Specialist Environmental Consultancy for Air Quality, Odour & Environmental Noise

Proof of Evidence by Steve Fraser

Air Quality Impacts from Proposed Biomass Power Plant, Bishop's Castle, Shropshire.

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1.0 INTRODUCTION

Qualifications and Experience

1.1 My name is Steve Fraser, an independent environmental consultant. I obtained a diploma in Environmental Health at Glasgow College of Technology in 1979, followed by a BSc in Environmental Health at the University of Strathclyde in 1982. A decade later I graduated as Master of Philosophy from the same University following a research project into the measurement and dispersion of industrial pollution. I am a Chartered Environmentalist, and hold full memberships for the Institute of Acoustics and the Chartered Institute of Wastes Management.

1.2 I have worked as a consultant in the private sector for 12 years. Before setting up my own company, The Airshed Ltd, in 2005, I was employed by RPS Planning Transport & Environment for nine years, latterly as a principal consultant. I was previously employed by the Scottish Environment Protection Agency (SEPA) as an Environmental Protection Officer, and by Cunninghame District Council, in Scotland as an Environmental Health Officer. I have conducted numerous air quality impact assessments for combustion-related projects including biomass fuelled installations, municipal solid waste (MSW) incineration plant and other large scale industrial facilities.

1.3 I have specialised in air quality and environmental noise impact assessment for most of my professional career. My recent air quality project experience includes: conducting assessments for MSW Energy from Waste (EFW) plants, large-scale biomass EFW processes, and smaller scale combined heat and power biomass projects for industrial and domestic applications. I have conducted three air quality assessments for large-scale biomass projects in the last year (up to 300,000 tonnes per annum).

1.4 I have presented technical papers on issues relating to atmospheric dispersion at national conferences organised by the Chartered Institute of Water and Environmental Management (CIWEM) in 2002, 2004, 2005 and 2006, the HARMO conference in 2007 and the ADMS 4 dispersion model user (peer) group conference in 2008.

Scope of Evidence

1.5 I appear at this Inquiry on behalf of Bishop's Castle Biomass Power Ltd as expert witness on potential adverse air quality impacts from the proposed development. I will also refer to the potential health-related impacts from residual pollutants.

1.6 In my experience it is good practice to agree the scope and methods for assessment with regulatory agencies, where the level of detail required for assessment is proportionate to the scale of development. In some cases, where the process is relatively small, it is acceptable to base the assessment on a screening model. This is accepted practice for environmental regulation within the UK e.g. both the Environment Agencies Guidance on Environmental Assessment[1] and DEFRA's Technical Guidance[2] on local air quality management (LAQM) include screening models as part of the assessment process.

1.7 Screening models are designed to be simple, robust tools and are designed to over-predict to ensure a conservative approach. Screening models are not site specific, so an effective screening model must include worst case dispersion factors for any location. The aim of a screening model approach is to help "*screen out*" processes that are unlikely to have significant adverse impacts. Thus if a screening model indicates that the impacts are acceptable, it is usually unnecessary to proceed further and conduct a more detailed site specific assessment.

1.8 I've been advised that the Environmental Health Department of South Shropshire District Council (SSDC) was consulted at the time of the application. Apparently several levels of screening assessment were conducted. This iterative approach is often used to inform the requirements for abatement. It is my understanding that the screening assessment helped inform the requirements for stack height and the level of abatement required.

1.9 From a technical perspective the screening assessment may be acceptable e.g. for Environmental Health Officers familiar with review and assessment process for LAQM. While the screening assessment may satisfy these

[1] Environment Agency 2003 H1 Horizontal Guidance Environmental Assessment and Appraisal of BAT.
[2] DEFRA 2003. Technical Guidance Local Air Quality Management TG03

technical requirements, the assessment philosophy may not be understood by the public and may be perceived as being less robust, or second best.

1.10 The Bishop's Castle Group (BCG) has raised concerns about deficiencies in the screening assessment, and the transparency of these predictions as well as concerns about the impacts of process emissions on community health.[3] Accordingly I advised the appellant that while I did not consider that the screening assessment was flawed, that a more detailed assessment would help communicate the likely impacts more effectively. This is particularly relevant for planning applications where the assessment should meet the information needs of the local community as well as SSDC Environmental Health Officers responsible for enforcement of LAQM Regulations.

1.11 I will address the issues raised by BCG where these relate to potential air quality impacts from process emissions. I have also reviewed the Appeal Statement prepared on behalf of BCG which includes some further comments on air quality issues.[4]

Potential Air Quality Impacts

1.12 The process is relatively small and falls well below the threshold for regulation under European IPPC regulation. The appellant has advised me that the process will have a maximum design capacity of 13MW net rated thermal input and consume up to 2.5 dry tonnes of biomass fuel per hour (~20,000 dry tonnes per annum). I have been advised by the appellant that the process will not use waste materials as fuel. The main pollutants of interest for this type of process are typically oxides of nitrogen (NO_x) and particles.

1.13 I have been advised that the appellant has specified maximum emission limits for the proposed plant for both NO_x and particles as part of the procurement process. I have also been advised that the combustion process will be designed to ensure that combustion gases will be oxidised in a secondary chamber for two seconds at above 850^{o}C. This should ensure the effective destruction of organic compounds.

[3] Andrew Cunninghame April 2008. NOTES ON THE DEVELOPERS' FULL AIR QUALITY REPORT FOR PLANNING APPLICATION 1/08/20502/F
[4] Scott Wilson November 2008. Appeal Statement Bishop's Castle Group

1.14 I have conducted an air quality impact assessment of the proposed scheme. The aim of my assessment is to provide an independent objective report to help inform the planning process. The dispersion modelling assessment submitted to the Inquiry is based on an assumed steady state emission at maximum throughput. The detailed assumptions are set out in my technical report.[5]

1.15 In my opinion the overall capacity for significant harm to arise is relatively low due to the small scale of the proposed development, the process design and the characteristics of the fuel. However, emissions from the process have the potential to affect the health of local residents and people using the adjacent cycle park, the allotment and adjacent footpaths. These impacts are considered within my technical report.

My Evidence

1.16 In my evidence I will state that the proposed facility is unlikely to cause significant harm to local residents, users of public open space, or footpaths or sensitive plants or ecology.

1.17 The main thrust of my evidence is that:

- properly designed and operated biomass plants such as the one proposed here have a low potential for causing harm;
- the biomass plant as proposed by the appellant does not involve the use of recycled materials or waste products, further reducing the potential for harm;
- the main air quality impacts are likely to occur relatively close to the process within an established industrial estate, so that significant adverse impacts are highly unlikely;
- the process can be controlled by appropriate planning conditions in accordance with Guidance within PPS 23 and that these conditions are likely to ensure effective means of preventing potential air quality impacts; and

[5] The Airshed 2nd February 2009. Air Quality Impact Assessment Biomass Energy Plant Bishop's Castle Shropshire.

- the impact from the proposed process is likely to be acceptable at sensitive receptors in terms of national and international environmental standards.

1.18. The nearest dwellings are approximately 250m from the proposed stack. These are relevant when considering long-term, annual mean exposures e.g. for PM_{10}, $PM_{2.5}$ and NO_2. People using public open space such as the adjacent allotments and the cycle park and pedestrians on pavements and footpaths may be exposed to short-term air pollution. These impacts have been assessed in accordance with UK Air Quality Objectives and Environment Agency Guidance.

1.19. The fuel feedstock is likely to contain trace elements of some metals. These may deposit on the ground either on the adjacent allotments or within private gardens. The significance of these impacts has been assessed using Environment Agency benchmarks. I have assessed the likely significance of dioxins and furans in terms of World Health Organisation and UK Department of Health guidance.

1.20. In principle the impacts may be prevented or minimised by appropriate location, design and engineering and the adoption of best practice measures. These adverse impacts are amenable to control. In practice this process may be controlled by appropriate planning conditions. The proposed abatement techniques are discussed in my technical report.[5]

1.21. My evidence is structured as follows:

- Relevant planning Guidance, environmental protection legislation and assessment standards are summarised in Section 2;

- In Section 3 of my evidence I will review the process description, discuss the potential sources of air pollution, the methods for mitigation and the likely impacts at the nearest receptors; and

- In Section 4 I will draw conclusions about the likely impacts from the proposed operation.

2.0 GUIDANCE, REGULATION AND STANDARDS

Planning Guidance

2.1. The UK Government has published planning advice on the requirements for Environmental Impact Assessments (EIA)[6]. According to this good practice Guide, the EIA must identify the likely environmental effects of a project through the study and analysis of individual issues, predicting and assessing the projected impacts and proposing measures to mitigate the effects. In my evidence I therefore consider the air quality impacts in terms of their likely significance. The EIA regulations do not apply to this application, but the general principles of environmental impact assessment provide a useful framework. I have approached the assessment as though these Regulations apply to the scheme.

PPS 23

2.2. Planning Policy Statements (PPSs) set out the Government's core policies and principles on the most important aspects of land use planning. Local planning authorities must take material considerations into account when determining planning applications.[7] PPS 23[8] includes Guidance on impacts that may be a material consideration in terms of a planning application. According to PPS 23 Annex A, this includes any development where fumes, gases, dust, steam or smell might be seriously detrimental to amenity or constitute a statutory nuisance under Part III of the Environmental Protection Act 1990.

2.3. The policies in PPS 23 are material to decisions on individual planning applications. PPS 23 states that the planning system should play a key role in determining the location of development which may be affected by major existing or potential sources of pollution. PPS 23 is mainly concerned about the potential impact of pollution on health, rather than amenity. PPS refers mainly to potential impacts on health as being a material planning consideration.

[6] OPDM 2000. Environmental impact assessment: guide to procedures
[7] ODPM 2005. The Planning System: General Principles
[8] ODPM 2004. Planning Policy Statement 23 Planning and Pollution Control

2.4. PPS 23 refers to the need to avoid development causing serious detriment to amenity. According to PPS 23, pollution should be taken into account where new industrial processes are proposed close to existing housing or other sensitive receptors. PPS 23 requires that the potential risk to health or amenity should be based on the normal operation of the process and that planning authorities should work on the assumption that the relevant pollution control regime will be properly applied and enforced. Annex 1 to this Guidance discusses circumstances where it may be appropriate for a planning authority to impose conditions relating to air quality.

Assessment Criteria

2.5. I have assessed the significance of the predicted air quality impacts in terms of the predicted process contribution expressed as a percentage of the relevant Environmental Quality Standard (EQS). These are based on UK Air Quality Objectives, Limit Values and benchmarks proposed in Environment Agency Guidance[9]. The UK Objectives are set out in Appendix 1 of my technical report. The basis of these standards is discussed in more detail below.

2.6. European Directive 2008/50/EC consolidates previous European air quality legislation provides a new regulatory framework for $PM_{2.5.}$ This will be transposed into UK domestic legislation by 2010.

2.7. The UK Government has published the UK Air Quality Strategy which sets out the measures intended to improve and protect ambient air quality and how the UK Government proposes to fulfil the UK's obligations under the European Directives.[10]

Nitrogen Dioxide

2.8. The main pollutant from the proposed process is likely to be Nitrogen Dioxide (NO_2). Oxides of nitrogen are produced as a result of the reaction between the nitrogen present in the atmosphere and within the fuel. Oxides of nitrogen (NO_x) include nitric oxide (NO) and nitrogen dioxide (NO_2). The proposed process has been selected to produce low NO_x emissions and is expected to produce less than 150mg/m^3 NO_x under steady state conditions. NO_2 is a secondary pollutant and the rate of

[9] Environment Agency July 2003. H1 Integrated Pollution Prevention and Control (IPPC) Environmental Assessment and Appraisal of BAT

conversion from NO_x depends on the background pollution and photo-oxidation.

2.9. At relatively high concentrations, NO_2 causes inflammation of the airways. Long-term exposure to nitrogen dioxide may also affect lung function. Exposure to nitrogen dioxide enhances the response to allergens in sensitised individuals. The UK Expert Panel on Air Quality Standards (EPAQS) recommended a short-term air quality standard of 286µg/m^3 measured as an hourly average[11]. European Air Quality Directive 2008/50/EC[12] imposes a limit value of 200µg/m^3 not to be exceeded more than 18 hours in any year. This Directive also requires that the annual mean does not exceed 40µg/$m^{3.}$ These standards were derived from the World Health Organisation guidelines for air quality.[13]

Particles

2.10. Particles from the proposed process will arise from fly ash entrained from the fuel bed. These may include trace elements of metals present in the fuel and aerosols of soot and organic compounds such as polycyclic aromatic hydrocarbons (PAHs). The quantity of organic compounds released from the stack depends on the efficiency of the secondary combustion chamber. The proposed installation will be equipped with a secondary chamber designed to ensure efficient combustion and minimise the release of total organic compounds (TOCs) to less than 20mg/m^3. The process will also be fitted with a fabric filter which will reduce particle emissions to less than 50mg/m^3.

2.11. Ambient particulate comprises particles of different sizes, from a few nanometres up to several tens of microns. Because the emissions will be passed through a fabric filter, most of the particles emitted from the process are likely to be less than 10um.

2.12. EPAQS proposed an air quality standard for PM_{10} of 50ug/m^3 as a 24 hour rolling mean.[14] This has been adopted in UK and European legislation, where the limit value should not be exceeded more than 35 days in any year. The annual mean PM_{10} must also be less than 40ug/m^3.

[10] DEFRA July 2007. The Air Quality Strategy for England Scotland Wales and Northern Ireland (Volume 1).
[11] EPAQS 1996. Nitrogen Dioxide
[12] http://ec.europa.eu/environment/air/legis.htm
[13] WHO Copenhagen 2000. http://www.euro.who.int/document/e71922.pdf
[14] EPAQS 1996. Particles

2.13. The main focus of interest in terms of human health is now particles below about 2.5µm in diameter. In the UK, the Department of Health-sponsored Committee on the Medical Effects of Air Pollution (COMEAP) has advised that "*in defining a coefficient linking $PM_{2.5}$ and mortality and advising on its use for quantification …. $PM_{2.5}$ is our chosen index of pollution.*"[15] $PM_{2.5}$ has now been adopted by the European Union as a Limit Value.

2.14. From a practical point of view, most of the current exposure data is available as PM_{10}, based on current instrumentation and adopted 2010 Air Quality Objectives for PM_{10} and there is little reliable information on background $PM_{2.5}$. However as a precautionary approach I have assumed the particle emissions are all $PM_{2.5}$.

Metals

2.15. Metals in air can have acute and chronic effects by direct inhalation or ingestion of contaminated food either exposed to the plume or grown in soil where pollution has deposited from the air. The proposed process will be fuelled by virgin material which is likely to contain very low levels of metals. I have used emission factors from the Environment Protection Agency in the United States (USEPA) to estimate likely emission of metals. These emission factors include emissions from uncontrolled processes, so that the predicted impacts are likely to be conservative.

2.16. The Environmental Quality Standards (EQS) used in the air quality impact assessment are derived from European Limit Values, and air quality standards published by the WHO or the Environment Agency. Thresholds for metal deposition are based on the EQSs published in H1[16]. The detailed calculations for these emissions and the EQSs are set out in the air quality impact assessment.

Organic Compounds

2.17. Wood burning processes are frequently associated with PAH emissions, mainly due to incomplete combustion. The range of PAHs emitted depends on the design of the combustion chamber and the conditions of

[15] Committee on the Medical Effects of Air Pollutants. Quantification of the Effects of Air Pollutants on Health in the UK. Interim Statement. 18th January 2006
http://www.advisorybodies.doh.gov.uk/comeap/pdfs/interimlongtermeffects2006.pdf

combustion. As discussed above, the process includes a secondary combustion chamber designed to provide good turbulent mixing, for two seconds at above 850°C. Much of the organic material is likely to be bound to particles and collected by the proposed bag filter. These measures should ensure that the release of total organic compounds (TOCs) is less than 20mg/m^3. I have used emission factors from the Environment Protection Agency in the United States (USEPA) to estimate the likely emission of PAHs. These emission factors include emissions from uncontrolled processes, so that the predicted impacts are likely to be conservative.

2.18. The EQSs used for PAHs in the air quality impact assessment are derived from European Limit Values and benchmarks published by the Environment Agency in H1. There are no published EQSs for dioxins or furans in air or deposition rates so it is not possible to assess these directly using benchmarks.

2.19. In my opinion the scale of this process is too small to warrant a detailed Health Impact Assessment. In my experience it is extremely improbable that this would be likely to identify any significant adverse impacts. However as a precautionary measure the appellant has asked me to consider the potential impacts from dioxins and furans since this topic has been raised by the BCG. These have been predicted using the emissions predicted from the dispersion model and the source-pathway-receptor model developed by the USEPA (HHRAP) and their significance assessed against WHO/UK Guidance. These are referenced in my air quality assessment.

[16] Environment Agency 2003. Horizontal Guidance H1. Environmental Assessment and Appraisal of BAT

3.0 LIKELY ENVIRONMENTAL IMPACTS

Process Emissions

3.1. The proposed process will have a maximum fuel use of 2.5 tonnes per hour. The emissions arise from an elevated point source release under controlled conditions:

- A 16m high stack with an efflux velocity of 15m/s at 180^{o}C;
- Emissions from the process are based on supplier estimates for combustion gases and will control NO_x and particles.
- Fugitive emissions of dust from ash handling will be prevented or minimised by the adoption of sealed ash hoppers.

3.2. The methods used to estimate the emissions from the process are set out in detail in the Air Quality Impact Assessment for the project.[5] [Refer to Tables 3.1 and Table 3.2] This assessment considers two emission Scenarios:

- Scenario 1 is based on the emission limits agreed with SSDC for NO_x and particles; and
- Scenario 2 is based on plausible worst case emissions.

3.3. The local authority has agreed maximum emission concentrations for NO_x and particles. This proposes short-term concentration limits for emissions, which if exceeded would trigger the controlled shutdown of the plant. Scenario 1 assesses the impacts for the process on the assumption that these short-term transient concentrations occur at all times.

3.4. As discussed above, the operator proposes that the plant will be subject to stringent performance requirements as part of the procurement process. Scenario 2 assesses the upper range of what I consider likely to be emitted from the process, taking account of typical industry performance and the proposed design. This is mainly relevant when considering the long term impacts of process emissions.

Predicted Impacts

3.5. I have used an advanced dispersion model to predict the likely pollution concentrations around the site, based on meteorological data from a range of sources and local topography. The dispersion model used is widely validated for industrial point sources and is recognised by the Environment Agency and DEFRA as an appropriate atmospheric dispersion model, subject to its proper use. The assessment includes a detailed model sensitivity analysis. This examines the significance of a range of model variables on process contribution.

3.6. There are limitations and uncertainties inherent in any dispersion model. The possible significance of these uncertainties is discussed in Table 1 attached. BCG and others opposing the scheme have raised concerns about the reliability of the assessment, due to its reliance on meteorological data from Birmingham Coleshill. I agree that this is potentially a weakness in the assessment.

3.7. However, bearing in the findings of the screening assessment, it is unlikely that these impacts would be significant. This is supported by the results from the model sensitivity analysis for meteorological data which shows that the model is unlikely to under predict the annual mean or short-term EQS, either due to lower wind speeds or increased periods of calm weather. This is considered in more detail within my technical report. This sensitivity analysis indicates that impacts would actually reduce if lower wind speeds are assumed.

3.8. The main dispersion mechanism affecting the predicted annual mean ground level concentrations at this site is mechanical turbulence caused by building downwash effect. These mechanical turbulence effects reduce with lower wind speeds.

3.9. To provide further confidence in the predictions, I have used other Meteorological Office supplied data based on the worst case year (2002), including data from Credenhill, Ringway and local NWP meteorological data for Bishop's Castle. This confirms that the Coleshill data is quite pessimistic compared to these other data sets. As expected, due to lower wind speeds, the predicted annual mean is lower when Bishop's Castle

NWP meteorological data is used. The predicted annual mean is actually ~50% lower at the worst case receptor considered in the study. Short-term impacts are not affected significantly either way.

3.10. The basis of the assessment criteria used is set out in Table 1 of my technical report. The results are summarised in Table 8 and their significance assessed in Table 9.

Short-term Air Quality Standards

3.11. Based on these predictions, the worst case concentration at any sensitive receptor for the most prominent pollutant, NO_2, is predicted to be less than 10% of the air quality standard, taking worst case meteorological and surface roughness conditions into account. There are some uncertainties in the short-term concentration of background for NO_2. In practice these uncertainties are not important since the short-term air quality standard is unlikely to be exceeded even assuming that all the emitted NO_x were present as NO_2.

Annual Mean Air Quality Standards

3.12. The model predicts that the annual mean impacts are well within the relevant standards and are either of marginal significance or insignificant in terms of the assessment criteria.

Dioxins and Furans

3.13. The results from the USEPA HHRAP model indicate that dioxin and furan impacts are insignificant i.e. $1/100^{th}$ of 1% of the World Health Organisation and UK Department of Health advisory limits. These results are summarised in Table 6 within the text of my report and detailed in Appendix 4.

Other Issues Raised by Third Parties

3.14. The BCG and Scott Wilson have raised a number of issues about the screening assessment and general difficulties in assessing air quality in Bishop's Castle. These are addressed in Table 2 attached.

3.15. It is a popular misconception that dispersion is inevitably worse during

inversion conditions. This is certainly the case where the releases are at or near ground level or if the plume possess insufficient thermal and mechanical buoyancy. The results from my sensitivity analysis in Appendix 3.1 show that the main impacts are likely to occur close to the plant. The main factor influencing dispersion is the process building, both for short term and long term pollution. This explains why the annual mean increases with wind speed due to the increased effects of mechanical turbulence causing increased building entrainment. The plots in Appendix 3.1 show dispersion under seven different stability conditions. Clearly the worst case impacts occur during unstable climatic conditions where the plume is brought to ground near the point of release source due to convective turbulence. Worst case in neutral conditions mainly occur due to the effects of mechanical turbulence – the effect of the process building.

3.16. In contrast, the impact during stable atmospheric conditions is much lower close to the site. Inversion conditions are therefore highly unlikely to affect short term impacts (the $99.79^{\%ile}$ which is driven by convective turbulence characterised by strong solar heating) nor are they likely to occur sufficiently often to affect the annual mean e.g. the NWP meteorological data for Bishop's Castle indicates that calms occurred 80 hours in 2002. The results from the sensitivity analysis discussed in Section 5 of my air quality report further support the conclusion that calms will not significantly affect air quality in terms of any recognised EQS.

4.0 CONCLUSIONS

4.1. Existing air quality in Bishop's Castle is very good.

4.2. The process is relatively small, the character of the fuel relatively benign and the proposed design is to a high standard. The potential for significant harm is therefore relatively low.

4.3. A conservative approach to assessment has been adopted and full account taken of model uncertainties. This demonstrates that the process is highly unlikely to significantly affect air quality.

4.4. The results from the source-pathway-receptor study confirm that the impacts from dioxins and furans are likely to be insignificant in terms of UK and international standards.

4.5. The mitigation proposed by the appellant represents best practice to prevent or minimise the release of emissions for this scale of plant.

4.6. The proposed design and mitigation measures should ensure that air quality impacts will be of marginal significance or insignificant at the nearest receptors.

4.7. The potential air quality impacts can be effectively controlled by appropriate planning conditions.

Table 1 – Uncertainty			
Area of uncertainty	**Cause of uncertainty**	**What's been done to minimise uncertainty**	**Potential magnitude**
What if the model assumptions are too optimistic? E.g. the release conditions are higher than predicted.	The emission concentrations used to predict emission rates are based on the supplier's estimated gas flows and emission limits proposed by SSDC. If the process exceeds these emission limits, the operator would be required to suspend operations. Although the assessment has been conducted on the basis of the maximum permitted emission concentrations, the supplier's guarantee limits are much lower than this. The only credible uncertainty about emissions relates to the volume of gases that may be discharged from the stack.	Pessimistic assumptions have been used for gas flow emission rates. Emissions will be tested during process commissioning. The emission concentrations are underwritten by a commercial guarantee and may be enforced by planning conditions if required.	Combustion calculations may be out by around 10%, and this has been taken into account in the assessment when determining emission rates.
Fugitive emissions	Emissions not considered in the assessment: e.g. fugitive dust or gases escaping from the process building.	The ash handling area is contained. The building is designed to provide good containment. The integrity of the building should be tested during commissioning and regularly thereafter as part of normal maintenance.	Should be insignificant if engineered out and controlled effectively.
Process variability	Variations in process operation not taken into account e.g. maintenance, operator error or plant failure.	The installation will not be permitted to operate if any of the critical process control and abatement plant is not available. The process conditions and stack gases will be continuously monitored. Operator training will be required as part of the site Environmental Management System (EMS).	Short-term variations in process emissions are relevant when considering emissions that have the potential to affect respiratory health e.g. short-term exposure to peak concentrations of NO_2. These will be controlled and monitored continuously. There is a sufficient safety margin in the process design to make this highly unlikely. Short-term process variability is insignificant when considering potential health impacts from long-term exposure.

Table 1 – Uncertainty			
Area of uncertainty	**Cause of uncertainty**	**What's been done to minimise uncertainty**	**Potential magnitude**
Uncertainties inherent in the mathematical dispersion model used in the assessment.	There are uncertainties inherent in all dispersion models. Mathematical models have been developed over the last 50 years or so to predict impacts from elevated point source releases. These models are intended to represent physical behaviour in the atmosphere with varying degrees of complexity. Generally speaking a dispersion model should only be used for regulatory purposes where it has a proven track record, with suitable published validation studies. The purpose of validation tests is to check the quality of a model for a given flow situation. Validation tests are the only method to ensure that a new model is applicable with confidence to certain types of flows. The more validation tests a model passes with acceptable accuracy, the more generally it can be applied. The goal of validation tests is to minimise and quantify modelling errors. In principle, it is reasonable to expect a model to give reliable predictions provided the conditions being assessed are similar to those for which the model was developed and prevailing at sites selected for validation studies. The dispersion model used to predict dispersion at the process is ADMS 4.1 (CERC 2007. ADMS-4, The Multiple Source Air Dispersion Model', CERC, Cambridge). This model was originally developed for use by UK regulatory agencies in the early 90's. Details of validation studies for this dispersion model are available at http://www.cerc.co.uk/software/publications.htm One of the main advantages of ADMS is that it can be used to predict dispersion for every hour in the year, for a 5 year period, in just a few hours of computer time. These dispersion models may be less reliable in some conditions: • where the conditions being assessed are more complicated e.g. complex terrain with slopes >1:3 near the point of release; or • where there is an unusual shape of building proposed or where more than one significant building is located near the stack.	An extensive model sensitivity analysis has been conducted to assess likely impacts. The emission rate and dispersion estimates would need to be out by almost an order of magnitude for an air quality standard to be exceeded.	As a rule- of-thumb dispersion models may be expected to be within ± 50% of the predicted value, assuming all the other assumptions (source emissions, meteorological conditions etc) are robust. This error needs to be taken into account in the assessment.

Table 1 – Uncertainty			
Area of uncertainty	**Cause of uncertainty**	**What's been done to minimise uncertainty**	**Potential magnitude**
Why rely on these models?	In some cases where there is reason to believe the conditions being assessed are outwith the conditions the model can adequately consider, then other assessment tools should be considered e.g. testing a physical scale model in a wind tunnel to provide additional confidence in predictions. Physical models can't readily consider worst case dispersion conditions e.g. inversions or highly unstable atmospheres. There are more complex mathematical models available e.g. computational fluid dynamics (CFD), but these take much longer to set up and run and can't practically consider the full range of meteorological conditions due to the duration of computer run time required.	There is no reason to believe that conditions at Bishop's Castle are outwith the range of model capability. This aspect has been discussed with SSDC.	N/A
Errors introduced by the model user.	Another category of error may arise due to the incorrect use of the model e.g. by using parameters that underestimate impacts. The assessment takes account of the requirements of the Royal Meteorological Society Policy Statement - Atmospheric Dispersion Modelling Guidelines on the justification of choice and use of models and the communication and reporting of results. This requires that dispersion modelling studies should include a sensitivity analysis for model inputs, to provide an estimate of the possible errors in the predictions.	The main aim of the air quality assessment is not actually to predict the most likely concentration of pollution. The aim is to assume the worst case, throughout the study, to ensure the process meets all environmental standards once it is actually operating. The sensitivity analysis conducted for this study considers the likely errors arising from meteorological data, surface roughness, efflux velocity, temperature of release, building and terrain effects and receptor height. The assessment includes detailed model outputs which enables others to cross check predictions independently.	Probably insignificant in terms of environmental impacts because the worst case has been assumed for all variables.

Table 1 – Uncertainty			
Area of uncertainty	**Cause of uncertainty**	**What's been done to minimise uncertainty**	**Potential magnitude**
Meteorological Data	Use of non site specific wind data. This could potentially be a major weakness in the assessment if the study relied on wind speed or frequency data that was not representative of the site. The data used in the assessment is based on observations obtained at Birmingham Coleshill. While this site is at the same longitude, it is 100m lower in altitude and in flat terrain. The proposed site at Bishop's Castle is on level ground, within a valley. The air temperature at Bishop's Castle is likely to be lower than at Coleshill. Wind speeds may be higher due to the increased height above sea level but reduced in some directions due to the effects of local terrain. The different wind pattern at Bishop's Castle could affect the distribution of pollution around the site.	The effects of lower temperature and different wind speeds has been considered. Meteorological data from two other sites have also been used to predict dispersion, for the sake of comparison. As an additional precaution NWP met data has been used to predict dispersion.	Reducing the air temperature has no effect on predictions. Reducing or increasing the wind speed by 1m/s has very little effect on the short-term 99.79%ile 1 hour NO_2, although this could conceivably alter the predicted location of short-term impacts. Increasing the annual mean wind increases the predicted annual mean airborne concentration by up to 20%, probably due to increased mechanical turbulence around the building. Reducing the wind speed by 1m/s reduces the annual mean slightly, by around 10%. The NWP data indicates that the Coleshill data is pessimistic and that the annual mean impact is are actually 50% lower when site specific data is used. Short-term impacts are less sensitive to these variations in met. data.
Other Model Parameters	Use of unrepresentative assumptions determined by the model user e.g. surface roughness, efflux velocity, stack temperature, building effects, terrain effects etc.	The assessment reports the significance of these effects for all receptors.	The assumed surface roughness can affect the predicted short-term airborne pollutant concentration by up to ~40% at some receptors. Realistic values have been used in the assessment. According to the model Guide, terrain effects should not be considered where slopes are <10% in which case terrain effects around most of the site should be ignored. According to ADMS terrain will increase the predicted short-term airborne pollutant concentration by up to 20% at some receptors. Separate model runs have been conducted to allow for other parameters e.g. building effects.

Table 1 – Uncertainty			
Area of uncertainty	**Cause of uncertainty**	**What's been done to minimise uncertainty**	**Potential magnitude**
Operator Trust	Will good practices actually be implemented by the appellant?	An operational protocol could be applied as a planning condition if required. The process operator should be committed to a policy of openness with the local community to demonstrate compliance.	N/A
Assuming the model predictions are correct, do we know for sure that the air quality standards provide adequate protection?	Most of the air quality standards are based on UK Objectives or European statutory limit values. These are usually based on a wide number of international epidemiological studies which have examined the relationship between exposure of human populations to air pollution and their effects on mortality and morbidity. The air quality standards used in this assessment are based on World Health Organisation, the UK Expert Panel on Air Quality Standards, Guidance published by the Committee on the Medical Effects of Air Pollutants and UK Environment Agency Guidance. For some pollutants, adverse health effects are no longer observed below a threshold. This observed level is then used to set a safe level, with an appropriate safety margin. For other pollutants there may be no 'no-effect' level in which case the standard is based on achieving the lowest possible exposure.	N/A	N/A
Significance of Model Uncertainty	Air quality assessments should take account of the overall significance of model uncertainties. E.g. if the model is predicting a short-term concentration of NO_2 of around 150 ug/m^3 and the standard is $200ug/m^3$ then given the above, there is probably insufficient model headroom.	The assessment takes account of best practice Guidelines for assessing overall model uncertainty.	This is a complex issue, but overall the approach adopted to assessment should ensure that air quality standards are highly unlikely to be exceeded.

Table 2 – Third Party Criticisms			
Topic / Issue	**Detail**	**Is this true?**	**Significance**
Bishop's Castle Group & Scott Wilson			
The meteorological data from Coleshill Birmingham does not represent conditions at the proposed site.	Wind speed and direction data at Bishop's Castle is different from Birmingham.	It is difficult to comment on this without further information about the specific siting of the meteorological station at Bishop's Castle. The Meteorological Office has very specific requirements for the location of instrumentation. Met. Office wind measurements are normally conducted at 10m above ground, away from local structures that could influence flow. The measured wind speeds and direction at Bishop's Castle may be greater than Birmingham due to real world differences. Alternatively the differences may be due to the differences in instrumentation, height of measurement, fetch, local surface roughness at both sites or local shielding at Bishop's Castle caused by buildings, trees and other obstacles. The NWP met. data wind speeds are lower than Coleshill, but this means the assessment is more conservative.	The potential significance is discussed in Table 1.
	Bishop's Castle has more calm days than Birmingham.	Yes, this is the case, about 3 times more frequent than Coleshill.	The results from the model (Appendix 3.1) indicate clearly that worst case impacts occur in unstable atmospheric conditions when the plume is brought back to ground close to the site due to convective turbulence. The frequency of inversion conditions is therefore highly unlikely to affect the 1 hour 99.79%ile. Lower wind speeds will reduce building wake effect and reduce plume entrainment. This is likely to reduce the annual mean. (model sensitivity analysis in Appendix 3.2)

Table 2 – Third Party Criticisms			
Topic / Issue	**Detail**	**Is this true?**	**Significance**
ADMS Model Issues	The model used does not consider calm conditions.	This is an acknowledged issue for all regulatory dispersion models e.g. ADMS and AERMOD.	The potential significance is considered in the model sensitivity analysis. These effects are likely to be insignificant both for the annual mean and the short-term predictions.
	The model does not consider plume grounding during inversions.	This is considered within the model. The model does predict grounding, but the plume grounding is so far from the site that the plume is well diluted and ground level concentrations are very low.	Not significant in terms of short or long-term objectives.
	The model does not consider the change from one stable to highly turbulent flow.	Air Quality Standards, instrumentation, weather records and dispersion models tend to work on intervals of 1 hour. Rapid changes in conditions from stable to unstable could in theory cause a transient increase in ground level concentrations e.g. when pollutants trapped in an inversion layer are mixed in an advancing front. Such events are rare, and would be very short-term.	Unlikely to be significant in terms of the 99.79%ile 1 hour or to affect the annual mean.

Table 2 – Third Party Criticisms			
Topic / Issue	**Detail**	**Is this true?**	**Significance**
Model Implementation Issues	Terrain data used in the model is incorrect.	The dispersion model uses a detailed topographical map from OS Landform Profile data.	Terrain effects are relatively small close to the site.
	The height of inversions has not been adequately considered e.g. inversions can locally exceed 350m.	The screening assessment examined a range of inversion conditions. This indicates that the plume would tend to penetrate an inversion layer more effectively where the layer is closer to the ground (because the plume has greater thermal and mechanical buoyancy). For higher inversions the plume is likely to be less effective in penetrating the layer. However because the layer is higher up, there is less risk of the plume being returned to ground level.	The model indicates that impacts are likely to be insignificant and that emissions are likely to be well within air quality objectives.
	The effect of buildings on dispersion e.g. the pelletiser and the sewage works have not been adequately considered.	This has been considered in the model sensitivity analysis. The main process building dominates building wake effects on the plume. Other structures are insignificant.	Not significant
	Stack height has not been optimised.	The appellant has sought to balance the need to ensure effective dispersion of emissions along with the need to minimise visual intrusion. Evidently increasing the stack height would reduce air quality impacts close to the site. The design proposed by the appellant meets tougher standards than would normally apply to this size of plant, with the intention of reducing the height of the stack necessary to ensure effective dispersion of residuals.	Not significant

Table 2 – Third Party Criticisms			
Topic / Issue	**Detail**	**Is this true?**	**Significance**
Procedural Issues	Composite set of data should be used combining local surface measurements with Birmingham's cloud cover data.	This could be conducted, provided the data was made available and is fit for purpose.	Unlikely to significantly change worst case annual mean or short-term impacts.
	Appellant could have conducted own meteorological survey as part of the study.	It is always a good idea to conduct site specific measurements for air quality studies and such data should be considered where it is available. Usually it is sufficient to rely on available data, and assess significant of likely differences between the site and the station used. Generally several years of data are required for dispersion modelling. The EA Guidance now requires 5 years of hourly sequential data. Even with modern instrumentation, the operation of a meteorological station is time consuming. It would however be unusual for a small scale project like this to be expected to undertake such an exercise.	Unlikely to significantly change worst case annual mean or short-term impacts.
	The assessment is likely to have underestimated exposure.	The AQIA includes a detailed sensitivity analysis which quantifies the likely errors for a range of parameters.	The impacts are likely to be of minor significance in terms of short-term and long-term air quality standards.
	Relying on the Coleshill data alone invalidates the air quality impact assessment.	It is acknowledged that there are possible differences between the site and the Met. Office station at Coleshill. The model includes a detailed sensitivity analysis which examines the significance of increased or reduced wind speeds on dispersion.	The impacts are likely to be of minor significance in terms of short-term and long-term air quality standards.
	No risk assessment has been conducted. The assessment does not consider the impacts of plant failure.	PPS 23 states that planning authorities should assume that environmental regulation will be effectively enforced and that the impacts should be assessed on the basis of normal operations.	The most likely consequence of uncontrolled emissions from the process would be the release of particles e.g. due to the sudden loss of the bag plant. This would be unlikely to cause the 24 hour PM_{10} objective to be exceeded provided the process was shut down as soon as practicable.
	A catastrophic plant failure could cause pollution affecting water supplies and an area of outstanding natural beauty.	The process is relatively small, does not involve any hazardous substances and has no potential to cause significant harm.	Not significant