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Office of Environmental Enforcement
South/South West Region
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Inniscarra
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IPPC Licnece Reg. No.: P0395-02

Your ref.: M678/NC05SMcD.doc

Date: February 1, 2007

Dear Ms. McDonnell,

As you are aware, Wyeth Nutritionals Ireland (WNI) have experienced difficulties in achieving and maintaining their current NOx emission limit values (ELVs) from their boilers since they were converted to operate using natural gas instead of heavy fuel oil.

To date, a great deal of work has been done in conjunction with the equipment manufacturers with many hours spent carrying out adjustments and measurements to try to reduce the concentrations of NOx in emissions from the boilers. Unfortunately the effort has resulted in the conclusion by all, that emissions below the current ELVs are not achievable on a continuous basis.

Comparing the NOx ELVs for boiler emissions in WNI's IPPC licence with the ELVs for NOx from boilers in the licences of other similar operations shows the limits for WNI to be significantly lower.

When the licence review application submitted in 2003 was examined, it revealed that the limits were proposed in an air dispersion model report submitted as part of the application. However, it appears that the 2003 report overestimated the worst-case ground level impacts with regard to NOx by assuming that all NOx released was in the form of NO_2 and predicted ground level concentrations based on dispersion of this NO_2.

In order to more accurately assess the impacts from the use of natural gas on site, URS was recently commissioned by WNI to re-examine the air

URS

Wyeth Nutritionals Ireland

Dispersion Modelling: Evaluation of Emission Limits for Natural Gas and Class D oil (<0.2%S)

24 January 2007
Final

Issue No 4
45078682/45078692

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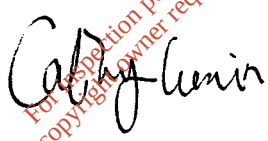
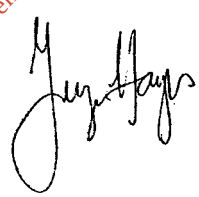
Prepared by	Cathy Cronin & Klara Kovacic		24/01/2007	Environmental Scientist
Checked and Approved by	Fergus Hayes		24/01/2007	Operations Director

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1. INTRODUCTION

1.1. Background

As part of the IPPC licence review process in 2003 to accommodate the installation of a new CHP unit, dispersion modelling[1] was completed to determine the air quality impacts of the new plant and two existing steam raising boilers on the Wyeth site. URS understands that one of the consequences of this exercise was the proposing of lower emission limits values (ELVs) for NO_x from the two existing boilers (Boilers 1 & 3) to ensure that there were no off-site exceedances of the NO_2 air quality standards defined in SI 271 (2002).

In the previous licence (Reg. No 395), NOx emission limits for the steam raising boilers were set at 750 mg/Nm^3 (as NO_2) up to a maximum mass flow rate of 40 kg/hr.

In the replacement licence (Reg. No P0395-02), the following emissions limits and implied mass flow limits were applied for gas-firing:

Plant	ELV mg/Nm^3 as NO_2	Mass Flow (*note 1*) kg/hr NO_2
CHP	300	18.42
Boiler 1	115	2.83
Boiler 3	115	1.84
Total		23.09

Note 1: for CHP, mass flow calculated by multiplication of ELV for NO2 by maximum licensed flue gas flow rate. For boiler 1 & 3, masses flow calculated from ELV multiplied by maximum flow rate provided by boiler manufacturer.

Since the finalisation of the current licence, site management has undertaken a number of operational and technical measures with the aim of long-term regular compliance with the NOx ELV for the boilers. These measures have not been succesfull and it has been determined that the current boilers cannot meet the 115 mg/Nm^3 ELV.

Therefore URS has been commissioned to re-examine the air quality impacts of NOx from the Wyeth site with a view to proposing appropriate NOx ELVs which:

- are technically achievable;
- do not result in any predicted exceedance of the statutory air quality standards for the NO_2.

[1] Air Dispersion Modelling for Wyeth Nutritional, Enterprise Ireland Environment Unit, April 2003.

Furthermore, the current licence permits the use of Class D gas oil (< 0.2% S) in the following circumstances:

- For the CHP: "during system test or emergency supply and not exceeding 20 hours per annum;
- For the boilers: "as a back-up fuel " and use to be agreed with the Agency.

Additional modelling has been carried out to determine the environmental impact of using Class D oil in both the CHP and the boilers to determine whether, from an air quality perspective, the use of Class D oil should continue to be restricted to emergency use only.

1.2. NOx and NO_2: Convention for Air Dispersion Modelling

The 2003 report assumed that all NOx released was in the form of NO_2 and ground level concentrations were predicted based on dispersion of this NO_2.

However for fossil fuel fired plant, NOx is a mixture of NO and NO_2, with up to 95% of the NOx in the form of NO. Once released from the stack, conversion of NO to NO_2 will take time and is limited by the atmospheric availability of ozone.

The exact rate of conversion of NO to NO_2 in the atmosphere is difficult to predict without good atmospheric ozone data. Consequently, convention in air dispersion modelling in the UK[2] and in Ireland has been to assume a 50% conversion rate for short-term averages, i.e. one-hour averages and 100% conversion for long-term averages.

Therefore, it appears that the 2003 report overestimated the worst-case ground level impacts with regard to NOx and the emission limits applied to Boilers 1 & 3 are unnecessarily conservative.

The current modelling exercise assumes a 50% conversion rate when burning both natural gas and oil.

2. MODEL INPUTS AND OUTPUTS

2.1. The ADMS Dispersion Model

URS has employed the ADMS dispersion model in the assessment. This is an advanced quasi-Gaussian dispersion model developed in the UK by Cambridge Environmental Research Consultants. It is used throughout Europe for dispersion modelling for regulatory purposes and is regularly used by URS Ireland in modelling studies completed for IPPC licensed facilities in Ireland.

[2] Guidance issued by the Air Quality Modelling and Assessment Unit of the Environment Agency

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[2] Guidance issued by the Air Quality Modelling and Assessment Unit of the Environment Agency

2.2. Model Inputs

2.2.1. Meteorological Data

Prevailing weather conditions can have a significant impact on ground level concentrations of compounds released to air from stacks. Wind speed and direction, in particular, impact the location and magnitude of the maximum ground level concentrations.

Meteorological data for the year 2003 from the met station at Shannon Airport was used in the model run.

The required input parameters for the model are:

- Wind speed;
- Wind direction;
- Temperature;
- Cloud cover;
- Month, day and hour data.

URS has completed a number of air dispersion modelling exercises for the Wyeth site using meteorological data from 2001 – 2003. The results have been similar for each year. Therefore, for this exercise, running the model for one years data is sufficient.

2.2.2. Topography

Local topography can have a significant impact on the dispersion of released materials. The ADMS model is capable of including topographical data, if required. There are two parameters which can be employed in the model to describe local topography, as detailed below.

Surface Roughness

This parameter is specified in all modelling assessments. Surface roughness describes the degree of ground turbulence caused by the passage of winds across surface structures. Ground turbulence is greater in urban areas than in rural areas, for example, due to the presence of tall buildings.

The area immediately surrounding the Wyeth site is relatively rural, with no significant local structures or forestry land. Based on a visit to the site area a surface roughness value of 0.3 metres has been chosen, which is typical for agricultural areas.

Complex Terrain

The presence of steep hills (known as complex terrain) in the vicinity of a site can effect dispersion of emissions. A gradient of 1:10 or greater is normally taken as the criteria for inclusion of terrain in a modelling assessment. Terrain data typically relates to significant

local gradients (i.e. local valleys or steep hills) rather than small local gradients on the site itself. URS completed a review of Ordnance Survey of Ireland maps and also visited the site to assess the regional terrain profile. Based on this review no requirement for inclusion of terrain data was identified, with no regional slopes greater than 1:10 identified in the expected area of impact of the stack releases from the site.

2.2.3. Building Effects and Stack Parameters

Site buildings can have a significant impact on the dispersion of point source emissions. Buildings impact the passage of wind across the site, with the potential for these disturbances to impact the plume released from a given stack, particularly if the building height is sufficiently elevated to result in disturbances at the height of the released plume.

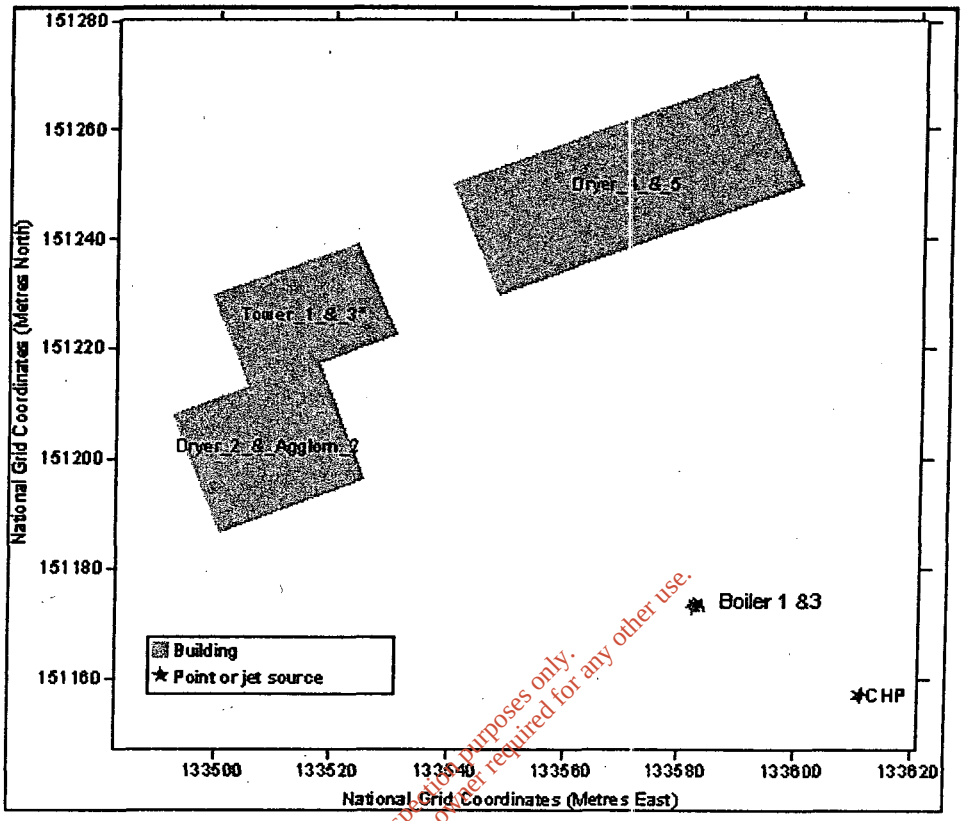
Typically buildings are considered to have an impact on dispersion if the building height is greater than 40 % of the stack height (i.e. buildings above 16 metres in height in the case of the Wyeth CHP and boiler stacks).

Based on this criteria there are a number of significant buildings at the Wyeth site, with the dimensions of the buildings being detailed in Table 2.1. The layout of the buildings as input to the model is illustrated in Figure 2.1.

Table 2.1: Dimensions of buildings input into the modelling assessment (adjacent buildings assumed as single building for modelling purposes)

Building	Height (m)	Length (m)	Width (m)
Dryer 1/3	33	27	18
Dryer 2/Agglomerator 2	29.5	27	23
Dryer 4/5	35	56	22

Figure 2.1:- ADMS visualisation of sites buildings included in the assessment (and also the stack locations)



The model requires detailed information on the stack dimensions and outputs in order to predict ground level concentrations of the released compounds (in this case NO_X). Stack information and emissions data are presented in Tables 2.2 and 2.3.

Table 2.2: Stack parameters and emissions data employed in the modelling assessment.

Stack	Height (metres)	Diameter (metres)
CHP	40	1.48
Boiler 1	40	1
Boiler 3	40	1

Table 2.3: Stack emissions parameters for Scenario 1 (current ELVs)

Plant	Flue Gas Flow Nm^3/hr *note 1*	Release Temp °C	Exit velocity m/s *note 2*	NOx as NO_2 g/s *note 3*
CHP	61,420	130	14.6	5.11
Boiler 1	24,596	220	15.6	0.79
Boiler 3	15,987	220	10.2	0.51

Note 1: *flue gas flow calculated from 100% load fuel usage and expressed at standardised reporting conditions for NOx ELV, i.e. dry gas, 101.3 kPa, 273 K and referenced to 15% oxygen for the CHP and 3 % oxygen for the boilers;*

Note 2: *exit velocity calculated from flue gas flow rates converted back to stack conditions and the stack diameters.*

Note 3: *NOx emission rates calculated from ELVs in the licence multiplied by the flue gas flows expressed at standardised conditions.*

2.3. Modelled Scenarios

Two scenarios were modelled, i.e.

Scenario 1: CHP plant Boiler 1 and Boiler 3 operating continuously at full load on natural gas for the full year at current ELVs

Scenario 2: CHP Plant, Boiler 1 & 3 running on Class D oil (<0.2%S)

The first scenario was run to determine the predicted off-site impacts at current ELVs when treating NOX conversion in line with convention. This information is then used to propose revised ELVs for NOx which are achievable and which do not give rise to any exceedance of the statutory air quality limit.

The second scenario was run to assess the impact of running the CHP Plant, Boiler 1 & 3 on Class D oil (<0.2%S) to establish whether, from an air quality perspective, restriction of the use of this fuel,as described in the current licence, is justified.

2.4. Air Quality Guideline Values

Statutory ambient air quality limits for NO_2 are included in Statutory Instrument No. 271 of 2002 – Air Quality Standards Regulations 2002. Details of the applicable limits are specified in Table 2.4.

Table 2.4: Ambient air quality limit values for NO_2 as specified in SI No. 271 of 2002

Parameter	Specified for	Averaging Period	Criteria ($\mu g/m^3$)
SO_2	Protection of human health	1 hour	350, not to be exceeded more than 24 times per annum (99.73 percentile)
SO_2	Protection of human health	1 hour	125, not to be exceeded more than 3 times per annum (99.18 percentile)
NO_2^A	Protection of human health	1 hour	200, not to exceeded more than 18 times per annum (99.79^{th} percentile)
NO_2^B	Protection of human health	Calendar year	40

Notes:
A – Margin of tolerance allowed, hence limit in 2005 is 250 $\mu g/m^3$, reducing by 10 $\mu g/m^3$ each year to reach 200 $\mu g/m^3$ on January 1st 2010;

B - Margin of tolerance allowed, hence limit in 2005 is 50 $\mu g/m^3$, reducing by 2 $\mu g/m^3$ each year to reach 40 $\mu g/m^3$ on January 1st 2010.

3. RESULTS AND DISCUSSION

3.1. Scenario 1

Results are presented in tabular format below assuming a 50% conversion rate for short-term average and 100% for the annual average. Results are the predicted maximum ground level concentrations.

Table 3.1: Maximum predicted ground level concentrations in $\mu g/m^3$.

Parameter	Criteria SI 271 Limits Values	Scenario 1: CHP, Boiler 1 & 3 operating continuously on natural gas for the full year at current ELVs
Annual Average NO_2 $\mu g/m^3$	**40**	6.7
99.79^{th} percentile, one-hour averages NO_2, $\mu g/m^3$	**200**	51.9

For Scenario 1, the results indicate that worst-case ground level impacts for NO_2 are well within the statutory limit values assuming that the CHP and both boilers operate at full load for a full year at the current ELVs using natural gas.

Based on the above analysis it is possible to predict the maximum NOx ELV, which can be safely accommodated for Boiler 1 and 3 while still remaining within the statutory limits at all off-site points. This figure is in excess of 700 mg/Nm^3 at 3% oxygen, dry gas 273 K and 101.3 kPa.

Information supplied by the burner manufacturer[3] indicates that NOx (expressed as NO_2) in the range 140 – 160 mg/Nm3 are achievable when firing on natural gas and 200 – 250 mg/Nm^3 when burning gas oil.

Therefore a reasonable limit value for gas or gas-oil firing should be 300 mg/Nm^3 as NO_2.

3.2. Scenario 2

Scenario 1 results support a revision to the NOx emission limit values. Following on from this, URS has run Scenario 2 to assess the impact of running the CHP Plant, Boiler 1 & Boiler 3 at these revised emission limit values and using Class D oil (<0.2%S) at full load for a year.

The following input data was used in this scenario.

[3] Email from Saake to Wyeth Nutritionals December 1st 2006

Table 3.2: Stack emissions parameters for Scenario 2.

Plant	Flue Gas Flow Nm^3/hr *note 1*	Release Temp °C	NO_x as NO_2 g/s *note 2*	SO_2 g/s *note 2*
CHP	61,420	130	7.67	2.6
Boiler 1	24,596	220	2.22	2.35
Boiler 3	15,987	220	1.46	1.53

Note 1: Flue gas flow calculated from 100% fuel usage and expressed at standardised reporting conditions for the SO_2 and NO_x ELVs, i.e. dry gas, 101.3 kPa, 273 K and referenced to 15% oxygen for the CHP and 3 % oxygen for the boilers.

Note 2: Emission rates calculated from flue gas flows and for SO_2: from S content of the fuel and for NOx: based on 450 mg/Nm^3 for the CHP and 300 mg/Nm^3 for the boilers. .

The maximum predicted ground level concentration results from this assessment are all well within the statutory air quality limits. Table 3.3 below outlines these results.

Table 3.3: Maximum predicted ground level concentrations (µg/m^3).

Parameter	Criteria	Scenario 2: CHP, Boiler 1 & 3 running at revised ELVs using Class D oil (<0.2%S) at full load for a year.
Annual Average NO_2	40	10
99.79th percentile, one-hour averages NO_2	200	127
Annual average SO_2	20	8.40
99.73th percentile one hour averages SO_2	350	151
99.18th percentile one hour averages SO_2	125	63

The EPA carry out monitoring of SO_2 at a monitoring station in Askeaton, with data being available for 2001 and 2002. The annual average SO_2 concentration for both these years is reported at 8 µg/m^3 and 9 µg/m^3, respectively, indicating relatively consistent annual average concentrations for SO_2 in the area of the Wyeth site. Again, the emissions from the Wyeth site are likely to have had some impact on the measured concentrations, so they can not be considered to be true background concentrations (i.e. without any impact

from site emissions), however for the purposes of the assessment an annual average concentration of 9 µg/m^3 is considered to be a suitably conservative value.

If this assumed value is added to the maximum predicted ground level concentration for the annual average SO_2, the annual average is within the statutory air quality limit. It must be noted that the modelling assessment is conservative predicting maximum ground level concentrations for the CHP, Boiler 1 & 3 at full load for a full year. In reality operations at the site would not require all three running at full load for the year.

3.3. Conclusions

The current NOx ELVs for Boiler 1 and 3 at 115 mg/Nm^3 are unnecessarily conservative from an air quality perspective.

The current boiler/burner arrangement cannot achieve the current ELVs.

Air dispersion modelling completed and reported upon in this document, predicts minimum air quality impacts at a NO_X ELV of 300 mg/Nm^3 for Boilers 1 & 3 and the burner manufacturer has indicated that compliance with this ELV is possible for both natural gas and Class D oil usage.

Air dispersion modelling of emission from the CHP and both Boilers 1 & 3 all firing at full load for a full year on natural gas or Class D oil will not result in any theoretical breach of the statutory air quality standards for NO_2 or SO_2, when complying with the following revised ELVs:

Plant	SO_2	NO_x (as NO_2)
CHP	155	300/450
Boiler 1	340	300
Boiler 3	340	300

Note:

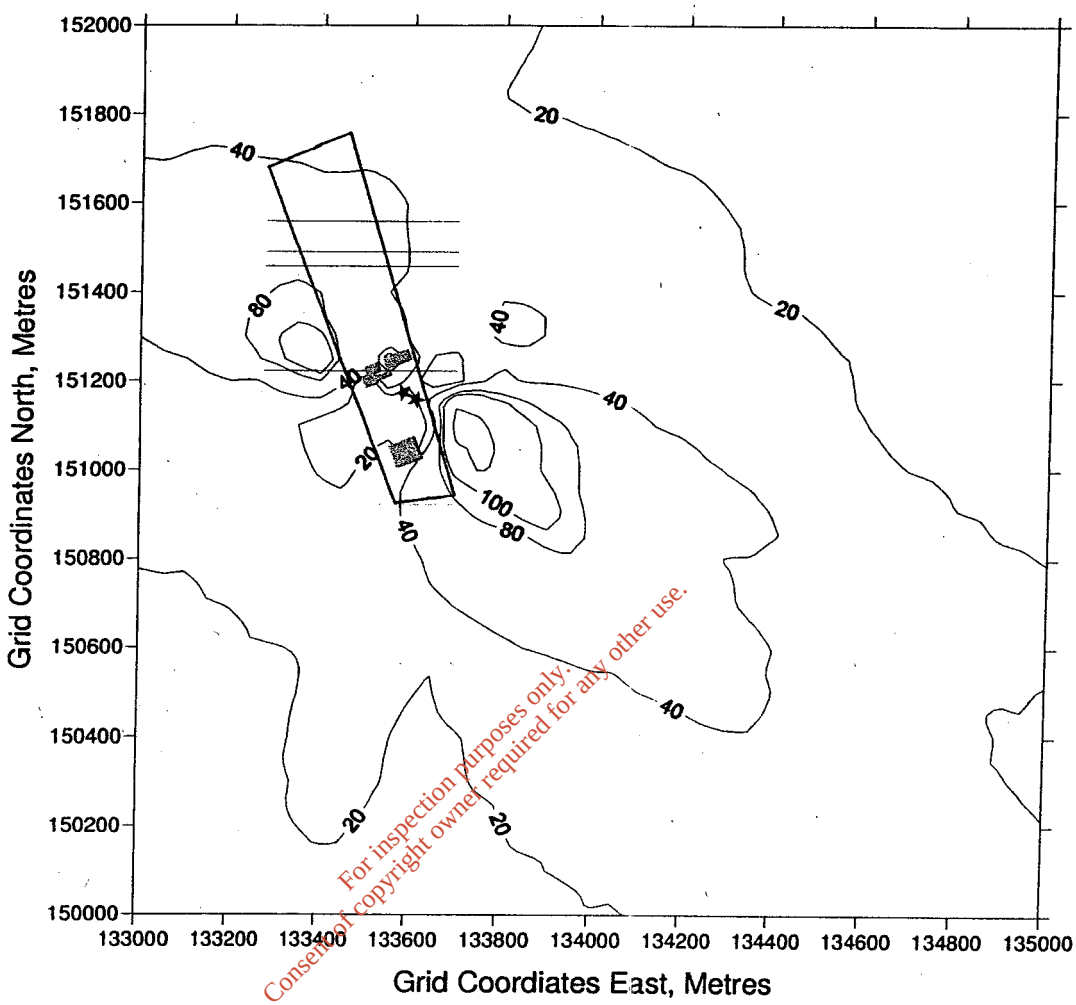
For CHP concentrations given in mg/Nm3, dry gas 101.3 kPA, 273 K corrected to 15% O_2. Higher NOx figure applies to Class D oil usage

For Boiler, concentrations given in mg/Nm3 dry gas, 101.3 kPA, 273 K and corrected to 3 % O_2

It must also be noted that the modelling assessment is conservative, modelling CHP and Boiler 1 and Boiler 3 emissions at full load for a full year. Normal operations at the site require only the CHP to run with the Boiler 1 or Boiler 3 on hot standby or alternatively the running of Boiler 1 with Boiler 3 on hot standby.

This assessment supports the application for revised NOx ELVs as above and the unrestricted use of Class D oil.

Figure 3.1: Scenario 1: CHP and 2 boilers - 99.79th percentile (µg/m3) 1-hour NO_2 concentrations (Site boundary outlined in red. Background concentrations not included.)



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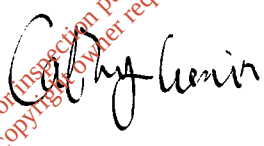
Prepared by	Cathy Cronin & Klara Kovacic		24/01/2007	Environmental Scientist
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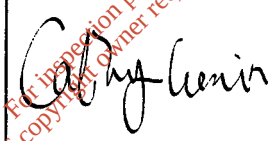
Prepared by	Cathy Cronin & Klara Kovacic		24/01/2007	Environmental Scientist
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1. INTRODUCTION

1.1. Background

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In the previous licence (Reg. No 395), NOx emission limits for the steam raising boilers were set at 750 mg/Nm^3 (as NO_2) up to a maximum mass flow rate of 40 kg/hr.

In the replacement licence (Reg. No P0395-02), the following emissions limits and implied mass flow limits were applied for gas-firing:

Plant	ELV mg/Nm^3 as NO_2	Mass Flow (*note 1*) kg/hr NO_2
CHP	300	18.42
Boiler 1	115	2.83
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Total		23.09

Note 1: for CHP, mass flow calculated by multiplication of ELV for NO2 by maximum licensed flue gas flow rate. For boiler 1 & 3, masses flow calculated from ELV multiplied by maximum flow rate provided by boiler manufacturer.

Since the finalisation of the current licence, site management has undertaken a number of operational and technical measures with the aim of long-term regular compliance with the NOx ELV for the boilers. These measures have not been succesfull and it has been determined that the current boilers cannot meet the 115 mg/Nm^3 ELV.

Therefore URS has been commissioned to re-examine the air quality impacts of NOx from the Wyeth site with a view to proposing appropriate NOx ELVs which:

- are technically achievable;
- do not result in any predicted exceedance of the statutory air quality standards for the NO_2

[1] Air Dispersion Modelling for Wyeth Nutritional, Enterprise Ireland Environment Unit, April 2003.

Furthermore, the current licence permits the use of Class D gas oil (< 0.2% S) in the following circumstances:

- For the CHP: "during system test or emergency supply and not exceeding 20 hours per annum;
- For the boilers: "as a back-up fuel " and use to be agreed with the Agency.

Additional modelling has been carried out to determine the environmental impact of using Class D oil in both the CHP and the boilers to determine whether, from an air quality perspective, the use of Class D oil should continue to be restricted to emergency use only.

1.2. NOx and NO_2: Convention for Air Dispersion Modelling

The 2003 report assumed that all NOx released was in the form of NO_2 and ground level concentrations were predicted based on dispersion of this NO_2.

However for fossil fuel fired plant, NOx is a mixture of NO and NO_2, with up to 95% of the NOx in the form of NO. Once released from the stack, conversion of NO to NO_2 will take time and is limited by the atmospheric availability of ozone.

The exact rate of conversion of NO to NO_2 in the atmosphere is difficult to predict without good atmospheric ozone data. Consequently, convention in air dispersion modelling in the UK[2] and in Ireland has been to assume a 50% conversion rate for short-term averages, i.e. one-hour averages and 100% conversion for long-term averages.

Therefore, it appears that the 2003 report overestimated the worst-case ground level impacts with regard to NOx and the emission limits applied to Boilers 1 & 3 are unnecessarily conservative.

The current modelling exercise assumes a 50% conversion rate when burning both natural gas and oil.

2. MODEL INPUTS AND OUTPUTS

2.1. The ADMS Dispersion Model

URS has employed the ADMS dispersion model in the assessment. This is an advanced quasi-Gaussian dispersion model developed in the UK by Cambridge Environmental Research Consultants. It is used throughout Europe for dispersion modelling for regulatory purposes and is regularly used by URS Ireland in modelling studies completed for IPPC licensed facilities in Ireland.

[2] Guidance issued by the Air Quality Modelling and Assessment Unit of the Environment Agency

2.2. Model Inputs

2.2.1. Meteorological Data

Prevailing weather conditions can have a significant impact on ground level concentrations of compounds released to air from stacks. Wind speed and direction, in particular, impact the location and magnitude of the maximum ground level concentrations.

Meteorological data for the year 2003 from the met station at Shannon Airport was used in the model run.

The required input parameters for the model are:

- Wind speed;
- Wind direction;
- Temperature;
- Cloud cover;
- Month, day and hour data.

URS has completed a number of air dispersion modelling exercises for the Wyeth site using meteorological data from 2001 – 2003. The results have been similar for each year. Therefore, for this exercise, running the model for one-years data is sufficient.

2.2.2. Topography

Local topography can have a significant impact on the dispersion of released materials. The ADMS model is capable of including topographical data, if required. There are two parameters which can be employed in the model to describe local topography, as detailed below.

Surface Roughness

This parameter is specified in all modelling assessments. Surface roughness describes the degree of ground turbulence caused by the passage of winds across surface structures. Ground turbulence is greater in urban areas than in rural areas, for example, due to the presence of tall buildings.

The area immediately surrounding the Wyeth site is relatively rural, with no significant local structures or forestry land. Based on a visit to the site area a surface roughness value of 0.3 metres has been chosen, which is typical for agricultural areas.

Complex Terrain

The presence of steep hills (known as complex terrain) in the vicinity of a site can effect dispersion of emissions. A gradient of 1:10 or greater is normally taken as the criteria for inclusion of terrain in a modelling assessment. Terrain data typically relates to significant

local gradients (i.e. local valleys or steep hills) rather than small local gradients on the site itself. URS completed a review of Ordnance Survey of Ireland maps and also visited the site to assess the regional terrain profile. Based on this review no requirement for inclusion of terrain data was identified, with no regional slopes greater than 1:10 identified in the expected area of impact of the stack releases from the site.

2.2.3. Building Effects and Stack Parameters

Site buildings can have a significant impact on the dispersion of point source emissions. Buildings impact the passage of wind across the site, with the potential for these disturbances to impact the plume released from a given stack, particularly if the building height is sufficiently elevated to result in disturbances at the height of the released plume.

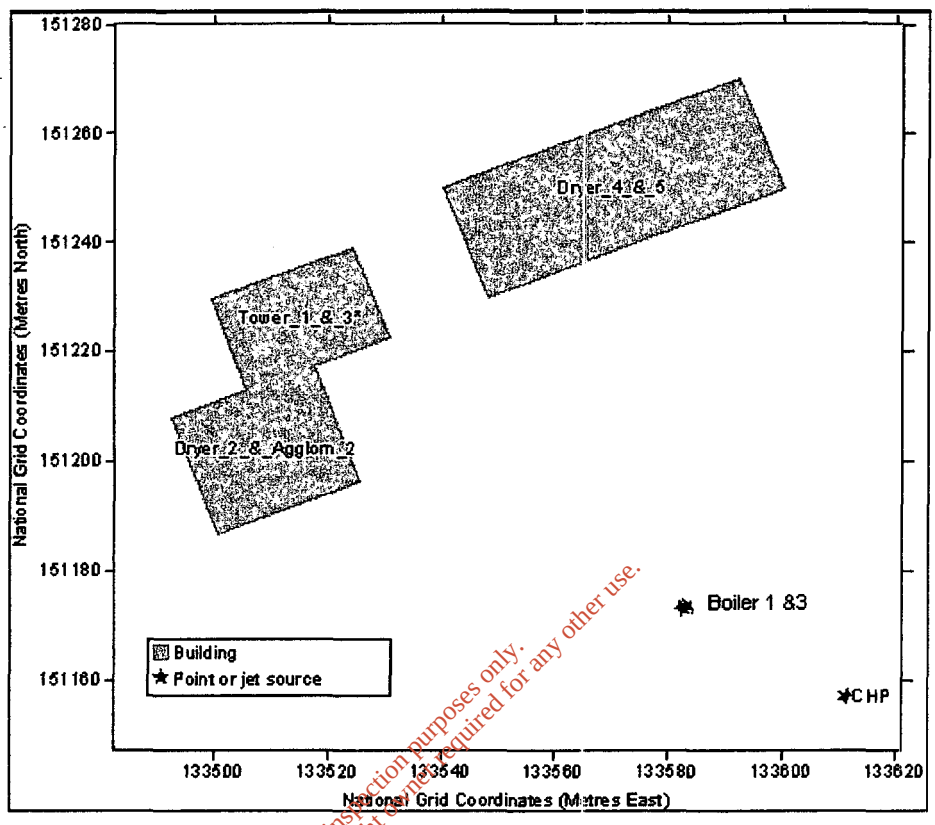
Typically buildings are considered to have an impact on dispersion if the building height is greater than 40 % of the stack height (i.e. buildings above 16 metres in height in the case of the Wyeth CHP and boiler stacks).

Based on this criteria there are a number of significant buildings at the Wyeth site, with the dimensions of the buildings being detailed in Table 2.1. The layout of the buildings as input to the model is illustrated in Figure 2.1.

Table 2.1: Dimensions of buildings input into the modelling assessment (adjacent buildings assumed as single building for modelling purposes)

Building	Height (m)	Length (m)	Width (m)
Dryer 1/3	33	27	18
Dryer 2/Agglomerator 2	29.5	27	23
Dryer 4/5	35	56	22

Figure 2.1: ADMS visualisation of sites buildings included in the assessment (and also the stack locations)



The model requires detailed information on the stack dimensions and outputs in order to predict ground level concentrations of the released compounds (in this case NO_X). Stack information and emissions data are presented in Tables 2.2 and 2.3.

Table 2.2: Stack parameters and emissions data employed in the modelling assessment.

Stack	Height (metres)	Diameter (metres)
CHP	40	1.48
Boiler 1	40	1
Boiler 3	40	1

Table 2.3: Stack emissions parameters for Scenario 1 (current ELVs)

Plant	Flue Gas Flow Nm^3/hr *note 1*	Release Temp °C	Exit velocity m/s *note 2*	NOx as NO_2 g/s *note 3*
CHP	61,420	130	14.6	5.11
Boiler 1	24,596	220	15.6	0.79
Boiler 3	15,987	220	10.2	0.51

Note 1: *flue gas flow calculated from 100% load fuel usage and expressed at standardised reporting conditions for NOx ELV, i.e. dry gas, 101.3 kPa, 273 K and referenced to 15% oxygen for the CHP and 3 % oxygen for the boilers;*

Note 2: *exit velocity calculated from flue gas flow rates converted back to stack conditions and the stack diameters.*

Note 3: *NOx emission rates calculated from ELVs in the licence multiplied by the flue gas flows expressed at standardised conditions.*

2.3. Modelled Scenarios

Two scenarios were modelled, i.e.

Scenario 1: CHP plant Boiler 1 and Boiler 3 operating continuously at full load on natural gas for the full year at current ELVs

Scenario 2: CHP Plant, Boiler 1 & 3 running on Class D oil (<0.2%S)

The first scenario was run to determine the predicted off-site impacts at current ELVs when treating NOX conversion in line with convention. This information is then used to propose revised ELVs for NOx which are achievable and which do not give rise to any exceedance of the statutory air quality limit.

The second scenario was run to assess the impact of running the CHP Plant, Boiler 1 & 3 on Class D oil (<0.2%S) to establish whether, from an air quality perspective, restriction of the use of this fuel,as described in the current licence, is justified.

2.4. Air Quality Guideline Values

Statutory ambient air quality limits for NO_2 are included in Statutory Instrument No. 271 of 2002 – Air Quality Standards Regulations 2002. Details of the applicable limits are specified in Table 2.4.

Table 2.4: Ambient air quality limit values for NO_2 as specified in SI No. 271 of 2002

Parameter	Specified for	Averaging Period	Criteria ($\mu g/m^3$)
SO_2	Protection of human health	1 hour	350, not to be exceeded more than 24 times per annum (99.73 percentile)
SO_2	Protection of human health	1 hour	125, not to be exceeded more than 3 times per annum (99.18 percentile)
NO_2^A	Protection of human health	1 hour	200, not to exceeded more than 18 times per annum (99.79th percentile)
NO_2^B	Protection of human health	Calendar year	40

Notes:
A – Margin of tolerance allowed, hence limit in 2005 is 250 $\mu g/m^3$, reducing by 10 $\mu g/m^3$ each year to reach 200 $\mu g/m^3$ on January 1st 2010;

B - Margin of tolerance allowed, hence limit in 2005 is 50 $\mu g/m^3$, reducing by 2 $\mu g/m^3$ each year to reach 40 $\mu g/m^3$ on January 1st 2010.

3. RESULTS AND DISCUSSION

3.1. Scenario 1

Results are presented in tabular format below assuming a 50% conversion rate for short-term average and 100% for the annual average. Results are the predicted maximum ground level concentrations.

Table 3.1: Maximum predicted ground level concentrations in $\mu g/m^3$.

Parameter	Criteria SI 271 Limits Values	Scenario 1: CHP, Boiler 1 & 3 operating continuously on natural gas for the full year at current ELVs
Annual Average NO_2 $\mu g/m^3$	**40**	6.7
99.79th percentile, one-hour averages NO_2, $\mu g/m^3$	**200**	51.9

For Scenario 1, the results indicate that worst-case ground level impacts for NO_2 are well within the statutory limit values assuming that the CHP and both boilers operate at full load for a full year at the current ELVs using natural gas.

Based on the above analysis it is possible to predict the maximum NOx ELV, which can be safely accommodated for Boiler 1 and 3 while still remaining within the statutory limits at all off-site points. This figure is in excess of 700 mg/Nm^3 at 3% oxygen, dry gas 273 K and 101.3 kPa.

Information supplied by the burner manufacturer[3] indicates that NOx (expressed as NO_2) in the range 140 – 160 mg/Nm3 are achievable when firing on natural gas and 200 – 250 mg/Nm^3 when burning gas oil.

Therefore a reasonable limit value for gas or gas-oil firing should be 300 mg/Nm^3 as NO_2.

3.2. Scenario 2

Scenario 1 results support a revision to the NOx emission limit values. Following on from this, URS has run Scenario 2 to assess the impact of running the CHP Plant, Boiler 1 & Boiler 3 at these revised emission limit values and using Class D oil (<0.2%S) at full load for a year.

The following input data was used in this scenario.

[3] Email from Saake to Wyeth Nutritionals December 1st 2006

Table 3.2: Stack emissions parameters for Scenario 2.

Plant	Flue Gas Flow Nm^3/hr *note 1*	Release Temp °C	NOx as NO_2 g/s *note 2*	SO_2 g/s *note 2*
CHP	61,420	130	7.67	2.6
Boiler 1	24,596	220	2.22	2.35
Boiler 3	15,987	220	1.46	1.53

Note 1: Flue gas flow calculated from 100% fuel usage and expressed at standardised reporting conditions for the SO_2 and NO_x ELVs, i.e. dry gas, 101.3 kPa, 273 K and referenced to 15% oxygen for the CHP and 3 % oxygen for the boilers.

Note 2: Emission rates calculated from flue gas flows and for SO_2: from S content of the fuel and for NOx: based on 450 mg/Nm^3 for the CHP and 300 mg/Nm^3 for the boilers. .

The maximum predicted ground level concentration results from this assessment are all well within the statutory air quality limits. Table 3.3 below outlines these results.

Table 3.3: Maximum predicted ground level concentrations (µg/m^3).

Parameter	Criteria	Scenario 2: CHP, Boiler 1 & 3 running at revised ELVs using Class D oil (<0.2%S) at full load for a year.
Annual Average NO_2	**40**	10
99.79th percentile, one-hour averages NO_2	**200**	127
Annual average SO_2	**20**	8.40
99.73th percentile one hour averages SO_2	**350**	151
99.18th percentile one hour averages SO_2	**125**	63

The EPA carry out monitoring of SO_2 at a monitoring station in Askeaton, with data being available for 2001 and 2002. The annual average SO_2 concentration for both these years is reported at 8 µg/m^3 and 9 µg/m^3, respectively, indicating relatively consistent annual average concentrations for SO_2 in the area of the Wyeth site. Again, the emissions from the Wyeth site are likely to have had some impact on the measured concentrations, so they can not be considered to be true background concentrations (i.e. without any impact

from site emissions), however for the purposes of the assessment an annual average concentration of 9 µg/m^3 is considered to be a suitably conservative value.

If this assumed value is added to the maximum predicted ground level concentration for the annual average SO_2, the annual average is within the statutory air quality limit. It must be noted that the modelling assessment is conservative predicting maximum ground level concentrations for the CHP, Boiler 1 & 3 at full load for a full year. In reality operations at the site would not require all three running at full load for the year.

3.3. Conclusions

The current NOx ELVs for Boiler 1 and 3 at 115 mg/Nm^3 are unnecessarily conservative from an air quality perspective.

The current boiler/burner arrangement cannot achieve the current ELVs.

Air dispersion modelling completed and reported upon in this document, predicts minimum air quality impacts at a NO_X ELV of 300 mg/Nm^3 for Boilers 1 & 3 and the burner manufacturer has indicated that compliance with this ELV is possible for both natural gas and Class D oil usage.

Air dispersion modelling of emission from the CHP and both Boilers 1 & 3 all firing at full load for a full year on natural gas or Class D oil will not result in any theoretical breach of the statutory air quality standards for NO_2 or SO_2, when complying with the following revised ELVs:

Plant	SO_2	NO_x (as NO_2)
CHP	155	300/450
Boiler 1	340	300
Boiler 3	340	300

Note:

For CHP concentrations given in mg/Nm3, dry gas 101.3 kPA, 273 K corrected to 15% O_2. Higher NOx figure applies to Class D oil usage

For Boiler, concentrations given in mg/Nm3 dry gas, 101.3 kPA, 273 K and corrected to 3 % O_2

It must also be noted that the modelling assessment is conservative, modelling CHP and Boiler 1 and Boiler 3 emissions at full load for a full year. Normal operations at the site require only the CHP to run with the Boiler 1 or Boiler 3 on hot standby or alternatively the running of Boiler 1 with Boiler 3 on hot standby.

This assessment supports the application for revised NOx ELVs as above and the unrestricted use of Class D oil.

Figure 3.1: Scenario 1: CHP and 2 boilers - 99.79th percentile (µg/m^3) 1-hour NO_2 concentrations (Site boundary outlined in red. Background concentrations not included.)