

Northacre Renewable Energy Limited

Northacre Facility

Schedule 5 Response – Additional Information

1 Background

Northacre Renewable Energy Limited (NREL) has applied to the Environment Agency (EA) for an Environmental Permit (EP) to operate the Northacre Renewable Energy Facility (the Facility) on land off Stephenson Road, Westbury, Wiltshire.

Fichtner Consulting Engineers Ltd (“Fichtner”) undertook an Odour, Bioaerosol and Taint Assessment (ref: S2862-0030-001RSF) in order to provide details on the likely impact of odour and bioaerosols on adjacent premises. This was submitted to the EA as part of the EP determination process.

Following the submission of this assessment, the EA issued a Schedule 5 request for additional information. As part of this request, the EA asked for the taint threshold used for benzaldehyde to be justified and for consideration as to whether other lower thresholds might apply. A response was provided on 06/12/21 (ref: S2862-0410-0049JRS).

As part of this response, reference was made to the taint thresholds for benzaldehyde in other media as set out in the L.J. Van Gemert 2003 publication “compilation of odour threshold values of compounds in air, water and other media (edition 2011)”. This analysis showed that taint thresholds for benzaldehyde are available from literature but none of these are comparable to dairy products. Therefore, the odour taint threshold for benzaldehyde was taken from literature based on detection in water.

To further justify that the threshold used in the Odour, Bioaerosol and Taint Assessment, which was based on detection in water, is applicable to the products produced by the Arla Dairy, additional analysis has been carried out. The analysis included a review of odour taint thresholds published in literature to identify any additional substances which have an odour taint threshold for both water and dairy products. Within the analysis a comparison has been made to determine whether the threshold for dairy products is higher than water. In addition, the conservative assumptions used in the analysis have been set out.

2 Analysis

2.1 Taint thresholds

Of all the substances listed in the L.J. Van Gemert 2011 publication, the only compound which is classified as an aldehyde (same group as benzaldehyde) and for which threshold values are available for water and other media is 4-Hydroxy-3-Methoxybenzaldehyde.

An odour threshold value of 7.413 mg/kg is presented in the L.J. Van Gemert 2011 publication for skim milk which is referenced as being taken from Karagul-Yuceer et al (2004)¹. In the same paper, the odour threshold value in water is 0.064 mg/kg, which is less than 1% of the value in skim milk. This suggests that the aldehyde is more easily detected in water than in skim milk, and hence using the threshold for water will overstate the impact in milk.

L.J. Van Gemert 2011 includes a number of other measurements of the odour threshold in water for this aldehyde.

Table 1: *Odour Tresholds in Water, 4-Hydroxy-3-Methoxybenzaldehyde*

Source	Threshold value (mg/kg)	% of Threshold in milk Karagul-Yuceer et al (2004)
Helbig (1939)	0.1533	2%
Cartwright & Kelly (1952)	0.2	3%
Cartwright & Kelly (1952)	3	40%
Appell (1969)	1	13%
Dietz & Traud (1978)	0.06	1%
Hermann & Abd El Salam (1980b, 1981)	0.226 - 1.78	3 - 24%
Tilger & Ziminska (1982)	0.28	4%
Tuorila et al (1982)	0.0290 - 0.107	0.4 – 1.4%
Mozell et al (1986); Schwartz et al (1987)	1.5 - 41	20 - 553%
Voirol & Daget (1986)	0.3 - 1.6	4 - 22%
Eccles et al (1989)	66.7	900%
Buttery & Ling (1995); Buttery et al (1997, 1999)	0.058	1%
Semmelroch et al (1995)	0.025	0.3%
Ong & Acree (1999)	1.2	16%
Karagul-Yuceer et al (2003, 2004)	0.064	1%
Schuh & Schieberle (2006)	0.025	0.3%
Czerny et al (2008)	0.053	1%
Czerny et al (2008)	0.21	3%
Note: Odour threshold values for 4-Hydroxy-3-Methoxybenzaldehyde in water as stated in L.J. Van Gemert 2011		

The range of threshold values is 0.025 to 66.7 mg/kg. However, there are two outliers in this range - Schwartz et al (1987) and Eccles et al (1989) – as the range of values from the other papers is 0.025 to 1.78 mg/kg. This means that the substance was detected in water at a much lower concentration in the other papers than in the outliers, and so it is more appropriate to consider the more stringent values.

¹ Evaluation of the character impact odorants in skim milk powder by sensory studies on model mixtures, J. Sens. Stud., 19, 1 -13.

Excluding the outliers, the odour threshold in water is 0.3% to 24% of the odour threshold in skim milk. Along with the direct comparison in Karagul-Yuceer et al (2004), this confirms that using the threshold for water will overstate the impact in milk.

We also note that the range of values for 4-Hydroxy-3-Methoxybenzaldehyde in water of 0.025 to 1.78 mg/kg is comparable to the range of values for benzaldehyde of 0.024 to 2.2 mg/kg, as reported in the Schedule 5 response, which suggests that their odour potential is similar.

In addition to the L.J. Van Gemert 2011 publication, reference has been made to an EA document (the determination of taste and odour in drinking water (2010)). This document has been withdrawn but includes a table of approximate odour threshold concentrations for substances in water and includes a threshold value for benzaldehyde of 35 µg/l. This equates to 0.035 mg/kg. The source of this value is not referenced in the EA document, but we note that it is the mid point of the range from Fabrellas et al (2004), which was used in the calculation within the Schedule 5 response. As demonstrated in the Schedule 5 response, even using the lower end of the range from Fabrellas et al (2004) the predicted odour taint to concentration ratio would be significantly lower than 1 for benzaldehyde, so we do not consider that using the value from the EA document would change the conclusions of the assessment.

2.2 Conservative Assumptions

This analysis was based on a number of conservative assumptions:

1. It was assumed that the odour abatement system runs at 70% efficiency, which is the lower value of the expected 70-99% efficiency.
2. It was assumed that there would be no abatement of benzaldehyde from the main stack, which is unlikely as the extracted air would go through the combustion process.
3. Dispersion modelling was carried out using five years of weather data and the maximum 1-hour concentration was used to compare with the thresholds. This accounts for the potential for either the odour abatement system or the main stack to be operating during the worst-case weather conditions for dispersion.
4. It was assumed that the process at the dairy needing ambient air is operating with:
 - a. an air intake rate of 165,000 m³/hr per line; and
 - b. a milk production rate of 5,500 kg/hr per line.

In Arla's Planning Technical Briefing Note, some slightly different information is provided.

- c. The air intake is stated to be 138,000 kg/hr per line at a density of 1.22 kg/m³, giving an intake flow rate of 113,114 m³/hr per line.
- d. The powder production lines are stated to have a capacity of 5 t/hr, or 5,000 kg/hr.
- e. The total production rate is stated to be 55,000 tonnes of milk powder per year, which implies an average production rate of 3,140 kg/hr.

Based on this, the values used in the assessment are assumed to be the peak design values. It is possible that the latest figures from Arla reflect optimised performance, such that the drier plant can now operate with less air and hence the intake of pollutants in the air per tonne of product is lower. This means that the assessment is conservative.

5. It was assumed that 90% of substances in the air would be transferred to the product. As explained in the Assessment, this appears to be very conservative. The background concentration of benzene, as reported in the air quality assessment, is 0.39 µg/m³, or 390 ng/m³. If 90% of this concentration were to transfer to the product, then the concentration of benzene in the product would be 0.0105 mg/kg, or around 10 times the health-based taint threshold of 0.001 mg/kg. Since it is assumed that Arla's current

product complies with the health-based taint threshold, the transfer rate to the product of benzene must be 10% or less.

Finally, the operations at the Dairy are described in section 3.1 of the Odour, Bioaerosol and Taint Assessment. This explains that the processes affected would be the production of powdered milk, where air is used to remove moisture from the milk concentration to produce the product. The product would need to be diluted before use. The analysis has not accounted for the dilution of product with water which would further reduce the amount of contaminant in the final milk product.

3 Conclusion

This analysis has demonstrated that of all the substances listed in the L.J. Van Gemert 2011 publication the only compound which is classified as an aldehyde (same group as benzaldehyde) and for which threshold values are available for water and other media is 4-Hydroxy-3-Methoxybenzaldehyde.

For this substance, the published odour threshold values in water are significantly lower than the odour threshold value in milk, with the exception of two outlier studies in which the aldehyde was only detected at much higher concentrations in water (and milk was not considered). Based on this analysis it is considered that the odour threshold value for benzaldehyde in water is likely to be lower than that which would be detected in milk products and so the taint assessment is conservative.



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