

# **FSAI Discussion Paper: Waste incineration and possible contamination of the food supply with dioxins**

## **Summary**

A priority task for the Food Safety Authority of Ireland (FSAI) since it was established in 1999 has been to monitor the food supply for contamination by dioxins. A number of studies carried out by the Authority over the past 3 years on foods likely to be contaminated by these environmental pollutants have concluded that levels in Irish-produced foods are extremely low and that consumers of these foods are not at risk. This discussion paper was prepared at the request of the FSAI Board and the Food Safety Consultative Council, and aims to respond to consumers' concerns regarding possible contamination of food supplies with dioxins.

Dioxins in the Irish environment primarily result from incomplete combustion of wastes, and the main source of dioxins according to the Environmental Protection Agency (EPA) is from uncontrolled burning of domestic waste. Ireland is currently faced with a waste management crisis, with most domestic and industrial wastes being disposed of to landfill while some toxic wastes are exported for incineration. Ireland is the only country in the European Union without municipal waste incineration facilities. Commercial incinerators are designed to burn waste at temperatures in excess of 850°C and at these temperatures dioxins are destroyed. In relation to the introduction of waste incineration in Ireland, as part of a national waste management strategy, the FSAI considers that such incineration facilities, if properly managed, will not contribute to dioxin levels in the food supply to any significant extent and will not affect food quality or safety. As part of an overall waste management strategy, as reflected in the EC Waste Hierarchy, incineration coupled with waste prevention, reduction, recycling and other treatment methods is the preferred option. In order to maximise consumer protection, it is vital however that rigorous monitoring programmes be maintained and that consideration be given to expanding environmental monitoring around any established incineration facilities. FSAI will endeavour to ensure that such programmes are put in place.

## Background

This report outlines the background issues relating to dioxin emissions as a consequence of municipal waste incineration and the possible impact on food safety and quality in Ireland. It was prepared at the request of the FSAI Board and the Food Safety Consultative Council.

The current waste management infrastructure in Ireland is unable to meet national demand (Department of the Environment and Local Government, 2002). Recent reports show that between 1995 and 1998, waste generation in Ireland increased by 89% (EPA, 2000, Forfás, 2001), this increase in waste generation being linked to economic growth. Additional data indicate that Irish citizens appear to produce far more waste than the European average; producing 576 kg of municipal waste, compared to a European average of 450 kg per person (Forfás, 2001).

Table 1 shows the main categories into which this waste can be grouped, based on the EPA National Waste Database for 1998 (EPA, 2000). About 80% of this waste, approximately 65 million tonnes, arose from agriculture, consisting mainly of organic slurries and farmyard manures. Municipal waste accounted for 2 million tonnes, while approximately 370,000 tonnes was categorised as hazardous waste. Almost all of the organic agricultural waste arising in Ireland is recycled as fertilizers on agricultural land. A category of agricultural waste not included in Table 1 is animal by-products. The slaughter and processing of 1.8 million cattle, 4 million pigs, 3.5 million sheep and 60 million poultry gives rise to around 550,000 tonnes of animal by-products annually. Animal by-products are those parts of the animal that are not suitable for human consumption. Some of these by-products like hides, are processed into leather and some used in the pet food industry. The remainder is rendered into meat and bone meal (MBM) and tallow. About 150,000 tonnes of MBM are produced annually. Under current regulations this is not allowed to be used in the food chain and requires disposal.

**Table 1. Categories of waste in Ireland**

Waste Category	1998	
	(Tonnes/annum)	(%)
Agricultural	64,578,724	80.7
Manufacturing	4,876,406	6.1
Mining & Quarrying	3,510,778	4.4
Construction & Demolition Waste	2,704,958	3.4
Municipal Waste	2,056,652	2.6
Dredge Spoils	734,000	0.9
Energy, Gas, & Water Supply	448,674	0.6
Urban Wastewater Sludges	505,686	0.6
Hazardous Waste	370,328	0.5
End-of-Life Vehicles/Scrap Metal	187,484	0.2
Drinking Water Sludges	38,988	0.0
Total	80,012,678	100.0

(source: EPA, 2000)

Currently, Ireland is mainly dependent on landfill for dealing with its wastes, with approximately 91% of municipal wastes and 85% of industrial wastes being disposed of in this way (EPA, 2000). Compared with most other European countries, Ireland has a very high dependency on landfill and is the only country devoid of municipal waste thermal treatment facilities. Much of the hazardous waste generated in the country is exported to other European countries for disposal, although a number of pharmaceutical and fine chemical manufacturing plants have been licensed by the Environmental Protection Agency for incineration of hazardous waste (see also under “Incineration” below). There are concerns about whether Ireland will be able to continue exporting its hazardous waste to other European countries, a situation that is highly susceptible to change in the receiving countries’ waste management strategies. As demonstrated by the recent food scare resulting from the addition of pharmaceutical waste which was exported from Ireland to animal feed in Belgium, Ireland cannot continue to export hazardous wastes and must develop a strategy for coping with the increasingly large volumes of other waste generated in the country.

The preferred option concerning waste management, as articulated in the Department of the Environment and Local Government’s Policy Statements (Department of the Environment and Local Government, 1998 and 2002) and reflecting the EC Waste Hierarchy, is prevention and minimisation, followed by re-use, recycling and biological treatment, energy recovery and environmentally sound disposal, either by thermal treatment (without energy recovery) or by landfill. Under this hierarchy, landfill should be a last resort after all the higher options have been exhausted (Department of the Environment and Local Government, 2002). A key point concerning this strategy is that irrespective of the amount of source reduction within an economy, there can never be a ‘zero’ waste situation. As a result, there will always be a need for a system to manage generated wastes. In applying the strategy at national level, reduction of the country's dependence on waste disposal by landfill is a primary objective for the Government as indicated, and it is planned to divert 50% of overall household waste away from landfill by 2013. The planned increased use of incineration as a waste management strategy has however raised concerns about the generation and emission of substances that are harmful to the environment and to human health. These include heavy metals, hydrogen chloride and, in particular, organic compounds including the polychlorinated dibenzo-p-dioxins (dioxins, PCDDs) and the polychlorinated dibenzofurans (furans, PCDFs). The following sections describe the incineration process and its current application in Ireland.

## **Incineration**

Incineration is the thermal oxidation of waste at temperatures in excess of 850 °C. Industrial hazardous waste incineration is used by a number of pharmaceutical or fine chemical manufacturing plants in Ireland although there is no central national facility for the incineration of such wastes. The *National Hazardous Waste Management Plan* (EPA 2001) has identified as one of the priorities for 2001-2006 ‘the development of hazardous waste landfill capacity and thermal treatment for hazardous wastes requiring disposal to achieve self sufficiency and reduce our reliance on export’. In 1998, it was estimated that some 65,631 tonnes of largely solvent waste were incinerated, of which some 47,751 tonnes were incinerated abroad.

The incineration of hazardous waste is licensed under the EPA by way of Integrated Pollution Control (IPC), which is being replaced by Integrated Pollution Prevention and Control with application of Best Available Technology Not Entailing Excessive Costs (BATNEEC).

Monitoring of the emissions from industrial hazardous waste incinerators is required as one of the licence conditions. In 2001, the EPA carried out a total of 1661 monitoring and inspection visits at facilities licensed under IPC, including full audits at 59 facilities (EPA Annual Report, 2001). The monitoring programmes carried out by the Agency involved the taking of 2,012 samples (mainly air emissions and wastewater discharges) and the carrying out of 33,357 individual analytical determinations.

Municipal waste is not incinerated in Ireland, although planning permission has been granted for a waste management facility which will include a 150,000 tonne/annum waste-to-energy plant (grate incinerator) in Co Meath. Application has also been made for a second waste management facility to be sited in Ringaskiddy, Co Cork. This second facility will include a waste-to-energy plant, which will incinerate 100,000 tonnes/annum of mixed municipal and hazardous wastes. Municipal incineration is considered to be an integral operation within integrated waste management plans.

In the past, municipal waste incinerators in other EU countries were considered to be one of the major sources of dioxins and other environmental pollution (UNEP, 1999, HRB, 2003). However, since the early 1990s, the application of stringent emission limit values to a broad range of environmental pollutants has significantly reduced the environmental impacts associated with municipal waste incineration. A combination of improved combustion practices and staged air pollution control techniques allows modern well-run municipal solid waste (MSW) incinerators to meet the environmental requirements embodied in the recent EC *Directive on the Incineration of Waste (2000/76/EC)*. Liquid effluents from waste incineration are also regulated to a high level. Solid residues, such as fly ash will probably be classified as hazardous waste and will require the provision of suitable landfill. At present there is no such MSW facility in Ireland. Gasification and pyrolysis are novel emerging technologies, which have the potential for recovering energy from a range of waste types, and are likely to have greater application to municipal waste disposal in future years. The environmental impacts of these processes in comparison with modern incinerator plants have not been fully evaluated.

### **Monitoring and control of emissions**

The EC Directive on the Incineration of Waste (2000/76/EC) requires the monitoring of emissions of major pollutants likely to arise during the incineration process. Continuous measurements of nitrogen oxides (NOX), carbon monoxide (CO), total dust, total organic compounds (TOC), hydrogen chloride (HCl), hydrogen fluoride (HF) and sulphur dioxide (SO<sub>2</sub>) are required, together with at least two measurements per year of heavy metals, dioxins (PCDDs) and furans (PCDFs) (one measurement of these latter pollutants must however be carried out at least every three months for the first 12 months of operation). Process operation parameters such as temperature in the combustion chamber, concentration of oxygen, pressure, temperature and water vapour content of the exhaust gas must also be monitored. Typical emissions of pollutants from MSW and industrial waste incinerators are presented below in Table 2, while the technologies that have been used to reduce these emissions are summarised in Table 3 (HRB, 2003).

**Table 2. Typical emission factors of selected pollutants from incinerators**

Component	MSW Incinerator (kg /tonne)	Industrial Waste Incinerator (kg/tonne)
Sulphur Dioxide (SO <sub>2</sub> )	0.4	0.07
Oxides of Nitrogen (NO <sub>x</sub> )	1.8	2.5
Carbon monoxide (CO)	0.5	0.125
Hydrochloric acid (HCl)	0.5 – 0.03	0.105
Lead (Pb)	0.0008	0.0035
Cadmium (Cd)	0.0001	0.003
Mercury (Hg)	0.0011	0.003
ΣPCBs	5.8 x 10 <sup>-6</sup>	Not reported
ΣPAHs	160 x 10 <sup>-6</sup>	0.00002
PCDD/F (Dioxins, Furans)	0.5 µg I-TEQ/tonne	0.5 µg I-TEQ/tonne

(Source: European Environment Agency 1999)

**Table 3. Technologies to treat air emissions**

Emission	Technology								
	Scrubber	Filter	Bio-filter	Cyclone	Wet ESP	Thermal Conditioning	Combined Filter, Lime and Activated Carbon injection	Odour Control	After-burners
Particulates		X		X	X		X		X
Sulphur and compounds	X		X				X		
Nitrogen and compounds			X						
Halogens and compounds	X						X		
Metals, metalloids, etc.		X		X	X		X		
Organic compounds	X		X				X		X
Phosphorus and compounds	X						X		
Odours	X		X					X	X
Water Vapour						X			

(Source: EPA, BATNEEC Guidance Notes 1996)

As can be seen from Table 2, the quantity of dioxins and furans typically generated in a modern, well-run incinerator is low, at 0.5 µg I-TEQ/tonne. Incineration of 1,000,000 tonnes of waste could thus be anticipated to result in the formation of 0.5 g of dioxin/furan. The recently published EPA Irish Dioxin Inventory (EPA, 2002, see “Dioxin Inventory” below) has estimated that the incinerators proposed for construction in Ireland, together with existing facilities, would contribute 2% of projected dioxin emissions to air, or a total of 2.2 g.

### **Dioxin occurrence and toxicity**

The term “dioxin” is commonly used to describe a family of organic chemicals with similar chemical structures and a common mechanism of toxicity. These substances derive their toxic characteristics from the presence of one or more halogen atoms, commonly chlorine and less commonly, bromine. There are 75 possible chlorinated dioxins (PCDDs, also known as polychlorinated dioxins) and 135 possible chlorinated furans (PCDFs). However, only 7 of the PCDDs and 10 of the PCDFs are regarded as being toxic. 2,3,7,8 TCDD (tetrachlorodibenzodioxin) is the most toxic of these.

Dioxins, when they are formed, typically occur not as single compounds but as a mixture of the different congeners. These chemicals are not manufactured intentionally on a large scale and are predominantly unwanted by-products of a wide range of manufacturing processes including smelting, bleaching of paper pulp and the manufacturing of some herbicides and pesticides. They can occur as unwanted products in chemical and combustion reactions. For example, in the manufacture of the phenoxy herbicides, 2,4-D and 2,4,5-T (2,4-dichlorophenoxy acetic acid, and 2,4,5-trichlorophenoxy acetic acid) small quantities of dioxins are present as impurities. Dioxins are found as impurities in the wood preservative pentachlorophenol (PCP) and are also formed during combustion of wood treated with PCP, which may explain the high levels of dioxins reported during some animal carcass incineration during the recent Foot and Mouth epidemic in the UK. However, the predominant source of dioxins arise from high temperature reactions which occur in combustion processes, such as incinerators, coal fired generation, diesel and petrol engines, cement kilns, steel smelting, wood burning and accidental fires. During the 1994 celebrations of “Bonfire Night” in the UK, measurements indicated a fourfold increase in dioxin levels near fires and fireworks displays.

As reported recently by the Health Research Board (HRB, 2003), the health outcomes that have been evaluated as a possible consequence of dioxin exposure include respiratory symptoms and illness, reproductive effects and the development of cancer. There are reports of some association between adverse health effects and living in the vicinity of either landfill sites or waste incinerators (HRB, 2003). In addition to studies of the possible consequences of non-specific exposure to emissions from waste incinerators, research has also been conducted to determine the presence or effects of exposure to certain substances known to be present in incinerator emissions. It is important to bear in mind that many studies were based on older incinerator facilities, which would not have had the same emission control standards as those applied today. It also is important to note that the development of cancer is most often due to a number of factors, both intrinsic and external. For many cancers the causes are not fully understood. It is widely accepted that long periods of time are often required between triggering an exposure and the development of the disease clinically. This increases the difficulties associated with attempting to pinpoint specific causes.

In November, 2001, the European Commission published its Community strategy for dioxins, furans and polychlorinated biphenyls (European Commission, 2001). This strategy stressed the need for further action to avoid environmental and adverse health effects from dioxins and PCBs, inter alia (to quote from the strategy) because:

- *bioaccumulation is continuing along the trophic chain and releases go on from landfills, polluted soils or sediments. The sharp decrease of background levels in the environment in the last 20 years will probably not be repeated in the coming decades,*
- *the toxic properties seem to have been underestimated and new epidemiological, toxicological and mechanistic data have emerged in particular with respect to neurodevelopmental, reproductive and endocrine effects, which indicate that dioxins and some PCBs have a broader impact on health than previously assumed, even in very low doses and in particular on the most vulnerable groups like breast-fed infants and the foetus, which is directly exposed to the accumulated maternal body burdens,*
- *the dietary exposure to dioxins and dioxin-like PCBs exceeds the tolerable weekly intake (TWI) or the tolerable daily intake (TDI) for a considerable part of the European population.*

The objectives of the Commission's strategy are to assess the current state of the environment and the ecosystem, to reduce human exposure to dioxins and PCBs in the short term and to maintain human exposure at safe levels in the medium to long term, and to reduce environmental effects from dioxins and PCBs, with a quantitative objective to reduce human intake levels (primarily from food) below 14 picograms WHO-TEQ per kg bodyweight per week. This strategy has underpinned many of the legislative measures on dioxins introduced by the Commission in the last few years, including the establishment of legislative limits for dioxins in a number of food- and feedstuffs.

### **Irish Dioxin Inventory**

As indicated above, the EPA recently commissioned a dioxin inventory for Ireland, which provides a detailed estimate of the relative contribution of different processes and/or sources to overall dioxin emissions (EPA, 2002). The report presents estimates of the quantity of dioxins and furans (referred to thereafter as "dioxins") emitted in 2000 and projected estimates for 2010. Based on a methodology developed by the United Nations Environment Programme (UNEP, 1999), the EPA estimated that 93g of dioxins were generated in Ireland in 2000. Of this, 73% of emissions were generated by uncontrolled combustion activities. The principal uncontrolled combustion activities are the domestic burning of waste (accounting for 58% of emissions) and accidental building fires (accounting for 11% of emissions). The best estimate for emissions to air in 2000 as a result of waste incineration was 0.02% or 0.0068 mg per annum, while the land spreading of sewage sludge accounted for 2% of emissions.

Dioxin emissions are projected to increase from 93g in 2000 to 110g in 2010, as shown in Table 4 (taken from the EPA report). Uncontrolled combustion activities will continue to be the largest contributor, accounting for 61% of projected emissions. The construction and operation of incinerators for municipal and hazardous waste, as proposed in regional and national plans, are forecast to contribute 17% of projected emissions (EPA 2002). The bulk

of these dioxins will be contained in incinerator ash, which will be managed under controlled conditions at licensed facilities, thereby limiting any potential release of dioxins to the environment. The EPA estimate that waste incineration will contribute 1.8% of projected dioxin emissions to air in 2010, compared with an estimate for 2000 of 0.02%. Dioxins in sewage sludge are projected to increase from 4g to 12g (accounting for 11% of projected emissions), based on the assumption that all sewage will receive treatment by 2010. Environmental reservoirs will increasingly become the primary source for dioxin contamination of food as emission controls become effective and more widespread.

A targeted monitoring programme for dioxin emissions is planned and will allow for more accurate quantification of dioxin emissions in future years. The new dioxin laboratory at University College Cork, funded by the Government, will carry out testing of the sources of dioxin emissions and their impact on the Irish environment.

**Table 4. Summary of estimated dioxin emissions to air, land and water in Ireland for 2010<sup>a</sup>**

	Air		Water		Land	
	Best estimate g/annum	% Contribution to total air emissions	Best estimate g/annum	%Contribution to total water emissions	Best estimate g/annum	%Contribution to total land emissions
<b>Waste Incineration</b>	0.5494	1.81	0.0060	1.83	18.006 <sup>b</sup>	22.82
<b>Ferrous and Non-ferrous Metal Production</b>	0.0509	0.17	0.0000	0.00	1.5705	1.99
<b>Power Generation and Heating</b>	2.4243	8.00	0.0000	0.00	3.9605	5.02
<b>Mineral Products</b>	0.6119	2.02	0.0000	0.00	0.0000	0.00
<b>Transport</b>	1.1697	3.86	0.0000	0.00	0.0000	0.00
<b>Uncontrolled Combustion Processes</b>	25.4898	84.13	0.0000	0.00	41.8518	53.05
<b>Production and Use of Chemical and Consumer Goods</b>	0.0000	0.00	0.0000	0.00	0.0000	0.00
<b>Miscellaneous</b>	0.0018	0.01	0.0000	0.00	0.0121	0.02
<b>Disposal/Landfill</b>	0.0000	0.00	0.3185	98.17	13.4883 <sup>c</sup>	17.10
<b>TOTAL</b>	30.2980	100.00	0.3245	100.00	78.8890	100.00

(from EPA, 2002)

<sup>a</sup>Data reported in grams; however, estimated emissions from some sectors are small, hence the data are reported to four decimal places to allow inclusion of this data. This does not imply an accuracy in the best estimate emissions to four decimal places.

<sup>b</sup>Incinerator bottom ash and flyash to be landfilled under controlled conditions at licensed facilities thereby limiting any potential release of dioxins to the environment. The term 'Land emissions' in this case means the deposit of waste in landfills.

<sup>c</sup>This figure is principally composed of contributions from sewage sludge management, in 2010, assumed to be 100% landspreading.

### Incineration emissions and the food chain

This report assesses the possible impact of introduction of waste incineration in Ireland, as part of a national waste management strategy, on the quality and safety of Irish food, specifically in relation to current and predicted levels of dioxins. In most countries, the bulk of the dietary intake of dioxins and related compounds is due to dioxin accumulation in the fat

of some fish and fish products, meat and meat products, and milk and dairy products. In Europe, the fractions of the dietary intake of dioxins contributed by these foods are fish and fish products: 2 – 63 %; meat and meat products: 6 – 32 %; milk and dairy products: 16 – 39 % (European Commission, 2000). Because animal-derived foods may be important dietary sources of dioxins, the contamination of animal feeds must also be considered. Current sources of dioxins entering the food supply include both environmental reservoirs and new emissions, due to combustion processes including waste incineration. The primary emission route is air. Reservoir sources include soil and sediment loads from historic emissions. Environmental reservoirs will increasingly become the primary source for dioxin contamination of food as emission controls become effective and more widespread. New emissions and reservoir sources share the same pathways to food. Therefore, measures to reduce the level of dioxin food contamination should focus on both reducing dioxin emissions and environmental reservoirs, as well as interrupting pathways into food, as reflected in the European Community strategy for dioxins, furans and polychlorinated biphenyls (European Commission, 2001). Interrupting contamination pathways has the advantage of being effective immediately; however source reduction measures will take years or decades to show their effects.

### **Control of levels of dioxins in food**

As already mentioned, the European Commission's strategy for dioxins, furans and polychlorinated biphenyls aims to reduce human exposure to dioxins and PCBs in the short term and to maintain human exposure at safe levels in the medium to long term, with a quantitative objective to reduce human intake levels (primarily from food) below 14 picograms WHO-TEQ per kg bodyweight per week. (European Commission, 2001). The general approach to reduction of exposure to dioxins in food involves reducing emissions to air, in addition to the establishment of legislative limits for dioxins in the most contaminated food- and feedingstuffs. As examples of emissions reduction efforts, several European countries (Austria, Germany, The Netherlands and Luxembourg) have already enacted regulations limiting the emissions from waste incinerators to 0.1 ng I-TEQ/m<sup>3</sup> with considerable success. In Germany for instance it has been estimated that the dioxin emissions from municipal solid waste incinerators (MSWI) could be reduced by 99% within 7 years to an overall emission of 4g I-TEQ/year, following introduction of this limit. The EC Directive on the Incineration of Waste (2000/76/EC) in MSWI, power plants, hazardous waste incineration plants and cement kilns also provides for a limit value of 0.1 ng I-TEQ/m<sup>3</sup>. It is accepted that emission controls on other primary sources of dioxins would also reduce exposures. Such measures will bring about considerable reduction in the total emissions into air and, subsequently, in deposition levels - a significant factor for the contamination of food and feed.

Similar reductions in emissions have occurred in the US, and are continuing due to both voluntary and regulatory efforts. A decrease of approximately 76% in estimated releases of dioxins (including furans) occurred between 1987 and 1995, with estimates of releases of dioxins to air, water, and land of approximately 14,000 grams in 1987 reduced to 3,300 grams I-TEQ in 1995 (U.S. EPA, 2000). These reductions were due primarily to reductions in air emissions from municipal and medical waste incinerators. Furthermore, based on limits to dioxins emissions in regulations promulgated since 1995 (for sources including municipal waste combustors, medical waste incinerators, hazardous waste incinerators, cement kilns burning hazardous waste, and pulp and paper facilities using chlorine bleached processes), an

additional 1800 grams I-TEQ reduction in dioxin emissions should occur. With these anticipated emission reductions, uncontrolled burning of household waste will become the largest currently quantifiable remaining source in the U.S., comprising approximately 600 grams I-TEQ per year.

Knowledge of emissions to water and solid waste is incomplete in comparison to data on emissions to air. Emissions via wastewater from industrial processes however are currently much lower than emissions into the air. The main sources are processes in which chlorine is produced or used to produce chlorinated compounds and the production of paper pulp using chlorine and chlorine dioxide as bleaching agent. The use of pentachlorophenol as fungicide in wood preservation and in the manufacture of textiles and leather has also been identified as a source of dioxins in wastewater and contaminated sewage sludge. Therefore the application of dioxin contaminated sewage sludge and sediments as fertilizers in agriculture is another potential source of dioxin in soil.

### **Current knowledge about dioxins in Irish food and the Irish environment**

A priority task for the Food Safety Authority of Ireland (FSAI) since it was established in 1999 has been to monitor the Irish food supply for contamination by dioxins, against the legislative limits established in the European Community in recent years, via Council Regulation No. 466/2001. A number of studies, as described below, have been carried out on foodstuffs anticipated to show high levels of dioxins, based on data from other countries, namely cows' milk, cream, fish and fish oils. A study has also been carried out on breast milk from Irish mothers, as part of a WHO collaborative study designed to compare levels of these contaminants in breast milk in different countries, as a reflection of dietary exposure.

#### **(i) FSAI cows' milk survey**

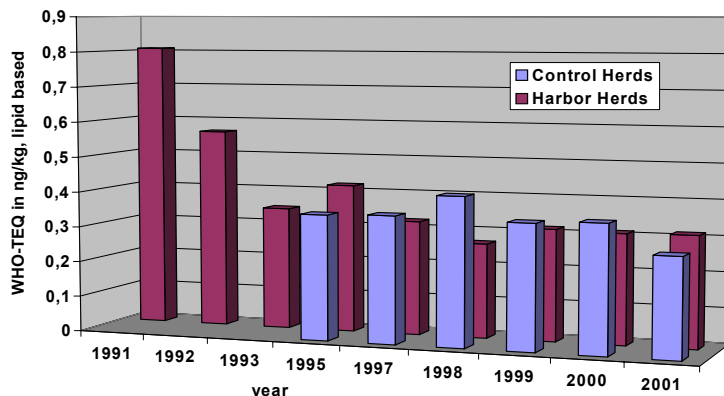
The study reported here was designed to examine possible changes in dioxin and polychlorinated biphenyl levels in the Cork harbour area, likely to be present due to the high concentration of chemical and pharmaceutical industries in the Cork harbour region. The study was recently carried out by the FSAI on milk samples from the tissue culture data bank collected by Cork County Council over a ten-year period spanning 1991 to 2001. From 1991 annual milk samples were collected from designated herds in the harbour area and from 1995 annual milk samples were also taken from control herds in areas not associated with the harbour.

As shown in Figure 1, mean levels of dioxins in milk from herds in the harbour area declined from 0.81 pg WHO-TEQ/g fat in 1991 to 0.31 in 2001. This equated to a decrease of just over 60% leaving the 2001 level at only a tenth of the maximum dioxin level allowed in milk by the European Union legislation (Council Regulation No. 466/2001). The reduction in dioxin levels was particularly marked in the period 1991 - 1994, coinciding with the introduction of the Environmental Protection Agency's Integrated Pollution Control licensing system. Levels of dioxins in milk from the control herds ranged from 0.28 to 0.42 pg WHO-TEQ/g fat over the period 1995 to 2001. The mean Irish dioxin levels of 0.2 to 0.4 pg WHO-TEQ/g fat reported for 1995-2000 from milk in the control herds can be compared with those reported for Belgium (2.06 pg/g), United Kingdom (1.01 pg/g), Netherlands (0.94 pg/g), France (0.67 pg/g) and Germany (0.57 pg/g) over 1995 to 1999 (SCOOP, 2000). A study carried out by

FSAI on samples of Irish cream have detected comparably low levels of dioxins to those found in the milk study.

**Figure 1**

**PCDD/Fs in Milk Samples from Ireland  
WHO-TEQ (PCDDs/PCDFs)**



**(ii) EPA cows' milk surveys and surveys on soil**

A series of surveys of cows' milk at fixed geographic locations have also been carried out by the EPA, to monitor trends in dioxin contamination. These studies have shown that the levels have been consistently lower than results from similar studies elsewhere in Europe. The EPA has also carried out surveys of dioxin levels in soil. Compared to more heavily industrialised countries, Ireland has significantly fewer problems in relation to dioxin contamination of land.

**(iii) FSAI survey of farmed trout and salmon**

Another recent study funded by the FSAI, and carried out with the assistance of the Marine Institute, looked at the potential dioxin contamination of fish, in advance of the new EU maximum limits for dioxins in foodstuffs which applied from April, 2002 under Council Regulation No. 466/2001. The levels of dioxins found in Irish farmed trout and salmon and wild Irish salmon (Table 5) were well below the maximum limit of 4pg WHO-TEQ/g wet weight fish set by the European legislation. The FSAI study showed that exposure to dioxins from the consumption of Irish farmed and wild fish as part of a balanced diet was well below the established safe limit.

**Table 5**

**Mean levels of dioxins and dioxin-like PCBs in Irish wild salmon, farmed salmon and farmed trout (results expressed on a wet weight basis)**

	Concentration (WHO-TEQ pg/g)	
	<i>PCDDs/PCDFs</i>	<i>Dioxin-like PCBs</i>
Wild salmon	0.34 (SD ± 0.13)	0.74 (SD ± 0.21)
Farmed salmon	0.87 (SD ± 0.24)	3.14 (SD ± 0.87)
Farmed trout	0.32 (SD ± 0.12)	1.04 (SD ± 0.26)

#### (iv) FSAI survey of fish oil capsules

This study on the potential dioxin contamination of fish oil capsules was carried out as part of the study on fish described above. Fish oil capsules were found to contain both dioxins and dioxin-like PCBs. The level found depended on the brand and the oil source. Those brands containing fish liver oil contained higher levels of dioxins than those brands containing fish body oils. Current European legislation sets a maximum limit for dioxins of 2 pg WHO-TEQ/g fat for “fish oils intended for human consumption”. 10 brands contained dioxin levels above the European limit while 5 brands contained dioxins at levels below the European limit. Three of these were fish body oil capsules and two were fish liver oil capsules. The maximum contamination was found at a level just over 5 times the maximum limit set in European legislation. In relation to the consumption of fish oil and fish liver oil supplements, the FSAI concluded that the levels of dioxins detected in these products posed no health risk provided consumers used the supplements in accordance with manufacturer’s instructions.

#### (v) WHO human breast milk survey

The FSAI has participated in the third round of a World Health Organisation-coordinated study of dioxin levels in human breast milk, the purpose of which was to produce reliable and comparable data on levels of dioxins in human milk. From the Irish perspective, participation in the study provided the opportunity to obtain baseline data on dioxins levels in the Irish population and hence an indication of exposure to dioxins present in the Irish environment. It also provided an opportunity to benchmark the levels of dioxins in breast milk in EU countries. As discussed previously, the primary source of human exposure is via the diet, due to their accumulation primarily in the fatty fraction of foods of animal origin. In turn, dioxins taken in via the diet accumulate primarily in fatty tissues in the human body, and in the case of lactating mothers are released into the fatty fraction of the breast milk. Four pooled samples were collected from first-time mothers in Dublin, Wicklow, Donegal and Cork. Each pooled sample comprised 10 separate breast milk samples. These were taken from mothers living in the area for the past five years with a first-born infant aged between 2-6 weeks. Analysis of samples was carried out at a recognised laboratory in Germany.

Preliminary results for Ireland have been received (for three of the four pools) and show that Irish levels of dioxins in human milk are low when compared to levels in other European countries. This is shown in Table 6, which presents initial results for the study, presented at a 2002 conference on dioxins (van Leeuwen and Malisch, 2002). These results provide valuable baseline information on the burden of dioxin exposure in Ireland.

**Table 6**  
**Levels of PCDDs, PCDFs and dioxin-like PCBs in human milk (2001/2002)**

Country	PCDDs/PCDFs WHO-TEQ pg/g fat		PCBs WHO-TEQ pg/g fat		Number of pools
	Median	Range	median	range	
Ireland	6.91	6.19 – 8.54	4.66	2.72 – 5.19	3
Norway	7.30	7.16 – 7.43	8.08	6.56 – 9.61	2
Finland	9.44	9.35 – 9.52	5.85	5.66 – 6.03	2
Sweden	9.58	–	9.71	–	1
Spain	11.90	10.41 – 18.32	11.65	9.96 – 16.97	3

Italy	12.66	9.40 – 14.83	16.29	11.02 – 19.33	4
The Netherlands	18.27	17.09 – 21.29	11.57	10.90 – 13.08	3

(adapted from van Leeuwen and Malisch, 2002, showing EU country data only)

## Conclusions

In conclusion, results of monitoring show that dioxins are found at low levels in Irish food and in the Irish environment, when compared with other countries. This is reflected at different points in the food chain and in the recent study of Irish mothers. Ireland continues to have lower levels of dioxins in the environment than most other European countries. This is most likely to be the result of a low level of heavy industry and consequently relatively low levels of emissions from industrial processes.

The EPA inventory of dioxin and furan emissions to air, land and water predicts a continued low level of dioxin emissions as a result of future municipal and hazardous waste incineration. Dioxin emissions are projected to increase from 93g in 2000 to 110g in 2010, and uncontrolled combustion activities will continue to be the largest contributor, accounting for 61% of projected emissions. As indicated above, it is generally accepted that most dioxin contamination of food currently arises as a result of emissions to air. The EPA estimate that waste incineration will contribute 1.8% of projected dioxin emissions to air, or 0.55g out of a total of 30.3 g total air emissions estimated for the year 2010. These quantities translate into very low predicted levels of dioxins in food, as currently found.

In relation to the possible impact of introduction of waste incineration in Ireland, as part of a national waste management strategy, on this currently largely satisfactory situation, the FSAI considers that such incineration facilities, if properly managed, will not contribute to dioxin levels in the food supply to any significant extent. The risks to health and sustainable development presented by the continued dependency on landfill as a method of waste disposal far outweigh any possible effects on food safety and quality. As part of an overall waste management strategy, as reflected in the EC Waste Hierarchy, incineration coupled with waste prevention, reduction, recycling and other treatment methods is the preferred option. In order to maximise consumer protection, it is vital however that rigorous monitoring programmes be maintained and that consideration be given to expanding environmental monitoring around any established incineration facilities. FSAI will endeavour to ensure that such programmes are put in place.

## References

Department of the Environment and Local Government (1998). *Changing Our Ways, a Policy Statement on Waste Management*.

Department of the Environment and Local Government (2002). *Delivering Change, a Policy Statement on Preventing and Recycling Waste*.

EPA (1996) *BATNEEC Guidance Note for the Waste Sector*, Revision 1 - 1996. Environmental Protection Agency, Wexford.

EPA (2000). *National Waste Database Report for 1998*. Crowe, M., Fanning, A., Nolan, K., Carty, G. and Howley, D., Environmental Protection Agency, Wexford. .

EPA Annual Report, 2001. Environmental Protection Agency, Wexford.

EPA (2001) *National Hazardous Waste Management Plan*. Environmental Protection Agency: Wexford

EPA (2002). *Inventory of Dioxin and Furan Emissions to Air, Land and Water in Ireland for 2000 and 2010 (200-DS-2-M1)*. Environmental Protection Agency: Wexford

European Commission (2000). *Assessment of dietary intake of dioxins and related PCBs by the population of EU Member States*. Report on scientific cooperation (SCOOP) task 3.2.5

European Commission (2001). *Community strategy for dioxins, furans and polychlorinated biphenyls*. Communication from the Commission to the Council, the European Parliament and the Economic and Social Committee (COM (2001) 593 final). Official Journal of the European Communities, C322/2

European Environment Agency (1999) *Emission Inventory Guidebook – Incineration of Domestic or Municipal Wastes and Incineration of Industrial Wastes* SNAP CODES: 090201, 090202. Joint EMP/CORINAIR Atmospheric Emission Inventory Guidebook (2Ed.) EEA: Copenhagen.

Forfás (2001). *Key Issues in Waste Management in Ireland*. The National Policy and Advisory Board for Enterprise, Trade, Science, Technology & Innovation, Dublin

FSAI (in press). Report on *Dioxins and furans in human breast milk in Ireland*. Food Safety Authority of Ireland

HRB (2003). *Health and Environmental Effects of Landfilling and Incineration of Waste – a Literature Review*. Report prepared for the Health Research Board, Dublin, at the request of the Department of the Environment and Local Government.

UNEP (1999). *Dioxin and Furan Inventories, National and Regional Emissions of PCDD/PCDF*. Report prepared for the United Nations Environment Programme, UNEP Chemicals, Geneva.

U.S. EPA (2000). *Database of Sources of Environmental Releases of Dioxin-Like Compounds in the United States: Reference Years 1987 and 1995* (EPA/600/C-01012), March, 2001.

van Leeuwen, FXR and Malisch, R. (2002). Results of the third round of the WHO-coordinated exposure study on the levels of PCBs, PCDDs and PCDFs in human milk. *Organohalogen Compounds*, Vol.56, 311-316