

POLLUTION PREVENTION CREMATORIA PROJECT FINAL REPORT

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Prepared for:



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EXECUTIVE SUMMARY

The Colorado Department of Public Health and Environment (CDPHE) identified mercury as a pollutant of high public health concern in Colorado and crematoria as one source of mercury air emissions in the State. CDPHE conceived and initiated the Crematoria Mercury Pollution Prevention Project in early 2006 to start a collaborative, voluntary effort with the crematoria industry to reduce mercury emissions. The project aimed to develop non-regulatory, voluntary mercury pollution prevention strategies that could be tested and disseminated throughout the state. The project sought to inform the crematoria industry and the public about the issue and enlist voluntary participation in much the same way as organ donor programs. CDPHE contracted Tetra Tech EM Inc. (Tetra Tech), a Colorado environmental consulting firm, to assist with project implementation and documentation.

Tetra Tech began the project by contacting crematoria, funeral homes, and trade associates within Colorado to create a team of stakeholders or a “steering committee” for the project. The stakeholders consisted of five local funeral professionals and one individual in Wisconsin who has completed extensive research about crematoria mercury emissions.

Tetra Tech developed a material balance methodology to calculate an emissions factor (a representative value that attempts to relate the quantity of a pollutant released to the atmosphere to an activity associated with release of the pollutant) for mercury emissions from crematoria. Based on its research and the emissions methodology it used, Tetra Tech determined the emissions factor in Colorado to be 3.2 grams per adult body created or a total of about 110 pounds of mercury released per year.

The options for reducing mercury emissions from crematories are limited to either controlling emissions of mercury from the crematory exhaust stack or removing the source (teeth containing amalgam) before cremation occurs. Using control technologies is cost prohibitive; air pollution control equipment would likely cost more than \$100K per crematory. However, removing teeth containing amalgam was problematic based on potential technical, professional, and social issues.

The project ended prematurely when crematoria industry representatives withdrew from the voluntary initiative in favor of a mandatory, regulatory approach. Nevertheless, CDHPE learned much about source reduction opportunities to reduce mercury emission from crematoria and the barriers that must be overcome before those opportunities can be implemented.

This report concludes with a discussion of the project accomplishments and a list of data gaps that were not resolved during the course of this project.

1.0 INTRODUCTION

The Colorado Department of Public Health and Environment (CDPHE) identified mercury as a pollutant of high public health concern in Colorado and crematoria as one source of mercury air emissions in the state. CDPHE conceived and initiated the Crematoria Mercury Pollution Prevention Project in early 2006 to start a collaborative, voluntary effort with the crematoria industry to reduce mercury emissions. The project aimed to develop non-regulatory, voluntary mercury pollution prevention strategies that could be tested and disseminated throughout the state. The project sought to inform the crematoria industry and the public about the issue and enlist voluntary participation in much the same way as organ donor programs. The project sought to inform the crematoria industry and the public about the issue and enlist voluntary participation in much the same way as organ donor programs. That is, it was envisioned that informed individuals and/or their families would ideally agree to have the mercury fillings removed prior to cremation. Such understanding would come from previous public education and outreach regarding the issue and from dialogue between the deceased and funeral industry representatives. The voluntary, participatory characteristics of the project were emphasized in order to balance the interests of funeral professionals, public health, and environmental protection. CDPHE contracted Tetra Tech EM Inc. (Tetra Tech), a Colorado environmental consulting firm, to assist with project implementation and documentation.

The project ended prematurely when crematoria industry representatives withdrew from voluntary initiative in favor of a mandatory, regulatory approach. Nevertheless, CDHPE learned much about source reduction opportunities to reduce mercury emission from crematoria and the barriers that must be overcome before those opportunities can be implemented. This report summarizes the project and its accomplishments. Specifically, this report describes the mercury and crematoria issue, stakeholder group formation, estimated mercury air emissions from crematoria, best management practices for controlling/reducing mercury emissions, stakeholder group concerns and project closure, and next steps and suggestions for future efforts.

2.0 OVERVIEW OF MERCURY AND CREMATORIA ISSUE

Mercury is a naturally occurring metal found throughout the environment. Mercury is contained in a variety of commercial products used in households, medical centers, and industry. It is also a trace element in coal and other raw materials used in manufacturing processes. In the environment, mercury is found in elemental (metallic) form and in inorganic and organic compounds. Human exposure to mercury can damage the kidneys and nervous system and affect sight, hearing, speech, and walking. Other symptoms of mercury neurotoxicity include personality changes, depression, irritability, nervousness, and the inability to concentrate. Mercury is a particularly serious problem for pregnant women and children. Fetuses and young children suffer the greatest risk because their nervous systems are still developing. They are four to five times more sensitive to mercury than are adults. [EPA and CPDHE 2006]

Mercury can be released into the environment from natural sources, such as volcanic and geothermal activity, or from anthropogenic (man-made) sources such as coal-fired power plants and other industrial activities. Some studies suggest that human activity contributes 50 to 70 percent of the mercury in the environment globally (Office of Air Quality and Standards Report to Congress 1997). Furthermore, mercury is a global issue because of the manner mercury cycles between the atmosphere and water bodies and thereby moves throughout the environment. For example, the U.S. Environmental Protection Agency (EPA) estimates that less than half the mercury deposition in the U.S. originates from U.S. sources.

Finally, mercury is among a group of pollutants called persistent bio-accumulative toxins, or PBTs. These pollutants “persist” in the environment, meaning that they do not break down or disperse. Mercury cannot be destroyed, it cannot be combusted, and it does not degrade. Once mercury enters the environment, it circulates in and out of the atmosphere and water bodies. Humans can be exposed to mercury from either of these sources (air and water) both directly and indirectly (that is, via the food chain).

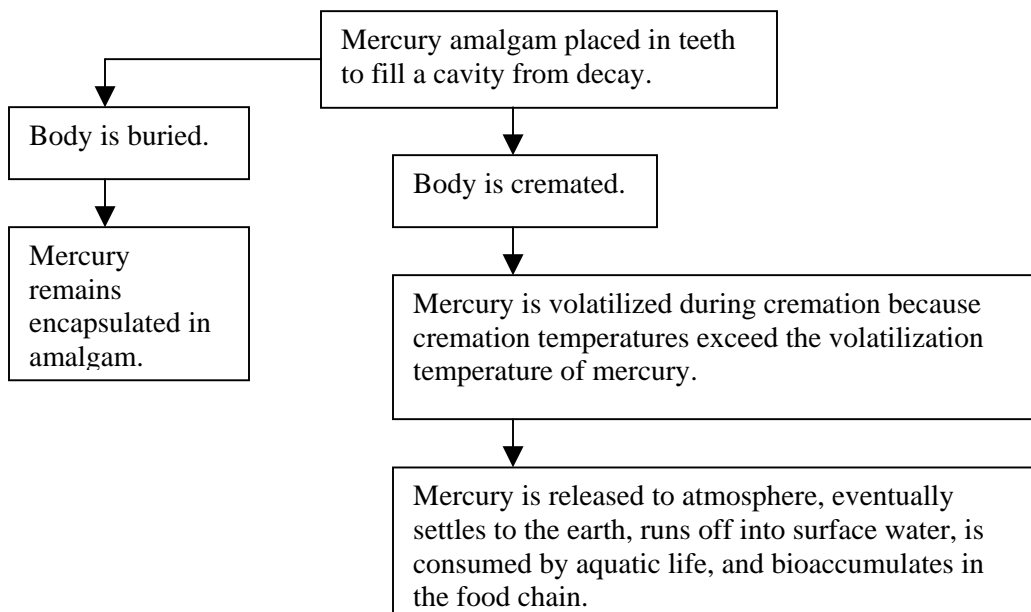
Colorado, like many states, recognized the public health concern associated with mercury pollution. As a result, in 2004, CDPHE initiated the “Mercury Free Colorado” campaign to inform citizens, businesses, and the medical community about the serious health threat associated with exposures to mercury and to develop preventive strategies to keep mercury out of the environment. This cross-media initiative involves participation from both the environmental (air, water, waste, and consumer protection) and health programs within CDPHE. One of the driving forces for this initiative is to prevent unacceptable levels of mercury in state rivers and lakes.

CDPHE performed a mercury source assessment to better understand and prioritize the sources of mercury pollution in Colorado. The assessment considered all potential sources of mercury releases – industrial processes, business and household product use, combustion, and natural phenomena.

As a result of this assessment, cremation emerged as source of relatively high concern. Preliminary estimates indicated cremation was among the “top 10” processes that contribute mercury to the environment, potentially accounting for as much as 12 percent of the emissions of mercury to air in the state [CDPHE, 2004].

Mercury is released during cremation from dental amalgam fillings (see Figure 1). Dental amalgam contains about 50 percent mercury, all of which is volatilized during the cremation process. In Colorado, cremation accounts for the disposition of about 50 percent of all deceased persons. In 2002, for example, there were 15,016 cremations in the state [reference] CDPHE estimates that these cremations released about 110 pound of mercury as air emissions (see Section 4.2). The increasing popularity of cremation and other factors (see Section 4.2) suggest that mercury emissions from crematoria will continue to rise over the next 30 years.

FIGURE 1 CREMATORY MERCURY EMISSIONS FLOW DIAGRAM



In the wake of successful mercury pollution prevention initiatives with other Colorado sources (such as those that relate to automotive switches, mercury thermometers, and dental wastes), CDPHE initiated and EPA Region 8 funded the Crematoria Mercury Pollution Prevention Project. The objective of the project was to reduce the amount of mercury released by identifying and promoting the use of best management practices (BMP) at Colorado’s crematoria. A central feature of the project was a collaborative partnership between CDPHE and the state’s crematoria, funeral homes, and related trade associations (the project “stakeholders”). The project aimed to develop non-regulatory, voluntary mercury pollution prevention strategies that could be tested and disseminated throughout the state.

The Crematoria Mercury Pollution Prevention Project had the following components or major tasks:

1. **Create a Stakeholder Group** comprised of crematoria and funeral home industry representatives and other interested or potentially affected parties.
2. **Develop an Emission Estimate** for mercury air emissions from Colorado crematoria; this task included reviewing CDPHE’s estimate and searching the literature for other attempts to measure or estimate mercury emissions from crematoria.
3. **Identify Best Management Practices (BMP)** for removing mercury from the cremation process.
4. **Develop and Distribute BMP Outreach Materials.**
5. **Prepare a Final Report** summarizing the project and its findings and accomplishments.
6. **Evaluate the Project** by assessing the extent to which BMPs were adopted by crematoria and any technical or economic concerns uncovered during BMP implementation.

3.0 STAKEHOLDER GROUP FORMATION AND MEETINGS

The first task of the Crematoria Mercury Pollution Prevention project involved contacting crematoria, funeral homes, and trade associates within Colorado to create a team of stakeholders or a “steering committee” for the project. The responsibilities of the members of this committee included the following:

- Represent the industry community
- Provide technical input and “reality checks”
- Review written materials such as the emissions estimate report, BMP outreach material, and final report
- Attend committee meetings

The names and affiliations for each of the committee members, as well as CDPHE staff consultant members associated with the project, are listed below. Appendix A contains contact information for each of these committee members.

- Daren Forbes, Horan and McConaty, President and Chief Executive Officer
- John Horan, Horan and McConaty, General Manager
- George Malesich, Denver Archdiocese and Denver Metro Funeral Directors Association President, Colorado Funeral Directors Association Secretary and Treasurer
- Rayanne Mori, Monarch Society Owner
- John Reindl, Dane County, Wisconsin, Recycling Manager
- Martha Thayer, Arapahoe Community College School of Mortuary Science Director
- Mark McMillan, CDPHE Mercury Program Manager
- Joni Canterbury, CDPHE Small Business Assistance

- Ron Hyman, CDPHE Registrar
- Michael Keefe, Tetra Tech
- Thomas Ouellette, D.D.S, Dentist
- Caitlin Rood, Tetra Tech

The stakeholders met formally as a group three times during the project: April 18, May 16, and June 27, 2006. Tetra Tech wrote formal notes for the April 18 and May 16 meeting and distributed the notes to the stakeholders via e-mail within 1 week after the meeting. Tetra Tech invited input on the accuracy of the notes from all members. The notes for each of these meetings are included as Appendix B.

4.0 MERCURY EMISSIONS ESTIMATE

The mercury emissions estimate task (Task 2) involved the following three activities, which are summarized in this section.

- Literature review for emissions estimate
- Mercury emissions factors and estimates
- Quality assurance (QA) review of CDPHE mercury emission estimates

4.1 Literature Review

Tetra Tech reviewed literature, data, and articles from Internet sites and contacted several sources for information on estimating mercury emissions from crematoria. These information sources are summarized below.

- *Summary of References on Mercury Emissions from Crematoria.* December 2005. Author: John Reindl, Department of Public Works, Dane County, Wisconsin
- *U.S. Health and Nutrition Examination Survey, 1999-2002.* Centers for Disease Control and Prevention (CDC).
- *Mercury Emissions from Crematoria – Consultation on an Assessment by the Environment Agency’s Local Authority Unit.* United Kingdom Department for Environment Food and Rural Affairs (Defra). 2003.
- *Mercury Emissions from Crematoria – Second Consultation.* Defra, 2004.
- “*Locating and Estimating Air Emissions from Sources of Mercury and Mercury Compounds.*” U.S. Environmental Protection Agency (EPA), EPA-454/R-97-012, 1997, <http://www.epa.gov/ttnchie1/le/mercury.pdf> [EPA 1997a].
- “*Mercury Study Report to Congress Volume II: An Inventory of Anthropogenic Mercury Emissions in the United States.*” EPA, EPA-452/R-97-004, 1997, <http://www.epa.gov/ttn/atw/112nmerc/volume2.pdf>. [EPA 1997b]
- Mills, Allan. “*Mercury and Crematorium Chimneys.*” Nature. Vol. 346, page 16. August 1990.
- Basu., M.K. , and Wilson, H.J. “*Mercury Risk from Teeth*”, Nature, Vol. 349, page 109. January 1991.
- Burton, V.J., “*Too Much Mercury.*” Nature. Vol. 351, page 704. June 1991.

- US EPA, *Emission Test Evaluation of a Crematory at Woodlawn Cemetery in The Bronx, NY*. EPA-454/R-99-049, 3 volumes, 1355 pages, on CD. September 1999.

4.2 Mercury Emissions Factors and Estimates

An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere to an activity associated with release of the pollutant. For crematoria, the emission factor should relate the quantity of mercury emitted into the air per body cremated. Emissions factors can be based on analytical results from stack testing or calculated by a material balance approach that relies on process knowledge.

Tetra Tech did not identify widely accepted or definitive emission factors for mercury from crematoria in the United States. EPA published two reports in 1997 that include emissions estimates for mercury from crematoria. The EPA 1997a report presents results from a 1992 stack test at a propane-fired crematorium in California. This report states an emissions factor of 1.5 grams mercury per body. EPA based this estimate on test data in a 1992 California Air Resources Board (CARB) report. The CARB report does not provide data on the age of the deceased or the number and size of fillings in the cadavers.

The EPA 1997b report references test results from a study confidentially provided to CARB. The average amount of mercury per cremation reported is 0.00094 grams per body. No information is provided about how the tests were conducted.

The United Kingdom (UK) used an emissions factor of 3.0 grams mercury per body in its 2002 National Atmospheric Emission Inventory (Defra 2003). Subsequent evaluation using a material balance approach suggested an appropriate emission factor for mercury from crematoria in the UK is 1.92 grams of mercury per body (Defra 2004).

In June 1999, the U.S. Environmental Protection Agency, in collaboration with the Cremation Association of North America (CANA) initiated a project to sample and analyze air emissions from the Woodlawn Cemetery crematory in Bronx, New York. The Woodlawn cremation unit is equipped with a wet scrubber air pollution control device. Emission samples were collected before and after the wet scrubber and analyzed for a variety of air pollutants, including mercury. Emissions were tested during nine cremations. Secondary chamber temperature was varied to investigate its potential impact on emissions: the first three cremations occurred at about 1450 F, the second three cremations occurred at about 1650 F, the final three cremations occurred at about 1840 F.

Mercury emissions measurements before the wet scrubber are as follows:

Run	Body Weight (lbs)	Age	Gender	Hg [before scrubber] (mg)
1	157	78	M	.547
2	163	70	F	.008
3	182	91	M	1.13
4	199	55	M	2.30
5	180	74	M	.309
6	188	76	M	.043
7	140	65	M	2.23
8	200	88	F	1.28
9	105	88	M	.697

Dental health information for the individuals cremated during the Woodlawn facility emission tests was not recorded. Specifically, the presence of edentulism (that is, total tooth loss/dentures) or the number of amalgam fillings in the deceased was not provided; therefore, no conclusions can be drawn from the test data about mercury emissions other than it ranged from 0.008 to 2.30 mg/cremation. Perhaps the best caveat for the Woodlawn data is the report's disclaimer: "This report presents the results of a single test program at a single cremation facility. It should not be assumed that these results would characterize emissions at other cremation facilities without further study."

Using data from the sources listed above, Tetra Tech derived a mercury emissions factor for crematoria and annual mercury emissions in Colorado by estimating reasonable, appropriate, and representative values for the following variables:

1. Quantity of mercury in a typical dental filling:
0.50 grams mercury per adult filling
2. Number of fillings per person:
8.6 fillings per adult person over 60 years of age
3. Percent of adult edentulous population (complete tooth loss):
25 percent of adults over 60 years of age
4. Number of cremations per year in Colorado:
15,061 in 2002

The values listed above for variables 1, 2, and 3 were assigned using professional judgment in comparison to the range of values found in various information sources, which are shown on the attached spreadsheet. Tetra Tech used data for adults over age 60 for variables 2 and 3 above; however, not all cremations in Colorado are for deceased individuals more than 60 years old. Number of fillings per person rises to 8.7 and edentulism decreases to about 5 percent for ages 40 to 59; therefore, using the values for adults over 60 is not an overly conservative approach. That is, it should not result in an excessive overestimate of mercury emissions. Note that the dental health of the cremated population is assumed to be the same as the dental health of the general population. The demographics of people who are cremated may not be the same as the general population because of religious or socioeconomic factors, but CDPHE assumes that the dental health of individuals who are cremated does not vary notably in comparison to the general population.

The mercury emissions factor was calculated by multiplying the quantity of mercury per filling times the number of fillings in an adult person times the percent of adults with teeth, or:

$$0.50 \times 8.6 \times 0.75 = 3.2 \text{ grams of mercury emitted per adult cremated}$$

This factor assumes the deceased all mercury in the dental fillings is (1) volatilized, and (2) emitted during the cremation process. In the journal *Nature*, Mills (1990) indicates that mercury in dental amalgam begins to decompose (volatilize) at 200 °C and completely volatilizes between 700 and 850 °C. Cremation usually occurs between 760 and 1,150 °C (www.reference.com/browse/wiki/Cremation).

Tetra Tech was unable to find sources of information that evaluated that extent that mercury bonds to particulate matter (ash) or the crematory stack walls during cremation. Reindl (2005) also did not find published articles on mercury in crematoria ash. However, he references a 2000 personal communication with a source in Norway who found mercury at levels less than 1 microgram per kilogram (kg) in four samples. Another communication with the same Norwegian source indicated mercury levels of 168, 20, and 2.3 milligrams per kilogram (mg/kg) (equivalent to parts per million) in dust, mortar, and brick

samples collected from a crematorium chimney. In light of the very limited data available on mercury deposition in ash or stack walls and the relatively low levels seen in the data obtained, Tetra Tech did not consider mercury deposition in ash or stack walls as a variable in the emission estimate derived for CDPHE.

The annual estimate of mercury emissions from crematoria in Colorado in 2002 was calculated by multiplying the emission factor times the number of cremations per year in Colorado, or:

$$3.2 \times 15,061 \times 0.002205 \text{ pounds/gram} = 110 \text{ pounds emitted in 2002}$$

4.3 Trends in Mercury Emissions from Cremation

The expected horizon and peak of mercury emissions from crematoria is over the next 30 years based on the following factors:

1. The front end of baby boom generation has just reached the average age of death.
2. The baby boom generation has better dental hygiene than preceding generations, resulting in less edentulism and therefore more teeth among the population than preceding generations at the time of death.
3. The most common material used to fill decayed teeth for most of the life of baby boomers was mercury amalgam fillings.
4. The baby boom generation preceded the common use of fluoride in drinking water and toothpaste. Therefore, this generation has more teeth at the age of death than preceding generations, but more decay and therefore amalgam fillings than subsequent generations.
5. Cremation rates are predicted to increase compared to current levels in the baby boom generation.

Mercury emissions from crematoria are expected to decrease after the baby boom generation. Two primary reasons are cited for this decrease. First, the use of mercury amalgam fillings is decreasing with time in favor of resin composite, tooth colored fillings. Second, subsequent generations on average have less fillings because of the prevalence of fluoride in drinking water and toothpaste.

4.4 QA Review of CDPHE Estimates

Tetra Tech reviewed the mercury emissions estimate for crematoria shown in the draft *Colorado Mercury Source Assessment 2004 Snapshot*, dated September 8, 2004, by CDPHE. Page 19 and 20 of this document include calculations to support the emission estimate from cremation. For its primary estimate, CDPHE used data found in the Reindl 2004 reference and two 1997 U.S. EPA reports (see Literature Review section of this report). CDPHE used these values, 0.00094 and 1.5 grams mercury per body, as low and high emission factors to establish a range of annual mercury emissions in Colorado in 2002 (using the recorded number of cremations). CDPHE also used the approximate midpoint between these two values (0.75 grams mercury/body) to derive a “best” estimate of 24.9 pounds of mercury per year.

Also in the draft 2004 *Colorado Mercury Source Assessment Snapshot*, CDPHE presented an alternative calculation using the same lower emission factor (0.00094 grams mercury/cremation) and an alternative higher emissions factor of 5.6 grams mercury per body. Reindl reports this value was communicated to him in an e-mail from a State of Maine official who referenced a report titled, “*The Northeast States and Eastern Canadian Provinces Mercury Study*.” However, Tetra Tech obtained this report and could not find the 5.6 grams mercury per body emission factor mentioned or discussed. The report does reference an emission factor of 1 gram mercury per body estimated by Doiran and Associates in 1997. CDPHE

calculated low and high emissions estimates using the values 0.00094 and 5.6 grams mercury per cremation. The “best” estimate, using a midpoint emission factor of 2.8 grams of mercury per body, was 93.0 pounds of mercury per year.

Tetra Tech’s comments on CDPHE’s emission estimates were as follows:

1. The emissions factors used for the first estimate in the snapshot report (0.00094 and 1.5 grams mercury per cremation) are derived from analytical tests at a crematoria in the late 1990s, as described in two 1997 EPA reports (EPA 1997a and EPA 1997b). Tetra Tech cautions against the definitive use of these data to represent emissions from cremation of a “typical” cremated body because:
 - a. The available (one data source is confidential and can therefore not be verified) data are based on one stack test performed in 1992.
 - b. The reports did not qualify the test conditions or indicate any information on the number or size of fillings in the bodies.
 - c. The reports do not include any data or statements to suggest the test data reflected a representative sample.
 - d. The reports do not include calculations that demonstrate how the emissions factors were derived from the test data.
2. The second (alternative) emission estimate in the snapshot report uses the same low emission factor (0.00094 grams mercury per body) and a high emission factor (5.6 grams mercury per body). The aforementioned comments apply to the low estimate. As for the high estimate, Tetra Tech could not verify the source or basis of the 5.6 grams mercury per body factor; therefore, it should not be used or should be used only with disclosure that it may be based on personal communication and that a primary source is not available.

The first emissions estimate in the snapshot report present high and best estimates with six significant figures; the low estimate is carried out to three significant figures. Likewise, the alternative calculation presents low estimates with three significant figures, high estimates with seven significant figures, and best estimates with six significant figures. The presentation of results with these numbers of significant figures, however, suggests an accuracy in the estimates that is not supported by the data. Tetra Tech recommended using two significant figures when the results of the emission calculations are presented.

5.0 BMPs FOR PREVENTING/CONTROLLING MERCURY EMISSIONS

The options for reducing mercury emissions from crematories are limited to either controlling emissions of mercury from the crematory stack or to removing the source (teeth containing amalgam) before cremation occurs. This section discusses each of these alternatives.

5.1 Control Technologies

Mercury control technologies have been under development for use on coal-fired power plants since EPA proposed a mercury rule to minimize emissions of mercury. These technologies may be suitable for crematoria with some modifications. The cost of air pollution control equipment for crematoria in the US is difficult to estimate due to lack of precedent – few (if any) crematoria have air pollution control equipment. One estimate suggests that the cost for air pollution control equipment would be \$175,000 (Reindl 2005).

Conventional air pollution control technology can capture some mercury. Existing controls like a fabric filter (FF) or electrostatic precipitator (ESP) can remove some mercury depending on the form of the mercury in the exiting gases. Mercury specific controls have been under development by U.S Department of Energy, major equipment vendors, Electric Power Research Institute, and EPA for many years for applications at coal-fired power plants. To date, use of activated carbon injection (ACI) has shown the most promise as a near-term mercury control technology. In a typical configuration, powdered activated carbon (PAC) is injected upstream of an existing particulate control device – either an ESP or FF. The PAC adsorbs the mercury from the gas and is subsequently captured along with the ash in the ESP or FF. Although initial field testing of ACI has been relatively successful, additional Research, Development, and Demonstration is required before it is considered a commercial technology for long term use. (DOE/NETL 2005)

More recently, field testing has begun on a number of alternative approaches to enhance ACI mercury capture including: 1) the use of chemically treated PACs that compensate for low chlorine concentrations in the gas; and 2) coal and flue gas chemical additives that promote mercury oxidation. In addition to ACI, other mercury control technologies are being tested to enhance mercury capture for plants equipped with other conventional control devices.

For application at a crematoria, a fixed bed or filter containing carbon or another mercury sorbent could be used after ash collection for mercury removal rather than injection of carbon into a gas stream with human ashes.

Some crematoria in Europe place selenium-containing ampoules in the firing chamber during cremations. These ampoules must be used in conjunction with air pollution control equipment. (Reindl 2005), According to Reindl, there is no reliable evidence that the selenium ampoules reduce mercury emissions from crematoria.

5.2 Tooth Removal

Tooth removal is another option for controlling mercury emissions from crematoria. The project team initially considered tooth removal as a less costly and less technically challenging alternative. However, the funeral professional stakeholders presented several potential technical challenges associated with tooth removal. The project ended before any of these potential technical challenges could be closely examined (see Section 6.0) to evaluate their validity and, if found valid, to assess possible resolutions. The remainder of this section describes the potential technical challenges associated with tooth removal that were discussed in the three stakeholder meetings.

When should the teeth be removed?

After a funeral home receives a body for cremation, it can be embalmed for showing during a funeral service or cremated immediately (that is, without embalming). If a body was not embalmed, the project team decided, the teeth could be removed any time before cremation provided (1) there was informed consent from the deceased or deceased's family and (2) appropriate tools and training were available. However, if a body must be prepared for viewing during a funeral service, the timing of tooth removal becomes a concern because any action that disrupts the structure or circulatory system of the face can impair embalming; these actions includes opening the jaw, which may be difficult if rigor mortis is present, and removing the teeth. Tooth removal after embalming is also complicated because the jaw is typically wired shut for the viewing and embalming can render the body practically immovable. Removing the teeth before embalming presented other issues, including:

- Potentially creating points where embalming or other fluids might leak
- Disturbing the skin and capillaries, causing swelling in the face during the embalming process
- Disturbing the capillaries so that the embalming fluid does not reach all area of the face, leading to noticeable discoloration during the viewing
- Leaving spaces in the mouth that cause the cheeks to sink

During the project, the stakeholders suggested contacting the State Anatomical Board embalmer, Mark Blatchley. Specifically, the group suggesting asking Mr. Blatchley if he could test the affect of tooth removal on embalming. Tetra Tech attempted to contact Mr. Blatchley; however, he did not return calls from messages left.

How should the jaw be opened?

One consideration that the funeral professional stakeholders raised about tooth removal was how to open the mouth if it was not open at the time of death. Stakeholders indicated that although rigor mortis is not always a constant state, if present opening the jaw could be particularly challenging because the jaw muscles are so strong. This issue is exacerbated if a body had been embalmed, as explained in the previous section. The practicing dentist in the stakeholder group, Dr. Tom Ouellette, indicated that a ratcheting dental tool exists to open closed mouths — for example, if a patient is unconscious during the oral procedure. The funeral professional stakeholders opined that opening the mouth of a body in rigor mortis may be more difficult than opening the mouth of an unconscious patient. CDPHE agreed to purchase a jaw-opening tool recommended by Dr. Ouellette for test purposes. Information about this device is summarized in Table 1.

How should the teeth be removed?

Another consideration about tooth removal was whether it would be necessary for the individual to be trained to identify which teeth to remove and how to remove them. The dentist on the project team, Dr. Ouellette, indicated that mercury-containing amalgams are easily identified in the mouth because they are either dark gray or black. Dr. Ouellette also indicated that tooth removal should not present any technical challenges in this scenario. In a live person, a dentist is needed to ensure that no pieces of tooth or root remain in the gums. When the only goal is to remove the amalgam from the deceased, however, the procedure should be straightforward, and leaving non-amalgam material in the mouth would not be a concern.

Dentists use special tools to remove teeth from the upper and lower jaws, which CDPHE ordered tested during this project with approval by the stakeholder group. The intent was to provide volunteers on the stakeholder group tools for a voluntary trial tooth removal. Two sets of three tools were ordered for the project, a tool to remove teeth from the upper jaw, a tool to remove teeth from the lower jaw, and a tool to open the mouth. The tools were ordered from a dental supply company and manufactured by J&J Instruments, Inc and Peerless Corporation. Model numbers, costs, and photos of each tool are provided in Table 1.




Before CDPHE ordered the tools, one stakeholder (Rayanne Mori) removed a tooth from a deceased person that was provided by the State and who died with an open mouth. Ms. Mori anecdotally reported that removing the amalgam-containing teeth was relatively easy and required a matter of a few seconds. In addition, another dentist that attended some of the stakeholder group meetings (Manuel Chavez)

reported that a family had once requested that he remove the teeth of a deceased patient. Dr. Chavez also reported relative ease in removing the teeth from the deceased person.

During the project, Tetra Tech and CDPHE attended two Denver Metro Funeral Director Association (DMFDA) meetings. During one of these meetings, one funeral professional indicated that he had removed teeth from time to time in response to family requests. This funeral professional indicated that in his experience, tooth removal before cremation, while not standard, was also not an uncommon activity.

In considering the situations when teeth would be removed, the funeral professional stakeholders indicated that certain circumstances would prevent consideration of tooth removal, such as if a body was found long after death and decay had set in, or if the person died of a communicable disease.

TABLE 1 TOOTH REMOVAL TOOLS

Tool	Part Number	Cost	Photo
Jaw opener J&J Instruments, Inc.	4268 7910	\$ 38.25	
Lower jaw tooth extractor Peerless Corporation F151	6295 0151	\$ 34.75	
Upper jaw tooth extractor Peerless Corporation F150	6295 0150	\$ 34.75	

What happens after the amalgam-containing teeth are removed?

Extracted teeth containing mercury amalgam fillings should be collected in a specified bin and recycled. Many waste amalgam vendors operate nationally and provide cost effective, convenient service. Most vendors provide a container to collect the amalgam waste and many offer turnkey operations. Five vendors and costs are listed in Table 2.

TABLE 2 WASTE AMALGAM RECYCLERS

Recycler	Cost
Amalgaway (800) 267-1467	\$99.95 for 1-gallon. Cost includes container, shipping and recycling
Dental Recyclers of North America (800) 360-1001	\$125 for 1-gallon \$200 for 2-gallons \$400 for 5-gallons
SolmeteX (510) 393-5115	\$100 for ½-gallon
Rebec (800) 569-1088	\$169 for 1-gallon
AERC Recycling Solutions www.aercrecycling.com (800) 554-2372	\$75.00 per 1-gallon pail. Cost does not include shipping.

5.3 Crematory Mercury Emissions Efforts in Other States

Two states, Maine and Minnesota, have introduced legislation focused on mercury emissions from crematoria. In Maine, LD 1664, “An Act To Limit Mercury Emissions from Crematoria,” would have required crematoria to either remove dental amalgams before cremation or to capture mercury emissions. The legislation was introduced on May 9, 2005, sent to the Committee on Natural Resources, which rejected it on May 23, 2005.

In Minnesota, SF 641 (companion to HF 661) would have require the removal of mercury amalgam restorations before cremation. The legislation was introduced on January 31, 2005 and referred to Health and Family Security. The legislation was rejected.

6.0 STAKEHOLDER GROUP CONCERNS AND PROJECT CLOSURE

The intended outcome of the project was to develop BMPs for reducing mercury emissions, create outreach material to explain those BMPs, and provide those materials to the appropriate individuals in the funeral profession or to the general public. The stakeholder group communicated in meetings and e-mail about the potential technical challenges described in Section 3 and potential resolutions to those challenges. Dental tools were purchased to enable a trial and two members of the stakeholder group volunteered to try these tools to assess the ease or difficulty and challenges in tooth removal and record the time required to remove teeth. However, before the trials were conducted, BMPs developed, and outreach materials created (project tasks 3 and 4), the stakeholders expressed professional and social concerns that ultimately ended the Crematoria Mercury Pollution Prevention Project. Table 3 summarizes the timeline of the major project milestones. The table refers to meetings and e-mail correspondence. Meeting notes and correspondence are provided in Appendices B and C. Following Table 3 is a more detailed description of the information included in the table. The section concludes with a summary of stakeholder concerns that led to their resignation from the project.

TABLE 3 MAJOR PROJECT MILESTONE TIMELINE

DATE	PURPOSE
April 18, 2006	• Introductions

DATE	PURPOSE
(meeting)	<ul style="list-style-type: none"> • Overview of Crematoria Initiative and this crematoria project • Review of research and mercury emissions estimate • Discuss BMPs and funeral professional stakeholders' professional, social, and technical concerns • Discuss potential audiences for outreach materials
May 16, 2006 (meeting)	<ul style="list-style-type: none"> • Final review of emissions estimate report • Discuss approach regarding selection of BMP and path of the project
June 1, 2006 (e-mail)	<ul style="list-style-type: none"> • Express stakeholder concerns regarding May 2006 article in <i>Mortuary Management Magazine</i> • Request to address concerns before moving forward with project
June 5, 2006 (e-mail)	<ul style="list-style-type: none"> • Response to May 2006 <i>Mortuary Management Magazine</i> article • Encourage stakeholders to bring issues up so that we can work through them together as a group.
June 6, 2006 (e-mail)	<ul style="list-style-type: none"> • Response to technical aspects of May 2006 <i>Mortuary Management Magazine</i> article
June 9, 2006 (e-mail)	<ul style="list-style-type: none"> • Express concern with availability and interpretation of emissions data • State lack of federal regulation or apparent future of regulations for human crematories • Indicate position regarding future of stakeholder involvement in project
June 27, 2006 (meeting)	<ul style="list-style-type: none"> • Review project history • Discus key concerns with May 2006 <i>Mortuary Management Magazine</i> article • Get stakeholders and project team on same page to proceed with project
July 13, 2006 (e-mail)	<ul style="list-style-type: none"> • Last stakeholder meeting addressed, but did not resolve stakeholder concerns • Reiterate same issues as June 9, 2006 e-mail • Support May 2006 <i>Mortuary Management Magazine</i> conclusions • Suggest CDPHE regulate community if it decides to • Express end of stakeholder involvement in project
July 18, 2006 (e-mail)	<ul style="list-style-type: none"> • Request continued stakeholder involvement
July , 2006 (e-mail)	<ul style="list-style-type: none"> • Decline further stakeholder involvement in project

The project began on February 10, 2006. The first weeks of the project focused on forming the stakeholder committee (see Section 3.0) and completing a mercury emissions estimate from crematoria (see Section 4.0). CDPHE and Tetra Tech presented the project concept at the quarterly DMFDA meeting on March 29, 2006. On April 18, the first stakeholder meeting was held.

Following the first meeting, the emissions estimate was refined and revised based on comments given by the stakeholders at the first stakeholder meeting. On May 16, 2006, a second stakeholder meeting was held. The purpose of this meeting was to discuss the BMPs and best approach for project outreach. Following this meeting, the project team began work on two fact sheets (one for crematoria professionals, another for the public), consent form language [similar to language used to obtain consent for the common (and mandatory) practice of pacemaker removal before cremation], and obtaining tools for tooth removal testing. Meeting notes and conclusions are summarized in Appendix B.

Following the May 16, 2006 meeting, Tetra Tech began preparing draft versions of the fact sheets and held a conference call with stakeholder member Martha Thayer regarding content of the fact sheets and

tone of the writing. Tetra Tech continued working on the draft outreach material and scheduled a second meeting with Ms. Thayer to review the draft materials on June 2, 2006. On June 1, 2006, Ms. Thayer sent an e-mail regarding a May 2006 *Mortuary Management Magazine* article she had recently read. The main points in the article were:

- ✓ There is a lack of stack test data from crematoria
- ✓ Human crematories are not considered solid waste combustion units
- ✓ EPA and Cremation Association of North America (CANA) teamed to perform stack test and Woodlawn Cemetery Crematoria in June 1999
- ✓ In 1999, EPA estimated 238 pounds of mercury emissions were released from all U.S. crematories

Ms. Thayer's June 1, 2006, e-mail indicated that she and some other stakeholder committee members had some concerns as a result of the information presented in the May 2006 *Mortuary Management Magazine* article and requested, on behalf of a majority of the committee members, to address concerns before moving forward with project.

In response to Ms. Thayer's e-mail, Tetra Tech and stakeholder committee member John Reindl sent separate e-mails regarding the concerns expressed in Ms. Thayer's June 1 e-mail. On June 5, 2006, Tetra Tech sent an e-mail to the stakeholder group that covered the following points:

- The Colorado crematoria project is not intended to specifically direct any regulatory decisions at the EPA, but to explore voluntary programs to reduce mercury emissions from crematoria.
- The May 2006 *Mortuary Management Magazine* article focuses on the fact that human remains are not considered solid waste and human crematoria are not considered solid waste combustion units and therefore not subject to solid waste regulations. That does not mean that crematoria are not subject to other present or future federal or state air emission regulations.
- The method EPA used to estimate emissions differs from the method used for this project and therefore the values cannot be directly compared.
- Tetra Tech's position is that EPA underestimated national mercury emission from crematoria and that the estimating method followed in this project was reasonable, used assumptions from referenced sources, and yielded a defensible estimate.
- The project team was not aware of other state programs that are presently focused on reducing mercury emissions from crematoria.
- Tetra Tech started creating draft outreach material, but ceased work on the fact sheets until stakeholder concerns are resolved.

The e-mail concluded by encouraging stakeholders to communicate their issues so that they could be discussed and resolved as a group. The following day, on June 6, 2006, John Reindl sent an e-mail to the stakeholders. Mr. Reindl was asked to participate in the stakeholder group because he has been preparing and updating a literature review related to mercury emissions from crematoria for several years. Included in his extensive literature review was the study upon which the May 2006 *Mortuary Management Magazine* was based, the Woodlawn Cemetery Crematory study. Mr. Reindl reviewed the study and has spoken several times with the author of the May 2006 *Mortuary Management Magazine* article who is also a contributing author to the Woodlawn study. Mr. Reindl's e-mail indicated this history as well as his comments regarding the Woodlawn study in his June 6, 2006 e-mail.

In his e-mail, Mr. Reindl mentioned there is considerable disagreement among the three principals of the Woodlawn study regarding the test accuracy and data interpretation. He emphasized that all three volumes of the study carry the following disclaimer:

This report presents the results of a single test program at a single cremation facility. It should not be assumed that these results would characterize emissions at other cremation facilities without further study.

In addition, the May 2006 *Mortuary Management Magazine* article and the Woodlawn study referred to an EPA estimate of 238 pounds of mercury emissions nationally from crematories. In his June 6, 2006 e-mail, Mr. Reindl noted that the most recent EPA estimate that he had seen for the emissions of mercury from crematoria in the U.S. was a January 2006 estimate - crematoria are estimated to have released 2,961 kilograms (6,526 pounds) of mercury. This EPA estimate is based on limited data. There are other estimates available, including one generated through a mercury flow model developed by Barr Engineering, Wisconsin DNR, and USEPA Region 5 (In Press).

On June 9, 2006, Ms. Thayer sent an e-mail on behalf of all the funeral professional stakeholders with lists of concerns, conclusions, and suggestions. Among the concerns, Ms. Thayer mentioned that the group was making decisions based upon limited and possibly inaccurate information because the data seemed to be “clearly up for interpretation.” Ms. Thayer also expressed the group’s professional unease about lack of precedent in any other state for a similar initiative and that extracting teeth presented a substantial concern with regard to dignity and respect of the human remains, sensitivity to families, and potential negative image of the funeral industry. Ms. Thayer’s e-mail included the following conclusions.

- “At this point there is not enough accurate and consistent data to move forward with the brochures [outreach material].
- When the EPA determines what category human remains will be placed in for regulations purposes the National Funeral Directors Association will be representing the Funeral Service Industry as stakeholders at the National level. Therefore, the stakeholders are not concerned about legislation at the National level without representation, and are comfortable with waiting.
- Everything that has been suggested has been on a voluntary basis. Without formal regulation or law, tooth extraction will result in little or no participation by Funeral Service Professionals in Colorado.”

The e-mail concluded by saying that until EPA moved forward with formal regulation, the stakeholders “question the need to move forward with this committee.”

After Ms. Thayer’s e-mail on June 6, 2006, Tetra Tech contacted the stakeholder group members and asked if they would be willing to participate in a stakeholder meeting to discuss their concerns rather than ending the project. The stakeholders agreed, and the third stakeholder meeting was held on June 27, 2006. In the meeting, the group reviewed items that were accepted at the end of the May 16, 2006, stakeholder meeting, discussed the May 2006 *Mortuary Management* article, reviewed Mr. Reindl’s email, and discussed cost of conducting a stack test in Colorado. The conclusions of the meeting are summarized in the following bullets.

- It is prohibitively costly and probably unnecessary to conduct a stack test in Colorado
- Stakeholders are concerned about setting a precedent with regard to tooth removal as the BMP

- Stakeholders agreed to move forward with the project as agreed upon at the end of the meeting on May 16, 2006
- One stakeholder agreed to draft language for an informed consent form
- Two stakeholders agreed to attempt voluntary tooth removal and to record data

On July 13, 2006, Ms. Thayer sent an e-mail on behalf of the funeral professionals on the stakeholder committee. She stated that the June 27 stakeholder meeting addressed, but did not resolve, stakeholder concerns. She indicated that the stakeholders had done some research with regard to some of the items discussed on June 27. As a result of their research, the stakeholders maintained their position presented in the June 9, 2006 e-mail and indicated that they supported the conclusions in the May 2006 *Mortuary Management Magazine* article. The stakeholders had spoken with legal council who advised stakeholders not to participate in a volunteer tooth removal program. Finally, the e-mail mentioned that taxpayers paid for control devices installed on European crematories and that the proposed legislation related to mercury emission from crematories in Maine and Minnesota did not pass. Based on their additional research, Ms. Thayer's July 13, 2006 e-mail concluded as follows:

“Based on all of the points made above, we believe a voluntary program is not an effective means to reach the State’s objective of decreasing the mercury emissions from crematoria. Therefore, our continued participation in this study no longer serves a useful purpose, and we will not, therefore, be available for any future meetings of the study group. We hope that the views expressed in this letter will be useful to you, regardless of the approach you take regarding mercury emissions or the nature of the report you prepare when the study is concluded. It is our recommendation that if the State wishes to address this issue, that it should be done as formal regulation.”

On July 18, 2006 CDPHE responded to Ms. Thayer’s e-mail saying that the issues with regard to moving forward with the project seem to be social and ethical in nature more than technical in nature. In the e-mail, CDPHE asked the stakeholders if there would be productive to continue working on the public understanding issue and to research other potential control technologies. Finally, CDPHE asked the stakeholders if they would be willing to find consensus on the need for control technologies.

On August 7, 2006, Ms. Thayer responded. She declined any further involvement with the stakeholder committee. Ms. Thayer indicated that she had been in contact with the other funeral service professionals on the committee and all had requested that they not be contacted for further involvement in the project.

Overall, the funeral professional members of the stakeholder committee cited concerns that led to their decision to discontinue involvement in the committee. Those concerns fell into three general categories, technical, professional, and social.

1. Technical Concerns. The “how, what, where, and when” of tooth removal. These concerns are discussed in Section 5.0 of this report.
2. Professional Concerns.
 - a. Public perception that funeral homes would profit from recovered mercury
 - b. Altering the deceased body is contrary to traditional mortuary education, practice, and philosophy
 - c. Concern regarding setting a precedent for other states
3. Social Concerns
 - a. General public reaction to the request to remove teeth

- b. Emotional reaction of family members when asked to remove teeth of their loved ones
- c. Removal of teeth seen as degradation of body

Because the project ended before most of the challenges were validated or resolved, the technical and social issues are speculative and based on stakeholder’s educated perspectives and the information and views gathered as a result of this project.

7.0 NEXT STEPS AND SUGGESTIONS FOR FUTURE EFFORTS

The Crematoria Mercury Pollution Prevention Project ended before its objectives were met; however, the project succeeded in raising awareness among all stakeholders about mercury pollution from crematoria and how it may be reduced. Important accomplishments of the project are highlighted below.

- CDPHE and funeral industry representatives met, became acquainted, and shared concerns and opinions in an open and respectful manner throughout the project, even as it faced a premature closure.
- CDPHE refined and received comments on an estimate of air emissions of mercury from crematoria in Colorado.
- CDPHE acquired considerable insight into the technical aspects of tooth removal and how it might be performed. Likewise, CDPHE was informed of powerful barriers to tooth removal associated with training for funeral professions and concern about public opinion.
- CDPHE received a clear message from Colorado funeral professionals on its intent to reduce mercury air emissions from crematoria: “It is our recommendation that if the State wishes to address this issue, that it should be done as formal regulation.” [Thayer, July 13, 2006]
- Ms. Thayer, the Arapahoe Community College Director, expressed her willingness to update the thanatochemistry curriculum to address the topic of mercury emissions from amalgam fillings during cremation.

EPA and other states interested in voluntary programs to reduce emissions of mercury will benefit from CDPHE’s experience, as it is described in this report. Specific data gaps that remain are addressed below for tooth removal and professional and social concerns.

Data Gaps for Tooth Removal

Are the tools identified and ordered for CDPHE’s project effective for opening the jaw and extracting the tooth? How much physical effort and strength are required?

How does tooth removal affect the embalming process?

Do the teeth fracture into fragments during removal? How does a fractured tooth affect the effort to remove amalgam from the body?

How much time is required to perform tooth removal (average and range)?

How much training is required to identify and remove the teeth?

What percentage of cremations are preceded by a viewing of the deceased in a funeral service; that is, what percentage of bodies cremated are first embalmed?

Professional/Societal Data Gaps

What type training and education could overcome the professional reluctance to “violate” the deceased in a physical way, such as tooth removal?

What is the public’s reaction to the idea of removing teeth that contain amalgam before cremation? Does the public respond differently to mandatory versus voluntary tooth removal?

What are the net costs for tooth removal (tools, labor, and disposal)? Would those costs be passed to the customer directly or indirectly?

Assuming a tooth removal program or requirement exists, what role do dentists play in educating the public (patients) when cavities (caries) are filled with mercury amalgam?

Is there a generational difference in how people perceive tooth removal? That is, will younger decision makers be more concerned about mercury’s affect on the environment and therefore be more amenable to tooth removal?

Most of these data gaps could be addressed by a voluntary trial of tooth removal at representative crematoria, as was planned and started in the CDPHE project described in this report. Scant anecdotal evidence recorded during this project suggests that tooth removal is relatively straightforward and that individuals (or their families) considering cremation would consent to tooth removal. However, data are insufficient to answer the questions posed above. Future initiatives, whether they are voluntary or regulatory, will confront these questions, which can only be answered through direct experience in a controlled trial.

8.0 REFERENCES

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<http://www.epa.gov/mercury/>

Reindl, John. Summary of References on Mercury Emissions from Crematoria. December 14, 2005.

APPENDIX A STAKEHOLDER CONTACT INFORMATION

Name	Organization	Phone	e-mail
Stakeholders			
Daren Forbes	Horan and McConaty	303-745-4418	dforbes@horanandmconaty.com
John Horan	Horan and McConaty	303-745-4418	jhoran@horanandmconaty.com
George Malesich	Denver Archdiocese	303-425-9511	george.malesich@archden.org
Rayanne Mori	Monarch Society	303-837-8712	rmori@monarchsociety.com
John Reindl	Dane County, Wisconsin	608-267-8815	reindl@co.da.wi.us
Michael Taylor	Taylor	303-344-1615	ltaylor7306@man.com
Martha Thayer	Arapahoe Community College	303-797-5954	martha.thayer@arapahoe.edu
Project Team			
Mark McMillan	CDPHE	303-692-3140	mark.mcmillan@state.co.us
Ron Hyman	CDPHE	303-692-2164	ronald.hyman@state.co.us
Joni Canterbury	CDPHE	303-692-3175	joni.canterbury@state.co.us
Caitlin Rood	Tetra Tech EMI	303-312-8880	caitlin.rood@ttemi.com
Michael Keefe	Tetra Tech EMI	719-251-8501	michaelkeefe@qwest.net
Tom Ouellette, D.D.S.	Tom Ouellette, D.D.S	303-296-1402	touellette@qwest.net

APPENDIX B STAKEHOLDER MEETING NOTES

MERCURY EMISSIONS FROM CREMATORIA REDUCTION INITIATIVE
STAKEHOLDER KICKOFF MEETING NOTES
April 18, 2006

I. Introductions

Meeting attendees:

- Daren Forbes, Horan and McConaty
- Martha Thayer, Arapahoe Community College Mortuary Sciences Program
- George Malesich, Denver Archdiocese
- Rayanne Mori, Monarch Society
- Manuel Chavez, D.D.S, Monarch Society
- John Reindl, Dane County, Wisconsin (via telephone)
- Mark McMillan, CDPHE
- Joni Canterbury, CDPHE
- Jill Cooper, CDPHE
- Howard Roitman, CDPHE
- Caitlin Rood, Tetra Tech EMI.
- Michael Keefe, Tetra Tech EMI
- Thomas Ouellette, D.D.S.

II. Overview of CDPHE Crematoria Initiative

- Crematoria are a significant source of mercury emissions in Colorado; a source likely to increase due to trends in cremation and number of deaths (due to deceased “baby boomers”).
- Mercury emissions are a high priority for CDHPE. CDPHE wants to work collaboratively with crematoria industry in Colorado on voluntary mercury emission reductions rather than impose potentially burdensome and costly regulations.

III. Review of Project Tasks and Timelines

- Main project tasks include (1) formation of the stakeholder group, (2) reviewing mercury emission estimates, (3) identifying practices for reducing mercury emissions from crematoria, (4) develop outreach/communication materials, (5) write a report describing the project, and (6) evaluate impact of project on Colorado crematoria.

IV. Review Emissions Estimates

- Mercury emissions from crematoria have not been measured (via “stack tests”) frequently enough or in controlled studies involving representative sample of cremations; thus Mercury emissions must be estimated empirically.

- The estimated mercury emission from Colorado crematoria presented during the meeting was based on the following: (1) typical amount mercury in an adult filling, (2) number of fillings per adult (>60 years), (3) percent of edentulous population (people missing all teeth), (4) number of cremations per year in Colorado. Using these factors, the estimated mercury emission from Colorado crematoria is 107 pounds per year.
- With regard to refining the emission estimate, data on amalgam use trends in the U.S. should be obtained (if available). Mr. Reindl indicated an organization in the northeast might have data relevant to amalgam use and anticipated trend in mercury emissions from crematoria.
- Other data should be obtained and presented that put crematoria mercury emissions in context. Also to frame the public health concerns about mercury in the state and nationally.
- Currently, about 51 to 52 percent of deceased bodies in Colorado are cremated. This percent is expected to continue to increase in Colorado with a currently anticipated peak in the mid 60 percent range.

V. Best Management Practices

- Meeting attendees discussed the two fundamental options to address mercury emissions from crematoria: (1) remove teeth containing amalgam before cremation or (2) install control technology/equipment on the crematoria “stack”. Attendees agreed that emission control equipment would be prohibitively expensive.
- Several concerns about removing teeth before cremation were raised:
 - ✓ Sensitivity to the emotional state of family of deceased with regard to raising the issue of tooth removal.
 - ✓ Public perception related to tooth removal for gold.
 - ✓ When the teeth would be removed and who would perform the removal.
 - ✓ Possible difficulties with tooth removal in cases where the person died with a closed mouth and subsequent rigor mortis interferes with access to teeth.
 - ✓ Technical concerns relative to embalming and potential damage to the circulatory system in the jaw and face.
 - ✓ Teeth (with amalgam) disposal issues must be investigated and communicated, including cost.
 - ✓ Other “costs to implement” should be estimated.
- There appeared to be a general agreement among meeting attendees that, at least initially, tooth removal should be a voluntary option presented to the deceased families.
- One attendee commented that individuals choosing crematoria may be more “environmentally aware” thus open to the concept of tooth with amalgam removal.

- Investigate parallels to the organ donor model for designating consent to remove teeth with amalgam.
- The idea of informal verbal surveys of crematoria clients about tooth removal to gauge reactions was presented.

VI. Communication/Outreach Methods

- Three audiences for communication/outreach were discussed:
 1. Communication materials (such as pamphlets or similar type of handout) for the public and deceased family members about mercury emissions, associated public health concerns, and the option to have amalgam-containing teeth removed.
 2. Communication materials for members of the crematoria industry explaining CDPHE's initiative and addressing the technical and social issues and resolutions.
 3. Handouts for dentist offices explaining public health concerns about mercury emissions associated with fillings and cremation; the intent would be to raise public awareness so the questions does not come as a surprise to grieving family responsible for the decision.
- Another possible outreach method mentioned was language for crematoria website that explain the dental mercury issue and informing the public that they may be asked if teeth with amalgam can be removed.
- Investigate if other outreach materials have been created in other states.

VII. Next Steps/Next Meeting

The next stakeholder group meeting will be scheduled for early May. This meeting will focus on resolving technical issues and concerns associated with tooth removal.

**MERCURY EMISSIONS FROM CREMATORIA REDUCTION INITIATIVE
STAKEHOLDER MEETING NOTES
May 16, 2006**

Meeting attendees:

- Martha Thayer, Arapahoe Community College Mortuary Sciences Program
- George Malesich, Denver Archdiocese
- Rayanne Mori, Monarch Society
- John Reindl, Dane County, Wisconsin (via telephone)
- Mark McMillan, CPDHE
- Caitlin Rood, Tetra Tech EMI.
- Michael Keefe, Tetra Tech EMI
- Thomas Ouellette, D.D.S.

VII. Meeting 1 minutes and emissions estimate report

- Tetra Tech received and incorporated comments on the Meeting 1 minutes and draft emissions report from Mark McMillan and sent the files to stakeholders for review. Tetra Tech no comments on the Meeting 1 minutes or the draft emissions estimate report from stakeholders.
- The values in the emissions estimate for Hg releases per body cremated and total Hg emissions in Colorado per year will appear in the fact sheets
- Meeting attendees agreed upon the inclusion of Hg emission numbers. Fact sheets will also put the estimated emission values in context by comparing to other Hg emission sources.
- Cremation demographics discussion; anecdotally most people who are cremated are not Catholic, Muslim, or Jewish and at the time of death did not live in at the community in which they grew up. Socioeconomics may also a factor because cremation can cost less than embalming but it is not necessarily the case in all circumstances. However, it is not possible to associate different dental health characteristics with demographic subgroups that affect cremation frequency; therefore, these considerations will be noted in the emissions report, but will not change the emissions estimate.

VIII. Review of approach

- Typical response about tooth removal from bereaved families during Rayanne's informal survey of her customers was 'you have to do what you have to do'. Tom also asked his dental patients and had the same overall reaction.
- Control devices are too costly to be a reasonable option
- Tooth extraction when reasonable with consent will be the general approach
- Seems likely that removal will need to be done post embalming and showing
- Trials need to be done to determine the logistics of removal
- Tetra Tech will write two fact sheets and a best management practices (BMP) technical report. The fact sheets will contain more general information and whereas the BMP report will contain more detailed, technical information. One fact sheet will be written for funeral directors and cremationists. The other will be written for the public. Some of the material in the two fact sheets will be the same, but the fact sheets will be written somewhat differently taking the different audiences into consideration. The BMP report will accompany the fact sheet for the funeral directors and cremationists.

- The family fact sheet should clearly state that teeth removal is a public health initiative and should discuss what will be done and avoid discussing what will not be done (i.e. avoid discussion of gold teeth)

IX. Action Items

Responsible Person	Action Item
Caitlin	Re-send email to stake holders with the draft emissions report with one more week for any comments. Add a statement to the emissions report to acknowledge varying demographics of cremated people and how that is not factored into the calculation.
Caitlin	Call Dr. John Speer with the Colorado School of Mines to discuss the project and request a review of the emissions report
Caitlin	Follow up with Mark regarding approach for initiating discussions with the Colorado Dental Association
Martha	Get name and contact information of the University of Colorado Health Sciences Center Embalmer
Caitlin	Call the University of Colorado Health Sciences Center Embalmer and ask if he can test tooth removal before and after embalming
Caitlin	Call Daren Forbes and ask if someone at Horan and McConaty can test tooth removal
George	Check to see how the Archdiocese feels about involvement in this project and if Josh would be willing to test tooth removal
Rayanne and possibly others	Attempt tooth removal and fill in data collection form. This will be used to assess the general cost (time) to remove teeth with amalgam.
Tom	Get prices and possibly order 2 sets of ratchets and upper and lower tooth extraction tools
Caitlin, Michael, and Mark	Develop data collection form for tooth extraction to include items such as time it takes to perform removal, number of removals, and general sense of ease to remove teeth.
Mark	Follow up with CFDA regarding presenting stakeholder findings at CFDA annual conference in September 2006
Rayanne	Send cremation consent form to Tetra Tech
Caitlin and Michael	Write tooth removal language to add to cremation consent form
Caitlin and Michael	Research disposal options
Stakeholder committee	Determine if coroners would be a potential resource for information about post mortem tooth removal.

IV. Next Steps/Next Meeting

The next major milestone will be the DMFDA Meeting on June 28, 2006. Before this meeting, Tetra Tech will write the draft fact sheets, provide the fact sheets to the stakeholders for review and comment, and incorporate those comments before the meeting. Ideally, meeting attendees will receive the revised draft copies of the fact sheets at the June 28 DMFDA meeting. 30 minutes of the June 28 meeting will be dedicated to the mercury emissions from cremation topic.

APPENDIX C PROJECT CORRESPONDENCE

From: Thayer, Martha [mailto:martha.thayer@arapahoe.edu]

Sent: Thursday, June 01, 2006 3:52 PM

To: dforbes@horanandmconaty.com; jhoran@horanandmconaty.com; rmori@monarchsociety.com; george.malesich@archden.org; Rood, Caitlin -- EMI; mjmcmill@smtpgate.dphe.state.co.us; rshyman@smtpgate.dphe.state.co.us

Subject: Follow-up on faxed Article

June 1, 2006

Dear Mark and Caitlin,

I am writing in response to the article that I faxed to you on May 30, 2006. Please let me know if you did not receive it, I would glad to resend the article. This article has shown me cause for concern in the current direction of the committee, in particular the extraction of the deceased's mercury filled teeth prior to cremation.

After the first meeting, it was my understanding that this was an issue that each of States were addressing in order to avoid having the Federal EPA mandating any national regulation concerning this matter. The article I submitted to you clearly disputes this..."At this time, EPA has no plans underway to regulate human or animal crematories."

The article also states, "Crematories represent 0% of the total inventory for national mercury emissions rates according to EPA and their Best Point Estimates." I do not understand how Colorado's crematories are the third offender of mercury emissions in the State at an estimated 8%. As there is no regulation in Colorado we do not have an accurate count of how many crematories are currently in operation. According to the Cremation Association of North America (www.cremationassociation.org) in 2003, Colorado had 47 operational crematories and cremated a total of 15,610 deceased persons. What is of concern to me is that in 2003, the State of California cremated 115,473 deceased persons in 181 crematories, and the State of Florida cremated 83,892 deceased person in 164 crematories. Do we know if California, Florida or any other states have submitted any emissions tests? Do we know if any other states have established task forces such as Colorado? If so, what recommendations have they made?

I have not spoken with all of the funeral directors on the committee but a majority have asked me to address these concerns of the group with you before we move forward. I have not received anything to date to proof on the brochure for the families. I have also not received a return phone call from the embalmer at the Anatomical Board.

I would like to give you the opportunity to respond to my concerns before I determine any future involvement I may have with the committee.

Sincerely,

Martha Thayer

From: Rood, Caitlin -- EMI

Sent: Monday, June 05, 2006 3:53 PM

To: 'Thayer, Martha'; 'George Malesich'; 'jhoran@horanandmconaty.com'; 'Reindl, John'; 'dforbes@horanandmconaty.com'; 'rmori@monarchsociety.com'

Cc: 'Joni Canterbury'; michael.keefe@msn.com; 'Ronald Hyman'; 'MARK J McMillan'; 'Tom Ouellette'

Subject: Follow-up on faxed article

Dear Stakeholders,

The purpose of this email is to briefly respond to the article and e-mail Martha sent to the group last week. Thanks to Martha and the rest of the stakeholders for bringing both resources and a healthy dose of skepticism to the group, all of which are good for this process. As a side note, Mark and Martha have also spoken on the phone about this subject earlier this morning.

- 1) While EPA headquarters is interested in our crematory mercury project and will read the final report of the project, the outcomes of the project are not intended specially to direct any decisions that EPA makes regarding regulating or not regulating mercury emissions from crematoria. Rather, EPA is interested in improving the state of knowledge around what is seen in some circles as an important issue.

Rahill's May 2006 Mortuary Management article focuses quite a bit on the fact that human remains are not considered solid waste and human crematoria are not considered solid waste combustion units and are therefore not subject to solid waste regulations. However, this does not mean, as you all know, that crematoria are not subject to any regulations, including other present and future federal and/or state air emission regulations.

- 2) The manner in which EPA estimated mercury emissions is different than the manner in which we have estimated mercury emissions for our project. EPA's 0% and 238 pounds cannot be compared to the 107 pounds estimated in our project because they are based on different assumptions and approaches. We are not asserting that Colorado's emissions represent 107 of the 238 total pounds. Rather, we feel that EPA has underestimated the total national emissions. EPA is in some agreement as well. (For example, EPA's estimate is based on stack tests, but it appears that there was no knowledge of the quantity of mercury in the cremated bodies. Therefore, there is no ability to complete a mass balance to determine the final disposition of the mercury releases.) Still, with that, we believe the approach we're developing is the most reasonable one and reflects the best science to date. Again, we will continue to look to you for your thoughts and perspectives on our estimate.
- 3) We are not aware of any other State programs that are presently focusing on reducing mercury emissions from crematoria. Some states have considered it (Maine comes to mind) but they - at least in Mark's opinion - failed to really consider all of the facets of the issue, environmental and social alike.
- 4) We are in the process of creating draft brochures for families and for funeral directors, but first want to ensure the stakeholders buy-in on the premise of the project before moving any further with outreach material.

Finally, please know that we appreciate your feedback and input as individuals and as a group to this project. The reason we requested your involvement in this project was to elicit such professional feedback. We ask that you continue to provide us with your input and to keep an open mind to this

project and process as we move forward. I think we can continue to work through this project smoothly if we all continue to bring our thoughts and concerns to the table and we work toward a solution together.

Thanks again for your participation - it is appreciated.

Caitlin

From: Thayer, Martha [mailto:martha.thayer@arapahoe.edu]

Sent: Friday, June 09, 2006 1:31 PM

To: Reindl, John; Rood, Caitlin -- EMI; George Malesich; jhoran@horanandmconaty.com; dforbes@horanandmconaty.com; rmori@monarchsociety.com

Cc: Joni Canterbury; michael.keefe@msn.com; Ronald Hyman; MARK J McMillan; Tom Ouellette

Subject: RE: Follow-up on faxed article - mercury emissions from cremation

Dear Caitlin,

Thanks to you and Mark for addressing the concerns that I brought forward on behalf of the funeral director stakeholders. I have been in contact with the majority of the stakeholders and the following concerns, conclusions and suggestions have been brought forward:

Concerns:

- We seem to be making decisions based upon limited and possibly inaccurate information and statistics.
- The data is clearly up for interpretation and there is confusion regarding who to follow; the representative of funeral service, or the State.
- There are no other States to look to in terms of having set precedence on this issue.
- Extracting the teeth from any human remains will always be a concern from the standpoint of dignity and respect of the remains, the sensitivity to the grieving families, and the potential negative public image that funeral service could receive as a result of this process.

Conclusions:

- At this point there is not enough accurate and consistent data to move forward with the brochures.
- When the EPA determines what category human remains will be placed in for regulations purposes the National Funeral Directors Association will be representing the Funeral Service Industry as stakeholders at the National level. Therefore, the stakeholders are not concerned about legislation at the National level without representation, and are comfortable with waiting.
- Everything that has been suggested has been on a voluntary basis. Without formal regulation or law, tooth extraction will result in little to no participation by Funeral Service Professionals in Colorado.

Suggestions:

- The stakeholders of the committee will commit to educating Funeral Directors, Mortuary Science Students, and industry leaders on this issue with the intent to bring awareness.
- When in the future the EPA moves forward with a classification of the remains and further regulations are implemented, then the stakeholders would be willing to revisit this issue, until then we question the need to move forward with this committee.

Sincerely,
Martha Thayer

From: Thayer, Martha [mailto:martha.thayer@arapahoe.edu]

Sent: Thursday, July 13, 2006 7:35 AM

To: Michael Keefe; Rood, Caitlin -- EMI; rmori@monarchsociety.com; George Malesich; Reindl, John; johnhoran@aol.com; forbessix@aol.com

Cc: MARK J McMillan; Tom Ouellette; Joni Canterbury; Ronald Hyman

Subject:

Dear Caitlin and Mark,

The last meeting left the Funeral Service Stakeholders feeling like the concerns brought forward before the last meeting, although addressed, were not resolved. The Funeral Service Stakeholders continued their dialogue and research after the meeting and are ready to make our formal recommendation at this time. Our concerns remain the same as brought forward in the last letter sent for your review.

Concerns:

- We seem to be making decisions based upon limited and possibly inaccurate information and statistics.
- The data is clearly up for interpretation and there is confusion regarding who to follow; the representative of funeral service, or the State.
- There are no other States to look to in terms of having set precedence on this issue.
- Extracting the teeth from any human remains will always be a concern from the standpoint of dignity and respect of the remains, the sensitivity to the grieving families, and the potential negative public image that funeral service could receive as a result of this process.

Additional Research:

- We have spoken with Paul Rahill at length about this issue and continue to support his interpretation of the mercury studies and his conclusions as published in the Mortuary Management magazine. He sent us an additional 12 pieces of documentation to read including an email sent to him by Mary Johnson, Environmental Engineer, U.S. EPA. The email was dated December 5, 2005 and Mary wrote, "At this time, EPA has no plans underway to regulate human or animal crematories."
- We have received legal counsel from an environmental attorney, Carol Green, who is outside counsel for the National Funeral Directors Association. After our conversations with Ms. Green we feel that it is not in the best interest of the Funeral Directors in the State of Colorado to participate in a voluntary tooth pulling program.
- We also spoke with Jack Springer, President of the Cremation Association of North America. He stated in part that the scrubbers/washers for the crematories in Europe have been paid for by the taxpayers and not by private business.
- The bills introduced in both Maine and Minnesota that were not passed have been studied and we have contacted the Executive Director of the Funeral Associations in each State. www.mainelegislature.org Search LD1664, www.revisor.leg.state.mn.us and Search HF661 or SF641. The Executive Director of the Maine Funeral Directors Association, Sally Belanger shared that the bill had been defeated in part due to testimony from a

legislature herself. She stated from her seat on the committee that as her husband has recently died she would have been horrified if a funeral director would have told her about tooth removal.

- It was suggested at the last meeting that the City of Minneapolis had done “something” in regards to mercury emissions even though the State initiative failed. The City amended Section 47.50 to require registration of crematoria on March 31, 2006.
<http://www.ci.minneapolis.mn.us/council/2006-meetings/20060512/HEE20060501agenda.asp>

Based on all of the points made above, we believe a voluntary program is not an effective means to reach the State’s objective of decreasing the mercury emissions from crematoria. Therefore, our continued participation in this study no longer serves a useful purpose, and we will not, therefore, be available for any future meetings of the study group. We hope that the views expressed in this letter will be useful to you, regardless of the approach you take regarding mercury emissions or the nature of the report you prepare when the study is concluded. It is our recommendation that if the State wishes to address this issue, that it should be done as formal regulation.

Sincerely,
Martha Thayer
Rayanne Mori
George Malesich
Darin Forbes
John Horan

From: MARK J McMillan [mailto:mjmcmill@smtpgate.dphe.state.co.us]
Sent: Tuesday, July 18, 2006 1:50 PM
To: forbessix@aol.com; johnhoran@aol.com; Martha Thayer; George Malesich;
John Reindl; rmori@monarchsociety.com; Michael Keefe; Tom Ouellette; Joni
Canterbury; Ronald Hyman; Rood, Caitlin -- EMI
Cc: JILL E Cooper; MIKE Silverstein
Subject: Re: Crematoria initiative

Martha et al -

Sorry for the delay in my response. I've been out on paternity leave these past couple of weeks (in case you're wondering - Joseph Hardy McMillan, 6 pounds, 7 ounces, 20 inches long) and am working through a hefty backlog of email.

I was a little surprised to read your email as I recall seeing just before that (in an email dated July 5) an encouraging response on Martha's additional research in this area. (I continue to think the best efforts are those that include some skepticism.) Seemed we were making progress coming out of each of the last two stakeholder meetings and DMFDA dinner presentations. Seemed we were making progress by looking to you, as leaders of the industry, for solutions. Nonetheless, I can appreciate the position you're in and, again, the State is not looking to create challenges but to resolve them.

A couple of comments/questions then for the stakeholders.

It sounds as if the largest challenges here are not so much of a technical nature in removing teeth (Rayanne and Dr. Chavez both confirmed this issue) but of the social and ethical issues. After all, as Martha pointed out, "Extracting the teeth from any human remains will always be a concern from the standpoint of dignity and respect of the remains, the sensitivity to the grieving families, and the potential negative public image that funeral service could receive as a result of this process." With that, is there value in continuing a group discussion purely to further the general understanding of this issue in its social and ethical context? I think this is very valuable information that frames this issue for others.

Also, an interesting approach that, I believe, Dr. Chavez introduced was something along the lines of determining some other way (besides tooth removal) to control mercury from the industry. For example, it was suggested that basic research on the use of some sort of control device inserted into the mouth before cremation might be developed to control this pollutant. (I sense it would work by binding up the mercury and keeping it from being emitted to the atmosphere.) Back to the idea of continuing our dialogue, are the stakeholders willing to support other control strategies, such as the one Dr. Chavez mentioned? Should we be relying on our professional judgment and group experience to brainstorm some other strategies (versus walking away from the process because it's challenging)?

Finally, in an email from Martha and others on June 9, it was stated "Everything that has been suggested has been on a voluntary basis. Without formal regulation or law, tooth extraction will result in little to no participation by Funeral Service Professionals in Colorado." Martha followed that up with ... "it is our recommendation that if the State wishes to address this issue, that it should be done as formal regulation." Knowing that this public health issue is not leaving us anytime soon, does this mean that the

stakeholders are willing to find some sort of consensus on the need for the control technologies? Naturally, this would move us away from the concept of removing amalgam fillings before cremation and have us focus on the use of mercury control technologies at the facilities. (It would also allow the group to start a dialogue on taxpayer support - an issue also brought up in the email.) Such consensus might be in the form of a brief paper describing the issue and the need for formal control technology regulations. There may be some other ways to demonstrate consensus as well. All opinions are welcome.

Regardless of the route we might consider here, again, I believe your involvement and leadership are important. I'll hope you consider these perspectives as well and share them with us. I think the best decisions are those made by the group.

Thanks in advance for your consideration and comments.

Regards, Mark

From: Thayer, Martha [mailto:martha.thayer@arapahoe.edu]

Sent: Monday, August 07, 2006 8:43 AM

To: MARK J McMillan; forbessix@aol.com; johnhoran@aol.com; George Malesich; John Reindl; rmori@monarchsociety.com; Michael Keefe; Tom Ouellette; Joni Canterbury; Ronald Hyman; Rood, Caitlin -- EMI

Cc: JILL E Cooper; MIKE Silverstein

Subject: RE: Crematoria initiative

Dear Mark,

I received your email dated July 18th, and a voicemail from you last week. I politely decline any further involvement with the committee. I feel strongly that what we have brought forward has been well researched and has already been discussed.

I personally have not found this challenging in a negative way, I have enjoyed learning about this topic and have gathered much information for curriculum development for the Thanatochemistry course at the college. I also do not see myself as having walked away from this. I participated, listened, researched, made conclusions, and presented a formal recommendation.

I have been in email contact with the other funeral service professionals on the committee and all have requested that they not be contacted for further involvement in the committee.

Sincerely,
Martha L. Thayer