigated dust emissions to impact upon these properties when the wind is blowing strongly from a southerly or south easterly direction. When wind is blowing form the east or north east, the proposed residential development at City Quay may be affected as these are approximately 75 m from the site boundary. There is therefore some small potential for unmitigated construction dust emissions to impact upon these properties when the wind is blowing from a northerly direction.

9.5.2 As with any construction site, dust may be generated as a result of surface preparation and earthworks, including earth moving and materials handling. Internal site traffic moving on un-metalled roads within the development site may cause sufficient mechanical disturbance of loose surface materials to generate dust during prolonged periods of dry weather. The proposed development includes the following main components which may, without sufficient management or mitigation, generate dust:

- Demolition of existing structures on site;
- Preparatory earthworks to allow the construction of the development; and
- The construction of the main components of the Renewable Energy Plant.

9.5.3 Other emissions will be associated with the plant and machinery used on the site during the construction phase and construction traffic using roads in the vicinity of the development. Emissions arising from construction traffic have been assessed as part of this air quality impact assessment, however due to the expected minor impact of the emissions arising from on-site construction plant and machinery, these do not form part of this air quality impact assessment.

9.5.4 There is the potential for a limited period of elevated emission concentrations[25] during commissioning of the boiler, although these will be short lived and with low flow rates. These emissions will be controlled through a

[24] Staffordshire County Council, Project W2R Provision of a Residual Waste Treatment Facility, Environmental Statement, May 2008

[25] i.e. levels in excess of those guaranteed for the normal operation of the Renewable Energy Plant as stipulated within the project specification

commissioning plan agreed with SEPA as part of the PPC permit. No significant impacts are expected and no further assessment has therefore been undertaken.

9.5.5 Pollutants that will be considered for the construction phase therefore comprise:

- Particulate matter comprising of $PM_{2.5}$, PM_{10} and larger dust particles; and
- Nitrogen dioxide and PM_{10} emissions from construction traffic emissions.

Operation

9.5.6 The combustion of biomass, and the emission control techniques which may be adopted, can result in flue gases containing the following species that have the potential to have a significant impact on local air quality:

- NO_x
- CO
- SO_2
- Particulate matter (including heavy metals)
- Ammonia
- Dioxins and furans
- VOCs
- HCl
- HF

9.5.7 Light fuel oil firing to stabilise combustion during start-up of the Renewable Energy Plant will also result in the emission of sulphur dioxide, oxides of nitrogen, carbon monoxide and particulates. Light fuel oil firing is likely to occur for less than 140 hours per annum during start-up operations and will result in emissions well within the limits given below for the combustion of biomass.

9.5.8 The emergency generator and firewater pump engine will not be used during normal operation other than for testing purposes to confirm their availability. The small size of these engines, coupled with their infrequent operation, will result in a minimal impact on local air quality. Therefore, their emissions are not assessed further within the air quality assessment.

9.5.9 Two 10 MWth light fuel oil fuelled auxiliary boilers may operate to provide steam for Combined Heat and Power users when the main Renewable Energy Plant is offline. The boilers will emit sulphur dioxide, oxides of nitrogen, carbon monoxide and particulate matter via a dedicated twin flue stack. Emissions from these auxiliary boilers have been included as part of the assessment and have been assessed against the short term air quality objectives as the boiler is only likely to operate for a maximum of 12% of the year.

9.5.10 There may also be visible water vapour plumes emitted under certain weather conditions from the main Renewable Energy Plant stack. The frequency of occurrence of this plume is assessed in detail in this chapter.

9.5.11 In addition, there is the potential for release of particulate matter and odour from fugitive dust blown from fuel and ash storage area and the ash silos and transfer area.

9.5.12 The storage and use of the fuel will be such that the potential for the formation and release of bioaerosols will be minimised. During normal operations the fuel will be used before the generation of bioaerosols can occur. In addition the fuel will be stored in enclosed buildings and/or in silos. Thus the potential for any release of bioaerosols is considered to be negligible.

9.5.13 The number of traffic movements associated with any fuel brought to site by road will be less than the traffic movements generated during the construction phase.

9.5.14 In summary, pollutants that will be considered in detail for the impact assessment during the operational phase of the Renewable Energy Plant therefore comprise:

- NO_x due to combustion of biomass fuel and light fuel oil within the main boiler;
- CO due to combustion of biomass and light fuel oil within the main boiler;

- PM_{10}, $PM_{2.5}$ and larger dust particles due to combustion of biomass and light fuel oil within the main boiler, and due to potential fugitive releases from fuel storage and processing areas;
- Ammonia, due to the potential use of Selective Non Catalytic Reduction to control NOx;
- HCl and HF due to the combustion of biomass within the main boiler;
- Other trace emissions (of heavy metals, VOCs, PAHs and dioxins and furans) due to the combustion of biomass within the main boiler; and
- The water vapour plume from the main boiler stack produced by the moisture content in the fuel.

Cumulative impacts

9.5.15 There is an existing refinery operated by Nynas, a specialised oil company located adjacent to the northern boundary of the proposed site which contributes to ground level pollutant concentrations within the vicinity of the plant

9.5.16 The baseline air quality levels used in this study will already include a contribution from the existing Nynas facility. However, a study was carried out by modelling the emissions from both facilities and comparing the cumulative impact with the air quality objectives (see Section 9.7.91). A sensitivity analysis was also carried out assessing the impact that the proposed buildings of the proposed Renewable Energy Plant will have on the emissions from the Nynas process. The emission parameters for this facility were obtained from SEPA[26] and are shown in Appendix C.

9.5.17 A biomass plant is proposed at a site on Explorer Road to the west of Dundee (the Hilcrest Wood to Energy Plant). This plant is over 6 km to the west of the proposed Dundee Renewable Energy Plant. The Hilcrest plant is a relatively small plant with a stack height of up to 20m, with any potential air quality impacts occurring within several hundred metres of the plant[27]. The air quality assessment carried out for the development indicated that there would not be any significant impacts in the vicinity of the plant. On this basis, there would not be any potential cumulative effects from this plant with respect to the proposed Renewable Energy Plant and it has not been considered in the cumulative assessment described above.

Decommissioning

9.5.18 All emissions from the Renewable Energy Plant will cease during decommissioning. There may, however, be dust generated during the demolition of the Renewable Energy Plant, as well as emissions from plant and machinery used on the site during the decommissioning phase and traffic using roads in the vicinity of the development. However, due to the expected minor impact of these emissions, plant and machinery emissions do not form part of this air quality impact assessment.

9.5.19 Pollutants that will be considered for the decommissioning phase therefore comprise:

- Particulate matter ($PM_{2.5}$, PM_{10} and larger dust particles).

9.6 Mitigation

Construction

9.6.1 Dust generation and dispersion during construction will be minimised through good construction practice and monitoring throughout the construction period. The mitigation measures will aim to prevent dust from being

[26] SEPA, information provided in an email, dated 12/04/2010

[27] Buro Happold Ltd, Bureau Veritas Report Atmospheric Dispersion Modelling for Nitrogen Dioxide and Particulate Matter, The Proposed Hilcrest Wood to Fuel Plant Explorer Road, Dundee, October 2007.

dispersed off-site and, thereby, protect nearby properties and other receptors from significant dust impacts. The following mitigation measures will be adopted where practicable and necessary:

- Plant and equipment will be designed and used in a manner which minimises dust generation;
- Water spray dampening of soils and spoil may be undertaken to prevent dust blow during hot, dry weather conditions;
- Careful location, grading and management of stockpiles of soil and similar materials will be undertaken to prevent wind-blow;
- Sealing and / or re-vegetation of completed earthworks will be undertaken as soon as reasonably practicable;
- Site roads will be surfaced early in the construction programme – vehicle speeds will be limited to less than 20 mph;
- Lorries will be sheeted during transportation of friable construction materials and spoil;
- Drop heights will be minimised during material transfer activities, such as unloading of friable materials;
- Regular cleaning of surfaced roads and maintenance of un-surfaced roads will be undertaken to reduce off-site transport of soils and to avoid dust generation;
- Wheel washing facilities will be provided for heavy commercial vehicles and any other vehicle which has an operating weight exceeding three tonnes entering the public road system; and
- Positioning and movement of construction equipment will be undertaken in a manner which minimises dust generation.

9.6.2 In order to ensure fugitive dust emissions are controlled to acceptable levels, regular monitoring will be undertaken. Such monitoring is likely to comprise the use of hand held portable monitors at a downwind location where exposure to dust emissions is likely to be highest. Where monitoring indicates high local concentrations prevention measures can be implemented.

Operation

9.6.3 A number of mitigation measures will be integral to the design and operation of the proposed Renewable Energy Plant. These will include:

- The use of modern combustion technology and potentially Selective Non Catalytic Reduction (SNCR) to control the generation of NOx emissions;
- The use of a low-chloride, low-ash, fuel (i.e. biomass and light fuel oil);
- The use of a low-sulphur fuel, (i.e. biomass and light fuel oil);
- The use of activated carbon to control heavy metals and dioxins and furans, when necessary;
- The use of lime injection to control acid gases when necessary;
- Appropriately designed stacks to ensure adequate dispersion of emissions to atmosphere;
- A high efficiency dust collection system (fabric-filters) which will control emissions of particulates;
- The use of effective combustion control to limit carbon monoxide and oxides of nitrogen emissions;
- The storage of fuels which may generate fugitive dust or odour emissions will be enclosed hence reducing the potential for wind-blown dust and odours;

- The transfer of fuel from the fuel storage areas to the Day Store and the boiler will be carried out using enclosed conveyor systems which will be designed to minimise production of dust. This will prevent the potential for wind-blown dust and odours;
- Fuel delivery areas will be enclosed where appropriate;
- The storage of ash in an enclosed silo; and
- Lorries will be sheeted during transportation of friable materials;

9.6.4 The main boiler stack will be fitted with Continuous Emissions Monitors to monitor the emissions of pollutants in accordance with the appropriate requirements of the PPC Regulations for co-incineration plants under the Waste Incineration Directive. The ammonia monitor will provide feedback to the reagent injection system of the SNCR to minimise emissions of ammonia (i.e. ammonia slip), where appropriate.

9.6.5 A comprehensive fire prevention and safety system will be adopted to minimise the risk of fire from the fuel store area. This is discussed in the Fire Prevention Method Statement which accompanies the Section 36 Application.

Decommissioning

9.6.6 A site closure plan will be produced and submitted to SEPA prior to the start of decommissioning and in accordance with environmental controls relevant at the time. This will include a range of mitigation measures similar to those noted above for the construction phase.

9.7 Assessment of Residual Effects

Construction

Dust

9.7.1 The level of dust generation and dispersion is dependent upon a number of factors including:

- The type of construction activities taking place;
- The occurrence of hot, dry weather;
- The prevailing wind speed and direction; and
- The mitigation measures adopted.

9.7.2 The potential for dust to be generated during the construction phase will be short-term and temporary in nature. Site clearance and bulk excavation works (the construction works of greatest potential impact) will be carried out during the initial phase of construction. Excavation and site levelling will use machinery such as front loaders, bulldozers and similar plant, with spoil material which will not be incorporated into development and landscaping being removed from site.

9.7.3 Residential receptors downwind of the predominant wind direction (that is wind blowing from the south-west of the site) would typically be the most susceptible to dust emissions. There are some residential dwellings to the east and north of the site. The nearest downwind dwelling is on Broughty Ferry Road, 300 m north of the proposed site. The closest property to the site is the City Quay development, to the west of the site, approximately 75 m from the western site boundary. There is the potential for unmitigated windblown dust emissions to reach these properties. The wind direction (based on 2009 data from Leuchars) is towards the closest receptor on Broughty Ferry Road (170^{o}-210^{o}) approximately 6.9% of the year and towards the City Quay site (60^{o}-100^{o}) approximately 10.9% of the year. The mitigation measures proposed above are considered likely to prevent such events from occurring. However, in the event that handheld monitoring finds that dust concentrations at these locations are unacceptable during certain meteorological conditions (i.e. a hot dry period), construction work will be tailored or additional mitigation put in place to ensure that particulate levels due to the construction works reduce to acceptable levels.

9.7.4 Given this fact, and with the use of the mitigation measures outlined above, the impacts of dust generation on receptors in the area will be minimised and no significant impact is predicted.

Road Traffic

9.7.5 Full details of the traffic generated during the construction phase are provided in Chapter 18 (Traffic and Transport). The maximum number of daily movements during the construction phase is 466. The distribution of the additional movements on the local road network is also set out in Chapter 18.

9.7.6 The potential impact from road traffic was determined by estimating the levels of the main road traffic pollutants at sensitive locations adjacent to the local road network where the maximum impact from traffic accessing the development site would occur. Locations close to the local road network further from the development will experience less increases in traffic. The assessment was carried out using the ADMS Roads 2.3 dispersion model and the results are set out in Table 9.6. This method is more detailed than using the Design Manual for Roads and Bridges (DMRB) screening tool.

9.7.7 The construction phase represents the maximum potential effect in terms of the increase in traffic generated by the development. Traffic movements generated during the operational and decommissioning phases of the development are significantly less than the movements assessed here.

Table 9.6: Estimated Levels of Road Traffic Pollutants During Construction

Location	Annual Mean PM_{10} ($\mu g/m^3$)	98.08^{th} percentile of 24-hour Mean PM_{10} concentrations	Annual Mean Nitrogen Dioxide ($\mu g/m^3$)
Air quality objective	*18*	*50*	*40*
Receptor 3, Residential property at Clock tower Apartment, close to East Dock Street			
Current situation	16.16	40.42	21.56
Current situation with construction traffic	16.16	40.42	21.57
Receptor 5, Residential property on Broughty Ferry Road			
Current situation	16.25	40.59	23.04
Current situation with construction traffic	16.25	40.59	23.06
Receptor 6, Residential Property at the Broughty Ferry Road and East Dock Street Junction			
Current situation	16.30	40.71	23.71
Current situation with construction traffic	16.31	40.71	23.78

9.7.8 At the closest properties to the main access route, the forecast levels of traffic-related air pollutants comply with the relevant air quality objectives, either with or without the proposed Renewable Energy Plant. The maximum increase in concentrations due to the construction traffic is forecast to be less than 0.2% of the annual mean nitrogen dioxide air quality objective. An increase of this level is classed as insignificant and would not be measureable in practice.

Operation

Road Traffic

9.7.9 Traffic flows likely to occur during the operational phase would be significantly less than those during the construction phase (i.e. 100 daily movements during the operational phase (which includes fuel deliveries and staff vehicles) compared to around 466 daily movements during the construction phase). As set out above, the construction phase of the development is forecast to result in an increase of less than 0.2% in levels of nitrogen dioxide and PM_{10} at the locations which could potentially be affected close to the local road network in the vicinity fo the development site. On this basis, the potential impact due to road traffic emissions during the operational phase will be significantly less than during the construction phase. Additional modelling for the operational phase was therefore not considered necessary.

9.7.10 As the impact from road traffic emissions is insignificant during the operational phase, there will not be a measureable contribution to the cumulative impact (i.e. at locations where the stack emissions also contribute to ground level concentrations) from road traffic emissions at any locations in the vicinity of the site.

Operational Emission Limits

9.7.11 Emissions from the Renewable Energy Plant will be in compliance with relevant legislation and at the levels agreed with SEPA as being achievable through the use of Best Available Techniques[28]. The fuels will include recovered timber, paper and cardboard which are classed as waste materials. Therefore, the plant will be designed to meet the requirements of the Waste Incineration Directive. As the main purpose of the plant is the generation of electricity and heat, the relevant emission limits are those of 'co-incineration' as defined in Annex II of the Directive. The plant will also be in accordance with the Large Combustion Plant Directive[29] and the draft Industrial Emissions Directive[30] for large combustion plants. Emission limits will be set by SEPA in the plant's PPC permit. For the purposes of this EIA, the concentrations presented in Table 9.7 have been assumed. Although emissions for all substances included in the PPC Regulations for co-incineration have been included in the assessment, as the fuel is biomass it is unlikely that all of these contaminants will be present in the flue gas all of the time. These are the maximum emissions anticipated and hence provide a pessimistic projection of the impacts of the proposed plant.

9.7.12 As biomass will be utilised for the majority of the year (98% of the anticipated operational hours of the main biomass boiler), the assessment is based on the emissions from combusting biomass.

9.7.13 Detailed atmospheric dispersion modelling using the ADMS 4.2 computer model has been carried out for operational emissions to identify the process contribution from the Renewable Energy Plant and identify the most appropriate stack height. Through the dispersion modelling study, it is concluded that a stack height of 90 m, gives sufficient dispersion of the flue gases, such that all residual effects are not significant and that all PECs, including the contributions from the other proposed developments in the area, are well within the relevant AQO and no exceedances are anticipated. This modelling, including the stack height selection study is discussed in Appendix C.

Atmospheric Dispersion Modelling

9.7.14 Table 9.7 presents the input parameters specified within the ADMS dispersion model for the detailed dispersion modelling analysis of the Dundee Renewable Energy Plant. Further details are given in Appendix C, including the emissions scenario utilised for the assessment and the conservative assumptions adopted throughout the modelling study. Two scenarios were modelled:

- Scenario 1: 70% virgin wood and 30% waste wood is combusted; and
- Scenario 2: 100% virgin wood is combusted.

9.7.15 For this assessment, the substances which may be emitted due to the combustion of waste wood, such as: heavy metals, dioxins, hydrogen chloride and hydrogen fluoride, have been assessed using Scenario 1 (these substances would not be emitted for Scenario 2 where only virgin wood is combusted). The assessment of all

[28] The term 'Best Available Techniques' (BAT) is defined as: Best meaning the most effective techniques for achieving a high level of protection of the environment as a whole; Available meaning techniques developed on a scale which allows them to be used in the relevant industrial sector, under economically and technically viable conditions, taking into account of the costs and advantages; and Techniques includes both the technology and the way the installation is designed, built, maintained, operated and decommissioned.

[29] Scottish Statutory Instrument 2002 no. 493. The Large Combustion Plant (Scotland) Regulations 2002.

[30] Commissions of the European Communities. The Draft Industrial Emissions Directive COM/2007/0844 final

other substances will be based on the emissions from Scenario 2, as this represents higher mass emissions compared to Scenario 1.

Table 9.7: Exhaust Gas Parameters as Used Within Dispersion Model

Parameter	Value	
	Scenario 1	Scenario 2
Stack height	90 m	90 m
Flue diameter at exit	3.83 m	3.83 m
Exhaust gas temperature	75 °C	75 °C
Exit gas exit velocity	15.8 m/s	18 m/s
Volumetric flow rate (at stack discharge conditions)	182 m^3/s	207 m^3/s
Volumetric flow rate (at standard reference conditions)*	122 Nm^3/s	132 Nm^3/s
Exit gas moisture content (at stack discharge conditions)	14.5%	19.2%
Exit gas oxygen content (at stack discharge conditions)	4.8%	5.1%
NO_x emission concentration (standard reference conditions)*	200 mg/Nm^3	200 mg/Nm^3
NO_x emission rate	24.5 g/s	26.3 g/s
CO emission concentration (standard reference conditions)*	220 mg/Nm^3	220 mg/Nm^3
CO emission rate	26.9 g/s	28.9 g/s
SO_2 emission concentration (standard reference conditions)*	75 mg/Nm^3	75 mg/Nm^3
SO_2 emission rate	9.17 g/s	9.9 g/s
PM_{10} emission concentration (standard reference conditions)*	10 mg/Nm^3	10 mg/Nm^3
PM_{10} emission rate	1.2 g/s	1.3 g/s
$PM_{2.5}$ emission concentration (standard reference conditions)*	10 mg/Nm^3	10 mg/Nm^3
$PM_{2.5}$ emission rate	1.2 g/s	1.3 g/s
HCl emission concentration (standard reference conditions)*	15 mg/Nm^3	-
HCl emission rate	1.8 g/s	-
HF emission concentration (standard reference conditions)*	1.5 mg/Nm^3	-
HF emission rate	0.2 g/s	-
VOC emission concentration (standard reference conditions)*	15 mg/Nm^3	15 mg/Nm^3
VOC emission rate	1.8 g/s	2.0 g/s
Dioxins and furans emission concentration (standard reference conditions)*	0.1 ng/Nm^3	-
Dioxins and furans emission rate	12.0 ng/s	-
Cadmium and thallium total emission concentration (standard reference conditions)*	0.025 mg/Nm^3	-
Cadmium and thallium total emission rate	0.0031 g/s	-
Mercury emission concentration (standard reference conditions)*	0.025 mg/Nm^3	-
2Mercury emission rate	0.0031 g/s	-
Antimony, arsenic, lead, chromium, cobalt, copper, manganese, nickel, vanadium total emission concentration (standard reference conditions)*	0.25 mg/Nm^3	-
Antimony, arsenic, lead, chromium, cobalt, copper, manganese, nickel, vanadium total emission rate	0.031 g/s	-
NH_3 emission concentration (standard reference conditions)*	10 mg/Nm^3	10 mg/Nm^3
NH_3 emission rate	1.2 g/s	1.3 g/s
PAH emission concentration (standard reference conditions)*	0.002 mg/Nm^3	0.002 mg/Nm^3
PAH emission rate	0.00024 g/s	0.00026 g/s
Notes: * Standard reference conditions are: 273 K, 101.3 kPa, dry gas and 6% Oxygen v/v		

Parameter	Value	
	Scenario 1	Scenario 2
For the assessment of $PM_{2.5}$, emissions of particulate matter were assumed to be entirely in the form of $PM_{2.5}$. Making this assumption is the most conservative approach		

Emissions of Metals

9.7.16 The Waste Incineration Directive sets an aggregate limit of 0.5 mg/Nm^3 on a group of nine metals (antimony, arsenic, lead, chromium, cobalt, copper, manganese, nickel, vanadium). Emissions of individual metals are likely to be well below the aggregate limit set out in the Waste Incineration Directive as virgin wood, which will comprise at least 70% of the biomass fuel combusted by the plant does not contain metals. Furthermore, only a small proportion of the 30% of non-virgin biomass to be consumed by the plant, the recovered biomass materials, will potentially contain traces of metals. The other non-virgin biomass materials will consist of willow, grasses and agricultural residues like rape-seed meal and are unlikely to contain any traces of metals. In addition, some of the recovered biomass materials will not contain metals as these will consist of paper and cardboard. On this basis, emissions of metals from the proposed plant will be significantly less than a plant combusting only 100% waste materials such as municipal waste and it was therefore assumed that the modelled level of emissions of metals would be half of the limit for these metals set out in the Waste Incineration Directive. The dispersion modelling study assumed that each metal was released at one ninth of the aggregate emission concentration adopted as the limit. Chromium is normally found in different forms (known as “oxidation states”), referred to as chromium II, chromium III, and chromium VI. Chromium VI is the most potentially toxic form. For Chromium (VI), it was assumed that 5% of chromium emissions are in the form of Chromium (VI)[31].

9.7.17 Emissions of cadmium and thallium are also measured as a group, and a limit applied to the group total. For the purposes of this study, it was assumed that both cadmium and thallium were present at half of the group emission limit, although this would not occur in practice. Again, this represents a conservative approach. In line with the approach taken for the group of nine metals, the emissions of these metals were assumed to be half of the aggregate limit set out in the Waste Incineration Directive. This also applies to emissions of mercury which has a specific emissions limit set out in the Waste Incineration Directive.

Emissions of VOCs

9.7.18 VOCs emitted from combustion process consist of a wide range of compounds and are not generally of concern with regards to local air environmental impacts. Consequently, emissions of VOCs were not assessed against any EALs. However, semi volatile organic compounds such as PAHs and dioxins were addressed.

Auxiliary Boilers

9.7.19 In addition to an assessment of the main boiler emissions, the emissions from the auxiliary boilers were assessed against the short term air quality objectives because the boilers will only run for a maximum of 12% of the year. As described in Chapter 6, the auxiliary boilers will be utilised to meet the heat demand of local heat users when the main boiler is not operational. The main boiler and auxiliary boilers will not operate at the same time. The emissions data for the auxiliary boilers are provided in Appendix C.

[31] Department for Environment, Food and Rural Affairs and the Devolved Administrations, Expert Panel on Air Quality Standards, Guidelines for metals and metalloids in ambient air for the protection of human health, May 2009

Assessment

9.7.20 The maximum ground level process contribution from the Renewable Energy Plant and the equivalent PEC for 2015 for each of the gaseous species considered are shown within Table 9.8.

9.7.21 Whilst five years hourly sequential meteorological data has been used for the detailed dispersion modelling (as discussed in Appendix C), the results shown below relate to the highest concentrations predicted during the five years modelled (2005 to 2009). It is therefore considered that this represents the maximum potential effect that could reasonably be expected to occur as a result of the Renewable Energy Plant. The other conservative assumptions utilised throughout the assessment to ensure model predictions are likely to be over-estimates rather than under-estimates are set out in Appendix C.

9.7.22 The site boundary, stack location and modelling domain are shown in Figure 9.1. Model results are shown graphically in Figures 9.2 – Figure 9.11 for substances where the PC was greater than 1% of the EQS for long term means or where the PC was greater than 10% of the EQS for short term means, therefore having the highest process contribution values as a proportion of the relevant air quality standards or guidelines (i.e. those substances with the most potential for effects on air quality). The contour plots showing the substances are as follows:

- Figure 9.2: Annual mean nitrogen dioxide process contributions (2007);
- Figure 9.3: 99.8th percentile of hourly mean nitrogen dioxide process contributions (2007);
- Figure 9.4: Annual mean PM_{10} and $PM_{2.5}$ process contributions (2007);
- Figure 9.5: 99.9th percentile of 15 minute mean sulphur dioxide process contributions (2007);
- Figure 9.6: 99.2nd percentile of daily mean sulphur dioxide process contributions (2005);
- Figure 9.7: Annual mean hydrogen chloride process contributions (2007);
- Figure 9.8: Annual mean cadmium process contributions (2007);
- Figure 9.9: Annual mean arsenic and nickel process contributions (2007);
- Figure 9.10: Annual mean chromium (VI) process contributions (2007); and
- Figure 9.11: Annual mean benzo(a)pyrene process contributions (2007).

9.7.23 The results presented in Table 9.8 are the maximum predicted concentrations at any off-site location for the assessment of annual mean and short term concentrations within the air quality study area. The concentrations at all other locations will be less than those presented in Table 9.8.

Table 9.8: Atmospheric Dispersion Modelling Results

Pollutant	Averaging period	EQS (µg/m³)	Adopted ambient air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC / EQS (%)	PEC / EQS (%)	Year of met dataset resulting in maximum PC
Nitrogen dioxide	Annual mean	40	20.7	5.5	26.2	14%	66%	2007
	1 hour mean (99.8th %ile)	200	41.4	20.2	61.6	10%	31%	2007
Carbon monoxide	Maximum 8 hour running mean	10,000	488	60	548	0.6%	5%	2007
PM_{10}	Annual mean	18	14.2	0.4	14.6	2.2%	81%	2007
	24 hour mean (98.08th %ile) (method 1)	50	34.5	0.8	35.3	1.6%	71%	2007
	24 hour mean (98.08th %ile) (method 2)	50	28.5	1.9	30.3	3.7%	61%	2009
$PM_{2.5}$	Annual mean	12	9.4	0.4	9.8	3.3%	82%	2007
Sulphur dioxide	15 minute mean (99.9th %ile) (method 1)	266	10.2	23.0	33.1	9%	12%	2006
	1 hour mean (99.9th %ile) (method 2)	266	10.2	30.0	40.1	11%	15%	2007
	1 hour mean (99.73th %ile)	350	10.2	21.4	31.6	6%	9%	2007
	24 hour mean (99.18th %ile)	125	10.2	15.4	25.6	12%	20%	2005
Hydrogen chloride	Annual mean	20	0.20	0.62	0.81	3.1%	4.1%	2007
	Maximum hourly mean	750	0.39	5.6	6.0	0.7%	0.8%	2005
Hydrogen fluoride	Annual mean	16	3.50	0.06	3.6	0.39%	22.3%	2007
	Maximum hourly mean	160	7.0	0.56	7.6	0.35%	4.7%	2005
Cadmium	Annual mean	0.005	0.00017	0.00051	0.0007	10%	14%	2007
	Maximum hourly mean	1.5	0.00034	0.005	0.005	0.31%	0.33%	2005
Thallium	Annual mean	1	0.00080	0.00051	0.0013	0.051%	0.13%	2007
	Maximum hourly mean	30	0.0016	0.005	0.006	0.016%	0.021%	2005
Mercury	Annual mean	0.25	0.0020	0.0010	0.0031	0.41%	1.2%	2007
	Maximum hourly mean	7.5	0.0041	0.009	0.0134	0.12%	0.18%	2005
Antimony	Annual mean	5	0.0017	0.0011	0.0028	0.023%	0.057%	2007
	Maximum hourly mean	150	0.0034	0.010	0.014	0.007%	0.009%	2005
Arsenic	Annual mean	0.003	0.00051	0.0011	0.0017	38%	55%	2007
	Maximum hourly mean	15	0.00102	0.010	0.011	0.07%	0.08%	2005
Lead	Annual mean	0.5	0.0084	0.0011	0.010	0.23%	1.9%	2007
Chromium (II and III)	Annual mean	5	0.0024	0.0011	0.004	0.02%	0.1%	2007
	Maximum hourly mean	150	0.0032	0.0104	0.014	0.01%	0.01%	2005
Chromium (VI)	Annual mean	0.0002	0.00012	0.00006	0.00018	28.6%	87.6%	2007
Cobalt	Annual mean	0.2	0.00070	0.0011	0.0018	0.6%	0.9%	2007
	Maximum hourly	6	0.00140	0.010	0.012	0.17%	0.20%	2005

Pollutant	Averaging period	EQS (µg/m³)	Adopted ambient air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC / EQS (%)	PEC / EQS (%)	Year of met dataset resulting in maximum PC
	mean							
Copper	Annual mean	10	0.0059	0.0011	0.0070	0.011%	0.070%	2007
	Maximum hourly mean	200	0.012	0.010	0.022	0.005%	0.011%	2005
Manganese	Annual mean	0.15	0.012	0.0011	0.013	0.76%	8.6%	2007
	Maximum hourly mean	1500	0.024	0.010	0.034	0.001%	0.002%	2009
Nickel	Annual mean	0.02	0.0009	0.0011	0.0020	5.7%	10%	2007
	Maximum hourly mean	30	0.0018	0.010	0.012	0.03%	0.04%	2005
Vanadium	Annual mean	5	0.0019	0.0011	0.0030	0.023%	0.061%	2007
	Maximum daily mean	1	0.0038	0.007	0.010	0.7%	1.0%	2009
Ammonia	Annual mean	180	1.2	0.4	1.6	0.2%	0.9%	2007
	Maximum hourly mean	2500	2.4	3.4	5.8	0.1%	0.2%	2006
BaP	Annual mean	0.001	0.00046	0.000079	0.00054	7.9%	54%	2007
Dioxins and furans	Annual mean	n/a	1.1×10^{-8}	4.1×10^{-9}	1.5×10^{-8}	n/a	n/a	2007
VOCs	Annual mean	n/a	No baseline	0.59	No baseline	n/a	No baseline	2007
	Maximum hourly mean	n/a	No baseline	5.1	No baseline	n/a	No baseline	2006
Note: BaP is Benzo(a)pyrene								

Impact Assessment

9.7.24 The results set out in Table 9.8 indicate that no air quality objectives or environmental assessment levels are forecast to be exceeded due to emissions from the proposed Dundee Renewable Energy Plant. Further details on the results for each substance are set out below.

Nitrogen dioxide

9.7.25 With reference to the nitrogen dioxide results presented within Table 9.8, operation of the Renewable Energy Plant it is predicted to contribute a maximum of 14% of the annual mean nitrogen dioxide objective and 10% of the 99.8th percentile of the 1 hour mean nitrogen dioxide objective. Combining the Renewable Energy Plant nitrogen dioxide PC with the adopted ambient air quality level, the PEC is calculated to be 66% of the annual mean nitrogen dioxide objective, and 31% of the 99.8th percentile of the 1 hour mean nitrogen dioxide objective.

9.7.26 As these PECs do not exceed or approach the AQO for nitrogen dioxide, the predicted impact of the Renewable Energy Plant on ambient nitrogen dioxide concentrations is considered not significant.

9.7.27 The results presented in Table 9.8 are the maximum predicted concentrations at any off-site location within Dundee. The maximum annual mean concentration is forecast to occur at industrial / commercial units adjacent to Eastern Wharf where the annual mean air quality objective would not apply. The maximum predicted annual mean nitrogen dioxide concentration at any existing sensitive human locations where the annual mean objective would apply is approximately 3 µg/m³ (see Figure 9.2). This maximum concentration is predicted at locations adjacent to Broughty Ferry Road. The concentration is equivalent to 7.5% of the air quality objective and is significantly less than the maximum predicted off-site concentration of 5.6 µg/m³ set out in Table 9.8. Even if the contribution from the nearby road is included in the baseline concentration (modelled at a value of approximately 3.1 µg/m³), the resulting PEC of 26.8 µg/m³ is well within the air quality objective at locations adjacent to Broughty Ferry Road.

9.7.28 At sensitive human locations towards the city centre, where ambient concentrations are close to or in excess of the annual mean air quality objective, the predicted concentrations due to emissions from the plant are even lower. For example at the King Street / Marketgait junction the predicted annual mean concentration is 0.7 $\mu g/m^3$ which is 1.8% of the air quality objective. An increase of this magnitude would not likely be measureable in practice. At the area encompassing where the automatic monitoring stations on Union Street and Whitehall Street are located, the predicted annual mean is less than 0.4 $\mu g/m^3$, which is less than 1% of the annual mean air quality objective.

Carbon monoxide

9.7.29 The carbon monoxide results presented within Table 9.8 indicate that operation of the Renewable Energy Plant is predicted to contribute only 0.6% of the maximum running 8 hour mean carbon monoxide objective. Combining the Renewable Energy Plant carbon monoxide PC with the adopted ambient air quality level, the PEC is calculated to be 5% of the maximum running 8 hour mean carbon monoxide objective. As this PEC does not exceed or approach the AQO for carbon monoxide, the predicted impact of the Renewable Energy Plant on ambient carbon monoxide concentrations is considered insignificant.

PM_{10}

9.7.30 Table 9.8 presents the results of the dispersion modelling with respect to PM_{10}. Operation of the Renewable Energy Plant is predicted to contribute a maximum 2.2% of the annual mean PM_{10} objective and 3.7% of the 98.1st percentile of the daily mean PM_{10} objective. Combining the Renewable Energy Plant PM_{10} PC with the relevant ambient air quality levels, the PEC is calculated to be 81% of the annual mean PM_{10} objective, and 71% of the 98.1st percentile of the daily mean PM_{10} objective. As these PECs do not exceed the AQO for PM_{10}, the predicted impact of the Renewable Energy Plant on ambient PM_{10} concentrations is considered not significant.

9.7.31 The results presented in Table 9.8 are the maximum predicted concentrations at any off-site location within Dundee. As discussed above, this occurs in areas where the annual mean objective does not apply. The maximum predicted annual mean PM_{10} concentration at any existing sensitive human locations where the annual mean objective would apply is approximately 0.21 $\mu g/m^3$ (see Figure 9.4). This maximum concentration is predicted to occur at locations adjacent to Broughty Ferry Road. The concentration is equivalent to 1.2% of the air quality objective and is significantly less than the maximum predicted off-site concentration of 0.4 $\mu g/m^3$ set out in Table 9.8.

9.7.32 At sensitive human locations towards the city centre, where ambient concentrations are close to or in excess of the annual mean air quality objective, the predicted concentrations due to emissions from the plant are even lower. At the King Street / Marketgait junction the predicted annual mean concentration is 0.04 $\mu g/m^3$ which is less than 0.3% of the air quality objective. An increase of this magnitude would not be measureable in practice. At other locations closer to the city centre, the predicted contribution from the proposed plant would is less.

$PM_{2.5}$

9.7.33 There are currently no statutory ambient air quality limits for $PM_{2.5}$ (particles of 2.5 µm and less) at present, however, future targets are included as part of the National Air Quality Strategy[32],. As $PM_{2.5}$ particles are a constituent of PM_{10}, which covers a range including larger particles, concentrations of $PM_{2.5}$ must be lower than those for PM_{10}. Table 9.8 shows that the maximum predicted annual average PC of $PM_{2.5}$ is 0.4 $\mu g/m^3$, which is 3.3% of the AQO for $PM_{2.5}$. With an assumed background of 9.4 $\mu g/m^3$, the maximum PEC of $PM_{2.5}$ is 9.8 $\mu g/m^3$, 82% of the AQO for $PM_{2.5}$ and therefore, even with the conservative assumption that all

[32] Department for Environment, Food and Rural Affairs, The Air Quality Strategy for England, Scotland, Wales and Northern Ireland, July 2007

particulate matter emissions from the proposed plant are $PM_{2.5}$, the PEC would be within the AQO. The baseline concentration utilised for the assessment is a large proportion of the air quality objective value. As stated in the conservative assumptions set out in Appendix C, if $PM_{2.5}$ emissions were 33% of the total particulate matter emissions, the predicted PC would be 0.13 μg/m^3, which is equivalent to 1.1% of the AQO. On this same basis, at locations where there is existing sensitive human receptors adjacent to Broughty Ferry Road or towards the city centre, the predicted concentrations due to emissions from the plant would be approximately 0.07 μg/m^3 or less, which is equivalent to 0.6% of the AQO.

Sulphur dioxide

9.7.34 With reference to the sulphur dioxide results presented within Table 9.8, operation of the Renewable Energy Plant is predicted to contribute a maximum of 11% to the 15-minute mean AQO, resulting in a PEC of 15% of the AQO when added to the adopted baseline level. PCs to the hourly and daily mean AQOs are predicted to be 6% and 12% respectively, resulting in PECs of 9% and 20% of the respective AQOs. As these PECs do not exceed or approach the AQO for sulphur dioxide, the predicted impact of the Renewable Energy Plant on ambient sulphur dioxide concentrations is considered not significant.

Hydrogen chloride and hydrogen fluoride

9.7.35 The results for hydrogen chloride demonstrates that based on the maximum predicted PC of 0.62 μg/m^3 for the annual mean and an adopted air quality level of 0.2 μg/m^3, the PC and the PEC represent 3.1% and 4.1% of the EAL respectively, these are both considered not significant in terms of their environmental impact. The maximum hourly mean values for hydrogen chloride generate a PC of 5.6 μg/m^3 with a baseline air quality level of 0.39 μg/m^3 generating a PEC of 6.0 μg/m^3. The PC and PEC represent 0.7% and 0.8% of the EAL respectively. These are considered insignificant in terms of their environmental impact.

9.7.36 The results for hydrogen fluoride demonstrates that based on the maximum predicted PC of 0.06 μg/m^3 for the annual mean and an adopted air quality level of 3.5 μg/m^3, the PC and the PEC represent 0.4% and 22.3% of the EAL respectively, these are both considered insignificant in terms of their environmental impact. The maximum hourly mean values for hydrogen chloride generate a PC of 0.56 μg/m^3 with a baseline air quality level of 7.0 μg/m^3 generating a PEC of 7.6 μg/m^3. The PC and PEC represent 0.35% and 4.7% of the EAL respectively. These are considered insignificant in terms of their environmental impact.

Cadmium and Thallium

9.7.37 The maximum annual mean PC for both cadmium and thallium is predicted to be 0.00051 μg/m^3. This is equivalent to 10% and 0.05% of the EAL for cadmium and thallium, respectively. The PEC as a percentage of the EAL is 14% and 0.13% for cadmium and thallium, respectively. This is considered not significant in terms of the environmental impact of these two species. The maximum hourly mean value PC for total cadmium and thallium is 0.005 μg/m^3, which represents 0.31% of the EAL for cadmium (the more stringent EAL) and is considered insignificant in terms of environmental impact.

Mercury

9.7.38 The results for mercury demonstrates that the predicted maximum annual mean PC is 0.001 μg/m^3, which is 0.41% of the EAL, and is considered insignificant. The maximum hourly mean value for mercury of 0.009 μg/m^3 represents 0.12% of the EAL, and again is considered insignificant. The PEC as a percentage of annual and hourly mean EAL is 1.2% and 0.18%, respectively.

Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel, Vanadium

9.7.39 The maximum predicted annual mean PC for each of these substances is 0.0011 μg/m^3. This maximum predicted PC as a percentage of the EAL is 38% for arsenic, as this has the most stringent EAL. For the other metals, with less stringent EALs, the contribution to the annual mean EAL ranges from 0.01% (copper) to 5.7% (nickel). For Chromium (VI), the annual mean PC is 0.00006 μg/m^3 which represents 29% of the EAL.

The maximum hourly mean value for these species is 0.01 µg/m^3 which represents 0.17% (cobalt) of the most stringent EAL. The maximum daily mean vanadium concentration is 0.007 µg/m^3 which represents 0.7% of the EAL. This is considered to be an insignificant environmental effect.

PAHs

9.7.40 Table 9.8 presents the results of the dispersion modelling with respect to PAHs, assumed to be in the form of benzo(a)pyrene. Operation of the Renewable Energy Plant is predicted to contribute a maximum 7.9% of the annual mean benzo(a)pyrene EAL. Combining the PC with the relevant ambient air quality levels, the PEC is calculated to be 54% of the annual mean benzo(a)pyrene EAL. As this PEC does not exceed the EAL for benzo(a)pyrene, the predicted impact of the Renewable Energy Plant on ambient benzo(a)pyrene and PAH concentrations is considered not significant.

Auxiliary Boiler

9.7.41 The results of the dispersion modelling of the auxiliary boiler are shown in Table C.28 of Appendix C. The results were only compared to the short term air quality objectives as described in Section 9.7.18. The results indicate that even assuming continuous operation throughout the year the predicted concentration form the auxiliary boiler will comply with the relevant air quality objectives.

Airborne Pollutants (Non-Threshold Substances)

9.7.42 Emissions of some substances do not exhibit any apparent threshold for effects. The health risks associated with levels of these substances need to be managed by controlling exposures to very low levels. One method of assessing levels of these substances is by comparing levels of the substances to air quality standards and guidelines, where these are available. These are set at levels which have no significant adverse health effects, based on current scientific knowledge. The risk of health effects can be reduced to a minimal level by ensuring that air quality standards and guidelines for these substances are not breached. This is set out above.

9.7.43 As well as this, it is also possible to calculate the possible effects on health due to forecast levels of these substances as a cross-check on the evaluation against air quality standards and guidelines.

9.7.44 The risks to health associated with emissions of carcinogenic substances are set out in Table 9.9. This calculation would be appropriate for an individual located permanently at the point of maximum modelled impact. Because all the carcinogens of potential concern act on the lung, it is appropriate to provide a maximum total incremental health risk due to exposure to all the carcinogenic substances assessed.

Table 9.9 Health Effects of Exposure to Carcinogens (Incremental Risk)

Substance	Dose-response factor (increase in lifetime cancer risk per 1 µg/m^3 increase in exposure)	Maximum modelled concentration (µg/m^3)	Incremental annual risk
Arsenic	0.0025 (µg/m^3)$^{-1}$	0.0011	4.1 x 10^{-8}
Nickel	0.00038 (µg/m^3)$^{-1}$	0.0011	6.2 x 10^{-9}
Chromium VI	0.004 (µg/m^3)$^{-1}$	0.00006	3.3 x 10^{-9}
Benzo(a)pyrene	0.09 (µg/m^3)$^{-1}$	0.000079	1.0 x 10^{-7}
Total			**1.5 x 10^{-7}**

9.7.45 The total incremental annual risk of contracting cancer due to emissions of carcinogenic substances from the Dundee Renewable Energy plant at the point of maximum modelled concentration is 1.5 × 10^{-7} per year. This value is equivalent to approximately a one in 6.5 million chance per year for an individual located at the point of maximum modelled concentration. A guideline set by the Royal Commission on Environmental Pollution[11] is one in one million per year – that is, the incremental risk associated with the proposed process is less than one sixth of the highest acceptable risk.

9.7.46 It is also possible to use the modelled concentrations to estimate the likely number per year of cancer cases which would be expected to arise in people living in the vicinity of the Dundee Renewable Energy Plant. The assessment was based on an area extending 5 km × 5 km centred on the Dundee Renewable Energy Plant, with a population density of 2,122 people/km^2. The assessment is set out in Table 9.10.

Table 9.10 Health Effects of Exposure to Carcinogens (Number of Additional Cases)

Substance	Average concentration (µg/m^3)	Number of additional cases per year
Arsenic	0.00008	0.00010
Nickel	0.00008	0.000015
Chromium VI	0.000004	0.000008
Benzo(a)pyrene	0.0000058	0.00025
Total		**0.00037**

9.7.47 The total number of additional cancer cases due to exposure to emissions from the proposed Dundee Renewable Energy Plant is estimated to be 0.00037 per year. This was based on the highest average modelled concentration for any of the five years of meteorological data. The study area was limited to a 5 km by 5 km zone surrounding the plant, minus the area taken up by the Firth of Tay. Extending the zone further would give an increase on this figure, but the modelling study indicates that the increase is a relatively small increment on the values shown in Table 9.10. This is because, as the study area is extended, the modelled concentrations decrease more rapidly than the size of the study area increases. Over a 25 year lifetime, the annual figures correspond to 0.009 additional cases in the study area (as a result of exposure to the substances listed in Table 9.10).

Outline Exposure Assessment for Dioxins and Furans

9.7.48 The model provides estimated exposure levels for different age groups, and different exposure patterns. As well as the likely maximum exposure relevant for most residents, the model provides estimated maximum exposure levels for farmers. A theoretical maximum exposure is also considered, based on extreme assumptions regarding exposure. This is referred to as the "maximum exposed individual" (MEI), and includes assumptions such as spending 100% of the time at the point of maximum modelled dioxin and furan concentrations, and eating exclusively produce grown at the point of maximum impact. Clearly, these assumptions will result in a substantial over-estimate of likely exposure.

9.7.49 The estimated exposure levels due to the Renewable Energy Plant are set out in Table 9.11.

Table 9.11: Estimated Exposures to Dioxins and Furans

Case	Maximum Estimated Exposure	Average Body Weight	Daily Exposure per Unit Body Weight	% of UK long-term Recommended Tolerable Daily Intake of 2 pg TEQ/ kgBW-Day
	pg TEQ /day	Kg	pg TEQ/(kgBW-Day)	
Adult MEI	5.1	70.1	0.073	3.7%
Adult Resident	0.45	70.1	0.0064	0.32%
Adult Farmer	0.19	70.1	0.0028	0.14%
Child MEI	1.5	15	0.101	5.1%
Child Resident	0.17	15	0.011	0.55%
Child of Farmer	0.065	15	0.0044	0.22%
Infant MEI	6.0	8.5	0.71	35%
Infant Resident	0.53	8.5	0.062	3.1%
Infant of Farmer	0.22	8.5	0.026	1.32%
School Child 6 to 11	0.31	32.5	0.0095	0.48%
School Child 11 to 16	0.33	52.5	0.0062	0.31%

9.7.50 The highest forecast level of exposure is for the hypothetical case of the infant MEI. The highest forecast exposure is 35% of the tolerable daily intake value. As noted above, extreme assumptions are used to assess the hypothetical MEI. The modelled exposure levels for residents and farmers are more realistic, while still likely to over-estimate exposure. The highest forecast exposure level for residents and farmers is approximately 3.1% of the tolerable daily intake value. While any increase in intake of dioxins and furans is undesirable, the forecast level of intake from the proposed facility is much smaller than could be detectable in practice, and is likely to be dwarfed by other sources of exposure such as consumption of fish and dairy products. Furthermore, these estimates are based on conservative assumptions regarding the emission concentration of dioxins and furans.

Modelling Results at Specific Multi-storey Buildings

9.7.51 The modelling study also assessed the impact on air quality at specific multi-storey buildings to see how the predicted contributions from the Renewable Energy Plant vary in height at specific multi storey apartments in the vicinity of the proposed plant. These locations are described in Section C5 of Appendix C.

9.7.52 The results indicate that at the City Quay development, the closest sensitive locations to the site and which experience the highest process contribution of the multi-storey buildings assessed, the maximum increase with height is 52% increase in the annual mean nitrogen dioxide process contributions between the ground and topmost floor. However, the highest annual mean nitrogen dioxide process contribution at the upper floors of the City Quay development is 1.5 µg/m^3, which is 3.8% of the relevant AQO and therefore no significant impact is predicted. A full summary of the results is given in Section C5 of Appendix C.

Modelling Sensitivity Analyses

9.7.53 Various sensitivity analyses were carried out to see how changes to some of the modelling options impact on the predicted modelled concentrations. These analyses were based on meteorological data from the RAF Leuchars meteorological station for 2007, which resulted in the highest predicted concentrations for most substances on the receptor grid. The sensitivity cases are summarised in Table 9.12.

Table 9.12: Sensitivity cases

Sensitivity Analyses	Description
Sensitivity Analysis 1	Model without the buildings option in ADMS, rather than with buildings
Sensitivity Analysis 2	Model without terrain, rather than with terrain
Sensitivity Analysis 3	Model with a fixed low surface roughness value of 0.001m rather than the variable values used in the main modelling
Sensitivity Analysis 4	Model with a fixed high surface roughness value of 1m selected rather than the variable values used in the main modelling
Sensitivity Analysis 5	Model using the RAF Leuchars 2009 meteorological data using an alternative dispersion model, AERMOD (as requested by SEPA)
Sensitivity Analysis 6	Model using measured wind speed and wind direction data from the DCC Broughty Ferry Automatic Monitoring Station with all other meteorological parameters from RAF Leuchars meteorological station
Sensitivity Analysis 7	Model with a 20 m receptor grid, rather than the 50 m used

9.7.54 The results of the sensitivity analysis are shown in Table 9.13 – Table 9.19.

Table 9.13: Sensitivity Analysis 1: Buildings

Substance	Averaging period	With buildings		Without buildings		Difference in PC / EQS (%)
		PC / EQS (%)	PEC / EQS (%)	PC / EQS (%)	PEC / EQS (%)	
Nitrogen Dioxide	Annual mean	13.9%	65.6%	4.0%	55.7%	-9.9%
	99.8th percentile of 1 hour means	10.1%	30.8%	3.8%	24.5%	-6.3%
Sulphur Dioxide	99.9th percentile of 15 minute means	11.3%	15.1%	4.7%	8.6%	-6.5%
	99.7th percentile of 1 hour means	6.1%	9.0%	2.2%	5.1%	-3.9%
	99.2nd percentile of daily means	11.4%	19.5%	3.3%	11.4%	-8.1%

9.7.55 The results set out in Table 9.13 indicate that the concentrations are higher with the significant buildings included in the model. Therefore, including the buildings is a conservative approach and the preferred option for this study.

Table 9.14: Sensitivity Analysis 2: Terrain

Substance	Averaging period	With terrain		Without terrain		Difference in PC / EQS (%)
		PC / EQS (%)	PEC / EQS (%)	PC / EQS (%)	PEC / EQS (%)	
Nitrogen Dioxide	Annual mean	13.9%	65.6%	14.2%	65.9%	0.30%
	99.8th percentile of 1 hour means	10.1%	30.8%	9.4%	30.1%	-0.70%
Sulphur Dioxide	99.9th percentile of 15 minute means	11.3%	15.1%	10.4%	14.2%	-0.84%
	99.7th percentile of 1 hour means	6.1%	9.0%	5.7%	8.6%	-0.41%
	99.2nd percentile of daily means	11.4%	19.5%	11.8%	20.0%	0.47%

9.7.56 The results set out in Table 9.14 indicate that the impact that the terrain has on the dispersion of emissions from the site is variable. In some cases the predicted concentrations increase slightly with the inclusion of the terrain in the model and other cases the concentration decreases slightly. The impact of terrain is not sufficient to affect the study findings. Including the terrain in the dispersion modelling is the preferred option for this study.

Table 9.15: Sensitivity Analysis 3 Variable Surface Roughness Compared to a Constant Surface Roughness of 0.001m

Substance	Averaging period	With variable surface roughness		With a fixed surface roughness of 0.001m		Difference in PC / EQS (%)
		PC / EQS (%)	PEC / EQS (%)	PC / EQS (%)	PEC / EQS (%)	
Nitrogen Dioxide	Annual mean	13.9%	65.6%	9.4%	61.1%	-4.5%
	99.8th percentile of 1 hour means	10.1%	30.8%	12.1%	32.8%	2.0%
Sulphur Dioxide	99.9th percentile of 15 minute means	11.3%	15.1%	14.6%	18.4%	3.3%
	99.7th percentile of 1 hour means	6.1%	9.0%	7.0%	9.9%	0.8%
	99.2nd percentile of daily means	11.4%	19.5%	10.7%	18.8%	-0.7%

Table 9.16: Sensitivity Analysis 4: Variable Surface Roughness Compared to a Constant Surface Roughness of 1m

Substance	Averaging period	With variable surface roughness		With a fixed surface roughness of 1m		Difference in PC / EQS (%)
		PC / EQS (%)	PEC / EQS (%)	PC / EQS (%)	PEC / EQS (%)	
Nitrogen Dioxide	Annual mean	13.9%	65.6%	14.8%	66.5%	0.9%
	99.8th percentile of 1 hour means	10.1%	30.8%	9.2%	29.9%	-0.9%
Sulphur Dioxide	99.9th percentile of 15 minute means	11.3%	15.1%	10.6%	14.4%	-0.7%
	99.7th percentile of 1 hour means	6.1%	9.0%	5.6%	8.5%	-0.5%
	99.2nd percentile of daily means	11.4%	19.5%	11.5%	19.7%	0.2%

9.7.57 The results set out in Table 9.15 and Table 9.16 indicates that the impact that the use of variable surface roughness is varied, with increases and decreases compared to using a constant surface roughness value. Including the variable surface roughness is considered a more realistic and the preferred option for this study.

Table 9.17: Sensitivity Analysis 5: AERMOD

Substance	Averaging period	With ADMS 4.2		With AERMOD		Difference in PC / EQS (%)
		PC / EQS (%)	PEC / EQS (%)	PC / EQS (%)	PEC / EQS (%)	
Nitrogen Dioxide	Annual mean	13.9%	65.6%	4.4%	56.2%	-9.4%
	99.8th percentile of 1 hour means	10.1%	30.8%	9.4%	30.1%	-0.7%
Sulphur Dioxide	99.9th percentile of 15 minute means	11.3%	15.1%	14.2%	18.0%	2.9%
	99.7th percentile of 1 hour means	6.1%	9.0%	4.7%	7.6%	-1.4%
	99.2nd percentile of daily means	11.4%	19.5%	6.1%	14.2%	-5.3%

9.7.58 The results set out in Table 9.17 indicate that the predicted ground level concentrations are generally higher with the ADMS model. Therefore, using the ADMS dispersion model, rather than AERMOD, for this study is considered to be a conservative approach and is the preferred option.

Table 9.18: Sensitivity Analysis 6: Meteorological data

Substance	Averaging period	Leuchars data		DCC data		Difference in PC / EQS (%)
		PC / EQS (%)	PEC / EQS (%)	PC / EQS (%)	PEC / EQS (%)	
Nitrogen Dioxide	Annual mean	13.9%	65.6%	9.3%	61.0%	-4.6%
	99.8th percentile of 1 hour means	10.1%	30.8%	10.5%	31.2%	0.4%
Sulphur Dioxide	99.9th percentile of 15 minute means	12.1%	15.9%	12.1%	15.9%	No change
	99.7th percentile of 1 hour means	6.1%	9.0%	6.2%	9.1%	0.1%
	99.2nd percentile of daily means	11.4%	19.5%	10.2%	18.3%	-1.2%

9.7.59 The meteorological data used in this study were obtained from the Leuchars meteorological station, located approximately 10 km south southeast of the site. Wind speed and direction data was also obtained from the DCC monitoring station located on Broughty Ferry Road. A sensitivity study was conducted to assess the difference in modelled process contributions using the Leuchars meteorological data and the wind measurements from DCC.

9.7.60 As DCC only measured wind speed and direction, all other meteorological parameters were assumed to be the same as at Leuchars. One year of hourly data were used in the models in line with the other sensitivity analyses (2007).

9.7.61 The model results (Table 9.18) using Leuchars meteorological data were higher overall than the model results using the DCC measured wind data. As the Leuchars meteorological data was used in the modelling, these results confirm that a conservative approach was adopted throughout the study and that annual mean concentrations set out in this chapter are likely to be overestimates.

Table 9.19: Sensitivity Analysis 7: 20 m Receptor Grid

Substance	Averaging period	With 50 m receptor grid		With 20 m receptor grid		Difference in PC / EQS (%)
		PC / EQS (%)	PEC / EQS (%)	PC / EQS (%)	PEC / EQS (%)	
Nitrogen Dioxide	Annual mean	13.9%	65.6%	13.9%	65.7%	0.08%
	99.8th percentile of 1 hour means	10.1%	30.8%	9.9%	30.6%	-0.2%
Sulphur Dioxide	99.9th percentile of 15 minute means	11.3%	15.1%	11.0%	14.8%	-0.3%
	99.7th percentile of 1 hour means	6.1%	9.0%	6.0%	8.9%	-0.1%
	99.2nd percentile of daily means	11.4%	19.5%	11.6%	19.7%	0.2%

9.7.62 The results set out in Table 9.19 indicate that the results from modelling air pollutant concentrations on a 20 m receptor grid compared with a 50 m receptor grid are variable. In one case the predicted concentrations increase when modelled on a 20 m receptor grid and in some cases the concentration remains constant or decreases marginally. The impact of modelling air pollution concentrations on a 20 m grid does not significantly affect the study findings. Using a 50 m receptor grid in the dispersion modelling is considered to be satisfactory for this study and provides a good balance between grid resolution and the size of the modelled grid.

Sensitivity analysis on Nynas emissions

9.7.63 In addition, a sensitivity scenario was carried out to assess the impact that the proposed Renewable Energy Plant buildings will have on emissions from the adjacent Nynas facility. The results are shown in Table 9.20.

Table 9.20: Sensitivity Analysis: Nynas results summary

Pollutant	Averaging period	EQS (µg/m³)	Nynas		Nynas with the biomass plant buildings		Difference in PC / EQS (%)
			PC / EQS (%)	PEC/ EQS (%)	PC/ EQS (%)	PEC/ EQS (%)	
Nitrogen dioxide	Annual mean	40	6.1%	58%	6.1%	58%	No change
	1 hour mean (99.8th %ile)	200	6.6%	27%	7.6%	28%	1.0%
PM_{10}	Annual mean	18	3.9%	83%	3.9%	83%	No change
	24 hour mean (98.08th %ile) (method 1)	50	2.8%	72%	2.8%	72%	No change
	24 hour mean (98.08th %ile) (method 2)	50	4.4%	61%	5.5%	62%	1.1%
$PM_{2.5}$	Annual mean	25	5.8%	84%	5.8%	84%	No change
Sulphur dioxide	15 minute mean (99.9th %ile) (method 1)	266	51%	54%	45%	49%	-5%
	1 hour mean (99.9th %ile) (method 2)	266	65%	69%	59%	63%	-6%
	1 hour mean (99.73th %ile)	350	23%	26%	31%	34%	8%
	24 hour mean (99.18th %ile)	125	24%	32%	28%	37%	5%

9.7.64 The results set out in Table 9.20 indicate that the predicted ground level concentrations do not change the annual mean concentrations due to the buildings of the Renewable Energy Plant. The largest change is a 8% increase in the 99.7th percentile of 1 hour mean sulphur dioxide concentrations. However, there are also decreases in the 15-minute mean concentrations. Therefore, it is concluded that the buildings of the proposed Renewable Energy Plant will not have a significant impact on the emissions from the Nynas facility.

Air quality, and nitrogen and acid deposition at designated sites

9.7.65 Figure 12.2 shows the internationally designated sites for nature conservation within 15 km of the proposed development site. There are 24 designated habitat sites within 15 km of proposed biomass site including the Firth of Tay and Eden Estuary (SPA/SAC), Barry Links (SAC) and River Tay (SAC) along with 21 designated SSSI. These are described in Chapter 12 Terrestrial Ecology.

Air Quality

9.7.66 Whilst only nitrogen dioxide may impact human health, both nitrogen dioxide and nitric oxide are absorbed by vegetation. Their effects on plants are additive and the scientific consensus is that they should be treated together (i.e. as total oxides of nitrogen (NO_x). Site specific information on background levels of the pollutants of concern with regards to such sites, i.e. oxides of nitrogen and sulphur dioxide, at each of the designated sites is available from the UK Air Quality Archive database and has been used in this assessment[18].

9.7.67 There are 24 potentially sensitive designated habitat sites within 15 km of the proposed facility. Forecast levels of oxides of nitrogen, sulphur dioxide and ammonia at these locations were assessed against the relevant standards and guidelines for protection of vegetation. The results in Table 9.21 show the modelled concentrations for the habitat sites with a PC greater than 1% of the relevant air quality objectives and guidelines for any substance. A full set of the results are given in Appendix C

9.7.68 The table also shows the expected maximum additional increments to the existing ground level concentrations of oxides of nitrogen and sulphur dioxide at the protected sites due to full load operation. The maximum concentrations over the five meteorological years modelled are presented to ensure a suitably precautionary approach.

Table 9.21: Predicted Maximum levels of released substances at designated habitat sites)

Pollutant	Designated Habitat Site	Averaging period	EQS (µg/m³)	Adopted ambient air quality level (µg/m³)	PC (µg/m³)	PEC (µg/m³)	PC / EQS (%)	PEC / EQS (%)
Oxides of nitrogen	Firth of Tay and Eden Estuary SPA/SAC	Annual mean	30	19.4	0.62	20.1	2.1%	66.9%
	Barry Links SAC			7.7	0.42	8.1	1.40%	27.1%
	Monifieth Bay SSSI			11.6	0.64	12.3	2.1%	40.9%
	Tayport – Tentsmuir Coast SSSI			9.2	0.27	9.5	0.89%	31.7%
Sulphur dioxide	Firth of Tay and Eden Estuary SPA/SAC	Annual mean	20	1.9	0.23	2.1	1.2%	10.5%
	Barry Links SAC			1.3	0.16	1.5	0.8%	7.4%
	Monifieth Bay SSSI			1.9	0.24	2.1	1.2%	10.5%
	Tayport – Tentsmuir Coast SSSI			1.2	0.10	1.3	0.50%	6.5%
Ammonia	Firth of Tay and Eden Estuary SPA/SAC	Annual mean	3	1.2	0.031	1.22	1.0%	40.7%
	Barry Links SAC		1		0.021	1.21	2.1%	121.1%
	Monifieth Bay SSSI		3		0.032	1.22	1.1%	40.7%
	Tayport – Tentsmuir Coast SSSI		1		0.013	1.20	1.3%	120.3%
	Firth of Tay and Eden Estuary SPA/SAC	Maximum hourly mean	3300	2.4	0.87	3.2	0.03%	0.10%
	Barry Links SAC				0.61	3.0	0.02%	0.09%
	Monifieth Bay SSSI				0.82	3.2	0.02%	0.10%
	Tayport – Tentsmuir Coast SSSI				0.80	3.2	0.02%	0.10%

9.7.69 The expected increments of oxides of nitrogen, sulphur dioxide and ammonia at the protected sites are low. The maximum annual average process contribution of either pollutant at any of the sites is 2.1% of the air quality objective and guidelines for the protection of vegetation. The predicted environmental concentrations comply with the respective guideline levels for all substances, except ammonia at Barry Links SAC and Tayport – Tentsmuir Coast SSSI, where the background concentration alone exceeds the air quality guideline value.

9.7.70 The annual mean oxides of nitrogen, sulphur dioxide and ammonia process contributions are greater than 1% at the sensitive habitat sites set out in Table 9.21. This indicates that the need for a further deposition assessment for these designated habitat sites. This is described below in the Acid and Nitrogen Deposition section.

9.7.71 In order to determine the potential impact beyond a radius if 15 km from the proposed plant, the results for each substance were plotted to determine where the predicted ground level concentrations (PC) of each substance fell below the 1% criteria (i.e. where PC / EQS was less than 1%). For the annual mean oxides of nitrogen, sulphur dioxide and ammonia (3 $\mu g/m^3$) guidelines, the 1% contour was at 15 km or less from the plant. For the 1 $\mu g/m^3$ guideline for ammonia, the 1% contour extended up to approximately 16.5 km to the east north-east of the plant. Information on the location of habitat sites greater than 15 km from the plant was obtained and the locations compared to this contour plot. There are no national or European designated habitat sites within the 1% contour for the annual mean ammonia guideline of 1 $\mu g/m^3$. On this basis, no designated habitat sites other than those assessed here will potentially be affected by emissions to air from the proposed plant.

Acid and Nitrogen Deposition

9.7.72 The rate of deposition of acidic compounds and nitrogen-containing species have been estimated at Firth of Tay and Eden Estuary SPA/SAC, Barry Links SPA/SSSI, Monifieth Bay SSSI and Tayport – Tentsmuir Coats SSSI. This allows the potential for adverse effects to be evaluated by comparison with critical loads for acid and nutrient nitrogen deposition. The assessment took account of emissions of sulphur dioxide, oxides of nitrogen and ammonia.

9.7.73 Critical load functions for acid deposition at European sites (SPA or SAC) are specified on the basis of both nitrogen-derived acid and sulphur-derived acid. This information, including existing deposition levels at habitat sites, is available on the UK Air pollution Information System (APIS)[33]. The critical load function contains separate critical load values for sulphur derived and nitrogen derived acid deposition and is site specific. The next step is to calculate the critical load as a total acid deposition value and this is carried out by summing the sulphur and nitrogen critical load function values. On this same basis, the process contribution is calculated by summing the sulphur and nitrogen derived acid deposition so that a direct comparison can be made to the total acid deposition critical load value calculated previously The process contribution can then be calculated as a percentage of this critical load value. At nationally designated sites (SSSI), the critical load is expressed on the as a single total acid deposition value and the process contribution was calculated by summing the sulphur and nitrogen derived acid deposition. Further information on the assessment of deposition is provided in Appendix C. The results are set out in Tables 9.22 and Table 9.23.

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33 UK Air Pollution Information System accessed at http://www.apis.ac.uk/

Table 9.22: Modelled acid deposition at designated sites (kEqH+ /ha/yr)

Site	Estimated acid deposition (kEqH+/ha-year)					
	Critical Load (CL)	PC	PC/CL (%)	Existing Levels	PEC	PEC/CL (%)
Firth of Tay and Eden Estuary SPA/SAC	Not sensitive to acid deposition (no critical load available)					
Barry Links SAC	0.61	0.037	6.1%	1.01	1.05	172%
Monifieth Bay SSSI	Not sensitive to acid deposition (no critical load available)					
Tayport – Tentsmuir Coast SSSI	Not sensitive to acid deposition (no critical load available)					

9.7.74 The results set out in Table 9.22 show that the majority of the sites are not sensitive to acid deposition. The critical load at Barry Links SAC is exceeded due to the existing background acid deposition. The acid deposition contribution is 6.1% of the critical load.

Table 9.23: Modelled nitrogen deposition at designated sites (kg nitrogen/ha/yr)

Site	Estimated nutrient N deposition (kgN/ha-year)					
	Critical Load (CL)	PC	PC/CL (%)	Existing Levels	PEC	PEC/CL (%)
Firth of Tay and Eden Estuary SPA/SAC	30	0.22	0.7%	7.6	7.82	26%
Barry Links SAC	10	0.15	1.5%	11.6	11.75	118%
Monifieth Bay SSSI	30	0.23	0.8%	13.6	13.83	46%
Tayport – Tentsmuir Coast SSSI	10	0.10	1.0%	9.4	9.50	95%

9.7.75 The results set out in Table 9.23 show that the nutrient nitrogen deposition is below the critical loads at all designated sites except for Barry Links SAC where the critical load is exceeded due to the existing background nitrogen deposition. The nitrogen deposition process contribution at Barry Links SAC is 1.5% of the lower range of the critical load. The process contribution at all the other habitat sites is below 1% of the lower range of the relevant critical loads.

9.7.76 With respect to European sites, a process contribution to acid or nitrogen deposition of more than 1% triggers the need for a Habitat Regulations Assessment. In this case the process contribution to acid and nutrient nitrogen deposition at Barry Links SAC is above this threshold. The significance of the predicted deposition at the SAC is addressed in Chapter 12 Terrestrial Ecology.

Effect of wind turbines on stack emissions

9.7.77 Forth Energy will be submitting a planning application for two wind turbines which will be located to the east of the proposed Dundee Renewable Energy Plant site (Figure 8.1). The turbine hubs are 80 m high and the rotors are 93 m in diameter. The wind turbines are proposed to be sited at approximately 807 m and 1,653 m from the proposed stack location. This is equivalent to 8.7 and 17.9 rotor diameters from the stack, respectively. This section focuses on the closer of the two turbines, as a conservative approach.

9.7.78 An analysis of the prevailing wind conditions was carried out to determine the likelihood of the wind blowing from the stack to the nearest wind turbine and vice versa. Based on the data recorded at Leuchars meteorological station, during the five year period 2005 – 2009, wind blew in the direction from the stack to the turbine approximately 38% of the time (wind directions 235° to 275°) and from the turbine to the stack approximately 4.5% of the time (wind directions 65° to 85°). Based on a year of data from Port of Dundee anemometer, wind blew in the direction from the stack to the turbine approximately 49% of the time (wind directions 235° to 275°) and from the turbine to the stack approximately 8.2% of the time (wind directions 65° to 85°).

9.7.79 As the wind blows from the stack to the turbine for over one third of the time, there is a reasonable concern that turbulence from the rotor may affect the plume dispersion in the vicinity of the turbine. However, at over 800 m from the stack, the plume is likely to have dispersed significantly before reaching the turbine location. The maximum concentrations set out in Table 9.8 and Figures 9.2 to 9.11, indicate that the highest ground level concentrations are experienced within 400 – 500 m of the stack location.

9.7.80 A sensitivity analysis was undertaken to determine if the plume would interact with the nearest wind turbine. Under neutral atmospheric conditions (which occur for approximately 50 – 70% of the time in the UK), the plume centreline is calculated to be at least 10 – 15 m higher than the highest point of the turbine rotors.

9.7.81 Sensitive human receptors are located approximately 660 m downwind of the turbine when the wind is coming from the stack. Any disruption to plume dispersion would be unlikely to have an impact on these sensitive receptors due to the large distances involved.

9.7.82 The situation where the wind blows from the wind turbine to the stack occurs rarely. Under these conditions, there is a concern that turbulent air in the wake of the turbine may affect the plume dispersion at the stack. When designing large wind farms, a distance of 5 to 7 rotor diameters is maintained between rows in a downwind direction, to avoid turbulence affecting the yield of the turbines in the second or third row[34]. At 8.7 rotor diameters away (807 m), any turbulence is likely to have reduced to a small level before the air reaches the stack.

9.7.83 A review of similar wind turbines in the Dundee area was carried out to confirm this. There are two wind turbines at the nearby Michelin Tyre facility, on Baldovie Road. The stack at that facility is located approximately 162 m (2.3 rotor diameters) from the nearest wind turbine. The adjacent Dundee Energy Recycling Ltd. Energy from Waste facility main plant and odour control stacks are located approximately 180 m (2.5 rotor diameters) and 271 m (3.8 rotor diameters) from the nearest wind turbine, respectively. On this basis, it is unlikely that the proposed wind turbines which are located at 8.7 and 17.8 rotor diameters from the proposed renewable energy plant stack will cause any significant issues with dispersion of emissions from the stack.

9.7.84 Based on the above analysis, it is concluded that the wind turbines will not have a significant effect on the dispersion of emissions from the proposed stack and will not lead to increased ground level concentrations at relevant receptor locations.

Sea Haar

9.7.85 The east coast of Scotland experiences a meteorological phenomenon known as Haar. Haar is a local name for a sea fog formation commonly occurring between April and September on or near the east coast or the Northern Isles.

9.7.86 Haar is formed when a warm parcel of air passes over the cold North Sea. The warm air at the bottom of the parcel is cooled by the cold air beneath it below its "dew-point", when the moisture within the parcel condenses. Under certain conditions, the air parcel is blown onshore and the condensate can be spread upwards to form the Haar[35].

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[34] Vestas, General Specification, V90 - 3.0 MW , 50 Hz, OptiSpeedTM Wind Turbine, Item no.: 950011.R7, 2005

[35] J.M Lewis, D Koracin, K.T Redmond, Fog Research in the United Kingdom and the United States, A Historical Essay Including Outlook, The Bulletin of the American Meteorological Society, Vol 85, Issue 3, p395 – 408, March 2004.

9.7.87 Ground level pollutant concentrations are often highest during warmer sunny conditions, when solar radiation more easily penetrates the atmosphere, resulting in increased atmospheric turbulence. Under Haar conditions, atmospheric turbulence is often decreased through a reduction in solar energy penetration to the ground, and the resulting cooling of the ground. As a result, ground level pollutant concentrations are predicted to be lower under Haar conditions.

9.7.88 However, more stable atmospheric conditions, coupled with a boundary layer temperature inversion, can reduce the boundary layer mixing height. Under these conditions, vertical mixing and dispersion of the pollutants released from the proposed Renewable Energy Plant stack may be reduced. However, if the stable conditions are such that the temperature inversion occurs at a level below the proposed stack height, this may also reduce the ground level pollutant concentrations.

9.7.89 Cooler conditions during the winter often reduce the likelihood of Haar formation, and so its impacts are less pronounced.

9.7.90 The dispersion modelling assessment for the proposed Renewable Energy Plant at Dundee has been undertaken using meteorological data collected at the Leuchars meteorological station, approximately 10 km southeast of the site. The location of the meteorological station on the east coast of Scotland is known to experience Haar conditions. Therefore, Haar conditions have been taken into account within the modelling assessment through the use of meteorological data recorded at this station. A sensitivity analysis using meteorological data recorded by DCC on Broughty Ferry Road was also included in the assessment and these data would also include Haar conditions.

Cumulative Impacts

9.7.91 As discussed in paragraph 9.4.3, the Nynas facility is located adjacent to the northern boundary of the proposed Renewable Energy Plant. In order to provide a conservative assessment, the predicted emissions from this facility have been modelled along with the proposed Renewable Energy Plant.

9.7.92 Using the same ADMS model, the predicted process contributions from the combined emissions have been combined with the baseline air quality levels. The baseline concentrations utilised in the assessment, particularly for PM_{10}, $PM_{2.5}$ and sulphur dioxide, already contain a contribution from the Nynas facility and therefore the results are likely to be an overestimate of the cumulative impact in practice.

9.7.93 The results of this modelling are presented in Table 9.24. These show the maximum predicted cumulative process contributions in any of the five years of modelling (2005-2009).

Table 9.24: Cumulative Atmospheric Dispersion Modelling Results

Pollutant	Averaging period	EQS ($\mu g/m^3$)	Adopted Ambient Air Quality Level ($\mu g/m^3$)	PC ($\mu g/m^3$)	PEC ($\mu g/m^3$)	PC / EQS (%)	PEC / EQS (%)
Nitrogen dioxide	Annual mean	40	20.7	7.6	28.3	19%	71%
	1 hour mean (99.8th %ile)	200	41.4	26.6	68.0	13%	34%
PM_{10}	Annual mean	18	14.2	1.0	15.2	5.5%	85%
	24 hour mean (98.08th %ile) (method 1)	50	34.5	2.0	36.5	4%	73%
	24 hour mean (98.08th %ile) (method 2)	50	28.5	3.5	32.0	7%	64%
$PM_{2.5}$	Annual mean	25	9.4	1.0	10.4	4%	87%
Sulphur dioxide	15 minute mean (99.9th %ile) (method 1)	266	10.2	162.1	172.2	61%	65%
	1 hour mean (99.9th %ile) (method 2)	266	10.2	205.8	215.9	77%	81%
	1 hour mean (99.73th %ile)	350	10.2	127.8	137.9	37%	39%
	24 hour mean (99.18th %ile)	125	10.2	51.1	61.3	41%	49%

Cumulative Impact Assessment

Nitrogen dioxide

9.7.94 With reference to the nitrogen dioxide results presented within Table 9.23, operation of the Renewable Energy Plant and the Nynas facility is predicted to contribute at most 19% of the annual mean nitrogen dioxide objective and 13% of the 99.8th percentile of hourly mean nitrogen dioxide objective. Combining the cumulative nitrogen dioxide PC with the adopted ambient air quality level, the PEC is calculated to be 71% of the annual mean nitrogen dioxide objective, and 34% of the 99.8th percentile of hourly mean nitrogen dioxide objective. As these PECs do not exceed or approach the AQO for nitrogen dioxide, the predicted impact of the Renewable Energy Plant in combination with the Nynas facility on ambient nitrogen dioxide concentrations is considered not significant.

PM_{10}

9.7.95 Table 9.23 presents the results of the dispersion modelling with respect to PM_{10}. Operation of the Renewable Energy Plant and the Nynas facility is predicted to contribute only 5.5% of the annual mean PM_{10} objective and 7% of the 98.1st percentile of the daily mean PM_{10} objective. Combining the cumulative PM_{10} PC with the relevant ambient air quality levels, the PEC is calculated to be 85% of the annual mean PM_{10} objective, and 73% of the 98.1st percentile of the daily mean PM_{10} objective. As these PECs do not exceed the AQO for PM_{10}, the predicted impact of the Renewable Energy Plant in combination with the Nynas facility on ambient PM_{10} concentrations is considered not significant.

$PM_{2.5}$

9.7.96 As discussed above there are no statutory ambient air quality limits for $PM_{2.5}$ (particles of 2.5 µm and less) at present, however, future targets are included as part of the National Air Quality Strategy. Table 9.23 shows that the maximum cumulative predicted annual average PC is 1.0 $\mu g/m^3$, which is 4% of the AQO for $PM_{2.5}$.

With an assumed background of 9.4 µg/m^3, the maximum PEC of $PM_{2.5}$ is 10.4 µg/m^3, 87% of the AQO for $PM_{2.5}$ and therefore, even with the conservative assumption that all particulate matter is $PM_{2.5}$, the cumulative PEC would be within the AQO and considered not significant.

Sulphur dioxide

9.7.97 With reference to the sulphur dioxide results presented within Table 9.23, operation of the Renewable Energy Plant and the Nynas facility is predicted to contribute a maximum of 77% to the 15-minute mean AQO, resulting in a PEC which is 81% of the AQO when added to the adopted baseline level. PCs to the hourly and daily mean AQOs are predicted to be 37% and 41% respectively, resulting in cumulative PECs of 39% and 49% of the respective AQOs. As these PECs do not exceed the AQOs for sulphur dioxide, the predicted impact of the Renewable Energy Plant in combination with the Nynas facility on ambient sulphur dioxide concentrations is considered not significant. The results indicate that the PC due to Nynas emissions are significantly higher than the proposed Renewable Energy Plant.

Plume Visibility Results

9.7.98 The Renewable Energy Plant has the potential to release a visible plume of water vapour from the stack. Under the meteorological conditions in the UK, such plumes are rare, only becoming visible when the water content of the air exceeds its holding capacity at that particular temperature. Existing thermal power stations in the UK (firing on gas, coal or oil) inherently produce few visible plumes however a biomass fired plant is more likely to produce a visible water vapour plume due to the composition and potentially higher moisture content of the fuel.

9.7.99 Table 9.25 presents the results of the plume visibility modelling undertaken using the emission data provided within Table 9.7 and meteorological data from RAF Leuchars covering the years 2005 to 2009.

Table 9.25: Plume Visibility Modelling Results

Parameter	Year					
	2005	2006	2007	2008	2009	Average
Plumes visible during daylight hours which extend outside the site boundary	80%	78%	79%	76%	79%	79%

9.7.100 The results set out in Table 9.25, indicate that the visible plume length extends beyond the site boundary during daylight hours on average 79% of the daylight hours in the year. This would be considered a high impact according to the SEPA guidance. The average plume length of the visible plumes during daylight hours is forecast to be 94 m. The relatively high occurrence of visible plumes during daylight hours is due to a number of factors as set out below:

- The air quality assessment was undertaken for the scenario where efficiency of the plant is maximised by recovering heat from the flue gas. This results in a lower flue gas temperature and increases the likelihood of the plume becoming visible. Less efficient combustion plant utilising the same fuel and where the flue gas temperatures are higher would have a lower occurrence of visible plumes;
- The air quality assessment was undertaken for the scenario which utilises 100% virgin wood chip (Scenario 2). The moisture content of the virgin wood chip is relatively high (up to approximately 40%) and is higher than other solid fuels such as coal. Non-virgin biomass materials and wood pellet has inherently lower moisture content and the predicted visible plumes would be less than presented above; and
- The eastern site boundary is less than 10m from the stack location and is downwind of the prevailing wind direction, thus increasing the likelihood that any visible plumes will extend beyond the boundary.

9.7.101 Overall, this is considered to potentially be a high impact. However, the land use downwind of the prevailing wind direction from the eastern site boundary is mainly industrial/commercial and the sensitivity to visible plumes would be less than more sensitive uses such as residential housing. A figure showing the distribution of the visible plumes during daylight hours is provided in Figure 9.12.

Decommissioning

9.7.102 As with the construction stage, the potential for dust to be generated during the decommissioning phase will be short-term and temporary in nature. Receptors downwind of the predominant wind direction (that is wind blowing from the west to south-west of the Renewable Energy Plant) would typically be the most susceptible to dust emissions. As discussed earlier, there are no receptors in this direction from the site. The nearest dwellings are approximately 300 m from the northern site boundary and 75 m from the western site boundary.

9.7.103 Given this fact, and with the use of the mitigation measures outlined above, it is predicted that the impacts of dust generation on receptors in the area will be minimised. Impacts due to dust generated from the proposed decommissioning of the Renewable Energy Plant are predicted to be negligible.

9.8 Summary and Conclusions

9.8.1 This chapter has addressed the potential for long-term impact on air quality arising from emissions of nitrogen dioxide, carbon monoxide, particulate matter (primarily PM_{10} and $PM_{2.5}$) and sulphur dioxide, as well as some trace species from the proposed development, and the shorter term impacts associated with emissions for particulate matter and traffic emissions from its construction and decommissioning. The predicted impacts have been assessed against the current legislative objectives.

9.8.2 The air quality impact assessment identified the relevant legislative air quality objectives and Environmental Assessment Levels for the protection of air quality for the above species and reviewed the existing ambient air quality within the area. A number of mitigation measures have been identified to reduce or remove potential impacts during the construction and operational phases; including suitable dust control and monitoring, the selection of efficient combustion technology, carefully selected stack height and the continuous monitoring of stack emissions.

9.8.3 With the use of the mitigation measures outlined in this chapter, the impacts of dust generation on sensitive receptors in the area will be minimised and no significant impact is predicted during the construction or decommissioning phases.

9.8.4 The potential impact due to road traffic emissions during the construction and operational phases is forecast to be insignificant.

9.8.5 Several conservative assumptions were adopted throughout the modelling assessment to ensure that the model predictions would likely be over-estimates rather than under-estimates, these are summarised below:

- It was assumed that the proposed Dundee Renewable Energy plant will operate continuously at maximum load. In practice, the plant will have periods of shut-down and maintenance.
- The study is based on emissions being continuously at the emission limits specified;
- The highest predicted concentration at any off-site location on land in Dundee was used in the assessment of environmental effects. Concentrations at other locations will be less than the maximum values presented;
- The highest predicted concentrations obtained using any of the five different years of met data have been used in this assessment. During a typical year the ground level concentrations are likely to be lower;
- It was assumed that 70% of oxides of nitrogen emitted from the plant will be converted to nitrogen dioxide at ground level in the vicinity of the plant for determination of the annual mean. It was assumed that 35%

of oxides of nitrogen will be converted to nitrogen dioxide for determination of the short term concentrations. The actual conversion to nitrogen dioxide is likely to be less than this;

- It was assumed that 100% of the particulate matter emitted from the plant is in the PM_{10} size fraction. The actual proportion will be less than 100%;
- It was assumed that 100% of the particulate matter emitted from the plant is in the $PM_{2.5}$ size fraction. The actual proportion will be less than 100%. Other studies submitted to SEPA have used a value of 33%;
- Use of Leuchars wind speed and direction data for the main dispersion modelling assessment provided considerably higher predicted annual mean concentrations than the locally measured data recorded at Broughty Ferry Road.

9.8.6 Even with the use of the above conservative assumptions, the dispersion modelling results indicated that no air quality objectives or Environmental Assessment Levels specified for the protection of human health were forecast to be exceeded due to emissions from the Renewable Energy Plant during the operational phase.

9.8.7 The calculated maximum process contributions to nitrogen and acid deposition at a number of designated habitat sites have been calculated for the Renewable Energy Plant. The assessment, using a number of conservative assumptions, found that the maximum process contribution to acid and nitrogen would be more than 1% of the relevant critical loads at Barry Links SAC. This will therefore trigger the need for a Habitat Regulations Appropriate Assessment[36] with respect to Barry Links and the significance of the predicted deposition is addressed in Chapter 12 Terrestrial Ecology. An Appropriate Assessment would be carried out to ensure that there would not be a significant adverse effect on the integrity of the European site in light of its conservation objectives.

9.8.8 A number of sensitivity analyses were carried out to ensure the dispersion modelling methodology and predictions were robust.

9.8.9 The visible plume will extend beyond the site boundary during daylight hours on average 79% of the year. This is due to a number of factors, including that the plant will be designed to be as energy efficient as possible.

9.8.10 The residual impact on air quality due to the construction, operation and decommissioning of the Renewable Energy Plant has been assessed and it is concluded that the plant will not have a significant impact with respect to all pollutants. The predicted environmental concentration (i.e. the process contribution plus background levels) are within the relevant air quality objectives and environmental assessment levels for each pollutant considered. Therefore, no significant residual effect with respect to local air quality is predicted.

[36] Environment Agency, 2007. EU Habitats and Birds Directive Handbook

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Abbreviations

The following is a list of abbreviations adopted in Chapter 9 Air Quality.

%	Per cent
°	Degrees
°C	Degrees Celsius
µg	Microgram(s)
ADMS	Atmospheric Dispersion Modelling System
APIS	Air Pollution Information System
AQG	Air quality guideline
AQMA	Air Quality Management Area
AQO	Air quality objective
AQS	Air quality strategy
AURN	Automatic Urban and Rural Network
BaP	Benzo(a)pyrene
CEH	Centre for Ecology and Hydrology
CL	Critical load
CO	Carbon monoxide
Co	Cobalt
Cr	Chromium
Cu	Copper
DCC	Dundee City Council
EAL	Environmental Assessment Level
EIA	Environmental Impact Assessment
EPAQS	Expert panel on air quality standards
ES	Environmental Statement
EU	European Union
FB	Fluidised bed
g/s	Grams per second
ha	Hectare(s)
HCl	Hydrogen chloride
HF	Hydrogen fluoride
Hg	Mercury
HGV	Heavy goods vehicle
K	Kelvins
kg	Kilogram(s)
km	Kilometre(s)
kPa	Kilopascal(s)
LAQM	Local Air Quality Management

m	Metre(s)
m/s	Metres per second
m3/s	Cubic metres per second
MEI	Maximum exposed individual
mg	Milligram(s)
mg/Nm3	Milligram per normal cubic metre
Mn	Manganese
mph	Miles per hour
MWth	Megawatts thermal
N	Nitrogen
ng	Nanograms
ng/s	Nanograms per second
NH3	Ammonia
Nm3	A cubic metre of gas at the quoted standard reference conditions
NOx	Oxides of nitrogen
PAHs	Poly aromatic hydrocarbons
PC	Process contribution
PEC	Predicted environmental concentration
PM10	Particulate matter less than 10 microns in aerodynamic diameter
PM2.5	Particulate matter less than 2.5 microns in aerodynamic diameter
PPC	Pollution Prevention and Control
RAF	Royal Air Force
SAC	Special Area of Conservation
Sb	Antimony
SEPA	Scottish Environmental Protection
SNCR	Selective Non Catalytic Reduction
SO2	Sulphur dioxide
SPA	Special Protection Area
SSSI	Sites of Special Scientific Interest
TDI	Tolerable daily intake
TEOM	Tapered element oscillating micro-balance
TEQ	Toxic equivalent
TG	Technical guidance
Tl	Thallium
UK	United Kingdom
V	Vanadium
v/v	Volume in volume
VOCs	Volatile Organic Compounds
WHO	World Health Organisation