

The Use of CDA Best Management Practices and Amalgam Separators to Improve the Management of Dental Wastewater

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ABSTRACT

Concerns over the persistence and effects of mercury in the environment, particularly in wastewater, have increased significantly over the past decade. Because mercury is a component of dental amalgam, comprising about 50 percent of amalgam among other metals, in recent years the concern has affected dental practices and even educational curricula in the dental schools. While numbers vary widely from area to area, on average, it is estimated dentistry contributes less than 1 percent of the mercury generated from human activity to the environment.¹ Despite dentistry's low contribution to the environmental mercury load, organized dentistry's position is that dentistry's role as a public health profession includes environmental stewardship, as well as patient safety, and that dental professionals must act responsibly by taking steps to prevent amalgam waste or any potentially harmful materials from entering the environment, no matter how small the amount. In support of this belief, both the California Dental Association and the American Dental

Association have developed recommendations for best practice that dental offices should follow when handling dental amalgam waste.^{2,3} Many dental schools and auxiliary programs have shown their commitment to minimizing detrimental effects to the environment, evidenced by the fact that most, if not all, have incorporated safe work practices including mercury hygiene procedures as part of clinical coursework. Some local jurisdictions hardest hit by the effects of mercury in wastewater have gone even further to recommend, or even require, the installation of amalgam separators in dental offices. This article will describe the history of BMPs and amalgam separators usage in California, and examine the practical aspects of their usage in reducing the discharge of dental amalgam into waste streams.



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The idea of controlling amalgam waste disposal is not a new one to California. Both the CDA and ADA have recommended environmentally responsible management of amalgam waste for many years.³ In the early 1990s, the City of San Francisco considered making mandatory the installation of amalgam separators in dental offices. The CDA, in conjunction with the local dental society, worked diligently to encourage San Francisco to promote BMPs instead of separators. More recently, as municipal wastewater treatment facilities, also termed local publicly owned treatment works (POTWs), are facing more stringent discharge limits, they have been forced to look “upstream” for controllable sources of mercury. Although its relative contribution to the environmental mercury load is low, dentistry has been identified as a controllable mercury source. Especially in areas with impaired water bodies, such as the San Francisco Bay Area and Los Angeles, dental offices are facing more rigorous regulatory control programs, some even having to install amalgam separators.

In Los Angeles, a BMP permit program has been implemented which requires regular reporting and a written plan.

In San Francisco, dentists are required to either install an amalgam separator or opt for a strict monitoring protocol. One of the concerns regarding separators in San Francisco involves the massive presence of mercury in the SF Bay from gold mining and mercury mining in the 19th century. The New Almaden mine in San Jose was the largest mercury mine in North America and the tailings leached into the bay. (Almost no mercury was mined east of California.) For this reason, the SF Bay is considered a special body of water, yet EPA regulations make no recognition of this.

Throughout California, local jurisdictions are, at a minimum, starting to require voluntary BMP programs. CDA continues to proactively collaborate with many local dental societies and POTWs in order to ensure consistency and fairness as POTWs enforce stricter discharge requirements on dental facilities connected to the municipal sewer systems.

Additionally, from a different regulatory perspective, in March 2003, the Department of Toxic Substances Control, the state agency in charge of administer-

The key to successful recycling of dental amalgam waste depends on effective collection of the material.

ing and enforcing hazardous waste laws, reclassified dental amalgam waste as a universal waste, which also made mandatory across the state some best management practices recommended by CDA (see BMPs in **Table 1**).⁴

Similar trends to eliminate mercury discharge to the environment have been occurring on the national level. Regional and statewide initiatives in the north, northeast, and northwest have consisted of regulatory approaches to minimizing dental amalgam discharges. The states of Maine, Connecticut, and New Hampshire have enacted laws requiring amalgam separators. Similar legislative attempts have been made and failed in California, New York, and Oregon, but could resurface again. Dental practices in Vermont, Massachusetts, and Rhode Island are being encouraged but are not required to install separators. Massachusetts is enacting regulations on installation

which will kick in 2005 or 2006 depending upon the success of voluntary programs. On the regional level, Wichita, Kan., and King County in Washington state have implemented strict regulatory control programs including a separator requirement.

Best Management Practices — What Are They?

Recycling is the preferred method of disposal for many consumer and industrial waste streams — paper and wood products, plastic, metals, chemicals, etc. Like most heavy metals, elemental mercury and silver can be easily collected and recycled in most industrial settings, including dentistry. If not to be recycled, these metals must be disposed as hazardous waste. The key to successful recycling of dental amalgam waste depends on effective collection of the material. Best management practices for amalgam waste disposal, as well as amalgam separator technologies, target amalgam’s efficient collection and removal both from wastewater and in solid form. Simply put, best management practices for amalgam waste disposal incorporate both environmental and occupational health control strategies into routine work procedures.

CDA has compiled a list of recommended best management practices for amalgam waste management.² These BMPs are designed to eliminate the use of bulk mercury in the dental office, to reduce amalgam waste generated and discharged to the environment, and to provide dental office personnel with practical, concise, and easy-to-follow procedures for handling amalgam waste. Perhaps the most effective and widespread BMP in dentistry has been the increased use of precapsulated dental amalgam over bulk mercury, which has remarkably lowered the amount of waste amalgam generated during a restorative procedure. This one control strategy has

resulted in significant improvement in occupational health and environmental impacts.⁵ Other BMP strategies include utilizing and maintaining chair and sink traps and filters properly, collecting scrap and contact amalgam for recycling, and training dental personnel. Additionally, CDA recommends the use of amalgam removal technologies, such as sedimentation systems or amalgam separators, in areas where mercury in wastewater discharges is a serious concern. Practices to avoid include placing amalgam waste of any kind (including extracted teeth with amalgams) in the biohazard (red) bag, the trash, or the sharps container; rinsing traps, filters, or screens over or down the drain, or into a wastebasket; disinfecting teeth or any item containing amalgam with any method that uses heat. Refer to **Table 1** for a complete list of CDA's recommended best management practices for amalgam waste management.

Efficiency of BMPs and Amalgam Separators

The efficiency and cost-effectiveness of BMPs by themselves has been shown to range up to about 78 percent. In a September 2002 evaluation for the ADA, ENVIRON International Corporation found that a well-managed dental office adhering to CDA's recommended BMPs could reduce amalgam being discharged to the municipal sewer system by as much as 78 percent.^{6,7} EPA has estimated that utilization of the chairside traps and vacuum pump filters captures approximately 70 percent of the mercury generated during an amalgam restoration procedure.⁸ The numerical cost of BMP implementation is low; however, time and discipline must be devoted to ensure their effectiveness in the dental office.

Amalgam separators target the capture of remaining amalgam particles that escape the traps and filters. Certification by the International Organization for Standardization (ISO) 11143 requires that

Table 1

Best Management Practices for Amalgam Waste

- Do not rinse amalgam-containing traps, filters, or containers in the sink.*
- Do not place amalgam, elemental mercury, broken or unusable amalgam capsules, extracted teeth with amalgam, or amalgam-containing traps and filters with medical waste or regular solid waste.*
- Recycle, or manage as hazardous waste, amalgam, elemental mercury, broken or unusable amalgam capsules, extracted teeth with amalgam, amalgam-containing waste from traps and filters.*
- Keep amalgam waste in an airtight container.*
- Separate excess contact dental amalgam that is retrieved during placement and place in an appropriate container.
- Use chairside traps to capture dental amalgam.
- Change, or clean, chairside traps frequently. Flush the vacuum system before changing the chairside trap.
- Change vacuum pump filters and screens at least monthly or as directed by the manufacturer.
- Check the p-trap under your sink for the presence of any amalgam-containing waste.
- Eliminate all use of bulk elemental mercury and use only precapsulated dental amalgam for amalgam restorations.
- Limit the amount of amalgam triturated to the closest amount necessary for the restoration. Keep a variety of amalgam capsule sizes on hand to ensure almost all triturated amalgam is used.
- Train staff who handle or may handle mercury-containing material on its proper use and disposal.
- Consider the use of amalgam removal technologies, such as sedimentation systems or amalgam separators if you practice in an area where mercury in wastewater discharges is a serious concern.

*Mandatory per California Code of Regulations Title 22.

amalgam separators be capable of reducing the amalgam concentration by 95 percent. Most ISO-certified separators on the market even reduce the levels by 99 percent.⁹ Even for dental offices that choose to install a separator, which is considered the best available control technology now, they still may end up with water quality that does not meet the local discharge limits. Some local areas with severely impaired water bodies have initiated either zero-mercury discharge limits or limits which are unattainable by even separator technology. This creates a

conundrum for both dental offices and regulators. Water quality regulators in these areas acknowledge that an amalgam separator is the best available technology for controlling mercury discharges in dental facilities. In California, those POTWs which are looking to require an amalgam separator or equivalent recognize amalgam separators as the current best available control technology, and accept that adherence to BMPs and the installation of a separator will exempt a dental facility from any additional requirements.

Table 2

Questions to Ask Your Amalgam Recycler

- What kind of amalgam waste do you accept?
- Do your services include pickup of amalgam waste from dental offices? If not, can amalgam waste be shipped to you?
- Do you provide packaging for storage, pickup or shipping of amalgam waste?
- If packaging is not provided, how should the waste be packaged?
- What types of waste can be packaged together?
- Do you accept whole filters from the vacuum pump for recycling?
- Is disinfection required for amalgam waste?
- How much do your services cost?
- Do you pay for clean noncontact (“scrap”) amalgam?
- Do you accept extracted teeth with amalgam restorations?
- Does your company have an Environmental Protection Agency, license or applicable state license to recycle/reclaim this material?
- Does the company use the proper forms required by the EPA and state agencies?
- To whom do you sell recovered mercury and silver from the amalgam waste?

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BMPs and Amalgam Separators — Putting Them into Practice

The types of amalgam wastes are defined as the following by the ADA:³

Non-contact amalgam (scrap) is excess mix left over at the end of a dental procedure. Many recyclers will buy this clean scrap.

Contact amalgam is amalgam that has been in contact with the patient. Examples are extracted teeth with amalgam restorations, carving scrap collected at chairside, and amalgam captured by chairside traps, filters, or screens.

Chairside traps capture amalgam waste during amalgam placement or removal procedures (traps from dental units dedicated strictly to hygiene may be placed in the regular garbage).

Vacuum pump filters or traps contain amalgam sludge and water. Some recyclers will accept whole filters while

others will require special handling of this material.

Amalgam sludge is the mixture of liquid and solid material collected within vacuum pump filters or other amalgam capture devices.

Empty amalgam capsules are the individually dosed containers left over after mixing precapsulated dental amalgam.

When following recommended BMPs or when performing maintenance on the amalgam removal equipment, it is very important to use proper personal protective equipment as necessary such as utility gloves, masks, protective eyewear, and gowns to minimize exposures to the body fluids mixed with the amalgam waste and the amalgam waste itself. Additionally, all personnel should be trained on the proper procedures to follow when performing this work, including cleaning up spills. The procedures

should be documented in a written plan.

As previously mentioned, BMPs target the efficient collection and recycling of dental amalgam waste. The first step in this process is to identify a state-approved recycler and then follow any instructions he or she may have in the collection and removal procedures. For example, some recyclers do not accept contact amalgam waste, or if they do, they require it be collected separately from scrap amalgam. Others may accept all forms of amalgam waste in the same container. Therefore, it is very important to follow the recycler's instructions. Consider keeping different types (e.g., contact and non-contact) of amalgam wastes in separate containers as required by your recycler. Refer to **Table 2** for more questions to ask amalgam recyclers.

Amalgam materials should be stocked in many capsule sizes in order to better select the right amount of material for a particular restoration. Non-contact (scrap) amalgam and amalgam capsules should be placed in a wide-mouth, airtight dry container marked “Scrap Dental Amalgam for Recycling.” The container lid should be well sealed. When the container is full, it should be sent to the recycler. If there is a spill of amalgam from a capsule, contain it and clean it up immediately with a commercially available mercury spill kit; follow the instructions on the spill kit.

When collecting contact amalgam from disposable or reusable chairside traps, first open the chairside unit to expose then trap. Then, if it is disposable, remove the trap and place it directly into a wide-mouthed, airtight container marked “Contact Dental Amalgam for Recycling.” If the trap is reusable, remove the trap and empty the contents into the wide-mouth, airtight container marked “Contact Dental Amalgam for Recycling.” Replace the trap into the chairside unit.

(Do *not* rinse the trap under running water as this could introduce dental amalgam into the waste stream). Make sure the container lid is well sealed and when the container is full, send it to a recycler. Traps from dental units dedicated strictly to dental hygiene procedures may be placed with the regular garbage.

Vacuum pump filters should be changed according to the manufacturer's recommended schedule. First, remove the filter and while holding the filter over a tray or other container that can catch any spills, decant as much of the liquid as possible without losing any visible amalgam. Then, put the lid on the filter and place the sealed container in the box in which it was originally shipped labeled "Contact Dental Amalgam for Recycling." When the box is full, the filters should be recycled.

Once the amalgam waste has been collected, it must be removed. As previously indicated, some amalgam waste recyclers have special requirements for collecting, storing and transporting amalgam waste. If you need to find a recycler, check with your city, county or local waste authority to see whether they have an amalgam waste recycling program. Additionally, the ADA has compiled a national directory of amalgam recyclers for reference. **Table 2** provides a list of questions to ask potential recyclers.¹⁰

The implementation of amalgam separators in a dental office is a very complex process and involves four major steps: purchase, installation, maintenance, and recycling. Amalgam separators come in many different sizes, shapes, and technologies. One size does not fit all. Refer to **Table 3** which contains a listing of ISO-certified amalgam separator models compiled by the ADA.¹⁰ The basic premise of the separator technology is to effectively handle flow without clogging and to allow suffi-

cient time for the amalgam particles to be separated out of the water and into a collection device. The removal technologies available on the market are sedimentation, filtration, ion exchange, centrifugation, or a combination of these. Sedimentation is used in the majority of amalgam separators, which relies on a settling tank which allows solid materials to settle out of the wastewater. These

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types of separators tend to be larger and require more space than other units. In addition to size constraints, other practical issues to consider when choosing a separator unit include cost, maintenance, reliability, ease of operation, utility requirements, capacity, dental office/building constraints, and regulatory factors. **Table 4** contains a buyer's checklist which outlines many of these considerations.¹⁰

The installation of the amalgam separator should only be conducted by a licensed plumber. If the unit is downstream of the vacuum system and requires power, a licensed electrician also should be contracted. Depending on the local area, special permitting under the building code may be required. Consultation with the building owner also is recommended. Oftentimes, dental supply companies can help to initiate and facilitate the installation process. The location of

the separator in the office will likely be either chairside or more commonly, as close as possible to the vacuum pump. If the unit is a gravity-fed unit, then it should be installed below grade.

Some difficulties to avoid with field installations include insufficient space or access to preferred installation location; compatibility with and condition of existing piping, local plumbing code interpretations, impact of vacuum system operation, and warranty impacts of existing in-situ equipment. For many offices in large buildings sharing a single vacuum system, the decisions become more complex. In all of these scenarios, replumbing may become necessary. In rare cases, separately plumbed cuspidor units may be required to be replumbed through a separator system.

Each amalgam separator requires ongoing maintenance and recycling to remove the collected amalgam. Maintenance factors, which consist of cost, frequency, ease, impact on treatment, and recycling methods vary significantly depending on the inherent characteristics of the individual amalgam separator unit as well as the individual office activities. For example, amalgam separators that utilize filtration will require filter replacement, and sedimentation units will require the collection tank or canister to be replaced. Annual maintenance costs typically range from \$300 to \$500, which generally includes the costs to recycle the contact amalgam waste (see **Table 3**). Amalgam waste collected by the amalgam separator should be recycled as described above for contact amalgam, or disposed according to California DTSC hazardous waste requirements.

Summary

In summary, as regulatory initiatives to minimize dental amalgam in wastewater become more widespread,

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Table 3

Amalgam Separator Models by Technology

Brand Name and Manufacturer	Purchase Or Lease Price*	Cost Replacement Parts	Recycling Included	Size in Inches (Depth x Width x Height)	Installation Site	Efficiency† (Certification‡)	Maintenance
Sedimentation							
Guardian Amalgam Collector models Air Techniques 1-800-AIRTECH www.airtechniques.com	Dry vacuum A110 (with Air Technique vacuum system): \$1,500; A1200 (with Air Technique vacuum system): \$1,500; wet vacuum A1300 (single pump system): \$2,995; A1400 (dual pump system): \$3,225	Replacement kit: \$750	Yes	6.25x1.5 x7.5	In-line at out of air/water separator (requires air/water separator); drains by	>95% (ISO 11143-certified)	Clean daily; replace collection container after one pound waste collection (usually six months)
Amalgam Collector models R&D Services 1-800-816-4995 1-206-525-4995 www.theamalgamcollector.com	CH9 or CH12: \$459; CE15 or CE18: \$695; CE24: \$1,250	Not applicable (canister replacement optional)	No	CH9: 6x6 x9 CH12: 6x6x12 CE15: 6x6x15 CE18: 6x6x18 CE24: 8x8x24	CH9 or CH12: chair-side in-line; CE15, CE18, CE24: in-line	>95% (ISO-11143-certified; King County [Washington] Industrial Waste Program-approved)	Adjust two external valves weekly; monitor liquid level and decant as needed to keep tubing 3 inches above sediment; add sterilant two to three times/week; sludge removal after two to five years depending on workload
BullfroHg Dental Recycling North America 1-800-360-1001 www.drna.com	\$50/month lease (two year minimum); \$695 purchase	Included in lease	Yes (lease); \$450 (purchase) annual kit cost	8.5x8.5 x20.5	In-line; AC power supply needed to pump settled effluent	98.3%-99.6% (ISO 11143-certified)	Replace separator annually

Table 3 continued

Brand Name and Manufacturer	Purchase Or Lease Price*	Cost Replacement Parts	Recycling Included	Size in Inches (Depth x Width x Height)	Installation Site	Efficiency† (Certification‡)	Maintenance
ECO II (Economy System Type II) Pure Water Development 1-877-638-2797 1-305-663-2989 www.ecotwo.com	\$550 plus \$54/month service fee	—	Yes	8.7x8.7x13.8	Chairside or in-line	>95% (ISO 11143-certified; King County [Washington] Industrial Waste Program - approved)	Apply cleaner daily (recommended); replace separator annually
REB models Rebec Simple Solutions 1-800-569-1088 www.rebecsolutions.	REB 1000: \$1,895; REB 5000: \$1,895; REB 7000: \$1,895; REB 9000: \$2,995	REB 1000: \$395; REB 5000: \$395; REB 7000: \$495; REB 9000: \$395	Yes	REB 1000: 8x22x23.5 REB 5000: 6x9.5x6.5 REB 7000: 6x20x6.5 REB 9000: 10x26x24	In-line	96.9% (ISO 11143-certified; King County [Washington] Industrial Waste Program - approved)	Annual recycling should be scheduled with the manufacturer
Sedimentation/Filtration							
Avprox AS-9 American Dental Accessories 1-800-331-7993	\$229.95	Replacement filter: \$78.95	No	5.5x5.5x16	In-line	95%-99% (ISO 11143-certified)	Replace every three to eight months depending on workload
MSS models Maximum Separation Systems 1-800-799-7147 www.amalgam separators.com	MSS Model 1000 (ff11 chairs): \$968; MSS Model 2000 (12-22 chairs) includes two settling tanks: \$1,395	Settling tank: \$165; tank recycling fee: \$185	No	1000: 15x18.5x24 2000: 15x18x28	In-line AC power supply needed for control panel	>95% (ISO 11143-certified; King County [Washington] Environmental Choice Program certificate§)	Replace settling tank annually; nonfoaming cleanser (recommended)
Sedimentation/Filtration/Ion Exchange							
ARU-10 Hygenitek 1-866-494-3648 www.hygenitek.com	\$499 (Service plan option: \$39/month)	Media filter canister¶: \$99; sedimentation tank: \$59	Yes	12x12x21	In-line	99.99% (ISO 11143-certified; King County [Washington] Industrial Waste Program - approved)	Apply cleanser daily; service plan: six-month cycle; replace media filter canister: six months; replace sedimentation tank: six-24 months depending on workload

Table 3 continued

Brand Name and Manufacturer	Purchase Or Lease Price*	Cost Replacement Parts	Recycling Included	Size in Inches (Depth x Width x Height)	Installation Site	Efficiency† (Certification‡)	Maintenance
Hg separator models SolmeteX 1-508-393-5115 www.solmetex.com	Hg5 (one-10 chairs): \$695; Hg10 (>10 chairs): \$7,450	Hg5 filter resin cartridge: \$150; Hg10 filter: \$150; Hg10 resin cartridge: \$275	No	Hg5: 10x13x29 Hg10: 48x24x48	Hg5: in-line line; hg10: after vacuum and sewer drain AC power supply needed	Hg5: >98% King County [Washington] Industrial Waste Program - approved); Hg10: <.02 parts per billion mercury in effluent	Hg5: Replace filter resin cartridge every six months; Hg10: weekly oxidizer tablet treatments; replace filter and resin cartridge quarterly
Merc II Bio-Sym Medical	\$1,295	Replacement unit installation and disposal: \$495	Yes	13x7x8	Chairside or in-line	>95% (ISO 1143-certified; King County [Washington] Industrial Waste Program-approved)	Replace unit annually
MRU models Dental Recycling North American	MRU 10C; MRU 100V	Costs included in lease fee	No	10C: 12x16x24 100V: 12x16x24	In-line In-line	>95% (ISO 1143-certified; King County [Washington] Industrial Waste Program-approved)	Replace separator, filter and absorbant column every six-12 months depending on workload
Rasch 890 models AB Dental Trends 1-360-354-4722 www.amalgam separation.com	890-1000: \$1,190; 890-6000: \$666	Canister: \$596	No	890-1000 12.75x10.25 x28.5 890-6000: 12.25x9.0 x5.12	In-line	>95% (ISO 1143-certified; King County [Washington] Industrial Waste Program-approved)	Replace canister every 18 months depending on workload

*Manufacturer's suggested retail price as of 2003.

†According to manufacturer.

‡ International Organization for Standardization Specification 1143 requires 95 percent removal.⁹

§ Canadian program.

¶ Costs apply only to customers who do not take the service plan option.

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Table 4

Amalgam Separator Buyer's Checklist

Factor	Comments
Office Considerations	
Operatories (number of chairs)	Offices with four or more chairs should consider central, not chairside, units
Number of amalgam restorations placed or removed per day	Offices that perform more than 40 amalgam-related activities per week may need a unit with a large storage capacity
Office operations (number of days per week)	
Dental practices located in your building Number and type	Consider combining similar flows with other offices if possible to share or reduce costs
Do you own or lease your space? Would lease stipulations affect installation of a separator? What terms are included for utilities maintenance?	Confirm that plumbing system modifications are consistent with lease provisions
Do you operate wet/dry cuspidors?	Wet cuspidors should be plumbed to a separate line if possible; if not possible, separator should have a holding or surge tank with sufficient capacity
Building Configuration	
Is sufficient space available to the air/water separator drain-line and sewer-line connection?	Certain separators rely on gravity flow and require adequate space from the air/water separator line to connect to the drain system
Access to electrical power (voltage)	Check the power supply needs for each model under consideration
Size and material of existing sewer connection	Separator installation should not constrict existing vacuum or drain-line requirements
Vacuum System	
Do you operate a wet or dry vacuum system?	Wet-ring vacuum pumps generate additional water flow that will require greater storage capacity
Will any warranty be affected by third-party installations?	Some warranties may be invalidated if parts of the system are modified by third parties
Is the vacuum system dedicated to your office?	Group practices that share vacuum systems may want to replumb or split costs associated with amalgam separator
Location of the vacuum system Basement or office?	Office-level systems may require smaller units
Space available adjacent to vacuum system (height, length and width)	Access to upstream piping is critical for maintenance and inspection of systems
Separator Specifications	
Recommended installation location Capacity (in chairs) Maximum flow rate Life-cycle cost	Evaluation model information against the specific conditions for the practice (such as space, plumbing, access, workload, regulatory considerations)
Other considerations	
In your group practice, who is responsible for Equipment servicing and maintenance? Water/sewage/utilities? Amalgam collection/recycling?	Group practices that share vacuum lines may need to discuss how the addition of an amalgam separator will affect allocation of cost and responsibilities, as well as make arrangements for access to the unit
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dentistry needs to heed the growing concerns about mercury coming from dental offices. All dentists should at a minimum follow CDA's best management practices, some of which are required by state law. Also, in areas hardest hit by the environmental mercury problem, it is recommended dentists put their environmental concerns into action by proactively installing an amalgam separator and ensuring that all amalgam waste is collected and sent to a reputable recycling facility. These actions send a great message to patients and to the public, demonstrating dentists care about the environment. **CDA**

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