Update Statement on the Review of Cancer Incidence near Municipal Solid Waste Incinerators

COC/09/S2 – March 2009

Introduction

1. In light of recent public interest and new European Union (EU) legislation on emissions from plants which incinerate or co-incinerate waste, we undertook a review of recent publications on cancer incidence near municipal solid waste incinerators (MSWIs). The COC last discussed this topic in the late 1990s following the publication of a study by the Small Area Health Statistics Unit on cancer incidence near incinerators in Great Britain (Elliott et al, 1996) and agreed a statement on MSWIs and cancer in 2000 (http://www.iacoc.org.uk/statements/Municipalsolidwasteincineratorscoc00s1march2000.htm). The statement concluded that "*The Committee was reassured that any potential risk of cancer due to residency (for periods in excess of 10 years) near to municipal solid waste incinerators was exceedingly low and probably not measurable by the most modern epidemiological techniques. The Committee agreed that, at the present time, there was no need for any further epidemiological investigations of cancer incidence near municipal solid waste incinerators".*

2. This update statement provides a review of reports and epidemiological investigations of cancer incidence near to MSWIs published since 2000 and the conclusions reached by the committee regarding the risk of cancer associated with living near to municipal incinerators. It also presents information on the new European Union (EU) Waste Incineration Directive and details of the legally binding limit values for the emission of environmental pollutants set out in the directive.

3. As of November 2008, there are eighteen MSWIs in operation in England and Wales, one in operation on the Isle of Man and two in operation in Scotland. Information on the location of the MSWIs in England and Wales can be found on the link below to "What is in my backyard?" on the EA website (http://www.environment-agency.gov.uk/homeandleisure/37793.aspx). All of these MSWI are Energy from Waste (EfW) incinerators, generating energy such as heat and electricity as products. The operators of the incinerators are responsible for monitoring the emissions to ensure that they meet with the limits in the EU Waste Incineration Directive (2000/76/EC, often termed "WID"). Monitoring is performed either through continuous emission monitors; this is available only for certain pollutants such as nitrogen oxides (NOx), sulphur dioxide (SO_2), carbon monoxide (CO), total organic carbon (TOC), dust and hydrogen chloride (HCl) or periodically for hydrogen fluoride (HF), heavy metals, polychlorinated dibenzo-*p*-dioxins and polychlorinated dibenzo-*p*-furans (PCDDs and PCDFs or "dioxins"), dioxin-like polychlorinated biphenyls (PCBs), and polyaromatic hydrocarbons (PAHs). The operator must

inform the Environment Agency (EA) within twenty-four hours of any breach of emission limits. In addition, the EA carries out yearly audits on all MSWIs.

4. The by-products of the incinerator process may contain potentially toxic pollutants and emissions, which will contribute to background pollution levels. We were informed that, since 1996, there have been significant cuts in emissions from incinerators in order to meet strict limits set by EU legislation. The EU WID, which applies to the incineration and co-incineration of both hazardous and non-hazardous waste, will further reduce the potential to pollute. The WID regulations introduced strict regulatory controls and minimum technical standards throughout the European Community for waste incinerators and co-incinerators which incinerate and co-incinerate waste. It was transposed into UK law on the 28th Dec 2002 and the new UK legislation has applied to new incinerators since the end of 2002. Older incinerators had until 28th Dec 2005 to meet these standards. The new directive aims to reduce and/or prevent possible negative effects on the environment caused by emissions into air, soil, surface water and groundwater and thus reduce the risks which these pose to human health. We were also informed that the protocol on persistent organic pollutants, signed by the Community within the framework of the United Nations Economic Commission for Europe (UN-ECE) Convention on long-range transboundary air pollution, sets legally binding limit values for the emission of PCDDs and PCDFs of 0.1 ng/m^3 TEQ (Toxic Equivalents)[1] for installations burning more than 3 tonnes per hour of municipal solid waste, 0.5 ng/m^3 TEQ for installations burning more than 1 tonne per hour of medical waste, and 0.2 ng/m^3 TEQ for installations burning more than 1 tonne per hour of hazardous waste. However, the WID imposes a tighter limit of 0.1 ng/m^3 TEQ on all incinerators and co-incinerators irrespective of the amount of waste being burned. The WID also outlines emission limit values (ELV)[2] for a number of other pollutants including dust, TOC (excluding carbon monoxide), HCl, HF, total NOx, mercury, cadmium, thallium and heavy metals. The average dioxin emissions from MSWIs in England and Wales for the period 2006-2008 were 0.024 ng/m^3 I-TEQs (data obtained from EA, 2009a). Based on this average emission level and the total waste capacity of the incinerators currently in operation, it can be estimated that the quantity of dioxins emitted each year from these MSWIs is approximately 0.45 g (EA, 2009b).

Summary of epidemiological studies published since 2000

5. Six further relevant epidemiological papers have been published since the 2000 statement, three of which investigated cancer incidence around a single incinerator in France. Positive associations were reported between exposure to pollutants from MSWI (principally, PCDDs and PCDFs) and non-Hodgkin's lymphoma (NHL), soft tissue sarcomas (STS), and childhood cancers. No association or a negative association was reported between emissions of PCDDs and PCDFs and invasive breast cancer. We note that all the

[1] The specific toxic equivalence factor to be used for each congener is defined in the WID. These are usually referred to as I-TEQs.
[2] The mass, expressed in terms of certain specific parameters, concentration and/or level of an emission, which may not be exceeded during one or more periods of time.

epidemiology studies were carried out on incinerators in operation prior to the imposition of the current strict controls on emissions.

6. Knox (2000) carried out an analysis of the birth and death addresses of all children in Great Britain who had died of cancer between 1953 and 1980 and who had moved at sometime between birth and death. He used a technique that compares distances from suspect sources such as MSWI to the address at birth and to the address at death. The study reported a greater incidence of cancer in children born close to incinerators and moving away than in those who were born further away and who moved closer to an incinerator. We note that this study has been criticised on the grounds that there was no information provided on the net migration of total population inwards and outwards from the vicinity of the plants and therefore no control for temporal changes in population densities (Defra, 2004). We agree with this criticism and also note the lack of control data, and the complex analysis. We are unable to draw any conclusions from the study.

7. Viel et al. (2000) examined the spatial distribution of soft-tissue sarcomas and non-Hodgkin's lymphoma during the period 1980 to 1995 around a MSWI in Besancon, France. The authors report that the incinerator opened in 1971, before the current EU emission limits were in place. The first time that the concentration of PCDDs and PCDFs of an exhaust gas was measured at this incinerator was in December 1997 when it was found to be 16.3 ng I-TEQ/m^3 in total. The authors found clusters of STS and NHL which were highly statistically significant ($p = 0.004$ and $p = 0.0003$, respectively) at the same location, which included the area around the MSWI. We note that the paper made no adjustments for socioeconomic confounding. Floret et al. (2003) carried out a population-based case-control study on the population living around the MSWI in Besancon, focusing on NHL. The study used cancer incidence data from the period 1980 to 1995 and the data were adjusted for a wide range of socioeconomic characteristics. The authors reported that the risk of developing NHL was 2.3 times higher (95% Confidence Interval (CI) 1.4-3.8) among individuals living in the area with the highest modelled average ground-level PCDD and PCDF concentrations than among those living in the area with the lowest concentrations. This study provides some evidence of an association between living near an incinerator and increased risk of NHL.

8. Prompted by previous results from the studies of Viel and his colleagues, a nationwide study was carried out to analyse the relation between cancer risk and past exposure to MSWIs among neighbouring populations (Viel et al., 2008a). The study took place in four French administrative departments, which were covered by a population based cancer registry. The study area comprised a total of 2270 communities (each census block group had a relatively homogenous population of approximately 2000 inhabitants). Cases were aged 15 years or older, had been diagnosed with NHL during the period of 1990-1999 and were living in the study area at the time of diagnosis. The authors state that the examined exposure period ranged from 1972 to 1985 (to allow a mean 10 year latency period) as a function of emission dates for the 13 incinerators that operated in the study area for at least one year during

this period. A Gaussian atmospheric diffusion model was used to compute the immission estimates, which serve as proxies for annual ambient air concentrations of chemicals attributable to the MSWI at a given location. Cumulative ground-level PCDD and PCDF concentrations were calculated for each block group. During the 1990-1999 time period, a total of 3974 incident cases of NHL was observed: 2147 among males (mean age: 61.49 years, standard deviation [sd]: 16.21 years), and 1827 among females (mean age: 66.06 years, sd: 16.44 years). The paper also reports that the Standardised Incidence Ratios (SIRs) for all the areas combined were 1.0 for males and 1.0 for females. The paper reports a statistically significant relationship at block group level between risk of NHL and PCDD/F exposure in both a univariate analysis ($p= 10^{-5}$) and a multivariate analysis (p=0.04). Five possible confounding factors were considered: population density, urbanisation, socio-economic level, airborne traffic pollution and industrial pollution. A positive and linear trend was obtained when the log-transformed SIR for NHL was plotted against square root transformed PCDD/F concentration, adjusting for confounding factors (industrial pollution, departments and population density). Relative Risk (RR) for persons living in highly exposed census block groups compared with those living in the slightly exposed block groups was 1.120 (95 % CI 1.002 – 1.251). Among males, an association between PCDD/F exposures (modelled ground-level concentrations) and NHL incidence was significant in the univariate model but not the multivariate analysis. Conversely, among females, RRs appeared statistically significant in both the univariate and multivariate models, yielding a RR of 1.178 for the latter. The authors conclude that the study adds further evidence to the link between NHL incidence and exposure to PCDDs and PCDFs emitted by MSWIs but that the findings cannot be extrapolated to current incinerators, which emit lower amounts of pollutants.

9. A further study by Viel et al (2008b) examined the association between PCDDs and PCDFs emitted from the MSWI in Besancon and the incidence of invasive breast cancer between 1996 to 2002 among women living in a geographical area described as ‘under direct influence’ of the facility. Average ground level concentrations of PCDDs and PCDFs were modelled, as before. The age distribution at diagnosis for all breast cancer cases combined showed a bimodal pattern with incidence peaks near ages 50 and 70 years. Among women aged less than 60 years old, no increased or decreased risk was found for any PCDD and PCDF exposure category. Conversely, for ages 60 years and over, women living in the highest exposed zone were 0.31 times less likely (95% CI, 0.08–0.89) to develop invasive breast cancer than women living in the very low emission area, with no relative risk estimate different from 1.0 for the other PCDD and PCDF risk categories.

10. A case control study by Comba et al (2003) evaluated the association between the incidence of soft tissue sarcoma in Mantua, Northern Italy, between 1989 and 1998 and residence near an incinerator of industrial waste. The authors reported a significant increase in the risk of soft tissue sarcomas associated with living within a 2 kilometre radius of the incinerator; the odds ratio associated with residence within 2 km, standardised by age and sex, was 31.4 (95% CI: 5.6 – 176.1), based on five exposed cases. At greater

distances, the risk rapidly decreased and showed a fluctuation around the null value of 1. Zambon et al. (2007) evaluated sarcoma risk in relation to the environmental pollution caused by PCDD and PCDF emissions from waste incinerators and industrial sources of airborne PCDDs and PCDFs within the Province of Venice. The study used cancer incidence data from the period 1990 to 1996 and residential history was reconstructed from 1960 to the date of diagnosis. Risk of sarcoma increased in relation to both the duration and the extent of exposure and was statistically significant in the group with the longest period and highest level of exposure (Odds Ratio (OR) 3.30, 95% CI: 1.24 - 8.76). In both sexes, risks increased in relation to the level of exposure but reached statistical significance only in women (OR 2.41, 95% CI: 1.04 - 5.59, P< 0.04). In the most exposed cases, there was a significant risk excess for connective and other soft tissue cancers (International Classification of Disease ICD-IX 171) with an OR = 3.27 (95% CI: 1.35 - 7.93). In neither of these studies were adjustments made for confounding factors.

11. In summary, we are unable to draw conclusions from the study by Knox (2000) for the reasons given above, and only limited conclusions can be drawn from the studies by Comba et al (2003) and Zambon et al (2007) because they included emission sources other than MSWIs and failed to adjust for confounding factors. Three of the further studies were carried out around the Besancon incinerator which was reported to emit far higher concentrations of PCDDs and PCDFs than currently permitted (Viel et al, 2000 and 2008b; Floret, 2003) and the fourth related to exposures from 1972 and 1985. Although these studies indicate some evidence of a positive association between two of the less common cancers i.e NHL and STS and residence near to incinerators in the past, the results cannot be extrapolated to current incinerators, which emit lower amounts of pollutants, as noted by Viel et al (2008). Moreover, they are inconsistent with the results of the larger study on cancer incidence around municipal incinerators carried out by the Small Area Health Statistics Unit (Elliott et al, 1996). We conclude, therefore, that there is no need to change the advice given in the previous statement in 2000 but that the situation should be kept under review.

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Abbreviations

CI = Confidence Interval; CO = carbon monoxide; EA = Environment Agency; EfW = Energy from Waste; ELV = emission limit values; EU = European Union; HCl = hydrogen chloride; HF = hydrogen fluoride; MSWIs = municipal solid waste incinerators;; NHL = non-Hodgkin's lymphoma; NOx = nitrogen

oxides; OR = Odds Ratio; PAHs = polyaromatic hydrocarbons; PCBs = polychlorinated biphenyls ; PCDDs = polychlorinated dibenzo-*p*-dioxins; PCDFs = polychlorinated dibenzo-*p*-furans; RR = relative Risk; SIRs = Standardised Incidence Ratios; SO_2 = sulphur dioxide; STS = soft tissue sarcoma; TEQs = Toxic Equivalent; TOC = total organic carbon; UN-ECE = United Nations Economic Commission for Europe; WID = Waste Incineration Directive