TECHNICAL ASSESSMENT

REVIEW OF THE DIOXINS AIRBORNE TOXIC CONTROL MEASURE FOR MEDICAL WASTE INCINERATORS

July 2003

INTRODUCTION

Senate Bill 25 (Escutia, 1999) added a new section to the Toxic Air Contaminant Program established in the Health and Safety Code (Chapter 3.5, section 39650 et seq.) with special provisions for children. In these provisions, the Office of Environmental Health Hazard Assessment (OEHHA) is required to develop a list of up to five toxic air contaminants (TACs) that may cause infants and children to be especially susceptible to illness. Dioxins and furans (collectively referred to as dioxins) were listed as one of those five chemicals by OEHHA in October 2001 (OEHHA, 2001). Senate Bill 25 (SB25) further requires the Air Resources Board (ARB) to review affected airborne toxic control measures for the TACs on the list to ensure they adequately protect infants and children. This report provides ARB's findings and recommendations from the assessment of the existing Dioxins Airborne Toxic Control Measure for Medical Waste Incinerators (Medical Waste Incinerator ATCM). This assessment was completed pursuant to the requirements of SB 25 to ensure that the ATCM continues to protect public health, particularly infants and children.

FINDINGS AND RECOMMENDATION

In 1990, the ARB adopted the Medical Waste Incinerator ATCM to reduce emissions of dioxins from these sources by 99 percent (ARB, 1990). A copy of the Medical Waste Incinerator ATCM is provided in Attachment A. At that time, medical waste incinerators were one of the largest known sources of air emissions of dioxins in California. The number of medical waste incinerators in the State has dropped sharply from about 150 when the Medical Waste Incinerator ATCM was adopted in 1990 to six today. Due to the small number of sources and low throughput levels of the remaining medical waste incinerators in California, staff is not recommending any revisions to the ATCM at this time.

Only one of the six medical waste incinerators has a high throughput and potential health risk in comparison to the other facilities. ARB staff will work with the appropriate air pollution control district where this facility is located to ensure that it has been thoroughly evaluated through the Hot Spots Program. This will require the facility to complete an emissions inventory that will be used to determine if a site-specific health risk assessment is needed to determine if the facility poses a significant risk. If significant, the facility would be required to notify the public of those risks and may be required to implement actions to reduce their risks below the level of significance.

BACKGROUND

General

Dioxins are the most potent group of compounds identified as TACs. The ARB identified dioxins as a TAC in 1986 and they are also listed as hazardous air pollutants by the United States Environmental Protection Agency (U.S. EPA) (ARB, 1986). Health effects from dioxins include impacts on children's immune systems, developmental effects, thyroid hormone effects, neurobehaviorial effects, and carcinogenic effects (OEHHA, 2001). These highly toxic compounds are formed as by-products during the combustion of materials and the manufacture of certain chlorinated chemicals. They are emitted into the atmosphere from a variety of processes including waste incineration, stationary fuel combustion, chemical manufacturing, and engine combustion. These toxic chemicals can be inhaled directly or can contaminate vegetation and be eaten by animals and humans. Dioxins can then accumulate both in the food chain and in the body.

Medical Waste in California

Medical waste is defined broadly in the Medical Waste Incinerator ATCM as follows: "all discarded putrescible and nonputrescible solid, semisolid, and liquid materials, including garbage, trash, refuse, paper, rubbish, food, ashes, plastics, industrial wastes, demolition and construction wastes, equipment, instruments, utensils, appliances, manure, and human or animal solid and semisolid wastes." More specifically, most medical waste is made up of the following types of waste:

- Laboratory waste such as human or animal specimen cultures, cultures and stocks of infection agents, wastes from the production of bacteria, viruses, and spores;
- Blood and other bodily fluids;
- Contaminated medical equipment;
- Sharps such as hypodermic needles, scalpel blades, broken vials, and pipettes;
- Surgery wastes such as gowns, gloves, and soiled dressings;
- Chemotherapeutic waste;
- Pharmaceutical waste; and
- Pathological waste such as tissues, organs, and body parts.

Over the past year, ARB staff has worked closely with the Department of Health Services (DHS) to understand how medical waste is regulated in California. DHS ensures the proper handling and disposal of medical waste throughout California. DHS is also responsible for the review and approval of alternative treatment technologies in the State. There are currently 23 alternative treatment technologies approved for use in California. The most commonly used alternative in California is autoclaving (steam sterilization). A description of several of these alternatives is given in Attachment B.

DHS estimates that California generates approximately 80 million pounds of medical waste per year. Three to five percent of this waste is required to be incinerated and consists of pathological waste, certain pharmaceuticals, and chemotherapeutic waste. Off-site treatment of medical waste costs about 16 to 40 cents per pound depending on the amount of waste and the location of the facility. There are some remote areas of the State where no off-site treatment service is available. There are approximately ten facilities permitted by DHS for off-site treatment.

The majority of the off-site treatment facilities use autoclaving to treat the medical waste. The overwhelming majority of the waste stream which requires incineration (about three to five percent) is sent out of state because there are no commercial medical waste incinerators that accept off-site waste remaining in California.

REGULATIONS AFFECTING MEDICAL WASTE INCINERATION

Medical Waste Incinerator ATCM

In 1990, the ARB adopted the Medical Waste Incinerator ATCM to reduce emissions of dioxins from medical waste incinerators by 99 percent (ARB, 1990). At that time, medical waste incinerators were one of the largest known air sources of dioxins in California. As a result of the ATCM, the number of medical waste incinerators in the State has dropped sharply from about 150 to six.

The Medical Waste Incinerator ATCM has increasingly stringent requirements depending upon the amount of waste burned. The ATCM requires all facilities which incinerate more than 25 tons per year (tpy) to demonstrate a 99 percent dioxins control efficiency or to meet an emissions limit of 10 nanograms of dioxin per kilogram of waste incinerated. Additionally, the facility must ensure that all persons who operate the incinerator receive operator training. Currently, this training is available via a training and certification course provided by the American Society of Mechanical Engineers (ASME). Facilities which incinerate between 10 and 25 tpy need only perform an initial source test in addition to operator training. Facilities which incinerate less than 10 tpy need only operator training.

All facilities are required to use good combustion practices such as maintaining specific temperatures and residence times in the combustion chamber. Other requirements include monitoring and recording of carbon monoxide, operating temperatures, and other key operating parameters. Additionally, all malfunctions and violations must be reported to the local air district. Table 1 summarizes the requirements for the Medical Waste Incinerator ATCM (a copy of the ATCM is attached as Appendix A).

Table 1. Summary of Requirements of the Medical Waste Incinerator ATCM

Amount of Waste Burned (tons per year)	**Emission Limit Or Control Efficiency**	**Source Test Required**	**Operator Training Required**
> 25	10 nanograms per kilogram of waste incinerated or 99% Control Efficiency	Yes	Yes
10 -25	None	Yes	Yes
< 10	None	No	Yes

Other Regulations for Medical Waste Incinerators

In 1997, U.S. EPA promulgated new source performance standards (NSPS) for new medical waste incinerators and emissions guidelines (guidelines) for existing medical waste incinerators. Requirements include source testing, emission limits, operator training, and monitoring requirements. Under the guidelines, some California facilities may be required to source test annually. However, the federal requirements do not provide any additional emission reduction benefit over the Medical Waste Incinerator ATCM.

Medical waste incinerators that only burn pathological waste are currently exempt from the federal regulations because their toxic emissions have been measured at lower levels than those that burn other types of medical waste. This is primarily because fewer plastics enter the waste stream. However, U.S. EPA has indicated that these units would be evaluated further.

Medical waste incinerators are also subject to California's AB 2588 "Hot Spots" Program. The Air Toxics (Hot Spots) Information and Assessment Act (Hot Spots Program or Program) was enacted in 1987 under Assembly Bill 2588 (Connelly). The goals of the Hot Spots Program are to collect air toxics emission data, identify facilities having localized impacts, ascertain health risks, notify nearby residents of potential high risk facilities, and in some cases, require a risk reduction audit and plan that would result in actions to reduce facility risk.

Several local air pollution control or air quality management districts (districts) have adopted rules for new and existing medical waste incinerators that are equivalent to or more stringent than the Medical Waste Incinerator ATCM. For example, the Bay Area and South Coast Air Quality Management Districts require all medical waste facilities, regardless of annual throughput, to meet the emission standards in the ATCM.

SUMMARY OF ACTIONS TO REVIEW ATCM

To evaluate the Medical Waste Incinerator ATCM, ARB staff 1) reconciled the inventory of medical waste incinerator facilities; 2) distributed the Medical Waste Incinerator Survey and conducted an analysis of the survey responses; 3) held a stakeholder meeting to solicit public input; 4) conducted site visits; 5) summarized non-incineration treatment technologies and evaluated specific alternative treatment options for each medical waste incinerator; and 6) conducted several risk assessments for generic facilities. A description of each of these activities follows.

Facility Inventory

ARB staff worked with DHS, county health departments, and local air districts to determine the current number of medical waste incinerators within the State. We have determined that six medical waste incinerators currently exist in California. Of those six, five burn various types of medical waste and one burns only pathological waste, a subset of medical waste. Pathological waste incinerators only burn human and animal body parts and/or tissue. The facility inventory is summarized in Table 2.

Medical Waste Incinerator Survey

ARB staff developed and distributed the Medical Waste Incinerator Survey (survey). The six-page survey requested information on several topics including types and amount of waste burned, operating schedule, control equipment, previous emissions, cost, and availability of on-site alternatives to incineration. All facilities completed and returned the survey. Table 2 shows the facility location, type of waste, and throughput for the medical waste incinerators in California.

Table 2. Medical Waste Incinerators in California

Facility Location City/County	Air Quality or Air Management District	Annual Throughput of Medical Waste[1] (tons per year)	Types of Medical Waste Incinerated
Clearlake/Lake	Lake County	1.4	Sharps only
Cedarville/Modoc	Modoc County	0.02	All medical waste
Lone Pine/Inyo	Great Basin Unified	0.8	All medical waste
Alturas/Modoc	Modoc County	1.0	All medical waste
Bishop/Inyo	Great Basin Unified	1.3	Pathological waste only
Ukiah/Mendocino	Mendocino County	12.5	Pathological waste only unless alternative treatment technology is out of service

1. The ATCM requires an emission standard for those facilities which incinerate 25 tons per year or more of medical waste.

Most of the medical waste incinerators are located in rural communities and operate at small hospitals or nursing homes. Half of the remaining six medical waste

incinerators have alternative treatments on-site, which are used to treat a portion of their medical waste.

Based on the survey, the average age of the medical waste incinerators is approximately 20 years. Most facilities did not know the remaining life expectancy for their respective incinerators; however, several indicated that they anticipated an approximate 30-year life span for the incinerator. Based on this, we would anticipate that within the next 10 years most incinerators would be retired. There are several reasons why we believe that these incinerators would not be replaced with new incinerators. There are larger capital costs associated with a new medical waste incinerator as compared to alternatives such as on-site autoclaving, pollution prevention, or off-site medical waste treatment. After the closure of California's last commercial medical waste incinerator in 2001 (Integrated Environmental Systems in Oakland) there has been a strong push in the medical waste industry to move towards non-incineration technologies. With an increasing demand by community and environmental groups for non-incineration technologies, medical waste generators are moving away from incineration and using non-incineration technologies. DHS has just recently approved a non-incineration technology to handle the entire medical waste stream (including pathological waste). As other non-incineration technologies are approved and become available we anticipate that medical waste incineration in California will gradually become obsolete.

Stakeholders Meeting

In April 2002, ARB staff conducted a stakeholder meeting to solicit input on the ATCM evaluation process. Meeting notices were sent to environmental and community groups, industry representatives, U.S. EPA, local air districts, state agencies, and other interested parties. At the meeting, staff presented information on SB 25, the purpose of the ATCM evaluation, requirements of the ATCM, the health effects of dioxins, and plans for the evaluation process.

Site Visits

Over the past year, ARB staff along with staff from DHS, conducted site visits to the six medical waste incinerators throughout California. The purpose of the site visits was to gain a better understanding of the physical characteristics of the incinerator as well as determine the location of nearby receptors such as residents, off-site workers, schools, and day care facilities. DHS staff attended the site visits to educate facility operators on non-incineration medical waste treatment alternatives.

Of the six medical waste incinerator facilities visited, two were hospitals and one was a nursing home. Following our site visit to the nursing home, the facility shut down their incinerator and is now using an off-site treatment facility. For the three remaining site visits, we determined that their medical waste incinerators met the animal crematoria exemption in the regulation and would not be subject to the Medical Waste Incinerator ATCM.

During the site visits, ARB and DHS staffs were particularly interested in observing any alternative treatment technologies on site. Site visits also gave us the opportunity to determine where the nearest receptors were to the incinerator. We were particularly interested in determining where the closest schools and day care centers were located. The nearest schools and day care centers were generally one-half mile away.

Evaluation of Facility-Specific Alternative Treatment Options

Following our survey response analysis and site visits, ARB staff was able to determine feasible non-incineration options for the medical waste incinerator facilities. Table 3 summarizes our findings.

Table 3. Possible Non-incineration Alternatives for Medical Waste Incinerators

Facility City Location	Type of Medical Waste Incinerated	Other On-site Non-incineration Treatment Alternatives	Possible Alternatives to Incineration	Cost Impacts
Clearlake	Sharps only	Autoclave	Treat sharps in autoclave or use a sharps mail-back program.	Anticipated cost savings for either alternative
Cedarville	General medical and pathological waste	None	Most general medical waste would be eligible for a mail-back program	Could be a small increase depending on frequency of mail-back
Lone Pine	General medical and pathological waste	None	Most general medical waste would be eligible for a mail-back program	Could be a small increase depending on frequency of mail-back
Alturas	General medical waste	None	Most general medical waste would be eligible for a mail-back program	Could be a small increase depending on frequency of mail-back
Bishop	Pathological waste only	Autoclave all general medical waste	N/A	N/A
Ukiah	Pathological waste; general medical waste when alternative treatment technology is out of service	Chemical treatment - bleach/hot water/shredding process	Off-site medical waste transport service	Anticipated cost savings depending on amount and frequency of pick-up

We did not conduct an assessment of alternatives to treating the pathological waste because at the time of our analysis DHS had not yet approved an alternative. However, they have just recently approved a pyrolysis technology which could be operating by the end of the year. To determine if this is a feasible alternative for pathological waste, emissions, cost, and other factors will need to be evaluated as more data becomes available.

Generic Health Risk Assessments

Because there is no available dioxin testing data or stack information from the six remaining medical waste incinerators, ARB staff developed generic facilities by using source test data from two small previously tested incinerators that are now closed. These two facilities were tested in the late 1980's for dioxins and other metals. ARB staff contacted U.S. EPA and other state and local agencies to locate more recent source test data for small medical waste incinerators. We acquired source test data from several medical waste incinerators from other states which showed that emission rates ranged from 1,000 times higher to 1,000 times lower as compared to the two units used for our generic risk assessments. Based on the wide range of emission rates and differences in the source test methodologies, we concluded that the older ARB source tests, which were based on the same ARB methods, were a better indicator of emissions and stack parameters in California.

To conduct our assessment we used two different sets of meteorology, the default SCREEN3 meteorology and the Alturas regional meteorology. Alturas meteorology was chosen because two of the six facilities are located in this region. Table 4 provides an overview of the ranges of potential multipathway health impacts at several distances using both default SCREEN3 and regional meteorological data from Alturas and the results from both sets of source tests. The potential risk presented in Table 4 is based on throughput for the six existing facilities. It is important to note that the risk values presented in Table 4 do not represent the actual risk for these facilities, but rather display a range of possible risks for a generic medical waste incinerator.

Table 4. Overview of the Potential Health Impacts from a Generic Medical Waste Incinerator

Facility (annual throughput in tpy)	SCREEN3				Alturas			
	Distance (meters)				Distance (meters)			
	20	PMI[1]	100	1000	20	PMI[1]	100	1000
	Cancer Risk (chances per million)[2,3]				Cancer Risk (chances per million)[2,3]			
Facility A (1.4)	<1	1-9	1-9	<1-3	<1	<1	<1	<1
Facility B (0.02)	<1	<1	<1	<1	<1	<1	<1	<1
Facility C (0.8)	<1	1-5	1-5	<1-2	<1	<1	<1	<1
Facility D (1.0)	<1	1-7	1-6	<1-2	<1	<1	<1	<1
Facility E (1.3)	<1	1-9	1-8	<1-3	<1	<1	<1	<1
Facility F (12.5)[4]	17-106	19-124	13-90	1-6	<1	1-10	1-7	<1

1. PMI means point of maximum impact.
2. All results are rounded. Results are based on the OEHHA Air Toxics Hot Spots Program Risk Assessment Guidelines, Part IV and draft SRP approved Part V. Uses a 70-year exposure duration. Multipathway risk includes inhalation, soil, dermal, and mother's milk pathways.
3. Range of risk is based on the range of two source test results.
4. Facility F was modeled with urban dispersion; therefore, potential health risks are higher closer in. All other facilities were modeled with rural dispersion.

The potential cancer risks presented in Table 4 include multipathway impacts. In this analysis we considered potential risk from inhalation, soil, dermal, and mother's milk pathways. In addition to dioxins, the following compounds were also considered in the cancer risk assessment: hexavalent chromium, arsenic, cadmium, nickel, and lead. With the exception of Facility F, for SCREEN3 meteorological conditions, the range of risks are from less than one to nine chances per million. With the same facilities, using Alturas meteorological conditions, the risks are below one chance per million. Using SCREEN3 meteorological conditions for Facility F, the risk ranges from one chance per million to 124 chances per million. Using regional meteorology from Alturas, the highest risk for Facility F is 10 chances per million.

Non-cancer chronic multipathway impacts were evaluated using a hazard index approach for dioxins, arsenic, cadmium, nickel, hexavalent chromium, and mercury. These compounds have non-cancer chronic reference exposure levels which allow you to evaluate the chronic non-cancer health impacts. For Facility F, the highest multipathway chronic hazard index with SCREEN3 meteorological conditions at the PMI is 5.8. Using regional meteorology from Alturas, the highest hazard index for Facility F is 0.5. For the remaining five facilities the highest total hazard indices using SCREEN3 meteorological conditions are less than 0.5. For Alturas meteorological conditions, the highest hazard index is 0.03. Hazard indices greater than 1.0 may be an indicator of potential non-cancer health impacts. Mercury has the largest contribution to the hazard index. The immunological and kidney systems are the primary target organ systems for chronic impacts.

Non-cancer acute (inhalation) impacts were also evaluated using a hazard index approach for arsenic, nickel, and mercury. These compounds have non-cancer acute reference exposure levels that allow you to evaluate acute (short-term) impacts. The

highest hazard index for acute non-cancer impacts at the PMI is 0.3. Generally, hazard indices less than 1.0 are not considered to be a concern to public health. Mercury has the largest contribution to the overall hazard index. The primary target organ systems for acute impacts are the developmental and reproductive systems.

Lead was evaluated by comparing the modeled 30-day concentration to the lead levels found in the Air Resources Board's Risk Management Guidelines for New, Modified, and Existing Sources of Lead (2001). The modeled 30-day concentrations for the generic facilities are not anticipated to be an issue and were found to be approximately 15 times lower than the highest air concentration that would be considered a significant risk for lead in a high exposure area.

ADVERSE ENVIRONMENTAL AND ENVIRONMENTAL JUSTICE IMPACTS

The remaining medical waste incinerators in the State are primarily located in remote rural type areas. It is the nature of the location that has necessitated the need for a few of these incinerators to remain in operation until cost-effective non-incineration technologies are available. Because there are no recommended revisions to the Medical Waste Incinerator ATCM, there are no identified adverse environmental or environmental justice impacts.

DIOXIN AMBIENT MONITORING AND EMISSIONS TESTING

ARB currently has several programs underway to gain a better understanding of ambient levels of dioxins and potential sources of concern. ARB is currently running a 10-site ambient air monitoring network for dioxins and dioxin-like polychlorinated biphenyls in highly populated urban areas. In addition to ambient monitoring, source testing is underway for potential source categories of concern. Source categories under consideration for testing include pathological waste incinerators, catalytic oxidizers used in soil remediation, oil refineries, drum reconditioners, landfills, and secondary metal recovery facilities. Staff is also investigating several approaches to conduct limited dioxin testing on heavy-duty diesel engines. Data collected under the ambient monitoring and source testing programs will be used to evaluate potential health impacts, assess the need for additional risk management strategies, and identify areas where additional study may be required.

ARB staff will also develop a small brochure or fact sheet which will provide facility operators information on non-incineration alternatives currently available to treat medical waste. We will work with the remaining facilities, with assistance from DHS, to develop cost-effective alternatives to incineration. Finally, staff will use data collected under the air monitoring and emissions testing program to continue to assess other source categories of concern.

REFERENCES

ARB, 1986. Technical Support Document Report on Chlorinated Dioxins and Dibenzofurans, Part A, California Air Resources Board, February 1986.

ARB, 1990. Proposed Dioxins Control Measure for Medical Waste Incinerators (Staff Report and Technical Support Document), California Air Resources Board, May 1990.

OEHHA, 2001. Prioritization of Toxic Air Contaminants – Children's Environmental Health Protection Act, Office of Environmental Health Hazard Assessment, October 2001.

Attachments