J Witt Ltd

Bioaerosol Risk assessment for Advetec aerobic Biodigestion Unit

Newbury Works, Coleford, BA3 5RX

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Bioaerosol Risk assessment for Advetec aerobic Biodigestion Unit

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1 INTRODUCTION

1.1 Background

JW Waste Recycling Ltd, trading as J Witt Ltd, has held a SR2015 No 6 permit for the site at Coleford since early 2017, allowing it to handle and treat up to 75kte of household, commercial and industrial each year.

In a move to continue its initiative to divert waste away from landfill, the Company formed a partnership with Advetec a biotechnology firm that focuses on minimizing the impact of non-recyclable waste on the environment using aerobic composting machines that combine robust engineering with bio-stimulants. Installing one, perhaps two, such Units will enable rapid aerobic digestion of organic matter found within waste received onto site and considerably reduce its volume too. It is expected that the resulting output will be fit to use as Solid Recovered Fuel (SRF).

The Advetec XO22 Unit already on site (though not being used until permitted) will handle up to 13te of "black bag" waste each day.

This risk assessment is focussed on the bioaerosols that are likely to arise from this process, and which might affect existing sensitive receptors.

No other waste on site is stored long enough to allow decomposition so no significant additional bioaerosols are considered likely.

1.2 Site Location and Context

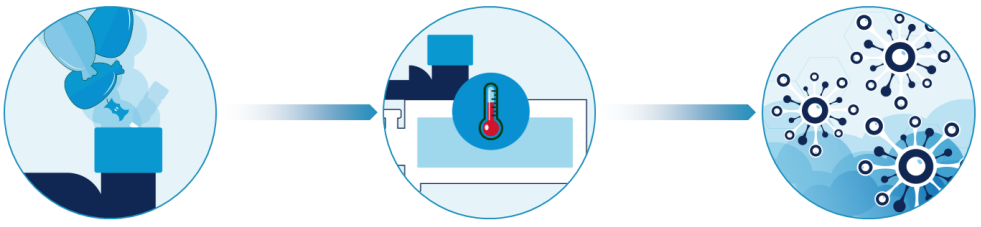
The site occupied by the J Witt Ltd Waste Transfer Station at Newbury Works is a remote location in the middle of the Somerset countryside well away from any potentially sensitive environmental receptors. The nearest house is 0.3km away, and the closest "medical" facility, a retirement home, is 1.2km away. Both are upwind of the prevailing winds (from the SW). The nearest Sensitive Receptor downwind is 400m away.

1.3 Plant Description

The Advetec XO22 process is a fully enclosed aerobic digestor. Aerobic digestion is a natural biological process in which micro-organisms breakdown organic material in the presence of oxygen. Aerobic bacteria digest and consume the organic material, typically on producing the by-products of heat, water vapour and carbon dioxide (CO2). The remaining 'floc' is biostabilised, dry and non-odorous.

[Note: *Anaerobic* digestion (AD) is the process in which micro-organisms break down organic material in the *absence of oxygen* and generate methane.]

Following the aerobic digestion process (which is circa. 72 hours) a mass reduction of circa. 50% and a volume reduction of 70%, with a moisture content of circa. 15%. This results in a floc that is suitable for onward recovery off-site as a Solid Recovered Fuel (SRF). An illustration of the process is provided below.



Step 1
Waste shredding

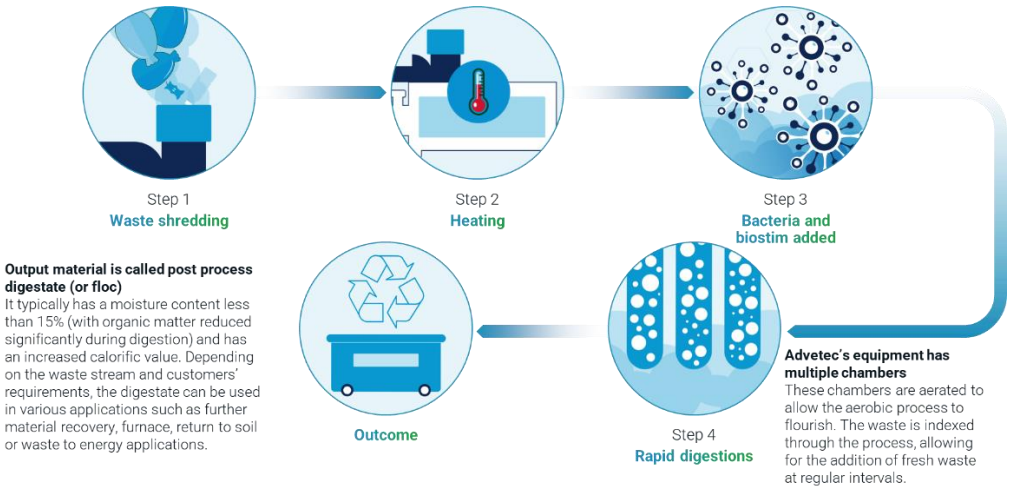
Waste goes through an industrial grade shredder
This begins the process and ensures that a consistent and optimum particle size enters the biomass.

Step 2
Heating

The system initially heats the waste to kick start the bacterial activity
Once optimum temperatures have been achieved the exothermic reaction self-generates the majority of the heat required. The heating system is then used to maintain the temperature above a minimum threshold for continual operation 24/7. This creates resiliency in the system for periods of inactivity.

Step 3
Bacteria and biostim added

Advetec's unique additives are added automatically
This ensures a robust and strong biomass is maintained and allows for the system to cope with the inevitable existence of biocides within the waste stream.



The only by-products from the aerobic digestion process are heat, water vapour, carbon dioxide (CO2), and the floc. The aerobic digestion process uses exothermic aerobic respiration and therefore generates its own heat, which is channelled internally back into the process, using a closed loop heating system. The process does not use supplemental water.

The XO units are accessed via a regulated cloud-based portal. Data points are collected, logged, and stored at programmable intervals, including temperature, humidity, rotational speeds, emissions monitoring, power consumption, maintenance schedules. Alert and alarm levels are programmed into the system to notify in the event of system errors or parameters moving out of range.

There is also an in-line gas monitoring system which continuously monitors levels of methane (CH_4), carbon monoxide (CO), volatile organic compound (VOCs) and sulphur dioxide (SO_2), which in the event of detection of any of these parameters, an alarm is raised.

Figure 1: North End Site Plan for J Witt Ltd at Coleford, BA3 5RX

Advetec XO22 Biodigestion Unit is shown just above its dedicated (yellow) shredder

Figure 2: Location of potential sensitive receptors identified around the site.

2 LEGISLATION & POLICY CONTEXT

2.1 Regulation of Aerobic Biodigestion Facilities

The management and control of emissions including bioaerosols released from the Biodigestion facility will be regulated by the EA using a Bespoke Permit to complement the SR2015 No 6 permit already in force.

2.2 Bioaerosol

Bioaerosol consists of airborne particles of biologically derived material, including microrganisms such as bacteria and fungi, viruses, parts of living organisms such as plant pollen, spores and endotoxins from bacterial cells or mycotoxins from fungi.

Ambient bioaerosol is a complex mixture of biological particles, including many species of bacteria and fungi. Populations are ubiquitous and variable. 'Background' levels typically range from 1 to 1,000 CFU/m^3 (colony forming units per cubic metre of air), of viable bioaerosol, although higher background levels may be encountered.

The small particle size of bioaerosols means that most bioaerosols are inhalable and some smaller particles may be respirable.

There is a limited scientific evidence base on the human health impacts of bioaerosols, and of any potential dose-response relationships. Previous research (CIWEM, 2002 & Enviros, 2004) has identified some associations between bioaerosol exposure and respiratory and gastro-intestinal illness, in particular inflammation of the respiratory system, coughs, fevers and exacerbation of existing respiratory illnesses. Possible links have also been established between bioaerosols and Organic Dust Toxic Syndrome (ODTS) (Rylander, 1997).

From a health risk point of view, Aspergillosis caused by *Aspergillus fumigatus*, can give rise to a severe infection of the respiratory system and can be fatal. Similarly, inhalation of other respirable biological dusts can lead to a condition called Farmers' Lung which causes inflammation of the respiratory system and can progress to a chronic condition which is considered to be dangerous.

As there is currently no clear evidence of dose-response relationships, no defined 'safe' limits have been determined in respect to mixed bioaerosol concentrations. Appropriate levels are therefore typically determined with reference to background levels as determined by monitoring.

The Waste Industry Health and Safety Forum Information Booklet WISH INFO 23 Bioaerosols in waste and recycling (Issue 1 October 2023) is informative.

The EA research document Health Effects of Composting – A Study of Three Compost Sites and Review of Past Data (2001) assumes reference levels for 'total' bacteria, total fungi and gram-negative bacteria of 1,000 CFU/m^3, 1,000 CFU/m^3 and 300 CFU/m^3 respectively. The EA published Guidance on the evaluation of bioaerosol risk assessments for composting facilities (2009), http://publications.environment-agency.gov.uk/pdf/GEHO0809BQUO-e-e.pdf which expanded on these levels and suggested threshold limits that should not be exceeded downwind of a composting facility.

2.2.1 Review of Bioaerosol Emissions from Aerobic Processes

These biodigestion technologies depend on large populations of microorganisms to break down organic material in the waste fed in to them, therefore there may be potential for fugitive emissions of bioaerosol from such waste treatment processes, when vented to atmosphere.

There is a large body of research into the impacts of bioaerosol emissions from the processing of organic wastes. Numerous studies have shown concentrations of bioaerosols decrease to background levels within 250m of open composting sites and this distance is typically lower for sites operating 'in vessel' technologies. One such example is a study by Defra, *'Bioaerosols and odour emissions from composting facilities' (Defra 2013)*.

Research indicates that bioaerosol concentrations decline rapidly with distance from outdoor composting facilities due to dilution and dispersion effects, and concentrations approach background values at a distance of about 100m downwind '*Exposure-response relationships for bioaerosol emissions from waste treatment processes Final report Defra Project: WR0606 IOM Contract: 611-00319' (Defra 2008)'*

2.2.2 Other Potential Bioaerosol Sources

Bioaerosol is ubiquitous from natural and other sources. Arable fields can lead to a high level of bacteria and fungi release (which can include A*spergillus fumigatus* spp) during certain parts of the growing and harvesting cycle, as can vegetated areas amongst arable land which can generate large numbers of spores during certain parts of the spring and summer seasons. Land used for livestock grazing and associated housing is also a potential bioaerosol source, particularly bacteria, deriving directly from livestock in fields and also from activities associated with livestock such as manure stock piling, manure spreading, and winter feed and bedding storage.

Newbury Works is surrounded by agricultural land.

3 ASSESSMENT OF IMPACTS

3.1 Approach to Site Specific Bioaerosol Risk Assessment (SSBRA)

A standard risk assessment methodology was used to develop a conceptual model for the site which characterises the environmental setting and the various source-pathway-receptor (S-P-R) linkages. These are summarised in the assessment presented below, where each significant S-P-R linkage identified is set out and analysed to give a qualitative assessment of risk.

The level of risk is a combination of the probability or frequency of occurrence of a defined hazard, and the magnitude of the consequences. In the assessment below, each element contributing to the assessment of risk is assigned a 'Very Low', 'Low', 'Medium' or 'High' rating to describe its influence on the final determination of risk and also to rank the degree of risk. Definitions are based on those provided by the Environment Agency's 2009 guidance on risk assessment.

3.2 Source Characterisation

The aerobic digestion process is by necessity enclosed, however under abnormal operational conditions any emission via an open vent may be expected to be a source of bioaerosols. Whilst noting the possibility, the risk of impacts from such infrequent emissions is not considered to be significant and they have not been considered further in this assessment.

Sources of bioaerosol emissions to air from the Advetec process are considered Table 1, below.

Table 1: Bioaerosol Emission Sources-'Critical Control Points'

Operation	Description of Operation	Potential for Bioaerosol Emissions
Feedstock Storage and loading of the Unit.	Waste in "Black Bags" is relatively contained compared with the same waste outside of bags, but, nonetheless the waste is to be shredded. The shredded waste will drop straight into the Biodigestion Unit and therefore will be quickly contained.	Low to Medium release potential: Reducing handling and drop heights when moving waste using mechanical shovels will be helpful.
Aerobic Biodigestion Unit(s)	Aerobic digestion uses aerobic bacteria to "compost" the incoming feedstock. This process results in a significant reduction in volume of waste and a residue which is of sufficient quality to be accepted as Solid Recovered Fuel (SRF). This process uses moist fermentation.	Very Low release potential: The aerobic digestion process is completely enclosed, therefore is unlikely to release bioaerosols. The Unit will be fitted with an automated process control system, activation of which, would result in the Unit being shut down and the chamber lids opened to allow the feedstock to aspirate naturally to atmosphere thus preventing the build-up of any unexpected gases. However this situation would only arise under abnormal conditions and therefore any resulting emissions will be extremely infrequent and short-lived.

Solid Recovered Fuel (SRF) Storage	SRF will be augured into a dedicated covered bay and dry-stored. It will be collected approximately weekly for transport to an Energy from Waste (EfW) plant.	Low to Medium release potential: The SRF Bay is a potential source of bioaerosol emissions. The SRF will be held in a partially enclosed area with a roof covering and three side walls. The quantity stored is expected to be up to approximately 10 tonnes before being transported off site. [Solid recovered fuel (SRF) is a refined form of RDF (refuse derived fuel) intended for use in energy recovery facilities.]

3.3 Identification of Receptors

The EA Guidance*: Bioaerosol monitoring at regulated facilities: RPS 209 (Updated 18 July 2023)* advises that bioaerosol risk assessment is required where receptors are present within 250m of relevant facilities.

In considering which receptors may be within 250m of the J Witt XO22 Biodigestion Unit the nearest residential locations were measured as the shortest distance between the receptor and the Advetec XO22 Biodigestion Unit.

No sensitive receptors within 250 metres were identified associated with residential facilities. There are however neighbouring industrial units at Newbury Works which are used as storage and occasional workshop facilities. (Occupancy <6hrs per day on average per week).

3.4 Pathway Characterisation

3.4.1 General Considerations

As well as providing a standardised approach to determining environmental risk the Source-Pathway-Receptor (SPR) model forms a framework for mitigating pollution, in this case by bioaerosols.

Source	Pathway	Receptor
		
Release of bioaerosols during loading of shredder feed hopper, operation of shredder and Biodigestion Unit, storing and transport of SRF	Airborne transportation.	Nearby sensitive receptors identified in Section 3.2
HAZARD		
Mucous Membrane; Irritation; Systemic symptoms e.g. fever, headache; Sensitisation; Allergic reaction; Infection e.g. *Aspergillus fumigatus*.		

The primary potential pathway for the transport of any bioaerosol emissions from the sources described above towards sensitive receptors is by wind transit.

The main factors relevant to the assessment of these pathways are separation distances (to potential receptors) and the meteorological conditions affecting the direction, distance and degree of dispersion of any bioaerosols released from the facility at any particular time.

If all other factors are equal (e.g. "no wind funnelling" – as is the case at Newbury Works), then those sensitive receptors closest to the Biodigestion Unit are generally at the highest risk of any impact, and the magnitude of any impact will increase or decrease depending on the frequency of wind directions from the proposed development towards any particular receptor.

The distance any bioaerosol particle has to travel from the source to a receptor may be deemed to be inversely proportional to the risk it presents i.e. bioaerosol concentrations will decrease rapidly from the source point, where emissions concentrations are expected to return to background levels within about 100 m (as per Defra study referenced in Section 2.2.1 above).

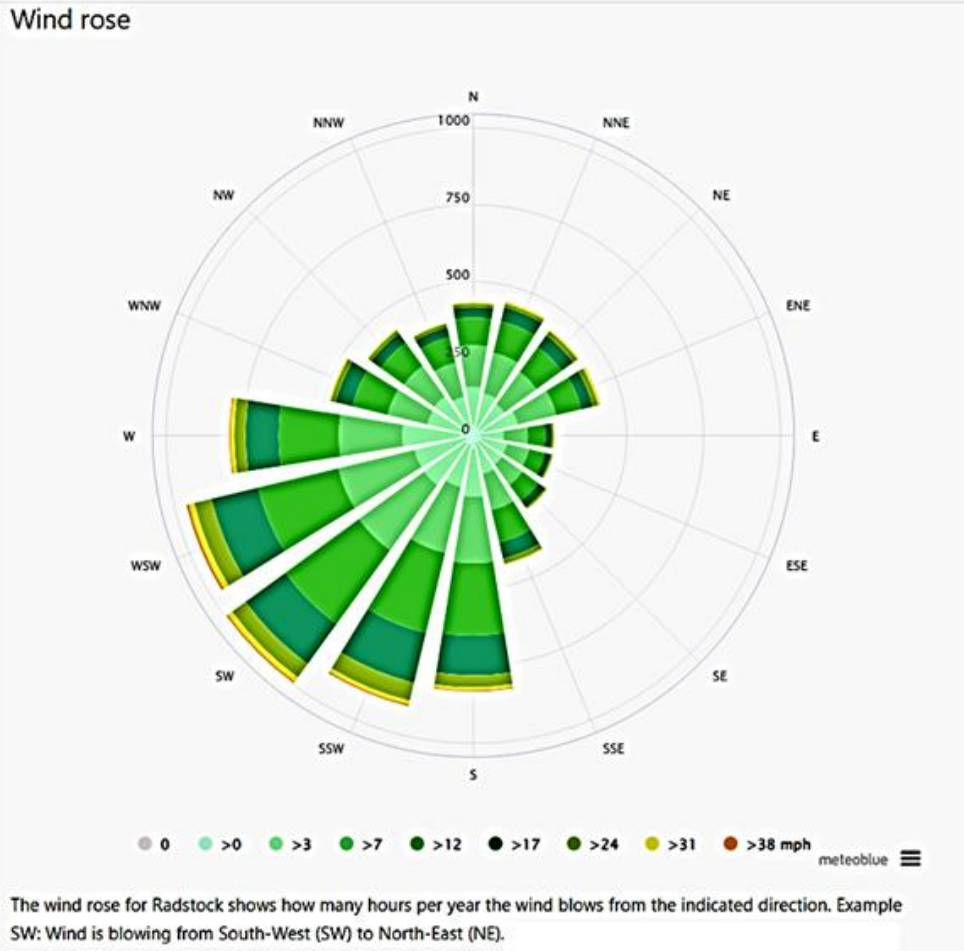
Indeed the main findings of the HSE's 2010 RR786 Research Report: Bioaerosol emissions from waste composting and the potential for workers' exposure (https://www.hse.gov.uk/research/rrpdf/rr786.pdf) was that "There was a general trend of decreasing bioaerosol with distance from the source……By 50m and 100m distances downwind of the process, bioaerosol concentrations were substantially reduced by comparison to those levels measurements at source." In the same document, levels were observed of between 1 and 4% of sources values when measured at 10m .

For individuals at a receptor site significant mitigation is achieved simply by remaining indoors (as is the case with most workers on the Newbury Works site).

3.4.2 Meteorological Conditions

Wind direction according to the UK Met Office, the prevailing wind direction in the area is South-Westerly. (http://www.metoffice.gov.uk/climate/uk/regional-climates/so)

Figure 4: Local wind rose



3.4.3 Wind in Relation to Sensitive Receptor Locations

Outside of Newbury Works industrial site there are no sensitive receptors within 250m. Other than J Witt Ltd. of the remaining industrial units on the site, the closest are 85m & 100m away and upwind.

The frequency of wind from Source to these Receptors is 11% per annum.

3.4.4 Probability Exposure

The probability of exposure examines the likelihood of the receptor being exposed. This takes into account the frequency that the receptor is downwind of site and the frequency that a release takes place. In line with the Guidance on the evaluation of bioaerosol risk assessments for composting facilities (2009), the probabilities of harm can be described as:

High: *exposure is probable*	Direct exposure with no / few barriers between source and receptor.
Medium: *exposure is fairly probable*	Barriers less controllable.
Low: *exposure unlikely*	Barriers exist to mitigate.
Very low: *exposure very unlikely*	Effective and multiple barriers.

For the closest receptor identified, the probability of exposure has been estimated based on the assumption that the operational hours will be 251 days a year and the potential receptors are workers in neighbouring industrial units, assuming potential exposure of 8 hours a day.

Given that the workers in question spend the majority of their time indoors then the following classification is thought appropriate.

Low: *exposure unlikely*	Barriers exist to mitigate.

3.4.5 Estimation of Exposure Concentrations

Measured bioaerosols values at the Advetec Biodigestion Unit at Cribbs Causeway (see accompanying Ambient Bioaerosols Monitoring Report SLR Ref: 416.11977.00001 Version No: 1 October 2021) showed Total Mesophilic Bacteria (Total Viable Count - TVC) concentrations of 48 CFU/m3 and <8 CFU/m3 for *Aspergillus fumigatus* at the Unit's Carbon Filter outlet.

The Advetec Unit installed awaiting commissioning at J Witt Ltd currently has no exhaust filtration, so If we assume that the carbon filter fitted to the Cribbs Causeway Unit removed just 99.5% of the bacterial, and also fungal load, from the exhaust gas then the pre-filtered values would be approaching 10,000 CFU/m3 TVC and AF 1600 CFU/m3

Taking the minimum reduction observed by HSE RR786 (see 3.4.1 above) researchers at 10m of 4%, then even allowing (pessimistically) just another 10% reduction at 80m (nearest receptor) then, given a pessimistic exposure period of 8hrs in each of the 251 days worked out of 365, and that this is for just 11% of the year (% time the wind blows towards the receptor) then the Total Mesophilic Bacteria (Total Viable Count - TVC) and *Aspergillus fumigatus* concentrations that might be expected at the nearest receptor can be calculated as 9 CFU/m3 and 1.5 CFU/m3 i.e. well below the limits set by M9 of 1,000 CFU/m3 for Total mesophilic bacteria, and a limit of 500 CFU/m3 for *Aspergillus fumigatus*.

It is recognised however that there may be higher peak concentrations during shredding operations though these will be of short duration and take place less than 10x per day.

3.5 Risk Assessment

Based on interpolation of the Cribbs Causeway results, and on the basis of the probability of exposure, the Total Mesophilic Bacteria (Total Viable Count - TVC) and *Aspergillus fumigatus* concentrations that might be expected at the nearest receptor are 9 CFU/m3 and 1.5 CFU/m3. Comparing these with data in the publication "Exposure-response relationships for bioaerosol emissions from waste treatment processes Final report Defra Project: WR0606 IOM Contract: 611-00319 Report Date: 18th January 2008" and the limits set by M9 of 1,000 CFU/m3 for Total mesophilic bacteria, and a limit of 500 CFU/m3 for *Aspergillus fumigatus* leads to the conclusion that the risk anticipated at the nearest receptor will be in the low to negligible range.

4 MITIGATION MEASURES

This risk assessment suggests that the risk of a significant impact is very low or low for all envisaged receptors. Nonetheless the Advetec Biodigestion Unit(s) are not yet in operation so future bioaerosols monitoring will be required to determine the exact levels of risk. When this is conducted it will be completed in line with EA Technical Guidance Note TGN M9 Environmental Monitoring of Bioaerosols at Regulated Facilities.

Should levels not be acceptable in practice when operation commences then Advetec engineers will design, build and fit suitable abatement technology to the XO22 Unit(s).

Clearly the Unit(s) will undergo planned maintenance and checks.

Site staff will be instructed to minimise the drop height of material from loaders into the Advetec XO22 Unit(s) feedstock bay and into its dedicated shredder in order to minimise the potential for bioaerosols generation.

5 CONCLUSIONS

Operations with one, ultimately perhaps two, Advetec XO22 Aerobic Biodigestion Units at J Witt Ltd's site at Newbury Works, Coleford, BA3 5RX may have the potential to result in emissions to air of bioaerosol. No sensitive receptors have been identified outside of the Newbury Works area as being within 250m of the Unit, but other neighbouring facilities occupied <6hrs per day per week at the Works are within 80m.

Because of such a potential this bioaerosol risk assessment has been prepared to facilitate assessment by the Environment Agency, prior to granting an Environmental Permit.

The assessment has been qualitative, based on the source-pathway-receptor conceptual model and carried out with reference to relevant guidance.