Appendix 6.2

Health Impact Assessment by EHA Occupational Health Hygiene Consultants (2015)

Incineration and human health

Human Health

Executive Summary

There have been extensive studies of the potential health effects of incinerators. Many of these are of historical incinerators which had much higher emissions than the one proposed and predate the various EU Directives which have imposed stringent limits on emissions.

The evidence is now very strong that well run, modern incinerators have no adverse effect on the human health of the communities around them. This is a position taken by a large number of highly reputable bodies quoted below.

Extensive modelling of potential emissions from the proposed development confirm that emissions from this facility will be within the relevant limits.

No adverse human health effects from the proposed facility are predicted.

Introduction

EHA was requested by Indaver to conduct an assessment of the potential effect on human health as part of the Environmental Impact Statement (EIS) of the proposed Resource Recovery Centre in Ringaskiddy, Co. Cork.

Indaver proposes to develop a Resource Recovery Centre in Ringaskiddy for the treatment of household, commercial and industrial, hazardous and non-hazardous waste. The proposed development, the Ringaskiddy Resource Recovery Centre, will include a waste-to-energy facility. The facility will use robust and proven

technology to process up to 240,000 tonnes per annum of residual waste. Both energy and recyclable materials will be recovered from this residual waste, which is currently landfilled or exported. The waste-to-energy facility will produce approximately 21 megawatts of electricity.

The proposed development will also include an upgrade of the local road (L2545) adjacent to the Indaver site to alleviate local flooding issues along the road. In addition, the proposed development will include the placement of shingle on the beach above the foreshore line along the eastern boundary of the Indaver site to reduce the rate of erosion of the cliff. .

The emissions, that would have potential to have an effect on human health, are primarily those to air. Therefore this assessment will primarily deal with possible health effects of potential emissions to air. We will however consider other routes such as emissions to water where there is the potential for human exposure. Indaver/EHA have considered what is the best method of assessment of potential human health impact assessment

Currently there is no legal requirement to perform a stand-alone Health Impact Assessment and as a result there is no “competent authority” in Ireland to assess these.
Also when the practicalities of performing a stand-alone Health Impact Assessment are examined there are great difficulties with this approach. Some of the main drawbacks are due to the fact that baseline data on human health for a defined geographical study area is very difficult to obtain and that which can be obtained may not be reliable or scientifically sound.
For example any baseline assessment would seek to quantify baseline levels of major human health diseases such as cancer and other relevant conditions such as asthma or perhaps cardiovascular disease.

When one begins to looks for this data it is quickly evident that there are problems. For most conditions no reliable data, in an accessible form, exists and where it does exist there are problems.

For cancer, reasonably reliable data is available as diagnosis is based on firm diagnostic criteria such as, for example, histological confirmation. There is a national data base maintained by the National Tumour Registry, and in many cases the data is even geographically analysed. This makes it almost unique amongst health conditions of interest. There are difficulties however even with this data. It is quite reliable when one examines it on a national basis but much less so for a defined geographical area. One reason for this is that cancer often has a long latent period, that is, the time between the exposure, to whatever may have contributed to the cancer, and the first signs of cancer. One environmental cause of cancer, for example, is asbestos where the time between exposure and cancer is as much as 40 years or more. Therefore if one uses a sufferer's place of residence at the time of diagnosis, one may miss critical factors such as place of residence when exposures that actually led to the cancer occurred. The person's previous residence is simply not available using National statistics.

Another issue may be that some specialist treatment centres may investigate cases more completely compared with peripheral centres. This can cause problems with classification of some illnesses where one might see an apparent larger number of cases of some conditions in urban areas where these specialist centres exist than other areas simply because of this difference in classification. Also the geographical reported statistics virtually never precisely match the area that is to be studied. For example it is impossible to get precise figures for a study are within a defined distance, say within a 3km radius of the proposed facility.

Other conditions can cause even more difficulties. For example, estimations of community prevalence of asthma may be very unreliable as they may depend more on the readiness of local doctors to diagnose the condition rather than on actual occurrence. Asking local general practitioners, for example, could grossly underestimate or overestimate the actual prevalence of the condition.

However if one only includes clinically proven cases diagnosed by specialist centres one may miss out on the greater number in the prevalence of the conditions and again the results will be skewed with higher incidence in those people who live in geographical proximity of these centres.
These are only examples of the problems faced with the approach. There are many others. In summary while it may be argued that this method might be appropriate for nationwide policy/ strategy decisions, but a standard Health Impact Assessment is neither legally required nor practical for a site specific project such as the proposed on for Ringakiddy.

This does not mean that we cannot reliably assess impact on health. Baseline environmental analysis, that is measuring currently levels of things like particulates, products of combustion and even dioxins, is by comparison an exact science. Measurements particularly when they are taken over a period of time in a number of different sites can give a very detailed picture of the background environment. Modelling for likely changes in this baseline environment caused by potential emissions is also remarkably reliable. The knowledge of the potential human health effects of these changes is also growing to an extent where we can make confident assertions. We are also learning more all the time about health thresholds for environmental agents. Thresholds are levels below which we do not expect any detrimental health effects. This means we can reliably extrapolate from potential changes in environmental conditions to potential impacts on human health. The use of this method therefore has the benefit of providing a simpler but more reliable method of assessment for a project such as this.
It is true to say that it is difficult to measure potential effects not directly affected by emissions, such as psychological effects or social wellbeing. However the assessment of these areas is more subjective regardless of the method chosen and at any rate the vast majority of possible detrimental effects to human health are related to emissions. In this project therefore a Human Health section of an overall Environmental Impact Assessment is used in the assessment.

Modelling and assessments contained elsewhere in the EIS are utilised to assist in this process. Not alone is this approach consistent with planning law it is more practical and accurate than other approaches.

For the assessment of potential effects on human health of the proposed facility both in the construction phase and in operation it is first necessary to identify the parameters that need to be studied. To do this a baseline evaluation has been conducted.

The steps taken in the baseline evaluation detailed in this chapter include identifying the study area and characterisation of the baseline environment with identification of sensitive populations and receptors. When we consider the potential for emission, considering a worst case scenario we are therefore able to assess likely impact on the sensitive or most vulnerable of the population. If the assessment reveals no significant impact on these people we can be confident that the rest of the population will be protected.

Population

When the potential effects on human health of any emissions are assessed, amongst the most important factors to be considered will be, the number of people who may be exposed, the duration of that exposure and the vulnerability or sensitivity of those individuals to those emissions.

Residential areas, public and private health facilities, workplaces, commercial areas and educational facilities are particularly important because significant numbers of persons usually spend significant time at these locations.

Places of worship and recreational areas are also important because of the significant numbers but the fact persons usually spend less time in these places, may be relevant for some emissions.

Agricultural areas usually have limited numbers of persons present and for a limited time but farm residences themselves are considered like any other homes.

The sensitivity of an area in this context refers to the vulnerability of the population. Vulnerable persons include the sick, the very young or old. Receptors that are considered to be very highly sensitive include health care facilities, both public and private, as these are more likely to include the elderly ill or infirm. Sensitive receptors also include schools, because of the children. When health impacts are assessed particular attention must be given to these groups.

The nearest villages and towns are Ringaskiddy, Shanbally as well as Monkstown, Carrigaline and Cobh as well as the south eastern suburbs of Cork city. There are however very few residences within 250 meters.

There nearest schools are primary schools including Ringaskiddy Lower Harbour as well as Shanbally and Loughbeg. There are also of course schools in Cobh, Monkstown and Carrigaline.

A considerable number of industries are situated in the Ringaskiddy area. This means that a considerable number of people work in area. When assessing environmental impact there are several reasons why persons at work are less vulnerable than, for example, residents. The most obvious of these is time. People typically spend about 40 hours per week in a work area whereas much more time is spent in the home. Of course some people who work in the area will also live in the area but again their exposure would not be expected to be any greater than a home maker for example who lives and works in the home. Also the population at work is less likely to include the vulnerable such as the very young, the very old and the ill. For these reasons if we use environmental levels designed to ensure the safety of residents it will automatically by sufficient to protect those at work.

This of course should not be confused with the workers in the facility itself who have potentially exposure higher than environmental levels. While their safety is part of the role of the Health and Safety Authority, the most appropriate measure

of workplace exposure for these individuals is the Occupational Exposure Limits Values or OELVs.

Incineration and Health

The introduction of waste incinerators has resulted in numerous studies of the effects of this process on human health. These have been carried out in either the occupational or community setting. Most of the published studies have looked at incinerators whose emissions of dioxins, particulates and heavy metal were far greater than would be emitted by a modern incinerator such as that proposed for Ringaskiddy. Basic scientific principles indicate that the more controlled the emissions are, the lower the level of toxins which are emitted, the less potential for any health effects.

Therefore the studies that are available, which will be discussed in more detail in the Literature review section, in many ways show a "worse than worst" case scenario for modern incinerators. They can nevertheless be valuable in making an assessment of the possible human health effects as if there is little discernable effect with poor controls, therefore we can be scientifically certain there will be still fewer with greater controls.

The health outcomes that have been examined in the various published studies include respiratory symptoms and illness, reproductive effects and the development of cancer. 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. In recent years more attention has also been given to particulate matter such as PM_{10} and $PM_{2.5}$

Emissions

The emissions of concern of such a facility will largely be to air and these have been extensively assessed elsewhere in the EIS. Refer to Chapter 8 **Air Quality** of the EIS.

Noise impact is detailed in Chapter 10 (Noise and Vibration) in both the Construction Phase and Operational Phase. The results of the cumulative impact assessment indicates that at the majority of noise sensitive locations in the vicinity of the development site, the operation of the proposed waste-to-energy facility is calculated to add 0 to 2dB(A) to the prevailing ambient noise environment. An increase of this magnitude is minor and is not considered to pose any significant noise impact.

In other words noise emissions will comply with EPA limits and will have no significance for human health.

The proposed facility will be operated in accordance with the strict terms of the EU Industrial Emissions Directive.

The ash and other residues will not be disposed of into the environment in an uncontrolled way.

The bottom ash is expected to be non-hazardous, under the transport regulations. Following conditioning, bottom ash is used in road construction in European countries. If there is no reuse option, bottom ash can be landfilled in a landfill for non-hazardous waste.

Boiler ash is expected to be non-hazardous, under the transport regulations. Tests will be carried out to determine whether it is suitable for disposal in a landfill for non-hazardous or hazardous waste.

The flue gas cleaning residues are expected to be hazardous for transport and will be handled and stored accordingly. Due to the leaching potential, it is expected that they would have to be disposed of in a landfill for hazardous waste or as a backfill in a salt mine.
If handled correctly, as proposed, the ash and other residues will pose no risk to human health.

The nature of the emissions may change depending on what is the intake of the facility. However the flue gas cleaning systems have been design to ensure that, regardless of the waste input, the emissions will not exceed the Industrial Emissions Directive limits. There is no doubt that incineration is the most satisfactory way of managing much of this residual municipal and hazardous waste, a fact supported by the WHO[18].

Regardless of what goes in, in terms of waste, however when one considers environmental effects it is what comes out in terms of the emissions that is important is assessing any detrimental effects to the environment. The air modelling detailed in Chapter 8 of the EIS is based on the emissions limits in the Industrial Emissions Directive

It is important to realise that the modelling performed is based on very much a worst case scenario. It assumes the highest levels of emissions allowed and the worst weather conditions. It takes into account the topography of the area and goes into such detail that it even considers the impact of a wind turbine in a nearby industrial facility, DePuy.

The predicted levels show no significant effect on existing air quality. Like any large construction project some mitigation is suggested in the Construction Phase however in the Operational Phase no further mitigation is required and the results for all parameters are very reassuring.

LITERATURE REVIEW

The human health issues related to incineration as a waste management technique were identified from evidence available in the literature.

Previously we have relied on the publication from 2003 by the Health Research Board on *Health and Environmental Effects of Landfilling and Incineration of Waste* [1] and the publication *A review of the environmental and Health effects of Waste Management* published in May 2004 by the UK Department of the Environment, Food and Rural Affairs [2].

Both of these are now somewhat dated. The studies quoted were largely related to older generation incinerators and prior to EU Directives which set limits on emissions but can be assessed in addition to more recent publications.

A PubMed electronic search was also performed on the 23 February 2015 using the key word "incineration" to identify further studies and any more recently published studies. A total of 4661 articles were identified. When the search was narrowed using the two words "incineration health" 1020 articles were identified. This could be further reduced if the terms were "waste incineration health" which identified 717. These are all of varying age and relevance.

Using other terms such as incinerator tended to narrow the search further but perhaps might omit relevant articles. A Google search on the same day revealed over 5 million hits but of course the tool used by the Medical profession is normally PubMed.

It is possible to refine searches in PubMed using a "review" filter and when this was done there were a total of 120 articles. This identifies the articles published in peer reviewed medical journals which attempted to review the available scientific information from other publications.

The aforementioned Health Research Board (HRB) report[1] was commissioned in 2003 to review existing data on waste management methods at that time. It presented the available data at that time. In general it did not make recommendations on the best solutions and in some ways this is disappointing but that was not its remit. Regarding the human health effects of incineration it stated:-

"*There is some evidence that incinerator emissions may be associated with respiratory morbidity. Acute and chronic respiratory symptoms are associated with incinerator emissions.*

A number of well-designed studies have reported associations between developing certain cancers and living close to incinerator sites. Specific cancers identified include primary liver cancer, laryngeal cancer, soft-tissue sarcoma and lung cancer. It is hard to separate the influences of other sources of pollutants, and other causes of cancer and, as a result, the evidence for a link between cancer and proximity to an incinerator is not conclusive.
Further research, using reliable estimates of exposure, over long periods of time, is required to determine whether living near landfill sites or incinerators increases the risk of developing cancer.
Studies of specific environmental agents and specific cancers may prove more definitive in the future."

The current status of this statement and its implications for facilities such as Ringakiddy will be explored in more detail in this assessment.

The DEFRA [2] report although covering many of the same studies went further in terms of scientific interpretation and in those terms was probably more helpful in an assessment of the risks or otherwise associated with a technology such as incineration. For example it said:

"We looked in detail at studies of incineration facilities, and found no consistent or convincing evidence of a link between cancer and incineration. There is little evidence that emissions from incinerators make respiratory problems worse. In most cases the incinerator contributes only a small proportion to local levels of pollutants."

Since the DEFRA report several important reviews were made. Some of the more important are summarized here.

WHO Workshop[3]

The World Health Organisation (WHO) published *Population health and waste management: scientific data and policy options. Report of a WHO workshop. Rome, Italy,* in March 2007. Published 2008
It states:
"Evidence is inadequate to draw conclusions that can be used to determine optimal policy choice on incineration: relatively few good quality studies exist and they refer to old generation incineration plants-an important distinction, as stack emissions from modern plants are much reduced compared to old generation plants. The adoption of emission abating technology, enforced by European Union EU has resulted in a less likely occurrence of measureable health effects on populations resident in the proximity of newer generation incinerators."

And

''Studies pointing to an increase in soft tissue sarcomas (STS) and non Hodgkin's lymphomas (NHL) support a possible aetiological role of 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8 T4CDD). The evidence is inadequate to draw conclusions that can be used to determine optimal policy choices on incineration: relatively few good quality studies exist and they refer mostly to old generation incineration plants – an important distinction, as stack emissions from modern plants are much reduced compared to old generation plants. The adoption of emission-abating technology, enforced by the European Union (EU), has resulted in a less likely occurrence of measurable health effects on populations resident in the proximity of new generation incinerators.''

The Porta review 2009 [4]

Systematic review of epidemiological studies on health effects associated with management of solid waste Daniela Porta et al Environ Health. 2009 Dec 23;8:60
As the title suggests it did concentrate on Municipal Solid Wastes (MSW) sites but did include others studies as well.

It reported:

In most cases the overall evidence was inadequate to establish a relationship between a specific waste process and health effects; the evidence from occupational studies was not sufficient to make an overall assessment. For community studies, at least for some processes, there was limited evidence of a causal relationship and a few studies were selected for a quantitative evaluation. In particular, for populations living within two kilometres of landfills there was limited evidence of congenital anomalies and low birth weight with excess risk of 2 percent and 6 percent, respectively. The excess risk tended to be higher when sites dealing with toxic wastes were considered. For populations living within three kilometres of old incinerators, there was limited evidence of an increased risk of cancer, with an estimated excess risk of 3.5 percent. The confidence in the evaluation and in the estimated excess risk tended to be higher for specific cancer forms such as non-Hodgkin's lymphoma and soft tissue sarcoma than for other cancers.

This is broadly in line with previous reviews. Of course the most important point is that these findings relate to "old" incinerators, 20 years or older. As pointed out in the EIS, and indeed in the WHO review quoted above, the proposed facility will have to comply with the strictest EU emission standards and simply cannot be compared to the older generation studied.

The Giusti Review 2009 [5]

A review of waste management practices and their impact on human health

References and further reading may be available for this article. To view references and further reading you must purchase this article.
L. Giusti Faculty of Health and Life Sciences, UWE Bristol *Waste Manag. 2009 Aug;29(8):2227-39*

This study concluded:

The main conclusion of the overall assessment of the literature is that the evidence of adverse health outcomes for the general population living near landfill sites, incinerators, composting facilities and nuclear installations is usually insufficient and inconclusive.

Forastie 2011 [6]

Forrastie et al performed a Health Impact Assessment of the effects of waste management including incineration in 3 countries, England, Italy and Slovakia.

Their conclusions were:

Past exposures from incinerators were likely to cause a sizeable health impact, especially for cancer, in Italy and England. However, the current impacts of landfilling and incineration can be characterized as moderate when compared to other sources of environmental pollution, e.g. traffic or industrial emissions, which have an importance on public health.

Mattiello 2013 [7]

This was a review entitled: Health effects associated with the disposal of solid waste in landfills and incinerators in populations living in surrounding areas: a systematic review published in 2013 by Mattiello et al concluded

It is confirmed that historically incinerators are an important source of pollution and harm for the health of populations living nearby; however, changes in technology are producing more reassuring results.

Sharma [8]

The impact of incinerators on human health and environment. Rev Environ Health. 2013;28(1):67-72. Sharma R[1], Sharma M, Sharma R, Sharma V

One review which is out of step with the others is an Indian article published in 2013. While one could criticise it's analysis perhaps the greatest point is it's origin in India outside the influence of the EU directive.

Incinerators releases a wide variety of pollutants depending on the composition of the waste, which leads to health deterioration and environmental degradation. The significant pollutants emitted are particulate matter, metals, acid gases, oxides of nitrogen, and sulfur, aside from the release of innumerable substances of unknown toxicity. This process of waste incineration poses a significant threat to public health and the environment. The major impact on health is the higher incidence of cancer and respiratory symptoms; other potential effects are congenital abnormalities, hormonal defects, and increase in sex ratio. The effect on the environmental is in the form of global warming, acidification, photochemical ozone or smog formation, eutrophication, and human and animal toxicity.

This is simply not consistent with the vast majority of published reviews so should be treated with great caution. It is included here, not because it is considered relevant for a European Incinerator but simply to be comprehensive.

In the EU the emission limits for the pollutants mentioned are very low and at levels which protect human health and the environment.

Public Health England [9]

Public Health England is a governmental body in the UK charged with analyzing information and making recommendations on issues that may pertain to human health in England.

A major study on incineration was commissioned by Public Health England. It is due for publication later this year (2015).

Public Health England made a noteworthy statement in 2015 when Dr Simon Bouffler deputy director of PHE's Centre for Radiation, Chemical and Environmental Hazards stated:

"that well run and regulated modern municipal waste incinerators are not a significant risk to public health remains valid, and the study is being carried out to extend the evidence base and to provide further information to the public on this subject.

While at the time of writing the official study has not been published some of the research has been published by Font et al in Atmospheric Environment in a separate article published in July 2015[10] stated:

'From our analysis we found no evidence of incinerator emissions in ambient metal concentrations around four UK MWIs [municipal waste incinerators]. The six UK MWIs studied contributed little to ambient PM10 [particulate matter] concentrations.'

Race Against Waste [11]

The website Race against Waste (raceagainstwaste.com) accessed 24th February 2015 was initially set up by the Department of Environment, Community & Local Government as part of a three year national communications and awareness campaign on waste management in Ireland.

This has a section: *Incineration The Facts.*

- There is a broad spectrum of chemicals emitted from incinerators but even in rural situations the overall contribution is usually less than 1% of existing background levels – including dioxins and furans.
- Even if 1 million tonnes of municipal waste was to be incinerated in Ireland this would contribute less than 2% of the dioxins emitted to the air (EPA 2001).
- The EPA, FSAI (Food Safety Authority of Ireland) and WHO have all indicated that properly managed well run incinerators do not impact on the environment or on human health.
- There are 11 incinerators operating in Ireland. Studies carried out by the Food Safety Authority of Ireland (FSAI) show no increase in dioxins in dairy products produced in the vicinity of the plants.
- Levels of dioxins in mother's breast milk and in dairy products (key indicators) have decreased over the past 20 years despite the increased use of incineration in Europe.
- Legislation controlling emissions from incinerators is among the strictest environmental legislation in the world.
- Incineration will not compete with recycling as infrastructure like thermal treatment plants and landfill will be sized to take the appropriate non-recyclable percentage of the waste stream.

- Old badly managed incinerators are being closed down in Europe where they do not comply with the new standards for monitoring and operating. However, new facilities are being provided in their place. Incineration capacity across Europe is increasing.
- Modern incinerators reduce waste to between 6-13% of the original volume. Of this, approximately 5-10% is bottom ash and is inert and only 1-3% of the original volume is fly ash requiring disposal in a special facility.
- Uncontrolled burning of waste is one of the biggest threats to the Irish environment today because it involves burning waste at temperature levels which create dioxins. Modern well-managed incinerators burn waste at much higher temperatures at which dioxins are destroyed. For example, a modern municipal incinerator treating 1 million tonnes of waste in controlled conditions, releases just 0.54 grams of dioxins to the atmosphere. Overall this is a very reassuring position.

World Health Organisation (W.H.O) [12]

The World Health Organization is the United Nations specialized agency for health. It was established on 7 April 1948. WHO's objective, as set out in its Constitution, is the attainment by all peoples of the highest possible level of health. Health is defined in WHO's Constitution as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.

WHO is governed by 192 Member States through the World Health Assembly. The Health Assembly is composed of representatives from WHO's Member States. The main tasks of the World Health Assembly are to approve the WHO programme and the budget for the following biennium and to decide major policy questions.

In a statement on incineration WHO said:

"The incineration of waste is a hygienic method of reducing its volume and weight which also reduces its potential to pollute. Not all wastes are suitable for combustion. Residues from incineration processes must still be landfilled, as must the non-combustible portion of the waste stream, so incineration alone cannot provide a disposal solution.
Generating electricity or producing hot water or steam as a by-product of the incineration process has the dual advantages of displacing energy generated from finite fossil fuels and improving the economics of waste incineration, which is the most capital-intensive waste disposal option."[12]

The latter point is particularly relevant to this facility as it will both generate electricity and has the potential to heat water for third party use.

Health Protection Agency (UK) 2010[13]

The Health Protection Agency is another UK Governmental agency who are responsible for making recommendation on the protection of health.
They issued a report in 2010. They said

While it is not possible to rule out adverse health effects from modern well regulated incinerators with complete certainty, any potential damage to health of those living close by is very small if detectable.

It goes on
Since any possible health effects are very small, if detectable, studies of Public Health around modern well managed municipal waste incinerators are not recommended.
This latter point is important as an agency as when a reputable and independent as the Health Protection Agency says this it is very reassuring.

As already stated these studies have proceeded anyway to give further evidence again.

European Council Directives

The Waste Incineration Directive (WID) introduced in 2000 set stringent operating conditions and sets minimum technical requirements for waste incineration and co-incineration. It consolidated new and existing incineration controls into a single piece of European legislation.

The requirements of the Directive were developed to reflect the ability of incineration plants to more cost effectively achieve high standards of emission control in comparison to the 1980s. Previous waste incineration directives only applied to municipal and hazardous waste. WID updated the requirements of the 1989 municipal waste incineration (MWI) directives (89/429/EEC and 89/369/EEC) and, merged them into the 1994 Hazardous Waste Incineration Directive (94/67/EC), consolidated new and existing incineration controls into a single piece of European legislation.

This has now been superseded by the Industrial Emissions Directive.
The Proposed facility will have to abide by the strictest of criteria from day 1.
The directive specifies air emission limits which must not be exceeded. The basis of the emission limits is to prevent, or limit as far as is practicable, negative effects on the environment and the resulting risks to human health.

POTENTIAL POLLUTANTS

Dioxins

'Dioxins' and 'furans' are generic terms for a group of more than 200 individual chemical compounds, all of which are of different toxicity. They cause chloracne, a skin condition which looks somewhat like teenage acne, if person is exposed to relatively huge quantities. They are carcinogenic particularly in some animal studies however there is far less objective evidence in humans.

Dioxins and furans will form spontaneously in a combustion process from chlorine atoms, carbon that has not been fully oxidised, and various catalysts in cooling smoke; hence, the process is the same for waste incineration plants, turf fires and tiled stoves alike. Each of the 200 dioxin and furan compounds is of a different degree of toxicity; for that reason, their so-called toxicity units (TUs) are determined and summarized into units of grams per toxicity unit (g TU).

Indeed the public concern on dioxins was so significant that the Food Safety Authority of Ireland (FSAI) published a report in 2003[15] on the potential effect on food if waste incineration of municipal waste was introduced into Ireland. They stated:-

" *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*".[15]

The WHO issued a fact sheet on dioxins No. 255 which was updated in June 2014.[18]

This stated:

"Proper incineration of contaminated material is the best available method of preventing and controlling exposure to dioxins. It can also destroy PCB-based waste oils. The incineration process requires high temperatures, over 850°C. For the destruction of large amounts of contaminated material, even higher temperatures - 1000°C or more - are required".

Regarding effects on human health it commented:

"*Short-term exposure of humans to high levels of dioxins may result in skin lesions, such as chloracne and patchy darkening of the skin, and altered liver function. Long-term exposure is linked to impairment of the immune system, the developing nervous system, the endocrine system and reproductive functions.*

Chronic exposure of animals to dioxins has resulted in several types of cancer. TCDD was evaluated by the WHO's International Agency for Research on Cancer (IARC) in 1997 and 2012. Based on animal data and on human epidemiology data, TCDD was classified by IARC as a "known human carcinogen". However, TCDD does not affect genetic material and there is a level of exposure below which cancer risk would be negligible.

Due to the omnipresence of dioxins, all people have background exposure and a certain level of dioxins in the body, leading to the so-called body burden. Current normal background exposure is not expected to affect human health on average. However, due to the high toxic potential of this class of compounds, efforts need to be undertaken to reduce current background exposure.

Much of the attention in debates in the past about the human health effects of incinerators has concentrated on dioxins and furans. This is despite the fact that most dioxins we are exposed to are in our diet. The major sources are dairy products, as well as some other foods.

One however rarely sees this fact highlighted in the press except perhaps after occasional “scares” such as the 2008 Italian one[19] when high levels of Dioxins were found in some agricultural products around Naples. Interesting this was attributed to illegal landfills not incineration.

In addition there was in 2008 a recall of Irish Pork products in relation to elevated dioxins. This was detected through routine monitoring of food. This was traced to contaminated feed which in turn traced back to contaminated oil. There was no evidence of a public health issue.

Because the food we eat is increasingly not from the immediate vicinity in which we live but rather from the broader national and international sources the effect of any source may be dispersed far and wide but equally we may be more vulnerable to high levels coming from all parts of the world rather than our own “back-yard”.

The dioxin emissions from modern incinerators are up to 1000 times less than 20 years ago. This can be seen from the situation in Germany, one of the countries in Europe that has studied this area most closely and one where environmental concerns are taken very seriously. Whereas in 1990 one third of all dioxin emissions in Germany came from waste incineration plants, for the year 2000 the figure was less than 1%. It is estimated that in Germany now for example that chimneys and tiled stoves in private households alone discharge approximately twenty times more dioxin into the environment than all the waste incineration plants together.[19] This is also evident from the fact that in winter airborne dioxin loads are up to five times higher than in summer when heating systems are out of operation but the incineration plants are still operating.

The results of dioxin sampling performed and detailed separately in Chapter 6 (Population and Human Health) of this EIS show that background soil PCDD/F concentrations for the sites sampled in the Ringskiddy area were typical of a

mixed urban/rural area. The PCDD/F values measured in the survey are well below any of the recorded levels or limits defined in the above literature and are low by international standards. This is despite the history of heavy industry in the area, most particularly the Irish Steel plant in the vicinity which now is closed. This source in particular, given the nature of the activity that was carried out there and recent well publicised soil contaminations within the plant itself, is likely to have emitted pollutants including dioxins far in excess of those which will be emitted by the proposed facility. It is doubly reassuring therefore that despite this the baseline levels are good.

It is of note that when the MARI (a theoretical Most At Risk Individual) is considered there is a small increase in weekly dioxin dose which remains well below the TWI (Tolerable Weekly Intake). It is estimated indeed that the increase was only 1.7% of the TWI. We use the theoretical being MARI because if the most vulnerable individual conceivable is unaffected then all individuals are unaffected. In fact this MARI does not exist as it is based on many "worst case" assumptions. No human being will be exposed to the extent of MARI and as MARI's exposure increase is tiny we can all be very reassured that Dioxins and Furans will not increase significantly.
Because of the absence of impact on the local levels, and bearing in mind most human dioxin exposure is dietary anyway and the food we eat and the milk we drink usually comes from far and wide it is a straightforward conclusion that the proposed facility will have no significant effect on dioxin intake either locally or nationally.

The EPA Annual Environmental Report 2014 [22] on the Indaver facility in Carranstown, Co. Meath shows that not alone are Dioxin emissions well below the licence limit but are a mere 0.4% of the Threshold Limit Value which is really negligible in Human Health terms.

Particulate Matter

Much of the attention on respiratory issues has occurred because of concerns regarding particulate matter or dust. This is despite much lower emissions from modern incinerators than was achievable heretofore. Virtually any development where combustion takes place, and that includes the heating systems and solid fuel or oil boilers for steam generation has the potential to emit particulate matter. However none of these other sources are as measured and regulated as incinerators.

Background particulate measurements were performed near Ringaskiddy. These suggest low levels of PM10 and PM2.5 in the area. These represent Particulate Matter less than 10 microns and 2.5 microns respectively. To put these numbers into perspective even the finest grain of sand will be in the order of 100 microns in diameter.

Just as we stated above that there has been a huge reduction in the amounts of dioxins emitted the same story is true with regard to particulate matter, or dust, emitted from incinerators. This matter will be dealt with more comprehensively later. Between 1990 and 2001 the particulate matter emitted by incinerators in Germany dropped from 25,000 tonnes of dust per year to 3,000 tonnes.[14]

Air modelling in Chapter 8 (Air Quality) of this document predicts that the contribution from the site in the context of this baseline is minor with levels even under maximum operation remaining significantly below levels which would be expected in urban areas even at the worst-case boundary receptor. Levels at the nearest residential receptor will be minor, with the annual contribution from Indaver Ireland and associated traffic will be small. Predicted levels for both PM 10 and PM 2.5 are well below relevant Air Quality Standards. This has also already been well established in Indaver's facility in Meath with emissions less than 1% of the Legal Limit.[22]

Other Air Quality Issues

Heavy metals, such as lead and mercury, are retained in the filtering devices of waste incineration plants. They are not regarded as carcinogens. Whether or not they are poisonous for human beings will depend on whether they reach their thresholds of effectiveness. In effect for these to have a human health effect, they must leave the incinerator in the form of emissions and enter the human body either by inhalation or ingestion and theoretically, but rarely in practice, through the skin.
For these substances, too, there has been an impressive decline in emissions from modern incinerators compared with historical measures. Improved controls and reduction in amounts in wastes presenting for treatment explains the marked reduction experience in their emissions.

For example whereas in 1990, emissions in Germany amounted to as much as 57,900 kilograms (kg) of lead and 347 kg of mercury from the incineration of household waste, the respective levels declined to 130.5 kg (equivalent to 0.2% of initial emissions) and 4.5 kg (1.3% of initial emissions) in the year 2001. [14]Thus, lead and mercury emissions from the incineration of household waste are also no longer significant for human exposure to emissions of toxic substances.

As has been performed for Dioxins and Particulate Matter (PM 10 and PM2.5) similar baselines assessments and modelling has been performed. These have included PAH (Polycyclic Aromatic Hydrocarbons), SO2 (Sulphur Dioxide), NO2 (Nitrogen Dioxide) and NOx, CO (Carbon Monoxides), TOC (assumed in worst case to be solely Benzene), HCl (Hydrochloric Acid) and HF (Hydrofluoric Acid). This is detailed in the Air Quality Chapter of this EIS. All of these predict levels are below Air Quality Standards even at maximum operation in worst case scenario weather conditions. It is reasonable from this to extrapolate no deleterious health effects.

The situation is identical with modelled metals. This included Mercury, Cadmium and Thallium as well as the sum of other relevant metals. Again the levels predicted are simply not consistent with a detrimental health effect.

SPECIFIC HEALTH ISSUES

Respiratory symptoms and illness

Some older studies, described in the 2003 HRB report[1] did show that symptoms of respiratory illness, such as chronic cough, wheeze and sinus trouble, were significantly greater in those living near a hazardous waste incinerator than in their control community. It should be noted that these studies predated much stricter environmental controls on the emissions of particulates to which the proposed Ringaskiddy site would operate.

Studies of self-reported symptoms must always be treated with caution as they can be more revealing about peoples' concerns rather than actual health effects. Again while there have been some of these in the past none were without issues.

As any respiratory symptom that might occur must in turn be related to increase in some airborne contaminant, be it particulate matter or products of combustion such as Sulphur Dioxide or Nitrogen Dioxide. It follows that with the vast reduction of the emission of these in newer incinerators, to levels where there is little or no change in the baseline conditions, these effects will not occur. In effect the emissions from modern incinerators will not cause coughs or respiratory symptoms.

Reproductive effects

Very often when one discusses incineration concerns are expressed about potential reproductive effects.

It is true that in the 1980s studies quoted in then HRB report[1] there were reported to be an increase in the frequency of twinning in human and cattle populations in an area in central Scotland at increased risk from incinerator emissions.

These findings have not been replicated.

The HRB[1] report also mentions a study of open chemical combustion in the Netherlands in the 1960's was carried out to investigate the incidence of orofacial clefts in the region and to determine any association with the local combustion facility. The authors concluded that these results inferred an association between the incinerator and the increased local incidence of orofacial clefts. Although this increase was probably a true finding, the possibility of other influencing factors, such as alternative sources of exposure, could not be ruled out.

This study is of open chemical burning and bears no relation to modern incineration and so is of no relevance to the proposed facility but again is described here as it is often quoted by persons opposing incineration per se.

A review performed by Ashworth et al [16] entitled *Waste incineration and adverse birth and neonatal outcomes: a systematic review* was published in 2014 and is probably the most authoritative ever published..

This concluded

"*that a comprehensive literature search yielded fourteen studies, encompassing a range of outcomes (including congenital anomalies, birth weight, twinning, stillbirths, sex ratio and infant death), exposure assessment methods and study designs. For congenital anomalies most studies reported no association with proximity to or emissions from waste incinerators and "all anomalies", but weak associations for neural tube and heart defects and stronger associations with facial clefts and urinary tract defects. There is limited evidence for an association*

between incineration and twinning and no evidence of an association with birth weight, stillbirths or sex ratio, but this may reflect the sparsity of studies exploring these outcomes.

It went on

"The current evidence-base is inconclusive and often limited by problems of exposure assessment, possible residual confounding, lack of statistical power with variability in study design and outcomes. However, we identified a number of higher quality studies reporting significant positive relationships with broad groups of congenital anomalies, warranting further investigation. Future studies should address the identified limitations in order to help improve our understanding of any potential adverse birth outcomes associated with incineration, particularly focussing on broad groups of anomalies, to inform risk assessment and waste policy."

While obviously warranting further examination overall this, in addition to other commentary on the area quoted above is reassuring.

Cancer

It is fair to say some studies have reported putative links between incinerators and cancers. However not one of these studies was without problems. In the past incinerators were often sited in urban, industrial and otherwise polluted areas. This introduced major confounders for studying cancers such as deprived populations, urban living, other sources of industrial pollutions, cigarette smoking habits etc.

It is also true that other studies did not support such a link.

The largest study by Elliot[20] in 1996 examined 72 incinerators. This included essentially all incineration plants, irrespective of age, up to 1987. This was by far

the largest and statistically probably the best study ever conducted. It studied a total of 14 million people. It nevertheless was unable to convincingly demonstrate an excess of cancers in areas within 7.5 km of incinerators once socio-economic confounding was taken into account.

There were reported individual increases for stomach, lung, colorectal and primary liver cancers. This however was thought to be largely due to residual confounding by socio-economic factors. Liver cancer, for example, was the most strongly significant (37% excess risk within 1 km of municipal waste incinerators) but, on review of cancer registration data, this cancer category was reported to be frequently misclassified or misdiagnosed (mainly secondary liver tumours). In a follow up study to investigate the validity of these liver cancer diagnoses, Elliot et al. (2000) attempted to determine the size of any true excess in the vicinity of municipal waste incinerators. In a sample of cases subjected to histological and medical record reviews, only about half were reported to be true primary liver cancer. This resulted in a re-estimation and significant reduction of the calculated excess risk previously reported.

The strong association between deprivation and primary liver cancer was thought to remain an influence on the residual result.

Nevertheless the overall finding from this very large study was of no increase in cancers in those living close to incinerators.

As a result of this study but also taking into account studies previously published, the UK Department of Health's Committee on Carcinogenicity (COC) published a statement in March 2000[23], evaluating the evidence linking cancer with proximity to municipal solid waste incinerators in the UK. The Committee specifically examined the results of these studies, and concluded that,

"*Any potential risk of cancer due to residency (for periods in excess of ten years) near to municipal solid waste incinerators was exceedingly low and probably not measurable by the most modern techniques".*[23]

The Committee agreed that the observed excess of all cancers, stomach, lung and colorectal cancers was due to socio-economic confounding and was not associated with emissions from incinerators. 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.

Indeed the DEFRA report [2] published in 2004 and referred to in the introduction of the Literature Review concluded:

"We looked in detail at studies of incineration facilities, and found no consistent or convincing evidence of a link between cancer and incineration. There is little evidence that emissions from incinerators make respiratory problems worse. In most cases the incinerator contributes only a small proportion to local levels of pollutants."

This absence of a measurable effect was evident even with older and undoubtedly dirtier incinerators. When this is true we can be as scientifically certain as we can be that there can be no effect with lower emissions from modern facilities regulated to the highest standards.

Repeatedly quoted papers.

Evaluation of the 4th Report of the British Society for Ecological Medicine: "The Health Effects of Waste Incinerators"

This report was published by the British Society of Ecological Medicine (BSEM) in February 2006.This "Society" appear to have little academic standing and we

are addressing the report here not because of scientific merit but rather the fact that it has been submitted by objectors in previous applications by Indaver .

Enviros, now known as SKM Enviros, was the company commissioned by the UK government to produce a literature review on health effects of waste management in 2004 commented on the BSEM report.

This states

"The study makes the common mistake of identifying incinerators as a significant source of emissions of fine particulate matter, dioxins and furans, volatile organic compounds and metals. In fact, incinerators do not make a significant contribution to emissions of these substances. This means that, while the report may make valid comments about the risks to health associated with exposure to these substances, the conclusion should be to consider what needs to be done to deal with the main sources of these emissions.
For example, emissions of PM_{10} from MSW incineration are approximately 100 tonnes per year, compared to 22,000 tonnes per year from electricity generation. Emissions of finer particles (e.g. $PM_{2.5}$ and PM_{1}) and secondary particles would be expected to be in a similar proportion. If it is right to be concerned about fine particulate matter, then attention needs to be paid to controlling emissions from electricity generation, road transport, agriculture and domestic sources. No discernible benefit would be gained by any policy change relating to waste incineration, because the source is simply too small to be significant."

It concluded:

"The report falls down badly in its understanding of incineration processes. It fails to consider the significance of incineration as a source of the substances of concern. It does not consider the possible significance of the dose of pollutants that could result from incinerators. It does not fairly consider the adverse effects that could be associated with alternatives to incineration. It relies on inaccurate

and outdated material. In view of these shortcomings, the report's conclusions with regard to the health effects of incineration are not reliable."

The Health Protection Agency in the UK also reviewed the report. It stated

"*The BSEM report is not a systematic review of the literature and there is no critical analysis of the quality of the included studies. Consequently the report presents a selective and inaccurate review of the scientific literature. For example the report has not considered important reviews such as the Defra review of environmental and health effects of waste management, the Committee on Carcinogenicity (COC) statement on cancer incidence near municipal solid waste incinerators in Great Britain or the Royal Society critique of the Defra review. In addition, several statements regarding health risks are not supported by appropriate scientific references, for example '…increased ischaemic heart disease has been reported in incinerator workers' is taken from a study regarding cement kilns 'They are therefore capable of extremely serious health consequences'.*

The authors have also failed to acknowledge the impact of the current legislative changes which minimises the potential for public exposure to emissions. The Waste Incineration Directive for example has strengthened the regulatory regime and provides for strict operating robust monitoring programmes.

There are misleading statements on health issues such as carcinogenicity and it misinterprets the 'precautionary principle'. The precautionary principle should be invoked if there is good reason to believe that harmful effects may occur and the level of scientific uncertainty regarding the consequences or likelihood of the risk is such, that the best available scientific methods to assess the risk with sufficient confidence is not complete, to inform decision making.

As there is a body of evidence strongly indicating that contemporary waste management practices of modern incinerators have at most, a minor effect on human health and the environment, there are no reasons for adopting the 'precautionary principle' to restrict the introduction of new incinerators.

Stockholm Convention

Again this has been referred to in the above "report" and also by objectors to previous Indaver applications. Again we will quote the Enviros response which we feel adequately deals with this area.

The BSEM Enviros Response states that "… incinerators will create vast amounts of dioxins, particularly in the ash for periods of 20-30 years…" An incinerator accepting 100,000 tonnes of waste per year over 25 years will result in the production of approximately 25 grams of dioxins and furans in solid residues and approximately 1 gram in emissions to air (expressed as toxic equivalent). For context, sources such as accidental fires, agricultural waste burning, industrial combustion and small scale waste burning (e.g. on building sites) all give rise to a thousand times more emissions to air.

Information on emissions in residues is harder to obtain, but landfill of household waste results in the production of more than one hundred times as much dioxin as would be contained in the ash from an incinerator. What can we conclude from this? The BSEM concludes that emissions at this level would constitute "tearing up" the Stockholm treaty. A more appropriate conclusion is that the UK should fulfil its responsibilities under the Stockholm treaty by dealing with sources such as those listed above. Enviros is working with the UK Government in this area. Preventing further development of waste incineration on these grounds risks diverting attention from much more important sources of unintentional persistent organic pollutants, and will make no detectable or significant difference to the unintentional production of dioxins and furans."

We would suggest the same comments apply to Ireland.

Conclusions

While some studies, particularly in the past, report health effects in relation to incinerators, nearly all of these studies are, by their nature, historical and refer to toxic or industrial burning processes. These virtually all pre-date modern technology and the associated large decreases in emissions. They also pre-date current regulatory restrictions on allowable emissions such as the EU Air Quality Directive and the EU Industrial Emissions Directive.

We know from direct experience that modern incinerators operate well within these stringent guidelines. The Indaver incinerator in Meath, widely predicted by objectors in advance of it's commissioning to greatly exceed those limits, has in operation been a great example of a well-run facility

Modelling for emissions of particulate matter in the form of PM_{10} and $PM_{2.5}$ does not support any likelihood of a detrimental health effect.

There has been nothing published in recent literature which would significantly change this position. Overall, there is little evidence to suggest that waste incinerators are associated with the increased respiratory symptoms, or other medical conditions, in the surrounding population. This is consistent with the data from risk assessments, emissions and ambient air monitoring in the vicinity of incinerators, which indicate that modern, well-managed facilities make a very small contribution to background levels of air pollution.

Multiple reputable reviews quoted above support this position.

The fact that the proposed facility will be operated in accordance with the strict terms of the EU Industrial Emissions Directive, means that emissions will be

lower than from practically all facilities assessed in publications cited herein, reducing even further any possible risk.
The EPA report[22] on emissions from the Indaver facility in Carranstown, Co. Meath shows not only are the emissions well within the Legal licenced limit but in many cases a small fraction of those. Dioxins are considerably less than 1% of the legal limit. This shows that in practice as well as in theory modern, well run incinerators, do not pose an environmental risk.

All information available on the Ringakiddy facility therefore, both from modelling and from actual results of a similar facility in Ireland, indicates that all emissions will be well within the statutory Air Quality Standards. These provide strong evidence that there will be no deleterious effect on human health either in the immediate vicinity or in the wider context, due to its operation.

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