NOTE ON
UNDERSTANDING & MANAGEMENT OF DIOXIN EMISSIONS
FROM
MEDICAL WASTE INCINERATORS (MWI).

**NOTE REFERANCE NO: MWI-01**
**MARCH 1997**

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By Homi R. Mullan

## *Preamble*

There has been a growing concern for treatment of Infectious Medical Waste in UK & USA during 1995, and in India, since April 1995, after the Notification issued by Ministry of Environment & Forests on Draft Rules called "Bio-Medical Waste Management and Handling) Rules,1995". The Bio-Medical waste has been classified as a hazardous Waste [1] , and a Universal label of "Biohazard Symbol", of locked horns, has been adopted. Incineration of Infectious Medical Waste is recommended and considered to be a Relatively SAFE method of Hazardous Infectious Bio-Medical Waste disposal [1]. Incineration has also evoked Environmental pollution concern. Whilst operating parameters and specification guidelines are being formed for Hospital Waste Incineration by HIMP in UK, EPA in USA and Central Pollution Control Board (CPCB) in India, one single factor which has come into prominence in the News Media is the serious concern due to Dioxin emissions. This note addresses as to what extent the Dioxin emissions from Medical Waste Incinerators (MWI) are assessed to be harmful for the living beings, and how the dioxin emissions are to be managed and controlled in western countries, so as to continue with the use of on-site and off-site Medical Waste Incineration units and plants.

## *Summary*

Royal Commission on Environmental Pollution (RCEP), UK, indicates that Incineration under carefully controlled condition is likely to represent the Best Practicable Environmental Option (BPEO), and was particularly suitable for Clinical Waste [3]. RCEP also states that '**We do not believe, however, that any method other than conventional Incinerators or landfill will be commercially available in the foreseeable future for unsorted Municipal waste**.'(1) Her Majesty's Inspectorate of Pollution (HMIP) has strongly recommended incineration as an alternative to landfill provided it meets with the emission guidelines laid by them.(3) The concentration limits set by HMIP on the release of Dioxins is **1 nanogram per cubic meter** (1 $\eta g\ m^{-3}$) and a target value of **0.1 $\eta g\ m^{-3}$**. [2]The public perception and fears of Dioxin emission are more with large incineration plant handling Municipal Solid Waste (MSW), and the media has failed to distinguish between clinical waste quantum with that of MSW being incinerated. However, estimated dioxins from MSW plant may contribute to about 20% of all man-made

sources of Dioxin in the environment, and clinical waste contribution is only 0.06% in U.K.[4]. Total waste in England and Wales is 2505.15 million tonnes per annum, of which Medical waste is 0.15 million tonnes per annum [1]. The quantum of clinical waste generated in USA is less than 1% of the total waste . Therefore **the first point to understand whilst dealing with Incineration of Medical waste is that the dioxin emissions are very minimal from the very small quantity of waste being incinerated**; more over there are methods & standards which further minimise the release of such Dioxins, even though there are no conclusive tests done on effects on human health due to levels of dioxin emissions from Incinerators.

Amongst the recent work (June 1996) carried out on Dioxin emissions from Medical Waste Incinerators, is from United States Environment Protection Agency (EPA).[4] Some of the findings of this report are quoted in this paragraph. From the database generated of existing Medical Waste Incinerators (MWI) in USA, and **Emission Factors** developed from available dioxin emissions, on the total **Toxic Equivalent Quantity** (TEQ) basis for USA, dioxin emissions have reduced from estimated 600 grams per year in 1990 to 150 grams per year in 1995, and is estimated to reduce to 14 to 15 grams per year by the year 2002; and in terms of **Total Mass** basis it has reduced from 29,000 grams per year in 1990 to 7,200 grams per year in 1995; and is estimated to reduced to 660 to 1100 grams per year 2002 [2]. MWI emission factors were developed which establishes that **Dioxin levels reduce with increase in combustion time (1/4 sec to 2 sec)** and by adopting Gas cleaning equipment. TEQ Factors in "**TEQ Dioxin/ lb. of waste**" reduces from $3.96 \times 10^{-9}$ at ¼ sec combustion control to $7.44 \times 10^{-11}$ at 2 sec combustion control, and further reduced to $1.01 \times 10^{-11}$ with wet scrubbers; Likewise for Dioxin Factors in "**lb. total dioxin/ lb. waste**" reduces from $1.94 \times 10^{-7}$ at ¼ sec combustion control to $3.65 \times 10^{-9}$ at 2 sec combustion control, and further reduced to $4.26 \times 10^{-10}$ with wet scrubbers attachment for cleaning the discharged gases from MWI [2]. **It is viewed that Small MWI's, those burning less than 200 pounds of waste per hour, to meet emission limits associated with good combustion**; **Medium size** (200 to 500 lb./ hr) may also be required to meet emission limits associated with good combustion controls; and **Large** (> 500 lb./hr) MWI's would have to meet emission limits associated with add-on scrubber systems [2]. **Further reduction of dioxin emission in future would be to separate their waste into Infectious and non- infectious portion.** It is anticipated that Infectious portion of the waste would be burnt on-site or at a commercial incinerator. [2] The non-infectious portion of the waste will not be burnt, but would go with MSW for land filling, as a result there will not be any dioxin emissions produced from the burning of non-infectious waste in MWI. [2]

### *Human Health Effects of Dioxin Emission from Incinerators.*

The Scottish office convened an independent review group under the chairmanship of professor J.K. Lenihan to examine allegations of ill-health concerned with operations of a hazardous waste incinerator and in particular the combustion of PCB's, in the vicinity of Bonnybridge, Denny and Larbert in Stirlingshire, Scotland. Having studied statistical data on a number of effects, the review group concluded that there was no evidence of increased rates of the

incidence of health effects such as cancer, congenital anomalies , spontaneous abortions and still births. [7]

**The RCEP report concludes that the total pollution load from modern and new incinerator plant should not be a cause for concern**. Incineration is a 'soft' target for pollution control even though it is not the primary source of problem, nor a significant risk in an area, has major financial implications for waste management, and eventually society [8].

Although no cases of human death or even long-term disability have been attributed to dioxins in United States or elsewhere, there is widespread fear among the public at large that dioxins pose a severe health threat to human life. The lethal animal dose of PCD's varies from one animal species to another with roughly the same body weight. The dioxin Lethal Dosage required in "**$LD_{50}$, μ/kg body weight**" is **1** for Guinea Pig, **22** for Rat (male) and **45** for Rat (female), and that for Hamster with roughly the same body weight is **5000**. Similar inconsistencies appear with dog at >300 and monkey <70 $LD_{50}$, μ/kg body weight. These differences in animal toxicity make extrapolation to human toxicity a difficult task. No experiments can be performed, and none can be performed, to determine human toxicity [6].

Dioxin (TCDD) is one of the most feared industrial contaminants and has been mentioned in context of the **Seveso (Italy)** industrial plant accident. It is carcinogenic and teratogenic in rodents at extremely low concentrations. However, if TCDD is compared with alcohol, the most important known human teratogen, it is perhaps, less significance. Ames & Gold (1990) point out that comparing the teratogenic potential of TCDD to that of alcohol for causing birth defects (after adjusting for their respective potency as determined in rodents tests), a daily consumption of the US Environmental Protection Agency reference dose of TCDD (6 femtograms) would be equivalent in teratogenic potential to a daily consumption of alcohol from 1/ 3,000,000 of a beer. This is equivalent of drinking a single beer (15 g of ethanol) over a period of 8000 years! Consumed in humans alcoholic beverages are both carcinogenic and teratogenic potential of TCDD with that of alcohol (having adjusted for the potency in rodents) shows that **ingesting the TCDD reference dose of 6 femtograms per kilogram per day is equivalent to a man drinking one beer every 345 years** [9].

Therefore, the **second point to note is that, not only the dioxin emissions from Medical Waste Incineration is insignificantly low**, but also that **there is no conclusive evidence of its likely effect to human health**. However as the New Source Performance Standards (NSPS) and emission guidelines are being discussed and formalised universally for Medical Wastes (clinical waste), it is necessary to implement on-site Medical Waste Incinerators with the available recommended universal guidelines.

## *Recommended Guidelines for New & Existing Medical Waste Incinerators to lower Dioxin emissions.*

1. Combustion Efficiency (CE) is calculated from the monitored CO and CO2 levels by the following equation, and should be maintained at >99.9% as promulgated by Toxic Substances Control Act (TSCA) [10].

$$CE = \frac{[CO_2]}{([CO_2] + [CO])} \times 100$$

   Where carbon dioxide [$CO_2$] is stack $CO_2$ concentration, and [CO] is stack carbon monoxide concentration.

2. For small Hospitals & small MWI's (< 200 lb./hr) [2] require adequate combustion (99.9%) to ensure that chimney gases are harmless and free from smell and smoke, when operated unattended, and having no chimney, requiring burning of supplementary fuel to ensure that temperature reached and residence time are adequate [11]. Recommended conditions for destruction of PCDD's (Dioxins) and PCDF' (Furans) are temperature above 1000 deg.C, residence time of > 2 seconds, and turbulence to ensure good mixing with excess air [10].

3. Select **Batch load** type for Small (200 lb./hr of waste) Incinerators, or **Continuous feed & continuous ash removal** incinerator for Medium (200 to 500 lb./hr) and Large (> 500 lb./hr) incinerator to maintain 99.9% combustion efficiency at all times. **Intermittent feed** system are not preferred as the combustion efficiency will be lowered during periodic waste feed and waste raking operations.

4. Segregate Infectious waste from non- infectious waste. Send only infectious waste for incineration, to reduce Dioxin emission from incineration.

5. Install Add-on wet scrubbers for Medium (200 to 500 lb./hr) and Large (> 500 lb./hr) capacity incinerators.

## *Conclusion :*

1. Incinerate all Infectious Medical (Clinical) Waste, on-site. Use landfill, only as an emergency, stand by to an Incinerator.

2. Dioxin emission from MWI is **not a threat** to Human Health; however maintain the required standards of 99.9% combustion efficiency; greater than 1000 deg.C exhaust gas temperature incineration.

3. Small capacity (< 200 lb. waste/hr) incinerator operating at above 1000 deg.C, and efficiency of > 99.9%, of batch load type, having high residence time and high turbulence, with smoke and odour free discharge incinerators, do not require high chimney.

4. Medium capacity (200 to 500 lb./hr) and large capacity ( > 500 lb./hr) incinerator require add-on wet scrubber or advanced gas cleaning equipment.

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**Reference Documents:**

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British Medical Association book. (BCL 363.7)

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3. Process Engineering- September 1993, "Taking the heat out of Incineration debate".

4. Issues in Environmental science & Technology (2)
"Waste Incineration and the environment" editors R.T. Hester and R.M. Harrison, topic 5 'Environmental Impact & Risk Assessment' by J. Petts, Page 17.

5. Chapter 16 'Medical Waste Management', Page 266, of "Hand Book of Environment Management and Technology" by Gwendolyn Holmes, Ben Ramnarine Singh and Louis Theodore.

6. "Hazardous Air Emissions from Incineratuion" by Calvin R. Brunner, P.E., Chapman & Hall, 1985, chapter 6 "Dioxin".

7. "Environmental Impact Assessment for Waste Treatment and Disposal Facilities" by Judith Petts & Gev Eduljee, 1994 John Wiley & Sons Ltd., page 222.

8. "Incineration as a Waste Management Option." By J. Petts.

9. "Ground Pollution" by Peter Attewell, E&FN Spon: 1st Edition 1993. Page 202, Toxicity in perspective.

10. "Waste Incineration and the Environment", Issues in Environmental Science and Technology, Editors R. E. Hester and R. M. Harrison, The Royal Society of Chemistry 1994, chapter 'The US approach to Incinerator Regulation' by E. M. Steverson. Chapter 'Pollution from Incineration: An overview' by P. T. Williams, page 44.

11. "Industrial Air Pollution Handbook", Editor Albert Parker; chapter 20 'Incineration of Refuse' by H.B. Johnson and J.M. Burnett. Page 596.

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**Abbrreviations**

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| NSPS | New Source Performance Standards |
| TEQ | Toxic Equivalent Quantity. |
| CPCB | Central Pollution Control Board, India |
| RCEP | Royal Commission on Environmental Pollution, UK |
| BPEO | Best Practicable Environmental Option |
| HMIP | Her Majesty's Inspectorate of Pollution, UK |
| MSW | Municipal Solid Waste |
| MWI | Medical Waste Incinerator |
| TSCA | Toxic Substances Control Act |
| TCDD | Tetrachloro-dibenzo-p-dioxin |
| TCDF | Tetrachloro dibenzo furan |

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