FICHTNER

Consulting Engineers Limited

Northacre Facility

Northacre Renewable Energy Limited

Schedule 5 Response

ENGINEERING + CONSULTING

Document approval

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Contents

1 Schedule 5 Request

1. **Please provide answers to the following and provide an updated air emissions management system to take account of your answers:**
   a. **A justification that the proposed air changes per hour of 2 during normal operation and 3 when using the odour abatement system, will provide sufficient negative pressure especially if the reception hall door(s) are opened (including if doors fail or become damaged and could not be closed).**

As explained in response to Q8 of the Schedule 5 Request, dated 30 July 2021, the Waste Reception Areas have been designed to provide the following air extraction rates to extract potentially odorous air from these areas:

- During normal operation (equivalent to 2.2 air changes per hour) - 96,500 Nm^3/h; and
- During periods of shutdown (equivalent to 3 air changes per hour) - 132,000 Nm^3/h.

The odour abatement systems within the Facility have been designed in accordance with the latest CIBSE guidance. 'CIBSE Guide B: Heating, ventilating, air conditioning and refrigeration, Part B1' Table 1.20 presents recommended allowances for air infiltration, in terms of air changes per hour, for selected building types. Whilst it does not present recommended allowances for waste treatment facilities it makes the recommendations for building/room types which are considered to be representative of large open areas, such as the Waste Receptions Areas at the Facility, as follows:

Table 1: Recommended allowances for air infiltration for selected building types

Building/room type	Air infiltration allowance - air changes/hour
Factories – 3000 m^3 to 10,000 m^3	0.5 to 1.0
Factories - over 10,000 m^3	0.25 to 0.75
Warehouses - working and packing areas	0.5
Warehouses - storage areas	0.2

This confirms that the proposed number of air changes are in excess of those specified in recognised standards for ventilation systems.

The number of air changes will be maintained by extracting air from the building either into the combustion process or into the odour control system. Air from outside of the building would be drawn into to replace the air being extracted, thus preventing potentially odorous air being released from the building.

The Tipping Hall has been designed as a fully enclosed building. It will have five automated roller-shutter doors. The roller shutter doors will only open for waste delivery vehicles to access the building. When the waste delivery vehicles are within the building the roller-shutter doors will close. To allow air flow into/through the building when the roller-shutter doors are closed, louvres will be fitted across the width of the building above the roller-shutter doors, as shown on the elevation drawings within the planning application.

During periods of normal operation, when waste deliveries are not occurring the doors will be closed, and the only air flow into the building will be via the louvres. As explained in response to Q1b, the building management system will control the opening and closing of the louvres as the doors to the Waste Reception Area are opened/closed.

The dimensions of the doors and louvres can be used to calculate the areas of these openings, and are provided in the following table:

	Width (m)	Height (m)	Area (m^2)
Door (x1)	5	6	30
Louvres (maximum)	34	1.8	61.2

Therefore, allowing for the building management system controlling the opening and closing of the doors and louvres to the Tipping Hall to maintain effective odour abatement from Waste Reception areas, the velocity of air flows through the openings into the building will be as follows:

Doors Open	Louvres Open (%)	Velocity through opening (m/s)	
		During periods of shutdown	During normal operation
0	100%	0.60	0.44
1	50%	0.60	0.44
2	0%	0.60	0.44
3	0%	0.41	0.30
4	0%	0.31	0.22
5	0%	0.24	0.18

Finally, in the extreme event that all of the doors to Tipping Hall are open, and the louvres are also open, the velocities through the doors will be as follows:

- During a period of shutdown - 0.17 m/s; and
- During normal operation - 0.13 m/s.

Therefore, this demonstrates that the Tipping Hall will be maintained at a suitable negative pressure, with a constant flow of air into the building, even in the extreme event that all doors to the Tipping Hall and the louvres are open.

c. How the building management system will monitor negative pressure to ensure that appropriate negative pressure and air changes are maintained.

The building management system will be subject to detailed design. However, the concept of the building management system is as follows:

- The building management system will be designed to be an automated control system, which will be linked to the Distribution Control System (DCS) for the process plant.
- The DCS will monitor the volumetric flow rate within the combustion process and the flow of combustion air from the waste reception areas.
- Using the air flows from the DCS, the building management system will control the opening and closing of the louvres within the Waste Tipping Hall, depending on the number of doors which are open for waste deliveries to ensure that the air flow into the building from the doors and louvres within the openings to maintain negative pressure allowing for changes in the volumetric flow rate within the Facility.

d. One standby carbon filter is proposed, provide justification as to whether this will be sufficient.

To allow for degradation of the filter material, the carbon will be replaced following a specified number of operating hours, which is normally specified by the supplier of the carbon filter/carbon filter media. The carbon filter will typically only be required to operate during periods of planned and unplanned shutdown of the Facility. Therefore, maintenance of the filter media can be undertaken whilst the Facility is in operation.

A back-up carbon filter system is proposed for the Facility to provide redundancy in the abatement of odour to enable maintenance of the carbon filter media to be undertaken on one of the duty filters either whilst the Facility is in operation, or if it is in shutdown.

Therefore, providing a single standby filter system will ensure that the odour abatement system is able to provide effective odour abatement at all times, including when undertaking maintenance on one of the filters.

e. **How would negative pressure be maintained during a power cut. Please consider both a power cut occurring during operation of the incinerator and if it were to occur during shut-down.**

In the event that there was a power cut at the Facility, the Facility would be able to generate power and operate in 'island mode'. This which would mean that the Facility would be able to maintain full operation without exporting power.

In the highly unlikely event that the Facility lost connection to the grid at the same time as a turbine failure, it would need to enter a shutdown sequence. In this scenario, Emergency Diesel Generators (EDG(s)) would maintain operation of the Facility, which would include providing negative pressure within the waste reception areas whilst the waste on the combustion bed was being burnt-out. Following completion of the shutdown sequence, the EDG(s) would continue to operate and provide emergency power to the site. Therefore, this would be able to provide back-up power for the operation of the odour abatement system in this scenario.

In accordance with the requirements of the Medium Combustion Plant Directive (MCPD), it is understood that an EDG can operate for up to 500 hours per annum and be exempt from the emission limit values in the MCPD.

2. **In your assessment an odour taint threshold for benzaldehyde of 0.32 mg/l was used. Please justify the use of this threshold and consider whether other lower thresholds might apply.**

The odour taint threshold value for benzaldehyde used in the assessment was as per the previous assessment carried out in 2008 by SLR for the Hills MBT[1]. This was referenced as 0.32 mg/kg from Tilgner and Ziminska (1982)[2] extracted from the L.J. Van Gemert 2003 publication "compilation of odour threshold values of compounds in air, water and other media (edition 2003)".

L.J. Van Gemert originally published the compilation in 1977 and in the following years a number of additional supplements were prepared. The most recent version of the L.J. Van Gemert publication is dated 2011[3] and is available from Oliemans Punter and Partners. The publisher explains that the present compilations are "*as complete as possible from the early days of olfactory and gustatory research until 2010 and are based on original sources from literature*"[4].

[1] SLR (2008) Northacre Resource Recovery Centre, Detailed Assessment of Air Quality

[2] Tilgner & Ziminska (1982) – The influence of storage time on sensory intensity of aroma and flavour substances, Nahrung 33, 433-442.

[3] L.J. Van Gement (2011) complications of odour threshold values of compounds in air, water and other media (second and enlarged edition)".

[4] http://www.leffingwell.com/bacis2.htm

The L.J. Van Gemert 2011 publication includes the following odour taint thresholds for benzaldehyde in various media:

Media	Threshold value (mg/kg)	Source
Liquid petrolatum	0.33	Proetz (1924)
Diethyl phthalate	44	Rosenthal (1927)
Propylene glycol	500	Moncrieff (1957)
Sugar-acid base	0.19	Williams and Ismil (1981)
White wine	3 – 3.5	Delfini (1987)
Diethyl phthalate	0.0001 – 1,000	Gross-Isseroff and Lancet (1988)
Diethyl phthalate	1,550	Gross-Isseroff and Lancet (1988)
Base sake	0.97 – 0.99	Utunomiya et al (2004a)
Base sake	1.9	Utunomiya et al (2004a)
14% ethanolic solution	5	Moreno et al (2005)
Deodorised edible oil	0.06	Garcia-Gonzalez et al (2008)
7% acetic acid solution	0.158	Tesfaye et al (2008)

As shown, none of the media are comparable to dairy products. Therefore, reference has been made to the odour thresholds for water set out in the L.J. Van Gemert (2011) publication. These are set out in the following table.

Threshold value (mg/kg)	Source
0.35	Buttery et al (1969b, 1971, 1987b, 1988a, 1994a, 1997, 1999; Guadagni (1970b) Hansen et al (1992) Buttery &Ling (1995, 1998)
0.32	**Tilgner & Ziminska (1982)**
1.4 – 2.2	Rabin & Cain (1986)
0.5 – 1.0	Delfini (1987)
3.5	Buttery et al (1990a); Buttery (1993)
1 – 4.6	Sugisawa et al (1991) Yang et al (1992) Tamura et al (1993, 1995)
0.3	Darriet et al (2002)
0.024 – 0.047	Fabrellas et al (2004)
0.35	Pino & Mesa (2006)
0.75089	Giri et al (2010)

As shown the only published threshold values which are lower than 0.32 mg/kg are Darriet et al (2002)[5], and Fabrellas et al (2004)[6]. Although these values are lower they are only slightly lower than that set from Tilgner & Ziminska (1982).

The concentration of benzaldehyde which is predicted to be transferred to the product from the odour extraction system and the main stack has been extracted from the Odour Bioaerosol & Taint Assessment as follows:

Emissions source	Concentration in product (mg/kg)
Main stack	1.67×10^{-4}
Odour extraction system	6.21×10^{-5}

Using the concentrations from each emission source, the odour taint to concentration ratio has been calculated based on the lower odour taint threshold values where there is a range. The results are shown in the table below:

Odour threshold value (mg/kg)	Source	Odour taint to conc. ratio	
		Main Stack	Odour extraction system
0.32	**Tilgner & Ziminska (1982)**	**0.0005**	**0.0002**
0.3	Darriet et al (2002)	0.0006	0.0002
0.024 – 0.047	Fabrellas et al (2004)	0.007 – 0.004	0.003 – 0.001

This is based on the conservative assumptions set out in the Odour Bioaerosol & Taint Assessment including a transfer rate of 90% to product.

As shown, using the slightly lower odour thresholds does not change the conclusion that the odour taint to concentration ratio for benzaldehyde is much less than 1 based on emissions from either the odour extraction system or the main stack.

Using the most stringent odour taint threshold value, the maximum concentration in product to have a concentration to product ratio of 1 would be 0.024 mg/kg. This is 0.069% of the concentration in product predicted from the odour extraction system, and 0.26% of the concentration in product predicted from the main stack, using the highly conservative assumption set out in the Odour, Bioaerosol and Taint Assessment. Therefore, the concentration in product as a result of the operation of the odour extraction system would need to be over 140 times larger, and from the operation of the main stack would need to be nearly 400 times larger, than that predicted for the odour taint to concentration ratio for benzaldehyde to be greater than 1.

It is understood that Ricardo Energy and Environment (Ricardo) has been commissioned by Arla Foods Limited to undertake an assessment of the potential health taint, taste taint and odour taint risks from the proposed Facility. Ricardo has identified a different odour taint threshold

[5] Impact odorants contributing to the fungus the aroma from grape berries contaminated by powdery mildew (Uncinula necator); incidence of enzymatic activities of the yeast *Saccharomyces cervisiae*, J. Agric. Food Chem. 50, 3277-3282

[6] Determination of odour threshold concentrations and does response relations in water of several minor disinfection by products, akdehydes and alkyl nitriles, Wate. Sci. Technol., 49, no. 9 267-272

for benzaldehyde than those identified within the L.J. Van Gemert 2011 publication, namely a threshold taken from Haese et al (2014)[7].

The value from Haese et al (2014) is from table 1 in that paper and stated as 0.010 – 4,600 µg/l, with a footnote showing that these were sourced from Young and Suffet (1999)[8] and Van Gemert (2011).

Van Gemert (2011) is the publication used in the preceding part of this analysis. We note that the upper end of the range in Haese et al (2014) is consistent with the highest taint threshold reported in Van Gemert (2011) of 4.6 mg/kg (or 4,600 ug/kg) and listed above.

The lower end of the range is from Young and Suffet (1999) and is over 1000 times smaller than the lowest value recorded in Van Gemert (2011). On reviewing Young and Suffet (1999), the source of the threshold value is Mallevialle and Suffet (1987)[9]. This is a report published by the American Water Works Association Research Foundation and is only available to subscribers to the Foundation. However, the abstract of the research project states "Reviews advances in the analysis and treatment of tastes and odors in drinking water and relates those advances to historical and current water treatment practices."[10] Hence, it is likely that the odour threshold referenced in Mallevialle and Suffet (1987) is actually sourced from a separate research paper.

The values presented in the L.J. Van Gemert publication are based on original sources from literature and includes reference to papers pre-dating the Mallevialle and Suffet (1987) report. Therefore, whilst the reference to the original source of the lower value stated in Mallevialle and Suffet (1987) cannot be found, it is considered that the values stated in L.J. Van Gemert (2011) are appropriate.

3. For the proposed emergency diesel generator please confirm

a. The thermal input (MW)

The thermal capacity of the Emergency Diesel Generator (EDG) will be subject to detailed design and procurement of the engines for the Facility. However, the thermal capacity of the EDG will be sized to provide sufficient power to shutdown the Facility and maintain operation of the odour abatement systems until the grid connection can be restored – refer to the response to Q3b.

Taking into consideration the parasitic load of the Facility (2.97 MWe), and a conservative electrical efficiency of 30%, the EDG will have a thermal capacity of approximately 9.6 MWth.

It is proposed the thermal capacity of the installed EDG is confirmed to the EA following completion of detailed design.

b. Further information on expected operating scenarios and duration

The EDG will only operate in the following scenarios:

- for testing and maintenance purposes – expected to be tested every two weeks for less than 30 minutes, so no more than 1 hour per month in total; and

[7] Haese et al (2014) – Tastes and Odors of Water – Quantifying Objective Analyses: A Review, Critical Reviews in Environmental Science and Technology, 44:2455-2501.

[8] Young and Suffet (1999) – Development of a standard method – analysis of compounds causing tastes and odors in drinking water. Wat. Sci. Tech Vol 40. No.6 pp 279 -285

[9] Mallevialle and Suffet (1987) Identification and Treatment of Tastes and Odours in Drinking Water. American Water Works Association Research Foundation, Denver, CO

[10] https://www.waterrf.org/research/projects/identification-and-treatment-tastes-and-odors-drinking-water

- in the event of loss of grid connection to maintain operation of the abatement and control systems to enable a safe shutdown the Facility – assumed to be typically no more than 4 hours for any one event.

  In this operating scenario, the EDG would need to operate at 100% load following the initial loss of grid connection. However, as the shutdown sequence progressed the abatement and control systems would be reduced in operation so that the EDG could operate at a reduced load to maintain operation of the odour abatement systems until the grid connection could be reinstated to enable the Facility to commence the start-up sequence with power for start-up being provided by the grid.

Therefore, apart from maintenance and testing purposes, which will be much less than 50 hours per annum, the EDG will only operate as an emergency/safety system to enable safe shutdown or provide back-up power in the event of a loss of grid connection. Typically, an EDG will need to operate to provide capacity for safe shutdown of the Facility less than once per year. It is understood that Hills Group has had to operate its EDG due to loss of grid connection once (July 2021) since 2017 when it started recording the incidents when its EDGs were required to operate. Therefore, taking into consideration the experience of the MBT facility, it is anticipated that the operation of EDGs due to loss of grid connection is likely to be a minimum of every 5 years.

It can be confirmed that the engines will be designed in accordance with the requirements of the recent proposed BAT requirements for new emergency standby diesel generators within IED permits as consulted with Energy UK and its members.

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