Review of Air Quality Assessment:

Flexible Generation Facility, Feeder Road, Bristol

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Experts in air quality
management & assessment

Document Control

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1 Introduction

1.1 This note has been prepared by Air Quality Consultants Ltd. on behalf of Residents Against Dirty Energy (RADE). It reviews the updated air quality assessment ('the Assessment') for the proposed Flexible Generation Facility, Feeder Road, St Phillip's March, Bristol, submitted on 02/06/16[1].

1.2 Owing to the timescale for conducting this review, it has not been possible to go through all the other information on the planning portal website or to deal with every aspect of the Assessment in detail. This note thus focuses on what are considered to be the key issues with the Assessment. It focuses on the operational impacts of the proposals on nitrogen dioxide (NO_2) concentrations, since professional experience suggests that these are likely to be the most significant impacts associated with a scheme such as this.

1 http://planningonline.bristol.gov.uk/online-applications/files/117FBAD057D946F40E64E27A894E1D4E/pdf/16_00719_F-AIR_QUALITY_ASSESSMENT_-_MAIN_REPORT-1490166.pdf

2 Model Input Parameters

Emission Rate

2.1 The nitrogen oxides (NOx) emission rate from each generator has been assumed to be 0.51 g/s. The Assessment states that this emission rate was supplied by Progress Group but gives no further details. Diesel generators are usually regulated according to the United States Environmental Protection Agency (USEPA) emissions standards. The latest - and cleanest - standard is termed 'Tier 4'. Tier 4 engines would emit significantly less than 0.51 g/s of NOx, and so it is assumed that the generators conform to the older – and dirtier – 'Tier 3' standard. If that is the case, then it would be usual to model emissions at the emissions limits for these plant, which is 3,500 mg/KWh, or effectively 1.2 g/s (i.e. more than twice the emissions that have been assumed).

2.2 Ideally, the generators should be specified to conform to the latest Tier 4 standard, which would minimise the impacts. If this is not to be the case then continuous monitoring of the emissions should be undertaken to ensure that the generators will emit no more than 0.51 g/s. If NOx emissions exceed 0.51 g/s per generator then the plant should be shut down until this emission rate can be confidently achieved.

Exhaust Velocity

2.3 The modelling has assumed an exit velocity of 59.8 m/s [2]. Even considering the addition of cooling air, this is an extremely high velocity for this type of plant. The authors of this review are not qualified to comment on the technical feasibility of this design, but are nevertheless quite surprised that neither the noise[3], nor the back pressures involved are prohibitive to this design.

2.4 The model results will be very sensitive to this parameter. For example, a basic model run carried out by AQC using the ADMS-5 dispersion model, the Bristol (2010) meteorological dataset, and the same model input parameters presented in the Assessment[4] showed that the contribution of the plant to 99.8th percentile of 1-hour mean NO_2 concentrations at St Philips Marsh Nursery would be predicted to increase by 160% (i.e. it would be 2.6 times the presented value) if the cooling air was removed from the exhaust stream (thus reducing the exit volumes to those achievable by the generators on their own).

2 Which is 134 mph. Across all stacks, this is almost 600 m^3/s (or the volume of an Olympic sized swimming pool being blown out of the stacks every 4 seconds).

3 The noise assessment (http://planningonline.bristol.gov.uk/online-applications/files/7DCD20A1C22234384FB745ED599DB392/pdf/16_00719_F-NOISE_IMPACT_ASSESSMENT-1392680.pdf) does not make specific reference to the 134 mph exhaust jets and appears to consider only noise from the generator engines themselves. It is thus unclear whether the noise from these jets was considered.

4 With the exception of building wake effects or terrain.

2.5 Given that the model results are dependent upon this exit velocity being achieved consistently, it is suggested that continuous monitoring is put in place to ensure the velocity does not drop below 59.8 m/s. If the velocity drops below this rate, it is suggested that the plant should shut down until this rate can be confidently maintained.

Exhaust Temperature

2.6 The temperature of the exhaust gas has been calculated to take account of the combined temperatures of the generator exhaust and the cooling air. It appears that this calculation has been done incorrectly. When calculating a combined temperature of two mixed gas streams, it is necessary to first express both volumes normalised to the same temperature. It appears that this was not done. Based on the information provided in the assessment, AQC has calculated the combined temperature to be 107^{o}C, which is significantly less than the 148^{o}C that has been modelled. The effect of this error will be to over-state the plume buoyancy and thus under-predict the impacts. The Assessment is thus likely to have under-predicted the impacts of the proposed development.

Meteorological Data

2.7 The Assessment began by looking at five years of meteorological data from the Bristol meteorological site. It determined that some of the individual years of data gave higher predictions at some receptors, while others gave higher predictions at other receptors. Rather than taking the more usual, and worst-case, approach of presenting the maximum prediction at any receptor across any year of data, all of the results presented are for a single year of data (2010), since this gave the highest predictions at certain receptors[5]. It is inevitable that using one of the alternative years would give higher predictions at some receptors than those that have been presented. Given that meteorological conditions vary year-on-year, the results for some receptors will not be robust; even if the results for the worst-case receptors are[5].

Assumed Operating Hours

2.8 The model has been run assuming that the plant will not be permitted to operate outside of the hours set out in Table D2 of the Assessment. For example, this means no operation between the hours of 8.30 PM and 7:00 AM between October and February. The potential impacts of operation outside of these periods have not been assessed and so the development should be prohibited from operating outside of these periods. The assumption is also made that the plant would only run for a maximum of 200 hours per year, but as explained in Paragraph 4.5 below, the way in which this was assessed was inappropriate and so this part of the Assessment should be ignored in any event.

5 Ironically, the Assessment discounts any impacts at these particular receptors in any event, since they do not represent relevant exposure to the objective.

3 Modelling Approach

3.1 The Assessment has used the AERMOD dispersion model, which is considered to be suitable. To calculate NO to NO_2 conversion in the plume, the assessment has used the Plume Volume Molar Ratio Method (PVMRM). This method is not often used in the UK since it is usually considered that there are simpler, and more robust, methods. The authors of the Assessment submitted with the application have, separately, carried out a sensitivity test based on using the PVMRM as well as an approach recommended by the UK Environment Agency, and have shown that the PVMRM is worst-case. However, this sensitivity test has been carried out using the estimated biodiesel emissions only. It is unclear why this sensitivity test was not carried out using the same diesel-based emissions as used in the Assessment. The PVMRM will give lower conversion rates at higher predicted concentrations, and so it is possible that, had the sensitivity test been based on the same emissions data as the assessment, it may have shown higher predictions using the UK Environment Agency approach. It is therefore possible that the assessment is not worst case.

Isopleths

3.2 The shapes of the contour isopleths are quite unusual for Bristol meteorological data. The predominant impacts are to the southwest. It would be more usual to see the biggest impacts, even short-term impacts, toward the northeast. Without access to more details on the model setup, it is not possible to see whether this is a genuine affect, or whether it represents an error.

Baseline Concentrations

3.3 It is not clear from the Assessment whether existing baseline levels have been included in the predicted concentrations. Given that there is no mention that baseline concentrations are included, it has been assumed that they have not, and that the numbers presented all relate to the Process Contributions (PCs) alone. A common approach used in the UK when adding baseline values to short-term predictions is to add twice the expected annual mean concentration.

3.4 The Assessment comments that measurements made at the urban background monitoring site at Higham Street will be representative of background concentrations at the site. While this may be true, the impacts of the proposed development cover a large number of roadside locations (and locations which will be influenced by other local emissions) and so existing concentrations at these receptors will be well above background levels.

3.5 Table 6 of the Assessment shows that annual mean nitrogen dioxide concentrations at roadside locations in this area were as high as 55.8 $\mu g/m^3$ in 2014. If twice this value (111.6 $\mu g/m^3$) were added to the short-term PCs that are shown in the report, exceedences of the short-term objective would be predicted over a much larger area[6].

3.6 The tabulated results and contour plots which show the number of hourly mean concentrations in exceedence of 200 μg/m^3 are thus all extremely misleading, since they take no account that a PC of less than 200 μg/m^3 may, when added to the existing concentrations, lead to an exceedence of the 200 μg/m^3 standard[7].

Averaging Periods

3.7 The assessment has focused on short-term impacts, stating that 200 hours of operation per year cannot have significant impacts in relation to annual mean concentrations. This is frequently not true. For example, if a plant were to add 100 μg/m^3 to a receptor for 200 hours, this would result in an increment to annual mean concentrations of 2.3 μg/m^3 (i.e. 100 * 200 / 8760). Given that the predicted 99.8th percentiles of 1-hour mean concentrations are well above 100 μg/m^3 at many receptors, the predicted increments to annual mean concentrations should also have been presented.

4 Interpretation

99.8th Percentiles of 1-hour Mean NO_2 Concentrations

4.1 Figure 6 shows the predicted 99.8th percentile of 1-hour mean NO_2 concentrations, based on the assumption that 18 of the hours of operation would coincide with the 18 hours of worst-case meteorology for each point on the grid (i.e. the impacts at any given point shown in Figure 6 could be experienced even if the plant were only to operate for 18 hours in a year, albeit that the chance of these hours coinciding with the 18 worst-case hours for meteorology is slim). Thus, discounting the comments made above regarding limitations in the model parameters, the predictions in Figure 6 provide a reasonable worst-case set of predicted PCs (i.e. the impacts of the plant on their own). Even without considering existing baseline levels, the area shown in red in Figure 6 (which represents the 200 μg/m^3 contour) is predicted to exceed the 1-hour objective.

4.2 As explained in Paragraph 3.5, in order to predict whether or not the 1-hour mean NO_2 objective would be exceeded, it would be appropriate to add between 45 μg/m^3 and 112 μg/m^3 to these predictions. On this basis, the area exceeding the objective would either (approximately) follow the 140 μg/m^3 contour, or the 80 μg/m^3 contour, depending on the proximity to an existing emission source such as a road. This means that the 1-hour NO_2 objective could be exceeded at St Philips

6 Even if twice the assumed annual mean background concentration (22.6 μg/m^3 x 2 = 45.2 μg/m^3) were added, it would add significantly to the area over which the 1-hour mean objective is predicted to be exceeded.

7 There are also other issues with these results, as explained in Paragraph 4.5.

Marsh Nursery, at the Paintworks development, and across a large part of the area shown in Figure 6 of the Assessment.

4.3 In terms of Table A, total 99.8th percentiles of 1-hour mean concentrations may be estimated by adding either 45 $\mu g/m^3$ or 112 $\mu g/m^3$ (depending upon whether or not the receptor is near to an existing emission source) to all of the receptor-specific predicted 99.8th percentile concentrations. This results in considerably more receptors where exceedences are predicted. St Philips Marsh Nursery is not, however, included as a receptor[8]. Given the sensitivity of this receptor, this is an important omission.

Calculating the Number of Hourly Exceedences of 200 $\mu g/m^3$

4.4 As well as presenting the 99.8th percentiles of 1-hour mean NO_2 concentrations, the Assessment has presented the number of exceedences of 200 $\mu g/m^3$ as a 1-hour mean concentration. This is not usually done for assessments against the UK objectives. The reason for this is that meteorological data usually contain gaps, and 'calm' conditions which cannot be modelled. For example, the 2010 meteorological dataset for Bristol contains 23 hours with no wind data at all, and a further 108 hours of calm conditions which cannot usually be modelled[9]. This makes the predicted number of hours with an exceedence a meaningless statistic, since there may be an additional 131 hours with exceedences which were probably not considered. Thus, the focus should be – as is usually the case with assessments done in the UK – on the 99.8th percentiles of 1-hour mean concentrations.

Scaling to 200 hours

4.5 Even though just 18 hours of operation could, on their own, give rise to the receptor-specific impacts shown in Figure 6, this is quite unlikely. Rather than calculating the probability of exceedences (i.e. how likely it is that meteorological conditions with the potential to give rise to impacts would coincide with the plant operating) the Assessment has taken the approach of simply reducing all of the predicted numbers of hourly exceedences by 94%. This reduction was derived on the basis that the plant will only run for 6% of the assumed model duration (i.e. 200 hours out of 3,607 hours). Given the limitations in calculating the number of hourly exceedences, this is not appropriate. In any event, it would not provide a reasonable worst-case assessment. This approach is considered to be an over-simplification which will present an optimistic picture of the impacts of the facility. A more robust, probability-based, assessment has not been carried out.

4.6 For the reasons given above, it is suggested that Figures 8 and 12 of the Assessment, along with all other aspects which scale the results down to take account of 200 hours of operation, are disregarded. This includes the assessment using the Institute of Air Quality Management impact

8 This particular error in the assessment has already been raised by the Council.

9 This is based on the dataset from the same observation station that is held by AQC. AQC does not have access to the precise data used in the Assessment.

descriptors. Without a robust assessment of the probability of the proposed plant having significant impacts, the only robust assessment is that shown in Figure 6, as described above, which shows potentially significant impacts.

5 Conclusions

5.1 If the Assessment had taken account of baseline concentrations, and focused on the robust set of predictions, then it would have predicted exceedences of the objective at many locations, including St Philips Marsh Nursery, and the Paintworks development. There are also issues with the way in which the model itself has been run and these may have caused the impacts to have been under-predicted.

5.2 It is unclear whether the assumptions made in the Assessment are the same as those in the noise assessment. A key concern in this respect is whether the noise assessment has accounted for a 134 mph exhaust velocity from the proposed stacks.

5.3 If, despite the potential for significant impacts, the development does proceed, monitoring of the emissions and release conditions should be carried out. This will be necessary in order to ensure that the impacts will not be significantly greater than those which have been predicted.

5.4 As explained in Section 1, this review has been carried out over a very short timeframe and thus the list of issues raised reflects what was identified in this time and may not be exhaustive.

6 Appendices

A1 Professional Experience

Prof. Duncan Laxen, BSc (Hons) MSc PhD MIEnvSc FIAQM

Prof Laxen is the Managing Director of Air Quality Consultants, a company which he founded in 1993. He has over forty years' experience in environmental sciences and has been a member of Defra's Air Quality Expert Group and the Department of Health's Committee on the Medical Effects of Air Pollution. He has been involved in major studies of air quality, including nitrogen dioxide, lead, dust, acid rain, PM_{10}, $PM_{2.5}$ and ozone and was responsible for setting up the UK's urban air quality monitoring network. Prof Laxen has been responsible for appraisals of all local authorities' air quality Review & Assessment reports and for providing guidance and support to local authorities carrying out their local air quality management duties. He has carried out air quality assessments for power stations; road schemes; ports; airports; railways; mineral and landfill sites; and residential/commercial developments. He has also been involved in numerous investigations into industrial emissions; ambient air quality; indoor air quality; nuisance dust and transport emissions. Prof Laxen has prepared specialist reviews on air quality topics and contributed to the development of air quality management in the UK. He has been an expert witness at numerous Public Inquiries, published over 70 scientific papers and given numerous presentations at conferences. He is a Fellow of the Institute of Air Quality Management.

Dr Ben Marner, BSc (Hons) PhD CSci MIEnvSc MIAQM

Dr Marner is a Technical Director with AQC and has seventeen years' experience in the field of air quality. He has been responsible for air quality and greenhouse gas assessments of road schemes, rail schemes, airports, power stations, waste incinerators, commercial developments and residential developments in the UK and abroad. He has been an expert witness at several public inquiries, where he has presented evidence on health-related air quality impacts, the impacts of air quality on sensitive ecosystems, and greenhouse gas impacts. He has extensive experience of using detailed dispersion models, as well as contributing to the development of modelling best practices. Dr Marner has arranged and overseen air quality monitoring surveys, as well as contributing to Defra guidance on harmonising monitoring methods. He has been responsible for air quality review and assessments on behalf of numerous local authorities. He has also developed methods to predict nitrogen deposition fluxes on behalf of the Environment Agency, provided support and advice to the UK Government's air quality review and assessment helpdesk, Transport Scotland, Transport for London, and numerous local authorities. He is a Member of the Institute of Air Quality Management and a Chartered Scientist.

Kieran Laxen, MEng (Hons) AMIEnvSc MIAQM

Mr Laxen is a Senior Consultant with AQC with over seven years' experience in the field of air quality management and assessment. Previously having two years' experience in scientific research on internal combustion engines, he now works in the field of air quality. He is involved in a wide range of development projects, most of which have involved use of ADMS modelling methodologies for biomass boilers, CHP plant and roads, and is also competent in the assessment of construction dust. He has pioneered the use of OpenAir software within the Company, which is used to analyse air quality monitoring data, and is responsible for routine calibration of air quality monitoring stations, together with data ratification. He is a Member of the Institute of Air Quality Management.

Ricky Gellatly, BSc (Hons) AMIEnvSc MIAQM

Mr Gellatly is a Senior Consultant with AQC with over four years' relevant experience. Prior to joining AQC he worked as an air quality consultant at Odournet UK Ltd. He has also worked as an oceanographer, and holds a first class degree in meteorology and oceanography from the University of East Anglia. He has undertaken air quality assessments for a wide range of projects, assessing many different pollution sources using both qualitative and quantitative methodologies, with most assessments having included dispersion modelling (using a variety of models). He has assessed road schemes, airports, energy from waste facilities, anaerobic digesters, poultry farms, urban extensions, rail freight interchanges, energy centres, waste handling sites, sewage works and shopping and sports centres, amongst others. He also has experience in ambient air quality monitoring, the analysis and interpretation of air quality monitoring data, monitoring and assessment of nuisance odours and the monitoring and assessment of construction dust.

Full CVs are available at www.aqconsultants.co.uk.