

The Quicksilver Caucus (QSC) is a coalition of State associations formed to address and resolve health and environmental problems resulting from the release of mercury to the environment. The membership of the QSC includes the Environmental Council of the States, the Association of State and Territorial Solid Waste Management Officials, the Association of State and Interstate Water Pollution Control Administrators, the Association of State Drinking Water Administrators, the National Association of Clean Air Agencies, and the National Pollution Prevention Roundtable.

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Dental Mercury Amalgam Waste Management White Paper

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Executive Summary

This paper provides information to assist states in considering how to reduce sources of dental mercury amalgam released to the environment from the dental sector. While dentists have reported a downward trend in the use of mercury amalgam for dental restoration for a variety of reasons, there are data being reported which demonstrates this reduction is rather minimal. Regardless, mercury from dental amalgam is a major source of controllable mercury released to the environment and likely will remain a significant concern into the future.

This paper focuses on achieving major reduction of mercury releases through the use of amalgam separators as the preferred best management practice. It examines issues related to the installation and use of amalgam separators including common features of dental amalgam programs, lessons learned from existing local and state programs, and recommendations for future action. Case studies of state and local programs which were the basis for much of the discussion in this paper are available in a separate document, “Case Studies of Five Dental Mercury Amalgam Separator Programs”.

Some common features of the dental amalgam programs include:

- Using local or regional programs in order to stimulate state programs;
- Initially being voluntary but later evolving into mandatory;
- Needing to determine which specific separators meet program requirements;
- Requiring dental practices to use best management practices in addition to separator installation; and
- Needing to consider which, if any, specialty dental practices should be exempt from amalgam separator requirements.

In addition to providing information on common features of these programs, the paper includes lessons learned related to the following issues:

- Amalgam separator selection
- Operation and maintenance of amalgam separators
- Communication and program implementation

Beyond providing information on lessons learned and common features of some existing dental mercury amalgam programs, this paper identifies some recommendations for future action related to amalgam management such as the need for education of dental practice employees, concerns about air emissions that result from amalgam use, and the need to address legacy mercury issues in dental office plumbing.

Introduction

Background

In November 2006, the Quicksilver Caucus (QSC) published a Mercury-Added Products White Paper that identified several sectors,¹ including dental clinics, where significant advances could be made in the reduction of use of and improved management of mercury. The recommendation to advance opportunities to reduce mercury releases in the dental sector gathered further momentum at the May 2007 meeting of state mercury policymakers in Madison, Wisconsin. There was particular interest in having QSC member associations and state agencies share information that would strengthen states' capacity to reduce sources of dental mercury amalgam released to the environment. As a first step in addressing the dental sector, the QSC has developed this white paper to share approaches adopted by state and local governments when working to reduce mercury releases and to provide a summary of key lessons learned in some of these programs.

This paper provides an overview of the use of dental amalgam, available non-mercury alternative restorative materials, information on amalgam separators, common components of some dental mercury amalgam separator programs, a summary of lessons learned from some existing state and local government programs from around the United States, and recommendations for future action.

Use of Dental Mercury Amalgam

Mercury comprises by weight approximately half of the metals used in common dental amalgam. Dental mercury amalgam has been regularly used in the treatment of cavities because it is easy to work with, durable, and has been viewed as cost effective. While years ago it was standard practice for dentists to mix their own amalgam, this has been almost universally replaced by pre-measured and sized amalgam capsules. The use of amalgam capsules, the reduction in cavities due to improved dental hygiene, and the availability of other restorative materials have contributed to dentists reporting a downward trend in the use of dental mercury amalgam.^{2,3} This assumption may be overstated as some data suggests mercury use in dentistry has decreased only slightly. For example, amalgam manufacturers and distributors are required to report every three years to the Interstate Mercury Education and Reduction Clearinghouse (IMERC) on mercury sales. In their 2004 submissions, data were presented that indicated the sale of mercury in dental amalgam in the United States in 2001 was 30.77 tons, decreasing only slightly to 30.39 tons in 2004.⁴

¹The product sectors identified as equally meriting national attention were lamps, thermostats, dental amalgam, thermometers, and non-vehicle switches, relays and flame sensors. Continued federal and state efforts in health care, schools, and end-of-life vehicle switches was also encouraged.

²Centers for Disease Control and Prevention. Dental Amalgam Use and Benefits. Available at <http://www.cdc.gov/oralhealth/publications/factsheets/amalgam.htm>

³Berthold, M. Restoratives: Trend data shows shift in use of materials, *American Dental Association News*, 2002, 33(11), 10-11.

⁴Interstate Mercury Education and Reduction Clearinghouse. Mercury-Added Products Database. Available at (<http://www.newmoa.org/prevention/mercury/imerc/Notification/index.cfm>)

Environmental Releases of Mercury

Mercury from dental amalgam is released to the environment through three primary pathways: in wastewater, as solid waste, and through cremation of bodies containing dental amalgam. The majority of dental mercury amalgam is discharged from dental offices to wastewater treatment systems where it usually settles out in sewage sludge that is either incinerated, heat treated, landfilled, and/or land applied as biosolids (also known as “sludge”). As there have been substantial accomplishments in reducing mercury in other business product sectors, dentists have become the largest source of mercury in wastewater influent.⁵ A study funded by the American Dental Association (ADA) estimated that dental offices discharge approximately six and a half tons of mercury per year to sewage treatment systems in the United States, which represents 50-53 percent of influent loading.⁶ While wastewater treatment plants can remove as much as 95 percent of the mercury from wastewater influent; the removed mercury is transferred from wastewater to biosolids or ash from which it can enter the environment, or be released directly to the atmosphere. Dental offices discharging wastewater to septic systems also have the potential to contaminate surrounding soils and groundwater, including wells.⁷ Additionally, mercury and mercury amalgam particles can accumulate in the plumbing of dental offices and sewer lines, and over time, continue releasing mercury into the wastewater.

In addition to wastewater concerns, waste amalgam that is improperly disposed in regulated medical waste (“red bag”) containers can be either incinerated or autoclaved, thus making it possible for volatilized mercury to escape into the environment. Mercury amalgam also accumulates on consumable dental supplies, such as cotton swabs and gauze. These materials are typically not considered potentially infectious regulated medical wastes, and are disposed with the regular solid waste. In some areas, solid waste is incinerated so the mercury in this waste can be released via air emissions.

Dental amalgam also contributes to mercury emissions from crematoria. A mercury flow worksheet developed for EPA Region 5 estimated that in the United States in 2005, just under 3,000 kilograms (6,613 lbs.) of mercury were released to the environment from crematoria.^{8,9}

⁵A study by the Association of Metropolitan Sewerage Agencies (now the National Association of Clean Water Agencies) found that dental offices are the largest source of mercury to publicly-owned treatment works (POTWs), contributing more than 35 percent of the influent mercury for the POTWs studied. Association of Metropolitan Sewerage Agencies. Mercury Source Control & Pollution Prevention Program Evaluation: Final Report. March 2002 (Amended July 2002).

⁶Vandeven, J. and McGinnis S.L. An Assessment of Mercury in the Form of Amalgam in Dental Wastewater in the United States. *Water, Air and Soil Pollution*, 2005, 164, 349-366.

⁷See Interagency Resource for Achieving Cooperation. Non-Residential Septic Tank Systems: Information for Business Users and Property Owners. Available at <http://www.lhwmp.org/IRAC/publications/Septic%20Tank%20Guidelines2004.pdf>. Washington State requires that dentists discharging to septic systems install a separator and obtain an industrial wastewater permit. See Washington Administrative Code: Chapter 173-216 WAC (non-domestic waste water); Chapter 246-290 WAC, state drinking water standards; and, Chapter 173-340 WAC, Model Toxics Control Act cleanup standards. Available at (<http://apps.leg.wa.gov/WAC/default.aspx>).

⁸Cain, A. Mercury Flow Workbook, US EPA, Region 5, Excel Spreadsheet, January 2006.

⁹Cremation is not the focus of this white paper but it is useful to be aware of and prepared for the topic of cremation to be raised during public policy discussions on amalgam.

Alternatives to Dental Mercury Amalgam

If dental practices or patients do not want to use mercury amalgam, there are several non-mercury restorative materials available. Presently, there are six types of restorative materials: mercury amalgam, resin composite, glass ionomer, resin ionomer, porcelain, and gold alloys.¹⁰ Each type of restorative material has advantages and disadvantages. Some factors that influence which restorative material is used include: cost, strength, durability, location of cavity, and aesthetics.

Historically, dental amalgam has been less expensive to the patient than other restorative materials and therefore has been favored for use. Today, although the cost of alternative materials is often higher than amalgam, their use is increasing as patients prefer tooth-colored restorations or have concerns over the use of mercury in their mouths (teeth). With the increasing use of alternative filling materials, insurance providers may also reimburse or cover the cost for them.

Amalgam Separators and Dental Amalgam Best Management Practices

For many municipalities, mercury discharges into sanitary sewer systems from dental offices do not meet local sewer use ordinance limits for mercury. To address this, dental offices can employ a number of best management practices (BMPs) to reduce mercury in their effluent. However, aside from using mercury-free alternatives, proper installation, operation, and maintenance of amalgam separators that meet or exceed the International Organization for Standardization (ISO) 11143:1999 (ISO 11143) standard along with proper maintenance of plumbing systems is the most effective means to significantly reduce mercury amalgam discharges from dental offices.¹¹ Appendix A lists resources available on-line that provide information on dental amalgam and best management practices.

Amalgam separators are increasingly important to waste amalgam capture as more dental office systems are installing “dry” vacuum systems. These systems have only one filter while more traditional “wet” vacuum systems have two filters. This means that without an amalgam separator, the dry vacuum systems have no secondary filtration.

Currently, nearly two dozen brands of amalgam separators are available that meet the ISO standard of removing at least 95 percent of the mercury amalgam.¹² Additionally, amalgam separators, which are readily available through dental supply companies, are in most cases straightforward to install, usually operate without electricity or chemical addition, allow easy recycling of the collected amalgam contents, and are relatively low cost for both installation and maintenance. As a result of these factors and their effectiveness in reducing mercury in dental office effluent, requiring installation of amalgam separators has been a policy initiative in many states and municipalities.

¹⁰From ADA. Dental Fillings Facts. Available at http://www.ada.org/prof/resources/topics/materials/dental_fillings_facts_full.pdf. Accessed January 21, 2008.

¹¹More may about ISO standards at: http://www.iso.org/iso/standards_development.htm

¹²Batchu, H. et al. Evaluating amalgam separators using an International Standard. *Journal of the American Medical Association*, 2006, 137: 999–1005; and Fan, P.L. et al. Laboratory evaluation of amalgam separators. *Journal of the American Medical Association*, 2002, 133: 577– 584.

In addition to state and municipal requirements, in October 2007, the ADA amended its “Best Management Practices for Amalgam Waste” by adding a recommendation that dentists use amalgam separators.¹³ The ADA defines dental BMPs as the use, proper waste handling, and disposal in the operation of equipment that includes chairside traps, vacuum filters, and amalgam separators compliant with ISO 11143. As summarized below in Table 1, the ADA BMPs also include equipment maintenance, recycling, and using a commercial waste disposal service.

Table 1: ADA Best Management Practices for Amalgam Waste¹³

DO	DON'T
<i>Do</i> use precapsulated alloys and stock a variety of capsule sizes	<i>Don't</i> use bulk mercury
<i>Do</i> recycle used disposable amalgam capsules	<i>Don't</i> put used disposable amalgam capsules in biohazard containers, infectious waste containers (red bags) or regular garbage
<i>Do</i> salvage, store and recycle non-contact amalgam (scrap amalgam)	<i>Don't</i> put non-contact amalgam waste in biohazard containers, infectious waste containers (red bags) or regular garbage
<i>Do</i> salvage (contact) amalgam pieces from restorations after removal and recycle the amalgam waste	<i>Don't</i> put contact amalgam waste in biohazard containers, infectious waste containers (red bags) or regular garbage
<i>Do</i> use chair-side traps, vacuum pump filters and amalgam separators to retain amalgam and recycle their contents.	<i>Don't</i> rinse devices containing amalgam over drains or sinks
<i>Do</i> recycle teeth that contain amalgam restorations. (Note: Ask your recycler whether or not extracted teeth with amalgam restorations require disinfection.)	<i>Don't</i> dispose of extracted teeth that contain amalgam restorations in biohazard containers, infectious waste containers (red bags), sharps containers or regular garbage
<i>Do</i> manage amalgam waste through recycling as much as possible	<i>Don't</i> flush amalgam waste down the drain or toilet
<i>Do</i> use line cleaners that minimize dissolution of amalgam	<i>Don't</i> use bleach or chlorine-containing cleaners to flush wastewater lines

Dental Amalgam Separator Programs

According to information compiled by the QSC, there are eleven states and numerous municipalities with mandatory programs requiring the use of dental mercury amalgam separators. Information for this report was solicited from Metropolitan Council Environmental Services (Minneapolis/St. Paul Minnesota publicly-owned treatment works), Maine, Massachusetts, New York, and Washington. Information on the King County, Washington, program was

¹³ADA. Best Management Practices for Amalgam Waste. 2007. Available at http://www.ada.org/prof/resources/topics/topics_amalgamwaste.pdf. Accessed January 19, 2008.

provided by the Washington Department of Ecology. The QSC selected these six programs because they represent a variety of types of programs and occur in diverse geographic areas. They include states with large populations and urban areas, such as New York, and states that are largely rural, such as Maine.

While not all programs had hard data on their results, data from Massachusetts, King County, and the Metropolitan Council Environmental Services (MCES) clearly demonstrate the value of amalgam separator installation programs. The Massachusetts and King County programs have each realized approximately 50 percent reductions of mercury in biosolids. The MCES program has tracked their progress by monitoring mercury in wastewater influent, and has achieved a 50 percent reduction in the amount of mercury discharged to the treatment plant.

Below is a discussion of some program components that are common to the programs reviewed and a list of some lessons learned by these and other programs. (Note: full descriptions of these programs are available in a separate document titled, “Case Studies of Five Dental Mercury Amalgam Separator Programs”.)

Common Program Components

Precursors to State Programs

The programs reviewed indicate that local and regional dental amalgam efforts often seem to be useful precursors to the development of statewide dental amalgam programs. Local (in-state) programs often garner invaluable knowledge and experience that eventually helps shape their respective state’s dental mercury reduction initiatives. Two such local programs reviewed for this paper are King County, Washington’s pilot effort, and Metropolitan Council Environmental Services’ (MCES) program.

Similarly, regional multi-state efforts have played a role in developing some state programs. For instance, dental sector mercury reduction goals were set in 2005 under the Mercury Action Plan of the New England Governors and Eastern Canadian Premiers such that by 2007 seventy-five percent and by 2010 ninety-five percent of the region’s dentists who generate mercury amalgam wastewater would install amalgam separators. These regional mercury reduction goals served as motivators for the development of the Maine and Massachusetts programs.

Currently, the Great Lakes States are developing a regional Great Lakes Mercury in Products Phase-Down Strategy for mercury containing products. In that strategy, dental mercury amalgam is one of the primary products being addressed. This strategy most likely will result in more Great Lakes states developing dental amalgam BMP programs, which are expected to include requiring dental mercury amalgam separators.

Voluntary vs. Mandatory Programs

All of the programs examined initially began as voluntary initiatives with Memoranda of Understanding (MOUs) with state dental associations, or as a result of regional initiatives that included recommendations for the development of mandatory programs. Regardless of how they began, all the programs reviewed for this paper now have mandatory components. For example, the

Washington State Department of Ecology initially negotiated an MOU with the Washington State Dental Association to give dentists a two-year grace period to install amalgam separators and implement other best management practices. Under the voluntary program, only 40 percent of dentists in Washington installed separators. This prompted the Department of Ecology not to extend the MOU and to require separator installation under existing state hazardous waste regulations.¹⁴ Similarly, in Massachusetts, although an MOU between Massachusetts Department of Environmental Protection and the Massachusetts Dental Society helped to raise awareness about amalgam separators, their use by dentists only increased modestly until a two-phase mandatory program evolved with incentives for early adopters. MCES saw comparable low separator installation rates until dentists were told they would be required to obtain a discharge permit, pay permit fees, conduct sampling, and submit reports to MCES if they did not install a separator. After dentists were told that, separator installation rates in the MCES jurisdiction increased to 100 percent. Table 2 identifies the components of programs reviewed in this paper.

Table 2: Mandatory vs. Voluntary Components of Programs Reviewed

Component	Program
Voluntary separator installation, but later a discharge permit was required if separators were not installed. Permitting would have included paying fees, meeting a mercury limit, and sampling and analyzing wastewater.	MCES
Voluntary separator installation followed up with mandatory component.	Massachusetts, Washington State, King County
Mandatory separator installation but special considerations if separators were installed prior to the requirements going into effect.	Maine, New York

While the addition of amalgam separators to the ADA’s BMPs should increase their installation, these are voluntary industry-recommended standards, and therefore may not result in a sufficient number of dentists adopting them to meet important environmental standards. When considering whether separator installation should be voluntary or mandatory, program managers should consider information published in the Fall 2007 edition of the *ADA Professional Product Review*¹⁵ where it was reported that a “survey of [ADA Clinical Evaluator Panel] members shows that relatively few panel members own an amalgam separator or plan to purchase one”.¹⁶ Also, while participation rates will be higher with mandatory programs, starting an amalgam separator installation program under a voluntary initiative should not be overlooked because it can serve as a meaningful first step in creating a program.

¹⁴Washington State Dangerous Waste Regulations, Washington Administrative Code, 173-303. http://www.ecy.wa.gov/programs/hwtr/reg_comp_guide/173-303.HTM.

¹⁵Dental Separators: A peer review. *ADA Professional Product Review*, 2007, 4:1.

¹⁶The ADA Clinical Evaluator Panel is a volunteer group of ADA members who contribute feedback for the clinical input segments of the ADA Professional Product Review™ program. More on the ADA Clinical Evaluator Panel can be found at <http://www.ada.org/prof/resources/pubs/ppr/ace.asp>

Separators

All of the programs examined require installation of amalgam separators compliant with at least the ISO 11143 Standard; however, specific removal efficiency requirements vary among programs. MCES and New York require installation of separators with a removal efficiency of 99 percent. By contrast, Massachusetts and Maine allowed a minimum removal efficiency of 95 percent, if the separators were installed prior to their laws going into effect. Separators installed after the laws took effect must have a minimum removal efficiency rating of 98 percent.

The method for ensuring that acceptable separators are installed varies among the programs. In some programs, the regulating body provides a list of approved separators. In other programs, dentists are provided a list of approved separators but may purchase separators not on the approved list as long as they provide documentation that the separator’s removal efficiency meets regulatory requirements. Programs that require separators to be “certified” should clearly define what constitutes certification and designate acceptable “certification body/ies”. The case study programs all recommend against evaluating and testing separators by individual states or POTWs. This has proven to be a difficult, time-consuming task, and once a regulator evaluates and approves certain separator models, they become the default certification body from that point forward. This function can be more efficiently accomplished by established certification bodies with significant experience in ISO 11143 work. Table 3 below identifies amalgam separator requirements of the programs examined.

Table 3: Separator Requirements of Programs Reviewed

Separator Requirements	Program
Pass the ISO 11143 Standard	King County, Maine, Massachusetts, MCES, New York, Washington
99 percent removal efficiency according to ISO 11143 Standard	MCES, New York
98 percent removal efficiency according to ISO 11143 Standard and 95 percent if installed prior to law going into effect	Maine, Massachusetts
95 percent removal efficiency (The basic ISO 11143 Standard)	King County, Washington
Specific list of separators provided by regulator	King County, Maine, MCES
Certified. Certification is a quality control, conformity assessment process in addition to ISO 11143 testing.	MCES ¹⁷ , New York
Alternative separator models can be approved if the dentist takes on the burden of ensuring that the unit meets all Maine DEP specifications including documentation that: (1) the separator achieves 98 percent efficiency at maximum flow, and (2) Maine DEP waste bureau has determined that the unit is "totally enclosed".	Maine

¹⁷Note that some older separator models on MCES’ list of approved separators may not be certified.

Best Management Practices

Beyond separator installation, all the programs reviewed require dental practices to use BMPs in order to control releases of mercury. Although, specific BMPs vary from program to program, they include practices such as:

- recycling of all mercury-containing waste;
- requiring all mercury-containing wastewater to pass through an amalgam separator;
- storage/recycling requirements for waste amalgam capsules; and
- training dental office staff on the proper procedures for operating and maintaining an amalgam separator.

Exemptions

When setting up an amalgam separator program, it is important for program managers to decide whether and what types of dental practices may receive an exemption. The programs reviewed for this paper varied in how they addressed exemptions for specialty dentists such as orthodontists, periodontists, prosthodontists, and oral/maxillofacial surgeons. Specialty dentists are not commonly thought to place or remove mercury amalgam restorations so some have been exempted from some of the programs. Programs have tended not to exempt endodontists as they can remove a significant amount of amalgam. Variations between state programs are apparent when the exemptions in Maine and Washington are compared. Maine law exempts only oral and maxillofacial surgery practices. In contrast, Washington State did not set its exemption based on type of practice rather they exempt specialists only if they:

- Do not place or remove amalgam fillings on ten or more practice days during the year and, if inspected, are able to show compliance with this requirement.
- Dispose of all other dangerous wastes, such as lead foils or used fixer, in an appropriate manner. No dangerous wastes should be intentionally put down the drain, disposed of as part of medical (red bag) waste, or sent to landfill without explicit permission from local authorities.¹⁸

Lessons Learned

In addition to the common program components that were identified through the six case studies, lessons learned by the programs profiled in the case studies and by other programs can be useful. Below is a set of lessons learned that provide valuable information for other states as they consider and create dental amalgam programs.

Amalgam Separator Selection

- To avoid problems associated with regulators having to review reports and certificates from unknown sources, states requiring the use of ISO 11143 compliant amalgam separators should determine and publicize who may test and certify the units.
- Programs should not adopt a list of approved separator models from another regulatory agency without first evaluating that agency's program.
- States should be aware that removal efficiency test results for separators can currently be manipulated by manufacturers using any maximum flow rate they want during ISO testing.

¹⁸Washington State Department of Ecology. Designation guidance for specialty dentists. Available at http://www.ecy.wa.gov/dentalbmps/specialty_guidance.html. Accessed January 21, 2008.

The ISO is considering this issue in a revision to ISO Standard 11143. More information on this revision is available in Appendix B.

Amalgam Separator Operation and Maintenance

- When setting guidelines and regulations for operation and maintenance of separators, states should be aware that many models of separators have a mechanism that allows wastewater to bypass the separator with little or no treatment if there is excessive flow or when the filters are full or clogged. As a result, separators should not be operated at flow rates in excess of the ISO tested flow rate, unless the separator has a built in flow restrictor and an adequately-sized surge tank.
- Since timely and appropriate maintenance of separator systems is critical, states should ensure that dental BMPs always include the “do’s and don’ts” for properly cleaning amalgam separators, traps, filters, and other related plumbing in dental practices. Bleach and other improper cleaning materials may cause mercury ‘spikes’ into wastewater originating from dental facilities and eliminate the mercury reductions derived from separators.
- Dental practices and their vendors should be required to follow manufacturer’s directions on separator installation, operation and maintenance, and maintain records of these activities.

Communication and Implementation

- When developing a dental amalgam reduction program, communicating with staff operating programs already in existence is highly advisable. More than likely these programs have already addressed the key issues that could arise.
- As states create and implement amalgam separator programs, they should plan to work with a wide variety of stakeholders from environmental groups and publicly-owned treatment works to the ADA and dental office supply companies. A list of potential stakeholders and their roles are available in Appendix C.
- States should be aware that a mercury waste manifest tracking system can help ensure proper recycling of mercury-containing wastes.
- To understand where coordination may be beneficial, programs should identify which entities in addition to environmental agencies visit dental facilities regularly. For example, licensed plumbing inspectors are in a position to observe and report on amalgam separator installation or lack thereof. The Connecticut Department of Environmental Protection has signed an MOU with x-ray equipment inspectors for them to include inspection of amalgam separators in their periodic visits to dental offices.
- Resources will always be an issue. States should be aware that some programs found that significantly more resources and staff time were needed to implement the program than was originally anticipated. Also, without funding to maintain technical assistance visits and to pursue regulatory violations, programs may struggle to succeed.
- Regulators need to be prepared to offer guidance on all aspects of their dental mercury amalgam reduction programs including:
 - o Providing information as to which amalgam separator models are acceptable since failure to provide this information may be interpreted as blanket approval of any amalgam separator; and
 - o Identifying testing laboratories and certification bodies from which amalgam separator manufacturers may contract for services.

- Developing a good working relationship with the state dental association is vital to program success as they can help with outreach and education.
- State environmental agencies should enlist dental licensing agencies and boards in outreach efforts.

Recommendations for Future Action

Although a lot of information has been gathered and much has been learned from programs that are addressing dental mercury amalgam, there are still outstanding issues that need to be studied and resolved. Below is a list of recommended actions to begin to address some of these issues.

- States should encourage EPA to designate a national or international organization to conduct separator testing under ISO 11143. Data from the testing results could be used to develop one list of separators that achieve 95% reduction or better at certain established flow rates. States and municipalities could use these data as the benchmark for an approved list of separators. If that is not possible, a stakeholder group should be established to recommend answers to questions such as:
 - Who is qualified to perform ISO 11143 testing and certification?
 - By whom and how are the laboratories and certification bodies to be accredited?
 - Has the ISO test been performed correctly?
 - Does each regulator in each jurisdiction have to evaluate test reports and certificates?
- Education of dental office staff regarding amalgam separators and BMPs should be pursued. Some specific recommendations for this include the following:
 - Dental assistant schools, dental hygiene schools, and dental schools should be required to teach students proper storage, use, handling, and spill clean-up of mercury amalgam. This will ensure that all positions in a dental practice that may handle mercury amalgam receive appropriate training.
 - Amalgam BMPs should be included in the continuing education programs for dentists, dental assistants, and hygienists.
 - When state and local programs have statutes in place that uniquely apply to dental practices, compliance with these requirements should be reviewed in the applicable state's dental licensure process.
- Mercury and mercury amalgam particles can settle at low points in plumbing and remain in the pipes of a facility or downstream sewer lines for many years. As a result, releases can occur over time as work is done on dental office plumbing systems, and during system cleaning and disinfection procedures. Therefore, dental office staff and plumbers need to be made aware of this issue and taught proper procedures for addressing it.
- Eliminating or decreasing mercury emissions to air during cremation is an emerging area of concern.
- Studies should be pursued to gather more information on mercury air emissions in dental offices during routine dental procedures, separator operation and maintenance, and handling of waste amalgam.
- There are very limited data on the mass load of mercury in municipal wastewater treatment plants, particularly carefully controlled studies before and after the implementation of

amalgam BMPs and installation of amalgam separators in tributary dental offices. Since dental amalgam represents 50% of the mercury influent to municipal treatment plants and the precise partitioning of that mercury to treatment plant grit, biosolids, air emissions, and effluent may be important to mercury control policy decisions, such studies should be conducted as soon as possible. The studies should be national in scope and funding with participating municipalities representing the range of wastewater treatment plant size and technology in the United States.

Wrap-up

State and federal mercury reduction programs increasingly focus on eliminating human uses and releases of mercury. Given that dental practices contribute significant amounts of mercury to the environment, addressing management of dental mercury amalgam is important. This paper provides information on features of and lessons learned from some current amalgam separator programs. Providing this information lays the groundwork for more discussion of amalgam separator programs and generally addressing mercury releases from dental practices.

Appendix A

Some Online Dental Amalgam Information Resources

January 2008

General

Northeast Waste Management Officials' Association's Mercury-Dental Topic Hub -
<http://www.newmoa.org/prevention/topichub/bibliography.cfm?hub=103&subsec=7&nav=100>

The National Association of Clean Water Agencies' Mercury Initiatives -
http://www.nacwa.org/index.php?option=com_content&task=view&id=64&Itemid=143

Best Management Practices

Best Management Practices for Dental Offices in New Hampshire: Tips for Reducing Hazardous, Universal, and Solid Wastes - <http://www.des.state.nh.us/nhppp/dentalBMP.pdf>

City of Boulder Best Management Practices for Dental Waste -
<http://www.p2pays.org/ref/03/02192.pdf>

Connecticut's Best Management Practices for Mercury Amalgam -
http://www.ct.gov/dep/cwp/view.asp?a=2708&q=323996&depNav_GID=1638

The Environmentally Responsible Dental Office: The Oregon Dentists' Guide to Best Management Practices of Dental Waste - <http://www.p2pays.org/ref/04/03294.pdf>

Narragansett Bay Commission's Environmental Best Practices for the Management of Waste Dental Amalgam –
<http://www.narrabay.com/Documents/PDFs/NewDentalBMP.pdf>

Recycling Amalgam Waste and Other Best Management Practices for Your Dental Office -
http://www.newmoa.org/prevention/topichub/103/Chicago_Dental_Society.pdf

Vermont's Environmental Best Management Practices Guidelines for Dental Offices –
<http://www.mercvt.org/pdf/dentalbmp.pdf>

Washington State's Best Management Practices for Dental Office Wastes -
<http://www.ecy.wa.gov/dentalbmps/>

Dental Office Pollution Prevention and Waste Management

Controlling Mercury in Wastewater Discharges from Dental Clinics -
<http://www.nacwa.org/images/stories/public/2006-01dmercwp.pdf>

The Environmental Guide for Dentistry: How to Properly Manage Waste from your Dental Practice -

http://www.neiwpcc.org/neiwpcc_docs/maine_dental.pdf

The Environmentally Responsible Dental Office: A Guide to Proper Waste Management in Connecticut Dental Offices –

http://www.ct.gov/dep/lib/dep/mercury/gen_info/NWF-CTdentalreport.pdf

Indiana’s How to Prevent Pollution From Your Dental Practice: A Guide for Dentists -

<http://www.p2pays.org/ref/03/02140.pdf>

Massachusetts’ Dental Amalgam & Mercury Recycling webpage -

<http://www.mass.gov/dep/service/dentists.htm#intro>

New York’s Guide for Dentists for Managing Mercury and Amalgam Wastes -

<http://www.dec.ny.gov/chemical/8845.html>

Other

Fillings: You Have Choices, Mercury Amalgam, & Other Filling Materials -

http://www.ct.gov/dep/lib/dep/mercury/gen_info/fillings_brochure.pdf

Recognition for Dental Providers Using Amalgam Removal Equipment -

<http://www.pca.state.mn.us/publications/wq-wwtp1-02.pdf>

Wisconsin’s Municipal Mercury Pollutant Minimization Program -

<http://dnr.wi.gov/org/caer/cea/mercury/potw.htm>

Appendix B

ISO 11143 Standard and Its Revision

Information on the current ISO 11143 standard, set in 1999 and currently being revised, can be found on the ISO's website at <http://www.iso.org>. The ISO 11143 standard spells out how an amalgam separator is to be tested in a laboratory, bench-top setting.

The main expected change in the testing standard as a result of the revision is the setting of a threshold for the "maximum flow rate". The threshold rate would be 1 liter/minute. In the past, some separators were tested at lower rates which meant that a manufacturer could petition to be on a state or local government's list of approved models by simply testing at a lower flow rate to achieve a higher removal efficiency. Another likely revision to the standard is a modification to standardize the flushing period duration. Also, the revised standard is expected to require additional information in the laboratory test report. This will give more technical information about the separator, such as physical dimensions, a photograph of the separator, more removal efficiency data (rather than just summary data), and the volume of the waste solids carrying capacity.

Appendix C

Dental Amalgam Stakeholders

Amalgam Separator Manufacturers and Distributors market amalgam separator equipment that meet the ISO 11143 standard. They sell equipment primarily through dental supply companies, and occasionally directly to dental offices. Most, but not all, also offer recycling and replacement services for full separator canisters.

American Dental Association (ADA) represents the aggregate interests of State Dental Associations and individual member dentists throughout the United States on many issues, including waste management issues. ADA conducts research on waste management issues too complex for individual State Dental Associations and performs educational and lobbying functions similar to State Dental Associations on a national level. Not all dentists belong to the ADA.

Dental Assistant Schools, Dental Hygienist Schools, and Dental Schools train future dental assistants, dental hygienists, and dentists. Working with them to deliver curriculum on separator installation, operation and maintenance, and BMPs can help institutionalize their use.

Dental Office Supply Companies sell traps, filters, and amalgam separators to individual dental offices. They identify available models and sizes of separators for an individual dental office. Many companies will also install separators as well as periodically inspect them for needed canister replacement. They generally do not transport or “take away” the used canisters.

Dental Patients are a driving force in the switch to non-amalgam restorations as the effects of mercury on health and the environment are becoming more widely known.

Dental Practices including staff use dental amalgam, generate waste amalgam, and implement waste amalgam capture and recycling practices. Some are required to report waste management practices to regulatory agencies.

Environmental Groups, such as Environmental Defense, the Mercury Policy Project, and the National Wildlife Federation, advocate for reductions in the use of mercury in products and for proper management and control of mercury wastes.

Insurance Companies and Other Entities that Reimburse or Cover the Cost of Dental Services provide reimbursement and cost coverage for dental services. These may be private dental insurance companies as well as public programs such as Medicare and state programs. Whether certain dental services are covered, such as non-amalgam restorations, can affect dental patients’ choices.

Mercury Waste Handlers and Recyclers manage, ship, and/or process the mercury amalgam waste captured in traps, filters, and separators. Mercury waste that is not recycled via the amalgam separator manufacturer is recycled or disposed of via independent waste handlers or mercury retort facilities. All major mercury retort companies have developed waste amalgam shipping packages tailored for use by dental offices.

Municipal Government – Departments of Public Works – Publicly Owned Treatment Works (POTWs) receive almost all of the waste dental mercury amalgam not captured and recycled by the dental office. The municipalities evaluate mercury impact on collection systems, treatment plant effluent, and biosolids. POTWs may administer pretreatment programs or pollutant minimization programs, and local sewer ordinances. The local ordinances may require dental office implementation of amalgam BMPs, or other options to reduce mercury, including installation of amalgam separators.

State Dental Associations or Societies represent the aggregate interests of individual member dentists within the state on many issues, including dental waste management. They conduct educational outreach to their members, lobby state government on their members' behalf, and report to the ADA. Opinions of individual state associations can differ from those expressed by the ADA. Not all dentists belong to their state association or society.

State Environmental Agencies evaluate and regulate mercury releases to the environment through the establishment of environmental standards for the protection of human health and the environment. They may implement voluntary or mandatory programs for dental office amalgam capture and recycling. Some state agencies may also impose conditions or requirements on POTWs for the handling of their biosolids, such as land application, incineration, or other management methods. State agencies regulate municipal solid and other waste facilities, such as municipal solid waste incinerators and landfills, and land application of sewage biosolids and biosolids incinerators.

U.S. Environmental Protection Agency (EPA) evaluates and controls mercury releases to the environment on a national level. Agency staff may encourage voluntary mercury source reduction or require mercury source reduction for mercury point sources including dental offices. The EPA also develops standards for waste management and air quality. The EPA implements reduction initiatives primarily by partnering with state agencies, by providing technical assistance and research support and in some cases by providing funding, such as pollution prevention grants.

