

# **Milk and Dioxins from Rose Energy**

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for

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## **PREFACE**

1. The following paper, prepared by Bob Foy of the Agri-Food and Bio-Sciences Institute, addresses some concerns which have been expressed about the potential impact of emissions, and specifically dioxins, from the proposed Rose Energy Biomass Fuelled Power Plant at Glenavy upon milk and the consequences for human health.
  
2. The proposed power plant not only requires planning permission but also a Permit under the Integrated Pollution Prevention and Control Regulations (NI) 2003. To obtain the IPPC Permit it must be shown that the proposed plant is fully compliant with the mandatory emissions standards under European and UK and Northern Ireland law. Those mandatory requirements are The Air Quality Limit Value Regulations (NI) 2002, updated by the policy and air quality objectives and standards of The Air Quality Strategy for the UK and Northern Ireland, and the emissions' limits imposed under the Waste Incineration Directive (2000/76/EC). The air quality standards look to the future and require that all proposed new plant meets the standards which are scheduled to become statutory requirements, initially in 2010. With the exception of exempt plants, all new power plants including that proposed by Rose Energy Ltd must meet WID emission limits now; those emission limits include for dioxins and furans.
  
3. The Rose Energy biomass fuelled power plant has been designed to comply with the air quality standards and WID emission limits; in practice it is expected that emissions will be significantly lower than those standards and limits. These standards and emission limits are considerably tighter than those under which coal and oil fired power stations in the United Kingdom and Northern Ireland currently operate. Without full compliance with the air quality and emission limits, which will be continuously monitored and regulated by the Government's Environment and Heritage Service, no IPPC Permit will be issued and maintained. Without the IPPC Permit the proposed Rose Energy plant cannot legally operate.

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Concern has been expressed that the Rose Energy Power Plant at Glenavy may result in milk from neighbouring dairy farms becoming contaminated by dioxins emitted from the plant. The environmental significance of dioxins is primarily a human health one and the very low risk posed by emissions of dioxins from the plant has been documented in the Human Health Assessment that is part of the Environmental Impact Assessment for the power plant. This paper is intended to provide further clarification as to the nature of the link between dioxins and milk produced near the power plant. The dioxins referred to are the polychlorinated dibenzo-p-dioxins and polychlorinated dibenzo furans as these are included in the emission inventory of the Rose Energy plant whereas dioxin-like polychlorobiphenyls (PCBs) are not.

1. Dioxins are now widely distributed throughout the biosphere and no environment can be considered to be dioxin free. Recently dioxins were found in every butter sample analysed from 37 countries (1). Human exposure is dominated by the food we eat, as direct inhalation represents only a small proportion, less than 5%, of total intake. Dioxins are found in virtually all foodstuffs but concentrations are highest in meat, fish, milk and dairy products. This reflects the high solubility of dioxin in fats as well as the tendency for dioxins to magnify or bioaccumulation within a food chain (2).
2. Current policy in the UK is to follow the guidance given by the WHO that daily intake should not exceed to the range 1-4 pg TEQ /kg body weight/day – referred to as the tolerable daily intake (TDI). The UK Committee on Toxicity recommend an average TDI of 2 pg TEQ/kg body weight/day. (Individual dioxins vary greatly in their toxicity and amounts of dioxin found in the environment are generally expressed in units of toxic equivalent units or TEQ.) The dioxin content of foodstuffs is also controlled by the European Commission Regulation EC 199/2006. This sets a maximum level of dioxins in milk and milk products of 3 pg TEQ /g fat or 3 ng TEQ kg<sup>-1</sup> fat (3, 4).
3. Dioxin levels in milk are a reflection of dioxins in the cows' diet from which they find their way into the milk. The few experimental studies on the rate of dioxin transfer from diet to milk report transfers to milk ranging from 1 to 40% of intake (5, 6). Elevated levels of dioxin in milk have occurred through the accidental or illegal contamination of imported dairy diets. In Germany and the Netherlands elevated levels in milk were traced to dioxins in citrus pulp from Brazil that was fed to cattle. In turn the dioxins originated from lime used to neutralise the pulp (7). In Belgium recycled and illegally contaminated oils were added to animal feeds and resulted in elevated dioxin levels. The dominant impact was from dioxin-like PCBs and contamination was most serious in poultry and pig meat rather than milk (8, 9). Elevated levels of dioxin in milk and beef in the USA were attributed to the contamination arising from wood preservatives used in farm buildings as the common wood preservative pentachlorophenol (PCP) is known to be contaminated by significant amounts of dioxin (10, 11).

4. Dioxins are present in soils due to atmospheric deposition. High rates of deposition raise concentrations in the soil as can repeated additions of sewage sludge to the land (12). Experimentally, no statistical difference has been found between the dioxin contents of crops grown on high dioxin soils compared to control or non-impacted soils. Uptake of dioxins via plant roots is therefore considered to be an insignificant pathway for dietary intake by humans (13, 5). However for grazing animals there is some evidence for a low rate of transfer from soil to animal and this may reflect the capacity of cattle to ingest soil while grazing (13). Although dioxins are stable and long-lived in the soil, dioxin levels in milk fell quite quickly, within three years, when high atmospheric deposition rates have been controlled (14). Similarly although dioxins are considered to have a long half life in animal tissue, in cattle which have been subject to high intakes, there is evidence for rapid decline in body burden of dioxin (6).
5. Contamination of milk by dioxins has occurred when cows have fed on grass that has been directly contaminated by atmospheric deposition of dioxins. The only case within the UK of milk being withdrawn from sale due to high dioxin level was from two farms close to the Coalite chemical plant at Bolsover in Derbyshire (15). Two nearby farms were shown in 1990 to have high dioxin levels of 40 and 42 ng TEQ kg<sup>-1</sup> fat. By comparison milk from farms located in rural areas of England and Wales had milk fat dioxin levels in the range 1.1-1.5 ng TEQ kg<sup>-1</sup> fat. At the time a control limit of dioxin in milk fat was set within GB at 17.5 ng TEQ kg<sup>-1</sup> fat and the milk from the two farms was withdrawn from sale. Twenty seven additional farms in the Bolsover area were also sampled but none had milk above the 17.5 limit with an observed range of 3.0 - 7.1 ng TEQ kg<sup>-1</sup> fat.
6. The Coalite site contained a chemical incineration plant as well facilities for manufacturing smokeless fuel and PCP, all of which had the potential to produce dioxins. The processes and the composition of the materials used at the Coalite site can not be regarded comparable to power generation at the Rose Energy plant or the composition of broiler litter and meat and bone meal that would be used as a feedstock for generating electricity. In addition the Coalite site was without dioxin mitigation processes and would not meet current regulations. Subsequently it was considered that the chemical incinerator was the dominant source of dioxins to the atmosphere (15). By the time monitoring of atmospheric deposition rates of dioxins in the vicinity of the Coalite site had commenced in October 1992 the incinerator had closed down. Measured atmospheric deposition rates in 1992-1993, with a median rate of 18 pg TEQ m<sup>-2</sup> day<sup>-1</sup> and a maximum rate of 25 pg TEQ m<sup>-2</sup> day<sup>-1</sup>, were not markedly different from rural sites in GB (16). Dioxin levels in milk from the two impacted farms had by over 80% from over 40 ng TEQ kg<sup>-1</sup> fat in 1990 to less than 10 ng TEQ kg<sup>-1</sup> fat in 1992 (14).
7. The only study of dioxins in milk from Northern Ireland was a survey of five farms and five retail dairies undertaken in 1993-1994 (17). Each location was sampled four times over a twelve month period. The concentration range of dioxins from the farms was very similar to that for rural farms in England and Wales quoted above. The range for mean values for the farms in Northern Ireland was 0.94 -1.7 ng TEQ kg<sup>-1</sup> fat. The range for individual milk samples was 0.84-3.0 ng TEQ kg<sup>-1</sup> fat. The dioxin

range in milk fat from the retail dairies was 1.1-1.3 ng TEQ kg<sup>-1</sup> fat and so in line with concentrations of the farm samples. One of the Northern Ireland farms tested was near Aghalee and so within 10 km of the proposed plant. Milk from this farm was low at 1.1 ng TEQ kg<sup>-1</sup> fat. A survey undertaken of soils in Northern Ireland in 1989 found dioxin levels that were considered to be at the lower end of the range observed for soils in England and Wales further indicating that levels of dioxins are low in Northern Ireland (18).

8. Milk sampled from the Irish Republic in 1993 showed levels of dioxin similar to those found in Northern Ireland of close to 1 ng TEQ kg<sup>-1</sup> fat (18). In keeping with general lowering of dioxin exposure throughout Europe dioxin levels in milk samples from Ireland have declined since 1993 (19, 20, 21). The international comparison of dioxins in butter showed that Ireland ranked 13 lowest out of 37 countries (1). Within Europe, only butter from Sweden, Finland, Norway and Latvia had lower dioxin burdens than from Ireland.
9. The Irish butter sample had a dioxin level of 0.23 ng TEQ kg<sup>-1</sup> fat (1). Five samples of butter from GB showed a range from 0.27 to 0.51 ng TEQ kg<sup>-1</sup> fat and, although higher than the Irish sample, well below the EC limit value of 3 ng TEQ kg<sup>-1</sup> fat. The average dioxin level in the GB butter of 0.42 ng TEQ kg<sup>-1</sup> fat was over 50% lower than the dioxin level recorded on a milk fat basis for milk from rural samples in England and Wales during the early 1990s pointing to a general decline in dioxin deposition. From this it is concluded that current levels of dioxin in milk from Northern Ireland continue to be low and well below the EU limit. From this it would be expected that only a large dose of dioxin emitted from the Rose Energy plant would be of significance to milk producers.
10. In contrast, even under the worst case scenario of operation the projected deposition of dioxins in the vicinity of the Rose Energy plant will be low in comparison to background deposition rates of dioxins measured in GB. Thus under the high emission scenario for dioxins given in Table 7.1 of the Airshed Report the maximum rate of dioxin deposition at any receptor near the plant is given as  $1.88 \times 10^{-9}$  mg TEQ m<sup>-2</sup> day<sup>-1</sup> or 1.88 pg TEQ m<sup>-2</sup> day<sup>-1</sup>. The map of projected deposition rates close to the plant, plotted in Figure 9 shows that deposition rates are mostly well below 1 pg TEQ m<sup>-2</sup> day<sup>-1</sup>. These rates can be considered low as they are similar to or below background deposition rates recorded in GB (20). Thus the median rate in 1993 at the rural site of Hazelrigg near Lancaster was 2 pg TEQ m<sup>-2</sup> day<sup>-1</sup> and the mean 81 pg TEQ m<sup>-2</sup> day<sup>-1</sup>. At, what was termed, a semi-background site at Llandegfedd Reservoir in Wales the median was 32 pg TEQ m<sup>-2</sup> day<sup>-1</sup> and the mean 36 pg TEQ m<sup>-2</sup> day<sup>-1</sup>.
11. Given the evidence that background or rural levels of atmospheric deposition in GB resulted in milk dioxin levels of close to 1 ng TEQ kg<sup>-1</sup> fat and hence well below the EU limit for milk fat of 3 ng TEQ kg<sup>-1</sup> fat, it can be concluded that the small additional dioxin deposition resulting from the Rose Energy Plant will not have a significant effect on dioxin levels in locally produced milk.

12. This conclusion is consistent with relatively small amounts of dioxin that the Rose Energy Plant will produce. The projected maximum dioxin emission of  $6.8 \times 10^{-9}$  TEQ g/s equates to an annual emission of  $0.215 \text{ TEQ g year}^{-1}$ , while the lower projection for emissions is  $0.09 \text{ TEQ g year}^{-1}$ . These amounts are small in comparison to an atmospheric emissions inventory total for the UK for 2005 of  $200 \text{ TEQ g year}^{-1}$  (21).

## References

- 1) Weiss, J., Pöpke O. & Bergman, Å. (2005) A worldwide survey of polychlorinated dibenzo-p-dioxins, dibenzofurans, and related contaminants in butter. *Ambio* 34: 589-597.
- 2) AEA Technologies (1999) *Compilation of EU dioxin exposure and health data. Summary Report*. Report produced for European Commission DG Environment & UK Department of the Environment Transport and the Regions (DETR). <http://ec.europa.eu/environment/dioxin/pdf/dioxin.pdf>
- 3) van Leeuwen, F.X. R., Feeley, M., Schrenk, D., Larsen, J.C., Farland, W. & Younes, M. (2000) Dioxins: WHO's tolerable daily intake (TDI) revisited. *Chemosphere* 40: 1095-1101
- 4) Committee on Toxicity (2001) *Statement on the tolerable daily intake for dioxins and dioxin like polychlorinated biphenyls*. Committee on Toxicity of Chemicals in Food, Consumer Products and the Environment. (COT/2001/07). <http://www.food.gov.uk/multimedia/pdfs/cot-diox-full.pdf>.
- 5) Rychen, G., Jurjanz, S., Toussaint, H. & Feidt, C. (2008) Dairy ruminant exposure to persistent organic pollutants and excretion to milk. *Animal* 2: 312-323.
- 6) Huwe, J.K. & Smith D.J. (2005) Laboratory and on-farm studies on the bioaccumulation and elimination of dioxins from a contaminated mineral supplement fed to dairy cows. *Journal of Agricultural and Food Chemistry* 53:2362-2370.
- 7) Malisch, R. (2000) Increase of the PCDD/F-contamination of milk, butter and meat samples by use of contaminated citrus pulp. *Chemosphere* 40:1041-1053.
- 8) van Larebeke, N., Hens, L., Schepens, P., Covaci, A., Baeyens, J., Everaert, K., Bernheim, J. L., Vlietinck, R., De Poorter, G. (2001) The Belgian PCB and dioxin incident of January-June 1999: Exposure data and potential impact on health. *Environmental Health Perspectives* 109: 265-273.
- 9) Schepens, P. J. C., Covaci, A., Jorens, P. G., Hens, L., Scharpé, S. & van Larebeke, N. (2001) Surprising findings following a Belgian food contamination with polychlorobiphenyls and dioxins. *Environmental Health Perspectives* 109: 101-103.
- 10) Huwe, J.K. (2002) Dioxins in food: A modern agricultural perspective. *Journal of Agricultural and Food Chemistry* 50: 1739-1750.
- 11) Fries, G. F., Paustenbach D. J., Mather D. B. & Luksemburg W. J. (1999) A congener specific evaluation of transfer of chlorinated dibenzo-p-dioxins and dibenzofurans to milk of cows following ingestion of pentachlorophenol-treated wood. *Environmental Science and Technology* 33: 1165-1170.
- 12) Sewart, A., Harrad, S.J., McLachlan, M.S, McGrath, S.P. & Jones K.C. (1995) PCDD/Fs and non PCBs in digested U.K. sewage sludges. *Chemosphere* 30:51-67.
- 13) Rideout, K. & Teschke, K. (2004) Potential for increased human foodborne exposure to PCDD/F when recycling sewage sludge to agricultural land. *Environmental Health Perspectives* 112: 959-969.
- 14) MAFF (1998) *Dioxins and PCBs in cows milk from the Bolsover area collected in October and November 1997*. Joint Food Safety and Standards Group. Food Surveillance Information Sheet, Number 143, March 1998. <http://archive.food.gov.uk/maff/archive/food/infosheet/1998/no143/143diox.htm>

- 15) Rose M. (2001) Studies made to assess risk concerning a 'dioxin' contamination incident near Bolsover, Derbyshire, UK. *Food Additives and Contaminants* 18:1094-1098.
- 16) AEA Technologies (1999) *Compilation of EU dioxin exposure and health data. Task 2 Environmental levels (Technical Annex)*. Report prepared for European Commission DG Environment & UK Department of the Environment Transport and the Regions (DETR)  
<http://ec.europa.eu/environment/dioxin/pdf/dioxin.pdf>
- 17) MAFF (1997) *Dioxins in cows' milk from Northern Ireland*. Joint Food Safety and Standards Group. Food Surveillance Information Sheet, Number 120, August 1997.  
<http://archive.food.gov.uk/maff/archive/food/infosheet/1997/no120/120diox.htm#ref18>
- 18) Caulfield J.J. & Ledgerwood F.K. (1989) *Survey of levels of polychlorinated dibenzo-p- dioxins and polychlorinated dibenzo furans in rural soils in Northern Ireland*. Environmental Monitoring Report No. 1. DOE (NI) Belfast.
- 19) O'Donovan, J. (2007) *Dioxin levels in milk 1991-2005*. Presentation at BVA Congress, Belfast 27-29 September 2007.  
[http://www.bva.co.uk/press/2007/07congress\\_dioxins\\_odonovan\\_pp.pdf](http://www.bva.co.uk/press/2007/07congress_dioxins_odonovan_pp.pdf)
- 20) FSA (2005) *Investigation into levels of dioxins, furans, PCBs and PBDEs in Irish food 2004*. Food Safety Authority of Ireland, Dublin. <http://www.fsai.ie/publications/reports/dioxins.pdf>.
- 21) NAEI (2007) *UK National Atmospheric Emissions Inventory for Dioxins (pcdd/f) up to 2005*.  
[http://www.naei.org.uk/pollutantdetail.php?poll\\_id=45](http://www.naei.org.uk/pollutantdetail.php?poll_id=45)